Volume 24 Study G-I-P-B

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Bill Sheffield, Governor

Annual Performance Report for

INVENTORY AND CATALOGING OF SPORT FISH AND SPORT FISH WATER OF WESTERN ALASKA

by

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RESEARCH PROJECT COMPLETION REPORT

State: Alaska Name: Sport Fish Investigations of Alaska

Project No.: F-9-15

Study No.: G-I Study Title: INVENTORY AND CATALOGING

Job No.: G-I-P-B Job Title: Inventory and Cataloging of Sport Fish and Sport Fish Waters of Western Alaska

Cooperator: Kenneth T. Alt

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ABSTRACT

Results of a 2-year study to collect baseline data on fish and fisheries habitat of the Innoko River drainage are presented. The sheefish, Stenodus leucichthys (Güldenstadt), was the primary study species. The Innoko River is a lowland type river characterized throughout most of its drainage length by slow flow, considerable meandering, and presence of interconnected lakes and sloughs. Fish associations reflect river habitat and northern pike, Esox lucius (Linnaeus); humpback whitefish, Coregonus pidschian (Gmelin); broad whitefish, Coregonus nasus (Pallas) and least cisco, Coregonus sardinella (Valenciennes), are the most abundant species.

Sheefish in the Innoko River system are part of the lower Yukon River anadromous population and do not spawn in the Innoko. Tag recovery information, results of ground surveys and analysis of biological information provided supporting information. Feeding areas in the Innoko system are mainly in the lower 140 miles of the Innoko River and lower Iditarod River, with some fish reaching the mouth of the Dishna River in the Innoko drainage and the mouth of the Yetna River in the Iditarod drainage.

Northern pike are year-round residents and spawn throughout the drainage. Fish up to 118 centimeters and 12.5 kilograms (27.5 lbs) were captured.

Humpback and broad whitefish, least cisco and sheefish undertake feeding migrations into the Innoko system immediately after breakup and disperse throughout the system to feed. Least cisco and humpback whitefish migrate up the Innoko to spawn above Cripple Landing in early October, while broad

* "S" = 100% State funding.

whitefish spawn in the upper Iditarod River. Age and growth studies of whitefish, sheefish and pike indicate growth rates similar to those of the same species in other waters of the Yukon drainage. Chinook salmon (Oncorhynchus tshawytscha (Walbaum); chum salmon, Oncorhynchus keta (Walbaum); coho salmon, Oncorhynchus kisutch (Walbaum); Arctic grayling, Thymallus arcticus (Pallas); and round whitefish, Prosopium cylindraceum (Pallas), are present in smaller numbers.

Whitefish, sheefish and salmon are the most important subsistence fishes for local residents. The recreational harvest is light.

In 1982 sheefish fingerlings were stocked in Harding Lake near Fairbanks. Growth and survival of sheefish stocked in other waters in interior Alaska during past years were studied. Fish (ranging from 150 to 210 millimeters) in Gull Lake near Delta Junction were caught by sport anglers during 1981.

KEY WORDS

Innoko River, Iditarod River, sheefish, least cisco, humpback whitefish, broad whitefish, northern pike, stream surveys, tag-recapture data, fish movements, age and growth studies, fish spawning, food habits, sheefish stocking, artificial propagation.

BACKGROUND

The first year of the Innoko River study dealt primarily with sheefish (Alt, 1982). During the second year emphasis was changed to a collection of base line life history data on all species in the Innoko system with emphasis on humpback and broad whitefish, least cisco and pike. General stream survey work and search for sheefish spawning grounds were concentrated in the upper Innoko River (Iditarod River mouth to Ophir) in 1981. In 1982 emphasis switched to the upper Iditarod River. Early summer 1982 research was centered around Shageluk Eddy, with sheefish tagging and index site test netting as primary research jobs.

The Innoko River drains 10,900 square miles of country between the Kuskokwim River hills and the Yukon River and eventually flows into the Yukon River at lat. 62° 12' N, long. 159° 43' W. (Fig. 1). The main Innoko heads south of Cloudy Mt. at lat. 63° 09' N, long. 156° 02' and flows NE, then SW 500 miles to the Yukon River. Its main mouth is at Red Wing Slough 1.5 miles E of Holy Cross, but much of its water flows into Paimiut and Innoko Sloughs. A distributary of the Yukon, Shageluk Slough and its tributary Holikachuk Slough enter the Innoko from the Yukon at Holikachuk and at Shageluk Eddy. A distributary of the Innoko, Paimiut Slough, flows SW 70 miles to the Yukon River SW of Great Paimiut and 21 mi SW of Holy Cross at 61° 56' N, 160° 08' W. The name Innoko is probably an Ingalik Indian name recorded by a Russian explorer Zagoskin in 1842 as "Innoko." Zagoskin and the Russian colonial administration on the Yukon applied the name "Tlegon to the stream's upper course, "Innoko or Shiltonotno" to the middle course and "Chagelyuk or Ittege" to the lower Innoko River.

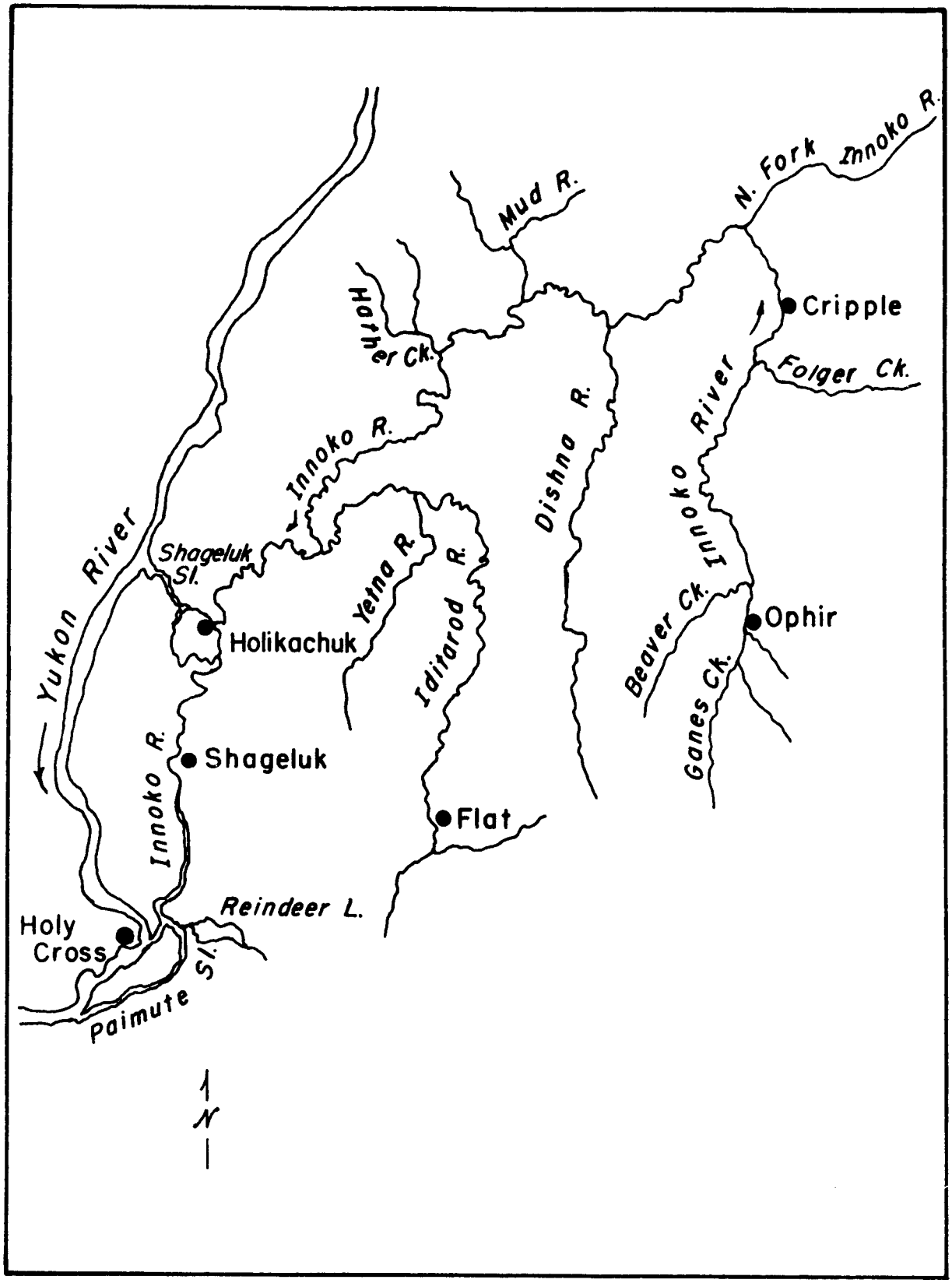

Figure 1. Innoko River study area.

All the early activity on the Innoko and Iditarod Rivers was related to gold mining. Except for cessation during the two world wars, mining has been carried on in headwater regions of the Innoko and Iditarod since 1910. During past years larger scale operations using dredges and heavy equipment have resulted in large amounts of silt entering the streams.

Table 1 lists common and scientific names and abbreviations of fish found in the study area.

RECOMMENDATIONS

Management

1. Monitoring of important sport fisheries in the study area should continue.

Research

1. Lake and stream surveys in waters between Ruby and Tanana should be completed with emphasis on location of sheefish spawning grounds.

2. Basic surveys of streams between McGrath and Sleetmute on the Kuskokwim River should be initiated, with emphasis on use by sheefish and pike.

3. Fish-Niukluk River survey work on the Seward Peninsula should be continued.

OBJECTIVES

1. To complete the physical inventory of the Innoko River System.

2. To determine movements, run timing and distribution of Arctic char, northern pike, sheefish and whitefish in the waters of the study area.

3. To collect basic life history information, including age and growth, spawning, and food habits from the Innoko River.

4. To continue evaluation of sheefish stocked in various interior Alaska waters.

TECHNIQUES

Innoko River surveys were conducted by riverboat from Fairbanks with supply points at Galena and Grayling. Airplane support was utilized to supply fuel in remote areas.

Fish were collected by gill net, seine and hook and line. Sampling was conducted in the main river systems as well as interconnected lakes and

Table 1. List of common names, scientific names, and abbreviations of fish found in study area.

Common Name	Scientific Name and Author	Abbreviation
Alaska blackfish	Dallia pectoralis Bean	BF
Arctic char	Salvelinus alpinus (Linnaeus)	AC
Arctic grayling	Thymallus arcticus (Pallas)	GR
Arctic lamprey	Lampetra japonica (Martens)	AL
Broad whitefish	Coregonus nasus (Pallas)	BWF
Burbot	Lota lota (Linnaeus)	BB
Chinook salmon	Oncorhynchus tshawytscha (Walbaum)	KS
Chum salmon	Oncorhynchus keta (Walbaum)	CS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Dolly Varden	Salvelinus malma (Walbaum)	DV
Humpback whitefish	Coregonus pidschian (Gmelin)	HWF
Inconnu (sheefish)	Stenodus leucichthys (Güldenstadt)	SF
Least cisco	Coregonus sardinella Valenciennes	LCI
Longnose sucker	Catostomus catostomus (Forster)	LNS
Ninespine stickleback	Pungitius pungitius (Linnaeus)	NP
Northern pike	Esox lucius Linnaeus	NP
Round whitefish	Prosopium cylindraceum (Pallas)	RWF
Slimy sculpin	Cottus cognatus Richardson	SSC
Sockeye salmon	Oncorhynchus nerka (Walbaum)	RS

sloughs. Scales were collected of all species for aging except that otoliths were used to age char and cleithrum bones were used for aging pike. The technique for collecting cleithrum bones and aging pike as well as the rationale for using this method has been described by Casselman (1980). The cleithrum bone was removed in the field, cleared of skin and meat and stored in a scale envelope. In the laboratory the bone was soaked and again cleaned. Annular rings were read using either low magnification of a dissecting scope or held up to the light and read without magnification. The bones were not stained. Char gill rakers and pyloric caecae were counted in the field. Sex and maturity of fish were determined through gross examination of the gonads. A designation as a consecutive spawner could often be made by observing egg retention and development of ova.

Sheefish were tagged with orange spaghetti tags. Rewards for returned tags were paid by the Division of Commercial Fisheries. Information on fish utilization and distribution, as well as insights into stream characteristics was obtained through conversation with residents of McGrath, Shageluk, Ruby, Holy Cross and Iditarod.

Egg takes and sheefish lake stocking were conducted in cooperation with the F.R.E.D. Division of the Alaska Department of Fish and Game. Samples for studying growth and survival were collected using gill nets and hook and line. Fyke nets were set in Gull Lake in July in an effort to conduct a Petersen population estimate.

FINDINGS

Innoko River Drainage Stream Surveys

The Innoko is mainly a lowland river characterized by large meanders, slow speed and abundance of lakes and interconnected sloughs, at least in the lower 150 miles. The current is very slow and gravel does not appear until 340 miles up the Innoko and 200 miles up the Iditarod. The stream in the lower reaches is 700-1000 feet wide and 20-50 feet deep.

An excellent description of the physiography, ecology and early history of the Innoko drainage is given by Stephenson (1979). During 1981 and 1982 research streams were muddy most of the summer. In 1981 Hunch Creek was extremely silty as late as October 2. Constant siltation has probably adversely affected round whitefish and grayling in the system. Boat navigation up the main Innoko River to Cripple Landing and up the Iditarod River to Iditarod was possible during summer.

For basic stream survey purposes the main stem Innoko was divided into six sections, the Iditarod into two sections, and minimal data are presented on seven tributary streams.

Innoko River

Section 1:

Section 1 extends from the mouth to Holikachuk, or approximately 90 miles. This section begins at the main mouth on Red Wing Slough. Additionally, a portion of Innoko water drains into the Yukon in this section via Innoko and Paimiut Sloughs. This section is characterized by wide, meandering loops of river with an abundance of sloughs and interconnected lakes. The Innoko is 650-1000 feet wide and 20-50 feet deep with a hole in Shageluk Eddy at Shageluk Rip measuring 72 ft deep. The stream is generally confined to a channel with high mud banks on the cut bank sides of the river. Bottom composition and river bars are soft mud. A few willows and grasses grow on the mud bars but streamside vegetation is thick throughout the section, especially near the mouth, with abundant birch, willow, alder, cottonwood and spruce. The river runs generally from north to south in this section. The water current is 1-2 mph and the water is stained and muddy from mining, as well as the addition of Yukon River water from Shageluk and Holikachuk Sloughs. A series of north-south hills are present along the east side of the river and at numerous locations the hills extend down to the river.

The only village of any consequence on the river, Shageluk, is located about 50 miles downstream of Holikachuk. Holikachuk was abandoned in the early 1960's and residents moved to Grayling on the Yukon River. The major lake on the Innoko, Reindeer Lake, is in the lower part of the section. Nets set at the mouth in late May took pike, humpback and broad whitefish and least cisco. This section of the river provides spawning habitat for pike and probably suckers, but is more important as a migration route for: chum, chinook and coho salmon; humpback and broad whitefish; least cisco; and sheefish. The main river serves as a feeding area for sheefish and pike, and sloughs and lakes off the main river are important feeding areas for three species of whitefish and pike. Other fish species captured in Section 1 include burbot, ninespine stickleback and suckers. Water temperature in the main river of Section 1 ranged from 6° to 14°C in late May and early June of 1981 and 1982 while 16° in late August 1981 and 12°C in late August 1982.

Section 2:

Section 2 comprises a 40-mile segment from Holikachuk upstream to the mouth of the Iditarod River. The river changes character immediately upstream of Holikachuk. The river is cleaner because of absence of Yukon River water, it is wider and slower, and current speed is 1 to 2 mph. The channel is less well defined and the river often spreads out into the willows. The river changes direction slightly and meanders generally northeast to southwest. Sloughs and lakes are abundant. In this section there are no hills on the east side of the river but a series of low hills parallel the river course on the west side of the river. Except for a few situations where these hills reach the river, bottom and shore composition is mud. Willows are dominant shore vegetation and in much of the section are the only vegetation present. Drainage is poor and most of the land is swampy.

Some trees are present on high elevations to the northwest of the river. Because of the slow-moving character of the Innoko, fish can feed in the main river as well as in lakes and sloughs.

This area is an important feeding area for whitefish, pike and, to a lesser extent, sheefish. Pike spawn in this section but most fish in this section are either feeding or moving further upstream to spawning areas. Dolly Varden char were captured in this section in August 1982.

Section 3:

Section 3 consists of a 160-mile segment of the Innoko from the Iditarod River mouth to Dishkakat. The Innoko becomes narrower and more confined to a channel. Current speed is slightly faster, approximately 2 mph, and the river is more shallow. The stream still meanders considerably. The drainage is poor and except for a few low isolated hills the habitat is mainly willow-dominated swamp, thus water entering the Innoko is stained. Again the bottom composition is mud and the first gravel appears at Dishkakat. The tributaries entering the Innoko in this section (Hammer, Grouch, Hather and Magitchlie Creeks and Mud River) are all slow moving streams with mud bottoms. Fish habitat is limited in this section as there are fewer lakes and sloughs than in lower sections. It contains pike spawning habitat and limited feeding habitat for whitefish. Whitefish captured in the vicinity of Hather Creek were on their upstream spawning migration and not feeding. Prespawning coho salmon were also captured here in early September. Water temperature on Sept. 1, 1981 was 15°C.

Section 4:

Section 4 from Dishkakat to the North Fork Innoko River is 120 miles. Current speed increases noticeably and, although considerable mud bars and mud bottom are present, bottoms of small gravel, sand and silt are more prevalent. The stream is generally confined to a single channel, with the cut bank generally covered by spruce, willow, alder and birch. The river still meanders considerably and the channel is generally 200 to 400 feet wide. Current speed is 2-3 mph. There are fewer sloughs and lakes present than in the lower river but a large number of small creeks enter the river from the northwest in the Wapoo Hills and from hills southeast of the stream. Major small streams are Finland, Wapoo, Tom, Horseshoe, Taft and Scandinavian Creeks. A major tributary, the Dishna River, enters the Innoko from the south about 20 miles upstream of Dishkakat. The smaller tributary streams all had low flow and appeared to provide little habitat for fish. No fish were captured at mouths of these streams. Section 4 appears to have few resident fish, except for pike. Most fish captured (whitefish and salmon) were migrating further upstream to spawn. Feeding sheefish were captured near the mouth of the Dishna River on the Innoko, but not further upstream. Water temperature September 3 was 11°C. The North Fork Innoko is another major tributary at the upper end of this section.

Section 5:

Section 5 is a 35-mile section from the North Fork Junction to Cripple Landing. The stream dramatically changes character above the North Fork.

The current is much more swift (up to 4 mph); the channel meanders less and in some of the faster areas is only 120 feet wide. The cut bank is usually mud, but gravel bars are present and bottom composition is generally small to medium-size gravel. This section has more eddies and probably provides more fish habitat than section 4. No grayling or round whitefish were captured here and it is suspected that they have been adversely affected by mining. Pike are resident here and they probably spawn in the vicinity. Prespawning least cisco, humpback whitefish and coho salmon were captured in this area and part of the upper reaches of Section 5 are probably used for whitefish spawning. Least cisco were observed spawning off the gravel runway at Cripple Landing on Oct. 5, 1981. Salmon probably spawn upstream of this area. At the North Fork the Innoko changes direction and runs from south to north. Water is quite shallow and Section 5 is generally above the zone of navigation during low water. During early September 1981 travel by propeller-driven outboard motorboat from North Fork to Cripple was extremely difficult. No tributary streams of any consequence enter the Innoko in Section 5. Water temperature below Cripple Landing was 9°C on Sept. 7, 1981.

Section 6:

Section 6 is the 80-mile stretch of upper river from Cripple Landing to Ophir. The stream is still 100-200 feet wide in the lower reaches of this section but becomes considerably smaller near Ophir, as many tributary streams enter in this section. The drainage valley becomes narrower and, beginning 8 miles above Cripple, hills parallel the river on both sides. Current speed in this section varies between 2-5 mph, being slowest in the meandering section below Ophir and swiftest below Beaver Creek and near Folger Creek. The stream is generally gravel bottom in this section and numerous gravel bars are present. Shore vegetation remains willow, alder, spruce, birch and cottonwood. The stream has some deep pools but the riffle areas are generally less than 2 feet deep by September and October. In 1981 upstream travel with propeller-driven craft was possible with great difficulty for only 7 miles above Cripple. The section from Ophir down to Cripple was floated by raft in late September and early October, 1981. Section 6 is used to a small extent for feeding by pike and grayling but is very important for spawning humpback whitefish, least cisco, and coho and chum salmon. Water temperature on Sept. 10, was 9° and on Oct. 5, 1981 was 0°C. Gravel size in the middle and upper parts of this section ranges from small gravel to cobble and boulder near Beaver Creek and Folger Creek. Gold mining occurs on a tributary of Hunch Creek. Other tributaries found in Section 6 include Dodge, Warner, American, Henry, Four Mile, Caribou, McLean and Creeks.

The part of the river above Ophir was not surveyed, but aerial flights indicate habitat similar to that below Ophir. The stream continues to meander beyond Ganes Creek, the major tributary of the upper river above Ophir. Local residents mention that king salmon, as well as some chum and coho salmon, spawn in this area. Other tributaries include Ophir, Gold-bottom, California, Yankee, Independence, Canadian and Roberts Creeks.

Major Tributaries of the Innoko River

Iditarod River:

The Iditarod River is over 350 miles long and enters the Innoko about 40 miles upstream of Holikachuk. The river generally flows from south to north. The entire drainage is tundra and low elevation spruce forest. The river meanders for its entire length. Total flow of the Iditarod is about 25% of that of the Innoko. The river was surveyed from the mouth to Dikeman (140 miles).

Section 1. The Iditarod comprises the lower 75 miles. The stream is 150-450 feet wide with water depth up to 30 feet. The Iditarod is slow-moving through this section, with current speed less than 2 miles per hour. Bank and bottom composition is mud. There is essentially no cut bank. The lower 40 miles of the river was one large lake in June of 1981. The extensive flooding is a common occurrence and no trees grow in the lower 35 miles. The lower half of this section contains an abundance of lakes and sloughs which provide excellent feeding habitat for broad and humpback whitefish, least cisco, pike and sheefish. Considerable pike spawning and rearing occurs. In mid-June 1981 water temperature in the lower Iditarod River was 17°C; in early September 1982 it was 14°C. In the upper part of Section 1, the river channel narrows, and fewer sloughs and a defined river channel are present. Willow is the dominant bank cover, but some birch and spruce is also present. Angling for pike in Section 1 was productive in June but not in September. The Yetna River comes in at the upper end of Section 1. Whitefish, sheefish and pike are present here, but no sheefish were found further upstream.

Section 2. This part of the Iditarod River consists of the section surveyed from Yetna River mouth to Dikeman, a distance of about 65 miles. The river has a single channel with high mud banks and heavy bank cover of willows, spruce and birch. The current is still slow, and the river has a mud bottom. Width is about 200 feet and depth is up to 25 feet. Sloughs are considerably less numerous here than further downstream and only a few small swamp-drained creeks enter the Iditarod. This part of the Iditarod is used mainly as a migration route for prespawning broad whitefish. A spawning run of least cisco, humpback whitefish and coho salmon, such as noted by Alt (1982), for the Innoko was not noted in the upper Iditarod.

Gravel is first found in the Iditarod River below Iditarod City. Local residents reported salmon, sheefish and grayling upstream of Iditarod City near Bonanza Creek. Based on test net results, the Iditarod River did not appear to support as much fish life as the Innoko River. Mining for gold continues in the area above Iditarod City near Flat, and contributes a heavy silt load.

Yetna River:

The Yetna River is the major tributary of the Iditarod and enters from the south. It is a lowland river with an abundance of lakes and sloughs. About 10 miles upstream, spruce and birch trees are found. The river is 100-200 feet wide and very slow-moving. Water is stained in color. Test

net results indicate that pike is the main species present, but feeding broad whitefish and least cisco were found in the lower 2 miles.

Hather Creek:

Hather Creek is a large Innoko tributary system draining about 520 sq miles of land to the south and east of the Kaiyuh Mountains. The system includes Minol, North Hather and Magitchlie Creeks. Only the lower 2 miles were surveyed and gill nets set here took only northern pike. Fish habitat looked poor and no sloughs were noted. Banks and stream bottom were mud. Flow was very slow and water was dark stained. The stream was 125 feet wide at the mouth. Water temperature on Sept. 1, 1981 was 15°C.

Mud River:

Mud River is a tributary system to the Innoko of about the same drainage size as Hather Creek. It drains the low, swampy area south of the Tlatl Hills and enters the Innoko about 20 miles upstream from Hather Creek. Major tributaries include the Little Mud, and Galatea Creek. The Mud River is similar to Hather Creek in that it is slow-moving, stained and has a mud bottom. Pike were taken at the mouth.

Dishna River:

Dishna River heads in the Kuskokwim Mountains and flows north for 60 miles before joining the Innoko River. It is slow at the mouth but gravel first appears about 2 miles upstream and current speed increases to over 2 mph. The stream is generally confined to a defined channel. Bank vegetation is thick and consists mainly of spruce, willow and birch. The stream is 250 feet wide at the mouth but soon narrows to 150 feet. No suitable locations for setting a gill net were found in the lower 4 miles of river but a net at the mouth took coho salmon and northern pike. Nets in the Innoko near the mouth of the Dishna took coho salmon, sheefish, pike and humpback and broad whitefish. Water temperature on Sept. 2 was 11°C. A major tributary, Tolstoi Creek, drains Tolstoi Lake in the Beaver Mts. This system has an excellent grayling population and also contains char. According to trappers, the run of fish in the Dishna is poor and consists mainly of chum salmon and pike.

North Fork Innoko River:

North Fork Innoko River enters the Innoko 35 miles downstream from Cripple Landing. It is a faster-flowing stream than Mud River and has sections of gravel and sand bottom in the lower 20 miles. The water is stained, reflecting the tundra type of drainage. The stream is 90-125 ft wide and generally confined to a single channel. Four net nights of fishing in the lower 20 miles on Sept. 8 took 2 humpback whitefish, 2 broad whitefish, 1 sockeye salmon and 10 pike. It appears that at least some whitefish spawn up the North Fork, although habitat observed did not appear suitable. The sockeye salmon was probably a stray from another system. Water temperature was 9°C on Sept. 8.

Folger Creek:

Folger Creek enters the Innoko about 22 miles upstream of Cripple Landing. It flows west from the Cripple Mountains and includes Dominion, South Fork and Butte Creeks. Folger Creek is the first mountain type stream encountered in the Innoko. Current speed at the mouth was over 4 mph, water was clear and bottom was composed of sand and gravel. No netting sites were found, but grayling were captured on hook and line. McGrath residents reported catching char in lower Folger Creek. Salmon may spawn in the stream but no carcasses were observed. Water temperature on Oct. 1, 1981 was 0°C.

Beaver Creek:

Beaver Creek heads in Beaver Mountain and flows north 40 miles before entering the Innoko River downstream of Ophir. The stream is mountain type with swift current and a gravel and rock bottom present to the mouth. The stream is 1-3 feet deep and 60-80 feet wide. It is an excellent spawning stream for chum and coho salmon, char and grayling. Chum salmon carcasses were observed in the lower ½ mile of Beaver Creek on Sept. 28. In 1 hour of angling eight grayling were captured. Water temperature on Sept. 28, 1981 was 1.5°C. Beaver Creek is used by recreational fishermen floating from Ophir to Cripple. Two small lakes are present at the head of Beaver Creek in Beaver Mountain but they were not surveyed.

Biological Data On Fishes of the Innoko Drainage

Eighteen species of freshwater fish are found in the Innoko River drainage (Table 1). These include: 4 salmon species; (chinook, chum, coho and sockeye; char (Dolly Varden); 4 whitefish species (humpback, broad and round whitefish and least cisco); sheefish; grayling; pike; sucker; burbot; lamprey; sculpin; stickleback; and blackfish. Sockeye salmon, round whitefish, stickleback, lamprey and blackfish were not found in large numbers. Fish are more abundant in the mainstem Innoko and its associated sloughs than in tributary rivers. Grayling are an exception and are found mainly in upstream mountain tributaries. The most important and most abundant species are the broad and humpback whitefish and least cisco. The sheefish and chum, chinook and coho salmon are locally important to Shageluk subsistence fishermen. Most of the abundant fish species in the Innoko, such as salmon, sheefish and whitefish, are highly migratory.

Sheefish

Population status:

Sheefish in the Innoko River system belong to the anadromous lower Yukon River population and do not constitute a local spawning population such as is found in the Nowitna, Tanana, upper Yukon and upper Porcupine Rivers. (See Alt, 1977b for summary of movements of lower Yukon River fish). This conclusion is based on: 1) absence of spawning fish in the fall season in the upper reaches of the Innoko and Iditarod Rivers, 2) analysis of tag recovery data, and 3)absence of sheefish fry moving down the Innoko River in June. Similarity of age and growth data between Innoko and Yukon fish and absence of fish under Age 5 provide supporting data.

In 1981, 60 sheefish were tagged in the lower 100 miles of the Innoko River, with the majority tagged at Shageluk Eddy 17 miles upstream of Shageluk. In 1982, 18 fish were tagged at Shageluk Eddy. To date only four of the 1981 tagged fish have been recovered. One was recovered at Shageluk Eddy in June of 1982, one was recovered at Kotlik at the mouth of the Yukon River in November 1981, one was recovered 18 miles below Ruby on August 26, 1981 and the fourth fish was recovered on July 10, 1982 at Kaltag (Fig. 2). The recovery of the tag at Kotlik indicates that the lower Yukon River is the overwintering area of Innoko River fish, and the two recoveries in the middle Yukon River, on the upstream spawning migration route of the anadromous lower Yukon population, confirms that Innoko River fish belong to that population. To date no 1982 tags have been recovered. Future recoveries should add supporting data.

Distribution:

Sheefish in the Innoko River drainage are limited to the mainstem Innoko and Iditarod Rivers (Table 2). In 1981 extensive netting was conducted in small lakes and sloughs of the Innoko below Holikachuk, including Reindeer Lake, but no sheefish were captured. In 1982 shallow lakes that had been dry in 1981 were netted and no sheefish were captured. Apparently most of the smaller tributary streams, e.g. Grouch, Mud, Hather, Folger and Beaver Creeks, do not contain sheefish. They were captured at the mouth of the Dishna River but no nets were set further up this major tributary. Residents of McGrath familiar with the Dishna had no knowledge of sheefish in this stream. Sheefish probably do not utilize either the North Fork Innoko River or the Yetna River (Iditarod system), as none were taken during test netting in the lower reaches of these two tributaries.

Sheefish were not captured further upstream in the Innoko River than the mouth of the Dishna River. During extensive test netting from Sept. 3 to Oct. 1, 1981 large catches of coho salmon, pike, least cisco and humpback whitefish were made but no sheefish were taken. Areas that had apparently suitable spawning habitat were found upstream and downstream of Folger Creek mouth. Trappers reported capturing sheefish in previous years in the first pool area above Cripple Landing and at the mouth of the North Fork Innoko in October by net and near the mouth of Folger Creek in late September on hook and line. A guide operating a lodge at Cripple Landing featured sheefish fishing, along with pike and grayling. Thus it would appear that, at least in some years, sheefish are distributed in the main Innoko up to the mouth of Folger Creek. It is not known if increased mining activity in recent years might have caused sheefish to cease their migration to this upper area. People who had knowledge of sheefish presence in the upper Innoko could not positively identify the fish as spawners; thus, fish reported may have been nonspawners. In the Iditarod in September 1982 sheefish were taken upstream only as far as the mouth of the Yetna River. Only two sheefish were captured in 11 net nights of fishing in the upper Iditarod (Table 2) and both were nonconsecutive spawners or immature fish. Miners and trappers had reported catching small numbers of sheefish in the upper Iditarod River in fall near the confluence of Otter and Bonanza Creeks.

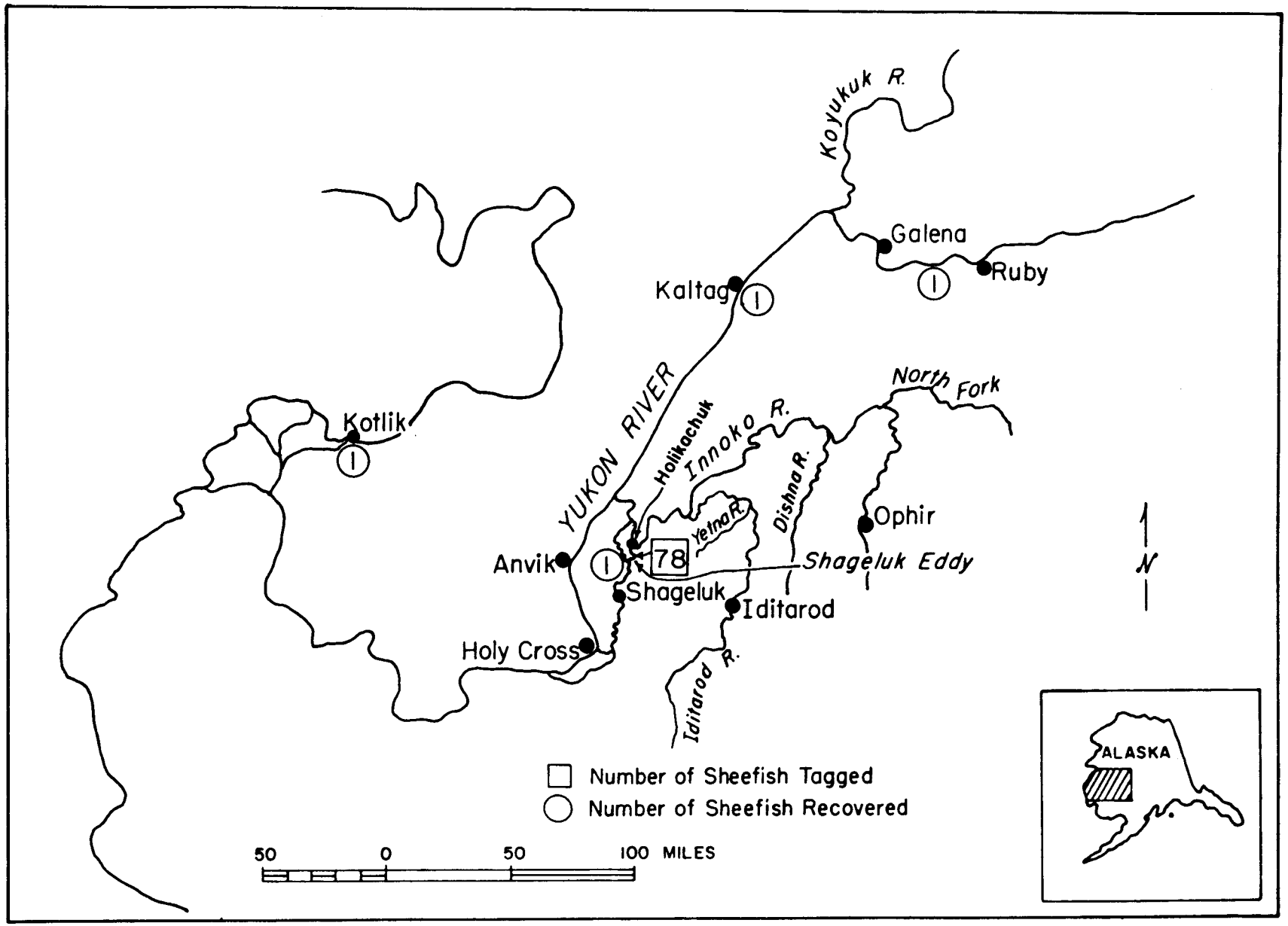

Figure 2. Sheefish tagging and recovery areas, Yukon River drainage.

Table 2. Test net results - Innoko River system, 1982.

Location	Date	Net Nights	Species Captured					
			SF	HWF	BWF	LCI	NP	Others
Shageluk Eddy	June 4-7	5	17	33	135	90	11	
Shageluk Eddy Lake	June 6			4	10	1	8	
Shageluk Eddy	June 14-16	4	12	6	34	27	14	
Shageluk Slough	June 15	1		4	6	50	4	
Pike Slough Mouth	June 15	1		4	4	11	2	
Iditarod River Mouth	June 16	3	1	5	12	50	6	
Mouth Holikachuk Slough	Aug. 28	2					11	1 sucker
Yetna River Mouth	Aug. 28	5	2		24		20	
Mile 102 Iditarod River	Aug. 31	3		1	10		5	
Lower Yetna River	Sept. 1	2			6	2	9	
Iditarod River Mouth	Sept. 2	1	1		2		6	

General Movements:

Summer movements. In 1981 sheefish were already present at the mouth of Holikachuk Slough and Shageluk Eddy by May 23. Breakup had occurred 2 weeks previously and residents of Shageluk, 17 miles downstream from Shageluk Eddy, had caught a few sheefish immediately after breakup. This indicates that at least some sheefish are either overwintering in the lower Innoko or enter the lower river under the ice. The latter is more probable, since one of the sheefish tagged at Shageluk Eddy was recovered on November 3 at Kotlik, at the mouth of the Yukon River. Gill net catches at Shageluk Eddy in late May averaged 1.7 sheefish per night, while nets set in the lower Innoko River, Red Wing, Paimiut and Reindeer Sloughs took only 0.7 sheefish per net night. In 1981 we failed to intercept the major part of the run. Shageluk residents said that the sheefish run was 3 to 4 weeks later than the whitefish run. In 1981 greatest abundance of sheefish was correlated with downstream migration of chum salmon fry in late May. In 1982 sheefish did not appear as abundant at Shageluk Eddy as in 1981 because none were caught on hook and line, while in 1981 over 50 were captured on hook and line. Gill net catches in early and late June, however, were higher in 1982, with an average of 3.2 sheefish per net night. In 1982, sheefish were present in low numbers in other areas of the Innoko River drainage in both June, August and September. Extreme high water in June 1982 probably affected sheefish summer movements.

In 1979, during a short reconnaissance trip in late June, large numbers of sheefish were observed feeding on young-of-the-year whitefish (least cisco, humpback and broad whitefish) in the lower 90 miles of the Innoko River. In 1981 the downstream migration of young whitefish was occurring in mid-June, and in mid-June 1982 only a few least cisco young were observed moving downstream.

Feeding fish migrate up the Innoko at least as far as the mouth of the Dishna River and possibly up to Folger Creek. In the Iditarod River they migrate as far as the mouth of the Yetna and probably beyond. It is felt that in most years the majority of feeding occurs in the Innoko River from the mouth of Red Wing Slough up to the mouth of the Iditarod River and in the lower Iditarod River, a total river distance of 130 miles. Feeding areas are scattered, but Shageluk Eddy, the lower Innoko, and the mouths of Holikachuk, Reindeer and Paimiut Sloughs, as well as the bluff 8 miles upstream of Shageluk, are favorite feeding areas.

Spawning Movements. Prespawning sheefish were captured at the mouth of Holikachuk Slough and at Shageluk Eddy on May 24, 1981 and June 5 in 1982. They are mixed with nonspawning fish. Of 31 fish examined in 1981, 16 of 20 males and one of 10 females were prespawners. In 1982, of 16 fish examined, seven of nine males and one of seven females were prespawners. In 1979, of 22 sheefish sampled, 17 of 18 males and three of four females were prespawners. The large preponderance of males over females on the Innoko feeding grounds (69% males 31% females) could be because more of the prespawning females continue directly up the Yukon River rather than entering the Innoko.

Since sheefish do not spawn in the Innoko River system, spawners must leave the summer feeding areas in July and August. This is confirmed by recovery

of two Innoko-tagged sheefish in the Yukon River, one at Kaltag on July 10 and one below Ruby on August 26. Once these fish reach the Yukon River they become part of the upstream spawning migration of the anadromous lower Yukon population. These fish then migrate either up the Koyukuk River to spawn above Hughes or continue up the Yukon River to spawn upstream of Rampart in October (Alt, 1977b). After spawning they migrate to the lower Yukon River for overwintering.

In August and September sampling in the Innoko in 1981 and 1982, only one out of 10 sheefish captured was a prespawner, indicating most prespawning fish had already left.

Age and Growth:

A total of 147 fish, including 24 from 1979, 91 from 1981 and 32 from 1982 were aged. The 1979 sample was captured mainly by hook and line and selected for smallest and largest fish. The 1981 sample was captured both by hook and line and gill net and all fish captured were aged. In 1982 all fish were captured by gill net. Generally gill-net captured fish have a larger average size than hook-and-line caught fish. Fish captured ranged in length from 551 to 915 mm and in weight from 1.7 to 9.1 kg (Table 3). Fish were five to twelve years old, with the majority being Age VII to IX. Age distribution represented in Table 3 is probably quite representative of the size and age of feeding sheefish present in the Innoko River. Size of fish captured in the 3 years of sampling varied with time and location. In late June 1979, fish captured at Shageluk Eddy were larger then fish caught in June of 1981 and 1982. Fish captured in May 1981 in Shageluk Eddy were larger than fish captured in June 1981. Fish captured both in the lower Innoko and in the upper reaches (Iditarod mouth to Dishna River and upper Iditarod River) were generally larger than fish caught at Shageluk Eddy. Many of the upstream fish were nonconsecutive spawners.

Growth of Innoko River fish is similar to or slightly faster than growth reported for fish of the anadromous lower Yukon River population (Alt 1973, 1974). Data presented in the two previous references were back calculated only to annulus formation, while data presented in Table 3 are calculated at capture. Data from both would be similar if computed in the same manner. Largest specimens of the anadromous lower Yukon River population include an Age XIV, 101-cm female from the lower Yukon River and an Age XV, 104 cm female from the Koyukuk River spawning grounds. The heaviest fish taken from the Innoko was 9.1 kg, while the 104-cm Koyukuk fish weighed 15 kg.

Age At Maturity:

Innoko River fish showed considerable variation in age at maturity. All females and all but one male of Age IV examined were immature. All females and three of six males of Age VI were immature. All three females and one of 10 males of Age VII were immature. At Age VIII all males (10) were mature, as were two of three females. All Age IX fish were mature. This closely follows data of Alt (1973), except that the Age IV male is the youngest age of maturity yet recorded for lower Yukon River fish.

Table 3. Age, length and age-weight relationship for 147 sheefish from Innoko River system in Alaska. Fork length given in mm at capture, weight given in kg. Length data also included from Alt (1980), weight data includes only 1981 and 1982 fish.

		Age at Capture							
		V	VI	VII	VIII	IX	X	XI	XII
Length mm	$\bar{x}$	585	594	660	707	752	800	848	882
	n	8	23	30	46	28	9	2	1
	Range	551-695	520-645	575-725	645-800	675-826	741-844	780-915	882
Weight kg	$\bar{x}$	1.74	2.10	2.82	3.74	4.37	5.82	9.09	
	n	4	5	11	13	6	5	1	
	Range	1.7-1.8	2.0-2.2	2.4-3.4	2.9-4.9	3.8-5.6	4.1-7.0	9.1	

Food Habits:

Whitefish, pike and salmon are the most important food items of Innoko River sheefish. Food habits of Innoko River sheefish vary according to time of the year and prey species available. In late June 1979 nearly all fish captured were feeding on downstream migrating young-of-the-year least cisco, broad whitefish and humpback whitefish. A few were feeding on young-of-the-year pike entering the Innoko from a slough.

In late May 1981, downstream migrant chum salmon fry, and to a lesser extent coho and chinook salmon smolts, were the most important food items. In June 1981, whitefish fry were important food items, with a few suckers, pike and lampreys also found in sheefish stomachs. In 1982, with the extreme high water of June, as well as a smaller downstream migration of whitefish fry, the few sheefish present near Shageluk Eddy had mainly empty stomachs.

In 1981 and 1982, sheefish captured later in the fall in the middle and upper reaches of the Innoko and Iditarod Rivers were feeding on yearling broad whitefish, small pike, suckers, caddis flies and ninespine stickleback.

Utilization:

The major utilization of Innoko River sheefish is for subsistence. Major effort is on the overwintering population in the lower Yukon River, but there is also light to moderate fishing pressure at Shageluk in the Innoko River, as well as from numerous villages and fish camps along their entire spawning migration route up the Koyukuk and Yukon Rivers. The longest migration recorded for fish of this population is 1,001 miles (1,600 km) and many of the fish probably travel over 800 miles. A few are taken in small commercial fisheries operating in the lower Yukon River. The sport harvest is light. There is a limited harvest near Shageluk, in the upper Innoko, in the upper Koyukuk and lower Alatna, and at clear water tributaries all along the spawning migration route.

Grayling

Grayling have a very limited distribution in the Innoko River system. They would not normally be expected to be present in the slower-moving waters of the lower Innoko and Iditarod systems. However, during all of our test netting and angling in waters of apparently suitable grayling habitat further upstream, few were taken. A gravel bottom and a current of over 2 mph first appeared in the area of of Rennies Landing (downstream of the North Fork). The main section of the Innoko River from Rennies Landing upstream to Ophir contained apparently suitable habitat--this is especially true of the area from the North Fork to Ophir. Approximately 12 net nights of test netting took two grayling. An additional 6 hours of hook and line fishing from Ophir to the North Fork took eight grayling (nearly all in lower Beaver Creek). The largest concentration of grayling observed was in Beaver Creek and in the Innoko River immediately downstream of Beaver Creek. The Folger Creek-Innoko River confluence also had fair numbers of grayling, although few were caught on hook and line.

It is probable that the many years of mining on the Innoko River have had a detrimental effect on the grayling in the main river. The habitat in the Innoko River from Rennies Landing up to Ophir should have supported grayling, but apparently they have been displaced into unmined tributary streams of the Innoko and only migrate down into the main Innoko in the fall or at the cessation of mining. Overwintering probably occurs in the main Innoko, with the fish migrating up into tributary streams for spawning. Test netting and hook and line fishing on the main Innoko from late May to early September took only two grayling in the Innoko. None were taken in the Iditarod River, but no test netting was conducted above Dikeman where a gravel bottom is first present.

Grayling captured ranged from 191 to 343 mm FL and 100 to 400 g (Table 4). Fish ranged in age from II to IX, with 5 and 6-year-old fish being most abundant.

Growth of Innoko River grayling is similar to growth of grayling from the Anvik River, Yukon River system (Alt, 1980) and the Goodpaster River, Tanana system (Tack, 1974), but only through Age V. After Age V growth of Innoko River fish is much slower than in other Yukon River streams and also slower than in Kuskokwim River streams (Alt, 1977a). The largest of 25 grayling sampled from the Innoko River was only 345 mm FL while grayling over 400 mm are common from other Alaskan streams.

All fish Age III and over were mature, including a 222 mm female. This is considerably smaller size and younger age at maturity than for other grayling in Alaska. Generally 275 mm, Age IV or V, is considered the average age at maturity in Alaska. No reason can be advanced for the earlier age and smaller size at maturity of Innoko River fish.

Grayling had fed mainly on insects, especially diptera larvae, but also adult water bugs (Order Hemiptera). Grayling captured the first 2 days of October at the Folger Creek-Innoko confluence, and in the Innoko River 5 miles above Cripple, had also eaten whitefish eggs. Both least cisco and humpback whitefish were actively spawning at those locations.

Grayling support a small sport fishery at Ophir and the mouth of Folger Creek. Anglers also fish for grayling in the upper Iditarod system near Flat. Excellent grayling fishing is available in Tolstoi Lake, located in the Beaver Mountains at the head of the Dishna River.

Least Cisco

Least cisco are migratory and possibly anadromous in the Innoko River system. Young-of-the-year cisco were observed passing downstream in the Innoko past Shageluk Eddy on June 11, 1981 and past the mouth of the Innoko River into the Yukon River on June 24, 1979. In 1981, very few least cisco fry were detected during an earlier trip from May 21 to 31, although chum salmon fry were migrating downstream heavily. In 1982 some least cisco fry were noted, but water levels were very high and it was difficult to determine amount of movement.

The upstream movement of least cisco into the Innoko River probably begins soon after ice out. Ciscos were taken in gill nets at Shageluk Eddy

Table 4. Age-length relationship for Arctic grayling from Innoko River drainage. Fork length in mm.

		Age at Capture							
		II	III	IV	V	VI	VII	VIII	IX
Length mm									
	$\bar{x}$	191	235	241	293	299	305	308	327
	n	2	3	1	7	6	2	2	2
	range	191	222-260	241	241-333	275-343	345	305-311	311-343
Weight g									
	$\bar{x}$		125		264	268	238	250	325
	n		3		6	6	2	2	2
	range		100-175		210-350	150-400	225-250	250	250-400

(90 miles upstream from mouth) on May 24th, the first day nets were set. Ciscos had probably been migrating upstream long before that date. An indication of the strength of the upstream migration of cisco in early summer is the daily catch in index nets set at Shageluk Eddy in 1981. On May 24, at probably the peak of the upstream movement, 53 least ciscos were taken per day, while only one was taken on June 14. On June 16 a net in the lower Iditarod River took only two least ciscos. In 1982 breakup was 2 weeks later and water conditions 10 feet higher than in 1981. The least cisco migration was evidently peaking during our first night of netting at the Shageluk Eddy index site on June 4, and 90 least ciscos were taken in 1 night. On June 13 the net took 27 least ciscos, indicating ciscos were still migrating upstream. A net at the lower Iditarod River contained 35 least ciscos. Least ciscos move into lakes and sloughs to feed all along their migration route. Test net results indicate the presence of least cisco in the lakes and sloughs, the main Iditarod River and the main Innoko above Holikachuk, where water speed is slow and food is available. The feeding migration is composed of mainly mature fish, but immature fish of Ages I and II also are present.

Spawning Movements:

After feeding for varying parts of the summer, least cisco prespawners leave feeding areas and continue up the Innoko toward spawning areas. They were encountered in the lower Iditarod River in late August, but it is not known if they would spawn in the Iditarod or Innoko River. Least cisco were not again encountered until early September above the North Fork on the main Innoko. None were taken in the North Fork. Prespawning least cisco were abundant in the Innoko from the area upstream of the North Fork to below Beaver Creek. It appeared that least cisco captured below Cripple Landing in the Innoko were still migrating up to spawning grounds. None were captured near the mouth of Beaver Creek in 1981 or in the middle and upper Iditarod River in September 1982. Two were captured in the Yetna River. One of the two would spawn the current year and it is not known if it would migrate up the Yetna or further up the Iditarod to spawn. No information is available on postspawning movements. The fish evidently move down to the Yukon River some time after spawning.

Spawning:

Least cisco are fall spawners and the main spawning grounds are located in the main Innoko River from Cripple Landing to 10 miles below Beaver Creek. A large spawning aggregation was observed in the area 15 miles below Beaver Creek on Sept. 29, 1981. They were actively spawning at 1 pm. Water temperature was 0.8°C. There was a moderate current, and bottom was composed mainly of small gravel. Water depth was 2 to 5 feet.

Ripe least cisco were caught in the Innoko River near the mouth of Folger Creek on Oct. 1, 1981. Water temperature was 0°C. Grayling were found to be feeding on whitefish eggs. Current speed in probable spawning areas was 4 to 5 mph and water depth 3 to 7 feet. Large numbers of least cisco were actively spawning in the Innoko 5 miles upstream of Cripple on Oct. 2. Water temperature was 0.8°C. This spawning ground was different from those observed further upstream. It was a very deep hole located in a bend of the river, with main current sweeping to the outside of the bend and a

large eddy with slow water on the inside of the bend. Fish were already spawning at 6:20 p.m. when we arrived and spawning continued at a steady rate until 8:30 p.m.. One spawning ascent (one pair of fish breaking the surface of the water) occurred approximately every minute during this busy period. Spawning activity is similar to that observed in the Chatanika River. The fish pair near the bottom of the water column then ascend to the surface, expelling eggs and milt as they do so. As they break the surface of the water they fall backward and proceed to the bottom prior to another spawning ascent. Most spawning took place in the deepest, swiftest water. Thus spawning occurred in water of 4 to 16 feet and in water velocity of 2 to 4 mph. The water was still slightly turbid from mining but had cleared considerably from Sept. 10. The swift current had swept the bottom gravel clear of silt, although eggs lodging in the slower, shallower water probably become covered with silt. Bottom composition in the area where most spawning occurred was mainly small and medium-size gravel.

Movement Of Young:

Young-of-the-year least cisco undertake a slow downstream migration to rearing areas, probably in the lower Yukon River. Least cisco fry were present on June 14, 1982 and were actively migrating down past Shageluk Eddy through June 21.

Age and Growth:

Least cisco from the Innoko River system are treated as one population, although it is possible that there may be two separate spawning areas. Fish sampled ranged in length from 116 to 406 mm, with the majority between 240 and 350 mm FL (Table 5). Weight ranged from 116 to 1,100 g, with females appearing to be slightly heavier than males. Cisco ages ranged from I to IX, with most Ages IV and V. Based on gill net captures the fish of Ages IV to VI are the most common in the population. In 2 years of sampling only one fish over 400 mm FL was captured, and only four fish from 380-400 mm were taken. Most of the large fish were taken in the vicinity of spawning grounds.

Least cisco grow rapidly for the first 3 years of life, with some individuals reaching 300 mm FL in their fourth year of life (Age III). Fish also showed a slower rate of growth in weight after Age III although there was a large increase noted for Age VI fish. This is an artifact caused by inclusion of the largest fish captured during the study (1,100 g).

Growth of Innoko River least cisco is faster than growth of least cisco from nearly all other waters of Alaska, especially through Age III (Alt 1977c, 1979, 1980). Only Chatanika River (Tanana drainage) and Aniak River (Kuskokwim River) fish are larger at Age VIII than Innoko fish. Maximum age of least cisco in Alaska is 12 years, but only three slow growing populations in Alaska (Harding Lake, Prudhoe Bay and Imuruk Basin) contained fish over Age IX.

All least cisco of Age III and two of six Age II fish were mature. The two Age II mature fish were 214 and 224 mm FL. Females were not mature until

Table 5. Age-length relationship for least cisco from Innoko River drainage, 1981-1982. Fork length in mm. Fish included 37 males, 22 females and 18 immature.

		Age								
		I	II	III	IV	V	VI	VII	VIII	IX
Length mm	$\bar{x}$	127	207	273	284	308	352	365	389	384
	n	11	7	9	26	12	4	4	3	1
	range	116-140	136-227	233-304	248-333	260-356	291-379	350-389	380-406	384
Weight g	$\bar{x}$		142	248	271	328	635	616	832	720
	n		5	8	26	12	4	4	3	1
	range		116-175	175-350	125-375	175-525	250-1100	440-800	720-1000	720

Age III and the smallest mature female found was 249 mm FL. The Chatanika River is the only other system where Age II mature ciscos were found (Alt, 1969).

Innoko River least cisco had empty stomachs while on the spring upstream migration. Those captured in feeding lakes and sloughs contained insects and cladocerans. All fish taken in September and October during the spawning migration and on the spawning grounds had empty stomachs.

Humpback Whitefish

Movements:

Humpback whitefish are one of the most abundant species of whitefish in the Innoko system. Their spring upstream migration is similar to that of least cisco, and large numbers were migrating past Shageluk Eddy on May 25, 1981. According to local Shageluk subsistence fishermen, the peak of the run had passed through on May 20. Although more broad whitefish than humpback whitefish were caught by subsistence fishermen, and by our index net at Shageluk Eddy, subsequent netting in summer feeding areas captured more humpback whitefish than broad whitefish. The upstream migration had almost completely passed upstream of Shageluk Eddy by June 19, as only one fish was captured at the index net site. In late May they were present in lake and slough areas of the Innoko River below Shageluk Eddy in the lower 90 miles of the river. Humpback whitefish were observed feeding in the slow-moving water of the main Innoko River from Holikuchuk Slough up to the Iditarod River and in the lower few miles of the Iditarod River in mid June. Gill net catches were especially high in the lower Iditarod River, its lakes and sloughs.

After feeding during the summer, prespawning humpback whitefish continue up the Innoko River to the spawning grounds. In 1981 they had already left the lower Iditarod, as none were captured at the mouth of the Iditarod or 2 mi upstream on August 30. They were taken in gill nets set in the Innoko River near the mouth of the Dishna River and below the mouth of the North Fork and two were taken in nets set in the North Fork of the Innoko. In early September prespawning fish were abundant between the North Fork and 5 miles above Cripple. During the late September-early October trip they were taken only between Fogler Creek and Cripple. Movement downstream to overwintering areas takes place in October and November. A trapper had reported catching some in early November at the mouth of North Fork.

Spawning:

Spawning occurs in the main Innoko River at least from Cripple up to Folger Creek. Spent and ripe humpback whitefish were taken near the mouth of Folger Creek on October 1, thus the spawning period is probably late September and early October. Water temperature was near 0°C and shore ice was forming. Current speed was 3 to 4 mph in probable spawning areas. The bottom composition was small and medium size gravel. Humpback whitefish spawning was observed in the early evening of October 1, in the main Innoko River, 5 miles upstream of Cripple. Most of the fish spawning in this area were least cisco. Water depth was 5 to 10 ft, current speed 2 to 3 mph and bottom composition was small and medium-size gravel.

Few humpback whitefish are present in the North Fork Innoko River but they probably spawn there. Only two prespawning fish were taken in 4 net nights of fishing up the North Fork. Only one humpback whitefish was captured in the upper Iditarod River in late August 1982. The fish was a nonconsecutive spawning female taken in a small lake off the Iditarod River 134 miles upstream. None were taken in the Yetna River. The conclusion is that humpback whitefish and least cisco spawn in the upper Innoko River and broad whitefish spawn in the upper Iditarod River. This is similar to the situation found in the Nowitna River where broad whitefish spawn in the upper Nowitna and least cisco and humpback whitefish spawn up the Sulukna River. The Chatanika River (Tanana system) and Big River (Kuskokwim system) also have least cisco and humpback whitefish as well as sheefish spawning together, with broad whitefish being absent (Alt, 1980).

Age and Growth:

Fish captured ranged in length from 333 to 520 mm FL and in weight from 425 to 2,200 g (Table 6). Fish were Age IV through XIV, with the majority Age I to XI. This grouping probably represents the dominant age structure of the spawning population. Most of the larger fish are males, although the two oldest fish (477 and 485 mm) were females. Growth is quite rapid the first 7 years of life, but slows considerably after that. There is considerable variation among fish in length at various ages. This difference often amounted to over 100 mm per year. The largest fish caught (520 mm) was only 8 years old while one fish at 437 mm FL was 11 years old.

Innoko River humpback whitefish grow faster than all other humpback whitefish populations in Alaska, especially through Age VII (Alt, 1979). Fish from other Yukon River streams (i.e. Chatanika, Ray, Nowitna Rivers, lower Yukon anadromous) have reached larger sizes by Age XI. No fish over Age XII have been found in rivers in Alaska. The heaviest fish captured in the Innoko at 2.2 kg (5.5 lbs) is smaller than fish caught by the author in Selawik Lake (9 lbs) or the Chatanika River (7.5 lbs).

With the exception of two males, all humpback whitefish captured in the Innoko system were mature. Of the eight fish captured that were under Age VII, only one was female (Age V, 445 mm). Thus, age at maturity is probably Age IV to V for males and V to VII for females, similar to that reported for other Alaska populations (Alt, 1979). In late May, many females were found with retained eggs from the previous fall's spawning. They appeared to be nonconsecutive spawners. Examination of gonads in mid June, however, indicated that these females were developing rapidly and would probably spawn again the current fall. All fish examined upstream of the North Fork were potential spawners. Therefore, consecutive spawning is the rule.

Food Habits:

Stomachs of whitefish migrating up the Innoko River in May were empty. All humpback whitefish captured near the spawning grounds from below North Fork to above Cripple in September and October also had empty stomachs. Thus, the feeding period for these fish lasts about 3 months in the summer and possibly during the winter. Of 25 stomachs containing food, caddis flies were the most commonly observed food item, followed by snails. Fifteen of

Table 6. Age-length and age-weight relationship for humpback whitefish from Innoko River drainage 1981-1982. Fork length in mm, weight in grams. Total sample = 58 fish.

		Age at Capture										
		IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Length mm	$\bar{x}$	344	364	388	430	432	465	479	463	490	501	481
	n	1	4	3	8	11	7	8	8	3	3	2
	range	344	333-445	340-455	370-495	375-520	435-511	446-517	437-480	475-501	497-502	485
Weight g	$\bar{x}$	550	706	817	1,112	1,082	1,126	1,428	1,359	1,500	1,567	1,400
	n	1	4	3	8	11	7	8	8	3	3	2
	range	550	425-1,250	550-1,250	575-1,700	700-2,000	1,000-1,250	700-2,200	750-850	1,300-1,950	1,250-1,750	1,300-1,500

the stomachs contained caddis flies, 12 contained snails, 4 contained beetles, 4 had clams, 3 had diptera larvae, 3 had cladocerans and 1 had copepods.

During June humpback whitefish were feeding heavily in the shallow lakes and sloughs of the lower Iditarod River, as well as in the Iditarod River.

Broad Whitefish

Broad whitefish are very abundant in the Innoko River system. Their upstream early summer migration corresponds closely to that of humpback whitefish and least cisco. Wintering areas are probably in the lower Innoko or the Yukon River. In 1981 the peak of the upstream migration at Shageluk Eddy was May 20, according to local subsistence fishermen. This was about 2 weeks after breakup. In 1982 this peak movement was about June 1. Broad whitefish move into the lake and slough environment to feed all along the lower 140 miles of the Innoko River and lower Iditarod River. In 1982 they were captured in shallow lakes that in 1981 had been dry because of low water levels.

The spawning migration of broad whitefish is less clear than those of humpback whitefish and least cisco. In 1981 and 1982 they were not present at the mouth of Holikachuk Slough in late August, but were present at the mouth of the Iditarod River.

In 1981, during early September sampling in the upper Innoko River, they were taken in the Innoko in small numbers near the mouth of Hather Creek and near the mouth of the Dishna River. Two prespawners were captured 8 miles up the North Fork of the Innoko during 4 net nights of fishing on September 8, 1981. Thus, it appears that at least some of the Innoko River broad whitefish spawn in the North Fork, unless they were still feeding. The habitat in the lower 20 miles of North Fork did not appear suitable for whitefish spawning. No broad whitefish were taken further up the Innoko River and it is assumed that they do not spawn with least cisco and humpback whitefish above Cripple.

In early September 1982 broad whitefish were taken in all areas of the Iditarod River surveyed. They were taken at the mouth of the Yetna River and 7 miles up the Yetna. Gill net sets below Dikeman (124 miles up the Iditarod) took broad whitefish. Except for one nonconsecutive spawning female, all fish were prespawners. No sampling was done above Dikeman, but since a gravel bottom first appears in the vicinity of Iditarod, the broad whitefish probably spawn near Iditarod. It is not known if the broad whitefish captured in the Yetna would spawn in its upper reaches. The lower 20 miles of the river did not have suitable gravel habitat.

Young-of-the-year broad whitefish were not observed, but Age I whitefish were captured during both summers from the mouth of the Iditarod River downstream.

Age and Growth:

Thirty-five broad whitefish from 115 to 605 mm FL were aged. Fish ranged in Age from I to XI (Table 7). There is considerable variation in size

Table 7. Age-length relationship for broad whitefish from Innoko River drainage, 1981-1982. Fork length in mm, weight in grams.

		Age										
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Length mm	$\bar{x}$	150	215	335	347	429	428	505	500	523	540	605
	n	6	1	1	5	2	4	3	5	6	1	1
	range	115-185	215	335	320-417	385-400	376-480	455-541	472-526	502-550	540	605
Weight g	$\bar{x}$			400	500	638	1,368	1,933	1,780	1,892	1,900	
	n			1	5	2	4	3	5	6	1	
	range			400	300-950	625-650	900-1,800	1,700-2,300	1,600-2,100	1,600-2,350	1,900	

among age groups. Part of this difference, especially at Age I, is that some of the fish were captured in late May at annulus formation and others were captured near the end of the growing season in September. Broad whitefish grow rapidly and are considerably longer at a given age than humpback whitefish. Broad whitefish from the Innoko River grow at about the same rate as the three fastest-growing populations in Alaska for which information is available (Porcupine River, Minto Flats and Holitna River; Alt, 1976). Growth of Innoko fish is considerably faster than growth for coastal populations of broad whitefish (i.e. Imuruk Basin and Sagavanirktok River).

All fish Age IV and under were immature with the exception of one 417-mm Age IV mature male. Of two Age V fish, a 400-mm male was immature, while a 387-mm female was mature. All Age VI and older fish except for a 376-mm female were mature. Maturity data indicate a somewhat earlier age at maturity for Innoko River males.

Based on field examination of fish, consecutive spawning is probably the rule for broad whitefish, but a nonconsecutive spawning female was taken at the mouth of the Dishna River.

Food Habits:

Innoko River broad whitefish do not feed during the spring upstream migration. Only five fish stomachs examined contained food. Food items of fish captured on summer feeding grounds were clams, caddis flies, snails, diptera larvae and beetles. One prespawning male taken up the North Fork had a full stomach. Other prespawning males from the Iditarod River had empty stomachs.

Northern Pike

Pike are the most widely distributed fish in the Innoko drainage; next to the Coregonus sp. they have the greatest abundance and biomass. They are the only species that was taken consistently during test netting in 1981 and 1982. In late May 1981 pike were distributed from sloughs and associated lakes in the lower river to sloughs and the main river near Holikachuk and Shageluk Eddy. They were abundant in the lower Iditarod in June of both years. In 1981, fall sampling, they were taken in all tributary rivers sampled (Hather and Grouch Creeks, and Mud, Dishna and North Fork Rivers) as well as the main fork up to 10 miles below Beaver Creek. In 1982 fall sampling they were taken in all parts of the Iditarod sampled, as well as in the lower Yetna River.

Movements:

Pike probably overwinter in the Innoko. Local residents do not report a large upstream spring movement similar to that of whitefish. Our gill net catches in late May and June at Shageluk Eddy suggested some movement in the main river, probably into spawning areas. Pike then left spawning areas and moved into the main river and lower reaches of sloughs for feeding.

The 1981 movement was associated with low water in spawning areas. In 1982 this movement was not noted, as extremely high water in June provided additional habitat. In fall, gill net catches indicated a probable movement from lakes and sloughs down to mouths of sloughs or into tributary streams. Many of these areas probably are used for overwintering. Further downstream movements to overwintering grounds probably occur, but late fall netting was not sufficient to ascertain this.

Young-of-the-year pike generally feed where hatched, but in 1981 we noted some movement from sloughs into the main Innoko River for feeding in June. During high water of 1982 this movement was not noted. Summer movements of pike of Ages I and II, are similar to those of adult pike, except that small pike seek shallower areas with more protection from predators.

Spawning:

Pike spawning occurs in sloughs and lakes off the main Innoko in the areas from Holikachuk downstream to the mouth. From Holikachuk to the Iditarod River mouth, the wide slow moving Innoko has habitat similar to a lake, and probably limited spawning occurs there. Water temperature in sloughs and shallow lakes is considerably higher in the period following breakup, thus pike spawning in those habitats begins earlier than in the main river. On May 23, 1981 a small slough near Holikachuk where pike were spawning had a temperature of 13°C, while the main river was 8°C. Most pike examined in the Innoko from Holikachuk to the mouth in late May had already spawned. Water temperature in the Innoko rose rapidly in 1981 and was 14°C May 29. During the first trip in 1982 northern pike captured in early June had also nearly completed spawning. Water level was higher, and both air and water temperatures were lower than in 1981. Again, lake and slough temperatures were higher than in the main Innoko. Water temperature at Shageluk Eddy on June 3 was 8.5°C.

Exact time of hatching has not been determined, but is probably in early June. Young-of-the-year pike were first observed in a slough across from Shageluk Eddy on June 16. Fish were 39 mm, water temperature was 16°C. Thereafter, young-of-the-year pike were located in abundance in lakes and sloughs of the Innoko and the lower Iditarod Rivers. Young-of-the-year pike increased in size from 45 mm on June 25 to 155 mm September 1, with some fish up to 172 mm.

Age and Growth:

Eighty-nine Innoko River pike ranging in size from 75 to 1,182 mm were aged. Fish ranged in age from young-of-the-year to Age XVIII (Table 8). The majority of fish sampled were Ages VII to X and, indeed, the majority of fish captured during the 2-year study, by both gill net and hook and line, were in this age-size group. Fish of all sizes were selected for aging. However no Age I fish and only one Age II fish were captured. It is assumed that fish of Ages I, II and III rear in the lake-river environment of the Innoko system, but our failure to capture them in any section of the river may disprove this assumption. The largest pike taken in the Innoko was 1,182 mm FL and weighed 12.5 kg (27.5 lbs). This is probably near the maximum size for Innoko River pike, although anglers had claimed that 30-lb pike were common.

Table 8. Age-length and age-weight relationships for Innoko River northern pike, 1981-1982.

		Age														
		0	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XVI	XVIII
Length mm	$\bar{X}$	126	350	405	512	573	610	710	748	813	891	910	989	1,005	1,110	1,182
	n	12	1	7	8	9	5	8	15	5	9	1	4	4	1	1
	range	75-187	350	307-450	426-555	505-637	585-748	625-775	615-885	802-824	846-960	910	935-1,070	900-1,070	1,110	1,182
Weight g	$\bar{x}$		360	579	951	1,556	2,683	2,788	3,365	4,210	5,628	5,750	7,187	8,783	10,000	12,500
	n		1	7	7	8	3	4	13	5	7	1	4	3	1	1
	range		360	275-775	460-1,200	1,150-2,100	1,500-2,500	2,300-3,550	1,975-5,350	3,700-4,700	4,950-7,300	5,750	5,250-9,250	5,500-11,550	10,000	12,500

No fish of Age XIV, XV or XVII were captured.

It is difficult to accurately compare ages and lengths of Innoko River pike with other populations in Alaska. Previously, most pike have been aged using scales. I feel that scales have overestimated considerably the age of pike in Alaska. Use of the cleithrum bone (Casselman, 1980) gives a more accurate age of the fish. Pike of a given size were found to be 3 to 5 years younger when compared to ages determined by reading scales. Pike of 725 mm from the Innoko River collected in 1979 were aged at Age XII using scales and fish averaging 574 mm were called Age IX using scales (Alt, 1980). Fish of similar size aged using the cleithrum were found to be Age VII to VIII and IV to V, respectively.

Pike become mature at Age III to IV for males and Age III to VI for females. Most females do not mature until Age IV to V. Consecutive spawning seems to be the rule.

Food Habits:

Feeding pike had consumed mainly fish but also a shrew and vole and water beetle. Fish eaten included salmon fry, lampreys, pike, suckers, least cisco and humpback whitefish. Whitefish, Coregonus sp., and pike were the most common species eaten.

Utilization:

Major utilization of pike in the Innoko River is for subsistence by Shageluk residents. The harvest is small, since residents prefer whitefish, salmon and sheefish. The recreational harvest is small and mainly centered in the lower river.

Round Whitefish

Only one round whitefish was taken in 2 years of netting in the Innoko River drainage. This 344-mm, 350-g fish was 8 years old. It was a ripe female captured on September 29, 1981 in the Innoko River at the mouth of Beaver Creek. This is the same area where grayling were abundant. Thus, the round whitefish probably came from Beaver Creek and would have spawned in the Innoko. The round whitefish is a species that would be expected to be abundant in the mainstem of the Innoko from Ophir downstream to Dishkakat. In most rivers of similar habitat in Alaska, round whitefish would be present. Since most fish would spend their entire life in the main river, it is probable that continued siltation from mining has had a very detrimental effect on round whitefish.

Char

Char (Salvelinus malma - alpinus complex) are present in the Innoko system in small numbers. Four were captured during 2 years of test netting. None were caught on hook and line. Gill raker counts (21-24 total counts) indicate that these char should be called Dolly Varden. Recent papers by Behnke (1980), and Armstrong and Morrow (1980) stipulate that char with the lower gill raker count of 20 to 23 are Dolly Varden rather than Arctic char. The four fish captured ranged in size from 458 to 519 mm FL ($\bar{x}$493 mm). This is similar in size to char taken in the Anvik and Andreavsky Rivers (Alt, 1981). These char are considered river resident

rather than anadromous and probably spend their entire life in the Innoko River or in adjacent areas of the Yukon. Nothing is known of their spawning location.

It is surprising that capture locations of char were in slower-moving water areas of the lower rivers. No char were captured in the area between Ophir and Cripple. Residents of McGrath and the Innoko River mentioned catching char in the upper Innoko in the fall. Respondents mentioned that fish were 10 inches or less in size. Possibly a resident population of small size char inhabit the upper Innoko and Beaver and Folger Creeks.

All char captured were females. Fish captured in early September were definitely adult nonspawners. Two were very dark-colored with dark pink spots. The fish caught at Shageluk Eddy in early June 1982 had 1.5-mm diameter eggs and would possibly develop to spawn in the fall. Paradoxically, this 519-mm fish was in the poorest condition of all four captured. It had greater length than the other three fish but weighed only 75% as much. None of the four fish had been feeding. These limited data seem to suggest that these fish are not Innoko River spawners, but have migrated from another system.

Salmon

Chinook, chum and coho salmon have spawning migrations up the Innoko River, but their numbers are considerably smaller than in more important spawning streams of the lower Yukon River. Chinooks and chums enter the river in early June and are taken at Shageluk in subsistence nets by mid June. In 1981 nets set in Shageluk Eddy took 0.08 chinook salmon and 3 chum salmon per net night in mid June. Chinook salmon spawn mainly in the upper Innoko above Ophir, including Ganes Creek. Chums also spawn in this area, in Beaver Creek, the Dishna River and probably the upper Iditarod River. In 1982 no chinook or chums were taken, as the run was late. In 1981 large numbers of coho salmon were taken in September in the lower Iditarod and in the Innoko upstream to Beaver Creek. Those taken in late September were spawning in the main river above Cripple, but were also entering Beaver Creek. They probably also spawn in the upper Iditarod, although none were taken during test netting in late August and September 1982. Young chum salmon and smolts of chinook and coho salmon migrate down the Innoko in May and early June and are preyed upon by sheefish and pike. A single sockeye salmon was taken Sept. 8, 1981, 8 miles up the North Fork. A few Innoko River salmon are taken by sport fishermen in the Folger Creek, Beaver Creek and Ophir areas, but fewer than 50 per year. Subsistence remains the major use in the Innoko.

Other Species

Burbot, ninespine stickleback, lampreys and sculpins are found in the Innoko drainage. None are present in high numbers except for burbot in the lower river. Low fish abundance in upriver gravel areas may be the result of years of mining which has silted the river.

Sheefish Lake And River Adaptability Study

Sheefish Stocking:

All sheefish raised in the Clear Hatchery in 1982 were stocked in Harding Lake, a 2,470-acre landlocked lake, located 44 miles south of Fairbanks on the Richardson Highway. In early June 141,735 fingerlings averaging 53 mm were stocked in Harding Lake. Additionally, 370 Age I fish averaging 280 mm were stocked on July 9, 1982.

Seining and gill-netting during the remainder of 1982 failed to take any sheefish, so it is not known if stocking was successful.

Evaluation of Past Sheefish Plants:

Craig Lake. This 17-acre lake was stocked with 3,200 fingerlings in June 1981. The lake was test netted in late May 1982 but no fish were taken. It is probable that some sheefish still survive and the lake will again be netted in 1983.

South Greely Pond. This pond was stocked with 10,000 fry in February 1977. None were recovered by test netting until 1980. Three fish were captured during 1 net night of fishing on August 5, 1982. None were captured in 3 hours of hook and line fishing. Fish were 470 to 510 mm FL ($\bar{x}$= 490 mm) and 2 to 2.5 lbs ($\bar{x}$=2.25 lbs). Growth has slowed considerably since 1980 when fish averaged 444 mm. Growth will continue to be slow as the pond has no forage fish. The two males were mature while the 510-mm female was developing. Stomachs were empty. Surface water temperature was 14°C.

Gull Lake. Gull Lake was stocked with 20,000 fry on January 19, 1981. By July of 1981 the fish ranged from 110 to 120 mm FL. Two fyke nets were set overnight on Aug. 4, 1982 in an effort to capture sheefish for a mark and release sheefish population estimate experiment. Only two fish were caught by fyke net, but 21 were captured in 4 hours of hook-and-line fishing. Fifteen fish were adipose finclipped and released and six were autopsied. The fish ranged in size from 155 to 207 mm ($\bar{x}$=174.5). Growth this second summer was about 50 mm. Most fish were in poor condition, probably due to overcrowding and lack of food. Five of the fish were feeding on insects (immature diptera larvae, adult diptera and Hymenoptera). One larger fish was feeding on slimy sculpins, the only forage fish in the lake. In the future it can be expected that the size difference between the largest and smallest individuals will become greater as the larger fish continue to feed on sculpins.

In August fish were actively jumping while preying on adult flying insects. A small Mepps bucktail spinner was successful in capturing sheefish, but greater success could probably be enjoyed using a small fly. A population estimate using gill net and hook and line capture will be attempted in 1983. Water temperature on August 3 was 18°C.

Four Mile Lake. Four sheefish were taken during 2 net nights of fishing in early September, 1982. None were caught on hook and line. Fish ranged in size from 417 to 605 mm (x = 479) and in weight from 1.74 to 3 lbs ($\bar{x}$ = 2.2 lbs). At least three of the fish were hatched and reared in the

lake, as the last stocking date was 1969. The two Age-IV fish would have been spawned in 1977 and hatched in 1978 and the Age-V fish would have been spawned in 1976 and hatched in 1977. Successful spawning in Four Mile Lake had already been documented for 1975, 1976 and 1977 (Alt 1981). Growth of all naturally reproduced fish was quite rapid the first years of life but slowed considerably after Age III.

Scales of the fourth fish contained eight or probably nine identifiable annuli. This 605-mm fish could have been a fish stocked in 1969, and the last three or four annuli were obliterated from the scale or had not formed because of severe stunting. The first six annuli showed rapid growth, similar to growth exhibited by fish stocked in 1969.

Two of the sheefish captured in 1982 were feeding on recently stocked rainbow trout, one was feeding on Daphnia and the 605-mm fish had an empty stomach. One Age-IV male was mature, while Age-IV and V females were immature. The Age-VIII female was a nonconsecutive spawner, but because of its poor physical condition, might not recover to spawn again.

Lakeview Pond. Lakeview Pond is a 30-acre man-made pond stocked with 10,000 sheefish fingerlings on May 10, 1981. Four fish were captured in the 3/4 inch square mesh section of a 125 ft graduated mesh net on August 3, 1982. Fish were 121 to 148 mm FL ($\bar{x}$=142 mm) in length and 19 to 24 g ($\bar{x}$=21 g). Fish had grown very little from November 1981 sampling when they averaged (130 mm FL and 16.3 g in weight). In contrast to many jaw deformities exhibited by 1981 captured fish, none were noted in 1982. With the slow growth rate exhibited by Lakeview Pond fish, it will probably be 1984 before the fish are a suitable size for angling.

Weigh Station Ponds. North and South Weigh Station Ponds, located 6 miles south of Fairbanks on the Richardson Highway, were stocked with 320 and 280 sheefish fingerlings, respectively, in 1981. A gill net was set overnight in both ponds on August 3, 1982. The net in North Weigh Station Pond took eight chubs and four suckers. The net in South Weigh Station pond contained one sheefish and six chubs. The sheefish was 271 mm FL and weighed 173 grams. The stomach contained three chubs 1 to 1½ inches in length. This fish is considerably larger than fish captured in Lakeview Pond (weight almost nine times as much). The presence of prey species and the small sheefish population density are reasons for fast growth of Weigh Station Pond sheefish.

Texas lake. Texas Lake was stocked under the ice in January 1981. Subsequent sampling took no fish. A March 1982 dissolved oxygen reading of 0 ppm gave reason to believe all fish had perished.

Manchu Lake. This 100-acre lake was stocked with 27 Age I sheefish in March 1978 and 40,000 fry on January 19, 1981. Two net nights of fishing on August 17 took one sheefish. This Age V fish had been stocked in 1978. It was a prespawning female 660 mm in length and weighed 7¼ lb. The fish was in excellent condition and had been feeding on diptera larvae and Gammarus sp. The scale indicated slow growth the second year of life, then rapid growth. None of the 1981 stocked sheefish were captured. They may

have been stocked in a portion of the lake that experiences low late winter dissolved oxygen readings. Future stockings will be of fingerlings during the open water period.

Eielson Cooling Pond. During 2 net nights of fishing on April 24, two sheefish were captured. Both were Age V and from the original 1977 stocking. The 525-mm, 3.75-lb male was mature, and the 580-mm, 5-lb female was also mature and contained many retained eggs in the body cavity, indicating an attempt to spawn in 1981. Both fish were feeding on leeches. No recovery was made of fish stocked in 1978, 1979 and 1981.

Scale analysis of the two fish captured indicates very slow growth the past 2 years.

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