Technical Report No. 24-03

Baseline Aquatic Biomonitoring for the Lost River Prospect, 2023

Audra L. J. Brase and Chelsea M. Clawson

March 2024

Alaska Department of Fish and Game Habitat Section

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in reports by Habitat Section and the Divisions of Sport Fish and Commercial Fisheries. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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. 24-03

BASELINE AQUATIC BIOMONITORING FOR THE LOST RIVER PROSPECT, 2023

By

Audra L. J. Brase and Chelsea M. Clawson
Habitat Section, Fairbanks

Alaska Department of Fish and Game
Habitat Section
1300 College Rd, Fairbanks, Alaska, 99701

March 2024

Cover: Mouth of Lost River, July 2023. Photograph by Audra Brase.

Technical Reports are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: http://www.adfg.alaska.gov/index.cfm?adfg=habitat_publications.main.

This publication has undergone editorial review.

Note: Product names used in the publication are included for completeness but do not constitute product endorsement. The Alaska Department of Fish and Game does not endorse or recommend any specific company or their products.

Audra L. J. Brase and Chelsea M. Clawson
Alaska Department of Fish and Game, Habitat Section
1300 College Rd., Fairbanks, AK 99701-1599, USA

This document should be cited as:
Brase, A.L.J. and Clawson, C.M. 2024. Baseline Aquatic Biomonitoring for the Lost River Prospect, 2023. Alaska Department of Fish and Game, Technical Report No. 24-03, Fairbanks, Alaska.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The authors would like to thank Lost River Mining, Inc. for their financial support and specifically Paul Jensen and Phillip Hanna for their logistical support in monitoring the fish and wildlife resources at the Lost River Prospect in 2023.

ADF&G Habitat staff Chelsea Clawson and Audra Brase performed the July baseline aquatic sampling; Maria Wessel and Audra Brase performed the August aerial survey; and Olivia Edwards and Lauren Yancy processed all periphyton samples in the ADF&G laboratory in Fairbanks. Nora Foster of NRF Taxonomic Services was responsible for sorting and identification of benthic macroinvertebrates.

Maria Wessel and Dr. Al Ott (ADF&G Habitat), and Jack DiMarchi (Lost River Mining, Inc.) provided constructive reviews of this report.

INTRODUCTION

In 2023, the Alaska Department of Fish and Game – Habitat Section (ADF&G) was approached by Lost River Mining, Inc. to start a baseline aquatic monitoring program in the Lost River drainage on the Seward Peninsula in the vicinity of the former Lost River mine site, located approximately 137 kilometers northwest of Nome, between Brevig Mission and Wales. The objectives of this first year of baseline work were to identify multiple sampling sites both upstream and downstream of potential mine influence, collect a range of biological data from the aquatic ecosystem at each site, and identify any fish use of the drainage. These data will be useful for preparing environmental documents and permit authorizations as the exploration activities continue.

Tin mining on the Seward Peninsula has occurred intermittently since the early 1900's. The Lost River mine was discovered in 1903, but production did not begin until Federal funding was provided under the Defense Production Act of 1950 (Lorain et al. 1958). Both placer and lode deposits were considered a strategic interest due to a lack of a domestic supply of tin. Lost River was the largest tin deposit of the United States and was a production mine from 1951 to 1955 (Aleksandrov 2010). Tin was widely used for many household and industry needs prior to World War II, but after World War II aluminum took the place of tin in most applications due to its lower cost and higher durability.

The Lost River drainage originates at an elevation of 425 meters in the York Mountains and flows south 15 kilometers to the Bering Sea. The river is a clear braided system that flows through a wide unvegetated gravel floodplain (Figure 1). The surrounding landscape is made up of rocky low hills with minimal vegetation, small flowering plants and occasional willows that are no more than 30 centimeters tall. The surrounding hills provide habitat for both caribou and introduced muskox[1]. There is debris from past mining operations scattered throughout the Lost River drainage, although it is primarily concentrated at the old mine site on Cassiterite Creek (Figure 2).

Lost River Inc. started exploration activities in 2022, and supported two camps for staff and contractors in 2023. The lower camp was near the mouth of Lost River and the airstrip, primarily housing consultants and visiting employees. The upper camp was approximately 11 kilometers

[1] Muskox were reintroduced to the Seward Peninsula from Nunivat in 1970, those Nunivat animals were descendants of muskox that were originally brought from Greenland in 1930 (Woodford 2021).

upstream on Lost River and housed the exploration crew and support staff, as it was closest to the drill rigs near the old mine site. Current exploration activities are for tin, tungsten and fluorspar (Gannon 2022).

Prior to the work described in this report, there was little documentation of the fish resources of Lost River. Steidtmann and Cathcart (1922) mention that "grayling and trout" were "fairly well stocked" in the drainages of the surrounding streams, but they made no mention of Pacific salmon species. This report summarizes the periphyton, aquatic invertebrate, and fish samples collected in July, and the results of an aerial survey performed in August 2023.

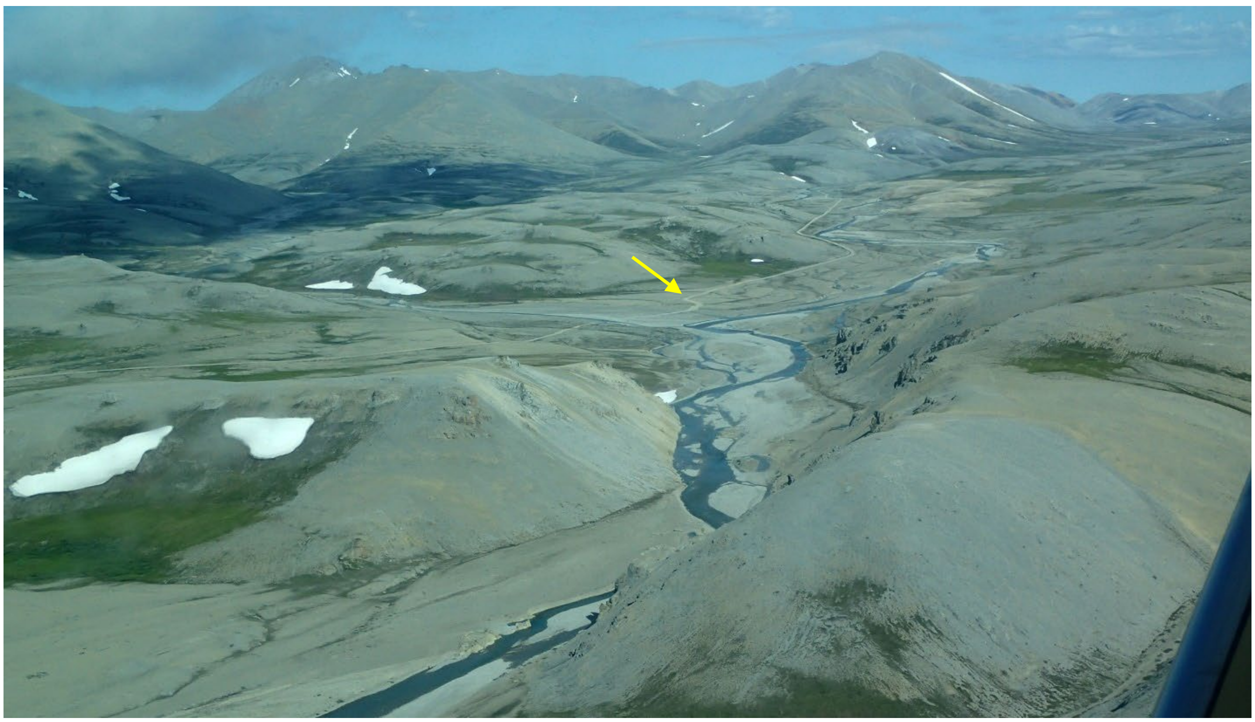

Figure 1. Lost River and the surrounding hills, looking upriver. The mine access road (yellow arrow) can be seen on the far side of the river, July 2023.

Figure 2. Examples of historic mining debris located adjacent (left) and upstream (right) of the upper camp at Cassiterite Creek, July 2023.

METHODS

Sampling Overview

The objectives of this first year of baseline aquatic monitoring at Lost River were to locate sample sites upstream and downstream of potential project facilities, document the productivity of the aquatic instream community at those sites, and identify any adult salmon use of the system. In 2023 there were two sampling events of the Lost River drainage. The first sampling event to identify sites and perform biomonitoring activities occurred from July 17 – 20. The second sampling event was an aerial survey by helicopter on August 24.

During the July sampling event, eight sites were identified for baseline sampling near the Lost River exploration site (Figure 3). Sampling sites were selected based on whether they could be accessed safely, the availability of appropriately sized rocks for periphyton collection, and whether there was deep enough water to fish minnow traps effectively. Three of the sampling locations were located upriver of the former mine site (Crystal and Esch creeks, and Upper Lost River), three were located downriver (Cassiterite Creek, Middle and Lower Lost River) and two were lower tributaries of Lost River (Curve Creek and Rapid River) (Figures 4 – 11). The characteristics of the streams at most of the sampling sites were very similar – relatively shallow (easily wadable), clear, riffle systems; swiftly flowing over clean rock and cobble. The Lower Lost River site was deeper, and tidally influenced since it was located approximately 500 meters from the river mouth.

At each of the eight baseline sampling sites replicate samples of the aquatic community were collected, including benthic macroinvertebrates, periphyton, and fish (Table 1). Measurements of basic water quality parameters (temperature, dissolved oxygen, conductivity, pH and turbidity) were also taken at each site. An additional fish sampling site was added in Cassiterite Creek due to fish being observed, but not caught at the first baseline site.

Table 1. List of baseline sites in the Lost River drainage sampled for periphyton, benthic macroinvertebrates and fish, July 2023.

Sample Site	Latitude	Longitude	Invertebrates	Periphyton	Fish
Lower Lost River	65.3927	-167.1480	X	X	X
Middle Lost River	65.4532	-167.1766	X	X	X
Upper Lost River	65.4914	-167.1892	X	X	X
Lower Rapid River	65.4057	-167.1668	X	X	X
Curve Creek	65.4279	-167.1848	X	X	X
Cassiterite Creek	65.4662	-167.1695	X	X	X
Upper Cassiterite Creek[1]	65.4715	-167.1627			X
Esch Creek	65.4751	-167.1816	X	X	X
Crystal Creek	65.4879	-167.1885	X	X	X

[1]Fish were observed in Cassiterite Creek, but were not captured during initial sampling, therefore a second site (Upper Cassiterite Creek) was selected and sampled.

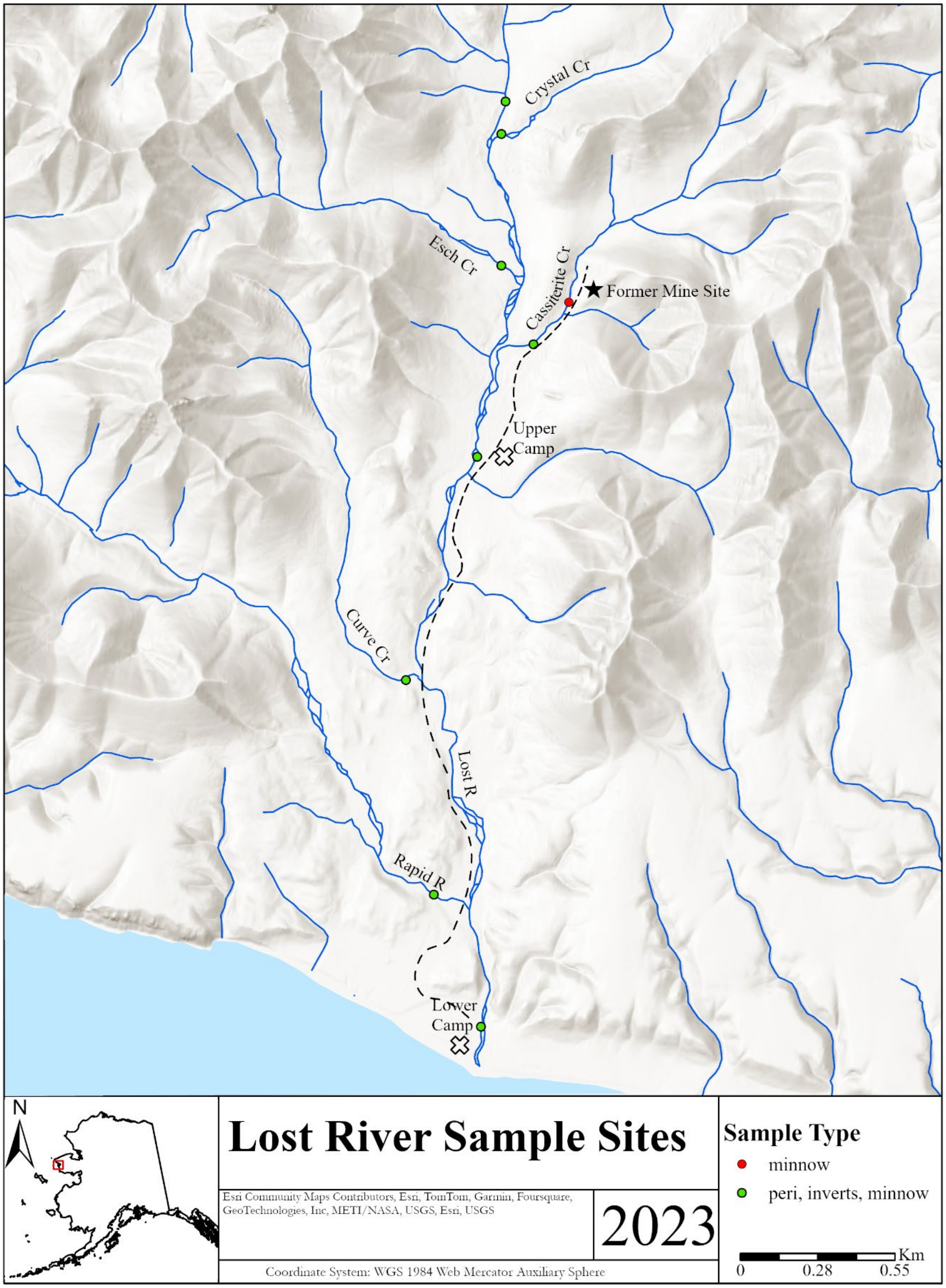

Figure 3. All locations sampled in the vicinity of the Lost River prospect in July 2023.

Figure 4. Crystal Creek baseline site, upstream (left) and downstream (right), July 2023.

Figure 5. Esch Creek baseline site, upstream (left) and downstream (right), July 2023.

Figure 6. Upper Lost River baseline site, upstream (left) and downstream (right), July 2023.

Figure 7. Cassiterite Creek baseline site, upstream (left) and downstream (right), July 2023.

Figure 8. Middle Lost River baseline site, upstream (left) and downstream (right), July 2023.

Figure 9. Lower Lost River baseline site, upstream (left) and downstream (right), July 2023.

Figure 10. Curve Creek baseline site, upstream (left) and downstream (right), July 2023.

Figure 11. Lower Rapid River baseline site, upstream (left) and downstream (right), July 2023.

Water Quality

Water quality can be variable in the vicinity of highly mineralized geologic features, therefore point measurements of water quality were taken at each baseline sampling site. These samples were concurrent with aquatic invertebrate and periphyton sampling but were collected above any sampling disturbance. A handheld multiparameter YSI was used to measure water temperature (°C), dissolved oxygen (mg/L), specific conductance (µS/cm), conductivity (µS/cm), and pH. The probe was placed in flowing water, and measurements were allowed to equilibrate for 15 minutes before being recorded. An Orion AQUAfast Turbidity meter was used to measure turbidity (NTU). At each site, the sample vial was rinsed with sample water three times, then filled with flowing water. Three readings of the sample were taken, and the average value of those readings was recorded.

Periphyton

Field Methods

Periphyton, or attached micro-algae, are sensitive to changes in water quality and are often used in monitoring studies to detect changes in aquatic communities. The presence of periphyton in a stream system is evidence of in-situ productivity (Ott and Morris 2010). Periphyton samples were collected at eight of the nine sample sites in the Lost River drainage (Table 1).

Ten smooth, flat, undisturbed and perennially wetted rocks, each at least 25 cm^2 were collected at each site. A 5 cm by 5 cm square of high-density flexible foam was placed on the rock. All the material around the foam was scrubbed off with a toothbrush and rinsed back into the stream. The toothbrush was also rinsed. The foam square was then removed from the rock, and that section of the rock was brushed and rinsed onto a 0.45 µm glass fiber filter receptacle attached to a hand vacuum pump. Material from the toothbrush was also rinsed onto the filter. The water was extracted from the periphyton covered filter using a hand vacuum pump. Just before all the water was pumped through the filter, one to two drops of magnesium carbonate ($MgCO_3$) were added to the water to prevent acidification and additional conversion of chlorophyll-a to phaeophytin.

Filters from each rock were folded in half, with the sample material on the inside, and placed in individual dry paper coffee filters. All ten coffee filters were placed in a zip-lock bag containing desiccant to absorb remaining moisture. The bags were then wrapped in aluminum foil to prevent light from reaching the samples, placed in a cooler with ice packs, then transferred to a freezer in camp. Samples were kept frozen until they were analyzed at the ADF&G laboratory in Fairbanks.

Laboratory Methods

In the lab, periphyton samples were removed from the freezer, the glass fiber filters were cut into small pieces and placed in individual 15 ml centrifuge tubes with 10 ml of 90% spectrophotometric grade acetone. Samples were secured in a vial rack covered with aluminum foil to reduce light exposure, and stored in a dark refrigerator overnight. On the following day (18-24 hours after preparation), samples were placed in a centrifuge and spun at 1,600 rpm for 20 minutes. Samples were then decanted individually into cuvettes and absorption values at 750 nm, 664 nm, 647 nm, and 630 nm were recorded on a split beam spectrophotometer. Each sample was treated with 80 µL of 0.1N hydrochloric acid for 90 seconds to convert the chlorophyll to phaeophytin and then absorbance was measured at 750 nm and 665 nm.

Trichromatic equations were used to estimate chlorophyll a, -b, and -c concentrations. Phaeophytin was calculated to determine if a chlorophyll-a conversion had occurred, and to correct chlorophyll-a concentrations for the presence of phaeophytin. Additional details regarding periphyton sampling and analysis methods can be found in ADF&G Technical Report No. 17-09 (Bradley 2017).

Benthic macroinvertebrates

Field Methods

At each of the eight benthic macroinvertebrate sample sites, five samples were collected using a Hess sampler (Table 1). The Hess stream bottom sampler has a 0.086 m^2 sample area and material is captured in a 200 mL cod end constructed with 300 µm mesh net. Rocks within the sample area were scoured by hand, and gravel, sand, and silt were disturbed to about 10 cm depth to dislodge benthic macroinvertebrates into the net. The cod end contents were then removed and placed in individual pre-labeled Nalgene bottles with denatured ethyl alcohol to preserve the samples.

Laboratory Methods

Samples were sorted and invertebrates identified to the lowest taxonomic level, typically family or genus, by a private aquatic invertebrate lab in Fairbanks. Because invertebrates belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) are more sensitive to water quality, the total number of individual specimens of EPT was calculated and compared to groups of other invertebrates, which are less sensitive. Macroinvertebrate density was calculated for each sample by dividing the number of macroinvertebrates by 0.086 m^2, the Hess sampling area. Mean density was estimated for each site by calculating the mean density among the five samples. Taxa richness is reported as the number of taxonomic groups identified to the lowest practical level. Insects of the orders Ephemeroptera, Plecoptera, Trichoptera, and Diptera were identified to genus, except nonbiting midges in the Chironomidae family. All others were identified to class or order. Terrestrial organisms were excluded from all calculations.

Fish

Minnow Trapping

During the July sampling trip, ten minnow traps baited with cured salmon eggs were placed upstream and downstream of each of the periphyton and aquatic invertebrate sampling locations.

At the baseline Cassiterite Creek sampling site, fish were observed, but not captured in the traps, therefore additional traps were set at Upper Cassiterite Creek (Table 1). Where possible, traps were placed in a variety of habitats, including cut banks and pools. Typically minnow traps are placed near large woody debris since that provides habitat and shelter for juvenile fish, but there was virtually no large woody debris in the Lost River drainage. In areas with high streamflow, rocks were added to the bottom of each trap for weight and to provide refuge for captured fish. Traps were soaked overnight and checked about 24 hours later. All captured fish were measured for fork or total length, depending on species.

Aerial Survey

The aerial survey was conducted by two observers in a helicopter flying slowly and low enough to accurately count fish but minimize fish disturbance (~30 m above the river). The survey began at the mouth of Lost River and proceeded up the main and side channels, and the tributaries. Because there was no helicopter based at Lost River in 2023, a helicopter was chartered from Nome (Bering Air). The aerial survey crew departed Nome at 9am on August 24, and after arriving at Lost River, performed the helicopter survey from approximately 11am – 1pm with one stop to refuel. A handheld GPS was used to mark large schools of fish, spawning redds and the upper extent of fish presence. Tributaries were flown until no additional fish were seen for approximately 15 minutes.

RESULTS

General

The weather during the first sampling event was highly variable. On July 17 it was sunny and clear with no wind. Subsequent days brought clouds, wind and rain with the heaviest rainfall event on the evening of July 19/20. The precipitation gage at the Nome airport (137 km south) recorded less than one centimeter of accumulation (Figure 12), however at Lost River an increase in stream height of 15 to 30 centimeters was observed.

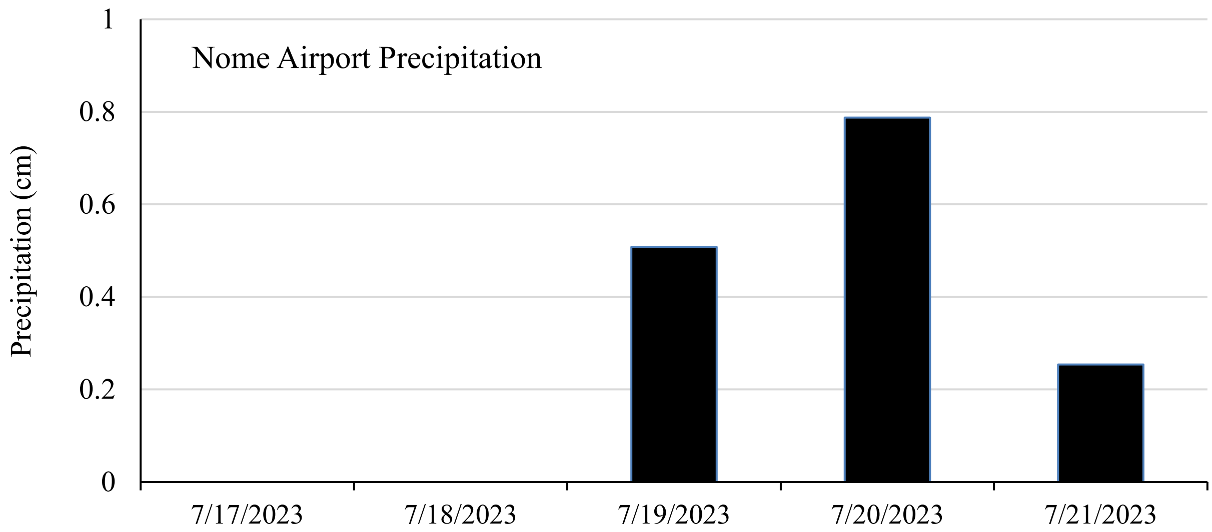

Figure 12. Precipitation (rainfall) at the Nome Airport, July 17-21, 2023. Note that this location is approximately 137 km south of Lost River, but it is the closest precipitation recording station to Lost River.

Water Quality

Although there was some variability, in general, the water at all sites was cold, alkaline and well oxygenated (Figure 13, Table 2). The EPA pH standard for aquatic life in freshwater is 6.5 – 9, and all point measurements taken in July meet that standard (USEPA 1086). Esch Creek in the upper part of the drainage stood out as having the lowest temperature (5.4 °C), the highest pH (8.51) and the highest dissolved oxygen (12.58 mg/L). Lower Rapid River site had the highest turbidity at 11.37 NTU compared to the average of 0.504 NTU for the remainder of the sampling sites (Table 2). This may have been influenced by the large snowfield that was still melting upriver from the sampling site in July and/or the high rainfall that occurred prior to collecting water quality data from the Lower Rapid River baseline site (Figure 14).

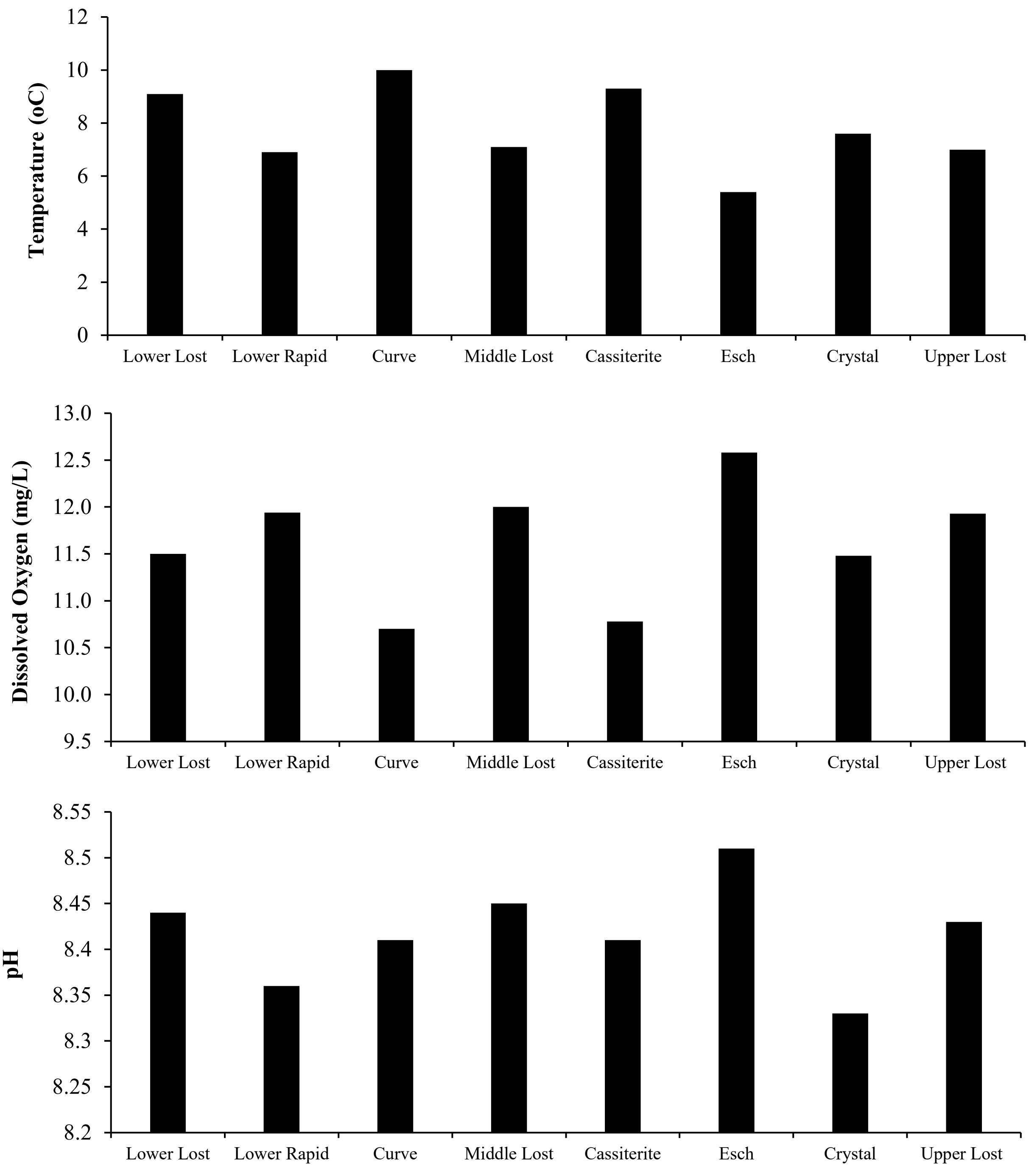

Figure 13. Temperature (top), dissolved oxygen (middle), and pH (bottom) water quality parameters in the Lost River drainage, July 2023. Sampling sites are listed from downriver to upriver - left to right on the x-axis.

Table 2. Water quality parameters from Lost River drainage sample sites, July 2023.

Site	Temp (ºC)	Dissolved O^2 (mg/L)	Specific Conductance (µS/cm)	Conductivity (µS/cm)	pH	Turbidity (NTU)
Lower Lost	9.10	11.50	204.8	142.4	8.44	0.85
Lower Rapid	6.90	11.94	168.2	110.1	8.36	11.37
Curve	10.00	10.70	216.6	154.4	8.41	0.16
Middle Lost	7.10	12.00	185.7	122.4	8.45	0.73
Cassiterite	9.30	10.78	177.2	128.2	8.41	0.86
Esch	5.40	12.58	166.9	104.5	8.51	0.35
Crystal	7.60	11.48	137.1	91.5	8.33	0.21
Upper Lost	7.00	11.93	173.4	113.8	8.43	0.37

Figure 14. Large snowfield remaining in Rapid River, located upstream from the baseline sample site location, July 20, 2023.

Periphyton

Mean chlorophyll-a concentrations were consistently low across all sampling sites, ranging from 0.07 mg/m^2 at Lower Rapid River to 3.76 mg/m^2 at Lower Lost River (Figure 15, Appendix 1). These values are low, but are within the range of chlorophyll-a concentrations found in other river systems monitored by ADF&G Habitat, such as those in the vicinity of Red Dog Mine and the Arctic-Bornite prospect (Clawson 2023a, Clawson 2023b, and Edwards 2023).

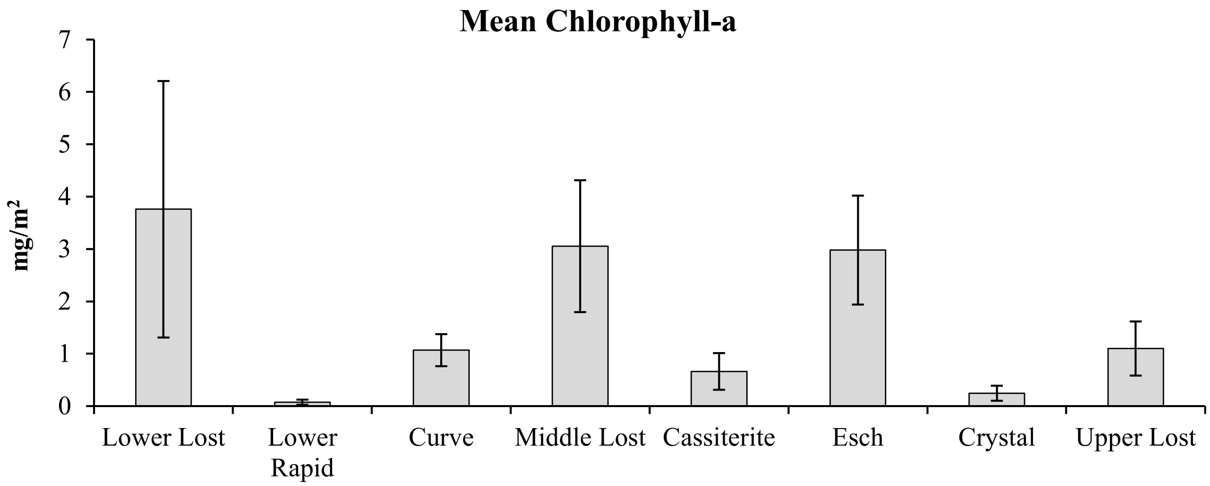

Figure 15. Mean chlorophyll-a concentrations ± 1 SD for all sites at Lost River, July 2023. Sampling sites are listed from downriver to upriver - left to right on the x-axis.

Benthic macroinvertebrates

The density and taxa richness of the benthic macroinvertebrates (BMI) found in the Lost River system was low, with an average of 1,410 BMI/m^2 and 9 different taxa per sampling site (Figures 16 and 17). Benthic macroinvertebrate density varies widely among sample sites at other locations monitored by ADF&G Habitat. For example, BMI density ranged from 28 to 10,393 BMI/m^2 at sample sites near Red Dog Mine in 2023, and from 88 to 4,971 BMI/m^2 at sample sites near the Arctic-Bornite prospect in 2023 (unpublished data). The Lower Lost River site had the greatest diversity and density with 16 taxa and an average of 3,907 BMI/m^2. The Cassiterite Creek site had the least diversity with only 6 taxa and Lower Rapid River had the lowest density with an average of 84 BMI/m^2 (Appendix 2).

The species composition was highly variable among the sampling sites. The samples from Lower Rapid River and Curve Creek contained high percentages of Diptera; whereas Esch and Crystal creeks and Upper Lost River had high percentages of Plecoptera in the samples (Figure 18). No Trichoptera were captured at any of the sample sites. Trichoptera are typically very low to completely absent in samples from other projects in northern Alaska. At the Arctic-Bornite prospect, Trichoptera were only captured at one out of the nine sample sites in 2023 (Clawson, unpublished data). Also of note were the numerous oligochaetes and large Tipula (cranefly larvae) observed in several of the samples (Figure 19).

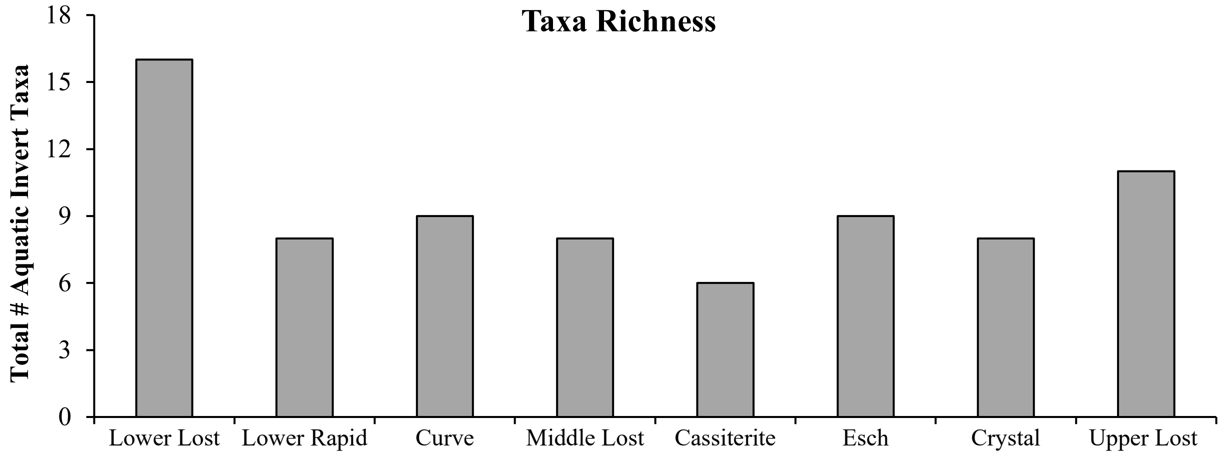

Figure 16. Benthic macroinvertebrate taxa richness at Lost River drainage sample sites, July 2023. Sampling sites are listed from downriver to upriver - left to right on the x-axis.

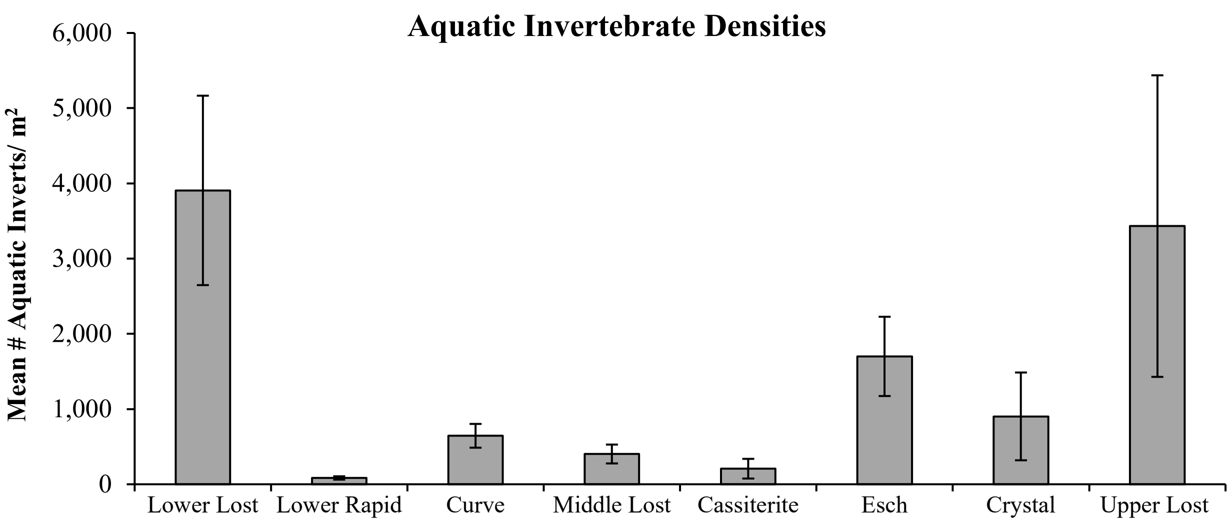

Figure 17. Mean number of benthic macroinvertebrates/ m² substrate at Lost River drainage sample sites, July 2023. Sampling sites are listed from downriver to upriver - left to right on the x-axis.

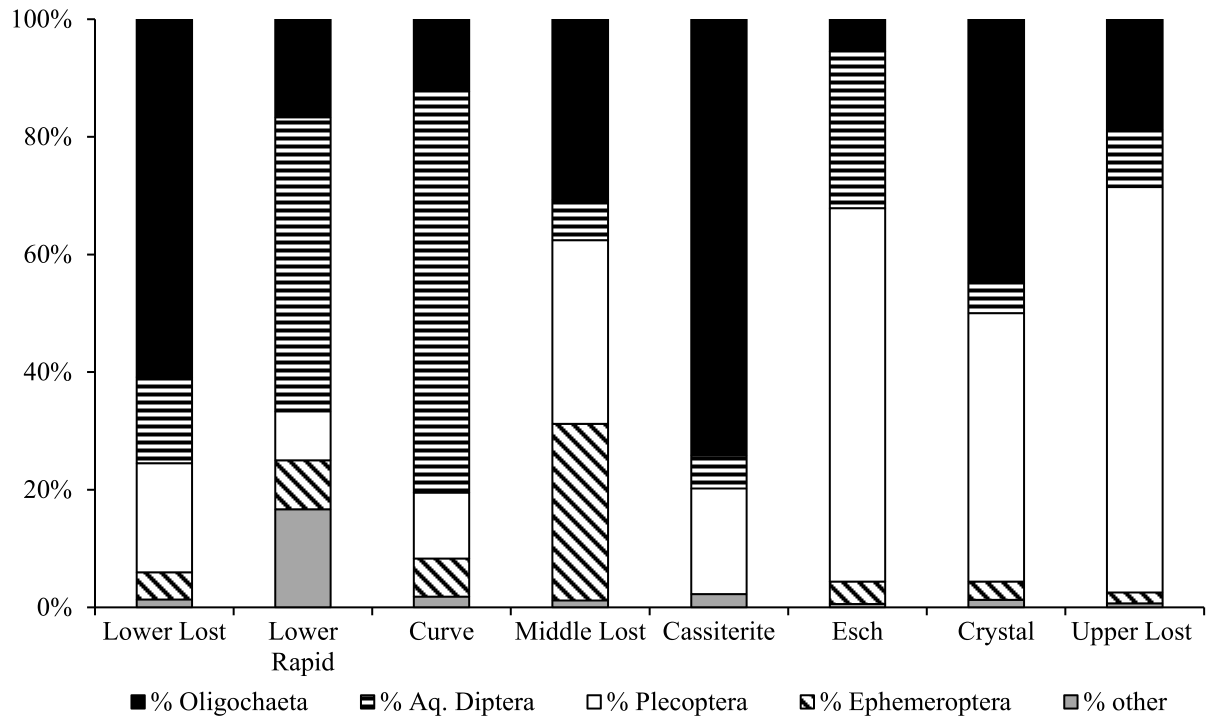

Figure 18. Mean percent EPT, Oligochaeta, Diptera and other taxa in the Lost River benthic macroinvertebrate samples, July 2023. Sampling sites are listed from downriver to upriver - left to right on the x-axis.

Figure 19. Two large Tipula (cranefly larvae) surrounded by numerous other benthic macroinvertebrates including oligochaetes and Plecoptera from the lower Lost River sampling site, 2023.

Fish Captures

During the July sampling event a total of six Dolly Varden were captured in the Lost River drainage. The fish ranged in size from 96 – 156 mm (Table 3). Among the six fish captured, there was variability in their sizes by tributary, the Dolly Varden captured in Curve Creek were smaller and slimmer than those captured in Esch and Crystal creeks (Figure 20). On the evening of July 19/20 there was a rainstorm event which caused the rivers to rise at least 15 cm overnight. Several minnow traps were unable to fish effectively, and two traps were lost at the Lower Rapid River site due to high water.

Two partial skeletons from adult fish were found on the banks of the Rapid River in July (Figure 21). This finding supported the suspicion that the Lost River drainage supported at least some salmon spawning, therefore an aerial survey was scheduled for August.

Table 3. Number, mean length, and length range of Dolly Varden captured in minnow traps, Lost River drainage, July 2023.

	Dolly Varden		
Sample Site	Number captured	Mean fork length (mm)	Length range (mm)
Lower Lost River[3]	0	-	-
Middle Lost River[2]	0	-	-
Upper Lost River[3]	0	-	-
Lower Rapid River[3]	0	-	-
Curve Creek	2	97	96-98
Cassiterite Creek	0	-	-
Upper Cassiterite Creek[4]	1	NA	155
Esch Creek	2	147.5	146-149
Crystal Creek[1]	1	NA	156

[1]A Dolly Varden was observed instream that may have been too large to enter a minnow trap.
[2]A small Dolly Varden (~100mm) was observed in a side channel.
[3]Most traps were not fishing effectively due to storm event and high water.
[4]Two Dolly Varden were observed in the mine's water intake pool that were too large to enter a minnow trap.

Figure 20. Variability of Dolly Varden captured in the Lost Creek drainage: Curve Creek (top), Crystal Creek (middle) and Esch Creek (bottom), July 2023.

Figure 21. Partial fish skeletons (left) and location where one was found (right), Rapid River is in the background of the right hand photo.

Aerial Survey

Survey conditions were above average with clear water and good visibility. Initial weather conditions were high clouds, a steady breeze and no precipitation, however winds were gusting to 30 mph by the end of the survey. During the aerial survey, it was noted that Curve Creek and Rapid River no longer had the surface connections to Lost River that had been observed in July (Figure 22), however there were still pools and surface water remaining upstream from the subsurface sections. The total fish count was approximately 2,500 pink salmon and 20 fish tentatively identified as sockeye salmon (Figures 23 and 24). Spawning redds were noted throughout the drainage. Due to deteriorating weather conditions (high winds) the survey crew was unable to get a positive identification of the red fish as sockeye salmon.

Figure 22. Rapid River (foreground) with lost surface connection to Lost River (background) and the exploration road low water crossing (yellow arrow), August 24, 2023.

Figure 23. Pink salmon in Lost River, from ground (left), from helicopter (right). Photo on left by Phil Hanna, Lost River Mining, August 16, 2023. Photo on right taken August 24, 2023.

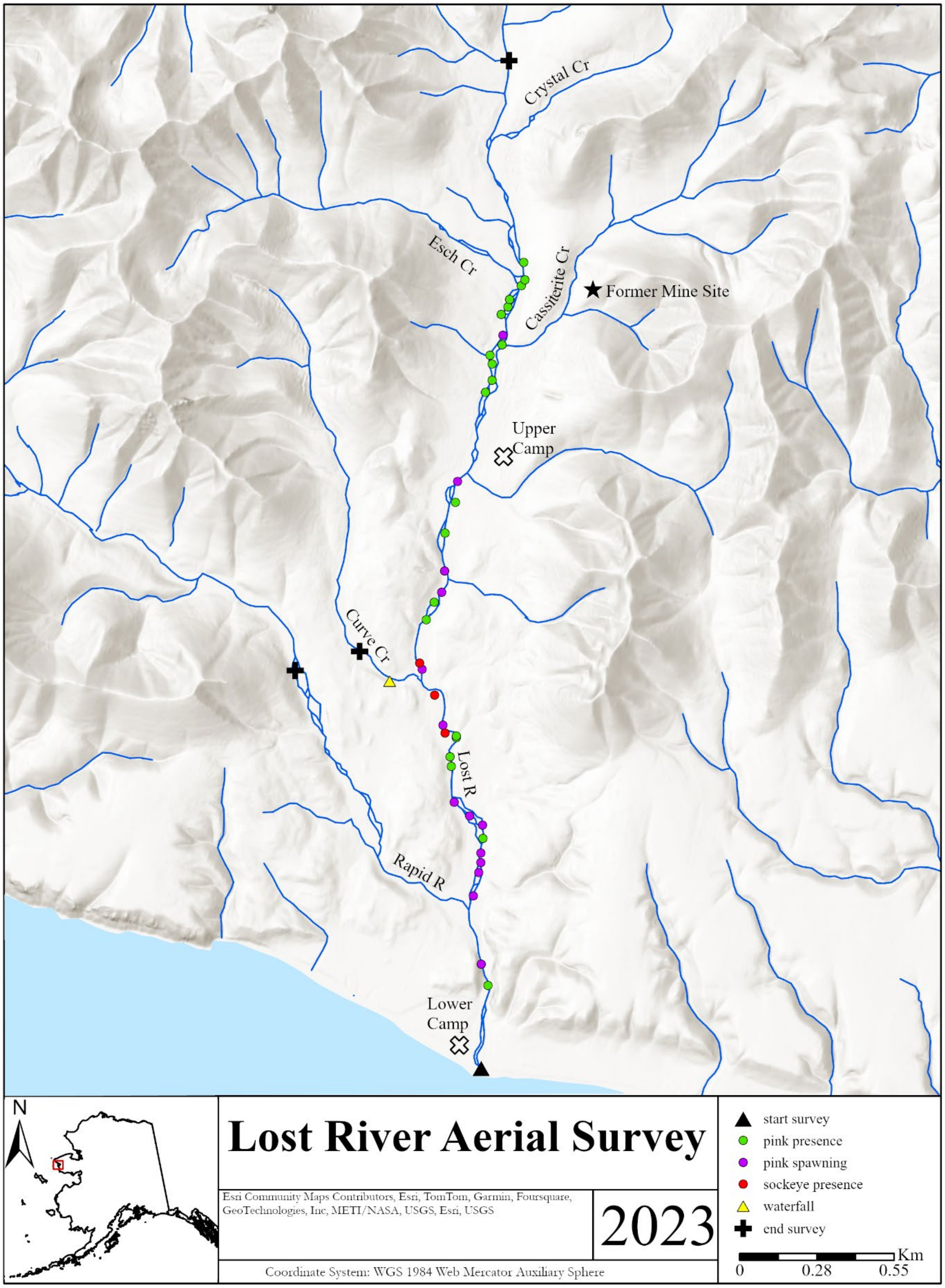

Figure 24. Map of Lost River drainage surveyed by helicopter on August 24, 2023. Colored circles indicate fish species, and spawning reaches.

DISCUSSION

Waterbodies throughout the Seward Peninsula support many species of Pacific salmon and resident fish such as Arctic grayling, however prior to 2023, there was little information regarding the fish populations or aquatic community of the Lost River drainage (Giefer and Graziano 2023, Scanlon 2022). The unusual landscape with little vegetation suggested that the area may not support fish populations. However, after completing the 2023 aquatic biomonitoring, fish presence was confirmed, including spawning pink salmon. This fish documentation, as well as the other initial baseline results, may be used to evaluate potential development activities and future changes in the aquatic ecosystem.

It is unknown whether the six juvenile Dolly Varden captured in the Lost River drainage were anadromous or resident fish. Because Lost River has a direct connection to the marine environment it is possible that the fish were anadromous. To make a definitive determination of anadromy would require lethal sampling of the fish and analysis of their otoliths for strontium (Sr) concentrations. If adult Dolly Varden spawn in the Lost River drainage, they likely enter the river in the fall, so future work should include aerial surveys to look for spawning Dolly Varden. During the next aerial survey, if red colored salmon are again observed, an attempt to capture some fish should be made to positively determine whether they are sockeye or coho salmon. Alternatively, eDNA samples may be collected and processed in an attempt to identify what other fish species may utilize the Lost River drainage.

Prior to arriving on site it was thought that many of the Lost River tributaries were seasonal ephemeral streams with consistent subsurface flow (Lorain et al. 1958). During the July sampling event all the tributaries besides Rapid River appeared to have continuous flow and surface connection to Lost River. Rapid River would vary throughout the day from flowing aboveground to going subsurface at the mine road crossing. These fluctuations would reduce the habitat available to benthic macroinvertebrates and dry out the rocks available for periphyton growth. In August, during the aerial survey, it was noted that Curve Creek and Rapid River had both lost their surface connections. However, the adult fish skeletons found in July lend support to the idea that Rapid River has a surface connection at least occasionally through the late summer spawning period. The Lower Rapid River baseline site had the lowest mean chlorophyll-a and benthic macroinvertebrate density values out of all the sample sites. This may be partially explained by the variable flow conditions of Rapid River, both daily and seasonally. Future sampling should consider selecting a baseline site further upriver that does not appear to go dry.

The estuarine influence at the Lower Lost River baseline site likely contributed to the higher number of benthic macroinvertebrate taxa and individuals observed due to the introduction and catchment of fine sediment and/or organics (Berthelsen et al. 2020). Unfortunately, the high rainfall event resulted in poor conditions for sampling fish in minnow traps at this site as it was suspected that fish species adapted to the estuarine environment may be caught here.

ADF&G recommends that baseline aquatic studies continue at Lost River for at least another two years. A minimum of three years of aquatic baseline data is recommended before evaluating potential impacts from development activities. In the case of Lost River, with the unusual nature of some of the tributaries periodically going subsurface, it will be of particular importance to collect several years of data due to the high variability inherent in the system. It will also be important to continue the aerial survey component and document the range in the number of spawning pink salmon, as Norton Sound even-year spawners are typically more numerous than odd-year spawners.

LITERATURE CITED

Aleksandrov, S.M. 2010. Skarn-Greisen Deposits if the Lost River and Mount Ear Ore Field, Seward Peninsula, Alaska, United States. Geochemistry International. Vol. 48, No. 12, pp 1220-1236.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1997. Revision to rapid bioassessment protocols for use in streams and rivers: periphyton, benthic, macroinvertebrates, and fish. EPA-841-D-97-002.

Berthelsen, A., P. Casannovas, J. Clapcott, D.E Clark, A. Wagenhoff, M. Patterson, and J. Sinner. 2020. Relationships in ecological health between connected stream and estuary ecosystems. Ecological Indicators. Vol. 115.

Bradley, P.T. 2017. Methods for aquatic life monitoring at the Red Dog Mine site. Alaska Department of Fish and Game, Technical Report No. 17-09, Fairbanks, AK.

Clawson, C.M. 2023a. Aquatic Biomonitoring at the Arctic-Bornite Prospect, 2022. Alaska Department of Fish and Game, Technical Report No. 23-04, Fairbanks, Alaska.

Clawson, C.M. 2023b. Aquatic Biomonitoring at Red Dog Mine, 2022. Alaska Department of Fish and Game, Technical Report No. 23-02, Fairbanks, Alaska.

Edwards, O.N. 2023. Baseline Aquatic Biomonitoring for the Anarraaq and Aktigiruq Prospects near the Red Dog Mine, 2022. Alaska Department of Fish and Game, Technical Report No. 23-03, Fairbanks, Alaska.

Gannon, M. 2022. Exploration for tin, minerals takes place at Lost River. The Nome Nugget. 18 August 2022.

Giefer, J., and S. Graziano. 2023. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Arctic Region, effective June 1, 2023. Alaska Department of Fish and Game, Special Publication No. 23-01, Anchorage.

Lorain, S.H., R.R. Wells, M. Mihelich, J.J. Mulligan, R.L. Thorne and J.A. Herdlick. 1958. Lode-Tin Mining at Lost River, Seward Peninsula, Alaska. Information Circular 7871. United States Department of the Interior – Bureau of Mines.

Ott, A.G., and W.A. Morris. 2010. Aquatic biomonitoring at Red Dog Mine, 2009. Alaska Department of Fish and Game Technical Report No. 10-02. Division of Habitat. Juneau.

Scanlon, B. 2022. Fishery management report for sport fisheries in the Northwest/North Slope Management Area, 2021. Alaska Department of Fish and Game, Fishery Management Report No. 22-22, Anchorage.

Steidtmann, E. and S.H. Cathcart. 1922. Geology of the York Tin Deposits Alaska. Department of the Interior United State Geological Survey. Bulletin 733. Washington D.C.

USEPA. 1986. Quality Criteria for Water (EPA 440/5-86-001). Environmental Protection Agency. Office of Water Regulations and Standards.

Woodford, R. 2021. Muskox on the Seward Peninsula - Near Extinction, Recovery and Sharing the Tundra. Alaska Fish & Wildlife News (online edition).

https://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=1007 - accessed February 2, 2024.

APPENDIX 1. Periphyton Standing Crop, Lost River Sample Sites 2023.

2023 Chloro Results - Lost River							
IDL = 0.09 mg/m^2			Linear Check Maximum = 65.03 mg/m^2				
EDL = 0.39 mg/m^2							
				Phaeo Corrected			
Site	Date Analyzed	Vial Chl a	Chl a mg/m2	**Chl a mg/m2**	**664/665 Ratio**	Chl b mg/m2	Chl c mg/m2
Lower Lost R	12/20/2023	2.92	11.69	9.83	1.55	1.67	0.35
Lower Lost R	12/20/2023	0.78	3.13	2.88	1.64	0.16	0.64
Lower Lost R	12/20/2023	1.44	5.76	4.59	1.51	1.02	0.60
Lower Lost R	12/20/2023	0.23	0.91	0.85	1.67	0.02	0.17
Lower Lost R	12/20/2023	0.22	0.86	0.75	1.58	0.05	0.08
Lower Lost R	12/20/2023	1.08	4.32	4.17	1.70	0.08	0.48
Lower Lost R	12/20/2023	0.96	3.83	3.63	1.68	0.00	0.41
Lower Lost R	12/20/2023	0.52	2.08	2.03	1.70	0.23	0.29
Lower Lost R	12/20/2023	1.36	5.45	4.70	1.57	0.87	0.47
Lower Lost R	12/20/2023	1.11	4.45	4.17	1.66	0.21	0.85
Rapid River	12/20/2023	0.01	0.04	0.00	1.00	0.05	0.06
Rapid River	12/20/2023	0.01	0.05	0.11		0.00	0.00
Rapid River	12/20/2023	0.13	0.51	0.11	1.09	0.39	0.63
Rapid River	12/20/2023	0.01	0.05	0.11		0.00	0.00
Rapid River	12/20/2023	0.04	0.16	0.00	0.80	0.20	0.34
Rapid River	12/20/2023	0.01	0.04	0.11		0.05	0.06
Rapid River	12/20/2023	0.01	0.04	0.11		0.05	0.06
Rapid River	12/20/2023	0.01	0.04	0.11		0.05	0.06
Rapid River	12/20/2023	0.01	0.04	0.11		0.05	0.06
Rapid River	12/20/2023	0.07	0.29	0.00	1.00	0.27	0.56
Curve Creek	12/19/2023	0.36	1.46	1.50	1.78	0.00	0.30
Curve Creek	12/19/2023	0.22	0.87	0.85	1.73	0.00	0.11
Curve Creek	12/19/2023	0.32	1.28	1.17	1.65	0.00	0.19
Curve Creek	12/19/2023	0.16	0.64	0.53	1.56	0.00	0.08
Curve Creek	12/19/2023	0.26	1.05	0.85	1.53	0.04	0.12
Curve Creek	12/19/2023	0.26	1.05	0.96	1.64	0.04	0.12
Curve Creek	12/19/2023	0.35	1.42	1.28	1.63	0.00	0.14
Curve Creek	12/19/2023	0.25	1.00	0.96	1.69	0.00	0.06
Curve Creek	12/19/2023	0.26	1.05	0.96	1.64	0.03	0.22
Curve Creek	12/19/2023	0.42	1.68	1.60	1.68	0.03	0.30

Middle Lost R	12/20/2023	1.34	5.35	5.13	1.70	0.00	0.53
Middle Lost R	12/20/2023	0.66	2.64	2.46	1.66	0.03	0.37
Middle Lost R	12/20/2023	0.41	1.64	1.50	1.64	0.00	0.14
Middle Lost R	12/20/2023	1.24	4.94	4.70	1.69	0.00	0.49
Middle Lost R	12/20/2023	0.99	3.97	3.84	1.71	0.00	0.36
Middle Lost R	12/20/2023	0.38	1.51	1.39	1.65	0.00	0.19
Middle Lost R	12/20/2023	1.10	4.39	4.17	1.68	0.00	0.46
Middle Lost R	12/20/2023	0.51	2.05	2.03	1.73	0.02	0.19
Middle Lost R	12/20/2023	0.65	2.59	2.46	1.68	0.06	0.28
Middle Lost R	12/20/2023	0.81	3.24	2.88	1.61	0.00	0.22
Cassiterite Ck	12/19/2023	0.30	1.18	1.17	1.73	0.03	0.27
Cassiterite Ck	12/19/2023	0.20	0.80	0.75	1.64	0.20	0.42
Cassiterite Ck	12/19/2023	0.36	1.46	1.39	1.68	0.00	0.20
Cassiterite Ck	12/19/2023	0.13	0.50	0.53	1.83	0.00	0.03
Cassiterite Ck	12/19/2023	0.09	0.37	0.32	1.60	0.00	0.08
Cassiterite Ck	12/19/2023	0.15	0.59	0.53	1.63	0.01	0.18
Cassiterite Ck	12/19/2023	0.19	0.77	0.75	1.70	0.01	0.13
Cassiterite Ck	12/19/2023	0.06	0.22	0.21	1.67	0.04	0.10
Cassiterite Ck	12/19/2023	0.11	0.45	0.43	1.67	0.01	0.04
Cassiterite Ck	12/19/2023	0.14	0.54	0.53	1.71	0.04	0.09
Esch Creek	12/19/2023	1.11	4.44	4.27	1.70	0.00	0.46
Esch Creek	12/19/2023	0.53	2.10	1.92	1.64	0.00	0.21
Esch Creek	12/19/2023	0.88	3.52	3.31	1.67	0.00	0.35
Esch Creek	12/19/2023	0.51	2.06	1.82	1.61	0.00	0.22
Esch Creek	12/19/2023	0.77	3.06	2.88	1.68	0.00	0.28
Esch Creek	12/19/2023	1.00	3.98	3.74	1.67	0.00	0.42
Esch Creek	12/19/2023	1.25	4.99	4.81	1.70	0.00	0.48
Esch Creek	12/19/2023	0.83	3.34	3.20	1.70	0.00	0.41
Esch Creek	12/19/2023	0.41	1.64	1.50	1.64	0.05	0.31
Esch Creek	12/19/2023	0.64	2.56	2.35	1.65	0.00	0.25
Crystal Creek	12/19/2023	0.04	0.18	0.21	2.00	0.06	0.11
Crystal Creek	12/19/2023	0.23	0.92	0.64	1.40	0.35	0.60
Crystal Creek	12/19/2023	0.03	0.14	0.11	1.50	0.01	0.05
Crystal Creek	12/19/2023	0.03	0.14	0.21	3.00	0.01	0.05
Crystal Creek	12/19/2023	0.07	0.26	0.21	1.50	0.09	0.16
Crystal Creek	12/19/2023	0.09	0.36	0.32	1.60	0.05	0.15
Crystal Creek	12/19/2023	0.17	0.69	0.21	1.14	0.44	0.83
Crystal Creek	12/19/2023	0.07	0.26	0.21	1.50	0.09	0.16
Crystal Creek	12/19/2023	0.03	0.13	0.11	1.50	0.08	0.12
Crystal Creek	12/19/2023	0.08	0.31	0.21	1.40	0.06	0.25
Upper Lost R	12/20/2023	0.43	1.74	1.60	1.65	0.00	0.13
Upper Lost R	12/20/2023	0.16	0.64	0.53	1.56	0.00	0.08
Upper Lost R	12/20/2023	0.37	1.47	1.39	1.68	0.00	0.13
Upper Lost R	12/20/2023	0.18	0.73	0.75	1.78	0.00	0.07
Upper Lost R	12/20/2023	0.16	0.64	0.64	1.75	0.00	0.08
Upper Lost R	12/20/2023	0.18	0.73	0.75	1.78	0.03	0.13
Upper Lost R	12/20/2023	0.30	1.19	1.17	1.73	0.00	0.10
Upper Lost R	12/20/2023	0.17	0.69	0.64	1.67	0.00	0.07
Upper Lost R	12/20/2023	0.57	2.28	2.24	1.72	0.00	0.22
Upper Lost R	12/20/2023	0.34	1.37	1.28	1.67	0.00	0.14

APPENDIX 2. Benthic Macroinvertebrate Samples, Lost River Sample Sites 2023.

			Lower Lost	Lower Rapid	Curve	Middle Lost	Cassiterite	Esch	Crystal	Upper Lost
Ephemeroptera	Baetidae	*Baetis*	14		3					
		Acentrella	1							
		not determined	1					1	4	4
	Heptageniidae	*Cinygmula*	59	3	12	52		5	1	1
		not determined	1		3			4		
	Ephemerelidae	*not determined*								11
	Not Determined		2					18	7	11
Plecoptera	Capniidae	*Capnia*	17		3					
		Eucapnopsis						1		
		Utacapnia				10				
		not determined	1		2	10	2	11	7	1
	Chloroperlidae	*Suwallia*	1							
		not determined	6							
	Nemouridae	*Podmosta*	261	3	22	13	5	179	12	409
		not determined	16			21	8	273	136	484
	Not Determined		10		4		1		22	124
Diptera	Chironomidae	larvae	207	14	158	7	2	170	16	118
	Chironomidae	pupae	31	4	16	4		14		20
	Ceratopogonidae		1							
	Empididae	*Chelifera*	1					1		
		Clinocera	1							
	Tipulidae	*Tipula*	4		14	1	3			
	Simuliidae	*Simulium*			1			9	4	6
	Not determined		1					1		
Coleoptera	Carabidae			1						
Collembola	Poduridae		1							
	Not Determined			2						
Hymenoptera	Symphyta									1
Acari	Acarina		1	1		1		4	5	4
Oligochaeta			1022	6	34	53	66	40	174	277
Copepoda	Cyclopoida		1							
	Calanoida						2			
	Harpacticoida		19	2	5					5
Terrestrial Flies					2					
Nematoda			13							1
Platyhelminthes			27	1	10	9	21	10	3	26