Technical Report No. 99-1

Fish Habitat Investigations in the Tanana River Watershed, 1997

by Carl R. Hemming and William A. Morris

June 1999

Alaska Department of Fish and Game **Habitat and Restoration Division**

Fish Habitat Investigations in the Tanana River Watershed, 1997

by

Carl R. Hemming and William A. Morris

Technical Report No. 99-1

Kenton P. Taylor
Director
Habitat and Restoration Division
Alaska Department of Fish and Game
P.O. Box 25526
Juneau Alaska 99802-5526

June 1999

Table Of Contents

List Of Tables

List Of Figures

Acknowledgments

There are several people that had significant roles in this project. Mr. Roger Post with the Alaska Department of Fish and Game (ADF&G), Habitat and Restoration Division, wrote the application for grant funding under section 319 of the nonpoint source pollution program. The grant was obtained with the help and assistance of Ms. Amy Ash of the Alaska Department of Environmental Conservation. Mr. Les Fortune of the Alaska Department of Natural Resources (ADNR), Division of Forestry also assisted with additional funding through a Reimbursable Services Agreement with ADF&G. Dr. Alvin G. Ott and Mr. Alan H. Townsend (ADF&G) did the preliminary investigation in the Fairbanks area and provided useful input on field techniques and sampling. Mr. Jack Winters (ADF&G) assembled an annotated bibliography that summarizes existing information on fish use of the Tanana River. Special thanks go to our enthusiastic and capable field assistant Ms. Stacey Simpers who also organized the data on spreadsheets. Mr. Jim Vohden of ADNR, Division of Mining and Water Management did the lab analysis on the water samples. Fred Andersen and Doug Fleming of ADF&G, Sport Fish Division loaned us a boat for field work in the Fairbanks area. Fronty Parker, Bill Ridder, and Doug Edwards (ADF&G, Sport Fish Division) loaned us a boat, helped with equipment repairs, provided bunk space, and gave us useful information on the river and fish populations in the Delta area. Nancy Ihlenfeldt (ADF&G) prepared some of the figures for this report. Christina M. Hemming assisted by lending us her boat.

Executive Summary

This report contains the results from 1997, the second year of a two-year field investigation undertaken in 1996 of juvenile fish and juvenile fish habitat in the Tanana River system. The goal of this study was to identify habitats used by juvenile fish and to describe the physical and water quality characteristics of these areas. We expanded the study in 1997 to include a sample area near Delta Junction, and continued sampling the Tanana River near Fairbanks (Ott et al. 1998). We captured fish in minnow traps and beach seines, and collected water samples at selected locations within each sample area. Water samples were analyzed for turbidity and total suspended solids.

Minnow traps were set at various locations within each sample area and left to fish overnight for about 24 hour intervals; sampling occurred monthly from May through August 1997. Minnow traps were set at up to 20 sites in the Fairbanks area, during the four sample periods, yielding 79 trap days of effort. Minnow traps were set at up to 15 locations during the four sample periods, for 58 trap days of effort in the Delta area. We captured 51 fish that included 7 species in the Fairbanks sample reach, and 179 fish that included 5 species in the Delta area. We organized the minnow trap fish capture data into five water classes based on visual characteristics of the water. We tested the five water classes using turbidity and total suspended solids measurements and found a significant difference in water quality measurements between each of the five classes. We evaluated minnow trap fish capture results by water class and found the greatest number of species and the largest catches in groundwater and tannic-stained runoff habitats.

Beach seining was conducted at various sites in both sample areas. All seine sites occurred in turbid-water areas with similar velocities, depths, and water quality characteristics. Seining in the Fairbanks area yielded 1,642 fish including 12 species. Delta-area sampling captured 930 fish of 9 species. Beach seine results identified temporal and spatial patterns of fish use in each sample area. Fish species found in each area were similar, but catch numbers varied between the two areas. Juvenile salmon were captured during the May and June sample periods in both the Fairbanks and Delta areas; however, chum salmon (*Oncorhynchus keta*) fry were more frequently captured in the Delta sample area. Groundwater upwelling areas produced the largest catches of chum salmon fry in the Delta area. In the Fairbanks sample area we found a similar pattern to that found in 1996, with lake chubs (*Couesius plumbeus*) and longnose suckers (*Catostomus catostomus*) captured most frequently. Slimy sculpin (*Cottus cognatus*) and chinook salmon *(Oncorhynchus tshawytscha*) were most often captured in association with gravel substrate areas.

Introduction

The Tanana River system supports a variety of fish species including freshwater resident and anadromous life history types. Logging and proposals for increased use of wood products from Interior Alaska forests have focused attention on the impacts of timber harvest on aquatic habitat and fish. Regulations for timber harvest activities (11 AAC 95) were promulgated by the Alaska Department of Natural Resources in 1993 under the authority of the 1990 Alaska Forest Resources and Practices Act (AS 41.17). Standards for the protection of riparian habitats were developed based primarily on fish, water quality, and hydraulic research conducted in Southeast Alaska. Riparian habitat protection standards also were developed for Interior Alaska without the benefit of area specific research. Research conducted by the Alaska Department of Fish and Game (ADF&G) has been directed toward the acquisition of data used in the management of sport, commercial, subsistence, and personal use fisheries. Fisheries research for management of sport, commercial and subsistence fisheries has focused on nonglacial river and stream habitats and use of glacial stream systems by adult Pacific salmon (*Oncorhynchus* spp.) and burbot (*Lota lota*). Little information is available on juvenile fish use of large, glacial, stream systems in Interior Alaska such as the Tanana River. The location of major salmon spawning areas has been identified and annual returns to these areas are estimated using various techniques. In the Tanana River system, Arctic grayling (*Thymallus arcticus*), northern pike (*Esox lucius*), burbot, sheefish (*Stenodus leucichthys*), least cisco (*Coregonus sardinella*), humpback whitefish (*Coregonus pidschian*) and Pacific salmon (*Oncorhynchus* spp.) are harvested in sport fisheries and have been the focus of considerable research, primarily within nonglacial streams, rivers, and lakes where most sport fisheries occur.

Previous investigations on fish and fish habitat in the Tanana River drainage are reviewed and summarized in an annotated bibliography by Ott et al. (1998). Results of their 1996 juvenile fish sampling in the Tanana River near Fairbanks are presented in a preliminary report (Ott et al. 1998). The sampling program was expanded in 1997 to include two study areas, one near Fairbanks, and one near Delta Junction, Alaska. Study objectives were to investigate selected aquatic habitats in the Tanana River floodplain during the open water season, to capture and identify juvenile fish species using specific habitats, and to identify physical characteristics and water quality of specific habitats used by juvenile fish. This report presents the results from our 1997 field investigations.

Methods

In 1997, we sampled two reaches of the Tanana River - an area near Fairbanks and an area near Delta Junction, Alaska. The Fairbanks sampling area included Salchaket Slough from the mouth upstream to Bear Creek (40 km), and the mainstem Tanana River from the Chena Pump Landing downstream to Willow Creek. The Delta sampling area, extended from Clearwater Lake Outlet to the Richardson Clearwater River (46 km). The two areas were sampled four times for 5-day sampling periods during open water season in May, June, July, and August. A jet-powered riverboat was used to access the sample sites. We captured fish with minnow traps and beach seines. We selected minnow trap locations that sampled various habitat types. We also selected seine sites in various habitat types, but physical conditions such as water depth, velocity, and obstructions limited the number of potential suitable sites. Habitats selected included groundwater stream systems, mainstem Tanana River groundwater upwelling areas, tannic-stained runoff streams, clear unsilted runoff streams, and silt-rich glacial waters. Substrate types included silt, gravel, and mixed silt/gravel areas. We used a Garmin® GPS 40 Personal Navigator to document each sample site.

Fish Capture

Wire mesh minnow traps, baited with salmon roe in perforated plastic bags designed to slowly release scent into the water, were used to capture juvenile fish. Each trap fished for about 24 hours. At each seine site three seine hauls were made with a 9.1 x 1.2 m net with 7 mm mesh. Seines were hauled upstream for a minimum distance of 10 m and then pulled to shore. Seining generally was limited to areas less than 1.25 m in depth and limited to areas relatively free of large woody debris. Fish captured in minnow traps and seines were identified, measured (fork length in mm), and released near the sample site. When large catches of a single species and size class were encountered, a sub-sample was measured to verify the species and size class, and the remainder were counted and released. Fish species identifications were made by examination of external characteristics using taxonomic keys for freshwater fish and pre-smolt salmon (Sturm 1988, Trautman 1973).

Physical Measurements

Water velocity was determined at each seine site using the “orange float method” by measuring the length of time that it took an orange to travel 100 ft. The 100-ft velocity measurement was repeated three times at each seine site and averaged to determine the velocity in feet per second within the area seined. Maximum depth was also recorded at each seine site. The substrate type (e.g., silt, sand, gravel) was described, water temperature measured, and a photograph taken of the site.

Water Quality Measurements

Water samples were collected in each sample area during each of the four sample periods and analyzed for turbidity (in NTU) and total suspended solids (TSS in mg/L). Water sample sites were selected to characterize different water types occurring in each sample area during each sampling period. Grab samples were collected in 1000 ml plastic bottles and refrigerated. Samples were then delivered to the Alaska Department of Natural Resources Water Quality Lab for analysis. The lab used EPA method 108.1 for turbidity and EPA method 160.2 for TSS.

The color of water can be used to evaluate water type and source subjectively. Nonglacial water that has a transparent color and is not stained is generally from a groundwater source (Figure 1). Gray/tan colored water is of glacial origin (Figure 2), while green water is a mixture of groundwater or nonglacial runoff and glacial water (Figure 3). Dark coffee colored or tannic-stained waters are generally fed by runoff from forested and wetland areas (Figure 4).

Data Analysis

The 33 water sample sites were placed in one of five water classes based on visual characteristics. The water classes were groundwater, glacial, tannic-stained runoff, mixed groundwater/glacial, and mixed tannic-stained/glacial. Visual characteristics for groundwater areas were transparent color, and excellent light penetration and visibility through the water column. Glacial waters were gray to brown in color and opaque, with poor light penetration and visibility. Tannic runoff waters were stained dark or coffee color and had intermediate light penetration. Mixed runoff/glacial areas were similar to tannic runoff areas but had higher turbidity and a brown/gray color. Mixed groundwater/glacial areas were most readily identified by their green coloration. ANOVA single factor analyses were conducted between water classes based on turbidity and total suspended solids results to identify true differences between the subjective classes. The results from the minnow traps were then grouped by water class, and Chi Square contingency tests and regression analysis were run to determine if fish were randomly distributed between water types.

Seine haul data were grouped according to substrate type and sampling period because all seine sites occurred in turbid water. The three types tested were silt, gravel, and mixed silt/gravel. Chi Square contingency tests and regression analyses were used to analyze potential differences in juvenile fish distribution with substrate, and seasonal changes of juvenile fish distribution. Differences in velocity and depth between sites were small because the seining technique was limited to a narrow range of depths and velocities; depth and velocity did not vary enough to allow statistical analysis.

Study Area and Sample Site Descriptions

Fairbanks Area

Salchaket Slough

Salchaket Slough is a 40-km slough system located south of Fairbanks within the Tanana Flats (Figure 5). Major systems draining into Salchaket Slough include groundwater systems, Bear and McDonald Creeks, and runoff groundwater systems such as Clear Creek. In the early part of the open water season, the majority of slough input is from runoff and groundwater, giving Salchaket Slough a non-glacial runoff appearance.

Figure 1. Cub Creek in late May illustrates the appearance of clear, groundwater upwelling systems.

Figure 2. Channels of the Tanana River exhibit a gray/brown color. This site was photographed in the Delta sampling area during May sampling.

Figure 3. This green tinted silt water is indicative of a mixed silt/groundwater area. This photo was taken near Bluff Cabin in the Delta sampling area.

Figure 4. Tannic-stained runoff systems are dark stained with relatively low turbidity. This photo was taken at the mouth of Willow Creek in the Fairbanks sampling area in May.

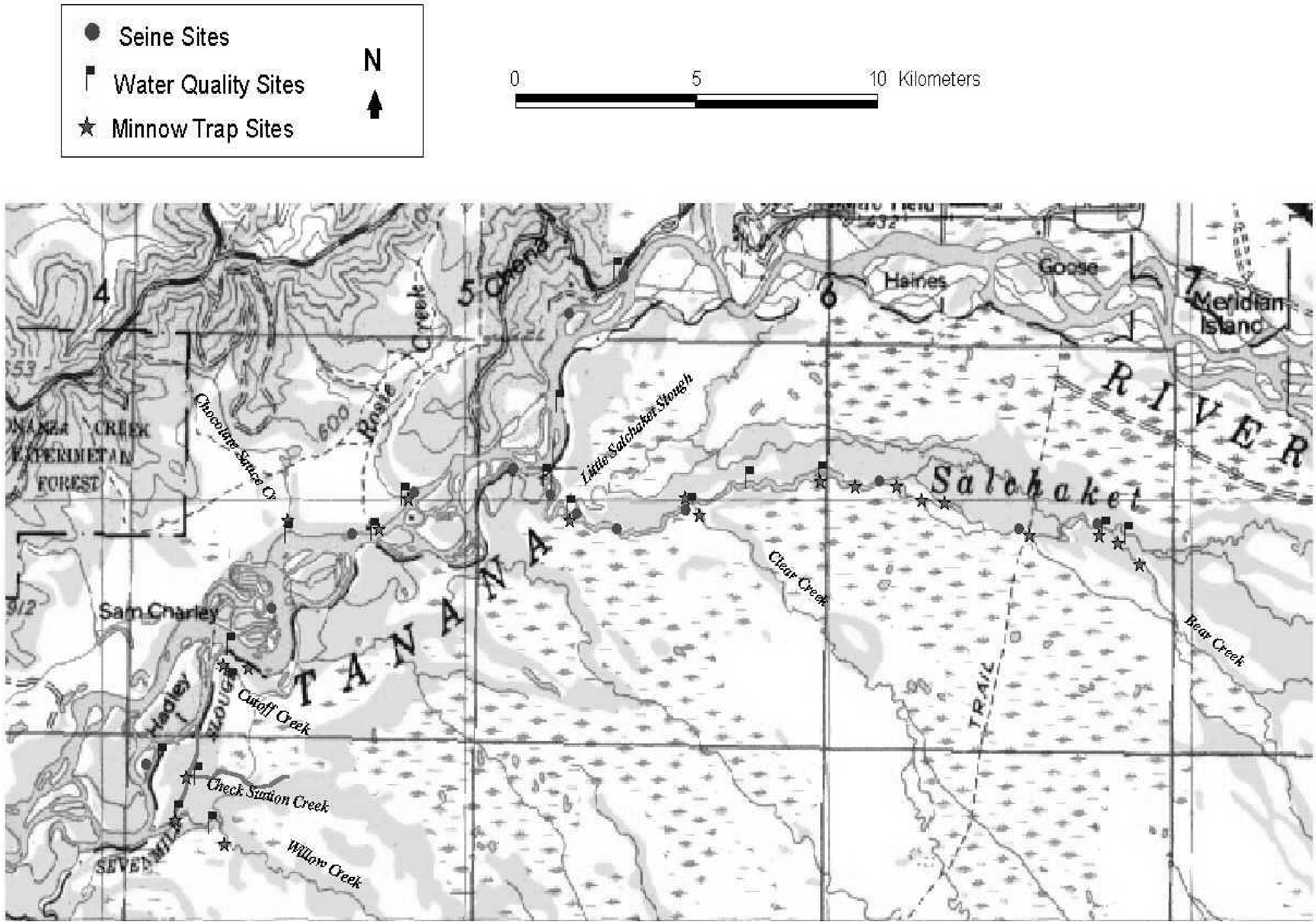

Figure 5. Fairbanks sampling area of the Tanana River and the location of seine, minnow trap, and water quality sample sites, 1997.

As discharge from glacial melt in the Tanana River increases throughout the summer, Salchaket Slough receives greater input from turbid channels of the Tanana River at the upstream end. The result is a glacial system, similar in appearance and turbidity to the Tanana River. Appendix I gives specific site data for all sampling sites within this sampling area.

Tanana River - Chena Pump to Willow Creek

The mainstem Tanana River in this area is characterized on the north bank by large rock bluffs with intermediary tannic runoff/bog drainages. The south bank of the river is bounded by the Tanana Flats, directly south of Fairbanks, and consists of wetlands and tannic-stained runoff systems draining into the Tanana River. Wetland complexes are found on both banks of the river with the most extensive wetlands found on the south bank in the Tanana Flats. The floodplain consists of numerous well-defined side sloughs, and extensive gravel and silt bars. Woody debris, small logjams, root wads and actively eroding cut-banks are common habitat types found along this stretch of river. Early in the open-water season, tannic runoff/wetland complex drainages can be seen as black/dark brown water input to the Tanana River. As glacial melt and Tanana River discharge increases, turbid water infiltrates the lower reaches of these systems causing a mixed appearance, with intermediate turbidity. Appendix II gives specific site data for all sampling sites in this sampling area.

Delta Area

The Delta sampling area extends from Clearwater Lake Outlet to the Richardson Clearwater River (Figure 6). On the south side of the Tanana River, large aquifers supply groundwater to clearwater stream systems and floodplain upwelling areas. This system of aquifers flows northward from the Alaska Range through alluvial deposits and is the source of large volumes of cool water with low levels of total suspended solids and low turbidity. Groundwater input zones are important for chum (*Oncorhynchus keta*) and coho salmon (*Oncorhynchus kisutch*) spawning and egg incubation, as well as important habitat for rearing Arctic grayling. Several salmon spawning areas exist within this reach, including the Delta Clearwater River, Clearwater Lake, Bluff Cabin Slough system, Blue Creek, the mouth of the Delta River, Clear Creek, the Richardson Clearwater River, and floodplain slough channels. Tannic-stained runoff systems such as Tenderfoot and Indian Creeks, and mixed runoff and groundwater systems such as the Goodpaster River and Shaw Creek occur on the north side of the Tanana River. Some of these systems offer spawning habitat for chinook salmon (*Oncorhynchus tshawytscha*). Water velocity is greater in the Delta sample area than in the Fairbanks area. There are numerous braided channels and evidence of recent channel shifts including accumulated log debris, extending for more than a kilometer in several areas. Appendix III gives specific site data for each sampling site within the sampling area.

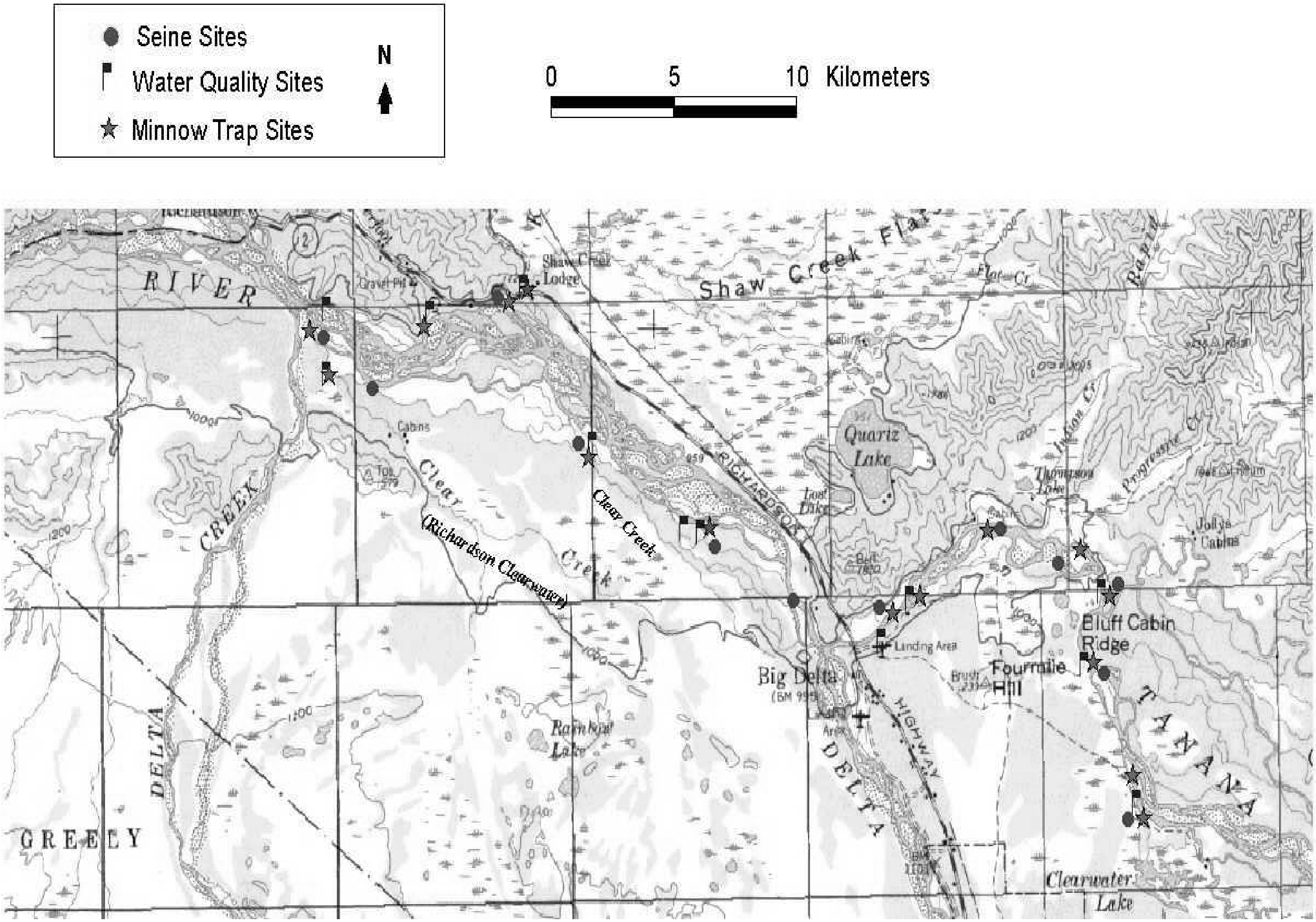

Figure 6. Delta sampling area of the Tanana River and the location of seine, minnow trap, and water sample sites, 1997.

Results

Water Type Analysis

Five water types were observed and sampled throughout the course of this project. Predominant water types found in both the Fairbanks and Delta study areas were glacial, groundwater, and tannic-stained runoff waters. Many areas also presented a combination of these water types yielding two additional classes of water; mixed glacial/tannic, and mixed glacial/groundwater. Sampling areas were observationally placed in one of these five types each time the site was sampled; water class at any given site often changed throughout the sampling season. One-way analysis of variance (ANOVA) was used to look at variation between and within water classes to determine if the water types were different based on turbidity and TSS data collected (Appendix VIII). Water classes were determined to be significantly different based on both turbidity ($F=20.63$, $p<0.001$) and TSS data ($F=19.36$, $p<0.001$) (Appendix IX). Water classes with high average turbidity consistently had high average TSS (Figure 7, Appendix VIII).

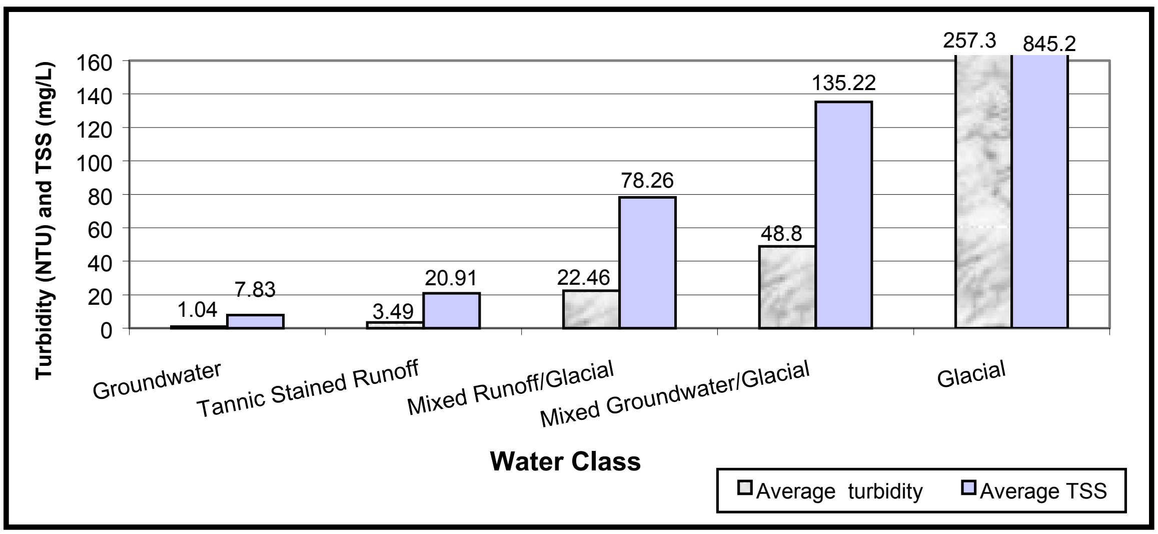

Figure 7. The relationship between total suspended solids and turbidity within water classes ordered by increasing turbidity.

Fairbanks Area

Minnow Traps

In the Fairbanks area, minnow traps were set at up to 20 different locations during the months of May, June, July, and August (Appendix IV). Seventy-nine trap days of effort were expended during the 1997 open water season. We captured 51 fish from seven species: coho salmon, chinook salmon, Arctic grayling, lake chub (*Couesius plumbeus)*, longnose sucker (*Catostomus catostomus*), round whitefish (*Prosopium cylindraceum*), and slimy sculpin (*Cottus cognatus*) (Table 1). Numbers of fish captured in minnow traps within the Fairbanks area were greatest in May and decreased with each subsequent sample period. In August during a high water flood event only one fish was captured. The most abundant fish caught was Chinook salmon, followed by, in decreasing order, lake chub, coho salmon, longnose sucker, slimy sculpin, round whitefish, and Arctic grayling. Chinook salmon were only captured during the May sampling period.

Table 1. Fish captured in minnow traps within the Fairbanks sampling area, 1997.

	Arctic grayling	*Coho salmon*	*Chinook salmon*	*Lake chub*	*Longnose sucker*	*Round whitefish*	*Slimy sculpin*	**Total**
May	0	3	18	3	2	0	0	**26**
June	0	2	0	11	2	0	2	**17**
July	1	2	0	1	1	0	2	**7**
Aug.	0	0	0	0	0	1	0	**1**
Total	**1**	**7**	**18**	**15**	**5**	**1**	**4**	**51**

In the Fairbanks area, the most fish were captured in tannic-stained waters. Traps set in groundwater/glacial areas caught the second largest number of fish. Groundwater area traps caught the third largest number of fish and had the greatest divergence of species (Figure 8 and Table 2).

Table 2. Fairbanks area minnow trap catch results with water type, 1997.

Water Type	*Number of Fish*	*Number of Species*
Groundwater	10	5
Glacial	2	2
Tannic-stained runoff	20	4
Mixed glacial/runoff	6	2
Mixed groundwater/glacial	13	3

Minnow trap data were converted to catch per unit effort (CPUE) to allow comparison between months and between water classes. Once trap data were standardized, trends in juvenile fish distribution based on temporal and turbidity effects were apparent. Plotting juvenile fish catches against water class, ordered by increasing average turbidity, indicates that juvenile fish use generally decreases as turbidity within a site increases (Figure 8). Glacial water had the lowest CPUEs. Analysis of CPUE data separated by month also yielded significant trends.

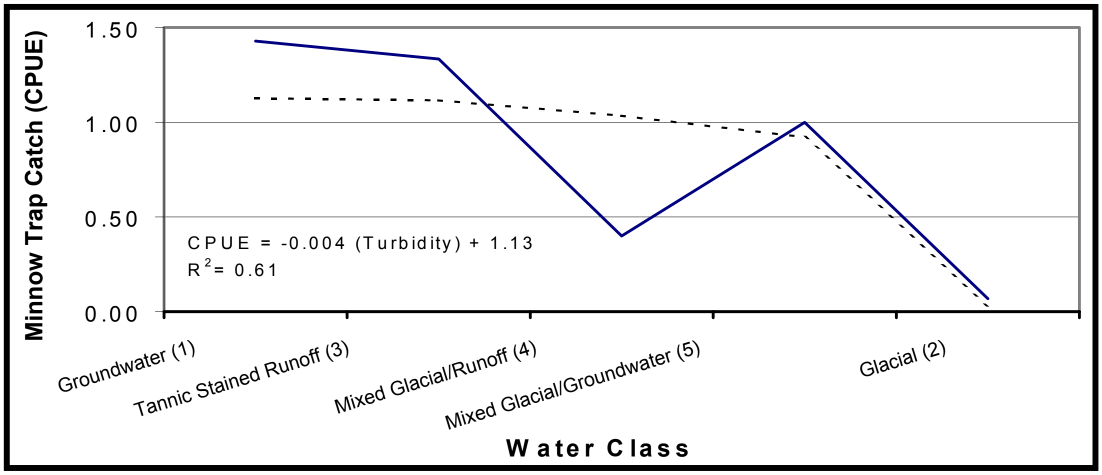

Figure 8. Relationship between increasing average turbidity and water classes, and juvenile fish use as determined by minnow trap CPUE in the Fairbanks sampling area.

Overall CPUE decreased considerably from May to August (Figure 9). Catch rates were highest in the Fairbanks area during May, when juvenile chinook salmon represented nearly 70% of the overall catch. Chinook salmon were only represented in May catches. CPUE decreased steadily throughout the season and was dominated by longnose suckers and lake chubs from June to August. Extreme low CPUE values for August are likely a result of a late summer flood event that occurred in 1997; most sampling areas had been infiltrated by high turbidity water.

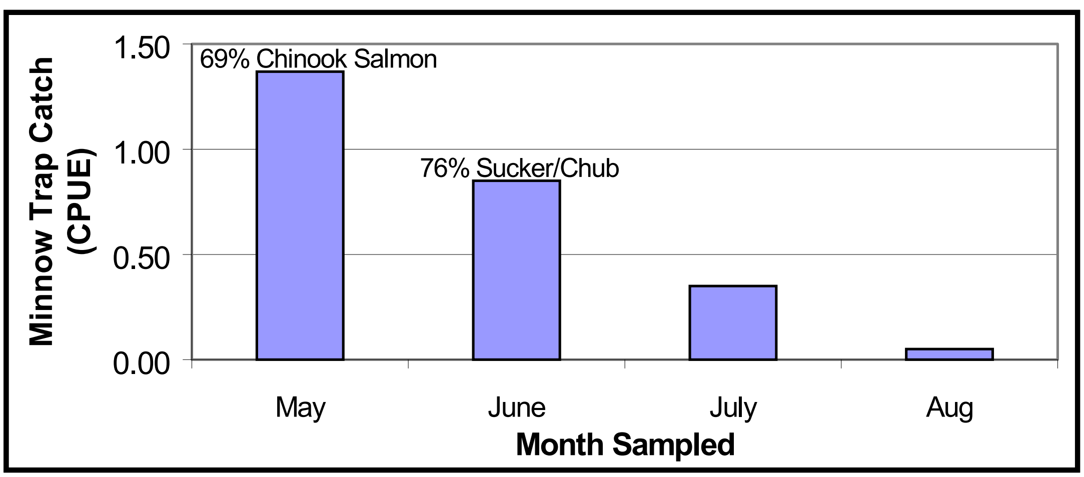

Figure 9. Minnow trap CPUE by month for the Fairbanks sampling area.

Species richness within the Fairbanks sampling area also differed between water classes (Figure 10). Groundwater habitats supported the greatest species richness in the Fairbanks sampling area followed by tannic-stained runoff habitats. In the Delta sampling area, tannic-stained runoff areas supported the greatest species richness followed by groundwater habitats. Areas with higher turbidity supported fewer juvenile fish species, as well as yielding lower CPUE. The Fairbanks sampling area exhibited greater species richness per habitat type than the Delta sampling area.

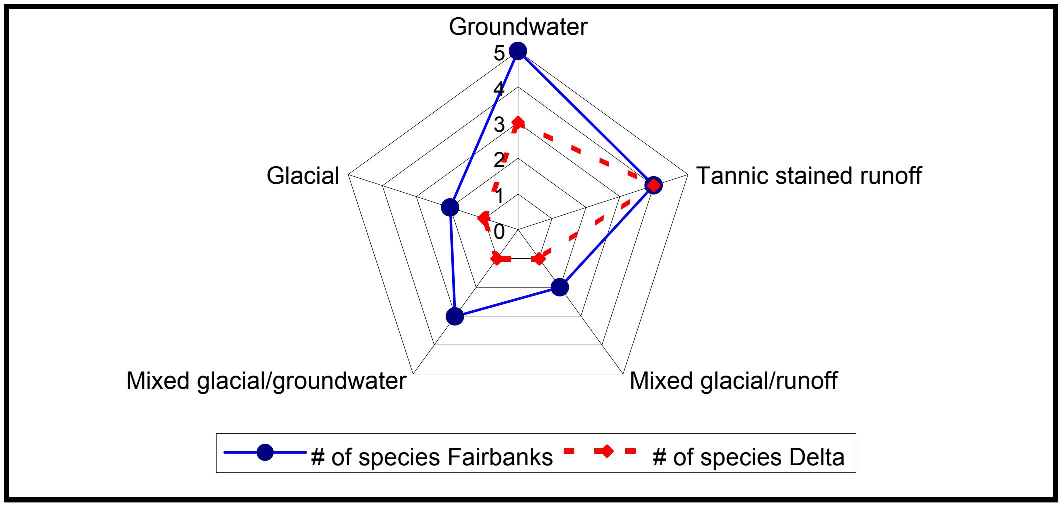

Figure 10. Species richness between water classes for the Fairbanks and Delta sampling areas. Numbered rings indicate the number of species encountered in minnow traps in each water class.

Seine Sites

In 1997, we made three seine hauls at each of 14 sites, during four sample periods, for a total of 168 seine hauls (Appendix VI). We captured 1,642 fish that included a combination of Arctic grayling, Arctic lamprey (*Lampetra japonica*), lake chub, longnose sucker, slimy sculpin, coho salmon, chinook salmon, chum salmon, burbot, northern pike, round whitefish, and humpback whitefish. The most frequently captured species were lake chubs and longnose suckers (Table 3). We captured the largest number of fish in June, followed by, in decreasing order, May, July and August. The June catch included 426 fish, primarily lake chubs and longnose suckers, from a site located in a shallow backwater area on a silt bar island. With the exception of one coho salmon captured in August, salmon were present only in May and June. We caught a large number of salmon in May at a gravel bar site on Sevenmile Slough.

Table 3. Fish species and numbers captured at seine sites within the Fairbanks sampling area, 1997.

Species	*May*	*June*	*July*	*August*	***Total***
Arctic grayling	0	20	41	4	**65**
Arctic lamprey	0	0	0	1	**1**
Burbot	0	0	0	1	**1**
Chum salmon	188	13	0	0	**201**
Coho salmon	57	6	0	1	**64**
Humpback whitefish	0	2	0	2	**4**
Chinook salmon	53	0	0	0	**53**
Lake chub	39	288	127	73	**527**
Longnose sucker	123	268	90	25	**506**
Northern pike	0	0	1	0	**1**
Round whitefish	2	45	17	6	**70**
Slimy sculpin	25	84	28	12	**149**
Total	**487**	**726**	**304**	**125**	**1642**

Standardization of seine catches to a CPUE allowed for additional analysis. CPUEs in the Fairbanks area where highest in June (Figure 11). CPUE within turbid water (all seine sites in the Fairbanks sampling area) tended to decrease over the summer season with the exception of high catch rates in June. High catch rates in June are the result of large numbers of suckers and chubs captured in a backwater area of a mainstem island. Figure 12 shows the average catch composition per seine haul by month. In May, salmon composed a large portion of the overall catch and were the prevalent species in edge habitats in the Tanana River Fairbanks sampling area. Sixty three percent of the salmon catch in May was chum salmon. In June, Longnose sucker and lake chub numbers far outweighed the contributions other species may have had on catch rates in a few sites (Figures 11 and 12). These two species continued their dominance of the catch in July and August.

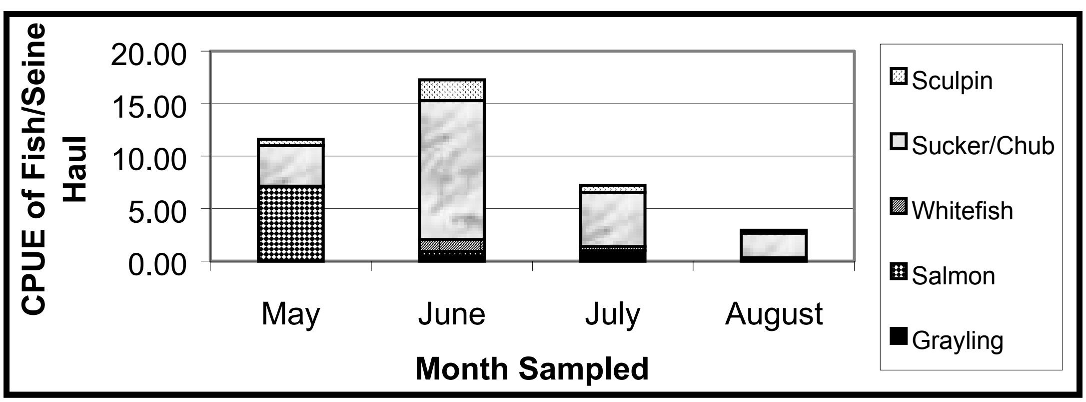

Figure 11. Average CPUE of fish by species captured per seine haul in the Fairbanks sampling area during each sampling period.

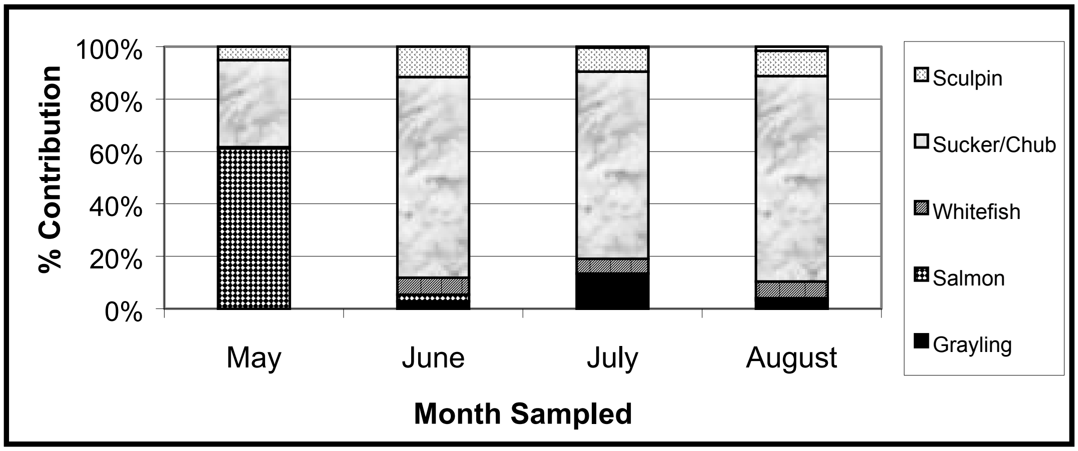

Figure 12. Relative contribution by species to overall seine catches by monthly sample period for the Fairbanks sampling area.

In the Fairbanks area, 58% of the seine hauls were over silt substrate, 35% over gravel, and 7% were over mixed sand/gravel. When corrected for fishing effort, the number of fish captured did not differ among the three substrate types tested. Lake chub and longnose suckers were captured most frequently in silt substrate areas, slimy sculpin over gravel substrates, and chinook salmon were captured solely in gravel areas, even though gravel habitats accounted for only 35% of the seine haul effort (Table 4).

Table 4. Seine results for three substrate types within the Fairbanks area, standardized as number of fish per seine haul, 1997.

Substrate	*AG*[1]	*CH*	*CO*	*KS*	*LC*	*LNS*	*RWF*	*HWF*	*SSc*	*Total*
Silt	0.32	1.05	0.39	0.00	4.88	3.95	0.38	0.04	0.38	**11.40**
Gravel	0.54	1.77	0.47	0.93	1.04	1.70	0.42	0.00	1.54	**8.42**
Silt/Gravel	0.33	0.08	0.00	0.00	0.75	3.17	0.83	0.00	2.08	**7.25**

[1] AG = Arctic grayling; CH = chum salmon; CO = coho salmon; KS = king salmon; LC = least cisco; LNS = longnose sucker; RWF = round whitefish; HWF = humpback whitefish; SSc = slimy sculpin

CPUE data across substrates yields a non-significant pattern, with the majority of fish captured over silt substrates, followed by gravel, and then silt/gravel substrates. In general, all species were captured more frequently over gravel except large numbers of longnose sucker and lake chub. The large numbers of longnose sucker and lake chub found over silt skewed the overall relationship towards higher catches over silt. Many areas seined were part of a mosaic of silt, gravel, and silt/gravel substrate in the general area that, depending on water levels, would be available for use by particular species of fish.

Delta Area

Minnow Traps

In the Delta sample area, minnow traps were set at up to 15 different locations, once during May/early June, June, July, and August (Appendix V). Fifty-eight trap days of effort were expended during the 1997 open water season. We captured 179 fish that included coho salmon, chinook salmon, lake chub, longnose sucker, and slimy sculpin (Table 5). Minnow trap catch rates in the Delta area were opposite of those found in the Fairbanks area. Catches increased slightly in each subsequent sample period, with the largest catches occurring in August. The most abundant caught fish in the Delta area was lake chub, followed by, in decreasing order, longnose sucker, coho salmon, slimy sculpin, and chinook salmon. Coho salmon was the only species captured in each of the four sample periods. In August, we captured a large number of lake chubs and longnose suckers in Tenderfoot Creek, a small tannic-stained runoff system entering the north bank of the Tanana River.

Table 5. Fish captured in minnow traps within the Delta sample area, 1997.

	Coho salmon	*Chinook salmon*	*Lake chub*	*Longnose sucker*	*Slimy sculpin*	**Total**
May	8	1	0	0	2	**11**
June	1	0	5	1	5	**12**
July	5	0	7	6	0	**18**
August	5	0	85	48	0	**138**
Total	**19**	**1**	**97**	**55**	**7**	**179**

Standardizing minnow trap data to catch per 24 hour set yielded several patterns of juvenile fish distribution in the Delta area. As average turbidity increases the trend is for juvenile fish catches to decrease (Figure 13). The small negative slope value obtained by this analysis is a result of the large jump in turbidity between mixed glacial waters and the Tanana River itself. All areas with significant glacial mixing had extremely low CPUE values. It is apparent that turbidity values as low as 22.5 NTU, as measured in mixed glacial/runoff areas, have an impact on juvenile fish distribution. Similar to Fairbanks minnow trap data, longnose sucker and lake chub numbers affect the relationship by dramatically increasing CPUE's in tannic-stained runoff areas.

Analysis of minnow trap data by month indicates juvenile fish catches are generally steady throughout the season with high numbers of longnose sucker and lake chub encountered in August (Figure 14). May catch data indicates that coho salmon are most frequently found early in the season but persist into August as well (Figure 14). Chum salmon are most frequently captured in May, along with some juvenile chinook salmon. The chinook salmon encountered in May were likely out-migrants. The majority of coho salmon encountered in May were most likely distributing to rearing areas. Species richness by water type was lower in the Delta area than in the Fairbanks area (Table 6).

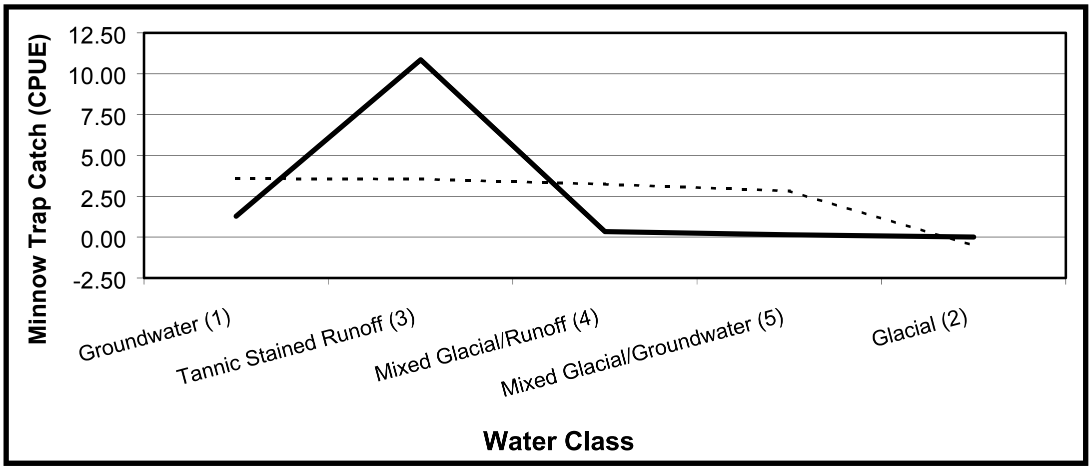

Figure 13. Relationship between increasing average turbidity and water classes, and juvenile fish use as determined by minnow trap CPUE in the Delta sampling area.

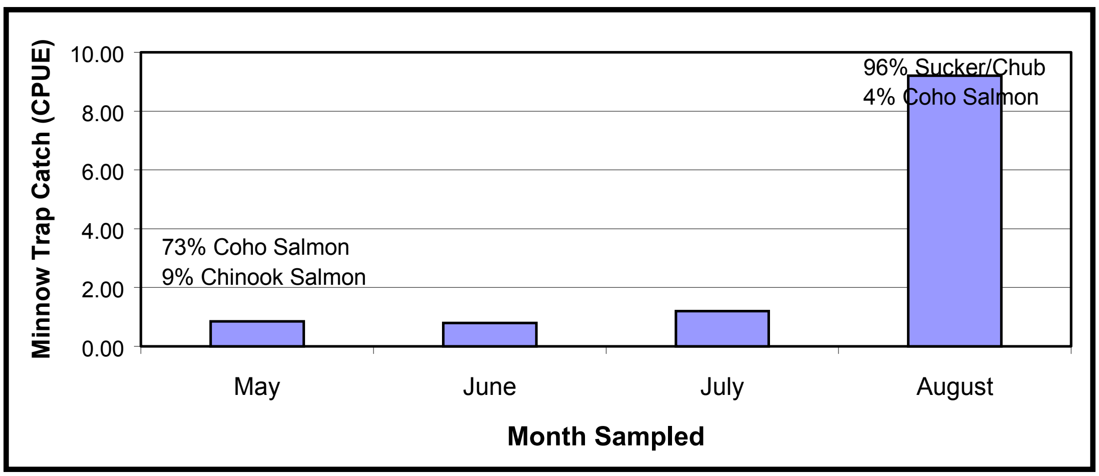

Figure 14. Minnow trap CPUE by month for the Delta sampling area.

Table 6. Delta area minnow trap catch results with water type, 1997.

Water Type	*Number of Fish*	*Number of Species*
Groundwater	23	3
Glacial	2	1
Tannic-stained runoff	152	4
Mixed glacial/runoff	1	1
Mixed groundwater/glacial	1	1

Tannic-stained runoff areas produced the highest number of species and number of fish in minnow traps, followed by groundwater systems. The majority of coho salmon were captured in groundwater areas, and chinook salmon were found in tannic-stained run-off systems such as the lower Goodpaster River.

Seine Sites

In the Delta area, seines were used at up to 11 sites. Three seine hauls were made at each site during four sample periods for a total of 132 seine hauls (Appendix VII). We captured 930 fish that included Arctic grayling, lake chub, longnose sucker, slimy sculpin, coho salmon, chum salmon, burbot, round whitefish, and humpback whitefish. The most abundant caught fish was chum salmon, followed by, in decreasing order, longnose sucker, slimy sculpin, lake chub, round whitefish, coho salmon, humpback whitefish, Arctic grayling, and burbot (Table 7). Fish abundance was greatest in June, followed by May, August, and July. Chum salmon fry were abundant in or near groundwater sources in May and June.

Table 7. Fish species and numbers captured at seine sites within the Delta sampling area, 1997.

Species	*May*	*June*	*July*	*August*	***Total***
Arctic grayling	4	0	1	3	**8**
Burbot	0	0	1	0	**1**
Chum salmon	98	439	0	0	**537**
Coho salmon	21	8	0	0	**29**
Humpback whitefish	5	0	0	3	**8**
Lake chub	6	9	1	30	**46**
Longnose sucker	52	23	9	62	**146**
Round whitefish	21	0	9	8	**38**
Slimy sculpin	58	52	3	4	**117**
Total	**265**	**531**	**24**	**110**	**930**

Analysis of CPUE seine data in turbid water indicates that juvenile fish distribution in the Delta area differs throughout the open-water season (Figure 15). Turbid water habitats produced the highest CPUEs in June, and were dominated by salmon in both May and June. In June, approximately 80% of fish captured in each seine haul were salmon, 98% being chum salmon (Figure 16). Similar to the Fairbanks area, temporal patterns appear to be important in fish distribution within the Delta area, however; these patterns are different. In the Fairbanks area salmon presence is more concentrated in May, whereas salmon are present in large numbers in the Delta area May through June, and to a lesser extent through August.

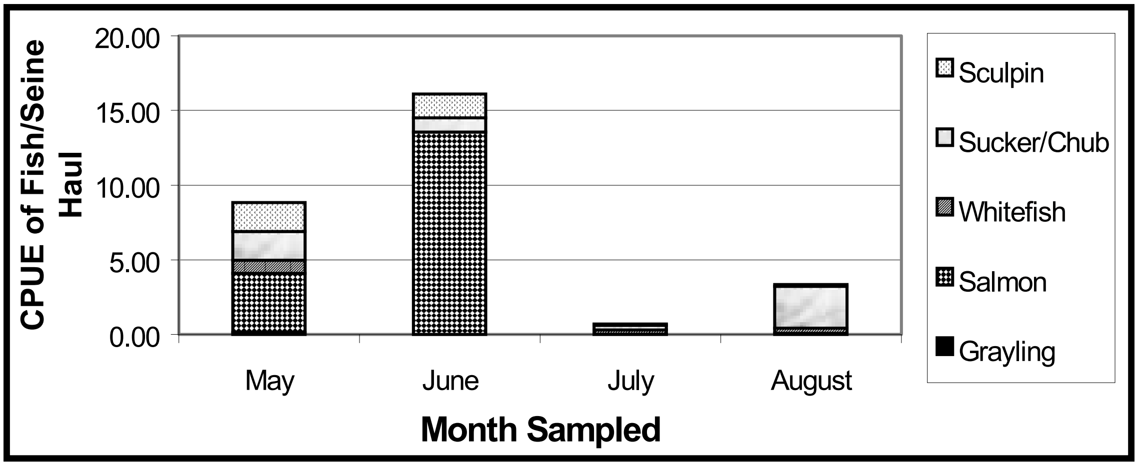

Figure 15. Average CPUE of fish by species captured per seine haul by monthly sample period in the Delta sampling area.

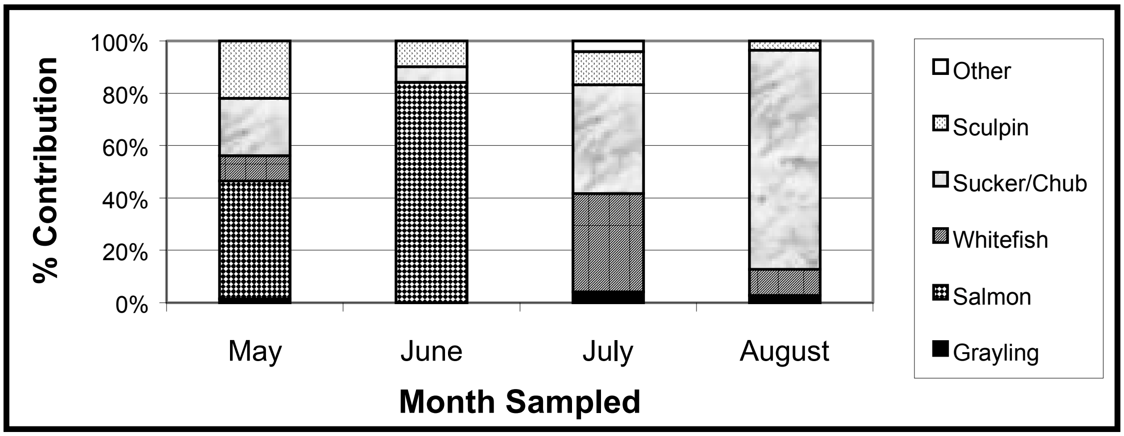

Figure 16. Relative contribution by species to overall seine catches by monthly sample period for the Delta sampling area.

In the Delta area, 57% of the seine hauls were over silt substrates, 39% were over gravel, and 4% were over mixed gravel/silt areas. When corrected for effort the number of fish captured did not differ among the three substrate types tested. Large numbers of chum salmon and longnose suckers were found in silt substrate areas, whereas gravel areas were used most heavily by slimy sculpin and chum salmon (Table 8). Lake chub, chum salmon, and longnose sucker were associated with the silt/gravel mix substrates.

Table 8. Seine results for three substrate types within the Delta area, standardized to number of fish per seine haul, 1997.

Substrate	*AG*[1]	*BB*	*CH*	*CO*	*HWF*	*LC*	*LNS*	*RWF*	*SSc*	*Total*
Silt	0.03	0.01	3.72	0.21	0.11	0.29	1.36	0.27	0.20	6.20
Gravel	0.12	0.00	1.25	0.25	0.00	0.29	0.67	0.35	1.84	4.78
Silt/Gravel	0.00	0.00	32.33	0.00	0.00	1.50	1.67	0.00	1.33	36.83

[1] AG = Arctic grayling; CH = chum salmon; CO = coho salmon; KS = king salmon; LC = least cisco; LNS = longnose sucker; RWF = round whitefish; HWF = humpback whitefish; SSc = slimy sculpin

AREA COMPARISONS

Minnow Traps

Fish species captured in the Delta and Fairbanks sample areas were similar with the exception of Arctic grayling and round whitefish. The total catch for each of these species was one fish, each caught in the Fairbanks area. Arctic grayling and round whitefish are not readily captured in minnow traps; therefore, these species have limited value for comparing habitats when using minnow traps. Species that were common to the Fairbanks and Delta sample areas were coho salmon, chinook salmon, lake chub, longnose sucker, and slimy sculpin. In each sample area, tannic-stained and groundwater or mixed groundwater/glacial water classes produced the largest number and species richness of fish.

In both the Fairbanks and Delta sampling areas, longnose suckers and lake chubs were most frequently found in tannic-stained runoff waters. Ninety-three percent of lake chubs captured in the Fairbanks sample area came from Willow Creek, Rosie Creek, and Check Station Creek, all tannic-stained streams. In the Delta sampling area, lake chubs were captured in Shaw Creek, Indian Creek, and Tenderfoot Creek, all tannic-stained streams.

Longnose suckers were captured in tannic-stained and groundwater areas in both Fairbanks and Delta sampling areas. In the Fairbanks sampling area, longnose suckers were captured in Chocolate Sauce and Rosie Creek, both tannic runoff systems, and in Bear Creek, a groundwater stream system. In the Delta sampling area, longnose suckers were captured in Tenderfoot Creek, a tannic-stained runoff system, and in Clearwater Lake Outlet, a groundwater stream system.

Coho salmon were captured in groundwater or mixed groundwater/glacial habitats in the Fairbanks and Delta sampling areas. In the Fairbanks sampling area, coho salmon were caught in traps set in Bear Creek, a groundwater stream system, at three sites on Salchaket Slough, and at the mouth of Clear Creek where it joins Salchaket Slough. Coho salmon were only captured in Salchaket Slough in May and June, a period when the slough system was dominated by groundwater prior to significant input of glacial water from the Tanana River. In the Delta area, coho salmon were captured in four groundwater stream systems: Blue Creek, Clear Creek, Clearwater Lake Outlet, and the Richardson Clearwater River. Coho salmon were also captured at two locations in the

Bluff Cabin Slough system, a groundwater upwelling side channel of the Tanana River. Bluff Cabin Slough is classified as a mixed groundwater/glacial habitat because it has significant groundwater input that mixes with glacial waters of the Tanana River. Coho salmon were captured in the Bluff Cabin slough system during May, prior to significant seasonal input of Tanana River glacial melt water. Coho salmon were also captured in Shaw Creek, a tannic runoff system. Caribou Creek, a tributary to the Shaw Creek system, is known to support rearing juvenile coho and chinook salmon, and provides spawning habitat for Arctic grayling (Ridder 1985). The presence of salmon in Shaw Creek, including spawning chum salmon in its lower reaches, indicates portions of the drainage receive groundwater input that mixes with tannic-stained runoff from forested wetlands. The number of groundwater stream systems and extensive areas of groundwater upwelling within the Tanana River floodplain in the Delta area are important factors that control the distribution of coho salmon.

In the Fairbanks sampling area, all chinook salmon were captured in the Salchaket Slough system during May. Salchaket Slough is classified as a groundwater habitat during May prior to seasonal glacial input from the Tanana River. The presence of chinook salmon in the slough system early in the open water season is evidence that spawning and wintering habitat is present in the area. Bear and McDonald Creeks drain into Salchaket Slough, are the source of groundwater to the slough system, and likely provide habitat for chinook salmon. In the Delta sample area, one chinook salmon was captured in May at the mouth of the Goodpaster River, a known spawning system for chinook salmon. Although the lower Goodpaster River is classified as a tannic runoff system based on visual characteristics of the water in its lower reaches, it differs from smaller tannic-stained systems, because extensive groundwater input occurs in the upper Goodpaster River system.

In the Fairbanks and Delta sampling areas, slimy sculpin were most frequently captured in groundwater areas. In the Fairbanks sampling area, slimy sculpin were captured in Bear Creek in June and July, and in Salchaket Slough in June. In the Delta sampling area, slimy sculpin were captured in Blue, Clear, and Cub Creeks, all areas classified as groundwater streams. In June, a few slimy sculpin also were captured in the Tanana River downstream of Shaw Creek and the Goodpaster River.

Seine Sites

Seine hauls captured Arctic grayling, burbot, chum salmon, coho salmon, humpback whitefish, least cisco, longnose suckers, round whitefish, and slimy sculpin in both the Fairbanks and Delta sample areas. Arctic lamprey, northern pike, and chinook salmon were only captured in the Fairbanks sample reach. The Arctic lamprey and northern pike catch each consisted of a single fish captured from Salchaket Slough just downstream from the mouth of Clear Creek.

Because our seining technique was limited to a narrow range of water depths and velocities we were unable to test for differences in fish distribution based on these physical characteristics. Further complicating analyses were changes from nonglacial to glacial water classifications as flows increased in the Tanana River in midsummer. Tests for differences in expected numbers of fish captured in areas with silt, gravel, and mixed substrate types failed to detect a difference in fish distribution with substrate (Fairbanks $X^2 = 1.16$, $df = 2.0$, $0.5 < p < 0.7$, Delta $X^2 = 1.73$, $df = 2.0$, $0.3 < p < 0.5$). Seining effort was not equally distributed between substrate types because suitable seining locations were most often found in silt substrate areas. The number of silt substrate sites increased in July and August as high water caused us to move seine sites up onto bars and into depositional areas where water velocity and depth decreased enough to allow use of this fish capture technique. While fish use and specific habitat characteristics could not be compared and evaluated, the seine haul capture data does document those fish species using shallow water areas of the Tanana River and identifies temporal use patterns among the species captured.

All 53 chinook salmon captured were seined from gravel substrate sites in the Fairbanks sampling area in May. Fifty were captured on the downstream end of a large gravel bar on Sevenmile Slough (Appendix III). Chinook salmon found in the Tanana River in May are downstream migrants that recently left rearing areas in large, clearwater runoff streams such as the Chena and Salcha Rivers (Francisco 1976).

In the Delta sample area, chum salmon were the most frequently captured species, whereas in Fairbanks chum salmon followed lake chubs and longnose suckers in frequency of capture. In May, chum salmon were found at all of the sample sites in the Delta area, while chum salmon were found at 50% of the sites in the Fairbanks area. In Fairbanks, chum salmon were found at six sites on the mainstem Tanana River and side channels, while chum salmon were found at only one of seven sites on Salchaket Slough. Out-migrating chum salmon use the mainstream Tanana and side channels as a migratory pathway early in the open water season. In June, chum salmon were captured in seine hauls at 9 of 11 (81%) sites in the Delta area. High catch rates were found near spawning and egg incubation areas. We found a more widespread distribution and greater capture frequency for juvenile chum salmon in the Delta sample area compared with that found in the Fairbanks area. Extensive groundwater areas occur in the Tanana River floodplain within the Delta sample area. These physical characteristics provide favorable conditions for spawning, egg incubation, and fry development which in turn result in a widespread distribution and greater numbers of juvenile chum salmon.

Coho salmon were captured at seine sites in the Fairbanks and Delta sample areas in May and June. In the Fairbanks sample area, coho salmon were captured in all of the sites on the mainstem Tanana and side channels in May, but at only one of seven sample sites on Salchaket Slough. Coho salmon out-migration occurs in May, a time coinciding with the higher catch rates found at mainstem Tanana River and side channel sites. In June, catch rates dropped markedly in the mainstem Tanana River and side channels. A similar pattern occurred in the Delta sampling area. In June, coho salmon were most frequently captured at sites near groundwater areas. June coho salmon catches were largest in the Fairbanks area at a site below Bear Creek, while a site below Clearwater Lake Outlet produced the largest catch in the Delta area. Coho salmon captured near groundwater streams such as Clearwater Lake Outlet and Bear Creek are in the freshwater rearing phase of their life history.

Slimy sculpin were captured in the Fairbanks and Delta sample areas during each of the four sample periods. The widest distribution was found during June and July in the Fairbanks sample area. The greatest numbers of slimy sculpin were captured in the Fairbanks sample area during June in gravel substrate areas. In the Delta sample area, slimy sculpin were most frequently captured in May and June, also over gravel substrates. Sites on Salchaket Slough produced the most slimy sculpin in the Fairbanks sample area. The lower Goodpaster River, a slough on the north side of the Tanana River floodplain downstream from the Richardson Highway Bridge, and a site downstream from the mouth of Shaw Creek produced the largest slimy sculpin catches in the Delta sample area.

We captured lake chubs in the Fairbanks and Delta sample areas during each of the four sample periods. The pattern of distribution within each sample area was similar with lake chubs occurring at the greatest number of sample sites in August. Lake chubs were more frequently captured in the Fairbanks sample area than in the Delta sample area. In the Fairbanks sample area, lake chubs were the most frequently captured species, whereas in the Delta sample area, lake chubs were fourth, following chum salmon, longnose sucker, and slimy sculpin. Lake chubs were most commonly caught over silt substrate.

The minnow trap data indicate that lake chubs occur in tannic-stained drainages. The greater number of tannic-stained drainages in the Fairbanks sample area may be a factor influencing lake chub distribution and capture frequency. The data from both areas indicate that lake chubs are more widely distributed in the Tanana River floodplain late in the open water season. Increased use of the Tanana River floodplain late in the open water season may occur as lake chubs move out of tannic-stained runoff streams that lack suitable overwintering habitat.

We captured longnose suckers in the Fairbanks and Delta sample areas during each of the four sample periods. Longnose suckers were the second most frequently captured species in each sample area. In the Delta sample area, longnose suckers were most frequently captured and found at the greatest number of sample sites in August. In the Fairbanks sample area, longnose suckers were found at over 50% of the sample sites during each of the four sample periods. Longnose suckers were most frequently captured in the Fairbanks area in June. Silt bar islands were the most productive seining locations in both sample areas.

Although Arctic grayling are commonly found in groundwater streams (Richardson and Delta Clearwater Rivers), large unsilted runoff rivers (Goodpaster River), and tannic or bog-fed stream systems (Shaw Creek) during the open water season, relatively few Arctic grayling were captured in our seine sampling of the Tanana River in the Delta area. Arctic grayling were captured more frequently in the Fairbanks area, with the greatest number of Arctic grayling occurring at sites on Salchaket Slough in June and July.

Arctic grayling undertake complex migrations between overwintering, spawning, and summer rearing habitats using the Tanana River as a migratory pathway to areas used during the open water season (Ridder 1991). Either the timing of our sampling did not cover the periods of Arctic grayling movement, or the shallow water areas that we seined are not used by Arctic grayling during these migrations.

We captured round whitefish in the Fairbanks and Delta sample areas during all sample periods. In the Delta sample area, round whitefish were captured at the greatest number of sample sites in July and August. The largest catch occurred in May at two gravel bar seine sites. In the Fairbanks sample area, round whitefish were most frequently captured and widely distributed in June. Seine sites on Salchaket Slough and low velocity backwater areas off the main channel of the Tanana River produced the largest number of round whitefish in the Fairbanks sample area.

Discussion

Water quality characteristics found at minnow trap sites varied markedly between sample periods because of changing levels of flow, and sediment deposition and transport in the Tanana River. This variability resulted in changes in habitat classification based on water type between sample periods (Figures 17 and 18). Areas previously assigned to a nonglacial water class became glacially influenced at higher flows. The rapidly changing physical characteristics of the Tanana River floodplain made the description of static sample sites a challenge. Changes in physical conditions (e.g., depth, flow, sediment deposition and transport) reduced the number of sites in some water classes. The water quality changes were accompanied by dramatic differences in minnow trap fishing success. Even with the variability in water quality and floodplain morphology, we did find similar patterns of fish species presence within the five water classes in both the Fairbanks and Delta sampling areas.

Upon combining the results of our 1997 water quality analysis and fish sampling data, an overall pattern of juvenile fish use and distribution in the Tanana River and associated tributaries can be seen. In general, juvenile fish in both sample areas use lower turbidity water habitats most often. As turbidity increases within a habitat, fish use and species richness tends to decrease. Tannic-stained waters tend to produce more fish than other areas, however, species composition is largely longnose sucker and lake chub, an important feeder fish but not a species of sport fishery management interest. However, high turbidity glacial waters receive heavy use during different times of the open-water season. During May and June salmon smolt are encountered at high rates in glacial waters of the Tanana River and side sloughs. This indicates that even glacial areas may be sensitive to perturbations that alter an area during this period. Additionally, most species encountered in glacial water habitats were associated with gravel substrates (either gravel or mixed silt/gravel). These areas may provide juvenile fish with resting places in small eddy currents created by the substrate. Furthermore, it is likely that some juvenile fish captured early in the study were on or near spawning sites, giving additional importance to early season sampling effort.

Using the data collected in this study, it is possible to create a hierarchy of habitats used by juvenile fish that may be susceptible to perturbation. Clearwater and tannic-stained systems are of primary concern because juvenile fish use these areas in high numbers throughout the year in the larger systems. Some of the smaller tannic-stained systems provide suitable habitat only during the open water season. High turbidity waters are also of concern but on a more seasonal basis. Given the data collected in 1997, May and June appear to be times when glacial waters may be most susceptible to perturbation. Additionally, areas with gravel substrate should be given additional concern. These areas are used by juvenile salmon early in the season; it is likely that adult salmon have

Figure 17. This photo of Cub Creek indicates the degree of water quality variation within sites throughout the open-water season. Compare to Figure 1, the same site in May.

Figure 18. As water levels in the Tanana River increase, smaller systems are backed-up and water quality changes dramatically. This photo of Willow Creek in July shows the silt infiltration. Compare to Figure 4, the same site in May.

spawned nearby which warrants additional concern over these habitats, including during the salmon spawning season and egg incubation (overwintering) period.

Data collected during this project in 1997 offer a limited picture of juvenile fish habitat use and juvenile fish distribution in the Tanana River and associated tributaries. This study is one of the first of its kind in a large glacial river system. We have documented patterns of juvenile fish distribution among various habitats in the Tanana drainage as well as identified temporal patterns of juvenile fish use within the study areas. The data collected in this study will provide researchers with a base to construct more quantitative studies in the Tanana River.

Recommendations

The fish habitat study indicates that tannic runoff and ground water habitats are the most important habitats for fish. Groundwater stream systems are sensitive throughout the year because juvenile coho salmon are present in these systems. Groundwater stream systems also provide important summer rearing areas for resident fish species like Arctic grayling.

Groundwater areas in the main and side channels of the Tanana River are important for spawning and incubation of chum salmon, and provide wintering areas for other fish species. These areas are most sensitive to disturbance between the fall spawning period and the period of juvenile out-migration (September through June). Winter access roads that include artificial ice thickening of river channel crossings have the potential to alter groundwater flow to upwelling areas and alter or reduce winter habitat for fish.

- Vegetated buffers to groundwater stream systems are probably necessary to maintain water quality. However, groundwater areas in the Tanana River drainage have not been adequately investigated. It is not currently known, based on existing data, what size buffers, if any, are necessary. Additional quantitative research is needed.

Small tannic-stained runoff systems also provide important habitat for fish, but fish use of smaller systems is limited to the open water season. Winter access road crossings of small non-groundwater streams should not impact fish if adequate bank protection measures are used.

- To protect water quality in tannic-stained runoff system, we recommend bank protection for winter road crossings. Effective bank protection techniques for winter roads include snow/ice ramps. Permanent gravel road crossings of tannic runoff systems should be designed to facilitate fish passage. Vegetative buffers on small tannic runoff systems are recommended to prevent degradation of summer rearing habitat. However, quantitative data are not presently available to support a specific recommendation.

The least sensitive habitats are glacial waters that are not influenced by groundwater upwelling. For these areas we recommend field review by a habitat biologist and adequate bank protection (snow/ice ramps) for winter road crossings. Areas where natural ice thickness is adequate for a road crossing are preferable to areas requiring artificial ice thickening. Artificial ice thickening has the potential to alter wintering habitat for fish.

Literature Cited

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

Ott, A. G., A. H. Townsend, and J. F. Winters. 1998. Juvenile fish use of selected habitats in the Tanana River near Fairbanks (Preliminary Report). ADF&G, Habitat and Restoration Division Tech. Rept. No. 97-1. Juneau. 133 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. 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.

Sturm, E. A. 1988. Description and identification of larval fishes in Alaskan freshwaters. MS Thesis. University of Alaska, Fairbanks. 201 pp.

Trautman, M. B. 1973. A guide to the collection and identification of presmolt salmon in Alaska with an illustrated key. NOAA Technical Memorandum NMFS ABFL-2. US Dept. of Commerce, Seattle WA. 20 pp.

Appendix I. Seine and minnow trap site descriptions in the Salchaket Slough subarea of the Fairbanks sampling area.

Minnow Trap Sites

F-B-97-1

GPS location: N 64° 43.861’, W 147° 39.857’. Located on Bear Creek, a groundwater tributary to Salchaket Slough. The trap is on the south bank 1 km upstream from the mouth. The stream bank is thickly vegetated with willow and alder at the trap site. Water color was clear during all sample periods except August when high water in the Tanana River moved glacial water into Bear Creek, giving it a green color.

F-B-97-2

GPS location: N 64° 44.038’, W 147°40.074’. The trap was located at the mouth of Bear Creek just above the influence of glacial water in the Salchaket Slough system. The trap is located along a cut bank among log sweepers and brush. In August, following a flood event on the Tanana River, the water color was glacial gray/brown.

F-B-97-3

GPS location: N 64°44.236’, W 147°40.586’. This trap was located on a channel of Salchaket Slough just downstream from Bear Creek. In May and June, this area had water appearing similar to Bear Creek, but in July, as water levels in the Tanana River increased, the water color changed to glacial tan/gray similar to that found in Salchaket Slough. The trap was in thick brush that extended into the water.

F-B-97-4

GPS location: N 64°44.168’, W 147°40.586’. This trap was located in a log jam just downstream from where a small tannic-stained bog drainage enters Salchaket Slough on the south side. In August, the logjam was under water and the trap was moved upstream into a quiet water area at the mouth of the bog drainage.

F-B-97-5

GPS location: N 64° 44.534’, W 147° 46.409’. This trap was located on the south side of Salchaket Slough along a cut bank among log sweepers. The stream bank is vegetated with alders.

F-B-97-6

GPS location: N 64° 44.576’, W 147° 47.173’. Located where a small, tannic-stained bog drainage enters on the south bank of Salchaket Slough.

F-B-97-7

GPS location: N 64° 44.846', W 147°48.003'. The trap was set at the upstream end of a large log jam on the north side of Salchaket Slough. A side channel runs to the north of the log jam and trap site. In August, water velocities at the log jam site had increased and the trap was moved upstream on the north bank to a slack water area.

F-B-97-8

GPS location: N 64° 44.811', W 147° 49.464'. Trap set along a cut bank on the south side of Salchaket Slough. The bank adjacent to the trap is vegetated with willow, alder, and grasses.

F-B-97-9

GPS location: N 64° 44.937', W 147° 50.428'. Trap set on the south bank of Salchaket Slough in a log jam at the upper end of a side channel. In August, the trap was moved downstream of the log jam because of high velocities at the trap site. The new site was a slack water area with emergent *Equisetum* sp. The bank is vegetated with alder and grasses.

F-B-97-10

GPS location: N 64° 44.401', W 147°54.863'. In Clear Creek above the influence of glacial water in Salchaket Slough. The trap is located 0.5 km upstream from where a side channel of Salchaket Slough enters Clear Creek. Clear Creek is fed by a mixture of nonglacial runoff and groundwater and has a greenish to dark stained color depending on water level and recent precipitation events.

F-B-97-11

GPS location: N 64° 44.614', W 147° 55.203'. Located at the mouth of Clear Creek below a high water channel of Salchaket Slough. In May and June, this site had nonglacial runoff water similar to upstream areas on Clear Creek. In July and August, after discharge in the Tanana River increased and a high water channel above the site became active, water color at the trap site changed to a gray/tan color.

F-B-97-12

GPS location: N 64° 44.333', W 147° 59.133'. Located at the mouth of Little Salchaket Slough along a cut bank with large spruce trees, brush, and logs in the water along the bank. In May and June, water in Little Salchaket Slough appeared more glacial with a gray/tan color, while Salchaket Slough appeared to be more influenced by groundwater and runoff with a dark stained, slightly turbid, appearance. In July and August, after discharge in the Tanana increased, Little Salchaket and Salchaket Slough had similar appearing tan/gray color water.

Seine Sites

F-S-97-1

GPS location: N 64° 44.507’, W 147° 59.858’. Located on a large silt bar on the inside of a meander loop on lower Salchaket Slough, downstream from Little Salchaket Slough. In August, following a flood event on the Tanana River a new layer of silt was deposited at the site.

F-S-97-2

GPS location: N 64° 44.28’, W 147° 59.049’. The site is located on a sand/silt bar opposite Little Salchaket Slough. In July, after water levels in the slough came up, the seine site included emergent vegetation consisting of *Equisetum* sp., and sedges. In August, emergent willows were within the area seined.

F-S-97-3

GPS location: N 64° 44.081’, W 147° 57.588’. Located on Salchaket Slough between Clear Creek and Little Salchaket Slough. In May and June, the site was a gravel bar. In July, after water levels came up, a portion of the area included emergent vegetation consisting of sedges and willows, and a portion was over a silt bar littered with sticks and other small woody debris. In August, the bar was completely under water and the seine area was moved to a shallow, slack water zone with emergent willows.

F-S-97-4

GPS location: N 64° 44.565’, W 147° 55.369’. Located on an island in Salchaket Slough just downstream from the mouth of Clear Creek. The area seined graded from gravel at the downstream end to silt at the upstream end. In July, the island was under water and the seine area was moved to the south bank of Salchaket Slough over a silt substrate with emergent *Equisetum* sp. In August, the area seined was within the willow zone.

F-S-97-5

GPS location: N 64° 44.875’, W 147° 48.461’. Located on a gravel bar on the south side of Salchaket Slough upstream from Clear Creek. The area sampled grades from silt to gravel. In August, the bar was under water and the seine site was moved into a shallow flooded area behind the bar. This area included emergent vegetation, consisting of willows and *Equisetum* sp.

F-S-97-6

GPS location: N 64° 44.323’, W 174°43.881’. Located on the south bank of Salchaket Slough below the Bonnifield Trail. In May and June, the seine site was over a large gravel bar. In July, after water in Salchaket Slough came up, the seine site was over silt and sand with emergent aquatic vegetation consisting of sedges. Small branches, logs and sticks littered the beach. In August, the seine area was in the short willow zone.

F-S-97-7

GPS location: N 64° 44.292’, W 147° 40.765’. Located immediately downstream from Bear Creek Slough on a gravel bar island littered with logs. The substrate was sand and gravel in the area seined. In July, the island was under water and the site was relocated 100 m downstream on the south bank of Salchaket Slough. The area seined was a silt bar. In August, the water advanced into the streamside vegetation and the area seined included emergent aquatic vegetation consisting of *Equisetum* sp.

Appendix II. Seine and minnow trap site descriptions in the Chena Pump to Willow Creek subarea of the Fairbanks sampling area.

Minnow Trap Sites

F-B-97-13

GPS location: N 64°40.378', W 148°11.500'. The traps were set in a side slough of Willow Creek 5 km upstream of the mouth. Willow Creek is a tannic-stained runoff system draining forested wetland areas of the Tanana Flats. Spruce forests border the trap site with several large trees in the water or leaning over the water. The slough has sedges along the bank and emergent and submerged aquatic vegetation. Northern pike, burbot, and sheefish are known to occur in the lower end of Willow Creek.

F-B-97-14

GPS location: N 64° 40.376', W 148° 12.487'. The traps were set at the mouth of Willow Creek along a cut bank, 50 m upstream from where Willow Creek joins a side channel of the Tanana River. The trap site is adjacent to a mature white spruce forest area. The site had tannic-stained water in May and June, but in July, the Tanana River moved into the lower end of Willow Creek and the site had tan/gray colored glacial water. In August, the Tanana River flood increased water levels in lower Willow Creek to the top of the cut bank or roughly one meter above levels observed in May and June.

F-B-97-15

GPS location: N 64° 41.515', W 148° 12.093'. The traps were set next to a beaver lodge on a cut bank. The site is located on the south bank of Sevenmile Slough 0.5 km upstream from the mouth of a slough channel. The area is forested and numerous trees and shrub vegetation have fallen into the water along the eroding riverbank. In August, the beaver dam was under water and the river was flooding over the top of the cut bank. The trap was moved to a backwater area about 50 m downstream of the beaver lodge and set in emergent streamside vegetation consisting of willows and alders.

F-B-97-16

GPS location: N 64° 41.975', W 148° 09.345'. The traps were set 100 m upstream from the mouth of Cutoff Creek on the south bank. Cutoff Creek is a name we gave this tannic-stained runoff stream. The trap was set along a cut bank among logs and brush. Spruce forest is the dominant vegetation type in the lower portion of the drainage, but extensive wetland and shrub areas occur in the watershed. In July and August, water levels in the Tanana River increased and lower Cutoff Creek was tan color/gray in color at the trap site.

F-B-97-17

GPS location: N 64° 44.034', W 148° 09.863'. Chocolate Sauce Creek is a name we gave this small, tannic-stained, system that drains a pond complex. Areas in and adjacent to the pond outlet channel are vegetated with *Equisetum* sp. that grades to grasses and willows back from the pond and the outlet channel. The trap was set in the outlet channel. In May, the water was coffee color, in June and July it was tan/gray as water from the Tanana River entered the inlet channel and pond. In August, overbank flooding of the Tanana River inundated the area and glacial water was flowing through the pond complex area.

F-B-97-18

GPS location: N 64° 44.180', W 148° 05.940'. The trap was located on the north bank of the Tanana River along a rock bluff with steep, near vertical walls to the water's edge.

F-B-97-19

GPS location: N 64° 44.590', W 148° 05.094'. The trap was set at the mouth of Rosie Creek, a small tannic-stained runoff system. The stream bank is vegetated with *Equisetum* sp., grasses and thick willow and alder. Rosie Creek had tannic-stained water in May, changed to glacial water in June and July as the Tanana River entered the mouth of the creek near the trap site. In August, flood waters entered lower Rosie Creek and flooded areas back from the stream banks, including the forested zone back from the stream channel.

F-B-97-20

GPS location: N 64° 40.803', W 148° 12.007'. The trap was located at the mouth of a small, tannic-stained, wetland drainage adjacent to the Fort Wainwright hunter check station. We named this stream Check Station Creek. We did not fish this site in May as water levels in Cutoff Slough were too shallow for boat access to the site. In June, water in Check Station Creek was coffee color from tannic runoff, in July glacial water from the Tanana River moved into the lower end of the drainage. The trap was set in emergent aquatic vegetation consisting of *Equisetum* sp. Away from the stream bank the vegetation changed to shrubs, primarily alder and willow, and then to mature, white spruce forest. In August, flood waters reached the top of the cut bank and extended into the willow-alder zone.

Seine Sites

F-S-97-8

GPS location: N 64° 40.957', W 148° 12.487'. Located at the downstream end of Sevenmile Slough on a large gravel bar. Back from the slough channel, the bar is vegetated with dense willow stands. Successional bands of vegetation run parallel to the river, with the taller willows exceeding 2 m in height. In July, much of the gravel bar was inundated and the seine area was over soft silt with small woody debris, and patches of emergent aquatic vegetation. In August, water advanced into the low willows.

F-S-97-9

GPS location: N 64° 43.024', W 148° 09.534'. Gravel bar south of Sam Charlie Island on the main channel of the Tanana. The seine area is composed of sand and gravel with woody debris. In August, the site was moved to a silt bar island along a side channel to avoid submerged debris at the main channel site.

F-S-97-10

GPS location: N 64° 44.007', W 148° 06.867'. Seine site located downstream from rock bluffs on the north bank of the Tanana River. The site is a sandbar with logs and patches of gravel and silt. In July, the site was moved upstream to avoid large logs that obstructed the area. The new seine area had a soft silt substrate and included numerous logs and root wads. In August, a channel cut through the silt bar island and the seine area was moved to the channel. The channel had a soft silt bottom and emergent willows were within the area seined.

F-S-97-11

GPS location: N 64° 44.668', W 148° 04.851'. Located on the island north of Rosie Creek. The seine site is at the upstream end of the island. The area seined was over soft silt substrate. In August, seining was over recently deposited, soft silt in emergent vegetation consisting of *Equisetum* sp. and willows.

F-S-97-12

GPS location: N 64° 44.908', W 148° 01.300'. Seine site is located downstream from the mouth of Salchaket Slough where a high water slough channel diverges to the north from the main channel of the Tanana River. In May, the seine area consisted of gravel and sand substrate with small woody debris scattered throughout the area. In June and July, the side channel was flowing and the seine site was shifted into the side channel where velocities were lower and seining occurred over silt with patches of gravel. Woody debris consisting of logs, limbs, and branches were encountered in the area seined. In August, seining occurred over freshly deposited silts.

F-S-97-13

GPS location: N 64° 46.293', W 148° 00.383'. The seine site is an island, located north of Luke's Camp. The area seined was a silt bar with woody debris littering the bottom. In June, a seine haul was made in a shallow, backwater area extending into the silt bar island. In August, seining occurred over soft, silt material that was recently deposited.

F-S-97-14

GPS location: N 64° 47.604', W 147° 57.375'. Located immediately downstream from Chena Pump Landing on the north bank of the Tanana River. The seine area has gravel substrate. In July and August, velocity increased at the downstream location and the sample area was shifted upstream to the gravel bar at Chena Pump Landing. This area is used as a boat launch site.

Appendix III. Seine and minnow trap site descriptions in the Delta sampling area.

Minnow Trap Sites

D-B-97-1

GPS location: N 64° 09.921', W 145° 48.595'. Located on a vegetated island north of the Tanana River 2.0 km upstream from the Richardson Highway Bridge and oil pipeline crossing. The trap site is off a cut bank on the main channel of the Tanana River. Mature white spruce forest occurs to the riverbank with trees, logs, and root wads above and below the water surface.

D-B 97-2

GPS location: N 64° 10.140', W 145° 47.139'. Located at the mouth of a groundwater stream system known locally as Blue Creek. This small groundwater stream enters on the south side of Tanana River. In May and June, the trap was set off a silt bar at the creek mouth. In July, the trap was moved 50 m upstream. In August, following a flood event the shoreline of Blue Creek had advanced into the white spruce trees on the north bank and the water was green color indicating mixing of groundwater with glacial water from the Tanana.

D-B-97-3

GPS location: N 64° 10.902', W 145° 38.577'. The trap site is located on the north bank of the Tanana River mainstem downstream from the mouth of the Goodpaster River. The trap site is along a cut bank with overhanging trees and brush. The area is a black spruce wetland with spruce and larch trees in the vicinity of the trap.

D-B-97-4

GPS location: N 64° 10.273', W 145° 37.516'. The trap was set at the mouth of the Goodpaster River on the upstream bank. The trap site is a cut bank in a spruce forest area with trees and thick brush extending to the bank and into the water. In May and June, the water color was dark, typical of large nonglacial runoff systems. In July and August, glacial water from the Tanana River entered the lower Goodpaster River from a upstream slough system.

D-B-97-5

GPS location: N 64° 08.958', W 145° 38.563'. The trap site is on the south bank of the Tanana River where the Bluff Cabin Slough joins the mainstem. The trap was set off a steep rock bluff vegetated with spruce and aspen. This stream reach is a known chum salmon spawning area. The trap site had green colored water in May and June. In July and August, when discharge in the Tanana River increased, the water was glacial in appearance.

D-B-97-6

GPS location: N 64° 07.003’, W 145° 36.158’. The trap is located on a side channel of the Tanana where a branch of the Bluff Cabin Slough system enters the mainstem. In May, water at the trap site was green in color. In June, July, and August, the water was glacial tan/gray color. The trap was set along a cut bank among overhanging alders. Vegetation in the area is a mixture of black spruce and alder.

D-B-97-7

GPS location: N 64° 06.417’, W 145° 35.960. Located in Clearwater Lake Outlet just upstream from the point where the outlet channel joins the Tanana River. In May, water at the trap site was green, in June clear, and in July and August glacial tan/gray. The trap was set off a cut bank among large root wads and white spruce trees. Vegetation at the site is open, mature white spruce. The August flood on the Tanana River deposited a large silt bar immediately above the trap site.

D-B-97-8

GPS location: N 64° 11.376’, W 145° 57.554’. The trap was set at the mouth of a small groundwater stream we called Cub Creek. In May and June, water color was clear, but in July and August, the water was glacial tan/gray color. The trap was set in a large scour hole created by a root wad. Vegetation in the area is a mixture of white spruce and balsam poplar.

D-B-97-9

GPS location: N 64° 12.731’, W 146° 03.554’. Located at the mouth of a groundwater stream known locally as Clear Creek. Clear colored water was found at this location during each of the four sample periods. The trap was set off a cut bank vegetated with grass, sedges, and overhanging spruce trees. Stream substrates are sand and gravel at the creek mouth.

D-B-97-10

GPS location: N 64° 15.527’, W 146° 06.799’. The trap site is located 1 km downstream from the mouth of Shaw Creek on a glacial, side channel that branches from the north side of Tanana River. The trap was set on an eroding cut bank with thick overhanging willows and alder. The opposite side of the slough is armored with large rip-rap to protect the Richardson Highway as it runs parallel to the river. In August, water levels were at the top of the cut bank and a fresh blanket of silt was deposited in the vegetated riparian zone adjacent to the slough channel.

D-B-97-11

GPS location: N 64° 15.691’, W 146° 06.400’. Trap set in Shaw Creek 0.75 km upstream from the Richardson Highway Bridge. The trap was located on the outside of a meander bend off a cut bank with trees and shrubs extending into the water. Vegetation in the area is a mixture of spruce and birch. The area inside the bend, opposite the trap is a mudbar vegetated with a thick stand of emergent aquatic plants, primarily aquatic sedges. Water color was dark tannic-stained during each of the four sample periods.

D-B-97-12

GPS location: N 64° 14.241', W 146° 16.342'. Trap site is on the Richardson Clearwater River off a cut bank vegetated with willow and alder. A small vegetated island is located just upstream from the trap site. Areas back from the stream bank are forested with birch and spruce. Transparent color water was found at the site in June, but in July and August, glacial water was present on the trap side of the channel while the opposite side of the channel had transparent color water. The streambed is composed of gravel. Arctic grayling were observed feeding in this stream reach.

D-B-97-13

GPS location: N 64° 14.923', W 146° 17.146'. Trap located on a slough channel downstream from the Richardson Clearwater River. Water color at the trap site was green in June, and tan/gray in July and August after high water sloughs of the Tanana River upstream of the site became active. The trap was set downstream from where two slough channels join off a cut bank. Overhanging alders and root wads line the slough channel at the trap site.

D-B-97-14

GPS location: N 64° 11.307', W 145° 40.784'. Located north of the Tanana River in Indian Creek, a small, tannic-stained runoff system that drains the Thompson Lake area. The trap was set in a pond area formed by beaver dams. The pond area has soft, silt substrate, emergent sedges, and numerous deadfall trees in the water. Vegetation in the area adjacent to the pond is mixed spruce/birch forest. Steep, rock bluffs are located on the north side of the pond. Water at the trap site was dark tannic-stained in June and more brown color in July and August as water from the Tanana River moved into the lower end of the drainage and the pond.

D-B-97-15

GPS location: N 64° 15.288', W 146° 11.600'. Trap located in Tenderfoot Creek 50 m upstream from the mouth. Water in Tenderfoot Creek was dark, tannic-stained in June, and more brown in July and August as Tanana River water moved into the lower end of the creek. Lower Tenderfoot Creek drains through a large silt bar vegetated with willows and covered with logs and root wads. The substrate in this section of Tenderfoot Creek including the Tanana River riparian zone is extremely soft silt.

Seine Sites

D-S-97-1

GPS location: N 64° 06.417', W 145° 35.960'. Seine site located on a side channel, on the south side of the Tanana River floodplain, immediately downstream from Clearwater Lake Outlet. In May and June, water downstream of Clearwater Lake outlet was green color, and in July and August it was tan/gray. During the first two sample periods, the area seined was a sand/silt bar. In July, water levels increased and the seine area included emergent vegetation. During the August flood, a new silt bar was deposited downstream from Clearwater Lake outlet and the seine area was moved slightly downstream to a backwater area behind the recently deposited silt bar.

D-S-97-2

GPS location: N 64° 08.911', W 145° 38.095'. The seine site is located on a sand/gravel island upstream from Bluff Cabin. In July and August, most of the gravel bar was flooded and the seine area was moved to a shallow backwater area with silt substrate, littered with small woody debris.

D-S-97-3

GPS location: N 64° 10.709', W 145° 38.192'. Seine site located on a gravel bar island downstream from the Goodpaster River on the main channel of the Tanana River. The substrate in the seined area is gravel and large cobbles. Logs were present in the area in July after water levels in the Tanana River had come up. In August, the gravel bar was under water and the seine area was moved to a channel between two recently deposited silt bar islands.

D-S-97-4

GPS location: N 64° 11.227', W 145° 40.872'. Seine site located on the north side of the Tanana River in the Thompson Lake area. The area seined is on a side channel that runs to the north of a large silt bar island, opposite tannic-stained Indian Creek. The substrate in the area seined was soft silt material. In August, a shallow backwater pool behind a silt bar was included in the area seined.

D-S-97-5

GPS location: N 64° 09.806', W 145° 49.115'. Seine site located on the north side of the Tanana River at the upstream end of a slough channel. The slough outlet is at the Tanana River pipeline bridge. In May and June, the site was a large gravel bar. In July, the gravel bar was under water and seining occurred along a small silt bar island. In August, an extensive silt bar had formed and seining occurred off the silt bar in shallow water over a soft silt substrate. Vegetation along the slough is mature white spruce.

D-S-97-6

GPS location: N 64° 10.247', W 145° 53.489'. The seine site is located at the downstream end of a side channel of the Tanana River. The side channel flows through the Whitestone Farms area on the south side of the river, downstream from the mouth of the Delta River. In June, the area seined was an extensive sand bar, in July the bar was submerged and water extended into the vegetated zone (willow). In August, high water prevented seining at the downstream end of the side channel and the seine site was moved to the upstream end of the island off a gravel bar littered with large logs. The island is vegetated with spruce and balsam poplar.

D-S-97-7

GPS location: N 64° 11.505', W 145° 57.892'. Seine site is on groundwater upwelling side channel located on the south side of the Tanana River. In early June, the area had green color water indicating a mix of glacial and groundwater. In late June, July, and August, the water was a glacial tan/gray color. In July, the seine area included emergent vegetation.

D-S-97-8

GPS location: N 64° 15.368', W 146° 08.332'(early June), N 64° 15.526', W 146° 06.508' (late June, July, and August). In June we seined a gravel/cobble bar on the main channel of the Tanana River downstream from Shaw Creek Slough. When water levels came up it became too swift and deep to seine in this area. The site was moved upstream into the slough channel opposite the mouth of Shaw Creek. The second location was a gravel bar in June and a silt bar backwater in July. In August, seining occurred over a freshly deposited silt in a shallow, backwater area.

D-S-97-9

GPS location: N 64° 14.612', W 146° 15.867'. The site is a gravel bar on the south side of the river where a side channel joins the mainstem. The area is vegetated with willow and alder grading to spruce forest behind a high water channel. An actively eroding cut bank and mature spruce forest occurs on the bank opposite the seine area. In August, the high water channel was flowing and this was area seined.

D-S-97-10

GPS location: N 64°14.901', W 146° 17.098'. The seine site is located on a slough channel downstream from the Richardson Clearwater River. In early June, the slough channel had transparent color water from the Richardson Clearwater River on one side and tan/gray color glacial water on the other side. In late June, the area had green color water with a mixture of glacial and groundwater. In July and August, the area had tan/gray color water as side channels of the Tanana River introduced glacial water upstream of the site. The seine site is located on a sand/gravel bar with silt terrace deposits. The bar has a thick stand of alders.

D-S-97-11

GPS location: N 64° 10.537', W 145° 37.119'. The site is located on the lower Goodpaster River and was added during the second sample period. In June, the seine area was a large gravel bar and the water was tannic-stained. In July and August, the water was tan/gray color and the seine area was over a soft silt bar with emergent *Equisetum* sp. and small woody debris.

APPENDIX IV. Fish captured in minnow traps in the Fairbanks sampling area, 1997.

				Forklengths of Fish Captured by Species						
Sample Site	Habitat Water Type	Date	Water Temp. (°C)	AG (mm)	LC (mm)	LNS (mm)	SSc (mm)	CO (mm)	KS (mm)	RWF (mm)
F-B-97-1	1	5/20/1997	n/a							
	1	6/10/1997	n/a							
	1	7/7/1997	7.0							
	5	8/13/1997	6.6							57
F-B-97-2	1	5/20/1997	n/a							
	1	6/10/1997	n/a				43	94		
	1	7/8/1997	7			89	90	50		
							90	50		
	5	8/13/1997	6.6							
F-B-97-3	1	5/20/1997	n/a							
	5	6/10/1997	n/a							
	2	7/8/1997	11.0							
	2	8/13/1997	10.55	44						
F-B-97-4	5	5/20/1997	n/a							
	5	6/10/1997	n/a							
	2	7/8/1997	12.6							
	2	8/13/1997	11.4							
F-B-97-5	5	5/20/1997	n/a							
	5	6/10/1997	n/a							
	2	7/7/1997	12.7							
	2	8/13/1997	11.3							
F-B97-6	5	5/20/1997	n/a							
	5	6/10/1997	n/a							
	2	7/8/1997	12.8							
	2	8/13/1997	11.4							
F-B-97-7	5	5/20/1997	n/a					66	93	
									64	
	5	6/10/1997	n/a							
	2	7/7/1997	12.8							
	2	8/13/1997	11.4							
F-B-97-8	5	5/20/1997	n/a					56	63	
									64	
									65	
									65	
									66	
									66	

APPENDIX IV. Fish captured n minnow traps in the Fairbanks sampling area, 1997.

F-B-97-8									68
(cont.)									70
									72
	5	5/20/1997							74
	5	6/10/1997	n/a				75		
	2	7/8/1997	12.9						
	2	8/13/1997	11.4						
F-B-97-9	4	5/20/1997	n/a					60	69
									70
									70
									74
	4	6/10/1997	n/a						
	2	7/8/1997	13.0						
	2	8/13/1997	11.4						
F-B-97-10	3	5/20/1997	n/a						
	3	6/10/1997	n/a						
	4	7/8/1997	13.3						
	4	8/13/1997	11.2						
F-B-97-11	3	5/20/1997	n/a						72
	3	6/10/1997	n/a					75	
	2	7/8/1997	13.3						
	2	8/13/1997	11.5						
F-B-97-12	4	5/20/1997	n/a						74
	4	6/10/1997	n/a						
	2	7/7/1997	13.3						
	2	8/13/1997	11.1						
F-B-97-13	3	5/22/1997	n/a						
	3	6/11/1997	n/a						
	4	7/9/1997	13.3						
	4	8/14/1997	13.2						
F-B-97-14	3	5/22/1997	n/a						
	3	6/11/1997	n/a						
	4	7/9/1997	n/a		64				
	4	8/14/1997	12.9						
F-B-97-15	2	5/22/1997	n/a						
	2	6/11/1997	n/a						
	2	7/9/1997	n/a						
	2	8/14/1997	9.2						

APPENDIX IV. Fish captured in minnow traps in the Fairbanks sampling area, 1997.

F-B-97-16	3	5/22/1997	n/a						
	3	6/11/1997	n/a						
	4	7/9/1997	n/a						
	4	8/14/1997	13.2						
F-B-97-17	3	5/22/1997	n/a		55	57			
						71			
	3	6/11/1997	n/a		113				
	4	7/9/1997	n/a						
	2	8/14/1997	11.2						
F-B-97-18	2	5/22/1997	n/a		48				
	2	6/11/1997	n/a						
	2	7/9/1997	n/a						
	2	8/14/1997	10.9						
F-B-97-19	3	5/22/1997	n/a		112				
	4	6/11/1997	n/a		69	83			
					81	89			
					81				
					82				
					82				
					83				
					84				
					96				
					98				
					113				
	2	7/9/1997	n/a						
	2	8/14/1997	11.8						
F-B-97-20	3	6/20/1997	n/a						
	3	7/9/1997	n/a						
	4	8/14/1997	11.9						
Species Key					**Habitat Water Type Key**				
AG = Arctic grayling			1 = Groundwater						
CO = Coho salmon			2 = Glacial						
KS = King salmon			3 = Tannic Stained Runoff						
LC = Lake chub			4 = Mixed Runoff/Glacial						
LNS = Longnose sucker			5 = Mixed Groundwater/Glacial						
RWF = Round whitefish									
SSc = Slimy sculpin									

APPENDIX V. Fish captured in minnow traps in the Delta sampling area, 1997.

				Forklengths of Fish Captured by Species				
Sample	Habitat	Date	Water	CO	KS	LC	LNS	SSc
Site	Water		Temp.	(mm)	(mm)	(mm)	(mm)	(mm)
	Type		(°C)					
D-B-97-1	2	5/28/1997	n/a					
	2	6/19/1997	11.5					
	2	7/15/1997	11.0					
	2	8/25/1997	9.2					
D-B-97-2	1	5/28/1997	n/a					
	1	6/16/1997	4.6	70				75
	1	7/15/1997	6					
	1	8/25/1997	4.8	66				
				75				
				79				
D-B-97-3	2	5/28/1997	n/a					
	2	6/19/1997	11.25					59
	2	7/15/1997	13.0					
	2	8/25/1997	9.2					
D-B-97-4	3	5/28/1997	n/a		65			
	3	6/16/1997	10.25					
	4	7/15/1997	14.0					
	4	8/25/1997	9.4					
D-B-97-5	1	5/28/1997	n/a	75				
				77				
				95				
				104				
	1	6/16/1997	8.3					
	2	7/15/1997	10.5					
	2	8/25/1997	7.8					
D-B-97-6	1	5/28/1997	n/a	63				
				83				
				84				
				87				
	1	6/16/1997	8.4					
	2	7/7/1997	12.8					
	2	8/25/1997	8.9					

APPENDIX V. Fish captured in minnow traps in the Delta sampling area, 1997.

D-B-97-7	1	5/28/1997	n/a					
	1	6/9/1997	8.4					
	5	7/15/1997	10.5	36			22	
		(dip net)		38				
				42				
				51				
	5	8/25/1997	7.4					
D-B-97-8	1	6/2/1997	9.2					30
	1	6/18/1997	8.5					
	2	7/16/1997	12.0					
	2	8/26/1997	6.8					
D-B-97-9	1	6/2/1997	8.2					43
	1	6/18/1997	6.0					50
								66
	1	7/16/1997	5.0	82				
	1	8/23/1997	3.6					
D-B-97-10	3	6/2/1997	n/a					
	3	6/18/1997	14.5					60
	3	7/16/1997	14.5					
	4	8/26/1997	9.4					
D-B-97-11	3	6/2/1997	6.2					
	3	6/18/1997	11.5					
	3	7/16/1997	11.5			86		
	3	8/25/1997	9.2	79				
D-B-97-12	1	6/2/1997	n/a					
	1	6/18/1997	9.0					
	5	7/16/1997	12.0					
	5	8/26/1997	5.8	89				
D-B-97-13	5	6/2/1997	n/a					
	5	6/18/1997	14.5					
	5	7/16/1997	13.5					
	5	8/26/1997	8.75					
D-B-97-14	3	6/16/1997	14.8			62		
						63		
						63		
						65		
						65		
	3	7/15/1997	16.5					
	3	8/25/1997	11.7					

APPENDIX V. Fish captured in minnow traps in the Delta sampling area, 1997.

D-B-97-15	3	6/18/1997	20.0				40
	3	7/16/1997	15.0			46	46
						52	48
						54	56
						54	
						55	
						55	
D-B-97-15		7/16/1997	15.0			65	
		(cont.)				72	
	3	8/26/1997	10.9			79 (41-60)	33 (41-60)
						6 (61-80)	13 (61-80)
							2 (81-100)

Species Key		**Habitat Water Type Key**		
CO = Coho salmon		1 = Groundwater		
KS = King salmon		2 = Glacial		
LC = Lake chub		3 = Tannic Stained Runoff		
LNS = Longnose sucker		4 = Mixed Runoff/Glacial		
SSc = Slimy sculpin		5 = Mixed Groundwater/Glacial		

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

							Forklengths of Fish Captured by Species											
Sample Site (haul #)	Date	Habitat Type (Water)	Bottom Type	Velocity (cfs)	Maximum Depth (ft.)	Water Temp. (°C)	AG (mm)	AL (mm)	BB (mm)	CH (mm)	CO (mm)	HWF (mm)	KS (mm)	LC (mm)	LNS (mm)	NP (mm)	RWF (mm)	SSc (mm)
F-S-97-1	5/19/1997	Glacial	Silt	1.3	1.5	6.1												
1																		
2																		
3											54				38			
	6/10/1997	Glacial	Silt	1.5	1.5	9.7												
1										40		89		55	25(28-40)		114	23
										40		124			23(41-50)			
										44					60			
															65			
															115			
2										36	72				32		28	
										45	73				34		41	
										46	77				37		42	
										46					38		61	
															41			
															43			
															55			
3														84	45			75
														88	45			96
															47			97
															54			110
															56			111
															80			
	7/8/1997	Glacial	Silt	1.0	1.5	14.7												
							37							70	48		30	
1							37							71	53			
							57							72	63			
														73	63			
														79	67			
														83	85			
														83	105			

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-1	7/8/1997	Glacial	Silt	1.0	1.5	14.7								85				
1														93				
(cont.)														102				
2							40							73	50		40	32
							43							74	51		41	
							58							79	60		42	
														79			55	
														91				
														95				
3							37							88	50		32	31
														90	58		50	33
																	64	
	8/21/1997	Glacial	Silt	1.5	1.8	9.8												
1			w/ emergent									174		31	81		59	34
			vegetation											31			52	
														35				
														35				
														37				
														45				
														51				
														52				
														52				
														54				
														59				
														60				
														66				
														67				
														70				
														70				
														71				
														76				
														95				

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks area, 1997.

F-S-97-1	8/21/1997	Glacial	Silt	1.5	1.8	9.8												
2														32	40		169	
3																		
F-S-97-2	5/19/1997	Glacial	Silt	1.6	1.9	7												
1															73			
2																		
3																		
	6/10/1997	Glacial	Silt	1.3	2.5	9.7												
1															36		86	30
															36			37
															37			69
2														63	35		107	59
															36			
															46			
3							65				79				37		90	30
	7/8/1997	Glacial	Silt	2.3	2.0	15.4												
1														54	28			37
														60				
														76				
														76				
														85				
2														71				
														75				
3														73				
														74				
														76				
	8/21/1997	Glacial	Silt	1.0	1.5	9.7												
1														70	420			
														70				
														104				
2														55				

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-2	8/21/1997	Glacial	Silt	1.0	1.5	9.7								71				
2														75				
(cont.)														75				
3																	154	
F-S-97-3	5/19/1997	Glacial	Gravel	1.7	0.9	7.8												
1																		34
2															49			
															94			
															113			
3															56			37
															82			
	6/10/1997	Glacial	Gravel	1.4	2	9.2												
1							73											29
																		48
																		53
																		54
																		57
2																	103	30
																	103	58
																	111	
3							77								157		88	25
																	92	26
																	100	28
																	101	28
																	101	30
																	105	32
																	110	33
3																	113	40
																		40
																		43
																		57

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-3	7/8/1997	Glacial	Silt	1.9	2.0	14.5												
1			(willow/sedge)				42							76	40			
															47			
															123			
2															74			
3																		
	8/13/1997	Glacial	Silt	1.3	1.0	11.7												
1			(willows)						285					108	195			
2																		
3																		
F-S-97-4	5/19/1997	Glacial	Gravel/silt	1.7	2.0	8.5												
1																		
2															37			22
																		23
3																		26
	6/9/1997	Glacial	Gravel/silt	0.9	2.0	12.4												
1																		25
2														31	41			26
														32				34
														33				34
														33				
3															27			24
															27			
	7/8/1997	Glacial	Silt	2.6	2.5	14.6												
			(Equisetum)															
1							44							94				
							44											
							47											
2							44								47	370		35
																		35
																		36

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-4	7/8/1997	Glacial	Silt	2.6	2.5	14.6												
2																		41
3							37							82			60	31
							45											32
																		35
																		70
	8/21/1997	Glacial	Silt	2.1	2.0	8.8												
			(willows)															
1														31	39		55	
2											39							26
3								130										
F-S-97-5	5/20/1997	Glacial	Gravel/silt	1.7	2	7.1												
1																		
2																		42
																		50
3																		51
	6/9/1997	Glacial	Gravel/silt	1.6	3.0	10.6												
1														27	26		212	28
														30	26			32
														49	27			34
															28			
															30			
															150			
2																	212	26
																		29
																		30
																		31
																		31
																		54
3							79								65			41

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-5	7/7/1997	Glacial	Gravel	1.7	1.0	15.5												
1							43							39	56			28
							45							70	59			29
							47							90	79			33
							48							90	101			37
														91	106			47
														106	156			
2							42							37	60			37
							43							37	65			40
							45							42	83			
							47							44	92			
														45	142			
														48				
														50				
														57				
														70				
														84				
														84				
														89				
														91				
														95				
3							40								26			
							45								27			
							47											
	8/12/1997	Glacial	Silt	0	0.5	12.1												
1			(Equisetum)											62	32			
			(willows)											80	64			
														92	93			
2														85	107			

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-6	5/20/1997	Glacial	Gravel	1.6	2.0	7.2												
1																		
2																		25
																		26
																		28
3																		21
																		22
																		23
																		23
																		23
																		25
																		25
																		25
																		27
	6/9/1997	Glacial	Gravel	2.3	1.0	10.5												
1							100			46							114	26
																		27
																		30
																		34
																		53
																		60
																		69
2							91											26
							100											35
							101											51
																		51
																		53
																		56
																		61
3							90										84	26
							100										109	27
							117											31

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-6	6/9/1997	Glacial	Gravel	2.3	1.0	10.5												
3																		54
	7/7/1997	Glacial	silt/sand	3.1	2.0	17.2												
1			(sedges)				48								45		97	31
																	144	
2							40								114		105	40
															130			43
3															130		107	
															151			
	8/12/1997	Glacial	Silt	1.3	2.0	11.8												
1			(willows)															
2																		
3																		
F-S-97-7	5/20/1997	Glacial	Gravel	2.1	2.5	8.2												
1																		
2																		
3										37								
	6/9/1997	Glacial	Gravel	2.6	2.0	11.1												
1							96							72				29
2														72				34
																		43
																		43
																		50
																		57
																		59
3							85				64				183		234	47
							87								99		110	51
							88											55
							95											60
							96											68
							104											

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-7	6/9/1997	Glacial	Gravel	2.6	2.0	11.1												
3							115											
(cont.)							116											
	7/7/1997	Glacial	Silt	0.9	3.0	13.7												
1																		42
2							31											
							31											
							31											
							42											
3							33							28(37-50)	13(51-60)			31
							33							10(51-70)	16(61-60)			
							37							8(71-84)	8(81-100)			
							38								6(101-120)			
							41								150			
							41								188			
							42								195			
							44								225			
							45											
	8/12/1997	Glacial	Silt	1.9	1.5	10.7												
1			(Equisetum)												81			
2														56	102			
															129			
															132			
3																		37
F-S-97-8	5/22/1997	Glacial	Gravel	1.5	0.8	8.8												
1										29(33-38)	8(58-70)		33(63-84)	11(28-41)	11(30-40)			
															12(41-60)			
															8(61-80)			
															81			
															83			
															84			

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-8	5/22/1997	Glacial	Gravel	1.5	0.8	8.8												
1															118			
(cont.)															125			
															134			
															182			
2										26(31-44)	67		69		44			
													73		57		97	29
													74		62			39
													77		62			
													83		62			
													91		63			
													95		68			
															69			
															73			
															74			
															74			
															74			
															78			
															79			
															82			
															82			
															84			
															84			
															97			
															112			
															113			
															135			
															150			
3										32(31-44)	62		62	35	49		85	
											65		63		55			
											68		67		57			
											75		68		62			

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-8	5/22/1997	Glacial	Gravel	1.5	0.8	8.8												
3											83		70		67			
(cont.)													72		85			
													73					
													77					
													78					
													79					
	6/11/1997	Glacial	Gravel	1.4	1.0	11.7												
1														67	43		26	
														96	44			
														110	141			
2														65	136			
														66				
3														35				33
														64				39
														66				40
														92				
	7/9/1997	Glacial	Silt	1.1	1.0	13.9												
1														71				
2														54	50			39
														55	56			
														61	59			
														65	69			
														68	71			
														71				
3							65							45	65			
														70	94			
														94				
	8/15/1997	Glacial	Silt	1.5	1.5	10.9												
1																		
2																		
3														74				

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-9	5/21/1997	Glacial	Gravel	0.8	3.0	9.1												
1													85					
2										32	72							
										33	64							
										35								
3										35	68		72					
										40	69		75					
											75							
	6/11/1997	Glacial	Gravel	1.6	2.0	12.3												
1										33								
2																		39
3																		30
	7/9/1997	Glacial	Gravel	1.1	2.5	14.4												
1																		
2																		
3																		33
	8/15/1997	Glacial	Silt	1.5	2.0	10.8												
1														60	39			33
														71	91			
														72				
														75				
														76				
														79				
														95				
2																		
3														57	95			
														66	103			
														67	111			
														76				
														76				
														89				
														89				

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-9	8/15/1997	Glacial	Silt	1.5	2.0	10.8												
3														100				
(cont.)														109				
F-S-97-10	5/22/1997	Glacial	Sand/silt	0.5	n/a	9.6												
1										22(30-40)	58				55			
											64							
											70							
											70							
											72							
											72							
											73							
											74							
2										9(30-40)	58				45			
											60				58			
											62							
											66							
											73							
											73							
3										45(30-40)	61			21(20-40)	20(20-40)			
														5(41-60)	18(41-60)			
	6/11/1997	Glacial	Silt	1.1	2.0	12.3												
1										34								
										35								
2										33								
3																	26	
	7/9/1997	Glacial	Silt	2.2	1.5	14.2												
1														60				
														63				
														85				
														89				
														90				

APPENDIX IV. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-10	7/9/1997	Glacial	Silt	2.2	1.5	14.2												
2														60				
														62				
														62				
														77				
3														60				
														69				
	8/21/1997	Glacial	Silt	1.3	2.5	10.9												
1														60				
2														55				
3														55				
F-S-97-11	5/23/1997	Glacial	Silt	0.8	2.5	8.6												
1										35	80							
										35								
2										32								
										35								
										35								
3										35	59							
										35	75							
										35								
										36								
	6/11/1997			2.2	3	12.1												
1																		
2																		
3																		
	7/10/1997	Glacial	Silt	0.8	1.0	n/a												
1														43				
														65				
														66				
														83				
2																		

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-11	7/10/1997	Glacial	Silt	0.8	1.0	n/a												
3																		
	8/22/1997	Glacial	Silt	0	2.5	11.0												
1			(willow)	(eddy)										54	42			
			(Equisetum)											55				
														61				
2															39			
3																		
F-S-97-12	5/23/1997	Glacial	Gravel	0.6	2.0	7.7												
1										32	70							
										33	72							
										37								
2										32								
										34								
3										37								25
	6/12/1997	Glacial	Silt/gravel	0.9	1.5	13.6												
1														62	10(32-40)		28	27
															9(41-50)			32
															52			42
															52			
															55			
															84			
															100			
															110			
2										37					35		26	
															113		28	
																	30	
																	31	
3														60			27	27
																	30	
																	30	

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-12	7/10/1997	Glacial	Gravel	0.9	1.0	n/a												
1														70			32	30
																	35	
2																		
3																		
	8/22/1997	Glacial	Silt	0.5	2.5	10.3												
1							85							75	85			
														99				
2																		
3																		
F-S-97-13	5/23/1997	Glacial	Silt	0.9	1.5	8.9												
1																		26
2										32	70							35
										33								
3										34	68				54			
										35	70				68			
											71				181			
											72							
											73							
											73							
											74							
											75							
											75							
											77							
											80							
	6/12/1997	Glacial	Silt	0.9	3.0	12.7												
1															70		32	
2																	30	
																	32	
																	32	
3			(backwater)								78			62(20-40)	12(20-40)		30	

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-13	6/12/1997	Glacial	Silt	0.9	3.0	12.7												
3			(backwater)											154(41-60)	99(41-60)		31	
(cont.)														33(61-80)	30(61-80)		31	
														15(81-100)	8(81-100)		32	
															113		34	
															141			
	7/10/1997	Glacial	Silt	1.1	1.0	n/a												
1														43				
														65				
														66				
														83				
2																		
3																		
	8/22/1997	Glacial	Silt	1.1	2.0	11.3												
1												117			92			22
															138			
2															42			
3															40			
F-S-97-14	5/23/1997	Glacial	Gravel	1.5	1.5	8.3												
1											65							
											70							
2																		
3											72			50	71			
											74				82			
											74				90			
															105			
	6/12/1997	Glacial	Gravel	1.3	3.5	13.0												
1																		
2																		
3															38			40

APPENDIX VI. Fish captured in, and habitat characteristics of, seine sites in the Fairbanks sampling area, 1997.

F-S-97-14	7/10/1997	Glacial	Gravel	1.5	2.5	n/a												
1																	51	
2																		33
3																	35	
	8/22/1997	Glacial	Gravel	1.4	2.0	11.6											41	
1																		26
																		30
																		32
																		34
																		35
																		36
2														40				
														42				
														47				
														50				
														52				
														57				
														71				
														98				
3														45				35
														47				
														55				
														61				
														73				
														114				
KEY																		
AG = Arctic grayling			**CO = Coho salmon**				**LNS = Longnose sucker**											
AL = Arctic lamprey			**HWF = Humpback whitefish**				**NP = Northern pike**											
BB = Burbot			**KS = King salmon**				**RWF = Round whitefish**											
CH = Chum salmon			**LC = Lake chub**				**SSc = Slimy sculpin**											

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

							Forklengths of Fish Captured by Species								
Sample Site (haul #)	Date	Habitat Type (Water)	Bottom Type	Vel. (cfs)	Max. Depth (ft.)	Water Temp. (°C)	AG (mm)	BB (mm)	CH (mm)	CO (mm)	HWF (mm)	LC (mm)	LNS (mm)	RWF (mm)	SSc (mm)
D-S-97-1	5/28/1997	mixed	sand	0	3.8	9.7									
1															
2							159		41(32-38)						
3															45
	6/16/1997	mixed	silt/sand	0	4.0	8.5									
1									22						
									26						
									26						
2									16(20-30)	31					
									14(31-41)	38					
3									6(20-30)	40					
									77(31-40)	42					
										42					
										43					
										45					
	7/14/1997	Glacial	Silt	0.9	1.5	10.5									
1			(vegetation)												
2															
3							27						27	35	
														43	
	8/25/1997	Glacial	Silt	0.7	2.5	8.4									
1											94		31		
													41		
													42		
													46		
2													26		
3													22		
D-S-97-2	5/28/1997	Glacial	Sand	0	1.5	13.1									
1									38	97			31	83	35
									35				71		40
									22				178		

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-2	5/28/1997	Glacial	Sand	0	1.5	13.1									
2										80				70	
										90				80	
														81	
														94	
3									32	90	118			110	74
									35	95	120				
	6/16/1997	Glacial	Silt/gravel	1.4	1.5	12.9									
1									28				104		41
									31				105		48
									32						
									35						
2									30				73		45
									32						50
									34						
3									30(28-38)				94		30
															31
															36
															37
	7/14/1997	Glacial	Silt	1.0	0.5	13.0									
1													119		
2															
3													77	58	
													80	65	
													98		
	8/25/1997	Glacial	Silt	0.5	0.5	10.5									
1													44		
2												81	40	62	
													43		
													48		
													60		
3													30	79	

APPENDIX VII. **Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.**

D-S-97-2	8/25/1997	Glacial	Silt	0.5	0.5	10.5							34		
3													36		
(cont.)													50		
													74		
D-S-97-3	5/28/1997	Glacial	Gravel	2.1	1.5	12.6									
1										95			92		30
													98		40
													125		46
													172		62
													175		
2									35	75					30
									36	96					30
															35
															35
3													43		30
													95		30
															33
															34
															35
															35
															42
															47
															50
	6/16/1997	Glacial	Gravel	2.3	1.5	n/a									
1										39					
2													247		
3															
	7/15/1997	Glacial	Gravel	1.5	2.0	14.0									
1															
2															
3															

APPENDIX VII. Fish captured in, and habitat characteristics of seine sites in the Delta sampling area, 1997.

D-S-97-3	8/26/1997	Glacial	Silt	0.6	3.0	9.1									
1												32	34	58	
												35	36		
												37	41		
												38	43		
												41	43		
												43	44		
													45		
													47		
													50		
													52		
													56		
													57		
													61		
													80		
2															
3													39		
													44		
													56		
D-S-97-4	5/29/1997	Glacial	Silt	0.4	2.0	12.1									
1													19		33
													31		
													31		
													33		
													33		
													34		
													34		
													35		
													37		
													38		
													38		

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-4	5/29/1997	Glacial	Silt	0.4	2.0	12.1									
1													38		
(cont.)													39		
													40		
													41		
													41		
													43		
													44		
													45		
													45		
													130		
2									33				33		25
													35		26
													38		36
													144		
3									37				39		35
													46		
													53		
													72		
	6/16/1997	Glacial	Silt	1.2	2.5	n/a									
1									30						
2									32						
3									29						
									30						
	7/14/1997	Glacial	Silt	2.0	2.0	15.5									
1															
2															
3													240	42	
	8/26/1997	Glacial	Silt	0.9	3.0	9.3									
1											76	40			
2												35	36		20
												37	41		

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-4	8/26/1997	Glacial	Silt	0.9	3.0	9.3									
2												44	41		
(cont.)												51	44		
												61	46		
												64	47		
												67	49		
													50		
													55		
													61		
													62		
													66		
													99		
3														76	26
D-S-97-5	5/29/1997	Glacial	Gravel	2.4	1.0	11.8									
1							94							86	29
														106	34
														108	37
															42
															44
															48
															50
															50
															51
2									34				75	78	34
									35				76	80	40
									37				108	95	44
													130	110	75
													145	110	
														177	
3									36				105	82	41
									37					90	51

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-5	5/29/1997	Glacial	Gravel	2.4	1.0	11.8									
3									42					94	54
(cont.)														95	
														101	
	6/17/1997	Glacial	Gravel	2.3	1.0	n/a									
1									32				134		32
									33						33
															34
															37
															39
															40
															40
															41
															41
															42
															45
2									32						36
															36
															36
															37
															37
															40
															40
															41
															43
															45
															46
3															34
															36
															37
															38
															40

APPENDIX VII. Fish sampling in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-5	6/17/1997	Glacial	Gravel	2.3	1.0	n/a									
3															42
(cont.)															42
															52
															52
															54
															87
	7/15/1997	Glacial	Gravel	1.4	0.5	14									
1															
2														73	
3															
	8/26/1997	Glacial	Silt	1.1	1.0	9.2									
1												86	35		
												103	37		
													41		
													42		
													43		
													45		
													91		
													94		
2												37	45	80	
												46	45		
												51			
												53			
												55			
3													52		
D-S-97-6	6/3/1997	Glacial	Sand	0.3	1.0	10.2									
1									35	66	96		41		
									40	66					
										67					
2									35	93	95		72		

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-6	6/3/1997	Glacial	Sand	0.3	1.0	10.2									
2									37						
3									32		85				46
									33						
									34						
	6/19/1997	Glacial	Silt	1.4	2.0	15.0									
1															
2															
3									36						
	7/17/1997	Glacial	Gravel	1	1.6	12.0									
1															
2															
3															
	8/26/1997	Glacial	Gravel	1.0	2.4	8.7									
1							83						98		
							84								
							191								
2														94	
3															
D-S 97-7	6/3/1997	Mixed	Silt	0	2.5	10.2									
1									37						
2															
3															
	6/19/1997	Mixed	Silt	0	3.0	14.0									
1									133(31-36)				37		
													42		
2									65(31-36)			88	39		
												97			
3									61(31-36)				37		
													41		
													50		

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S 97-7	7/17/1997	Glacial	Silt	1.3	1.5	12.0									
1															
2															35
3														52	
														57	
	8/26/1997	Glacial	Silt	1.3	1	7.2									
1													81		
2															
3															
D-S-97-8	6/3/1997	Glacial	Gravel	2.0	1.5	12.1									
1									41						30
															32
															33
															35
															41
															45
															46
2															36
															36
															36
															37
3									34	67		52			31
									36						32
									37						60
									37						
									38						
									40						
									40						
									40						
									43						

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-8	6/18/1997	Glacial	Gravel	1.3	1.5	15.5									
1									34			92	47		30
									34			106	60		30
									35				78		33
									35				93		52
									35				139		
									36				232		
									36						
									36						
									36						
									37						
2									31			105	40		
													291		
3												85	226		30
												87	240		
												87			
												93			
	7/16/1997	Glacial	Gravel	2.1	1.5	16.5									
1															
2															
3												84	105		36
													111		39
	8/26/1997	Glacial	Silt	0.9	2.0	9.8									
1													34		
													59		
2															
3															
D-S-97-9	6/3/1997	Glacial	Gravel	0.8	3.0	12.4									
1										98		54			
2							73		36	98		54			
									40			54			

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-9	6/3/1997	Glacial	Gravel	0.8	3.0	12.4									
2									40						
3												40			
												54			
	6/18/1997	Glacial	Gravel	1.4	3	14.0									
1															31
															63
2															
3									30				36		
	7/16/1997	Glacial	Gravel	3.8	1.5	13.5									
1															
2															
3															
	8/26/1997	Glacial	Gravel	1.4	3.0	8.4									
1															
2														72	
3												53			
D-S-97-10	6/3/1997	Mixed	Gravel	0	2.0	12									
1							142		33	65			70		
									37	70			74		
									37	75			295		
									38	89					
									43	92					
2									32	87			72	95	
									34				183		
									39						
3									47						34
	6/18/1997	Mixed	Gravel	2.6	3.0	14.5									
1															
2									32						
									33						

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-10	6/18/1997	Mixed	Gravel	2.6	3.0	14.5									
2									34						
3									30						
									32						
									32						
									34						
	7/16/1997	Glacial	Silt	2.2	2.5	14.0									
1															
2															
3															
	8/26/1997	Glacial	Gravel/sand	1.5	1.0	8.6									
1												54			
												56			
												77			
2												45			
												51			
												52			
3												64			
D-S-97-11	6/16/1997	runoff	gravel	2.6	1.0	13.0									
1									35						27
									35						41
									35						
									35						
									37						
									37						
									37						
									38						
									40						
									40						
									40						
									41						

APPENDIX VII. Fish captured in, and habitat characteristics of, seine sites in the Delta sampling area, 1997.

D-S-97-11	6/16/1997	runoff	gravel	2.6	1.0	13.0									
2															
3															33
															34
	7/14/1997	Glacial	Silt	0.9	2.0	16.5									
1								307					175		
2														57	
3															
	8/25/1997	Glacial	Silt	1.6	3.0	10.5									
1			(vegetation)												
2											177				
3													208	81	29
															31
KEY															
AG = Arctic grayling			**CO = Coho salmon**					**LNS = Longnose sucker**							
BB = Burbot			**HWF = Humpback whitefish**					**RWF = Round whitefish**							
CH = Chum salmon			**LC = Lake chub**					**SSc = Slimy sculpin**							

APPENDIX VIII. Results of water quality sampling grouped by water class and mean values for each class.

Water Class	Location	Date	Turbidity	TSS
			(NTU)	(mg/l)
Groundwater # 1	Bear Creek	21-May	1.1	4.1
		9-Jun	2.3	6.1
		8-Jul	1.0	8.0
	Salchaket Sl. u/s Clear Cr.	21-May	1.3	9.3
	Clearwater Lake Outlet	29-May	2.2	16.9
		17-Jun	0.2	4.8
	Bluff Cabin	29-May	3.4	23
		17-Jun	0.9	35.3
	Blue Creek	29-May	0.6	2.1
		17-Jun	0.4	7.2
		15-Jul	0.5	2.3
		25-Aug	1.3	11.2
	Cub Creek	3-Jun	1.0	2.7
		19-Jun	0.9	1.8
	Clear Creek (Delta)	3-Jun	0.9	5.8
		19-Jun	0.3	0.5
		16-Jul	1.2	8.1
		27-Aug	1.1	7.6
	Richardson Clearwater	3-Jun	0.4	2.1
		19-Jun	0.6	2.3
		16-Jul	0.5	4.7
		27-Aug	0.8	6.3
Mean Values for Groundwater Systems:			**1.0**	**7.8**
Glacial # 2	Tanana River @ Cutoff Cr.	10-Jul	170	380
		15-Aug	450	3100
	Seven Mile Slough	22-May	20	130
	Tanana R. @ Goodpaster R.	17-Jun	120	274
		15-Jul	190	470
		25-Aug	80	295
	Tanana R. @ Chena Pump	21-May	28	221
		21-Jun	110	439
		10-Jul	150	282
		15-Aug	800	2380
	Tanana R. u/s Salchaket Sl.	22-May	9.1	73.6
		10-Jul	550	1430
	Bluffs Mainstem Tanana R.	10-Jul	160	310
		15-Aug	280	1670
	Tanana R. @ Big Delta	29-May	50	157
		17-Jun	120	152
		15-Jul	500	1450
		25-Aug	70	225
	Tanana R. d/s Delta River	3-Jun	27	172
		19-Jun	220	594
		15-Jul	500	2000
	Tanana d/s Richardson CW	19-Jun	120	471
		16-Jul	500	1320
		27-Aug	130	497
	Bluff Cabin	15-Jul	210	637

APPENDIX VII. Results of water quality sampling grouped by water class and mean values for each class.

	Bluff Cabin	25-Aug	75	295
	Tanana R. @ Salchaket Sl.	8-Jul	390	902
		12-Aug	340	1110
	Mouth Little Salchaket Sl.	7-Jul	190	618
		12-Aug	240	704
	Rosie Creek @ mouth	10-Jul	300	362
		15-Aug	600	1310
	Chocolate Sauce Creek	15-Aug	1000	2500
	Bear Creek Slough	8-Jul	330	976
		12-Aug	350	1180
	Clear Cr. @ Salchaket Sl.	8-Jul	110	409
		12-Aug	170	765
	Cub Creek	16-Jul	250	1820
		27-Aug	150	1220
	Richardson Clearwater	16-Jul	400	1180
		27-Aug	90	153
Mean Values for Glacial Systems:			**257.3**	**845.2**
Tannic Stained Runoff # 3	Clear Creek	21-May	1.1	50.5
		9-Jun	4.7	47.9
		8-Jul	5.7	10.1
		12-Aug	3.3	7.8
	Rosie Creek	22-May	21	121
	Chocolate Sauce Creek	22-May	4.2	21
		12-Jun	3.1	34.9
	Cutoff Creek	22-May	1.6	5.6
		12-Jun	1.1	0.6
	Check Station Creek	10-Jul	5.1	28.8
	Willow Creek @ mouth	22-May	3.6	14.5
		12-Jun	1.3	16.7
	Willow Creek u/s	10-Jul	5.3	4.1
		15-Aug	3.4	3.9
	Goodpaster R. @ mouth	29-May	0.5	9.6
		17-Jun	0.8	0.6
	Indian Creek	25-Aug	1.8	6.5
	Shaw Creek	3-Jun	0.9	9.4
		19-Jun	0.3	2.9
		16-Jul	4.1	10.2
		27-Aug	1.1	1.1
	Tenderfoot Creek	19-Jun	2.8	52.4
Mean Values for Tannic Stained Systems:			**3.5**	**20.9**
Mixed Runoff/Glacial # 4	Salchaket Sl. @ mouth	21-May	11.0	76.5
		9-Jun	8.7	88.2
	L. Salchaket Sl. @ mouth	21-May	22.0	200.0
		9-Jun	5.7	57.9
	Rosie Creek	12-Jun	100.0	209.0
	Chocolate Sauce Creek	10-Jul	20.0	313.0
	Cutoff Creek	10-Jul	7.8	13.8
		15-Aug	9.2	28.5

APPENDIX VII. Results of water quality sampling grouped by water class and mean values for each class.

	Check Station Creek	15-Aug	45.0	75.5
	Willow Creek mouth	10-Jul	7.4	8.7
		15-Aug	19.0	41.4
	Goodpaster River mouth	15-Jul	45.0	22.2
		25-Aug	22.0	16.7
	Indian Creek	17-Jun	19.0	85.9
		15-Jul	19.0	36.4
	Tenderfoot Creek	16-Jul	12.0	30.0
		27-Aug	9.1	26.7
Mean Values for Mixed Runoff/Glacial Systems:			**22.5**	**78.3**
Mixed Groundwater/Glacial # 5	Bear Creek Slough	9-Jun	17.0	109.0
	Mouth Bear Creek	12-Aug	26.0	81.5
	Clearwater Lake Outlet	15-Jul	11.0	28.9
		25-Aug	80.0	57.7
	Cub Creek Slough	19-Jun	110.0	399.0
Mean Values for Mixed Groundwater/Glacial Systems:			**48.8**	**135.2**

APPENDIX IX. Statistical analysis of water quality data used to test for differences between five water quality classes.

ANOVA: Single Factor	**TURBIDITY**					
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
1	22	22.9	1.05	0.5635		
2	41	10549.1	257.30	47382.22		
3	22	76.8	3.49	18.1809		
4	17	381.9	22.46	536.1224		
5	5	244.0	48.80	1919.7		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1546983.65	4	386745.9	20.6325	1.76E-12	2.460801
Within Groups	1911939.23	102	18744.5			
Total	3458922.88	106				
ANOVA: Single Factor	**TSS**					
Groups	*Count*	*Sum*	*Average*	*Variance*		
1	22	172.2	7.83	65.07827		
2	41	34653.6	845.21	537694.1		
3	22	460.1	20.91	769.0489		
4	17	1330.4	78.26	7131.209		
5	5	676.1	135.22	22616.63		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16498656.68	4	4124664	19.36119	7.08E-12	2.460801
Within Groups	21729846.67	102	213037.7			
Total	38228503.35	106				
Water Class	**Description**					
1	Groundwater					
2	Glacial					
3	Tannic Stained Runoff					
4	Mixed Runoff/Glacial					
5	Mixed Groundwater/Glacial					