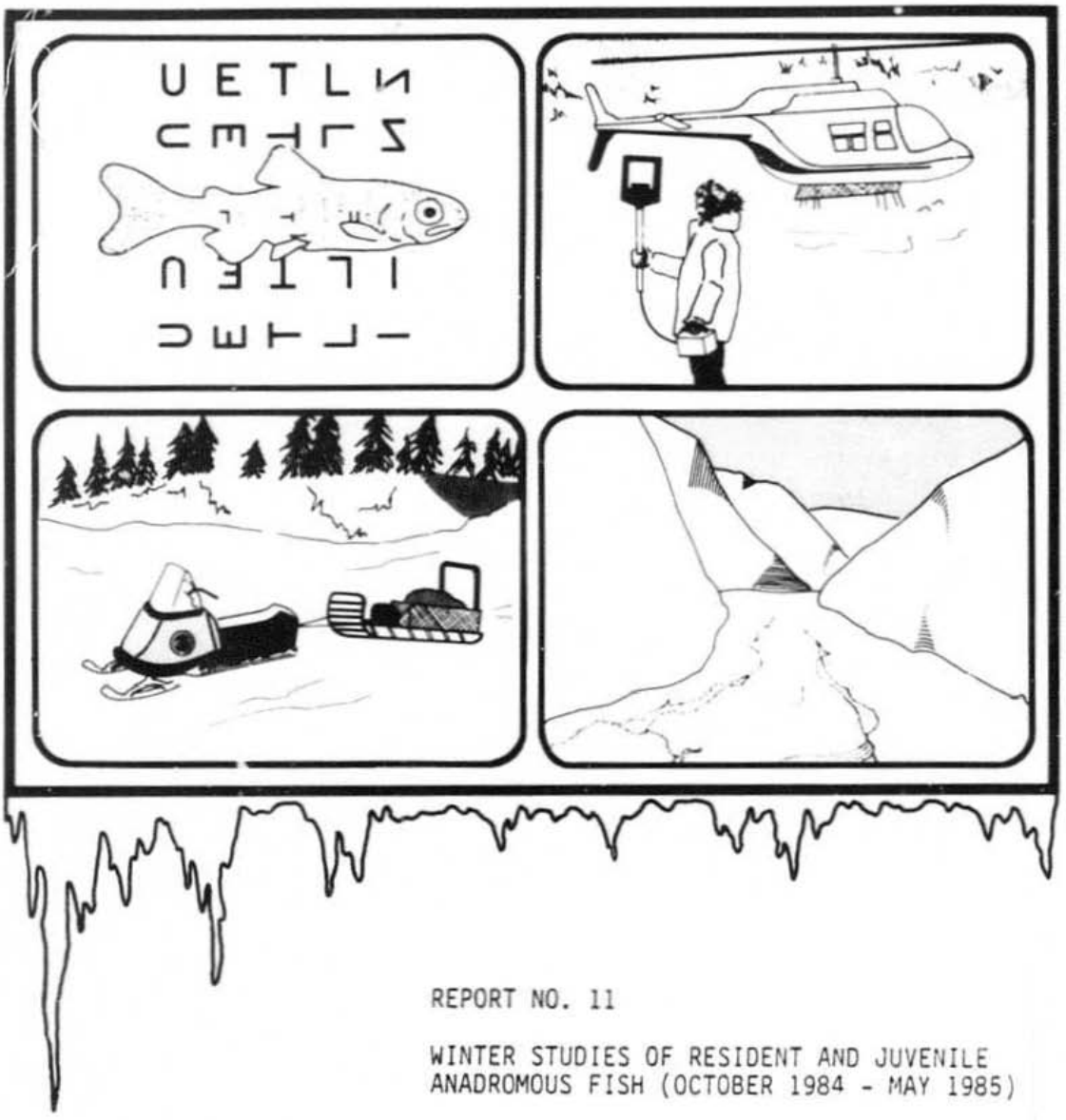

REPORT NO. 11

WINTER STUDIES OF RESIDENT AND JUVENILE ANADROMOUS FISH (OCTOBER 1984 - MAY 1985)

PART 1

ALASKA DEPARTMENT OF FISH AND GAME
SUSITNA HYDRO AQUATIC STUDIES REPORT SERIES

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ALASKA DEPARTMENT OF FISH AND GAME

SUSITNA RIVER AQUATIC STUDIES PROGRAM

REPORT NO. 11

WINTER STUDIES OF RESIDENT AND JUVENILE ANADROMOUS FISH (OCTOBER 1984 - MAY 1985)

PART 1

Prepared for: Alaska Power Authority
P.O. Box 190869
Anchorage, Alaska 99519-0869

January 1986

PREFACE

This report is one of a series of reports prepared for the Alaska Power Authority (APA) by the Alaska Department of Fish and Game (ADF&G) to provide information to be used in evaluating the feasibility of the proposed Susitna Hydroelectric Project. The ADF&G Susitna River Aquatic Studies Program was initiated in November 1980.

This report covers winter studies (RSA Task 34) conducted from October 15, 1984 through May 15, 1985 on juvenile salmon and resident fish species of the Susitna River. In addition, some radio telemetry monitoring data is also included for resident fish that were radio tagged in September and early October 1984. This volume is divided into two parts.

Part 1 presents the results of winter resident fish studies in both the lower and middle river. Monitoring of selected resident fish movements through the use of radio tags was continued. Efforts were also made to describe the overwintering habitat associated with rainbow trout, burbot, and Arctic grayling, and to identify the timing and locations of burbot spawning in the lower river.

Part 2 discusses the juvenile chinook and coho salmon studies during the winter of 1984-85 in the middle river. Findings from this study using cold branding/mark-recapture techniques further define the distribution and relative abundance of overwintering juvenile salmon and generate site specific population estimates and an estimate of the number of juvenile chinook which overwinter in the middle reach.

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CONTENTS OF REPORT NO. 11

TITLES IN THIS SERIES

Report Number	Title	Publication Date
1	Adult Anadromous Fish Investigations: May - October 1983	April 1984
2	Resident and Juvenile Anadromous Fish Investigations: May - October 1983	July 1984
3	Aquatic Habitat and Instream Flow Investigations: May - October 1983	September 1984
4	Access and Transmission Corridor Aquatic Investigations: May - October 1983	September 1984
5	Winter Aquatic Investigations: September 1983 to May 1984	March 1985
6	Adult Anadromous Fish Investigations: May - October 1984	June 1985
7	Resident and Juvenile Anadromous Fish Investigations: May - October 1984	July 1985
8	Availability of Invertebrate Food Sources for Rearing Juvenile Chinook Salmon in Turbid Susitna River Habitats	July 1985
9	Summary of Salmon Fishery Data for Selected Middle Susitna River Sites	August 1985
10	Preliminary Evaluations of Potential Fish Mitigation Sites in the Middle Susitna River	November 1985
11	Winter Studies of Resident and Juvenile Anadromous Fish (October 1984 - May 1985)	January 1986

PART 1

Winter Resident Fish Distribution and Habitat Studies Conducted in the Susitna River Below Devil Canyon, 1984-85

WINTER RESIDENT FISH DISTRIBUTION AND HABITAT STUDIES CONDUCTED IN THE SUSITNA RIVER BELOW DEVIL CANYON, 1984-85

Report No. 11, Part 1

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ABSTRACT

Studies of selected resident fish species were conducted in both the lower (below the Chulitna River confluence) and middle (between the Chulitna River confluence and Devil Canyon) Susitna River during the winter of 1984-85. These studies present distribution and habitat data collected from resident fish which were radio tagged in the spring and fall of 1984. Additional studies were done on the lower Susitna River to document the timing and locations of spawning burbot. Findings from radio telemetry studies indicate that middle river rainbow trout overwintered in the mainstem Susitna River, whereas lower river rainbow trout usually overwintered in side channels. Most rainbow trout overwintered from 0.0 to 4.0 miles below the mouth of the tributary they were tagged at. Rainbow trout in both reaches of river overwintered in areas of low to moderate water velocities (0.0-2.5 fps) and in areas with surface ice. No rainbow trout overwintered in areas that had anchor ice. Middle river rainbow trout were found in slightly deeper waters than lower river rainbow trout. Several middle river rainbow trout overwintered close to each other suggesting that this species congregate during the winter or that overwintering habitat is limited, resulting in cohabitation. Two pronounced winter movements were recorded for rainbow trout in both reaches of river: one between mid-September and mid-October, and one between mid-December and mid-January. Most rainbow trout begin to migrate from the mainstem to tributaries during breakup in May. Lower river burbot spawned between late January and early February. Four spawning sites at the Deshka River were documented. Several radio tagged burbot probably spawned in the mainstem Susitna River between RM 13.0 and RM 92.0. Burbot showed both a pre- and post-spawning migration of up to 20 miles. Monitoring data suggest some middle river Arctic grayling overwinter in the mainstem at RM 147.0, near Portage Creek (RM 148.8), while other stocks migrate 40.0 miles downriver to overwinter in the mainstem Susitna River near Talkeetna.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF TABLES

LIST OF APPENDIX TABLES

1.0 INTRODUCTION

Resident Fish Studies were initiated in the fall of 1980 to determine the relative abundance, distribution, seasonal movements, and habitat characteristics of resident fish in the lower and middle Susitna River. Between 1980 and 1984, sampling for resident fish was primarily done with boat electrofishing during the open-water periods, mid-May to mid-October. Studies have also been conducted during the winters (November-April) of 1980-81, 1982-83, and 1983-84 (ADF&G 1981b, 1983c; Sundet and Pechek 1985). The results of past winter studies, however, have been generally inconclusive. The difficulty of sampling resident fish, other than burbot, effectively with standard methods (electrofishing, gillnetting, and angling) is due to winter conditions such as ice cover and frazil ice (slush ice). For this reason, the results of winter resident fish studies have been limited to describing the distribution, relative abundance, and suspected spawning areas of burbot (Lota lota Linnaeus). Sampling for burbot in the winter includes the use of baited hooks on trotlines.

A radio tagging program was initiated in the fall of 1981 to describe the distribution, movement, and habitat use of selected species of resident fish. Since that time, the movements of radio tagged rainbow trout (Salmo gairdneri Richardson) and burbot have been monitored throughout the winters of 1981-82, 1982-83, and 1983-84 (ADF&G 1983b, 1983c; Sundet and Pechek 1985). In addition, Arctic grayling (Thymallus arcticus Pallus) were monitored over the winter of 1982-83 (ADF&G 1983c). However, due to the low numbers of fish tagged each fall and the expiration of radio tag batteries before ground surveys could commence, only limited winter rearing habitat data have been collected for rainbow trout, burbot, and Arctic grayling. Therefore, biologists sought to radio tag a larger number of these resident fish in the fall of 1984 and conduct tracking surveys more frequently during the winter of 1984-85 to provide better documentation of winter distribution and habitat use.

The initial objectives of the 1984-85 winter studies of resident fish in the Susitna River were:

1. To describe the distribution and habitat associated with overwintering rainbow trout in the lower Susitna River (between Cook Inlet and the Chulitna River confluence).

2. To estimate the response of lower river rainbow trout overwintering habitat at selected sites (radio tagged fish relocation sites) to hydraulic changes during the winter period.

Although the primary intent of this study was to monitor the winter movements of fifty radio tagged rainbow trout in the lower Susitna River, biologists were only able to capture ten rainbow trout in this reach that were large enough to be radio tagged. Therefore, thirteen rainbow trout in the middle Susitna River (between the Chulitna River confluence and Devil Canyon) were also radio tagged during the fall to increase our knowledge of the distribution, movements, and habitat

associated with overwintering rainbow trout in that reach of river (a secondary objective). In addition, 15 rainbow trout which were radio tagged in the spring of 1984 were monitored through the winter until the batteries of their radio tags expired. Five middle river Arctic grayling and 14 lower river burbot were also radio tagged in the fall of 1984 using radio tags which had not been deployed during previous radio tagging efforts. These fish were also monitored through the winter of 1984-85. Another secondary objective of the winter studies, was to identify the locations and timing of burbot spawning in the lower Susitna River using radio telemetry.

This report primarily addresses winter resident fish studies which were conducted from November 1, 1984 to April 1, 1985. However, radio telemetry monitoring data for fish tagged in September and October 1984 are also presented. These data include movements from the time of tagging through the end of May, because breakup was late and did not occur until May 24 in 1985 (R&M 1985). In addition, winter monitoring data are presented from several middle river rainbow trout radio tagged during May and June 1984.

2.0 METHODS

2.1 Study Locations

2.1.1 Radio telemetry

Selection of radio tagging sites in the lower Susitna River during the fall of 1984 were based on resident fish capture data from 1981 and 1982 (ADF&G 1981b, 1983b). The primary capture efforts for radio tagging rainbow trout were focused in the mainstem Susitna at the mouths of the Deshka River, Willow Creek (RM 49.1), Little Willow Creek (RM 50.5), Kashwitna River (RM 61.0), Sheep Creek Slough (RM 66.1), Montana Creek (RM 77.0), and the Talkeetna River (RM 97.0) (Figure 1). The upper reaches of Sheep Creek (RM 67.7), Goose Creek (RM 72.0), and Montana Creek were also sampled for summer rearing rainbow trout. Efforts to capture burbot for radio tagging were focused at the mouth of the Deshka River, although backwater areas in the mainstem Susitna River were also sampled.

Selection of radio tagging sites in the middle Susitna River during the spring and fall of 1984 were based on resident fish distribution data collected during the 1981, 1982, and 1983 open-water field seasons (ADF&G 1981b, 1983b; Sundet and Wenger 1984). Based on these data, primary efforts to capture and radio tag rainbow trout and Arctic grayling in the mainstem Susitna were focused at the mouths of Whiskers Creek (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) (Figure 1). Some rainbow trout were also caught and radio tagged in the upper reaches of Fourth of July Creek, Indian River, and Portage Creek during May and June 1984.

2.1.2 Burbot spawning

Sampling sites were chosen in conjunction with the radio telemetry study. During the winter of 1984-85, radio tagged burbot were located in the mainstem Susitna River, between RM 6.6 and RM 93.2, and in the Deshka River[1] [river mile (RM) 40.6, tributary river miles (TRM's) 0.0 - 29.5] (Figure 1).

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[1] This tributary is identified on USGS topographic maps (1958) as Kroto Creek. However, the more common name for this tributary is the Deshka River and that is the name which has been used in this and past reports.

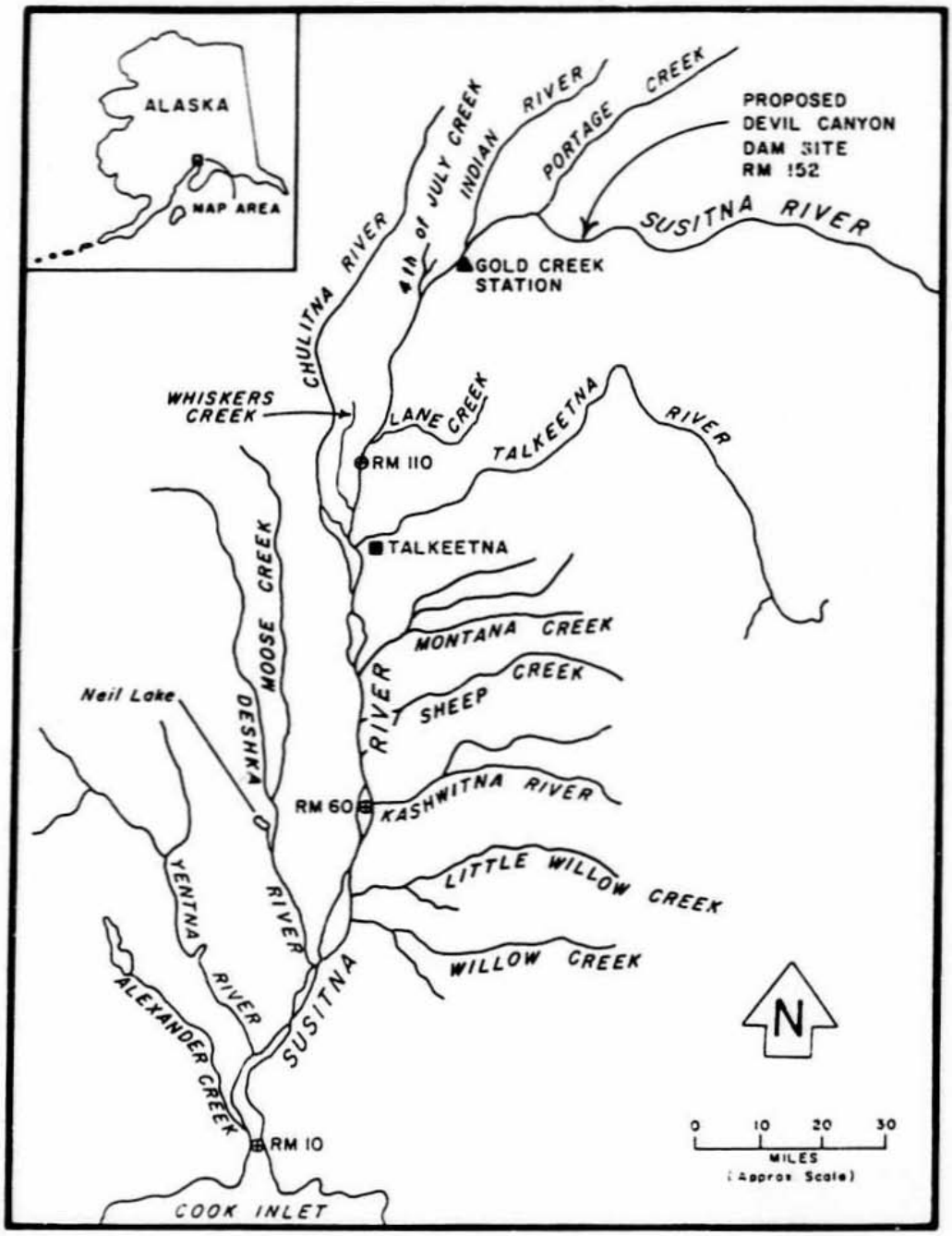

Figure 1. Map of the Susitna River and its main tributaries between Cook Inlet and Devil Canyon.

2.2 Data Collection

2.2.1 Radio telemetry

Most rainbow trout and all Arctic grayling which were radio tagged in 1984 were captured by boat electrofishing or by hook and line (Appendix Tables A-1, A-5, and A-7; Sundet and Pechek 1985). Some rainbow trout were also captured in hoop nets. Burbot which were radio tagged were captured by boat electrofishing or hoop net (Appendix Table A-3). Scales were taken from rainbow trout and Arctic grayling for age analysis.

Habitat parameters were measured at radio tagged fish relocation sites during the winter of 1984-85. During ground surveys in December, January, and February, radio tagged fish were located to within a four-foot-radius and habitat measurements were made as close to the signal as possible. Habitat parameters measured included mean column water velocity, water depths, ice thickness, the presence or absence of slush ice, substrate type, and general water quality (surface water temperature, dissolved oxygen, conductivity, and pH). Specific habitat data collection methodologies are summarized in ADF&G (1983a). During the ground surveys, the fate of each located radio tagged fish was also determined. This was done by pinpointing each radio tagged fish, creating a disturbance to frighten the fish (i.e., ice drill over each fish), and then repinpoint each fish to determine if the fish had moved.

Sampling gear was set near most radio tagged fish when ground surveyed to document if fish are concentrated in the winter, and to capture burbot for a spawning study. Baited trotlines and burbot sets were set near radio tagged burbot to capture that species. Trotlines, burbot sets, angling, and gill nets were set or used near radio tagged rainbow trout.

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 (ATS of Bethel, Minnesota) were used in the 1984-85 study. Two types of radio tags were used: internal and external. Internal radio tags were provided by both Smith-Root and ATS while external radio tags were provided solely by ATS. Smith-Root radio tags with a six or a nine month life expectancy were implanted in burbot. Advanced Telemetry Systems radio tags with 6-11 month life expectancies were implanted in rainbow trout and also several burbot when the supply of Smith-Root tags was exhausted. Since past efforts to internally radio tag Arctic grayling have failed (ADF&G 1983c), ATS external radio tags were attached to this species.

Smith-Root transmitters (Model P40-500L 3v) were identical to those used in previous resident fish telemetry studies (ADF&G 1981a, 1983b, 1983c).

Smith-Root transmitters used in the 1984-85 studies had pulse rates of 0.5, 1.0, or 3.0 pulses per second (pps). The 0.5 pps radio tags have a life expectancy of nine months; the others had a life expectancy of six months. Advanced Telemetry Systems internal transmitters (Model 10-35) were identical to those used in 1983 and 1984 summer telemetry studies with pulse rates between 1.0 and 2.4 pps (Sundet and Wenger 1984; Sundet and Pechek 1985). The life expectancy of these tags were eleven months and six months, respectively.

The Advanced Telemetry Systems external radio tags (Model RM625) that were used were the same as those used in 1984 summer studies (Sundet and Pechek 1985). The power source for the transmitters was a 1.4 volt mercury battery providing a life expectancy of 90 days. Pulse rates for these tags were 2.4 pps.

Transmitter frequencies used (40.600-40.770 MHz) were the same range as those used in 1983 and 1984 summer studies (Sundet and Wenger 1984; Sundet and Pechek 1985). 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.

Transmitter implantation

Based on personal communications with Carl Burger (USFWS) and experience gathered from the previous three years of radio telemetry studies, the minimum fork length of rainbow trout and Arctic grayling radio tagged in the summer and fall of 1984 was 380 mm (ADF&G 1983b, 1983c; Sundet and Wenger 1984). The minimum total length of burbot to be radio tagged was 525 mm.

Internal radio tags were implanted using the same procedures described in Ziebell (1973) and discussed in Sundet and Wenger (1984). External tags were attached in a manner similar to attaching Peterson discs (Sundet and Pechek 1985). Before surgery or attaching external tags, fish were anesthetized with MS-222 (tricaine methane sulfonate).

After radio tagging, the fish were placed into a live box and held upright until they regained their equilibrium. The fish were then held overnight whenever possible for observation. The following day the sutures were checked and the transmitter's signal was tested before releasing each radio tagged fish near their point of capture.

Tracking

Biologists radio tracked fish over the mainstem Susitna between RM's 0.0 and 154.0 primarily by fixed-wing aircraft or helicopter during the winter of 1984-85. Aerial radio tracking was done using methods described in ADF&G (1981c). Between September and freeze-up (mid-October) 1984, radio tracking was conducted by boat or fixed-wing aircraft approximately every 10-14 days. Between freeze-up and late May 1985, radio tracking was done by fixed-wing aircraft or helicopter every 20 days. Radio tracking was done less often from December through April than from September through November because past winter's work has

shown that resident fish move less during the winter than during the fall or other seasons (ADF&G 1983b, 1983c; Sundet and Pechek 1985).

Additionally, tracking flights were made regularly over the Deshka River (TRM's 0.0 to 29.5) to specifically monitor radio tagged burbot. Fixed-wing radio tracking was also done occasionally over various tributaries such as Yentna River (RM 28.5), Willow Creek, Little Willow Creek, Fourth of July Creek, and Portage Creek to monitor if radio tagged fish not found in the mainstem Susitna River had migrated into tributaries.

When helicopters were used for tracking, fish were pinpointed and habitat data were collected whenever it was possible to land near their relocations. Open water and thin surface ice prevented landing or pinpointing fish at some radio tagged fish relocations. Occasionally, snowmobiles were used instead of helicopters during the winter to track and pinpoint radio tagged fish.

2.2.2 Burbot spawning

Burbot were captured during the winter of 1984-85 by baited trotlines and burbot sets. Catch and biological data on burbot were also taken from sportfishermen on the Deshka River during the winter.

Biological data on captured fish (age, length, sex, and sexual maturity) were collected as outlined in ADF&G (1983a). Otoliths for age determination were taken from burbot sampling mortalities.

Habitat parameters were measured at suspected burbot spawning areas. The same habitat parameters were measured at suspected spawning areas as those taken during ground surveys at radio tagged fish relocations.

3.0 RESULTS

3.1 Lower Susitna River

3.1.1 Rainbow trout

Ten rainbow trout were radio tagged in the lower Susitna River between September 6 and October 12, 1984. A summary of their capture, biological, and radio tagging data is presented in Appendix Table A-1. During intensive surveys to radio tag rainbow trout in the upper reaches of several east side tributaries such as Montana Creek during September 1984, only three rainbow trout large enough to accommodate a radio tag were captured and subsequently radio tagged.

Seven lower river rainbow trout were captured and radio tagged between RM 49.5 and RM 96.0; four of these fish were captured in mainstem or side channel areas of the Susitna River and three fish were captured at clear-water tributary mouths.

Two of the ten radio tagged rainbow trout yielded little data. Rainbow trout 609-2.0 was only found once, one week after and within 0.1 mile of where it was tagged and released. Because this fish was not observed again, the battery of its radio tag was believed to have expired soon after release.[2] Rainbow trout 739-2.3 moved consistently downriver after it was tagged and was found during a ground survey on January 14 at RM 9.6 (Figure 2). Because the fish was located in very shallow water, only several inches deep, and it did not move after ice drilling, we believed the fish was dead.

Figures 2 and 3 show movements of eight radio tagged rainbow trout which were monitored during the winter period. Two of the three rainbow trout (609-1.3 and 620-1.2) which were tagged in the upper reaches of east side tributaries remained in the tributaries for at least two weeks before outmigrating to the mainstem Susitna. The third rainbow trout that was tagged in a tributary (599-1.2) moved into the mainstem Susitna soon after being tagged. By early October, all three of these rainbow trout were found in the mainstem Susitna.

After moving into the mainstem Susitna, the three rainbow trout which were radio tagged in tributaries, as well as the other five successfully radio tagged rainbow trout, showed variable movements. Six of the eight radio tagged rainbow trout showed a general downstream movement. Three of these fish (599-1.2, 650-1.3, 660-1.0) eventually moving back upriver

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[2] The fish was later recaptured by a sportfisherman on September 1, 1985 at TRM 5.5 of Little Willow Creek. He reported the fish had healed from its surgery, appeared healthy, and the radio tag was still in its body cavity.

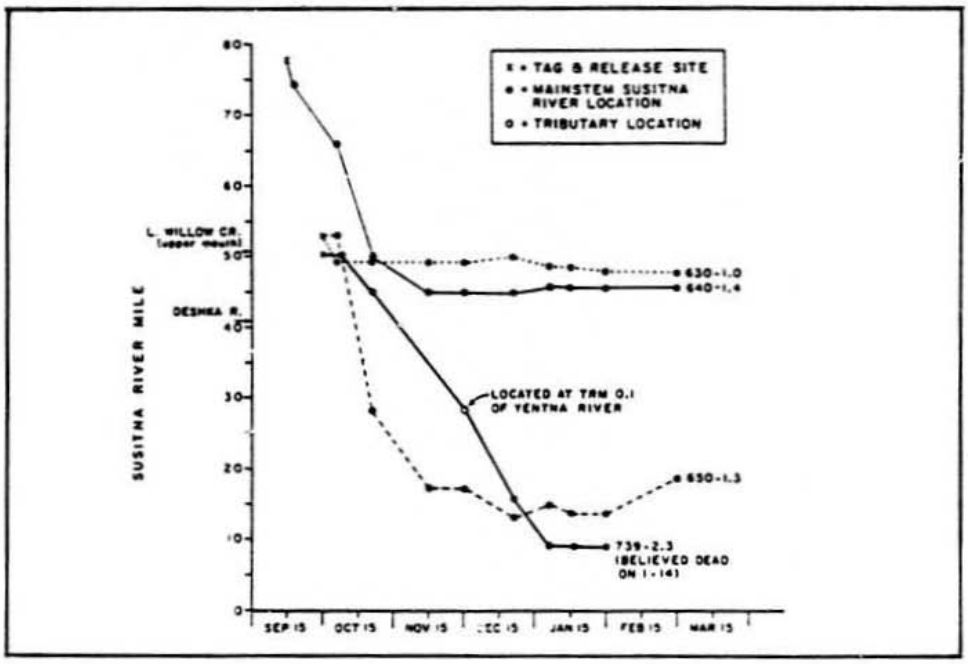

Figure 2. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to March 1985.

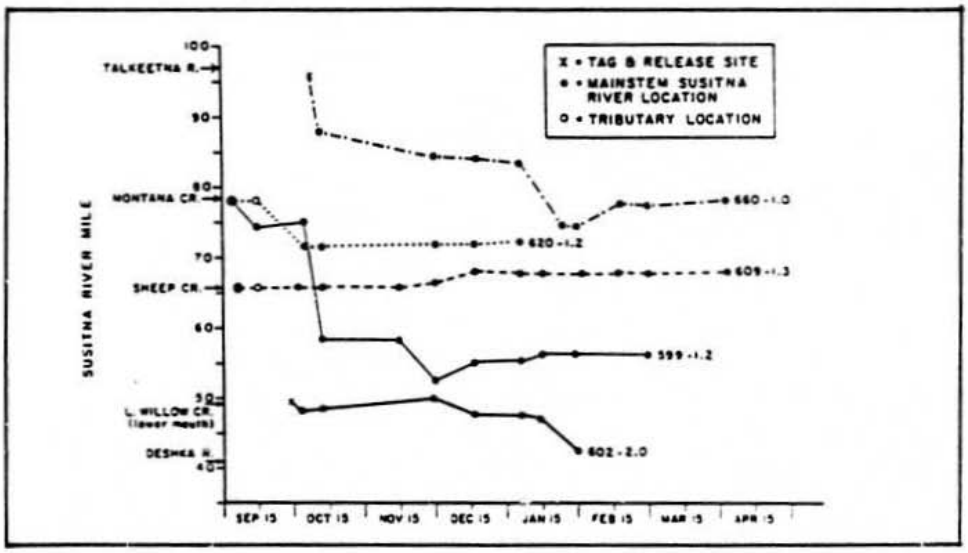

Figure 3. Movement of five radio tagged rainbow trout in the Susitna River, September 1984 to April 1985.

during the winter. Two fish (602-2.0 and 630-1.0) moved a short distance (1.5 miles) downriver for the winter and another (640-1.4) moved rapidly downriver (28.0 miles) before holding. The remaining two fish (609-1.3 and 620-1.2) moved upriver a short distance (1.0 miles). The maximum upriver movement by a radio tagged rainbow trout (650-1.3) was 5.5 miles. This fish also exhibited the maximum downriver movement (20.0 miles).

During mid-January or February, ground surveys were done in the vicinity of eight of the ten radio tagged rainbow trout. At this time, rainbow trout 739-2.3 was found dead and seven fish were believed to be alive.

Four of the fish (602-2.0, 609-1.3, 630-1.0, and 640-1.4) were found in side channels approximately 200 feet wide and in water less than four feet deep (Appendix Table A-5). The remaining three rainbow trout were found in the mainstem Susitna in waters between 1.5 and 10.0 feet deep. Rainbow trout (599-1.2) was found in an open-water area and it remained there for much of the winter. The other six fish remained under ice cover for much of the winter and little open water was observed near any of these fish during fixed-wing tracking surveys. A summary of the habitat data collected at rainbow trout relocation sites are presented in Table 1. Specific measurements at each radio tagged fish relocation are presented in Appendix Table A-2.

Five of seven radio tagged rainbow trout moved between 30 and 200 feet when the ice was drilled over them. With regard to the two fish that did not move, rainbow trout 739-2.3 was dead and rainbow trout 660-1.0 was believed to be alive because it had recently moved upriver 3.0 miles. Sampling gear was set overnight near five radio tagged rainbow trout. None of the radio tagged rainbow trout were caught, but seven non-spawning burbot were captured in mid-January near rainbow trout 640-1.4 at RM 46.0 (Appendix Table B-1).

3.1.2 Burbot

Fourteen burbot were radio tagged in the lower river between September 14 and October 17, 1984. Eight of these fish were radio tagged at the Deshka River (RM 40.6). Another three burbot were radio tagged in the mainstem Susitna close to the Deshka River. The remaining three burbot were radio tagged elsewhere in the mainstem Susitna. Appendix Table A-3 lists the biological, capture, and radio tagging data for these fish.

Little data were provided by four of the radio tagged burbot. Two fish (610-3.0 and 629-3.0) apparently died soon after they were tagged and their movement is not discussed further. The battery of a third radio tagged burbot (619-2.2) apparently expired soon after it was deployed (Figures 4 and 5). The remaining burbot (770-2.4) was recaptured by a sportfisherman 2.5 months later and 1.5 miles upriver of where it had originally been radio tagged and released (Figure 4).

The movements of the ten remaining radio tagged burbot were variable. All ten exhibited an upstream movement between 0.4 miles and 30.2 miles (Figures 4, 5, and 6) and a downstream movement. Burbot 659-1.0 moved

Table 1. Summary of habitat data collected at radio tagged rainbow trout relocation sites in the lower Susitna River, January and February 1985.

	Water Depth (ft)	Ice Depth (ft)	Slush Depth (ft)	Water[a] Velocity (fps)	Substrate	Surface Water Temperature (°C)	Surface Water DO (mg/l)	Surface Water Conductivity (umhos/cm)	Surface Water pH
n	7	7	7	7	6	6	2	6	6
$\bar{X}$	3.5	1.8	0.0	1.0	sand/gravel	-0.2	10.6	184	7.0
Minimum	0.4	0.0	0.0	0.0	silt	-0.3	10.2	160	6.7
25th Percentile	1.3	1.4	0.0	0.2	--	-0.3	10.2	171	6.8
Median	1.5	2.0	0.0	0.4	--	-0.2	10.6	189	6.9
75th Percentile	5.0	2.5	0.0	1.4	--	0.0	10.9	195	7.2
Maximum	10.0	3.0	0.0	3.5	cobble	0.0	10.9	202	7.3

[a] Mean column water velocity

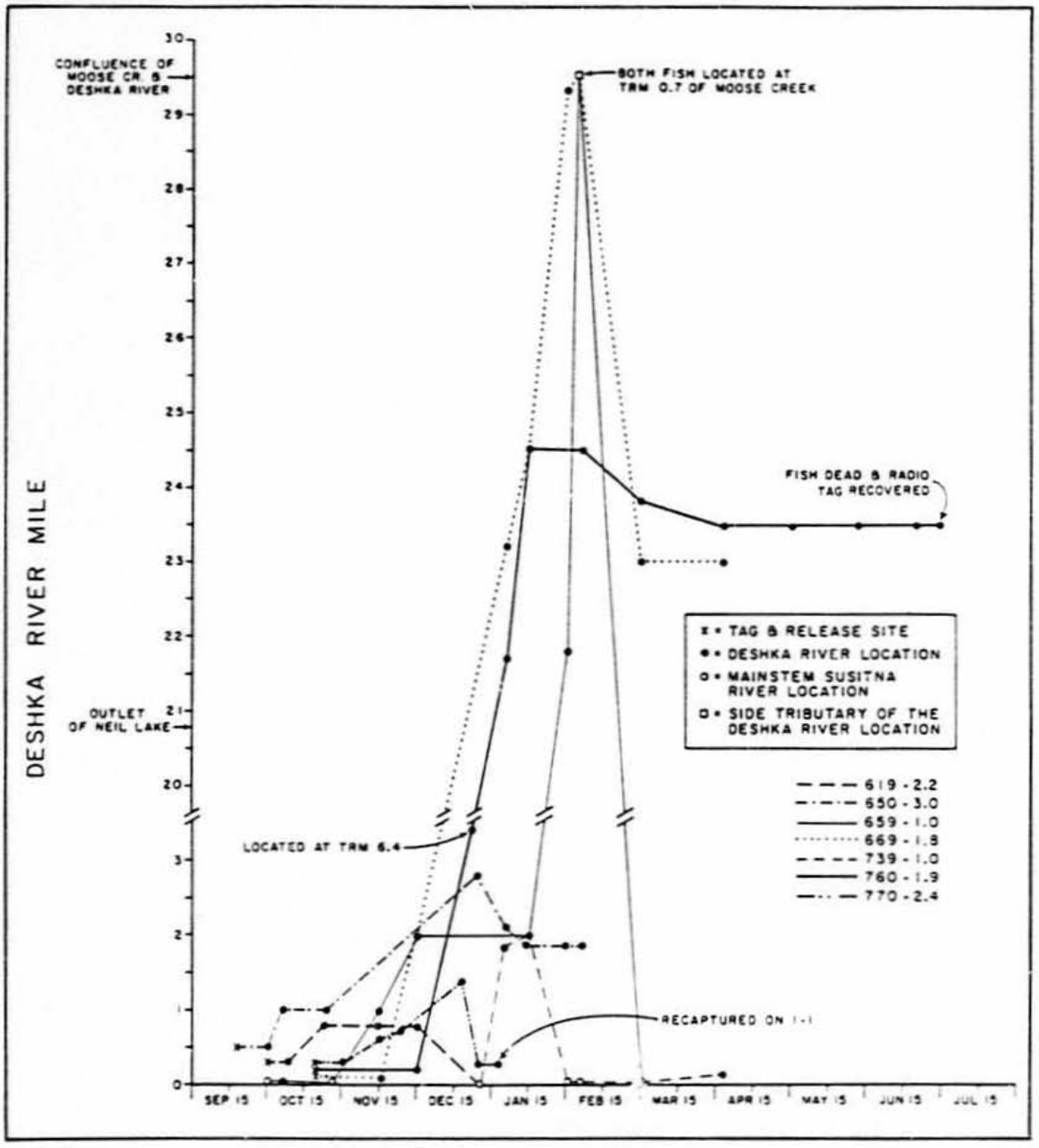

Figure 4. Movement of seven radio tagged burbot in the Deshka River (RM 40.6), September 1984 to July 1985.

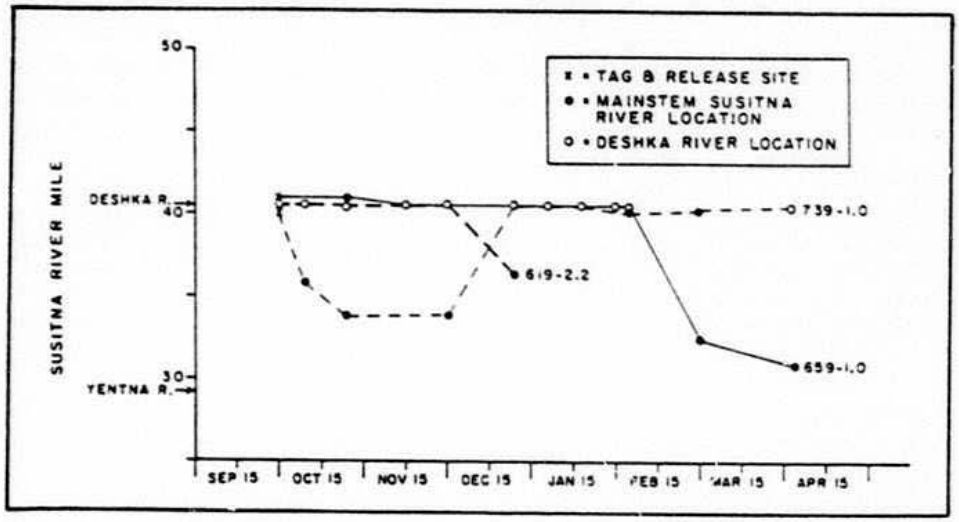

Figure 5. Movement of three radio tagged burbot in the Susitna River, September 1984 to April 1985.

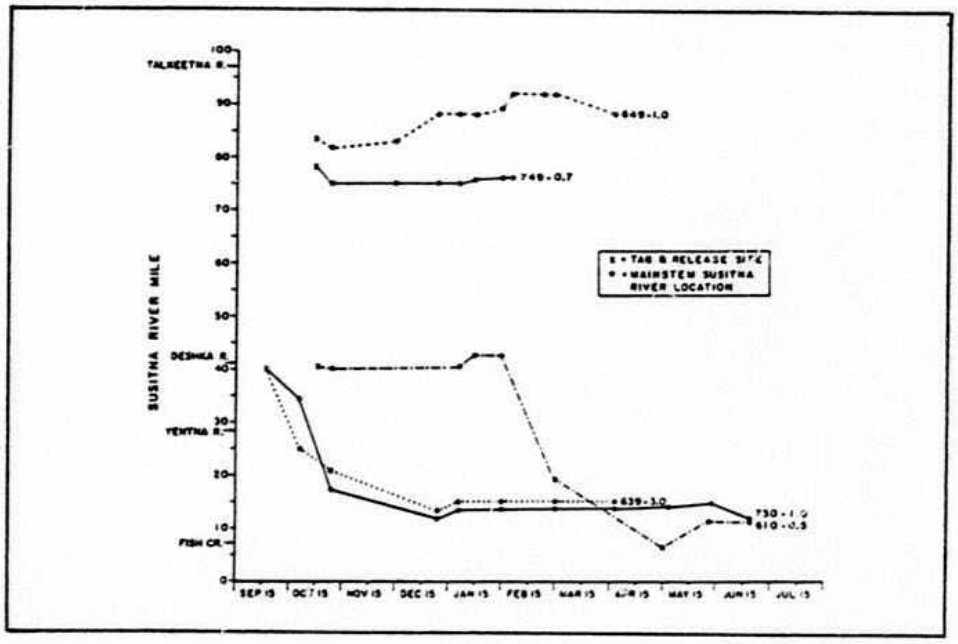

Figure 6. Movement of five radio tagged burbot in the Susitna River, September 1984 to June 1985.

downriver 39.8 miles after ascending the Deshka River (Figures 4 and 5), which was the longest downstream movement recorded for a burbot in this study.

Five radio tagged burbot spent much of the winter in the Deshka River. Three of these fish (659-1.0, 669-1.8, 760-1.9) migrated to the upper reaches of the Deshka River and two were found at TRM 0.7 of Moose Creek on February 5. Moose Creek flows into the Deshka River at TRM 29.5. Two other radio tagged burbot (650-3.0 and 739-1.0) spent much of the winter near TRM 2.0 of the Deshka River. Burbot 659-1.0 moved to the upper reaches of the Deshka River after spending 1.5 months at TRM 2.0.

Movement data were also collected on five radio tagged burbot which remained in the mainstem during the winter of 1984-85 (Figure 6). Generally one fish (649-1.0) moved upriver, another (749-0.7) remained relatively stationary, and the remaining three burbot (610-0.5, 639-3.0, 730-1.0) moved downriver to the lower reaches of the Susitna River (RM's 6.6 to 17.0). The first two fish were tagged in the mainstem near the Parks Highway (RM 84.0) and the latter three fish were tagged in the mainstem near the mouth of the Deshka River.

From mid-December through February, movement data collected during ground surveys indicated that most (9 of 10) of the radio tagged burbot were alive. Seven of the nine fish moved after ice drilling was done over them. Burbot 629-3.0 was believed to be dead during a ground survey on January 16. Although no movement was detected after ice drilling over the remaining two fish (649-1.0 and 650-3.0), those fish were believed to be alive because one had recently moved upstream and the other moved upstream on a later survey.

Habitat measurements taken at 14 radio tagged burbot relocations showed they were generally found in low water velocities and water depths less than 6.0 feet deep in the Deshka River, and in low water velocities and variable depths in the mainstem (Table 2). However, few areas in the Deshka River are believed to be over 6.0 feet deep (water depth) during the winter. By comparison, the lower mainstem Susitna River has many areas which have winter water depths greater than 6.0 feet. The radio tagged burbot were also generally found under solid ice cover. In three instances, radio tagged burbot were found near open leads but still under ice. In one instance, a radio tagged burbot was found under two feet of surface overflow. Table 2 presents a summary of habitat data collected at the radio tagged burbot relocation sites. Specific habitat measurements at each relocation site are presented in Appendix Table A-4.

During ground surveys, burbot sets and trotlines were set overnight near several radio tagged burbot. Although none of the radio tagged burbot were recaptured, 32 untagged burbot were captured in varying stages of sexual maturity (Appendix Table B-1).

By May, only one radio tagged burbot (760-1.9) was found in the upper reaches of the Deshka River. During a ground survey in late June, the radio tag of this fish was found in shallow water along the bank of the

Table 2. Summary of habitat data collected at radio tagged burbot relocation sites in the lower Susitna River, December 1984 and February 1985.

	Water Depth (ft)	Ice Depth (ft)	Slush Depth (ft)	Water[a] Velocity (fps)	Substrate	Surface Water Temperature (°C)	Surface Water DO (mg/l)	Surface Water Conductivity (umhos/cm)	Surface Water pH
Mainstem Sites:									
n	4	4	4	4	4	3	2	3	3
$\bar{X}$	3.3	2.3	1.9	0.1	gravel/cobble	-0.1	12.2	145	7.2
Minimum	0.2	1.5	0.0	0.0	sand	-0.2	11.5	74	7.1
25th Percentile	0.8	1.8	0.1	0.0	--	-0.1	11.5	123	7.2
Median	2.7	2.3	1.7	0.1	--	0.0	12.2	172	7.3
75th Percentile	5.9	2.8	3.8	0.1	--	0.0	12.9	180	7.3
Maximum	7.8	3.0	4.3	0.1	cobble	0.0	12.9	188	7.3
Deshka River Sites:									
n	10	10	10	10	10	9	5	9	9
$\bar{X}$	1.1	2.3	0.0	0.3	gravel/sand	0.0	9.1	79	6.8
Minimum	0.1	1.5	0.0	0.0	sand	-0.2	8.4	58	6.4
25th Percentile	0.2	2.0	0.0	0.1	--	-0.2	8.6	67	6.8
Median	1.1	2.5	0.0	0.4	--	0.1	9.0	74	6.9
75th Percentile	2.0	2.5	0.0	0.4	--	+0.1	9.0	92	7.0
Maximum	3.0	2.9	0.0	0.5	cobble	+0.2	10.4	101	7.2

[a] Mean column water velocity

Deshka River at TRM 23.5. Tracking data suggests that this fish may have died after mid-February.

A second burbot which had been radio tagged in 1984 was recaptured during 1985. A sportfisherman caught burbot 649-1.0 at the mouth of Sunshine Creek (RM 85.7) on July 30, 1985. Prior to its recapture, it had been located by aerial survey in the mainstem Susitna at RM 88.0 on April 4, 1985. The sportfisherman reported the fish appeared healthy.

Biological characteristics: sexual development, age, length, and sex composition

Non-, pre-, and post-spawning burbot were captured by biologists in the Susitna River and the Deshka River between December 17, 1984 and February 8, 1985. In addition, burbot catch and biological data were obtained from a sportfisherman at the Deshka River who recorded his catch data from late November to mid-December 1984.

Lower river pre-spawning burbot were captured from November 25 to January 16. Post-spawned burbot were first captured on February 5 at TRM 0.7 of Moose Creek. All burbot captured after February 5 were post- or non-spawners. Several non-spawners were also captured before February 5. Sampling locations and catch per unit effort (CPUE) of all burbot captured during the winter of 1984-85 are presented in Appendix Table B-1.

Between November 25 and February 8, sex was determined for 63 burbot by necropsy and their sexual maturities were recorded (Appendix Table B-2). Fifty-three of the 67 burbot were aged. Ages ranged from 5 to 12 with ages 7 (20.8%), 6 (15.1%), 8 (15.1%) and 9 (15.1%) comprising the majority of the sample. Lengths of aged fish ranged from 405 mm to 740 mm in total length (TL) (Appendix Table B-3). Figure 7 illustrates the average length and range of lengths for each age class of burbot sampled between December 1984 and February 1985.

Of the 53 burbot aged, 35 fish were pre- or post-spawners. Eight of the pre- or post-spawners were males ranging from 405 mm to 740 mm (TL) and encompassing age classes 6 to 11. The remaining 27 pre- or post-spawning aged females ranged from 360 mm to 780 mm (TL) and encompassed age classes 5 to 12. The remaining 18 burbot aged were non-spawners. Five non-spawners were males ranging in length from 410 mm to 665 mm and age from 5 to 8 years. The 13 non-spawning females ranged in length from 400 mm to 705 mm and age from 5 to 12 years.

3.2 Middle Susitna River

3.2.1 Rainbow trout

Thirteen rainbow trout were radio tagged in the middle river during September and October 1984 and their movements were monitored over the winter of 1984-85. Another 15 rainbow trout which were radio tagged in May and June 1984 were also monitored over the winter until their transmitter batteries expired. Capture, biological, and radio tagging

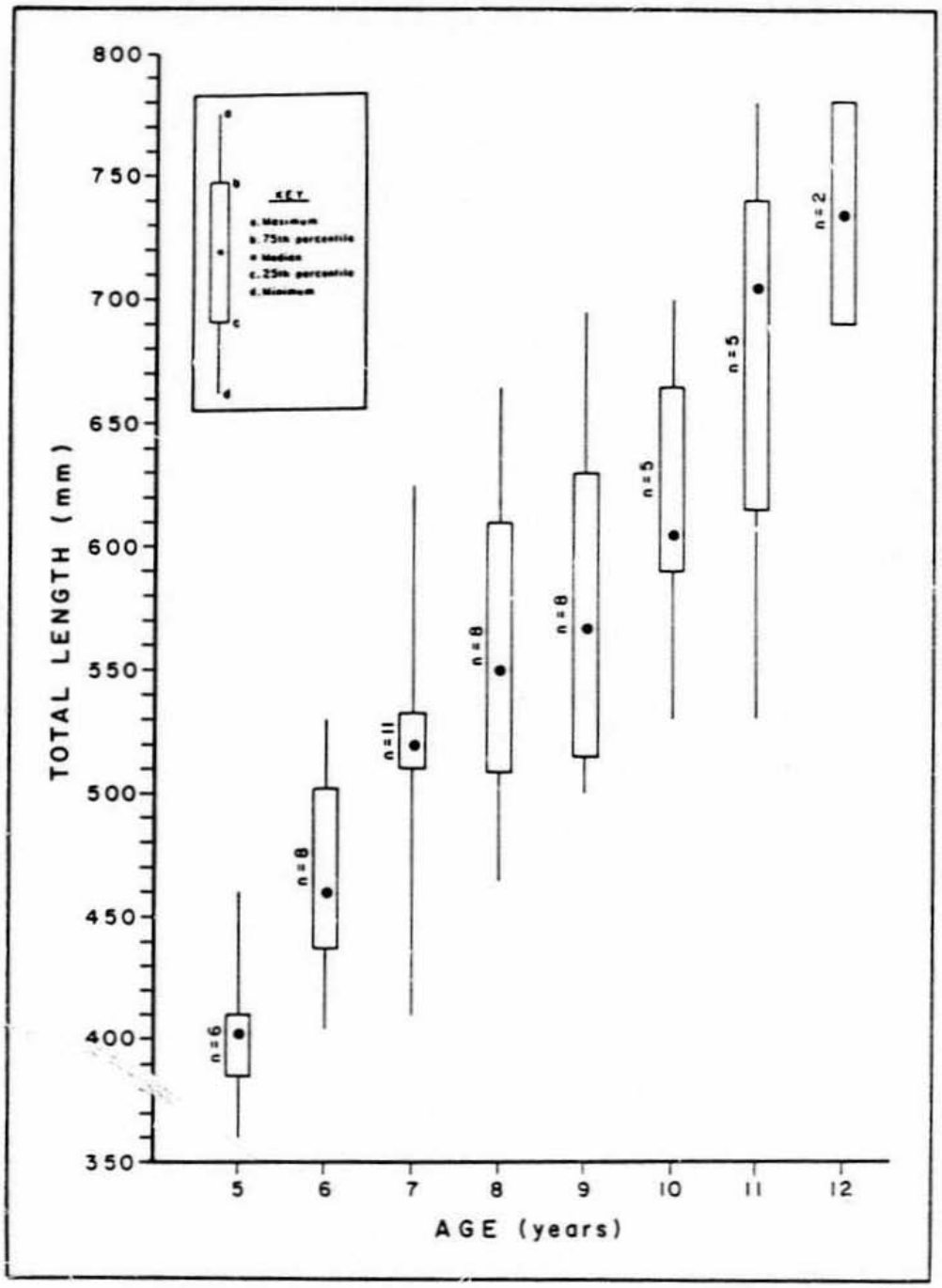

Figure 7. Age-length relationships for burbot captured in the Susitna River between Cook Inlet and Devil Canyon, December 1984 through February 1985.

data for the rainbow trout radio tagged in the fall of 1984 are provided in Appendix Table A-5. Capture data for the rainbow trout which were radio tagged during the spring of 1984 are reported in Sundet and Pechek (1985) along with monitoring data between May and November 1984.

Little useful data were collected from six of the radio tagged rainbow trout because they expired during the fall of 1984 or the winter of 1984-85. Two of these fish (598-1.6 and 670-1.2) probably died before November 1984 and their fates are discussed in Sundet and Pechek (1985). Two rainbow trout were determined to be dead (740-1.4 and 749-1.1) during ground surveys in late January or early February. Rainbow trout 618-2.1 was believed dead during a late January ground survey (Figure 8). The remaining rainbow trout (719-1.6) moved upriver during late September, but then slowly moved back downriver and was believed dead during an early February ground survey (Figure 9).

The other 22 rainbow trout were determined or believed to have survived the winter. All of these rainbow trout outmigrated from tributaries to the mainstem by early October and their movements are presented in Figures 8 through 12.

Overwintering movements of radio tagged rainbow trout can be grouped into three categories based on the distance the fish move from where they were tagged. These categories are: (1) fish movements $\leq$ 4.0 miles, (2) fish movements $\geq$ 4.1 miles and $\leq$ 15.0 miles, and (3) fish movements $\geq$ 15.0 miles. Twenty-two radio tagged rainbow trout overwintered in the mainstem Susitna, however overwintering movements of only 21 of these rainbow trout are discussed.[3] Fourteen of 21 fish overwintering within 4.0 miles of their Susitna River tagging sites or the mouths of the tributaries where they were tagged. Five of the radio tagged rainbow trout (608-1.9, 620-1.2, 630-1.0, 709-1.2, 770-1.1) overwintered between 4.1 and 15.0 miles from their Susitna River tagging location or the mouths of the tributaries where they were tagged (Figures 9, 10, and 11). The remaining two radio tagged rainbow trout (640-1.0 and 759-1.7) were found 90 and 94 miles from where they were tagged in late September (Figure 8). Because these two fish moved downriver so rapidly and so far, it appears they were injured during capture or tagging. These two fish then seemed to recover and attempted to move back upriver. We believe that both fish died in early or late February, because thereafter they either moved downriver or remained stationary.

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[3] Rainbow trout (728-1.0) escaped from a live box that was located 10 miles downriver from its recapture point while it was being held for observation. Because this fish was accidentally displaced, its overwintering movements were considered questionable. Therefore, overwintering movements of this rainbow trout are not included in this discussion.

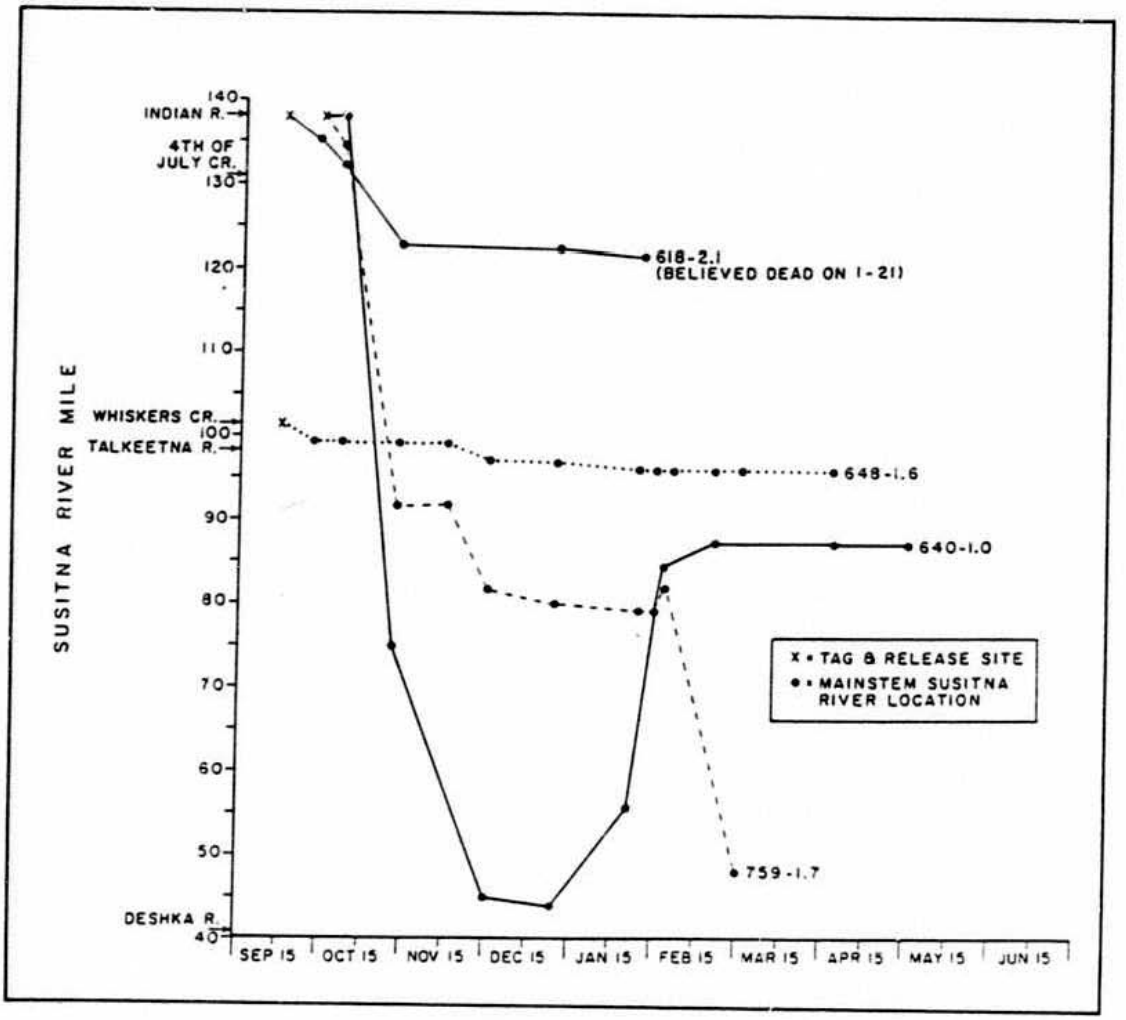

Figure 8. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to May 1985.

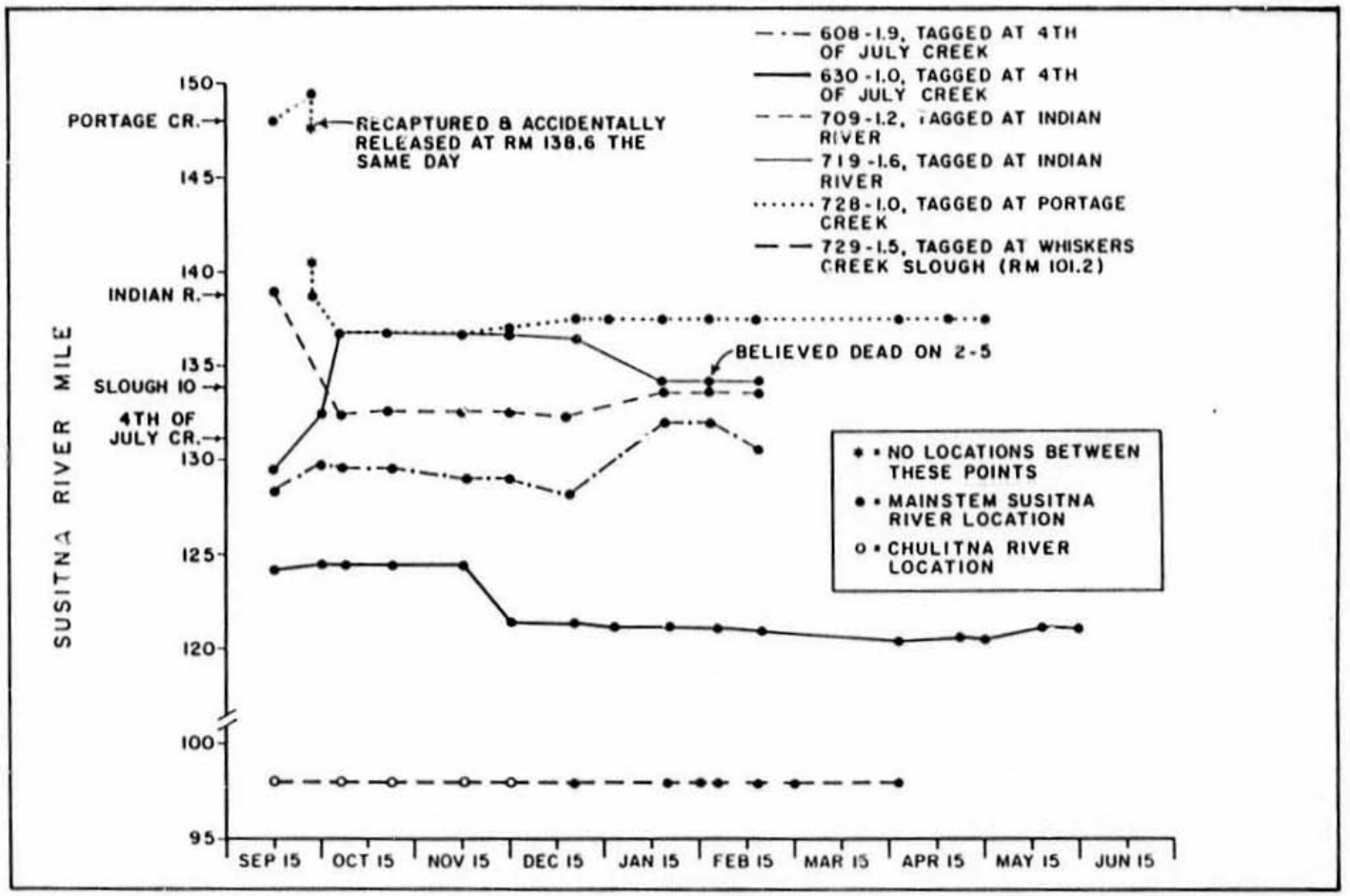

Figure 9. Winter movement of six radio tagged rainbow trout which were tagged during the spring of 1984, September 1984 to May 1985.

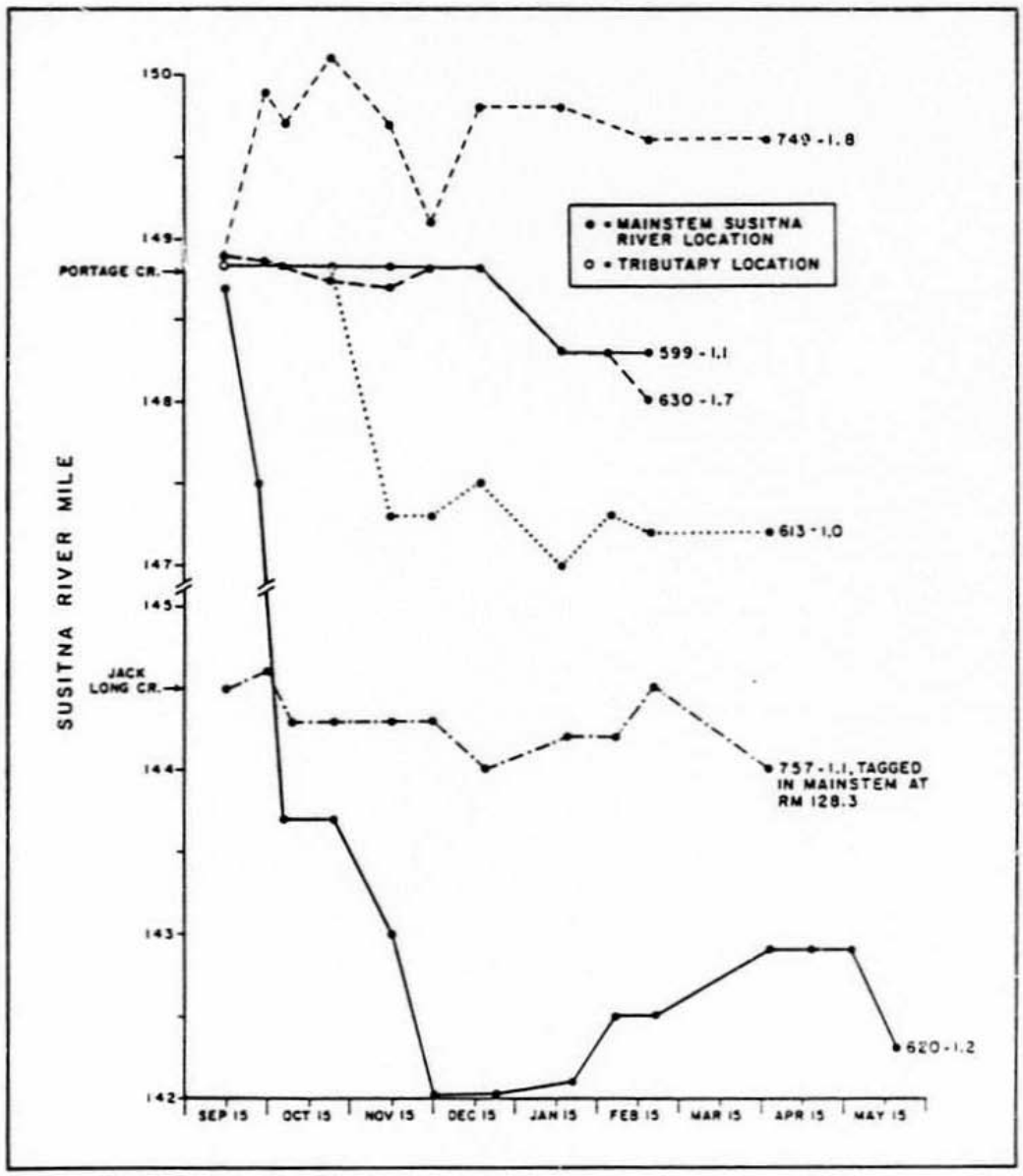

Figure 10. Winter movement of six radio tagged rainbow trout which were tagged during the spring of 1984 in the Susitna River, September 1984 to May 1985. All except one fish was tagged in Portage Creek.

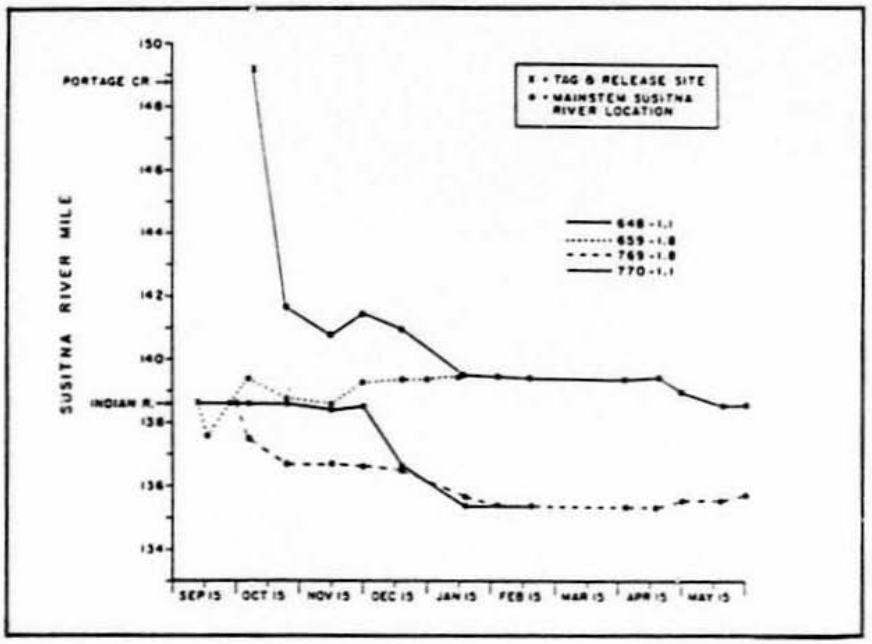

Figure 11. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to May 1985.

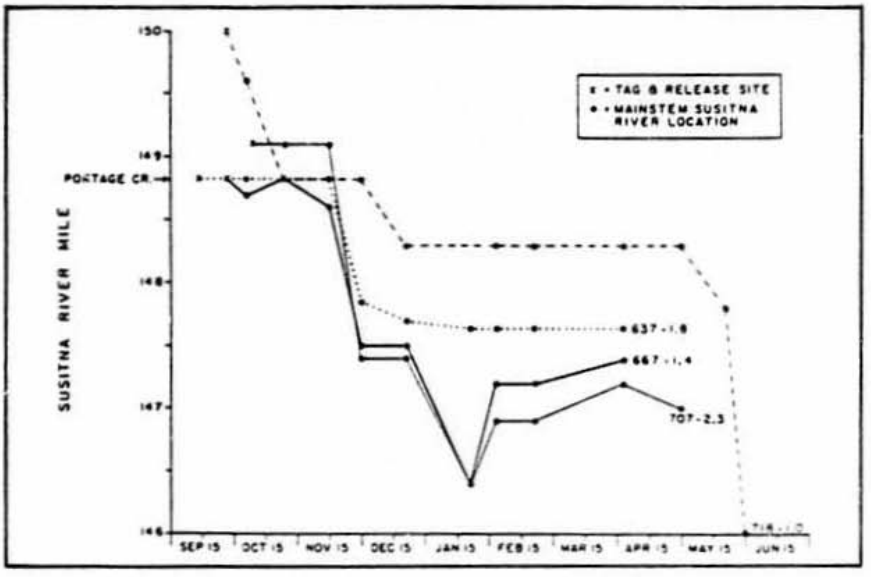

Figure 12. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to May 1985.

Only two radio tagged rainbow trout (659-1.8 and 749-1.8) overwintered upstream of their mid-October locations for more than two months.

Groups of two or more radio tagged rainbow trout overwintered in several specific sections of the mainstem Susitna River. Eight rainbow trout were found between RM's 146.0 and 151.0 (Figures 10 and 12), four rainbow trout were found between RM's 135.0 and 140.0 (Figure 11), and two rainbow trout were found between RM's 97.0 and 100.0 (Figures 8 and 9).

Generally, radio tagged rainbow trout monitored over the winter of 1984-1985 moved the greatest distance between mid-September and late November 1984. Some radio tagged fish also appeared to move between late December and mid-January. In addition, the few rainbow trout with radio tags still functioning in the spring appeared to move again in early April.

During ground surveys conducted in January and February, habitat data were collected at 29 fish relocations from 23 different radio tagged rainbow trout which were determined or believed to be alive. During these relocation surveys, all of the radio tagged rainbow trout were found in the mainstem Susitna and generally in waters of low to moderate velocities and of moderate depths. Most (26 of 29) rainbow trout relocations were in areas that were covered with ice, however, ten relocations were within 200 feet of open leads. Table 3 summarizes the habitat data collected at the 29 fish relocations and specific measurements taken at each fish relocation site are presented in Appendix Table A-6.

Often two or more radio tagged rainbow trout were found within 100 feet of each other during ground surveys. Sites where radio tagged fish were found together were: RM's 135.4, 139.5, 146.4, 147.0, and 148.3. In one instance at RM 147.0, a radio tagged rainbow trout (613-1.0) was found 50 feet from a radio tagged Arctic grayling (740-2.3).

During ice drilling at the radio tagged rainbow trout relocation sites, movement was detected at 19 of 25 sites. None of the radio tagged rainbow trout were recaptured when burbot sets and trotlines were set at several of the relocation sites, however, several non-tagged fish were captured. Three burbot were captured near rainbow trout 630-1.0 and one burbot was captured near a rainbow trout that was believed to be dead (598-1.6) (Appendix Table B-1). One rainbow trout was captured by hook and line at RM 146.4, near rainbow trout 667-1.4 and 707-2.3 in early February.

During ground surveys, habitat measurements were also taken at the relocations of six radio tagged rainbow trout which were determined or believed dead. These fish were found in little or no water (Appendix Table A-6).

Table 3. Summary of habitat data collected at radio tagged rainbow trout relocation sites in the middle Susitna River, January and February 1985.

	Water Depth (ft)	Ice Depth (ft)	Slush Depth (ft)	Water[a] Velocity (fps)	Substrate	Surface Water Temperature (°C)	Surface Water DO (mg/l)	Surface Water Conductivity (umhos/cm)	Surface Water pH
n	28	28	28	28	28	27	24	27	25
$\bar{X}$	4.4	2.3	0.4	0.9	cobble	0.0	12.9	235	7.2
Minimum	0.9	0.0	0.0	0.0	silt	-0.2	10.2	140	6.0
25th Percentile	3.5	1.9	0.0	0.3	--	-0.2	11.9	227	7.0
Median	4.1	2.5	0.0	0.7	--	-0.1	12.8	239	7.2
75th Percentile	5.3	2.9	0.0	1.5	--	0.0	14.6	252	7.4
Maximum	10.0	4.3	3.7	2.5	cobble	+0.3	15.7	306	7.7

[a] Mean column water velocity

3.2.2 Arctic Grayling

Five Arctic grayling were radio tagged in the middle river on September 11 or September 26, 1984. Appendix Table A-7 presents the capture, biological, and radio tagging data for these fish.

Winter movements of three of the radio tagged Arctic grayling (610-2.4, 629-2.2, 639-2.3) contrasted with the movements of the remaining two fish (600-2.4 and 740-2.3) (Figure 13). These three fish moved rapidly downriver (between 36.6 and 63.6 miles) in the mainstem Susitna River immediately after being tagged and released at the mouth of Indian River. The other two fish remained relatively stationary in the mainstem Susitna River, just downriver from their tagging site at the mouth of Portage Creek. One of the fish which moved rapidly downriver (610-2.4) also became relatively stationary after moving 36.6 miles in 20 days.

Two of the Arctic grayling which moved rapidly downriver (629-2.2 and 639-2.3) provided little data because the batteries of their radio tags were presumed to have expired prematurely. Biologists failed to discover these fish during intensified monitoring flights in the areas where the two fish were last found.

During winter ground surveys in mid-January, only two of the five Arctic grayling's radio tags were transmitting signals. Arctic grayling 600-2.4 was found dead under solid ice. Arctic grayling 740-2.3 was alive at RM 147.0, 50 feet from rainbow trout 613-1.0. During ice drilling, the Arctic grayling moved 35 feet. Habitat data collected near Arctic grayling 740-2.3 on January 21 included: water depth = 2.3 ft, ice depth = 3.0 ft, slush ice - absent, water velocity = 0.3 fps; water quality parameters: pH = 7.4, DO = 14.5 mg/l, conductivity = 228 umhos/cm, water temperature = -0.2°C; and the substrate was 60% cobble and 40% gravel.

Arctic grayling 740-2.3 was also located during subsequent ground surveys. On February 5, this Arctic grayling was pinpointed at the same location where it was in mid-January (along the east shore of an island). On February 28, it was found 0.4 miles upriver of the earlier locations in the east channel of the Susitna River in a deep back eddy near open water. No additional winter habitat data was collected for this fish.

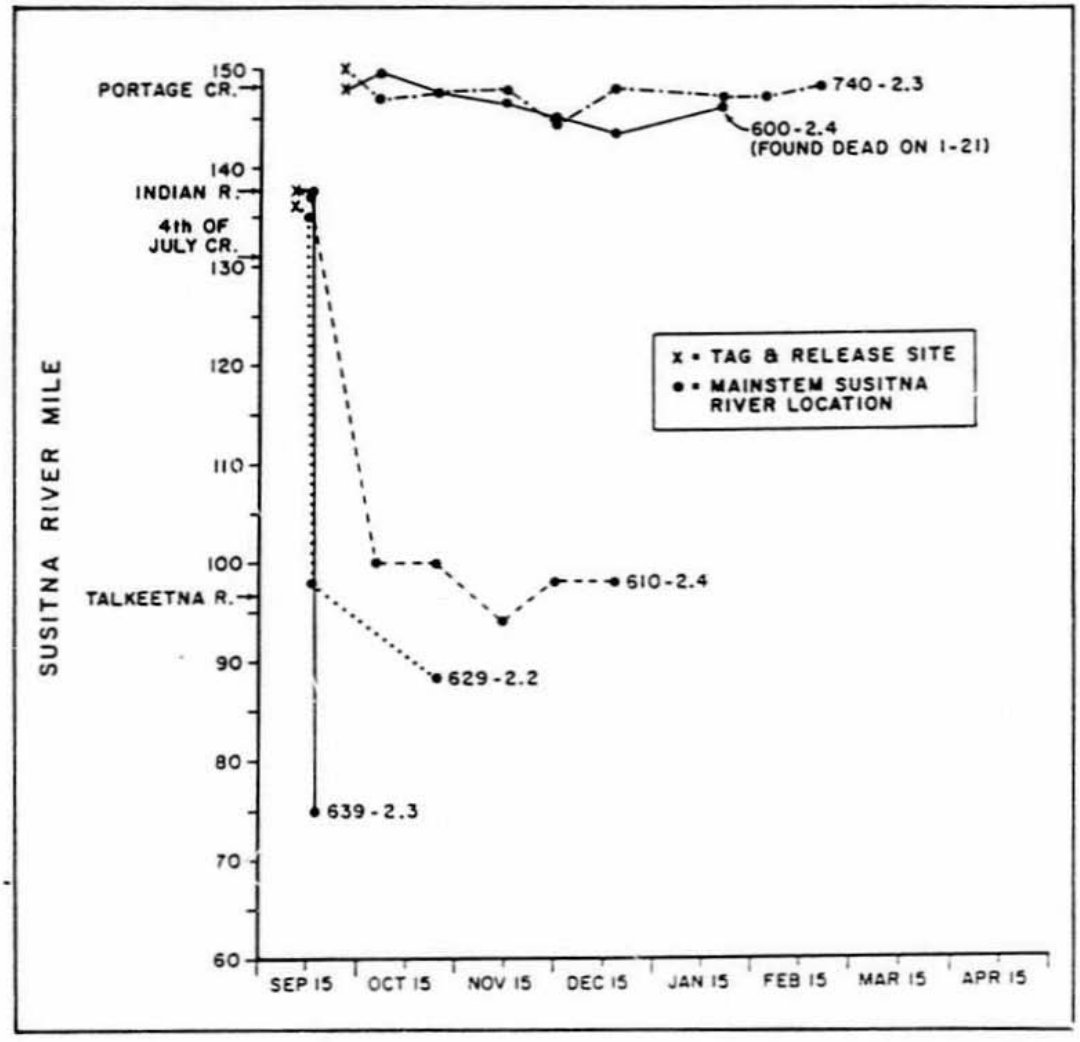

Figure 13. Movement of five radio tagged Arctic grayling in the Susitna River, September 1984 to February 1985.

4.0 DISCUSSION

Few practical and efficient methods are available to sample resident fish populations in the Susitna River during the winter. Baited trotlines were found to be effective for capturing burbot, hoop nets were difficult to set, and electrofishing was impossible. Winter studies in other areas of Alaska have found gill nets to be effective for sampling fish populations other than burbot (Bendock 1981, 1982, 1983; Hallberg 1984). Attempts to use gill nets in the Susitna River during the winter of 1980-81 and 1984-85 to help determine the presence and abundance of resident fish at specific sites (radio tagged fish relocations) have been largely unsuccessful due to: 1) shallow water at sampling sites, 2) water velocities that are too strong to set a net, and/or 3) presence of slush or frazil ice which fouls the net.

While winter resident fish abundance studies have largely failed, winter movements of select resident fish in the Susitna River are now better understood through the use of radio telemetry. Radio telemetry has also enabled us to locate overwintering areas of resident fish in the Susitna River so that habitat parameters of these areas could be evaluated. Although radio telemetry has provided us with the best data on the overwintering behavior of select fish, some reservations may be necessary before placing absolute confidence in this data because of biases. These biases may be due to the size of fish radio tagged (generally, the largest fish of a species are radio tagged), effects of capture and radio tagging (refer to Section 4.2.2), and the small sample sizes of fish radio tagged in comparison to the overall population sizes of those species.

Examination of data collected during the falls and winters from 1980-85 enable us to make several general conclusions. Between late September and October in 1982, 1983, and 1984 overall resident fish catches and catch rates decreased despite the fact that at these times, conductivity increased thereby increasing the efficiency of boat electrofishing (ADF&G 1983b; Sundet and Wenger 1984; Sundet and Pechek 1985). Since more fish move out of tributaries into the mainstem Susitna River in the fall, initial beliefs were that catches would increase instead of decrease in October. However, water clarity increases substantially during this time and fish may move into deeper water for cover. Habitat suitability studies show that some species of mainstem Susitna River resident fish are found more often in turbid water, that provides cover, than clear water areas (Suchanek et al. 1984). In 1984, mainstem waters appeared to be less turbid during October than in other years (1981-83). In October of 1984, even when boat electrofishing was done in waters up to six feet deep at normal productive areas such as the mouth of Portage Creek, few resident fish of any species were captured compared to September catches.

Other support for the assumption that fish move into deeper mainstem waters as turbidities decrease are provided by radio tagged fish and hook and line data (unpublished data). Radio tagged rainbow trout and Arctic grayling pinpointed in October of 1983 and 1984 were all found in water greater than six feet deep. Biologists angling in October at the mouths of productive middle river tributaries such as Portage Creek have

found that rainbow trout and Arctic grayling are captured more frequently in deep water during the day. Biologists have also observed that their angling catches are higher at dusk than during the day, indicating that fish move from deeper to shallower waters in the evening. This diurnal-nocturnal type of movement has been documented by other studies with fish using darkness as cover for feeding purposes (Campbell and Neuner 1985).

Previous ADF&G winter studies have indicated that radio tagged fish may seek overwintering areas that are at or near a source of groundwater upwelling (ADF&G 1983b, 1983c, 1983d; Sundet and Wenger 1984; Sundet and Pechek 1985). Evidence of possible groundwater upwelling in these studies were suggested by higher conductivity measurements in several overwintering areas where radio tagged fish were found. During the winter of 1984-85, however, high conductivities were recorded at all the radio tagged fish relocation sites in the mainstem Susitna including those sites where fish were believed to be dead. In addition, all conductivities measured at two control sites in the mainstem Susitna, at Gold Creek (RM 136.7) and at RM 133.8, were also high (in excess of 200 umhos/cm). Therefore, we were not able to determine whether radio tagged fish were overwintering in mainstem areas with or without groundwater upwelling from conductivity measurements of surface water in this study. Perhaps groundwater upwelling could be detected at resident fish overwintering sites in future studies by taking conductivity measurements of the water immediately above or in the substrate, rather than at mean water column depths where groundwater and surface waters appear to be mixed and could not be differentiated.

Winter capture data of resident fish in the Susitna River from 1980-85, coupled with radio tagged fish data suggest that resident fish seek specific areas to overwinter (ADF&G 1983b, 1983c, 1983d). For example, rainbow trout seem to prefer side channel habitats with slow water velocities for overwintering. In addition, radio tagged fish of one species were found with fish of the same and other species. Other winter studies in Alaska, especially on the North Slope, have found several fish species inhabiting the same wintering areas (Bendock 1981, 1982; Bendock and Burr 1984; Hallberg 1984). Bendock suggested this "cohabitation" may occur because few suitable overwintering areas exist and, therefore, fish are concentrated in certain areas. Hallberg (1984) found several different species of resident fish in the same area during the winter, however, he did not find fish in large concentrations. These studies identify water depth, deteriorated water quality (low DO), and frazil (slush) ice as factors which limit areas where resident fish can overwinter. Anchor ice, cover, and water velocities are also believed to limit overwinter areas (Maciolek and Needham 1952; Needham and Jones 1959; Chapman and Bjornn 1969; Campbell and Neuner 1985). Principal factors which probably affect the overwintering of middle Susitna River resident fish are the presence of slush and anchor ice, high water velocities, available cover, and the dewatering of side channels. Since there is less anchor ice formation and a greater number of large side channels in the lower Susitna River, available cover and high water velocities are probably the critical limiting factors for overwintering in the lower river. Turbidity is believed to be a less important factor in determining overwintering habitat for resident fish.

Winter mainstem turbidities are generally less than 2 nephelometric units (APA 1983). Resident fish are believed to seek deeper areas or areas under ice for cover during the winter months.

At times during the winters of 1983-84 and 1984-85, extensive formations of anchor ice and slush ice were observed in the middle Susitna River, especially above RM 120.0. Slush ice has been reported to impair the functioning of fish gills (Tack 1938 in Armstrong 1982). Anchor ice disrupts and decreases the areas of overwintering, and is suspected to increase overwintering trout mortality (Cerven 1973; Needham and Jones 1959). Since anchor ice is not found under ice cover, in areas of groundwater upwelling, or in water depths over 6.0 feet (Karl Schoch, pers. comm), these are the types of areas where resident fish may prefer to overwinter.

Although there is little field data, Susitna River resident fish mortalities are probably higher during the winter than the summer. Maciolek and Needham (1952) found 50% of marked trout died during the 1950-51 winter at Convict Creek, California. They attributed most of these mortalities to dewatering of side channels where most of the trout overwintered. Needham and Jones (1959) also believed high winter mortalities of fish were due to physical catastrophies such as floods, entrapment under collapsed snow banks, and dewatering. Reimers (1957) found that physical catastrophies caused more trout mortalities than the lack of food availability. There appears to be sufficient food available for adult resident fish in the Susitna during the winter. Although the Resident Fish Study did not include a food habits study, biologists necropsied the stomachs of adult resident fish mortalities (mostly burbot) while conducting winter surveys on the Susitna River between 1980 and 1985. Observed stomach contents of necropsied fish indicated that most had been actively feeding prior to capture. Juvenile salmon, resident fish, and invertebrates were found in fish stomachs during the winter (unpublished data).

4.1 Lower Susitna River

4.1.1 Rainbow trout

Until 1984, the overwintering phase of the life history of lower Susitna River rainbow trout had been largely interpreted from 1981 and 1982 open-water catch per unit effort (CPUE) data, and monitoring data from several rainbow trout which were radio tagged in the fall of 1981 and 1982. Although we planned to radio tag 50 rainbow trout in 1984 to increase our knowledge of rainbow trout populations in the lower river, we were only able to successfully radio tag and monitor eight fish over the winter. These data, although limited, added to our knowledge of the overwintering movements and habitats of rainbow trout in the lower Susitna River.

We believe that rainbow trout begin moving out of east side tributaries into the lower Susitna mainstem in late August. The fall outmigration from tributaries seems to coincide with late August and early September floods which are followed by rapidly decreasing tributary discharges, decreases in water temperatures, reduced photoperiod, and declining food

sources (Sundet and Pechek 1985). In 1984, a flood occurred in the lower Susitna drainage between August 20 and 30. Biologists captured few rainbow rainbow trout when they sampled the upper reaches of several of the smaller east side tributaries (i.e., Montana Creek) in early September. During this sampling trip, we noted that the water levels in these tributaries were decreasing rapidly and that there were fewer adult salmon present after September 1. The reduction in the number of adult salmon is believed to be significant because this signaled a reduction in food supply (i.e., salmon eggs) for rainbow trout. Movement data from three radio tagged rainbow trout indicate that a number of rainbow trout outmigrated from these tributaries to the mainstem Susitna between early September and early October (Figure 3).

During September, sport fish catches of rainbow trout increase at the mouths of east side tributaries. High catches of rainbow trout were observed or reported at the mouths of Kashwitna River and Talkeetna River until mid-October when slush ice began to form in these rivers (Roy Bloomfield and Earle Foster, pers. comm.). However, fall catches of rainbow trout at these tributary mouths were reported to be lower in 1984 than in past years (Earle Foster, pers. comm.). These decreased catches seem to indicate that many fish were flushed out of these east side tributaries, earlier than usual, by the late August flood.

Tag-and-recapture data also indicate that some rainbow trout outmigrate from the Talkeetna River (Sundet and Wenger 1984). However, we do not know why these fish would leave this tributary since there are several lakes (i.e., Mama and Papa Bear lakes) in this subdrainage that would appear to be suitable overwintering areas.

Limited data indicate that some small rainbow trout and few large rainbow trout outmigrate from the Deshka River in the fall (Sundet and Pechek 1985).

Data from three winters of monitoring radio tagged rainbow trout indicate that lower river rainbow trout exhibit two general types of migrational behaviors during the winter. Approximately half of the radio tagged rainbow trout overwintered in the mainstem near the tributary where they were tagged (probably their summer rearing and natal tributary) (ADF&G 1983b, 1983c; Figures 2 and 3). The other half of the radio tagged fish generally overwintered between 10 and 20 miles downriver of their tagging sites.

Lower river rainbow trout may prefer to overwinter in side channels rather than the mainstem Susitna. During the winter of 1981-82, two radio tagged rainbow trout were pinpointed in side channels (ADF&G 1983b). In January and February of 1985, four of seven radio tagged rainbow trout were pinpointed in side channels. These side channels were 100-300 feet wide with waters probably no greater than four feet deep. Measurements taken at winter radio tagged fish relocations show rainbow trout are found mostly in areas with low to moderate water velocities and depths (ADF&G 1983d; Table 1). In two cases, however, radio tagged fish were pinpointed in deep water areas (Appendix Table

A-2). Only one of nine radio tagged rainbow trout pinpointed and believed alive during the winter ground surveys was in an open-water area (ADF&G 1983d; Appendix Table A-2).

Elsewhere, few studies have determined the overwintering requirements of rainbow trout. Studies by Maciolek and Needham (1952) and Needham and Jones (1959) indicate that rainbow trout prefer to overwinter in areas with ice cover and suggest that rainbow trout use surface ice as a protective cover. Chapman and Bjornn (1969) found winter cover was important for overwintering fish, especially areas with large rocks. Since much of the substrate in the lower Susitna River is composed of sand and gravel, areas with surface ice and low water velocities are probably very important for the success of overwintering rainbow trout in this reach. Other salmonid studies have found that mean water velocity is the most critical parameter in the selection of an overwintering site (Wichers 1978).

Lower Susitna River rainbow trout exhibited pronounced mainstem movements in early October and late December (ADF&G 1983b; Figures 2 and 3). During other times in the fall and winter of 1981-82, 1982-83, and 1984-85, rainbow trout in the lower river were relatively sedentary. The early October movement occurred during freeze-up when fish were apparently seeking overwintering areas. Studies conducted in the middle Susitna River show a similar movement (ADF&G 1983c; Sundet and Pechek 1985). Chapman and Bjornn (1969) found that a downstream movement also occurs during the fall for salmonids. Bjornn (1971) indicated that a downstream movement did not occur during or preceding winter if sufficient winter cover was available. We do not know the full extent of effects that freeze-up has on lower Susitna River rainbow trout populations, however we have observed movements of some radio tagged rainbow trout during this time. On the lower Susitna River, slush ice usually begins to flow in early October, an ice bridge usually forms by late October, and 90% of the lower river is frozen over by late November (R&M 1981, 1982, 1983, 1984, 1985). Also during freeze-up, the mainstem discharge typically decreases rapidly. In 1984, the Susitna discharge at Sunshine was 22,300 cfs on September 15, 12,000 cfs on October 15, and 6,200 cfs on November 15 (USGS 1985 provisional data; Figure 14).

The second pronounced winter movement of lower river rainbow trout occurs in late December when the river is nearly 100% frozen over and air temperatures usually drop below -25°C for the first time in the winter. Logan (1963) found that trout moved more in December, January, and February when temperatures were low and surface ice was present. We do not believe that mainstem discharge is responsible for the late December movements of rainbow trout because flows are relatively stable at this time (Figure 14).

Beginning in early May, lower river rainbow trout begin to migrate from the mainstem Susitna River into tributaries for summer rearing (ADF&G 1981b, 1983b; Sundet and Pechek 1985). Unfortunately, the exact timing of this spring movement has not been documented because all of the radio tags dispensed in 1981, 1982, and 1984 in lower river rainbow trout

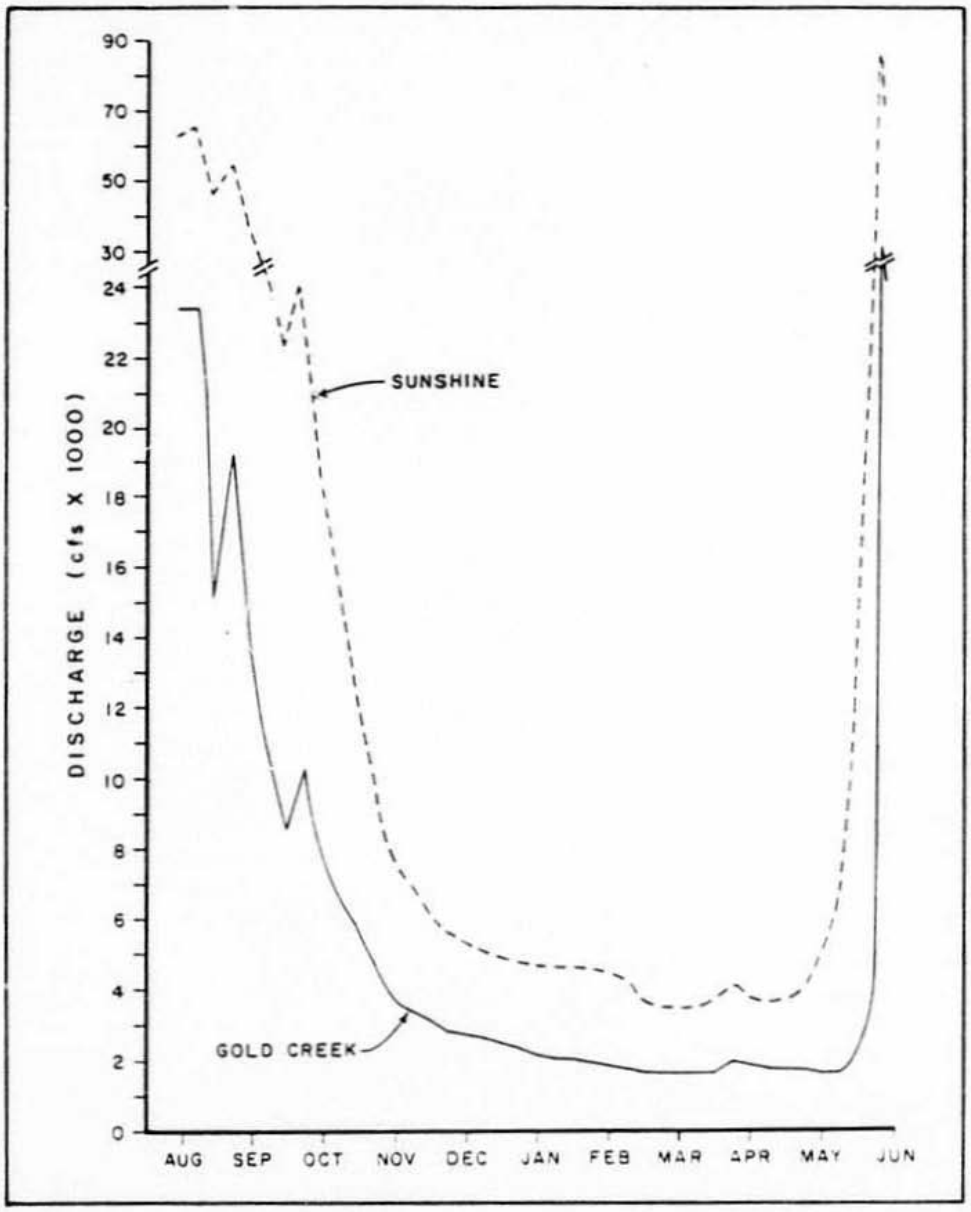

Figure 14. Susitna River discharge at Sunshine (RM 84.0) and at Gold Creek (RM 136.7), August 1984 to June 1985. All measurements are provisional data provided by USGS.

ceased functioning before April of the following year. However, tag-and-recapture data indicate that rainbow trout continue to migrate from the mainstem to tributaries through late May (ADF&G 1981b, 1983b). Some May and June tag recoveries have been made 30 miles above their tagging sites suggesting that some lower river rainbow trout make extensive upriver migrations in the spring.

During the summer, lower Susitna River burbot have been commonly found in the turbid mainstem and its adjacent turbid sloughs and side channels (ADF&G 1981b, 1983b; Sundet and Pechek 1985). Past summer catch data show that a definite correlation exists between adult burbot numbers and turbidity in the Susitna River (Hale 1983; Suchanek and Hale 1983).

4.1.2 Burbot

In the lower Susitna River a pronounced migration of burbot occurs in the fall from the mainstem Susitna into Alexander Creek and the Deshka River (ADF&G 1981b, 1983b; Sundet and Pechek 1985). Data collected in 1981 shows that this movement begins in Alexander Creek during mid-August and in the Deshka River during late August. During these times, adult burbot were found in Alexander Creek as far up as TRM 4.0 and in the Deshka River up to TRM 4.5. Since burbot spawn during the winter, this movement is probably associated with a pre-spawning migration.

Limited catch data from the Deshka River in 1984 suggests that burbot began moving into this river in early September (Sundet and Pechek 1985). However, since no burbot sampling was done at the Deshka River in July or August of 1984, it is possible that some burbot may have moved into the Deshka River prior to September. Sorokin (1971) found burbot moved into Lake Baikal tributaries in the fall as water temperatures approached 10 to 12°C.

In 1984, intensive sampling for burbot was conducted at the Deshka River (TRM's 0.0-6.0) during the spring and fall. Catch data from these studies suggest that a number of sub-adults [between 200 and 390 mm (TL)] move to the spawning areas with adult burbot. The classification of sub-adults and adults was determined by their relative spawning maturity. Since 1982, approximately 85% of burbot greater than 390 mm (TL) were spawners (ADF&G 1983b, 1983c; Appendix Table B-2). Although some burbot in the Susitna River are capable of spawning when they reach a length of 310 mm (TL), a larger percentage of burbot do not spawn until they are greater than or equal to 390 mm. From early September to mid-October 1984, 57 to 64% of the burbot catches at the Deshka River were sub-adults. During this time, burbot catches increased (50 in early September, 121 in late September, and 103 in early October) with approximately the same effort. The catch per unit effort (CPUE), however, was the highest in early October. A similar seasonal increase in catch and CPUE occurred in 1981 (ADF&G 1981b). Other studies have found a similar seasonal increase in burbot catches during the open-water season. Hallberg (1984), sampling in the mainstem Tanana River near the mouth of the Chena River from mid-June to early October,

captured 50% of that his seasonal burbot catch during early October. He speculated his catches increased because freeze-up forced burbot to relocate from some Tanana River sloughs and side channels into the mainstem Tanana making them more concentrated and susceptible to trapping.

Sex composition data collected between 1981 and 1985 show that female burbot have been more numerous than males in the Susitna River and that burbot sex ratios (male to female) have fluctuated from 1:1.1 to 1:3.1 (Table 4). Tested by chi square statistic; (χ^2=9.41, df=3, for α = 0.05 there is a significant difference in the sex ratio between years).

Since burbot spawn under the ice, no burbot spawning has been observed in the Susitna River drainage. However, several spawning sites have been documented in the Deshka River by systematically sampling the same area over time and observing radio tagged burbot. Burbot spawning is believed to occur at TRM's 0.0, 1.9, 2.0, and 24.5 of the Deshka River (ADF&G 1983c). Until the winter of 1984-1985, burbot were believed to spawn only in the lower reaches of the Deshka River. During the winter of 1984-1985, two radio tagged burbot ascended the Deshka River and apparently spawned at TRM 24.5. Trotlines set near the radio tagged burbot at TRM 24.5 in mid-January captured several non-tagged burbot which were close to spawning. Figure 15 shows a map of the suspected burbot spawning area at TRM 24.5 of the Deshka River and Figure 1 shows a larger view of this area in relation to the Susitna River drainage. Maps of other Deshka River sites where burbot are believed to have spawned are provided in ADF&G (1983c).

During the winter of 1982-1983 and 1984-1985, burbot were believed to have spawned at the four sites in the Deshka River between mid-January and early February. These sites are characterized by low to moderate water velocities (0.0-2.1 fps) and depths (0.2-9.0 ft) over a sand to cobble substrate. The higher velocities and depths were recorded at the interface of the Deshka River and the mainstem Susitna. Point specific data collected at radio tagged burbot relocations in mid-January 1985 suggest that some burbot may spawn in the upper reaches of the Deshka River in water depths as low as 0.2 feet. Conductivity data collected in 1985 at TRM 24.5 of the Deshka River suggest that upwelling may occur at this location. Elsewhere in the Deshka River, recorded winter conductivity readings have been lower (between 58-68 umhos/cm compared to 101 umhos/cm at TRM 24.5) (ADF&G 1983c; Appendix Table A-4). Some other winter Deshka River conductivities have been higher (83 umhos/cm), but those were taken (winter of 1982-83) at the interface of the Deshka River and the mainstem Susitna (ADF&G 1983c).

Burbot are also believed to spawn in the mainstem Susitna River. Support for this hypothesis is provided by radio tagged burbot. Since approximately 85% of burbot over 390 mm (TL) are spawners for a given year (ADF&G 1983c), and burbot radio tagged are all over 525 mm, it is likely that several of the radio tagged fish monitored over the winters of 1981-82, 1982-83, and 1984-85 spawned in the mainstem Susitna River

Table 4. Sex composition and sex ratio data for Susitna River burbot, November 1980 through February 1985.

	Male	Female	Ratio
(Nov. 1980 - Aug. 1981)[a]	52	56	1:1.1
(Sept. 1981 - Mar. 1982)[b]	20	32	1:1.6
(Dec. 1982 - Mar. 1983)[c]	23	46	1:2.0
(Dec. 1984 - Feb. 1985)[d]	13	40	1:3.1
TOTAL	108	174	1:1.6

[a] ADF&G (1981b)

[b] ADF&G (1983b)

[c] ADF&G (1983c)

[d] Appendix Figure B-2 in this report

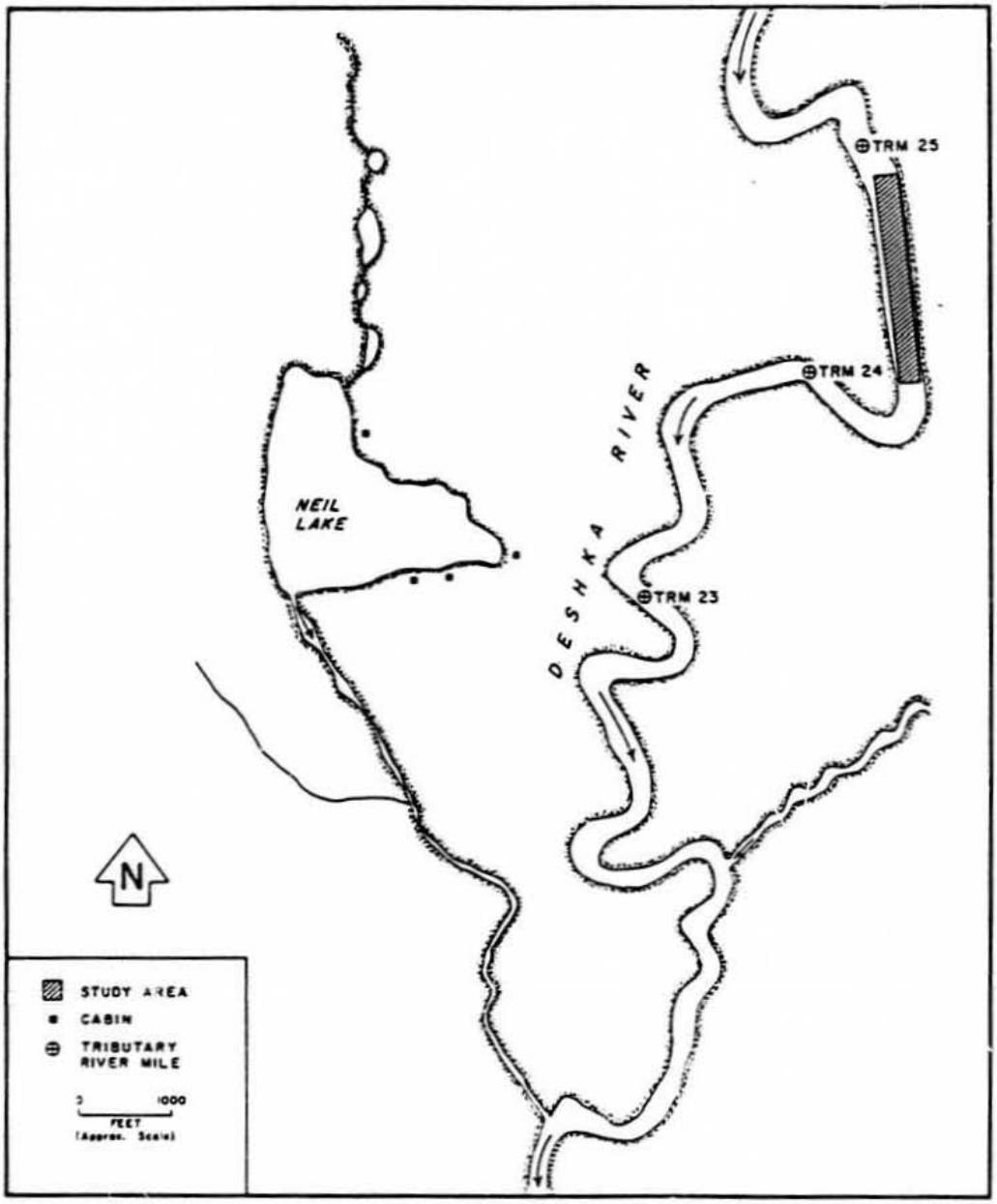

Figure 15. Suspected burbot spawning area at TRM 24.5 of the Deshka River (RM 40.6).

(ADF&G 1983b, 1983c). Eleven burbot radio tagged in 1981 and 1982 remained in the mainstem between RM's 19.0 and 89.6 during January and February. In 1984, five radio tagged burbot remained in the mainstem between RM's 13.0 and 92.0 during the spawning period. Several of the fish monitored in the winter of 1984-85 migrated over 20 miles to the lower reaches of the Susitna River (RM 13.0) and may have spawned there. One radio tagged burbot monitored over the winter of 1982-83 may have moved 113.0 miles to spawn at RM 26.0 (ADF&G 1983c).

Comparisons of several years of radio tagged burbot monitoring data indicate that mainstem spawning may occur between RM's 74.0 - 92.0. Some radio tagged burbot have remained in this reach of the river every winter that they have been monitored. This area is characterized by large bends in the river which provides many back eddies. Water depths are generally moderate to deep and water velocities range from 0.0 to an estimated 8.0 fps. In these areas, point specific measurements taken at radio tagged burbot relocations suggest spawning occurs in moderately deep waters with little water velocity (ADF&G 1983b, 1983c, 1983d). A number of burbot have also been found under slush ice where the water is less than two feet deep.

Although burbot spawning has been observed elsewhere in areas of open water (Sorokin 1971), our observations suggest that burbot in the Susitna River use spawning areas with ice cover. In January and February, the lower Susitna River and its tributaries are over 95% ice covered (R&M 1981, 1982, 1983, 1984, 1985).

After early February, radio tagged burbot in the lower Susitna River dispersed from their suspected spawning areas. Data from the winters of 1981-82 and 1982-83 show a slight downstream movement (0.5-7.0 miles) (ADF&G 1983b, 1983c). Meanwhile, data from the winter of 1984-85 tracked one burbot (659-1.0) which ascended 20 miles and another (669-1.8) 6 miles up the Deshka River after apparently spawning. Another fish (739-1.0), moved 2.0 miles downriver and into the mainstem. Other studies have reported variable post-spawning movements. MacCrimmon (1959) observed an upriver post-spawning movement and Sorokin (1971) observed a downriver post-spawning movement.

Burbot catches in the Deshka River are generally high from December to February and then decrease substantially after February (ADF&G 1983b, 1983c). Some burbot still remain in the Deshka River in May after breakup, however, burbot CPUE is low during May. Several burbot have been captured by sportfishermen at the mouth of the Deshka River in late May, but in most cases, fishing occurred near the interface zone of the Susitna and Deshka River waters. Since burbot are light and temperature sensitive (Scott and Grossman 1973), we believe that most burbot move out of clear-water tributaries into the mainstem Susitna as the ice cover decreases and water temperatures increase.

4.2 Middle Susitna River

4.2.1 Rainbow trout

During the summer, most middle river rainbow trout rear in clear-water tributaries such as Fourth of July Creek (RM 131.1), Indian River (RM 138.6), and Portage Creek (RM 148.8) (Sundet and Wenger 1984; Sundet and Pechek 1985). In early September, rainbow trout start outmigrating from tributaries to the mainstem Susitna River for overwintering. By October 6 (1983 and 1984), all of the radio tagged rainbow trout had moved into the mainstem Susitna. The fall outmigration from the tributaries appears to correspond with a decrease in tributary water discharge (Sundet and Pechek 1985). However, other factors such as photoperiodism, and declining water temperatures and food sources (i.e., salmon eggs) may contribute to this outmigration. Studies done in 1984 suggest the fall outmigration from tributaries is complete before tributary water temperatures decline to 2°C (Sundet and Pechek 1985).

Monitoring data over three years show about half (24 of 46 successfully radio tagged rainbow trout) of the middle river rainbow trout overwinter in the mainstem Susitna River between 0.0 and 4.0 miles from their Susitna River tagging site or the mouth of the tributary where they were tagged (ADF&G 1983c; Sundet and Pechek 1985; Figures 8 to 12). Only eight of 46 radio tagged fish monitored over three years migrated over 15.0 miles to an overwintering site.

After rainbow trout outmigrate from tributaries in the fall, they generally move downriver. A small percentage of radio tagged rainbow trout from 1982-85 (10.8%), however, have overwintered above or at the tributary mouth where they were found in mid-September. Bjornn (1971) suggested that a downstream movement preceding winter did not occur if sufficient winter cover was available locally.

Most middle river rainbow trout overwinter in the mainstem, however, several radio tagged fish have overwintered at the mouth of Indian River or in side channels such as Gash Creek Side Channel (ADF&G 1983c; Sundet and Pechek 1985). In contrast, lower river rainbow trout overwinter more often in side channels than the mainstem Susitna. However, in the lower river many more side channels are available for overwintering than in the middle river.

Until the winter of 1984-85, little data was available on the specific areas and habitat conditions where overwintering middle river rainbow trout are found. The primary problem experienced during past winter ground surveys (winters of 1982-83 and 1983-84), conducted to pinpoint radio tagged fish and collect habitat data at overwintering sites, has been a lack of ice cover in areas where fish were located. Between November and mid-January, most areas where radio tagged fish overwinter in the middle river are open. For example, in mid-January 1984, 14 of 17 radio tagged fish were found in open-water areas where biologists were unable to make precise habitat measurements. Based on general observations, these rainbow trout appeared to be overwintering in pool

or riffle areas with no anchor ice. After mid-January in past winter studies, batteries of radio tags began expiring from rainbow trout radio tagged during the previous open-water period. Therefore, fewer fish were available for collection of point specific data during mid-winter ground surveys when most of the river is frozen.

Between slush ice formation (in early October) and freeze-up (mid-January), most middle river rainbow trout probably use water depth over a rock substrate as their primary cover. Lewis (1967 cited in Chapman and Bjornn 1969) also found that with the onset of winter adult rainbow trout moved into deeper water.

During January and February when most of the river is frozen, radio tracking data suggests that middle river rainbow trout prefer areas under surface ice with low to moderate water velocities (0.0 to 2.5 fps) and moderate water depths (3.0 - 6.0 ft) (ADF&G 1983c; Sundet and Pechek 1985; Table 3). In areas with higher water velocities (>1.0 fps), rubble or cobble substrates predominate. Rainbow trout may use the larger substrate in these higher velocity areas for cover. Chapman and Bjornn (1969) determined that areas with large rocks substrates provided important overwintering fish habitat. Lewis (1969) reported that cover is important to trout in terms of security and photonegative response.

While substrate and water depths can provide mid-winter cover for rainbow trout, it appears that surface ice is the preferred cover. During the past three years, most radio tagged rainbow trout in the middle river have been found under surface ice in mid-winter (ADF&G 1983c; Sundet and Pechek 1985). Radio tagged fish monitored in January and February of 1985 were located within 100 feet of an open lead, suggesting rainbow trout prefer to use surface ice as cover. Winter studies elsewhere report depth and substrate are important in selection of rainbow trout overwintering habitat, but only as they relate to cover and velocity (Campbell and Neuner 1985).

Although surface ice does appear to be an important mid-winter cover type, several radio tagged fish have shown there is suitable overwintering habitat in deep (>6.0 ft) open-water areas of the middle Susitna River as well (ADF&G 1983c; Appendix Table A-6).

Over three winters, radio tagged rainbow trout have generally overwintered in certain sections of the middle river. These sections are: RM's 95-101, 110-115, 128-140, and 144-151. In all cases, a major clear-water tributary is located within these sections. The upper three sections are characterized by deep pools adjacent to bedrock banks with some gently sloping shores. The lower section (RM 95 to RM 101) is composed of several miles of both the lower (RM 0.0 to RM 98.5) and middle river (RM 98.5 to RM 152.0). Between RM 98.5 and RM 101.0, there are several channels between islands. Below RM 98.5 there are more channels, but the water depth is greater than the area above RM 98.5. Several Whiskers Creek rainbow trout have overwintered in the area just below the Chulitna River confluence (RM 98.5).

During the winter of 1984-85, a number of radio tagged rainbow trout were found within 100 feet of each other. This suggests that middle river rainbow trout congregate during the winter or that suitable winter habitat is extremely limited thereby causing fish to concentrate in specific areas.

Although slush ice and anchor ice are common in the middle river in the winter, no radio tagged rainbow trout have been found in areas with anchor ice and few have been found under slush ice during winter surveys.

As with lower river rainbow trout, two pronounced winter movements occur for middle river rainbow trout. In addition, middle river radio telemetry data indicates that a spring migration from the mainstem to the tributaries also occurs.

Most radio tagged rainbow trout in the middle river show some movement between mid-September and mid-October and again between mid-December and mid-January. The former movement occurred at the beginning of freeze-up (usually early October, R&M 1985) when fish were probably moving to suitable overwintering habitat. Although slush ice begins to form in the middle river in early October, the majority of the middle river is not covered with surface ice until late December (R&M 1981, 1982, 1983, 1984, 1985). During mid-December, air temperatures usually drop below -30°C for the first time in the winter. This decrease in temperature accelerates ice formation and may contribute to increased rainbow trout activity in December (refer to section 4.1.1 for further details). Similar to lower river rainbow trout, a correlation appears to exist between the early October movement of middle river fish and mainstem Susitna discharge. During freeze-up, mainstem discharges typically decrease rapidly (USGS 1985 provisional data at Gold Creek; Figure 14). However, the late December rainbow trout movement does not appear to be affected by the mainstem discharge because Susitna flows are generally stable at this time.

Spring movements of radio tagged fish indicate that most rainbow trout begin an upriver migration from the mainstem Susitna to clear-water tributaries in early May. This movement occurs during or just prior to breakup when the mainstem discharge begins to increase. However, some radio tagged rainbow trout appear to begin migrating as early as March (ADF&G 1983c; Sundet and Pechek 1985). Several fish monitored in May of 1984 moved 10 miles upriver in a few days (Sundet and Pechek 1985). This rapid upriver movement in May is probably a spawning run. One of the fish which moved rapidly upriver in May of 1984 was recaptured and found to be a pre-spawning female (rainbow trout 670-1.4).

4.2.2 Arctic Grayling

Until the winter of 1984-85, little data was collected on overwintering middle Susitna River Arctic grayling. Insights to the overwintering distribution and habitat of Arctic grayling were largely interpreted from catch per unit effort (CPUE) and tag-and-recapture data gathered

during the 1981-84 open-water periods. These data suggested that most middle river Arctic grayling overwinter near their summer rearing tributaries. The two tributaries which support the most Arctic grayling in the middle reach of the Susitna River are Indian River (RM 138.6) and Portage Creek (RM 148.8) (ADF&G 1981b, 1983b; Sundet and Wenger 1984; Sundet and Pechek 1985). Population data, as well as data from one radio tagged Arctic grayling, indicate that Arctic grayling begin outmigrating from the upper reaches of tributaries to the mainstem Susitna in late August and most are in the mainstem by mid-October. Schallock (1966) speculated that the outmigration of Arctic grayling in the Chatanika River begins slowly in mid-July. Tack (1980) found that the Arctic grayling outmigration from the upper to the lower reaches of the Chena River is later, and spread over a longer period of time (September through December). Tack hypothesized that Arctic grayling moved out of bog streams because water depths greatly decrease, and out of spring-fed streams because of the formation of frazil (slush) ice (Tack pers. comm. in Armstrong 1982). After reaching the mainstem Susitna, most Portage Creek fish were believed to overwinter between RM 147.0 and RM 151.0, and most Indian River fish were believed to overwinter near that tributary. However, some 1983-84 tag-and-recapture data suggested that a long downstream migration to overwintering areas may occur for some Indian River and Portage Creek fish (Sundet and Pechek 1985). Several of these fish were recaptured quite a distance downriver suggesting one overwintering area in the middle river may be near Slough 6A (RM 112.3).

Data from five radio tagged fish monitored during the winter of 1984-85 support both beliefs; some middle river Arctic grayling overwinter near their summer rearing tributary and others move farther downstream to overwinter. Similar overwintering movements for Arctic grayling have been reported by Armstrong (1982), Tack (1972, 1980), Rolland Holmes (pers. comm.).

Two of the 1984 radio tagged Arctic grayling overwintered near their tagging sites (Portage Creek) and the other three fish (tagged in Indian River) moved over 30 miles downriver to overwinter near or below Talkeetna. Both fish from Portage Creek selected overwintering areas in the mainstem Susitna between RM 147.0 and RM 148.0. This area has a large island (referred to by locals as Fat Canoe Island) in the center of the streambed with shallow shorelines, and steep bedrock banks and deep pools along the east and west banks of the mainstem. Because the shoals of the island are suspected of having upwelling and because of the deep pools in the mainstem, this area was previously thought to be capable of maintaining a sizeable population of overwintering fish (Sundet and Wenger 1984; Sundet and Pechek 1985). A number of rainbow trout that were radio tagged in 1984 overwintered in this area.

Although specific habitat data for Arctic grayling have not been collected at other middle river areas during the winter, it is probable that Arctic grayling do overwinter in other sections of the middle river with habitat similar to that found between RM 147.0 and RM 148.0.

While limited data suggests that most middle river Arctic grayling overwinter near their summer rearing tributaries, several recaptured (Floy anchor tagged fish) and radio tagged Arctic grayling have been found up to 63.5 miles downstream from their tagging sites. Two hypotheses for this phenomenon are: (1) either the fish were injured during capture or tagging, and then drifted downriver, or (2) some fish migrate rapidly, considerable distances downstream during September or October to overwintering areas in the mainstem Susitna. Unfortunately, data which is currently available do not enable us to determine if either or both of these explanations are true. During radio tagging efforts in the spring we have found that fish normally move upriver and any sudden, long movement downriver indicates these fish were injured. Injuries are most often detected within 14 days of tagging. It is unlikely, however, that all three of the fish radio tagged in the fall of 1984 were injured, so there may be an extensive downstream migration occurring for middle river Arctic grayling in the fall. Other Alaska studies have shown that Arctic grayling can rapidly move long distances to overwintering areas (West and Wiswar 1985; Rolland Holmes, pers. comm). Studies have shown that these long movements typically occur from small muskeg streams (e.g., Whiskers Creek) or small gravel and mountain streams (e.g., Indian River) to suitable larger river overwintering areas (e.g., the Susitna River). Past studies (1981-84) may have failed to determine long distance movements of Arctic grayling because the fall downriver migration appears to occur very quickly, and the spring upriver migration occurs under the ice or during breakup before open-water sampling occurs. We do not know why middle river stocks from Indian River migrate so far downstream to overwinter when "apparent" suitable overwintering habitat exist near RM's 147.0, 136.0, 133.6, and 125.0. These areas are characterized by deep waters with areas of slow to moderate water velocity and they do provide suitable overwintering habitat for middle river rainbow trout (refer to Section 4.2.1).

5.0 CONTRIBUTORS

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APPENDICES

8.0 APPENDICES

APPENDIX A

RADIO TAGGED FISH TAGGING AND HABITAT DATA

Appendix Table A-1. Summary of tagging data for radio tagged rainbow trout captured on the Susitna River between Cook Inlet and the Chulitna River confluence, September and October 1984.

Radio Frequency	Floy Tag Number	Fork Lengths (mm)	Age	Method Captured	Location Captured and Released	RM/TRM	Date Captured	Date Released
599-1.2	5483	398	6	H.L.	Montana Creek	77.0/5.0	9/6	9/6
602-2.0	18929	385	6	E.F.	Little Willow Creek (lower mouth)	49.5/0.0	9/30	9/30
609-1.3	5488	392	6	H.L.	Sheep Creek	67.7/5.0	9/7	9/7
609-2.0	18953	458	6	E.F.	Mainstem - East Channel	53.0	9/30	9/30
620-1.2	5485	436	7	H.L.	Montana Creek	77.0/5.0	9/6	9/6
630-1.0	18952	525	9	E.F.	Mainstem - East Channel	53.0	9/30	9/30
640-1.4	18715	395	6	E.F.	Montana Creek	77.0/0.0	9/15	9/15
650-1.3	18954	425	7	E.F.	Mainstem - East Channel	53.0	9/30	9/30
660-1.0	19116	423	--	E.F.	Mainstem - East Channel	96.0	10/12	10/12
739-2.3	18969	457	7	E.F.	Little Willow Creek (upper mouth)	50.1/0.0	9/30	9/30

TOTAL = 10

RM = River mile
TRM = Tributary river mile
-- = Not aged
EF = Electrofishing
HL = Hook and line

Appendix Table A-2. Radio tagged lower Susitna River rainbow trout habitat measurements taken at their relocations in January and February 1985. Fish were tagged in 1984. All but rainbow trout 739-2.3 were believed alive at the time habitat measurements were taken.

Radio Frequency	Date	Site Description	RM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments
599-1.2	1/15	Mainstem	56.5	o	-	10.0*	0.0	0.0	3.5*	-	-	-	-	-	In open water so no specific measurements could be taken; fish's fate was unknown
602-2.0	1/15	Side Channel approximately 200' wide	46.8	c	±30.0	1.5	1.5	0.0	0.8*	sand	-0.3	-	160	6.8	
609-1.3	2/5	Side Channel approximately 200' wide	66.9	c	-50.0	0.4	2.0	0.0	0.0	silt/gravel	0.0	10.9	188	6.9	
630-1.0	1/16	Side Channel approximately 200' wide	49.0	c	+200.0	1.2	2.8	0.0	0.1*	silt	0.2	-	202	7.2	
640-1.4	1/15	Side Channel approximately 200' wide	46.0	c	-150.0	1.4	1.3	0.0	0.3*	sand/gravel	-0.3	-	171	6.8	
650-1.3	1/14	Mainstem	14.3	c	±100.0	8.5	2.1	0.0	1.9	sand	-0.2	-	195	6.7	200.0 ft from an open lead
660-1.0	2/21	Mainstem	77.4	c	0.0	1.5	3.0	0.0	0.4	gravel/cobble	-0.2	10.2	190	7.3	
739-2.3[a]	1/14	Mainstem	9.6	c	0.0	1.0	2.5	0.0	0.0	sand	0.0	-	278	7.2	believed dead

* = Estimated measurements because meter did not work or open water.
\- = No movement or no measurements taken.
a = Fish believed dead.

Appendix Table A-3. Summary of tagging data for radio tagged burbot captured on the Susitna River between Cook Inlet and the Chulitna River confluence, September and October 1984.

Radio Frequency	Brand of Tag	Floy Tag Number	Total Lengths (mm)	Method Captured	Location Captured and Released	RM/TRM	Date Captured	Date Released
610-0.5	Smith-Root	14740	685	H.N.	Deshka River	40.6/0.0	10/14	10/17
610-3.0	Smith-Root	18346	753	E.F.	Mainstem	93.2	9/15	9/15
619-2.2	Smith-Root	18991	570	H.N.	Deshka River	40.6/1.0	10/1	10/1
629-3.0	Smith-Root	14995	575	H.N.	Deshka River	40.6/1.0	9/14	9/17
639-3.0	Smith-Root	18833	567	E.F.	Mainstem	40.0	9/17	9/17
649-1.0	Smith-Root	19158	795	E.F.	Mainstem	83.9	10/15	10/15
650-3.0	Smith-Root	13934	535	H.N.	Deshka River	40.6/0.5	9/16	9/17
659-1.0	Smith-Root	18911	637	E.F.	Mainstem	40.8	9/29	9/29
669-1.8	ATS	14739	635	H.N.	Deshka River	40.6/0.0	10/14	10/17
730-1.0	Smith-Root	18401	578	H.N.	Mainstem	40.4	9/18	9/18
739-1.0	Smith-Root	13994	679	H.N.	Deshka River	40.6/1.0	9/28	9/29
749-0.7	Smith-Root	19152	568	E.F.	Mainstem	78.0	10/15	10/15
760-1.9	ATS	14992	635	H.N.	Deshka River	40.6/0.0	10/15	10/17
770-2.4	ATS	14749	709	H.N.	Deshka River	40.6/0.0	10/15	10/17

Total = 14

RM = River mile
TRM = Tributary river mile
EF = Electrofishing
HN = Hoop net
ATS = Advanced Telemetry System

Appendix Table A-4. Radio tagged lower Susitna River burbot habitat measurements taken at their relocations from December 1984 to February 1985. Fish were tagged in 1984 and all fish were believed alive at the time habitat measurements were taken.

Radio Frequency	Date	Site Description	RM/TRM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments
610-0.5	1/16	Mainstem	42.1	c	-150.0	7.8	3.0	3.3	0.1	gravel/cobble	0.0	-	172.0	7.1	
649-1.0	1/24	Mainstem	98.0	c	0.0	0.2	1.5	4.3	0.0	cobble	-	-	-	-	100.0' from an open lead
650-3.0	1/12	Deshka River	40.6/1.9	c	0.0	1.0	2.5	0.0	0.4	gravel/sand	-	-	-	-	
650-3.0	2/7	Deshka River	40.6/1.9	c	0.0	1.1	2.9	0.0	0.2	sand/gravel	0.0	10.4	74.0	6.9	
659-1.0	12/16	Deshka River	40.6/2.0	c	0.0	2.0	2.0	0.0	0.5	gravel/cobble	-0.2	8.4	73.0	6.4	
659-1.0	1/12	Deshka River	40.6/2.0	c	0.0	2.0	2.0	0.0	0.1	sand/gravel	-0.1	-	87.0	7.0	located on the opposite side of the river from 12/16
659-1.0	2/4	Moose Creek, a tributary of the Deshka River at TRM 29.5	40.6/0.7	c	-10.0	0.2	2.5	0.0	0.4	gravel/sand	0.1	9.0	58.0	6.9	75.0' from an open lead
669-1.8	1/15	Deshka River	40.6/24.5	c	+20.0	0.1	2.2	0.0	0.0	gravel	-0.2	-	97.0	6.8	on 1/16 found at TRM 25.5
669-1.8	2/4	Moose Creek, a tributary of Deshka River at TRM 29.5	40.6/0.7	c	-10.0	0.2	2.5	0.0	0.4	gravel/sand	0.1	9.0	58.0	6.9	located 100.0' from burbot 659-1.0 and 75.0' from an open lead
739-1.0	1/12	Deshka River	40.6/2.0	c	-300.0	1.6	2.7	0.0	0.3	sand/gravel	-0.1	-	92.0	7.0	located 100.0' below burbot 659-1.0
739-1.0	2/7	Mainstem	40.7	c	0.0	1.3	2.5	0.0	0.0	gravel/cobble	-0.2	11.5	74.0	7.3	
750-0.7	1/24	Mainstem	75.4	c	-200.0	4.0	2.0	0.1	0.1	gravel/sand	0.0	12.9	188.0	7.3	
760-1.9	1/15	Deshka River	40.6/24.5	c	+20.0	0.2	2.5	0.0	0.0	gravel	+0.2	-	101.0	7.2	
760-1.9	2/4	Deshka River	40.6/24.5	2.0' of overflow	-	-	-	-	-	-	-	-	-	-	located 200.0' below the 1/15 location
770-3.0	12/16	Deshka River	40.6/1.4	c	-600.0	3.0	1.5	0.0	0.6	sand/gravel	-0.2	8.6	67.0	6.4	captured on 1/1 at TRM 0.3

R = River mile
TR = Tributary river mile
- = No movement or measurements taken because meter did not work or overflow.

Appendix Table A-5. Summary of tagging data for radio tagged rainbow trout captured on the Susitna River between the Chulitna River confluence and Devil Canyon, September and October 1984.

Radio Frequency	Floy Tag Number	Fork Lengths (mm)	Age/ Sex	Method Captured	Location Captured and Released	River Mile	Date Captured	Date Released
618-2.1	18321	468	7/-	E.F.	Indian River	138.6	9/12	9/13
640-1.0	18479	420	6/-	H.L.	Indian River	138.6	9/27	9/28
637-1.8	18146	471	8/-	E.F.	Portage Creek	148.8	9/13	9/13
648-1.1	17676	400	6/-	E.F.	Indian River	138.6	9/11	9/12
648-1.6	18346 (recap)	400	-/-	E.F.	Whiskers Creek Slough	101.2	9/14	9/14
659-1.8	17675	411	7/-	E.F.	Indian River	138.6	9/11	9/12
667-1.4	17608	455	-/-	H.L.	Portage Creek	148.8	9/26	9/26
707-2.3	19208	410	6/-	E.F.	Mainstem	149.2	10/9	10/9
718-1.0	18445	410	6/-	E.F.	Mainstem	150.0	9/26	9/26
749-1.1	2823	475	8/-	E.F.	Slough 20	140.1	9/27	9/27
759-1.7	18480	412	5/-	H.L.	Indian River	138.6	9/27	9/28
770-1.1	19207	436	6/-	E.F.	Mainstem	149.2	10/9	10/9
769-1.8	18481	457	7/M	H.L.	Indian River	138.6	9/27	9/28

TOTAL = 13

-- = Not sexed or not aged
EF = Electrofishing
HL = Hook and line

Appendix Table A-6. Radio tagged middle Susitna River rainbow trout habitat measurements taken at their relocations in January and February 1985. Fish were tagged in 1984. All fish were believed alive at the time habitat measurements were taken except where noted.

Radio Frequency	Date	Site Description	RM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Depths (ft) Ice	Depths (ft) Slush	Velocity (fps)	Substrate	Water Quality Temp°C	Water Quality DO mg/l	Water Quality umhos/cm	Water Quality pH	General Comments[a]
599-1.1	1/22	Mainstem	148.3	c	-100.0	4.4	2.9	0.0	1.5	cobble/gravel	-0.2	15.5	250	7.6	100 ft. from RT rainbow 630-1.7 and 718-1.0
599-1.1	2/20	Mainstem	148.3	c	-100.0	4.7	3.0	0.0	1.4	rubble/cobble	-0.2	11.4	231	-	100 ft from RT rainbow 718-1.0
613-1.0	1/21	Mainstem	147.0	c	+25.0	1.5	3.1	0.0	0.3	cobble/gravel	-0.2	14.6	254	6.0	50 ft from RT grayling 740-2.3
613-1.0	2/21	Mainstem	147.2	c	-25.0	5.3	2.2	0.0	0.5	rubble/cobble	-0.1	12.7	306	7.7	50 ft from RT rainbow 667-1.4 and was 75 ft from an open lead
608-1.9	1/21	Mainstem	132.0	c	+50.0	0.9	2.7	2.3	0.0	cobble	-0.1	12.4	230	7.1	
620-1.2	1/23	Mainstem	142.1	c	+200.0	4.6	2.6	0.0	0.1	rubble/cobble	0.0	12.6	232	7.0	50 ft from an open lead
629-1.0	1/21	Mainstem	121.2	c	±25.0	3.5	1.5	0.0	0.3	sand/cobble	+0.3	12.0	187	7.0	50 ft from an open lead, 100 ft away on 1/22 from 1/21 location.
630-1.7	1/22	Mainstem	148.3	c	-50.0	3.9	2.8	0.0	1.8	rubble/cobble	+0.2	15.7	246	7.2	100 ft from RT rainbow 599-1.1 and 718-1.0
640-1.0	1/16	West Mainstem Channel	53.3	c	-150.0	4.5	3.3	0.2	0.1*	sand	0.0	-	183	7.0	
637-1.8	1/22	Mainstem	147.6	c	0.0	5.3	2.2	0.0	1.6	gravel	+0.1	13.1	244	7.4	probably alive, moved upriver 20 ft next day
637-1.8	2/5	Mainstem	147.5	c	-50.0	-	-	-	-	-	-	-	-	-	
648-1.1	2/5	Mainstem	135.4	c	-100.0	3.5	2.5	0.0	1.0	rubble/cobble	-0.1	11.9	239	7.0	100 ft from RT rainbow 769-1.8
648-1.1	2/20	Mainstem	135.4	c	0.0	2.2	2.3	2.0	1.0	cobble/gravel	0.0	11.4	280	7.2	100 ft from RT rainbow 769-1.8 and 200 ft from an open lead
648-1.6	1/23	Mainstem	96.3	c	-400.0	3.0	3.4	0.0	0.5	cobble	+0.2	11.9	225	7.0	40 ft from an open lead
659-1.8	1/25	Mainstem	139.5	c	+200.0	7.0	1.6	0.0	0.1	rubble/cobble	0.0	13.6	258	7.2	100 ft from an open lead and 50 ft from RT rainbow 770-1.1

Appendix Table A-6 (Continued).

Radio Frequency	Date	Site Description	RM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	µmhos/cm	pH	General Comments[a]
667-1.4	1/21	Mainstem	146.4	o	-	10.0*	0.0	0.0	2.5*	cobble	0.1	-	195	7.4	in an open lead and 50 ft from RT rainbow 707-2.3, probably alive
667-1.4	2/21	Mainstem	147.2	c	-25.0	3.5	2.0	0.0	0.2	rubble/cobble	-0.1	12.8	293	7.7	50 ft from RT rainbow 613-1.0 and 125 ft from an open lead
709-1.2	1/21	Mainstem	133.6	o	-	6.0*	0.0	0.0	1.5*	gravel/cobble	-	-	-	-	below Slough 10 in open lead, probably alive
707-2.3	1/21	Mainstem	146.4	o	-	10.0*	0.0	0.0	2.5*	cobble	-0.1	-	195	7.4	in an open lead and 50 ft from RT rainbow 667-1.4, probably alive
718-1.0	1/22	Mainstem	148.3	c	-100.0	3.9	2.8	0.0	1.8	rubble/cobble	-0.2	15.7	246	7.2	100 ft from RT rainbow 599-1.1 and 630-1.7
718-1.0	2/20	Mainstem	148.3	c	-100.0	1.5	3.0	3.5	0.5	rubble/cobble	-0.2	11.4	231	-	100 ft from RT rainbow 599-1.1
728-1.0	2/5	Mainstem	137.6	c	0.0	4.0	2.5	0.0	0.4	rubble/cobble	-0.1	14.8	270	7.0	fate was undetermined
729-1.5	1/23	Mainstem	98.6	c	+100.0	4.2	2.6	0.0	0.2	silt	+0.2	13.5	228	7.4	75 ft from an open lead
749-1.5[b]	1/22	Mainstem	149.8	c	-	6.7	4.3	0.0	1.8	rubble/cobble	-0.1	13.5	245	7.3	strange signal
757-1.1	1/22	Mainstem	144.2	c	+20.0	4.0	1.8	0.0	0.3	cobble/rubble	-0.2	10.2	170.0	7.2	
759-1.7	1/24	Mainstem	79.7	c	0.0	1.0	2.8	3.7	0.2	rubble	0.0	13.4	140.0	6.6	believed dead on 1/24 but later proved alive because it moved upriver
770-1.1	1/25	Mainstem	139.5	c	-800.0	5.2	1.8	0.0	0.9	rubble/cobble	0.0	14.6	249	7.4	100 ft from an open lead and 50 ft from RT rainbow 659-1.8
769-1.8	2/5	Mainstem	135.4	c	0.0	3.5	2.5	0.0	1.0	rubble/cobble	-0.1	11.9	239	7.0	100 ft from RT rainbow 648-1.1
769-1.8	2/20	Mainstem	135.4	c	0.0	4.3	2.2	0.0	1.3	cobble/gravel	+0.3	10.6	286	7.3	100 ft from RT rainbow 648-1.1 and 200 ft from an open lead

Appendix Table A-6 (Continued).

Radio Frequency	Date	Site Description	RM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments[a]
Radio tagged rainbow trout believed dead															
598-1.6	1/14	Side Channel	31.8	c	0.0	1.0	1.6	0.0	0.4	sand	-0.2	-	183	6.8	
618-2.1	1/21	Mainstem	123.8	c	0.0	1.9	3.4	0.0	0.4	cobble	0.0	14.1	236	6.6	on east bank pps. 3.0
719-1.6	2/5	Side Channel below Slough 11	134.1	c	0.0	0.0	2.0	0.0	0.0	cobble	-	-	-	-	
Radio tagged rainbow trout determined dead															
670-1.2	1/25	Mainstem	136.5	c		0.0	1.0								
740-1.4	2/5	Plume of Indian River	138.3	o		0.2	0.0								
749-1.1	1/23	Mainstem	139.9	c		0.0	3.0								

a = RT = radio tagged

b = Strange signal that was difficult to pinpoint. Measurements however were probably taken within 20 ft of the fish.

* = Estimated measurements because water did not work or open water.

- = No movement or measurements taken because of open water or meters were not working.

Appendix Table A-7. Summary of tagging data for radio tagged Arctic grayling captured on the Susitna River between the Chulitna River confluence and Devil Canyon, September 1984.

Radio Frequency	Floy Tag Number	Fork Lengths (mm)	Age	Method Captured	Location Captured and Released	River Mile	Date Captured	Date Released
600-2.4	14455 (recap)	390	9	H.L.	Portage Creek	148.8	9/26	9/26
610-2.4	--	390	8	E.F.	Indian River	138.6	9/11	9/12
629-2.2	17914	390	--	E.F.	Mainstem	137.7	9/11	9/12
639-2.3	17915	408	--	E.F.	Indian River	138.6	9/11	9/12
740-2.3	18448	409	9	E.F.	Mainstem	150.0	9/26	9/26

TOTAL = 5

-- = Not aged or not Floy tagged
EF = Electrofishing
HL = Hook and line

APPENDIX B

BURBOT BIOLOGICAL CHARACTERISTICS AND RESIDENT FISH CATCH DATA

Appendix Table B-1. Resident fish catch per unit effort (CPUE) at selected sites on the Susitna River and its tributaries between Cook Inlet and Devil Canyon, November 1984 to February 1985.

Location	RM/TRM	Date(s) Sampled	Method of Capture[a]	BURBOT CATCH[b] Numbers of Pre-Spawners Captured M	F	Numbers of Post-Spawners Captured M	F	Numbers of Non-Spawners Captured M	F	Other Species Catch	Number of Gear	Total Number of Hours Fished	CPUE[c] For All Burbot Captured	CPUE[c] For Other Species Captured	Comments[d]
Sampling gear set to primarily capture lower river burbot															
Mainstem	35.6	1/16-17	TL						1		3	72.0	0.3	0.0	near RT burbot 629-3.0
Mainstem	40.5	12/16-17	TL		1						1	20.0	1.0	0.0	
Deshka River	40.6/0.0	11/24-25	BS	4	4						10	160.0	0.8	0.0	sportfisherman's catch
	/0.0	12/7-8	BS	3							5	80.0	0.6	0.0	sportfisherman's catch
	/0.0	12/15-17	BS	5	5			3			18	420.0	0.7	0.0	
	/1.9	1/12-13	TL		1				1		2	48.0	1.0	0.0	near RT burbot 650-3.0
	/1.9	2/7-8	BS			1					1	24.0	1.0	0.0	near RT burbot 650-3.0
	/1.9	2/7-8	TL			3			1		3	72.0	1.3	0.0	
	/2.0	1/12-13	BS		1						1	21.0	1.0	0.0	near RT burbot 659-1.0
	/2.0	1/12-13	TL		5	3			1		2	42.0	3.0	0.0	and 739-1.0
	/2.0	2/7-8	TL			1			1		4	96.0	0.5	0.0	RT burbot 660-1.0 and 739-1.0 were located near here on 1/12
	/24.5	1/15-16	TL	4	4						3	72.0	2.7	0.0	near RT burbot 669-1.8 and 760-1.9
Moose Creek a trib. of Deshka River at TRM 29.5	40.6/0.7	2/4-5	BS								2	48.0	0.0	0.0	near RT burbot 659-1.0
		2/4-5	TL			1	3				3	72.0	1.3	0.0	and 669-1.8
Mainstem	40.7	2/7-8	BS			1					3	63.0	0.3	0.0	near RT burbot 739-1.0
		2/7-8	TL								2	42.0	0.0	0.0	
Mainstem	42.1	1/16-17	TL								3	72.0	0.0	0.0	near RT burbot 610-0.5
Mainstem	75.4	1/23-24	TL					1	1		3	72.0	0.7	0.0	near RT burbot 750-0.7
Mainstem	88.0	1/23-24	BS								6	144.0	0.0	0.0	near RT burbot 649-1.0
Mainstem	92.0	2/21-22	BS								1	24.0	0.0	0.0	near RT burbot 649-1.0
	92.0	2/21-22	TL								1	24.0	0.0	0.0	
TOTAL CATCH =				16	21	1	9	4	6	0					

Appendix Table B-1 (Continued).

Location	RM/TRM	Date(s) Sampled	Method of Capture[a]	BURBOT CATCH[b] Numbers of Pre-Spawners Captured M	F	Numbers of Post-Spawners Captured M	F	Numbers of Non-Spawners Captured M	F	Other Species Catch	Number of Gear	Total Number of Hours Fished	CPUE[c] For All Burbot Captured	CPUE[c] For Other Species Captured	Comments[d]
Sampling gear set to primarily capture lower river rainbow trout															
Mainstem	9.6	1/14-15	BS								2	48.0	0.0	0.0	near RT rainbow trout 739-2.3 which was believed dead
Mainstem	14.3	1/14-15	GN								2	44.0	0.0	0.0	near RT rainbow trout 650-1.3
Side Channel	46.0	1/15-16	TL					2	5		2	48.0	3.5	0.0	near RT rainbow trout 640-1.4
Side Channel	46.8	1/15-16	TL								2	48.0	0.0	0.0	near RT rainbow trout 602-2.0
Mainstem	77.4	2/21-22	TL								2	48.0	0.0	0.0	near RT rainbow trout 660-1.0
TOTAL CATCH =								2	5						
Sampling gear set to primarily capture middle river rainbow trout															
Side Channel	31.8	1/14-15	TL						1		1	24.0	1.0	0.0	near RT rainbow trout 598-1.6 which was believed dead
Mainstem	86.8	2/21-22	GN								1	24.0	0.0	0.0	
	86.8	2/21-22	BS								1	24.0	0.0	0.0	near RT rainbow trout 640-1.0
	86.8	2/21-22	TL								1	24.0	0.0	0.0	
Mainstem	121.2	1/21-22	BS						1		1	24.0	1.0	0.0	near RT rainbow trout 630-1.0
	121.2	1/21-22	TL		2						1	24.0	2.0	0.0	
Mainstem	132.0	1/21-22	BS								1	24.0	0.0	0.0	near RT rainbow trout 608-1.9
	132.0	1/21-22	TL								1	24.0	0.0	0.0	
Mainstem	133.5	2/6	HL								2	0.5	0.0	0.0	
Mainstem	133.6	1/21-22	GN								1	24.0	0.0	0.0	near RT rainbow trout 709-1.2
		1/21-22	TL								1	24.0	0.0	0.0	
		2/6	HL								2	1.2	0.0	0.0	

Appendix Table B-1 (Continued).

Location	RM/IRM	Date(s) Sampled	Method of Capture[a]	BURBOT CATCH[b] Numbers of Pre-Spawners Captured M	F	Number of Post-Spawners Captured M	F	Numbers of Non-Spawners Captured M	F	Other Species Catch	Number of Gear	Total Number of Hours Fished	CPUE[c] For All Burbot Captured	CPUE[c] For Other Species Captured	Comments[d]
Mainstem	135.4	2/20-21	BS								1	24.0	0.0	0.0	near RT rainbow trout 648-1.1
	135.4	2/20-21	TL								2	48.0	0.0	0.0	and 769-1.8
Mainstem	146.4	1/21-22	GN								1	24.0	0.0	0.0	near RT rainbow trout 667-1.4
		1/21-22	TL								1	24.0	0.0	0.0	and 707-2.3
		2/6	HL							1 Rainbow	2	0.8	0.0	1.2	
		2/20-21	BS								1	24.0	0.0	0.0	
		2/20-21	TL								1	24.0	0.0	0.0	
Mainstem	147.2	2/21-22	GN								1	24.0	0.0	0.0	near RT rainbow trout 613-1.0
		2/21-22	BS								1	24.0	0.0	0.0	and 667-1.4
		2/21-22	TL								1	24.0	0.0	0.0	
Mainstem	147.6	1/22-23	TL								2	48.0	0.0	0.0	near RT rainbow trout 637-1.8
Mainstem	148.3	2/20-21	BS								1	24.0	0.0	0.0	near RT rainbow trout 599-1.1
	148.3	2/20-21	TL								2	48.0	0.0	0.0	and 718-1.0
TOTAL CATCH =				2				2		1 Rainbow					

[a] GN = Gill net
BS = Burbot set
TL = Trotline
HL = Hook and line

[b] M = Male
F = Female

[c] CPUE for trotlines are catch per trotline day. There are six hooks on one trotline. CPUE for a burbot set is calculated the same way, however, there is only one hook per burbot set.

[d] RT = Radio tagged fish

Appendix Table B-2. Relative sexual maturity of burbot captured on the Susitna River between Cook Inlet and Devil Canyon, December 1984 to February 1985.

Condition of Gonads	Total Length (mm)	Age	Date Captured	Area of Capture	River Mile / Tributary River Mile
Sex - Male					
pre-spawn	405	6	1/16	Deshka River	40.6/24.5
non-spawn	410	5	1/16	Deshka River	40.6/0.0
pre-spawn	410	7	1/16	Deshka River	40.6/24.5
non-spawn	520	7	12/17	Deshka River	40.6/0.0
non-spawn	525	7	1/16	Mainstem	46.0
pre-spawn	533	8	12/16	Deshka River	40.6/0.0
pre-spawn	535	8	1/16	Deshka River	40.6/24.5
pre-spawn	565	7	12/16	Deshka River	40.6/0.0
pre-spawn	590	10	1/16	Deshka River	40.6/24.5
non-spawn	625	7	1/16	Mainstem	46.0
non-spawn	665	8	1/25	Mainstem	75.4
pre-spawn	740	11	12/16	Deshka River	40.6/0.0
post-spawn	430	6	2/5	Moose Creek off Deshka R.	29.5/0.5
Total number of males = 13					
Sex - Female					
non-spawn	400	5	1/22	Mainstem	121.2
non-spawn	405	5	1/14	Deshka River	40.6/1.8
non-spawn	460	5	1/16	Mainstem	46.0
pre-spawn	465	8	1/16	Deshka River	40.6/24.5
pre-spawn	485	8	1/14	Deshka River	40.6/1.9
non-spawn	490	6	1/16	Mainstem	46.0
pre-spawn	490	7	1/16	Deshka River	40.6/24.5
pre-spawn	510	7	12/17	Mainstem	40.5
pre-spawn	510	7	1/14	Deshka River	40.6/2.0
non-spawn	515	6	2/8	Deshka River	40.6/1.9
non-spawn	515	9	1/15	Mainstem	31.8
pre-spawn	520	7	1/16	Deshka River	40.6/24.5
pre-spawn	524	7	12/16	Deshka River	40.6/0.0
pre-spawn	530	6	12/17	Deshka River	40.6/0.0
pre-spawn	530	10	1/16	Deshka River	40.6/24.5
pre-spawn	530	11	1/14	Deshka River	40.6/2.0
non-spawn	540	7	2/8	Deshka River	40.6/2.0
non-spawn	565	8	1/14	Deshka River	40.6/2.0
pre-spawn	575	8	1/14	Deshka River	40.6/2.0
non-spawn	600	9	1/16	Mainstem	46.0
pre-spawn	605	10	1/14	Deshka River	40.6/2.0
pre-spawn	615	11	1/14	Deshka River	40.6/2.0
non-spawn	645	8	1/16	Mainstem	46.0
non-spawn	660	9	1/17	Mainstem	35.6
pre-spawn	665	10	12/17	Deshka River	40.6/0.0
non-spawn	690	12	1/16	Mainstem	46.0
pre-spawn	695	9	1/15	Deshka River	40.6/2.0
pre-spawn	700	10	12/17	Deshka River	40.6/0.0
non-spawn	705	11	1/25	Mainstem	75.4
pre-spawn	780	11	1/22	Mainstem	121.2
pre-spawn	780	12	1/22	Mainstem	121.2
post-spawn	360	5	2/5	Moose Creek off Deshka R.	29.5/0.5
post-spawn	385	5	2/8	Deshka River	40.6/1.9
post-spawn	445	6	2/5	Moose Creek off Deshka R.	29.5/0.5
post-spawn	450	6	2/5	Moose Creek off Deshka R.	29.5/0.5
post-spawn	470	5	2/8	Deshka River	40.6/1.9
post-spawn	500	9	2/8	Deshka River	40.6/1.9
post-spawn	515	9	2/8	Deshka River	40.6/1.9
post-spawn	535	9	2/8	Deshka River	40.6/2.0
post-spawn	620	9	2/8	Mainstem	40.7
Total number of females = 40					

Appendix Table B-3. Burbot age-length[1] relationships by sex on the Susitna River between Cook Inlet and Devil Canyon, December 1984 to February 1985.

Age (Years)	Sex	Cook Inlet to Chulitna Confluence: Total No. of fish Sampled	Mean length (mm)	Range of length (mm)	Chulitna Confluence to Devil Canyon: Total No. of fish Sampled	Mean length (mm)	Range of length (mm)	Both Sexes: Cook Inlet to Devil Canyon: Total No. of fish Sampled	Percent Frequency	Mean length (mm)	Range of length (mm)
5	M	1	410	-	-	-	-	6	11.3	403	360-460
	F	4	403	360-460	1	400	-				
6	M	2	418	405-430	-	-	-	8	15.1	467	405-530
	F	6	483	445-530	-	-	-				
7	M	5	529	410-625	-	-	-	11	20.8	522	410-625
	F	6	516	490-540	-	-	-				
8	M	3	578	533-665	-	-	-	8	15.1	559	465-665
	F	5	547	465-645	-	-	-				
9	F	8	590	500-695	-	-	-	8	15.1	580	500-695
10	M	1	590	-	-	-	-	5	9.4	618	530-700
	F	4	625	530-700	-	-	-				
11	M	1	740	-	-	-	-	5	9.4	674	530-780
	F	3	617	530-705	1	780	-				
12	M	1	690	-	1	780	-	2	3.8	735	690-780
TOTAL		50	539	360-705	3	653	400-780	53	100.0	546	360-780

[1] Total length, nose-tail