Technical Report No. 23-05

Baseline Aquatic Biomonitoring at Illinois Creek Mine and Associated Prospects, 2022

by

Lauren E. Yancy and Olivia N. Edwards

June 2023

Alaska Department of Fish and Game **Habitat Section**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
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

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

TECHNICAL REPORT NO. 23-05

BASELINE AQUATIC BIOMONITORING AT ILLINOIS CREEK MINE AND ASSOCIATED PROSPECTS, 2022

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June 2023

Cover: Aquatic macroinvertebrate sampling in Upper Illinois Creek, June 2022. Photograph by Olivia Edwards.

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EXECUTIVE SUMMARY

This report summarizes the results of 2022 biomonitoring work in streams near the historic Illinois Creek Mine, as well as the associated Honker and Round Top prospects. Biomonitoring efforts included surveys of periphyton, aquatic macroinvertebrates, and juvenile fish. These efforts aim to establish a benchmark data set prior to prospect development and monitor for potential ecological effects of the historic mine.

Juvenile coho salmon were collected in June 2022 using minnow traps in Illinois Creek, one unnamed tributary to Little Mud River, and streams in the nearby California, Minnesota, Eddy, and Dome Creek drainages (Figure 1). Overall, 22 sites were sampled, including two streams near the mine camp that may be impacted by proposed road routes.

Juvenile coho salmon from Illinois Creek were analyzed for whole body concentrations of several elements, and their length frequencies were described. Juvenile coho salmon catches at this site were lower in 2022 than those reported in 2020 and 2021 but do fall within the historical catch range from the mid-1990s to 2021. All juvenile coho salmon captured were freshwater age-1 fish; young-of-year individuals were not observed in 2022. The whole body element concentrations of the 15 retained juvenile coho salmon from lower Illinois Creek were comparable to historical data from the late 1990s, as well as 2020 and 2021. The mean zinc level in fish tissues was the lowest recorded and arsenic had the highest mean value compared with past data.

Aquatic macroinvertebrates and periphyton were sampled in upper Illinois Creek. Aquatic macroinvertebrate density doubled in 2022 compared with density recorded in 2021. Species composition has changed since the switch from Surber to Hess sampler in 2021, but the proportions of taxonomic groups is comparable for 2021 and 2022. Illinois Creek pheophytin corrected chlorophyll-a values were three times higher than the previous two years of sampling.

Fish presence minnow trap sampling has shown consistent numbers of resident fish species (e.g., slimy sculpin, Dolly Varden, Alaska blackfish), while the juvenile coho salmon observations have been variable from 2020 to 2022. New sample sites in 2022 were: Water Pump Creek, where juvenile coho salmon and Dolly Varden were captured, and Lower Twin Creek where resident fish species were captured.

INTRODUCTION

The historic Illinois Creek gold and silver mine and associated prospects are located in the southern Kaiyuh Mountains about 90 km southwest of Galena, Alaska. An open pit mine was operated in the area by USMX Incorporated from 1996 to 1998 and Viceroy Resources Corporation 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.

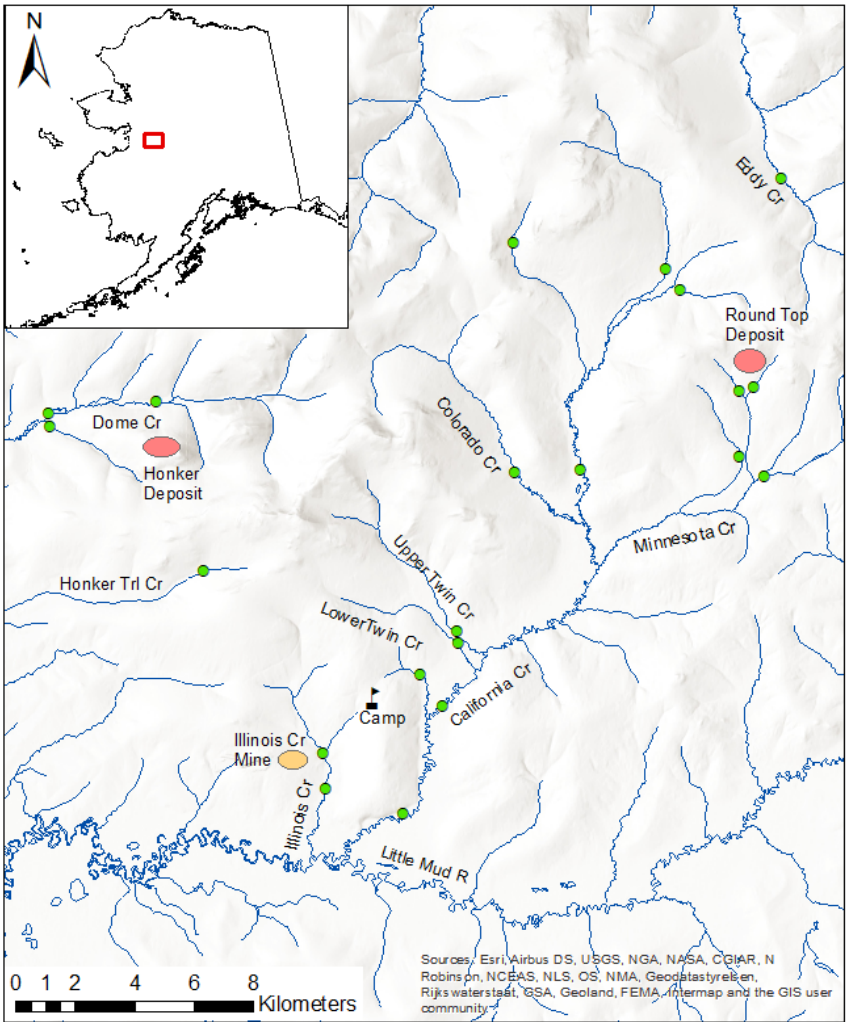

Figure 1. July 2022 sample sites (green circles) surrounding the Illinois Creek Mine, Honker deposit, and Round Top deposit.

The ADF&G Habitat Section collected fish presence data and calculated juvenile salmon population estimates at the mine between 1995 and 1998 (Winters 1996-1998b). During this period, sampling focused on Illinois Creek using minnow traps for juvenile salmon, and visual surveys were performed on foot for adult salmon. Whole body element analyses and 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 to 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 erodes easily, and stream substrate transitions from small boulders to sand and silt within a few kilometers.

Fish communities vary depending on stream characteristics. These consist 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 lower reaches. Abundant large beaver dam complexes in these drainages impact fish distribution on a decades long timescale.

The goal of current sampling efforts is to quantify benchmark biological conditions in Illinois Creek and nearby watersheds to track changes over time. Juvenile salmon were collected from Illinois Creek to compare catch numbers, size distributions, and whole body element concentrations to previous year's data. Additionally, periphyton and aquatic macroinvertebrates were collected from upper Illinois Creek. Fish presence data were also recorded from other streams that may be impacted by the development of the Honker and Round Top prospects and their related infrastructure.

METHODS

Fish Presence

Ten minnow traps baited with cured salmon roe in perforated plastic bags were set in each sampled stream for approximately 24 hours. When traps were collected, the species and fork length (FL) of every captured salmonid were recorded. Total length (TL) was recorded for species with round caudal fins, such as slimy sculpin and Alaska blackfish.

Juvenile Coho Salmon Whole Body Elements

In lower Illinois Creek, 15 juvenile coho salmon between 80 to 110 mm FL 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 kept frozen until lab analyses were performed.

Retained juvenile coho salmon were analyzed for arsenic, cadmium, copper, lead, mercury, selenium, zinc, and silver by ACZ Laboratories in Steamboat Springs, Colorado. Mercury was measured using direct combustion, and other elements by inductively coupled plasma mass spectroscopy. 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.

Mean element concentrations were compared with past values of juvenile coho salmon from Illinois Creek. In addition, concentrations from other Alaskan fish species of a similar life stage and trophic level were used to draw comparisons across the state in historically mined areas, exploration prospects, or active mining areas.

Aquatic Macroinvertebrates

In upper Illinois Creek, approximately 100 m downstream of the minnow trapping reach, a 0.086 m^2 Hess sampler was used to collect five invertebrate samples. For each replicate, the Hess sampler was set in place and all rocks within the circular sampling area were dislodged from the stream bed and thoroughly agitated to release invertebrates downstream into the cod end. Insect samples were preserved in 90% ethanol and stored at room temperature until lab analysis. NRF Taxonomic Services located in Fairbanks, Alaska identified and enumerated the samples.

Aquatic macroinvertebrate data were described as the average number of individuals/m^2 of stream bed, as well as the percent belonging to orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), aquatic Diptera (flies), and "other." A Surber sampler was used in 2020 for aquatic macroinvertebrates, which adds a component of drift collection to the benthic sampling but is still comparable among Hess sampler aquatic macroinvertebrate densities.

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 water impurities, whereas EPT taxa are more sensitive making them good bioindicators for high water quality.

Periphyton

Periphyton sample collection and lab analyses follow the rapid bioassessment techniques of Barbour et al. 1997. In upper Illinois Creek ten completely submerged rocks were selected for periphyton 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 the 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. Material trapped on the brush was also rinsed onto 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. Samples were stored frozen until chlorophyll-a concentration of each sample was measured in the ADF&G lab. These concentrations are a metric for estimating periphyton standing crop and primary productivity in the stream.

RESULTS AND DISCUSSION

Illinois Creek

Illinois Creek is located directly between the historic mine pit and current mine camp (Figure 1), which are across the drainage from each other and are connected by a gravel road. Two locations were sampled 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 June 2022, 31 juvenile coho salmon, 2 Alaska blackfish, and 3 slimy sculpin were caught at this site. Catches here have been historically variable, ranging from 11 to 346 juvenile coho salmon per sampling event (Winters 1996-1998b). Although the 2022 juvenile coho salmon catch falls within this range, it is considerably lower than catches in 2020 (304; Burrows 2020) and 2021 (116; Burrows and Edwards 2022). Fifteen coho salmon were kept from this reach of Illinois Creek for whole body element analysis. Previous work also found juvenile burbot at this location (Winters 1996-1998b). Burbot were likely utilizing the low flow habitat created by multiple beaver dam complexes during that period, which have since washed out.

Figure 2. Lower Illinois Creek, June 2022.

The 2022 length frequency distribution of juvenile coho salmon from this site illustrates the presence of freshwater age-1+ individuals with an absence of young-of-year individuals (Figure 3), differing from previous length frequency plots from June 2020 and June 2021 Illinois Creek Technical Reports (Burrows 2020; Burrows and Edwards 2021). In June, young-of-year coho

salmon have recently emerged from the gravel and are generally shorter than 40 mm. The size of young-of-year individuals as well as timing of sampling influences capture success. The freshwater age-1+ fish captured in 2022 ranged from 69 to 99 mm (Figure 3). Approximately half of the captured fish were in an intermediate size range of 80 to 90 mm.

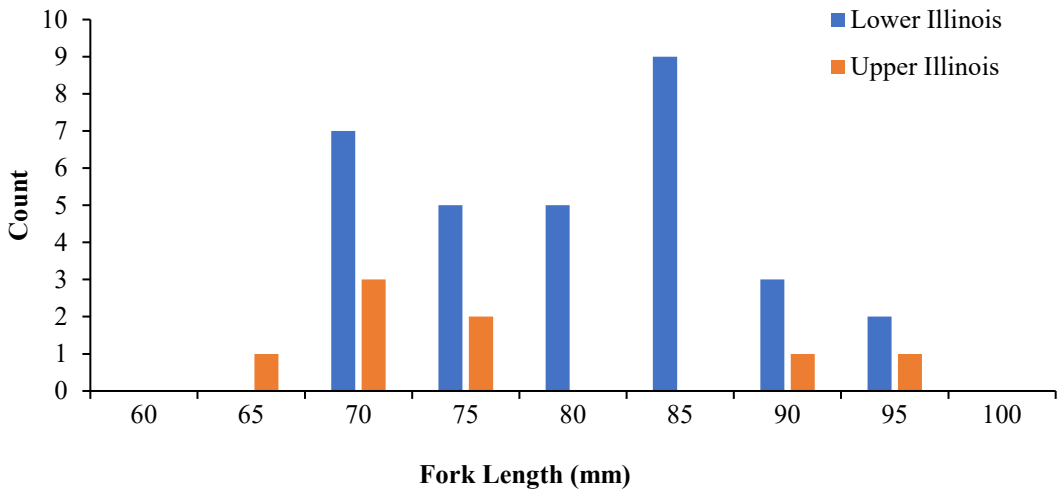

Figure 3. Length frequency distribution of juvenile coho salmon in lower and upper Illinois Creek, June 2022.

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 groundwater spring enters the stream approximately 200 m upstream of the upper limit of our sampling reach. In June of 2022, eight freshwater age-1+ coho salmon and eight slimy sculpin were captured at this location. Juvenile coho salmon catch in 2022 was considerably lower than in 2021 when 229 coho salmon were captured (Burrows and Edwards 2022) and at the low end of the overall range of catches between the 1990s and 2020 (Winters 1996-1998b; Burrows 2020; Appendix 1).

Figure 4. Upper Illinois Creek, downstream of the warm groundwater spring, June 2022.

Juvenile Coho Salmon Whole Body Elements

Whole body element concentrations are expressed as mg/kg dry mass for each analyzed fish in 2022. The values are listed in Appendix 3 and displayed in Figure 5. Data from past biomonitoring reports (Winters 1996; Burrows 2020; Burrows and Edwards 2021) are also included in Appendix 3. All references to "historic" element data in this section refer to data from Winters 1996.

Silver concentrations were below the MDL in all samples in 2022 (Figure 5). The MDL concentrations ranged from 0.06 to 0.10 mg/kg in 2022 but will vary because the amount detectable is based on percent solids in each individual sample. Concentrations were also below MDL for all samples in 2020 and 2021 (Appendix 3). Similarly, 19 out of 30 samples were below the MDL for silver in 1996, and the mean value of the remaining 11 samples was 0.05 mg/kg (Appendix 3). Whole body silver concentrations below the MDL were similarly observed in juvenile Dolly Varden near the Pebble Prospect (Legere and Timothy 2016).

The mean arsenic concentration was 4.03 mg/kg in 2022 (Figure 5). This is above mean concentrations in all past years of data that ranges from 1.75 to 3.38 mg/kg (Appendix 3). These concentrations fall between those found in juvenile Dolly Varden from streams around the Pebble Prospect (Brekken et al. 2022), and are above concentrations found in juvenile coho salmon in the middle Kuskokwim River region which is a heavily mineralized area subject to historic and present day mining (Matz et al. 2017).

The mean cadmium concentration was 0.11 mg/kg in 2022 (Figure 5). This is slightly above the mean observed in 2020 (0.09 mg/kg) and 2021 (0.07 mg/kg). It should be noted that only five samples were analyzed for cadmium in 1996, when mean value was 0.04 mg/kg, versus 15 samples since 2020 (Appendix 3). These concentrations are below those found in juvenile Dolly Varden in Anxiety Ridge Creek near the Red Dog Mine (Clawson 2022a), and similar to levels reported in juvenile Dolly Varden near the Pebble Prospect (Legere and Timothy 2016).

The mean copper concentration was 2.92 mg/kg in 2022 (Figure 5). This is similar to past mean concentrations that range from 2.97 to 3.59 mg/kg (Appendix 3). These concentrations are on the low end of copper levels found in juvenile Dolly Varden captured in active mine drainages throughout the state of Alaska (Legere and Timothy 2016).

The mean mercury concentration was 0.26 mg/kg in 2022 (Figure 5). This is comparable to mean concentrations in 2020 and 2021, but nearly three times higher than in 1996 (0.08 mg/kg; Appendix 3). Current juvenile coho salmon mercury concentrations are similar to those found in juvenile coho salmon in historically mined areas in Resurrection Creek on the Kenai Peninsula (MacFarlane 2004) but are slightly above levels seen in juvenile Dolly Varden near the Pebble Prospect (Legere and Timothy 2016).

The mean lead concentration was 0.12 mg/kg in 2022 (Figure 5). This is comparable to mean concentrations in all past years of data (Appendix 3). These concentrations are similar to values reported for juvenile Dolly Varden near the Pebble Prospect (Legere and Timothy 2016), and below values seen from Buddy and Anxiety Ridge Creeks near Red Dog Mine (Clawson 2022a).

The mean selenium concentration was 0.99 mg/kg in 2022 (Figure 5). This is below the mean concentration in 2021 (1.16 mg/kg) and in 2020 (1.23 mg/kg; Appendix 3). These mean concentrations are less than one quarter of those found in juvenile Dolly Varden in drainages near the Red Dog mine from 2005 to 2021 (Clawson 2022a), and similar to levels found in the Upper Talarik Creek near the Pebble Prospect (Legere and Timothy 2016). Historic samples from Illinois Creek were not tested for selenium.

The mean zinc concentration was 123 mg/kg in 2022 (Figure 5) which is slightly lower than mean the concentration in 2020 (137 mg/kg) and in 2021 (136 mg/kg; Appendix 3). These zinc

concentrations are similar to those found in juvenile Dolly Varden in streams surrounding the Red Dog Mine (Clawson 2022a), as well as concentrations reported near the Pebble Prospect (Legere and Timothy 2016). Historic samples from Illinois Creek were not tested for zinc.

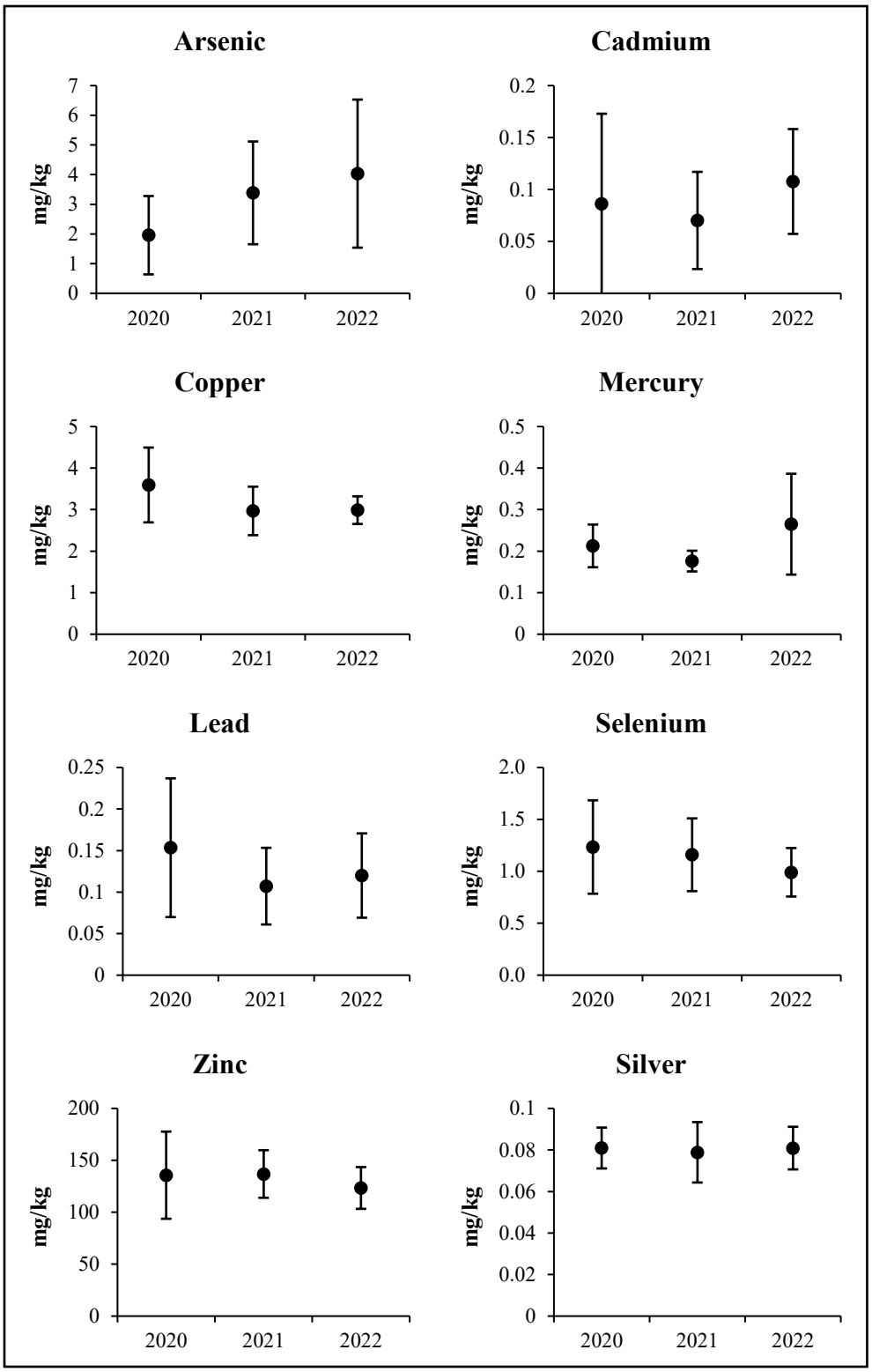

Figure 5. Juvenile coho salmon whole body mean element concentrations (dry weight) ± 1 SD in Illinois Creek (n=15), 2020-2022.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates in 2022 averaged 19,027 (± 5,810 SD) individuals/m^2 of stream bed, which is substantially higher than the recorded average of 7,922 (± 5,920 SD) in 2021 (Figure 6). In 2020 when a Surber sampler was used to collect aquatic macroinvertebrates, there was an average of 8,757 (± 3,432 SD) individuals/m^2 of stream bed.

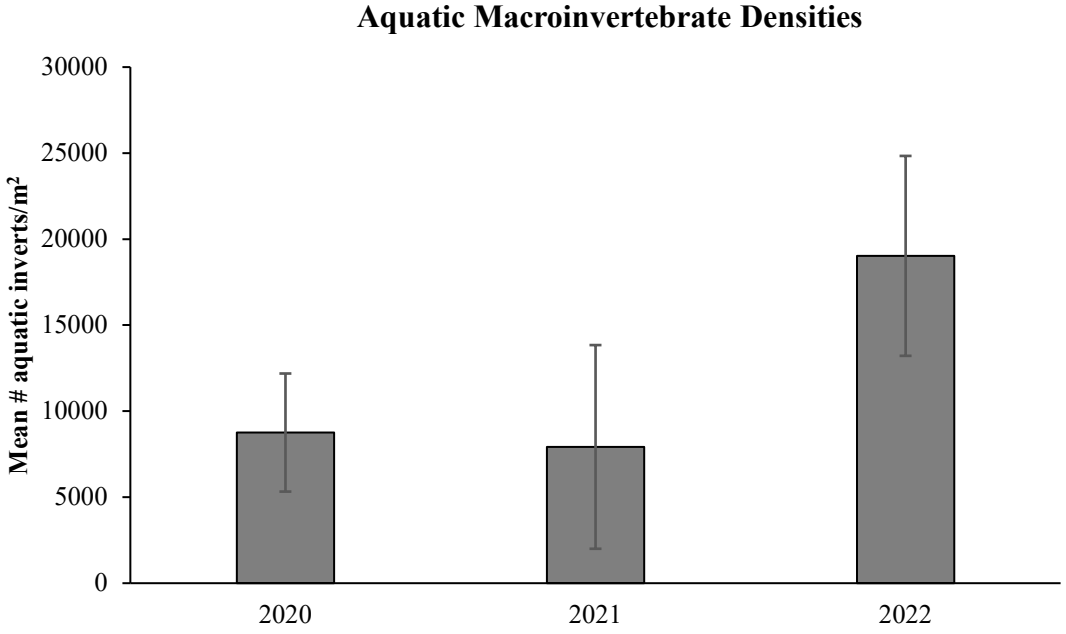

Figure 6. Mean number of aquatic macroinvertebrates/m^2 substrate (± 1 standard deviation), 2020-2022.

The EPT taxa made up 29% of the aquatic macroinvertebrate samples in 2022, compared with 20% in 2020 and 41% in 2021. Ephemerotera had a higher presence than past years, making up for the low percentage of Plecoptera and Trichoptera (3%; Figure 7). In 2022, 11% of the samples were composed of "other" macroinvertebrates, predominately Acarina (mites) and Platyhelminthes (flatworms). Changes in taxa composition may be due to the switch to Hess samplers from Surber samplers in 2021.

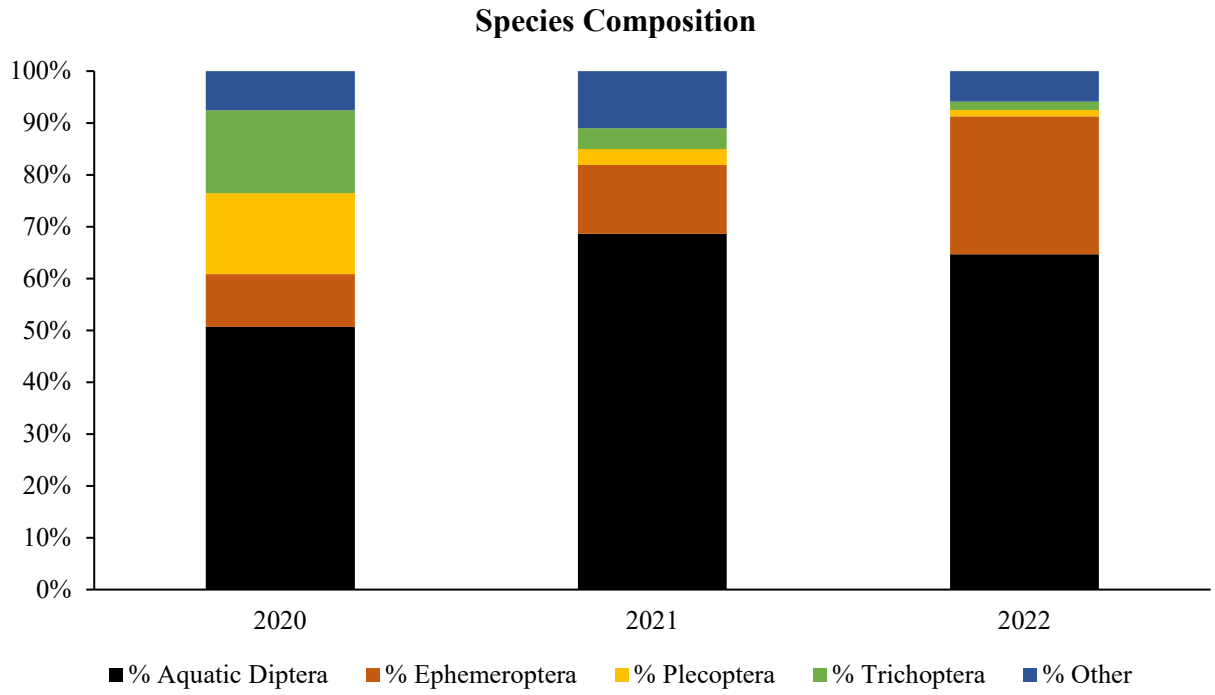

Figure 7. Aquatic macroinvertebrate species composition, upper Illinois Creek, 2020-2022.

Periphyton

In 2022, mean pheophytin corrected chlorophyll-a concentration in upper Illinois Creek was higher than previously recorded (19.06 ± 19.44 SD mg/m^2) with a large range of concentrations (Figure 8). This is approximately 3 to 4 times higher than the mean concentration in 2020 (6.27 ± 6.84 SD mg/m^2) and in 2021 (4.27 ± 2.74 SD mg/m^2; Appendix 2). The elevated concentration in 2022 is similar to streams with the highest chlorophyll-a concentrations (e.g., Upper Ruby Creek) near the Arctic and Bornite prospects (Clawson 2021).

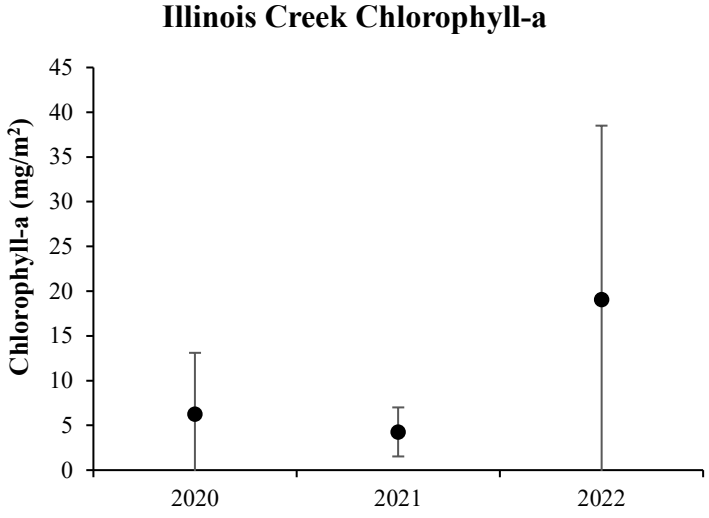

Figure 8. Pheophytin corrected chlorophyll-a mean concentrations ± 1 SD in Illinois Creek, 2020-2022.

Fish Presence

California Creek

The California Creek watershed drains the western side of the Round Top prospect and may be affected by development of this deposit and proposed road infrastructure (Figure 1). California Creek is a tributary of Little Mud Creek and is documented in the ADF&G Anadromous Waters Catalog for supporting chum and Chinook salmon spawning, and coho and Chinook juvenile salmon rearing habitat. Ten sites on California Creek and nearby tributaries were sampled in 2022 for fish presence.

Lower California Creek: Site 1

California Creek Site 1 is approximately 2.5 km upstream of its confluence with the Little Mud River and is the farthest downstream sample site in the drainage (Figure 1). The stream channel has low gradient with deep pools and large woody debris build up at river bends (Figure 9). Silt and gravel are the predominant sediment and wadable riffle sections are sparsely distributed in this section of California Creek. Seven slimy sculpin were captured at this site. Juvenile coho salmon were recorded in 2020 and 2021, but none were captured in 2022.

Figure 9. California Creek near its confluence with the Little Mud River, June 2022.

Lower California Creek: Site 2

Located approximately 5 km upstream of Lower California Creek Site 1 (Figure 1), this reach has similar characteristics as Site 1, but the substrate contains more gravel and sand, and less silt (Figure 10). Eleven juvenile coho salmon, six slimy sculpin, one Dolly Varden, and three Alaska

blackfish were caught at this site. Small schools of juvenile salmonids were also visually observed in the slack water. In 1995, 154 juvenile Chinook salmon were recorded here, but none have been captured since.

Figure 10. Lower California Creek slack water (left) and downstream view (right), June 2022.

Water Pump Creek (locally accepted name)

Water Pump Creek is a small, approximately 2.5 km long tributary of California Creek with headwaters originating just north of camp and the airstrip (Figure 1). Water is withdrawn from the headwaters to support camp activities. At the sampling location there are some cut banks and woody debris in the water (Figure 11). The substrate is predominately cobble and gravel. This was the first year this site was sampled, and 26 juvenile coho salmon and 3 Dolly Varden were captured.

Figure 11. Water Pump Creek, June 2022.

Lower Twin Creek (locally accepted name)

Lower Twin Creek is located between camp and Colorado Creek (Figure 1). The drainage has a moderate gradient and meanders throughout different channels, with beaver complexes above our sample location. At the lower site, there is very dense riparian vegetation, including willow, spruce, and cottonwood along the streambanks (Figure 12). No photos were taken at this new sample site in 2022. One slimy sculpin and three Dolly Varden were captured here. The proposed Round Top road would cross this drainage.

Figure 12. Lower Twin Creek at the helicopter landing zone, June 2022.

Upper Twin Creek (locally accepted name)

Upper Twin Creek, formerly referred to as "California Creek unnamed tributary 3" (Burrows 2020), is below a series of beaver complexes approximately 0.5 km downstream of the original 2020 sample site. The stream is approximately 2 to 3 m wide, and the substrate is gravel and small cobble with some sandy patches (Figure 13). One Dolly Varden and one Alaska Blackfish were captured here. The proposed Round Top road would cross the stream near this location.

Figure 13. Upper Twin Creek, June 2022.

Colorado Creek

Colorado Creek is approximately halfway between the Illinois Creek Mine and the Round Top Prospect and flows into upper California Creek from the west (Figure 1). The stream is up to 8 m wide at the sample location, and the substrate is sand and gravel. The mainstem channel primarily runs unimpeded, with some beaver activity in the stream with large established beaver complexes on the adjacent floodplains which is dominated by deciduous shrubs (Figure 14). Two Dolly Varden and three slimy sculpin were caught at this site. The proposed Round Top road would cross this drainage.

Figure 14. Colorado Creek downstream (left) and an upstream breached beaver dam (right), June 2022.

California Creek: Upstream of Colorado Creek

This California Creek site is approximately 2.5 km upstream of the mouth of Colorado Creek (Figure 1). It is a shallow, swift reach with occasional deeper pools and a cobble dominated substrate (Figure 15). The site is surrounded by black spruce bog with mature willows lining the bank. Twenty three juvenile coho salmon and two slimy sculpin were captured at this site. The proposed Round Top road would cross the stream near this location.

Figure 15. California Creek upstream of Colorado Creek downstream view (left) and lateral view (right), June 2022.

California Creek Headwaters

This is the most upstream site on California Creek, northwest of the Round Top Deposit and approximately 7 km downstream of the true California Creek headwaters (Figure 1). There was a large beaver complex downstream from the sample site, but within the sample reach the stream was wide and shallow with cobble substrate (Figure 16). Riparian vegetation consisted of white spruce and well established willows. No photos were taken of our sample reach in 2022. Five Dolly Varden were captured at this site.

Figure 16. California Creek headwaters in July 2020 (left) and the downstream beaver complex in June 2022 (right).

California Creek: Unnamed Tributary 1

This stream is approximately 2 m wide and has a medium gradient with a cobble and small boulder bed (Figure 17). Cutbanks are abundant, and riparian vegetation consists of alder and willow. The tributary enters California Creek from the east (Figure 1). No photos of the stream were taken in 2022. Nine slimy sculpin were caught at this site. Species diversity in 2022 was lower than 2020 when juvenile coho salmon and Dolly Varden were also captured.

Figure 17. California Creek, unnamed tributary 1 in July 2020 (left) and the landing zone in June 2022 (right).

California Creek: Unnamed Tributary 2

This tributary is a small, high gradient cascading stream with abundant step pools and vertical drops up to 1.5 m (Figure 18). The tributary flows into upper California Creek from the northwest (Figure 1). It has a very dense alder and willow canopy with cobble and boulder substrate. Twenty Dolly Varden were caught at this location, roughly twice those caught in July 2020 (Appendix 1).

Figure 18. California Creek, unnamed tributary 2 cascade from July 2020 (left) and the landing zone looking away from the stream in June 2022 (right).

Minnesota Creek

Minnesota Creek is a tributary of California Creek and drains the area to the southeast and south of the Round Top Prospect. The proposed Round Top road would cross the top of this drainage. One site on Minnesota Creek and three unnamed tributaries were sampled for fish presence.

Upper Minnesota Creek

This reach of Minnesota Creek is moderately incised with a cobble and gravel substrate. Thick deciduous shrubs line the banks (Figure 19). Two juvenile coho salmon, ten Dolly Varden, and nine slimy sculpin were caught here.

Figure 19. Upper Minnesota Creek upstream (left) and lateral (right), June 2022.

Minnesota Creek: Unnamed Tributary 1

This tributary is narrow, deeply incised with intermittent sections of subsurface flow. The riparian vegetation consists of very thick willows and alder and the substrate is made up of small cobbles and silt (Figure 20). Six Dolly Varden were caught here.

Figure 20. Unnamed Minnesota Creek tributary 1 upstream (left) and lateral (right), June 2022.

Minnesota Creek: Unnamed Tributary 2

This stream is approximately 2 m wide and meets Minnesota Creek unnamed tributary 1 approximately 100 m below the sample reach. There was red precipitate build up on submerged woody debris and the primarily gravel substrate (Figure 21). The sample site flows through mixed deciduous shrubs and black spruce bog. No fish were captured here.

Figure 21. Unnamed Minnesota Creek tributary 2 upstream (left) and downstream (right), June 2022.

Minnesota Creek: Unnamed Tributary 3

This stream is approximately 1.5 m wide and deeply incised with primarily gravel substrate, silty pools, and intermittent dense overhanging vegetation (Figure 22). Two slimy sculpin, one Dolly Varden, and one Alaska blackfish were caught here.

Figure 22. Unnamed Minnesota Creek tributary 3 lateral (left) and downstream (right), June 2022.

Eddy Creek

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 gravel and cobble substrate, moderate gradient with swift riffles, and interspersed deeper pools and runs (Figure 23). There is thick grassy and deciduous cover on the slightly incised banks. One slimy sculpin and three Dolly Varden were caught at this site. This landing zone was several hundred meters upstream from the original sample site in 2020, above a large beaver dam. This physical barrier may explain why zero juvenile coho salmon were captured in 2021 and 2022, while six were caught here in 2020 (Appendix 1).

Figure 23. Eddy Creek upstream (left) and downstream (right), June 2022.

Honker Trail Creek (locally accepted name)

This tributary of the West Fork Mud River is located between Illinois Creek and the Honker Deposit (Figure 1). Honker Trail Creek is a high gradient tundra stream with abundant step pools and rapids (Figure 24). The substrate is dominated by boulders and cobbles and the stream is shaded by dense alder and willow. Ten Dolly Varden were caught at this location. The proposed mine road system would cross this drainage.

Figure 24. Honker Trail Creek upstream (left) and downstream (right), June 2022.

Dome Creek

The Dome Creek watershed drains into 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 of Dome Creek.

Upper Dome Creek

This section of Dome Creek is fast flowing with interspersed slow pools. Riparian vegetation varies along the length of the reach ranging from tall grass and sedges to large birch trees (Figure 25). The substrate is predominantly gravel and cobble. Adjacent beaver complexes overflow into the creek alongside incised channels. Three slimy sculpin and one Dolly Varden were caught here.

Figure 25. Upper Dome Creek upstream (left) and downstream (right), June 2022.

Lower Dome Creek

This reach of Dome Creek has gravel and cobble substrate, slightly incised banks, and deep pools (Figure 26). The reach is located between two large beaver dam complexes. The riparian vegetation consists of willows and tall grasses. Eight Alaska blackfish, three slimy sculpin, and six Dolly Varden were caught at this site in 2022. In 2020, six juvenile coho salmon were caught at this location, but have not been observed since (Appendix 1).

Figure 26. Lower Dome Creek upstream (left) and downstream view of a washed out beaver dam (right), June 2022.

Dome Creek: Unnamed Tributary

This unnamed tributary of Dome Creek is a small tundra stream with cut banks and fine gravel substrate. The area experienced a wildfire in 2019, but streamside deciduous shrubs survived in good condition, and there is significant alder and willow cover (Figure 27). One slimy sculpin and one Dolly Varden were collected here in 2022. In 2021, the sample site was approximately 800 m upstream of the 2022 location, and twenty one Dolly Varden were caught in a single trap placed at the outlet of a cold-water spring.

Figure 27. Landing zone (left) and unnamed Dome Creek tributary (right), June 2022.

CONCLUSION

This report summarizes the current environmental conditions in watersheds near the historic Illinois Creek Mine and surrounding prospects. Sampling in June instead of July for the 2022 field season likely contributed to the lower catches of young-of-year coho salmon. Low flows in June 2022 allowed for effective minnow trapping; resident fish species recorded were similar with past years. Overall, the number of juvenile coho salmon captured at all sites in the vicinity of the Illinois Creek Mine and associated prospects has declined since 2020. Staying consistent in timing of sampling would allow for better comparisons with historical and present-day biomonitoring efforts among years. However, sampling a range of time within one year is beneficial because some fish populations move seasonally. Juvenile coho salmon whole body element concentrations were generally similar to past years. The low flows in June 2022 may have contributed to the high pheophytin corrected chlorophyll-a concentrations in Illinois Creek, but values might also be expected to naturally fluctuate during open water season due to a variety of environmental influences.

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 from 2020 to 2022. Chinook salmon runs in the greater Yukon River drainage have been in decline for over a decade, and the population formerly rearing in the California Creek drainage may have been extirpated. ADF&G recommends continued annual biomonitoring as outlined in this report to build a baseline dataset that captures any natural variability in these systems. ADF&G also suggests expanding sampling near the Honker and Round Top prospects, to include periphyton, aquatic macroinvertebrate, and juvenile fish whole body element sampling. It will be important to document baseline conditions in these watersheds as they are being considered for future mine development. Additional recommendations include conducting aerial surveys in August and/or September to determine if there are adult Dolly Varden, coho and/or Chinook salmon spawning in the vicinity of the Illinois Creek mine and associated Honker and Round Top prospects.

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APPENDIX 1: Fish catches by sample site (WGS 84) and species.

Location 2022	Latitude	Longitude	Juvenile Coho Salmon	Slimy Sculpin	Dolly Varden	Alaska Blackfish
Lower Illinois Crk*	64.0288	-157.8666	31	3		2
Upper Illinois Crk	64.0395	-157.8696	8	8		
Lower California Crk 1	64.0230	-157.8117		7		
Lower California Crk 2	64.0557	-157.7892	11	6	1	3
Water Pump Crk**	64.0649	-157.8057	26		3	
Lower Twin Crk**	64.0750	-157.7813		1	3	
Upper Twin Crk**	64.0778	-157.7850			1	1
Colorado Crk	64.1276	-157.7487		3	2	
CA Crk u/s CO Crk	64.1293	-157.7035	23	2		
CA Crk Headwaters	64.1914	-157.6519			5	
California Crk Trib 1	64.1854	-157.6413		9		
California Crk Trib 2	64.1968	-157.7586			20	
Upper Minnesota Crk	64.1306	-157.5760	2	9	10	
Minnesota Crk Trib 1	64.1549	-157.5944			6	
Minnesota Crk Trib 2	64.1549	-157.5918				
Minnesota Crk Trib 3	64.1358	-157.5934		2	1	1
Eddy Crk	64.2206	-157.5747		1	3	
Honker Trail Crk**	64.0924	-157.9603			10	
Upper Dome Crk	64.1424	-157.9996		3	1	
Lower Dome Crk	64.1371	-158.0735		3	6	8
Dome Crk Trib	64.1331	-158.0719		1	1	

* Fifteen juvenile coho salmon were retained for whole-body element analysis.

** Unnamed stream with locally accepted names.

Location 2021	Latitude	Longitude	Juvenile Coho Salmon	Slimy Sculpin	Dolly Varden	Alaska Blackfish
Lower Illinois Crk*	64.0280	-157.8667	116	8		1
Upper Illinois Crk	64.0395	-157.8696	229	7		
Lower California Crk 1	64.0228	-157.8127	2	10		2
Lower California Crk 2	64.0557	-157.7892	34			
CA Crk u/s CO Crk	64.1363	-157.7087	4	9	1	1
Eddy Crk	64.2231	-157.5799		1	7	
Honker Trail Crk**	64.0917	-157.9635			11	
Upper Dome Crk	64.1424	-157.9996		16		2
Lower Dome Crk	64.1368	-158.0659		2	7	12
Dome Crk Trib	64.1301	-158.0569			22	

* Fifteen juvenile coho salmon were retained for whole-body element analysis.

** Unnamed stream with locally accepted names.

Location 2020	Latitude	Longitude	Juvenile Coho Salmon	Slimy Sculpin	Dolly Varden	Alaska Blackfish
Lower Illinois Crk*	64.0280	-157.8667	304	7		
Upper Illinois Crk*	64.0395	-157.8696	62	6		
Lower California Crk 1	64.0228	-157.8127	11	4		1
Lower California Crk 2***	64.0557	-157.7892	79			1
Upper Twin Crk**	64.0816	-157.7903			3	
Colorado Crk	64.1276	-157.7487		2	3	
CA Crk u/s CO Crk	64.1363	-157.7087	42	3	1	1
CA Crk Headwaters	64.1918	-157.6515		3	9	
California Crk Trib 1	64.1854	-157.6413	7	3	2	
California Crk Trib 2	64.1967	-157.7584			8	
Upper Minnesota Crk	64.1306	-157.5760	14		3	
Minnesota Crk Trib 1	64.1552	-157.5928			2	
Minnesota Crk Trib 2	64.1552	-157.5928				
Minnesota Crk Trib 3	64.1376	-157.5924	11	9	4	2
Eddy Crk	64.2231	-157.5799	6	1	6	
Honker Trail Crk**	64.0917	-157.9635			15	
Upper Dome Crk	64.1424	-157.9996		4		4
Lower Dome Crk	64.1368	-158.0659	6	6	1	
Dome Crk Trib	64.1301	-158.0569			4	

* Fifteen juvenile coho salmon were retained for elemental analysis: 7 from lower, 8 from upper.

** Unnamed stream with locally accepted names.

*** One Arctic Grayling was caught here.

APPENDIX 2: Pheophytin-corrected chlorophyll-a concentrations (mg/m^2) from upper Illinois Creek, 2020 to 2022.

Sample #	**2020**	**2021**	**2022**
1	5.34	2.67	3.95
2	2.35	3.63	3.74
3	1.28	6.51	5.45
4	1.17	9.93	9.08
5	11.21	3.74	18.05
6	3.31	2.03	2.46
7	24.45	1.17	13.35
8	4.05	1.82	44.96
9	1.06	7.90	63.87
10	8.44	3.31	25.74
Mean	4.27	6.27	19.06

APPENDIX 3: Whole-body element concentrations of silver (Ag), arsenic (As), cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), selenium (Se), antimony (Sb), chromium (Cr), and nickel (Ni) in juvenile coho salmon from Illinois Creek Element concentrations (mg/kg dry weight), 2020-2022 and 1996. Each sample represents results from one fish. In 1996 data, ND indicates concentrations below the MDL (minimum detectable limit).

2022

Sample #	Ag	As	Cd	Cu	Hg	Pb	Se	Zn
1	0.07	6.47	0.13	3.64	0.19	0.07	1.08	150.62
2	0.07	1.19	0.04	2.85	0.55	0.15	0.88	110.23
3	0.09	5.13	0.24	3.43	0.16	0.11	0.91	117.52
4	0.09	2.00	0.06	2.55	0.40	0.11	0.92	102.82
5	0.07	3.79	0.10	2.71	0.13	0.09	0.86	118.22
6	0.08	7.31	0.08	3.00	0.16	0.08	0.83	128.93
7	0.09	2.89	0.14	2.80	0.11	0.09	1.02	115.11
8	0.08	1.79	0.14	2.48	0.36	0.10	0.63	91.44
9	0.06	10.75	0.14	3.56	0.18	0.22	1.05	159.84
10	0.09	1.94	0.08	2.84	0.31	0.09	1.01	100.80
11	0.10	1.92	0.06	2.98	0.35	0.10	0.82	107.66
12	0.10	2.56	0.05	2.93	0.41	0.10	0.79	129.78
13	0.07	3.83	0.09	2.92	0.18	0.07	1.15	123.60
14	0.08	4.88	0.12	3.27	0.27	0.21	1.26	159.15
15	0.07	4.05	0.16	2.83	0.23	0.21	1.65	135.11
Mean	0.08	4.03	0.11	2.99	0.26	0.12	0.99	123.39
SD	0.01	2.50	0.05	0.33	0.12	0.05	0.23	20.10

2021

Sample #	Ag	As	Cd	Cu	Hg	Pb	Se	Zn
1	0.09	2.10	0.05	3.30	0.20	0.09	0.95	135.60
2	0.10	2.10	0.05	2.88	0.15	0.10	1.10	136.40
3	0.07	6.70	0.06	3.57	0.20	0.14	1.40	128.60
4	0.06	7.20	0.08	2.86	0.20	0.09	1.10	135.60
5	0.12	2.50	0.09	4.55	0.21	0.12	2.20	200.60
6	0.07	3.20	0.06	3.10	0.16	0.07	1.20	142.20
7	0.09	1.80	0.05	2.58	0.21	0.09	0.94	129.60
8	0.07	1.90	0.13	2.43	0.15	0.07	1.00	115.50
9	0.09	2.30	0.04	2.27	0.17	0.09	1.60	138.20
10	0.08	2.40	0.06	3.17	0.16	0.08	0.97	145.50
11	0.08	5.50	0.06	3.36	0.16	0.22	0.91	101.50
12	0.08	4.90	0.05	3.05	0.18	0.13	1.10	172.00
13	0.06	2.70	0.04	2.23	0.16	0.06	1.00	129.90
14	0.07	2.60	0.22	2.85	0.19	0.19	1.10	126.30
15	0.06	2.60	0.03	2.32	0.12	0.06	0.79	115.40
Mean	0.08	3.37	0.07	2.97	0.17	0.11	1.16	136.86
SD	0.02	1.73	0.05	0.58	0.03	0.04	0.34	22.88

2020

Sample #	Ag	As	Cd	Cu	Hg	Pb	Se	Zn
1	0.09	3.60	0.06	3.40	0.27	0.18	1.50	163.30
2	0.08	2.30	0.07	2.70	0.17	0.24	1.20	106.00
3	0.06	3.60	0.10	3.40	0.19	0.09	1.80	138.10
4	0.07	3.80	0.06	5.00	0.21	0.27	1.70	135.10
5	0.07	3.30	0.06	3.10	0.20	0.12	0.96	119.00
6	0.08	2.90	0.10	4.90	0.17	0.34	1.56	223.10
7	0.11	3.60	0.40	5.30	0.24	0.24	2.39	225.20
8	0.08	0.62	0.06	3.20	0.13	0.08	0.98	140.20
9	0.08	0.44	0.04	2.90	0.15	0.08	0.82	131.10
10	0.08	0.70	0.04	2.40	0.20	0.08	0.94	142.90
11	0.08	0.84	0.11	3.50	0.25	0.08	1.20	150.70
12	0.09	1.30	0.04	4.70	0.22	16.30	0.86	87.40
13	0.09	0.49	0.04	3.70	0.34	0.12	0.88	100.50
14	0.08	1.30	0.06	2.70	0.19	0.08	1.00	79.10
15	0.08	0.57	0.04	3.00	0.26	0.15	0.72	93.90
Mean	0.08	1.96	0.09	3.59	0.21	1.23	1.23	135.71
SD	0.01	1.32	0.09	0.90	0.05	4.03	0.45	41.97

1996

Sample #	Ag	As	Cd	Cu	Hg	Pb	Cr	Ni	Sb
1	ND	0.5	0.04	3.96	0.12	0.15	8.7	1.2	0.06
2	ND	0.6	0.09	2.85	0.03	0.11	0.5	0.3	0.13
3	ND	ND	0.03	2.27	ND	0.07	0.6	0.3	0.09
4	ND	0.7	0.03	2.32	0.14	0.27	0.7	0.4	0.34
5	ND	0.6	0.03	2.65	0.07	0.15	0.6	0.3	0.14
6	ND	1.6		4.01	0.07				
7	ND	1.5		3.54	0.10				
8	ND	ND		3.40	0.08				
9	ND	1.0		3.17	0.08				
10	ND	1.1		2.65	0.07				
11	ND	1.6		3.26	0.07				
12	ND	1.0		2.69	0.13				
13	ND	1.3		2.75	0.08				
14	ND	1.1		2.69	0.08				
15	ND	3.0		2.84	0.10				
16	ND	1.9		2.64	0.12				
17	ND	3.5		3.32	0.08				
18	ND	2.3		3.38	0.07				
19	ND	3.0		2.77	0.07				
20	0.02	2.0		2.71	0.06				
21	0.08	1.6		2.44	0.06				
22	0.03	2.0		3.06	0.08				
23	0.11	1.9		2.23	0.11				
24	0.04	2.4		2.31	0.08				
25	0.02	1.9		3.52	0.08				
26	0.03	2.7		2.55	0.06				
27	0.03	2.1		2.23	0.07				
28	0.03	1.2		2.61	0.07				
29	0.08	3.1		2.46	0.10				
30	0.03	1.9		5.92	0.07				
Mean	0.05	1.75	0.04	2.97	0.08	0.15	2.22	0.50	0.15
SD	0.03	0.80	0.02	0.73	0.02	0.07	3.24	0.35	0.10