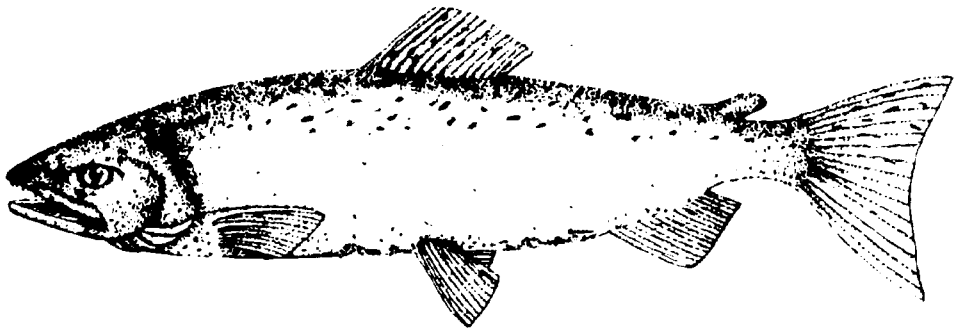
# ILLINOIS CREEK MINE FISH MONITORING STUDY: EMPHASIS ON JUVENILE COHO SALMON

by

Jack F. Winters

Technical Report 96-7



Alaska Department of Fish and Game
Habitat and Restoration Division

June 1996

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## ACKNOWLEDGEMENTS

USMX, Inc. provided most of the funding for this project. Paul Valenti, USMX, Inc. approved the funding and supported the project. Rick Richins, RTR, Inc., coordinated the inception, planning, and operational considerations of the project. John Lamborn, USMX, Inc., and Robin Tolbert, North Pacific Mining Corp., provided considerable assistance with field logistics at the mine. Phyllis Weber Scannell (ADF&G) assisted with planning, data collection and analyses, and report editing. Paul Valenti, Rick Richins, and Al Ott (ADF&G) also reviewed the report and provided constructive comments.

# INTRODUCTION

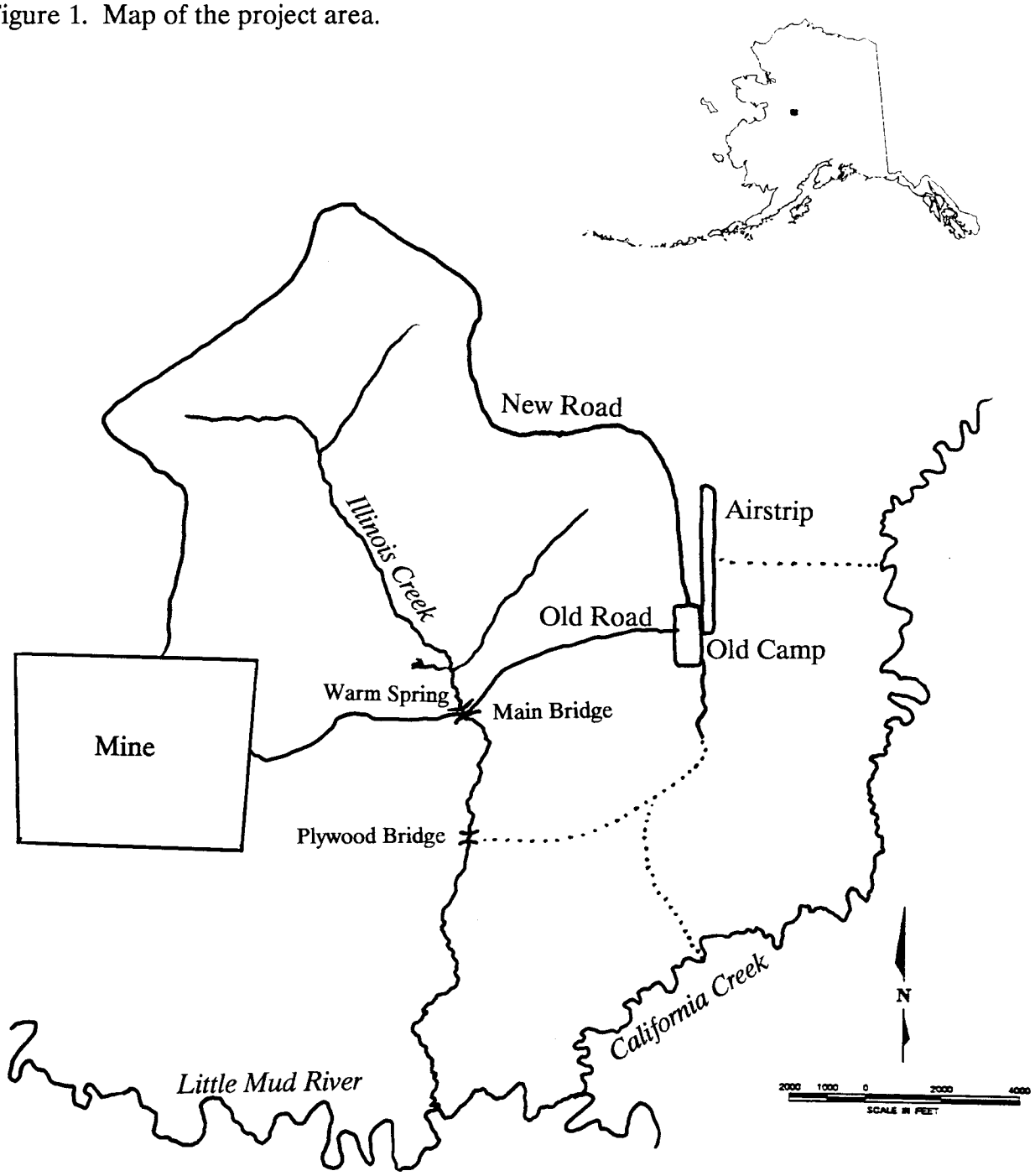
The Illinois Creek Mine Project is an open pit hardrock gold and silver mine that is being developed by USMX, Inc. The mine is located in the southern Kaiyuh Mountains, about 92 km southwest of Galena (Figure 1). As currently proposed, the mine will produce up to about 1,000,000 tons of ore and 3,000,000 tons of waste rock yearly from three pits, disturbing 18 to 20 ha in the main pit and 2.4 to 3.2 ha in two smaller pits. The mine will have an active life of six to eight years, with ore mined six to eight months of the year, and processed on-site with a cyanide heap leach process potentially operating year-round. The heap leach pad will cover about 26 ha and be underlain by a double synthetic liner. The facility is designed to achieve zero discharge, with the pregnant cyanide solution stored in the heap and pumped directly to the processing plant for gold recovery. A formal closure and reclamation plan, including heap detoxification, surface drainage control, reclamation of waste rock dumps and other disturbed areas, and monitoring the site following closure, has been developed for the project.

The mine site is located about 1.6 km from Illinois Creek, which is used by coho (*Onchorhynchus kisutch*) and chum salmon (*O. keta*) for spawning, and by juvenile coho and chinook salmon (*O. tshawytscha*) for rearing. Illinois Creek also contains Arctic grayling (*Thymallus arcticus*), Dolly Varden (*Salvelinus malma*), Alaska blackfish (*Dallia pectoralis*), burbot (*Lota lota*), and slimy sculpin (*Cottus cognatus*). Mine workers have reported seeing northern pike (*Esox lucius*) in Illinois Creek. Illinois Creek flows into the Little Mud River which flows into the Mud River. The Mud River then flows into the Innoko River. The southern unit of the Innoko National Wildlife Refuge includes portions of the Little Mud, Mud, and Innoko rivers.

## Pre-1995 Knowledge of Fish Distribution in Illinois Creek and Surrounding Waters

Information on the distribution, numbers, and species of fish in the Illinois Creek drainage and surrounding areas is limited. A brief reconnaissance and field investigation was conducted in 1991 by Northern Ecological Services (Morsell 1991). In October 1994, Northern Ecological Services conducted a brief reconnaissance survey of a proposed access route from the Yukon River to the Illinois Creek mine site and field investigations of fish and habitat in Illinois Creek (Morsell 1994).

Figure 1. Map of the project area.



In 1991, sampling with minnow traps on August 9 and 10 confirmed the presence of juvenile coho salmon in Illinois Creek at and above the mine road crossing (Morsell 1991). Eight adult chum salmon carcasses and one live adult chum salmon were observed in Illinois Creek. Six chum salmon were above the main bridge and three were downstream of the bridge. Chum salmon were first noted at the road crossing by camp personnel in late July. A second run of chum salmon (up to 30 fish) was noted by camp personnel starting in late September and continuing into mid October. These fish were in Illinois Creek between the road crossing and the upper springs. One chinook salmon was reported in this same general area. Small numbers of Arctic grayling were observed in Illinois Creek above and below the mine road crossing.

On October 12, 1994, 43 adult coho salmon were observed in a one mile reach of Illinois Creek approximately centered on the mine road crossing. All fish were downstream from the warm spring area and all except one were downstream of the mine access road bridge. Juvenile coho salmon 60 to 100 mm long were observed in the portion of Illinois Creek directly affected by warm springs. Eight Arctic grayling 80 to 150 mm long were observed in the warm spring area. One slimy sculpin was observed near the headwater springs.

Additional fish sampling in the region of the Illinois Creek Mine has been limited primarily to the Innoko River and its larger tributaries, both upstream and downstream of the mine. Alt (1983) collected baseline data on fish and fish habitat in 1982 and 1983 in the Innoko River and some of its major tributaries. Fish collected or observed in these river systems were sheefish (*Stenodus leucichthys*), least cisco (*Corregonus sardinella*), broad whitefish (*C. nasus*), humpback whitefish (*C. pidschian*), round whitefish (*Prosopium cylindraceum*), Arctic grayling, northern pike, burbot, ninespine stickleback (*Pungitius pungitius*), Arctic lamprey (*Lampetra japonica*), slimy sculpin, chinook salmon, coho salmon, and chum salmon. More recent fish sampling focused on the assessment of salmon stocks in the Innoko River and its major tributaries within the Innoko National Wildlife Refuge (Rost 1988, Millard 1995).

## OBJECTIVES

The Alaska Department of Fish and Game conducted investigations on the fish resources of Illinois Creek and neighboring waters to assess possible impacts to fish and fish habitat from development of the Illinois Creek Mine. Potential effects from mine development include changes in sediments entering Illinois Creek from mine activities and surface disturbance; alterations of surface flow and run-off from the mine area; alterations to groundwater flow, or alterations to the flow of groundwater springs supplying water to Illinois Creek; and changes in surface and subsurface water quality (e.g., metals, total dissolved solids, cyanide and process chemicals) from mine activities during operations and, potentially, post-closure.

ADF&G's fish investigations in Illinois Creek are proposed for the entire active life of the mine and several years past closure. The objectives of these investigations are to:

(1) determine the mid summer (July-August) numbers and distribution of juvenile coho salmon in Illinois Creek.

(2) determine presence of adult salmon and their distribution in Illinois Creek in late July and in late September-early October.

(3) determine pre-mining whole-body concentrations of selected metals in 30 juvenile coho salmon from Illinois Creek.

(4) determine the occurrence and distribution of fish species other than salmon in Illinois Creek.

(5) determine the occurrence of juvenile coho salmon and other species in California Creek at trail-accessible locations.

Besides the five objectives proposed for this study, gathering of additional information was proposed if logistics and time permitted. This information included documentation of the presence and distribution of fish in neighboring streams (e.g., Colorado Creek, Little Mud River), the documentation of use of the mine area and Illinois Creek by wildlife species, and collection of juvenile coho salmon for histological examination of selected tissues.

## METHODS

### Salmon Distribution and Abundance

Juvenile coho salmon in Illinois Creek were captured with minnow traps baited with frozen salmon roe contained in perforated plastic bags. Three sets of 10 minnow traps were placed in 3 reaches of Illinois Creek for 24 to 48 hr and the locations recorded. One reach was from the main bridge upstream to and including parts of the three main forks of Illinois Creek (about 0.25 km linear distance) (Figure 2). The second reach was from the main bridge downstream about 0.4 km. The third reach was about 0.3 km long and was centered around the plywood bridge (a small log and plywood structure) at the downstream access point to Illinois Creek. One set of six minnow traps was fished for 24 hr in California Creek at the two trail access points. Latitude and longitude for all July sample sites and for the upstream limits of observed salmon distribution were obtained with a global positioning system (GPS) receiver.

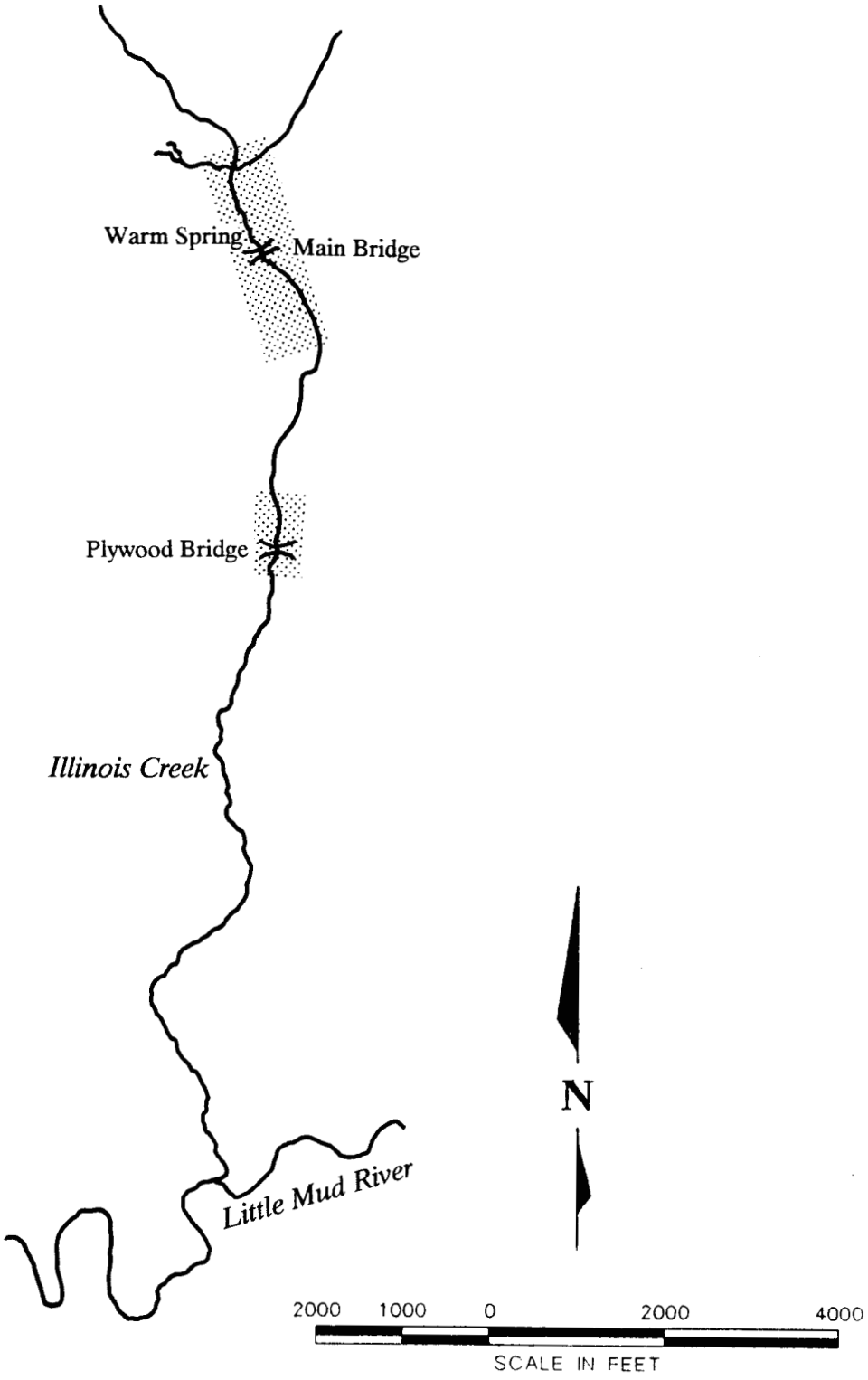
In late July, two days were spent capturing, marking with an adipose fin clip, and releasing juvenile coho salmon to estimate relative abundance of these fish in Illinois Creek. The minnow traps were removed from the stream and after a period of two days, the traps were again placed in the stream at the original capture locations and fished for one day. All recaptured juvenile salmon were measured and examined for an adipose fin clip.

Adult chum salmon were counted in Illinois Creek upstream of the main bridge by walking alongside or in the creek. Adult coho salmon were counted by: walking alongside or in the creek in the sample reaches upstream and immediately downstream of the main bridge; and by walking alongside the creek in the plywood bridge sample reach.

### Collection of Salmon for Metals Concentrations Analyses

Thirty juvenile coho salmon were collected in Illinois Creek for whole-body analyses of metals concentrations on July 19 to establish baseline pre-mining conditions. The larger of the two apparent age classes (80 to 117 mm fish) found in the stream were selected to ensure adequate amounts of tissue for the analyses. Because the larger-

Figure 2. Sampling areas in Illinois Creek in 1995.



sized fish were not common in the trap catches and no more than six were found in any one trap (most did not have any), fish were collected from all three sample reaches in Illinois Creek. The juvenile coho salmon were taken from the minnow traps, measured, placed in numbered pre-cleaned plastic bottles (EPA protocol C, Series 300), and stored on ice in a cooler. The samples were shipped to Fairbanks on July 20 where they were frozen pending analyses. The samples were shipped frozen to a private laboratory where whole-body analyses were performed using U.S. EPA standard methods.

ICP-MS analyses for eight metals and cold vapor atomic absorption analyses for mercury were performed as an initial screening for metals in five juvenile fish. The results of the initial screening were used to select the elements for which the remaining 25 samples would be analyzed. Metals ultimately selected for analyses were based on their presence in the ore and waste rock, their potential presence in the final heap solution following cyanide detoxification, and their toxicity to fish.

Four spawned adult coho salmon were collected with a dip net on October 3 for whole-body metals analyses. Three were taken in the area of the main bridge and one near the upper limit of observed adult coho distribution. The fish were placed in clean plastic bags, placed on ice at the mine site, transported to Fairbanks the following day, and frozen. The samples were shipped frozen to a private laboratory where whole-body analyses were performed using U.S. EPA standard methods.

Five spawned adult chum salmon were collected on July 23 for metals analyses. These fish were frozen at the mine site, transported to Fairbanks, and stored frozen. These fish ultimately were not analyzed for metals concentrations.

Collection of Juvenile Coho Salmon for Histological Analyses

Twenty juvenile coho salmon (10 of each age class) were collected from Illinois Creek for histological analyses of various tissues. All of the smaller-sized fish (56 to 74 mm) were taken from trap sites upstream of the main bridge. Five of the larger fish were taken from additional traps set upstream of the main sampling reach on Illinois Creek; the other five fish were taken from traps in the plywood bridge sampling reach. The fish were killed by severing the spinal column behind the head with scissors. The opercula were removed and slits were made in the body wall to facilitate preservation of the gills and internal organs. The fish were preserved in

tissue fixative (Davidson's Solution) for 5 to 7 days and then placed in 65% ethanol. Histological analyses of tissues were conducted by the U.S. Fish and Wildlife Fish Technology Center in Bozeman, Montana.

Other Fish Species

Species other than juvenile salmon caught in minnow traps were measured and released without fin clips. Estimates of size and number were recorded for free-swimming fish observed during visual observations of the creek.

# RESULTS

## Streams

### Illinois Creek

Illinois Creek is about 7 to 8 km long and drains an area of about 30 $km^2$. Minor disturbance along Illinois Creek has been restricted to stream crossings and water withdrawal associated with mineral exploration activity. The main bridge across Illinois Creek was installed in September 1991 to facilitate mining claim development and to minimize adverse effects to salmon in the creek. Before installation of the bridge, the creek was forded immediately upstream of the bridge site. The ford crossing alongside the main bridge is still used occasionally when equipment weight exceeds the limits of the bridge. A plywood and log foot bridge spans the creek at the location of the warm spring. An infiltration gallery for water withdrawal at the warm spring had been dug at some time in the past but now the only evidence of this activity is the disturbed ground where the excavated material has been replaced. A plywood and log bridge from earlier exploration activity remains in place at the lower trail crossing of Illinois Creek, about 1 km downstream of the main bridge.

The character of Illinois Creek varies considerably within the 1.5 km encompassing the upper reach of observed fish distribution. Illinois Creek ranges from about 1 m wide in its upper forks to about 10 m wide at its widest point near the warm spring. In most locations, it is about 4 to 6 m wide. Depths generally range from 0.2 m to over 2 m. Silt to large cobbles or small rock forms the stream bottom, depending on location and water velocity.

Three forks emanating from local springs or runoff and springs farther up the valley join about 0.2 km above the main bridge to form one single channel that characterizes Illinois Creek for its remaining length (Figure 3). The east and middle forks are incised, up to 1 m deep, lined with grasses and sedges, and are from 1 to 2 m wide. The west fork is wider (2 to 3 m), shallower ($<0.5$ m), has a bottom of rock and sand, and is derived from springs emanating from the toe of a spruce-covered hillside.

From the forks to the main bridge, the creek is 3 to 5 m wide and 0.3 to 1 m deep, with a gravel, cobble, or rock bottom in most places (Figure 4). Willow, alder,


Figure 3. The upper reaches of Illinois Creek.


Figure 4. Illinois Creek from the headwater forks to the main bridge.

grasses, sedges, and other plants are dense along the stream banks and overhang much of the stream. Springs discharge to the stream at many locations. In the area of the warm spring discharge just upstream of the main bridge, abundant filamentous algae grow on the stream bottom.

Downstream of the main bridge, the stream becomes more sinuous, contains deeper pools (deeper than 2 m in places), has higher banks (2 to 3 m in places), and contains numerous logs and woody debris (Figure 5). Occasional riffles have cobble or gravel bottoms. The remainder of the stream appears to have a silt or sand bottom, although the depths of the pools and debris restricts the ability to visually determine the composition of the substrate. Vegetation along the banks also is dense and overhangs much of the stream.

California Creek

California Creek is a much larger stream than Illinois Creek (Figure 6). It is about 30 m wide at the primary trail access points from the Illinois Creek Mine airstrip and camp. It is deeper than 2 m in many places. Small sand and gravel bars occur on the inside of some meanders.

**Adult Salmon Surveys**

Adult chum salmon were first seen in Illinois Creek on July 13 near the main bridge (J. Lamborn, USMX, pers. comm.). Sixty eight live and 1 dead adult chum salmon were observed in Illinois Creek on July 17 from the main bridge upstream as far as viewing conditions allowed. Fish were distributed throughout this reach, with no concentrations in any particular area. Four adult fish were in the middle fork about 50 m upstream of the confluence of the forks. Downstream of the main bridge, streamside vegetation and general stream characteristics made a thorough assessment of the numbers of adults present difficult; thus, adult chum salmon were not counted in this reach. Observations during juvenile coho salmon sampling in reaches downstream of the main bridge indicated few adult chum salmon were spawning in these downstream locations.

Adult coho salmon were not abundant in Illinois Creek in 1995. Adult coho salmon were reported in Illinois Creek on September 20 (Oldaker 1996). Eleven adult coho

Figure 5. The lower sampling area of Illinois Creek.

Figure 6. California Creek at the lower trail access point.

salmon were in the stream on October 2. Five adults were upstream of the bridge and six were downstream. The fish upstream of the bridge were about 60 m (1 fish), 170 m (1 fish), and 350 m (3 fish) upstream (distance measured point to point). The farthest upstream adults were about 100 m farther upstream than were chum salmon observed in late July. The fish downstream of the bridge were about 40 m (3 fish), 180 m (1 fish), 190 m (1 fish), and 310 m (1 fish) downstream. No adult coho salmon were observed in the section of Illinois Creek surrounding the plywood bridge about 1 km downstream of the main bridge.

A recount of the adult salmon present in Illinois Creek on October 3 (following removal of four adults for metals analyses) produced seven adult coho salmon: six within 50 m of either side of the main bridge and one at the upper limit of adult salmon distribution in the creek. The creek was not examined more than 100 m downstream of the main bridge on October 3. A recount on October 4 produced 7 adults: 3 at the bridge and one each at 90, 130, 310, and 340 m downstream of the main bridge. The reach of stream surrounding the plywood bridge was not examined on October 4.

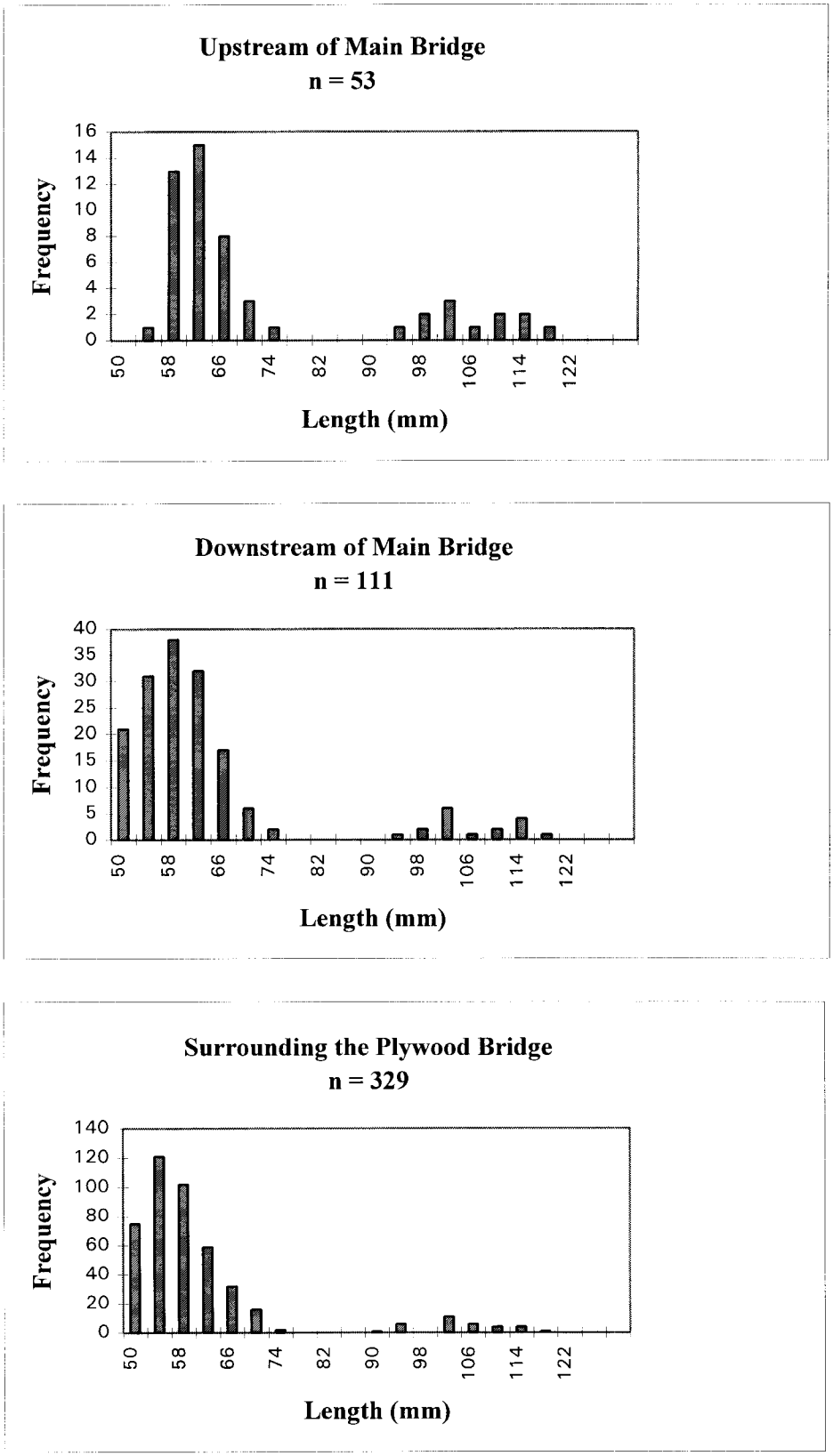
**Juvenile Fish Presence and Relative Abundance**

Illinois Creek - July

On July 18, 10 minnow traps were set in each of the three reaches of Illinois Creek. The traps were examined 24 hr later, all captured fish measured, and the adipose fin of juvenile coho salmon clipped. Traps contained primarily juvenile coho salmon, mostly young-of-the-year but also a few one year old fish. Other species caught in the traps (both initial mark and recapture events) were Alaska blackfish, Dolly Varden, slimy sculpin, and burbot. The blackfish were found in the sedge-lined east fork of Illinois Creek, an area at one time inundated by a beaver pond. The slimy sculpin were scattered throughout the creek. Burbot and the one Dolly Varden were found downstream of the main bridge. About 10 Arctic grayling, 100 to 200 mm long, were observed near one of the entry points of discharge from the warm spring upstream of the bridge.

The juvenile coho salmon ranged in length from 42 to 118 mm, with young-of-the-year salmon generally 47 to 70 mm and one year old coho salmon generally 90 to 110 mm (Figure 7). The total catch for the initial sampling event was 493 juvenile

Figure 7. Length-frequency distribution of juvenile coho salmon in three Illinois Creek sampling areas on July 19, 1995.



coho salmon. Mean lengths of juvenile coho salmon differed significantly among the three sampling reaches (ANOVA, $p = 1.76 \cdot 10^{-7}$) (Table 1).

Traps set in the reaches downstream of the main bridge and at the plywood bridge generally had larger catches than did traps upstream of the main bridge. The maximum catch was about 65 juvenile coho salmon per trap, most of which were young-of-the-year fish. Several traps upstream of the main bridge did not catch fish.

On July 22, the 30 minnow traps were reset to recapture coho salmon in Illinois Creek. The length frequency distribution of salmon captured in this event was similar to that observed in the initial capture event (Figure 8). Mean lengths of juvenile coho salmon measured during the recapture event differed significantly among the three sampling reaches (ANOVA, $p = 0.006186$) (Table 1). Comparisons of mean length (Student's t, $p = 0.000889$) of juvenile coho salmon between initial and recapture events indicated a significant difference only for the downstream sample reach. Length frequency distributions for all juvenile coho salmon sampled in July for each sample reach and for the entire sampling period are presented in Figures 9 and 10.

Of the 583 total juvenile coho salmon recaptured, only 26 (4.5%) were fish marked on July 19. The distribution of recaptures was not uniform. Recaptures were found in 10 of 30 traps; 1 trap in the reach above the bridge; 2 traps in the reach below the bridge; and 7 traps in the reach surrounding the plywood bridge. Recaptures per trap ranged from one to six fish. The irregular distribution of recaptures precluded development of any meaningful population estimate.

Illinois Creek - October

Ten minnow traps were set on October 2 upstream of the main bridge at the same sample sites used in July. All but one trap contained juvenile coho salmon. Two juvenile chinook salmon, 87 and 103 mm long, were caught in a trap set just upstream of the warm spring.

The 160 juvenile coho salmon caught in October ranged from 50 to 127 mm long, with most fish from 65 to 90 mm (Figure 11). The mean length of juvenile coho salmon was $82.7 \pm 16.4$ mm. The shift in the length-frequency distribution for juvenile coho salmon upstream of the main bridge between late July (Figure 10) and early October (Figure 11) indicates a 15 to 20 mm gain in length over this period.

Table 1. Mean length of juvenile coho salmon in Illinois Creek by sampling area and sampling period.

| | Original Capture | | Recapture | |
|---|---|---|---|---|
| | $\bar{x} \pm sd$ | n | $\bar{x} \pm sd$ | n |
| Upstream | 70.6 ± 19.1 | 53 | 67.2 ± 20.6 | 29 |
| Downstream | 57.7 ± 12.0 | 111 | 61.9 ± 12.9 | 208 |
| Plywood Bridge | 59.4 ± 14.3 | 329 | 59.7 ± 13.6 | 346 |
| Combined | 60.2 ± 14.8 | 493 | 60.9 ± 13.4 | 583 |

Figure 8. Length-frequency distribution of juvenile coho salmon in three sampling areas in Illinois Creek on July 23, 1995.

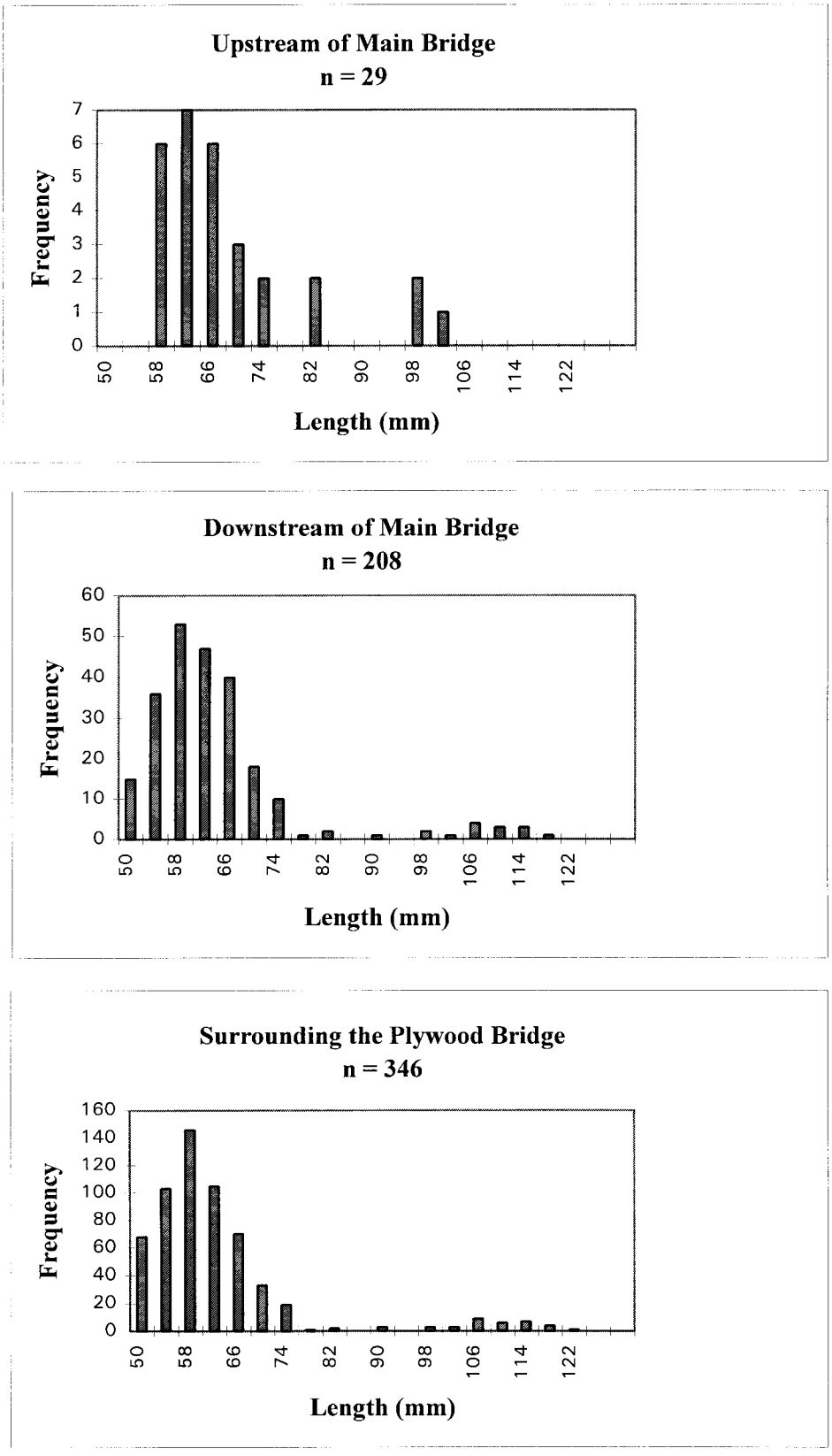


Figure 9. Combined length-frequency distribution of juvenile coho salmon by sample reach captured during the initial and recapture events in Illinois Creek, July 1995.

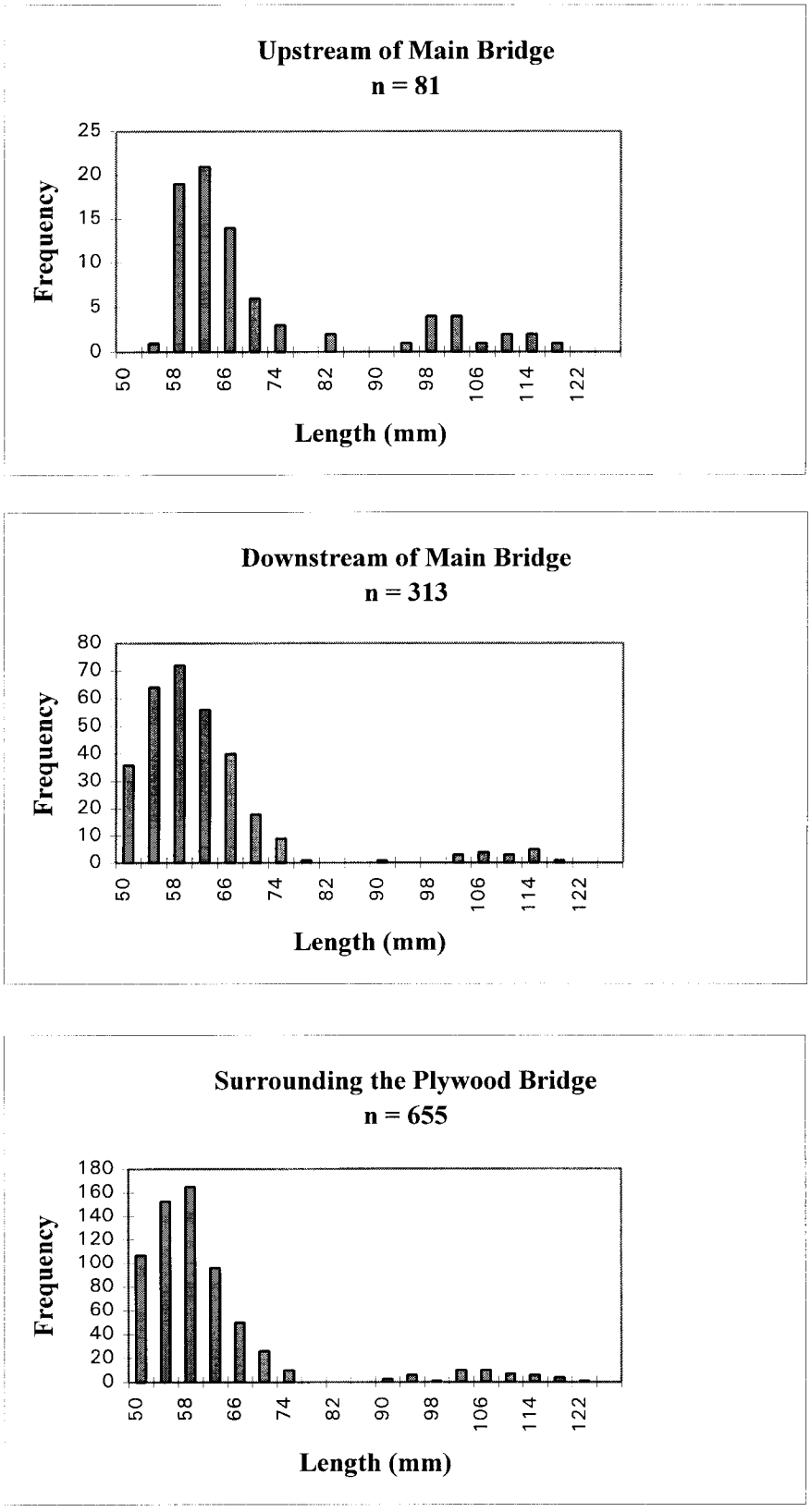


Figure 10. Length-frequency distribution of all juvenile coho salmon captured in Illinois Creek in July 1995.

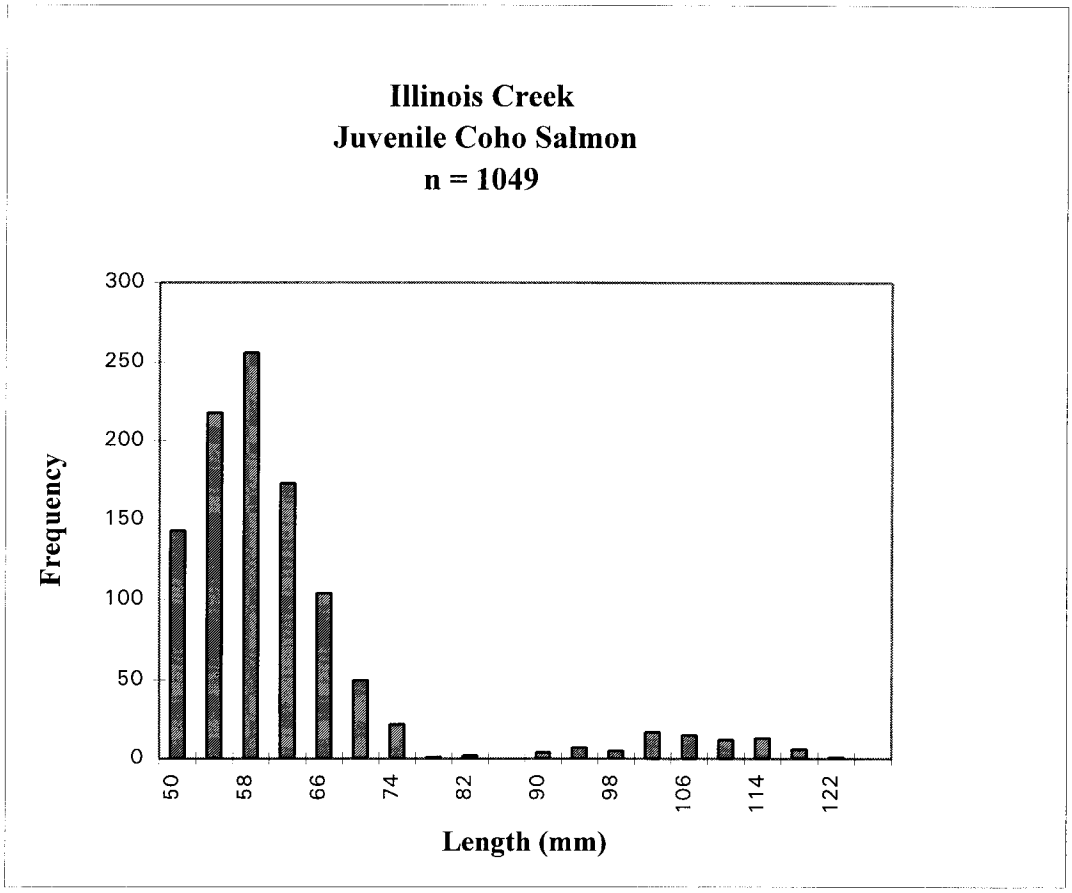
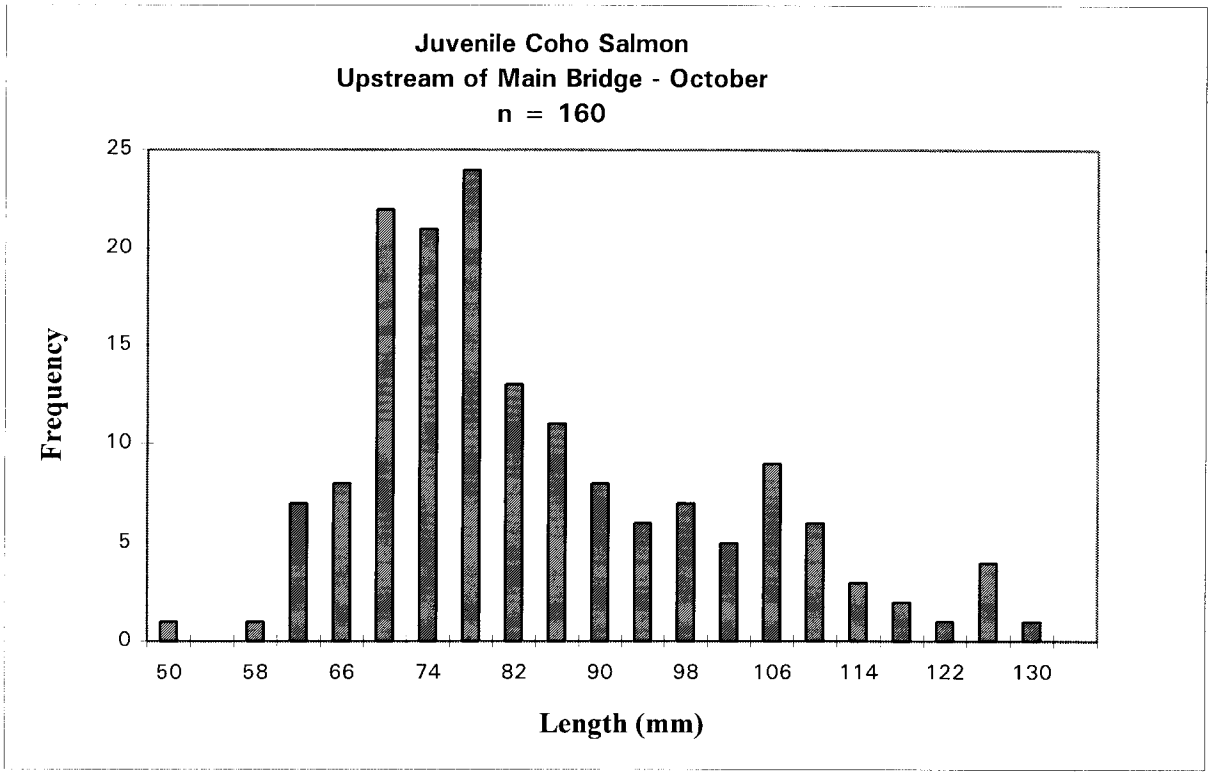


Figure 11. Length-frequency distribution of juvenile coho salmon captured in Illinois Creek upstream of the main bridge on October 3, 1995.



Juvenile coho salmon also were distributed at least 75 m farther upstream than they were in July. Trap catches and visual observations indicated juvenile coho salmon were more uniformly distributed in this reach of stream than in July.

California Creek, Colorado Creek, and Little Mud River

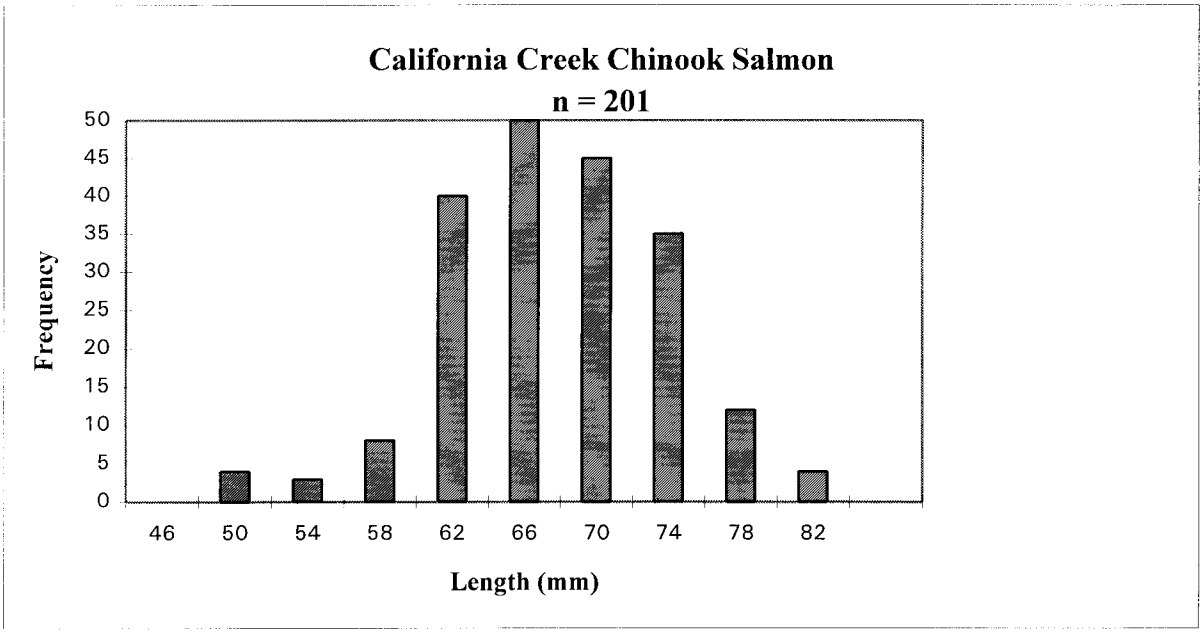
Six minnow traps were set for 24 hr along about 125 m of the west bank of California Creek at the upper trail access point on July 22. Six minnow traps also were set along about 250 m of the west bank of California Creek at the lower trail access point. Traps were placed in water 1 to 2 m deep along cutbanks, in eddies, behind deadfalls, or in the main current.

The catch in California Creek was primarily juvenile chinook salmon, with a few juvenile coho salmon and slimy sculpin. The total catch was 47 chinook salmon for the lower California Creek site and 154 for the upper site. The chinook salmon ranged from 47 to 80 mm in length (Figure 12). The mean length of chinook salmon was 66.3 ± 6.1 mm. The 15 coho salmon juveniles (from both sampling locations) ranged from 49 to 115 mm in length and had a mean length of 73.6 ± 19.5 mm.

K. Mueller (USFWS) set minnow traps on July 20 in Colorado and California creeks, and in the Little Mud River. The California Creek sites were approximately 3.2 and 14.5 km upstream of the Illinois Creek airstrip. The Colorado Creek site was about 3.2 km upstream of its mouth, and the Little Mud River sites were 3.2 to 4.8 km downstream of the mouth of Illinois Creek.

The 14 USFWS California Creek traps contained juvenile salmon (mostly chinook, but some coho also were present), a number of small Dolly Varden, a few slimy sculpin, and one Alaska blackfish. The Colorado Creek trap contained 76 juvenile salmon. Thirteen traps set at the two sites in the Little Mud River caught four slimy sculpin and one juvenile salmon.

Figure 12. Length-frequency distribution of juvenile chinook salmon captured in California Creek on July 23, 1995.



**Metals Concentrations in Coho Salmon**

Juvenile Salmon

Metals concentrations in whole-body juvenile coho salmon are presented in Figure 13 and in Appendix 2. Quality control data for the juvenile coho salmon metals samples are presented in Appendix 3. The 30 juvenile coho salmon were analyzed in two groups: 5 fish for 9 metals and the remaining 25 fish for 4 metals of the original series of 9 metals. Copper and arsenic were found in highest concentrations; silver was the lowest. Concentrations of silver were at or below the method reporting limit (MRL) for 21 of 30 samples. The remaining samples of silver were slightly above the MRL. Concentrations of cadmium were near the MRL.

Adult Salmon

Metals concentrations in four whole-body spawned adult coho salmon are presented in Figure 14 and in Appendix 4. Quality control data for the adult coho salmon metals samples are presented in Appendix 5. Copper concentrations were the highest of the metals analyzed; silver concentrations were the lowest.

**Histological Sampling of Tissues from Juvenile Coho Salmon**

Histological analyses of gill, heart, kidney, liver, pyloric caeca/stomach, intestine, and gonad tissues from 20 juvenile coho salmon, 10 from each of the two age classes, showed the fish to be in good condition. A copy of the laboratory analyses report is presented as Appendix 6.

Figure 13. Median, maximum, and minimum concentrations of selected metals (mg/kg dry weight) in juvenile coho salmon. Method Reporting Limit used in calculations if non-detection was reported for an analyte by the analytical laboratory. n= 5 for Cd, Cr, Pb, Ni, and Sb; n= 30 for As, Ag, Cu, and Hg.

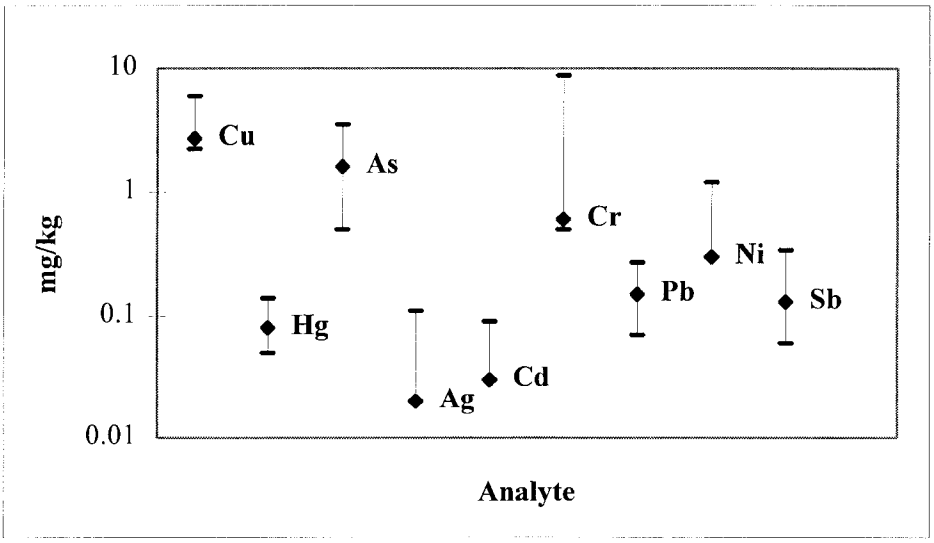
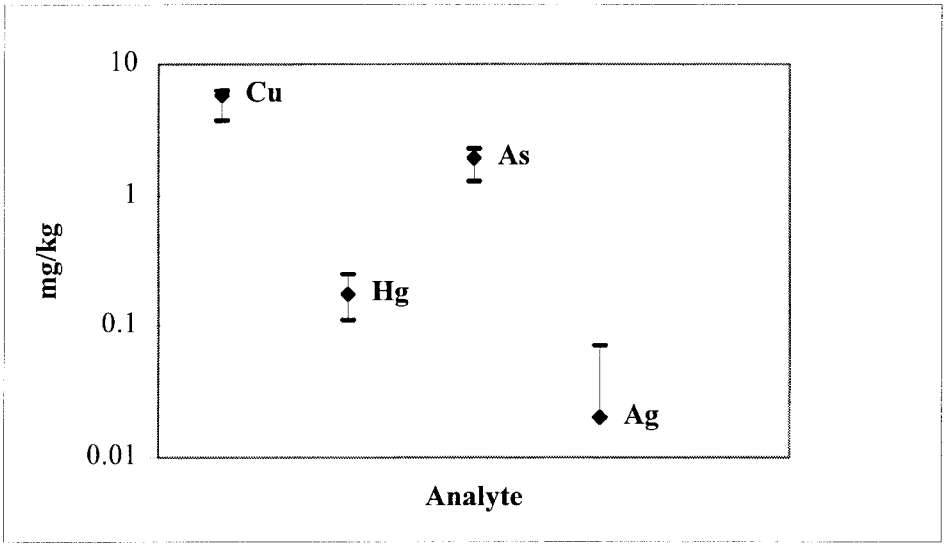


Figure 14. Median, maximum, and minimum concentrations of selected metals (mg/kg dry weight) in four adult coho salmon. Method Reporting Limit used in calculations if non-detection for an analyte was reported by the analytical laboratory.



## DISCUSSION

Adult salmon documented to date in Illinois Creek include summer chum salmon and coho salmon. The late run of fall chum salmon in Illinois Creek in late September reported by camp personnel (Morsell 1991) may have been coho salmon that were mistakenly identified as chum salmon. Only adult coho salmon were observed in Illinois Creek in October 1995.

Numbers of summer chum salmon were high in the Yukon River drainage in 1995. This may be the reason the numbers of summer chum salmon observed in Illinois Creek in 1995 were considerably higher than those observed in 1991, the only other year for which information on summer chum salmon in the Illinois Creek drainage is available. Although the summer chum salmon run in the Yukon River drainage was above average in 1991 (K. Schultz, ADF&G, pers. comm.), Morsell (1991) reported only nine adult chum salmon, eight of which were carcasses, in Illinois Creek on August 9 and 10, 1991. This considerably lower number may be a function of the later salmon survey in 1991; salmon carcasses may have washed downstream from the areas observed or been removed by scavengers.

Numbers of adult coho salmon in Illinois Creek were considerably lower in 1995 than in 1994. Morsell (1994) reported 43 adult coho salmon in 1.6 km of Illinois Creek centered on the main bridge. Most of the fish in 1994 were downstream of the main bridge. In 1995, the distribution was approximately equal upstream and downstream of the main bridge. Those adult coho salmon more than 50 m downstream of the main bridge appeared to be traveling and were not on or near any apparent redds. Those upstream of or near the bridge generally were paired and holding near redds or suitable locations for redds.

The streambanks and streambottom of Illinois Creek prevent a visual census of adult salmon. Cutbanks with abundant overhanging vegetation, undercut banks, logs, and deep pools make it impossible to see all potential areas of the stream that may hold fish, or to safely walk the banks or walk within the stream to count fish, particularly in the area downstream of the main bridge. Some of the adult coho salmon were holding under cutbanks, particularly in the uppermost reaches of Illinois Creek. By observing the creek from the same locations year after year, relative estimates of the number of adult salmon in the creek can be made.

It is possible that salmon (adult or juveniles) occur farther upstream in the middle fork of Illinois Creek than observed in early October. Incised stream channels, undercut banks and overhanging streamside grass make following channels and observing fish difficult. More intensive sampling would be needed to determine the maximum upstream distribution of salmon in this system.

Length frequency analyses of juvenile coho salmon conducted by Morsell (1991) suggested the presence of two and possibly three age classes of coho salmon in Illinois Creek. These age classes consisted of young-of-the-year fish and fish one year old, with the possibility of an additional class of two year old fish. Length frequency analyses in this study indicated two year classes of juvenile coho salmon are present in Illinois Creek in July. The most numerous year class contains fish hatched in the current year. The other substantially less numerous age class is made up of fish hatched one year earlier. This indicates most of the juvenile coho salmon in Illinois Creek leave the system as they become one year old fish, with a limited number of individuals staying in the system for an additional year and leaving at two years of age.

Morsell (1991) reported that juvenile coho salmon were more abundant in the vicinity of the main bridge and above, based on a visual survey of the creek. In the current study, juvenile coho salmon were more easily observed in the reach of creek upstream of the main bridge; however, minnow trap catches showed juvenile coho salmon were more abundant in areas downstream of the main bridge in July. This spatial difference in abundance probably is related to different stream characteristics, habitat differences, and potentially, food resources available to fish above and below the main bridge.

Compared with downstream trap catches, the catches of coho salmon upstream of the main bridge were relatively poor. In several instances, traps set in the midst of or slightly upstream of a school of juvenile coho salmon caught few fish. Abundant aquatic insects and loose eggs from spawning adults may have provided an abundant food supply, making the salmon eggs in the traps less attractive. Catches were larger in traps downstream of the bridge where few chum salmon were spawning. Differences in stream characteristics and substrate may account for differences in numbers of fish using these areas. These habitat differences also may influence the amount and type of aquatic food resources available to the fish.

The primary purpose of sampling juvenile coho salmon for concentrations of metals was to establish and assess baseline concentrations before mining as a benchmark for future comparisons. As little information concerning metals concentrations in juvenile coho salmon in Alaska is available, species with similar feeding habits and trophic levels were compared. Metals concentrations, however, would not necessarily be expected to be consistent from area to area, or from species to species. Species with similar feeding habits and trophic levels in Alaska for which metals data are available include Arctic grayling and Dolly Varden.

Metals concentrations in whole-body juvenile coho salmon in Illinois Creek are generally similar to or less than concentrations of the same metals found in other fish species in Alaska. Cadmium concentrations in juvenile coho salmon from Illinois Creek were over an order of magnitude lower than cadmium concentrations in whole body juvenile Dolly Varden from Anxiety Ridge Creek in the Noatak River drainage and from the North Fork Red Dog Creek in the Wulik River drainage (Ott and Weber Scannell 1994). Cadmium concentrations in Dolly Varden from Camp Creek in the Northern Unit of the Innoko National Wildlife Refuge (Mueller et al. in prep) were higher than those found in juvenile coho salmon from Illinois Creek. Lead concentrations in juvenile coho salmon from Illinois Creek were comparable to those found in juvenile Dolly Varden in the North Fork Red Dog Creek (Ott and Weber Scannell 1994). Juvenile coho salmon from Illinois Creek contained concentrations of silver, chromium, and lead that were similar to; concentrations of copper, mercury, nickel, and cadmium less than; and concentrations of arsenic that were greater than those found in small juvenile Dolly Varden in the Sherman Creek drainage near the Kensington Mine in southeast Alaska (Konopacky Environmental 1996).

Concentrations of arsenic, lead, cadmium, and mercury found in Illinois Creek juvenile coho salmon were similar to concentrations found in Arctic grayling in Fish Creek near Fairbanks (Weber Scannell and Ott 1994). Concentrations of these metals were slightly higher in Illinois Creek juvenile coho salmon than were concentrations found in Arctic grayling in the Chena River (Lowe et al. 1985, Schmitt and Brumbaugh 1990).

Concentrations of mercury and nickel were lower in Illinois Creek juvenile coho salmon than were concentrations of these metals in whole-body Arctic grayling from

the Kanuti National Wildlife Refuge (Mueller et al. 1995). Concentrations of chromium and lead in these two species in these two areas were similar.

The concentrations of metals in four adult coho salmon were similar to those found in juvenile coho salmon. Copper and mercury concentrations in adults were higher than in juveniles. Concentrations of arsenic were approximately the same in adult and juvenile fish. The comparable concentrations of arsenic and higher concentrations of copper and mercury in the adults indicate continued accumulation of these metals in coho salmon sometime between leaving Illinois Creek as smolt and returning as adults to spawn. Silver was below the MRL for most of the samples from the adult fish as it was in the juvenile fish.

## SUMMARY

Adult summer chum salmon and coho salmon were present in Illinois Creek in 1995. Other species captured or observed in Illinois Creek were slimy sculpin, Arctic grayling, burbot, Alaska blackfish, chinook salmon, and Dolly Varden.

Adult chum salmon were first reported in Illinois Creek at the main bridge on July 13. Sixty eight live and one dead adult chum salmon were counted in Illinois Creek from the main bridge upstream. Adult coho salmon were observed in Illinois Creek on September 20. From October 2 through 4, a maximum of 11 adult coho salmon were observed in Illinois Creek, upstream and downstream of the main bridge.

Juvenile coho salmon were distributed throughout the reaches of Illinois Creek examined in this study. Juvenile coho salmon were more abundant downstream of the main bridge crossing. Juvenile coho salmon were distributed farther upstream and more uniformly upstream of the bridge in October than in July. Two age classes of juvenile coho salmon were present in Illinois Creek: young-of-the-year fish and fish one year old. Young-of-the-year fish were considerably more abundant than the one year old fish.

Thirty juvenile and four adult coho salmon were collected and analyzed for whole-body concentrations of four to nine metals. Copper and arsenic were found in the highest concentrations; silver was the lowest. Concentrations of metals in juvenile coho salmon were similar to or lower than those found in other similar trophic level fish species in Alaska.

Histological analyses of tissues from juvenile coho salmon indicated fish were in good condition.

California Creek, a stream east of and considerably larger than Illinois Creek, was sampled minimally. Species that were captured in California Creek were mostly juvenile chinook salmon, with a few juvenile coho salmon and slimy sculpin.

The low metals concentrations and good body condition observed in juvenile coho salmon, the mixture of fish species, good quality water, and abundant aquatic insects indicate Illinois Creek is a healthy, productive stream. Baseline data collected during this study will enable evaluations of future conditions in Illinois Creek to determine if any changes are natural or anthropogenic in nature.

## LITERATURE CITED


Alt, K.T. 1983. Inventory and cataloging of sport fish and sport fish waters of western Alaska. ADF&G. Fed. Aid in Fish Rest. Ann. Perf. Rept. Vol. 24. Proj. F-9-15, Study G-I. Juneau. 37 pp.

Konopacky Environmental. 1996. Concentrations of nine trace elements in various size-classes of Dolly Varden char, prickly sculpin, and pink salmon collected from Sherman Creek, located near the Kensington Mine, Southeast Alaska, during 1995 and 1996. Annual Rept. - 1995/1996. Volume 2 of 2. Meridian, Idaho. 103 pp + appendices.

Lowe, T.P., T.W. May, W.G. Brumbaugh, and D.A. Kane. 1985. National contaminant biomonitoring program: Concentrations of seven elements in freshwater fish, 1978-1981. Arch. Environ. Contam. Toxicol. 14:363-388.

Millard, M.J. 1995. Preliminary assessment of the salmon stocks of the Innoko and Dishna rivers, Innoko National Wildlife Refuge, Alaska, 1993. Fishery Data Series Number 95-2. USDI: USFWS. Fairbanks. 16 pp.

Morsell, J.W. 1991. Aquatic Resources Assessment Study: Illinois Creek Gold Project. Final Report. Prepared for North Pacific Mining Corporation by Northern Ecological Services. 11 pp.

Morsell, J.W. 1994. Illinois Creek Project aquatic habitat resource analysis trip report - Oct. 10-12, 1994. Letter to B. Jokela and M. Watson from Northern Ecological Services, Anchorage. 7 pp.

Mueller, K.A., E. Snyder-Conn, and M. Bertram. in prep. Water quality, and metal and metalloid contaminants in sediments and fish of Koyukuk, Nowitna, and the Northern Unit of Innoko National Wildlife Refuges, Alaska, 1991. Tech. Rept. NAES-TR-96-01. USDI:USFWS. Fairbanks.

Oldaker, P. 1996. File Diary, September 20, 1995. Page 15 *in* Illinois Creek Project Hydrogeologic Evaluation. Vol. II. USMX Consolidated Mining Permit Application. Denver.

Ott, A.G. and P. Weber Scannell. 1994. Fish monitoring study, Red Dog Mine in the Wulik River drainage, emphasis on Dolly Varden (*Salvelinus malma*), summary report 1990-1993. Tech. Rept. 94-1. Alaska Dept. of Fish and Game, Habitat and Restoration Division. Juneau. 63 pp.

Rost, P. 1988. Innoko Refuge salmon spawning investigation, 1987. Unpubl. trip rept. U.S. Fish and Wildlife Service, Fishery Assistance Office, Fairbanks, Alaska.

Schmitt, C.J. and W.G. Brumbaugh. 1990. National contaminant biomonitoring program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium, and zinc in U.S. freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:731-747.

Weber Scannell, P. and A.G. Ott. 1994. Aquatic habitat of Fish Creek before development of the Fort Knox gold mine, 1992-1993. Tech. Rept. 94-5. Alaska Dept. of Fish and Game, Habitat and Restoration Division. Juneau. 79 pp.

Appendix 1. Site descriptions and locations of minnow traps set in Illinois and California creeks.

**Illinois Creek**

Site U1.

Description: Tail of riffle; sandy bottom; 50 cm deep water.

Location: 64°02.25' N 157°52.10' W; 0.06 km upstream of main bridge.

Site U2.

Description: Tail of riffle; cobble/rock bottom; 30 cm deep water.

Location: 64°02.27' N 157°52.11' W; 0.07 km upstream of main bridge.

Site U3.

Description: Small pool behind a sedge-covered mound in the eastern margin of the stream; gravel/cobble bottom; 30 cm deep water.

Location: 64°02.29' N 157°52.12' W; 0.09 km upstream of main bridge.

Site U4.

Description: Run; cobble bottom; 40 cm deep water.

Location: 64°02.28' N 157°52.13' W; 0.11 km upstream of main bridge.

Site U5.

Description: Small eddy at the tail of a riffle; sand/gravel bottom; 35 cm deep water.

Location: 64°02.30' N 157°52.12' W; 0.11 km upstream of main bridge.

Site U6.

Description: Pool; sand to cobble bottom; 60 cm deep water.

Location: 64°02.33' N 157°52.15' W; 0.17 km upstream of main bridge.

Site U7.

Description: Large pool at the base of a small chute about 50 m below the forks; sand to cobble bottom; 80 cm deep water.

Location: 64°02.36' N 157°52.17' W; 0.22 km upstream of main bridge.

Site U8.

Description: West fork of Illinois Creek; small pool; sand bottom between scattered large rock; 40 cm deep water.

Location: 64°02.34' N 157°52.23' W; 0.22 km upstream of main bridge.

Site U9.

Description: Middle fork of Illinois Creek; long run; gravel/cobble bottom; 50 cm deep water.

Location: 64°02.39' N 157°52.19' W; 0.24 km upstream of main bridge.

Appendix 1, continued.

**Illinois Creek**

Site U10.

Description: East fork of Illinois Creek; pool in sedge-lined channel; silt bottom; 50 cm deep water.

Location: 64°02.40' N 157°52.13' W; 0.25 km upstream of main bridge.

Site D1.

Description: Long pool; silt/sand bottom; 100 cm deep water.

Location: 64°02.24' N 157°52.02' W; 0.04 km downstream of main bridge.

Site D2.

Description: Large pool; silt bottom; 50 cm deep water.

Location: 64°02.21' N 157°52.00' W; 0.09 km downstream of main bridge.

Site D3.

Description: Pool behind a root wad; silt/sand bottom; 40 cm deep.

Location: 64°02.19' N 157°51.94' W; 0.12 km downstream of main bridge.

Site D4.

Description: Pool above log/riffle; cobble bottom overlain with silt; pool 100 cm deep; trap set in 50 cm deep water

Location: 64°02.20' N 157°51.93' W; 0.13 km downstream of main bridge.

Site D5.

Description: Pool; silt sedimented cobble bottom; pool 150 cm deep; trap set in 100 cm deep water.

Location: 64°02.18' N 157°51.89' W; 0.18 km downstream of main bridge.

Site D6.

Description: Pool.

Location: 64°02.17' N 157°51.90' W; 0.19 km downstream of main bridge.

Site D7.

Description: Pool behind root wad; silt/sand sedimented cobble bottom; pool 100 cm deep; trap set in 50 cm deep water.

Location: 64°02.14' N 157°51.91' W; 0.23 km downstream of main bridge.

Site D8.

Description: Pool; silt to cobble bottom; pool 200 cm deep; trap set in 100 cm deep water.

Location: 64°2.12' N 157°51.82' W; 0.31 km downstream of main bridge.

Appendix 1, continued.

**Illinois Creek**

Site D9.
Description: Run; silt and cobble bottom; 40 cm deep.
Location: 64°02.10' N 157°51.82' W; 0.34 km downstream of main bridge.

Site D10:
Description: Pool; silt and cobble bottom; 80 cm deep.
Location: 64°02.07' N 157°51.85' W; 0.38 km downstream of main bridge.

Site P1.
Description: Pool; silted cobble; pool 100 cm deep; trap set in 35 cm deep water.
Location: 64°01.82' N 157°52.04' W; 0.22 km upstream of plywood bridge

Site P2.
Description: Run; silted cobble; 100 cm deep water; trap set in 25 cm deep water.
Location: 64°01.81' N 157°52.03' W; 0.21 km upstream of plywood bridge

Site P3.
Description: Pool; silt/sand bottom; 150 cm deep water; trap set in 100 cm deep water.
Location: 64°01.78' N 157°52.03' W; 0.14 km upstream of plywood bridge

Site P4.
Description: Pool; sand bottom; 100 cm deep.
Location: 64°01.74' N 157°52.02' W; 0.07 km upstream of plywood bridge

Site P5.
Description: Pool; silt/sand bottom; 100 cm deep water; trap set in 40 cm deep water.
Location: 64°01.72' N 157°52.02' W; 0.05 km upstream of plywood bridge

Site P6.
Description: Pool; silt/sand bottom; pool 100 to 200 cm deep; trap set in 100 cm deep water.
Location: 64°01.71' N 157°51.95' W; at plywood bridge

Site P7.
Description: Pool; sand/silt bottom; wood debris; 200 cm deep; trap set in 150 cm deep water.
Location: 64°01.69' N 157°52.03' W; 0.03 km downstream of plywood bridge

Appendix 1, continued.

**Illinois Creek**

Site P8.
Description: Run/pool; sand/silt bottom; 40 cm deep.
Location: 64°01.66' N 157°52.01' W; 0.05 km downstream of plywood bridge

Site P9.
Description: Pool along cutbank; sand bottom; 100 cm deep.
Location: 64°01.67' N 157°52.01' W; 0.07 km downstream of plywood bridge

Site P10.
Description: Pool; log debris; 200 cm deep.
Location: 64°01.67' N 157°51.98' W; 0.08 km downstream of plywood bridge

**Lower California Creek Sites**

The six Lower California Creek minnow trap sites were set along about 250 m of creek centered on the following location: 64°00.94' N 157°50.53' W

Site 1. Pool/eddy along deadfall; trap set in 100 cm deep water.

Site 2. Eddy along cutbank; trap set in 100 cm deep water.

Site 3. Trap set in 100 cm deep water along cutbank.

Site 4. Trap set in 100 cm deep water at tail of large eddy; gravel/cobble bottom.

Site 5. Trap set in 200 cm deep water along cutbank; cobble bottom.

Site 6. Trap set in 100 cm deep water; cobble bottom.

**Upper California Creek Sites**

The six Upper California Creek minnow trap sites were set along about 125 m of creek upstream of Site 1 located at the following location: 64°02.77' N 157°47.85' W.

Site 1. Trap set in 50 cm deep water along a gravel bar; sand bottom.

Site 2. Trap set in 40 cm deep water along a sedge-lined bank; gravel bottom.

Site 3. Trap set behind root wad in 50 cm deep water.

Site 4. Trap set in over 100 cm deep water along undercut bank in main current.

Appendix 1, *concluded.*

**Upper California Creek Sites**

Site 5. Trap set in turbulent eddy behind fallen tree.

Site 6. Trap set in turbulent eddy behind fallen tree.

Appendix 2. Concentrations of metals in juvenile coho salmon from Illinois Creek in July 1995. All concentrations expressed as mg/kg dry weight. Analyses were whole body fish.

| Collector | Date Collected | Trap Location | Fish Spp | Length mm | Ag mg/kg | As mg/kg | Hg mg/kg | Cu mg/kg | Cd mg/kg | Cr mg/kg | Pb mg/kg | Ni mg/kg | Sb mg/kg | % Solids | Composite # fish |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ADF&G | 7/19/95 | U10 | Co | 109 | ND | 0.5 | 0.12 | 3.96 | 0.04 | 8.7 | 0.15 | 1.2 | 0.06 | 23.9 | 1 |
| ADF&G | 7/19/95 | U10 | Co | 97 | ND | 0.6 | 0.06 | 2.85 | 0.09 | 0.5 | 0.11 | 0.3 | 0.13 | 25.5 | 1 |
| ADF&G | 7/19/95 | U10 | Co | 100 | ND | ND | ND | 2.27 | 0.03 | 0.6 | 0.07 | 0.3 | 0.09 | 24.1 | 1 |
| ADF&G | 7/19/95 | U10 | Co | 94 | ND | 0.7 | 0.14 | 2.32 | 0.03 | 0.7 | 0.27 | 0.4 | 0.34 | 22.7 | 1 |
| ADF&G | 7/19/95 | U10 | Co | 100 | ND | 0.6 | 0.07 | 2.65 | 0.03 | 0.6 | 0.15 | 0.3 | 0.14 | 23.7 | 1 |
| ADF&G | 7/19/95 | D6 | Co | 105 | 0.02 | 1.6 | 0.07 | 4.01 | | | | | | 25.8 | 1 |
| ADF&G | 7/19/95 | U2 | Co | 111 | 0.08 | 1.5 | 0.10 | 3.54 | | | | | | 23.8 | 1 |
| ADF&G | 7/19/95 | U10 | Co | 80 | ND | ND | 0.08 | 3.4 | | | | | | 21.0 | 1 |
| ADF&G | 7/19/95 | U2 | Co | 105 | ND | 1.0 | 0.08 | 3.17 | | | | | | 23.5 | 1 |
| ADF&G | 7/19/95 | U3 | Co | 117 | 0.03 | 1.1 | 0.07 | 2.65 | | | | | | 27.6 | 1 |
| ADF&G | 7/19/95 | U1 | Co | 99 | 0.03 | 1.6 | 0.07 | 3.26 | | | | | | 25.2 | 1 |
| ADF&G | 7/19/95 | U4 | Co | 114 | 0.11 | 1.0 | 0.13 | 2.69 | | | | | | 25.8 | 1 |
| ADF&G | 7/19/95 | D8 | Co | 114 | ND | 1.3 | 0.08 | 2.75 | | | | | | 26.9 | 1 |
| ADF&G | 7/19/95 | D6 | Co | 97 | ND | 1.1 | 0.08 | 2.69 | | | | | | 20.2 | 1 |
| ADF&G | 7/19/95 | U4 | Co | 97 | 0.04 | 3.0 | 0.10 | 2.84 | | | | | | 22.9 | 1 |
| ADF&G | 7/19/95 | D6 | Co | 104 | 0.02 | 1.9 | 0.12 | 2.64 | | | | | | 22.0 | 1 |
| ADF&G | 7/19/95 | D7 | Co | 101 | 0.03 | 3.5 | 0.08 | 3.32 | | | | | | 22.2 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 100 | ND | 2.3 | 0.07 | 2.38 | | | | | | 22.5 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 110 | ND | 3.0 | 0.07 | 2.77 | | | | | | 25.9 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 101 | ND | 2.0 | 0.06 | 2.71 | | | | | | 25.3 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 102 | ND | 1.6 | 0.06 | 2.44 | | | | | | 27.2 | 1 |
| ADF&G | 7/19/95 | D5 | Co | 111 | ND | 2.0 | 0.08 | 3.06 | | | | | | 25.3 | 1 |
| ADF&G | 7/19/95 | U3 | Co | 110 | 0.03 | 1.9 | 0.11 | 2.23 | | | | | | 26.8 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 101 | ND | 2.4 | 0.08 | 2.31 | | | | | | 24.9 | 1 |
| ADF&G | 7/19/95 | D8 | Co | 100 | 0.03 | 1.9 | 0.08 | 3.52 | | | | | | 19.4 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 107 | ND | 2.7 | 0.06 | 2.55 | | | | | | 24.3 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 100 | ND | 2.1 | 0.07 | 2.23 | | | | | | 25.3 | 1 |
| ADF&G | 7/19/95 | D8 | Co | 102 | ND | 1.2 | 0.07 | 2.61 | | | | | | 26.0 | 1 |
| ADF&G | 7/19/95 | P4 | Co | 94 | ND | 3.1 | 0.10 | 2.46 | | | | | | 22.5 | 1 |
| ADF&G | 7/19/95 | D6 | Co | 107 | 0.08 | 1.9 | 0.07 | 5.92 | | | | | | 23.8 | 1 |

Co = coho salmon

ND = metal was not detected

Appendix 3. Quality control/quality assurance data for concentrations of metals from juvenile coho salmon from Illinois Creek in July 1995. All concentrations expressed as mg/kg.

## Duplicate Samples

| Dates of Samples QA/QC applies to | Metal | Method | MRL | Sample A | Sample B | %Relative Difference | Sample C | Sample D | %Relative Difference |
|---|---|---|---|---|---|---|---|---|---|
| 7/19/95 | Sb | 200.8 | 0.02 | 0.06 | 0.05 | 17 | | | |
| 7/19/95 | As | 200.8 | 0.5 | 0.5 | 0.5 | <1 | | | |
| 7/19/95 | Cd | 200.8 | 0.02 | 0.04 | 0.03 | 25 | | | |
| 7/19/95 | Cr | 200.8 | 0.2 | 8.7 | 8.6 | 1 | | | |
| 7/19/95 | Cu | 200.8 | 0.05 | 3.96 | 3.58 | 10 | | | |
| 7/19/95 | Pb | 200.8 | 0.02 | 0.15 | 0.15 | <1 | | | |
| 7/19/95 | Hg | 7471 | 0.05 | 0.12 | 0.10 | 9 | | | |
| 7/19/95 | Ni | 200.8 | 0.2 | 1.2 | 1.1 | 8 | | | |
| 7/19/95 | Ag | 200.8 | 0.02 | ND | 0.02 | NC | | | |
| 7/19/95 | Ag | 200.8 | 0.02 | 0.08 | 0.08 | <1 | 0.08 | 0.09 | 12 |
| 7/19/95 | As | 200.8 | 0.5 | 1.5 | 1.5 | <1 | 1.9 | 1.8 | 6 |
| 7/19/95 | Cu | 200.8 | 0.05 | 3.54 | 3.83 | 8 | 5.92 | 5.64 | 5 |
| 7/19/95 | Hg | 7471 | 0.05 | 0.13 | 0.10 | 25 | 0.08 | 0.09 | 12 |

ND = not detected at MRL
NC = not calculated
MRL = Method Reporting Limit

Appendix 3, continued.

| | | | Matrix Spike Results | | | | | | Method Blank | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dates of Samples QA/QC applies to | Sample | Metal | Method | MRL | Spike Level | Sample Result | Spike Result | % Recovery | MB1 | MB2 |
| 7/19/95 | A | Sb | 200.8 | 0.02 | 12 | 0.09 | 11.5 | 95 | ND | |
| | | As | 200.8 | 0.5 | 19 | ND | 17.0 | 89 | ND | |
| | | Cd | 200.8 | 0.02 | 4.7 | 0.03 | 4.23 | 89 | ND | |
| | | Cr | 200.8 | 0.2 | 4.7 | 0.6 | 5.4 | 102 | ND | |
| | | Cu | 200.8 | 0.05 | 23 | 2.27 | 24.0 | 94 | ND | |
| | | Pb | 200.8 | 0.02 | 47 | 0.07 | 48.3 | 103 | ND | |
| | | Hg | 7471 | 0.05 | 1.2 | ND | 1.35 | 112 | ND | |
| | | Ni | 200.8 | 0.2 | 47 | 0.3 | 44.7 | 94 | ND | |
| | | Ag | 200.8 | 0.02 | 4.7 | ND | 4.38 | 93 | ND | |
| 7/19/95 | B | Ag | 200.8 | 0.02 | 1.0 | 0.08 | 1.34 | 126 | ND | |
| | | As | 200.8 | 0.5 | 10 | 1.5 | 12.5 | 110 | ND | |
| | | Cu | 200.8 | 0.05 | 20 | 3.54 | 23.7 | 101 | ND | |
| | | Hg | 7471 | 0.05 | 0.33 | 0.07 | 0.36 | 88 | ND | |
| 7/19/95 | C | Ag | 200.8 | 0.02 | 1.0 | 0.08 | 1.34 | 126 | | ND |
| | | As | 200.8 | 0.5 | 10 | 1.9 | 11.8 | 99 | | ND |
| | | Cu | 200.8 | 0.05 | 20 | 5.92 | 23.8 | 89 | | ND |
| | | Hg | 7471 | 0.05 | 0.33 | 0.11 | 0.39 | 85 | | ND |

ND = not detected at MRL
MRL = Method Reporting Limit

Appendix 3, concluded.

## Recovery of Standard Reference Material

| Dates of Samples QA/QC applies to | Metal | Method | MRL | TRUE Value mg/kg | Laboratory Result mg/kg | TRUE Value mg/kg | Laboratory Result mg/kg |
|---|---|---|---|---|---|---|---|
| 7/19/95 | Ag | 200.8 | 0.02 | 0.608±0.032 | 0.59 | 0.608±0.032 | 0.64 |
| | As | 200.8 | 0.5 | 16.6±1.1 | 15.0 | 16.6±1.1 | 15 |
| | Cu | 200.8 | 0.05 | 25.8±1.1 | 26.6 | 25.8±1.1 | 26.2 |
| | Hg | 7471 | 0.05 | 0.33±0.06 | 0.30 | 0.33±0.06 | 0.29 |

Appendix 4. Concentrations of metals in adult coho salmon from Illinois Creek. All concentrations expressed as mg/kg dry weight. Analyses were whole body fish.

| Collector | Date | Location | Fish Spp | Weight kg | Length mm | Ag mg/kg | As mg/kg | Hg mg/kg | Cu mg/kg | % Solids | Composite # fish |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ADF&G | 10/3/95 | Main Bridge | Co | 2.1 | 530 | ND | 2.1 | 0.11 | 3.76 | 21.3 | 1 |
| ADF&G | 10/3/95 | Main Bridge | Co | 1.8 | 485 | ND | 1.8 | 0.25 | 6.31 | 16.5 | 1 |
| ADF&G | 10/3/95 | Main Bridge | Co | 2.1 | 520 | 0.07 | 1.3 | 0.21 | 5.69 | 17.8 | 1 |
| ADF&G | 10/3/95 | Main Bridge | Co | 1.7 | 485 | ND | 2.3 | 0.14 | 5.94 | 15.6 | 1 |

Co = coho salmon
ND = metal was not detected

Appendix 5. Quality control/quality assurance data for concentrations of metals from adult coho salmon from Illinois Creek in October 1995. All concentrations expressed as mg/kg.

| | | | Duplicate Samples | | | | | Matrix Spike Results | | | | | Recovery of Standard Reference Material | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dates of Samples QA/QC applies to | Metal | Method | MRL | Sample A | Sample B | %Relative Difference | Spike Level | Sample Result | Spike Result | % Recovery | Method Blank | | TRUE Value mg/kg | Laboratory Result mg/kg |
| 10/3/95 | Ag | 200.8 | 0.02 | 0.07 | 0.04 | 50 | 1.0 | 0.07 | 1.02 | 95 | ND | | NC | NC |
| 10/3/95 | As | 200.8 | 0.5 | 1.3 | 1.3 | <1 | 10 | 1.3 | 10.0 | 87 | ND | | 24.6±2.2 | 26.6 |
| 10/3/95 | Cu | 200.8 | 0.05 | 5.69 | 5.60 | 2 | 20 | 5.69 | 20.4 | 74 | ND | | 439±22 | 355 |
| 10/3/95 | Hg | 7471 | 0.02 | 0.11 | 0.08 | 30 | 0.45 | 0.11 | 0.52 | 91 | ND | | 0.33±0.06 | 0.37 |

ND = not detected at MRL
NC = not calculated
MRL = Method Reporting Limit

Appendix 6. Histological analyses of selected tissues of juvenile coho salmon from Illinois Creek. Analyses performed by the US Fish and Wildlife Service, Fish Technology Center, Bozeman, Montana.

## BFTC HISTO REPORT

Coho salmon (*Onocorhynchus kisutch*), Illinois Creek and dolly varden (*Salvelinus malma*), Evaingiknuk and Red Dog Creeks were received as preserved specimens. Gill, heart,kidney, liver, pyloric caeca/stomach, intestine and gonad tissues were dissected and processed by standard histological technique. Sections were stained with hematoxylin-eosin or Giemsa and examined 63x-1000x on a Zeiss microscope. Sections were read "blind" (without knowledge of group or sight collected from). Cellular changes were rated on a scale of 1-5: minimal(1), mild(2), moderate(3), moderately-severe(4), severe(5).

**Coho - Illinois Cr.**
20 fish examined

Gill - overall good condition; mild to moderate thickening of gill epithelium 18 fish; 2 of the 18 also showed moderate fusion of lamellae.

Heart - mostly normal; one fish showed focal, mild degenerative changes in cardiac muscle.

Kidney - myxosporean parasite, *Myxidium* sp., in kidney tubules of 13 fish; no lesions associated with infection. Hyaline droplet degeneration tubule epithelium seen in two fish; one mild, one moderately-severe. Mild to moderate proliferation of hematopoietic tissue seen in 8 fish and moderate accumulations of melanomacrophages in 3 fish.

Liver - no degenerative or necrotic changes seen in hepatocytes. Glycogen vacuolation was mostly mild (6) or moderate (7); the remaining showed minimal or no glycogen in hepatocytes. Small lympocytic foci were noted in 9 fish.

GI - normal; rodlet cells abundant in the mucosal epithelium of the intestine in two fish.

Gonad - normal in 4 fish with ovarian tissue.

Summary: Overall, histological examination showed these fish to be in good condition. Glycogen vacuolation of hepatocytes is related to feeding activity. Livers with little or no glycogen vacuolation suggest that the fish has not been feeding and has utilized the stored glycogen. Infection with the myxosporean parasite, *Myxidium* sp. did not induced pathological lesions or a host response. "Non-pathogenic" myxosporean parasites are increasingly being used as biological tags in anadromous salmon.