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

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Copper River Delta – circa 1932 – photo courtesy of Perry Davis

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Executive Summary

This West Copper River Delta Assessment (West Delta) is an ecosystem analysis at the landscape scale; it is both an analysis and an information gathering process. The purpose is to develop an understanding of the processes and interactions occurring in the West Copper River Delta Watersheds and document them. This analysis includes the Scott River, Sheridan River, McKinley Lake, and Copper River Delta West watershed associations. Figure **1.2** displays the location of the analysis area.

This report focuses on the issues and key questions identified for this analysis area. The area is described in terms of its biological, physical, and social features. Information used in the analysis include: water uses, vegetative patterns and distribution, disturbance regimes, fish and wildlife species and their habitats, hydrology, soils, and human use patterns including heritage, subsistence, and recreation. Individual resource reports are also available for additional information. Chapter 3 and 5 were updated in April 2007 to reflect new regional and national emphasis areas.

The Chugach Forest Land and Resource Management Plan (Forest Plan) was revised and the Record of Decision signed in May 2002. Landscape analyses are a step between the Forest Plan and project implementation. They describe how the Forest Plan can be implemented in a particular area. 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. The resulting report is not a decision document, but it can be used in future site-specific analyses.

The West Copper River Delta analysis area is about 313,600 acres. A team of resource specialists from the Cordova Ranger District and Chugach National Forest Supervisor's Office prepared this assessment. During the analysis, participation and involvement of other Federal and State Agencies, City of Cordova, local Tribal Governments and landowners was encouraged. A public meeting was held August 28, 2002.

Following are the six steps used to conduct the analysis and corresponding chapters in this report.

- Step 1 – Characterization (Chapter 2)
- Step 2 – Issues and Key Questions (Chapter 3)
- Step 3 – Current conditions (Chapter 2)
- Step 4 – Historical Conditions (Chapter 2)
- Step 5 – Interpretation & Synthesis (Chapter 4)
- Step 6 – Recommendations (Chapter 5)

Chapter 1 – Introduction

Purpose

This report is a landscape scale ecosystem analysis. The purpose is to develop and document an understanding of the processes and interactions occurring in the analysis area. The West Copper River Delta (West Delta) analysis area includes four watershed associations: the Scott River, Sheridan River, McKinley Lake, and Copper River Delta West.

Figure 1.1-Channels, sloughs, and wetland ponds on the West Copper River Delta. The Scott Glacier is in the distance (May, 2001).

The Analysis Area

The analysis area is approximately 313,600 acres (excluding salt water) of coastal wetlands, tidal sloughs, barrier islands, glacial outwash plains, glaciers, and steep glaciated mountains just east of Cordova, Alaska (Figure 1.1). The 757 square mile analysis area is bounded by Eyak River on the west, the Chugach Mountain Range on the north, the Copper River on the east, and the Gulf of Alaska to the south. The Copper River Highway, which follows the old railroad bed, provides access across the Copper River Delta to the Million Dollar Bridge (at Mile 48). This assessment covers the portion of the highway to about Mile 37.

The West Delta analysis area is part of the Cordova Ranger District of the Chugach National Forest and is accessible by highway from Cordova. People use the area to view wildlife, hunt, fish, trap, hike, pick berries, gather wood, drive, boat, canoe, kayak, snowmobile, and ski and for subsistence activities. The Copper River Delta also attracts abundant wildlife, including millions of migrating shorebirds every spring. 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 Scott and Sheridan Rivers also shape the lowlands of the West Delta, each carrying high sediment loads from glaciers in the Chugach Mountains.

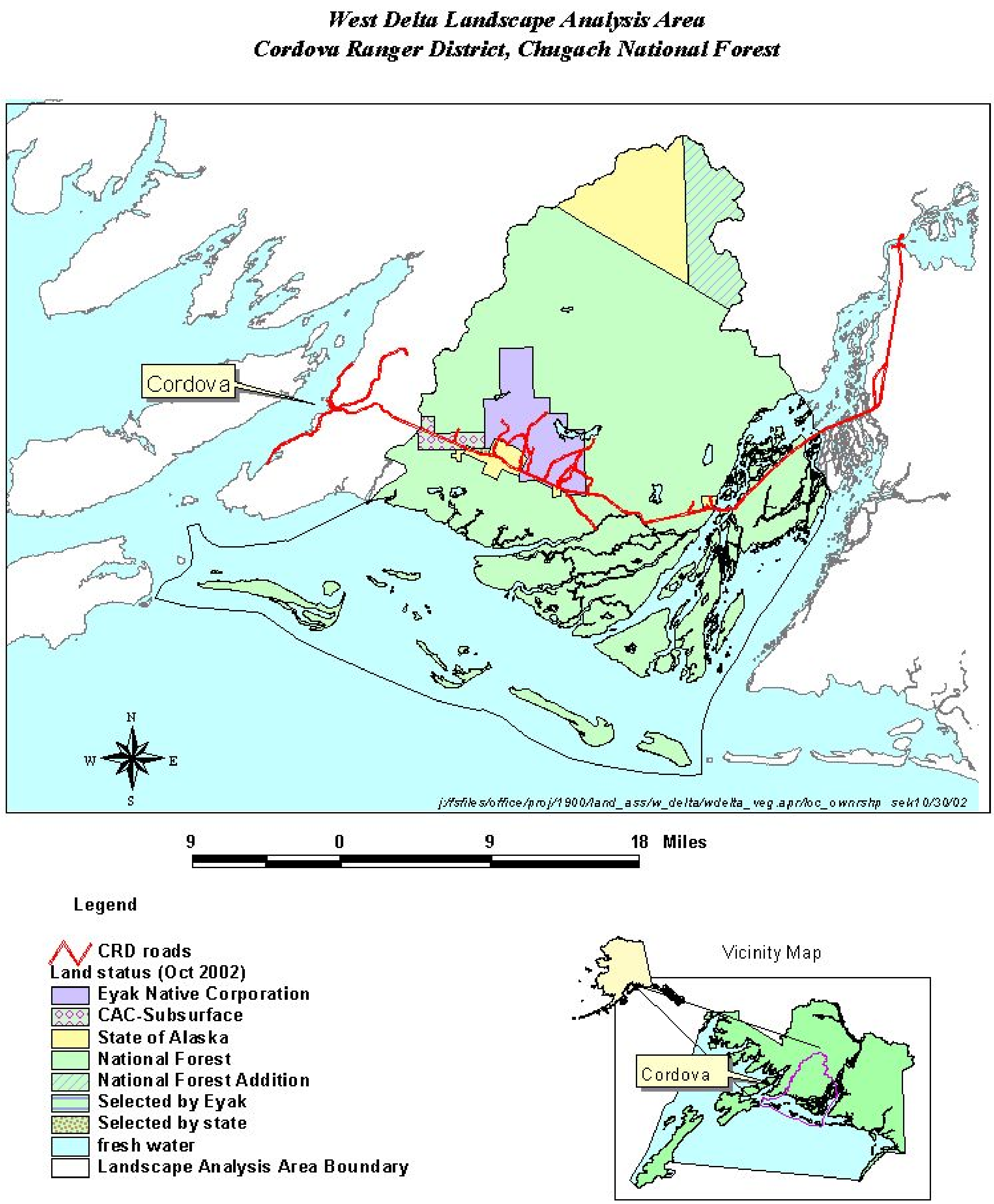


Figure 1.2-Vicinity map and landownership patterns for the West Delta analysis area

The Copper River supports the largest salmon fishery in central Alaska. Five salmon species and two 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).

The area has a mix of ownerships, including State and Native corporations. Table 1.1 summarizes the acreage for each. Chugach Alaska Corporation retained subsurface rights on portions of the lands that were bought from Eyak Native Corporation and became part of the National Forest System. On these lands, the Forest Service administers the surface resources and access. Approximately 84% of the analysis area is National Forest System land. Figure 1.2 displays the location of the analysis area and landownership patterns.

Table 1.1-Summary of land ownership

Ownership	Acres	% of area
National Forest	247,950.6	79.1 %
National Forest – ANILCA Addition	15,545.8	5.0%
State of Alaska	27,823.7	8.9%
Eyak Native Corporation	19,061.4	6.1 %
Selected by Eyak Corp.	0.5	~ %
USFS Surface, Chugach Alaska Corp. - Subsurface	3,086.4	1.0 %
Selected by Chugach Alaska Corporation – ANCSA 14(h)(1)	400	.0013%
Selected - State	119.2	~ %
Total	313,588	100%

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, especially waterfowl, 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.

Relationship to the revised Chugach Land and Resource Management Plan

The Chugach Forest Land and Resource Management Plan (Forest Plan) was revised and the Record of Decision signed in May 2002. Chapter 3 of the revised Forest Plan outlines Forest-wide direction, goals and objectives, and standards and guidelines. Chapter 4 of the revised Forest Plan describes Management Area direction for each prescription. This chapter describes each prescription's theme and management intent with regards to the desired future condition for ecological and social systems, displays activities that are allowed, and prescription specific standards and guidelines. The management prescriptions present in this analysis area include Proposed Research Natural Area (Copper Sands), Backcountry, and ANILCA 501(b)-2 and 3. Figure 1.3 displays the management direction across the analysis area and Table 1.2 lists the management direction by planning polygon.

The EVOS fee simple lands have specific management goals that reflect the goals of the *Exxon Valdez* oil spill (EVOS) settlement agreement. Lands acquired under the EVOS purchases are surface estate or surface conservation easements. The Chugach Alaska Corporation reserves the subsurface title and is entitled to access for exploration and development of the subsurface estate such as minerals, oil, and gas.

Table 1.2-Management Direction for West Delta Analysis Area

Planning Polygon #	Overall Prescription	Summer Recreation Motorized use	Winter Recreation Motorized Use
C057	210: Backcountry	Open to All Motorized Use	Open to all Motorized Use
C073	221: EVOS fee simple	Closed to motorized use	Closed to motorized use
C058, C059, C060, C061	213: ANILCA 501(b)-2	Closed to motorized use, except for subsistence	Open to all motorized use
C082, C083, C085	213: ANILCA 501(b)-2	Open to motorized use	Open to all motorized use
C084, C113	213: ANILCA 501(b)-2	Closed to motorized use, except for subsistence	Closed to motorized use, except for subsistence
C097, C100, C103	213: ANILCA 501(b)-2	Open to all motorized use	Open to all motorized use
C102, C104 thru C107, C114, C115	213: ANILCA 501(b)-2	Closed to motorized use, except for subsistence	Open to all motorized use
C101, C112	321: ANILCA 501(b)-3	Open to all motorized use	Open to all motorized use
Copper Sands	141: Proposed Research Natural Area	Closed to motorized use	Closed to motorized use
Outer islands (Egg, etc)	213: ANILCA 501(b)-2	Open to motorized in nonvegetated areas only	Open to motorized use.

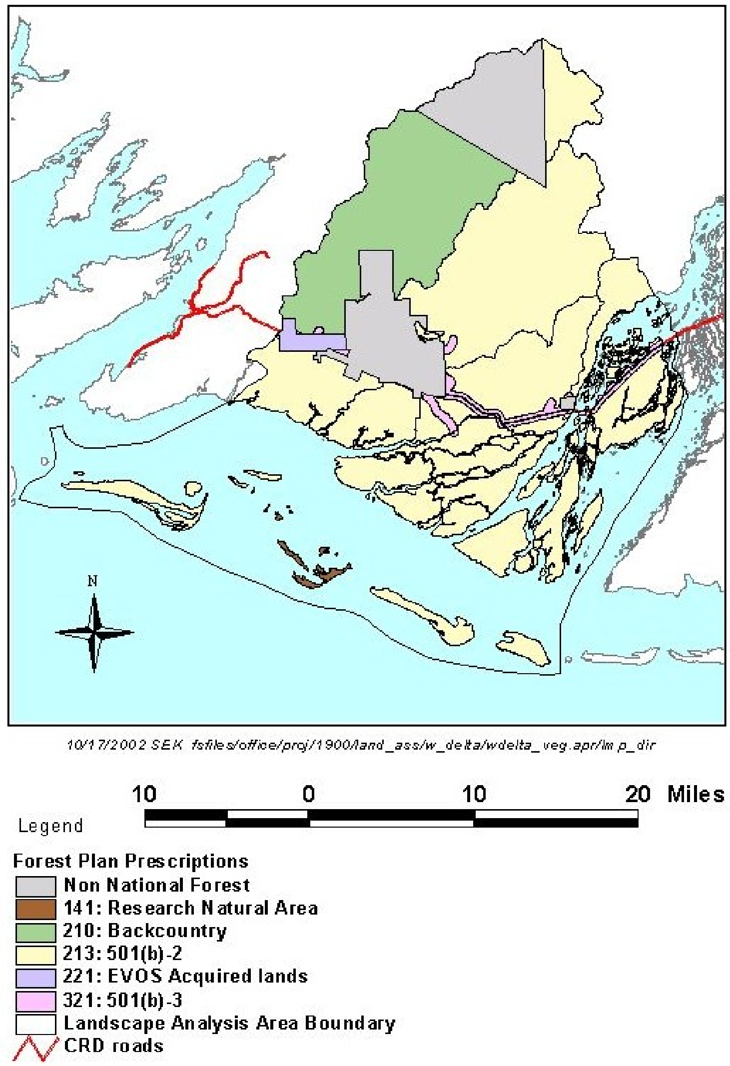


Figure 1.3-Forest Plan Direction for the West Delta Analysis Area

The type of motorized use allowed varies across the analysis area. Figure 1.4 displays the motorized recreation access for both summer and winter. If the summer motorized use is listed as "Open to all motorized use", it includes off-highway vehicles (OHV's), helicopters, and airboats on land. If the winter recreation motorized use is listed as "Open to all motorized use", it includes snowmachines, helicopters, and other craft. Winter is defined as December 1 through April 30. New Forest Service constructed roads are not allowed in areas with the Backcountry or ANILCA 501(b)-2 prescription.

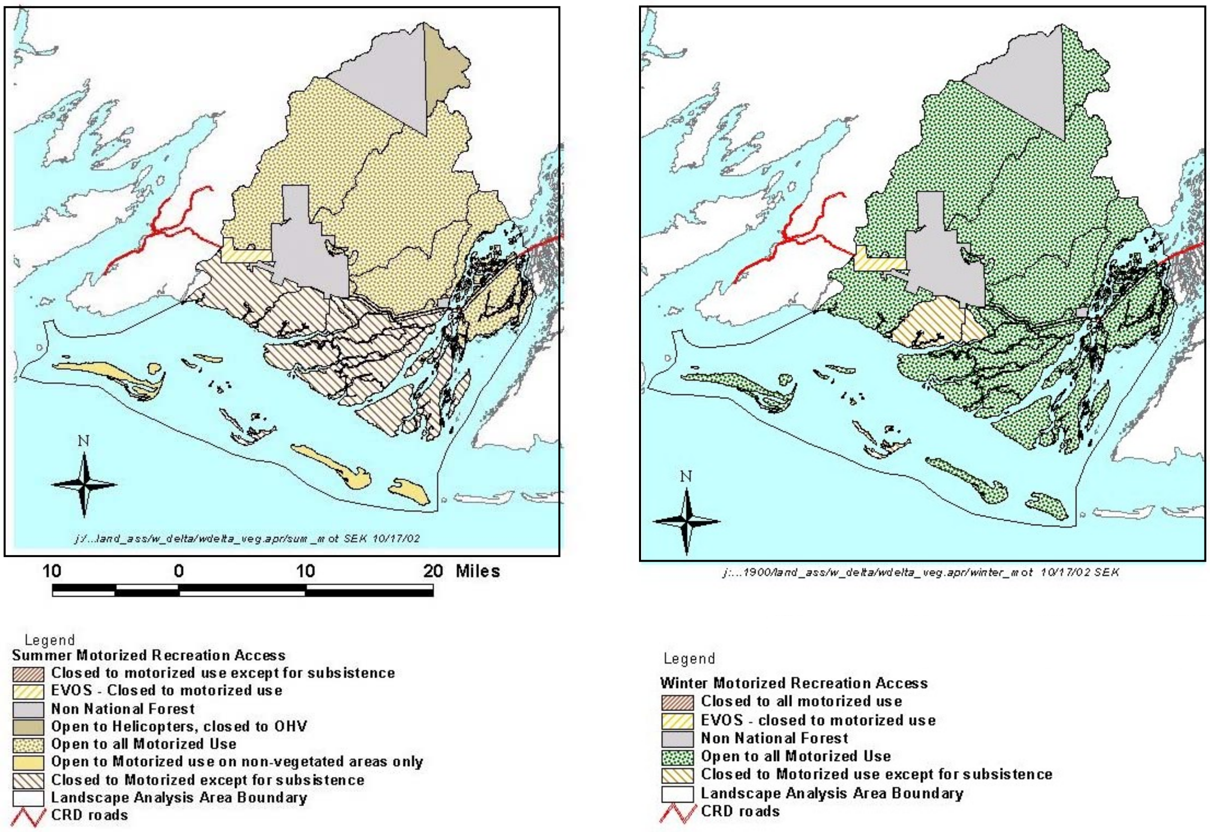


Figure 1.4-Summer and winter motorized recreation access

Chapter 2 – Analysis Area Description

Physical Characteristics

Location

This analysis addresses approximately 313,600 acres of the Copper River Delta east of Cordova, Alaska. It includes the Scott River, Sheridan River, McKinley Lake, and Copper River Delta West watershed associations. The analysis area is bounded by Eyak River, the Chugach Mountain Range, the Pacific Ocean and the Copper River.

Elevations in the analysis area range from sea level along the coast to 6,567 feet at the head of the West Arm of the Scott Glacier in the northern tip of the analysis area. Approximately 57% of the land in the analysis area, including the entire deltaic plain, is less than 1000 feet in elevation. Slope gradients within the analysis area range from zero to over 100%. However, 70% of the land area, including the entire deltaic plain, consists of slopes of less than 20%.

Climate

The analysis area lies within the Humid Temperate Domain of ECOMAP (ECOMAP 1993). The maritime climate consists of mild wet summers and cool wet winters. The Alaska current delivering warm ocean currents to the area, frequent atmospheric low-pressure systems in the Gulf of Alaska, and the Chugach Mountains contribute to this climate (Boggs 2000). Mean annual temperature varies from 34 to 42.1°F across the Copper River Delta (delta). The mean maximum snowpack increases from 9.8 to 78.7 inches as one proceeds inland on the delta. The growing season on the delta is about 107 days (May 10 to September 30), and the area has an average of 262 cloudy days per year (Boggs, 2000).

Temperature - Mean annual temperature at the Merle K. (Mudhole) Smith Airport is 38.5°F, the mean minimum January temperature is 15.2°F, and the mean maximum July temperature is 61.4°F (WRCC 2002). Table 2.1 displays the monthly climate summary for this weather station located near the middle of the West Delta analysis area.

Table 2.1-Monthly climate summary for Mudhole Smith Airport, Cordova, AK (Station 502177). (WRCC 2002).

Cordova Airport	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave Max. Temp. (F)	30.8	34.7	38.2	44.8	52.2	58.2	61.4	61.4	56	46.6	37.2	32.6	46.2
Ave Min. Temp. (F)	15.2	18.7	21.4	28.9	36.1	43	46.8	45.6	40.1	32.1	23.5	18.7	30.8
Ave Mean Temp. (F)	23	26.7	29.8	36.9	44.2	50.6	54.1	53.5	48	39.3	30.3	25.6	38.5
Ave Total Precipitation (in)	6.15	6.46	5.57	5.5	6.09	5.11	6.23	9.11	13.8	12.2	8.02	8.64	92.89
Ave Total Snowfall (in)	21.1	20.9	24.4	11.6	0.9	0	0	0	0	2.9	11.3	25.7	118.8
Ave Snow Depth (in)	8	10	11	5	1	0	0	0	0	0	2	5	4

Precipitation - The Mudhole Smith Airport receives an average of 93 inches of precipitation per year (WRCC 2002). This is the result of northwestward moving storm systems that encounter the Chugach Range and subsequently release moisture as rain or snow. At elevations below 1000 feet, snowfall generally falls between mid-October and mid-May, and rain can occur at any time of the year. Because of the orogenic effects of low-pressure systems encountering the peaks of the Chugach and Heney ranges, average annual precipitation greatly increases with elevation, from less than 80 inches over the ocean to 140 inches at the base of the glaciers and over 200 inches at the top of the highest peaks (Figure 2.1). September is the wettest month, and June is the driest. Large, high intensity rainstorms are common in September and October. A display of the climate summary for the airport is shown in the Walter climate diagram (Walter 1984), Appendix A, Figure A-1.

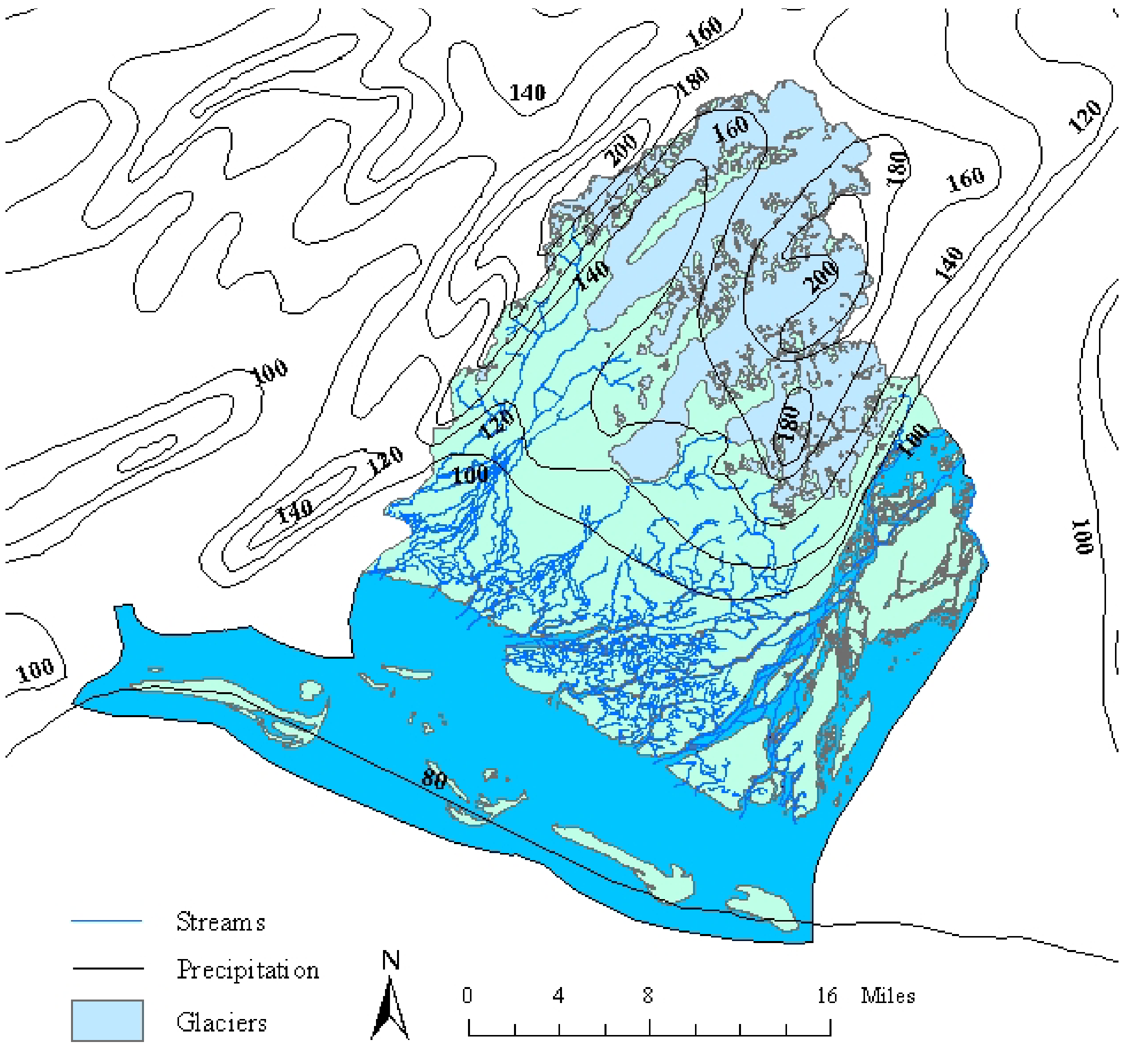


Figure 2.1-Isohyet map of mean annual precipitation (in inches) for West Delta analysis area.

Snowfall and snowpack - No monitored snow courses or SNOTEL sites exist in or near the West Delta analysis area. However, weather records from the Mudhole Smith Airport show an average annual total snowfall of 119 inches and an average March snowpack depth of 11 inches (WRCC 2002). Alpine watersheds receive vastly more snowfall than at the airport due to a higher percentage of the precipitation falling as snow and the higher precipitation that occurs at higher elevations. The percentage of precipitation as snowfall increases from about 15% at the airport to over 60% above 4000 feet elevation. Measurements made on other glaciers in the region indicate average annual maximum snowpack depths of well over 200 inches at elevations above 4000 feet.

Wind speed and direction - The Copper River canyon is the only gap in the Chugach Range between the Copper River Delta and the interior of Alaska. Strong winds frequently occur in this corridor because of the pressure gradient that exists between the high-pressure systems of the interior and the low-pressure storms of the Gulf of Alaska. Sustained downriver winter winds can last from several hours to several weeks and have winds speeds exceeding 60 miles per hour (mph) with gusts of 120 mph (Thilenius 1990). The canyon creates a microclimate at the mouth of the Copper River, and in comparison with the majority of the analysis area, this portion of the delta experiences heavier snowfall, colder temperatures, and later spring snow melt (Boggs 2000). The mouth of the Copper River also has different vegetative patterns as well as linear sand dunes, which are not found in other areas of the delta. Storm systems moving across the western portions of the delta are also associated with high velocity winds, occasionally reaching 75 to over 100 mph, although less severe than the Copper River winds. The prevailing wind direction is east and the average wind speed for this part of the delta is 5 mph (Boggs 2000). These winds cause snow to build up on the west sides of high peaks and ridges, creating permanent snowfields and numerous glaciers in the Chugach Range.

Ecological Classification

Using the National Hierarchy of Ecological Units (ECOMAP 1993), the majority of the analysis area that is not ice fields lies within the Northern Gulf Forelands Ecological Section as described and mapped by Davidson (1996). This Ecological Section is divided into the Copper River and Copper River Delta Ecological Subsections (Figure 2.2). A total of 144,803 acres (46% of the land area) in the analysis area lies within the Copper River Delta Subsection. The flatlands of this subsection consist 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.

A total of 36,876 acres (12% of the land area) lies within the Copper River Subsection of the Northern Gulf Forelands Section. This subsection 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 a maritime and a continental climate. The abrupt line separating these two subsections is partially the result of climatic factors influenced by the Copper River Canyon. 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.

A total of 12,924 acres (4% of the land area) lie within the Prince William Sound Islands Subsection of the Northern Gulf Fjordlands Section. This subsection includes the steep, rugged, coastal mountains in the northwest corner of the analysis area.

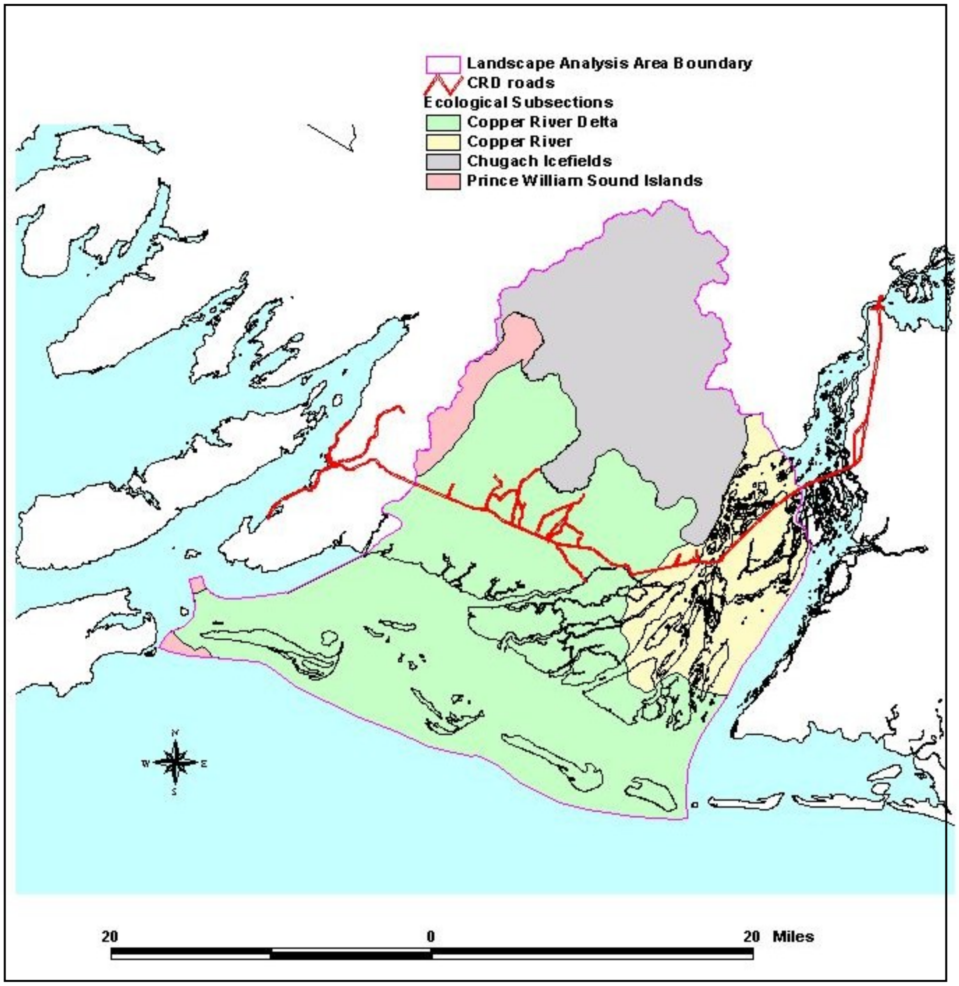


Figure 2.2-Ecological subsections present in the West Delta analysis area

A total of 118,971 acres (38% of the land area) lie within the Chugach Icefields Subsection of the Kenai Mountains Section. This subsection includes the icefields, glaciers, and rugged mountains of the northern portion of the analysis area and is characterized by high precipitation and large winter snowpacks.

Geology

The West Delta analysis area is characterized by the contrasting flat deltaic plain of surficial deposits and the steep, rugged, high relief landforms of the Chugach Range that rise abruptly from the delta. Quaternary deposits overlie 47% of the land area in the analysis area and nearly the entire Copper River deltaic plain (Figure 2.3). These deposits consist of undifferentiated deposits, dunes, supraglacial moraines, landslide deposits, lakes, and terminal, lateral, and ground moraines (Winkler and Plafker 1993). South of the Chugach Range, a few small bedrock outcrops protrude from these surficial deposits as tree-covered hills.

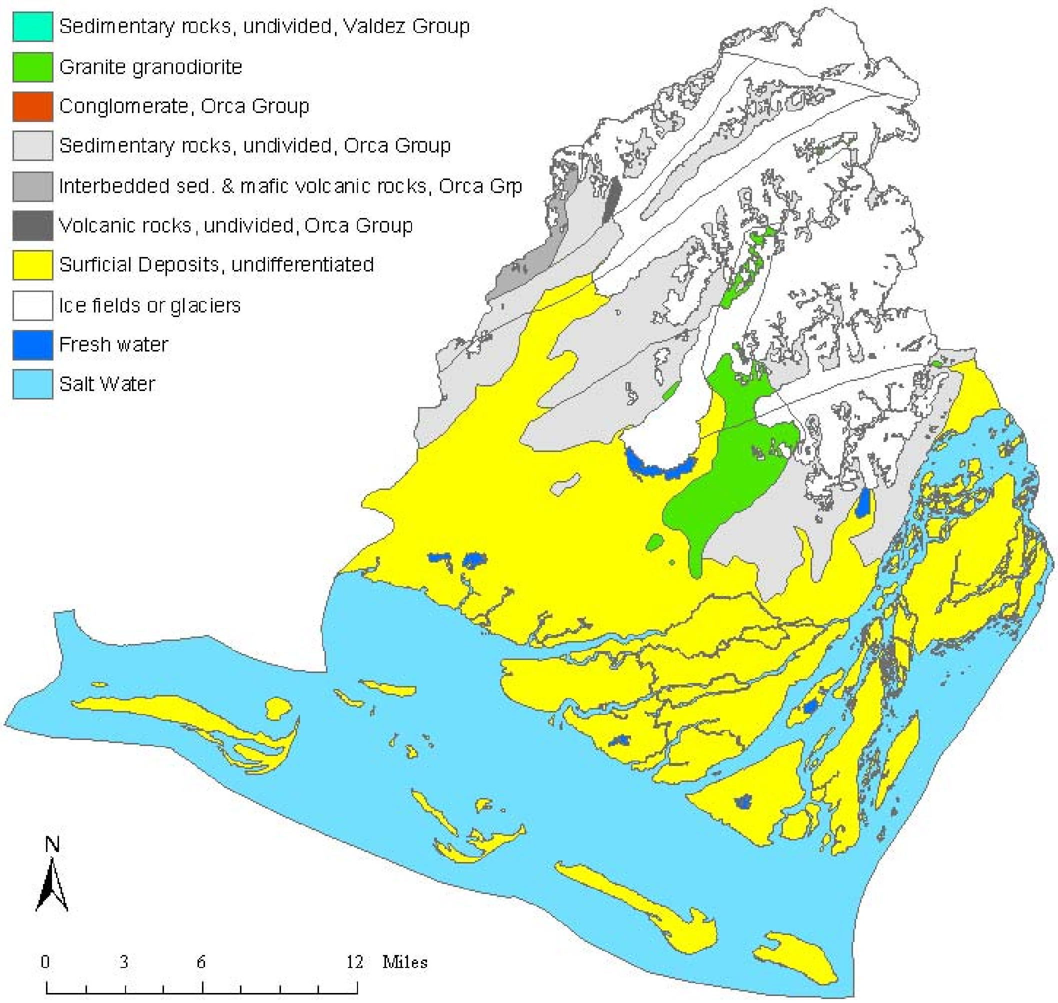


Figure 2.3-West Delta analysis area geologic map.

Data from USDA Forest Service, updated 1997. Original geologic boundaries were digitized from the Geologic Map of the Chugach NF, AK, prepared by the USGS branch of Alaska Geology, 1985.

The portion of the Chugach Range within the analysis area is predominantly composed of sedimentary and low-grade metamorphic rocks of the Paleocene Orca Group. These highly deformed and fractured rocks consist of thick bedded brown and gray sandstones, black limestones, arkoses, thin zones of slate, greywacke, argillite, and conglomerate greenstones with basalt flows (Professional Fisheries Consultant 1982). Because glaciers cover the majority of the valleys and high areas of the Chugach Range in this area, sequences of the Orca Group are exposed only in the Chugach foothills and high peaks. Eocene granite granodiorite is also exposed in a band east of Sheridan Lake and Sheridan Glacier. The West Copper River Delta Landscape Analysis Minerals and Geology Report (Huber 2003) provides more detailed information.

The Copper River Delta began forming when the main trunk of the Copper and other local glaciers began to recede at the end of the Wisconsin glacial period, about 10,000 before present (BP). The receding Scott, Sheridan, Sherman, and Saddlebag Glaciers produced the material deposited in alluvial outwash fans at the terminus of their valleys. These fans now form one large outwash plain west of the Copper River (Tarr and Martin 1914). The fine sediment of the delta came from a large flash flood when a proglacial lake occupying the Copper River basin breached an ice dam in the Copper River canyon. Lake sediment was redeposited in the ocean, which at the time was at the mouth of the Copper River Canyon. Later, the delta was uplifted above the ocean (Reimnitz 1966).

Crustal uplift and lowland submergence have created the landscape along the coast near the Copper River Delta. Uplift ranged from 98 feet near Katalla and Wingham Island to 197 feet at Cape Suckling as evidenced by marine terraces. Approximate dates of documented uplift range from 7,650 ±350 BP years of a marine terrace at Katalla to 3,770 BP ± 200 years near Yakataga (Reimnitz 1966). The area then entered a cyclic period of submergence interrupted by uplifts as evidenced by layers of organic matter in the soil to depths of nearly 65 feet in places along the Copper River Highway and Alaganik Slough. Two such obvious organic layers, visible in the cutbanks of Alaganik Slough and other places on the delta occur at depths of 9.5 to 10.5 feet and at about 16 feet. These layers contain remains of large trees suggesting the presence of ancient forests on the delta. These forests have been carbon dated to have occurred about 700 to 860 years before present for one forest and about 1700 years before present for the other.

A more recent example of the tectonic effects on the geomorphology of the delta is the uplift caused by the earthquake in 1964. Uplift ranged from about 6 feet on the west delta to about 10 feet on the tidal flats of the east delta. Uplift is generally less further inland (Plafker 1969). The uplift raised the original landmass so that it was no longer affected by salt water and intertidal lands emerged. Numerous drainage channels from the Copper River that flowed through the delta were either raised above the water level or filled with sediment so they now only carry water at the highest flows. Erosion of the uplifted cut banks increased significantly because they were now exposed to wave action and the currents in the faster flowing sloughs and rivers. Other lower energy slough channels with vegetated banks have maintained much of their original configuration.

The deltaic portion of the analysis area is a relatively level plain cut by an intricate pattern of inter-tidal slough channels. Since the 1964 uplift, these channels have cut deeper creating steep cutbanks and slough levees that dam up fresh water ponds or marshes. The uplift also created a new levee along the old wave-cut shoreline.

Expansive, very low gradient tidal flats extend into the ocean. Numerous river and tidal channels help drain the water during the tidal changes. In between the tidal channels are very shallow tidal pans. Thilenius (1989) felt that wave action and tidal scouring in these pans might cause ponds to form.

Landforms

Boggs (2000) recognizes 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 2.4. As shown in Figure 2.4, 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.

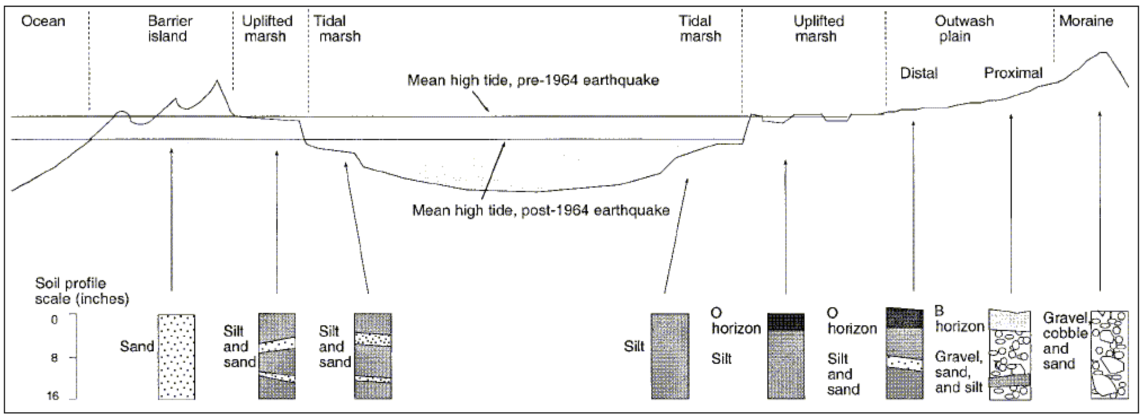


Figure 2.4-Idealized cross section of major landscapes and soil characteristics on the Copper River Delta (from Boggs 2000).

Barrier islands - Barrier islands are located along the coast and include Egg Island, Copper Sands, and Grass Island. Numerous spits also extend along beaches of the Delta. Both barrier islands and spits are created by the large input of sand and silt from the Copper River. Longshore currents circulating in a counterclockwise pattern around the Gulf of Alaska move this sediment parallel to the shoreline. Barrier islands form parallel to these currents where vegetation stabilizes the sediment. Barrier islands protect the shore from wave action in the Gulf of Alaska. In general, barrier islands and spits increased in size and elevation after uplift from the 1964 earthquake (Boggs 2000).

Tidal marshes - Tidal marshes are present all along the coast of the Copper River Delta between the barrier islands and the uplifted marshes. Tidal marshes consist of mudflats, marshes, and tidal channels. The protection from the barrier islands creates a low energy environment allowing these tidal marshes to form (Boggs 2000). The extent of these tidal marshes is constantly increasing as sediment from the Scott, Sheridan, and Copper rivers is deposited.

Uplifted marshes - Uplifted marshes are located south of the Copper River Highway. They were previously tidal marshes that were uplifted and now occupy the zone between the glacial outwash plains and the present tidal marshes. These uplifted marshes include freshwater streams, ponds, levees, peatlands, and bogs. Beaver dams often control channel morphology since beaver activity is high. Ponds generally remain full, and soils are saturated. Flood sediments spilling out of the channels create pond-forming levees along the channels. Tidal channels are incised within the marshes, eroding laterally and headward. Distributary sloughs in the silts of the lower portion of the watersheds are deep and generally have low width-to-depth ratios and vegetated banks, although banks are somewhat unstable because of the non-cohesive nature of the substrate.

Outwash plains – Besides the Copper River, large glacial rivers emerge from the Scott, Sheridan, and Sherman glaciers, depositing abundant sediment onto the Delta. Glacial outwash plains are controlled by the large sediment supply from glacial moraines and the subglacial grinding of bedrock, as well as the large fluctuations in flows. Coarser sediments (sand, gravel, and cobbles) at the glacial terminus grade to fine sediments (predominantly coarse silt and very fine sand) toward the Gulf of Alaska. Channels in these glacial outwash plains are generally braided with high width-to-depth ratios, generally greater than 50:1 (Benda et al. 1991). Channel banks are highly unstable, and channel migration continuously occurs.

Linear dunes - As a result of the strong Copper River winds, linear sand dunes are present exclusively at the mouth of the Copper River from Long Island to the Gulf of Alaska (Figure 2.5). Because frozen ground limits aeolian sediment transport in the winter, summer winds are the primary forces creating the constantly shifting dunes (Boggs 2000). However, on cold, clear windy days in the winter, quite a bit of sand gets dispersed as is evidence by the amount of dust in the air.

Figure 2.5-Large vegetated linear sand dunes in the Copper River Delta. View is upstream; Childs Glacier is in the distance (August, 1982).

Soils

As summarized by Boggs (2000), the Copper River supplies the primary sediment load necessary for the development of the delta, carrying about 1.07 x 10^6 tons of sediment per year (Reimnitz 1966). This sediment consists of fine sands and coarse silts.

Nearshore transport of sediment on the edge of the delta maintains the barrier islands and spits that form the seaward border of the estuary. These barrier islands and spits of fine and medium sands extend from Softuk Bar near Katalla to Point Whitshed. These islands shelter the estuary from offshore ocean currents and allow finer sands and silts to deposit enabling tidal marshes to form on the edges of the estuary.

The glaciers flowing from drainages feeding the Copper River Delta advance and retreat over time, destroying and creating new landscapes. Glacial streams deposit sediment across the delta as massive outwash plains.

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 zone between the alluvial fans and the raised delta, the raised delta, and the active tidal flats. Virtually all of the soils in these units 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 a higher percentage of coarse silt and very fine sand in the slough levees relative to the finer silts in the other deltaic soils.

Wetlands

Based on US Fish and Wildlife Service mapping, wetlands cover 259,691 acres, or 54% of the analysis area, including ocean water and the Copper River channels (Figure 2.6). Nearly the entire deltaic plain is classified as wetlands. The mountainous and glaciated northern portion of the analysis area contains very infrequent, small, and isolated occurrences of wetlands.

Estuarine wetlands, the intertidal zone between the coast and the barrier islands, are the most abundant type of wetlands present in the analysis area, covering 106,659 acres. The majority of the land area consists of palustrine and riverine wetlands, covering 85,396 and 58,750 acres respectively. Riverine wetlands are widespread throughout the glacial outwash plains of the Scott, Sheridan, and Copper River systems and palustrine wetlands occupy the lowlands between these larger channels. Lacustrine wetlands occupy 4,010 acres scattered throughout the area and include the larger lakes. Marine wetlands, covering 4,877 acres, are located only along the southern coast of the barrier islands. The Soils and Wetlands Report for the West Copper River Delta Landscape Assessment (Davidson 2003) has a breakdown by landtype association.

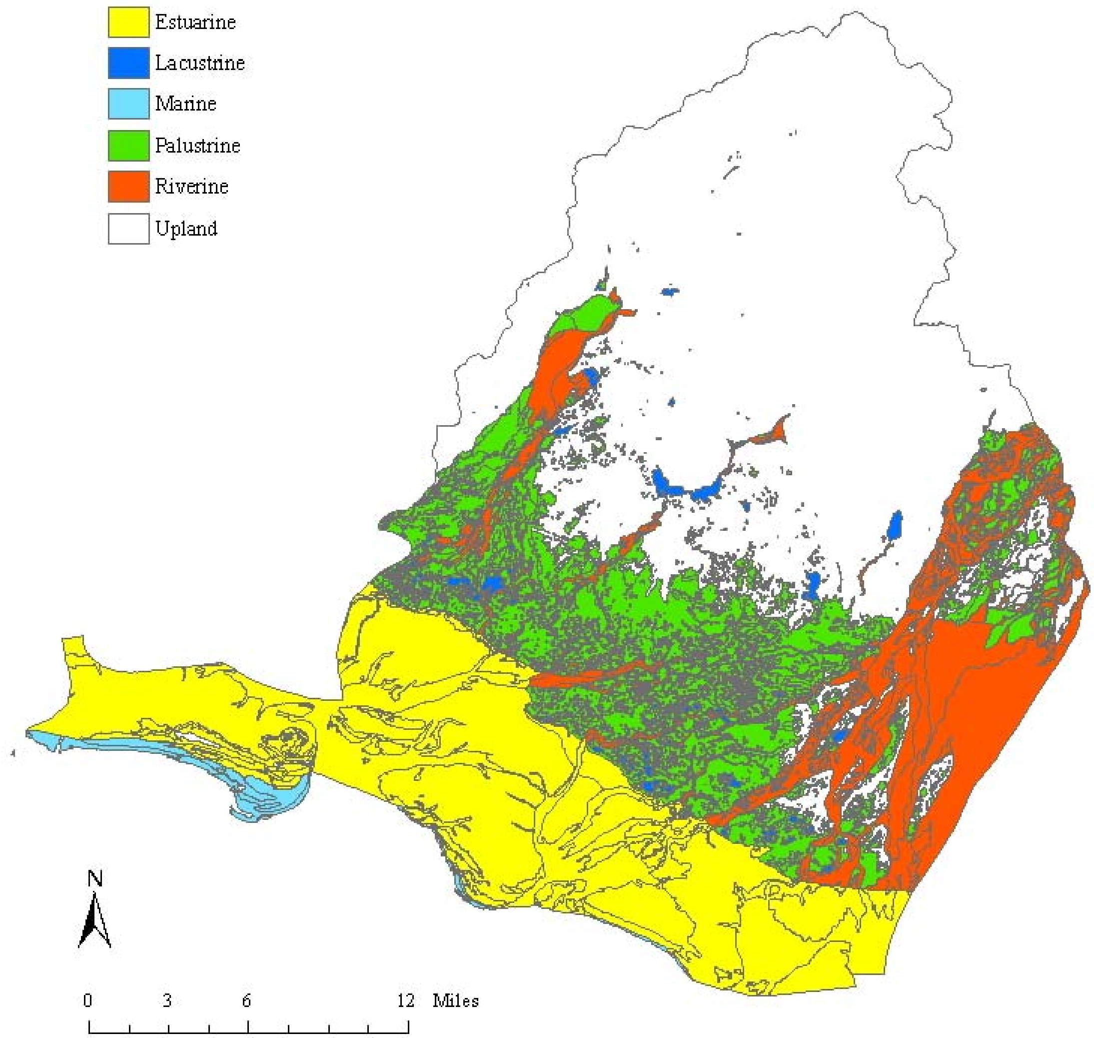


Figure 2.6-Wetland classification for the West Delta analysis area.

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.

Hydrology

The analysis area includes four watershed associations. The Scott River, Sheridan River, and Copper River Delta West watersheds each have broad, braided distributary channels with extensive networks of interconnecting channels and sloughs. The McKinley Lake watershed drains the foothills and peaks just west of the Copper River into Alaganik Slough and consists of seven subwatersheds. Refer to Figure 2.7 and Table 2.2 for location and acreages of each. Approximately 313,600 acres (65%) of the analysis area is land. The remaining 171,000 acres (35%) of the analysis area consists of ocean waters in the Gulf of Alaska as well as channels of the Copper River. The West Copper River Delta Hydrologic Condition Assessment (MacFarlane 2002) provides a more detailed discussion of the hydrologic conditions of the analysis area.

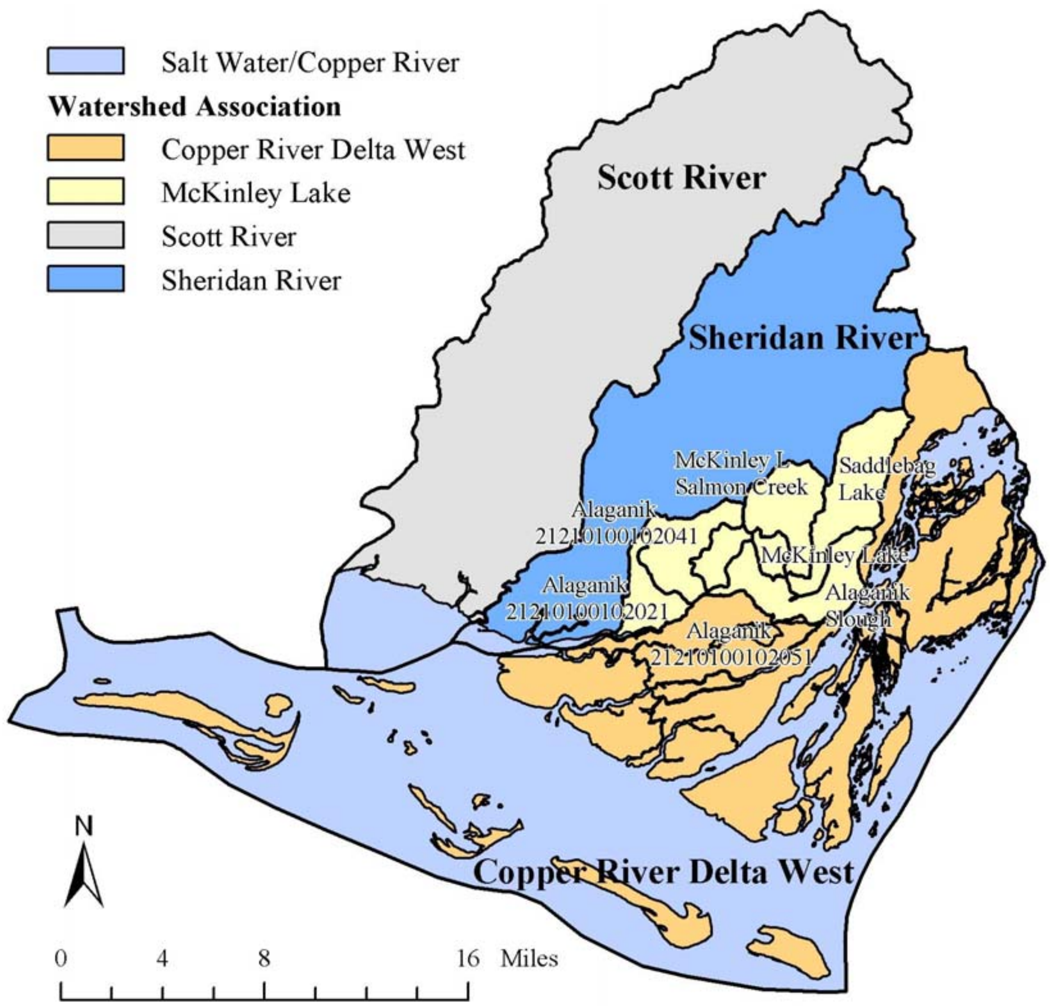


Figure 2.7-West Delta analysis area watersheds and subwatersheds. Stream and watershed data from USDA Forest Service. Stream data updated 1998, watershed data updated 1997.

Table 2.2-West Delta analysis area watershed and subwatershed characteristics.

	Watershed	Total area (acres)	Land area (acres)	Approx Max elev. (ft)	Approx Min elev. (ft)
Scott River		**130,907**	**120,213**	**6567**	**0**
Sheridan River		**79,294**	**77,243**	**6528**	**0**
McKinley Lake		**32,328**	**32,004**	**4300**	**0**
Subwatersheds	Saddlebag Lake	8173	8173	4300	0
	McKinley Lake Salmon Creek	5668	5668	4100	0
	Alaganik 21210100102051	2023	2021	2300	0
	McKinley Lake	1245	1245	2300	0
	Alaganik Slough	6613	6476	2300	0
	Alaganik 21210100102041	5242	5229	3000	0
	Alaganik 21210100102021	3365	3192	300	0
Copper River Delta West		**242,065**	**84,114**	**4200**	**0**
TOTAL – entire analysis area		484,593	313,574		

Glaciation is an important factor that has contributed to the present form of the West Delta. The Chugach Mountains rise dramatically from the delta to peaks with elevations between 4000 and 6500 feet. Glaciers cover about 89,700 acres, or 29% of the analysis area, including the majority of the high valleys of the mountains in the northern portion of the analysis area. These glaciers flow south and southwest toward the delta, and large glacial rivers emerge from the glaciers as broad, braided glacial outwash channels. The central and most prominent portion of the analysis area is a very low gradient (generally less than 1%) deltaic plain consisting of multiple distributary channels and sloughs that enter the Gulf of Alaska, as well as numerous wetlands, ponds, and lakes. Lakes cover approximately 8,771 acres or 3% of the analysis area. The 728-acre Sheridan Lake, formed by the retreating Sheridan Glacier, is the largest lake.

A total of 666 miles of stream lie within the analysis area, delineated using 1:63,360 USGS orthophoto quads magnified to a scale of 1:31,380 (USDA Forest Service 1998). The prominent drainages in the analysis area are Ibeck Creek, the Scott River, the Sheridan River, Alaganik Slough, and the Copper River. A total of 98% of the streams and rivers in the analysis area are less than 1000 feet in elevation, as most channels are located on the deltaic plain of the Copper River. Because of heavy glaciation, few streams are located in the mountains in the northern portion of the analysis area, and virtually no streams are located above 2000 feet elevation.

The construction of the Copper River and Northwest Railroad from 1906 to 1911 and the Copper River Highway 50 years later altered water flow and vegetation communities of the Copper River Delta (Christensen and Mastrantonio 1999). The numerous Copper River Highway bridges over the channels of the Scott, Sheridan, and Copper Rivers are static locations in a very dynamic environment, leading to various problems associated with channel widening, migration, abandonment, scour, and aggradation. Flood control dikes and spur dikes were constructed upstream of some of these bridges to control the positions of these channels, although channel migration can quickly render these dikes ineffective. Because these channels have all moved since the highway was constructed, the bridges do not always reflect the natural channel pattern. The valley bottom will eventually aggrade to the elevation of the highway.

Streams on the Chugach National Forest were classified using aerial photography and a system developed by the Tongass National Forest (USDA FS 1992) (Figure 2.8 and Appendix A, Table A.1). Because field verification is limited in much of this area, many assigned channel type and aquatic biota data may be inaccurate. Field verification is necessary for project-level decisions.

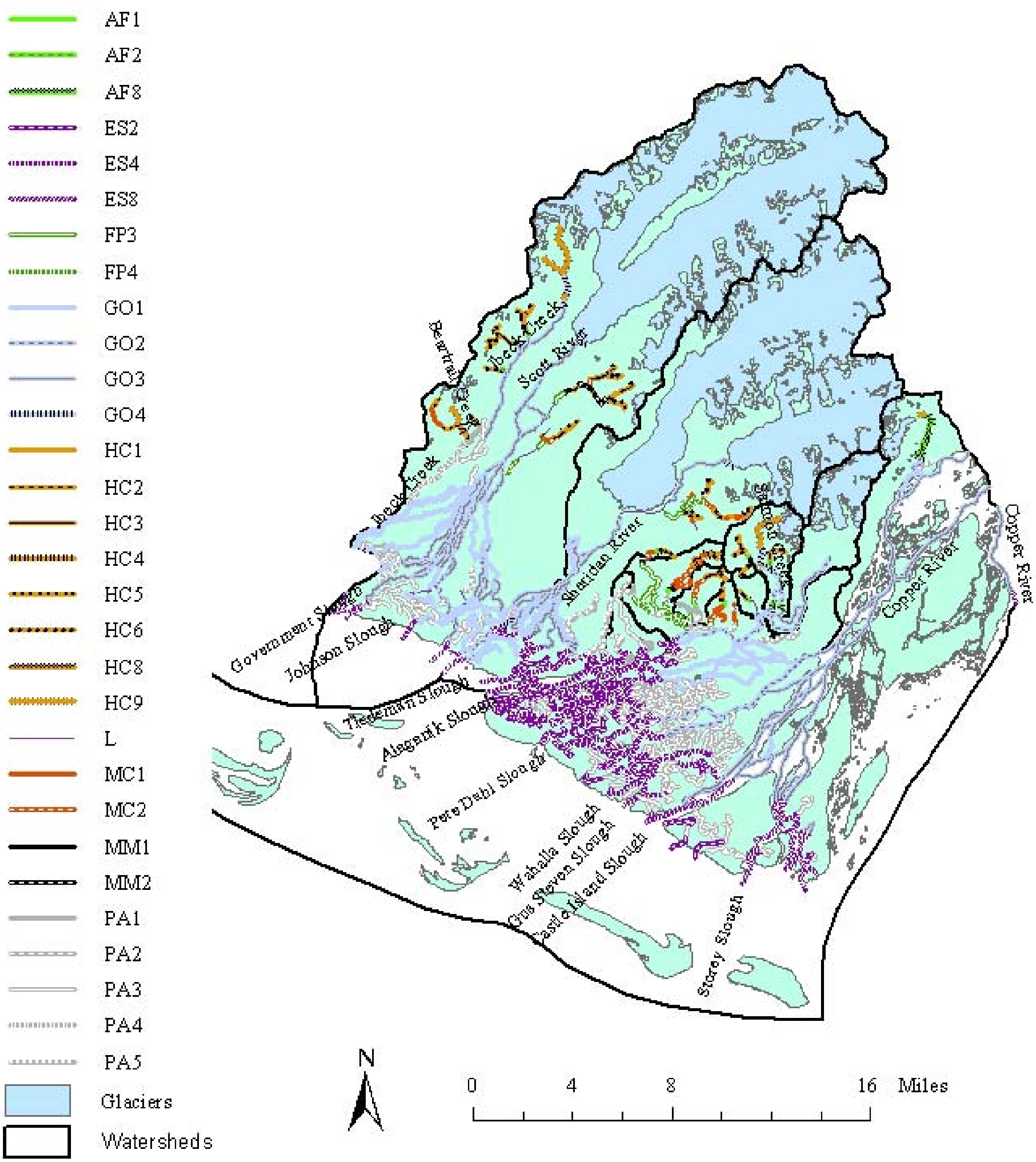


Figure 2.8-Stream classification in the West Delta analysis area.

Data from USDA FS, updated 1998. Channel types from USDA FS, AK Region (1992).

Based on the current Chugach National Forest database, 43 % of the channels in the analysis area, including the Scott, Sheridan, and Copper River systems, are of the Glacial Outwash process group (GO). Palustrine channels (PA) and estuarine channels (ES), each comprising 23% of the channels, become more common in the lower portions of the delta, as gradients decrease to near zero and tidal influences become dominant. Because glaciers cover much of the Chugach Range, the northern 25% of the analysis area contains no mapped stream channels. Small headwater streams are not mapped in the headwaters of the Scott and Sheridan Rivers, but the major glaciers have subglacial drainage systems. Only small percentages of the channels throughout the analysis area are in the High Gradient Contained (HC), Floodplain (FP), Moderate Gradient Contained (MC), and Moderate Gradient Mixed Control (MM) process groups.

Copper River - With a total length of 290 miles and a drainage area of 24,200 square miles, the Copper River drains the 6th largest basin in Alaska (Brabets 1997). Although only the western portion of the lower 20 miles of the Copper River is in the analysis area, the Copper River controls processes of sediment deposition and climatic effects that influence the entire Copper River Delta. Approximately 18% of the Copper River basin consists of glaciers (Brabets 1997). Within the analysis area the Copper River is a Large Braided Glacial Outwash Channel. The lower portion of the river spreads into numerous palustrine, estuarine, and glacial outwash channels before entering the Gulf of Alaska. At its mouth, the Copper River is approximately 12 miles wide (Figure 2.9).

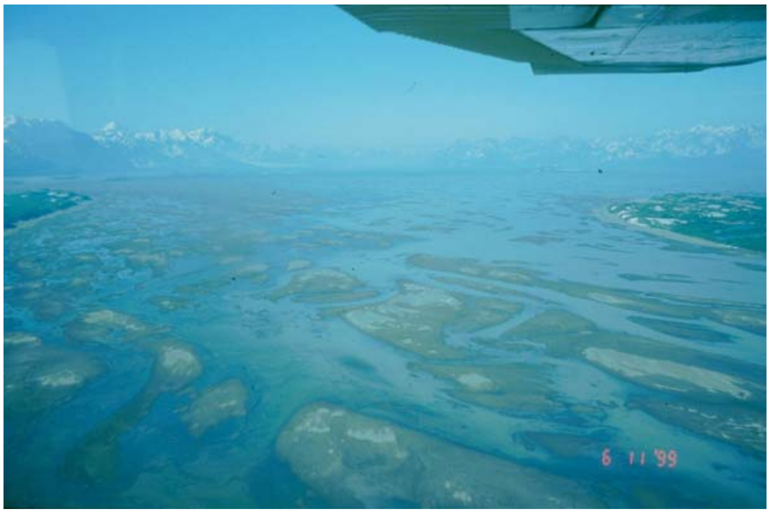


Figure 2.9-Copper River and Delta, looking upstream (June, 1999).

Because it is an active glacial outwash system, channel changes in the Copper River occur frequently and sometimes dramatically. High magnitude, low frequency floods cause the greatest changes in the lower Copper River. High magnitude peak flows have the potential to cause further channel shifts. Shifting flows can cause some channels to become dry and others to scour and enlarge, creating many difficulties with bridge locations, maintenance, and repair. In the past few years, the flow has shifted to the east.

From 1908 to 1981, the majority of the discharge of the river occupied the western channels, passing under the Flag Point bridges (Figure 2.10). At this time, small channels also existed under the remaining bridges. Surprisingly, no major channel changes occurred in the Copper River as a result of the 1964 earthquake (Brabets 1997). The 1981 flood, with a recurrence interval greater than 100 years, deposited sediment in the western channels and shifted flow patterns to the east. Cross sectional surveys indicated a ten times increase in cross sectional area of the channel under bridge 342, corresponding to decreases in size of the other channels. The 1981 flooding also caused the Copper River to cut a channel through the highway at the approach to Bridge 342. Because of channel scour at Bridge 342, the Alaska Department of Transportation lengthened the bridge, and constructed spur dikes upstream in 1987.

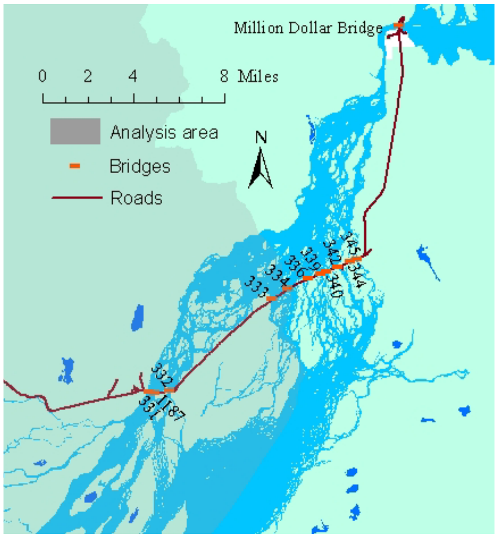


Figure 2.10-Locations of the Copper River Highway bridges over the Copper River.

Channel bars downstream of the highway are generally well vegetated because the fixed bridge location prevents channel migration and new channel formation. This also corresponds to increased aggradation in the current channels, as well as aggradation upstream of the highway. The increased flow under bridge 342 has increased the width of the channel upstream of the bridge, but the channel downstream reflects the narrower width of the bridge.

Scott River - The 17-mile long Scott River is a large, braided glacial river draining the Scott Glacier. Nearly the entire length of the river is a Large Braided Glacial Outwash Channel, occupying the 1.5 to 7 mile wide Scott River outwash plain (Figure 2.11). At its downstream end, the Scott River splits into multiple channels, forming an extensive network of glacial outwash, palustrine, and estuarine channels through the delta until it reaches the Gulf of Alaska.

Figure 2.11-Scott River, looking upstream toward the Scott Glacier (August 1982).

Because of the Scott River's high sediment loads and large fluctuating flows, channel changes in the outwash plain occur quickly and continuously, and the valley continues to aggrade with new sediment. In 1983, channels beneath the glacier shifted to the west, and the main river channel shifted from the east side to the west side of the valley (Blanchet 1983). Portions of the Scott River began to enter Ibeck Creek, changing the flow regime and increasing the turbidity of Ibeck Creek. This also altered flow regimes under bridges of the Copper River Highway, resulting in channel narrowing at bridge locations, greater flow velocities, and greater scour potential (Figure 2.12). These bridges also inhibit future channel migration.

Figure 2.12-Copper River Highway Mile-8 Bridge over a channel of the Scott River, looking upstream. The bridge constricts the flow considerably (September, 1984).

Portions of the Scott River also entered Eyak River, increasing turbidity and affecting sport fishing (Blanchet 1983). The additional flow introduced into the Eyak River decreased the ability for the Eyak River to drain Eyak Lake, increasing the flood risk around the City of Cordova. A dike was built in the 1960's to direct Scott River flood flows to the east. A proposal is currently being considered to build another flood control dike west of the Scott River downstream of the highway. Observations made in September 2001 indicate that Scott River flows appear to be shifting back toward the east and a smaller portion of the Scott River is entering Eyak River (Hodges 2001). This may provide some relief to the flooding problem on the Eyak River.

Sheridan River - The Sheridan River (also called "Glacier River") flows out of Sheridan Lake at the base of the Sheridan Glacier, draining the Sheridan and Sherman Glaciers. The river begins at the outlet of the 728-acre Sheridan Lake and flows approximately 10 miles southwest to the Gulf of Alaska. The majority of the Sheridan River is confined to a single, wide channel (GO3) incised into a large glacial outwash plain, and the lower portion of the river fans into a network of glacial outwash and estuarine channels. The Sherman River flows the short distance from the base of the Sherman Glacier into Sheridan Lake.

Before 1908, Sheridan River emerged directly from Sheridan Glacier, and Sheridan Lake did not exist. In 1950, glacial recession caused some small lakes to form at the base of the Sheridan Glacier, and the flow of the river was split between two forks (Figure 2.13). Sherman River entered the east fork channel. The west fork dried up in 1971 (US Army Corps of Engineers 1975), and in the early 1970's, the Alaska Department of Transportation built a 1.5-mile long flood control dike to channel flows from the east fork under the bridge at Mile 16. However, by 1974, the lakes joined into a single lake, and almost all of the flow shifted into the center fork. Because Sheridan Lake acts as a storage reservoir for sediment from Sheridan and Sherman Glaciers, sediment loads in the river decreased significantly. The result was downcutting of the Sheridan River into a single channel, incision of the lake outlet, and isolation of the previous outwash plain from streamflows. Although sediment transport at the lake outlet was low, bank erosion associated with the incising channel contributed to high sediment loads downstream. Since 1974, the center fork has carried all flow from the Sheridan and Sherman Glaciers, and the surrounding floodplain remains as a terrace, isolated from the flows of the incised center fork. Although Sheridan Lake will enlarge as Sheridan Glacier retreats, glacial sediment will continue to fill the lake. When the lake eventually fills, Sheridan River will once again carry high sediment loads, causing aggradation on the outwash plain and a shift to a braided channel pattern (Blanchet 1996).

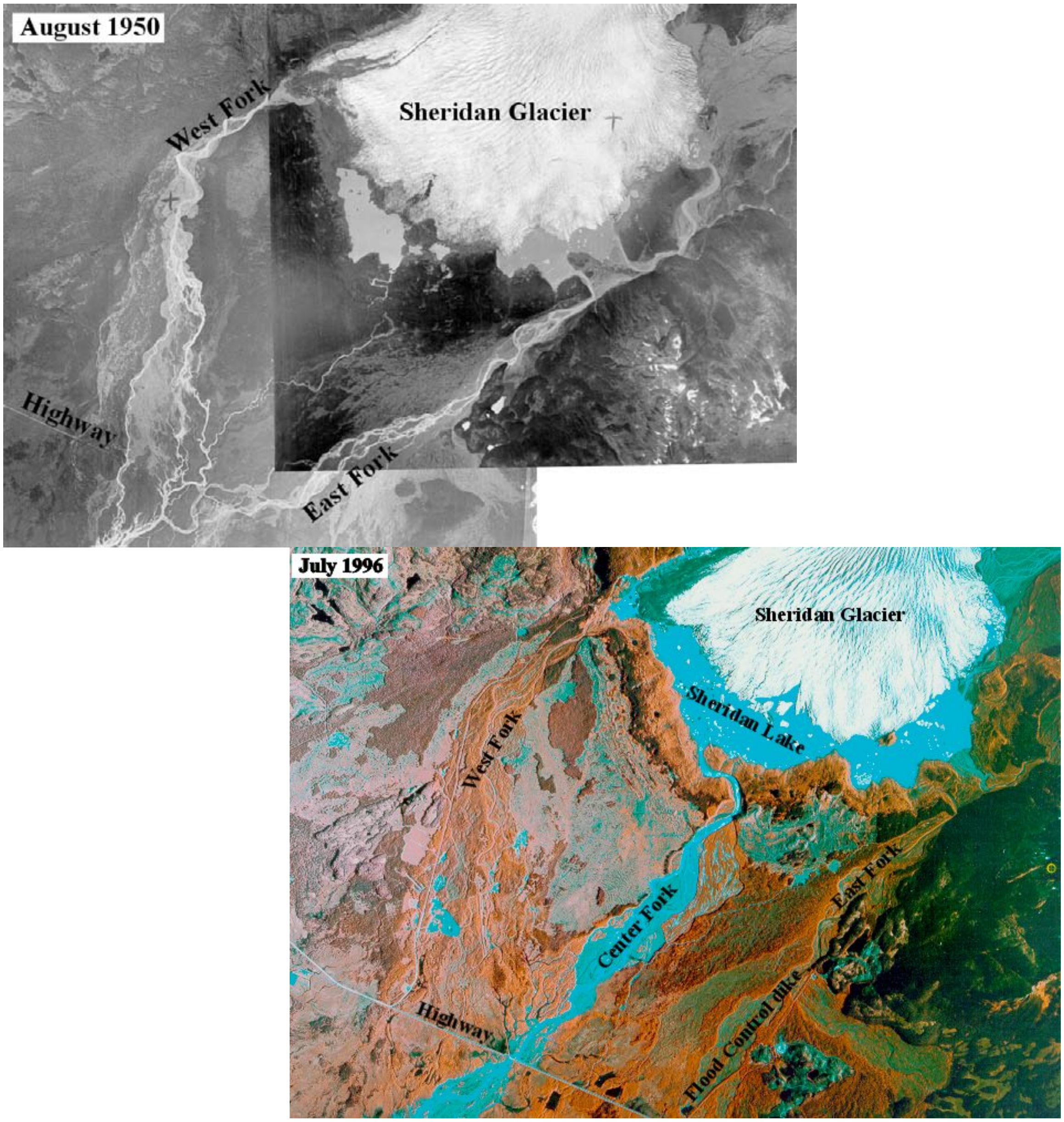


Figure 2.13-Channel changes in the Sheridan River and the Sheridan Glacier between August 1950 (top) and July 1996 (bottom).

Current conditions of the Sheridan River reflect changes in channel morphology from a braided outwash fan to a single, stable, incised channel. Upstream of the highway, the main channel of the river has migrated slightly to the east. However, the fixed location of the bridge prevents migration of the channel downstream of the highway (Figure 2.14), and does not allow for the increased width of the Sheridan River channel with all of the flow consolidated into the center fork. Portions of the channel now run west along the side of the highway before passing under the bridge and continuing downstream, leading to increased sediment deposition upstream of the highway.

Figure 2.14-Copper River Highway bridge over the Sheridan River, view downstream. The bridge restricts channel migration downstream of the highway (August 1982).

Surface Water Quantity

Streamflow data are limited in the analysis area. United States Geological Survey (USGS) flow records are available from 1988 to 1995 for the Copper River at the Million Dollar Bridge, about 20 miles upstream of the mouth of the rive. Because the Copper River basin extends far into interior Alaska, these flow data do not reflect the flow regime of other watersheds in the analysis area. Nevertheless, the flow regime of the Copper River plays a large role in sediment delivery and deposition on the delta. Flow data and peak discharges were also synthesized for the Copper River at the Million Dollar Bridge for the period between 1950 and 1987, based on daily flow records during this period from Chitina, 65 miles upstream of the Million Dollar Bridge (USGS station #15212000) (Brabets 1997).

Glaciers largely influence flows on the Copper River. Flows increase dramatically in late May and early June during snowmelt runoff with the majority of the flow occurring from June through September. Peak flows generally occur in July and early August during the peak of glacial melting (Figure 2.15). Typical high flows range from 150,000 to 200,000 cfs (Table 2.3). The record peak flow recorded in 1981 corresponded to a greater than 100-year flood event (Brabets 1997). Van Cleve glacial outburst floods are typically about 300,000 cfs, representing an increase of 150,000 cfs from normal flows (Brabets 1997). On average, winter low flows remain at a constant 8,000 to 13,000 cfs from early December to mid-April, as a result of the colder climate of the interior Copper River Basin. Based on flow data from 1991 to 1993, about half of the flow was in the channels under the Flag Point Bridges on the west side of the river, and about 40% of the flow was under bridge 342 on the east side of the river (Brabets 1997).

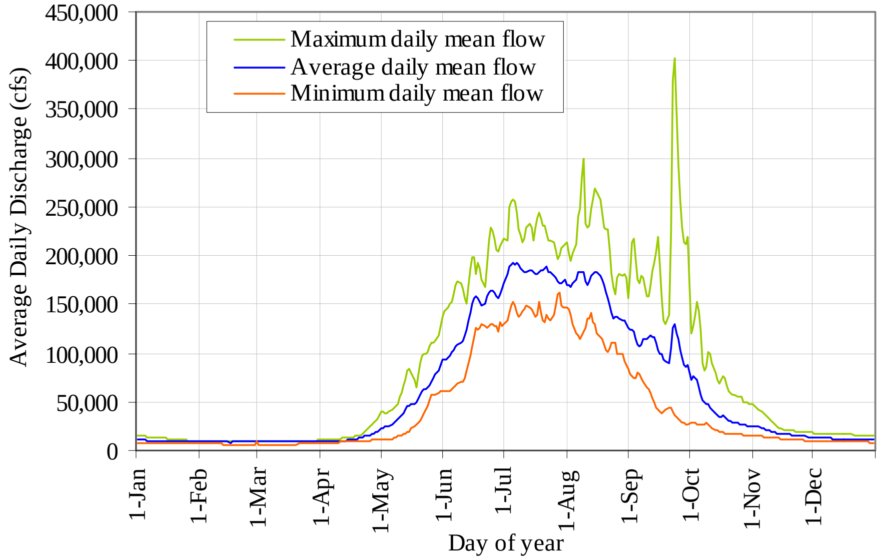


Figure 2.15-Average daily streamflows for Copper River at Million Dollar Bridge, USGS gauging station #19020104. Period of record 06/01/88 to 09/30/95 (USGS 2002).

Table 2.3-Daily streamflow statistics for the Copper River at the Million Dollar Bridge. Data from Brabets (1997).

Copper River at Million Dollar Bridge near Cordova, AK	
Long term average discharge (1950-1995)	57,400 cfs
Extreme minimum daily flow	4100 cfs (1970)
Record instantaneous peak flow	470,000 cfs (1981)
Median annual peak flow (Q_2)	Approx 220,000 cfs
Flow per square mile (for median annual peak flow)	9.1 cfs / sq mi
10-year peak flow (Q_{10})	Approx 300,000 cfs
Flow per square mile (for 10-year peak flow)	12.4 cfs / sq mi

No flow records are available for the Scott or Sheridan Rivers. Large glaciers control the flow regime of these rivers. Low, steady flows likely occur from November through April while the glaciers remain frozen, and flows increase dramatically with snowmelt in May and June. Peak flows likely occur in late July and early August, corresponding to the peak of glacial melting. Average flows during the rainy season of September and October may increase, although not to the magnitude of the summer glacial peak. Sheridan Lake, at the base of the Sheridan Glacier, attenuates flood flows from the Sheridan and Sherman Glaciers.

Smaller, non-glaciated watersheds within the analysis area have peak flows in June, resulting from snowmelt. They are more responsive to late summer and fall rainstorms, which are capable of creating flows of high magnitude and short duration, generally lasting 1 to 3 days. Ibeck Creek, draining a small, glaciated valley south of the Shephard Glacier, likely has a flow regime characteristic of both glaciated and non-glaciated streams. Outflow volumes of larger rivers as well as the size and stage of the tides affect intertidal slough flow volumes and velocities.

Water Quality and Sedimentation

A limited amount of water quality data was collected at several USGS stations between 1990 and 1995. These stations are all located at the highway bridges over the channels of the Copper River between Flag Point and the Million Dollar Bridge. Chemical and physical water quality parameters were measured at the USGS gauging station at the Million Dollar Bridge, but only suspended sediment concentrations, particle sizes, and discharges were measured at the other Copper River bridge locations.

Water quality data were measured from 1990 to 1995 in the Copper River at the USGS gauging station at the Million Dollar Bridge (USDI GS 2002). This site shows a lack of toxic pollutants due to the very limited amount of motorized activity or human development along the river, but had extremely high turbidity. The high turbidity is naturally occurring as a result of the extraordinarily high sediment loads from upstream in the Copper River. The highest turbidity values, ranging from 700 to 800 NTU, occurred in September and October at relatively low flows, likely indicating sediment input from intense fall rainstorms. At normal high flows (greater than 100,000 cfs), turbidity values generally ranged from 100 to 600 NTU. Dissolved oxygen levels ranged from 10 to 15 mg/L, well within acceptable levels set by the Alaska Department of Environmental Conservation (ADEC 1999). Levels of pH were slightly basic ranging from 7.7 to 8.5, and temperatures did not exceed 11.5^{o} F. Both are within the acceptable range set by ADEC.

Wissmar et al. (1991) measured the chemical characteristics of river, stream, marsh pond, and slough habitats throughout the Copper River Delta. They determined that water chemistry in wetland water bodies is greatly influenced by carbon dioxide, which leads to higher total alkalinity, as well as greater concentrations of calcium and magnesium cations. The decomposition of vegetation and organic material is the source of this carbon dioxide. Nutrients are recycled in these environments, and water has long retention times. Nitrogen and phosphorous concentrations were found to vary widely between different habitats. These data are summarized in Wissmar et al. (1991).

At the Million Dollar Bridge, the total suspended sediment load in the Copper River measured between 1991 and 1993 ranged from 63 to 78 million tons per year, averaging 69 million tons per year (Brabets 1997). The suspended sediment yield per square mile of watershed is more than twice that measured on any other Alaskan River (Brabets 1997). This is the result of a high discharge per square mile, glacial sources, and the presence of extensive, erodible late-Pleistocene lacustrine deposits in the interior Copper River Basin. Suspended sediment concentrations of the Copper River channels were measured at each of the lower highway bridges from 1991 to 1993 and ranged from 1000 to 2500 mg/L during peak flows in August (Brabets 1997, USGS 2002). Suspended sediment loads increased with increasing discharge. At discharges greater than 100,000 cfs, the total suspended sediment load is higher at the highway bridges than at the Million Dollar Bridge (Brabets 1997). This occurs because Miles Lake, upstream of the Million Dollar Bridge, acts as a settling pond and the river picks up considerable sediment from its bed and banks, as well as from Childs Glacier, as it crosses the delta.

Very little bedload transport occurs just downstream of the outlet of Miles Lake at the Million Dollar Bridge because Miles Lake is a settling basin, and the outlet channel is well-armored with large rocks from the terminal moraine of Miles Glacier. The bed material size decreases downstream, and bedload transport begins downstream of Childs Glacier. Bed material consists of coarse to very coarse gravel upstream of the Flag Point Bridge, and medium sand to medium gravel at the Flag Point Bridge (Brabets 1997). Bedload discharges measured at that bridge between 1991 and 1993 ranged from less than 1,000 to almost 7,000 tons per day (Brabets 1997). This represents less than 10% of the total sediment discharge at this location.

Ground Water

Groundwater is prevalent throughout the deltaic plain. A shallow water table, high rates of precipitation, snowmelt, and glacial melt, and the permeable glacial deposits of the glacial outwash fans allow for constant movement of groundwater toward the south. A thick layer of impermeable marine silts lies beneath the prograding wedge-shaped glacial outwash deposits that comprise much of the Copper River Delta. Because the glacial outwash deposits are coarsest near the glaciers and finer toward the south, rates of groundwater movement are highest near the glaciers, decreasing southward. Accordingly, the water table is furthest from the surface near the glaciers, where infiltration rates are high. To the south, the surface slopes downward to eventually meet the water table, and groundwater emerges to the surface at the terminus of the glacial outwash wedge. This point is marked by the many springs in these areas that flow downstream into the wetlands of the uplifted tidal marshes.

The city of Cordova recently built a landfill 1.25 miles northeast of the highway at Mile 17, in the Sheridan River outwash plain. Leakage of toxic substances from this dump may have an effect on the water quality of groundwater and wetlands downstream of the site. The city of Cordova is monitoring the site.

Biological Characteristics

Fish

Historic fisheries resource conditions were likely controlled by the dynamic geomorphic and tectonic activity on the Copper River Delta. Over the past 2,000 years, there has been persistent subsidence of land interrupted by punctuated intervals of uplift due to earthquakes occurring at intervals of 600 – 1,000 years (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 over periods following uplift and this will influence fish habitat and populations. Populations may have naturally fluctuated around periods of subsidence and uplift. The most recent uplift (2 – 3 meters) occurred in 1964 and the relative amounts of spawning and freshwater rearing habitat are believed to have increased since the earthquake. However, documented information on historic distributions, abundances, and aquatic habitat conditions in the analysis area is limited.

Habitat Characteristics - Streams in the analysis area were also classified by their fish habitat stream class values (Figure 2.16, Table 2.4), based on aerial photography and field verification. Nearly all of the streams in the analysis area (92%) are Class I streams with anadromous fish habitat. Most streams are located on the relatively low gradient delta with no upstream migration barriers. The Class II and III streams are located primarily in the foothills of the headwaters of the McKinley Lake watershed, as well as the small side tributaries of Ibeck Creek and the Scott River. Detailed fisheries information for each stream is available in the West Copper River Landscape Assessment - Fisheries report (Lang 2003).

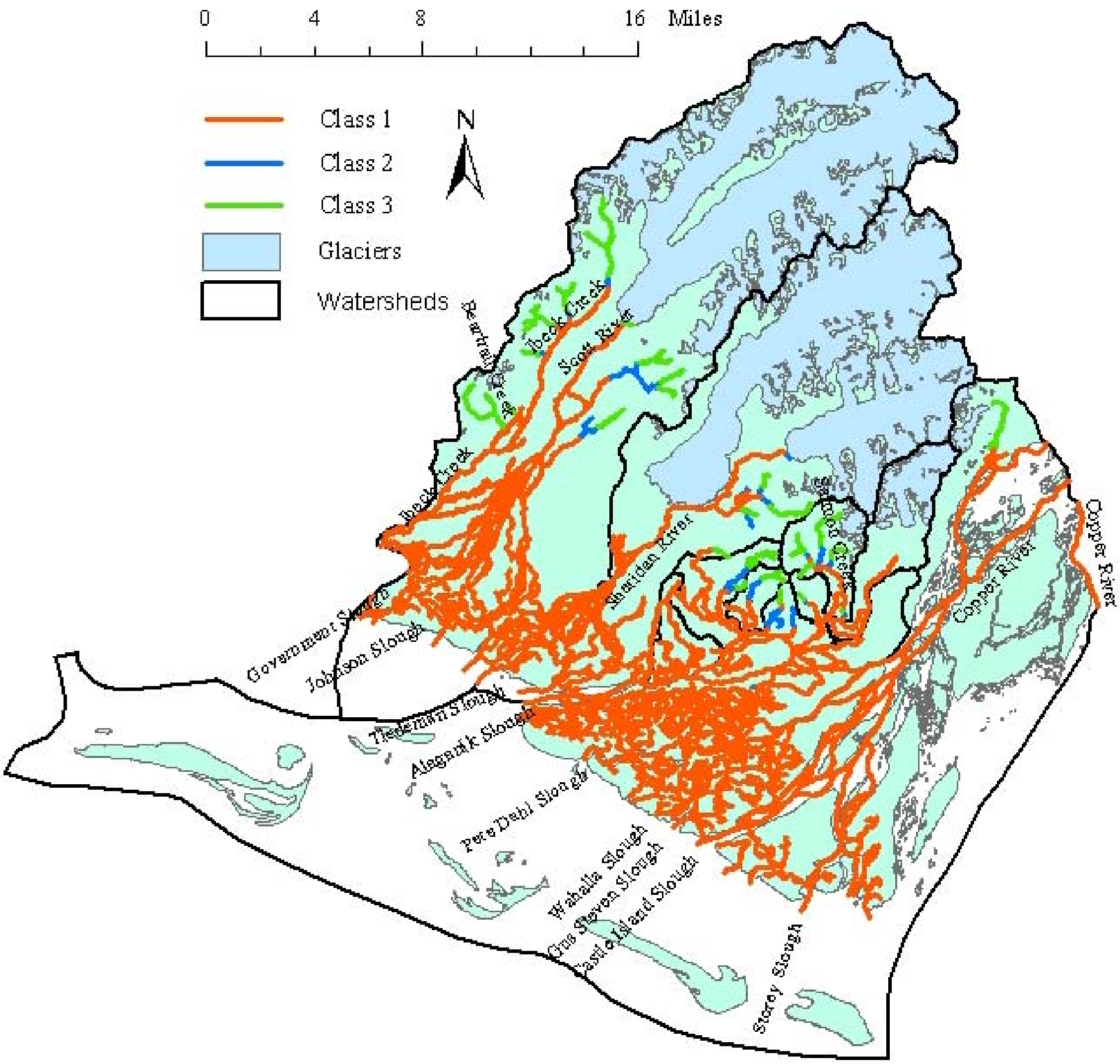


Figure 2.16-Fish habitat stream classification for the West Delta analysis area.

Data from USDA FS, updated 1998. Channel types are from USDA FS, AK Region (1992).

Table 2.4-Fish habitat stream classification (USDA FS, AK Region 1992) in the West Delta analysis area. Data from USDA FS, updated 1998.

Class	Description	Miles of stream	Percent of total
Class I	Streams with anadromous or adfluvial lake and stream habitat	612	92
Class II	Streams with resident fish populations. Generally steep (6-15% gradient), can include streams from 0-5% gradient without anadromous fish	14	2
Class III	Streams with no fish populations that have potential water quality influence on downstream aquatic habitats	40	6
Total		666	

The glaciers and steep terrain of the Chugach and Heney Mountain ranges are important influences on fish habitat in the northwestern portion of the analysis area. The Scott, Sheridan, Sherman, and Saddlebag Glaciers and their terminal lakes lie at the heads of the major river valleys. These large glacial rivers are characterized by braided channels and cold, turbid waters that are relatively unproductive fish rearing habitats (Allan 1995). Fish use these channels primarily for migrating to spawning and rearing habitats, although eulachon do use these channels for spawning..

Relatively small, clear-water stream systems originate in non-glacial drainages of the Chugach and Heney mountain ranges. These systems are fed by rain and snowmelt and eventually flow into one of the major glacial rivers. The headwaters of these systems are typically steep, high gradient contained channels that mainly transport sediment (USDA Forest Service 1992). Gravels used by anadromous salmon for spawning are transported from these areas and deposited downstream where channels have a lower gradient and are less contained. Coniferous forests dominate the riparian zones in these headwater streams 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 high gradients and large substrates.

Transitional stream reaches, between high gradient headwater tributaries and glacial outwash channels, are where much of the spawning and rearing habitat for salmonids exists. Many of these lower stream reach channels are of the floodplain process group. 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 in these channels and they provide depth and diversity of habitat necessary for overwintering survival of salmonids (Bustard et al. 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 high rainfall, and steep, flashy, headwater streams can result in frequent flooding of stream channels lower in the watershed. Floods can dislodge and transport aquatic and terrestrial invertebrates downstream, making them more vulnerable to predation by juvenile salmonids (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 seeps and springs are another form of clear-water systems on the West Copper River Delta. These systems typically originate from subsurface groundwater flow from adjacent glacial rivers. For example, the 26/27 Mile system is spring-fed from the nearby Saddlebag Glacier River. 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 overwintering habitat for stream rearing fishes because they may offer consistent flows and relatively warm temperatures during the winter months (Cunjak 1986).

The lower delta and offshore barrier islands provide a complex of aquatic habitats that consists of ocean beaches, mudflats, estuaries, sloughs, ponds, and marsh (Benda et al. 1991). Little is known about fish use of these habitats, however, the highest diversity of fish species may be present since both salt and freshwater species may occur in this tidally influenced area. 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 intertidal areas (Yeoh 1991, Otto 1971). Salmon smolts migrate through the lower delta area and may forage in the estuaries prior to migrating to the open ocean. The freshwater interbasin 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 where there is no tidal influence such as beaver ponds. Many sloughs are oxygenated by tidal flushes.

The Copper River and several distributary slough channels (Pete Dahl, Wahalla, Castle Island) are the primary influences on fish and fish habitat on the western side of the analysis area. These braided glacial outwash and tidal slough channels provide little salmonid spawning habitat. Anadromous fish may use these channels as migratory corridors. Eulachon, an important subsistence fish, do use these channels for both migration and spawning.

Fish distribution and species present - The complex aquatic habitats in the analysis area support a rich diversity of fishes. Anadromous salmonids are present in all four of the watersheds and 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*) and chum salmon (*O. keta*), and steelhead (*O. mykiss*) (ADF&G 1998). Some resident forms of lake trout, Dolly Varden, and coastal cutthroat trout occur in the analysis area (Trotter 1997). Other freshwater fishes present are round whitefish (*Prosopium cylindraceum*), arctic grayling (*Thymallus arcticus*), three-spine stickleback (*Gasterosteus aculeatus*), slimy sculpin (*Cottus cognathus*), prickly sculpin (*C. aster*), eulachon (*Thaleichthys pacificus*), burbot

(*Lota lota*), pacific lamprey (*Lampetra tridenttata*), green sturgeon (*Acipenser medirostris*), and white sturgeon (*A. transmontanus*) (Page and Burr 1991).

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).

There are many biological factors that 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 of these streams is composed of deciduous species, thus annual inputs from leaf litter to streams can be a substantial source of nutrients. Two dominant species of riparian vegetation, alder (*Alnus 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 in close proximity to spawning gravels may be highly productive because spawning salmon provide food and nutrients to stream rearing resident and juvenile salmonids (Bilby et al. 1996, 1998). 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).

The effects of commercial fishing and other human influences are discussed in Chapter 4, Conditions and Trends.

Current distribution of the key fish species - As previously mentioned, the current database is missing some stream information and may contain inaccurate information about streams. The current stream layer is being updated as to fish distribution. Figure 2.17 displays the distribution for coho and sockeye salmon, Dolly Varden, and coastal cutthroat trout.

Coho salmon are the most widely distributed species in the analysis area. Based on the current GIS corporate stream layer (July 2002), they can be present at some life stage in all of the watersheds in approximately 122 miles of streams.

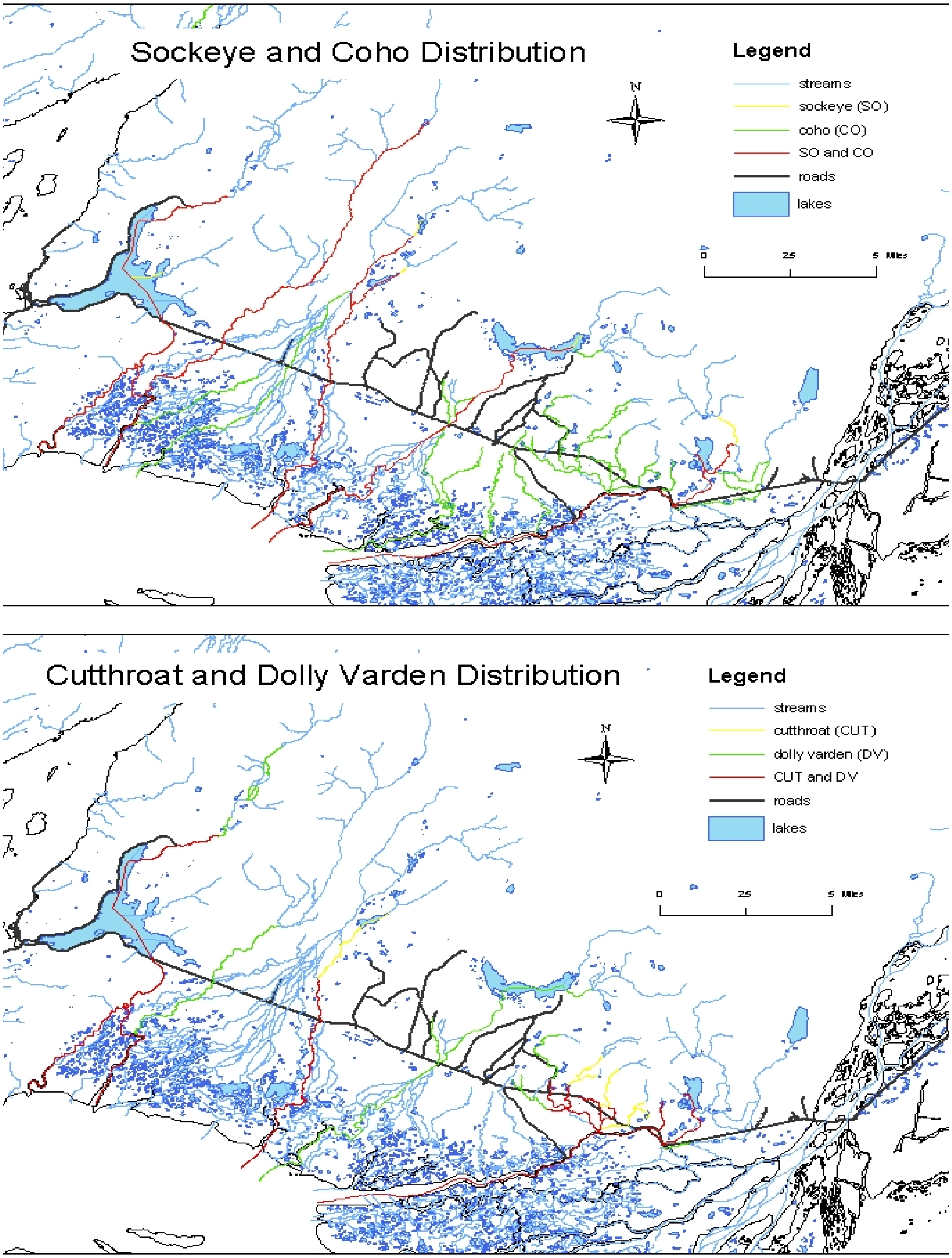


Figure 2.17-Distribution of the key fish species in the analysis area based on current GIS corporate stream layer (USDA Forest Service 2002).

Sockeye salmon appear to be the next most widely distributed species. They can be present at some life stage in approximately 68 miles of streams in the analysis area (USDA Forest Service 1998). Sockeye salmon populations are generally associated with lakes because juveniles often rear in lakes for 1 to 3 years before migrating to the ocean as smolts (Groot and Margolis 1991). Elsner and McKinley Lakes are probably important sockeye salmon rearing habitats.

Dolly Varden and coastal cutthroat trout are found in 66 and 47 miles of streams in the analysis area, respectively. These species may be more widely distributed; however, small populations, wide-ranging migrations, and insufficient data make it difficult to determine the distributions of these two species.

Vegetation

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 (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*) forests became established about 3,000 years ago. The vegetation of the Copper River Delta 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 and as a result is highly dynamic. There is strong historical evidence that the vegetational development on the delta has gone through a least two cycles from the low meadow/shrub stage to the spruce forest stage. This indicates that there has been sufficient time between the submerged and uplifted cycles to allow the vegetation to progress to a forested stage.

Before 1964, much of the delta was covered by brackish marshes dominated by sedges (*Carex* spp.) 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 12.1 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) all indicate that before the earthquake there were either none or only minor occurrences of woody shrubs on the foreshore levees with an increasingly greater number of occurrences 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.

Figure 2.18 suggests that, 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.

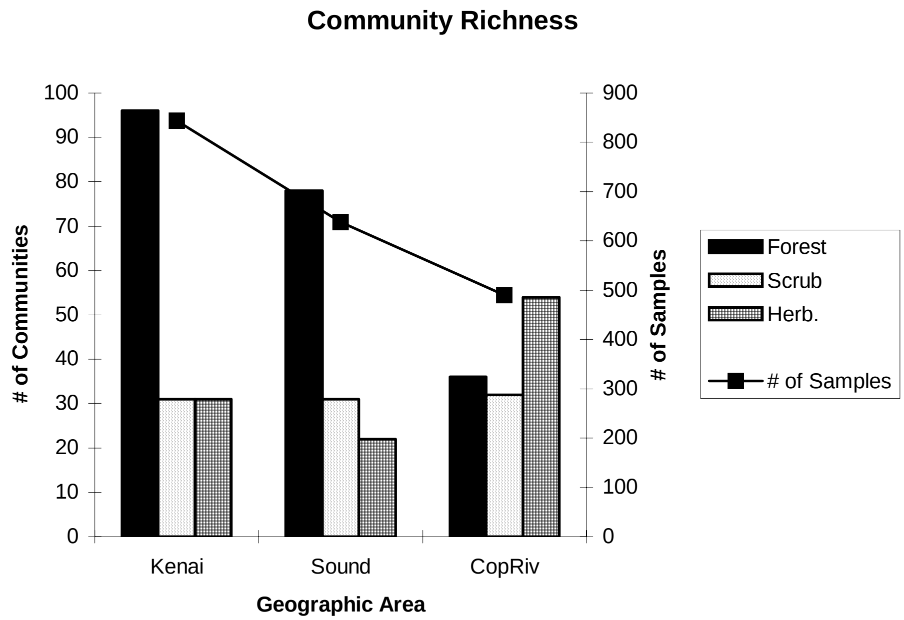


Figure 2.18-Plant community richness by formation class and geographic area, i.e., Kenai Peninsula, Prince William Sound, and Copper River Delta (from USDA FS 2002c).

The vegetation cover type in the analysis area ranges from marsh, grass, willow, muskeg, needle leaf forests, broadleaf forest, alpine, rock, snow and ice. The characteristic needleleaf forest species include Sitka Spruce, mountain hemlock, and western hemlock. Salmonberry, devils club, early blueberry, Alaska blueberry, and skunk cabbage dominate the understory of the needleleaf forests. The 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, Sitka sedge, burreed, yellow pond lily, fireweed, beach rye, Pacific silverweed, Nootka lupine, and dwarf alkali grass (DeVelice et al. 2001).

Figure 2.19 and Table 2.5 display the land cover type and acreages for each for the analysis area using Chugach NF corporate work done by Markon and Williams (Markon and Williams 1996). It more accurately displays the vegetation for the delta than the cover types generated from the timber type layers currently in the GIS corporate database. The timber type generated vegetation map and acreages are located in Appendix A (Figure A-2 and Table A-1) for comparison.

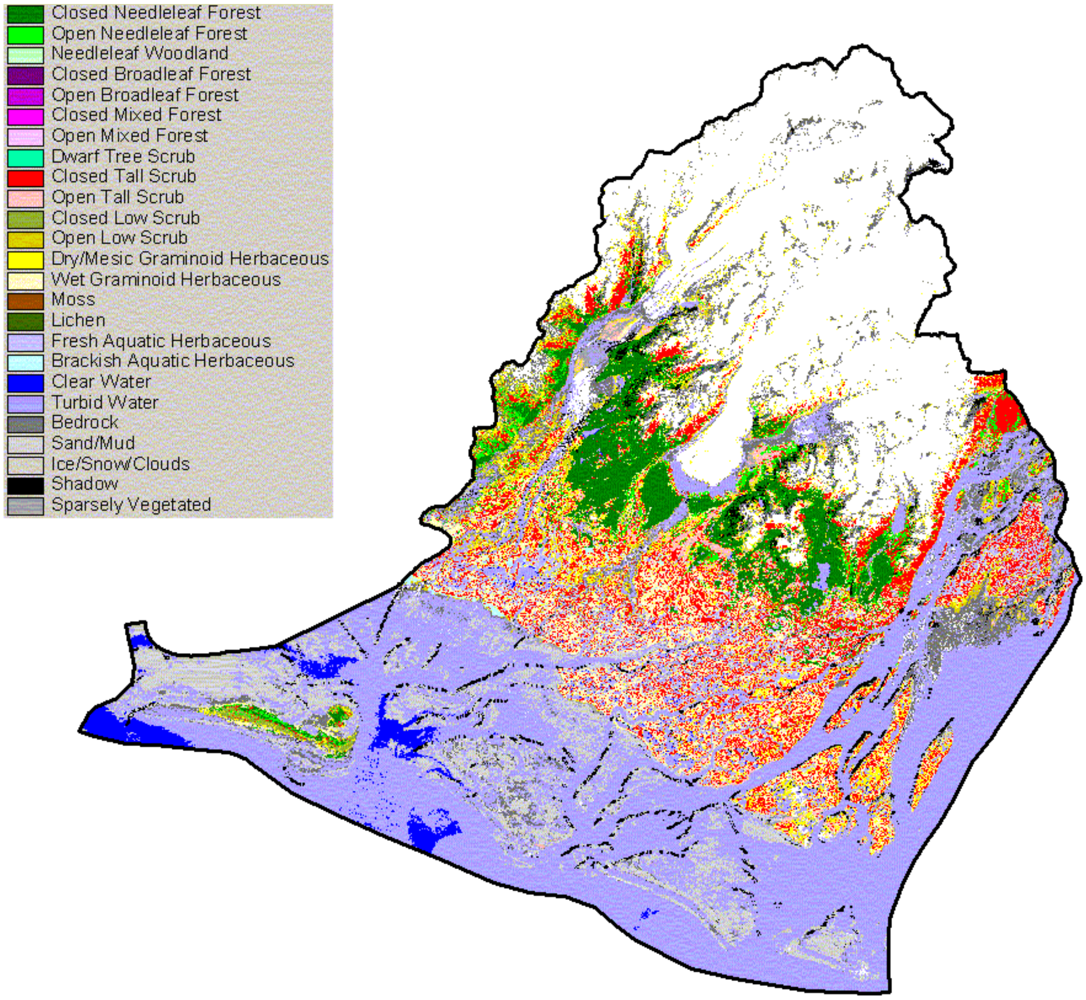


Figure 2.19 – Land cover types of the West Delta Analysis area from Markon & Williams (1996).

Table 2.5-Cover types of West Delta analysis area

Cover Type	Acres	Percent of Area
Closed Needleleaf forest	24,660	5.03%
Open Needleleaf forest	6,605	1.35%
Closed tall scrub	35,274	7.19%
Open tall scrub	5995	1.22%
Closed low scrub	1950	0.40%
Open low scrub	6993	1.43%
Dry/mesic graminoid herbaceous	19,438	3.96%
Wet graminoid herbaceous	29,255	5.96%
Fresh aquatic herbaceous	8960	1.83%
Brackish aquatic herbaceous	954	0.19%
Clear water	7325	1.49%
Turbid water	154,996	31.60%
Bedrock	26,421	5.39%
Sand/Mud	34561	7.05%
Ice/Snow/clouds	111,281	22.68%
Shadow	9834	2.00%
Sparsely vegetated	6062	1.24%
Total Area	313,588	100%

Table 2.6 summarizes the known size class for forested acres. This information is based on 1976 timber type data and aerial photo interpretation and has not been updated. Size information is not available for a majority of the area. The timber type records only include information for National Forest System lands coded with one of the three conifer timber types listed (Sitka spruce, Hemlock, Hemlock-spruce).

Table 2.6-Acres of each size class on National Forest System lands.

Size Class	Total acres
Seedling / sapling (0.1 – 4.9 inches)	180
Pole size (5-8.9" dbh)	1,296
Young Growth Sawtimber (9.0" dbh or greater & <150 yrs old)	5,337
Old Growth Sawtimber (9.0" dbh or greater & >150 yrs old)	7,855
Total	14,668

The Copper River Delta is experiencing a shift in vegetation as a result of the 1964 earthquake. Sitka spruce is becoming established in many areas previously occupied by alder or willow. Therefore, the acres of "seedling/sapling" size trees are underreported.

Wildlife

The West Copper River Delta is a diverse landscape including 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). This diversity provides habitat for many species. Following is a description of the bird, mammal, amphibian, and invertebrate species of the area.

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 bird species were documented on two breeding bird survey (BBS) routes in the analysis area (Appendix A, Table A.3) and represent some of the more common breeders of the Copper River Delta. Not represented in the survey data are several species of raptors that breed commonly within the analysis area, as bald eagles, northern harriers, short-eared owls, and northern goshawks.

The 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 (*Cygnus buccinator*), Canada goose (*Branta canadensis*), white-fronted goose (*Anser albifrons*), northern pintail (*Anas acuta*), mallard (*A. platyrhynchos*), green-winged teal (*A. crecca*), and American widgeon (*A. americana*). 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.

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 2.7 lists the bird species found on the west Copper River Delta, that are of management concern by either the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), Alaska Department of Fish and Game (ADF&G), or the National Audubon Society. The Forest Service addresses how each of these species is affected by proposed projects in site-specific environmental analyses.

Table 2.7 - 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 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

Although much of the habitat in the area, and the associated avifauna, is in near pristine condition, some bird-related issues exist. Following are species or groups of birds meriting special attention.

Shorebirds. Coastal areas of south-central 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 (*Limnodromus griseus*) 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 use this area during migration as well. These birds use mudflats as critical feeding areas to replenish their fat reserves during their long migrations to breeding grounds.

Mudflats of the west Copper River Delta are important feeding areas for migrating shorebirds. Shorebirds make extensive use of tidal areas near the mouth of the Copper River, Alaganik Slough and surrounding the barrier islands.

Gulls. From 8,000 to 10,000 glaucous-winged gulls (*Larus glaucescens*) nest on Egg Island, representing the largest colony in the northeast Gulf of Alaska (Patten and Patten 1976). Mew gulls (*L. canus*), and several species of songbirds, shorebirds, and raptors all nest on Egg Island and other barrier islands of the Copper River Delta. A survey in 1988 found 0.8% of households utilized gull eggs as food (Stratton 1992). Currently, taking of eggs is not legal. Changes in federal regulations, for subsistence purposes, could create a demand for egg harvest in the future. Gulls nesting on Egg Island disperse to other areas to feed, and occur in large densities at food sources such as the fish processing plants in Cordova, and at fish spawning runs on the delta.

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).

Trumpeter Swan. Trumpeter swans are a Region 10 sensitive species. They nest on the delta and surrounding wetlands. Although some swans over-winter on ice-free waters on the delta, 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).

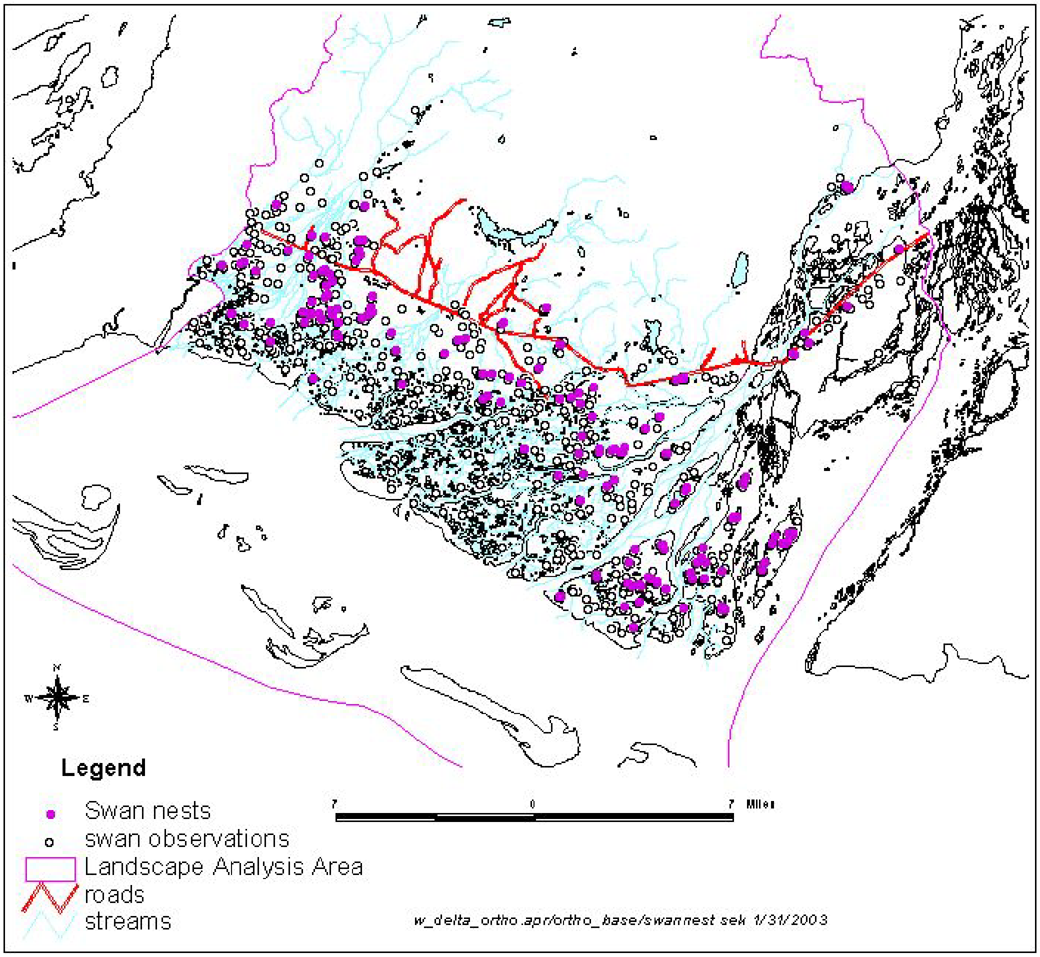


Figure 2.20-Distribution of trumpeter swan nests and observations in the West Delta analysis area

Bald eagle. The bald eagle (*Haliaeetus leucocephalus*) is an abundant and conspicuous resident of the North Gulf Coast and Prince William Sound region (Isleib and Kessel 1973). Bald eagles are year-round residents using large diameter trees (spruce hemlock, cottonwood) for nest sites, and feeding in streams, lakes, and marine waters. Salmon in spawning streams can concentrate large numbers of eagles. From 21 to 410 bald eagles were observed on Cordova Christmas Bird counts between 1970 and 2001. The bald eagle is a species of special concern on the Chugach National Forest. The USFWS and USFS have an interagency agreement for bald eagle management in the Alaska Region. It includes standards and guidelines for regulating human disturbance within identified bald eagle use areas.

USFS bald eagle nest surveys have located many nests within the analysis area. Bald eagle nests are found wherever suitable nest trees exist on or near the delta (Figure 2.21).

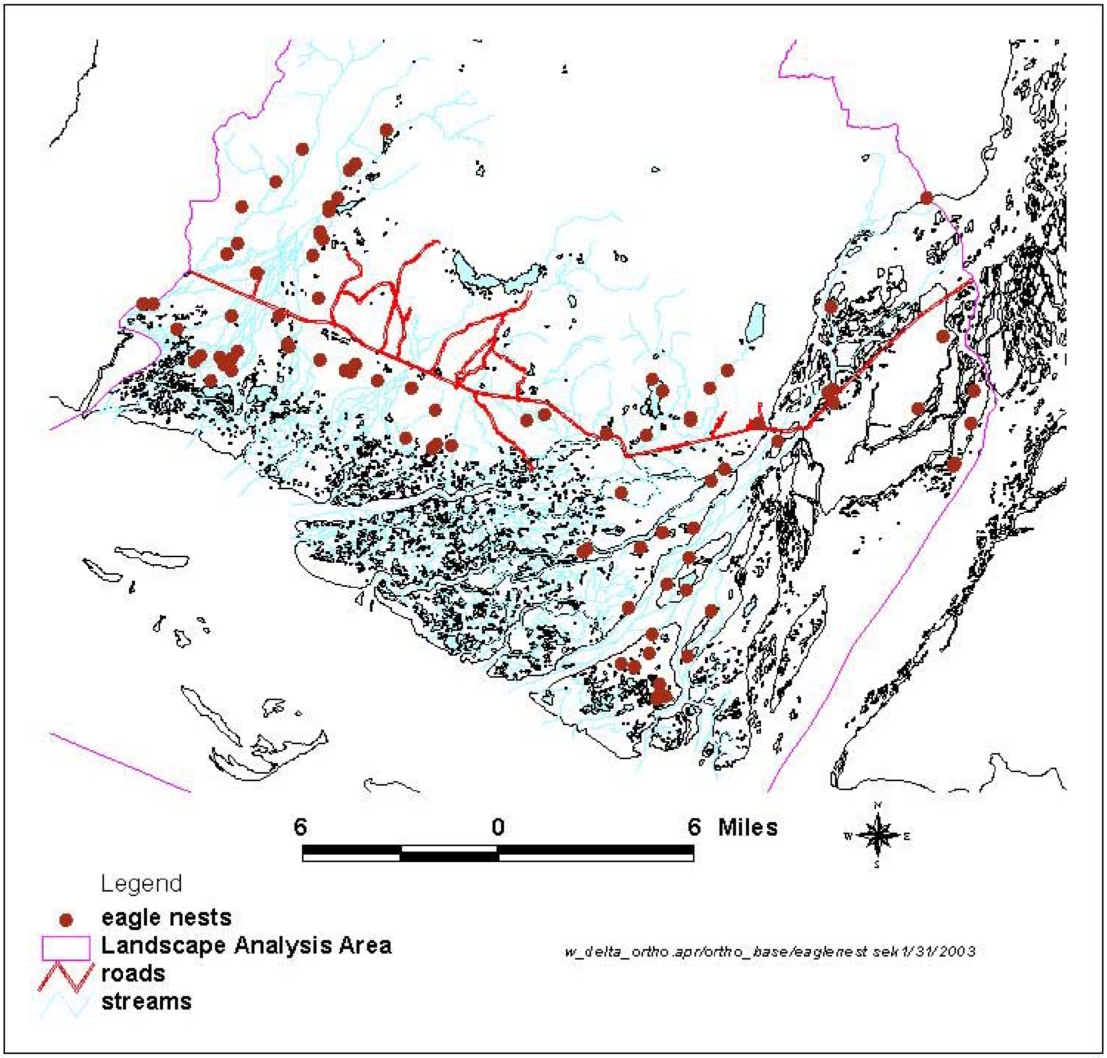


Figure 2.21-Distribution of bald eagle nests within the West Delta analysis area

Northern Goshawk. The northern goshawk is the largest North American accipiter and a Region 10 sensitive species. It is a forest habitat generalist, breeding in coniferous, deciduous, or mixed forests across its holarctic range (Reynolds et al. 1992). 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). In Alaska, goshawks are most often associated with old growth forests (McGowan 1975, Crocker-Bedford 1993, Titus 1996). It is considered a non-migratory resident in the Prince William Sound area (Isleib and Kessel 1973).

Due to concerns over population declines, the northern goshawk is currently listed by the USFWS as a species of management concern. Species of management concern include those species for which there is some evidence of vulnerability, but not enough data to consider a listing proposal under the Endangered Species Act of 1973. Goshawk population declines 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 fairly common resident of the North Gulf Coast and Prince William Sound (Isleib and Kessel 1973). Numerous sightings of northern goshawks and at least 1 nest have been recorded within the analysis area. None were sighted in the area used for firewood cutting on the Saddlebag road during a survey conducted in the summer of 1994.

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 15 April and 5 May. 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 area, but none are known within the analysis area.

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.

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 in the analysis area.

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. BBS data from 1993–1997 show alder flycatchers east of the 27-mile bridge in 1993, but absent in all other years. A partial BBS in 2002 showed alder flycatchers to be fairly common east of Mile 17 of the highway.

Gray-cheeked Thrush. The Gray-cheeked thrush is a considered a Species of Special Concern by the state of Alaska. Isleib and Kessel (1973) state that the gray-cheeked thrush is a rare migrant and rare local breeder in the Prince William Sound-North Gulf Coast region. However, BBS data show this species to be fairly common east of Mile 30 of the highway. They have been seen in the Alaganik area in the fall.

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 analysis area (Isleib and Kessel 1973), although they have been seen near Cordova during migration.

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 were detected in spruce-hemlock/alder forest, spruce-hemlock forest, and alder habitats on breeding bird surveys conducted west of this analysis area. (Lance et al. 1996).

Mammals - The West Copper River Delta landscape analysis area includes extensive wetlands, and habitats ranging from low elevation forest to alpine. Thirty-one species of mammals were documented in the area surrounding Eyak Lake during the development of a management plan for the lake (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, not documented at Eyak Lake are probably present in the West Delta analysis area, such as the least weasel (*Mustela nivalis*), and voles, lemmings, and mice. Marine mammals found along the coast include Dall porpoises, harbor seals, sea otter, sea lions, killer whales and humpback whales (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 spring sources of herbaceous vegetation, berry patches are used during summer, and salmon streams are important to bears during summer and fall. Brown bears also make use of moose habitat where they prey on moose calves in early summer. MacCracken et al. (1997) thought brown bears to be the primary predator of moose calves. They reported, however, that the translocation of 16 brown bears from the delta in May 1987 (40-50% of the bear population) resulted in no detectable increase in calf survival or recruitment.

Brown bears have value in Alaska as both a hunted and a viewed resource. Brown bear hunting season on the west Copper River Delta (a portion of Game Management Unit 6C) runs from September 1 through May 31. Residents and nonresidents may take one brown bear every regulatory year. Although brown bears are relatively common on the West Delta, no consistent viewing opportunities for them exist.

Steller sea lion. The Steller sea lion (*Eumetopias jubatus*) is an Alaskan species of special concern and the western population is considered endangered by the USFWS. Its range extends along the rim of the North Pacific Ocean from eastern Asia, along the coast of Alaska, and south to California. Populations have declined in south-central Alaska, but are fairly stable in southeast Alaska. Steller sea lions inhabit the waters adjacent to the Copper River Delta. No sea lion haul-outs or rookeries occur nearby, however. Sea lions may occur at the mouth of Copper River tributaries and move upstream during salmon migrations.

Harbor Seal. The harbor seal is listed as a species of special concern by the state of Alaska. It occurs in Alaska along the coast from British Columbia north to Kuskokwim Bay and west throughout the Aleutian Islands. They inhabit Prince William Sound and the Gulf of Alaska, including the waters of the west Copper River Delta. Harbor seals haul out of the water periodically to rest, give birth, and nurse their pups. Reefs, sand and gravel beaches, sand and mud bars, and glacial and sea ice are commonly used for hauling sites. Seals haul-out in large numbers on sandbars at the mouth of the Copper River. Harbor seals follow spawning salmon beyond Child's Glacier on the Copper River and have been seen as far inland as McKinley Lake in the Alaganik system. Harbor seals have declined in several areas of the Gulf of Alaska and Prince William Sound since the mid 1970s. Alaska Natives, under the 1972 Marine Mammal Protection Act, may hunt harbor seals.

Mountain goat. Mountain goats use cliffs, alpine, subalpine, and old growth habitats. It is thought that winter habitat is the most limiting factor in South-central Alaska (Suring et al. 1988). They 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 mountainous portions of the analysis area.

Sitka black-tailed deer. These deer were introduced to islands in Prince William Sound in the 1930's. Deer have subsequently populated most of the islands in the Sound and portions of the adjacent mainland. Some deer probably inhabit the forested areas throughout the analysis area and use alpine habitats in summer. Deer populations in forested portions of the analysis area are thought to be of extremely low density.

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).

Previous work done by MacCracken et al. (1997) suggested a potential carrying capacity of 380 moose in years of severe winter to 1,424 in years of mild winter for the Copper River Delta. In an effort to increase moose numbers, managers have reduced the number of cow permits. The harvest of cow moose was reduced to 5 in 1995 in an attempt to reach a population objective of 400. The moose population on the west Copper River Delta has remained relatively stable through the 1990's. Preliminary results from the moose body condition study have shown Copper River Delta moose to be in excellent condition, indicating little competition for available browse at current population levels (Meyers and Logan 2002).

Moose are highly valued by the local community as a food source. In 2002, 683 local residents applied for the 20 subsistence moose permits. Moose are also important to locals and visitors as a viewing resource.

Amphibians - Three species of amphibians occur in Alaska and two of these are found in the analysis area. 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 while the western toads are generally found in open, non-forested areas near fresh water. Although declines in amphibian populations have been documented worldwide, no data exists on the status of amphibians on the Chugach National Forest.

Invertebrates - The European black slug (*Arion ater*) was probably introduced accidentally about 15 years ago and has become widespread near Cordova. The slugs are slowly working their way across the Copper River Delta. This invasion has occurred within the last 10 years. Total extent of their invasion and implications to native fauna and flora are unknown. There are native slugs in the area.

Human Dimension

Human Occupation

People have 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 A.D. (Birket-Smith 1953:20).

The Eyak were traditionally located in the Malaspina-Yakutat Forelands area and controlled territory as far east as Dry Bay. The Eyak spoke a language related to Athapaskan, which may be distantly related to Tlingit. In the late 1700s, the Tlingit expanded into the area and pushed the Eyak west into the Bering River-Controller Bay area. By the early 19th century, the Eyak had moved into the Copper River area and near what is now Cordova, forcing the Sugpiaq back into Prince William Sound (Birket-Smith and de Laguna 1938:17-18, 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, and west to Mountain Slough, Point Whitshed, and the edge of Prince William Sound.

The Ahtna was the third Native cultural group that occasionally used the area. 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).

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 Eyaks and Russians occurred sometime after Captain James Cook’s contact with Prince William Sound inhabitants in 1778. Russian posts may have been established on Eyak River and near the mouth of the Copper River during a sovereignty period that ended in 1867 (Allen 1887; Birket-Smith and de Laguna 1938:18). The Russians enforced peace between the Eyak and the Suqpiaq/Chugach, after which the Eyak expanded their territory as far north as Port Gravina (Birket-Smith and de Laguna 1938:18).

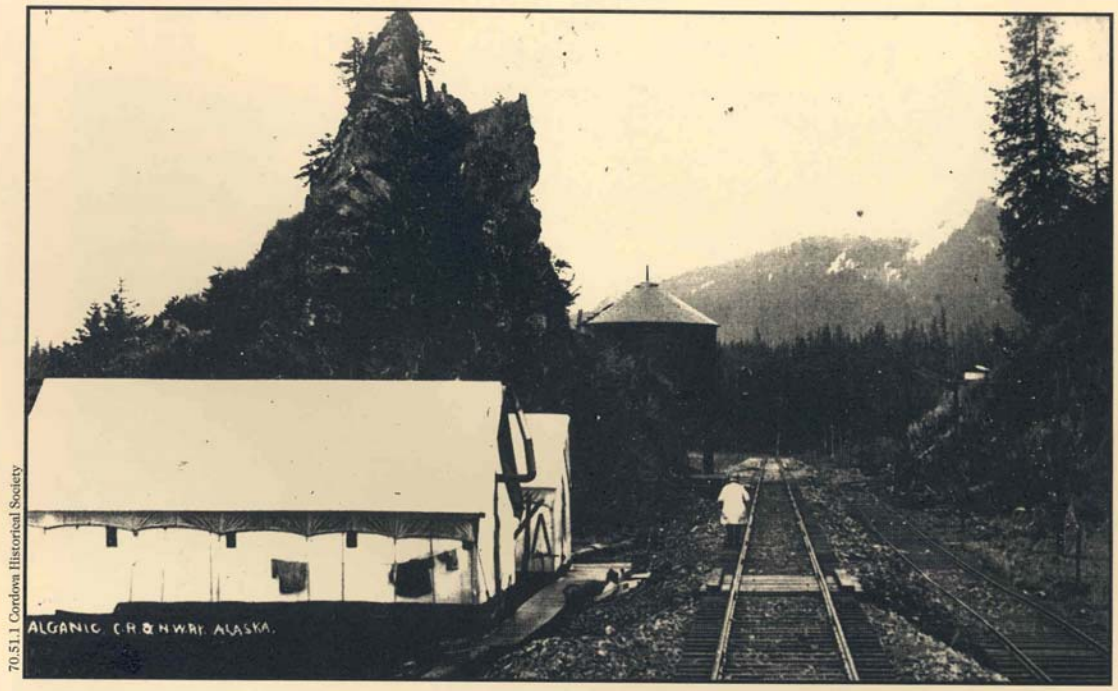
There were four Eyak villages in the Copper River/Cordova area, but only one, the village of Alaganik, is within the analysis area. Alaganik village was one of the oldest villages and was located at Mile 21 of the present day highway. Eyak settlement probably began here after 1825, when fighting between the Eyak-Yakutat Tlingit and the Sugpiaq/Chugach resulted in the Sugpiaq/Chugach giving up Controller Bay (de Laguna 1990:195). Charles Rosenburg established a trading post at Alaganik around 1890. Many gold rush prospectors stopped there before traveling up the Copper River. The villagers experienced a severe epidemic of a Western disease in 1892 or 1893, after which Alaganik was abandoned, and the inhabitants moved to the town called “tc’i˙c”, meaning “whelk”, and known as “Old Town” on the isthmus between Eyak Lake and Cordova Bay (now Orca Bay) (Birket-Smith and de Laguna 1938:18-19, 21). In 1885, Allen reported a village or camp called “Sakhalis”or “Skatalis” a few miles downstream from Alaganik that had originally been built as a Russian trading post, or redoubt, at the mouth of the Copper River.

Until the gold rushes of the 1890’s, contact between Native and Non-Native Alaskans in the Copper River ecosystem was primarily related to the fur trade. The Pacific Packing Company built the first cannery in Prince William Sound between 1897 and 1899, at Odiak near the present location of Cordova, however Native Alaskans were not employed in canneries until about 1900 (Buzzell 2001:12, de Laguna 1990:195). The discovery of oil near Katalla, and the building of the Copper River and Northwestern Railroad contributed to the destitution and decimation of the Eyak, as they were forced from their homes, overfishing destroyed their subsistence base, and alcohol addiction and epidemic diseases resulted in the death of a large part of the population. There were fewer than 20 Eyak living at Old Town, Cordova in 1920 (de Laguna 1990:195).

Prospectors found gold deposits in the analysis area in 1898 (Cordova Daily Alaskan, January 29 and December 13, 1910). Prospecting and development work continued through 1906, when “a flurry of activity began”, with over 100 claims filed by 1909 (Buzzell 2001:16). Development work on the McKinley Lake Mine continued until the early 1960s (Buzzell 2001: ii).

Cordova developed quickly in 1906, adjacent to the Eyak village of “tc’iˑc”, fueled by Michael J. Heney 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, with 30 miles of track laid by December of the same year (Lethcoe and Lethcoe 1994:63-64). These developments 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 the railroad closed in 1938 when the copper mines were depleted.

Access to the Mile 18-22 area provided by the Copper River and Northwestern Railroad allowed settlement and development of the site of the earlier village of Alaganik. The Chugach National Forest, established in 1906, issued permits for farms for fox and other fur-bearers. Track walkers and tie hackers for the railroad also lived intermittently in the area. The Pipeline Lakes and the McKinley Lake Mine trails, at Miles 21 and 22, which may have been used by the villagers of Alaganik in the 19th century, were part of the Forest’s system of maintained trails by at least 1926, when records discussed widening the existing trail.



Alaganic Slough served as a watering stop for the Copper River and Northwestern Railway which ran from 1911 to 1938.

Figure 2.22-Photo of Alaganik Slough from 2000 Cordova calendar. Courtesy of Cordova Historical Society 70.51.1

Recreation use of the area by residents of Cordova has a long history, beginning in the early twentieth century. Prior to 1938, when the Copper River and Northwestern Railroad shut down, an Interstate Commerce Commission Report noted: "during the summer months, special tourist trains have been operated between Cordova and Child's Glacier" (Pritchard 1939). The McKinley Trail Cabin, first known as the McKinley Lake Shelter Cabin, was built before 1952. Now, Cordova's tourism industry is growing at an estimated rate of 3 to 7 % annually (Christensen and Mastrantonio 1999). Visitors enjoy activities such as fishing, hunting, hiking, bird watching, mountaineering, river rafting and sightseeing.

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 watershed remain formally unevaluated for the National Register of Historic Places (NRHP). Twenty-five cultural resources have been visited and/or archaeologically surveyed in the analysis area, and twelve have been reported but not yet archaeologically verified and/or surveyed. The West Copper River

Delta Heritage Resources Report prepared by Linda Yarborough (2002) has more detailed information.

Prehistoric archaeological sites in Prince William Sound and the Copper River Delta are only known to date from within the past 4000 years, encompassing three cultural phases: Uqciuvit (about 4000-2500 B.P.), Palugvik (about 2500-900 B.P.) and Chugach (about 900-200 B.P.) (Yarborough 2000). The protohistoric period dates between A.D. 1741, when Vitus Bering made landfall on Kayak Island, and A.D. 1778, when Captain James Cook made direct contact with Native inhabitants of Prince William Sound. The historic period began in the area in A.D. 1778. The following period of time, through A.D. 1867, is characterized as the Russian Period.

The literature suggests that numerous cultural sites of a historic, and possibly prehistoric, nature are present in addition to the currently known sites. The majority of known cultural sites are historic. Only one reported site within the analysis area is possibly prehistoric. This site is named "Ikherkhamut", but its location is unverified. In 2003, cultural resource inventory work in the Mile 14 to Mile 22 area will verify the nature of additional sites. The sites noted in Table 2.9 are only those known at this time, and should not be interpreted as being the only ones in the analysis area.

This milepost stood along the Copper River and Northwestern Railway at Alaganik Slough in the 1930s pointing the way down the tracks to Cordova.

The Native sites are primarily those associated with Alaganik, the Eyak village established in the early 1800s and occupied for a little less than a century. Although Teben'kov reported Alaganik village in 1847, the earliest non-Native descriptions of Alaganik are by Jacobsen, who was collecting ethnographic materials for a Berlin Museum in 1883. Abercrombie, an explorer for the U.S. Army who visited the village in 1884, and Allen, another Army explorer, who visited the village in 1885 also described the village in their reports (Abercrombie 1900, Allen 1887, Birket-Smith and de Laguna 1938:19-21). The name Alaganik is currently associated with both the village, and an Archaeological District that includes two graveyards, a historic midden, and the Rosenburg trading post site. The CR&NW railroad right-of-way ran through the historic cemetery at Alaganik. The current graveyards are in part reburial areas, where human remains excavated by railroad building crews in the early twentieth century were reburied with Russian Orthodox crosses. The Rosenburg site buildings were burned in the 1930s by the Forest Service, but the site that includes the footprints of the buildings may contain associated artifacts, is still considered a historic archaeological site.

Table 2.9-Native Alaskan and related sites

Alaganik Village	COR-019	Eyak village reported by Teben'kov in 1847, abandoned during 1890s. Recognized as a cultural district, remains include foundation remnants of six log structures, from 4m x 8m to 5m x 22m in size; five burials in one area (COR-181); 4 burials in another (COR-180); and an historic midden area (COR-179). Site tested in 1930,1978, 1981 and 1982.
Historic Midden	COR-179	Historic midden (#1) tested in 1981 and 1982. Material collected appears to relate to late 1800s. Site is within Alaganik (COR-019).
CMT Grove	COR-283	Notched Trees reported to the Forest Service
Russian Explorers Graves	COR-023	Original card notes this as reported as graves of Russian explorers; cited report lists them as Indian graves. Probably duplicated by COR-180 AND COR-181.
Russian Orthodox Cemetery	COR-180	Cemetery area includes series of 4 Russian Orthodox graves marked by crosses & balustrades. Site within Alaganik (COR-019). Probable duplicate, along with COR-181, of COR-023.
Russian Orthodox Cemetery	COR-181	Cemetery area with five Russian Orthodox graves marked by balustrades. Site within Alaganik (COR-019). Probable duplicate, along with COR-180, of COR-023.
Rosenberg's Trading Post	COR-176	Trading post operated by Charles Rosenberg between 1890 and 1930. The USFS burned the structures in 1930s. Features include foundations of three structures (5.5m x 10m, 5.2m x 6m, 5m x 6m), an outhouse, and miscellaneous historic debris.

The heritage resources associated with the Copper River and Northwestern Railroad fall into four categories: transportation corridors, related trails and physical remains of the same; camps and living areas; structures such as bridges and trestles; and remains of transport vehicles. Two communications and transportation sites are known. Both are near the Cordova Airport. The Naval Radio Station has lost its historic integrity due to the construction of the airport, to the west (Table 2.10).

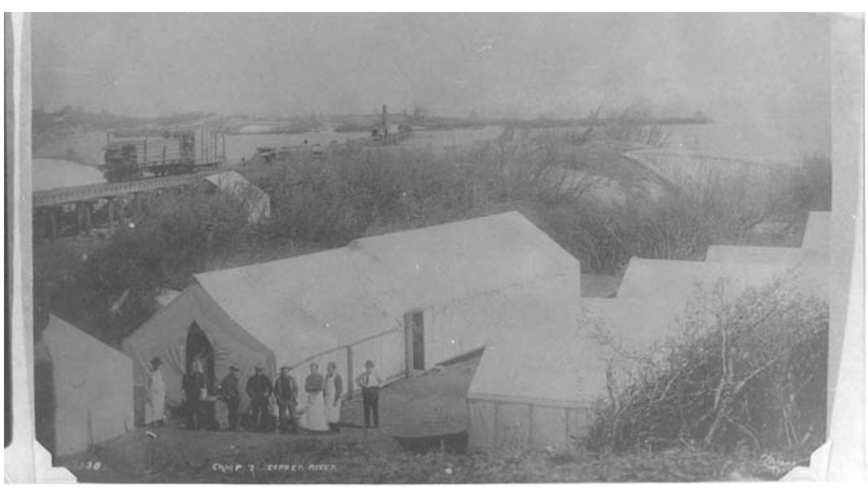


Figure 2.23- Photo from Copper River and Northwestern Railroad construction era.

Camp 7 along Copper R. Photo on file at SO, Chugach NF, Year unknown, between 1906 and 1938.

Table 2.10-Transportation and communication related sites		
Site Name	**Site Number**	**Description**
Copper River and Northwestern Railroad-related sites		
Copper River & Northwest RR	VAL-047	The railbed is a 196-mile linear feature constructed from Cordova to Kennecott between 1907-1911. By 1992 the railbed in the Valdez quad had been converted to a roadbed except for the section between the Tasnuna R. (Mile 82) & the Tiekel Station (Mile 100).
Pipeline Lakes Trail	COR-533	Historic trail, pipeline along trail used to provide water to steam locomotives of the Copper River & Northwestern Railway.
Alaganik Siding	COR-177	Rows of moss-covered railroad ties, several rails, metal debris, and moss-covered boards with metal rings attached were noted. Siding was used as a water supply station and rock quarry for the Copper River and Northwestern Railway.
CR&NW RR Ties	COR-183	A pile of about 25 railroad ties, many with metal shoes still attached, present in 1981.
Camp 30 (R.R. Maintenance Station)	COR-025	Remains of wooden foundations of two buildings (26' x 36' and 26' x 47'), the remains of a small shed, and a well, 87' north of the road. Buildings have been burned.
Alaganik Slough Bridge	COR-182	A 16'-4" x 161' curved bridge constructed during the 1940s from timbers from old railway trestles. May have been built to replace original structure.
CR&NW RR Trestle	COR-151	Remains of a wooden railroad trestle, approx. 12' long and 4' high, and a short portion of railroad grade.
CR&NW RR Debris	COR-184	A series of curved boards lying over rotted crosspieces noted in 1981. May be the remains of Copper River and Northwestern Railway rolling stock or of an unknown structure.
Communications and Transportation Related Sites		
Naval Radio Station Cordova, Hanscom Site	COR-445	The second of 3 Naval Radio Station Cordova sites. The site was built in 1917. By 1925 there was an operations & machine shop building, a powerhouse, 3 cottages, barracks, 31 1,000-gallon storage tanks on a reinforced concrete platform, a 1,500-gallon tank on blocking, & several other associated buildings & structures. Only foundations and historic debris remain at the site.
Cordova Garrison at CAA Airfield	COR-461	Civil Aeronautics Association site on municipal land west of airport.

Three heritage resources are associated with an anomalous gold deposit north of McKinley Lake, which is unique in the analysis area (Table 2.11). McKinley Lake Mine is eligible for the NRHP for its association with Dr. William Chase and its potential to yield information about the living conditions of early 20th century miners. The McKinley Lake Trail, which accesses the mine, is in part eligible for the National Register because of its association with the Civilian Conservation Corps (CCC), and also for the part it played in the transportation system of the early 20th century. The Storey Mine has not been evaluated for the National Register, but may be eligible.

Table 2.11-Mining and Related Sites		
Site Name	**Site Number**	**Description**
McKinley Lake Trail	COR-532	A 2.5 mile historic trail with FS records dating back to at least 1926; widened to provide caterpillar tractor & truck access to McKinley Lake Mine in 1927; CCC work on the trail in 1939; possibly used as early as the 19th century.
McKinley Lake Mine	COR-449	Site includes the remains of the McKinley Lake Mining company. Mine workings & debris in the area include a caved adit, two shafts, trenches, rock dump piles, remains of a ball mill, caterpillar tractors, dump trucks, a floatation unit, gasoline generators/air compressors, the remains of a shop & 4 cabins, water pipe & wire wound water pipe, an overgrown corduroy road & rail bed, pelton wheel, two bridges & associated mining debris piles & can dumps.
Storey Creek Mine	COR-451	Storey Creek Mine is composed of two adits at different elevations, the remains of a building, a Pelton wheel, a fallen cable for an aerial tram and two collapsed cabins.

Recreation in the area has been an important activity since pre-World War II days, as evidenced by documentation of tourist day trips on the CR&NW railroad to the Pipeline Lakes and McKinley Lake Trails area for people to hike and picnic. The cabin now known as the McKinley Trail Cabin, with its associated midden, located near the McKinley Lake trailhead, was built no later than the mid-twentieth century, when it was known as the McKinley Lake Shelter Cabin (Table 2.12).

Table 2.12-Historic Recreation Related Sites

McKinley Trail Cabin	COR-462	Built before 1952, the site consists of a 16'X14' log cabin with a deck on the west end. The cabin is constructed of logs with sill logs placed on a log foundation & has a gable roof with metal roofing. Logs have been painted brown and are chinked with moss. The south & east walls have windows & the west wall has a door. A few logs are deteriorating, especially on the east wall below the window. Site has a picnic table, fire grate to the south & an outhouse to the north & has been used as a public use recreation cabin at least since 1961.
McKinley Lake Cabin Midden	COR-178	Cabin (COR-462) and historic midden.

Three other sites in the analysis area have been assigned Alaska Heritage Resource Survey numbers, but have not yet been evaluated for the National Register; their association with a particular theme is not known (Table 2.13).

Table 2.13-Other Sites

Site Name	Site Number	Description
Structural Ruins	COR-531	Three structural ruins, corrugated metal, can dump, cache pit, outhouse hole, fence posts.
McKinley Lake North Cabin	COR-463	A habitation site with deteriorated remains of a cabin with only two courses of logs remaining. No architectural or construction features can be determined by the current remains which are extremely weathered. No roof or floor remains.
Rex Beach Cabin	COR-018	Cabin site of Rex Beach, author of The Iron Trail; structure may no longer exist.

Eight additional mining related sites, a cannery related site, and a Native hunting site have been reported or documented historically in the analysis area, but their locations are not yet confirmed and their condition, integrity and significance is unknown (Table 2.14).

Table 2.14-Reported but unconfirmed sites in the analysis area

Site Name	Cultural Period
Seal Camp	unknown
Cannery Settlement	historic
Bear Creek Mine	historic
Riley Group Prospects	historic
Ibeck Creek (mine)	historic
Green Top (prospect)	historic
Flynn & Scott (prospect)	historic
Kelly & Macormack (prospect)	historic
Northern Scott Glacier (prospect)	historic
Scott Glacier (prospect)	historic

At this time, none of these sites are interpreted for the public. Interpretive signs for McKinley Lake Mine will be installed by June 2003, and a brochure will be available. The adits and shafts at McKinley Lake Mine have been made safe through a cooperative project carried out by the Cordova Ranger District, and the State of Alaska Department of Lands and Minerals and Office of History and Archaeology.

Minerals and Mining

The U.S. Geological Survey assessed the mineral resource potential of the Chugach National Forest for the Forest Plan Revision (Nelson and Miller 2000). The report strictly focused on locatable mineral resources. It did not cover leasable resources such as coal, oil, or gas, or salable resources such as common variety rock, gravel, and sand. According to their report, most of the analysis area lacks geologic criteria indicating potential for resources, contains resources not addressed in the report, or contains deposits having a low probability of future development activity. There are two tracts within the analysis area that were identified and determined to have mineral resource potential, and they are briefly discussed below. The West Copper River Delta Geology and Minerals Resource Report (Huber 2003) provides additional detailed information.

Copper River Addition Tract- The mineral estate within the ANILCA Copper River addition (801,600 acres) to the Forest is withdrawn from operation of the mining laws, but is available under the leasing laws (ANILCA Sec. 502). The small portion of the Copper River Tract in the analysis area is displayed as “National Forest Addition” in Figure 1.2 on page 3. It is mostly overlain with ice. Outside of the National Forest, mineralized belts containing Cyprus-type deposits and both Chugach-gold and placer gold deposits, including mines and prospects trend east into this tract (Nelson et al. 1984). Based on the presence of favorable geologic units, known mineral occurrences, geochemical anomalies, and geophysical data, the mineralized belts likely continue into this tract making it highly favorable for containing undiscovered resources.

McKinley Peak Tract - This tract contains identified gold resources and has been rated as having moderate potential for development of Chugach-type gold deposits. The McKinley Lake mine (Figure 2.24) and several prospects are contained within this tract (Haney and Jansons 1987). Production from this mine was minor at only 16 ounces of gold.

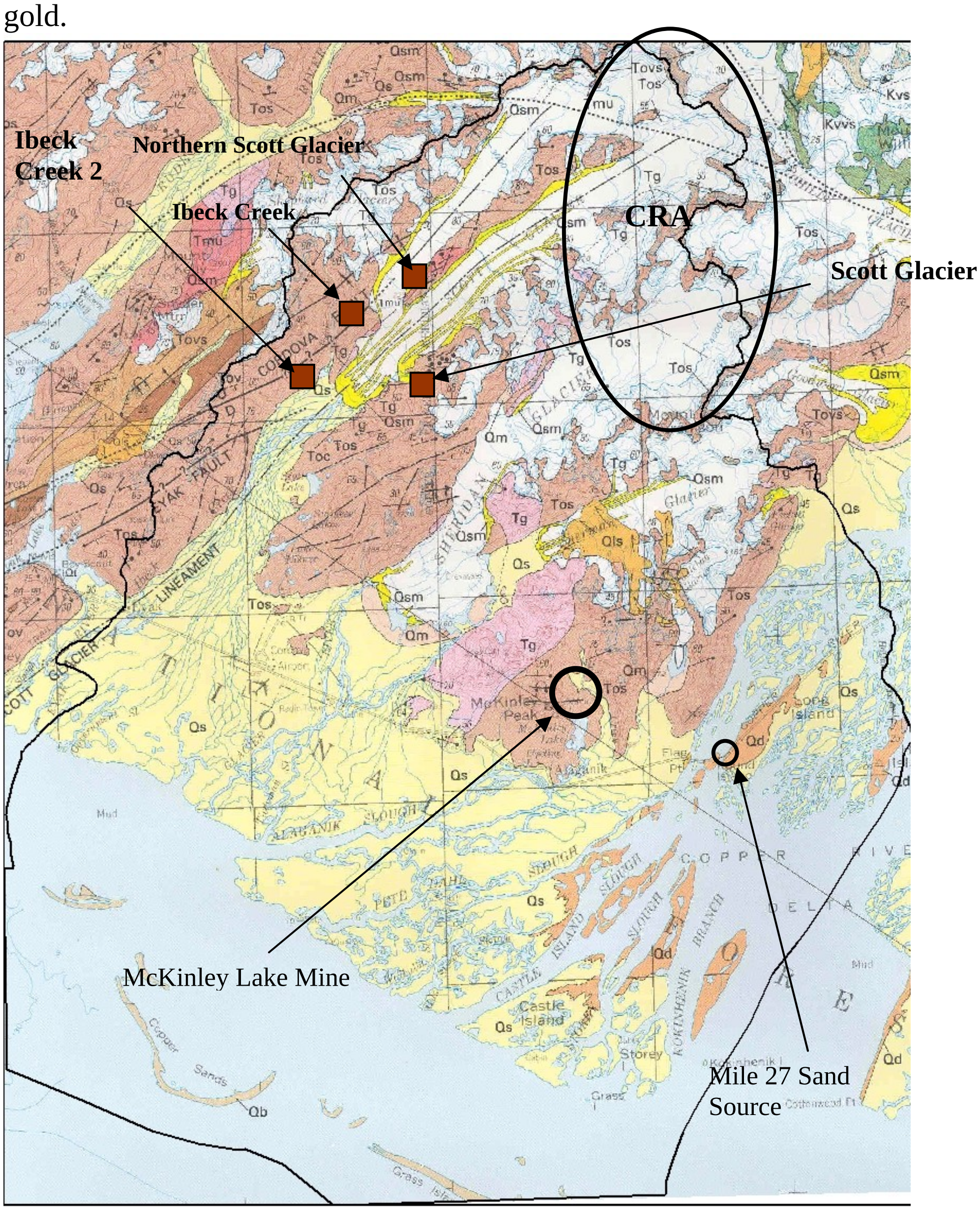


Figure 2.24-Location of mineral resources with geologic map of the West Copper River Delta Landscape Analysis Area. From Winkler and Plafker, 1993.

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

Locatable minerals. The Orca Group rock is known to host copper and massive sulfide deposits throughout Prince William Sound region. There are four massive sulfide occurrences (Jansons et al. 1984) along Scott Glacier, as shown in Figure 2.24. Of the minerals identified in these occurrences, copper is of the primary interest. One of the four is reported to have an 80-foot adit; no production has occurred. A discussion of each follows:

1. The Northern Scott Glacier occurrence is a red-stained outcrop in slates and greenstone. The U.S. Bureau of Mines rated it as having low mineral development potential for zinc.

2. The Scott Glacier occurrence consists of sulfide lenses and disseminations in rock and shear zones. The U.S. Bureau of Mines rated it as having moderate mineral development potential for copper, zinc, and silver.

3. The Ibeck Creek occurrence is a 14-foot wide shear zone in greenstone containing small lenses and dissemination of sulfide minerals. An 80-foot adit was reported. The U.S. Bureau of Mines rated it as having moderate mineral development potential for copper, zinc, lead, and silver.

4. The Ibeck Creek 2 occurrence is a red-stained greenstone outcrop with disseminated pyrite. There are no workings. The U.S. Bureau of Mines rated it as having low mineral development potential for zinc.

Gold occurs at one small locality near McKinley Lake and McKinley Peak. The Copper River Addition portion of the analysis area is also favorable for undiscovered copper and gold resources (Nelson and Miller 2000).

The McKinley Lake area (Figure 2.24) is underlain by slate and greywacke of the Tertiary Orca Group, which is intruded by a biotite granite pluton some 2 miles northwest of McKinley Lake. The pluton is nearly 2 miles wide and extends at least 5 miles along a N50-55^{o}E trend. At the granite-slate/greywacke contact, the intruded rocks have been metamorphosed to the albite-epidote hornfels facies. Hydrothermal alteration of the granite is common and widespread.

The U.S. Bureau of Mines reports 4 prospects in the McKinley gold district (Jansons et al. 1984). Most of the past mining activity occurred at the McKinley Mining (Pioneer) group that had 1,410 feet of workings and the Lucky Strike group that had more than 1,097 feet of workings. Altogether, there were 17 adits, crosscuts, and drifts reported with at least 2,540 feet of workings. The Storey Creek adit was the largest single working, containing 585 feet of crosscut and 157 feet of drifting. The lower McKinley adit was next at 564 feet. A map displaying these workings is located in the West Delta Geology and Minerals Resource Report (Huber 2003).

Only the Lucky Strike and McKinley Mining group of workings continuously reported gold in assays over the years of prospecting, but the values were not consistent or reproducible. Richelson (1934) noted, “It is not quite understood how such encouraging assay returns are obtained unless the samples are ‘picked’ for they certainly do not indicate the general run of the ground”. Haney and Jansons (1987) investigated the area in 1980 and did not find any economic gold-bearing zones during their fieldwork or any economic gold concentrations in any of the samples analyzed.

Although historically many mining claims have been staked in the McKinley Lake area, currently, no recorded mining claims, either placer or lode, exist in the analysis area. One recent mining claim, McKinley Lake #3 was located May 20, 1992 by David C. Brookens and was subsequently forfeited September 1, 2002. The decision was issued by BLM on November 7, 2002. The claim no longer exists.

Leasable minerals. There is no known potential for oil and gas, coal or any other leasable mineral deposits within the analysis area. The Tertiary Orca Group has no hydrocarbon potential (Bruns 1996, Plafker et al. 1987). However, the Copper River Addition (CRA) portion of the analysis area is closed to mineral entry and minerals that are normally locatable (on lands open to mineral entry) become leasable on “acquired” lands such as the CRA. The CRA is considered to have high potential for undiscovered resources of gold and copper.

Salable minerals. Sand and gravel resources are abundant in the analysis area and along the highway corridor. Sand and gravel has been used from National Forest, State, and private lands. Rock for shot rock or riprap is not abundant along the road corridor. While good quality clay for low-temperature firing for pottery occurs east of the Copper River, this quality of clay is not known to occur in the analysis area.

The Mile 27 common-use sand source is along the Copper River Highway on tidal flats in the upper Copper River Delta (Figure 2.25). The deposit consists of unvegetated fine-grained, well-sorted, wind-blown sand (Figure 2.26). Sediments are primarily fine-grained; over 90% by weight are particles less than 0.1 millimeters. It is particularly well suited to making asphalt pavement since it can be used as is, with no processing required. With the high winds blowing down the Copper River continually replenishing the sand, this deposit can be considered a renewable resource.

There is currently a request for a permit for sand from this source. The sand would be used for making asphalt for road repairs and driveways in Cordova. Recent sales that have occurred this site are: 1990 to Wilson Construction, 1993 to Gunnerson Construction, 1996 to Summit Paving, and 1998 to the Alaska Department of Transportation. Stipulations for the permits included among other requirements, that no stripping of vegetative material is allowed and the area must be recontoured after excavation. There are other sources of this material along the highway. One such site, similar in quality to the Mile 27 site is located on private land at Mile 16.

Figure 2.25- Location of Copper River Highway Mile-27 Sand source

Figure 2.26- Overview of Copper River Hwy, Mile 27 sand source. Photo by Carol S. Huber, 1994.

Roads

The analysis area contains approximately 11.2 miles of Forest Service System roads, 20 miles of State Highway # 10 (Copper River Highway), a 1.5-mile city maintained road accessing the landfill and many miles of abandoned logging roads on private lands. The Copper River Highway is 48 miles in length and provides the primarily access through the analysis area. After traversing the Scott, Sheridan, McKinley and Copper River Delta West watersheds, the highway terminates in the North Copper River/Tasnuna River watershed at the Million Dollar Bridge. It was established in the early 1950's using the abandoned Copper River Northwest Railroad bed.

Most of the private roads, except those that provide access for Eyak shareholders and homesite allotments have been closed to vehicles. Bridges and culverts have been removed and barriers installed. These roads are generally constructed to low to moderate standards and are surfaced with native gravel.

The six Forest Service System roads within the analysis area range from 0.1 to 4.1 miles in length. A description of each follows:

Cabin Lake Road - is a narrow, two lane, native gravel surfaced road. It begins at Mile 13 of the Copper River Highway and goes in a northerly direction for 2.7 miles. The road originally accessed a day-use area, campground, and trailhead. When the Eyak Native Corporation selected the lands in this area, the road was retained as an easement. The campground and day-use site no longer exist. The road accesses the Lake Elsner site easement /trail head. This site easement is designated as a staging area for preparing to access public lands. Visitors using the site for recreational activities must obtain authorization from the Eyak Native Corporation.

Sheridan Glacier Road - is a two lane, native gravel surfaced easement road that starts at Mile 14 of the highway and travels northeast for 4.1 miles where it ends at the Sheridan Mountain site easement/trailhead. This site also used to be a day-use area prior to Native land selections. Easement regulation prohibits activities that are not directly related to accessing public lands. This area is designated as a staging area for preparing to access public lands. Anyone participating in recreational activities on the site needs authorization from Eyak Native Corporation.

Alaganik Slough Road - is a narrow, two lane, native gravel surfaced road 3.2 miles long. It starts at mile 16.8 of the highway and travels southeast to the Alaganik Slough Day-use area. Recreation activities include; fishing, hunting (big game & waterfowl), wildlife viewing, cross-country skiing, snow machining, picnicking & boating. A portion is an easement across Eyak Native Corporation land.

Mile 18 Roads - are located at Mile 18 of the highway and access two very small day-use sites. Together they consist of 0.1 miles of one lane graveled road. Recreational opportunities consist of picnicking, fishing, and wildlife viewing.

Mile 22 Day-Use Area - is located at mile 22 of the highway and consists of a 0.1-mile long road, a parking area, a day-use area, and a boat ramp. The two-lane road has a native gravel surface. Recreational opportunities include fishing, boating, and picnicking.

Saddlebag Glacier Road - is a narrow, two lane, native gravel surfaced road 1.0 mile long. The road starts at Mile 25 of the highway and extends north to a woodcutting area and the Saddlebag Glacier Trailhead. Recreational opportunities include hunting (big game), hiking, mountain biking, camping, wildlife viewing, cross-country skiing, and snow machining.

Recreation Facilities and Use

Recreational developments within the West Delta analysis area include; trails, easements, public recreational cabins, developed interpretive and day-use sites, boat ramps and accessible wildlife viewing platforms. 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. Figure 2.27 displays the location of the recreation facilities across the delta.

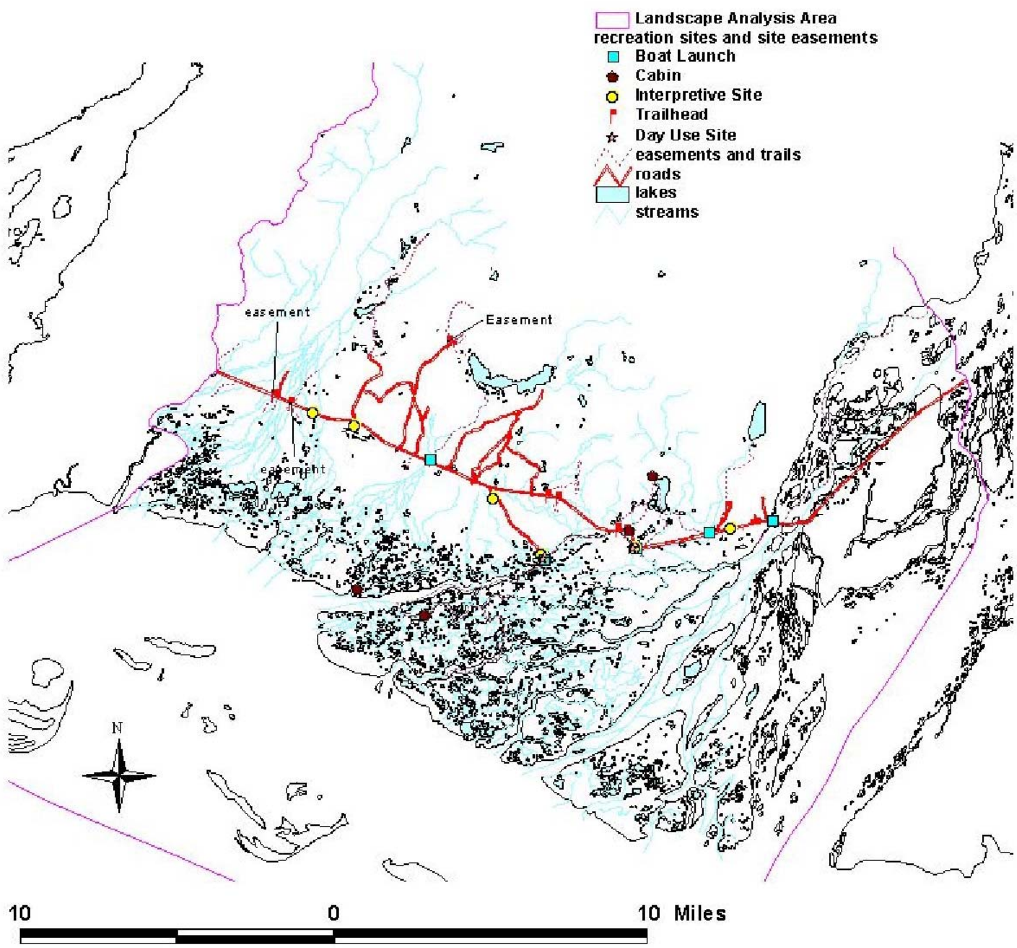


Figure 2.27 – Trails, cabins, and developed recreation sites in the analysis area

Boat Launches – The <u>Alaganik Slough Boat Launch</u> is a component of the Alaganik Slough Day Use Area located at the south end of the Alaganik Slough Road. Date of construction is uncertain but was prior to 1984. The ramp consists of concrete slabs linked together by hooks and eyes. The boat launch provides access to Alaganik Slough and is used for a number of activities such as: hunting big game and waterfowl, sport and subsistence fishing, accessing public recreation cabins and special use cabins, and boating. Use levels are moderate to high from June through October and low the rest of the year. For a number of reasons, some understood – other not, the riverbed at the end of the ramp is becoming shallower. At low tides the lack of water depth causes problems when launching boats. This is a critical access point to the delta and a solution is needed.

Mile 22 Boat Launch is part of the Mile 22 Day Use Area. No major development or expenditure of funds has been dedicated to this boat launch, however a Capital Improvement Project (CIP) proposal is being submitted in 2003. The upper portion is surfaced with gravel while the lower consists of sand. Many visitors go upstream towards McKinley Lake while others use the boat launch as a put-in to travel downstream to the Alaganik Slough boat launch. Recreation activities consist of fishing, hunting, boating, and accessing a public recreation cabin. Recreation use is moderate to low from June through September and low for the remainder of the year.

Cabins - Pete Dahl Cabin is located 0.9 miles up Pete Dahl Cutoff on the east side. The Cutoff branches off Alaganik Slough about six miles downstream from the Alaganik Slough Boat Launch. The cabin is 12’ by 14’ of standard stick- frame construction, with an oil stove, and sleeps 6. It is accessible by floatplane at high tide (about 10 minutes from Cordova) or by boat. Use fees are $25.00/night. The cabin is unavailable for public use April 1st through August 31st due to administrative use. Recreation opportunities include waterfowl hunting, camping, and viewing wildlife and scenery.

Tiedeman Slough Cabin is located on the east shore of Tiedeman Slough, approximately 150’ north of the confluence of Tiedeman and Alaganik sloughs. Tiedeman Slough is about 1.5 miles downstream from the confluence of Pete Dahl Cutoff and Alaganik Slough. The Pan Abode cedar log cabin is 12’ by 14’, sleeps six, and has an oil stove. Accessible by floatplane at high tide (about 10 minutes from Cordova) or boat, the cabin is available year-round for$25.00/ night. Recreational opportunities consist of hunting waterfowl and viewing wildlife and scenery and use is low.

McKinley Lake Cabin is located on the northern end of McKinley Lake at the end of the 2.4 miles long McKinley Lake Trail. The cabin was impounded in 1970 from an illegal mining operation. The cabin was renovated in1988 with a new roof, deck, windows, interior, and a wood stove. It is a 14’ by 20’stick frame style cabin that sleeps six people. It is available year round for $35/night and can be reached by the McKinley Lake Trail, by floatplane (about 10 minutes from Cordova), or by boat via Alaganik Slough and McKinley Lake. Boat access is usually during periods of high water (June thru September). Recreational opportunities include hunting, fishing, viewing wildlife and interpretive education at the Lucky Strike Mine site. Recreation use is low.

McKinley Trail Cabin is located at the beginning of the McKinley Lake Trail, approximately 80 yards from the trailhead at mile 21.6 of the highway. It is a traditional log cabin built prior to 1950. Forest Service crews renovated the cabin in 1987 (new roof, deck, interior and a wood stove installed). The cabin sleeps six, is available year round, and rents for $35/night. The cabin’s current condition is poor and is scheduled for replacement in 2004. It will be replaced with a universally designed Pan Abode cedar cabin. Its proximity to the road makes it highly desirable for families and groups (girl &

boy scouts). Recreation opportunities include hunting big game and waterfowl, fishing, and hiking. Recreation Use is moderate.

Developed Recreation Facilities – The Delta Entrance Pavilion is located at Mile 10.7 of the highway and provides interpretive information to visitors as they enter the National Forest System lands. The pavilion was built in 1990 as part of the Copper River Delta Interpretive and Recreation Project. Recreation use is moderate and opportunities include interpretive education and viewing scenery and wildlife.

Airport Interpretive Display is located at the Merle K. (Mudhole) Smith Airport at Mile 12 of the highway. The display was installed in 1987 and 1988. It provides a basic overview of how the Cordova Ranger District is managed and a map of the Copper River Delta showing developed and dispersed recreation sites. Use is high.

Alaganik Day-Use Area is at the end of the Alaganik Slough Road that branches off the highway at Mile16.9. The site consists of five picnic sites, an information kiosk, and a double vault toilet. Other amenities in the immediate area include: the Alaganik Slough Boardwalk, the Alaganik Anglers' Trail and the Alaganik Slough Boat Launch. The site was developed as an alternative access point for the delta and barrier islands in the late 1960's after the 1964 earthquake nullified existing access points. Recreation opportunities include picnicking, fishing, and viewing wildlife and scenery. Recreation use at the site is considered moderate to low.

Mile 18 Day-Use Area consists of two small day-use sites (two picnic tables each) on separate ponds. Each site has its own access road, parking area, and toilet (outhouse w/vault). The area was used as a gravel source during the 1990 Copper River Delta Interpretive and Recreation Project. The Fisheries Staff worked with the Engineers to plan the gravel extraction in a way that would make the future pond more natural looking. This "more natural look" was achieved by designing an island in the middle of the lake. As a result, the site is known as One-Eyed Pond. Recreation opportunities include fishing, picnicking, and viewing wildlife and scenery. Recreation use is low.

Trails – Lake Elsner Trail is a 6.1-mile trail easement through Eyak Native Corporation land located at the end of Cabin Lake road. The trail was built in 1934 as 3.7 mile loop trail to Lake Elsner with a 2.15 mile extension to Siamese Lakes. In the 1980's, the Eyak Native Corporation selected these lands under the Alaska Native Claims Settlement Act (ANSCA). After the lands were conveyed to the Native Corporation, the trail has been managed as an easement to public lands rather than a recreation trail. The loop section of the trail was eliminated and the main trail extended to provide access to public lands east of the Scott River drainage. The first mile is maintained to the Class III level (Developed /Improved), the remainder is maintained at the Class I level (Primitive\Undeveloped). Recreation use is low.

Sheridan Mountain Trail is located at the end of the Sheridan Glacier Road. The trail is 3.1 miles long and is an easement through Eyak Native Corporation lands. The trail was built in 1934 and was originally 1.9 miles long. After the surrounding lands were conveyed to the Eyak Native Corporation under ANSCA, the trail was managed as an easement rather than a recreation trail. In 1994, the trail was extended 1.2 miles into the alpine by Raleigh International volunteer crews. Unlike most easements, this trail is managed at the Class III level. Due to its current condition, a Deferred Maintenance CIP proposal has been submitted and is scheduled for 2005 and 2006. Recreation use is low. This trail provides opportunities for hunting, camping, and viewing scenery and wildlife.

Muskeg Meander Trail is located on the north side of the highway at Mile 18.6. The 3.1-mile cross-country ski trail was constructed in 1989. Recreation opportunities are limited to skiing and viewing scenery. Recreation use is low due to the fact that the trail was designed as a winter use only trail and maintaining adequate snow depths is hampered by the maritime climate.

Haystack Trail is located on the south side of the highway at Mile 18.8. The Forest Service with International and Appalachian Mountain Club volunteers built this 0.8-mile trail in 1990 and 1991. Work included installing planking on 0.4 miles of eroded trail tread. The trail travels south along a geologic formation called a "haystack" and provides hikers with a rare elevated view of the delta. Recreation opportunities include: hiking, hunting, and viewing scenery and wildlife. Hikers of all ages use the trail and use is high. The trail is maintained at the Class III level.

McKinley Lakes Trail is located on the north side of the highway at Mile 21.6. The Lucky Strike Mining Company began constructing this trail in 1927, and the Forest Service finished it in 1934. It is 2.4 miles long and ends at the north end of McKinley Lake. The McKinley Trail cabin is located at the beginning of the trail and the McKinley Lake cabin is located at the end. Recreation use is moderate, and opportunities include: hunting, camping, historical education, and viewing scenery and wildlife. Maintenance is at a Class III level.

Pipeline Lakes Trail is located on the north side of the highway at Mile 21.4. The trail was originally a route for a pipeline that supplied water for steam locomotives operating on the Copper River & Northwestern Railroad in the early 1900's. Today, the trail is 1.8 miles long and accesses all five of the Pipeline Lakes. It loops around and joins the McKinley Lake Trail about midway along that trail. In 1998, the Cordova District Fisheries and Recreation personnel reconstructed the existing trail and began building access spurs to individual lakes. Work is to be completed in 2003. The trail passes through forests, muskegs, and by lakes providing hunting, berry picking, fishing, and scenery and wildlife viewing opportunities. Maintenance is at the Class III level and recreation use is moderate.

An abandoned section of trail that could provide a second loop option is an excellent deferred maintenance trail reconstruction project. This abandoned spur has not been maintained and is not included on the District's trail inventory. In the past, people could hike the Pipeline Lakes trail to the first group of ponds and take this spur back to the road. This section would cut the return hiking time in half and provide an excellent loop trail opportunity.

Saddlebag Glacier Trail is 3.1 miles long and located at the end of a short road at Mile 25 of the highway. This easy-going trail winds its way through cottonwood and spruce forests and ends at the outlet of Saddlebag Lake gaining approximately 100 feet of elevation. The last 1.5 miles was completed in 1992 by a group of international volunteers. Recreation opportunities consist of hunting, mountain biking, cross-country skiing, snow machining, and scenery and wildlife viewing. Maintenance is at a Class III level and recreation use is low.

Alaganik Slough Boardwalk is part of the Alaganik Slough Day Use Area at the end of the Alaganik Slough road. The 900-foot long boardwalk was constructed in 1993 and 1994 by Forest Service crews, two groups of international volunteers, and four Appalachian Mountain Club volunteer crews. There is a 100-foot spur with an enclosed viewing structure near the beginning and an elevated viewing platform at the end. Interpretive signs are provided. Recreational use is moderate to high and opportunities consist of viewing wildlife, birds, and scenery. Maintenance is at the Class V level.

Mile 25 Fish Interpretive Trail is located on the south side of the highway at Mile 25. This 0.1-mile trail was built in 1987 in conjunction with a stream rehabilitation project. Streambanks were armored, streambeds were resurfaced with more favorable sized spawning gravel, plunge pools were created, and artificial shelter structures were constructed. Interpretive signs explaining the need and benefits of the project were erected at two sites. The trail parallels the stream offering views of the various structures and has a log bench at the end. Recreational use is low and opportunities consist of viewing scenery and wildlife and reading the interpretive signs. The trail is maintained at a Class III level.

Alaganik Anglers' Trail is located on Alaganik road about 100 yards north of the Alaganik Slough Day Use Area parking lot. The trail is roughly 0.4 miles long and was jointly constructed by Cordova District Fisheries and Trails crews in 2002. The first half of the trail is made from Geoblock, a plastic product, laid on the ground. The second half of the trail is 2" x 12" pressured treated planks placed on the ground. The District is testing Geoblock as an alternative trail surface material. This route has been used for many years to access fishing sites on Alaganik Slough and 18 Mile Creek. Because of the fragile nature of these wetlands, establishing a hardened trail surface was the only way to mitigate the escalating resource damage. Even though the purpose is to provide access to sport fishing sites, the completion of the overlook at the end of the trail may attract other users besides anglers. The maintenance is at the Class III level. Recreation use is high during August and September, but low for the remainder of the year.

Unofficial Sites - Mile 16 Pond has no developed structures aside from the 40-yard access road to the pond. Groups of all sizes (church camps, science camps, summer camps and families) use the site for picnicking, boating, pond ecology studies, and swimming.

Mile 20 Angler's Trail originates just east of the fishing hole and pullout at approximately Mile 20 of the highway. The trail was created by people fishing 20 Mile Creek and parallels the creek to the south for approximately one mile to Alaganik Slough.

It is rapidly showing signs of over use and will need the same attention as the Alaganik Anglers' Trail.

Mile 28 Swimming Hole is a natural sinkhole in the sand dune country just east of the 27 Mile Bridge filled throughout the summer by melting snow drifts. The site has a clear and level area that provides parking but no developed structures. Mothers and children are the primary users of the site during the summer. Peak use days have a dozen vehicles and 30+ people.

Easements

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 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 use allowed on 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 3,000 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. Trails however are not placed to normal Forest Service Standards. No tread is developed on trail easements. They are normally cleared with chainsaws to a six-foot wide corridor with an 8-foot high clearing limit. 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.

Some trail easements coincide with pre-existing trails. Table 2.15 lists the eleven trail easements, nine site easements, and five road easements in the analysis area and Figure 2.27 displays the location of the easements. In 1998, the *Exxon Valdez* Oil Spill Trustee Council negotiated a purchase agreement that included fee simple purchase of approximately five sections within the analysis area. The comments section indicates those easements located on those acquired lands.

Table 2.15-Easement trails and sites within the West Delta analysis area		
Name	**Easement ID Number**	**Length (miles)/ comments**
Trail Easements		
North Ibeck Creek Tr.	EIN 120 GD9	1.4 mi,. Fee Simple acquisition
Lydick Slough Tr.	EIN 139 GD9	1.3 mi., Fee Simple acquisition
East Ibeck Creek Tr.	EIN 121 G	1.8 mi., Fee Simple acquisition
Sand Road Tr.	EIN 141 GD9	0.6 mi., Fee Simple acquisition
SW Scott Glacier Slough Tr.	EIN 124GD9	0.5 mi., Fee Simple acquisition
SE Scott Glacier Slough Tr.	EIN 126GD9	0.3 mi., Fee Simple acquisition
Lake Elsner Tr.	EIN 131G	6.1 mi.,
Sheridan Glacier Face Tr.	EIN 133aG	1.2 mi.,
Sheridan Lake Tr.	EIN 133bG	0.7 mi., Considered for relinquishment
South Pit Rd Tr.	EIN 135aG	0.2 mi.,
Road Easements		
Cabin Lake Rd.	EIN 129aGD9	1.7 miles/easement 2.7 miles total length
Sheridan Glacier Rd.	EIN 132G	2.9 miles/easement 4.1 miles total length
Gravel Rd.	EIN 134C	.5 miles/easement .5 miles total length
Sheridan R. Boat launch Rd.	EIN 134 aGE	.1 miles/easement .1 miles total length
Alaganik Rd.	EIN 305 C4	.2 miles/easement 3.2 miles total length
Goat Camp Rd.	EIN 135G	3.7 miles/easement 3.7 miles total length
Site Easements **		
North Ibeck Creek Site	Ein 120 aGD9	Fee Simple acquisition
East Ibeck Creek Site	EIN 121aG	Fee Simple acquisition
Sand Road Site	EIN 141aGD9	Fee Simple acquisition
SE Scott Glacier Sl Site	EIN 126aGD9	Fee Simple acquisition
Cabin Lake Site	EIN 129GD9	
Sheridan Glacier Site	EIN 132aG	
Sheridan Lake Site	EIN 133cG	Considered for relinquishment
Gravel Rd. site	EIN 134b	
Sheridan R. Boat launch	EIN 134 GE	

** Note: All site easements are between .5 and 1.0 acres in size.

Special Uses

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

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 Alaganik Day Use Site and the 22-mile boat launch.

Cordova Coastal Outfitters (COR7) - The permit authorizes activities in many locations and includes commercial interpretive sightseeing, photography, hiking, and sight-seeing opportunities at Haystack, McKinley Lake, Pipeline, and Saddlebag Glacier trails as well as use of uplands along Alaganik Slough.

Alaska River Rafters (COR6) - In addition to commercially guided river rafting, this permit holder is authorized occasional day hike use of the Haystack, McKinley Lake, and Saddlebag Glacier trails. The permit holder takes out rafts at the Sheridan River boat launch easement.

Camp AlaskaTours (GLA23) - The permit authorizes activities in many locations and includes commercial interpretive sightseeing, photography, hiking, and sightseeing opportunities at Haystack, McKinley Lake, Pipeline and Saddlebag Glacier trails as well as use of uplands along Alaganik Slough.

Native Sun Charters and Copper River Tours (COR 50) - This jetboat sightseeing operation will be issued a permit in 2003 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.

Chapter 3 – Issues and Key Questions

Additions to Wildlife issues and key questions were made in April 2007.

Physical

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. What effects does the Copper River Hwy, its bridges, and associated levees have on channel morphology, sediment deposition, and the timing of flood flows on the glacial channels throughout the West Delta, and what effects do flood events and channel migration have on the highway?
   - *See hydrology sections in Chapter 2 and Chapter 4.*

3. How do glacial recession and glacial processes affect streamflows, channel and valley morphology, and water quality throughout the West Delta? How do these changes affect management of the West Delta?
   - *See hydrology and geology sections in Chapter 2 and Chapter 4.*

4. What is the erosion potential in the analysis area, in particular in areas where construction of trails is being considered, development proposed and human use is occurring? The concern also includes resource damage associated with the increased use of unofficial trails to fishing spots, off-road vehicle use in muskegs, and bank erosion caused by airboat and jet boats.
   - *See Chapter 4 for discussion.*

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). 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(s) will occur.*

Fish

1. Maintain quality of spawning and rearing habitat and water quality for anadromous and resident fish in the primary streams and lakes of the area.
   - *There is concern about bank stability in high use sport fishing areas – is erosion and bank trampling affecting juvenile salmonid rearing habitat?*
   - *Identify and estimate the amount and condition of key spawning, rearing, and overwintering habitat for coho and sockeye salmon, cutthroat and Dolly Varden trout.*

2. What is the status of coho salmon, cutthroat and Dolly Varden trout in the primary fish bearing streams and lakes in the analysis area?
   Coho Salmon:
   - *Sport harvest – how many fish are being harvested and how much use is occurring on the West Delta?*
   - *Establish a reliable means to estimate escapement numbers of adult salmon.*
   - *Use of the lower Delta/Estuary areas by juveniles as rearing habitat.*

   Sockeye Salmon:
   - *Genetics – is there any impact of upper Copper River hatchery fish on wild populations on the Delta?*
   - *Varying life histories of juveniles and the effect on productivity. What factors influence life history strategies? Is there an association between life history patterns and channel type morphology or other subwatershed characteristics?*
   - *Habitat use of the lower Delta/Estuary areas by juveniles as rearing habitat.*

   Cutthroat Trout and Dolly Varden:
   - *Sport harvest – how many fish are being harvested, how much use is occurring on the West Delta?*
   - *Population estimates and seasonal use in the different systems.*
   - *What extent does sport fishing target cutthroat and Dolly Varden trout in the analysis area and what are the potential impacts to these species?*
3. Are all culverts passable to all life stages at all times of the year?
4. What are the impacts of the gravel pit ponds – are they creating fish habitat for the key species?
5. What is the mortality associated with catch and release fishing for the different species and the different gear types being used by anglers?

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 is low in the analysis area. See Chapters 2 and 4 for further discussion.*

3. Should the Forest supply sand and gravel along the highway corridor to meet local demands?
   - *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.*

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, for conditions and trend of recreation facilities.*
2. Impacts of Recreation use – Off-road vehicle use, especially in muskegs and sport fishing use across delta for coho salmon
3. There are two access routes to Sheridan Lake; only one needs to be retained. Ensure the one skaters use is retained.
4. Any concerns about snowmachine use in winter for ptarmigan hunting and recreation? Any opportunities?
5. Concerns about impacts of airboat and jet boat use.
6. Concern about Alaganik boat launch – cannot launch boat at low tide because sand build up does not allow trailer to get deep enough to float a boat, unless it is a very small boat. Can it be improved?
7. Any concerns about golfing and 4-wheeler's on dry Scott River bed sand at 7.5 mile? Any opportunities?
   - *The golfing occurs on both private and public land. The use is not consistent with the allowed use of the easement.*
8. Is there an opportunity for another campground on the delta closer than Childs Glacier?
   - *In the Childs Glacier EA, it was decided to encourage development of additional facilities on Native Corporation lands. Providing some limited overnight opportunities is being considered in the One-Eyed Pond site plan.*

Research Natural Area (RNA)

1. What are the management implications of establishing the Copper Sands RNA?
   - *The 1,500-acre Copper Sands area was proposed as an RNA to represent a barrier island environment. The revised Forest Plan (USDA Forest Service 2002b) direction emphasizes non-manipulative research, monitoring, education, and the maintenance of natural diversity, allowing natural physical and biological processes to prevail without human intervention. Recreation uses that interfere with the purpose of the RNA may be restricted. No roads, trails, fences, or signs are allowed unless they contribute to the objectives or the protection of the RNA.*

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?
   - (river rafting, hiking, bus tours...)
2. There is a concern about outfitter & guides using airboats and jet boats.
3. There is concern about the illegal guiding for coho salmon sport fishing taking place on the Delta. These activities take place all summer, but primarily in August and September.

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 200X). Refer to Chapter 4, Vegetation section.*
3. Can the Forest Service meet the demand for houselogs and firewood with limited areas of large trees considering the primary goal is conservation of fish and wildlife habitat?
   - *Once airport timber is gone, it may be difficult to provide large diameter trees from accessible National Forest System lands on the Delta to meet demand. Refer to Chapter 4.*
4. How is the vegetative composition on the delta going to change over time?
   - *Refer to Develice et al. (2001), Boggs (2000), and Chapter 4, Succession.*

Water Quality

1. What are the potential effects of recreational activities (airboats, jetboats, and snowmachines), highway traffic, and the municipal dump on water quality of surface water and groundwater in the analysis area?
   - *Motorized recreation is fairly limited because of the low population and isolation of this area. However, these activities may introduce small amounts of oil and gasoline to the watershed that could affect wetlands downstream. Oil and gasoline spills from vehicles along the highway are possible sources of water pollution. Water quality data collected on the West Delta are limited, and no data have been collected to demonstrate the effects of these factors on water quality. The municipal dump may also be a source of toxic pollutants to the groundwater and wetlands downstream. The City is currently collecting data on the water quality around the dump.*

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.*

3. What are the effects of plant succession on habitat for species of concern?
    - *See Chapter 4.*
4. How do we meet the increasing recreation, fishing, and hunting demands on the West Copper River Delta while still providing a quality public lands experience and preventing impacts to wildlife resources?
5. How extensive is the European black slug invasion on the West Delta, and are they influencing forest understory and other species?
6. What are the public information and education needs that will promote conservation and stewardship?
7. What are the wildlife connections and issues between the West Copper River Delta and other wetlands along the Pacific Flyway?

Chapter 4 – Conditions and Trends

Landtype Associations in the area

Landtype associations are the most generalized map units of the Ecological Hierarchy (Bailey, 1993) at the landscape level. They are based on similar geomorphic process, soil complexes, stream types, geology, and plant communities in repeatable patterns. They provide a simple method to delineate the landscape and provide guidance of limitations for implementing management activities or projects. Figure 4.1 displays the landtype associations present in the analysis area and Table 4.1 displays the acreages for each.

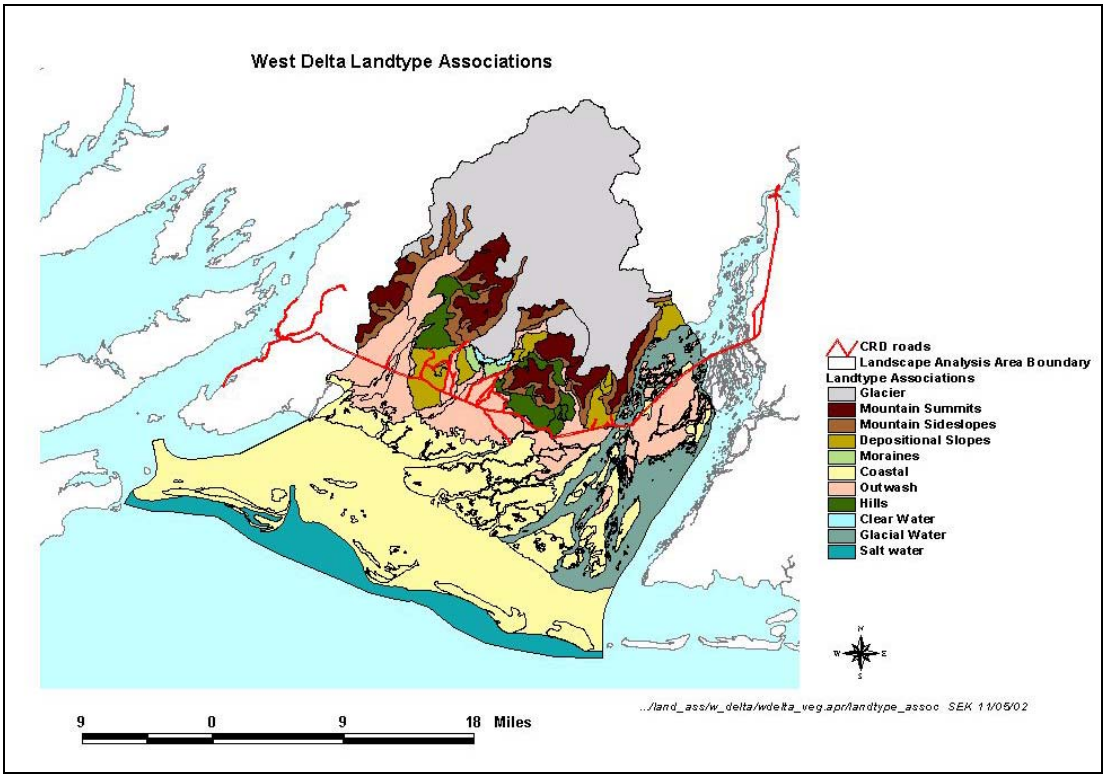


Figure 4.1-Landtype Associations in the West Delta analysis area

Table 4.1-Acres of each Landtype Association in the West Delta Analysis Area.

Landtype Association (Map Unit)	Acreage
Glaciers (00)	109,922
Mountain Summits (10)	21,748
Mountain Sideslopes (30)	21,079
Depositional Slopes (40)	14,206
Moraines (60)	1,474
Coastal (70)	166,129
Outwash (80)	63,282
Hills (90)	12,303
Clear Water (CW)	728
Glacial Water (GW)	40,796
Salt Water (SW)	32,918

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 - This association includes all active major glaciers and ice fields and the included rock peaks or nunataks. The major process shaping this unit is the formation and movement of ice and all associated rock and soil.

Mountain Summits - This association includes the ridges, peaks, cirque headwalls and basins and the associated scree slopes. Glaciation has been the most dominant historical geomorphic force that shaped the landscape. In some cases, frost fracturing has resulted in rounded mountaintops and ridges cover by a layer of loose rock. Most of the water runs off the surface where bedrock is exposed or beneath the surface where significant depths of loose rock have accumulated. In areas of sufficient soil, the vegetation is mostly low growing forbs, grasses, and lichens and some willows and other woody plants in localized wet areas.

Mountain Sideslopes - This association includes sideslopes, glaciated or non-glaciated, smooth or irregular, that normally receive surface or subsurface water draining from alpine landscapes. Slope steepness ranges from 15 to 70 %. The most dominant process shaping the steeper slopes in this category is erosion and transporting sediment down slope due to gravity. Erosion from surface water usually results in a parallel drainage pattern with V-notched channels of variable depths and densities. Soil and rock loosened by frost and water rolls down the slope or is carried down by avalanches. This material is deposited on the lower, less steep slopes. The soils are normally medium textured, well drained, and moderately to well developed. Some of these soils on the lower slopes consist of compact glacial till, which are more poorly drained and less productive for forests than other soils in the association. The upper sideslopes are commonly vegetated with low growing subalpine plants which grade into mixed communities of grasses, shrubs, and trees on the lower slopes. The location of trees is strongly dependent on disturbance by avalanches.

Coastal - This association includes landscapes that result from marine processes such as tidal fluctuations, wave carving and splash, and blowing sand. Examples include estuaries, beaches, marine deltas, and marine terraces. Most often these sites have slopes less than 15 %. The soil may consist of either poorly drained silts deposited in low energy environments or well-drained sands deposited in high energy environments. Some of the landscapes have been uplifted by isostatic rebound after glacial recession or from earthquakes. Uplifted landscapes are no longer associated with the active processes of the ocean and may be located inland from the ocean. The vegetation found on these landforms depends on how long the site has been separated from active wave processes, and the drainage of the soil. Old uplifted beaches have some of the most productive forested sites on the forest. The poorly drained soils on deltas or tidal flats, and marine terraces produce the largest expanses of wetlands.

Depositional Slopes – This association includes the lower depositional foot slopes at the bottom of the long sideslopes and river terraces that have high cutbanks and relief and are no longer affected by floods or active river cutting. These landscapes normally receive water from runoff and sediment from adjacent uplands. The drainage pattern is usually dendritic. The soils are usually well drained, deep, and medium to coarse textured except immediately below long sideslopes where the drainage may be poor due to the 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 association includes all major glacial depositional features such as glacial moraines, esters, kettles, and kames. It normally occurs at the junction of two glaciers, adjacent lower mountain sideslopes, or in the bottoms of glacial valleys. Most of the relief is mounds ranging in height from 10 to 100 feet with slope gradients of 25 to 65 %. The soils are poorly to well drained and consist of nonsorted 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 association includes all landscapes resulting from fluvial deposition of sediment from upland erosion. Much of this association is exposed to occasional or frequent flooding depending on their proximity to rivers. Examples are alluvial plains, glacial outwash plains, braided glacial rivers and the included islands or sand bars, low relief river terraces, and narrow valley bottoms that contain a combination of the above landscapes. This association also includes large sand dunes. The soils include both poorly drained lacustrine silts and clays, and well-drained alluvial loams, sands, and gravels. 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 - This association includes hills and plateaus that do not receive surface or subsurface water flow from adjacent uplands. It excludes major rivers or creeks that may flow through the hills that come from other areas. The surface character is often controlled by the stratigraphy of the bedrock. A veneer of glacial till frequently covers these landscapes. The soils are normally well drained, medium to coarse texture on the sideslopes, and poorly drained fine to medium textured and shallow in the basins or low areas between the hills. 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.

Geomorphic processes in the area

Geomorphic processes are the dominant driving successional force on the delta. Land and aquatic features of the delta constantly change under the influence of glacier and riverine sediments, tectonic uplift, and tidal action (Kruger and Tyler 1995). There has been a repetition of uplift, subsidence and sedimentation on the delta and it is reflected in the stratigraphy. The relics of past vegetation are interbedded with fine sediments from tidal deposits and coarse sediments from glacial meltwater flood (Thelinius 1995).

The Copper River Delta began to form about 9,000 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 and transported large amounts of sediment to the Gulf of Alaska. This began the delta's development, although these deposits did not rise above sea level until over 2500 years later (Reimnitz 1966). During the past 5,000 years, tectonic uplift has occurred regularly, approximately every 600 years (Boggs 2000). Currently, the Copper River transports an average of 69 million tons of sediment per year, mostly as suspended sediment (Brabets 1997). Although high rates of subsidence compensate for the rapid uplift and sedimentation rates, the net result is a seaward expansion of the delta.

The Copper River Delta is a high-destructive delta. Twelve-foot tidal fluctuations with strong ocean currents and waves quickly transport and rework sediment delivered by the river, creating its truncated shape (Boggs 2000). Counterclockwise tidal currents in the Gulf of Alaska push a plume of sediment from the Copper River to the northwest along the coastline to as far as Montague Island. Glacial outwash plains and uplifted marshes are the dominant landforms on the deltaic plain, which comprises a large portion of the analysis area. In addition to the processes associated with the Copper River, the glaciers of the Chugach Mountains in the northern portion of the analysis area have a large effect on the geomorphology of the Copper River Delta.

Tectonic

The 1964 earthquake was the most recent of at least five similar coseismic uplifts that have occurred in the last 3000+ years (Thilenius 1995). The intervals between previous uplifts were about 790, 670, 950, and 600 years. The catastrophic, magnitude 9.2 earthquake of March 27, 1964, with an epicenter 80 miles northwest of the mouth of the Copper River, resulted in 6 to 12 feet of uplift on the West 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 delta. 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). The earthquake also caused numerous landslides throughout the region, including large rockslides from Shattered Peak and Pyramid Peak that covered a large portion of the Sherman Glacier.

Glacial

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 occurred in the Holocene, beginning 12,000 years ago, and numerous episodes of small advances and retreats occurred. Over the last 200 to 300 years, glaciers in this area have decreased in size, with several small advances (Blanchet 1996).

Saddlebag Glacier - The 4.5 mi^2 Saddlebag Glacier occupies a small valley just west of the Copper River and drains into the McKinley Lake watershed. Since 1899, it has slowly receded, leaving the one-mile long Saddlebag Lake between the glacial terminus and the end moraine (US Army Corps Eng. 1975). The 1964 earthquake caused a series of rockslides, which covered much of the lower portion of the glacier, possibly slowing the rate of recession (US Army Corps Eng.1975). The glacier is currently close to receding out of Saddlebag Lake.

Scott Glacier - The Scott Glacier covers approximately 67 mi^2 (Blanchet 1983). Its terminus retreated about one half mile between 1950 and 1996 and currently continues to retreat. The size, aspect, elevation, and slope of the Scott Glacier are all similar to those of the Sheridan Glacier. However, no lake exists at the base of the Scott Glacier, allowing larger inputs of sediment into the Scott River outwash plain.

Sheridan Glacier - The Sheridan Glacier flows approximately 15 miles southwest from icefields in the Chugach Mountains and has an area of 39 mi^2 (US Army Corp Eng 1975). End moraines indicate that the Sheridan-Sherman glacier complex extended about 3 miles past the current terminus of the Sheridan Glacier in the Late Pleistocene to mid-Holocene (Tuthill et al. 1968). The most recent glacial maximum of the Sheridan Glacier occurred in 1700, and the glacier has since retreated about 1 mile (US Army Corp Eng 1975). Since 1910, the Sheridan Glacier has receded 0.5 miles, and between 1910 and 1965, the glacier thinned 200 to 300 feet at its terminus. Sheridan Lake now occupies the area between the glacial terminus and the large end moraine to the south. Considerably more thinning has occurred since 1965 (Blanchet 1996). The rate of downglacier movement was estimated to be about 990 feet per year from 1938 to 1941, 660 ft/yr from 1941 to 1950, 240 ft/yr from 1950 to 1959, and 230 ft/yr from 1959 to 1965 (Tuthill et al. 1968).

Sherman Glacier - The Sherman Glacier lies just east of the Sheridan Glacier, flows west about 8 miles from icefields in the Chugach Mountains and covers an area of about 21 square miles (US Army Corp Eng 1975). The most recent glacial maximum of the Sherman Glacier occurred around 1880. Between 1910 and 1964, the glacier retreated almost 4000 feet and thinned considerably. From 1910 to 1959, the glacier receded an average of 65 feet per year, but this rate increased to 150 ft/yr in the years preceding the 1964 earthquake (US Army Corp Eng 1975). The earthquake triggered large rock avalanches from Shattered Peak and Avalanche Peak, depositing 33.7 million cubic yards and 6.4 million cubic yards of rock onto Sherman Glacier, respectively (Plafker 1968). These events covered 3.3 mi^2 of the lower glacier with a uniform 4-foot thick blanket of rock debris (Figure 4.2). This debris covered one third of the ablation zone of the glacier, insulating it, and lowering the rate of melting by 40% (Bull and Marangunic 1968). This initiated a small glacial advance of a few hundred feet. As the rock material is transported off the glacier, the area on the glacier covered by rock decreases, causing an increase in melting. The glacier appears to have nearly stopped advancing, and glacial recession will likely resume in the near future (Blanchet 1996).

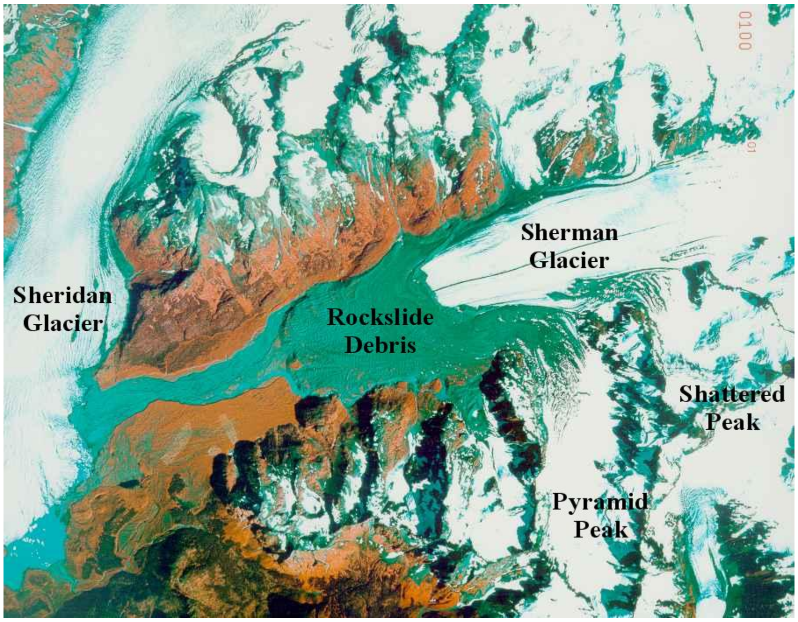


Figure 4.2-Sherman Glacier, July 1996.

The lower portion of the glacier is covered with 1964 rockslide debris from Shattered Peak and Pyramid Peak.

Erosion

The two major categories of erosion are surface soil erosion and landslip erosion or landslides. Surface soil erosion results from the movement of individual soil particles by either water or wind. Landslides are the movement of large masses of soil and other material as a large body under the force of gravity.

Surface Erosion - Surface soil erosion is normally not a major issue on the Chugach National Forest. All except the youngest soils are covered by an extensive layer of organic material, the thickness ranging from a few inches to many feet, consisting of a layer of peat, moss, and other herbaceous plants. Two exceptions are the active glacial rivers and pre-vegetative terrain that is exposed when glaciers recede.

The Agricultural Research Service (ARS) developed an erodibility factor (k) that quantifies the ability of a soil particle to be separated and moved by water. The ratings range from a low of 0.02 to a high of 0.64. This along with other factors can be used in formulas and predictive models to estimate the amount of an exposed soil that will erode on a bare slope of 9%, prior to the influence of vegetation, rock, different slope gradients, and rainfall intensity and volume.

The soils of the delta are of the most concern where rivers are actively eroding banks and in places easily accessible by people and vehicles. The raised marshland soil is mostly a silt loam texture and has an estimated erodibility factor of 0.49. This soil is relatively impermeable and only moderately cohesive, so water will run off the surface and erode the small particles. Soils on the gravel bars, beaches, and streams are usually sands and gravels. The particle size of these soils is larger that silt, and the permeability is relatively high, so water will infiltrate the soils relatively quickly. It takes more water to move the larger particles; hence these soils are less erodible with an erodibility factor of 0.10 to 0.25. Most of these soils are adjacent to flowing water, not vegetated, and are constantly eroding. The finer deltaic soils are protected by vegetation, but removal of the vegetation will induce significant erosion in the form of trenches and gullies.

Landslides - Approximately 41,145 acres of land have slopes over 56% in the West Delta analysis area. Table 4.2 displays the acreage for each slope category by Landtype Association. Much of land with slopes greater than 56% in the Mountain Summits and Glaciers landtype associations include snowfields and glaciers, rock cliffs, rock talus, and relatively stable bedrock slopes with alpine vegetation. The Mountain Sideslopes association usually has the most landslides. There are many factors that contribute to the occurrence of landslides in this landtype. This landtype association contains long, straight slopes that have a slope gradient greater than 56% and there is usually a large alpine area above this Association to collect ground water that runs down the sideslopes. The glacier process that shaped these sideslopes, left compacted till on the lower slopes. Figure 4.3 shows the Landtype Associations overlaid with the slope categories of less than 56%, 56 to 72%, and greater than 72% for the northern portion of the analysis area. The remainder of the analysis area is relatively flat, less than 56% slope.

Table 4.2-Acreage of each slope categories by Landtype Association.

Landtype Association	Acreage for each Slope Category		
	Slopes <56%	56 to 72%	Slopes >72%
Glaciers (00)	88,942	8,457	12,394
Mountain Summits (10)	10,988	4,095	6,640
Mountain Sideslopes (30)	11,946	4,151	4,938
Depositional Slopes (40)	14,151	9	5
Moraines (60)	1,474	0	0
Coastal (70)	67,882	0	0
Outwash (80)	62,007	46	6
Hills (90)	11,890	223	181

Areas with frequent landslides or having the potential for landslides usually present an unnecessary risk for most soil disturbing management activities. Landslides most often occur on slopes greater 72% (Swanston 1997), but can occur on slopes with gradients less that 72 % if the correct soil and hydrologic conditions are present. The most critical factor used in the landslide risk assessment is the steepness of the slope.

The majority of the slopes over 56% not covered by glaciers are located in the Mountain Sideslopes and the Mountain Summits landtype associations with a minor amount in the Depositional association. Most of the soils in these associations have a loamy skeletal texture and are well drained, which places them in the low to moderate landslide risk category. Large alpine areas above the Mountain Sideslopes association usually collect ground water that runs down the sideslopes. Many sideslopes shaped by glaciers have a water-restricting layer of compact till. The compact till or shallow soil depth to bedrock appears to be necessary to perch the additional water that increases the risk for landslides. Extensive soil surveys to determine the frequency of compact till or other landslide contributing features have not been done since management activities have not been proposed in areas with a potential for landslides and the limited access to these areas.

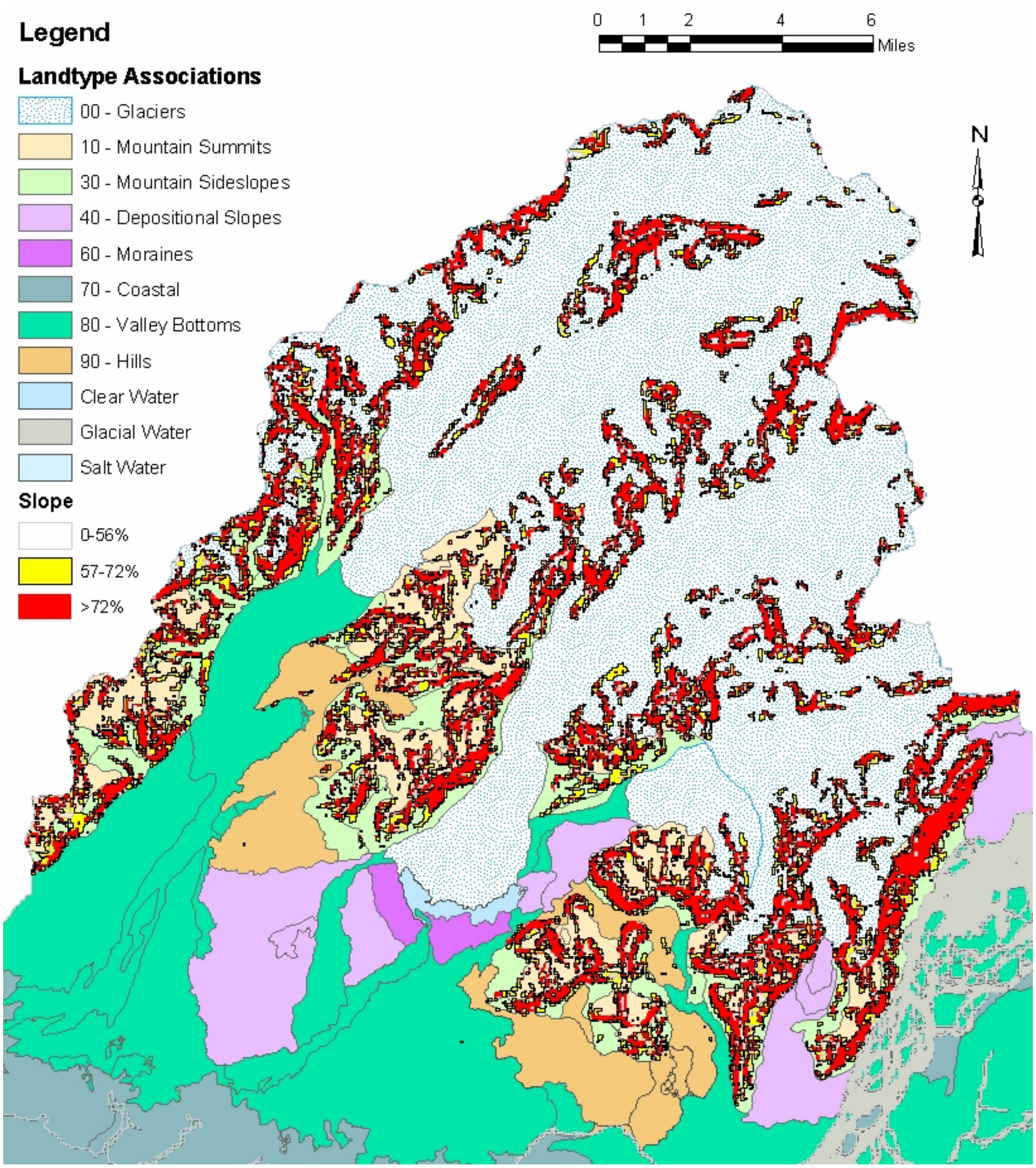


Figure 4.3-Slope categories and locations in the Landtype Associations

(Only the northern portion of the analysis area is displayed since the rest is relatively flat)

A preliminary analysis for a potential landslide occurrence was done for representative soils on sideslopes with historic landslides using a method developed by Douglas N. Swanston (1997) for the Tongass Land Management Plan. This method uses data easily collected in the field including soil properties such as soil texture, parent material, depth, drainage; and specific topographic conditions such as slope shape, length, gradient, and drainage density. The risk assessment weights each of the characteristics as to their relative importance, and then provides a numerical landslide failure rating. A higher rating indicates a higher the risk for a landslide. For estimated soil conditions on the west slope of Scott River valley, the risk rating was 69. With increased ground water draining through the soil, the risk rating increased to 73. Neither estimate uses data verified on the ground. Sites with a risk rating above 63 are considered to have a relatively "high risk" for landslides. Any soil disturbance will increase the risk.

Assuming wet soil conditions produces a higher rating that the drier version for the Scott River location. The analysis also shows that soils derived from lake deposits have a "very high risk" for landslides because fine textured soils derived from lake deposits absorb large amounts water and have little cohesion. The individual calculation sheets for each site and the definitions for the ratings are located in the West Delta Soils Resource report prepared by Dean Davidson.

Factors affecting hydrology and water quality

The following factors have the greatest influence on flow quantity, flow quality, the timing of flow, and channel morphology of streams and rivers in the analysis area. Many of these factors are interrelated, and of the listed factors, management can only control roads, recreation use, and municipal development.

Drainage basin morphometry

The drainage basin morphometry of the analysis area is characterized by a sharp contrast between the flat, low-lying delta to the south and the steep, rugged, glaciated mountains to the north. The high elevations of the Chugach Range favor the formation of glaciers and allow for increased snowfall, greatly affecting the total amount of runoff, although the morphometry of the Copper River basin of interior Alaska controls the quantity of water in the Copper River. Drainage basin morphometry also has numerous indirect effects on water quality and the timing of flows. Glaciers in the Chugach Range increase turbidity and control the timing of flows, and wetlands in the delta improve water quality and attenuate flood flows. Flashy flows are more common in the low elevation foothills of the McKinley Lake watershed.

Glaciers

Glaciers are the driving force behind many hydrologic processes that occur on the West Copper River Delta. Glaciers affect water quantity by providing long-term storage of water as ice. Increased glacial melting corresponds to increased flows in glacial rivers. The water quality of many rivers and streams of the area is highly turbid, as glacial rivers carry high suspended sediment loads derived from glacial deposits. Glaciers control the timing of flows on the Scott, Sheridan, and Copper Rivers, and peak flows correspond to periods of peak glacial melting. Winter flows remain steady and low, as glacial melting does not occur during this time. Glacial processes determine the balance between sediment production and glacial meltwater, which defines channel morphology downstream of the glaciers. Glacial advance produces larger sediment loads, causing increased aggradation and channel migration in the glacial outwash plain.

Precipitation

The amount of rainfall directly influences streamflow quantity and timing throughout the analysis area. Large late summer and fall rainstorms create significant peak flows that can be larger than peak flows from snow and glacier melt. The deltaic plain is more influenced by rainfall, whereas the Chugach Range and glaciers are more affected by snowfall. High flows from large rainstorms can increase turbidity, although glacial processes are responsible for the high turbidity of glacial rivers. Channel morphology adjusts to the size of the large peak flows in late summer and fall.

Stream response to rainfall is relatively slow because of the flat topography throughout much of the deltaic plain. However, the small watersheds in the Chugach foothills have flashy regimes. Long lasting storms will create large increases in streamflows and corresponding increases in turbidity. Channel morphology will adjust to these high flows. Because streams and rivers in the analysis area do not respond quickly to rainfall, the frequency and intensity of storms have only a moderate effect on the quantity, quality, and timing of flows. Intense rainstorms that occur in the fall can produce large amounts of sediment. Because of the highly adjustable substrate, intense rainstorms that create large flood peaks can also cause dynamic changes in channel morphology.

High stream flows from snowmelt, glacial melt, and fall rainstorms have a large effect on the quantity, quality, and timing of flows. Snowmelt and glacial melt peaks are generally sustained, whereas fall rainfall peaks are short in duration. All of these peak flows are capable of increasing turbidity. Extreme peak flows on glacial rivers can cause dramatic changes in morphology. The 1981 peak flows on the Copper River caused significant channel shifting, deposition, and scour at the Copper River Highway bridges.

Natural Lakes

The small natural lakes that are present throughout the deltaic plain have little influence on the amount of surface water. However, Sheridan Lake and Saddlebag Lake lie at the base of glaciers, capturing sediment shed from these glaciers and greatly decreasing sediment loads and turbidity downstream. This effect has caused the Sheridan River to incise into a single channel within its outwash plain, drastically altering its channel morphology. These lakes also moderately affect the timing of flows by attenuating floods, which increases the duration but decreases the intensity of peak flows.

Wetlands/Riparian areas

Wetlands cover most of the deltaic plain and can greatly affect water quality and timing, but have little effect on the quantity of surface water. Because palustrine channels in the deltaic plain are unconfined to valleys, wetlands and floodplains allow sediment to settle during floods, improving water quality and stabilizing these channels. Wetlands and riparian areas also attenuate flood flows because of the resistance provided by the abundant vegetation.

Roads

Roads in the analysis area are very limited; the Copper River Highway is the only major road that crosses the delta. Roads have no effect on the quantity of flow in the analysis area. Water quality could potentially be affected by oil or gasoline spills along the highway, but use is low. The timing of flows in the larger glacial rivers is somewhat affected by the highway. Changes in channel morphology resulting from the highway and the fixed location of the bridges have occurred. Many of these channels have migrated so that the bridges are no longer in the natural flow pattern of the channel, resulting in the road blocking the flow of the channel path and aggradation upstream of the road. In some cases, bridges are much narrower than the natural channel width, resulting in increased conveyance of flows and increased potential for channel scour. The bridges inhibit channel migration, decrease channel width, and cause sediment deposition upstream of the highway. Before the railroad was constructed, these braided glacial rivers actively migrated across their outwash fans. The significance of changes in channel migration and sediment deposition caused by the highway is moderate. The recovery potential for these systems back to reference conditions with the highway in place is slight. The highway is a necessary economic, social, and recreational component of the area. Enlarging bridges may ease some of the channel migration issues, but because these rivers are so dynamic, potential channel migration problems will develop at any bridge location.

Recreation

Compared to the Kenai Peninsula, recreational use of the West Delta is generally low because of the Cordova's small population and the area's isolation. Recreation has no effect on surface water quantity or timing. Water quality can be affected by trails across wetlands, which may cause local increases in turbidity. Motorized recreation on the delta, in the form of snowmobiles, jetboats, airboats, and ATV's increases the potential of oil and gas pollution in the watersheds. However, the use of motorized vehicles is low considering the size of the analysis area. Recreational activities have a limited effect on channel morphology on the delta.

Municipal Development

The municipal dump located north of the highway at Mile 17 may have moderate effects on groundwater quality, but has no effects on the quantity or timing of flows, or channel morphology. Pollutants from the dump may enter the water table because of high precipitation and high soil infiltration rates. Groundwater flow can deliver these pollutants to the wetlands south of the highway. This is an important issue because the health of these wetlands is vital for aquatic and terrestrial habitat. The city of Cordova is monitoring the groundwater quality.

Conditions and trends of fisheries resources

The West Delta Fisheries Resource Report (Lang 2003) contains detailed escapement and habitat information for each system of the analysis area. Overall, the stream habitat in the analysis area is in relatively pristine condition due to the absence of anthropogenic impacts other than the highway, airport, and landfill.

Population trends of the key fish species

The Alaska Department of Fish and Game 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.

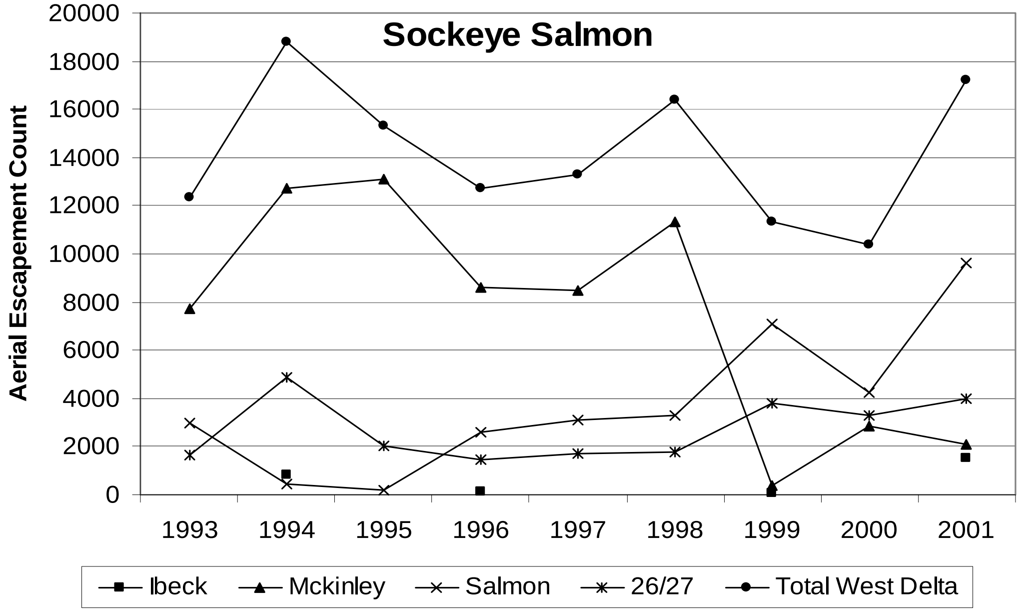
The aerial escapement counts provide an abundance trend for salmon, however the estimation technique is limited by weather conditions, stream flows, and visibility (Gray et al. 2002). Overall, aerial escapement counts show a stable trend in the sockeye salmon population for the years 1993 – 2001 for the analysis area (Figure 4.4)**.** Total West Delta escapements have ranged from 10,370 to 18,820 and averaged 14,204 sockeye salmon over this time (Gray et al. 2002). The commercial harvest of sockeye salmon in the Copper River District has increased since 1974. However, it is difficult to distinguish between upriver and Copper River Delta stocks of commercially harvested sockeye salmon, so harvest data is of little use in determining trends of fish stocks of the analysis area.

The commercial harvest of coho salmon in the Copper River District has been less than that for sockeye salmon with a ten-year average (1991-2000) of 295,641. The majority of commercially harvested coho salmon are of Copper River Delta origin, however it is not possible to tell what watershed the fish came from. Therefore, aerial counts conducted by ADF&G are the best indicator of population trends at a smaller scale. Total West Copper River Delta escapements have ranged from 9,930 to 19,420 and averaged 15,451 coho salmon (Gray et al. 2002). Overall, aerial escapement counts show a slightly increasing trend in the coho salmon population for 1992 through 2001 (Figure 4.4). However, this trend is due to recent high escapement counts in Ibeck Creek. Other systems show a relatively low but stable trend over this period of time.

Sport, commercial, and subsistence fishing

Commercial Fishing - Commercial fishing has occurred in the waters around the mouth of the Copper River since at least 1898 (Thompson 1964). 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). The fishing season has begun in mid-May since the early 1960’s and has typically closed in the fall (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 currently the targeted species.

The fishery consists of both “upriver” and Copper River Delta 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.



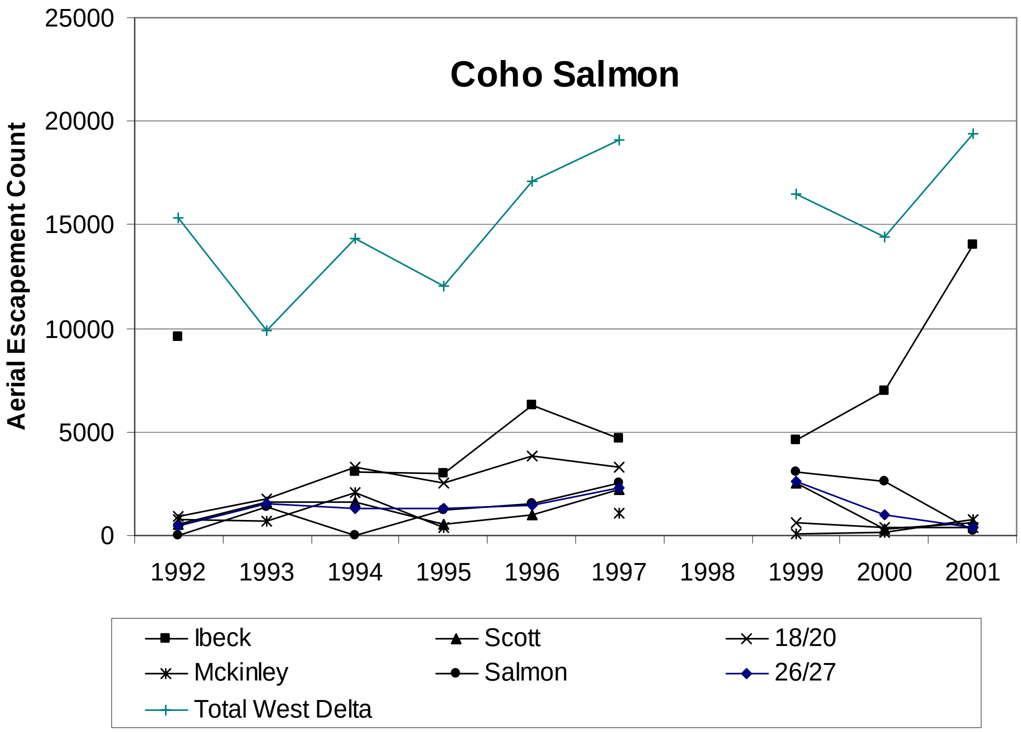


Figure 4.4 - Recent peak aerial escapement counts for sockeye and coho salmon in major stream systems in the West Delta Analysis Area. (Gray et al. 2002).

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. Anglers have easy access to streams in the analysis area via the highway. This may be a concern for fish populations and fish habitat. High levels of use and access by anglers on streams can lead to over harvest and habitat degradation (King 2002).

A statewide mail-in sportfish survey has generated estimates of angler use on the major streams accessed by the Cordova Road System (including the Copper River Highway). According to these surveys, angling pressure has increased since 1983, and the highest level observed was in 1999 at 19,907 angler days (Figure 4.5). Although these numbers include streams outside of the analysis area, it is believed that the same general pattern has been experienced on streams within the analysis area since most are accessible via the Copper River Highway.

Mail-in surveys were also used to estimate the number of fish harvested by anglers (Figure 4.6). Coho salmon had the highest harvest rate of the key species during the period from 1996 – 1999 (Figure 4.6). Coho salmon harvest on the Alaganik Slough between the years 1990 – 1999 increased slightly; harvests have ranged from a low of 316 in 1990 to a high of 1,480 in 1996 (Miller and Stratton 2000).

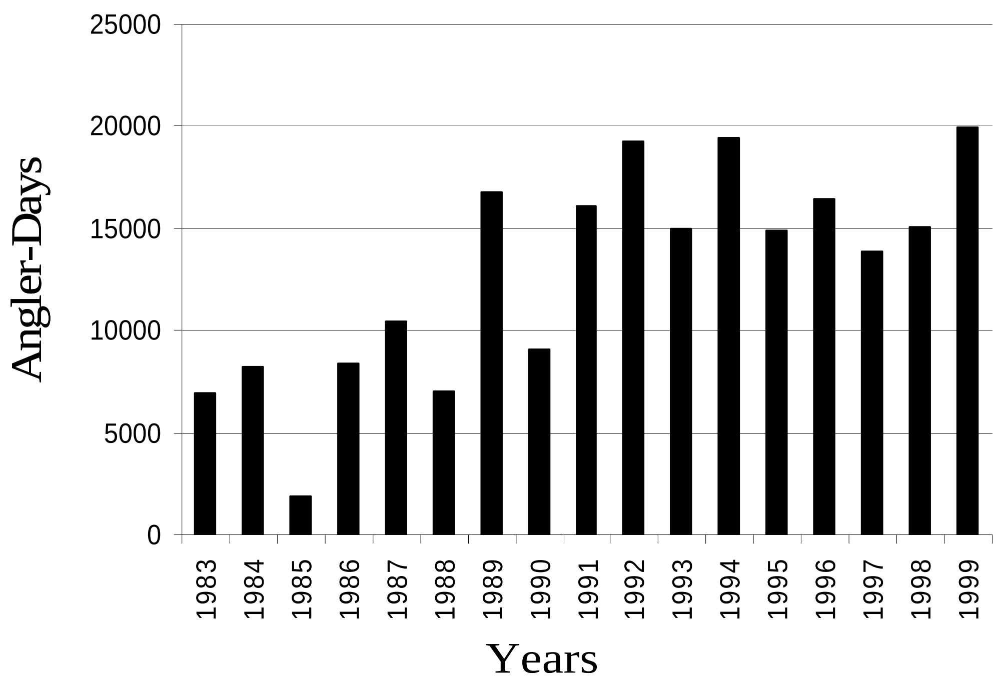


Figure 4.5 - Estimated angler use on streams accessible via the Cordova Road System (including the Copper River Highway) between the years 1983 – 1999, based on statewide mail-in angler surveys (Miller and Stratton 2000).

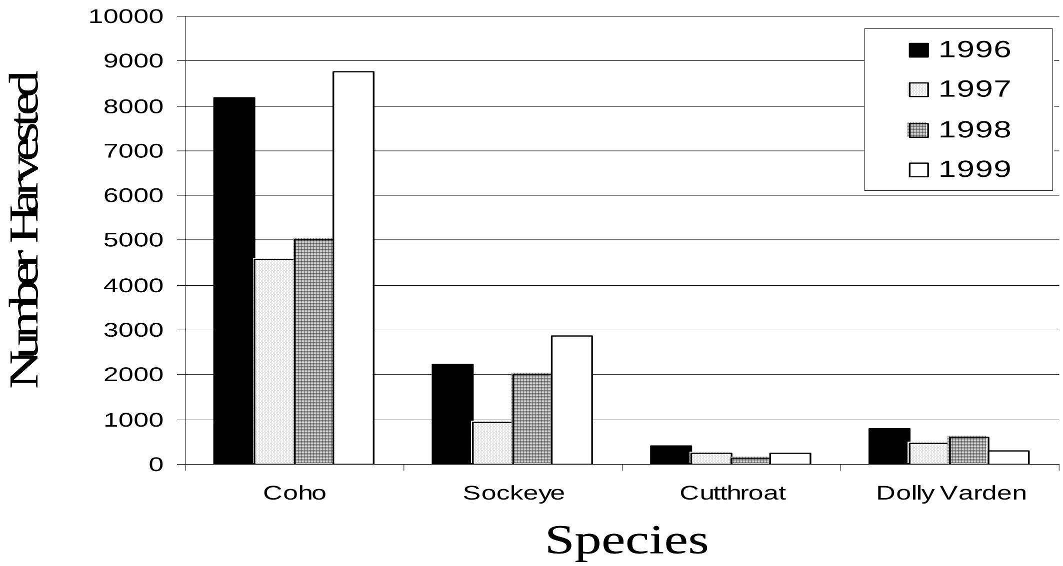


Figure 4.6 - Estimated harvest by species on streams accessible via the Cordova Road System (including the Copper River Highway) between the years 1983 – 1999, based on statewide mail-in angler surveys (Miller and Stratton 2000).

The period of heaviest use by anglers is in the fall when adult coho salmon begin returning to streams. Since coho salmon are a MIS species, there is a need to better assess angler use and monitor its impact on current populations. The Cordova Ranger District initiated a voluntary angler survey program in the fall of 2002. From August 19 to September 29, harvest surveys were conducted at the airport asking anglers leaving Cordova about their fishing experience. This harvest survey targeted visitors to Cordova and does not represent the local resident anglers. Based on the results, 665 visitors fished on streams in the fall of 2002 and harvested 1,845 coho salmon of nearly 6,000 coho estimated caught (Table 4.3). This shows that a significant number of visiting coho salmon anglers are practicing "catch and release" fishing.

Table 4.3 - Sportfish use and harvest by visitors to the analysis area in the fall of 2002.

Watershed	Location	# of Anglers	Angler Days	Coho Caught	Coho harvested
Scott	Ibeck	320	743	2864	831
	Scott River	9	71	98	78
	11-Mile	78	150	400	215
	Cabin Lake	2	4	11	0
Total		**409**	**968**	**3373**	**1124**
McKinley	18 – Mile	35	79	603	125
	Alaganik	169	373	1648	535
	Goose Meadows	2	6	63	9
	Wrong Way	38	57	281	46
	McKinley Lake	8	20	30	6
	Pipeline Lakes	4	5	0	0
Total		**256**	**540**	**2625**	**721**
Grand total		**665**	**1508**	**5998**	**1845**

Subsistence Fishing - Subsistence fishing using nets occurred prior to 1960 on the West Delta of the Copper River. A ban on using nets in freshwater for harvesting salmon occurred in 1960, which resulted in most subsistence users converting to the use of rod and reel to harvest salmon under sportfishing regulations in freshwater (Stratton 1989). Now, most of the subsistence fishing for salmon occurs in the marine waters of the Copper River Delta using small boats with 50 fathom gillnets. Many of the West Delta river systems empty into this area and some of the sockeye 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 salmon and rainbow trout is not legal under state or federal regulation in any of the streams within this analysis area. However, salmon and rainbow trout harvest is allowed under sportfishing regulations in these systems. The Alaganik and Elsner rivers are the main systems in this analysis area containing sockeye salmon. Several other systems contain sockeye salmon, but freshwater escapement is small ranging from a few hundred to less than 20 adults. The current daily sportfishing bag limit of three sockeye salmon in these rivers allows for a subsistence opportunity, but sockeye salmon are not easily caught with sportfishing gear so most are taken in the marine gillnet fishery.

Coho salmon are found in nearly all of the freshwater streams on the West Delta. The current sportfishing bag limit of three coho salmon per day provides an opportunity for subsistence users to obtain salmon from freshwater as this species readily takes sportfishing tackle.

The subsistence harvest of fish other than salmon and rainbow trout is allowed in the freshwaters of this analysis area by state and federal regulation. The only non-salmon species that has a significant subsistence harvest in freshwater at this time is eulachon (*Thaleichthys pacificus)* smelt. The State Board of Fisheries has determined that eulachon have a customary and traditional subsistence use in Prince William Sound. The allowable take for subsistence use is unlimited per individual. 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. In most years, smaller runs of eulachon are also found in Ibeck Creek and Alaganik River. Occasionally, eulachon are found in other river systems such as the Eyak, Scott and Sheridan Rivers. The majority of the subsistence harvest of eulachon occurs in the Ibeck, Alaganik and Copper Rivers. Ibeck Creek receives the most fishing pressure for eulachon primarily because of its close proximity to the population center of Cordova and the timing of the run is earlier than the other systems. However, eulachon do not enter that system every year. Very little is known about eulachon that return to these systems, although some initial studies are being conducted on the Copper River to estimate the biomass, age, weight and length of returning adults in the western channel that passes upstream of the 27 Mile bridge. Studies on the amount of eulachon used by local residents are also being conducted.

Subsistence fishing for other freshwater species occurs, but is very limited in amounts harvested. The reported 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 incidental to salmon in the gillnet subsistence fishery. Occasional subsistence harvest of whitefish and trout occurs in McKinley Lake and some of the smaller freshwater lakes in this analysis area, but the fish harvest is small and infrequent.

Future subsistence harvest in this analysis area is expected to grow slowly as the population of Cordova increases. Currently, most of the subsistence harvest of sockeye and chinook salmon is done in marine waters offshore of this analysis area. The harvest of coho salmon is accomplished in both the marine and freshwaters. The freshwater harvest occurs using sportfishing regulations. Several days of sportfishing may be required however, to harvest sufficient salmon instead of harvesting the desired number in one trip.

The ability of freshwater trout and whitefish stocks to meet subsistence needs is unknown. Little or no data is available on population sizes 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 Ibeck Creek in any one-year is also unknown. Intensive subsistence harvest of eulachon in this system in the future may exceed the reproductive ability of this stock. However, there is some evidence that eulachon do not always return to the same stream from which they were spawned (Betts 1994, Hinrichsen 1998). If eulachon do not show any fidelity to their natal stream, then the biomass for the entire West Delta may contribute to the Ibeck River system. However, the early run timing of eulachon in this system is somewhat unique and it may be a separate stock from the later runs in the other river systems. More studies are needed to determine the stock spawning biomass and the biologically sustainable harvest amount of eulachon.

Other potential influences on 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.

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.

Roads - 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). Stream crossings by roads usually lead to an unnatural change in channel geometry and result in some form of channel adjustment that can be detrimental to fish (Furniss et al. 1991). Bridges tend to restrict channel geometry least and therefore affect fish and fish habitat least (Furniss et al. 1991). Culverts 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 amount of roads in the analysis area is limited and no new roads on Forest Service lands are proposed. Current road density is 0.08 km/km^2 (USDA Forest Service 2000). At such low densities, it is unlikely that roads are negatively impacting salmonid spawning or rearing habitat. However, the Copper River Highway is the main road in the analysis area and crosses most major rivers and streams. This road may have an impact on channel morphology and salmon migration. Bridges are in place at the major rivers crossings: Ibeck, Scott, Glacier (Sheridan), and Alaganik. However culverts were used for the smaller stream crossings. Culverts are more likely to cause problems for both juvenile and adult migration (Furniss et al. 1991). There has not been a comprehensive analysis of the culverts in the West Copper River Delta analysis area. A road condition survey is planned for FY2003.

In the past, gravel used for road or levee construction has been extracted directly from streams or from floodplains adjacent to streams near the Copper River Highway. Several ponds have been produced as a result of the gravel extraction. Crews from the Cordova Ranger District enhanced two gravel pit ponds in 1992 by planting alders and other vegetation in the riparian area around the perimeter of the ponds. These ponds may provide additional juvenile salmonid rearing and overwinter habitat, but recent surveys in the ponds have not been conducted. The current use of these ponds by fish or the effectiveness of the riparian vegetation enhancement is unknown. A survey of the physical and biological properties of these ponds may assist in future gravel extraction projects where the potential to create fish habitat exists.

Foot trails – Foot trails have the potential to impact fish habitat in a similar way as roads. Heavily used or improperly maintained trails near streams can lead to bank erosion and stream substrate sedimentation (King 2002). There are many designated trails in the analysis area, most of which traverse streams and wetland habitats where erosion may impact fish habitat. Some trails were constructed to allow easier access to sportfishing locations. Angler use and adjacent stream habitat condition should be monitored closely on the Alaganik Trail, Mile 18 Fisherman’s Trail, and Eyak River Trail. Many other trails travel across and adjacent to streams in the analysis area and therefore have the potential to affect fish habitat. There has not been a comprehensive analysis of trail/stream crossing conditions in the analysis area.

Timber harvesting and mining - Other potentially negative human influences on the fisheries resources in the analysis area are minimal. The most recent timber harvest occurred on private lands around Lake Elsner in the late 1980’s through early 1990’s. Mining occurred by McKinley Lake in the early 1900’s, but no observable impacts to the fisheries resources currently exist. Presently, no commercial logging or mining are occurring in the analysis area and none is expected to take place within the next 10 years.

Factors affecting vegetation

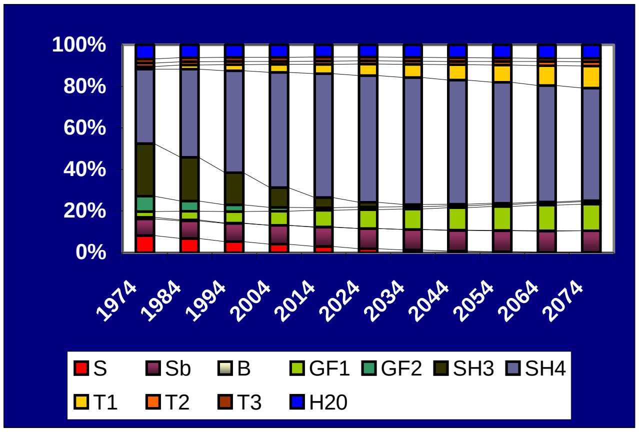
Tectonic influences on vegetation succession

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 the uplift caused by the 1964 earthquake, vegetation succession on the delta has been occurring rapidly on the uplifted marsh (Crow 1968, Potyondy et al. 1975b, Scheierl and Meyer 1977, Boggs 2000). 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. This succession has had a dramatic effect on wildlife habitat (Crow 1972, Campbell 1990).

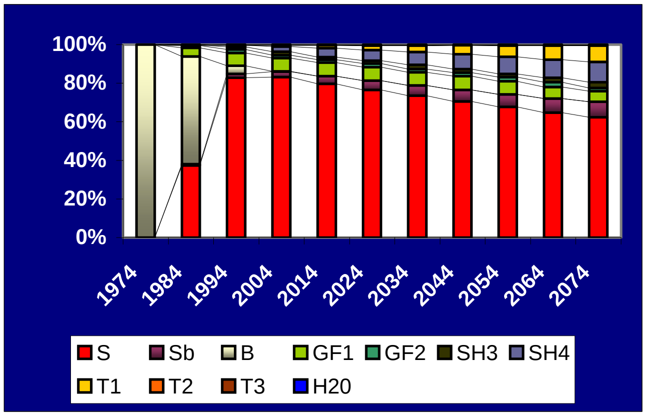
Understanding vegetation succession, spatially and temporally, on the Copper River Delta has a direct influence on management strategies for many species of wildlife. Detailed information about the role of succession on the Delta is available in DeVelice et al. (2001) and Boggs (2000). A computer model 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. This was accomplished by 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. The model is available on CD-ROM and displays the predicted transitions for outwash plain, uplifted marsh and new marsh landscapes.

The model predicts that the greatest change in composition of vegetation would occur on the new marsh followed by the uplifted marsh (DeVelice et al. 2001). Composition on the outwash plain was predicted to be relatively stable at the landscape scale (Figure 4.7a). In contrast, 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 (Figure 4.7b). On the uplifted marsh over the 100-year simulation period, peatland (i.e., sedge-bog transition) area is projected to increase from near zero to over 60 % (124 to 35,064 acres) while tall sedge landcover drops from about 45 % to almost zero (28,910 to 12 acres) (Figure 4.7c). On the combined new marsh and uplifted marsh, the total area of woody vegetation increased from a total of 2,483 acres in 1974 to 21,400 acres in 2074 (DeVelice, et al. 2001).

a)



b)



c)

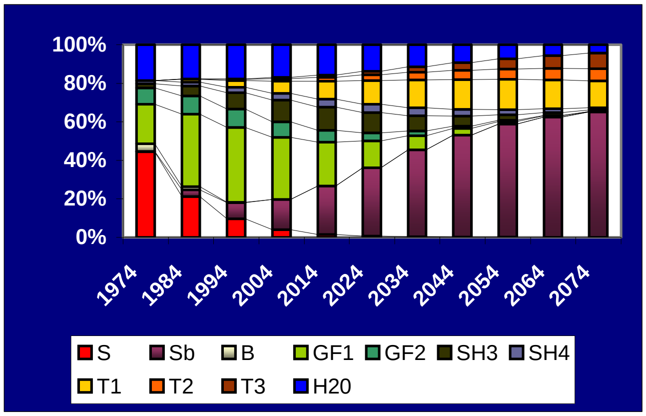


Figure 4.7-Projected landcover transitions on the a) outwash plain, b) new marsh, and c) uplifted marsh of the west Copper River Delta over the 1974-2074 simulation period (DeVelice et al. 2001).

Units are % of total area of landscape type. 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.

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 4.8 and 4.9. Figures 4.10 and 4.11 illustrate sequences on the uplifted marsh and tidal marshes respectively.

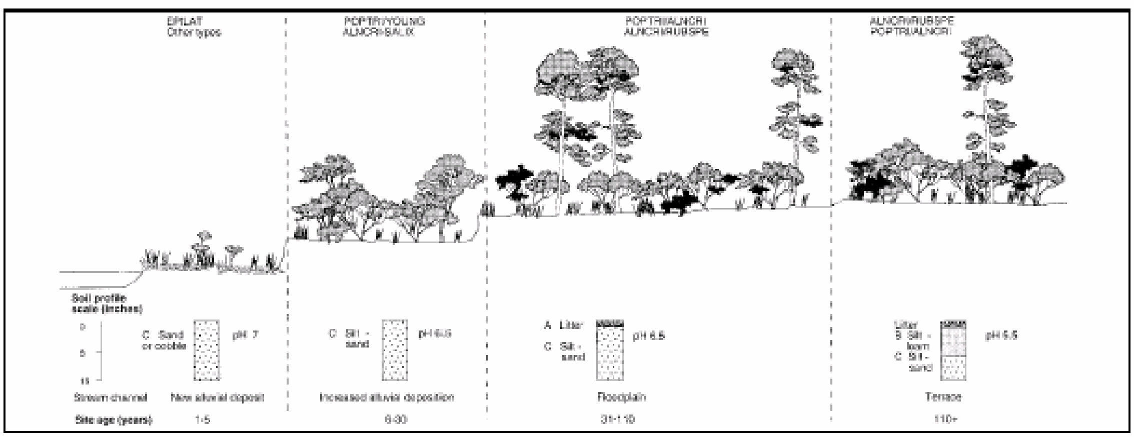


Figure 4.8-Idealized cross-section of vegetation succession and soil and landform development on well-drained terraces of the Copper River outwash plain, within the Copper River Subsection (ECOMAP1993) (Boggs 2000, Figure 10).

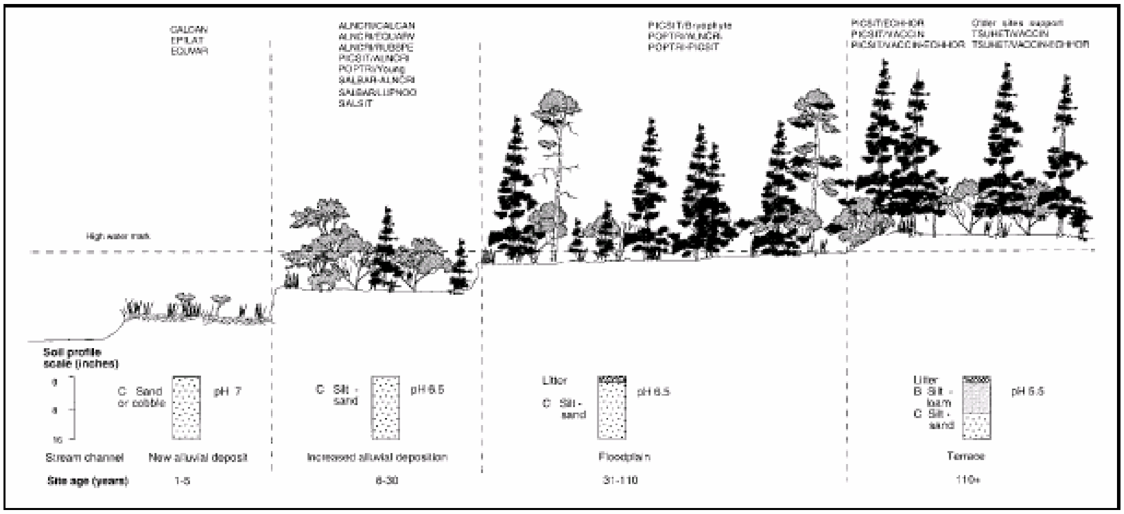


Figure 4.9-Idealized cross-section of vegetation succession and soil and landform development on well-drained terraces of outwash plains and floodplains within the Copper River Delta subsection (ECOMAP 1993) (Boggs 2000, Figure 11).

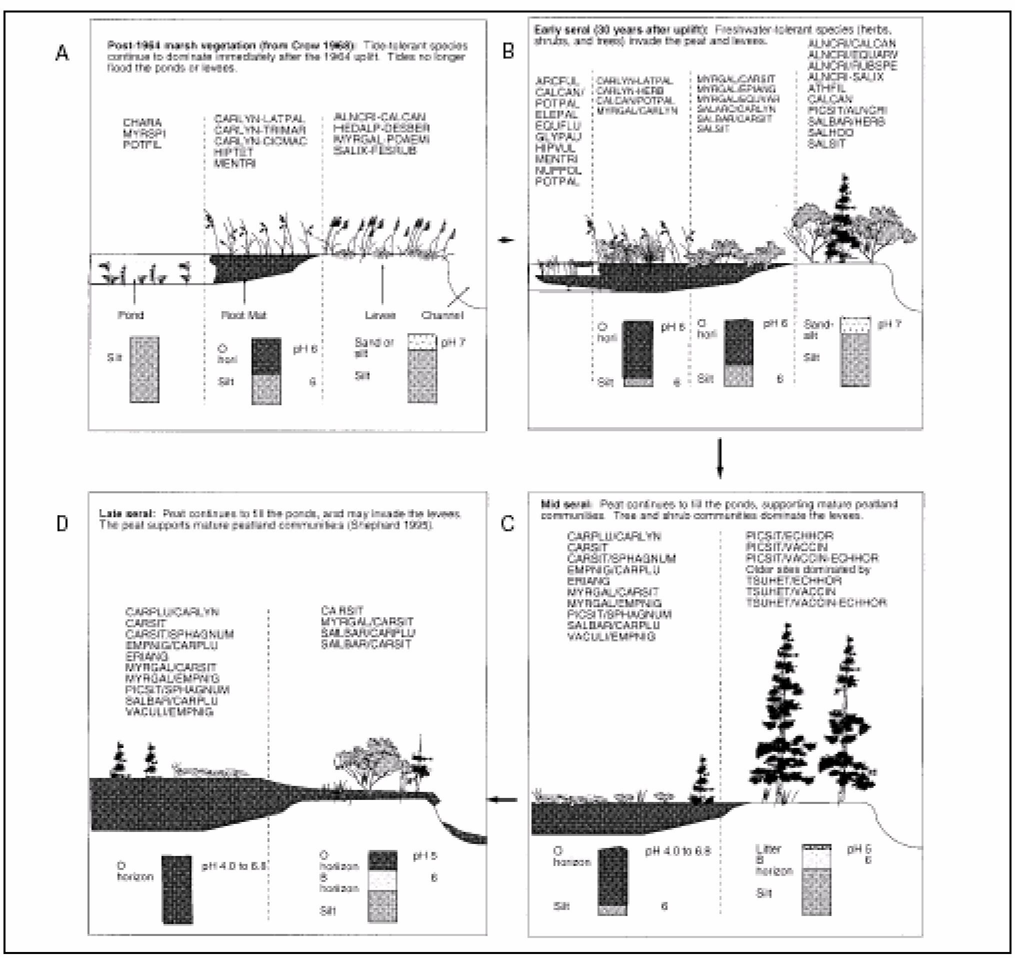


Figure 4.10-Idealized cross-section of vegetation succession and soil and landform development on uplifted marshes (Boggs 2000, Figure 13).

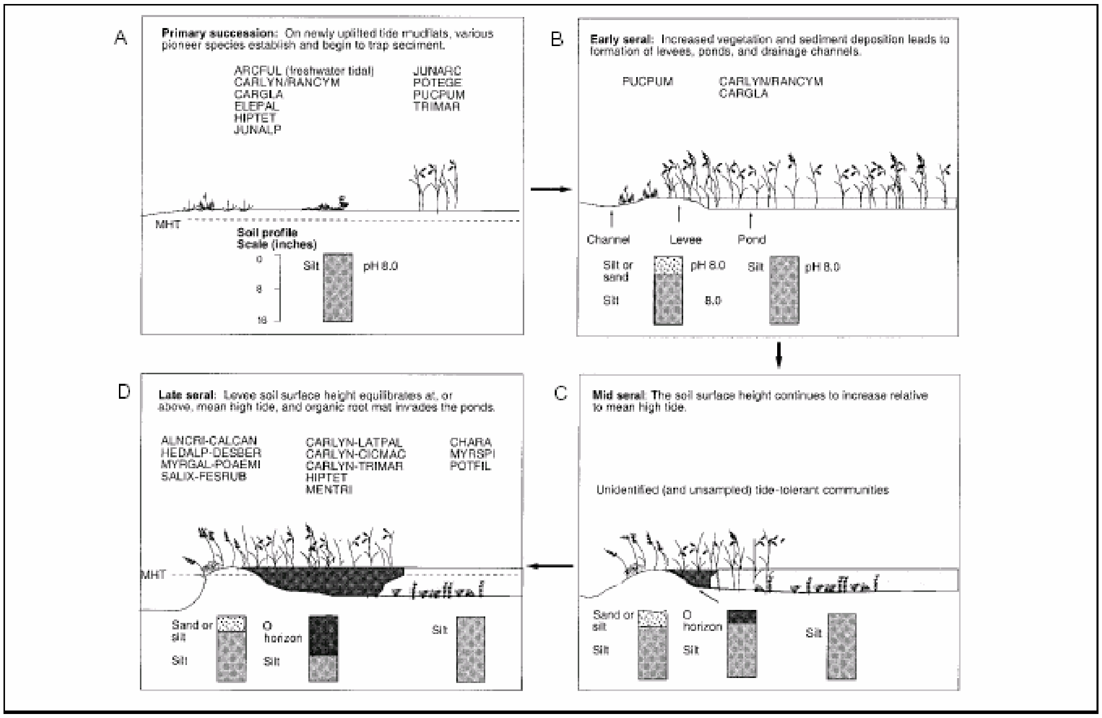


Figure 4.11-Idealized cross-section of vegetation succession and soil and landform development on tidal marshes (Boggs 2000, Figure 14).

Soil influences on vegetation development

Continuous changes in the river channels on outwash floodplains limit the time available for vegetation to progress into forested communities. These changing channels erode established vegetation, and 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. This keeps the water tolerant vegetation in an herbaceous or shrubby stage with specific plant species that are more tolerant of wet soils.

The infiltration and permeability of the soil, which influence the drainage characteristics, probably have the greatest influence on the 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 1960's to tall, dense shrub, spruce and cottonwood in the late 1980's and 90’s.

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.

Marsh (1996) determined that "*Equisetum* appeared to contribute to the community productivity by acting as a phosphorus pump, supporting nitrogen-fixing microorganisms, and producing high quality litter that decomposed rapidly". Because of its deep roots, *Equisetum* is able to pump phosphorus up from the C-horizon contributing to the O-horizon nutrient pools (Marsh 1996).

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 avalanches can cause trees to be blown over in front of the snow avalanche. Scattered windthrow commonly occurs along forest edges due to the high winds that frequent the Delta.

Insect and Diseases

Insect and diseases are two disturbance regimes that can shape forest composition, structure and development. In this area, these agents most commonly affect forest ecosystems on an individual or group of trees basis, not on a landscape scale. In 1996 and 1997 a Western black-headed budworm outbreak caused quite a bit of defoliation of spruce and hemlock in and around Cordova including the West Copper River Delta. About 30,000 acres of defoliation were observed in those years in Prince William Sound altogether. No outbreaks were observed in 1998-2000, however nearly 21,000 acres were affected in 2001, a minor portion occurring in the analysis area. These outbreaks are cyclical in nature, characterized by a rapid increase in numbers followed by rapid declines 1 to 5 years later.

Moose

Moose may have a role in increasing plant productivity even though they consume large quantities of vegetation. Moose 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 only show what has been harvested since the 1950's. The timber was used for fuel, houses, boats, railroads, mining timbers, fish wheels, and canneries. Less than 150 acres were harvested on the Copper River Delta from 1950 to 1980. The majority of the commercial timber harvest occurred in the late 1980's and early 1990's on Eyak Native Corporation lands. An estimated 8,670 acres was harvested in less than 10 years. Timber harvest in the area has gradually declined over the years until it only occurs in small areas or as single tree harvest for personal use. Table 4.4 displays the amount of harvest that has taken place in the area. Commercial harvest since the 1980's has occurred on Eyak Native Corporation land only. Personal use sawtimber and firewood has been harvested from State (by airport) and National Forest System lands. Scattered windthrow occurs every year in the area, most frequently along edges of old and newly clearcut harvested areas.

Table 4.4-Recorded harvest in analysis area

Year	Acres harvested – National Forest	Acres harvested - private
1900 - 1949	0 recorded – scattered select harvest	
1950-1969	75 acres, plus scattered select harvest at 17 sites	
1970-1979	34	
1980-2002	4 – personal use, plus select harvest	8,670 (Eyak), 75 (State)

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. There is a demand for firewood, houselogs, and sawtimber from accessible National Forest System lands near Cordova. This demand for wood from National Forest System lands is expected to increase as the material left on the harvested areas on Eyak Native Corporation lands deteriorates and the 2 MMBF of wood cut and decked from around the airport in 1998-99 is depleted. About 70 permits (10 MBF each) have been issued for this decked timber each year for the past two years. It is expected that this decked wood may last a couple more years.

The number of households using wood for heat is estimated to be about 180 (Kesti 1997). A five-cord average for each household would result in 900 cords or 360 MBF being harvested per year. Assuming an average volume of 12 MBF per acre, harvesting 360 MBF per year would result in 30 acres of clearcut harvest. If an area were thinned instead of clearcut, more acres would be needed to meet demand. At this time there is only one area accessible by a road on National Forest that is managed for personal use firewood and it is being thinned from below to retain large diameter trees for goshawk habitat. A silvicultural prescription and harvest plan were prepared in 1997 (Kesti 1997).

As spruce becomes more established on the delta, there may be potential for thinning the smaller diameter trees to provide complex forest structure sooner. However, the public has not been interested in cutting trees less than 12 inches in diameter.

Invasive Plant Species

In 1997, a basic inventory for non-native plant species (including invasive species) was conducted in the Copper River Delta area (Duffy 2002). The surveys were limited to the "front-country," with an emphasis on areas of human disturbance such as roads, trailheads, and recreation sites. 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. Twenty-five taxa of non-native plants were found at the survey sites in the Copper River Delta area (Duffy 2002). Of these 25 taxa shown on Table 4.5, 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 4.5. As defined in Executive Order 13112[1], 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[2].

Table 4.5-Non-native plant taxa observed during the 1997 surveys in the Copper River Delta area (Duffy 2002).

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[3]	ox-eye daisy
Lolium perenne ssp. *perenne*[4]	perennial ryegrass
Matricaria discoidea[5]	pineapple weed
Papaver nudicaule ssp. *nudicaule*	Iceland poppy
Phleum pratense	Timothy
Plantago major var. *major*	common plantain
Plantago major var. *pilgeri*	Pilger's common plantain
Poa annua	annual bluegrass
Poa pratensis	Kentucky bluegrass
Poa trivialis	rough bluegrass
Ranunculus repens	creeping buttercup

[1] http://www.invasivespecies.gov/laws/execorder.shtml
[2] http://plants.usda.gov/
[3] synonym = *Chrysanthemum leucanthemum* L.
[4] synonym = *Lolium perenne* L.
[5] synonym = *Matricaria matricarioides* (Less.) Porter

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

Duffy (2002) summarizes his survey of the area with the following statements:

- 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).
- Non-native plants were, by and large, confined to areas of great human modification and use, and nearly disappeared beyond the road corridors.
- The number and abundance of non-native species declined as distance from Cordova increased.
- A low number of both non-native and native species is present in the biophysically harsh Copper River Ecological Subsection.
- 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.
- 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, *Isoetes truncata* in the West Delta landscape analysis area. 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 - maritime beaches, upper beach meadows, well drained open areas
Botrychium yaaxudakeit - maritime beaches, upper beach meadows, well drained open areas
Carex lenticularis var. dolia - 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 - maritime beaches, upper beach meadows
Puccinellia kamtschatica - maritime beaches, upper beach meadows
Romanzoffia unalaschcensis - forest edges, streamsides/riverbanks, rock outcrops
Stellaria ruscifolia ssp *aleutica* - lake margins, marshy areas, alpine & subalpine habitats

Wildlife

Vegetation changes resulting from the uplift of the Copper River Delta during the 1964 earthquake have affected many species of wildlife. 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. Of special concern is the change in vegetation initiated by an earthquake in 1964 that uplifted the area 6-12 feet. 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 in south central Alaska, representing the largest breeding population of trumpeter swans in North America (Groves et al. 1998) (Figure 4.12).

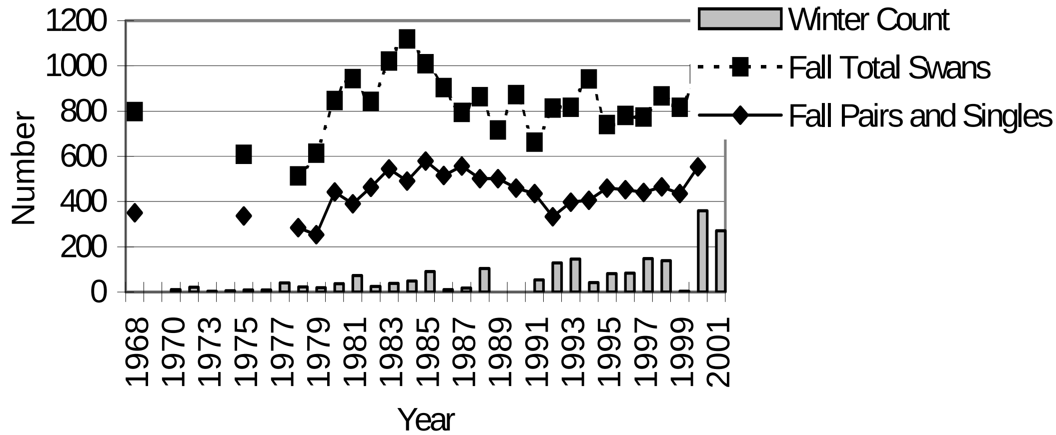


Figure 4.12-Winter and fall counts of trumpeter swans on the Copper River Delta

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 southcentral 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 (Figure 4.13). The most recent population estimates distinguishes the subspecies as one of the numerically smallest populations of Canada geese in North America.

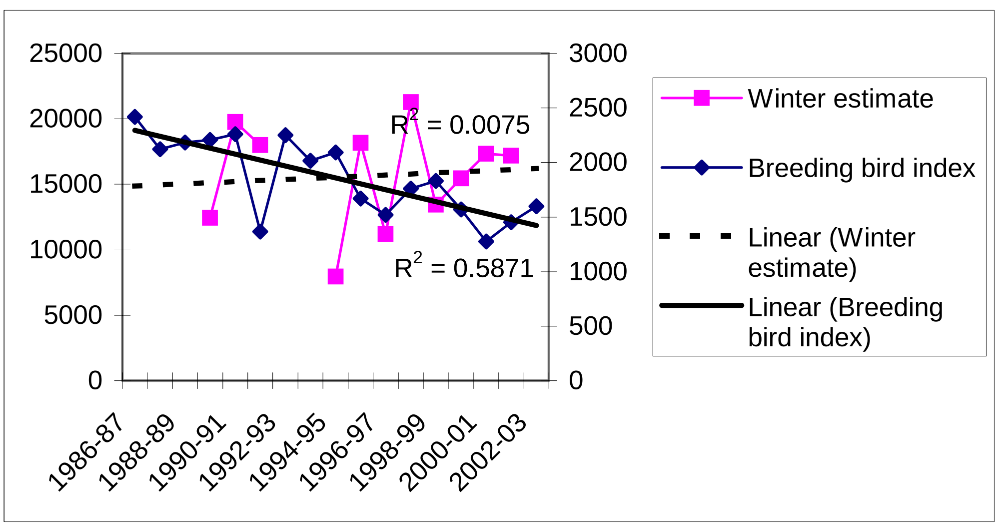


Figure 4.13-Population trend of dusky Canada geese, as measured by winter population estimates and a breeding bird index.

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. Periodic tidal flooding maintained broad expanses of sedge and salt-tolerant forb habitats dissected by an extensive network of drainage channels and sloughs. Prior to the earthquake, geese selected mixed forb/low shrub nest sites on the slightly elevated slough levees (Trainer 1959). Before the earthquake, avian nest predation was low, mammalian predators rarely frequented the lower 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).

The 1964 earthquake uplifted the entire delta 1.8-3.4 m (Remnitz 1966, Thilenius 1995). 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 (*Salix* spp.) and alder (*Alnus sinuata*). Nest losses from brown bear (*Ursus arctos*), coyotes (*Canis latrans*), and red fox (*Vulpes fulva*) 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 (Fig. 2)(Pacific Flyway Council 1992, Bromley and Rothe 1999).

The precipitous decline in the early 1980's 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).

Since 1984, more than 850 artificial nest islands have been installed on the Copper River Delta, Alaska to enhance nest success of dusky Canada geese. In summer 2002, Cordova Ranger District Personnel visited the remaining 357 islands to monitor nesting and conduct maintenance. Eighty-eight (81%) of the 108 dusky nests found were successful, which is as high as the program has produced (Meyers et al. 2002). From the successful nests, 387 goslings were hatched. Nest success on artificial islands has averaged 64% between 1984 and 2002, double the success at natural sites (32%) in the area.

Moose

The moose population on the west Copper River Delta has remained relatively stable through the 1990's. Recent moose population estimates for Unit 6C on the Copper River Delta have been 354 and 341 moose for the winters of 2000/2001 and 2001/2002, respectively (Figure 4.14). Preliminary results from the moose body condition study have shown Copper River Delta to moose to be in excellent condition, indicating little competition for available browse at current population levels (Meyers and Logan 2002). Although the population has shown slow growth or a stable trend, it has not increased towards the population objective as rapidly as expected.

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). Between 1987-1989, calf survival to 30 June (the date before which 94% of calf losses occurred) ranged from 0.03 to 0.24 and recruitment varied 0 calves/100 females to 36 calves/100 females (McCracken et al. 1997). Although recruitment values for this population over time are not known, the percent of calves in the population has fluctuated since 1988 (Figure 4.15).

Stephenson et al. (1998) evaluated the use of a rotary axe to treat stands on moose winter range, where willow (*Salix spp.*) had become senescent and alder had begun to dominate. Alder (*Alnus sinuata*) mass declined on treated sites while current annual growth of Sitka willow (*Salix sitchensis*), increased (Stephenson et al. 1998). This method has the potential to increase moose browse on the winter range that has decreased in productivity due to plant succession on the Delta.

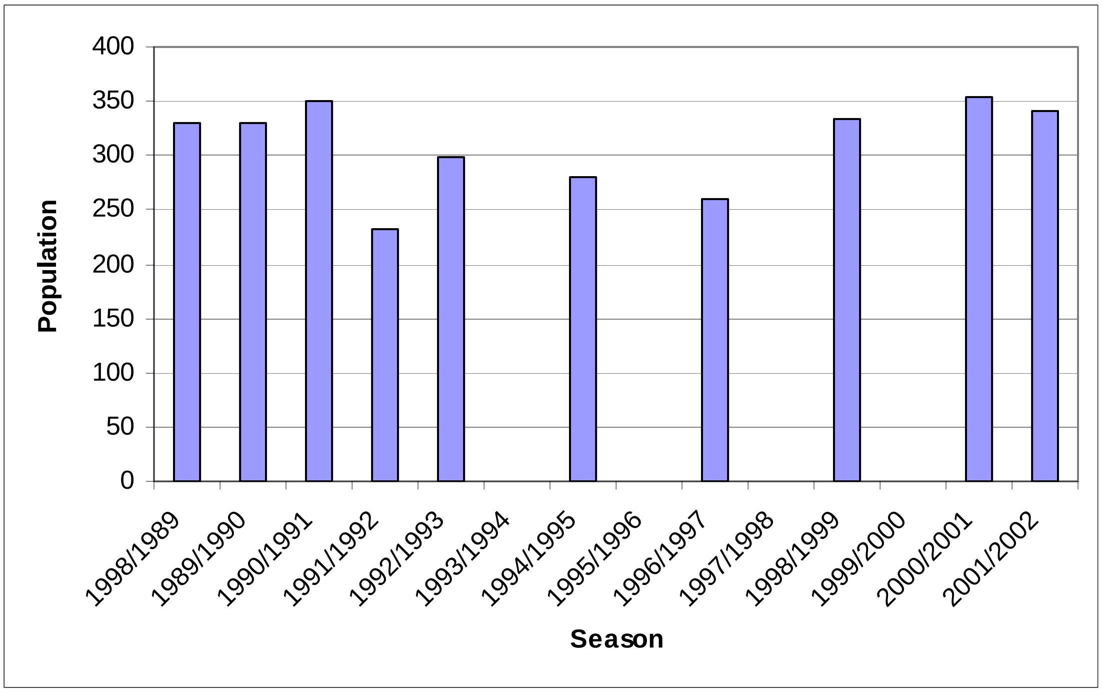


Figure 4.14-Moose population in Unit 6(C) as estimated from counts aerial counts. Missing bars represent years that no survey was conducted.

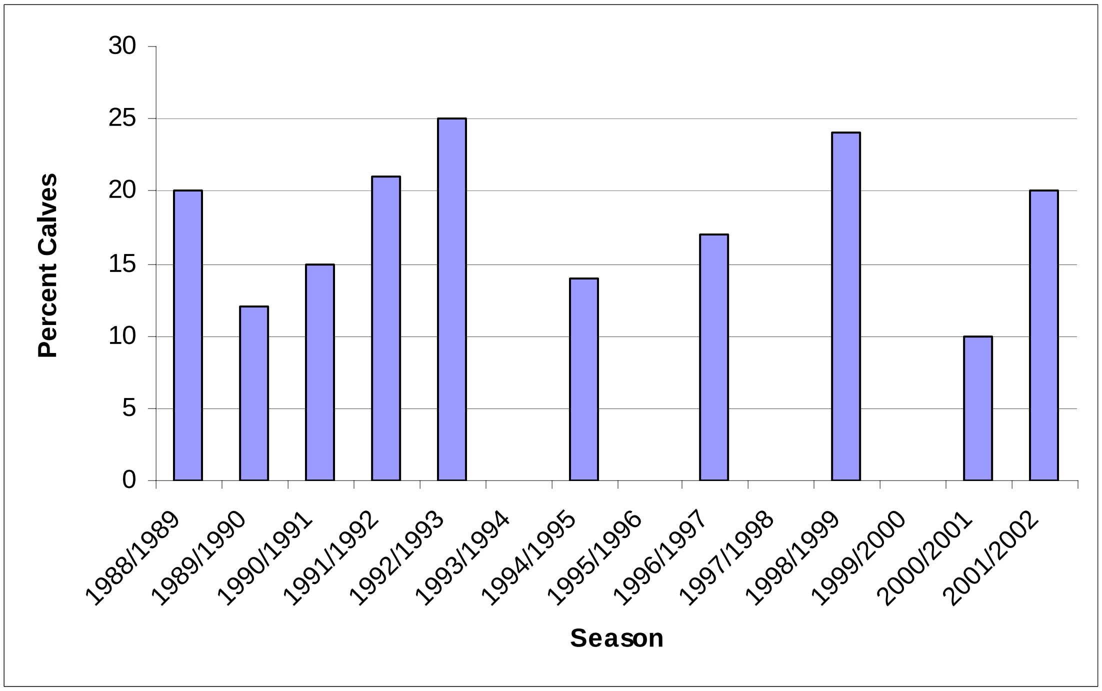


Figure 4.15-Percent of all moose counted on aerial surveys that are calves in Unit 6(C) moose population. Missing bars represent years that no survey was conducted.

Sport and Subsistence Hunting

Subsistence uses of wildlife resources within the analysis area date back to prehistoric times. Native Eyak Indians and Chugach Eskimos inhabited the region historically, making use of abundant fish and game resources (Stratton 1992). Europeans first explored the area in the late eighteenth century and the town site at Cordova has had continual occupation since the early 1900's. Today, 98% of Cordova households use natural resources and 88% of those households harvest these resources themselves (Stratton 1992). Thirty percent of Cordova households participated in subsistence hunting, while others fished, trapped, and gathered plants.

In recent times, harvest of most wildlife has been managed by ADF&G. The USFWS has managed seasons and bag limits for migratory waterfowl such as Canada geese and ducks. ADF&G provides for many subsistence uses of wildlife through their general hunting and trapping regulations for black bear, brown bear, Sitka black-tailed deer, mountain goat, moose, wolf, wolverine, beaver, coyote, red fox, lynx, red squirrel, spruce grouse, ptarmigan, and hare on the Copper River Delta.

Federal management of subsistence harvest began in 1990. Customary and Traditional (C&T) determinations have been made for black bear, mountain goat, moose, and wolf in Game Management Unit 6C, which includes the West Delta landscape analysis area. These species make up the bulk of subsistence wildlife uses on the Copper River Delta. Details for how these subsistence hunts have evolved follow in each species account below:

Black Bear - Rural residents of Units 6(C) and 6(D), have a C&T determination for black bears in Unit 6(C), except that there is no federal subsistence priority for residents of Whittier. Approximately 5% of Cordova households reported using black bear in 1988 (Stratton 1992). The federal harvest limit is one bear from September 1 through June 30. Currently, ADF&G regulations also allow the harvest of one bear by residents and nonresidents of Alaska, and the same season length; therefore, all harvest takes place under state regulations. In times of shortage, subsistence users would have priority over other users.

Mountain Goat - Rural residents of Units 6(C) and 6(D) have a C&T determination for mountain goats in those units. There is no federal season for goats in Unit 6(C) since all subsistence needs are currently being met by the State managed registration hunt for mountain goats in that unit, which includes this analysis area. Less than 3% of households reported using mountain goat in 1988 (Stratton 1992). The season for mountain goats runs from September 15 through January 31.

Moose - Moose are not native to the Copper River Delta so no long-term use of them in this area is known. Moose have been heavily used for subsistence in areas where they occur historically and the introduced moose population on the delta has become very important to the local community, with 52% of households reporting using moose in 1988 (Stratton 1992). Hunting began in 1960.

The ADF&G managed harvest of moose on the Copper River Delta until 2000 when the first federal subsistence hunt for cow moose was implemented. Prior to 2000, Unit 6(C) was open to all state residents by a draw permit system. Up to 20 bull moose and 10 cow moose were harvested annually. Currently, the ADFG and the Cordova Ranger District of the USFS manage moose harvest on the Copper River Delta, cooperatively. Residents of Units 6(A), 6(B), and 6(C) have a C&T determination for moose in Unit 6(C). Fifteen bull moose and 5 cow moose draw permits are issued to federal subsistence users by the USFS through a random drawing to Cordova residents only while 5 bull moose draw permits are issued by ADF&G. The 5-cow harvest represents the entire cow harvest for the unit. There is a high demand for available permits with 683 Cordova residents applying for the 20 permits in 2002. Since 2000, a permit has been issued each year to the Native Village of Eyak to harvest 1 bull moose for their annual Memorial/Sobriety Day Potlatch.

Sitka black-tailed deer - Currently, state bag limits in Game Management Unit 6 allows the harvest of 5 deer by state residents and no special subsistence season exists. This species does not typically inhabit the analysis area, but it is common in other parts of Unit 6.

Wolf - Residents of Units 6, 9, 10 (Unimak Island only), 11-13 and the residents of Chickaloon, and 16-26 have a C&T determination for wolves in Unit 6(C). Five wolves may be harvested between August 10 and April 30.

Condition and trends of heritage resources

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:

1) River valleys, lake and river systems providing passes or portages across larger land masses;
2) All areas between mean high water and 150 ft. in elevation above mean high water, regardless of slope angle;
3) Areas of former lode and placer mining activity;
4) 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;
5) Caves, rock shelters, and igneous rock formations known for caves and rock shelters;
6) Known sources of potential raw materials;
7) Other areas identified through literature or oral history research/sources.

Currently known cultural resources are primarily within the Copper River Highway corridor. Although historic Native Alaskan cultural resources are among those known to be present, no prehistoric resources are known at this time within the analysis area. 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 or along Forest trails.

The revised Forest Plan states that the desired future condition for cultural resources is 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. These are listed in the West Delta Heritage Resource Report (Yarborough 2002).

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. An example of indirect disturbance is the trail in the Mile 18 area of the Copper River Highway, which began as a minor user developed trail. Increased use has resulted in a need for the District to address erosion and possible damage to a cultural resource site crossed by the trail.

An example of a direct impact to a cultural resource is the proposal to remove and/or demolish the McKinley Trail Cabin. It is significant as one of only two post-World War II recreation cabins on the Forest. The proposal to build a new accessible cabin in the same area requires an evaluation of the cabin and the associated midden for National Register eligibility. If determined eligible, a mitigation plan will be made with the State Historic Preservation Officer. Another example of direct impact is the maintenance of historic trails, such as the Pipeline Lakes Trail, which may have corduroy or other types of tread. The link between the Pipeline Lakes Trail and the Civilian Conservation Corps makes it eligible for the National Register of Historic Places. A preservation plan for such trails is needed for future maintenance.

ANSCA recognized the importance of Native Alaskan historic and cemetery sites which may no longer be used, but are still culturally significant, and allowed for their selection by and conveyance to Regional Native Corporations. Currently, three of these selections are in the vicinity of the historic village of Alaganik, which incorporate Eyak related sites and are 2.72 acres, 240 acres, and 160 acres in size (Figure 4.16). It is expected that these selections will eventually be conveyed. This status should be considered for all projects within a mile of the highway between Mile 18.5 and 22.

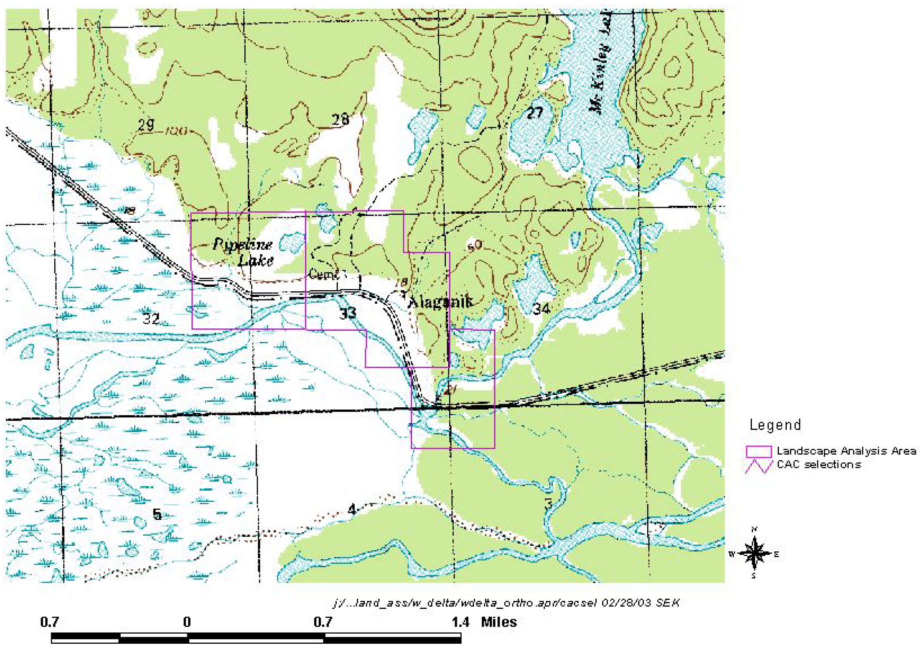


Figure 4.16 -ANSCA selections by CAC around mile 18-22 of highway.

Over 99% of the analysis area has not been inventoried for cultural resources, resulting in the Forest not complying with NHPA section 110 and Executive Order 11593. Of the 35 known cultural resources in the analysis area, 10 either need to be documented and evaluated for the National Register of Historic Places or need to have evaluations and nominations completed. The one known historic building that may be eligible for the National Register has not been rehabilitated, and no management or maintenance plans are in place for it. Interpretive signs are located at the Mile 22 picnic site and are being installed at the McKinley Lake Mine.

Although there might be minimal management desired for an 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

Campgrounds

In the 1988 Delta Recreation Plan, a site near Snag Lake on the north side of the highway at Mile 18 was identified as a potential campground. Forest Service engineering staff considered the road construction cost prohibitive. The area east of Sheridan Lake and south of Sherman Glacier was also considered. Again road construction and maintenance costs plus wildlife and fish concerns eliminated the site from further consideration. The Childs Glacier site was selected for several reasons. First, it is a destination site with public support recommending camping facilities. Second, the two 40-acre parcels at the Childs Glacier/Million Dollar Bridge area were specifically withheld from conveyance to Chugach Alaska Corporation (CNI Settlement Agreement of 1982) to help fulfill the need for public recreation and transportation facilities in the area. Many of the other possible sites within this analysis area are wetlands and the cost of constructing in wetlands and the likelihood of being granted a permit by the Army Corps of Engineers eliminated these sites from further consideration. Another consideration is the availability of non-National Forest System lands. Any future consideration of additional camping facilities needs to consider whether the Forest Service would compete with the private sector.

Trails

Of the 22.1 miles of trail within the analysis area, 7.4 have been constructed during the last 15 years in an effort to meet the growing demand and provide new opportunities such as cross-country skiing, alpine hiking, family hikes and interpretation. 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 "fully-developed" (accessible) boardwalk to "developed" to "primitive" to winter cross-country ski trails. The McKinley Lake Trail provides access to two public recreation cabins while Sheridan Mt. Trail provides access to backcountry alpine areas offering remote camping opportunities. To meet future demand, the Forest Service will need to address the deferred maintenance backlog for trails and bring them up to standard (Sheridan Mt., Haystack, & Alaganik Boardwalk), reestablish abandoned trail sections (Pipeline & McKinley Lake), and identify easements that could offer new access or opportunities.

Because of the emphasis on new construction, the deferred maintenance backlog has increased. Future areas of emphasis within the analysis area are Sheridan Mountain Trail, Alaganik Boardwalk, Haystack Trail and the Copper River Trail.

Motorized and non-motorized opportunities

The public demand for both motorized and non-motorized areas is high and the trend is expected to continue. This analysis area generally falls within the home range boundaries. The home range concept identifies areas within close proximity to a community as an area where commercial activities such as fish and game guiding and heli-skiing are indirect conflict with resident activities. Therefore, commercial activities such as these will not be significant in this analysis area.

The Forest Plan identifies areas open and closed to motorized use in winter and summer. Winter and summer motorized recreation access maps are displayed in Figure 1.4, page 4. With a few exceptions, during summer, the lands north of the highway are open to all motorized use and the lands south of the highway are closed (except for subsistence uses) to all motorized uses. During winter, both sides of the highway are open to all motorized use. The exceptions to these generalities are: subsistence uses, private lands, EVOS buy back lands, and winter moose range. Currently, the regulations associated with the EVOS lands and the need to cross them in order to access public lands open to OHV activities has become a major issue.

Another major mode of off –road transportation is airboats. In the past the number of airboats and the areas they used 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 (accessing Isolated SUP Cabins, hunting, fishing, etc.) has elevated the priority of this issue.

OHV Closures - No major changes occurred regarding OHV restriction in the West Delta analysis area as a result of Forest Plan Revision. However, administration of Eyak Native Corporation lands returned to the Forest Service through the EVOS settlement has highlighted several new concerns. Easement locations, access restrictions, and further defining of OHV's are currently being worked on**.**

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 friend and relatives. As commercial development grew (Outfitters, Guides, and Bed & Breakfasts), watching wildlife became a secondary benefit to the primary activity. Only recently has it been deemed viable as a commercial venture. Providing transportation to shorebird areas with ornithological expertise is a rapidly growing business in the spring. Shorebird migrations follow well-established paths along the coastline accessible by boat on Alaganik Slough. Viewing big game as bear, moose, and goat is also popular, but no concentrations at specific locations occur as with shorebirds.

Outfitters and Guides

Outfitting and guiding services in this analysis area are limited due to the fact that consumptive special use permits (hunting and fishing) are not authorized. A large portion of the analysis area is considered "home range" and is managed for local and unguided visitors. Special use permits are allowed for non-consumptive activities such as hiking, viewing wildlife and scenery, and boating (rafting, jet boating, kayaking, etc.) Demand for these types of activities and others are rising causing capacity concerns and user conflict issues.

Although this area has no authorized special use permits for consumptive outfitted or guided activities, unauthorized use occurs and is on the rise. Numerous entrepreneurs have started outfitting and/or guiding fishing clients on the delta. The majority of these clients visit during the August-September coho salmon season but several operators are targeting additional opportunities. This illegal activity is a critical element for the management of this analysis area and needs priority status in our law enforcement workload.

Mineral resources development

Mineral development is often perceived as causing negative impacts to surface resources and conflicting with other uses of the land. Mineral development can be and is managed to minimize such impacts. However, mineral development should not be an issue in the analysis area since potential is low.

Locatable Minerals

Although much of the land is open to mineral entry, there are no 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 and that mineral development will likely not occur in the analysis area. The lack of mining history for the analysis area also indicates a general lack of interest for prospecting and development of mineral resources in this area. Minerals are often found and development occurs where minerals have been found previously. Locatable mineral development is unlikely to occur in the analysis area and therefore should not be an issue.

Leasable Minerals

The Orca Group is not known to host oil, gas or coal deposits. There are no active leases and no permits for exploration within the analysis area. Oil, gas, or coal development is highly unlikely to occur in the analysis area based on the geology, lack of known deposits, and lack of interest in searching for them. Since leasable minerals are not known to occur, leasable mineral development should not be an issue.

The highly favorable (for undiscovered mineral resources) 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 has been filed for metallic minerals in the CRA. There is a complete lack of mining history in the CRA tract and a lack of industry interest in searching for mineral deposits. Leasable metallic mineral development should not be an issue.

Salable Minerals

The geology is highly favorable for deposits of this type and there is a history of the development of sand and gravel deposits along the Copper River Highway. State and private lands can probably supply the local need for common variety mineral materials.

An exception to this might be the sand deposit at Mile 27. It is well sorted and well sized for asphalt manufacture. The Forest has a history of making this material available and that will probably continue. Since materials sales are discretionary, the Forest may 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.

Mineral materials do occur in the analysis area and these deposits have been developed and utilized both on and off of National Forest System lands within the analysis area. The Revised Forest Plan provides for, but does not require that mineral materials be made available for local purposes. The utilization of the Mile 27 sand results in minimal disturbance since the area is unvegetated and the wind-blown sand is essentially a renewable resource.

Chapter 5 – Recommendations for inventory, monitoring, and projects

The Copper River Delta has been the focus of much research. It is particularly well suited for interdisciplinary research that can increase our understanding of the ways plants, animals, including humans, adapt to changing environments. The Delta presents an excellent opportunity to learn more about ecological processes that have not been influenced greatly by humans in the past 50 years (Christensen and Mastrantonio 1999). Universities involved include Yale, Oregon State, University of Idaho, and University of Alaska. The Pacific Northwest Research Station has often cooperated with this research and conducted its own studies. Additional wildlife and vegetation projects proposals were added in 2007 to reflect regional and national emphasis areas.

Inventory and monitoring proposals

Fish

1. Survey fish habitat (spawning, rearing, overwintering) in the major anadromous streams in the analysis area. Streams could be classified in order of importance based on relative abundance of the adult escapement documented in this analysis: Ibeck Creek, Salmon Creek, McKinley Lake and its tributaries, Mile 18 and Goose Meadows, Lake Elsner, Black Hole Creek, 25-Mile area, and Pipeline 4. This includes "ground-truthing" channel types to determine accuracy of existing information.
2. Determine status and relative abundance of coho, Dolly Varden, and cutthroat trout.
    a. Conduct a creel census to determine impact sport fishing is having on cutthroat trout and Dolly Varden.
    b. Identify key habitats and estimate population numbers of Dolly Varden and cutthroat trout in the McKinley Lake watershed.
    c. Determine Cutthroat trout growth, movement, and use of Pipeline Lake 4 and the outlet stream.
3. Monitor the escapement of spawning adults in the major anadromous streams in the analysis area. Can use on-the-ground escapement counts in small, relatively easy to access streams, but we may need to develop alternative methods on larger, and more remote streams. A comment made at the August 2002 open house, was that the Forest Service should coordinate with ADF&G on aerial and land based surveys. Suggestions made included exploring techniques for land-based counts such as video, sonar, towers, etc. and have the Forest Service provide land based counts in August and September for potential use by ADF&G for in-season management.
    a. A counting tower or weir could be used on Ibeck Creek to obtain escapement counts of coho salmon. Ibeck Creek coho salmon appear to constitute a significant portion of the total spawning run in the analysis area. This survey method may assist in managing the commercial coho salmon fishery. ADF&G is a potential partner.

   b. Install a series of fish wheels on the Alaganik Slough and the major tributary streams to obtain adult escapement estimates for sockeye and coho salmon in the McKinley Lake watershed. This survey may assist in managing the commercial salmon fishery. ADF&G and the Native Village of Eyak are potential partners.
4. Species use and population estimates of fish in the gravel pit ponds in the Mile 18 stream system.
5. Monitor smolt production, timing, and life history patterns of coho and sockeye salmon in the McKinley, Saddlebag and Salmon creek subwatersheds by using a screw trap operation at Mile 22 bridge on Alaganik Slough in the spring. ADF&G is a potential partner.
6. Continue to monitor fall sportfish harvest by distributing fish creel census questionnaires to visiting anglers leaving Cordova at the airport. Incorporate the Copper River Watershed's Fishwatch data on weekend use during the summer along the Copper River Highway.
7. Survey stream habitat in areas receiving high use by anglers in the fall. Survey locations should include: Ibeck Creek around the Copper River Highway bridge, Scott River around the 11-Mile bridge, Alaganik Slough around the boat ramp and angler access trail, Goose Meadows (Mile 20), Mile 18, and Alaganik Slough around the Mile 22 bridge. Survey trails crossing or paralleling streams for current or potential erosion problems that could affect fish habitat.
8. Inventory and survey culverts in the analysis area to make sure they are affording passage to all species and life history stages of fish.
9. Collect baseline water quality parameters across the delta.

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. It is the goal of the Forest's Heritage Program to completely inventory the cultural resources of the Forest and develop a database. For this analysis area, there are two options depending on funding levels. Refer to the Heritage Resources Report for details.

   - ***Option 1*** would involve completing the inventory and evaluation of cultural resources of the analysis area over a period of 20 years and building a predictive model from existing samples after completing archaeological survey of 78,397 acres, or 25% of the analysis area. This 25% sample would take an estimated five years, assuming survey of approximately 15,000 acres per year.

   - ***Option 2*** would involve completing the inventory and evaluation of cultural resources of the analysis area over a period of 40 years and building a predictive model from existing samples after completing archaeological survey of 78,397 acres, or 25% of the analysis area. It would take an estimated 10 years to complete this 25% sample, assuming survey of approximately 7,500 acres per year.

Vegetation Resources

1. Update timber and vegetation databases to include Eyak Native Corporation land information 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. Determine areas where thinning may be used to benefit fish and wildlife and may provide a source of fuel wood or other products.
3. 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).
4. 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).
5. 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. Locate and document bald eagle nests on the Copper River Delta.
2. Monitoring northern goshawk population trends.
3. Determine current dusky Canada goose habitat relationships in order to determine possible habitat changes that may influence goose populations as succession occurs on the Copper River Delta.
4. Conduct ground based nest searches on random plots on the West Copper River Delta to monitor dusky Canada goose population. Monitor goose harvest on Copper River Delta for presence of dusky Canada geese.
5. Determine the number of trumpeter swans wintering on the West Delta, identify key components of trumpeter swan nesting habitat, and monitor the trumpeter swan population on the Copper River Delta.
6. Monitor moose population trends on the Copper River Delta, determine current moose habitat relationships in order to determine possible habitat changes that may influence moose populations as succession occurs in wintering areas on the Copper River Delta, and determine key winter areas for moose. Assess moose calf mortality and primary predators.
7. Develop a management plan to ensure the longevity of these areas. Implement habitat enhancement outlined in the moose management plan and monitor its effectiveness.
8. Conduct goat harvest unit surveys to maintain a sustainable harvest of mountain goats for subsistence take and identify home range fidelity and seasonal movements of mountain goats.
9. Assess distribution and density of European black slugs on the Cordova Ranger District.
10. Conduct bird surveys on random plots under the Alaska Landbird Monitoring System (ALMS).

11. Determine Rusty blackbird population, nest density and success, and habitat association and contaminant load of birds on the West Copper River Delta.
12. Determine gull nesting densities, habitat associations and nest success on Egg Island. Determine extent of toxicants in gull eggs on mainland and barrier islands.
13. Determine the spring /fall habitat use of waterfowl on the West Delta and vegetation characteristics of ponds used by migrating waterfowl.
14. Determine pond types on the delta and vertebrate and invertebrate species by pond type. Determine associations between pond type and vegetation succession. Develop "permanent" pond plots that are sampled on 5 year intervals to detect future changes.
15. Determine beaver dispersion and productivity on the West Delta and assess the extent of beaver habitat modification to vegetation and surface water area.
16. Determine nesting ecology and spatial distribution of horned grebes, red-throated loons and short-billed dowitchers.
17. Determine associations between water bird species habitat use and population trends over time across the West Copper River Delta.
18. Develop spring migration shorebird population estimator on the West Delta.
19. Determine species, distribution, and abundance of intertidal food resources on the mudflats.
20. Determine the effects of global warming on timing of bird arrival and nesting.
21. Inventory marine mammal habitat in the West Delta analysis area.
22. Determine ptarmigan habitat use.
23. Assess wildlife resources on small islands in the West Delta analysis area.
24. Determine wolf populations, habitat associations, and wolf population genetics on the West Delta.
25. Determine diet selection of river otters on the West Delta.
26. Determine wolverine diet selection and home range.
27. Monitor amphibian distribution and abundance.
28. Assist in development and execution of the annual Shorebird Festival.
29. Survey Research Natural Areas to evaluate effect of human activities.
30. Monitor motorized and non-motorized access to determine if Forest Plan direction is minimizing impacts to wildlife resources.

Potential projects for West 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, and the decision to implement or not would be documented in the appropriate decision document.

Table 5.1-Potential projects in analysis area listed in revised Forest Plan			
Projects by category	Year planned	Est. cost (M$)	Description
Trail Construction			
Goose Meadows Angler Trail (mile 20)	2002-2003	$60.0	Improve fishing access
One-eyed Pond sport fishing (mile-18)	2004	$10.4	Improve fishing access
Trail Reconstruction			
Pipeline Lakes Trail	2002-2004	$26.0	Reduce backlog of deferred maintenance
Sheridan Mountain Trail	2005-2006	$150.0	Reduce backlog of deferred maintenance
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 west delta)
Rehabilitate cabins on the Copper R. Delta	2004-2012	$120.0	Reconstruct 2 cabins to reduce backlog of deferred maintenance.
Mile 18 day use site *(one-eyed pond)*	2007-2008	$440.0	Improve existing picnic area.
Fish habitat enhancement and inventory			
Sheridan glacier stream channel	2002	$11.0	Plant native vegetation in riparian zone, Install structure to stabilize and improve streambanks.
Mile 17 Coho salmon habitat	2002-03	$94.0	Thin riparian vegetation, create habitat through off channel development
Cutthroat Trout habitat	2002-2005	$68.5	Cutthroat trout escapements to determine high use areas & enhancement opportunities; enhance 14 miles of stream.
Wildlife habitat enhancement			
Copper River Delta Dusky Canada Goose habitat	2002-2004	$370.0	Monitor & maintain 450 artificial nest islands. Put artificial hiding cover over nests to reduce bald eagle predation.

The IDT and public identified projects for the analysis area to meet the desired future condition as described in the revised Forest Plan. An open house was held in August 2002 where people expressed their concerns and ideas. Additional proposals were identified in 2007 to reflect national and regional emphasis areas. These potential projects would be further analyzed through the NEPA process with additional public involvement before a decision is made.

1. An idea raised was to develop and distribute an education program about cultural resources. The feeling was that the Native groups want people to respect and then understand and see what the ancient peoples of this area did. It was suggested that a research project on their behalf be carried out. The Forest Service should coordinate with the Eyak Native Corporation, Native Village of Eyak, Chugach Alaska Corporation, and the museum. The city is considering a new community center that includes a new museum.

2. Interpret cultural resources and human uses of the area, especially along the Copper River Highway. Consult with the Native Village of Eyak. Coordinate with the State in highway right-of-way.

3. Coordinate and work in partnership with the Native Village of Eyak (NVE) regarding inventory, interpretation, and possible NVE developed projects associated with the Old Eyak Native Village 14h(1) site, in the interim (which is likely to be several years), prior to the site being conveyed to the Chugach Alaska Corporation.

4. Stream habitat rehabilitation in the Lake Elsner area to mitigate degradation caused during logging. The Copper River Watershed Project and the Eyak Native Corporation are potential partners.

5. Pipeline Lakes 3 and 4 habitat rehabilitation/alteration to improve fish passage at the outlet and over-wintering conditions for cutthroat trout populations.

6. Improve drainage and stream crossing on Mile17.5 access road to reduce impacts to spawning fish.

7. Devise and conduct a study to examine catch and release mortality for the key species using different types of angling gear.

8. There is an opportunity to develop a barrier–free fishing access site as part of Alaganik day–use site or another developed site on the West Copper River Delta.

9. Another idea was to re-establish the old section of the Pipeline Lakes Trail to reopen an abandoned loop. Providing interpretive signs about this historic trail and the McKinley Lake Mine Trail would be educational opportunity. Both trailheads are within a tenth of a mile of each other and are located in an area of rich cultural history. The local native corporation is interested in conveying that information to its members and other visitors. Whether this trail location could serve multiple functions or would need to be relocated needs to be determined. A concern raised with re-establishment of this trail is the potential negative affects it could have on the 14 h(1) native grave/burial site the old trail crosses just prior to joining the road. Also, re-establishment of this trail would result in three junctions of a trail system to the highway within ¼ mile of each other.

10. Another comment was that the Forest Service needed to maintain existing trails before building new ones. Although maintaining existing trails would be the first priority, this would not necessarily preclude the option of constructing new trail while this was occurring.

11. Another concern was that the trails needed to be maintained at the interpretative areas along the spawning channels at Mile 26.

12. A question raised was "is there a place for a campground closer to town than Childs Glacier?" Most of the available National Forest System lands have problems with flooding, have limited ground suitable for construction, poor road conditions (Snag lake), or do not have any attractions. One option is to find out whether the Eyak Native Corporation has any plans for the old Cabin Lake campground or other sites.

13. Expansion of One-Eyed Pond (18 Mile) - When this area was developed in 1990, it was well known that the site had more potential for providing recreational opportunities. Development discussions have included a universally designed access trail around the pond to provide more fishing opportunities, more picnicking sites, and interpretive displays about fish and wildlife habitat and management practices in the area. Ideas include camping sites, a stream viewing boardwalk, and underwater viewing area. A master plan was started in 2003.

14. Mile 18 Anglers' Trail is a non-system trail created by people fishing 18 Mile Creek during the coho salmon season (Aug./Sept.). The conditions are similar to Alaganik and 20 Mile angler trails. In the past, the amount of use did not exceed the ground vegetation's ability to recover. However, in recent years use has increased to a level that mandates mitigation before resource damage becomes irreversible. In 2002, the District Fisheries staff began a trail material test project of 200 feet of experimental tread. The District will submit a CIP project to complete the trail. The proposal involves a trailhead at mile 18.3 of the highway across from the Muskeg Meander Trailhead. The trail would provide access to the Mile 18 system and also loop around the west and south side of the Haystack and connect about midway along the Haystack Trail. The project can address the escalating resource damage and fishing access needs, and increase the hiking options of the Haystack Trail users.

15. Mile 20 Anglers' Trail is another trail pioneered by people fishing the 20-mile system and Alaganik Slough for coho salmon in August and September. To date, no attempt to mitigate the resources damage has been undertaken; however, the district staff is considering this trail as a potential CIP project.

16. McKinley Lake Trail Extension. There are indications that the McKinley Lake Trail used to extend beyond the Lucky Strike mine. The terrain to the north and northwest of the Lucky Strike Mine appears to be suitable for extending the trail near the Sherman Glacier. From that point the next step would be connecting to the old Goat Camp Road. McKinley Lake Trail would be lengthened by about 5.5 miles.

17. The myriad of waterways on the delta has the potential to transport forest visitors to more areas of the delta 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). The maze of sloughs between Alaganik and Pete Dahl sloughs was partially mapped in 1987 but no additional work has occurred. Paddle trails on the Delta could increase the range of recreation opportunities and disperse visitors but to date remains untapped.

18. The draft Copper Sands RNA establishment record suggests it may be desirable to periodically schedule the removal of debris from the beaches of the RNA. Plastic waste, derelict fishing vessels and gear, and other miscellaneous trash introduced into the waters of the North Pacific makes their way onto the beaches of the RNA. The highly energetic shoreline environment has incorporated these wastes into the accumulating sand islands of the area. Items such as wooden posts with jagged metal objects attached, steel cables, and random debris are obstacles that can be hazardous to visitors or wildlife walking along beaches.

19. Remove invasive plants on Forest Service and adjacent lands with a priority on those species with the highest scores for invasiveness (Alaska Natural Heritage Program Score).

20. Develop LIDAR Classification on West Delta to assist in succession and pond ecology modeling.

21. Integrate beaver occupancy and influence into the current vegetation succession model of the Copper River Delta.

22. Move non-productive artificial nest islands to optimum ponds after artificial nest island plan is complete. Construct new artificial nest islands to replace damaged islands that were subsequently removed. Install a test set of artificial nest islands in dusky Canada goose sparse density nesting areas. Once installed monitor islands and compare nest success to islands in high density areas. Develop an action plan for the future direction of artificial nest island program.

23. Create wildlife interpretive signs and education brochures for visitors to the Chugach National Forest.

24. Develop a proposal to nominate the West Copper River Delta as a Long Term Ecological Research Site.

25. Develop and maintain GIS database of animal and habitat locations.

Implementation Recommendations

Copper Sands Research Natural Area

The draft establishment record for the area (Juday and DeVelice 2002) states that although the entire Copper Sands RNA is National Forest System land, the intricate and rapidly changing inter-digitations of state submerged lands makes cooperative approaches to management desirable.

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.

Soils and Wetlands

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.

The soil of the raised delta has a high erodibility factor. As long as there is a protective vegetation cover, erosion will remain minimal. Soil erosion on the raised marsh is presently restricted to sloughing of slough and river cut banks exposed in the 1964 uplift. If the protective vegetation of the raised marsh were removed, soil erosion from storm runoff would create channels that would eventually drain the ponds.

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 uplift from the 1964 earthquake increased drainage of slough levees and the new marsh. The increase in soil drainage created suitable hydrologic conditions for shrub and forest vegetation. 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 necessitate a second mapping effort on the Delta.

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 project 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.

Invasive 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 following text from the Revised Forest Plan (USDA Forest Service 2002b):

- Prevent introduction and spread of exotic plants and reduce areas of current infestation. (Revised Forest Plan, page 3-4)
- Identify infestations of exotic plant species and maintain infestation data in a standard database. (Revised Forest Plan, page 3-4)
- Treat infestations with a high potential to spread. (Revised Forest Plan, page 3-4)
- Incorporate exotic plant prevention and control into project planning and design. (Revised Forest Plan, page 3-25)
- Treatment measures may be taken on exotic plants and animals to minimize their impacts on ecological processes. (Revised Forest Plan, page 4-10, repeated on other pages)

Mineral resource development

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.

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Appendix A – Maps, Tables, and Graphs

Climate

The following Walter climate diagram (Walter 1984) is based on data from the Cordova FAA weather station located at the Merle K.Smith airport at mile 13 (EarthInfo, Inc. 1995). This weather station is in the central portion of the West Delta.

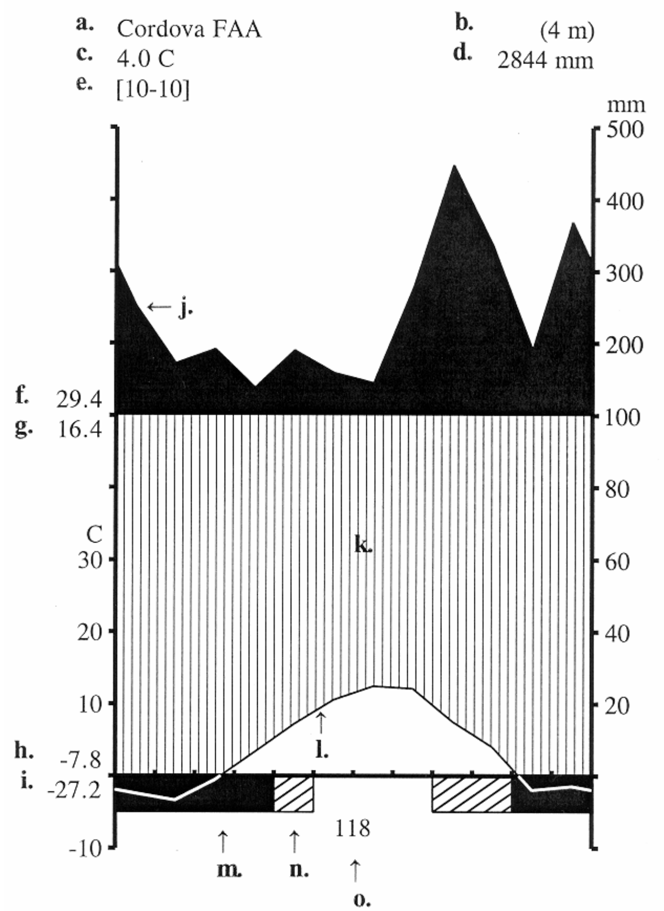

Figure A.1-Walter climate diagram for Cordova FAA weather station.

Abscissa: months, starting in January. Ordinate: one division = 10°C or 20 mm precipitation (note: above 100 mm of monthly precipitation, increments shift from 20 to 100 mm per division); a = station, b = elevation above sea level, c = mean annual temperature, d = mean annual precipitation, e = refers to 10 years of temperature and precipitation records (1985 through 1994 used for the diagram), f = highest temperature recorded over the 10 year period, g = mean daily maximum temperature of the warmest month, h = mean daily minimum temperature of the coldest month, i = lowest temperature recorded over the 10 year period, j = mean monthly precipitation curve, k = relative humidity season (vertical shading for monthly precipitation less than 100 mm, black shading for monthly precipitation greater than 100 mm), l = mean monthly temperature curve, m = months with mean daily minimum temperature below 0°C (black shading), n = months with absolute minimum temperature below 0°C (diagonal shading), and o = mean duration of frost-free period in days.

Hydrology

Stream miles for each process group are shown in Table A.1.

Table A.1 – Channel types present in the analysis area. Classification system and data from USDA FS AK region (1992), Data updated 1998

Code	Channel type description	Stream miles	Percent of total
AF1	Moderate Gradient Alluvial Fan Channel	0.9	0.1
AF2	High Gradient Alluvial Cone Channel	0.6	0.1
AF8	Glacial Alluvial Cone Channel	3.2	0.5
ES2	Narrow Small Substrate Estuarine Channel	44.7	6.7
ES4	Large Estuarine Channel	88.5	13.3
ES8	Broad Braided Glacial Outwash Estuarine Channel	19.6	2.9
FP3	Narrow Low Gradient Flood Plain Channel	8.3	1.2
FP4	Low Gradient Flood Plain Channel	6.1	0.9
GO1	Glacial Outwash Flood Plain Side Channel	94.3	14.2
GO2	Large Meandering Glacial Outwash Channel	29.3	4.4
GO3	Large Braided Glacial Outwash Channel	159.1	23.9
GO4	Moderate Width Glacial Channel	4.5	0.7
HC1	Shallowly Incised Muskeg Channel	0.8	0.1
HC2	Shallowly to Moderately Incised Footslope Channel	1.8	0.3
HC3	Deeply Incised Upper Valley Channel	5.1	0.8
HC4	Deeply Incised Muskeg Channel	1.4	0.2
HC5	Shallowly Incised Very High Gradient Channel	4.7	0.7
HC6	Deeply Incised Mountainslope Channel	12.4	1.9
HC8	Moderate/High Gradient Glacial Cascade Channel	0.8	0.1
HC9	High Gradient Incised Glacial Torrent Channel	7.2	1.1
MC1	Narrow Shallow Contained Channel	5.9	0.9
MC2	Moderate Width and Incision, Contained Channel	3.7	0.6
MM1	Narrow Mixed Control Channel	1.5	0.2
MM2	Moderate Width Mixed Control Channel	2.0	0.3
PA1	Narrow Placid Flow Channel	6.0	0.9
PA2	Moderate Width Placid Flow Channel	0.6	0.1
PA3	Shallow Groundwater Fed Slough	108.2	16.2
PA4	Flood Plain Backwater Slough	19.1	2.9
PA5	Beaver Dam/Pond Channel	16.0	2.4
L	Bodies of water (Lakes)	10.1 acres	1.5
	TOTAL	666	100

Vegetation

Figure A.2 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. It has not been updated since that date except for two polygons that were corrected for this analysis. One polygon encompassing State land in upper Chugach range was originally coded as “no data” (39,474 acres). For this analysis, it was assumed to be 85% snow and ice and 15% rock. 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. However, during an earlier analysis, it was estimated that there was a total of 9,032 acres of Sitka spruce and mixed hemlock-spruce forest on Eyak Native Corporation lands in the Sheridan River drainage (Kesti 1997). This would increase the forested acres component by 3%. This increase is not reflected in Table A.2.   Table A.2 does not include salt water (176,984 acres).

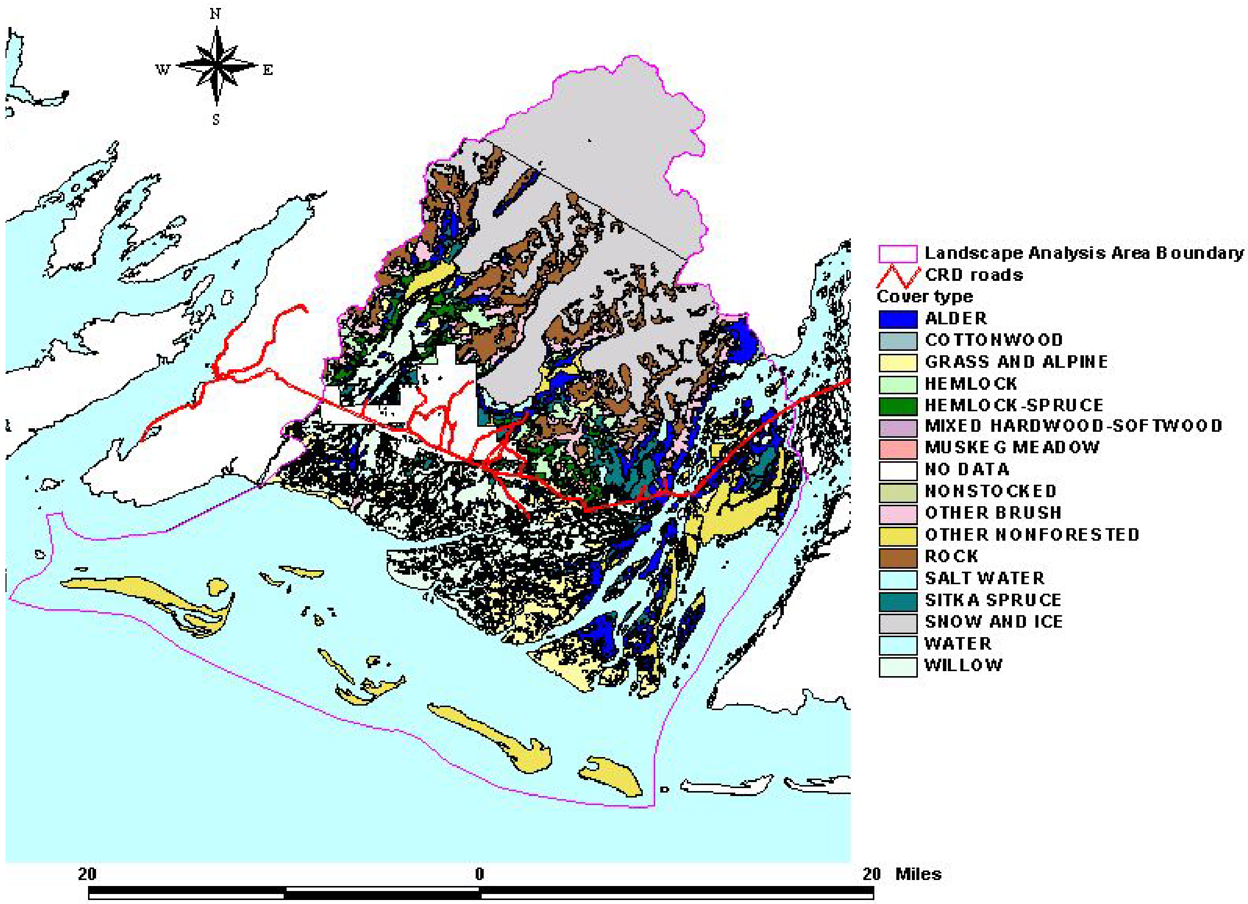

Figure A.2 – Vegetation cover from timber type maps for analysis area.

Table A.2-Vegetation characteristics of West Delta analysis area		
Vegetation Type	Acres	Percent of Area
Alder	22,497	7.2 %
Brush - other	12,678	4.0%
Cottonwood	894	0.3%
Grass and Alpine	22,388	7.2%
Hemlock	9,197	2.9%
Hemlock-Spruce	6,227	2.0%

Table A.2-Vegetation characteristics of West Delta analysis area		
Vegetation Type	Acres	Percent of Area
Mixed Hardwood-Softwood	33	~%
Sitka Spruce	12,646	4.0%
Muskeg	613	0.2%
Willow	43,652	14.0 %
Rock	33,866	10.8%
Snow and Ice	88,587	28.2%
Other nonforest	28,474	9.1%
Water	13,985	4.5%
No Data	17,848	5.7%
Total Area	313,588	100%

Wildlife

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

Table A.3 – Bird species detected on 2 Breeding Bird Survey routes on Copper River Delta 1993 - 1995	
Horned Grebe	*Podiceps auritus*
Red-throated Loon	*Gavia stellata*
Common Loon	*Gavia immer*
Great Blue Heron	*Ardea herodias*
Canada Goose	*Branta canadensis*
Trumpeter Swan	*Olor buccinator*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Blue-winged Teal	*Anas discors*
Green-winged Teal	*Anas crecca*
Ring-necked Duck	*Aythya collaris*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Bald Eagle	*Haliaeetus leucocephalus*
Red-tailed Hawk	*Buteo jamaicensis*
Northern Harrier	*Circus cyaneus*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Spotted Sandpiper	*Actitis macularia*
Least Sandpiper	*Calidris minutilla*
Short-billed Dowitcher	*Limnodromus griseus*
Common Snipe	*Gallinago gallinago*
Red-necked Phalarope	*Phalaropus lobatus*
Mew Gull	*Larus canus*

Table A.3 – Bird species detected on 2 Breeding Bird Survey routes on Copper River Delta 1993 - 1995	
Glaucous-winged Gull	*Larus glaucescens*
Arctic Tern	*Sterna paradisaea*
Rufous Hummingbird	*Selasphorus rufus*
Great Horned Owl	*Bubo virginianus*
Belted Kingfisher	*Ceryle alcyon*
Hairy Woodpecker	*Picoides villosus*
Downy Woodpecker	*Picoides pubescens*
Red-shafted Flicker	*Colaptes cafer*
Olive-sided Flycatcher	*Contopus borealis*
Western Wood-Pewee	*Contopus sordidulus*
Alder Flycatcher	*Empidonax alnorium*
Say's Phoebe	*Sayornis saya*
Steller's Jay	*Cyanocitta stelleri*
Black-billed Magpie	*Cyanocitta stelleri*
Northwestern Crow	*Corvus caurinus*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Hirundo pyrrhonota*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Chestnut-backed Chickadee	*Poecile rufescens*
Boreal Chickadee	*Parus hudsonica*
Red-breasted Nuthatch	*Sitta canadensis*
Brown Creeper	*Certhia americana*
Winter Wren	*Troglodytes troglodytes*
American Dipper	*Cinclus mexicanus*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Arctic Warbler	*Phylloscopus borealis*
Townsend's Solitaire	*Myadestes townsendi*
Gray-cheeked Thrush	*Catharus minimus*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Varied Thrush	*Ixoreus naevius*
Orange-crowned Warbler	*Vermivora celata*
Yellow Warbler	*Dendroica petechia*
Myrtle Warbler	*Dendroica coronata*
Townsend's Warbler	*Dendroica townsendi*
Blackpoll Warbler	*Dendroica striata*
Northern Waterthrush	*Seiurus noveboracensis*
Wilson's Warbler	*Wilsonia pusilla*

Table A.3 – Bird species detected on 2 Breeding Bird Survey routes on Copper River Delta 1993 - 1995	
Chipping Sparrow??????	*Spizella passerina*
Savannah Sparrow	*Passerculus sandwichensis*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
White-crowned Sparrow	*Zonotrichia leucophrys*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Slate-colored Junco	*Junco hyemalis hyemalis*
Oregon Junco	*Junco hyemalis oregonus*
Red-winged Blackbird	*Agelaius phoeniceus*
Rusty Blackbird	*Euphagus carolinus*
Pine Grosbeak	*Pinicola enucleator*
Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Common Redpoll	*Carduelis flammea*
Pine Siskin	*Carduelis pinus*

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/wdelta

Resource Reports (/wdelta/resource_rpts)

Fisheries Report – Dirk Lang
Recreation Resource Report – Dixon Sherman and Bruce Campbell
West Copper River Delta Hydrology Report – Bill MacFarlane
Wildlife Assessment & Wildlife Subsistence reports – Milo Burcham
Heritage Resources Report - Linda Yarborough
West Delta Soils and Wetlands Report – Dean Davidson
West Delta Minerals and Geology Report – Carol Huber
Subsistence Fisheries Report – Tim Joyce

GIS products (/wdelta/gis)

Two arcview projects are available for use in the electronic file as shown above. They are wdelt_orth.apr and wdelt_veg.apr. JPEG's of all layouts are available in the maps_figures folder.

Shapefiles and coverages 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 coverages.

Table B.1- Available arcview projects and products

Project	Views available	Themes with View
wdelt_orth.apr	Ortho base map	Swan nests and swan observations, eagle nests, recreation sites and site easements, easements and trails, mines, roads, lakes, streams, stream update, landscape analysis boundary.
layouts		CAC select, eagle nests, swan nests, mines, recreation and easement sites and trails,
wdelt_veg.apr	Veg_base	Crd roads, lands status(Oct 2002), summer motorized Rec, winter motorized rec, Forest Plan prescription, Landscape Analysis Boundary, watershed boundaries, Forest Type, DU map, size class, Landtype Associations, Ecological subsections, Cover type,
	Ortho_base	Landownership, wd_roads, size class, cover type, forest type,
	District w/wdla boundary	
	Alaska_CNF	
layouts		Ecosubsections, landstat10_02, landtype_assoc, lmp_dir, location_ownership, saddlebag road location, sum_mot, wint_mot, veg_cover.