Fishery Data Series No. 95-21

Creel Surveys Conducted in Interior Alaska During 1994

by

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and

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September 1995

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

Creel surveys were conducted on three major fisheries within the Tanana River drainage, Alaska, during 1994. These fisheries included the Delta Clearwater Arctic grayling *Thymallus arcticus*, fishery, the Minto Flats northern pike *Esox lucius* fishery, and the Salcha River chinook salmon *Oncorhynchus tshawytscha* fishery. Effort, catch, and harvest were estimated for the Salcha River chinook salmon fishery. Age composition and Relative Stock Density (RSD) of the harvest were estimated for the Delta Clearwater River Arctic grayling and Minto Flats northern pike fisheries. Angler demographics were estimated for all three fisheries. Estimates of angler ratings of the quality of fishing at the Delta Clearwater River Arctic grayling fishery are reported.

At the Delta Clearwater River, 52% (SE = 3) of Arctic grayling sampled in the harvest were in the "preferred" RSD category. Age 5 Arctic grayling comprised 22% (SE = 3) of the harvest sample. Thirty-eight percent (SE = 2) of anglers interviewed at the Delta Clearwater River rated the quality of fishing as "good".

Age 3 comprised 36% (SE = 3) of the northern pike sampled from the harvest at Minto Flats. Sixty-two percent (SE = 3) of the northern pike sampled from the harvest during the Minto Flats survey were of the "quality" RSD category.

The creel survey at the Salcha River was conducted from 8 July through 31 July. During this period, anglers expended an estimated 15,032 (SE = 3,698) angler-hours of effort to catch a total of 832 chinook salmon (SE = 323), of which 776 (SE = 321) were harvested.

Key words: Creel survey, Arctic grayling, northern pike, chinook salmon, age composition, Relative Stock Density, catch, harvest, angler effort, angler demographics, interior Alaska, Tanana River drainage.

INTRODUCTION

The Arctic-Yukon-Kuskokwim (AYK) Region encompasses an area that covers almost two-thirds of the State of Alaska and includes all of Alaska north of Bristol Bay and the Alaska Range (Figure 1). Within this area, the state's largest river systems (Yukon, Kuskokwim, Colville, and Noatak) are found, along with thousands of lakes, and thousands of miles of streams. These waters support a large number of recreational fisheries for both freshwater and anadromous fish species that include Arctic cisco *Coregonus autumnalis*, Arctic char *Salvelinus alpinus*, Arctic grayling *Thymallus arcticus*, anadromous chinook salmon *Oncorhynchus tshawytscha*, anadromous and land-locked coho salmon *O. kisutch*, anadromous chum salmon *O. keta*, burbot *Lota lota*, Dolly Varden *S. malma*, humpback whitefish *C. pidschian*, lake trout *S. namaycush*, least cisco *C. sardinella*, northern pike *Esox lucius*, rainbow trout *O. mykiss*, round whitefish *Prosopium cylindraceum*, and sheefish *Stenodus leucichthys*.

For sport fishery management purposes, the AYK Region has been divided into two areas, the Tanana River drainage (includes all waters within the Tanana River drainage), and the AYK area (includes all waters outside the Tanana River drainage; Figure 1). Even though the AYK Region encompasses a very large area, the majority (approximately 75%) of the recreational angler effort and harvest occurs near the major population centers (Fairbanks, Delta Junction, and Tok) within the Tanana River drainage (Mills 1979-1994; and see Figure 2).

From 1977 through 1982, harvest of all fish species increased about 19% annually to a peak of about 179,000 for the Tanana River drainage. A record harvest for the entire AYK Region, of 274,541 fish occurred in 1982 (Figure 2). From 1983 to 1987, harvest generally decreased in both the Tanana River drainage and AYK Region. The decrease in harvest that occurred during this time was probably the result of the overharvest of the major species in the Tanana River drainage in prior years. Because of this decline, restrictive management regulations were

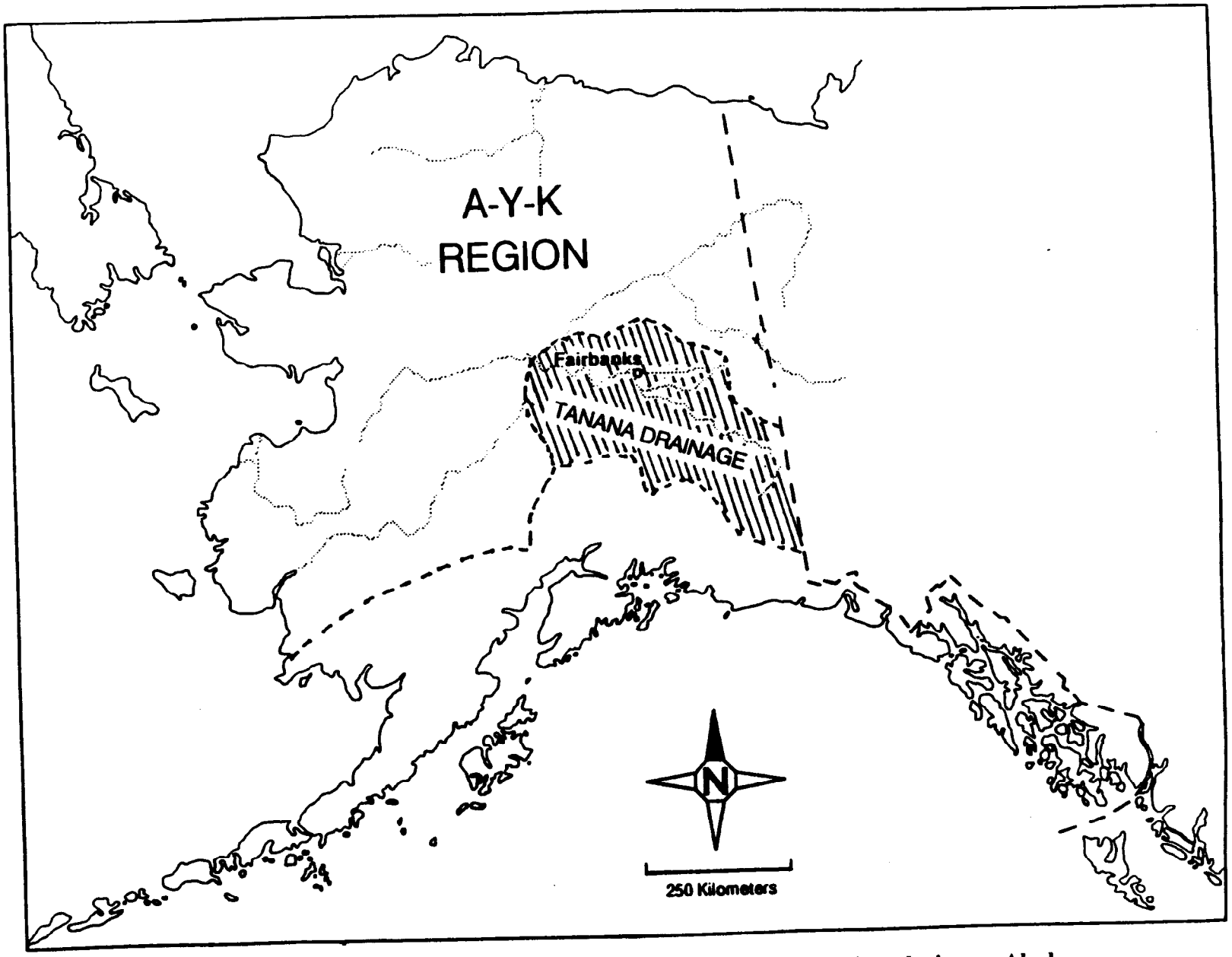

Figure 1.-Map of Arctic-Yukon-Kuskokwim (AYK) Region and Tanana River drainage, Alaska.

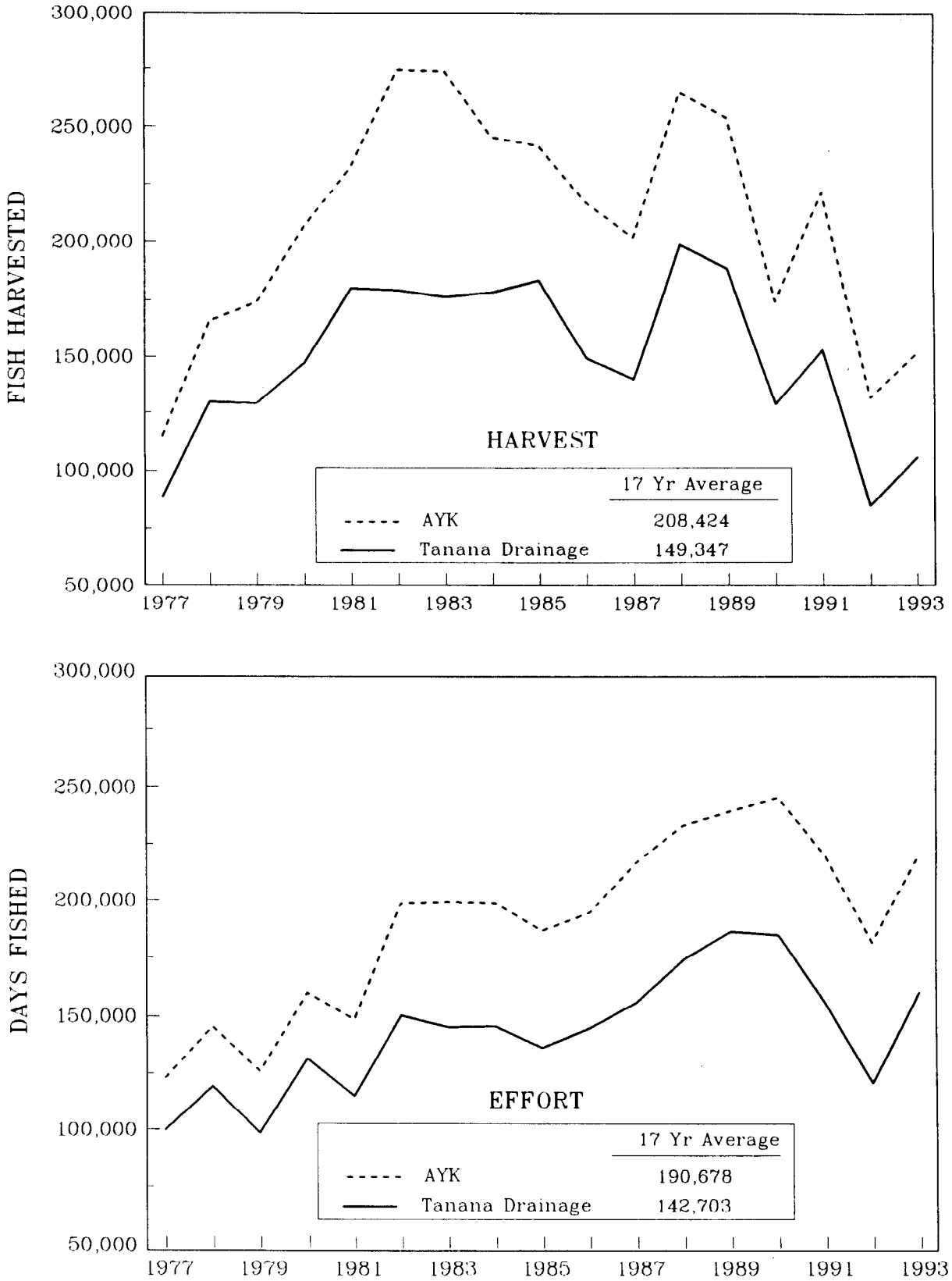

Figure 2.-Effort (days fished) and harvest of all fish species by recreational anglers in the AYK Region and the Tanana River drainage, 1977-1993.

instituted for the major fisheries in the Tanana River drainage in 1987 and 1988. In spite of restrictive regulations, harvest and angler effort increased in 1988. Harvests of all sport fish species in the Tanana River drainage have dropped substantially since a peak in 1988. While days fished have also decreased since 1988, a marked increase occurred between 1992 and 1993 (Figure 2).

Monitoring of the Tanana River drainage recreational fisheries is important to evaluate the effectiveness of the stocking program, and to assess the consequences of newly-imposed restrictive regulations on indigenous stocks. Conservation of indigenous stocks is desired in interior Alaska, through use of restrictive regulations and by diverting fishing pressure to stocked species. One method of assessing the success of conservation efforts is through the use of creel surveys.

The long term goals of the creel survey program are to: (1) develop historical data bases to allow monitoring of both the recreational fisheries and the exploited fish populations; (2) develop regulations that reflect the desires of the angling public while ensuring the sustained health of the resource; and (3) estimate the effects of management regulations on the fisheries, fish populations, and recreational angling public.

A comprehensive analysis of the three creel surveys that were conducted by the Alaska Department of Fish and Game (ADF&G) in the AYK Region during 1994 is presented in this report. A creel survey scheduled for the Chatanika River whitefish spear fishery was canceled because the fishery was closed by Emergency Order.

DELTA CLEARWATER RIVER ARCTIC GRAYLING FISHERY

INTRODUCTION

The Delta Clearwater River, located approximately 13 km northeast of Delta Junction, supports a popular Arctic grayling fishery during the summer months. The main channel of the river is approximately 32 km long. The river drains an area of about 1,000 km^2. Public access to the river is available at the State of Alaska Clearwater Campground at kilometer 13 of the river (Figure 3).

Fishing generally begins on the Delta Clearwater River in mid to late May, when larger Arctic grayling begin to migrate to their summer feeding areas in the upper part of the river. From 1977 to 1988, an average of 6,340 angler-days were expended annually to harvest an average of 5,158 Arctic grayling (Mills 1979-1989). Angler effort peaked in 1986 at 10,137 angler-days. However, in 1986, harvest dropped to the lowest level (2,343) since 1977. Because of concern for the fishery and the decline in harvest, emergency regulations were set forth on the Delta Clearwater River to protect the Arctic grayling stock(s) in 1987. These emergency regulations became permanent regulations in 1988 and remain in effect today. The regulations implemented were:

1. a 12 in minimum length limit for Arctic grayling;
2. a no-bait restriction (only artificial flies and lures may be used); and,
3. catch-and-release fishing from 1 April to the first Saturday of June (spring closure).

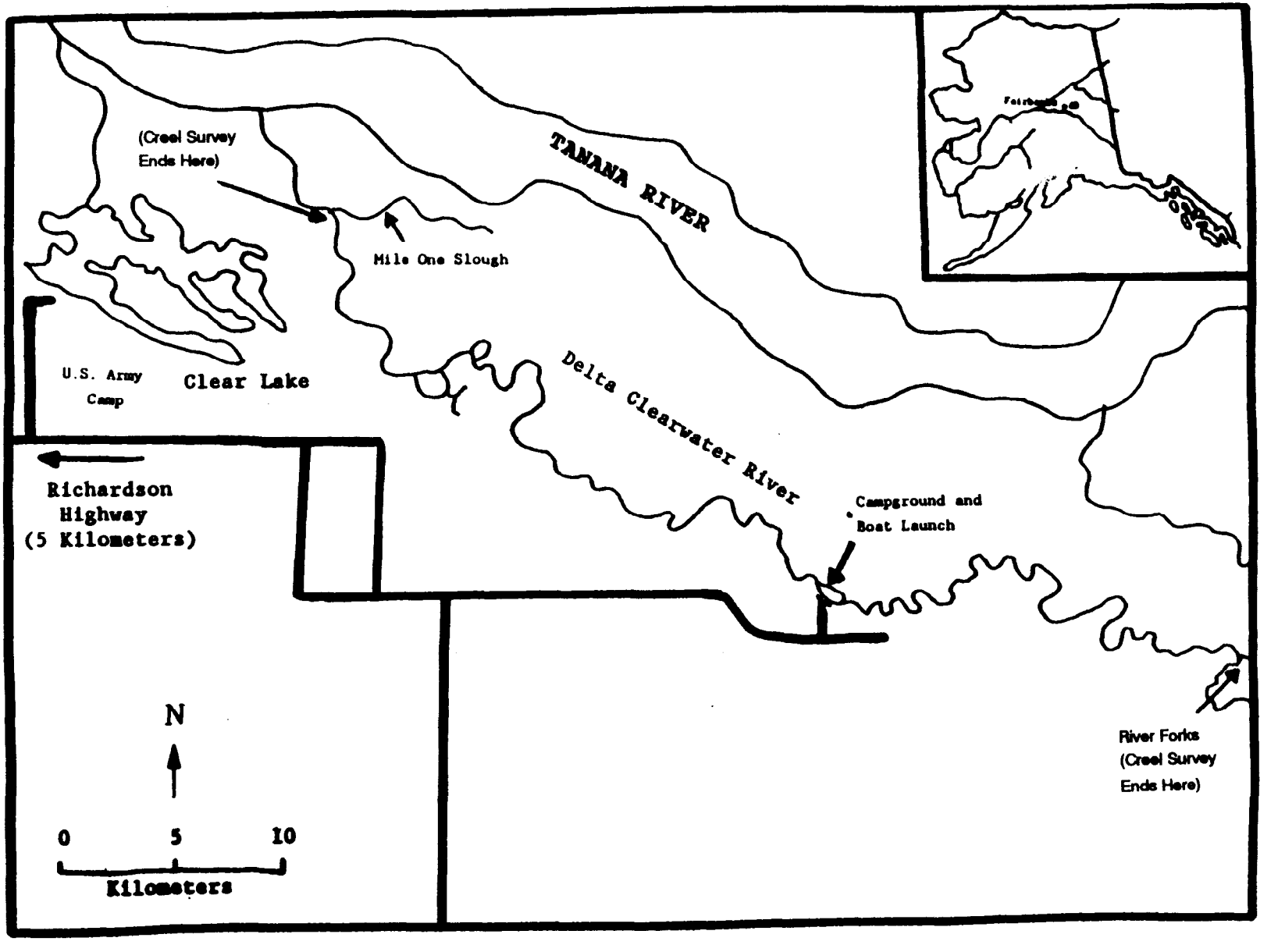

Figure 3.-Map of the Delta Clearwater River, Tanana River drainage, Alaska.

To examine the effects of these new regulations, an onsite creel survey was initiated on the Delta Clearwater River grayling fishery in 1986 and continued until 1990. Since 1991 ADF&G has relied upon the Statewide Harvest Survey to provide estimates of catch, harvest, and effort for Arctic grayling in the Delta Clearwater River. However, the Statewide Harvest Survey does not provide data on the age and size composition of the harvest. Consequently, the focus of the 1994 creel survey was to obtain information on the size and age composition of the harvest of Arctic grayling from the Delta Clearwater River. Specific objectives for the Delta Clearwater River creel survey in 1994 are listed below.

1. To provide post-season estimates of the percent age and length composition, relative stock density (RSD) for Arctic grayling harvested in the Delta Clearwater River sport fishery.
2. To estimate the percent composition within the following demographic categories of anglers interviewed at the Delta Clearwater River:
    a) male/female;
    b) adult/youth;
    c) resident/nonresident;
    d) nonmilitary/military; and,
    e) terminal fishing gear (spinning gear or fly fishing gear).
3. To estimate the percent rating by anglers of the quality of fishing at the Delta Clearwater River.

STUDY DESIGN

A single access survey with information obtained from completed-trip interviews of individual anglers was used to estimate all parameters. The majority of anglers fishing the Delta Clearwater River gain access to the river at the State of Alaska Clearwater Campground, consequently all angler interviews were conducted at this location

In an attempt to maximize angler contacts, sampling effort was conducted during those times (days and hours) when the most angler-trips and subsequently the most catch and harvest occurs. Evaluation of the most recent (1990) creel survey conducted at the Delta Clearwater River indicated that 83% of the anglers interviewed and 60% of the angling effort (angler-hours) occurred on the weekend days, Friday, Saturday and Sunday (Hallberg and Bingham 1991). The 1990 data also showed that 80% of the angler interviews and 63% of the angling effort (angler hours) occurred between 1500 and 2200 h. To maximize angler contacts, the creel clerk interviewed all anglers who had completed fishing and were exiting the campground area between 1300 to 2200 h every Friday, Saturday, and Sunday from 4 June through 14 August 1994. Since a consistently systematic (in days) sample survey was planned, and since all anglers exiting the fishery during the scheduled samples were interviewed this survey is of the self-weighted type described in Bernard et al. (*In prep*).

Attempts were made to sample all Arctic grayling harvested by anglers exiting the fishery during the sampled periods. All fish were measured to the nearest mm (fork length) and scale sampled.

DATA COLLECTION

All Arctic grayling were measured to the nearest mm (fork length) and scale samples were collected for age determination. Scale samples were collected from the preferred area approximately six rows above the lateral line just posterior to the insertion of the dorsal fin. In the laboratory, the scale samples were processed by immersion in a solution of hot water, soap and hydrolytic enzyme and then mounted on gum cards. The gum cards were used to make triacetate impressions of the scales (30 seconds at 137,895 kPa, at a temperature of 97°C). Ages were determined by counting the annuli on these impressions with the aid of a microfiche reader. Determination of an individual fish's age were obtained only once for each readable set of scales.

The creel clerk recorded the fish length, date and location of capture and any other pertinent information directly on to scale envelopes.

To estimate percent composition within demographic and tackle use categories, the following information was collected from individual anglers:

1) angler gender (male/female);
2) age class (either youth under 16 years old or adult);
3) Alaskan resident or nonresident;
4) military or nonmilitary; and,
5) type of terminal fishing gear (spinning gear or fly fishing gear).

Anglers were asked to rate the quality of fishing at the Delta Clearwater River using the following ratings; (1) = excellent; (2) = good; (3) = fair; (4) = poor; and (5) = no opinion.

All age and length data along with the interview data have been archived (Appendix A1).

DATA ANALYSIS

Estimates of age composition for the sampled Arctic grayling were calculated. All data were treated as if the data were obtained by a simple random sampling procedure. The age composition data collected from the sampled harvest at Delta Clearwater River were assumed to be the result of a self-weighting sample survey (i.e., equal proportions of the harvest sampled throughout the survey). Accordingly, the resultant age composition estimates should be unbiased for the entire harvest in 1995.

The proportion of the sampled Arctic grayling harvested that are age u was estimated by:

$$\hat{p}_u = \frac{n_u}{n} \qquad (1)$$

where: n_u is the number of the sampled Arctic grayling harvested that were age u; and n is the total number of Arctic grayling sampled for age determination.

The variance of the estimated proportion was estimated by the standard equation for the variance of a binomial proportion (Cochran 1977, equation 3.8, page 52, omitting the finite population correction factor):

$$\hat{V}[\hat{p}_u] = \frac{\hat{p}_u(1-\hat{p}_u)}{n-1}. \quad (2)$$

Standard errors were calculated by taking the square root of the variance estimates.

Estimates of age composition in percentages were calculated simply as the proportions multiplied by 100% (the same conversion is used for the standard errors).

Size composition was estimated in a similar manner, replacing age class with the RSD categories of Gabelhouse (1984) for Arctic grayling. The RSD categories used were: "stock" (150 to 269 mm FL); "quality" (270 to 339 mm FL); "preferred" (340 to 449 mm FL); "memorable" (450 to 559 mm FL); and, "trophy" (greater than 559 mm FL).

Estimates of the proportion of angler-trips by demographic, gear type, or angler satisfaction categories were also calculated as described above. The various categories represented the ages (the *u* subscript) and the number of anglers interviewed represented the sample size (n) in equations (1) and (2). As with the age and size composition estimates the estimates obtained by these procedures were assumed to be unbiased if the survey is of the self-weighted type as designed. However, since the schedule only called for sampling on the "weekend days" of Friday-Sunday, then estimates of angler demographics may be biased if the make-up of the fishery varies among the days in the week. Avid anglers (anglers who fish more often than less-avid anglers) were more likely to be interviewed than less-avid anglers. Therefore these estimates are assumed to be only representative of angler-trips not anglers.

RESULTS

A total of 523 anglers were interviewed during the period from 4 June to 14 August. Of those anglers interviewed 96% (SE = 1) were male, 85% (SE = 2) were adult, and 79% (SE = 2) were residents of Alaska. Fifty-five percent (SE = 2) of those anglers interviewed used fly fishing gear (Table 1).

Of the 384 anglers interviewed who had an opinion as to the quality of fishing at the Delta Clearwater River, 17% (SE = 2) rated the fishery as excellent, 52% (SE = 3) rated it as good, 26% (SE = 2) rated it fair, and 5% (SE = 1) rated the fishery as poor. A total of 139 anglers gave no opinion as to the quality of fishing at the Delta Clearwater River in 1994.

Ages were determined for 251 Arctic grayling harvested during the creel survey. Harvested Arctic grayling ranged in age from 3 to 12 years (Table 2). Age 5 was the predominant age class accounting for 22% (SE = 3) of the harvest.

Length data were collected from 281 Arctic grayling. The predominant RSD category for the harvested Arctic grayling was preferred, comprising 52% (SE = 3) of the harvest (Table 2). Forty-six percent (SE = 3) of the harvest was of the quality category. One percent (SE = 1) of the fish were in the memorable category and no fish were sampled in the trophy category.

Table 1.-Estimates of various angler demographic categories and terminal gear use for the 1994 Delta Clearwater River Arctic grayling fishery from 4 June through 14 August.

Category	Number Interviewed	Percent	SE
Female	20	4	1
Male	503	96	1
Youth	77	15	2
Adult	446	85	2
Non-Resident	112	21	2
Resident	411	79	2
Tackle:			
Spin	237	45	2
Fly	286	55	2

Table 2.-Estimates of the contributions of each age class, mean fork length (mm) at age, and Relative Stock Density of Arctic grayling in the harvest sample from the Delta Clearwater River from 4 June through 14 August 1994.

	Age Composition			
Age	Number	Percent	SE(%)	Mean FL (mm)
3	4	1	1	298
4	46	18	2	302
5	55	22	3	325
6	42	17	2	336
7	49	19	3	362
8	22	9	2	376
9	17	7	2	396
10	7	3	1	413
11	7	3	1	418
12	2	1	1	429
Total	251	100		

	Relative Stock Density (RSD)			
Category	Range (mm)	Number	Percent	SE
Stock	150-269	3	1	1
Quality	270-339	131	46	3
Preferred	340-449	145	52	3
Memorable	450-559	2	1	1
Trophy	≥560	0		
Total		281	100	

DISCUSSION

The emphasis of 1994 creel survey of the Delta Clearwater River Arctic grayling fishery was to obtain age and size composition of the Arctic grayling harvest. The age and length composition in 1994 was very similar to the 1990 sample (Hallberg and Bingham 1991). The preferred category of fish between 340 and 449 mm fork length comprised 52% of the 1994 sample and 51% in 1990. The quality size category (fish between 270 and 339 mm fork length) accounted for 46% of the sample in 1994 and 48% in 1990.

The age composition data of Arctic grayling harvested in 1994 differed only slightly from that observed in 1990. Age 7 predominated in 1990 representing 24% of the sample (Hallberg and Bingham 1991), while age 5 Arctic grayling was the most abundant age class in the 1994 sample at 22%.

Anglers' opinion of the quality of fishing for Arctic grayling in the Delta Clearwater River remains high in that 68% rated their experience as either excellent or good.[1] In 1990, 32% and 29% of those anglers interviewed who registered an opinion on the quality of fishing at the Delta Clearwater River, rated the fishery as excellent and good, respectively (Hallberg and Bingham 1991). However, the 1994 survey showed a drop to 16% of the anglers who rated the fishery as excellent, and an increase to 52% who rated the fishery as good. Reasons as to why the number of anglers who rated the fishery as excellent (32% in 1990) decreased to 16% in 1994, a drop of 50%, is unclear at this time. One possibility is that there may be less Arctic grayling in the Delta Clearwater available to the anglers. Since 1990 ADF&G has used the Statewide Harvest Survey to obtain estimates of catch, harvest and effort. Results of the Statewide Harvest Survey during this period indicate that angling effort has remained fairly constant averaging 4,800 angler-days (Mills 1991 through 1994). However, the harvest of Arctic grayling from 1991 to 1992 dropped 63% from 2,165 to 797 fish (Mills 1992 and 1993). This was followed by yet another 45% drop in harvest in 1993 to an all time low of 437 Arctic grayling (Mills 1994). The number of Arctic grayling caught, but not harvested, decreased by 54% from 12,424 in 1990 to 5,712 in 1993. Beginning in 1995, ADF&G will initiate an intensive investigation of the Arctic grayling in the Delta Clearwater River which along with continued monitoring of the sport fishery should better our understanding of dynamics of this stock(s).

MINTO FLATS NORTHERN PIKE FISHERY

INTRODUCTION

Minto Flats, located about 50 km west of Fairbanks, is a 200,000 ha area composed of marshes and lakes interconnected by sloughs, streams, and four major rivers: the Chatanika, Goldstream, Tatalina, and Tolovana (Figure 4). The rivers, streams, and sloughs are slow flowing and meandering, and the lakes are shallow, productive, and contain large amounts of aquatic vegetation. The amount of aquatic habitat suitable to support fish populations in Minto Flats has been estimated at about 6,000 surface hectares. All waters of Minto Flats eventually drain into the Tanana River.

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[1] Note, however, that onsite survey's of the opinions of anglers regarding the quality of fishing are often known to be biased towards satisfied anglers. Anglers who are satisfied with the fishing quality are more likely to fish more often. Since we made no correction for avidity bias then more satisfied (and more avid) anglers would bias our estimates of angler satisfaction. A similar bias is also assumed to exist in previous surveys of this fishery. However, the degree of bias may not be the same from one survey to the next.

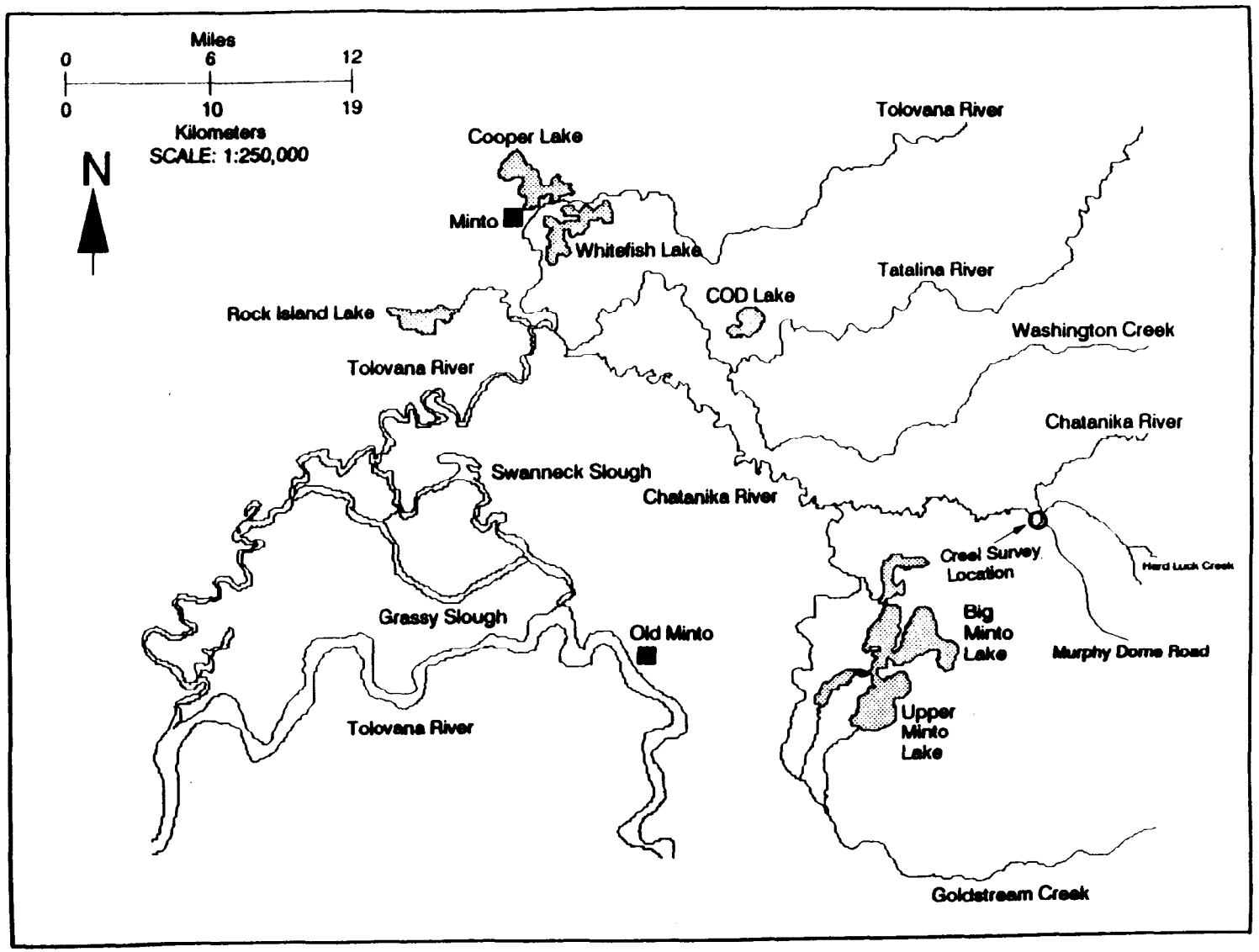

Figure 4.-Map of Minto Flats, Tanana River drainage, Alaska.

Next to Arctic grayling, northern pike are the most sought after indigenous sport fish species in interior Alaska (Holmes 1987). Although sport fishers harvest several species of fish from Minto Flats, the recreational fishery centers almost entirely on northern pike.

Recreational fishing effort and sport harvests of fish in Minto Flats have been monitored since 1977 through the Statewide Harvest Survey (Mills 1979 - 1994), which used a postal questionnaire sent to randomly selected sport anglers. Since 1977, between 60% and 90% of the annual harvest of northern pike in Alaska comes from interior Alaska with 54% of the estimated statewide harvest taking place in the Tanana River drainage (Mills 1979 - 1994). Minto Flats has supported the largest sport fishery for northern pike in Alaska in 13 of the previous 17 years (Mills 1979 - 1994). Since 1977, fishing effort has ranged from a low of about 700 angler-days in 1989 to a high of about 3,900 angler-days in 1977 and has averaged about 2,100 angler-days. An average of approximately 2,300 northern pike per year have been harvested from Minto Flats by sport fishermen since 1977. The largest harvest took place in 1986 when approximately 3,900 northern pike were harvested and the lowest harvest took place in 1989 when approximately 900 northern pike were taken by sport anglers (Mills 1979 - 1994).

In addition to sport harvest, there is a subsistence fishery on northern pike by the people of Minto Village. This subsistence fishery occurs primarily in the spring and fall with gill nets and hook and line. The most reliable estimate of the subsistence harvest of northern pike was obtained during 1984, when 45 Minto Village households were surveyed (Andrews 1988). Results of the survey revealed that the total village harvest was 3,003 northern pike. Preliminary data obtained from a similar survey completed in January 1995 indicated that 58 Minto Village households reported a harvest of 2,997 northern pike during the 1994 calendar year (Hallberg *In prep*).

One component missing from the Statewide Harvest Survey is information on the age and size of individual northern pike harvested from Minto Flats. For this reason a creel survey designed to collect the age and size (Relative Stock Densities) composition of the harvest was implemented in 1994.

Information from the creel survey along with a planned stock assessment program will provide managers with a better idea of how harvest may be affecting abundance.

The specific objectives of the 1994 creel survey of the Minto Flats northern pike fishery were to:

1. Estimate the percent age composition and percent RSD for northern pike harvested from Minto Flats.
2. Estimate the percent composition within the following demographic categories of anglers interviewed, who fished for northern pike in Minto Flats:
    a) male/female;
    b) adult/youth;
    c) resident/nonresident; and,
    d) nonmilitary/military.

STUDY DESIGN

The Minto Flats northern pike creel survey in 1994 was of the single access type with information obtained from interviews with individual (completed-trip) anglers. Since the majority of anglers

gain access to the more popular eastern side of Minto Flats known as "Minto Lakes" by boat via the Murphy Dome Road extension which terminates at the Chatanika River, all interviews were conducted at this location.

Anglers usually begin arriving at the end of the Murphy Dome Road on Friday evening or Saturday morning. After launching their boats in the Chatanika River, anglers motor downstream, approximately 20 km to Goldstream Creek and then follow it upstream about 10 km to what is commonly referred to as the Big Minto Lakes area. Most angling parties spend one or two nights out fishing before returning to the landing on Sunday afternoon. To maximize angler contacts, a creel clerk was stationed at the end of the Murphy Dome Road from 1300 to 1900 h every Sunday afternoon, from 5 June through 31 August 1994. A consistently systematic (in days) sample survey was planned, and since all anglers exiting the fishery during the scheduled samples were interviewed this survey is of the "self-weighted" type described in Bernard et al. (*In prep*).

Attempts were made to sample all northern pike harvested by those anglers exiting the fishery during the sampled periods.

DATA COLLECTION

During the interview the creel clerk measured all northern pike to the nearest mm (fork length), and collected a minimum of three scales to be used for age determination. Scale samples were collected from the preferred area adjacent to but not on the lateral line above the pelvic fins as described by Williams (1955). In the laboratory, scales were processed by immersion in a solution of hot water, soap and hydrolytic enzyme and then mounted on gum cards. The gum cards are used to make triacetate impressions of the scales (30 seconds at 137,895 kPa, at a temperature of 97° C). Ages were then determined by counting the annuli on these impressions with the aid of a microfiche reader. Determination of an individual fish's age was obtained only once for each readable set of scales.

The creel clerk recorded the fish length, date and location of capture along with any other pertinent information directly on to the scale envelope.

To estimate angler demographic categories, the following information was collected from individual anglers:

1) angler gender (male/female);
2) age class (either youth under 16 years old or adult);
3) Alaskan resident or nonresident; and,
4) military or nonmilitary.

All age and length data along with the interview data have been archived (Appendix A1).

DATA ANALYSIS

The same procedures outlined in the Data Analysis section for the Delta Clearwater Arctic grayling study were followed for the Minto Flats northern pike study.

The RSD categories of Gabelhouse (1984) for northern pike size composition were: stock (290 to 529 mm FL); quality (530 to 659 mm FL); preferred (660 to 859 mm FL); memorable (860 to 1079 mm FL); and, trophy (greater than 1080 mm FL).

Since only Sundays were sampled, then estimates of angler demographics may be biased if the make-up of the fishery varied among the days in the week.

RESULTS

A total of 286 anglers were interviewed during 5 June through 31 August (Table 3). The demographic profile of the anglers sampled shows that the majority of the anglers were male (81%, SE = 2), adult 81% (SE = 2), and non-military (69%, SE =3).

Age composition data were obtained from a total of 273 northern pike (Table 4). Northern pike ranged in age from 2 to 10 years with 3 year olds being the predominant age class representing 36% (SE = 3) of the sample. Age 4 fish represented 26% (SE = 3) and age 5 fish 17% (SE = 2) of the total sample.

Length composition data were collected from 247 northern pike harvested during the Minto Flats fishery (Table 4). The majority of the sample (62%, SE = 3) were between 530 and 659 mm total length, which is the quality RSD category. Thirty-one percent (SE = 3) were of the preferred category and 5% (SE = 1) and 2% (SE = 1) were of the stock and memorable categories, respectively. No trophy size northern pike were encountered in the 1994 creel survey. The mean fork length of all northern pike sampled was 636 mm.

DISCUSSION

When we compare the size and age composition of northern pike harvested from Minto Flats with other recently surveyed fisheries we see some similarities. The quality RSD category was also the predominant size category for northern pike harvested at Harding Lake in 1990 and George Lake in 1991 representing 73% (SE = 7) and 54% (SE = 7) respectively, (Hallberg and Bingham 1991, 1992). However, the age composition of northern pike in the George Lake sample showed that the majority of the fish harvested were age 5 (27%, SE = 5) and age 6 (24%, SE = 5), with only 3% (SE = 2) being age 3. The reason why 3-year olds were the most abundant year class observed in this year's Minto Flats sample is not known at this time. Perhaps the closure of the winter sport fishery for northern pike that occurred in 1986 (which extends through the spawning period), coupled with several years of high water conditions, have benefited the northern pike populations throughout Minto Flats, and may be contributing to what appears to be good recruitment of young fish. Consequently this may account for the high proportion of younger (age 3) northern pike in the harvest at Minto Flats as compared to other systems such as George Lake.

SALCHA RIVER CHINOOK SALMON FISHERY

INTRODUCTION

The Salcha River is located about 67 km southeast of Fairbanks on the Richardson Highway (Figure 5). The Salcha River supports a popular chinook salmon recreational fishery that occurs during the month of July. The chinook salmon run in the Salcha River is the largest documented run in the middle Yukon River drainage (Barton 1985). From 1977 to 1993 the chinook salmon harvest from the Salcha River has ranged from 62 to 808 annually, averaging 445 (Mills 1979-

Table 3.-Estimates of various angler demographic categories for the Minto Flats northern pike fishery from 5 June through 31 August 1994.

Category	Number	Percent	SE(%)
Female	55	19	2
Male	231	81	2
Youth	53	19	2
Adult	233	81	2
Non military	196	69	3
Military	90	31	3
Total	286		

Table 4.-Estimates of the contributions of each age class, mean fork length (mm) at age, and Relative Stock Density of northern pike in the harvest sample from Minto Flats from 5 June through 31 August 1994.

	Age Composition				
Age	Number	Percent	SE	Mean FL (mm)	SE (FL)
2	3	1	1	472	11
3	98	36	3	574	41
4	71	26	3	614	59
5	46	17	2	679	65
6	29	10	2	686	62
7	16	6	1	766	68
8	6	2	1	712	63
9	2	1	1	800	28
10	2	1	1	967	25
Total	273	100			

	Relative Stock Density (RSD)			
Category	Range (mm)	Number	Percent	SE(%)
Small	≤289	0		
Stock	290-529	13	5	1
Quality	530-659	154	62	3
Preferred	660-859	75	31	3
Memorable	860-1079	5	2	1
Trophy	≥1080	0		
Total		247	100	

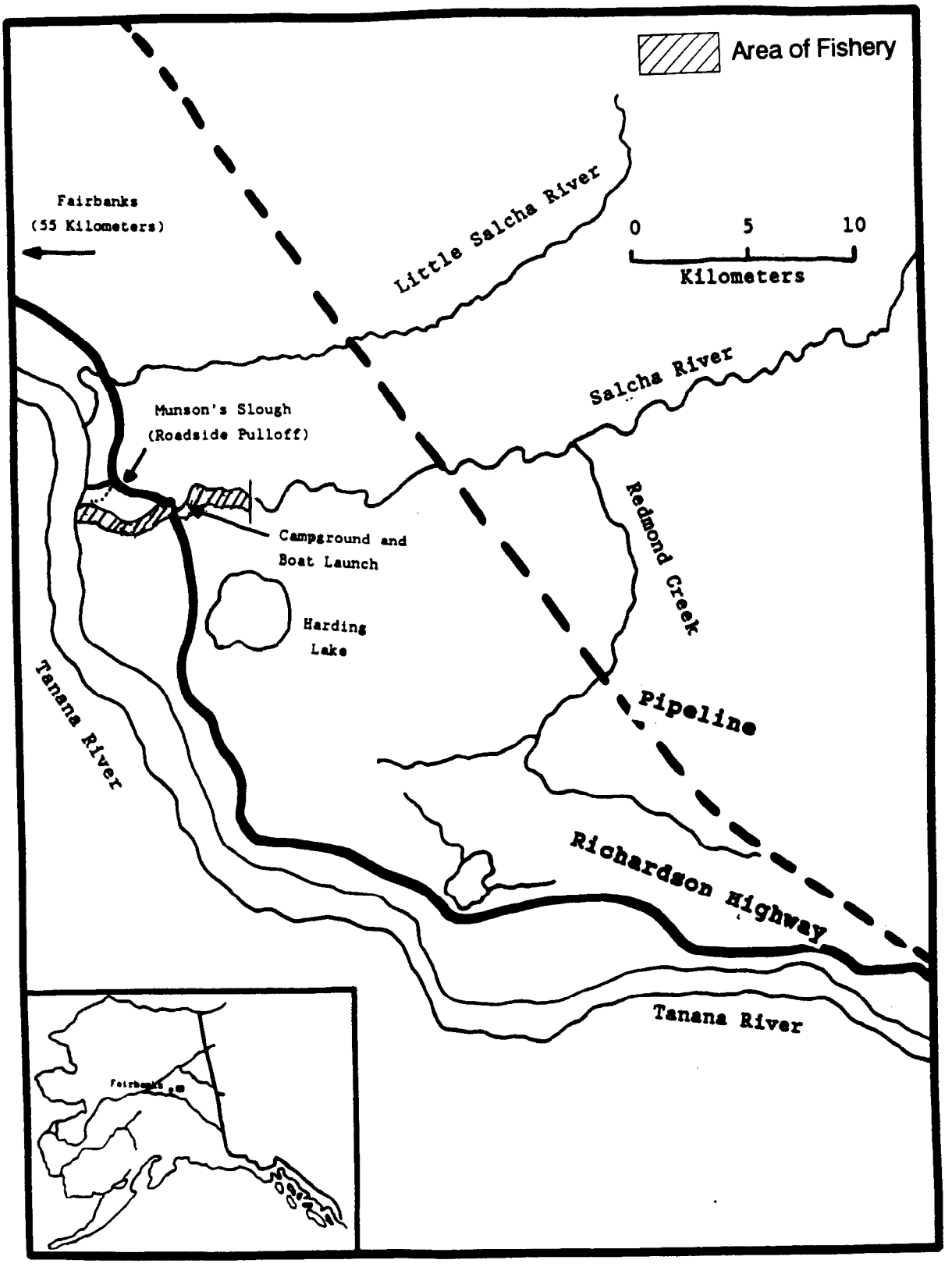

Figure 5.-Map of the Salcha River, Tanana River drainage, Alaska.

1994). Until 1987, salmon fishing was allowed in the lower 29 km of the river. However, chinook salmon are known to spawn in this lower portion of the river. For this reason, the Alaska Board of Fisheries in 1988 restricted the area open to salmon fishing to the lower 8 km of the Salcha River and, established a guideline harvest range for the Salcha River recreational chinook salmon fishery of 300 to 700 fish. In order to ensure that the recreational harvest does not exceed the allocated range, and because the Yukon River salmon stocks are being fully utilized by all user groups, it is imperative that the sport harvest of chinook salmon from the Salcha River be monitored in season.

Chinook salmon usually begin arriving at the Salcha River during the second week of July. For the past several years the majority of the chinook salmon anglers at the Salcha River fished the lower 0.8 km of the river and exited the area at the Munson Slough parking lot located along the Richardson Highway. Since 1989 ADF&G has used this area to conduct single access, direct expansion type creel surveys (Hallberg and Bingham 1991-1993). However, shortly after the 1993 creel survey began it became apparent that little effort and almost no harvest was reported from anglers who exited the fishery via the Munson Slough area. Further inspection of the lower Salcha River revealed that the river here was turbid to the point where sport fishing was nearly impossible. The source of the silty water was from a slough of the glacial-fed Tanana River which was entering the Salcha River upstream of the traditional fishing area. Anglers responded almost immediately by moving upstream of the silty water and fishing for chinook salmon near the Richardson Highway bridge.

Anticipating similar conditions during the 1994 fishing season, ADF&G redesigned the creel survey to utilize roving angler counts along with angler interviews to estimate CPUE to monitor the fishery.

The specific objectives for the 1994 survey of the Salcha River chinook salmon fishery were to:

1. Estimate angler effort for, and the catch and harvest of chinook salmon in the Salcha River fishery.
2. Estimate the percent composition within the following demographic categories of anglers interviewed and their gear use at the Salcha River:
    a) male/female;
    b) adult/youth;
    c) resident/nonresident;
    d) military/nonmilitary; and,
    e) fishing gear (spinner gear or fly fishing gear).

STUDY DESIGN

The creel survey in 1994 was conducted in the lower 8 km of the Salcha River (the area open to salmon fishing). While the majority of the fishing is from shore, a small but increasing amount of effort is from boat anglers. The creel survey was scheduled to occur from 8 July through 31 July. A stratified multistage sample survey was used to obtain estimates of angler effort for, and the catch and harvest of chinook salmon during the 1994 Salcha River fishery. The sampling

procedure itself consisted of a roving-type creel survey. Both the angler counts and the interviews with completed-trip anglers were conducted by one technician.

The fishing and sampling day was defined as the entire 24 h period form 0001 to 2400 h. However, historical data have indicated that the majority of the angling effort occurs between the hours of 1601 to 2400 each day. Consequently, these hours were defined as the "peak time of day" stratum and the remaining hours in the day were classified as the "nonpeak time of day stratum".

The calendar days (8-31 July) within each stratum represent the 1st stage sampling units in the multistage design for the 1994 survey. Days to sample within each stratum were selected systematically. Every third day was the peak time of day stratum and every sixth day was the nonpeak time of day stratum. The starting date to "initialize" the systematic sampling was chosen at random, with the proviso that the days to sample for each stratum never overlap (designed to be a one technician survey).

The entire 8 h within each sampling day for the peak time of day stratum was defined as a sampling period. The completed-trip anglers who exited the fishery during this period were the 2nd stage sampling units. Correspondingly, the angler counts represent the 2nd stage units for estimating angler effort within each sampled period (i.e., calendar day for the peak time of day stratum). Each angler count took approximately 30 min to conduct. Three counts per sampled day were conducted for the peak time of day stratum. Interviews with anglers who had completed fishing and were exiting the area were conducted by the creel technician during the sample day between the angler counts. The count times were selected at random from the following five systematic combinations (with equal probability):

Combination	Time for Count 1	Time for Count 2	Time for Count 3
(1)	1601-1632	1841-1912	2121-2152
(2)	1633-1704	1913-1944	2153-2224
(3)	1705-1736	1945-2016	2225-2256
(4)	1737-1808	2017-2048	2257-2328
(5)	1809-1840	2049-2120	2329-2400

The sampling day for the nonpeak time of day stratum was subdivided into three sampling periods each 5 h and 20 min in length: 0001-0520, 0521-1040, and 1041-1600. These sampling periods were selected at random without replacement for each sampled day within this stratum. The sampling periods represent the 2nd stage sampling units in the 3-stage sample survey for the nonpeak time of day stratum. The completed-trip anglers who exit the fishery during the selected sampling period (within each sampled day) represent the 3rd stage units for sampling.

Three counts per sampled period were conducted for the nonpeak time of day stratum. The count times were selected at random from the three following systematic combinations associated with the noted sampling period:

Sample Period Combination		Time for Count 1	Time for Count 2	Time for Count for
0001-0520	(1)	0001-0035	0147-0222	0334-0409
	(2)	0036-0111	0223-0257	0410-0444
	(3)	0112-0146	0258-0333	0445-0520
0521-1040	(1)	0521-0555	0707-0742	0854-0929
	(2)	0556-0631	0743-0817	0930-1004
	(3)	0632-0706	0818-0853	1005-1040
1041-1600	(1)	1041-1115	1227-1302	1414-1449
	(2)	1116-1151	1303-1337	1450-1524
	(3)	1152-1226	1338-1413	1525-1600

The number of angler counts to conduct per sampled day or period for both strata was set to the lowest possible number of counts that allows for variance estimation by the procedure recommended by Wolter (1985) for estimating the variance of an estimate from systematic sampling. Since previous creel surveys of this fishery have all been of the direct expansion type, information from the previous survey was not specifically used to calculate the "optimum" number of counts to conduct (vis-á-vis the procedures outlined in Bernard et al. *In prep*). Instead the interview data from previous years was evaluated to ascertain the likelihood of obtaining completed-trip angler interviews when active angling occurs given the amount of interview time expended by the creel technician. This evaluation indicated that anymore than the minimal number of counts per sampled day or period would most likely lead to days or periods (with positive angler counts) with no angler interviews.

DATA COLLECTION

The creel clerk (utilizing a boat) conducted three counts per sampled period of anglers actively engaged in fishing along the lower 8 km of the Salcha River. Counts began at the top or bottom of the 8 km section. This starting point and consequently the direction of travel were randomly selected. Angler counts took approximately 30 min to complete and all angler interviews were conducted between counts.

During each interview, the following information was collected from individual anglers:

1) the amount of time he or she spent fishing;
2) the number of chinook salmon caught;
3) the number of chinook salmon harvested;
4) angler gender (male/female);
5) age class (either youth under 16 years old or adult);

6) Alaskan resident or nonresident;

7) military or nonmilitary; and,

8) fishing gear used (spinning or fly fishing gear).

Data were archived (Appendix A1).

DATA ANALYSIS

The procedures outlined in Bernard et al. (*In prep*) were used to estimate effort for, and catch and harvest of chinook salmon. These estimation procedures were those appropriate for:

1. a two-stage roving survey, with days as first stage units, and angler interviews with angler counts as second stage units for the peak time of day stratum; and,
2. a three-stage roving survey, with days as first stage units, sampling periods as second stage units, and angler interviews with angler counts as third stage units for the nonpeak time of day stratum.

Note, however, the actual calculations were all conducted as if both strata were three stage surveys (with the peak time of day stratum having only one period per day).

Angler Effort

Within each sampling period (second-stage sampling unit *j*) within each sampled day (first-stage sampling unit *i*) within each stratum (stratum *h*), total angler effort (in hours) and its variance are estimated as:

$$\hat{E}_{hij} = \bar{x}_{hij} T_{hij} \tag{3}$$

$$\hat{V}\left[\hat{E}_{hij}\right] = \hat{V}\left[\bar{x}_{hij}\right] T_{hij}^2 \tag{4}$$

where $\hat{E}_{hij}$ is estimated fishing effort in angler-hours, $\bar{x}_{hij}$ is the average number of anglers counted fishing, T_{hij} is the number of hours in each sampling period (equal to 5.3 h for the nonpeak time of day stratum and equal to 8 h for the peak time of day stratum), and $\hat{V}\left[\bar{x}_{hij}\right]$ is the estimated variance of $\bar{x}_{hij}$, obtained approximately by using the successive difference formula appropriate for systematic samples (adapted from Wolter 1985, equation 7.2.4, page 251). The successive difference formula is:

$$\hat{V}\left[\bar{x}_{hij}\right] \approx \frac{\sum_{k=2}^{r_{hij}} \left(x_{hijk} - x_{hij(k-1)}\right)^2}{2\, r_{hij}(r_{hij} - 1)} \tag{5}$$

where x_{hijk} is the angler count and r_{hij} is the number of angler counts per period (equal to three for all periods sampled).

Angler effort within each sampled day for each stratum was then estimated by expanding over periods within each day:

$$\hat{E}_{hi} = Q_{hi} \bar{E}_{hi} \tag{6}$$

where

$$\overline{E}_{hi} = \frac{\sum_{i=1}^{q_{hi}} \hat{E}_{hij}}{q_{hi}}. \tag{7}$$

Q_{hi} is the number of periods in each sampled day (equal to three for the nonpeak stratum and equal to one for the peak time of day stratum), and q_{hi} is the number of periods sampled (equal to two for the nonpeak time of day stratum and equal to one for the peak time of day stratum).

Estimates of angler effort within each stratum were similarly calculated by expanding over days:

$$\hat{E}_h = D_h \overline{E}_h \tag{8}$$

where

$$\overline{E}_h = \frac{\sum_{i=1}^{d_h} \hat{E}_{hi}}{d_h}. \tag{9}$$

D_h is the number of days available for sampling within each stratum (equal to 24 for all strata), and d_h is the number of days sampled within each stratum.

The stratum estimate of angler effort variance is calculated as:

$$\hat{V}\left[\hat{E}_h\right] = \left(1 - f_{1h}\right)\frac{D_h^2}{d_h}\frac{\sum_{i=1}^{d_h}\left(\hat{E}_{hi} - \overline{E}_h\right)^2}{d_h - 1} + f_{1h}\frac{D_h^2}{d_h^2}\sum_{i=1}^{d_h}\left[\left(1 - f_{2hi}\right)\frac{Q_{hi}^2}{q_{hi}}\frac{\sum_{j=1}^{q_{hi}}\left(\hat{E}_{hij} - \overline{E}_{hi}\right)^2}{q_{hi} - 1}\right] + f_{1h}\frac{D_h^2}{d_h^2}\sum_{i=1}^{d_h}\left[f_{2hi}\frac{Q_{hi}^2}{q_{hi}^2}\sum_{j=1}^{q_{hi}}\hat{V}\left[\hat{E}_{hij}\right]\right] \tag{10}$$

where f_{1h} is the first-stage sampling fraction (d_h/D_h), and f_{2hi} is the second-stage sampling fraction for first-stage unit i (q_{hi}/Q_{hi}). Note that since $q_{hi} = Q_{hi}$ for the peak time of day stratum, then the second major term in equation 10 equates to zero for this stratum.

The total angler effort (across all strata) and its variance was calculated simply as:

$$\hat{E} = \sum_{h=1}^{L} \hat{E}_h \tag{11}$$

$$\hat{V}\left[\hat{E}\right] = \sum_{h=1}^{L} \hat{V}\left[\hat{E}_h\right] \tag{12}$$

where L is the number of strata (equal to two for this survey).

Harvest and Catch

Estimates of mean chinook salmon harvest per unit effort were calculated using a jackknife procedure (Efron 1982) to reduce bias. First, the mean harvest of angler-trips was divided by the mean length of trip to estimate the sample ratio of HPUE:

$$\overline{HPUE}_{hij} = \frac{\bar{H}_{hij}}{\bar{e}_{hij}} = \frac{\sum_{l=1}^{m_{hij}} H_{hijl} \Big/ m_{hij}}{\sum_{l=1}^{m_{hij}} e_{hijl} \Big/ m_{hij}} = \frac{\sum_{l=1}^{m_{hij}} H_{hijl}}{\sum_{l=1}^{m_{hij}} e_{hijl}} \tag{13}$$

where H_{hijl} is the chinook salmon harvest during an angler trip l, e_{hijl} is the effort expended (in hours) during angler-trip l, and m_{hij} is the number of interviews. Since the above estimate of mean HPUE has an inherent bias of order $1/m_{hij}$ (Cochran 1977), the jackknifed estimate of mean HPUE was calculated (Efron 1982):

$$\overline{HPUE}^{*}_{hij} = \frac{\sum_{m=1}^{m_{hij}} HPUE^{*}_{hijm}}{m_{hij}} \tag{14}$$

where

$$HPUE^{*}_{hijm} = \frac{\sum_{\substack{l=1 \\ l \neq m}}^{m_{hij}} H_{hijl}}{\sum_{\substack{l=1 \\ l \neq m}}^{m_{hij}} e_{hijl}}. \tag{15}$$

The jackknifed estimate was used to reduce the inherent bias to order $1/m^{2}_{hij}$ through the adjustment:

$$\overline{HPUE}^{**}_{hij} = m_{hij}\left[\overline{HPUE}_{hij} - \overline{HPUE}^{*}_{hij}\right] + \overline{HPUE}^{*}_{hij}. \tag{16}$$

The variance of $\overline{HPUE}^{**}_{hij}$ was the variance of $\overline{HPUE}^{*}_{hij}$:

$$\hat{V}\left[\overline{HPUE}^{**}_{hij}\right] = \hat{V}\left[\overline{HPUE}^{*}_{hij}\right] = \frac{m_{hij}-1}{m_{hij}} \sum_{m=1}^{m_{hij}} \left[HPUE^{*}_{hijm} - \overline{HPUE}^{*}_{hij}\right]^{2}. \tag{17}$$

Mean catch per unit effort (CPUE) was estimated using equations (13)-(17), after first substituting catch C_{hijl} for harvest H_{hijl}.

Total number of chinook salmon harvested by anglers during each sampling period within each sampled day for each stratum was estimated as the product of estimated effort and estimated mean HPUE:

$$\hat{H}_{hij} = \hat{E}_{hij}\overline{HPUE}^{**}_{hij} \tag{18}$$

and its variance followed Goodman (1960)

$$\hat{V}\left[\hat{H}_{hij}\right] = \hat{V}\left[\overline{HPUE}^{**}_{hij}\right]\hat{E}^2_{hij} + \hat{V}\left[\hat{E}_{hij}\right]\overline{HPUE}^{**2}_{hij} - \hat{V}\left[\overline{HPUE}^{**}_{hij}\right]\hat{V}\left[\hat{E}_{hij}\right]. \tag{19}$$

Total number of chinook salmon harvested during day unit i of stratum h was estimated by expanding over sampling periods within each day:

$$\hat{H}_{hi} = Q_{hi}\overline{H}_{hi} \tag{20}$$

where:

$$\overline{H}_{hi} = \frac{\sum_{j=1}^{q_{hi}} \hat{H}_{hij}}{q_{hi}}. \tag{21}$$

Likewise, the total number of chinook salmon harvested for stratum h was estimated by expanding over days:

$$\hat{H}_h = D_h\overline{H}_h \tag{22}$$

where

$$\overline{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h}. \tag{23}$$

Its variance was estimated as:

$$V\left(\hat{H}_h\right) = \left(1 - f_{1h}\right)\frac{D_h^2}{d_h}\frac{\sum_{i=1}^{d_h}\left(\hat{H}_{hi} - \overline{H}_h\right)^2}{d_h - 1} + f_{1h}\frac{D_h^2}{d_h^2}\sum_{i=1}^{d_h}\left[\left(1 - f_{2hi}\right)\frac{Q_{hi}^2}{q_{hi}}\frac{\sum_{j=1}^{q_{hi}}\left(\hat{H}_{hij} - \overline{H}_{hi}\right)^2}{q_{hi} - 1}\right] + f_{1h}\frac{D_h^2}{d_h^2}\sum_{i=1}^{d_h}\left[f_{2hi}\frac{Q_{hi}^2}{q_{hi}}\frac{\sum_{j=1}^{q_{hi}} V\left[\hat{H}_{hij}\right]}{q_{hi}}\right] \tag{24}$$

where q'_{hi} is the number of periods sampled in day i in which the variance of the harvest can be estimated (when $m_{hij}>1$).

Total chinook salmon harvested during the fishery and its variance was estimated by summing over strata:

$$\hat{H} = \sum_{h=1}^{L} \hat{H}_h \tag{25}$$

$$\hat{V}\left[\hat{H}\right] = \sum_{h=1}^{L} \hat{V}\left[\hat{H}_h\right]. \tag{26}$$

Catch statistics were estimated similarly, after substituting $\overline{\text{CPUE}}^{**}_{hi}$ for $\overline{\text{HPUE}}^{**}_{hi}$ in equations (18) through (26).

The procedures outlined in equations (18) through (26) were followed for most sampled days to estimate catch and harvest. During the two periods sampled on 29 July 1994 within the nonpeak time of day stratum the procedures were altered. Both periods sampled had a low number of anglers counted (with $\bar{x}_{hij} = 0.6$ for the first period sampled and $\bar{x}_{hij} = 3.3$), but no anglers were interviewed during the first period, and only one (very successful) angler was interviewed during the second period. This combination would have resulted in a highly biased estimate of catch and harvest for this one sample day which would have biased high the total estimates of catch and harvest. Accordingly, refined estimates of CPUE and HPUE were imputed for these two periods, as follows:

> The imputation made was to "clone" interviews collected on 30 July 1994 that were sampled during the peak time of day stratum, but to treat the resultant estimates as if only one angler was interviewed for each period so that variances were not artificially reduced (more than they would be otherwise). The assumption being that CPUE and HPUE estimated during the peak time of day stratum on the following day would be closer to their true values than that estimated from only one angler interviewed.

Angler-trip Proportions

Estimates of the proportion of angler-trips by demographic or gear type categories were calculated as described above in the Data Analysis subsection of the Delta Clearwater Arctic grayling study.

Assumptions

The assumptions necessary for unbiased point and variance estimates of angler effort, catch, harvest, obtained by the procedures outlined above included the following:

1. anglers interviewed were representative of the total angler population;
2. anglers accurately reported their hours of fishing effort, the number of fish caught, and the number of fish released; and,
3. the angler count process was approximately instantaneous, or the survey technician traveled substantially faster than anglers move about or exit or enter the fishery.

Similarly, unbiased point and variance estimates of angler demographics and gear type proportions depended upon the validity of the above assumptions as well as the following additional assumptions:

4. the creel clerk accurately classified anglers and the interviewed anglers accurately report their demographic characteristics and the gear type used during the trip; and,
5. either the interview data were self-weighting, that is an equal proportion of the total angler-trips are sampled throughout the survey or the parameters of interest do not vary throughout the survey.

There were no direct ways of evaluating or testing the first assumption. Anglers were expected to have fairly good recollection of the time spent fishing and the total number of fish caught. Numbers of fish harvested were directly observed and recorded by the creel clerk, and as such no similar assumption is listed for estimation of harvest. Similarly, anglers were expected to accurately report their demographic characteristics (assumption 4).

The angler count process was not instantaneous (one-half hour to conduct the count). However, the assumption that the creel technician traveled (and counted) the fishery substantially faster than anglers moved about the fishery was most likely valid.

The fifth assumption was determined to be valid by an analysis of similarly collected interviews during the 1990, 1991, and 1992 surveys of this fishery (Hallberg and Bingham 1991-1993).

No correction for angler avidity was made and therefore estimates of angler demographics and gear usage are only reflective of the proportion of angler-trips

RESULTS

The 1994 creel survey began on 8 July and was terminated on 31 July. Interviews were obtained from a total of 465 anglers who had completed their fishing trip and were preparing to exit the Salcha River chinook salmon fishery. The majority of anglers interviewed at the Salcha River, were male (77%, SE = 2), adult (89%, SE = 1), and residents of the State of Alaska (97%, SE = 1) (Table 5). Seventy percent (SE = 2) of the anglers were military. All anglers interviewed were using spinning gear as opposed to fly fishing gear.

A total of 15,032 (SE = 3,689) angler-hours were expended to catch an estimated 832 (SE = 323) chinook salmon of which 776 (SE = 321) were harvested (Table 6).

DISCUSSION

In 1993 a slough of the glacial fed Tanana River flooded the lower 1.6 km of the Salcha River with silty water. Anglers who traditionally fish for chinook salmon in this portion of the lower Salcha River were forced to move upstream of the silty water and fish near the Richardson Highway bridge. A single access (direct expansion) creel survey design had been used successfully prior to 1993 when the fishery occurred in the very lower part of the Salcha River. However, when the fishery moved upstream and anglers were able to enter and exit the area at many locations, this sampling design type provided only partial estimates of catch, effort and harvest in 1993. Anticipating the same situation happening in 1994, ADF&G redesigned the creel survey utilizing roving-type interviews to obtain catch and harvest information along with counts of fishermen to estimate angling effort.

Table 5.-Estimates of various angler demographic categories and terminal gear use at the Salcha River chinook salmon fishery from 8 to 31 July 1994.

Parameter	Number Interviewed	Percentage	SE
Male	358	77	2
Female	107	23	2
Youth	53	11	1
Adult	412	89	1
Resident	450	97	1
Non-resident	15	3	1
Military	324	70	2
Non-Military	141	30	2
Spinner	465	100	0
Fly	0	0%	0

Table 6.-Estimates of angler effort for and catch and harvest of chinook salmon at the Salcha River from 8 to 31 July 1994.

	Sampling Stratum		
	Peak (1601-2400)	Non-peak (0001-1600)	Total
Number of Days Sampled	8	4	
Number of Anglers Interviewed	355	110	465
Effort Estimate (angler-hours)	7,048	7,984	15,032
SE of Effort Estimate	637	3,634	3,689
Catch Estimate	429	403	832
SE of Catch Estimate	64	316	323
Harvest Estimate	373	403	776
SE of Harvest Estimate	54	316	321

This decision to change the study design proved to be correct as the very lower portion of the Salcha River once again remained silty for the duration of the fishery.

The 1993 and 1994 fishing seasons were very similar in that water levels in the Salcha River remained very low and clear. Chinook salmon abundance was high enough that the minimum spawning escapement goal of 7,100 fish set by ADF&G was obtained by 20 July in both years. In fact, the sport fishing bag limit was increased by emergency order regulation from one to two chinook salmon per day in both 1993 and 1994 as a result of large, early escapement.

The sampling design used in 1994 provided estimates of insufficient precision for angler effort. Angling effort during the non-peak fishing period (between 0001-1600 h) of 7,984 angler hours was 12% higher than for the peak hours (between 1601-2400 h) which was estimated at 7,048 angler-hours. However, the large standard error for the non-peak period of 3,634 angler-hours (CV >45%) indicates this estimate is not very precise. By using a second creel clerk, an increased number of angler counts during the non-peak period should improve the precision of the estimates. The use of two creel clerks would also provide increased angler interviews for more precise HPUE estimates. The survey could also be redesigned to improve estimates with additional staff.

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APPENDIX A

Appendix A.-Angler interview, angler count, and biological data files developed for creel surveys in interior Alaska in 1994.

U0060IA4.DTA	Delta Clearwater River Arctic grayling fishery, creel survey angler interview data. Interviews with anglers who had completed their fishing trip and were exiting the Delta Clearwater River at the State of Alaska campground.
U0060LC4.DTA	Delta Clearwater River Arctic grayling tagging length data.
U0140IA4.DTA	Minto Flats northern pike fishery, creel survey angler interview data. Interviews with anglers who had completed their fishing trip and were exiting Minto Flats at the end of the Murphy Dome road.
U0140LC4.DTA	Minto Flats northern pike tagging length data.
U0050IA4.DTA	Salcha River chinook salmon fishery, creel survey angler interview data. Interviews with anglers who had completed their fishing trip and were exiting the Salcha River .
U0050CA4.DTA	Salcha River chinook salmon fishery, creel survey angler count data.