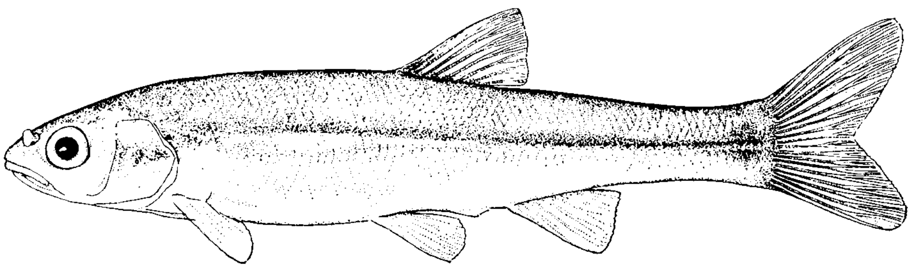
Technical Report No. 97-1

Juvenile Fish Use of Selected Habitats in the Tanana River Near Fairbanks (Preliminary Report)

by Alvin G. Ott, Jack F. Winters, and Alan H. Townsend



March 1998

Alaska Department of Fish and Game

Habitat and Restoration Division

JUVENILE FISH USE OF SELECTED HABITATS IN THE TANANA RIVER NEAR FAIRBANKS (PRELIMINARY REPORT)

By

Alvin G. Ott, Jack F. Winters, and Alan H. Townsend

Technical Report No. 97-1

Janet Kowalski
Director
Habitat and Restoration Division
Alaska Department of Fish and Game
P.O. Box 25526
Juneau, Alaska 99802-5526

March 1998

TABLE OF CONTENTS

LIST OF TABLES ii

LIST OF FIGURES iii

ACKNOWLEDGMENTS iv

EXECUTIVE SUMMARY v

INTRODUCTION 1

METHODS AND SAMPLE AREA 2

RESULTS 6
- Minnow Traps 6
- Seining 8

DISCUSSION 16
- Habitat Types and Juvenile Fish Use 16
- Fish Species Summaries 19

LITERATURE CITED 22

APPENDIX 1 - MINNOW TRAP DATA 25

APPENDIX 2 - SEINE HAUL HABITAT TYPES 37

APPENDIX 3 - SEINE HAUL DATA 41

APPENDIX 4 - ANNOTATED BIBLIOGRAPHY 59

LIST OF TABLES

1. Number of fish caught, by species, in minnow traps fished in the Tanana River (tributaries, backwaters, wetlands, main channel) in 1994 and 1996. 7

2. Number of minnow trap days and catch of coho salmon juveniles by habitat type in the Tanana River in 1996. 7

3. Number of fish caught, by species, using a seine in the Tanana River in 1994 and 1996. 8

4. The number and length (range, average, standard deviation) of juvenile coho salmon caught by seining in the Tanana River from May 28 to July 2, 1996. 10

5. Number of coho salmon juveniles captured by seining in various habitat types in the Tanana River from May 28 to June 6, 1996. 11

6. Number of lake chub captured by seining in various habitats in the Tanana River during 1994 and 1996. 14

7. Number of longnose sucker captured by seining in various habitats in the Tanana River during 1994 and 1996. 15

LIST OF FIGURES

1. Tanana River, Salchaket Slough to Crooked Creek. 3

2. Tanana River, Fairbanks to Salchaket Slough.......... 4

3. Minnow trap fished in scour hole next to a root wad caught 7 juvenile coho salmon (top photo). Coho salmon juveniles were caught along gravel/silt beaches (bottom photo). 9

4. Seine haul 96-15 made in backwater habitat caught two juvenile coho salmon and one chum salmon fry (top photo). Seine haul 96-10 made in gravel riffle habitat caught ten juvenile coho salmon and one chum salmon fry (bottom photo). 12

5. Seine haul 96-13 made in silt beach habitat caught 19 juvenile coho salmon and one chum salmon fry on May 28 (top photo). Twenty juvenile coho salmon were caught in seine haul 96-14 in gravel/silt beach habitat (bottom photo).......... 13

ACKNOWLEDGMENTS

We thank Mr. Les Fortune (Division of Forestry, Alaska Department of Natural Resources) for providing funding to initiate our fish study in the Tanana River. We also thank Mr. Fred Andersen (Division of Sport Fish) for providing equipment to conduct field work and Mr. William A. Morris III for assisting with field data collection. Our thanks to Mr. Matt Evenson (Division of Sport Fish) and Mr. Russ Holder (Commercial Fisheries, Management and Development Division) for their constructive review of the report.

EXECUTIVE SUMMARY

During the summer of 1996, we conducted the first year of a two year study of juvenile fish abundance in various habitats of the Tanana River. Limited sampling in 1994 provided guidance on techniques and locations. Fish were collected using seines, minnow traps, and electrofishing. Tanana River habitat types sampled included rocky bluffs, gravel bars, silt bars, root wads, cutbanks, backwaters, clearwater tributaries, connected wetlands, and tannin-colored sloughs. Predominate fish species found were longnose sucker (*Catostomus catostomus*) and lake chub (*Couesius plumbeus*). These species were captured in most of the habitat types sampled. Young-of-the-year longnose suckers were most abundant in tannin-colored sloughs and the interconnected wetland complex. Backwater habitats within the active floodplain of the Tanana River were used preferentially by longnose suckers and lake chub. Coho salmon (*Oncorhynchus kisutch*) juveniles were abundant in late May/early June 1996 and catches were highest in the main channel of the river. Chinook salmon (*Oncorhynchus tshawytscha*) outmigrants were not found and a few chum salmon (*Oncorhynchus keta*) fry were caught in 1996. Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*), least cisco (*Coregonus sardinella*), burbot (*Lota lota*), and northern pike (*Esox lucius*) were occasionally caught in the Tanana River or in the lower parts of tributaries and sloughs.

INTRODUCTION

The Tanana River supports a variety of fish species including burbot (*Lota lota*), round whitefish (*Prosopium cylindraceum*), humpback whitefish (*Coregonus pidschian*), least cisco (*Coregonus sardinella*), Arctic lamprey (*Lampetra japonica*), sheefish (*Stenodus leucichthys*), broad whitefish (*Coregonus nasus*), lake chub (*Couesius plumbeus*), slimy sculpin (*Cottus cognatus*), northern pike (*Esox lucius*), longnose sucker (*Catostomus catostomus*), Arctic grayling (*Thymallus arcticus*), chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), and coho salmon (*Oncorhynchus kisutch*). Most fisheries investigations in the Tanana River drainage have focused on clearwater tributaries supporting important commercial and sport fisheries and salmon spawning habitat.

Logging in Interior Alaska along the Tanana River has been concentrated in mature white spruce stands on both state and private lands. Generally, logged areas have been small and widely distributed between Nenana and Tok. Most logging has occurred during winter months when timber resources could be accessed using snow and ice roads to cross wetlands and waterbodies. In 1990, the State of Alaska passed the Forest Practices Act (FPA) relating to forest resources and practices and to the management of forest lands. Regulations to implement the FPA were promulgated by the Alaska Department of Natural Resources (ADNR) in 1993. Riparian standards contained in the FPA and in the 1993 regulations for coastal stream system buffers were based, in part, on fish, water quality, and hydraulic research conducted in southeast Alaska. Riparian habitat protection standards also were adopted for Interior Alaska; however, there is a paucity of data to assess the importance of buffers, particularly for a large-braided glacial system such as the Tanana River.

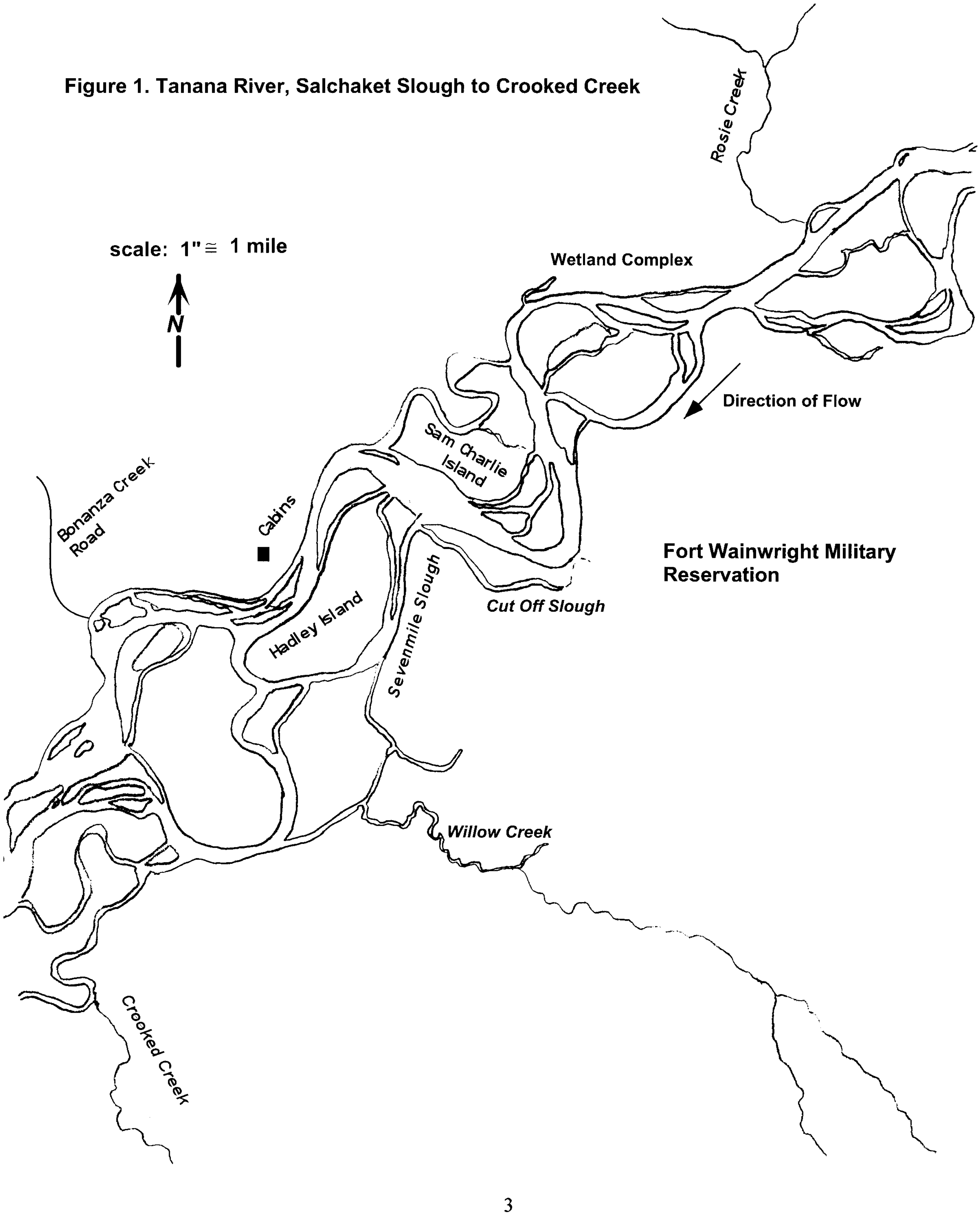
The ADNR submitted a request for and obtained limited funding to initiate research in Interior Alaska relative to logging. In response to a request from ADNR, we proposed a preliminary two-season fisheries study for the mainstem Tanana River, including a literature review of existing fisheries data. Our objective was to gather data on fish species use of various habitat types present in the Tanana River drainage. Our field work and sampling methods focused on juvenile fish.

METHODS AND SAMPLE AREA

Our sample area included the Tanana River, clearwater tributaries, tannin-colored sloughs, and connected wetlands between Fairbanks and the mouth of the Wood River. Fish sampling in this area in 1994 (not associated with this project) provided information on sampling techniques and locations. In 1996, the first year of our two year study, we sampled the Tanana River from just above Fairbanks to the Bonanza Creek Road (Figures 1 and 2). The sample area was selected because of its proximity to Fairbanks and the fact that some fisheries work has been done in this reach by the department and the University of Alaska Fairbanks. A 6.5 m long welded aluminum boat powered with a 90 horsepower jet outboard motor was used to access sample sites.

Emphasis was placed on finding juvenile fish in various habitat types of the Tanana River and its tributaries. Sampling began in early spring (following breakup) and terminated in July. Fish were collected using a seine, minnow traps, and an electrofisher. A Smith-Root Model 15-A backpack electrofisher was used to sample fish in shallow-water areas along the edge of the Tanana River and in sloughs. The electrofisher was used once although effective fish capture was low due to poor visibility in turbid water. Visual observations from a boat and a small-mesh dip net were used in tannic blackwater sloughs to collect and identify young-of-the-year fish. Fish also were collected with a 9.1 m by 1.2 m seine with 7 mm mesh. Seining was limited to areas with a depth of less than 1 m. Areas containing extensive inwater debris were avoided. Seines were pulled upstream for about 15 m and then pulled shoreward. Where water velocities and substrate made upstream seining difficult, downstream seining was used. In backwater areas, the seine was pulled upstream and the area covered by the seine was recorded. Minnow traps baited with salmon roe contained in perforated plastic containers also were used to sample fish at sites along cut banks, rock outcrops, near large woody debris, in backwaters, and along gravel and silt beaches. Minnow traps were fished in the main channel, side channels, and in sloughs of the Tanana River. Traps were fished for about 24 hr and were rebaited when reset.

Figure 1. Tanana River, Salchaket Slough to Crooked Creek



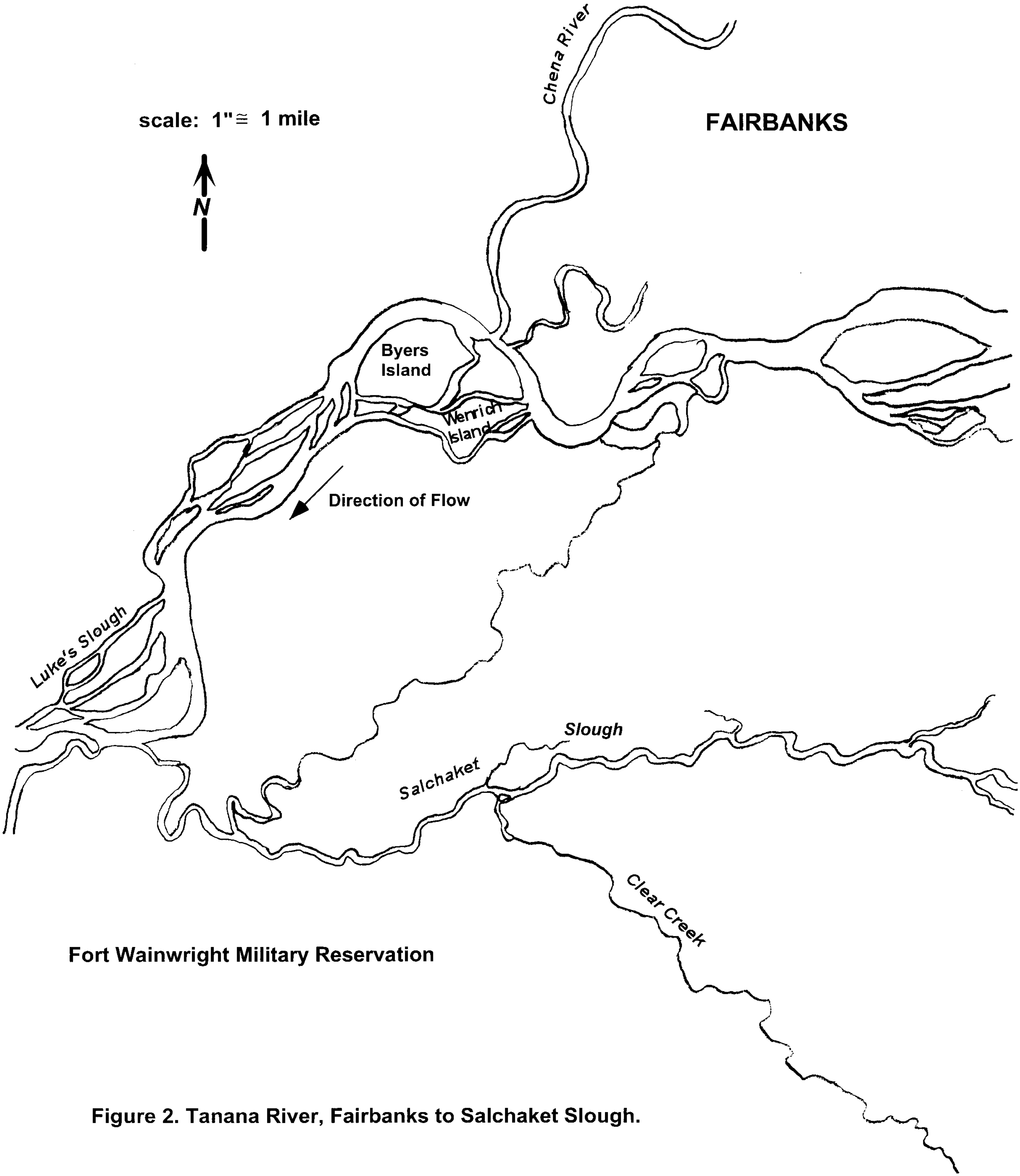


Figure 2. Tanana River, Fairbanks to Salchaket Slough.

Habitats sampled were visually assessed and selected sample sites were photographed. Habitat descriptions included water clarity, location, substrate type, presence of large woody debris, water depth, temperature, and velocity.

Fish were identified to species and measured. If large numbers of the same fish species were collected, a representative subsample was measured. Fork lengths (FL) in mm were recorded for all fish except burbot and slimy sculpin; total length (TL) was recorded for these species. Most fish were released; selected individuals were retained for positive identification.

RESULTS

Tanana River habitat types sampled included rocky bluffs, gravel bars, silt bars, root wads, cutbanks, backwaters, clearwater tributaries, connected wetlands, and tannin-colored sloughs. Substrate type along rocky bluffs varied from angular material to gravel, sand and silt. At gravel and silts bars, root wads, cutbanks, and backwaters, substrate type included gravel, silt and sand. In clearwater tributaries, substrate was mainly gravel. In backwaters the bottom generally was silty. Wetlands and tannin-colored sloughs had some gravel but most of the bottom was organic matter. Turbidity in the Tanana River was high (100 to 200 NTUs) but clear in the clearwater tributaries, and stained but clear in tannin-colored sloughs and the wetland complex. Emergent vegetation was nearly absent in the Tanana River except for some of the backwaters. Woody debris was common in all habitat types but most prevalent in the tannin-colored backwater sloughs.

Thousands of young-of-the-year longnose suckers were observed (visual) in Cut Off Slough, Willow Creek, and in a wetland complex connected to the Tanana River in 1994 and 1996. Abbreviations for the fish species referenced in this report are as follows: lake chub (LC), longnose sucker (LNS), slimy sculpin (CN), burbot (BB), Arctic grayling (AG), round whitefish (RWF), least cisco (LCI), coho salmon (CO), chum salmon (CS), and northern pike (NP).

Minnow Traps

Minnow traps fished in selected habitats in 1994 and 1996 caught lake chub, slimy sculpin, longnose sucker, burbot, Arctic grayling, round whitefish, and coho salmon. Lake chub was the most common fish caught in minnow traps in 1994 and juvenile coho salmon was the most frequent species encountered in 1996 (Table 1). A description of the habitat type and the length of fish caught by species is presented in Appendix 1.

We fished minnow traps in early June and mid-July in 1994 and in early June in 1996. Juvenile coho salmon were captured in various habitat types (Table 2) including gravel/silt, gravel, and silt beaches, along gravel and silt cutbanks, and in a scour hole

Table 1. Number of fish caught, by species, in minnow traps fished in the Tanana River (tributaries, backwaters, wetlands, main channel) in 1994 and 1996.

Year	Number Trap Days	LC	LNS	CN	BB	AG	RWF	CO
1994	56	167	28	5	3	1	1	0
1996	24	18	1	0	0	0	0	29

Table 2. Number of minnow trap days and catch of coho salmon juveniles by habitat type in the Tanana River in 1996.

Habitat Type	Number of Trap Days	Number of Coho Salmon
gravel/silt beach	1	6
gravel beach	5	4
silt beach	4	9
gravel/silt cutbank	1	0
gravel cutbank	3	1
silt cutbank	5	2
cobble, rocky bluff	3	0
gravel/silt root wad beach	1	7
silt, root wad, cutbank	1	0

next to a root wad. Juvenile coho salmon were captured in 1996 but not in 1994. The highest catch for one trap was seven juvenile coho salmon in a scour pool next to a root wad (Figure 3). Gravel/silt, gravel, and silt beaches where 10 of the traps were placed caught a total of 19 juvenile coho salmon (Figure 3).

In mid-July 1994 we caught no fish in Clear Creek and four slimy sculpin in McDonald Creek. Clear and McDonald Creeks (tributaries to Salchaket Slough) are clearwater, cold, spring-fed systems used by Arctic grayling. The lower 400 m of Bear Creek (also a tributary to Salchaket Slough), where it was influenced by waters from Salchaket Slough, produced lake chubs and longnose suckers in six minnow traps fished for one day (Appendix 1). The lake chubs were ripe and appeared to be spawning in a gravel/silt substrate. Water was slightly turbid and a milky color due to the mix of clearwater from Bear Creek and turbid waters from Salchaket Slough. Six traps fished in Cut Off Slough and six in Willow Creek in 1994, which are both tannic blackwater sloughs containing extensive inwater woody debris and emergent aquatic vegetation, caught no fish.

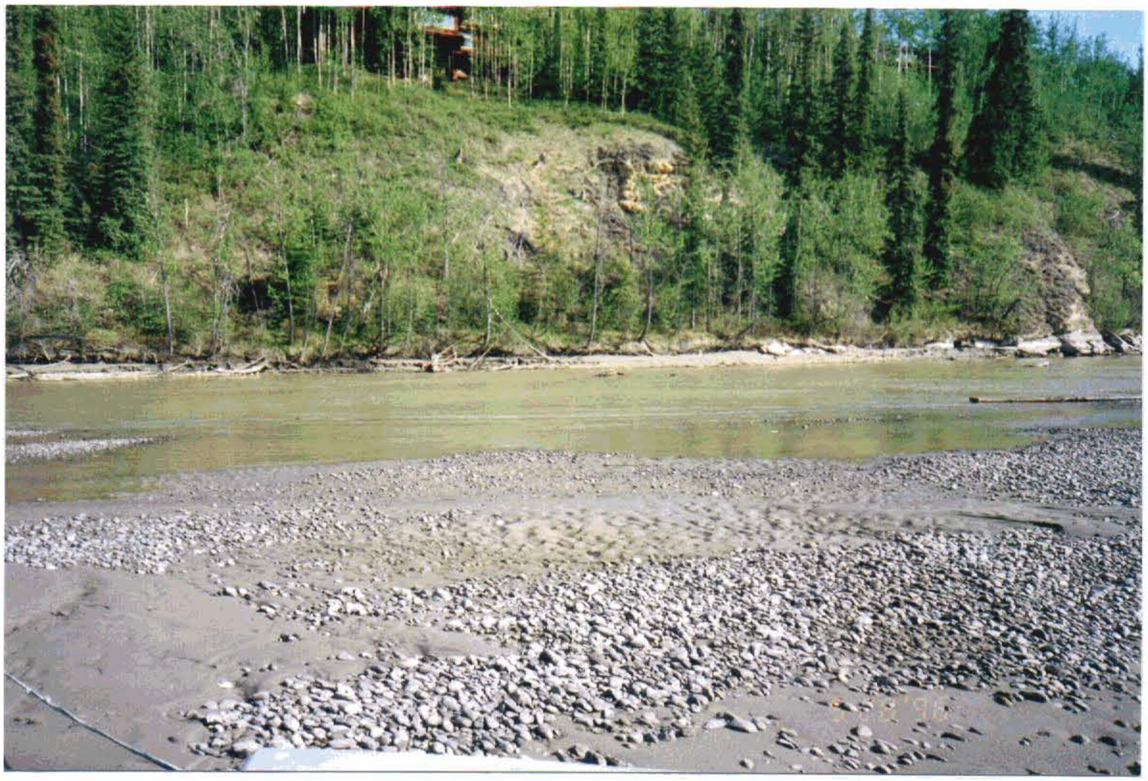
Seining

We caught lake chub, longnose sucker, slimy sculpin, burbot, Arctic grayling, round whitefish, least cisco, northern pike, and coho and chum salmon with 58 seine hauls in selected habitats in 1996. In 1994 we seined six times catching lake chub, longnose sucker, slimy sculpin, and burbot. The most frequently caught species in both years were lake chub and longnose sucker. In 1996 coho salmon juveniles were common (Table 3) and chum salmon were present. The total catch of burbot, round whitefish, least cisco, and Arctic grayling in both 1994 and 1996 was low.

Table 3. Number of fish caught, by species, using a seine in the Tanana River in 1994 and 1996.

Year	Number of Hauls	LC	LNS	CN	BB	AG	RWF	LCI	CO	CS	NP
94	6	363	119	1	1	0	0	0	0	0	0
96	58	294	242	35	3	4	2	1	157	18	1

Figure 3. Minnow trap fished in scour hole next to a root wad caught 7 juvenile coho salmon (top photo). Coho salmon juveniles were caught along gravel/silt beaches (bottom photo).



Data on habitat type sampled, the number and length of fish caught, and date are presented in Appendices 2 and 3. In 1996, we seined on May 27, 28, and 29, June 4 and 6, and July 2. We caught chum salmon juveniles on May 28, May 29, and July 2. We caught seven chum salmon juveniles, 37 to 42 mm long, in an isolated scour pool below a log jam on May 29. Water levels had dropped since breakup and the scour pool was isolated from surface flow. These chum salmon fry probably had been trapped in the pool for a least one week.

Coho salmon juveniles were caught from May 28 to July 2 (Table 4). With the exception of one coho salmon in July, all juveniles were caught in late May and early June. Catch per unit of effort peaked on May 29 but decreased substantially by the 6th of June. The range, average length, and standard deviation for juvenile coho salmon were similar for the late May and early June sample periods.

Table 4. The number and length (range, average, standard deviation) of juvenile coho salmon caught by seining in the Tanana River from May 28 to July 2, 1996[1].

Date	Number of Hauls	Number of Coho Salmon	Catch Per Seine Haul	Length (Range, mm)	Average	Standard Deviation
5/28/96	6	38	6.3	60-94	68.5	7.2
5/29/96	8	82	10.3	57-90	70.5	7.2
6/4/96	10	34	3.4	56-81	68.6	5.9
6/6/96	5	2	0.4	59-66	62.5	
7/2/96	21	1	<0.1	73		

[1]The seven seine hauls made in Salchaket Slough on May 27, 1996 did not catch juvenile salmon and were not included in the data set. Due to low water levels in the Tanana River, juvenile salmon moving down the river from known upstream spawning areas may not have had access to Salchaket Slough.

From May 28 to June 6, 155 coho salmon juveniles were caught in several habitat types including gravel and gravel/silt riffles, along silt and gravel/silt beaches, and in backwaters (Table 5). Lower catches generally were found in backwater habitats (Figure 4). Catches varied considerably even in similar habitat types. Average seine haul catches of coho salmon in gravel or silt habitats ranged from 4.5 in gravel/silt riffle to 10 in gravel/silt beach habitat (Figure 5).

Table 5. Number of coho salmon juveniles captured by seining in various habitat types in the Tanana River from May 28 to June 6, 1996.

Habitat Type	Number of Seine Hauls	Number of Coho Salmon	Catch/Seine Haul
gravel/silt beach	2	20	10
silt beach	4	31	7.8
gravel riffle	14	87	6.2
gravel/silt riffle	2	9	4.5
gravel/silt backwater	3	5	1.7
gravel backwater	2	0	0
silt backwater	2	3	1.5

Longnose sucker and lake chub were the most common species collected in both 1994 and 1996. Lake chubs were caught in all habitat types sampled but the highest catches occurred in backwater habitats, particularly those with woody debris and aquatic vegetation (Table 6). Longnose suckers also were caught in all habitat types with highest catches occurring in backwater habitats (Table 7). Backwater habitats in the Tanana River are not stable and change throughout the summer months with fluctuations in water level associated with breakup, post-breakup, glacial melt, fall storms, and freezeup.

Figure 4. Seine haul 96-15 made in backwater habitat caught two juvenile coho salmon and one chum salmon fry (top photo). Seine haul 96-10 made in gravel riffle habitat caught ten juvenile coho salmon and one chum salmon fry (bottom photo).

Figure 5. Seine haul 96-13 made in silt beach habitat caught 19 juvenile coho salmon and one chum salmon fry on May 28 (top photo). Twenty juvenile coho salmon were caught in seine haul 96-14 in gravel/silt beach habitat (bottom photo).

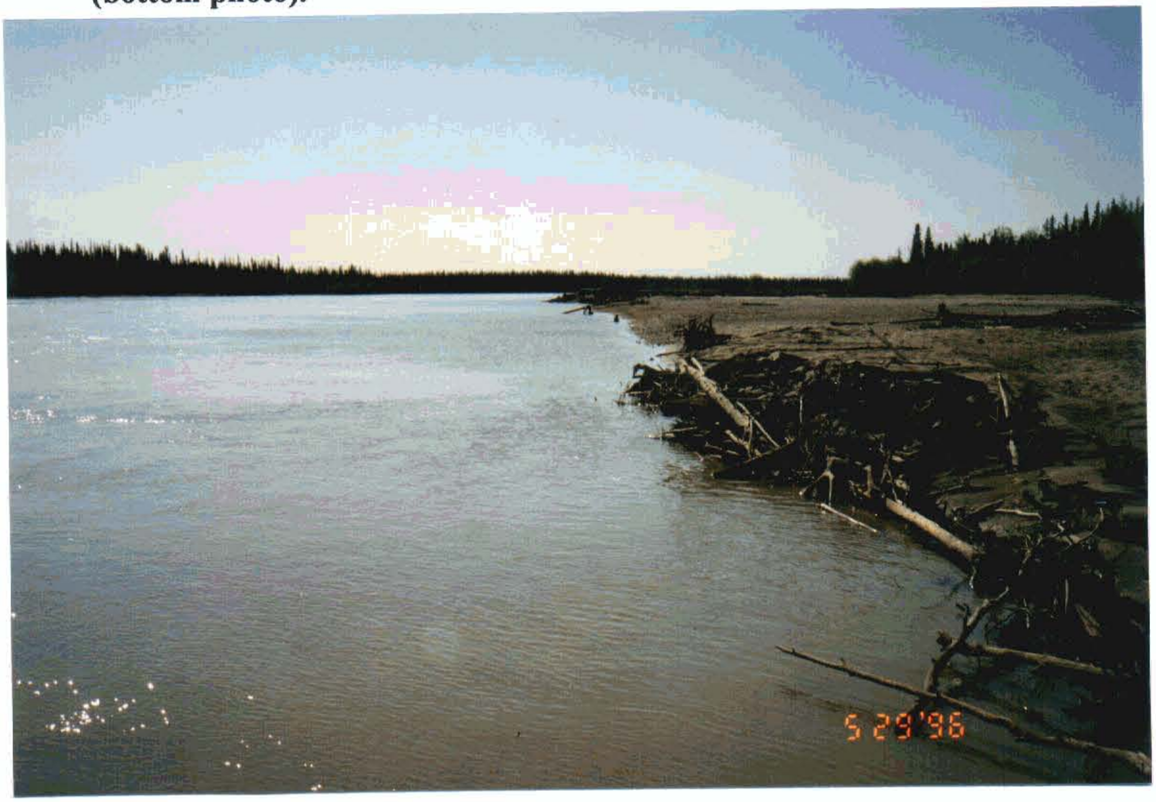


Table 6. Number of lake chub captured by seining in various habitats in the Tanana River during 1994 and 1996.

Habitat Type	Number of Seine Hauls	Number of Lake Chub	Catch/Seine Haul
gravel/silt beach	6	7	1.1
silt beach	6	44	7.3
gravel riffle	27	91	3.4
gravel/silt riffle	11	148	13.5
gravel/silt backwater	1	16	16
gravel backwater	4	12	3
silt backwater	2	0	0
silt backwater with woody debris	1	101	101
gravel silt backwater with woody debris	1	15	15
silt backwater with aquatic vegetation	1	227	227

Table 7. Number of longnose sucker captured by seining in various habitats in the Tanana River during 1994 and 1996.

Habitat Type	Number of Seine Hauls	Number of Longnose Sucker	Catch/Seine Haul
gravel/silt beach	6	10	1.7
silt beach	6	11	1.8
gravel riffle	27	67	2.5
gravel/silt riffle	11	41	3.7
gravel/silt backwater	1	0	0
gravel backwater	4	20	5
silt backwater	2	3	1.5
silt backwater with woody debris	1	25	25
gravel/silt backwater with woody debris	1	19	19
silt backwater with aquatic vegetation	1	70	70

DISCUSSION

An annotated bibliography has been prepared which summarizes primarily references of fish and fish habitat in the Tanana River drainage (Appendix 4). Our bibliography also includes references of applicable fish species found in glacial systems outside interior Alaska. Additional references will be annotated for the final summary report. Selected references are used in the discussion which follows.

Habitat Types and Juvenile Fish Use

Sampling of the Tanana River was designed to gather preliminary data on juvenile fish use of a variety of habitat types including spring-fed tributaries, interconnected wetlands, and blackwater tannin sloughs, as well as the main channel, side channels, and sloughs of the river. Mecum (1984) described various habitat types of the Tanana River and collected quantitative data on water quality, flow characteristics, and substrate type in relation to fish catches. Mecum (1984) found lake chub and longnose suckers to be the most common species in the Tanana River. We found longnose suckers and lake chub to be the most abundant fish species. Chen (1968) also reported the most abundant species in the Tanana River were lake chub, longnose suckers, and slimy sculpin.

Mecum (1984) found both lake chub and longnose suckers preferred certain habitats. He found young-of-the-year lake chub preferred shallow backwater habitats over silt and sand substrates with velocities from 0 to 9 cm/s. Catch rates for juvenile lake chub were not significantly different among seining sites. Adult lake chub preferred shallow riffle areas over gravel and rubble-cobble substrates. Young and juvenile lake chub selected habitats where water velocity was less than 30 cm/s whereas adults were captured more frequently when velocities exceeded 30 cm/s. In 1996 we caught lake chubs with seines in all habitat types sampled but the highest catches occurred in backwater habitats, particularly those with woody debris and aquatic vegetation. Seine hauls made in backwater habitats probably are more efficient than in other habitat types.

Mecum (1984) found young-of-the-year longnose suckers occurred in habitat with current velocities from 0 to 9 cm/s, depths from 0 to 9 cm, and at silt and sand substrates at a greater frequency than expected. Juvenile longnose suckers tended to occupy areas with higher velocities, greater depths, and substrates of larger particle size than young-of-the-year. We caught juvenile longnose suckers in all habitat types, with highest catches occurring in backwater habitats.

Backwater habitats in the active floodplain, including sloughs, of the Tanana River are limited, and flow and water quality in these habitats change over the summer. In blackwater-sloughs (Cut Off, Willow Creek) and in the connected wetland complex, habitat is more stable and these are the areas supporting thousands of young-of-the-year longnose suckers but few juvenile longnose suckers or lake chub. Visual observations made from a boat in a blackwater slough of the Nowitna River (September 1990 through 1996) were very similar: young-of-the-year longnose suckers were abundant and actively fed upon by northern pike and sheefish.

Predominant resident fish species in the turbid waters of the Tanana River during the summer season are adapted for benthic feeding (slimy sculpin, longnose suckers, lake chub) whereas sight-feeding fish (Arctic grayling, round whitefish) are found in clearwater habitats (Mecum 1984). Tanana River spring-fed systems are characterized by fairly constant temperatures, discharges, and clarity due to their ground water sources (Ridder 1984). Only coho salmon spawn and overwinter in the spring-fed systems (Pearse 1974); the others (Arctic grayling, round whitefish) use them as summer feeding areas (Ridder 1984). Spring-fed systems such as the Delta Clearwater River and Richardson Clearwater Creek (south side Tanana River tributaries) upstream of the head of Salchaket Slough support coho salmon.

Hallberg (1979) sampled the lower parts of Fivemile Clearwater, Clear, Bear, and McDonald Creeks and found a variety of fish but documented juvenile coho salmon only in Fivemile Clearwater Creek. We also were unable to capture juvenile coho salmon in Clear, Bear, or McDonald Creeks with minnow traps in 1994. We did not catch juvenile coho salmon in Salchaket Slough during the same time period we were finding this species in the mainstem of the Tanana River. Reasons for their apparent absence from Bear, McDonald, and Clear Creeks is not known but we speculate winter flow is not adequate to support incubation of eggs or survival of newly hatched fry.

Juvenile coho salmon were abundant during our 1996 sample in the Tanana River and while captured in various habitat types, catch per unit effort was lower in backwater habitats and highest along the edges of the main channel (gravel and silt beaches and riffles). Catch rates declined rapidly from late May to early June. Mecum (1984) caught most of the juvenile coho salmon in main channel border or shoreline and main channel sandbar habitats. Water velocities in these habitats are relatively slow (15 to 60 cm/s). Murphy (1989) found juvenile coho salmon densities in the Taku River (southeastern Alaska) were highest in still or slow water (<11 cm/s), but these measurements were made for rearing fish and not outmigrating smolts. We speculate that the apparent preferential habitat use by juvenile coho salmon in our 1996 sample was because the fish were actively outmigrating and more abundant along the main current and thus subject to a higher catch rate in this area.

Blackwater sloughs (Cut Off fed by surface flow, Willow Creek fed by both surface flow and springs) are tannin-stained, and contain extensive inwater woody debris and emergent aquatic vegetation. Thousands of young-of-the-year longnose suckers were present by mid-summer, suggesting that this species spawned in these habitats during spring. An interconnected wetland complex similar in characteristics to Cut Off and Willow Creek sloughs but containing extensive shallow-water habitat (<1 m) and aquatic emergent vegetation, also contained thousands of young-of-the-year longnose suckers by mid-summer. The abundance of this species in Cut Off and Willow Creeks and the cover provided by debris, dark waters, and aquatic vegetation serve as major attractants and habitat components for predatory fish such as northern pike, sheefish, and burbot.

Juvenile chinook salmon were not found in the Tanana River even though outmigration from the Chena River peaked during late May in 1996 (Peterson 1997, in press). Juvenile chinook salmon catches in the Chena River were highest in the main current and greatly reduced in backwater or slack water habitats; chinook smolts did not enter minnow traps but young-of-the-year did (Peterson 1997, in press). Mecum (1984) only found young-of-the-year chinook salmon in tributary mouths (Chena River) and modified slough habitats. He also found none in the Tanana River. Francisco (1976) found that young-of-the-year chinook salmon in the Salcha River were most common in deep holes, around brush piles and beaver houses, and in sloughs. Use of tributary streams to the Salcha River seemed to be concentrated in the lower mile. Murphy et al. (1989) found densities of rearing chinook salmon highest in slow to moderate current (1 to 20 cm/s) in the Taku River, a glacial system in southeast Alaska. Juvenile chinook salmon in the Taku River primarily were in sloughs, channel edges, off-channel terrace tributaries, and tributary mouths. We sampled similar habitats in the Tanana River but did not catch any juvenile chinook salmon. We speculate that outmigrating chinook salmon are using the higher velocity water in the mainstem Tanana River and gear type (seines), which is limited to shallow water with lower velocities, failed to catch them. Furthermore, based on Peterson's (1997, in press) work, chinook salmon smolts would not have been vulnerable to the baited minnow traps.

Fish Species Summaries

Many investigators working on Arctic grayling in tributaries of the Tanana River have found interstream movement, with fish using different drainages for rearing (Richardson Clearwater and Fivemile Clearwater Creeks) and spawning (Caribou Creek), with overwintering occurring in the mainstem Tanana River (Clark and Ridder 1988; Ridder 1994; Clark 1993).

Trends in Arctic grayling movement indicate a migration from spawning areas in unsilted rapid runoff and bog-fed systems to spring-fed systems for feeding, with a high degree of specificity to feeding areas (Ridder 1991). Based on tag recovery data for Arctic grayling using tributaries of the Tanana River for spawning and rearing (Schallock 1965, Reed 1961, Van Wyhe 1964), it is apparent that these fish are using the Tanana River as a migratory corridor and as overwintering habitat. Schallock (1966) found Arctic grayling in the Tanana River during mid-October feeding on fall chum salmon eggs and he observed one large school of about 200 fish in the Tanana River during December. The near total absence of juvenile Arctic grayling in the mainstem Tanana River during our May, June, and July sample periods supports the hypothesis that the main river is not used for summer rearing by juvenile Arctic grayling.

Salmon spawning areas in the mainstem of the Tanana River are virtually impossible to document due to turbid water conditions. The only radio telemetry study conducted to date to determine salmon spawning areas was done in 1989 by Barton (1992). Fall chum salmon spawning was documented in the mainstem and sloughs of the Tanana River from near Upper Salchaket Slough to the mouth of George Lake. Specific spawning areas were identified for 131 fish. Ninety-seven of these fish spawned in the floodplain of the Tanana River between upper Salchaket Slough and the mouth of the Little Gerstle River. In Barton's concluding remarks, he states that at least in some years, the numerous and relatively smaller spawning areas in the mainstem Tanana

River, when taken collectively, contribute more substantially to total Tanana River fall chum salmon spawning escapement than previously realized.

In the Delta River in 1976, downstream migration of the chum smolt began in early April and peaked on April 28 and again on May 17 following increased river flows (Francisco 1977). In 1977 chum salmon fry emerged in early-to-mid April, with peak outmigration occurring in the two weeks from April 8 to 21 (Francisco and Dinneford, 1977; Dinneford 1978). In 1976 in the Salcha River, chinook salmon smolt outmigration probably peaked before May 25; chum salmon smolt outmigration continued through at least May 26 (Dinneford 1977). Peak smolt outmigration in the Salcha River for both chum and chinook salmon occurred during a high water event from May 10 through 15 (Francisco 1976). Our sampling in the Tanana River in 1996 probably began after the peak outmigration for chum salmon fry, but we did capture a few chum salmon fry from late May through early July. The size variability of chum salmon collected in early July (34, 37, and 44 mm) indicate that hatching and fry emergence are occurring over an extended period of time.

Burbot work in the Tanana River system has focused on determining movement patterns, estimating the population size, and identifying spawning areas. Burbot are caught primarily with hoop traps and most are large (>300 mm) due to trap net size. Hallberg (1984) used fyke nets set in side channels and backwater slough systems of the Tanana River to capture burbot. Burbot stomach contents revealed longnose sucker, humpback whitefish, lake chub, and round whitefish accounted for 65% of the identifiable food items. These four species were often captured in the fyke nets along with the burbot. A population estimate of burbot in a 6.4 km section of the Tanana River near Rosie Creek near Fairbanks provided an estimate of 2,892 burbot greater than 300 mm (Hallberg 1987). Burbot tend to stay in the same reach of the Tanana River with most movement occurring during summer and winter (Evenson 1988). Radiotagged burbot spawned in the mainstem Tanana River in late-January to early February (Evenson 1993).

Evenson (1989) found that burbot are resident to a given area for a period of 1.5 years but then tend to move upstream. Populations mix between river systems such as the Tanana, Chena, Salcha, and Goodpaster (Evenson 1989, 1990). Sorokin (1984) described two burbot spawning areas in the Burgul'deyka, a western tributary of Baikal. He concluded, based on other investigations and his work in the Burgul'deyka, that burbot select quiet places of the rivers for spawning - stream mouths and channels forming deep places (i.e., tributary mouth) with an undercurrent of fresh water ensuring a supply of oxygen. Eggs are carried downstream in the spring prior to hatching.

We caught few small burbot in the mainstem Tanana River, yet spawning has been documented here and one would assume that juvenile burbot rear in the variety of habitats provided by the Tanana River. Methods used, especially minnow traps, have proven extremely effective in the capture of small burbot in pond type habitats in the Fish Creek system. The only report of finding young-of-the-year burbot in the Tanana River was by Chen (1968). One possible explanation is that juvenile burbot move out of the Tanana River proper and enter clearwater tributaries to rear. Sampling done in the headwaters of the Chena and Chatanika River drainages has produced catches of juvenile burbot (<200 mm) in virtually every stream. Movements by juvenile burbot into these streams probably occur during the summer months, with peak use occurring in the fall prior to outmigration.

The Tanana River provides a number of habitats that are used by multiple fish species for a variety of purposes throughout the year. Many of the available habitats are used only seasonally, as decreases in flow associated with freezeup eliminate access by fish to these habitats. The main channels of the Tanana River become increasingly important to fish as ice in tributaries and shallow areas forces fish to areas of deeper water for the winter. The complete magnitude of fish use of the Tanana River will be very difficult to assess due to turbid water, depth, velocity, and ice cover.

LITERATURE CITED

Barton, L.H. 1992. Tanana River, Alaska, fall chum salmon radio telemetry study. ADF&G. Fisheries Research Bulletin No. 92-01. Juneau. 16 pp.

Chen, L.C. 1968. The biology and taxonomy of the burbot, Lota lota leptura, in interior Alaska. Biol. Pap. Univ. Alaska, No 11. 53 pp.

Clark, R.A. 1993. Interannual intrastream movements of Arctic grayling in the Chena, Salcha, and Goodpaster rivers. ADF&G. Fishery Manuscript No. 93-2. Anchorage. 163 pp.

Clark, R.A., and W.P. Ridder. 1988. Stock assessment of Arctic grayling in the Tanana River drainage. ADF&G. Div. of Sport Fish, Fishery Data Series No. 54. Juneau. 79 pp.

Dinneford, W.B. 1977. Third interim report of the commercial fish - technical evaluation study: Salcha River. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 17. 88 pp.

Dinneford, W. B. 1978. Final report of the commercial fish - technical evaluation study: Tanana and Delta Rivers. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 20. 52 pp.

Evenson, M.J. 1988. Movement, abundance and length composition of Tanana River burbot stocks during 1987. ADF&G. Div. of Sport Fish, Fishery Data Series No. 56. Juneau. 42 pp.

Evenson, M.J. 1989. Biological characteristics of burbot in rivers of interior Alaska during 1988. ADF&G. Div. of Sport Fish, Fishery Data Series No. 109. Juneau. 47 pp.

Evenson, M.J. 1990. Movement, abundance, and length composition of burbot in rivers of interior Alaska during 1989. ADF&G. Div. of Sport Fish, Fishery Data Series 90-3. Juneau. 26 pp.

Evenson, M.J. 1993. Seasonal movements of radio-implanted burbot in the Tanana River drainage. ADF&G. Fishery Data Series No. 93-47. Anchorage. 27 pp.

Francisco, K. 1976. First interim report of the commercial fish - technical evaluation study. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 4. 86 pp.

Francisco, K. 1977. Second interim report of the commercial fish - technical evaluation study. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 9. 46 pp.

Literature Cited (continued).

Francisco, K., and W.B. Dinneford. 1977. Fourth interim report of the commercial fish - technical evaluation study: Tanana and Delta Rivers. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 19. 50 pp.

Hallberg, J.E. 1980. Population structure, migratory patterns, and habitat requirements of the Arctic grayling. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 21. Proj. R-I, Job R-I-A. 22 pp.

Hallberg, J. 1984. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters - Fairbanks District. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 25. Proj. F-9-16, Job G-III-H. 34 pp.

Hallberg, J.E., R.A. Holmes, and R.D. Peckham. 1987. Movement, abundance, and length composition of 1986 Tanana River burbot stocks. ADF&G. Div. of Sport Fish, Fishery Data Series No. 13. Juneau. 21 pp.

Mecum, R.D. 1984. Habitat utilization by fishes in the Tanana River near Fairbanks, Alaska. M.S. Thesis. University of Alaska, Fairbanks, Alaska. 128 pp.

Murphy, M.L., J. Heifetz, J.F. Thedinga, S.W. Johnson, and K.V. Koski. 1989. Habitat utilization by juvenile Pacific salmon (*Onchorynchus*) in the glacial Taku River, Southeast Alaska. Can. J. Fish. Aquat. Sci. 46:1677-1685.

Pearse, G.A. 1974. A study of a typical spring fed stream of interior Alaska. Annual report of progress. ADF&G Fed. Aid in Fish. Rest. Vol. 15. Proj. F-9-6, Job G-III-G. 49 pp.

Peterson, B. 1997 (in press). Estimation of abundance and mortality of emigrating chum and chinook salmon outmigrants in the Chena River, Alaska. M.S. Thesis, University of Alaska, Fairbanks.

Reed, R.J. 1961. Investigation of the Tanana River grayling fisheries. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-2, Job 3-B. pp. 195-214.

Ridder, W.P. 1984. The life history and population dynamics of exploited stocks of Arctic grayling associated with the Delta and Richardson Clearwater Rivers. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 25. Proj. F-9-16, Job G-III-G. 49 pp.

Ridder, W.P. 1991. Summary of recaptures of Arctic grayling tagged in the middle Tanana River drainage, 1977 through 1990. ADF&G. Fishery Data Series No. 91-34. Juneau. 97 pp.

Ridder, W.P. 1994. Contributions of Arctic grayling from Caribou Creek to the Richardson Clearwater River and Shaw Creek, 1980 through 1988. ADF&G. Fishery Data Series No. 94-49. Anchorage. 53 pp.

Literature Cited (concluded).

Schallock, E. 1965. Investigations of the Tanana River grayling fisheries, migratory studies. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-6, Job 16-B. 12 pp.

Schallock, E. 1966. Investigations of the Tanana River and Tangle Lakes fisheries: migratory and population study. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-7, Job 16-B. 16 pp.

Sorokin, V.N. 1971. The spawning and spawning grounds of the burbot [*Lota lota* (L.)]. J. Ichthyol. 11(6) 907-915.

Van Wyhe, G. 1964. Investigations of the Tanana River grayling fisheries: migration study. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-5, Job 14-B. 15 pp.

APPENDIX 1 MINNOW TRAP DATA

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	cobble/silt	M-94-1							
Hot Slough	rocky bluff								
6/6/94	(turbid)								
Tanana	cobble/silt	M-94-1							
Hot Slough	rocky bluff								
6/7/94	(turbid)								
Tanana	cobble/silt	M-94-2	53						
Hot Slough	rocky bluff		75						
6/6/94	(turbid)								
Tanana	cobble/silt	M-94-2	79						
Hot Slough	rocky bluff		98						
6/7/94	(turbid)								
Tanana	silt	M-94-3	61						
Hot Slough	rocky bluff		65						
6/6/94	(turbid)								
Tanana	silt	M-94-3							
Hot Slough	rocky bluff								
6/7/94	(turbid)								
Tanana	silt	M-94-4							
Hot Slough	rocky bluff								
6/6/94	(turbid)								
Tanana	silt	M-94-4							
Hot Slough	rocky bluff								
6/7/94	(turbid)								
Tanana	cobble/silt	M-94-5	71						
Hot Slough	rocky bluff		90						
6/6/94	(turbid)								
Tanana	cobble/silt	M-94-5							
Hot Slough	rocky bluff								
6/7/94	(turbid)								
Tanana	cobble	M-94-6	61						
Hot Slough	rocky bluff		71						
6/6/94	(turbid)		78						

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	cobble	M-94-6	78						
Hot Slough	rocky bluff	(con't)							
6/6/94	(turbid)								
Tanana	cobble	M-94-6							
Hot Slough	rocky bluff								
6/7/94	(turbid)								
Tanana	cobble/gravel	M-94-7							
Rosie Creek	rocky bluff								
6/14/94	(turbid)								
Tanana	cobble/gravel	M-94-8							
Rosie Creek	rocky bluff								
6/14/94	(turbid)								
Tanana	cobble/gravel	M-94-9							
Rosie Creek	rocky bluff								
6/14/94	(turbid)								
Tanana	cobble/gravel	M-94-10							
Rosie Creek	rocky bluff								
6/14/94	(turbid)								
Tanana	cobble/gravel	M-94-11				190			
Rosie Creek	rocky bluff								
6/14/94	(turbid)								
Tanana	cobble/gravel	M-94-12	55	94					
Rosie Creek	rocky bluff		59						
6/14/94	(turbid)		63						
			63						
			68						
			70						
			80						
			82						
			84						
			95						
			100						
			102						
			127						
Tanana	silt	M-94-13							
6/14/94	backwater								
	(turbid)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	silt	M-94-14	110						
6/14/94	backwater								
	(turbid)								
Tanana	gravel beach	M-94-15							
6/14/94	(turbid)								
Tanana	gravel beach	M-94-16							
6/14/94	(turbid)								
Tanana	gravel beach	M-94-17							
6/14/94	(turbid)								
Tanana	gravel beach	M-94-18	110						
6/14/94	(turbid)								
Tanana	silt, root wad	M-94-19							
6/14/94	(turbid)								
Tanana	silt, root wad	M-94-20							
6/14/94	(turbid)								
Tanana	silt, root wad	M-94-21							
6/14/94	(turbid)								
Tanana	silt, root wad	M-94-22							
6/14/94	(turbid)								
Tanana	silt, root wad	M-94-23							
6/14/94	(turbid)								
Tanana	silt, root wad	M-94-24							
6/14/94	(turbid)								
Tanana	gravel/silt	M-94-25							
6/14/94	beach								
	(turbid)								
Tanana	gravel/silt	M-94-26							
6/14/94	beach								
	(turbid)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	silt	M-94-27	46						
6/14/94	backwater		46						
	(green)		48						
			56						
			60						
			72						
			72						
Tanana	silt	M-94-28	40						
6/14/94	backwater		44						
	(green)		44						
			44						
			44						
			46						
			46						
			50						
Tanana	silt	M-94-29							
6/14/94	backwater								
	(orange)								
Tanana	silt	M-94-30							
6/14/94	backwater								
	(orange)								
Clear Creek	gravel, cut	M-94-31							
7/13/94	bank (clear)								
Clear Creek	gravel, cut	M-94-32							
7/13/94	bank (clear)								
Clear Creek	gravel, cut	M-94-33							
7/13/94	bank (clear)								
Clear Creek	gravel, cut	M-94-34							
7/13/94	bank (clear)								
Clear Creek	gravel, cut	M-94-35							
7/13/94	bank (clear)								
Clear Creek	gravel, cut	M-94-36							
7/13/94	bank (clear)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
McDonald	gravel, cut	M-94-37			68				
Creek 7/13/94	bank (clear)								
McDonald	gravel, cut	M-94-38							
Creek 7/13/94	bank (clear)								
McDonald	gravel, cut	M-94-39			30				
Creek 7/13/94	bank (clear)								
McDonald	gravel, cut	M-94-40			72				
Creek 7/13/94	bank (clear)				75				
McDonald	gravel, cut	M-94-41							
Creek 7/13/94	bank (clear)								
McDonald	gravel, cut	M-94-42							
Creek 7/13/94	bank (clear)								
Bear Creek	gravel/silt	M-94-43	53						
7/13/94	beach		61						
	(milky)		66						
			72						
			78						
			80						
			83						
			84						
			85						
			88						
			88						
			91						
			92						
			110						
Bear Creek	gravel/silt	M-94-44	44	55					
7/13/94	beach		45	65					
	(milky)		52	80					
			52	120					
			53	132					
			53						
			55						
			58						
			64						
			70						
			72						

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Bear Creek	gravel/silt	M-94-44	80						
7/13/94	beach	(con't)	80						
	(milky)		82						
			84						
			86						
			87						
Bear Creek	gravel/silt		90						
7/13/94	beach		91						
	(milky)		91						
			92						
			94						
			95						
			101						
			105						
			115						
			116						
Bear Creek	gravel/silt	M-94-45	57	73					
7/13/94	beach		58	107					
	(milky)		60	107					
			67	112					
			68						
			70						
			72						
			76						
			78						
			82						
			84						
			84						
			84						
			84						
			86						
			86						
			88						
			93						
			94						
			96						
			98						
			103						
			117						
Bear Creek	gravel/silt	M-94-46	87	55					
7/13/94	beach			62					
	(milky)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Bear Creek	gravel/silt	M-94-47	57						
7/13/94	beach								
	(milky)								
Bear Creek	gravel/silt	M-94-48	51	64					
7/13/94	beach		62	70					
	(milky)		83	99					
			87						
			89						
			98						
Salchaket	gravel/silt	M-94-49	80						
7/13/94	beach		105						
	(turbid)								
Salchaket	gravel/silt	M-94-50							
7/13/94	beach								
	(turbid)								
Salchaket	gravel/silt	M-94-51							
7/13/94	beach								
	(turbid)								
Salchaket	gravel/silt	M-94-52						53	
7/13/94	beach								
	(turbid)								
Salchaket	gravel/silt	M-94-53							
7/13/94	beach								
	(turbid)								
Salchaket	gravel/silt	M-94-54			41		65		
7/13/94	beach								
	(turbid)								
Tanana	wetland	M-94-55							
7/14/94	(connected)								
	(tannic, black)								
Tanana	wetland	M-94-56				130			
7/14/94	(connected)								
	(tannic, black)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	wetland	M-94-57		70					
7/14/94	(connected)								
	(tannic, black)								
Tanana	wetland	M-94-58	56	59					
7/14/94	(connected)		57	67					
	(tannic, black)		60						
			67						
Tanana	wetland	M-94-59	50	49					
7/14/94	(connected)		59						
	(tannic, black)								
Tanana	wetland	M-94-60	62	60					
7/14/94	(connected)								
	(tannic, black)								
Tanana	silt/debris	M-94-61							
Cut Off	backwater								
7/14/94	(tannic, black)								
Tanana	silt/debris	M-94-62							
Cut Off	backwater								
7/14/94	(tannic, black)								
Tanana	silt/debris	M-94-63							
Cut Off	backwater								
7/14/94	(tannic, black)								
Tanana	silt/debris	M-94-64							
Cut Off	backwater								
7/14/94	(tannic, black)								
Tanana	silt/debris	M-94-65							
Cut Off	backwater								
7/14/94	(tannic, black)								
Tanana	silt/debris	M-94-66							
Cut Off	backwater								
7/14/94	(tannic, black)								
Willow Creek	silt/debris	M-94-67							
7/14/94	backwater								
	(tannic, black)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Willow Creek	silt/debris	M-94-68							
7/14/94	backwater								
	(tannic, black)								
Willow Creek	silt/debris	M-94-69							
7/14/94	backwater								
	(tannic, black)								
Willow Creek	silt/debris	M-94-70							
7/14/94	backwater								
	(tannic, black)								
Willow Creek	silt/debris	M-94-71							
7/14/94	backwater								
	(tannic, black)								
Willow Creek	silt/debris	M-94-72							
7/14/94	backwater								
	(tannic, black)								
Tanana	silt, root wad	M-94-73							
7/14/94	(turbid)								
Tanana	silt	M-94-74	48	51					
7/14/94	backwater		50	52					
	(turbid)		60						
			65						
Tanana	silt beach	M-94-75							
7/14/94	(turbid)								
Tanana	silt	M-94-76	46	48					
7/14/94	backwater		47	62					
	(turbid)		50	62					
			50	68					
			52	72					
			52	110					
			56						
			56						
			70						
			78						
Tanana	silt beach	M-94-77							
7/14/94	(turbid)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	silt/debris	M-94-78	46			140			
7/14/94	backwater		48						
	(milky)		48						
			49						
			51						
			51						
			52						
			52						
			53						
			54						
			54						
			56						
			58						
			58						
			60						
			60						
			60						
			69						
			69						
			70						
			71						
			71						
			73						
			74						
			75						
			76						
			80						
			83						
			105						
			106						
Tanana	gravel/silt	M-96-1							63
6/7/96	beach								64
	(turbid)								67
									68
									74
									75
Tanana	silt, cut bank	M-96-2							
6/7/96	(turbid)								
Tanana	silt, cut bank	M-96-3	55						
6/7/96	(turbid)								

Appendix 1 (continued).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	silt beach	M-96-4							63
6/7/96	(turbid)								65
Tanana	gravel beach	M-96-5	55						
6/7/96	(turbid)		61						
			69						
Tanana	gravel, cut	M-96-6							
6/7/96	bank (turbid)								
Tanana	cobble, rocky	M-96-7							
6/7/96	bluff (turbid)								
Tanana	silt beach	M-96-8							61
6/7/96	(turbid)								66
									67
									71
Tanana	gravel/silt	M-96-9	66	65					63
6/7/96	root wad		69						68
	(turbid)		121						68
									71
									72
									73
									74
Tanana	gravel, cut	M-96-10							66
6/7/96	bank (turbid)								
Tanana	gravel/silt	M-96-11							
6/7/96	cut bank								
	(turbid)								
Tanana	cobble, rocky	M-96-12							
6/7/96	bluff (turbid)								
Tanana	gravel beach	M-96-13							
6/7/96	(turbid)								
Tanana	silt, root wad	M-96-14	57						
6/7/96	cut bank		108						
	(turbid)								

Appendix 1 (concluded).

Sample Site (Date)	Habitat Description	Minnow Trap ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	CO (mm)
Tanana	cobble, rocky	M-96-15	61						
6/7/96	bluff (turbid)		79						
			88						
			101						
Tanana	silt beach	M-96-16	60						
6/7/96	(turbid)								
Tanana	silt, cut bank	M-96-17							
6/7/96	(turbid)								
Tanana	gravel beach	M-96-18	62						
6/7/96	(turbid)		66						
			95						
Tanana	gravel beach	M-96-19							62
6/7/96	(turbid)								65
									71
									76
Tanana	silt, cut bank	M-96-20							63
6/7/96	(turbid)								72
Tanana	gravel, cut	M-96-21	64						
6/7/96	bank (turbid)								
Tanana	silt beach	M-96-22							69
6/7/96	(turbid)								70
									73
Tanana	gravel beach	M-96-23							
6/7/96	(turbid)								
Tanana	silt, cut bank	M-96-24							
6/7/96	(turbid)								

LEGEND

LC - Lake Chub

LNS - Longnose Sucker

CN - Slimy Sculpin

BB - Burbot

AG - Arctic Grayling

RWF - Round Whitefish

CO - Coho Salmon

APPENDIX 2 SEINE HAUL HABITAT TYPES

Seine sample sites 96-1 through 96-7 were located in Salchaket Slough. Sites 96-8 through 96-32 were along the mainstem Tanana River including side channels and sloughs from 1.6 km above the mouth of the Chena River to the Bonanza Creek road. A physical description of each seine sample site follows:

96-1 (Section 17, T2S, R2W) - The sample site was a backwater notch along the inside of a meander. The shoreline was silty with a gentle slope and the substrate consisted of silt, sand, and gravel with iron staining. Water was turbid, 4 cm to 0.6 m deep, and water velocity was zero.

96-2 (Section 16, T2S, R2W) - The sample site was a gravel riffle. Water was turbid, 4 cm to 0.3 m deep, and water velocity ranged from 0.3 to 0.6 m/s. Substrate was iron stained.

96-3 (Section 15, T2S, R2W) - The sample site was a gravel riffle at the mouth of Clear Creek. Water was turbid, 4 cm to 0.3 m deep, and water velocity ranged from 0.3 to 0.6 m/s. Substrate was iron stained.

96-4 (Section 14, T2S, R2W) - The sample site was located about 1.6 km upstream of Clear Creek. It was a gravel riffle. Water was turbid, 4 cm to 0.45 m deep, and water velocity ranged from 0.3 to 0.6 m/s. Substrate was iron stained.

96-5 (Section 14, T2S, R2W) - The sample site was along a gravel shoreline next to Site 96-4. Water was turbid, 4 cm to 0.45 m deep, and water velocity ranged from 0.3 to 0.6 m/s. Substrate was iron stained.

96-6 (Section 18, T2S, R1W) - The sample site was a gravel beach grading to silt covered gravel away from the beach. Water was turbid, 4 cm to 0.6 m deep, and water velocity was less than 0.3 m/s. Substrate was lightly stained with iron.

96-7 (Section 17, T2S, R1W) - The sample site was located about 6.4 km upstream of Clear Creek along a gravel beach with a gentle slope. Substrate was silty gravel with a 12 to 14 cm tree extending 3 m into the water. Water was turbid, 4 cm to 0.75 m deep, and water velocity was less than 0.3 m/s. Sampling was conducted immediately downstream of the tree.

96-8 (Section 5, T2S, R2W) - The sample site was a coarse gravel bar adjacent to the main channel of the Tanana River about 0.8 km below Chena Pump Campground. The gravel bar near Rosie Creek subdivision was unvegetated. Water was turbid, 12 cm to 0.9 m deep, and water velocity ranged from 0.6 to 0.9 m/s.

Appendix 2 (continued).

96-9 (Section 5, T2S, R2W) - The sample site was a mid-channel sandy gravel bar with a 7.6 m wide channel through the bar. Water was turbid, 12 cm to 0.9 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-10 (Section 5, T2S, R2W) - The sample site was a gravel bar below the entrance to Luke's Slough. Water was turbid, 12 cm to 0.6 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-11 (Section 22, T2S, R3W) - The sample site was a gravel bar between split entrance channels to a side slough. Area seined was adjacent to the main channel. Water was turbid, 4 cm to 0.6 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-12 (Section 22, T2S, R3W) - The sample site was a small entrance channel to a slough less than 1 m wide. Substrate was silty gravel. Water was turbid, 4 cm deep, and water velocity was less than 0.3 m/s.

96-13 (Section 21, T2S, R3W) - The sample site was the head of a high water channel at the upstream end of Sam Charley Island. Substrate was silt. Water was turbid, 12 cm to 0.9 m deep, and water velocity ranged from 0.15 to 0.3 m/s. The area seined was adjacent to the main channel.

96-14 (Section 33, T2S, R3W) - The sample site was a mid-channel bar. Substrate was gravel and silt. Water was turbid, 12 cm to 0.3 m deep, and water velocity ranged from 0.15 to 0.3 m/s.

96-15 (Section 28, T2S, R3W) - The sample site was a silt/mud bar at the mouth of a highwater slough downstream of Sam Charley Island. The area seined was a backwater pocket, 0.3 to 0.6 m deep, and turbid with no current.

96-16 (Section 28, T2S, R3W) - The sample site was a silty gravel area at the mouth of a highwater slough downstream of Sam Charley Island. Water was turbid, 12 cm to 0.3 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-17 (Section 29, T2S, R3W) - The sample site was an isolated scour pool below the base of a log jam on a gravel bar. The scour pool was at the head of a highwater channel on the south side of Hadley Island. Water was clear, 12 cm to 0.6 m deep, and there was no visible current. Substrate was gravel and silt.

96-18 (Section 29, T2S, R3W) - The sample site was a gravel bar at the head of Hadley Island. Water was turbid, 0.15 to 0.3 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-19 (Section 31, T2S, R3W) - The sample site was a gravel bar along the north bank of a secondary channel below Bill Arvey's cabin. Water was turbid, 0.15 to 0.6 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

Appendix 2 (continued).

96-20 (Section 31, T2S, R3W) - The sample site was a backwater depression in a silt/gravel bar on north side of river in a secondary channel. Water was turbid, 0.15 to 0.45 m deep, and there was no visible current. The substrate was silt covered and firm.

96-21 (Section 11, T3S, R4W) - The sample site was a mid-river bar adjacent to the main channel near the Bonanza Creek road. Water was turbid, 4 to 12 cm deep, and water velocity ranged from 0.3 to 0.6 m/s. Substrate was gravel.

96-22 (Section 8, T2S, R2W) - The sample site was a backwater area with shallow flow over a gravel riffle to the backwater. The area seined was on the south side of the island at the head of Luke's Slough. Water was turbid, 0.15 to 0.9 m deep, and water velocity was less than 0.15 m/s. Substrate was gravel.

96-23 (Section 29, T2S, R3W) - The sample site was a shallow backwater at the mouth of Sam Charley Slough. Substrate was gravel and there was some flow into the backwater over a gravel riffle. Water was turbid, 4 cm to 0.45 m deep, and water velocity was less than 0.15 m/s.

96-24 (Section 29, T2S, R3W) - The sample site was a shallow run through a gravel bar at the mouth of Sam Charley Slough. Substrate was gravel. Water was turbid, 4 to 12 cm deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-25 (Section 5, T2S, R2W) - The sample site was a silty gravel bar along the south bank about 50 m below the head of Luke's Slough. Water was turbid, 0.15 to 0.6 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

96-26 (Section 7, T2S, R2W) - The sample site was a gravel bar and riffle immediately above a channel split in Luke's Slough. Water was turbid, 9 cm to 0.15 m deep, and water velocity ranged from 0.3 to 0.6 m/s.

94-27 and 96-27 (Section 13, T2S, R3W) - The sample site was a gravel riffle and beach at the upper end of the bar near Rosie Creek. Water was turbid, 4 cm to 0.3 m deep, and water velocity ranged from 0.15 to 0.3 m/s.

96-28 (Section 22, T2S, R3W) - The sample site was a gravel beach and elongated backwater pool. Inwater debris affected seining at this site. Water was turbid, 0.15 to 0.15 m deep, and there was no visible flow. Substrate was gravel with woody debris.

96-29 (Section 31, T2S, R3W) - The sample site was a small channel through a silty gravel bar between the main channel and a side channel of the river. Substrate was silt over gravel. Water was turbid, 0.15 to 0.9 m deep, and water velocity was less than 0.3 m/s.

Appendix 2 (concluded).

96-30 (Section 22, T2S, R3W) - The sample site was a gravel silt bar along the main channel upstream of the mouth of Shortcut Slough. Substrate was silt. Water was turbid, 0.15 to 0.6 m deep, and water velocity was less than 0.3 m/s.

96-31 (Section 25, T1S, R2W) - The sample site was a mid-river bar about 2 km upstream of the Chena River. The area seined was a broad, shallow pool with overflow entering the pool from the main channel. Substrate was silty gravel. Water was turbid, 4 to 12 cm deep, and water velocity was less than 0.15 m/s.

96-32 (Section 36, T1S, R2W) - The sample site was a mid-river bar about 2 km upstream of the Chena River. The area seined was a side channel with a gravel bottom. Water was turbid, 4 cm to 0.3 m deep, and water velocity ranged from 0.15 to 0.3 m/s.

94-33 (Section 7, T2S, R2W) - The sample site was a silt/mud bar along the main channel of the river. Water was turbid, 4 cm to 0.6 m deep, and water velocity was less than 0.15 m/s.

94-34 (Section 14, T2S, R3W) - The sample site was a backwater along the main channel. Substrate was silt with inwater debris. Water was turbid, 4 cm to 0.3 m deep, and water velocity was zero.

94-35 (Section 14, T2S, R3W) - The sample site was a backwater in a slough along the south side of river. Substrate was silt with emergent aquatic vegetation. Water was turbid, 4 to 12 cm deep, and water velocity was zero.

94-36 (Section 14, T2S, R3W) - The sample site was a backwater in a side channel of the river. Substrate was gravel and silt. Water was turbid, 4 to 12 cm deep, and water velocity was zero.

APPENDIX 3 SEINE HAUL DATA

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Salchaket	gravel/silt	96-1	38									
5/27/96	backwater		39									
			40									
			41									
			43									
			43									
			44									
			44									
			45									
			45									
			46									
			46									
			46									
			47									
			50									
			50									
Salchaket	gravel riffle	96-2	34	42								
5/27/96			44	68								
Salchaket	gravel riffle	96-3	41	84	46		75					
5/27/96			45	94			79					
			50	100			88					
			50	116			159					
			52									
			54									
			54									
			55									
			57									
			60									
			62									
			62									
			67									
			68									
			68									
			93									
			145									
Salchaket	gravel riffle	96-4										
5/27/96												
Salchaket	gravel riffle	96-5			48							
5/27/96												

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Salchaket	gravel/silt	96-6										
5/27/96	beach											
Salchaket	gravel/silt	96-7										
5/27/96	beach											
Tanana	gravel riffle	96-8								61		
5/28/96										65		
										66		
										68		
Tanana	gravel riffle	96-8	89	51	43					56		
6/4/96		3 hauls		57	55					61		
										62		
										62		
										64		
										65		
										65		
										65		
										65		
										66		
										66		
										67		
										67		
										68		
										68		
										68		
										69		
										70		
										70		
										70		
										71		
										72		
										73		
										73		
										74		
										75		
										78		
										81		
Tanana	silt beach	96-9	57	90	39					61		
5/28/96					46					68		

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	silt beach	96-9								64		
6/4/96												
Tanana	gravel riffle	96-10	60	72	43					63	45	
5/28/96				76	56					65		
				80	64					69		
				87						70		
				92						72		
				115						76		
				155						77		
										78		
										83		
										94		
Tanana	gravel riffle	96-10	52	115	35			109				
6/4/96		3 hauls		120	37							
				133	44							
				233	46							
				361	54							
					59							
					60							
Tanana	gravel/silt	96-11			40					61		
5/28/96	riffle									69		
										82		
Tanana	gravel/silt	96-12	50									
5/28/96	beach		52									
			53									
			53									
			64									
Tanana	silt beach	96-13	56	76						60	43	
5/28/96			56	98						60		
				100						62		
				142						62		
										63		
										63		
										63		
										63		
										66		
										66		

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	silt beach	96-13								68		
5/28/96		(con't)								68		
										68		
										68		
										68		
										70		
										71		
										72		
										73		
Tanana	silt beach	96-13	52	88						62		
5/29/96			53							62		
			54							64		
			55							64		
			62							66		
										67		
										71		
										72		
										73		
Tanana	gravel/silt	96-14		77						61		
5/29/96	beach			80						62		
				192						63		
										63		
										64		
										65		
										67		
										68		
										68		
										69		
										69		
										69		
										73		
										78		
										82		
										82		
										82		
										85		
										87		
										87		
Tanana	silt	96-15		83					138	71	38	
5/29/96	backwater									72		

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel/silt	96-16		56	62					64		
5/29/96	riffle			57						67		
				115						68		
										70		
										72		
										87		
Tanana	gravel/silt	96-17	40	34							37	
5/29/96	scour pool			38							37	
				40							38	
				41							38	
				41							38	
				42							40	
				42							42	
				47								
				47								
				47								
				52								
				52								
Tanana	gravel/riffle	96-18	67	117	43					62		
5/29/96				134	52					65		
Tanana	gravel/riffle	96-19	47							57	37	
5/29/96			57							60		
			58							67		
			60									
			62									
			64									
			67									
Tanana	silt	96-20		55						74		
5/29/96	backwater			82								
Tanana	gravel riffle	96-21	59	62						59	47	
5/29/96				70						60	47	
				87						62	48	
										64	51	
										65		
										66		
										66		
										66		
										67		
										67		

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel riffle	96-21								67		
5/29/96		(con't)								68		
										68		
										68		
										68		
										69		
										70		
										70		
										70		
										70		
										72		
										73		
										73		
										74		
										74		
										74		
										74		
										74		
										74		
										74		
										75		
										75		
										76		
										76		
										78		
										81		
										81		
										84		
										90		
Tanana	gravel riffle	96-21	42	89								
(Bonanza			53	107								
Creek			68	123								
Road)			70	124								
7/2/96			74	128								
			75	178								
			80	218								
			81									
			86									
			90									
			91									
			96									

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel riffle	96-21	47	88								
(Bonanza			80	88								
Creek			96	121								
Road)				127								
7/2/96												
Tanana	gravel/silt	96-22	42	49	36	130		89		60		
6/4/96	with	3 hauls	42	50	41	222				63		
	backwater		47	51	44	282				75		
			52	54	47					79		
			52	55	52					79		
			53	62								
			55	72								
			57	93								
			57	98								
			59	98								
			63	101								
			68	104								
			71	108								
			74									
			78									
			83									
			91									
Sam	gravel	96-23	51	38								
Charley	backwater		66	45								
Slough				50								
6/6/96				57								
Sam	gravel	96-23		48	36							
Charley	backwater			50	37							
Slough				56	39							
6/6/96				58	41							
				70	42							
				77	42							
				83	44							
				85								
				125								
				155								
				155								
				205								

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Sam	gravel riffle	96-24		100						59		
Charley				113								
Slough				114								
6/6/96				121								
				137								
				141								
				150								
				167								
Sam	gravel riffle	96-24		45								
Charley				49								
Slough				54								
6/6/96				63								
Sam	gravel riffle	96-24	47	52						66		
Charley				70								
Slough				95								
6/6/96				97								
				102								
				103								
				110								
				135								
				156								
				182								
Luke's	gravel/silt	96-25	32	52								
Slough	riffle		34	55								
7/2/96			34	57								
			36	57								
			41	63								
			42	74								
			43	84								
			43									
			43									
			44									
			44									
			44									
			45									
			46									
			46									
			46									
			46									
			47									
			47									

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Luke's	gravel/silt	96-25	47									
Slough	riffle	(con't)	47									
7/2/96			48									
			48									
			48									
			48									
			49									
			50									
			50									
			50									
			50									
			50									
			51									
			52									
			53									
			53									
			55									
			56									
			56									
			56									
			56									
			57									
			58									
			59									
			62									
			62									
			63									
			64									
			64									
			64									
			65									
			67									
			68									
			68									
			72									
			73									
			74									
			75									
			81									
			82									
			90									

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Luke's	gravel/silt	96-25	38	60								227
Slough	riffle		50	66								
7/2/96			56	72								
			64	76								
			72	79								
			78	94								
				104								
				115								
				116								
				172								
Luke's	gravel/silt	96-25	48	68	72					73		
Slough	riffle		62	83								
7/2/96			62	110								
			64									
			70									
			71									
			77									
Luke's	gravel riffle	96-26	36	54	50							
Slough		2 hauls	43	57								
7/2/96			44	59								
			46	61								
			46	61								
			47	64								
			47	70								
			51	74								
			52	85								
			54									
			54									
			55									
			56									
			60									
			65									
			67									
			68									
			68									
			68									
			68									
			68									
			68									
			70									
			71									
			72									

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Luke's	gravel riffle	96-26	74									
Slough		(con't)	74									
7/2/96		2 hauls	75									
			77									
			78									
			81									
			82									
			91									
			92									
			96									
			97									
			102									
			103									
Tanana	gravel riffle	94-27	60			15						
(Rosie												
Creek)												
7/14/94												
Tanana	gravel riffle	96-27		181								
(Rosie												
Creek)												
7/2/96												
Tanana	gravel riffle	96-27	61									
(Rosie												
Creek)												
7/2/96												
Tanana	gravel riffle	96-27	89									
(Rosie												
Creek)												
7/2/96												
Tanana	gravel riffle	96-27	52								44	
(Rosie			76									
Creek)			81									
7/2/96												
Shortcut	gravel	96-28			37							
Slough	backwater											
7/2/96												

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Shortcut	gravel	96-28	41	58								
Slough	backwater		50	67								
7/2/96			58	72								
			67	209								
			68									
			68									
			71									
			75									
			95									
			118									
Tanana	gravel/silt	96-29	40								37	
Arvey's	riffle		46									
Cabin			49									
7/2/96			54									
			61									
			62									
			66									
			67									
Tanana	gravel/silt	96-29		115								
Arvey's	riffle											
Cabin												
7/2/96												
Tanana	gravel/silt	96-30		87								
(Rosie	beach											
Creek)												
7/2/96												
Tanana	gravel/silt	96-30	55	66								
(Rosie	beach		55	68								
Creek)				73								
7/2/96				82								
				85								
				116								
Tanana	gravel/silt	96-31		57								
(Above	riffle											
Chena)												
7/2/96												

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel/silt	96-31	38	42								
(Above	riffle		41	43								
Chena)			41	43								
7/2/96			42	44								
			42	44								
			42	45								
			42	46								
			43	46								
			43	46								
			44	47								
			44	48								
			44	48								
			44	48								
			45	48								
			45	49								
			46	49								
			46	50								
			47	51								
			47	52								
			48	52								
			48	52								
			48	52								
			49	53								
			49	53								
			50	53								
			51	53								
			52	54								
			53	54								
			54	54								
			55	54								
			56	55								
			57	55								
			58	55								
			60	55								
			62	56								
			64	56								
			66	57								
			68	57								
			68	59								
			70	60								
			70	60								
			71	61								
			74	61								
			77	61								

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel/silt	96-31	80	61								
(Above	riffle	(con't)	80	62								
Chena)			89	62								
7/2/96			92	63								
			96	63								
				63								
				65								
				66								
				67								
				67								
				68								
				74								
				75								
				78								
				81								
				84								
				85								
				90								
				91								
				94								
				95								
				98								
				100								
				101								
				102								
				111								
				157								
Tanana	gravel/silt	96-32	56	56							34	
(Above	riffle		65	68								
Chena)			69	72								
7/2/96			72	85								
			72	125								
			75	129								
			80									
			84									
			96									
			97									
Tanana	gravel/silt	96-32	38	48								
(Above	riffle		38	50								
Chena)			40	54								
7/2/96				54								
				54								

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel/silt	96-32		55								
(Above	riffle	(con't)		59								
Chena)				60								
7/2/96												
Tanana	silt beach	94-33	46	207								
7/14/94			55									
			58									
			60									
			65									
			66									
			67									
			68									
			68									
			68									
			70									
			74									
			86									
Tanana	silt beach	94-33	55	74	42							
7/14/94			55	80								
			56	88								
			58	130								
			58									
			58									
Tanana	silt/debris	94-34	46	45								
(Rosie	backwater		46	47								
Creek)			47	48								
7/14/94			48	48								
			48	50								
			48	54								
			48	55								
			48	56								
			48	57								
			48	58								
			48	64								
			48	66								
			48	68								
			48	69								
			50	70								
			50	70								
			50	77								
			50	85								

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	silt/debris	94-34	50	98								
(Rosie	backwater	(con't)	50	102								
Creek)			51	110								
7/14/94			52	111								
			52	115								
			52	123								
			52	150								
			52									
			52									
			52									
			53									
			53									
			53									
			54									
			54									
			54									
			54									
			54									
			54									
			54									
			54									
			55									
			55									
			55									
			55									
			56									
			57									
			57									
			57									
			57									
			57									
			58									
			58									
			58									
			58									
			58									
			60									
			60									
			62									
			62									
			62									
			63									
			63									
			64									

Appendix 3 (continued).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	silt/debris	94-34	64									
(Rosie	backwater	(con't)	64									
Creek)			64									
7/14/94			64									
			64									
			65									
			66									
			66									
			67									
			68									
			68									
			68									
			68									
			68									
			68									
			68									
			69									
			69									
			70									
			70									
			72									
			72									
			73									
			74									
			77									
			77									
			82									
			82									
			83									
			84									
			87									
			88									
			92									
			92									
			93									
			96									
			98									
			105									
			111									
Tanana	silt	94-35										
7/14/94	backwater											

Appendix 3 (concluded).

Sample Site (Date)	Habitat Description	Seine Haul ID	LC (mm)	LNS (mm)	CN (mm)	BB (mm)	AG (mm)	RWF (mm)	LCI (mm)	CO (mm)	CS (mm)	NP (mm)
Tanana	gravel/silt	94-36	45	48								
7/14/94	backwater		45	52								
	with debris		51	53								
			52	54								
			53	54								
			55	55								
			58	56								
			58	57								
			59	58								
			60	58								
			60	59								
			64	60								
			65	60								
			69	61								
			92	63								
				66								
				68								
				142								
				162								

LEGEND

LC - Lake Chub

LNS - Longnose Sucker

CN - Slimy Sculpin

BB - Burbot

AG - Arctic Grayling

RWF - Round Whitefish

LCI - Least Cisco

CO - Coho Salmon

CS - Chum Salmon

NP - Northern Pike

APPENDIX 4 - ANNOTATED BIBLIOGRAPHY

Barton, L.H. 1992. Tanana River, Alaska, fall chum salmon radio telemetry study. ADF&G. Fisheries Research Bulletin No. 92-01. Juneau. 16 pp.

A total of 210 Tanana River fall chum salmon was radio tagged in fall 1989 about 11 km below Fairbanks. Previous surveys documented fall chum spawning areas only in those areas where visual surveys could be conducted.

Specific spawning areas were identified for 131 fish. Ninety-seven of these fish spawned in the floodplain of the Tanana River between upper Salchaket Slough and the mouth of the Little Gerstle River. Six different spawning areas were identified in the mainstem Tanana River between upper Salchaket Slough and the Little Delta River. Specific spawning sites were observed in mainstem channels or sloughs near Salchaket Slough, the mouths of the Little Salcha and Salcha Rivers, Flag Hill, Silver Fox Lodge, and about 5 km below the Little Delta River. Four spawning areas were found between the Little Delta River and Delta Creek.

About 17.6% of the 131 fish for which spawning areas were determined used the Delta River for spawning. Only three tagged fish were believed to have spawned above the Gerstle River. The furthest upstream spawner was near the mouth of George Creek. Overall, about 82% of the spawners were tracked to areas upstream of the Little Delta River.

In Barton's concluding remarks he states that at least in some years, the numerous and relatively smaller spawning areas in the mainstem Tanana River, when taken collectively, contribute more substantially to total Tanana River fall chum salmon spawning escapement than previously realized.

Tanana River / chum salmon / Delta River / Delta Creek / Little Delta River

Appendix 4 (continued).

Breeser, S.W., F.D. Stearns, M.W. Smith, R.L. West, and J.B. Reynolds. 1988. Observations of movements and habitat preferences of burbot in an Alaskan glacial river system. Trans. Am. Fish. Soc. 117(5):506-509.

Movements of 21 radio-tagged burbot in the upper Tanana River drainage from the Northway area to Tetlin were recorded from October 1983 to December 1984. The tagged burbot ranged from 50 to 95 cm long. The fish were tracked at three week intervals. Burbot were relocated up to 68 km downstream and 84 km upstream from release sites. The longest combined upstream and downstream movement of an individual fish was 125 km. The longest upstream movements occurred from November to March, although burbot moved during all seasons. Most tagged burbot apparently preferred the main channels; those fish that moved into clear tributaries did so in late summer after water velocities had dropped and turbidity had decreased.

Burbot / Upper Tanana River drainage

Appendix 4 (continued).

Chen, L.C. 1968. The biology and taxonomy of the burbot, Lota lota leptura, in interior Alaska. Biol. Pap. Univ. Alaska, No 11. 53 pp.

This study was done on burbot in the Yukon and Tanana Rivers. Taxonomic data on burbot, length and age and length and weight relationships, and reproductive and food habits are presented.

Young-of-the-year burbot were seined during high water on flooded grassy beaches in the upper Yukon River. Young-of-the-year burbot were also found in an isolated pond in the upper Chena River. Young-of-the-year burbot were caught in the Tanana River using seines in late July.

Small burbot feed primarily on benthic invertebrates, mainly Plecoptera, but change to a diet of fish as they grow. The most abundant species in both the Yukon and Tanana Rivers are longnose suckers, lake chub, and slimy sculpin.

Tanana River / Yukon River / burbot

Appendix 4 (continued).

Clark, R.A. 1993. Interannual intrastream movements of Arctic grayling in the Chena, Salcha, and Goodpaster rivers. ADF&G. Fishery Manuscript No. 93-2. Anchorage. 163 pp.

This paper examines intrastream movements of Arctic grayling based on data collected from 1987 through 1992. The research attempted to quantify estimated rates of movement of Arctic grayling and to determine if movements were of a magnitude that might seriously bias estimates of mortality in a stock assessment program.

Based on release-recovery data collected on all three study river sections, there appeared to be interannual movement of Arctic grayling in the upstream and downstream directions. However, with few exceptions, the majority of releases in all study sections did not move after up to 5 years. On average 75 to 93% of fish that survived and did not leave the Chena River and Goodpaster River study sections, did not move from the release area during the investigation. Maximum movement between areas of the Goodpaster River was observed in year 4, with 19% of releases moving exclusively upstream.

Very little net movement of Arctic grayling was observed in the Goodpaster River during the first 2 years at large. There was net movement upstream after 3 and 4 years at large. Data suggest fish move upstream in this system as they grow larger and older. Estimates of mortality calculated for this particular study section of the Goodpaster River may be biased low, while estimates of age and size composition may be biased towards younger, smaller fish.

Chena River / Salcha River / Goodpaster River / Arctic grayling

Appendix 4 (continued).

Clark, J.H., M. J. Evenson, and R.R. Riffe. 1991. Ovary size, mean egg diameters, and fecundity of Tanana River burbot. ADF&G. Fishery Data Series No. 91-64. Juneau. 30 pp.

The purpose of this report was to present information concerning ovary volume and mass, mean diameters of eggs, estimates of fecundity, and a total length-fecundity relationship developed from these data. Ninety-seven study burbot ranged from 504 to 1,040 mm (mean of 736 mm), with ovary weights of 18 to 635 gm (mean of 184 gm). Estimated mean egg diameters in ovaries of the study fish ranged from 0.41 to 0.69 mm. Estimated fecundity ranged from 184,000 to 2,910,000 eggs.

Tanana River / burbot

Appendix 4 (continued).

Clark, R.A., and W.P. Ridder. 1987. Abundance and length composition of selected grayling stocks in the Tanana Drainage during 1986. ADF&G. Div. of Sport Fish, Fishery Data Series No. 26. Juneau. 55 pp.

This report describes field studies conducted during 1986 on stocks of Arctic grayling in the Delta Clearwater, Richardson Clearwater, Goodpaster, Chena, Chatanika, and Salcha rivers, One Mile Slough, Caribou and Shaw creeks, and Fielding and Tangle lakes.

Sampling in the Richardson Clearwater River was conducted between 21 and 30 July. The Arctic grayling population was estimated to be 1,418 fish larger than 150 mm. Twenty seven of the Arctic grayling sampled in the Richardson Clearwater River were tagged previously in other waterbodies in other years (24 from Caribou Creek, 1 from Rapids Creek, and 2 from the Goodpaster River).

The post-spawning migration of Arctic grayling out of Caribou Creek was sampled with a weir from 2 to 18 June. A total of 817 Arctic grayling, of which 320 were considered adults, was captured.

The Shaw Creek spring Arctic grayling fishery was closed in 1987.

Delta Clearwater River / Richardson Clearwater River / One Mile Slough / Goodpaster River / Chena River / Chatanika River / Salcha River / Arctic grayling

Appendix 4 (continued).

Clark, R.A., and W.P. Ridder. 1988. Stock assessment of Arctic grayling in the Tanana River drainage. ADF&G. Div. of Sport Fish, Fishery Data Series No. 54. Juneau. 79 pp.

This report describes field studies conducted during 1987 on stocks of Arctic grayling in the Delta Clearwater, Richardson Clearwater, Goodpaster, Chena, Chatanika, and Salcha rivers, Caribou and Shaw creeks, and Fielding and Tangle lakes.

Sampling in the Richardson Clearwater River was conducted between 7 July and 3 August. The Arctic grayling population was estimated to be 2,775 fish larger than 250 mm in the lower 12.8 km of the river. Seventy five of the Arctic grayling sampled in the Richardson Clearwater River were tagged previously in other waterbodies in other years (54 from Caribou Creek, 18 from the mouth of Shaw Creek, and 3 from the Goodpaster River).

The post-spawning migration of Arctic grayling out of Caribou Creek was sampled with a weir from 3 to 11 June. A total of 932 Arctic grayling, of which 315 were considered sexually mature, was captured. Tag returns included 77 Arctic grayling tagged at Caribou Creek in previous years, one Arctic grayling tagged at Clear Creek in 1984, and 4 Arctic grayling tagged 1.5 months earlier at the mouth of Shaw Creek.

Electrofishing at the mouth of Shaw Creek before breakup from April 15 to 23 found Arctic grayling consistently only in two small areas. One area was located 0.8 km above the mouth in a backwater slough approximately 50 m wide, 300 m long, and 3 m deep. The other area was 0.8 km below the mouth in the main channel of the Tanana River. Arctic grayling were holding in a 100 m long and 1 m deep section of water adjacent to the main current. Two hundred eighty eight Arctic grayling were captured during this sampling. Thirty nine Arctic grayling were initially tagged in previous years: 37 at the Caribou Creek weir, 1 tagged at the mouth of Caribou Creek in 1979, and 1 tagged in Clear Creek in 1984. Population estimates for Arctic grayling in Shaw Creek are provided and discussed.

Delta Clearwater River / Richardson Clearwater River / One Mile Slough / Goodpaster River / Chena River / Chatanika River / Salcha River / Arctic grayling

Appendix 4 (continued).

Clark, R.A., and W.P. Ridder. 1987. Tanana Drainage creel census and harvest surveys, 1986. Fishery Data Series No. 12. ADF&G Fed. Aid in Fish. Rest. Proj. F-10-2, Job G-8-3. Juneau. 91 pp.

This report describes the creel census programs conducted within the Tanana River drainage during 1986. Included in this report are descriptions of Arctic grayling fisheries at Shaw Creek and the Delta Clearwater River.

Creel surveys at Shaw Creek from April 25 to May 4, produced an estimated harvest of 270 Arctic grayling. Adult Arctic grayling (> 270 mm) represented 85% of a sample of 156 fish. A maximum harvest goal of 1,000 Arctic grayling has been set for this fishery.

Shaw Creek / Delta Clearwater River / Arctic grayling

Appendix 4 (continued).

Dinneford, W. B. 1978. Final report of the commercial fish - technical evaluation study: Salcha River. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 21. 93 pp.

This report presents the results of the third and final year of studies on the Salcha River that measured adult king and chum salmon escapement, distribution, sex ratio, age-class trends, fecundity, and egg retention. The distribution, summer food habits, and relative numbers of juvenile king salmon also were examined in the Salcha River and six tributary streams. Limnological data were collected from the Salcha River and the six tributary streams. These studies were designed to provide information for the determination of potential and actual effects of the buried Trans-Alaska Pipeline crossing of the Salcha River and its tributaries.

The estimated escapement of king salmon in the Salcha River in 1977 was 1,202 fish, 109% of the 18 year average. Twelve and one half percent of the spawning kings were below the pipeline crossing and 87.5% were above the crossing. Eight hundred thirty seven summer chum salmon were counted in the Salcha River in 1977, about 30% of the 18 year average. Six and one half percent of the total chum salmon escapement was below the pipeline crossing, the second highest percentage in this section in the period from 1973-1977.

The relative abundance of king salmon fry was highest in McCoy and Redmond creeks, tributaries of the Salcha River. The distribution of king salmon juveniles in 1977 and spawners in 1976 showed little correlation, indicating there is a great deal of movement of fry from pre-emergence to rearing locations. Side channels were occupied by the majority of rearing king salmon (36%) during the June to September period while riffles were the least favored (18%) [other categories included slough (24%) and pool (22%)]. Data suggest that rearing juvenile king salmon may use only the lower one half to one mile of the tributary streams.

Aquatic organisms in the orders Diptera (Chironomidae), Plecoptera, and Tricoptera were the most important food items of juvenile king salmon.

Up to 85% of the rearing kings and 26% and 29% of spawning chum and king salmon, respectively, could be lost as a result of a spill at the McCoy Creek crossing during average distribution. During periods when smolts or spawners are concentrated below pipe crossing sites, complete loss of a year class could result.

Salcha River / chinook salmon / chum salmon

Appendix 4 (continued).

Dinneford, W. B. 1978. Final report of the commercial fish - technical evaluation study: Tanana and Delta Rivers. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 20. 52 pp.

Fall chum salmon escapement, distribution, timing, age class and length trends, fecundity and egg retention were measured in the Delta and Tanana rivers in 1977 as part of studies associated with the construction of the Trans-Alaska Pipeline.

Limited data concerning development of chum salmon eggs and juveniles are presented. Fry in the Delta River emerged in early-to-mid April with peak outmigration occurring in early-to-mid May.

Rip rap bank protection on the south bank of the Tanana River at Big Delta caused at least a short term avoidance of the area by spawning chum salmon. Spawner distribution in 1976, the year of construction, indicated that only 20 to 25% of the traditional number of spawners used the disturbed area. The distribution of spawners in 1974 and 1977 was similar, suggesting the cause of the low count in 1976 was sediment-choked spawning gravel from construction activities that was eliminated by normal high water flows before the 1977 run reached the spawning grounds.

It was estimated that a break in the pipeline at Jarvis Creek could kill the entire Delta River chum population of spawners or pre-smolt, while a break over the Tanana River could similarly affect an entire class of migrant adults (fall) and/or pre-smolt juveniles (spring) found below the line for an undetermined distance downstream.

Delta River / Tanana River / chum salmon

Appendix 4 (continued).

Dinneford, W.B. 1977. Third interim report of the commercial fish - technical evaluation study: Salcha River. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 17. 88 pp.

This report describes the results of field studies conducted on the Salcha River and the lower reaches of six of its tributaries during 1976. Field studies examined pipeline construction impacts, the distribution and abundance of adult chum and king salmon and their redds, juvenile food habits, and the timing of smolt outmigration.

Installation of the Trans-Alaska Pipeline under the Salcha River in March 1976 introduced an estimated 1166 tons of sediment to areas immediately downstream of the crossing during the 17 day construction period. Water quality data for the Salcha River during this construction period are presented.

One third as many king salmon redds were located within 1800 ft of the downstream side of the pipeline crossing in 1976 following instream construction activities as were located in this reach in 1975.

Emergence of king salmon fry from natal gravels took place through mid June and possibly to the end of June. King salmon smolt outmigration probably peaked before May 25; chum salmon smolt outmigration continued through at least May 26. The lower 0.75 to 1.5 miles of tributary streams were found to be valuable rearing habitat for king salmon juveniles. Large numbers of king salmon fry moved into slow, deep water in the main river in September.

Juvenile chum salmon stomachs most commonly contained Chironomids, Plecopterans, and Simuliids; king salmon stomachs most commonly contained Chironomids, terrestrial Dipterans, and Ephemeropterans.

Limited limnological data are presented for the Salcha River and the lower portions of six tributary streams.

Salcha River / chum salmon / chinook salmon

Appendix 4 (continued).

Evenson, M.J. 1994. Stock assessment of burbot in the Tanana and Chena rivers, 1993. ADF&G. Fishery Data Series No. 94-11. Anchorage. 21 pp.

Burbot were sampled in two 24 km sections of the Tanana and Chena rivers as part of an ongoing stock assessment program. The study area included a 24 km section of the Tanana River extending downstream from the confluence of the Chena River, and a 24 km section of the Chena River extending upstream from its confluence with the Tanana River. Hoop traps were used to capture burbot. Estimates of mean catch per unit effort, mean length, length distributions, and proportions of catch for three size categories were calculated.

Tanana River / Chena River / burbot

Appendix 4 (continued).

Evenson, M.J. 1993. Seasonal movements of radio-implanted burbot in the Tanana River drainage. ADF&G. Fishery Data Series No. 93-47. Anchorage. 27 pp.

Radio-transmitters were surgically implanted in 40 large (greater than 650 mm) and 15 small (less than 450 mm) burbot in the Tanana and Chena rivers in the vicinity of Fairbanks from 24 August to 4 September 1992. Radio-tracking occurred from September 1992 to July 1993.

Small burbot moved shorter distances than did large burbot between all consecutive tracking periods. Total ranges of small burbot averaged 17 km and were all less than 40 km. Ranges of large burbot averaged 57 km and were between 5 and 255 km. The largest movement downstream from the point of release was 224 km, whereas the largest upstream movement was 85 km.

The high frequency of downstream movements documented in this study were at odds with previously recorded tag returns which indicated movements tended to be upstream. This discrepancy may be related to recovery from transmitter implantation, mortality or expulsion of transmitters, or biased tag return data from unequal distribution of sampling effort among river areas.

Mean movements of large burbot were greatest during periods coinciding with river freeze-up and breakup, and were smallest during periods coinciding with spawning. There was substantial interchange of burbot between the Tanana and Chena rivers.

Fourteen general spawning locations were identified in the Tanana and Chena rivers for 33 large burbot. The largest concentration of large burbot was in the vicinity of Whiskey Island where six fish were located throughout the spawning period.

Tanana River / Chena River / burbot

Appendix 4 (continued).

Evenson, M.J. 1993. A summary of abundance, catch per unit effort, and mean length estimates of burbot sampled in rivers of interior Alaska, 1986-1992. ADF&G. Fishery Data Series No. 93-15. Anchorage. 28 pp.

Catch per unit effort and mean length of burbot in one 24 km section of the Chena River and one 24 km section of the Tanana River immediately downstream from the mouth of the Chena River were estimated during 1992. Catch per unit effort and mean length estimates are presented for 66 river sections for the years 1986 to 1992. Rivers sampled included the Tanana, Chena, Tolovana, Yukon, Kantishna, Goodpaster, Chisana, and Nenana.

Tanana River / Chena River / Tolovana River / Yukon River / Kantishna River / Chisana River / Goodpaster River / Nenana River / burbot

Appendix 4 (continued).

Evenson, M.J. 1992. Abundance and size composition of burbot in rivers of interior Alaska during 1991. ADF&G. Fishery Data Series No. 92-12. Juneau. 39 pp.

This paper reports the results of field studies conducted from June through October 1991 examining the abundance of burbot in sections of the Tolovana and Chena rivers, mean catch-per-unit-effort in sections of the Tolovana, Chena, Yukon, Tanana, and Nenana rivers, and mean length of burbot 450 mm and longer captured in these same sections of river. An estimate of mean length for all burbot captured in a short section of lower Goldstream Creek. Sampled river sections were as follows; Tolovana - 48 km from Swanneck Slough to the Tanana River; Nenana - 24 km from the Tanana River upstream; Tanana - 24 km from the mouth of the Chena River downstream; Chena - 24 km from its mouth upstream; Yukon - 24 km from the Dalton Highway downstream; and Goldstream Creek - 6 km from its mouth upstream.

Abundance of burbot 450 mm total length and larger was 6,047 (SE = 2,240) for the Tolovana River section and 1,702 (SE = 330) for the Chena River section. Mean catch-per-unit effort per 24 hr set ranged from 0.41 (SE = 0.03) to 1.04 (SE = 0.06). Mean length of fully recruited burbot ranged from 534 mm (SE = 4) in the Tanana River section to 750 mm (SE = 8) in the Yukon River section.

Tanana River / Yukon River / Tolovana River / Chena River / Nenana River / Goldstream Creek / burbot.

Appendix 4 (continued).

Evenson, M.J., and P. Hansen. 1991. Assessment of harvest characteristics of the Tanana River burbot sport fishery in 1990 using a postal questionnaire. ADF&G. Fishery Data Series No. 91-67. Juneau. 42 pp.

This report describes the results of a postal questionnaire survey used to assess the harvest of burbot in the Tanana River. Most harvest (78%) occurred during open water periods. Harvest was nearly equal between hand-held lines (57%) and set-lines (43%). More burbot were harvested in the middle river (73% [Fairbanks area]) than in the upper (20% [upstream of Delta]) or lower (7% [below Nenana]) river. Most anglers surveyed (69%) caught 1 to 5 burbot during one day of fishing. Large daily catches of burbot (11 to 15) occurred on only 14% of the fishing days.

Tanana River / burbot

Appendix 4 (continued).

Evenson, M.J. 1990. Age and length at sexual maturity of burbot in the Tanana River, Alaska. ADF&G. Fishery Manuscript No. 90-2. 10 pp.

Length, sex, age, and maturity of 351 burbot collected in the Tanana River between early November and mid February (Nov 1987-Feb 1990) were determined. Ages ranged from 4 to 18 and lengths ranged from 368 to 1,076 mm. Onset of sexual maturity was first noted at age 4 and 452 mm for males and age 6 and 498 mm for females. Burbot not in spawning condition were found in almost all age classes and length categories. It was concluded burbot exhibit some degree of intermittent or nonconsecutive spawning. The age at which 50 percent of the females reached maturity was estimated to be 5 years. The length at which 50 percent of the females reached maturity was estimated to be 480 mm.

Tanana River / burbot

Appendix 4 (continued).

Evenson, M.J. 1990. Movement, abundance, and length composition of burbot in rivers of interior Alaska during 1989. ADF&G. Div. of Sport Fish, Fishery Data Series 90-3. Juneau. 26 pp.

This paper reports the results of field studies conducted on burbot in the Tanana, Chena, Goodpaster, Chisana, Tolovana, Kantishna, and Yukon rivers during summer 1989. Burbot were captured with hoop traps. Data regarding catch-per-unit effort, movements, and length frequency are presented.

Before 1989, no movement of burbot into or through one section of the Tanana River (river km 594 to 712) had been documented, suggesting that two stocks of burbot occurred in the mainstem river. During 1989, one burbot was recovered upstream of this section which had been tagged in a downstream section, one burbot which was tagged in this section moved through to an upstream location, and one burbot which was tagged in an upstream location moved downstream into this section. These movements indicated that there is interchange of burbot throughout the length of the river.

Catches of burbot in the Yukon and Kantishna rivers were too low to assess movements between the Yukon and Tanana rivers and between the Kantishna and Tanana rivers.

Tanana River / Chena River / Goodpaster River / Tolovana River / Kantishna River / Chisana River / Yukon River / burbot

Appendix 4 (continued).

Evenson, M.J. 1989. Biological characteristics of burbot in rivers of interior Alaska during 1988. ADF&G. Div. of Sport Fish, Fishery Data Series No. 109. Juneau. 47 pp.

This paper reports the results of field studies conducted in 1988 in six sections of the Tanana River from Manley Hot Springs upstream to near Tok, in one section of the Yukon River, in one section of the Tolovana River, and in one section of the Chena River. In 1988, 2,305 burbot were captured in hoop traps and tagged in the Tanana, Chena, and Tolovana rivers. Length frequency, age, movement, catch per unit effort, and gear selectivity data are presented.

Movement information from tag recoveries indicate burbot are 76% resident (captured within 8 km of the tagging site) to a given area up to a period of 1.5 years. The percentage of burbot remaining resident to an area is lower (48%) after a period of 1.5 years, indicating burbot are not completely resident to an area throughout their lifetime. Movements are predominantly upstream. Downstream movements are infrequent and short ranging. Movements were most frequent in the fall and winter and were likely feeding migrations (fall) in response to prey outmigrations from tributary systems or spawning migrations (winter).

Movement of burbot between the Tanana River and the Tolovana, Goodpaster, and Chena rivers indicated stocks of burbot in these systems are not isolated. Few small (300-449 mm) burbot were captured in the Tolovana River, suggesting that spawning and rearing of burbot may not occur in this system. Migrations of burbot into the Chena River in the fall may be related to feeding, spawning, or both. Tag returns also indicate the Goodpaster River may be used for spawning.

Tag returns also indicated at least two isolated stocks of burbot exist in the mainstem Tanana River with the boundary lying near the mouth of George Creek (river km 594). The boundary area is characterized by swift current, which may act as a barrier to burbot migration, and relatively low burbot densities.

Tanana River / Chena River / Tolovana River / Yukon River / burbot

Appendix 4 (continued).

Evenson, M.J. 1988. Movement, abundance and length composition of Tanana River burbot stocks during 1987. ADF&G. Div. of Sport Fish, Fishery Data Series No. 56. Juneau. 42 pp.

This paper reports the results of field studies conducted in 1987 in the Tanana River from Manley Hot Springs upstream to its headwaters near Northway. In 1987, 4,516 burbot (greater than or equal to 300 mm total length) were captured in hoop traps and tagged. Length frequency, growth, age, and movement data are presented. Population estimates are provided for sections of the Tanana River near Rosie Creek and near Healy Lake.

Tag returns indicated 72% of burbot were recaptured within 8 km of tagging sites, 25% moved upstream greater than 8 km, and 3% moved downstream 8 km or more. The median distance traveled was 27 km, with a maximum distance of 265 km. A greater percentage of movement was documented during summer (June, July, August) and winter (December, January, February) than in fall or spring. Of fish captured in winter, almost 70% had made significant movements (usually in an upstream direction). The winter movements are probably associated with spawning and summer movements may be correlated with feeding.

Tanana River / burbot

Appendix 4 (continued).

Fleming, D.F., R.A. Clark, and W.P. Ridder. 1992. Stock assessment of Arctic grayling in the Salcha, Chatanika, Goodpaster, and Delta Clearwater rivers during 1991. ADF&G. Fishery Data Series No. 92-17. Juneau. 108 pp.

Estimates of abundance of Arctic grayling greater than 149 mm, and age and size composition were derived from sampling conducted on identified reaches of the Salcha, Chatanika, Goodpaster, and Delta Clearwater rivers during summer 1991. Brief summaries of the streams and historical fishery information are presented for each stream. Mark-recapture sampling by electrofishing was used to estimate abundance.

Salcha River / Chatanika River / Goodpaster River / Delta Clearwater River / Arctic grayling

Appendix 4 (continued).

Francisco, K., and W.B. Dinneford. 1977. Fourth interim report of the commercial fish - technical evaluation study: Tanana and Delta Rivers. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 19. 50 pp.

This paper reports the results of studies conducted from September 1976 through May 1977. The distribution and abundance of chum and coho salmon were determined through test gillnet fishing, aerial surveys and ground surveys. Carcass sampling was used to determine the age and sex composition of chum and coho salmon. Early life history information and the timing of smolt outmigration was recorded for chum salmon in the Delta River.

An estimated 39 to 43 chum salmon spawned in 1976 in the Tanana River next to riprap installed as part of the Trans-Alaska Pipeline crossing. In 1974, prior to construction, an estimated 247 chum salmon spawned in the area. Fish distribution in 1974 and 1976 was similar, and the estimated escapement for the area was higher in 1976 than in 1974.

Delta River chum salmon hatched after about 122 days of incubation (October 7 to February 3). The first emerged fry were seen on April 6, which indicates about 185 days from spawning to emergence. Outmigration peaked in the two weeks from April 8 to April 21.

Water chemistry data are presented for the Delta River chum salmon spawning area for April through May 1977.

Delta River / Tanana River / chum salmon

Appendix 4 (continued).

Francisco, K. 1977. Second interim report of the commercial fish - technical evaluation study. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 9. 46 pp.

This paper reports the results of studies conducted from October 1975 to June 1976 on the early life history of chum salmon in the Delta River.

Chum salmon spawning occurred from mid October through November. Hatching began in early February and continued until mid March. Emergence from the gravels began in early April and continued through the third week in April. Downstream migration of the chum smolt began in early April, with very few remaining in the river for rearing before moving downstream. Outmigration peaked on April 28 and on May 17 following increased river flows. Survival to smolt outmigration was estimated to be 2.9 to 4.9% of the potential egg deposition. Total smolt production in the Delta River in spring 1975 was estimated at 72,500 to 191,900 smolts.

A small number of king salmon juveniles, young-of-the-year and age 1 fish, were captured in the Delta River. King salmon are not known to spawn in the Delta River. A small number of coho smolt, age 1, also were caught in the lower Delta River. Limnological data are presented for April and May 1976.

Delta River / chum salmon / coho salmon / chinook salmon

Appendix 4 (continued).

Francisco, K. 1976. First interim report of the commercial fish - technical evaluation study. Joint State/Federal Fish and Wildlife Advisory Team. Special Report No. 4. 86 pp.

The objectives of this study were to determine the distribution, abundance and timing of fall chum and coho salmon spawning above and below the Trans-Alaska Pipeline crossing of the Tanana River at Big Delta that could be affected by the construction and operation of the pipeline, sample chum and coho salmon escapement for age-sex-size information, and to obtain early life history information for Delta River chum salmon (development, emergence, and outmigration timing). The time period of the early life history studies was from November 1974 through May 1975. Distribution studies of adult salmon were conducted from September to December 1975. Studies of chinook and chum salmon juveniles and adults in the Salcha River also were described.

Water temperatures, dissolved oxygen content, flow, and ice conditions were reported for the lower Delta River. Limited data regarding chum salmon fry growth and development and emergence are presented. The distribution and abundance of fall chum and coho adult salmon was incompletely determined because of poor survey conditions.

King salmon fry in the Salcha River were most common in the deep holes, around the brush piles and beaver houses, and in the sloughs. Fry also were found in riffle areas but were not very abundant. The number of fry using beaver food caches increased dramatically in September and were speculated to be important potential overwintering areas. King salmon fry use of tributary streams seemed to be concentrated in the lower mile of the tributaries. Some limited growth data for king salmon fry are presented.

Limited limnological data are presented for the Salcha River and several of its tributaries. Adult king and chum salmon distributions, and age and sex distribution were presented. The peak smolt outmigration for both chum and king salmon occurred during a high water event from May 10 through 15.

Tanana River / Delta River / chum salmon / Salcha River / chinook salmon

Appendix 4 (continued).

Hallberg, J.E., R.A. Holmes, and R.D. Peckham. 1987. Movement, abundance, and length composition of 1986 Tanana River burbot stocks. ADF&G. Div. of Sport Fish, Fishery Data Series No. 13. Juneau. 21 pp.

This paper reports the results of field studies conducted in 1986 in the Tanana River from Manley Hot Springs upstream to its headwaters near Northway. [Sections not sampled included the area from Moose Creek upstream to Big Delta]. In 1986, 3,541 burbot (greater than or equal to 300 mm total length) were captured in hoop traps and tagged. Length frequency and age data are presented.

A population estimate of burbot in a 6.4 km section of the Tanana River near Rosie Creek near Fairbanks provided an estimate of 2,892 burbot greater than 300 mm.

Tag returns obtained from area anglers and continued sampling indicate that burbot move upstream more than downstream after release. The greatest recorded movement was by a burbot that moved 256 km upstream over a period of 1,244 days. Three burbot were recaptured in the Goodpaster River during winter, suggesting that these fish may have moved into this river to spawn.

Tanana River / burbot

Appendix 4 (continued).

Hallberg, J.E. 1986. Interior burbot study, Part A: Tanana River burbot study. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 27. Proj. F-10-1, Job N-8-1. 16 pp.

This report focuses on burbot age determination from otoliths and vertebrae; length, weight, and sex of sampled burbot; and results of additional burbot tagging in the Tanana River.

During the 1985 field season, 998 burbot were captured in seven sections of the Tanana River from the Wood River upstream to the mouth of the Healy River. Burbot appeared to be distributed throughout the Tanana River and apparently occupied all types of habitat [no habitat descriptions provided or associated with hoop trap catches]. Tag returns suggest burbot remain fairly resident within an area; if movement occurs, it is usually in an upstream direction.

Tanana River / burbot

Appendix 4 (continued).

Hallberg, J. 1985. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters - Fairbanks District. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 26. Proj. F-9-17, Job G-III-H. 26 pp.

This report has a short section on the 1984 component of the burbot life history study in the lower Chena and Tanana rivers.

Eleven tagged burbot were captured by anglers from September 1983 to November 1984. Two of the 11 fish were caught near the mouth of Moose Creek, 30 miles upstream of the mouth of the Chena River, where one fish was tagged, and 38 miles above Rosie Creek, where the other fish was tagged. The other nine burbot were captured within 3 miles of where they had been tagged. All of these fish had been tagged from about 5 miles upstream to 15 miles downstream of the mouth of the Chena River. The nine fish were recaptured from 22 days to 15 months after tagging.

In 1984, 61 burbot were tagged in an area 25 to 30 miles downstream of the mouth of the Chena River and another 36 were tagged between Moose Creek and about 5 miles upstream of the mouth of the Chena River. Both locations were outside areas of heavy fishing. One burbot that was tagged in late September 1984 25 miles below the mouth of the Chena River was caught 41 days later at the mouth of the Chena River.

Four burbot were radio-tagged in the Tanana River in 1984, three about 30 miles below the mouth of the Chena River and one about 25 miles upstream of the mouth of the Chena River.

Age and length composition data are presented for 115 burbot sampled in the Tanana River during the 1983 and 1984 field seasons.

Tanana River / Chena River / burbot

Appendix 4 (continued).

Hallberg, J. 1984. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters - Fairbanks District. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 25. Proj. F-9-16, Job G-III-H. 34 pp.

This report contains a section describing the initiation of a burbot study in the lower Chena River and in the Tanana River from about 5 miles above to about 15 miles below the mouth of the Chena River. Fyke nets set in side channels and backwater slough systems were used to capture burbot in June, August, September, and October. Radio transmitters were surgically implanted in four burbot.

Stomach contents of 60 burbot revealed longnose sucker, humpback whitefish, lake chub, and round whitefish accounted for 65% of the identifiable food items. These four species were often captured in the fyke nets along with the burbot. The remainder of the stomach contents included lamprey, burbot, chinook salmon smolts, Arctic grayling, northern pike, insects, and a single shrew.

Two burbot moved as far as 15 to 18 miles downstream within the Tanana River from where they were tagged and then slowly moved back upstream. One burbot moved about 6 miles upstream into the Chena River. One burbot slowly moved about 7 miles up the Tanana River from where it was tagged and remained in the area of the mouth of the Chena River.

Tanana River / burbot

Appendix 4 (continued).

Hallberg, J.E. 1980. Population structure, migratory patterns, and habitat requirements of the Arctic grayling. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 21. Proj. R-I, Job R-I-A. 22 pp.

This report includes stream survey data collected in 1979 for four clearwater tributaries (Clear Creek, Fivemile Clearwater, Bear Creek, and McDonald Creek) of the Tanana River.

In mid May, shortly after breakup, schools of round whitefish and an occasional Arctic grayling were observed in the lower five miles of the Fivemile Clearwater. Coho salmon fry were also observed at this time. Ten Arctic grayling collected at the mouth of the Fivemile Clearwater in mid May were immature or had recently spawned. In mid June, Arctic grayling and round whitefish were distributed throughout the lower five miles. In mid August, only a few Arctic grayling remained; a few concentrations of round whitefish were present. Arctic grayling apparently use the Fivemile Clearwater only during the summer months for feeding and rearing; no evidence of spawning was found.

Clear Creek (Tanana Flats near Fairbanks) was surveyed in late May, shortly after breakup. Arctic grayling were distributed throughout the lower 15 miles of stream. Recently spawned Arctic grayling were present but it was not determined if spawning had occurred in Clear Creek or elsewhere. Longnose suckers, round whitefish, humpback whitefish, burbot, sheefish, and Arctic grayling were caught in a gill net set about two miles from the mouth of the creek. Northern pike and slimy sculpin were observed but not captured. Nets set at the mouth and five miles upstream in late August caught least cisco, round whitefish, burbot, longnose sucker, and Arctic grayling, but not in numbers as in late May.

Arctic grayling, round whitefish, and longnose suckers were observed in the lower six miles of McDonald Creek (Tanana Flats near Fairbanks) in late May. Twelve sampled Arctic grayling ranged in length from 175 to 380 mm, with a mean length of 264 mm.

In late August, Arctic grayling and round whitefish were the most abundant species in the lower four miles of Bear Creek (Tanana Flats near Fairbanks). Slimy sculpins were also present and longnose suckers were observed at the mouth of the creek.

Temperature, alkalinity, hardness, pH, carbon dioxide and total acidity were measured in each of the streams.

Clear Creek / Fivemile Clearwater / Bear Creek / McDonald Creek / Arctic grayling / round whitefish / other fish

Appendix 4 (continued).

Hillman, T.W., J.S. Griffith, and W.S. Platts. 1987. Summer and winter habitat selection by juvenile chinook salmon in a highly sedimented Idaho stream. Trans. Am. Fish. Soc. 16(2):185-195.

Summer and winter habitat used by age 0 spring chinook salmon was assessed in the Red River, an Idaho stream heavily imbedded with fine sediment. Chinook salmon used habitats with water velocities less than 20 cm/sec, depths of 20 to 80 cm, and close associations with cover (undercut banks). During summer, 95% of the age 0 chinook salmon were concentrated in pool and glide habitat, predominantly along the sides and tail-ends of this habitat. About 5% of the chinook salmon were in riffles, and these fish were found behind boulders greater than 25 cm in diameter, where water velocities were comparable to velocities used by juveniles in glides and pools. As fish became larger, they selected faster, deeper water. Fish that remained in the study area during winter selected areas where submerged sedges and grasses overhanging undercut banks provided cover and where water velocities were less than 12 cm/sec.

Cobble (mean maximum diameter, 19 cm; range 9 to 37 cm) was piled 26 cm deep on the streambed to evaluate the relationship between sediment and winter habitat selection by juvenile chinook salmon. After cobble substrate was added to the streambed beneath undercut banks and in midchannel in a glide and a riffle habitat, eight times more chinook salmon used the cobble substrate (in November) than in the previous year. Significantly more chinook salmon used cobble placed under banks than any other area.

Idaho / chinook salmon

Appendix 4 (continued).

Holmes, R., W. Ridder, and R. Clark. 1986. Tanana Drainage Arctic grayling. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 27. Proj. F-10-1, Job G-8-1. 68 pp.

This report describes the results of monitoring of the stock status, population dynamics, and fisheries of the major Arctic grayling populations of the Tanana River drainage. Estimates or indices of Arctic grayling populations were made on the Chena, Salcha, Chatanika, Goodpaster, Delta Clearwater and Richardson Clearwater rivers. Creel censuses were conducted on four spring and two summer Arctic grayling fisheries. Population modeling of the Chena River Arctic grayling population under seven management schemes is presented.

The Shaw Creek spring Arctic grayling fishery, during the 4 day period it was open, harvested an estimated 1,533 Arctic grayling.

Operation of the Caribou Creek weir from June 4 to June 15 produced a catch of 1,190 downstream moving fish: 386 Arctic grayling, 256 humpback whitefish, 100 round whitefish, 341 least cisco, 52 longnose suckers, 53 lake chubs, 1 slimy sculpin, and 1 northern pike.

Shaw Creek / Caribou Creek / Richardson Clearwater / Delta Clearwater / Goodpaster River / Chena River / Salcha River / Chatanika River / Arctic grayling / other fish

Appendix 4 (continued).

Kogl, D.R. 1965. Springs and ground-water as factors affecting survival of chum salmon spawn in a sub-arctic stream. M.S. Thesis. Univ. Alaska, Fairbanks. 59 pp.

The distribution of spawning chum salmon in relation to springs and ground-water seepage, and the survival of chum salmon eggs in these areas, was studied in the Chena River in 1963-1965. The study area was located on the Chena River, about 64 miles upstream from its mouth and immediately upstream of the mouth of Horner Creek.

Temperature and water quality information (dissolved oxygen concentrations, pH, iron, alkalinity, and hardness) were recorded. Plastic standpipes were used to obtain in-river groundwater temperature and water quality measurements. Egg survival, and survival and growth of embryos were recorded.

All seepage water analyzed during the summer and winter had (1) a pH of 6.5, (2) a temperature lower than the main river in summer and higher in winter, (3) an iron content of about 0.1 to 0.3 mg/l, and (4) a lower dissolved oxygen content than surface waters of the main river. Intragravel water temperatures generally were 1 to 2°C higher than the study area surface water. Surface dissolved oxygen concentration was 5.7 mg/l in late October and declined to about 2.0 mg/l by March. Average dissolved oxygen concentrations of intragravel water at the estimated time of egg hatching (December 1) was about 3.8 mg/l. Intragravel water dissolved oxygen concentrations were usually lower than that of the surface, but in those cases where temperatures were lower, dissolved oxygen was higher.

Intragravel water hardness increased from about 86 mg/l during incubation to about 103 mg/l about one month after hatching began. Alkalinity initially was 69 mg/l and increased to 86 mg/l during the same period.

Chum salmon chose well defined spawning sites that were directly or indirectly affected by groundwater seepages. Chum salmon spawned at depths ranging from 0.05 to 1.2 m and in water velocities of 0.0 to 0.6 mps. Chinook salmon spawned at water depths of 1.2 to 1.8 m and velocities of 0.5 to 0.8 mps.

Average survival of eggs was 84.2%. Alevins hatching from eggs incubated at higher dissolved oxygen concentrations were larger in size (dry weight) than those incubated at lower dissolved oxygen concentrations.

Chena River / chum salmon / chinook salmon

Appendix 4 (continued).

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish. Res. Bd. Can. 27:1215-1224.

This research paper reports the results of field research comparing the habitat distributions of juvenile coho and fall chinook salmon during the first three months of stream life in a river with stabilized flows in British Columbia.

The smaller fry of both species occupied marginal areas in association with bank cover, particularly in back-eddies, behind fallen trees, undercut tree roots, and other well-protected areas. Both species preferred locations close to shelter, but adjacent to water of high velocity (40 cm/sec). The largest concentration of fish gradually shifted from marginal to midstream locations, with chinook preceding coho in the shift from margin to midstream. Chinook occupied higher velocity locations than coho, apparently because of their larger size at any given time.

British Columbia / chinook salmon / coho salmon

Appendix 4 (continued).

Loftus, W.F., and H.L. Lenon. 1977. Food habits of the salmon smolts *Oncorhynchus tshawytscha* and *O. keta*, from the Salcha River, Alaska. Trans. Am. Fish. Soc. 106(3): 235-240.

Stomach contents of 454 chinook and 121 chum salmon smolt caught in the Salcha River at the Richardson Highway Bridge between 16 May and 8 June 1973 were examined. Immature aquatic insects of the orders Diptera, Plecoptera, and Ephemeroptera predominated in the diets of both salmon species, although adult dipterans were frequently consumed by chum salmon smolts. Chinook salmon preyed more heavily on plecopterans than did chum salmon. Chironomidae was the most important family of food organisms for both species.

Salcha River / chinook salmon / chum salmon

Appendix 4 (continued).

Mecum, R.D. 1984. Habitat utilization by fishes in the Tanana River near Fairbanks, Alaska. M.S. Thesis. University of Alaska, Fairbanks, Alaska. 128 pp.

This study evaluated summer habitat use by fish in the Tanana River, in the lower portion of the Chena River, and in two sloughs of the river modified by river training structures. Lake chub and longnose suckers were common in all habitat types. Whitefishes, juvenile salmon, and northern pike preferred habitats with a high water clarity. Burbot were found in deeper, turbid waters.

Habitat types in the Tanana River included the main channel (extremely high velocity >150 cm/s, deep water sometimes exceeding 8 m), main channel border or shoreline (30 m wide, greatly reduced current, shallower depth, presence of submerged cover), main channel sandbars, side channels (departures from main channel with summer flow, velocities greater, depths shallower, and substrates larger at head than in lower reaches), intermittent side sloughs (overflow channels that act as backwaters, little or no flow with emergent aquatic vegetation), intermittent side channels (dewater during all but moderate to high river stages), and modified sloughs (river training structures alter water quality and flow).

Using minnow traps the most common species captured were longnose suckers, lake chub, and slimy sculpin in the Tanana River and in altered habitats (Morgan and Groin 1). Highest catch occurred in Morgan (blackwater slough, surface flow blocked).

Using seines the most common species captured were longnose suckers, lake chub, and slimy sculpin in Tanana River habitats. Young-of-the-year lake chub preferred shallow backwater habitats over silt and sand substates with velocities from 0 to 9 cm/s. Catch rates for juvenile lake chub were not significantly different among seining sites. Adult lake chubs preferred shallow riffle areas over gravel and rubble-cobble substrates. Young and juvenile lake chub selected habitats where water velocity was less than 30 cm/s while adults were captured more frequently when velocities exceeded 30 cm/s. Young-of-the-year longnose suckers occurred at velocities from 0 to 9 cm/s, depths from 0 to 0.09 m, and at silt and sand substrates in greater frequency than expected. Juvenile longnose suckers tended to occupy higher velocities, greater depths, and substrates of larger particle size.

Young-of-the-year chinook salmon were only found in tributary mouth and modified slough habitats and young-of-the-year chum salmon were abundant only during spring outmigration.

Predominant fish species present in the Tanana River habitats are adapted for benthic feeding (slimy sculpin, longnose suckers, lake chub) while sight feeding fish (Arctic grayling, round whitefish) were found in clearwater habitats.

Tanana River / longnose suckers / burbot / lake chub / slimy sculpin

Appendix 4 (continued).

Murphy, M.L., J. Heifetz, J.F. Thedinga, S.W. Johnson, and K.V. Koski. 1989. Habitat utilization by juvenile Pacific salmon (*Oncorhynchus*) in the glacial Taku River, Southeast Alaska. Can. J. Fish. Aquat. Sci. 46:1677-1685.

This research paper reports the results of field studies conducted to determine juvenile salmon use of the lower Taku River in southeast Alaska during summer 1986. Sockeye, coho, and chinook salmon were present within the study area. Chinook salmon were predominantly age 0 (99%) and ranged from 40 to 93 mm FL. Seining was used to estimate fish density.

Habitat was classified into two broad categories: river habitats -- main channels, backwaters, braids, channel edges, and sloughs within the active river; and off-channel habitats -- beaver ponds, terrace tributaries, tributary mouths, and upland sloughs on the valley floor.

Mean water velocity was lowest (0-5 cm/s) in sloughs, backwaters, tributary mouths, upland sloughs, and beaver ponds; intermediate (10-21 cm/s) in braids, channel edges, and terrace tributaries; and highest (102 cm/s) in main channels. Main channels, except for channel edges, were assumed too swift (mean, 102 cm/s) to contain rearing salmon. Mean depth ranged from 0.3 m in braids to 1.0 m in beaver ponds and 2.9 m in main channels. Typically, river habitats were turbid (means, 240-400 JTU), whereas off-channel habitats were clear or humic (means, 20-208 JTU). Water temperatures were 2-4°C higher in beaver ponds and upland sloughs than in channel edges, braids, and terrace tributaries.

The distribution of salmon was most closely related to water velocity, and turbidity had a secondary influence. Sockeye and coho densities were highest in still or slow water (<11 cm/s), whereas chinook density was highest in slow-to-moderate current (1 to 20 cm/s). All species were virtually absent from areas with currents greater than 30 cm/s. Differences in water velocity may have masked effects of turbidity. Chinook density was similar in areas of different turbidity.

In the active channel of the lower Taku River, substrate is mostly compacted gravel, sand, and mud, providing little cover from the turbulent flow, and the only suitable habitat occurs along the channel edge. Other studies have shown juvenile chinook salmon can inhabit areas with current as fast as 70 cm/s where coarse substrate (20-40 cm diameter) provided cover from the fast current.

Mean salmon density in the habitat types corresponded to water velocity but also differed between the river and off-channel areas. Chinook primarily were in river habitats with mean velocities of 3 to 15 cm/s, particularly sloughs and channel edges (means, 6-8 fish/100 m^2), and off-channel terrace tributaries and tributary mouths (means, 5-8 fish/100 m^2). Chinook were virtually absent from beaver ponds and upland sloughs (<1 fish/100 m^2).

Taku River / southeast Alaska / chinook salmon / coho salmon / sockeye salmon

Appendix 4 (continued).

Murphy, M.L., J. Heifetz, S.W. Johnson, K.V. Koski, and J.F. Thedinga. 1986. Effects of clear-cut logging with and without buffer strips on juvenile salmonids in Alaskan streams. Can. J. Fish. Aquat. Sci. 43:1521-1533.

This research paper reports the results of field studies conducted in southeastern Alaska that were designed to assess the short-term effects of logging on the density and habitat use of streams by juvenile coho salmon, steelhead, cutthroat trout, and Dolly Varden in old growth forest and in clearcuts with and without stream buffers. All streams were apparently nonglacial. Winter and summer habitat use was examined. Old growth forest contained Sitka spruce and western hemlock. Clearcuts were 1 to 12 years old with trees cut to both streambanks. Buffered reaches were on 3 to 10 year old clearcuts: one bank had a strip of uncut streamside trees 15 to 130 m wide; the other side had undisturbed forest.

Clearcut stream reaches had less undercut bank, canopy density, pool volume, and debris and more periphyton than old growth reaches. Clearcut reaches were less stable than old growth reaches, having significantly greater point bar formation, sediment packing, and scour and deposition. Buffered reaches had more debris than old growth reaches but did not differ consistently from old growth reaches in any other habitat variable.

Most pools were formed by debris, and pool volume and debris volume were positively related. Periphyton biomass and benthos density were positively related.

Summer density of coho fry averaged more than two times greater in both buffered and clearcut reaches than in old growth reaches. Summer fry density was directly related to periphyton biomass and benthos. The more periphyton a reach had, the more fry it had, and the clearcut and buffered reaches with open canopy and abundant periphyton had the most fry.

In winter, density of coho salmon fry was still greater in buffered than in old growth reaches. Clearcut reaches no longer had significantly more fry than old growth reaches. Both summer food abundance and debris appeared to influence winter density of coho fry. The more periphyton a reach had in summer and the more debris, the more fry it had in winter.

Summer food abundance limited summer fry densities and quality of winter habitat (i.e., debris) determined winter survival.

Coho salmon parr were equally abundant in old growth, buffered, and clearcut reaches in summer, but significantly less abundant in clearcut than in old growth reaches in winter. If debris was left in clearcut reaches, or added in buffered reaches, coho salmon parr were abundant (10 to 22/100 m^2) in winter. If debris had been removed from clearcut reaches, parr were scarce (<2/100 m^2) in winter.

Southeast Alaska / coho salmon / Dolly Varden / cutthroat trout / steelhead

Appendix 4 (continued).

Pearse, G. 1987. An annotated bibliography of burbot (Lota lota) with emphasis on studies conducted on northern and Alaskan burbot stocks. ADF&G. Div. of Sport Fish, Fishery Manuscript No. 4. Juneau. 134 pp.

This bibliography contains 599 references that are briefly described, generally in one or two sentences. Key word indexing is provided.

Burbot / Alaska

Appendix 4 (continued).

Pearse, G.A., and R. Conrad. 1986. Interior burbot study, Part C: Hoop trap catch per unit effort standardization. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 27. Proj. F-10-1, Job N-8-1. 50 pp.

This report documents findings relative to sampling methods, baiting strategy, catch vs depth, effort, photoperiod, and other factors found to influence catch per unit effort of burbot. This component of the study was conducted primarily in Fielding Lake, with additional work conducted in Harding Lake and the Tanana River between the Wood River upstream to the mouth of the Healy River.

Habitat descriptors (main channel, side channel, backwater slough, depth, and flow) for each of the net sites were reportedly recorded although none are presented in the report. Traps rebaited and moved daily in the Tanana River had the highest catch per unit effort. Catch rates declined after one net-night for traps not moved. Captured burbot retained in hoop traps in the Tanana River showed physical damage after two net-nights.

Tanana River / burbot

Appendix 4 (continued).

Pearse, G.A. 1976. A study of typical spring-fed streams of interior Alaska. ADF&G. Fed. Aid in Fish. Rest. Vol. 17. Proj. F-9-8, Job No. G-III-G. Juneau. 18 pp.

This report provides information on Arctic grayling and round whitefish in the Delta Clearwater River for the 1975 field season. Included are results of monitoring of Arctic grayling and round whitefish stock composition and relative abundance (age and length composition), and a stock enhancement program for Arctic grayling in the Delta Clearwater River.

Delta Clearwater River / Arctic grayling / round whitefish

Appendix 4 (continued).

Pearse, G.A. 1976. Inventory and cataloging of the sport fish and sport fish waters of interior Alaska, Tanana River drainage between Tok and Little Delta rivers. ADF&G. Fed. Aid in Fish. Rest. Vol. 17. Proj. F-9-8, Job No. G-I-L. Juneau. 45 pp.

This report provides a brief summary of fish species present, basic water chemistry data (D.O., temperature, CO_2, pH, alkalinity, hardness), access, and a brief habitat description for streams primarily along the Richardson and Alaska Highways from the Little Delta River to the Tok River. Also included are a few small clearwater streams along the south bank of the Tanana River between the Little Delta and Delta Rivers (Kiana Creek, Clearwater creeks) and a few small streams located along the north bank of the Tanana River between the Johnson and Robertson Rivers. Some streams have actual fish presence data; for others, species that may be present are listed. Similar data are provided for lakes along the road system and for lakes without roadside access along the north and south banks of the Tanana River.

Kiana Creek / Clearwaters / Tanana drainage streams / Arctic grayling / northern pike / whitefish / slimy sculpin / coho salmon / longnose sucker / lake chub

Appendix 4 (continued).

Pearse, G.A. 1974. A study of a typical spring fed stream of interior Alaska. Annual report of progress. ADF&G Fed. Aid in Fish. Rest. Vol. 15. Proj. F-9-6, Job G-III-G. 49 pp.

This paper reports the results of field work conducted on the Delta and Richardson Clearwater rivers in 1972 and 1973 examining the distribution, movements, abundance, life history information, and food habits of Arctic grayling and round whitefish, and certain aspects of coho salmon life history. Water quality values for temperature, pH, alkalinity, hardness, dissolved oxygen, and carbon dioxide are presented.

Smaller (<300 mm) Arctic grayling entered the Delta Clearwater in early April, with larger Arctic grayling entering the river in mid May and June. Most of the fish moved downstream in fall; a few remained through mid winter. All were absent in March 1973. No ripe pre-spawning Arctic grayling were collected in the Delta Clearwater; however, nine young-of-the-year were captured in the lower river in late July 1973, indicating a few Arctic grayling do spawn in the system. Rearing grayling emigrate from spawning rivers such as the Goodpaster River and Shaw Creek, and migrate to summer feeding areas such as the Delta and Richardson Clearwater rivers.

Arctic grayling tagged in the Goodpaster River in May were recaptured in the Delta Clearwater later in the summer. Arctic grayling tagged in the Goodpaster River in late summer were captured the following year in the Richardson Clearwater and Clearwater Lake. Arctic grayling tagged in the Delta Clearwater in May and June were captured later in the summer in Clearwater Lake and the Goodpaster River.

Round whitefish tagged in the Tanana River between the mouths of the Delta Clearwater and Goodpaster rivers, and near the mouth of the Delta River in late March were recaptured in the Delta Clearwater, Richardson Clearwater, Tanana River, and Clearwater Lake. No young-of-the-year round whitefish were captured in the Delta Clearwater, which suggests spawning does not occur in this system. Few round whitefish were seen in early September in the Delta Clearwater. Two round whitefish tagged in the Delta Clearwater were observed in a large school of pre-spawning round whitefish in the Goodpaster River in mid September.

Pre-spawning coho salmon were first observed in the Delta Clearwater in 1973 on September 24. Peak spawning occurred around mid October. About 350 to 400 coho salmon were observed in the Richardson Clearwater. Coho and chum salmon were observed in the lower seven miles of the Richardson Clearwater. Young-of-the-year and age 1 coho salmon were observed and captured along the stream margins in cover areas during summer. Some also were captured in spring areas. Rearing fish were absent from the stream margins in fall but were captured in greater numbers in spring areas at this time. Springs are the preferred overwintering habitat for these age classes of salmon. The majority of coho smolt had outmigrated before May 25; some were captured in the Tanana River near the mouth of the Delta River in March.

Delta Clearwater / Richardson Clearwater / Tanana River / Arctic grayling / round whitefish / coho salmon

Appendix 4 (continued).

Peckham, R. 1984. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters - Delta District. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 25. Proj. F-9-16, Job G-III-I. 25 pp.

One section of this report describes the degradation of the Delta Clearwater River from spring runoff from the Delta Agricultural Project in May 1982.

A dark humic stain that obscured the bottoms of pools and numbers of fish was visible in the river from May 6 to at least May 17. The stain resulted from the large volume of spring runoff from cleared fields which flowed through the greenbelt strip into the river's north fork. A firebreak trail constructed during a fire in 1979, which originated in the agricultural project during clearing operations, contributed to the problem by channeling the flow to within one-half mile of the headwaters.

An index of relative abundance showed Arctic grayling at the lowest level in seven years. Sport harvest surveys also revealed a decline in catch rates.

In December 1982, rehabilitation efforts of the fireline trail began and involved pushing most of the material originally removed back into the fireline. In addition, about 12 small detention dams were constructed across the fireline trail to retard the flow and allow runoff water to spread into the undisturbed greenbelt area rather than being channeled toward the river.

Monitoring of the spring runoff was conducted in April and May 1983. Less snowfall during winter 1982-83 and a gradual spring melt, unlike 1982, resulted in much less runoff from agricultural lands. Most runoff reaching the fireline trail was contained in the first two detention dams. No staining was observed in the Delta Clearwater River in 1983.

Delta Clearwater River / agricultural runoff

Appendix 4 (continued).

Peckham, R.D. 1980. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters, Delta district. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 21. Proj. F-9-12, Job G-III-I. 25 pp.

This report describes field studies conducted in 1979 that included estimates of angler harvest of Arctic grayling on the Tanana River and Shaw Creek, stream surveys on Shaw Creek and two of its tributaries, and sampling on the Goodpaster River.

An early spring fishery for Arctic grayling and round whitefish occurs in open water on the Tanana River at Big Delta from late March through mid April. An estimated 1,029 angler hours of effort during a 15 day sampling period caught an estimated 309 Arctic grayling and 134 round whitefish. Sampled Arctic grayling averaged 266 mm in length with a range of 203 to 365 mm. Round whitefish averaged 326 mm with a range of 250 to 405 mm.

Highway reconstruction in 1976 altered the Tanana River downstream of Shaw Creek, eliminating the pool which in the past attracted Arctic grayling for a period of two to three weeks before breakup on Shaw Creek. Since highway reconstruction, the concentration of Arctic grayling and the resulting sport fishery have not occurred.

Arctic grayling were observed spawning in the lower four miles of Rapids Creek, a tributary of Shaw Creek, on May 17 and 18. Spawning was observed over sandy-silt bottom and organic debris, usually in flowing water just below beaver dams. No Arctic grayling were seen in the upper four miles of Rapids Creek.

A small downstream weir was installed on September 10 and operated for four days on Caribou Creek, a tributary to Shaw Creek. Eight species were captured: Arctic grayling, humpback whitefish, longnose sucker, slimy sculpin, round whitefish, lake chub, coho salmon, and northern pike. Mean lengths and ranges are provided for each species.

Shaw Creek / Caribou Creek / Rapids Creek / Tanana River / Arctic grayling / other species

Appendix 4 (continued).

Peckham R.D. 1979. Evaluation of interior Alaska and sport fish with emphasis on managed water, Delta District. ADF&G. Fed. Aid in Fish. Rest. Vol. 20. Proj. F-9-11, Job No. G-III-I. Juneau. 27 pp.

This report includes information regarding the results of a late June 1978 sampling effort aimed at estimating population levels of Arctic grayling in two 4.8 km sections of the lower Goodpaster River. Age and length frequency information also is presented. The relative abundance of Arctic grayling, round whitefish, and longnose suckers is reported in terms of fish captured per hour (by electrofishing).

Fish population sampling was conducted in the lower 3.2 km of Shaw Creek in late September by electrofishing. One hour of shocking produced 72 Arctic grayling, 13 round whitefish, 6 humpback whitefish, 2 longnose suckers, 1 coho salmon, and 2 chum salmon. Age frequency and length data are presented for Arctic grayling.

Coho salmon spawners numbered 4,798 in the Delta Clearwater River.

Goodpaster River / Delta Clearwater River / Shaw Creek / Arctic grayling / round whitefish / longnose sucker / humpback whitefish / coho salmon / chum salmon

Appendix 4 (continued).

Peckham, R.D., and W.P. Ridder. 1979. A study of a typical spring-fed stream of interior Alaska. ADF&G. Fed. Aid in Fish Rest. Vol 20. Proj. F-9-12, Job No. G-III-G. Juneau. 38 pp.

This report presents the results of investigations aimed primarily at monitoring the abundance of Arctic grayling and round whitefish in the Delta Clearwater river in April 1978, the results of index sampling of Arctic grayling and round whitefish in July, harvest data for Arctic grayling in the Delta Clearwater River, and assessment of Arctic grayling stock enhancement in the Delta Clearwater River. Age frequency and length data are presented for Arctic grayling. Relative capture rates are presented for Arctic grayling and round whitefish.

Index sampling was conducted on the Richardson Clearwater River on August 31. Age frequency and length data are presented as well as the capture rate per hour of Arctic grayling and round whitefish.

Delta Clearwater River / Richardson Clearwater River / Arctic grayling / round whitefish

Appendix 4 (continued).

Peckham, R.D. 1978. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters, Delta district. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 19. Proj. F-9-10, Job G-III-I. 19 pp.

This paper reports the results of field studies conducted in 1977 that included Arctic grayling studies in the lower Goodpaster River, fish sampling in Shaw Creek, and coho salmon counts in the Delta Clearwater River.

Fish populations in Shaw Creek were sampled in July by electrofishing to determine species composition and relative abundance. A 4.8 km reach of Shaw Creek from Caribou Creek downstream was sampled (the Tanana River is located another 4.8 km downstream). Riverboat access is limited to the lower 10 km due to fallen trees in the stream above that point. A total of 11 Arctic grayling were captured in about 1 hour of shocking time. Three round whitefish, 1 slimy sculpin, and 10 longnose suckers also were captured.

On August 29, the lower 4.8 km of Shaw Creek were electrofished. Five Arctic grayling and several burbot and longnose suckers were captured. All except one Arctic grayling were captured at the confluence of Shaw Creek and the Tanana River.

An angler caught one 635 mm sheefish in the lower kilometer of Shaw Creek on July 30, 1977.

On October 24 and 25, 4,793 coho salmon were counted in the Delta Clearwater River.

Shaw Creek / Delta Clearwater / Arctic grayling / longnose sucker / round whitefish / sheefish / burbot.

Appendix 4 (continued).

Peckham, R.D. 1978. A study of a typical spring-fed stream in interior Alaska. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 19. Proj. F-9-10, Job G-III-G. 13 pp.

This report summarizes the 1977 field sampling efforts for the Delta Clearwater River. Information presented includes Arctic grayling and round whitefish abundance, Arctic grayling age-length relationships, early spring fish movements, harvest information, and assessments of pond-reared Arctic grayling stocked into spring areas of the Delta Clearwater River. Age, length, and capture rates for Arctic grayling are presented for the Richardson Clearwater River.

On June 14 and 15, most of the spring tributaries entering the Richardson Clearwater River were visually examined. Rearing coho salmon were numerous, but no Arctic grayling were observed. The main channel of the Richardson Clearwater River was visually inspected to mile 9; Arctic grayling and round whitefish were observed to the fork near mile 7, but no fish were seen above that point.

The Richardson Clearwater River was electrofished from mile 7 downstream on August 30. One hundred four Arctic grayling and 123 round whitefish were captured. The Arctic grayling ranged from 182 to 416 mm in length with a mean of 291 mm. Only 5 Arctic grayling were less than 215 mm.

Arctic grayling, round whitefish, coho salmon, least cisco, slimy sculpin, humpback whitefish, longnose sucker, and burbot were captured by fyke net and electrofishing from April 21 to May 5 in One Mile Slough, a side channel of the Tanana River that enters the Delta Clearwater at mile 1. The slough is fed by spring upwelling during the months the Tanana River is non-glacial.

Delta Clearwater / Tanana River / round whitefish / Arctic grayling

Appendix 4 (continued).

Peckham, R.D. 1977. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters, Delta district. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 18. Proj. F-9-9, Job G-III-I. 14 pp.

This paper reports the results of field studies conducted in 1976 that included Arctic grayling studies in the lower Goodpaster River, fish sampling in Shaw Creek, and coho salmon counts in the Delta Clearwater River.

Fish populations in Shaw Creek were sampled in July by electrofishing to determine species composition and relative abundance. A 4.8 km reach of Shaw Creek from Caribou Creek downstream was sampled (the Tanana River is located another 4.8 km downstream). Riverboat access is limited to the lower 10 km due to fallen trees in the stream above that point.

A total of 89 Arctic grayling was captured in 3.75 hours of shocking time (23/hour). Round whitefish, humpback whitefish, and longnose suckers were captured at rates of 7, 4, and 33 fish/hour.

On October 21 and 22, 1,920 coho salmon were counted in the Delta Clearwater River.

Shaw Creek / Delta Clearwater / Arctic grayling / longnose sucker / round whitefish / humpback whitefish

Appendix 4 (continued).

Peckham, R.D. 1977. A study of a typical spring fed stream of interior Alaska. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 18. Proj. F-9-9, Job G-III-G. 14 pp.

This report summarizes the 1976 field sampling efforts for the Delta Clearwater River. Information presented includes Arctic grayling and round whitefish abundance, Arctic grayling age-length relationships, early spring fish movements, harvest information, and assessments of pond-reared Arctic grayling stocked into spring areas of the Delta Clearwater River.

Arctic grayling, round whitefish, coho salmon, least cisco, slimy sculpin, humpback whitefish, and burbot were captured by fyke net from April 20 to May 1 in One Mile Slough, a side channel of the Tanana River that enters the Delta Clearwater at mile 1. The slough is fed by spring upwelling during the months the Tanana River is non-glacial.

Delta Clearwater / Tanana River / round whitefish / Arctic grayling

Appendix 4 (continued).

Peckham R.D. 1976. Evaluation of interior Alaska and sport fish with emphasis on managed water, Delta District. ADF&G. Fed. Aid in Fish. Rest. Vol. 17. Proj. F-9-8, Job No. G-III-I. Juneau. 20 pp.

This report includes information regarding the results of a late June 1975 sampling effort aimed at estimating population levels of Arctic grayling in two 4.8 km sections of the lower Goodpaster River. Age and length frequency information also is presented. The relative abundance of Arctic grayling, round whitefish, and longnose suckers is reported in terms of fish captured per hour (by electrofishing).

The April Shaw Creek Arctic grayling fishery was monitored in 1975. The estimated harvest of Arctic grayling was between 1,000 and 1,300 fish.

Goodpaster River / Arctic grayling / round whitefish / longnose sucker

Appendix 4 (continued).

Peckham, R.D. 1975. Evaluation of interior Alaska waters and sport fish with emphasis on stocked lakes. Annual report of progress. ADF&G Fed. Aid in Fish. Rest. Vol. 16. Proj. F-9-7, Job G-III-E. 25 pp.

A short section of this report briefly describes an early Arctic grayling fishery at the mouth of Shaw Creek in the second and third weeks of April as ice breakup occurs. Creel census returns indicated 195 Arctic grayling ranging from 180 to 411 mm (mean = 294 mm) in length were caught during the four day fishing period. It was estimated that the 35 anglers contacted represented about one half of the total use of the fishery during the four day period.

Shaw Creek / Arctic grayling

Appendix 4 (continued).

Peckham, R.D. 1972. Inventory and cataloging of the sport fish and sport fish waters in interior Alaska. Annual report of progress. ADF&G Fed. Aid in Fish. Rest. Vol. 13. Proj. F-9-4, Job G-1-G. 17 pp.

Approximately 600 salmon spawners (species not identified) were counted during aerial counts on the Richardson Clearwater River.

Richardson Clearwater / salmon

Appendix 4 (continued).

Peterson, B. 1997 (in press). Estimation of abundance and mortality of emigrating chum and chinook salmon outmigrants in the Chena River, Alaska. M.S. Thesis, University of Alaska, Fairbanks.

Chinook and chum salmon fry were collected above and below the Chena Flood Control Project (dam) during 1995 and 1996. Outmigration peaked in May and began prior to the time when ice cleared allowing trap placement. Time of movement between the upper and lower traps exceeded what would be expected based on average water velocity and active movement. Growth occurred between trap sites, indicating that fish were feeding. However, age 1 chinook salmon smolts were not captured using minnow traps. Diurnal movement patterns were noted for chinook but not for chum salmon outmigrants. Movements were viewed in relation to discharge (catch increased during peak flow events), time (diurnal movement of chinook salmon), and temperature (numbers decreased as temperatures increased). Large numbers of age zero chinook salmon passed through the sample area indicating downstream displacement. The age zero chinook salmon were caught in baited minnow traps. Mortality rates were computed for both chum and chinook salmon smolts but seemed high to be real, particularly for chum (estimated mortality for chum was 80 to 90%, estimated mortality for chinook was 10 to 40%). Sample gear used consisted of screw traps, minnow traps, and seining. The most effective gear type was the screw traps.

Chena River / chum salmon / chinook salmon

Appendix 4 (continued).

Reed, R.D., and S.T. Elliot. 1972. Effects of logging on Dolly Varden. Annual report of progress. ADF&G Fed. Aid in Fish. Rest. Vol. 13. Proj. F-9-4, Job R-IV-B. 62 pp.

This report contains photographs of poor logging practices and also contains an annotated bibliography of the effects of logging on fish. Most studies that were conducted in Alaska to date were included.

Dolly Varden / coho salmon / cutthroat trout / rainbow trout / Southeast Alaska

Appendix 4 (continued).

Reed, R.J. 1961. Investigation of the Tanana River grayling fisheries. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-2, Job 3-B. pp. 195-214.

This paper reports the results of field studies conducted in summer 1960 that investigated the movements of Arctic grayling in the Chatanika and Goodpaster rivers, and the Delta Clearwater.

Adult Arctic grayling appeared in the Delta Clearwater in early May, with migration peaking in mid May. Adult fish moved upstream to the two forks between mid May and mid June. Adult fish moved out of the two forks from mid-to-late June, spreading out in the main river in riffle areas. Immature fish moved into the river in late June, moved upstream throughout July and by mid August, reached their maximum upstream movement. Adult and immature fish began downstream movements in September and were concentrated in the lower three miles of the river at the end of September.

Arctic grayling / Delta Clearwater / Chatanika River / Goodpaster River

Appendix 4 (continued).

Richards, C., P.J. Cernera, M.P. Ramey, and D.W. Reiser. 1992. Development of off-channel habitats for use by juvenile chinook salmon. N. Am. J. Fish. Manage. 12(4):721-727.

Four series of off-channel mining dredge ponds were connected to Yankee Fork of the Salmon River in Idaho by excavating channels to increase rearing habitat for juvenile spring chinook salmon. Intake structures were placed at the upstream ends to control flow into the ponds. Redwood weirs were placed at the downstream ends of most ponds to control water level and flow through the ponds. Boulders were placed in the channels to improve the available rearing habitat and to minimize barriers to migration into and among the ponds.

Hatchery and wild age 0 chinook salmon were present in the river. Densities were significantly greater in channel than in other habitats (open water, bank) and greater in habitats with cover (boulders, woody debris, macrophytes, and algal mats) than those without cover. Densities in channel habitat with cover were several times those in any other habitat. Channel habitat received disproportionately heavy use; 32% of the fish in one pond series and 80% in another occupied this habitat even though it accounted for less than 10% of all available habitat. Fish appeared to avoid water without cover. Channel habitat provided the physical conditions of low water velocity (<30 cm/sec) and moderate depths (0.1 to 0.5 m) that simulate natural small backwater channels.

The authors noted that the abnormally high densities of fish found in this study may be related in part to the hatchery origin of the fish (the fish were reared in high density flow-through vats).

Idaho / chinook salmon

Appendix 4 (continued).

Ridder, W.P. 1994. Contributions of Arctic grayling from Caribou Creek to the Richardson Clearwater River and Shaw Creek, 1980 through 1988. ADF&G. Fishery Data Series No. 94-49. Anchorage. 53 pp.

This report provides estimates of the proportion of Arctic grayling that are subsequently found in the Richardson Clearwater River during summer after emigrating from Caribou Creek (tributary of Shaw Creek) after spawning that same year. Abundance, length frequencies, harvest, and angling effort data are presented for the Richardson Clearwater River and for Shaw Creek.

On average, two-thirds of the Arctic grayling in the Richardson Clearwater River are comprised of fish that emigrated from Caribou Creek the same year. The remaining one-third of the population could be comprised of fish from other tributaries of the Shaw Creek drainage, or from other donor systems, or a combination of donors.

On average, one-half of the Arctic grayling at the mouth of Shaw Creek during the pre-spawning migration is comprised of fish that originated from Caribou Creek the prior year. The remaining one-half could be comprised of new recruits to Caribou Creek, fish from other tributaries to Shaw Creek, fish from other systems, or a combination of all of these potential donors.

On average, three-fourths of the Arctic grayling in Caribou Creek during the post-spawning migration is comprised of fish that originated from Caribou Creek the prior year. The remaining one-fourth should be comprised of new recruits to Caribou Creek if homing to natal streams for spawning was occurring.

Tanana River / Shaw Creek / Caribou Creek / Richardson Clearwater River / Arctic grayling

Appendix 4 (continued).

Ridder, W.P. 1994. Arctic grayling investigations in the Tok River drainage during 1993. ADF&G. Fishery Data Series No. 94-19. Anchorage. 43 pp.

This study was conducted in April, May, June, and September 1993 to determine the age and size composition of Arctic grayling larger than 149 mm in the Tok Overflow for an initial assessment of the population in this system. Sampling was expanded to include other locations within 21 km of the Tok Overflow when few fish were found in the Tok Overflow. Other areas sampled included the Tok Overflow #2, the Little Tok River, the Tok River, and Mineral Lake Outlet. Stream descriptions and descriptions of each fishery are provided. Length and age composition data are provided.

The Tok River below the Tok Overflow was found to be an overwintering area for Arctic grayling that disperse upstream to at least Mineral Lake Outlet.

Water temperatures indicated the Tok Overflow to be the coldest stream in the study area and likely inhospitable as a summer feeding area for Arctic grayling. Daily high stream temperatures ranged from 2.7 to 4.8°C between 15 April and 6 August. Arctic grayling (56 fish between 200 and 300 mm) were found at the mouth of the Tok Overflow only on 22 June (five other surveys were conducted) when the stream temperature at the mouth was 5.9°C.

The Tok River drainage is the only locale in the Tanana River drainage that supports a significant Dolly Varden fishery. Dolly Varden were captured in the Tok Overflow and the Tok Overflow #2. Two Dolly Varden were active on a redd in the Tok Overflow on 13 September. Eighteen Dolly Varden in the Tok Overflow #2 in June averaged 142 mm in length (range = 101 to 191 mm; SD = 20). Five Dolly Varden captured in the Tok Overflow #2 averaged 159 mm (range = 115 to 212 mm; SD = 32).

Tok River / Little Tok River / Tok Overflow / Mineral Lake Outlet / Arctic grayling / Dolly Varden

Appendix 4 (continued).

Ridder, W.P., T.R. McKinley, and R.A. Clark. 1993. Stock assessment of Arctic grayling in the Salcha, Chatanika, and Goodpaster rivers during 1992. ADF&G. Fishery Data Series No. 93-11. Anchorage. 117 pp.

Estimates of abundance of Arctic grayling, and age and size composition were derived from sampling conducted on identified reaches of the Salcha, Chatanika, and Goodpaster rivers during summer 1992. Brief summaries of the streams and historical fishery information is presented for each stream. Mark-recapture sampling by electrofishing was used to estimate abundance.

Goodpaster River / Chatanika River / Salcha River / Arctic grayling

Appendix 4 (continued).

Ridder, W.P. 1991. Summary of recaptures of Arctic grayling tagged in the middle Tanana River drainage, 1977 through 1990. ADF&G. Fishery Data Series No. 91-34. Juneau. 97 pp.

This paper uses tag recoveries to summarize the seasonal movements of Arctic grayling in the middle Tanana River drainage from the Volkmar River to the Salcha River. Research programs from 1952 through 1990 emphasizing movements of Arctic grayling are briefly summarized. Extensive appendices containing information regarding tagging locations and recapture locations from 1977 to 1990 are presented. Stream classifications (silted and unsilted rapid runoff, bog-fed, and spring-fed), use by Arctic grayling, and harvest are discussed.

Trends in movement indicate a migration from spawning areas in unsilted rapid runoff and bog-fed systems to spring-fed systems for feeding. Major systems of migration include: from Caribou/Shaw Creek to the Richardson Clearwater River; and from the Goodpaster and Volkmar rivers to the Delta Clearwater River. Data also indicate a high degree of specificity to feeding areas, especially to the Delta and Richardson Clearwater rivers.

Tanana River / Delta Clearwater River / Richardson Clearwater River / Goodpaster River / Shaw Creek / Salcha River / Caribou Creek / Volkmar River / Rapids Creek / Arctic grayling

Appendix 4 (continued).

Ridder, W.P. 1989. Age, length, sex, and abundance of Arctic grayling in the Richardson Clearwater River and Shaw Creek, 1988. ADF&G. Div. of Sport Fish, Fishery Data Series No. 120. Juneau. 35 pp.

This paper reports the results of field studies conducted within a 1 km section of the Tanana River at the mouth of Shaw Creek in April 1988 (before ice breakup in Shaw Creek) and in a 12.8 km section of the Richardson Clearwater River in July 1988. Arctic grayling were captured by electrofishing.

The estimated abundance of Arctic grayling (greater than 249 mm FL) in the Richardson Clearwater River was 4,599 (SE = 751; 95% CI = 3,127 to 6,071). The estimated abundance of Arctic grayling in Shaw Creek (greater than 270 mm FL) was 6,080 (SE = 3,596; CV = 59.1%).

Shaw Creek / Richardson Clearwater River / Tanana River / Arctic grayling

Appendix 4 (continued).

Ridder, W.P. 1985. The life history and population dynamics of exploited stocks of Arctic grayling associated with the Delta and Richardson Clearwater Rivers. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 26. Proj. F-9-17, Job G-III-G. 58 pp.

This paper reports the results of field studies conducted in 1983 including monitoring of the in-migration of juvenile Arctic grayling to the Delta Clearwater at One Mile Slough from April 16 to May 11, population estimates of Arctic grayling in the Goodpaster River in June, index sampling of Arctic grayling and round whitefish in the Delta Clearwater River and Richardson Clearwater River in July, creel census data for the Delta Clearwater River and Shaw Creek, stocking and assessment of Arctic grayling stock enhancement in the Delta Clearwater, and Arctic grayling tagging on Caribou Creek.

In 1984, 913 Arctic grayling were harvested at the Shaw Creek spring fishery (April 8 to June 25).

A weir on Caribou Creek was operated from June 5 to June 15 to capture downstream moving fish. Ten species totaling 1,786 fish were captured: 1,163 Arctic grayling, 308 longnose suckers, 208 lake chubs, 81 round whitefish, 16 humpback whitefish, 4 least cisco, 3 northern pike, 1 slimy sculpin, 1 chinook salmon, and 1 coho salmon.

Delta Clearwater River / Richardson Clearwater / Shaw Creek / Caribou Creek / Goodpaster River / Arctic grayling / other fish

Appendix 4 (continued).

Ridder, W.P. 1984. The life history and population dynamics of exploited stocks of Arctic grayling associated with the Delta and Richardson Clearwater Rivers. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 25. Proj. F-9-16, Job G-III-G. 49 pp.

This paper reports the results of field studies conducted in 1983 including index sampling of Arctic grayling and round whitefish in the Delta Clearwater River and Richardson Clearwater River in July, a fish survey on Clear Creek in August, creel census data for the Delta and Richardson Clearwaters and Shaw Creek, assessment of Arctic grayling stock enhancement in the Delta Clearwater, and Arctic grayling tagging on Caribou and Rapids creeks (tributaries to Shaw Creek), Ptarmigan Creek (tributary of Delta Creek), Buchanen Creek (tributary of the Little Delta River), and Kiana Creek (tributary to the Tanana River 15 mi below the Richardson Clearwater).

Sampling in Clear Creek (south bank of the Tanana River between Shaw Creek and Big Delta) on August 8 noted young-of-the-year coho salmon immediately downstream of an impassable beaver dam at mile 6 and no other fish were seen except one Arctic grayling at the mouth of the stream. A helicopter overflight on June 30 noted fish throughout the stream from the beaver dam to the stream mouth. The August 8 observations were the earliest in which the creek was devoid of Arctic grayling.

The estimated harvest of Arctic grayling in the Richardson Clearwater was around 1,500 to 2,000 fish. The estimated harvest of Arctic grayling in the Shaw Creek spring fishery was 1,864.

The Caribou Creek weir operated from June 2 to June 20 and captured downstream moving fish only. A total of 1,676 Arctic grayling were captured.

Spring-fed systems are characterized by fairly constant temperatures, discharges, and crystal clarity due to their ground water sources. Predominant fish species are Arctic grayling, round whitefish, coho salmon, and longnose suckers. Only cohos spawn and overwinter in the systems; the others use them as summer feeding areas. Arctic grayling and round whitefish begin arriving in April, with the migration of Arctic grayling lasting into June. In general, juvenile Arctic grayling and some subadults arrive directly from overwintering areas in the Tanana River and precede the adults and subadults that arrive from various spawning streams in the area. The known spawning streams include the Volkmar and Goodpaster rivers, and in the Shaw Creek drainage, Caribou and Rapids creeks. Outmigration begins in late August or early September, continues through the late fall spawning period of coho salmon, and is essentially complete by late November.

Richardson Clearwater River / Delta Clearwater River / Shaw Creek / Caribou Creek / Rapids Creek / Kiana Creek / Ptarmigan Creek / Buchanen Creek / Arctic grayling

Appendix 4 (continued).

Ridder, W.P. 1983. A study of a typical spring-fed stream of interior Alaska. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 24. Proj. F-9-15, Job G-III-G. 54 pp.

This paper reports the results of field studies conducted in 1982 including spring monitoring of Arctic grayling and round whitefish at Mile One Slough from mid April to early May, index sampling of Arctic grayling and round whitefish in the Delta Clearwater River and Richardson Clearwater River in July, a fish survey on Clear Creek in July, creel census data for the Delta and Richardson Clearwaters and Shaw Creek, assessment of Arctic grayling stock enhancement in the Delta Clearwater, and Arctic grayling tagging on Caribou Creek and the Volkmar and Goodpaster rivers.

The number of Arctic grayling per mile in the Richardson Clearwater River was estimated at 1,582. Angler catch in the Richardson Clearwater River recorded from a voluntary creel census was 602 Arctic grayling, of which 413 were harvested. The total estimated harvest for the Richardson Clearwater River in 1982 was 1,843 Arctic grayling. Harvests were 995 in 1980 and 1,522 in 1981.

An estimated 979 Arctic grayling were harvested in the Shaw Creek spring fishery in 1982, considerably less than the harvest estimate of 4,343 in 1981. The difference in harvest was attributed to treacherous ice conditions during breakup and the shorter time interval between the breakup of Shaw Creek and the Tanana River in 1982 than in 1981.

The Caribou Creek weir was operated from June 1 to June 20 and captured 6,789 fish of 10 species. The catch of Arctic grayling totaled 3,876; upstream migrants totaled 1,814, downstream migrants totaled 2,062.

The principal destination of Arctic grayling outmigrating from Caribou Creek is the Richardson Clearwater River. Volkmar River Arctic grayling tend to appear in the Delta Clearwater River.

Delta Clearwater River / Richardson Clearwater River / Caribou Creek / Shaw Creek / Arctic grayling

Appendix 4 (continued).

Ridder, W.P. 1982. A study of a typical spring-fed stream of interior Alaska. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 23. Proj. F-9-14, Job G-III-G. 61 pp.

This paper reports the results of field studies conducted in 1981 including spring monitoring of Arctic grayling and round whitefish at Mile One Slough from mid April to early May, index sampling of Arctic grayling and round whitefish in the Delta Clearwater River in July, sampling on the Richardson Clearwater in July, fish surveys on Clear Creek in July, creel census data for the Delta and Richardson Clearwaters and Shaw Creek, assessment of Arctic grayling stock enhancement in the Delta Clearwater, Arctic grayling tagging on Caribou Creek and the Volkmar River, and coho salmon spawning escapement on the Delta Clearwater River.

A creel census was conducted on Shaw Creek from April 5 to 22. The late breakup of Shaw Creek and changing Tanana River channels allowed Arctic grayling to concentrate in numbers off the mouth of Shaw Creek for the first time in five years. The estimated catch of Arctic grayling was 6,087, of which 4,343 were harvested. Tag returns generated by the fishery totaled 100, 83 of which were from fish tagged in Caribou Creek in 1980.

A weir was operated on Caribou Creek from June 6 through June 19. Total catch was 4,730 fish of nine species, 1,802 of which were upstream migrants. Arctic grayling comprised 2,122 of the total catch: 367 were upstream migrants and 1,755 were downstream migrants. Water temperature appeared to be correlated with numbers of Arctic grayling leaving the creek. When the temperature of Caribou Creek first reached 11°C, upstream migrant catches of Arctic grayling dropped while downstream migrant catches increased, both significantly. Catches of other species were not affected by water temperature. Other species captured at the weir included: longnose sucker (1,645), humpback whitefish (276), round whitefish (293), least cisco (27), lake chub (329), northern pike (2), slimy sculpin (26), and coho salmon (10).

On October 21, 8,563 adult coho salmon were estimated in the Delta Clearwater River.

Delta Clearwater / Richardson Clearwater / Clear Creek / Caribou Creek / Shaw Creek / Arctic grayling / other fish

Appendix 4 (continued).

Ridder, W.P. 1981. A study of a typical spring-fed stream of interior Alaska. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 22. Proj. F-9-13, Job G-III-G. 59 pp.

This paper reports the results of field studies conducted in 1980 including spring monitoring of Arctic grayling and round whitefish at Mile One Slough from mid April to early May, index sampling of Arctic grayling and round whitefish in the Delta Clearwater River in July, sampling on the Richardson Clearwater in July, fish surveys on Clear Creek in July, creel census data for the Delta and Richardson Clearwaters, assessment of Arctic grayling stock enhancement in the Delta Clearwater, Arctic grayling tagging on Caribou Creek and the Volkmar River, and coho salmon spawning escapement on the Delta Clearwater River.

A fyke trap was operated on Caribou Creek, a tributary of Shaw Creek, from May 14 to May 22 to catch upstream migrants. The catch of in-migrants primarily included lake chubs, juvenile Arctic grayling, and least cisco. Of the 151 Arctic grayling captured, 20 were classified as prespawning adults; the remainder as immatures. The trap was fished from May 22 until June 12 to capture downstream migrants. A total of 1,547 Arctic grayling were captured, 1,255 of which were greater than 200 mm long and were tagged. About 900 of these Arctic grayling were classified as mature adults.

Recaptures of Caribou Creek tagged Arctic grayling were predominantly in the Richardson Clearwater. Other locations of captured Caribou Creek Arctic grayling included Shaw and Clear creeks, the Delta and Fivemile Clearwater rivers, and the Salcha River.

Tag recoveries indicated the Delta Clearwater River as a prime summer feeding destination for the post-spawning migration of Volkmar River Arctic grayling.

Sampling in Clear Creek (south bank of the Tanana River between Shaw Creek and Big Delta) was conducted on July 7. Round whitefish and rearing coho salmon were absent from the creek. Arctic grayling were predominantly immature or subadult fish, whereas the reverse is true for the Delta and Richardson Clearwater systems. The few larger Arctic grayling observed in Clear Creek were in the lower reaches, which is the reverse of the larger systems. Fish distribution appeared to be influenced by temperature, in that no fish were captured or observed until the creek's midpoint although suitable habitat was available. The temperature gradient was 4.0°C in the upper mile to 5.5°C at roughly its mid-point, and to 7.0°C near its mouth.

On October 27 and 28, 3,946 adult coho salmon were counted in the Delta Clearwater River.

Delta Clearwater / Richardson Clearwater / Clear Creek / Caribou Creek / Shaw Creek / Arctic grayling / other fish

Appendix 4 (continued).

Roach, S.M. 1994. Stock assessment of Arctic grayling in the Salcha, Chatanika, and Goodpaster rivers during 1993. ADF&G. Fishery Data Series No. 94-13. Anchorage. 109 pp.

Abundances and length and age compositions of Arctic grayling were estimated for portions of the Salcha, Goodpaster, and Chatanika rivers using single-sample mark-recapture experiments. Boat-mounted electrofishing gear was used to capture the fish. Brief descriptions of the study streams and fisheries are presented. Historic data summaries also are presented.

Salcha River / Chatanika River / Goodpaster River / Arctic grayling

Appendix 4 (continued).

Roach, S.M., and M.J. Evenson. 1993. A geometric approach for estimating and predicting fecundity of Tanana River burbot. ADF&G. Fishery Data Series No. 93-38. Anchorage. 36 pp.

Fecundities of 295 burbot collected from 1988 through 1992 were estimated using mean egg diameters and volumes of the ovaries. Mean egg diameter was 0.533 mm. Estimated fecundities of the sampled burbot ranged from 23,937 to 3,477,699 eggs, with a mean of 969,986 eggs (mean total length = 703 mm, range 424 to 1,040 mm; mean age = 10 yr, range 5 to 18 yr). Predicted fecundities for fish from 450 to 1,075 mm ranged from 271,000 to 2,517,000 eggs. Predicted fecundities for fish from age 5 to 18 ranged from 374,000 to 1,880,000 eggs.

Tanana River / burbot

Appendix 4 (continued).

Schallock, E. 1965. Investigations of the Tanana River grayling fisheries, migratory studies. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-6, Job 16-B. 12 pp.

This annual report describes results of studies conducted in 1964 of movements, growth rates, and tag loss in Arctic grayling in the Delta Clearwater, Richardson Clearwater, and the Goodpaster River.

The Arctic grayling of the Delta Clearwater move upstream during the summer months (June to September) whereas the fish in the Goodpaster River exhibit both upstream and downstream tendencies with the majority of the fish showing no movement. It is suspected the intrastream movement pattern found in the Goodpaster River is the result of the upstream migration occurring earlier in the season and being masked by the high water of breakup. By the time conditions allow sampling, fish generally have established residency and little net change occurs thereafter.

Inter-stream system movement trends that appeared in 1964 were tendencies for Arctic grayling to move from the Goodpaster River and the Clearwater Lake area into the Delta Clearwater. The absence of ripe fish and young-of-the-year in the Delta Clearwater, the presence of these two groups in the Goodpaster River, and a documented emigration of Goodpaster River fish and immigration of fish into the Delta Clearwater, supports the conclusion that the Goodpaster River is supplying the Delta Clearwater with some of its fish.

Adult Arctic grayling probably spawn in the Goodpaster River and some move to the Delta and Richardson Clearwaters. The Goodpaster River then may serve as a rearing area for the offspring of the adults that take summer residency in the Delta and Richardson Clearwaters.

Tag recoveries of inter-system moving fish were made in the summer following tagging and suggest fish may congregate in the Tanana River in winter.

Information on growth rates is presented for Goodpaster River and Delta Clearwater Arctic grayling.

Delta Clearwater / Richardson Clearwater / Goodpaster River / Arctic grayling

Appendix 4 (continued).

Schallock, E. 1966. Investigations of the Tanana River and Tangle Lakes fisheries: migratory and population study. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-7, Job 16-B. 16 pp.

This paper describes field work conducted in summer 1965 on Arctic grayling in the Delta Clearwater, Fielding Lake, and the Tangle Lakes systems. Field work included migration, growth, fecundity, spawning, parasite, and overwintering, and tag loss studies.

Limited data from work conducted in the Delta Clearwater indicated similar results to that described in Schallock (1965). Delta Clearwater Arctic grayling tag recoveries indicated some upstream and downstream movement, and for short tag to tag-recovery intervals, no movement phenomena during the summer. Tag recoveries also indicated immigration from Clearwater Lake and the Goodpaster River.

Netting in the Delta Clearwater - Tanana Slough area in mid October produced 22 Arctic grayling, all of which were located downstream of chum salmon redds. Sixty nine percent of the retained Arctic grayling contained salmon eggs in their stomach contents. One short sampling effort in mid December in the campground area revealed one large school of about 200 fish (several were tentatively identified as Arctic grayling; the remainder were considered whitefish). Several other small schools of unidentified fish also were seen.

Delta Clearwater / Tangle Lakes / Fielding Lake / Arctic grayling

Appendix 4 (continued).

Sorokin, V.N. 1971. The spawning and spawning grounds of the burbot [*Lota lota* (L.)]. J. Ichthyol. 11(6) 907-915.

Two burbot spawning areas were found in the Burgul'deyka, a western tributary of Baikal. The Burgul'deyka is 30 m wide at its mouth and 78 km long. Both spawning areas were located where a tributary entered the river. One was 3 km above the mouth and second was 7 km. Both spawning areas were characterized by near zero water velocity. The spawning area located 7 km above the mouth was investigated more thoroughly because open water was present. Burbot laid their eggs in among large cobble and boulder covered with a thin layer of ooze and with large amounts of leaves and rubbish in the inlet area of the tributary. Water was transparent, 0°C, and had a weak current (0.3 cm/s). Most of the eggs were at the head of the inlet pool in water that did not exceed 10 cm deep and 30 cm in width. Egg density was greatest nearer the point of entry of the stream into the inlet where it reached 800,000/m^2. Large numbers of benthic invertebrates were present. Sorokin concluded that based on other investigations and his work in the Burgul'deyka that burbot select quiet places of the rivers for spawning - stream mouths and channels forming deep places with an undercurrent of fresh water ensuring a supply of oxygen. Eggs are carried downstream in the spring prior to hatching.

Survival estimates from egg to larvae were estimated for the Kichera River. In 1968, mean survival to larvae was estimated at 0.125%. In 1969, mean survival to larvae was estimated at 0.175%.

Burgul'deyka / burbot

Appendix 4 (continued).

Tack, S.L. 1980. Migrations and distributions of Arctic grayling, *Thymallus arcticus* (Pallus), in Interior and Arctic Alaska. Annual performance report. ADF&G Fed. Aid in Fish. Rest. Vol. 21. Proj. R-I, Job R-I. 32 pp.

This report describes in detail seasonal migrations and distributions of Arctic grayling for five basic river types in Interior and Arctic Alaska. River types included: unsilted rapid runoff streams (Chena, Salcha); silted rapid runoff streams (Tanana, Yukon); spring-fed streams (Delta Clearwater); bog-fed streams (Shaw Creek, Little Salcha River); and glacier-fed streams (heavy silt load in summer only; generally have little or no fish life). Information presented includes overwintering distribution, prespawning migration, spawning distribution, postspawning migration, summer distribution, fall migration, and miscellaneous short-term movements.

Tanana River drainage / Arctic grayling

Appendix 4 (continued).

Van Hyning, J.M. 1976. Salmon surveys of the upper Tanana River, 1976. Prepared for the Gulf Interstate Engineering Co. by NERKA Inc. Fairbanks. 30 pp.

The purpose of this study was to review available information regarding salmon stocks in the upper Tanana River and to conduct a field survey to determine the extent of salmon spawning in the area during fall 1976. This study was part of the field environmental studies conducted for the proposed Northwest Alaska Gas pipeline.

The paper provides a brief summary of life history information for chinook, coho, and chum salmon for the Interior river drainages. Fall chum spawning ecology in the Delta River and the Tanana River near the Delta River is briefly described.

Aerial surveys were conducted over potential salmon spawning areas of the upper Tanana River upstream of Delta Junction from early October to early November 1976. Additional limited ground surveys were made where the Alaska Highway and the Haines Pipeline crossed tributary streams.

No salmon were observed in the Tanana River or its tributaries above the major known spawning areas near Bluff Cabin Slough. Escapements of fall chum salmon in the Delta River were reported to be average for 1976.

The paper describes surveys from 1975 and anecdotal reports of salmon spawning or catches in the Chisana River and the Tanana River near Tetlin and near George Lake.

Upper Tanana River drainage / chum

Appendix 4 (continued).

Van Wyhe, G. 1964. Investigations of the Tanana River grayling fisheries: migration study. Annual report of progress. ADF&G Fed. Aid in Fish Rest. Proj. No. F-5-R-5, Job 14-B. 15 pp.

This paper reports the results of field studies conducted in summer 1963 on the movements, growth, and food habits of Arctic grayling in the Delta Clearwater, Richardson Clearwater, Shaw Creek, and the Goodpaster River.

Tag recoveries indicated a strong tendency for Arctic grayling to return to the same stream year after year (93%). Inter-stream movements were recorded for 7% of the tag recoveries. Arctic grayling tagged in the Goodpaster River were recaptured in the Delta Clearwater and the Richardson Clearwater. One Arctic grayling tagged in the Delta Clearwater was recaptured in the Goodpaster River. One Arctic grayling tagged in Shaw Creek was recaptured in the Delta Clearwater. The inter-stream movements that were recorded between the tagging date and the recovery date usually did not occur in the same year (i.e., most fish remained in the same stream during the ice-free period).

Qualitative bottom sampling was used to determine the presence and relative numbers of aquatic organisms present in the streams. Food habits of Arctic grayling were determined from stomach samples.

Delta Clearwater / Richardson Clearwater / Shaw Creek / Goodpaster River / Arctic grayling