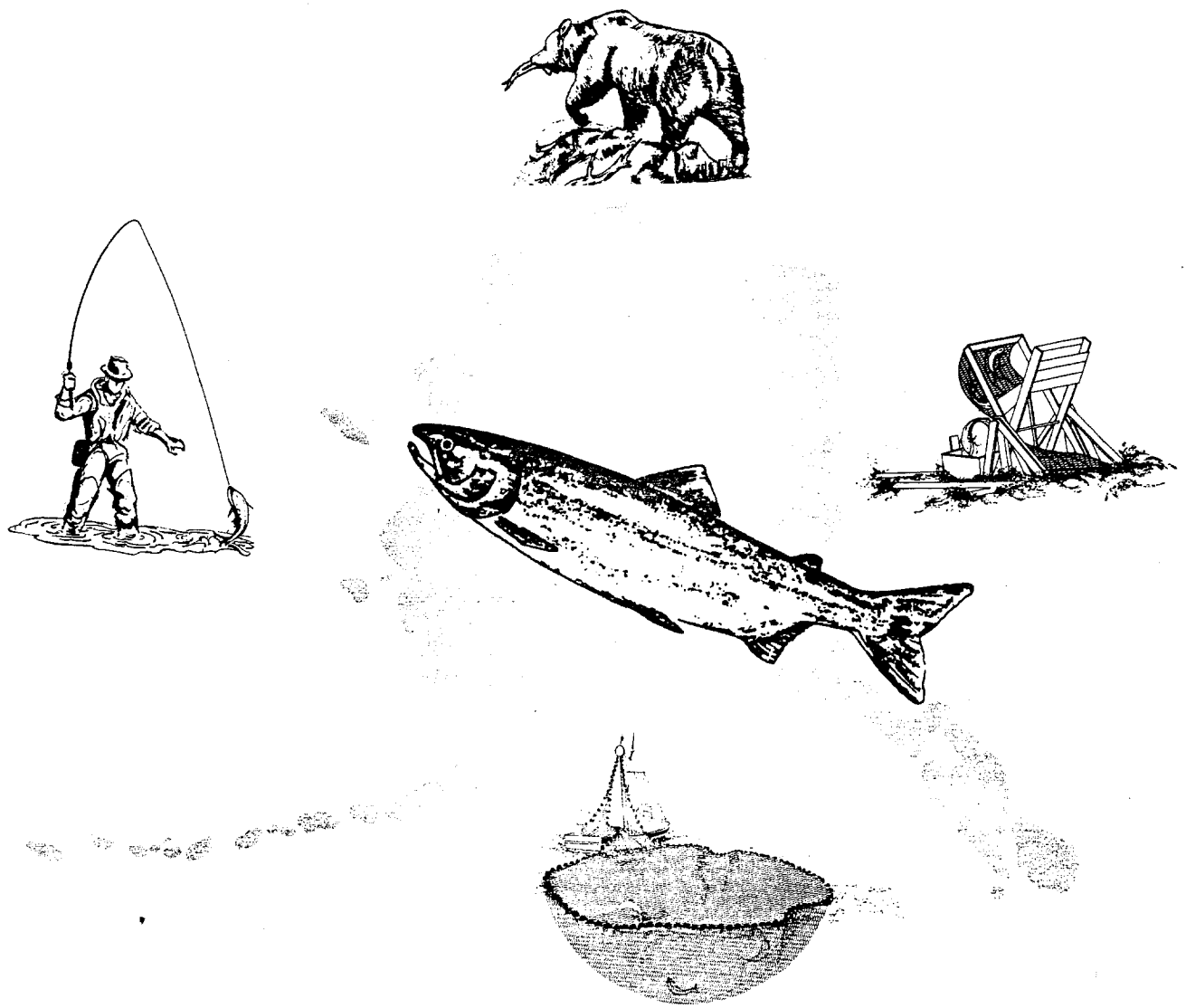
Fisheries Management Plan

YUKON DELTA NATIONAL WILDLIFE REFUGE



January 1992

Region 7

U.S. Fish and Wildlife Service • Department of the Interior

FISHERY MANAGEMENT PLAN

Yukon Delta National Wildlife Refuge

FY 1992 - 1996

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December 1991

YUKON DELTA NATIONAL WILDLIFE REFUGE
FISHERY MANAGEMENT PLAN

SUMMARY STATEMENT

The Yukon Delta National Wildlife Refuge Fishery Management Plan provides management direction to ensure conservation of fish species and habitats while, at the same time, allowing the users some level of harvest. The Plan defines the purposes of the refuge and develops management objectives and specific tasks designed to address identified problems on the refuge.

A description of the environment is presented and fishery resources, human use, management history and major issues and concerns are described. This material was obtained from a literature search coupled with information provided by the agencies' fish and wildlife biologists. Objectives and tasks were developed from concerns using strategies and referencing constraints such as legal mandates, allocation issues and logistics. Tasks were then assigned priorities and Federal tasks were assigned costs for each year of their continuation. The plan is designed to span a 5-year period at which time it will be updated.

Major concerns identified during the planning process included an incomplete baseline of fishery data, possible overharvest of fish, the need for a better public information and education program, habitat degradation and declining water quality.

Objectives developed to address major concerns ranged from program administration to data collection activities. In general, objectives are aimed at administering the fishery management program based on the best available information while obtaining more data to improve the information base.

Various fishery management strategies were developed to help guide the implementation of management activities. Application of fishery management strategies will occur as a cooperative effort between the Alaska Department of Fish and Game (Department) and the U.S. Fish and Wildlife Service (Service). Day to day operations are guided by a Memorandum of Understanding between the Service and the Department. It should be noted that this plan does not include habitat management activities, which will be addressed in a separate habitat management plan.

Priority tasks for both the Service and the Department over the next five years will emphasize administration of the current fishery program. Over and above this, Service priorities will emphasize the baseline investigations of key Kuskokwim and Yukon River tributary drainages on the refuge and the development of a better public information and education program. Priority tasks of the Department vary by division.

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SECTION 1: INTRODUCTION

The fishery management plan for the Yukon Delta National Wildlife Refuge is one of a series of detailed refuge management plans mandated by the refuge's Comprehensive Conservation Plan (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988). The purposes for the Yukon Delta National Wildlife Refuge, established by the Alaska National Interest Lands Conservation Act in 1980, have been adopted as the goals of fishery management on the refuge. The purposes of the refuge include:

(i) To conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, shorebirds, seabirds, whistling swans, emperor, white-fronted and Canada geese, black brant and other migratory birds, salmon, muskox and marine mammals;

(ii) To fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats;

(iii) To provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents; and

(iv) To ensure, to the maximum extent possible and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge.

This fishery management plan steps down the fishery management goals into objectives and specific tasks. The plan is designed to be effective for five (5) years until 1996 when it will be reviewed and revised if necessary.

SECTION 2: GENERAL PHYSICAL AND BIOLOGICAL ENVIRONMENT

The Yukon Delta National Wildlife Refuge is the largest of Alaska's 16 refuges and encompasses some 19.6 million acres (7.93 million hectares) of federal land on the Yukon-Kuskokwim Delta (including Nelson and Nunivak Islands) in western Alaska (Figure 1). Both the Yukon and Kuskokwim Rivers, major salmon migration rivers, traverse the refuge. These rivers have created one of the largest river deltas in the world. The Yukon-Kuskokwim Delta is the dominant landscape of the refuge and is the principal feature that shapes and influences the character of the region (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Physical Environment

Climate

The climate of the Yukon Delta National Wildlife Refuge is greatly influenced by its position between the Bering Sea and the mountains of

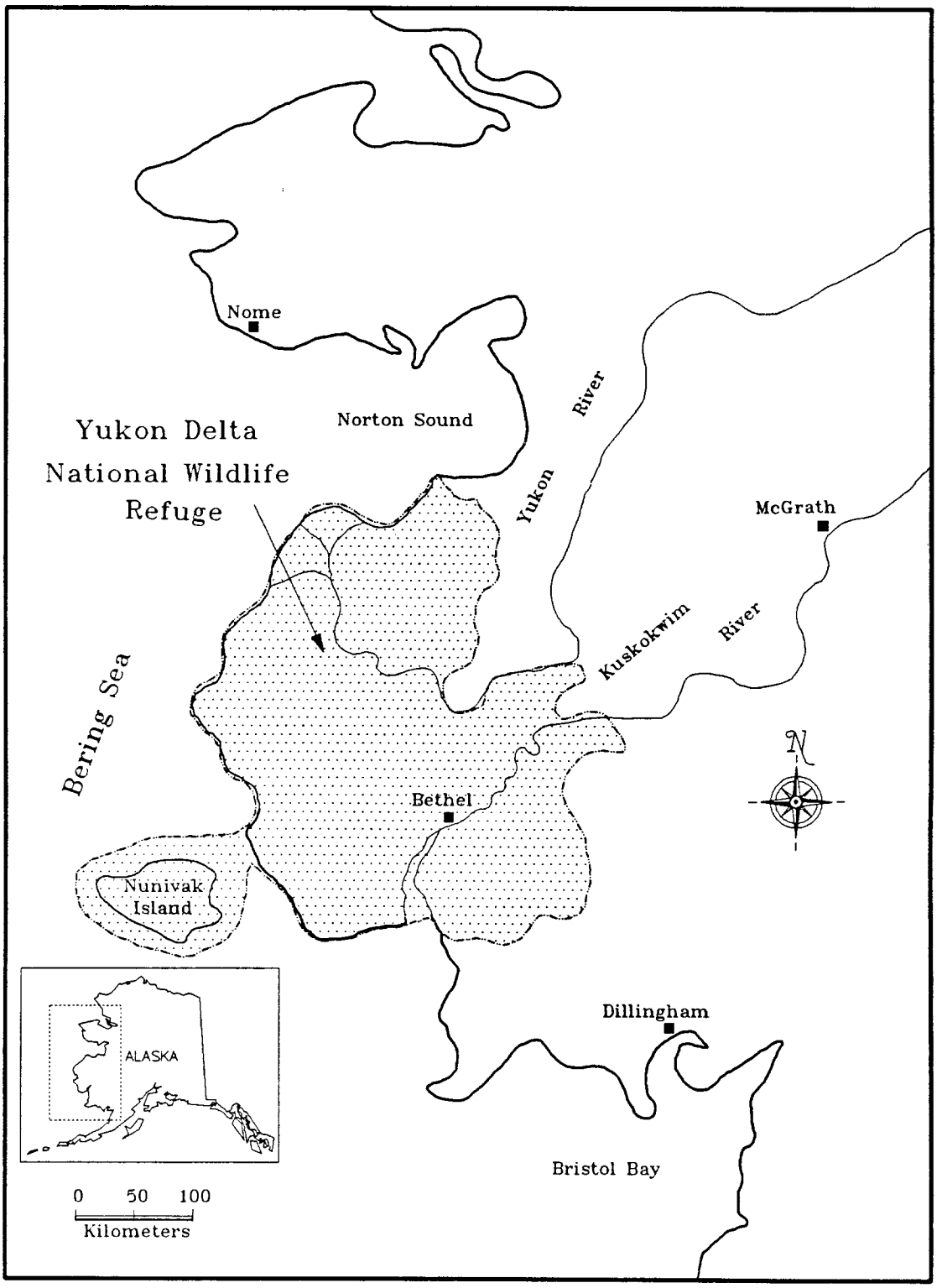

Figure 1. Location of the Yukon Delta National Wildlife Refuge, Alaska.

interior Alaska. This position creates three distinct climatic zones. The maritime zone encompasses the coastal area and islands, is influenced by the presence of the Bering Sea, and has relatively moderate temperatures and high precipitation. The continental zone of the refuge interior is influenced by the large land mass and generally has more extreme temperatures and less precipitation than the maritime zone. The transition zone is located between the other two zones and has characteristics of each. The frost-free period on the Yukon Delta is between late May and early to mid-September.

Topography

The primary physical feature of the Yukon Delta National Wildlife Refuge is the combined river delta of the Yukon and Kuskokwim Rivers. The fan-shaped Yukon-Kuskokwim Delta is a low-lying plain dotted with innumerable lakes. The delta stretches 250 miles (402 km) from Norton Sound and the Nulato Hills in the north to Kuskokwim Bay in the south and 200 miles (322 km) inland from the coast to the Kuskokwim Mountains. The coastal plain, including the delta, is contrasted by uplands and mountains to the north, east and south and several small mountain groups scattered across the coastal plain. Two major islands are located within the refuge. Nunivak Island lies 18 miles (29 km) off shore. Nelson Island is separated from the delta by the Ninglick River to the north, Baird Inlet to the northeast and the Kolavinarak River to the east.

Geology

The geology of the Yukon Delta National Wildlife Refuge is relatively uniform, particularly on the coastal plain. The refuge reflects the uplifting and subsidence of highly deformed sedimentary and volcanic rocks during the Cretaceous time. The coastal deposits which cover most of the Yukon Delta National Wildlife Refuge are underlain by Cenozoic gravel and silts. Upland areas and islands of the refuge have more varied geology. The vast coastal lowlands that comprise most of the refuge are made up of older coastal deposits of interlayered alluvial and marine sediments including coastal delta deposits. Most of the delta sediments were transported from interior Alaska to the delta by the Kuskokwim and Yukon rivers, although some sediments are derived from local bedrock areas.

Soils

The soils associations of the Yukon Delta National Wildlife Refuge are fairly uniform, poorly drained, stratified loams, silts and sands overlain with a thick layer of peat. The lowlands are underlain by moderately thick permafrost except around major water bodies. Well-drained soils found on natural levees and low terraces along the Yukon and Kuskokwim rivers are considered 25 to 50 percent arable. However, cool temperatures, a short growing season, spring flooding, lack of a farming tradition and remoteness make commercial agriculture a poor risk.

Mineral Resources

There are few indications of mineral occurrence throughout most of the refuge. The greatest concentration of minerals appears in the southeast portion of the refuge along the Kilbuck Mountains. Thin non-commercial seams of bituminous coal have been found within the Cretaceous sandstone formations on Nunivak and Nelson Islands. In general, the geologic formations common over much of the refuge are not favorable for metallic mineral deposits. However, there is evidence of mineral occurrence, particularly gold, in the Kilbuck Mountains. There are also indications of antimony, tin, silver and mercury on the refuge, although none of these minerals have been produced. The thick Cretaceous and older rocks which border the Yukon-Kuskokwim lowlands to the north and east are composed of dense and impermeable sediments having extremely poor characteristics for petroleum reservoirs. A study of hydrocarbon reservoir and source rock characteristics in the area indicate very low potential for commercial quantities of oil and gas. Petroleum potential in offshore areas may be slightly greater than onshore, but is still considered low.

Water Resources

The abundance of water in lakes and streams is the most significant characteristic of the Yukon-Kuskokwim Delta since water covers more than half of the land surface in many areas. The Yukon-Kuskokwim Delta was formed by ancient and recent deposits from the Yukon and Kuskokwim rivers forming a large, flat plain covered with innumerable lakes and ponds. The variety and abundance of both freshwater and estuarine habitats support large populations of fish and wildlife. Thus, water-based resources dominate the economy providing major food sources, determining village locations and dictating primary routes and modes of transportation.

Rivers. The Yukon River is the largest river in Alaska and the fourth longest in North America. It flows over 2,300 miles (3,700 km) from its headwaters in British Columbia, Canada, to its mouths on the Bering Sea and encompasses roughly 35 percent of the state of Alaska. It is bordered on the north by the steep Nulato Hills and on the south by broad delta lowlands. On the refuge, it flows sluggishly across the plain of the Yukon-Kuskokwim Delta, is over a mile wide at many points, and is frequently braided by sandbars. Three main and several minor mouths empty into the Bering Sea. These distributaries of the Yukon River are referred to as the "passes". Flooding due to river ice jams and to late summer-early fall storms plays a major role in the channel location of the Yukon River and its delta. Major tributaries to the Yukon River on the refuge include the Andreafsky, Atchuelinguk and Archuelinguk rivers which originate in the Nulato Hills north of the Yukon River and flow southwest.

The Kuskokwim River is the second largest river in Alaska. Its headwaters are on the western slope of the Alaska Range, 680 miles (1,094 km) from its mouth. It drains the slopes of the Alaska Range and

the Kuskokwim Mountains and empties into the Bering Sea south of the Yukon River. Major tributaries to the Kuskokwim River within the refuge boundaries include the Eek, Kwethluk, Kisaralik, Tuluksak, Aniak, Gweek, Johnson and Kialik rivers. The Eek, Kwethluk, Kisaralik, Tuluksak and Aniak rivers originate in the southeastern portion of the watershed in the Kilbuck Mountains. They flow for short distances over high glacial plateaus and through the foothills before reaching the wet lowland tundra for the remainder of their courses. These streams are straight, clear and swift over most of their courses and have highly fluctuating water levels due to snowmelt and summer rain. The Gweek, Johnson and Kialik rivers enter the Kuskokwim River from the north and west and are slower-moving, originating in the lowland sloughs and lakes of the delta plain. They are sluggish having little elevation between their headwaters and mouths. Water levels are relatively stable and by mid-summer many may become choked with aquatic vegetation.

Several large rivers empty into the Bering Sea between the Yukon and Kuskokwim rivers. These include the Black, Kokechik, Kashunuk, Aphrewn, Keoklevik, Manokinak and Azun rivers which are all former channels of the Yukon River. These rivers are under tidal influence up to 40 miles (64 km) from their mouths and broaden into major estuaries. These rivers, as well as several smaller ones, allow coastal waters to flood inland during high and storm tides.

Nunivak Island, located about 18 miles (29 km) offshore from the Yukon-Kuskokwim Delta in the Bering Sea, has over 70 streams and rivers. The rivers vary in length from the 30 mile (48 km) Mekoryuk River to the four mile (6 km) Jayalik River. All of the rivers have their headwaters in the interior uplands of the island and drain into the sea.

Lakes and Ponds. It is estimated that there are about 500,000 lakes and ponds on the entire delta and, for the most part, water covers more than half of the land surface. These ponds and lakes vary in size from less than one acre to thousands of acres and many are connected to the sea by ancient river channels.

Lakes and ponds of the Yukon-Kuskokwim Delta are uniformly shallow. Few have depths that exceed six feet (2 m) and even large lakes may average less than one or two feet deep (0.3 to 0.6 m). In other characteristics, such as size, water supply, origin and productivity, lakes and ponds may vary significantly. Those in the most recent fluvial and deltaic deposits of coastal areas are generally small and result from natural depressions left during the formation of the Delta or subsequent changes in river channels. Water supply of most such lakes and ponds depends primarily on snowmelt and on tidal flooding. By mid-summer some smaller coastal ponds may be dry or contain only shallow puddles.

Lakes in geologically older parts of the Delta are generally much larger than those in coastal regions and are formed primarily in depressions caused by thawing of frozen ground. Smaller lakes are generally in closed basins having no inlet or outlet, but larger lakes are drained.

Along major rivers, oxbow lakes or remnants of former river channels are common.

Most of the lakes and ponds on Nunivak Island are located on low, marshy terrain and are shallow. Small closed drainage systems are present in these sink areas. Several deep lakes occupy extinct volcanic craters.

Groundwater resources of the Yukon Delta National Wildlife Refuge have not been thoroughly investigated.

Water Quality

There have been no comprehensive studies of water quality on the Yukon-Kuskokwim Delta and available data is limited. The Kuskokwim River is turbid throughout most of its length due to glaciation and stream bank erosion. The southern and eastern tributaries to the Kuskokwim are clear in their upper reaches near the Kilbuck Mountains. They turn brown with a heavy silt load in the lower 25 miles.

The Yukon River normally carries a relatively high sediment load during the summer although most of its tributaries carry less. Streams on the Yukon Delta probably carry larger percentages of organic material than sands and silts. The meandering streams of the delta plain are sluggish, have stable water levels, and may become choked with aquatic vegetation in the summer.

Ponds in coastal areas are nearly all brackish, the degree of salinity depending on frequency of flooding and distance from the sea. Most waters, both coastal and inland, are brown from organic stains. Similarly, many are largely lacking in animal life because nutrients are quickly absorbed by vegetation. Waters in the warmer, inland parts of the Delta are somewhat more fertile because of the more rapid decomposition of plants releasing nutrients.

Water Rights

Federal reserved water rights were automatically granted to each national wildlife refuge by Congress to support the various purposes for which each refuge was established. These water rights have the same priority date as that of the creation of the refuge. However, to validate these water rights, the amount of water required must be quantified and granted via a declaratory judgement as part of a state or federal court basin wide adjudication process. There is no time limit for quantifying these water rights.

The federal government also has the opportunity to acquire state water rights administratively under Alaska Statute 46.15 for portions of or all of its water bodies within refuges without quantifying and asserting its Federal Reserved Claim for water. This approach eliminates the mandatory judiciary basin wide adjudication requirement and is potentially less costly and time consuming.

The approach taken to acquire water rights will most likely be based upon the existing and pending claims and priorities for water rights under the state system. Regardless of the process selected, the Fish and Wildlife Service will work cooperatively with the State of Alaska and its citizens to acquire its water rights.

Biological Environment

Vegetation and Land Cover Types

The Yukon Delta National Wildlife Refuge lies within the northern boreal subzone of southwestern Alaska. The coastal plain of the refuge is scarcely above sea level and is frequently inundated by tides from the Bering Sea. Tall scrub and forest vegetation are found inland in the eastern interior areas of the refuge. Vegetation communities on the refuge are adapted to permafrost, periodic flooding by tidal or riverine water and wind. The periodic flooding favors graminoid dominated plant complexes. Forest communities make up only about five percent of the refuge lands, mostly along the Yukon and Kuskokwim rivers as they enter the refuge and in the lower mountains and hills.

Endangered Species

American peregrine falcons nest along the Kisaralik River in the Kilbuck Mountains as well as along the lower Yukon River. Eskimo curlews historically were found on the Yukon-Kuskokwim Delta during fall and spring. Short-tailed albatross is a pelagic species and is occasionally sighted in offshore areas of Alaska. Probable occurrences of any existent population on the refuge would be offshore along the coastal fringe or on Nunivak Island.

Birds

Waterfowl, geese, ducks, swans and shorebirds migrate every summer to the refuge to breed and raise their young in the vast delta wetlands. As goose habitat, the refuge is unparalleled and is considered one of the best in America. The refuge has the largest tundra swan population in Alaska. The Yukon-Kuskokwim Delta is considered the largest and most important shorebird habitat in the Pacific Flyway and is the largest single expanse of intertidal habitat in North or South America. Eighteen species of raptors have been recorded on the refuge. Nesting raptors are common throughout the upland areas of the refuge. The Kisaralik River, located in the Kilbuck Mountains, has the highest combined diversity of nesting raptors in Alaska (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Mammals

Seals, walrus and beluga whales are the key sea mammals using coastal and marine habitats of the Yukon Delta National Wildlife Refuge. Gray, minke, bowhead and killer whales, as well as harbor porpoises, are also

found in Bering Sea waters. Bearded, harbor, ribbon and ringed seals and Stellar sea lions are all found in the Bering Sea offshore of the refuge. Moose are found along the Yukon and Kuskokwim rivers, mostly in the eastern half of the refuge. Caribou are found in both the Andreafsky hills and Kilbuck mountains. Muskox were introduced onto Nunivak Island in 1935 and 1936. The transplant was successful and the population has grown significantly. All three species of bear found in North America are known to occur on the refuge. Grizzly and black bears are most common and are found mainly in the interior of the refuge in the Andreafsky Hills and Kilbuck Mountains and near the major rivers. Polar bears are spotted on rare occasions along the coast of the delta when the Bering Sea ice pack stretches unusually far south. Beaver and muskrat occur throughout most of the Yukon Delta National Wildlife Refuge. Mink of the Yukon-Kuskokwim Delta are among the largest in the world and as such are one of the key furbearers of the region. Other furbearers include river otter, wolverine, lynx and wolves. Arctic fox are abundant along the coast while red fox are abundant in the interior.

For more detailed information concerning the physical or biological environment of the Yukon Delta National Wildlife Refuge, consult the refuge Comprehensive Conservation Plan.

SECTION 3: FISHERY RESOURCES

General Overview

The Yukon Delta National Wildlife Refuge supports an abundance of both resident and anadromous fish populations that are vital to the region's economy and subsistence way of life. The Yukon and Kuskokwim rivers and their tributaries provide valuable spawning and rearing habitats for five species of Pacific salmon and important resident fish species such as northern pike (*Esox lucius*), burbot (*Lota lota*), sheefish (*Stenodus leucichthys*), and various whitefish species. Many other rivers and streams on the refuge support one or more of these species as well. The Yukon Delta National Wildlife Refuge is practically inundated with lakes and ponds that provide habitat for other resident fish species such as the Alaska blackfish (*Dallia pectoralis*). The coastal areas support significant populations of Pacific herring (*Clupea harengus pallasi*) that are important for commercial and subsistence purposes. Many other fish species are found on the refuge as well and a list of species known to occur on the refuge is found in Table 1.

Watershed Descriptions

The refuge has been partitioned into five major regions. The following section provides a brief overview of each region and a more detailed description of the various watersheds within that region. Information on the physical characteristics of the watershed and water quality are provided as available. Data on the distribution and abundance of the various fish species and their habitats is also provided. Lastly,

Table 1. Common and scientific names of fish species that are known to occur on the Yukon Delta National Wildlife Refuge, Alaska.

Scientific Name	Common Name
Lampetra japonica	Arctic lamprey
Lampetra tridentata	Pacific lamprey
Clupea harengus pallasi	Pacific herring
Coregonus autumnalis	Arctic cisco
Coregonus laurettae	Bering cisco
Coregonus nasus	broad whitefish
Coregonus pidschian	humpback whitefish
Coregonus sardinella	least cisco
Oncorhynchus gorbuscha	pink salmon
Oncorhynchus keta	chum salmon
Oncorhynchus kisutch	coho salmon
Oncorhynchus mykiss	rainbow trout
Oncorhynchus nerka	sockeye salmon
Oncorhynchus tshawytscha	chinook salmon
Prosopium cylindraceum	round whitefish
Salvelinus alpinus	Arctic char
Salvelinus malma	Dolly Varden
Salvelinus namaycush	lake trout
Stenodus leucichthys	inconnu (sheefish)
Thymallus arcticus	Arctic grayling
Hypomesus olidus	pond smelt
Mallotus villosus	capelin
Osmerus mordax	rainbow smelt
Dallia pectoralis	Alaska blackfish
Esox lucius	northern pike
Catostomus catostomus	longnose sucker
Percopsis omiscomaycus	trout-perch
Boreoganus saida	Arctic cod
Eleginus gracilis	saffron cod
Gadus macrocephalus	Pacific cod
Lota lota	burbot
Gasterosteus aculeatus	threespine stickleback
Pungitius pungitius	ninespine stickleback
Stichaeidae	pricklebacks
Hexagrammos stelleri	whitespotted greenling
Cottus cognatus	slimy sculpin
Megalocottus platycephalus	belligerent sculpin
Myoxocephalus quadricornis	fourhorn sculpin
Occella dodecaedron	Bering poacher
Hippoglossus stenolepis	Pacific halibut
Limanda aspera	yellowfin sole
Liopsetta glacialis	Arctic flounder
Parophrys vetulus	English sole
Platichthys stellatus	starry flounder

potential impacts to fish and fish habitat in each watershed is discussed where information is available.

Kuskokwim River Region

The Kuskokwim River is the second largest river in Alaska. Its headwaters are on the western slope of the Alaska Range, 680 miles (1,094 km) from its mouth. It drains the slopes of the Alaska Range and the Kuskokwim Mountains and empties into the Bering Sea south of the Yukon River (Figure 2). The mean annual discharge over 32 years at Crooked Creek, upstream of the refuge was 41,220 cfs (1,167 m^3/s) with flows ranging from a high of 392,000 cfs (11,101 m^3/s) in June 1964 to a low of 6,100 cfs (173 m^3/s) in March 1966 (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988). Major tributaries to the Kuskokwim River within the refuge include the Eek, Kwethluk, Kisaralik, Tuluksak, Aniak and Johnson rivers. The Eek, Kwethluk, Kisaralik, Tuluksak and Aniak rivers originate in the southeastern portion of the watershed in the Kilbuck Mountains at elevations near 2,000 feet (610 m). They flow for short distances over high glacial plateaus then 20 to 40 miles (32 to 64 km) through foothills before reaching the wet lowland tundra for the remainder of their courses (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988). Clear and swift over most of their course, they have unstable water levels due to snowmelt and rain. They freeze up in October and become ice-free in May. The Johnson River enters from the north and is slower-moving, originating in the lowland sloughs and lakes of the delta plain. Information and data on the physical characteristics and fisheries resources for the principal tributaries of the Kuskokwim River are provided below.

Kuskokwim River Mainstem

The Kuskokwim River mainstem extends from the mouth of the river upstream to the refuge boundary near the community of Aniak. The area is characterized by river lowlands and floodplains. The Kuskokwim River flows very slowly in this area, meanders considerably, and is extensively braided with numerous sloughs and backwaters.

The mainstem is used as a migration corridor for adult chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), pink (*O. gorbuscha*) and sockeye (*O. nerka*) salmon that return to spawn in upriver tributaries. Spawning or rearing of salmon in the mainstem have not been documented (Alaska Department of Fish and Game 1986b). Other species that have been observed in the mainstem include northern pike, broad whitefish (*Coregonus nasus*), humpback whitefish (*C. pidschian*), Arctic grayling (*Thymallus arcticus*), sheefish, Arctic char (*Salvelinus alpinus*), burbot, least cisco (*C. sardinella*) and Arctic cisco (*C. autumnalis*)(Alaska Department of Fish and Game 1986c; Baxter 1967).

Aniak River

The Aniak River flows out of Aniak Lake in a northerly direction for about 100 miles (161 km) before joining the Kuskokwim River. The

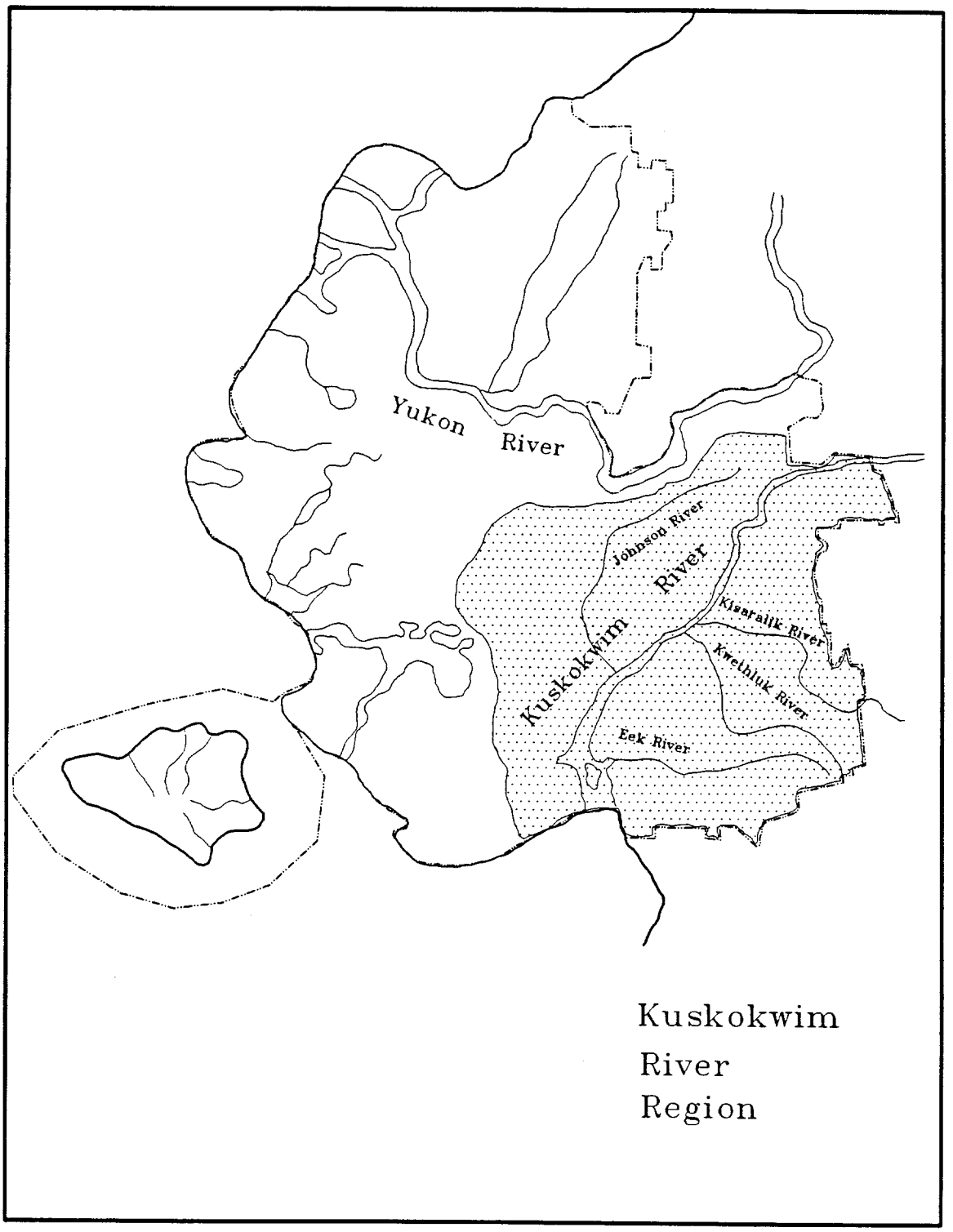

Figure 2. Kuskokwim River Region on the Yukon Delta National Wildlife Refuge, Alaska.

watershed is about 2,230 square miles (5,776 km^2) and has several major tributaries including the Doestock and Buckstock rivers and Grassy and Dead End sloughs. Most of the drainage upstream from the mouth of the Buckstock River is off the Yukon Delta National Wildlife Refuge. The Buckstock River enters the Aniak River from the east about 50 miles (80 km) upstream from the Aniak-Kuskokwim confluence. The lower reaches are shallow, about 50 to 60 feet (15 to 18 m) wide, characterized by overhanging banks, gravel substrates and summer flows of 150 cfs (4.2 m^3/s). The Doestock River enters the Aniak River from the east about nine miles upstream from the Aniak-Kuskokwim confluence. The Doestock River is slow moving, meandering, is about 70 to 90 feet (21 to 27 m) wide and has mud substrates. The mainstem Aniak River between the Buckstock and Doestock rivers is characterized by extensive braiding, gravel bars, downed timber, sloughs, side channels and pool habitats. Below the Doestock River, the Aniak River forms a single meandering channel characterized by swift currents, silty bottoms and mud banks that are heavily forested (Alt 1977).

The Aniak River supports both resident and anadromous fish populations. Chinook, coho, sockeye, pink and chum salmon spawn and rear in the Aniak watershed (Alaska Department of Fish and Game 1986b). Burbot, Arctic grayling, northern pike, Arctic char/Dolly Varden (*S. malma*), least cisco, Bering cisco (*C. laurettae*), broad whitefish, round whitefish (*Prosopium cylindraceum*), humpback whitefish and rainbow trout (*O. mykiss*) all occur in the Aniak River. Arctic grayling, round whitefish, Arctic char/Dolly Varden and rainbow trout appear to be the primary species that occur in the upper reaches above Buckstock Creek. Near the mouth of Aniak Creek and the upper reaches are known areas of rainbow trout overwintering habitat (Alaska Department of Fish and Game 1986c).

Because most of the upper Aniak River watershed is not within the Yukon Delta National Wildlife Refuge, considerable potential exists for impacts on fish populations in the lower reaches from various activities in the upper reaches, such as mining.

Eek River

The Eek River flows in a west-northwesterly direction for about 110 miles (177 km), drains about 1,400 square miles (3,626 km^2) and has two principal tributaries, the Middle Fork and the Ugaklik River. The mainstem has its origin in the Eek Mountains about 25 miles (40 km) upstream of Eek Lake. The Middle Fork originates south of the mainstem between the Great Ridge and the Eek Mountains. The Ugaklik River has its origin south of and flows parallel to the Middle Fork for most of its course. After leaving the Eek Mountains, both the mainstem and Middle Fork meander through open, moist tundra terrain and have their confluence approximately 55 miles (88 km) upstream from the mouth. The lower 12 miles (19 km) of the Middle Fork has a fine gravel bottom, an average width of 90 feet (27.4 m), an average depth of 1.7 feet (0.5 m), and a midsummer flow of 491 cfs (13.9 m^3/s). Five miles (8 km) above its confluence with the Middle Fork, the mainstem is larger, with an

average width of 100 feet (30.5 m), average depth of 1.9 feet (0.6 m) and a midsummer flow of 776 cfs (22 m^3/s). The upper reaches of the mainstem has a slope of 17.6 feet/mile (3.3 m/km), which is much steeper than the 5 to 10 feet/mile (0.9 to 1.9 m/km) exhibited by other southeastern tributaries of the Kuskokwim River (Alt 1977).

Much of the mainstem in its upper reaches is narrow and shallow with many sweepers and rocky bars. Below the confluence, the Eek River meanders considerably, with few tundra banks and deep, slow-moving silty water influenced by tides. The bottom is muddy with some fine gravel.

The lower Eek is characterized by many deep pools, eddies, riffles and submerged willows. Just downstream of the confluence, near the community of Eek, the river is over 300 feet (91 m) wide and over 5 feet (1.5 m) deep. The Ugaklik River enters from the south in this section and is a slow moving, silty river, 75 feet (22.8 m) wide and 2.5 feet (0.7 m) deep at the mouth. The Eenayarak River joins the Eek near its mouth to form the Eek channel of Kuskokwim Bay (Alt 1977).

For the most part, water quality does not appear to be limiting fish populations in the Eek River. However, data are extremely limited. Alt (1977) measured alkalinity, hardness, and pH in the mainstem above the Middle Fork to be 43 mg/l, 43 mg/l and 7.5, respectively. The water color in Eek Lake is brownish and the river is generally silty, especially in the lower reaches.

The Eek River supports five species of Pacific salmon. Escapement information is limited for this stream due to its remoteness and funding limitations. In 1988, a mid-summer aerial survey index count of 2,459 chinook, 3,920 chum and 304 sockeye salmon was obtained (Alaska Department of Fish and Game 1989a).

Chinook salmon occur primarily in the upper reaches of the mainstem above the Middle Fork and in the Middle Fork itself. Peak spawning probably occurs the last week of July (Baxter 1977; Alt 1977). Sockeye salmon are mainstem spawners in a 9 mile (15 km) section near river mile 130 (rkm 210). Spawning appears to peak during the first week of August (Baxter 1977). Coho salmon have been observed in the upper reaches of the river above the Middle Fork. Coho salmon enter the river late and although neither Alt (1977) nor Baxter (1977) observed them spawning, spawning probably occurs in late August through October. Pink salmon are relatively abundant in the Eek River and are found throughout the entire length of the river. However, spawning appears to be concentrated between river mile 58 and 86 (rkm 93 and 139) and probably occurs in the last week of July (Baxter 1977). Chum salmon are scattered throughout the Eek River as far upstream as river mile 152 (rkm 245). Most spawning occurs between river mile 58 and 119 (rkm 93 and 192) and probably peaks the third week of July (Baxter 1977).

Resident fish species include northern pike, Arctic grayling, Arctic char/Dolly Varden, round whitefish and humpback whitefish. Northern pike are relatively abundant in the lower reaches below river mile 58

(rkm 93) and are the only species that inhabits Eek Lake. Arctic grayling are the most common fish species in the river and are found in the middle and upper reaches including Ugaklik River. Arctic char/Dolly Varden are fairly common, especially above river mile 57 (rkm 92)(Baxter 1977; Alt 1977). Alt (1977) found humpback whitefish in the lower 40 miles (64 km) of the river while round whitefish were found only in the upper reaches of the mainstem. Rainbow trout have been collected in the Middle Fork of the Eek River (Eaton, U.S. Fish and Wildlife Service, Anchorage, Alaska, personal communication).

Fishery resources in the Eek River appear to be in good condition at present and potential impacts are probably minimal. The Eek River is relatively uninfluenced except for commercial fishing in the mainstem of the Kuskokwim River and local subsistence use of some resources. Mining has occurred in the past but is not presently going on. Recreational use is very minimal and the potential for increased use is expected to be very low.

Johnson River

The Johnson River originates from Portage Lakes west of Portage Mountains between the Kuskokwim and Yukon rivers. From Portage Lakes, it flows southwest for most of its course and then flows directly south before it joins the Kuskokwim River about 20 miles (32 km) downstream from Bethel. The Johnson River is one of the largest watersheds in the Kuskokwim drainage on the Yukon Delta National Wildlife Refuge and has several major tributaries. The Pikmiktalik River is the largest tributary to the Johnson River and has its origin in Arhymot Lake. It parallels the mainstem of the Johnson River for its entire length and enters the Johnson River about 15 miles (24 km) upstream from the Johnson's confluence with the Kuskokwim River. Other tributaries include the Kvichauak, the Mogak, and Patu rivers.

The Johnson River watershed is characterized by lowlands with little relief. The area is almost completely covered with numerous lakes most of which are relatively large. The lower reaches of the Johnson River connect a number of the largest lakes forming an extensive contiguous body of water in that area.

Little information is available on the fish populations in Johnson River. However, it is known that the system does not support any appreciable numbers of Pacific salmon (Francisco, Alaska Department of Fish and Game, personal communication). Northern pike and whitefish are both known to occur in the Johnson River and Portage Lakes support populations of whitefish, northern pike, burbot and Alaska blackfish.

Subsistence use of resident populations of northern pike and whitefish and natural changes in the local systems (e.g. beaver dams and lake sedimentation) may present a potential impact to the fishery resources in the Johnson River drainage at the present time (Francisco, Alaska Department of Fish and Game, personal communication).

Kasigluk River

The Kasigluk River originates in the Kilbuck Mountains, flows northwest approximately 100 miles (161 km), and drains an area of 250 square miles (647 km^2). The upper Kasigluk winds through a narrow valley and is characterized by numerous riffle areas and medium sized gravel substrates. The stream gradient in this section is slight, less than 10.5 ft/mile (2 m/km)(Baxter 1979).

The Little Kasigluk enters the mainstem about 50 miles (80.5 km) upstream from the mainstem's confluence with the Kuskokwim River. This section of the Kasigluk is characterized by numerous snags and sweepers, is about 50 feet (15 m) wide and has medium sized gravel substrates.

The lower reaches are primarily mud-bottomed with flows of about 240 cfs (6.8 m^3/s). The Kasigluk parallels the Kisaralik River for about 10 miles (16 km) in this area and receives overflow from it during periods of higher flows. The Kasigluk River enters the Kuskokwim River about 20 miles (32 km) upstream from Bethel (Alt 1977).

In general, water quality is good in the Kasigluk River. The water is mostly clear in the upper reaches but turns turbid and silty in the middle and lower reaches. On August 11, 1975, alkalinity was 34 mg/l, hardness was 51 mg/l and pH was 7.5 (Alt 1977).

Although little information is available on the fishery resources in the Kasigluk River, it is known to support a variety of anadromous and resident fish species. Five species of Pacific salmon occur in the Kasigluk River. Spawning occurs in the upper and middle reaches above river mile 28 (rkm 45). Chinook, chum and coho salmon appear to be the most abundant species in the upper reaches (Baxter 1979).

Resident fish species include broad whitefish, humpback whitefish, round whitefish, least cisco, Arctic grayling, Arctic char/Dolly Varden, rainbow trout, pond smelt (*Hypomesus olidus*), northern pike, Alaska blackfish, longnose sucker (*Catostomus catostomus*), burbot, ninespine stickleback (*Pungitius pungitius*) and slimy sculpin (*Cottus cognatus*) (Baxter 1979). In addition to the above, Alt (1977) collected sheefish in the lower sections. Alt found that rainbow trout, most Arctic char/Dolly Varden and Arctic grayling were collected in the middle reaches while most of the northern pike, broad whitefish and humpback whitefish were collected in the lower reaches.

Very little information is available on resource management activities in the Kasigluk River drainage. However, there are several activities that could pose potential impacts to the fishery resources. Sport fishing is very popular on the Kasigluk River, especially for rainbow trout. Also, there are several valid mining claims in the drainage (U.S. Department of Interior, U.S. Fish and Wildlife Service 1986). Baxter (1979) conducted his survey in response to efforts by the Association of Village Council Presidents to initiate salmon enhancement activities on the Little Kasigluk River.

Kisaralik River

The Kisaralik River originates in the Kilbuck Mountains, flows in a northwesterly direction for about 111 miles (178 km) and drains a watershed of 1,460 square miles (3,781 km^2) consisting of two headwater lakes and seven major tributaries. Elevations range from about 1,500 feet (457 m) at Kisaralik Lake to less than 50 feet (15 m) in the lowlands (U.S. Department of the Interior, National Park Service 1984). The headwater lakes and upper 18 miles (29 km) of the river are located on state land while the remainder of the watershed is within the refuge.

The upper reaches, in the vicinity of the refuge boundary, are characterized by large gravel and rubble substrates and a gradient of about 20 feet/mile (3.8 m/km). Both Golden Gate and Upper Falls are located in these upper reaches. Major tributaries that join the mainstem in this section include Swift, Solomon and Quicksilver creeks.

Quartz Creek enters the Kisaralik River about 33 miles (53 km) above the Kisaralik-Kuskokwim confluence. From Quartz Creek downstream for about 15 miles (24 km), the Kisaralik River is characterized by extensive braiding with many log jams and submerged trees, a substrate of fine to coarse gravel, average depths of 10-15 inches (25-38 cm), widths of 40 to 60 feet (12 to 18 m) and swift currents consisting of 90 to 100 percent riffle habitats (Alt 1977). Nukluk and Clear creeks enter the Kisaralik River from the east in this section.

The lower 20 miles (32 km) of the Kisaralik River is characterized by extensive meandering, mud and sand substrates, an average width of 120 feet (36.5 m), an average depth of 4.5 feet (1.4 m) and a gradient less than 2.6 feet/mile (0.5 m/km). The Kisaralik River has its confluence with the Kuskokwim River about 30 miles (48 km) upstream from Bethel (Alt 1977).

Generally, water quality in the river and tributaries is relatively good. Kisaralik Lake, the upper reaches of the river and most of the tributaries are clear although the lower river reaches are brown and turbid. Overall, the river carries a suspended sediment concentration of less than 100 mg/l (Heritage Conservation and Recreation Service 1979). Measurements of dissolved oxygen in the river and several tributaries were at saturation, 12 mg/l, while measurements of pH and alkalinity ranged from 7.3 to 8.2 and from 34 to 103 mg/l, respectively (U.S. Department of Interior, National Park Service 1984). Ice formation and freeze-up begins in mid-September with break-up in the lakes and river occurring in early June. More detailed information and data for specific tributaries and stream reaches is available in Baxter (1982).

The Kisaralik River supports abundant anadromous and resident fish species. Five species of Pacific salmon occur in the drainage although very little is known about these populations. Annual aerial survey index counts since 1960 have averaged 677 (63-2,417) and 3,230 (40-10,921) for chinook and chum salmon, respectively (Schneiderhan 1988;

unpublished data, Alaska Department of Fish and Game, Anchorage, Alaska). (Since these are aerial survey counts, these numbers are minimum estimates of escapement). Chinook salmon have been observed as far upstream as the North Fork (Baxter 1982) and are known to reach Kisaralik Lake (U.S. Department of Interior, National Park Service 1984). Coho salmon are known to occur throughout the mainstem and above Golden Gate Falls (Baxter 1982). Chinook, sockeye and chum salmon spawn in July and August while pink salmon spawn in July and coho salmon spawn in September, October and possibly through December. Spawning occurs in areas where adequate gravel is available, primarily in the middle reaches of the river and its tributaries. More specific information is available in Baxter (1982).

Rainbow trout occur throughout the middle reaches of the river below Golden Gate Falls (U.S. Department of Interior, National Park Service 1984) and are believed to spawn sometime during April and May in the middle reaches of the river (Baxter 1982).

Arctic char/Dolly Varden are relatively abundant and occur throughout most of the drainage, including Kisaralik Lake. Arctic char/Dolly Varden are believed to be resident and anadromous populations are not known to occur. Spawning occurs in August and September in the middle and upper reaches of the river and tributaries (Baxter 1982).

Arctic grayling occur in the middle and upper reaches of the river and in Kisaralik Lake. Spawning is believed to occur throughout the drainage during May and June. Lake trout (*S. namaycush*) occur in Kisaralik and North Fork lakes. Lake trout spawning is believed to occur from July through October. Northern pike are commonly found in the lower reaches of the river where they spawn in sloughs and tundra ponds during May and June. Sheefish are occasionally found in the extreme lower reaches of the river where they come to feed, although they spawn and rear elsewhere in the Kuskokwim drainage (Alt 1977).

Other resident fish species that inhabit the Kisaralik River include: Alaska blackfish, burbot, round whitefish, humpback whitefish, broad whitefish, least cisco, Arctic cisco, Arctic lamprey (*Lampetra japonica*), pond smelt, rainbow smelt (*Osmerus mordax*), longnose sucker, slimy sculpin and ninespine stickleback (Heritage Conservation and Recreation Service 1979; Baxter 1982). Other details on some of the above species can be found in Baxter (1982) and Alt (1977).

There are no mining, grazing or timber harvesting activities in the drainage. This is primarily due to difficult access. There are no roads or summer trails along the river and only a few unimproved landing strips. Access is primarily by boat or float plane, although snowmachines are used in the winter. At the same time, the Kisaralik River is apparently becoming increasingly popular with recreationists, especially groups who fly into the headwater lakes and float the river to its mouth. As recreational use of the river increases, specific management strategies will be needed to insure that fish populations are maintained. Also, the Kuskokwim River supports an important commercial

fishery for salmon. Although no commercial fishing is allowed on the Kisaralik River, management of the fishery in the mainstem Kuskokwim River could potentially impact Kisaralik River salmon stocks that contribute to it.

Kwethluk River

The Kwethluk River originates in the Eek and Crooked Mountains, flows northwest for 138 miles (222 km) and drains a watershed of 1,300 square miles (3,367 km^2). The headwaters of the Kwethluk River are formed primarily by Canyon (Crooked) Creek which flows west out of the Crooked Mountains and joins the Kwethluk River in the upper Kilbuck Mountain foothills. The middle reaches of the Kwethluk River are characterized by active braiding, medium sized gravel substrate types and smaller gravel-bottomed side channels. The main channel averages 100 feet (160 m) in width and 1.9 feet (0.6 m) in depth. Midsummer flows average 1,084 cfs (30.7 m^3/s). Farther downstream, a single channel forms that is characterized by gravel substrates and mud banks. The lower 29 miles (46.6 km) of the Kwethluk River consist of deeper, muddy bottomed channels averaging 175 feet (53 m) in width. Currents are much slower and the river meanders considerably. The Kwethluk River enters the Kuskokwim River about 20 miles (32 km) upstream from Bethel.

Water quality is apparently good although very little data have been collected. Alt (1977) measured alkalinity, hardness and pH in three sections of the river during 1976. Alkalinity ranged from 43 mg/l in the upper reaches to 34 mg/l in the lower reaches. Hardness was 51 mg/l in all three sections. Measurements of pH ranged from 7.5 in the upper reaches to 7.7 in the lower reaches.

The Kwethluk River supports five species of Pacific salmon, although little data are available on these populations. Spawning and rearing habitats are restricted to the middle and upper reaches above river mile 50 (rkm 80). Most spawning occurs in the main channel although chum salmon spawn occasionally in side channels (Alt 1977). Annual aerial survey index counts since 1960 have averaged 981 (50-2,034) and 4,523 (820-19,621) chinook and chum salmon, respectively (Schneiderhan 1988; unpublished data, Alaska Department of Fish and Game, Anchorage, Alaska). (Since these are aerial survey counts, these numbers are minimum estimates of escapement).

Although very little information is available, it is known that the Kwethluk River provides good habitat for a variety of resident fish species. Rainbow trout are nominally abundant and the river has excellent habitat for this species, as well as Arctic char/Dolly Varden and Arctic grayling in the middle reaches. The lower reaches of the river support northern pike, burbot, humpback whitefish, broad whitefish, least cisco and sheefish (Alt 1977; Alaska Department of Fish and Game 1975).

The Kwethluk River receives a measurable level of recreational use, especially sport angling for rainbow trout. The ready access to the

Kwethluk River from Bethel by boat could greatly facilitate increased recreational use and sport fishing, posing a potential impact to sport fish populations, especially rainbow trout. Past and current mining activities on this stream also represent a potential threat to fish stocks.

Tuluksak River

The Tuluksak River originates in the Kilbuck Mountains, flows in a westerly direction for about 85 miles (136 km) and drains a 900 square mile (2,331 km^2) watershed. The upper reaches have a summer flow of about 386 cfs (10.9 m^3/s), have gravel substrates, an average width of 52 feet (15.8 m) and an average depth of 1.6 feet (0.5 m)(Alt 1977). The section is characterized by swift currents, straight channels and numerous log jams and downed trees. The lower 30 miles (48 km) of the Tuluksak River has primarily mud and sand substrates, an average width of 85 feet (26 m) and is characterized by slower currents and considerable meandering (Alt 1977). The Fog River, which drains about 320 square miles (829 km^2), and Otter Creek are primary tributaries that enter the Tuluksak River in the lower-middle reaches. Granite, Slate and Nugget creeks are smaller and enter the Tuluksak River in the upper reaches and headwaters.

The Tuluksak River supports a number of anadromous and resident fish populations. Chinook salmon spawn and rear primarily in the middle reaches of the mainstem although a few are known to enter the Fog River. Chum salmon spawn in the lower reaches and lower Fog River. Coho have the widest spawning distribution of any salmon in the Tuluksak River. Spawning occurs in the middle reaches of the mainstem but mostly in the tributaries. Granite and Slate creeks probably have the highest densities of spawning and rearing coho. Populations also occur in the Fog River, Otter Creek and Nugget Creek. Pink salmon occur in the Tuluksak River but their distribution is not known (Francisco and Sundberg 1983; Andrews and Peterson 1983).

Rainbow trout, Arctic char/Dolly Varden and Arctic grayling also occur in the Tuluksak River as well as slimy sculpin, round whitefish, Arctic lamprey, Alaska blackfish, longnose sucker and threespine stickleback (Francisco and Sundberg 1983).

Previous mining has reduced the quality of salmon habitat particularly for chinook salmon (Francisco and Sundberg 1983). Extensive mining could pose a significant impact to fish populations in the Tuluksak River. The middle reaches of the mainstem between the Fog River and Slate Creek are important for chinook spawning and rearing while Granite and Slate creeks are important for coho spawning and rearing. Most of these areas are in the middle and upper reaches of the Tuluksak River, just off the refuge.

Other Watersheds

Other principal watersheds in the Kuskokwim River drainage include Bogus, Discovery, Kuskokwak and Swift creeks and the Gweek, Kialuk and Tagayarak rivers. Generally, very little information is available on fish populations in these watersheds. Subsistence harvest of some species occurs in various areas. Species documented to occur in each watershed are listed in Table 2.

North Coast Region

The North Coast Region lies in the northern part of the Yukon Delta National Wildlife Refuge south of St. Michael and between the Apoon mouth of the Yukon River and the Andreafsky Hills (Figure 3). Major watersheds of the region include the Pastolik, Pastoliak, Pikmiktalik, Koguk, Kuiak and Nunavulnuk rivers and Charlie Green Creek. For the most part, all of the watersheds flow north or northwest and enter the Pastol Bay - Stephans Pass area of Norton Sound. Except for the Pastolik River, most of the major watersheds have their headwaters in the Andreafsky Wilderness on the western slopes of the Andreafsky Hills. Specific information on the physical characteristics of the major watersheds and their fisheries resources is given below.

Koguk River

The Koguk River originates on the western slopes of the Andreafsky Hills in the Andreafsky Wilderness area. It flows generally north and enters Norton Sound just north of the Pikmiktalik River. The upper reaches are characterized by mountainous terrain with noticeable stream gradients. The lower reaches are characterized by coastal lowlands and a number of small lakes and ponds. Koguk River has a slight tannic coloring during summer (Lean 1982).

The Koguk River supports chum, pink and chinook salmon throughout most of the mainstem and smaller tributaries in the lower reaches. Several areas in the lower reaches have been documented as chum and pink salmon spawning habitat (Alaska Department of Fish and Game 1986b). The Koguk River is considered one of the three most productive salmon streams in the region. Arctic char/Dolly Varden and whitefish occur throughout the drainage also but nothing is known about spawning or rearing habitats for these species (Alaska Department of Fish and Game 1986c).

Subsistence harvest of salmon in the region is relatively intense. Increases in the level of salmon harvest could cause a significant impact to those populations (Lean 1982).

Pastolik River

The Pastolik River originates south of Pastol Bay between the Yukon River and the Andreafsky Hills. The mainstem of the Pastolik River flows north and enters Pastol Bay just east of the Apoon mouth of the

Table 2. Fish species documented to occur in various Kuskokwim River tributaries.

Watershed	Species							
	northern pike	least cisco	Arctic cisco	broad whitefish	humpback whitefish	sheefish	Arctic char/ Dolly Varden	burbot
Bogus Creek[1]	X	X		X	X			
Discovery Creek[1]	X	X		X	X			
Gweek River[1,2]	X	X		X	X	X	X	X
Kialik River[1]	X	X	X	X	X	X		X
Kuskokwak Creek[1,2,3]			X	X	X		X	X
Tagayarak River[1]	X	X	X	X	X	X		X

[1] Alaska Department of Fish and Game 1986c.
[2] Alaska Department of Fish and Game 1986b.
[3] Alaska Department of Fish and Game 1986d.

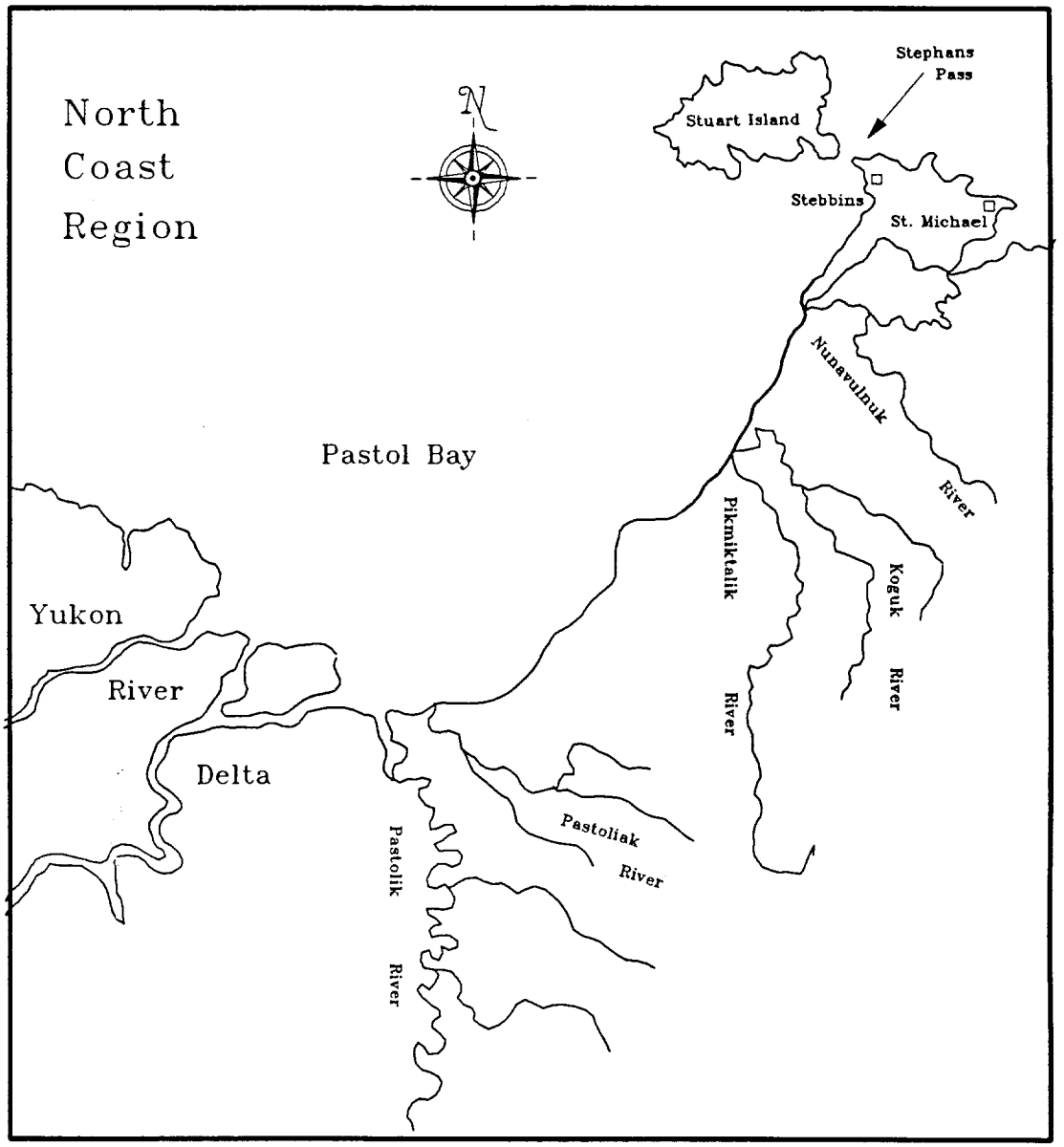

Figure 3. North Coast Region of the Yukon Delta National Wildlife Refuge, Alaska.

Yukon River. Most of the tributaries flow west out of the Andreafsky Hills. The Pastolik River watershed is characterized by hills and mountains in the upper reaches and headwaters and by lowlands covered with numerous lakes and ponds in the lower reaches. The mainstem is almost always quite turbid although several tributaries have relatively clear water. A secchi disc reading in the 1982 survey of the main stem was 2.6 feet (0.8 m)(Lean 1982).

The Pastolik River supports anadromous and resident fish populations. Chum, pink, coho and chinook salmon all occur in the Pastolik River. Spawning areas for all these species have been documented near the mouth while spawning and rearing areas for chinook and coho salmon have been documented for the mouth and upper reaches (Alaska Department of Fish and Game 1986b). Arctic char/Dolly Varden and whitefish occur throughout the drainage (Alaska Department of Fish and Game 1986c). The Pastolik River has been determined to be one of three most important salmon producing streams in the region (Lean 1982).

Stocks of salmon in the Pastolik River are utilized fairly heavily for subsistence purposes. Significant increases in harvest levels, either subsistence or commercial, would pose a potential impact to salmon stocks in the Pastolik River watershed (Lean 1982).

Pikmiktalik River

The Pikmiktalik River originates on the western slopes of the Andreafsky Hills and flows north before entering Norton Sound about 10 miles (16 km) northeast of Pt. Romanof. The Pikmiktalik River is the second largest watershed in the region. The upper reaches lie within the Andreafsky Wilderness and are characterized by hills and moderate stream gradients. The lower reaches are characterized by the coastal lowlands that have a moderate number of smaller lakes and ponds. The Pikmiktalik River tends to become somewhat turbid during rainstorm events although it clears up after several days (Lean 1982).

The Pikmiktalik River supports pink, chum, coho and chinook salmon. Pink and chum salmon spawning areas have been documented in the lower, middle and upper reaches (Alaska Department of Fish and Game 1986e). The Pikmiktalik River is considered one of the three most productive salmon streams in the region. The watershed lies within the general range and distribution of Arctic char/Dolly Varden and whitefish and probably supports both species (Alaska Department of Fish and Game 1986c).

Subsistence harvest of salmon in the region is relatively high. Increases in salmon harvest is probably the most important potential impact to salmon populations in the area (Lean 1982).

Other Watersheds

Other watersheds in the region include Charlie Green Creek, Kuiak River, Nunavulnuk River and the Pastoliak River. Very little information is

available on fish populations in these watersheds. Species documented to occur in each watershed are listed in Table 3. Subsistence harvest is relatively high in the area. Increased salmon harvest, either subsistence or commercial, is the most important potential impact to salmon populations in the area (Lean 1982).

Nunivak Island Region

Nunivak Island is located in the Bering Sea off the west coast of Alaska and is separated from Nelson Island by the 18 mile (29 km) wide Etolin Strait (Figure 4). Nunivak Island has more than 70 rivers and streams. They vary in length from the 30 mile (48 km) long Mekoryuk River to the 4 mile (6.4 km) Jayalik River. All the rivers on the island drain into the sea and have their origins in the interior. For the most part, the streams are shallow and usually average less than 2 feet (0.6 m) deep. Few streams are wider than 50 feet (15 m). Stream substrates are most generally boulders, rubble and gravel and suitable spawning substrate for salmon and Arctic char/Dolly Varden are characteristic. Nearly all the streams have clear water (Wilderness Record 1974). Specific stream characteristics for some of the major drainages are listed in Table 4.

The rivers and streams on Nunivak Island support both resident and anadromous fish populations. Pink, chum, coho and sockeye salmon all occur on Nunivak Island. Chinook salmon fingerlings were reported caught during a survey in 1965 (Hout 1966), but the finding is not included on the Department's Anadromous Waters Catalog for the area (Alaska Department of Fish and Game 1986b).

Coho and chum salmon are the most common and widely distributed species of salmon on the island. Pink salmon are moderately abundant. Sockeye salmon occur only in the Dooksook River on the southwest part of the island. Resident species include Arctic char/Dolly Varden, Arctic grayling, Alaska blackfish, threespine stickleback and ninespine stickleback (Hout 1966). Arctic char/Dolly Varden occur in all the streams that have been surveyed (Alaska Department of Fish and Game 1986c). Arctic grayling occur only in the Kiyakyaliksmiut River. Rainbow trout/steelhead were reportedly observed in several streams during a 1965 survey (Hout 1966) but this species is not listed in the Department's most recent Regional Habitat Guides (Alaska Department of Fish and Game 1986c). A list of the major drainages on Nunivak Island and fish species that have been documented to occur there are listed in Table 5.

The Yukon Delta National Wildlife Refuge boundary extends out from the shoreline around Nunivak Island into the Bering Sea for 10 to 25 miles (16 to 40 km). This area provides habitat for a number of marine fish species, including Pacific herring, smelt, Pacific halibut (*Hippoglossus stenolepis*), English sole (*Parophrys vetulus*) and starry flounder (*Platichthys stellatus*)(Hout 1966).

Table 3. Fish species documented to occur in various watersheds along the northern coast of the Yukon Delta National Wildlife Refuge, Alaska.

	Species				
Watershed	chum salmon	pink salmon	sheefish	whitefish	Reference
Kuiak River	X	X	X	X	ADFG 1986b, 1986c
Nunavulvuk River	X	X	X	X	ADFG 1986b
Pastolik River	X	X			ADFG 1986b

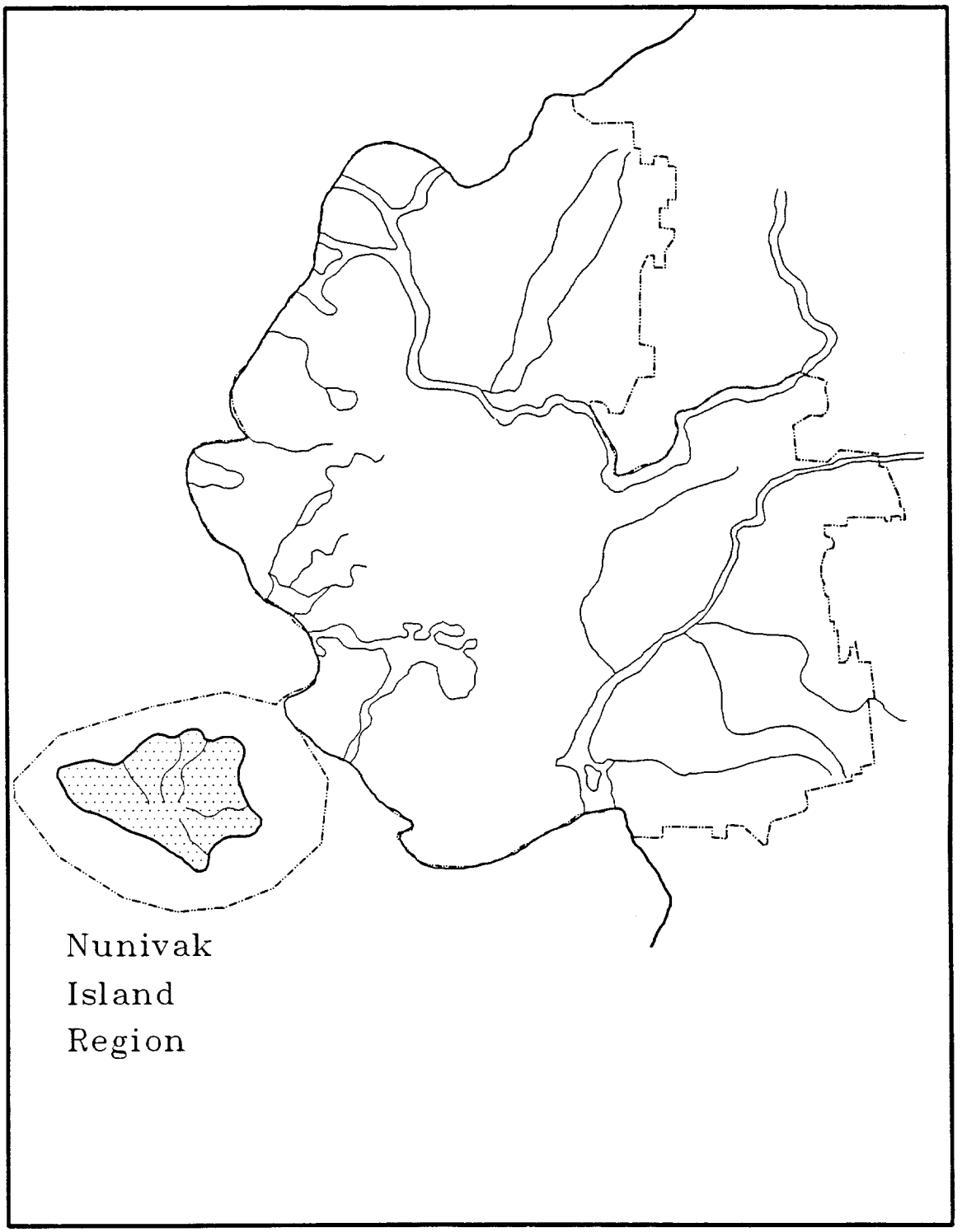

Figure 4. Nunivak Island Region on the Yukon Delta National Wildlife Refuge, Alaska.

Table 4. Stream characteristics for some of the major drainages on Nunivak Island, Yukon Delta National Wildlife Refuge, Alaska (Hout 1966).

Drainage	Length[1] (miles)	Average[2] Width (feet)	Average[3] Depth (inches)	Gradient[4] (ft./miles)	Major Bottom Substrates
Nash Harbor Creek	4.5 (7.2)	20 (6.1)	10 (25.4)	44 (8.3)	rubble/gravel
Dooksook River	2.5 (4.0)	20 (6.1)	10 (25.4)	66 (12.5)	rubble/boulder gravel
Dahloongamiut River	9.0 (14.5)	50 (15.2)	18 (45.7)	47 (8.9)	rubble/gravel
Kiyakyaliksamiut River	17.0 (27.3)	50 (15.2)	24 (60.9)	25 (4.7)	rubble/gravel
Chakwakamiut River	16.0 (25.7)	55 (16.7)	24 (60.9)	40 (7.6)	rubble/gravel
Jayalik River	3.5 (5.6)	10 (3.0)	6 (15.2)	57 (10.8)	gravel
Binajoaksmiut River	10.0 (16.0)	25 (7.6)	12 (30.5)	40 (7.6)	rubble/gravel
Duchikmiut River	10.0 (16.0)	20 (6.1)	12 (30.5)	44 (8.3)	gravel

[1] Values in parentheses are kilometers
[2] Values in parentheses are meters
[3] Values in parentheses are centimeters
[4] Values in parentheses are meters per kilometer

Table 5. Major drainages on Nunivak Island and fish species documented to be present (Hout 1966).

Drainage	Species	References
Mekoryuk River	Arctic char/Dolly Varden Chum salmon Coho salmon Pink salmon Chinook salmon[2]	ADFG[1] 1986b, 1986c
Anluk Creek	Arctic char/Dolly Varden	ADFG 1986c
Kaliksneethnook River	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c
Koweejoougak River	Arctic char/Dolly Varden Chum salmon Coho salmon	ADFG 1986b, 1986c
Nigikmuit Creek	Arctic char/Dolly Varden	ADFG 1986b, 1986c
Kahniruk River	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c
Nariksmiut River	Arctic char/Dolly Varden Pink salmon Chum salmon	ADFG 1986b, 1986c
Ahding River	Arctic char/Dolly Varden Coho salmon Chum salmon	ADFG 1986b, 1986c
Antingmiut Creek	Arctic char/Dolly Varden	ADFG 1986c
Bimahyook Creek	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c
Dadinowik Creek	Arctic char/Dolly Varden	ADFG 1986b
Nash Harbor Creek	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c
Ahlik River	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c

Table 5. (Continued).

Drainage	Species	References
Dooksook River	Arctic char/Dolly Varden Sockeye salmon Chum salmon Sculpins & Sticklebacks	ADFG 1986b, 1986c; Hout 1966
Dahloongamiut River	Arctic char/Dolly Varden Coho salmon Chum salmon	ADFG 1986b, 1986c
Kiyakyaliksmiut River	Arctic char/Dolly Varden Arctic grayling Chum salmon Coho salmon	ADFG 1986b, 1986c
Chakwakamiut River	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c
Jayalik River	Arctic char/Dolly Varden	ADFG 1986c
Binajoaksmiut River	Arctic char/Dolly Varden Chum salmon	ADFG 1986b, 1986c
Duchikmiut River	Arctic char/Dolly Varden Chum salmon Pink salmon Coho salmon	ADFG 1986b, 1986c

[1] Alaska Department of Fish and Game
[2] Reported by Hout (1966) but not supported by the Department's Anadromous Waters Catalog.

Subsistence and commercial fisheries for Pacific herring are major activities on the island. Increased commercial harvest rates of this species could pose a significant impact on Pacific herring populations.

West Coast Region

The West Coast Region consists of that area on the western coast of the Yukon Delta National Wildlife Refuge south of the Yukon River and north of the Kuskokwim River (Figure 5). All the major drainages in the area flow into the Bering Sea. The area is characterized by delta lowlands with innumerable lakes and ponds and extensively meandering rivers and streams. Several of the major rivers, such as the Black, Kashunuk and Manokinak rivers were previously part of the Yukon River which have been cut off by meandering and deposition. Other major features include Nelson Island, Baird Inlet and Dall Lake. More detailed information on the major watersheds and their respective fishery resources is given below.

Black River

The Black River originates on the Yukon Delta southwest of Mountain Village and north of the Kashunuk River. The Black River is an old section of the Yukon River which has been cut off by meandering and deposition. The Black River flows west, northwest and empties into the Bering Sea about 50 miles (80 km) north of Scammon Bay. The Black River watershed is characterized by coastal lowlands, river floodplains with many large lakes and innumerable small lakes and ponds and has formed numerous sloughs, oxbows, and cutoff channels. Kusilvak Mountain is the only major relief in the area and rises to 2,190 feet (668 m) above sea level.

Most of the Black River watershed is unsurveyed. Chinook and chum salmon have been documented at the mouth and several locations on the mainstem (Alaska Department of Fish and Game 1986b). Burbot, northern pike, Arctic cisco, least cisco, broad whitefish, humpback whitefish and sheefish have been documented at the mouth and several locations along the mainstem. The remainder of the watershed remains unsurveyed although it lies within the general range and distribution for northern pike, whitefish and burbot (Alaska Department of Fish and Game 1986c).

A commercial salmon fishery occurs in the lower portion and at the mouth of the Black River and is part of District 1 in the lower Yukon River Management Area. This fishery is primarily an intercept fishery for chinook and chum salmon destined for the Yukon River. Subsistence use of fishery resources probably occurs to a relatively high degree. At the present time, probable impacts to the fishery resources in the Black River watershed are expected to be low.

Kashunuk River

The Kashunuk River is a distributary of the Yukon River that originates on the Yukon Delta a few miles south of the Yukon River near Pilot

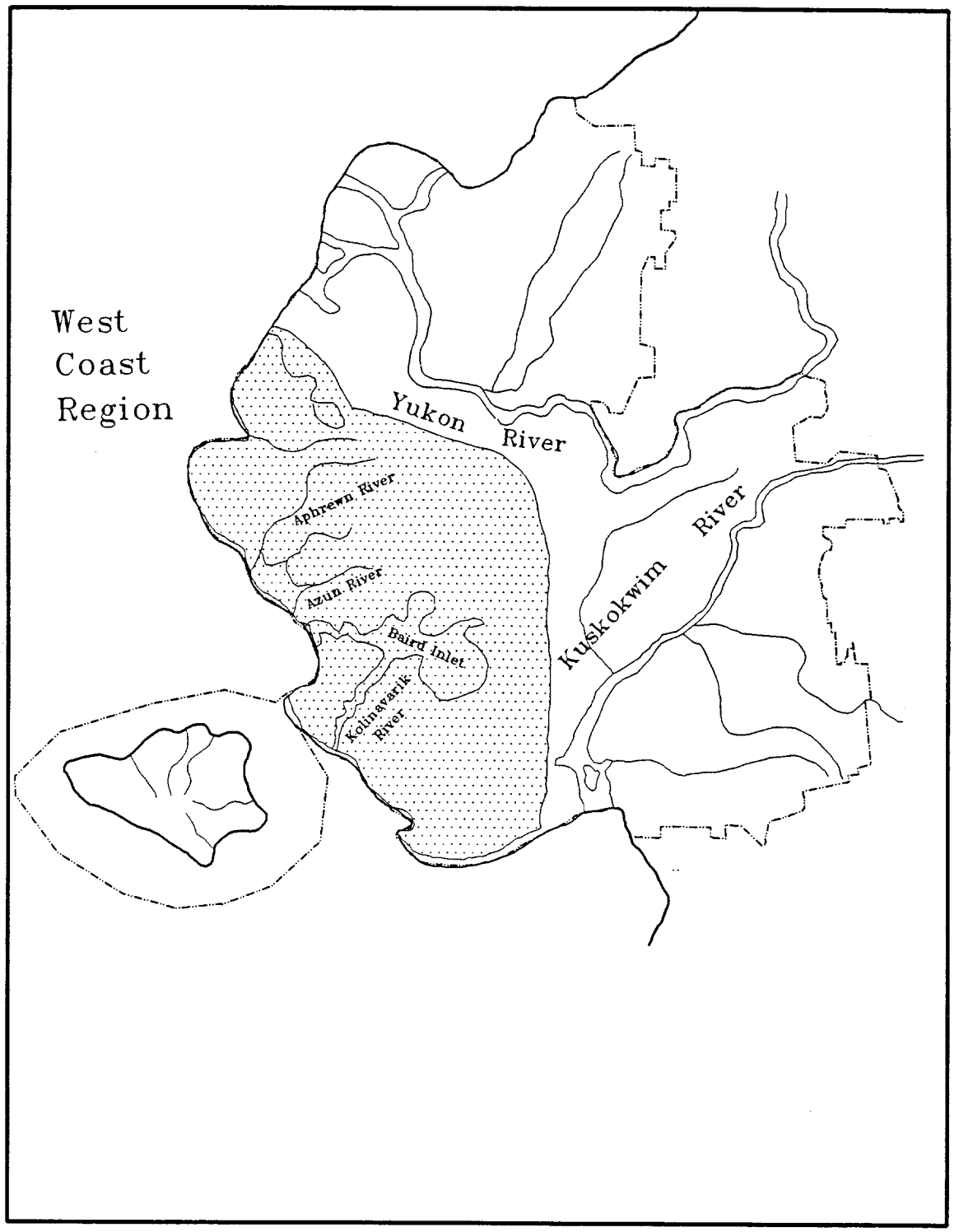

Figure 5. West Coast Region on the Yukon Delta National Wildlife Refuge, Alaska.

Station. The Kashunuk River flows west forming several distributaries that empty into the Bering Sea. The watershed is characterized by delta and coastal lowlands, river floodplains and innumerable lakes and ponds. In the upper reaches, the Kashunuk River meanders extensively and forms numerous sloughs, oxbows and cut off channels. The lower reaches are very similar with very extensive distributary activity.

Chum, pink and chinook salmon have been documented in the Kashunuk River, as well as the Aphrewn and Kokechik rivers, all the way into the upper reaches above the Kokechik River confluence (Alaska Department of Fish and Game 1986b). The Kashunuk River also supports resident fish populations. Least cisco, sheefish, humpback whitefish and broad whitefish occur throughout the watershed. Arctic cisco is relatively common throughout the lower reaches below the Kokechik confluence. Arctic char/Dolly Varden and northern pike have been documented at several locations in the upper reaches. Burbot and northern pike have been documented below the Kokechik River confluence down to Nanvaranak Lake. Except for the mainstem areas, the rest of the watershed remains unsurveyed although it lies within the general distribution and range for burbot, northern pike, and whitefish (Alaska Department of Fish and Game 1986b; 1986c). Alaska blackfish are also relatively common in the area (U.S. Department of the Interior, U.S. Fish and Wildlife Service 1988).

Subsistence harvest of salmon and resident fish species by local residents of Hooper Bay is the primary resource utilization activity in the area. No other information is available on probable impacts to fish populations.

Manokinak River

The Manokinak River has its origin on the Yukon Delta in the area of Kgun Lake south of the Kashunuk River and north of the Ingakslugwat Hills. It flows southwest forming several distributaries which flow into Hazen Bay. The Manokinak River watershed is characterized by coastal lowlands, river floodplains, many large lakes and innumerable small lakes and ponds. The Manokinak River meanders extensively in the upper reaches forming many sloughs, oxbows and cut off channels. The upper reaches are dominated by two major features; Kgun Lake and the Ingakslugwat Hills. The lower reaches are characterized by extensive distributary activity.

Chinook, chum and pink salmon have been documented at various mainstem locations along the Manokinak and Azun rivers all the way to the upper end of Kgun Lake. However, most of the drainage other than the mainstem areas remains unsurveyed and the presence or absence of salmon is undocumented. Arctic cisco, least cisco, and sheefish occur throughout the lower reaches below the Azun River confluence. Burbot, northern pike, least cisco, humpback whitefish and broad whitefish have been documented in Kgun Lake and the mainstem above Nuskealik Lake. However, from Nuskealik Lake downstream to Hazen Bay, the presence or absence of several species has not been documented (Alaska Department of Fish and

Game 1986b; 1986c). Alaska blackfish are very abundant in Kgun Lake (Maciolek 1986).

Subsistence harvest of salmon and resident fish populations by local residents is the primary resource use activity in the area. No other information is available although probable impacts to fishery resources in the Manokinak River are expected to be minor.

Baird Inlet

The Baird Inlet watershed area is located south of the Manokinak River and west of the Kuskokwim River. Except for Nelson Island, the area is characterized by coastal lowlands with many large and innumerable small lakes and ponds. Baird Inlet is the largest interior body of water on the Yukon Delta National Wildlife Refuge and is one of two major features of the area. Baird Inlet has two outlets to the Bering Sea; the Ninglick River, which flows west and into Hazen Bay and the Kolavinarak River, which flows south and into the Etolin Strait. These two rivers actually form the other major feature of the area, Nelson Island, which is characterized by considerable relief.

The only waters that have been surveyed where salmon have been either documented present or absent include the Ninglick River, Kolavinarak River, the perimeter of Baird Inlet and several streams along the periphery of Nelson Island. Pink salmon have been documented at the mouth of the Ninglick River, throughout Baird Inlet to its farthest extent and throughout the Kolavinarak River. Chum salmon have been documented throughout the Kolavinarak River. Chum, pink, coho and chinook salmon have been documented in various streams throughout Nelson Island (Alaska Department of Fish and Game 1986b). Resident fish that have either been documented to be present or whose general distribution and range lie within the Baird Inlet area include Arctic char/Dolly Varden, burbot, northern pike, Arctic cisco, least cisco and humpback whitefish.

Subsistence harvest of salmon and resident fish populations is the primary resource use in the area. No other information is available on probable impacts which are expected to be minimal.

Other Watersheds

Other watersheds in the region include the Kun, Kinia, Kuguklik and Ishkowik rivers. These watersheds are primarily unsurveyed although Arctic cisco have been documented to occur in various places (Alaska Department of Fish and Game 1986b; 1986c). Although subsistence harvest of fish populations occur in these areas, very little information is available on the harvest levels.

Yukon River Region

The Yukon River Region is located in the northern portion of the Yukon Delta National Wildlife Refuge directly north and west of the Kuskokwim

River drainage (Figure 6). The region consists of the Yukon Delta proper, the mainstem Yukon River from the community of Mt. Village upstream to the refuge boundary near Holy Cross and three major tributaries; the Archuelinguk, the Atchuelinguk and Andreafsky rivers.

The Yukon River is the largest of two primary river systems that flow through the Yukon Delta National Wildlife Refuge. It is the largest river in Alaska and encompasses approximately 330,000 square miles (854,700 km^2). The average discharge of the Yukon River is approximately 40,000 cfs (1,133 m^3/s) during the winter when it is fed by base flow. During spring breakup, the major hydrologic event of the year, the discharge may increase to over 1,000,000 cfs (28,320 m^3/s). Average annual flows of 500,000 cfs (14,160 m^3/s) carry over 78.6 million tons (88 million metric tons) of suspended sediment consisting of silt and very fine sand (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

The Yukon River provides important habitat for a variety of fish populations including five species of Pacific salmon, several species of whitefish, Arctic char/Dolly Varden, northern pike, Arctic grayling and burbot (Alaska Department of Fish and Game 1985a). For the most part, the lower Yukon River is used by the majority of salmon populations as a migration corridor to their spawning and rearing habitat farther upstream. However, several tributaries of the lower Yukon support some of the largest escapements of chinook, summer chum and pink salmon populations in the entire Yukon River drainage. Information and data available on the physical characteristics and the fishery resources of the major areas and tributaries of the Yukon River Region are provided below.

Andreafsky River

The Andreafsky River originates in the Nulato Hills, flows south for 120 miles (193 km), and drains a watershed of about 2,100 square miles (5,439 km^2) before it enters the Yukon River approximately 100 miles (160 km) upstream from the Yukon River mouth. The Andreafsky River has one major tributary, the East Fork, which flows parallel to the mainstem, drains about 750 square miles (1,942 km), and enters the mainstem about 4 miles (6.4 km) upstream from the Andreafsky's confluence with the Yukon River. Allen Creek is a minor tributary that flows out of the west and enters the mainstem in the middle reaches.

Both the mainstem of the Andreafsky and the East Fork originate at about 1,100 feet (335 m) elevation and have an average gradient of almost 9 feet/mile (1.7 m/km). The upper reaches of the Andreafsky River flow through alpine tundra, have stream widths of 30 to 40 feet (9 to 12 m) and depths of 1 to 2 feet (0.3 to 0.6 m). The lower reaches flow through forest habitat dominated by balsam, willow and white spruce and have stream depths of over 10 feet (16 m). At the mouth, the Andreafsky River is over 1,200 feet (366 m) wide. The bottom substrates are composed primarily of gravel and rubble. No major rapids or falls are known to exist.

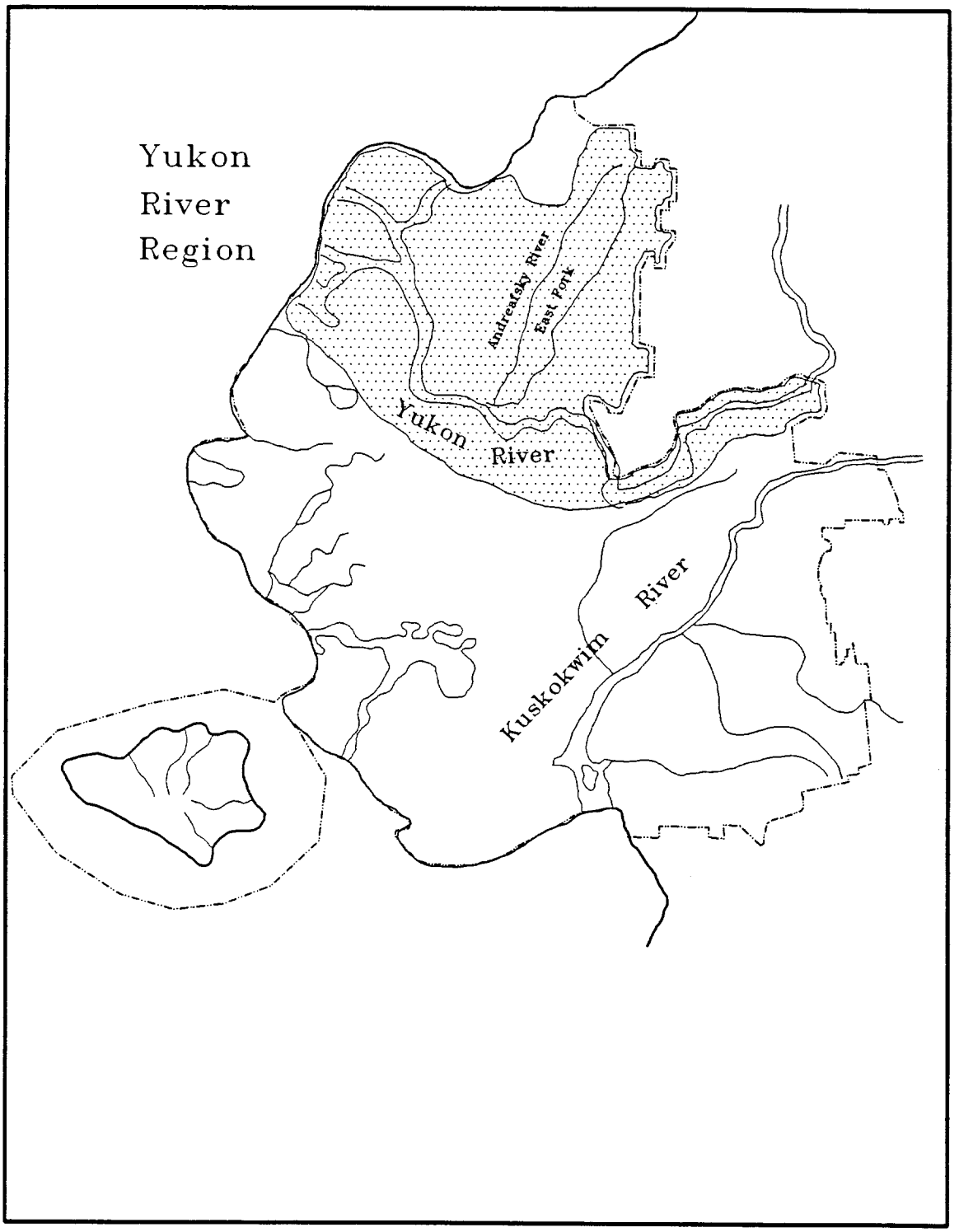

Figure 6. Yukon River Region on the Yukon Delta National Wildlife Refuge, Alaska.

The Andreafsky River and the East Fork are non-glacial rivers with extremely clear waters. The watershed is generally stable and sediment loads are minimal. Maximum discharge is most often reached after break-up in May or early June. High water levels also occur occasionally during July or August after heavy rains. Water temperatures range from 32°F (0°C) in the winter to 50-55°F (10° - 12.7°C) in July. Ice begins forming in late October and may reach 4 feet (1.2 m) or more in thickness by mid-winter (Bureau of Outdoor Recreation 1974).

The Andreafsky River supports a wide variety of both resident and anadromous fish populations. It is an important spawning area for summer chum, coho, pink and chinook salmon in the Yukon River (Barton 1984). The most abundant salmon species in the Andreafsky River is the summer chum salmon. The Andreafsky River supports the second largest escapement of summer chum salmon in the entire Yukon river drainage (Buklis 1985; Barton 1984). Generally, the mainstem supports a larger escapement than the East Fork. From 1973 to 1989, aerial survey index counts of summer chum salmon escapement for the East Fork ranged from 43,056 to 223,485 fish while aerial survey index counts for the mainstem ranged from 33,578 to 238,565 fish during the same time period (McLean et al. 1977; Joint Canada/United States Yukon River Technical Committee 1990; Barton 1984). Department sonar and tower counting studies on the East Fork have resulted in total season population estimates for the years 1981-84 and in 1986 (Buklis 1985). Although the exact spawning distribution has not been determined, Pourchot (1974) found chum salmon as far as 102 miles (163 km) upstream from St. Marys.

The Andreafsky River supports the second largest escapement of chinook salmon in the Yukon river drainage based on aerial survey index counts (Buklis 1985). Generally, the mainstem supports a larger escapement than the East Fork. From 1973 to 1989, estimated escapements of chinook salmon into the mainstem ranged from 285 to 3,158 fish while escapements into the East Fork ranged from 818 to 2,487 fish during the same time period (McLean et al. 1977; Joint Canada/United States Yukon River Technical Committee 1990; Barton 1984). Chinook salmon have been observed as far upstream as 85 miles (136 km) above St. Marys (Pourchot 1974).

The Andreafsky River also supports populations of pink and coho salmon. Escapements of pink salmon into the Andreafsky River are believed to be the largest in the Yukon River drainage (Buklis 1985; Barton 1984). Pink salmon have been observed as far as 85 miles (136 km) upstream from St. Marys (Pourchot 1974).

Although data are very limited on the life histories and population dynamics of resident fish species in the Andreafsky River, it is known to support large populations of Arctic char/Dolly Varden, Arctic grayling, northern pike and whitefish. Pourchot (1974) observed Arctic grayling and Arctic char/Dolly Varden throughout the river and captured

several Arctic grayling and Arctic char/Dolly Varden which were nearly 20 inches (50.8 cm) in length.

The Andreafsky River, including the East Fork, was designated a wild river by the Alaska National Interest Lands Conservation Act and much of the upper watershed is included in the 1.3 million acre (526,110 ha) Andreafsky Wilderness. Thus, the Andreafsky River watershed, and its fishery resources are relatively unimpacted by resource management activities. At the same time, the lower Yukon River, Commercial Fishing district 1, supports a major commercial salmon fishery. Approximately 70% of the total Yukon River commercial catch of chinook salmon is taken in District 1 (Wilcock 1984). Management of the Yukon River commercial salmon fishery probably has the greatest potential for influencing the Andreafsky River salmon stocks than any other activity.

Archuelinguk River

The Archuelinguk River has its origin in the southern part of the Andreafsky Hills in the Andreafsky Wilderness Area and flows southwesterly before entering the Yukon River near Mountain Village. The Archuelinguk River watershed is about 265 square miles (686 km^2) and is characterized by mountainous terrain and moderate stream gradients.

The Archuelinguk River supports both resident and anadromous fish populations. Spawning and rearing of pink, chum, coho and chinook salmon have been documented in this drainage (Alaska Department of Fish and Game 1986b). Arctic char/Dolly Varden, burbot, northern pike and round whitefish occur in the Archuelinguk River (Alaska Department of Fish and Game 1986c). However, information on the spawning and rearing habitats for these species is not available.

Except for subsistence harvest of salmon and resident fish species, fish populations in Archuelinguk River receive little attention. The potential for sport fishing and other recreational activities is considered to be minimal because of poor accessibility although some sport fishing by local residents does occur. A major commercial fishery in the lower mainstem Yukon River undoubtedly intercepts salmon destined for the Archuelinguk River. However, interception rates have not been estimated. Increased commercial harvest in the future could pose a significant impact to salmon populations in the watershed.

Atchuelinguk River

The Atchuelinguk River has its origin in the northeastern portion of the Andreafsky Hills and flows southwesterly before it enters the Yukon River near Pilot Station. The Atchuelinguk River watershed lies just east of the Andreafsky River watershed and drains about 2,240 square miles (5,801 km^2). Tributaries to this river include the Nageethluk and Kugukutauk rivers which have watersheds of about 575 and 330 square miles (1,489 and 855 km), respectively. These two tributaries originate in the foothills east of the Atchuelinguk mainstem and flow west across lowland valley terrain. The Atchuelinguk River watershed is

characterized by mountainous terrain on the west and lowland valley terrain on the east.

The Atchuelinguk River supports both resident and anadromous fish populations. Chinook, coho and chum salmon have been documented in the watershed (Alaska Department of Fish and Game 1986b). Resident fish species that occur here include burbot, northern pike, Arctic grayling, Arctic char/Dolly Varden, Bering cisco, least cisco, sheefish, humpback whitefish, broad whitefish and round whitefish (Alaska Department of Fish and Game 1986c).

Except for subsistence harvest of salmon and resident species in the Atchuelinguk River, fish populations receive little attention. Sport fishing and recreation in the drainage has low potential because of poor accessibility. A major commercial fishery in the lower mainstem Yukon River presents a potential impact to Atchuelinguk salmon stocks. Interception rates have not been estimated and increased commercial harvest could significantly decrease salmon escapement into the Atchuelinguk watershed.

Yukon Delta

The Yukon Delta consists of that area downstream from the village of Mukialik and includes all waters associated with and connected to the Kwikluak Pass, Kawanak Pass, and the Apoon Pass distributaries. The delta is nearly flat with a slope of 1:5000 and is characterized by active and inactive distributary channels, interconnecting marshes and lakes, natural levies and channel bars. Low willow, aspen, sedge and grasses are dominate vegetation types. The delta is significantly influenced by the mixture of diurnal and semi-diurnal tidal cycles and frequent storm surges (National Oceanographic and Aeronautic Administration 1986).

The delta supports a variety of both marine and freshwater species that include resident and anadromous populations. Five species of Pacific salmon occur on the delta. Chinook, coho, chum, pink and sockeye salmon utilize the major channels for migration corridors into the upper river. Most of the interior area of the delta remains unsurveyed for the presence or absence of salmon (Alaska Department of Fish and Game 1986b). Other relatively common species include sheefish, whitefish and cisco. A complete species list is given in Table 6.

Subsistence and commercial fishing both occur in this area. Commercial fishing is the major activity on the Yukon River Delta that poses a potential impact to the fishery resources. Sport fishing and recreation has low potential on the delta.

Yukon River Mainstem

The Yukon River mainstem extends from Mountain Village upstream to the refuge boundary about 20 miles (32 km) downstream from Holy Cross. The area is characterized by river lowlands and floodplains. The Yukon

Table 6. List of common and scientific names of fish species caught during the winter 1984 and summer 1985 surveys of the Yukon River Delta (National Oceanic and Atmospheric Administration 1986).

Common Name	Scientific Name
Anadromous	
pink salmon	*Oncorhynchus gorbuscha*
chum salmon	*Oncorhynchus keta*
coho salmon	*Oncorhynchus kisutch*
chinook salmon	*Oncorhynchus tshawytscha*
Dolly Varden/Arctic char	*Salvelinus* sp.
inconnu (sheefish)	*Stenodus leucichthys*
humpback whitefish	*Coregonus pidschian*
broad whitefish	*Coregonus nasus*
round whitefish	*Prosopium cylindraceum*
Arctic cisco	*Coregonus autumnalis*
Bering cisco	*Coregonus laurettae*
least cisco	*Coregonus sandinella*
boreal smelt	*Osmerus mordax*
threespine stickleback	*Gasterosteus aculeatus*
ninespine stickleback	*Pungitius pungitius*
Arctic lamprey	*Lampetra japonica*
Freshwater	
pond smelt	*Hypomesus olidus*
longnose sucker	*Catostomus catostomus*
northern pike	*Esox lucius*
burbot	*Lota lota*
Alaska blackfish	*Dallia pectoralis*
trout-perch	*Percopsis omiscomaycus*
Marine	
starry flounder	*Platichthys stellatus*
Arctic flounder	*Liopsetta glacialis*
Arctic cod	*Boreogadus saida*
saffron cod	*Eleginus gracilis*
fourhorn sculpin	*Myoxocephalus quadricornis*
Pacific herring	*Clupea harengus pallasi*
capelin	*Mallotus villosus*
Bering poacher	*Occella dodecaedron*
pricklebacks	Stichaeidae
whitespotted greenling	*Hexagrammos stelleri*

River flows very slowly in this area and is extensively braided with numerous sloughs and backwaters. Two river tributaries join the Yukon River from the south in this area, the Reindeer and Talbiksok rivers. This portion of the Yukon River supports both resident and anadromous fish populations. Five species of Pacific salmon occur in this section of the Yukon River. Adjacent areas, including the Reindeer and Talbiksok rivers, are unsurveyed for the presence or absence of salmon (Alaska Department of Fish and Game 1986b). Resident fish species include Arctic char/Dolly Varden, Arctic grayling, burbot, northern pike, round whitefish, Arctic cisco, Bering cisco, humpback whitefish, broad whitefish and sheefish (Alaska Department of Fish and Game 1986c).

Subsistence harvest of salmon and resident species and commercial harvest of salmon are the major activities occurring in this section of the Yukon River. Increased rates of harvest could pose potential impacts to those populations.

SECTION 4: HUMAN USE AND MANAGEMENT HISTORY

The fishery resources of the Yukon Delta National Wildlife Refuge play a major role in the regional economy and culture of the area. This section of the fishery management plan describes that role, how the fishery resources were used in the past, how they are used and managed today, and the kinds of uses that can be anticipated in the future. A general overview and history of the various management activities carried out on the Yukon Delta National Wildlife Refuge is presented in Table 7. In general, fish are used in three ways on the Yukon Delta National Wildlife Refuge; commercially, for subsistence and for recreation. The following is a more detailed description of each use and its importance.

Commercial Fisheries

Commercial fishing on the Yukon Delta National Wildlife Refuge started in the early 1900's but did not develop until the early 1960's. Improvements in fishing gear, better processing capabilities and increased participation by fishermen significantly expanded the commercial fisheries in recent years. Limited entry regulations were enacted in 1976 for some salmon fisheries and in 1988 for some herring fisheries to limit the number of fishermen participating in these fisheries.

The commercial fisheries on the Yukon Delta National Wildlife Refuge are regulated by the State and managed cooperatively by the Service and Department. Commercial fisheries are concentrated in the lower Yukon River, the lower Kuskokwim River, along the western coastline and Nunivak Island. Each of these areas and its fisheries are discussed below.

Table 7. Summary of fishery management activities carried out on the Yukon Delta National Wildlife Refuge, Alaska.

Watershed	Management Activity	Chronology	Agency
Lower Yukon River	Regulation of commercial and subsistence fisheries.	1960-Present	Comm. Fish ADFG[1]
	Salmon tagging studies.	1961-1973	Comm. Fish ADFG
	Scale pattern analysis/chinook salmon stock identification and catch apportionment to run of origin.	1980-Present	Comm. Fish ADFG
	Salmon spawning escapement surveys.	1953-1959 1960-Present	USFWS[2]; Comm. Fish ADFG
	Genetic stock identification of chinook and chum salmon stocks.	1987-Present	USFWS
	Salmon test fishing.	1963-Present	Comm. Fish ADFG
	Hatchery site investigation.	1983	FRED[3] ADFG
	Modeling of chinook salmon migration timing.	1983	Comm. Fish ADFG
	Age, sex, and size composition of salmon catch.	1969-Present	Comm. Fish ADFG
	Investigation of juvenile salmon and non-salmon fishes in the Yukon River Delta.	1986	NOAA[4]
	Subsistence salmon harvest surveys.	1961-Present	Comm. Fish ADFG
	Mainstem sonar salmon enumeration.	1985-Present	Comm. Fish ADFG
	Investigation of subsistence salmon fishery in the lower Yukon River.	1982	Subs.[5] ADFG

Table 7. (Continued).

Watershed	Management Activity	Chronology	Agency
	Study on resource use and socio-economic systems: case studies of fishing and hunting in communities of lower Yukon River.	1983	Subs. ADFG
	Investigation of subsistence harvest of Pacific salmon in the Yukon River.	1989	Subs. ADFG
	Fishery investigations.	1957-1958 1956	USFWS USFWS
Andreafsky River	Spawning salmon escapement surveys.		
	Aerial surveys (both forks).	1961-Present	Comm. Fish ADFG
	Side scanning sonar (East Fork).	1981-1984, 1986	
	Counting tower.	1986-1988	Comm. Fish ADFG
	Age and sex composition of adult salmon carcass surveys.	1981-Present	
	Wild and scenic river analysis	1974	BOR[6]
Atchuelinguk & Archuelinguk Rivers	Spawning salmon escapement surveys.	1974-Present	Comm. Fish ADFG
North Coastal Region[7]	Salmon stock assessment project.	1981-1982	Comm. Fish ADFG
	Regulation of commercial and subsistence fisheries.	1960-Present	Comm. Fish ADFG
Nunivak Is.	Regulation of commercial and subsistence fisheries.	1960-Present	Comm. Fish ADFG
	Pacific herring test fishing.	1989-Present	Comm. Fish ADFG
	Biomass estimates of Pacific herring stocks.	1985-Present	Comm. Fish ADFG
	Investigations on subsistence use of Pacific herring.	1984, 1989	Subs. ADFG
	Fisheries resources survey.	1965	USFWS

Table 7. (Continued).

Watershed	Management Activity	Chronology	Agency
Nelson Is. and surrounding area	Regulation of commercial and subsistence Pacific herring fisheries.	1960-Present	Comm. Fish ADFG
	Subsistence surveys of Pacific herring harvest.	1975-Present	Comm. Fish; Subs. ADFG
	Biomass estimates of Pacific herring stocks.	1985-Present	Comm. Fish ADFG
	Investigations on subsistence use of Pacific herring.	1984, 1986, 1987, 1989	Subs. ADFG
	Test fishing-Pacific herring stocks.	1978-Present	Comm. Fish ADFG
Kokechik Bay	Management activites are the same as Nelson Island above.	1980-Present	Comm. Fish ADFG
Lower Kuskokwim R.	Regulation of commercial and subsistence fisheries.	1960-Present	Comm. Fish ADFG
	Salmon tagging.	1961, 1962, 1966, 1989	Comm. Fish ADFG
	Investigations of abundance, age, sex, and size of salmon catches and escapements.	1982-Present	Comm. Fish ADFG
	Subsistence investigation.	1986	Subs. ADFG
	Survey of food use in middle Kuskokwim River.	1981	Subs. ADFG
	Resource use patterns in central Kuskokwim River area.	1986	Subs. ADFG
	Investigation of resource use areas.	1982	Subs. ADFG
	Investigation of Kuskokwim River chinook salmon subsistence fisheries.	1986	Subs. ADFG
	Survey of food in middle Kuskokwim River.	1980	Subs. ADFG

Table 7. (Continued).

Watershed	Management Activity	Chronology	Agency
	Test fishing at Bethel.	1966-Present	Comm. Fish ADFG
	Subsistence salmon harvest surveys.	1960-Present	Comm. Fish; Subs. ADFG
	Investigation of beavers and fish.	1984-1985	USFWS
Aniak River	Side scan sonar project.	1980-Present	Comm. Fish ADFG
	Aerial spawning surveys.	1961-Present	Comm. Fish ADFG
	Stream survey.	1975	Sport Fish[8] ADFG
Eek River	Reconnaissance survey.	1976	Comm. Fish ADFG
	Aerial spawning surveys.	1964-Present	Comm. Fish ADFG
	Stream survey.	1975-1976	Sport Fish ADFG
Kasigluk River	Reconnaisance survey.	1978	Comm. Fish ADFG
	Aerial spawning surveys.	1959-Present	Comm. Fish ADFG
	Stream survey.	1975-1976	Sport Fish ADFG
Kisaralik River	Wild and scenic river analysis.	1978	Heritage Cons.& Rec. Service
	Stream and lake survey.	1981-1982	Comm. Fish ADFG
	Wild and scenic river analysis.	1976	BLM[9]
	Sport fish investigation and stream and lake study.	1975-1976	Sport Fish ADFG
	Aerial spawning surveys.	1959-Present	Comm. Fish ADFG

Table 7. (Continued).

Watershed	Management Activity	Chronology	Agency
	General survey of fish and wildlife resources.	1984	USFWS
Kwethluk River	Stream survey.	1975-1976	Sport Fish ADFG
	Aerial spawning surveys.	1961-Present	Comm. Fish ADFG
	Side-scan sonar project.	1979	Comm. Fish ADFG
Tuluksak River	Survey of resource use.	1980-1983	Subs. ADFG
	Fisheries reconnaissance.	1983	Comm. Fish ADFG
	Stream survey - distribution of salmon habitat and mining effects.	1975-1976	Comm. Fish and Habitat[10] ADFG
Hooper Bay	Investigation of subsistence use and resource harvest patterns.	1983	Subs. ADFG
	Salmon tagging.	1986	BSFA[11]
Kwigillingok	Investigation of subsistence use and resource harvest patterns.	1983	Subs. ADFG

[1] Division of Commercial Fisheries, Alaska Department of Fish and Game
[2] U.S. Fish and Wildlife Service, U.S. Department of Interior
[3] Fisheries Rehabilitation, Enhancement, and Development Division, Alaska Department of Fish and Game
[4] National Oceanic and Atmospheric Administration, U.S. Department of Commerce
[5] Division of Subsistence, Alaska Department of Fish and Game
[6] Bureau of Outdoor Recreation, U.S. Department of Interior
[7] All the waters between the Apoon mouth of the Yukon River and Stephans Pass near Stebbins-St. Michaels
[8] Division of Sport Fisheries, Alaska Department of Fish and Game
[9] Bureau of Land Management, U.S. Department of Interior
[10] Division of Habitat, Alaska Department of Fish and Game
[11] Bering Sea Fisheries Association

Kuskokwim River

Early History. The Kuskokwim area commercial salmon fishery is the oldest in the Arctic-Yukon-Kuskokwim Region with catches reported as early as 1913. For many years, small commercial mild-cure operations were conducted in or near Kuskokwim Bay while the Kuskokwim River fishery remained virtually undeveloped. During the 1930's, when dog teams were extensively used for freight hauling, a commercial fishery operated in the McGrath area for the sale of dried salmon as dog food. This fishery declined with the diminishing use of dog teams. The Kuskokwim area experienced little additional commercial effort until Alaska became a state more than 20 years later. The commercial salmon industry has grown significantly since statehood as area fishermen have been making the difficult transition from a subsistence culture to a cash economy. Fishing effort increased greatly during the 1970's, but stabilized with enactment of limited entry regulations in 1976. The trend toward increasing boat horsepower, more efficient hull types, use of more efficient nylon and plastic gill nets, and increased numbers of tenders has contributed significantly to the greater efficiency of the commercial fishery in recent years which allows similar harvest levels to be realized in less time. The overall expansion of the commercial fishery could not have been accomplished without the improvements in markets, processing facilities and fishery management strategies that have occurred throughout the area (Alaska Department of Fish and Game 1985a).

Recent Development and Trends. The management objective for all species and all districts is to meet established escapement objectives and allow harvest of fish that are surplus to spawning requirements. Subsistence fishing receives the highest priority of all uses of the fishery resource. Prior to 1983, management strategy was based on the harvest-guideline concept. However, in 1983, management strategy was changed to an escapement-objective based concept. By 1983, area escapement data became sufficient to establish provisional salmon spawning escapement objectives in major spawning tributaries. Salmon escapement objectives for Kuskokwim River tributaries on the refuge are listed in Table 8. The change in management strategy appears to be increasing the annual harvests and escapements (Table 9), although it is too early to determine if this strategy will provide a long term increase in production (Alaska Department of Fish and Game 1989a).

The index of annual spawning escapements is accomplished through low level aerial surveys using single-engine fixed-wing aircraft. Key streams and lakes throughout the area are surveyed. A weir on the Krogrukuik River, a sonar counter on the Aniak River and a sonar counter on the mainstem Kuskokwim River a few kilometers upstream of Bethel provide more accurate estimates of escapement and allow calibration of some aerial surveys. Turbid water conditions and inclement weather often prevent accurate aerial estimates of escapement.

Distributing harvest throughout the run is accomplished primarily by adjusting the number and duration of commercial fishing periods and

Table 8. Chinook, sockeye, coho and chum salmon escapement index objectives for Kuskokwim River tributaries on the Yukon Delta National Wildlife Refuge, Alaska (Alaska Department of Fish and Game 1989a).

Tributary	Escapement Objective			
	chinook salmon	sockeye salmon	coho salmon	chum salmon
1. Kwethluk River				
a. 3-step Mt. to Canyon Creek	1,000	-	-	7,000
b. Canyon Creek	200	-	-	-
2. Kisaralik River (Airstrip to Kisaralik Lake)	1,000	-	-	8,000
3. Kasigluk River (upper to lower)	1,000	-	-	5,000
4. Tuluksak River (Fog R. to Bear Cr.)	400	-	-	5,000

Table 9. Lower Kuskokwim River, District 1, and the middle Kuskokwim River, District 2, combined commercial salmon harvest, 1960-1989 (Alaska Department of Fish and Game 1989a).

Date	chinook salmon	sockeye salmon	coho salmon	pink salmon	chum salmon	Total
1960	5,969	0	2,498	0	0	8,467
1961	18,918	0	5,044	0	0	23,962
1962	15,341	0	12,432	0	0	27,773
1963	12,016	0	15,660	0	0	27,676
1964	17,149	0	28,613	0	0	45,762
1965	21,989	0	12,191	0	0	34,180
1966	25,545	0	22,985	0	0	48,530
1967	29,986	0	56,313	0	148	86,447
1968	34,278	0	127,306	0	187	161,771
1969	43,997	322	83,765	0	7,165	135,249
1970	39,290	117	38,601	44	1,664	79,716
1971	40,274	2,606	5,253	0	68,914	117,047
1972	39,454	102	22,579	8	78,619	140,762
1973	32,838	369	130,876	33	148,746	312,862
1974	18,664	136	147,269	84	171,887	338,040
1975	21,720	23	81,945	10	181,840	285,538
1976	30,735	2,971	88,501	133	177,864	300,204
1977	35,830	9,379	241,364	203	248,721	535,497
1978	45,641	733	213,393	5,832	248,656	514,255
1979	38,966	1,054	219,060	78	261,874	521,032
1980	35,881	360	222,012	803	483,211	742,267
1981	47,663	48,375	211,251	292	418,677	726,258
1982	48,234	33,154	447,117	1,748	278,306	808,559
1983	33,174	68,885	196,287	211	276,698	575,205
1984	31,742	48,575	623,447	2,942	351,718	1,058,424
1985	37,889	106,647	335,606	75	199,478	679,695
1986	19,414	95,433	659,988	3,422	309,213	1,087,470
1987	36,179	136,602	399,467	43	574,336	1,146,627
1988	55,716	92,205	524,296	10,825	1,381,674	2,064,536
1989[1]	43,217	42,747	479,856	464	749,182	1,315,466
5 Yr Ave 1985-89	38,483	94,691	479,843	2,965	642,777	1,258,759

[1] Alaska Department of Fish and Game 1990a

varying the time intervals between the fishing periods. Usually, fishing periods last from 6 to 12 hours depending on the species, effort and return magnitude (Alaska Department of Fish and Game 1989a). Lower Kuskokwim River commercial fishermen operate highly mobile drift gill nets. This type of fishing involves laying out 300 feet (50 fathoms) of gill net from a skiff and then drifting with the river current. Drift net fishing requires a section of river that is relatively free of snags. Set gill nets are not utilized to a great extent by commercial fishermen and are used mainly for subsistence fishing. Commercial set gill nets are fished in small eddies along the bank of the Kuskokwim River and larger eddies out in the main river. Set gill netting is done with much shorter nets, usually 30 to 90 feet (5 to 15 fathoms) in length (Alaska Department of Fish and Game 1985b).

Because of declining escapements of Kuskokwim River chinook salmon, the commercial fishery was restricted to six inch (15 cm) or smaller stretched mesh gill nets starting in 1985 to reduce the harvest of larger female chinook salmon. Although the proportion of females in the commercial fishery appeared to be declining and the proportion of females in the escapement at the Kogrukluk weir appeared to be increasing, the overall spawning escapement did not appear to be increasing. Finally, in 1987, the Alaska Board of Fisheries approved regulations that eliminated directed commercial harvest of chinook salmon in order to continue to provide for sustained levels of subsistence harvest (Alaska Department of Fish and Game 1989a).

The change in fishing regulations has resulted in the Kuskokwim River chinook salmon spawning escapement objectives being met only twice since 1981. Although overall Kuskokwim River escapement objectives for chinook salmon are improving, chinook salmon spawning escapement in individual streams on the Yukon Delta National Wildlife Refuge continue to be below escapement objectives. However, the Kwethluk River chinook salmon escapement objective was achieved in 1989 and 1990, the first times since 1979.

Sockeye salmon are also harvested incidentally to chum salmon in Districts 1 and 2. Before 1981, sockeye and chum salmon in commercial or subsistence catches were not accurately identified in the Kuskokwim River. For this reason, the true accounting of the sockeye and chum salmon harvest in the main Kuskokwim River is not known. Fishermen, processors, and the Department have worked since 1981 to identify each species accurately in the commercial harvest. Sockeye salmon have comprised 6 to 24 percent of the chum-sockeye salmon catch since 1981. Before 1981, the reported sockeye salmon catch was less than two percent of the chum-sockeye salmon catch (Table 9). The limited sockeye salmon database and interviews with lifelong residents of the drainage suggest that the recent increase in catch is not all due to the improved reporting. The size of the sockeye salmon return seems to have increased in recent years. Because of limited data, there are no escapement objectives for sockeye salmon in the Kuskokwim River (Alaska Department of Fish and Game 1989a).

Before 1971, chum salmon commercial harvests were incidental to chinook and coho salmon commercial harvests. In 1971, a Kuskokwim River commercial chum salmon fishery was initiated because data indicated that populations were large enough and productive enough to support a directed commercial fishery without impacting the subsistence fishery (Alaska Department of Fish and Game 1985b). Annual commercial harvest in Districts 1 and 2 have increased steadily since the inception of the fishery with a record catch of 1,381,674 chum salmon harvested in 1988 (Table 9).

Commercial Fishing Regulations. Commercial fishing regulations are established by the Alaska Board of Fisheries and are listed in the 1990-1991 edition of the Arctic-Yukon-Kuskokwim Region, Commercial and Subsistence Fishing Regulations, Salmon and Miscellaneous Finfish. The following summary was taken from Chapter 7 - Kuskokwim Area (Alaska Department of Fish and Game 1990b).

Commercial salmon fishing occurs in two districts on the refuge (Figure 7). District 1 consists of that portion of the Kuskokwim river upstream from Apokak Slough to approximately one mile above the mouth of the Tuluksak River. District 2 is that portion of the Kuskokwim River just below Lower Kalskag to the downstream edge of Chuathbaluk.

Commercial salmon fishing seasons are opened and closed by emergency order and usually close on September 1. Fishing periods, generally six hours in length, are established by emergency order and their frequency is determined by run strength.

The only gear authorized for commercial fishing are drift and set gill nets. Gill nets must be clearly identified, have six inch (15 mm) or smaller mesh, be no deeper than 45 meshes and may not exceed 50 fathoms in length.

Salmon may not be taken in the following locations: 1) waters of the Kuskokwim River drainage not in Districts 1 and 2; 2) tributaries and 3) waters of Kuskokwak Slough.

The objective of the Kuskokwim River Salmon Management Plan is to provide guidelines for the management of sustained yields of salmon stocks large enough to provide for subsistence needs and an economically viable commercial fishery.

It is the intent of the Alaska Board of Fisheries that Kuskokwim River chinook salmon be managed in a conservative manner consistent with sustained yield principles, a subsistence priority and an intent that available surpluses of other salmon stocks be taken. In order to accomplish these objectives, the Department shall manage the Kuskokwim River commercial salmon fishery as follows: 1) There may not be a directed commercial chinook salmon fishery; 2) only those waters of District 1 downstream of the Department regulatory markers located at Bethel may be open during the first fishing period; 3) there must be at least three eight hour fishing periods in June; 4) although no directed

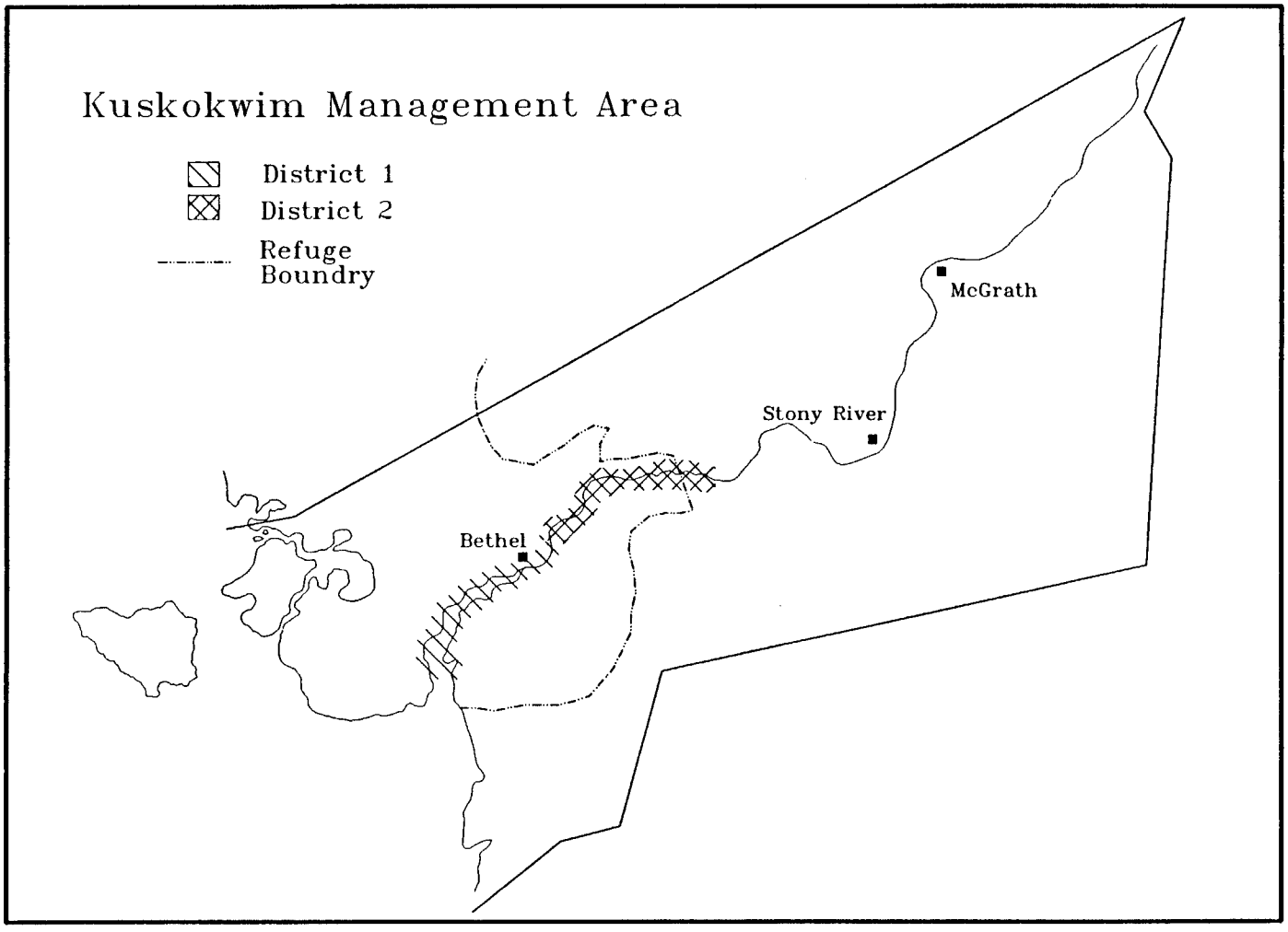

Figure 7. Kuskokwim Management Area, Alaska Department of Fish and Game commercial fishing districts on the lower Yukon River, Alaska.

fishery on chinook salmon is allowed, the incidental catch guideline harvest level for chinook salmon taken during fisheries directed on other species is 15,000 to 50,000 fish; 5) to the extent possible, the Department shall provide at least 24 hours advance notice of the opening of District 1 and 2 fishing periods and 6) District 1 and District 2 fishing periods are from 1:00 p.m. until 7:00 p.m.; when longer fishing periods are allowed, the extra time is to be divided before 1:00 p.m. and after 7:00 p.m.

Nunivak/Nelson Islands

Early History. The Nelson-Nunivak islands area was closed by emergency order to commercial fishing in 1978 when commercial Pacific herring fisheries first began in the Kuskokwim Area. This was done to protect the subsistence Pacific herring fishery that was identified by the Department's Outer Continental Shelf Environmental Assessment Program. In 1979, the Alaska Board of Fisheries closed the area to protect the subsistence fishery and the Department continued to conduct research on the Pacific herring stocks in the area.

Recent Development and Trends. Increased knowledge of Pacific herring abundance, subsistence fisheries, and increased public interest in a commercial fishery resulted in the Alaska Board of Fisheries providing for a commercial fishing season for the first time during 1985 (Alaska Department of Fish and Game 1985b). This fishery is managed more conservatively than other commercial herring fisheries in the state to avoid a conflict with the subsistence fishery.

Pacific herring return to the Nelson and Nunivak Islands Districts between early May and early June depending on ice and weather conditions. Peak Pacific herring spawning probably occurs 7-14 days after the Togiak District, similar with that of the Cape Romanzof District. In the past, surveys of these districts have been hampered by weather conditions, time limitations and budget constraints. The 1985-1989 estimated biomass and commercial harvest of Pacific herring in the Nunivak and Nelson Islands Districts are presented in Table 10.

Harvested fish species other than salmon or Pacific herring are primarily used for subsistence or recreational purposes. Commercial fishing for halibut occurs in Etolin Strait and along the southern shore of Nunivak Island. Limited commercial endeavors are allowed in many areas by permit, but may be prohibited in some freshwater areas. Commercial harvest of whitefish centers around the broad whitefish, which are harvested with gillnets. This commercial fishery is extremely limited.

Commercial Fishing Regulations. Commercial fishing regulations for Pacific herring are established by the Alaska Board of Fisheries and are listed in the 1990 Commercial Herring Fishing Regulations. The following summary was taken from Article 3, Statistical Area W, Kuskokwim Area (Alaska Department of Fish and Game 1990c).

Table 10. Estimated biomass and harvest in short tons (ST) and metric tons (MT) of Pacific herring in the Nunivak and Nelson Island Districts for 1985-1989 (Alaska Department of Fish and Game 1989b).

District	Year	Estimated Biomass		Harvest	
		ST	MT	ST	MT
Nunivak Island	1985	5,700	5,171	358	325
	1986	6,000	5,443	511	463
	1987	4,400	3,992	414	375
	1988	2,800	2,540	0	0
	1989	617	560	116	105
Nelson Island	1985	9,500	8,618	977	886
	1986	7,300	6,622	886	804
	1987	8,100	7,348	923	837
	1988	7,152	6,448	775	703
	1989	3,316	3,008	233	211

Commercial fishing for Pacific herring occurs in two districts on the refuge, the Nelson Island and Nunivak Island Districts. Pacific herring may be taken only from May 1 through June 30 and fishing periods are established by emergency order. Gillnets are the only legal gear for taking Pacific herring.

Due to the importance of subsistence utilization of herring by local residents in the Nelson Island District, special measures are necessary to insure that the subsistence priority required by state law is provided during development of the commercial herring fishery in this area. Regulations necessary for the orderly development of the commercial herring fishery in the Nelson Island District do not in any way restrict the taking of herring or other fish for subsistence purposes. In addition, commercial fishermen may retain fish for subsistence use.

In order to provide additional protection of the subsistence herring fishery, the following guidelines were provided: 1) The commercial fishery will be allowed to take up to 15 percent of the available herring biomass, compared to up to twenty percent for most other fisheries having stocks of similar size and condition; 2) The commercial fishing season will be opened when a biomass of 1000-1500 metric tons or spawning activity is documented; 3) Periodic closures of the commercial fishery will be scheduled, during which time subsistence fishing will be the only activity allowed; 4) Several important subsistence use areas occur throughout the district, including waters north of Cape Vancouver, and specific areas may be closed to commercial fishing to insure the adequacy of subsistence harvests and 5) The Department will use all available means, including input from local residents, to insure the adequacy of subsistence herring harvests during the commercial fishing season.

Yukon River

Early History. The first recorded commercial harvest of Yukon River salmon in Alaska was in 1918 when Carlisle Packing Company operated a floating cannery at Andreafsky (now St. Mary's). Relatively large catches of chinook, coho and chum salmon were made during the first four years of this fishery. Since this time, commercial fisheries in the Yukon River have expanded significantly, especially since 1959 when Alaska became a state (Alaska Department of Fish and Game 1988). The relatively recent development and expansion of the commercial salmon fishery has enabled many area residents to obtain a cash income. In recent years (1978-1987) fishermen have received approximately 6.7 million dollars annually. The vast majority of all commercial fishermen are Yup'ik Eskimo and Athabascan Indian residents of the Yukon River drainage (Alaska Department of Fish and Game 1988).

Recent Development and Trends. The overall objective of the Yukon River area research and management programs is to manage the various salmon runs on an optimum sustained yield basis. Subsistence fishing has been designated by the Alaska State Legislature and the Alaska Board of

Fisheries as the highest priority use. Where the dependence upon subsistence fishing has declined, the Department has liberalized regulations to allow development of commercial fisheries (Alaska Department of Fish and Game 1988). Department management plans for the commercial fishery provide for both subsistence fishing and conservation requirements.

It has been a policy of the Department to maintain current levels of commercial utilization in order to establish definite trends in subsistence utilization and to obtain more information on the relationship between the salmon catch and return. Because increases in commercial fishing efficiency are expected, the Department anticipates that present regulations will be maintained or become even more restrictive. Such action is essential to maintain the priority of subsistence fishing and provide spawning escapements necessary for continued sustained yield harvest of the resource. As a result of the above factors the management of the Yukon River salmon runs must take a conservative approach (Alaska Department of Fish and Game 1988).

The basic regulations that govern the commercial salmon harvest in the area are fishing season openings or closures, fishing periods, mesh size restrictions and/or guideline harvest ranges. Commercial fishing in the lower Yukon River has been greatly curtailed in recent years and is currently allowed for a total of one to two days a week during the open season which depends on the district and species involved. Season guideline harvest ranges are utilized for the chinook and fall chum salmon fisheries throughout the area. Fishing effort usually occurs during the entire run and not just during any particular segment of the run (Alaska Department of Fish and Game 1988).

During the fishing season, if it becomes apparent that the run is substantially smaller or larger than needed for escapement and subsistence requirements, the commercial harvest can be adjusted through the use of emergency orders to close or open fishing periods.

The Yukon River drainage is too extensive for complete comprehensive escapement coverage during any given season. Consequently, low-level aerial surveys are the primary method used to obtain escapement information. However, comprehensive enumeration studies, by intensified ground surveys, counting towers, weirs and hydroacoustic projects, are also conducted. The overall objective of escapement enumeration in the Yukon Management Area is to determine abundance (or indices of relative abundance), timing and distribution of spawning salmon populations throughout the drainage (Alaska Department of Fish and Game 1988).

Aerial escapement estimates are made for as many spawning streams as possible within the confines of fiscal, manpower and weather restraints. Representative selected spawning streams or "index areas" have been identified and receive highest priority due to their importance as spawning areas. Escapement estimates of index streams not only provide yearly escapement trends but also allow for post-season

evaluation of management strategies (Alaska Department of Fish and Game 1988).

Preliminary escapement objectives for the Lower Yukon River Area (within the refuge) have only been developed for the Andreafsky River. For chinook salmon, minimum and optimum escapement objectives for the east and west forks are 1,100-1,600 and 700-1,000 fish, respectively. For summer chum salmon, minimum and optimum escapement objectives for the east and west forks are 76,000-109,000 and 62,000-116,000, respectively (Alaska Department of Fish and Game 1988).

The majority of the salmon catch is presently processed as a fresh/frozen product in contrast to earlier years when canning and salting were of greater importance. Salmon are processed at shore-based or floating operations and also transported via aircraft outside the area for processing. In the upper Yukon River area production of salmon roe (purchased directly from fishermen) has increased in recent years (Alaska Department of Fish and Game 1988).

Since commercial salmon fishing began in 1918, most of the Yukon River harvest has occurred in the lower river area. The area was managed primarily for chinook salmon although both chinook and chum salmon are now harvested. The season for chinook salmon usually was closed during late June or early July by emergency order (Alaska Department of Fish and Game 1988).

Commercial fishing effort has increased sharply since 1961. Set gill nets and drift gill nets are the legal gear types used. A limited entry program was established in 1976 which helped to stabilize participation. In 1987, 711 Commercial Fisheries Entry Commission gill net permits were issued (Alaska Department of Fish and Game 1988).

During 1975-1980, chinook salmon harvests in Districts 1 and 2 averaged 95,054 fish. From 1981-1986, the average was 101,863 fish (Table 11).

Excluding the 1920's, sale of other species of salmon captured during the chinook salmon season in the area of Districts 1 and 2 has only been allowed since 1967. The incidental catch of summer chum salmon was limited during the chinook salmon season as fishermen could only use gill nets of eight inch or greater (20.3 cm) stretched mesh. However, beginning in 1970, each fisherman could substitute up to 300 feet (50 fathoms) of any mesh size gill net in Districts 1 and 2. In 1973, all mesh size restrictions were lifted during the chinook salmon season (June 1 through early July) in order to allow greater opportunity to use small mesh nets which are selective toward the more abundant chum salmon. These fishery openings are designated as unrestricted mesh size fishing periods. However, the majority of fishermen continue to fish the larger mesh chinook salmon nets during the unrestricted mesh size fishing periods (Alaska Department of Fish and Game 1988).

Table 11. Commercial chinook salmon catch data, Districts 1 and 2, Lower Yukon River area, 1975-1989 (Alaska Department of Fish and Game, 1988).

Year	District 1	District 2	Total
1975	44,585	11,315	55,900
1976	62,410	16,556	78,966
1977	69,915	16,722	86,637
1978	59,006	32,924	91,930
1979	75,007	41,498	116,505
1980	90,382	50,004	140,386
1981	99,506	45,781	145,287
1982	74,450	39,132	113,582
1983	95,457	43,229	138,686
1984	74,671	36,697	111,368
1985	90,011	48,365	138,376
1986	53,035	41,849	94,884
1987	76,643	47,458	124,101
1988[1]	57,109	35,188	92,297
1989[1]	59,153	33,225	92,378

[1] Dan Bergstrom, Alaska Department of Fish and Game, personal communication.

Since 1961, the commercial fishing season in the lower Yukon River districts, except during the 1987 season, has been reopened following the closure of the chinook salmon season. Primarily chum and coho salmon are taken during the second season. Prior to 1973, the mid-season closure during most of July and often late June was initially for the purpose of insuring an adequate supply of summer chum salmon for upriver subsistence fishermen. This closure also provided protection for the late stages of the chinook salmon run (Alaska Department of Fish and Game 1988).

During the past 15 years, summer chum salmon harvests have increased and more intensive management has been directed toward these stocks as well as chinook salmon. Since 1985, restricted mesh size (six inch maximum mesh size) fishing periods have been allowed prior to and/or during the traditional chinook salmon fishing season. Prior to 1985, restricted mesh fishing periods were only allowed after the chinook salmon season (late June or early July). In recent years (1979-1989), the lower Yukon River area commercial summer chum salmon catch has averaged 672,244 fish annually (Table 12).

The fall chum salmon fishing season is defined as that period after July 15 in District 1. Chum salmon caught after this date are considered fall chum salmon although small numbers of summer chum salmon are incidently taken. Since 1983, there has been a mid-season closure during late July and/or early August to protect early arriving fall chum salmon stocks and to provide time for the Department to assess run strength.

Fall chum salmon have been harvested in the lower Yukon River area beginning in 1961. Since expansion of the fishery in 1969, lower Yukon River area fall chum salmon catches have averaged 192,456 fish annually (1969-89)(Table 13).

In 1974, a 200,000 fall chum salmon quota (after mid-July) was implemented for the combined lower three districts. Also, fishing time was reduced from four to three days a week in Districts 1 and 2. In 1979, fishing time was reduced further to two days a week and the 200,000 quota was replaced by a flexible guideline harvest range of 120,000-220,000 chum salmon (Alaska Department of Fish and Game 1988).

Effective for the 1983-85 seasons, fishing time was regulated by emergency order in Districts 1, 2 and 3. Fishing was further restricted during the 1986 and 1987 seasons by establishment of the Yukon River Fall Chum Salmon Management Plan which reduced the guideline harvest range to 0-110,000 fish for all three lower Yukon River districts. The commercial fishery was implemented by emergency order authority (Alaska Department of Fish and Game 1988).

The harvest of coho salmon in the lower Yukon River is incidental to the harvest of fall chum salmon. Coho salmon peak during mid to late August and lower Yukon River coho salmon catches since 1971 have averaged 29,805 fish annually (1971-89)(Table 14).

Table 12. Commercial summer chum salmon sales by district, Lower Yukon River area, 1977-1989 (Alaska Department of Fish and Game 1988).

Year	District 1	District 2	District 3	Total
1977	250,652	105,679	3,412	359,743
1978	393,785	227,548	27,003	648,336
1979	369,934	172,838	40,015	582,787
1980	391,252	308,704	44,782	744,738
1981	507,158	351,878	54,471	913,507
1982	249,516	182,344	4,086	435,946
1983	451,164	248,092	14,600	713,856
1984	292,676	236,931	1,087	530,694
1985	247,486	188,099	1,792	437,377
1986	381,127	288,427	422	669,996
1987	222,898	174,876	3,501	401,275
1988[1]	648,198	425,172	13,965	1,087,335
1989[1]	547,631	343,962	7,578	899,171
5 Yr Ave 1977-81	382,556	233,329	33,937	649,822
5 Yr Ave 1985-89	409,468	284,107	5,452	699,031

[1] Daniel J. Schneiderhan, Alaska Department of Fish and Game, personal communication.

Table 13. Commercial fall chum salmon sales by district, Lower Yukon River area, 1966-1989 (Alaska Department of Fish and Game 1988).

Year	District 1	District 2	District 3	Total
1966	69,836	-	1,209	71,045
1967	36,451	-	1,823	38,274
1968	49,857	-	3,068	52,925
1969	128,866	-	1,722	130,588
1970	200,306	4,858	3,285	208,449
1971	188,533	-	-	188,533
1972	136,711	12,898	1,313	150,922
1973	173,783	45,304	-	219,087
1974	176,036	53,540	552	230,128
1975	158,183	51,666	5,590	215,439
1976	105,851	21,212	4,250	131,313
1977	131,758	51,994	15,851	199,603
1978	127,947	51,646	11,527	191,120
1979	109,406	94,042	25,955	229,403
1980	106,829	83,881	13,519	204,229
1981	167,834	154,883	19,043	341,760
1982	97,484	96,581	5,815	199,880
1983	124,371	85,645	10,018	220,034
1984	78,751	70,803	6,429	155,983
1985	129,948	40,490	5,164	175,602
1986	59,352	51,307	2,793	113,452
1987[1]	-	-	-	-
1988[2]	45,529	31,861	2,090	79,480
1989[2]	77,876	97,906	15,332	191,114
5 Yr Ave 1977-81	128,755	87,289	17,179	233,223
5 Yr Ave 1984-89	78,291	58,473	6,362	143,126

[1] The fall chum salmon commercial season was not opened due to insufficient run strength (Wilcock 1989).
[2] Daniel J. Schneiderhan, Alaska Department of Fish and Game, personal communication.

Table 14. Commercial coho salmon sales by district, Lower Yukon River area, 1971-1989 (Alaska Department of Fish and Game 1988).

Year	District 1	District 2	District 3	Subtotal
1971	12,165	-	-	12,165
1972	21,705	506	-	22,211
1973	34,860	1,781	-	36,641
1974	13,713	176	-	13,889
1975	2,288	200	-	2,488
1976	4,064	17	-	4,081
1977	31,720	5,319	538	37,577
1978	16,460	5,835	758	23,053
1979	11,369	2,850	-	14,219
1980	4,829	2,660	-	7,489
1981	13,129	7,848	419	21,396
1982	15,115	14,179	87	29,381
1983	4,595	2,557	-	7,152
1984	29,472	43,064	621	73,157
1985	27,676	17,125	171	44,972
1986	24,824	21,197	793	46,814
1987[1]	-	-	-	-
1988[2]	36,435	34,776	1,419	72,630
1989[2]	24,670	38,517	3,988	67,175
5 Yr Ave 1977-81	15,501	4,902	343	20,747
5 Yr Ave 1984-89	28,615	30,936	1,254	60,950

[1] The commercial coho salmon season was not opened to protect the fall chum salmon run (Wilcock 1989).
[2] Daniel J. Schneiderhan, Alaska Department of Fish and Game, personal communication.

A commercial fishery for Pacific herring was started near Cape Romanzof in 1980. Commercial fishing is restricted to the waters of Kokechik Bay although outer district waters can be opened by emergency order in the Cape Romanzof to Point Smith area if a greater proportion of the spawning occurs in this area compared to Kokechik Bay. The arrival and spawning of Pacific herring occurs from mid-May to mid-June. Major intertidal spawning areas are located on the north shore of Kokechik Bay and to a lesser extent the south shore of Scammon Bay (Alaska Department of Fish and Game 1985c).

Although the fishery occurs within the external boundaries of the Yukon Delta National Wildlife Refuge, the submerged land in Kokechik Bay is state land.

Commercial catches have ranged from 611 ST (554 MT) in 1980 to 1,865 ST (1,692 MT) in 1986 with an average catch of 1,054 ST (956 MT) per year (Alaska Department of Fish and Game 1989b).

Commercial Fishing Regulations. Commercial fishing is regulated by the Alaska Board of Fisheries. The following summary was taken from Chapter Five, Yukon Area, in the 1990-1991 edition of the Arctic-Yukon-Kuskokwim Region, Commercial and Subsistence Fishing Regulations, Salmon and Miscellaneous Finfish (Alaska Department of Fish and Game 1990b).

Commercial fishing occurs in the lower portion of the Yukon River Management Area, Districts 1, 2 and 3 (Figure 8)(that portion of District 3 upstream from Great Palmiut Island is off the refuge). District 1 consists of that portion of the Yukon River drainage from its terminus upstream to the mouth of the Anuk River and all waters of the Black River including waters within one nautical mile of its terminus. District 2 consists of that portion of the Yukon River drainage from the mouth of the Anuk River upstream to Toklik and includes the Anuk River drainage. District 3 consists of that portion of the Yukon River drainage from Toklik upstream to the mouth of an unnamed slough downstream from Old Paradise Village.

Fishing periods are established by emergency order. Salmon may be taken in Districts 1, 2 and 3 only as follows: 1) During the early season which will open by emergency order between June 5 and June 15 and will close by emergency order between July 19 and July 25 and 2) The late season will open by emergency order.

In Districts 1, 2 and 3, only set and drift gill nets may be operated, except that in District 1 after July 19, only set gill nets may be operated in the following locations: 1) waters of the Black River including waters within one nautical mile of its terminus; 2) waters of Kwikluak Pass downstream of Agmulegut and the waters of Kwemeluk Pass; 3) waters of Alakanuk Pass downstream from the mouth of Kuiukpak Slough; 4) waters of Kwiguk Pass downstream of the mouth of Kawokhawik Slough; 5) waters of Kawanak Pass downstream from Sea Gull Point; 6) waters of

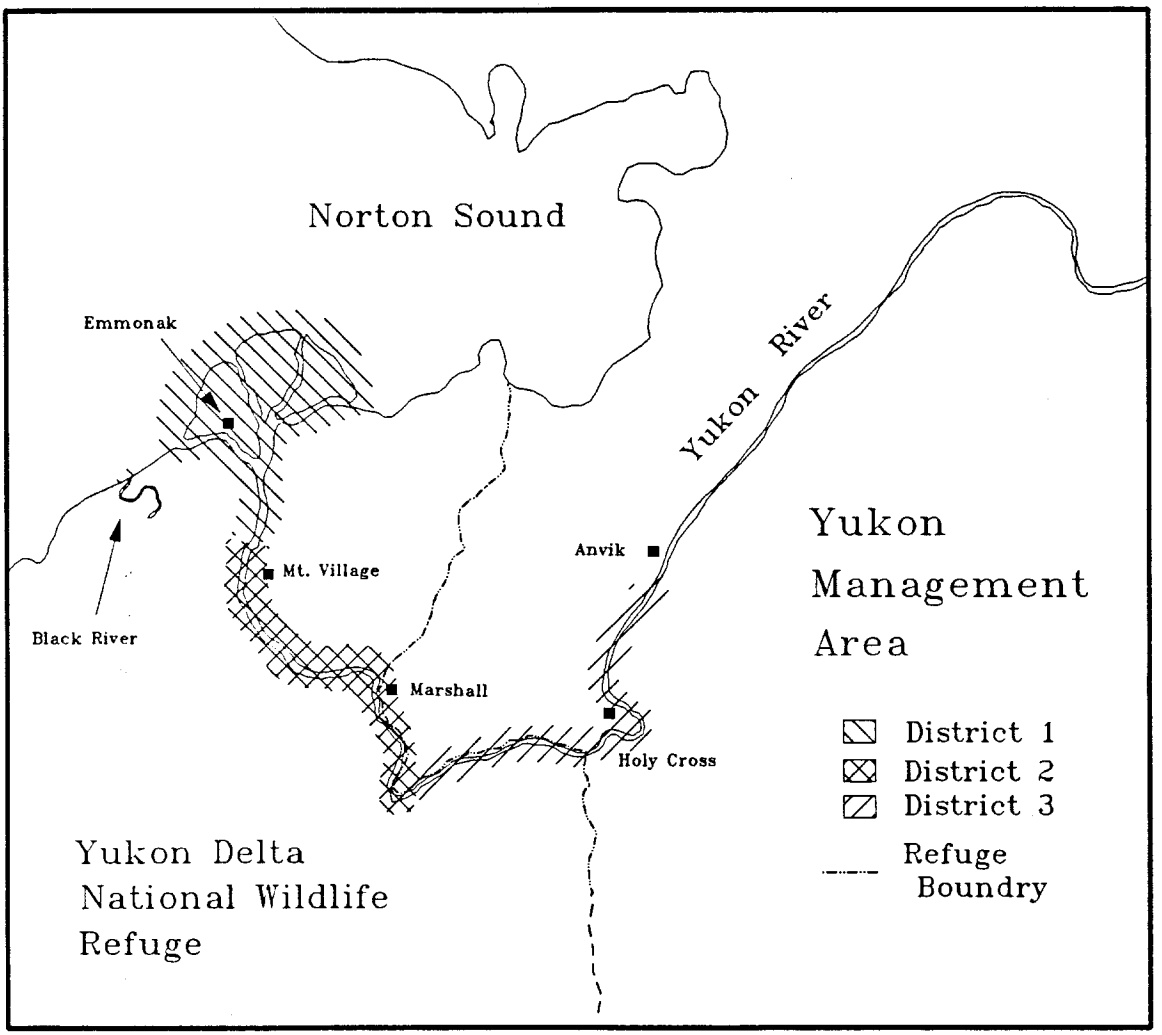

Figure 8. Yukon Management Area, Alaska Department of Fish and Game commercial fishing districts on the lower Yukon River, Alaska.

Kwikpak Pass downstream from Sea Gull Point and 7) waters of Apoon Pass downstream of the mouth of the Kotlik River and waters of Okwega Pass downstream from its confluence with Apoon Pass.

No person may operate set gill net gear that exceeds 150 fathoms in aggregate length; no person may operate drift gill net gear that exceeds 50 fathoms in length. In Districts 1 and 2, salmon may be taken only with gill nets of six inch or smaller mesh during periods established by emergency order. In District 3, salmon may be taken only with gill nets of six inch or smaller mesh during periods established by emergency order.

Fishwheels are not legal commercial fishing gear in Districts 1, 2 and 3. Fishwheel baskets must be stopped from rotating in the water during periods closed to commercial and subsistence fishing. The fishwheel registrant is responsible for the operation of the fishwheel. Each drift gill net in operation must have at one end, a red keg, buoy, or cluster of floats plainly and legibly marked with the fisherman's five digit CFEC permit serial number. Each set gill net and fishwheel in operation must be identified.

In District 1, no person may set or operate any part of a set gill net within 300 feet (91.4 m) of another set gill net. In District 2, no person may set or operate any part of a set gill net within 200 feet (61 m) of another set gill net.

Salmon may not be taken in the following waters: 1) Acharon Channel of the south mouth area of the Yukon River west of a two and one half nautical mile long line located below Chris Point to the opposite site of the channel; 2) other waters farther than one nautical mile seaward from any grassland bank in District 1; 3) waters west of one nautical mile radius from the mouth of the Black river and 4) waters upstream of the Andreafsky River mouth.

When the chinook salmon guideline harvest level has been attained, the season in the district will be closed and a later season may be announced to attain guideline harvest levels for the other species of salmon. The guideline for District 1 and District 2 is 60,000 - 120,000 chinook salmon. The guideline for District 3 is 1,800 - 2,200 chinook salmon.

The Department manages the Yukon River summer chum salmon commercial fishery for a guideline harvest range of 400,000 to 1,200,000 summer chum salmon. A total of 251,000 to 755,000 summer chum salmon can be taken from Districts 1 and 2 and 6,000 to 19,000 summer chum salmon can be taken from District 3.

The Department manages the Yukon River fall chum salmon fishery in accordance with the following guidelines: 1) Districts 1 and 2 will be closed to commercial salmon fishing on July 15 and will reopen by emergency order and 2) the guideline harvest range for Districts 1, 2 and 3 will be 60,000 to 220,000 fall chum salmon.

Subsistence Fisheries

The aboriginal population of the Yukon-Kuskokwim Delta is among the largest of any similar native-occupied region in Alaska. The extensive fishery resources of the area was most likely a key factor in this population development. Chum, chinook and coho salmon respectively are the most heavily used salmon species, while several whitefish species, northern pike, sheefish, Alaska blackfish, burbot and Pacific herring are also harvested. A variety of marine species are utilized around Nunivak and Nelson islands. Historically, a large proportion of subsistence-caught fish were used to feed sled dogs and for trade. In recent years, dependence on sled dogs has decreased due to the increased use of snowmobiles and airplanes. A reduced subsistence harvest of some species in various areas reflects this phenomenon. Fish are of major importance in the subsistence economy and account for 30-60% or more of the yearly food supply in most Yukon Delta villages (U.S. Department of the Interior, Alaska Planning Group 1973; Wolfe 1981).

Kuskokwim River

The subsistence salmon fishery in the Kuskokwim River is the largest and most intense of its kind in Alaska. Dependence upon subsistence-caught salmon is higher for Kuskokwim River villages than for Yukon River villages (U.S. Department of the Interior, Alaska Planning Group 1973). One or more Yupik villages is present at the mouth or just upstream of each Kuskokwim River tributary. Salmon, using the river as a migration corridor to reach these spawning tributaries, are intercepted by subsistence fisheries in these locations. The majority of the catch is taken with nylon gillnets, which have largely replaced traditional gillnets, fish traps, and fishwheels (Alaska Department of Fish and Game 1989a).

Chum salmon have traditionally been the most abundant salmon in Kuskokwim River subsistence harvests, but the efficiency of modern fishing gear has recently increased the take of chinook salmon. Run strength, employment opportunities, and commercial fisheries management also affect subsistence harvest. Pink and sockeye salmon exhibit small runs into the Kuskokwim River and are harvested incidental to the chum and chinook salmon harvest. Coho salmon have traditionally not been utilized due to poor weather conditions for drying fish and preoccupation with other subsistence activities during the run (Alaska Department of Fish and Game 1989a). Improved reporting for coho salmon since 1987 is yielding a more accurate picture of harvest and use. Subsistence chinook and other "small" salmon catches from 1960-1987 are summarized in Tables 15 and 16, respectively.

Most of the salmon harvested during the summer is processed for use throughout the year. The majority is smoked and dried, frozen, salted, or eaten fresh. Use of salmon for dog food is another important use. Traps, fish weirs, and nets are used in fall and early winter to catch whitefish, sheefish, Alaska blackfish and burbot. Sheefish, northern pike, burbot, Arctic grayling, rainbow trout and Arctic char/Dolly

Table 15. Subsistence chinook salmon harvest for Kuskokwim River area villages within the Yukon Delta National Wildlife Refuge, Alaska, 1960-1988 (Alaska Department of Fish and Game 1989a).

Village	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Kipnuk	-	248	11	123	75	-[1]	-	-	-	-	-	-	0	0	-
Kwigillingok	250	35	43	106	339	-[1]	250	957	70	-	220	200	10	75	-
Kongiganak	-[2]	-[2]	-[2]	-[2]	-	-	-	-	-	385	891	41	0	-	-
Tuntutuliak	226	2,226	842	2,853	1,826	1,575	3,097	3,462	2,214	2,195	3,558	1,841	3,214	2,859	1,577
Eek	-	-	-	-	-[3]	-[3]	2,921	4,572	2,566	2,038	2,065	1,882	1,969	1,981	2,356
Kasigluk	135	1,215	127	1,302	-[3]	-[3]	1,032	2,766	1,485	2,888	3,931	1,645	1,292	1,864	1,411
Nunapitchuk	683	2,042	848	1,874	636	490	2,213	1,926	1,750	2,279	4,680	1,978	2,496	2,663	1,165
Atmautluak	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	1,205	548	864	1,106	382
Napakiak	1,830	2,573	2,191	3,148	2,677	2,872	3,658	3,895	2,468	3,456	4,960	1,868	2,009	1,763	1,224
Napaskiak	536	1,258	759	1,569	2,201	1,071	2,710	2,998	1,663	2,227	3,446	1,916	1,578	2,048	900
Oscarville	1,968	282	75	309	339	688	322	1,127	393	457	542	570	196	586	180
Bethel	1,923	4,150	1,378	7,019	4,114	3,371	8,046	13,925	6,205	7,472	17,026	8,731	8,371	8,898	4,631
Kwethluk	2,692	3,763	2,329	5,050	3,262	2,887	6,551	6,993	2,848	3,187	7,932	5,564	5,137	3,444	2,694
Akiachak	1,626	3,052	1,800	2,533	3,488	3,685	4,904	5,543	3,755	2,602	7,022	4,818	3,872	2,592	1,726
Akiak	1,865	3,159	906	2,869	2,495	1,345	3,670	3,660	1,822	1,275	3,290	2,688	1,899	1,895	1,292
Tuluksak	737	1,486	493	1,295	572	1,021	1,576	1,709	1,048	1,131	1,995	1,280	1,318	1,322	883
Lower Kalskag	961	571	-[3]	-[3]	710	-[3]	-[3]	-[3]	1,502	2,102	2,146	2,355	2,604	1,309	1,586
Upper Kalskag	667	1,049	-[3]	-[3]	1,143	-[3]	-[3]	-3	1,619	1,623	734	601	401	938	463
Aniak	1,057	688	185	602	1,104	-[3]	2,072	1,280	517	1,406	2,136	1,076	2,105	1,030	1,952
Total	17,156	27,797	11,987	30,652	24,642	19,005	43,022	54,813	31,925	36,813	67,779	39,602	39,335	36,373	24,422

Table 15 (Continued).

Village	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Ave 1983-87
Kipnuk	-	-	-	-	-	-	-	60	-	-	-	-	-	-
Kwigillingok	-	75	382	75	-	-	-	-	-	-	-	-	-	-
Kongiganak	-	122	361	-	-	-	-	52	-	-	235	-	-	-
Tuntutuliak	3,492	4,807	2,470	1,656	2,268	2,545	4,446	1,984	2,523	3,519	2,644	2,452	2,522	2,732
Eek	2,110	3,232	2,675	1,807	2,003	1,557	1,731	2,578	2,040	-	1,436	-	-	-
Kasigluk	1,713	1,613	1,324	608	1,142	1,704	3,377	3,115	-	-	2,054	-	-	-
Nunapitchuk	2,092	2,578	2,622	2,178	2,109	2,612	2,918	2,577	2,688	-	2,019	3,410	3,372	2,872
Atmautluak	1,042	1,159	1,015	966	2,242	1,288	1,247	1,752	-	-	1,559	-	-	-
Napakiak	2,864	3,330	2,702	2,140	2,191	2,582	3,017	3,500	2,047	-	1,805	-	2,760	-
Napaskiak	2,303	3,566	1,989	2,122	2,085	3,160	2,911	2,872	-	-	2,155	-	2,907	-
Oscarville	891	623	672	349	629	477	495	523	-	-	916	-	745	-
Bethel	11,688	13,215	9,408	6,905	11,564	12,591	15,367	13,516	8,492	11,066	6,940	11,984	8,107	9,318
Kwethluk	3,179	4,193	5,563	3,172	6,919	7,627	6,167	5,897	-	6,732	4,937	5,824	8,779	6,568
Akiachak	3,534	4,915	5,407	2,951	4,818	5,405	3,094	4,468	-	5,588	3,254	-	4,871	-
Akiak	2,837	3,076	2,880	1,850	3,567	3,355	2,386	2,745	-	3,413	2,975	-	3,683	-
Tuluksak	1,338	1,411	2,906	1,906	1,489	2,807	2,446	2,220	1,671	2,286	2,749	-	3,712	-
Lower Kalskag	2,755	4,536	1,750	1,951	2,821	3,917	3,271	2,594	-	3,242	1,707	1,666	-	2,205
Upper Kalskag	1,752	1,413	2,813	1,253	1,590	1,889	1,171	963	-	657	605	587	-	616
Aniak	1,391	1,490	4,991	1,331	2,634	2,750	3,102	2,071	3,174	1,847	1,828	4,624	2,131	2,258
Total	44,981	55,354	51,930	33,220	50,071	56,266	57,146	53,487	22,635	32,350	39,818	30,547	43,589	38,071

[1] Data collected, combined with unspecified village or villages.
[2] Village not yet founded.
[3] Data collected, but reported with another village.

Table 16. Subsistence "small"[1] salmon harvest for Kuskokwim River area villages within the Yukon Delta National Wildlife Refuge, Alaska, 1960-1988 (Alaska Department of Fish and Game 1989a).

Village	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Kipnuk	-	2,959	739	1,877	1,395	-[2]	-	-	-	-	-	-	0	-	-
Kwigillingok	1,430	320	1,251	685	1,663	-[2]	680	2,847	2,800	-	340	500	1,284	770	-
Kongiganak	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	2,481	3,597	610	0	37	-
Tuntutuliak	4,101	8,526	9,692	6,791	8,445	15,943	10,524	15,625	15,384	17,464	10,600	9,964	11,103	13,572	28,321
Eek	-	-	-	-	-[4]	-[4]	1,340	3,071	2,989	3,437	4,855	2,213	783	2,401	4,227
Kasigluk	1,400	3,657	1,705	1,020	-[4]	-[4]	1,762	2,309	5,251	3,308	5,731	2,043	1,934	6,090	6,773
Nunapitchuk	2,743	4,868	7,474	2,462	1,171	4,251	3,095	6,278	9,941	6,933	11,412	3,375	5,600	7,663	12,498
Atmautluak	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	1,191	1,197	947	2,818	4,585
Napakiak	9,888	5,789	6,167	3,711	12,307	12,170	9,167	14,624	13,280	12,390	16,371	4,427	5,191	8,461	21,494
Napaskiak	5,199	4,286	5,546	3,584	6,275	25,969	9,090	8,325	12,526	12,237	11,169	7,039	8,858	8,478	20,467
Oscarville	3,948	1,680	1,723	1,025	487	8,125	504	1,983	2,104	2,743	4,669	1,675	498	3,081	5,617
Bethel	12,972	2,845	8,470	8,623	15,423	18,820	13,769	16,629	31,622	14,615	33,475	9,905	16,885	33,930	34,892
Kwethluk	32,975	21,106	22,788	13,188	19,186	22,869	23,610	24,294	35,090	23,463	27,702	13,941	11,721	19,565	39,747
Akiachak	15,932	12,578	10,521	6,725	10,085	23,979	13,998	13,936	21,409	10,646	29,776	12,298	9,266	9,864	15,108
Akiak	13,061	8,205	6,551	8,478	9,659	10,422	10,746	9,085	18,849	9,853	13,003	9,264	5,108	6,118	18,434
Tuluksak	19,261	7,928	8,526	10,289	9,777	11,678	12,048	10,458	11,114	6,057	7,626	5,115	5,145	5,946	13,261
Lower Kalskag	11,563	7,764	-[4]	-[4]	9,472	-[4]	-[4]	-[4]	8,483	10,621	11,158	3,509	3,490	2,873	12,265
Upper Kalskag	38,398	27,149	-[4]	-[4]	11,391	-[4]	-[4]	-[4]	11,244	9,413	5,309	3,530	1,460	5,607	9,631
Aniak	36,673	15,935	10,120	10,608	17,874	-[4]	12,930	16,158	19,221	15,126	10,030	4,933	5,243	13,547	9,305
Total	209,544	145,595	101,273	79,066	134,610	154,216	123,263	145,622	221,207	160,787	208,014	95,538	94,516	150,821	256,625

Table 16 (Continued).

Village	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Ave 1983-87
Kipnuk								280							
Kwigillingok		463	1,595	60				[3]							
Kongiganak		439	595					206			803				
Tuntutuliak	7,429	8,390	9,109	5,563	5,300	8,305	5,873	8,500	3,585	5,103	5,934	3,075	6,381		4,816
Eek	2,754	3,637	1,286	1,055	625	743	1,188	1,012	1,441		644				
Kasigluk	3,708	4,044	3,504	1,242	2,179	5,172	2,983	6,876	5,337						
Nunapitchuk	5,447	6,466	8,991	4,369	5,189	6,354	5,465	8,646	7,137		5,799	6,679	5,809		6,356
Atmautluak	2,524	3,361	3,319	3,720	5,170	4,405	2,663	4,787			5,774				
Napakiak	11,630	9,265	7,945	5,163	6,281	6,102	6,667	8,618	3,120		5,017		4,256		
Napaskiak	12,930	21,380	11,588	8,376	5,251	7,391	7,290	10,139			6,991		9,031		
Oscarville	3,237	2,376	1,910	1,213	956	1,363	1,260	1,665			2,286		1,573		
Bethel	26,808	26,533	14,957	12,394	21,240	22,593	35,093	37,857	20,367	18,863	12,746	26,866	11,901		18,129
Kwethluk	19,183	26,443	25,405	11,311	14,173	18,188	10,736	16,837		14,516	12,476	15,778	11,484		13,563
Akiachak	14,008	15,298	18,233	8,824	8,403	11,481	6,292	13,083		13,214	9,176		7,887		10,092
Akiak	13,890	12,163	13,728	8,720	11,705	10,125	10,736	9,339		8,027	8,133		5,748		7,303
Tuluksak	7,819	11,673	7,575	4,386	4,874	7,641	6,500	5,040	5,077	9,407	7,750		5,199		6,858
Lower Kalskag	9,823	17,158	7,886	3,508	8,659	7,903	3,894	6,925		8,886	5,728	3,734			6,116
Upper Kalskag	6,904	8,527	11,720	6,100	5,955	6,020	5,746	5,362		2,568	2,087	5,268			3,307
Aniak	9,597	13,355	21,256	7,600	14,936	13,091	11,922	14,946	23,549	8,849	11,127	8,842	7,891		12,052
Total	157,691	190,971	170,602	93,604	120,896	136,877	124,308	160,118	64,176	89,433	107,808	70,242	77,160		81,764

[1] Includes chum, sockeye, and coho salmon.
[2] Data collected, combined with unspecified village or villages.
[3] Data not collected.
[4] Data collected, but reported with another village.

Varden are taken through the ice by jigging. Some of the winter catch is frozen, but most is dried or eaten fresh. The whitefish species are probably the most important in the non-salmon subsistence fishery due to their year-long availability. Funds are not available to monitor subsistence harvest of resident fish species. Pacific herring is an important species to coastal villages of the Yukon-Kuskokwim Delta area. Chinook salmon are the preferred salmon species in the subsistence diet. Subsistence catches of this species often exceed commercial catches in the Kuskokwim River (Alaska Department of Fish and Game 1989a).

Department subsistence salmon harvest surveys are conducted each year and consist of catch calendar distribution, personal interviews, and/or catch questionnaires.

Subsistence Fishing Regulations. Subsistence fishing is regulated by the Alaska Board of Fisheries. The following summary was taken from Chapter 1, Article 5-Kuskokwim Area, as listed in the 1990-1991 edition of the Arctic-Yukon-Kuskokwim Region, Commercial and Subsistence Fishing Regulations, Salmon and Miscellaneous Finfish (Alaska Department of Fish and Game 1990b).

The Kuskokwim Area consists of all waters between the westernmost point of the Naskonat Peninsula and the southernmost tip of Cape Newenham, including the waters surrounding Nunivak and St. Matthew Islands and those waters draining into the Bering Sea.

In District 1 and those waters of the Kuskokwim River between Districts 1 and 2, excluding the Kuskokwak Slough, salmon may be taken at any time except for 16 hours before, during and for six hours after, each open commercial salmon fishing period for District 1. In District 1, Kuskokuak Slough only, salmon may be taken at any time except: 1) from June 1 through July 31, salmon may not be taken for 24 hours before and during each open commercial salmon fishing period in the district and 2) from August 1 through August 31, salmon may not be taken for 15 hours before and during each open commercial salmon fishing period in the district. In District 2, and anywhere in tributaries that flow into the Kuskokwim River within that district, salmon may be taken at any time, expect that from June 1 through September 8 salmon may not be taken for 24 hours before, during and six hours after each open commercial salmon fishing period in the district.

Salmon may only be taken by gill net, beach seine, or fishwheel except that salmon may also be taken by spear in the Holitna River drainage. the aggregate length of set gill nets or drift gill nets in use by any individual for taking salmon may not exceed 50 fathoms. Fish other than salmon may only be taken by set gill net, drift gill net, beach seine, fishwheel, pot, long line, fyke net, dip net, jigging gear, spear or lead. Each subsistence gill net operated in tributaries of the Kuskokwim River must be attached to the bank, fished substantially perpendicular to the bank and in a substantially straight line. In that portion of the Kuskokwim River drainage from the north end of Eek Island upstream to the mouth of the Kolmakof River, no part of a set gill net

located within a tributary to the Kuskokwim River may be set or operated within 150 feet of another set gill net. A gill net may obstruct not more than one-half the width of any fish stream. A stationary fishing device may obstruct not more than one-half the width of any salmon stream.

Nunivak and Nelson Islands

The fish of Nunivak Island are one of the most important subsistence resources on the island. Chum salmon are primarily consumed, even though coho salmon are the most abundant. Species harvested in the subsistence fishery include chum, coho, sockeye and pink salmon, Pacific halibut, Arctic char, Dolly Varden, Alaska blackfish, tomcod, flounder, Pacific herring and smelt (Hout 1966).

Flounder, Arctic char and Dolly Varden are caught incidental to salmon in beach seines, tomcod are taken through the ice by jigging, and Pacific herring are harvested with gill nets or beach seines in May and early June.

The Department's Division of Commercial Fisheries has responsibility for monitoring and managing the subsistence fisheries in the Nunivak/Nelson Island area in navigable waters.

Coastal residents in this area have always used Pacific herring for subsistence purposes. The communities of Nelson Island and surrounding vicinity, which include Newtok, Tununak, Chefornak, Toksook Bay, Nightmute and the northern Kuskokwim Bay communities of Kipnuk, Kongiganak and Kwigillingok, harvest Pacific herring with gill nets (Pete 1984). The fish are primarily dried in strings and stored to be used throughout the remainder of the year. Fishermen tend to prefer the "second run" or the younger age class fish for this purpose because they are smaller, contain less body fat, and are easier to dry.

Subsistence harvest surveys were conducted in 1986 and 1987 by the Department's Division of Subsistence for the communities of Tunuvak, Newtok, Toksook Bay and Nightmute. Total estimated harvests of Pacific herring for 1986 and 1987 were 151.6 and 125.8 metric tons, respectively (Pete and Kreher 1986; Pete et al. 1987).

Pacific halibut are found in the marine waters off the coasts of Nelson and Nunivak islands. Periodic contact with these areas have shown that Pacific halibut is used for subsistence purposes by the residents of Nelson Island and Nunivak Island. There are two primary methods of harvesting these fish, jigging and longlining. The majority of both the commercial and subsistence harvest is taken by jigging with handlines (Alaska Department of Fish and Game 1985b).

Yukon River

The following narrative was summarized from the Yukon River Annual Management Report-1987 (Alaska Department of Fish and Game 1988).

There are approximately 10,000-15,000 rural residents in the Yukon River basin, the majority of whom reside in excess of 45 small villages scattered along the coast and major river systems. Nearly all of these native people are dependent to varying degrees on fish and wildlife resources for their livelihood.

Subsistence fishermen operate gill nets primarily in the mainstem rivers and, to a lesser extent, in the coastal marine waters, capturing mainly salmon, whitefish and sheefish. Beach seines are occasionally used near spawning grounds to catch schooling or spawning salmon or other species of fish. Traps and fish weirs of various designs are also used to capture whitefish, blackfish and burbot, usually in the fall and winter months. Sheefish, northern pike, Arctic char, Dolly Varden and saffron cod are frequently taken through the ice by handlines. Dip nets are used in late May and early June to take smelt in the delta area and in late October-early November to take lamprey in the main Yukon River downstream of Grayling (Alaska Department of Fish and Game 1988).

There is usually little intentional wastage of fish taken for subsistence purposes. The major portion is sun dried or smoked for later consumption while the head and viscera may be fed to sled dogs.

Comprehensive annual surveys of the Yukon River subsistence salmon fishery were initiated by the Department in 1961. Data obtained cannot be easily compared with that of earlier years which was often incomplete or lacking for many years. However, there are records indicating that in excess of one million salmon (mainly chum) were taken for subsistence in some years during the early 1900's and even as late as 1940.

The Department's subsistence fishery surveys (personal interview, catch calendar and/or catch questionnaires) obtain catch, effort and other associated data from villages and fish camps along the main stem river and major tributaries.

About 1930, the airplane began replacing the sled dog as a mail and supply carrier, starting the gradual decline of the subsistence salmon fishery. This decline has been accelerated in the past years as increased welfare payments and employment opportunities, including commercial fishing activities, have become available to the rural residents. The reduction in subsistence fishing is not necessarily related to fish abundance, but mainly reflect decreases in effort and dependence due to a changing way of life.

To illustrate changes in effort, there were 393 fishwheels operated on the Yukon River in 1918. The number of fishwheels recorded during the 1970 survey was an all-time low of 56, a 67% decrease since 1961. However, because of the expansion of the upper Yukon River commercial fishery in 1973, the amount of fishwheel gear used for subsistence sharply increased to 207 units in 1981 (Alaska Department of Fish and Game 1988).

Another very important factor tending to affect subsistence fishing effort during recent years is the increasing use of snowmachines which may be replacing sled dogs at a faster rate than the airplane. Since considerable numbers of salmon and other fish are fed to sled dogs, fewer fish will be required for subsistence purposes as the canine population declines. In 1961 each fishing family kept an average of 7.7 sled dogs while in 1972, this figure was down to 3.8 sled dogs. However, due to the renewed interest in sled dog racing, the number of dogs per family increased to 6.8 in 1981. The number of snowmachines owned by fishing families was first documented in 1967, with an average of 0.4 snowmachines per family. Since then, the number of snowmachines has steadily increased and in recent years the average number of snowmachines has exceeded 1.1 per family (Alaska Department of Fish and Game 1988).

Reflecting the above changes in effort and dependency, the subsistence salmon catch has substantially decreased since the early 1960's. The harvest of salmon other than chinook averaged 416,585 fish during 1961-1965. During the period 1966-1973, catches averaged 209,636, a decrease of 50 percent. However, during 1974-1983, the subsistence chum salmon catches, mainly used for dog food, have increased, averaging 364,721. This increase can be attributed to above average size runs, especially summer chum salmon, subsistence roe sales and increasing numbers of recreational sled dog teams (Alaska Department of Fish and Game 1988).

Subsistence catches of chinook salmon, which are used mainly for human consumption, have remained relatively constant during the period 1961-1977, generally averaging 15-25,000 per year. During 1977-1987, chinook salmon catches have increased substantially, averaging about 38,600 fish per year (Alaska Department of Fish and Game 1988). Subsistence salmon catches from 1978 to 1987 in the lower Yukon River are listed by species in Table 17.

It should be noted that the practice of keeping sled dogs is much more common in the upper Yukon River area than in the delta area and is considered a major factor affecting fishing effort. It is also likely that the sale of subsistence-caught salmon roe (legal from 1974-1977) increased subsistence chum salmon catches above normal food and domestic use requirements during that period. Subsistence roe sales were not considered a significant factor affecting domestic use harvests in the twelve major villages in the lower Yukon River area (Alaska Department of Fish and Game 1988).

Subsistence fisheries which target on non-salmon species such as northern pike, sheefish and whitefish are inadequately documented and their overall significance is not well known (Alaska Department of Fish and Game 1988). Non-salmon species play important roles in both upriver and downriver economies.

Subsistence Fishing Regulations. Subsistence fishing in navigable waters is regulated by the Alaska Board of Fisheries. The following

Table 17. Subsistence salmon catches by district in the lower Yukon River, 1978-1987 (Alaska Department of Fish and Game 1988).

Species	District	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Chinook salmon	1	5,246	2,879	3,669	2,282	2,311	6,263	4,624	3,071	5,275	7,278
	2	3,964	4,268	3,674	3,580	2,109	9,065	7,172	3,468	6,483	9,866
	3	3,902	3,263	4,783	4,001	3,359	4,910	4,394	3,342	4,252	4,661
	Total[1]	13,112	10,410	12,126	9,863	7,779	20,238	16,190	9,881	16,010	21,805
Summer chum salmon	1	30,897	16,144	15,972	11,310	18,452	24,679	28,459	24,349	38,854	30,760
	2	21,684	23,276	13,681	14,218	18,442	27,396	26,996	19,795	42,496	33,134
	3	1,706	2,946	3,242	4,929	5,840	4,609	7,351	3,687	5,528	4,161
	Total[1]	54,287	42,366	32,895	30,457	42,734	56,684	62,806	47,831	85,878	68,055
Fall chum salmon	1	390	15,788	7,433	15,540	10,016	8,238	8,885	13,275	9,000	18,467
	2	1,297	14,662	12,435	11,770	9,511	10,341	11,394	11,544	13,483	13,454
	3	266	2,443	2,320	2,893	1,659	2,863	2,233	2,290	1,785	2,853
	Total[1]	1,953	32,893	22,188	30,203	21,186	21,442	22,512	27,109	24,268	34,774
Coho salmon	1	1,142	3,184	1,808	3,769	11,192	3,590	6,095	3,246	2,725	6,396
	2	598	1,132	4,801	3,736	10,229	6,072	7,066	4,834	9,140	6,894
	3	223	12	91	490	675	917	740	376	781	682
	Total[1]	1,963	4,328	6,700	7,995	22,096	10,579	13,901	8,456	12,646	13,972

[1] Includes the community of Holy Cross which is not on the refuge.

summary was taken from Chapter 1, Article 4 - Yukon Area, as listed in the 1990-1991 edition of the Arctic-Yukon-Kuskokwim Region, Commercial and Subsistence Fishing Regulations, Salmon and Miscellaneous Finfish (Alaska Department of Fish and Game 1990b).

The Yukon Area includes all waters of Alaska between Canal Point Light and the westernmost point of the Naskonat Peninsula, including those draining into the Bering Sea.

In Districts 1, 2 and 3, salmon may be taken only during the open weekly fishing periods of the commercial salmon fishing season and may not be taken for 24 hours before the opening and 24 hours after the closure of the commercial salmon fishing season, with the except that through July 19 subsistence fishing periods will be established by emergency order every other weekend during commercial salmon fishing closures and after July 19 in District 1, except for the set net only locations described in 5 AAC 05.330(a)(1)-(8), and in District 2, a 24 hour subsistence fishing period will be established by emergency order each weekend during commercial fishing closures. Except as provided in 5 AAC 01.225, and except as may be provided by the terms of a subsistence fishing permit, there is no closed season on fish other than salmon.

Salmon may only be taken by gill net, beach seine or fishwheel. In Districts 1, 2 and 3, commercial fishermen may not take salmon for subsistence purposes by gill nets larger than six-inch mesh during periods established by emergency order. Fish other than salmon and halibut may be taken only by set gill net, drift gill net, beach seine, fishwheel, long line, fyke net, dip net, jigging gear, spear or lead, subject to the following restrictions, which also apply to subsistence salmon fishing: 1) during the open weekly fishing periods of the commercial salmon fishing season, a commercial fisherman may not operate more than one type of gear at a time, for commercial and subsistence purposes, except that in Subdistrict 4-A, upstream from the mouth of Stink Creek, a commercial fisherman may, at any time, assist subsistence fishermen in the operation of subsistence fishing gear; 2) the aggregate length of set gill net in use by an individual may not exceed 150 fathoms and each drift gill net in use by an individual may not exceed 50 fathoms in length and 3) a gill net may obstruct not more than one-half the width of any fish stream; a stationary fishing device may obstruct not more than one-half width of any salmon stream. Salmon may be taken only by set gill nets in those locations described in 5 AAC 05.330(a)(1)-(8). Halibut may be taken only by a single hand held line with no more than three hooks attached.

Delta Plain

The abundant salmon resources of the Yukon and Kuskokwim rivers are generally unavailable to residents of the Delta Plain lowlands between the Yukon and Kuskokwim rivers. However, dependence upon fish is equally important to the subsistence economy of villages in these areas. Subsistence harvests of Pacific herring are very important socially,

economically and nutritionally. The Nelson Island region has the highest subsistence Pacific herring dependence in Alaska today (Henning et al. 1979). Historically, natives along the Delta coast used gill nets, seines and dipnets to take Pacific herring. Presently, gillnets are the primary harvest method.

The Pacific herring fishery is highly seasonal, lasting for only 2 weeks from May to early June, and requires annual harvest migrations for villages not situated on or near productive Pacific herring areas. Two spawning runs usually occur during this time period. The second run is preferred by native fishermen due to the smaller size, less amount of body fat, and ease in drying these younger age class fish (Alaska Department of Fish and Game 1984). The fish are primarily dried in strings and stored to be used throughout the year.

Whitefish, stickleback, Alaska blackfish, northern pike, tomcod and burbot are harvested in the sloughs, lakes and creeks of the Delta Plain lowlands.

A small harvest of chinook salmon is caught in gillnets during the coastal Pacific herring harvest near Cape Vancouver and smelt are harvested with dipnets immediately following the Pacific herring run (Hout 1968).

Yukon Delta National Wildlife Refuge Communities

Data concerning the subsistence harvest of various resources and where those resources are generally taken by local residents were collected and assimilated by the Service (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988) for the Yukon Delta National Wildlife Refuge Comprehensive Conservation Plan. The following narrative was extracted from the Yukon Delta National Wildlife Refuge Final Comprehensive Conservation Plan:

Forty-two communities were included in the study of subsistence resource harvesting on the Yukon Delta Refuge. The harvesting of subsistence resources accounts for a significant part of the livelihood of residents of all the communities surveyed. Boats are the primary means of access to harvest areas during the summer (times of open water); snowmobiles and dog sleds provide access to winter use areas.

Holy Cross. Holy Cross is located on the west bank of Ghost Creek Slough, off the Yukon River. In 1988, there were 294 residents in Holy Cross (Alaska Department of Labor 1990). Holy Cross is farther upstream on the Yukon River than any other community considered in the plan. Although the community is outside the refuge boundary, its residents do use the refuge to harvest subsistence resources.

Salmon are caught using drift and set gill nets on the Yukon River as far downstream as the lower end of Tucker Slough. Chinook, coho and chum salmon are the main species taken. Whitefish, burbot, sheefish

and northern pike are also taken in this section of the Yukon River. Ice fishing is the most prevalent type of fishing for these species.

Russian Mission. Russian Mission is located on the west bank of the Yukon River, about 50 miles southeast of St. Mary's. In 1988, the community had 266 residents (Alaska Department of Labor 1990).

Salmon are caught in the Yukon River from Pitkas Point upstream to Pearl Island. Chinook, coho and chum salmon are taken with both set and drift gill nets. Other fish are caught in the Yukon River and sloughs along the river from Devil's Elbow upstream to the lower end of the Paimiut Hills. Lamprey, burbot, sheefish, whitefish, cisco and northern pike are caught in the main river. Popular Alaska blackfish areas are just south of Devil's Elbow, south of Roosevelt Island and immediately east of Russian Mission. Some people go southeast to Arhymot Lake for winter fishing. Two small lakes, approximately 15 miles west of Engineer Lake, are important whitefish areas.

Marshall. Marshall is on Poltes Slough on the east bank of the Yukon River about 35 miles southeast of St. Mary's. In 1988, there were 284 people living in Marshall (Alaska Department of Labor 1990).

Salmon are caught in the Yukon River from immediately above Pilot Station to about 10 miles below Russian Mission. Both set and drift gill nets are used to catch chinook, coho and chum salmon. Other species of fish are harvested in areas close to the village. Two unnamed lakes about eight miles north of Devil's Elbow are very popular areas to set gill nets for whitefish in the spring and fall. Northern pike jigging is popular on two rivers just north of Marshall, the Kuyukutuk River and an unnamed drainage. Set gill nets are also used to take whitefish, sheefish and northern pike in the fall on the main creek flowing into Engineer Lake. Whitefish, cisco, northern pike, sheefish, burbot and lamprey are caught in the Yukon River in a section of the river extending from approximately seven miles downstream of Marshall to about 40 miles upstream. The upper section of Reindeer River is also important for northern pike jigging in winter. Alaska blackfish are caught primarily in the small lakes and streams between the Reindeer and Yukon rivers.

Pilot Station. Pilot Station is located on the northwest bank of the Yukon River eleven miles east of St. Mary's. The population was 451 in 1988 (Alaska Department of Labor 1990).

Salmon are caught in the Yukon River from 20 miles upstream of the village to the head of Kwikpak and Kwikluak passes. Both set and drift gill nets are used to harvest chinook, coho and chum salmon. Other fish are caught in the area between the village and the Ingakslugwat Hills. The Kashunuk Slough, the upper section of the Reindeer River, the lower two-thirds of the Atchuelinguk River, and the lower stretches of the East Fork of the Andreafsky River are other important fishing areas. Whitefish, sheefish, burbot, lamprey (eels) and cisco are usually caught

in the main rivers of the area, while Alaska blackfish, northern pike and whitefish are caught in the smaller rivers and lakes.

Pitkas Point. Pitkas Point is located near the confluence of the Yukon and Andreafsky rivers, about five miles southwest of St. Mary's. The population was 105 in 1988 (Alaska Department of Labor 1990). Most salmon fishing is done in the Yukon River from just below Pilot Station to about ten miles downstream of Pitkas Point. Both set and drift gill nets are used to harvest chinook, coho and chum salmon.

St. Mary's. St. Mary's is located on the north bank of the Andreafsky River about five miles upstream from its confluence with the Yukon River. In 1988, St. Mary's had 491 residents (Alaska Department of Labor 1990). It is incorporated as a first class city and serves as a subregional transportation and service center.

Salmon are caught in the Yukon River from Pilot Station downstream to Kwikluak and Kwikpak passes using both set and drift gill nets. Salmon fishing also occurs in the Andreafsky River from St. Mary's to its confluence with the Yukon River using set gill nets. Chinook, chum and coho salmon are all harvested. Other fish are caught in the rivers, lakes and ponds in a 30 mile area south of the community as well as in the Andreafsky and Yukon rivers. Whitefish, sheefish, lamprey and burbot are the primary species caught in the Andreafsky and Yukon rivers while whitefish, Alaska blackfish and northern pike are caught in the waters south of the Yukon River. Northern pike jigging is popular in the northern water bodies around Ungulungwak Hill and east of the Kusilvak Mountains.

Mountain Village. Mountain Village is located on the north bank of the Yukon River approximately 20 miles west of St. Mary's. It was a summer fish camp until a general store was opened in 1908 resulting in the establishment of a permanent village. By 1988, the community had 742 residents (Alaska Department of Labor 1990).

Salmon fishing occurs in the Yukon River and adjacent sloughs form upper Kwikluak and Kwikpak passes upstream to Pilot Station. Set and drift gill nets are used to harvest primarily chinook, coho and chum salmon. Other fish species are caught in a broad area that extends from the community, west to Kwikpak Pass, south to Nunavakanuk and Aropuk lakes and east to Pilot Station. The Atchuelinguk, Andreafsky and Archuelinguk drainages are also important fishing areas. Whitefish, sheefish, burbot, northern pike, Alaska blackfish, lamprey and cisco are the main species taken.

Emmonak. Emmonak is located at the mouth of the Yukon River on the north bank of Kwiguk Pass, 175 miles north of Bethel. Emmonak had 664 residents in 1988 (Alaska Department of Labor 1990).

Most salmon fishing takes place in the Yukon River from Fish Village downstream through all the major passes of the river. Both set and drift gill nets are used. Set gill nets are also used on the coastal

shoreline from Apoon Pass to south of the Black River. Chinook, coho and chum salmon are the main species harvested. Other fish, such as stickleback, Alaska blackfish, whitefish, sheefish, burbot, smelt and northern pike are taken throughout the year from the entire delta area including the Black River drainage.

Sheldon Point. Sheldon Point is located on the south side of Kwemeluk Pass (the southernmost pass of the Yukon River), about nine miles south of Alakanuk. No mention of the community was made prior to the 1950 U.S. census. In 1988, there were 126 residents in Sheldon Point (Alaska Department of Labor 1990).

Salmon fishing occurs on the passes of the Yukon River as far upstream as Fish Village and down the coast to the Black River. Drift and set gill nets are used in the river and set gill nets are used along the coast. Chinook, coho and chum salmon are the primary species taken. Other fishing takes place year-round in basically the same area as small game hunting. Sheefish, whitefish, northern pike, burbot, Alaska blackfish and sticklebacks are some of the species taken.

Alakanuk. Alakanuk is located at the east entrance of Alakanuk Pass, the major southern channel of the Yukon River, approximately 15 miles east of the Bering Sea. The community is a long established Eskimo village. It was first reported by the U.S. Coast and Geodetic Service in 1899. In 1988, there were 565 residents (Alaska Department of Labor 1990).

Salmon, primarily chinook, coho and chum, are harvested from May to October in the coastal area from south of the Black River to Kwiguk Pass. Salmon are also taken in Kwemeluk and Kwikluak passes and up the Yukon River as far as Mountain Village. Other fish are taken in the rivers, sloughs and lakes of the area and from a coastal area extending from south of the Black River to north of Kwiguk Pass. Whitefish, burbot, sheefish, sticklebacks, Alaska blackfish, smelt and northern pike are the main species harvested. Fishing for these species occurs year-round.

Kotlik. Kotlik is located on a slough of Apoon Pass approximately seven miles from Pastol Bay on Norton Sound. It is considered one of the larger ports and commercial centers on the lower Yukon River. There were 443 residents in 1988 (Alaska Department of Labor 1990).

Salmon are taken from May through September along the coast from the mouth of Apoon Pass to Kwiguk Pass and in all the main passes in between as far upstream as Fish Village. Chinook, coho and chum salmon are the main species harvested. Fishing for other species occurs year-round in the rivers and sloughs of the northern part of the Yukon River Delta from the coast upstream to the fork of Apoon and Kwikpak passes. Species taken include cod, sheefish, whitefish, burbot, Alaska blackfish, northern pike and cisco.

Stebbins and St. Michael. St. Michael is located on the east coast of St. Michael Island in Norton Sound just outside the northern tip of the Yukon Delta Refuge. In 1988, 303 residents lived in this community (Alaska Department of Labor 1990). Because of its location, the residents of St. Michael rely heavily on the sea for their subsistence activities.

Salmon fishing occurs in the rivers and sloughs along the coast from the northern boundary of the refuge west to an area approximately midway between the mouths of Apoon and Kwanak passes. Chinook, coho and chum salmon are the main species caught. Fishing for whitefish and char occurs in the rivers and sloughs from Point Romanzof north to the refuge boundary although most non-salmon fishing takes place north of the refuge.

Scammon Bay. Scammon Bay is located north of Hooper Bay at the base of the Askinuk Mountains. It is on the south bank of the Kun River, one mile from the Bering Sea. In 1988, 308 residents lived in this community (Alaska Department of Labor 1990).

Salmon are caught primarily along the coast from south Hazen Bay to the Kwikpak Pass area. Salmon fishing also occurs in the lower stretches of some of the main rivers in the area. Both drift and set gill nets are used to catch chinook, chum, pink and coho salmon. Most of these fish are destined for the Yukon River.

Other fish are caught in water bodies around the community. The area around the lower Black River and the Black River itself below Nunavakanuk Lake, the Kun River and its tributaries, and the area around the Kokechik River west of Kagankagati Lake are among the most popular areas. Alaska blackfish, cisco, northern pike, sticklebacks, whitefish, burbot, sheefish and cod are the main species caught.

Hooper Bay. The community of Hooper Bay had a population of 807 in 1988 (Alaska Department of Labor 1990). It is the largest coastal community in the Yukon-Kuskokwim area. The village is located on the shores of Hooper Bay two miles from the Bering Sea. The protected bay and the abundance of natural resources were two important considerations in locating the village at its present site.

Salmon are caught mainly with set gill nets in Hooper Bay and numerous rivers near the community. A popular area is the tidal flats inward of Nuok Spit. The lower Kokechik River, the Kashunuk River from Nanvaranak Lake downstream to the Keoklevik River, the Keoklevik River and the mouth of the Kashunuk River are all important salmon fishing areas. Chinook and chum salmon are the primary species caught. Some pink and coho salmon are also taken. Most of these fish are destined for the Yukon River.

Other fish are caught around Nuok Spit and the entire periphery of Hooper Bay. Areas around the mouth of the Kokechik River, inland to the flats south of the Askinuk Mountains, along the Kaskunuk River, around

Nashak Lake and south to Angyoyaravak Bay are also important. The species caught can be divided into three categories. Marine species include flounder, saffron cod and sculpin; the main freshwater species are Alaska blackfish, burbot and sheefish; and anadromous species include Bering cisco and humpback whitefish. Pacific herring are caught along the north shore of Kokechik Bay and in Hooper Bay.

Chevak. Chevak is located on the north bank of Ninglikfak River, which empties into Hooper Bay 17 miles to the east. In 1988, 594 people lived in the village (Alaska Department of Labor 1990).

Salmon fishing occurs primarily along the coast and in the lower stretches of some rivers from Nuok Spit in Hooper Bay south to the mouth of the Aphrewn River. Set and drift gill nets are used to catch chum, chinook, pink and coho salmon. Fish species caught can be divided into three categories. Marine species include flounder and sculpin; freshwater species include Alaska blackfish, cisco, northern pike, sticklebacks, whitefish, burbot and sheefish; anadromous species include cod, Bering cisco and humpback whitefish.

Chevak residents harvest Pacific herring fishing in Hooper Bay as well as Kokechik Bay. Pacific herring spawn on kelp is gathered along the coast near the village of Scammon Bay.

Tununak. Tununak is well placed on a high isthmus at the mouth of the Tununak River on the shores of Tununak Bay on Nelson Island. The population in 1988 was 335 (Alaska Department of Labor 1990). The location provides excellent access to both sea and river hunting and fishing.

Pacific salmon are caught along the coast from south of the Ninglick River around Cape Vancouver to Kangirlvar Bay. Both set and drift gill nets are used to catch five species of salmon. Other fish species are caught in both coastal and inland areas. The coastal species, including Pacific herring, cod, Pacific halibut and flounder, are caught (often with nets) from the Ninglick River to Kangirlvar Bay. Cod are also caught upstream from the mouth of the Ninglick River.

Smelt are caught with dipnets in the small streams around the village. Pacific herring and herring spawn on kelp are taken along the coast for 10 miles on either side of the village. Inland species are caught in the area south of the village, in an area south and east of Nightmute, over the entire length of the Kolavanarak River including both the Kinaruk and Chakchak rivers, on the upper Ninglick River and in the Baird Inlet area around Kagalurpak and Kaghasuk lakes. Burbot, northern pike, whitefish and Arctic char/Dolly Varden are caught primarily in the larger rivers and lakes; Alaska blackfish and sticklebacks are caught mainly in the smaller streams and ponds.

Newtok. Newtok is located on the Kealavik River north of Nelson Island. The population in 1988 was 220 (Alaska Department of Labor 1990).

Salmon are taken in the coastal area from Kangirlvar Bay north to the Aphrewn River and in the lower Ninglick, Azun, Manokinak and Aphrewn rivers. Set and drift gill nets are used in catching five species of Pacific salmon.

Other fish are caught in both coastal and inland waters. Coastal species are caught from the mouth of Azun River to Kangirlvar Bay. Nets are used to catch Pacific herring, cod and flounder, while jigging is used to catch Pacific halibut and cod. Cod are also caught in the lower stretches of most of the main rivers in the area. Smelt are normally caught with dip nets or jigging in the area around the community. Pacific herring (and roe) are normally taken in the coastal area around Tununak. Inland species are caught in an area which includes the upper Kolavinarak River drainage, Kaghasuk and Aropuk lakes and the Manokinak River drainage to its mouth. Burbot, northern pike, Dolly Varden and whitefish are caught in the major rivers and lakes; sticklebacks and Alaska blackfish are taken from the smaller streams and ponds.

Toksook Bay. In 1988, 421 people lived in Toksook Bay (Alaska Department of Labor 1990). Located seven miles from Tununak on Kangirlvar Bay, it enjoys excellent access to both sea and riverine subsistence resources. The residents of Toksook Bay take most of their salmon in the same areas as the residents of Tununak although some people go as far north as the Azun and Aphrewn rivers to fish for salmon. Other fish species are also caught in basically the same areas except Toksook Bay residents make little use of the Ninglick River and the northern shore of Baird Inlet.

Nightmute. Nightmute is located at the base of a steep mountain on the Toksook River on Nelson Island. It faces marshy tundra to the south. The 1988 population was 161 (Alaska Department of Labor 1990).

Salmon are caught in Kangirlvar Bay and in the Toksook River upstream to above Nightmute. Drift and set gill nets are used in the bay, while set gill nets are mainly used in the river. Other fish are caught in the lower section of the Kolavinarak River and in some of its upper drainages, in Baird Inlet and in the area south of the village. Whitefish, Alaska blackfish, smelt, northern pike and burbot are the main species taken. Pacific herring are caught along the north shore of Kangirlvar Bay.

Chefornak. Chefornak is located southeast of Nelson Island at the confluence of the Keguk and Kinia rivers. In 1988, 293 people lived in the community (Alaska Department of Labor 1990).

Pacific salmon are caught using drift gill nets along the coast from Kinak Bay to Nelson Island. Other fish are caught in the same area used for small game hunting although the area along the north shore of Baird Inlet is also fished. This area is a favorite northern pike fishing

area. The main rivers are used for cod, smelt, sticklebacks, flounder, burbot and whitefish, while Alaska blackfish and northern pike are usually caught in the smaller ponds and streams. Smelt are caught during their brief run in May by using drift gill nets in the Kinia River.

Mekoryuk. Mekoryuk is located at the mouth of Shoal Bay on the north shore of Nunivak Island. The 1988 population was 190 (Alaska Department of Labor 1990).

Salmon are caught mainly in the mouths of the rivers and streams on the southern half of the island although some people do use the northern half. Seines are used to catch chinook, chum and pink salmon. Other species are caught in both the coastal and inland areas. The main species caught in the coastal area around the entire island are Pacific halibut, cod, sculpin, Pacific herring, capelin and flounder. Pacific herring is caught primarily along the island's east side. Arctic char, Dolly Varden, Arctic grayling and Alaska blackfish are caught in the rivers, streams and ponds on the island.

Kongiganak and Kwigillingok. Kongiganak is located on the north shore of Kuskokwim Bay just a few miles east of Kwigillingok. In 1988, there were 283 residents in Kongiganak (Alaska Department of Labor 1990).

Salmon fishing, using drift gill nets, usually occurs along the coast from the villages to the mouth of the Kuskokwim river and upstream near Bethel. Three major fishing areas, the mouth of the Kuskokwim River upstream to the north end of Eek Island, the Kuskokwim River north of Eek Island and the mouths of the Kwigillingok and Ishkowik rivers can be identified. Chinook, chum, sockeye and coho salmon are all caught. Other fish species are taken in the rivers, streams and lakes in an area which extends from the mouth of the Kuskokwim River across to Dall Lake and south to Kinak Bay. Some people travel up the Eenayarak River drainage almost to Napaskiak to catch Alaska blackfish and whitefish. Pacific herring are caught around Pingurbek Island.

Sculpin, sole, whitefish, Bering cisco and cod are usually caught using beach seines near the mouths of rivers close to the villages. After freezeup, cod and stickleback are caught mainly with dipnets, while Alaska blackfish are taken more often in the lakes, ponds and small streams using traps. In addition to fish, residents of both communities harvest clams in the tidal flats near the communities as well as from the offshore islands west of Kipnuk.

Eek and Quinhagak. Eek is located on the Eek River 12 miles east of the Kuskokwim River. In 1988, there were 279 residents in Eek (Alaska Department of Labor 1990).

Quinhagak is located at the mouth of the Kanektok River on the east side of Kuskokwim Bay (Togiak National Wildlife Refuge). There were 424 people living in Quinhagak in 1984. Harvest areas used by the residents of both communities are similar. Residents of the two communities

harvest fish (other than salmon) in an area east of the Kuskokwim River from Napaskiak to Eek Lake south to the Kanektok River and along the coast. Fish caught include Arctic grayling, trout, Alaska blackfish, whitefish and northern pike.

The residents of Eek fish for salmon in the Kuskokwim River from its mouth upstream to Tuntutuliak. Both drift and set gill nets are used. Fishing with drift and set gill nets occurs on the Eek River, upstream as far as 25 miles on both forks. Residents of Quinhagak do most of their salmon fishing on the Togiak Refuge. Quinhagak residents do use drift gill nets along the coast from the refuge boundary north to Warehouse Creek.

Tuntutuliak. Tuntutuliak is located three miles northwest of the confluence of the Kinak and Kuskokwim rivers. In 1988, it had a population of 296 people (Alaska Department of Labor 1990). The residents share the subsistence features of both the coastal and riverine villages.

Salmon fishing occurs on the Kuskokwim River from its mouth to above the confluence of the Johnson River. One of the most important salmon fishing areas for Tuntutuliak is the area immediately above the confluence of these two rivers. Both drift and set gill nets are used with five species of Pacific salmon taken.

Other fish species are harvested in an area extending north to below Nunavakpak Lake, west to Dall Lake, and south to Kwigillingok. The main fish species caught are whitefish, Alaska blackfish, sheefish, burbot and northern pike with some shellfish taken also. Some residents also fish in the larger lakes along the Eenayarak River as far north as Napaskiak. Whitefish is the main species sought in this area.

Nunapitchuk, Atmautluak, and Kasigluk. Nunapitchuk is located on both banks of the Johnson River about 26 miles northwest of Bethel. The population of Nunapitchuk was 372 in 1988 (Alaska Department of Labor 1990). Atmautluak is located on the Pikmiktalik River twelve miles southeast of Nunapitchuk. Founded in the 1970's, the village had 239 residents in 1988 (Alaska Department of Labor 1990). Kasigluk is located two miles west of Nunapitchuk in the Johnson River drainage. There were 433 residents in Kasigluk in 1988 (Alaska Department of Labor 1990).

The area used for fishing extends south as far as Tuntutuliak, as far west as Newtok and north to the Yukon River as far as Marshall and to Tuluksak on the Kuskokwim. Whitefish, burbot, Alaska blackfish, northern pike and sheefish are the main fish taken. Whitefish and sheefish are primarily caught during ice-free periods while northern pike, Alaska blackfish and burbot are important species caught after freezeup.

Salmon fishing for subsistence use occurs from May through September along the Kuskokwim River from its mouth upstream to Tuluksak. Most

salmon are taken from the area between Tuntutuliak and Bethel. Chinook, coho and chum salmon are the main species harvested although a few sockeye and pink salmon are also caught.

Napakiak. Napakiak is located on the Kuskokwim River ten miles southwest of Bethel. The population in 1988 was 315 (Alaska Department of Labor 1990).

Five species of salmon are caught by Napakiak residents using set and drift gill nets. The area around the confluence of the Johnson and Kuskokwim rivers is the most popular for salmon fishing. Other fish species are harvested year round in a number of different areas. The Eenayarak River area is important for whitefish; the Kiatik River area is important for whitefish, northern pike and sheefish; and the lower Johnson River is important for northern pike and whitefish. Smelt are caught in the Kuskokwim River.

Oscarville. Approximately six miles downstream from Bethel, Oscarville is situated on the west bank of the Kuskokwim River across from Napaskiak. Oscarville was founded in 1908 as a trading post. The community had a population of 67 in 1988 (Alaska Department of Labor 1990).

Pacific salmon are primarily caught in the Kuskokwim River around the confluence of the Johnson River with all species found in the region being harvested. Both drift and set gill nets are used. Other fish are caught in the rivers, lakes and sloughs south of the community through the Eenayarak drainage to Eek Island and in the area west of the Kuskokwim River from its mouth north to Nunapitchuk. The area north of Dall Lake is used for Alaska blackfish while Whitefish Lake near Kalskag is a popular area for whitefish. Other fish caught are burbot, northern pike, sheefish and smelt.

Napaskiak. Napaskiak is located at the mouth of the Napaskiak River six miles south of Bethel. The population of Napaskiak was 331 in 1988 (Alaska Department of Labor 1990).

Whitefish, sheefish, northern pike, burbot and Alaska blackfish are caught in the rivers, sloughs and lakes south of the community to the Eek River drainage, and west of the Kuskokwim River from its mouth to Nunapitchuk. Alaska blackfish, burbot and northern pike are caught mainly in the winter while whitefish and sheefish are caught year around. Residents also go up the Kwethluk and Kisaralik rivers in the summer to fish for trout, Arctic char, Dolly Varden and Arctic grayling. Drift and set gill nets are used to catch salmon in the Kuskokwim River from the confluence of the Johnson River to the confluence of the Kwethluk River.

Bethel. Bethel is located on the Kuskokwim River eighty-six miles from the Bering Sea. It is located at the upper navigation limit for ocean-going vessels on the Kuskokwim River. Bethel is the public service and commercial center for the Yukon-Kuskokwim Region. It is the

regional seat of government for federal, state and regional agencies. Its status as a commercial center is based on its role as a transportation hub and service center (insurance, construction, repair, etc.). In 1988, it had 4,390 residents (Alaska Department of Labor 1990). While the residents of Bethel rely more on a cash economy than any other community in the area, subsistence harvesting is still very important.

Salmon are caught in the Kuskokwim River from below Akiachak downstream to Fowler Island. Set and drift gill nets are used to catch five species of salmon. Other fish are caught in the Johnson River upstream to above Nunapitchuk; in the upper Eenayarak River drainage; in the Kuskokwim River ten miles above and below Bethel; in the Gweek River; in the Kuskokwim River above Tuluksak; along the western side of Aropuk Lake and in the upper Manokinak River. Northern pike, whitefish, burbot, sheefish, Alaska blackfish and smelt are the main species caught. The lower Kwethluk and Kisaralik drainages are used for trout, Arctic grayling, Arctic char and Dolly Varden.

Kwethluk. Kwethluk is located on the south bank of the Kwethluk River about a mile east of its confluence with the Kuskokwak Slough, a branch of the Kuskokwim River eleven miles east of Bethel. There were 538 residents in Kwethluk in 1988 (Alaska Department of Labor 1990).

Kwethluk residents harvest five salmon species from a stretch of the Kuskokwim River extending approximately seven miles above to seven miles below the village. Both set and drift gill nets are used. Nets are also used on the lower Kwethluk River. Fishing also occurs on the upper Kwethluk and on the Kisaralik drainage. Trout, Arctic grayling, Arctic char and Dolly Varden are caught in the upper two-thirds of the Kwethluk and Kisaralik drainages, while whitefish, sheefish, smelt, burbot and northern pike are caught primarily in the Kuskokwim River and its tributaries near the community. Alaska blackfish, northern pike and whitefish are caught in the smaller streams and ponds near Kwethluk.

Akiak. Akiak is located on the north bank of the Kuskokwim River opposite the mouth of the Kisaralik River. It is about 20 miles northeast of Bethel. In 1988, there were 259 people living in Akiak (Alaska Department of Labor 1990).

Salmon fishing for coho and chum salmon occurs in the Kisaralik River. Set gill nets are the primary method of fishing, particularly in the lower portion of the river. In addition, salmon are caught in the Kuskokwim River from below Akiak upstream to Tuluksak. Both set and drift gill nets are used with five salmon species harvested. Other fish species, such as northern pike, whitefish, sheefish and burbot are caught in the rivers and sloughs along the Kuskokwim River from the mouth of the Johnson River upstream to the Tuluksak area. Almost the entire length of the Kisaralik River is fished for trout, Arctic char, Dolly Varden and Arctic grayling. Whitefish and other species

are caught in the Whitefish Lake area and northern pike are caught in the Kulik Lake area.

Akiakchak. Akiakchak is located on the north bank of the Kuskokwim River about 13 miles northeast of Bethel. In 1988, the community had 468 residents (Alaska Department of Labor 1990).

Salmon are caught in the lower two-thirds of the Kisaralik River. Drift and set gill nets are the primary methods of fishing, particularly in the lower stretches of the river. Coho and chum salmon are the main species caught. Salmon are also taken in the Kuskokwim River from Bethel to Akiakchak with five salmon species taken using drift and set gill nets. Other species are caught in almost the entire eastern half of the refuge from the Eek River east to the refuge boundary and north to below Aniak and to above Russian Mission and Marshall on the Yukon River. Fishing occurs as far west as Aropuk Lake. Northern pike, whitefish, sheefish, Alaska blackfish and burbot are caught in the rivers, lakes and streams of the area, while trout, Arctic char/Dolly Varden and Arctic grayling are caught in the upland rivers such as the Kwethluk, Kisaralik and Tuluksak. Lamprey are sometimes harvested in the Yukon River.

Tuluksak. Tuluksak is located on the south bank of the Tuluksak River, 36 miles northeast of Bethel. By 1988, the population of Tuluksak was 357 (Alaska Department of Labor 1990).

Salmon are caught in the Kuskokwim River from near Kwethluk upstream to 25 miles above Tuluksak and in the lower Tuluksak River. Both set and drift gill nets are used to catch five species of salmon. Other fish are caught in the Kuskokwim River and the adjoining rivers, sloughs and lakes. On the east side the area use extends from the Tuluksak drainage to above Whitefish Lake. On the west side, it extends from the headwaters of the Johnson River down through the middle section over to Tuluksak. Whitefish, sheefish, northern pike and Alaska blackfish are the main species caught.

Upper and Lower Kalskag. Upper Kalskag is located on the north bank of the Kuskokwim River, 24 miles west of Aniak. Lower Kalskag is located on the north bank of the Kuskokwim River, 27 miles west of Aniak. In 1988, approximately 273 people lived in the community (Alaska Department of Labor 1990). Upper and Lower Kalskag use the same basic harvest areas.

Salmon are caught in the Kuskokwim River corridor from 15 miles below the communities upstream to Aniak. Five Pacific salmon species are taken by using set and drift gill nets. Other species, such as whitefish, sheefish, burbot, northern pike, smelt and lamprey are caught in this same corridor. The Portage Lakes area is used for whitefish, northern pike, burbot and Alaska blackfish while Whitefish Lake is popular for whitefish and northern pike.

Aniak. Aniak is located on the south bank of the Kuskokwim River at the head of Aniak Slough on the eastern boundary of the refuge. In 1988, Aniak had a population of 558 (Alaska Department of Labor 1990). Aniak functions as a subregional center for transportation and public service, although the economy is still heavily dependent on the subsistence harvest of resources.

Pacific salmon are taken in the Kuskokwim River from above Kalskag upstream to the refuge boundary and in the Aniak River to the refuge boundary. Five species of salmon found in the area are harvested from both the Kuskokwim and Aniak drainages. Other fish are caught in an area primarily south and west of the community. Trout, Arctic grayling, Arctic char and Dolly Varden are caught in the upper sections of most of the drainages coming out of the Kilbuck Mountains from the Aniak River south to the Kisaralik River. Other species are caught in the waters from Aniak west to the Portage Lakes area and south to Akiak as well as in the Portage Lakes area and in the Aniak River drainage. Whitefish, sheefish, northern pike, burbot and lamprey are caught in the main water bodies, while Alaska blackfish, northern pike and whitefish are caught in the smaller bodies of water.

Chuathbaluk. Chuathbaluk had a population of 127 people in 1988 (Alaska Department of Labor 1990). It is located on the Kuskokwim River about ten miles upstream from Aniak. It is the most upstream of the Kuskokwim River villages in the study area and while it is outside the refuge boundary its residents utilize the refuge to harvest resources.

Salmon are caught in the Kuskokwim River corridor from the refuge boundary to just above Kalskag. Five species of Pacific salmon are taken. Other species are taken in the various bodies of water found in the same general areas as are used for small game hunting and furbearer trapping. Whitefish, sheefish, northern pike, burbot and lamprey are caught in the main water bodies, while Alaska blackfish, northern pike and whitefish are caught primarily in the smaller bodies of water. Trout, Arctic grayling, Arctic char and Dolly Varden are caught in the upper reaches of the Aniak drainage and other Kilbuck Mountain rivers south to below the Tuluksak drainage.

Additional Information and Subsistence Studies

More detailed and comprehensive data and information is available on subsistence use of fish throughout the Yukon Delta and Kuskokwim River region from the Division of Subsistence, Alaska Department of Fish and Game. A number of in-depth subsistence investigations have been conducted by this agency. Subsistence use in the Aniak River area was conducted by Charnley (1983) and by Brelsford et al. (1987). Wolfe (1981) conducted a comprehensive study of the subsistence lifestyle of communities in the Norton Sound and Yukon River Delta areas. Stickney (1984) investigated the subsistence use of resources in the central Bering Sea area, specifically Hooper Bay and Kwigillingok. A series of reports on the subsistence harvest of Pacific herring in the Nelson and Nunivak Island areas are available from the Division of Subsistence

(Pete 1984; Pete and Kreher 1988; Pete et al. 1987). Subsistence use of resources in the Tuluksak River area by residents of Tuluksak, Alaska, was investigated by Andrews and Peterson (1983). Other investigations and surveys conducted by the Division of Subsistence and other authors on the Yukon-Kuskokwim Delta area include: Andrews and Coffing 1986; Andrews 1986; Fienup-Riordan 1986; Charnley 1982; Jonrowe 1980; Stickney 1980, 1981; Walker et al. 1989; Wolfe 1982; Wolfe and Ellanna 1983; Wolfe et al. 1986.

Sport Fisheries

The sport fishery in the Yukon/Kuskokwim areas is not a significant impact on the salmon resource. Because most of the river systems pass through uninhabited or remote areas, transportation becomes a major influence on the ability of sport fishermen to reach the fishing grounds. Most local residents are involved in the commercial or subsistence fishery and do not feel the need to supplement their catches by sport fishing.

The Yukon Delta National Wildlife Refuge is within the Arctic-Yukon-Kuskokwim sport fishing area. The following summary of sport fish regulations within the refuge was taken from the 1990 Alaska Sport Fishing Regulations Summary (Alaska Department of Fish and Game 1990d).

Kuskokwim River:

Chinook salmon - One per day, one in possession and no size limit.
Other salmon - Five per day, five in possession and no size limit.
Rainbow trout[a] - Two per day, two in possession and only one over 20 inches.
Arctic grayling - Ten per day, ten in possession and no size limit.
Lake trout - Four per day, four in possession and no size limit.
Arctic Char and Dolly Varden - Ten per day, ten in possession and no size limit.
Sheefish - Ten per day, ten in possession and no size limit.
Northern pike - Ten per day, ten in possession and no size limit.
Burbot - 15 per day, 15 in possession and no size limit.
Halibut - Two per day, four in possession and no size limit. Season open from February 1 to December 31.

[a] Special Regulation: In all flowing waters of the Aniak River drainage upstream of its confluence with Doestock Creek, only unbaited, single-hook artificial lures may be used. Rainbow trout may not be possessed or retained; all rainbow trout caught must be released immediately.

Yukon River:

Chinook salmon - Three per day, three in possession and only two may exceed 28 inches.
Other salmon - Ten per day, ten in possession and no size limit.
Arctic grayling - Ten per day, ten in possession and no size limit.
Lake trout - Four per day, four in possession and no size limit.
Arctic char and Dolly Varden - Ten per day, ten in possession and no size limit.
Sheefish - Ten per day, ten in possession and no size limit.
Northern pike - Ten per day, ten in possession and no size limit.
Burbot - 15 per day, 15 in possession and no size limit.
Halibut - Two per day, four in possession and no size limit. Season open from February 1 to December 31.

In the Yukon/Kuskokwim area, the Kisaralik and Kwethluk rivers are favored sport fishing streams for Bethel residents and other area fishermen and visitors. These rivers are navigable in their lower reaches and are preferred by many local sport fishermen. Sport fishing also takes place in the Kasigluk River.

SECTION 5: ISSUES AND CONCERNS

This section of the Plan provides a listing and discussion of the various fishery management issues and concerns that have been identified for the Yukon Delta National Wildlife Refuge. A number of general concerns were identified by the public, the Service and other agencies through the refuge Comprehensive Conservation Planning process (Table 18). A discussion of this process and its results are provided. In a separate process, more specific issues and concerns were identified by the Kenai Fishery Assistance Office in various meetings with the Yukon Delta National Wildlife Refuge staff and Department personnel. These issues are narrower in scope than those identified in the Comprehensive Conservation Planning process and apply to specific watersheds and fish species. These issues are listed in Table 19 and a more detailed discussion of these issues and concerns is provided.

Source Documents

Section 304(g)(4) of the Alaska National Interest Lands Conservation Act requires the Service to consult with appropriate state agencies and Native corporations to ensure public interests and concerns are addressed in the development of the refuge Comprehensive Conservation Plan. It also requires hearings to assure that residents affected by the administration of the refuge have an opportunity to present their views. Therefore, one of the first steps in the planning process was to develop a public participation and interagency coordination program to assist in identifying the issues which needed to be addressed in the plan and the significant problems associated with the refuge. That program was conducted during the winter of 1984 and 1985.

Table 18. Fishery related issues and concerns for the Yukon Delta National Wildlife Refuge, Alaska, and adjacent lands (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Issues and Concerns	Yukon Delta NWR CCP-1988		State Position Paper 1984
	Public	FWS	
Access and transportation	X		X
Sport fishing/recreation	X	X	
Wilderness	X		
Oil and gas development	X		
Threats to water quality	X		
Mining	X		
Information and education	X		X
Traditional way of life and values	X		X
Role of local residents in refuge management	X		
Beaver-fish interactions	X		X
Law enforcement needs	X		
Private in-holdings		X	X
Use and development of adjacent lands		X	
Boundary adjustments and land exchanges	X	X	X
Lack of detailed fish and wildlife resource data		X	X
Depressed fish and wildlife populations		X	
Difficulties in managing the refuge		X	
Management facilities			X
Hydropower projects			X
Fish and wildlife management coordination between State and FWS			X

Table 19. Specific fishery resources issues and concerns identified for the Yukon Delta National Wildlife Refuge, Alaska.

Issues and concerns	Source					
	YDNWR[1]	FAO[2]	Comm. Fish[3]	Sport Fish[4]	Sub.[5]	Habitat[6]
Specific populations of salmon and resident fish on the refuge are depressed or potentially overharvested.	X		X			
Present and potential impacts of recreational and other uses of the Eek, Kisaralik, Kwethluk, Aniak and Andreafsky watersheds on the fishery resources of those watersheds.	X			X	X	
Local fishermen and area residents do not always support management recommendations for fishery harvest regulations because they are not fully informed and educated about fishery resources and management.	X	X	X			
Management has not been completely successful in convincing local fishermen and the Board of Fisheries that recommendations for fishery harvest regulations are necessary because additional information of a more sophisticated nature are needed.			X			
The potential for conflict between subsistence and commercial uses of fishery resources in the Yukon and Kuskokwim Rivers, the Etolin Strait and Kokechik Bay need to be examined.					X	

Table 19 (Continued).

Issues and concerns	Source					
	YDNWR[1]	FAO[2]	Comm. Fish[3]	Sport Fish[4]	Sub.[5]	Habitat[6]
Refuge fishery resources may be impacted because of insufficient monitoring and enforcement of proposed and ongoing instream development activities. Deterioration of water quality due to placer mining in the Aniak, Tuluksak, Kwethluk, Kisaralik, and Bonasila watersheds.					X	X
The absence of professional fishery expertise on the refuge staff significantly impacts the refuge's ability to handle the routine fishery management problems on the refuge.	X	X				
The commercial fishery on the southern side of Nunivak Island could have a negative impact on fish species used by seabirds for forage.	X					

[1] Yukon Delta National Wildlife Refuge
[2] Kenai Fishery Assistance Office
[3] Alaska Department of Fish and Game, Commercial Fisheries Division
[4] Alaska Department of Fish and Game, Sport Fish Division
[5] Alaska Department of Fish and Game, Subsistence Division
[6] Alaska Department of Fish and Game, Habitat Division

Section 304(g) of the Alaska National Interest Lands Conservation Act requires the Service to identify and describe "significant problems which may adversely affect the populations and habitats of fish and wildlife" found on the refuge. Significant problems affecting the Yukon Delta National Wildlife Refuge were identified by the planning team and the refuge staff.

Early in 1984, the State of Alaska provided the Service with resource management recommendations for the Yukon Delta National Wildlife Refuge and surrounding area. The paper identified the State's current management policies and objectives, identified management issues and recommended solutions to these issues.

The general issues and concerns that were identified by the refuge Comprehensive Conservation Planning process and by the State of Alaska are listed in Table 18.

Specific Issues and Concerns

Depressed Fish Populations

Several fish populations on the refuge have become depressed in recent years. Although the loss of habitat has probably contributed to this situation in some instances, increasing demand and harvest in the commercial and subsistence fisheries of the area have been cited as the major reason for depressed fish populations on the refuge. The importance of fish to the regional economy and subsistence lifestyle has made this one of the most important fishery issues on the refuge. Specific fish populations and the particular concerns that have been identified are discussed below.

Kuskokwim River Chinook Salmon. Chinook salmon in the Kuskokwim River have become seriously depressed over the past several years. In fact, the Department's Commercial Fisheries Division and the refuge staff have identified this as the most important fisheries concern on the refuge. Of particular concern are chinook populations in the Tuluksak, Kisaralik, Kasigluk, Kwethluk, and Eek rivers. These are the only Kuskokwim River tributaries on the refuge that produce chinook salmon. Spawning escapements in these streams, as well as other Kuskokwim River index streams, have been below management objectives for a number of years and populations have continued to steadily decrease despite efforts to reduce and restrict harvest levels.

Current management of Kuskokwim River chinook salmon populations are complicated by two basic factors. First, attempting to manage individual stocks in a mixed-stock fishery is extremely difficult and demands a highly sophisticated and extensive data base which is currently not available. Secondly, the local public needs to become better informed and educated about fisheries resources and management. Without public support, management cannot implement the necessary actions required to accomplish their objectives.

Yukon River Chum Salmon. Although fall chum salmon do not originate on the refuge and only spawn in the upper reaches of the Yukon River in the interior of Alaska and Canada, this run is harvested quite intensively by the commercial fisheries in the lower Yukon River on the refuge. Commercial and subsistence fisheries in the upper reaches of the Yukon River add significantly to the total harvest. Due to excessive fishing, the escapement of most fall chum salmon stocks was below desired levels during 1982-1984 and 1986. Commercial fishing restrictions in Alaska since 1986 have resulted in improved escapement of most Alaskan stocks. However, Canadian stocks have not responded as favorably.

Successful management of this population will depend a lot on the outcome of current negotiations relative to a U.S.-Canada Treaty. Mutual agreement on the allocation of harvest of fall chum salmon to both parties will be necessary if overharvest is to be avoided.

Kuskokwim River Whitefish and Northern Pike. Whitefish and northern pike in the Kuskokwim River are used extensively for subsistence by local residents in the region. For the past several years, concern has been expressed by local fishermen that populations of whitefish and northern pike have been declining in several tributaries, particularly the Johnson and Gweek rivers. The Department's Commercial Fisheries Division identified this as an important fisheries concern for the refuge.

Reasons for apparent declines in population levels are not completely understood. Growing beaver populations were cited by local fishermen as the most likely cause. However, research on the interrelationships between beaver and whitefish populations failed to support that contention (Maciolek 1986). Overharvest by subsistence fishermen has also been suggested as a possible cause of declining fish populations. However, available data are not sufficient to accurately determine the extent or reasons for declining whitefish and northern pike populations. In order to insure that stable populations are maintained, data needs to be collected on the extent that whitefish and northern pike populations are harvested as well as the dynamics of these populations.

Increasing Use of Specific Watersheds

Several watersheds on the refuge are beginning to receive increased use over past years and the expectation is that it will continue to increase in the future. As use increases, the present and potential impacts on the fishery resources will also increase. The Department's Sport Fish and Subsistence Divisions and the refuge staff have identified this as a significant fisheries issue on the refuge, specifically for the Eek, Kisaralik, Kwethluk, Aniak and Andreafsky rivers.

The Aniak, Kisaralik, Kwethluk and Eek rivers are the major systems that support rainbow trout populations on the refuge. This area represents the northern most distribution of rainbow trout in Western Alaska. This species is highly desired and sought after by recreational fishermen. Although no permitted guided fishing is in operation on the refuge,

interest in guided fishing for rainbow trout in these refuge streams has increased significantly the past few years. Concern has been expressed that increasing pressure by recreational fishermen and other user groups could result in depressed rainbow trout populations. Very little data are available on exploitation rates or population dynamics of rainbow trout in these refuge streams.

The Aniak, Kwethluk, Kisaralik and Andreafsky rivers have become increasingly popular with floaters and hikers in addition to sport fishermen. Concern has been expressed that as use of these watersheds increases, potential impacts to the fishery and other resources will also increase. Specific concerns that have been identified include: water quality and habitat changes due to increased human presence and the use of jet-boats, displacement of wildlife populations along the riverine corridor, potential increased mortality of "caught and released" fish and the potential impact of "catch and release" regulations on fish populations, potential overharvest of selected fish populations and potential conflicts between different user groups, specifically subsistence and recreational users.

Better Public Information and Education

The need for better public information and education has been identified as a very significant issue affecting the refuge fishery resources. The public considered this an important issue during the refuge Comprehensive Conservation Planning process. The need for the Service to disseminate more information to refuge users was mentioned by a number of people. Comments were also received on the need for local people to be better educated about threats to fish and wildlife populations. More information should be given to villagers about fishing regulations to avoid violations and more information should be distributed about the lack of enforcement activities on the refuge (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

The Department's Commercial Fisheries Division and the refuge staff identified another aspect of the public education and information issue. Local fishermen and area residents are not fully informed and educated about the fundamental aspects of fisheries biology, ecology and population dynamics of important commercial and subsistence species, especially salmon. In the past few years, regulations have started becoming more restrictive as heavily fished populations have become more depressed. Because of their lack of understanding, local fishermen and area residents do not always support management recommendations for fishery harvest regulations.

In 1989, subsistence and commercial fishermen joined together with commercial fish processors to form the Kuskokwim River Salmon Management Working Group (Working Group). The Working Group has worked closely with the Department for the past two fishing seasons to provide in-season recommendations for openings and closing of the Kuskokwim River fishery and to help develop a comprehensive management plan for all Kuskokwim River salmon stocks (Alaska Department of Fish and Game 1990).

This cooperative effort has gone a long way towards addressing this issue. For more detailed information concerning the recent history, development, and accomplishments of the Kuskokwim River Salmon Management Working Group, see Albrecht (1990). However, this does not meet the need for providing a more comprehensive public education and information program for the general population.

Incomplete Baseline of Fishery Information

An incomplete baseline of information on fish and wildlife populations, habitats and their uses was a significant problem identified by the planning team and refuge staff during the Comprehensive Conservation Planning process. In subsequent meetings with the Kenai Fishery Assistance Office and refuge staff, the Department's Commercial Fish Division identified an incomplete database to be a significant issue affecting fisheries and fisheries management on the refuge. Managers have not been completely successful in convincing local fishermen and the Board of Fisheries that recommendations for fishery harvest regulations are necessary because additional basic information of a more sophisticated nature are needed. Specific data and information needs are identified and discussed below.

Salmon Spawning Escapement Data. Spawning escapement data for salmon populations in the Kuskokwim River drainage are very limited. Spawning escapement counts are limited primarily to aerial surveys of specific index streams. Total counts are not obtained and management must rely on escapement trends. Data on age, sex, and size of all salmon species are collected only at the Holitna River weir. These data are applied to all other salmon stocks in the Kuskokwim River. Kuskokwim River tributaries on the refuge for which these data need to be collected include the Eek, Kwethluk, Kasigluk, Kisaralik and Tuluksak rivers. Similar data needs to be collected in the Atchuelinguk, a tributary of the Yukon River.

Anadromous Fish Distribution. The distribution of various anadromous fish species, especially salmon, are not completely known in a number of watersheds. Unless data are available on the presence or absence of these species, important areas of spawning and rearing habitat cannot be properly protected. Specific priority streams that have sections which need to be surveyed include the Eek, Kwethluk, Kasigluk, Kisaralik and Tuluksak rivers in the Kuskokwim River drainage; the Andreafsky, Atchuelinguk and Archuelinguk rivers in the Yukon River drainage; and the Pastolik, Pastoliak and Pikmiktalik rivers that drain into Pastol Bay.

Salmon Spawning and Rearing Habitat. Quantitative information on the extent of spawning and rearing habitats available in refuge streams is unavailable. These data are necessary so that accurate estimates of stream carrying capacity and production rates can be made. High priority refuge streams that need to be surveyed include the Eek, Kwethluk, Kasigluk, Kisaralik and Tuluksak rivers.

Hazen Bay, Hooper Bay, and Baird Inlet Salmon Populations. Local residents in these areas have voiced a strong desire to develop commercial fisheries on local salmon stocks in the area. The Department has resisted public pressure because data on the population dynamics of these stocks are not available. Until information on the population size, mortality, survival and production rates of these stocks are obtained, determinations on the feasibility of initiating new commercial fisheries cannot be made.

Subsistence Use of Fishery Resources. Fishery resources are absolutely vital for the subsistence lifestyle of the local residents on the refuge. However, very little information is available on the subsistence use of fishery resources on the refuge. Subsistence use of non-salmon species such as whitefish, northern pike and smelt is poorly documented. The Department's Division of Subsistence has identified a number of watersheds on the Refuge where basic subsistence use information is needed.

For all of the refuge drainages the following information needs to be collected: species harvested, where harvest occurs, by whom, how much is harvested, during which seasons, the method(s) that are used, the locations and timespans that fish camps are used (as well as other camps along each drainage) and the impacts of beaver proliferation on tundra streams.

Specific watersheds that are particularly important and for which these data need to be collected include: the Gweek, Johnson, Eek, Kwigillingok, Kongiganak, Kukuglik, Keguk, Kinia, Toksook, Tununak, Ikanlugtulik, Ukak, Aprewn, Azun, Kashunak, Black, Izaniknek and Pitmiktalik watersheds. Etolin Strait and Kokechik Bay were also identified as important areas for data collection as listed above in addition to Pacific herring stock separation and definition, monitoring of new bottomfish commercial fishing and the impacts on subsistence (particularly Pacific halibut, cod, and proposed capelin and yellow fin sole fisheries in Etolin Strait).

Potential Conflict Between User Groups

The Department's Division of Subsistence identified the potential conflict between commercial and subsistence use of refuge fishery resources as a significant issue. Stocks of Pacific salmon returning to the Yukon and Kuskokwim rivers are not only important to subsistence users but these fisheries are also heavily fished in the commercial fisheries and provide one of the few sources of income to the local economy.

The Etolin Strait and Kokechik Bay were identified as other important areas of potential conflict between commercial and subsistence uses of fishery resources. Concern was expressed over the potential impacts of commercial Pacific herring fisheries on subsistence use of this species. Other fisheries of concern include bottom fisheries such as Pacific halibut, cod and proposed fisheries for capelin and yellow-fin-sole. Of

special interest is the potential impact of these commercial fisheries on marine mammal predators that are important to subsistence users.

Impacts of Instream Development Projects on Fisheries

Considerable concern has been expressed by the various divisions of the Department about the potential deterioration of water quality, and subsequent impacts to fish and fish habitat, due to placer mining on the refuge. Specific watersheds that were identified included Aniak, Tuluksak, Kwethluk, Kisaralik, and Bonasila. In addition, the Division of Habitat was concerned that refuge fishery resources may be impacted because of insufficient monitoring and enforcement of proposed and on-going instream development activities.

Refuge Fishery Biologist

The absence of professional fishery expertise on the refuge staff significantly impacts the refuge's ability to handle the routine fishery management problems on the refuge.

With intensive commercial fisheries occurring in the Yukon and Kuskokwim rivers, as well as extensive subsistence harvest of fish throughout the refuge, day to day coordination is needed to assure that refuge concerns are met. This level of coordination is beyond the present staffing and budget of the Kenai Fishery Assistance Office and would be better served by a refuge fishery biologist.

Commercial Fishing Around Nunivak Island

The refuge staff is concerned about the potential impact of commercial fishing on seabird populations on the southern side of Nunivak Island. Fish harvested in the commercial fishery are used as forage by seabirds.

SECTION 6: GOALS AND OBJECTIVES

The intent of the Fisheries Management Plan is to address the issues and concerns identified for the refuge within the context of the purposes or goals for which the refuge was established by the Alaska National Interest Lands Conservation Act. This section of the Fishery Management Plan lists the objectives needed to develop the management actions required to address these issues and concerns. The specific objectives for the refuge fisheries program are listed under the goals which they support.

Goal A: To conserve fish and wildlife populations and habitats in their natural diversity.

Objective A-1: To administer the fishery management program on the Yukon Delta National Wildlife Refuge through 1996.

Objective A-2: To estimate salmon run sizes in the Kuskokwim River through 1996.

Objective A-3: To estimate the quantity and composition of the commercial salmon harvest in the Kuskokwim River through 1996.

Objective A-4: To quantify the population size and harvest of Nelson and Nunivak islands Pacific herring stocks through 1996.

Objective A-5: To estimate salmon run sizes in the Yukon River through 1996.

Objective A-6: To estimate the quantity and composition of the commercial salmon harvest in the Yukon River through 1996.

Objective A-7: To inventory salmon spawning and rearing habitat in eight refuge streams by 1996.

Objective A-8: To conduct a public information and education program on fisheries resources and management through 1996.

Objective A-9: To determine the population dynamics and the harvest levels of resident fish in seven refuge watersheds by 1996.

Objective A-10: To determine the distribution of rearing salmon in the mainstem Kuskokwim River by 1996.

Objective A-11: To determine the upper drainage distribution of anadromous fish species in 11 refuge streams by 1996.

Objective A-12: To determine the population dynamics of salmon populations in the Baird Inlet and Hooper Bay/Hazen Bay areas by 1996.

Goal B: To fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats.

Objective B-1: To provide salmon stock identification and separation data under the U.S./Canada Yukon River agreement.

Goal C: To provide, in a manner consistent with the purposes set forth in Goals A and B, above, the opportunity for continued subsistence use by local residents.

Objective C-1: To estimate subsistence harvest of fish in the Kuskokwim River through 1996.

Objective C-2: To estimate the subsistence harvest of fish in the Yukon River through 1996.

Objective C-3: To expand the subsistence use data base for refuge villages and watersheds by 1996.

Goal D: To ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in Goal A, water quality and necessary water quantity within the refuge.

Objective D-1: To develop a water quality data base for 8 refuge rivers by 1996.

Objective D-2: To administrate the authority and responsibilities under the Alaska Anadromous Fish Act and Fish Ways Act through 1996.

SECTION 7: STRATEGIES AND CONSTRAINTS

Common Management Direction

In the Yukon Delta National Wildlife Refuge Comprehensive Conservation Plan, refuge lands were divided into various areas to be managed under four different management categories. Each management category is a set of refuge management strategies applied to an area (in light of its resources and existing and potential uses) to facilitate management and accomplishment of refuge purposes. Table 20 provides a brief description of how the refuge will be managed under each category. In addition, a variety of fishery management concepts (Table 21) and activities that can be applied under each category (Table 22) have been developed.

Fishery management activities may be applied only if they are compatible with refuge purposes. Compatibility will be determined on the basis of an activity's impact on fish and wildlife. Application of the fishery management strategies described below will occur as a cooperative effort between the Department and the Service. Day-to-day operations are guided by a Memorandum of Understanding between the Service and the Department dated March 13, 1982 (Appendix 2).

The Service and Department will cooperate in the collection of fishery management data from refuge originating species. Cooperative efforts to maintain counting towers, sonar sites, weirs and to conduct aerial surveys will be initiated. These projects will benefit both agencies by reducing overall operations cost and increasing the accuracy of data used to make management recommendations. The large refuge land base and abundance of fish species occurring on the refuge requires the sharing of law enforcement responsibilities. The State's Department of Public

Table 20. Comparison of the land management categories for managing the Yukon Delta National Wildlife Refuge (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Category	Description
Moderate Management	This category encompasses undeveloped areas where habitat and public use are managed to provide varied benefits in a natural setting. Existing fish and wildlife populations will be maintained, although some development could occur.
Minimal Management	This category is intended to maintain the pristine condition of those areas which have high fish and wildlife and wilderness values, but have not been designated as wilderness by Congress. Unlike designated wilderness, minimal management lands could be reclassified administratively by the Service if it is determined that such a change was necessary or desirable.
Wild River Management	The Andreafsky River from its source, including all headwaters, and the East Fork, within the boundary of the refuge was designated by Congress as a Wild River within the Wild and Scenic River System. The goal of this management category is to protect and enhance the values for which the Andreafsky River was designated while providing for public recreation and resource uses which do not adversely impact or degrade those values.
Wilderness Management	The designated wilderness category is similar to the minimal management category for permitted administrative and public uses. However, certain activities are legislatively prohibited by the Wilderness Act, and modified by the Alaska National Interest Lands Conservation Act. Only congressional action would allow such activities to occur in designated wilderness.

Table 21. Fishery management concepts that will be used on the Yukon Delta National Wildlife Refuge (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Sustained Yield

This concept applies to waters where management is primarily directed toward providing the fisherman with the opportunity to harvest fish. Sustained yield fisheries may be restored by stocking, but the yield to the fisherman is a fish which grows to catchable size in the wild. The opportunity to catch trophy fish, unique species, wild and catchable fish is not a major intent of this concept, even though base yield fisheries are supported by natural reproduction, and trophy and unique fish species occasionally enter the catch.

Wild Concept

This concept applies to waters where management is primarily directed toward maintaining long term commercial, subsistence, and sport fisheries that are totally supported by natural reproduction relying upon existing refuge stocks. Harvest is to be aligned to insure adequate escapement levels to sustain the current fisheries. Either no harvest or limited harvest of spawning adults is expected in spawning areas.

Trophy Concept

This concept applies to waters where management is primarily directed toward providing the fisherman with the opportunity to catch "larger than average" or "more flavorful than average" fish. A water that typically produces larger than average fish is not necessarily a trophy water unless this is a major objective of present and future management. In order to be managed under the trophy concept, a water must have relatively high productivity and/or abundant forage, management procedures such as restrictive creel limits, and limitations for fish pressure are usually employed. A trophy water typically will not support as much use as a sustained yield or put, grow, and take managed water.

Put, Grow, and Take

This concept applies to waters where management is directed toward allowing the fisherman to consumptively harvest fish. All of the harvest from waters managed under this concept is comprised of fish which are stocked as fry or fingerlings from a fish hatching facility. Most waters managed for put, grow, and take lack the potential for natural reproduction of salmonids and thus, must be supported by repeated stocking. Put, grow, and take waters can be managed to sustain high visitor use.

Table 21 (Continued).

Commercial Supplemented

This concept applies to waters where management is directed to maintain commercial fisheries relying, in part, upon artificially produced or translocated fish to restore a species. A liberal harvest of spawning adults will probably be allowed when successful spawning, rearing, or migration activity becomes established. This concept in commercial fish management may incorporate repeated introductions of fish species to maintain fish stocks at a sustained level.

Commercial Enhancement

This concept applies to waters where management is directed to maintain commercial fisheries relying, in part, upon artificially produced fish and a supplement to the stock. A liberal harvest of spawning adults may be allowed when spawning runs become established. This concept in commercial fish management may incorporate habitat alteration including barrier removal, construction and installation of weirs, fishways, fish hatching and rearing facilities, and spawning channels. Sport and subsistence harvest of the commercial product may or may not occur.

Table 22. Fishery management activities allowed in the Yukon Delta National Wildlife Refuge under each management category (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
FISHERIES DEVELOPMENT[1] Collection of data and information on fish populations and their habitats, modification of fish habitat, fish hatchery programs and related activities, fishery regulation, supplemental production, and other activities designed to accomplish management goals and objectives.				
Fish Passes				
Construction or installation of a fish ladder, removal of a barrier (e.g., beaver dam), or other activity to enable fish to get past a natural or man-made barrier to reach unaccessible habitat; may be either permanent or temporary.	May be permitted on a case-by-case basis subject to the provisions of NEPA and a compatibility determination	Same as (I)	Same as (I) except permanent facilities will normally not be permitted	Same as (III)
Fish Weirs				
Construction and installation of an instream fish counting facility; may be either permanent or temporary. Permanent weirs have a permanent instream anchoring device while temporary weirs do not. The above water structure for both types of weirs would be removed after the season of use.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I) except permanent facilities will not normally be permitted	Same as (III)

Table 22 (Continued).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
Spawning Channels Construction and maintenance of an artificial gravel laden channel where water quality and quantity is controlled to facilitate spawning by fish.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I) except permanent facilities will not normally be permitted	Same as (III)
Physical Habitat Modifications Activities designed to physically modify aquatic habitats, for the purpose of affecting production of target fish species.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I) except permanent facilities will normally not be permitted	Same as (III)
Chemical Habitat Modifications Introduction of either organic or inorganic chemicals on an annual or temporary basis to an aquatic environment to control the production of target fish species.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I) except permanent facilities will normally not be permitted	Same as (III)
Native Fish Re-introductions Re-introduction of native species for the purpose of re-establishing historic populations.	May be permitted	Same as (I)	Same as (I)	Same as (I)

Table 22 (Continued).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
Native Fish Introductions Introduction of a fish species native to North America outside their original range.	May be permitted on a case-by-case basis	Same as (I)	Same as (I)	Same as (I)
Exotic Fish Introductions Introduction of species not native to North America.	Not permitted	Same as (I)	Same as (I)	Same as (I)
Fish Rearing Ponds Use of natural ponds for rearing fry or fingerling fish to a larger size	May be permitted on a case by case basis subject to the provisions of NEPA and a compatibility determination	Same as (I)	Same as (I)	Same as (I)
Fish Hatcheries Construction and operation of required facilities for incubation of fish eggs and/or rearing of fish fry, fingerlings, or smolts; either permanent or temporary. Permanent hatchery could be operated seasonally or year-round; would be permanently maintained. Temporary hatchery would be operated seasonally; is project related (removed at project completion).	May be permitted on a case-by-case basis subject to the provisions of NEPA and a compatibility determination	Same as (I)	Same as (I) except permanent facilities will not normally be permitted	Same as (III)

Table 22 (Continued).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
Supplemental Fish Production Planting fertilized or eyed eggs, fed or unfed fry, fingerlings, presmolts, or smolts, which have been incubated, hatched, fed, and/or reared at a hatchery or temporary rearing facility and are subsequently introduced into the species' natural environment.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I)	Same as (I)
Fish Egg Taking Site Installation and operation of temporary facilities that use adult spawning fish to take eggs for the establishment of a brook stock or for use in supplemental production. Both facilities and activities would be on an "as needed" basis.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I)	Same as (I)
Predator/Competitor Control Removing or reducing predators and/or competitor fish species for the purpose of controlling the production of a target fish species.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination	Same as (I)	Same as (I)	Same as (I)

Table 22 (Continued).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
HABITAT/POPULATION MANAGEMENT ACTIVITIES				
Research and Management Studies				
Collection of data necessary for refuge management decisions or to further science. Priority will be given to studies that contribute to the conservation and management of native fish and wildlife populations and their habitats. Studies may be conducted by the Service or by other researchers under Service guidance and/or consent.	Will be routinely practiced provided the studies do not conflict with refuge purposes	Same as (I)	Same as (I)	Same as (I)
Ecological Monitoring				
Activities or studies that address how fish and wildlife and their habitats are changing, due to either natural or human causes.	Will be routinely practiced	Same as (I)	Same as (I)	Same as (I)
Fish and Wildlife Activities				
Using acceptable management techniques to obtain information on species distributions, habitats, and population dynamics to meet refuge objectives.	Will be routinely practiced	Same as (I)	Same as (I)	Same as (I)

Table 22 (Continued).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
Marking and Banding				
To contribute information on population trends, survival, and movements necessary for the overall management of the species. Cooperation with the Department and other institutions will be stressed.	Will be routinely practiced as long as the activities do not conflict with refuge purposes.	Same as (I)	Same as (I)	Same as (I)
Habitat Improvement				
Mechanical manipulation including activities such as large scale tree crushing, water impoundments, diversions, etc.	May be permitted on a case-by-case basis subject to provisions of NEPA and a compatibility determination.	Same as (I) except that in minimal manage-areas, this activity may be considered subject to appropriate plan revision.	Same as (I)	Not permitted
Minor habitat improvements including nesting devices, temporary actions to protect habitat, beaver dam removal, etc.	May be permitted subject to provisions of NEPA and a compatibility determination.	Same as (I)	Same as (I)	Same as (I)

Table 22 (Continued).

Management activity	Intensive management (I)	Moderate and minimal management (II)	Wild river management (III)	Wilderness management (IV)
Water Quality and Quantity				
Monitoring of water quality and quantity to enable the Service to propose mitigation or adverse effects that originate on or off the refuge.	Will be routinely practiced	Same as (I)	Same as (I)	Same as (I)

'Temporary - Any structure or man-made improvement which can be readily and completely dismantled and removed from the site when the period of authorized use terminates.

Notes:
- A site-specific compatibility determination will be required for all activities or use requiring special use permits.
- If management emergencies occur on the refuge, it may be necessary to allow action which would otherwise be prohibited.
- Management of activities occurring on navigable waters will be coordinated with appropriate State agencies.

Safety, Division of Fish and Wildlife Protection, will enforce state regulations within and adjacent to the refuge. The Service will either issue federal citations or transfer to State jurisdiction violations of state laws occurring within the refuge boundaries.

The Service and Department will cooperatively evaluate the results of field studies and surveys with respect to both refuge originating and resident species. The Service will confer and work closely with the Department on a local level in the interpretation of the results and the development of future management direction. The Service may recommend changes in state regulations when biological information indicates that fish or wildlife populations are adversely impacted, not meeting objectives or the quality of the recreational experience is unsatisfactory.

Fishery Management Strategies

Fisheries management on the refuge will be directed towards maintaining, to the maximum extent possible, the natural diversity of fish populations and their habitats throughout the refuge. Presently, fish populations are managed under the "Wild Concept" of fisheries management throughout the refuge and there are no plans to introduce any other management concepts to the refuge in the immediate future. There are no plans for any habitat improvement projects although they are allowed throughout the refuge, depending on the management category. Several techniques for restoration and enhancement of fishery populations may be allowed on the refuge (including hatcheries, physical and chemical habitat manipulation, and supplemental fish production), although new permanent facilities for fisheries management purposes would not be permitted in designated wilderness unless essential to accomplish refuge management objectives. No plans exist to use any of these techniques in the immediate future.

The emphasis of fishery management on the refuge over the next five years will be directed towards: 1) Establishing a permanent fisheries biologist on the refuge staff; 2) Collecting baseline data on important fish populations and watersheds; 3) Developing a better public information and education program and 4) Addressing species specific and watershed specific problems that have been identified.

Depressed Fish Populations

Initially, activities will concentrate on identifying the primary factors responsible for limiting fish population sizes. Once those factors have been identified, projects will be designed to quantify the important relationships between limiting factors and fish populations, i.e., survival and mortality rates. Results will then be used by the refuge manager and project leader to develop appropriate management actions that will restore the affected fish populations to more desirable sizes.

Increasing Use of Specific Watersheds

Projects will be designed to quantify fisheries related public use occurring on identified watersheds. Data will be collected to determine the types of uses that occur, the magnitude of each type of use, and the distribution of each type of use over space and time. These data will be used by the refuge manager and project leader to evaluate the potential impacts of various public uses on fishery resources and the need for corrective management action.

Better Public Information and Education

A better public information and education program on fisheries resources and management will be developed in two primary ways. First, a public information and education element will be incorporated into all fishery management activities and projects conducted on the refuge and will include specific funding for this element in the project budget. The magnitude of the information and education element will depend on the sensitivity of the issue being addressed and will be determined by the refuge manager in consultation with the project leader.

Emphasis of the information and education element will be directed towards informing local residents and the general public about the issue being addressed, the need for the particular actions being taken, benefits to the public from the results, and to develop enhanced public awareness and involvement in fishery resource management on the refuge. The information and education element may include the distribution of information pamphlets or other written materials, paid public announcements, public meetings and other similar or related activities that are deemed appropriate by the refuge manager and project leader.

Independent of specific fishery projects being conducted on the refuge, efforts will also be made to help the general public to become better informed and educated about fundamental aspects of fisheries biology, ecology and population dynamics of important commercial and subsistence species, especially salmon. Particular efforts will be made to increase the public's understanding of fish populations, their exploitation and the role of fisheries management and regulation.

This aspect of the information and education program will emphasize the development of general educational materials and may include posters, calendars, various type pamphlets or booklets, videos, various types of primary or secondary educational curriculum, and other similar or related materials deemed appropriate by the refuge manager and project leader.

Incomplete Baseline of Fishery Information

Projects will occur primarily on high priority watersheds where specific data have already been identified for collection. However, baseline data will eventually be collected from all refuge watersheds. Data collection will concentrate on quantifying general community structure

(species composition, relative abundance, and distribution), population dynamics of important species, quantifying spawning and rearing habitats of selected species, water quality and quantity and levels of public use and fish harvest.

Potential Conflict Between User Groups

The Lands Act established priority of use for fish and wildlife resources on the refuge. Where potential conflict between one or more user groups for a particular fishery resource has been identified, the resource will be quantitatively assessed to determine the harvestable surplus which will be allocated according to priorities of use as established by the Lands Act.

Impacts of Instream Development Projects on Fisheries

A list of all past and ongoing mining activities as well as inactive mining claims that are on the refuge or are on streams that drain into the refuge is being compiled by the Department's Division of Habitat. Specific sites that are identified to have the highest potential for deterioration of water quality and impacts to fish populations and habitats will be noted and efforts made to monitor on site activities.

Refuge Fishery Biologist

Establishing a permanent fishery biologist on the refuge staff is a high priority. The position would provide the necessary coordination between the refuge staff, other Service offices, the various Department divisions (Subsistence, Commercial Fisheries, etc.) and other groups such as subsistence and commercial fishermen on fishery management related issues, concerns and activities occurring on the refuge. The refuge fishery biologist would provide the primary support for implementation and carrying out the information and education elements of the Fishery Management Plan. Responsibilities would also include providing assistance in planning and conducting specific fishery projects in conjunction with the Kenai Fishery Assistance Office, conducting routing baseline surveys of fish populations and habitats, conducting spawning escapement surveys and other routine fishery activities on the refuge. The position has been identified as part of the staffing needs of the refuge in the refuge Comprehensive Conservation Plan (U.S. Department of Interior, U.S. Fish and Wildlife Service 1988).

Commercial Fishing Around Nunivak Island

Projects will be designed to determine the basic relationships and interactions between seabird populations and fish species used as forage. These data will be used to assess and mitigate changes in prey populations due to commercial fishing.

Constraints to Management

In implementing these strategies the following constraints must be considered for anadromous and resident species: 1) more complete database needed to properly manage these fisheries; 2) limited funds and personnel to obtain needed data; 3) regulatory changes needed to meet objectives may conflict with the desires of some user groups or the Department; 4) regulations will be difficult to enforce, especially in remote areas; 5) resistance may be met in gathering information from user groups; 6) population structures may be severely impacted from over use before regulations can be implemented to reduce the impact; 7) refuge purposes and Department goals and objectives may not be compatible and 8) even with the most restrictive harvest regulations fragile resources may suffer from over use.

SECTION 8: FISHERY MANAGEMENT PROGRAM

Programs to help the Service and the Department supply the basic fishery data needs of the Yukon Delta National Wildlife Refuge are shown in Table 23. Agencies other than the "Responsible Office," as designated in Table 23, may participate in carrying out some of the tasks identified.

SECTION 9: PRIORITY OF TASKS

The priority of tasks for the Service fishery program as seen by the refuge staff are as shown in Table 24. The priority of tasks for the Department's Division of Commercial Fisheries are shown in Tables 25 and 26. The priority of tasks for the Department's Habitat and Subsistence Divisions are shown in Tables 27 and 28 respectively.

Table 23. Fishery management activities for the Yukon Delta National Wildlife Refuge, 1992-1996.

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Goal A: To conserve fish and wildlife populations and habitats in their natural diversity.			
Objective A-1: To administer the fishery management program on the Yukon Delta National Wildlife Refuge through 1995.	Task A-1-1: Conduct fish law enforcement activities.	YDNWR[1]; FWP[2]	Continuing Effort
	Task A-1-2: Issue special use permits.	YDNWR	Continuing Effort
	Task A-1-3: Establish harvest levels.	ADFG - Sport[3], Comm.[4]; YDNWR	Continuing Effort
	Task A-1-4: Present formal proposals to Alaska Board of Fisheries.	ADFG - Sport, Comm.; USFWS-RD[5]	Continuing Effort
	Task A-1-5: Conduct fishery planning activities.	ADFG - Sport, Subs[6]., Comm.; YDNWR; FAO[7]; AFWRC[8]	1992/5,000/0.1 1993/5,000/0.1 1994/6,000/0.1 1995/6,000/0.1 1996/7,000/0.1
	Task A-1-6: Process fish data.	ADFG - Sport, Subs., Comm.; FAO; AFWRC	Continuing Effort

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-1 (continued).	Task A-1-7: Develop cooperative agreements.	ADFG - Sport, Subs., Comm.; FAO; YDNWR;	Continuing Effort
	Task A-1-8: Report data collected.	ADFG - Sport, Subs., Comm.	Continuing Effort
	Task A-1-9: Conduct agency coordination and technical assistance.	ADFG - Sport, Subs., Comm.; FAO; YDNWR; AFWRC	1992/5,000/0.1 1993/5,000/0.1 1994/6,000/0.1 1995/6,000/0.1 1996/7,000/0.1
	Task A-1-10: Attend meetings regarding local resource problems.	ADFG - Sport, Subs., Comm.; FAO; YDNWR; AFWRC	Continuing Effort
	Task A-1-11: Fund a permanent fishery biologist position for refuge staff.	YDNWR	1992/60,000/1.0 1993/60,000/1.0 1994/60,000/1.0 1995/60,000/1.0 1996/60,000/1.0
Objective A-2: To estimate salmon run sizes in the Kuskokwim River through 1995.	Task A-2-1: Conduct test fishing in the mainstem Kuskokwim River to index run magnitude.	ADFG - Comm.	Continuing Effort

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-2: (Continued)	Task A-2-2: Conduct spawning escapement counts of salmon in the Kuskokwim River index streams.	ADFG - Comm.; FAO; YDNWR	Continuing Effort 1992/100,000/0.6 1993/50,000/0.6 1994/55,000/0.6 1995/60,000/0.6 1996/65,000/0.6
	Task A-2-3: Operate Kuskokwim River sonar.	ADFG - Comm.	Continuing Effort
	Task A-2-4: Operate Aniak River sonar.	ADFG - Comm.	Continuing Effort
	Task A-2-5: Conduct salmon carcass surveys on selected Kuskokwim River index streams to determine age and composition of spawning populations.	YDNWR; FAO	1992/17,000/0.2 1993/17,000/0.2 1994/18,000/0.2 1995/18,000/0.2 1996/19,000/0.2
	Task A-2-6: Conduct a lower Kuskokwim River salmon stock identification program.	ADFG - Comm.; YDNWR; FAO	1992/55,000/0.3 1993/130,000/0.3 1994/110,000/0.3 1995/90,000/0.3 1996/85,000/0.3

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-3: To estimate the quantity and composition of the commercial salmon harvest in the Kuskokwim River through 1995.	Task A-3-1: Conduct in-season commercial catch sampling for age, weight, and length data.	ADFG - Comm.	Continuing Effort
	Task A-3-2: Estimate the commercial harvest from fish ticket information.	ADFG - Comm.	Continuing Effort
Objective A-4: To quantify the population size and harvest of Nelson and Nunivak islands Pacific herring stocks through 1995.	Task A-4-1: Conduct biomass estimates of herring stocks for Nelson and Nunivak islands through aerial surveys.	ADFG - Comm.	Continuing Effort
	Task A-4-2: Estimate the subsistence harvest of herring for Nelson Island and Nunivak Island.	ADFG - Comm.	Continuing Effort
	Task A-4-3: Estimate the commercial harvest of herring for Nelson Island and Nunivak Island.	ADFG - Comm.	Continuing Effort

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-5: To estimate salmon run sizes in the Yukon River through 1995.	Task A-5-1: Conduct test fishing in the Lower Yukon River.	ADFG - Comm.	Continuing Effort
	Task A-5-2: Conduct aerial spawning escapement counts of salmon in Yukon River index streams.	ADFG - Comm.	Continuing Effort
	Task A-5-3: Operate sonar in the mainstem Yukon River.	ADFG - Comm.	Continuing Effort
Objective A-6: To estimate the quantity and composition of the commercial salmon harvest in the Yukon River through 1995.	Task A-6-1: Conduct in-season commercial catch sampling for age, weight, and length data and effort.	ADFG - Comm.	Continuing Effort
	Task A-6-2: Estimate the commercial harvest from fish ticket information.	ADFG - Comm.	Continuing Effort

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-7: To inventory salmon spawning and rearing habitat in eight refuge streams by 1995	Task A-7-1: Conduct habitat survey on Eek River.	FAO	1994/50,000/0.3 1995/5,000/0.1
	Task A-7-2: Conduct habitat survey on Kwethluk River.	FAO	1992/45,000/0.3 1993/4,000/0.1
	Task A-7-3: Conduct habitat survey on Kisaralik River.	FAO	1993/50,000/0.3 1994/5,000/0.1
	Task A-7-4: Conduct habitat survey on Kasigluk River.	FAO	1993/50,000/0.3 1994/5,000/0.1
	Task A-7-5: Conduct habitat survey on Tuluksak River.	FAO	1993/55,000/0.3 1994/5,000/0.1
	Task A-7-6: Conduct habitat survey on Andreafsky River.	FAO	1995/60,000/0.3 1996/6,000/0.1
	Task A-7-7: Conduct habitat survey on Achuelinguk River.	FAO	1995/50,000/0.3 1996/6,000/0.1
	Task A-7-8: Conduct habitat survey on Archuelinguk River.	FAO	1996/50,000/0.3

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-8: To conduct a public information and education program on fisheries resources and management through 1995.	Task A-8-1: Develop and conduct a fisheries resources public information and education program.	FAO; YDNWR	Continuing Effort
Objective A-9: To determine the population dynamics and the harvest levels of resident fish in seven refuge watersheds by 1995.	Task A-9-1: Conduct baseline survey of Johnson River.	FAO	1994/50,000/0.5 1995/55,000/0.5 1996/15,000/0.2
	Task A-9-2: Conduct baseline survey of Gweek River.	FAO	1994/50,000/0.5 1995/55,000/0.5 1996/15,000/0.2
	Task A-9-3: Conduct baseline survey of Andreafsky River.	FAO	1995/60,000/0.5 1996/60,000/0.5
	Task A-9-4: Conduct baseline survey of the Eek River.	FAO	1994/50,000/0.5 1995/55,000/0.5 1996/15,000/0.2

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-9 (continued).	Task A-9-5: Conduct baseline survey of the Kisaralik River.	FAO	1992/45,000/0.5 1993/50,000/0.5 1994/15,000/0.2
	Task A-9-6: Conduct a baseline survey of the Kwethluk River.	FAO	1992/45,000/0.5 1993/50,000/0.5 1994/15,000/0.2
	Task A-9-7: Conduct a baseline survey of the Aniak River.	FAO	1994/50,000/0.5 1995/60,000/0.5 1996/15,000/0.2
Objective A-10: To determine the distribution of rearing salmon in the mainstem Kuskokwim River by 1995.	Task A-10-1: Conduct baseline survey of the lower Kuskokwim River mainstem.	FAO	1993/45,000/0.3 1994/15,000/0.2
Objective A-11: To determine the upper drainage distribution of anadromous fish species in 11 refuge streams by 1995.	Task A-11-1: Conduct upper drainage survey on the Tuluksak River.	FAO	1993/55,000/0.3 1994/5,000/0.1
	Task A-11-2: Conduct upper drainage survey on the Kisaralik River.	FAO	1993/50,000/0.3 1994/5,000/0.1

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-11: (Continued).	Task A-11-3: Conduct upper drainage survey on the Kasigluk River.	FAO	1993/50,000/0.3 1994/5,000/0.3
	Task A-11-4: Conduct upper drainage survey on the Kwethluk River.	FAO	1992/45,000/0.3 1993/4,000/0.1
	Task A-11-5: Conduct upper drainage survey on the Eek River.	FAO	1995/55,000/0.3 1996/6,000/0.1
	Task A-11-6: Conduct upper drainage survey on the Andreafsky River.	FAO	1996/50,000/0.3
	Task A-11-7: Conduct upper drainage survey on the Atchuelinguk River.	FAO	1995/50,000/0.3 1996/6,000/0.1
	Task A-11-8: Conduct upper drainage survey on the Archuelinguk River.	FAO	1996/50,000/.3
	Task A-11-9: Conduct upper drainage survey on the Pastolik River.	FAO	1996/50,000/.3

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-11: (Continued).	Task A-11-10: Conduct upper drainage survey on the Pastoliak River.	FAO	1996/50,000/0.3
	Task A-11-11: Conduct upper drainage survey on the Pikmiktalik River.	FAO	1996/50,000/0.3
Objective A-12: To determine the population dynamics of salmon populations in the Baird Inlet and Hooper Bay/Hazen Bay areas by 1995.	Task A-12-1: Conduct a baseline study of salmon populations in the Baird Inlet area.	FAO	1995/60,000/0.5 1996/65,000/0.5
	Task A-12-2: Conduct a baseline study of salmon populations in the Hooper Bay/Hazen Bay area.	FAO	1995/60,000/0.5 1996/65,000/0

Goal B: To fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats.

Objective B-1: To provide salmon stock identification and separation data under the U.S./Canada Yukon River Agreement.	Task B-1-1: Collect and analyze scale samples from commercial chinook salmon catch for stock I.D. and separation.	ADFG - Comm.	Continuing Effort

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective B-1 (continued)	Task B-1-2: Collect and analyze (electrophoresis) samples from commercial catch for stock ID and separation.	AFWRC; ADFG - Comm.; FMS[9]	1992/250,000/0.3
	Task B-1-3: Collect data on the age, sex, size composition, and stock origins of salmon harvested in each of the major channels in the Yukon River delta.	ADF&G - Comm.	Continuing Effort
Goal C: To provide in a manner consistent with the purposes set forth in Goals A and B above, the opportunity for continued subsistence use by local residents.			
Objective C-1: To estimate subsistence harvest of fish in the Kuskokwim River through 1995.	Task C-1-1: Conduct house to house subsistence harvest surveys of salmon.	ADFG - Comm. Subs.; YDNWR; FAO	Continuing Effort Continuing Effort 1992/11,000/0.1 1993/11,000/0.1 1994/14,000/0.1 1995/14,000/0.1 1996/16,000/0.1

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective C: (Continued)	Task C-1-2: Conduct house to house subsistence harvest surveys of resident fish.	YDNWR; ADFG - Subs.; FAO	Continuing Effort Continuing Effort 1992/11,000/0.1 1993/11,000/0.1 1994/14,000/0.1 1995/14,000/0.1 1996/16,000/0.1
Objective C-2: To estimate subsistence harvest of fish in the Yukon River through 1995.	Task C-2-1: Conduct house to house subsistence harvest surveys for salmon.	ADFG - Comm.	Continuing Effort
Objective C-3: To expand the subsistence use data base for refuge villages and watersheds by 1995.	Task C-3-1: Conduct baseline surveys and research on specific priority areas and rivers.	ADFG - Subs.	Continuing Effort
Goal D: To ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in Goal A, water quality and necessary water quantity within the refuge.			
Objective D-1: To develop a water quality data base for 8 refuge rivers by 1995.	Tasks are part of the river surveys indentified under Goal A.	YDNWR; FAO	Continuing effort

Table 23 (Continued).

Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective D-2: To administrate the authority and responsibilities under the Alaska Anadromous Fish Act and Fish Ways Act through 1995.	Task D-2-1: Review requests for permits for all instream development activities in fish habitat.	ADFG; Hab[10].	Continuing Effort
	Task D-2-2: Conduct on site inspections of most permitted activities.	ADFG; Hab.	Continuing Effort
	Task D-2-3: Conduct occasional sampling and inventory associated with proposed or ongoing permitted activities.	ADFG; Hab.	Continuing Effort

[1] Yukon Delta National Wildlife Refuge
[2] Alaska Department of Public Safety, Division of Fish and Wildlife Protection
[3] Alaska Department of Fish and Game, Sport Fish Division
[4] Alaska Department of Fish and Game, Division of Commercial Fisheries
[5] U.S. Fish and Wildlife Service, Regional Director
[6] Alaska Department of Fish and Game, Subsistence Division
[7] U.S. Fish and Wildlife Service, Kenai Fishery Assistance Office
[8] U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center
[9] U.S. Fish and Wildlife Service, Fisheries Management Services
[10] Alaska Department of Fish and Game, Division of Habitat

Table 24. Priority of tasks and funding for fishery management activities to be conducted by the U.S. Fish and Wildlife Service on the Yukon Delta National Wildlife Refuge, 1992-1996.

Task	Description	FY 1992 Funding	Cumulative Total
A-1-5	Fishery planning activities	5,000	5,000
A-1-9	Technical assistance	5,000	10,000
A-1-11	Refuge fishery biologist	60,000	75,000
B-1-2	Yukon River salmon stock identification	250,000	335,000
A-2-6	Kuskokwim River salmon stock identification	55,000	390,000
A-2-2	Salmon spawning escapement counts	100,000	490,000
A-2-5	Salmon carcass surveys	17,000	507,000
C-1-1	Subsistence salmon harvest survey	11,000	518,000
A-9-6	Baseline survey of Kwethluk River	45,000	563,000
A-7-2	Habitat survey of Kwethluk River	45,000	608,000
A-11-4	Upper drainage survey of Kwethluk River	45,000	653,000
A-9-5	Baseline survey of Kisaralik River	45,000	698,000
C-1-2	Subsistence harvest survey - resident fish	11,000	709,000

Table 24 (Continued).

Task	Description	FY 1993 Funding	Cumulative Total
A-1-5	Fishery planning activities	5,000	5,000
A-1-9	Technical assistance	5,000	10,000
A-1-11	Refuge fishery biologist	60,000	75,000
A-2-6	Kuskokwim River salmon stock identification	130,000	205,000
A-7-2	Conduct habitat survey of Kwethluk River	4,000	209,000
A-11-4	Upper drainage survey of Kwethluk River	4,000	213,000
A-2-2	Salmon spawning escapement counts	50,000	263,000
A-2-5	Salmon carcass surveys	17,000	280,000
C-1-1	Subsistence salmon harvest survey	11,000	291,000
A-9-6	Baseline survey of Kwethluk River	50,000	341,000
A-9-5	Baseline survey of Kisaralik River	50,000	391,000
A-7-3	Habitat survey of Kisaralik River	50,000	441,000
A-11-2	Upper drainage survey of Kisaralik River	50,000	491,000
A-10-1	Baseline survey of Lower Kuskokwim River	45,000	536,000
A-7-4	Habitat survey of Kasigluk River	50,000	586,000
A-11-3	Upper drainage survey of Kasigluk River	50,000	636,000
A-7-5	Habitat survey of Tuluksak River	55,000	691,000
A-11-1	Upper drainage survey of Tuluksak River	55,000	746,000
C-1-2	Subsistence harvest survey - resident fish	11,000	757,000

Table 24 (Continued).

Task	Description	FY 1994 Funding	Cumulative Total
A-1-5	Fishery planning activities	6,000	6,000
A-1-9	Technical assistance	6,000	12,000
A-1-11	Refuge fishery biologist	60,000	78,000
A-2-6	Kuskokwim River salmon stock identification	110,000	188,000
A-7-3	Habitat survey of Kisaralik River	5,000	193,000
A-7-4	Habitat survey of Kasigluk River	5,000	198,000
A-7-5	Habitat survey of Tuluksak River	5,000	203,000
A-9-5	Baseline survey of Kisaralik River	15,000	218,000
A-9-6	Baseline survey of Kwethluk River	15,000	233,000
A-10-1	Baseline survey of lower Kuskokwim River	15,000	248,000
A-11-1	Upper drainage survey of Tuluksak River	5,000	253,000
A-11-2	Upper drainage survey of Kisaralik River	5,000	258,000
A-11-3	Upper drainage survey of Kasigluk River	5,000	263,000
A-2-2	Salmon spawning escapement counts	55,000	318,000
A-2-5	Salmon carcass surveys	18,000	336,000
C-1-1	Subsistence salmon harvest surveys	14,000	350,000
A-9-4	Baseline survey of Eek River	50,000	400,000
A-7-1	Habitat survey of Eek River	50,000	450,000
A-9-7	Baseline survey of Aniak River	50,000	500,000
A-9-1	Baseline survey of Johnson River	50,000	550,000
A-9-2	Baseline survey of Gweek River	50,000	600,000
C-1-2	Subsistence harvest survey - resident fish	14,000	614,000

Table 24 (Continued).

Task	Description	FY 1995 Funding	Cumulative Total
A-1-5	Fishery planning activities	6,000	6,000
A-1-9	Technical assistance	6,000	12,000
A-1-11	Refuge fishery biologist	60,000	78,000
A-2-6	Kuskokwim River salmon stock identification	90,000	168,000
A-7-1	Habitat survey of Eek River upper drainage	5,000	173,000
A-2-2	Salmon spawning escapement counts	60,000	233,000
A-2-5	Salmon carcass surveys	18,000	251,000
C-1-1	Subsistence salmon harvest surveys	14,000	265,000
A-9-4	Baseline survey of Eek River	55,000	320,000
A-11-5	Upper drainage survey of Eek River	55,000	375,000
A-9-7	Baseline survey of Aniak River	60,000	435,000
A-9-1	Baseline survey of Johnson River	55,000	490,000
A-9-2	Baseline survey of Gweek River	55,000	545,000
A-9-3	Baseline survey of Andreafsky River	60,000	605,000
A-7-6	Habitat survey of Andreafsky River	60,000	665,000
A-12-1	Baird Inlet salmon population baseline study	60,000	725,000
A-12-2	Hooper Bay/Hazen Bay salmon population study	60,000	785,000
A-7-7	Habitat survey of Atchuelinguk River	50,000	835,000
A-11-7	Upper drainage survey of Atchuelinguk River	50,000	885,000
C-1-2	Subsistence harvest survey - resident fish	14,000	899,000

Table 24 (Continued).

Task	Description	FY 1996 Funding	Cumulative Total
A-1-5	Fishery planning activities	7,000	7,000
A-1-9	Technical assistance	7,000	14,000
A-1-11	Refuge fishery biologist	60,000	81,000
A-2-6	Kuskokwim River salmon stock identification	85,000	161,000
A-7-6	Habitat survey of Andreafsky River	6,000	167,000
A-7-7	Habitat survey of Atchuelinguk River	6,000	173,000
A-9-1	Baseline survey of Johnson River	15,000	188,000
A-9-2	Baseline survey of Gweek River	15,000	203,000
A-9-4	Baseline survey of Eek River	15,000	218,000
A-9-7	Baseline survey of Aniak River	15,000	233,000
A-11-5	Upper drainage survey of Eek River	6,000	239,000
A-11-7	Upper drainage survey of Atchuelinguk River	6,000	245,000
A-2-2	Salmon spawning escapement counts	65,000	310,000
A-2-5	Salmon carcass surveys	19,000	329,000
C-1-1	Subsistence salmon harvest surveys	16,000	345,000
A-9-3	Baseline survey of Andreafsky River	60,000	405,000
A-11-6	Upper drainage survey of Andreafsky River	50,000	455,000
A-12-1	Baird Inlet salmon population baseline study	65,000	520,000
A-12-2	Hooper Bay/Hazen Bay salmon population study	65,000	585,000
A-7-8	Habitat survey of Archuelinguk River	50,000	635,000
A-11-8	Upper drainage survey of Archuelinguk River	50,000	685,000
A-11-9	Upper drainage survey of Pastolik River	50,000	735,000
A-11-10	Upper drainage survey of Pastoliak River	50,000	785,000
A-11-11	Upper drainage survey of Pikmiktalik River	50,000	835,000
C-1-2	Subsistence harvest survey - resident fish	16,000	851,000

Table 25. Tasks by priority level for the Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Management Area, 1992-1996.

Priority	Task
1	Administrative tasks.
2	Process fish ticket data to estimate commercial harvest.
3	Estimate commercial herring harvest.
4	Conduct test net fishing in lower mainstem of Kuskokwim River.
5	Conduct sampling of commercial salmon catches for age-weight-length data.
6	Operate Aniak River side scan sonar.
7	Conduct aerial salmon spawning escapement counts.
8	Estimate Pacific herring biomass from aerial surveys.
9	Operate Kuskokwim River side scan sonar.
10	Estimate subsistence harvest of salmon.
11	Estimate subsistence harvest of Pacific herring.
12	Conduct Kuskokwim River tagging program.
13	Operate Kwethluk River side scan sonar.
14	Estimate subsistence harvest of resident fish species.

Table 26. Tasks by priority level for the Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Management Area, 1992-1996.

Priority	Task
1.	Administrative tasks.
2.	Operate Yukon River side scan sonar.
3.	Conduct set and drift test net fishing in lower Yukon River.
4.	Conduct aerial salmon spawning escapement counts.
5.	Process fish ticket data to estimate commercial harvest.
6.	Conduct subsistence harvest surveys.
7.	Conduct sampling of commercial and subsistence salmon catches for age-weight-length data.
8.	Conduct chinook and chum salmon stock biology programs.
9.	Operate Anvik River side scan sonar.
10.	Separation of salmon stocks in major channels of the Yukon River delta.

Table 27. Tasks by priority level for the Alaska Department of Fish and Game, Habitat Division, 1992-1996.

Priority	Task
1	Administrative tasks.
2	Review permit requests for all instream development activities.
3	Conduct on-site inspections of permitted activities.
4	Conduct sampling and inventory associated with proposed or ongoing instream development activities.

Table 28. Tasks by priority level for the Alaska Department of Fish and Game, Subsistence Division, 1992-1996.

Priority	Task
1.	Collect subsistence salmon harvest data for Yukon and Kuskokwim River drainage communities.
2.	Conduct subsistence Pacific herring harvest surveys for Nelson and Nunivak Islands.
3.	Collect data on the harvest and biological status of non-salmon fish stocks in the following rivers: Kuskokwim River mainstem, Kwethluk, Kasigluk, Kisaralik, Johnson, Gweek, Eek, Kialik, Black, Kolvinpak, Kashunak, Aprewn, Izaviknek, Pitmiktalik, Pastolik, Yukon River main stem, and Andreafsky rivers.
4.	Collect data on the status of sport fish stocks in the Kisaralik, Kwethluk, Eek, and Andreafsky rivers in order to evaluate the potential impact of increasing recreational fishing on subsistence use.
5.	Investigate potential impact of water quality in the Tuluksak, Kisaralik, and Kwethluk rivers on the water supplies and fisheries of the community.
6.	Investigate potential impacts of increased recreational use of the Tuluksak and Kisaralik rivers on important wildlife populations.

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The report provides a description of the area and district boundaries, the fishery resources, the commercial and subsistence fisheries, and the management program for the Kuskokwim Commercial Management Area. Catch statistics for the 1983 commercial and subsistence fisheries are listed by species for each district and historical catch statistics are summarized in appendices.

Alaska Department of Fish and Game. 1985a. Annual Management Report - 1984. Yukon River Area. Division of Commercial Fisheries. Anchorage, Alaska.

The report provides a description of the area and district boundaries, the fishery resources, the commercial and subsistence fisheries, and the management program for the Yukon Commercial Management Area. Catch statistics for the 1984 commercial and subsistence fisheries are listed by species for each district and historical catch statistics are summarized. Outlook for 1985 fishing season is discussed.

Alaska Department of Fish and Game. 1985b. Annual Management Report-1984 Kuskokwim Area. Division of Commercial Fisheries. Anchorage, Alaska.

The report provides a description of the area and district boundaries, the fishery resources, the commercial and subsistence fisheries, and the management program for the Kuskokwim Commercial Management Area. Catch statistics for the 1984 commercial and subsistence fisheries are listed by species for each district and historical catch statistics are summarized in appendices.

Alaska Department of Fish and Game. 1985c. 1985 Herring Fishery Management Plan-Cape Romanzof District. Division of Commercial Fisheries. Anchorage, Alaska.

The report provides a description of the commercial herring fishing stocks, fishing district, management strategy, management regulations, and research projects.

Alaska Department of Fish and Game. 1986a. Distribution, Abundance, and human use of fish and wildlife. Alaska Habitat Management Guide, Western and Interior Regions. Division of Habitat. Juneau, Alaska.

The Alaska Habitat Management Guide provides data and information on the abundance, distribution, life functions, and habitat requirements of selected fish and wildlife species in the western and interior regions of Alaska as well as human use patterns in rural communities.

Alaska Department of Fish and Game. 1986b. An atlas to the catalog of waters important for spawning, rearing, or migration of anadromous fishes. Western Resource Management Region IV. Division of Habitat Protection. Anchorage, Alaska.

The atlas provides U.S. Geological Survey maps that depict specific spawning and rearing areas as well as migration routes of anadromous fish species in the western region of Alaska.

Alaska Department of Fish and Game. 1986c. Alaska habitat management guide reference maps, western and interior regions, Volume III - distribution of freshwater fish, marine fish, and shell fish. Division of Habitat Protection. Anchorage, Alaska.

The guides provide maps that depict the general distribution of freshwater fish, marine fish, and shell fish in the western and interior regions of Alaska.

Alaska Department of Fish and Game. 1986d. Alaska habitat management guide reference maps, western and interior regions, Volume IV - distribution of anadromous fish and human use of fish. Division of Habitat Protection. Anchorage, Alaska.

The guide provides maps that depict the general distribution and human use of various species of anadromous fish in the western and interior regions of Alaska.

Alaska Department of Fish and Game. 1986e. An atlas to the catalog of waters important for spawning, rearing, or migration of anadromous fishes. Arctic Resource Management Region V. Division of Habitat Protection. Anchorage, Alaska.

The atlas provides U.S. Geological Survey maps that depict specific spawning and rearing areas as well as migration routes of anadromous fish species in the Arctic region of Alaska.

Alaska Department of Fish and Game. 1988. Annual Management Report - 1987. Yukon River Area. Division of Commercial Fisheries. Anchorage, Alaska.

The report provides a description of the area and district boundaries, the fishery resources, the commercial and subsistence fisheries, and the management program for the Yukon Commercial Management Area. Catch statistics for the 1987 commercial and subsistence fisheries are listed by species for each district and historical catch statistics are summarized. Outlook for 1988 fishing season is discussed.

Alaska Department of Fish and Game. 1989a. Annual Management Report Kuskokwim Area, 1988. Division of Commercial Fisheries. Anchorage, Alaska.

The report provides a description of the area and district boundaries, the fishery resources, the commercial and subsistence fisheries, and the management program for the Kuskokwim Commercial Management Area. Catch statistics for the 1988 commercial and subsistence fisheries are listed by species for each district and historical catch statistics are summarized in appendices.

Alaska Department of Fish and Game. 1989b. Pacific herring stocks and fisheries in the Arctic-Yukon-Kuskokwim Region of the Northeastern Bering Sea, Alaska, 1989. A report to the Alaska Board of Fisheries October 1989. Division of Commercial Fisheries. Anchorage, Alaska.

Alaska Department of Fish and Game. 1990a. Report to the Board of Fisheries, Kuskokwim Area Salmon 1989. Division of Commercial Fisheries. Anchorage, Alaska.

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A two-year study was conducted of various lower Kuskokwim River tributaries to provide baseline data on streams and lakes and the fish populations they support. Streams surveyed include the Aniak, Tuluksak, Kisaralik, Kasigluk, Kwethluk, and Eek Rivers. Fifteen lakes were also surveyed. Physical, chemical, and biological data were collected from all lakes and streams. The report provides a summary of the data for each stream and lake and life history information for each fish species collected.

Andrews, E. and R. Peterson. 1983. Wild resource use of the Tuluksak River Drainage by residents of Tuluksak, 1980-1983. Technical Paper No. 87. Alaska Department of Fish and Game, Division of Subsistence. Fairbanks, Alaska.

The study shows that the Tuluksak River and adjacent areas are used intensively for resource utilization by the residents of Tuluksak. Moose, bear, waterfowl, berries and whitefish are particularly important. The study documents not only the kinds of resources used but where and when utilization occurs.

Andrews, E. and M. Coffing. 1986. Kuskokwim River subsistence chinook fisheries: an overview. Technical Paper Number 146. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

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A preliminary study on the life history of whitefish and sheefish in the lower Kuskokwim River area.

Baxter, Rae. 1977. Eek River reconnaissance survey, 1975. Miscellaneous Report No. 10. Alaska Department of Fish and Game, Commercial Fisheries Division. Bethel, Alaska.

A fishery survey was conducted on the lower 253 km of the Eek River. The abundance and spawning distribution of the

various salmon species was observed. Species lists of other flora and fauna were recorded. The report contains a discussion of historical and subsistence utilization, potential research sites, and potential for recreational uses.

Baxter, R. 1979. Kasigluk River reconnaissance survey, 1978. Kuskokwim Resource Report No. 4. Alaska Department of Fish and Game, Division of Commercial Fisheries. Bethel, Alaska.

Ground surveys were conducted by boat to collect data on fish composition, abundance, and distribution in the Kasigluk River. Data were also collected on stream habitat parameters and flow characteristics. Aerial surveys were conducted to identify salmon spawning areas.

Baxter, Rae. 1982. Kisaralik drainage stream and lake inventory, 1981-1982. Kuskokwim Resource Report No. 6. Alaska Department of Fish and Game, Division of Commercial Fisheries. Bethel, Alaska.

A fishery survey was conducted of the Kisaralik River watershed included the headwater lakes and main tributaries. Data were recorded on fish species composition, relative abundance and distribution. Water characteristics, stream type, bottom type, and other types of related data were recorded for major stream sections of the watershed.

Brelsford, T., R. Peterson, and T.L. Haynes. 1987. An overview of resource use patterns in three central Kuskokwim communities: Aniak, Crooked Creek, and Red Devil. Technical Paper Number 141. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This paper documents the contemporary subsistence harvest areas, seasonal use patterns, and resource and regulatory concerns of the residents of Aniak, Crooked Creek, and Red Devil, Alaska.

Buklis, L.S. 1985. Anvik and Andreafsky River salmon studies, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries. Anchorage, Alaska.

The report provides salmon spawning escapement data for the Anvik and Andreafsky River watersheds for 1985. Data were collected by side scanning sonar and aerial surveys in the Anvik River. Data were collected with side scanning sonar, a counting tower, and aerial survey techniques.

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Charnley, S. 1984. Human ecology of two central Kuskokwim communities: Chuathbaluk and Sleetmute. Technical Paper Number 81. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This report describes the hunting, fishing, trapping, and gathering in Chuathbaluk and Sleetmute and is based on field work that took place between June 1982 and June 1983.

Fienup-Riordan, A. 1986. When our bad season comes: a cultural account of subsistence harvesting and harvest disruption on the Yukon Delta. Alaska Anthropological Association Monograph Series No. 1. Anchorage, Alaska.

A description of the ecological, economic and cultural constraints that circumscribe subsistence harvests of residents of three communities living on and south of the Yukon River Delta. The study also discusses potential effects of a disruption of subsistence harvests.

Francisco, R.K. and K.A. Sundberg. 1983. 1983, Tuluksak River fisheries reconnaissance survey with special emphasis on the effects of gold dredging. Kuskokwim Resource Inventory Report, No. 6. Alaska Department of Fish and Game. Anchorage, Alaska.

A survey of the salmon populations of the Tuluksak River was conducted in 1983 with the primary purpose of providing data to evaluate the potential impact of mining practices on fisheries resources and habitats. Data on spawning distribution of adult salmon species was collected and compared with historical data. Distribution of juvenile salmon was also investigated.

Henning, R.A., M. Loken, B. Olds, L. Morgan, and J. Reardon. 1979. Yukon-Kuskokwim Delta. Alaska Geographic, Vol. 6, No. 1.

The report provides a brief overview of the land, resources, the people, the culture, the economy, and the way of life on the Yukon Delta. The effect of modern culture and technology on the native subsistence lifestyle is discussed.

Heritage Conservation and Recreation Service. 1979. Kisaralik River - A wild and scenic river analysis. Preliminary Report.

A survey of the Kisaralik River was conducted to determine the rivers suitability for designation as wild and scenic. Information in the report include river characteristics, climate, land use and ownership, water quality, soils and vegetation,

geology and minerals, and fish and wildlife resources. The report recommended that a portion of the river be designated as a wild river area under the National Wild and Scenic River system.

Hout, J.L. 1966. Fish and wildlife resources of Nunivak Island. Part 1: Fisheries Project Report No. 1. U.S. Fish and Wildlife Service.

A survey of the fishery resources and resource utilization was conducted in 1965. Major streams were surveyed to determine escapement numbers and spawning distribution. All active fish camps were visited to determine the numbers of fish caught and methods of capture and preservation.

Hout, J.L. 1968. Nelson Island. Alaska Sportsman, June 1968: 59-60.

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A survey of the fishery resources in the Stebbins-St. Michael's area was conducted to evaluate the potential for establishing a commercial fishery on local salmon stocks. Data were collected on the abundance and distribution of various salmon species. The report concluded that the stocks were insufficient to support a viable commercial fishery in light of subsistence harvests and current market conditions.

Maciolek, J.A. 1986. Interrelationship of beaver and fishes on the Yukon Delta National Wildlife Refuge. Final Report prepared for the U.S. Fish and Wildlife Service, Division of Fishery Resources. Anchorage, Alaska.

Field studies were conducted in selected areas on the Yukon Delta in 1984 and 1985 to determine how recent beaver invasions have affected migrations of fishes in shallow ponds. The report concluded that beavers do not appear to be a serious widespread problem on the Delta but local situations exist where beaver activities affect both fish migration and boat navigation.

McLean, R.F., W.A. Bucher, and B.A. Cross. 1977. A compilation of fish and wildlife resource information for the State of Alaska. Volume 3 - Commercial Fisheries. Compiled by the Alaska Department of Fish and Game, under contract to the Alaska Federal - State Land Use Planning Commission.

The report is a compilation of existing information for commercial and subsistence salmon fisheries of the State of Alaska. Data are presented on a geographical basis. Past and present management techniques are discussed.

National Oceanic and Atmospheric Administration. 1986. Distribution, seasonal abundance, and feeding dependencies of juvenile salmon and non-salmonid fishes in the Yukon River Delta. Draft report for contract No. 84-ABC-00178, prepared for the Ocean Assessment Division. Anchorage, Alaska.

The report concerns a one-year investigation of the distribution, seasonal abundance, and feeding dependencies of juvenile salmon and non-salmonid fishes in the Yukon River Delta. The investigation started in December 1984 and concluded in September 1985. Data were collected primarily to assess the potential vulnerability of fish and delta habitats to oil and gas development.

Pete, M.C. 1984. Subsistence use of herring in the Nelson Island region of Alaska. Technical Paper Number 113. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This report summarizes information on the subsistence use of Pacific herring by nine coastal communities in the Nelson Island Region.

Pete, M.C. and R.E. Kreher. 1986. Subsistence herring fishing in the Nelson Island district, 1986. Technical Paper Number 144. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This report presents results of research in 1986 on subsistence herring production by residents of four communities and one field camp in the Nelson Island area.

Pete, M.C., D.E. Albrecht, and R.E. Kreher. 1987. Subsistence herring fishing in Nelson Island district and northern Kuskokwim Bay, 1987. Technical Paper Number 160. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This report summarizes research done in 1987 on subsistence herring production by residents of five communities and one seasonal camp in the Nelson Island and north shore of Kuskokwim Bay.

Pourchot, P. 1974. Log of Andreafsky River field Inspection - July 22 to July 31, 1974. Memorandum. U.S. Bureau of Reclamation, Alaska Field Office. Anchorage, Alaska.

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Stickney, A.A. 1981. Middle Kuskokwim food survey II. Technical Paper Number 53. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

Stickney, A. 1984. Coastal ecology with wild resource use in the central Bering Sea area: Hooper Bay and Kwigillingok. Technical Paper Number 85. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This report provides a description of hunting, fishing, trapping, and gathering of wild resources by residents of Hooper Bay and Kwigillingok, Alaska.

U.S. Department of Interior, Alaska Planning Group. 1973. Yukon Delta National Wildlife Refuge, Final Environmental Statement.

The report is a final environmental statement on the evaluation of the potential impact of combining the Clarence Rhode National Wildlife Range, the Hazen Bay National Wildlife Refuge and approximately 4.7 million acres of adjacent public lands into the Yukon Delta National Wildlife Refuge.

U.S. Department of Interior, U.S. Fish and Wildlife Service. 1986. River rating scales for public use values - Yukon Delta National Wildlife Refuge. Branch of Public Use and Information. Anchorage, Alaska.

Forty-eight rivers on the Yukon Delta National Wildlife Refuge were dated for public use. Data generated through this process was intended to supply planners and resource managers information for setting priorities.

U.S. Department of Interior, U.S. Fish and Wildlife Service. 1988. Yukon Delta National Wildlife Refuge, Comprehensive Conservation Plan, Environmental Impact Statement, Wilderness Review and Wild River Plan. Final Report. Anchorage, Alaska.

The Refuge Comprehensive Conservation Plan provides information on the overall direction which resource management on the Yukon Delta National Wildlife Refuge will take in the future. Important resources and particular issues and concerns specific to the Yukon Delta area are discussed and evaluated. Various alternatives for management are presented and evaluated and the preferred management alternative is selected.

U.S. Department of Interior, National Park Service. 1984. Kisaralik River - Draft wild and scenic river study. Anchorage Area Office. Anchorage, Alaska.

The natural resources of the Kisaralik River were evaluated to provide a basis to determine the suitability of the Kisaralik River for designation as a wild and scenic river. The river was determined to be eligible but recommendations were made not to designate the Kisaralik as a wild and scenic river.

Walker, R.J., E. Andrews, D.B. Andersen, and N. Chaced. 1989. Subsistence harvest of Pacific salmon in the Yukon River drainage, Alaska, 1977-1988. Technical Paper Number 187. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

Wilcock, J.A. 1984. Origins of chinook salmon (Oncorhynchus tschawytscha Walbaum) in the Yukon River fisheries, 1983. Information Leaflet No. 243. Alaska Department of Fish and Game, Division of Commercial Fisheries. Juneau, Alaska.

Linear discriminant analysis of scale patterns and age composition data of chinook salmon from the spawning escapements and catches on the Yukon River were used to allocate Districts 1, 2, and 3 commercial harvests to geographic region of origin. Estimates of run contribution to the Districts 1, 2, and 3 subsistence fisheries were based on trends in run composition of the commercial catches. Upriver catches were apportioned based on geography. The total 1983 Yukon River harvest of chinook salmon was 105,565 (51.4%) upper Yukon, 744,859 (36.4%) middle Yukon, and 25,036 (12.2%) lower Yukon fish.

Wilcock, J.A. 1987. Age, sex, and size of Yukon River salmon catches and escapements, 1987. Technical Fishery Report 89-14. Alaska Department of Fish and Game, Division of Commercial Fisheries. Juneau, Alaska.

Wilderness Record. 1974. Nunivak National Wildlife Refuge. Second Judicial District, Alaska.

The report provided a summary of the natural resources of Nunivak Island and the objectives for managing the area.

Wolfe, R.J. 1981. Norton Sound/Yukon Delta sociocultural systems baseline analysis. Technical Paper Number 59. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

This document describes fishing, hunting, trapping, gathering, and marketing activities in the Yukon Delta region during 1980 and 1981.

Wolfe, R.J. 1982. The subsistence salmon fishery in the lower Yukon River. Technical Paper Number 60. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

Wolfe, R.J. and L.J. Ellanna. 1983. Resource use and socioeconomic systems: case studies of fishing and hunting in Alaska communities. Technical Paper Number 61. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

Wolfe, R.J., J.A. Fall, V. Fay, S. Georgette, J. Magdanz, S. Pederson, M. Pete, and J. Schichnes. 1986. The roll of fish and wildlife in the economies of Barrow, Bethel, Dillingham, and Nome. Technical Paper Number 154. Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

APPENDIX 1

MEMORANDUM OF UNDERSTANDING BETWEEN THE ALASKA DEPARTMENT OF FISH AND GAME, JUNEAU, ALASKA, AND THE U.S. FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR, ANCHORAGE, ALASKA

Appendix 1. Memorandum of Understanding between the Alaska Department of Fish and Game, Juneau, Alaska, and the U.S. Fish and Wildlife Service, Department of the Interior, Anchorage, Alaska.

This Master Memorandum of Understanding between the State of Alaska, Department of Fish and Game, hereinafter referred to as the Department, and the U.S. Fish and Wildlife Service, hereinafter referred to as the Service, reflects the general policy guidelines within which the two agencies agree to operate.

WHEREAS, the Department, under the Constitution, laws and regulations of the State of Alaska, is responsible for the management, protection, maintenance, enhancement, rehabilitation, and extension of the fish and wildlife resources of the State on a sustained yield principle, subject to preferences among beneficial uses; and

WHEREAS, the Service, by authority of the Constitution, laws of Congress and regulations of the U.S. Department of Interior has mandated management responsibility for certain species or classes of wildlife and is responsible for the management of Service lands in Alaska, and the conservation of fish and wildlife resources on these lands; and

WHEREAS, the Department and the Service share a mutual concern for fish and wildlife resources and their habitats and both are engaged in extensive fish and wildlife conservation, management, and protection programs and desire to develop and maintain a cooperative relationship which will be in the best interest of both parties, the concerned fish and wildlife resources and their habitats, and produce the greatest public benefit; and

WHEREAS, it has been recognized in the Alaska National Interest Lands Conservation Act and subsequent implementing Federal regulations that the resources and use of Service lands in Alaska are substantially different than those of other states; and

WHEREAS, the Department and the Service recognize the increasing need to coordinate resource planning and policy development;

NOW, THEREFORE, the parties hereto hereby agree as follows:

THE DEPARTMENT OF FISH AND GAME AGREES:

1. To recognize the Service as the agency with the responsibility to manage migratory birds, endangered species, and other species mandated by Federal law, and on Service lands in Alaska to conserve fish and wildlife and their habitats and regulate human use.

2. To manage fish and resident wildlife populations in their natural diversity on Service lands.

3. To consult with the Regional Director in a timely manner and comply with applicable Federal laws and regulations before embarking on enhancement or construction activities on Service lands.

THE FISH AND WILDLIFE SERVICE AGREES:

1. To recognize the Department as the agency with the primary responsibility to manage fish and resident wildlife within the State of Alaska.

2. To recognize the right of the Department to enter Service lands at any time to conduct routine management activities which do not involve construction, disturbance to the land, or alterations of ecosystems.

3. To cooperate with the Department in planning for enhancement or development activities on Service lands which require permits, environmental assessments, compatibility assessments, or similar regulatory documents by responding to the Department in a timely manner with requirements, time tables, and any other necessary input.

4. To manage the fish and wildlife habitat on Service lands so as to insure conservation of fish and wildlife populations and their habitats in their natural diversity.

5. To consider carefully the impact of any proposed treaties or international agreements relating to fish and wildlife resources on the State of Alaska which could diminish the jurisdictional authority of the State and to consult freely with the State when these treaties or agreements have a primary impact on the State.

6. To review present U.S. Fish and Wildlife Service policies and any future proposed changes in those policies in consultation with the Department to determine if modified or special policies are needed for Alaska.

7. To adopt refuge management plans whose provisions--including provision for animal damage control--are in substantial agreement with the Department's fish and wildlife management plans, unless such plans are determined formally to be incompatible with the purposes for which the respective refuges were established.

8. To utilize the State's regulatory process to the maximum extent allowed by Federal law in developing new or modifying existing Federal regulations or proposing changes in existing State regulations governing or affecting the taking of fish and wildlife on Service lands in Alaska.

THE DEPARTMENT OF FISH AND GAME AND THE FISH AND WILDLIFE SERVICE MUTUALLY AGREE:

1. To coordinate planning for management of fish and wildlife resources on Service lands so that conflicts arising from differing legal mandates, objectives, and policies either do not arise or are minimized.

2. To consult with each other when developing policy and legislation which affects the attainment of wildlife resource management goals and objectives, or management plans.

3. To recognize that the taking of fish and wildlife by hunting, trapping, or fishing on Service lands in Alaska is authorized in accordance with applicable State and Federal law unless State regulations are found to be incompatible with documented Refuge goals, objectives, or management plans.

4. To develop such supplemental memoranda of understanding between the Commissioner and the Regional Director as may be required to implement the policies contained herein.

5. That this Master Memorandum of Understanding shall become effective when signed by the Commissioner of the Alaska Department of Fish and Game and the Alaska Regional Director of the U.S. Fish and Wildlife Service and shall continue in force until terminated by either party by providing notice in writing 120 days in advance of the intended date of termination.

6. That amendments to this Master Memorandum of Understanding may be proposed by either party and shall become effective upon approval by both parties.

STATE OF ALASKA	U.S. DEPARTMENT OF THE INTERIOR
Department of Fish and Game	Fish and Wildlife Service
Ronald O. Skoog, Commissioner	Keith M. Schreiner, Regional Director, Alaska
March 13, 1982 Date	March 13, 1982 Date

CONCURRENCE AND APPROVAL PAGE

Project Leader: Gary M. Sanner Date: 10/25/91
Kenai Fishery Assistance Office

Refuge Manager: Ronald L. Perry Date: 11/1/91
Yukon Delta National Wildlife Refuge

Supervisor, FMS: Larry C. Gilman Acting Date: 12/26/91

Dep. Asst. Regional Director: [illegible] Date: 12-26-91
Fish and Wildlife Enhancement

Asst. Regional Director: Paul R. Schmidt Date: 12-26-91
Refuges and Wildlife

Acting Regional Director: R. Daniel Pennington Date: 12/26/91

Regional Office Disposition