STATE OF ALASKA

*Jay S. Hammond, Governor*

Annual Performance Report for

# A LIFE HISTORY STUDY OF SHEEFISH AND WHITEFISH IN ALASKA

by

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Volume 19 Study No. R-II

RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska

Project No.: F-9-10

Study No.: R-II Study Title: A LIFE HISTORY STUDY OF SHEEFISH AND WHITEFISH IN ALASKA

Period Covered: July 1, 1977 to June 30, 1978

ABSTRACT

Results of 1977 sheefish, Stenodus leucichthys (Guldenstadt), egg takes and fry stocking are presented. Fry placed in holding pens in the Eielson Air Force Base cooling pond exhibited rapid growth but poor survival. Test netting of previously stocked lakes indicates that growth is very slow in Lost Lake because of extreme competition and in Four Mile Lake because of absence of fish prey species. Comparative studies of Kobuk River spawning sheefish indicate little difference in population structure between 1965-1968 and 1976-1977. When adjustments are made for sampling error, mean size of males and females for the two sampling periods are similar. Full recruitment of females to the spawning population remained at age XIV, while full recruitment for males increased from age IX in 1965-1968 to age XI in 1976-1977. Reduced numbers of younger males is suggested as a cause for the shift.

Surveys in the lower Koyukuk River indicated that the anadromous portion of the lower Yukon sheefish population had not begun entering the Koyukuk by late May. These results and the capture of prespawning sheefish at the mouth of the Nowitna River in late May, as well as in the Sulukna River (upper Nowitna) in September confirm the status of Nowitna River sheefish as a local population.

Search for spawning grounds of anadromous sheefish passing through Rampart in the fall centered in the area of the Yukon River between Stevens Village and Ft. Yukon but spawning grounds were not located. Sheefish spawning grounds and prespawning sheefish were found in the Salmon Fork of the Black River in late September but this was found to be a small local population of slow growing, small sheefish.

Fecundity studies of the Yukon River sheefish captured at Rampart gave egg counts of 105,900-230,000 eggs, while two females from the Salmon Fork River had 27,000 and 36,000 eggs.

BACKGROUND

Major goals of the sheefish lake and river adaptability study are to perfect egg taking techniques, hatch and rear the fish in a hatchery situation, interim rear the fry in ponds, stock fingerlings in suitable waters and to follow progress of past plants. Egg take success prior to 1976 was poor, but in 1976 a camp was set up on the Koyukuk River above Hughes and crews remained until eggs were ripe. Prespawners from the Yukon River at Rampart were transported by air to holding areas in Birch Lake and Fire Lake Hatchery for ripening. Those at Birch Lake were injected with the hormone HGC (human chorionic gonadotropin) to hasten ripening of the eggs. Hatching the eggs in the hatchery has posed no great problems, but eggs hatch out 2-3 months before they would in the wild because hatchery water temperature is higher than in spawning rivers. Growth rates of sheefish stocked in Four Mile Lake in 1968 and 1969 continue to decrease, probably because of absence of prey fish in the lake.

Sheefish life history research studies were suspended during the two-year fisheries resource study of waters of the lower Kuskokwim River and Kuskokwim Bay in 1975 and 1976. Major life history research aspects have been completed and published. To detect if any changes have occurred in the population structure of sheefish, it is necessary to conduct population dynamics studies at various intervals. A large amount of sex-age-length-weight data existed for sheefish spawners of the Kobuk River from 1966 to 1968. Similar data were collected during 1976-1977 to see if the population had changed during the last decade. Similar studies are recommended within the next three years for the heavily utilized Kuskokwim River population.

Population status of major sheefish populations in Alaska has been well established through extensive tagging programs. Status of possible local populations of sheefish in the Yukon River is less well understood. The large numbers of sheefish found at the mouth of the Nowitna River immediately after breakup were hypothesized as being either a local population or a segment of the lower Yukon population which spawns above Rampart (Alt, 1975). Search for spawning grounds of the andromous sheefish passing through Rampart in the fall has been unsuccessful. In the current study this search concentrated in the Yukon River and its tributaries between Stevens Village and Ft. Yukon. Additional searches for these spawning grounds on the Salmon Fork of the Black River were conducted and results are discussed in this report.

Knowledge of run timing of prespawning sheefish of the lower Yukon population into the Koyukuk River is an essential aspect of stock separation in this area of the Yukon River. Failure to find any number of prespawning sheefish entering the Koyukuk River immediately after breakup during the present study adds credence to the hypothesis that Nowitna River sheefish are a local population. As prespawners are present in the Nowitna mouth at breakup, timing of entry into the Koyukuk River needs to be documented in future years. Search for spawning grounds of sheefish passing through Rampart is still the major unsolved link in the life history of Yukon

River sheefish. Future research should address this problem as well as determine population status of sheefish in the Innoko and Kateel rivers and tributaries of the lower Tanana River (Manley Hot Springs to Tanana). Discovery of rearing areas of sheefish hatched in the upper Koyukuk River was unsuccessful during the present study, but catches of sheefish fry in the lower Yukon River in late June and early July suggest that fry of Koyukuk River fish may descend into the lower Yukon River for rearing. Rearing areas of sheefish of the Kobuk River-Selawik population have not been found and future research in the delta areas of these two rivers is recommended.

## TECHNIQUES

The Koyukuk River sheefish used for the egg take were captured by hook and line and by beach seine by native subsistence fishermen. Yukon River sheefish were captured by gill net set at 19 Mile Research Site above Rampart, held in holding pens, then flown to Birch Lake by float equipped aircraft. Injections of human chorionic gonadotropin were given intramuscularly four days after arrival at Birch Lake.

Ft. Wainwright and Eielson Air Force Base experiments were conducted in cooling ponds (3.6 hectare) on the respective bases. Rearing pens were constructed of plywood and wood frame covered with nylon screen. Sheefish stocked in various lakes and ponds in the lake and river adaptability study were sampled using fyke traps, gill nets and hook and line.

Kobuk River sheefish used in the comparative age and growth study in 1976-1977 were captured by hook and line. No beach seined or gill net caught fish were available for analysis. Scales of the 1966-1968 and the 1976-1977 captured fish were mounted between glass slides and read on an Eberbach projector.

Fish were captured in the Nowitna River, lower Koyukuk River, middle Yukon River, Rampart, Salmon Fork and Black River using gill nets of 5.0, 6.5, and 7.5 cm bar mesh 25-32 m in length and 2-3.2 m deep, and standard graduated mesh gill nets 40 m long and 2 m deep. Three sheefish were captured in the Salmon Fork River on hook and line.

Ovary samples collected from sheefish in the middle Yukon River at Rampart were selected to cover the entire size range of spawning females. The Salmon Fork River sample consisted of the two smallest females captured. Egg numbers were determined volumetrically by determining the volume of 2,000 eggs and comparing this with the total volume of all eggs in the two ovaries.

Common and scientific names and abbreviations of fish mentioned in this report are listed in Table 1.

Table 1. List of common and scientific names of fishes mentioned in this report and abbreviations used.

| Common Name | Scientific Name | Abbreviation |
|---|---|---|
| Coho (silver) salmon | *Oncorhynchus kisutch* (Walbaum) | SS |
| Chum salmon | *O. keta* (Walbaum) | CS |
| Rainbow trout | *Salmo gairdneri* Richardson | RT |
| Sheefish | *Stenodus leucichthys* (Güldenstadt) | SF |
| Humpback whitefish | *Coregonus pidschian* (Gmelin) | HWF |
| Broad whitefish | *C. nasus* (Pallas) | BWF |
| Least cisco | *C. sardinella* Valenciennes | LCI |
| Round whitefish | *Prosopium cylindraceum* (Pallas) | RWF |
| Grayling | *Thymallus arcticus* (Pallas) | GR |
| Northern pike | *Esox lucius* Linnaeus | NP |
| Lake chub | *Couesius plumbeus* (Agassiz) | LC |
| Longnose sucker | *Catostomus catostomus* (Forster) | S |
| Burbot | *Lota lota* (Linnaeus) | BB |
| Trout-perch | *Percopsis omiscomaycus* (Walbaum) | TP |

RECOMMENDATIONS

1. The search for spawning grounds of sheefish passing through Rampart should be conducted in the middle Yukon River between Circle and Eagle.

2. Abundance and distribution of sheefish in the lower Tanana River should be studied.

3. Run timing of anadromous sheefish entering the Koyukuk River should be established.

4. Population status of sheefish in the Innoko River should be determined.

5. A representative sample of sheefish from feeding areas on the Holitna River in July should be aged and population structure compared with the 1967-1969 population structure.

Job R-II-A A Sheefish Lake and River Adaptability Study.

OBJECTIVES

1. To refine egg take techniques.

2. To interim rear sheefish to fingerling size.

3. To stock various lakes and streams in Interior Alaska.

4. To evaluate success of past plants.

FINDINGS

1977 Egg Takes

On October 4 approximately 220,000 eggs were taken from sheefish on the Koyukuk River 12 km above Hughes. After fertilization, eggs were flown to Fire Lake Hatchery, Eagle River. Survival to eyed egg stage was 125,000 eggs (57%).

The Koyukuk River fish became ripe later in 1977 than in other years and two females held in pens from September 24 when camp was first established until October 4 when the project terminated never did ripen. Sheefish were in very low abundance in traditional spawning areas above Hughes. Extensive hook and line fishing by Fish and Game biologists and extensive beach seining by native subsistence fishermen took only 12 sheefish (8 males, 4 females) prior to October 4.

From September 21 to 25, 12 prespawning female sheefish and 13 males were captured in the Yukon River at Rampart, held in pens, and flown to ripening pens at Birch Lake on September 27 and 30. Six of the females and five

males were injected with 2,000-2,500 IU of the hormone HCG (human chorionic gonadotropin) on October 3 to induce spawning. Males ranged in weight from 3.2 kg (7 lbs) to 5.5 kg (12 lbs), and females ranged from 4.1 kg (9 lbs) to 9.1 kg (20 lbs). All fish were painted with a concentrated solution of malachite green to prevent spread of fungus.

Water temperatures at the Birch Lake holding facility ranged from 4°C on October 3 to 2.5°C on October 12. Two females had died by October 3 and there was a gradual die-off of fish, especially females. By October 12 all of the eight remaining males, including injected and noninjected fish, were running some milt. Only three females were alive at this time (two injected and one noninjected fish). On October 12, 80,000 eggs were taken from an injected 9.1 kg female and fertilized. This female had a blockage in the vent and only a few of the eggs could be taken. These eggs did poorly at the hatchery and by December 1 only 4,000 eyed eggs remained and they died soon after hatching in mid January, 1978.

## 1977 Stocking Results

Sheefish hatched in the Fire Lake Hatchery in January of 1977 were stocked according to the following schedule:

| Date | Location | No. of Fry |
|---|---|---|
| Feb. 10 | Clear BMEWS raceway | 5,000 |
| Feb. 10 | Lake on Ft. Greely #1 | 10,000 |
| Feb. 10 | Lake on Ft. Greely #2 | 10,000 |
| March 14 | Ft. Wainwright cooling pond | 5,000 |
| March 14 | Eielson AFB cooling pond | 5,000 |
| March 21 | Sansing Pond Clear BMEWS | 25,000 |
| April 7 | Eielson AFB Cooling Pond | 1,000 |

The remaining fry in the hatchery (50,000 as of March 22) were being fed brine shrimp and Oregon moist mash. An additional 1,000 fry were held in an aquarium at 11.1°C (52°F) and were feeding and actively swimming up to April 4. They all died suddenly on April 4, possibly from introduction of salt water with the brine shrimp. The 50,000 left in the troughs at 1.0°C water began showing signs of weakness by mid March and mortality increased. By April 7 only 1,000 very weak fry remained and they were stocked in the Eielson cooling pond.

## Rearing Experiments

Screen enclosed rearing pens of 1.2 x 1.2 x 2.4 m were placed in cooling ponds at Ft. Wainwright and Eielson Air Force Base. Five thousand fry were placed in each on March 14. Water temperature ranged from 7.5°C to 12.0°C for the Wainwright Pond (March 14-April 14) and 10.5°C to 20°C for the Eielson pond (March 14-May 2). Water quality and plankton fauna were similar in both ponds but from the onset it became apparent that the Eielson fish were growing and surviving better. Five fish from Wainwright

on March 29 averaged 14.8 mm total length while five fish from Eielson averaged 16.4 mm. On April 14 the Wainwright pen was drained and only 30 fry in poor condition remained. They were placed in a pen at Eielson. The Eielson fish continued to do well although it was noticed by early April that some of the fry appeared thin and emaciated while the others were robust. By April 14 most of the smaller fish had died and the remaining fry appeared to be of uniform size ($\bar{x}$ total length 20.7 mm, n=3).

A hole was discovered in the pen in late April and many of the fry probably escaped into the cooling pond. Numbers of fry in the pen in early May appeared to get smaller and smaller. Many back swimmers (Notonectidae) were observed in the pen in early May and were able to successfully prey on sheefish fry.

The fry were removed on May 9 and stocked in a shallow winterkill pond near Donnelly Dome for interim rearing. About 200 fish were stocked, all in excellent condition. A sample of six fish which died during the transplant ranged from 24 to 27 mm total length ($\bar{x}$ = 25.2 mm). A small number of fry stocked were considerably larger and deeper bodied and it is suspected that they were cannibalistic.

It appeared that the use of the Eielson cooling pond for interim rearing can be successful if pens are made insect proof and the possible cannibalism problem can be solved. Releasing the fry into the cooling pond by mid April might be desirable. A gill net set in the cooling pond on October 10 took two of the sheefish that had escaped; their fork lengths were 290 and 286 mm. This is exceptional growth. The age 0 fish had 58 and 62 circuli while most wild sheefish have 12-18 circuli at age I.

No trace was found of the sheefish placed in the Sansing rearing pond or the radar dome raceway at Clear. There were rainbow trout in the pond which may have eaten the small fry.

Sheefish Growth and Survival in Stocked Lakes

Waters stocked with sheefish were checked in June (visual observations), mid August (fyke net overnight), and December (one net night), but no sheefish were captured or observed. Oxygen levels in the Ft. Greely lakes are suitable for fish overwintering and it is expected that some fish will be captured at a later date.

Lost Lake:

Three sheefish were taken by gill net in Lost Lake in early June and four fish were taken on August 19. The August sample was 232-245 mm fork length. Three were feeding on diptera larvae and one had eaten chubs. These fish were stocked through the ice in February 1973. In July of 1973, 200,000 silver salmon fry were planted in this small lake. Seventeen sheefish (160 mm fork length average) were taken in a smolt outmigrant trap in June of 1975. Analysis of scales of the sheefish taken in 1977 indicate that 70%-72% of the growth in length was put on in the first year

and 28%-30% was put on during the period from annulus formation in 1974 to August of 1977. Growth had begun to increase from annulus formation in 1977 to capture date. Most silver salmon had completed their life cycle by 1977 and chubs had reinvaded the lake and were becoming available to sheefish. The silver salmon also showed the extreme stunted condition after formation of the 1974 annulus.

Four Mile Lake:

Four Mile Lake near Tok was sampled in June 1977. Ten sheefish were captured; five during 4 hours of hook and line fishing and five in an overnight gill net set. Six females averaged 625 mm and 3.47 kg while four males averaged 617 mm and 2.98 kg. Of seven fish aged, four were age VIII (1969 plant) and three were age IX (1968 plant). Scale analysis indicates that the sheefish have grown very little the past 3 to 4 years. One cycle of 9,800 silver salmon were stocked in the lake (1972-1975), and since no salmon were found in sheefish stomachs during this period it was assumed that the two species were competing. In June 1977, 25,000 rainbow trout were stocked in Four Mile Lake. Unless the remaining sheefish in Four Mile Lake forage on these rainbow trout, they will continue the slower rate of growth because a diet of only freshwater shrimp and insects is not sufficient for continued rapid growth.

Four of the six females captured in 1977 had large eggs (>1.7 mm) and would have spawned in the fall. The other two had many retained eggs in the body cavity and apparently were not successful at spawning. There are no inlet or outlet streams in Four Mile Lake, thus spawning, if attempted, is probably unsuccessful.

Job R-II-B Movements, Abundance and Spawning Ecology of Sheefish in Middle Yukon River and Lower Koyukuk River

OBJECTIVES

1. Determine summer run timing and abundance of sheefish in the vicinity of the mouth and lower reaches of the Koyukuk River.

2. To locate spawning grounds of sheefish of the middle Yukon River population.

3. To collect life history information of sheefish from other areas of Alaska as time permits.

FINDINGS

Kobuk River Comparative Age and Growth Study 1965-1968 and 1976-1977

Sheefish males collected near the spawning grounds on the Kobuk River by hook and line averaged 801 mm fork length (range 691-876) while females averaged 910 mm (range 810-1,029 mm) (Table 2). Mean weight of males

Table 2. Mean fork length and weight of Kobuk River spawning sheefish, 1965-1968 and 1976-1977. 1965 data from Alt (1969), 1966-1968 data from Geiger (1968).

| | Males | | | | | Females | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | F.L. (mm) | Range | Weight (kg) | Range | n | F.L. (mm) | Range | Weight (kg) | Range |
| 1965 | 32 | | | 5.1 | 2.6-8.0 | 36 | | | 9.7 | 5.4-16.1 |
| 1966 | 65 | 771 | 650-950 | 4.8 | 2.7-9.1 | 88 | 943 | 820-1,140 | 9.4 | 4.8-22.3 |
| 1967 | 104 | 774 | | 4.8 | | 99 | 961 | 850-1,130 | 10.7 | |
| 1968 | 276 | 770 | 667-901 | 5.1 | 2.7-8.5 | 193 | 967 | 760-1,120 | 12.3 | |
| 1976-77 | 47 | 801 | 699-876 | 5.1 | 3.2-6.8 | 48 | 910 | 810-1,029 | 8.2 | 5.9-12.5 |

was 5.1 kg (range 3.2-6.8 kg) and for females was 8.2 kg (range 5.9-12.5 kg).

Average length of the 1976-1977 sample of 47 males was slightly greater than the length of the 1965-1968 sample but there was little weight difference. Average lengths of the 1976-1977 sample of 48 females was slightly less than the 1965-1968 sample but the average weight was considerably less. The 1976-1977 weight was 4.1 kg less than the 1968 weight.

The length-age and weight-age range for the 1976-1977 sample for both males and females is considerably narrower than the earlier sample, with males and females from only five age classes as compared with nine age classes for males and 13 age classes for females from the earlier sample (Table 3). This discrepancy can partly be explained by the smaller sample and the single sample gear (hook and line) employed in 1976-1977. Gill nets and beach seines would be expected to have taken more females over age XVI. Beach seines generally take a more representative sample of the spawning population. Gill nets used in past sheefish studies were shown to take more of the larger females, while hook and line generally captured more of the small active males (Geiger, 1968). The combined catch data from 1966-1968 used in Table 2 utilized fish taken almost in equal proportions by the three methods, thus it could be considered more representative than the 1976-1977 data. Since very few fish of age VIII and under were taken by hook and line in 1976-1977 either we were unable to capture them or they were absent from the spawning population.

In the course of one decade it appears that the population structure of the Kobuk River spawning population is little changed. There may be a slight shift in full recruitment to the spawning population for males from age IX and X to age X and XI. If this is happening it could be the result of a weak year class or greater natural or harvest mortality.

Full recruitment of females to the spawning population is still at age XIV, a very critical factor in future management of sheefish populations in the Selawik-Kobuk areas.

Surveys

Koyukuk River:

Test netting in the lower 144 km (90 miles) of the Koyukuk River from May 27 to 30, 1977 took only four sheefish during 12 net nights of fishing (Table 4). The fish taken 5 km up the Koyukuk was an immature feeder while fish taken near the mouth of the Kateel River included an immature feeder and a prespawning male and female. Two possibilities are suggested by the low sheefish catch in the Koyukuk River. It is probable that the segment of the Lower Yukon sheefish population that spawns above Hughes in the Koyukuk River does not enter the Koyukuk River until later in the summer, perhaps July or August. The prespawning sheefish seldom reach Hughes until early September, and a heavy upstream migration of fish of

Table 3. Age, sex and size composition of spawning sheefish upper Kobuk River 1966-1968 and 1976-1977. Mean fork length in mm; mean weight in kg. No fish less than age VII were captured. Data for 1966-1968 sheefish from Geiger (1968).

| | | Age Class | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VII | VIII | IX | X | XI | XII | XIII | XIV | XV | XVI | XVII | XVIII | IXI | XX | XXI |
| 1966-1968 n=820 | | | | | | | | | | | | | | | | |
| Males n=447 | n | 17 | 65 | 101 | 91 | 58 | 43 | 45 | 21 | 6 | | | | | | |
| | F.L. | 667 | 680 | 725 | 751 | 816 | 857 | 868 | 875 | 901 | | | | | | |
| | Weight | 2.86 | 3.22 | 3.95 | 4.63 | 5.76 | 6.49 | 7.26 | 7.62 | 8.48 | | | | | | |
| Females n=373 | n | | 5 | | 11 | 19 | 28 | 67 | 92 | 54 | 38 | 25 | 17 | 10 | 5 | 2 |
| | F.L. | | 821 | | 871 | 859 | 903 | 934 | 949 | 966 | 998 | 1,026 | 1,080 | 1,101 | 1,105 | 1,090 |
| | Weight | | 5.80 | | 7.39 | 7.17 | 8.39 | 9.62 | 10.52 | 11.11 | 13.25 | 14.61 | 16.60 | 17.15 | 19.69 | 17.15 |
| 1976-1977 n=95 | | | | | | | | | | | | | | | | |
| Males n=49 | n | | 3 | 5 | 8 | 16 | 13 | 4 | | | | | | | | |
| | F.L. | | 729 | 739 | 767 | 805 | 885 | 860 | | | | | | | | |
| | Weight | | 4.196 | 3.992 | 4.366 | 5.330 | 5.645 | 5.971 | | | | | | | | |
| Females n=46 | n | | | | 5 | 11 | 8 | 13 | 7 | 2 | | | | | | |
| | F.L. | | | | 843 | 889 | 894 | 924 | 960 | 993 | | | | | | |
| | Weight | | | | 6.69 | 7.31 | 7,90 | 7.88 | 10.03 | 11.17 | | | | | | |

Table 4. Test net results lower Koyukuk River, May-June 1977. Nowitna R, Yuki R. and mainstem Yukon results are shown for comparison.

| Location | Date | Net Nights | Water Temp. °C | No. Fish Captured | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | SF | HWF | BWF | LCI | NP | BB | S | GR | RWF | LC | TP |
| 5 km up Koyukuk R. | 5/27-28 | 5 | 5.5 | 1 | 40 | 19 | 44 | 16 | 2 | 3 | 6 | | | |
| Gisasa R. | 5/29 | 3 | 5.5 | 0 | 17 | 21 | 17 | 4 | | | 13 | | | |
| Koyukuk R. at Kateel R. mouth | 5/30 | 3 | 6.5 | 3 | 12 | 6 | 12 | 4 | | 6 | 12 | 1 | | |
| Kateel R. at Honshu R. mouth | 5/30 | 1 | 7.0 | | | | | 1 | | | 6 | | | |
| Yuki R. mouth | 5/26 | 2 | | 3 | 5 | | 25 | 10 | 1 | 2 | | | 1 | |
| Nowitna R. mouth | 5/25 | 4 | 7.0 | 46 | 5 | 38 | 59 | 14 | | | | | 6 | |
| Nowitna R. mouth | 6/1-2 | 7 | 11.0 | 57 | 15 | 7 | 30 | 38 | | 1 | | | 6 | |
| Yukon R. 19 km below Galena | 5/31 | 3 | | 3 | 26 | 1 | 6 | 9 | 1 | 10 | 2 | 4 | 3 | 1 |

this population is noted every year in late May and early June in the lower Yukon River, 1,100-1,350 km downstream. The second possibility is that the prespawning fish found near the mouth of the Kateel River constitute a local population with spawning grounds in the upper Kateel River. Local residents reported catching sheefish a considerable distance up the Kateel River during late summer.

No rearing sheefish were captured in the lower Koyukuk River. The section of the Koyukuk River surveyed was very swift in late May, and had a paucity of sloughs and slow moving water to furnish habitat for rearing sheefish. Rearing areas are possibly further upstream in the area near Huslia or further downstream in the main Yukon River.

Nowitna River:

Test netting was conducted in early September on the Sulukna River 290 km up from the mouth of the Nowitna River and in the main Nowitna 310-320 km up from the mouth. Overnight sets 7 km and 16 km up the Sulukna River took 10 prespawning sheefish, thus confirming the Sulukna River as the spawning ground for the Nowitna River population of sheefish. Nets set in the upper Nowitna River for six nights took only northern pike, grayling, spawning chum salmon and broad whitefish but no sheefish, indicating that all sheefish enter the Sulukna to spawn.

Actual spawning grounds on the Sulukna River were not located because navigation by boat upstream of 16 km was impossible. Aerial reconnaissance of the Sulukna River indicated that suitable spawning habitat might exist from 7 km to 48 km upstream. Velocity readings were not taken but current speed is probably the same as Koyukuk River spawning areas. Gravel size in the area surveyed by boat appeared to be suitable for spawning. The stream is approximately 30 m wide, and water depth on September 2 was 0.3-0.8 m in the riffle areas, with deeper holes having water as deep as 2.5 m. Water temperature on September 2 was 3.1°C. Prespawning humpback whitefish were taken in the same location as the sheefish in the Sulukna River.

Test net results in the lower Nowitna River and lower Koyukuk River offer additional proof that the Nowitna sheefish constitute a separate local population (Table 4). Since few prespawning sheefish were entering the Koyukuk in late May, the presence of large numbers of sheefish at the mouth of the Nowitna indicate that it is a local population rather than part of the spawning migration up the Yukon River.

The 103 sheefish taken in 1977 included a majority of mature fish (prespawners and nonconsecutive spawners). The catch included five fish which had been tagged between 1972 and 1974. To date 37 of the 399 fish tagged at the mouth of the Nowitna during that study have been recovered. All except three were recovered near the location tagged or slightly downstream. None have been recovered in the lower Yukon River. By contrast 29 of 187 fish tagged at Marshall on the lower Yukon River in May of 1974 have been recovered, including over 70% in villages in the lower Yukon but also in the middle Yukon and Koyukuk rivers (Alt, 1977).

## Sheefish Egg Counts

Egg counts of six prespawning sheefish taken from the Yukon River at the 19 Mile Research Site above Rampart ranged from 105,900 for a 5.23 kg fish to 230,000 for a 9.66 kg fish (Table 5).

Egg counts of two prespawning sheefish from the Salmon Fork of the Black River spawning grounds near the mouth of Kevinjik Creek were 27,000 for a 1.95 kg fish and 36,000 for a 2.16 kg fish. In this sample only the two smallest females were selected.

The Rampart fish belong to the anadromous lower Yukon population and were taken on the spawning migration route on September 23. The average size of spawning females is 6.69 kg, thus an average fish would have approximately 170,000 to 180,000 eggs.

The size of Salmon Fork female spawners is considerably smaller than in any spawning population studied in Alaska, and based on limited data their egg counts are only a fraction of that for females in other populations. The average size of Salmon Fork River females is 3.14 kg and 674 mm (n=11).

The only other sheefish fecundity data are from Geiger (1969) who estimated fecundity for 13 Kobuk River spawners at 90,700 for a 4.6 kg fish to 459,400 for a 21.4 kg fish. The Kobuk River sample ranged from age IX to XIX, with most fish age XIII to XVIII and 76 to 111 cm. The Kobuk egg count was most closely correlated with fish weight. For the 13 fish, ovary weight averaged 20% of body weight and there were 9,000 eggs per pound of body weight. In the Kobuk sample a fish with 289,000 eggs weighed 14 kg.

## Middle Yukon River Spawning Ground Surveys

Search for spawning grounds of sheefish passing through the Rampart area of the Yukon River failed to locate spawning grounds or large concentrations of spawning fish. The surveys conducted between Rampart and Ft. Yukon during mid September took 54 fish but only 11 mature sheefish upstream from the 19 Mile Research Site above Rampart.

Two sheefish were taken during three net nights of fishing at the mouth of the Porcupine River (one mature male and one mature 6.4 kg female); four fish, all immature, were taken during five net nights of fishing in the lower 4 km of Chandalar River. Thirteen fish (including 7 mature males, 1 mature female) were taken in eddies or swift water areas of the main Yukon River and Beaver Slough of the Yukon River in 13 net nights of fishing, but no sheefish were taken during two net nights of fishing at the mouth of Beaver Creek. Four fish (all immature) were taken in a dead slough of the Yukon River below Beaver during two net nights; one fish (immature) was taken at the mouth of the Hodzana River (two net nights) and 30 fish (all mature) were taken during three net nights of fishing in the eddy at 19 Mile Research Site above Rampart.

Table 5. Egg counts of selected females from the Yukon River at Rampart and the Salmon Fork of the Black River.

| Location | Weight (kg) | F.L. (mm) | Age | Egg Diameter (mm) | No. Eggs |
|---|---|---|---|---|---|
| Rampart | 5.23 | 745 | X | 2.5 | 105,900 |
| | 5.23 | 750 | X | 2.5 | 127,800 |
| | 5.23 | 775 | X | 2.4 | 147,200 |
| | 6.48 | 777 | XI | 2.4 | 170,000 |
| | 7.50 | 877 | XII | 2.3 | 197,800 |
| | 9.66 | 915 | | 2.4 | 230,000 |
| Salmon Fork River | 1.95 | 585 | VIII | 2.4 | 27,000 |
| | 2.16 | 605 | VIII | 2.5 | 36,000 |

These data indicate presence of at least small numbers of prespawning sheefish upstream of the 19 Mile Research Site in the main Yukon River near Beaver and at the mouth of the Porcupine River.

A survey of the Porcupine River in late September 1973 located a small population of sheefish 236 km upstream but no mature fish below this point (Alt, 1974). The few mature sheefish taken in the Porcupine would not account for the large number of sheefish passing through Rampart. The capture of two prespawning sheefish at the mouth of the Porcupine River complicates the picture. These fish could have been heading to: (1) the upper Porcupine River, (2) the Sheenjek River, (3) the Black River, or (4) further up the Yukon River. Ft. Yukon residents said sheefish do not spawn up the Sheenjek River and none were observed during 1973 aerial and boat surveys.

The size of the prespawning female caught at the mouth of the Porcupine River (6.3 kg) is considerably larger than the size of spawning females found in the upper Porcupine River and in the Salmon Fork of the Black River but similar in size to the female spawners passing through Rampart. The 6.3 kg fish also had a dart tag wound. Dart tags were used only for tagging fish in the section between the Nowitna and the Porcupine rivers, thus at least one of the two mature fish came from the middle Yukon River.

Black River-Salmon Fork River Study

The search for spawning grounds of sheefish passing through Rampart in the fall was also conducted in the Salmon Fork of the Black River. Spawning grounds were located but were of a local population rather than of the anadromous lower Yukon population (Fig. 1).

Movements:

Overwintering areas of sheefish of the Black and Salmon Fork rivers are evidently in the deeper holes of the slow moving Black River, as residents of Chalkytsik (125 km up the Black River) take both mature and immature fish immediately after breakup in May. There is evidently some interchange between sheefish in the Black River and Yukon system as a 54 cm immature sheefish tagged at the mouth of Hess Creek (Yukon River) on September 30, 1974 was captured on June 3, 1977 at Chalkytsik in the Black River. This may indicate that at least some of the sheefish found off tributary rivers of the middle Yukon River in June are of Black River-Salmon Fork origin. Other spawning grounds for middle Yukon River sheefish probably exist. Some fish also belong to the lower Yukon population, as a fish tagged at Hess Creek mouth on June 3, 1974 was recovered at the mouth of the Yukon River in January 1976.

Data do not support the hypothesis that Black River and Porcupine River sheefish belong to the same population, although there is probably some intermingling near the mouth of Black River and both groups have similar growth rates.

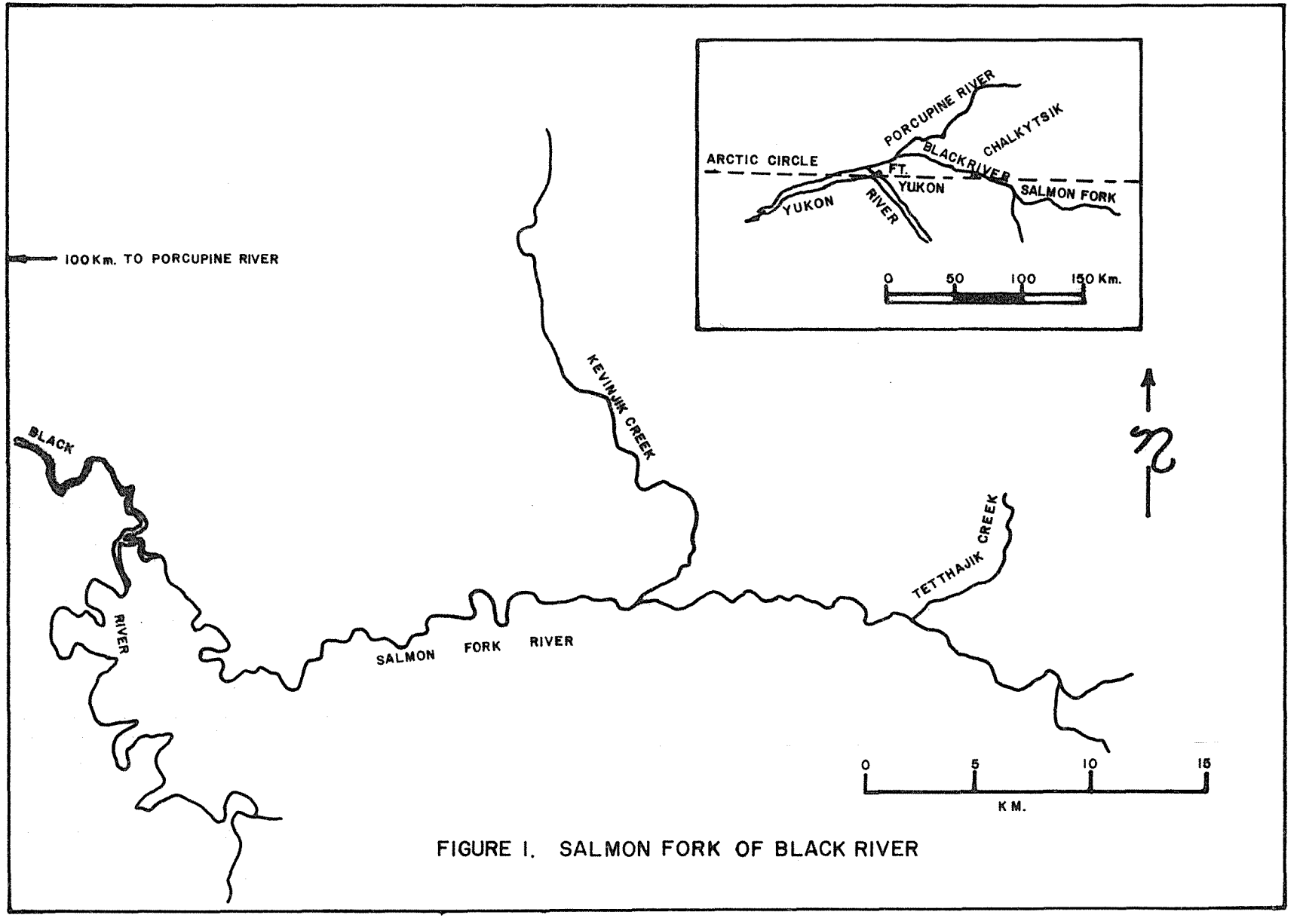


FIGURE I. SALMON FORK OF BLACK RIVER

In the Black River proper a few feeding sheefish have been reported in the Black River from the mouth of the Salmon Fork River up to the mouth of Grayling Creek but no spawners have been reported. An immature sheefish was taken at the mouth of Kevinjik Creek in the Salmon Fork River but probably no spawning occurs there.

Prespawning sheefish and a few immature fish were present in the vicinity of the spawning grounds as early as August 28 in 1977, the first date a subsistence net was first used by a local trapper. Test netting efforts at the Salmon Forks of Black River by Fish and Game personnel from September 22 to 29 took 17 sheefish; all but one were prespawners (Table 6). There appeared to be no buildup in numbers in late September and the highest catch of two sheefish per net night does not indicate a large spawning population. There is probably a slow movement during the summer up to the spawning grounds on the Salmon Fork, as Chalkytsik residents mention catching mature sheefish only early in the summer.

Spawning:

Sex products could be pressed from sheefish captured during the last week of September, indicating that spawning would soon commence. No large concentration of prespawners was found in the area of the Salmon Fork of the Black River near Kevinjik Creek. Only 17 sheefish were captured during 18 net nights of fishing, no fish were observed during aerial flights and only one sheefish was observed during boat surveys from 10 km below Kevinjik Creek to 20 km above Kevinjik Creek. Flow of the Salmon Fork River on September 23 at low water in a pool area was calculated at 39 $m^3$/sec. The stream is approximately 65 m wide in the area 2.5 km below the mouth of Kevinjik Creek and the average depth is 0.59 m.

Mean size of Salmon Fork River spawners is quite small, with 21 males averaging 592 mm fork length (530-670 mm) and 1.86 kg (1.48-2.61), while 11 females were 674 mm fork length (585-794) and 3.41 kg (1.93-4.23 kg). Mean weight of Rampart female spawners, by comparison, is 6.69 kg.

The Salmon Fork River in the vicinity of Kevinjik Creek, where the sheefish probably spawn, contains approximately 30% riffle area and 70% pool area in the 10 km below Kevinjik Creek and 40% riffle area and 60% pool area in the 10-20 km below Kevinjik Creek. The current in most pool areas is too slow to keep the gravel cleared of algae. Most riffle areas are too shallow (<1 m) for sheefish spawning, and it appears that spawning areas would be located where the river constricts, forming a chute which has velocity usually in excess of 2.5 mph and water depth 1 to 3 m deep. A probable spawning area is located 3 km below Kevinjik Creek where the stream is 30 m wide, has an average depth of 1.5 m, and a velocity of 1.22 m/sec. Bottom type in this area is 5% sand and silt, 5% small gravel, 10% medium gravel, and 80% large gravel and rubble. Most of the large and coarse gravel is over 50 mm in diameter and includes rock over 200 mm. Gravel composition over the entire area of the Salmon Fork River surveyed is similar.

Table 6. Catch statistics Salmon Fork of Black River September 22-30. Three sheefish were also caught on hook and line.

| Location | Net Nights | Fish Captured | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | SF | CS | HWF | BWF | LCI | GR | NP |
| 3 km below Kevinjik Cr. | 10 | 8 | 101 | 7 | 7 | 2 | 0 | 2 |
| 8 km above Kevinjik Cr. | 8 | 9 | 102 | 16 | 11 | 0 | 11 | 2 |

Water temperatures of the Salmon Fork River ranged from 6.5°C on September 21 to 3°C on September 30. The area 3 km below Kevinjik Creek was checked during early evening for spawning activity between September 25 and 29, but none was observed.

Local residents report that the river rarely freezes before late October due mainly to spring water influences from Kevinjik Creek and the Salmon Fork River.

Age and Growth:

Sheefish captured in the Black River at Chalkytsik and the Salmon Fork River near Kevinjik Creek ranged in age from V to XIII, with ages VII to XI being most common (Table 7).

Mature females ranged in age from VIII to XIII, while mature males ranged in age from VII to X. Sex was not recorded on many of the subsistence captured sheefish, but two immature males captured in the Salmon Fork River were age VII, and one age VIII female from the Black River was immature. Two nonconsecutive spawning females were captured in the Salmon Fork River.

Sheefish from the Black River-Salmon Fork grow considerably slower than sheefish taken at Rampart in the fall and at mouths of tributary rivers of the middle Yukon River during the summer (Alt, 1974). Their growth is similar to growth of sheefish from the Porcupine River (Alt, 1974) and for sheefish from the upper Yukon River (Alt, 1969).

## DISCUSSION

Based on numbers of spawning fish and considerably slower growth, it is apparent that sheefish spawning in the Salmon Fork River are not of the same population as those passing through Rampart in the Yukon River. These fish probably represent a small local population living in the Black River and spawning in the Salmon Fork River. Similarity of growth rate suggests that they could be closely allied with sheefish of the Porcupine River population. There is probably some intermixing of the two populations but the Porcupine population spawns in the upper Porcupine River. Similarity of growth between Salmon Fork sheefish and sheefish of the upper Yukon population (Alt, 1969) is probably a result of similar environmental conditions. Spawning grounds of the upper Yukon population have not been located but indirect evidence indicates they are in tributary rivers between the mouth of the Charley River and the mouth of the Seventymile River.

Table 7. Age-length relationships of sheefish taken in Black River at Chalkytsik and Salmon Fork River near the mouth of Kevinjik Creek. Mean fork length given in mm. No fish under age V were taken.

| Stream | Age at Capture | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | V | VI | VII | VIII | IX | X | XI | XII | XIII |
| Black R. - Salmon Fork R. n-54 | 470 n=1 | 521 n=1 | 581 n=8 | 589 n=15 | 615 n=16 | 686 n=4 | 683 n=6 | 733 n=2 | 794 n=1 |

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