APPENDIX D

Scanned 1985 Eyak Lake AMSA Resource Inventory & Analysis

Scanned 1985 Eyak Lake AMSA Issues of Concern, Goals, & Objectives

NOTE: SCANNED 1985 EYAK LAKE AMSA PLAN

Resource Inventory & Analysis
All text describing the socio-economic setting has been extracted from the scanned file. This information has been updated and can be found in Chapter Three of the Cordova Coastal Management Plan.

Issues, Goals, & Objectives
Some text describing the issues, goals, and objectives has been extracted from the scanned file. Some information regarding issues, goals, and objectives has been updated and can be found in Chapter Four of the Cordova Coastal Management Plan.

Management Measures
All text from the 1985 AMSA plan describing management measures has been extracted from the scanned file. These management measures are now called Enforceable Policies and can be found in Chapter Six of the Cordova Coastal Management Plan, and in Appendix A.

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EYAK LAKE AMSA

COOPERATIVE MANAGEMENT PLAN

CONCEPTUALLY APPROVED

March, 1985

Prepared For
The Eyak Lake AMSA Study Team

By

Professional Fishery Consultants
Cordova, Alaska

The preparation of this report was financed in part by funds from the Alaska Coastal Management Program and the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, United States Department of Commerce, administered by the Municipal and Regional Assistance Division, Alaska Department of Community and Regional Affairs, and the City of Cordova, Alaska.

Bo Eyak Lake ANSA Study Team Consists of Representatives of the Following Organizations

Alaska Department of Community and Regional Affairs

Alaska Department of Environmental Conservation

Alaska Department of Fish and Game

Alaska Department of Natural Resources

Alaska Department of Transportation / Public Facility

Alaska Office of Coastal Management

City of Cordova

Eyak Corporation

United States Fish and Wildlife Service

United States Forest Service

The Eyak Corporation was afforded the opportunity to participate in the development of this report but chose not to do so.

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INTRODUCTION

On February 9, 1981, the Alaska Coastal Policy Council met in Cordova and approved the Cordova Coastal Management Program as submitted by the City of Cordova. In its approval action, the Council made several recommendations including preparation of a cooperative management plan for Eyak Lake by the City and affected private landholders and public agencies. As only a small portion of Eyak Lake is located within municipal limits, the City did not feel it appropriate to include that small portion within its coastal area, and suggested the appropriate time to develop a plan for Eyak Lake would be when the entirety of the Lake could be included in a single planning effort. The Coastal Policy Council recommended the City, in cooperation with appropriate State agencies and other affected parties, identify Eyak Lake as an Area Meriting Special Attention (AMSA) and proceed with preparing such a cooperative plan.

AUTHORIZATION

In recognition of the value of Eyak Lake to the City of Cordova and to Eyak Corporation, the major private landowner in the Project Area, the City and Eyak Corporation, together with the State and Federal agencies concerned with the lake, have agreed that special management efforts are needed to protect the Lake's water quality, fish and wildlife habitats, and recreational values while accommodating probable future development adjacent to Eyak Lake. In order to formulate and guide this management plan, a Study Team was formed with the City of Cordova assigned the role of lead agency. The study team consists of representatives of the following organizations: City of Cordova, Eyak Corporation, State Office of Coastal Management, Alaska Department of Community and Regional Affairs, Alaska Department of Environmental Conservation, Alaska Department of Fish and Game, Alaska Department of Natural Resources, Alaska Department of Transportation/Public Facilities, U.S. Fish and Wildlife Service, and the U.S. Forest Service.

The project was carried out to the extent possible through a consensus effort. If the Study Team is unable to arrive at a consensus position in the Study Team Final Report, the State Coastal Policy Council will be the final arbitrator of any policy decisions regarding the proposed AMSA designation. On February 27, 1981, the Study Team conducted its first meeting where the problem was defined, the issues spelled out, data needs identified, the work program outlined and a course of future action chosen. As a result of that meeting in which the decision was made to contract the Study, a Request for Proposals was issued that included a Scope of Services that basically outlined the required work and time frames.

The City of Cordova entered into a contract with the Department of Community and Regional Affairs to carry out the Scope of

Services by way of a grant received through the Alaska Coastal Management Program.

The City of Cordova on September 9, 1981, entered into an agreement with Professional Fishery Consultants of Cordova, Alaska, for completing all work program tasks and study products specified in the Scope of Services culminating in a management plan for Eyak Lake.

The plan shall comply with 6 AAC 80.160 AREAS WHICH MERIT SPECIAL ATTENTION of the Standards and Guidelines of the Alaska Coastal Management Program.

PURPOSE AND SCOPE

The purpose of the work program is to develop an AMSA proposal for Eyak Lake to fulfill the Study Team's project goals as defined below and implement the Coastal Policy Council's recommendation.

The goals of this project are to develop objectives, policies and actions to:

(1) maintain and/or improve the water quality of Eyak Lake;

(2) maintain and/or improve the fishery production of Eyak Lake;

(3) maintain and/or improve the wildlife habitat values associated with Eyak Lake;

(4) accommodate existing and appropriate future residential, commercial, and facilities development within the planning area;

(5) develop and maintain recreational opportunities and maintain the scenic values associated with Eyak Lake.

Shown in Figure 1 is the project area covered by this study. The boundary is described as: On the south, the Copper River Highway from approximately Mile 7 west to the Eyak River Bridge; thence upslope from the south side of the highway to the 500 foot contour line and westerly along the 500 foot contour line to the extended projection of LeFevre Road; thence north along the projection and LeFevre Road and its extended projection to the base of Tripod Hill which shall form the boundary on the west. The 500 foot contour line beginning at the base of Tripod Hill to a point where it crosses Power Creek above Ohman Falls; thence southerly along the east shore of Eyak Lake to the intersection with the section line between Sections 32 and 33; thence south along the section line to its junction with the CRH (point of beginning) which shall form the north and east boundaries.

ACKNOWLEDGEMENTS

A unique partnership was formed at the advent of this project composed of the Study Team and the Contractor. The uniqueness derives from the manner in which the study was conducted -- at various points along the way the progress and proposed action was reviewed by the Study Team resulting in renewed direction for the Contractor. A most significant aspect of this approach will, as a result of the Contractor's Draft Plan, cause the Study Team and Contractor to negotiate a final management scheme in which all parties having management authority in the project area will have agreed on management direction for the management plan. Throughout the study the Study Team has responded in a significant way and has materially aided the progress to date. Special thanks go to Mr. Perry Lovett, past City Manager; Mr. Malcolm (Mac) MacMaster, Utilities Superintendent; Mr. Robert Krebbs, past Planning Coordinator, and Mr. David Dengel, current Planning Coordinator, for their valuable assistance from the City of Cordova. Additionally, the local staffs of the Alaska Department of Fish and Game and the Chugach National Forest helped in many ways. We thank Ms. Mary Mueller of Sitka and Mr. Alan Batten of the University of Alaska Museum for their help in aquatic plant identification, and Mr. Dave Bartow of Prince William Sound Aquaculture Corporation for his suggestions on limnological and bathymetric sampling. Thanks also to Mr. Rae Baxter for assistance in identifying the molluscs.

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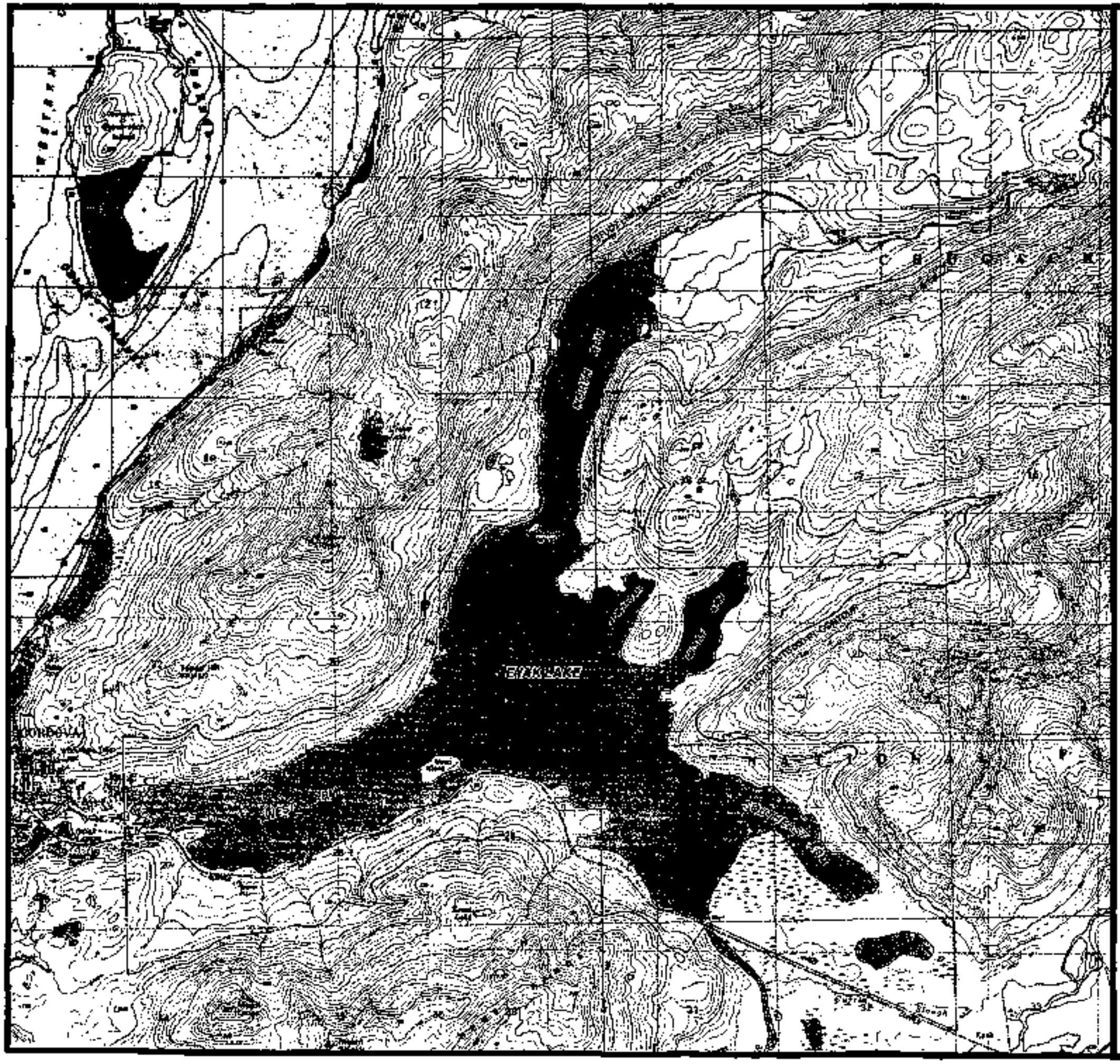

Cordova CMP Appendix D

Figure 1

CHAPTER ONE: PHYSICAL DESCRIPTION

Eyak Lake is a shallow body of fresh water located adjacent to the City of Cordova with approximately 9% of the lake being within the city limits. The map in Figure 2 will be helpful in visualizing the description. The lake is shaped like a three-armed starfish (or "Y"-shaped) and is immediately surrounded by mountains ranging in heights of 2100 to 3500 feet. Gaps in this mountain perimeter are located at the tip of each of the arms the "Eyak Gap" at the tip of the southeast arm that opens out onto the Copper River Delta, the gap at the tip of the west arm that opens into Orca Inlet and is the general location of the City of Cordova developed area, and Power Creek Valley extending northeasterly from the tip of the north arm.

Twenty-four hundred acre Eyak Lake has 18.9 miles of shoreline, an average depth of less than 8 feet, and a greatest depth of approximately 23 feet. Bathymetry for the lake is shown in Figure 3. The methodology used to determine the bathymetry consisted of running transects across the lake by boat between various points around the lakeshore and continuously recording the depths on a recording fathometer after which the transects were plotted on a map and the contours interpolated from the plotted data. The channels were plotted in the same way along with the aid of aerial photo interpretation. The lake is flat-bottomed (very flat) averaging six to eight feet deep with the exception of the gutters or stream channels cut into the lake bottom which vary from 1-1/2 feet to 12 feet deeper than the surrounding bottom. It is questionable how the channels formed, but if the lake area was ever a tidal flat that drained toward Eyak River, Orca Inlet, or both, that would account for the channel pattern.

The lake bottom substrate is generally mud in the form of silt ranging from soft to hard-packed and occasionally overlain with organic matter or slightly mixed with organic matter. Around the shoreline usually in depths less than five or six feet, is generally a ribbon of gravel extending out from shore from several feet to as much as 170 feet in delta areas of small streams. In some areas this "ribbon" has a large percentage of rock and, in a very few areas, sand or a mixture of gravel, sand and rock.

At least fifteen aquatic plant species inhabit the lake (see list of plants in Appendix E), one of which has not been identified in Alaska prior to this study. The plant with the first recorded siting in Alaska is Elodea canadensis Michx., Frog's-bit (Batten, 1983; Mueller, 1981: personal communications). Aquatic plants cover virtually the entire bottom of Eyak Lake in densities ranging from a few plants per square foot to thick masses of vegetation. Generally no plants grow in the gravel strip around the shoreline - only in the mud bottom. Both this substrate data and the aquatic plant data were collected along the bathymetry transects at regular intervals using grab samples and supplementing this data with visual observations through the ice.

The lake drains at the southeastern tip through Eyak River into the Gulf of Alaska. A sheet pile weir, established after the 1964 earthquake to maintain lake level, is located at the outlet. The lake water surface lowered during the earthquake as the Cordova region was uplifted approximately six feet. Prior to the quake the Copper River flats gillnet fleet was able to use Eyak River to go to and from the fishing grounds tying up at "the spit" during closed fishing periods. Now the weir prevents passage into the lake of all but the smallest boats. Elevation at the top of the weir equals 17.5 feet above ocean datum 0.00'MLLW.

Besides the watershed surrounding the lake, Power Creek watershed is the major contributing water source for Eyak Lake. U.S. Geological Survey established stream gauging station No. 15216000 on Power Creek about 1-1/2 miles downstream from Ohman Falls in July, 1913. Eyak Lake's drainage area above the weir site is 40.5 square miles while that portion above the gaging station on Power Creek is 20.5 square miles, and that between the weir and gaging station is 20.0 square miles (Lyon Associates, 1970). National Weather Service data indicate that 27 percent of the Power Creek Basin is covered by glaciers. Power Creek flows from Shepard Glacier through a steep walled valley to Eyak Lake.

An ancient landslide bisects the valley just above Ohman Falls with a large fan-shaped ridge 300 to 400 feet in height. This landslide dammed Power Creek forming a large lake upstream of Ohman Falls where glacial precosses produced rapid infilling of this lake with silt, sand and gravel until the natural dam was breached and the recent valley was cut to the present configuration of Power Creek. Ohman Falls drops 175 feet in a horizontal distance of approximately 500 feet, and then the creek falls about 200 feet in the remaining 1-1/2 miles to Eyak Lake (Stone & Webster, 1982).

LAND STATUS

The City of Cordova controls land uses within its corporate limits which extend eastward from Orca Inlet to approximately the midpoint of the west arm of Eyak Lake (the City basically has jurisdiction over the land surrounding the west half of West Arm). (See Figure 3). Land along both the north and south shores of the eastern half of West Arm is state land while the Eyak Corporation (a Native village corporation), through the Alaska Native Claims Settlement Act (ANCSA), has interim conveyance to title on the land surrounding the remainder of the lakeshore except for existing individual private homesites. In general terms, Eyak Corporation land entitlement surrounds the eastern three-fourths of Eyak Lake shoreline.

Once federal lands of the Chugach National Forest were dominant immediately adjacent to Cordova and Eyak Lake, but the state and Native corporation selections have relegated federal ownership to the higher, less desirable country back from the lake edge and road system.

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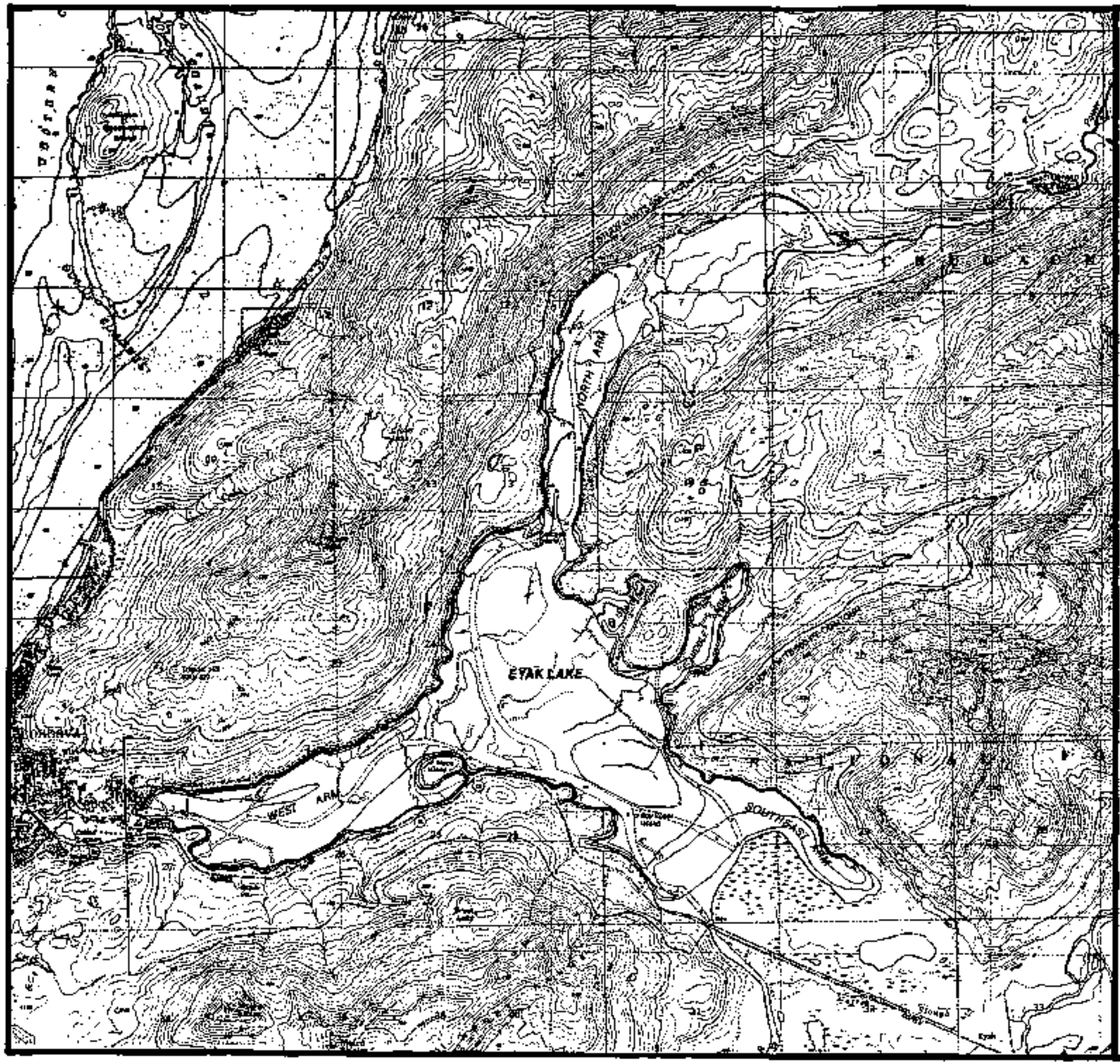

EYAK LAKE BATHYMETRY

Bathymetry Showing 2Foot Contour Lines

Lake Channels with Channel Depths

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 2

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PLAN

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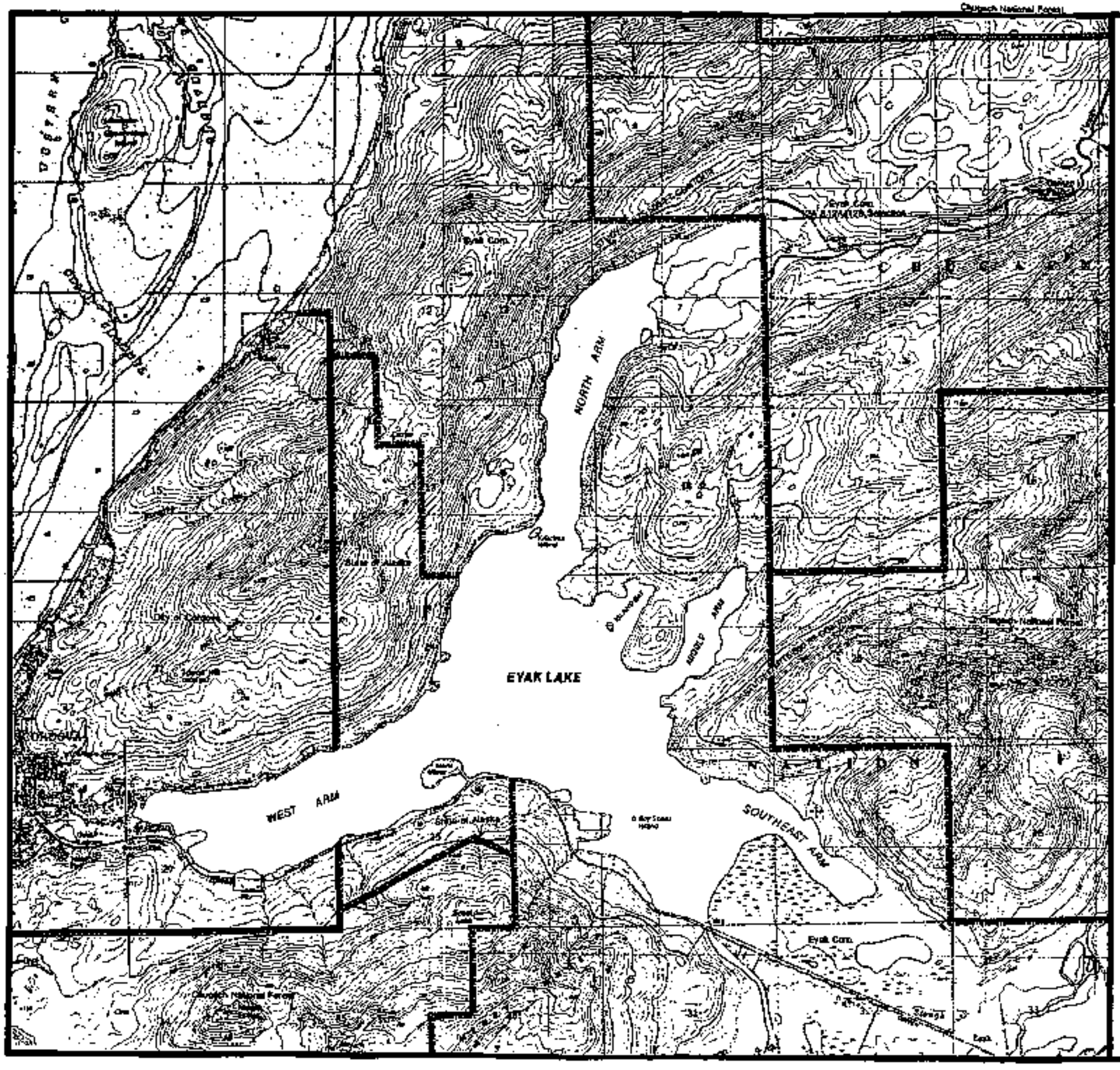
LAND OWNERSHIP MAP

- Cordova City Limits
- State Land Boundary
- Eyak Corp. 82A & 82AU2B Selection Boundary
- Eyak Corp. Boundary
- Chugach National Forest Boundary
- Private Lands



NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 3

Land jurisdictional boundaries are not static at this time as the state is entitled to select additional land under the Statehood Act, some of which could come from the Cordova area, and the village and regional Native corporation selections have not been completely resolved. Much of the land behind (from the viewpoint of the lakeshore) the Eyak Corporation land has been identified by the village and regional Native corporations under ANCSA Sections 12A and 12B and could become private land. Also, since the Eyak Corporation could not select lands within two miles of the corporate limits of the City of Cordova and a gap exists between the two mile limit and their current boundary, a further land adjustment will probably be in order. This would amount to the Eyak Corporation receiving title to the gap land, approaching the two mile limit line as closely as possible with a stair-stepping of quarter-quarter sections (40 acre square blocks) up to the two mile limit line.

Eyak Corporation has authority over their land (which is private land in every respect) to subdivide it into homesite sized parcels or develop it in any other way within the law.

The lake bed, stream and river beds of all navigable waterways are also state lands or shore lands as authorized by federal statute Public Law 31, Chapter 65, Section 2A of the Submerged Lands Act. Demarkation of these lands is done by determining the ordinary high water mark of the lake or stream if no survey has been done.

CLIMATE

The study area has a maritime climate with cool relatively mild winters, and heavy precipitation year round with a high incidence of cloudiness. The modifying influence of the ocean and the latitude cause relatively small seasonal and diurnal temperature variations. Strong winds and storms are common as broad storm tracks with their associated lows move up the Aleutians into the northern Gulf of Alaska throughout the year and pound this area of the coast with surface winds occasionally reaching 75 to over 100 m.p.h. The coastal storms in combination with the steep slopes of the surrounding mountains and the attendant airmass uplift are the causes of the heavy precipitation. Record breaking rains fell in Cordova during August 1981, when, from the 1st to the 17th of the month, 56.0 inches had been recorded with August 7 being the day of heaviest rainfall on record for that year in the city - 16.6 inches. Winds normally come out of the east, flowing and gusting into and across the study area from "Eyak Gap" and out of the West Arm, over the City of Cordova and into Orca Inlet. Average annual precipitation is 168 inches (14 feet) which includes 116 inches of snowfall. The number of cloudy days each year averages 262. Some additional climatic data is listed below from Alaska Regional Profiles: Southcentral Region (UofA, 1974).

Average temperature range: (deg. F) Summer 44 - 61, Winter 21 - 39
Extreme temperature range: (deg. F.) -23 to 81
Average wind: E 4.5 kts. (7.8 k.p.h.)

Average temperature in January: 23 deg. F. July: 54 deg. F.
Mean date of last Spring occurrence of 32 deg. F.: May 27
Mean date of first Fall occurrence of 32 deg. F.: September 13
Growing season w/temperatures above 40 deg. F.: 145 days

GEOLOGY

The best summary description of the geology of the study area appears in Cordova Power Supply Feasibility Analysis - Summary Progress Report by Stone and Webster (1982) and is quoted liberally below.

Eyak Lake is one of a set of weakly developed topographic lows - valleys trending northwest - in relation to the major northeast trending fjords along the coastline between Valdez and Kayak Island. These gross regional geomorphic trends are probably related to regional fracture patterns and major structural features resulting from the tectonic history of the area.

The rocks in the study area belong to the Orca Group which are slightly metamorphosed sedimentary series including thick bedded brown and gray sandstones, black limestones, arkoses with thin zones of slate and shale, and occasional conglomerate greenstones associated with highly mafic basalt flows. These rocks are highly deformed and fractured with extensive secondary quartz emplacement occurring along the fractures ranging in thickness from a fraction of an inch to several feet.

The structural geology is characterized by highly deformed rocks, tightly folded and faulted along a northeast orientation. This structural feature results from active subduction of the Pacific plate which is occurring along the southern coast of Alaska and extending westward along the Aleutian Island arc. A fault follows the course of Power Creek and dips to the northwest as shown on map of local major faults (Figure 5).

Turn-of-the-century investigators identified Power Creek as the best stream within the vicinity of Cordova for hydroelectric development. However, based on recent on-site geological and geotechnical investigations, the Corps of Engineers has eliminated the possibility of developing a large storage dam above Ohman Falls capable of regulating Power Creek. The type of material of the ancient landslide mass at Ohman Falls is a considerable concern. The absence of surface drainage within the landslide area indicates that this mass is highly permeable. It has been observed that there are no permanent streamflows across the mass and that none of the larger depressions, which reach a maximum depth of 100 feet, contain water. Also noted were numerous springs and seeps downstream of Ohman Falls at elevation 350 feet. The landslide mass probably consists of broken and jumbled fragments of the original sedimentary rocks typical of the area. They are now weak, highly permeable and in a stable configuration. Underground water flow is suggested and has been further verified by Jack Chisum of Chisum Flying Service, Cordova, while he was

serving the Power Creek drill sites by helicopter and flying over the area frequently. He observed mud flowing from the depressions ("spring holes") near the mouth of Hatchery Creek. Power Creek was running relatively clear at the time so the most obvious conclusion is that drilling mud entered underground flow routes above Ohman Falls and emerged in the "spring holes" in and near the lake. During the winter when surrounding water temperature was 32 deg. F., the water coming from these "spring holes" was 39 deg. F.

Power Creek carries a considerable sediment load, which is derived from several sources including stream channel erosion, mass wasting into the channel from steep adjacent slopes, and glacial and avalanche debris. The total annual sediment load in Power Creek has been conservatively estimated at 4.1 to 6.2 acre feet.

Most of the City of Cordova is built on argillite (shale-like) and graywacke (sandstone) bedrock, but the southside of the city is situated on unconsolidated fluvio-glacial deposits (glacial drift) at least 140 feet thick that fill a low divide between the waters of Orca Inlet and Eyak Lake.

NATURAL HAZARDS

Natural hazards exist in the study area ranging from common strong winds to occasional violent seismic activity (see Figure 4). Blizzards, fog, and torrential rains significantly reduce visibility and in some extreme blizzards, "white-out" conditions arise that reduce visibility to zero. Wind damage has included blown-down highway signs, turned-over campers, and blown-off roofs as well as blowing moving vehicles off ice-slick roads. Although the Cordova Coastal Management Plan states, "Cordova is situated to take maximum advantage of the climatic buffers that these immediate mountain ranges provide (wind and storm front impacts are minimized)", the gaps around the lake, previously described, appear to funnel the storms' fury and intensify or magnify the forces.

FLOODING

There is evidence, including historic photographs, that flooding has occurred on the lake where water has been over the City Airport runway in the early 1930's, in 1949, in September 1958, and again in August 1981 (See Figure 4.)

As stated in the Cordova Flood Insurance Study (USHUD, 1978):

> "The principal flood problem in Cordova is caused by high water in Eyak Lake. The Eyak River, which drains Eyak Lake, does not have the capacity for peak flow and hence the lake level rises. The weir which was added does slightly increase the flooding problem. The weir will be submerged several feet during flood flows. During the August 1981 flood, water was estimated to be seven feet above the top of the weir (Fauell, 1982). Had the

weir not been installed, the flooding problem probably would have been reduced as the lake and Eyak River eroded towards prequake levels."

Streamflow from Scott Glacier changed pattern in July 1983, (USFS, 1983) resulting in a major portion of the waters of the Scott River exiting from the west side of the glacier's terminus rather than from the east side as they had previously. Now a major portion of the glacial waters from the Scott River combine with Ibeck Creek and cause this previously clearwater stream to become glacially turbid. Just below the Mile 7, C.R.H. bridge, Lydick Slough branches off from the main channel of Ibeck Creek and enters into Eyak River about 3 miles further downstream. Approximately two miles below the bridge, Lydick Slough flows to within about 250 feet of Eyak River, separated from it by a low, forested neck of land. Since Lydick Slough is now carrying some of the Scott River water and sediment, it's water level is above that of Eyak River, and it spills across the narrow neck of land into Eyak River. Finally, Lydick Slough merges with Eyak River about another mile downstream of the spillover.

There are several consequences of this streamflow change, but here we will deal with flooding assumptions. Raised water levels on Lydick Slough (in combination with Scott River water) have caused water to back up on Eyak River above the junction of the two streams resulting in some flooding of the Forest Service cabin and Lydick Slough Trail. Since the Scott River shift, more water must now flow into Eyak River below the lake and may cause a greater backwater effect for water trying to flow out of the lake than previous to the shift. This may increase the flooding potential around the lake.

Another Study, Feasibility Study - Eyak Lake Water Stabilization, (Lyon Associates, Inc., 1970) calculated flood flows, lake level elevations, and discharge capabilities of Eyak River. They described an example flood situation: "Due to the flow characteristics of Eyak River, the maximum river flow, when the lake level is at elevation 21.20' and at low tide, is calculated to be only 5100 c.f.s. (cubic feet per second). This is less than the 20 year storm flood flow (11,800 c.f.s.). This means that under present conditions, floods will occur in the Eyak Lake area because Eyak River cannot handle the storm flows from the Eyak Lake drainage area." This conclusion was drawn prior to the Scott River channel change so, in light of this new development, flooding problems around the lake may be intensified. See Table 1 showing peak discharges which were computed for Eyak Lake in the Cordova Flood Insurance Study (USHUD, 1978) using standard hydrologic and hydraulic study methods.

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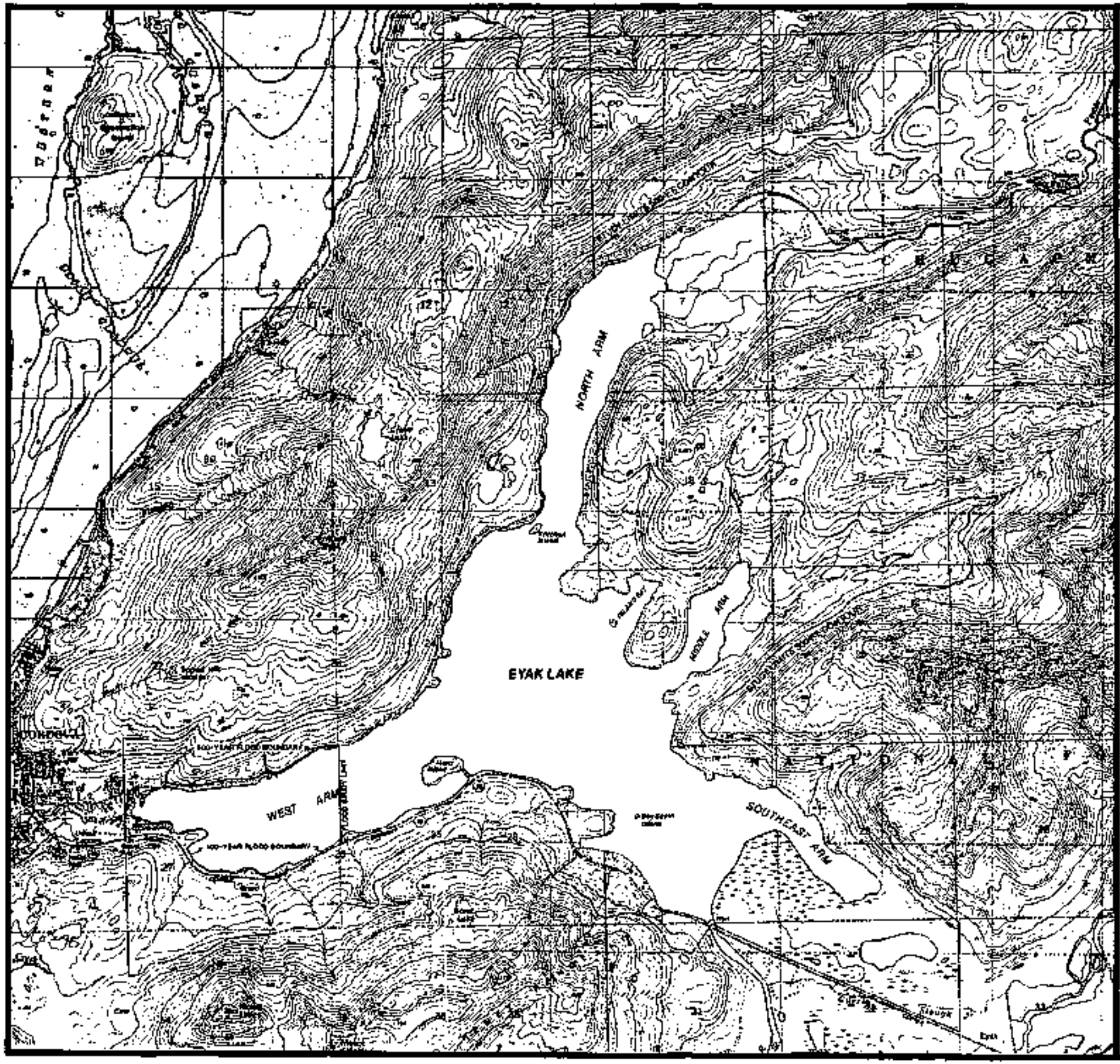

HAZARD AREA MAP

- Avalanche Area
- Landslide Area
- 100-Year Flood Boundary
- 500-Year Flood Boundary

Note: Flood information was obtained from the Flood Insurance Study—City of Cordova, Alaska, USHUD 1978

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 4

TABLE 1

SUMMARY OF DISCHARGES

Flooding Source and location	Drainage Area (sq miles)	Peak Discharges (cfs) 10-yr	50-yr	100-yr	500-yr
Eyak Lake at outlet	40.5	8,700	13,700	16,300	23,800
Power Creek USGS Gage No. 2160	20.5	5,200	8,700	10,600	16,500

In the Lyons Associates study, they indicated a possible method to eliminate the flood potential of the lake by installing a channel from the lake through Cordova to the Gulf of Alaska. In the transmittal letter for the study report is this summary statement, "During past floods, the water found its way out of the lake by an old channel through Cordova. This has been further blocked since then by the highway fill. The culverts installed under the highway at this point do not look adequate to handle the excess..." The USFS (1983) study of the Scott River channel changes makes the same recommendation as one of their alternative solutions to the flooding problem - provide an overspill outlet from Eyak Lake's West Arm into Odiak Slough and Orca Inlet (by digging a channel through the low bridge of land separating Eyak Lake and Odiak Slough or by placing culvert pipe through this section and burying it).

AVALANCHE

A large landslide and snow avalanche area occurs which presents a hazard along the Copper River Highway at approximately Mile 5. According to local residents, Martie Samuelson and Mary Ann Addington, in personal interviews, a large avalanche occurred in 1964 that covered the highway about 30 feet deep with avalanche debris and extended to and across the Mile 5 Cutoff Road burying it with about 6 feet of debris and knocking down several trees. The avalanche generated wind blew down two 6 to 8" diameter trees in a residence site on the lakeshore. Mary Ann was buried with her dog in that avalanche and Martie, a neighbor who was looking out his window at the time, watched the two trees blow down in his yard and then was part of the rescue crew that dug Mary Ann out of the avalanche debris. Another avalanche crossed the highway and ran out into the head of the Christian Center Beach Bay in 1969 or 1970 (See Figure 4.)

Many avalanche tracks are visible at elevations above the study area and could, in large storm years, break loose and reach the study area even though the ancient tracks are now forested and not very evident.

EARTHQUAKES

The Eyak Lake study area is located on a major fault zone and is

classified into seismic Zone 4 which designates the highest level of risk in the Uniform Building Code. This governs the design and planning of structures and is based on potential severity, frequency and damage from seismic activity. Seismic Zone 4 designates an area of potentially high severity of seismic activity, high frequency of occurrence and high potential damage due to ground shaking.

Earthquake hazards result from the effect of the earth's movements on man and his activities:

1) primary hazards - the immediate results from the earthquake itself

   a) upthrusting or lifting of the crust
   b) subsiding or dropping away of the crust
   c) vibratory motion

2) secondary effects

   a) movement of masses of earth and rock
   b) landslides
   c) soil failure (liquefaction)
   d) seiches
   e) fires

In an interview with John Rogers, project engineer for the Alaska Seismic Study, U.S. Geological Survey, The Cordova Times of 11/12/81 reported:

> This area is of interest to seismologists because Cordova sits on the boundary between the Pacific plate and the North American plate. As the Pacific plate slides under the North American plate, a large amount of seismic activity occurs.
>
> Cordova is located near the Yakataga gap, which is picked by seismologists as an area to have a large earthquake in the future within ten years or so.
>
> The Yakataga gap covers the area between Cape Yakataga and Kayak Island. As the fault in that area has not broken in a long time, the pressure is increasing and eventually an earthquake will relieve pressure along the faultline.

The largest known event to affect the study area is the Prince William Sound earthquake which occurred in 1964. The magnitude of this event registered 8.5 on the Richter scale and its epicenter was located 67 miles northeast of Cordova. Surface rupture associated with this event resulted in 6 feet of vertical uplift and 40 feet of lateral displacement along the coast near Cordova. Compared to other communities affected by the earthquake, tectonic uplift did far more damage in Cordova than seismic vibration and waves combined. In spite of the violent ground shaking, sharp jars, surface ground waves, ground fissures, and differential

settling, it is significant that the Eyak River Bridge which has foundations on bedrock was not damaged (USGS, 542-G, 1964).

Stone and Webster (1982) reported: "There are many active faults in the study area, the largest system is the Contact fault located mid-way between Cordova and Valdez. Some of these faults have undergone significant displacements associated with seismic events during historic time."

Figure 5. Local major faults. (Source: TAMS, 1981).

All evidence points to the fact that there will be future earthquakes. Planning for development should consider the whys of past earthquake damage and move ahead accordingly.

OTHER HAZARDS

The tsunami, a tidal wave generated by sudden tectonic displacement, possibly could affect the study area depending on the intensity of the event, however, the likelihood of this happening would be rated as "extremely rare". Teleseismic tsunami are earthquake generated while the local or seiche tsunami is generated by massive rock or earth slides either above or below water. A seiche can occur when enclosed or inland bodies of water are agitated to violent action caused by an earthquake, or by a landslide or avalanche which rapidly dumps large amounts of material into the body of water or by motion of its bottom. Eyak Lake is subject to seiche formation and its accompanying destruction.

Mass earth movement such as rock falls, landslides, and debris flows result from slope instability and are initiated in various ways including earthquake shaking and soil liquefaction. Local

examples are: 1) the Power Creek slides that dammed the valley above Ohman Falls and 2) the mountainside that shook loose and slid across Sherman Glacier during the 1964 earthquake. There is not sufficient data to predict the possibility of this massive wasting around Eyak Lake except that one area (the avalanche path at Mile 5 1/2 CRH) appears threatening. Talus rubble lays on top of bedrock on this over-steepened slope and the instability has been increased with the borrow removal of the toe of the slope. These conditions are likely to exist: 1) massive weight of material resting on steep bedrock, held to the bedrock by friction, and with the supporting base removed; 2) lubrication of interface between rock and talus by groundwater flow; 3) potential liquefaction of the unsupported mass; 4) potential seismic shock waves.

Two natural landslides occurred in 1982 in the vicinity of the study area: 1) about one mile upstream of the Mile 7, C.R.H. bridge on the mountainside leading down to the bank of Ibeck Creek, and 2) on Power Creek just below Ohman Falls bringing a large debris wedge down to the creek which has resulted in additional sediment load being carried to Eyak Lake (USFS, 1983).

CHAPTER TWO: SOILS

INTRODUCTION

This chapter contains soils and landforms information for the Eyak Lake study area prepared by Robert H. Heucker, Soil Scientist, Chugach National Forest, Anchorage, Alaska, 1981.

Much of the area consists of steep glacial sideslopes and ice scoured hills. The soils are shallow and there are many bedrock exposures and vertical rock walls, especially at the higher elevations. Except for the muskegs, avalanche areas, and landslides, these areas are forested. The rest of the area consists primarily of out wash plains which contain stratified soils and generally have a high water table and a high flood hazard. The higher, better drained areas are forested and the lower areas contain mostly alder, willow, sedges, rushes, and grass.

This survey was made by observing external features of the area on aerial photographs and drawing preliminary mapping unit boundaries based on such characteristics as tree canopy, slope, landform, and wetness problems. These preliminary boundaries were then checked and altered as necessary in the field. (Figure 6 shows the mapping units.) Soil properties and features of the landscape which have management implications were checked on each mapping unit, as much as possible, and limitation and suitability ratings were determined based on National Soils Handbook Notice 24 which provides definitions for the ratings land criteria for rating the soils.

Due to the very limited amount of time spent in the field gathering information, it was not possible to thoroughly study all of the mapping units and some of the ratings are based primarily on features of the land which could be observed from a distance such as slope gradient, avalanche and landslide areas, and drainage characteristics. Heavy rainfall during the time of the survey also caused flooding on much of Mapping Units 6 and 7 and this prevented access to some areas and made it impossible to observe some of the soils. Detailed soil descriptions were not made in any area, but sufficient information was gathered to rate the soils for the selected management activities. Most of the soils information was gathered from the lower elevations which generally are not as severely limited as the higher areas. The Soil and Water Resource Inventory of the Copper River Delta, prepared by Dean Davidson and Charles Harnish in 1978, provided additional information that was used in this chapter. Although there may be considerable variation in the soils at different locations on the same mapping unit, the ratings assigned to each unit should be a good reflection of the problems that can be expected.

MAPPING UNIT DESCRIPTIONS AND MANAGEMENT CONSIDERATIONS

The following descriptions summarize the soil properties

associated with each mapping unit. See Figure 6 for map of soil mapping units. They include a topographic description of each unit and major factors which limit development.

Mapping Unit 1

Area: 955 acres - 24.4 percent of total mapped area

Description: Mapping Unit 1 occurs on forested hills which have relatively short slope lengths. The slope gradient of the hillsides ranges from about 25 percent to steeper than 90 percent. Bedrock or a compact, nearly impermeable layer is frequently found near the surface which restricts drainage on the flat, benchy areas and causes water to seep down the hillsides at a shallow depth. The flat areas often have a high water table and show some mottling. Small streams are present and flow beneath the surface in some areas. Muskegs are common on the flat areas and they generally have narrow, and sometimes deep channels flowing through them.

The mineral soils have an organic mat that is 15.2 to 20.3 cm (6 to 8 inches) thick. Soil textures range from silt loam to sandy loam near the surface and the substratum is normally sandy and contains more than 40 percent gravel, cobbles, and stones by volume in varying mixtures. In depositional areas the soils are deep and contain a high amount of gravel and larger fragments. There are also isolated pockets that have a clayey texture. Most of the soils are moderately to well developed and are classified as Spodosols or Inceptisols.

The organic soils vary considerably in depth and generally become less decomposed with depth. The lower horizons are usually fibric. Thin layers of mineral soil are commonly found between organic horizons. The organic material is generally resting on a silt loam or sandy loam substratum which tends to be high in gravel, cobbles, and stones. The water table varies in depth and is at the surface in some areas and much deeper in others. These organic soils occur on slope gradients of up to 20 percent.

Management Considerations: The major limiting factors for Mapping Unit 1 are slope gradient, depth to bedrock, wetness, and organic soils. There are severe limitations for paths and trails on slope gradients greater than 25 percent and severe limitations for all of the other rated management activities on slope gradients steeper than 15 percent. Wetness is a problem on the muskegs and wherever there is a restricting layer that causes water to be held near the surface or to seep through the soil near the surface. The depth to bedrock causes moderate or severe limitations over much of the unit for shallow excavations and septic tank absorption fields, but there are many depositional areas, especially at lower elevations, where this is not a problem. The bedrock presents moderate limitations for dwellings without basements when it occurs between 50.8 and 101.6 cm. (20

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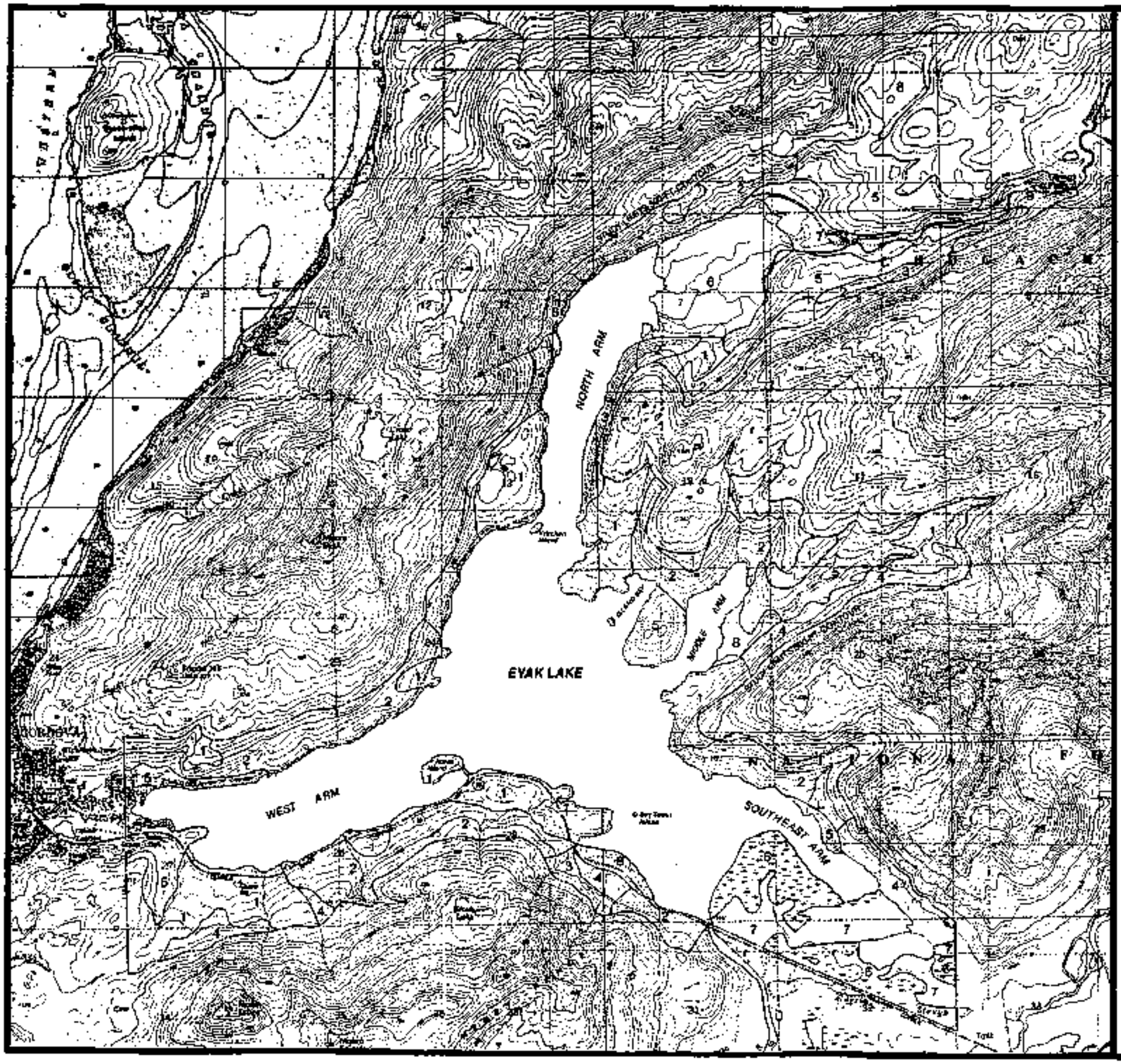


LOCATION OF SOIL MAPPING UNITS

NOTE: For Legend See Text

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 6

and 40 inches) of the surface, for septic tank absorption fields when it is between 101.6 and 182.9 cm. (40 and 72 inches) of the surface, and for the other activities when it is between 101.6 and 152.4 cm. (40 and 60 inches). The limitation is severe if the bedrock is deeper than these limits. Potential frost action moderately limits local roads on mineral soils. The muskegs have severe limitations for all of the rated management activities. Road and trail construction should be restricted on slopes steeper than 45 percent and avoided on slopes over 65 percent due to high erosion and landslide hazards. Most of Mapping Unit 1 provides an improbable source of sand or gravel either because suitable material is not present or the layers are too thin, although there are some suitable sites in the low elevation depositional area. The benches may provide a fair to poor source of roadfill material but are limited by the depth of the bedrock, slope gradient, and thickness of suitable material.

Mapping Unit 2

Area: 1037 acres = 26.4 percent of total mapped area

Description: Mapping Unit 2 occurs on long, steep, forested glacial sideslopes. The surface is frequently benchy and contains vertical rock faces, especially at the higher elevations. Numerous small streams are present and most are not deeply incised and are probably intermittant. Slope gradients range up to 120 percent or more in the high areas to less than 40 percent in the low areas. Some of the benches are nearly level. Bedrock outcrops, some of which are covered with moss, are common at the higher elevations. Few muskegs are present.

The soils are generally shallow except at the lower elevations and in small depositional areas at the higher elevations. The shallow soils generally have a silt loam to loamy texture and lack coarse fragments, but a few areas contain a coarse, compact layer of soil that impedes drainage. The soils at the lower elevations tend to be deeper than those that occur on Mapping Unit 1 and exhibit stratification in some areas indicating that the till has been reworked by water to some extent. The stratified layers are frequently compact and the gravel well fitted. During wet periods, water seeps downslope over the compact layers, resulting in wet conditions near the surface.

Management Considerations: The major limiting factors for Mapping Unit 2 are slope gradient, depth to bedrock, and wetness. The slope gradient causes severe limitations for all of the rated management activities on the steep sideslopes and slight to moderate limitations on the benches, depending on whether or not the slopes are steeper than 8 percent. The shallow depth to bedrock causes moderate or severe limitations for all of the rated management activities except for paths and trails, some of the low elevation depositional areas, and for campgrounds when the soils are deeper than 50.8 cm. (20 inches). All of the rated management activities have moderate or slight limitations due to wetness. At

some locatins, it may be possible to reduce this limitation by constructing diversions around any planned management activities. The soils have moderate to severe limitations for local roads due to low strength and a potential frost action hazard. In areas where compact till is present on the sideslopes, it presents severe limitations for septic tank absorption fields and sanitary landfills. The ratings tend to be less severe on the low elevation depositional areas. Mapping Unit 2 provides a poor source of roadfill material primarily due to the steep slopes and shallow soil depth, although some of the low elevation depositional areas may be suitable. It provides an improbable source of either sand or gravel except in isolated pockets where the soils are stratified.

Mapping Unit 3

Area: 122 acres - 3.1 percent of total mapped area

Description: Mapping Unit 3 occurs on very steep glacial sideslopes. Rock slides are numerous and the surface is littered with talus and scree. The unit is forested except for the slide paths.

The soils are probably loamy in texture. They have a high coarse fragment content, especially along the slide paths, and are well mixed. Some areas consist almost entirely of angular rock fragments that have accumulated at the bottom of some of the slopes.

Management Considerations: Mapping Unit 3 has severe limitations for all of the rated management activities due to the steep slope gradients. It also has high or very high avalanche and landslide hazards and the soils would be unstable if the vegetation cover was removed. It is a poor source of roadfill material for the same reasons, plus it has too many large stones in the accessible areas. It has been rated as an improbable source of sand or grvael, although it does provide a source of larger rocks that could be crushed into gravel-sized fragments.

Mapping Unit 4

Area: 240 acres - 6.1 percent of total mapping area

Description: Mapping Unit 4 occurs on steep avalanche paths. The unit is similar to Mapping Unit 3 except that it is primarly non-forested, the slope gradients are somewhat less, and the soils do not have as many coarse fragments. The vegetation consists of alder and grass. Some trees are present along the edges, but they are susceptible to avalanche damage.

The soils generally have a loamy texture and are well mixed. Some areas may be wet due to water seeping down the slope near the surface over bedrock or a layer of compact till. The gravel and cobble content is high.

Management Considerations: Mapping Unit 4 has severe limitations for all of the rated management activities due to the steep slope gradients and the high avalanche hazard. It has been rated as a poor source of roadfill material because of the slope gradient, but the lower portion of the unit is not as steep and may provide a suitable source. Mapping Unit 4 is an improbable source of sand and a variable source of gravel that may be suitable in some and not in others.

Mapping Unit 5

Area: 654 acres = 16.7 percent of total mapped area

Description: Mapping Unit 5 is similar to Mapping Unit 1 but lacks the wet, organic soils. It contains a dense tree canopy and consists of small hills and benches. Slope lengths are relatively short. The slope gradients may be as steep as 100 percent on the sideslopes but generally is shallower. The hilltops and benches are gently sloping to flat. The surface is hummocky and there are few bedrock outcrops.

The soils are well developed on the sideslopes an relatively deep. Textures are loamy near the surface and become coarser with depth. Gravel and cobbles are present in only small amounts near the surface and increase to 30 to 40 percent with depth. The organic mat is about 12.7 cm. (5 in.) thick. The soils on the flat areas are not as well developed and tend to have a higher coarse fragment content. Isolated locations have a perched or seasonally high water table.

Management Considerations: The sideslopes of Mapping Unit 5 have severe limitations for all of the rated management activities due to the steep slope gradients. Depth to bedrock is also a limiting feature on the sideslopes for all but campgrounds and paths and trails. The benches and flat areas only have slight limitations for campgrounds, paths and trails, local roads, and dwellings without basements. Frost action and the isolated areas that have a high water table may be a problem for local roads at some locations. Depth to bedrock, in most areas and wetness result in moderate limitations for shadow excavations, septic tank absorption fields, and sanitary landfills. Mapping Unit 5 provides a poor source of roadfill material on the sideslopes due to the steep gradient and a fair source of material on the benches and flat areas, limited primarily by thickness and the amount of material available. The entire unit provides as improbable source of either sand or gravel.

Mapping Unit 6

Area: 480 acres = 12.2 percent of total mapped area

Description: Mapping Unit 6 occurs on non-forested outwash plains. It has a high water table and much of it is frequently flooded. The unit is poorly to very poorly drained except for

stream levees and localized areas along the margin. The lower areas generally have a vegetative cover of rushes and sedges. Somewhat higher sites contain willow, devil's club, and grass. Some spruce trees are found on higher better drained soils, especially along the margins of the unit. Slope gradients range from 0 to 5 percent and the topography is often hummocky. Many small ponds and streams are present.

The soils are deep and consist of stratified layers of sand, silt, and gravel. Some isolated pockets of organic soil are also present.

Management Considerations: Mapping Unit 6 has severe limitations for all of the rated management activities due to wetness problems and/or high flood hazard. It also provides a poor filter material for septic tank absorption fields and presents seepage problems for sanitary landfills which should be avoided on this unit. In general, this unit provides a poor source of roadfill material due to the high water table, but suitable locations can be found along the margins. Mapping Unit 6 provides a probable source of both sand and gravel, but field investigation would be necessary to locate suitable sites for the desired particle size.

Mapping Unit 7

Area: 262 acres = 6.7 percent of total mapped area

Description: Mapping Unit 7 occurs on outwash plains and is similar to Mapping Unit 6 except that it is forested and the water table is not as high in most places. The tree canopy is greater than 30 percent and there is a considerable amount of alder, willow, and devil's club. The area has a high flood hazard and low areas have a high water table. The slope gradient is generally less than 5 percent and the surface is hummocky and has many streams flowing through it.

The soils consist of stratified layers of sand, silt, and gravel. High areas have a very rapid permeability and are excessively drained and the lower areas are often poorly to very poorly drained.

Management Considerations: Mapping Unit 7 has only slight limitations for paths and trails. Where flooding or wetness is a problem, there are severe limitations for campgrounds and dwellings without basements and moderate limitations for local roads and shallow excavations. The soils present severe limitations for septic tank absorption fields because they are a poor filter material and for sanitary landfill due to seepage problem. Both of these rated uses have flooding and wetness problems in many areas. The soils provide a fair source of roadfill material and are a probable source of sand and gravel, although field investigation would be necessary to locate suitable sites for the desired article size.

Mapping Unit 8

Area: 109 acres = 2.8 percent of total mapped area

Description: Mapping Unit 8 consists of alluvial fans. About 60 to 70 percent of this unit is forested with spruce and hemlock and the rest has a cover that is primarily alder, salmonberry, and devil's club. The nonforested portions of the fans generally have a high avalanche hazard. Small active and abandoned stream channels are common. Slope gradients typically range from 5 to 20 percent but may be steeper near the top at the apex.

The soils are depositional in nature and are generally well drained. Soil textures are variable from location to location and range from loam to coarse sand. Soil depths are greater than 100 cm. (39.4 in.). The percentage of gravel and cobbles by volume is high, but their relative proportions are variable. Either one may be present in amounts of 70 percent or more by volume. The coarse fragments are normally rounded.

Management Considerations: Due to the changing conditions that are found across this unit, the ratings for the selected management activities are highly variable. The following conditions are the limiting factors. The high avalanche hazard on the non-forested areas limit most uses for at least part of the year. Flooding in the vicinity of the active streams is also a problem, but this would not affect projects that can be located away from the streams. The slope gradient is a factor primarily on the upper part of the unit. The high amount of large or small stones also limits use, but on-site investigation would be necessary to determine which, if either, is a problem at a particular location. Layers of coarse-textured soil cause seepage problems for sanitary landfills and provide a poor filter material for septic tank absorption field over most of the unit. In general, Mapping Unit 8 provides a probable source of sand, but some suitable sources are probably available.

Mapping Unit 9

Area: 64 acres = 1.6 percent of total mapped area

Description: Mapping Unit 9 consists of non-forested river cut sideslopes. Vegetation is primarily alder, salmonberry, devil's club, and small forbs. The slopes are very steep and have a gradient of up to 75 percent or more. Bedrock is near the surface in some areas. The slopes are relatively stable, but some small slides are present and a considerable amount of erosion would occur if the vegetation was removed. Much of this mapping unit has a high avalanche hazard. The deeper soils probably contain a high amount of gravel and a lesser amount of cobble and are well drained. Soil textures range from loam to loamy sand.

Management Considerations: Mapping Unit 9 has severe limitation for all of the rated management activities. The major limiting

factor is the steep slope gradient. In addition to that, many potential uses are limited by the high avalanche hazard over most of the unit and by the shallow bedrock on part of the unit. Mapping Unit 9 is rated as an improbable source of either sand or gravel. Some of the deeper soils probably provide a suitable source of gravel, but access is limited. The unit provides a poor source of roadfill material due primarily to the steep slope gradients and access problems.

RATING SOILS FOR SELECTED USES

Soils are rated for the uses expected to be important or potentially important to users of this report (See Table 2). Ratings for proposed uses are given in terms of limitations and restrictive features or suitability and restrictive features. The definitions of the ratings are as follows.

Limitation Ratings

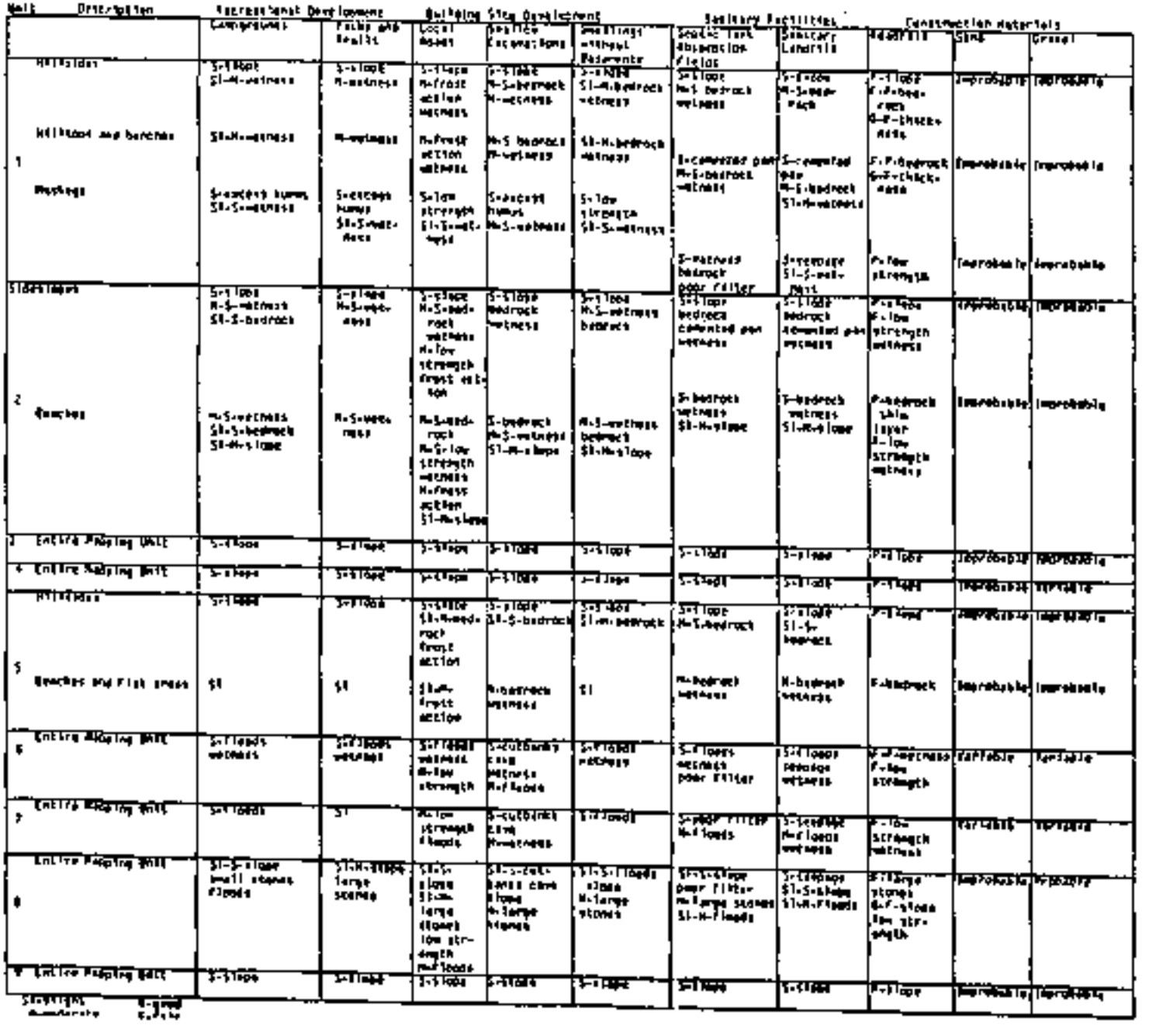
Soils are rated in their "natural" state; no unusual modification of the soil site or material is made other than that which is considered normal practice for the rated use.

Slight (SL) - is the rating given soils that have properties favorable for the use. The degree of limitation is minor and can be overcome easily. Good performance and low maintenance can be expected.

Moderate (M) - is the rating given soils that have properties moderately favorable for the use. The degree of limitation can be overcome or modified by special planning, design, or maintenance during some part of the year, the expected performance of the structure or other planned use is somewhat less desirable than for soils rated "slight". Some soils rated "moderate" require treatment such as artificial drainage, control of runoff to reduce erosion, extended septic tank absorption fields, extra excavation, or some modification of certain features through manipulation of the soil. For these soils, modification is needed for those construction plans generally used for soils of slight limitation. Modification may include specially designed foundations, extra reinforcement of structures, sump pumps, and the like.

Severe (S) - is the rating given soils that have one or more properties unfavorable for the rated use, such as steep slopes, bedrock near the surface, flooding, high shrink-swell potential, a seasonal high water table, or low strength. This degree of limitation generally requires major soil reclamation, special design, or intensive maintenance. Some of these soils, however, can be improved by reducing or removing the soil feature that limits use, but in most situations, it is difficult and costly to alter the soil or to design a structure so as to compensate for a severe degree of limitation.

TABLE 2. SOIL RATINGS FOR SELECTED USES.



In rating soils for non-farm uses, it is important to remember that engineers and others can modify soil features or can design or adjust the plans for a structure to compensate for most degrees of limitations. Most of these practices, however, are costly. The manager must be willing to live with a few limitations, providing the use does not violate codes or regulations. The final decision in selecting a site for a particular use is a personal one and generally involves weighing the cost for site preparation and maintenance.

Suitability Ratings

Soils are rated in their "natural" state, that is, no unusual modifications of the soil site or materials are made other than that which is normal practice for the rated use.

Good (G) - means the soils have properties favorable for the use. Good performance and low maintenance can be expected.

Fair (F) - means the soil is moderately favorable for the use. One or more soil properties make these soils less desirable than these rated "good".

Poor (P) - means the soil has one or more properties unfavorable for the use. Overcoming the unfavorable property requires special design, extra maintenance, or costly alteration.

SELECTED USES

Recreational Development

Soils are rated according to limitations that affect their suitability for camp areas, picnic areas, and paths and trails. Not considered in this rating, but important in evaluating a site, are location, accessibility of the area, size and shape of the area, its scenic quality, the ability of the soil to support vegetation, access to water, availability of potential water impoundment sites, and either access to public service lines or the capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreational use by the duration of flooding and the season when it occurs. On-site assessment of duration and frequency of flooding is essential in planning recreational facilities.

Camp Areas are tracts of land used intensively for tents, trailers, and campers and the accompanying activities of outdoor living. Camp areas require such site preparation as shaping and leveling for tents and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The soils are rated on the basis of soil properties that influence the ease of developing camping areas and the performance of the camping area after development. Soil properties that influence trafficability and promote the growth of

vegetation after heavy use are important.

Slope, stoniness, and depth to bedrock or cemented pan are the main concerns in developing camp areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm to heavy foot traffic, and not be dusty when dry. Soil properties that influence trafficability are texture of the surface layer, wetness, permeability, and large stones. Slow permeability and clayey surface textures are not as severe a limitation to dry regions of the country; however, silty soils may be more of a problem because they are dusty.

Soil properties that influence the growth of plants are depth to bedrock or cemented pans, permeability, and the presence of toxic materials. Soils that flood are particularly hazardous for camp areas because of the danger to life and property.

Paths and trails are used for walking, horseback riding, and other uses and require little or no cutting or filling. The ratings are based on the properties that influence trafficability and erodibility. These are stoniness, wetness, texture of the surface layer, slope, flooding, erodibility, and in dry regions, dustiness.

Building Site Development

Soil properties influence development of building sites, including the selection of the site, the design of the structure, construction, and after construction, performance and maintenance.

Soil limitation ratings of slight, moderate, and severe are given for local roads and streets, shallow excavations, and dwellings without basements.

Local Roads and Streets - Limitation ratings are given for the use of soils for construction of improved local roads and streets that have all-weather surfacing (commonly of asphalt or concrete) and that are expected to carry automobile traffic all year. These roads and streets are graded to shed water and conventional drainage measures are provided. With the exception of a hard surface, the roads and streets are built mainly from the soil at hand. The properties that affect local roads and streets are those that influence the case of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or cemented pan, depth to water table, flooding, the amount of large stones, and slope. The properties that affect traffic-supporting capacity are soil strength, shrink-swell behavior, potential frost action, and depth to high water table. Soil slippage may be a problem on certain sloping soils.

Shallow Excavations - are trenches or holes dug in the soil to maximum depth of five or six feet. They are used for pipelines, sewerlines, telephone and power transmission lines, basements,

open ditches, grave sites, and the like. The excavations are most commonly made by trenching machines or backhoes.

The ratings are based on the soil properties that influence ease of digging and the resistance to sloughing. Depth and hardness of bedrock or cemented pan, the bulk density of the soil, and the amount of large stones influence the ease of digging, filling, and compacting. Depth to the seasonal high water table influence the resistance to sloughing.

Dwellings Without Basements - are buildings of three stories or less without basements. The foundation is assumed to be spread footings of reinforced concrete built on undisturbed soil at a depth of two feet or the depth of maximum frost penetration, whichever is deeper. The ratings are based on properties affecting soil strength and settlement under a load and those that affect excavation and settlement are the presence of a high water table and flooding and the shrink-swell behavior and compressibility of the soils. Compressibility is inferred from the Unified Classification System. Properties influencing the ease and amount of excavation are flooding, high water table, slope, depth to bedrock or cement pan, and the amount of coarse fragment.

Sanitary Facilities

The nature of the soil is important in selecting sites for septic tank absorption fields and in identifying limiting soil properties and site features to be considered in planning, design, and installation. Those soil properties that determine the ease of excavation or installation of these facilities will also affect the ratings.

Soil limitation ratings of slight, moderate, or severe are given for septic tank absorption fields.

Septic Tank Absorption Fields - are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. The centerline depth of the tile is assumed to be at a depth of 24 inches. Only the soil between depths of 24 and 72 inches is considered in making the ratings. The soil properties and site features considered are those that affect the absorption of the effluent, those that affect the construction of the system, and those that may affect public health.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, cemented pan, or ice, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock, ice, or cemented pan interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils. Some soils are underlain

by loose sand and gravel or fractured bedrock at a depth of less than four feet below the distribution lines. In these soils, the absorption field may not adequately filter the effluent, and as a result, ground water supplies in the area may be contaminated.

Percolation tests are used by some regulatory agencies to evaluate the soil's suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at a minimum absorptive capacity. The percolation rates do not correspond to the permeability rates because they are measured by different methods. Experience indicates that soils having percolation rates (1) faster than 45 minutes per inch function satisfactorily, (2) between 45 and 60 minutes per inch have moderate limitations, and (3) slower than 60 minutes per inch have severe limitations. In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sanitary Landfills (Trench) - Sanitary landfill is a method of disposing of solid waste by placing refuse in an excavated trench. The waste is spread, compacted, and covered daily with a thin layer of soil that is excavated from the trench. When the trench is full, a final cover of soil material at least two feet thick is placed over the landfill.

Ratings are based on properties to a depth normally observed during soil mapping. However, because trenches may be as deep as 15 feet or more, geologic investigations are needed to determine the potential for pollution of ground water as well as to determine the design needed. These investigations, generally arranged for by the landfill developer, include examinations of stratification, rock formations, and geologic conditions that might lead to the conducting of leachates to aquifers, wells, water courses, and other water sources. The presence of hard, non-ripple bedrock, crevioed bedrock, or highly permeable strata in or immediately underlying the proposed trench bottom is undesirable from the standpoint of excavation and potential pollution of underground water. Properties that influence risk of pollution, ease of excavation, trafficability, and revegetation are major considerations. Soils that flood or have a water table within the depth of excavation present a potential pollution hazard and cause difficulty in excavating.

Soil slope is an important consideration because it affects the work involved in road construction, the performance of roads, and the control of surface water around the landfill. Soil slope may also cause difficulty in construction of the trenches where the trench bottoms must be kept level and oriented to follow the contour.

The ease with which the trench is dug and with which a soil can be used as daily and final cover is based largely on texture and

consistence of the soil. The texture and consistence of a soil determine the degree of workability of the soil both when dry and when wet. Soils that are plastic and sticky when wet are difficult to excavate, grade, or compact, and to place in a uniformly thick cover over a layer of refuse.

The upper most part of the final cover should be soil material that is favorable for the growth of plants. It should not contain excess sodium or salt and should not be too acid. In comparison with other horizons, the A horizon in most soils has the best workability and highest content of organic matter. Thus, for a trench-type landfill operation, it may be desirable to stockpile the surface layer for use in final blanketing of the fill.

Construction Material

Suitability ratings of good, fair, or poor are given for soils used as a source of roadfill. Ratings of probable and improbable means that the source material is unlikely to occur within or below the soil. This rating does not consider the quality of the source material, because quality depends on how the source material will be used.

Roadfill - consists of soil material that is excavated from its original position and used in road embankments elsewhere. The evaluation for roadfill are for low embankments generally less than six feet and are less exacting in design than high embankments such as used in super highways. The rating is given for the whole soil, form the surface to a depth of about five feet, based on the assumption that soil horizons will be mixed in loading, dumping, and spreading. Soils are rated as to the amount of material available for excavation, the ease of excavation, and how well the material performs after it is in place.

Soil properties that affect the amount of material available for excavation are thickness of suitable material above bedrock or other material that is not as suitable. The percent of coarse fraction greater than three inches, depth to high water table, and slope are properties that influence the ease of excavation. Some damage to the borrow area is expected, but if revegetation and erosion control could become serious problems, the soil is rated severe.

Sand - as a construction material is usually defined as the size of particles ranging from .074 mm to 4.75 mm in diameter. Specifications for each purpose vary widely. The intent of this rating is to show only the probability of finding material in suitable quantity. The suitability of the sand for specific purposes is not evaluated.

The properties used to evaluate the soil as a probable source for sand are the grain size, the thickness of the sand layer, and the amount of rock fragments in the soil material.

If the lowest layer of the soil contains sand, the soil is rated as a probable source regardless of thickness. The assumption is that the sand layer below the depth of observation exceeds the minimum thickness.

Gravel - as a construction material is defined as the size of particles ranging from 4.75 mm to 76 mm (3 in) in diameter. Gravel is used in great quantities in many kinds of construction. Specifications for each purpose vary widely. The intent of this rating is to show only the probability of finding material in suitable quantity. The suitability of the gravel for specific purposes is not evaluated.

The properties used to evaluate the soil as a probable source for gravel are particle size, the thickness of the gravel layer, and the amount of rock fragments in the soil material. If the lowest layer of the soil contains gravel, the soil is rated as a probable source regardless of thickness. The assumption is that the gravel layer below the depth of observation exceeds the minimum thickness.

GLOSSARY

Coarse Fragments

Rock or mineral fragments having a diameter of 2 mm to 25.4 cm (10 in); gravel and cobbles.

Cobbles

Rounded or partly rounded fragments of rock having a diameter of 7.6 to 25.4 cm (3-10 in).

Fabric Material

The least decomposed of all organic soil material. Fabric peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin.

Gravel

As used in the text, rounded or angular fragments of rock between 2 mm and 7.6 cm (3 in) in diameter; as used in Table 2 for construction material, rounded or angular fragments or rock between 4.76 mm and 7.7 cm (3 in) in diameter.

Mottles

Spots or blotches of a different color; mottling in soils usually indicates poor aeration and lack of good drainage.

Muskegs

A common name applied to meadows of the generally timbered country which have very poorly drained organic soils derived from a sphagnum, sedge, grass, and/or herbaceous mat.

Outwash Plains

An extensive lowland area of mainly sandy or coarse textured glacial outwash deposited by meltwater streams beyond the active glacial ice.

Perched Water Table

A water table above an impermeable bed underlain by unsaturated material of sufficient permeability to allow movement of ground water.

Permeability

The ease with which water passes through a layer of soil.

Sand

As used in the text, a soil separate consisting of particles between 0.05 and 2.0 mm in diameter; as used in table 2 for construction material, a soil separate consisting of particles between 0.074 and 4.76 mm in diameter.

Scree

A heap of rock waste at the base of a cliff or a sheet of coarse debris mantling a mountain slope.

Stones

Rock fragments 25.4 to 61.0 cm (10 to 24 in) in diameter.

Stratified

Arranged in or composed of layers or strata of geologic material.

Substratum

The part of the soil below which the processes of soil formation are active.

Talus

A collection of fallen disintegrated material which has formed a slope at the foot of a steeper declivity.

Till

Unsorted and unstratified glacial drift, generally unconsolidated, deposited directly by a glacier.

Water Table

The upper limit of the soil or underlying rock material that is wholly saturated with water.

CHAPTER THREE: WATER QUALITY

There is a close relationship between upland use and water quality. The severity of impact is almost totally related to the intensity of development where commercial, industrial, and multi-family land uses have a much greater impact on water quality than single-family or low density single-family land uses. Water quality problems arise from both point and non-point sources. Point source is a waste discharge entering a water course at a single point, usually a pipe as in the case of outfalls from sewage treatment, whereas non-point source is refuse, entering a water body at many points, either from the land surface directly or through the ground water regime (an example might be human waste runoff and leaching from unimproved campsites). Eyak Lake is a shallow body of fresh water. The small overall volume of fresh water in the lake when compared to the large surface area makes Eyak Lake especially susceptible to point and non-point source pollution.

Sewage and hazardous wastes from upland sites is being discharged into the lake both from point and non-point sources. Pollutants loading would suggest that runoff is entering the lake carrying with it pollutants from the residential streets and yards, as well as grease, oils, and heavy metals from the various commercial enterprises around the lake, and from the power plant and road oiling. Circulation or flushing determines the localized impact of the contaminants in the water - the dispersion of the wastes or their distribution. Suspended sediment is generally a detrimental and serious pollutant and it is transported and circulated in the lake.

Water quality monitoring by ADEC (see Appendix D for water sampling data) revealed presence of heavy metals, specifically manganese, cadmium, lead, and iron, in significant concentrations to cause concern. According to EPA (USEPA, 1978), the chemical contaminants of heavy metals can cause health problems varying from minor irritations to traumatic death.

Manganese was present at a higher level than EPA recommendations for drinking water (USEPA, 1976) at one-fourth of the sample stations (2, 6, 7, 8, and 10) (see figure 7 for sampling station locations) which were primarily at the tip of the West Arm.

Lead was detected at a level slightly higher than EPA recommendations at one of the 20 sampling stations (4) which happens to be just offshore of one of the air taxi operations bases. Road oiling runoff is a likely source of the lead as one study (USEPA, 1972) found that waste crankcase oil contains approximately 1% by weight of lead compounds.

Cadmium was found to exceed recommended concentrations for aquatic life (salmonids and cladocerans) at three stations (2, 4, and 16) although the lower limit of quantification for cadmium (0.0001 mg/l) was well above the EPA maximum priority pollutant

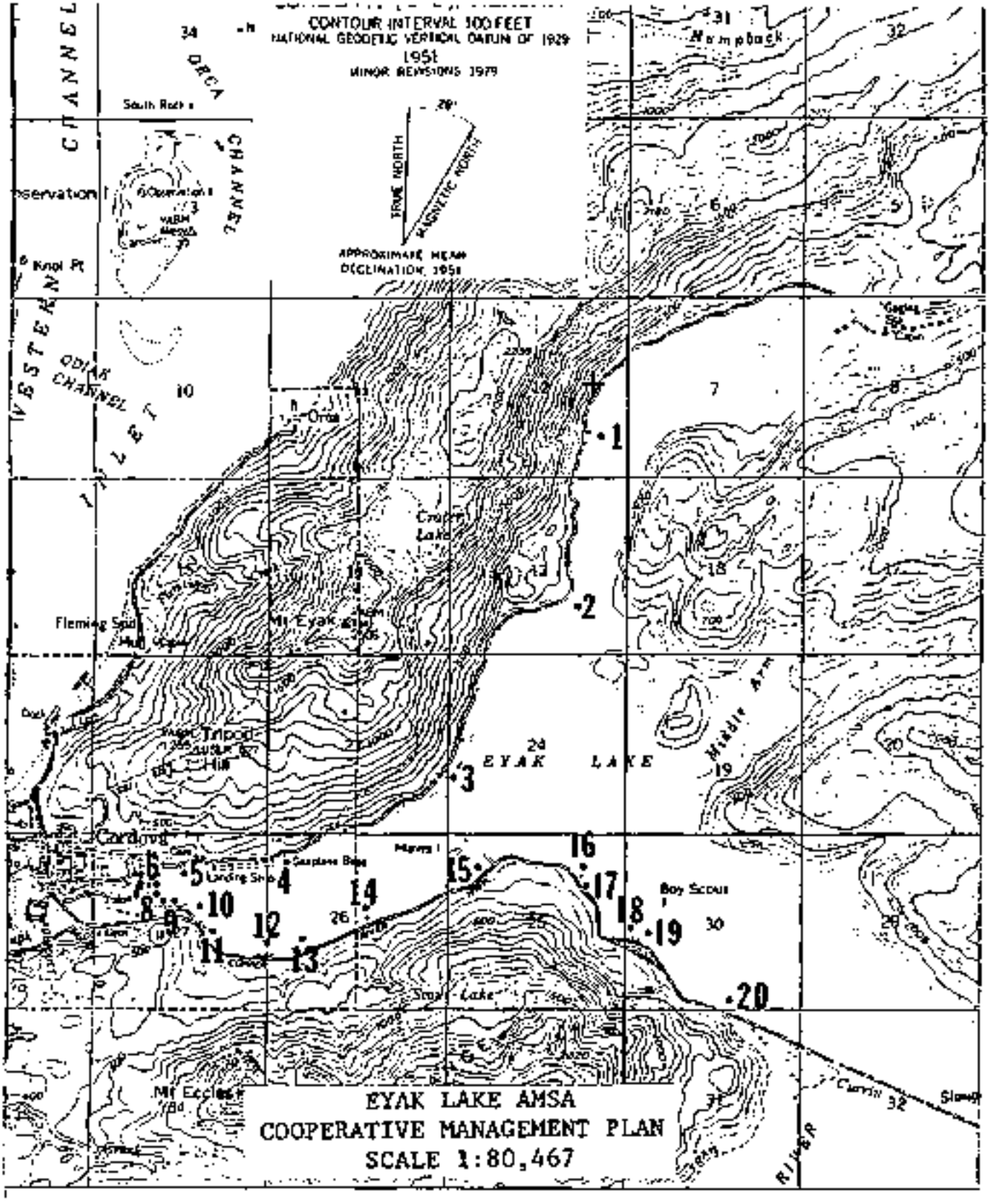


Figure 7. Alaska Department of Environmental Conservation water sample site locations, 1-20.

concentration (0.0004) for aquatic life. Cadmium is extremely harmful in various concentration levels in water as it is toxic to most aquatic organisms studied and its toxicity is accumulative (Canada Fisheries & Environment, 1977). Of some species of fish that were tested, Salmonids appear to be the most sensitive to low levels of cadmium in water (USEPA, 1978). "Cadmium accumulation and its toxicity - acute and chronic - to aquatic life generates concern, for all levels of the food chain are affected" (Canada Fisheries & Environment, 1977).

Cadmium is used as an alloy in bearings, in the manufacture of motor oils and tires to name a few possible sources for the contamination in lake waters (Canada Fisheries & Environment, 1977). One study (Hassel et. al., 1980) determined that highway traffic (lead from gasoline engine exhaust and cadmium from tires) correlated highly with the concentration of heavy metals in adjacent stream sediments and these stream sediments appear to serve as the storage reservoir and primary source for bioconcentration of heavy metals. (Several of the aforementioned studies indicate the need for investigation of community dynamics to more directly assay the threat to aquatic ecosystems posed by heavy metal contamination.)

Iron was found to be above EPA recommendations at three sample stations (2, 8, and 20) although not at dangerous levels.

Arsenic, barium, chromium, mercury, selenium, and silver were also examined and found to not indicate a level of concern or were not detectable at the limit of quantification.

There is evidence of fecal contamination in nearly all peripheral inhabited areas of the lake (ADEC). The presence of fecal coliforms in water is a good indication that fecal material and possibly disease germs may also be present. The higher the coliform count, the greater the danger in untreated water. Fecal coliform were found at each of the twenty sample sites ranging to a high of 245 f.c./100 ml.. Alaska water quality regulations allow up to 20 f.c. /100 ml. based on a minimum of 5 samples taken in a period of 30 day for both drinking water, seafood processors and contact recreation (swimming, etc.). The relative high concentrations of f.c. near the residential areas of the lake suggests the possibility of inadequate sewage treatment and/or direct discharge of sewage into the lake. Dye studies at selected residential sites along the lakeshore have indicated inadequate sewage treatment, contributing to the f.c. concentrations in the lake. Three sites have been located where direct discharge of raw and/or septic tank effluent is occurring. Five sewage treatment/disposal systems were found within 100 feet (minimum separation distance, State requirement) of the lake, and more systems are suspected.

Fish damage from the effects of sewage effluents have been attributed to several causes depending on which author you read--introduction of poisonous compounds, the decrease of the

dissolved oxygen as the result of bacterial decomposition and algal bloom, the increase of turbidity of water by suspended materials, the covering of fish food and spawning ground by deposited solid matter, the encouragement of fungus development, the shift in the biological balance in the waters, the increase of the incidence in fish diseases, and the production of tastes and odor in fish flesh (Tsai, 1975). One thing common to most of the reports, though, is the fact that sewage effluents do upset the natural regime of the water they enter.

Soil conditions adjacent to the lake appear to allow rapid water transport through the soil structure. Precipitation data for the Cordova area was collected over the sampling period to determine if a correlation existed between high rainfall and high f.c. count. There is the possibility that the soil conditions near the lake allow the rainfall to move rapidly through the sewage absorption systems carrying pollutants, not yet purified by the percolation properties of the soil, to the lake.

The soil ratings for septic tank absorption fields are "severe" or "moderate to severe" for most of the AMSA with a few exceptions where the ratings are "slight" or "moderate" (see Table 2). The exceptions are hilltops and benches in Unit 1, benches in Unit 2, benches and flat areas in Unit 5, and most sites in Unit 8. Percolation tests can be made to evaluate individual sites.

The State's water quality regulations applying to bodies of water (rivers, streams, lakes) were very general prior to 1969. Simply stated, no waste disposal system was allowed to contaminate the waters of the State in a manner which might cause a public health hazard. The minimum horizontal separation distances that were specified in the 1959 regulations (50 feet) were changed in 1969 to require greater separation distance (100 feet) between a water supply and any sewage disposal system. However, the 1959 and 1969 regulations remained unchanged regarding contamination of water supplies in that no one could cause the pollution of a groundwater supply by disposal of sewage or other hazardous material(s). Regulation changes in April, 1973, set a minimum 40,000 sq. ft. (0.9 acre) lot size for on-lot wastewater disposal where an on-lot water supply existed. In October of the same year, a 100 foot minimum horizontal separation distance was required between a lake, stream, river or coastal waters and a septic tank, soil absorption system or privy. Additionally, minimum vertical separation distance was established between the soil absorption system and the highest seasonable watertable elevation (4 foot minimum). The purpose of the minimum horizontal and vertical separation distances is to provide purification and ultimate disposal of septic tank effluent. The degree of the purification is primarily dependent on the soil type, loading rates and travel distance before entering the watertable. There is no background water quality data to indicate if the lake water is deteriorating and, if so, at what rate. The data generated by ADEC sample collection/anaylsis, dye study and on-site investigation indicates that contamination does exist and that the probability of an

increase in contamination is of concern.

As the Cordova area developed the people constructed whatever was necessary to sustain their activities. There have been on-lot sewage and water systems installed prior to 1980 that did not receive on-site inspections by local or state agency personnel. As a rule, systems installed prior to 1980 were approved if the owner/installer verbally stated to ADEC that the system met all requirements for on-site water supply and wastewater disposal systems. Where systems were in the ground and covered, inspections of sewage disposal systems were meaningless because proper construction could not be verified. Nevertheless, this was standard procedure and numerous systems were installed illegally, not according to State requirements. In no case are these illegally installed systems acceptable today. Any system that was installed illegally must be upgraded to meet state codes. There are no "grandfather" rights inherent in these systems regardless of their prior "approval". It is important that this aspect of existing systems is understood. The discharge of waste into a watertable and the resulting contamination of drinking water supplies can not be compromised. The options for limiting contamination to the lake from human fecal contamination include: 1) installation of holding tanks on lots too small for septic tank/leachfield application 2) upgrading failing on-lot systems to meet current disposal regulations 3) providing a collection and treatment system.

At the present time, the holding tank concept is currently not feasible as there is no holding tank pumping service in Cordova capable of handling this quantity of waste disposal. (Currently one 300-gallon pumper tank is in use in Cordova. A family of four people produces about 75 gallons/person/day, or over 2,000 gallons/week. This would require 7 trips to empty a single 2,000 gallon tank each week. Five homes, currently violating separation distance requirements, necessitates 35 trips/week.) The City has indicated that this steady dumping of concentrated sewage to the existing city sewage treatment plant would require modifications of operations to meet current EPA-NPDES permit restrictions. Pumping costs are an additional burden to the homeowner and can be considerable in some cases (large families). This should only be considered a temporary measure and not a long term solution.

Upgrading existing systems might suffice in cases where lot sizes and separation distances can be met and where groundwater requirements are not jeopardized. However, where lots are unable to conform to sizing requirements, the conventional septic tank or aeration chamber system will still not meet State codes and are therefore unacceptable installations. A treatment method currently under study includes a secondary treatment system followed by a sand filter, then discharge. It may be possible that this system could be installed within the 100 foot minimum separation distance (distance to be determined by soils investigation, ground slope, etc.). Secondary treatment followed by chlorination of effluent and direct discharge to land or water

is allowable in many situations. However, where anadromous fish are present, even trace concentrations of chlorine are devastating to the fry, and these systems are not acceptable. Thus, a secondary treatment system followed by sand filtration is a potential treatment scheme for small lots near Eyak Lake.

A conceptual agreement has been reached between the DOT/PF and property owners along the Copper River Highway for encroachment into the highway right-of-way to allow for construction of leach fields on lots which are too small to meet the 100 foot minimum horizontal separation distance from the lake. This will allow for an interim solution to upgrade failing systems until a more long term solution is available. An accurate count and analysis of each lot and treatment system would indicate the extent of this potential problem. The ultimate solution might be to extend the city sewage collection system to a point which best serves to eliminate the lake's human influences contamination.

Water quality impacts can be minimized through exercising the best management practices and enforcing State regulations and statutes for sewage treatment and disposal. Where violations of the State's water quality and/or wastewater regulations are found to occur in the Eyak Lake area, ADEC will assist the public to correct any deficiencies. If necessary, ADEC will follow a consistent enforcement policy toward good management practices. On-going water quality monitoring will provide a means of knowing the status of lake water quality and allow management decisions based upon analytical data rather than speculation.

On-going monitoring for fecal coliform is recommended with a minimum sampling schedule of twice yearly--during the spring thaw and in fall prior to lake freeze-up.

Sewage discharge with the resultant fecal coliform pollution cannot be tolerated in Eyak Lake as it diminishes its usefulness as a potable water source, a place for contact recreation, and potential threat to the fishery resource (increased BOD therefore reduces overwinter carrying capacity). As soon as possible after the adoption of this plan, it is recommended that DEC complete an inspection of all private septic systems with a followup listing requirements for those systems not in compliance and time constraints on the requirements.

Soil conditions, heavy annual precipitation, and past development practices, singly or in combination, are not conducive to leach field septic systems; and since there have been problems with drinking water pollution at residences in and adjacent to the AMSA; and since land use density can be increased in this area of demand that exceeds supply; it is recommended that the City of Cordova, DCRA, DEC, and DH&S conduct a joint feasibility study and public awareness program during FY 1985 to determine the feasibility, construction costs, and economic cost/benefit of a sewer and water system extension along the Copper River Highway from the present terminus of the City of Cordova water and sewer

systems to approximately Mile 7 CRH to serve all adjacent properties. In addition, similar extensions should be formed to serve the properties adjacent to the City field. An additional side benefit to a water supply and hydrant system would be reduced insurance premiums and better fire protection to those properties served. As an example, all residences outside the city limits are in Class 10, but could be classed in Class 8 if served by a hydrant system. On a new $70,000 home the insurance premiums would drop from $606 a year to $340. Similarly, an older $50,000 home would be insured at a cost of $800 per year as Class 10, but only $447 if in Class 8.

SEDIMENTATION AND TURBIDITY

Glacially fed Power Creek carries a relatively high concentration of suspended sediment and bed load. Stone and Webster (1982) predicted an average amount of sediment per year of between 3500 and 5400 tons. During high stream flow years the amount trapped could be as high as two or three times that estimate. The sediment has been assumed to be comprised of 10 percent clay, 33 percent silt, and 57 percent sand. This composition has a weight of 81 lbs/cu. ft. Based on this density, 3200 to 5000 cu. yds. of sediment per year would collect in the reservoir should a dam be built at Ohman Falls.

It is assumed that this sediment (or most of it) reaches the lake, however, it is not known how much passes through the lake and over the weir as suspended load. Prior to glacial melting each summer, the North Arm water is relatively clear. Once glacier melting begins, Power Creek carries suspended glacial flour into the North Arm, through the central body of the lake and over the weir. West Arm, Island Bay, and Middle Arm remain relatively clear of the turbidity except during lengthy storm periods. Life expectancy of the lake due to infilling could possibly be estimated through core sampling and analysis of the lake bottom.

The general turbidity pattern may influence aquatic vegetation growth, species composition, and associated biota as well as the biotic production of the ecosystem (ADF&G, 1983).

Further recommendations related to water quality are in order. Continued monitoring of the lake water by DEC is necessary to develop trend data on DO and BOD and to track the relationship between fecal coliform and the control measures described above. In addition, since heavy metals can have disastrous effects on zooplankton that travel up the food chain, sampling for heavy metals must be continued as well as phytoplankton sampling initiated at the earliest feasible date. With ADF&G currently doing phytoplankton sampling in the area it would be a simple process for that agency to add Eyak Lake to its sampling locations. This is especially important to ADF&G since the tie in with the fishery resource is quite apparent. Because of ground water pollution potential as well as surface runoff it is recommended that no solid waste disposal site be located in the

AMSA. The importance of this can not be overemphasized as there has been a recent proposal (by the City of Cordova to the Eyak Corporation) to create a site at Mile 7, CRH which would threaten the wetland habitat with pollutants.

The ground and surface waters of the study areas are subject to chronic, long term oil pollution (petroleum hydrocarbons) that comes from such sources as road oiling runoff, aircraft fuel sump draining and refueling spills, home heating fuel spill runoff, the ever present outboard motor fuel discharge, and the simple drippings that leak from all internal combustion engines. In the case of road oiling for dust control, an EPA study in New Jersey (EPA, 1972) concluded that: 1) roughly 1% of the total oil conservatively estimated to have been applied to the test roads remains in the top inch of road surface with minimal penetration below this top inch; 2) oil leaves the road during wet weather by floatation from wet road surface material and by floatation of oil-wet road surface particles; 3) lead, which is contained in the waste crankcase oil, also leaves the road surface with runoff. This same study found that waste crankcase oil contained approximately 1% by weight of lead and that it was ineffective as a road oil since it ran off rapidly following rains. In 1974, Alaska began controlling surface oiling in the state through a permit process and because of concern of water pollution, prohibited the use of waste oil for surface oiling in all of rain-drenched southeastern Alaska except for Haines and Skagway (Environmental Services, Ltd., 1979). Rainfall in the Cordova area is quite similar to southeastern Alaska and presents the same kind of runoff potential. According to DOT/PF representatives, a total of about 7000 gallons of waste oil is applied to Cordova roads in an average year and prior to the Cordova Electric Cooperative's generating plant recycling system, an additional 12,000 gallons of waste oil was used for road oiling from that facility (Environmental Services, Ltd., 1982). According to a NOAA technical report (NOAA, 1977) the most toxic fuel is probably gasoline because of its high content of aromatics and other low-boiling hydrocarbons which are relatively highly soluble in water. Weathering removes much of the more voilatile, toxic fractions so that newly spilled fuels are more toxic than weathered oil.

Although it is not clear what the long-term effects of chronic oil pollution on aquatic life will be, the conservative approach would advocate stringent limitations on oil discharges until more information becomes available regarding effects on the ecosystem.

In order to stop the indiscriminate dumping of waste oil especially in the vicinity of the air taxi operations, aircraft service facilities, and the automotive repair shop in City Field, the leasors of those properties (DOT/PF and City of Cordova) shall establish a lease requirement for on-site storage of the waste oils. DEC shall furnish recommendations for suitable storage containers and other applicable requirements. It follows then that the City of Cordova is obligated to develop ways and means of

collection and disposal of the petroleum wastes. Use of the material as a fuel or for re-refining are possibilities. Although outside the scope of this study, indiscriminate dumping of waste oil is a widespread problem in and around Cordova and the only way to obtain some control is to provide a collection facility that is available to all residents. The problem is not simple as many other substances besides waste oil - solvents, paint thinners, etc. - require proper disposal, but complicate the problem.

Road oiling for dust control is probably the greatest detriment to Eyak Lake water quality as the high rainfall flushes the oil and its toxic pollutants into the lake and adjacent streams. Other dust control measures are available such as road surfacing or spreading water. It is recommended that DEC no longer issue permits for surface oiling anywhere in the Eyak Lake AMSA.

Fuel sump draining directly into the lake from floatplanes is a long-time practice, the extent of which has not been calculated. Land based planes at City Field are also guilty except that the fuel is drained onto the ground and what doesn't dissipate into the air eventually finds its way into the lake. Aircraft operators should be required to collect their drained fuel and maintain suitable containers for temporary storage of the drained fuel.

Recent testing of outboard motor pollution done under the auspices of EPA revealed preliminary findings that outboard motors do not pollute. As testing continues, however, we can assume that outboard use is not a threat to water quality at this time.

It is common knowledge that a significantly large oil spill or leak has occurred in the vicinity of the power house at the western tip of the lake and has resulted in oil to seep into the lake. Oil will bubble to the surface when the lake bottom is disturbed in the vicinity of the Spit at Nirvana Park and is an apparent indication of the problem. Long detention times of these pollutants may magnify their impacts during periods when the lake is ice covered, inflows and outflows are minimal and the water quiescent. Dispersion and distribution of wastes determines the local impact of contaminates in the water. This is controlled by circulation patterns and rate of flushing in the lake.

Since the power plant has long been suspected as a source of waste oil and diesel spill pollution into lake waters, this plan recommends DEC and the Cordova Electric Cooperative to conduct a joint study to determine the extent of this problem, if any, and outline the steps necessary to alleviate it either directly or through mitigating measures.

Power Creek, being glacially fed and moving through an eroding steam channel with mass wasting from steep adjacent slopes and avalanche debris adding to the problem, carries a considerable sediment load. A conservative estimate of the total annual sediment load in Power Creek is 4.1 to 6.1 acre feet. One

prediction showed the average amount of suspended sediment per year to be between 3500 and 5400 tons with that amount doubled or tripled during high stream flow years (Stone and Webster, 1982).

Being fed primarily by Power Creek, Eyak Lake acts as a settling basin, and, surprisingly, many parts of the lake remain quite clear even though the incoming flow from Power Creek is turbid. On the other hand, the runoff that occurs in the Murchison Falls Creek drainage basin is almost void of soil erosion problems and remains quite clear even during high runoff periods. This helps make Murchison Falls Creek an "excellent raw water source" for drinking water. (Merrell et al., 1980).

Previous water quality data for Eyak Lake also indicated that the water quality was poorest in the most westerly end of the lake and that the poorer quality was attributable to pollution resulting from the residential development adjacent to the lake. Since that time, a wastewater collection and treatment system has been installed in Cordova and the most likely potential causes of the pollution (septic tank leach systems) in the west end of the lake have been removed by connection to the sewer system (Merrell et. al., 1980).

Sediment pollution has detrimental effects on aquatic life and is caused by both natural events and man's activities and we see examples of both in Eyak Lake--glacial silt from Power Creek basin and sediment runoff from construction activities on the uplands, as examples. Sediment deposited in spawning gravels hampers survival of fish eggs, alevin and fry; decreases the permeability of gravel substrates used for spawning; and may inhibit production of aquatic plants and invertebrate fauna thus reducing the food available to rearing and resident fish. Sediment is a natural phenomenon and occurs in generally predictable seasonal cycles of clear and turbid waters. During the water period of the year, runoff and clear and turbid waters. During the warm period of the year, runoff and glacial melt increase. Aquatic communities have developed in rhythm with the turbid-clear cycle (ADF&G, 1983).

It is important to get some more detailed information regarding phosphorous concentrations throughout the lake. It would be of value to analyze some selected sediments for total phosphorous. This information in conjunction with a measure of the primary productivity of the lake and the members of the phytoplanktonic community would be invaluable in determining the current trophic status of the lake.

High DO (dissolved oxygen) and low BOD (biochemical oxygen demand) were found in a year even when the lake was ice covered for many months. This is a good condition for overwintering of fish. Apparently the decaying plants were not a problem either in terms of oxygen under the above conditions. Heavy snow cover may reverse the conditions and in severe winters, low DO and high BOD may limit fish survival and productivity.

An important relationship that is not known at this time is that between phytoplankton, zooplankton, and the opacity of the water, and the photosynthesis process in the various regions of the lake. We need to understand their composition, population structure, phenology and contribution to the ecosystem. A connected relationship is that between the water opacity and sunlight penetration as it affects plant growth and water column heating.

Because of the lessened severity of impact on water quality, single-family and low density single-family land uses are recommended within the AMSA.

The water treatment plant is a potential pollution source because of the use of chemicals (notably chlorine) and back-flushing to clear the filters. ADEC should assist the City to develop a set of required procedures for the plant to reduce the potential for lake pollution.

Core sampling of the lake bottom should be done to obtain detailed information regarding phosphorus concentrations. Information on total phosphorus measured in conjunction with the primary productivity and phytoplankton community would be valuable in determining the current trophic status of the lake.

CHAPTER FOUR: BIRDS AND MAMMALS

Thirty-one mammal species have been recorded in the study area from the small shrews and voles to brown bear and moose.

One hundred thirty-nine species of birds have been recorded on or over the Eyak Lake study area. The area's close proximity to marine habitats and major bird migration routes contributes to the large number of species. Twenty-nine species are known to breed within the study area while twenty additional species are listed as "probable" breeders. Twenty-four other species are "suspected" breeders in the area.

The objectives of this chapter are:

(1) to describe the habitats available and utilized by birds and mammals in the Eyak Lake study area;
(2) to list the birds recorded, their status, abundance, and habitat affinities in the study area;
(3) to make an annotated list of the mammals occurring in the study area;
(4) to include special interest species within the study area with comments on land management practices.

The bulk of these data were gathered during the 20 year period from February, 1962 to February, 1982. Some of these data were published in "Birds of the North Gulf Coast - Prince William Sound Region, Alaska" by M.E. 'Pete' Isleib and Brian Kessel, Biol. Papers University of Alaska, No. 14, 1973. Other data within this chapter have been gathered by the consultants in conjunction with other field work and by local Forest Service and Fish and Game personnel. Local residents provided additional information on the occurrence and abundance of some mammals.

DESCRIPTION OF HABITATS

Within the study area we have identified twelve habitat types utilized by birds and mammals, some of which are very limited in area. The presence or absence of preferred habitat types plays a critical role in the distribution and abundance of most birds and mammals.

1. Tundra: In the study area, tundra is alpine in distribution and extremely limited to a few hectares on slopes on the northeast side and is, with few exceptions, little used by birds and mammals. Vegetation consists primarily of low, often mat-forming plants. Important species include Crowberry, Alpine and Dwarf blueberries, Mountain Heather, Alpine Azalea, Alaska Moss Heather, sedges, and a number of other herbs, mosses and lichens.

2. Shrub Thickets: Primarily composed of Sitka Alder, shrubs are extensive in the study area, occurring on steep slopes and along the lakeshore. Being pioneering species, alders and

salmonberry readily invade disturbed areas such as avalanche tracks, stream borders, and cutover areas. In later stages of shrub thicket development, various other forms of woody vegetation become common components including blueberry, Stink Currant, and Red-berried Elder. Shrubs in the Power Creek Delta are also composed of a variety of willows and Red-berried Elder. Often Devil's Club is associated with climax alder thickets, making penetration difficult at best. Other species in thickets include a wide variety of ferns, grasses, sedges, mosses, and, in damp open spots, dense growths of Cow Parsnip and False Hellebore. Shrub thickets vary in height from 2 to 6+ meters, with the taller forms most common in riparian areas.

3. Hemlock/Sitka Spruce Forest: The Eyak Lake study area is phytogeographically a part of the Hemlock/Sitka Spruce coastal/subalpine forests of the Pacific Coast. Occurring in most of the upland of the study area, the forest is primarily composed of Sitka Spruce, and Western and Mountain hemlock varying in height from 15 to 30+ meters and up to 1 meter DBH. The understory of the coniferous forest is composed of many shrubs such as blueberry, Fool's Huckleberry, Sitka Alder, and Mountain Ash (see 2 above). The ground cover is dominated by mosses, a wide variety of herbs, ferns, club-mosses, Dwarf Dogwood, Twisted Stalk, Goldthread, and bramble.

4. Bogs: Known locally as muskegs, bogs are naturally occurring open areas where drainage is poor - generally within coniferous forests. Small areas of bogs occur near the reservoir, above the Copper River Highway, on the slope above the Power Creek Road at the entrance of North Arm, and on slopes around Island Bay and Middle Arm. Sphagnum moss predominates in these sites and, after decades, the underlying decaying vegetation becomes peat. Other plants associated with bogs include sedges, Cotton Grass, Sweetgale, Bog Cranberry, blueberries, Labrador Tea, Crowberry, Bog Rosemary, Cloudberry, Grass-of-Parnassus, and sundew. Small shallow ponds and puddles are commonly associated with bogs.

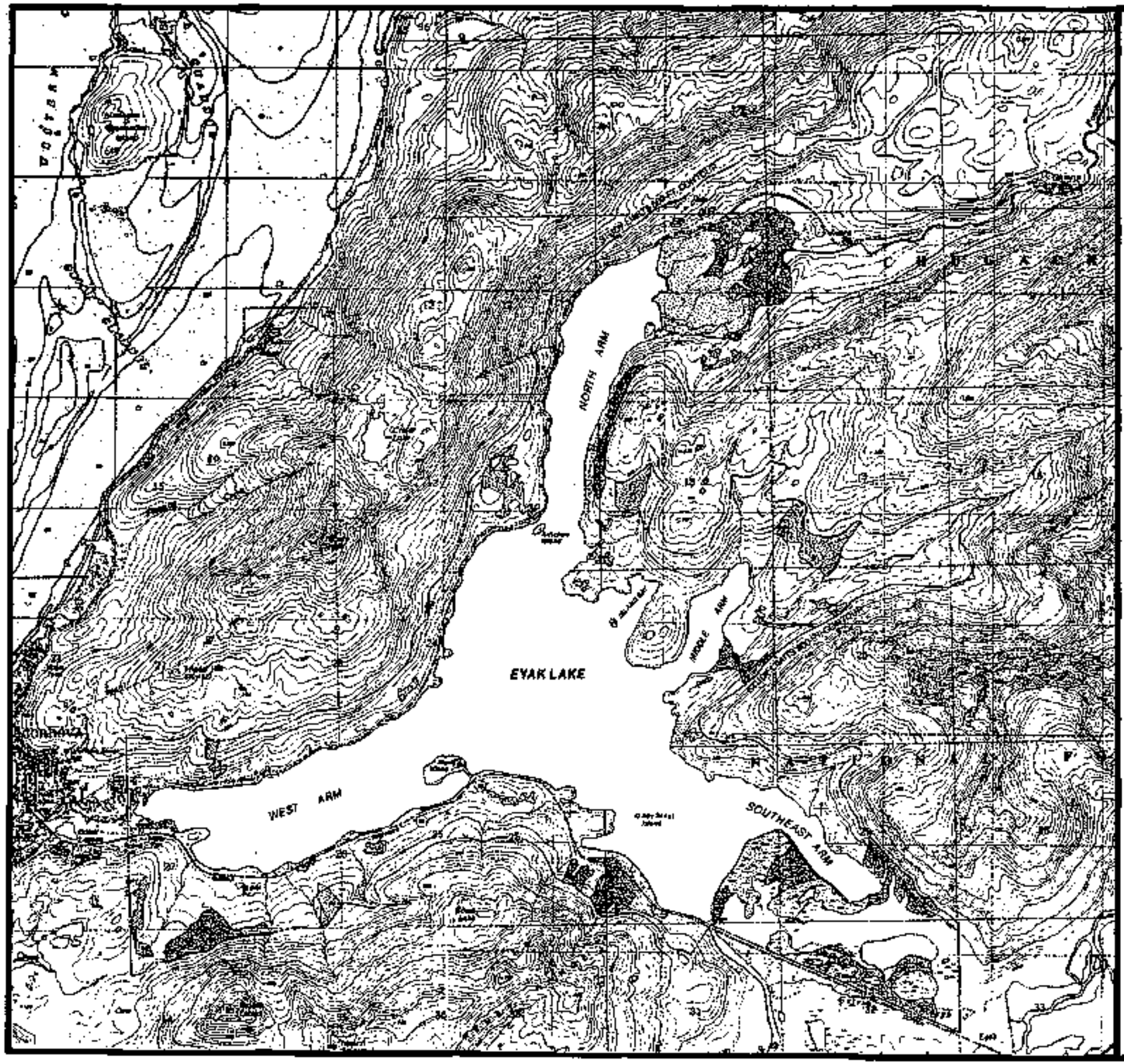
5. Mixed Deciduous-Spruce Woodlands: Small stands of Black Cottonwood often intermixed with Sitka Alder and Sitka Spruce are located along the lakeshore. Several sites occur along Power Creek Road and the Copper River Highway. The understory vegetation includes a wide variety of shrubs such as salmonberry, Highbush Cranberry, and willows.

6. Marshes: Small areas of marshes are located south of Southeast Arm and the Copper River Highway and on the Power Creek Delta into Eyak Lake. Marshes in the study area include a wide variety of shrubs: willows, alder, Sweetgale. Other species include horsetail, grasses, sedges, Cotton Grass, Grass-of-Parnassus, and vetch. Vegetation within marsh ponds includes pondweeds, manna grass, Yellow Water Lilies, bullrushes, spikerush, buttercup, and Water Milfoil.

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PLAN

November 2007

Alaska Coastal Management Program



VEGETATION MAP

- Sitka Thicket
- Cliffs, Bluffs, Scree Slopes
- Bog (muskeg)
- Hemlock-Spruce Forest
- Marsh
- Mixed Deciduous—Spruce Woodland

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 8

7. Lacustrine Waters: This includes Eyak Lake (2,400 acres) and the large pond (40 acres) south of Southeast Arm where a pair of Trumpeter Swans nest. The lake vegetations includes a wide variety of aqautic plants. The consultants' survey of the lake has mapped the extent of the vegetation and these data are included elsewhere. The most abundant of these aquatic plants includes Sage Pondweed, Clasping-leaf Pondweed, and Water Milfoil. Yellow Water Lilies occur in several locations near the lakeshore.

8. Fluviatile Waters: The flowing waters of the study area include numerous small and short streams draining slopes above the lake. Power Creek is the only flowing water body of substantial volume.

9. Cliffs, Bluffs, and Scree Slopes: Upland cliffs, bluffs, and screes occur on the slopes bordering sections of the study area. Mostly devoid of vegetation, these sites are little used by most birds and mammals, but in some instances may provide nesting sites for ravens and Violet-green Swallows and denning sites for Hoary Marmots.

10. Residential Zones and Man-made Structures: Man-made structures and residential zones offer several alternative habitats to birds and mammals. Nesting and denning sites are available to Tree and Barn swallows and several small rodents. Bird feeders provide additional food sources.

11. Shorelines, Beaches and Open Areas: Along the approximately 20 miles of shoreline on Eyak Lake and the large pond, several forms of rocky, gravel, sand, and mud surfaces provide several micro-habitats. These small areas provide resting, foraging, and/or nesting sites for several bird species. The city airport on the lakeshore is included in this habitat form. Vegetation is sparse or non-existent.

12. Air Above: The study area straddles a portion of the coastal migration corridor. Many bird species that do not utilize lands and waters in the study area are annual migrants through the "Eyak Gap."* The list of users includes many waterbirds and raptors, e.g. Sandhill Cranes, Snow Geese, and Peregrine Falcons. (Note: The term "Eyak Gap" is newly coined to describe an avian corridor through air space between the Heney Mountains south of Eyak Lake and the Chugach Mountains to the north. In the spring, birds flying westward across the upper Copper River Delta at a few hundred feet elevation can visually observe a portion of Prince William Sound and often use this short-cut. The reverse route is used by fall migrants, and the gap is used all summer by gulls enroute between Cordova waterfront and the Copper River Delta.)

PHENOLOGY

1. Spring: As the lengthening of daylight hours become apparent in February, spring (if it equates to flowers and singing robins)

is still months away. Yet a re-awakening is in progress. There is a regional population shift of redpolls headed west toward Prince William Sound, and noticeable to the keen observer are the aerial courtship antics of ravens flying to and from their roost on the slope above Northern Arm. Snow Buntings, rarely noticed amid the snow showers, are the first migrants to pass through the study area beginning the second week of March. By the end of March, the paired Trumpeter Swans that wintered in the Eyak system are making daily forays to what may be their nesting ponds on the adjacent Copper River Delta. By the first of April, other swans that wintered farther south, along with Mallards and Pintails, are the vanguard of the thousands of birds that will pass through during the following six weeks.

Spring migrant birds that pass through the study area arrive from the east after crossing the Copper River Delta. If low clouds with rain or snow squalls obstruct migration south of the Heney Range, flock after flock of waterfowl and cranes pass through "Eyak Gap" over Eyak Lake and Cordova before entering Prince William Sound. Peak period for migrant geese is from April 19th to May 9th. The peak for cranes is April 27th to May 12th. Six to twelve miles south of the study area many millions of migrants move westerly between mid-April and the end of May. Phenomenal concentrations of shorebirds occur on the tidal flats of the western Copper River Delta and Orca Inlet. The study area is remote from most of these happenings except when extremely strong southeast winds and rain halt migration and birds are forced to seek shelter. At such times, flocks of shorebirds are found along the shores of Lake Eyak.

The first songbirds are heard in the forest about the study area in April - Varied Thrush in early April, Ruby-crowned Kinglet in late April. The first American Robins and Tree Swallows are observed during the last days of April. The first shorebirds in the study area are Common Snipe and Greater Yellowlegs, arriving the third week of April; their vocalizations of arrival are apparent to anyone visiting the southeast arm of the lake. As the ice in the lake breaks up, many species of ducks and other waterbirds can be found in the open lake waters. By mid-May the songbirds are arriving, at times almost enmasse overnight as migrant waves arrive in the area. Sparrows, thrushes, and swallows are followed by warblers in late May. In the still, warm mornings the forest will seem to ring with calls and songs of many birds.

The area's smallest and one of its most colorful breeding birds, the Rufous Hummingbird, is commonly noted as it arrives in May. Homeowners in the area regularly put out bright red sugar-water feeders to attract these interesting birds. By the end of the first week of June, all transcients have passed, and summer resident birds are on their territory. The last to arrive are some warblers and flycatchers.

2.Summer: Great Horned Owls begin nesting in March, Bald Eagles and Trumpeter Swans in April, but most species await warmer weather in May and June to begin nesting. During early June the forest rings with a symphony of bird sounds. By solstice, the official beginning of summer, most young have hatched. The hemlock-spruce forests are home to the Varied Thrushes. In the long daylight/dusk hours of June, their odd, insect-like calls can be heard at all times. The Hermit Thrushes' flute-like series of calls are heard mainly in the mornings and evenings. The loud, bubbling call of the Ruby-crowned Kinglet and the warbling calls of Fox Sparrows are heard during rain or shine along the roads and trails of the study area.

During the summer as well as throughout the year, large concentrations of gulls are attracted to wastes produced by the fish processing plants on the Cordova waterfront. Over 10,000 gulls are semi-resident on or around the waterfront during June, July, and August. In addition to many nonbreeding gulls, breeding gulls from the Copper River Delta where they nest are attracted by the unnatural abundance of food. Many of these gulls regularly pass to and fro through the "Eyak Gap" enroute. At the height of the summer, as many as several hundred gulls at a time utilize Eyak Lake as resting and loitering area. Along Power Creek in summer, one can see views of colorful Harlequin Ducks and the queer little bird that walks on the bottom of mountain streams, the Dipper. Several pairs of each have been found nesting in the Power Creek drainage. Along the northeast lakeshore, loons and mergansers trailed by downy young are frequently seen. Spotted Sandpipers are to be expected. As the summer wanes in late July and August, the first birds to depart are swallows. Flocks of swallows over the lake during late July are beginning their southward migration.

3. Fall: Migration is an important aspect of fall utilization of the area, though it is less dramatic than in spring. Many migrant birds pass through on their way southward, but movement is more diffuse and less hurried, extending from July to December. For the most part, fall migration is the reverse of spring, with birds entering from Prince William Sound heading eastward onto the Copper River Delta.

Fall migration begins in July with swallows. Peak movements of most passerines (song birds) occur between mid-August and mid-September, but thrushes and sparrows are still moving through during October. Periodically, during good cone crop years, mass movements of Pine Siskins and crossbills take place during fall and early winter. Generally, the movement is easterly through the forests. At times these movements also include numbers of Redbreasted Nuthatches. During September and October, large movements of waterfowl and cranes pass over Cordova and the study area to staging marshes on the Copper River Delta. On clear days with light west or southerly winds, a regular movement of hawks and eagles are aloft, moving east on the updrafts of the ridges bordering Eyak Lake.

The Power Creek Delta is heavily used by scavenging gulls and eagles from September until freeze-up. The food source is the dead and dying Red and Silver salmon. Concentrations of diving ducks (up to 300+ individuals) occur in North Arm, Middle Arm/Island Bay, Southeast Arm, and in the west lee of Mavis Island. The largest flocks are principally composed of Greater Scaup. Severe southeast storms and considerable precipitation normally occur in September and October. Some storms are accompanied by prolonged winds of hurricane force. These severe storms restrict migratory movements, and large numbers of sparrows and thrushes are forced down. On these occasions, the shrub thickets will abound with birds. If the storms are timed with the major waterfowl exodus of western Alaska (mid-October), after the storm passes, large numbers of Snow and Canada geese and Whistling Swans arrive over the study area after crossing Prince William Sound from Cook Inlet. As long as Eyak Lake remains unfrozen, several hundred waterbirds are present including gulls, loons, grebes, a few cormorants, Canada Geese, a wide variety of ducks, and a few Great Blue Herons. During freeze-up, the birds that remain are largely concentrated in two areas: Power Creek Delta and the lake outlet near the weir.

4. Winter: As winter sets in during December, impressive numbers of eagles and swans may occur. Up to 400 Bald Eagles have been censused in the North Arm/Power Creek area. Aggregations of several species of waterfowl including over 100 Trumpeter Swans have been censused at the lake outlet/weir. As food supplies of dead salmon diminish, the eagles disperse to other areas. As the lake freezes tighter, some of the swans move to Southeast Alaska.

Annually since 1969, a census of birds has been taken in the Cordova area during the Christmas/New Year period. Two areas in the study area are carefully surveyed: Power Creek/North Arm and the Eyak weir. The censuses have shown that land areas are utilized by relatively few bird species most of which are resident: raptors, ptarmigan, and Spruce Grouse, and several passerines, notably corvids and fringillids. Some fringillids, especially Pine Siskins, crossbills, and redpolls, vary in abundance from year to year, numbering in the thousands some years but being essentially absent in others. Their abundance is related to the food available and is high in good cone crop years.

Even in the coldest weather, some waterfowl remain on small patches of open water near the weir and in the warm upswelling springs on the Power Creek Delta. One of the hardiest of birds, which even sings in sub-zero weather, is the Dipper.

BIRDS OF EYAK LAKE STUDY AREA

During the 20-year period of 1962-1982, the following records of occurrence of birds in the Cordova area have been compiled (see Tables 3, 4, and 5).

Two hundred ten (210) species of birds have been recorded within

10 NM of the Eyak Lake study area. One hundred eighty-six (186) species of birds have been recorded within the study area combined with the Cordova city boundaries. One hundred thirty-nine (139) species have been recorded on or over the Eyak Lake study area.

The great variance between the numbers is due almost entirely to the lack of marine habitats in the study area. But the study area's close proximity to marine habitats and major bird migration routes enhances the areas list as considerable spillover occurs, especially during migration.

From observations of nests or of young that are too young to have traveled any distance, 29 species of birds are known to breed within the study area. Additionally, 20 species are listed as "probable" breeders. This group includes species for which no nests or recently fledged young have been observed. But some presumed breeding pairs have been recorded in preferred habitats doing courtship, defending territory, or carrying food. This suggests that additional fieldwork would prove fruitful in confirming nesting.

Twenty four (24) species are listed as "suspected" breeding birds. This group includes species for which little or no evidence of nesting has been recorded in the study area, but a preferred nesting habitat does occur, and the species nest regularly in contiguous areas. This suggests that breeding within the study area could be confirmed in some cases if a long-term study was undertaken.

MAMMALS OF EYAK LAKE STUDY AREA

The following 31 mammal species have been recorded within the study area.

1. Masked Shrew (Sorex cinereus)
2. Dusky Shrew (Sorex obscurus)
3. Water Shrew (Sorex palustris)
4. Little Brown Myotis (Myotis lucifugus)
5. Collard Pika (Ochotona collaris)
6. Snowshoe Hare (Lepus americanus)
7. Hoary Marmot (Marota caligata)
8. Red Squirrel (Tamiasciurus hudsonicus)
9. Beaver (Castor canadensis)
10. Northern Red-backed Vole (Clethrionomys rutilus)
11. Tundra Vole (Microtus oeconomus)
12. Muskrat (Ondatra zibethicus)
13. Northern Bog Lemming (Synaptomys borealis)
*14. Norway Rat (Rattuls norvegicus)
*15. House Mouse (Mus musculus)
16. Porcupine (Erethizon dorsatum)
17. Coyote (Canis latrans)
18. Gray Wolf (Canis lupus)
19. Red Fox (Vulpes vulpes)
20. Black Bear (Ursus americanus)

TABLE 3. OCCURENCE OF BIRDS IN THE STUDY AREA.

KEY:

Abundance	Month	Observation Frequency Period
Common	▬▬	Observed Daily = Present
Fairly Common	——	Observed Weekly = Present
Incommon	— — —	Irregularly Observed = Not Always Present
Rare/Casual	· · · ·	Observed Once or More = Not Always Present

Breeding K = Known nesting
P = Probably nesting
S = Suspected nesting

SPECIES	BREEDS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Primary Habitat or Area of Use
*Common Loon	K	·	·	·	—	▬	▬	▬	▬	▬	▬	—	—	Lake Waters
Yellow-billed Loon											·	·	·	Lake Waters
Arctic Loon						—								Lake Waters
Red-throated Loon					—	—				—	—	—		Lake Waters
Red-necked Grebe						—					—	—		Lake Waters
Horned Grebe	S					—	—			—	▬	—		Lake Waters
Pied-billed Grebe		·	·	·	·	·	·					·	·	Lake Waters
Double-crested Cormorant						—	—		—	▬	▬	—		Lake Waters/Shoreline
Great Blue Heron		·	·	·	·	·	·	·	·	·	—	—	—	Lake Shore Habitat
Whistling Swan		—	—	—	—	—	—				—	—	—	Lake Waters
*Trumpeter Swan	K	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	Lake Waters
Canada Goose	S				—	—	—	—	—	—	—	—	—	Lake Shore/Marshes
White-fronted Goose						—				—	—			Air above
Snow Goose						—					—			Air above
Mallard	K				—	▬	▬	▬	▬	▬	▬	—	—	Lake Waters/Marshes
Gadwall		·	·	·	·	·	·	—	—			—	—	Lake Waters/Marshes
Pintail	K	·	·	·	·	·	—	▬	▬	▬	—	—	—	Lake Waters/Marshes
Green-winged Teal	P	—	—	—	—	·	·	—	—	—	—	—	—	Lake Waters/Marshes
Blue-winged Teal						·	·				·	·		Lake Waters/Marshes
Northern Shoveler	S					—	—				—	—		Lake Waters/Marshes
European Wigeon						·					·	·		Lake Waters/Marshes
American Wigeon	P	·	·	·	·	·	▬	▬	▬	▬	▬	·	·	Lake Waters/Marshes
Canvas Back						—	—				—	—		Lake Waters
Redhead						—	—				—	—		Lake Waters
Ring-necked Duck						—	—				—	—		Lake Waters
Greater Scaup		—	—	—	—	—	—	—	—	—	▬	▬	—	Lake Waters
Lesser Scaup		·	·	·	·	·	·	—	—			—	—	Lake Waters
Tufted Duck		·	·	·	·	·	·					·	·	Lake Waters

ECIES	BREEDS	J A N	F E B	M A R	A P R	M A Y	J U N	J U L	A U G	S E P	O C T	N O V	D E C	Primary Habitat or Area of Use
mmon Goldeneye														Lake Waters
rrow's Goldeneye	P													Lake Waters
fflehead														Lake Waters
dsquaw														Lake Waters
rlequin Duck	K													Power Creek Waters
ite-winged Scoter														Lake Waters
rf Scoter														Lake Waters
oded Merganser														Lake & Stream Waters
mmon Merganser	K													Lake & Stream Waters
d-breasted Merganser	S													Lake Waters
shawk	S													Forested Habitats
arp-shinned Hawk	S													Forested & Shrub Habitat
ugh-Legged Hawk														Air Above
ld Eagle	K													Air Above,Forest/Shore
rsh Hawk	S													Air Above
prey														Air Above
rfalcon														Air Above
regrine Falcon														Air Above
rlin	S													Forests & Woodlands
erican Kestrel														Forests & Woodlands
ruce Grouse	K													Forests
llow Ptarmigan	P													Tundra & Shrub
ndhill Crane														Air Above
erican Coot														Lake Waters
mipalmated Plover														Lake Shore
lldeer														Lake Shore
dsonian Godwit														Lake Shore
imbrel														Air Above
eater Yellowlegs	K													Marsh & Lake Shore
sser Yellowlegs	S													Marsh & Lake Shore
litary Sandpiper														Marsh
otted Sandpiper	K													Lake & Stream Shore
rthern Phalarope	P													Lake Waters & Marsh
mmon Snipe	K													Marsh & Lake Shore
ort-billed Dowitcher														Lake Shore
stern Sandpiper														Lake Shore
ast Sandpiper	P													Lake Shore & Marsh
ctorial Sandpiper														Lake Shore & Marsh
nlin														Lake Shore
rasitic Jaeger														Lake Waters
aucous Gull														Waters & Shorelines
aucous-winged Gull														Waters & Shorelines
rring Gull														Waters & Shorelines
w Gull	S													Waters & Shorelines
naparte's Gull														Waters & Shorelines
ory Gull														Accidental
ctic Tern	P													Waters & Shorelines

CIES	BREEDS	J A N	F E B	M A R	A P R	M A Y	J U N	J U L	A U G	S E P	O C T	N O V	D E C	Primary Habitat or Area of Use
bled Murrelet	S													Forest
rning Dove														Accidental
at Horned Owl	P													Forest & Woodlands
k Owl														Forest & Shrub
rt-eared Owl														Shrub & Marsh
eal Owl														Forest
-whet Owl	S													Forest
ous Hummingbird	K													Forest & Shrub
ted Kingfisher	K													Shorelines
mon Flicker														Forest & Woodlands
low-bellied Sapsucker														Forest & Woodlands
ry Woodpecker	S													Forest & Woodlands
ny Woodpecker	S													Forest & Woodlands
thern Three-toed Woodpecker														Forests
er Flycatcher	S													Shrub
ve-sided Flycatcher														Forest & Shrub
let-green Swallow	P													Cliff Bluffs/Screes/Resid
e Swallow	M													Forest & Residential
k Swallow	P													Air Above & Shorelines
n Swallow	M													Residential
ff Swallow														Air Above
ller's Jay	M													Forest & Shrub/Residentia
ck-billed Magpie	P													Forest & Shrub/Shorelines
mon Raven	P													Forest,Residential/Shorel
thwestern Crow	P													Forest,Residential/Shorel
ck-capped Chickadee														Forest & Shrub
stnut-backed Chickadee	M													Forest
-breasted Nuthatch	S													Forest
wn Creeper	P													Forest
per	M													Flowing Waters & Lakeshor
ter Wren	S													Forest
rican Robin	M													Forest & Shrub
ied Thrush	M													Forest & Shrub
mit Thrush	M													Forest & Shrub
nsends Solitaire														Shrub & Woodlands
den-crowned Kinglet	S													Forest
y-crowned Kinglet	M													Forest & Woodlands & Shru
er Pipit	S													Lakeshore & Timber
emian Waxwing														Forest & Woodlands
thern Shrike	S													Forest & Woodlands & Shru
rling														Residential Areas
nge-crowned Warbler	M													Forest & Woodlands & Shru
low Warbler	P													Shrub
low-rumped Warbler														Forest & Woodlands & Shru
nsend's Warbler	M													Forest
son's Warbler	P													Forest & Woodlands & Shru
ty Blackbird	S													Woodlands/Shrubs/Marshes Lakeshores

PECIES	B R E E D S	J A N	F E B	M A R	A P R	M A Y	J U N	J U L	A U G	S E P	O C T	N O V	D E C	Primary Habitat or Area of Use
ine Grosbeak	P													Forest, Woodlands & Shr
ray-crowned Rosy Finch	S													Cliffs Bluff & Scree
oary Redpoll														Forest, Woodlands & Shr
ommon Redpoll	P													Forest, Woodlands & Shr
ine Siskin	P													Forest, Woodlands & Shr
ed Crossbill	S													Forest
hite-winged Crossbill	S													Forest
avannah Sparrow	K													Marsh
ark-eyed Junco	K													Forest, Woodlands & Shr
ree Sparrow														Shrub & Marsh
hite-crowned Sparrow														Shrub
olden-crowned Sparrow	K													Shrub
ox Sparrow	K													Shrbb
incoln's Sparrow	P													Shrub & Marsh
ong Sparrow	K													Shrub & Marsh & Lakesho
apland Longspur														Marsh & Lakeshore
now Bunting														Marsh & Lakeshore

TABLE 4. OCCURRENCE OF BIRDS NOT RECORDED WITHIN THE STUDY AREA, BUT OCCURRING WITHIN 10 NAUTICAL MILES OF THE STUDY AREA.

KEY:

Annual = X Rare = R

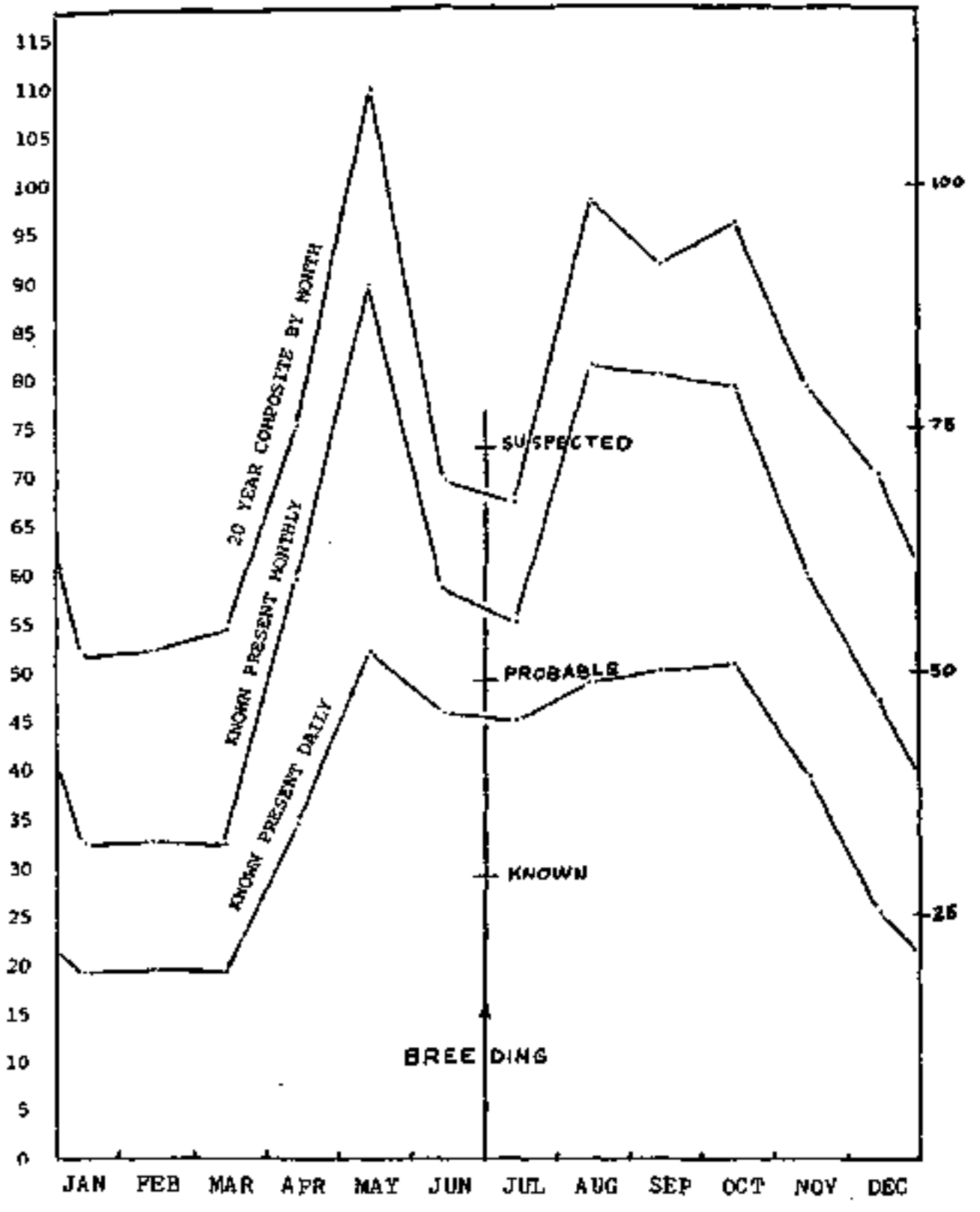
Common = C Accidental = A

Uncommon = U

SPECIES	ANNUAL	ABUNDANCE	BREEDS	PRIMARY HABITAT
Northern Fulmar		R		Marine Waters
Fork-tailed Storm Petrel	X	U		Marine Waters
Pelagic Cormorant	X	C	X	Marine Waters
Red-faced Cormorant	X	C	C	Marine Waters
Whooper Swan		A		Marshes
Brant	X	U		Tidal Plants
Emperor Goose		R		Marine Waters
Black Duck		R		Marshes
Cinnamon Teal		R		Marshes
Steller's Eider	X	U		Marine Waters
Common Eider		R		Marine Waters
King Eider	X	U		Marine Waters
Black Scoter	X	C		Marine Waters
Red-tailed Hawk		R		Woodlands
Swainson's Hawk		R		Woodlands
Golden Eagle		R		Open Sky
Rock Ptarmigan	X	U	P	Alpine Tundra
Black Oystercatcher	X	C	X	Rocky Shorelines
American Golden Plover	X	C		Tide Flats
Black-bellied Plover	X	C		Tide Flats
Dotterel		A		Tide Flats
Bar-tailed Godwit		R		Tide Flats
Marbled Godwit		R		Tide Flats
Bristled-thighed Curlew		R		Tide Flats
Upland Plover		R		Open Uplands
Wandering Tattler	X	U		Rocky Shorelines
Ruddy Turnstone	X	C		Tide Flats/Rocky Shorelines
Black Turnstone	X	C		Rocky Shorelines
Red Phalarope		R		Marine Waters
Long-billed Dowitcher	X	C		Tide Flats
Surfbird	X	C		Tide Flats/Rocky Shorelines
Red Knot	X	C		Tide Flats
Sanderling	X	C		Tide Flats
Semipalmated Sandpiper	X	U		Tide Flats
Rufous-necked Sandpiper		R		Tide Flats
Baird's Sandpiper	X	U		Marshes
Sharp-tailed Sandpiper		R		Marshes
Rock Sandpiper	X	C		Rocky Shorelines
Curlew Sandpiper		A		Tide Flats
Buff-breasted Sandpiper		A		Marshes

SPECIES	ANNUAL	ABUNDANCE	BREEDS	PRIMARY HABITAT
Ruff		R		Marshes
Pomarine Jaeger	X	U		Marine Waters
Long-tailed Jaeger		R		Marine Waters
Thayer's Gull	X	U		Marine Waters
Ring-billed Gull		R		Marine Waters
Black-legged Kittiwake	X	C	K	Marine Waters
Sabine's Gull	X	U		Marine Waters
Aleutian Tern	X	C	K	Marshes/Marine Waters
Common Murre	X	C		Marine Waters
Thick-billed Murre		R		Marine Waters
Pigeon Guillemot	X	C	K	Marine Waters
Kittlitz's Murrelet	X	U		Marine Waters
Ancient Murrelet	X	U		Marine Waters
Horned Puffin		R		Marine Waters
Tufted Puffin	X	U	K	Marine Waters
Screech Owl		R	S	Woodlands
Snowy Owl		R		Marshes
Common Nighthawk		R		Open Sky
Vaux's Swift		A		Open Sky
Anna's Hummingbird		R	S	Woodlands
Eastern Kingbird		R		Woodlands
Western Kingbird		R		Brushlands
Say's Phoebe		R		Open Uplands
Western Wood Pewee	X	U		Woodlands
Horned Lark		R		Open Uplands
Purple Martin		A		Open Sky
Gray Jay		R		Brushlands
Wheatear		R		Open Uplands
Swainson's Thrush	X	U	P	Woodlands
Gray-cheeked Thrush	X	U	P	Woodlands
Yellow Wagtail		R		Open Uplands
Cedar Waxwing		A		Woodlands
Blackpoll Warbler		R		Woodlands
Northern Waterthrush	X	U		Wet Woodlands
Common Yellowthroat		R		Wet Brushlands
Yellow-headed Blackbird		A		Marshes
Red-winged Blackbird	X	U	P	Marshes
Brown-headed Cowbird	X	U	S	Woodlands
Scarlet Tanager		A		Woodlands
Brambling		R		Brushlands
White-throated Sparrow		R		Brushlands

TABLE 5. NUMBERS OF BIRD SPECIES KNOWN TO OCCUR ANNUALLY BY DAY, BY MONTH AND 20 YEAR COMPOSITE BY MONTH.



(Full one day bird census-surveys in the study area have recorded from a low of 14 species observed in 6 hours during late February to a high of 58 species observed in 9 hours during late May)

21. Brown Bear (Ursus arctos)
22. Martin (Martes americana)
23. Ermine (Mustela erminea).
24. Mink (Mustela vision)
25. Wolverine (Gulo gulo)
26. River Otter (Lutra canadensis)
27. Lynx (Felis lynx)
28. Harbor Seal (Phoca vitulina)
** 29. Sitka Black-tailed Deer (Odocoileus hemionus sitkensis)
** 30. Moose (Alces alces)
31. Mountain Goal (Oreamnos americanus)

*Natural expansion of inadvertantly introduced populations to continguous areas.

**Natural expansion of introduced populations to contiguous areas.

The foregoing list is undoubtedly incomplete. Some terrestrial mammals that occur in contiguous areas of the Copper River Delta and Prince William Sound have not been recorded in the study area. Least Weasel (Mustela nivalis) and several species of small rodents (mice, voles, lemmings, jumping mice) known or suspected to occur in areas immediately adjacent to the study area have not been specifically researched for inclusion in this resource inventory. A fairly complete inventory would require several monthes of small mammal trappings throughout the various habitat forms occuring in the study area. The results of such efforts were not considered a priority.

ANNOTATED LIST

1. Masked Shrew
2. Dusky Shrew
3. Water Shrew

Shrews are fairly common resident mammals in a wide variety of habitats in the study area. These three species were observed by the consultants in conjuction with other field work. Masked and Dusky shrews are regularly found in the ground cover of Hemlock/Spruce forests and shrub thicket habitats. Water Shrew is less well known but can be expected to occur on the edges of lacustrine and fluviatile water habitats throughout the study area.

4. Little Brown Myotis, commonly referred to as the Little Brown Bat, is presumed to be a year-round resident of the study area, but observations of this are lacking. This animal has been noted somewhat regularly from May to early December but is fairly common only in October when fall migrant populations pass through the region. The consultants, in conjunction with other field work, observed seven individuals catching insects along a short stretch of Power Creek Road on October 14, 1982. Other individuals were observed through the fall near the Power Creek

Delta, along the Copper River Highway, and near the Eyak Lake weir/outlet.

5. Collared Pika occurs locally in alpine scree at higher elevations around Eyak Lake. None have been observed below 500 ft. elevation, but it is presumed that a few occur at or near that elevation on the northeast slopes of the study area.

6. Snowshoe Hares in small numbers occur in forest edge and in shrub thicket habitats on the eastern portion of the study area. Their presence elsewhere in the study area is less regular being dependent to some extent on the stage of cyclic populations from the contiguous uplands of the Copper River Delta.

7. Hoary Marmot occurs as an uncommon resident in the mountains bordering Eyak Lake with some individuals ranging downslope into the study area in alpine tundra and scree slope habitats.

8. Red Squirrels are fairly common residents throughout the Hemlock/Spruce forest habitat. They occur frequently in and near developed subdivided lands bordering the lake and are probably the most frequently observed wild mammal in the study area.

9. Beaver occurs in small numbers in the study area. A few individuals are resident on the Power Creek Delta, and others are irregularly noted on shorelines and banks of Eyak Lake and on the 40-acre pond between the Copper River Highway and Southeast Arm.

10. Northern Red-backed Vole
11. Tundra Vole

Voles occur in a wide variety of habitats in the study area. Red-backed Vole occurs most frequently in the forest, woodland, shrub habitats. Tundra Voles are most frequent in the drier areas of the marshes and the brushy lowlands along Southeast Arm. Voles and Lemmings are cyclic in abundance, in some years being plentiful and in others almost absent.

12. Muskrats are uncommon in the study area, being most frequent in marsh, pond, and stream habitats near Southeast Arm. Very few individuals range elsewhere around the shores of Eyak Lake.

13. Northern Bog Lemming is a resident through most of the marsh, bog, and forested habitats of the study area. The abundance of this species and other small rodents is not well documented. Some small rodents, however, including voles, lemmings, and mice are in general quite numerous in the study area.

14. Norway Rat is present in Cordova and is resident along the West Arm in the city limits. Its presence elsewhere in the study area is not known, but it can be expected at least irregularly in a wide variety of habitats along the shoreline of Eyak Lake.

15. House Mouse can be expected to occur in or near any human-inhabited structures. This mouse is present in Cordova and in the older structures of "old town" adjacent to West Arm. It is not as pioneering as Norway Rat and probably does not occur away from man-made structures around Eyak Lake.

16. Porcupines are common residents in the Hemlock/Spruce forest habitat throughout the study area. They are regularly observed along the Power Creek Road and the Copper River Highway. Porcupines can be expected to occur in all terrestrial habitats of the study area and are one of the most frequently observed wild mammals in the area.

17. Coyotes are common on adjacent uplands of the Copper River Delta, and they are regularly observed on Eyak Lake when it is frozen during the winter. They occur in the study are most frequently in the uninhabited area between Southeast Arm and North Arm.

18. Gray Wolf occurs irregularly in the study area. A pack of wolves is believed to range through the uplands of the Copper River Delta and west to at least the Rude River Valley in Prince William Sound. Wolves have been reported in North Arm during mid-winter (Jerry McCune, per commun.) when they were presumably en route between the aforementioned regions.

19. Red Fox is an uncommon resident on contiguous upland of the Copper River Delta and is presumed to occur infrequently ranging into eastern portions of the study area. No observations were reported during the winter of 1981-82.

20. Black Bears are residents of forested and shrub thicket habitats of the study area. They range from the alpine tundra slopes above the study area to lake and streamside habitats. Black Bears are most frequently encountered in the North Arm/Power Creek and Southeast Arm areas. No attempt was made to survey the populations visiting the study area annually, but a rough estimate places this annual number at between 20 and 50 individuals.

21. Brown Bears are annually reported in the study area. Semi-resident individuals appear from spring to fall along North Arm, Power Creek, and the northeast shoreline of the lake to Southeast Arm and east to Ibeck Creek. Like Black Bears, Brown Bears are primarily vegetarians but will feed extensively on spawning salmon and prey upon other mammals if they are readily available. A rough estimate of the numbers that annually range into the study area is 10 to 20 individuals.

22. Martins are rare residents in the forest portions of the

study area. Trappers report only a few of these animals in the area. This mammal has been reported more frequently in recent years than in past decades.

23. Ermine or Short-tailed Weasel is a fairly common resident in the study area and is found in a wide variety of habitats including lakeshore and streamside areas.

24. Mink are fairly common residents of lakeshore and streamside habitats in the study area. Mink are trapped along the lakeshore and road systems in November. Mink are also found in other habitats throughout the study area.

25. Wolverine are rare visitors in the study area. This wide ranging mustelid can be expected to occur irregularly in all areas except highly developed or residential locations.

26. River Otter are fairly common residents of the study area. Most frequently observed at the lake weir/outlet, these mammals range widely through the study area and regularly frequent several lakeside and Power Creek shoreline sites.

27. Lynx are very rare visitors to the study area. Found in forest and shrub habitats, they range into the area from adjacent lands on the upper Copper River Delta. Very few individuals occur annually in the study area.

28. Harbor Seals range upriver from Gulf and Delta marine habitats into Eyak Lake in summer and fall. Whether the seals are following salmon for a continued food source or they are strictly randomly wandering, is unknown. Nevertheless, a few to upward of 30 seals have been reported in Eyak Lake during late summer. They have been observed chasing and feeding on spawning salmon while in the lake.

29. Sitka Black-tailed Deer are uncommon residents in the Hemlock/Spruce forests around Eyak Lake. Introduced into nearby Prince William Sound some 60 years ago, the deer subsequently have occupied most of the islands in the Sound and portions of the adjacent mainland. Local hunters report that a small number of deer are resident on the slopes above the northeast shoreline in the Island Bay/Middle Arm area. In conjunction with other field work, the consultants regularly recorded deer tracks along Power Creek Road. Some 25 to 50 individual deer range into the study area sometime during the year.

30. Moose were introduced to the Copper River Delta between 1949 and 1959. Subsequently, a few individuals regularly wander to areas around Eyak Lake. The forests and shrub thickets between Southeast Arm and the Copper River Highway are within the regular range of several individuals in the Ibeck Creek area contiguous to the 40 acre pond. Probably 10 to 20 moose range into the study area annually.

31. Mountain Goats are residents of the upper forested slopes and alpine tundra habitats around Eyak Lake. Rarely do individuals wander to the lower elevations of the lakeshore and the road systems. While most of the year goats remain above 500 ft. elevation, forest and shrub habitats are regularly utilized in winter, especially on the northern sides of the study area. It is estimated that some 20 to 40 goats range into the study area annually.

SPECIAL INTEREST SPECIES

Of all the birds and mammals that use the study area, four birds (Common Loon, Trumpeter Swan, Bald Eagle, and Glaucous-winged Gull) are identified as special interest species. No mammals have that distinction.

Special interest species (or species of special interest) were chosen for specific discussion on the basis of one or several of the following criteria in relation to the entire list of birds and mammals that use the study area: 1) their significance in terms of widespread public interest and sentiment, 2) their susceptability to human disturbance, 3) their visibility, 4) potential for significant population fluctuations, 5) scarcity, and 6) their potential impact on the human population.

Gavia immer COMMON LOON

The Common Loon is a regular spring and fall migrant on Eyak Lake. During late April and May, migrants are regularly observed flying northwestward through the "Eyak Gap". During ice-free springs some individuals stop to linger and feed before continuing their migration. Up to 20 migrant individuals have been observed on the lake at one time.

Two to four pairs of Common Loons are breeding summer residents on the lake. Their eerie calls, well known to boaters and lakeshore residents, can be heard during the summer's twilight hours. Their shoreline nesting sites include the more secluded shoreline between the Southeast Arm and North Arm and the small islands in Island Bay where adults with downy young have been observed in July.

Fall migrants or late lingering summer residents are regularly noted until the first freeze-up (usually November) and occur as scattered individuals in all areas of the lake. In mild winters in which the lake remains largely unfrozen, the Common Loon has been recorded every month.

Description of Values and Conflicts:

The errie cries of the Common Loon are legend and well known as loons appear commonly in the mythology of northern peoples. The crazy calls in rebounding echos during the summer twilight provide an extra touch of mystery to the Eyak Lake wilderness setting.

Loons can withstand only limited activity near their nesting sites. Titus and Van Druff (1981), studying the response of the Common Loon to recreation pressure in northeastern Minnesota, found "Hatching success was significantly greater on smaller (generally remote) lakes on no-motor lakes, and for less visible nests. Loon pairs on smaller lakes (trends only), on no-motor lakes, and with few human contacts showed greater success in brood rearing." The nesting area of the Common Loon, once undoubtedly the whole lakeshore, is now restricted to the uninhabited northeast shore between North Arm and Southeast Arm. If human developments and activities were occurring regularly in the Middle Arm/Island Bay area, most if not all of the breeding pairs on the lake would be displaced.

If no continual human activities occur on the northeast shoreline from late May to early July, Common Loons will continue to nest in the area. Roads, homesites and logging are not recommended.

Olor buccinator TRUMPETER SWAN

The Trumpeter Swan is a well known resident of the Eyak Lake area. Spring migrants that have wintered farther south are among the earliest arrivals on the Copper River Delta beginning in late March. Depending on the availability of open freshwater ponds on the adjacent delta, Eyak Lake is used by migrants to varying degrees during April. Through-bound migrants occur in April and May with several hundred stopping enroute. Non-breeding sub-adults linger after the spring migrants and are occasionally seen until early June before wandering off to spend the summer/late summer molt period at a site remote from disturbance. Martin Lake and Bering Lake, some 50 miles east, are typical summer molt sites. It is probable that Eyak Lake, historically, was also a summer molting lake site for Trumpeter Swans until human disturbances became frequent.

A pair of Trumpeter Swans has repeatedly nested on the 40 acre forest pond a few hundred yards from the end of Southeast Arm. In the past 5 years (1977-81), the pair has raised to flying age a total of 27 cygnets:

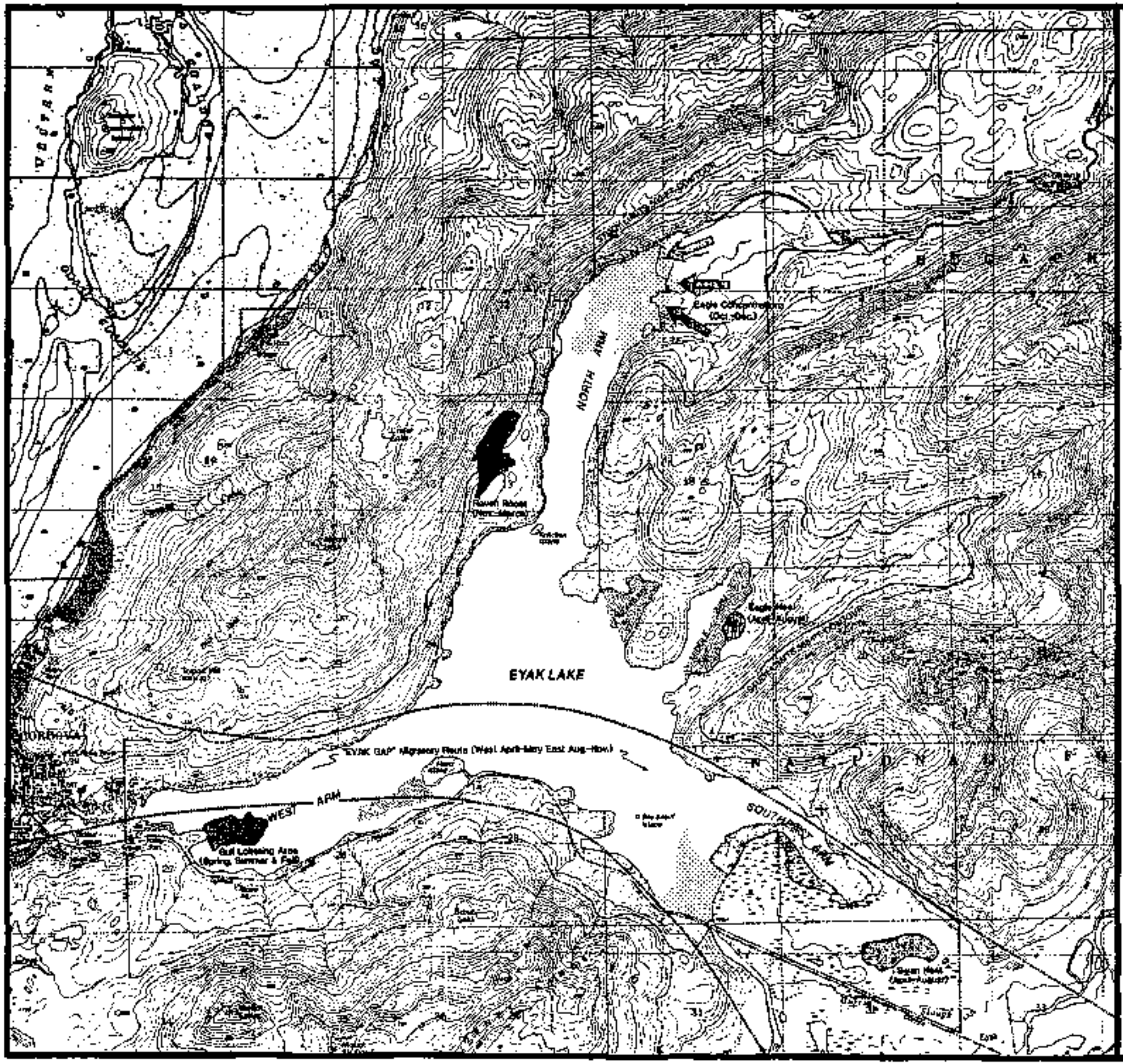
1977 = 6 cygnets
1978 = 7 cygnets
1979 = 4 cygnets
1980 = 3 cygnets
1981 = 7 cygnets

Swans are again on Eyak Lake in August as the family group from the 40 acre pond walk overland to the lake and utilize the Southeast Arm. A few pairs and family groups appear on the lake in September, but the majority occur from October to early December. Numbers vary as some leave, others arrive, and other open freshwater areas on the contiguous Copper River Delta remain available. At times during late fall, total numbers in the Eyak Lake study area include several counts of 150 to 250 individuals.

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PLAN

November 2007

Alaska Coastal Management Program



BIRD CONCENTRATIONS MAP

- Special Areas (see label near each area)
- Migrant and Wintering waterfowl/swans (Sept.-May)
- Migratory Waterfowl (April-June)
- Migratory Waterfowl (Sept.-Nov.)

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 9

A few family groups winter on the open freshwater outlet at Eyak weir/river and on the Power Creek Delta. Some 10 to 70 birds have wintered annually at these locations for the past 20 years. During the cold winters of 1970-71 and 1981-82, there was not enough open water to sustain the birds, and mortality occurred. In 1981-82, 9 bodies were counted at the weir/river and 3 bodies at Power Creek Delta. The actual mortality probably included 23 or more birds. Cause of death is attributed primarily to starvation, although actual death was caused by freezing into fast-forming ice, slaying by Bald Eagles, and entanglement by fishing lures and lines.

The Eyak Lake study area is contiguous to the Copper River Delta Wildlife Management Area and the Bering River Trumpeter Swan Management Area, which are areas of special concern to state and federal resource agencies.

Trumpeter Swans are staging a comeback after being decimated. They have actually become extinct in much of their historical range. Their numbers 50 years ago were probably less than 1,000 individuals, but the population today is close to 10,000 of which approximately 7,000 breed and 1,000 winter in Alaska. The adjacent Copper River and Bering River regions have played an important part in this recovery.

Description of Values and Conflicts:

Swans have played a part in human legend and mystery for thousands of years, and swans attract considerable attention. The highway pulloff at the lake outlet is utilized by a large percentage of Cordova residents. At some point during the year, swan watching is a recreational pastime for most Cordova residents and many visiting tourists. The Copper River Highway is the only location in Alaska where this swan can be observed year-round. Cordova has been suggested and promoted as the location for a Swan Research Center by several eminent scientists, wildlife research managers, and the Trumpeter Swan Society.

The primary conflict that affects Trumpeter Swans is their requirement for seclusion at nesting sites. The nesting pair at the 40 acre pond in the study area has been successful due to its seclusion. The location is well screened by a forest fringe, and the marsh between the highway and the forest fringe restricts easy foot access. These swans are known, from banding by the U.S. Fish and Wildlife Service, to be the same birds that winter at the Eyak Lake weir. A similar forest pond approximately one mile south across the highway was used by nesting swans until a road was built to the pond edge two years ago. This constituted sufficient disturbance to displace nesting birds. This example falls in line with Timm's (1978) observations that as cabins are built at swan use areas, the number of cabins had a marked downward effect on the return rate of the swans to these use areas. Timm (1978) found in his study in the Susitna Basin that an overland separation of even 0.5 miles appeared to be an adequate buffer to

human disturbance. If the forest fringe became an area of human disturbance during the summer, undoubtedly this highly productive site would no longer be used. Hansen et. al. (1971) observed that "Although the swans on the Copper River Delta may not have been molested intentionally by the public, the varied and more frequent level of human activity seems to have had a detrimental effect in comparison to the more isolated nesting areas. A forced and rapid movement of cygnets from one body of water to another less secure, induced by human intrusion, appeared to be the greatest factor leading to higher mortality rates."

An additional conflict can occur if the ice in Eyak Lake restricts the swans to a few open areas and these locations are also used by float planes or boating recreationists. This causes a displacement of the swans to secondary locations which may have more limited food resources for swans. Displacement of the birds must be considered detrimental.

Other causes of swan displacement are target practice, discharge of firearms, and waterfowl hunting in the vicinity of resting/feeding swans. These activities are not infrequent on the Eyak Lake shoreline. Cordova area residents become disturbed when these birds are displaced from areas where swan watching is a regular pastime (Eyak Lake weir and Power Creek Delta).

At public hearings in Cordova chaired by the study consultants, comments by lakeshore homeowners frequently included complaints of indiscriminate firearm discharge and small game/waterfowl hunting within range of residential areas and sites where swans were attempting to forage for aquatic vegetation.

Haliaeetus leucocephalus BALD EAGLE

Thousands of eagles annually are visitors through the "Eyak Gap" area. Bald Eagles are conspicuous residents and visitors in the study area in April and May and from October through December. During these months, eagles are numerous in the area as migrants soar on up drafts over the slopes and in lakeshore habitats. The highest one-day count of eagles in the study area is 416 congregated mainly in North Arm/Power Creek on December 27, 1969. The attraction was dead and dying spawned-out salmon. Fifty to 100 eagles at one time in late fall at this site is an annual and expected volume. Higher concentrations are dependent on the availability of alternate food sources to other locations in eastern Prince William Sound and the Copper River Delta.

From June through September and from January through March, eagle numbers are considerably lower than during spring and fall, but some individuals are resident. The only annually-used eagle nest known is on the eastside of Middle Arm. Pairs have been recorded apparently on territory in North Arm and Southeast Arm, but eyries have not been located and nesting attempts or successes are unknown. Historically, Eyak Lake shores provided sites for at least several pairs of eagles, but a reduction of available food

and repeated human disturbances have displaced birds which formerly used these areas. Terres (1980), states human disturbance at nest sites as one of the general causes of declining populations of bald eagles while Mathisen (1968), reported "... human activity at levels existing on the Chippewa (north central Minnesota) is not an important source of disturbance and has no measurable effect on nesting success or nest occupancy. Most human activity around nest sites in this region occurred during the latter part of the nesting cycle when family ties were strongest."; and Newman et.al. (1977), working on San Juan Island, Washington, reported significant increase in human activity near eagle nests have not caused a decline, but, in fact, nest surveys show that numbers of nests and occupied nests have increased significantly.

Stalmaster and Newman (1978), studied wintering bald eagles with the following results: "Eagle distribution and daily activity patterns were changed in response to human presence. Eagles were displaced to areas of lower human activity, preventing effective use of all feeding sites and forcing more birds to use marginal habitat and a smaller area. Feeding birds were disturbed by the mere presence of humans and generally did not return to the site of disturbance for several hours. Sensitivity to disturbance increased with age. Eagles showed evidence of habituation to routine human activities and noise. They were most tolerant when the source of noise was concealed from view. Gun shots caused overt escape behavior. Non-routine activity on the river channel was most disturbing."

In most years nesting activity begins in April, and young eagles fledge in August. During years of late springs with ice and snow lingering on Eyak Lake until mid- or late May, the nesting season is delayed by as much as a month.

Bald eagles are not fully mature until their fifth year, and the life span of individuals may be over 20 years. Paired eagles often remain as mates for a number of years. Young eagles, sub-adults, unmated birds and individuals that have lost their mates may total some 30 percent of the total eagle population. They often wander from one food source to another, and range widely in this quest. The sight of eagles soaring above the upper slopes and peaks of the Chugach and Heney Mountains is a daily, year-round occurrence.

During late winter when open lake/river waters are restricted to Power Creek Delta and Eyak weir, a few individuals are usually perched on nearby forest lookouts watching for fish, fowl, or mammalian prey. This includes hunger-weakened swans and fish brought to the surface by mergansers or Land Otters.

Description of Values and Conflicts:

The American Bald Eagle is the symbol and national bird of the United States. Bountied in Alaska until 1952, thousands of

eagles were killed annually prior to the removal of the bounty. Indiscriminant shooting of eagles and other so-called "varmits" continued into the 1960's. By the 1970's only a relatively few eagles were shot or shot at. There have been instances, however, where eagles were killed to provide talons and feathers for the jewelry trade.

In the continental United States, the bald eagle is considered an endangered species. Throughout the lower 48 states, declines in certain bald eagle populations have continued from the 1930's to the present in spite of reductions within this past decade of chlorinated hydrocarbon pesticide use.

Loss or deterioration of suitable habitat resulting from human activity may have replaced pesticide contamination as the major contibuting factor in the decline of the eagle populations in the lower 48 states.

Here in Alaska, Bald Eagle populations probably increased after the bounty removal in 1952 and stabilized by the end of the 1960's and early 1970's.

Between now and the end of this century, we can expect to see reductions in Alaskan eagle populations as a result of the following growing conflicts:

(a) elimination of suitable nest trees due to logging activities;

(b) deterioration of nesting areas due to human activities, e.g.,road construction, land developments in currently remote areas;

(c) distruption of aquatic ecosystems, a prey base for eagles;

(d) more refined fish and game management schemes which fail to include the food needs of eagles and other animals.

In the Eyak Lake study area as elsewhere, Bald Eagles can withstand only limited human activities near nesting sites. The nesting area of the Bald Eagle, which once undoubtedly included the entire Eyak Lake shoreline, is now restricted to the uninhabited northeast shore between North Arm and Southeast Arm. The pair in Middle Arm is expected to continue to occupy the site if no continual human activities occur on the northeast shoreline from April to August. Roads, homesites, and logging are not recommended.

Larus glaucescens GLAUCOUS-WINGED GULL

The Glaucous-Winged Gull is the common "sea gull" in coastal areas of the Gulf of Alaska. While it does not nest in the Eyak

Lake study area, it is numerically one of the most abundant birds in the area from late April to November. It is present on the nearby Cordova waterfront and landfill site year-round, numbering from a few hundred in mid-winter to several thousand daily during mid-summer seafood processing activities. Some 10,000 Glaucous-Winged Gulls nest on Egg Island on the Copper River Delta, and many of these birds forage into eastern Prince William Sound. Along Eyak River and across Eyak Lake is a regular daily flight route for many gulls that forage along the Cordova waterfront. Of special interest is the gull's use of portions of the study area particularly West Arm.

Besides the flow of traversing birds through "Eyak Gap", many loiter, preen, bathe, and otherwise occupy themselves for hours each day on portions of West Arm.

The most regularly used water area is a few hundred meters east of Powder House Point, 1/4 mile south of the City Airport. Occasionally the runway area of the City Airport is used as is the water area closer to the end of West Arm. When ice covers Eyak Lake, gulls continue to use these areas but to a more limited degree.

Any food sources around Eyak Lake are quickly exploited by gulls. Many gulls are found in spawning areas scavenging dead and dying salmon during late summer and fall.

Several other species of gulls also occur in the study area, and some individuals of other species are found among the Glaucous-winged Gulls loitering in West Arm.

The number of Glaucous-Winged Gulls using these sites varies according to weather conditions, time of day, stage of tide at waterfront sites, and the amount of food resources available on the Cordova waterfront. Gull numbers ranged from 0 to 500+ and were most common from May to October. For several hours each day the birds trade back and forth between lake loitering sites and the Cordova waterfront.

Descriptions of Values and Conflicts:

Gulls add something to the action and form of the study area. Gulls, being scavengers, are a help in cleaning up bits and pieces of animal matter such as fish carcasses and dog feces. Crows, ravens and eagles contribute to this scavenging activity, and little remains unexamined by them collectively in the study area.

These gulls are known to carry many human pathogens that could cause serious health problems if released into the community water supply untreated (Patten and Patten, 1979). The site of the proposed lakewater intake to the city water supply is sufficiently removed to eliminate or minimize this possible hazard.

Gulls roosting near the flight path of aircraft at the city field and the most frequently used float plane area pose a hazard to small aircraft. It is unlikely that the gulls could be displaced from the area by any simple means.

Patten and Patten (1979), consider the unnaturally inflated gull population the result of man enhancing the carrying capacity of the environment for weedy, or nuisance species, which are adapted to disturbed environments and utilize artificial food. They say that Alaska could be on the sill of a major ecological disruption due to the gull population increases and the resulting potential.

ENDANGERED SPECIES

Short-tailed Albatross, Aleutian Canada Goose, and Eskimo Curlew are listed as endangered species of Alaskan avifauna. The American and Arctic Peregine Falcon are listed as threatened species of the Alaskan avifauna. Of the above species only the Peregrine Falcon is known to occur in the Eyak Lake study area.

Three races (subspecies) of Peregrine Falcon occur in Alaska:

(a) Peale's (Falco peregrinus pealei)
(b) American peregine falcon (F. p. anatum)
(c) Arctic (F. P. tundrius)

The Peale's Peregrine is a large dark Pacific coastal race that is largely non-migratory. And because it is non-migratory, it has not been subjected to high chlorinated hydrocarbon pesticide levels as have the other races. The Peale's Peregrine has not been included with the other races on the list of endangered or threatened species. The Peale's Peregrine is the most frequently observed race in the Copper River Delta/Prince William Sound region. Its nearest known nesting eyries are 40 miles from the study area. Of the other two races, only the Anatum Peregrine has been observed flying over and near the study area. It is considered a very rare irregular migrant visitor through the area.

DISCUSSIONS AND RECOMMENDATIONS

All wildlife habitat is important and all loss of habitat is detrimental to a degree. The degree depends on the extent of similar habitat in the general area that displaced wildlife can move to. While some shift in location of wildlife populations or individuals may occur, usually the same or similar type of habitat is already being used by the affected species. Severe modifications or loss of species or change in it's behavior (loss of breeding activity) could be the long term result.

The eastern shoreline of the lake from Power Creek Delta to the outlet weir is currently undeveloped and relatively undisturbed, and provides important habitat for pink, red, and silver salmon spawning; Trumpeter Swan rearing and over-wintering; Common Loon

breeding; Bald Eagle concentration area and nesting site; and fall resting area for numerous waterbirds.

The area is vulnerable natural habitat with a high natural productivity. It is "essential" habitat for the above mentioned species. Lakeside development is occurring and/or planned for increasing segments of the shoreline and adjacent uplands including some conceptual plans for the eastern shoreline (resort facility, recreational subdivision, and road proposed).

Since private land, which this is, is open for development; a simplistic solution would be to transfer this land back into public ownership where the management can more adequately be publically controlled. Two options, or a combination of the two, exist to resolve this issue -- 1) a tri-partite land trade between the Eyak Corporation, the U.S. Forest Service, and the Alaska Department of Natural Resources; and 2) City of Cordova land claim under ANCSA 14 (c) (3), (a means for the City of Cordova to obtain title to Eyak Corporation land based on a show of need by the City). The lands generally recommended to be transferred back into public ownership are all land north of the Copper River Highway in Sections 30, 31, 32; all of Sections 7, 18, 19, 29; and the portions of Sections 13, and 24 that adjoin

Land trades are complicated, time consuming, and require great justification. In light of this, other possibilities might be better suited to protect the resource values on the backside of the lake. Cooperative management of that land is one such option in which all parties benefit and the resources receive the desired protection. It is recommended that the Eyak Corporation, U.S.F.S., DNR, ADF&G, and the City of Cordova meet following adoption of this plan to prepare a study plan that has the resolution of this issue, in light of but not limited to the above possibilities, as its goal.

Indiscriminate firewood cutting around the shoreline of the lake and in the wetland adjacent to Southeast Arm has caused the elimination of many eagle perching trees as well as other potential threatening alterations of the habitat. It is strongly recommended that timber cutting, except for needed land clearing, be planned and managed to protect the wildlife and scenic resources particularily in the areas shown in Fig. 11. Each land managing agency should revise their cutting regulations/policy and issue conditional permits in the areas where cutting influences habitat and enforce their regulations/policy to stop the past destruction. This should halt impairment of the visual quality of the area as well.

Disturbance of the birds by shooting and waterfowl hunting displaces the birds and can be especially critical during some seasons of the year. An example is harrassment of the swans near the weir when the only open water may be right there and no alternative resting/feeding place exists within many miles. Residents near the weir and near Power Creek have testified to the

shooting disturbances. Shooting around human habitation is also very dangerous to the residents. For these reasons the Eyak Lake AMSA should be dedicated as a "bird sanctuary". This should not work much of a hardship on hunters as it would be only slightly less convienient to hunt in an alternate location. The local Department of Fish and Game staff and the Copper River/Prince William Sound Fish and Game Advisory Committee shall both prepare and submit proposals covering this concept for the Game Board meeting following adoption of this plan. This process provides wide opportunity for public input.

The wetland north of the Copper River Highway and adjacent to the weir and Southeast Arm is important in many respects. The most obvious is the highly productive pair of swans that nest on the 40 acre pond in the wetland. They move to the Southeast Arm in the later stages of rearing and finally overwinter near the weir as a family group. The wetland also serves as a natural buffer to flooding and is possibly a recharge area for the aquifer that serves the wells at the residences around Mile 6 and 7. All the more reason to get this land back into public ownership where it can be protected from development.

Motorized traffic is disturbing to the swans and other birds that rely on the backside of the lake and adjacent wetland. The access road to the weir should be blocked off as there are alternate boat launching ramps and picnic sites (ADF&G, DOT/PF, and Eyak Corporation action). Floatplanes have used the weir area at times in the spring during herring seining season when that was the only open water available causing much disturbance to the swans. This practice must cease and now there is an alternative for the planes in the small boat harbor. Enforcement of this restriction will be an educational action with voluntary compliance expected. It is recommended that the game biologist on the local ADF&G staff be responsible for the educational process. Restrictions on floatplane docking in an other section of this plan will aid in the above action.

Off-road vehicles such as snowmachines, airboats, and three-wheelers are agents of wildlife harrassment when operated near animals and birds particularily during certain seasons of the year. Regulations should be established by the landowner (Eyak Corporation) of the Power Creek Delta and the wetland adjacent to Southeast Arm to prohibit off-road vehicles in those areas. These regulations should be similar in nature to those in effect on Eyak Corporation land and National Forest Land in the Copper River Delta.

Motor-powered boats are not restricted at this time, however, harrassment of wildlife may require future restrictions.

CHAPTER FIVE: FISHERIES

INTRODUCTION

Fisheries resources of Eyak Lake include 10 species of fish (see Table 6), most of which contribute to the commercial, sport and subsistence fisheries of the area. Sockeye and coho salmon are dominant members of the salmon family in the lake and utilize it for spawning, rearing and wintering. Aerial estimates of sockeye salmon spawners derived during 1961 through 1981 ranged from 463 to 28,366 fish with a mean of approximately 11,200 fish. Aerial estimates of coho salmon spawners derived during 14 years between 1964 and 1981 ranged from 150 to 9,200 fish with a mean of approximately 3,200 (Fridgen, personal communication). Small numbers of pink salmon also spawn in tributaries to the lake. King salmon are infrequently observed.

TABLE 6

FISH SPECIES OF EYAK LAKE

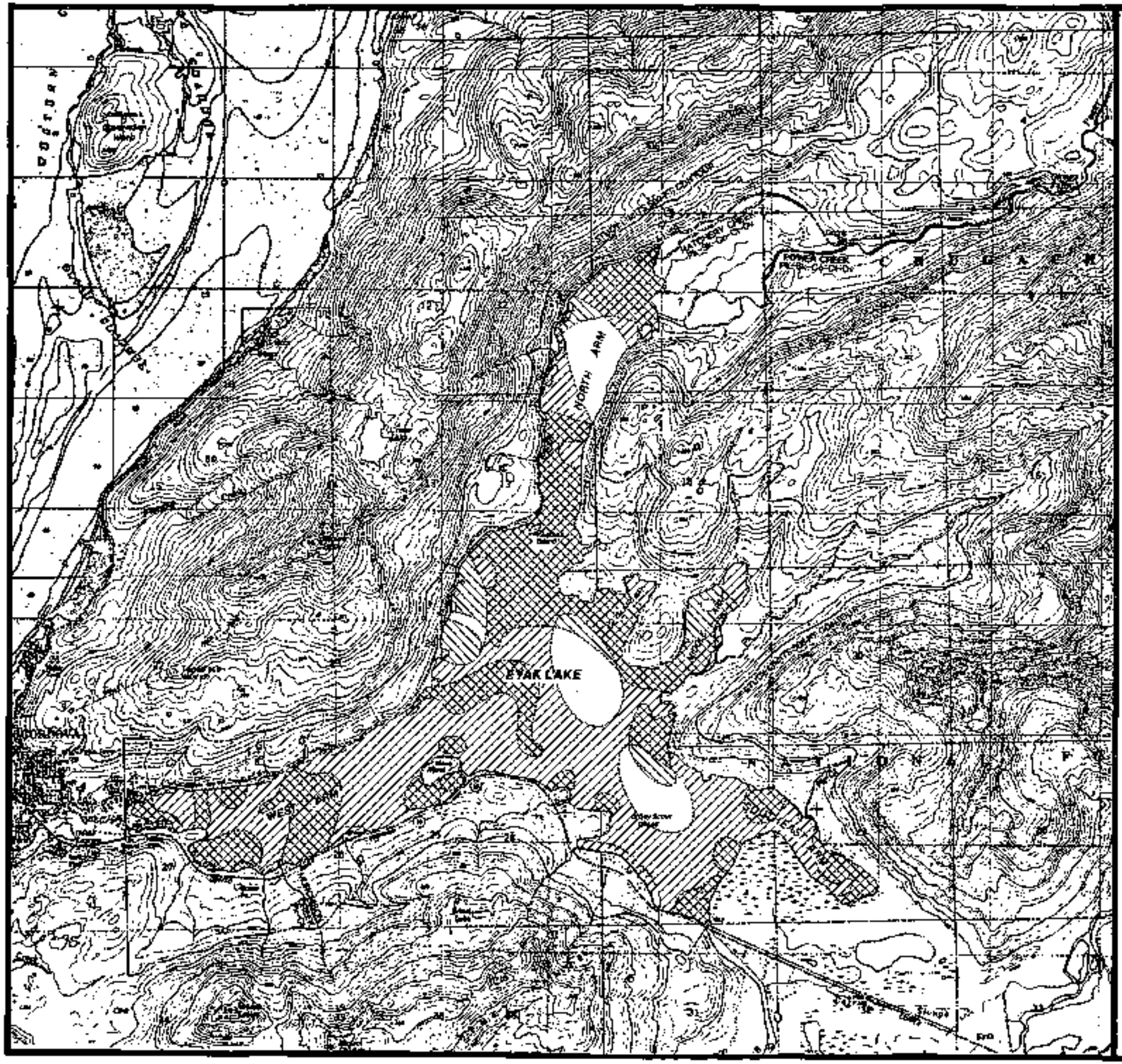
Scientific Name	Common Name
Coregonus pidschian (Gmelin)	humpback whitefish
Cottus asper Richardson	prickly sculpin
Gasterosteus aculeatus Linnaeus	threespine stickleback
Oncorhynchus nerka (Walbaum)	sockeye salmon
Oncorhynchus kisutch (Walbaum)	coho salmon
Oncorhynchus tshawytscha (Walbaum)	chinook salmon
Oncorhynchus gorbuscha (Walbaum)	pink salmon
Salmo clarki (Richardson)	cutthroat trout
Salvelinus malma (Walbaum)	Dolly Varden
Thaleichthys pacificus (Richardson)	eulachon

The number of Eyak Lake salmon harvested in the commercial fishery is not known; however, it is conceivable that harvests have exceeded escapements by 50 percent. This is based on commonly observed recruitment rate of 2.5 adults returning per spawner. Coho, sockeye, cutthroat trout and Dolly Varden are taken by sport fishermen in Eyak River. The lake is closed to salmon fishing. The majority of coho salmon caught by sport fishermen in the freshwater areas of Prince William Sound and Copper River drainage have in recent years been taken in Eyak River. Dolly Varden, cutthroat trout and humpback whitefish are also sought after by subsistence fishermen fishing with gillnets in Eyak Lake in winter.

Studies were conducted during late summer and early fall of 1981, winter of 1982, and spring/summer of 1982 to describe and quantify spawning, rearing and wintering habitat on a site and species specific basis. Observations of relative abundance, feeding habits, and length-sex characteristics were also recorded. Aquatic vegetation, clams and snails were also collected for species identification. The following information is a summary.

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PLAN

Alaska Coastal Management Program



FISHERY HABITAT

Localities of Juvenile Coho and Sockeye Salmon
- Sept.-Apr.
- Jan.-Feb.

Lake Spawning
- Sockeye Salmon

Stream Spawning
- PK—Pink Salmon
- CO—Coho Salmon
- SK—Sockeye Salmon
- CT—Cutthroat Trout
- DV—Dolly Varden Trout

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Figure 10

SPAWNING AREAS

SOCKEYE SALMON

Sockeye salmon spawners were widely distributed in Eyak Lake in 1981 and 1982 (Figure 12). Spawning occurred in both stream and lake habitat. Major lake shore spawning populations were found at spawning area A, B, M, Q, and T. Two tributary streams, Hatchery Creek (r), and Power Creek (s) had spawning sockeye populations totaling about 16 percent of the total spawners observed in 1981. No sockeye spawning was seen in other tributary streams although sockeye use several stream deltas for spawning. Stream deltas are important spawning areas in the lake and contributed about 8 percent of the sockeye spawners. Spring fed gravel beaches adjacent to streams, terminal beaches at the foot of talus slopes and the terminus of an alluvial valley supported the largest spawning populations of sockeye. These areas contributed 76 percent of the total observed sockeye in 1981.

Sockeye spawning areas were identified as such by the actual use of the stream or beach by spawning sockeye. Streams were walked and notes taken on visual estimates of types of substrate, gradient, flow and depth. Distance was measured by pacing and using a measure of three feet per step. Results of stream spawning habitat surveys are listed in Table 7. Of the streams listed in the table only Hatchery Creek, map letter r, and Power Creek, map letter s, were used for spawning by sockeye. Other streams listed in Table 7 have what appeared to be suitable spawning gravel, but for reasons not known these streams were not used. Beach spawning habitat was identified by observing use of the area by spawning sockeye. Each beach was measured by using a skiff for transport, probing the bottom with a metal rod and measuring with a tape out from shore. Potential square yards of beach spawning gravel was calculated for each site in the lake. Results of the measurements are depicted in Table 8 for each spawning beach. A total of 75,361 square yards of potential sockeye beach spawning gravel was calculated for Eyak Lake.

COHO SALMON

Coho salmon were found spawning only in Hatchery Creek (r) and Power Creek (s) tributaries of Eyak Lake (Figure 10). No beach spawning coho were observed although one observation suggested that some coho may have spawned on beach habitat in 1981. In the early 1960's the consultant observed a pair of coho in a small unnamed stream (f) at the head of the West Arm (Figure 10).

From opinions of ADF&G personnel stationed at Cordova, the majority of cohos entering Eyak Lake migrate up Power Creek (Nation, et al, 1980). This study substantiates those opinions and shows Power Creek (s) to be the major coho spawning area of Eyak Lake. On November 2, 1981, 2,177 coho were counted between the Power Creek cable crossing and a point three-fourths mile downstream. Two separate surveys of Hatchery Creek in October,

1981, produced a count of 26 and 50 coho spawners. Coho salmon potential spawning habitat is shown in Table 7 for several streams, but spawning only occurred in Hatchery Creek (r) and Power Creek (s). According to local ADF&G personel, since much coho spawning in Eyak Lake occurs in October-November and the lake is normally ice covered at this time, its probably not fair to speculate that there is that there is no beach spawning by coho salmon in Eyak Lake.

DOLLY VARDEN

Spawning populations of Dolly Varden were found in only two tributaries, Hatchery Creek (r) and Power Creek (s), (Figure 10), although several other streams appeared to have suitable spawning habitat. Potential Dolly Varden spawning habitat is given in Table 7. Power Creek is reported to contain a good population of Dolly Varden below Ohman Falls and several large individuals were seen mingling with spawning sockeye in October (Nation, et al, 1980). In past years large numbers (20 -30) of sexually mature Dolly Varden were observed by the consultant being taken from Power Creek in the vicinity of the USGS gauging station in October.

CUTTHROAT TROUT

Cutthroat trout spawning occurs in small, clearwater, gravel-bottomed streams during April through early June, peaking in May (ADF&G, 1978). In Eyak Lake numerous small tributaries have suitable habitat for cutthroat spawning. Cutthroat spawners or reds of spawners were found in nine tributary streams of Eyak Lake (Figure 10). Potential cutthroat spawning habitat is listed in Table 7.

HUMPBACK WHITEFISH

Spawning habitat of humpback whitefish is described as the shallow reaches of rivers and rocky reef areas of lakes (ADF&G, 1978). Sexually mature members of humpback whitefish populations begin movements to their spawning grounds in the summer and early autumn. Spawning takes place in the late afternoon and evening from mid-September to mid-October, with some lake spawners not completing spawning until January (ADF&G, 1978).

Spawning humpback whitefish were not found in Eyak Lake during this study although a few sexually mature fish were captured in gillnets.

REARING AND WINTERING AREAS

SOCKEYE SALMON

Sockeye salmon juveniles in late-fall and early-summer of 1981 were apparently distributed in all offshore areas of the lake. Sampling indicated that nearshore waters were only partially

TABLE 7

SPAWNING HABITAT SURVEYS
OF EYAK LAKE TRIBUTARIES

Map Ltr	Distance Surveyed (Ft.) 1/	Average Width (Ft.)	Average Depth (In.)	Bottom Type A	B	C	D	Percent E 2/	Classification By Species 3/ Ct&D	PK	CO	SK
b	690	10	10	10	40	40	5	5	E	E	E	E
c	315	6	4	2	40	40	15	3	E	E	E	E
g	230	6	6	2	20	15	15	48	G	G	G	G
h	440	6	6	2	2	10	10	73	P	F	F	F
i	210	4.5	4	2	18	10	10	60	G	F	F	F
j	65	1.5	2	2	10	30	10	48	F	E	G	G
k	115	3	2.5	0	5	2	3	90	P	P	P	P
l	30	4	4	30	30	20	10	10	E	G	F	F
m	40	4	3.5	20	30	30	10	10	E	E	G	G
n	65	5	4	10	30	20	20	20	E	G	G	G
p	45	6	5	10	10	20	20	40	F	G	G	G
q	50	8	3	30	40	20	10	0	E	G	F	F
r	5,280	10	6	30	30	20	10	10	E	G	G	G
s4/	5,280	60	18	20	40	20	15	5	E	G	G	G
t	100	6	5	0	2	2	2	94	P	P	P	P
u	3,960	20	12	20	30	30	10	10	E	E	G	G
v	315	12	10	5	20	20	20	35	G	G	G	G

1/ Each stream was surveyed from the mouth to a point upstream considered to be a migration barrier or unsuitable spawning habitat.

2/ A = sand or mud; B = fine gravel; C = medium gravel; D = large gravel; E = rock, boulder or bedrock.

3/ D = Dolly Varden trout; Ct = cutthroat trout; PK = pink salmon; CO = coho salmon; SK = sockeye salmon. P = poor; F = fair; G = good; E = excellent.

4/ Power Creek was surveyed from the mouth upstream to the USGS gauge. The remainder of Power Creek between the USGS gauge and Ohman Falls was previously reported upon by USF&WS (Nation, et. al., 1980).

TABLE 8

ESTIMATED AREA OF SUITABLE SALMON SPAWNING GRAVEL IN EYAK LAKE, BY LOCATION

Map Letter 1/	Location	Square yards of Gravel
A	Five Mile Beach	13,775
B	Collins Residence Beach	2,778
C	Cunningham Residence Beach	8,613
D-E	Murchison Falls Creek to Good Residence	23,701
F	Roadside Parking	156
G	Powder House	544
J	Chisum Air Service Beach	367
K	Blake-Justice Residence Beach	1,944
L	Nippell Beach	694
M	Boat Landing Beach	1,560
N	North Arm Stream Mouth	924
P	Stream South McCune Beach	
Q	McCune Residence Beach	1,667
R	Solf Creek Delta	1,444
S	North Arm Stream Mouth	133
T	Middle Arm South Beach	16,350
U	Queen's Chair Creek Delta	478
Y	Skater's Cabin Beach	233
Totals	Square Yards	75,361
	Acres	15.57

1/See Figure 12

utilized by this species. The determination of winter distribution was not possible due to lack of a means to capture this species when the lake was covered with ice.

COHO SALMON

Data collected during late summer and early-fall of 1981 suggest that major portions of the lake were not utilized by coho salmon juveniles (Figure 13). Locations where fish were caught tended to be clumped together. Greatest densities were observed in the Southeast Arm. Large portions of the central part of the lake and half of the West and North arms of the lake appeared to have been devoid of juvenile coho salmon. According to Crone (1981, personal communication) the distribution of coho salmon juveniles in Eyak Lake appears to be typical of their distribution in lakes jointly inhabited by sockeye salmon juveniles. In the presence of sockeye salmon, coho salmon tend to inhabit the nearshore water where they commonly feed on benthic invertebrates or whatever is available. Sockeye salmon have finer gillrakers than coho salmon, and, in the pelagic offshore waters of a lake where zooplankton are commonly the major prey, they can outcompete coho salmon. Locations where coho salmon were captured tended to be areas in which large, surfacing vegetation was noted. This vegetation may serve as prefer red substrate for prey and protective cover for coho salmon. The true distribution of sockeye salmon may be related more to where the vegetation and the more territorial coho are distributed. Analysis of stomach contents indicates that 99 percent of coho salmon juveniles were feeding in late-summer and early-fall of 1981 and that 50 percent were feeding on insects and 34 percent were feeding on snails.

Data collected in winter of 1982 suggest that more of the lake was utilized in winter than in summer (Figure 10). The highest concentrations were observed in the West Arm. The wider distribution may reflect the loss of prey habitat associated with winter die off of vegetation. Analysis of stomach contents indicates that 66 percent of juvenile coho salmon were feeding in winter and that 14 percent were feeding on snail and 12 percent were feeding on insects.

DOLLY VARDEN

Dolly Varden of Eyak Lake are believed to be anadromous. Catch data suggest that Dolly Varden utilize the lake as an over-wintering area.

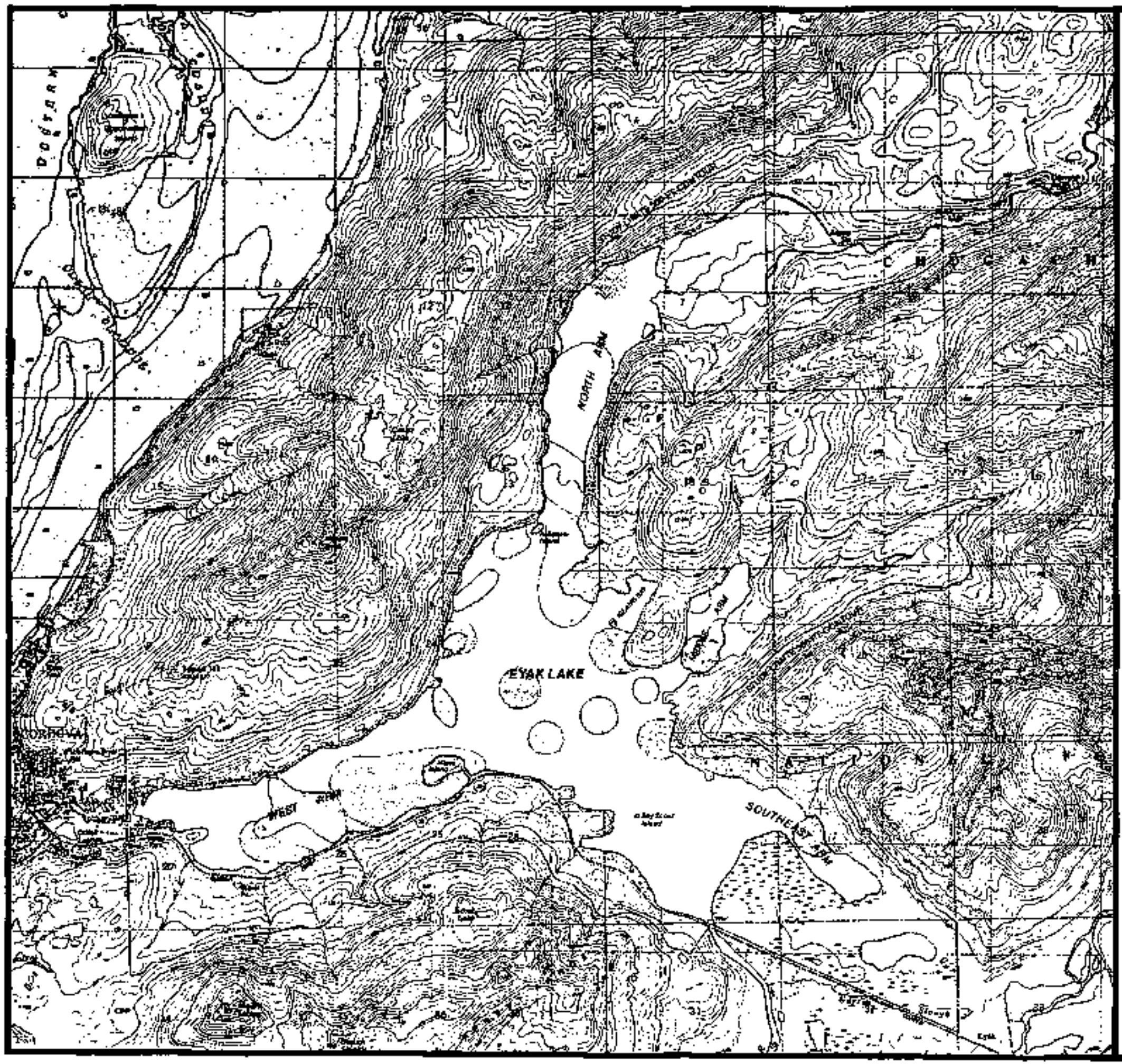
Data collected during late-summer, early-fall and winter suggest that fingerling Dolly Varden (less than 171 mm overall length) were few in number and/or inhabited only a few areas of the lake (Figure 11).

Analysis of stomach contents suggest that all fingerling Dolly Varden were feeding in late-summer and early-fall of 1981 and that approximately 57 percent were feeding on snails and 40 percent

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PLAN

November 2007

Alaska Coastal Management Program



DOLLY VARDEN LOCATION MAP

Locations of Dolly Varden Trout

Sept.-Nov.

Jan.-Feb.

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 11

were feeding on insects.

Data collected in January and February, 1982 suggest that only 29 percent of the fingerlings were feeding. Approximately 61 percent of feeding fish had snails in their stomachs.

Fish larger than 171 mm were captured generally in all offshore areas of the lake during both the open-water and iced-over periods. Gonad inspections suggested that spawning commenced in early October, 1981.

Stomach content analysis of fish larger than 171 mm indicated that 59 percent were feeding in late-summer and early-fall, 1981 and that 29 percent were feeding in January and February, 1982. During the open water period, 43 percent of feeding fish contained salmon eggs and 29 percent contained snails. During winter, 62 percent of feeding fish contained snails.

CUTTHROAT TROUT

This species is also believed to be anadromous, entering the lake in late summer, spawning in spring and out migrating shortly thereafter. No fish smaller than 151 mm were captured during summer, fall and winter. These data suggest that recruitment is low. Catches during summer, fall and winter also suggest that cutthroat trout were less abundant than Dolly Vardan, and that distribution was limited to southern portions of the lake. Roughly one-half of the trout contained food items during both open water and winter periods. Fish were the predominantly observed food item.

OTHER SPECIES

Other species collected included threespine stickleback, humpback whitefish, king salmon, eulachon, sculpin and seven species of molluscs. Stickle back were the most abundant species of other finfish species captured. As with coho salmon, stickleback were distributed, during late-summer and early-fall, primarily in the peripheral areas of the lake and tended to be absent in the central portion of the lake. In winter, this pattern changed, and this species was captured in most locations.

Humpback whitefish catches consisted of large specimens 242 to 422 mm. The lack of juveniles suggests a low recruitment rate. The distribution of this species was difficult to define due to the low catch rate.

Two king salmon adult and one eulachon were also captured. Sculpin were infrequently captured.

Molluscs collected consisted of three species of clams and four species of snails.

DISCUSSION AND RECOMMENDATIONS

Fishery production is very much tied in with water quality so that the management provisions pertaining to water quality will also benefit the fishery resource.

Dissolved oxygen (DO) sampling should be conducted periodically when the lake is ice covered to delineate anaerobic (DO deficient) areas and determine the suitability of the lake as fish wintering habitat. Efforts should be concentrated in late winter and when the ice is snow covered.

Minnow trap sampling during January and February, 1982 indicated the presence of at least two areas where DO concentrations near the bottom were insufficient to sustain coho and sockeye salmon fingerlings captured in minnow traps. It is believed that this apparent low DO is due to decomposition of macrophytes (submerged vegetation) and possibly domestic sewage.

Further studies are recommended to improve the information base upon which fisheries management activities are directed. The trophic status of the lake must be determined with ortho-phosphate testing and analysis and phytoplankton sampling and analysis as a minimum. The relationship between dissolved oxygen and the biochemical oxygen demand must be established. Attempts must be made to determine the source or sources of the cadmium and lead found in the water samples. Core sampling of the lake bottom is needed to determine the build-up rate of sediments and the general pattern of build-up.

There are possible solutions to the above problems. To site some examples for a high BOD situation: aereate the water with bubbler pipes, increase winter lake depth for increased water under the ice, eliminate sewage inflow that uses oxygen in decomposition, weed control to reduce the mass of decaying vegetation, or dredging to increase water depth. Recognizing that some of the possible solutions are not as feasible as others, there are, in fact, solutions.

Management of the fisheries of the Eyak Lake system is hampered by the lack of monitored and adequately quantified data although escapement has been documented for sockeye salmon for 25 years. In order to gather the proper data so that control of the fishery is more positive, ADF&G should make provision to modify the weir structure to: 1) allow greater control of the lake level; and 2) provide for counting returning adult salmon, cutthroat trout, and Dolly Varden, and outmigrating juveniles. The lake level control (possibly a "stop log" dam) is expected to allow faster discharge in the summer and maintain summer water level during winter.

The cutthroat trout population in Eyak Lake is apparently rather limited. To assure the future of an Eyak Lake population requires the protection of tributary spawning streams. All tributary streams should be closed to cutthroat trout fishing. ADF&G staff

and the local Fish and Game Advisory Committee should submit proposals to the Board of Fisheries to close the Eyak Lake tributaries to cutthroat trout fishing.

The "sheet pile" water level control structure should be modified to allow for greater control of the lake level and provide a weir for counting adult and juvenile salmon as well as Dolly Varden and cutthroat trout.

The lake level is commonly highest during the sockeye salmon spawning season and lowest during winter. Sockeye salmon commonly spawn in numerous nearshore areas around the lake. Alevin (yolk fry) survival may be adversely impacted by lake level drawdown (normal lowering after fall rains) and the resultant dewatering or freezing of spawning areas. A removable "stop log" dam installed at the outlet may allow for faster discharge of the lake in summer and the maintenance of the summer water level during winter. Another type of outlet control structure may be required beyond the "stop log" dam. Outlet flow modifications, however, may influence ice conditions and the resident Trumpeter Swan flock. Another outlet structure could be constructed, possibly at the west end of the lake, to control flooding on the lake. This is discussed elsewhere in the report.

A counting weir may provide the fishery manager with a means to manage the commercial and sport fisheries and achieve the optimum escapement and maximum harvests of sockeye and coho salmon. According to Koenings (personal communication) the sockeye salmon productive potential of a given lake is commonly related to the volume of the euphotic zone or light penetration zone of the lake. He has observed that an "average" sockeye salmon lake produces approximately 2,800 adults (catch and escapement) per one million cubic meters of euphotic zone. It is estimated that the euphotic zone of Eyak Lake encompasses roughly 24 million cubic meters. The productive potential of the lake may, therefore, be 67,000 adult sockeye salmon. Assuming a recruitment rate similar to Bristol Bay sockeye salmon of 2.5 adults returning per spawner, this equates to an average escapement of 27,000 fish and an average harvest of 40,000 fish. Estimates of escapement magnitude during 1961 through 1981 indicated an average escapement of 11,200 sockeye salmon. An increase in average escapement magnitude from 11,200 to 27,000 fish could result in an increase in harvests from an estimated 17,000 fish to 40,000 fish. Assuming an average weight of 7.0 pounds and an average ex-vessel value of $1.40 (1981 dollars), the commercial value of sockeye salmon harvested would increase from an estimated $165,000 to $392,000.

A comparison of estimates of the amount of sockeye salmon spawning area and estimates of the minimum territorial requirements of female sockeye salmon suggest that sufficient spawning area is available for 27,000 spawners. The amount of beach and stream (Hatchery and Power Creeks) was estimated to be 75,000 square yards and 370,000 square yards respectively. Mathisen (MS Thesis) observed at Pick Creek (Wood River in western Alaska) that female

sockeye salmon require spawning territory of 4.4 to 8.3 square yards to spawn successfully.

The data base for estimating the potential of Eyak Lake for producing coho salmon is unfortunately not as complete as that for sockeye salmon. In lakes inhabited by sockeye and coho salmon juveniles, coho salmon tend to restrict their distribution to the littoral zone, i.e., those areas inhabited by submerged vegetation. A comparison of estimates of adult coho salmon production of five nearby sockeye-coho lakes and estimates of the volume of the littoral zones of these lakes suggest that an average of 900 adult coho salmon may be produced per million cubic meters of littoral zone waters. This is based on available escapement data, actual or assumed return data and bathymetric measurements taken at Martin, Little Martin, Tokun, McKinley and Bear (near Seward) lakes. Data collected during late-summer and early-fall, 1982 suggest that approximately 50 percent of Eyak Lake was utilized by coho salmon juveniles during the ice-free period. The majority of fish growth occurs during this period. The volume of the portion of Eyak Lake utilized by coho salmon is estimated to be 12 million cubic meters. The productive potential may, therefore, be estimated to be 8,000 adult coho salmon. Assuming a recruitment rate of 2.5 adults returning per spawner, this equates to an average escapement of 3,200 fish and an average catch of 4,800 fish. Aerial escapement surveys indicate that the average escapement during 11 recent years has been approximately 3,200 coho salmon (this is not a highly reliable escapement estimate as escapement data is extremely limited and, in addition, consists of early season peak counts).

Spawning area is not considered to be a factor limiting coho salmon production in Eyak Lake. The majority of coho salmon spawn in Power Creek and Hatchery Creek. Fingerling length data collected during 1981 suggest that two age classes of coho salmon were present and that food availability may limit coho salmon production. According to Koenings (personal communication) coho and sockeye salmon juveniles under optimum conditions grow quickly and the majority leave the lake environment after one year. Competition for food and space with subsequent generations is minimized. In situations in which the number of juveniles is excessive in relation to food supply or space, fish grow at a slower rate and do not reach smolt size until the second or third year of lake residency. The parent escapements associated with the two age classes encountered in 1981 encompassed 6,000 and 9,200 spawners.

A smolt weir would allow management personnel to count the outmigration of sockeye and coho salmon as well as Dolly Varden and cutthroat trout. Total outmigration estimates when used in conjunction with length, weight, age, and escapement data would be useful in the determination of optimum escapement levels. Smolt marking could be conducted to facilitate the determination of marine survival rates and harvested areas.

For purposes of the discussion in this section, a number of calculations including spawning densities, survival rates, carrying capacities, fishery interception rates, etc., are theoretical and are based on or extrapolated from other studies and are not necessarily directly applicable to Eyak Lake.

Aerial and ground escapement survey methods utilized in the past should be continued after an adult weir is installed to gauge the accuracy of historic escapement counts.

The food habits of sockeye and coho salmon as well as Dolly Varden should be monitored in conjunction with plankton and benthic food studies. These data would be useful in the determination of lake carrying capacity.

To prevent further encroachment on the spawning beds from lakeshore development the Alaska Department of Community and Regional Affairs should provide technical assistance to the City of Cordova in pursuing funds to document the existing shoreline, both already developed and expected to be developed with a series of photographs and field notes. Any non-permitted encroachment that is detected can then be verified and proper measures taken. In this same vein, DOT&PF shall coordinate their road work with ADF&G so that roadfill that might enter the lake can be directed to suitable sites.

In view of the possibility that upland development may be harmful to the underground aquifer, and not having adequate knowledge of the hydrological regime, it is recommended that permitting agencies review development proposals and, where necessary, require hydrologic investigation attesting to specific engine ering practices or structures that would alleviate or mitigate the problem. It is also suggested that ADF&G study the feasibility of amending AS 16.05 and 5 AAC 95 to include underground aquifers in the regulations.

Proposed development activities involving the excavation of hillside areas should be reviewed to ascertain the impact of excavation on the underground flow of water from upland areas to near-shore spawning areas. The usefullness of these spawning areas may largely be dependent on the continued flow of water. A specific example of a potential problem is in regards to the borrow pit at Mile 5 1/2 CRH. Groundwater running down the mountainside forms the aquifer that upwells through the gravel of the spawning beds keeping the fish eggs alive. At the borrow pit the soil and underlying gravel and rock fragments have been removed down to bedrock causing the ground water to become surface water and follow surface water courses into the lake. This may effectively cut off the aquifer to the spawning gravel although some water may seep back into the aquifer below the pit. Freezing weather conditions may intensify the process as the groundwater reaches the surface on the exposed bedrock and freezes.

A dearth of specific knowledge about the hydrological regime is

apparent for the area around Eyak Lake and, more particularly, about the underground aquifer system and its relation to the salmon spawning beds in the lake. To correct this situation, a hydrological study is recommended that would establish the surface and groundwater dynamic regime surrounding and including Eyak Lake and relate this information to a set of guidelines that include recommendations with respect to road construction, clearing of vegetation, building construction, and waste disposal so that the biological productivity of the lake is maintained.

CHAPTER SIX: THE VISUAL RESOURCE

Where land and water meet as in the Eyak Lake study area, there are special opportunities for development and special needs for environmental protection. This is even more important in the study area as the land portion rises abruptly from the lake shore to majestic alpine mountain tops. The visual landscape thus becomes a dominant factor influencing feelings and attitudes about the area and concern is evident about the quality of this visual environment. Because of this concern, it has become appropriate to establish the "visual landscape" as a basic resource, to be "treated as an essential part of and receive equal consideration with the other basic resources of the land".

In order to deal with this visual landscape resource in some objective way, it must be described, categorized, analyzed, and whatever else is necessary so that we are all looking at it in approximately the same way. For purposes of this plan, a "system" that was developed by the U.S. Forest Service was chosen (USFS, 1977 and 1979). The USFS system was developed to identify the visual characteristics of the landscape and to analyze, in advance, the visual effects of resource management activities. Simplistically, the Forest Service proposed to inventory the visual resource and to provide measurable standards for the management of it. (A more detailed description of the system can be found at the end of this chapter.

Applying the system to the Eyak Lake study area, variety of the landscape was characterized because landscapes with the most variety and diversity have the greatest potential for high scenic quality. This was based on the distinguishing characteristics of landform, rock formations, waterforms, and vegetative patterns and, as one might guess, the AMSA rated in the highest classification - the Variety Class was Class A.

Then another classification was made for the area Sensitivity Level. This is basically a measure of people's concern for the scenic quality and again the area reached the highest sensitivity level - Level 1.

When these two classifications (Variety Class A and Sensitivity Level 1) are put into the "system", the result is Quality Objectives which are keyed to the variety classes and sensitivity levels. There are five quality objectives for the visual management of the lands and each one describes a different degree of acceptable alteration of the natural landscape based upon the importance of the esthetics.

The Quality Objective for the Eyak Lake area was found to be Retention. Retention is defined as, "This visual quality objective provides for management activities which are not visually evident". Under this objective, activities may only repeat form, line, color, and texture which are frequently found in this type of landscape. Also, changes should not be evident in

the size, amount, intensity, direction, pattern, etc.

Retention also defines how long the changes, that an activity or operation creates, should be evident. It calls for immediate reduction of the evidence of the change. In other words, if logging occurred in the AMSA, the visual change on the landscape because of the logging, would have to be taken care of during the operation or immediately after. There are many ways to reduce the contrast that activities create on the landscape, such as seeding vegetative clearings and cut or fill slopes, hand planting of large stock, painting structures, etc.

The bottom line is that visual impacts in the AMSA should be mitigated to maintain the appearance of the natural diversity of the landscape in line with the sensitivity of the viewer.

Applying the U.S. Forest Service's Visual Management System to the area, personnel of the Chugach National Forest found:

The Eyak Lake area is highly scenic. The large lake, steep mountains, and the vegetation patterns combine to make a highly interesting landscape. The area is on the border between the Prince William Sound and the Yakutat Character Types. The Variety Class for this area is Class A - distinctive to the character type. The Sensitivity Level for Eyak Lake, the Copper River Highway and the road to Power Creek are all Sensitivity Level 1. This means that the majority of the people using these places and viewing the surrounding landscape have a high concern for what they see. Because of the lake and two roads, most of the surrounding landscape is visible from at least one place. Areas within about 1/2 mile of the lake shoreline are seen in foreground and beyond 1/2 mile are seen in middleground. Because of the enclosed area (by mountains) and the limited viewing distances there is no background seen area (beyond 5 miles). The resultant Visual Quality Objective (VQO) for the area around Eyak Lake and essentially to the ridgeline surrounding it is Retention (of the visual character). This means that management activities, ie., road construction, timber sales, power lines, etc., should not be visually evident. Any visual impacts created should be mitigated immediately. Additionally, activities should be designed with an emphasis to minimize visual impacts.

For those readers who desire more details on the system, several excerpts from Visual Character Types (USFS ,1979) are presented below:

> As part of the land planning process the scenic quality of individual landscapes are classified according to the amount of variety present. This helps to determine these landscapes which are most important and those of lesser value from a scenic quality standpoint. This classification is based upon the premise that all landscapes have some value, but those with the most variety or diversity have the greatest potential for high scenic quality.

The visual character types recognized here for Alaska's National Forest lands are discreet geographic units of land each having distinguishing visual characteristics of landform, rock formations, waterforms and vegetative patterns. Character types are usually based upon total visual characteristics and not upon any one single characteristic, although landform may at times be most influential. The physiographic features of the land were used as an initial basis for determining visual character types based upon Physiographic Division of Alaska (Wahrafteg, USGS) and Landscapes of Alaska (USGS). In addition vegetative features based upon Major Ecosystems of Alaska (Joint Federal-State Land Use Planning Commission for Alaska) was used to further adjust character type boundaries according to vegetative type and quantity.

When classifying landscape variety for extremely large areas of land, the need for frames of reference quickly becomes apparent. If, for example, the frame of reference were based on entire southeast Alaska (Tongass Forest) some of the large land areas of comparatively less spectacular scenery might have much of their entire visual character modified leaving relatively small remnants of the natural character. Such a gross change would be inappropriate to human scale and use. For example, the whole of a major island might be treated as one variety class while users of the island may in fact find a range of visual experiences within the context of that particular island.

Objectives for defining the visual character types for Alaska's National Forest lands are:

To serve as frames of reference (character types) for classifying the relative scenic quality of the land's physical features.

To establish criteria for determining Variety classes.

To help ensure that management direction and activities maintain a range of visual experiences in each character type as the Visual Management System is implemented.

CHAPTER SEVEN: HUMAN USES

ECONOMIC GROWTH POTENTIAL

In order to make reasonable predictions of probable future development patterns in Cordova, it is first necessary to make predictions of future economic and population growth for this community.

Cordova's economy is very heavily dominated by the fishing and fish processing industry. However, other sources of economic strength exist in the tourism industry and in certain government activities, most notably those of the U.S. Coast Guard. In addition, the Cordova area has some potential for new industries, of which development of the Bering River coal fields presently shows the greatest promise. These industries are called "basic" or exogenous industries, those whose fortunes are determined by local forces, rest. Thus, gains in basic industry are essential for long-term community growth.

FISHING AND FISH PROCESSING

Fishing and fish processing has been important in the Cordova area since the turn of the century and today is the major economic activity in this community. Cordova is the center of fishing and fish processing operations for a 38,000 square mile region which takes in the Prince William Sound, the Copper River and Bering River fishery areas. All five salmon species are taken and processed locally, as are salmon eggs, king crab, tanner crab, shrimp, Dungeness crab, razor clams, halibut, herring roe, herring roe on kelp and herring for bait and food. These species are processed locally by four major processors and a number of small operators.

The salmon fisheries of the Cordova area are highly complex. Pinks are the major species taken in Prince William Sound itself. The Copper River area is primarily a red salmon fishery with kings and cohos also important, while the Bering River area is mainly a coho fishery with reds also being significant.

Until recently, salmon catches in the Cordova area trended downward, as they did elsewhere in the State. After 1978, however, this trend reversed, with total catches setting new records for each year since 1979 (except 1980) (see Table 9). The total catch of close to 25 million salmon in 1982 is the largest in the 87-year history of the commercial salmon fishing in the area.

The recovery of the salmon fishery in the Prince William Sound area is believed to be due to several factors including institution of the 200 mile limit (no hard biological data exists to support this belief), operation of a highly successful hatchery program and to the recovery of the runs from damage wrought by the 1964 earthquake, and to the recent favorable climatic trend.

TABLE 9

COMMERCIAL SALMON CATCH
ALL PRINCE WILLIAM SOUND DISTRICTS a/
1972 - 1982
(number of fish)

Year	King	Red	Coho	Pink	Chum	Total
1972	23,003	976,115	124,670	57,090	46,088	1,226,966
1973	22,638	473,044	199,019	2,065,844	740,017	3,500,562
1974	20,602	741,340	76,041	458,619	89,210	1,385,812
1975	22,325	546,634	84,109	4,453,041	101,286	5,207,395
1976	32,755	1,009,035	160,495	3,022,429	370,668	4,595,382
1977	22,864	953,782	179,777	4,537,808	576,395	6,270,626
1978	30,435	505,509	312,930	2,917,499	489,771	4,256,144 c/
1979	20,078	369,583	315,774	15,638,258	349,615	16,693,308 d/
1980	8,735	230,193	331,837	14,219,566	477,699	15,268,030 b/ e/
1981	21,374	795,392	382,347	20,183,844	1,884,845	23,267,802 b/ f/
1982	49,632	2,732,648	614,834	20,300,439	1,346,038	24,683,591 b/ g/

a/ Includes catches by all gear types from the General purse seine, Coghill, Unakwik, Eshamy, Copper River and Bering River districts.
b/ Preliminary figures.
c/ Includes 133,648 pinks from hatchery harvests.
d/ Includes 223,761 pinks from hatchery harvests.
e/ Includes 346,828 pinks from hatchery harvests.
f/ Includes 707,037 pink, 118 chum, and 1 red salmon from hatchery harvests.
g/ Includes 1,356,918 fish from hatchery harvests.

Source: Alaska Department of Fish and Game.

A limited amount of halibut is delivered to Cordova fish processors, totalling 712,000 pounds in 1982. This is an international fishery with catch levels and the length of the fishing season regulated by the International Pacific Halibut Commission. Although catches have trended upward in recent years, this is a minor fishery in the Cordova area.

The herring sac roe fishery has been a significant, although highly seasonal, element in Cordova's fishing and fish processing industry since 1969, with catch quotas established in 1974. The 1981 catch of 12,703 metric tons was the highest on record. The 1982 catch of 6,789 metric tons was well below the 1981 level but was still the second highest to date. Herring spawn is another important seasonal fishery here. The peak harvest for herring spawn on kelp in the Prince William Sound area was in 1981 when a 13,162 metric tons was taken. The 1982 harvest of 8,012 metric tons was well below the 1981 level but was still relatively high compared to previous years.

Herring is also taken for bait and food. The 1981-82 harvest of 1,145 metric tons was fairly average although it involved more fishing effort than the previous four years.

Shellfish are an important element in Cordova's fishing and fish processing industry, with tanner, Dungeness and king crab, shrimp and razor clams all being taken commercially.

Tanner crab is the major shellfish species taken in the Cordova area. Commercial production of this species here dates back only to 1968. However, it has been an important addition to the local fishing and fish processing industry as it has lessened the community's dependence on the salmon fishery and has served to extend the fishing season through the winter months. Peak catches of tanner crab took place during the 1972-73 season when a total harvest of close to 14 million pounds was recorded (Table 10). Catches in recent years have been well below that level, with the 1981-82 harvest totalling about 3 million pounds.

Dungeness crab has been taken in the Cordova area for years, with the size of the catch being strongly influenced by West Coast market conditions. Catches have also been affected by sea otter predation, particularly in Orca Inlet where no fishing for this species has taken place since 1979. The 1982 catch of 762,132 pounds was below the 1981 level, but was higher than any other year since 1978.

Garshelis (1983), reported in his Ph.D. Thesis that clams dominate the diet of sea otters in Prince William Sound followed by crabs in second place. In Nelson Bay near Cordova, he found that adult sea otters consumed, on average, 14 dungeness crabs per day and subadults consumed about 10. With a 1980-81 population ranging from 25 to 180 sea otters the estimated annual consumption amounted to 370,000 dungeness crabs in Nelson Bay, more than half of which were commercially harvestable size. "Only one year after

TABLE 10

COMMERCIAL SHELLFISH CATCH BY SPECIES
ALL PRINCE WILLIAM SOUND DISTRICTS
1972 – 1982
(pounds)

Year	King Crab	Dungeness Crab	Tanner Crab	Shrimp	Razor Clams
1972	296,200	724,673	7,788,498	10,955	30,326
1973	207,916	806,377	13,927,868	9,562	30,818
1974	85,379	559,164	10,158,000	22,202	29,747
1975	53,423	818,041	3,854,000	30,426	15,443
1976	17,087	290,332	7,132,744	136,127	1,516
1977	86,595	735,609	2,321,348	177,033	2,160
1978	114,000	2,053,461	4,806,674	453,598	29,865
1979	65,688	652,924	7,050,555	678,067	12,904
1980	39,735	690,819	5,992,717	631,501	5,831
1981*	30,992	1,509,257	2,775,831	215,463	28,709
1982*	140,392	762,132	3,078,951	524,606	15,275

* Preliminary figures.
Note: Tanner crab catches for 1971-72, 1972-73, etc., not calendar years. Similarly for king crab from 1976-77 onward.

Source: Alaska Department of Fish and Game.

otters arrived in this bay, low crab numbers forced closure of a commercial crab harvest in this part of PWS for the first time on record."

King crab has traditionally been a minor fishery in the Cordova area. Both blue and red king crab are taken. The 1982 catch of 140,392 pounds was the highest since 1973. However, this is very small when compared with Alaska's major king crab producing areas.

The shrimp fisheries of the Prince William Sound area have exhibited significant growth during the past six years. The area has both a pot and a trawl shrimp fishery. Almost all commercial trawl shrimp harvesting takes place in Icy Bay, while the bulk of the catch and effort in the pot shrimp fishery occurs in central and western Prince William Sound. Most pot caught shrimp are delivered to the Anchorage/Kenai Peninsula area through either Whittier or Seward, with only a small quantity coming to Cordova for local fresh market sales. In 1982, a total of 346,099 pounds was taken in the Prince William Sound area trawl shrimp fishery and 178,507 pounds in the area's pot shrimp fishery.

Razor clams have been harvested in the Cordova area since the early 1900's but are a minor element in the community's fishing and fish processing industry today. The decline in commercial production is said to be due to a combination of factors including competition from East Coast producers, a decline in clam populations resulting from the 1964 earthquake, lengthy procedures needed to certify clam beaches in regard to paralytic shellfish poisoning, and to predation by sea otters (Garshelis, 1983, reported that sea otters consumed, on average, more than 80 clams daily and the total otter population in Orca Inlet and Hawkins Island Cutoff ranged between 400-900). Razor clam production in the Prince William Sound area in 1982 totalled only 15,275 pounds, well below pre-earthquake levels.

Bottomfish species are the subject of a good deal of interest in Cordova although, except for halibut, most groundfish taken in this area are currently used only for bait. Surveys by the National Marine Fisheries Service indicate a low level of bottomfish stocks in Prince William Sound. However, if a bottomfish industry is successfully established elsewhere in the State, it is possible that this fishery might also be developed in the Cordova area.

Salmon is the fishery which has recently shown the most sustained growth in the Prince William Sound area. Cordova fishermen were the pioneers in the hatchery program when local concern over declining salmon stocks led to the formation of the Prince William Sound Aquaculture Corporation in the winter of 1974-75. The corporation acquired a hatchery site at the old San Juan cannery on Sawmill Bay near the southwestern entrance to Prince William Sound and had its first returns of pink salmon in 1977 and of chum salmon in 1980. In 1983, the Corporation released 100 million pink and 10 million chum fry. To date, an average total marine

survival rate of 5.6 percent has been experienced, well above the 2 percent survival rate originally projected.

Another four hatcheries have been established in the Prince William Sound area, two by the State (at Cannery Creek and Main Bay) and two small private facilities. In addition, the Prince William Sound Aquaculture Corporation is proposing to build a second major hatchery, this one at Esther Lake, on Esther Island near Whittier.

In summary, Cordova's fishing and fish processing industry continues to dominate this community's economy and appears likely to do so through the foreseeable future. In terms of employment, the number of fishermen in the salmon and herring fisheries remains relatively constant because of limited entry regulations. However, increased levels of success by these fishermen has undoubtedly been translated into higher levels of spending locally and, thus, into increases in secondary employment. In addition, the introduction of commercial shellfish fisheries in the Cordova area during the past fifteen years has changed the community's fishing and fish processing industry from a highly seasonal to a year-round activity. In turn, this has encouraged fishermen to make greater investments in Cordova and has contributed to additional growth in secondary employment.

To better accommodate the needs of its fishing fleet, the City of Cordova has expanded its small boat harbor from 327 to 827 slips. This project was completed during the summer of 1983 and also includes the addition of a 12-acre fill area immediately adjacent to the boat harbor. A second fill area located immediately north of the Cordova industrial park will provide additional land for industrial use. These improvements should increase the efficiency of Cordova's fishing and fish processing industry and increase the atttractiveness as a fishing port.

TOURISM AND RECREATION

Except for areas in the immediate vicinity of Whittier, the Prince William Sound area has a largely undeveloped recreation potential. Although it is a relatively short distance from Anchorage, it is fairly isolated and, as a result, serves only a minor share of that metropolitan area's recreation market. This is particularly true of Cordova which is inaccessible by land and inconvenient to reach by ferry.

Cordova does, however, have excellent air service. The community is served daily by jet flights to Anchorage and Juneau, weather permitting, and by smaller aircraft flights to Anchorage and Valdez. As a result, most travel to and from Cordova by residents and visitors alike is by air.

A high proportion of tourists who now visit Cordova are sportsmen. The area's black and brown bear, moose, mountain goat and deer attract big game hunters. The Copper River flats rank high in

bird hunting areas in North America. In addition, sport fishermen are attracted by the availability of salmon and halibut, plus flounder, Dolly Varden, cutthroat trout and rainbow trout, as well as by opportunities for clam digging.

The Cordova area also has spectacular scenery. In town, Mount Eccles and Mount Eyak provide a striking backdrop to the city, while both Orca Inlet and Eyak Lake are water areas with a high degree of visual interest. These scenic attractions bring in some visitors to the community, as do special events such as the Iceworm Festival.

Some increases in tourism in the Cordova area can be expected in the future. However, the recent decision by the Governor not to complete a highway linking Cordova with the Southcentral Alaska highway system will continue to make the ferry system the only means of ground access to the community. As a result, it is probable that most visitors to Cordova will continue to travel here by air and that the city will not experience a growth in demand for campground and motel facilities that could be expected from increased highway traveling tourists. Nevertheless, as Anchorage grows, increasing numbers of residents of that metropolitan area are likely to fly to Cordova to take advantage of the amenities offered here, especially recreational boating opportunities.

MILITARY

Military-related activities are significant in Cordova's economy and promise to continue to be so in the future. Cordova is the home port for a U.S. Coast Guard cutter which has a complement of 56 personnel and is charged with the responsibility for search and rescue operations in the area between Yakutat and Seward, as well as aids to navigation and other duties. Coast Guard personnel in Cordova live in town, many of them with their families, a situation which has a positive impact on the local economy.

The Coast Guard has long been interested in establishing a helicopter air facility at Cordova to provide more effective rescue and recovery services in the Copper River delta area. A three phase project to realize this goal has been developed. The first involved construction of a helicopter hangar at Cordova's Mile 13 airport in 1979. This phase also involved the stationing of a helicopter in the community beginning in the summer of 1983.

Currently for the second phase of this project, the contract to build the 12 person Bachelor Enlisted Quarters (BEQ) and upgrade the hanger has been awarded. This phase involves the stationing of a helicopter in Cordova with an eight member crew on a 30 day rotation from Kodiak, plus 2 or 3 support personnel to be based in Cordova once the BEQ in built. Upgrading of the hanger taxiway is also scheduled. This phase is expected to be completed by late 1984.

The third phase of the planned Coast Guard expansion program at Cordova would involve establishment of a full air station in the community, with two helicopters stationed here on a permanent full-time basis and staffed by 59 persons plus their dependents. According to the Coast Guard, this phase of development will occur in the next 6 to 8 years if the establishment of a permanent air station is determined to be feasible.

COAL

Coal has long been of interest in the Cordova area. The Bering River coal fields, located east of the Copper River, were discovered in 1896. However, the withdrawal from entry of Alaska's coal lands in 1906 prevented the exploitation of these and other Alaska coal reserves at that time.

There has been a renewed interest in the development potential of the Bering River coal fields. Chugach Natives, Inc., the regional Native ANCSA corporation in the Cordova area, has entered into a partnership with a Korean firm, KADCO, Inc., to explore the corporation's holdings in the eastern portion of the Bering River coal fields. The exploration program began in 1981 and is expected to continue for another 3 to 5 years. To date, exploratory drilling efforts on Chugach Natives, Inc.'s lands have identified 62 million tons of anthracite coal, considered be a 20-year supply. According to spokesmen for Chugach Natives Inc., an annual production level of between 2 and 3 million tons would have to be maintained in order for the corporation to amortize its investment.

No decision to develop the Bering River coal fields' reserves has yet been made. Nor is it yet clear what role Cordova would play should a decision be made to go ahead with a mine development. According to the City of Cordova, 32 miles of road would need to be built from Mile 38.5 of the Copper River Highway to the mine area to provide a road linking the mine and Cordova. Furthermore the possible development of a port facility at Kanak Island, southeast of Katella, has been discussed for shipping the coal out of the region. Thus, it is possible that Cordova might experience few direct benefits from Bering River coal field development. However, the City of Cordova is hopeful that development of a mine here could at least provide an opportunity for the community to gain access to cheaper power and, as a result, act as a stimulus to other economic development in town. Presently, Cordova relies exclusively on expensive diesel-generated electric power.

Although the feasibility of mining the Bering River Coal Field has not yet been determined, the Wheelabrator Coal Services Company's Assessment of the Feasibility and Implementation of Port and Transportation System Alternatives for the Bering River Coal Field (a pre-feasibility level study) concluded, in part:

> "Although the proposed development of the Bering River Coal Field would not be without significant obstacles to overcome

prior to implementation, there appear to be none which could not be overcome if properly addressed. The assessment did not reveal any 'fatal flaws' in the proposed development."

"It appears from the results of the assessment that the ultimate criteria which will determine the feasibility of the proposed Bering River Coal Field development are economic in nature. (Three of the most significant factors in determining economic viability are annual production rate, mining costs, and market value)."

"...the proposed development does not appear to be economically feasible at this time except under a 'best case' scenario which cannot be considered a realistic possibility."

OTHER

The actions and activities of the Eyak Corporation, the village corporation in the Cordova area which was formed under provisions of the Alaska Native Claims Settlement Act, will have a significant impact on Cordova's economy through the foreseeable future. Under the terms of the Claims Act, the Eyak Corporation has a total land entitlement of 115,000 acres, of which between 63,000 and 66,000 acres had been interim conveyed by the end of February 1983. Some of these lands are in the immediate vicinity of Cordova, making the Corporation a significant force in future community development.

The business activities of the Eyak Corporation to date have been relatively modest but this could change in the future. The Corporation is involved, however, in several land development projects. By far the largest is the subdivision out past the end of Whitshed Road. Three hundred and twenty six lots in this subdivision have been conveyed to Eyak Corporation stockholders, with the remaining 90 or so lots scheduled to be sold to the general public later in 1983. All lots are at least 2 acres in area.

The Eyak Corporation also has or is considering other land development projects. A small subdivision of 5 one-acre lots on Eyak Lake is currently being marketed by the Corporation. The Corporation is also considering disposing of 4 or 5 additional parcels along Whitshed Road.

No other existing or potential economic activities in the Cordova area appear likely to have significant impact on the community's economy in the foreseeable future. There is a small sawmill on airport property at Mile 13 of the Copper River Highway and the Eyak Corporation may be involved in a modest amount of timber development in about 5 years. However, the potential for economic growth derived from wood products in the area is extremely modest.

Cordova felt very little impact from the April 1976 Gulf of Alaska outer continental shelf oil and gas sale although local

expectations ran high at one point. An OCS lease sale is scheduled for the Gulf of Alaska - Cook Inlet area in October 1984. Given the lack of success encountered by the industry in previous Northern Gulf of Alaska exploration efforts, no significant impacts on Cordova's economy are expected from this source.

No mining claims are known on State owned lands within the AMSA but the area is underlain by a volcanic-sedimentary sequence of rocks which has the potential to host base and precious metal deposits. This same sequence of rock hosts base metal deposits in the Tatitlek area, approximately 40 miles northwest of Cordova.

As a result of a subsistence survey conducted in March 1980 in Cordova (North Pacific Rim, 1981) of both Native and non-Native households, it was concluded that "Although different industries have encouraged the growth of a cash-based economy, the lifestyle and the diet of the people in the Eyak-Cordova area still strongly reflect the heritage of a traditional relationship between human beings and the natural resources." The survey indicated there was no significant difference between the Native and the non-Native responses to the survey. Information gathered in the survey reflects subsistence activities and concerns during and throughout 1979 and pointed out an apparent lessening dependence directly on the resources, however, such perennial activities as drying fish, smoking fish, seal-hunting and berry-picking have persisted over the years without any direct relationship to the size of income.

Although the survey results showed the majority of use to be concentrated on marine resources, a significant proportion of households used or harvested resources that could have come from the Eyak Lake study area including cutthroat trout, Dolly Varden, mallard, deer, and berries.

POPULATION

PRESENT POPULATION

According to the census, a total of 1,879 people lived in the City of Cordova in 1980. A special State-supervised census conducted by the City of Cordova in September 1981 counted 2,223 local residents, with the City claiming 2,241 residents in July 1982 for State Revenue Sharing purposes.

The number of persons counted by the 1980 Census and subsequent counts excludes a large number of transient fishermen and processing workers, many of whom live on boats or in bunkhouses or live by camping or squatting during the fishing season. Although these people impact the level of community services and utilities provided by the City, they do not have a major impact on land for residential use until individuals reach a decision to buy or construct their own land-based accommodations. Thus, although City census figures are on the "low" side, they are used in this report.

In addition to City residents, there is a significant number of people living outside Cordova's corporate boundaries, from the eastern end of Eyak Lake out to the Mile 13 airport and beyond the Whiskey Ridge subdivision out Whitshed Road. Based on an estimate of 120 housing units in these areas with an average of 2.58 per unit (1980 Census figure for the City of Cordova), about 310 people live outside Cordova but within its immediate road-connected area. When these people are added to the City's population, a total of 2,550 people are estimated to live in Cordova and its immediate road-connected area.

FUTURE POPULATION AND HOUSING REQUIREMENTS

Following a review of the various components of Cordova's economy, previous estimates of probable population growth in this community developed by Alaska Consultants, Inc. and others were reviewed. From this review, population projections developed for Cordova in 1978 by Alaska Consultants, Inc. for the Alaska OCS Office of the Bureau of Land Management under a non-OCS scenario were determined to be the most realistic. These projections were developed in conjunction with comprehensive review of Cordova's economy and projections of employment. They assumed that Cordova would continue to function as a major fishing and fish processing center and that it would not be impacted by offshore oil and gas development, assumptions which remain valid today.

Based on those projections, future population growth in the immediate vicinity of Cordova is as follows:

1984	2,550
1988	2,755
1993	3,026
1998	3,364

Using the above figures and based on the current ratio of 2.58 persons per unit, an additional 80 housing units (excluding replacement units) are projected to be needed in the immediate Cordova area by 1988, another 105 units between 1988 and 1993 and yet another 131 units between 1993 and 1998. All told, this represents a net addition (i.e. excluding replacement units) of 316 units in the Cordova area by 1998, or an equivalent of about one-third of the community's present housing stock.

DEVELOPMENT PATTERNS

EXISTING DEVELOPMENT PATTERNS

Cordova's present land use pattern has been shaped by its physical setting, its past and by the dependence of its major industry on a waterfront location. The community's form was also modified by

the 1964 earthquake which raised land here by between 6.5 and 7.5 feet.

Topography has been a major factor in determining the form of Cordova's development. Mount Eyak to the north and Mount Eccles to the south have limited most development to the foothills of Mount Eyak or to a narrow and often poorly drained valley between the two mountains. Most land in these two areas is now developed and more recent development has taken place along the shores of Eyak Lake and out Whitshed Road.

Cordova's commercial district is concentrated on First and Second Streets, on the bluff overlooking the harbor, although some additional commercial uses are located in the harbor waterfront area. The community's three major industrial areas all face onto Orca Inlet, one centered on the boat harbor, a second located further north in the vicinity of Municipal Dock and the third still further north at Orca. The most concentrated residential development is located uphill from the business district although it is inhibited by relief. Some relatively dense residential development has also taken place in the lower portion of town on the peninsula where the school is located and in portions of Old Town. However, development in Old Town is made inefficient by poor platting and characterized by a mixture of trailer parks and heavy equipment storage.

According to the Census, there was a total of 728 housing units in Cordova in 1980, an increase of 70.9 percent over the 426 counted here in 1970. A count of housing units in Cordova in 1975 by Alaska Consultants, Inc. found a total of 585 units in the City, excluding transient bunkhouse accommodations, indicating that increases in the number of units here took place at a reasonably consistent rate during that ten year period.

Using the ratio between population and housing units of 2.58 recorded by the 1980 Census, it is assumed that Cordova's July 1982 population of 2,241 occupied a total of about 869 dwelling units. Approximately 83 of these units, or 10 percent, are located around the shores of Eyak Lake (on both sides of the road) within Cordova's corporate limits. An additional 29 units are located along Eyak Lake outside Cordova's corporate limits but within the Eyak Lake study area. All told, around Eyak Lake (on both sides of the road) currently account for about 11 percent of all units in Cordova and its immediate road-connected area.

Eyak Lake Study Area

An annotated categorical list of current and proposed use sites is presented with map locations shown in Fig. 12 where the location is identified using the number from the following list.

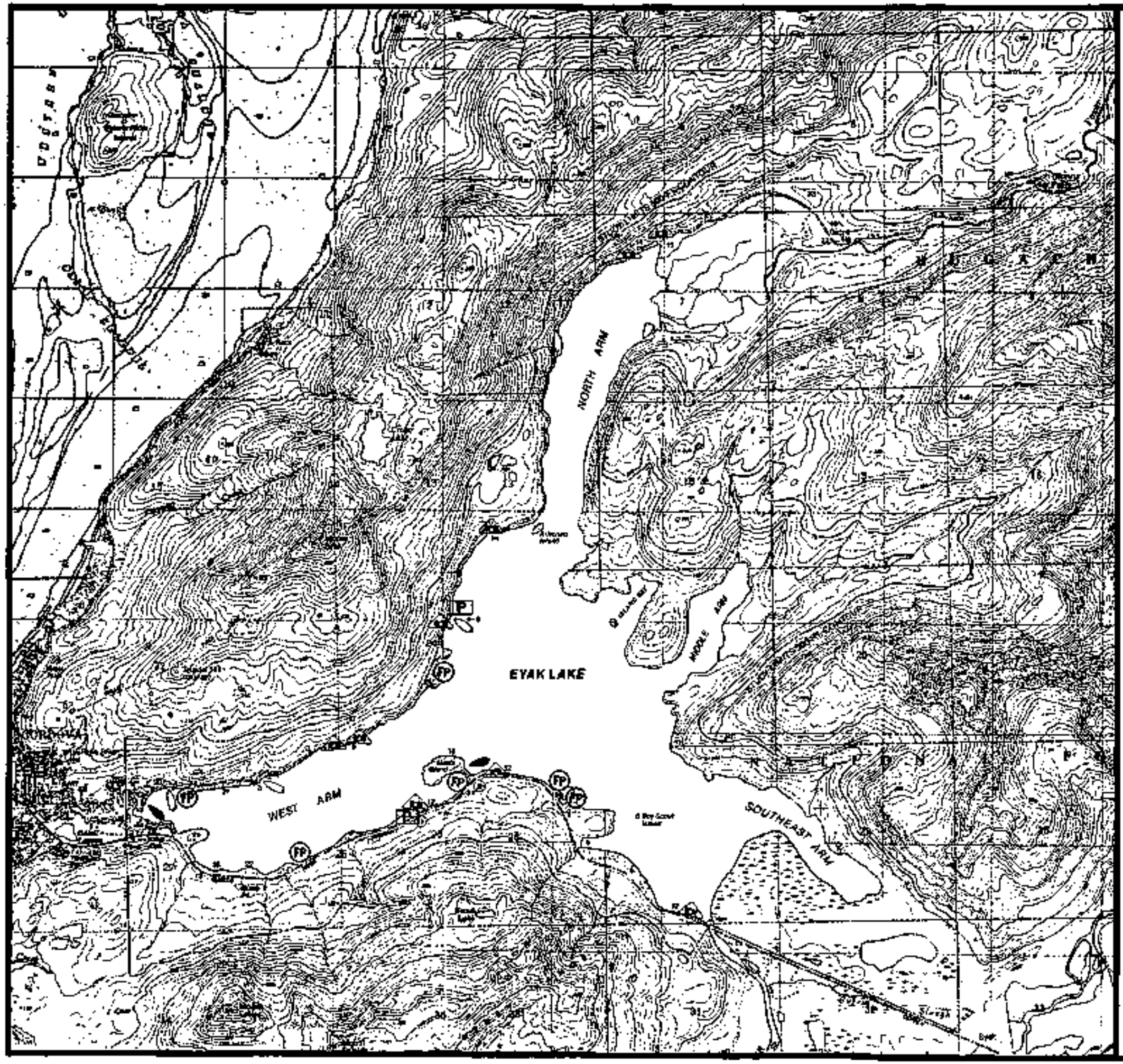
Boat Ramps or Launching Places That Accommodate Trailered Boats:

1. Eyak River Boat Landing - Accessible from the Copper River

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PLAN

November 2007

Alaska Coastal Management Program



EXISTING/RECOMMENDED LAND USE

Existing Land Use

- Buildings
- FP — Flood Plains Parking
- Boat Launching Ramps
- Road Turnouts (Viewing Area)
- Gravel Road
- Paved Road
- Trail

Recommended Recreation Land Use

- P — Picnic Areas
- Boat Launches

NOTE: Turn-outs are existing and recommended as either picnic or viewing areas.

Use Sites:

1. Eyak River
2. Wood Ramp
3. Concrete Ramp
4. No. Shore
5. Beach
6. Nirvana Park
7. Spit, picnic
8. Skaters Cabin
9. Beach-picnic
10. Stream Gage
11. Weir Road
12. CRH Turnouts
13. Spit-View
14. Rd. Turnouts
15. Hatchery Cr.
16. Mavis Is.
17. Crater Lk. Tr.
18. Power Cr. Tr.
19. Mt. Eccles
20. Collins
21. Causeway
22. P. Collins
23. Spitgrasses
24. Air Taxi
25. M. Jackson
27. Airstrip
28. Power Plant
29. Mobile Park
30. Cemetery
31. Shop
32. Cable Cross
33. Borrow Pits
35. Water Plant

NORTH

3,000 0 3,000 Feet

1,000 0 1,000 Meters

Contour Interval: 20 meters

Cordova CMP Appendix D

Figure 12

Highway and just outside the study area, this facility is approximately one-half mile downstream from the weir, is managed by the Chugach National Forest, and has parking for about 20 vehicles. Riverboats can run into the lake through the weir slot except at low water.

2. Wooden Plank Ramp - Located in front of the Chitina Air Service hanger, the ramp is leased by Chitina Air Service from the City and is not available for boat launching.

3. Concrete Ramp - This ramp was recently installed a concrete bridge deck into the lake off the east end of the airport runway. Vehicle and trailer parking occurs between the roadway and runway, is limited in size, and may present a hazard to the proximity to the runway and to Chisum Air's helicopter facility.

4. North Shore Beach - This informal launching place is an accessible beach along the Power Creek Road between the Richard Davis place and Kritchen Island. The u-shaped driveway and beach are unimproved and provide parking for three vehicles at most.

Picnic Sites and Informal Areas:

6. Nirvana Park - Developed in the 1920's, this once elaborate park at the northwest corner of West Arm is in the stages of rehabilitation by the City of Cordova. A covered picnic shelter was constructed in 1982.

7. The Spit - Extending into the lake from Nirvana Park, this narrow strip of land owned by the City is used by swimmers and occasionally for picnics and viewing.

8. Skater's Cabin - Along Power Creek Road, approximately one-half mile east of Eyak Lake airstrip (City field), is a warming cabin built by the Forest Service for skaters. This is a popular picnic and swimming site, trailhead for Crater Lake Trail, and includes tables, two outhouses, and substantial vehicle parking lots. Considerable group use occurs here.

9. North Shore Beach - Also listed as a boat launching beach, this site serves informal picnicking.

10. Power Creek Stream Gaging Station - This site is basically a road turnout near the terminus of Power Creek Road adjacent to the stream gaging station and is used as an informal picnic area as well as a sport fishing site.

Viewing or Scenic Areas:

11. Weir Access Road - Just east of Eyak River Bridge, this short road provides access for weir maintenance and has been used for scenic and swan viewing, some picnicking, and launching small boats. Public sentiment is strong against use of this site as indiscriminate shooting occurs, especially at night, endangering

residents at Mile 5. Indiscriminant use disturbs the waterfowl, and visitors leave their trash to blow around.

12. CRH Turnouts - All these turnouts are on the lake side of the highway and all are blacktopped. The first one, as you leave town, is just west of Powder House Point. The next is about one-half mile west of Mavis Island Causeway. Just east of the causeway, the third turnout displays a monument and sign describing the historic Copper River-Northwestern Railroad. The next turnout, immediately west of Eyak River Bridge, is used intensely for swan observations during freeze-up. Litter is a continuing problem at each of these sites.

13. The Spit - Previously listed.

14. Power Creek Road Turnouts - There are several turnouts along this road used mainly to view the wildlife, although they also accommodate informal picnicking.

15. Hatchery Creek Culvert Crossing - This site is heavily used from mid-July through the salmon spawning season for viewing, close-up, the intriguing spawning phase of the Sockeye and Coho salmon life cycles. Parking causes traffic congestion at times. This is also a favored spot to view bears as they come to feed on salmon carcasses.

Other Recreation Sites:

16. Mavis Island Recreation Facility - This proposed facility is on State land leased to the Cordova Chapter of the American Legion and covers the entirety of Mavis Island. Plans call for development of three distinct use facilities. The west half of the island will be a youth group campsite with tent platforms, fireplace grates, bathhouse, and paths. A public picnic ground and swimming beach is planned for the western tip of the island complete with tables, pavilion, and bathhouse. The area between will have an American Legion/VFW clubhouse, large parking area, float plane docking beach on the south side, and a dock extending out from the north shoreline. Some work has begun on this development.

17. Crater Lake Trail - Beginning across the road from Skater's Cabin and traversing 2-1/2 miles up the mountain to Carter Lake, this trail is one of the most widely used recreation facilities in the study area. A parking lot is available at the trailhead.

18. Power Creek Trail - This trail takes off from the end of Power Creek Road and provides access to Power Creek Valley above Ohman Falls.

19. Mt. Eccles Recreation Area - An area of 4,420 acres, including Mt. Eccles and Heney Peak and the land westward to the coast has been proposed by Alaska Division of Parks (See Office of Coastal Management, 1980) as an AMSA for public and/or private

recreation for watershed protection. This area, noted for its recreation potential and scenic beauty as well as currently comprising the City of Cordova watershed, extends into the study area along the south shore of the West Arm and was conceptually considered by the State for its sea coast to mountain top attributes (continuum of vegetation and landforms from snowfield to sea coast) in a relatively short distance.

Float Plane Docking Sites:

20. Collin's Peninsula - At approximately Mile 4 CRH is a peninsula owned by Cliff Collins. A float plane docks in the bay to the east and one in the protected cove on the west side of the peninsula.

21. Mavis Island Causeway - Four to five planes tie up to the west side of the causeway using the causeway to provide protection from the prevailing winds and waves.

22. Phil Collins Residence - A float plane dock is built into the shoreline in front of this residence at approximately Mile 2 CRH.

23. The Spit - About six planes tie up in the lee of the spit and another four or five tie up in the same cove but in the shelter of Nirvana Park.

24. Air Taxi Docks - Three air taxi operators maintain float plane docks; two just beyond the west end of the runway and one just beyond the east end of the runway.

25. Mike Jackson Residence - On occasion, one plane utilizes this residence site located about 2-1/2 miles from town on Power Creek.

Other Uses:

26. Residences - Most of the residences in the study area are concentrated on the flat fluvio-glacial deposit at the west end of the lake and on the lower slopes above Lake Avenue. Scattered ribbon development has occurred along both sides of the lake with the houses being built on the relatively flat area of outwash deltas of the streams dumping into the lake. In more recent years, some residence construction has occurred on the first terrace or bench above the lakeshore.

27. Eyak Lake Airstrip - Also known as Municipal Airport and City Field, this facility has a 1,950 foot gravel runway and is located on the north shore of West Arm along Power Creek Road. Connected with the airport are the facilities of the air taxi operators and other local pilots such as hangers, offices, gear sheds, fuel storage tanks, helicopter platform, float plane docks, airplane tiedown lots, and several living quarters.

28. Power Plant and City Shop - Located on the edge of the lake on the southwest corner of West Arm, this complex includes a diesel generation power plant, fuel storage, tanks, utility shops and storage, City maintenance shop, pumphouse, substation, cooling point, and City dog pound.

29. Mobile Home Park - Adjacent to and immediately east of the power plant is a relatively large mobile home park that underwent expansion in 1975. Several additional mobile homes are situated just south of the power plant.

30. Cemetery - Located across Lake Avenue from the Spit, this graveyard has no additional spaces and contains the remains of residents and workers of early Cordova.

31. Contractor Shop - At the corner of Lake Avenue and LePevre Road is a contractor's residence with additional shop buildings and heavy equipment storage. This same contractor operates a concrete batch plant at the junction of LePevre Road and CRH.

32. Power Creek Cable Crossing - This site is approximately one-third of a mile downstream from the USGS gaging station and consists of a two-person cable car suspended by cable between towers on opposite banks of Power Creek.

33. Borrow Pits - Several borrow pits have been developed along Power Creek Road (Cordova Highway) basically for road maintenance purposes. The most notable pit in the study area is at the toe of the avalanche path at mile 5-1/2 CRH for which management implications are discussed elsewhere in this report.

34. Archaeological Sites - According to communications from Chugach Natives, Inc, and Eyak Corporation, no known sites of archaeological interest exist in the study area.

35. Water Treatment Plant - This facility, on the south shore of West Arm between Murchison Falls Creek and Powder House Point, was completed in 1985.

A field survey of land development patterns around Eyak Lake was conducted in February 1983. This survey covered the area from Mile 7 of the Copper River Highway toward town and around the Cordova Highway side of Eyak Lake to Power Creek. Between Mile 7 and the Eyak Lake weir which marks the beginning of the study area on the south side of the Highway, it found 39 single family dwelling units, 7 trailers, a restaurant, pig farm, a Forest Service boat landing and several boathouses, as well as outdoor crab pot storage areas.

From the Eyak Lake weir to Cordova's corporate limits via the Copper River Highway, a total of 24 single family dwelling units and 2 trailers were counted. Another 11 single family dwelling units, the Powder House bar, a couple of warehouses and the Murchison Falls water treatment site were recorded along the

Highway between Cordova's corporate limits and the Lakeshore trailer court. The Lakeshore trailer court contained a total of 35 trailers in February 1983; while the power plant, 2 Forest Service crew houses, a Forest Service warehouse and 3 trailers were located in the immediate vicinity of the power plant at the corner of the Copper River Highway and LeFevre Street. Eight single family dwelling units, 3 trailers, a shed and the offices of the Eyak Corporation were located along LeFevre Street between the Copper River Highway and Lake Avenue; a 5-plex, a 4-plex, a warehouse, Nirvana Park and an old cemetary are located off Lake Avenue between LeFevre Street and the Eyak Lake airstrip; and several aircraft hangers, an automotive repair shop, air taxi service offices, 2 single family residences and 2 apartments were counted adjacent to the Eyak Lake airstrip. Along the Cordova Highway, (Power Creek Road) beyond the airstrip to Cordova's corporate limits, a cannery, 6 single-family dwelling units and a skater's cabin were identified; while between Cordova's city limits and the end of the road at Power Creek, another 4 single-family dwelling units (one on an island in Eyak Lake) were recorded.

In summary, a total of 113 dwelling units were recorded on both sides of the road along the shores of Eyak Lake in February 1983. By type, 57 were single-family dwelling units, 13 were apartments or multi-family structures (dwelling unit counts did not include units north of Lake Avenue except the ones fronting on Lake Avenue) and the remaining 43 were in trailers. Commercial uses in the study area included a restaurant, a bar, offices of the Eyak Corporation and air taxi offices at the Eyak Lake airstrip. Industrial-type uses included the Cordova power plant, a Forest Service warehouse, a small cannery, a construction headquarters, a welding shop, two aircraft service shops, hangers associated with operation of the Eyak Lake airstrip, the airstrip itself and several warehouses and sheds. Miscellaneous public and semi-public uses included Nirvana Park, an old cemetery and a picnic ground plus a skater's cabin.

FUTURE DEVELOPMENT PATTERNS

In terms of future development patterns in the Cordova area, it is not anticipated that they will change much from those which presently exist in this community. No fundamental changes in the commununity's economy have been forcasted to take place. Therefore, no dramatically new demands for different types of land are expected to to be felt.

Cordova has been fortunate in that it has managed to retain a single dominant commercial district on the bluff area overlooking the harbor. Some additional commercial development has taken place adjacent to the boat harbor, much of it serving the needs of the transient fishing fleet and of seafood processors in that area. No significant drift of commercial uses is expected to take place outside these two areas in the future.

Cordova's existing industrial areas are also generally well defined. They are centered around seafood processing activities and require locations with tidewater access on Orca Inlet. Several scattered industrial sites have developed over the years in the AMSA such as the Airport, power plant, and, most recently, the water treatment plant which is currently under construction. The City is in the process of increasing the efficiency of its boat harbor and creating new industrial areas adjacent to it through the use of dredged materials. Thus, no significant new demands for general industrial space outside these existing areas are foreseen in the Cordova area in the foreseeable future.

There is no well defined warehousing area in Cordova, excluding fisheries storage areas. A good deal of use is located in the Old Town area, often mixed with residential single-family units and trailer courts. The City's 1976 comprehensive development plan recommended an area in the vicinity of the power plant extending north to Chase Avenue and across the south side of the Copper River Highway be reserved for light industrial use, primarily reflecting existing land use in that area.

Future residential development is the critical element in Cordova's future land use pattern. While the addition of more apartment units in the area uphill from the business district is likely to take place in the future, development in this steep area is difficult and expensive and it is probable that an increased share of new homes in the community will be built in the area out Whitshed Road and along both sides of the road around Eyak Lake in the future. Development of the Eyak Corporation's subdivision beyond the present end of Whitshed Road should result in Cordova's residential development pattern becoming much more dispersed in the future and will also necessitate an upgrading of Whitshed Road. The more limited availability of building sites should result in a lesser amount of residential development around Eyak Lake than is expected out Whitshed Road. However, the scenic attractiveness of Eyak Lake puts lots in this area at a premium.

Eyak Lake Study Area

With a few notable exceptions, development along both sides of the road around Eyak Lake is predominately residential and is expected to remain so through the future. The two major exceptions to this are the Cordova power plant and the Eyak Lake airstrip, both of which are expected to remain in their present locations although the power plant has been associated with some pollution problems in Eyak Lake in the past.

In terms of future development patterns around Eyak Lake, it is projected that no significant new industrial uses will locate in this area under the "high", "low" or the "most probable" development rate assumptions, except for the possible addition of hangar and other facilities associated with the Eyak Lake airstrip. Similarly, no significant additional commercial development is foreseen in this area. Thus, probable

future development patterns are assessed in 5-year time frames under "high", "low" and "most probable" development rate assumptions only for residential uses.

At the present time, about 11 percent of all housing units in the immediate Cordova area are located along both sides of the road around Eyak Lake. Based in part on knowledge of building plans by several individuals around the lake, it is projected that the percentage of Cordova's dwelling units which are in the study area will increase to 13 percent of all units in the community by 1988 and remain at that rate thereafter under a "most probable" development rate scenario. Under a "low" development rate scenario, it is assumed that the proportion of dwelling units in the study area will increase to 12 percent of all those in the community by 1988 and remain at that rate through 1998.

The "high" development rate scenario assumes that a relatively large proportion of new development around Eyak Lake will be in the form of trailers. Under this scenario, dwelling units in the Eyak Lake study area would account for 15 percent of all those in the immediate Cordova area from 1988 through 1998.

In terms of numbers, the number of dwelling units along both sides of the road in the Eyak Lake study area under a "most probable" development scenario should be in the neighborhood of 139 by 1988, 152 by 1993, and 170 by 1998 (see Table 11). The "low" development rate scenario envisages slightly fewer units -- a total of 128 by 1988, 145 by 1993, and 156 by 1998. The "high" scenario foresees significantly more -- 160 by 1988, 176 by 1993, and 196 by 1998.

In terms of type of residential units which are most likely to be added in the Eyak Lake study area during the next fifteen years, it is likely that single family units will continue to predominate. However, the addition of another trailer park is rumored and at least several trailers appear likely to be added. Construction of more multi-family units also is likely, especially in the LeFevre Street/Lake Avenue area.

DISCUSSION AND RECOMMENDATIONS

As the human use analysis pointed out: no significant new industrial uses will locate in the AMSA except for facilities associated with the airstrip; no significant commercial development is foreseen; and residential uses are the only uses anticipated with single-family units predominating. By 1998 under the "most probable" development scenario 170 dwelling units will be located within the AMSA including those just outside the AMSA in the area of Mile 6-7 of the Copper River Highway. At present there are 112 dwelling units including 46 in the Mile 6-7 area. In the next 15 years 58 new units are anticipated.

The policies and allowable uses stated later in this plan infer that residential is the preferred and best use of the land around

the lake with the exception of those areas needed for habitat protection and recreation pursuits. Control of land use and development to meet this goal may be achieved in several ways: through various forms of land use control and development regulation such as zoning; through governmental policy on location of public facilities and services, such as roads or sewer lines. Since a small portion of the land in the AMSA is within the Cordova City limits and, therefore, regulated by zoning and a comprehensive development plan, this leaves the major land area outside municipal zoning control. Land owned by the State outside the city limits will conform to the controls established in this plan as a form of zoning. Federal lands are not bound by State coastal management plans, except for spillover effects caused by projects on federal lands onto state, municipal, or private lands. Development of the private land outside the city limits is another story and must be controlled in another fashion. This will be accomplished by the permitting agencies as they review development proposals in light of the policies in this plan.

The City of Cordova may be able to exercise extra-territorial jurisdiction over the Eyak Lake watershed pursuant to AS 29.48.0 37 (b). For the watershed within the City limits, amendments to the City zoning ordinance is the most effective way to preserve the watershed. Adoption of a special watershed management ordinance will preserve the watershed outside of the City limits.

A more positive control measure would be for the City of Cordova to annex the land outside its municipal boundaries and implement the planning and zoning powers granted by the State to Cities of the Home Rule Class. This direction is recommended. Cordova is a First Class City and has adopted a home rule charter. It has all legislative powers not prohibited by law or charter. It must provide planning, platting, zoning, taxation, and education; and it can add other powers for the services of police, water, sewer, etc., by council action.

The 1976 Cordova Comprehensive Development Plan recommended a major increase to Cordova's corporate boundaries. At a minimum, the Plan suggested the City of Cordova should consider increasing its boundaries to extend as far northwest as Gravina Point, as far west as Hinchinbrook Island, as far east as Cape Suckling, and as far inland as the Chugach National Forest boundary.

This plan recommends an annexation process to be initiated upon adoption by the Coastal Policy Council. As a minimum land area, annexation should include all land within the Eyak Lake AMSA. Although outside the AMSA boundary, the entire drainage basin of Eyak Lake and the other watersheds that feed the communities water withdrawal points should be included. If, for some reason or other, the annexation process has negative results, the above mentioned option for extra-territorial jurisdiction should be implemented for the watershed.

The Eyak Lake AMSA Management Plan relies heavily on state and

federal statutes and regulations as authorities behind its policies and rules. These are compiled in the Alaska Land and Water Use Guide published by the State of Alaska, Office of Coastal Management.

Re-occurring hazards that jeopardize human life and property exist in the AMSA. Known geophysical hazard areas and areas of high development potential in which there is a substantial possibility that geophysical hazards may occur are: 1) flooding all around the lake, in the wetlands east of the weir, and in the Power Creek Delta area; 2) avalanche in the Mile 5, CRH area. Development in areas identified above may not be approved by the appropriate state authority or by the City of Cordova until siting, design and construction measures for minimizing property damage and protecting against loss of life have been approved.

The Alaska Department of Military Affairs should encourage appropriate federal and state agencies to improve information on types and locations of hazard areas in the AMSA. This agency should also instigate a study to determine the feasibility of a second outlet from the lake to reduce flood flows. The study should consider such solutions as a ditch along the CRH or a culvert whose function is to "kick in" when the lake level reaches some pre-determined height above the weir elevation. Lyon Associates (1970), reported, "During past floods, the water found its way out of the Lake by an old channel through Cordova. This has been further blocked since then by the highway fill. The culverts installed under the highway at this point do not look adequate to handle the excess."

In July of 1983, the Scott River began exiting largely from the west side of the Scott Glacier terminus rather than the east side as it had previously done. Now, the majority of Scott River water is flowing down the Ibeck Creek channel and spilling over into Eyak River about 1.5 miles downstream from Eyak Lake. According to a USFS hydrologist (USFS, 1983), the spillover means that Eyak River will have more water in it than in the past and will be less capable of draining the lake at flood stage. This means that the lake level will likely rise higher than in the past for the same flood conditions and could endanger buildings around the lake and along Eyak River.

Overwhelmingly apparent from the survey results (see Appendix A) is the importance of the Eyak Lake area in terms of scenic and recreation values. Non-consumptive uses are extremely high on the list by the percent age of people taking part in these activities. The scenic beauty and environmental quality of the area are the reasons these activities rate so high.

All indications point to increased development around the lake so it is important to make provisions for future recreation use and to maintain the overall scenic quality.

The Christian Center Beach (previously a Forest Service Picnic

TABLE 11

PROJECTED NUMBER OF DWELLING UNITS
"LOW", "MOST PROBABLE" AND "HIGH" DEVELOPMENT RATE SCENARIOS a/
CORDOVA AREA AND EYAK LAKE STUDY AREA
1988, 1993 AND 1998

Year	Number of Dwelling Units			
	Cordova Area b/	Eyak Lake Study Area		
		Low	Most Probable	High
1983 c/	989	112	112	112
1988	1,068	128	139	160
1993	1,173	145	152	176
1998	1,304	156	170	196

a/ "Low" development scenario assumes that dwelling units in the Eyak Lake study area account for 12 percent of all those in the Cordova area from 1988 through 1998; the "most probable" scenario assumes 13 percent and the "high" scenario assumes 15 percent for the same time period.

b/ Forecast of dwelling units for the Cordova area assumes a constant 2.58 persons per unit through 1998.

c/ Number of dwelling units in Cordova area estimated based on population count by City of Cordova. Number of units in Eyak Lake study area counted in February 1983.

Source: Alaska Consultants, Inc.

Ground near Mile 5, CRH) was primarily a group use facility, but has been transferred to the Eyak Corporation under ANCSA and has been subdivided for development. To provide for group use now and in the long term, it is recommended that DNR issue a long-term public recreation lease on Mavis Island and the causeway with the addition of a boat launching ramp near the southeast corner of the causeway. This site is currently under lease to the Cordova Post, American Legion Club so this recommendation concerns the lease clauses which define public recreation as the long-term use and requires that of any lessee, current or future.

The City of Cordova should continue to redevelop and maintain Nirvana Park and Spit to serve the community's recreation needs. In its preparation of a Capital Improvements Plan, the City should include construction of a boat launching ramp on the Spit.

Highway and road turnouts serve a variety of purposes with scenic and wildlife viewing as primary attractions. DOT&PF should permanently dedicate the four paved turnouts along the CRH as public scenic viewpoints and maintain them as such. In addition, that agency should dedicate similar places along the Cordova Highway (Power Creek Road) in the long range highway maintenance/reconstruction plans. The process recommended to identify appropriate turnouts along this road is a committee composed of a representative from each of the following organizations: Cordova City Council, Cordova Land Coalition, Copper River/Prince William Sound Fish and Game Advisory Committee, and the local Maintenance Supervisor of DOT&PF. The local Maintenance Supervisor should convene this committee immediately upon adoption of this plan, develop the turnout nominations, hold a public hearing, and introduce final nominations into the highway planning process. These turnouts should be permanently dedicated to prevent other uses from conflicting. Nominations recommended in this plan are: 1) the mouth of Hatchery Creek, 2) the salmon spawning hole where the road crosses Hatchery Creek, 3) the stream gauging station on Power Creek, 4) a site adjacent to the spring hole in the lake approximately 1/2 mile southwest of the mouth of Hatchery Creek, 5) the site at the "Elk's Watering Hole", 6) and one at the boat landing beach approximately 1/2 mile beyond the Davis residence. Several of these nominated turnouts could accommodate a modest picnic facility.

Picnic sites will become more important as shoreline development proceeds. For this reason it is recommended that DNR reserve and dedicate the following sites for this use (all these sites are currently State land): the boat landing beach on the north shore; the timbered hill on the lake side of the CRH adjacent to the turnout just west of Mavis Island. The weir access road has been used in the past for picnicking, but the activities connected with it, namely shooting, have posed a danger to residents at Mile 5. Shooting also disturbs the resting waterfowl so it is recommended that DOT&PF barricade the road to prevent vehicle access subject to approval of the landowner on whose land the road exists.

Three boat launching ramps are available on the lake. The wooden, city-owned ramp at Chitina Air Service lease would likely cause difficulty with the critical air taxi operations so this ramp should be officially listed as "off limits" to boats by the City of Cordova. The concrete ramp at the east end of the city airstrip lacks only a small amount of adequate and safe parking space nearby but out of the way of aircraft operations to serve most users. DOT&PF should include this need in their airport master planning effort. The boat landing beach on the north shore currently serves as an unimproved boat launching site and this use should be planned into the DNR picnic site previously mentioned.

Two new boat launching ramps are recommended. The first priority is a ramp located at the southeast corner of Mavis Island causeway which should be included in the site plan for the Mavis Island American Legion lease. This site has the built in feature of adequate parking. The second priority is a ramp at Nirvana Park spit. This facility is recommended for the City of Cordova to include in its capital improvement plan for the park.

Crater Lake Trail, now on State land, is the most popular and heavily used trail in the Cordova area. The State should improve the trail and perform regular maintenance or enter into agreements with the U.S.F.S. and/or the City to accomplish this task. Such agreements may be the best solution as DNR has no permanent physical presence in Cordova. Power Creek Trail is in ANCSA over selection status but remains a public easement managed by the Forest Service. This trail also needs improvement. The Forest Service has placed this project in their program of work for the next five years for maintenance and improvement.

Navigability of the weir by small boats is a desire that has been expressed by many people at the several public hearings held during this study. This plan recommends under the fisheries section, conversion of the weir to facilitate a fish counting structure. Economically, more is at stake with the fishery resource than with navigability of the weir so the priority use goes to the fish. If possible and feasible, it is recommended that navigability be designed and built into the counting structure that is recommended elsewhere in the plan. The Forest Service boat landing on Eyak River will afford sufficient convenience to users that need access to the river.

This plan recommends that ORV use be restricted to the developed roadways in the vicinity of Power Creek Delta and the wetlands from the weir east to the AMSA boundary in order to minimize disturbance to bird life.

Aircraft float plane docking and operations shall be restricted from the open water near the weir and southeast arm during the winter months. This will prevent aircraft from disturbing the eagles, swans and loons.

Overlapping into the AMSA is an area of 4,420 acres that was

proposed by ADNR-Division of Parks as a special area in the Alaska Coastal Zone (OCM,1980). This area rises from the shore of Orca Inlet up the slopes of Mt. Eccles and includes the drainages of Nicolet, Heney, and Eccles Creeks and the city reservoir area, and swings around the mountain to approximately Murchison Falls Creek on the Eyak Lake side. Included in the DNR proposal were proposed management objectives: to preserve the natural beauty of the coast as seen from Cordova homes and roads, and to provide recreation opportunities for Cordova residents, as well as protecting the watershed. These objectives are still valid today. Opportunities for preparing the Mt. Eccles AMSA plan should be explored by the City of Cordova upon completion of the Eyak Lake AMSA.

The scenic quality found within the AMSA is highly acclaimed and revered. Changes in this visual resource are directly related to the degree of vegetative manipulation through activities such as timber harvest, subdivision development, etc. Since the visual quality objective for the area has been designated as "retention" (of the visual character), all applicable land management agencies and corporations, and land developers shall be guided by the following management direction: management activities, i.e., road construction, powerlines, etc. should not be visually evident; any visual impacts created should be mitigated immediately, and activities should be designed with an emphasis to minimize visual impacts. Additionally, timber harvest activities require mitigation plans, both because of the sensitivity of the area and because all such activity would be highly visible.

CHAPTER EIGHT: ISSUES AND CONFLICTS

The following list indicates the present and anticipated conflicts among uses and activities within or adjacent to the study area and was developed with the help of public hearing input during the course of the study. Throughout the course of the field work connected with this study, the majority of these issues and conflicts became obvious. They are grouped below according to the five major categories of this management plan.

WATER QUALITY

A-1 Oil pollution from spills and surface runoff (incipient pollution)

A-2 Raw sewage pollution from direct outfalls and inoperative septic systems

A-3 Suspected power plant oil spill problem

A-4 Road oiling vs. water quality

A-5 Airplane fuel draining and spills vs. water quality

A-6 Land clearing vs. erosion (siltation)

FISHERY PRODUCTION

B-1 Loss of fish spawning habitat from:

- Home building fill
- Road fills
- Airport fill

B-2 Harrassment of spawning fish by direct people disturbance

B-3 Removal of shoreline gravel by local landowners and DOT/PF

B-4 Pushing landslide material into lake from along Power Creek Road

B-5 Development vs. spawning beaches:

- Harassment to spawning fish
- Degradation of spawning environment
- Disruption of ground aquifer

B-6 Possible increase BOD from domestic sewage oxidation that lowers the lake overwinter carrying capacity

B-7 Potential future extreme seismic activity that is predicted for the area will, in all likelihood, alter the lake level.

WILDLIFE HABITAT

C-1 Harassment of swans by hunters, recreational shooting, and ORV's

C-2 Resting gulls interferring with aircraft operations

C-3 Airplanes vs. birds, fish, peace of mind (noise pollution)

C-4 Illegal (indiscriminant) firewood cutting vs. habitat vs. visual quality

C-5 Spreading float plane parking enlarges the conflict area.

C-6 Development in wetlands reduces habitat and alters water movement.

FUTURE DEVELOPMENT

D-1 Gravel extraction from Mile 5 slide area upsetting the underground hydrologic system and triggering mass wasting

D-2 Urban development inevitably encroaches on wildlife habitat

D-3 Sedimentation from land development activities

D-4 Development in stream corridors disrupts surface drainage

D-5 Proposed development of a road around the backside of the lake could adversely impact some resources

D-6 Mining vs. habitat, scenery, siltation, etc.

D-7 Development in geological hazard areas causes life and Property hazard;

Avalanche paths
Floodplains

D-8 Construction not complying w/earthquake and flood protection measures causes property damage and threat to life safety

D-9 Bering coal development (access and transmission line) is a potential significant development

D-10 Copper River Highway link to the Interior is just a matter of time.

RECREATION AND SCENIC VALUES

E-1 Logging or land clearing vs. visual quality and habitat damage

E-2 Power boaters vs. viewers, birds, and peace of mind

E-3 Urban development vs. visual resource vs. access to shoreline

E-4 Shooting vs. public health and safety

E-5 ORV's disturbing wildlife and residents

E-6 Navigability of weir is poor reducing trafficability to and from Eyak River

E-7 Conflicting developments may occur adjacent to scenic highway turnouts so as to reduce their acceptability and usefulness.

CHAPTER NINE

MANAGEMENT SCHEME

The management scheme for the Eyak Lake AMSA is presented here. It the objective and intent of this management scheme to:

1. Utilize existing governmental structures, authorities and regulations to the maximum extent feasible to achieve the objectives of this AMSA Plan.

2. Recognize that existing development and non-conforming uses occur, but such recognition does not imply the allowance of similar uses and activities within the AMSA in the future.

3. Not to arbitrarily or unreasonably exclude or restrict residential uses of private water front land.

The Eyak Lake area is of particular concern because of its unique characteristics. It is an area of significant and valuable natural importance that deserves protection and it is suited for and subject to commercial and economic activities. The various natural systems and man-made influences at work in the area have been described and analyzed elsewhere. In this chapter we deal with the suitability of specific activities and uses in relation to the natural ability of the land to accept those uses without impairment. Any use or activity, whether of public or private property, that is dependent on access to or through the area or would affect habitats and processes, air or water quality, and historical and recreational scenic values, are subject to this Eyak Lake Management Plan. This plan and program does not substitute for, but it does coordinate, compliment, and supplement federal and state land and water management controls affecting the AMSA. Guidance is provided for all land use decisions within the area.

GUIDELINES AND POLICIES

Policies and guidelines pertaining to uses and activities are here delineated and are to be used as a guide in preparing plans for conducting activities or developing uses within the Eyak Lake AMSA. These policies and guidelines will be used to determine the acceptability of the proposal.

The policies were developed on the basis of the stated goals, the inventory data and analysis, and from the identified issues and conflicts. The enforceable policies provide the basic framework for management decisions. All proposed uses and activities should be evaluated to determine if they are consistent with the applicable policies. Within each policy group, there may be individuals which would not be applicable.

Guidelines, since they do not have the "enforceability" of the policies, should be adhered to by the prudent developer to insure

a measure of protection of the resources.

Several of the policies that follow are preceded by the phrase "where feasible and prudent" which means consistent with sound engineering practices and not resulting in economic, social or environmental problems that outweigh the public benefit to be derived from strict compliance with the policy.

Once this plan is adopted, these enforceable policies become state regulations and shall be implemented by state and federal land and water management agencies and the City of Cordova.

"On private lands outside the City limits, some of the policies will be effective through voluntary participation directed somewhat by public sentiment. Policies within the AMSA are voluntary on private lands only as long as state or federal permits or activities are not needed for actions by private individuals. Once permits become required, voluntary participation is no longer applicable."

"All Alaska Coastal Management Program regulations remain in effect, and are a part of this program."

POLICIES WHICH ARE ENFORCEABLE

General Policies

0-1) To utilize existing governmental structures, authorities and regulations to the maximum extent feasible to achieve the objectives of this AMSA management plan.

0-2) Federal and State agencies shall not issue a permit for any activity covered under this Plan, without first notifying the City of Cordova and without first complying with all applicable policies of the AMSA Management Plan.

Water Quality

1-1) In areas with poorly draining soils, development that has sewage or waste (gray water) associated with it shall not be allowed unless connected to a sewer line or connected to a self contained holding type system.

1-2) The natural water circulation patterns in the lake shall be maintained and essential geo-hydraulic processes of accretion, transport, and erosion shall not be interrupted.

1-3) Storm water runoff controls sufficient to prevent water quality degradation shall be imposed on development adjacent to Eyak Lake and adjoining tributaries.

1-4) No development shall take place without providing adequate measures to provide for natural surface drainage runoff.

1-5) Clearing and grading operations shall be conducted in a manner so as to prevent soil erosion and sediment runoff into Eyak Lake and adjoining tributaries. The developer is responsible for utilizing the best available erosion control measures to minimize erosion and sediment runoff during clearing and construction of a proposed project. Prior to completion of a proposed project, the developer will be responsible to submit a plan stating how cleared land will be stabilized to prevent future erosion and sedimentation of the lake.

1-6) Spreading oil or other pollution agents (as defined by EPA for dust control or surface stabilization) shall not be permitted.

1-7) No contaminants shall be discharged into lake and stream waters which would degrade water quality below State or Federal standards.

Fishery Production

2-1) Maintenance and enhancement of fisheries shall be given priority consideration for shorelines. Shorelines having banks,

beaches, and beds critical to the preservation of the fisheries resource base shall be maintained in its productive natural condition.

2-2) A coordinated review shall be required with the local office of ADF&G and appropriate federal and state agencies before any activity in a water body is undertaken.

2-3) Facilities for storing and distributing fuel shall not be located within the active floodplain of a stream.

Wildlife Habitat

3-1) In freshwater marshes and wetlands, maintenance of the natural functions is the highest priority. Development is prohibited except where it will not alter the natural functions or fish and wildlife habitat and where it meets a greater long-term public need.

3-2) All public works activities such as transportation projects, utilities, sewers, and drainage activities shall protect any freshwater marshes and wetlands from adverse impacts.

3-3) Wildlife habitat adjacent to the eastern shore of the lake from the mouth of Hatchery Creek to the ADF&G weir, including the wetland north of the C.R.H. and east to the AMSA boundary, shall be protected from adverse impacts. The resources principally using this habitat are the feeding and resting birdlife and nesting eagles, swans and loons particularly. Management shall maintain or enhance the biological, physical, and chemical characteristics which contribute to the east shore's capacity to support living resources.

3-4) Habitat of swans, eagles and loons shall be protected.

Future Development

4-1) Priority shall be given to water-dependent and water related uses and activities in this AMSA except adjacent to the Cordova Airport, Lake Avenue, LePevre Road, and C.R.H. as far east as Powder House Point, with the exception of residential, subject to local zoning ordinances. Uses and activities that are neither water-dependent nor water-related shall only be allowed if there is no feasible or prudent inland alternative to meet the public need for the use or activity.

Recreation and Scenic Values

5-1) Provide and protect points of recreational and visual access to the shoreline and stream deltas, consistent with public safety and private property rights.

5-2) Off-road vehicles such as snowmachines, airboats, and 3-wheelers are prohibited on the Power Creek Delta, the wetland

adjacent to Southeast Arm, and all lake tributary streambeds, except as necessary for public health and safety and maintenance.

5-3) Off-road vehicles shall be limited to designated routes and/or areas to insure protection of users and resource values, to minimize conflicts.

5-4) Timber harvest activities shall be managed so as to protect the AMSA from adverse visual impacts. Mitigation plans describing how visual impacts will be minimized shall be developed by the land managing agency or land owner, and approved by the land managing agency. Compliance with the mitigation plan is required.

5-5) Utilities shall be installed underground wherever possible.

5-6) Public beach designations, swimming areas, camping sites, toilets, and picnic facilities shall be established and existing facilities improved where public need warrants and public funding is available.

5-7) The State should provide/increase the buffer areas around existing highway turnouts by developing complimentary uses such as picnic sites adjacent to the turnouts and/or restricting uses of adjacent state land so conflicting uses don't arise.

5-8) The following areas and trails shall be retained, classified, and/or managed as recreation resources. (See Figure 16.) The managing agency is shown for each area.

a. boat ramp (City) - east end of runway
b. north shore beach (DNR) - boat launch and picnic area
c. Nirvana Park (City) - picnic and group use
d. The Spit (City) - swimming, picnicking, viewing, floatplane moorage
e. Skater's Cabin (City) - picnic, skating, swimming, trailhead and group use
f. Power Creek stream gaging station (turnout, DOT/PF) - road tournout, informal picnicking, sport fishing
g. Power Creek cable crossing (Eyak) - access
h. Hatchery Creek culvert crossing (Eyak & DOT/PF) - spawning fish and bear viewing
i. Power Creek Road turnouts (DOT/PF) - wildlife and scenic viewing, informal picnicking
j. Power Creek trail (USFS) - hiking and access
k. Crater Lake trail (DNR) - hiking and access
l. CRH turnouts (DOT/PF) - scenic viewing
m. Mavis Island and causeway (DNR) - public recreation
n. Weir access road (Eyak and DOT/PF) - access
o. Eyak River bridge turnout (DOT/PF) - swan viewing, trailhead for Eyak River Trail, scenic point

RECOMMENDED GUILDELINES AND POLICIES FOR EYAK LAKE AREA MERITING SPECIAL ATTENTION

Water Quality

1-1) Upland habitats shall be managed to retain natural drainage patterns and vegetation cover on steep slopes (70% or greater), and along shorelines and stream banks to prevent excessive runoff and erosion, protect surface water quality and natural ground water recharge areas.

Wildlife Habitat

2-1) Birdlife shall be protected from disturbance, especially from discharge of firearms and motorized vehicles and equipment during freezeup conditions in the vicinity of open water near the AF&G weir.

Future Development

3-1) This plan shall not arbitrarily or unreasonably exclude or restrict residential uses of private waterfront land.

3-2) Where feasible and prudent, developments in or over the water, such as piets, docks and protective structures shall be located, designed, and maintained in a manner which prevents adverse impacts upon air and water quality, fish, wildlife, scenic and vegetative resources.

Recreation and Scenic Values

4-1) The State DOT/PF should maintain the identified highway pullouts for scenic and viewing purposes.

4-2) All agencies shall strive to maintain the potential for high quality public recreation in the AMSA by their actions.

4-3) Recreation and access developments shall preserve or enhance scenic views and vistas as well as improve the aesthetic value of the area.

CHAPTER TEN: IMPLEMENTATION

The Eyak Lake AMSA Management Plan is to be implemented through the exercise of existing state and federal regulations and authorities wherever possible. The main purpose for this design is to avoid creating additional regulatory structures.

INSIDE THE CITY LIMITS

The City of Cordova has stringent and positive controls over land use within its corporate boundaries. The City will incorporate the plan policies and specific management direction that applies into its comprehensive development plan, zoning regulations, building codes, etc., and exercise its authority in the usual manner of cities of the Home Rule Class.

City annexation of the land and water area in the AMSA is the only sure strategy that will insure consistent handling of all uses and activities both inside and outside the City and insure residents the most certainty as to the future of the Eyak Lake area. This AMSA Management Plan recommends an annexation process to be initiated by the City upon adoption of the plan by the Coastal Policy Council. As a minimum, annexation should include all the land within the Eyak Lake AMSA. In addition, the entire drainage basin of Eyak Lake and the other watersheds that feed the community's water withdrawal points should be included. As an option, Cordova can protect its water sources through extra-territorial powers granted them by the State (AS 29.48.037). Adoption of a special watershed management ordinance would be the most appropriate way to protect an extra-territorial water source (ADCRA, ADEC, 1983).

CITY CONSISTENCY REVIEW PROCEDURE INSIDE CITY LIMITS

The following consistency review procedure will be adopted by the City of Cordova following approval of this plan by the Coastal Policy Council:

I. Applications for project review are received by the City Clerk, logged and dated. After processing they are forwarded to the Development Coordinator.

II. Development Coordinator reviews application, requests additional information from applicant within 7 days if necessary and completes the Checklist for Consistency Recommendations. (See Appendix G for checklist.)

III. After initial review, the application is routed as follows:

A. Local Permits

1. For applications not requiring Planning and Zoning Commission action, authorization resides with the Development Coordinator.

2. For applications requiring Planning and Zoning Commission action, the Development Coordinator prepares findings and recommendations and schedules hearing before the Commission.

B. State and Federal Project Review

1. For projects not requiring Planning Commission review, the Development Coordinator determines consistency of project with Eyak Lake AMSA Management Program using the consistency checklist, and forwards completed determination to City Manager for approval.

2. For uses and activities, subject to Planning Commission review, the Development Coordinator prepares written findings and schedules hearings before Commission. Planning Commission makes final determination.

OUTSIDE THE CITY LIMITS

Until such time as annexation is finalized, the following process will be followed on lands outside the City:

State and federal agencies that have management jurisdiction in the AMSA shall exercise their mandated authorities as they pertain. The agencies will implement the policies and the specific management direction in this plan and be guided therefrom in both conducting their agency affairs and in permitting any uses that come under their purview. In other words, the agencies must incorporate the provisions of this plan as an additional set of rules under which they exercise their existing regulatory authorities (AS 46.40.090(a), AS 46.40.200).

The City of Cordova will provide written comments with respect to consistency with this program for all projects which have the potential of significant impact on the resources of the AMSA. The City will make the advisory consistency recommendations citing mitigating technology which it has determined to be effective in reducing the impact the project could have. The City will also be an active participant in local land management agency planning efforts. On private land outside the City Limits some of the policies will be effective only through voluntary participation directed somewhat by public sentiment. Policies in AMSAs are voluntary on private lands only as long as State or federal permits or activities are not needed for actions by private individuals. Once permits become involved, voluntary participation is no longer applicable. The issues and conflicts reflect, in many cases, competition for scarce resources. In dealing with the issues and resolving the conflicts it is expected that there will be tradeoffs between resource development and protection to achieve the balance necessary to allow human presence on the land.

IV. Review Timeframe. For projects which fall within the State project consistency review procedures (6AAC 50), the City will follow the established schedules and review deadlines.

V. Monitoring Procedures. It is the responsibility of the Development Coordinator to monitor development activities within the district to ensure compliance with the coastal management plan. Periodic field inspections of State, Federal, and City development projects will take place. As well, the Development Coordinator will monitor other development projects for compliance with the plan during routine field checks.

VI. Enforcement Procedures. Violations of the Eyak Lake AMSA Cooperative Management plan will be reported to the City Manager. Appropriate action will be determined by the City Manager and may take the form of one or more of the following actions:

A. Informal resolution of the problem with affected parties.

B. Legal or other appropriate action in conjunction with enforcement of local codes, ordinances or regulations.

C. Legal or other appropriate action separate from enforcement of another local code, ordinance, or regulation.

D. Reporting violation to State or federal agency for agency enforcement.

APPENDIX A: HUMAN USE SURVEY RESULTS

A survey of Cordova residents and visitors was carried out during the summer of 1982 in order to ascertain attitudes toward water quality, fish and wildlife, recreation, urban development, scenery and other values associated with Eyak Lake; to determine those areas around Eyak Lake which people thought to be most important; to find out what attitudes were toward urban development around the lake; and to pinpoint the use of Eyak Lake and immediately adjacent areas for the range of recreation and hunting activities.

A total of 104 persons were surveyed, of whom all but 6 were local residents. Excluding 2 persons who did not respond, the two sexes were equally represented. More than two-thirds (69.1 percent) of the local people interviewed had lived in Cordova for more than 10 years or all of their lives, although only 17.3 percent lived in homes which fronted onto Eyak Lake or were located immediately across the street from the lake.

A disproportionately high percentage (91.3 percent) of persons interviewed were white. By occupation, farming, fishery, forestry and related occupations (i.e., fishermen) was the major group interviewed, accounting for 23.1 percent of the total. This group was followed by those in professional, technical and managerial occupations (18.3 percent), clerical and sales occupations (15.4 percent) and structural work occupations (7.7 percent). However, 21.1 percent of the people surveyed were not in the labor force, either because they were housewives or were retired. Finally, of the 71 persons who responded to the questionnaire, the median household income was in the vicinity of $40,000 in 1981, with more than one-quarter (26.8 percent) reporting a household income in excess of $50,000 for for that year.

When asked to indicate if they considered water quality, fish and wildlife, recreation, urban development, scenery or other values to be the most important in relation to Eyak Lake, most people selected fish and wildlife (42.3 percent) or water quality (35.6 percent). When asked why they had selected these particular values first, people who had answered "fish and wildlife" most often cited the fact that the lake was a salmon spawning area or that it was essential to the area's commercial salmon fishery. Those who answered "water quality" for the most part said that they did so because all of the other values associated with the lake were dependent on water quality.

People were also asked to indicate which of the same values they considered to be the least important in relation to Eyak Lake. By far the most frequently cited (56.7 percent) was "urban development". Those who gave this response said that they did so because other areas were available for urban development or that urban development was not necessary in this area. They also said that they thought that other values associated with the lake were more important and that urban development, in their opinion, could

destroy those values. Others cited pollution resulting from urban development.

When asked what part of the scenery around Eyak Lake was most important to them, respondents gave both general answers such as the whole area and the mountains and answers which listed specific locations. Of the latter, the most frequently mentioned were Power Creek/Hatchery Creek, the Eyak River bridge area, Queen's Chair and Middle Arm.

People were also asked questions specifically relating to their views on the subject of urban development around Eyak Lake. When asked if they would like to see more or less development around the lake than there is today or if they would prefer that it remain about the same, most (54.8 percent) said that they preferred the status quo. About one-fifth of the respondents (20.2 percent) said that they would prefer less urban development around the lake, with only 19.2 percent saying that they would like to see more. The remaining respondents either had no opinion on the subject or did not answer the question.

When people who had indicated that they would like to see less development around Eyak Lake were asked their reason for this, the largest number of responses reflected concerns about pollution. Those who wanted to see more development around the lake said that they would like to see only a limited amount of additional urban development here or simply said that land was available and the community needed room for expansion.

To ascertain the use of Eyak Lake and immediately surrounding areas for outdoor recreation-related activities, people were asked to indicate if they used this area often, sometimes or never for a total of 25 different activities. Of a total of 96 respondents (i.e., excluding the 6 visitors surveyed), 69 said that they often observed scenery, 63 said that they often observed Trumpeter swans and 62 said that they often drove for pleasure in this area. Observing fish spawning, ice skating, photography, sport fishing, bird watching, picnicking, berry picking, boating and walking for pleasure were also cited by more than 20 respondents as activities in which they often participated in this area.

People were also questioned about there participation in hunting, fishing, trapping and other food gathering activities in the Cordova area in 1981 and the proportion of these activities which had taken place in the immediate vicinity of Eyak Lake. The specific activities included bear, deer and goat hunting, trapping, berry picking and cutthroat trout, whitefish and Dolly Varden fishing. Of these activities, only berry picking and cutthroat trout and Dolly Varden fishing activities were significant in the immediate vicinity of Eyak Lake.

Finally, people were asked if they or others in their household had used two specific facilities -- the Christian Center Beach at Mile 5 of the Copper River Highway and the Skater's Cabin on Eyak

Lake -- during the past year. Of the 83 people who responded, 26 or 31.3 percent said that they or someone in their household had used the Christian Center Beach during the past year. Exactly half of the 94 people who answered the same question relating to the Skater's Cabin, said that they or someone in their household had used that facility sometime during the past year.

In summary, the people who answered the Eyak Lake survey felt strongly that the water quality and fish and wildlife values of this area should be preserved, did not want to see additional urban development taking place here and valued the area's recreational assets.

APPENDIX B: REFERENCE

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APPENDIX C: ABBREVIATIONS

ADC&RA	Alaska Dept. of Community & Regional Affairs
ADEC	Alaska Dept. of Environmental Conservation
ADF&G	Alaska Dept. of Fish and Game
ADMA	Alaska Dept. of Military Affairs
ADNR	Alaska Dept. of Natural Resources
ADOT/PF	Alaska Dept. of Transportation & Public Facilities
AMSA	Areas Meriting Special Attention
CRH	Copper River Highway
OCM	Alaska Office of Coastal Management
USDC	United States Dept. of Commerce
USDHUD	United States Dept. of Housing & Urban Development
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USF&WS	United States Fish and Wildlife Service
USGS	United States Geological Survey
Weir	ADF&G Weir at Eyak Lake outlet - Mile 5-1/2 CRH

APPENDIX D: WATER SAMPLING DATA

TABLE 1. EYAK LAKE BOD's (mg/L). $\bar{X}$ = MEAN CONCENTRATION, s = STANDARD DEVIATION, n = NUMBER OF OBSERVATIONS (1981-82)

Station	12/16	2/22	3/25	4/16	$\bar{X}$	s	n
1A		2.1	1.4	1.1	1.53	0.51	3
1	0.55	3.4	0.3	1.3	1.39	1.41	4
1B		1.4	0.9	1.3	1.20	0.26	3
2	3.9	1.0	1.4	0.6	1.73	1.49	4
3	1.63	1.3	1.2	1.2	1.33	0.20	4
4A		3.5	1.0	0.7	1.73	1.54	3
4	2.95	1.5	1.1	0.5	1.56	1.02	4
4B		0.10	1.6	1.0	0.90	0.75	3
5	1.95	4.7	0.4	0.9	1.99	1.92	4
6A							
6	1.75			0.9	1.33	0.60	2
6B		0.4					
7A		2.1					
7	1.6	3.2	0.4	0.6	1.45	1.28	4
7B		1.3					
8A		1.2	0.6		0.90	0.42	2
8	1.75		1.0	0.5	1.08	0.63	3
8B			1.1				
9	1.15	1.5	1.4	0.8	1.11	0.30	4
10	1.65	1.9		0.7	1.22	0.48	3
11	0.30	3.7	0.6	0.5	1.28	1.62	4
12	1.15	2.5	0.2	1.0	1.21	0.95	4
13	0.7	3.8	0.2	0.9	1.40	1.63	4
14	1.55		0.6	0.8	0.98	0.50	3
15			0.7	0.6	0.65	0.07	2
16A			0.3				
16	6.3		0.7	0.7	2.57	3.23	3
16B			0.7				
17A							
17	0.6		0.1	0.5	0.40	0.26	3
17B							
18	0.45		0.4	0.7	0.52	0.16	3
19A			0.6				
19	0.75		0.1	0.8	0.62	0.28	3
20	0.85	5.3	0.1	0.9	1.78	2.37	4

BLE 2. RYAN LAKE, DISSOLVED OXYGEN (mg/L), TEMPERATURES (°c)

DEPTH (FT.)

(12/15-16/81, 4/14/82)

ication	D.O. Top	D.O. Bottom	°c Bot.	SAT	°c Top	SAT	Depth
1A	12.4	11.1	3.0	13.5	2.0	13.8	
1	12.1	11.2	3.0	13.5	0.0	14.6	3
1B	11.5	11.3	3.0	13.5	0.0	14.6	
2	8.8	10.3	0.0	14.6	0.0	14.6	4
3	13	12.5	3.0	13.5	1.0	14.2	6
4A	12.2	11.8	3.0	13.5	1.0	14.2	
4	6.0	11.0	3.0	13.5	1 0	14.2	7
4B	5.0	12.1	4.0	13.1	1.0	14.2	
5	5.0	10.0	3.0	13.5	1.0	14.2	
6)Dry							2
7)Dry							1
8	7.2	10.1	3.0	13.5	1.0	14.2	7
9A	9.1	10.2	4.0	13.1	1.0	14.2	
9	7.9	10.2	4.0	13.1	1.0	14.2	7
9B	8.8	11.0	4.0	13.1	0	14.6	
10	9.0	9.6	3.0	13.5	1.0	14.2	7
11	9.0	10.8	4.0	13.1	1.0	14.2	7
12	10.6	9.8	5.0	12.8	2.0	13.8	8
13	9.8	10.4	4.0	13.1	2.0	13.8	1
14A	12.3	12.2	5.0	12.8	1.0	14.2	
14	10.6	10.0	4.0	13.1	0	14.6	6
14B	14.0	11.4	4.0	13.1	0	14.6	
15	11.8	11.2	3.0	13.5	0	14.6	6
16	11.8	8.8	3.0	13.5	1.0	14.2	3
17	12.0	12.4	1.0	14.2	1.0	14.2	4
18	12.8	10.6	4.0	13.1	0.0	14.6	1
19	12.0	11.0	3.0	13.5	0.0	14.6	1
20	11.9	12.0	1.0	14.2	1.0	14.2	2

$\bar{X}$ = 10.34	$\bar{X}$ = 10.89	$\bar{X}$ = 3.23	$\bar{X}$ = 0.77
s = 2.57	s = 0.93	s = 1.14	s = 0.65
n = 26	n = 26	n = 26	n = 26

TABLE 3. PRIORITY POLLUTANTS (mg/L), TURBIDITY (NTU's)

UNITS mg/L	STATIONS SAMPLED 12/15 - 16/81										LOWER LIMIT OF QUANTIFICATION
	2	4	6	8	10	12	14	16	18	20	
As	ND	ND	ND	TR	ND	ND	ND	0.005	ND	ND	0.005
Ba	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	0.200
Cd	0.002	0.001	TR	TR	TR	ND	TR	0.003	ND	ND	0.001
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Fe	0.12	TR	0.27	0.14	0.14	TR	TR	0.026	0.110	1.100	0.100
Pb	ND	ND	ND	ND	ND	ND	ND	0.006	ND	ND	0.005
Mn	0.017	TR	0.064	0.024	0.010	ND	ND	0.016	TR	0.043	0.005
Hg	ND	ND	ND	ND	ND	ND	ND	ND	TR	ND	0.001
Se	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.003
Ag	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.003
Na	TR	TR	TR	TR	TR	ND	ND	TR	TR	TR	0.030
NO_3	ND	ND	TR	ND	TR	ND	ND	ND	TR	ND	1.000
$O\text{-}PO_4$	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.500
TURB	0.34	0.57	0.50	0.67	0.85	0.20	0.32	0.57	0.35	1.5	
TWFR	9.1	8.7	4.0	5.0	4.6	5.6	7.1	9.4	2.0	7.5	
TTHM	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

ABLE 3. (Con't) PRIORITY POLLUTANTS (mg/L), TURBIDITY (NTU's)

	STATIONS										
UNITS mg/L	STATIONS SAMPLED 4/14/82										LOWER LIMIT OF QUANTIFICATION
	2	4	6	8	10	12	14	16	18	20	
As	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.005
Ba	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.200
Cd	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.001
Cr	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.005
Fe	0.34	0.22	DRY	0.46	0.12	ND	0.13	0.11	ND	0.31	0.100
Pb	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.005
Mn	0.071	0.015	DRY	0.050	0.250	0.029	0.008	0.032	0.022	0.041	0.005
Hg	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.001
Se	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.003
Ag	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.003
Na	ND	ND	DRY	ND	ND	ND	ND	ND	ND	ND	0.030
NO_3	<0.05	<0.05	DRY	<0.05	<0.05	0.06	0.07	<0.05	0.05	0.01	0.050
$O\text{-}PO_4$	<0.05	<0.05	DRY	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.500
TURB	1.7	1.4	DRY	3.9	0.7	0.6	0.4	0.6	0.6	3.2	
TWPR	6.0	8.0	DRY	8.0	7.0	7.0	8.0	8.0	10.0	13.0	

TABLE 4. E.P.A. MAXIMUM PRIORITY POLLUTANT CONCENTRATIONS (UNITS Mg/L)

ELEMENT	DRINKING WATER	AQUATIC LIFE
Arsenic (As)	0.050	———
Barium (Ba)	1.000	———
Cadmium (Cd)	0.010	(Soft water) 0.00004 (Salmonids & Cladocerans)
Chromium (Cr)	0.050	0.100
Iron (Fe)	0.300	1.000
Lead (Pb)	0.050	0.01 times 96 hr L.C. 50
Mercury (Hg)	0.002	0.050
Manganese (Mn)	0.050	———
Selenium (Se)	0.010	0.01 times 96 hr L.C. 50
Silver (Ag)	0.050	0.01 times 96 hr L.C. 50
Nitrate (NO_3)	10.000	———

BLE 5. FECAL COLIFORM ANALYSIS.

(12/15-16/81, 4/14/82)

STATION	RESULT	STATION	RESULT
1 A	NEGATIVE	9 B	POSITIVE
1	NEGATIVE	10	NEGATIVE
1 B	POSITIVE	11	NEGATIVE
2	NEGATIVE	12	NEGATIVE
3	NEGATIVE	13	NEGATIVE
4 A	NEGATIVE	14 A	NEGATIVE
4	NEGATIVE	14	NEGATIVE
4 B	NEGATIVE	14 B	NEGATIVE
5	POSITIVE	16	NEGATIVE
6	POSITIVE	17	NEGATIVE
7	NEGATIVE	18	NEGATIVE
8	POSITIVE	12	NEGATIVE
9	NEGATIVE	20	NEGATIVE

TABLE 6. EYAK LAKE SAMPLING RESULTS
BOD's, D.O. (mg/l)
4-13-82

Station #	Temp. C Bottom	Temp. C Top	D.O. Bottom	D.O. Top	BOD_5
1A	2	3	12.4	11.1	11.1
1	3	0	12.1	11.2	1.3
1B	1	0	Sat.	11.3	1.3
2	0	0	8.8	10.3	0.6
3	3	1	13.0	12.5	1.2
4A	3	1	12.2	11.8	0.7
4	3	1	6.0	11.3	0.5
4B	4	1	5.0	12.1	1.0
5	3	1	5.0	10.0	0.9
6	-	-	day	-	0.8
7	-	-	day	-	0.6
8	3	1	7.2	10.3	0.5
9A	4	1	9.3	10.2	-
9	4	1	7.9	10.0	0.8
9B	4	0	8.8	11.0	0.9
10	3	1	9.0	9.6	0.7
11	4	1	9.0	10.8	0.5
12	5	2	10.6	9.8	1.0
13	4	2	9.6	10.4	0.9
14A	5	1	12.3	12.2	0.3
14	4	0	10.6	10.6	0.8
14B	4	0	14	11.4	0.4
15	3	0	11.8	11.2	0.6
16	3	1	11.8	8.8	0.8
17	1	1	12.8	12.4	0.5
18	4	0	12.9	10.6	0.7
19	3	0	12	11.0	0.8
20	1	1	12	12.0	0.9
Rockslide	2	4	0.2	11.2	

TABLE 7. EYAK LAKE SAMPLES
DISSOLVED OXYGEN
8-18-82

Station #	Temp. (C) Bottom	Temp. (C) Top	DO (mg/l) Bottom	DO (mg/l) 1' Depth
1.	10	12	13.8	13.0
2.	11	12½	13.1	12.6
3.	15	15	10.5	10.3
4.	15	15.5	10.2	10.3
5.	16	16	10.5	10.4
6.	15	16	10	10.4
7.	16	16	9.4	9.8
8.	15.5	16	9.8	9.6
9.	16	16.2	10.1	9.9
10.	16	16	10	10.2
11.	15.5	15	10.7	10.8
12.	16	16	10.2	10.7
13.	15.6	16	9.8	9.8
14.	16	16	10.8	12.0
15.	16.5	16.5	10.3	10.4
16.	14	15	11	11.2
17.	14	14.5	10.2	10.6
18.	13	15	11.1	11.8
19.	14.5	15	11.2	11.5
20.	15	15	11.2	11.3

TABLE 7. (Con't) EYAK LAKE SAMPLES
DISSOLVED OXYGEN
9-8-82

Station #	Temp. (C) Bottom	Temp. (C) Top	DO (mg/l) Bottom	DO (mg/l) 1' Depth
1.	7	6.5	11.8	11.3
2.	7	7	11.3	11.2
3.	11	11	10.8	10.8
4.	11	10	10.8	11.0
5.	11	11	11.2	11.0
6.	11	10	10.8	10.8
7.	11	11	10.5	10.5
8.	11	11	10.5	10.5
9.	11	11	10.8	10.7
10.	11	11	10.8	10.8
11.	11	11	10.8	10.3
12.	11	11	11	10.8
13.	10.5	10	9.8	9.6
14.	10.5	10.5	10.6	10.6
15.	11	11	10.4	10.4
16.	10.5	10	10.8	10.9
17.	10	9.5	11.0	9.6
18.	10	8.5	11	10.6
19.	10	10	11.2	11.0
20.	10	10	11.2	11.2

TABLE 8. EYAK LAKE SAMPLES
HEAVY METALS
9-8-82

Station #	Lead	Cadmium	Manganese
1.	<5	<2	44
2.	"	"	105
3.	"	"	<10
4.	59	<2	<10
5.	<5	<2	10
6.	<5	<2	38
7.	"	"	70
8.	"	"	57
9.	"	"	13
10.	"	"	<10
11.	"	"	"
12.	"	"	"
13.	"	"	"
14.	"	"	"
15.	"	"	"
16.	"	"	21
17.	"	"	22
18.	"	"	22
19.	"	"	21
20.	"	"	23

units micrograms/liter

TABLE 9. EYAK LAKE SAMPLES
FECAL COLI TEST RESULTS

Station#	4-17-82	7-1-82	7-27-82	8-19-82	9-8-82	10-10-82	11-12-82
1A	+						
1	-	+	-	-	+(6)	38	
1B	+						
2	-	+	+(2)	(2)	+(7)	1	2
3	-	+	-	-	+(2)	51	1
4A	-						
4	-	+	-	-	+(6)	8	1
4B	-						
5	+	+	-	-	+(31)	53	3
6	+	+	-	-	+(59)	27	3
7	+	+	-	-	+(56)	37	3
8	+	+	-	-	+(43)	245	4
9	-	+	-	(2)	+(25)	84	3
9B	+						
10	-	+	+(244)	-	+(29)	14	0
11	+	+	-	-	+(16)	10	3
12	+	-	-	-	+(29)	5	0
13	+	-	-	-	+(11)	4	0
14A	+						
14	+	+	+(6)	-	+(5)	0	0
14B	+						
15	+	+	-	-	+(2)	3	0
16	+	+	+(1)	-	-	0	0
17	+	+	-	-	-	1	0
18	+	+	-	-	+(1)	33	0
19	+	+	-	-	+(18)	13	0
20	+	+	-	-	+(8)	4	0

+ indicates positive coliform presence
- indicates negative coliform presence
numbers represent coliform count per 100 ml sample

Area Precipitation (sample date + two days previous)

.03	.82	.12	.02	1.9	2.7

TABLE 10. PRECIPITATION DATA
CORDOVA FAA

DAY	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
1	0	T	0	.18****	0	.01	.44	1.54
2	0	0	0	0	0	.20	.06	.29
3	0	0	0	0	.02	.05	.47	.82
4	0	0	0	.65	0	.02	.01	.92
5	0	0	0	.24	0	1.95	T	0
6	0	.08	0	0	.03	1.89	.46	0
7	0	0	T	.07	.31	.01	.66	0
8	.13	.12	.02	.05	1.38	0****	.60	.54
9	.02	.56	T	.01	.10	.06	1.74	0
10	.05	.44	.08	.37	.01	.06	.32****	0
11	0	.37	.71	T	.12		0	0
12	0	.0	.32	.20	0		.03	0****
13	0	.16	.11	0	T		2.01	.60
14	.32	.57	.29	.01	.10		1.57	0
15	0	.30	.23	.17	.15		2.31	0
16	.03	0	.28	.64	T		0	
17	T****	.21	.77	.07	.01		.64	
18	T	.31	.07	.01	.01		2.21	
19	.22	.05	.13	.01	0****		2.87	
20	.82	.12	.87	0	0		.19	
21	.58	.02	.21	.23	0		.89	
22	.01	0	.02	.17	.03		.96	
23	0	-	0	1.35	.28		0	
24	.02	.09	0	.19	.12		0	
25	.22	0	.32	.12	.08		0	
26	.99	T	0	T	0		.63	
27	.33	T	0	0****	1.22		.02	
28	.50	.15	.01	T	.98		.23	
29	.18	0	.62	1.55	1.04		.45	
30	.10	0	.02	.80	.95		.55	
31	T	0	-	.01	-			

***denotes sample collection date

APPENDIX E: AQUATIC PLANT SPECIES LIST

Species	Common Name
Callitriche sp. (hermaphroditica L.)	Water Starwort
Carex kelloggii W. Boott	Sedge
carex saxatilis L. subsp. laxa (Trautv.) Kalela	Sedge
Carex sitchensis Prescott	Sedge
Chara Sp.	Stoneplant
Elodea canadensis Richard in Michx.	Frog's-Bit
Fontinalis antisyretica Hedw.	Water Moss
Gramineae sp.	Grass
Isoetes muricata Dur.	Quillwort
Juncus articus Willd.	Rush
Myriophyllum spicatum L.	Water Milfoil
Nuphar polysepalum Engelm.	Western Yellow Pond-Lily
Potamogeton perfoliatus L. subsp. richardsonii (Bennett) Hult.	Pondweed
Ranunculus trichophyllus Chaix.	Water Crowfoot
Sparganium angustifolium Michx.	Bur-reed

APPENDIX F

SUMMARY OF RECOMMENDATIONS BY IMPACTED AGENCY

The following recommendations listed by agency grouping is a compilation of the recommendations that appeared in the various chapters in this plan. It must be emphasized here that these are recommendations only and not agency directives. Aside from the value of the enforceable policies, the carrying out of these recommendations would do much to fulfill the goals of this plan.

EYAK CORPORATION

1. Consider the establishment of regulations which prohibit ORV's from using Power Creek Delta and the wetland adjacent to Southeast Arm.

2. Revise cutting regulations/policy (firewood) and issue only conditional permits in areas where cutting influences habitat.

CITY OF CORDOVA

1. Establish a lease requirement on City-leased land in the AMSA for on-site storage of waste oils.

2. Develop ways and means of collection and disposal of petroleum wastes and institute such a program.

3. Institute an annexation program consistent with the dedication to maintain the integrity of Eyak Lake and the aquifer system feeding the lake and the outlet stream.

4. Continue to redevelop and maintain Nirvana Park and Spit to serve the community's recreation needs including a boat ramp on the Spit placed in the capital improvement plan for the Park.

5. The wooden ramp at the Chitina Air Service lease site "off-limits" to boats.

ALASKA DEPARTMENT OF FISH AND GAME

1. Modify the weir to allow for greater control of the lake level and provide a structure for counting adult migrating fish and, if possible and feasible, design navigability into the weir.

2. A smolt weir should be considered to collect the data necessary in the determination of optimum escapement levels.

3. Smolt marking should be conducted to facilitate the determination of marine survival rates and harvest areas.

4. Monitor the food habits of sockeye and Coho salmon as well as Dolly Varden in conjunction with plankton and benthic food studies to facilitate the determination of lake carrying capacity.

5. With the CR/PWS Fish and Game Advisory Committee, prepare and submit to the Board of Game proposals addressing the concept of Eyak Lake ANSA as a bird sanctuary.

6. Conduct an education program prior to and during spring herring seining season with the objective to prevent spotter planes from using the open water at the weir area for operations (which disturbs the swans).

7. Study the feasibility of amending AS 16.05; 5AAC 95 to include underground aquifers in the regulations.

8. With CR/PWS Fish and Game Advisory Committee, submit proposals to the Board of Fish to close Eyak Lake tributaries to cutthroat fishing.

9. Cooperate with ADEC in a phytoplankton study.

AK DEPARTMENT COMMUNITY AND REGIONAL AFFAIRS

1. Provide technical assistance to the City of Cordova in pursuing funds to document the existing shoreline, both already developed and expected to be developed, with a series of photographs and field notes for encroachment control.

AK DEPARTMENT OF ENVIRONMENTAL CONSERVATION

1. Conduct a minimum of twice-yearly sampling for fecal coliform (during spring thaw and in fall prior to lake freeze-up).

2. Continue monitoring for heavy metals and attempt to determine the source or sources of cadmium and lead.

3. Do core sampling of lake bottom sediment:

   a. To determine the rate and area extent of sediment buildup to predict the aging of the lake

   b. Sample sediment for total phosphorous as a factor in determining the current trophic status of the lake (this information in conjunction with a measure of the primary productivity of the lake and the members of the phytoplanktonic community would be invaluable in determining the current trophic status of the lake)

4. Sample and key out the phytoplankton in cooperation with ADF&G.

5. Continue monitoring of lake water to develop trend data on DO and BOD and track the relationship between fecal coliform and various control measures. Efforts should be concentrated in late winter and when the lake is snow covered.

6. Conduct a joint study with Cordova Electric Cooperative on the suspected pollution of lake waters originating from the power plant, to determine the extent of the problem, if any, and outline the steps necessary to alleviate it either directly or through mitigating measures.

7. Furnish recommendations for suitable storage containers and other applicable requirements for a waste oil collection system.

8. Establish a moratorium on issuing permits for surface oiling anywhere in the Eyak Lake AMSA.

9. Within one year of the adoption of this plan, complete an inspection of all private septic systems with a follow-up listing requirements for those systems not in compliance and time constraints on the requirements.

10. With the City of Cordova, develop procedures to identify and clean up point and non-point pollution sources within the City Limits.

11. Collect baseline water quality data from Eyak Lake.

12. Assist the City to develop a set of required procedures for the water treatment plant to reduce the potential for lake pollution.

AK DEPARTMENT OF MILITARY AFFAIRS

1. Encourage appropriate federal and state agencies to improve information on types and locations of hazard areas in the AMSA.

2. Instigate a study to determine the feasibility of a second outlet from Eyak Lake to reduce flood flows.

AK DEPARTMENT OF NATURAL RESOURCES

1. Retain for long-term public recreation use, Mavis Island and Causeway with the addition of a boat launching ramp near the southeast corner of the causeway.

2. Dedicate the following sites in agency planning as public picnic sites:

   a. boat landing beach on the north shore;

   b. the timbered hill on the lake side of the CRH adjacent to the turnout just west of Mavis Island.

3. Develop and implement a trail maintenance program for Crater Lake Trail in conjunction with the City of Cordova and the U.S.F.S.

4. Revise cutting regulations/policy (firewood) and issue only conditional permits in areas where cutting influences habitat.

5. Restrict float plane docking and operations to basically the west half of the lake.

6. With the City and the Eyak Corporation, develop off-road vehicle (ORV) regulations for the area within the AMSA.

AK DEPT. OF TRANSPORTATION AND PUBLIC FACILITIES

1. Institute a lease requirement for on-site storage of waste oil on all property in the AMSA leased by this agency.

2. Permanently dedicate the four paved turnouts along the CRH as public scenic viewpoints and maintain them as such either through the normal budget process, cooperative agreement, or another adequate method. In addition, provide for buffer zones around the turnouts to prevent conflicts.

3. The local Maintenance Supervisor with a representative from each of the following organizations -- Cordova City Council, Cordova Land Coalition, and CR/PWS Fish and Game Advisory Committee -- should, upon adoption of this plan, develop nominations for scenic turnouts along the Cordova Highway (Power Creek Road), hold a public hearing, and introduce final nominations into the highway planning process to be permanently dedicated as scenic turnouts.

4. Barricade the weir access road to prevent vehicle access subject to approval of the landowner.

5. Include in the Cordova Airport Master Plan adequate and safe parking space for users of the concrete boat ramp at the west end of the City Airstrip.

6. Coordinate road maintenance and reconstruction with ADF&G so that roadfill that might enter the lake can be directed to suitable sites.

7. Investigate the possibility of paving Power Creek Road from the intersection of Lake Avenue and LePevre to Chisum's.

U.S. FOREST SERVICE

1. Place Power Creek Trail maintenance in future recreation work plans and budgets.

COMBINED EFFORTS

1. City of Cordova, DCRA, DEC, and DHSS conduct a joint feasibility study and public awareness program during FY 1985 to determine feasibility, construction costs, economic cost/benefits for a sewer collection and/or water distribution system

extension along the Copper River Highway to Mile 6 and the along Power Creek Road to the City limits.

2. City of Cordova, ADF&G, DEC, and DNR conduct a hydrology study to ascertain the impact of excavation on the underground flow of water from the upland areas to near-shore spawning areas.

3. City of Cordova, Eyak Corporation, DNR, and USPS prepare a joint study plan on potential management of the land adjacent to the east shore of the lake, considering such possibilities as cooperative management plans, land trades, etc., that would protect the identified values.

4. Permitting agencies should review development proposals and, where necessary require hydrological investigations attesting to specific engineering practices and structures that would alleviate or mitigate the problem.

APPENDIX G

EYAK LAKE AMSA COOPERATIVE MANAGEMENT PROGRAM CHECKLIST FOR CONSISTENCY RECOMMENDATIONS

1. Who is the applicant for the proposed action?

_____
(name of developer)

2. Who is the reviewing agency?

_____
(Name of State or Federal Agency)

3. For State and Federal actions, when is the district's recommendation due to the agency?

Date_____, 19____.

If district cannot respond within the required timeframe, the agency should be contacted and an extension requested.

Extension Date_____, 19____.

4. For local actions, when is a local decision on the application required to be complete?

Date_____, 19____.

5. What is the action that is being proposed? (Give a brief description, such as "widening of road" or "construction of hydroelectric facilities.")

_____
_____
_____

6. Where is the proposed action located?

____Saltwater shoreline segment of the district.

_____
(Identify location)

____Eyak Lake interim management segment.

_____
(Identify location)

____Area meriting special attention.

_____
(Name)

7. In what management unit is the proposed action located?

____Preservation
____Conservation
____Development I
____Development II
____Eyak Lake Management Area

8. What type of use or activity is proposed?

____Business & Commercial
____Marine Services
____Transporation Facility
____Utilities
____Port & Industrial
____Residential
____Landfill
____Piers/dock
____Shore Defense Works
____Offshore Facilities
____Business Signs on Premises
____Other

9. Is the type of use or activity permitted, not permitted, or permitted under specific circumstances in the management unit? (Reference Table 3.1.)

____Permitted
____Not Permitted
____Permitted as accessory use
____Permitted, if conditions specified on Page 3.13 of the CCMP are satisfied (requires Planning Commission review at a public hearing).

10. If the proposed use is not specific in Table 3.1, does it meet the criteria for a permitted use provided on Page 3.13? (Requires Planning Commission review at a public hearing.)

____Yes ____No

11. Is the action consistent with the policies applicable to the type of activity and the Management Unit affected?

____Yes ____No

If not consistent, reference the specific policy(ies) with which the action is not consistent and describe why the action is inconsistent. Cite the policy statement and reference number. Reference any pertinent resource information used in the determination of inconsistency and provide page and/or map references for the inventory data.

References_____
_____
_____

12. Is the action consistent with the management plan for an area meriting special attention in which the action is located?

____Yes ____No

If not, with which elements of the management plan is the proposed use inconsistent?

_____

_____

13. What is the district's consistency determination for the proposed action?

____Consistent with coastal management program.
____Consistent with coastal management program, if stipulations are applied (refer to question 13).
____Inconsistent with coastal management program.

14. Based on the evaluation of consistency conducted in items 10 and 11, what changes or conditions does the district recommend that may resolve conflicts and make the action consistent with the coastal management program?

_____

_____

_____