

FISHERY DATA SERIES NO. 12

TANANA DRAINAGE CREEL CENSUS AND HARVEST SURVEYS, 1986

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ABSTRACT

From spring 1986 to spring 1987, 16 creel surveys were conducted on the major fisheries of the Tanana drainage. Angler effort, catch rate, and harvest were estimated for 10 of these fisheries. Catch rate was estimated for the other six fisheries. Catch composition and angler demographics were estimated for all 16 fisheries. Fish species sampled during creel surveys include: Arctic grayling (*Thymallus arcticus* Pallas), lake trout (*Salvelinus namaycush* Walbaum), burbot (*Lota lota* Linnaeus), rainbow trout (*Salmo gairdneri* Richardson), landlocked coho salmon (*Oncorhynchus kisutch* Walbaum), anadromous chinook salmon (*Oncorhynchus tshawytscha* Walbaum), anadromous chum salmon (*Oncorhynchus keta* Walbaum), least cisco (*Coregonus sardinella* Valenciennes), humpback whitefish (*Coregonus pidschian* Gmelin), and round whitefish (*Prosopium cylindraceum* Pallas).

Harvests in the two major grayling fisheries of the Tanana drainage (upper Chena River and Delta Clearwater River) were at historic lows in 1986. Harvests in these two fisheries were 3,326 and 1,701 fish, respectively. Catch rates of spring grayling fisheries were also at record lows in 1986, ranging from 0.65 fish harvested per hour in Piledriver Slough to 0.09 fish harvested per hour in Badger Slough. Catch rates in two major lake trout fisheries (Fielding Lake and Tangle Lakes) averaged from 0.00 fish harvested per hour to 0.11 fish harvested per hour. Relatively high harvests and catch rates were estimated for the major stocked lake fisheries of the Tanana drainage.

KEY WORDS: creel census, harvest, catch rate, angler effort, angler demographics, size and age, Interior Alaska, Tanana River drainage.

INTRODUCTION

Objectives of Creel Census Program

Sport fishing effort has increased on Arctic-Yukon-Kuskokwim (AYK; Alaska Department of Fish and Game Region III) waters by more than 7% per year during the period 1977-1984 (Mills 1979-1985). The majority of this effort is expended in waters of the Tanana drainage that are near the interior Alaska population centers. Population increases in the AYK region, which include major increases in military personnel, should serve to continue this trend toward increasing fishing effort.

Some interior Alaska fisheries such as the Chena River and Shaw Creek grayling fisheries already show some signs of over-exploitation, including decreasing population abundance, decreasing mean length at age, and shift in age structure to younger age groups (Holmes, et al. 1986). In the rapidly developing burbot (*Lota lota* Linnaeus), lake trout (*Salvelinus namaycush* Walbaum) and northern pike (*Esox lucius* Linnaeus) fisheries, the status of the stock and sport harvests are so poorly understood that no estimate of the effect of fishing pressure is currently possible. On

other waters, newly developing sport fisheries are causing allocation conflicts with existing commercial and subsistence fisheries.

Fishery Descriptions

Creel surveys are planned for 16 of the major fisheries of the Tanana drainage (Table 1). In all cases the status of the fishery resource has not been adequately defined and long term data bases are needed to develop sound management policies. Harvest, effort, CPUE, and biological data obtained from these fisheries provide an important portion of the needed data bases. Additional information will be obtained for specific fisheries. These include information on: catch allocation among user groups, temporal and spatial use patterns, angler characteristics and their desires for a fishery, sport fishery impact on indigenous stocks, stocked fish contribution to a fishery, contribution of specific cohorts to the harvest, and effectiveness of inseason management decisions. The long-term goals of this creel census project are to: develop a historical data base to monitor both the sport fishery and the exploited fish populations; develop regulations that reflect the desires of the angling public while ensuring the health of the resource; and, determine the effect of management regulations on the fishery and fish population.

River Grayling Fisheries:

There are two major grayling fisheries that occur in the Fairbanks/Delta Junction area. These fisheries usually start in mid-May and continue into the late spring and summer months. Some fishing also occurs in early September, as grayling begin their migration to overwintering areas.

Upper Chena River. The largest Arctic grayling (*Thymallus arcticus* Pallas) fishery in Alaska is the upper Chena River. This fishery attracts a large number of anglers because it is close to Fairbanks and the river is largely accessible by road (Figure 1). The Chena River fishery is expected to receive increased angler pressure in the future as the population of the Fairbanks area increases. Previous research indicates that under the current regulatory regime this stock will be negatively impacted by continued growth of the fishery (Holmes, et al. 1986). Since 1981, both harvest and CPUE have declined on the Upper Chena River (Holmes 1985).

The average length of harvested grayling for the past 10 years has been 246 mm and the proportion of "quality" grayling (> 300 mm) has ranged from 10% to 30%. The relatively small average length and decreased abundance of grayling are commonly commented on by anglers. Identification of angler desires for the fishery was one of the goals of the 1986 creel census. In addition, this research provided integral information on grayling fishing mortality and rate of exploitation for the Tanana Drainage Arctic Grayling Research project.

Delta Clearwater River. Located approximately 8 miles northeast of Delta Junction, the Delta Clearwater River supports a popular sport fishery for grayling and a growing fishery for a fall run of coho salmon (*Oncorhynchus kisutch* Walbaum). The main channel of the river is approximately 20 miles long. The Delta Clearwater River drains an area of approximately 350 square miles. Public access is available at the State of Alaska Clear-

Table 1. Scheduled creel surveys for Arctic-Yukon-Kuskokwim Region in 1986.

Water body	Species ¹	Creel Census Estimates			
		CPUE/Ang. Inf.	A-L ²	Effort	Harvest
Chena River	GR	x	x	x	x
Delta Clearwater	GR	x	x	x	x
<u>Spring Fisheries</u>					
Badger Slough	GR	x	x		
Piledriver Slough	GR	x	x		
Chena Dam Site	GR	x	x	x	x
Shaw Creek	GR	x	x	x	x
Fielding Lake	GR,LT,BB	x	x	x	x
Tangle Lakes	GR,LT,BB	x	x		
Chena Lake	RT,SS	x	x	x	x
Birch Lake	RT,SS	x	x	x	x
Quartz Lake	RT,SS	x	x	x	x
Salcha River	KS,CS	x	x	x	x
Chatanika River	WF	x	x	x	x
<u>Winter Fisheries</u>					
Chena Lake	RT,SS	x	x	x	x
Birch Lake	RT,SS	x	x	x	x
Quartz Lake	RT,SS	x	x	x	x

¹ GR = Arctic grayling, LT = lake trout, BB = burbot,
 KS = chinook salmon, CS = chum salmon, RT = rainbow trout,
 SS = coho salmon (land-locked), WF = whitefish.

² Age and length data

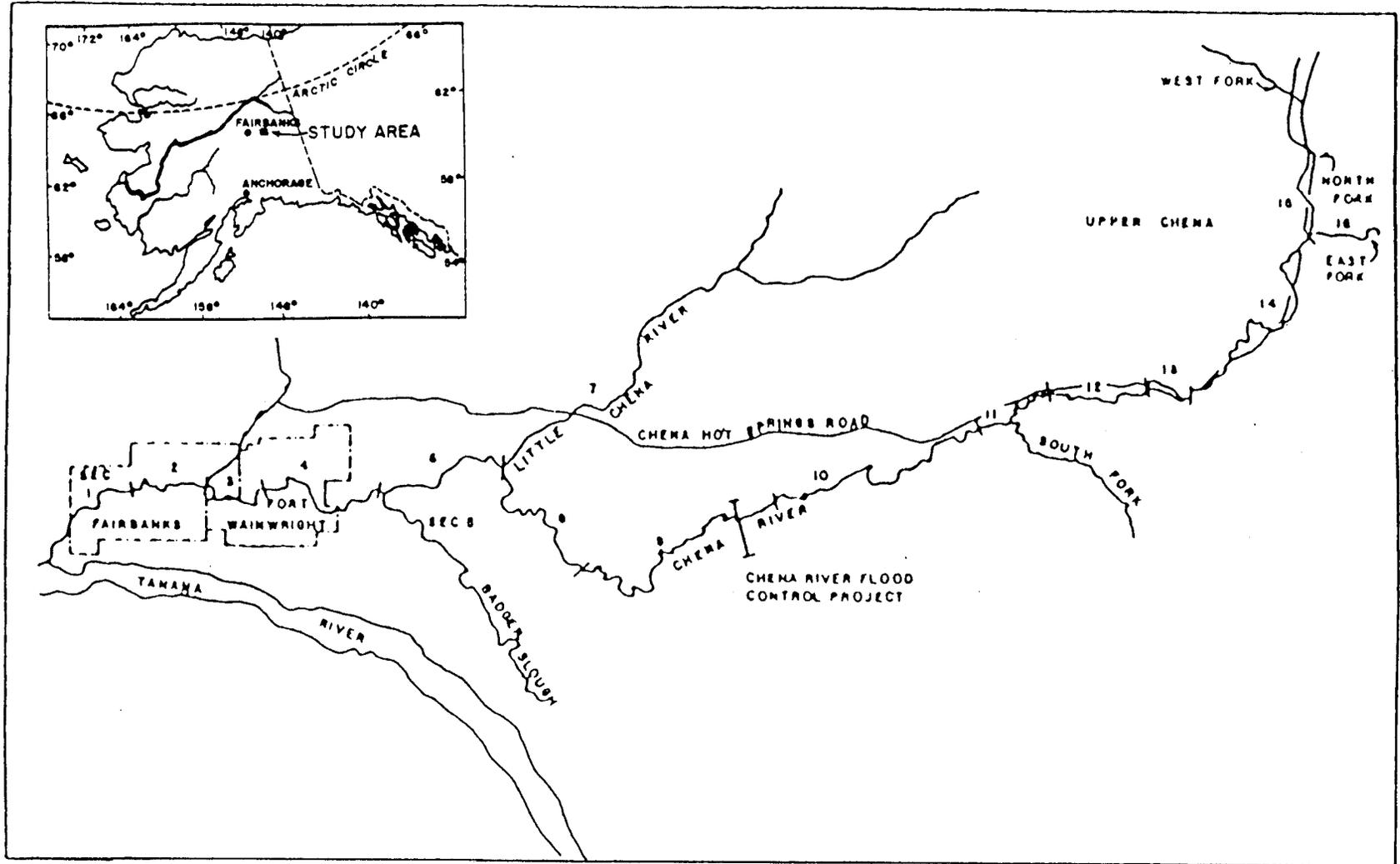


Figure 1. The upper Chena River and Badger Slough showing the proximity of the Chena Hot Springs Road to the river.

water Campground at Mile 8 of the river and at a U.S. Army facility on Clearwater Lake (Figure 2).

Fishing begins on the Delta Clearwater River in mid to late May when the larger grayling begin to migrate to their summer feeding areas in the river. From 1977-1984, an average of 5,830 angler days were expended annually to harvest an average of 6,103 fish (Mills 1979-1985). About 70% of the anglers on the Delta Clearwater fish from boats and the other 30% from shore. Hatchery reared and pond reared grayling have been stocked into the Delta Clearwater annually since 1974 and have provided as much as 31% of the total Delta Clearwater grayling harvest (Ridder 1984).

Spring Grayling Fisheries:

Four major spring grayling fisheries occur in the Fairbanks/Delta Junction area. These fisheries share many common characteristics. All are the first open water fisheries of the year commencing with the first ice free periods in the spring. As such, they are very popular with sport anglers. These early season fisheries correspond with the spawning migrations of grayling stocks, therefore, many larger prespawning adults are harvested. These fisheries usually last less than one month and end with high water or the completion of spawning.

Badger Slough. Located approximately 5 miles to the east of Fairbanks, Badger Slough is a spring-fed tributary of the Chena River (Figure 1). The fishery occurs from about mid-April to the end of May. The harvest of grayling and total angler-days of effort have averaged 4,515 and 6,016, respectively, since 1979 (Mills 1981-1985). As with the other spring grayling fisheries, a significant proportion of the catch is composed of spawning adults. In 1985, 27% ($\pm 8.0\%$)¹ of the catch was composed of spawning grayling. The Badger Slough creel census is designed to estimate CPUE and sample the catch to determine the proportion of adult grayling in the harvest.

Piledriver Slough. Once a slough of the Tanana River, Piledriver Slough is now a spring-fed tributary of Moose Creek. Dike construction from the Moose Creek Flood Control Project blocked the upstream end of Piledriver Slough in the late 1970s. With the silty waters of the Tanana blocked, Piledriver Slough began to flow with clear spring water. An early season fishery has recently developed to harvest the grayling that occupy the slough. Mills (1985) estimated that 4,651 angler-hours were expended on Piledriver Slough in 1984 to harvest 3,751 grayling. The first year that an on-site creel census was conducted on Piledriver Slough was 1985. The mean size of fish harvested was 250 (± 29 mm). Only 4.0% ($\pm 5.1\%$) of the fish harvested from Piledriver Slough were of spawning size. The goal of the Piledriver Slough creel census is to estimate CPUE and the proportion of adult grayling in the harvest.

Chena River Dam Site. Dam construction on the Chena River has resulted in increased access to an area known as the Chena River Dam Site. The spring grayling fishery is located downstream from the Chena Dam Site control

¹ All quantities given as ($\pm x$) are for 95% confidence intervals.

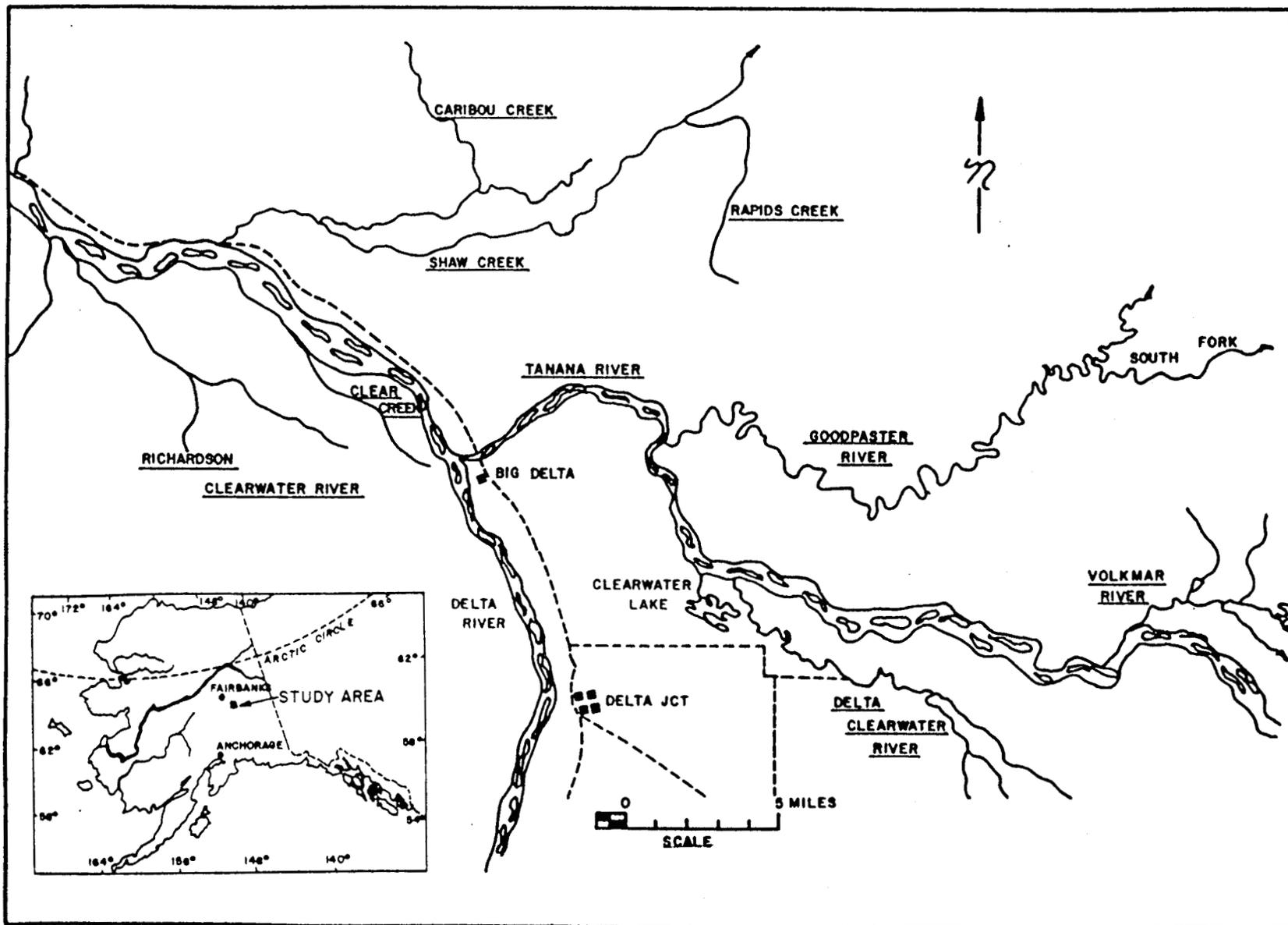


Figure 2. The Delta Clearwater River and Shaw Creek showing their proximity to Delta Junction.

structure (Figure 1). A creel census was initiated in May 1985. The fishery begins with the first ice melt in the area and continues for 2 to 3 weeks until water levels rise and water clarity decreases. The average CPUE was 0.62 (\pm 0.25) grayling per hour in 1985. Including catch and release fishing, the CPUE was 1.52 (\pm 0.85) grayling per hour. A very large proportion of the grayling harvested here were of spawning size (64.4% \pm 10.3%). The high proportion of large grayling in the harvest indicates that the fishery is harvesting fish during upstream migration to spawning areas.

Because this fishery takes place in a short stream section, it is possible to make angler counts and estimate effort and harvest. During the 18 days of the creel census in 1985, an estimated 1,831 (\pm 701) angler-hours were expended to harvest an estimated 1,136 (\pm 1,235) grayling. Of this harvest, 731 fish were estimated to be spawning adults. The large size of this harvest, coupled with the selection for large fish, makes this an important fishery. A more intensive creel census is planned for 1986 to improve the precision of estimates, to monitor the size and the age structure of the catch, and to determine if an emergency closure is necessary to protect Chena River grayling spawning stocks.

Shaw Creek. Located about 20 miles southwest of Delta Junction, Shaw Creek is one of the major spring grayling fisheries in the Tanana drainage (Figure 2). This bog-fed system is a major spawning area for fish that later migrate to summer feeding areas in the Richardson Clearwater and other area rivers. The fishery here resumed in 1981 after a 5 year hiatus caused by highway realignment. The fishery has been monitored during a 2 to 3 week period in mid-April every year since it reopened. Anglers fish for grayling at the mouth of Shaw Creek and in the Tanana River before ice breakup occurs in Shaw Creek. Because of springs located upstream, this section of the Tanana River is free of ice as early as mid-April. Fishing ends with ice-out in Shaw Creek when fish continue their upstream migration to spawning areas. About 60% of anglers are Alaska residents and the other 40% are mostly military personnel. All fishing occurs from the shore.

Since 1981, effort and harvest have averaged 1,700 angler-hours and 1,930 grayling, respectively (Mills 1982-1985). Harvested fish have averaged 311 mm and approximately 87% have been of spawning size. Large ice jams in Shaw Creek periodically occur, blocking the upstream passage of spawning grayling. Grayling are extremely susceptible to overharvest when this occurs. Twice since 1981 the fishery has been closed by emergency order to prevent overharvest.

In 1985 a creel survey covering all time periods was conducted and a management plan developed whereby emergency closure was initiated when CPUE of specific sizes of fish reached a certain level. Preliminary analysis of harvest data and population estimates indicates that a harvest of about 1,500 grayling at Shaw creek exceeds the sustainable yield, resulting in a decline in population size. Therefore, a maximum harvest goal of 1,000 grayling has been set to prevent further decreases in population size. The goal of the Shaw Creek creel census is to monitor daily harvest levels to determine when and if an inseason emergency closure is necessary.

Lake Fisheries:

There are two lakes in the Tanana drainage that support popular sport fisheries for grayling, lake trout, and burbot. Grayling and lake trout fishing occurs primarily in the summer months, with some winter ice fishing for lake trout. Burbot fishing occurs in the winter months when set lines are the most popular gear.

Fielding Lake. Located 65 miles south of Delta Junction on the Richardson Highway, Fielding Lake is a large oligotrophic lake situated at an elevation of 2,973 feet in the Alaska Range (Figure 3). A 2-mile gravel road links the highway to the 1,660 acre lake. Facilities at the lake include a commercial launching site, a lodge, a State campground, and private cabins.

The lake supports a fishery on grayling, lake trout, and burbot. From 1981 to 1984, the fishing pressure on all species has averaged 1,685 angler-days with an average harvest of 1,982 grayling, 276 lake trout, and 245 burbot (Mills 1982-1985). On-site creel census programs were conducted in 1976, 1982 and 1985. CPUE (fish/hour) estimates have ranged from 0.31 to 0.43 for grayling and from 0.02 to 0.07 for lake trout (Peckham 1977 and 1983; Holmes, et al. 1986). Burbot were caught almost exclusively with set lines prior to 1984. The burbot set line fishery was closed by emergency order from 17 May to 31 December 1984. A 1985 regulation limited burbot fishing to hand held rods from 16 May to 14 October. The winter set line fishery occurs mainly during March and April. Ice-out occurs about mid-June and the heaviest angling pressure occurs during the subsequent 30-day period. In 1985, 82% of the angler contacts during creel surveys occurred at this time. The goal of the Fielding Lake creel census is to provide a long term data base of catch, effort, and biological data for this mixed species fishery to be used to develop management strategies to protect these wild stocks.

Tangle Lakes. The most popular fishery on the Denali Highway, Tangle Lakes is a 20-mile long lake/stream system that includes five named lakes and approximately 70 miles of tributary streams (Figure 3). Twenty-two miles west of Paxson, the Denali Highway bisects the system between Upper Tangle and Round Tangle Lakes. There are Bureau of Land Management campgrounds adjacent to the river at both lakes. A popular 40-mile float trip of the Delta River begins at Round Tangle Lake.

The Tangle Lakes system has supported popular fisheries on grayling, lake trout, and burbot since the construction of the Denali highway in the 1950s. The heaviest pressure occurs on Upper and Round Tangle Lakes and the interconnecting Tangle River. Creel census programs were conducted in 1968, 1973, 1976, and 1985 (Roguski and Winslow 1969; Peckham 1974 and 1977; and Holmes, et al. 1986). Since 1978 effort has averaged 6,606 angler-days and an average of 6,264 grayling, 873 lake trout, and 118 burbot have been harvested annually (Mills 1979-1985). The goal of this creel census is to develop a long term data base on CPUE, catch composition, and angler demographics for this important wild stock fishery.

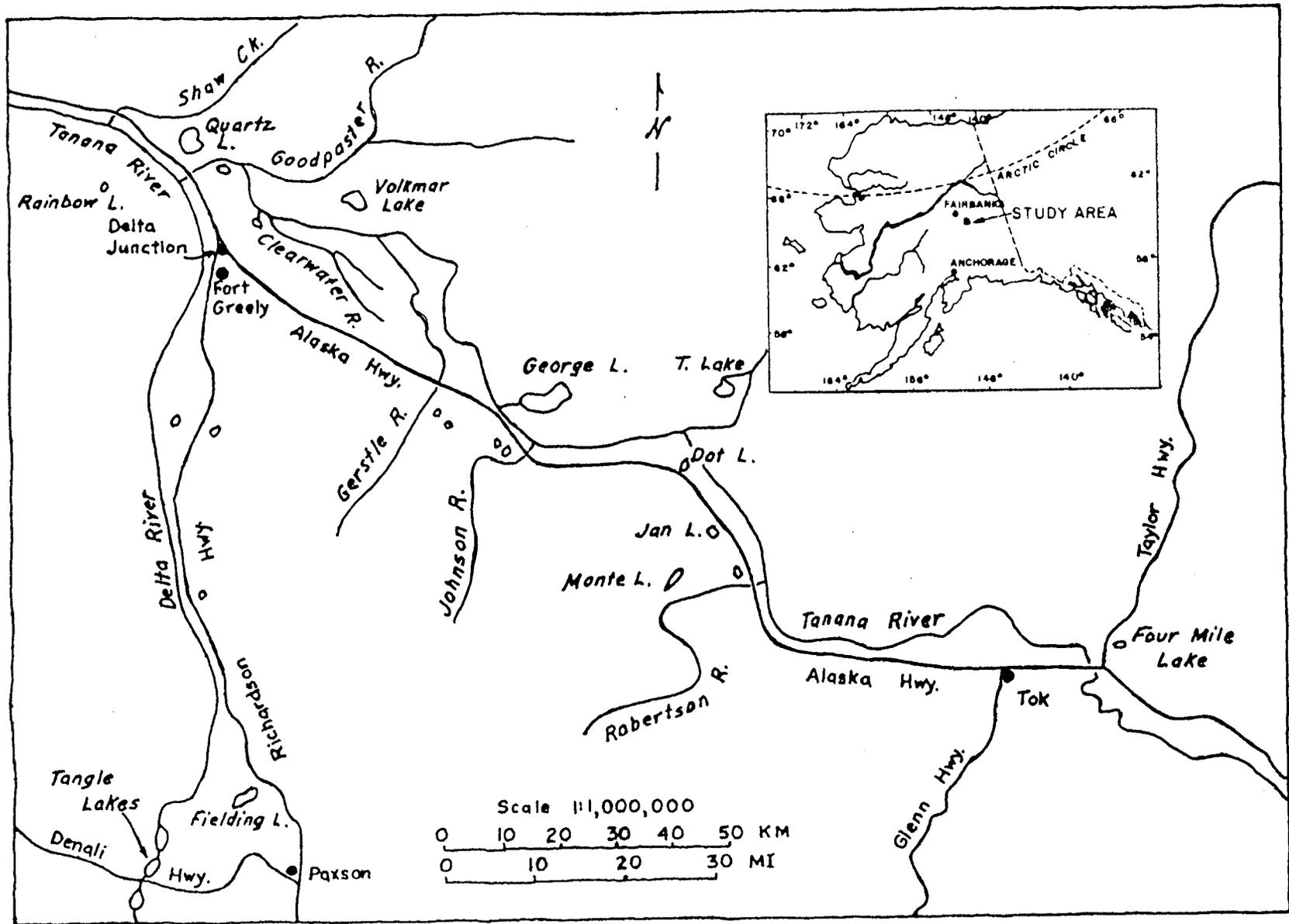


Figure 3. Location of Quartz Lake, Fielding Lake, and the Tangle Lakes.

Stocked Lake Fisheries:

Increasing angling pressure on the indigenous fish stocks of the Tanana drainage prompted the Alaska Department of Fish and Game to begin stocking rainbow trout (*Salmo gairdneri* Richardson) and coho salmon in chemically rehabilitated and manmade lakes along the road system. There are three major stocked lake fisheries that occur along the Richardson Highway, annually supporting one-third of all angling pressure in the drainage. The three major fisheries occur at Chena Lake, Birch Lake, and Quartz Lake.

Chena Lake. Habitat loss, due to construction of the Moose Creek Flood Control structure, was mitigated by the formation of Chena Lake and the Chena Lake and River Recreation areas. Chena Lake is located about 20 miles from Fairbanks within the area of the Moose Creek Flood Control Project. The lake was formed by connecting a series of gravel pits from the construction of the flood control dykes. Chena Lake was chemically rehabilitated in 1981 and has been stocked with rainbow trout and coho salmon annually since. Because of the proximity of the lake to a large population base, which includes North Pole, Fairbanks, Fort Wainwright, and Eielson Air Force Base, angling pressure and harvest have been very heavy.

It is felt that use of the area has removed some of the pressure on the wild stock fisheries near Fairbanks (Holmes 1985). Timely estimates of harvest, CPUE, angler effort, and catch composition are provided by an on-site creel census. These estimates will be added to the existing data base and used to assist in setting future stocking levels and to determine types and brood stocks of fish that maximize returns of stocked fish to anglers' creels.

Birch Lake. Another popular lake that supports a stocked rainbow trout and coho salmon fishery is Birch Lake, an 803-surface acre lake 56 miles southeast of Fairbanks on the Richardson Highway (Figure 4). Public access is provided at two sites and there is a U.S. Air Force recreation camp as well. About half the shoreline is private land with cabins.

Chemical rehabilitation in 1966 removed humpback whitefish (*Coregonus pidschian* Gmelin), least cisco (*Coregonus sardinella* Valenciennes), burbot, slimy sculpin (*Cottus cognatus* Richardson), and northern pike. Since then, a popular summer and winter sport fishery has been maintained by stocking rainbow trout and coho salmon fingerlings and subcatchable rainbow trout. Since 1980, an average of about 30,000 angler-hours per year have been expended to harvest an average of about 20,000 rainbow trout and coho salmon (Mills 1981-1985). Timely estimates of harvest, CPUE, angler-effort, and catch composition are provided by an annual on-site summer and winter creel census. These estimates will be added to the long term data base and used to assist in setting future stocking levels and to determine types and strains of fish to be stocked.

Quartz Lake. The most popular stocked rainbow trout and coho salmon fishery in the Tanana drainage occurs at Quartz Lake. Quartz Lake is a 1500-acre lake located near Milepost 278 on the Richardson Highway, approximately 16 miles northwest of Delta Junction (Figure 3). The lake

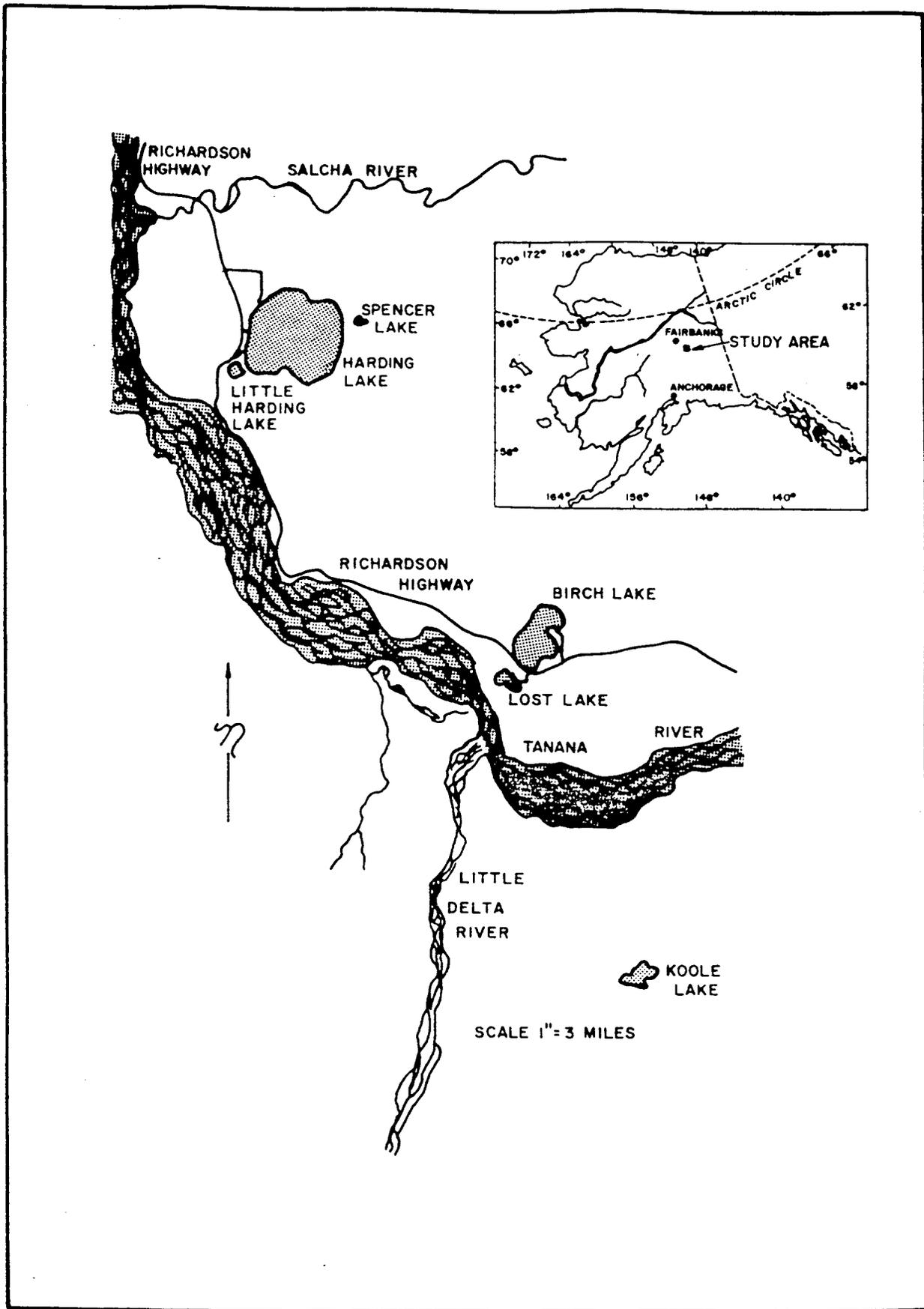


Figure 4. The location of Birch Lake in the Tanana drainage.

was chemically rehabilitated in 1970 to eliminate northern pike and least cisco. Rainbow trout and coho salmon have been stocked annually since 1970. There is one access road to the lake. The state maintains a boat launch and campground on the lake. Lands surrounding the southern half of the lake comprise a state recreation area. The northern shoreline is privately held and contains a dozen cabins and one commercial lodge.

The lake supports summer and winter fisheries. Creel census surveys have been conducted on the lake since 1972. For the period 1978-1984, the average annual creel census estimates for Quartz Lake are 13,155 angler-days of effort and a harvest of 2,186 rainbows and 25,056 coho harvested (Mills 1979-1985). Timely estimates of harvest, CPUE, angler effort, and catch composition are provided by an annual summer and winter on-site creel census. These estimates will be added to the long term data base and will be used to assist in setting future stocking levels and to determine types and strains of fish to be stocked.

River Salmon and Whitefish Fisheries:

The Salcha River, due to its location along the road system and presence of a large spawning run of chinook salmon (*Oncorhynchus tshawytscha* Walbaum), supports the largest recreational anadromous salmon fishery in the Tanana drainage.

Another popular fishery that occurs in the fall of the year is whitefish spearing. Usually the last open water fishery of the year, the Chatanika River supports the largest whitefish fishery in Alaska.

Salcha River. Located about 40 miles from Fairbanks, the Salcha River supports popular grayling, chinook and chum salmon (*Oncorhynchus keta* Walbaum) sport fisheries (Figure 4). The chinook salmon run in the Salcha River is the largest documented run in the middle Yukon River drainage (Barton 1985). The chinook salmon sport fishery lasts about 1 month beginning in late June. Angler effort appears to be increasing. Fishing is allowed on the lower 14 miles of the river and the chinook salmon bag limit is one fish per day. Water conditions can have a major effect on the sport harvest. The goal of this creel census is to develop a data base and monitor the effect of the fishery on this important stock.

Chatanika River. Located north of Fairbanks and accessed via the Steese and Elliot Highways, the Chatanika River supports a summer grayling fishery, a summer chinook salmon fishery, and an intensive whitefish spearing fishery in the fall (Figure 5). Turbidity from placer mining on tributary streams has caused a reduction in grayling catches in recent years. The Chatanika is a major spawning area for least cisco, round whitefish (*Prosopium cylindraceum* Pallas), and humpback whitefish. A spear fishery occurs during the fall spawning runs of these species, beginning on 1 September and ending when the river freezes in October. While the entire Tanana Drainage is open to spearfishing at this time, the Chatanika River near the Elliot Highway bridge accounts for an estimated 90% of all spearing effort. There is no bag limit for whitefish in this fishery. Harvest since 1978 has average 4,700 fish per year (Mills 1979-1985). The CPUE has averaged about 2-3 fish per hour since 1972 (Hallberg 1985). Stock status of the fall whitefish populations has not

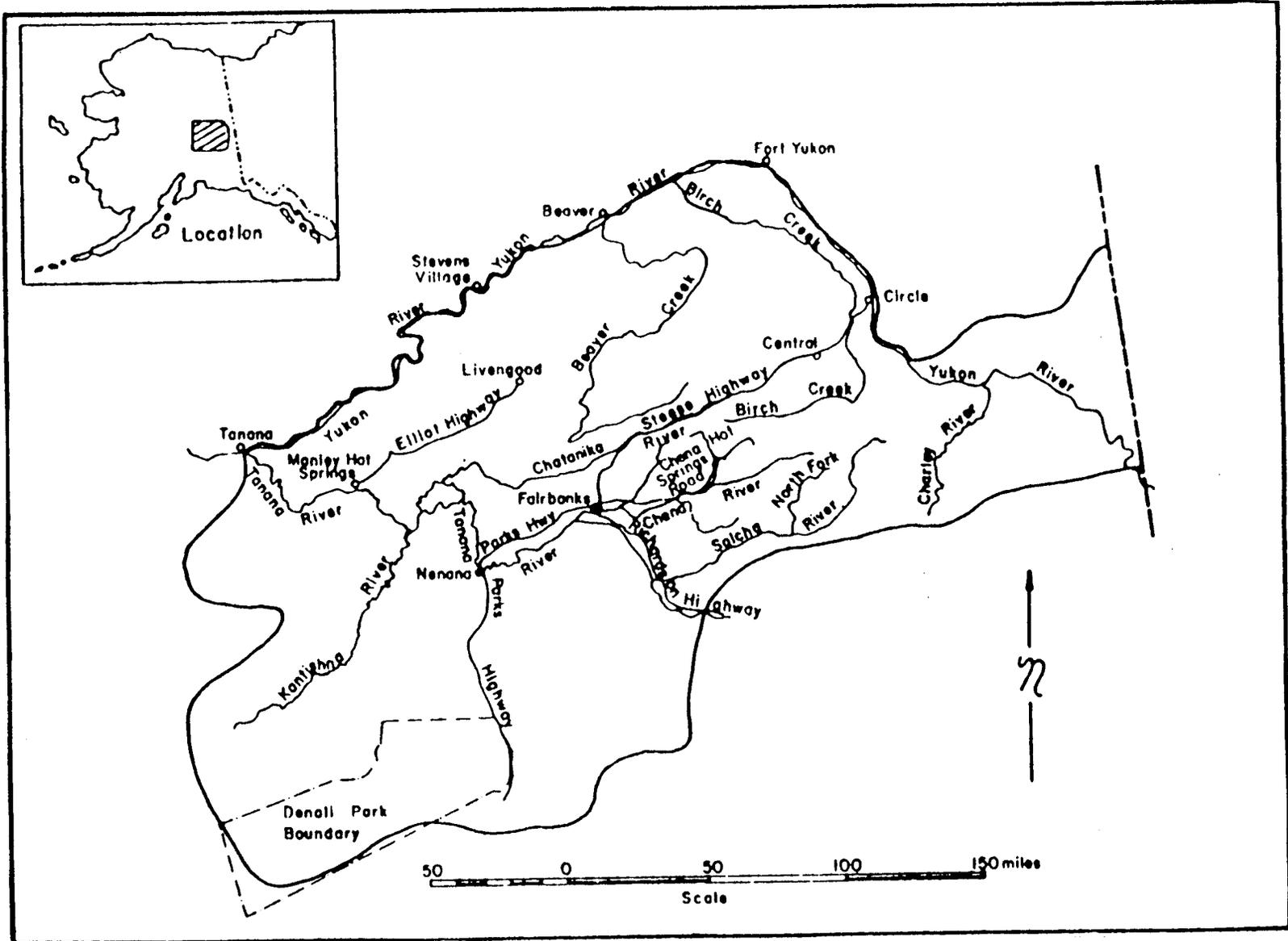


Figure 5. Chatanika River and Salcha River creel census sites in the Tanana Drainage.

been determined and the effect of this fall fishery is unknown. A stock evaluation study is currently underway and the annual creel census of the fall fishery contributes information to this project.

METHODS

Study Design

Harvest studies performed in the AYK region are of two types; those which estimate effort, harvest, and CPUE (hereafter referred to as effort surveys) and those which estimate only CPUE (hereafter referred to as CPUE studies). Sampling procedures used in all effort surveys are essentially the same and sampling procedures for CPUE studies are the same for all studies. A description of the general study design and data collection procedures follows. This is followed by a fishery specific sampling design and data collection section for each creel census.

General Sampling Procedures:

All creel surveys are based upon a stratified random sampling design. The strata in each fishery are defined to increase the relative precision of the estimates of angler effort (i.e., levels of angler-effort are expected to be similar within a stratum) and are based on historical creel census data. The number of angler counts and/or interviews collected in each fishery is determined by creel census technician time available each month and an estimate of the minimum number of samples needed to achieve the desired level of precision according to procedures described in Cochran (1977). Allocation of sampling effort among strata in a fishery is determined by optimal allocation based on strata variances (assuming constant costs for collection among strata). Variance estimates for strata are from the most recent creel census conducted for a fishery.

Effort is estimated from counts of anglers during randomly selected time periods within a stratum. None of the angler counts in effort creel surveys take more than one hour to complete, therefore, they are considered to be instantaneous estimates of the number of anglers present (Neuhold and Lu 1957). Both roving and stationary counts are used in the surveys depending upon the fishery. Roving creel surveys are used in fisheries with many access points or that extend over a large area. Stationary counts are used in fisheries with a limited number of access points.

Angler interviews are used to collect: angler CPUE data for the species of interest; angler demographics; and, biological data from harvested fish. For effort creel surveys, angler interviews are conducted in randomly selected time blocks within the same strata employed for angler count sampling design.

The sampling schedule for a creel census is developed by determining the number of sample units in each stratum. Sample units are defined as the time allocated to collect a sample. The sample units are then numbered consecutively for an entire month. The units to be sampled in each stratum are selected from a random number table by drawing numbers without

replacement until the number of samples designated for that stratum has been reached. This procedure is done independently for each stratum. The length of the sample unit (hours allocated to conduct angler count(s) and/or angler interviews) for each fishery is based upon the type of count (roving or stationary) and the estimated time required to obtain a sufficient number of interviews (for stationary counts) or to cover the entire fishery (roving counts). Multiple angler counts are conducted during some sampling periods¹. For multiple counts, a randomly selected time during each hour of the sample period is selected for an angler count. Table 2 summarizes much of the basic information on the design of each creel survey.

General Data Collection:

Only anglers actively fishing are counted during angler counts. For roving counts, the creel census technician counts anglers while traveling from one end of the fishery to the other (the direction of travel for the count is determined randomly) at a constant rate of speed. Stationary counts are made from one or two vantage points where an entire fishery can be seen. Angler counts are recorded on Alaska Department of Fish and Game Creel Census - Angler Count Form Version 1.1.

Interviews are conducted for individual anglers and are not group interviews. Depending on the fishery, the interviews are either complete trip or incomplete trip interviews. The majority of interviews during the roving creel surveys are for incomplete trips. Only interviews of angler who have completed fishing for the day are obtained when a stationary survey at an access point is conducted.

All anglers present during the sample period are interviewed if possible. Anglers are randomly selected for interview if all anglers cannot be contacted. Interviewed anglers are asked the length of time spent fishing; number of fish caught by species; number of fish kept by species; and various user group characterization questions (sex, residency, fishing method, etc.). In addition, anglers are asked several questions regarding management strategies and regulations. These questions are altered slightly for each fishery depending upon specific regulation changes that may be proposed for that fishery. All interview data are recorded on Alaska Department of Fish and Game Angler Interview Form Version 1.1.

Biological data (length and/or age data) is collected for the species of interest from all fish present in the creel of each interviewed angler. Based on past experience, it is necessary to sample all fish to obtain the sample sizes needed to achieve the specified levels of relative precision. The mid-eye to fork of tail length is measured for chinook and chum salmon and the tip of snout to fork of tail length is measured for all other species. All length measurements are recorded to the nearest 1 mm. Aging structures collected are otoliths, scales, and opercles for lake trout, otoliths and vertebrae for burbot, and scales for all other species

¹ Sample period and sample units are used interchangeably.

Table 2. Summary information for creel surveys conducted in the AYK Region in 1986.

Fishery	Period	Number of Strata	Hours in Sample Unit	Completed/Incomplete	Roving/Stationary	Angler Types
Chena River	1 May - 15 Sept.	4	2	Cmp./Incmp.	Roving	Shore
Delta Clearwater	15 May - 31 August	4	4	Cmp./Incmp.	Roving	Bt/Sh
<u>Spring Fisheries</u>						
Badger Slough	1 May - 31 May	3	2	Cmp./Incmp.	Roving	Shore
Piledriver Slough	1 May - 31 May	3	2	Cmp./Incmp.	Roving	Shore
Chena Dam Site	1 May - 25 May	3	2	Completed	Stationary	Shore
Shaw Creek	April - May	2	4	Completed	Stationary	Shore
<u>Lake Fisheries</u>						
Fielding Lake	15 June - 31 August	2	7	Completed	Stationary	Bt/Sh
Tangle Lakes	15 June - 31 August	2	7	Completed	Stationary	Bt/Sh
Chena Lake	1 June - 31 August	4	3	Completed	Stationary	Bt/Sh
Birch Lake	1 June - 31 August	2	3	Completed	Stationary	Bt/Sh
Quartz Lake	1 June - 31 August	2	3	Completed	Stationary	Bt/Sh
<u>River Fisheries</u>						
Salcha River	1 July - 31 July	2	3	Completed	Stationary	Bt/Sh
Chatanika River	Sept. - Oct.	2	4	Cmp./Incmp.	Stationary	Bt/Sh
<u>Winter Fisheries</u>						
Chena Lake	1 Nov. - 15 April	2	2	Cmp./Incmp.	Roving	Ice
Birch Lake	1 Nov. - 15 April	2	2	Cmp./Incmp.	Roving	Ice
Quartz Lake	1 Nov. - 15 April	2	2	Cmp./Incmp.	Roving	Ice

Table 3). All length and age data are recorded on the Alaska Department of Fish and Game Standard Age Weight Length Form Version 1.1.

Fishery Specific Study Design and Data Collection

Each fishery presents a unique set of sampling problems, most of which are caused by the differing access methods and angler use patterns of these fisheries. Therefore, each fishery has a specific set of sampling methods that were developed to optimize creel census clerk time while adhering to the general principles of statistical survey technique. Fishery specific study designs and data collection procedures are described in the following sections.

Upper Chena River Grayling Fishery:

The upper Chena River grayling fishery occurs on a 26 mile section of the Chena Hot Springs Road that parallels the Chena River. Numerous access points are available to anglers including eight bridges, three state campsites, and four side roads. About 90% of the fishing occurs from shore near these access areas. Some anglers reach more remote areas by floating between access points. The Chena River creel census is a roving creel census.

Holmes (1981) found that 83% of the fishing effort occurred between 0800 hours and 2200 hours on the upper Chena River. Therefore, the fishing day is considered to be 14 hours long. Each month is divided into four time strata: (1) weekdays 1100 hours to 1900 hours ; (2) weekdays 0800 hours to 1100 hours and 1900 hours to 2200 hours; (3) weekends and holidays 1100 hours to 1900 hours; and (4) weekends and holidays 0800 hours to 1100 hours and 1900 hours to 2200 hours. Optimum allocation indicates that 38%, 26%, 26%, and 10% of monthly sampling effort should be expended in strata 1, 2, 3, and 4, respectively. The sample period for the upper Chena River creel census is 2 hours.

This roving creel census is conducted from 1 May to 15 September. Twenty angler count/interview samples are collected each month. These are distributed among the strata as described above.

The field sampling procedure is as follows. At the start of a selected 2 hour time period, a coin is tossed to determine if an angler count or interviews will be made first. Angler counts are made by driving the main road and all side roads on which anglers are usually located. Angler counts take an average of 40 minutes to complete. The remainder of the sample period is spent conducting angler interviews. Most interviews are incomplete trip interviews.

Delta Clearwater River Grayling Fishery:

Public access to the Delta Clearwater River is available at the State of Alaska Clearwater Campground and at the U.S. Army camp on Clearwater Lake. Approximately 30% of the fishing effort is from shore anglers who fish within a mile of these access areas. The remainder of the effort is from riverboat anglers and cabin owners along the entire 20 miles of the river. Ridder (1982) found that approximately 98% of the fishing effort occurs on

Table 3. Summary of biological data collected from each fish species during AYK creel surveys in 1986.

Species	Type of length Measurement	Age structure
Arctic grayling	FL ¹	scales
Lake trout	FL	scales, otoliths, opercles
Burbot	TL ²	otoliths, vertebrae
Chinook salmon	EF ³	scales
Chum salmon	EF	scales
Coho salmon ⁴	FL	scales
Rainbow trout	FL	scales
Whitefish	FL	scales

- ¹ Tip of snout to fork of tail
² Tip of snout to tip of tail
³ Mid-eye to fork of tail
⁴ Land-locked coho salmon

the 14-mile section of the mainstem Delta Clearwater River that is surveyed. This is a roving creel census.

Fishing occurs on the Delta Clearwater River primarily between 0900 hours and 2100 hours. There are 4 monthly sampling strata; (1) weekdays 0900 hours to 2100 hours, (2) weekends and holidays 0900 hours to 1300 hours, (3) weekends and holidays 1300 hours to 1700 hours, and (4) weekends and holidays 1700 hours to 2100 hours. Sampling effort is distributed 55% to stratum 1 and 15% to each of the other strata. The sample period for the Delta Clearwater River creel census is 4 hours.

The Delta Clearwater River creel census is conducted from about 15 May to 31 August. Twenty angler count/interview samples are collected each month and are distributed among the strata as described above. Angler counts take approximately one hour to complete. The remainder of the 4 hour sample period is used to collect angler interviews. Most interviews are incomplete trip interviews.

The field sampling procedure is as follows. At the start of a selected 4-hour sampling period, the creel census clerk launches a riverboat at the Clearwater Campground (located at the approximate center of the sample area). The direction of sampling (upstream or downstream) and whether counts and interviews are conducted first are determined by coin tosses. Angler counts are made in one direction and angler interviews are performed in the opposite direction. The same procedure is followed for counts and interviews for the other half of the fishery. A typical example of the sampling procedure is; (1) interview anglers on the upstream half of the fishery, (2) count anglers on the upstream fishery, (3) count anglers on the downstream fishery, (4) interview downstream anglers on the return trip to the access area. Counts of anglers in each direction usually take 30 minutes to perform.

Badger Slough/Piledriver Slough Grayling Fisheries:

These fisheries are located east of Fairbanks near the Richardson Highway. Badger Slough is paralleled by Badger Road. Fishing access is available along the length of Badger Slough at approximately 15 road crossings. Piledriver Slough has access provided at three road crossings. Almost all fishing is from shore. A combined creel census sampling design is used for these two fisheries. These are roving CPUE creel surveys.

Angler effort is concentrated in the evenings and on weekends. Three sampling strata are used; (1) weekdays 1600 hours to 2200 hours, (2) weekdays 0800 hours to 1600 hours, and (3) weekends and holidays 0800 hours to 2200 hours. About 40%, 20%, and 40% of the sampling effort is allocated to strata 1, 2, and 3, respectively. The sample period for Badger Slough/Piledriver Slough creel census is 2 hours.

In 1986, this creel census is conducted from 1 May to 8 June. A total of 30 sample units, distributed among strata as described above, are sampled.

The sampling procedure is as follows. At the beginning of the 2 hour sampling period, the creel census clerk drives the length of Badger Road and interviews all anglers that can be contacted. The clerk continues

eastward on the Richardson Highway and interviews all anglers at access points of Piledriver Slough. Interviews are performed in the reverse order, interviewing anglers fishing Piledriver Slough first, on the drive back to Fairbanks. Anglers previously interviewed that day are not reinterviewed. The majority of CPUE interviews are for incomplete trips.

Chena River Dam Site Grayling Fishery:

This spring grayling fishery is confined to a $\frac{1}{2}$ -mile section of the Chena River directly downstream of the flood control structure. Access to the area is limited to a single road. A stationary creel census is used because all anglers can be counted from the parking lot adjacent to the fishing area. All fishing is from shore.

The temporal distribution of angling effort for this fishery is similar to that of the Badger Slough/Piledriver Slough fisheries, therefore, the same strata developed for those fisheries are used. The sample period for the Chena River Dam Site creel census is 2 hours.

Approximate dates of this fishery are 1 May to 25 May. Ten angler count/interview samples are collected each week. These are distributed among strata identically to the Badger Slough/Piledriver Slough creel census.

The field sampling procedure is as follows. The creel census clerk is stationed at a single access point during the entire 2-hour sampling period. All anglers leaving the area are interviewed, therefore, all CPUE estimates come from completed trip interviews. Within each hour of the sample period, a time is randomly selected to perform an instantaneous count of all anglers.

Shaw Creek Grayling Fishery:

This spring grayling fishery is confined to a $\frac{1}{2}$ -mile area at the mouth of Shaw Creek. Access to the area is limited to a single road. All anglers can be counted from the access point. All fishing is from the shore. A maximum harvest goal of 1,000 grayling has been set for this spring fishery. This requires an intensive creel census to estimate harvest on a daily basis. The fishery will be closed by emergency order when it is estimated that 1,000 fish have been harvested.

Depending on ice conditions, angling effort can become very heavy only 1 day after ice-out or effort can build slowly over several days. This fishery is stratified by weekday and weekend days (there is no stratification within a day). The fishing day is defined from 0700 hours to 2300 hours. The sample period for the Shaw Creek creel census is 4 hours. After ice out, a random sampling design of 25% of the sample units is used until daily angling effort is estimated to be greater than 50 angler-hours per day. A total census of the fishery is begun at this point. The total census is conducted for 4 days or until the harvest goal is met. Past fishery harvest rates suggest that the harvest goal will be met in less than 4 days. If catch rates are low, and the harvest goal is not reached in 4 days, a stratified random sample of 25% of weekday strata and 50% of weekend strata is conducted until the harvest goal is met.

This fishery usually begins by mid-April. In 1986, the creel census was conducted from 24 April to 4 May. The field sampling procedure is as follows. During the stratified random sampling, the creel census clerk is stationed at the single access point for the entire 4-hour sampling period. A time is randomly selected to count anglers during each hour of the sample period. Completed trip interviews are conducted as anglers leave the fishery. During the total census, a census technician is present during the entire fishing day and all anglers entering the fishery are counted and all anglers leaving the fishery are interviewed.

Fielding Lake Grayling, Lake Trout, and Burbot Fishery:

Access to Fielding Lake is limited to a single road from the Richardson Highway. All anglers enter and leave the fishery in a confined access area which includes a commercial boat launch facility. Both shore and boat anglers use the area. Fishing begins with ice-out in mid- to late June. The majority of angling effort occurs during the month after ice-out. Immediately after breakup, an intensive grayling tagging program is scheduled for 1 to 2 weeks. The tagging crew conducts angler counts and interviews all anglers leaving the fishery throughout the fishing day. The data obtained from this census are used to determine appropriate strata for the fishery and to determine sample sizes needed to obtain angler-hour, harvest, and CPUE estimates for the remainder of the fishery.

The Fielding Lake creel census is scheduled from about mid- or late June (depending on ice conditions) to the end of August. In 1986, the creel census is conducted from 24 June to 31 August. The field sampling procedure is as follows. Counts of anglers are made at randomly selected times within each hour of the fishing day. Counts are made from a boat and take about 10 minutes to complete. The same procedure is followed for the remainder of the fishery except counts and interviews are conducted during randomly selected sample units.

Tangle Lakes Grayling, Lake Trout, and Burbot Fishery:

Access to the two main lakes (Upper Tangle and Round Tangle Lakes) is provided at a Bureau of Land Management campground at each lake. Both shore and boat anglers use this area. Anglers also commonly fish the short stream that connects the two lakes (Tangle River). Because of the time required, resources are not available to perform an effort creel survey on both Tangle Lakes and Fielding Lake. Therefore, the Tangle Lakes creel census is designed to estimate CPUE and to sample the catch for biological data.

The fishing day is defined as 0800 hours to 2200 hours. The sample design uses weekend/holiday and weekday strata. The sample period for the Tangle Lakes creel census is 7 hours.

The creel census is conducted from 15 June to 31 August. A creel clerk is stationed at the lake access points for each 7-hour sampling period. The two lake access areas are approximately 3/4 mile apart, connected by a road that parallels the Tangle River. The clerk monitors both areas and attempts to conduct interviews of all anglers who have completed fishing.

Chena Lake Fishery:

Access to Chena Lake is limited to a single road leading to a North Star Borough camping and boat launch facility. Both shore and boat anglers use this area.

The fishing day is defined to be from 0800 hours to 2200 hours. Each month is divided into four strata; (1) weekdays 1200 hours to 2200 hours, (2) weekdays 0800 hours to 1200 hours, (3) weekends/holidays 1200 hours to 2200 hours, and (4) weekends/holidays 0800 hours to 1200 hours. Optimum allocation indicates that about 50% of sampling effort should occur during stratum 1, 40% during stratum 3, and 5% each in strata 2 and 4. The sample period for the Chena Lake creel census is 3 hours.

The creel census is conducted from 1 June to 31 August. Eleven angler count/interview samples are collected each month. During each sample period, an angler count is conducted at a randomly selected time in each hour. Completed trip interviews are collected from all anglers leaving the fishery.

The sampling design is as follows. The entire lake can be viewed for angler counts from two locations. The angler count takes about 10 minutes to complete. For the remainder of the hour, the creel clerk interviews all anglers leaving the fishery.

Birch Lake Fishery:

Fishing access to Birch Lake is provided at a state boat launching facility, a Richardson Highway pullout, and a U.S. Army recreation area. These access points are located on the east side of the lake within a $\frac{1}{2}$ mile of each other. Both shore and boat anglers use the lake. The majority of the shore anglers are located near the highway pullout.

The fishing day is considered to be from 0800 hours to 2300 hours. Each month is divided into two strata; (1) weekdays and (2) weekends/holidays. Each stratum is divided into 3-hour sample units. About 40% of the monthly sampling effort is allocated to the weekend stratum and about 60% to the weekday stratum.

In 1986, the Birch Lake creel census is conducted from breakup to 31 August. Each month, 4 weekend sample units and 6 weekday sample units are randomly selected for sampling. In order to maximize sampling efficiency the sampling design for this lake includes the Quartz Lake creel census (described in the next section). When a sample period for one fishery is selected, either the preceding or following period for the other fishery is randomly selected.

The field sampling procedure is as follows. Counts of anglers are made at randomly selected times within each hour of each 3-hour sample period. The entire lake can be viewed from two locations. The angler counts take about 10 minutes to complete. For the remainder of each hour, the creel census clerk conducts completed trip angler interviews at one of the three access areas. The clerk spends 1 hour (randomly selected) at each of the

access areas. The clerk leaves any station to interview anglers seen at one of the other locations whenever possible.

Quartz Lake Fishery:

Access to Quartz Lake is limited to a single road leading to a state camping and boat launch facility. Both shore and boat anglers use the area.

The fishing day is considered to be from 0800 hours to 2300 hours. Each month is divided into two strata; (1) weekdays and (2) weekends/holidays. About 40% of the monthly sampling effort is allocated to the weekend stratum and about 60% to the weekday stratum.

In 1986, the Quartz Lake creel census is conducted from breakup to 31 August. Each month, 4 weekend and 6 weekday sample units are randomly selected for sampling. To maximize sampling efficiency the sampling design is coordinated with the Birch Lake creel census.

The field sampling procedure is as follows. Counts of anglers are made at randomly selected times within each hour of the 3-hour sample period. The entire lake can be viewed from the boat launching area. For the remainder of each hour, the creel census clerk conducts completed trip interviews of all anglers leaving the lake.

Salcha River Chinook Salmon Fishery:

Two major access areas are available to Salcha River anglers. All boat anglers launch at the State Park access area near the Richardson Highway river crossing. Most shore anglers park at a Richardson Highway pulloff located about 1 mile west of the river and walk to the mouth of the Salcha River. Boat and shore anglers exert about equal amounts of fishing effort.

The fishery is stratified into weekend and weekday strata. Sampling effort is evenly distributed between weekday and weekend strata. The fishing day is defined to be from 0600 hours to 2400 hours. Each day is divided into 3-hour sample units.

The creel census is conducted during chinook salmon spawning run (the month of July). An angler count is conducted at a randomly selected time each hour of the sample period and angler interviews are performed during the remainder of the time. Ten periods are sampled each week.

The field sampling procedure is as follows. Anglers are counted between the access point and the mouth of the Salcha River using a riverboat at a randomly selected time within each hour of the sample unit. Angler counts in this 3-mile river section take about 10 minutes to perform. For the remainder of the of each sample period, the creel census clerk conducts completed trip angler interviews at the access points. The creel census clerk is stationed for 25 minutes at the boat launch area and 25 minutes at the shore angler access area each hour.

Chatanika River Whitefish Fishery:

This creel survey is conducted in a state campground and boat launch area. Most anglers enter and exit the fishery from two locations within this area and the major portion of the fishery is confined to a mile long section of river near this site. The majority of fishing is from shore, although there is a small amount of effort from boat anglers.

Fishing occurs primarily during the evenings from 2000 hours to 2400 hours. The sample unit for this fishery is the entire 4-hour fishing day. Weekend and weekday strata are used in this sample design. Sampling effort is allocated 55% and 45% to the weekday and weekend strata, respectively.

The creel census of the Chatanika River whitefish fishery is conducted during the months of September and October. A total of nine sample units are collected each month. One angler count is conducted at a randomly selected time in each hour of the sample unit. All anglers leaving the fishery are interviewed. These are completed trip interviews.

The field sampling procedure is as follows. A complete angler count of the fishery is made by visiting three viewing locations. The entire count takes about 10 minutes to complete. The remainder of each hour is devoted to angler interviews. The creel clerk spends approximately 25 minutes of each hour at each of the two major exit locations.

Winter Stocked-lakes Fisheries:

Ice fishing activities on Chena, Birch, and Quartz Lakes are generally confined to a small area. Access to the lakes is by road or snow machine. Most anglers fish from small ice houses. The winter creel surveys use roving counts and interviews.

The fishing day in each month is defined by the length of the day (as defined by the average hours of daylight specified by the National Weather Service). Sampling units are 2 hours long. Therefore, the number of sampling units in each month varies. Each month is divided into weekend and weekday strata. About 25% of the sampling effort is allocated to the weekday stratum and about 75% to the weekend stratum.

Winter creel surveys are conducted from mid-November to breakup (mid-April) on each of these lakes. Six sample units per month are surveyed on each lake. An angler count is conducted at a randomly selected time within each hour of the 2-hour sample unit.

The winter sampling procedures are as follows. The creel census clerk conducts roving angler counts using a snow machine. Each count takes about 10 minutes to perform. The remainder of the time is spent conducting completed trip angler interviews. About 30 minutes before the end of each sample period, the creel census clerk obtains incomplete trip interviews from the remaining anglers.

Data Analysis

Estimation of angler-effort, CPUE, and harvest is based on the expansion of sample unit angler counts, catch, and effort to the entire stratum. The following data analyses are used to estimate the primary parameters of the fishery, namely total angler-effort, catch rate, and harvest.

Estimation of Angler Effort:

For each fishery, the mean number of anglers per count is calculated by:

$$(1) \quad \bar{X} = (1/N) \sum_{i=1}^L N_i \bar{x}_i,$$

where:

\bar{X} = the mean number of anglers per count for a fishery,

\bar{x}_i = the mean number of anglers per count for stratum i ,

N = the total number of hours in a fishery,

N_i = the total number of hours in stratum i , and

L = the total number of strata.

The sampling variance of the mean number of anglers per count is:

$$(2) \quad \hat{V}(\bar{X}) = (1/N^2) \sum_{i=1}^L N_i^2 [(N_i - n_i)/N_i] [s_i^2/n_i]$$

where:

N , N_i , and L are defined in equation (1),

n_i = the total number of angler counts in stratum i , and

s_i^2 = the sample variance for stratum i .

The total number of angler-hours (E_T) in each fishery is estimated by (Lambou 1961) as:

$$(3) \quad E_T = N\bar{X} = \sum_{i=1}^L N_i \bar{x}_i.$$

The variance for the estimate of total angler-hours is

$$(4) \quad \hat{V}(E_T) = N^2 \hat{V}(\bar{X})$$

Estimation of CPUE:

The method of estimating CPUE for a species is determined by first testing the hypothesis that CPUE from incomplete-trip interviews is an unbiased estimate of CPUE from completed-trip interviews. This hypothesis is tested by comparing the CPUE of incomplete trips and completed trips from the same fishery and stratum. For a specific fishery and species, CPUE for testing this hypothesis is estimated for completed and for incomplete trips by the jackknife procedure (Efron 1982):

$$(5) \quad \text{CPUE}_{ik} = \frac{1}{a_i - 1} \left[\frac{\sum_{j \neq k} c_{ij}}{\sum_{j \neq k} e_{ij}} \right]_{k=1}^{a_i}$$

where:

CPUE_{ik} = average CPUE of all anglers interviewed during stratum i , excluding the k th angler,

a_i = the number of anglers interviewed during stratum i ,

c_{ij} = the catch of angler j interviewed during stratum i ,

e_{ij} = the effort, in hours fished, of angler j interviewed during stratum i , and

$k = 1, 2, 3, \dots, a_i$.

And,

$$(6) \quad \text{CPUE}_i = \frac{1}{a_i} \sum_{k=1}^{a_i} \text{CPUE}_{ik}$$

where:

CPUE_{ik} , a_i , and k are defined in equation 5, and

CPUE_i = the jackknife CPUE of anglers interviewed during stratum i .

Omitting the finite population correction factor, the variance of CPUE is estimated by the jackknife procedure:

$$(7) \quad \hat{V}(\text{CPUE}_i) = \frac{a_i - 1}{a_i} \sum_{k=1}^n [\text{CPUE}_{ik} - \text{CPUE}_i]^2$$

where:

CPUE_{ik}, CPUE_i, a_i, and k are defined in equations 5 and 6, and
 $\hat{V}(CPUE_i)$ = jackknife variance of CPUE of anglers interviewed during stratum i.

An independent t-test will be used to test the hypothesis. If we fail to reject the hypothesis, i.e., incomplete trip interviews provide unbiased estimates of completed trip interviews, then CPUE for stratum i in a fishery is estimated by equations 5 and 6 as before (pooling completed and incomplete trip interviews). The variance of CPUE for stratum i in a fishery is then estimated by equation 7. If we reject this hypothesis, then CPUE and variance for stratum i in a fishery is estimated with completed trip interviews only (using equations 5, 6, and 7 as above).

Finite population correction factors are applied to CPUE variance estimates when the total number of anglers in stratum i of a fishery can be estimated (effort surveys only). The finite population correction factor for the CPUE variance estimate of stratum i of a fishery is estimated by (D.R. Bernard, pers. comm., Alaska Department of Fish and Game, Sport Fish Research and Technical Services, Anchorage):

$$(8) \quad \hat{A}_i = \frac{N_i \bar{x}_i}{a_i \sum_{j=1} e_{ij}}$$

where:

\hat{A}_i = the estimated total number of anglers fishing during stratum i,

N_i and \bar{x}_i are defined in equation 1, and

a_i and e_{ij} are defined in equation 5.

Then,

$$(9) \quad \hat{f}_i = 1 - \frac{a_i}{\hat{A}_i}$$

where: \hat{f}_i = the finite population correction factor of estimated CPUE variance during stratum i, and

A_i and a_i are defined in equation 8 and equation 5, respectively.

The estimate of variance of CPUE_i is then,

$$(10) \quad \hat{V}(CPUE_i) = \hat{f}_i \cdot \hat{V}(CPUE_i)$$

where $\hat{V}(CPUE_i)$ and f_i are defined above.

Estimation of Harvest:

The total harvest for a species (CT) for a fishery is estimated by:

$$(11) \quad C_T = \sum_{i=1}^L (E_i CPUE_i),$$

where: E_i = the estimated total angler hours expended in stratum i , and

$CPUE_i$ = the jackknife CPUE for stratum i .

The variance of C_T (assuming strata estimates are independent) is estimated using the formula for the product of two random variables (Goodman 1960):

$$(12) \quad \hat{V}(C_T) = \sum_{i=1}^L \hat{V}(E_i CPUE_i) =$$
$$\sum_{i=1}^L [E_i^2 \hat{V}(CPUE_i) + CPUE_i^2 \hat{V}(E_i) - \hat{V}(E_i) \hat{V}(CPUE_i)]$$

The assumptions necessary for these analyses are:

- (1) Incomplete trip angler interviews provide an unbiased estimate of completed trip CPUE in roving creel surveys.
- (2) Interviewed anglers are representative of the total angler population.
- (3) No significant fishing effort occurs outside the defined fishing day.
- (4) Anglers are interviewed in approximate proportion to their abundance in any given sample unit.

Analysis of Biological Data:

The species age composition and mean length at age of fish harvested in the sport fishery is determined from all samples collected during creel surveys. The normal theory approximation of the binomial distribution is used to establish 95% confidence intervals for the estimated proportion by age group. Mean length is calculated for each age group. The t-distribution is used to establish 95% confidence intervals for each age specific mean length. Relative Stock Density (RSD) is estimated for the harvest of each species in a fishery (Gablehouse 1984). The normal theory approximation of the binomial distribution is used to establish 95% confidence intervals for the estimated RSD. Minimum stock, quality,

preferred, memorable, and trophy lengths are determined as outlined by Gablehouse (1984).

RESULTS AND DISCUSSION

Angler effort, catch rates, harvest, and demographics are presented on a fishery by fishery basis. Opinions asked of anglers concerning management options are compiled in this report, but no analyses performed on these data. All angler opinion data are analyzed and interpreted in Holmes et al. (1987).

Upper Chena River Grayling Fishery

Creel survey of the upper Chena River grayling fishery began on 10 May and continued until 15 September. Angler counts totaled 124 and angler interviews totaled 62 complete trip interviews and 276 incomplete interviews. Estimated angler effort during creel survey is 10,716 angler-hours ($\pm 1,879$ angler-hours), with angler-effort in the months of May and June accounting for 64% of the estimate (Table 4). CPUE ranges from a low of 0.23 grayling per hour in June to a high of 0.74 grayling per hour in September. Overall CPUE is 0.31 grayling harvested per hour (± 0.30 grayling per hour). The estimated harvest during this time period is 3,326 grayling ($\pm 1,476$ grayling), with harvest in the month of May accounting for 32% of the total. Low overall CPUE is also indicated by the high frequency of anglers (51%) who harvested no fish during complete trip interviews performed at the fishery (Table 5). Of the anglers interviewed after completing their trip, only 2% had harvested the daily bag limit of five grayling.

Biological data were collected from 118 grayling harvested during the upper Chena River fishery. Age at harvest ranges from 2 (third summer) to 10 years (eleventh summer), with age-6 dominating (34%) the sample (Table 6). Mean fork length of the sample is 271 mm (± 8 mm), approximately equal to the mean length of age-6 grayling in the harvest. Equal proportions of the harvest sample are of stock and quality size, with 6% of the harvest sample of in the preferred size range (Table 7).

The demographic profile of anglers utilizing the upper Chena River grayling fishery shows that the majority of anglers are adult males who reside in the State of Alaska and live near Fairbanks (Table 8). Tourists account for 9% of all anglers interviewed, while military personnel account for 6% of anglers interviewed. Spinning lures are used as terminal gear by 24% of anglers interviewed. Fifty-four percent of anglers interviewed do not know the daily bag limit for grayling (five grayling per day). Of anglers asked how they would rate the fishing on the upper Chena River, 63% rate it as good or excellent, while 37% rate it as fair or poor (Table 9). Minimum length limits, spring closure of the fishery, fly and lure only regulations, and stocking of rainbow trout are management actions endorsed by over 50% of upper Chena River anglers (Table 9). Forty-seven percent of anglers interviewed endorsed a catch and release area on the upper Chena River, while the majority of anglers discouraged a bag limit reduction.

Table 4. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by month calculated from angler interviews and counts at the upper Chena River grayling fishery, 10 May to 15 September, 1986.

Month	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	¹ n	Total	se	±CI	² n	Mean	se	±CI	Total	se	±CI
10-31 May	19	3,463	390	765	75	0.31	0.14	0.27	1,081	440	862
1-30 June	37	3,400	260	510	120	0.23	0.11	0.21	781	254	498
1-31 July	30	2,268	724	1,419	83	0.32	0.13	0.26	716	439	860
1-30 August	28	1,146	336	658	40	0.38	0.17	0.33	431	292	572
1-15 Sept.	10	429	89	175	20	0.74	0.42	0.83	316	179	350
May - Sept.	124	10,716	959	1,879	338	0.31	0.15	0.30	3,326	773	1,476

¹ n = Number of instantaneous hourly angler counts.

² n = Number of angler interviews (complete and incomplete trips).

Table 5. Distribution of harvest among anglers interviewed at three summer grayling fisheries, 1986.

Number harvested	Delta Clearwater:		Fielding Lake:		Upper Chena River:	
	n ¹	p ²	n	p	n	p
0	68	0.70	109	0.65	31	0.51
1	11	0.11	23	0.14	11	0.18
2	8	0.08	15	0.09	5	0.08
3	3	0.03	7	0.04	5	0.08
4	4	0.04	9	0.05	8	0.13
5	3	0.03	4	0.03	1	0.02
Total	97		167		61	

¹ n = Number of anglers interviewed (complete trip interviews only).
² p = Proportion of anglers interviewed that harvested a certain number of grayling.

Table 6. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the upper Chena River grayling fishery, 10 May to 15 September, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
2	3	0.03	0.18	195	6	28
3	17	0.14	0.17	201	7	14
4	16	0.14	0.17	247	5	10
5	11	0.09	0.17	265	6	13
6	40	0.34	0.15	285	3	6
7	18	0.15	0.17	303	4	8
8	8	0.07	0.17	335	8	18
9	3	0.03	0.18	356	2	8
10	2	0.02	0.18	378	12	157
All ages	118	1.00		271	4	8

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

³ Confidence interval based on t-distribution with n-1 degrees of freedom.

Table 7. Relative Stock Density (RSD) indices and 95% confidence intervals calculated from harvest samples taken from two river grayling fisheries in spring and summer, 1986.

Category	Minimum length:		Delta Clearwater:		Upper Chena River:	
	mm	in	RSD ¹	±CI ²	RSD	±CI
Stock	150	5.9	13	6	43	9
Quality	270	10.6	54	8	51	9
Preferred	340	13.4	33	8	6	13
Memorable	450	17.7	0	0	0	0
Trophy	560	22.0	0	0	0	0
Sample size			138		128	

¹ RSD = Relative Stock Density index expressed as a percentage.
² ±CI = 95% confidence interval calculated from the normal theory approximation to the binomial distribution.

Table 8. Demographic profiles of anglers utilizing rivers and streams for grayling, chinook salmon, and whitefish fishing during summer and fall, 1986.

Category	Chena River: grayling (n = 338)		Delta Clearwater: grayling (n = 230)		Salcha River: chinook (n = 244)		Chatanika R. whitefish (n = 272)	
	-----		-----		-----		-----	
	n ¹	% ²	n	%	n	%	n	%
Male	263	78	189	82	220	90	246	91
Female	65	19	39	17	23	9	26	9
Adult	268	79	185	80	225	92	270	99
Youth	63	19	37	16	14	6	2	1
Resident	275	81	177	77	183	75	269	98
Non-resident	46	14	45	19	24	10	1	1
Unknown	17	5	8	4	37	15	1	1
Local	255	75	64	28	188	77	264	97
Non-local	57	17	148	64	14	6	3	1
Unknown	26	8	18	8	42	17	5	2
Tourist	32	9	26	11	2	1	2	1
Military	20	6	12	5	138	56	11	4
Neither	286	85	192	84	104	43	259	95
Gear type:								
Spinners	80	24	119	52	199	81	0	0
Bait	30	9	16	7	15	6	0	0
Jigs	27	8	7	3	0	0	0	0
Trolling	0	0	0	0	0	0	0	0
Flies	59	17	62	27	1	1	0	0
Spears	0	0	0	0	0	0	272	100
Unknown	142	42	26	11	29	18	0	0

¹ n = Number of interviews.

² % = Percentage of total interviews.

Table 9. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the upper Chena River grayling fishery, 10 May to 15 September, 1986.

Question	Responses
Do you know the daily bag limit for grayling?	Yes = 120 (46%) No = 142 (54%) ----- Total = 262 (100%)
How would you rate the fishing here this year?	Excellent = 38 (20%) Good = 83 (43%) Fair = 53 (27%) Poor = 20 (10%) ----- Total = 194 (100%)
<u>Management Questions:</u>	
1. Minimum length limit of 10 inches for grayling?	Approve = 161 (76%) Disapprove = 30 (14%) No opinion = 21 (10%) ----- Total = 212 (100%)
2. Reduce bag limit from 5 to 2 grayling per day?	Approve = 37 (17%) Disapprove = 156 (72%) No opinion = 23 (11%) ----- Total = 216 (100%)
3. Section of Chena River for catch-and-release?	Approve = 102 (47%) Disapprove = 82 (38%) No opinion = 31 (15%) ----- Total = 215 (100%)
4. Stock rainbow trout in the Chena River?	Approve = 174 (81%) Disapprove = 25 (12%) No opinion = 17 (7%) ----- Total = 216 (100%)
5. Close grayling fishing until May 15?	Approve = 111 (52%) Disapprove = 57 (26%) No opinion = 47 (22%) ----- Total = 215 (100%)
6. Section of Chena River for flies and lures only?	Approve = 111 (52%) Disapprove = 68 (32%) No opinion = 36 (16%) ----- Total = 215 (100%)

Delta Clearwater River Grayling Fishery

Creel surveys of the Delta Clearwater River began on 15 May and continued until 1 Sept. Angler counts totaled 119, and 230 angler interviews were performed. Completed trips are represented in 97 interviews, or 42% of the total. Estimated angler effort during the survey is 5,481 angler-hours ($\pm 1,264$ angler-hours) with effort in the first 6 weeks accounting for approximately half the total (Table 10). CPUE of completed trip anglers ranges from a low of 0.14 grayling harvested per hour in July to a high of 0.56 grayling per hour in August. Boat anglers have a CPUE of 0.30 ± 0.13 grayling per hour, while shore anglers have a CPUE of 0.17 ± 0.16 grayling per hour. Overall CPUE is 0.31 grayling harvested per hour (± 0.29 fish per hour). The estimated harvest during the survey is 1,701 grayling ($\pm 1,243$ grayling). Although July accounts for 29% of the estimated effort, July harvest is only 13% of the total. Of the completed trip angler interviews, 70% of anglers harvested no grayling, while 3% kept their limit of five fish (Table 5).

Biological data were collected from 123 grayling harvested in the river in 1986. Ages for these fish range from 2 (third summer) to 11 (twelfth summer) with ages 6 and 5 equally represented (23 and 26%, respectively) in the sample (Table 11). Mean length of the sample is 321 mm (± 8 mm), which approximates the mean length of age 6 fish in the harvest. Adult grayling, nearly all those of quality size and larger (≥ 270 mm), account for 87% of the sample (Table 7). Fish in the preferred category comprise 33% of the harvest sample. Four stocked fish were recovered in the harvest sample. Thirty percent of the harvest sample from the age-1 and age-2 year classes are from the grayling enhancement program (Skaugstad 1987). One grayling tagged in the Goodpaster River was also recovered in the sample.

The demographic profile of all anglers interviewed at the fishery indicates that 80% are adult males residing in the state (Table 8). The majority of anglers (64%) live outside the Delta area. Military personnel account for 5% of the interviews, while tourists comprise 11% of angler interviews. Most interviewed anglers (52%) use spinning gear, while 27% use flies and 7% use bait. Forty-seven percent of anglers interviewed do not know the bag limit (Table 12). Forty-two percent of anglers interviewed rate the fishing as either good or excellent while 58% rate it as fair or poor. Length limits, gear restrictions, and continued enhancement of the Delta Clearwater River with stocked grayling are the most popular management options among anglers (Table 12).

Badger Slough Grayling Fishery

The CPUE study on Badger Slough started on 1 May and continued until 8 June. Twenty-five complete trip interviews and 101 incomplete trip interviews were collected during this CPUE study. The overall CPUE estimate is 0.09 grayling harvested per hour (± 0.09 grayling per hour). CPUE ranges from 0 grayling per hour in stratum 1 to 0.16 grayling per hour in stratum 2 (Table 13). A high frequency of zero catches (81%) is observed from complete trip interviews at Badger Slough (Table 14). Only 8% of anglers interviewed after completing fishing had harvested the daily bag limit of five grayling.

Table 10. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by month calculated from angler interviews and counts at the Delta Clearwater River grayling fishery, 15 May to 1 September, 1986.

Month	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
15-31 May	12	843	135	264	53	0.36	0.18	0.36	304	207	406
1-30 June	35	1,887	165	323	98	0.28	0.12	0.24	533	359	704
1-31 July	32	1,605	191	375	45	0.14	0.10	0.19	225	168	329
1 Aug-1 Sept	40	1,145	107	208	30	0.56	0.20	0.40	639	449	880
May - Sept.	119	5,481	645	1,264	226	0.31	0.15	0.29	1,701	634	1,243

¹ n = Number of instantaneous hourly angler counts.
² n = Number of angler interviews (complete and incomplete trips).

Table 11. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Delta Clearwater River grayling fishery, 15 May to 1 September, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
2	5	0.04	0.03	251	20	54
3	8	0.07	0.04	239	8	20
4	13	0.11	0.05	284	8	17
5	28	0.23	0.07	300	5	10
6	32	0.26	0.08	324	4	9
7	17	0.14	0.06	356	6	13
8	12	0.10	0.05	381	5	10
9	4	0.03	0.03	375	12	38
10	2	0.02	0.02	436	1	13
11	2	0.02	0.02	429	1	6
12	1	0.01	0.01	417	0	0
Total	123	1.00		321	4	8

¹ p = Proportion of the sample.

² Confidence interval based on the normal theory approximation of the binomial distribution.

³ Confidence interval based on the t-distribution with n-1 degrees of freedom.

Table 12. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Delta Clearwater River grayling fishery, 15 May to 1 September, 1986.

Question	Responses
Do you know the daily bag limit for grayling?	Yes = 33 (53%)
	No = 29 (47%)
	----- Total = 62 (100%)
How would you rate the fishing here this year?	Excellent = 22 (15%)
	Good = 38 (27%)
	Fair = 34 (24%)
	Poor = 49 (34%)
	----- Total = 143 (100%)
<u>Management Questions:</u>	
1. Minimum length limit of 10 inches for grayling?	Approve = 27 (45%)
	Disapprove = 7 (12%)
	No opinion = 26 (43%)
	----- Total = 60 (100%)
2. Reduce bag limit from 5 to 2 grayling per day?	Approve = 4 (7%)
	Disapprove = 31 (52%)
	No opinion = 25 (42%)
	----- Total = 60 (100%)
3. Section of river for catch-and-release?	Approve = 10 (17%)
	Disapprove = 28 (47%)
	No opinion = 22 (37%)
	----- Total = 60 (100%)
4. Stock grayling in river?	Approve = 35 (58%)
	Disapprove = 3 (5%)
	No opinion = 22 (37%)
	----- Total = 60 (100%)
5. Section of river for flies and lures only?	Approve = 18 (31%)
	Disapprove = 15 (25%)
	No opinion = 26 (44%)
	----- Total = 59 (100%)

Table 13. Estimates of catch rate (grayling harvested per hour) and 95% confidence interval by stratum calculated from angler interviews at the Badger Slough and Piledriver Slough spring grayling fisheries, 1 May to 8 June, 1986.

Stratum	Badger Slough:				Piledriver Slough:			
	n ¹	CPUE	se	±CI	n	CPUE	se	±CI
Weekdays								
0800 - 1600	5	0.00	0.00	0.00	10	0.85	0.45	0.87
Weekdays								
1600 - 2200	57	0.16	0.06	0.12	74	0.79	0.15	0.29
Weekends								
0800 - 2200	64	0.10	0.05	0.09	72	0.30	0.11	0.22
All strata	126	0.09	0.04	0.09	156	0.65	0.28	0.55

¹ n = Number of angler interviews (complete and incomplete trips).

Table 14. Distribution of harvest among anglers interviewed at spring grayling fisheries, 1986.

Number harvested	Shaw Creek:		Badger Slough:		Piledriver Slough:	
	n ¹	p ²	n	p	n	p
0	264	0.75	21	0.81	34	0.63
1	37	0.11	0	0.00	2	0.03
2	16	0.05	2	0.08	3	0.06
3	15	0.04	1	0.03	6	0.11
4	11	0.03	0	0.00	3	0.06
5	9	0.03	2	0.08	6	0.11
Total	352		26		54	

¹ n = Number of anglers interviewed (complete trips only).

² p = Proportion of anglers interviewed that harvested a certain number of grayling.

Biological data were collected from 20 grayling harvested during CPUE studies on Badger Slough. Seventy percent of the sample is either 3 or 4 years of age, and age at harvest ranges from 3 to 7 years (Table 15). Mean fork length of the sample is 261 mm (\pm 14 mm). Approximately equal proportions of grayling sampled are of stock size and quality size, while none of the grayling sampled are of preferred size (Table 16).

The demographic profile of anglers utilizing the Badger Slough spring grayling fishery is similar to that of the upper Chena River fishery, except that no tourists are found to be using this spring grayling fishery. Military personnel account for 10% of all anglers interviewed. Typical of most spring fisheries, almost one-half of the anglers interviewed use bait on their terminal gear (Table 17). Sixty-six percent of Badger Slough anglers did not know the daily bag limit for grayling. Anglers were not asked to rate the fishing at Badger Slough until late in the fishery (Table 18). A minimum length limit, catch and release areas, and stocking of rainbow trout are the most frequently endorsed management actions of Badger Slough anglers (Table 18).

Piledriver Slough Grayling Fishery

The CPUE study of the Piledriver Slough spring grayling fishery started on 1 May and continued until 8 June. Fifty-four complete trip interviews and 102 incomplete trip interviews were collected during this CPUE study. The overall CPUE is 0.65 grayling harvested per hour (\pm 0.55 grayling per hour; Table 13). The frequency of zero catches among complete trip interviews is 63%, while 11% of anglers interviewed after finishing their trip had harvested the daily bag limit of five grayling (Table 14).

Biological data were collected from 115 grayling harvested from the Piledriver Slough fishery. Ninety percent of the sample is either 4 or 5 years old at harvest, with ages in the sample ranging from 2 to 6 years (Table 19). Mean fork length of grayling sampled from the harvest is 243 mm (\pm 4 mm), approximately equaling the mean fork length at age 4. A high proportion of the sample is of stock size (85%), with the remaining 15% of quality size (Table 16). None of the grayling sampled are of preferred size.

The demographic profile of anglers utilizing the Piledriver Slough spring grayling fishery is similar to that of the Badger Slough fishery, although only 28% of anglers use bait as terminal gear (Table 17). Military personnel account for 57% of all anglers interviewed, while only 1% of anglers are tourists. Fifty percent of anglers interviewed use flies as terminal gear. Sixty-two percent of anglers asked about their knowledge of the legal daily bag limit responded in the affirmative (Table 20). Ninety-five percent of anglers asked to rate the Piledriver Slough grayling fishery responded with either good or excellent. Minimum length limits, catch and release regulations, and stocking of rainbow trout are the most popular management options among Piledriver Slough anglers (Table 20).

Table 15. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Badger Slough spring grayling fishery, 1 May to 8 June, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
3	6	0.30	0.37	231	5	12
4	8	0.40	0.34	264	9	21
5	1	0.05	0.43	244	0	0
6	3	0.15	0.40	279	13	55
7	2	0.10	0.42	303	4	49
All ages	20	1.00		261	7	14

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

³ Confidence interval based on t-distribution with n-1 degrees of freedom.

Table 16. Relative Stock Density (RSD) and 95% confidence intervals calculated from harvest samples taken from 3 spring grayling fisheries, 1986.

Category	Minimum length:		Shaw Creek:		Badger Slough:		Piledriver Slough:	
	mm	in	RSD ¹	±CI ²	RSD	±CI	RSD	±CI
Stock	150	5.9	15	5	52	21	85	6
Quality	270	10.6	68	7	48	21	15	6
Preferred	340	13.4	17	5	0	0	0	0
Memorable	450	17.7	0	0	0	0	0	0
Trophy	560	22.0	0	0	0	0	0	0
Sample size			184		21		118	

¹ RSD = Relative Stock Density expressed as a percentage.

² ±CI = 95% confidence interval calculated from the normal theory approximation to the binomial distribution.

Table 17. Demographic profiles of anglers utilizing rivers and sloughs for grayling fishing in the spring of 1986.

Category	Shaw Creek: (n = 389)		Badger Slough: (n = 126)		Piledriver Slough: (n = 156)	
	n ¹	% ²	n	%	n	%
Male	339	88	106	84	141	90
Female	45	8	16	13	15	10
Adult	337	87	81	64	144	92
Youth	49	13	42	33	12	8
Resident	265	68	110	87	92	59
Non-resident	0	0	0	0	0	0
Unknown	125	32	16	13	64	41
Local	88	23	116	92	126	81
Non-local	274	70	1	1	11	7
Unknown	27	7	9	7	19	12
Tourist	0	0	0	0	2	1
Military	122	34	12	10	89	57
Neither	267	66	114	90	65	42
Gear type:						
Spinners	9	2	29	23	31	20
Bait	356	92	62	49	44	28
Jigs	4	1	1	1	1	1
Flies	12	3	27	21	78	50
Unknown	8	2	7	6	2	1

¹ n = Number of interviews.

² % = Percentage of total interviews.

Table 18. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Badger Slough spring grayling fishery, 1 May to 8 June, 1986.

Question	Responses
Do you know the daily bag limit for grayling?	Yes = 35 (66%)
	No = 18 (34%)
	----- Total = 53 (100%)
How would you rate the fishing here this year?	Excellent = 0 (0%)
	Good = 0 (0%)
	Fair = 1 (100%)
	Poor = 0 (0%)
	----- Total = 1 (100%)
<u>Management Questions:</u>	
1. Minimum length limit of 10 inches for grayling?	Approve = 45 (82%)
	Disapprove = 10 (18%)
	No opinion = 0 (0%)
	----- Total = 55 (100%)
2. Reduce bag limit from 5 to 2 grayling per day?	Approve = 5 (9%)
	Disapprove = 49 (86%)
	No opinion = 3 (5%)
	----- Total = 57 (100%)
3. Section of Badger Slough for catch-and-release?	Approve = 40 (71%)
	Disapprove = 15 (27%)
	No opinion = 1 (2%)
	----- Total = 56 (100%)
4. Stock rainbow trout in the Badger Slough?	Approve = 52 (91%)
	Disapprove = 3 (5%)
	No opinion = 2 (4%)
	----- Total = 57 (100%)
5. Close grayling fishing until May 15?	Approve = 27 (47%)
	Disapprove = 25 (44%)
	No opinion = 5 (9%)
	----- Total = 57 (100%)
6. Section of Badger Slough for flies and lures?	Approve = 33 (58%)
	Disapprove = 21 (37%)
	No opinion = 3 (5%)
	----- Total = 57 (100%)

Table 19. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Piledriver Slough spring grayling fishery, 1 May to 8 June, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
2	1	0.01	0.18	142	0	0
3	7	0.06	0.18	197	5	12
4	69	0.60	0.12	239	2	5
5	35	0.30	0.15	259	3	5
6	3	0.03	0.18	276	2	9
All ages	115	1.00		243	2	4

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

Table 20. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Piledriver Slough spring grayling fishery, 1 May to 8 June, 1986.

Question	Responses
Do you know the daily bag limit for grayling?	Yes = 52 (62%)
	No = 32 (38%)
	----- Total = 84 (100%)
How would you rate the fishing here this year?	Excellent = 10 (45%)
	Good = 11 (50%)
	Fair = 1 (5%)
	Poor = 0 (0%)
	----- Total = 22 (100%)
<u>Management Questions:</u>	
1. Minimum length limit of 10 inches for grayling?	Approve = 83 (84%)
	Disapprove = 15 (15%)
	No opinion = 1 (1%)
	----- Total = 99 (100%)
2. Reduce bag limit from 5 to 2 grayling per day?	Approve = 13 (13%)
	Disapprove = 79 (80%)
	No opinion = 7 (7%)
	----- Total = 99 (100%)
3. Section of Piledriver Slough for catch-and-release?	Approve = 61 (62%)
	Disapprove = 29 (30%)
	No opinion = 8 (8%)
	----- Total = 98 (100%)
4. Stock rainbow trout in the Piledriver Slough?	Approve = 85 (86%)
	Disapprove = 9 (9%)
	No opinion = 5 (5%)
	----- Total = 99 (100%)
5. Close grayling fishing until May 15?	Approve = 42 (43%)
	Disapprove = 40 (40%)
	No opinion = 17 (17%)
	----- Total = 99 (100%)
6. Section of Piledriver Slough for flies and lures?	Approve = 52 (53%)
	Disapprove = 38 (38%)
	No opinion = 9 (9%)
	----- Total = 99 (100%)

Chena River Dam Site Grayling Fishery

Creel survey of the Chena Dam site spring grayling fishery began on 1 May and was discontinued on 8 May due to low angler participation and non-existent grayling harvest in this fishery. Extremely thick ice cover and earlier migration timing of spawning grayling probably accounts for the lack of any significant fishery this year. Holmes et al. (1986) found that when ice breakup and migration timing of spawners coincide, the Chena River Dam site fishery will occur and can harvest large numbers (1,200 grayling in 18 days in 1985) of spawning grayling.

Shaw Creek Grayling Fishery

The creel survey of the Shaw Creek spring grayling fishery lasted 10 days in 1986, approximately the interval between breakup of the Tanana River and breakup of Shaw Creek. From 25 April through 4 May, a total of 353 anglers were interviewed of which 321 represented completed trips. Angler counts were made in 102 (64%) of the 160 possible hourly fishing periods during this time. The estimate of effort is 1,003 angler-hours (± 74 angler-hours) (Table 21). Effort during the last 4 days accounts for 15% of the total estimate, reflecting the poor fishing conditions (turbid water) in the Tanana River and Shaw Creek. CPUE ranges from 0.00 grayling harvested per hour on the first and last 4 days of the fishery to 0.51 grayling per hour on 29 April (Table 21). Mean CPUE is 0.27 grayling harvested per hour (± 0.14 grayling per hour). The estimated harvest during the period is 270 grayling (± 80 grayling). Based on completed trip interviews, 75% of the anglers harvested no grayling while only 3% kept their limit (Table 14).

Biological data were collected from 156 grayling harvested during the fishery. Age at harvest ranged from 4 (fifth spring) to 12 years (thirteenth spring) with age 6 dominating the sample (Table 22). Mean fork length of the sample was 308 mm (± 8 mm). Adult grayling, approximately all those of quality size and greater (≥ 270 mm in fork length), represent 85% of the sample (Table 16). Grayling of preferred to memorable size (340 to 449 mm; 13.4 to 17.7 inches) comprise 17% of the harvest sample. Recoveries of grayling tagged in the drainage one or more years previously totaled 6 fish out of 184 examined during the survey. Tagging data and population abundance are presented in Clark and Ridder (1987).

The demographic profile of anglers at the fishery shows that over 87% of interviewed anglers are adult males residing in the state of Alaska, outside the Delta and Shaw Creek areas (Table 17). Military personnel account for 34% of anglers interviewed, while local anglers comprise only 23% of those interviewed. Bait, predominantly salmon eggs, is used by 92% of all anglers. Anglers were not asked about knowledge of the bag limit or to rate the fishing at Shaw Creek. A minimum length limit is endorsed by 76% of Shaw Creek anglers, while the majority of anglers have no opinion concerning maximum length limits, catch and release areas, reduced bag limits, spring closures, and gear restrictions (Table 23).

Table 21. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by day calculated from angler interviews and counts at the Shaw Creek spring grayling fishery, 24 April to 4 May 1986.

Day	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
25 April	7	66	33	64	6	0.00	0.00	0.00	0	0	0
26 April	16	223	0	0	101	0.33	0.00	0.00	74	0	0
27 April	13	167	35	69	76	0.31	0.03	0.07	52	12	24
28 April	16	127	0	0	50	0.32	0.03	0.05	41	3	6
29 April	11	118	54	106	16	0.51	0.13	0.26	61	31	61
30 April	7	146	49	95	20	0.30	0.13	0.26	44	24	46
1 May	8	18	20	40	0	0.00	0.00	0.00	0	0	0
2 May	6	32	35	68	9	0.00	0.00	0.00	0	0	0
3 May	11	57	26	52	25	0.00	0.00	0.00	0	0	0
4 May	7	48	42	83	18	0.00	0.00	0.00	0	0	0
Totals	102	1,003	38	74	321	0.27	0.07	0.14	270	41	80

¹ n = Number of instantaneous hourly angler counts.

² n = Number of angler interviews (complete trips).

Table 22. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Shaw Creek spring grayling fishery, 25 April to 4 May, 1986.

Age	Age Composition:			Fork Length(mm) :		
	n	p ¹	±CI ²	Mean	se	±CI ³
4	5	0.03	0.03	262	6	17
5	31	0.20	0.06	278	4	8
6	64	0.41	0.08	299	3	6
7	37	0.24	0.07	327	4	8
8	12	0.08	0.04	349	4	9
9	4	0.03	0.02	373	15	48
10	2	0.01	0.02	399	0	0
11	0	0.00	0.00	ND		
12	1	0.01	0.01	417	0	0
Total	156	1.00		308	3	6

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

³ Confidence interval based on the t-distribution with n-1 degrees of freedom.

ND = No data collected.

Table 23. Number and percent response of anglers interviewed about opinions of management options at the Shaw Creek spring grayling fishery, April 25 to May 4, 1986.

Question	Responses
1. Minimum length limit of 10 inches for grayling?	Approve = 139 (76%) Disapprove = 25 (14%) No opinion = 19 (10%) ----- Total = 183 (100%)
2. Maximum length limit of 13 inches?	Approve = 26 (14%) Disapprove = 23 (13%) No opinion = 115 (66%) ----- Total = 183 (100%)
3. Catch and release fishing only?	Approve = 38 (21%) Disapprove = 31 (17%) No opinion = 113 (62%) ----- Total = 182 (100%)
4. Reduce bag limit from 5 to 2 grayling?	Approve = 43 (24%) Disapprove = 23 (13%) No opinion = 115 (64%) ----- Total = 181 (100%)
5. Close grayling fishing until May 15?	Approve = 37 (20%) Disapprove = 45 (25%) No opinion = 99 (55%) ----- Total = 181 (100%)
6. Restrict fishing to flies and lures?	Approve = 16 (9%) Disapprove = 53 (29%) No opinion = 114 (62%) ----- Total = 99 (100%)

Fielding Lake Grayling, Lake Trout, and Burbot Fishery

The creel survey of Fielding Lake and its outlet stream began on 24 June and continued through 31 August. A total of 96 angler counts were performed at the lake and outlet stream, with 404 anglers in 202 boats and 75 shore anglers counted overall. A total of 192 lake and 49 outlet stream anglers were interviewed, of which 197 (82%) represent completed trip interviews. Completed trip interviews included 91 anglers targeting for grayling, 27 anglers targeting for lake trout, three anglers targeting for burbot, and 79 anglers who did not specify a target species. Estimated total angler-effort for the system is 3,657 angler-hours (± 610 angler-hours) with 72% of the total effort occurring in the first 2 weeks of the census (Tables 24 and 25). Grayling anglers fishing in the lake and the outlet account for 51% and 14% of the total angler effort, respectively. Lake trout anglers account for 35% of total angling effort. CPUE estimates for grayling from completed trip interviews are 0.45 harvested per hour (± 0.63) for anglers fishing the outlet stream and 0.31 harvested per hour (± 0.23) for anglers fishing the lake. CPUE for lake trout from complete trip interviews of anglers who were not targeting on grayling is 0.06 lake trout harvested per hour (± 0.07). Lake trout CPUE for 27 anglers specifically targeting on lake trout is 0.12 lake trout harvested per hour (± 0.10). Estimated harvest during the survey is 861 grayling (± 748) and 72 lake trout (± 62). Of the grayling harvest, 573 (67%) come from anglers fishing the lake. The distribution of the harvest among 167 grayling anglers contacted at the completion of their trip shows that 65% of them harvested no grayling, while 4% got their limit of five grayling (Table 5). The distribution of lake trout harvest among 27 anglers specifically fishing for lake trout shows that 26% of them were successful; no lake trout angler harvested more than two lake trout.

Age and length data were collected from 149 grayling, most of which were harvested in the lake. The ages of 112 of these fish range from 3 to 8, with a modal age of 6 (Table 26). Eighty percent of this sample are age 5 and older. Adult grayling, those of quality size and larger (≥ 270 mm), make up 77% of the total sample (Table 27). Harvest sampling efforts also recovered 16 grayling tagged in late June (see Clark and Ridder 1987).

Lake trout age and length data were collected from 22 harvested fish sampled during the survey. Ages of 18 of these fish range from 5 (sixth summer) to 9 (10th summer) with 44% at age 7. Mean fork length of the harvest sample is 431 mm (± 29 mm), with a range of 350 to 605 mm. Harvest sampling efforts also recovered four lake trout tagged in previous years (see Burr 1987).

The demographic profile of 257 anglers interviewed at the fishery shows that Fielding Lake anglers are predominantly adult males residing in the state outside of the Fielding area (Table 28). No tourists and few military personnel were interviewed. The preferred gear of 58% of the anglers is spinning tackle. Nineteen percent of anglers use flies in Fielding Lake. Trolling was preferred by 3% of anglers interviewed. Seventy-six percent of the anglers know the bag limit for grayling and lake trout. Asked to rate the fishing at Fielding Lake, 37% of the anglers rate it as good to excellent while 63% rate it as fair to poor (Table 29).

Table 24. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by statistical period calculated from angler interviews and counts at the Fielding Lake grayling and lake trout fishery, 24 June to 31 August, 1986.

Stat. Period	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
<u>Grayling:</u>											
WD ³ 6/24-7/8	23	591	281	551	28	0.46	0.12	0.23	270	155	304
WE 6/24-7/8	21	905	373	732	80	0.27	0.06	0.12	241	101	198
WD 7/9-8/31	22	248	322	632	15	0.17	0.22	0.44	41	34	67
WE 7/9-8/31	30	123	131	256	16	0.16	0.11	0.22	20	22	43
June - August	96	1,866	112	220	139	0.31	0.12	0.23	573	190	372
<u>Lake trout:</u>											
WD 6/24-7/8	23	169	78	153	8	0.12	0.07	0.13	20	11	21
WE 6/24-7/8	21	667	341	668	59	0.05	0.05	0.09	31	16	32
WD 7/9-8/31	22	231	310	608	14	0.00	0.00	0.00	0	0	0
WE 7/9-8/31	30	215	253	497	28	0.10	0.05	0.09	21	25	48
June - August	96	1,283	101	197	109	0.06	0.04	0.07	72	31	62

¹ n = Number of instantaneous hourly angler counts.
² n = Number of angler interviews (complete trips).
³ WE = Weekend days, WD = Weekday days

Table 25. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by statistical period calculated from angler interviews and counts at the Fielding Lake outlet grayling fishery, 24 June to 31 August, 1986.

Stat. Period	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
WD ³ 6/24-7/8	23	146	152	297	14	0.00	0.00	0.00	0	0	0
WE 6/24-7/8	21	123	114	223	4	1.00	0.57	1.12	123	117	230
WD 7/9-8/31	22	193	411	806	9	0.28	0.20	0.39	55	92	180
WE 7/9-8/31	30	45	115	225	7	1.10	0.34	0.67	49	121	237
June - August	96	508	99	193	34	0.45	0.32	0.63	228	192	376

¹ n = Number of instantaneous hourly angler counts.
² n = Number of angler interviews (complete trips).
³ WD = Weekday days, WE = Weekend days

Table 26. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Fielding Lake grayling fishery, 24 June to 31 August, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
3	8	0.07	0.05	210	16	37
4	14	0.13	0.06	273	5	10
5	22	0.20	0.07	301	5	10
6	44	0.39	0.09	335	3	6
7	16	0.14	0.06	362	3	6
8	8	0.07	0.05	381	5	11
Total	112	1.00		304	5	10

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

³ Confidence interval based on t-distribution with n-1 degrees of freedom.

Table 27. Relative Stock Density (RSD) and 95% confidence intervals calculated from harvest samples taken from three lake system grayling fisheries, 24 June to 31 August, 1986.

Category	Minimum length:		Fielding Lake:		Tangle Lakes System:			
	-----		-----		Tangle Lakes:		Tangle River:	
	mm	in	RSD ¹	±CI ²	RSD	±CI	RSD	±CI
Stock	150	5.9	23	7	23	7	74	8
Quality	270	10.6	40	8	57	9	23	7
Preferred	340	13.4	36	8	19	7	3	3
Memorable	450	17.7	0	0	0	0	0	0
Trophy	560	22.0	0	0	0	0	0	0
Sample size			149		124		119	

¹ RSD = Relative Stock Density expressed as a percentage.

² ±CI = 95% confidence interval calculated from the normal theory approximation to the binomial distribution.

Table 28. Demographic profiles of anglers utilizing lakes for grayling, lake trout, and burbot fishing during summer, 1986.

Category	Fielding Lake: (n = 257)		Tangle Lakes: (n = 263)	
	n ¹	% ²	n	%
Male	186	72	201	76
Female	62	24	53	20
Adult	211	82	226	86
Youth	37	14	28	11
Resident	222	86	224	85
Non-resident	19	7	22	8
Unknown	16	7	17	7
Local	7	3	3	1
Non-local	213	83	227	86
Unknown	37	14	33	13
Tourist	1	0	1	0
Military	4	2	9	3
Neither	252	97	253	96
Gear type:				
Spinners	148	58	113	43
Bait	3	1	16	6
Jigs	2	1	0	0
Trolling	7	3	10	4
Flies	50	19	87	33
Unknown	47	18	37	14

¹ Number of interviews.

² Percentage of total interviews.

Table 29. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Fielding Lake grayling, lake trout, and burbot fishery, 24 June to 31 August, 1986.

Question	Responses
Do you know the daily bag limits here?	Yes = 57 (76%)
	No = 18 (24%)

	Total = 75 (100%)
How would you rate the fishing here this year?	Excellent = 12 (7%)
	Good = 51 (30%)
	Fair = 64 (37%)
	Poor = 44 (26%)

	Total = 171 (100%)
<u>Management Questions:</u>	
1. Is public boat access adequate?	Yes = 32 (48%)
	No = 25 (37%)
	No opinion = 10 (15%)

	Total = 67 (100%)
2. To improve burbot fishing would you approve of:	
	a. lower bag limits?
	Approve = 12 (18%)
	Disapprove = 4 (6%)
	No opinion = 50 (76%)

	Total = 66 (100%)
	b. reduced fishing seasons?
	Approve = 10 (15%)
	Disapprove = 5 (8%)
	No opinion = 51 (77%)

	Total = 66 (100%)
	c. size limits?
	Approve = 13 (20%)
	Disapprove = 4 (6%)
	No opinion = 49 (74%)

	Total = 66 (100%)

(continued)

Table 29. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Fielding Lake grayling, lake trout, and burbot fishery, 24 June to 31 August, 1986 (continued).

Question	Responses
3. To improve lake trout fishing would you approve of:	
a. lower bag limits?	Approve = 18 (27%) Disapprove = 6 (9%) No opinion = 42 (64%) ----- Total = 66 (100%)
b. reduced fishing seasons?	Approve = 11 (17%) Disapprove = 12 (18%) No opinion = 43 (65%) ----- Total = 66 (100%)
c. size limits?	Approve = 18 (27%) Disapprove = 8 (12%) No opinion = 40 (76%) ----- Total = 66 (100%)

Tangle Lakes Grayling, Lake Trout, and Burbot Fishery

The CPUE study of the Tangle Lakes grayling, lake trout, and burbot fishery ran from 24 June to 31 August. A total of 258 completed trip interviews were obtained from grayling and lake trout anglers fishing the upper and lower lakes and the portion of the Tangle River between the two lakes (Table 30). No burbot anglers were contacted. Grayling CPUE is lowest in the lakes downstream from the Tangle River; 0.28 grayling harvested per hour during weekdays and 0.58 during weekends. The highest grayling CPUE occurs in the Tangle River, with 1.17 and 1.32 grayling harvested per hour during weekdays and weekends, respectively. Grayling CPUE in the upper lakes is 1.63 grayling per hour during weekdays and 0.74 grayling per hour on weekends.

Grayling age and length data were collected from 124 fish harvested in the upper and lower lakes. The ages of 111 of these fish ranged from 2 (third summer) to 8 (Table 31). Ages 3 thru 6 make up 89% of the sample. Each of these age classes have near equal representation in the sample. Fifty-six percent of the sample is age 5 and older. The mean length of these fish is 300 mm (\pm 8 mm). Adult grayling, those of quality size and larger (\geq 270 mm), make up 77% of the total sample (Table 27).

Age and length data were also collected from 119 grayling harvested in the Tangle River. The ages of 114 of these fish ranges from 2 (third summer) to 7 (Table 32). The harvest sample is dominated by immature grayling of ages 2, 3, and 4; only 16% of the sample is at age 5 and older. The mean length of these fish is 252 mm (\pm 7 mm). Adult grayling, those of quality size and larger (\geq 270 mm), comprise 26% of the total sample (Table 27).

Lake trout age and length data were obtained from 12 harvested fish sampled during the survey. This sample came exclusively from the lakes below the Tangle River. Ages of 11 of these fish range from 5 (sixth summer) to 13, with ages 6 and 7 comprising 64% of the sample. The total sample has a mean length of 332 mm (\pm 39 mm) within a range of 261 to 460 mm. There are no fish of quality size and larger (\geq 475 mm).

The demographic profile of 263 anglers interviewed at the fishery show that Tangle Lakes anglers are predominantly adult males residing in the state outside of the Paxson and Tangle Lakes area (Table 28). Only 1 tourist and 9 military personnel were interviewed. The preferred gear of 43% of anglers interviewed is spinning tackle. Fly tackle is the next most popular terminal gear (33% of anglers interviewed). Trolling is used by 4% of anglers at Tangle Lakes. Fifty-nine percent of 77 lake anglers know the bag limit for grayling, lake trout, and burbot (Table 33). Asked to rate the fishing, 43% of 154 anglers rate it good to excellent while 57% rate it fair to poor.

Chena Lake Fishery

Creel survey of the Chena Lake rainbow trout and coho salmon fishery began on 1 June and continued until 31 August. Angler counts totaled 99 and angler interviews totaled 109 complete trips and 87 incomplete trips. Estimated angler effort during the creel survey is 7,312 angler-hours (\pm 1,019 angler-hours), with angler-effort in June accounting for

Table 30. Estimates of catch rate (fish harvested per hour) and 95% confidence interval by weekday and weekend strata calculated from angler interviews taken in the Tangle Lakes system grayling and lake trout fisheries, 24 June to 31 August, 1986.

Stratum	Lower Tangle Lakes:				Upper Tangle Lakes:				Tangle River			
	n ¹	CPUE	se	±CI	n	CPUE	se	±CI	n	CPUE	se	±CI
<u>Grayling</u>												
Weekdays												
0800 - 2200	17	0.28	0.13	0.26	5	1.63	0.37	0.72	15	1.17	0.41	0.80
Weekends												
0800 - 2200	64	0.58	0.10	0.19	32	0.74	0.12	0.23	26	1.32	0.22	0.43
<u>Lake trout</u>												
Weekdays												
0800 - 2200	12	0.00	0.00	0.00	5	0.00	0.00	0.00	7	0.11	0.11	0.21
Weekends												
0800 - 2200	45	0.11	0.03	0.07	18	0.00	0.00	0.00	12	0.00	0.00	0.00

¹ n = Number of angler interviews (complete trips).

Table 31. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Tangle Lakes grayling fishery, 24 June to 31 August, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
2	1	0.01	0.00	221	0	0
3	24	0.22	0.08	242	5	10
4	24	0.22	0.08	283	3	7
5	26	0.23	0.08	310	3	7
6	25	0.23	0.08	334	3	6
7	10	0.09	0.05	355	4	9
8	1	0.01	0.00	380	0	0
Total	111	1.00		300	4	8

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

³ Confidence interval based on t-distribution with n-1 degrees of freedom.

Table 32. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for Arctic grayling in the harvest sample from the Tangle River grayling fishery, 24 June to 31 August, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
2	15	0.13	0.06	200	5	11
3	56	0.49	0.09	235	3	5
4	25	0.22	0.08	268	2	5
5	9	0.08	0.05	297	10	23
6	6	0.05	0.04	337	8	20
7	3	0.03	0.03	371	7	30
Total	114	1.00		252	4	7

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of the binomial distribution.

³ Confidence interval based on t-distribution with n-1 degrees of freedom.

Table 33. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Tangle Lakes grayling, lake trout, and burbot fishery, 24 June to 31 August, 1986.

Question	Responses
Do you know the daily bag limits here?	Yes = 51 (59%) No = 36 (41%) ----- Total = 77 (100%)
How would you rate the fishing here this year?	Excellent = 27 (18%) Good = 38 (25%) Fair = 62 (40%) Poor = 27 (18%) ----- Total = 154 (100%)
<u>Management Questions:</u>	
1. Is public boat access adequate?	Yes = 69 (80%) No = 0 (0%) No opinion = 17 (20%) ----- Total = 86 (100%)
2. To improve burbot fishing would you approve of:	
a. lower bag limits?	Approve = 5 (6%) Disapprove = 3 (4%) No opinion = 69 (90%) ----- Total = 77 (100%)
b. reduced fishing seasons?	Approve = 3 (4%) Disapprove = 6 (8%) No opinion = 68 (88%) ----- Total = 77 (100%)
c. size limits?	Approve = 4 (5%) Disapprove = 5 (6%) No opinion = 68 (88%) ----- Total = 77 (100%)

(continued)

Table 33. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Tangle Lakes grayling, lake trout, and burbot fishery, 24 June to 31 August, 1986 (continued).

Question	Responses
3. To improve lake trout fishing would you approve of:	
a. lower bag limits?	Approve = 18 (23%) Disapprove = 17 (22%) No opinion = 42 (55%) ----- Total = 77 (100%)
b. reduced fishing seasons?	Approve = 6 (8%) Disapprove = 27 (35%) No opinion = 44 (57%) ----- Total = 77 (100%)
c. size limits?	Approve = 17 (22%) Disapprove = 16 (21%) No opinion = 44 (57%) ----- Total = 77 (100%)

41% of this estimate (Table 34). Rainbow trout CPUE ranges from 0.68 fish harvested per hour in June to 1.40 fish harvested per hour in July. Overall rainbow trout CPUE is 0.93 fish harvested per hour (\pm 0.79 fish harvested per hour). Coho salmon CPUE ranges from 0.05 fish harvested per hour in July to 0.23 fish harvested per hour in August. Overall coho salmon CPUE is 0.14 fish harvested per hour (\pm 0.19 fish harvested per hour). Harvest of rainbow trout is greatest in July, with 3,123 fish taken. Overall rainbow trout harvest is 6,743 (\pm 3,916) fish. Harvest of coho salmon is greatest in August, with approximately one-half the overall harvest taken. Overall coho salmon harvest is 1,043 (\pm 822) fish. Frequency of zero catches of rainbow trout is 64% among anglers who have completed fishing, while 84% of anglers catch no coho salmon during a complete trip (Table 35). Less than 1% of anglers catch the daily bag limit of 12 rainbow trout or catch the daily bag limit of 13 coho salmon.

Biological data were collected from 198 rainbow trout and 49 coho salmon during creel survey of the Chena Lake fishery. Proportional contributions of each stocking class to the Chena Lake fishery are described in Doxey (1987). None of the rainbow trout and coho salmon in the harvest samples are of quality size or larger (Table 36).

The demographic profile of anglers utilizing the Chena Lake rainbow trout and coho salmon fishery is dominated by adult males who reside in the Fairbanks/North Pole area. Tourists account for only 1% of anglers interviewed, while military personnel account for 23% of all anglers interviewed (Table 37). Bait is the most often used terminal gear at Chena Lake, accounting for 53% of all anglers interviewed. Fifty-two percent of anglers interviewed do not know the daily bag limits for rainbow trout and coho salmon (Table 38). Chena Lake is rated as either good or excellent by 73% of anglers interviewed during creel survey. Grayling and northern pike are the most frequently requested species to be stocked in Chena Lake (Table 38).

Birch Lake Fishery

The summer creel survey of Birch Lake began on 19 May and continued through 31 August (Table 39). A total of 89 angler counts were performed. Estimated total angler-effort for the lake is 15,746 angler-hours (\pm 2,892 angler-hours) with 53% of the total effort occurring in June. Completed trip interviews totaled 98 of the 184 anglers interviewed. Of the interviewed anglers, 95 fish from boats and 75 fish from shore. Monthly CPUE estimates for rainbows range from 0.39 fish harvested per hour in May to 0.10 fish per hour in June, with an overall CPUE of 0.16 fish harvested per hour (\pm 0.21). Monthly CPUE estimates for coho range from 0.01 fish harvested per hour in June and July to 0.25 fish per hour in August, with an overall CPUE of 0.03 fish harvested per hour (\pm 0.12). The estimated harvest during the survey is 2,534 rainbow trout (\pm 1,530) and 466 coho salmon (\pm 530). The distribution of harvest among anglers who were contacted at the completion of their trip shows that 84% of them harvest no rainbow trout and 95% harvest no coho salmon (Table 35). No anglers took their limit of 12 rainbow trout or 13 coho salmon.

Table 34. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by month calculated from angler interviews and counts at the Chena Lakes rainbow trout and coho salmon fishery, 1 June to 31 August, 1986.

Month	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	¹ n	Total	se	±CI	² n	Mean	se	±CI	Total	se	±CI
<u>Rainbow Trout:</u>											
1-30 June	33	2,982	343	672	75	0.68	0.26	0.51	2,019	1,022	2,004
1-31 July	33	2,234	243	475	48	1.40	0.61	1.19	3,123	739	1,449
1-30 August	33	2,096	266	522	73	0.76	0.32	0.64	1,600	1,029	2,017
June - August	99	7,312	520	1,019	196	0.93	0.40	0.79	6,743	1,998	3,916
<u>Coho Salmon:</u>											
1-30 June	33	2,982	343	672	75	0.14	0.07	0.13	433	261	511
1-31 July	33	2,234	243	475	48	0.05	0.05	0.10	120	107	210
1-30 August	33	2,096	266	522	73	0.23	0.15	0.29	490	311	609
June - August	99	7,312	520	1,019	196	0.14	0.09	0.19	1,043	420	822

¹ n = Number of instantaneous hourly angler counts.

² n = Number of angler interviews (complete and incomplete trips).

Table 35. Distribution of harvest among anglers interviewed at stocked lake rainbow trout and coho salmon fisheries, 1986.

Number harvested	Chena Lake:				Birch Lake:				Quartz Lake:			
	RT		SS		RT		SS		RT		SS	
	n ¹	p ²	n	p	n	p	n	p	n	p	n	p
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
0	71	0.64	93	0.84	82	0.84	93	0.95	166	0.53	184	0.65
1	7	0.06	8	0.07	6	0.06	2	0.02	57	0.18	27	0.09
2	5	0.04	3	0.03	1	0.01	0	0.00	38	0.12	14	0.05
3	5	0.04	3	0.03	4	0.04	1	0.01	18	0.06	10	0.04
4	4	0.04	3	0.03	0	0.00	0	0.00	14	0.04	14	0.05
5	2	0.02	0	0.00	3	0.03	0	0.00	5	0.02	8	0.03
6	2	0.02	0	0.00	1	0.01	0	0.00	4	0.01	6	0.02
7	2	0.02	0	0.00	1	0.01	0	0.00	2	0.01	6	0.02
8	2	0.02	0	0.00	0	0.00	0	0.00	2	0.01	2	0.01
9	2	0.02	0	0.00	0	0.00	1	0.01	1	0.00	1	0.00
10	8	0.07	0	0.00	0	0.00	0	0.00	6	0.02	13	0.05
11	0	0.00	0	0.00	0	0.00	0	0.00	1	0.00	0	0.00
12	1	0.01	1	0.01	0	0.00	1	0.01	0	0.00	0	0.00
Total	111		111		98		98		314		285	

¹ n = Number of anglers interviewed (complete interviews only).
² p = Proportion of anglers interviewed that harvested a certain number of rainbow trout or coho salmon.

Table 36. Relative Stock Density (RSD) and 95% confidence intervals calculated from harvest samples taken from three stocked lake rainbow trout and coho salmon fisheries, 1 June to 31 August, 1986.

Category	Minimum length:		Chena Lake:		Birch Lake:		Quartz Lake:	
	mm	in	RSD ¹	±CI ²	RSD	±CI	RSD	±CI
<u>Rainbow trout:</u>								
Stock	220	8.7	100	0	78	8	93	3
Quality	390	15.3	0	0	2	3	7	3
Preferred	490	19.3	0	0	1	2	0	0
Memorable	650	25.6	0	0	0	0	0	0
Trophy	810	31.9	0	0	0	0	0	0
Sample size			198		96		342	
<u>Coho salmon:</u>								
Stock	140	5.5	100	0	78	19	61	5
Quality	230	9.0	0	0	17	17	34	5
Preferred	300	11.8	0	0	6	11	5	2
Memorable	380	14.9	0	0	0	0	0	0
Trophy	460	18.1	0	0	0	0	0	0
Sample size			49		18		382	

¹ RSD = Relative Stock Density expressed as a percentage.

² ±CI = 95% confidence interval calculated from the normal theory approximation to the binomial distribution.

Table 37. Demographic profiles of anglers utilizing stocked lakes for rainbow trout and coho salmon fishing during summer, 1986.

Category	Chena Lake: (n = 196)		Birch Lake: (n = 184)		Quartz Lake: (n = 625)	
	n ¹	% ²	n	%	n	%
Male	142	72	125	68	424	68
Female	52	27	47	26	106	17
Adult	131	67	144	78	445	71
Youth	62	32	28	15	82	13
Resident	173	88	152	83	459	73
Non-resident	14	7	20	11	59	9
Unknown	9	5	12	6	107	18
Local	172	88	21	11	62	10
Non-local	15	7	148	80	426	68
Unknown	9	5	15	9	137	22
Tourist	3	1	54	29	107	17
Military	45	23	75	41	91	15
Neither	148	76	55	30	427	68
Gear type:						
Spinners	53	27	112	61	284	45
Bait	103	53	41	22	194	31
Jigs	0	0	0	0	4	1
Troll	0	0	2	1	6	1
Flies	32	16	6	3	10	2
Unknown	8	4	23	13	127	20

¹ Number of interviews.

² Percentage of total interviews.

Table 38. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Chena Lakes rainbow trout and coho salmon fishery, 1 June to 31 August, 1986.

Question	Responses			
Do you know the daily bag limit for these species?	Yes	=	88 (48%)	
	No	=	97 (52%)	
	-----			Total = 185 (100%)
How would you rate the fishing here this year?	Excellent	=	46 (35%)	
	Good	=	50 (38%)	
	Fair	=	19 (15%)	
	Poor	=	16 (12%)	
	-----			Total = 131 (100%)
<u>Management Question:</u>				
What kinds of fish species would you like to see stocked in this lake in the future?				
Species	First choice	Second choice	Third choice	Total
Northern pike	= 9 (24%)	0 (0%)	0 (0%)	9 (21%)
Walleye pike	= 2 (5%)	2 (40%)	0 (0%)	4 (9%)
King salmon	= 1 (3%)	0 (0%)	0 (0%)	1 (2%)
Kokanee	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
Lake trout	= 2 (5%)	0 (0%)	0 (0%)	2 (5%)
Dolly Varden	= 2 (5%)	1 (20%)	0 (0%)	3 (7%)
Burbot	= 1 (3%)	0 (0%)	0 (0%)	1 (2%)
Warmwater fish	= 3 (8%)	0 (0%)	0 (0%)	3 (7%)
Other trout	= 0 (0%)	0 (0%)	1 (100%)	1 (2%)
Whitefish	= 1 (3%)	0 (0%)	0 (0%)	1 (2%)
Sheefish	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
Grayling	= 13 (35%)	2 (40%)	0 (0%)	15 (35%)
Other fish	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
No opinion	= 3 (8%)	0 (0%)	0 (0%)	3 (7%)
<hr/>				
Total	= 37 (100%)	5 (100%)	1 (100%)	43 (100%)

Table 39. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by month calculated from angler interviews and counts at the Birch Lake rainbow trout and coho salmon fishery, 19 May to 31 August, 1986.

Month	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
<u>Rainbow Trout:</u>											
19-31 May	5	1,808	125	246	14	0.39	0.27	0.53	696	392	768
1-30 June	30	8,383	1,322	2,591	103	0.10	0.04	0.09	825	521	1,021
1-31 July	24	2,784	400	784	32	0.20	0.08	0.16	569	319	625
1-30 August	30	2,772	290	568	24	0.16	0.08	0.16	444	288	564
May - August	89	15,746	1,475	2,892	173	0.16	0.11	0.21	2,534	781	1,530
<u>Coho Salmon:</u>											
19-31 May	5	1,808	125	246	14	0.13	0.16	0.31	230	235	461
1-30 June	30	8,383	1,322	2,591	103	0.01	0.01	0.02	78	78	152
1-31 July	24	2,784	400	784	32	0.01	0.01	0.02	17	17	33
1-30 August	30	2,772	290	568	24	0.25	0.05	0.10	141	108	211
May - August	89	15,746	1,475	2,892	173	0.03	0.06	0.12	466	270	530

¹ n = Number of instantaneous hourly angler counts.

² n = Number of angler interviews (complete and incomplete trips).

Length data were collected from 96 rainbow trout and 18 coho salmon. Rainbow trout fork length ranges from 135 mm to 581 mm, with a mean of 255 mm (\pm 15 mm). The RSD categories of the rainbow trout harvest show that 78% are of stock size and 3% are of quality size and larger (Table 36). Coho salmon in the harvest sample range from 198 mm to 331 mm fork length, with a mean of 224 mm (\pm 9 mm). The RSD categories of the coho salmon harvest show that 78% are of stock size and 23% are of quality size or larger. For additional analysis regarding catch composition refer to Doxey (1987).

The demographic profile of 184 anglers interviewed at the fishery shows that Birch Lake anglers are predominantly adult males residing in the state outside of the Birch Lake area (Table 37). Tourists and military personnel account for 29 and 41% of the angler interviews, respectively. The preferred gear of 61% of the anglers is spinning tackle, while 22% use bait (salmon eggs, cocktail shrimp, or kernel corn). Four percent of the anglers use flies or jigs. Fifty-five percent of 38 anglers know the bag limit for each species (Table 40). Twenty-six percent of 116 anglers rate fishing quality at Birch Lake as good to excellent, while 74% rate it as fair to poor. Northern pike are the most frequently requested new species to be stocked at Birch Lake (Table 40).

Quartz Lake Fishery

The summer creel survey of Quartz Lake began on 19 May and continued through 31 August (Table 41). A total of 101 angler counts were performed. Estimated total angler-effort for the lake is 27,008 angler-hours (\pm 3,039 angler-hours) with 39% of the total effort occurring in June. Completed trip interviews totaled 442 or 71% of the 625 anglers interviewed. These anglers include 443 (86%) boat anglers and 75 (14%) shore anglers. Overall CPUE estimates from completed trip interviews are 0.30 rainbow trout harvested per hour (\pm 0.15) and 0.29 coho salmon harvested per hour (\pm 0.16). Monthly CPUE estimates for rainbow trout remained relatively constant during the 3½ month survey ranging from 0.24 fish per hour in June to 0.36 fish per hour in May. Monthly CPUE estimates for coho are dissimilar among months, with 0.59 fish harvested per hour in July, nearly double the estimate CPUE in the other months. The estimated harvest during the survey is 8,088 (\pm 3,463) rainbow trout and 7,906 (\pm 5,541) coho salmon. The distribution of the harvest among anglers who had completed fishing shows that 53% of these anglers harvested no rainbow trout and 65% harvested no coho salmon (Table 35). No anglers took their limit of 12 rainbow trout or 13 coho salmon.

Length data were collected from 342 rainbow trout and 382 coho salmon. Rainbow trout in the harvest sample range from 105 mm to 460 mm in fork length with a mean of 304 mm (\pm 5 mm). RSD categories from the rainbow trout harvest show that 93% are of stock size and 7% are of quality size (Table 36). Coho salmon in the harvest sample range in length from 100 mm to 346 mm with a mean of 214 mm (\pm 5 mm). RSD categories of the coho salmon harvest show that 61% are of stock size and 39% are of quality size or larger. For additional analysis regarding catch composition, refer to Doxey (1987).

Table 40. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Birch Lake rainbow trout and coho salmon fishery, 19 May to 31 August, 1986.

Question	Responses
Do you know the daily bag limit for these species?	Yes = 21 (55%)
	No = 17 (45%)
	----- Total = 38 (100%)
How would you rate the fishing here this year?	Excellent = 8 (7%)
	Good = 22 (19%)
	Fair = 22 (19%)
	Poor = 64 (55%)
	----- Total = 116 (100%)
Is public boat access adequate?	Yes = 22 (59%)
	No = 6 (16%)
	No opinion = 9 (24%)
	----- Total = 37 (100%)

Management Question:

What kinds of fish species would you like to see stocked in this lake in the future?

Species	First choice	Second choice	Third choice	Total
Northern pike =	7 (15%)	1 (50%)	0 (0%)	8 (16%)
Walleye pike =	4 (8%)	1 (50%)	0 (0%)	5 (10%)
King salmon =	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Kokanee =	3 (6%)	0 (0%)	0 (0%)	3 (6%)
Lake trout =	1 (2%)	0 (0%)	0 (0%)	1 (2%)
Dolly Varden =	2 (4%)	0 (0%)	0 (0%)	2 (4%)
Burbot =	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Warmwater fish =	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other trout =	3 (6%)	0 (0%)	0 (0%)	3 (6%)
Whitefish =	0 (0%)	0 (0%)	0 (0%)	1 (0%)
Sheefish =	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Grayling =	2 (4%)	0 (0%)	0 (0%)	2 (4%)
Other fish =	2 (4%)	0 (0%)	0 (0%)	2 (4%)
No opinion =	24 (50%)	0 (0%)	0 (0%)	24 (48%)
Total =	48 (100%)	2 (100%)	0 (100%)	50 (100%)

Table 41. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by month calculated from angler interviews and counts at the Quartz Lake rainbow trout and coho salmon fishery, 19 May to 30 August, 1986.

Month	Effort (angler hours):			Catch rate (fish/hour):			Harvest (fish):				
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
<u>Rainbow Trout:</u>											
19-31 May	13	2,540	238	466	79	0.36	0.10	0.20	918	254	498
1-30 June	31	10,656	914	1,792	139	0.24	0.08	0.16	2,551	1,104	2,164
1-31 July	27	6,222	914	1,791	98	0.32	0.08	0.16	1,963	908	1,779
1-30 August	30	7,590	721	1,413	126	0.35	0.06	0.12	2,657	1,007	1,974
May - August	101	27,008	1,551	3,039	442	0.30	0.08	0.15	8,088	1,767	3,463
<u>Coho Salmon:</u>											
19-31 May	13	2,540	238	466	79	0.29	0.10	0.19	748	219	430
1-30 June	31	10,656	914	1,792	139	0.18	0.06	0.11	1,931	807	1,582
1-31 July	27	6,222	914	1,791	98	0.59	0.13	0.25	3,681	2,530	4,958
1-30 August	30	7,590	721	1,413	126	0.20	0.06	0.12	1,545	945	1,853
May - August	101	27,008	1,551	3,039	442	0.29	0.08	0.16	7,906	2,827	5,541

¹ n = Number of instantaneous hourly angler counts.

² n = Number of angler interviews (complete trips).

The demographic profile of 625 anglers interviewed at the fishery shows that Quartz Lake anglers are predominantly adult males residing in the state outside of the Quartz Lake/Delta Junction area (Table 37). Tourists and military personnel account for 17 and 15% of the angler interviews, respectively. The preferred gear of 45% of anglers interviewed is spinning tackle. Thirty-one percent use bait as terminal gear (salmon eggs, cocktail shrimp, and/or kernel corn). Four percent of the anglers use flies, jigs, or troll gear. Fifty percent of the 150 anglers interviewed during creel survey know the bag limit for each species (Table 42). Forty-eight percent of 383 anglers rated fishing quality at Quartz Lake as good to excellent while 52% rated it as fair to poor.

Salcha River Chinook Salmon Fishery

The creel survey of the Salcha River chinook salmon fishery began on 7 July and continued until 28 July when high water prevented anglers from harvesting additional chinook salmon. Angler counts totaled 78 and angler interviews totaled 242 complete trips. Estimated angler effort during the creel survey is 11,242 angler-hours ($\pm 1,662$ angler-hours), with angling-effort during the week of 14 July accounting for 67% of this estimate (Table 43). CPUE ranges from a low of 0.00 chinook salmon harvested per hour to a high of 0.07 harvested per hour. The daily bag limit of one chinook salmon may account for the low overall CPUE of 0.05 harvested per hour (± 0.02 harvested per hour). The estimated harvest during 7 July to 28 July is 526 chinook salmon (± 423 chinook salmon). No observations were made of chum salmon harvest during the same time period. Of the 242 anglers contacted after completing their trip, only 31 of these had harvested chinook salmon (13% of complete trips).

Biological data were collected from 31 chinook salmon harvested during the Salcha River fishery. Scales were not collected for age composition, but the highest proportion of the harvest sample is of memorable ($65\% \pm 17\%$), based on incremental lengths suggested by Gablehouse (1984) (Table 44). Twenty-six percent of the harvest sample is of preferred to size.

The demographic profile of anglers utilizing the Salcha River chinook salmon fishery is dominated by adult males in the military who reside within the Fairbanks/North Pole area (Table 8). Military personnel account for 56% of all anglers interviewed, while tourists account for only 1% of anglers interviewed. Spinning lures are used as terminal gear by 81% of anglers interviewed, with bait and flies accounting for 7%. Most of the anglers interviewed (87%) know that the daily bag limit is one chinook salmon (Table 45). Forty-three percent of anglers interviewed rate fishing at the Salcha River as good or excellent, while 57% rate fishing as fair or poor. Season closures and chinook salmon enhancement (through stocking) are endorsed by the majority of Salcha River chinook salmon anglers (Table 45).

Chatanika River Whitefish Fishery

The creel survey of the Chatanika River/Elliott Highway whitefish fishery began on 14 September and continued to 14 October when river flooding prevented angler participation. Angler counts totaled 87 and angler interviews totaled 171 complete trips. Estimated angler-effort during the

Table 42. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Quartz Lake rainbow trout and coho salmon fishery, 19 May to 30 August, 1986.

Question	Responses	
Do you know the daily bag limit for these species?	Yes	= 75 (50%)
	No	= 75 (50%)

	Total	= 150 (100%)
How would you rate the fishing here this year?	Excellent	= 50 (13%)
	Good	= 133 (35%)
	Fair	= 106 (28%)
	Poor	= 94 (25%)

	Total	= 383 (100%)
Is public boat access adequate?	Yes	= 94 (66%)
	No	= 19 (13%)
	No opinion	= 30 (21%)

	Total	= 143 (100%)

Management Question:

What kinds of fish species would you like to see stocked in this lake in the future?

Species	First choice	Second choice	Third choice	Total
Northern pike	= 4 (3%)	0 (0%)	0 (0%)	4 (3%)
Walleye pike	= 4 (3%)	1 (%)	0 (0%)	5 (4%)
King salmon	= 1 (1%)	0 (0%)	0 (0%)	1 (1%)
Kokanee	= 2 (2%)	0 (0%)	0 (0%)	2 (2%)
Lake trout	= 5 (4%)	0 (0%)	0 (0%)	5 (4%)
Dolly Varden	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
Burbot	= 3 (2%)	0 (0%)	0 (0%)	3 (2%)
Warmwater fish	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other trout	= 1 (1%)	2 (%)	0 (0%)	3 (2%)
Whitefish	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
Sheefish	= 3 (2%)	0 (0%)	0 (0%)	3 (2%)
Grayling	= 1 (1%)	0 (0%)	0 (0%)	1 (1%)
Other fish	= 0 (0%)	0 (0%)	0 (0%)	0 (0%)
No opinion	= 103 (81%)	0 (0%)	0 (0%)	103 (81%)
Total	= 124 (100%)	3 (100%)	0 (100%)	127 (100%)

Table 43. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by statistical period calculated from angler interviews and counts at the Salcha River chinook salmon fishery, 7 July to 28 July, 1986.

Stat. Period	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
7-11 July	12	698	603	1,182	6	0.00	0.00	0.00	0	0	0
12-13 July	15	787	277	543	59	0.01	0.00	0.01	6	6	11
14-18 July	12	6,308	2,644	5,182	77	0.07	0.01	0.03	475	215	421
19-20 July	15	1,260	486	952	76	0.03	0.02	0.05	32	15	30
21-25 July	9	220	320	627	15	0.06	0.09	0.18	13	17	34
26-27 July	9	260	159	311	3	0.00	0.00	0.00	0	0	0
28 July	6	1,710	655	1,284	8	0.00	0.00	0.00	0	0	0
7-28 July	78	11,242	848	1,662	242	0.05	0.01	0.02	526	216	423

¹ n = Number of instantaneous hourly angler counts.
² n = Number of angler interviews (complete trips).

Table 44. Relative Stock Density (RSD) and 95% confidence intervals calculated from harvest samples taken from the Salcha River chinook salmon fishery, 7 July to 28 July, 1986.

Category	Minimum length:		Salcha River:	
	mm	in	RSD ¹	±CI ²
Stock	250	9.8	0	0
Quality	460	18.1	3	6
Preferred	570	22.4	26	15
Memorable	750	29.5	65	17
Trophy	940	37.0	6	8
Sample size			31	

¹ RSD = Relative Stock Density expressed as a percentage.

² ±CI = 95% confidence interval calculated from the normal theory approximation to the binomial distribution.

Table 45. Number and percent response of anglers interviewed about knowledge of daily bag limit, quality of fishing, and opinions of management options at the Salcha River chinook fishery, 7 July to 28 July, 1986.

Question	Responses
Do you know the daily bag limit for chinook?	Yes = 202 (87%)
	No = 30 (13%)

	Total = 232 (100%)
How would you rate the fishing here this year?	Excellent = 16 (28%)
	Good = 9 (15%)
	Fair = 18 (31%)
	Poor = 15 (26%)

Total = 58 (100%)	
<u>Management Questions:</u>	
1. Is public boat access adequate?	Yes = 46 (81%)
	No = 7 (12%)
	No opinion = 4 (7%)

Total = 57 (100%)	
2. Would you approve of a season closure?	Approve = 118 (64%)
	Disapprove = 46 (25%)
	No opinion = 19 (11%)

Total = 183 (100%)	
3. Would you like to see chinook stocked here?	Approve = 156 (86%)
	Disapprove = 20 (11%)
	No opinion = 6 (3%)

Total = 182 (100%)	

creel survey is 3,309 angler-hours (± 223 angler-hours), with angler-effort during the period 26 September to 2 October accounting for 45% of this estimate (Table 46). CPUE of least cisco ranges from a low of 0.00 fish harvested per hour during the last week of the survey to a high of 8.04 least cisco harvested per hour during the weekend of 29 September. Overall CPUE for least cisco is 5.01 fish harvested per hour (± 1.99 harvested per hour). The estimated harvest of least cisco is 16,575 fish ($\pm 4,925$ fish).

CPUE of humpback whitefish ranges from a low of 0.00 fish harvested per hour to a high of 4.48 fish harvested per hour (Table 46). Overall CPUE for humpback whitefish is 0.76 fish harvested per hour (± 1.31 harvested per hour). The estimated harvest of humpback whitefish is 2,528 fish ($\pm 1,791$ fish).

CPUE of round whitefish ranges from a low of 0.00 fish harvested per hour to a high of 0.39 fish harvested per hour (Table 46). Overall CPUE for round whitefish is 0.18 fish harvested per hour (± 0.20 harvested per hour). The estimated harvest of round whitefish is 583 fish (± 330 fish). The estimated total harvest of the three whitefish species is 19,686 fish.

Biological data were collected from 629 least cisco and 232 humpback whitefish harvested during the Chatanika River/Elliot Highway fishery. Age at harvest of least cisco ranges from 2 to 7 years, with age-4 fish accounting for 50% ($\pm 6\%$) of the harvest sample (Table 47). The mean fork length of age-4 least cisco is 312 mm (± 2 mm). Age at harvest of humpback whitefish ranges from 3 to 10 years, with age-5 fish accounting for 44% ($\pm 10\%$) of the harvest sample. The mean fork length of age-5 humpback whitefish is 391 mm (± 2 mm). Relative Stock Density indices were not calculated for the two whitefish species. As world record data become available for these species, RSD categories will be determined.

The demographic profile of anglers utilizing the Chatanika River/Elliot Highway whitefish fishery is dominated by adult males who reside in the Fairbanks/Fox area. Tourists account for only 1% of all anglers interviewed, while military personnel account for 4% of all anglers interviewed. All of the anglers interviewed use spears to harvest whitefish (Table 8).

Winter Stocked-lakes Fisheries

The creel survey of the Chena Lake winter fishery began on 2 November and continued until 29 April. A total of 118 angler interviews were taken during the period. CPUE of rainbow trout ranges from a low of no fish harvested per hour in April to a high of 1.02 (± 0.54) fish harvested per hour in November (Table 48). CPUE of coho salmon ranges from a low of no fish harvested per hour in April to a high of 1.48 (± 0.28) fish harvested per hour in February.

The creel survey of the Birch Lake winter fishery was conducted at the same time as the Chena Lakes fishery. A total of 413 angler interviews were taken during the period. CPUE of rainbow trout ranges from a low of 0.60 (± 0.25) fish harvested per hour in December to a high of 2.12 (± 0.62) fish harvested per hour in March (Table 48). CPUE of coho salmon

Table 46. Estimates of effort, catch rate (fish per hour), harvest, and 95% confidence intervals by statistical period calculated from angler interviews and counts at the Chatanika River/ Elliot Highway whitefish spear-fishery, 14 September to 14 October, 1986.

Stat. Period	Effort (angler hours):				Catch rate (fish/hour):				Harvest (fish):		
	n ¹	Total	se	±CI	n ²	Mean	se	±CI	Total	se	±CI
<u>Least Cisco:</u>											
14 Sept.	4	14	6	12	7	0.12	0.07	0.14	2	1	2
15-18 Sept.	8	178	68	133	13	3.59	1.52	2.97	638	349	683
19-21 Sept.	8	246	127	250	25	1.41	0.39	0.76	347	198	387
22-25 Sept.	10	302	93	182	37	2.81	0.44	0.87	850	291	570
26-28 Sept.	10	764	199	390	17	6.90	1.02	2.00	5,271	1,568	3,074
29 Sept-2 Oct	10	732	174	340	22	8.04	1.35	2.65	5,886	1,696	3,325
3-5 Oct.	10	552	109	214	19	2.77	0.44	0.86	1,528	384	753
6-9 Oct.	10	402	118	232	15	4.99	1.27	2.48	2,006	765	1,500
10 Oct.	5	121	0	0	16	0.38	0.08	0.17	46	10	20
11-14 Oct.	12	0	0	0	0	0.00	0.00	0.00	0	0	0
Totals	87	3,309	114	223	171	5.01	1.01	1.99	16,575	2,513	4,925
<u>Humpback whitefish:</u>											
14 Sept.	4	14	6	12	7	0.00	0.00	0.00	0	0	0
15-18 Sept.	8	178	68	133	13	0.33	0.10	0.20	58	28	54
19-21 Sept.	8	246	127	250	25	0.12	0.06	0.11	30	20	38
22-25 Sept.	10	302	93	182	37	0.08	0.04	0.07	25	13	25
Sept. 26-28	10	764	199	390	17	0.10	0.06	0.12	74	51	99
29 Sept-2 Oct	10	732	174	340	22	0.34	0.10	0.19	246	91	179
3-5 Oct.	10	552	109	214	19	0.33	0.08	0.15	183	55	108
6-9 Oct.	10	402	118	232	15	4.48	1.91	3.74	1,800	905	1,773
10 Oct.	5	121	0	0	16	0.93	0.22	0.42	113	26	51
11-14 Oct.	12	0	0	0	0	0.00	0.00	0.00	0	0	0
Totals	87	3,309	114	223	171	0.76	0.67	1.31	2,528	914	1,791
<u>Round whitefish:</u>											
14 Sept.	4	14	6	12	7	0.00	0.00	0.00	0	0	0
15-18 Sept.	8	178	68	133	13	0.20	0.09	0.18	36	20	40
19-21 Sept.	8	246	127	250	25	0.05	0.03	0.06	12	9	17
22-25 Sept.	10	302	93	182	37	0.08	0.03	0.06	25	12	23
26-28 Sept.	10	764	199	390	17	0.39	0.18	0.36	297	157	307
29 Sept-2 Oct	10	732	174	340	22	0.08	0.04	0.08	57	32	62
3-5 Oct.	10	552	109	214	19	0.19	0.06	0.12	105	39	77
6-9 Oct.	10	402	118	232	15	0.10	0.05	0.09	38	22	42
10 Oct.	5	121	0	0	16	0.11	0.09	0.18	13	11	22
11-14 Oct.	12	0	0	0	0	0.00	0.00	0.00	0	0	0
Totals	87	3,309	114	223	171	0.18	0.10	0.20	583	168	330

¹ n = Number of instantaneous hourly angler counts.

² n = Number of angler interviews (complete trips).

Table 47. Estimates of the proportional contributions of each age class, mean fork length (mm) at age, and 95% confidence intervals for two whitefish species in the harvest sample from the Chatanika River/Elliot Highway whitefish spear fishery, 14 September to 14 October, 1986.

Age	Age Composition:			Fork Length(mm):		
	n	p ¹	±CI ²	Mean	se	±CI ³
<u>Least Cisco:</u>						
2	2	0.00	0.08	288	13	159
3	195	0.31	0.07	305	1	2
4	314	0.50	0.06	312	1	2
5	93	0.15	0.07	329	3	5
6	17	0.03	0.08	348	4	9
7	8	0.01	0.08	361	7	17
Total	629	1.00		313	1	2
<u>Humpback whitefish:</u>						
3	1	0.00	0.13	354	13	159
4	50	0.22	0.11	370	1	2
5	102	0.44	0.10	391	1	2
6	33	0.14	0.12	402	3	5
7	19	0.08	0.12	414	4	9
8	19	0.08	0.12	432	7	17
9	6	0.03	0.13	428	17	44
10	2	0.01	0.13	438	2	19
Total	232	1.00		395	2	4

¹ p = Proportion of sample.

² Confidence interval based on normal theory approximation of binomial distribution.

³ Confidence interval based on t-distribution with n-1 degrees of freedom.

Table 48. Estimates of catch rate (fish harvested per hour) and 95% confidence interval by month calculated from angler interviews at three stocked-lake rainbow trout and coho salmon fisheries, 15 November, 1986 to 29 April, 1987.

Stratum	Chena Lake:				Birch Lake:				Quartz Lake:			
	¹ n	CPUE	se	±CI	n	CPUE	se	±CI	n	CPUE	se	±CI
<u>Rainbow trout:</u>												
November	21	1.02	0.28	0.54	39	1.48	0.32	0.64	73	0.35	0.07	0.15
December	40	0.64	0.27	0.54	99	0.60	0.13	0.25	149	0.70	0.17	0.33
January	22	0.74	0.26	0.51	95	0.74	0.12	0.24	186	0.51	0.13	0.26
February	11	0.48	0.35	0.69	90	1.02	0.18	0.36	113	0.26	0.07	0.14
March	16	0.48	0.55	1.08	46	2.12	0.31	0.62	107	0.19	0.07	0.14
April	9	0.00	0.00	0.00	44	0.78	0.17	0.34	85	0.12	0.03	0.06
<u>Coho salmon:</u>												
November	21	1.28	0.63	1.23	39	1.21	0.23	0.46	73	1.61	0.17	0.33
December	40	0.54	0.20	0.39	99	0.33	0.12	0.24	149	0.57	0.16	0.32
January	22	0.95	0.31	0.62	95	0.62	0.17	0.33	186	0.62	0.21	0.40
February	11	1.48	0.14	0.28	90	0.26	0.08	0.16	113	0.71	0.13	0.25
March	16	0.38	0.35	0.70	46	0.64	0.18	0.36	107	0.80	0.10	0.19
April	9	0.00	0.00	0.00	44	0.12	0.06	0.12	85	0.57	0.09	0.18

¹ n = Number of angler interviews (complete and incomplete trips).

ranges from a low of 0.12 (\pm 0.12) fish harvested per hour in April to a high of 1.21 (\pm 0.46) fish harvested per hour in November.

The creel survey of the Quartz Lake winter fishery was conducted at the same time as the Chena and Birch Lakes fisheries. A total of 713 angler interviews were taken during the period. CPUE of rainbow trout ranges from a low of 0.12 (\pm 0.06) fish harvested per hour in April to a high of 0.70 (\pm 0.33) fish harvested per hour in December (Table 48). CPUE of coho salmon ranges from a low of 0.57 (\pm 0.18) fish harvested per hour in December and April to a high of 1.61 (\pm 0.17) fish harvested per hour in November.

Biological data were collected from 55 rainbow trout and 44 coho salmon harvested during the Chena Lake winter fishery. All of the harvest sample of rainbow trout are smaller than quality size, while 98% of the coho salmon harvest sample are smaller than quality size (Table 49).

Biological data were collected from 411 rainbow trout and 263 coho salmon harvested during the Birch Lake winter fishery. Almost all (99%) of the rainbow trout harvest sample are less than quality size, while 66% of the coho salmon harvest sample are less than quality size (Table 49).

Of the 397 rainbow trout sampled for biological information in the Quartz Lake winter fishery, 97% of fish are of stock size (Table 49). The remaining 3% of rainbow trout sampled are of quality size. Biological data were collected from 715 coho salmon in the Quartz Lake fishery, of which 81% are of stock size and 19% are of quality size. Analyses of stocking classes represented in the harvest from Chena, Birch, and Quartz Lakes are presented in Doxey (1987).

The demographic profiles of anglers utilizing the Chena, Birch, and Quartz Lakes winter fishery are dominated by adult males who reside in the Fairbanks/Delta Junction area (Table 50). Chena Lake has the highest percentage of children (youths) fishing for rainbow trout and coho salmon in these three fisheries. Less than 1% of anglers interviewed are tourists. No tourists interviewed at either Chena or Birch Lake. Participation of military personnel in these fisheries is highest at Birch and Quartz Lakes, accounting for 15 to 16% of all anglers interviewed. Terminal gear used is generally similar for all three lakes. Bait anglers account for 66% of all interviews, and jig anglers account for 10 to 25% of all interviews (Table 50).

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Table 49. Relative Stock Density (RSD) and 95% confidence intervals calculated from harvest samples taken from three stocked lake rainbow trout and coho salmon fisheries, 15 November, 1986 to 29 April, 1987.

Category	Minimum length:		Chena Lake:		Birch Lake:		Quartz Lake:	
	mm	in	RSD ¹	±CI ²	RSD	±CI	RSD	±CI
<u>Rainbow trout:</u>								
Stock	220	8.7	100	0	99	1	97	2
Quality	390	15.3	0	0	1	1	3	2
Preferred	490	19.3	0	0	0	0	0	0
Memorable	650	25.6	0	0	0	0	0	0
Trophy	810	31.9	0	0	0	0	0	0
Sample size			55		411		397	
<u>Coho salmon:</u>								
Stock	140	5.5	98	4	66	6	81	3
Quality	230	9.0	2	4	33	6	19	3
Preferred	300	11.8	0	0	1	1	0	0
Memorable	380	14.9	0	0	0	0	0	0
Trophy	460	18.1	0	0	0	0	0	0
Sample size			44		263		715	

¹ RSD = Relative Stock Density expressed as a percentage.

² ±CI = 95% confidence interval calculated from the normal theory approximation to the binomial distribution.

Table 50. Demographic profiles of anglers utilizing stocked lakes for rainbow trout and coho salmon fishing from November through April, 1986 - 1987.

Category	Chena Lake: (n = 94)		Birch Lake: (n = 326)		Quartz Lake: (n = 530)	
	n ¹	% ²	n	%	n	%
Male	75	80	271	83	423	80
Female	7	7	32	10	40	7
Adult	54	57	258	79	416	78
Youth	28	30	44	13	48	9
Resident	85	90	300	92	462	87
Non-resident	0	0	0	0	2	0
Unknown	9	10	26	8	66	13
Local	84	89	287	88	443	83
Non-local	0	0	14	4	21	4
Unknown	10	11	25	8	66	13
Tourist	0	0	0	0	1	0
Military	2	2	49	15	87	16
Neither	92	98	277	85	442	84
Gear type:						
Spinners	0	0	0	0	0	0
Bait	62	66	216	66	352	66
Jigs	9	10	81	25	106	20
Flies	0	0	0	0	0	0
Unknown	23	24	29	9	72	14

¹ n = Number of angler interviews.

² % = Percentage of total interviews.

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