Clinton Creek Site

2017-2018 Fish and Fish Habitat Existing Conditions Studies

Report

Prepared for:

Government of Yukon
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CLINTON CREEK FISH AND FISH HABITAT STUDIES

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1. INTRODUCTION

The Government of Yukon, Assessment and Abandoned Mines Branch (AAM) is preparing for the remediation of the Clinton Creek Site (the Site), an abandoned asbestos mine located approximately 75 km northwest of the City of Dawson, Yukon (100 km by road). The mine operated from 1967 to 1978 and 940,000 tonnes of white chrysotile asbestos was mined from three pits. The Site is located within the traditional territory of Tr'ondëk Hwëch'in First Nation (THFN).

As part of the planning process, Ecological Logistics & Research Ltd. (ELR) was retained by AAM to conduct existing environment studies at the Site to gain an understanding of some of the existing environmental conditions. This information will help inform the environmental and socio-economic effects assessment that will be required as part of the Site remediation process.

This report presents information on fisheries existing environment studies conducted by ELR at the Site between 2016 and 2018. These studies were based on an earlier scoping and planning process where ELR reviewed existing information and available literature related to fisheries and aquatic resources, and provided recommendations to AAM. The 2016-2018 field studies scope was based on specific portions of AAM's overall intended scope of work related to fisheries and aquatic environment studies.

2. OBJECTIVES AND SCOPE

The primary objective of the fisheries existing conditions studies was to collect information on fish and fish habitat at the Site to contribute towards describing existing conditions at the Site for the purpose of an anticipated project assessment by the Yukon Environmental and Socio-economic Board (YESAB). The study components included in ELR's scope of work were based on YESAB's *Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions* (2005)*,* including:

For each drainage potentially affected by the project:

- Provide details on fish presence, abundance, and spatial/temporal distribution.
- Document critical and sensitive habitats, including relevant spawning, over-wintering and migration periods and locations, rare and/or endangered species and habitats.
- Provide details on fisheries resources and aquatic habitat at all stream crossings.
- Provide stream classifications for the water courses in the project area.
- Provide 1:50,000 map(s) identifying/indicating fisheries resource(s).
- Include information and baseline data on study methods, riparian fish habitat surveys, fish sampling, and results of other fieldwork within the potentially affected drainages.

AAM requested that ELR complete three specific scopes of work related to these information requirements:

- A survey to investigate for potential spawning activity of Arctic Grayling.

- A survey of overwinter fish habitat use in relation to the Site.
- A survey of mid summer fish habitat use in relation to the Site.

Additionally, to support these field studies and the overall base of information describing the Site, ELR also conducted:

- Stream reach delineation and mapping of Clinton Creek.
- Habitat inventory for those stream reaches where ELR found information gaps.

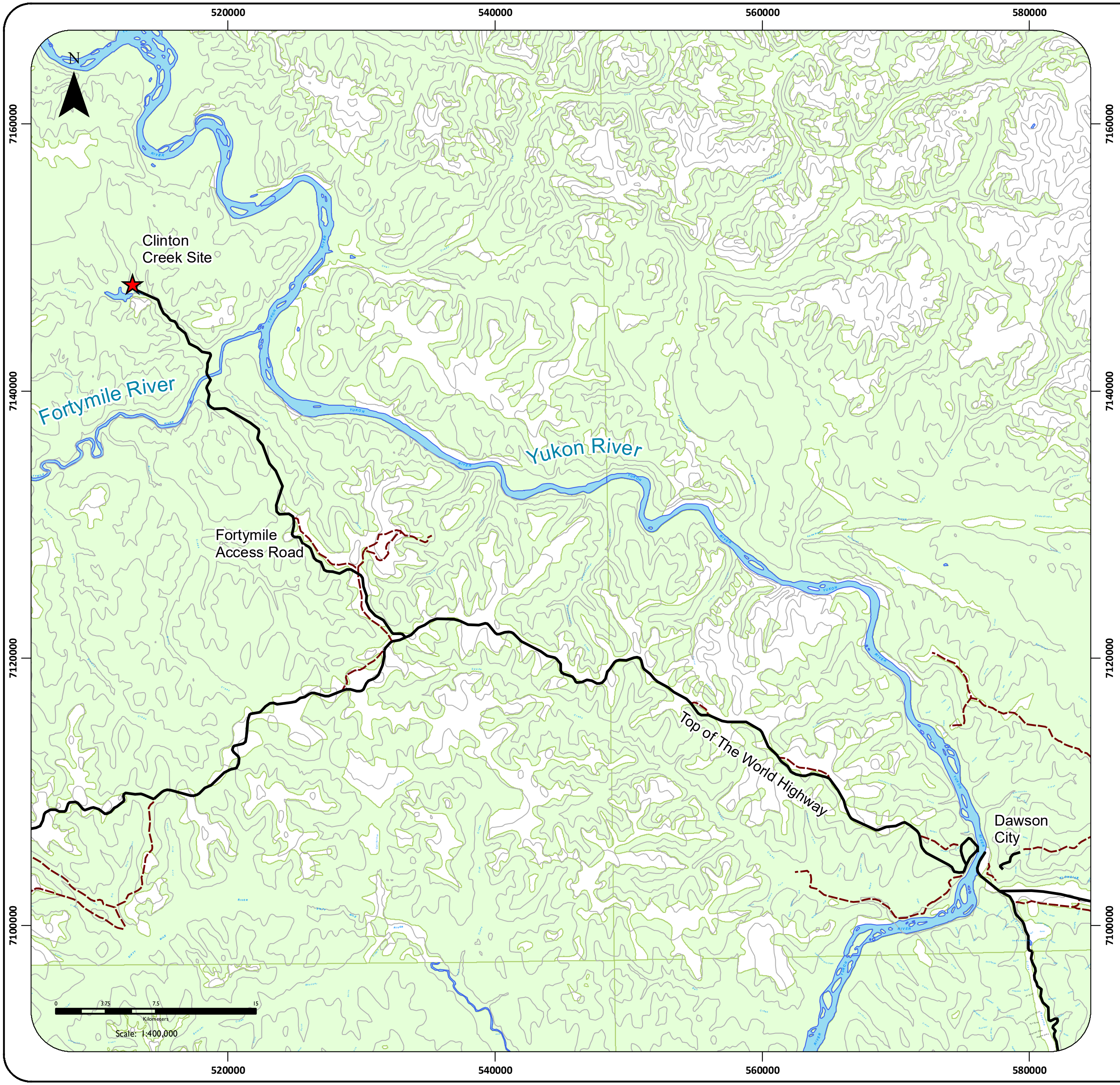
3. GEOGRAPHIC SCOPE

3.1 CLINTON CREEK SITE OVERVIEW

The Clinton Creek Site (the Site) is located approximately 75 km northwest of the City of Dawson (Dawson), Yukon and is within the Tr'ondëk Hwëch'in First Nation (THFN) Traditional Territory (Figure 3.1-1). The Site is a former asbestos mine and was operated by the Cassiar Asbestos Corporation Limited for 10 years between 1967 and 1978). Approximately 16 million tonnes of rock were mined from three pits and contained 940,000 tonnes of chrysotile asbestos. Some remedial activities at Site were attempted by the company between 1978 and 1992, then in 2002 the Government of Canada worked to stabilize the Site under the emergency section of the *Canada Water Act*. From 2003, the Government of Yukon has implemented care and maintenance of the Site, and more recently has led the development of a remediation plan funded by the Government of Canada.

The main features of the Site include a large open pit quarry containing water (Porcupine Pit Lake and Snowshoe Pit Lake), a waste rock area, a tailings area located between a decommissioned mill site and Wolverine Creek, a disused airstrip, and Hudgeon Lake, a lake that formed along the alignment of Clinton Creek when waste rock migrated into the creek and partially cut off its flow (Figure 3.1-1). Engineered structures currently help maintain flow in Clinton Creek, which flows into the Fortymile River, and in turn into the Yukon River.

The Site is located close to the northern boundary of the Klondike Plateau Ecoregion which is characterized by V-shaped valleys and extensive upland boulder fields, having been exposed to a long period of weathering as the area was not glaciated during the last ice age and forms part of Beringia (Yukon Ecoregions Working Group 2004). Boreal coniferous forest accounts for about 60% of the land cover followed by alpine tundra (20%), mixed forest (15%), and wetlands and lakes (5%). Discontinuous permafrost is present throughout the region and is reflected in stunted black spruce woodlands on north facing slopes (Yukon Ecoregions Working Group 2004) as can be seen on the north-facing slopes around Hudgeon Lake and along Clinton Creek. The area typically receives between 300 and 500 mm of precipitation annually with the wettest period being from June through to August. The area experiences wide temperature variations with mean January temperatures ranging from -23 to -32°C, and from 10 to 15°C in July. Extreme temperatures occur in the valleys and range from -60°C to 35°C (Yukon Ecoregions Working Group 2004).



Document Path: M:\GIS_Projects\18-278 Clinton Creek 2018 Baseline\Fisheries\Report Figures\2019 03 30 Fig 3.1-1 Region Overview.mxd

elr
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Client:

Yukon

LEGEND

- Clinton Creek Site

Roads and Trails

FEATURE

- Road
- Limited-use road
- 500 ft Contour Interval
- Wetlands
- Waterbodies
- Vegetation

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Approved by: C. Jastrebski

Date: March 30, 2019

ELR Project: 18-278.3

CLINTON CREEK SITE

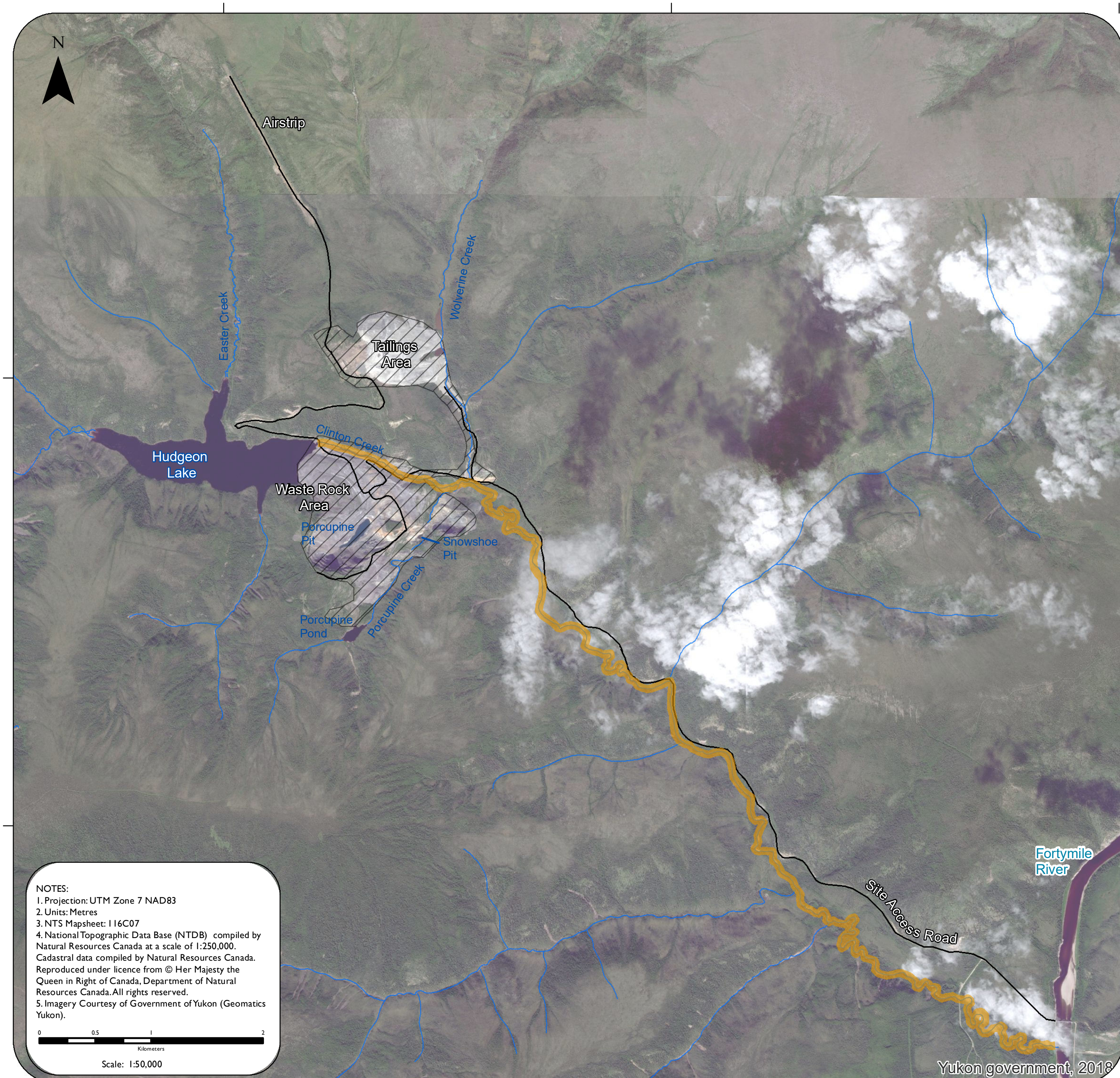
2017-2018 Fish and Fish Habitat Existing Conditions Studies

FIGURE 3.1-1

Clinton Creek Site Regional Overview

3.2 STUDY AREA

ELR's 2017-2018 fish and fish habitat studies were focused on Clinton Creek, between the outlet of Hudgeon Lake and the mouth of Clinton Creek at the Fortymile River. This area of watercourse was chosen to build upon data from earlier studies that included other Site area watercourses. The extent of the study area is shown in Figure 3.2-1.



NOTES:
1. Projection: UTM Zone 7 NAD83
2. Units: Metres
3. NTS Mapsheet: 116C07
4. National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:250,000. Cadastral data compiled by Natural Resources Canada. Reproduced under licence from © Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.
5. Imagery Courtesy of Government of Yukon (Geomatics Yukon).

0 0.5 1 2
Kilometers

Scale: 1:50,000

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LEGEND
- Clinton Creek Study Area
- Site Access Road
- Watercourses
- Infrastructure Extent

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CLINTON CREEK SITE
2017-2018 Fish and Fish Habitat
Existing Conditions Studies

FIGURE 3.2-1
Clinton Creek Study Area

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4. REACH DELINEATION & HABITAT INVENTORY

ELR conducted stream reach delineation, stream reach mapping, and fish habitat assessment and inventory to expand on earlier studies to characterize stream morphology, fish habitat characteristics, and to more generally contextualize fish presence and habitat use within Clinton Creek. Characterizing such existing conditions of fish habitat and stream morphology will help to facilitate an understanding for some of the critical environmental factors that influence seasonal fish distributions. As existing conditions change, whether through remedial actions or natural alterations to existing instream habitats, this understanding may prove essential in assessing implications for fish use and species distribution within the system. In the context of this study, a stream reach is defined as a '*relatively homogenous length of stream having a sequence of repeating structural characteristics (or processes) and fish habitat types*' (RISC 2001).

The fish habitat characterization and inventory conducted within ELR's scope of work was not intended to describe the Site on a standalone basis. This work was intended to build upon previous studies conducted by Laberge (2017), and are intended to serve as supporting or supplementary data for this previous work. Laberge (2017) conducted studies prior to stream reach delineation, and the additional inventory locations were necessary to characterize previously un-characterized reaches and to build upon the overall understanding of the Clinton Creek system to allow for better inference of the changes in fisheries usage of the watercourse on an annual basis.

4.1 METHODS

ELR delineated and catalogued stream reaches and inventoried fish habitat according to the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures* (RISC standards; RISC, 2001).

4.1.1 Stream Reach Delineation

As outlined by the RISC standards, stream reach delineation was initially completed as a desktop analysis, prior to any supporting field investigations. This included a review of available satellite imagery and aerial photography for the Site, as well as topographic base map data, which was used to assess general stream morphology and gradient of the watercourse. Each stream reach was identified based on uniformity among four key physical factors: channel pattern, channel confinement, stream gradient, and streambed and bank material. Reach boundaries were identified as significant changes of one or more of these factors which persisted for greater than 100 meters in stream length. Tributaries or confluences (e.g. confluence with Wolverine or Eagle Creek) were only assessed as reach boundaries if an inflow resulted in significant alterations to stream morphology of Clinton Creek. Previously identified barriers to fish passage (e.g. lower gabion structure) were also used in stream reach delineation, and were typically categorized as reach boundaries or breaks. Reach numbering followed conventions set out by the RIC standards, which assigns a numerical identification in upstream sequential order starting with the furthest downstream location to be included in the study (i.e. mouth of Clinton Creek).

Following the desktop delineation, ELR used helicopter reconnaissance under both winter and summer conditions to ground truth and refine stream reach delineation and to describe the stream characteristics. A winter reconnaissance was completed on February 28, 2018 during the overwintering surveys described in Section 6, and a summer reconnaissance was completed on July 16, 2018 during summer distribution studies (Section 5). Both surveys used a Eurocopter A-Star Helicopter, flown in an upstream direction at a low cruising speed. Two ELR staff members conducted the surveys from the left-hand side of the helicopter; one recording field notes and conducting a real-time comparison to the desktop reach delineation, and the other compiling a photo set and collecting GPS coordinates of significant watercourse features. Significant features documented during the flights included active and inactive beaver dam structures, off-channel hydrological features (e.g. wetlands or oxbow lakes), major fish habitat features, potential barriers to fish passage, stream reach boundary transitions, tributary inflows, and areas of significant ice accumulation (in the case of winter surveys). As stream morphology was not easily observed during the winter season, data collected during this reconnaissance was primarily used to describe winter hydrological conditions and ice accumulation that may influence the distribution of overwintering fish.

4.1.2 Habitat Inventory

Habitat inventories were conducted according to the *Reconnaissance (1:20,000) Fish and Fish Habitat Assessment Inventory: Standards and Procedures* (RIC 2001). As described above (Section 4.1.1), inventory locations were selected based on a review of existing habitat data within the context of the newly delineated reach segments. As stream habitat inventory locations outlined in Laberge (2017) were selected based on existing water quality sample stations, additional habitat assessment was required to expand this inventory into some unassessed habitat types or reach segments.

At each sampling station, ELR established a representative area of the stream by walking along the channel in the survey area (i.e., a segment of channel that was representative of the stream in the reach including the study site). Habitat features were assessed along a length of channel ranging from 100 m to 125 m (dependent on channel width). ELR then used habitat site cards designed by the RISC in the field to ensure all required data were included in the inventory. These site cards provide a structure to collecting data describing a variety of instream fish habitat and stream channel characteristics, including:

- Physical stream channel characteristics
  - Bankfull width measured at the elevation of the regular high water mark on each streambank;
  - Wetted width measured between the streambanks at water surface level at the time of the site visit;
  - Bankfull depth measured from deepest part of channel to line bisecting the bankfull mark of each streambank; and
  - Residual pool depth measured the difference between the maximum pool depth and the outlet crest depth.
- Channel gradient measured the slope of the channel bed.
- Stream morphology characteristics (e.g., riffle, run, and pool).
- Stream substrate composition and characteristics, including dominant and subdominant substrates
- D95 - diameter of bed material particles that are larger than 95% of the materials in the stream channel.
- D - diameter of the largest particle on the channel bed that will be moved at channel forming flow levels.
- Bank slope and characteristics, riparian vegetation characteristics, and percent crown closure.
- Instream cover composition and abundance.

- Large-scale channel reach characteristics (disturbances, confinement, stream pattern, etc.).

All stream or streambed material measurements were completed using a retractable tape measure or ruler; stream velocity measurements were collected using a Swoffer Model 2100 Series Current Velocity Meter; canopy cover was measured using a field densitometer; and water temperature was recorded using an Oakton multimeter.

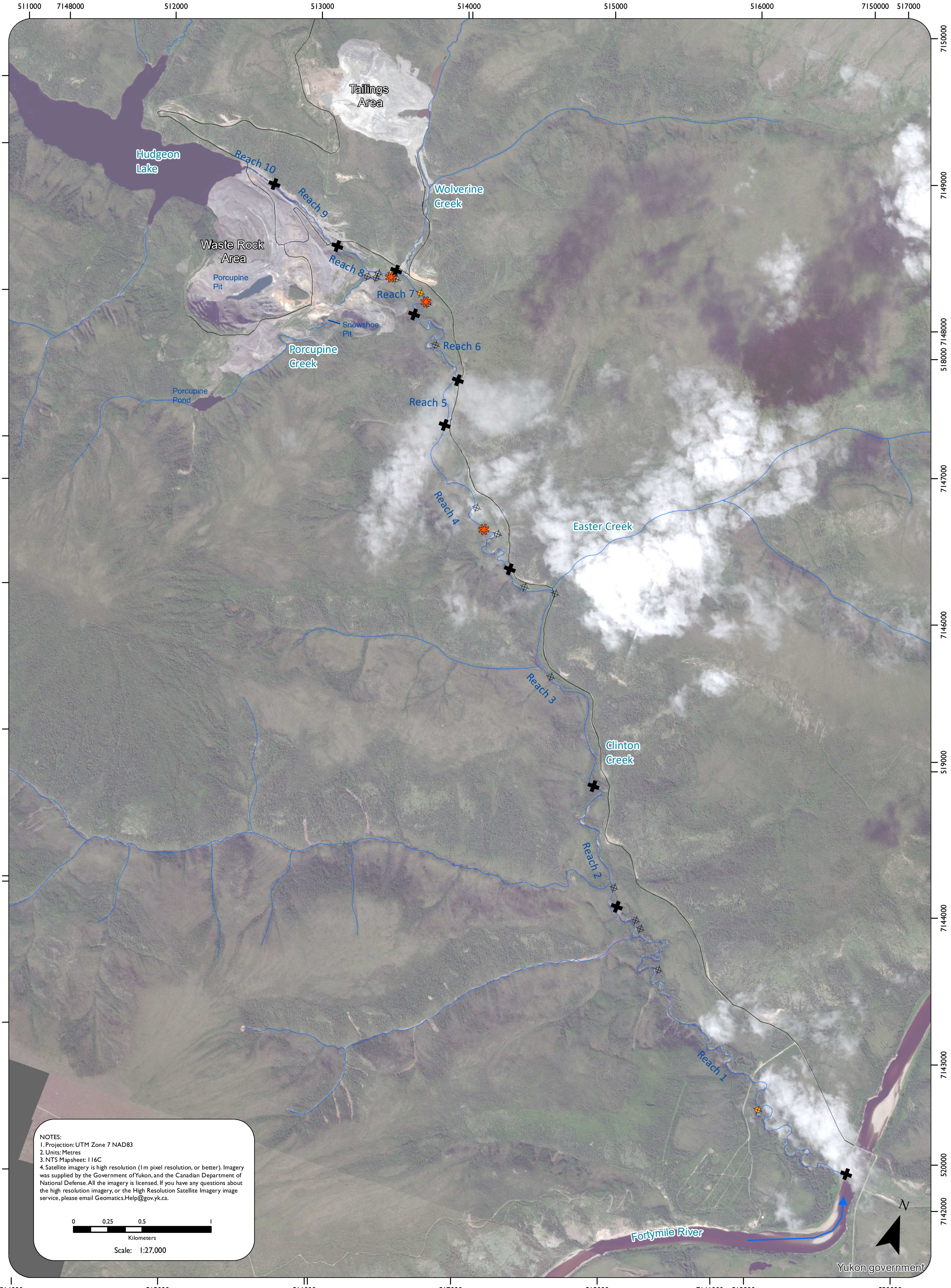
4.2 RESULTS

4.2.1 Stream Reach Delineation

As detailed in the methods above, satellite and aerial imagery for the Site was reviewed to establish a preliminary delineation of stream reach segments prior to field reconnaissance. This included high resolution imagery provided through the Government of Yukon (July 26, 2012 GeoEye Satellite image with 0.5 m resolution). The imagery was generally clear, with some cloud cover masking lower and mid sections of Clinton Creek (Figure 4.2-1). This image reviewed was collected during a period of low to moderate water levels. When available, stream gradients were calculated for each delineated reach using upper and lower elevations compiled from a Canadian Digital Elevation Dataset (CDED) with 16 metre resolution. Reach length was measured digitally using the available imagery. Desktop stream gradient calculations were not possible in some instances where CDED and satellite imagery datasets showed inconsistencies and calculations show erroneous results. All stream gradients provided in Table 4.2-1 were recalculated following field verification of reach boundaries.

The winter season reconnaissance flight was completed on February 28, 2018, and the summer season reconnaissance flight was completed on July 16, 2018. Both flights were completed on clear days with no visibility or weather-related issues. During the winter season flight Clinton Creek (including Hudgeon Lake) was predominantly ice covered, with aufeis accumulation occurring in some areas where the creek became confined by the surrounding topography. ELR observed a limited number of open water sections directly adjacent to existing Site infrastructure. During the summer season, Clinton Creek was at a low to moderate water level, with many exposed side and point gravel bars.

The final reach delineation of Clinton Creek was dictated primarily by stream pattern and confinement. The lowest section of the creek was unconfined with an irregular meandering pattern. The level of confinement changed repeatedly in mid-reaches of the creek where the stream winded through steeper terrain. This in turn altered the general morphology and stream pattern throughout the length of Clinton Creek. The Site infrastructure area (previous mine infrastructure) has also significantly altered the morphology of Clinton Creek. This includes the formation of Hudgeon Lake caused by the slumping of waste rock, the construction of a series of gabion control structures in the uppermost reach, the formation of an entrenched canyon feature, as well as braided section that occurs where the creek flows through the Mine Site and has deposited large amounts of streambed material from the waste rock area. In addition, beaver activity on Clinton Creek has also played a key role in the alteration of stream morphology, including changes to stream flow patterns, sedimentation, as well as the development of a large wetland feature directly downstream of the Site infrastructure area.



Document Path: M:\GIS_Projects\18-278 Clinton Creek 2018 Baseline\Fisheries\Report Figures\2019 03 30 Figure 4.2-1 Stream Reaches.mxd

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Client: Yukon

LEGEND

- Primary Site Roads
- Site Area Watercourses
- Clinton Creek Reach Boundaries
- 2018 Habitat Sampling Locations

Beaver Dam Observations

- Active
- Inactive or Old

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CLINTON CREEK SITE
2017-2018 Fish and Fish Habitat Existing Conditions Studies

FIGURE 4.2-1
Clinton Creek Reach Delineation

Table 4.2-1: Results of Reach Delineation Assessment of Clinton Creek

Reach ID	D/S Reach Boundary (UTM; 7W)		Reach Length (m)	Gradient (%)	Pattern	Confinement	Islands	Bars	Coupling
	E	N							
Reach 1	230601	7153866	4,420	0.63	IM	UN	None	SIDE / DIAG	DC
Reach 2	228374	7155328	1,130	1.76	IR	OC	None	SIDE	PC
Reach 3	227990	7156134	2,116	1.41	IM	FC	None	SIDE	PC
Reach 4	227004	7157507	1,657	0.78	IM	OC	None	SIDE	PC
Reach 5	226281	7158400	440	NC	SI	CO	None	SIDE	PC
Reach 6	226294	7158739	456	NC	IM	OC	None	SIDE	PC
Reach 7	225864	7159123	430	NC	IR	OC	None	SIDE	PC
Reach 8	225658	7159396	530	NC	IR	EN	AN	BR	PC
Reach 9	225200	7159462	647	NC	SI	EN	None	DIAG	CO
Reach 10	224644	7159784	255	NC	ST	N/A	None	None	CO

Notes:
Gradient: NC = Not calculated
Pattern: IM = irregular meandering, IR = irregular wandering, SI = sinuous, and ST = straight.
Confinement: UN = unconfined, FC = frequently confined, OC = occasionally confined, EN = entrenched, CO = confined, and N/A = not applicable
Islands: AN = Anastomosing
Bars: SIDE = Side Bar/Point Bar, BR = Braided Channel, DIAG = Diagonal Bar
Coupling: DC = decoupled, PC = partially coupled, CO = coupled

Reach 1

Reach 1 extends 4,420 meters, from the mouth of Clinton Creek upstream to a point where the creek becomes occasionally confined (Figure 4.2-1, Photo 1). This is the longest reach that was delineated on the system. Reach 1 is unconfined throughout, meanders irregularly, with a relatively low calculated stream gradient (0.63%). The reach is decoupled and had numerous exposed side/point and diagonal gravel bars during the survey. This reach has been heavily influenced by beaver activity with one functional and three blown-out beaver dams documented during the summer flight. No aufeis accumulation was reported during the winter season flight, however the reach was completely ice covered with no open water sections. Three small oxbow lakes were documented adjacent to the reach, none of which had surface water connections to Clinton Creek.

Fish habitat within Reach 1 was abundant, with many deep pools located along meander bends and potential for undercut banks as the stream meanders through a mature forested area. Small woody debris, as well as overhanging deadfall and riparian vegetation were also observed throughout. Abundant beaver activity was observed within this reach, and appears to have altered stream substrates at some locations, presumably as damming allows for accumulation and release of material.

Reach 2

Reach 2 extends for 1,130 meters, from where the creek becomes occasionally confined until it transitions to a more constricted flow path (becoming frequently confined in Reach 3) (Figure 4.2-1, Photo 2). Reach 2 is occasionally confined, meanders irregularly, and has an increased calculated stream gradient (1.76%). The reach is partially coupled with numerous side/point gravel bars distributed throughout. Reach 2 appears to have less beaver activity compared to Reach 1, with only a single blown-out beaver dam documented during the summer flight. Some aufeis accumulation was observed within this section during the winter flight, limited mainly to areas of increased channel confinement.

Fish habitat coverage was found to be relatively limited within Reach 2 in comparison to Reach 1. Pool habitats and overhanging deadfall were still observed along meander bends and some large boulder features were identified along straight riffles or glide sections.

Reach 3

Reach 3 extends for 2,116 meters, from where the creek becomes frequently confined until it transitions back to a less constricted flow path (becoming occasionally confined in Reach 4) (Figure 4.2-1, Photo 3). Reach 3 is frequently confined, meanders irregularly, and has a slightly lower calculated stream gradient (1.41%). The reach is partially coupled with numerous side/point gravel bars distributed throughout. Reach 3 appears to be heavily used by beavers, with one functional and three blown-out beaver dams documented during the summer flight. Aufeis accumulation was observed throughout the confined sections of this reach during the winter flight. One small ephemeral stream, as well as the confluence of Eagle Creek occur within this segment. Reach 3 also includes a short canyon-like section (confined on both sides) with a steep gradient that occurs between the inflows of the small ephemeral stream and Eagle Creek.

Fish habitat within Reach 3 is limited, with the majority of quality cover features occurring at the confluence of Eagle and Clinton creeks. Large boulders and channel margins would allow for fish movement through the canyon-like section. Some additional pools exist on meander bends but are generally limited relative to other sections.

Reach 4

Reach 4 extends for 1,657 meters, from where the creek becomes occasionally confined until it transitions back to a more constricted flow path (becoming confined in Reach 5) (Figure 4.2-1, Photo 4). Reach 4 is occasionally confined, irregular meandering, with a reduced calculated stream gradient (0.78%). This reach is partially coupled with numerous side/point gravel bars distributed throughout. Diagonal bars also likely occur within this reach during periods of low water. A mid-channel bedrock outcrop occurs at the upstream extent of this reach. Reach 4 shows some signs of beaver activity, with two blown-out dams documented during the summer flight. A number of off-channel ponds occur within this reach segment, none of which were connected to the main channel at the time of the survey.

Instream fish cover is more abundant in Reach 4 in comparison to segments both upstream and downstream of this section. This reach includes a series of large meanders which accommodate the formation of deep pools along the meander cut banks.

Reach 5

Reach 5 extends for 440 meters, from where the creek becomes confined until it transitions back to a less constricted flow path (becoming occasionally confined in Reach 6) (Figure 4.2-1, Photo 5). Reach 5 is primarily confined with a sinuous stream channel pattern (stream gradient not calculated). The reach is partially coupled with limited exposed gravel bars observed. Approximately half of the reach length has a straight channel pattern with confining bedrock banks on both sides. No signs of beaver activity were observed during the summer flight.

Fish habitat within Reach 5 is limited. Swiftwater, cascades, and long riffles were observed throughout its length. Cover habitats for fish were limited to large boulder features and channel margins. No barriers to fish passage were observed.

Reach 6

Reach 6 extends for 456 meters, from where the creek becomes occasionally confined until it transitions to a wetland feature that occur directly downstream of the Clinton Creek Site (within Reach 7) (Figure 4.2-1, Photo 6). Reach 6 is occasionally confined with an irregularly meandering stream channel pattern (stream gradient not calculated). The reach is partially coupled with numerous side/point gravel bars distributed throughout. Beaver activity within this reach is limited, with only one blown-out beaver dam observed during the summer flight.

Reach 7

Reach 7 extends for 430 meters, where the creek forms a large wetland feature that occurs directly downstream of the Clinton Creek Mine site (Figure 4.2-1, Photo 7). The main channel within Reach 7 is occasionally confined with an irregular wandering channel pattern, generally following the perimeter of a wetland (stream gradient measured at 1.0%). The wetland (i.e. fen or shallow open water) appears to have been created primarily through beaver activity (a product of both active and abandoned beaver structures), including a large dam and abandoned lodge that channelize the main stem of Clinton Creek and direct flows to the north side of the valley.

Surface water from Clinton Creek appears to seep through this controlling dam, allowing for shallow open water features to develop downgradient of the structure. The area is likely flooded intermittently during high water conditions. Outflow of the wetland intersects back with the main channel near the downstream extent of this reach. Groundwater contributions from the surrounding topography may also play a role in maintaining these wetted features throughout the season. The contribution of groundwater is apparent in the wetland outflow, which shows significant accumulation of mineral precipitates in streambed substrates. One active beaver dam and many abandoned structures were observed along this reach during the summer flight. The confluence of Clinton Creek and Wolverine Creek also occurs within the upper portion of this reach.

Fish habitat within Reach 7 was abundant, with some deep pools, overhanging vegetation, and small woody debris occurring in the lower section of the reach. Some of the shallow open water features show surface connections to the main channel of Clinton Creek and likely provide opportunities for juvenile rearing and foraging, as well as refuge habitats during periods of high water.

Reach 8

Reach 8 extends for 530 meters through the confines of the Clinton Creek Site infrastructure area. In this reach it is believed that the channel has shifted to the south from its original position, likely due to the original channel being blocked with deposited sediments from the channel reaches above (in the waste rock area) (Figure 4.2-1, Photo 8). Reach 8 is generally channelized, entrenched and confined to the south in the upstream portion of its length, and it then becomes braided and anastomosing further downstream (Stream gradient measured at 1.5%). The flow path within this reach likely changes seasonally following spring freshet, as the creek braids primarily through unconsolidated gravels and willow shrub vegetation. This reach is also marked by an apparent increase in groundwater contribution. Two major groundwater seepage channels, which emerge from unconsolidated gravels within the floodplain, have developed along this reach. The seepage channels intersect with the main stem of Clinton Creek near its downstream extent of Reach 8. Signs of previous beaver activity are abundant within this reach, including two functional dam structures that create ponding at the outlet of Porcupine Creek.

Fish habitat within Reach 8 is moderately abundant, with some deep pools located where the creek becomes confined, as well as shallow side channel habitats that could be utilized for rearing and refuge for juvenile or young-of-year (YOY) fish. Groundwater seepage channels appear to be relatively poor quality in terms fish habitat, as a thick accumulation of red algae covers the majority of substrates.

Reach 9

Reach 9 extends for 647 meters, where the creek flows through an entrenched canyon with steep and unstable canyon walls (Figure 4.2-1, Photo 9). Reach 9 was entrenched with a straight stream channel pattern throughout. Large boulders occur throughout the length of the reach as well as other signs of slide materials from the canyon walls. No signs of beaver activity were observed along this reach.

Fish habitat within Reach 9 is limited, with the majority of the reach representing a long riffle/cascading feature. No barriers to fish passage were observed within this reach.

Reach 10

Reach 10 extends for 255 meters, where the stream is controlled by a series of four constructed gabion structures (Figure 4.2-1, Photo 10). The channel pattern remains straight throughout the length of this reach and undergoes four drops, each of which are considered impassable by fish. At the time of the survey, the lowest gabion structure had experienced geotechnical failure and a large quantity of material had blown out from underneath the structure and deposited within the lowest plunge pool. No signs of beaver activity were observed within this reach, however beavers are known to inhabit Hudgeon Lake located directly upstream.

Fish habitat within Reach 10 is limited to the plunge pools located downstream of lowest gabion structure. When functioning as designed, this would consist of one large, deep pool, however due to structural failure this included a series of smaller pools distributed throughout the slumped material. These gabion drop structures are considered to be barriers to upstream fish passage.

4.2.2 Beaver Dams and Barriers to Fish Passage

ELR identified three active beaver dams and 15 inactive or blown out (broken, not restricting water flow) during the July 16, 2018 reach mapping exercise. The active beaver dams were observed in Reaches 1, 3, and 7 (Photos 11-13, Figure 4.2-1). Each spanned the entire width of Clinton Creek and was holding back a moderate volume of water. The extent to which these beaver dams were acting as barriers to fish passage was not directly investigated, and previous studies have suggested that they act as partial or complete barriers to fish movement at times, in particular upstream movements (Von Finster 2012). The presence and changing nature of beaver dams (several active and numerous inactive observed in 2018) and their influence on fish distribution supports the concept that fish distribution in Clinton Creek is dynamic and related to the presence of barriers when fish re-enter the creek from overwintering areas downstream.

No permanent natural barriers to fish passage exist on Clinton Creek (such as cascades or other bedrock features). The gabion structures located at Reach 10 are considered to maintain a barrier to upstream fish movement, and these structures are considered to be the uppermost limit of fish distribution in Clinton Creek (Photo 10).

4.2.3 Stream Habitat Inventory

ELR completed habitat inventories at several locations on Clinton Creek, as described in Section 4.1.2. Three locations (in Reaches 4, 7, and 8; Figure 4.2-1) were selected based on a comparison of stream reach delineation results (Section 4.2.1) with previously completed fish habitat studies on Clinton Creek (i.e., Laberge 2017), as if was found that habitat descriptions did not exist within these reaches. ELR completed the Inventories between July 17 and July 20, 2018, during a period of low to moderate water level. Habitat descriptions are provided in the following section, while a summary of habitat results are presented in Table 4.2-2 below.

Reach 4

ELR completed a habitat inventory in Reach 4 on July 17, 2018 (Figure 4.2-1). The total length of the inventory site was 100 m. The stream at this location formed a riffle-pool sequence throughout its length. Based on on-site characterization, the stream characteristics were similar to those identified during the reach delineation. Streambed materials were predominantly cobbles, with fines representing the subdominant material. ELR found the average residual pool depth to be 0.44 m within this section.

Consistent with the observations performed during reach mapping (Section 4.2.1), instream fish cover within Reach 4 consisted primarily of pool habitats (3%) located along meander bends. Additionally, undercut banks (3%) and small woody debris (2%) also contribute to a total estimated 8-9% fish cover within this section. These habitats form where the stream is unconfined, allowing the flow path to meander through mature forested areas. Beaver activity also appears to contribute to the availability of cover habitats by contributing woody materials that accumulate in clumps throughout the stream.

Pools within this reach may function as important holding sites for migrating fish, as areas both upstream and downstream of this reach are confined, leaving cover habitat relatively limited. Detailed habitat data is provided in Table 4.2-2, and Photos 14 and 15 show the characteristics at the Reach 4 habitat assessment site.

Table 4.2-2: Summary of Habitat Inventory Results from Selection Locations on Clinton Creek

Parameters	Reach 4 17/07/18	Reach 7 19/07/18	Reach 8 20/07/18
Reach Length (m)	1,657	430	530
Survey Length (m)	100	100	300
Residual Pool Depth (m) – Min./Max./Avg. (n)	0.2 / 0.6 / 0.44 (5)	0.3 / 1.1 / 0.6 (4)	0.5 / 0.9 / 0.7 (5)
Channel Width (m) - Min./Max./Avg. (n)	8.9 / 22.5 / 16.6 (8)	9.6 / 25.9 / 16.4 (8)	6.9 / 51.3 / 23.8 (6)
Wetted Width (m) - Min./Max./Avg. (n)	5.1 / 12.2 / 7.7 (8)	3.5 / 9.6 / 7.2 (8)	4.4 / 17.2 / 7.8 (6)
Bankfull Depth (m) - Min./Max./Avg. (n)	1.3 / 2.0 / 1.5 (4)	0.7 / 1.7 / 0.97 (4)	-
Range of Stream Gradient - (%)	1.0 - 1.5	0 - 1.0	1.0 - 2.0
Stream Velocity (m/s) - Min./Max./Avg. (n)	0.22 / 0.92 / 0.65 (3)	0.3 / 0.5 / 0.41 (3)	0.44 / 0.77 / 0.63 (3)
Dominant Substrate (D)	Cobble	Sand	Gravel
Subdominant Substrate (subD)	Fines	Cobble	Cobble
D95 (cm)	22	16	210
D (cm)	15	13	16
General Morph. Characteristics[1]	RPc-w	RPc	RPg-w
Water Temperature (°C)	13.9	15.2	16.0
Total Fish Habitat Cover (%)	<10	<10	<5
Primary Fish Habitat Components (%)	Small woody debris (2) Large wood debris (0) Boulder (0) Undercut (3) Deep pool (3) Overstream vegetation (<1) Instream vegetation (0)	Small woody debris (2) Large wood debris (0) Boulder (0) Undercut (<1) Deep pool (5) Overstream vegetation (<1) Instream vegetation (0)	Small woody debris (<1) Large wood debris (0) Boulder (<1) Undercut (<1) Deep pool (3) Overstream vegetation (<1) Instream vegetation (0)
Riparian Habitat Composition	Veg. Type - Shrub Stage – Shrub / Mature Forest	Veg. Type - Shrub Stage – Shrub / Mature Forest	Veg. Type - Shrub Stage – Shrub / Mature Forest
Crown Closure (%)	1-20	1-20	0 -20
Channel Characteristics[2]	Islands - None Bars – Side & Diagonal Coupling - Partial Confinement - Occasional	Islands - None Bars – Side & Diagonal Coupling - Partial Confinement - Occasional	Islands - AN Bars - Braided Coupling - Partial Confinement - Occasional

Table Notes:
[1] General Morph. Characteristics are described using RIC 2001, acronyms are as follows: RP = Riffle-Pool with cobble bed material, RPg= Riffle-Pool with gravel bed material.
[2] Channel Characteristics are described using RIC 2001, Acronyms are as follows: AN = anastomosing

Reach 7

ELR completed a habitat inventory in Reach 7 on July 19, 2018 (Figure 4.2-1). The total length of the inventory site was 100 m. The stream at this location formed a riffle-pool sequence, as well as a long shallow riffle feature directly downstream of an active beaver dam. The habitat inventory was completed along the main channel of Clinton Creek and therefore does not include the wetland or open water habitats described in Section 4.2.1. The long riffle downstream of the active beaver dam was the only inconsistency in stream morphology not identified during reach delineation. Streambed materials were predominantly sand, with cobble representing the subdominant material. ELR found the average residual pool depth of to be 0.6 m within this section.

Instream fish cover within Reach 7 consisted primarily of pool habitats (5%), including a series of pools that have formed near the outflow of the wetland. Additionally, a trace amount of undercut bank habitat (<1%), small woody debris (2%), and overhanging vegetation (<1%) also contribute to a total estimated 7-8% of fish cover within this section. Beaver activity has extensively altered habitats within this reach, as described in Section 4.2.1. Detailed habitat data is provided in Table 4.2-2, and Photos 16 and 17 show the characteristics at the Reach 7 habitat assessment site.

Reach 8

ELR completed a habitat inventory in Reach 8 on July 20, 2018 (Figure 4.2-1). The total length of the inventory site was 300 m. As described in Section 4.2-1, the upper portion of Reach 8 is entrenched, middle section unconfined and braided, while the lowest section forms a more typical riffle-pool sequence. The habitat inventory included sections of all three features within site length. Streambed materials were predominantly gravel, with cobble representing the subdominant material. ELR found the average residual pool depth to be 0.7 m within this section.

Instream fish cover within Reach 8 consisted primarily of pool features occurring in the lower areas of the reach. One pool in particular, which formed at a point where the stream became confined near an abandoned beaver lodge, was noted to have a maximum residual depth of 0.9 m. The braided portions of this reach offered limited cover for fish with relatively shallow channels and only trace amounts of other cover (e.g. boulders and undercut banks). The upper entrenched section of this reach was fast moving, offering only limited channel margin holding areas for fish. Detailed habitat data is provided in Table 4.2-2, and Photos 18 and 19 show the characteristics at the Reach 8 habitat assessment site.

4.3 Summary and Discussion - Stream Reach Delineation and Habitat Survey

ELR completed stream reach delineation and limited habitat mapping on Clinton Creek with the objective of building upon the existing habitat data for the watercourse, identifying potential barriers to fish movement, and developing a detailed stream reach delineation on which other work components could be based.

ELR successfully completed stream reach mapping and identified 10 reaches between the outlet of Clinton Creek and the outflow of Clinton Creek at the Fortymile River, based on conditions in February and July of 2018. ELR observed the signs of moderate beaver activity; three active beaver dams and fifteen inactive or old beaver dams were observed, with the former suggesting that beaver activity in Clinton Creek is dynamic and frequently changing. No other barriers to fish passage were observed by ELR during the reach mapping, and the three observed dams are not considered to be barriers to passage based on the fish distribution observed by ELR in the spring of 2017 and summer of 2018 (Sections 5 and 7).

5. Arctic Grayling Spawning & Young-of-Year Surveys

Spawning habitats for fish represent important or key habitat features within watercourses. Arctic Grayling inhabit Clinton Creek, and therefore an investigation was planned and implemented to provide recent data to describe spawning of this species in Clinton Creek. The objective was to determine whether there is evidence that spawning is occurring in the creek, and if so, to describe to the extent possible the locations and timing of spawning.

5.1 Methods

5.1.1 Spring Spawning Survey

A snorkel survey had been planned for the spring of 2017, to visually document Arctic Grayling occurrence and spawning activity within Clinton Creek. ELR mobilized to the Site and attempted to complete this snorkel survey according to a pre-established field plan, however it could not be completed as intended because underwater visibility in Clinton Creek at the time of the survey was found to be too limited to allow meaningful observations to be made.

During the snorkel survey attempt, water temperature measurements were collected using a YSI Professional Plus multimeter with quattro cable. This instrument was calibrated at the start of the program, checked daily, and re-calibrated if necessary. Turbidity measurements were collected using a LaMotte 2020we field turbidity meter, with results recorded as Nephelometric Turbidity Units (NTUs).

At the start of the snorkel survey attempt, ELR tested the range of underwater visibility; this is a standard practice when completing snorkel surveys, in order for the crew to know the effective distance that can be observed from the surveyors. ELR completed visibility tests by having one staff member submerged underwater with snorkeling equipment, while the other was positioned in chest waders at a 10 meter distance. The staff with chest waders was instructed to move slowly toward other until they were visible underwater, at which time the distance from the observer was measured. At the same time, stream turbidity was measured to provide a reference between turbidity and visibility. This test was repeated a minimum of 5 times in different locations or conditions.

Following decision with AAM and the decision to discontinue snorkel survey attempt, alternative options for investigating spawning activity within Clinton Creek were considered. The primary factors that were considered during this discussion were: 1) that the site is relatively remote and it is not possible to monitor conditions on an ongoing basis; 2) that elevated instream turbidity would limit other types of investigations that required visual observations; and 3) invasive investigations during the spawning period are generally not advisable and are not permitted by Fisheries and Oceans Canada, as they can result in harm to eggs or developing larvae. Accordingly, the selected option for further study was a spring young-of-year survey.

5.1.2 Spring Young-of-Year Survey

ELR planned and implemented a spring Arctic Grayling YOY survey to investigate whether spawning of this species had occurred in Clinton Creek, and if so, which areas of the Creek had been used (or what the measurable upstream extent of the spawning was). This survey was based on the following assumptions:

- That the distribution of YOY Arctic Grayling (AG) would broadly represent the distribution of eggs or spawning sites during the time soon after egg emergence.

- That YOY AG would not move upstream (against the current), but rather would be found in calm sheltered areas near but downstream of spawning sites.
- That the presence of YOY AG early after egg emergence would provide evidence of spawning within a limited area upstream of that site.

The timing of the return visit was based incubation times for eggs of Arctic Graying, which is thought to range between 8 and 25-days following the spawn depending on mean water temperatures (Stewart et al. 2007).

ELR completed the YOY survey in an upstream to downstream sequence to ensure that YOY AG were at their furthest possible upstream extent during the survey (minimizing their chance to move downstream), as the upstream extent of spawning was of particular interest in the survey. ELR selected a series of sites for investigation based on accessibility, with the overall objective of stratifying effort along the total length of the creek. The updated reach mapping had not been completed at this time, and therefore it was not possible to fully stratify the sampling according to stream reach.

ELR's intent was to sample sites for YOY AG using a fine mesh beach seine net to allow for capture even in turbid water. However, at the first survey sampling point (upper section of Reach 10) it was observed that YOY Arctic Grayling were less developed than anticipated (<20 mm in length), and some were able to pass through the mesh of the seine. In response to this, ELR also collected visual observations in addition to seine netting, and it was found that YOY AG could be observed in calm channel habitats. Where seine netting was not possible at a particular survey location (e.g. due to habitat constraints) visual observations became the only survey method for that area.

Visual surveys were completed by slowly walking the channel periphery in chest waders, lightly disturbing the water surface with a meter stick, and observing any resulting fish movement. If fish movement was observed, a UTM location, count, and general description of the habitat feature and fish behavior was recorded. Low velocity riffles, shallow backwater pools, side channels, and calm channel margins were of particular focus of the surveys. Seine netting efforts targeted either pool or slow glide features, and information describing the location, size of the area seined, habitat, and resulting catch (including fish fork or total length where appropriate) was recorded. Due to the delicate nature of YOY fish, no attempts to catalogue lengths of YOY AG was made, and the focus was on their identification and enumeration.

5.2 RESULTS

5.2.1 Spring Spawning Survey

ELR travelled to the Site to begin an Arctic Grayling spawning survey on June 2, 2017. The water levels in Site watercourses were observed to be moderate to low (i.e., past peak freshet), however the clarity of the water was still indicative of spring melt conditions (turbid, brown stained, with visible suspended solids). As a first step, ELR conducted a visibility test to determine the suitability of performing a snorkel spawning survey in Clinton Creek at that time, and found that underwater visibility was limited to 30 to 40 cm (Photo 20). A series of turbidity measurements were recorded at the same time to determine whether water clarity was consistent throughout Clinton Creek, and water temperature was also measured to determine whether the temperatures were conducive for Arctic Grayling spawning.

ELR measured water turbidity in the main channel of Clinton Creek to range between 4.21 and 6.89 NTU (Table 5.2-1). Water temperatures were found to range between 9.6 and 15.4°C. ELR also took measurements from the two major tributaries to Clinton Creek (Eagle Creek and Wolverine Creek), and found that these tributaries had lower temperatures and higher turbidity compared to Clinton Creek (Photo 21). The stream inputs to Hudgeon Lake and the groundwater seepage channels within Reach 8 also had lower temperatures compared with the main Clinton Creek channel, but did not have elevated turbidity. In general, the highest temperature (13.7-15.4˚C) and lowest turbidity (3.82-4.78 NTU) were observed between the outflow of Hudgeon Lake and the inlet of Wolverine Creek, and that these parameters fluctuated slightly throughout length of the creek (related to the source of inputs), showing a trend towards reduced temperatures in the lower reaches (9.6°C).

After a discussion of these observations with AAM, a decision was made to discontinue the snorkel survey attempt as it was uncertain if or when conditions may become suitable for this type of survey. It was believed that the timing and water temperature in Clinton Creek were favorable for spawning at that time, with Arctic Grayling thought to spawn between May and June when water temperatures are between 4-16˚C (Stewart et al. 2007).

Table 5.2-1: Summary of Water Temperature and Turbidity Measurements Recorded During the Spring Spawning Survey

Clinton Creek Reach No. or Tributary	Date	UTM (7W)		Water Temp. (°C)	Water Turbidity (NTU)	Description
		E	N			
1	02/06/2017	518545	7142467	9.6	5.70	Clinton Creek, lower ford crossing (access to old townsite)
3	03/06/2017	516025	7144925	12.2	6.89	Clinton Creek, downstream of Eagle Creek
	03/06/2017	515952	7145286	13.1	5.08	Clinton Creek, directly upstream of Eagle Creek confluence
4	03/06/2017	515638	7145305	10.7	4.21	Clinton Creek, above Eagle Creek and below Wolverine Creek
6	03/06/2017	514403	7146969	12.8	6.35	Downstream of Wolverine Creek and wetland area
	03/06/2017	514368	7146816	12.8	5.99	Downstream of Wolverine Creek and wetland area
7	03/06/2017	514166	7147076	13.7	3.82	Clinton Creek, directly upstream of Wolverine Creek confluence
8	03/06/2017	513636	7147116	15.0	4.27	Clinton Creek, primary ford crossing (below gabion structures)
10	03/06/2017	512852	7147420	15.4	4.78	Clinton Creek, outlet of Hudgeon Lake
Tributaries & Inputs	03/06/2017	515981	7145352	4.4	25.9	Lower Eagle Creek
	03/06/2017	514180	7147189	6.9	16.7	Lower Wolverine Creek
	03/06/2017	513981	7147127	10.5	0.06	Groundwater seepage pond within Clinton Creek floodplain (GWCC5)
	04/06/2017	512031	7147954	2.7	4.5	North arm inlet stream to Hudgeon Lake
	04/06/2017	510892	7147485	4.2	4.55	West arm inlet stream to Hudgeon Lake

5.2.2 Spring Young-of-Year Survey

ELR completed the spring Arctic Grayling YOY survey between June 24 and June 25, 2017. At the time of this event, water levels and instream turbidity in Clinton Creek were both low in comparison to the conditions that had been observed during the snorkel survey attempt in early June site visit (Section 5.2.1). ELR observed upon first observations that Arctic Grayling had already hatched and emerged from the substrate, and ranged in size from 20 to 44 mm (fork length). As stated in Section 5.1.2, reach delineation had yet to be completed on Clinton Creek and therefore not all reaches described in this report are represented in the data (Table 5.2-2).

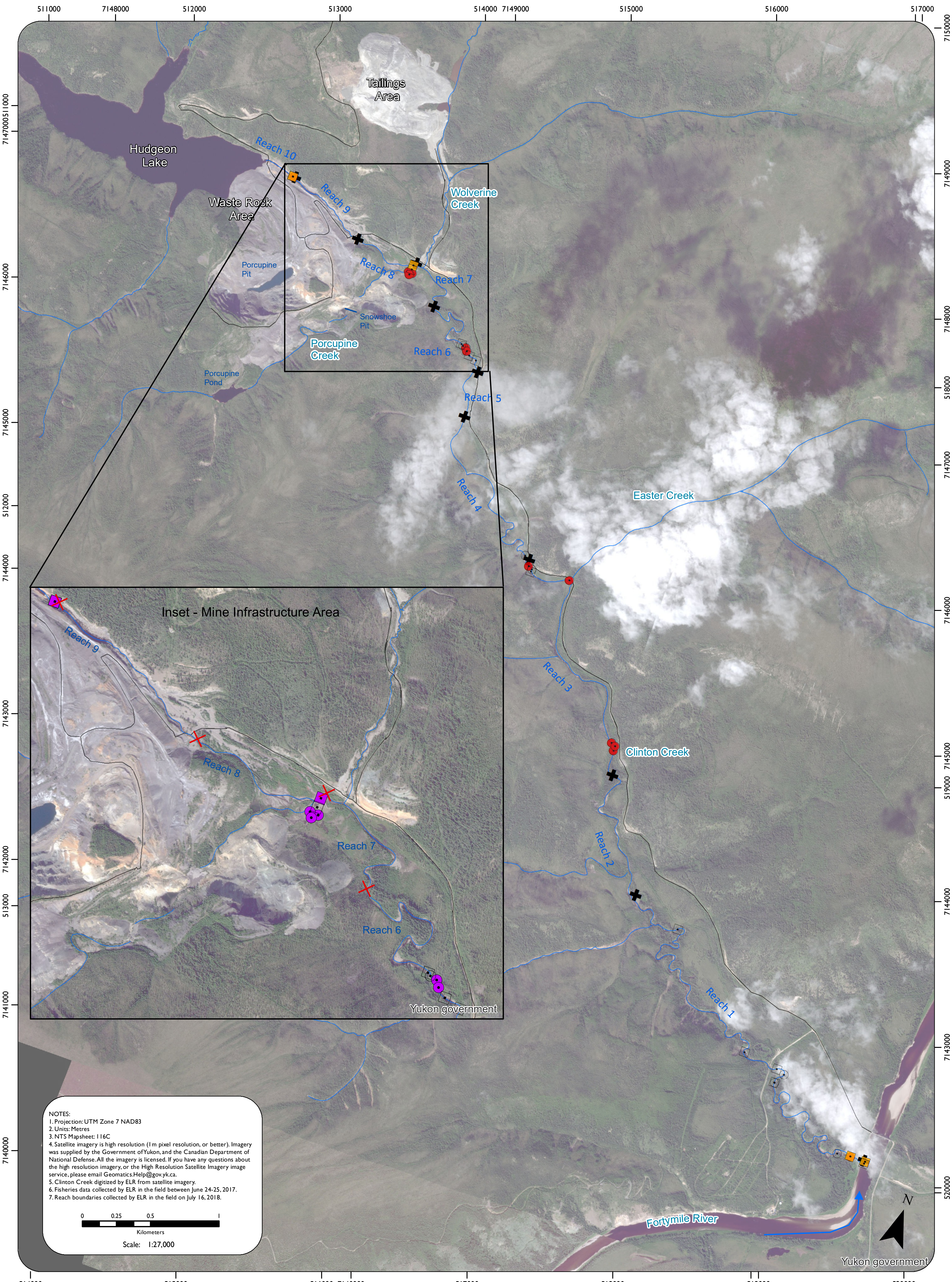
ELR completed seine netting or visual observations in eight areas along the length of Clinton Creek; three areas in Reach 1, two areas in Reach 3, and one area each in Reaches 6, 8, and 10 (Figure 5.2-1). This included a total of 17 seine net pulls (samples), and 21 visual observation locations (Table 5.2-2). YOY fish were observed in areas 1, 4, 5, 6, 7, and 8.

Table 5.2-2: Summary of Effort Level and Presence of Young-of-Year Arctic Grayling by Stream Sampling Area

Sampling Area	Stream Reach	Efforts within The Area (Number)		YOY Arctic Grayling Present
		Seine Net Pulls	Visual Observation Areas	
1	1	3	2	✓
2		3	2	
3		1	-	
4	3	-	3	✓
5		1	4	✓
6	6	3	6	✓
7	8	2	3	✓
8	10	4	1	✓

5.2.2.1 Seine Netting Summary

A summary of all seine netting effort and catch data is provided in Table 5.2-3, with locations shown on Figure 5.2-1; the total of 17 seine net pulls captured 49 fish; 32 Arctic Grayling and 17 Slimy Sculpin (no other species were captured during this survey). Of the 32 Arctic Grayling captured, 7 were YOY (size range: 20-44 mm), 17 were juvenile (size range: 129-198 mm), and 8 were adults (size range: 204-370 mm). Of the 7 YOY captured, 3 were captured in the upper reaches (Reach 10 and 8; size range 20-25 mm), while 4 were captured in the lower reaches (Reach 1; size range 27-44 mm). YOY captured in the upper reaches were transparent and appeared newly emerged (e.g. one larval still had a yolk sac), whereas those captured in Reach 1 (including at the mouth of Clinton Creek) were more developed. This may have indicated that spawning started earlier in lower reaches, or that higher temperatures may have also increased the rate of development for larval AG. These possibilities cannot be determined but the observation was noteworthy.



LEGEND

- Primary Site Roads
- Site Area Watercourses
- Clinton Creek Reach Boundaries

Seine Netting Locations

- No YOY Arctic Grayling Captured
- YOY Arctic Grayling Captured

Ad_YOY_Obs

- Juvenile or Adult Arctic Grayling Observed
- YOY Arctic Grayling Observed

elr Ecological Logistics & Research Ltd.

Client:

Yukon

Drawn by: A. Nicholson

Approved by: C. Jastrebski

Date: March 30, 2019

ELR Project: 18-278.3

CLINTON CREEK SITE

2017-2018 Fish and Fish Habitat Existing Conditions Studies

FIGURE 5.2-1

Location of Visual Observation and Seine Netting Locations During the 2017 Clinton Creek Young-of-Year Arctic Grayling Survey

Document Path: M:\GIS_Projects\18-278 Clinton Creek 2018 Baseline\Fisheries\Report Figures\2019 03 30 Fig 5.2-1 YOY Survey.mxd

Table 5.2-2: Summary of Seine Netting Efforts & Catch Results for the Spring Young-of-Year Survey Completed on Clinton Creek

Sampling Area	Stream Reach	Site ID*	Date	Max. Depth (m)	Pool Area (m^2)	Total Catch Summary**			YOY AG Present
						AG	SS	Total	
1	1	SN14	24/06/2017	-	-	1		1	✓
		SN15	24/06/2017	-	-	3	1	4	✓
		SN16	24/06/2017	-	-				×
2		SN11	24/06/2017	-	30		1	1	×
		SN12	24/06/2017	0.5	32				×
		SN13	24/06/2017	-	-		1	1	×
3		SN17	25/06/2017	0.25	12				×
5	3	SN10	24/06/2017	0.35	15				×
6	6	SN7	24/06/2017	0.65	10		1	1	×
		SN8	24/06/2017	-	-		4	4	×
		SN9	24/06/2017	0.45	24		2	2	×
7	8	SN5	24/06/2017	0.4	20	1	5	6	✓
		SN6	24/06/2017	0.38	32		2	2	×
8	10	SN1	24/06/2017	0.78	150	25		25	×
		SN2	24/06/2017	0.5	150	2		2	✓
		SN3	24/06/2017	0.5	150				×
		SN4	24/06/2017	0.7	80				×
	Total	-	-	-	705	32	17	49	✓

Notes:
Shaded rows indicate those sites where YOY AG were present.
**Site ID can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
***Totals reflect all life stages, not only YOY. Catch summary abbreviations, AG = Arctic Grayling, SS = Slimy Sculpin.*

5.2.2.2 *Visual Observation Summary*

A summary of all visual observation data is provided in Table 5.2-3, with locations shown on Figure 5.2-1. ELR made a total of 18 visual observations of Arctic Grayling during these surveys; 11 observations of YOY, and 7 of adult or juvenile fish. Although no samples were retained for taxonomic identification, (the goal was to limit mortality of fish), the timing, size, behavior, and habitat selection of these fish was indicative of Arctic Grayling, and it is of the opinion of ELR that the YOY observations listed in this study represent grayling use and distribution within Clinton Creek.

Table 5.2-3: Summary of Visual Observation Efforts & Results for the Spring Young-of-Year Survey Completed on Clinton Creek

Sampling Area	Stream Reach	Date	UTM (7W)		Observations	YOY AG Present
			E	N		
1	1	24/06/2017	519342	7142040	Many (>10) juvenile or YOY AG observed (~45mm length).	✓
		24/06/2017	519241	7142028	1 juvenile AG observed.	×
2		24/06/2017	518679	7142436	1 juvenile or adult AG observed surfacing on u/s side of beaver dam.	×
		24/06/2017	518637	7142357	Many (>10) juvenile AG observed, (~60-160 mm), below undercut bank.	×
4	3	24/06/2017	516668	7144284	2 YOY AG observed.	✓
		24/06/2017	516699	7144234	1 YOY AG observed in shallow pool directly above cascade boulder feature.	✓
		24/06/2017	516699	7144270	1 YOY AG observed in small eddy pool.	✓
5		24/06/2017	515684	7145277	Many juvenile AG observed (~100-150mm).	×
		24/06/2017	515972	7145294	1 YOY AG observed adjacent to Eagle Creek confluence.	✓
	4	24/06/2017	515656	7145291	1 YOY AG observed in main channel, u/s in shallow pool.	✓
		24/06/2017	515606	7145356	1 juvenile or adult AG observed surfacing u/s of beaver dam.	×
6	6	24/06/2017	514679	7146633	YOY (>3) observed in side channel. Shallow glide/riffle.	✓
		24/06/2017	514655	716639	School of adult AG observed. Slow moving shallow pool with deadfall cover, cobble/gravel substrate. Possible spawning site.	×
		24/06/2017	514693	7146612	~30 YOY AG observed. Gravel/cobble substrate.	✓
7	8	24/06/2017	514125	7147011	Many YOY (>10) observed in shallow side channel, (max. depth 5 cm. Darting under cobble substrate. Adult AG also spotted within the main channel of this reach.	✓
		24/06/2017	514096	7147012	Many YOY observed in braided channel section, cobble/gravel substrate.	✓
		24/06/2017	514106	7146995	YOY AG observed, as well as AG adult in undercut channel periphery.	✓
8	10	24/06/2017	513066	7147376	YOY AG observed. Too small to be captured in seine (<25 mm). Appear to have recently emerged, most are still transparent, with distinct lateral line. Yolk sac still present on one.	✓

Notes:
Shaded rows indicate sites where YOY AG were observed
***Abbreviations, AG = Arctic grayling, YOY = Young of Year*

5.2.2.3 Summary of Observations

YOY Arctic Grayling were either observed or captured in every reach included in this survey, and occurred as far upstream as the plunge pool below the lowest gabion structure (Reach 10; only two individuals captured) and as far downstream as the mouth of Clinton Creek (Reach 1).

The greatest observed densities of YOY Arctic Grayling were in area 7 (Reach 8; multiple groups >10 fish; Photo 22). This occurred in a section of Reach 8 where the channel is braided, as well as downstream of this braided area where a series of groundwater seeps enter the main stem and the stream becomes re-channelized. The largest single school of YOY Arctic Grayling (~30 fish) was observed in area 6 (Reach 6), in a location that was in close proximity of a number of adult Arctic Grayling using habitats that would be suitable for spawning. Larger schools of YOY grayling were also observed in areas 1 and 2 of Reach 1 (Photo 23; >10 fish in each); these were much larger in size (~45 mm) compared to those observed in the upper reaches (~25mm). All other recoded YOY observations were of either discrete individuals or small schools of fish (<5 fish).

It should be noted that a large congregation of adult and juvenile Arctic Grayling (25 fish) were documented in the lowest gabion plunge pool, in addition to YOY observations.

While some movement and dispersal downstream is to be expected as the YOY emerge, the distribution observed by ELR suggests that 1) spawning can occur and did occur in 2017 as far as the uppermost distribution of fish in the creek, which is the gabion structures at Reach 10; 2) that the large density of YOY observed in Reach 7 suggests that the area within and immediately downstream of the previous mine infrastructure provided for spawning in 2017; and that 3) multiple spawning areas within the creek were likely in 2017 given the widespread distribution of YOY throughout its length.

Considering that Hudgeon Lake is a surface water body that appears to help warm Clinton Creek in the spring (as evidenced by water temperature measurements) and could act to moderate flows in relation to the cooler and more turbid tributary influences downstream (e.g., Wolverine and Eagle creeks), it is the opinion of ELR that the base of the gabion structures (Reach 10), and the length of channel through Reaches 7 and 8 are likely provide a number of suitable spawning areas due to their stable hydrological and temperature regimes, as long as these areas are accessible to Arctic Grayling migrating upstream in the spring (i.e., that no barriers to fish movement exist). Arctic Grayling are known to use stream areas near lake outlet areas for spawning (ELR unpublished data, Stewart et al. 2007), and the observations at Clinton Creek were consistent with this pattern. This species will also select other stream habitats and show some adaptability in the areas they select, and this also occurs in the context of barriers to upstream movement (Arctic Grayling will spawn at the upstream extent of passable stream; Stewart et al. 2007).

6. Fish Overwintering Survey

Winter is a period of time when fish rely on habitable areas that often represent a subset of their summer distribution. This is because during winter, stream flows are reduced and the availability of instream habitats can be further limited by aufeis accumulation, cold temperatures, and a lack of connectivity between habitats. Therefore, fish rely on those specific habitats (frequently pools, deep glides, lakes, and large rivers) that remain habitable for the entire winter, and where these habitats are present in smaller watercourses they are considered to be important to the overall lifecycle of the fish.

6.1 Methods

ELR designed and implemented a fish overwintering survey that used a multiple lines of evidence approach to investigate use and distribution of fish in Clinton Creek during the winter. These lines of evidence consisted of:

- Environmental DNA (eDNA) sampling to assess biological evidence of presence.
- Water quality sampling to assess suitability of key parameters in winter.
- Underwater camera observations beneath the ice.
- Gee (minnow) trapping efforts.

6.1.1 Pre-planning

ELR's target habitat for the overwintering study was pool habitat within Clinton Creek; such areas are the most likely to provide habitat through the winter due to greater depth to resist freezing to bottom. As such specific habitats can be difficult to locate during winter surveys, ELR conducted a planning reconnaissance during the fall of 2017 to identify and clearly mark potential overwintering locations to be assessed during the winter. At this time, ELR identified representative deep pool habitats throughout the length of the main channel of Clinton Creek. At each pool, a detailed location was recorded (UTM location using handheld GPS), and the habitat features at each were described and recorded, access details were recorded, and the site as flagged for a winter site visit (e.g. direction and distance from the flag to the pool).

6.1.2 Winter Survey

In the late winter of 2018, ELR then returned to the Site to conduct the overwintering survey; the Site was accessed during the winter by helicopter, with ELR staff traveling daily from Dawson City, Yukon. The survey was conducted in a downstream to upstream sequence, in order to avoid eDNA sample contamination or disturbance to upstream habitats.

Upon arriving at each previously marked location, ELR first used a gas-powered ice auger to determine whether the pool existing during winter (whether water occurred at the site). Thickness of ice (m), depth of water beneath the ice (m), site location (UTM coordinates), and site photos were then recorded or collected. Where collected, eDNA samples were collected next and stored for transport (refer to Section 6.1.2.1), followed by collection of in-situ water quality measurements (Section 6.1.2.2). Finally, Gee traps were baited and set (Section 6.1.2.3). When returning to each site later (to check and remove the Gee traps), an underwater camera was then used to take visual observations for fish (Section 6.1.2.4).

This order of methods was selected to reduce the potential for contamination during eDNA sampling, as well as to take advantage of the baited minnow traps as potential attractant for fish prior to underwater observations.

6.1.2.1 Environmental DNA

eDNA Sample Collection

Environmental Deoxyribonucleic acid (DNA; eDNA) sampling was completed in accordance with British Columbia (BC) Ministry of Environment (MoE) *Environmental DNA Protocol for Freshwater Aquatic Ecosystems Version 2.2* (BC Moe 2017). For this project ELR worked with Aurora Ecological Consulting of Victoria BC, as well as the Helbing Laboratory at the University of Victoria.

ELR collected eDNA samples from five locations on Clinton Creek. The sampling locations (detailed in Section 6.2) were selected in an effort to balance the program cost with providing the resolution needed for the study.

During field sampling, ELR collected three replicate (1.0 litre) samples at each location using sealable polypropylene Nalgene sample containers. Samplers wore powder free disposable Nitrile gloves during sampling to avoid contamination, and the sample containers were also prepared so as to avoid contamination. Once retained, samples were labeled accordingly and stored in coolers with warming packs to protect the samples from freezing while in transit. At the end of each field day, samples were transported by helicopter back to Dawson City, Yukon, and refrigerated until filtering was complete. ELR disinfected common items between the field sides to avoid any cross-contamination of DNA; this included the ice Auger and other tools used to open the ice (e.g. axe), and this was completed using a 1:1 bleach rinsing solution. Samples were collected prior to any other equipment entering the water course at any site.

Water samples are filtered following collection to capture DNA strands on the filter, and this filter is then submitted to the laboratory for analysis (and the filtered water is then discarded). Each replicate sample was filtered through a Nalgene analytical test filter funnel, with 0.45 µm cellulose nitrate membrane. This was completed by pumping air from the side arm of a polypropylene filtering flask using a peristaltic pump. Removal of air from the flask creates suction, allowing the sample to be pulled down through the test filter and into the filtering flask. As described in the BC MoE protocol (BC MoE 2017), samples were filtered until either 1.0 liter of sample volume had passed through the membrane or 60 minutes time had elapsed. Once one of these endpoints had been achieved, the pump was run for an additional 20 minutes in order to dry out the cellulose membrane. Three replicate blank samples were also prepared during the filtering process for quality assurance and quality control (QAQC) purposes. This consisted of filtering laboratory supplied de-ionized water using the same process and equipment as with the samples. Blanks were preserved and transported alongside the regular samples.

Once each sample had been filtered, the membrane was carefully folded and transferred to a coin envelope using sterilized forceps. The envelope (containing the membrane), was then transferred to a Whirl-Pak sample bag that had been labeled and pre-loaded with silica desiccants for dry storage and transport. After the field program, all samples were shipped under Chain of Custody (COC) to the Laboratory to be analyzed.

eDNA Laboratory & Analysis

Quantitative polymerase chain reaction (qPCR) analysis was completed for two target species; Chinook Salmon and Arctic Grayling. Eight qPCR sample runs (each being a prepared qPCR sample) were completed by the laboratory for each replicate sample, with the goal of the qPCR being to replicate and therefore amplify the signal of DNA being present for a particular species. These amplified DNA strands use DNA base pairs (building blocks) that incorporate a material that allows for them to be detected, thereby allowing the laboratory to detect whether the DNA for a particular species was present in a sample. The following criteria were used to categorize a positive and negative results from each site.

- If any of the three replicate samples yielded a positive qPCR result for three or more of eight runs (≥3/8), the site was categorized as positive, regardless of the other to replicate sample scores.
- If at least one of the samples yielded a positive qPCR result for exactly two of eight runs (=2/8) and the second and third replicates received a score ≥ 1/8 (i.e., not zero), the site was categorized as suspected. In this case, all three replicates were considered, and the site assignation was made in the context of the species ecology with consideration of both habitat connectivity and quality as well as proximity to extant sites (i.e., adjacent).
- If all three samples yielded a positive qPCR results for ≤1/8 runs, the site was categorized as negative.

The qPCR analysis uses primers, which are short chains of DNA particular to a specific species; these act as templates for the replication of DNA for only that species. The primers for the species selected for the overwintering study were validated (tested) by the University of Victoria. Laboratory eDNA technical bulletins for each assay are provided in Appendix B. These species (Arctic Grayling & Chinook Salmon) were selected based on what species were anticipated to overwinter in Clinton Creek based on a review of existing literature, as well as on the availability of validated primers.

6.1.2.2 In-Situ Water Quality Sampling

The objective of the in-situ water quality sampling was to confirm that basic water quality parameters were suitable to the overwintering survival of fish at the sites sampled. The two primary parameters of key interest were water temperature (which could suggest groundwater inputs if temperatures were slightly higher in a given location), and dissolved oxygen (which requires a minimum concentration to be able to sustain aquatic life).

ELR collected in-situ water quality measurements using a YSI Professional Plus multimeter with quattro cable. Measurements included water temperature (˚C), pH (pH units), conductivity (µs/cm), specific conductivity (µs/cm), oxygen-reduction potential (Redox; mv), and dissolved oxygen (in both mg/l and %). ELR calibrated the meter at the start of the program, checked calibration daily, and re-calibrated it when necessary.

6.1.2.3 Gee Traps

Gee traps were deployed following eDNA sample collection to avoid potential DNA contamination, using the same ice auger holes used for other sampling. Using either the auger or an ice chisel, a hole of sufficient diameter was made to accommodate the Gee traps. All traps were baited with imitation fish roe, which was tied with monofilament line and netting within the trap. The traps were then secured to either ice or the streambank with utility cord, flagged, and the auger hole buried in snow to prevent further thick ice from developing. The trap location, set time and date, as well as any notable habitat related information were recorded at the time of setting the traps. All of the traps were set for approximately 24-hours prior to being removed and checked. All captured fish were identified, enumerated, and measured (fork-length, or total length in the case of Slimy Sculpin).

6.1.2.4 Underwater Cameras

ELR recorded underwater observations using a GoPro Hero5 camera and waterproof casing, mounted to a telescopic pole. The camera used in this study was Wi-Fi enabled, and a coaxial cable suitable for transmission of a Wi-Fi frequency was used as an antenna, secured to the cameras outer casing, and run up the telescopic pole to an iPhone SE. This allowed for a live feed of camera footage to be viewed in the field, allowing for specific observations and for the observer to identify areas for additional footage, if required. This method was described by Davis *et al.* (2016) using similar equipment to observe fish in ice covered shallow streams. All underwater observations were also recorded for later viewing.

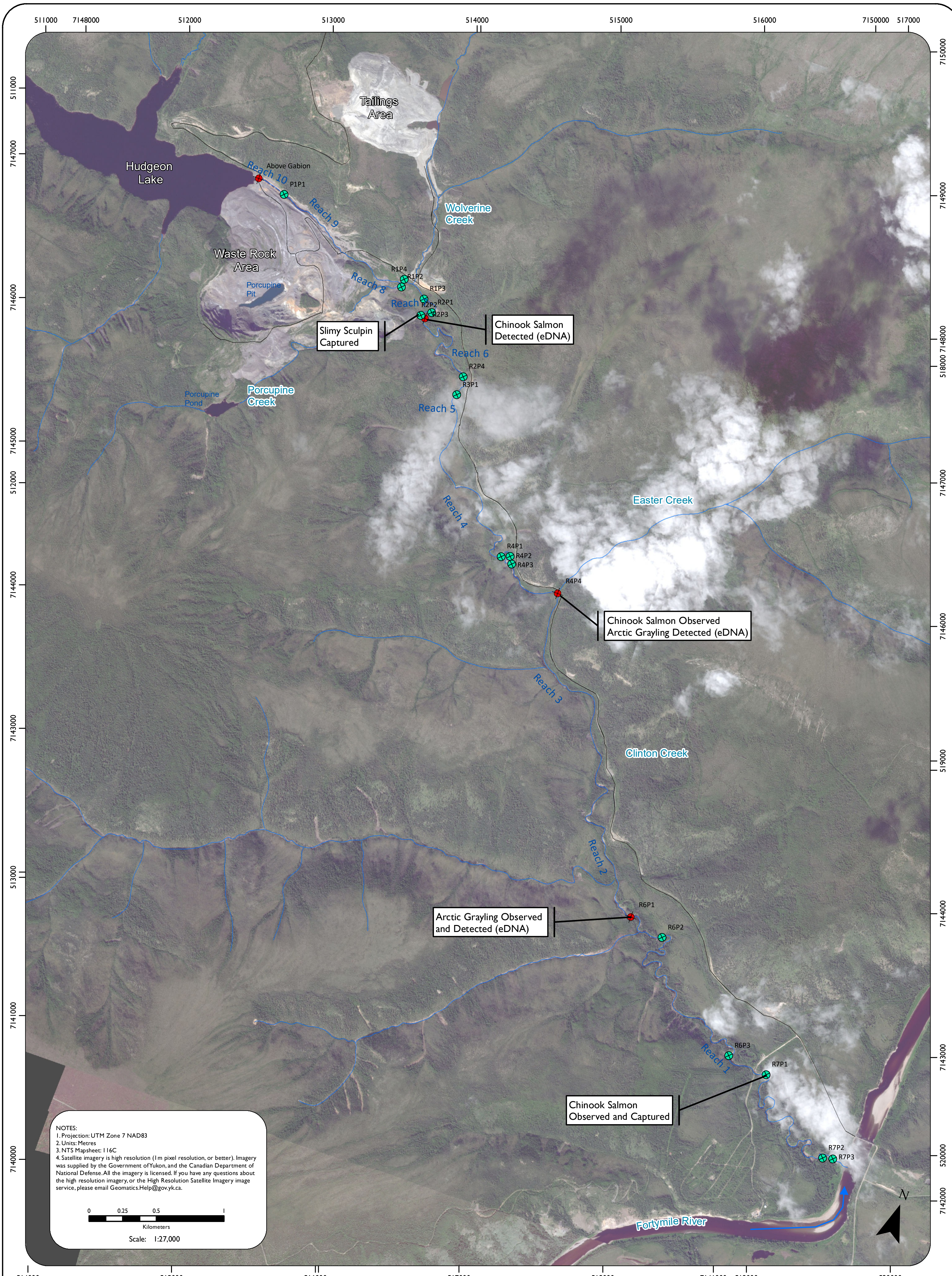
ELR recorded underwater observations when returning to Gee trapping locations (i.e., 24-hours following set times). This allowed some time for the Gee trap bait to attract fish to the immediate area, increasing the chance of observations. Once arrived at the location, ELR first cleared snow and ice from the pre-existing auger hole using an ice chisel and shovel. A 5-minute quiet period was then allowed to allow fish present within the stream to settle following any disturbance. The camera was then carefully lowered into the water column and the height adjusted based on water depth. A total observation time of 20 minutes was completed at each location. This involved 360 degree observation of the site. All footage was reviewed following the field event to ensure no observation areas were missed.

6.2 RESULTS

ELR visited the Clinton Creek Site on October 11, 2017 to identify and mark potential fish overwintering sites. ELR identified and flagged a total of 23 pool habitats during this visit. ELR then returned to the Site between February 26 and March 1, 2018 to complete the fish overwintering surveys. 20 of the 23 previously flagged pool sites were assessed during the study; with the remaining three identified sites not being visited due to the observation of significant aufeis accumulation at the time of the survey.

Of the 20 sites included in the survey, eight were found to be either frozen to ground or to have ice too thick, suggesting that they were frozen to ground as well, or near that (greater than 1.5 m). One additional site was found to have water levels too low to survey. The remaining 11 sites were found to be suitable and were surveyed. Of these 11 sites; in-situ water quality was tested at all, Gee traps were deployed at 10, underwater camera observations were completed at 8, and eDNA sampling was completed at 5. Gee traps and underwater camera observations were not used in combination at all locations, as in some cases, the depth of water was insufficient to deploy traps, or the presence of open water rendered the use of camera unnecessary. A summary of sites visited during this program, including methods used at each location is provided in Table 6.2-1, with locations shown in Figure 6.2-1.

In general weather conditions were variable during the overwintering survey, with ambient air temperatures ranging from -10 to -30˚C . Clinton Creek was observed to be primarily ice covered throughout its length, with only a few small areas of open water occurring within Reaches 7 and 8. Significant aufeis accumulation was also observed throughout the length of Clinton Creek, isolated primarily to where the creek becomes confined by the surrounding topography.



Document Path: M:\GIS_Projects\18-278 Clinton Creek 2018 Baseline\Fisheries\Report Figures\2019 03 30 Figure 6.2-1 Overwinter.mxd

Ecological Logistics & Research Ltd.

Client:

LEGEND

Primary Site Roads

Site Area Watercourses

Overwinter Survey Location Types

Overwinter Survey Location

Overwinter Survey Location, Including eDNA

Drawn by: C. Jastrebski

Approved by: C. Jastrebski

Date: March 30, 2019

ELR Project: 18-278.3

CLINTON CREEK SITE

2017-2018 Fish and Fish Habitat Existing Conditions Studies

FIGURE 6.2-1

Location of Survey Locations and Key Observations from 2018 Clinton Creek Overwintering Study

Table 6.2-1: Summary of Sites, Methods Employed and Key Observations for the Clinton Creek Fish Overwintering Survey

Stream Reach	Site Name	Date	UTM Location (7W)		Methods Used			Results
			E	N	GT	CAM	eDNA	
1	R7P3	26/02/2018	519330	7142048	✓	✓	×	1 UND fish observed (CAM), no catch (GT)
	R7P2	26/02/2018	519256	7142029	×	×	×	Site found frozen
	R7P1	26/02/2018	518651	7142466	✓	✓	×	5 CH captured (GT), 7 CH observed (CAM)
	R6P3	01/03/2018	518344	7142504	×	×	×	Insufficient depth for methods
	R6P2	01/03/2018	517580	7143158	×	×	×	Site found frozen
	R6P1	27/02/2018	517312	7143222	✓	✓	✓	AG detected (eDNA), 2 AG observed (CAM), no catch (GT)
3	R4P4	26/02/2018	515983	7145290	✓	✓	✓	AG detected (eDNA), 2 CH observed (CAM), no catch (GT)
4	R4P3	01/03/2018	515588	7145377	✓	✓	×	No fish caught (GT) or observed (CAM)
	R4P2	01/03/2018	515557	7145426	×	×	×	Site found frozen
	R4P1	01/03/2018	515496	7145402	✓	✓	×	No fish caught (GT) or observed (CAM)
5	R3P1	28/02/2018	514776	7146417	×	×	×	Site found frozen
6	R2P4	28/02/2018	514776	7146559	×	×	×	Site found frozen
7	R2P3	28/02/2018	514361	7146867	✓	✓	✓	CH detected (eDNA), no fish caught (GT) or observed (CAM)
	R2P2	28/02/2018	514327	7146879	✓	×	×	4 SS captured (GT)
	R2P1	28/02/2018	514394	7146926	×	×	×	Site found frozen
	R1P4	01/03/2018	514120	7147087	✓	×	×	No fish caught (GT)
8	R1P3	01/03/2018	514307	7147001	✓	✓	×	No fish caught (GT) or observed (CAM)
	R1P2	27/02/2018	514118	7147027	×	×	×	Site found frozen
10	P1P1	28/02/2018	513068	7147374	×	×	×	Site found frozen
	Above Gabion	28/02/2018	512851	7147422	×	×	✓	No fish detected (eDNA)

Notes:
Sample Methods: GT = Gee Traps; CAM = Underwater Camera; eDNA = Environmental DNA
Species Codes: CH = Chinook Salmon; AG = Arctic Grayling; UND = unidentified

6.2.1 In-situ Water Quality

ELR measured in-situ water quality at all 11 survey locations (Table 6.2-2). At 3 of locations, subzero air temperatures caused technical issues with the pH and oxidation reduction potential (ORP) sensors of the water quality instrument, and values are therefore not provided for those locations. Dissolved oxygen (DO) concentrations were found to range between 2.72 and 13.39 mg/l within Clinton Creek, and concentrations were therefore considered sufficient for fish survival. The lowest DO concentration was found to be lowest in Reach 1 (Site R7P3; 2.72 mg/l), where ice thickness was greatest (0.85 m) and water depth was relatively shallow (0.33 m). However, ORP was observed to be higher to the lower reaches (Reach 1 & 3; range: 189.1 to 220.6 mv) and lower in the upper reaches (Reach 7 and 10; range: 25.8 to 133.7 mv). It should be noted that the highest ORP values measured in the upper reaches (133.7 mv) was located directly upstream of an active beaver dam with shallow waters, fine substrates, and many organics and woody debris observed.

Water temperature, pH, and conductivity measurements were relatively consistent throughout the length of Clinton Creek, with the exception of the outlet of Hudgeon Lake. The outlet of Hudgeon Lake shows much lower specific conductivity (798.7 μs/cm) and ORP (25.8 mv) values, reflecting the difference between surface water storage within the lake and groundwater baseflow feeding the stream from the waste rock area.

Table 6.2-2: Summary of In-situ Water Quality Measurements Collected for the Clinton Creek Fish Overwintering Survey

Reach	Site*	Date	Time	Ice Thickness	Water Depth	Water Temp.	pH	Cond.	Sp. Cond.	Redox	DO	
		dd/mm (2018)	hh:mm	m	m	°C	pH units	µs/cm	µs/cm	mv	mg/l	%
1	R7P3	26/02	13:38	0.85	0.33	0	8.85	810	1552	198.1	2.72	18.7
	R7P1	26/02	15:37	0.41	0.39	0	8.27	823	1575	203.4	2.99	20.6
	R6P1	27/02	12:55	0.55	0.88	0.1	7.13	1030	1975	199.5	12.6	87.5
3	R4P4	26/02	17:04	0.56	0.8	0	7.7	943	1807	220.6	8.99	62.9
4	R4P3	01/03	13:22	0.34	1.3	-0.1	-	962	1844	-	12.49	86.2
	R4P1	01/03	12:25	0.32	0.45	-0.1	-	766	1471	-	7.43	51
7	R2P3	28/02	15:04	0.08	0.51	0.1	8.57	889	1694	68.4	9.21	63.6
	R2P2	28/02	15:29	0.01	0.4	0.2	8.6	897	1707	65.7	8.6	89.7
	R1P3	01/03	16:28	0.06	0.47	0.1	7.96	847	1612	133.7	13.39	92.4
8	R1P4	01/03	10:50	0.03	0.3	0.2	-	904	1713	-	11.49	78.5
10	Above Gabion	28/02	17:14	0.04	0.12	0.1	8.49	418.6	798.7	25.8	9.59	66.4

Notes:
**Site can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
Shaded cells indicate confirmed overwinter sites, either through minnow trapping, underwater camera, or eDNA methods.

6.2.2 eDNA

ELR completed eDNA testing for 5 locations (with 3 replicates collected in each); two in Reach 1, one in Reach 3, one in Reach 7, and one in Reach 10 (Table 6.2-3). Sample sites were distributed throughout the length of Clinton Creek, with the intention of investigating a generalized distribution and upstream extent of overwintering Chinook Salmon and Arctic Grayling. Two of the five sample locations were submitted to the laboratory as a positive control, one for Arctic Grayling (Reach 1 site) and the other for Chinook Salmon (Reach 3 site; where these species had been confirmed through underwater camera observations).

Of the 5 locations sampled, replicates collected from one location (lower Reach 1) were not submitted to the laboratory, as both target species were identified to overwinter upstream of this site and results were therefore superfluous. Under the same logic, the test was not performed for Chinook Salmon at the upper Reach 1 site, as Chinook Salmon had already been confirmed to overwinter upstream of this location.

Samples collected in Reach 1 were tested only for Arctic Grayling, and yielded a positive qPCR result for two of three replicate samples (0/8, 7/8, and 8/8). These results suggest that Arctic Grayling are using the site sampled, or areas directly upstream of this location, for overwintering.

Samples collected in Reach 3 were tested for both Arctic Grayling and Chinook Salmon, and yielded a positive qPCR result for two of three (3/8, 0/8, and 4/8) and zero of three (0/8, 0/8, and 0/8) replicate samples, respectively. These results suggest that Arctic Grayling are likely to be using this site, or areas directly upstream of this location, for overwintering. It should be noted that ELR did observe Chinook Salmon at this site through underwater camera observations following eDNA sample collection. The eDNA results for this site are therefore considered to be a false negative. This could indicate that the signal (concentration to DNA in the stream) was not strong enough to be fully amplified (e.g. few individuals) or that there was some isolated error in process.

Samples collected in Reach 7 were tested for both Arctic Grayling and Chinook Salmon, and yielded a positive qPCR result for zero of three (0/8, 1/8, and 1/8) and one of three (3/8, 1/8, and 2/8) replicate samples, respectively. These results suggest that neither Arctic Grayling nor Chinook are likely to be using this site, or areas directly upstream of this location, for overwintering.

Samples collected above the gabions (i.e., at the outlet of Hudgeon Lake) were tested for both Arctic Grayling and Chinook Salmon, and yielded a negative qPCR result (0/8, 0/8, and 0/8) for both species in all three replicate samples. These results suggest that neither Arctic Grayling nor Chinook Salmon are likely to be using this site, or areas directly upstream of this location, for overwintering.

All three blanks prepared during this program yielded a negative qPCR results for all runs (0/8), indicating that sample contamination during filtration, preservation, and sample transport is unlikely.

Table 6.2-3: Summary of eDNA Laboratory Results for Clinton Creek Overwintering Fish Studies

Reach	Site / Lab ID[1]	Collection Date	Vol. Collected (ml)	Vol. Filtered (ml)	Arctic Grayling (THAR[1])				Chinook Salmon (ONTS[2])				eDNA Detected (species)
					THAR Obs.	THAR Tested	Freq.	Result	ONTS Obs.	ONTS Tested	Freq.	Result	
Reach 1	R6P1	27/02/2018	1000	260	✓	✓	0/8	×	×	×	-	-	**YES (THAR)**
	R6P1	27/02/2018	1000	310	✓	✓	**7/8**	✓	×	×	-	-	
	R6P1	27/02/2018	1000	380	✓	✓	**8/8**	✓	×	×	-	-	
Reach 3	R4P4	26/02/2018	1000	310	×	✓	**3/8**	✓	✓	✓	0/8	×	**YES (THAR)**
	R4P4	26/02/2018	1000	340	×	✓	0/8	×	✓	✓	0/8	×	
	R4P4	26/02/2018	1000	510	×	✓	**4/8**	✓	✓	✓	0/8	×	
Reach 7	R2P3	28/02/2018	1000	1000	×	✓	0/8	×	×	✓	**3/8**	✓	**YES (ONTS)**
	R2P3	28/02/2018	1000	1000	×	✓	1/8	×	×	✓	1/8	×	
	R2P3	28/02/2018	1000	1000	×	✓	1/8	×	×	✓	2/8	×	
Reach 10	Above Gabion	28/02/2018	1000	560	×	✓	0/8	×	×	✓	0/8	×	NO
	Above Gabion	28/02/2018	1000	650	×	✓	0/8	×	×	✓	0/8	×	
	Above Gabion	28/02/2018	1000	1000	×	✓	0/8	×	×	✓	0/8	×	
QAQC	Blank	28/02/2018	1000	930	×	✓	0/8	×	×	✓	0/8	×	NO
	Blank	04/03/2018	1000	1000	×	✓	0/8	×	×	✓	0/8	×	
	Blank	05/03/2018	1000	1000	×	✓	0/8	×	×	✓	0/8	×	

Notes:

Shaded cells with bold text indicate those with positive eDNA results

Abbreviations: Obs. = Observed; Freq. = Frequency

[1] *Thymallus arcticus* (THAR; Arctic Grayling))

[2] *Oncorhynchus tschawytscha* (ONTS; Chinook salmon)

6.2.3 Gee Trapping Efforts

Gee traps were set at nine locations within the main channel of Clinton Creek; three in Reach 1, one in Reach 3, two in Reach 4, three in Reach 7, one in Reach 8, and one in Reach 10 (Table 6.2-4). The resulting total of trapping effort was 211 hours and 14 minutes during the survey. Fish were captured at only two of the 9 trap locations. Within Reach 1, five juvenile Chinook Salmon (parr stage) were captured. This site was located ~50 m downstream of the lower ford crossing (access to the old townsite) and immediately upstream of an active beaver dam. Within Reach 7, four Slimy Sculpin were captured. This occurred in an open water pool habitat located downstream of the Reach 7 wetland outlet; groundwater sources to stream discharge were apparent at this site (e.g. open water and mineral precipitate observed within substrate).

No other fish were captured during these studies. A summary of all gee trapping efforts are provided in Table 6.2-4.

Table 6.2-4: Summary of Gee Trapping Efforts & Catch Results Completed for the Clinton Creek Fish Overwintering Survey

Reach	Site ID*	Set Date	Set Time	Pull Date	Pull Time	Effort (hh:mm)	Catch Summary**					
							AG	CH	SS	LNS	RW	Total
1	R7P3	26/02/2018	14:11	27/02/2018	13:27	23:16	0	0	0	0	0	0
	R7P1	26/02/2018	16:05	27/02/2018	14:35	22:30	0	5	0	0	0	5
	R6P1	27/02/2018	12:55	28/02/2018	12:50	23:55	0	0	0	0	0	0
3	R4P4	26/02/2018	17:20	27/02/2018	15:43	22:23	0	0	0	0	0	0
4	R4P3	01/03/2018	13:22	02/03/2018	12:55	23:33	0	0	0	0	0	0
	R4P1	01/03/2018	12:25	02/03/2018	12:15	23:50	0	0	0	0	0	0
7	R2P3	28/02/2018	15:09	01/03/2018	15:10	24:01	0	0	0	0	0	0
	R2P2	28/02/2018	15:32	01/03/2018	15:22	23:50	0	0	4	0	0	4
	R1P3	01/03/2018	16:28	02/03/2018	16:24	23:56	0	0	0	0	0	0
Total	-	-	-	-	-	211:14	0	5	4	0	0	9

Notes:
Shaded rows indicate those Sites where fish were captured through Gee trapping.
**Site ID can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
***Catch summary abbreviations, AG = Arctic Grayling, CH = Chinook Salmon, SS = Slimy Sculpin, LNS = Longnose Sucker, RW = Round Whitefish.*

6.2.4 Underwater Camera Observations

Underwater camera observations were completed at 8 locations within the main channel of Clinton Creek; three in Reach 1, one in Reach 3, two in Reach 4, and two in Reach 7 (Table 6.2-5). A 20 minute observation period was completed at each site, resulting in a total of 2 hours and 45 minutes of observation for the program. ELR observed a total of 12 fish during this period, two Arctic Grayling, nine Chinook, and one unidentified fish. All of these fish were observed at survey sites located in the lower reaches, 10 fish in Reach 1, and two fish in Reach 3.

ELR observed fish in three separate locations in Reach 1, two of which were in reservoirs directly upstream of active beaver dams. A school of 7 juvenile Chinook Salmon (parr stage) were observed at one of these two sites (Photo 24). Two subadult Arctic Grayling were also observed within Reach 1 in the second of the two reservoirs (Photo 25). A single unidentified fish (possibly a juvenile Round Whitefish) was observed ~100 m upstream from the mouth of Clinton Creek, under thick ice (0.85 m) and in a relatively shallow pool (0.33 m).

ELR also observed two juvenile Chinook Salmon in a pool of reach 3, again in a reservoir upstream of a beaver dam (Photo 26).

Table 6.2-5: Summary of Underwater Camera Observations Completed for the Clinton Creek Fish Overwintering Survey

Reach	Site ID	Date	Start Time	End Time	Est. Visibility (m)	Effort (hh:mm)	Observation Summary**					
							AG	CH	SS	LNS	RW	Total
1	R7P3	27/02/2018	13:35	14:00	2	00:25	0	0	0	0	0	1***
	R7P1	27/02/2018	14:48	15:08	2-3	00:20	0	7	0	0	0	7
	R6P1	28/02/2018	12:57	13:17	1	00:20	2	0	0	0	0	2
3	R4P4	27/02/2018	15:48	16:08	1	00:20	0	2	0	0	0	2
4	R4P3	02/03/2018	12:58	13:18	1-2	00:20	0	0	0	0	0	0
	R4P1	02/03/2018	12:28	12:48	2	00:20	0	0	0	0	0	0
7	R2P3	01/03/2018	15:33	15:53	1	00:20	0	0	0	0	0	0
	R1P3	02/03/2018	16:28	16:48	1	00:20	0	0	0	0	0	0
Total	-	-	-	-	-	02:45	2	9	0	0	0	12

Notes:
**Site ID can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
***Catch summary abbreviations, AG = Arctic Grayling, CH = Chinook Salmon, SS = Slimy Sculpin, LNS = Longnose Sucker, RW = Round Whitefish.*
****one unidentified fish was observed.*

6.3 Summary of Observations and Discussion

The combination of survey techniques (eDNA, visual observations, and Gee trapping) was considered to be effective for detecting fish, and in particular the eDNA data detected both species investigated further upstream than they were visually observed (Reach 7 compared to observations in Reach 3 for Chinook Salmon and Reach 3 compared to observations in Reach 1 for Arctic Grayling). Slimy Sculpin were only captured through Gee trapping, which is consistent with their general habitat use (generally concealed within the substrate and not in the water column).

The overall results of ELR's overwintering study indicate that Clinton Creek was being used by Chinook Salmon as far upstream as Reach 7, and by Arctic Grayling as far upstream as Reach 3. This confirms that the creek is habitable and does support fish in winter. The overall low number of suitable sites observed and number of observed fish suggest that the creek does not provide a large amount or a high quality of overwintering habitat. In addition to the low number of fish observed, adult fish were absent from ELR's observations. However, the creek is habitable to near the previous mine infrastructure area (Reach 7). It is acknowledged that the study was only performed during one winter, and that the distribution of fish from year to year is likely variable due to the dynamic nature of beaver dams in limiting fish movement. Based on the 2018 observations, it is the opinion of ELR that Clinton Creek is not likely provide key or limiting overwintering habitat, and that it is likely that the majority of fish exit the watercourse prior to winter.

7. SUMMER FISH SURVEYS

A survey of summer fish distribution was recommended as part of the existing conditions studies, in order to provide recent data describing fish habitat usage of Clinton Creek in the mid-summer period. The existing data describing such distributions was getting outdated, and the recently collected fish distribution data (Laberge 2016) was collected during the fall when water temperatures would have begun dropping, and when some fish may have started an outmigration towards overwintering areas.

7.1 METHODS

ELR conducted a summer fish distribution survey using multiple capture techniques in order to investigate the spatial extent of fish use within Clinton Creek. This survey was planned for the mid-summer, with the intention of capturing general summer distributions (i.e., between spring and fall migrations). The study used a combination of backpack electrofishing and seine netting at the primary capture methods, with Gee traps serving as a secondary approach when habitat constraints required. Although some attempts were made to equally stratify fishing efforts between delineated stream reaches, this proved difficult as differing proportions of habitat types and reach lengths required the application different proportions of capture methods. No fish sampling was conducted in Reach 9, as this reach consists of a steep canyon-like feature and access to this area is restricted.

7.1.1 Backpack Electrofishing

Backpack electrofishing was completed using a Smith-Root LR-24 Backpack Electrofisher. Electrofishing settings, including output voltage, duty cycle, and output frequency, were adjusted based on local conditions (e.g., water temperature, velocity, conductivity, and fish reaction). Electrofishing was used to target shallow riffle and glide features within the main channel of Clinton Creek. Efforts were completed moving in an upstream direction, one staff member operating the electrofisher and the other netting any turned fish. Power was not supplied constantly while moving upstream, but rather staggered to avoid pushing fish with the outer edge of the voltage line where they are repelled.

Electrofisher settings, as well as number of seconds, and a GPS track of the traveled stream length was recorded for each effort. All captured fish were documented, including the species and fork-length (or total length in the case of Slimy Sculpin) of each individual. The number of additional turned fish (attracted by the electric field but not netted) was also documented, included where the species was not known.

7.1.1.1 *Electrofishing Data Analysis*

ELR calculated basic effort (areas sampled and distribution of efforts) and catch (species and catch numbers) summaries according to stream reach sampled to provide an overview of catch and distribution. ELR also compared catch rates between reaches by calculating standard units of capture rate referred to as catch per unit effort (CPUE). The study design was not intended or designed provide detailed quantitative estimates of fish abundance or density, such as through multiple pass electrofishing of channel segments. Rather, CPUE was intended to provide an additional level of context through which to compare the study results between reaches.

CPUE was calculated for each reach, and included all fish that were documented within the program, including both captured and "turned" fish that were visible but not captured and measured. CPUE was calculated for Arctic Grayling, Chinook Salmon and Slimy Sculpin independently. All other species were excluded from CPUE calculations due to low catch rates. CPUE was calculated as the number of fish per minute (fish/min) according to the following formula:

$$CPUE\ (\#\,fish/minute) = \frac{Total\ Number\ of\ Captures\ in\ (x)}{\sum_x \frac{effort\ duration\ (s)}{60}}$$

Where x is the number of documented fish in a particular effort calculation, and s is the total number electrofishing effort in seconds.

7.1.2 Seine Netting

Seine netting efforts were completed using either a 7.5 x 1.8 m or 4.5 x 1.5 m beach seine net (41 mm diameter mesh). Seine netting was used to target pools and slow-moving glide features within Clinton Creek. Seine nets were pulled from downstream to upstream, which allowed the stream current to pillow-out the net and prevented upstream disturbance to the target habitats. If the net became tangled or snagged, the effort was determined unsuccessful and was not been added to the summary of efforts included in this report. For each effort, the pool area (m^2), location (UTM), habitat type and description, reach number, and resulting catch were recorded. All captured fish were documented, including the species and fork-length (or total length in the case of Slimy Sculpin) of each individual.

7.1.2.1 *Seine Netting Data Analysis*

ELR calculated basic effort (areas sampled and distribution of efforts) and catch (species and catch numbers) summaries for each seine netting effort and for efforts within each reach, and compared catch rates between reaches by calculating standard units of rate of capture referred to as catch per unit effort (CPUE). The study design was not intended or designed provide detailed quantitative estimates of fish abundance or density. Seine netting effectiveness in stream environments is highly variable and catch rates are not directly indicative of abundance or density. Rather, this technique provides an effective method to investigate areas of the stream that may not be accessible through other methods. CPUE was calculated only to provide an additional level of context through which to compare the study results between reaches.

CPUE was calculated for each reach, and for Arctic Grayling, Chinook Salmon and Slimy Sculpin independently. All other species were excluded from CPUE calculations due to low catch rates. CPUE was calculated as the number of fish per m^2 of netted area, according to the following formula:

$$CPUE\ (\#\,fish/m^2) = \frac{Total\ Number\ of\ Captures\ in\ (x)}{\sum_x Seine\ Netting\ Area\ (m^2)}$$

Where x is the number of documented fish in a particular effort calculation, and m^2 is the area sampled in a seine net effort.

7.1.3 Gee Trapping

Gee traps were used only when the habitat of a site excluded the two primary capture methods (i.e., electrofishing and seine netting) from being used. This was typically conducted in areas of either standing water or deep pool habitats within the main channel of Clinton Creek. All traps were baited with imitation fish roe, which was tied with monofilament and netting. The traps were then secured to a nearby tree with utility cord, and flagged with permit number and contact information. All traps were set for approximately 24-hours. All captured fish were documented, including the species and fork-length (or total length in the case of Slimy Sculpin) of each individual.

7.2 Results

ELR completed the summer distribution survey between the dates of July 16 and 20, 2018. All stream reaches were assessed, with the exception of Reach 9 (as noted above, due to access restrictions). An overview of the results is provided by reach in Table 7.2-1, followed by results for individual methods. Sample Locations are shown in Figures 7.2-1 and 7.2-2.

Table 7.2-1: Summary of Assessment Efforts and Catch Results According to Stream Reach Number for the Clinton Creek Summer Fish Distribution Survey

Reach	Effort Type (Unit of Effort)	Total Effort	Catch Summary[1]						CPUE[2]		
			AG	CH	SS	LNS	RW	Total	AG	CH	SS
Reach 1	Seine Netting (m^2)	353	45	8	6	2	0	61	0.13	0.02	0.02
	Electrofishing (s)	1300	2	0	7	0	0	9	0.09	0.00	0.32
	Subtotal of Catch (Reach)	-	47	8	13	2	0	70	-	-	-
Reach 2	Seine Netting (m^2)	114	1	0	6	0	0	7	0.01	0.00	0.05
	Electrofishing (s)	737	0	0	2	0	0	2	0.00	0.00	0.16
	Subtotal of Catch (Reach)	-	1	0	8	0	0	9	-	-	-
Reach 3	Seine Netting (m^2)	92	11	6	18	2	1	38	0.12	0.07	0.20
	Electrofishing (s)	872	0	0	1	0	0	1	0.00	0.00	0.07
	Subtotal of Catch (Reach)	-	11	6	19	2	1	39	-	-	-
Reach 4	Seine Netting (m^2)	52	7	0	30	1	0	38	0.13	0.00	0.58
	Electrofishing (s)	900	1	0	1	0	2	4	0.07	0.00	0.07
	Subtotal of Catch (Reach)	-	8	0	31	1	2	42	-	-	-
Reach 5	Seine Netting (m^2)	80	4	1	3	0	0	8	0.05	0.01	0.04
	Electrofishing (s)	900	0	0	17	0	0	17	0.00	0.00	1.13
	Subtotal of Catch (Reach)	-	4	1	20	0	0	25	-	-	-
Reach 6	Seine Netting (m^2)	68	2	0	2	0	1	5	0.03	0.00	0.03
	Electrofishing (s)	915	0	0	9	2	0	11	0.00	0.00	0.59
	Subtotal of Catch (Reach)	-	2	0	11	2	1	16	-	-	-

Reach	Effort Type (Unit of Effort)	Total Effort	Catch Summary[1]						CPUE[2]		
			AG	CH	SS	LNS	RW	Total	AG	CH	SS
Reach 7	Seine Netting (m^2)	61	7	1	2	0	0	10	0.11	0.02	0.03
	Electrofishing (s)	n/a	1	0	11	0	1	13	-	-	-
	Minnow Trapping (hh:mm)	153:12	0	0	7	0	0	7	-	-	-
	Angling Efforts (hh:mm)	00:10	0	0	0	0	0	0	-	-	-
	Subtotal of Catch (Reach)	-	8	1	20	0	1	30	-	-	-
Reach 8	Seine Netting (m^2)	59	15	0	2	0	0	17	0.25	0.00	0.03
	Electrofishing (s)	872	0	0	1	0	0	1	0.00	0.00	0.07
	Minnow Trapping (hh:mm)	117:46	0	0	1	0	0	1	-	-	-
	Angling Efforts (hh:mm)	00:10	0	0	0	0	0	0	-	-	-
	Subtotal of Catch (Reach)	-	15	0	4	0	0	19	-	-	-
Reach 10	Electrofishing (s)	251	5	0	8	1	0	14	1.20	0.00	1.91
	Minnow Trapping (hh:mm)	116:27	1	0	1	1	0	3	-	-	-
	Subtotal of Catch (Reach)	-	6	0	9	2	0	17	-	-	-
Total Catch for all Reaches and Methods		-	102	16	135	9	5	267	-	-	-

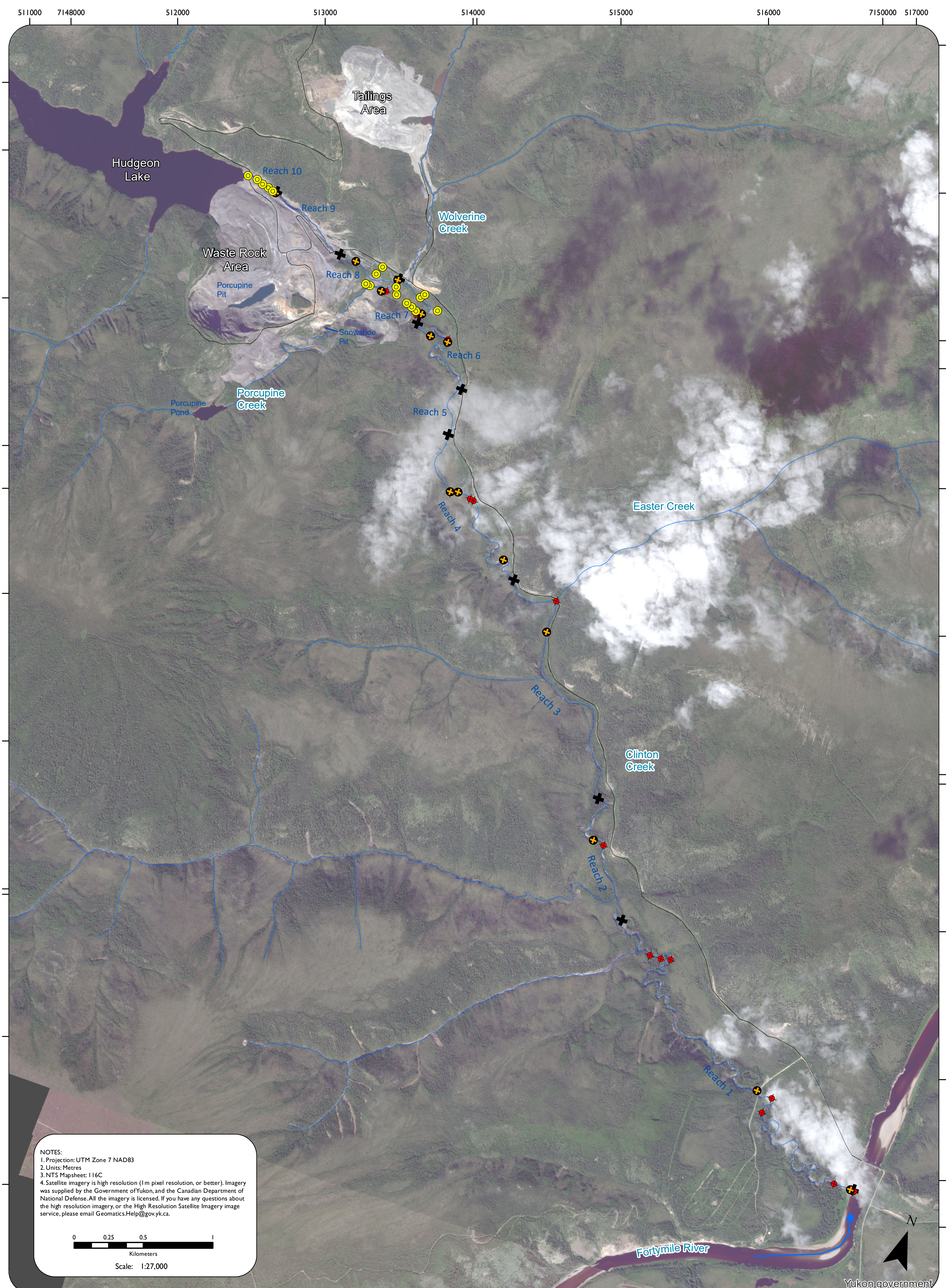
Notes:
[1]Catch summary abbreviations, AG = Arctic Grayling, CH = Chinook Salmon, SS = Slimy Sculpin, LNS = longnose Sucker, RW = Round Whitefish.
[2] CPUE = Catch per Unit Effort; Units for electrofishing = #fish/minute of effort; Units for Seine Netting = # fish/m^2 of habitat

7.2.1 Backpack Electrofishing

ELR electrofished at 14 locations distributed amongst the nine sampled reaches (Figures 7.2-1 and 7.2-2, Table 7.2-2). A total of 1,829 m of stream was assessed during 6,747 seconds of electrofishing effort, during which time ELR captured 72 fish, with an additional 60 fish being turned and not captured. Of the 72 captured fish, 57 were Slimy Sculpin, nine were Arctic Grayling, three were Round Whitefish, and three were Longnose Suckers.

Electrofishing CPUE by species and reach is provided in Table 7.2-1, and shown graphically in Figure 7.2-3. Across all reaches, the electrofishing CPUE in Clinton Creek was 0.07 fish/min for Arctic Grayling and 0.41 fish/min for Slimy Sculpin. Within individual reaches, the highest observed catch rates for Arctic Grayling were in Reach 10 (1.2 fish/min), followed next by 0.09 fish/min in Reach 1. The highest observed catch rates for Slimy Sculpin were in Reach 10 (1.91 fish/min), followed by 1.13 fish/min in Reach 5. ELR's efforts in Reach 10 were concentrated in the former plunge pool located downstream of the lowest gabion structure; adult and juvenile fish appeared to be congregated in this area resulting in the highest density and diversity of fish species observed during the survey. ELR also observed such concentrated usage of this plunge pool area during previous fish salvage work at the Site in August of 2015 (ELR, unpublished data).

No Chinook Salmon were captured during electrofishing efforts.



LEGEND

- Gee Trapping Sites
- Electrofishing Sites
- Seine Netting Sites
- Clinton Creek Reach Boundaries
- Site Area Watercourses
- Primary Site Roads

elr Ecological Logistics & Research Ltd.

Client:

Yukon

Drawn by: C. Jastrebski

Approved by: C. Jastrebski

Date: March 30, 2019

ELR Project: 18-278.3

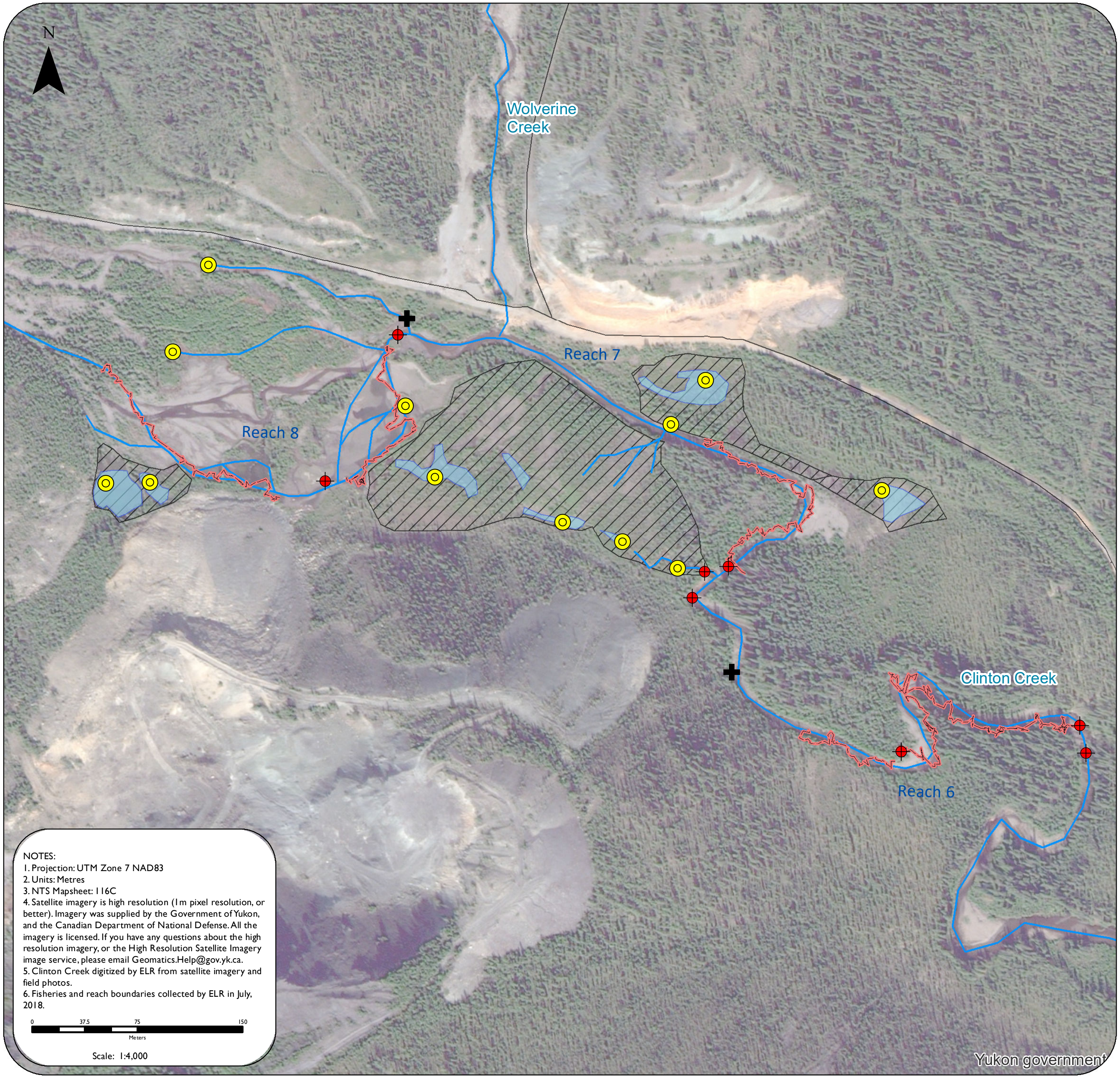
CLINTON CREEK SITE

2017-2018 Fish and Fish Habitat Existing Conditions Studies

FIGURE 7.2-1

Location of Study Sites for the 2018 Clinton Creek Summer Distribution Survey

Document Path: M:\GIS_Projects\18-278 Clinton Creek 2018 Baseline\Fisheries\Report Figures\2019 03 30 Figure 7.2-1 Summer.mxd



NOTES:
1. Projection: UTM Zone 7 NAD83
2. Units: Metres
3. NTS Mapsheet: 116C
4. Satellite imagery is high resolution (1m pixel resolution, or better). Imagery was supplied by the Government of Yukon, and the Canadian Department of National Defense. All the imagery is licensed. If you have any questions about the high resolution imagery, or the High Resolution Satellite Imagery image service, please email Geomatics.Help@gov.yk.ca.
5. Clinton Creek digitized by ELR from satellite imagery and field photos.
6. Fisheries and reach boundaries collected by ELR in July, 2018.

0 37.5 75 150
Meters

Scale: 1:4,000

Ecological Logistics & Research Ltd.

Client:

Yukon

LEGEND

- Primary Site Roads
- Site Area Watercourses
- Standing Water and Ponds
- Approximate Extent of Wetland
- Clinton Creek Reach Boundaries
- Gee Trapping Sites
- Seine Netting Sites
- Electrofishing Areas

Drawn by: A. Nicholson

Approved by: C. Jastrebski

Date: March 30, 2019

ELR Project: 18-278.3

CLINTON CREEK SITE
2017-2018 Fish and Fish Habitat Existing Conditions Studies

FIGURE 7.2-2
Location of Study Sites for the 2018 Summer Distribution Survey, Infrastructure Area

Document Path: M:\GIS_Projects\18-278 Clinton Creek 2018 Baseline\Fisheries\Report Figures\2019 03 30 Figure 7.2-2 Summer_WLArea.mxd

Table 7.2-2: Summary of Electrofishing Efforts & Catch Results During the Clinton Creek Summer Distribution Survey

Reach	Site ID*	Date	Stream Length (m)	Volts (v)	Seconds (s)	Catch Summary**						Fish Turned
						AG	CH	SS	LNS	RW	Total	
Reach 1	R1EF1	16/07/2018	147	144	700	2	0	5	0	0	7	4
	R1EF2	16/07/2018	111	150	600	0	0	2	0	0	2	5
Reach 2	R2EF1	17/07/2018	128	180	737	0	0	2	0	0	2	1
Reach 3	R3EF1	17/07/2018	149	160	872	0	0	1	0	0	1	10
Reach 4	R4EF1	17/07/2018	222	160	900	1	0	1	0	2	4	4
Reach 5	R5EF1	18/07/2018	107	160	429	0	0	9	0	0	9	2
	R5EF2	18/07/2018	106	160	471	0	0	8	0	0	8	6
Reach 6	R6EF1	18/07/2018	242	190	457	0	0	5	2	0	7	6
	R6EF2	18/07/2018	75	190	458	0	0	4	0	0	4	5
Reach 7	R7EF1	18/07/2018	170	190	-	1	0	11	0	1	13	4
Reach 8	R8EF1	19/07/2018	164	160-180	270	0	0	0	0	0	0	1
	R8EF2	19/07/2018	91	160-180		0	0	0	0	0	0	2
	R8EF3	19/07/2018	45	160-180	332	0	0	1	0	0	1	2
Reach 10	R10EF1	20/10/2018	72	180	251	5	0	8	1	0	14	8
Totals					6,747	9	0	57	3	3	72	60

Notes
**Site ID can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
***Catch summary abbreviations, AG = Arctic Grayling, CH = Chinook Salmon, SS = Slimy Sculpin, LNS = Longnose Sucker, RW = Round Whitefish.*

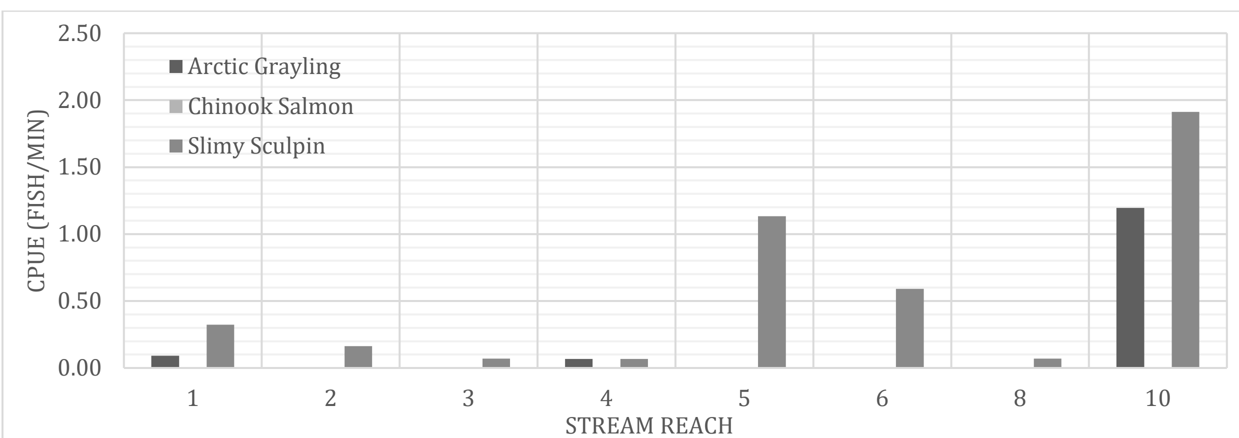


Figure 7.2-3: Catch Per Unit of Electrofishing Effort According to Stream Reach in the 2018 Summer Fish Distribution Survey of Clinton Creek

7.2.2 Seine Netting

ELR completed seine netting efforts at 32 locations distributed amongst eight of the nine surveyed stream reaches (Table 7.2-3, Figures 7.2-1 and 7.2-2). A total area of 879 m^2 of pool or slow glide habitat was targeted with these efforts, during which 184 fish were captured; 92 Arctic Grayling, 16 Chinook Salmon, 69 Slimy Sculpin, 5 Longnose Suckers, and 2 Round Whitefish.

Seine netting CPUE by species and reach is provided in Table 7.2-1, and shown graphically in Figure 7.2-4. Across all reaches, the seine netting CPUE in Clinton Creek was 0.10 fish/m^2 for Arctic Grayling, 0.02 fish/m^2 for Chinook Salmon, and 0.08 fish/m^2 for Slimy Sculpin. Within individual reaches, the highest observed catch rates for Arctic Grayling were in Reach 8 (0.25 fish/m^2), followed next by 0.13 fish/m^2 in Reaches 1 and 4. The highest observed catch rates for Chinook Salmon were in Reach 3 (0.07 fish/m^2), followed by 0.02 fish/m^2 in Reaches 1 and 7). The highest observed catch rates for Slimy Sculpin were in Reach 4 (0.58 fish/m^2), followed by 0.20 fish/m^2 in Reach 3.

Within Reach 3, 38 fish of various species were captured in 3 seine net pulls resulting in the greatest density and diversity of juvenile and adult fish found within the program (of seine netting efforts). This high CPUE is believed to be reflective of preferential fish use of a large pool feature that occurs at the confluence of Eagle and Clinton Creeks.

Within Reach 4, 38 fish of various species were captured in only two seine netting efforts (52 m^2 total). The catch in these two seine net pulls consisted almost entirely of YOY Slimy Sculpin (30 fish), many of which were of a similar size (<30 mm). The site consisted of a deep pool habitat (0.72-0.76 m deep) with gravel substrates, which occurred along a meandering section of the creek. These densities of Slimy Sculpin were not encountered anywhere else during the survey.

Table 7.2-3: Summary of Seine Netting Efforts & Catch Results Completed for Clinton Creek Summer Distribution Survey

Reach	Site ID*	Date	Max. Depth (m)	Pool Area (m^2)	Catch Summary**					
					AG	CH	SS	LNS	RW	Total
Reach 1	R1SN1	16/07/2018	0.59	20	1	0	0	0	0	1
	R1SN2	16/07/2018	0.59	48	15	1	0	0	0	16
	R1SN3	16/07/2018	0.45	36	4	0	1	1	0	6
	R1SN4	16/07/2018	0.56	48	21	1	0	1	0	23
	R1SN5	16/07/2018	0.8	48	0	0	0	0	0	0
	R1SN6	16/07/2018	0.8	72	4	0	1	0	0	5
	R1SN7	16/07/2018	1.1	18	0	0	1	0	0	1
	R1SN8	20/07/2018	0.55	15	0	0	0	0	0	0
	R1SN9	20/07/2018	0.3	24	0	1	1	0	0	2
	R1SN10	20/07/2018	0.8	24	0	5	2	0	0	7
Reach 2	R2SN1	17/07/2018	0.77	64	1	0	5	0	0	6
	R2SN2	17/07/2018	0.29	50	0	0	1	0	0	1
Reach 3	R3SN1	17/07/2018	0.62	24	7	5	9	2	0	23
	R3SN2	17/07/2018	0.64	36	4	1	8	0	1	14
	R3SN3	17/07/2018	0.45	32	0	0	1	0	0	1
Reach 4	R4SN1	17/07/2018	0.76	32	7	0	30	1	0	38
	R4SN2	17/07/2018	0.72	20	0	0	0	0	0	0

Reach	Site ID*	Date	Max. Depth (m)	Pool Area (m^2)	Catch Summary**					
					AG	CH	SS	LNS	RW	Total
Reach 5	R5SN1	18/07/2018	0.4	20	0	0	0	0	0	0
	R5SN2	18/07/2018	0.4	16	2	0	3	0	0	5
	R5SN3	18/07/2018	0.37	20	1	0	0	0	0	1
	R5SN4	18/07/2018	0.5	12	1	1	0	0	0	2
	R5SN5	18/07/2018	0.4	12	0	0	0	0	0	0
Reach 6	R6SN1	18/07/2018	0.27	15	0	0	2	0	1	3
	R6SN2	18/07/2018	0.73	21	0	0	0	0	0	0
	R6SN3	18/07/2018	0.8	24	0	0	0	0	0	0
	R6SN4	18/07/2018	0.4	8	2	0	0	0	0	2
Reach 7	R7SN1	18/07/2018	0.86	18	4	0	1	0	0	5
	R7SN2	18/07/2018	0.61	28	2	1	1	0	0	4
	R7SN3	18/07/2018	0.62	15	1	0	0	0	0	1
Reach 8	R8SN1	19/07/2018	0.76	24	15	0	1	0	0	16
	R8SN2	19/07/2018	0.64	20	0	0	0	0	0	0
	R8SN3	19/07/2018	0.7	15	0	0	1	0	0	1
Totals	-	-	-	879	92	16	69	5	2	184

*Notes: *Site ID can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
***Catch summary abbreviations, AG = Arctic Grayling, CH = Chinook Salmon, SS = Slimy Sculpin, LNS = Longnose Sucker, RW = Round Whitefish.*

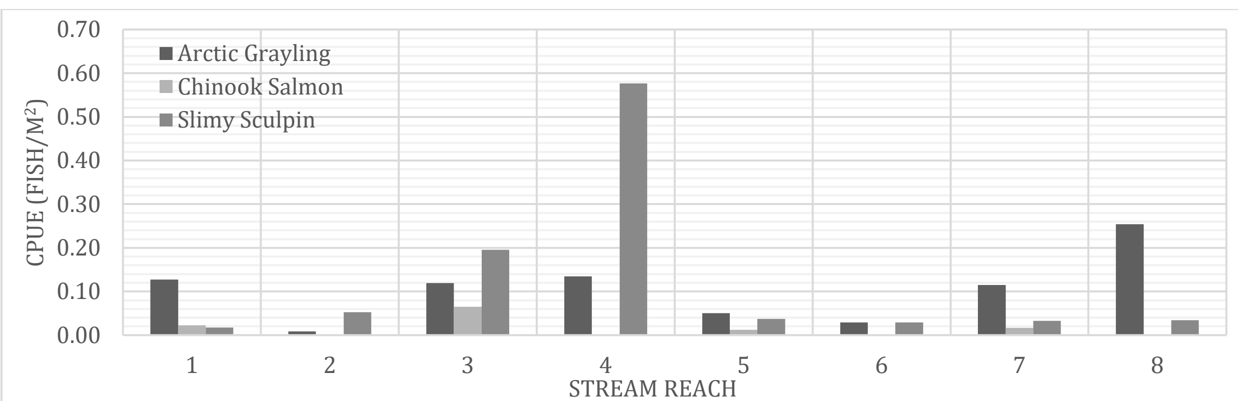


Figure 7.2-4: Catch Per Unit of Seine Netting Effort According to Stream Reach in the 2018 Summer Fish Distribution Survey of Clinton Creek

7.2.3 Gee Trapping

ELR completed Gee trapping efforts at 17 locations distributed across three of the nine samples reaches (Table 7.2-4, Figures 7.2-1 and 7.2-2). This included seven locations in Reach 7 (153:12 trap hours), five in Reach 8 (117:46 trap hours), and five in Reach 10 (116:27 trap hours). The total combined trapping effort was 387 hours and 25 minutes during the survey. A total of 11 fish were captured, including nine Slimy Sculpin, one Arctic Grayling, and one Longnose Sucker.

Gee traps were used to investigate fish use of standing water or deep pool habitats that could not be targeted through seine netting or electrofishing efforts. This included investigations into the connectivity and distribution of fish within a wetland feature in Reach 7, a deep scour pool and two beaver ponds in Reach 8, as well as confirmation of fish presence/absence in the gabion pools located in Reach 10.

Within Reach 7, fish were captured in traps set in waterbodies on the north side of the channel (Site IDs R7MT5 and R7MT6) as well as in the outlet stream of main wetland feature (Site ID R7MT1; Figure 7.2-2). Only Slimy Sculpin were captured using minnow traps within Reach 7. No fish were captured or observed in the open water habitats on the south side of the main channel (e.g. Site IDs R7MT4, R7MT3, and R7MT2).

Within Reach 8, only a single Slimy Sculpin was captured in a deep scour pool (~2.0 m depth) located at the confluence of multiple braided channels (Site ID R8MT1; Figure 7.2-2). No fish were captured from traps set in the two beaver ponds located within this reach.

Within Reach 10, fish were only captured below the lowest existing gabion structure. The catch included one Arctic Grayling, one Slimy Sculpin, and one Longnose Sucker. This is consistent with earlier findings, confirming that fish distribution does not likely occur above the lowest gabion.

Table 7.2-4: Summary of Minnow Trapping Efforts & Catch Results Completed for Clinton Creek Summer Distribution Survey

Reach	Site ID*	Set Date	Set Time	Pull Date	Pull Time	Effort (hh:mm)	Catch Summary**					
							AG	CH	SS	LNS	RW	Total
Reach 7	R7MT1	18/07/2018	16:25	19/07/2018	14:25	22:00	0	0	5	0	0	5
	R7MT2	18/07/2018	16:36	19/07/2018	14:40	22:04	0	0	0	0	0	0
	R7MT3	18/07/2018	16:47	19/07/2018	14:46	21:59	0	0	0	0	0	0
	R7MT4	18/07/2018	17:02	19/07/2018	14:57	21:55	0	0	0	0	0	0
	R7MT5	18/07/2018	17:24	19/07/2018	15:16	21:52	0	0	1	0	0	1
	R7MT6	18/07/2018	17:33	19/07/2018	15:20	21:47	0	0	1	0	0	1
	R7MT7	18/07/2018	18:10	19/07/2018	15:45	21:35	0	0	0	0	0	0
Reach 8	R8MT1	19/07/2018	10:07	20/07/2018	10:06	23:59	0	0	1	0	0	1
	R8MT2	19/07/2018	11:58	20/07/2018	11:23	23:25	0	0	0	0	0	0
	R8MT3	19/07/2018	12:06	20/07/2018	11:25	23:19	0	0	0	0	0	0
	R8MT4	19/07/2018	12:35	20/07/2018	12:34	23:59	0	0	0	0	0	0
	R8MT5	19/07/2018	13:24	20/07/2018	12:28	23:04	0	0	0	0	0	0
Reach 10	R10MT1	19/07/2018	08:44	20/07/2018	08:10	23:26	0	0	0	0	0	0
	R10MT2	19/07/2018	08:49	20/07/2018	08:04	23:15	1	0	1	1	0	3
	R10MT3	19/07/2018	08:56	20/07/2018	08:13	23:17	0	0	0	0	0	0
	R10MT4	19/07/2018	09:00	20/07/2018	08:16	23:16	0	0	0	0	0	0
	R10MT5	19/07/2018	09:06	20/07/2018	08:19	23:13	0	0	0	0	0	0
Totals	-	-	-	-	-	387:25	1	0	9	1	0	11

Notes:
**Site ID can be used to track individual fish within the Catch Data Summary Table (Appendix A).*
***Catch summary abbreviations, AG = Arctic Grayling, CH = Chinook Salmon, SS = Slimy Sculpin, LNS = Longnose Sucker, RW = Round Whitefish.*

7.3 Summary of Observations and Discussion

ELR found fish to be distributed throughout Clinton Creek during July of 2018, with fish being captured in each of the nine reaches investigated. Chinook Salmon were captured only through seine netting, and this capture technique appeared to be the most effective overall in the watercourse, followed by electrofishing and finally, Gee trapping.

Chinook Salmon were captured at lower than expected densities, and included young of year and 1+ (one year old) individuals based on body length. The highest catch rates for this species were in Reaches 3 and 1, however they were captured as far upstream as Reach 7. Given that Clinton Creek is a non-natal stream for this species (spawning is not documented in the watercourse), it is likely that densities may be greater in the late summer and fall as young of year Chinook Salmon are attracted to the watercourse by late season resources or water temperatures. Von Finster (2012) noted that research has suggested that Chinook Salmon to not begin entering Clinton Creek until early to mid-July annually.

Arctic Grayling were most frequently captured through seine netting, and were captured in each reach investigated. To review the distribution of this species by life stage and reach, ELR broadly classified the catch of Arctic Grayling into YOY, juvenile, and adult classes, the result of which is shown in Figure 7.3-1 below. Arctic Grayling were most numerous in Reach 1, primarily due to the capture of a large number of YOY. Adults were captured in Reaches 1, 7, and 8, with the highest densities observed in the uppermost reaches. YOY were captured in all reaches except Reach 10, however Reaches 1, 7, and 8 appear to provide the best rearing habitat and highest densities of YOY. From the perspective of catch rate (CPUE), electrofishing catch rate was uneven and heavily skewed towards reach 10 (Figure 7.2-2), while seine netting catch rate was more evenly distributed and highest in Reach 7 (Figure 7.2-3).

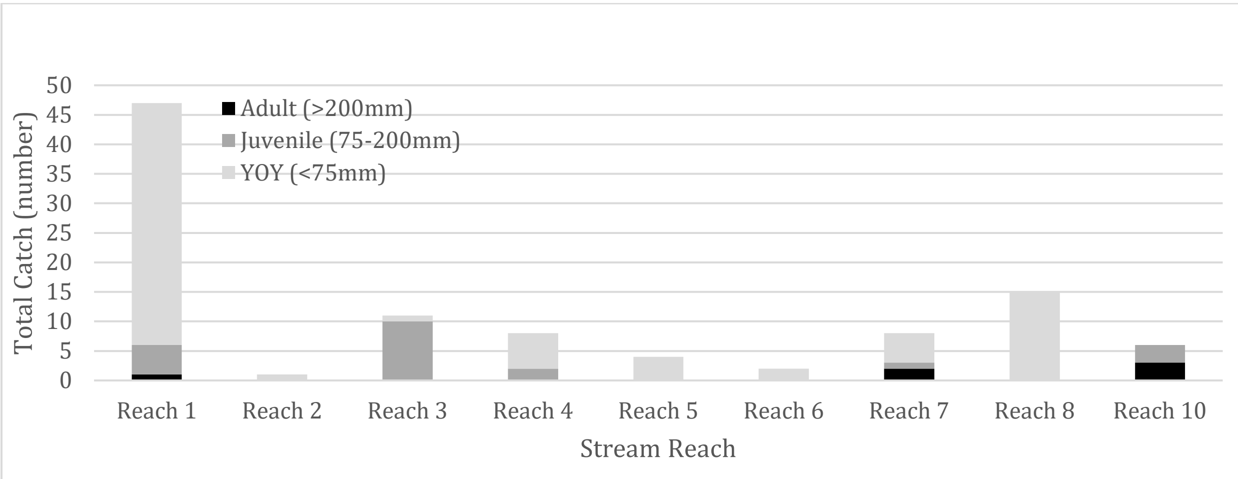


Figure 7.3-1: Chart Showing Life Stage Distribution and Total Catch of Arctic Grayling for Clinton Creek Summer Distribution Studies

Slimy sculpin were most frequently captured through seine netting and electrofishing, and were captured in each reach investigated. To review the distribution of this species by life stage and reach, ELR broadly classified the catch of Slimy Sculpin into YOY, juvenile, and adult classes, the result of which is shown in Figure 7.3-2 below. Slimy Sculpin were most numerous in Reach 4, primarily due to the capture of a large number of YOY in that reach. Adults were captured in all reaches, with the highest densities observed in Reaches 5 and 7. As Slimy Sculpin are not migratory, but rather show a fidelity to areas within the stream, the generally consistent distribution by age class throughout the stream was as expected. Catch rates (CPUE) for this species were not consistent across reaches, with the highest electrofishing catch rates being in Reaches 5, 6, and 10 and the highest seine netting catch rates being in Reaches 3 and 4 (Figures 7.2-2 and 7.2-3).

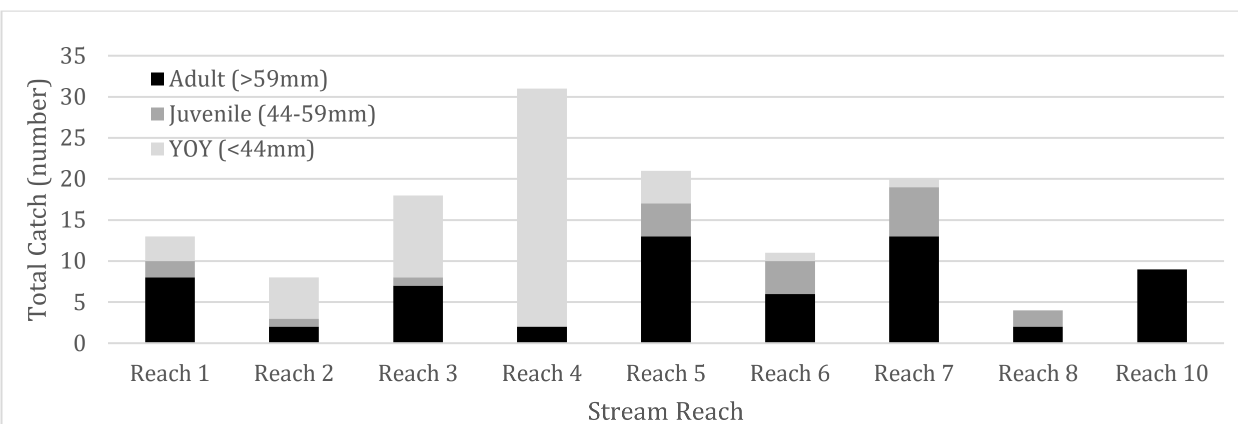


Figure 7.3-2: Chart Showing Life Stage Distribution and Total Catch of Slimy Sculpin for Clinton Creek Summer Distribution Studies

8. CLOSURE

Ecological Logistics & Research Ltd. prepared this 2017-2018 Clinton Creek fish and fish habitat existing conditions report for the Government of Yukon, Assessment and Abandoned Mines Branch. This report summarizes the efforts and results of fish and fish habitat study program at the Clinton Creek Site from April of 2017 to July of 2018. We trust this report meets the needs of describing this work at this time, but please do not hesitate to contact the undersigned should you require further information or clarification.

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PHOTOGRAPHS

Photo 1: Aerial view of a typical length of Reach 1. Note the mid-channel bars and undercut banks. Photo taken July 16, 2018.

Photo 2: Aerial view of a typical length of Reach 2. Photo taken July 16, 2018.

Photo 3: Aerial view of a typical length of Reach 3. Note the straightness of the channel, and the confining feature in the left forefront. Photo taken July 16, 2018.

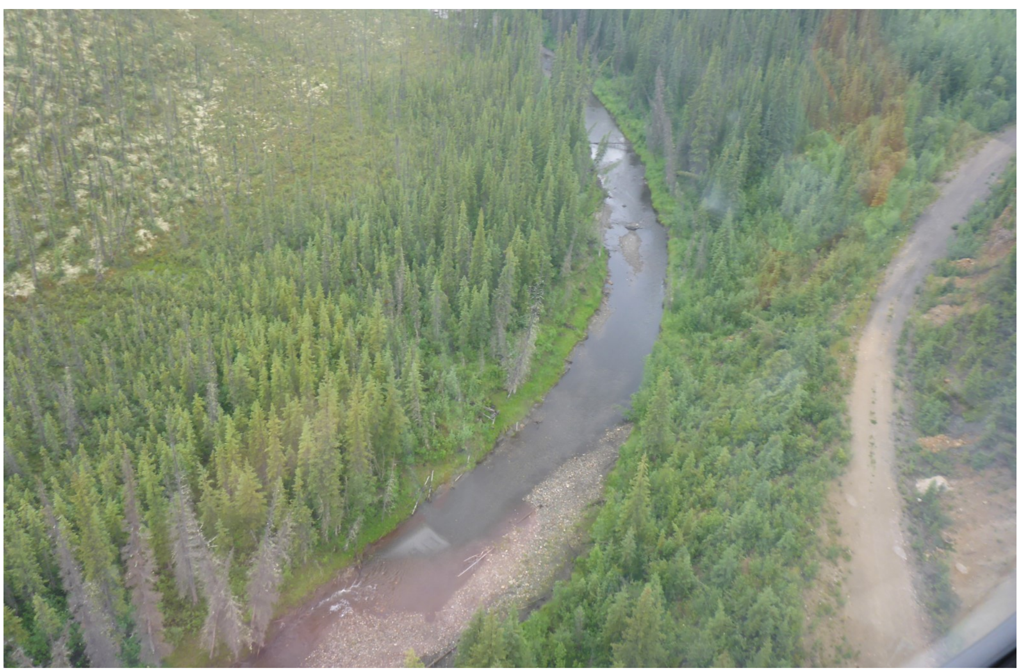

Photo 4: Aerial view of a typical length of Reach 4. Photo taken July 16, 2018.

Photo 5: Aerial view of a typical length of Reach 5. Note the confining features in the right background. Photo taken July 16, 2018.

Photo 6: Aerial view of a typical section of Reach 6. Note the meandering nature of the stream and frequent bars. Photo taken July 16, 2018.

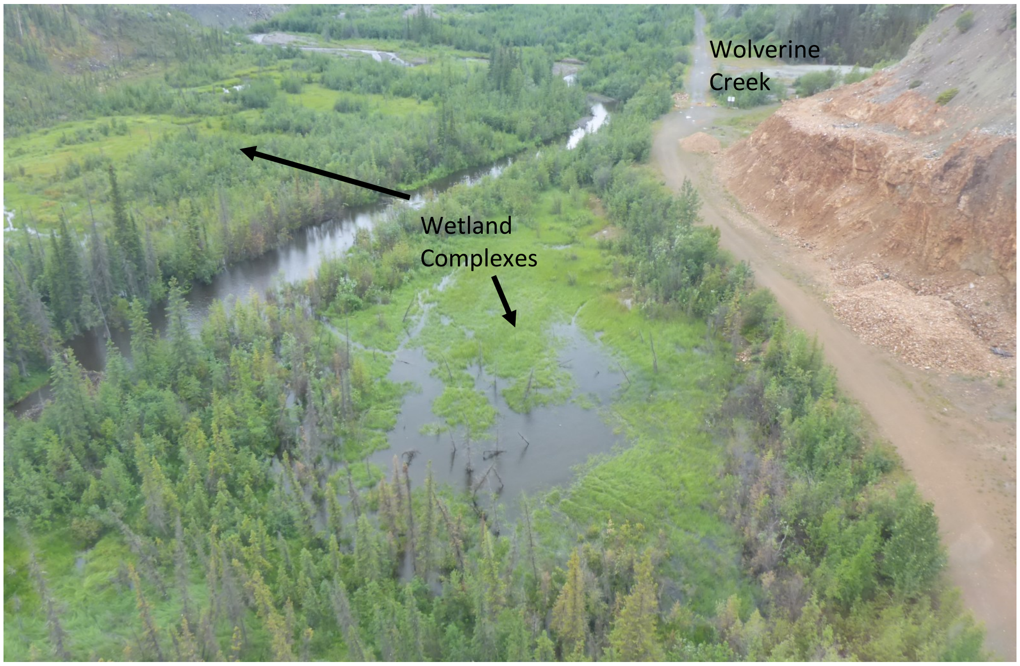

Photo 7: Aerial view of a typical length of Reach 7. Note the wetland complexes present on both sides of Clinton Creek. The confluence with Wolverine Creek is in the right background. Photo taken July 16, 2018.

Photo 8: Aerial view of a typical section of Reach 8. A previous alignment of Clinton Creek is in the photo right, and the current stream is partially confined in the photo background. Photo taken July 16, 2018.

Photo 9: Aerial view of Reach 9 showing the incised canyon feature and steep gradient. Photo taken July 16, 2018.

Photo 10: Aerial view of the gabion structures at Reach 10, with Hudgeon Lake in the background. Photo taken July 16, 2018.

Photo 11: View of a channel-width beaver dam in Reach 1. Photo taken July 16, 2018.

Photo 12: View of a channel-width beaver dam in Reach 3. Photo taken July 16, 2018.

Photo 13: View of a channel-width beaver dam in Reach 7. Photo taken July 16, 2018.

Photo 14: View of the habitat assessment area of Reach 4, looking downstream. Photo taken July 20, 2018.

Photo 15: View of the habitat assessment area at Reach 4, looking upstream. Photo taken July 19, 2018.

Photo 16: View of the habitat assessment area at Reach 7, looking downstream. Photo taken July 19, 2018.

Photo 17: View of the habitat assessment area at Reach 7, looking upstream. Photo taken July 19, 2018.

Photo 18: View of the habitat assessment area at Reach 8, looking downstream. Photo taken July 20, 2018.

Photo 19: View of the habitat assessment area at Reach 8, looking upstream. Photo taken July 20, 2018.

Photo 20: View of Clinton Creek (area within Reach 1) taken during the snorkel survey attempt. This photo gives an example of the level of turbidity encountered. Photo taken June 2, 2017.

Photo 21: View of the outlet of Wolverine Creek at the time of the snorkel survey attempt, showing the input of sediment coming from Wolverine Creek (photo left). Photo taken June 3, 2017.

Photo 22: View of typical calm (pool) habitat in Reach 7 where young of year Arctic Grayling were observed. Photo taken June 24, 2017.

Photo 23: View of typical calm glide habitat in Reach 1 where young of year Arctic Grayling were observed. Photo taken June 24. 2017.

Photo 24: Photo of juvenile Chinook Salmon observed in Reach 1 (Site R7P1) during the overwintering survey. Photo taken February 26, 2017.

Photo 25: Photo of a juvenile Arctic Grayling observed in Reach 1 (Site R6P1) during the overwintering survey. Photo taken February 27, 2017.

Photo 26: Photo of a juvenile Chinook Salmon observed in Reach 3 (Site R4P4) during the overwintering survey. Photo taken February 26, 2017.

APPENDIX A – SUMMARY OF FISH CAPTURE DATA

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
24/Jun/17	YOY	SN1	SN	AG	221	-	Y
24/Jun/17	YOY	SN1	SN	AG	204	-	Y
24/Jun/17	YOY	SN1	SN	AG	198	-	Y
24/Jun/17	YOY	SN1	SN	AG	255	-	Y
24/Jun/17	YOY	SN1	SN	AG	161	-	Y
24/Jun/17	YOY	SN1	SN	AG	180	-	Y
24/Jun/17	YOY	SN1	SN	AG	129	-	Y
24/Jun/17	YOY	SN1	SN	AG	210	-	Y
24/Jun/17	YOY	SN1	SN	AG	199	-	Y
24/Jun/17	YOY	SN1	SN	AG	228	-	Y
24/Jun/17	YOY	SN1	SN	AG	135	-	Y
24/Jun/17	YOY	SN1	SN	AG	190	-	Y
24/Jun/17	YOY	SN1	SN	AG	174	-	Y
24/Jun/17	YOY	SN1	SN	AG	189	-	Y
24/Jun/17	YOY	SN1	SN	AG	211	-	Y
24/Jun/17	YOY	SN1	SN	AG	177	-	Y
24/Jun/17	YOY	SN1	SN	AG	175	-	Y
24/Jun/17	YOY	SN1	SN	AG	164	-	Y
24/Jun/17	YOY	SN1	SN	AG	160	-	Y
24/Jun/17	YOY	SN1	SN	AG	176	-	Y
24/Jun/17	YOY	SN1	SN	AG	189	-	Y
24/Jun/17	YOY	SN1	SN	AG	151	-	Y
24/Jun/17	YOY	SN1	SN	AG	162	-	Y
24/Jun/17	YOY	SN1	SN	AG	315	-	Y
24/Jun/17	YOY	SN1	SN	AG	370	-	Y
24/Jun/17	YOY	SN14	SN	AG	44	-	Y
24/Jun/17	YOY	SN15	SN	AG	30	-	Y
24/Jun/17	YOY	SN15	SN	AG	27	-	Y
24/Jun/17	YOY	SN15	SN	AG	31	-	Y
24/Jun/17	YOY	SN2	SN	AG	<25	-	Y
24/Jun/17	YOY	SN2	SN	AG	<25	-	Y
24/Jun/17	YOY	SN5	SN	AG	20	-	Y
28/Feb/18	OW	R2P2	GT	SS	-	50	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
28/Feb/18	OW	R2P2	GT	SS	-	53	Y
28/Feb/18	OW	R2P2	GT	SS	-	49	Y
28/Feb/18	OW	R2P2	GT	SS	-	61	Y
26/Feb/18	OW	R7P1	GT	CH	69	-	Y
26/Feb/18	OW	R7P1	GT	CH	71	-	Y
26/Feb/18	OW	R7P1	GT	CH	76	-	Y
26/Feb/18	OW	R7P1	GT	CH	70	-	Y
26/Feb/18	OW	R7P1	GT	CH	73	-	Y
16/Jul/18	SD	R1SN1	SN	AG	35	-	Y
16/Jul/18	SD	R1SN2	SN	AG	187	-	Y
16/Jul/18	SD	R1SN2	SN	AG	216	-	Y
16/Jul/18	SD	R1SN2	SN	AG	196	-	Y
16/Jul/18	SD	R1SN2	SN	AG	117	-	Y
16/Jul/18	SD	R1SN2	SN	AG	87	-	Y
16/Jul/18	SD	R1SN2	SN	AG	49	-	Y
16/Jul/18	SD	R1SN2	SN	AG	41	-	Y
16/Jul/18	SD	R1SN2	SN	AG	42	-	Y
16/Jul/18	SD	R1SN2	SN	CH	51	-	Y
16/Jul/18	SD	R1SN2	SN	AG	50	-	Y
16/Jul/18	SD	R1SN2	SN	AG	45	-	Y
16/Jul/18	SD	R1SN2	SN	AG	43	-	Y
16/Jul/18	SD	R1SN2	SN	AG	41	-	Y
16/Jul/18	SD	R1SN2	SN	AG	42	-	Y
16/Jul/18	SD	R1SN2	SN	AG	41	-	Y
16/Jul/18	SD	R1SN2	SN	AG	43	-	Y
16/Jul/18	SD	R1SN3	SN	LNS	66	-	Y
16/Jul/18	SD	R1SN3	SN	AG	41	-	Y
16/Jul/18	SD	R1SN3	SN	AG	47	-	Y
16/Jul/18	SD	R1SN3	SN	AG	54	-	Y
16/Jul/18	SD	R1SN3	SN	AG	36	-	Y
16/Jul/18	SD	R1SN3	SN	SS	40	-	Y
16/Jul/18	SD	R1SN4	SN	AG	48	-	Y
16/Jul/18	SD	R1SN4	SN	AG	54	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
16/Jul/18	SD	R1SN4	SN	AG	41	-	Y
16/Jul/18	SD	R1SN4	SN	AG	44	-	Y
16/Jul/18	SD	R1SN4	SN	LNS	44	-	Y
16/Jul/18	SD	R1SN4	SN	AG	43	-	Y
16/Jul/18	SD	R1SN4	SN	AG	42	-	Y
16/Jul/18	SD	R1SN4	SN	AG	38	-	Y
16/Jul/18	SD	R1SN4	SN	AG	44	-	Y
16/Jul/18	SD	R1SN4	SN	CH	58	-	Y
16/Jul/18	SD	R1SN4	SN	AG	43	-	Y
16/Jul/18	SD	R1SN4	SN	AG	39	-	Y
16/Jul/18	SD	R1SN4	SN	AG	43	-	Y
16/Jul/18	SD	R1SN4	SN	AG	46	-	Y
16/Jul/18	SD	R1SN4	SN	AG	49	-	Y
16/Jul/18	SD	R1SN4	SN	AG	51	-	Y
16/Jul/18	SD	R1SN4	SN	AG	44	-	Y
16/Jul/18	SD	R1SN4	SN	AG	41	-	Y
16/Jul/18	SD	R1SN4	SN	AG	41	-	Y
16/Jul/18	SD	R1SN4	SN	AG	33	-	Y
16/Jul/18	SD	R1SN4	SN	AG	28	-	Y
16/Jul/18	SD	R1SN4	SN	AG	38	-	Y
16/Jul/18	SD	R1SN4	SN	AG	46	-	Y
16/Jul/18	SD	R1EF1	EF	SS	55	-	Y
16/Jul/18	SD	R1EF1	EF	AG	36	-	Y
16/Jul/18	SD	R1EF1	EF	SS	74	-	Y
16/Jul/18	SD	R1EF1	EF	SS	74	-	Y
16/Jul/18	SD	R1EF1	EF	SS	73	-	Y
16/Jul/18	SD	R1EF1	EF	AG	43	-	Y
16/Jul/18	SD	R1EF1	EF	SS	77	-	Y
16/Jul/18	SD	R1SN6	SN	AG	191	-	Y
16/Jul/18	SD	R1SN6	SN	SS	59	-	Y
16/Jul/18	SD	R1SN6	SN	AG	34	-	Y
16/Jul/18	SD	R1SN6	SN	AG	27	-	Y
16/Jul/18	SD	R1SN6	SN	AG	32	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
16/Jul/18	SD	R1SN7	SN	SS	92	-	Y
16/Jul/18	SD	R1EF2	EF	SS	76	-	Y
16/Jul/18	SD	R1EF2	EF	SS	58	-	Y
17/Jul/18	SD	R2SN1	SN	SS	40	-	Y
17/Jul/18	SD	R2SN1	SN	SS	37	-	Y
17/Jul/18	SD	R2SN1	SN	SS	33	-	Y
17/Jul/18	SD	R2SN1	SN	AG	43	-	Y
17/Jul/18	SD	R2SN1	SN	SS	34	-	Y
17/Jul/18	SD	R2SN1	SN	SS	33	-	Y
17/Jul/18	SD	R2SN2	SN	SS	61	-	Y
17/Jul/18	SD	R2EF1	EF	SS	60	-	Y
17/Jul/18	SD	R2EF1	EF	SS	44	-	Y
17/Jul/18	SD	R3SN1	SN	CH	66	-	Y
17/Jul/18	SD	R3SN1	SN	SS	36	-	Y
17/Jul/18	SD	R3SN1	SN	SS	30	-	Y
17/Jul/18	SD	R3SN1	SN	SS	29	-	Y
17/Jul/18	SD	R3SN1	SN	SS	32	-	Y
17/Jul/18	SD	R3SN1	SN	SS	30	-	Y
17/Jul/18	SD	R3SN1	SN	AG	159	-	Y
17/Jul/18	SD	R3SN1	SN	CH	105	-	Y
17/Jul/18	SD	R3SN1	SN	AG	106	-	Y
17/Jul/18	SD	R3SN1	SN	CH	65	-	Y
17/Jul/18	SD	R3SN1	SN	AG	-	-	Y
17/Jul/18	SD	R3SN1	SN	AG	105	-	Y
17/Jul/18	SD	R3SN1	SN	LNS	113	-	Y
17/Jul/18	SD	R3SN1	SN	LNS	105	-	Y
17/Jul/18	SD	R3SN1	SN	AG	95	-	Y
17/Jul/18	SD	R3SN1	SN	SS	64	-	Y
17/Jul/18	SD	R3SN1	SN	SS	67	-	Y
17/Jul/18	SD	R3SN1	SN	AG	85	-	Y
17/Jul/18	SD	R3SN1	SN	SS	39	-	Y
17/Jul/18	SD	R3SN1	SN	AG	84	-	Y
17/Jul/18	SD	R3SN1	SN	SS	36	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
17/Jul/18	SD	R3SN1	SN	CH	65	-	Y
17/Jul/18	SD	R3SN1	SN	CH	64	-	Y
17/Jul/18	SD	R3SN2	SN	AG	172	-	Y
17/Jul/18	SD	R3SN2	SN	AG	195	-	Y
17/Jul/18	SD	R3SN2	SN	AG	136	-	Y
17/Jul/18	SD	R3SN2	SN	RW	116	-	Y
17/Jul/18	SD	R3SN2	SN	AG	111	-	Y
17/Jul/18	SD	R3SN2	SN	SS	70	-	Y
17/Jul/18	SD	R3SN2	SN	SS	68	-	Y
17/Jul/18	SD	R3SN2	SN	SS	61	-	Y
17/Jul/18	SD	R3SN2	SN	CH	71	-	Y
17/Jul/18	SD	R3SN2	SN	SS	64	-	Y
17/Jul/18	SD	R3SN2	SN	SS	56	-	Y
17/Jul/18	SD	R3SN2	SN	SS	41	-	Y
17/Jul/18	SD	R3SN2	SN	SS	38	-	Y
17/Jul/18	SD	R3SN2	SN	SS	36	-	Y
17/Jul/18	SD	R3SN3	SN	SS	62	-	Y
17/Jul/18	SD	R4SN1	SN	LNS	150	-	Y
17/Jul/18	SD	R4SN1	SN	SS	38	-	Y
17/Jul/18	SD	R4SN1	SN	SS	38	-	Y
17/Jul/18	SD	R4SN1	SN	AG	34	-	Y
17/Jul/18	SD	R4SN1	SN	SS	35	-	Y
17/Jul/18	SD	R4SN1	SN	SS	75	-	Y
17/Jul/18	SD	R4SN1	SN	SS	40	-	Y
17/Jul/18	SD	R4SN1	SN	SS	28	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	AG	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	AG	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	AG	107	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	SS	<30	-	Y
17/Jul/18	SD	R4SN1	SN	AG	<30	-	Y
17/Jul/18	SD	R4SN1	SN	AG	<30	-	Y
17/Jul/18	SD	R4SN1	SN	AG	<30	-	Y
17/Jul/18	SD	R4EF1	EF	RW	211	-	Y
17/Jul/18	SD	R4EF1	EF	RW	175	-	Y
17/Jul/18	SD	R4EF1	EF	AG	123	-	Y
17/Jul/18	SD	R4EF1	EF	SS	75	-	Y
18/Jul/18	SD	R5SN2	SN	SS	85	-	Y
18/Jul/18	SD	R5SN2	SN	SS	57	-	Y
18/Jul/18	SD	R5SN2	SN	AG	32	-	Y
18/Jul/18	SD	R5SN2	SN	SS	36	-	Y
18/Jul/18	SD	R5SN2	SN	AG	32	-	Y
18/Jul/18	SD	R5SN3	SN	AG	39	-	Y
18/Jul/18	SD	R5EF1	EF	SS	80	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
18/Jul/18	SD	R5EF1	EF	SS	84	-	Y
18/Jul/18	SD	R5EF1	EF	SS	61	-	Y
18/Jul/18	SD	R5EF1	EF	SS	63	-	Y
18/Jul/18	SD	R5EF1	EF	SS	55	-	Y
18/Jul/18	SD	R5EF1	EF	SS	44	-	Y
18/Jul/18	SD	R5EF1	EF	SS	37	-	Y
18/Jul/18	SD	R5EF1	EF	SS	40	-	Y
18/Jul/18	SD	R5EF1	EF	SS	36	-	Y
18/Jul/18	SD	R5SN4	SN	SS	82	-	Y
18/Jul/18	SD	R5SN4	SN	AG	34	-	Y
18/Jul/18	SD	R5EF2	EF	SS	94	-	Y
18/Jul/18	SD	R5EF2	EF	SS	87	-	Y
18/Jul/18	SD	R5EF2	EF	SS	67	-	Y
18/Jul/18	SD	R5EF2	EF	SS	55	-	Y
18/Jul/18	SD	R5EF2	EF	SS	78	-	Y
18/Jul/18	SD	R5EF2	EF	SS	71	-	Y
18/Jul/18	SD	R5EF2	EF	SS	61	-	Y
18/Jul/18	SD	R5EF2	EF	SS	76	-	Y
18/Jul/18	SD	R6SN1	SN	SS	45	-	Y
18/Jul/18	SD	R6SN1	SN	SS	42	-	Y
18/Jul/18	SD	R6SN1	SN	RW	115	-	Y
18/Jul/18	SD	R6EF1	EF	LNS	212	-	Y
18/Jul/18	SD	R6EF1	EF	LNS	174	-	Y
18/Jul/18	SD	R6EF1	EF	SS	75	-	Y
18/Jul/18	SD	R6EF1	EF	SS	61	-	Y
18/Jul/18	SD	R6EF1	EF	SS	81	-	Y
18/Jul/18	SD	R6EF1	EF	SS	80	-	Y
18/Jul/18	SD	R6EF1	EF	SS	44	-	Y
18/Jul/18	SD	R6SN4	SN	AG	37	-	Y
18/Jul/18	SD	R6SN4	SN	AG	58	-	Y
18/Jul/18	SD	R6EF2	EF	SS	80	-	Y
18/Jul/18	SD	R6EF2	EF	SS	79	-	Y
18/Jul/18	SD	R6EF2	EF	SS	45	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
18/Jul/18	SD	R6EF2	EF	SS	45	-	Y
18/Jul/18	SD	R7SN1	SN	AG	41	-	Y
18/Jul/18	SD	R7SN1	SN	AG	33	-	Y
18/Jul/18	SD	R7SN1	SN	AG	37	-	Y
18/Jul/18	SD	R7SN1	SN	SS	56	-	Y
18/Jul/18	SD	R7SN1	SN	AG	41	-	Y
18/Jul/18	SD	R7SN2	SN	AG	190	-	Y
18/Jul/18	SD	R7SN2	SN	AG	249	-	Y
18/Jul/18	SD	R7SN2	SN	SS	74	-	Y
18/Jul/18	SD	R7SN2	SN	CH	66	-	Y
18/Jul/18	SD	R7SN3	SN	AG	43	-	Y
18/Jul/18	SD	R7EF1	EF	RW	225	-	Y
18/Jul/18	SD	R7EF1	EF	AG	270	-	Y
18/Jul/18	SD	R7EF1	EF	SS	90	-	Y
18/Jul/18	SD	R7EF1	EF	SS	45	-	Y
18/Jul/18	SD	R7EF1	EF	SS	70	-	Y
18/Jul/18	SD	R7EF1	EF	SS	98	-	Y
18/Jul/18	SD	R7EF1	EF	SS	80	-	Y
18/Jul/18	SD	R7EF1	EF	SS	45	-	Y
18/Jul/18	SD	R7EF1	EF	SS	74	-	Y
18/Jul/18	SD	R7EF1	EF	SS	73	-	Y
18/Jul/18	SD	R7EF1	EF	SS	44	-	Y
18/Jul/18	SD	R7EF1	EF	SS	58	-	Y
18/Jul/18	SD	R7EF1	EF	SS	41	-	Y
19/Jul/18	SD	R7MT1	GT	SS	83	-	Y
19/Jul/18	SD	R7MT1	GT	SS	91	-	Y
19/Jul/18	SD	R7MT1	GT	SS	69	-	Y
19/Jul/18	SD	R7MT1	GT	SS	92	-	Y
19/Jul/18	SD	R7MT1	GT	SS	84	-	Y
19/Jul/18	SD	R7MT5	GT	SS	60	-	Y
19/Jul/18	SD	R7MT6	GT	SS	55	-	Y
20/Jul/18	SD	R10MT2	GT	SS	68	-	Y
20/Jul/18	SD	R10MT2	GT	LNS	137	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
20/Jul/18	SD	R10MT2	GT	AG	123	-	Y
20/Jul/18	SD	R8MT1	GT	SS	96	-	Y
19/Jul/18	SD	R8SN1	SN	AG	54	-	Y
19/Jul/18	SD	R8SN1	SN	AG	47	-	Y
19/Jul/18	SD	R8SN1	SN	AG	48	-	Y
19/Jul/18	SD	R8SN1	SN	AG	52	-	Y
19/Jul/18	SD	R8SN1	SN	AG	54	-	Y
19/Jul/18	SD	R8SN1	SN	AG	52	-	Y
19/Jul/18	SD	R8SN1	SN	SS	48	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN1	SN	AG	<55	-	Y
19/Jul/18	SD	R8SN3	SN	SS	47	-	Y
19/Jul/18	SD	R8EF3	EF	SS	67	-	Y
20/Jul/18	SD	R10EF1	EF	AG	290	-	Y
20/Jul/18	SD	R10EF1	EF	AG	264	-	Y
20/Jul/18	SD	R10EF1	EF	AG	207	-	Y
20/Jul/18	SD	R10EF1	EF	AG	148	-	Y
20/Jul/18	SD	R10EF1	EF	LNS	137	-	Y
20/Jul/18	SD	R10EF1	EF	SS	66	-	Y
20/Jul/18	SD	R10EF1	EF	AG	108	-	Y
20/Jul/18	SD	R10EF1	EF	SS	75	-	Y
20/Jul/18	SD	R10EF1	EF	SS	76	-	Y
20/Jul/18	SD	R10EF1	EF	SS	83	-	Y
20/Jul/18	SD	R10EF1	EF	SS	69	-	Y
20/Jul/18	SD	R10EF1	EF	SS	68	-	Y
20/Jul/18	SD	R10EF1	EF	SS	72	-	Y

Date	Study[1]	Location	Gear Type[2]	Species[3]	Fork Length (mm)	Total Length (mm)	Release Status
20/Jul/18	SD	R10EF1	EF	SS	66	-	Y
20/Jul/18	SD	R1SN9	SN	SS	39	-	Y
20/Jul/18	SD	R1SN9	SN	CH	76	-	Y
20/Jul/18	SD	R1SN10	SN	CH	70	-	Y
20/Jul/18	SD	R1SN10	SN	CH	60	-	Y
20/Jul/18	SD	R1SN10	SN	CH	64	-	Y
20/Jul/18	SD	R1SN10	SN	SS	64	-	Y
20/Jul/18	SD	R1SN10	SN	CH	58	-	Y
20/Jul/18	SD	R1SN10	SN	SS	36	-	Y
20/Jul/18	SD	R1SN10	SN	CH	63	-	Y

Notes:

1 Survey: YOY = Young of Year; OW = Overwintering; SD=Summer Distribution

Gear Type: EF = Backpack electrofisher; SN = Seine net; GT = Gee Trap

Species Codes: AG = Arctic Grayling; SS = Slimy Sculpin; BB = Burbot

APPENDIX B – ENVIRONMENTAL DNA ASSAY INFORMATION

Helbing Laboratory eDNA Technical Bulletin

All eDNA tools are validated through a rigorous multi-step evaluation protocol that includes tests of DNA target specificity and amplification sensitivity.

General eDNA Assay Information

Target Species : Chinook Salmon *(Oncorhynchus tschawytscha)*
Species Abbreviation : ONTS
eDNA qPCR Tool : eONTS5
eDNA qPCR Format : TaqMan

eDNA Assay Specificity Tests

A. qPCR Activity : Multi-species analysis of eDNA tool efficacy

Multiple qPCR reactions (n=25) performed per target DNA. Detection within the standardized eDNA qPCR assay = Yes

ONTS	ONKI	ONNE	ONGO	ONKE	ONMY	ONCL	THAR	LICA	HOSA	NTC
Yes	No	No	No	No	No	No	No	No	No	No

B. Confirmation of gene-specificity in eDNA assay :

eDNA Assay Sensitivity Test

DNA (ug/L)	Detection Frequency (n=25)	Binomial Standard error (n=8)
5	0.96	0.069282
1	0.96	0.069282
0.2	0.92	0.095917
0.04	0.68	0.164924
0.008	0.28	0.158745
0	0.00	0.000000

Appendix: Abbreviations

Chinook Salmon(*Oncorhynchus tschawytscha*)	ONTS
Coho Salmon (*Oncorhynchus kisutch)*	ONKI
Sockeye Salmon *(Oncorhynchus nerka)*	ONNE
Pink Salmon *(Oncorhynchus gorbuscha)*	ONGO
Chum Salmon *(Oncorhynchus keta)*	ONKE
Rainbow Trout *(Oncorhynchus mykiss)*	ONMY
Cuttthroat Trout *(Oncorhynchus clarkii)*	ONCL
Arctic Gralying *(Thymallus arcticus)*	THAR
American Bullfrog *(Lithobates(Rana) catesbeiana)*	LICA
Human (*Homo sapiens*)	HOSA
qPCR no template control	NTC
quantitative real-time polymerase chain reaction	qPCR
environmental DNA	eDNA

Helbing Laboratory eDNA Technical Bulletin

All eDNA tools are validated through a rigorous multi-step evaluation protocol that includes tests of DNA target specificity and amplification sensitivity.

General eDNA Assay Information

Target Species	:	Arctic Grayling *(Thymallus arcticus)*
Species Abbreviation	:	THAR
eDNA qPCR Tool	:	eTHAR1
eDNA qPCR Format	:	TaqMan

eDNA Assay Specificity Tests

A. qPCR Activity : Multi-species analysis of eDNA tool efficacy

Multiple qPCR reactions (n=25) performed per target DNA. Detection within the standardized eDNA qPCR assay = Yes

ONTS	ONKI	ONNE	ONGO	ONKE	ONMY	ONCL	THAR	LICA	HOSA	NTC
No	No	No	No	No	No	No	Yes	No	No	No

B. Confirmation of gene-specificity in eDNA assay :

eDNA Assay Sensitivity Test

DNA (ug/L)	Detection Frequency (n=25)	Binomial Standard error (n=8)
5	0.96	0.069282032
1	0.92	0.09591663
0.2	0.88	0.114891253
0.04	0.44	0.175499288
0.008	0.16	0.129614814
0	0.00	0

Appendix: Abbreviations

Chinook Salmon(*Oncorhynchus tschawytscha*)	ONTS
Coho Salmon (*Oncorhynchus kisutch)*	ONKI
Sockeye Salmon *(Oncorhynchus nerka)*	ONNE
Pink Salmon *(Oncorhynchus gorbuscha)*	ONGO
Chum Salmon *(Oncorhynchus keta)*	ONKE
Rainbow Trout *(Oncorhynchus mykiss)*	ONMY
Cuttthroat Trout *(Oncorhynchus clarkii)*	ONCL
Arctic Gralying *(Thymallus arcticus)*	THAR
American Bullfrog *(Lithobates(Rana) catesbeiana)*	LICA
Human (*Homo sapiens*)	HOSA
qPCR no template control	NTC
quantitative real-time polymerase chain reaction	qPCR
environmental DNA	eDNA