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Abundance and Composition of Sheefish in the Kobuk River, 1994 - 1995

by

Thomas T. Taube

July 1996

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd
Spell out acre and ton.	

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s
Spell out year, month, and week.	

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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by

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ABSTRACT

The goal of this study was to determine the stock status of spawning sheefish *Stenodus leucichthys* in the upper Kobuk River, with the objectives of estimating abundance, and length and age composition of spawning sheefish in a 130 km reach of the upper Kobuk River. Sampling was conducted September 9 - 25, 1994 and August 18 - September 27, 1995. Sheefish were collected by hook and line, and beach seine. Length, sex, and age data were collected and sheefish were marked with a Floy tag. Length, sex, and age data were taken from subsistence caught sheefish. Flooding of the Kobuk River during the summer of 1994 delayed and shortened the sampling period, thereby reducing sample size and preventing the estimation of abundance. However, length and age composition of the sample were determined. Sheefish examined ranged from 10 to 21 years of age. The largest proportion of female sheefish was age 14 and age 13 for males. The 875 mm category had the largest proportion of female sheefish, while the 800 mm category had the largest proportion of males. Sheefish of age 9 or less were absent from the 1994 sample. In 1995, 32,273 (SE = 5,908) sheefish were estimated in the area between Kobuk Village and Reed River prior to spawning. Sheefish examined ranged from age 9 to age 23. The largest proportion of female sheefish was age 14 and age 12 for males. The largest proportion of female sheefish was in the 925 mm category and in the 800 mm category for the male sheefish. Sampling of the subsistence and commercial fisheries in Hotham Inlet was conducted November 13 - 16, 1995. Sheefish examined ranged from age 7 to age 16. The largest proportion of sheefish was in the 750 mm category. Sampling in 1996 will require larger sample sizes and focus effort on sheefish holding locations within the study area.

Key words: sheefish, *Stenodus leucichthys,* Kobuk River, abundance estimate, length composition, age composition, spawning.

INTRODUCTION

Sheefish *Stenodus leucichthys* or inconnu has a worldwide holarctic distribution ranging from the White Sea in Russia at 40° E. longitude across Siberia, Alaska and northwestern Canada to the Anderson River at 128° W. longitude (Alt 1969).

In Alaska the species is mainly confined to large river drainages and their associated brackish water environments. Major populations occur in the Kuskokwim, Yukon and Kobuk/Selawik rivers. Except for spawning, sheefish occupy slow moving reaches of rivers, overwintering near the mouths of large river systems or in large freshwater lakes and inlets. Sheefish migrate long distances upstream to spawn in late fall. In the Yukon River sheefish may travel 1,600 km to spawning areas while those in the Kobuk River spawn approximately 320 to 400 km upstream.

The spawning migration of mature sheefish in the Kobuk River is an extension of the seasonal feeding migration of the population which begins soon after ice breakup in the spring. Sheefish move upstream rapidly, reaching Kiana, 100 km upstream from the mouth of the Kobuk River, by late June (Figure 1). Nonspawners seldom migrate more than 180 km upstream from the mouth of the Kobuk River, but spawners continue upriver reaching Ambler in mid-July. As fish reach Ambler, 265 km upstream from the mouth of the Kobuk River, the migration slows and fish disperse. They reach spawning areas between Kobuk Village and Reed River (544 to 672 km upstream from the mouth of the Kobuk River) from August through early September. Spawning occurs a few days prior to the beginning of freeze up (appearance of frazzle ice). After spawning a downstream migration occurs (Alt 1969 and 1987). Alt (1987) found only one nonspawning sheefish in the vicinity of the spawning grounds. It is therefore assumed that all sheefish encountered in this area will be spawners.

The Kobuk/Selawik population contains the largest sheefish in Alaska; individuals up to 26.5 kg have been captured (Alt 1987). Because of their large size and relatively easy access, Kobuk

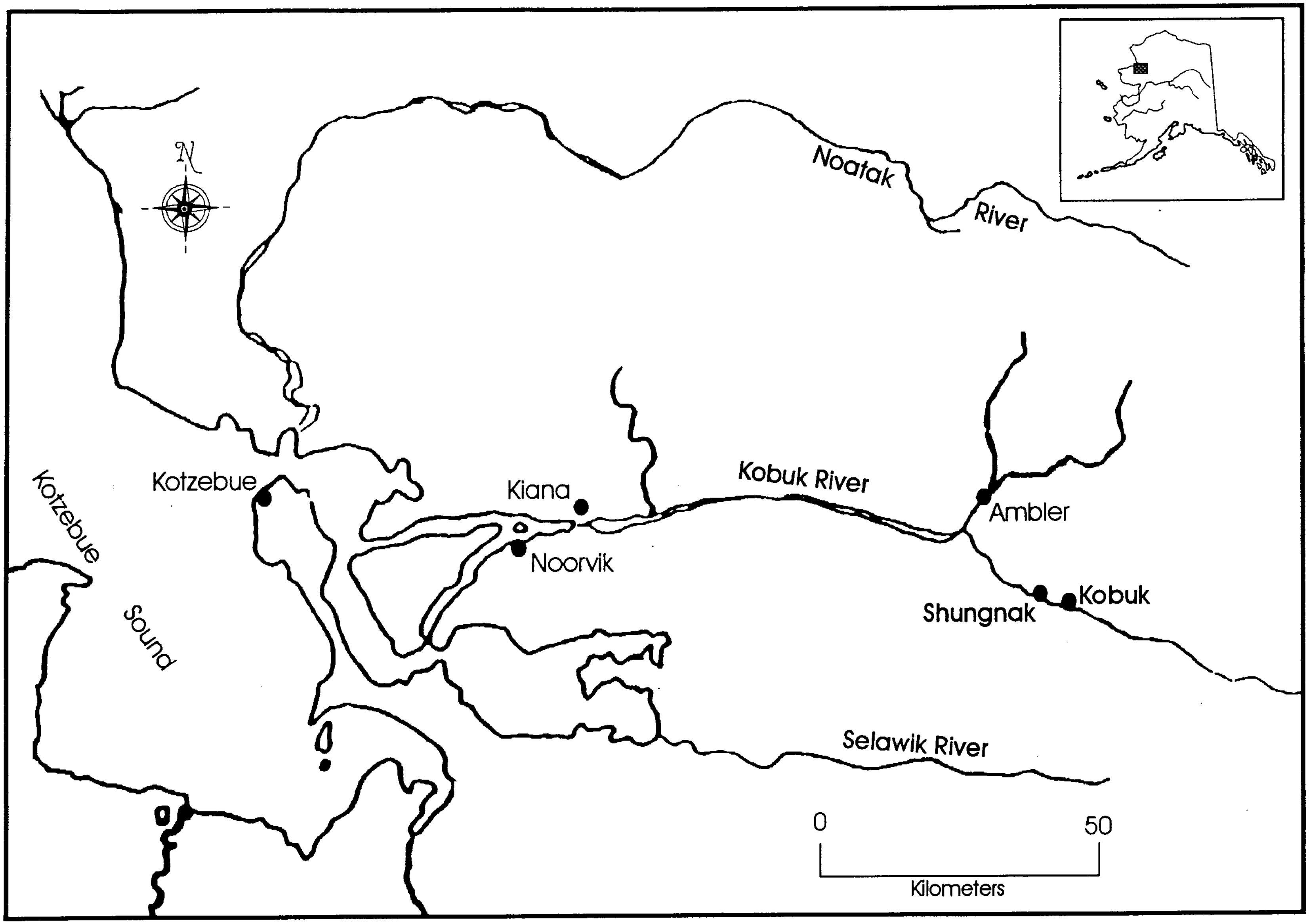

Figure 1.-Map of Kobuk River and surrounding area.

River sheefish are highly sought by sport anglers. Since the inception of the Alaska Department of Fish and Game (ADF&G) trophy fish program in 1967 through 1992, 8 of 9 trophy sheefish registered have been taken from the Kobuk river. All official Hall of Fame 1994 world fresh water fish records of North America (tackle and line class) for sport angled sheefish are from fish caught in the Kobuk River (National Fresh Water Fishing Hall Of Fame, Hayward, Wisconsin).

Estimated sport fish harvests of these fish from the Kobuk River from 1977 to 1994 have averaged 818 fish, ranging from 131 in 1989 to 1,886 in 1982 (Mills 1979 - 1994, Howe, et al. 1995). During this time period sheefish from the Kobuk River have accounted for 34% of the statewide sport harvest of sheefish and 59% of the sport harvest of sheefish for northwestern Alaska. Estimated sport fish catches of these fish from the Kobuk River from 1990 to 1994 have averaged 1,080 fish (Mills 1991 - 1994, Howe, et al. 1995). During this time period the Kobuk River has accounted for 23% of the statewide and 60% of the northwestern Alaska sport catch of sheefish.

Current sport fishing regulations for sheefish in the Kobuk River are: 2 per day, 2 in possession, with no size limit for sheefish upstream of the mouth of the Mauneluk River and 10 per day, 10 in possession, with no size limit for the remainder of the Kobuk River. Prior to 1988 the sport fishing regulations for sheefish in the Kobuk River were 10 fish per day, no possession limit, and no size limit. Concerns for the maintenance of this sheefish stock and continuance of this unique trophy fishery were the motivation behind these proposals submitted by ADF&G to and adopted by the Alaska Board of Fisheries in 1987.

In addition to supporting an important sport fishery in the Kobuk River, Kobuk/Selawik sheefish are taken in both subsistence and commercial fisheries (Appendix A). The major harvest is for subsistence with reported harvests as high as 31,292 sheefish (Lean et al. 1993). From 1967 through 1995 the estimated commercial harvest has averaged 1,203 fish. Lean et al. (1992) suggest that commercial harvests have remained relatively high. It is suspected that the undocumented commercial harvest is significant and totals should be considered minimum estimates. The subsistence fishery occurs throughout the Kotzebue District which includes the Kobuk and Selawik rivers, Selawik Lake, and Hotham Inlet (Lean et al. 1992).

Currently the subsistence fishery is not regulated. Lean et al. (1992) reported that during the 1960's, age, sex, and length data indicated sheefish stocks were being overharvested by commercial and subsistence fisheries in the Kotzebue district. Consequently, an annual area commercial harvest quota of 25,000 pounds of sheefish was instituted.

Data on the number of sheefish spawning in the Kobuk River are intermittent and the result of aerial surveys conducted by ADF&G Division of Commercial Fisheries Management and Development. Between 1966 and 1971, aerial counts averaged 3,706 and ranged from 1,025 to 8,166 (Alt 1987). Intermittent aerial counts since 1979 (1979, 1980, 1984, 1991, and 1992) have averaged 5,617 and have ranged from 1,772 to 17,335 (Lean et al. 1993). A mark-recapture experiment conducted in 1970 estimated 7,130 spawners, while an aerial survey in 1970 counted only 3,220 spawners (Alt 1987).

Past work on sheefish in Alaska was summarized by Alt (1987) and includes data on the ecology, movements, growth, and stock status of all known Alaskan stocks. The Subsistence Division (ADF&G) investigated conflicts (real and perceived) between user groups on the upper Kobuk River in 1989 (Georgette and Loon 1990). The Sport Fish Division (ADF&G) has had no projects directed toward Kobuk River sheefish since 1979.

The goal of this project is to describe the stock status of spawning sheefish in the upper Kobuk River. In order to accurately and precisely describe the stock status of spawning sheefish in the upper Kobuk River, project objectives and tasks for the non federally-funded study in 1994 were to estimate:

1. the abundance of sheefish spawning in a 130 km reach of the upper Kobuk River such that the estimate is within 25% of the true abundance 90% of the time;
2. the length and age compositions of sheefish spawning in a 130 km reach of the upper Kobuk River such that the estimates are within 5 percentage points of the actual values 95% of the time;
3. the length and age compositions of Arctic grayling in the upper Kobuk River such that the estimates are within 5 percentage points of the actual value 90% of the time; and,
4. the length and age compositions of prespawning least cisco, broad and humpback whitefish in the upper Kobuk River such that the estimates are within 5 percentage points of the actual value 90% of the time.

Objectives for the 1995 Federal Aid project F-10-11, R-3-5(b) were to estimate:

1. the abundance of sheefish spawning in a 130 km reach of the upper Kobuk River such that the estimate is within 25% of the true abundance 90% of the time;
2. the length and age compositions of sheefish spawning in a 130 km reach of the upper Kobuk River such that the estimates are within 5 percentage points of the actual values 95% of the time; and,
3. the length and age compositions of sheefish examined from the spring subsistence fishery at Hotham Inlet such that the estimates are within 10 percentage point of the actual values 95% of the time.

In addition, sampling of winter commercial and subsistence sheefish fisheries in Hotham Inlet was conducted.

METHODS

DATA COLLECTION

The study area for the abundance estimates consisted of a 130 km stretch of the Kobuk River divided into three sections: 1) Kobuk Village to the Mauneluk River (48 km or 30 miles); 2) Mauneluk River to the Selby River (32 km or 20 miles); and 3) Selby River to the Reed River (50 km or 31 miles) (Figure 2). Sampling occurred from August 15-16 and September 9-25, 1994 and August 18 - September 27, 1995, throughout the study area.

In 1994, the marking event (event 1) occurred from August 15-16, September 9-16 and the recapture event (event 2) occurred from September 17-25. Sampling during event 1 in 1994 was disrupted due to flooding of the Kobuk River during August and September. Sheefish were sampled using hook and line, and a 61.5 m (200 ft) beach seine during both events. When possible, sheefish harvested in the subsistence fishery were sampled during both events in 1994. In 1995, event 1 occurred from August 18 - September 7 and event 2 occurred from September 8-27. Sheefish were sampled using hook and line only during event 1. Hook and line, 61.5 m

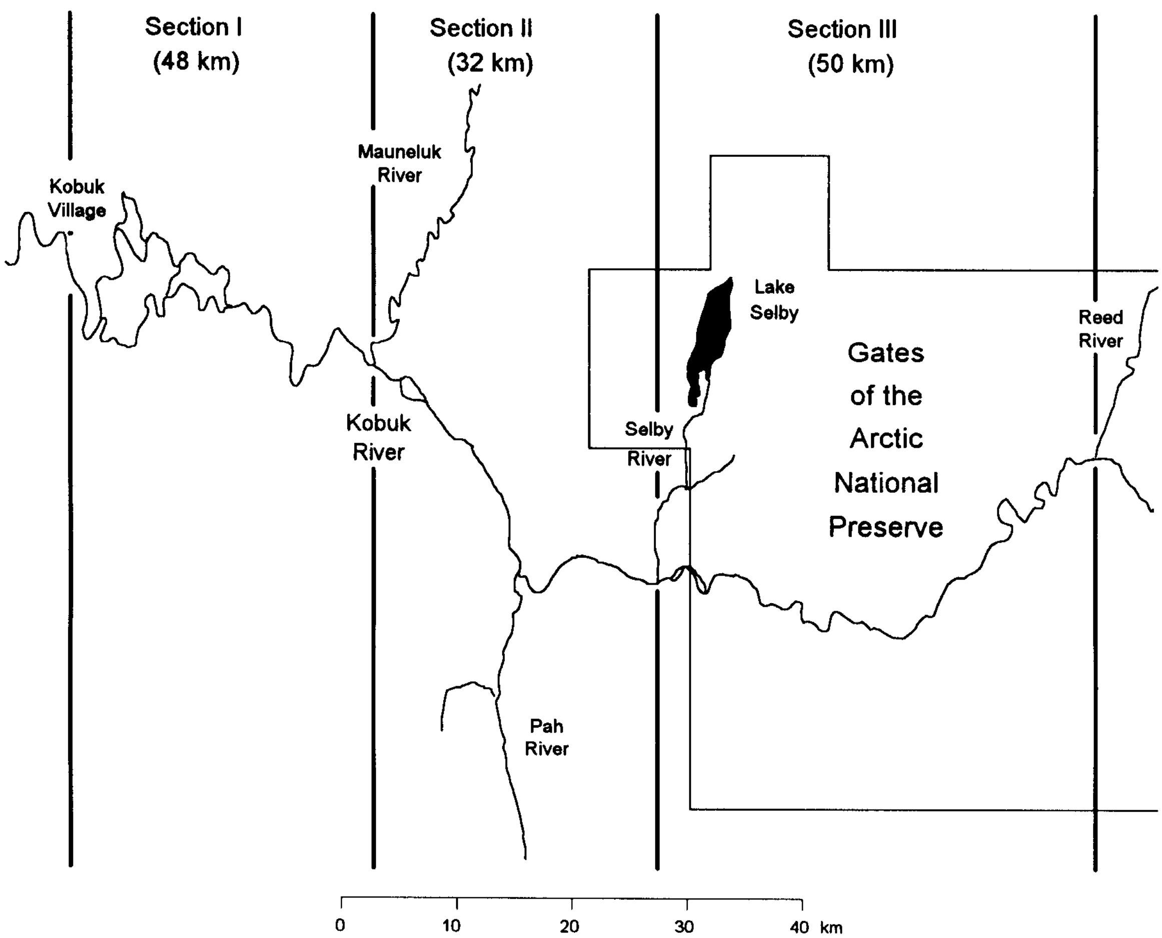

Figure 2.-Area of the Kobuk River sampled for sheefish in 1994 and 1995.

beach seine, and the subsistence gillnet fishery were used to sample sheefish during event 2. The start of event 2 in 1995 coincided with the targeting of sheefish by the subsistence gillnets within the study area.

A crew of four to six persons sampled sheefish with hook and line from two boats (two to three crew members per boat). These fish were located and caught primarily in the main channel of the Kobuk River in moderate velocity water off the river bottom. Length , sex, tag number, finclip, date, river section and river mile were recorded on Tagging Length Version 1.0 mark-sense forms. All captured sheefish were examined for Floy tags and prior finclips and measured to the nearest millimeter of fork length. During both event 1 and 2, untagged sheefish judged to be in a healthy condition were released after being marked with an individually numbered Floy FD-67 internal anchor tag inserted at the base of the dorsal fin so that the tag locked between the posterior interneural rays. Various fin clips were applied to all tagged fish identifying the river section and the event in which the fish were marked in case tag loss occurred between events. The sex and maturity of each live fish was determined by the presence of sex products. Fish for which sex could not be determined were recorded as neither male or female. Sheefish were landed as expediently as possible and usually processed in under 30 s. Fish were then held in the water, head facing the current and released once they were judged to be in a healthy condition. Fish that were injured or severely bleeding were not tagged. At least three scales were taken from the left side of the body just posterior of the dorsal fin approximately midway between the lateral line and the base of the dorsal fin (Alt 1969). The scales were placed into coin envelopes for later mounting onto gum cards. Coin envelopes were labeled appropriately to correspond with the mark-sense forms. The scales were mounted onto gum cards and impressions were made on 20 mil acetate sheets using a Carver press at 241,315 kPa (35,000 psi) heated to 145° C for 135 seconds. Scales were read on a Micron 770 microfiche reader (32X). Annulus determination was made using criteria described by Alt (1969). Ages were then recorded into the edited data file.

Sheefish sampled by beach seine were processed in the manner described above. One boat and a crew of at least four was used during seining. The spawning grounds were located in shallow (< 1.5 m), high velocity water. A rope harness was attached to each end of the seine with a 16 m lead. One or two crew members stayed on shore holding one lead, while the remaining crew pushed the boat into the current. The seine was let out parallel to the shore as the current took the boat downstream. Immediately after the seine was set, other lead was then motored to shore, the ends were brought together and the entire seine pulled to shore.

Sheefish caught in the subsistence fishery were examined whenever permission was granted by the subsistence users. These fish were examined for tags and secondary marks, length and sex were recorded and scale samples were taken. During sampling in 1994, incidentally caught Arctic grayling, least cisco, broad, and humpback whitefish were sampled for age and length data. In 1995, subsistence and commercial gillnet fisheries in Hotham Inlet were sampled during November 13 - 16, and sampling was conducted by a two person crew on snowmachines. These gillnets are fished beneath the ice. When a net was pulled, permission to sample the catch was obtained. All sheefish captured in a net were sampled for length and age data as described above. Sampling of the spring fishery was not accomplished due to poor weather and ice conditions in April and May 1994.

Abundance Estimation

The number of sheefish spawning in the Kobuk River was estimated using the Bailey modification of the Petersen estimator (Seber 1982). Population abundance and the approximate variance of the estimate was calculated with the following formulas (Seber 1982).

$$\hat{N} = \frac{M(C+1)}{(R+1)} \tag{1}$$

$$V[\hat{N}] = \frac{M^2(C+1)(C-R)}{(R+1)^2(R+2)} \tag{2}$$

where:

M = the number marked during the first sampling event;

C = the number examined during the second sampling event; and,

R = the number captured during the second sampling event with marks from the first sampling event.

A two event mark-recapture experiment on a closed fish population is unbiased if the following conditions are met:

1. catching and handling the fish does not affect the probability of recapture;
2. fish do not lose marks between events;
3. recruitment and mortality do not occur between sampling events (recruitment or mortality can occur, but not both);
4. every fish must have an equal probability of being marked and released alive during the first sampling event; or every fish must have an equal probability of being captured during the second sampling event; or marked fish mix completely with unmarked fish between sampling events (Seber 1982).

Condition 1 was met because only sheefish that were judged to be in good condition after capture were marked prior to being released. Condition 2 was met by double marking each fish (Floy tag and finclip) in order to determine if marks were lost between events. In regards to condition 3, we know that mortality induced by the subsistence fishery occurred during both events in 1994. Since it was assumed that both marked and unmarked portions of the population were equally likely to be harvested in the fishery, this did not affect the accuracy of the abundance estimate. In 1995, the start of event 2 coincided with the targeting of sheefish by the subsistence fishery; any mortality that occurred during event 1 was assumed to be negligible. However, there was a possibility that not all pre-spawning sheefish were on the spawning grounds prior to initiation of the marking event (event 1) and as such condition 3 would be violated. Marked-to-unmarked ratios by each river section during each week of event 2 were evaluated to determine if recruitment to the population had occurred.

To evaluate condition 4, the marked-to-unmarked ratio at each river section during event 2 was compared using the Chi-square statistic and contingency table. Movement and/or mixing of marked sheefish with unmarked sheefish was determined by visual comparison of the frequency of marked fish recaptured in the second event that moved from one river section to another with the frequency of unmarked fish examined in the second event in each river section.(Appendix B1).

The hypothesis of equal probability of capture of fish by size between each sampling event was tested with Kolmogorov-Smirnov two sample tests (Appendix B2). The first test involved the lengths of marked fish recaptured during the second event versus the lengths of those fish marked during the first event. The second test compared the lengths of fish marked during the first event with fish examined during the second event (Seber 1982).

AGE AND LENGTH COMPOSITION

Estimates of length and age composition were calculated as follows (Cochran 1977):

$$\hat{p}_j = \frac{n_j}{n} \tag{3}$$

$$\hat{V}[\hat{p}_j] = \frac{\hat{p}_j(1-\hat{p}_j)}{n-1} \tag{4}$$

where:

n_j = the number in the sample from group j:

n = the sample size; and,

$\hat{p}_j$ = the estimated fraction of the population that is made up of group j.

The estimated abundance of each group j in the population is:

$$\hat{N}_j = \hat{p}_j\hat{N} \tag{5}$$

where:

$\hat{N}_j$ = the estimated number of fish in the population in group j; and

$\hat{N}$ = the estimated population.

The variance of $\hat{N}_j$ is the exact variance of a product (Goodman 1960) (subtracted term ignored since one term has an exact variance and the other term has a sampling variance as per D. R. Bernard, Alaska Department of Fish and Game, personal communication):

$$\hat{V}[\hat{N}_j] = \hat{V}[\hat{p}_j]\hat{N}^2 + V[\hat{N}]\hat{p}_j^2 \tag{6}$$

RESULTS

1994 RESULTS

Abundance Estimation

No estimate of abundance of spawning sheefish in the Kobuk River between Kobuk Village and the confluence of the Reed River was calculated. Due to flooding of the Kobuk River during the summer of 1994, sampling was delayed and sample size of marked sheefish captured during the second sampling event was not sufficient to estimate spawning abundance.

A total of 875 unique sheefish were examined during the 1994 sampling period. Of these, approximately 51% were captured by hook and line, 23% by seine, and 26% by gillnet in the subsistence fishery (Table 1). Nearly the same amount of sheefish were caught in section 2 (399) as section 3 (403), substantially fewer fish were caught in section 1 (73). Two hundred ninety-three sheefish captured by hook and line and seine were marked during event 1. Only 1 marked fish was observed in 515 sheefish examined during event 2. Sheefish examined during event 2 were caught by hook and line, seine, and subsistence gillnet. Sixty-eight sheefish caught by the subsistence fishery during event 1 were sampled for length and age data. Due to an insufficient number of recaptures during event 2 and small sample size during both events, an unbiased abundance estimate could not be calculated.

Table 1.-Sheefish marked, examined, recaptured, and R/C ratio by event, gear type, and river section for the 1994 sampling period.

		Event 1	Event 2		
		8/15-16, 9/9-16	9/17-25		
Gear Type	River Section	Sheefish Marked (M)	Sheefish Examined (C)	Sheefish recaptured (R)	R/C
Seine	1	0	0	0	0
	2	3	0	0	0
	3	0	185	1	0.005
	Total	3	185	1	0.005
H & L	1	0	1	0	0
	2	280	11	0	0
	3	10	164	0	0
	Total	290	176	0	0
Gillnet	1	0	72	0	0
	2	68	37	0	0
	3	0	45	0	0
	Total	68	154	0	0
Total		361	515	1	0.002

Hook and line sampling was conducted in all three sections, but only one sheefish was caught in section 1. The largest catches with the beach seine occurred on the spawning grounds in section 3. Only three sheefish were captured by seine in section 2. No sheefish were captured by seine in section 1. Samples from the subsistence catch were taken from camps at 24, 64, and 98 km (river miles 15, 40, and 61) above Kobuk Village (Appendix C).

Age and Length Composition

Length and age composition samples were taken from all the unique sheefish examined during the sampling period. The largest proportion of sheefish in the sample was in the 825 mm category ($p = 0.164$, SE = 0.0004) (Figure 3). The largest proportion of female sheefish was in the 875 mm category ($p = 0.245$, SE = 0.0013) and in the 800 mm category for the male sheefish ($p = 0.237$, SE = 0.0008). Length distribution of female sheefish examined was significantly different than that of male sheefish ($D = 0.338$, $P = 0$)(Figure 3). The mean length of all sheefish examined was 834 mm ($n = 874$). Mean length of male sheefish was 801 mm ($n = 536$) and 889 mm ($n = 331$) for females. No length was recorded for one sheefish and sex was not determined for eight sheefish.

The ages of all sheefish examined ranged from age 10 to age 21, male sheefish ranged in age from 10 to 19 years, while female sheefish ranged from 10 to 21 years. The largest proportion of male sheefish was age 13 ($p = 0.32$, SE = 0.0009) and female sheefish was age 14 ($p = 0.255$, SE = 0.0014). Age 13 fish were the largest proportion of 831 sheefish examined ($p = 0.285$, SE = 0.0005). Sex composition of sheefish examined in 1994 was 62% male and 38% female. A summary of length and age composition data is found in Appendix D.

During sampling in 1994, spawning activity was observed or reported between 93 to 99 km (river miles 58 to 62) above Kobuk Village as early as September 20. The majority of sheefish captured at this site on September 24-25 were spawned out. This was the only site spawning was observed or reported during the sampling period. Several other sites had high catches of sheefish, either by subsistence nets or hook and line sampling; since spawning was not observed at these areas, they may have been prespawning holding areas. Thirty-nine percent (341) of all sheefish examined were captured around 64 km (river mile 40) above Kobuk Village, 304 of these were captured prior to September 17. Other sites at which 30 or more sheefish were captured were located around 24, 48, and 85 km (river miles 15, 30, and 53) above Kobuk Village (Appendix C). Length and age composition of incidentally caught Arctic grayling and whitefish are found in Appendix E.

1995 Results

Abundance Estimation

A total of 910 sheefish were marked during event 1, and 1,341 sheefish were examined during event 2 (Table 2). Twenty-seven marked sheefish were recaptured during the second event, 23 by gillnet and four by seine. No marked fish were observed in 349 sheefish captured by hook and line during the second sampling event. Gillnet and seine samples had similar proportions of marked to unmarked sheefish during event 2. The hook and line sample would be expected to catch marked and unmarked sheefish in a similar proportion to gillnet and seine unless another factor such as gear avoidance was involved. The use of the hook and line data from event 2 would result in an overestimate of the abundance. For this reason, sheefish captured by hook and line during the second event were excluded from the abundance estimate. Only 11 sheefish were captured by all gear types in section 1 during the second event (eight by gillnet and three by hook and line). Since sampling effort was distributed throughout the study area, it was assumed that the majority of sheefish had moved out of section 1 and into sections 2 and 3. To prevent bias due to small sample size, the data from section 1 was combined with section 2 data when conditions 3 and 4 were tested. Therefore, for the purpose of estimating abundance, 910 sheefish were marked (M), 992 sheefish were examined (C), and 27 sheefish were recaptured (R). The abundance of

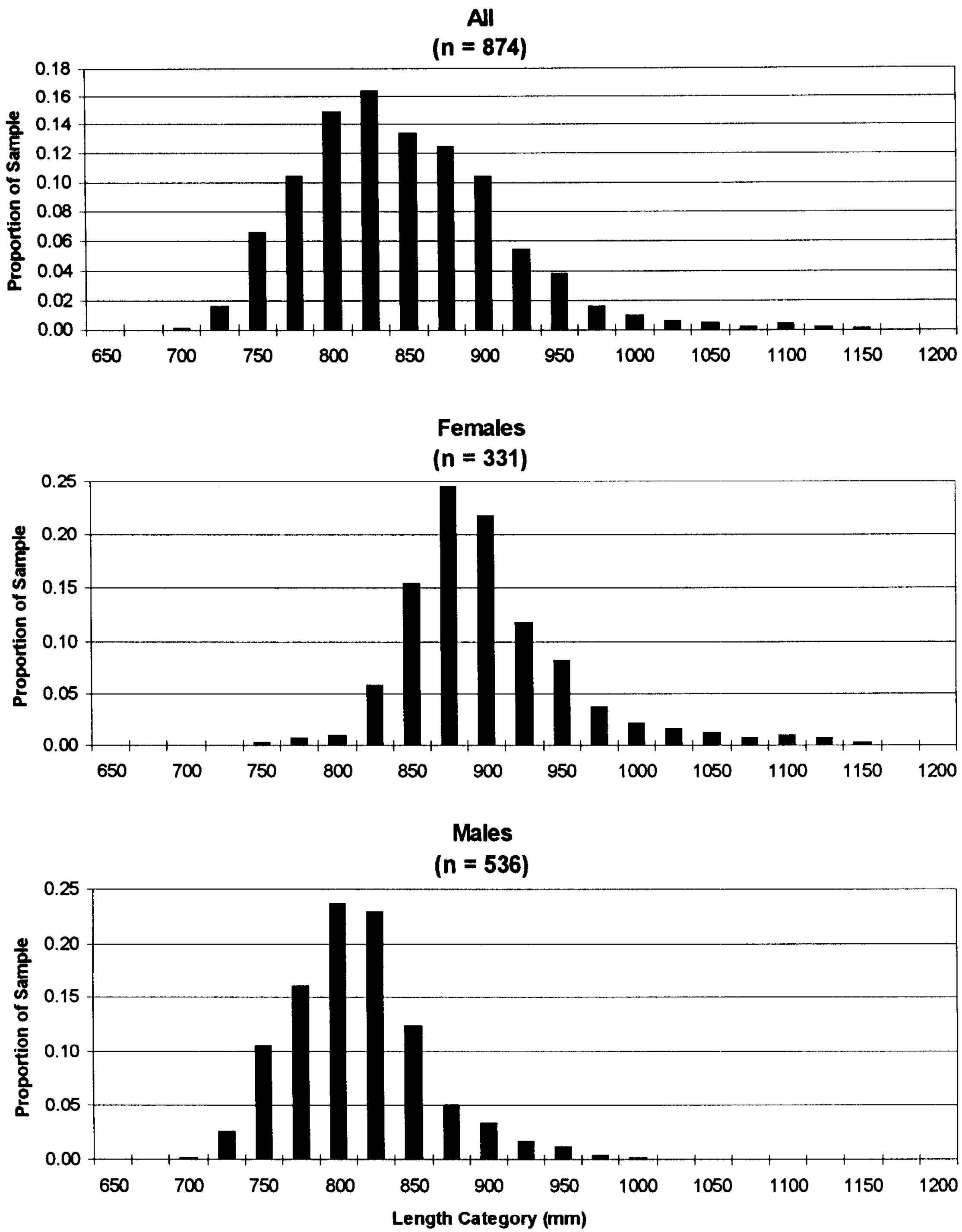

Figure 3.-Length composition of sheefish caught from the Kobuk River during both sampling events in 1994.

spawning sheefish on the Kobuk River between Kobuk Village and Reed River in 1995 was 32,273 (SE = 5,908).

A total of 2,266 sheefish (including recaptures) were caught during the sampling period, 925 during the first event and 1,341 during the second. Fifteen sheefish were not marked due to poor condition at the time of capture or were marked during event 1 and recaptured during event 2 in the subsistence fishery without the total number of sheefish captured known. No sheefish were netted in the subsistence fishery during event 1, because the subsistence fishery targets salmon and whitefish during this time. During event 2, 61% of the sheefish examined were captured by subsistence gillnet, 26% by hook and line, and 13% by seine.

Table 2.-Sheefish marked, examined, recaptured, and R/C ratio by event, gear type, and river section for the 1995 sampling period.

		Event 1	Event 2		
		8/18 - 9/7/95	9/8 - 27/95		
Gear Type	River Section	Sheefish Marked (M)	Sheefish Examined (C)	Sheefish Recaptured (R)	R/C
Seine	1	0	0	0	0
	2	0	0	0	0
	3	0	173	4	0.023
	Total	0	173	4	0.023
H & L	1	157	3	0	0
	2	543	169	0	0
	3	210	177	0	0
	Total	910	349	0	0
Gillnet	1	0	8	0	0
	2	0	642	19	0.030
	3	0	169	4	0.024
	Total	0	819	23	0.028
Total		910	1,341	27	0.020

The condition that recruitment does not occur between sampling events was not violated. There was no significant difference in the marked to unmarked ratio by section during each week of event 2 (section 1/2: $\chi^2 = 0.9969$, P = 0.62; section 3: $\chi^2 = 0.3383$, P = 0.85), therefore recruitment to the population was unlikely. Since the subsistence gillnet fishery did not target sheefish during the first event, it was assumed that mortality during event 1 was negligible. Therefore, since both mortality and recruitment did not occur during either event, the abundance estimate is germane to the time of the marking event (August 18 - September 7, 1995).

There was no significant difference in the marked-to-unmarked ratio at each section ($\chi^2 = 0.1102$, P = 0.74), therefore the capture probability of marked fish was the same in all river sections. Of the 27 sheefish marked during the first event and recaptured during the second, 52% moved upstream to another section, 44% stayed within the section in which it was marked, and 4% moved downstream. The ratio of marked fish recaptured in each river section was similar to the ratio of unmarked fish examined in each river section. This indicates that movement and/or complete mixing of marked and unmarked fish occurred across river sections and catchability of marked and unmarked fish was equal. Therefore, condition 4 was not violated and stratification by river section for the abundance estimate was not necessary.

There was no significant difference between the lengths of sheefish marked during the first event and marked sheefish recaptured during the second (D = 0.2086, P = 0.20). There was a significant difference in lengths of fish marked during the first event and fish examined during the second (D = 0.2053, P = 0). According to the criteria followed to detect bias due to unequal catchability by length, stratification by length was not necessary for the abundance estimate (Appendix B2). There was size selectivity during the first sampling event but not the second, lengths and ages from the second event were used to estimate length and age composition.

Age and Length Composition

Kobuk River

Length and age composition samples were taken from all unique sheefish examined during the second event, according to methods in Appendix B2. Samples from sheefish caught by hook and line during event 2 were not included in the length and age composition, since they were excluded from the abundance estimate. The largest proportion of sheefish in the sample was in the 825 mm category (p = 0.129, SE = 0.0001) (Figure 4). The largest proportion of female sheefish was in the 925 mm category (p = 0.202, SE = 0.0004) and in the 800 mm category for the male sheefish (p = 0.230, SE = 0.0003). Length distribution of female sheefish examined was significantly different than that of male sheefish (D = 0.804, P = 0) (Figure 4). The mean length of all sheefish examined was 872 mm (n = 992). Mean length of male sheefish was 807 mm (n = 535) and 950 mm (n = 451) for females. Sex was not determined for six sheefish examined during the second event.

The ages of all sheefish examined ranged from 9 to 23 years; male sheefish ranged in age from 9 to 19 years, while female sheefish ranged from 11 to 23 years. The largest proportion of male sheefish was age 12 (p = 0.30, SE = 0.0005) and female sheefish was age 14 (p = 0.20, SE = 0.0004). Age 12 fish were the largest proportion of all 844 sheefish examined (p = 0.19, SE = 0.0002).

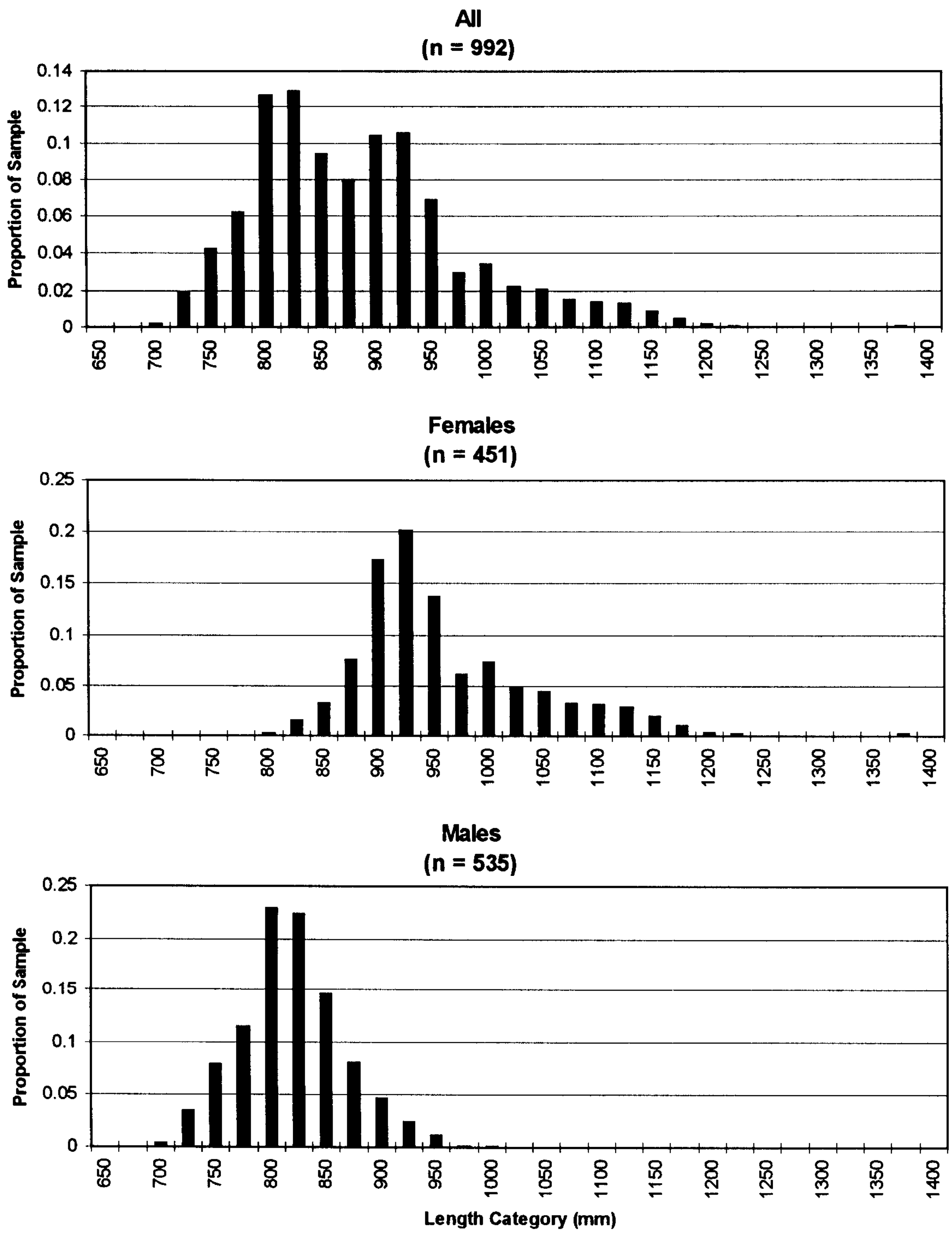

Figure 4.-Length composition of sheefish examined from the Kobuk River during sampling in 1995.

Sex composition of sheefish examined in 1995 was 54% male and 46% female. Alt (1969) also reported a composition of 54% male and 46% female sheefish in the area of the Kobuk River spawning grounds. Ratios of male to female sheefish captured on spawning grounds of other river systems have ranged from 2.2:1 at the Chatanika River to 4.7:1 at Big River (Kuskokwim) (Alt 1987).

During sampling in 1995, spawning activity was observed or reported at 42 and 93 km (river miles 26 and 58) above Kobuk Village beginning September 24. Spawned out sheefish began to show up in the gillnet catch after this time but, the majority of sheefish captured were not spawned out even the last day of sampling (September 27). These were the only sites spawning was observed or reported during the second event. Several other sites had high catches of sheefish, either by subsistence nets or seining; since spawning was not observed at these areas, they may have been prespawning holding areas. Sixty-four percent (637) of all sheefish examined during the second event were captured around 64 km (river mile 40) above Kobuk Village, this area was the main site for subsistence gillnets in the sampling area. There were gillnets fishing this site 17 of the 20 days of the second event. Other sites at which 30 or more sheefish were captured (during either event) are found in Appendix C.

Hotham Inlet

Length and age composition samples were taken from all unique sheefish examined from the subsistence/commercial fishery on Hotham Inlet during November 1995. Sex was not determined since sheefish were not examined internally. The largest proportion of sheefish were found in the 750 mm category (Figure 5). The length distribution of sheefish examined in Hotham Inlet was significantly smaller than sheefish examined during the second event on the Kobuk River ($D = 0.449$, $P = 0$). Both mature and immature sheefish are available to the subsistence/commercial fishery, which would account for the difference in length distribution. The ages of all sheefish examined on Hotham Inlet ranged from 7 to 16 years, with age 11 the predominant age class ($p = 0.24$, $SE = 0.21$). A summary of length and age composition data of sheefish examined on the Kobuk River and Hotham Inlet in 1995 is found in Appendix D.

Tags were collected from four sheefish during sampling and 16 additional tags were returned to the ADF&G Commercial Fisheries Management and Development office in Kotzebue. Of these, 17 were tagged on the Kobuk River (11 in 1994, six in 1995) and three were from sheefish tagged on the Selawik River during 1994 and 1995. A 1994 tag and 1995 tag were captured in the same net. The amount of time from when the six Kobuk River fish were tagged at the study area until being caught in Hotham Inlet ranged from 70 to 136 days.

DISCUSSION

Due to the flooding during the summer of 1994, distribution of spawning sheefish in the study area of the upper Kobuk River may not have been typical of previous years. High water levels may have prevented sheefish from spawning in historic spawning areas. Alt (1987) suggested a upriver shift in spawning activity from 38 - 45 km above Kobuk Village to areas below the Mauneluk River (48 km above Kobuk Village) and above the Selby River (80 km above Kobuk Village) over time and due to physical changes in the river. These may be the reasons why spawning activity was only observed upstream of the Selby River in 1994. In 1995, a Shungnak elder reported sheefish spawning activity across from her fish camp at 42 km (26 miles) above Kobuk Village. The sampling crew observed spawning activity in the evening off a gravel

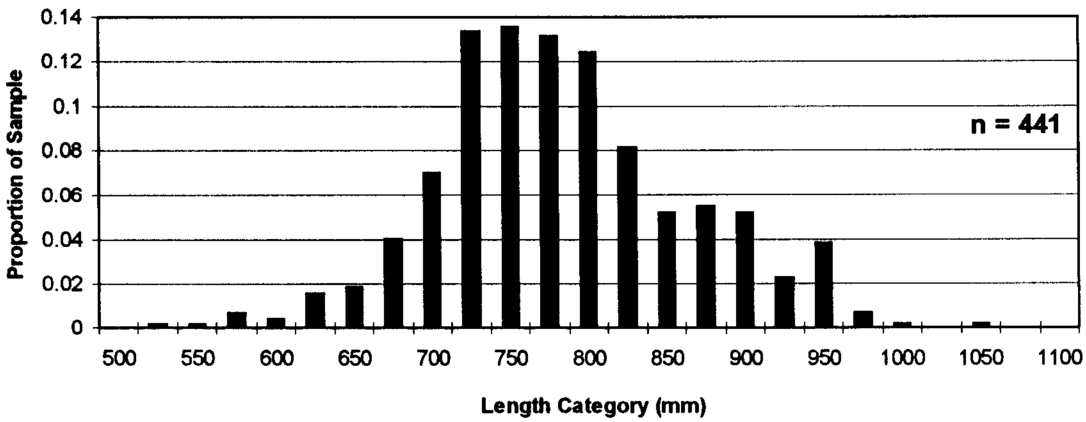

Figure 5.-Length composition of sheefish examined from Hotham Inlet during sampling in 1995.

bar at 93 km (58 miles) above Kobuk Village. Large numbers of sheefish were captured by gillnet at 64 and 98 km (40 and 61 miles) and by hook and line at 102 km (64 miles) above Kobuk Village during September 24 - 27. These large concentrations of sheefish could indicate spawning sites in the vicinity of these areas. River conditions were near normal in 1995, as a result spawning activity occurred in areas previously reported.

Kobuk River sheefish become sexually mature at age 7 for males and age 9 for females (Alt 1987). Alt (1987) reported that all sampled males age 11 and females age 14 had spawned at least once. None of the sheefish sampled in 1994 were less than 10 years in age. Alt (1969) reported a mean length at age 10 of 656 mm for Kobuk River sheefish. The smallest sheefish examined for aging data in 1994 was 709 mm. This may account for the lack of sheefish under age 10 in the 1994 sample. Why there were no sheefish (particularly males) under age 10 in the 1994 sample is unclear, it may reflect poor year class recruitment or be a factor of the flooding. In contrast, river conditions were relatively normal in 1995 and sheefish sampled were as young as age 7 during the first event and age 9 during the second. There were 16 sheefish less than 709 mm captured by all gear types during both events, 38% were age 9 or less. The fact that sheefish less than age 10 were captured during sampling in 1995 is likely due to a combination of river conditions, larger sample size and longer sampling period.

Tag loss did not appear to be a problem during sampling in 1994 and 1995. No sheefish captured had secondary marks without having a Floy tag. There was also no sampling mortality of sheefish in 1994 and only one sheefish mortality in 1995. Several fish each year were released bleeding from the gills, but they were not tagged. It was not observed if these fish died from their injuries. Due to current or deep water it was difficult to see the fish after released and if fish swam away strongly it was assumed that they survived. There were no reports from other users of the river that tagged sheefish were observed behaving erratically or found dead. It is therefore believed that mortality due to handling and sampling methods was negligible.

Alt (1969) proposed that male sheefish spawn every year while females do not. Four sheefish that had been marked during sampling in 1994 were recaptured during sampling on the Kobuk River in 1995. All four of these fish were males. Approximately 630 sheefish tagged in 1994 and 1,365 tagged in 1995 will be at large during sampling in 1996. If males do spawn every year, male sheefish tagged in 1994 and 1995 should be on the spawning grounds in 1996, as may female sheefish tagged in 1994, if females spawn every other year.

The estimate of 32,273 sheefish between Kobuk Village and Reed River was substantially larger than expected. To estimate a population of this size within 25% of the true abundance 90% of the time, 1,168 sheefish will need to be marked and examined in 1996. In 1995, 910 sheefish were marked in event 1 and 1,341 sheefish were examined during event 2. Since movement between sections occurred during the events 1 and 2, sampling during 1996 could target holding areas within each section without bias to the estimate and optimize sampling during the marking event. This would allow the number of marked sheefish to be achieved within the same time period or less. In addition to hook and line, seining should be attempted if sheefish are congregated in suitable areas during the marking event. Hook and line was not effective in capturing marked sheefish during the second event which may be due to gear avoidance and should not be used during the second event, unless there is a hiatus between events. Gillnets and seining may provide a recapture event sample large enough to provide a abundance estimate, if the effort that was spent hook and line sampling is spent checking gillnets and seining. Seining was not effective in 1994 and 1995 until fish were at the spawning areas. Large congregations of sheefish were seen in 1995 prior to spawning, but often these fish were not in areas suitable to seine or only in suitable areas for a short duration. Alt (1969) reported spawning activity only in the early evening and seining at this time may result in greater capture success. Sampling in the evening may also lead to the discovery of new spawning areas suitable for seining, that were overlooked during midday since fish were not present. To avoid problems of mortality and recruitment occurring at the same time during an event, the start of the second event should coincide with the targeting of sheefish by the subsistence fishery. As in 1995, sampling in 1996 should concentrate on conducting the marking event prior to spawning and the recapture event during spawning.

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APPENDIX A

Appendix A1.-Sheefish sport fish harvests and catch, 1977-94 (Mills 1977-94, Howe, 1995).

Year	Kobuk River Harvest	Kobuk River Catch[a]	NW Alaska Harvest	NW Alaska Catch[a]	Alaska Harvest	Alaska Catch[a]
1977	625	-	656	-	1,247	-
1978	307	-	506	-	1,291	-
1979	682	-	709	-	1,542	-
1980	1,248	-	1,713	-	2,411	-
1981	1,015	-	1,263	-	2,239	-
1982	1,886	-	2,222	-	3,281	-
1983	1,448	-	2,079	-	3,323	-
1984	740[b]	-	3,050	-	3,947	-
1985	1,330[b]	-	1,645	-	2,520	-
1986	1,590	-	3,363	-	3,721	-
1987	865	-	1,836	-	2,597	-
1988	964[b]	-	964	-	3,221	-
1989	131	-	629	-	2,306	-
1990	151	336	151	403	750	3,360
1991	579	1,568	603	1,616	2,256	3,989
1992	627	2,034	1,904	3,678	2,933	6,587
1993	395	1,074	1,029	2,273	1,619	6,666
1994	135	386	564	958	1,511	2,981

[a] Sport fish catch was not reported until 1990.

[b] Sheefish harvest is for streams of NW Alaska.

Appendix A2.-Reported subsistence sheefish harvests, Kotzebue District, 1966-1994 (taken from Lean et al. 1993)[a].

Year	Number of Fishermen Interviewed	Reported Harvest	Average Catch Per Fishermen
1966-67	13	22,40	16
1967-68	14	31,29	21
1968-69	14	11,87	8
1970	16	13,92	8
1971	15	13,58	8
1972	7	3,83	4
1973	6	4,88	7
1974	5	1,06	1
1975	6	1,63	2
1976	5	96	1
1977	9	1,81	1
1978	9	1,81	1
1979	7	3,98	5
1980	7	3,11	4
1981	6	6,65	10
5/82-4/83[b]	13	4,70	3
5/83-4/84[b]	2	76	2
5/84-9/84	3	2,80	9
1985[c]		6	3
1986[b,c]	7	72	1
1987[c]	4	27	
1988[c,d]			
1989[c]			
1990[c]			
1991	4	2,18	5
1992	4	2,82	6
1993[d]			
1994	25	3,18	1

[a] Due to limited survey effort during many years total catch and effort should be regarded as minimum figures only and are not comparable from year to year.

[b] Summer catches only; winter catches were not documented.

[c] Villages were not surveyed for subsistence sheefish harvests from 1985 to present; figures shown are catches reported during the fall chum salmon subsistence surveys, and may include summer as well as winter catches.

[d] Subsistence sheefish catches not documented.

Appendix A3.-Kotzebue District winter commercial sheefish harvest statistics, 1967-95 (taken from Lean et al. 1993)[a].

Year[b]	No. of Fishermen	No. of Fish	Total Pounds	Average Pounds	Price/Pound	Estimated Value
1967[c]		4,000	26,000	6.5	$0.20	$5,200
1968	10	792	4,752	6.0	$0.22	$1,045
1969	17	2,340	15,209	6.5	$0.25	$3,802
1970[c]		2,206			$0.14	
1971	4	73	720	9.9	$0.13	$95
1972	5	456	4,071	8.9	$0.16	$651
1973	11	2,322	15,604	6.7	$0.20	$3,121
1974	6	1,080[d]	6,265	5.8	$0.30	$1,880
1975	[c]	2,543[d]	24,161	9.5	$0.30	$7,248
1976	14	2,633	19,484	7.4	$0.30	$5,845
1977	2	566	5,004	8.8	$0.30	$1,501
1978	11	2,870	26,200	9.1	$0.40	$10,480
1979[e]						
1980	4	1,175	8,225	7.0	$0.50	$4,113
1981	1	278	1,836	6.6	$0.75	$1,377
1982	11	2,629[f]	17,376	6.6	$0.75	$13,032
1983	8	1,424	13,395	9.4	$0.50	$6,698
1984	5	927[d]	10,403	11.2	$0.55	$5,722
1985	4	342[d]	3,902	11.4	$0.51	$1,990
1986	2	26	312	12.0	$0.75	$234
1987	3	670	5,414	8.1	$0.49	$2,653
1988	3	943	7,373	7.8	$0.45	$3,318
1989	8	2,335	16,749	7.2	$0.51	$8,542
1990[c]	6	687	5,617	8.2		
1991	5	852	8,224	9.7	$0.50	$4,112
1992	3	289	2,850	9.9	$0.65	$1,853
1993	1	210[d]	1,700	8.1	$0.50	$850
1994[e]						
1995[g]	1	226	2,240	9.9	$0.50	$1,120

[a] Data is not exact, in some instances total catch poundage was determined from average weight and catch data. Similarly, various price/pound figures were determined from price/fish and average weight data.
[b] Season was from October 1 to September 30. Year indicated would be the year the commercial season ended. For example, the year 1980 would represent October 1, 1979 to September 30, 1980.
[c] Data unavailable or incomplete.
[d] Numbers of fish not always reported. Estimates were based on average weights from reported sales which documented the number of fish.
[e] No reported commercial catches.
[f] Estimate based on historical average weight.
[g] Table is updated from draft 1995 season summary.

APPENDIX B

Appendix B1.-Methodology to alleviate bias due to unequal catchability by river section.

Result of χ^2 Test[a]	Inspection of Fish Movement[b]
Case I:	
"Accept H_o"	No movement between sections
There is no differential capture probability by river section or marked fish completely mixed with unmarked fish within each river section.	
Case II:	
"Accept H_o"	Movement between sections
There is no differential capture probability by river section or marked fish completely mixed with unmarked fish across river sections.	
Case III:	
"Reject H_o"	No movement between sections
There is differential capture probability by river section or marked fish did not mix completely with unmarked fish within at least one river section.	
Case IV:	
"Reject H_o"	Movement between sections
There is differential capture probability by river section or marked fish did not mix completely with unmarked fish across river sections.	

[a] The χ^2 test compares the frequency of marked fish recaptured during the second event in each river section with the frequency of unmarked fish examined in the second event in each river section. H_o: the capture probability of marked fish in the second event is the same in all river sections.

[b] Inspection of fish movement is a visual comparison of the frequency of marked fish recaptured in the second event that moved from one river section to another with the frequency of unmarked fish examined in the second event in each river sections.

Case I: Calculate one unstratified abundance estimate using the Petersen estimator (Seber 1982).

Case II: Calculate one unstratified abundance estimate using the Petersen estimator (Seber 1982).

Case III: Completely stratify the experiment by river section , calculate abundance estimate for each using the Petersen estimator (Seber 1982), and sum abundance estimates.

Case IV: Completely stratify the experiment by river section . Calculate abundance estimates for each using the Petersen estimator (Seber 1982) and sum estimates. Calculate abundance with the partially stratified model of Darroch (1961) and compare with the sum of Petersen estimates. If estimates are dissimilar, discard the sum of Petersen estimates and use the Darroch estimate as the estimate of abundance. If estimates are similar, discard the estimate with the largest variance.

Appendix B2.-Methodologies for alleviating bias due to gear selectivity by means of statistical inference (Bernard and Hansen 1992).

Results of Hypothesis Tests (K-S and χ^2) on Lengths of Fish Marked during First Event and Recaptured during Second Event	Results of Hypothesis Tests (K-S) on Lengths of fish Captured during First Event and during Second Event
Case I:	
"Accept" H_o	"Accept" H_o
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_o	Reject H_o
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_o	"Accept" H_o
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_o	Reject H_o
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data.

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Also, calculate a single estimate of abundance without stratification.

Case IVa: If the stratified and unstratified abundance estimates for the entire population are dissimilar, discard the unstratified estimate. Only use the lengths, ages, and sexes from the second sampling event to estimate proportions in composition, and apply formulae to correct for size bias to data from the second event.

Case IVb: If the stratified and unstratified abundance estimates for the entire population are similar, discard the estimate with the larger variance. Only use the lengths, ages, and sexes from the first sampling event to estimate proportions in compositions, and do not apply formulae to correct for size bias.

APPENDIX C

Appendix C1.-Sampling and subsistence sheefish catch by event, gear type, and river mile[a] during 1994.

River	Event 1			Event 2			Total
	August 15-16, September 9-16			September 17- 25			
Mile	H & L	Seine	Gillnet	H & L	Seine	Gillnet	Catch
15	0	0	0	0	0	72	72
26	0	0	0	0	1	0	1
30	0	29	0	0	1	0	30
33	0	6	0	0	0	0	6
37	0	3	0	0	0	0	3
40	3	233	68	0	0	37	341
41	0	9	0	0	6	0	15
43	0	0	0	0	3	0	3
46	0	0	0	0	1	0	1
50	0	0	0	1	0	0	1
53	0	9	0	9	14	0	32
55	0	0	0	6	0	0	6
56	0	0	0	5	0	0	5
57	0	0	0	2	0	0	2
58	0	0	0	24	5	0	29
59	0	0	0	9	12	0	21
60	0	0	0	129	57	0	186
61	0	0	0	0	4	45	49
62	0	0	0	0	29	0	29
63	0	0	0	0	1	0	1
66	0	0	0	0	11	0	11
67	0	0	0	0	3	0	3
68	0	0	0	0	4	0	4
69	0	0	0	0	7	0	7
70	0	0	0	0	3	0	3
71	0	0	0	0	12	0	12
75	0	0	0	0	2	0	2
76	0	1	0	0	0	0	1
Total	3	290	68	185	176	154	876

[a] River mile is the distance upstream of Kobuk Village.

Appendix C2.-Sampling and subsistence sheefish catch by event, gear type, and river mile[a] during 1995.

River Mile	Event 1 August 18 - September 7 H & L	Event 2 September 8-27 H & L	Event 2 September 8-27 Seine	Event 2 September 8-27 Gillnet	Total Catch
3	2	0	0	0	2
4	120	0	0	0	120
8	1	0	0	0	1
11	1	0	0	0	1
12	1	0	0	0	1
13	1	0	0	8	9
14	2	0	0	0	2
20	8	0	0	0	8
24	1	0	0	0	1
25	1	0	0	0	1
26	6	3	0	0	9
27	1	0	0	0	1
28	6	0	0	0	6
29	9	0	0	0	9
30	2	2	0	5	9
31	32	0	0	0	32
32	1	0	0	0	1
33	14	0	0	0	14
34	3	0	0	0	3
35	2	0	0	0	2
36	1	0	0	0	1
37	5	0	0	0	5
38	13	19	0	0	32
39	245	114	0	0	359
40	211	11	0	637	859
45	0	23	0	0	23
46	3	0	0	0	3
48	2	0	0	0	2
50	20	0	0	0	20
51	7	0	0	0	7
52	11	1	0	0	12
53	5	2	0	0	7
55	7	13	0	0	20
56	15	4	0	0	19
57	16	3	0	36	55
58	1	13	62	0	76

-continued-

Appendix C2.-(Page 2 of 2).

River Mile	Event 1 H & L	Event 2 H & L	Event 2 Seine	Event 2 Gillnet	Total Catch
59	23	12	4	0	39
60	112	35	107	21	275
61	0	0	0	112	112
63	0	1	0	0	1
64	6	51	0	0	57
65	8	2	0	0	10
67	0	2	0	0	2
68	0	2	0	0	2
69	0	4	0	0	4
71	0	4	0	0	4
74	0	22	0	0	22
79	0	6	0	0	6
Total	925	349	173	819	2,266

[a] River mile is the distance upstream of Kobuk Village.

APPENDIX D

Appendix D1a.-Length composition of sheefish examined from the Kobuk River, 1994.

	All Fish				Female				Male			
Length	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
600	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
625	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
650	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
675	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
700	1	0.00	1.31E-06	0.0011	0	0.00	0	0	1	0.00	3.48E-06	0.0019
725	14	0.02	1.81E-05	0.0042	0	0.00	0	0	14	0.03	4.75E-05	0.0069
750	58	0.07	7.1E-05	0.0084	1	0.00	9.13E-06	0.0030	56	0.10	0.000175	0.0132
775	91	0.10	0.000107	0.0103	2	0.01	1.82E-05	0.0043	86	0.16	0.000252	0.0159
800	130	0.15	0.000145	0.0120	3	0.01	2.72E-05	0.0052	127	0.24	0.000338	0.0184
825	143	0.16	0.000157	0.0125	19	0.06	0.000164	0.0128	123	0.23	0.000331	0.0182
850	117	0.13	0.000133	0.0115	51	0.15	0.000395	0.0199	66	0.12	0.000202	0.0142
875	109	0.12	0.000125	0.0112	81	0.24	0.00056	0.0237	27	0.05	8.94E-05	0.0095
900	91	0.10	0.000107	0.0103	72	0.22	0.000516	0.0227	18	0.03	6.07E-05	0.0078
925	48	0.05	5.95E-05	0.0077	39	0.12	0.000315	0.0177	9	0.02	3.09E-05	0.0056
950	33	0.04	4.16E-05	0.0065	27	0.08	0.000227	0.0151	6	0.01	2.07E-05	0.0045
975	14	0.02	1.81E-05	0.0042	12	0.04	0.000106	0.0103	2	0.00	6.95E-06	0.0026
1000	8	0.01	1.04E-05	0.0032	7	0.02	6.27E-05	0.0079	1	0.00	3.48E-06	0.0019
1025	5	0.01	6.52E-06	0.0026	5	0.02	4.51E-05	0.0067	0	0.00	0	0
1050	4	0.00	5.22E-06	0.0023	4	0.01	3.62E-05	0.0060	0	0.00	0	0
1075	2	0.00	2.62E-06	0.0016	2	0.01	1.82E-05	0.0043	0	0.00	0	0
1100	3	0.00	3.92E-06	0.0020	3	0.01	2.72E-05	0.0052	0	0.00	0	0
1125	2	0.00	2.62E-06	0.0016	2	0.01	1.82E-05	0.0043	0	0.00	0	0
1150	1	0.00	1.31E-06	0.0011	1	0.00	9.13E-06	0.0030	0	0.00	0	0
1175	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
1200	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
Total	874	1.00			331	1.00			536	1.00		

Appendix D1b.-Length composition of sheefish examined during the second event from the Kobuk River, September 8 - 27, 1995.

	All Fish							Female				Male			
Length	Frequency	p	V(p)	SE	N	V(N)	SE	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
650	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
675	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	2	0.002	2.03E-06	1.42E-03	65	2256	48	0	0	0	0	2	0.004	6.97E-06	0.003
725	19	0.019	1.90E-05	4.35E-03	618	32547	180	0	0	0	0	19	0.036	6.41E-05	0.008
750	42	0.042	4.09E-05	6.40E-03	1366	105176	324	0	0	0	0	42	0.079	1.35E-04	0.012
775	62	0.063	5.91E-05	7.69E-03	2017	197915	445	0	0	0	0	62	0.116	1.92E-04	0.014
800	126	0.127	1.12E-04	1.06E-02	4099	679606	824	1	0.002	4.92E-06	0.002	123	0.230	3.32E-04	0.018
825	128	0.129	1.13E-04	1.06E-02	4164	699199	836	7	0.016	3.40E-05	0.006	120	0.224	3.26E-04	0.018
850	93	0.094	8.57E-05	9.26E-03	3026	396044	629	15	0.033	7.15E-05	0.008	78	0.146	2.33E-04	0.015
875	79	0.080	7.40E-05	8.60E-03	2570	298379	546	34	0.075	1.55E-04	0.012	43	0.080	1.38E-04	0.012
900	103	0.104	9.39E-05	9.69E-03	3351	474060	689	78	0.173	3.18E-04	0.018	25	0.047	8.34E-05	0.009
925	105	0.106	9.55E-05	9.77E-03	3416	490489	700	91	0.202	3.58E-04	0.019	13	0.024	4.44E-05	0.007
950	68	0.069	6.44E-05	8.03E-03	2212	231103	481	62	0.137	2.63E-04	0.016	6	0.011	2.08E-05	0.005
975	29	0.029	2.86E-05	5.35E-03	943	59653	244	28	0.062	1.29E-04	0.011	1	0.002	3.49E-06	0.002
1000	34	0.034	3.34E-05	5.78E-03	1106	75786	275	33	0.073	1.51E-04	0.012	1	0.002	3.49E-06	0.002
1025	22	0.022	2.19E-05	4.68E-03	716	39957	200	22	0.049	1.03E-04	0.010	0	0	0	0
1050	20	0.020	1.99E-05	4.46E-03	651	34948	187	20	0.044	9.42E-05	0.010	0	0	0	0
1075	15	0.015	1.50E-05	3.88E-03	488	23631	154	15	0.033	7.15E-05	0.008	0	0	0	0
1100	14	0.014	1.40E-05	3.75E-03	455	21574	147	14	0.031	6.68E-05	0.008	0	0	0	0
1125	13	0.013	1.31E-05	3.61E-03	423	19586	140	13	0.029	6.22E-05	0.008	0	0	0	0
1150	9	0.009	9.07E-06	3.01E-03	293	12321	111	9	0.020	4.35E-05	0.007	0	0	0	0
1175	5	0.005	5.06E-06	2.25E-03	163	6157	78	5	0.011	2.44E-05	0.005	0	0	0	0
1200	2	0.002	2.03E-06	1.42E-03	65	2256	48	2	0.004	9.81E-06	0.003	0	0	0	0
1225	1	0.001	1.02E-06	1.01E-03	33	1094	33	1	0.002	4.92E-06	0.002	0	0	0	0
1250 - 1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1375	1	0	0	0	33	1094	33	1	0.002	4.92E-06	0.002	0	0	0	0
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	992				32,273			451				535			

Appendix D1c.-Length composition of sheefish examined from Hotham Inlet, November 1995.

	All Fish			
Length	Frequency	p	V(p)	SE
500	0	0	0	0
525	1	0.002	5.1E-06	0.002
550	1	0.002	5.1E-06	0.002
575	3	0.007	1.5E-05	0.004
600	2	0.005	1.0E-05	0.003
625	7	0.016	3.6E-05	0.006
650	8	0.018	4.0E-05	0.006
675	18	0.041	8.9E-05	0.009
700	31	0.070	1.5E-04	0.012
725	59	0.134	2.6E-04	0.016
750	60	0.136	2.7E-04	0.016
775	58	0.132	2.6E-04	0.016
800	55	0.125	2.5E-04	0.016
825	36	0.082	1.7E-04	0.013
850	23	0.052	1.1E-04	0.011
875	24	0.054	1.2E-04	0.011
900	23	0.052	1.1E-04	0.011
925	10	0.023	5.0E-05	0.007
950	17	0.039	8.4E-05	0.009
975	3	0.007	1.5E-05	0.004
1000	1	0.002	5.1E-06	0.002
1025	0	0	0	0
1050	1	0.002	5.1E-06	0.002
1075	0	0	0	0
1100	0	0	0	0
Total	441	1		

Appendix D2a.-Age composition of sheefish examined from the Kobuk River, 1994.

	All Fish				Female				Male			
Age	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
7	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
8	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
9	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
10	9	0.01	1.29E-05	0.0036	1	0.00	9.89E-06	0.0031	8	0.02	3.07E-05	0.0055
11	59	0.07	7.95E-05	0.0089	6	0.02	5.84E-05	0.0076	52	0.10	0.000182	0.0135
12	142	0.17	0.000171	0.0131	24	0.08	0.00022	0.0148	117	0.23	0.000351	0.0187
13	237	0.29	0.000246	0.0157	74	0.23	0.000563	0.0237	162	0.32	0.00043	0.0207
14	170	0.20	0.000196	0.0140	81	0.25	0.000599	0.0245	88	0.17	0.000283	0.0168
15	109	0.13	0.000137	0.0117	59	0.19	0.000477	0.0218	48	0.09	0.000169	0.0130
16	50	0.06	6.81E-05	0.0083	29	0.09	0.000261	0.0162	21	0.04	7.85E-05	0.0089
17	26	0.03	3.65E-05	0.0060	20	0.06	0.000186	0.0136	6	0.01	2.31E-05	0.0048
18	16	0.02	2.28E-05	0.0048	13	0.04	0.000124	0.0111	3	0.01	1.16E-05	0.0034
19	6	0.01	8.64E-06	0.0029	4	0.01	3.92E-05	0.0063	2	0.00	7.77E-06	0.0028
20	4	0.00	5.77E-06	0.0024	4	0.01	3.92E-05	0.0063	0	0.00	0	0
21	3	0.00	4.33E-06	0.0021	3	0.01	2.95E-05	0.0054	0	0.00	0	0
22	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0
Total	831	1.00			318	1.00			507	1.00		

Appendix D2b.-Age composition of sheefish examined during the second event from the Kobuk River, September 8 - 27, 1995.

	All Fish							Female				Male			
Age	Frequency	p	V(p)	SE	N	V(N)	SE	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
7	0	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0
9	10	0.012	1.39E-05	0.004	382	19365	139	0	0	0	0	10	0.023	5.39E-05	0.007
10	50	0.059	6.61E-05	0.008	1912	191346	437	0	0	0	0	48	0.113	2.35E-04	0.015
11	82	0.097	1.04E-04	0.010	3135	437822	662	4	0.010	2.34E-05	0.005	78	0.183	3.52E-04	0.019
12	159	0.188	1.81E-04	0.013	6080	1427571	1195	32	0.078	1.74E-04	0.013	126	0.296	4.90E-04	0.022
13	150	0.178	1.73E-04	0.013	5736	1282962	1133	59	0.143	2.99E-04	0.017	90	0.211	3.92E-04	0.020
14	119	0.141	1.44E-04	0.012	4550	843469	918	81	0.197	3.84E-04	0.020	37	0.087	1.87E-04	0.014
15	76	0.090	9.72E-05	0.010	2906	384235	620	57	0.138	2.90E-04	0.017	19	0.045	1.00E-04	0.010
16	55	0.065	7.23E-05	0.009	2103	223478	473	45	0.109	2.37E-04	0.015	9	0.021	4.87E-05	0.007
17	53	0.063	6.98E-05	0.008	2027	210342	459	50	0.121	2.59E-04	0.016	3	0.007	1.65E-05	0.004
18	39	0.046	5.23E-05	0.007	1491	128975	359	34	0.083	1.84E-04	0.014	5	0.012	2.73E-05	0.005
19	24	0.028	3.28E-05	0.006	918	62355	250	23	0.056	1.28E-04	0.011	1	0.002	5.51E-06	0.002
20	20	0.024	2.74E-05	0.005	765	48182	220	20	0.049	1.12E-04	0.011	0	0	0	0
21	5	0.006	6.99E-06	0.003	191	8501	92	5	0.012	2.92E-05	0.005	0	0	0	0
22	1	0.001	1.40E-06	0.001	38	1511	39	1	0.002	5.89E-06	0.002	0	0	0	0
23	1	0.001	1.40E-06	0.001	38	1511	39	1	0.002	5.89E-06	0.002	0	0	0	0
24	0	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0
Total	844				32273			412				426			

Appendix D2c.-Age composition of sheefish examined from Hotham Inlet, November, 1995.

	All Fish			
Age	Frequency	p	V(p)	SE
6	0	0	0	0
7	5	0.012	2.8E-05	0.005
8	15	0.035	8.1E-05	0.009
9	49	0.116	2.4E-04	0.016
10	99	0.234	4.2E-04	0.021
11	102	0.241	4.3E-04	0.021
12	50	0.118	2.5E-04	0.016
13	59	0.139	2.8E-04	0.017
14	32	0.076	1.7E-04	0.013
15	9	0.021	4.9E-05	0.007
16	3	0.007	1.7E-05	0.004
17	0	0	0	0
18	0	0	0	0
Total	423	1		

APPENDIX E

Appendix E1a.-Length composition of broad and humpback whitefish examined from the Kobuk River, 1994.

	Broad whitefish				Humpback whitefish			
Length	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
200	0	0	0	0	1	0.002	4.53E-06	0.0021
210	0	0	0	0	0	0	0	0
220	0	0	0	0	1	0.002	4.53E-06	0.0021
230	0	0	0	0	1	0.002	4.53E-06	0.0021
240	0	0	0	0	5	0.011	2.24E-05	0.0047
250	0	0	0	0	12	0.026	5.3E-05	0.0073
260	0	0	0	0	1	0.002	4.53E-06	0.0021
270	0	0	0	0	1	0.002	4.53E-06	0.0021
280	0	0	0	0	0	0	0	0
290	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0
310	0	0	0	0	0	0	0	0
320	0	0	0	0	1	0.002	4.53E-06	0.0021
330	0	0	0	0	4	0.009	1.8E-05	0.0042
340	0	0	0	0	8	0.017	3.57E-05	0.0060
350	0	0	0	0	13	0.028	5.73E-05	0.0076
360	1	0.053	0.0028	0.0526	37	0.079	0.000155	0.0124
370	0	0	0	0	42	0.089	0.000174	0.0132
380	0	0	0	0	61	0.130	0.000241	0.0155
390	0	0	0	0	52	0.111	0.00021	0.0145
400	0	0	0	0	52	0.111	0.00021	0.0145
410	0	0	0	0	54	0.115	0.000217	0.0147
420	0	0	0	0	38	0.081	0.000158	0.0126
430	0	0	0	0	27	0.057	0.000115	0.0107
440	0	0	0	0	16	0.034	7.01E-05	0.0084
450	1	0.053	0.0028	0.0526	18	0.038	7.85E-05	0.0089
460	1	0.053	0.0028	0.0526	9	0.019	4E-05	0.0063
470	1	0.053	0.0028	0.0526	5	0.011	2.24E-05	0.0047
480	1	0.053	0.0028	0.0526	3	0.006	1.35E-05	0.0037
490	4	0.211	0.0092	0.0961	3	0.006	1.35E-05	0.0037
500	2	0.105	0.0052	0.0723	1	0.002	4.53E-06	0.0021
510	3	0.158	0.0074	0.0859	0	0	0	0
520	2	0.105	0.0052	0.0723	1	0.002	4.53E-06	0.0021
530	1	0.053	0.0028	0.0526	1	0.002	4.53E-06	0.0021
540	0	0	0	0	1	0.002	4.53E-06	0.0021
550	0	0	0	0	0	0	0	0
560	0	0	0	0	0	0	0	0
570	0	0	0	0	0	0	0	0
580	0	0	0	0	0	0	0	0
590	0	0	0	0	0	0	0	0
600	0	0	0	0	1	0.002	4.53E-06	0.0021
610-770	0	0	0	0	0	0	0	0
780	1	0.053	0.0028	0.0526	0	0	0	0
790	1	0.053	0.0028	0.0526	0	0	0	0
800	0	0	0	0	0	0	0	0
Total	19	1.000			470	1.000		

Appendix E1b.-Length composition of round whitefish and Arctic grayling examined from the Kobuk River, 1994.

	Round whitefish				Arctic grayling			
Length	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
180	0	0	0	0	0	0	0	0
190	0	0	0	0	2	0.012	0.00007	0.0086
200	0	0	0	0	7	0.043	0.00025	0.0159
210	0	0	0	0	6	0.037	0.00022	0.0148
220	0	0	0	0	14	0.086	0.00048	0.0220
230	2	0.059	0.0017	0.0410	8	0.049	0.00029	0.0170
240	2	0.059	0.0017	0.0410	6	0.037	0.00022	0.0148
250	1	0.029	0.0009	0.0294	6	0.037	0.00022	0.0148
260	2	0.059	0.0017	0.0410	3	0.018	0.00011	0.0106
270	0	0	0	0	8	0.049	0.00029	0.0170
280	2	0.059	0.0017	0.0410	10	0.061	0.00036	0.0189
290	0	0	0	0	8	0.049	0.00029	0.0170
300	1	0.029	0.0009	0.0294	14	0.086	0.00048	0.0220
310	1	0.029	0.0009	0.0294	12	0.074	0.00042	0.0205
320	3	0.088	0.0024	0.0494	16	0.098	0.00055	0.0234
330	3	0.088	0.0024	0.0494	12	0.074	0.00042	0.0205
340	3	0.088	0.0024	0.0494	7	0.043	0.00025	0.0159
350	0	0	0	0	6	0.037	0.00022	0.0148
360	7	0.206	0.0050	0.0704	6	0.037	0.00022	0.0148
370	3	0.088	0.0024	0.0494	6	0.037	0.00022	0.0148
380	3	0.088	0.0024	0.0494	2	0.012	0.00007	0.0086
390	1	0.029	0.0009	0.0294	1	0.006	0.00004	0.0061
400	0	0	0	0	1	0.006	0.00004	0.0061
410	0	0	0	0	2	0.012	0.00007	0.0086
420	0	0	0	0	0	0	0	0
430	0	0	0	0	0	0	0	0
440	0	0	0	0	0	0	0	0
450	0	0	0	0	0	0	0	0
460	0	0	0	0	0	0	0	0
470	0	0	0	0	0	0	0	0
480	0	0	0	0	0	0	0	0
490	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0
Total	34	1.000			163	1.000		

Appendix E2a.-Age composition of broad, round, and humpback whitefish, and Arctic grayling examined from the Kobuk River, 1994.

	Broad whitefish				Round whitefish				Humpback whitefish				Arctic grayling			
Age	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE	Frequency	p	V(p)	SE
2	0	0	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0.000	0	0	7	0.054	0.0004	0.0200
5	0	0	0	0	2	0.074	0.0026	0.0514	5	0.013	0.0000	0.0060	20	0.155	0.0010	0.0320
6	0	0	0	0	5	0.185	0.0058	0.0762	10	0.027	0.0001	0.0084	23	0.178	0.0011	0.0338
7	0	0	0	0	3	0.111	0.0038	0.0616	1	0.003	0.0000	0.0027	24	0.186	0.0012	0.0344
8	0	0	0	0	4	0.148	0.0049	0.0697	19	0.051	0.0001	0.0114	29	0.225	0.0014	0.0369
9	1	0.056	0.0031	0.0556	10	0.370	0.0090	0.0947	30	0.081	0.0002	0.0141	14	0.109	0.0008	0.0275
10	2	0.111	0.0058	0.0762	2	0.074	0.0026	0.0514	50	0.134	0.0003	0.0177	7	0.054	0.0004	0.0200
11	3	0.167	0.0082	0.0904	1	0.037	0.0014	0.0370	67	0.180	0.0004	0.0200	3	0.023	0.0002	0.0133
12	4	0.222	0.0102	0.1008	0	0	0	0	99	0.266	0.0005	0.0229	1	0.008	0.0001	0.0078
13	2	0.111	0.0058	0.0762	0	0	0	0	55	0.148	0.0003	0.0184	1	0.008	0.0001	0.0078
14	0	0	0	0	0	0	0	0	23	0.062	0.0002	0.0125	0	0	0	0
15	1	0.056	0.0031	0.0556	0	0	0	0	7	0.019	0.0001	0.0071	0	0	0	0
16	2	0.111	0.0058	0.0762	0	0	0	0	5	0.013	0.0000	0.0060	0	0	0	0
17	2	0.111	0.0058	0.0762	0	0	0	0	0	0	0	0	0	0	0	0
18	1	0.056	0.0031	0.0556	0	0	0	0	1	0.003	0.0000	0.0027	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	18	1.000			27	1.000			372	1.000			129	1.000		

Appendix F

Appendix F.-Data files used in the preparation of this report.

Data File	Description	Status
X0040L-4.XLS	Sheefish biological data, Kobuk River 1994	Previously submitted
X0040L-5.XLS	Sheefish biological data, Kobuk River 1995	Included
X7310L-5.XLS	Sheefish biological data, Hotham Inlet 1995	Included