PART 5

Resident Fish Distribution and Population Dynamics in the Susitna River below Devil Canyon

RESIDENT FISH DISTRIBUTION AND POPULATION DYNAMICS IN THE SUSITNA RIVER BELOW DEVIL CANYON

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by Richard L. Sundet and Mark N. Wenger

Alaska Department of Fish and Game
Susitna Hydro Aquatic Studies
2207 Spenard Road
Anchorage, Alaska 99503

ABSTRACT

Studies of resident fish during 1983 were concentrated on the reach of the Susitna River between the Chulitna River confluence and Devil Canyon. With the use of radio telemetry and mark and recapture methods, the seasonal distribution of rainbow trout and estimates of local abundance were obtained. Examination of recapture data over the past several years suggests that the rainbow trout population in this reach is probably less than 4,000 fish. Most of the concentrations are in the smaller tributaries, particularly Fourth of July Creek, which also has the only significant amount of successful spawning documented so far in this portion of the Susitna basin. The large tributaries, Portage Creek and Indian River, had comparatively small numbers of rearing rainbow trout. This species spends much of its annual life cycle in the mainstem Susitna near tributary mouth areas or mixing zone confluences of sloughs. Much of the migratory movements during the summer appear to be in response to the influx of adult salmon spawners, whose eggs apparently provide a major source of food. Radio tagged rainbow trout movement data suggests that the mainstem is important for overwintering. Limited data from tagged rainbow trout below the Chulitna River confluence suggests the reach of river between RM 78.0 and Talkeetna may also be an important overwintering area for Talkeetna River stocks as well. Spawning of round whitefish in October and probably burbot in January is directly influenced by mainstem flows. Young age class Arctic grayling and round whitefish appear to reside in the mainstem Susitna, usually near tributary or slough mouths. Nearly all of the spawning and most of the rearing of older age class Arctic grayling occurs in tributaries. Arctic grayling overwinter in the mainstem Susitna. Dolly Varden are rare in this reach of the Susitna. Selected sites have been established that can be used to monitor catch per unit effort of the resident species, and consequently their response to flow regulation of the proposed hydroelectric project.

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1.0 INTRODUCTION

Study of resident fish[1/] species began in the fall of 1980 to collect baseline data to meet the following objectives:

A. Define seasonal distribution and relative abundance of resident fish species in the Susitna River between Cook Inlet and Devil Canyon.

B. Characterize the seasonal habitat requirements of selected resident fish species within the study area.

During the 1983-84 season, the Resident Fish Studies were refined to also address the following sub-objective:

C. Quantify the important habitat parameters associated with spawning and rearing (growth) of selected resident fish species and measure fish density in spawning and rearing habitats to provide an estimate of habitat quality.

The rationale behind these objectives is that often there can be changes in fish populations after the construction of a hydroelectric dam. These postproject effects result from changes in water temperature, flow, turbidity, and other water quality parameters. Preproject baseline fisheries data and their correlation to habitat conditions, therefore, are necessary to evaluate the potential impact to these fisheries.

Studies on how resident fisheries are affected by hydro-projects similar in magnitude to the Susitna proposals are limited. One of the better pre- and post-project studies was conducted by the Montana Department of Fish, Wildlife, and Parks on the Kootenai River below the Libby Dam site (MDFW&P 1983). The overall effects of the dam were conducive to increased production of rainbow trout and mountain whitefish but adversely affected sturgeon. A quality sport fishery has arisen in the regulated waters below the project after an initial five year problem with supersaturation of dissolved gas. In recent years, however, the average size of the rainbow trout have decreased, which may be related to sport fishing and perhaps to changes in invertebrate comunity structure caused by power peaking fluctuations. The system remains one of the more productive rivers in this portion of the state of Montana. Provision for proper downstream flow is considered by these researchers to be the primary reason the fisheries have developed favorably after project operation.

Sport fishing for rainbow trout and Arctic grayling in the Susitna River drainage occurs throughout the open water season, primarily around the mouths of clearwater tributaries. Burbot fishing occurs mostly in the mainstem Susitna River or at the mouths of clear water tributaries during both summer and winter. In the Chulitna River confluence to

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1/ For the purposes of this report "resident fish" will be defined as any fish species which spend their entire life cycle within the Susitna River drainage.

Devil Canyon reach of the Susitna River, the reach that will probably be most affected by the proposed hydroelectric project, sport fishing occurs at Whiskers Creek [river mile (RM) 101.4], Lane Creek (RM 113.6), Fourth of July Creek (RM 131.1), Indian River (RM 138.6), and Portage Creek (RM 148.8). Current information on the extent of the harvest of these resident fish species is limited to data available from Mills (1982) for the entire Susitna River basin. These catches have been stable for the past five years, with the average harvest of rainbow trout and burbot at 20,000 and 700 fish respectively. The level of fishing effort will probably increase in the Susitna River drainage during the next decade.

2.0 METHODS

This report addresses resident fish studies conducted during the open water period of 1983, spawning surveys done in early May, and radio telemetry results through December 1, 1983. Telemetry results are presented through December 1 to show the movement patterns during the transition period from open water to winter conditions. Although most of the sampling occurred in the mainstem Susitna River between the Chulitna River confluence to Devil Canyon, a few other areas were also studied.

2.1 Study Locations

2.1.1 Relative abundance measurements

Thirteen index sites were sampled twice per month by boat electrofishing to monitor seasonal trends in relative abundance of resident fish (Figure 1). In addition, other mainstem, side channel, slough, and tributary sites on the Susitna River between the Chulitna River confluence and Devil Canyon were also sampled intermittently.

The upper reaches of Fourth of July Creek (RM 131.1), Indian River (RM 138.6), and Portage Creek (RM 148.8) were sampled to determine the extent of resident fish spawning and rearing. These tributaries were selected because of their size, their proximity to Devil Canyon, and their relatively high abundance of resident fish species. Fourth of July Creek was sampled in May, June and July between tributary river mile (TRM) 0.0 and TRM 2.3. Indian River was sampled in June and August between TRM 1.5 and TRM 14.0, while Portage Creek was sampled in June at TRM 6.0 and TRM 10.0.

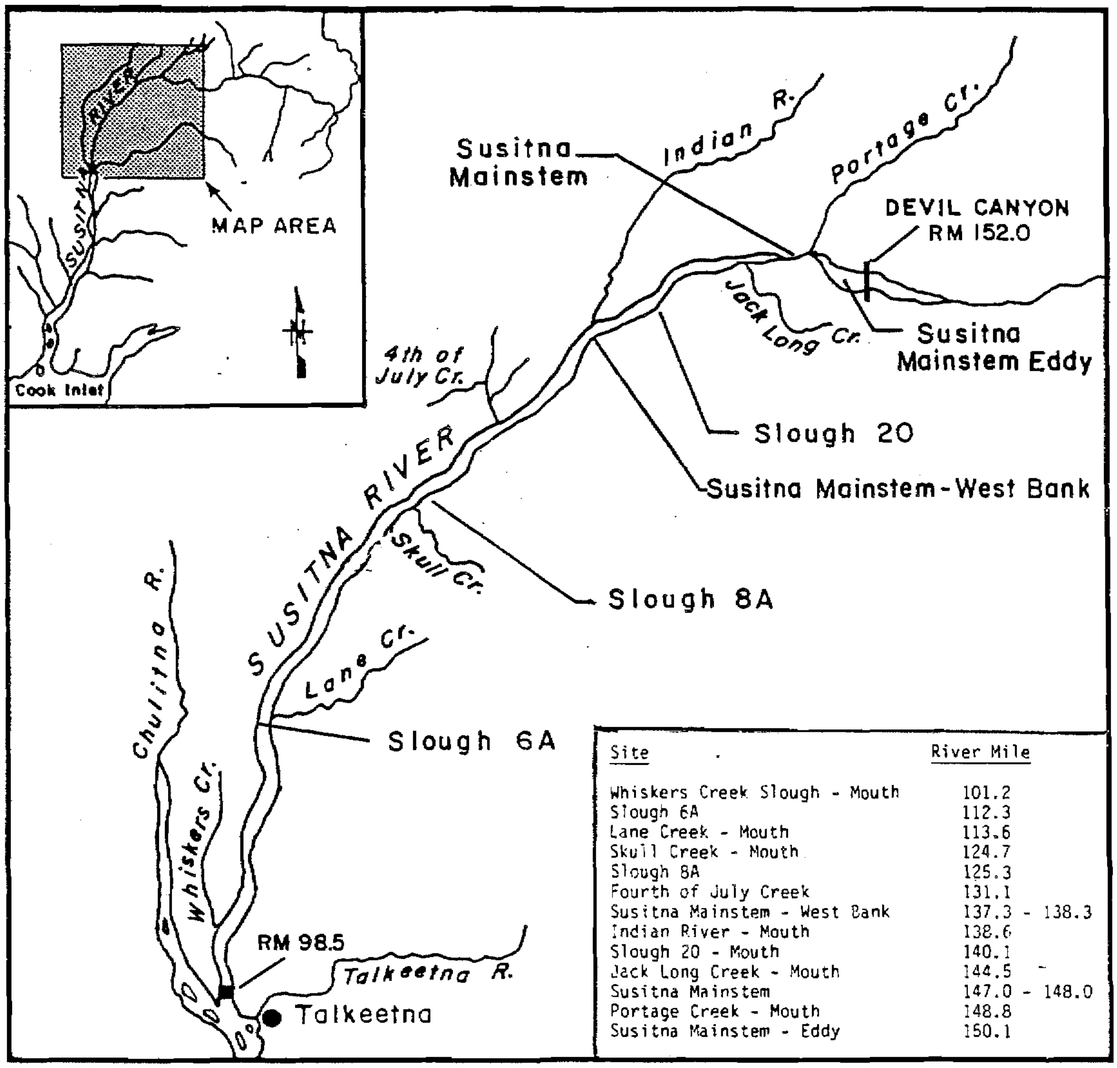
Resident fish catches recorded at four fishwheel sites, two downstream migrant traps (RM 103.0), and 35 juvenile salmon rearing study sites were also examined to evaluate trends in relative abundance and seasonal movements.

2.1.2 Population estimates

Resident fish population estimates were attempted at five sites on the Susitna River between the Chulitna River confluence and Devil Canyon (Table 1). These sites included a slough, a side channel, a tributary, a tributary mouth, and a one-mile reach of the mainstem Susitna River.

2.1.3 Radio telemetry

Selection of radio tagging sites in the mainstem Susitna between the Chulitna River confluence and Devil Canyon were based on resident fish distribution data collected during the 1981 and 1982 open water field seasons (ADF&G 1981c; 1983b). Primary efforts to capture rainbow trout (*Salmo gairdneri* Richardson) in the mainstem were focused at the mouths of Whiskers Creek (RM 101.4), Lane Creek (RM 113.6), Fourth of July Creek (RM 131.1) and Indian River (RM 138.6). Backwater areas in the mainstem were sampled for burbot (*Lota lota* Linnaeus). The upper



Site	River Mile
Whiskers Creek Slough - Mouth	101.2
Slough 6A	112.3
Lane Creek - Mouth	113.6
Skull Creek - Mouth	124.7
Slough 8A	125.3
Fourth of July Creek	131.1
Susitna Mainstem - West Bank	137.3 - 138.3
Indian River - Mouth	138.6
Slough 20 - Mouth	140.1
Jack Long Creek - Mouth	144.5
Susitna Mainstem	147.0 - 148.0
Portage Creek - Mouth	148.8
Susitna Mainstem - Eddy	150.1

Figure 1. Resident fish study sites on the Susitna River between the Chulitna River confluence and Devil Canyon, 1983.

Table 1. Resident fish population estimate sites on the Susitna River between the Chulitna River confluence and Devil Canyon, 1983.

Location	RM	TRM	Dates	Occasion	Methods
Slough 8A	125.3	--	7/15-7/17	6	boat electro-fishing
4th of July Creek	131.1	0.0-0.8	7/19-7/21	3	hook & line
Mainstem	131.0-131.8	--	7/15-7/16	4	gill net and hoop net
Mainstem	138.9-140.1	--	7/1-7/4	4	trotline, burbot sets, and hoop nets
Jack Long Creek	144.5	0.0	8/10	3	boat electro-fishing

Note - Population estimates were also begun at seven other locations in 1983 but were not completed due to insufficient captures of fish.

reaches of Fourth of July Creek, Indian River, and Portage Creek were also sampled for spawning or rearing rainbow trout.

2.2 Data Collection

2.2.1 Relative abundance

Resident fish were collected at mainstem and tributary sites primarily with a boat mounted electrofishing unit (Plate 1). A Coffelt Model VVP-3E boat electrofishing unit powered by a 2,500 watt Onan generator was used for boat electrofishing and techniques used are described in the 1982-83 procedures manual (ADF&G 1983a). Secondary gear types used included downstream migrant traps at RM 103.0, backpack electrofishing units, gill nets, hook and line, hoop nets, trotlines, and catfish traps. Baited hoop nets, trotlines and catfish traps were used mainly to capture burbot. Catfish traps were introduced as a new sampling technique in 1983. They were set and fished using techniques similar to those described for hoop nets (ADF&G 1983a).

All resident fish were identified to species. Biological data (age, length, sex, and sexual maturity) were collected as outlined in the 1982-83 procedures manual. Scales for age determination were taken from a representative sample of rainbow trout, Arctic grayling (Thymallus arcticus Pallas), round whitefish (Prosopium cylindraceum Pallas), humpback whitefish (Coregonus pidschian Gmelin), and longnose suckers (Catostomus catostomus Forster).

Survival rates for selected resident fish species were calculated using catch and age data following the methods of Everhart et al. (1975). The log of the number of fish for each age class was plotted. Then, a regression line was fit to the descending leg of the graph. Points (numbers in an age class) in the descended leg were used after the peak and to the oldest age class consisting of greater than three points. The equations are:

$$\log_e S = Z$$

$$S = e^{-Z} = e^{b}$$

where: S = survival

Z = instantaneous mortality rate

b = slope of regression between the log of the number of fish and year classes

Resident fish spawning data were collected whenever gravid female fish were captured. A gravid female fish was defined in this study as one which expelled eggs when its abdomen was palpated. Because of turbidity, direct observations of redds was not possible.

A tag-and-recapture program was continued in 1983 to monitor the seasonal movements of adult resident fish. Floy anchor tags were used to tag seven species of adult resident fish: humpback whitefish, round

Plate 1. Electrofishing with a boat mounted electroshocking unit at Mainstem Susitna-gravel bar opposite Montana Creek (RM 78.0).

whitefish, burbot, longnose suckers, rainbow trout, Arctic grayling, and Dolly Varden (Salvelinus malma Walbaum). All resident fish that appeared healthy after capture and were large enough to be tagged were tagged. Burbot with a total length of 225 millimeters (mm) or greater were tagged. All other resident fish with fork lengths greater than 200 mm were tagged. Tag recoveries were made by the resident fish study group, the adult salmon fishwheel crews, and the angling public.

2.2.2 Population estimates

Population estimates for rainbow trout, Arctic grayling, burbot, round whitefish, and longnose suckers were attempted at five representative sites (Table 1). The study design followed that outlined by Otis et al. (1978) and White et al. (1982) which uses a computer program called CAPTURE to calculate the population estimates and associated statistics. Fourth of July Creek was sampled with hook and line gear to capture rainbow trout and Arctic grayling. Trotlines and hoop nets were used at Mainstem (RM 138.9 - 140.1) to collect burbot. Boat electrofishing and gill nets were used at the remaining three sites to capture resident fish species. Each site was sampled on three to six occasions over a period of one to four days. Resident fish over 200 mm in length were Floy anchor tagged while smaller fish were marked by clipping the upper tip of the caudal fin. Catch and recapture information from 1982 indicated that resident fish movement is at a minimum during late July and early August (ADF&G 1983b). This is important because the CAPTURE model is only valid for closed populations. Population estimates for some species were not obtained at all study sites because of insufficient capture of fish.

The CAPTURE program indicates whether the data set meets the assumption if a closed population (i.e., no in- or out-migration during the sampling period). The program selects one model which best fits the data set out of several possible models. The different models allow for various effects on capture probability such as behavioral effects (for example, fish that are hook-shy or will not take a lure after having done so once). The program also calculates capture probabilities and provides confidence limits on the population estimates.

Population estimates for all species except burbot were made by a capture-recapture model from the CAPTURE computer program. Population estimates for burbot were made using a multiple removal model instead of the capture-recapture model because of the lack of burbot recaptures.

Although population estimates were attempted at five sites, population estimates were only able to be calculated for rainbow trout at Fourth of July Creek and burbot at mainstem Susitna (RM 138.9 - 140.1). Population estimates of resident fish at Jack Long Creek and at the mainstem site between RM 131.0 - 131.8 were not generated due to insufficient numbers of fish captured. Population estimates of resident fish at Slough 8A were also not generated due to low numbers of fish captured for three species, while for two species (longnose suckers and round whitefish) population estimates were inaccurate due to the wrong CAPTURE models used.

In addition to the five sites sampled three or more times, population estimates were stopped at seven other sites in 1983 due to insufficient fish captures during the first sampling occasion. Two of these sites were sampled for burbot in the mainstem at RM 128.3 - 129.3 and at RM 147.0 - 147.3. The remaining five sites were in Indian River between TRM 1.5 - 14.0.

2.2.3 Radio telemetry

2.2.3.1 Equipment

Radio telemetry receiving equipment used in this study was developed by Smith-Root Incorporated in Vancouver, Washington. Receiving equipment consisted of a low frequency (40 MHz) radio tracking receiver (Model RF-40) and scanner (Model SR-40), and a loop antenna (Model LA-40).

Radio transmitters manufactured by Smith-Root Incorporated and Advanced Telemetry Systems (Bethel, Minnesota) were used in the 1983 study. Advanced Telemetry System radio tags with a nine month life expectancy were used in rainbow trout. Smith-Root radio tags with a six month life expectancy were implanted in burbot and a few large rainbow trout.

Advanced Telemetry System transmitters (model BEI 10-35) were cylindrically shaped, encapsulated in epoxy, and had flexible 30 cm external antennas. The copper wire antennas were cut down to 15-20 cm to make implanting easier yet still provide a suitable receiving range. The Advanced Telemetry System transmitters measured 5.6 cm in length, 1.2 cm in diameter and had a dry weight of approximately 13.3 gm. The power source for the transmitters were 3.4 volt lithium batteries providing life expectancies of 200-270 days, depending on the pulse rate. Transmitter frequencies ranged between 40.600 and 40.770 MHz and had pulse rates between 1.0 and 2.0 per second. Radio frequencies from 40.680 - 40.700 MHz were not used to avoid interference with transmitting Alascom radio signals on frequency 40.690.

Smith-Root transmitters were identical to those used in previous resident fish telemetry studies with exception of the pulse rates (ADF&G 1981d; 1983a;1983b). Smith-Root transmitters used in the 1983 studies had pulse rates of 3.0 pulses per second and a life expectancy of 180 days.

All radio tags were immersed in cold water (1-5°C) for 48 hours to ensure they were transmitting properly before they were implanted in fish.

2.2.3.2 Transmitter implantation

Rainbow trout used for radio telemetry studies were captured by drift gill net, boat electrofishing, or hook and line. All burbot used in radio telemetry studies were captured by boat electrofishing. Based on personal communications with Carl Burger (USFWS) and experience gathered from the previous two years of radio telemetry studies, minimum lengths of rainbow trout and burbot radio tagged were set at 380 mm fork length and 525 mm total length, respectively. No injured or lethargic fish were radio tagged. Each fish radio tagged was placed in a 14 gallon cooler filled with a solution of river water and an anesthetic MS-222 (tricaine methane-sulfonate). After the fish were anesthetized, their lengths were measured to the nearest millimeter (fork length for rainbow trout and total length for burbot). Scales were taken from rainbow trout for aging. All radio tagged fish were marked with Floy anchor tags to identify them during subsequent recaptures.

With the exception of two rainbow trout, transmitters were surgically implanted in the coelom using a procedure described in Ziebell (1973). An incision was made on the midline of the ventral surface midway between the pectoral and pelvic fins, and a half capsule of ampicillin (an antibiotic used to prevent infection) was sprinkled into the body cavity. The length of the incision for the Advanced Telemetry System tag was 2.0-2.5 centimeters (cm) and a 3.0-3.5 cm incision was made for the Smith-Root tag. The radio tags were inserted anteriorly with the antenna extended fully toward the posterior of the fish. Incisions were closed with four to seven individual sutures of commercial silk (Plate 2).

Two rainbow trout received subcutaneous implants of Advanced Telemetry System radio transmitters using techniques which had been tested on rainbow trout in the Elmendorf Hatchery. The procedure involved making a 2.0-2.5 cm perpendicular incision through the skin below the posterior of the dorsal fin. A 1.0 cm diameter sharpening steel was used to tunnel anteriorly beneath the skin and separate the skin from the muscle. The radio tag was then inserted through the incision under the skin to the anterior end of the tunneled area. This positioned the anterior end of the radio tag approximately 3-5 cm behind the base of the fish's head with the antenna trailing out the incision. The incision was closed with 3-4 silk sutures (Plate 3).

After the surgical implantation of the radio tag, the fish was placed into a live box and held upright until it regained its equilibrium. The fish was then held overnight for observation. The following day the sutures were checked and the transmitter's signal was tested before releasing the radio tagged fish near the point of capture.

2.2.3.3 Tracking

Biologists radio tracked fish by boat, by aircraft and by ground surveys. Radio tracking by boat and ground surveys was conducted in the mainstem Susitna from Talkeetna (RM 97.0) to Devil Canyon (RM 150.5) once every 10-14 days from mid-May until mid-October 1983. Ground tracking was conducted primarily at tributary mouths and in the lower reaches of tributaries.

Aerial tracking, using methods described in Adult Anadromous Investigations (ADF&G 1981b), was conducted twice per month from mid-May through October 1983. In November and December 1983, aerial tracking was conducted once per month.

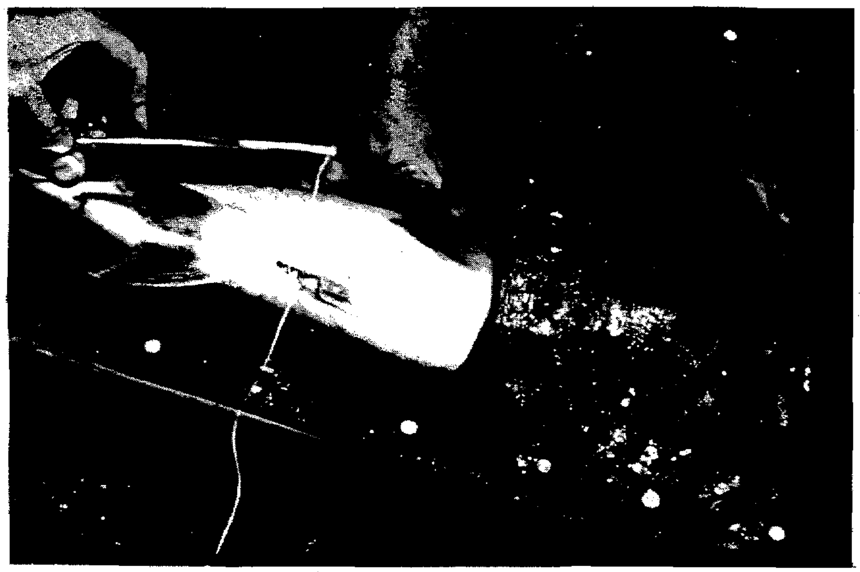


Plate 2. Implanting a radio tag into the abdomen of a rainbow trout.

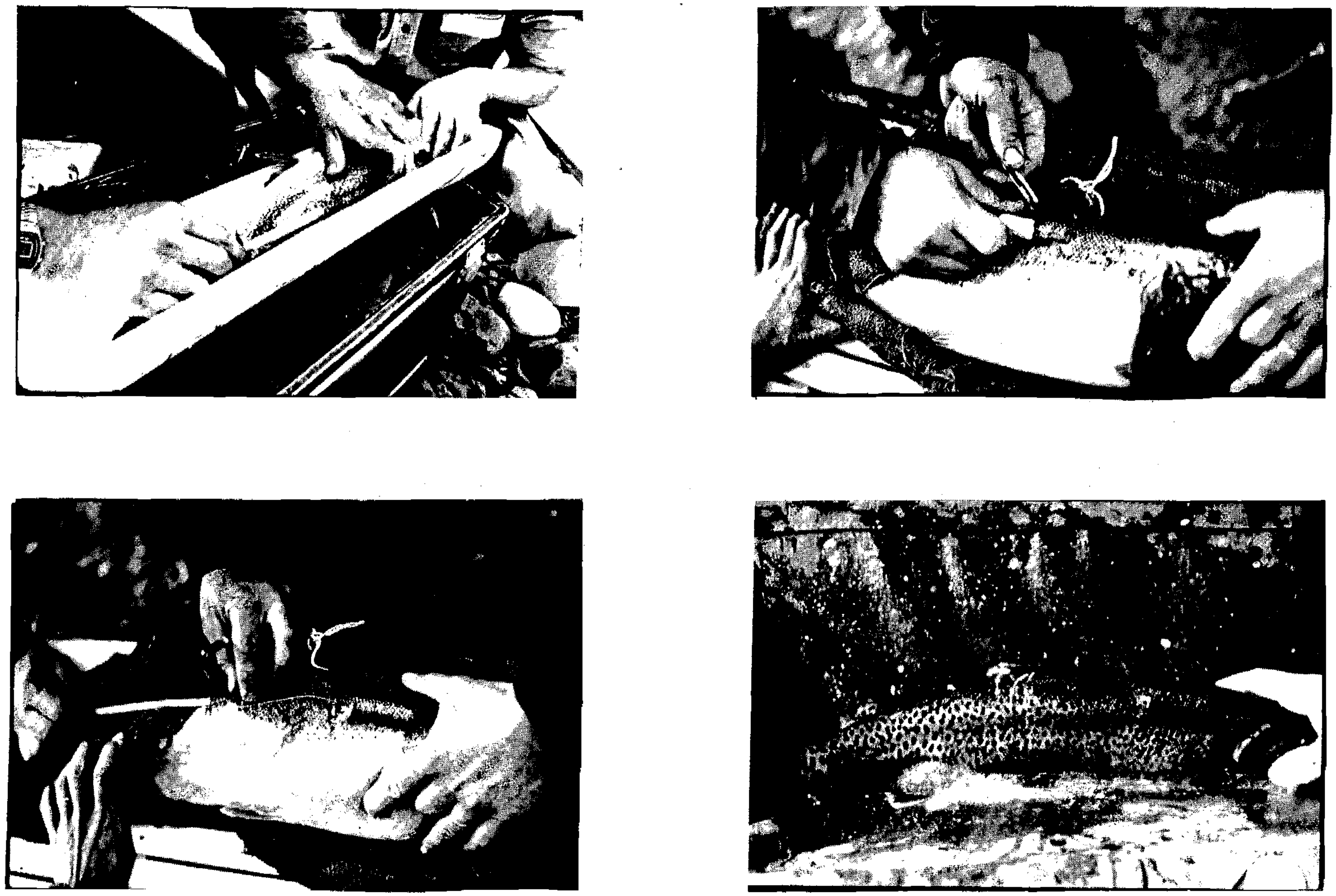


Plate 3. Implanting a radio tag under the skin of a rainbow trout.

2.3 Data Recording and Analysis

Biological data and catch data were recorded at relative abundance study sites as specified in the 1983-84 procedures manual (ADF&G 1984). Habitat data were also collected at resident fish spawning sites and are presented in Part 6 of this report. These data included, but were not limited to, species, length, sex, water velocity, substrate, location, time sampled, and gear type used. Biological and catch data were also recorded at sites where population estimates were obtained and where fish were collected for the radio telemetry study.

Data collected for resident fish relative abundance, population estimates, and radio telemetry were checked for accuracy and completeness following each sampling trip. Relative abundance data were submitted to the data processing unit for key punching. Radio telemetry data was filed for hand compilation at a later date. Printouts of the initial relative abundance data were returned to the individuals who collected the data to be rechecked for errors before being incorporated into the computer data base for analysis.

Analysis of relative abundance, length frequency and catch per unit effort data were provided by the data processing group. Population estimates for resident fish species were computed using the computer program CAPTURE, described by Otis et al. (1978) and White et al.(1982).

An analysis of variance of juvenile salmon catch rate at the juvenile salmon study sites was also run on juvenile round whitefish which were relatively abundant at those sites. Details of the analysis are given in Part 2 of this report.

3.0 RESULTS

3.1 Rainbow Trout

3.1.1 Distribution and relative abundance

Four hundred twenty-eight rainbow trout were captured by Susitna Hydro study groups using various methods between Cook Inlet and Devil Canyon from May to October 1983 (Table 2). Most of these fish were captured on the Susitna River above the Chulitna River confluence by hook and line (43.2%) or boat electrofishing (35.3%).

One hundred sixty-three rainbow trout were caught by a resident fish study crew at 12 selected sites between the Chulitna River confluence and Devil Canyon. Most (80.4%) of these fish were captured by boat electrofishing. The highest catches of rainbow trout at these sites by all gear types were at Fourth of July Creek (RM 131.1) and Indian River (RM 138.6) where 46 and 45 fish were caught respectively. Other sites where relatively high rainbow trout catches were made included Whiskers Creek Slough (RM 101.2), Lane Creek (RM 113.6) and Portage Creek (RM 148.8).

Two hundred twenty-eight rainbow trout were captured by the resident fish crew at sites other than the twelve selected sites. Most (78%) of these fish were captured in Fourth of July Creek between TRM 0.1 and TRM 1.5. In addition to the 391 rainbow trout captured by the resident fish crew, other Su Hydro study groups captured 37 rainbow trout.

The maximum seasonal catch of 168 rainbow trout (all gear types) was recorded in late July. Relatively high catches were also recorded in early (43) and late (41) September (Table 2).

3.1.2 Movement and migration

Twenty-nine rainbow trout were radio tagged at ten different sites on the Susitna River between the Chulitna River confluence and Devil Canyon from May 12 to October 5, 1983. Eighty-three percent of these radio tagged rainbow trout were captured and released at the mouths of tributary streams. Appendix Table B-1 presents a summary of capture and biological data for the individual radio tagged fish. Individual movements of radio tagged rainbow trout during 1983 are presented in Figures 2-5. During the tracking period, ten radio tagged rainbow trout moved downriver over 0.5 mile, four moved upriver over 0.5 mile and seven had both downstream and upstream movements over 0.5 mile. The remaining five radio tagged rainbow trout moved less than 0.5 mile throughout the tracking period. Eighteen rainbow trout moved downstream from 0.1 to 26.7 miles (average of 6.9 miles), with most of the downstream movement occurring after September 1. Eleven rainbow trout moved upstream from 0.4 - 12.0 miles, with an average upstream move of 2.4 miles.

During 1983, one radio tagged rainbow trout was reported caught by a sport fisherman. This rainbow trout (648-1.6) was radio tagged on June 7th in Whiskers Creek (TRM 0.1) and recaptured by a sport fisherman on

Table 2. Rainbow trout catch on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

Study Group	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Total
Resident Fish Study												
Boat Electrofishing	-	17[a]	14	11	5	15	4	5	26	30	24	151
Other Gear	6	1	22	21	0	145	2	17	15	9	2	240
Juvenile Anadromous Habitat Studies(JAHS)	0	0	1	0	1	4	1	1	1	2	0	11
Downstream Migrant Trap	-	0	0	0	2	3	4	3	0	0	-	12
Fishwheel sites	-	-	1	1	5	1	2	3	1	-	-	14 [b]
Total	6	18	38	33	13	168	13	29	43	41	26	428

- = No effort

[a] One rainbow was captured below the Chulitna River confluence.

[b] Seven rainbows were captured in fishwheels below the Chulitna River confluence. Yentna Station (RM 27.5, TRM 4.0) capturing three in early July. The remaining four were captured during early June, early August, late August, and in September at Sunshine Station (RM 79.0).

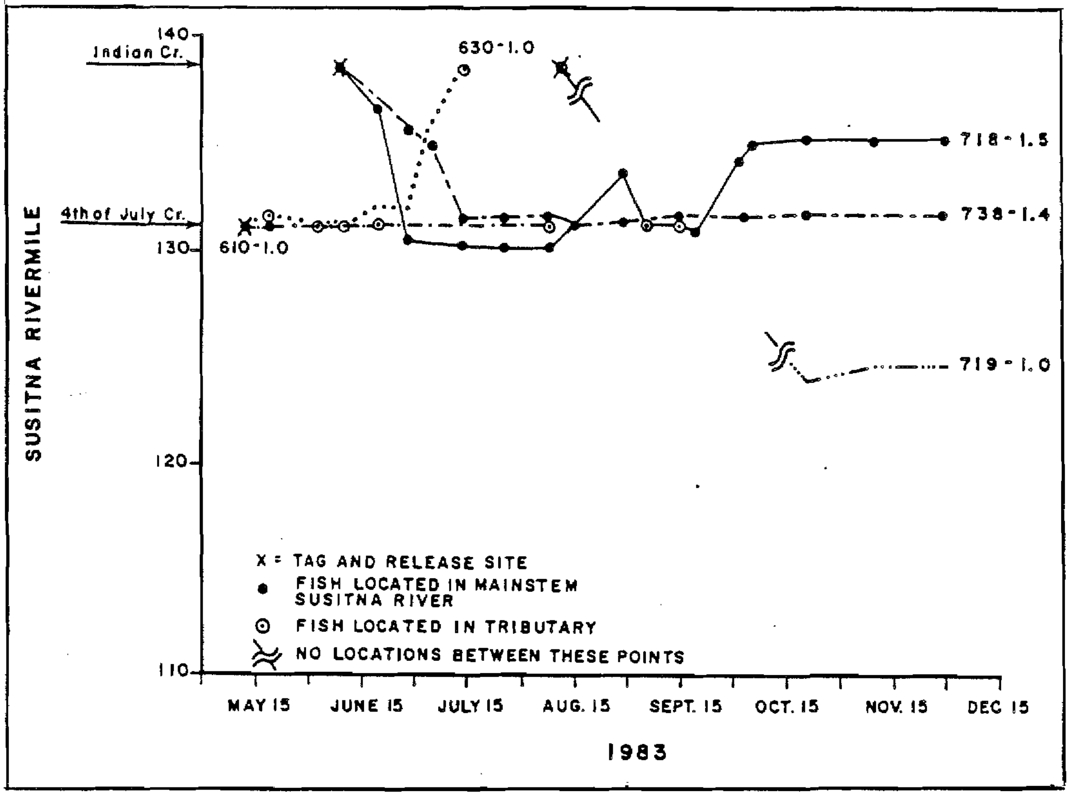


Figure 2. Movement of five radio tagged rainbow trout in the Susitna River below Devil Canyon, May to December 1983.

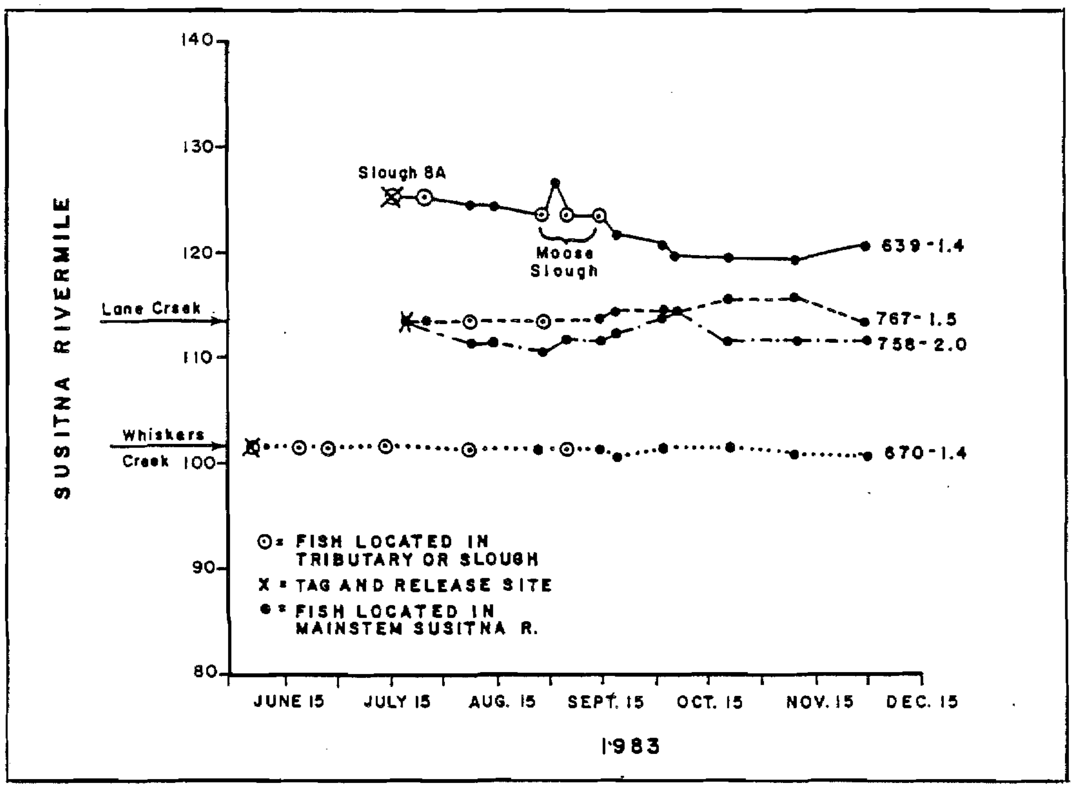


Figure 3. Movement of four radio tagged rainbow trout in the Susitna River below Devil Canyon, June to December 1983.

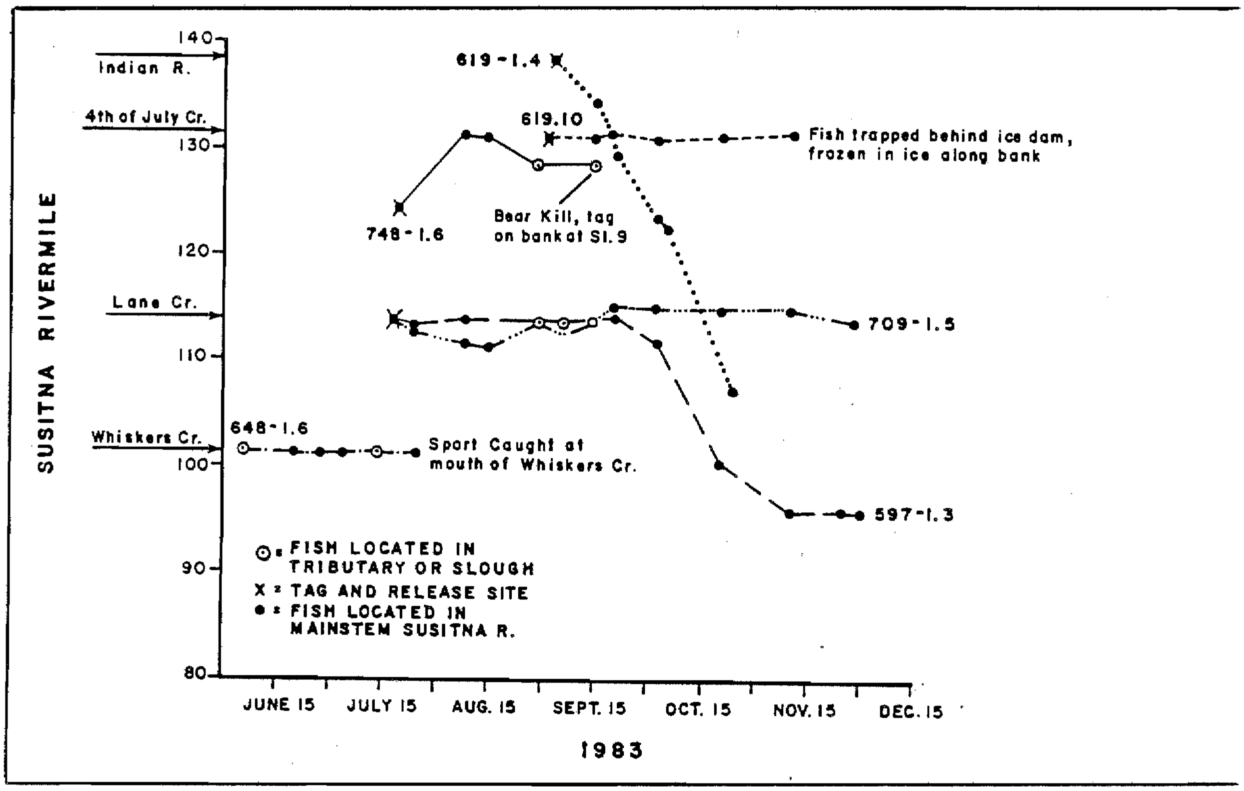


Figure 4. Movement of six radio. tagged rainbow trout in the Susitna River below Devil Canyon, June to December 1983.

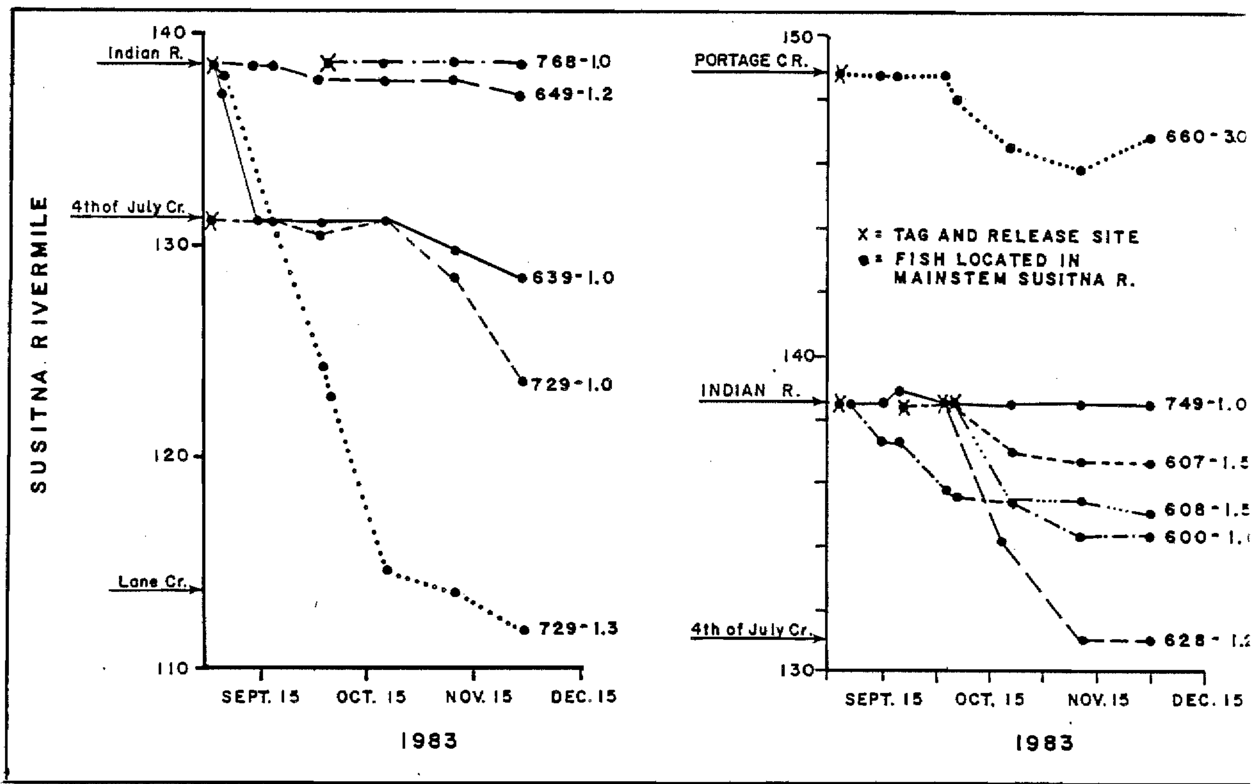


Figure 5. Movement of eleven radio tagged rainbow trout in the Susitna River below Devil Canyon, September to December 1983.

August 8th at the mouth of Whiskers Creek (TRM 0.0). The angler reported that the rainbow trout was in excellent condition and that the sutured incision had healed nicely. Radio tracking data showed that this rainbow trout did move short distances above and below the tagging site before being recaptured, but it largely stayed in the same general area for summer rearing.

Three of the 29 radio tagged rainbow trout provided little or no movement and migration data. One rainbow trout (668-1) radio tagged by the under-the-skin method either dropped its transmitter or died in Moose Slough (RM 123.5). When the slough's water became clear during September, neither the rainbow trout or transmitter could be found. Thereafter, rainbow trout radio tags were surgically implanted. Only one rainbow trout (628-2) was presumed to have been injured from the tagging or capture process during 1983. Immediately following its release, this rainbow trout moved rapidly downriver and was extremely lethargic when recaptured by boat electrofishing 20 days later. A third radio tagged rainbow trout (659-1.8) was injured when it was accidentally recaptured by boat electrofishing and it also moved rapidly downstream. With the exception of these three rainbow trout, it appeared that the remaining radio tagged rainbow trout exhibited normal behavior after being radio tagged.

Floy anchor tagged rainbow trout also provided information on rainbow trout movements. During 1983, 275 rainbow trout were Floy anchor tagged and 35 recoveries were made. Five rainbow trout were recovered at the same site where they were tagged. Sixteen rainbow trout were recovered within 5.0 miles of their tagging site. The remaining 14 rainbow trout were recaptured an average of 18.7 miles from where they were tagged. Ninety-four percent of the recaptured rainbows were recovered in or at mouths of tributaries such as Fourth of July Creek (12, RM 131.1) and Clear Creek (4), a tributary 6.0 miles up the Talkeetna River (RM 97.0). The most rapid movement recorded for a rainbow trout in 1983 was an upstream movement of 37.4 miles in 40 days during the spring. The maximum movement documented for all rainbow trout tagged to date was 53.0 miles by a rainbow trout tagged on July 19, 1982 at Jack Long Creek (RM 144.5) and recaptured at Clear Creek (TRM 0.0) on June 30, 1983.

3.1.3 Population estimates

The population estimate of rainbow trout in Fourth of July Creek between TRM 0.0-0.8 using the behavioral model from the CAPTURE computer program was determined to be 107 rainbow trout. The standard error of this estimate was 15.10 and the 95% confidence interval was from 82-137. The catch during the three day sampling period was 42, 22 and 18 respectively; in addition, eight fish were recaptured.

3.2 Burbot

3.1.2 Distribution and relative abundance

A total of 163 burbot were captured in the Susitna River between the Chulitna River confluence and Devil Canyon during 1983 (Table 3). Most (78 of 118) of the burbot captured by resident fish biologists were

Table 3. Burbot catch on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

Study Group	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Total
Resident Fish Study Boat Electrofishing	-	7	5	3	4	13	10	0	10	8	2	62
Other Gear	0	16	0	6	13	0	5	0	0	16	0	56
Juvenile Anadromous Habitat Studies(JAHS)	0	2	0	5	2	2	2	4	1	0	0	18
Downstream Migrant Trap	-	1	8	3	1	1	4	4	0	0	-	22
Fishwheel sites	-	-	0	0	0	4[a/]	0	0	1[b/]	-	-	5
Total	0	26	13	17	20	20	21	8	12	24	2	163

- = No effort

a/ One burbot was captured in a fishwheel at Yentna River Station (RM 27.5, TRM 4.0).

b/ One burbot was captured in a fishwheel at Sunshine Station (RM 79.0).

caught in the mainstem Susitna River or side channel sites. Burbot were most abundant at mainstem RM 139.6 (18 burbot), mainstem RM 102.5 (16 burbot), and mainstem RM 147.0-148.0.

3.2.2 Movement and migration

From August 18 to September 3, 1983, four burbot were radio tagged on the Susitna River between RM 113.6 and RM 147.5. A summary of 1983 data for radio tagged burbot is presented in Appendix Table B-2.

Radio tagged burbot movements were variable (Figure 6). One radio tagged burbot (610-3) remained within 3.6 miles of its capture site for three months. Two other radio tagged burbot (639-3 and 720-3) moved slowly downstream after their release 11.9 and 13.6 miles, respectively, and remained at these locations. Between its release on September 1 and October 21, radio tagged burbot (670-3) moved 36.5 miles downstream. Three radio tagged burbot also made small movement upstream. Burbot (610-3) moved upstream 2.5 miles, burbot (720-3) moved upstream 0.6 miles, and burbot (670-3) moved upstream 0.4 miles.

One hundred eight burbot were Floy anchor tagged and three burbot were recaptured in 1983. Movements exhibited by these burbot were minimal. All three Floy anchor tagged burbot were recaptured with 0.1 miles of their tagging location.

3.2.3 Population estimates

The burbot population estimate for the mainstem Susitna River between RM 138.9-140.1 was 15 burbot with a standard error of 4.18 and a 95% confidence interval of 13-24 burbot. The catch was 6, 1, 4 and 2 respectively for the four days sampled; no burbot were recaptured.

3.3 Arctic Grayling

3.3.1 Distribution and relative abundance

A total of 1,165 Arctic grayling were captured on the Susitna River between the Chulitna River confluence and Devil Canyon in 1983 (Table 4). Arctic grayling were most abundant at a mainstem site (RM 137.3-138.3) where 195 Arctic grayling were captured. Other sites where more than 60 Arctic grayling were captured are Lane Creek (RM 113.6), Indian River (138.6) and Portage Creek (RM 148.8). Catches of Arctic grayling were high in the spring at Whiskers Creek Slough (RM 101.2) and at RM 150.1 in the mainstem. During the summer, most Arctic grayling were captured in late May - early June and in September. The maximum Arctic grayling catch by all gear types (307 fish) was recorded in late September.

3.3.2 Movement and migration

Seven hundred sixty-five Arctic grayling were Floy anchor tagged and forty-one Arctic grayling were recaptured in 1983. Sixty-one percent of the recovered fish were from fish tagged in 1981 or 1982. Recaptured Arctic grayling movements ranged from 0.0 to 29.4 miles with an average

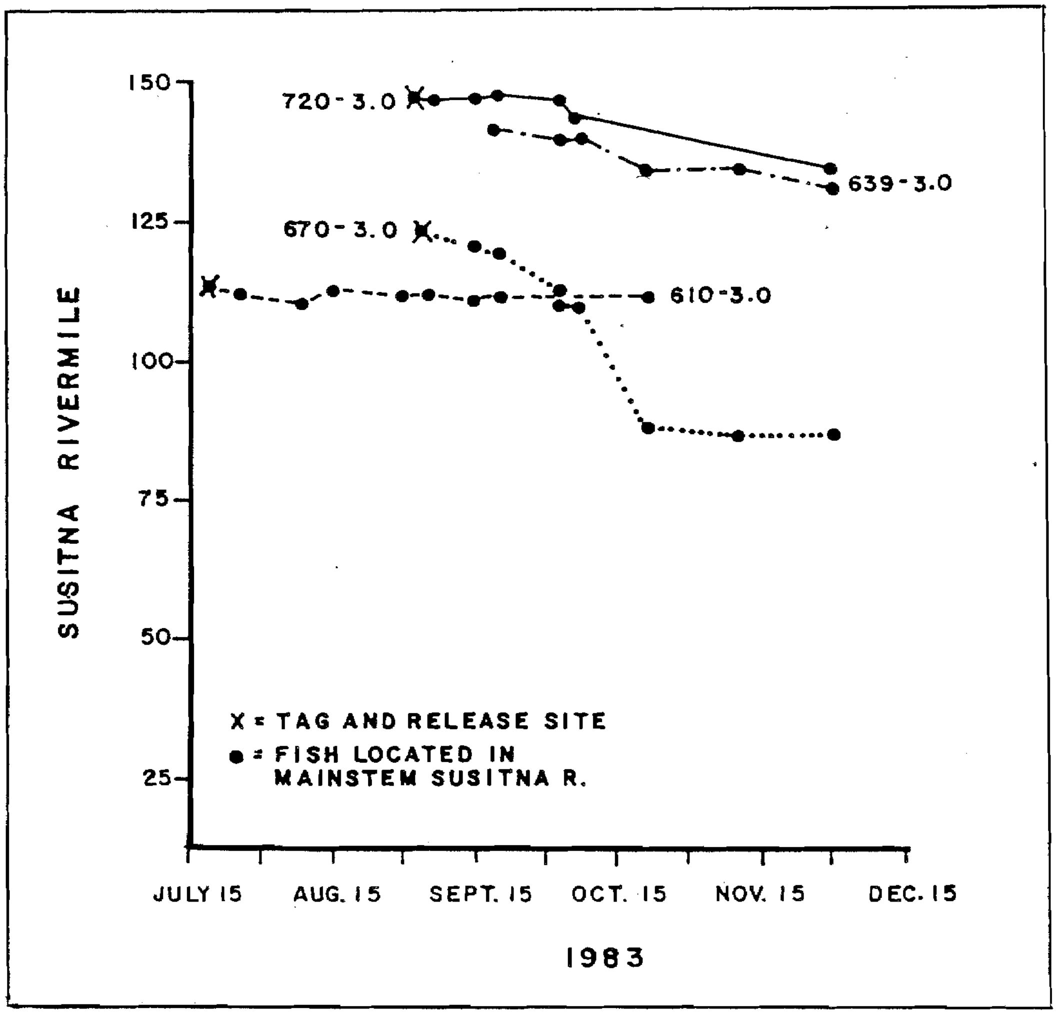


Figure 6. Movement of four radio tagged burbot in the Susitna River below Devil Canyon, July to December 1983.

Table 4. Arctic grayling catch on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

Study Group	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Total
Resident Fish Study Boat Electrofishing	-	136 a/	126	72	19	89	57	12	169	299	35	1,014
Other Gear	0	29	7	17	6	5	4	7	2	8	1	86
Juvenile Anadromous Habitat Studies(JAHS)	0	0	0	0	9	3	6	3	0	0	0	21
Downstream Migrant Trap	-	1	5	13	8	4	5	1	0	0	-	37
Fishwheel sites	-	-	1	2	0	1	1	2	5	-	-	12 b/
Total	0	166	139	104	42	102	73	25	176	307	36	1,170

- = No effort.

a/ Two Arctic grayling were captured below Chulitna River confluence.

b/ Three Arctic grayling were captured in fishwheels at Sunshine Station (RM 79.0). One was caught in late August and two were caught in September.

movement of 5.4 miles. About half (19) of the 43 recaptured Arctic grayling were recaptured at their tagging sites. Another six Arctic grayling were recovered within 5.0 miles of their tagging sites. The remaining 18 Arctic grayling recaptures moved an average of 12.5 miles from their tagging locations. Thirty of the 43 recoveries were made in tributaries or at tributary mouths. Eight Arctic grayling were recaptured at Fourth of July Creek (RM 131.1) and seven at Lane Creek (RM 113.6).

3.4 Round Whitefish

3.4.1 Distribution and relative abundance

A total of 4,917 round whitefish were captured in 1983 on the Susitna River between the Chulitna River confluence and Devil Canyon (Table 5). Many of the round whitefish were juveniles (< 200 mm) captured by two downstream migrant traps at RM 103.0.

The analysis of variance on the round whitefish catch at juvenile salmon rearing sites (JAHS sites) , which was almost all juvenile fish, showed that time of year had a significant effect on the catch rate (Part 2 of this Report). Juveniles were captured mainly in July and August at the JAHS sites; however, sampling efforts in their preferred habitat (turbid side sloughs and side channels) was minimal in June. The fish were in the river and moving earlier than July as evidenced by the catch at the downstream migrant traps (also almost all juveniles) in June.

Adult round whitefish (≥ 200 mm) were most abundant at a mainstem site between RM 147.0-RM 148.0. Other sites where over 100 adult round whitefish were captured were Slough 8A (RM 125.3), a mainstem site between RM 137.3-138.3, Indian River (RM 138.6), Jack Long Creek (RM 144.5), and Portage Creek (RM 148.8). Boat electrofishing catches of round whitefish were the highest in early September. Relatively high catches were also made in early June, late July, late September, and October.

3.4.2 Movement and migration

During 1983, 1,081 round whitefish were Floy anchor tagged and 73 round whitefish were recovered. Most of the 36 recoveries were from round whitefish tagged in 1982. The maximum downstream movement for round whitefish was 69.5 miles and the maximum upstream movement was 17.0 miles.

Thirty round whitefish were recaptured at sites where they were originally tagged. Twenty-seven were recaptured within 5.0 miles of their tagging locations. The remaining 16 tagged round whitefish moved an average of 18.5 miles downstream before being recaptured.

Thirty-three of round whitefish tag recaptures were made at tributary mouths and two were made 3.0-5.0 miles upstream of tributary mouths. Another 29 were recovered in the mainstem and the remaining nine were recovered in sloughs.

Table 5. Round whitefish catch on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

Study Group	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Total
Resident Fish Study Boat Electrofishing	-	58 a/	138	60	106	244	100	8	270	174	161	1,319
Other Gear	0	6	21	0	4	3	0	0	1	6	2	43
Juvenile Anadromous Habitat Studies(JAHS)	0	0	0	0	307	99	172	41	9	1	0	629
Downstream Migrant Trap	-	5	56	871	1,539	295	66	59	9	1	-	2,901
Fishwheel sites	-	-	2	4	0	3	0	23	16	-	-	48 b/
Total	0	69	217	935	1,956	644	338	131	305	182	163	4,940

- = No effort.

a/ Three round whitefish were captured below the Chulitna River confluence.

b/ Twenty round whitefish were captured below the Chulitna River confluence. Fishwheels at Yentna Station (RM 27.5, TRM 4.0) captured two in August. Fishwheels at Sunshine Station(RM 79.0) captured one in early June, one in late June, six in August, and 10 in September.

3.5 Humpback Whitefish

3.5.1 Distribution and relative abundance

Eight hundred twenty humpback whitefish (*Coregonus pidschian*) were captured in the Susitna River during 1983 with most (83.5%) being captured above the Chulitna River confluence (Table 6). Downstream migrant traps (RM 103.0) and fishwheels captured the majority (92.6%) of the humpback whitefish.

A total of 466 juvenile humpback whitefish (< 200 mm) were captured by two downstream migrant traps. The maximum catch of humpback whitefish at the downstream migrant traps occurred during late July. Relatively high catches were also recorded during early July and early August.

Fishwheels captured 293 adult humpback whitefish. Fishwheels at Yentna River station (RM 28.5, TRM 4.0) captured 60.8% of the humpback whitefish caught by fishwheels. The maximum seasonal humpback whitefish catch (137 fish) by fishwheel was recorded in late August.

Boat electrofishing catches of humpback whitefish (36) were most numerous at the mouth Slough 8A (RM 125.3). Gill net and hoop net humpback whitefish catches (14) were greatest in Slough 6A (RM 112.3). JAHS crews captured nine juvenile humpback whitefish in Slough 22 (RM 144.3) with beach seines.

3.5.2 Movement and migration

In 1983, 329 humpback whitefish were tagged with Floy anchor tags. Three tagged humpback whitefish were recaptured in 1983. One recaptured humpback whitefish moved upriver 17.0 miles in two days. A second tagged humpback whitefish moved downriver 11.0 miles in 43 days. The third humpback whitefish, tagged in 1982, moved downriver 8.7 miles in one year.

3.6 Longnose Suckers

3.6.1 Distribution and relative abundance

A total of 713 longnose suckers were captured in the Susitna River in 1983 (Table 7). All but 20 of these were captured in the Susitna River between the Chulitna River confluence and Devil Canyon.

Boat electrofishing longnose sucker catches were most abundant at Slough 8A (RM 125.3), Lane Creek (RM 113.6), Fourth of July Creek (RM 131.1), a mainstem site between RM 147.0-RM 148.0, and Portage Creek (RM 148.8) during late July and early August.

Juvenile longnose suckers (< 200 mm) were captured incidentally by beach seines and backpack electroshocker at mainstem and slough sites by JAHS crews. Longnose sucker juveniles captured at JAHS sites were most abundant at Mainstem II (RM 114.4). The downstream migrant traps at RM 103.0 also captured 111 juvenile longnose suckers.

Table 6. Humpback whitefish catch on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

Study Group	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Total
Resident Fish Study Boat Electrofishing	-	0	0	2	7	18	2	0	3	4	0	36
Other Gear	0	0	14	0	0	0	0	0	0	0	0	14
Juvenile Anadromous Habitat Studies(JAHS)	0	0	0	0	9	1	1	0	0	0	0	11
Downstream Migrant Trap	-	0	0	11	93	228	92	40	2	0	-	466
Fishwheel sites	-	-	3	6	33	81	15	137	18	-	-	293[a/]
Total	0	0	17	19	142	328	110	177	23	4	0	820

- = No effort.

[a/] A total of 235 humpback whitefish were captured below the Chulitna River confluence. Yentna Station fishwheels (RM 27.5, TRM 4.0) captured 178 and Sunshine Station fishwheels (RM 79.0) captured 57. Yentna Station humpback whitefish catch by two week periods from early July to early September was 28, 59, 11, 76, and 4, respectively. Catch at Sunshine Station by two week periods from early June to early September was 3, 1, 0, 1, 2, 45, and 5, respectively.

Table 7. Longnose sucker catch on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

Study Group	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15	Aug 16-31	Sept 1-15	Sept 16-30	Oct 1-15	Total
Resident Fish Study Boat Electrofishing	-	3	20	29	37	37	85	0	90	43	5	349
Other Gear	0	26	32	2	19	4	0	0	3	1	6	93
Juvenile Anadromous Habitat Studies(JAHS)	1	6	2	8	14	11	26	29	21	4	0	122[1]
Downstream Migrant Trap	-	3	30	6	10	14	11	35	2	0	-	111
Fishwheel sites	-	-	2	4	11	12	0	7	2	-	-	38
Total	1	38	86	49	91	78	122	71	118	48	11	713

- = No effort

[1] Three fish were captured below the Chulitna River confluence with one being captured in late May and two in early June.

[2] Seventeen fish were captured below the confluence with Yentna station (RM 27.5, TRM 4.0) capturing two in early July, six in late July and one in early September. The remaining nine fish were captured at Sunshine station (RM 79.0) with one being captured in early June, two in early July, one in late July, three in late August, and one in early Septembber.

3.6.2 Movement and migration

During 1983, 467 longnose suckers were tagged with Floy anchor tags and 24 longnose suckers were recaptured. Six longnose suckers were recaptured at their tagging sites and another seven were recaptured less than 5.0 miles from their tagging sites. Six tagged longnose suckers moved downriver (5.0 to 47.6 miles) and five moving upriver (5.0 to 36.9 miles). The average movement of the 11 fish which moved over 5.0 miles was 18.5 miles.

The most rapid movement recorded for a tagged longnose sucker was 25.5 miles over a period of 15 days. This longnose sucker was tagged on June 6 at Slough 6A (RM 112.3) and recaptured on June 21 at mainstem RM 137.8.

3.7 Other Species

3.7.1 Dolly Varden

A total of 47 Dolly Varden were captured in the Susitna River in 1983. Most (89%) of these were captured in the Susitna River between the Chulitna River confluence and Devil Canyon. The largest Dolly Varden catches in this reach of river were made at the mouth of Portage Creek (30%) and at the mouth of Indian River (19%).

During 1983, 12 Dolly Varden were tagged and two were recaptured. One fish was recaptured at Kashwitna River (RM 61.0) and the other recaptured at Clear Creek, a tributary of the Talkeetna River (RM 97.0, TRM 6.0). Both fish had moved upriver (2.5 miles and 10.0 miles, respectively) from their tagging site.

3.7.2 Threespine stickleback

A total of 1,834 threespine stickleback (*Gasterosterus aculeatus* Linnaeus) were captured in 1983. Downstream migrant traps at RM 103.0 captured 1,601 and the remaining fish were captured incidentally by JAHS crews with beach seines or backpack electroshockers. Among the JAHS sampling sites threespine stickleback were most abundant at Slough 5 (RM 107.6). Most threespine stickleback young of the year were captured in early August.

3.7.3 Arctic lamprey

A total of 69 Arctic lamprey (*Lampetra japonica* Martens) were captured in the Susitna River in 1983. Forty-four were captured by the downstream migrant trap at RM 103.0. Arctic lamprey catches at the downstream migrant traps were highest in late May and late June. The remaining Arctic lamprey were captured with a backpack electroshocker at Chase Creek (RM 106.9) in late August.

4.0 DISCUSSION

4.1 Rainbow Trout

The 1983 studies provided considerable information about the distribution of rainbow trout in the Susitna River between the Chulitna River confluence and Devil Canyon. The deployment of radio tags yielded over 6 months of data on the distribution of rainbow trout and gave new insights into their movement which previously had been hypothesized from catch per unit effort data. In Part 6 of this report, the distribution of this species by macro and microhabitat is described. Although our data is somewhat limited in the early spring, the seasonal distribution of rainbow trout within the Susitna River system is reasonably well documented. The following discussion includes descriptions of what we have learned about the life history of this species and its vulnerability to altered conditions in the mainstem Susitna River. We have also established index areas (Table 1) and have estimated the population size of rainbow trout in one of the tributaries (Fourth of July Creek) important to this species.

Rainbow trout catch rates in 1981 and 1982 in the mainstem Susitna rapidly dropped off after June suggesting movement out of mainstem areas and probably into tributaries. This movement was verified by random sampling of the upper reaches of tributaries during 1983 and reinforced by studies of radio tagged fish during the summer. The highest catches of rainbow trout were recorded in Fourth of July Creek where significant spawning activity was documented. Minnow trap catches of juveniles rainbow trout during 1983 was the highest recorded since the onset of these studies in 1981. Spawning occurred in late May-early June as suggested by the capture of pre- and post-spawned adults and movements into Fourth of July Creek by two radio tagged fish. Movements of radio tagged fish out of this tributary after spawning suggests that at least some of the fish will emigrate from their spawning tributaries to other forage areas.

Random sampling for rainbow trout was conducted during 1983 in most tributaries of the Susitna River between the Chulitna River confluence and Devil Canyon. Fourth of July Creek had the highest concentration of rainbow trout as reflected by the CPUE. These data suggest that adult rainbow trout move into tributaries during the spring to spawn and some of these fish remain in the tributaries throughout the summer.

Examination of the limiting factors during the life cycle of rainbow trout will help evaluate the vulnerability or the enhancement potential of this species under postproject conditions. The comparatively small numbers of juvenile rainbow trout collected, during the three years of this study suggests reproduction could be limiting or survival of juvenile is very low. Our survival data suggests this species shows a relatively high turnover rate compared with other species but not necessarily a younger age of maturity.

Catch rates of juvenile (<200 mm, Age 3) rainbow trout in Indian River and Portage Creek have been very low suggesting poor rearing or low spawning success in these major tributaries (ADF&G 1981c; 1983b). In contrast, the catch of juvenile rainbow trout in Fourth of July Creek in 1983 was the highest recorded since resident fish studies began in 1981. Because so few juvenile rainbow trout have been captured in the mainstem it appears that the juveniles primarily rear in the upper reaches of tributaries and move little.

Radio tagged rainbow trout using the mainstem Susitna for summer rearing were often located near tributary mouths, especially from August through mid-September. The association of rainbow trout with tributaries during this period coincides with the timing of spawning chum and pink salmon (Barrett et al. 1984). The concentration of rainbow trout at tributary mouths and their periodic ascents into tributaries is believed to be due to the abundance of food (salmon eggs) in these areas. Rainbow trout, presumably feeding on salmon eggs, were observed being chased from spawning redds by male chum salmon (Part 6 of this report). The abnormally expanded ventral body cavities of other rainbow trout captured in August and September in both 1982 and 1983 also provide evidence of rainbows foraging on salmon eggs.

In addition to the concentration of rainbow trout at tributaries during summer periods, radio tagged rainbow trout were observed holding in several sloughs [Moose (RM 123.5), A^1 (RM 124.6), 8A (RM 125.3), and 9 (RM 128.3)]. The use of these sloughs by radio tagged rainbow trout in August and September coincided with the presence of spawning chum salmon in these same sloughs (Barrett et al. 1984). Although high turbidities prevented actual observation in most of these instances, it is suspected that these fish were in the sloughs to feed on salmon eggs. This hypothesis is substantiated in one case; one radio tagged rainbow trout was observed in Slough A^1 milling around spawning chum salmon in an area of clear water (Barry Stratton pers. comm.)

Areas of the mainstem Susitna River not influenced by tributaries or sloughs were also used during summer months by radio tagged rainbow trout. The mainstem, however, appears to be more of a migration path between tributaries and sloughs rather than a holding area during the open water season.

By mid-September, all radio tagged rainbow trout in tributaries had descended to the mouths. This movement supports the hypothesis that most adult rainbow trout outmigrate from tributaries during fall to overwinter in the mainstem (ADF&G 1983b). The hypothesis is further supported by the increased catch rate of rainbow trout at tributary mouths in September. Rainbow trout in the middle Susitna River are vulnerable to sport fishing during these fall outmigrations. Local anglers take advantage of the outmigration at the mouth of Indian River (RM 138.6) each fall. As the Susitna River basin continues to develop, the rainbow trout population may decline from the increased fishing pressure.

Beginning in October, radio tagged rainbow trout began to move away from tributary mouths into the mainstem Susitna River. By early December only six of 20 radio tagged rainbow trout were within the influence of a tributary. Because of the difficulty of characterizing winter habitat, we are uncertain why radio tagged rainbow trout seek mainstem areas in the winter.

The recaptures of six Floy anchor tagged rainbow trout at Clear Creek in the Talkeetna River drainage suggests that this tributary may be an important summer rearing area for adult rainbow trout. Tag deployment data indicated that these rainbow trout also overwinter in the mainstem Susitna River between RM 77.0 and RM 87.0.

The final activity pursued during the 1983 studies was the establishment of index areas to monitor annual changes in the populations of rainbow trout and other species. Population (density) estimates were planned for five sites but were found to be unfeasible because of low capture rates. Only the lower reach of Fourth of July Creek had sufficient numbers of rainbow trout recaptures to generate a population estimate (107 fish greater that 150 mm FL.). A discussion of the methodological problems of estimating population sizes for resident fish in this system and other areas are included in Appendix D. Catch per unit effort data will probably have to suffice as an estimator of site specific densities of resident species. An examination of the annual recovery of tagged fish as a percentage of tags deployed provides a more robust perspective of the population of rainbow trout in this reach. A true "population" estimate cannot be made from this data because of lack of randomness of the sample over the entire reach, mortality between years, emigration, etc. Nevertheless, our tagging efforts have been broadly distributed in habitats associated with the mainstem Susitna in this reach. The movements of radio tagged fish also suggests that our samples include fish from throughout the basin rather than representing only the specific locale where they were collected. Of 92 rainbow trout tags deployed in this reach in 1981, only seven out of 221 rainbow trout captured in 1982 were tagged recaptures from fish tagged in 1981. If no mortality or recruitment were considered, this would provide an estimate of about 2,581 rainbow trout. Using 1982 and 1983 data the population estimate for rainbow trout (5,057) is low.[2/] However, our mortality estimate for rainbow trout suggests high mortality of the post-spawning fish, which when coupled with recruitment would substantially reduce this estimate, probably by over half. This must be tempered with the non-randomness of the sampling effort, which probably eliminated significant portions of the population from sampling effort and decreased the estimate.

2/ In 1983, 10 out of 365 rainbow trout (> 200 mm) recaptures were tagged in 1982. A total of 151 rainbow trout were tagged on the Susitna River in 1982 between the Chulitna River confluence and Devil Canyon. The population estimate equation used was:

$$N = \frac{(X+1)(Y+1)}{(Z+1)}$$

where

N = Population estimate
X = Number of fish tagged in preceding year
Y = Number of fish tagged in current year
Z = Number of recaptures made in current year from fish tagged in preceding year

This order of magnitude estimate provides an approximation of the extent of the resource at stake in this basin and can be used as a starting point to assess potential management concerns if increased sport fishing pressure follows development of the hydroelectric project.

Current data indicates that rainbow trout in the Susitna River between the Chulitna River confluence and Devil Canyon use three primary tributaries for spawning [Whiskers Creek (RM 101.4), Lane Creek (RM 113.6) and Fourth of July Creek (RM 131.1)]. It is not known why only a few rainbow trout spawn in the larger Indian River (RM 138.6) and Portage Creek (RM 148.8) except that these rivers are close to the northernmost range of the species. With a better knowledge of rainbow trout spawning or rearing limitations in these two systems, possible enhancement of habitat within these tributaries could be made to increase rainbow trout populations.

While few rainbow trout have been captured during the springs of 1981 to 1983, data shows that spawning primarily occurs between late May to mid-June and that both sexes spawn after Age 5+.

The occurrence of so few juvenile rainbow trout ($<$ 100 fish captured or observed) in the mainstem or at tributary mouths suggests that spawning probably occurs in the upper reaches of tributaries. The low numbers of juveniles found in mainstem areas further implies that primary rearing of juvenile rainbow trout occurs in the upper reaches of tributaries.

Catch data from the upper reaches of three tributaries [Fourth of July Creek (RM 131.1, TRM 0.0-2.3), Indian River (RM 138.6, TRM 0.0-14.0) and Portage Creek (RM 148.8, TRM 0.0-10.0)] indicates a higher incidence of rainbow trout spawning in Fourth of July Creek than in the other two tributaries.

A further indication of the importance of Fourth of July Creek to rainbow trout spawning was made by examining the movements of two radio tagged rainbow trout captured and tagged in mid-May 1983 at the mouth of Fourth of July Creek. After their release, both fish migrated to the upper reaches of the tributary between TRM 1.0 and TRM 1.5. The radio tagged rainbow trout were prevented from moving upstream beyond TRM 1.8 by an apparent fish barrier; two waterfalls (2.1 and 3.9 meters high respectively) that are located back-to-back in the main channel with no plunge pool between them. No juvenile or adult resident fish or salmon were observed or captured above this barrier. Presumably both of these rainbow trout spawned between TRM's 1.0 and 1.5 in early June. After spawning, one of these fish dropped out of Fourth of July Creek and moved upriver into Indian River between late June and mid-July for summer rearing.

With habitat enhancement, Fourth of July could potentially become a greater producer of rainbow trout. While there are numerous pools for juvenile rearing in Fourth of July Creek from TRM's 0.6-1.8, there are few areas that appear to have suitable spawning gravel. Suitable spawning habitat does exist, however, above the barrier. Therefore a potential mitigation measures to enhance rainbow trout in the Susitna River between the Chulitna River confluence and Devil Canyon would be to remove the fish barrier at TRM 1.8 and allow rainbow trout to migrate further upstream and utilize the abundance of spawning gravel which exists there.

Rainbow trout growth and length data also suggest that reproduction is the major limiting factor to rainbow trout populations in the Susitna River. Age-length data taken during 1981-83 show rainbow trout are fast growers over all age classes (ADF&G 1981c; 1983b) Growth of Susitna stocks have been found to be similar to other nothern populations (ADF&G 1983f). Although Susitna rainbow trout are relative fast growers, they appear to have a short life span. Since 1981, the largest and oldest rainbow trout captured was 612 mm in fork length and nine years old. Using data from fish captured by hook and line and boat electrofishing, the survival rate for rainbow trout in the Susitna River was found to be only 33.3%. Reasons for the low survival rate are not known, however, hatchery personnel at Elmendorf report that mortalities of post-spawning male and female rainbow trout are exceedingly high, as do Scott and Grossman (1973). This may also be due to low egg and juvenile survival. In addition, another possible reason for the low survival rate of rainbow trout may be high overwintering mortalities. High winter mortalities of rainbow trout are most likely to result from physical catastrophes such as dewatering, collapsed snow banks, and anchor ice formation (Needham and Jones 1959; Needham and Slater 1945). Reimer (1957) found that physical catastrophes caused more mortalities than the lack of food availability.

4.2 Burbot

Burbot occupy the turbid waters of the mainstem Susitna and apparently rear and spawn in reaches directly influenced by mainstem flow. In the Susitna River, this species appears to avoid clear water areas although it is found over a broad range of conditions in other areas. Because of winter effects of regulated flow on water temperature and the potential for clearing of the mainstem Susitna, this species has a relatively high potential to be adversely affected by habitat alterations although increases in prey species may be a net benefit. Because alternative modes of operation of the project will probably influence turbidity levels appreciably, and the behavioral response to turbidity changes is the most likely effect on this species, we have focused our studies on monitoring this species to determine the extent of the resource at risk. The presence of juveniles in this reach suggests spawning occurs in this area but our efforts at data collection during the spawning season in January have not been sufficient to locate specific spawning sites. The spawning does not appear to be as important or concentrated as in major spawning areas in the lower river, such as the mouth of the Deshka River.

Burbot catches between 1981 and 1983 indicate that burbot seem to prefer mainstem sites or slough mouths rather than tributary mouths or tributaries in the Chulitna River confluence to Devil Canyon reach. In this reach, burbot are found more often in backwater areas, however they have also been captured in fast, shallow water.

Burbot movements in the Susitna River occur primarily before and after their spawning period in late January. Data collected during three years (1981-83) of monitoring 20 radio tagged fish show that instream migrations begin in September and last until March (ADF&G 1983b; 1983e). While most of the radio tagged burbot moved little during the spawning period, some have moved over ten miles with one moving 113.6 miles in 1982-83. This movement has been discussed previously in the 1982-83 winter report and fish tagged in 1983 show similar behavior (ADF&G 1983e). Although most movement information for burbot to date has been from fish radio tagged during the fall, one fish was monitored throughout the summer in 1983. This burbot (610-3.0) moved only 3.6 miles from its tagging site between July 19 to October 21 (Figure 6).

It appears that there is an adequate food supply for burbot in the mainstem Susitna during the summer. During 1982 and 1983, electrofishing crews captured few burbot near spawning salmon compared to other resident fish species. Although necropsied burbot have been found with salmon eggs in their stomachs, Morrow (1980) states that burbot are an omnivorous carnivore with a strong preference for fish.

A burbot population estimate study conducted in a one-mile reach of the mainstem estimated a population of 15 burbot. Because no recaptures were made, the confidence in this value is very limited. Although the removal method used in the estimate is quite robust, the low probability of capture makes the methodology somewhat suspect. A very high trap avoidance appears to be a characteristic of this species. This aspect of burbot behavior also limits the value of interpreting our annual tag recoveries with respect to population estimates of the entire reach. The very small percentage of tags deployed that were recovered suggest either high avoidance to recapture, high mortality of tagging, or very large populations. Monitoring changes in population by catch per unit effort appear to be the most reliable method for long term study of this species.

Catch data from 1981-83 shows few adult burbot captured in the Susitna River above the Chulitna River confluence compared to below the confluence (ADF&G 1981c, 1983b). In addition, relatively few juvenile burbot have been captured in the reach above the Chulitna River confluence. This leads us to believe that few burbot spawn in the Susitna River between the Chulitna River confluence and Devil Canyon. During intensive sampling by Juvenile Anadromous Habitat Studies (JAHS) in 1983 at 35 sites above the confluence, only 18 juvenile burbot were captured by beach seining or by backpack electroshocking. Catch data from the downstream migrant traps at RM 103.0 in 1982 (70 juvenile burbot) and 1983 (22 juvenile burbot) also supports the hypothesis that little spawning occurs above the confluence.

The exact spawning locations and numbers of burbot spawners in the reach above the Chulitna River confluence is not known. It is speculated that burbot spawning in this reach occurs primarily at the mouths of sloughs and in deep backwater areas influenced by ground water. Support for this theory are the juveniles found at Slough 9 in 1982, and the high numbers of adult fish found in deep backwater areas compared to other types of habitat. In addition, prior winter studies on the Susitna below the confluence suggest that spawning and rearing burbot seek areas of upwelling. This behavior could apply to areas above the confluence as well (ADF&G 1983e).

Age-length data for burbot captured between 1981 and 1983 show that Susitna River burbot grow rapidly up through Age 4 and then their growth rate slows to approximately 40 mm a year (ADF&G 1983e). To date, the oldest resident fish captured in the Susitna River was an Age 15 burbot.

Pooled age-length data from burbot captured between 1981 and 1983 showed that the survival rate is relatively high (70.5%). To pool the data in determining the instantaneous survival rate, we assumed that the survival rate was constant between years sampled. Since burbot live long and the mainstem where they reside is relatively stable between years, we believe the assumption was met.

Morrow (1980) states that burbot have a high reproductive capacity and their survival rate is quite high. Therefore the limiting factor for the burbot population in the Susitna River between the Chulitna River confluence and Devil Canyon may be the amount of acceptable habitat for spawning or rearing, or lack of food. Burbot production in this reach may be limited by one or several of these factors. Burbot are less numerous and appear to be slightly smaller for a given age class in this reach of river in comparison to the reach of river downstream of the Chulitna confluence (ADF&G 1981c, 1983b, 1983e). Susitna River burbot appear to grow faster than burbot studied in interior Alaska by Chen (1969). The mean total length of Age 5 burbot in the Susitna River was 453 mm and Chen reported a mean total length of 355 mm for the same age class in interior Alaska.

4.3 Arctic Grayling

Arctic grayling provide local sport fisheries at tributary mouths in this reach of the Susitna. Our data suggest that overwintering in mainstem areas may be of major importance for this species. Summer rearing of Arctic grayling in the mainstem Susitna appears to be limited to younger age class fish, apparently unable to maintain territories in the more favorable habitat of the clear water tributaries. The data we have obtained provides a basis to evaluate the population trends over time and changes in the populations in response to mainstem habitat changes and overwintering conditions.

Six sites which were sampled consistently by boat electrofishing in 1982 and 1983 and produced relatively high numbers of Arctic grayling were Whiskers Creek Slough (RM 101.2), Lane Creek (RM 113.6), Fourth of July Creek (RM 131.1), Indian River (RM 138.6), Jack Long Creek (RM 144.5), and Portage Creek (RM 148.8).

Tag and recapture data support the theory that most Arctic grayling spawn in tributaries. Recoveries of tagged fish in May and early June show movement into tributaries.

Boat electrofishing catch data in 1982 suggests that most of the large Arctic grayling move into tributaries immediately after ice out (ADF&G 1983b). In 1981, adult Arctic grayling were gillnetted in early May at open water tributaries when the mainstem was still partially covered with ice (ADF&G 1981c), indicating that Arctic grayling begin moving prior to the open water sampling. Boat electrofishing data from 1983 support 1981 findings. We did not monitor tributary temperatures which probably influence Arctic grayling movements more than ice cover on the mainstem and may also account for the differences in timing between years. Arctic grayling elsewhere in Alaska begin to migrate as the water temperature increases to about 1°C (Armstrong 1982).

Data from 12 spawning Arctic grayling captured at RM 150.1 in late May 1983 suggest that either mainstem spawning occurs there or that spawning occurs nearby. Since no Arctic grayling recaptures have been made above Devil Canyon (RM 150.1-161.0) from fish tagged below Devil Canyon and no tagged fish have been observed in the tributaries in the canyon [Cheechako Creek (RM 152.5), Chinook Creek (RM 156.8), and Devils Creek (RM 161.0)], it appears unlikely that lower or middle river Arctic grayling spawn above RM 150.1.

Higher CPUE's for Arctic grayling were recorded in late July during 1983 than in past years at the mouths of several tributary sites such as Indian River (RM 138.6) and Jack Long Creek (RM 144.5). We are not certain why this occurred, however, the drought which decreased the water levels in these tributaries during 1983 may have caused some Arctic grayling to move out of the tributaries earlier than in 1982.

Recaptures of Floy anchor tagged Arctic grayling show that a strong spring migration of Arctic grayling occurs in the Susitna River. In the summer, most Arctic grayling have been recaptured at or near their tagging locations. This suggests that Arctic grayling do not move far from their summer rearing areas. The outmigration of adult Arctic grayling from tributaries to the mainstem occur in September. Boat electrofishing CPUE's in 1982 and 1983 increased steadily from late August through late September and then decreased in early October. This suggests that most of the Arctic grayling have moved into the mainstem by the end of September.

Little is known about Arctic grayling distribution during the winter in the Susitna River. It is believed that many Arctic grayling overwinter in the mainstem Susitna, however, specific overwintering areas in the mainstem have not been identified. It is also believed that significant numbers of Arctic grayling overwinter in Portage Creek. This tributary is characterized by many deep (20 feet) pools which may provide adequate overwintering conditions for Arctic grayling. The proportion of the population that uses this habitat is not known.

The survival rate of Arctic grayling between the Chulitna River confluence and Devil Canyon is 56%, which is similar to the population above Devil Canyon. Although few individuals grow past 400 mm fork length or Age 8, there appears to be a high recruitment from the younger age classes, notably Ages 3 and 4.

Since reproduction is relatively high for Arctic grayling, the availability of rearing habitat may be a critical factor for this species (Scott and Crossman 1973). Studies in 1982 indicate that younger fish, Age classes 2 to 4, use the mainstem Susitna to a limited extents, probably due to their displacement from tributaries by the territorial behavior of the larger fish (ADF&G 1983b). Future changes in the availability of rearing habitat may be expected to directly affect the population size of Arctic grayling in the Susitna River.

The congregation of older Arctic grayling (>300mm) at the mouths of only a few selected streams between the Chulitna River confluence and Devil Canyon makes them vulnerable to overfishing. Local residents have stated that fishing for Arctic grayling has deteriorated since 1970 because of increased fishing pressure (Harold Larsen pers. comm.).

4.4 Round Whitefish

The distribution and abundance of round whitefish in the Susitna River between the Chulitna River confluence and Devil Canyon in 1983 was similar to findings in 1981 and 1982.

The catch of round whitefish has increased substantially each year since 1981 because of increased electrofishing efforts and the addition of downstream migrant traps. The deployment of a second downstream migrant trap off the west bank of the Susitna River (RM 103.0) contributed significantly to the increased round whitefish catch in 1983.

Pooled CPUE rates based on boat electrofishing data from 1982 and 1983 showed that CPUE's at tributary or slough sites were much higher than at mainstem sites above the Chulitna River confluence (ADF&G 1983b). During both years sampling efficiency appeared to be the same for mainstem and tributary or slough sites. Although boat electrofishing CPUE's of round whitefish are generally lower at mainstem sites compared to tributary sites, high CPUE's were recorded in the mainstem during June in both 1982 and 1983. Relatively high catch rates in the mainstem were also recorded in September of both years. Pooled boat electrofishing data from 1982 showed higher catch rates of round whitefish at all sites above the Chulitna River confluence than below. We speculated this was due to more preferable habitat in this reach of river. In 1983, mainstem boat electrofishing data pooled into three subreaches (RM 98.5 - 115.5, RM 115.6 - 138.5, and RM 132.6 - 150.1) showed that round whitefish are most abundant in the area between RM 132.6 - RM 150.1 in the Susitna River above the Chulitna River confluence.

Extensive sampling by JAHS crews above the Chulitna River confluence in 1983 showed that juvenile round whitefish are found more frequently at mainstem and slough sites than at tributary sites. Although it is unknown where they hatched, it is probable that round whitefish prefer areas with slow velocities and turbid water for rearing.

Seasonal boat electrofishing CPUE's at tributary sites above the Chulitna River confluence during 1982 were the highest in late June, late August and late September (ADF&G 1983b). It was speculated in 1982 that the high catches during June and September were due to migration of fish into and out of tributaries. A similar trend in movement was observed in the 1983 boat electrofishing CPUE data.

Most of the recaptured round whitefish from 1981-83 showed little movement. During this time, only 26 of 110 recaptured round whitefish moved over 5.0 miles (ADF&G 1981c, 1983b). Round whitefish recaptured in 1981 and 1982 exhibited a pronounced fall movement. In 1983 round whitefish exhibited a general downstream movement throughout the summer.

The longest move documented for a tagged round whitefish was 69.5 miles downriver from its tagging site. This fish was recaptured in 1983 by a sport fisherman at Willow Creek (RM 49.1).

While round whitefish spawning has not been observed in the mainstem, the distribution of sexually ripe males and females captured suggests that spawning probably occurs within mainstem areas. Sexually ripe male and female round whitefish have been found in the mainstem Susitna River during early October in 1981, 1982 and 1983.

Although few sexually ripe round whitefish were captured in 1981 and 1982, over 50 were captured in 1983. This was due to differences in sampling efficiencies rather than variability in timing of spawning. In 1983 extensive boat electrofishing was done in early October, while in 1981 and 1982 mechanical breakdowns of electrofishing equipment limited sampling during this time.

Since 1981, nine locations have been determined to be spawning sites for round whitefish in the mainstem Susitna according to the criterion used to determine a spawning site (female fish able to discharge eggs upon palpation). In 1981 and 1982 spawning was observed at RM 100.8 and RM 102.6, respectively. In 1983 seven sites were found including four mainstem sites (RM 102.0, RM 114.0, RM 142.0 and 147.0) and three tributary mouth sites [Lane Creek (RM 113.6), Indian River (RM 138.6) and Portage Creek (148.8)].

Catch data suggests that round whitefish spawning may occur throughout the mainstem. Sexually mature fish (> 300mm) have been captured during October in locations characterized by slow to moderate water velocities with silt to rubble substrate. Most sexually ripe fish have been captured in pairs or small groups. Mass spawning behavior of round whitefish has been reported elsewhere (Normandeau 1969; Bryan and Kato 1975).

Large schools of adult round whitefish have also been captured at the mouth of Portage Creek and Indian River in late September. This may indicate that some round whitefish use these tributaries to spawn.

While catch data suggests that spawning areas of round whitefish are widespread in the mainstem, the selection of specific spawning sites may not be random. Anchor ice, water fluctuations and ice cover can all limit egg survival. Due to these reasons, round whitefish in the Susitna River may seek out areas which have an adequate influx of ground water. Habitat data taken at one mainstem site (RM 147.0 in 1983), where eight sexually ripe males and females were captured, supports this hypothesis. Specific conductance was relatively high (160 umhos/cm) in this area indicating an area of upwelling. This hypothesis is also believed to be true for another mainstem spawning species in the Susitna River, chum salmon (ADF&G 1983c).

There is probably an upstream spawning run of round whitefish in the fall. Spawning takes place at temperatures slightly above 0°C (Morrow 1980). Many of the juveniles subsequently migrate to the lower river for rearing during their first year as evidenced by the catch rate of juveniles in the downstream migrant traps.

Comparisons of 1981-1983 age-length data for round whitefish shows considerable differences in each age class. Although results are similar between 1981 and 1982, we believe the findings in 1983 are more accurate. Fish were probably underaged in 1981 and 1982. Although positive aging cannot be verified for fish of all three years, comparisons of the annuli of scales from fish initially tagged in 1982, and recaptured in 1983 provided better information on when round whitefish in the Susitna River form their annuli.

Age-length data in 1983 show that round whitefish are one of the older living resident fish species in the lower Susitna River with fish older than Age 8 occurring rather often. The oldest round whitefish found in the Susitna River by our crews was Age 12. Subsamples of aged fish also show that the population appears stable with fish captured frequently over all spawning age classes Age 5 and older.

Most round whitefish in the Susitna River have rather slow growth rates. This slow growth begins at Age 3, decreases steadily thereafter, and becomes almost non-existent after Age 10. Few round whitefish in the Susitna River attain fork lengths greater than 390 mm. However, scale analysis showed four fish experienced periods of extremely rapid growth. For example, one fish aged at four years old was 265 mm fork length while the mean fork length of 33 aged fish was 187 mm and the 95 percent confidence intervals ranged from 141-233 mm. This fish showed extremely rapid growth during the first and second years of its life. Based on recapture data and reports of round whitefish being found in brackish water (McAllister 1964; Morin et al. 1982) we believe that this fish may have migrated from the estuary. Tag-and-recapture data from 1981 to 1983 show that some round whitefish migrate long distances in the Susitna River.

4.5 Humpback Whitefish

Humpback whitefish have been found in the Susitna River from RM 10.1 to RM 150.1, however, they are captured infrequently except during certain time periods (ADF&G 1981c; 1983b). Sampling in 1981 and 1982 in the reach of river below and above the Chulitna River confluence (RM 98.5) further showed that humpback whitefish were more numerous in the reach of river below the Chulitna River confluence than above.

Although boat electrofishing in 1983 was limited to sampling above the confluence, the data show a similar humpback whitefish distribution and abundance in this reach of river as in prior years. Pooled boat electrofishing CPUE data in 1982 and 1983 reveal generally higher humpback whitefish densities at tributary or slough sites than at mainstem sites (ADF&G 1983b).

Fishwheel catches in 1982 and 1983 indicate similar yearly distributions and abundance of adult humpback whitefish. Peak catches at fishwheels during both years were in late August with 148 and 137 fish captured in 1982 and 1983 respectively.

Few juvenile humpback whitefish have been captured from 1981 to 1983 except by the downstream migrant traps (RM 103.0). It is currently unknown where most young juvenile humpback whitefish rear.

Morrow (1980) reports that adult humpback whitefish move little except during the spawning run beginning in June and lasting throughout September. In the Susitna River, fishwheel catches in 1982 and 1983 also reveal a spawning run occurs during this time period. Catches during both years peaked at Yentna (RM 28.5, TRM 4.0) and Sunshine (RM 79.0) in late August (ADF&G 1983b). High catches were also recorded at Talkeetna (RM 103.0) and at Curry (RM 120.0) in late August or early September. Fishwheel catch data recorded at Sunshine in 1981 reflect a similar a mid-September peak in catch (ADF&G 1981c). Susitan River humpback whitefish spawning is presumed to occur in October in tributaries.

Tag-recapture data on humpback whitefish is limited but seems to indicate a spawning or overwintering movement. Three fish tagged in September 1981 were recaptured in May or early July 1982, presumably before they migrated again in fall 1982. Since these fish were recaptured long distances (16-38 miles) downriver, it is thought that these fish were originally tagged during their upstream migration in September. After spawning, they returned downriver to overwinter where they were recaptured in 1982. In addition, two fish tagged and recovered in 1983 also show an upstream movement. One fish moved 11.0 miles from late June to mid-August, while another moved 17.0 miles in two days in mid-July, possibly an early spawning movement.

While little is known of juvenile humpback whitefish distribution and movement, downstream migrant trap catches in 1983 suggest that there is a downstream movement of juvenile humpback whitefish during late July. Nearly all of these fish were young of the year.

Comparisons of mean lengths of humpback whitefish by age class between 1981, 1982, and 1983 shows little differences. However, comparisons of humpback whitefish age-length data by reach indicate that fish below the Chulitna River confluence appear to be larger than fish between the Chulitna confluence and Devil Canyon (ADF&G 1981c; 1983b).

Scale analyses indicated that some humpback whitefish undergo a period of very rapid growth during their first two years of life. The data suggest that some humpback whitefish may spend part of their life history rearing in an estuarian environment. Elsewhere in Alaska, ADF&G (unpublished), Alt (1979) and Berg (1948), report that *C. pidschian* does not venture into estuary zones as often as other species of the humpback whitefish complex.

4.6 Longnose Sucker

Longnose suckers occur throughout the Susitna River below Devil Canyon, however, they appear to be more abundant in the reach of river below the Chulitna River confluence (RM 98.5) (ADF&G 1981c; 1983b). Boat electrofishing catches in 1982 and 1983 were higher at tributary and slough sites than at mainstem sites. Boat electrofishing data in both years showed higher CPUE's at tributary and slough sites above the confluence in August and September than in June or July. Longnose suckers may move into tributary and slough sites in August and September to feed on salmon eggs.

Recapture data indicate that adult longnose suckers are relatively sedentary. Thirty-two of 45 longnose suckers recaptured from 1981 to 1983 did not move over 5.0 miles from their tagging locations (ADF&G 1981c; 1983b).

Movements of the remaining 13 recaptured longnose suckers suggest an upstream migration occurs in the spring and a downstream movement occurs in the fall to overwintering areas.

Catch per unit effort data also support the hypothesis that there is a spring and fall movement. Boat electrofishing catch rates at sites sampled above the Chulitna River confluence progressively increased in the spring and the fall in 1982 and 1983 (ADF&G 1983b).

Inferences of population dynamics for longnose suckers aged between 1981 and 1983 are difficult due to problems with aging this species accurately by scale analysis. While longnose sucker age data from 1983 is similar to 1981 data up to Age 7, results from 1982 are similar to 1983 data only up to Age 3 and to 1981 data only after Age 6. Bond (1972) found that he could accurately determine the ages of a closely related species of sucker (white sucker, *C. commersoni*) by scale analysis up to Age 9. However, since the mean lengths of several longnose sucker age classes from our data vary considerably from year to year, we believe that scale analysis is not an accurate technique for aging longnose suckers on the Susitna River.

Another indication of the problem relating to age determination of longnose suckers was provided by examining scales from two recaptured fish one year later. One of the recaptured longnose suckers was accurately aged for both years and the other was misaged both years. By comparing scales from the two years, no new annulus was formed on the 1983 scale. Other studies of longnose suckers show similar results in regard to the failure of tagged fish to form an annulus (Geen et al. 1966). Bucholz and Carlander (1963) suggest that when there is little or no growth, fish do not forming a scale annulus. Evidently, this is prevalent among longnose suckers in the Susitna River.

Several authors suggest alternate methods to age suckers. Beamish and Harvey (1969) found that by using cross sections of pectoral fin rays they were able to age older fish. Quinn and Rose (1982) found that aging by pectoral fin rays for slower growing populations of suckers this method was reliable only up to Age 7 suckers. They further imply that otoliths are the best method to age older suckers.

While it is difficult to characterize the oldest age classes of Susitna River longnose suckers, it appears that above the Chulitna River confluence annual growth increments decline steadily after Age 5 (ADF&G 1981c, 1983b). Age-length data from longnose suckers captured in the Susitna River below the Chulitna River confluence in 1981 and 1982 indicate that fish continue to grow steadily after Age 5. Catch data from these two years also show a higher frequency of larger fish being caught below the Chulitna confluence. This is probably due to more favorable habitat conditions in this reach which allows for more growth.

4.7 Other Species

4.7.1 Dolly Varden

Dolly Varden occur throughout the Susitna River drainage, however, extremely low catches have been made from 1981 to 1983. The most productive areas are the Kashwitna River (RM 61.0), Lane Creek (RM 113.6), Indian River (RM 138.6), and Portage Creek (RM 148.8).

Catch data from 1982 show that Dolly Varden move out of the mainstem and into tributaries by late June (ADF&G 1983b). After June, catch rates at all sites influenced by the mainstem river stayed low all summer in 1982 and 1983. It is thought that Dolly Varden rear in the upper reaches of tributaries until fall and then migrate back into the mainstem to overwinter. Although it is not known when the exact timing of the fall outmigration occurs, anglers at the mouth of the Talkeetna River and Kashwitna River report high catches after mid-September (S. Kreuger and R. Bloomfield pers. comm.).

Tag-recapture data from a small number of Dolly Varden recovered in 1982 and 1983 show an upstream spring movement as well as a summer movement (ADF&G 1983b). In 1982 it was speculated this may be due to a spawning movement.

Two out of nine Dolly Varden recaptured between 1981 and 1983 were recovered in Clear Creek, suggesting that this tributary creek may be an important producer of Dolly Varden in the lower Susitna River.

4.7.2 Threespine stickleback

Distribution and abundance of threespine stickleback appears to be variable in the Susitna River. In 1981 sticklebacks were found upstream as far as RM 146.9, in 1982 they were found upriver only to RM 101.2, and in 1983 upriver to RM 112.3 (ADF&G 1981c; 1983b). A comparison of catches at several sites sampled all three years suggest that catches peaked in 1981 and increased again in 1983. While over 2,000 threespine sticklebacks were captured at Slough 6A in 1981, none were captured in 1982 and 77 were caught in 1983.

Capture data in 1981 and 1982 suggest an upstream migration begins to occur during late May (ADF&G 1981c; 1983b). This movement is presumed to originate from the estuary as a spawning migration.

Downstream migrant trap data suggest that threespine stickleback outmigrate in the summer following emergence. Thirty-two age 0+ (under 40 mm) threespine stickleback were captured in 1982 by a downstream migrant trap, while approximately 1,406 of 1,601 threespine stickleback captured by these traps in 1983 were age 0+.

The catch in 1982 was lower than in 1983 probably due to a smaller spawning population in 1982. Morrow (1980) also reports that after hatching, young of the year threespine stickleback immediately move downstream to brackish water.

4.7.3 Arctic lamprey

Arctic lamprey are believed to be abundant in the Susitna River below RM 50.5 and decrease in abundance above this river mile (ADF&G 1983b). Most Arctic lampreys have been captured at the mouths of small tributaries such as Chase Creek (ADF&G 1981c; 1983b). Arctic lamprey distribution and abundance data from 1983 was similar to 1981 and 1982 for the reach of river above the Chulitna River confluence (RM 98.5). Less than 100 Arctic lamprey have been captured each year.

5.0 CONTRIBUTORS

Data was collected by Richard Sundet and Mark Wenger with help from Kathrin Zosel.

Dana Schmidt provided the study design. Steve Hale assisted with running the CAPTURE program.

Data processing was done by Allen Bingham, Gail Heineman, Donna Buchholz, Carol Kerkvliet, Kathrin Zosel, and Alice Freeman.

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APPENDIX A

Gear Efficiency and Selectivity and Tag Retention

INTRODUCTION

Between August 9 and October 7, 1983, the responses of 13 radio tagged fish (12 rainbow trout and one burbot) to boat motors, electrofishing, and the generator in the electrofishing boat were observed.

METHODS

Gear efficiency

Boat electrofishing efficiency was analyzed by reviewing field notes concerning observed effects of electroshocking on radio tagged fish.

Several radio tagged fish were also tested to observe their responses to other noises associated with boat electrofishing such as boat motors and the electric generator which powers the electrofishing unit.

Gear selectivity

Gear selectivity of the different gear types was evaluated by examining length frequency distributions by gear type.

Tag retention efficiency

The external Floy anchor tag (model FD-67) has been used to tag resident fish since January 1981 to determine seasonal and yearly movements. The dimensions of the tag and tagging procedure are explained in the 1981 procedures manual (ADF&G 1981c). Disc dangler tags were used to tag burbot for several months during 1981 and spring 1982.

The efficiency of the Floy anchor tag was evaluated for Arctic grayling and round whitefish by comparing the number of fish with tag scars to the total number of fish with tag scars and Floy anchor tags of that species recaptured in 1983. By subtracting this ratio from 1.00, Floy anchor tag retention efficiencies were determined. Tag retention efficiencies for rainbow trout and longnose suckers were not determined because the smaller scales on these species regenerate rapidly and make it difficult to detect tag scars.

RESULTS

Gear efficiency - Response of radio tagged fish to boat electrofishing

During these 13 observations, all radio tracking was conducted by the electrofishing boat.

Two of the rainbow trout and one burbot were recaptured and the others fled from the sound of the boat or generator, or the electric field and avoided capture.

Rainbow trout (659-2.0) and burbot (639-3) were accidentally recaptured during routine sampling. Rainbow trout (628-2.0) had moved 10.9 miles downriver in 20 days and it appeared healthy when it was recaptured, but it was late presumed to have died due to tagging injuries. The remaining ten radio tagged fish moved away from the electrofishing boat during the experiment. The location of each fish was pinpointed before and after each experiment to observe their behavior.

Six fish moved away from the sampling area when electrofishing occurred in their vicinities. Three of these fish (rainbow trout 718-1.5, 738-1.4 and 748-1.6) were located at the mouth of Fourth of July Creek (RM 131.1) on August 14. After 20.0 minutes of electrofishing at the mouth of the creek the tagged fish all moved out of the area. Rainbow trout (718-1.5) was relocated 0.6 miles downriver on the opposite bank of the Susitna River. Rainbow trout (738-1.4) moved 200 yards into a side channel. Rainbow trout (748-1.6) moved 150 feet downriver and into the main channel of the Susitna. All three returned to the mouth later that day. Rainbow trout (639-1.4) was located at Moose Slough (RM 123.5) on August 14. After electrofishing the area for 19.0 minutes, the fish was relocated 20 feet from its original location in a deeper section (10 feet) of the slough. Another rainbow trout (670-1.4) was located at the mouth of Whiskers Creek Slough (RM 101.2) on October 7. This area was shocked for 12 minutes and the tagged fish was not captured. After shocking, the fish was found to have moved 20 feet into the main channel. The remaining rainbow trout (660-3) was located at the mouth of Portage Creek (RM 148.8) on September 19. This area was shocked for 26.5 minutes. This fish was seen moving in 3.5 feet of water away from the electric probe. After electrofishing, this fish was found approximately 20 feet from its previous location in deeper water.

At all sites where these six radio tagged fish were located, other non-radio tagged fish were captured during electrofishing.

On September 17 three fish were tested for responses to the sound of the boat's electrofishing generator. These fish (rainbow trout 597-1.3, 709-1.5 and 768-1.5) were located next to the bank of the mainstem river within 100 yards of each other at RM 114.3.

After locating the fish, the boat was positioned approximately 10 feet away from each fish and the generator was started. All three fish moved 100-200 feet downriver after the generator was started. This was done twice for each fish and the response was the same each time.

Ten fish were tested to observe their responses to the boat's motor. The ten fish included the six which fled during electrofishing (rainbow trout 718-1.5, 738-1.4, 748-1.6, 639-1.4, 670-1.4, and 660-3), the three that fled during the operation of the generator (rainbow trout 597-1.3, 709-1.5 and 768-1.5), and one other fish (rainbow 649-1.2). All but one fish (649-1.2) remained in the same area when the boat was near them. The estimated distance between the boat and each fish was from 10-30 feet.

Rainbow trout (649-1.2) was located at the mouth of Indian River (RM 138.6) on September 19. While moving towards the fish and monitoring at the same time, the fish moved across the river (200 yards). After locating and moving towards the fish on the opposite side, the fish returned to the mouth. The closest distance the boat came to the fish was estimated at 100 feet.

Gear Selectivity

Rainbow trout

Rainbow trout were captured by nine of the 11 sampling techniques used during the 1983 resident fish studies. The length frequencies of the rainbow trout captured by the four methods accounting for 95% of the total catch are shown in Appendix Figure A-1. Hook and line and boat electrofishing techniques sampled a wide range of lengths (89 - 612 mm), while minnow and migrant traps captured only juvenile fish (30 -191 mm).

Burbot

Burbot were captured by seven of the 11 sampling techniques used during the 1983 resident fish studies. Ninety-three percent of all the burbot caught were captured by the four techniques shown in Appendix Figure A-2. Boat electrofishing sampled the widest range of lengths (107 - 751 mm), while the migrant trap collected only juvenile fish (26 - 134 mm).

Arctic grayling

Arctic were captured by five of the 11 sampling techniques used during the 1983 resident fish studies. Boat electrofishing accounted for 90% of the total Arctic grayling catch. The five techniques which captured Arctic grayling are shown in Appendix Figure A-3. Boat electrofishing sampled the widest range of lengths (97 - 444 mm) and the smolt trap, with the exception of a few incidental adult catches, only sampled the juveniles (36 - 175 mm). The other methods only sampled the fish between 200 and 400 mm.

Round whitefish

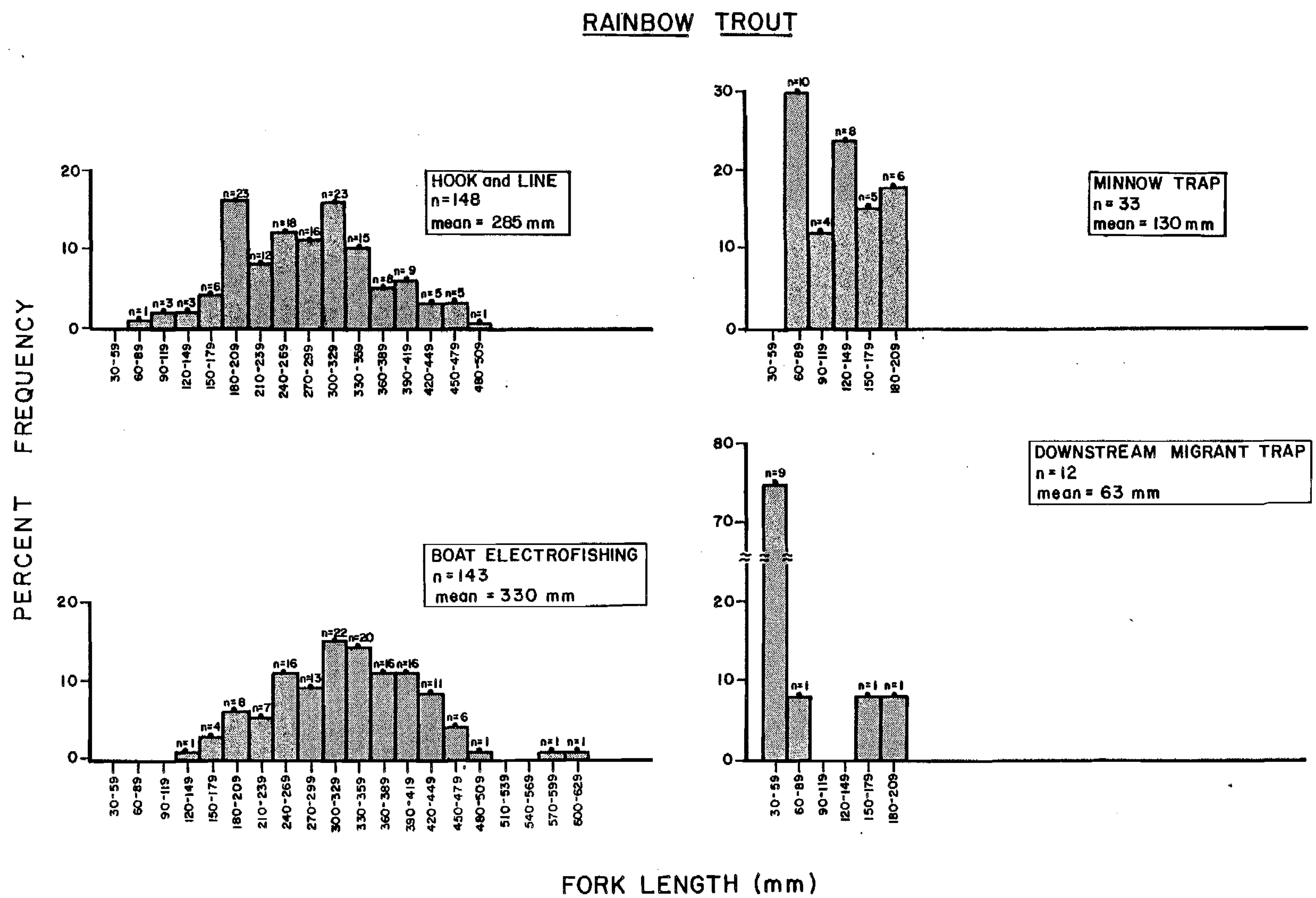
Round whitefish were captured by five of the 11 sampling techniques used during the 1983 resident fish studies. The length frequencies of the round whitefish captured by the four major methods (hook and line captured only one fish) are shown in Appendix Figure A-4. Boat electrofishing and the migrant traps accounted for 98% of the total catch. Boat electrofishing sampled a wide range of lengths (94 -403mm) while the migrant trap captured mainly juveniles (23 - 208mm).

Humpback whitefish

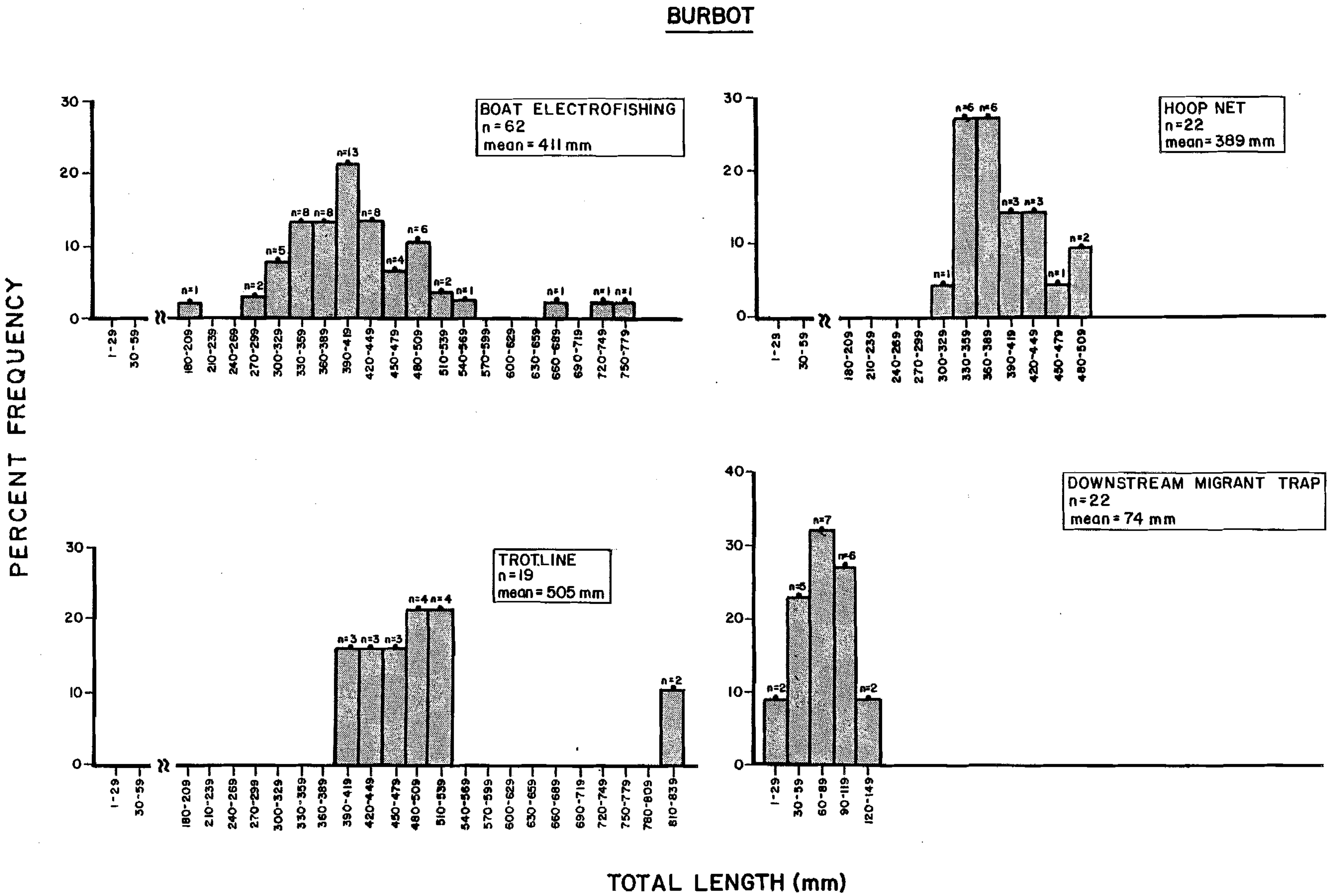
Humpback whitefish were captured by four of the 11 sampling techniques used during the 1983 resident fish studies. The length frequencies of the humpback whitefish captured by these four methods are shown in Appendix Figure A-5. The migrant traps accounted for 77% of the total catch, most being juvenile (30 - 145mm). The other methods were selective for fish between 140 and 480mm.

Longnose sucker

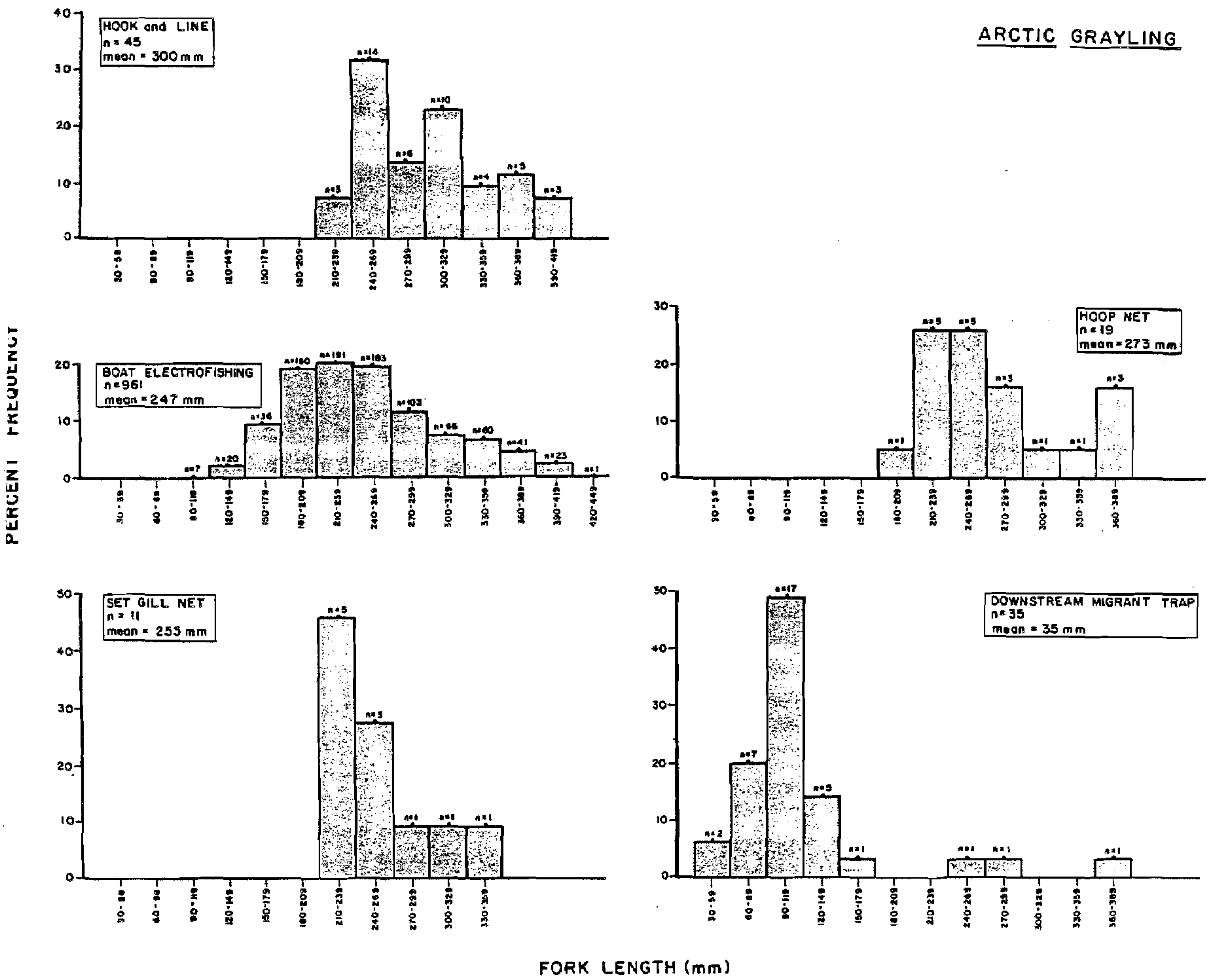
Longnose sucker were captured by five of the 11 sampling techniques used during the 1983 resident fish studies. The length frequencies of the



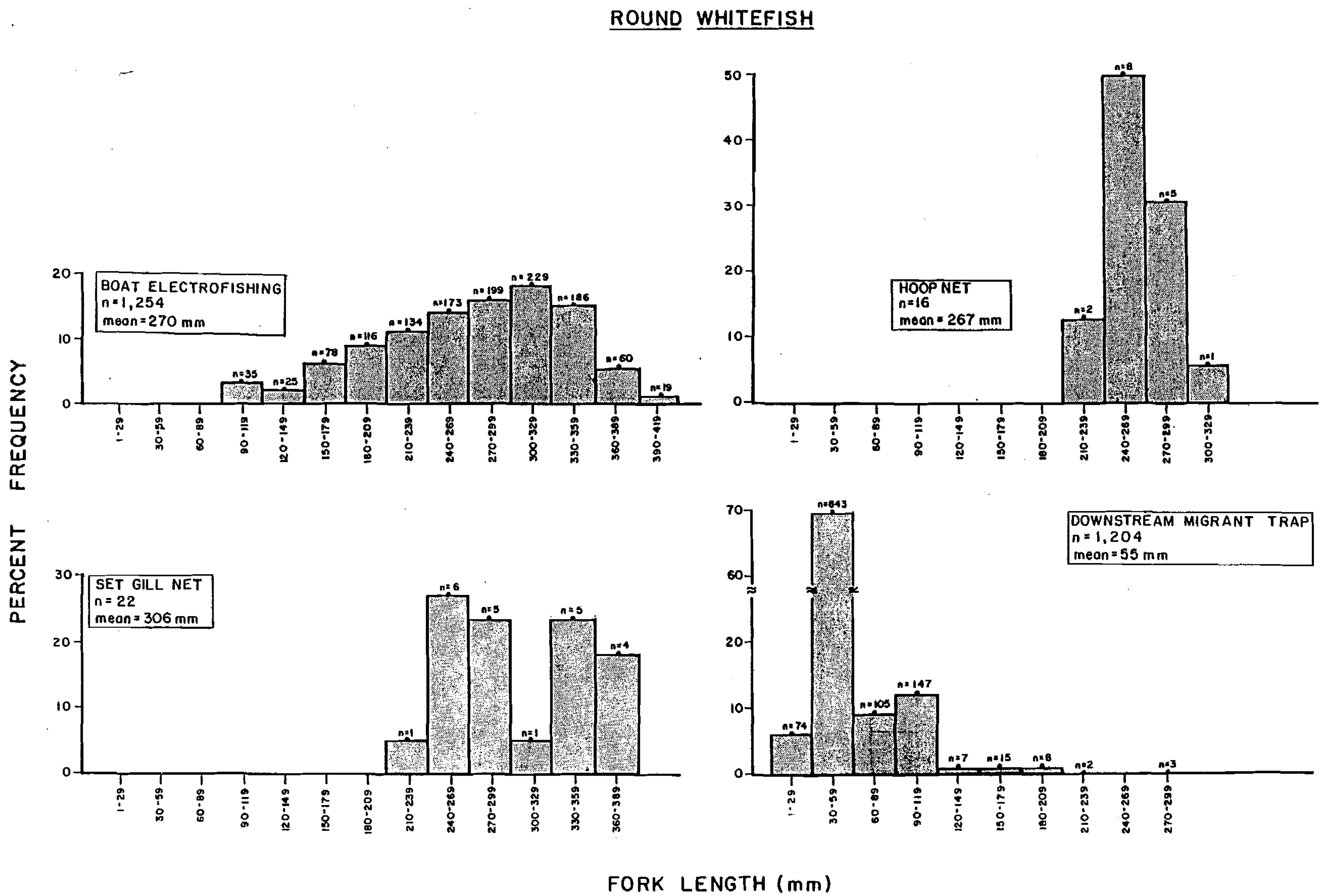
Appendix Figure A-1. Gear selectivity for rainbow trout in the Susitna River, May through October 1983.



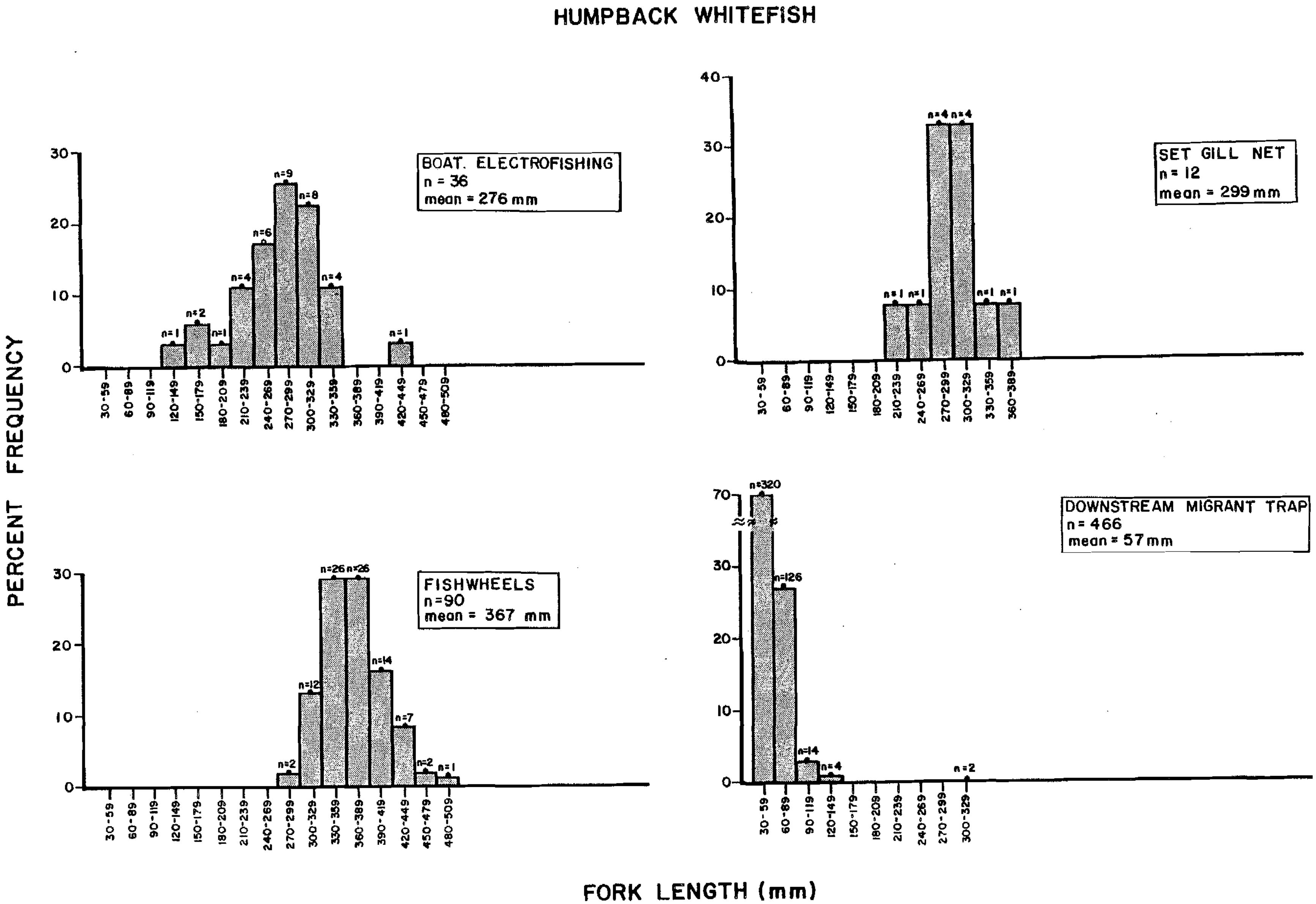
Appendix Figure A-2. Gear selectivity for burbot in the Susitna River, May through October 1983.



Appendix Figure A-3. Gear selectivity for Arctic grayling in the Susitna River, May through October 1983.



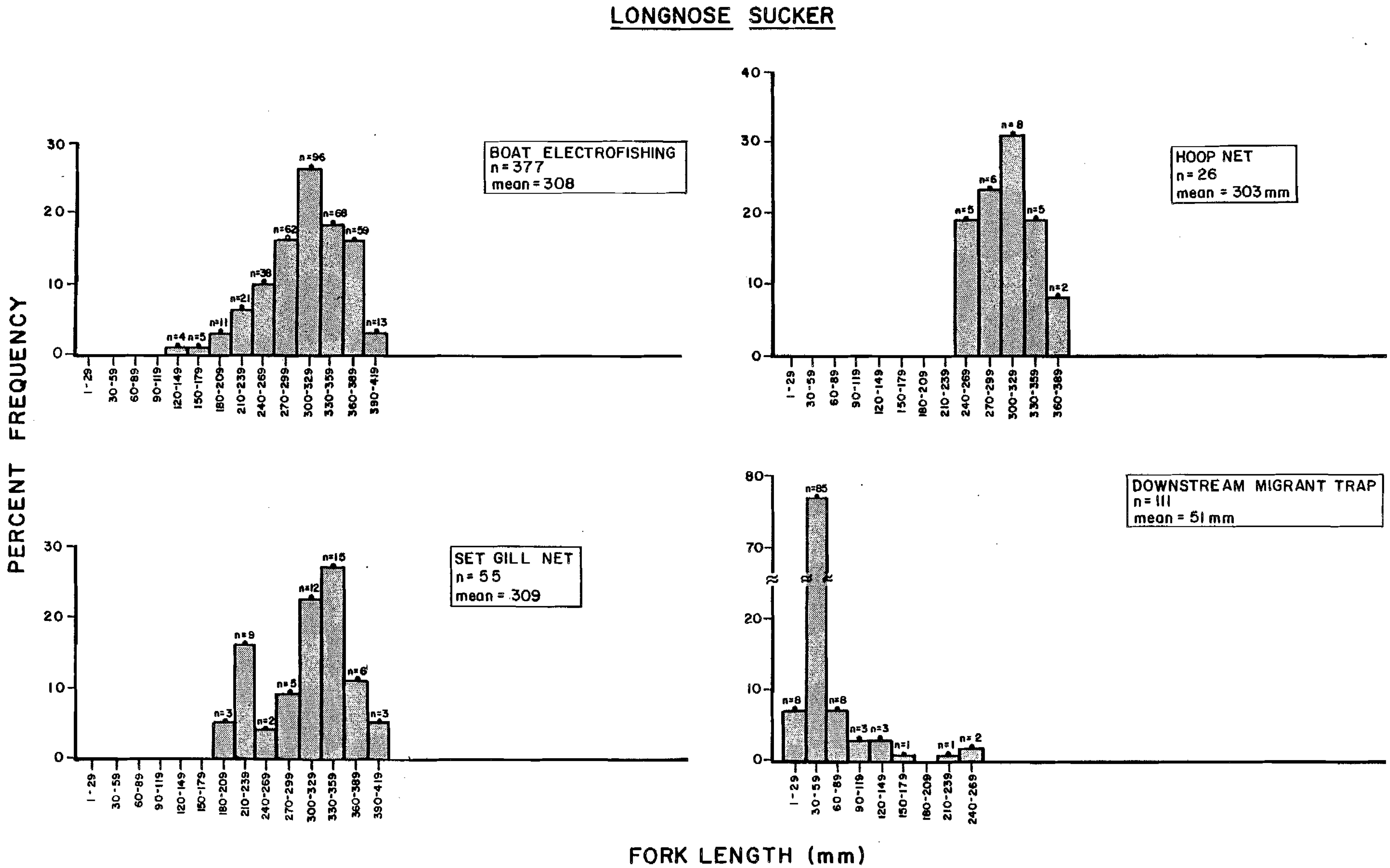
Appendix Figure A-4. Gear selectivity for round whitefish in the Susitna River, May through October 1983.



Appendix Figure A-5. Gear selectivity for humpback whitefish in the Susitna River, May through October longnose suckers captured by these four major methods are shown in Appendix Figure A-6 (hook and line captured only 2 fish). Boat electrofishing accounted for 66% of the total catch and captured the widest range of lengths (133-407mm). The migrant trap once again captured mainly juvenile longnose suckers (21-175mm) while the net methods were selective for the median lengths (200-380mm).

Tag retention efficiency

The Floy anchor tag efficiency determined for round whitefish in the Susitna River during 1983 was 77.5 percent with 20 of 89 recaptured round whitefish showing a tag scar. The tag efficiency, meanwhile, for Arctic grayling during 1983 was 69.4 percent with 15 of 49 recaptured Arctic grayling showing a tag scar.



Appendix Figure A-6. Gear selectivity for longnose suckers in the Susitna River, May through October 1983.

DISCUSSION

Gear efficiency - Response of radio tagged fish to boat electrofishing

Observed responses of 13 radio tagged fish to boat electrofishing equipment suggest that fish learn to avoid recapture. A similar hypothesis has been reported elsewhere (Jacobs and Swink 1982).

Only three of the 13 radio tagged fish were recaptured and the others avoided the electrofishing boat. Twelve of these fish were originally captured by electrofishing and one by hook and line (670-1.4).

Since only one of ten fish moved away from the sound of the boat motor, it appeared that they disassociate the effects of the electric field and capture to the sound of boat motors. This was probably due to the constant "traffic" on the river between the time of capture and when the experiment occurred. This enabled the fish to become acclimated to the sound of boat motors.

While most of the fish did not respond to the sound of boat motors, they did respond to generator noise. All of the fish tested for a response to generator noise moved away from the source of the noise. Prior to these observations we believed that the radio tagged fish would not associate the generator sound with the electric field because of the extended periods of time between successive samplings.

It appears that while boat electrofishing provides a good method to capture fish for collection of biological data, it is a poor method by itself for a tag-and-recapture program since fish learn to avoid the field.

Gear selectivity

For each of the six species that the gear selectivity study was conducted on, there was always at least one sampling technique which sampled a wide range of lengths, one that sampled only the juveniles and others that sampled a small segment of the population between the smallest and largest. Boat electrofishing was generally the best technique in sampling a wide range of lengths, while the downstream migrant traps was often the most effective means of capturing juveniles.

Tag retention efficiency

Studies in 1983 show that the Floy anchor tag, model FD-67, is lost from 25 percent of recaptured round whitefish and Arctic grayling. Other studies have also reported tag losses using the model FD-67 anchor tag. Wilbur and Duchow (1973) reported tag losses on largemouth bass up to 78 percent using the model FD-67 tag. Arctic grayling tagging studies in the Chena River and the upper Susitna River basin reported 10 percent tag losses (R. Holmes and M. Stratton, pers. comm., respectively).

Rawstroms (1973) reported that the primary reason for tag shedding is improper securement. He found that tag retention rates increase if the tag is inserted behind the interneurals rather than into the dorsal musculature. Rawstroms also stated that secondary causes of tag loss occur due to breakage of the T-section of the tag or to separation of the vinyl tube from the monofilament anchor.

Our studies also suggest that the primary cause of tag loss is improper placement of the tag. Very few (under five) tagged fish in our study have been found without the vinyl tube. Observations of recaptured round whitefish and Arctic grayling show that an ulcer forms around the area where the tag has been inserted. Since both these species have large scales, regeneration may be impeded due to the constant movement of the external part of the Floy tag. The constant movement impedes regeneration, and the wound ultimately enlarges. With the greater hole from the wound, the tag falls out enabling the scales to regenerate or to form a scar. Other resident fish species such as rainbow trout and longnose suckers probably have higher tag retention rates than Arctic grayling and round whitefish. This may be due to their smaller scales which adhere to the tag better.

Although some Floy anchor tags are lost due to shedding it is still the best tag to use for our studies because it can be deployed rapidly and because it is more economical to use than other types of tags.

Tag losses during our 1983 studies appeared to decrease due to better placement of tags. In 1982 most of the tags were injected into the dorsal musculature. In 1983, tags were anchored at the base of the dorsal fin.

APPENDIX B

Radio Tagged Fish Movement Data

Appendix Table B-1. Summary of tagging data for radio tagged rainbow trout on the Susitna River Between Cook Inlet and Devil Canyon, May to December 1983.

Radio Frequency/Fork Length (mm)	Age/ Sex	Method captured	Location Captured	River Mile	Date Capt'd	Date Rels'd
597-1.3/424	6, F	EF	Lane Creek	113.6	7/18	7/19
600-1.0/508	-, F	HL	Indian River	138.6	9/2	9/2
607-1.5/385	7, M	HL	Indian River	132.6	9/18	9/19
608-1.2/444	8, -	EF	Indian River	138.6	10/4	10/5
610-1.0/548	-, M	DN	4th of July Cr	131.1	5/11	5/12
619-1.0/440	-, M	HL	4th of July Cr	138.6	9/1	9/2
619-1.4/387	5, -	EF	Indian River	138.6	9/2	9/3
628-1.2/423	6, -	EF	Indian River	113.6	10/4	10/5
630-1.0/558	-, M	DN	4th of July Cr	131.1	5/11	5/12
639-1.0/382	6, -	EF	Indian River	138.6	9/2	9/3
639-1.4/460	-, -	EF	Slough 8A	125.3	7/16	7/17
648-1.6/405	6, F	HL	Whiskers Cr	TRM 0.2	6/5	6/6
649-1.2/427	7, -	EF	Indian River	138.6	9/2	9/3
660-3.0/508	8, F	EF	Protage Cr	148.8	9/2	9/3
670-1.4/391	7, -	HL	Whiskers Cr	TRM 0.2	6/6	6/7
709-1.5/418	-, -	EF	Lane Creek	113.6	7/18	7/19
718-1.5/376	5, -	EF	Indian River	138.6	6/8	6/9
719-1.0/455	5, -	HL	Indian River	TRM 5.0	8/11	8/11
729-1.0/455	-, F	HL	4th of July Cr	131.1	9/1	9/2
729-1.3/446	6, M	HL	Indian River	138.6	9/2	9/3
738-1.4/455	-, -	EF	Indian River	138.6	6/8	6/9
748-1.6/442	-, F	EF	Skull Creek	124.5	7/18	7/19
749-1.0/438	7, -	HL	Indian River	138.6	9/2	9/3
758-20/416	7, -	EF	Lane Creek	113.6	7/18	7/19
767-1.5/435	6, -	EF	Lane Creek	113.6	7/18	7/19
768-1.0/432	6, F	EF	Indian River	138.6	10/4	10/5

- = Not sexed or not aged, EF = Electrofishing, HL = Hook & Line, DN = Drift Net

Appendix Table B-2. Summary of tagging and tracking data for radio tagged burbot on the Susitna River between Cook Inlet and Devil Canyon, July to December 1983.

Radio Frequency/ Total length (mm)	Method Captured	Date Capt'd	River Mile	Date Rels'd	July	August			September			October			Nov	Dec
					25 B[b]	8 P[a]	15 B	29 P	5 B	15 P	19 B	3 P	6 B	21 P	10 P	1 P
610-3.0/550	Electroshock	7/18	113.6	7/19	112.3	110.0	112.5	112.0	112.0	111.3	112.0	112.0	112.0	112.0	NS[c]	NS
639-3.0/728	Electroshock	9/18	142.0	9/19								140.0	140.0	134.3	134.3	131.8
670-3.0/677	Electroshock	9/1	123.5	9/2					123.5	120.5	118.6	110.2	110.2	88.0	87.3	87.7
720-3.0/750	Electroshock	9/3	147.5	9/3					146.9	146.7	147.3	147.0	144.0	NS	NS	134.8

[a] Tracked by plane
[b] Tracked by boat
[c] No signal

APPENDIX C

Population and Biological Characteristics

Rainbow Trout

The sexual maturity of 28 rainbow trout from the Susitna River were examined between May 11 and July 18, 1983. Sexually ripe pre-spawners were captured from May 11 to June 7. Spawned out rainbow trout were captured from June 5 to July 18.

Fork lengths of 16 male rainbow trout examined for sexual maturity ranged from 260-558 mm with a mean of 403 mm. The fork lengths of twelve sexually mature female rainbow trout ranged from 325-454 mm with a mean of 399 mm.

Ages of twenty-one rainbow trout ranged five to eight (Appendix Figure C-1).

A total of 424 rainbow trout were captured between the Chulitna River confluence and Devil Canyon during 1983. The length frequency composition for rainbow trout is presented in Appendix Figure C-2. Fork lengths ranged from 30-612 mm with a mean of 284 mm.

Scale analysis was used to determine the ages of 265 rainbow trout captured on the Susitna River between the Chulitna River confluence and Devil Canyon. Ages ranged from one to nine. Ages 3 (18.1%), 4 (18.1%), 5 (25.3%) and 6 (17.7%) rainbow trout were the most abundant age classes (Appendix Table C-1). A graphical presentation of age-length data in Appendix Figure C-3 shows a steady growth rate for rainbow trout.

Two hundred forty-four of the 265 rainbow trout aged were captured by boat electrofishing or hook and line. Data from fish captured by these two methods, were used to calculate an instantaneous survival rate of 33.3 percent by using age versus catch (Appendix Figure C-4).

Burbot

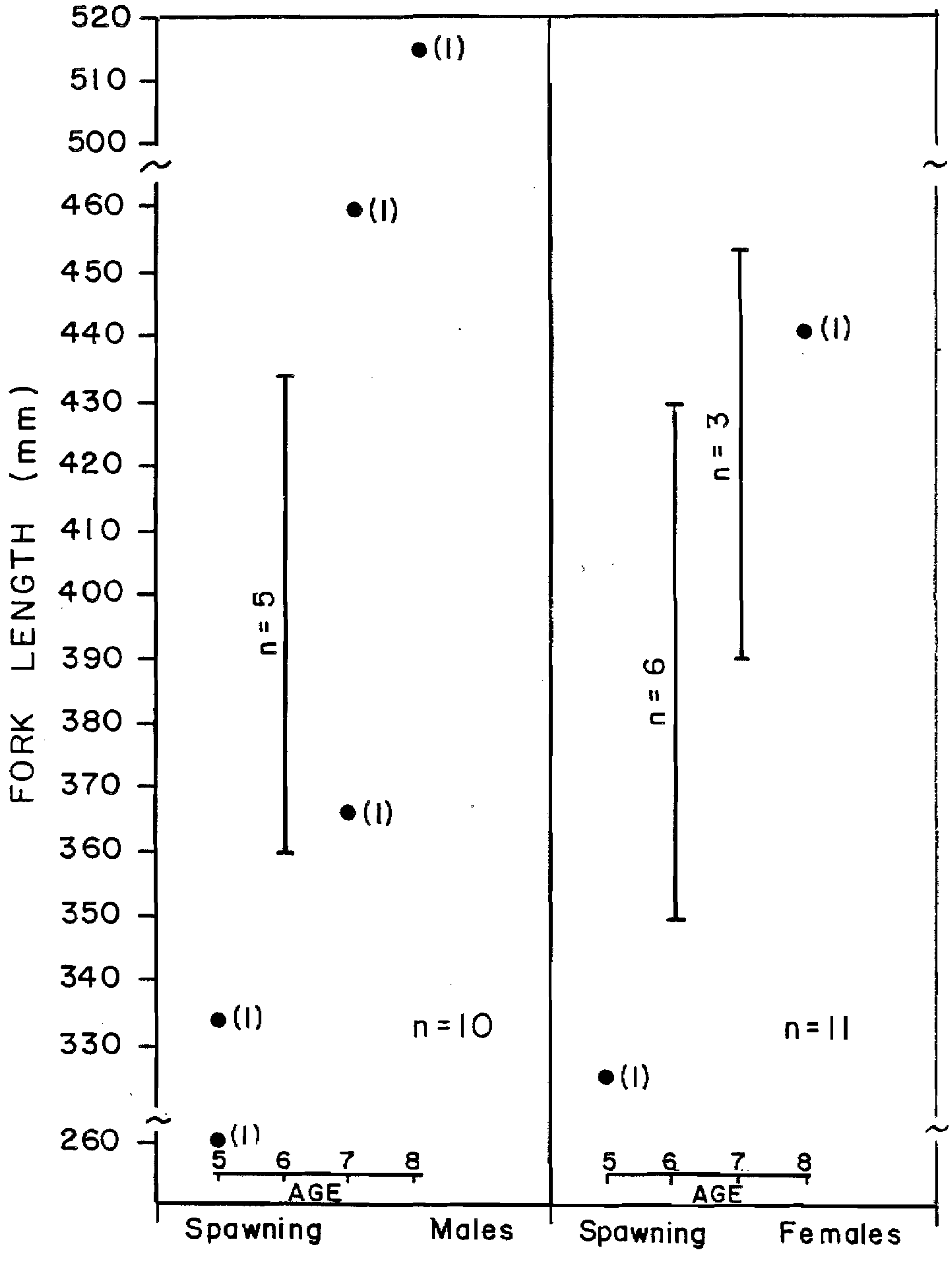
One hundred sixty one burbot were captured in the Susitna River between the Chulitna River confluence and Devil Canyon during 1983. Total lengths measured on 135 burbot ranged from 26-815 mm with a mean of 366 mm (Appendix Figure C-5). Most of the burbot measured ranged from 330 mm to 510 mm in total length.

Few juvenile burbot (total length $<$ 200 mm) were captured in 1983. The majority (22 of 24) of the juvenile burbot measured were caught by the downstream migrant traps at RM 103.0.

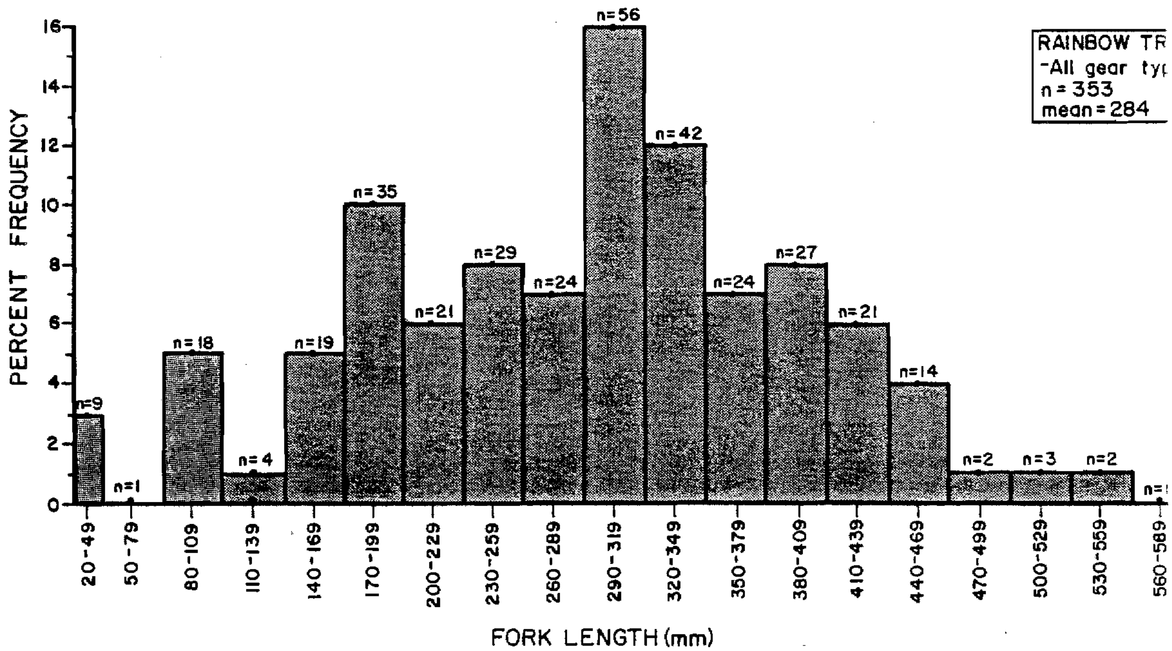
The instantaneous survival rate for burbot was calculated using pooled data from fish aged from otoliths from January 1981 to March 1983. The instantaneous survival rate for burbot aged in this time period was calculated to be 70.5 % (Appendix Figure C-6).

Arctic Grayling

The sexual maturities of 51 Arctic grayling from the Susitna River were examined between May 20 and June 22, 1983. Sexually ripe pre-spawners



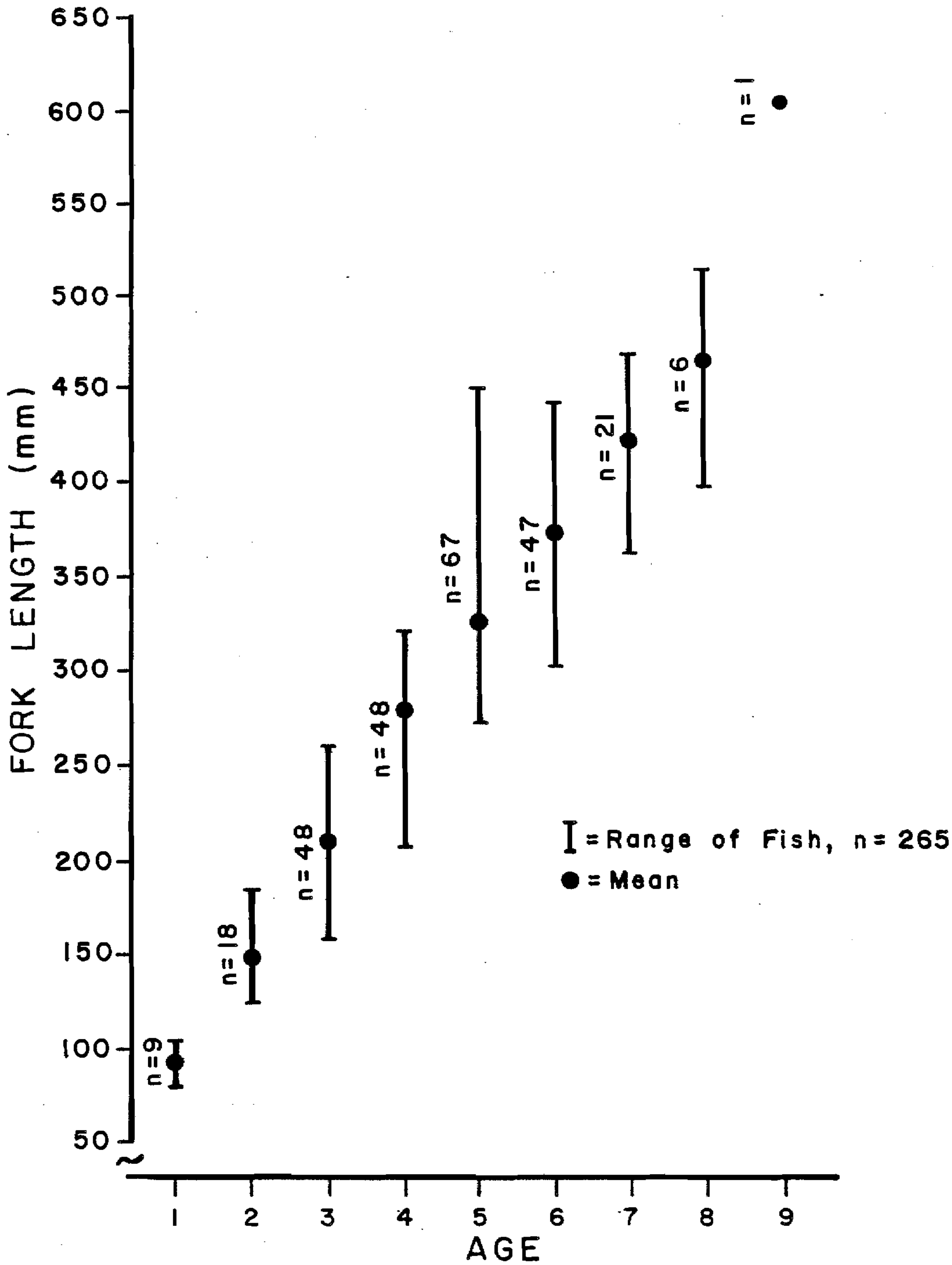
Appendix Figure C-1. Age and length relationship for spawning rainbow trout captured in the Susitna River between the Chulitna River confluence and Devil Canyon, May 11 through July 18, 1983.



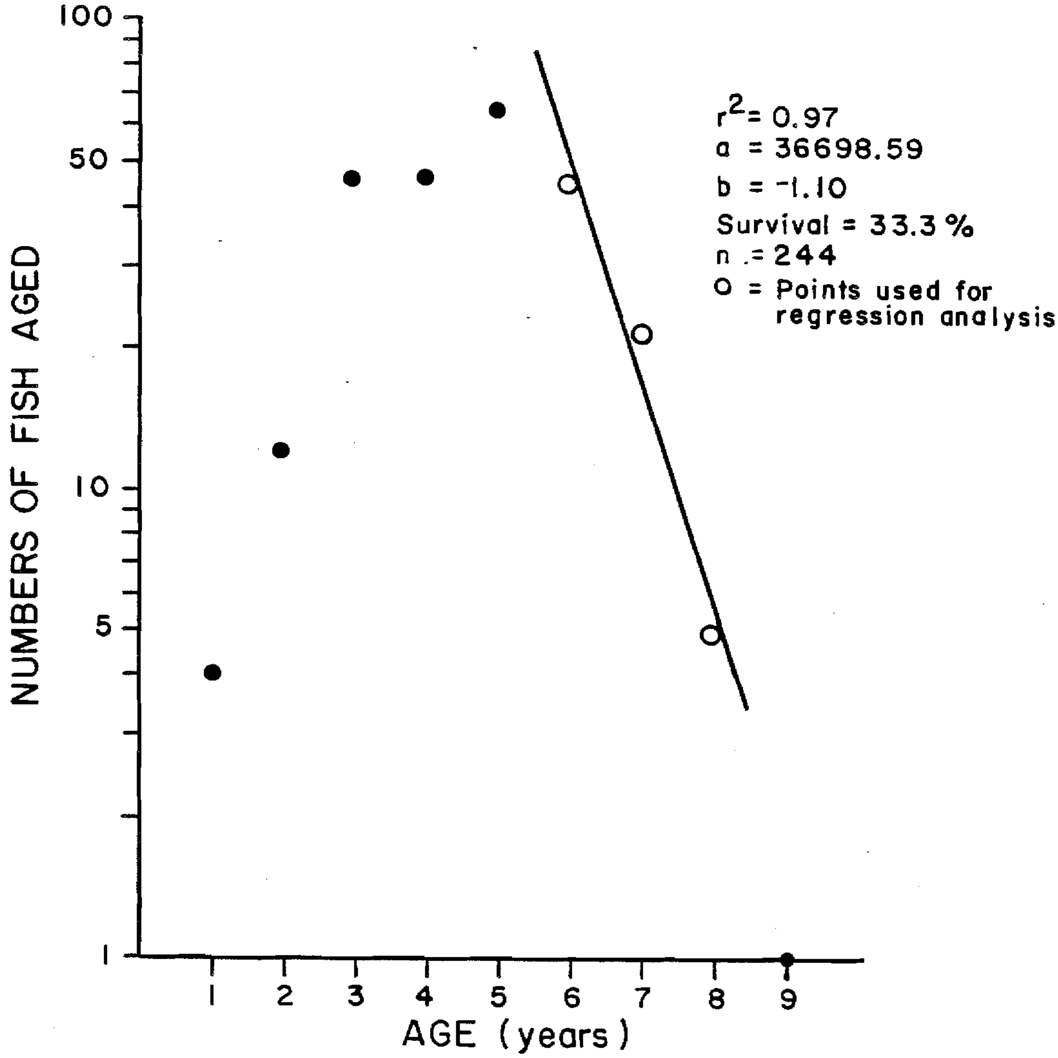
Appendix Figure C-2. Length frequency composition of rainbow trout captured in the Susitna River between the Chulitna River confluence and Devil Canyon by all gear types, May to October 1983.

Appendix Table C-1. Rainbow trout age-length relationships on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

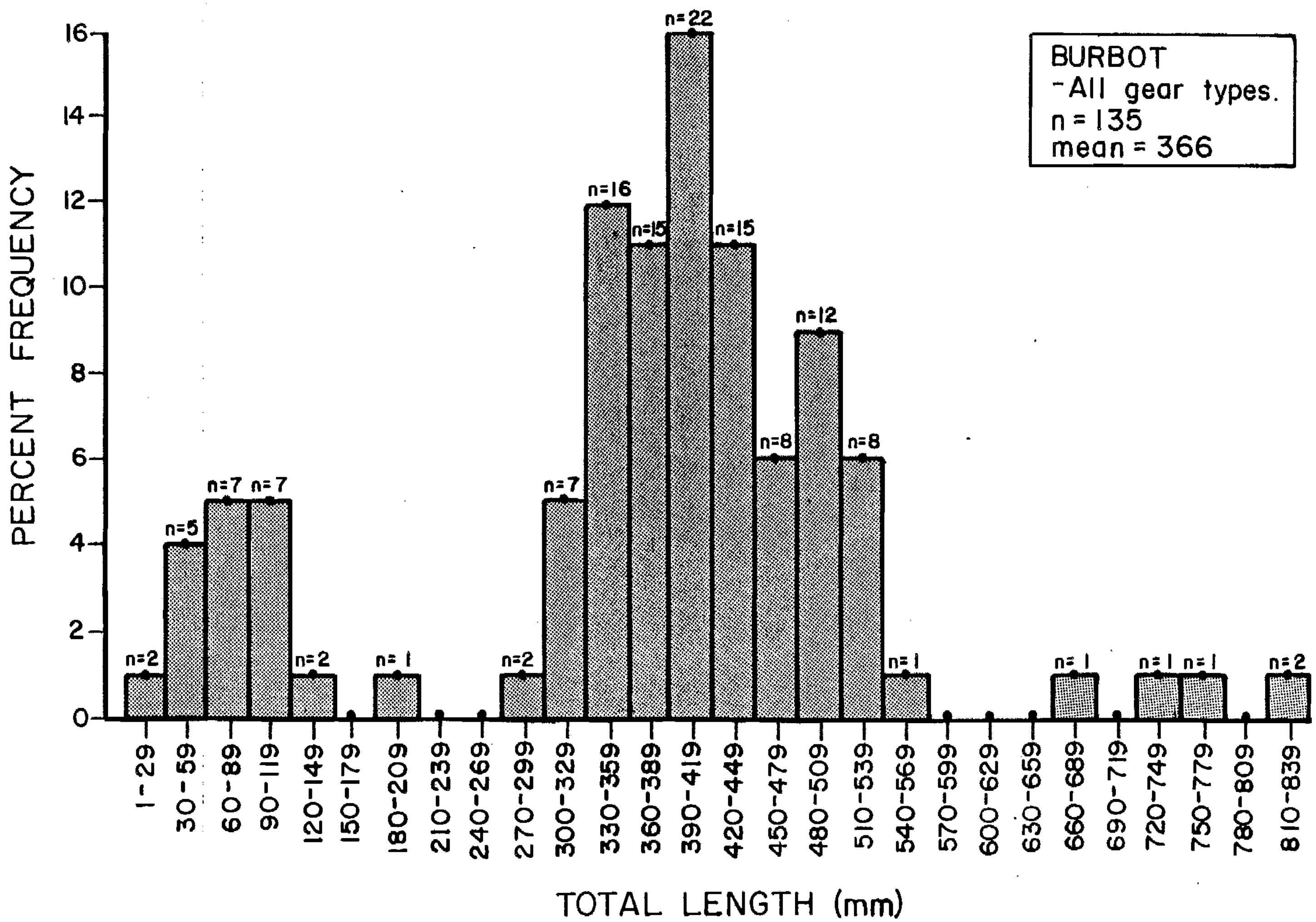
Age (years)	Total No. of Fish Sampled	Length (mm) Mean	Standard Deviation	95% Confidence Intervals	Range
Fish Captured by Boat Electrofishing and Hook and Line					
1	5	97	9.43	85 - 109	93 - 106
2	12	155	15.51	145 - 165	124 - 180
3	46	210	31.54	201 - 219	159 - 260
4	45	274	33.55	264 - 284	205 - 329
5	65	331	36.62	322 - 340	260 - 455
6	45	377	38.84	365 - 389	301 - 446
7	21	423	31.45	409 - 437	366 - 471
8	5	452	43.67	398 - 506	390 - 508
9	1	612			
Total	244	306			193 - 612
Fish Captured by All Methods					
1	9	92	7.95	86 - 98	84 - 106
2	18	150	14.96	143 - 157	124 - 180
3	48	210	31.15	201 - 219	159 - 260
4	48	275	33.50	265 - 285	205 - 329
5	67	330	36.00	321 - 339	260 - 455
6	47	378	38.41	367 - 389	301 - 446
7	21	423	31.45	409 - 437	366 - 471
8	6	462	46.86	413 - 511	390 - 515
9	1	612			
Total	265	298			84 - 612



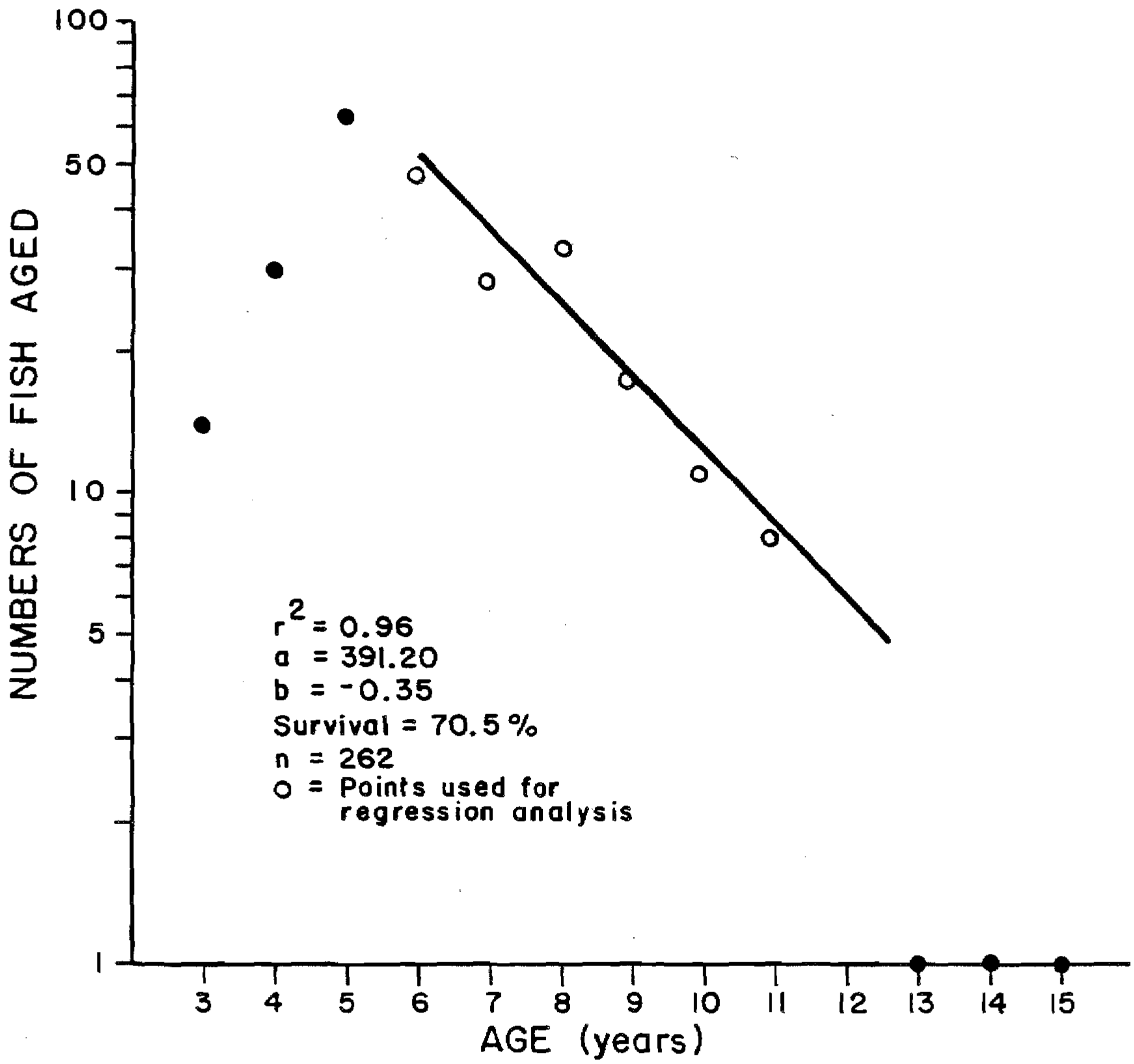
Appendix Figure C-3. Age and length relationships for rainbow trout captured in the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.



Appendix Figure C-4. Survival rate curve for rainbow trout captured in the Susitna River between the Chulitna River confluence and Devil Canyon, 1983.



Appendix Figure C-5. Length frequency composition of burbot captured in the Susitna River between the Chulitna River confluence and Devil Canyon by all gear types, May to October 1983.



Appendix Figure C-6. Survival rate curve for pooled burbot catch data from the Susitna River between Cook Inlet and Devil Canyon, 1981 to 1983.

were captured from May 20 to May 24. Post spawners were captured from May 21 to June 22.

Fork lengths for 30 male Arctic grayling which spawned in 1983 ranged from 308-444 mm with a mean length of 367 mm. Twenty-one female Arctic grayling spawners had fork lengths ranging from 320-386 mm with a mean of 349 mm.

Ages of 29 of the 30 male Arctic grayling examined for spawning condition ranged from Age 5 to Age 10. Ages of 19 female Arctic grayling spawners ranged from Age 5 to Age 8 (Appendix Figure C-7).

A total of 1,168 Arctic grayling were captured on the Susitna River between the Chulitna River confluence and Devil Canyon during 1983. Fork lengths of 1,071 of those fish were measured to the nearest millimeter. Arctic grayling fork lengths ranged from 30 mm to 444 mm with a mean of 246 mm (Appendix Figure C-8). Juvenile Arctic grayling (fork length under 200 mm) made up 26.4% of the catch.

Age analysis from scales of 523 Arctic grayling captured on the Susitna River between the Chulitna River confluence and Devil Canyon yielded ages which ranged from age 0+ to Age 10 (Appendix Figure C-9). Ages 3 (27.0%) and 4 (31.4%) were sampled most often (Appendix Table C-2).

Five hundred sixteen of the 523 Arctic grayling aged were captured by boat electrofishing, hook and line, and hoop net. The instantaneous survival rate for Arctic grayling captured by these three methods was calculated at 56.0 % (Appendix Figure C-10).

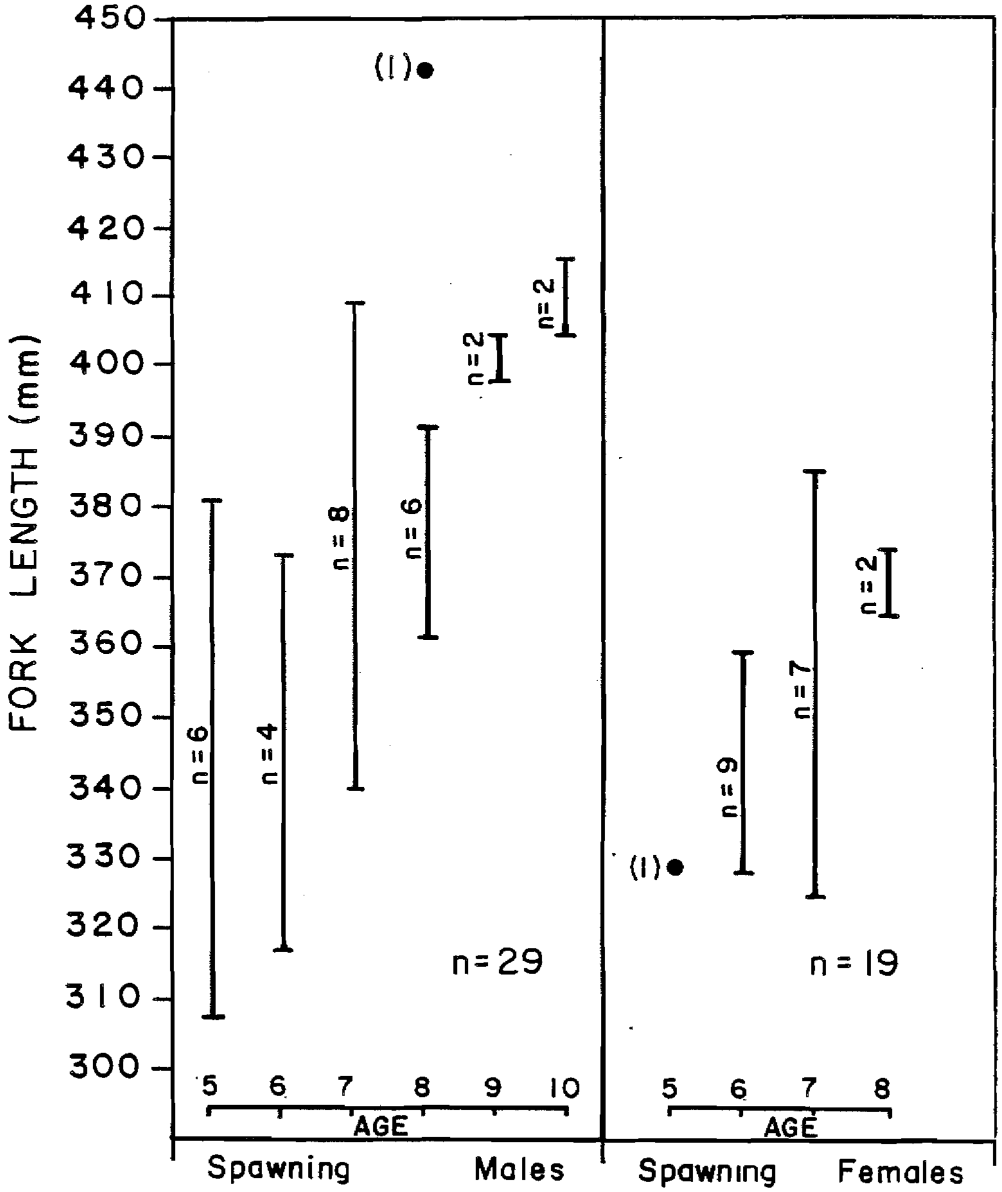
Round Whitefish

Sexual maturity was determined for a subsample of round whitefish captured on the Susitna River between the Chulitna River confluence and Devil Canyon from October 3 to October 7, 1983. Forty males and 12 female round whitefish were sampled, all were pre-spawners. Fork lengths of the males ranged from 266 mm to 380 mm with a mean of 319 mm. Fork lengths for the females ranged from 319 mm to 403 mm with a mean of 355 mm. Ages of seventeen of the spawning males ranged from Age 5 to Age 8 (Appendix Figure C-11). One female was Age 7.

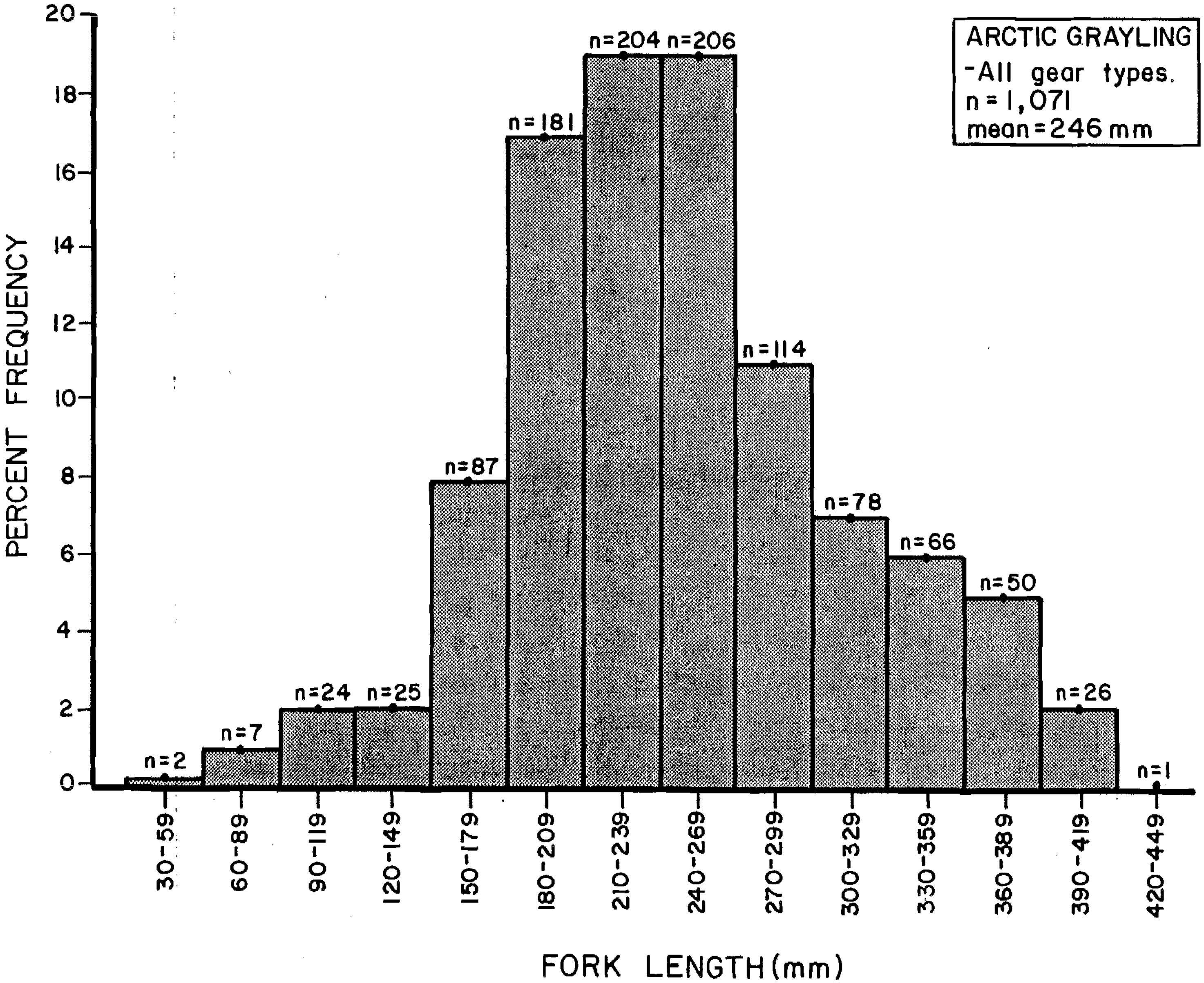
In October 1983 three spawning sites for round whitefish were found. Two sites were at the mouth of tributaries, Lane Creek (RM 113.6) and Portage Creek (RM 148.8), and the other site was in the mainstem Susitna at RM 147.0 off an island. At each site several extremely ripe females and males were captured. Female round whitefish expelled eggs when their abdomens were palpated. No spent fish were captured at these sites.

Fork lengths of 2,497 round whitefish ranged from 23-403 mm with a mean of 167 mm. Appendix Figure C-12 illustrates the length frequency composition of all fish measured.

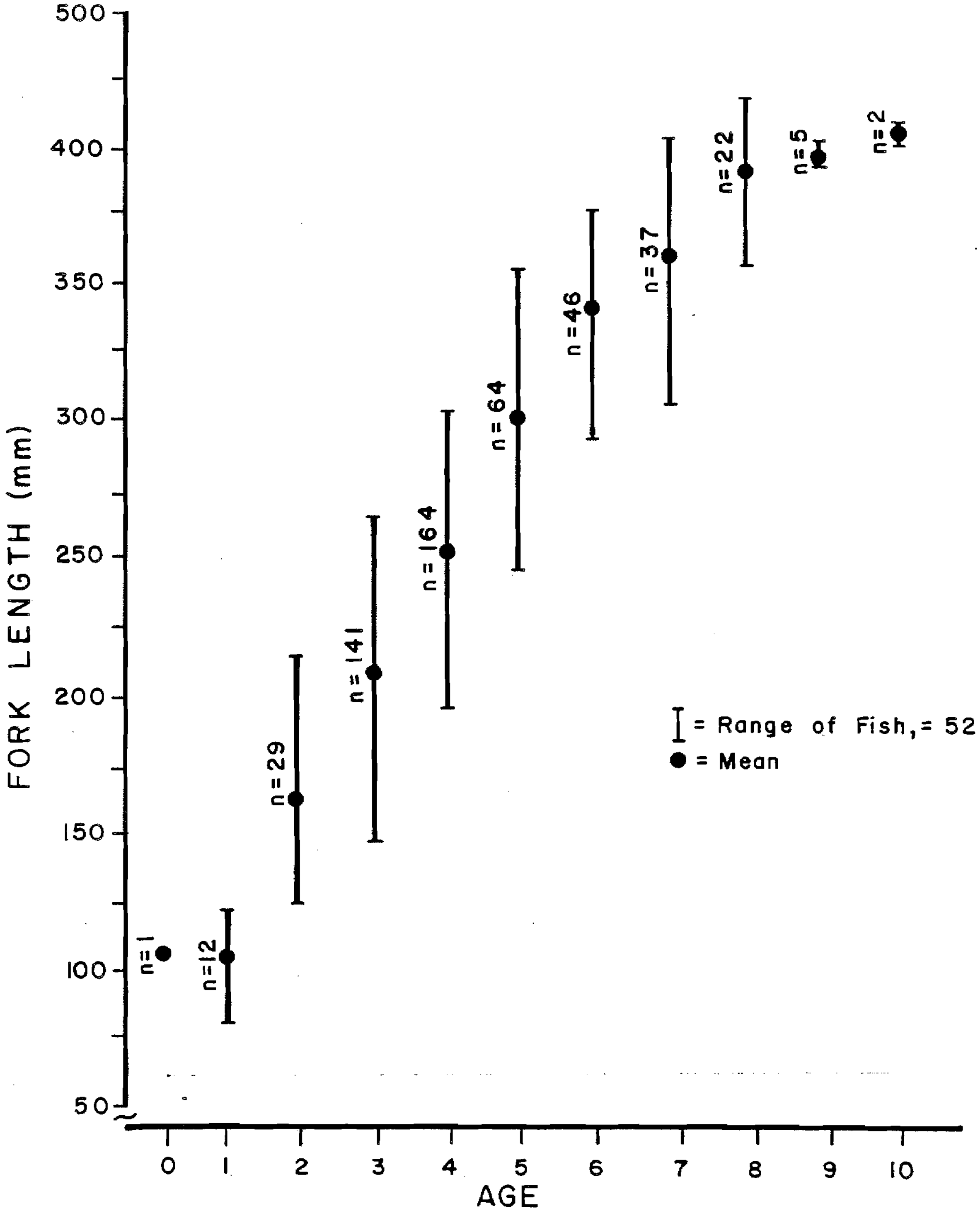
Four hundred fifty-six round whitefish were aged using scale analysis. Ages ranged from Age 1 to Age 12 and Ages 4 (12.3%), 5 (16.2%), 6



Appendix Figure C-7. Age and length relationships for spawning Arctic grayling captured in the Susitna River between the Chulitna River confluence and Devil Canyon, May 20 to June 22, 1983.



Appendix Figure C-8. Length frequency composition of Arctic grayling captured in the Susitna River between

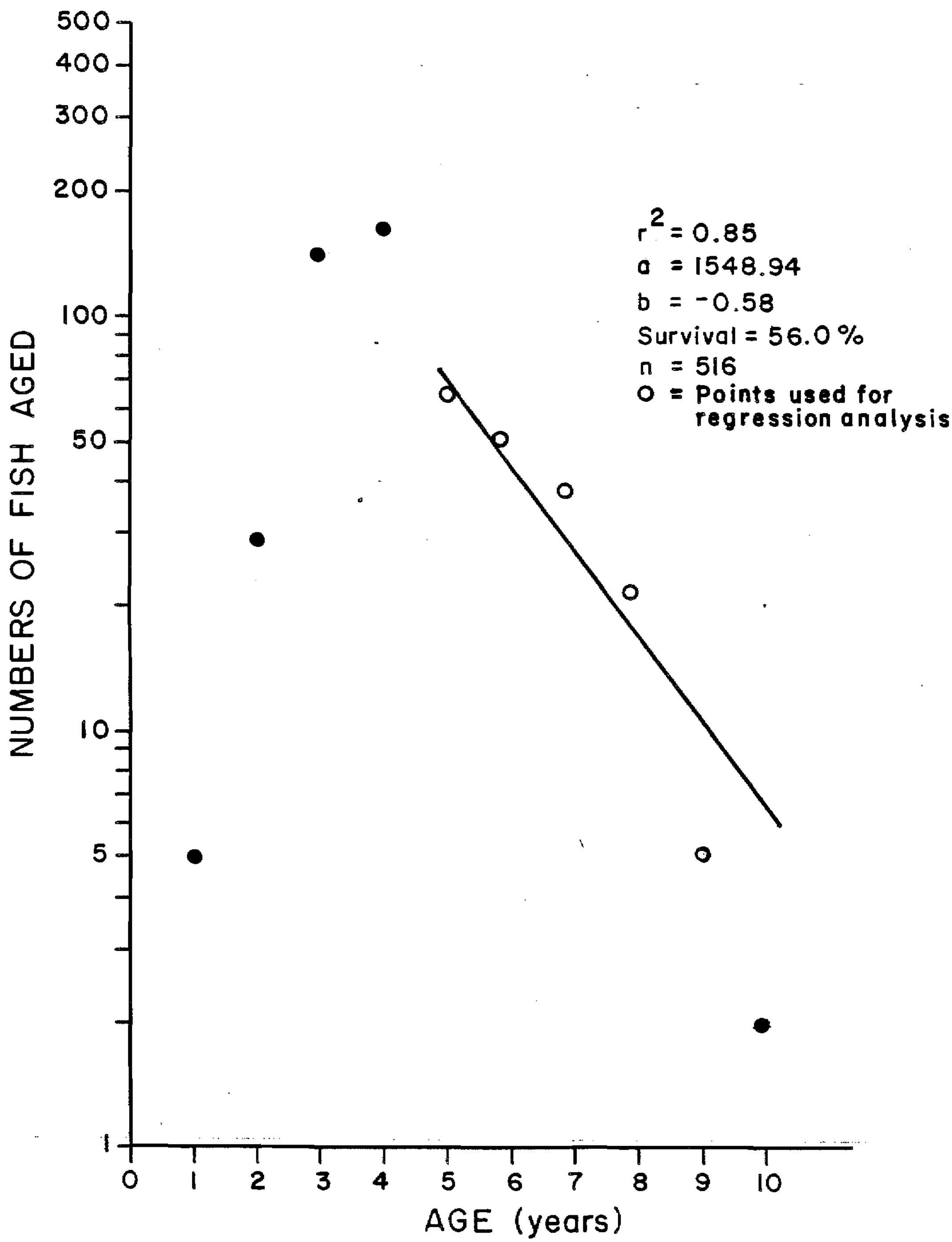


Appendix Figure C-9. Age and length relationship for Arctic grayling captured in the Susitna River between the Chulitr River confluence and Devil Canyon, May to October 1983.

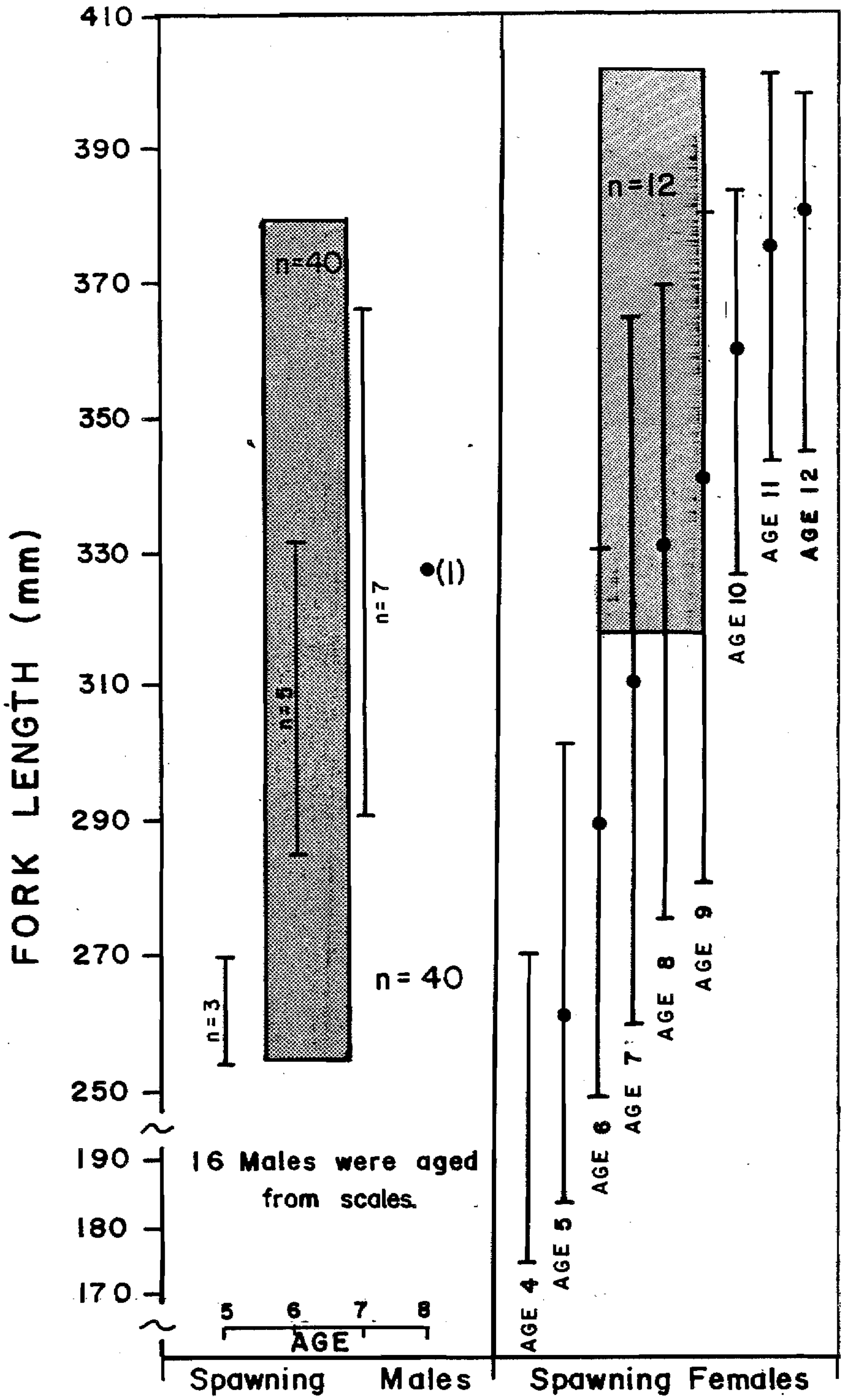
Appendix Table C-2. Arctic grayling age-length relationships on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983. Fish aged were captured by boat electrofishing, hook and line and hoop net.

Age (years)	Total No. of Fish Sampled	Length (mm) Mean	Standard Deviation	95% Confidence Intervals	Range
0	1	108			
1	5	113	9.63	101 - 125	97 - 122
*1	12	105	12.83	97 - 113	80 - 122
2	29	160	19.92	152 - 168	126 - 212
3	141	207	25.38	203 - 211	142 - 265
4	164	254	24.76	250 - 258	198 - 315
5	64	301	28.72	294 - 308	245 - 365
6	46	341	19.45	335 - 347	290 - 380
7	37	364	23.52	356 - 372	315 - 409
8	22	390	19.87	381 - 399	362 - 444
9	5	396	6.28	388 - 404	390 - 405
10	2	411	7.78	341 - 481	405 - 416
*Total	523	261			80 - 444

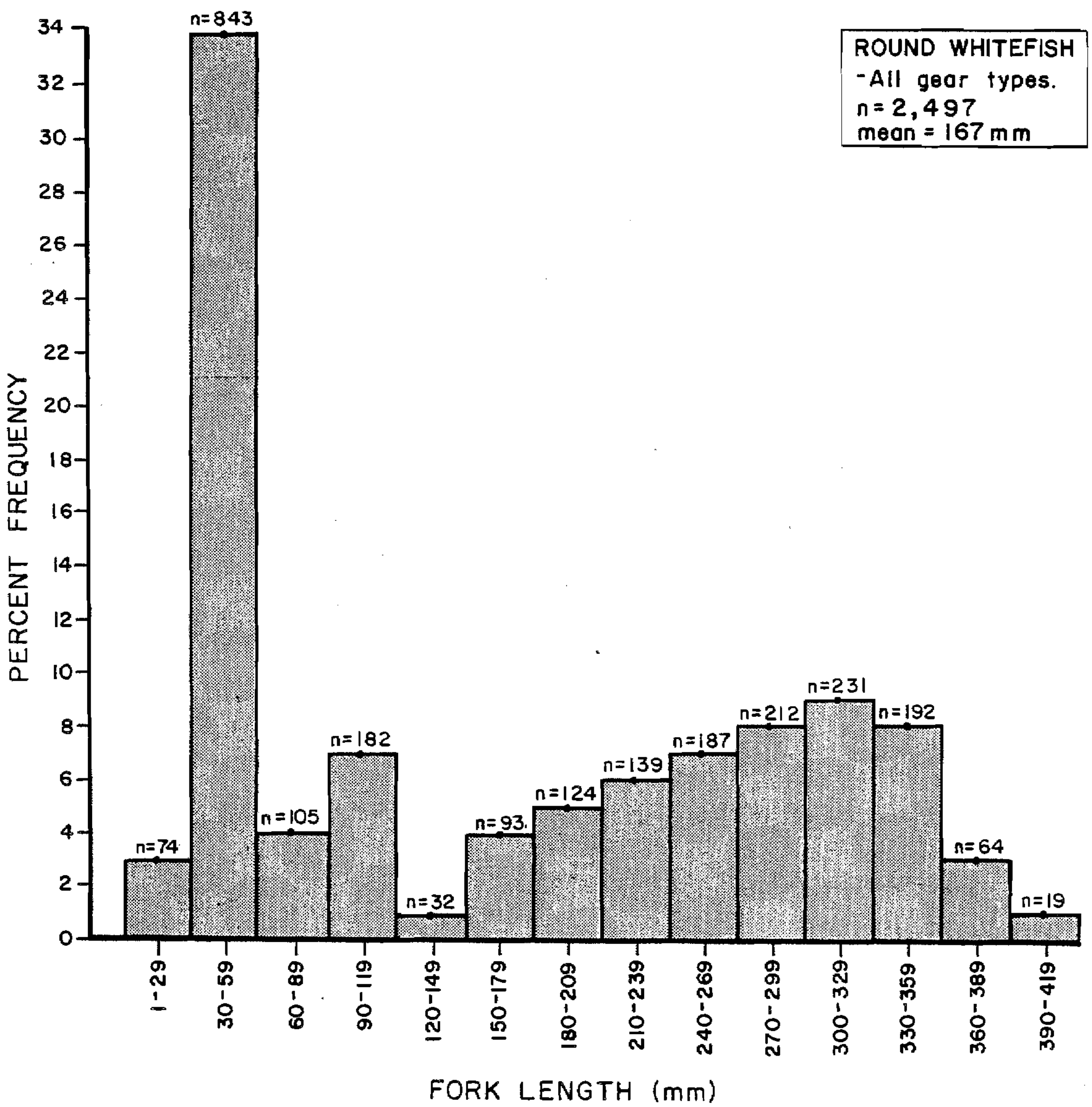
* Aged fish caught by all sampling methods.



Appendix Figure C-10. Survival rate curve for Arctic grayling captured in the Susitna River between the Chulitna River confluence and Devil Canyon, 1983.



Appendix Figure C-11. Age and length relationship for spawning round whitefish in the Susitna River between the Chulitna River confluence and Devil Canyon, October 4 to November 7, 1983.



Appendix Figure C-12. Length frequency composition of round whitefish captured in the Susitna River between the Chulitna River confluence and Devil Canyon by all gear types, May to October 1983.

(11.4%), 7 (13.4%), and 8 (11.6%) were sampled most often (Appendix Table C-3). Appendix Figure C-13 shows rapid growth rates for Susitna River round whitefish to Age 3 then slower growth rates thereafter.

Four hundred nineteen round whitefish were captured by boat electrofishing and aged. The instantaneous survival rate for round whitefish captured by boat electrofishing was determined to be 58.3 % (Appendix Figure C-14).

Humpback Whitefish

Eight hundred twenty humpback whitefish were captured in the Susitna River between Cook Inlet and Devil Canyon during 1983. Fork lengths of 604 humpback whitefish were measured to the nearest millimeter. Fork lengths ranged from 30-480 mm with a mean of 125 mm. The length frequency composition of the humpback whitefish catch is presented in Appendix Figure C-15.

Ages of 78 humpback whitefish captured in the Yentna River (TRM 4.0) and 41 humpback whitefish captured in the Susitna between the Chulitna River confluence and Devil Canyon were determined by scale analysis. Ages from fish captured on the Yentna River ranged from Age 5 to Age 12 with Ages 6 (25.6%), 7 (18.0%) and 8 (20.5%) predominating (Appendix Table C-4). Humpback whitefish were captured between the Chulitna River confluence and Devil Canyon ranged from Age 1 to Age 8 with Ages 4 (26.8%) and 5 (22.0%) predominating. The age-length relationship of humpback whitefish presented in Appendix Figure C-16 shows that humpback whitefish are slow growing with a wide range of fork lengths occurring at several age classes.

Longnose Suckers

Sexual maturity was determined for 55 longnose suckers captured on the Susitna River from May 22 to September 20, 1983. Sexually ripe male longnose suckers were captured throughout the summer. Sexually ripe female longnose suckers were captured during June and September. Spawned out males and females were captured from June 6 to July 18.

Fork lengths for the spawning male longnose suckers ranged from 282-392 mm with a mean of 332 mm. Spawning female longnose suckers ranged from 300-408 mm with a mean of 348 mm.

Thirteen of the male longnose suckers were aged by scale analysis with ages ranging from six to nine (Appendix Figure C-17). Eight female longnose suckers aged ranging from seven to ten years old.

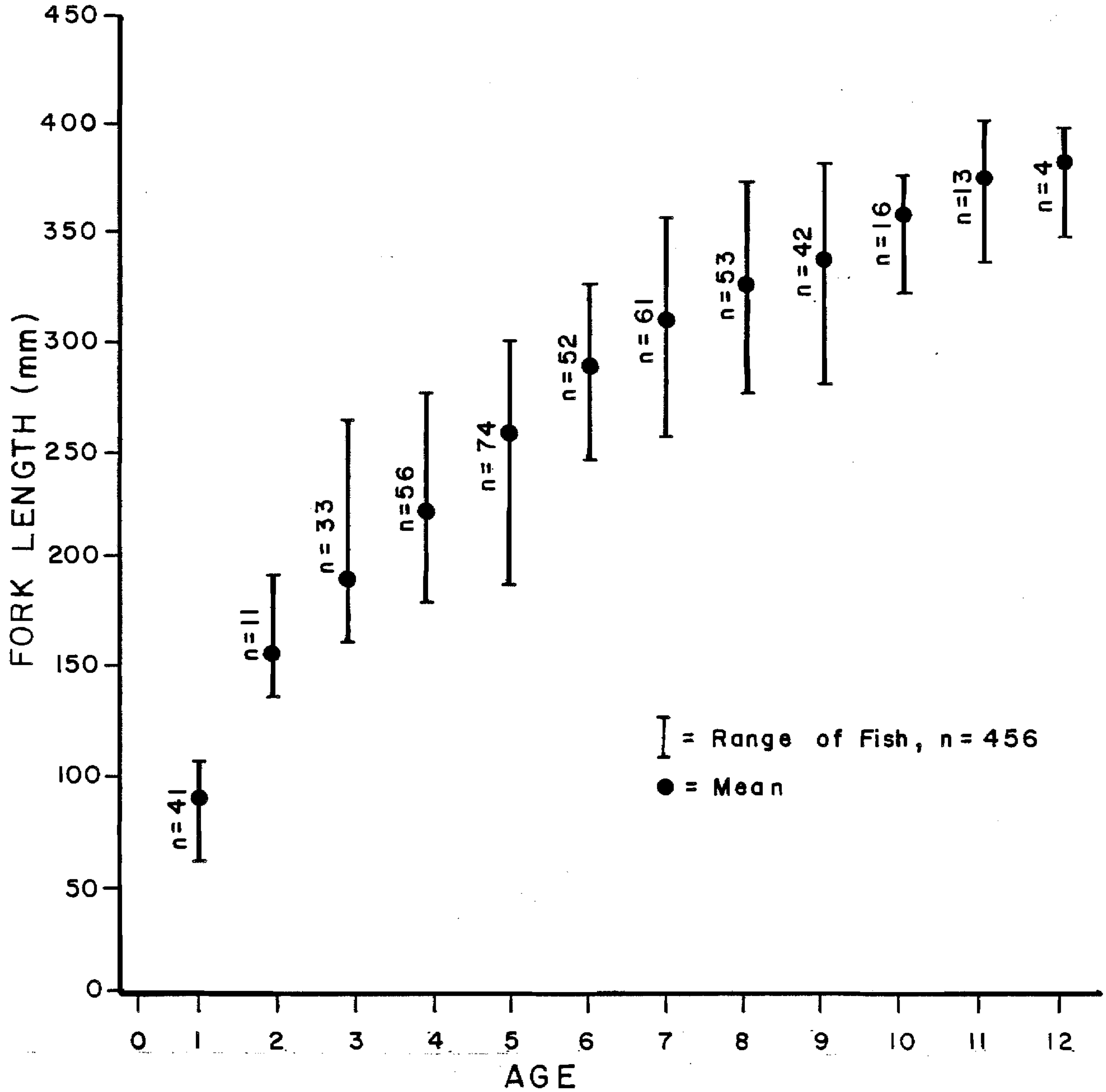
Fork lengths of 571 longnose suckers were measured. Fork lengths of longnose suckers ranged from 21-411 mm with a mean of 258 mm. The length frequency composition of longnose suckers captured in 1983 is presented in Appendix Figure C-18.

One hundred thirty-six longnose suckers were aged by scale analysis. Ages ranged from Age 1 to Age 11 and Ages 7 (23.5%) and 8 (25.0%) were the most abundant age classes encountered (Appendix Table C-5).

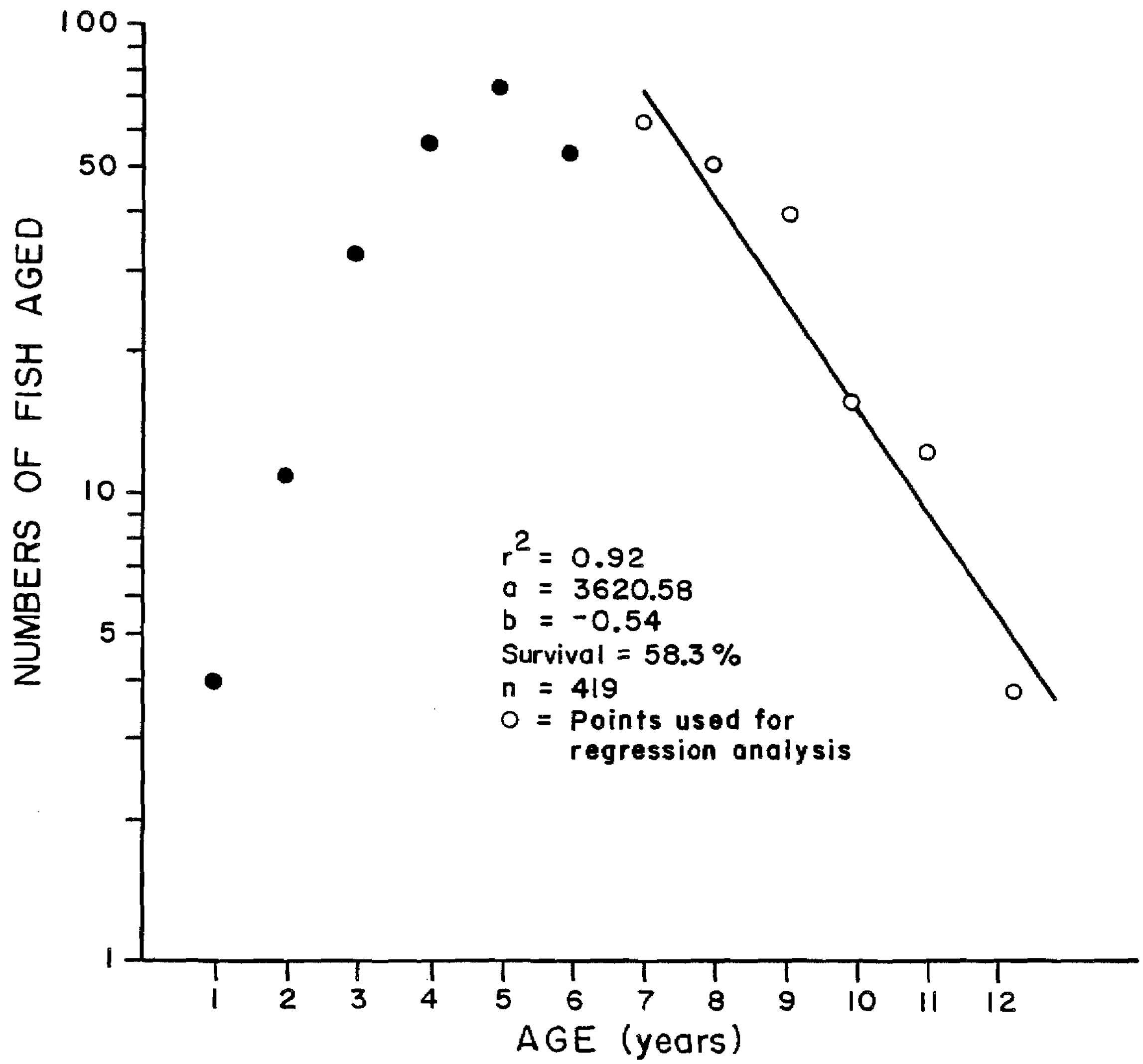
Appendix Table C-3. Round whitefish age-length relationships on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983. Fish aged were captured by boat electrofishing.

Age (years)	Total No. of Fish Sampled	Length (mm)			
		Mean	Standard Deviation	95% Confidence Intervals	Range
1	4	102	4.57	95 - 109	95 - 105
*1	41	89	11.90	85 - 93	67 - 110
2	11	152	15.94	141 - 163	135 - 187
3	33	187	22.34	179 - 195	154 - 265
4	56	222	20.13	217 - 227	174 - 271
5	74	262	20.74	257 - 267	184 - 302
6	52	290	42.67	278 - 302	248 - 332
7	61	311	21.65	305 - 317	260 - 366
8	53	332	19.15	327 - 337	276 - 386
9	42	342	19.44	336 - 348	282 - 390
10	16	362	19.70	352 - 372	327 - 384
11	13	376	19.45	364 - 388	388 - 403
12	4	382	23.96	344 - 422	346 - 397
*Total	456	267			67 - 403

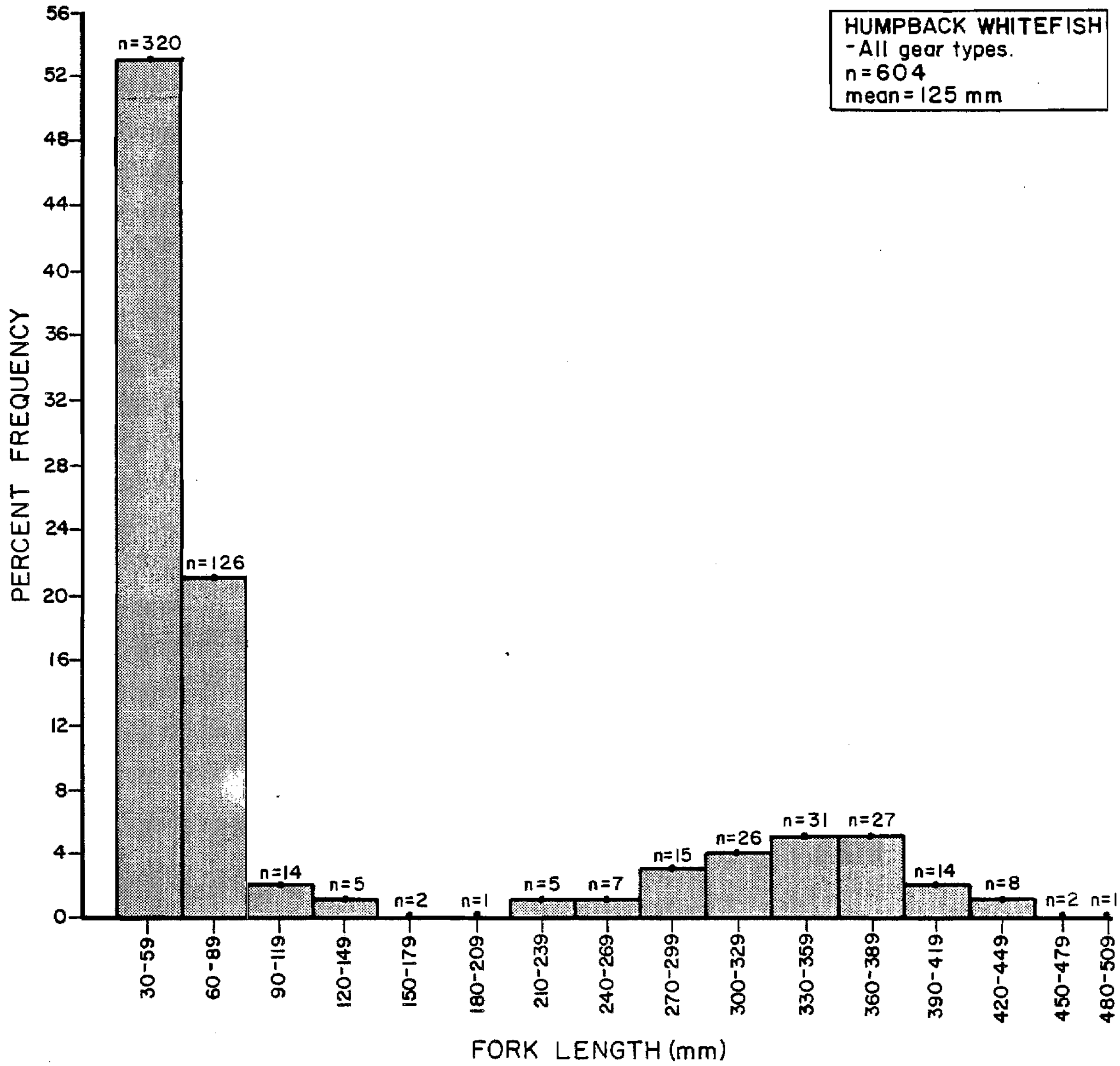
* Aged fish caught by all sampling methods.



Appendix Figure C-13. Age and length relationships for round whitefish captured in the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.



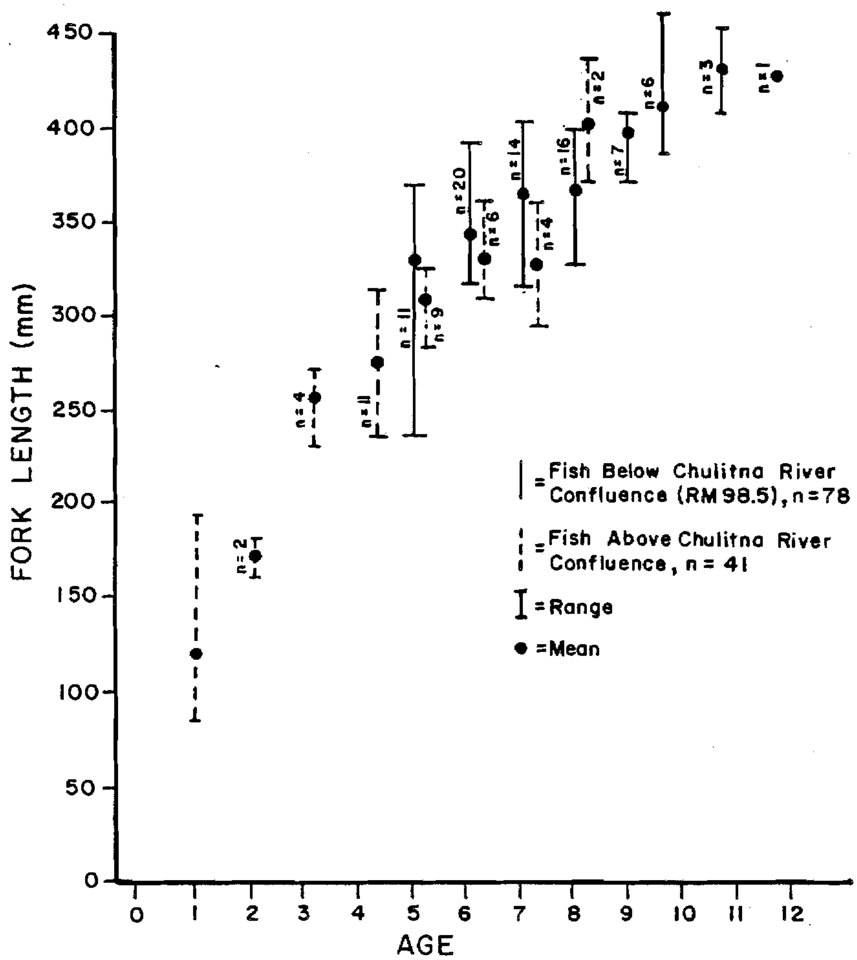
Appendix Figure C-14. Survival rate curve for round whitefish captured in the Susitna River between the Chulitna River confluence and Devil Canyon, 1983.



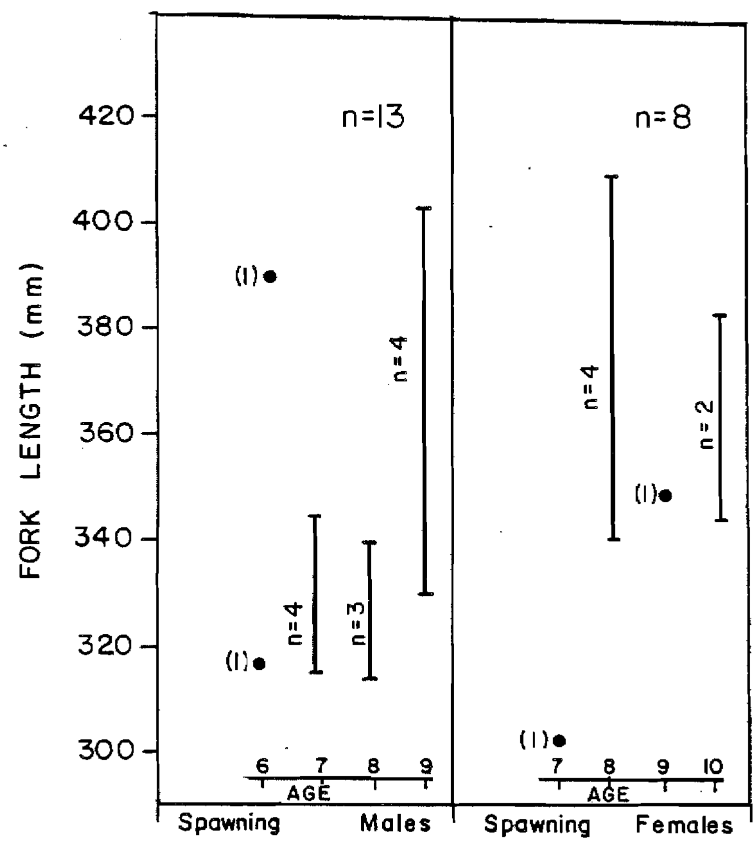
Appendix Figure C-15. Length frequency composition of humpback whitefish captured in the Susitna River between Cook Inlet and Devil Canyon by all gear types, May to October 1983.

Appendix Table C-4. Humpback whitefish age-length relationships on the Susitna River between Cook Inlet and Devil Canyon, May to October 1983. Fish aged were captured by all sampling methods.

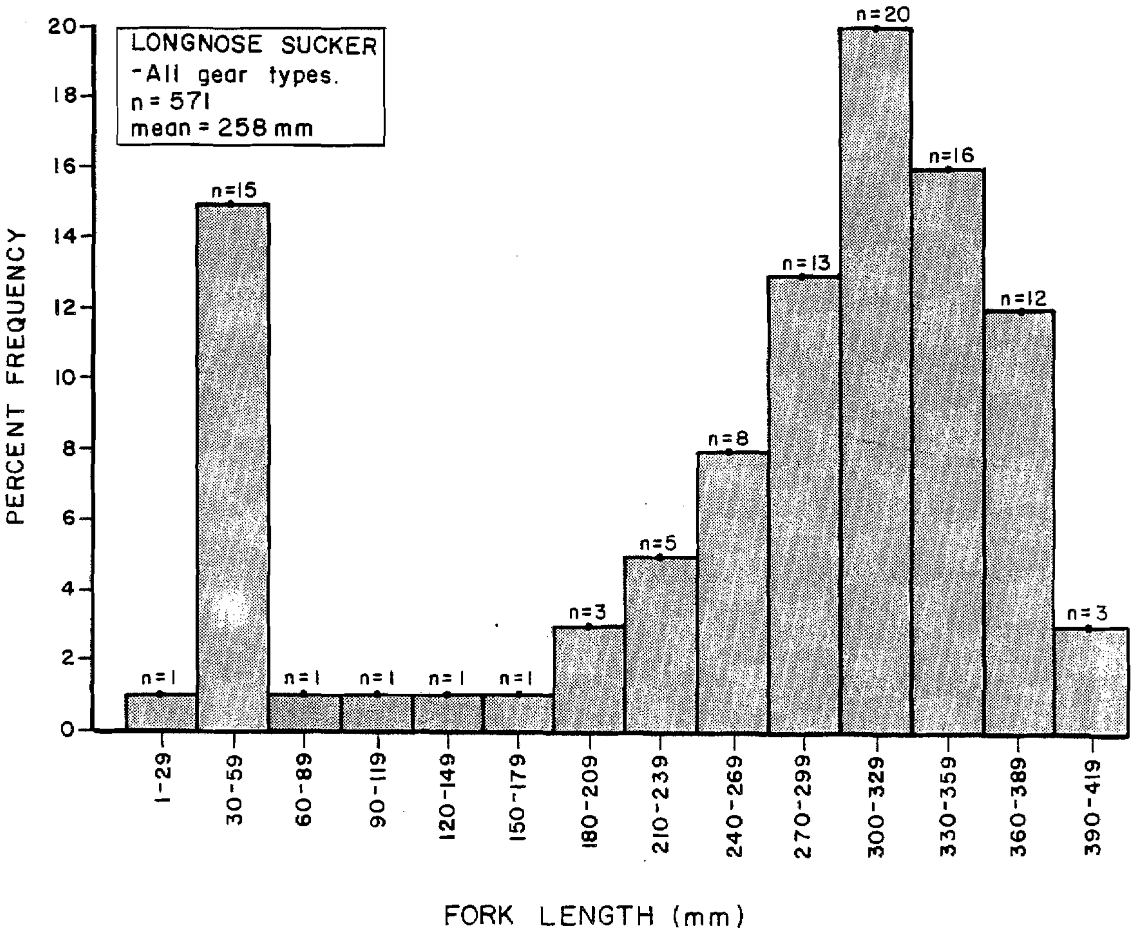
	Yentna River (TRM 4.0)					Chulitna Confluence to Devil Canyon					Yentna River to Devil Canyon				
		Length (mm)					Length (mm)					Length (mm)			
Age (years)	Total No. of fish Sampled	Mean	Standard Deviation	95% Confidence Intervals	Range	Total No. of fish Sampled	Mean	Standard Deviation	95% Confidence Intervals	Range	Total No. of fish Sampled	Mean	Standard Deviation	95% Confidence Intervals	Range
1						3	121	60.72	0 - 272	77 - 190	3	121	60.72	0 - 272	77 - 190
2						2	159	10.07	69 - 249	153 - 165	2	159	10.07	69 - 249	153 - 165
3						4	251	18.96	221 - 281	228 - 268	4	251	18.96	221 - 281	228 - 268
4						11	270	22.04	255 - 285	236 - 311	11	270	22.04	255 - 285	236 - 311
5	11	334	25.08	317 - 351	286 - 363	9	303	13.82	292 - 314	281 - 322	20	320	25.54	308 - 332	281 - 363
6	20	348	22.74	337 - 359	316 - 390	6	330	18.23	311 - 349	303 - 358	26	343	22.80	334 - 352	303 - 390
7	14	367	25.51	352 - 382	318 - 404	4	322	29.18	276 - 368	288 - 356	18	350	31.82	334 - 366	288 - 404
8	16	367	22.25	355 - 379	329 - 400	2	402	49.50	0 - 847	367 - 437	18	371	26.63	358 - 384	329 - 437
9	7	397	22.22	376 - 418	369 - 410						7	397	22.22	376 - 418	369 - 410
10	6	416	31.06	383 - 449	377 - 458						6	416	31.06	383 - 449	377 - 458
11	3	430	20.03	380 - 480	409 - 449						3	430	20.03	380 - 480	409 - 449
12	1	419									1	419			
Total	78	367			286 - 458	41	279			77 - 437	119	337			77 - 458



Appendix Figure C-16. Age and length relationship for humpback whitefish captured in the Susitna River between Cook Inlet and Devil Canyon, May to October 1983.



Appendix Figure C-17. Age and length relationships for spawning longnose suckers captured in the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.



Appendix Figure C-18. Length frequency composition of longnose suckers captured in the Susitna River between the Chulitna River confluence and Devil Canyon by all gear types, May to October 1983.

Appendix Table C-5. Longnose sucker age-length relationships on the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983. Fish aged were captured by all methods.

Age (years)	Total No. of Fish Sampled	Length (mm)			
		Mean	Standard Deviation	95% Confidence Intervals	Range
1	3	81	11.37	53 - 109	68 - 90
2	2	127	10.28	35 - 219	120 - 133
3	7	196	18.51	179 - 213	168 - 219
4	2	244	3.54	212 - 276	241 - 246
5	10	245	23.97	228 - 262	208 - 282
6	16	291	21.74	279 - 303	256 - 321
7	32	320	25.90	311 - 329	276 - 370
8	34	347	27.60	337 - 357	307 - 408
9	17	364	24.36	351 - 377	330 - 407
10	10	363	20.72	348 - 378	336 - 403
11	3	372	16.26	332 - 412	360 - 383
Total	136	312			68 - 408

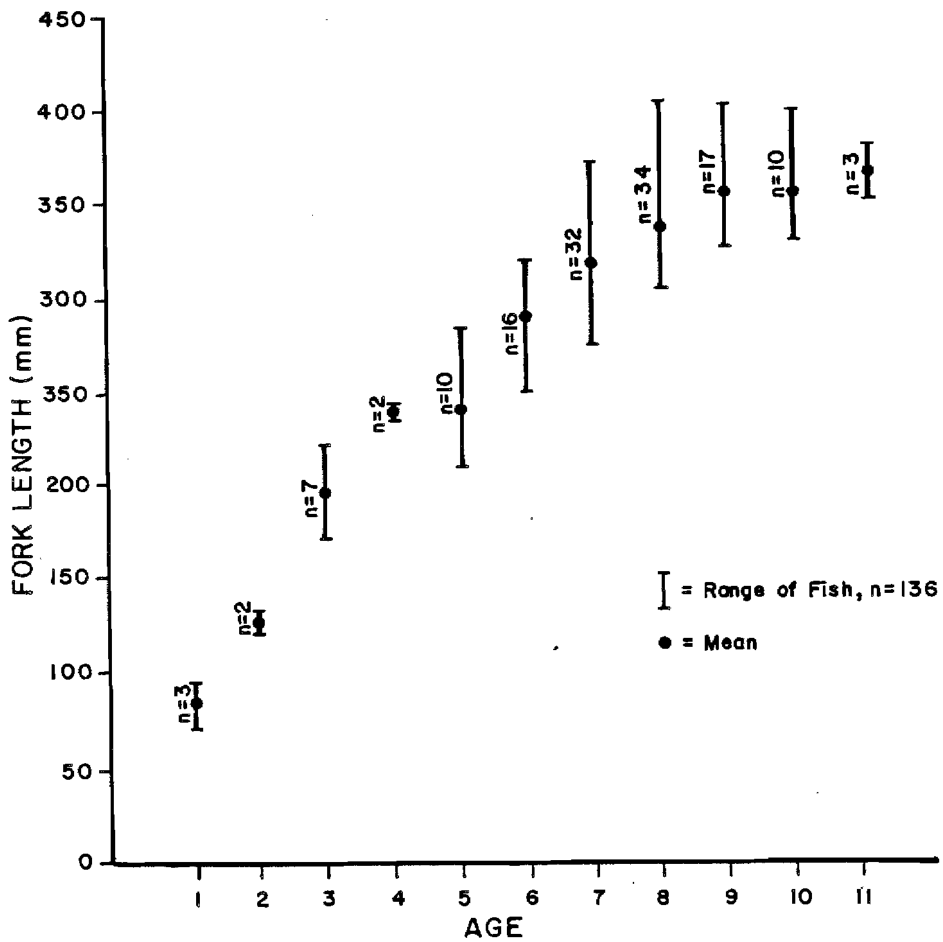
Appendix Figure C-19 shows that the growth rate of longnose suckers in the Susitna River between the Chulitna River confluence and Devil Canyon is relatively slow.

Dolly Varden

Seventeen Dolly Varden were captured on the Susitna River in 1983. Eight fish were captured by boat electrofishing and seven by the downstream migrant traps at RM 103.0. The downstream migrant traps Dolly Varden catches were all juveniles ($<$ 200 mm). Fork lengths of boat electrofishing Dolly Varden catches ranged from 146-320 mm.

Threespine Stickleback

Five hundred and seventy-four threespine stickleback were captured by the downstream migrant traps at RM 103.0 in 1983. Total lengths of these threespine stickleback ranged from 11-93 mm with a mean of 31 mm.



Appendix Figure C-19. Age and length relationship for longnose suckers captured in the Susitna River between the Chulitna River confluence and Devil Canyon, May to October 1983.

APPENDIX D

Population Estimates

During the course of the 1983 Resident Fish Studies, biases and assumptions relating to the population estimates of resident fish were identified. These biases fall into two general categories, those caused by behavior or other attributes of the biology of the fish and those caused by the sampling technique (Appendix D-1). The biases for each of the population estimates made were shown to be different depending on the species, area, and gear type used for sampling, or by a combination of these three factors.

The major bias associated with the rainbow trout population estimate in Fourth of July Creek (RM 131.1) was behavioral, the avoidance of recapture. After a fish was captured and marked, the capture probability of that fish decreased substantially since it learned to avoid the lure. This was observed during the second and third occasion of sampling. Although the lure was put before the marked fish, it did not strike. To correct for this bias, a behavioral model (a type of removal model) which allowed for decreases in capture probabilities was used in calculating the population estimate.

A secondary bias of the population estimate for rainbow trout at Fourth of July Creek was the size selectivity of sampling gear, resulting in variations in individual capture probabilities. Smaller fish have been reported to have a smaller capture probability than larger ones in other population estimates (ADF&G 1983d). This was also true for rainbows in Fourth of July Creek; angling was ineffective in capturing fish under 151 mm in fork length.

The population estimate of 107 rainbows in Fourth of July Creek therefore pertains only to rainbow trout over 150 mm.

Similar biases were shown at a mainstem site between RM 138.9-140.1 where a burbot population estimate was made. Since no burbot were recaptured at this site during the four day sampling period, a removal model was used to generate a population estimate. Other tag and recapture data from 1981-83 have also shown that burbot evidently learn to avoid recapture since less than ten have been recaptured during three years of sampling.

A secondary bias of size selectivity as found for rainbow trout in Fourth of July Creek, for the population estimate of burbot was evident since no burbot under 300 mm total length were captured. The population estimate of burbot in this reach of the mainstem river should therefore be applicable only to burbot over 300 mm in length.

To minimize the effects of in- or outmigration, sampling for rainbow trout was done in July. Electrofishing during July and August 1982 captured few rainbow trout in the mainstem indicating that rainbow trout are residing in the tributaries during this time period.

To minimize the possibility of in- or outmigration for burbot, sampling was done in July because catch results from 1981-82 and radio tagged burbot data from 1982 show that burbot move only from September to March.

Appendix Table D-1 Biases, corrections, and assumptions which affect the resident fish population estimates below Devil Canyon, 1983.

Bias:	Lack of randomness of mark or recapture effort.
Correction:	Stratification of habitat location by habitat type.
Assumption:	Random mark and recapture effort.
Bias:	Unequal recapture probability due to time between censusing.
Correction:	Use of multiple census estimator during a short time period.
Assumption:	Time does not affect recapture probability.
Bias:	Population is open geographically.
Correction:	Use of July and August data only; period of minimal movement.
Assumption:	Population is closed geographically.
Bias:	Heterogeneity; variance in the probability of capture and recapture between age classes.
Correction:	Stratification of age class for entire population, develop correction factor for populations.
Assumption:	Population estimates limited to Age IV and older fish due only to insufficient sample sizes of smaller fish.

Although population estimates were generated for burbot in the mainstem Susitna, problems were incountered with calculating population estimates for other resident species in the mainstem during 1983. For instance, catch information shows the major biases associated with the population estimates made at Slough 8A (RM 125.3) were probably that the fish migrated in and out of the site during the sampling (not a closed population) and that there was an avoidance of fish to electrofishing which was the method of capture used in Slough 8A. Sampling was done at this site during only a 72 hour period (twice a day for three days) to correct for the geographical bias, however, failed. The resultant population estimate, for example, of round whitefish at this site was believed inaccurate since the estimate was 896 but had a standard error of 294.43 using the population model selected by the computer as best fitting the data. The low catch of round whitefish at Slough 8A on two occasions compared to the other four occasions (25, 3, 38, 28, 28, and 8) showed that fish were moving in and out of the slough during at least these two time periods.

The movements of round whitefish as well as other species during these two time periods, meanwhile, were probably due to the changing turbidity in Slough 8A during the sampling period. The mainstem river was approximately 0.5 feet lower on those two occasions compared to the other four occasions. As the mainstem water decreased, the slough became clearer. The decreased round whitefish catches on these two occasions suggests that the fish moved into the mainstem when the water in the slough was no longer turbid enough to provide adequate cover.

Resident fish also appeared to avoid electrofishing and this avoidance was not anticipated prior to conducting the estimates. Of 130 round whitefish captured in Slough 8A during six occasions only nine (6.9%) were recaptured. Similar recapture percentages and speculation on fish avoidance to boat electrofishing were reported by Jacobs and Swink (1982). They found, however, that differences in turbidities did not affect capture efficiencies, although this may have been due to their study area not having as large changes in turbidities as our study did. They further point out that use of electrofishing alone for mark and recapture estimates in large rivers are generally unsuccessful because not enough fish are recaptured.

In order to make accurate population estimates for resident fish other than burbot in the mainstem Susitna River, methods have to be changed from those used in 1983. Jacobs and Swink (1982) suggested using boat electrofishing coupled with rotenone but this is not applicable to the Susitna River. Electrofishing coupled with baited trapnets may prove more successful, or large seining nets could be used to block the ends of channels and sloughs . Another more difficult method would be the use of population estimate models that allow for in- and outmigration (open population models).

Population estimates for resident fish in tributaries to the Susitna River can be made if enough fish of a given species are captured. Population estimates of rainbow trout in Fourth of July Creek succeeded because relatively large numbers of rainbow trout were captured and recaptured and because there was little or no in- or outmigration during the sampling period. The time period of sampling was very important at Fourth of July Creek. Sampling was conducted during mid-July because the flows were extremely low and no adult salmon were in the tributary (Estes and Vincent-Lang 1984). Biologists, therefore, had easy access along the stream and the fish were easily caught because less food in the form of salmon eggs was present in the system.

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Part 5
Resident Fish Distribution and Population Dynamics in the Susitna River below Devil Canyon

ALASKA DEPARTMENT OF FISH AND GAME
SUSITNA HYDRO AQUATIC STUDIES

REPORT NO. 2

RESIDENT AND JUVENILE ANADROMOUS FISH INVESTIGATIONS (MAY - OCTOBER 1983)

Edited by:

Dana C. Schmidt
Stephen S. Hale
Drew L. Crawford
Paul M. Suchanek

Prepared for:

Alaska Power Authority
334 W. Fifth Avenue, Second Floor
Anchorage, Alaska 99501

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