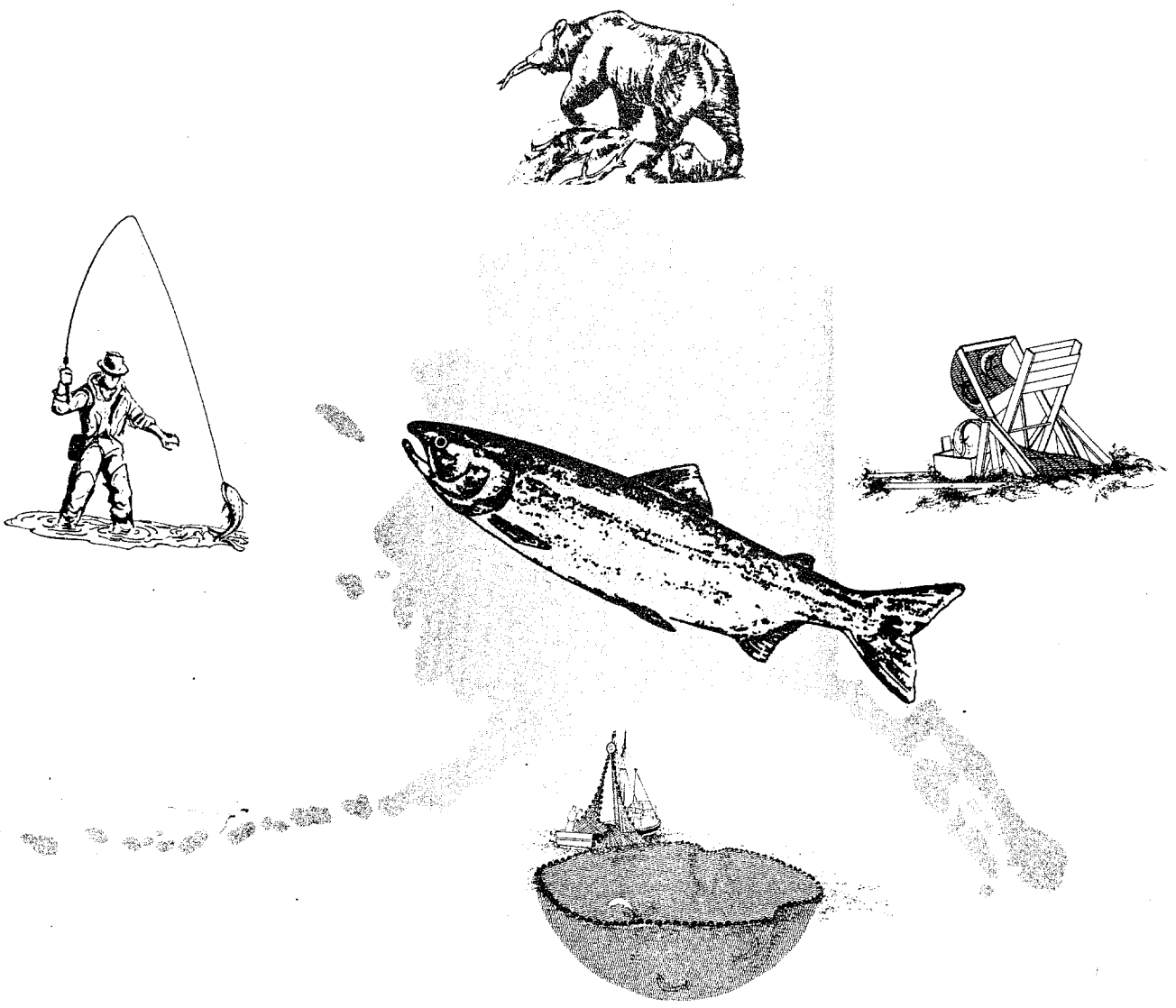
Fishery Management Plan

KOYUKUK NATIONAL WILDLIFE REFUGE



January 1993

Region 7

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

FISHERY MANAGEMENT PLAN
KOYUKUK NATIONAL WILDLIFE REFUGE
and
NORTHERN UNIT OF INNOKO NATIONAL WILDLIFE REFUGE
U.S. FISH AND WILDLIFE SERVICE

Effective October 1, 1993
to September 30, 1997

Koyukuk National Wildlife Refuge
P.O. Box 287
Galena, Alaska 99741
and
Fish and Wildlife Enhancement
Fishery Assistance Office
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January 1993

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SUMMARY STATEMENT

The Fishery Management Plan (Fishery Plan) for the Koyukuk National Wildlife Refuge (Koyukuk Refuge) and the Northern Unit of Innoko National Wildlife Refuge (Northern Unit of Innoko Refuge) provides comprehensive management direction to insure that fish species and habitats are conserved, while maintaining sustainable harvests. The Fishery Plan defines refuge purposes and systematically develops management objectives and specific tasks based on these purposes. Tasks are assigned priorities and Federal tasks are assigned annual costs for their continuation. This plan spans a 5-year period at which time it will be updated. It should be noted that this particular document does not include habitat or public use management activities, which will be addressed in separate planning efforts.

A description of the environment is presented and fishery resources, human use, management history, and major issues and concerns described. Objectives and tasks are developed from the issues and concerns. Major concerns identified during the planning process included an incomplete baseline of fishery information with which to refine fishery resource procedures, possible overharvest of salmon stocks, and impacts from development and use of lands adjacent to the refuge. Most of these concerns are largely beyond the direct control of refuge management as they take place outside refuge boundaries.

Objectives developed to address major concerns range from program administration to data collection activities. In general, objectives are aimed at administering the present fishery management program at the current level, using the best available information, while obtaining additional data to improve the information base.

Work priorities for both the U.S. Fish and Wildlife Service (Service) and the Alaska Department of Fish and Game (Department) over the next five years will emphasize tasks relating to the administration of the current fishery program. Beyond this, the Service will emphasize monitoring and genetic identification of refuge salmon stocks, evaluate impacts of off-refuge mining activities, and collect baseline fishery data on the numerous rivers, sloughs, and lakes throughout the two refuges. Management is accomplished cooperatively with the Department and is promulgated by a Master Memorandum of Understanding (1982). An annotated bibliography is included to index available information related to refuge fishery resources.

SECTION 1. INTRODUCTION

The purposes for which the Koyukuk Refuge is established and shall be managed include:

> (i) to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, waterfowl and other migratory birds, moose, caribou (including participation in coordinated ecological studies and management of Western Arctic caribou herd), furbearers, and salmon;
>
> (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 practicable and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge.

The Northern Unit of Innoko Refuge will be managed in a similar way to the Koyukuk Refuge with the except of (i) which is:

> (i) to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, waterfowl, peregrine falcons, other migratory birds, black bear, moose, furbearers, and other mammals and salmon.

The Alaska National Interest Lands Conservation Act (Alaska Lands Act), Section 304, requires the preparation and periodic revisions of a Refuge Comprehensive Conservation Plan (Conservation Plan) for each refuge. One function of the Conservation Plan is to specify a program for management and conservation of fishery resources of the refuge. This Fishery Plan is a five-year plan which outlines strategies to obtain needed fishery information for verification and support of natural diversity of refuge fish stocks, to support continued subsistence use of fishery resources, and protect refuge habitat. In preparing this Fishery Plan, consideration has been included for the multiple use of the aquatic habitat, including waterfowl, terrestrial mammals, and human use of the resources.

Management of the Kaiyuh Flats, originally the Northern Unit of Innoko Refuge, has formally shifted to the Koyukuk Refuge and is included in this Fishery Plan. The refuge fishery is managed cooperatively by the Service and the Department and is promulgated by a Master Memorandum of Understanding dated March 13, 1982 (Appendix A).

Koyukuk Refuge (Figure 1) is located in west central Alaska, about 270 air miles west of Fairbanks and 330 air miles northwest of Anchorage. The refuge headquarters is in Galena, a community located on the north bank of the Yukon River approximately seven air miles south of the refuge's 4.5 million acres.

The refuge is situated in a roughly circular floodplain basin of the Koyukuk River, just north of its confluence with the Yukon River. The extensive forested floodplain is surrounded by the Nulato Hills on the west, the Purcell Mountains and Zane Hills on the north, the Galena Mountains on the east, and the Yukon River on the south. Many lakes, sloughs, and rivers characterize the refuge. The Koyukuk River is the dominant

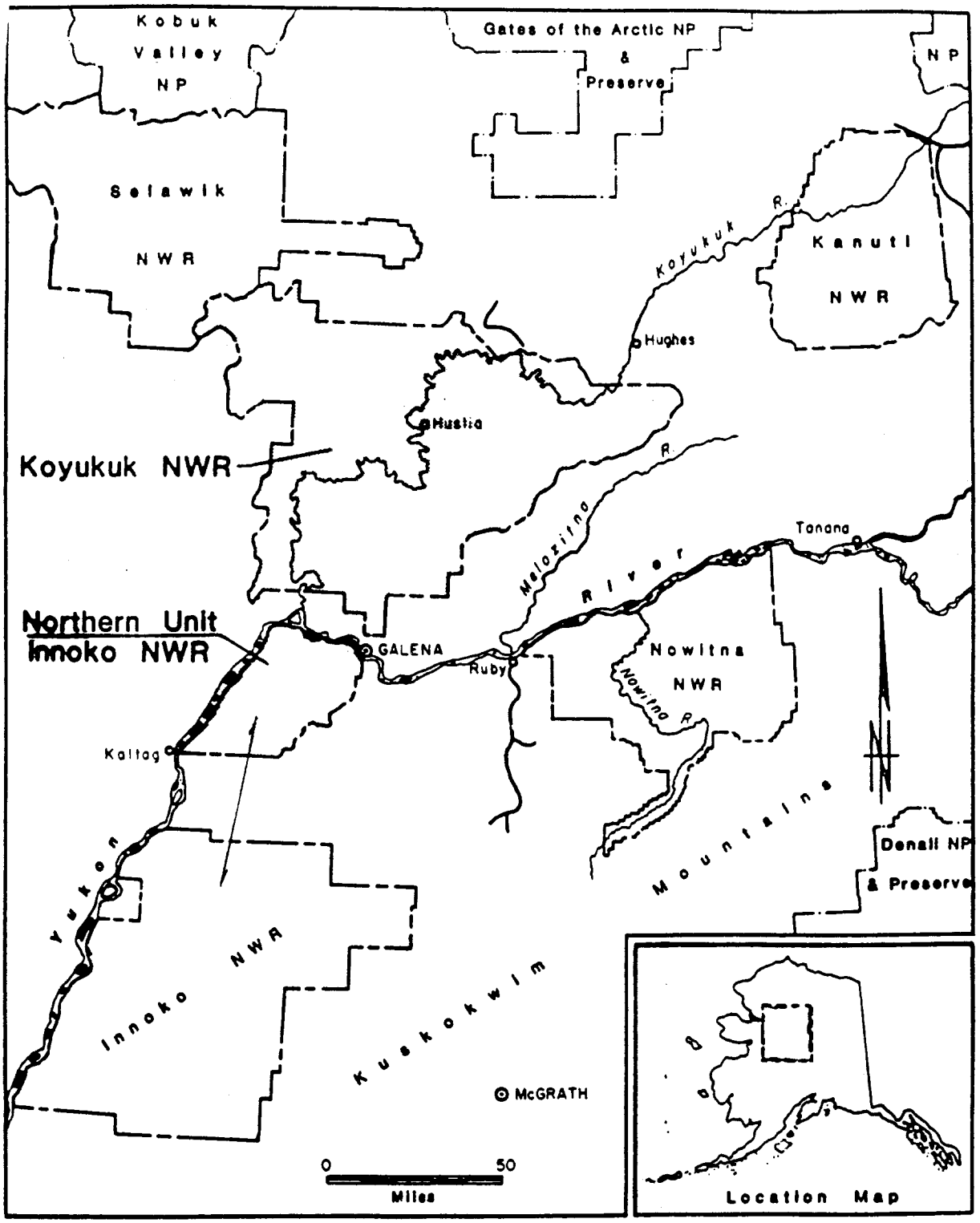

Figure 1. Location of the Koyukuk Refuge and the Northern Unit of Innoko Refuge.

natural landmark meandering more than 300 miles from northeast to southwest across the refuge before joining the Yukon River.

The Northern Unit of the Innoko Refuge (Figure 1) lies southwest of Galena. The external boundary of the unit encompasses approximately 751,000 acres. The unit is an extensive floodplain consisting of water and wetlands known as the Kaiyuh Flats. The unit is bounded on the north and west by the Yukon River and on the east and south by the Kaiyuh Mountains.

SECTION 2. GENERAL PHYSICAL AND BIOLOGICAL ENVIRONMENT

Physical Environment

Climate

Koyukuk and Innoko refuges have a continental subarctic climate which is characterized by great seasonal extremes of temperature and daylight. Galena, located approximately 125 miles south of the Arctic Circle, has a mean annual temperature of 25.2°F and a January mean of -9°F. Temperature extremes range from near 90°F in summer to approximately -75°F in winter.

Ice is present in the lakes from early October to late May. The Yukon River at Galena freezes in October with breakup in mid-May. The Koyukuk River at Hughes freezes in late October with breakup in early May.

Land Status

Major legislation affecting land ownership in Alaskan refuges includes the Alaska Statehood Act, the Alaska Native Claims Settlement Act of 1971, and the Alaska Lands Act. These laws transferred lands from Federal to State and Native ownership.

The land status of Koyukuk and Innoko refuges is constantly changing because lands within the boundary selected by individual Natives, Native corporations, and the State are in the process of being conveyed, relinquished, or rejected. Figure 2 depicts the ownership arrangement as of September, 1985.

Of the 4,496,100 acres of land within the Koyukuk Refuge boundary, 3,735,700 acres (83%) remains in federal ownership. Of this land, approximately 400,000 acres has been designated as wilderness.

The Northern Unit of Innoko Refuge includes 750,800 acres of lands of which 350,800 acres (47%) are under the jurisdiction of the Service.

Topography

The major features of the Koyukuk Refuge and the Northern Unit of Innoko Refuge are the Koyukuk and Kaiyuh flats. The Koyukuk Flats in the Koyukuk Refuge is an extensive lowland and is drained by the Yukon River and its tributaries. Streams meander across the lowland and have numerous side sloughs. East of the Koyukuk Flats is an area of low, gently rounded ridges interspersed with irregular lowlands and broad flat divides known as the Indian River Uplands. This area is drained by the Koyukuk River. Many of the streams have extremely irregular courses. Numerous thaw lakes are present in the lowlands, valleys, and broad passes.

North of the Koyukuk Flats lies the Pah River section of the western Alaska province. Here a diversified topography includes compact groups of hills and low mountains, including the Purcell Mountains and Zane Hills with elevations up to 4,000 feet, surrounded by rolling plateaus and lowlands. The southern and eastern parts drain via the Huslia and Hogatza rivers into the Koyukuk River.

Located to the west of the Koyukuk Flats are the Nulato Hills. Streams on the east side of the Nulato Hills flow to the Yukon River either directly or via the Koyukuk River. Major streams are markedly parallel, flowing northeast along fault zones.

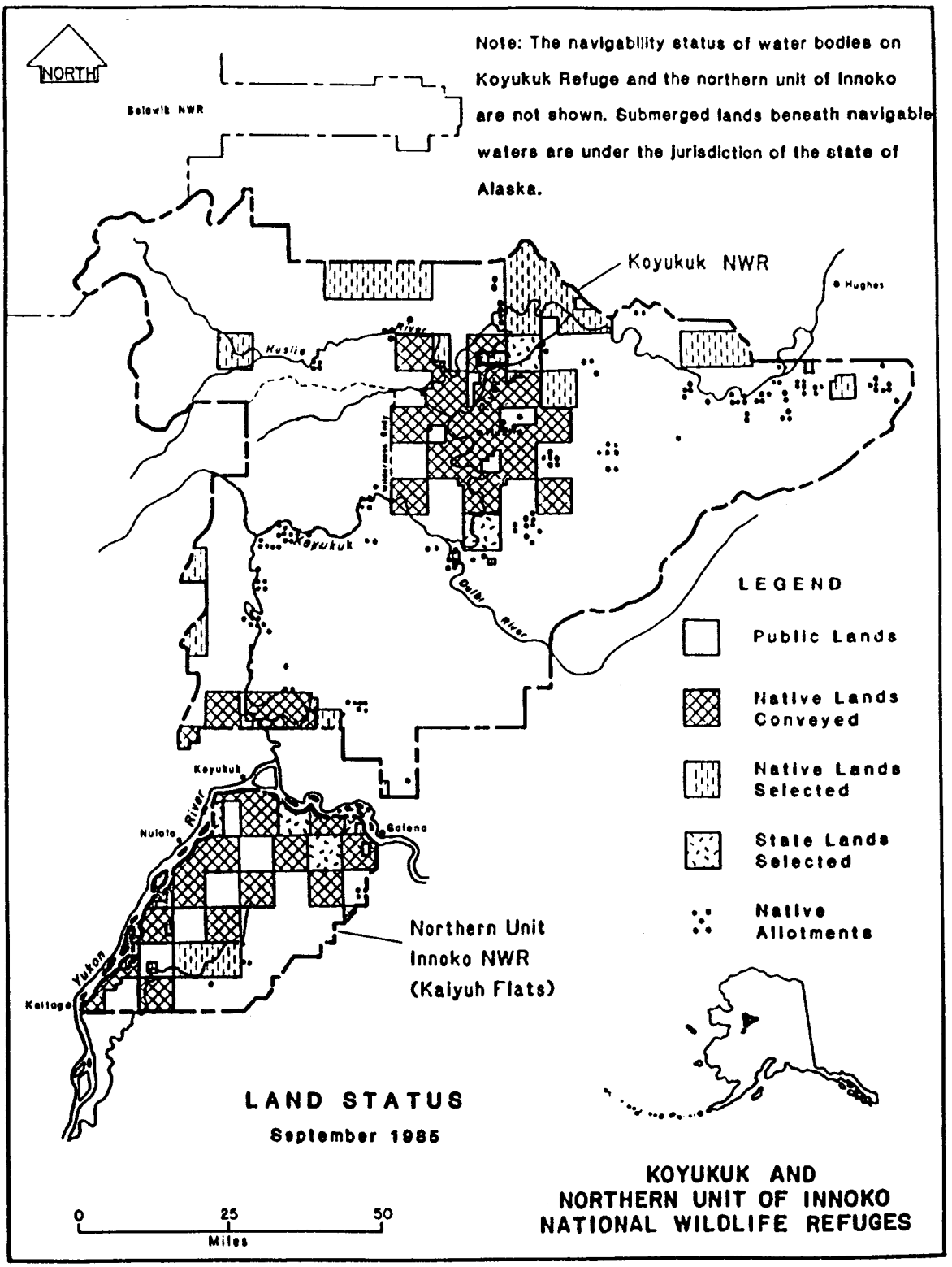

Figure 2. Land status, Koyukuk Refuge and the Northern Unit of Innoko Refuge.

The Kaiyuh Flats in the Northern Unit of Innoko Refuge is an extensive lowland drained by the Yukon River and its tributaries. Numerous thaw lakes and slough systems occur throughout the lowland. To the south and east of the refuge are the Kaiyuh Mountains, with rounded to flat summits and gentle slopes.

Geology

The Koyukuk Refuge and the Northern Unit of Innoko Refuge are located within the Yukon-Koyukuk province, a "basin" of volcanic origin. Being a depression, the province is called a basin. Perimeters of the basin are metamorphosed continental rock borderlands: the southern Brooks Range on the north and the Ruby Uplift on the east. The Yukon-Koyukuk Basin is generally a mass of andesitic volcanics overlying mafic and ultramafic rock. In terms of plate tectonics the Yukon-Koyukuk Basin is believed to be a drifted piece of oceanic crust which collided with the continental crust of the southern Brooks Range and the Ruby Uplift. During upthrusting of the mafic rocks into the metamorphic borderlands, new volcanism occurred. With this volcanism, andesites of the drifted plate floor were raised in a broad arch. After basin filling of the arch, the area was left with two successor basins at sea level. The eastern most parallels the present Yukon and lower Kuskokwim rivers.

Soils

Soil associations are collections of individual soils grouped by landscape position and texture. Soil associations found in the Koyukuk Refuge and the Northern Unit of Innoko Refuge are fairly uniform, with poorly drained silt loams dominating. These soils are continually wet and are generally underlain by continuous permafrost, except near large water bodies, where permafrost is discontinuous. Combined with peat, these soils are found on over 80 percent of refuge lands.

Minerals

Sites of known or indicated mineralization and produced placers in the vicinity of the Koyukuk Refuge and the Northern Unit of Innoko Refuge are identified in Figure 3.

Placer gold has been produced at various times; with Utopia Creek, Indian River, and Bear Creek being the major sites. From 1957 to 1975, 1981 to 1984, and 1990 to present, the Bear Creek placer at Hogatza has been worked by a dredge. Currently, active mining occurs on the Hogatza River.

Seventy-seven lode claims located southwest of Bear Mountain and two other lode claims located in the southeast Zane Hills have been identified in Bureau of Land Management records. These are no longer listed as valid claims. Two prospects noted in Bureau of Mines records are west of Sun Mountain and in the Zane Hills south of Caribou Mountain. Copper has been reported at both prospects.

The Yukon-Koyukuk geologic province was classified as a possible petroleum province. However, subsequent studies indicate that the sedimentary rock types present in the province are generally unfavorable for deposits of oil and gas, having been involved in severe compression and dislocation. One stratigraphic test hole, Nulato No. 1 (west-southwest of the community of Nulato) was drilled to a depth of 12,000 feet entirely in Cretaceous sedimentary rocks.

A coal bearing unit crops out along the west edge of the Koyukuk Refuge, south of the Kateel River (Figure 3). The coal is bituminous. Thicknesses are, at most, six inches.

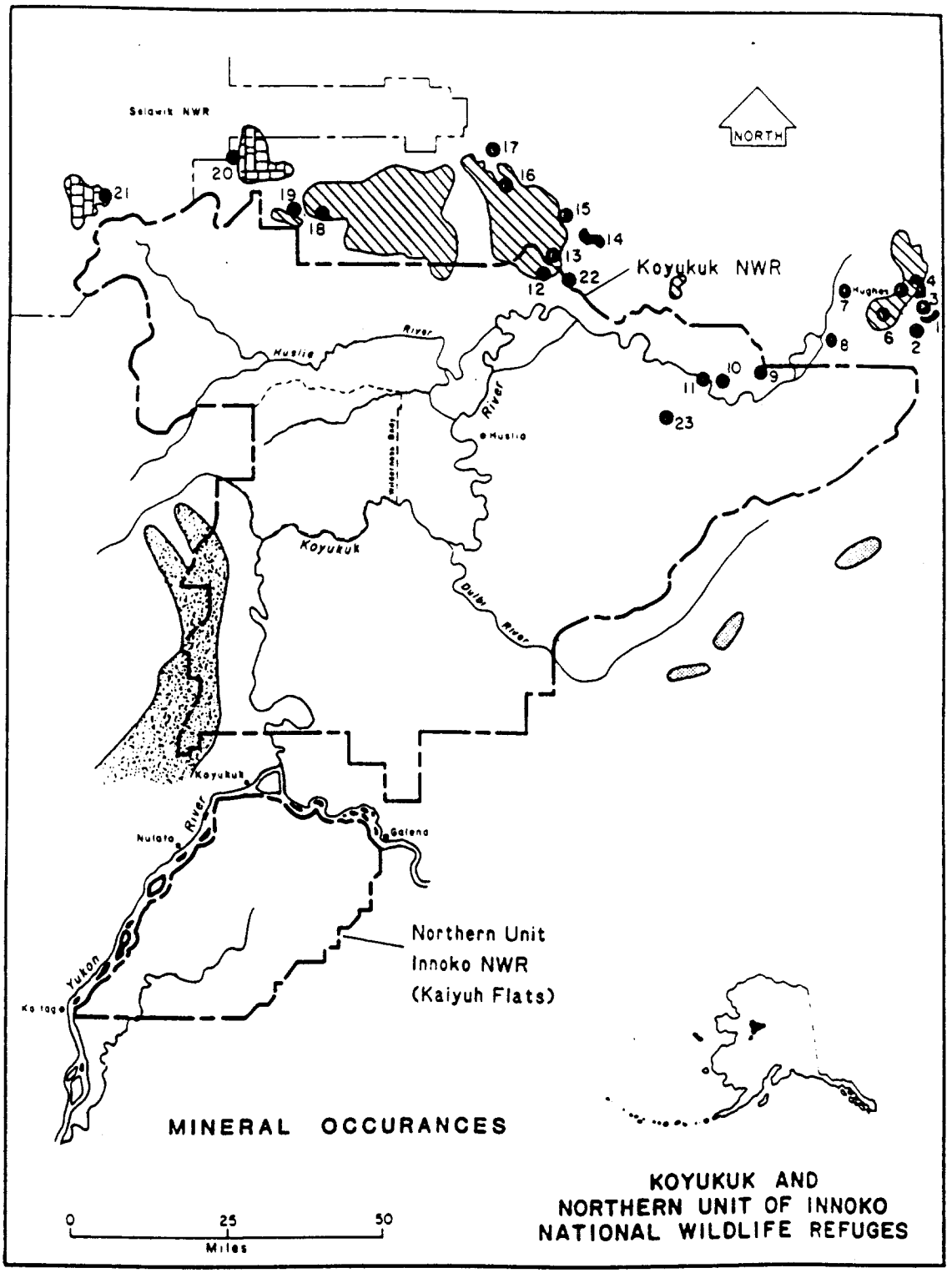

Figure 3. Mineral occurrences in the region of the Koyukuk Refuge and the Northern Unit of Innoko Refuge.

Legend

Places of produced placers, prospects, visible ore minerals, favorable geology, geochemical anomalies, and other indications of mineralization. Elements in parantheses indicate presence in anomalous amounts in stream sediments and rock chips. (Sources: Eberlein et al., 1977; Miller and Ferrians, 1968; U.S. Bureau of Mines Mineral Industry Locator System records.)

1. Utopia Creek placer.
2. South of Utopia Creek--intrusives along fault zone in andesite and barite boulders (Ag, Pb, Zn, Cu, Sb, Au).
3. North of Utopia Creek--intrusives and alteration in andesite; visible ore minerals (Pb, Zn, Cu, Mo, Ag, Au).
4. Indian River, Black Creek, Felix Creek, and Snyder Creek placers.
5. Black Creek area--altered volcaniclastics near pluton contact (Cu).
6. Pocahontas Creek placer.
7. Hughes Bar placer.
8. Florence Bar placer.
9. Sun Mountain area--dikes, limestone, altered andesite.
10. Sun Mountain prospect (Cu?).
11. Batza Slough--large float block high in Ag, Pb, Au.
12. Unnamed prospect--intrusive and veins in and near border phase of pluton (Ag, Au, Pb, Bi, W, Cu).
13. Caribou Mountain area--quartz monzonite with disseminate uranium-bearing minerals (U, Th).
14. Bear Creek (Hogatza) placer.
15. Area east of Zane Hills pluton--bostonite and nepheline syenite dikes with uranium-bearing minerals.
16. South Dakli area--gently dipping pluton contact, probable roof zone, quartz veins, visible ore minerals (Cu).
17. North Dakli area--three-foot thick quartz veins in altered andesite, probable roof zone (Cu).
18. West end Wheeler Creek pluton--uraniferous alaskite (U, Th).
19. Upper Billy Hawk Creek area--ten square mile area of one to two-foot thick quartz veins, visible ore minerals (Ag, Pb, Cu).
20. Shovel Creek placer area--pluton contact, probable quartz-tourmaline sulphide veins (Au).
21. Ekiek pluton contact zone (U, Th).

Mining claims in or within one mile of refuge. (no longer listed as valid claims in Bureau of Land Management records.)

22. T. 8 N., R. 14 E., Sec. 22--2 lode claims.
23. T. 4 N., R. 17 E., Sec. 9, 16--77 lode claims.

Terranes favorable or permissible for mineral deposits. (Source: Hawley, et al., 1983.)


Alkalic granite


Undivided granite, includes alkalic plutons


Ophiolite terrane, permissible for Cr, Co, Ni, Pt


Coal bearing sandstone and shale

Figure 3. Continued.

Water Resources

Water is a dominant element of the landscape on the Koyukuk Refuge and the Northern Unit of Innoko Refuge. Lakes, sloughs, and streams are present in abundance throughout the lowland areas. There are an estimated 15,000 lakes and over 5,500 miles of rivers and streams within the boundaries of the refuges. The abundance of water has major impacts on the fish and wildlife populations, human uses, and management of the refuge. Surface and ground water provides for such diverse purposes as domestic and institutional uses, navigation, sites for small aircraft landings, fish and wildlife habitat, and recreation.

The Koyukuk Refuge and the Northern Unit of Innoko Refuge are within the drainage basin of the Yukon River, the fifth largest river in North America. The Yukon River flows along the northern and western boundaries of the Northern Unit of Innoko Refuge. Major drainages of the refuges are listed in Table 1.

The Koyukuk River is the main tributary of the Yukon River in the vicinity of the refuges, joining the Yukon River near the village of Koyukuk approximately 30 river miles downstream from Galena. The Koyukuk River and its major tributaries drain the area encompassing the Koyukuk Refuge. The headwaters of the Gisasa, Honhosa, Kateel, Huslia, Dakli, and Hogatza rivers drain the western and northern areas of the refuge and are located in the Nulato Hills, Purcell Mountains, and Zane Hills. The Dulbi, Indian, and Little Indian rivers drain much of the eastern and southeastern areas of the refuge, with headwaters in the Indian River Uplands. The Natlaratlen River drains a small area along the southern boundary of Koyukuk Refuge.

The Khotol River is the only major tributary to the Yukon draining from the Kaiyuh Flats, though a number of smaller streams, such as Bishop Creek and Soonkakat River, also provide drainage from this area.

The rivers and most streams in the Koyukuk and Kaiyuh flats are characterized by a low gradient, an extremely meandering course, and extensive spring flooding. Small streams are numerous, and though some have steep gradients in their upland headwaters, the lower portions meander across the lowlands in a pattern similar to the larger rivers.

Although data related to runoff are limited for the refuges, it is known that mean annual runoff over the region is low, averaging 0.5 to 1.0 cubic feet per second (cfs) per square mile. The Schwatka and Endicott mountains in the Brooks Range are a major source of runoff in the Koyukuk River drainage. Mean annual peak runoff in the mountains is near 50 cfs per square mile, decreasing to 10 cfs or less in the lowlands where the refuges are located. Annual peak flows are the result of spring snowmelt (May and June) and heavy summer rainfalls. Extensive recharge to groundwater aquifers occurs during the summer, ensuring year-round water availability.

Flooding is common for both the Yukon and Koyukuk rivers. Relatively short summers concentrate the major portions of the annual runoff into less than five months. High flows occur from May through September; low flows from October to April. In late September, freezing in the headwaters commences, rapidly advancing downstream. By April, in many areas, flow is gradually reduced to only an infiltration of groundwater in the stream bed. In May, ice in the rivers is broken up by higher flows resulting from increased runoff from snowmelt. This rapid spring snowmelt may overflow frozen or ice-jammed channels, often resulting in spectacular spring breakup floods. The Yukon River is particularly susceptible to flooding due to river ice jams during spring breakup, making Galena vulnerable to flooding on a yearly basis.

Table 1. Major drainages of the Koyukuk Refuge and the Northern Unit of Innoko Refuge.

Tributary	Drainage
Koyukuk Refuge	
Koyukuk River	Yukon River
Natlaratlen River	Koyukuk River-Yukon River
Gisasa River	Koyukuk River
Kateel River	Koyukuk River
Honhosa River	Koyukuk River
Pitka River	Koyukuk River
Dulbi River	Koyukuk River
Cottonwood Creek	Dulbi River
Nayuka River	Dulbi Slough-Koyukuk River
Huslia River	Koyukuk River
Nulitna River	Huslia River
Billy Hawk Creek	Huslia River
Dakli River	Koyukuk River
Hogatza River	Koyukuk River
Little Indian River	Koyukuk River
Indian River	Koyukuk River
Dulbi Slough	Koyukuk River
Bear Creek	Yukon River
Northern Unit of Innoko Refuge	
Bishop Creek	Yukon River
Khotol River	Yukon River
Kaiyuh Slough	Yukon River

Peak discharges in the region generally occur following breakup. Smaller peaks sometimes occur during the summer from heavy precipitation. The presence of permafrost in most areas prevents rainfall from infiltrating; thus, a large percentage of rainfall during large storm events becomes runoff and may result in localized flooding.

The Koyukuk Refuge and the Northern Unit of Innoko Refuge have an estimated 15,000 lakes. Lake types include: ice-formed lakes on the flats (thaw lakes), river-flooded lowland lakes, and oxbow lakes. Few lakes in the area exceed 1,000 acres and most are less than 100 acres. Spring runoff, summer thunderstorms, and river flooding charge the lakes. Therefore, most lakes have variable water depths and shorelines from year to year. Closed basins in bog areas generally maintain stable water levels, while closed basins in drier areas are charged by infrequent flooding and exhibit long periods of receding depths. The vast majority of lakes on the refuge have been created by thawing of the underlying permafrost. This process has been described by Livingstone and Bryan (1958) for other areas of interior Alaska.

Thaw lakes are typically round to moderately irregular in shape and generally have very shallow depths (maximum depth less than 3 meters). Exceptions to this exist where beaver have dammed up outlets and where ice lenses have thawed, creating deep pockets. Oxbow lakes are formed from cutoffs of the meandering river channel in the lower gradient courses of the Yukon and Koyukuk rivers. These lakes are much less common than thaw lakes on the refuge. Most oxbow lakes are closely associated with larger river channels and therefore are either connected or subject to frequent flooding.

Water temperatures in shallow lakes reach 70°F or greater in midsummer, creating ideal conditions for heavy growth of aquatic plants and invertebrates. Lakes are normally clear although some may be slightly turbid during periods of flooding. Most waters are stained brown from organics that leach from surrounding uplands.

Water Quality

The chemical quality of surface waters in the area is generally good. Dissolved solids range from less than 50 to 200 milligrams per liter (mg/l). The major rivers, Yukon and Koyukuk rivers, have the highest dissolved solids content. Most waters in the region are of the calcium bicarbonate type. Surface waters sampled have generally been within water quality guidelines. However, a few streams, principally smaller ones that drain lowlands, contain naturally high levels of iron.

Heavy metal and water chemistry tests were conducted on the Hogatza River in June and September, 1984 (Deschermeier and Hawkinson *in preparation*). Mining has occurred on the Hogatza River since 1957, though no mining activities were occurring at the time of the sampling. Water samples were analyzed for 23 elements. Iron exceeded State of Alaska drinking water standards in the samples. All other elements were either below detectable limits or below recommended levels. Tissue samples of northern pike from the Hogatza River and Camp and Caribou creeks were found to contain mercury levels that exceeded the U.S. Food and Drug Administration's action level of 1.00 ppm wet weight (Service, unpublished data, 1987). Additional samples are needed before any conclusions can be drawn.

Streams of the Koyukuk River drainage are naturally clear (non-glacial), commonly carrying little sediment, though heavy silt loads may be carried at flood stage. For the lower Koyukuk River maximum sediment concentrations only reach about 100 mg/l under normal conditions. The Koyukuk River at Hughes has an average rate of sediment yield in the upstream basin of only 50 tons per square mile, one of the lowest rates in the state. The sediment load is discharged into the Yukon River at Koyukuk Village.

The Yukon River, through this region, carries a sediment concentration of over 300 mg/l, with an average yield of roughly 300 tons of sediment per square mile. The primary sources of sediment are from glaciers in its headwaters and from the Tanana River system which enters the Yukon River further upstream. Most of this sediment yield is carried during the summer months.

Water Rights

Water rights were reserved for the refuge by Congress to support the purposes for which each refuge was established. 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. The State of Alaska recommends that the Service utilize the State adjudication process for filing for water rights on Service lands.

Biological Environment

Vegetation

The Koyukuk Refuge and the Northern Unit of Innoko Refuge are within the northern boreal zone of central Alaska. Vegetation patterns in the area are complex; primarily the result of an intensive fire history, sediment deposition during periodic flooding, a braided drainage system, discontinuous permafrost, and sand dune action. Fire is a major ecological force. The area's hot dry summers have given it the richest fire history of any of the Alaskan refuges (Bureau of Land Management, fire history files). Approximately 1.3 million acres of the Koyukuk Refuge area has burned in the last 30 years. Almost all of these fires were lightening caused.

Lower elevations adjacent to the rivers are dominated by forests. Black and white spruce (*Picea mariana* and *P. glauca*), balsam poplar *Populus balsamifera*, paper birch *Betula papyrifera*, and aspen *Populus tremuloides* are the most important species.

After forest, dwarf shrub/peatland is the most common vegetation cover type. Vast sections of the refuge are included in this category. The dwarf shrub stratum is dominated by labrador tea *Ledum decumbens*, crowberry *Empetrum vaginatum*, blueberry *Vaccinium* spp., and dwarf birch (*Betula glandulosa* and *B. nana*). The peatland is formed by accumulation of sphagnum moss.

Wildlife (fisheries dependent)

Several species of birds utilize fisheries resources including gulls, terns, ducks, loons, grebes, eagles, osprey, and kingfishers. Mammals, including mink, otter, and black and brown bear, also utilize fishery resources.

Fish

Section 3 contained a description of important fish species found on the refuges.

Endangered Species

The American peregrine falcon is the only endangered species known to utilize refuge habitat. No endangered fish species have been recorded in the area.

SECTION 3. FISHERY RESOURCES

Species Description

Twenty-one species of fish have been reported on the Koyukuk Refuge and the Northern Unit of Innoko Refuge (Table 2); however, more species may be present since few comprehensive fishery inventories have been completed to date. The following species descriptions and general life history information are taken from previous investigations throughout the interior Yukon River drainage as well as specific information within the refuge where available.

Chinook (king) Salmon
The chinook salmon harvested from the Koyukuk Refuge and the Northern Unit of Innoko Refuge are part of the Yukon River run which is one of the largest natural chinook runs of any river system in the world (Regnart 1984). Spawning chinook salmon have been observed by aerial survey techniques in the Kateel, Indian, Dakli, Gisasa, and Koyukuk rivers (Barton 1984). Adult chinook salmon enter the refuge fishery from late June to mid-July on their way to spawning streams, both within the Koyukuk Refuge and farther up the Koyukuk and Yukon rivers. Spawning is generally completed by early August and, after die-off, carcasses become important nutrient sources for wildlife and organic enrichment that will enhance fish food production. Eggs overwinter in stream gravel and hatch in early spring. Many refuge streams are important feeding areas and migration routes for juvenile chinook salmon since the majority begin their seaward migration in their second year of life. After extensive migrations to the Bering Sea and portions of the North Pacific, they mature and return as adults in their third through seventh year of life.

Chum Salmon
The chum salmon of the refuge area are part of the Yukon River population, one of the largest wild runs of any river system in North America. Two distinct chum salmon runs are evident; the summer chum salmon arrive in late June to mid-July and the fall chum salmon arrive in mid to late August. Summer chum salmon average about one pound less than fall chum salmon (McLean, Butcher, and Cross 1977).

Several streams within the Koyukuk Refuge contain spawning areas utilized by summer chum salmon: Koyukuk, Dakli, Gisasa, Indian, Kateel, and North Fork of the Huslia rivers, and Billy Hawk Creek (Barton 1984; Hawkinson and Deschermeier 1985). Little is known about the spawning habitat for fall run chum salmon in refuge streams. Many chum salmon migrate past refuge lands to spawn in the upper Koyukuk and Yukon rivers. Chum salmon eggs overwinter in gravel redds and hatch in the early spring. After hatching the small chum fry begin migration to salt water rearing areas where they will mature and return as three to six year olds, with the majority returning at age-4 (Buklis and Barton 1984).

Coho Salmon
Coho salmon began entering refuge waters in mid-September enroute to spawning areas in the upper Yukon and Koyukuk rivers. Spawning generally occurs in October and can extend into mid-November. Eggs hatch the following spring and the immature salmon remain in fresh water generally two years before migrating to the Bering Sea and parts of the North Pacific where they will mature. The majority return to their natal streams to spawn as three and four year olds. Specific spawning areas within refuge streams have not been identified.

Table 2. Fish of the Koyukuk Refuge and the Northern Unit of Innoko Refuge (Morrow 1980).

Common Name	Scientific Name
	PETROMYZONTIDAE
Arctic lamprey	*Lampetra japonica*
	SALMONIDAE
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Dolly Varden char	*Salvelinus malma*
Arctic grayling	*Thymallus arcticus*
Least cisco	*Coregonus sardinella*
Broad whitefish	*Coregonus nasus*
Humpback whitefish	*Coregonus pidschian*
Bering cisco	*Coregonus lauretta*
Round whitefish	*Prosopium cylindraceum*
Inconnu (sheefish)	*Stenodus leucichthys*
	UMBRIDAE
Alaska blackfish	*Dallia pectoralis*
	ESOCIDAE
Northern pike	*Esox lucius*
	CYPRINIDAE
Lake chub	*Couesius plumbeus*
	CATASTOMIDAE
Longnose sucker	*Catostomus catostomus*
	PERCOPSIDAE
Trout-perch	*Percopsis omiscomaycus*
	GADIDAE
Burbot	*Lota lota*
	COTTIDAE
Slimy sculpin	*Cottus cognatus*

Dolly Varden Char
The char of the refuge streams appear to be resident populations. Although specific locations have not been identified on the refuge they likely occur in upper reaches of clear water streams that have a perennial ground water source (Morrow 1980). Spawning activity begins in September and continues into late October. The eggs overwinter in gravel redds and hatch in early spring. The fry emerge several days later. Resident char populations are generally much smaller in body size than anadromous populations.

Arctic Grayling
Arctic grayling are widely distributed throughout the area in clear, cold streams and lakes. Tributaries to the Koyukuk River support large populations of Arctic grayling. Spawning migrations from mainstem areas of large rivers to smaller headwater streams begin shortly after breakup. Fry hatch in 11 to 23 days producing small, fragile young. The species at this stage is especially vulnerable to catastrophic losses due to spring flooding. Grayling tend to migrate from the upper reaches and tributaries downstream to overwinter in the deeper water areas of mainstem rivers. Mining on the Hogatza River and Bishop and Camp creeks may have caused declines in grayling populations as postulated by Alt (1983) for some mined streams in the Innoko River drainage.

Least Cisco
Least cisco are abundant in most refuge lakes and slow moving streams. Spawning runs begin during mid-September to spawning areas in the upper reaches of clearwater streams. Eggs overwinter in the gravel and hatch in early spring. Specific spawning areas are unknown.

Broad Whitefish
Broad whitefish are common in larger river-lake-slough systems and prefer areas of slower moving water. They are also found in landlocked lakes. Spawning activity of all whitefish is similar. They begin lengthy migration runs to spawning areas in mid-September. Spawning is usually complete by mid-October. Most broad whitefish are mature by age six or seven. No specific spawning areas have been identified for whitefish found in refuge streams.

Humpback Whitefish
Most common on the larger river systems of the refuge, humpback whitefish prefer the slower moving waters in the river-lake-slough systems. They are also found in landlocked lakes. Sexually mature by age five to seven, humpback whitefish migrate to spawning areas from mid-September to mid-October. Specific spawning locations are unknown. The humpback whitefish is often confused with the broad whitefish.

Round Whitefish
Round whitefish are found in refuge clearwater streams with gravel bottoms. They prefer the swifter headwater areas although they are also found in larger rivers and lakes. The round whitefish spawning period is from mid-September to mid-October. Specific spawning areas are unknown.

Inconnu (sheefish)
There are five major inconnu populations identified in Alaska. Inconnu on the refuge belong to the lower Yukon River anadromous population. This group is most abundant in the turbid waters of the Koyukuk and Yukon rivers and in associated lake areas. In May, inconnu move from overwintering areas in the lower Yukon River to feeding areas throughout the middle Yukon River. Though they remain primarily in mainstem rivers, inconnu occasionally feed in lower reaches of tributary streams. In August and September, inconnu began migrations to spawning grounds on the Koyukuk, Alatna, and

middle Yukon rivers. Two specific spawning areas have been identified on the Koyukuk River; 0.5 km downstream from Hughes and between 9.5 km and 12.5 km upstream from Hughes (Alt 1975).

Koyukuk River inconnu spawn in late September and early October while Yukon River fish spawn in mid-October. A rapid post-spawning downstream migration occurs with many fish overwintering in the lower reaches of the Yukon River. Males mature at five to nine years old and females at five to ten years in age. Inconnu are generally non-consecutive year spawners and are distinguished from other whitefish by the large mouth and large body size of up to 50 pounds, though the inconnu on the refuge seldom attain this size. Inconnu have been reported to be present in the upper Kateel River. Specifics on habitat usage and inconnu abundance on refuge tributary streams are unknown.

Northern Pike
Northern pike are present in the mid to lower reaches of almost all the stream areas on the Koyukuk Refuge and the Northern Unit of Innoko Refuge. Twenty-two out of 24 Koyukuk Refuge lowland and oxbow lakes surveyed by the Service in 1985 (Glesne 1986) contained northern pike, accounting for nearly 80% of all fish caught. Spawning takes place in weedy areas in lakes, sloughs, and flooded areas of river systems as soon as the ice breaks up. Spawning in streams or river-connected lakes is usually associated with lengthy migration runs. Northern pike mature in three to four years in Alaska. Common food items include whitefish and young northern pike, although the mature northern pike is very opportunistic and will feed on anything from small insects to small mammals.

Burbot
Burbot are winter spawners. Spawning can take place as early as mid-December to as late as early April. Most Alaska populations spawn in January and February (Chen 1969). They are found in the deeper areas of the major river systems but forage in the shallower areas at spawning time and during nocturnal feeding periods. Burbot are especially abundant in slow moving turbid water areas, such as the lower Koyukuk River. Alaskan burbot are slow growing and long-lived with maturation occurring in the fourth to seventh year. Evidence suggests that burbot are alternate year spawners. Little information is available about spawning or rearing areas of burbot that utilize refuge waters.

Habitat Description

Fish habitat occurring within the Koyukuk Refuge and the Northern Unit of Innoko Refuge is of five general types: (1) the Yukon River mainstem; (2) the Koyukuk River mainstem; (3) the sloughs and backwaters of the Yukon and Koyukuk rivers; (4) the tributary streams of the Yukon and Koyukuk rivers; and (5) the thousands of lakes, ponds, and marshes of the Koyukuk and Kaiyuh flats.

Fisheries resources contained within these general habitat types are described as follows:

Yukon River Mainstem
Several characteristics of the mainstem Yukon River may limit its value as fish habitat except for overwintering and as a route for fish movement and migration. The high concentration of suspended sediments and its associated turbidity limit primary production and aquatic insects upon which fish depend for food. Bottom materials range from fine silt up to boulders. During low water, gravel-silt bars are evident throughout the main channel. The total amount of spawning area and rearing habitat afforded by the mainstem Yukon River for resident and migratory fish species is unknown.

Koyukuk River Mainstem
The mainstem Koyukuk River provides an important diversity of fish habitat for a number of resident and anadromous fish species. Chinook, chum, and coho salmon, inconnu, broad and humpback whitefish, least cisco, and burbot use the Koyukuk River as a route to spawning areas in the upper reaches of the mainstem and tributary streams. Alt (1975) located an anadromous population of inconnu utilizing the Koyukuk and Yukon River systems. The Koyukuk River also provides overwintering and rearing habitat for many resident species including northern pike, whitefish, burbot, longnose suckers, and Alaska blackfish.

Yukon and Koyukuk Rivers Slough Systems
The backwaters of the Yukon and Koyukuk rivers are of great importance as a rearing area for small fish. Currents are almost nonexistent and silt loads are at least partially deposited, producing a mud bottom and lessened turbidity. Vegetation such as horsetail occurs at the margins of many backwater areas and affords excellent cover for small fish. Broad, humpback, and round whitefish, northern pike, Arctic grayling, longnose sucker, inconnu, burbot, lake chub, slimy sculpin, and Arctic lamprey have all been reported within these backwater systems. More detailed studies on habitat utilization and species abundance are needed to better understand the significance of these areas as fish habitat.

Tributary Streams of the Yukon and Koyukuk Rivers
The major tributaries of the Koyukuk and Yukon rivers located within the Koyukuk Refuge and the Northern Unit of Innoko Refuge are listed in Table 1. Most of these rivers and streams run through the Koyukuk or Kaiyuh flats and are characterized by a low gradient, an extremely meandering course, and extensive spring flooding. Northern pike, whitefish, burbot, and longnose suckers are abundant and heavily utilized in the local subsistence fishery. Chinook and chum salmon use the clear upper reaches of many of these tributaries for spawning. The Dakli, Gisasa, Indian, Kateel, and North Fork of the Huslia rivers, and Billy Hawk Creek have been identified as salmon spawning streams. Arctic grayling are very abundant in the upper reaches of most tributaries and, where perennial ground water sources exist, resident Dolly Varden char may occur.

Lake Habitat
The Koyukuk Refuge and the Northern Unit of Innoko Refuge have an estimated 15,000 lakes. Lake types include thaw lakes, river flooded lowlands, and oxbows. Productivity and fisheries use on Koyukuk Refuge and five other interior Alaskan refuges were investigated by Glesne (1986). Generally, lakes on the Koyukuk Refuge exhibited average values in all measured edaphic parameters compared to the other five refuges studied. Major factors affecting productivity and fisheries use are related to the edaphic characteristics of the surrounding area, connections to rivers, potential for flooding, and lake morphometry. Water quality characteristics of thaw lakes relating to productivity were generally lower for deeper lakes and lakes isolated from river systems. Lakes connected to rivers or periodically receiving flood waters exhibited higher value for alkalinity, conductivity, and nutrient concentrations.

Thaw lakes without river connections and with low probability of flooding were generally devoid of fish. The primary limiting factor is shallow depth, making the habitat unsuitable for overwintering. Those with adequate depth (mean depth generally greater than 3 meters) had populations of northern pike only or northern pike and Alaska blackfish. Thaw lakes connected to rivers exhibited greater density and diversity of fish. Primary species collected in these lakes included broad whitefish, northern pike, humpback whitefish, least cisco, and longnose suckers. It is expected that these lakes are

primarily used as summer feeding and rearing areas as depths are too shallow to permit overwintering.

Most oxbow lakes are closely associated with larger river channels and therefore are either connected or subject to frequent flooding. Fish species composition and abundance is similar to river connected thaw lakes. Oxbow lakes exhibit greater depth and most are capable of providing overwintering habitat for fish.

SECTION 4. HUMAN USE AND MANAGEMENT HISTORY

Commercial Fishing

Records of commercial fishing in the Alaskan portion of the Yukon River date to 1918, when commercial packing of salmon began in the Yukon River delta. Heavy commercial fishing in the lower river met with considerable opposition due to poor upriver subsistence catches. As a result, the commercial fishery was closed from 1925 through 1931. When the fishery reopened in 1932, only chinook salmon were harvested on a sustained basis. Commercial catches of chinook salmon averaged approximately 30,000 fish annually from 1918-1959. Since 1961, chum and coho salmon have been commercially harvested on an annual basis.

As an aid to better management of the commercial fishery, the Yukon River was divided into three districts in 1954. Since 1959, the Department has managed the Yukon River commercial fishery and redistricted the upper Yukon River to include the area from Old Paradise Village (below Anvik) to the Canadian border. In 1974, the Department revised the district boundaries in the upper Yukon River. Districts 1 and 2 remained the same while districts 3 and 4 were reduced in size. In addition, two new districts were created to better manage the rapidly expanding fisheries of the upper Yukon and Tanana rivers.

The Northern Unit of Innoko Refuge borders part of subdistrict 4A (334-41) and 4C (334-43; Figure 4). The summer chum salmon run is of paramount importance in district 4. The largest harvest in this district occurs in subdistrict 4A, averaging 83% of the total salmon harvest from 1984-1988 (Table 3). In 1988, commercial fishing permits by village were: Kaltag, 2 gill nets and 13 fishwheels; Nulato, 1 gill net and 19 fishwheels; Koyukuk, 3 fishwheels; and Galena, 5 gill nets and 21 fishwheels.

Salmon stocks that spawn on the refuge are subject to harvest in the mixed stock commercial fishery in the Yukon River. In recent years, both fall chum and chinook salmon stocks have been overharvested resulting in reduced commercial fishing times. Management of Yukon River salmon stocks and the fishery is a complex and difficult task due to the extreme size of the drainage, with salmon fishing covering 1,400 miles of the river. Consequently, it is not possible to manage the fisheries for escapement of specific stocks. Many of the Yukon River fall chum and chinook salmon are trans-boundary stocks originating in the Canadian portion of the river. Negotiations are currently in progress with Canada in developing a Yukon River Salmon Treaty to address allocation issues.

Commercial fishing in the refuge area is regulated by the Department (Appendix B) through the use of a permit system which includes harvest quotas and in-season harvest regulations. Commercial salmon fishing is not permitted on any of the Alaskan tributaries of the Yukon River (including the Koyukuk River), except the Tanana River. Commercial fishing for some resident freshwater fish species may be authorized in various Yukon River waters under terms of a special permit stipulating harvest reporting and conservation measures, although such a permit has never been issued for the area. Commercial salmon fishing quotas established by the Alaska Board of Fisheries for district 4 have flexible annual guideline harvests of 2,250-2,850 chinook salmon and 5,000-40,000 fall chum and coho salmon (district 4A is closed to fall chum and coho harvests).

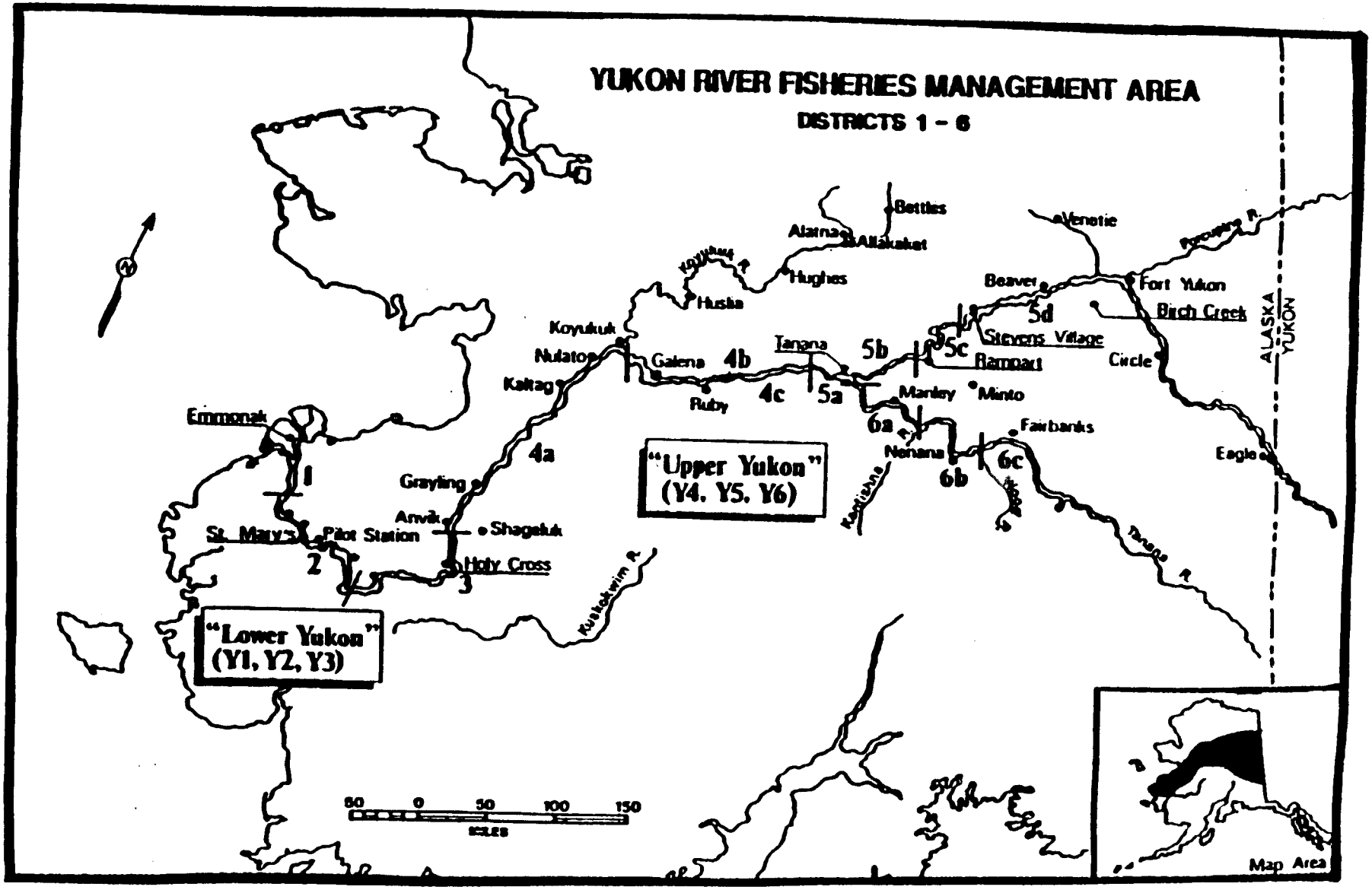

Figure 4. Alaska Department of Fish and Game commercial fishing management districts along the Yukon River (courtesy of the Department's Division of Commercial Fish).

Table 3. Yukon area commercial salmon catch, 1984-1988 average (Whitmore et al. 1990).

District/ subdistrict	Chinook	Summer chum[a]	Roe[b]	Fall chum[ac]	Roe[bc]	Coho[d]	Total salmon[e]
District 4	1,362	13,472	211,894	12,446	2,054	678	241,906
4A	25	10,719	189,755	0	0	-	200,499
4B	658	1,585	19,076	7,425	939	-	29,383
4C	680	1,186	3,063	5,051	1,115	-	11,095
Upper Yukon (districts 4-6)	6,177	58,972	213,209	56,219	2,164	8,977	345,718
Lower Yukon (districts 1-3)	114,272	625,335	0	131,129	0	59,393	930,129
Total	120,449	684,307	213,209	187,348	2,164	68,370	1,275,847

[a] Majority of annual harvests for subdistricts 4A through 4C rounded to nearest 100.
[b] Roe in pounds.
[c] The 1987 fall chum salmon fishing season was closed and not included in calculating averages.
[d] Subdistrict harvest totals not reported.
[e] One pound roe is equivalent to one female chum salmon.

Subsistence Fishing

The majority of the Koyukuk Refuge and the Northern Unit of Innoko Refuge lie within the territory of the Koyukon Athapaskan Indians; the Northern Unit of Innoko Refuge falls into the Lower Yukon subdivision, while the Koyukuk Refuge falls into the Koyukuk River subdivision. Historically, the Koyukon Athapaskans depended heavily on the anadromous fish resources of the Yukon and Koyukuk rivers along with a variety of resident fish species. They frequently occupied large semi-permanent villages during the summers, most commonly located near the primary fishing grounds. Fish provided a stable and consistent food source which is of particular importance when populations of large mammals fluctuated.

Fishery resources are still a very important food source for subsistence users. Chinook, chum, and coho salmon, Arctic grayling, whitefish, inconnu, Alaska blackfish, northern pike, longnose sucker, and burbot are the primary species sought in the area's subsistence fishery. Presently, the main subsistence users are from the Yukon River communities of Kaltag, Nulato, Koyukuk, and Galena, and the Koyukuk River villages of Huslia and Hughes. Subsistence fishing occurs year round, although summer and fall runs of salmon are the most important in terms of volume. The majority of households participate in subsistence activities and many who do not participate directly use resources provided through sharing. Fish are usually harvested with nets or fishwheels and are dried on racks for later use.

Table 4 contains the annual subsistence salmon harvest for the six villages in the area: 1984-1988 average (Walker et al. 1989). The majority of the subsistence catch is from the mainstem Yukon River and probably represent mostly off-refuge stocks. Chum salmon made up 93% of the total salmon catch (1984-1988 average). Subsistence salmon fishing on the Koyukuk River is authorized seven days per week, while the Yukon River fishery, where commercial fishing also occurs, is more highly regulated (Department's subsistence fishing regulations, Appendix C). The subsistence harvest information for non-salmon species is very limited. Subsistence surveys of all harvested fish species have been conducted in two of the Koyukuk River villages (Tables 5 and 6). Whitefish were the most common non-salmon species harvested.

Sport Fishing

Northern pike and Arctic grayling are probably the most important sport fishing species. Currently, one guide fishes in refuge waters. In 1990, an estimated 2,500 northern pike were captured with the majority released (Koyukuk Refuge activities report, 1990). There are no available references containing specific sport harvest data for the area. The Department's Sport Fishing Regulation Summary within the Arctic-Yukon-Kuskokwim area contains regulations for sport fish harvest within refuge waters (Appendix D).

Table 4. Subsistence harvest of Yukon River salmon resources by villages in the vicinity of the Koyukuk Refuge and the Northern Unit of Innoko Refuge, 1984-1988 average (Walker et al. 1989).

Village	Average annual salmon harvest				
	Chinook	Summer chum	Fall chum	Coho	Total
Kaltag	904	17,115	2,938	46	21,003
Nulato	1,485	10,679	2,310	180	14,654
Koyukuk	618	6,227	1,526	276	8,647
Galena	1,371	12,300	6,276	873	20,820
Huslia	133	12,487	1,934	74	14,628
Hughes	427	8,325	972	128	9,852
Total	4,938	67,133	15,956	1,577	89,604

Table 5. Hughes subsistence fishing harvest data from 19 participating households, 1982 (Marcotte and Haynes 1985).

Resource	Number of households	Mean harvest per household	Harvest range	Total community harvest
Chinook salmon	13	38.9	5-150	506
Summer chum salmon	13	984.6	200-4,000	12,800
Fall chum salmon	12	110.2	3-300	1,323
Arctic grayling	16	86.0	3-300	1,376
Whitefish	14	152.5	10-500	2,135
Inconnu	15	21.3	1-100	320
Northern pike	10	21.1	3-100	211
Longnose sucker	6	8.2	5-10	49
Burbot	2	30.0	10-50	60

Table 6. Huslia subsistence fishing harvest data from 56 participating households, 1983 (Marcotte 1986).

Resource	Number of households	Mean harvest per household	Harvest range	Total community harvest
Chinook salmon	19	15.4	1-110	292
Summer chum salmon	23	895.0	50-4,000	20,585
Fall chum salmon	17	94.2	5-300	1,602
Arctic grayling	1	17.0	17	17
Whitefish	30	155.0	5-1,000	4,650
Inconnu	22	38.3	3-300	843
Northern pike	28	69.5	4-400	1,947
Longnose sucker	15	18.8	2-50	282
Burbot	10	20.5	1-100	205
Alaska blackfish[a]	1	600	600	600

[a] Alaska blackfish presented in number of pounds.

SECTION 5. ISSUES AND CONCERNS

Section 304(g)(4) of the Alaska Lands Act required the Service to consult with appropriate state agencies and Native corporations to ensure public interests and concerns would be addressed in the plans. It also required hearings to assure that residents affected by the administration of the refuge had an opportunity to present their views. Public meetings were held in Hughes, Huslia, Koyukuk, Galena, Nulato, Kaltag, Anchorage, and Fairbanks. Issues and concerns were developed using information gathered from these meetings and consultations.

A potential exists for the alteration or reduction of the genetic diversity of wild salmon stocks on refuges caused by artificial salmon enhancement efforts.

The Yukon River is one of a few remaining large rivers in North America that produces large numbers of salmon, has had minimal habitat disturbance, and has no major hydroelectric dams along its course. Commercial and subsistence harvest of salmon takes place from its mouth and continues upstream almost 1,400 miles. The demand placed on Yukon River chinook and fall chum salmon exceeds the capacity of wild stocks to satisfy all user groups. Consequently, several stocks are depressed and fishery managers continually strive to rebuild these stocks through more precise harvest management controls. Another approach being considered to alleviate the ever-growing demand placed upon these stocks is supplemental hatchery production. The State Legislature is considering expansion of the Clear Hatchery located in the Nenana River drainage southwest of Fairbanks.

Given the mixed species and mixed stock nature of most Yukon River fisheries, supplemental hatchery production must be carefully planned so as not to risk further depletion of wild salmon stocks. Innoko, Nowitna, Koyukuk, Kanuti, and Yukon Flats National Wildlife refuges all contain numerous individual stocks that make up a part of the Yukon River fishery. Many of these stocks are relatively small which make them extremely vulnerable to overharvest in an intensive fishery. Consequently, should mainstem harvest levels increase in response to hatchery production of salmon, then small refuge stocks risk reduction or elimination. Genetic straying and introduction of diseases from hatchery produced fish may also affect refuge wild stocks. Hatchery produced fish that stray and interbreed with wild populations can alter the wild gene pool, reduce stock fitness, and threaten the survival of wild populations (Department's Genetic Policy, 1985).

If used as a stock rebuilding tool, this project could greatly benefit wild salmon stocks and eventually increase salmon harvests beyond recent levels. However, considerable planning and development of genetic safeguards will be required before any large scale enhancement project is undertaken. It is recommended that a comprehensive salmon plan, as required by Alaska Statutes (sections 16.10.375-.475), be prepared for the Yukon River fishery prior to initiation of artificial production projects. This plan should address disease, genetics, wild stock conservation, mixed stock (wild versus hatchery) fishery management, and other important management issues associated with supplemental salmon production. The plan should also include cost/benefit assessment which explicitly identifies the full compliment of management and research programs needed to adequately address wild stock management concerns. The Service should be consulted in plan development to ensure refuge stock protection.

A potential exists for overharvest of refuge salmon stocks due to interception at off-refuge locations.

High seas and in-river commercial and subsistence fishing activities can have a significant impact on the number of chum, coho, and chinook salmon reaching the refuge due to the mixing of salmon stocks within these fisheries. Small stocks of several hundred fish or less are more likely to be overharvested than are larger stocks. Fishery managers need methods to evaluate escapement of selected salmon stocks, both in-season and post-season. The

Service and Department are developing stock identification within the mixed stock fishery of the lower Yukon River which may ultimately help refine spawning escapement goals to individual drainages. The Alaska Lands Act requires the Service to provide for subsistence harvest as local residents rely heavily on fisheries harvest for sustenance. Both chum and chinook salmon constitute an important source of protein for subsistence users. The Service and Department are participating in Treaty negotiations with Canada concerning allocation and conservation issues for trans-boundary chinook and fall chum salmon.

Incomplete fishery baseline information on which to base management decisions.
The Koyukuk Refuge and the Northern Unit of Innoko Refuge encompass an expansive complex of fisheries habitats where information is lacking. Over-exploitation of the refuge fish stocks may occur both on and off the refuge. Additional data are needed as a basis for preparing salmon spawning escapement goals and to assess the impacts of development on the refuge. Information is urgently needed to expand the scientific knowledge base for life histories of fish, enhance management capabilities, and provide information to people utilizing fishery resources.

Increased sport fishing pressure may cause future decreases in the size structure and harvestable population size of northern pike.
In recent years the Kaiyuh Flats has become a popular destination for guided sports fishers. The majority of the catch is northern pike. Trophy size fish are harvested with the majority of captured fish being released. An increase in harvest could result in older year classes being cropped-off of the population. Information on present harvest levels and size structure are inadequate to ensure that a quality fishery will remain.

Additional subsistence harvest information is needed to ensure continued diversity of fish stocks occurring on the refuge.
Fish population information for the subsistence species harvested within the refuge should be collected to protect the natural diversity and abundance of the species and to provide information to make recommendations for acceptable harvest levels.

Continued harvest of salmon resources is directly related to the continued provision to insure proper escapement levels to refuge spawning streams. Failure to provide for salmon escapement may result in failure to provide for subsistence harvest of fish stocks occurring on the refuge.

Placer mining activities, both on and off refuge lands, may affect refuge aquatic habitat and water quality.
Mining activities may have introduced excessive amounts of sediment to streams causing deleterious affects to fish habitat, especially spawning gravels. Placer mining activities can cause increased levels of turbidity and the amount of sediment transported in streams. However, current mining technology and State and Federal regulations governing mining discharge have substantially reduced sediment pollution. Potential sources of sediment input can occur during periods of high rainfall. However, there is insufficient data currently available to determine the extent (if any) mining practices have had on refuge fish habitat and fish populations. Active mining presently occurs on the Hogatza River, outside the Koyukuk Refuge boundary. Water quality sampling of refuge streams will allow monitoring of any upstream disturbances that may affect refuge fish habitat.

The use and development of inholdings and lands adjacent to the refuge may adversely affect fish populations and their habitat on the refuge.
Concerns include loss and/or alteration of habitat, increased pollution, increased exploitation of available fishery resources, and increased human use. Coordination between federal, state, and local agencies during all land use planning activities is desirable to assure management consistency with adjacent lands. Parcels of privately owned land within the refuge boundaries could be developed in the future for a variety of uses. The unguided

future development of residential, agriculture, mineral, and other commercial activities could impact refuge fish populations and habitat.

Water rights were reserved, subject to quantification, for Alaskan National Wildlife refuges under the Alaska Lands Act. Streams originating off-refuge are subjected to water reservation by villages and private individuals on a first come first serve basis. Based on this scenario, water needed for refuge fishery resources could be allocated for other than fish and wildlife purposes.

SECTION 6. GOALS AND OBJECTIVES

This section of the plan states the fishery management goals and objectives of the refuge. The goals are derived from the four purposes listed in the Alaska Lands Act for which the refuge was designated. In addition to these goals, the refuge will meet all Federal legal mandates with respect to the administration and conservation of refuge fishery resources.

Goal I: To conserve fish and wildlife populations and habitats in their natural diversity including but not limited to salmon.

Objective I-A: To administer the fishery management program on the refuge as a continuing commitment through 1997.

Objective I-B: To regulate and monitor the harvest of refuge fish populations in accordance with agency regulations as a continuing commitment through 1997.

Objective I-C: To monitor escapement of Koyukuk River drainage salmon stocks as a continuing commitment through 1997.

Objective I-D: To determine the major spawning and rearing areas for chinook, chum, and coho salmon in six tributaries of the Koyukuk River by 1997.

Objective I-E: To evaluate the impacts of mining activities on the fish populations of refuge streams and develop habitat protection recommendations by 1996.

Objective I-F: To complete fish population and habitat studies on four refuge streams and two slough systems by 1997.

Objective I-G: To determine inconnu spawning areas for refuge tributaries by 1997.

Objective I-H: To complete fish population studies on three refuge lakes by 1995.

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

Objective II-A: To determine locations and size of spawning stocks of chinook and fall chum salmon on the refuge by 1997.

Goal III: Provide, in a manner consistent with the purposes set forth in Goals I and II, the opportunity for continued subsistence uses of fish resources by local residents.

Objective III-A: To assist the Department in monitoring and evaluating subsistence harvest within the refuge as a continuing commitment through 1997.

Goal IV: Ensure to the maximum extent possible, in a manner consistent with the purposes set forth in Goal I, that the water quality and water quantity within the refuge is maintained.

Objective IV-A: To collect water quality and quantity data on refuge streams affected by upstream mining activities by 1996.

SECTION 7. STRATEGIES AND CONSTRAINTS

Management Strategies

The management of fish and wildlife in Alaska is guided by the Master Memorandum of Understanding (Appendix A) signed by the Commissioner of the Department and the Regional Director of the Service. Under this agreement, the Service is "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".

The Department has "primary responsibility to manage fish and resident wildlife within the State of Alaska". The State's regulatory process is to be used "to the maximum extent allowed by Federal law in developing new or modifying existing Federal regulation or proposing changes to existing State regulations governing or affecting the taking of fish and wildlife on Service lands in Alaska.

Commercial, sport, and subsistence fisheries are managed in accordance with the regulations and policies of the Service, the Department, and the Alaska Board of Fisheries. Management direction recognizes subsistence use as the highest priority among beneficial human uses of the resources. On July 1, 1990, the Federal government under Service leadership assumed management of subsistence harvest of fish and game on federal lands in Alaska.

Any Service proposal for modifying fish seasons, bag limits, and/or methods and means of fishing in navigable waters would be made in cooperation with the Department to the Alaska Board of Fisheries. Waters of the Koyukuk Refuge and the Northern Unit of Innoko Refuge (including the water column and submerged lands beneath these waters) which may be classified as navigable are under the jurisdiction of the State of Alaska. However, the Service has the authority to regulate certain activities on navigable waters when refuge purposes are threatened or violated, and for conservation purposes. This authority stems from two provisions of the United States Constitution, the Property Clause and the Commerce Clause; Alaska Lands Act; authorities of the National Wildlife Refuge Administration Act of 1966; the Endangered Species Act of 1973; the Estuarine Area Study Act of 1968; the 1899 Rivers and Harbors Act; The Migratory Bird Treaty Act of 1918; and the Fish and Wildlife Coordination Act of 1958. When necessary, the Service will coordinate with the appropriate state agencies in an attempt to cooperatively resolve all issues related to the quantification of water for other than fish and wildlife uses.

Sport fishing will continue to be allowed in all refuge areas, although production capacity is limited and intensive sport fishing may impact fish populations. Restrictions may be pursued to control the harvest of some populations if they are determined to be over-exploited. The Service has adopted a national policy to provide increased recreational fishing opportunities on national wildlife refuges. The Service will determine where and if this activity can best be accomplished without adversely impacting fish populations, subsistence activities, and wildlife resources. Changes in seasons, methods, and means of the sport fishery harvest may be proposed pending this evaluation.

Setting escapement goals and harvest regulations is a cooperative effort between the Service, the Department, and the public and will be accomplished through the future development of a fishery database for all species and ecosystems within the refuge. Consequently, many fishery investigations identified in this plan center on survey and inventory of the existing fishery resources of the Koyukuk Refuge and the Northern Unit of Innoko Refuge. The Service will also review Department fishery management projects to ensure that they are compatible with the general management directions developed within the Koyukuk

Conservation Plan. All fisheries work on the refuge will be coordinated with the refuge manager, the Service's Fishery Assistance Office in Fairbanks, and the Department's local offices.

The Service will strive to maintain fish populations at their current levels, recognizing natural fluctuations and cycles, with management of wild stocks in their natural state being the first priority. The Service has a keen interest in protecting fish spawning areas and water quantity and quality for the Koyukuk and the Northern Unit of Innoko Refuge. The potential impacts of any activity on fish populations, habitat, and water quality will be carefully evaluated prior to permitting these activities on the refuge. All streams on the refuge will be considered potential spawning-rearing-migration route streams until such time as studies prove differently. For development activities on refuge lands, the Service will design special use permits to safeguard aquatic habitat and spawning habitat quality. For development activities taking place outside the refuge but affecting spawning habitat on the refuge, the Service will request assistance from the State of Alaska, Bureau of Land Management, Environmental Protection Agency, and the U.S. Army Corp of Engineers whose jurisdictions are to enforce regulations governing riverine water quality and habitat protection.

Coho and chinook salmon have previously been identified by the Service as national resource species. The Service has developed general management strategies for each species in its Alaska Regional Resource Plan. Strategies relevant for refuges, such as collecting survey data, monitoring populations, and protecting habitats, are reflected in the management directions developed for this plan.

In designated wilderness areas, temporary facilities may be permitted to maintain, restore, or enhance fisheries if the stocks have been reduced or are threatened as long as the facilities do not significantly detract from wilderness values. New permanent facilities will not be permitted in designated wilderness for fishery management purposes unless they are essential to accomplish refuge management objectives or are part of an approved scientific study. New permanent facilities may be permitted outside of designated wilderness provided these facilities are supported by a viable management strategy. The need for permanent or temporary fishery facilities are not anticipated for the 5-year duration of this plan.

Anadromous Fish Management

Service efforts will focus on collecting more complete data on the numbers and locations of spawning salmon within the Koyukuk River and its tributaries. Chinook and summer chum salmon stocks have been documented to spawn in the Koyukuk River drainage: Koyukuk, Dakli, Gisasa, Indian, Kateel and North Fork of the Huslia rivers, and Billy Hawk Creek. Information on annual spawning escapement for coho and fall chum salmon and detailed descriptions of spawning and rearing areas for all salmon species are very limited. Radio telemetry, on-ground stream inventories, aerial surveys, test netting, and side-scanning sonar will be used to determine numbers and locations of spawning salmon and rearing habitat. This information will be used to support stipulations in special use permits, develop recommendations for spawning escapement goals, and protection of spawning and rearing habitat. Salmon escapement goals will be developed to support reproduction of the species and ultimately sustain harvests for human and non-human use. The Koyukuk, Dakli, Gisasa, and Indian rivers are Department salmon escapement index streams and are surveyed annually to monitor escapement of summer chum and chinook salmon. It is anticipated that the Department will continue these aerial surveys; however, should state funding be eliminated the Service would make an intensive effort to continue these projects.

Salmon stocks throughout the refuge remain genetically unidentified. With the potential threat of overharvesting of small stocks and environmental disturbances such as upstream mining activities, efforts will be made to genetically identify these salmon stocks where baseline information is available. In most cases, samples will be collected from juveniles so that identification will not impact existing small populations. The ability to identify a genetically similar strain of salmon will then be possible should harvest apportionment by stock and/or rehabilitation of a depleted stock be required in the future.

The Department's Division of Commercial Fish annually conducts subsistence salmon harvest surveys in most of the villages adjacent to and within refuge boundaries. These surveys provide valuable information to resource managers regarding trends in utilization of fishery resources for subsistence purposes and overall harvest of salmon throughout the Yukon River drainage. It is anticipated that these surveys will be continued by the Department provided that funds are made available. If not, the Service will make an effort to continue these surveys.

Inconnu have been documented to spawn in the mainstem Koyukuk River near Hughes, approximately 25 river kilometers upstream of the Koyukuk Refuge boundary (Alt 1975). Inconnu have also been reported in the Kateel River, Dulbi River, and Camp Creek on the Kaiyuh Flats, although specifics on habitat usage and abundance are unknown. Intensive fall sampling at the mouths of refuge tributaries, as well as at suspected spawning riverine habitats, will more clearly define refuge stocks. Radio transmitters will be implanted in captured individuals identified as prespawners to identify spawning habitats and movement patterns throughout the refuge. This information will be used to support stipulations in special use permits to protect inconnu populations and their habitats.

Resident Fish Management

Monitoring harvest of resident fish species by sport and subsistence users is of paramount importance for maintaining healthy fish populations. Guided sports fishing activities have increased in recent years necessitating the need for reliable quantitative harvest information for northern pike. A relative length index of the harvestable population would provide needed information on population trends through time. Efforts will be made to acquire relative length information from guided sports anglers on the Northern Unit of Innoko Refuge. Available information concerning subsistence harvest of resident fish species is very limited for the Koyukuk Refuge and the Northern Unit of Innoko Refuge. Subsistence fishing activities on waters outside refuge boundaries may impact trans-boundary refuge stocks.

Information on resident fish populations in the area are extremely limited. Past and present mining activities may have significantly disturbed fish habitat in Bishop and Camp creeks of the Northern Unit of Innoko Refuge and on the Hogatza River in the Koyukuk Refuge. To fulfill the Alaska Lands Act mandates for conservation of fish populations and continuation of subsistence opportunities, it is important to document what fish populations currently utilize these systems and to assess aquatic habitat potential. Baseline information on resident fish utilization of other refuge streams needs to be collected to insure proper management of this important refuge resource.

The Koyukuk Refuge and the Northern Unit of Innoko Refuge have an ongoing water quality and contaminant sampling program which is being conducted on major tributaries within refuge boundaries. Water, sediment, and fish tissue are being collected on each tributary sampled. A baseline data collection effort will be pursued for some tributaries in the contaminant sampling program for the purpose of documenting any change. The Service's Fisheries Assistance Office, Fairbanks, will assist in the data gathering efforts in conjunction with fisheries investigations when requested.

Two of the major riverine habitat types identified in this plan are the extensive slough and stream systems of the Yukon and Koyukuk rivers. Information regarding the use of these habitat types by resident fish species is very limited. Species composition and abundance data along with specific habitat use information will be gathered from two sloughs and four streams. This data will help provide information necessary to protect fishery habitat from future degradation.

Planned resident fishery investigations on refuge lakes will be limited to studies on lakes that are associated with refuge duck brood plots. Extensive vegetative studies have been conducted for some of these lakes, although additional fishery and physio-chemical descriptions will greatly enhance present information. Data collection will emphasize fish species distribution, age composition, growth rates, habitat descriptions, and associated water quality. These lakes apparently receive little subsistence pressure throughout the year; however, the current harvest levels are unknown as are the impacts to the fish populations. Fish populations will be monitored using various sampling techniques including traps, nets, and hook-and-line gear. Information will be used to evaluate and refine current harvest management strategies.

Management Constraints

A critical factor in implementing any of the specific fishery tasks identified in this plan will be the level of available funding. Specific tasks have been prioritized (Section 9) to accommodate a given funding level. Service administrators are presently working towards obtaining special appropriations for implementation of these tasks.

The remoteness and expansive size of the drainages on the Koyukuk Refuge and the Northern Unit of Innoko Refuge restricts our ability to gather the fishery data needed for assessing current harvest of the refuge's fishery resources. Fishery management is complicated further by the migratory behavior of most fish species indigenous to the refuge. Refuge fish exhibit migrations from 50 to over 3,000 miles associated with yearly spawning and life cycles. The total ecosystem for three of the five Pacific salmon species (chinook, chum, and coho) includes refuge streams, the Yukon River, parts of the north Pacific Ocean, and the Bering Sea. Interception of refuge salmon stocks occurs throughout this ecosystem making spawning escapement objectives for individual tributaries extremely difficult to achieve.

Anticipated constraints common in anadromous and resident species investigations include: (1) regulatory changes that may be needed for protection of a species may conflict with the desires of user groups; (2) regulations are difficult to enforce in remote areas of the refuge; (3) resistance may be encountered when gathering information from user groups; and (4) population structures could be impacted and difficult to assess before regulations can be implemented.

Constraints specific to salmon investigations include: (1) run timing on tributary streams would occur nearly simultaneously, requiring separate field crews to be located in the lower reaches of each tributary; (2) live capture and healthy release of radio-tagged salmon requires continuous monitoring of gill nets which entails many man-hours of effort; (3) the effectiveness of aerial fish counting is largely dependent on weather and water conditions during the predicted peak spawning period; and (4) out-migration of salmon fry occurs at ice-out, making sampling difficult because of high water and ice conditions.

SECTION 8. FISHERY MANAGEMENT ACTIVITIES FOR THE KOYUKUK REFUGE AND NORTHERN UNIT OF INNOKO REFUGE, FISCAL YEARS 1993-1997.

Goals	Objectives	Tasks	Responsible office	Date/ funding/FTE[a]
Goal I: To conserve fish and wildlife populations and habitat in their natural diversity including but not limited to salmon.				
	Objective I-A. To administer the fishery management program on the refuge as a continuing commitment through 1997.	Task I-A-1. Administer the on-going refuge fishery program by preparing management recommendations, attending planning meetings, preparing news releases, and coordinating both intra and interagency fisheries matters.	Koyukuk Refuge	1993/10,000/0.5 1994/10,000/0.5 1995/10,000/0.5 1996/10,000/0.5 1997/10,000/0.5
		Task I-A-2. Provide technical advise to Koyukuk Refuge staff.	Fairbanks, Fishery Assistance Office (FAO)	1993/10,000/0.2 1994/10,000/0.2 1995/10,000/0.2 1996/10,000/0.2 1997/10,000/0.2
	Objective I-B. To regulate and monitor the harvest of refuge fish populations in accordance with agency regulations as a continuing commitment through 1997.	Task I-B-1. Regulate and monitor commercial salmon harvests by district and season.	Commercial Fish Division (Department)	Continuing commitment
		Task I-B-2. Regulate and monitor sport fish harvests.	Sport Fish Division (Department)	Continuing commitment
		Task I-B-3. Monitor sport harvest of northern pike in the Kaiyuh Flats.	Koyukuk Refuge	1993/12,000/0.4 1994/12,000/0.4 1995/12,000/0.4 1996/12,000/0.4 1997/12,000/0.4

Goals	Objectives	Tasks	Responsible office	Date/ funding/FTE[a]
		Task I-B-4. Monitor subsistence fisheries harvests in Kaltag, Nulato, and Huslia.	Koyukuk Refuge	1993/20,000/0.5 1994/20,000/0.5 1995/20,000/0.5 1996/20,000/0.5 1997/20,000/0.5
		Task I-B-5. Regulate and monitor subsistence fisheries harvests in cooperation with the Service (Task I-B-4).	Commercial and Subsistence Divisions (Department)	Continuing commitment
		Task I-B-6. Present formal proposals to the Alaska Board of Fisheries.	Department	Continuing commitment
		Task I-B-7. Review and comment on proposals for Alaska Board of Fisheries.	Koyukuk Refuge	1993/2,000/0.1 1994/2,000/0.1 1995/2,000/0.1 1996/2,000/0.1 1197/2,000/0.1
		Task I-B-8. Conduct fishery law enforcement activities.	Fish & Wildlife Protection	Continuing commitment
	Objective I-C. To monitor escapement of Koyukuk River drainage salmon stocks as a continuing commitment through 1997.	Task I-C-1. Conduct low level aerial surveys during peak spawning periods to determine relative escapement for summer and fall chum, chinook, and coho salmon on the refuge tributary streams of the Koyukuk River.	Fairbanks FAO; Koyukuk Refuge	1993/6,000/0.2 1994/6,000/0.2 1995/6,000/0.2 1996/6,000/0.2 1997/6,000/0.2

Goals	Objectives	Tasks	Responsible office	Date/ funding/FTE[a]
		Task I-C-2. Evaluate the feasibility of test netting, counting tower, weir, and side scan sonar operations for monitoring salmon escapement on Koyukuk River and its tributaries.	Fairbanks FAO	1993/10,000/0.4 1994/10,000/0.4 1995/10,000/0.4 1996/10,000/0.4
	Objective I-D. To determine the major spawning and rearing areas for chinook, chum, and coho salmon in six tributaries of the Koyukuk River by 1997.	Task I-D-1. Conduct radio telemetry and follow-up aerial surveys to determine spawning areas for chinook, chum, and coho salmon on the Koyukuk River drainage in conjunction with Task I-C-1.	Fairbanks FAO; Koyukuk Refuge	1993/25,000/0.4 1994/25,000/0.4 1995/25,000/0.4
		Task I-D-2. Conduct on the ground inventories on the Koyukuk River tributaries to identify rearing habitat for chinook, chum, and coho salmon in conjunction with Task I-F-2.	Fairbanks FAO; Koyukuk Refuge	1993/15,000/0.4 1994/15,000/0.4 1995/15,000/0.4 1996/15,000/0.4 1997/15,000/0.4
		Task I-D-3. Collect tissue samples of rearing juvenile salmon for electrophoretic stock i.d. in conjunction with Tasks I-D-2 and I-F-2.	Fairbanks FAO; Alaska Fish and Wildlife Research Center	1993/20,000/0.4 1994/20,000/0.4 1995/20,000/0.4
	Objective I-E. To evaluate the impacts of mining activities on the fish populations of refuge streams and develop habitat protection recommendations by 1996.	Task I-E-1. Conduct a comprehensive fishery inventory and water quality study on some tributaries included in the refuge contaminant sampling program. Management recommendations will be made upon completion of the project.	Fairbanks FAO; Koyukuk Refuge	1993/40,000/0.6 1994/40,000/0.6 1995/40,000/0.6 1996/5,000/0.6

Goals	Objectives	Tasks	Responsible office	Date/ funding/FTE[a]
	Objective I-F. To complete fish population and habitat studies on four refuge streams and two slough systems by 1997.	Task I-F-1. Develop a relative length index for harvestable northern pike in the Kaiyuh Flats.	Fairbanks FAO; Koyukuk Refuge	1993/25,000/0.8 1994/25,000/0.8
		Task I-F-2. Conduct resident fish population studies on the Kateel, Gisasa, Huslia, and Natlaratlen rivers and Dulbi and Kaiyuh slough areas in conjunction with Tasks I-D-2 and I-F-1.	Fairbanks FAO	1993/25,000/0.8 1994/25,000/0.8 1995/25,000/0.8 1996/25,000/0.8 1997/25,000/0.8
	Objective I-G. To determine inconnu spawning areas for refuge tributaries by 1997.	Task I-G-1. Conduct radio telemetry and follow-up aerial surveys to determine key spawning areas for inconnu on Koyukuk River tributaries and Kaiyuh Flats in conjunction with Task I-D-1 and I-F-2.	Fairbanks FAO; Koyukuk Refuge	1993/10,000/0.2 1994/10,000/0.2 1995/10,000/0.2 1996/10,000/0.2 1997/10,000/0.2
	Objective I-H. To complete fish population studies on three refuge lakes by 1995.	Task I-H-1. Examine age structure and length frequency distribution of fish populations on three refuge waterfowl brood plot lakes.	Fairbanks FAO; Koyukuk Refuge	1993/20,000/0.5 1994/20,000/0.5 1995/20,000/0.5
Goal II:	**To fulfill international treaty obligations of the United States with respect to fish and their habitats.**			
	Objective II-A. To determine locations and size of spawning stocks of chinook and fall chum salmon by 1997.	Task II-A-1. Conduct annual aerial surveys of salmon spawning grounds on refuge streams to determine relative escapement indices as outlined in Tasks I-C-1 and I-D-1.	Fairbanks FAO	See Tasks I-C-1 and I-D-1

Goals	Objectives	Tasks	Responsible office	Date/ funding/FTE[a]
Goal III: Provide, in a manner consistent with the purposes set forth in Goals I and II, the opportunity for continued subsistence uses of fish resources by local residents.				
	Objective III-A. To assist the Department in monitoring and evaluating subsistence harvest within the refuge as a continuing commitment through 1997.	Task III-A-1. Conduct annual surveys within the villages located in or near refuge boundaries for anadromous and resident fish harvested for subsistence purposes.	Koyukuk Refuge Commercial and Subsistence Divisions (Department)	See Task I-B-4 Continuing commitment
Goal IV: Ensure to the maximum extent possible, in a manner consistent with the purposes set forth in Goal I, that the water quality and the water quantity within the refuge is maintained.				
	Objective IV-A. To collect water quality and quantity data on refuge streams affected by upstream mining activities by 1996.	Task IV-A-1. Collect water quality and quantity data from established monitoring stations on the Hogatza River and Caribou, Bishop, and Camp creeks.	Koyukuk Refuge	See Task I-E-1

[a] FTE = full-time equivalent.

SECTION 9. PRIORITY OF TASKS (Service)

The priority of tasks identified by the refuge and to be conducted by the Service are listed below. Administrative tasks are considered to be the highest priority for each year. FAO = Fairbanks Fishery Assistance Office; KR = Koyukuk Refuge.

Priority	Task	Funding	Cumulative total	Responsible office
	FY 1993			
1.	(I-A-1) Administer fishery program	10,000	10,000	KR
2.	(I-A-2) Provide technical advise to refuge	10,000	20,000	FAO
3.	(I-C-1) Aerial salmon surveys	6,000	26,000	FAO; KR
4.	(I-D-1) Salmon telemetry surveys	25,000	51,000	FAO; KR
5.	(I-D-2) Salmon habitat inventories	15,000	66,000	FAO; KR
6.	(I-E-1) Mined-stream inventories	40,000	106,000	FAO; KR
7.	(I-B-3) Monitor northern pike harvest	12,000	118,000	KR
8.	(I-B-4) Monitor subsistence fish harvest	20,000	138,000	KR
9.	(I-B-7) Review proposals to Fishery Board	2,000	140,000	KR
10.	(I-F-1) Develop pike length index	25,000	165,000	FAO; KR
11.	(I-F-2) Resident fish stream inventories	25,000	190,000	FAO
12.	(I-D-3) Electrophoretic salmon stock i.d.	20,000	210,000	FAO
13.	(I-G-1) Inconnu spawning investigations	10,000	220,000	FAO; KR
14.	(I-C-2) Salmon monitoring feasibility	10,000	230,000	FAO
15.	(I-H-1) Lake study	20,000	250,000	FAO; KR
	FY 1994			
1.	(I-A-1) Administer fishery program	10,000	10,000	KR
2.	(I-A-2) Provide technical advise to refuge	10,000	20,000	FAO
3.	(I-C-1) Aerial salmon surveys	6,000	26,000	FAO; KR
4.	(I-D-1) Salmon telemetry surveys	25,000	51,000	FAO; KR
5.	(I-D-2) Salmon habitat inventories	15,000	66,000	FAO; KR
6.	(I-E-1) Mined-stream inventories	40,000	106,000	FAO; KR
7.	(I-B-3) Monitor northern pike harvest	12,000	118,000	KR
8.	(I-B-4) Monitor subsistence fish harvest	20,000	138,000	KR
9.	(I-B-7) Review proposals to Fishery Board	2,000	140,000	KR
10.	(I-F-1) Develop pike length index	25,000	165,000	FAO; KR
11.	(I-F-2) Resident fish stream inventories	25,000	190,000	FAO
12.	(I-D-3) Electrophoretic salmon stock i.d.	20,000	210,000	FAO
13.	(I-G-1) Inconnu spawning investigations	10,000	220,000	FAO; KR
14.	(I-C-2) Salmon monitoring feasibility	10,000	230,000	FAO
15.	(I-H-1) Lake study	20,000	250,000	FAO; KR
	FY 1995			
1.	(I-A-1) Administer fishery program	10,000	10,000	KR
2.	(I-A-2) Provide technical advise to refuge	10,000	20,000	FAO
3.	(I-C-1) Aerial salmon surveys	6,000	26,000	FAO; KR
4.	(I-D-1) Salmon telemetry surveys	25,000	51,000	FAO; KR
5.	(I-D-2) Salmon habitat inventories	15,000	66,000	FAO; KR
6.	(I-E-1) Mined-stream inventories	40,000	106,000	FAO; KR
7.	(I-B-3) Monitor northern pike harvest	12,000	118,000	KR

Priority	Task	Funding	Cumulative total	Responsible office
	FY 1995 (continued)			
8.	(I-B-4) Monitor subsistence fish harvest	20,000	138,000	KR
9.	(I-B-7) Review proposals to Fishery Board	2,000	140,000	KR
10.	(I-F-2) Resident fish stream inventories	25,000	165,000	FAO
11.	(I-D-3) Electrophoretic salmon stock i.d.	20,000	185,000	FAO
12.	(I-G-1) Inconnu spawning investigations	10,000	195,000	FAO; KR
13.	(I-C-2) Salmon monitoring feasibility	10,000	205,000	FAO
14.	(I-H-1) Lake study	20,000	225,000	FAO; KR
	FY 1996			
1.	(I-A-1) Administer fishery program	10,000	10,000	KR
2.	(I-A-2) Provide technical advise to refuge	10,000	20,000	FAO
3.	(I-C-1) Aerial salmon surveys	6,000	26,000	FAO; KR
4.	(I-D-2) Salmon habitat inventories	15,000	41,000	FAO; KR
5.	(I-E-1) Mined-stream inventories	5,000	46,000	FAO; KR
6.	(I-B-3) Monitor northern pike harvest	12,000	58,000	KR
7.	(I-B-4) Monitor subsistence fish harvest	20,000	78,000	KR
8.	(I-B-7) Review proposals to Fishery Board	2,000	80,000	KR
9.	(I-F-2) Resident fish stream inventories	25,000	105,000	FAO
10.	(I-G-1) Inconnu spawning investigations	10,000	115,000	FAO; KR
11.	(I-C-2) Salmon monitoring feasibility	10,000	125,000	FAO
	FY 1997			
1.	(I-A-1) Administer fishery program	10,000	10,000	KR
2.	(I-A-2) Provide technical advise to refuge	10,000	20,000	FAO
3.	(I-C-1) Aerial salmon surveys	6,000	26,000	FAO; KR
4.	(I-D-2) Salmon habitat inventories	15,000	41,000	FAO; KR
5.	(I-B-3) Monitor northern pike harvest	12,000	53,000	KR
6.	(I-B-4) Monitor subsistence fish harvest	20,000	73,000	KR
7.	(I-B-7) Review proposals to Fishery Board	2,000	75,000	KR
8.	(I-F-2) Resident fish stream inventories	25,000	100,000	FAO
9.	(I-G-1) Inconnu spawning investigations	10,000	110,000	FAO; KR

PRIORITY OF TASKS (Department)

Priority	Task	Funding	Responsible office
1.	Regulate commercial, subsistence, and sport fisheries harvests including interaction with the Board of Fisheries on regulatory issues.	Continuing commitment	Commercial and Sport Fish Divisions
2.	Monitor commercial and subsistence salmon harvests.	Continuing commitment	Commercial and Subsistence Divisions
3.	Monitor sport fishery harvest	Continuing commitment	Sport Fish Division
4.	Subsistence resident fishery surveys.	Continuing commitment	Subsistence Division
5.	Conduct aerial surveys of salmon index streams.	Continuing commitment	Commercial Division
6.	Inventory anadromous and resident fish species on selected streams		Comm. Fish Sport Fish

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The books contain salmon migration streams and spawning areas.

Alaska Department of Fish and Game. 1984. Alaska commercial salmon catches, 1887-1983. Juneau, Alaska.

The book contains a listing of historical commercial catches by area and species.

Alt, K.T. 1973. Age and growth of inconnu *Stenodus leucichthys* in Alaska. Journal of the Fishery Research Board of Canada 30:425-459.

Growth of Kuskokwim, Kobuk, Selawik, lower Yukon, upper Yukon, and Minto Flats inconnu populations were examined.

Alt, K.T. 1975. A life history study of sheefish and whitefish in Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-5, Study R-11, Juneau, Alaska.

The study indicates two middle Yukon River inconnu populations. Lower Yukon River (Koyukuk River and middle Yukon River) inconnu are anadromous but there may be local sub-populations. The upper Yukon River inconnu (Porcupine River) are a resident population and exhibit a slower growth rate.

Alt, K.T. 1976. Age and growth of Alaskan broad whitefish *Coregonus nasus*. Transactions of the American Fishery Society 4:526-528.

This report provides age and growth data for 341 Alaska broad whitefish from several locations in interior and northern Alaska. Fish ranged from 23-64 cm fork length and were three to 13 years old. Broad whitefish from interior Alaska were approximately 12 cm longer by age seven than the northern fish. Length of the growing season is proposed as the main reason for the differences. Males reached sexual maturity between ages five and nine and females between ages five to ten.

Alt, K.T. 1979. Contributions to the life history of the humpback whitefish in Alaska. Transactions of the American Fishery Society 108:156-160.

Humpback whitefish are mainly distributed north of the Alaska Range and are found in lakes, streams, and brackish water. Feeding migrations into lake and slough areas occur soon after ice break-up, with out-migration occurring during freeze-up. Many spawning populations migrate upstream during summer and fall and spawn in upper reaches of rivers. Spawning generally occurs during late September and October over gravel stream bottoms. Fish studied reached 540 mm fork length at age 14 and maturity is usually reached between ages five and seven.

Alt, K.T. 1980. Life history study of sheefish in Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-13, Study R-11, volume 21, Juneau, Alaska.

This is a report of inconnu capture at the mouths of Anvik and Khotol rivers and throughout the first 100 miles of the Innoko River. These fish are identified as an anadromous population.

Alt, K.T. 1981. Life history study of sheefish in Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-13, Study R-11, volume 22:25-27, Juneau, Alaska.

This report presents a synthesis of inconnu population status and movements for the lower Yukon River, along with a discussion of anadromous and locally occurring populations in the Yukon, Koyukuk, Nowitna, Porcupine, and Tanana rivers.

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Arctic Environmental Information and Data Center. 1975. Anadromous fish inventory. Anchorage, Alaska.

The book contains information on escapement, commercial harvest, and subsistence use of anadromous fish for the National Wildlife refuges and other federal areas in Alaska.

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Bjerklie, D.M., and J.D. LaPerriere. 1984. Gold-mining effects on stream hydrology and water quality, Circle quadrangle, Alaska. Draft Report. Institute of Water Resources, University of Alaska, Fairbanks, Alaska.

The effects of placer mining on the hydrology and water quality of several interior Alaska streams were studied. It was found that placer mining increased turbidity, settleable solids, non-filtrable and filtrable residues, and total iron.

Buklis, L.S. 1982. Anvik River summer chum salmon stock biology. Alaska Department of Fish and Game, Division of Commercial Fish, Informational Leaflet 204, Anchorage, Alaska.

The paper contains sonar counts and aerial survey information for the Anvik River chum salmon. Total escapement records are available for 1971-1981, age and sex composition, and commercial and subsistence harvest. Recommended escapement for the river is set at 320,000-487,000. Returns for brood years 1972-1976 were 0.51-4.19 per spawner. Mean passage at the sonar site was July 7, 1979, July 11, 1980, and July 3, 1981.

Buklis, L.S., and L.H. Barton. 1984. Yukon River fall chum salmon biology and stock status. Alaska Department of Fish and Game, Division of Commercial Fish, Technical Report, Anchorage, Alaska.

The report presents a comprehensive review of information available on the life history, stock composition, exploitation, escapement, and stock status of Yukon River fall chum salmon.

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Appendix A. Master Memorandum of Understanding between the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

MASTER MEMORANDUM OF UNDERSTANDING
BETWEEN
THE ALASKA DEPARTMENT OF FISH AND GAME
Juneau, Alaska
AND
THE U.S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF INTERIOR
Anchorage, Alaska

The 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 a mandated 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 interests 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 do 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 species 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 of 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 onto Service lands at any time to conduct routine management activities which do not involve construction, disturbance of 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 of the State of Alaska which could diminish the jurisdiction 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

Department of Fish
and Game

Ronald O. Skoog
Commissioner

March 13, 1982

U.S. DEPARTMENT OF
THE INTERIOR
Fish and Wildlife Service

Keith M. Schreiner
Regional Director, Alaska

March 13, 1982

Appendix B. Alaska Department of Fish and Game commercial fishing regulations applicable on the Koyukuk Refuge and the Northern Unit of Innoko Refuge (through 1990).

Important commercial fishing regulations promulgated by the Alaska Board of Fisheries applicable to the Koyukuk Refuge and the Northern Unit of Innoko Refuge and adjacent portions of the Yukon River (district 4 of the Yukon management area) includes the following:

Freshwater Fishery

1. Whitefish, sheefish, char, trout, pike, burbot, and lamprey may be taken or purchased under authority of a permit secured from the commissioner of his local representative.

2. The permit may designate the time and area of fishing, type and amount of fishing gear that can be operated, and the species and number of fish that can be taken.

3. All fishing gear must be plainly and legibly marked with the operator's name and permanent vessel license plate number or the fishing permit number.

4. These species when taken incidentally in conjunction with commercial salmon fishing are legally taken and possessed without a permit.

Salmon Fishery

1. The fishing season opens by emergency order between June 10 and June 25, and closes after August 1.

2. During the fishing season salmon may be taken 4 days a week (6 p.m. Sunday to 6 p.m. Tuesday and 6 p.m. Wednesday to 6 p.m. Friday).

3. Salmon may be taken by set gill nets and fishwheels; no person may operate more than one fishwheel or more than one type of gear at any one time.

4. Salmon may only be taken with gill nets of six inch or smaller mesh after a date specified by emergency order issued between July 10 and July 31.

5. Gill nets may not obstruct more than one-half the width of any waterway.

6. Fishing gear cannot be operated closer than 200 feet to other commercial or subsistence fishing gear except that from Old Paradise Village upstream to a point four miles upstream from Anvik there is no minimum distance requirement between fishwheels.

7. Tributaries of the Yukon and Tanana rivers are closed to salmon fishing.

8. Fishing gear must be marked with the fisherman's name and five digit Commercial Fisheries Entry Commission permit serial number; for set gill nets this identification must be placed on a red keg, buoy, or cluster of floats attached to the outer end of the net.

9. No person may operate gear in the commercial taking of fishery resources without a valid entry permit or interim-use permit issued by the Commercial Fisheries Entry Commission.

10. Purchases or sales of raw fish must be recorded on Alaska Department of Fish and Game fish tickets which are submitted to local Department representatives at least once a week or as otherwise specified by the Department.

11. The season is closed by emergency order when the following guideline harvest levels have been attained:

    a) 2,250 - 2,850 king salmon in district 4 (from a marker 3/4 mil downstream from Old Paradise Village to Illinois Creek at Kallands).

    b) 113,000 - 338,000 summer chum salmon or the equivalent roe poundage of 61,000 to 183,000 pounds or some combination of fish and pounds of roe.

    c) 5,000 - 40,000 fall chum and coho salmon combined. Subdistrict 4A is closed.

Appendix C. Alaska Department of Fish and Game subsistence fishing regulations applicable on the Koyukuk Refuge and the Northern Unit of Innoko Refuge (through 1990).

Federal (Alaska Lands Act) and State (Alaska Statutes - Title 16) laws establish subsistence use as a priority use of Alaska's fish and game resources. Important subsistence fishing regulations promulgated by the Alaska Board of Fisheries applicable to the Koyukuk Refuge and Northern Unit of Innoko Refuge and adjacent portions of the Yukon River drainage (Koyukuk River and Yukon management area district 4) include the following:

1. There are no restrictions on the numbers of fish that can be taken for subsistence purposes.

2. Fish other than salmon may be taken at any time in any area by gill net, beach seine, fishwheel, fyke net, dip net, jigging gear, and spear.

3. Salmon may be taken in district 4 at any time unless the waters are closed to subsistence fishing, restricted by permit stipulations, or restricted by the commercial fishing season. Salmon may not be taken for 24 hours before the opening and 24 hours after the closure of the commercial fishing season and may be taken only during the open weekly fishing periods of the commercial salmon fishing season. There is no closed season on the Koyukuk River.

4. Salmon may be taken by gill net, beach seine, and fishwheel.

5. Fish may be taken without a subsistence fishing permit.

6. Fishing gear shall be plainly and legibly marked with the first initial, last name, and address of the operator.

7. 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.

8. Commercial fishermen may not take salmon for subsistence purposes during the commercial salmon season by gill nets larger than six inch mesh after a date specified by emergency order. Does not apply to the Koyukuk River.

9. Commercial fishermen may retain fish for their personal (subsistence) use from their lawfully taken commercial catch. Does not apply to the Koyukuk River.

10. All salmon caught by Commercial Fisheries Entry Commission permit holders during commercial periods in district 4 will be reported in numbers of fish tickets. Fish taken from commercial catches in district 4 and used for subsistence purposes are to be reported in the commercial catch. Does not apply to the Koyukuk River.

Appendix D. Alaska Department of Fish and Game sport fish regulations applicable on the Koyukuk Refuge and the Northern Unit of Innoko Refuge (through 1988).

Species	Year		
	1986	1987	1988
Chinook salmon	5/day; 5/possession no size limit	same as 1986 " "	3/day; 3/possession; 2 > 20 inches
Other salmon	10/day; 10/possession no size limit	" "	same as 1986
Grayling (char)	15/day; 30/possession (3/day; 6/possession) > 20 inches	" "	10/day; 10/possession for each species; no size limit
Sheefish	10/day; no possession limit; no size limit	" " " "	10/day; 10/possession no size limit
Northern pike	No bag or possession limit	" "	10/day; 10/possession
Burbot	No bag or possession limit	" "	15/day; 15/possession no size limit

CONCURRENCE AND APPROVAL

RECOMMEND APPROVAL:

Project Leader, Fairbanks Fishery Assistance Office — Date: 5/23/91

Supervisor, Fisheries Management Services — Date: 3/6/92

CONCUR:

Refuge Manager, Koyukuk Refuge — Date: 6/5/91

Associate Manager Refuges and Wildlife — Date: 3/7/91

PROGRAM APPROVALS:

Acting Assistant Regional Director, Fish and Wildlife Enhancement — Date: 3/03/92

Assistant Regional Director, Wildlife and Refuges — Date: 3/19/92

APPROVED:

Regional Director, Region 7 — Date: 12/17/92