

Technical Report No. 22-03

Baseline Aquatic Biomonitoring: Illinois Creek Mine and Associated Prospects, 2021

by

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March 2022

Alaska Department of Fish and Game

Habitat Section



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Weights and measures (metric)		General		Mathematics, statistics	
centimeter	cm	Alaska Administrative Code	AAC	<i>all standard mathematical signs, symbols and abbreviations</i>	
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H _A
gram	g	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	<i>e</i>
hectare	ha	at	@	catch per unit effort	CPUE
kilogram	kg	compass directions:		coefficient of variation	CV
kilometer	km	east	E	common test statistics	(F, t, χ^2 , etc.)
liter	L	north	N	confidence interval	CI
meter	m	south	S	correlation coefficient (multiple)	R
milliliter	mL	west	W	correlation coefficient (simple)	r
millimeter	mm	copyright	©	covariance	cov
		corporate suffixes:		degree (angular)	°
Weights and measures (English)		Company	Co.	degrees of freedom	df
cubic feet per second	ft ³ /s	Corporation	Corp.	expected value	<i>E</i>
foot	ft	Incorporated	Inc.	greater than	>
gallon	gal	Limited	Ltd.	greater than or equal to	≥
inch	in	District of Columbia	D.C.	harvest per unit effort	HPUE
mile	mi	et alii (and others)	et al.	less than	<
nautical mile	nmi	et cetera (and so forth)	etc.	less than or equal to	≤
ounce	oz	exempli gratia (for example)	e.g.	logarithm (natural)	ln
pound	lb	Federal Information Code	FIC	logarithm (base 10)	log
quart	qt	id est (that is)	i.e.	logarithm (specify base)	log ₂ , etc.
yard	yd	latitude or longitude	lat or long	minute (angular)	'
		monetary symbols (U.S.)	\$, ¢	not significant	NS
Time and temperature		months (tables and figures): first three letters	Jan,...,Dec	null hypothesis	H ₀
day	d	registered trademark	®	percent	%
degrees Celsius	°C	trademark	™	probability	P
degrees Fahrenheit	°F	United States (adjective)	U.S.	probability of a type I error (rejection of the null hypothesis when true)	α
degrees kelvin	K	United States of America (noun)	USA	probability of a type II error (acceptance of the null hypothesis when false)	β
hour	h	U.S.C.	United States Code	second (angular)	"
minute	min	U.S. state	use two-letter abbreviations (e.g., AK, WA)	standard deviation	SD
second	s			standard error	SE
				variance	
Physics and chemistry				population	Var
all atomic symbols				sample	var
alternating current	AC				
ampere	A				
calorie	cal				
direct current	DC				
hertz	Hz				
horsepower	hp				
hydrogen ion activity (negative log of)	pH				
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

TECHNICAL REPORT NO. 22-03

**BASELINE AQUATIC BIOMONITORING: ILLINOIS CREEK MINE AND
ASSOCIATED PROSPECTS, 2021**

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March 2022

Cover: Juvenile coho salmon caught in California Creek drainage, July 2021.

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Executive Summary

This report summarizes the results of 2021 biomonitoring work in streams potentially impacted by the Illinois Creek Mine, as well as the associated Honker and Round Top prospects.

Biomonitoring efforts included surveys of periphyton and aquatic macroinvertebrates and juvenile fish. Periphyton and aquatic macroinvertebrates were sampled in Illinois Creek only. Juvenile fish were captured in minnow traps in Illinois Creek, as well as streams in the nearby Dome, California, and Eddy Creek drainages and one unnamed tributary of the Little Mud River. Due to poor weather and limited helicopter time, we were unable to sample the Minnesota and Colorado Creek drainages (Figure 1). We chose to prioritize sites that represented major drainage basins surrounding the mine and prospects over sites potentially impacted by proposed road routes. In total, we trapped 10 of the 19 sites sampled in 2020.

Juvenile coho salmon from Illinois Creek were analyzed for whole-body concentrations of several elements, and their length frequencies were described. Juvenile coho salmon catch sizes, population characteristics, and element concentrations in 2021 generally were comparable to historical data from the late 1990s, as well as 2020. The exceptions were whole-body arsenic concentration, which was elevated in 2021 relative to both 2020 and historical data, and mercury concentration, which remains elevated compared to historical data. The Illinois Creek periphyton standing crop in 2021 was similar to that seen in 2020, but the phylogenetic makeup of the macroinvertebrate population was noticeably different in 2021.

Introduction

The Illinois Creek gold-silver mine is located in the southern Kaiyuk Mountains about 90km southwest of Galena. The open pit mine was operated by USMX Inc. from 1996 to 1998, and Viceroy Resources Corp. from 1998 to 2000. ARG Group leased the mine from the State of Alaska until 2002, and fees from their operation were used for reclamation. The operation has since been acquired by Western Alaska Copper and Gold, and there is no active mining at this time. The nearby Honker and Round Top prospects (Figure 1) are currently undergoing mineral exploration. Two proposed roads would connect each prospect to the existing mine road complex.

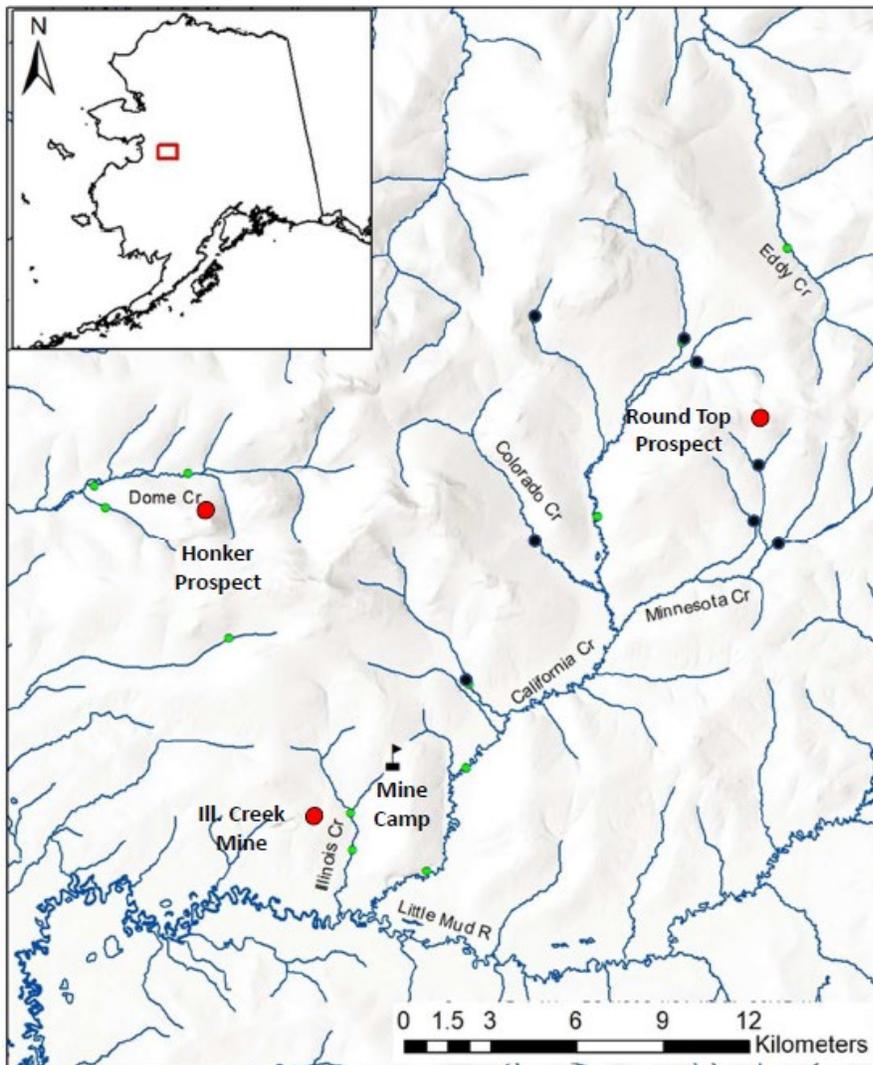


Figure 1: July 2021 sample sites (green circles) surrounding the Illinois Creek Mine, Honker deposit, and Round Top deposit. Sites sampled in 2020 but not revisited in 2021 are represented by black circles.

The ADF&G Habitat Section collected fish presence and juvenile salmon population data at the mine between 1995 and 1998 (Winters 1996, 1997, 1998a, 1998b). During this period, sampling focused on Illinois Creek. Juvenile salmon were captured in Illinois Creek using minnow traps, and visual surveys were performed on foot for adult salmon. Full-body element analyses, as well as histological analyses, were performed on juvenile coho salmon from Illinois Creek in 1995. Limited minnow trapping was done in California Creek in 1995 but was not continued from 1996-1998.

Streams in the area vary considerably in physical characteristics but tend to rapidly transition from steep upland streams to lower gradient meandering incised streams. The dominant rock type in the area is schist, which decomposes rapidly, and stream substrate transitions from small boulders to sand and silt in just a few kilometers.

Fish communities vary depending on stream characteristics, consisting primarily of resident Dolly Varden and slimy sculpin in high-gradient headwater streams, and mixed communities of Alaska blackfish, slimy sculpin, Arctic grayling, and juvenile salmon in the lower reaches. Abundant large beaver dam complexes in these drainages impact fish distribution on a decades-long timescale.

The goal of current sampling effort is to quantify benchmark biological conditions on Illinois Creek and nearby watersheds for tracking changes over time. We continued sampling juvenile salmon in Illinois Creek to compare catch sizes, size distributions, and whole-body element concentrations to existing data. Additionally, we collected periphyton and aquatic macroinvertebrates in Illinois Creek. We recorded fish-presence data in other streams that may be impacted by the development of the Honker and Round Top prospects and their related infrastructure.

Methods

Fish Presence

Minnow traps were baited with cured salmon roe in perforated plastic bags. Ten traps were set at each of the ten sample sites for approximately 24 hours. When traps were collected, the species and fork-length of every captured salmonid were recorded. Total length was recorded for species with round caudal fins, such as slimy sculpin and Alaska blackfish.

Fish Tissue Elements

In Illinois Creek, 15 juvenile coho salmon with fork-lengths from 80 to 110mm were retained for whole-body element analysis. Fish were handled with class 100 nitrile gloves, which were changed between sites and whenever they contacted soil, metal, clothing, or vegetation. Retained fish were euthanized immediately via cranial concussion and placed individually in labeled zip-loc bags. Samples were frozen upon returning from the sample site and kept frozen until analysis was performed.

Retained juvenile coho salmon were analyzed for arsenic, cadmium, copper, lead, mercury, selenium, zinc, and silver. The whole-body element analyses were performed by ACZ Laboratories in Steamboat Springs, Colorado. Mercury was measured using direct combustion, and other elements by inductively coupled plasma mass spectroscopy. Due to shipping delays, juvenile fish samples arrived at the lab mostly thawed but not degraded enough to affect the element analyses.

Periphyton

In upper Illinois Creek ten completely submerged rocks were selected for sampling, each with an appropriately sized flat surface exposed to sunlight. A 5-cm by 5-cm square of flexible foam was placed on the flat surface, and all material outside of that square was removed with a toothbrush. The scrubbed area and brush were then thoroughly rinsed with freshwater. The foam square was removed, the remaining section brushed, and the periphyton rinsed onto a 0.45 μm glass fiber filter receptacle. Material trapped on the brush was then rinsed into the filter, and water was removed with a hand vacuum pump. Two drops of magnesium carbonate (MgCO_3) solution were added to the water near the end of the evacuation process to prevent acidification and chlorophyll degradation.

Filters from each rock were folded in half, with sample material facing inwards, and placed in individual dry paper coffee filters. All ten coffee filters were immediately wrapped in aluminum foil to prevent chlorophyll degradation, placed in a zip-lock bag with desiccant to remove any remaining water, and stored in a cooler with ice. Upon removal from the field, samples were stored frozen. In the lab, the chlorophyll-a area-density of each sample was measured using the methods of Barbour et al. (1999).

Aquatic Macroinvertebrates

In upper Illinois Creek – approximately 100 meters downstream of the minnow trapping reach a 0.086 m² Hess sampler was used to collect five invertebrate samples. For each sample, the net was set in place and all rocks within the Surber sampling area were dislodged from the stream bed and thoroughly agitated to release invertebrates downstream into the net. Insect samples were preserved in 90% ethanol and stored at room temperature until identification could be performed. NRF Taxonomic Services located in Fairbanks, Alaska identified and enumerated the samples.

Aquatic macroinvertebrates were expressed as the average number of individuals/m² of stream bed, as well as the percent belonging to orders Ephemeroptera, Plecoptera, Trichoptera, Aquatic Diptera, and “other”.

The combined percentage of Ephemeroptera, Plecoptera, and Trichoptera (EPT) were compared with the percent Chironomidae (a subset of aquatic Diptera). Chironomidae are generally tolerant to pollution, whereas EPT taxa are more sensitive.

Results and Discussion

Illinois Creek: Illinois Creek is located directly between the mine pit and mine camp (Figure 1), which are across the drainage from each other and are connected by a gravel road. We sampled two locations in this stream.

Lower Illinois Creek: This stretch of Illinois Creek has a silt and mud bed with abundant decayed organic matter. It is an incised, low-gradient meandering stream with deciduous shrubs lining the banks (Figure 2). In July of 2021, 116 juvenile coho salmon, one Alaska blackfish, and eight slimy sculpin were caught at this site. Catches here have been historically variable, ranging from 11 to 655 juvenile coho salmon per sampling event (Winters 1996-1998, Burrows 2020). Previous work also found juvenile burbot at this location, however the drainage had multiple beaver dams during that period, which have since washed out (Winters 1996-1998). Fifteen coho salmon were kept from this reach of Illinois Creek for whole-body element analysis. Fish presence and abundance data from all sites sampled in 2020 and 2021 is supplied in Appendix 1.



Figure 2: Lower Illinois Creek, downstream of the historical trail crossing.

The length-frequency distribution of juvenile coho salmon from this site illustrates the presence of two age classes (Figure 3). Age-0 fish ranged from approximately 45 to 80mm, while age-1 fish ranged from 90 to 115mm (Figure 3). Several fish were in an intermediate size range of 80 to 90mm.

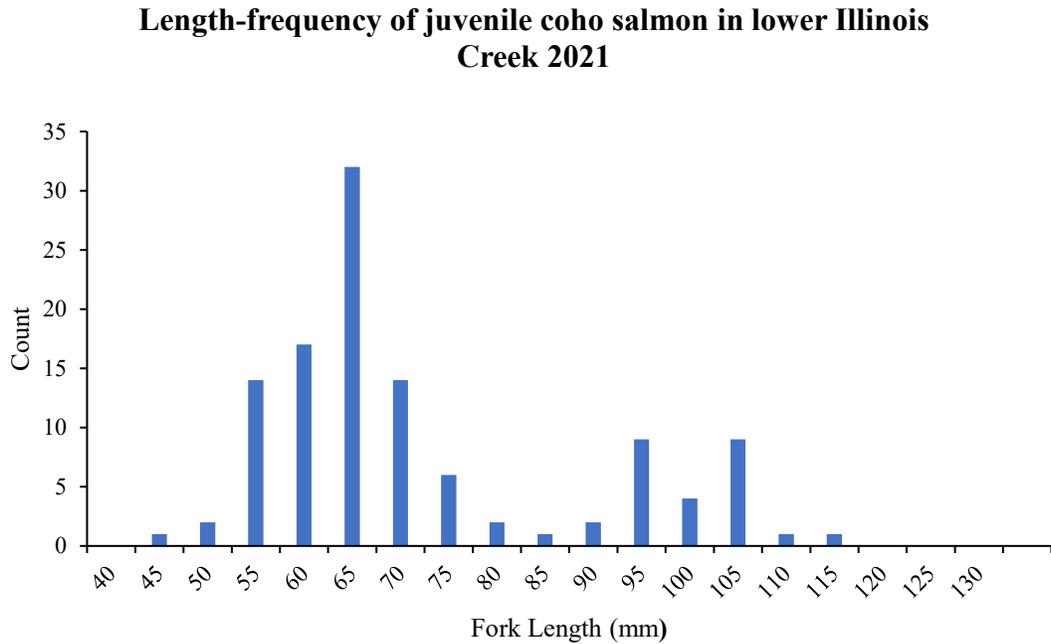


Figure 3: Length-frequency distribution of juvenile coho salmon in lower Illinois Creek, July 2021.

Upper Illinois Creek: The stream bed in this location consists of gravel and cobble, with some boulder-sized pieces of schist and quartz. This reach of the stream is surrounded by a mixture of wet meadows and deciduous shrubs (Figure 4). A warm spring enters the stream approximately 200m upstream of the upper limit of our sampling reach. 229 juvenile coho salmon and seven slimy sculpin were caught at this location. These catches are considerably higher than during the 1990s and 2020, when catches ranged from 14 to 62 coho salmon (Winters 1996-1998, Burrows 2020).



Figure 4. Upper Illinois Creek, immediately downstream of the warm springs, July 2021.

Similar to lower Illinois Creek, two distinct age classes of juvenile coho salmon were present, but fewer fish were age 1 (Figure 5).

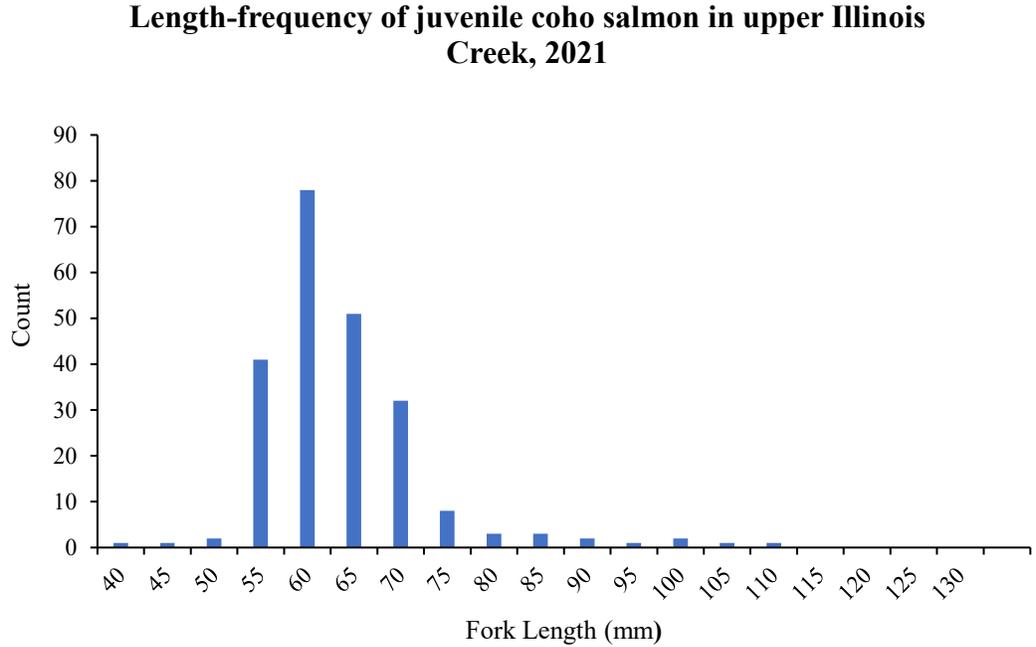


Figure 5. Length-frequency distribution of juvenile coho salmon in upper Illinois Creek, 2021.

Aquatic Invertebrates

Aquatic macroinvertebrates in 2021 averaged 7922 (± 5920) individuals/m² of stream bed. This is approximately 10% lower than total invertebrates encountered in 2020. Of the taxa sampled in

2021, 13% were Ephemeroptera, 3% were Plecoptera, and 4% were Trichoptera, for a total of 20% EPT. This compares to 42% EPT in 2020. In 2021, populations of Plecoptera and Trichoptera were lower than those in 2020, while the population of Ephemeroptera was higher (Figure 6). The aquatic macroinvertebrate population in 2021 was dominated by aquatic Diptera – 60% of all invertebrates sampled were Chironomids while 9% were other aquatic Diptera – for a total of 69% (Figure 6). This is somewhat elevated compared to the 49% Chironomids and 2% other aquatic Diptera found in 2020. Eleven percent of invertebrates in 2021 belonged to other groups.

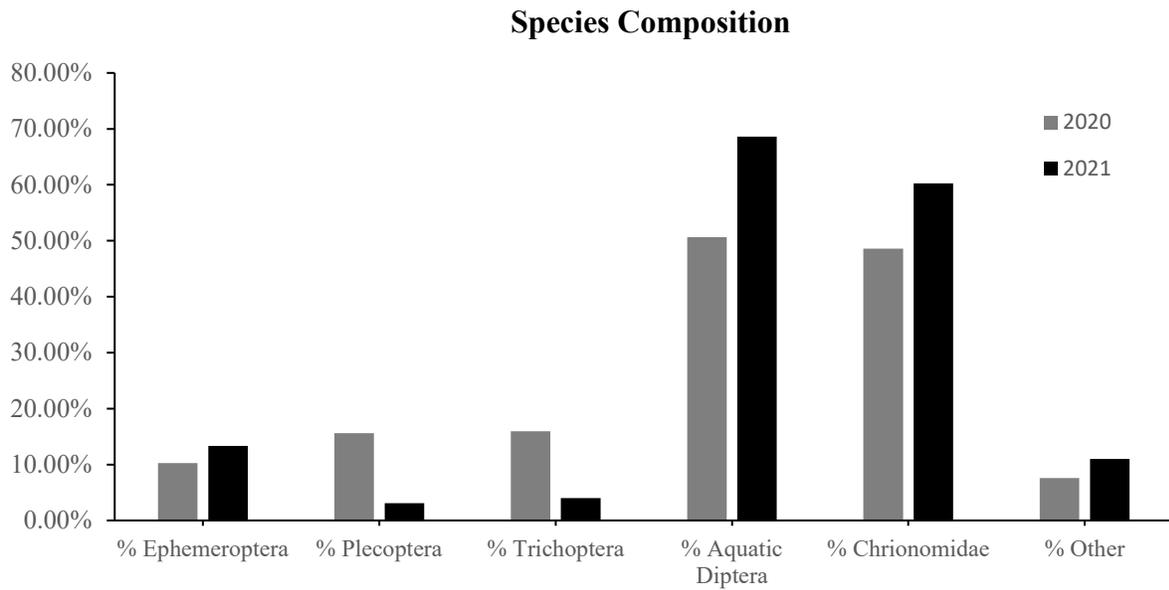


Figure 6: Species composition of aquatic macroinvertebrates found in upper Illinois Creek in 2020 and 2021.

Periphyton

Pheophytin-corrected chlorophyll-a area densities in upper Illinois Creek had a median value of 3.47 mg/m² (Figure 7). This is comparable to the area density of 3.68 mg/m² seen in 2020 (Appendix 2) and is similar to levels seen in multiple fish-bearing streams surrounding the Red Dog Mine (Clawson and Ott 2020).

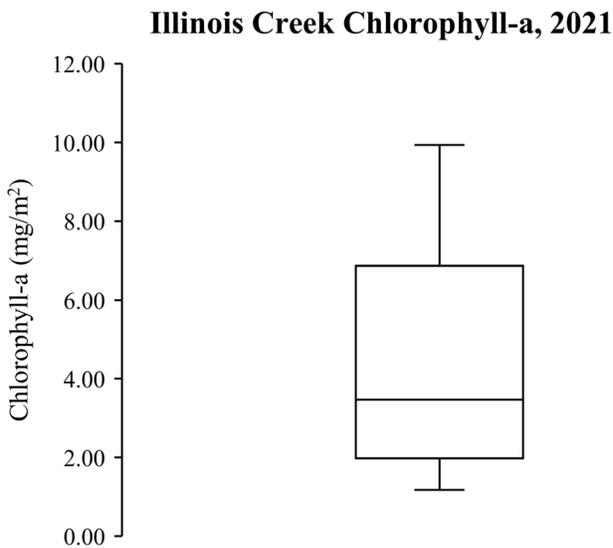


Figure 7: Pheophytin-corrected chlorophyll-a area-density in Illinois Creek, July 2021. Horizontal line represents the median value. Box indicates first and third quartiles, whisker max and min, dot outliers.

Juvenile Coho Elements

Element concentrations expressed as mg/kg dry mass for each analyzed fish are listed in Appendix 3. All references to historic element data in this section refer to data presented by Winters (1996). Data from Winters' 1996, as well as Burrows 2020 report, are included in Appendix 3. When an element was measured at concentrations below the Minimum Detectable Limit (MDL), the MDL was reported as the concentration of the element for that fish.

Element concentrations in juvenile coho salmon in Illinois Creek were generally similar to or less than concentrations of the same elements found in other Alaskan fish species of a similar life stage and trophic level. Whole-body concentrations of zinc, copper, and arsenic were detected at the

highest levels of the elements analyzed (Figure 8, Figure 9). Zinc was present at a median value of 136 mg/kg in 2021 (Figure 9). This was nearly identical to the 135 mg/kg seen in 2020. These are similar to zinc concentrations found in juvenile Dolly Varden in streams surrounding the Red Dog Mine and is approximately double the levels found in Arctic grayling from Bons Pond, also near Red Dog Mine (Clawson and Ott 2020). Historic samples from Illinois Creek were not tested for zinc.

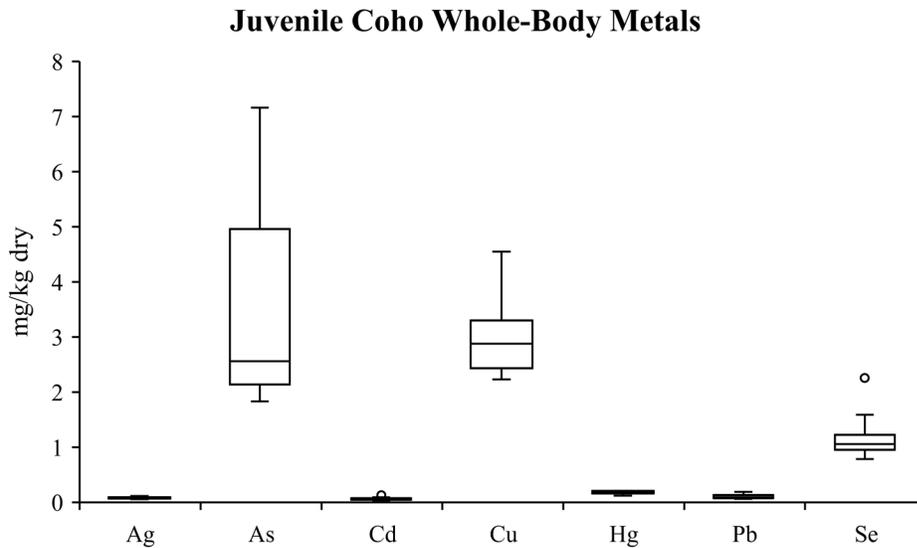


Figure 8: Whole-body concentration of silver (Ag), arsenic (As), cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), and selenium (Se) in juvenile coho salmon from Illinois Creek (n=15). Horizontal line represents the median value. Box indicates first and third quartiles, whisker max and min, dot outliers.

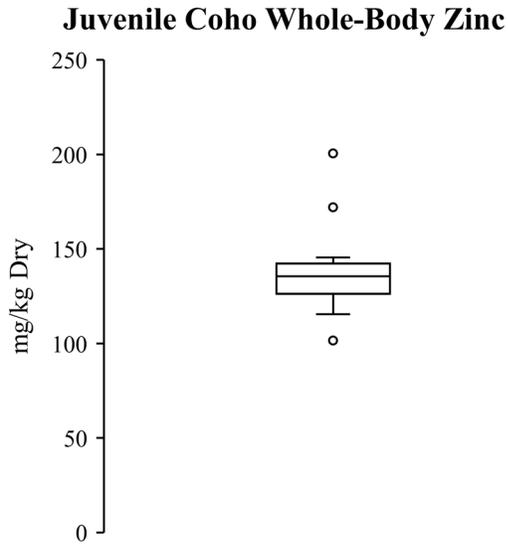


Figure 9: Whole-body zinc concentration of juvenile coho salmon from Illinois creek (n=15). Horizontal line represents the median value. Box indicates first and third quartiles, whisker max and min, dot outliers.

The median copper concentration in the juvenile coho salmon was 2.88 mg/kg in 2021. This was slightly lower than 2020 (3.35 mg/kg) but comparable to the median concentration found in 1996 (2.73 mg/kg). These concentrations are generally comparable with copper levels found in juvenile Dolly Varden captured in active mine drainages throughout the state of Alaska (Legere and Timothy 2016).

Arsenic was present at a median concentration of 2.6 mg/kg in 2021. This is considerably higher than concentrations found in 2020 (1.4 mg/kg), and 1996 (1.75mg/kg). These concentrations fall between those found in juvenile Dolly Varden from streams near the Pebble Prospect (Legere and Timothy 2016) and multiple streams in the Middle Kuskokwim River Region (Metz et al. 2017); the 2021 concentrations are at the high end of this range.

Whole-body cadmium concentrations had a median value of 0.057 mg/kg in 2021. This is similar to the 0.06 mg/kg observed in 2020; however, it was double the 1996 median concentration. It should be noted that only five samples were analyzed for cadmium in 1996 versus 15 in 2020 and 2021. These concentrations are an order of magnitude lower than those of juvenile Dolly Varden in Anxiety Ridge Creek near the Red Dog Mine (Clawson and Ott 2020).

Mercury concentrations had a median value of 0.17 mg/kg in 2021. This is similar to the 0.20 mg/kg seen in 2020, but considerably higher than the 0.08 mg/kg measured in 1996. Current juvenile coho salmon mercury concentrations are similar to those found in juvenile coho salmon in Resurrection Creek on the Kenai Peninsula (MacFarlane 2004).

Lead had a median concentration of 0.09 mg/kg in 2021. This was slightly lower than the 0.12 mg/kg seen in 2020, and 0.15 mg/kg in 1996. Lead levels found in juvenile coho salmon in Illinois Creek are comparable to those found in Arctic grayling in Fish Creek prior to the development of the Fort Knox Gold Mine (Weber Scannell and Ott 1994).

Selenium was present at a median value of 1.05 mg/kg in 2021. This was comparable to the concentration of 1.02 mg/kg seen in 2020. Selenium was not measured in 1996 juvenile coho salmon. These median concentrations are approximately one quarter those found in juvenile Dolly Varden from drainages near the Red Dog mine from 2005 to 2019 (Clawson and Ott 2020).

Silver was below the MDL in all samples in 2021 (Figure 8). This was also true for all 15 samples in 2020 (Appendix 3). Similarly, 21 out of 30 samples were below the MDL for silver in 1996, and the median value of the remaining nine samples was only 0.03mg/kg (Appendix 3).

Fish Presence

In addition to the two sites sampled on Illinois Creek, eight additional streams were sampled for fish presence with baited minnow traps in 2021. They are presented in this section grouped by drainage. Total catches for each site are summarized in Appendix 1.

California Creek

The California Creek watershed drains the western side of the Round Top prospect and could be affected by the development of this deposit and the related road infrastructure (Figure 1).

Lower California Creek: Site 1



Figure 10: California Creek near its confluence with the Little Mud River, July 2021.

The lowest reach of California Creek is slow and meandering and is punctuated with mild riffles. Log jams and cut banks are common. The substrate is mixed sand and silt, and mature white spruce and birch forests shade much of the stream. Two juvenile coho salmon, ten slimy sculpin, and one Alaska blackfish were caught at this location. Forty-seven juvenile Chinook salmon were caught near this site in 1995, but none were caught in 2020 or 2021.

Lower California Creek: Site 2



Figure 11: Lower California Creek, July 2021.

Located approximately 5km upstream of Site 1, this reach of the stream has similar characteristics as Site 1, but the substrate contains more gravel and sand, and less silt. Thirty-four juvenile coho salmon were caught at this site. In 1995, there were 154 juvenile Chinook salmon caught in this stretch of stream, however none were caught in 2020 or 2021.

California Creek: upstream of Colorado Creek

This sampling site is approximately 3km upstream of the mouth of Colorado Creek (Figure 1). It is a shallow, swift stream with occasional deeper pools and a cobble dominated substrate. The proposed Round Top winter trail would cross the stream near this location. The site is surrounded by black spruce bogs with mature willows at the bank. Nine slimy sculpin, four juvenile coho salmon, one Dolly Varden, and one Alaska blackfish were caught at this sample site. No photos were taken of this stream.

Unnamed Stream



Figure 12: Unnamed stream, downstream of winter trail crossing, July 2021.

This tributary of the West Fork Mud River is a high-gradient tundra stream with abundant step pools and rapids. The substrate is dominated by boulders and cobbles. The stream is shaded by dense alder and willow. It is located between Illinois Creek and the Honker Deposit (Figure 1), and the drainage would be crossed by an expansion of the mine road system. Eleven Dolly Varden were caught at this location.

Dome Creek

The Dome Creek watershed is a tributary to the West Fork of the Mud River and is immediately north of the Honker Prospect. Two locations were sampled on Dome Creek, and one location on an unnamed tributary.

Upper Dome Creek



Figure 13: Upper Dome Creek, July 2021.

This section of Dome Creek is fast flowing with interspersed slow pools. Streamside vegetation is dominated by tall grass and sedges too short to form a canopy, and the substrate is predominantly gravel and cobble. Sixteen slimy sculpin and two Alaska blackfish were caught here.

Lower Dome Creek



Figure 14: Lower Dome Creek, July 2020.

This reach of Dome Creek has a gravel and cobble bed, slightly incised beds, and deep pools. The stream is lined by willow stands and tall grasses and is located between two large beaver dam complexes. Twelve Alaska blackfish, two slimy sculpin, and seven Dolly Varden were caught at this site in 2021. In 2020, six juvenile coho salmon were caught at this location (Appendix 1).

Dome Creek: Unnamed Tributary



Figure 15: Unnamed Dome Creek tributary, July 2021.

This is a small tundra stream with frequent cut banks and fine gravel substrate. The area experienced a wildfire in 2019, but stream-side deciduous shrubs survived in good condition, and it has significant alder and willow cover. Twenty-two Dolly Varden were caught at this site. Twenty-one of those fish were caught in a single trap placed at the outlet of a cold-water spring.

Eddy Creek



Figure 16: Eddy Creek, July 2021.

Eddy Creek is a tributary of the Khotol River and drains the area north of the Round Top Prospect (Figure 1). The sample site has a gravel and cobble bed, a moderate gradient with swift riffles, and is interspersed by deeper pools and runs. There is thick grassy and deciduous cover on the slightly incised banks. One slimy sculpin and seven Dolly Varden were caught at this site in 2021. This landing zone was several hundred meters upstream from the previous year's sampling, placing us above a large beaver dam. This physical barrier may explain why zero juvenile coho salmon were captured in 2021, while six were caught here in 2020 (Appendix 1).

CONCLUSION

This report summarizes the current environmental conditions in watersheds near the historic Illinois Creek Mine and surrounding prospects. If future aquatic sampling is planned, we recommend continuation of periphyton and aquatic invertebrate sampling, fish surveys, and juvenile fish whole-body element analysis. Natural variability in juvenile fish populations and whole-body element concentrations, as well as natural fluctuations in aquatic macroinvertebrate relative abundance would be better captured with a long-term dataset. Future work should be focused on developing annual monitoring to expand the dataset and better inform our understanding of what species utilize target areas around the deposits. For instance, juvenile Chinook salmon were documented in California Creek in 1995, however none were captured in 2020 or 2021. Chinook salmon runs in the greater Yukon River drainage have experienced low numbers for over a decade, and the population formerly rearing in the California Creek drainage may have been extirpated. Additional recommendations include conducting aerial surveys to determine if there are adult Dolly Varden, coho and/or Chinook salmon spawning areas in the vicinity of the Illinois Creek mine and associated prospects.

Literature Cited

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Appendix 1: Fish catches by species and site 2021 (top) and 2020 (bottom), Illinois Creek biomonitoring project.

Location (2021)	Lat	Long	Juvenile Coho	Slimy Sculpin	Dolly Varden	Alaska Blackfish	Arctic Grayling	Coho Retained for Elements
Lower Illinois Ck	64.0280	-157.8667	116	8	-	1	-	15
Upper Illinois Ck	64.0395	-157.8696	229	7	-	-	-	-
Lower California Ck: 1	64.0228	-157.8127	2	10	-	2	-	-
Lower California Ck 2	64.0557	-157.7892	34	-	-	-	-	-
California Ck: US Colorado Ck	64.1363	-157.7487	4	9	1	1	-	-
Upper Dome Ck	64.1424	-157.9996	-	16	-	2	-	-
Lower Dome Ck	64.1368	-158.0659	-	2	7	12	-	-
Dome Creek Trib	64.1301	-157.0569	-	-	22	-	-	-
Eddy Ck	64.2231	-157.5799	-	1	7	-	-	-
Unnamed Ck: Honker Trail	64.0917	-157.9635	-	-	11	-	-	-
Location (2020)	Lat	Long	Juvenile Coho	Slimy Sculpin	Dolly Varden	Alaska Blackfish	Arctic Grayling	Coho Retained for Elements
Lower Illinois Ck	64.0280	-157.8667	304	7	-	-	-	7
Upper Illinois Ck	64.0395	-157.8696	62	6	-	-	-	8
Lower California Ck: 1	64.0228	-157.8127	11	4	-	1	-	-
Lower California Ck 2	64.0557	-157.7892	79	-	-	1	1	-
California Ck Headwaters	64.1918	-157.6515	-	3	9	-	-	-
California Ck: US Colorado Ck	64.1363	-157.7487	42	3	1	1	-	-
California Ck Trib 1	64.1854	-157.6413	7	3	2	-	-	-
California Ck Trib 2	64.1967	157.7584	-	-	8	-	-	-

California Ck Trib 3	64.0816	-157.7903	-	-	3	-	-	-
Colorado Ck	64.1276	-157.7487	-	2	3	-	-	-
Unnamed Ck: Winter Trail	64.0917	-157.9635	-	-	15	-	-	-
Upper Dome Ck	64.1424	-157.9996	-	4	-	4	-	-
Lower Dome Ck	64.1368	-158.0659	6	6	1	-	-	-
Dome Creek Trib	64.1301	-157.0569	-	-	4	-	-	-
Eddy Ck	64.2231	-157.5799	6	1	6	-	-	-
Upper Minnesota Ck	64.1306	-157.5760	14	-	3	-	-	-
Minnesota Trib 1	64.1552	-157.5928	-	-	2	-	-	-
Minnesota Trib 2	64.1552	-157.5928	-	-	-	-	-	-
Minnesota Trib 3	64.1376	-157.5924	11	9	4	2	-	-

Appendix 2: Pheophytin-corrected chlorophyll-a area density (mg/m²) in samples from upper Illinois Creek in 2021 and 2020.

	2021 Chlorophyll-a (mg/m ²)	2020 Chlorophyll-a (mg/m ²)
	2.67	5.34
	3.63	2.35
	6.51	1.28
	9.93	1.17
	3.74	11.21
	2.03	3.31
	1.17	24.45
	1.82	4.05
	7.90	1.06
	3.31	8.44
Median	3.47	3.68

Appendix 3: Element concentrations (mg/kg dry weight) in juvenile coho salmon from Illinois Creek in 2021, 2020 and 1996. Each row represents one fish. In 1996 data, ND indicates concentrations below the MDL. * Indicates outliers not shown in in-text graphs.

2021

Element	Ag	As	Hg	Cu	Cd	Pb	Se	Zn
	0.089	2.1	0.2	3.3	0.047	0.089	0.951	135.6
	0.097	2.1	0.15	2.88	0.049	0.096	1.1	136.4
	0.069	6.7	0.2	3.57	0.061	0.14	1.4	128.6
	0.058	7.2	0.2	2.86	0.075	0.094	1.1	135.6
	0.12	2.5	0.21	4.55	0.089	0.12	2.2	200.6
	0.068	3.2	0.16	3.1	0.062	0.068	1.2	142.2
	0.09	1.8	0.21	2.58	0.045	0.09	0.94	129.6
	0.073	1.9	0.15	2.43	0.13	0.073	1	115.5
	0.085	2.3	0.17	2.27	0.043	0.085	1.6	138.2
	0.079	2.4	0.16	3.17	0.057	0.079	0.97	145.5
	0.08	5.5	0.16	3.36	0.061	0.22	0.91	101.5
	0.081	4.9	0.18	3.05	0.047	0.13	1.1	172
	0.062	2.7	0.16	2.23	0.035	0.062	1	129.9
	0.073	2.6	0.19	2.85	0.22	0.19	1.1	126.3
	0.064	2.6	0.12	2.32	0.031	0.064	0.79	115.4
Median	0.079	2.6	0.17	2.88	0.057	0.09	1.1	135.6

2020

Element	Ag	As	Hg	Cu	Cd	Pb	Se	Zn
	0.09	3.6	0.27	3.4	0.064	0.18	1.5	163.3
	0.076	2.3	0.17	2.7	0.066	0.24	1.2	106
	0.064	3.6	0.19	3.4	0.1	0.09	1.8	138.1
	0.074	3.8	0.21	5	0.063	0.27	1.7	135.1
	0.073	3.3	0.2	3.1	0.064	0.12	0.96	119
	0.079	2.9	0.17	4.9	0.1	0.34	1.56	223.1
	0.11	3.6	0.24	5.3	0.4	0.24	2.39	225.2
	0.079	0.62	0.13	3.2	0.059	0.079	0.98	140.2
	0.082	0.44	0.15	2.9	0.041	0.082	0.82	131.1
	0.079	0.7	0.2	2.4	0.042	0.079	0.94	142.9
	0.078	0.84	0.25	3.5	0.11	0.078	1.2	150.7
	0.085	1.3	0.22	4.7	0.043	*16.3	0.86	87.4
	0.088	0.49	0.34	3.7	0.044	0.12	0.88	100.5
	0.08	1.3	0.19	2.7	0.059	0.08	1	79.1
	0.077	0.57	0.26	3	0.038	0.15	0.72	93.9
Median	0.079	1.3	0.2	3.4	0.063	0.12	1	135.1

Appendix 3: Concluded

1996

Element	Ag	As	Hg	Cu	Cd	Cr	Pb	Ni	Sb
	ND	0.5	0.12	3.96	0.04	8.7	0.15	1.2	0.06
	ND	0.6	0.03	2.85	0.09	0.5	0.11	0.3	0.13
	ND	ND	ND	2.27	0.03	0.6	0.07	0.3	0.09
	ND	0.7	0.14	2.32	0.03	0.7	0.27	0.4	0.34
	ND	0.6	0.07	2.65	0.03	0.6	0.15	0.3	0.14
	ND	1.6	0.07	4.01	-				
	ND	1.5	0.1	3.54					
	ND	ND	0.08	3.4					
	ND	1	0.08	3.17					
	ND	1.1	0.07	2.65					
	ND	1.6	0.07	3.26					
	ND	1	0.13	2.69					
	ND	1.3	0.08	2.75					
	ND	1.1	0.08	2.69					
	ND	3	0.1	2.84					
	ND	1.9	0.12	2.64					
	ND	3.5	0.08	3.32					
	ND	2.3	0.07	3.38					
	ND	3	0.07	2.77					
	0.02	2	0.06	2.71					
	0.08	1.6	0.06	2.44					
	0.03	2.0	0.08	3.06					
	0.11	1.9	0.11	2.23					
	0.04	2.4	0.08	2.31					
	0.02	1.9	0.08	3.52					
	0.03	2.7	0.06	2.55					
	0.03	2.1	0.07	2.23					
	0.03	1.2	0.07	2.61					
	0.08	3.1	0.1	2.46					
	0.03	1.9	0.07	5.92					
Median	0.03	1.75	0.08	2.73	0.03	0.6	0.15	0.6	0.13