Fishing Branch River Chum Salmon Instream Incubation Trial (Year 1)

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EXECUTIVE SUMMARY

The Fishing Branch River is a major spawning destination for Porcupine River chum salmon. This project involved a trial to test the use of instream egg incubation to increase numbers of returning chum salmon to the Fishing Branch River in the Porcupine River watershed. Numbers of returning chum salmon have been falling in recent decades; however, the specific reason for these declines is not fully understood. It is believed a large number of chum salmon spawn in an area that is known to seasonally dewater; this portion of the river is wetted during the spawning period but during the late winter, flows cease and the area no longer has flowing water. The project involved collecting brood stock and using different incubation media to conduct instream incubation at various locations throughout the Fishing Branch River to better understand survival and emergent timing at different locations on the river.

Brood stock for the project was collected in the upper reaches of the Fishing Branch River in an area known to dewater during the winter months. A total of 4,991 eggs were collected and planted at various sites downriver from the brood stock collection site. Brood stock collecting and egg planting took place on September 30, 2019, and October 2, 2019. Fertilized eggs were planted at seven sites throughout the river including: a site close to the 2018 dewatered limit, a primary side channel, a groundwater fed tributary and in the margins of the main channel. The eggs were deployed using a combination of open and closed incubation media, Whitlock Vibert boxes, closed egg tubes (mesh bags. Eggs were also planted directly into the artificial redds using egg insertion pipes.

Success monitoring was conducted April 28, 2020, to determine hatching success at the sites. Inferred emergence success rates were variable across the site. The success rates for the small and large bags ranged from 0 to 52%. Results for the Whitlock Vibert boxes were not available as several were not found and suspected to be dug up by bears or spawning chum. A number of boxes were found to have nothing in them with no signs of dead eggs or alevin and no live alevin – this has not occurred during other similar projects and may be a result of the limited number of monitoring events.

The methods used for this trial project and the results gathered suggest that the approach has merit for increasing the number of returning spawners, particularly if brood stock is collected in the area known to seasonally dewater. A number of lessons were learned over the duration of the 2019/2020 project which should be able to make the second year of the instream egg incubation trial more successful.

ACKNOWLEDGEMENTS

Darius Elias of the Vuntut Gwitchin Government contributed to project planning and direction. Trix Tanner (Salmonid Enhancement Program - Fisheries and Oceans Canada) assisted with project permitting and provided advice on overall project direction. Funding for this project was provided by the Yukon River Panel's Restoration and Enhancement Fund and helicopter funding was provided by the Polar Continental Shelf Program.

AUTHORSHIP

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Dawn Hansen was the field crew leader for this project with assistance from Ben Schonewille and Scott Cavasin from EDI. Caleb Charlie from Vuntut Gwitchin First Nation also assisted during the field work portion of the project.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The Fishing Branch River is a major spawning destination for Porcupine River chum salmon (*Oncorhynchus keta*). Past Restoration and Enhancement panel work (CRE-27-03 through CRE-27-10) has indicated that in excess of 65% of chum salmon in the upper Porcupine River have been known to spawn in the upper reaches of Fishing Branch River, above the site of the Fisheries and Oceans Canada (DFO) enumeration weir (Map 1). The 2011 Integrated Fisheries Management Plan developed by DFO and the Yukon River Panel included an escapement goal of 22,000 to 49,000 chum salmon at the Fishing Branch weir (JTC 2018). Since 2006, counts at the Fishing Branch weir have displayed a downward trend and fallen within the lower end of, or below, this range during the last several years. Returns during 2016 and 2018 have been stronger but still well below historical levels; the 2019 also failed to meet the escapement goal with a final count of 18,170 at the weir (JTC (Joint Technical Committee of the Yukon River U.S./Canada Panel) 2020).

In light of these declines in chum salmon productivity, Vuntut Gwitchin Government (VGG) conducted four years of chum spawning habitat assessments and monitoring between 2013 to 2018. A key finding of the habitat assessment work was that a portion of the Fishing Branch River becomes dewatered during the winter months resulting in complete egg mortality for chum that spawn in this area (EDI Environmental Dynamics Inc. 2014, 2018a, b). The extent of this seasonally dewatered area varies from year to year and increases in length over the course of the winter and early spring. In some years, as many as 20% of the total number of redds upstream of the enumeration weir become dewatered (EDI Environmental Dynamics Inc. 2014, 2018a, b).

During 2017/2018, VGG and DFO collaborated on a trial project to transport chum eggs from the Fishing Branch River to raise eggs to fry stage in Whitehorse and then transport the fry back to Fishing Branch River during the spring. Unfortunately, this project was not completed due to a catastrophic fire at the McIntyre Creek facility.

The current project (instream egg incubation) potentially provides another tool to aid in chum stock restoration. It does not have many of the logistical issues of egg/fry transport or ecological risks, such as disease transfer and fry size at the time of release. Additionally, instream incubation has the advantage of having the eggs incubate under natural conditions. The Fishing Branch River has very good water quality for egg incubation including year-round open water due to the large groundwater inputs. Collection and fertilization of eggs considerably increases fertilization rates over natural conditions, thus allowing for higher egg survival. A drawback of instream incubation is that determining success can be a challenge given that the exact number of fry produced can be difficult to determine; however, new methods are proposed as a component of this project and other proposed instream incubation projects for Chinook salmon (*Oncorhynchus tshawytscha*) (e.g. Teslin Tlingit Council's Deadman Creek project and Tr'ondëk Hwëch'in's Klondike River project) to better determine success (EDI Environmental Dynamics Inc. 2017, 2019).

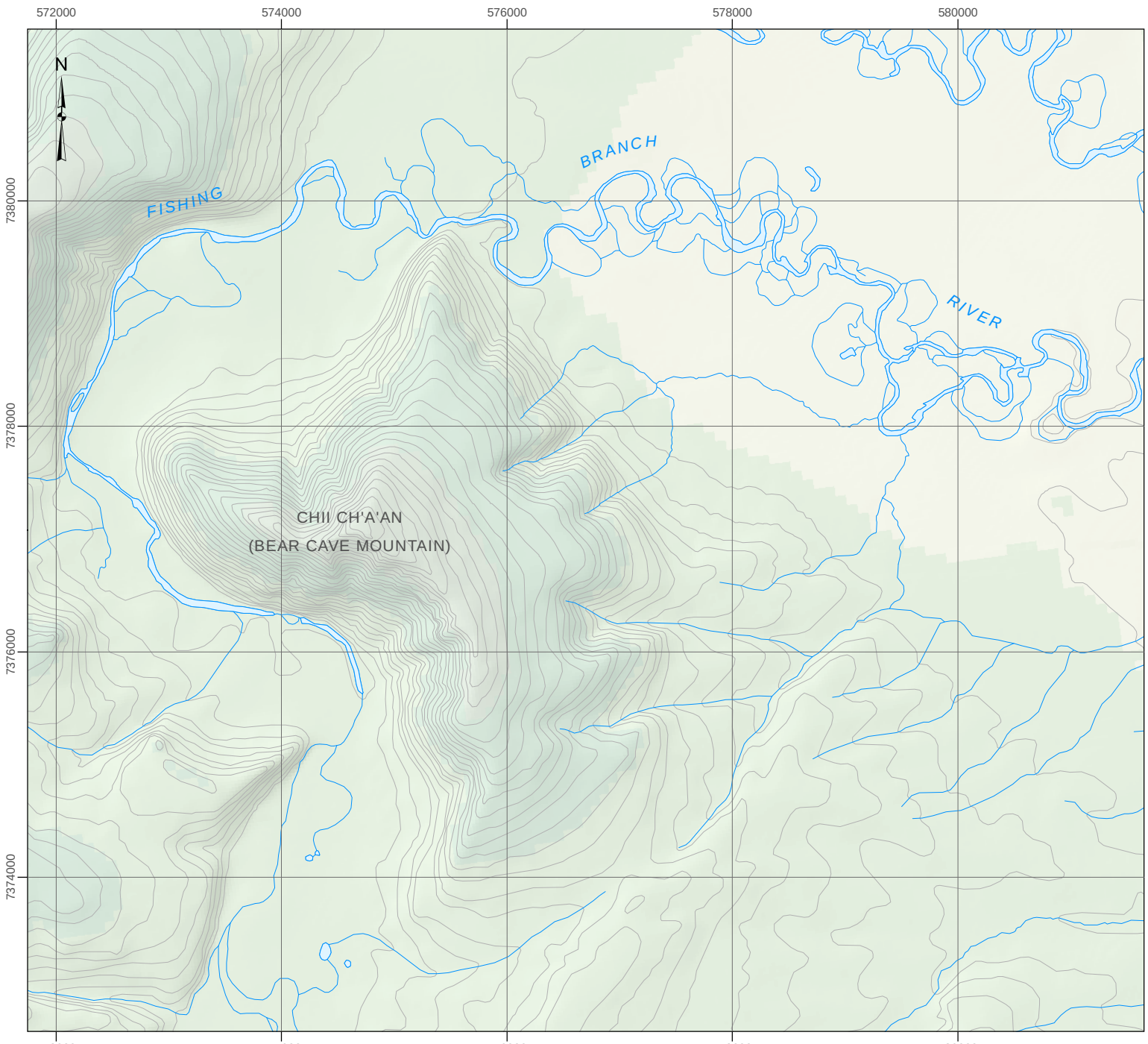
With this information in mind, the 2019 project aimed to remove spawning female chum salmon from the seasonally dewatered area, conduct an on-site egg take/fertilization and plant the fertilized eggs elsewhere in the river in spawning areas that do not become dewatered. The project also involved a very small egg take at

Fishing Branch to conduct instream egg incubation (assays) to collect data on egg survival in different habitats including areas that may be influenced by the seasonally dewatered area. The results of the 2019 work are intended to provide information on the feasibility of employing instream egg incubation as a method to help restore the chum spawning stock in the Fishing Branch River.

1.1 OBJECTIVES

The specific objectives for year one of the chum salmon instream egg incubation trial in the Fishing Branch River include:

- conducting an aerial chum redd survey within an extent that is consistent to previous years;
- collecting brood stock, conducting an on-site egg take/fertilization, and deploying up to 20,000 eggs at up to 12 sites in main and side channel (groundwater fed tributary) habitats; and,
- installing time lapse cameras within the vicinity of the seasonally dewatered area to document changes in habitat conditions over the winter.



Map 1. Overview of project area

Legend

- Contour (10m interval)
- Watercourse
- Waterbody

Map scale 1:50,000 (printed at 8.5x11)
Map Projection: NAD 1983 UTM Zone 7N

Data Sources

Digital Elevation Model and 1:50,000 National Topographic Database (NTDB) provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Disclaimer
EDI Environmental Dynamics Inc. has made every effort to ensure this map is free of errors. Data has been derived from a variety of digital sources and, as such, EDI does not warrant the accuracy, completeness, or reliability of this map or its data.

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2 METHODS

2.1 AERIAL SURVEY

An aerial survey was conducted to enumerate chum salmon redds within the project study area via helicopter. The survey was conducted from the lower reaches of the Fishing Branch River and documented redds both upstream and downstream of the dewatered limits identified in winter 2014, 2016 and 2017 (EDI Environmental Dynamics Inc. 2014, 2018a). The survey included enumerating redds in side-channel habitats, particularly in the lower portion of the study area.

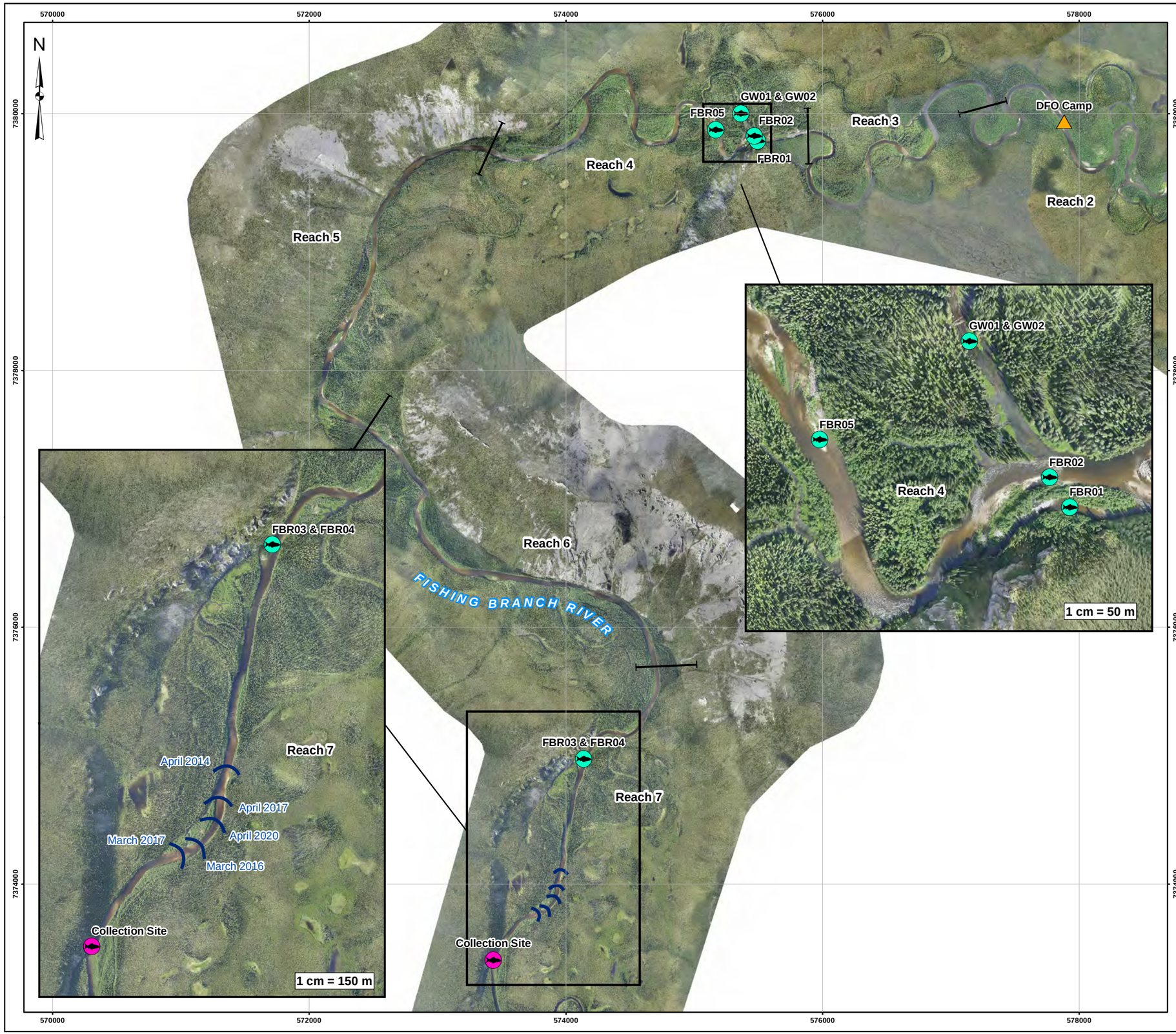
During the survey, observers were in the front and back seats on the passenger side of the helicopter looking over the river, with the best possible vantage point at approximately 30-45 m above ground level and flying 15 to 17 knots. Surveys were completed in an upstream direction. Observers wore polarized glasses to reduce glare and increase visibility into the water. All observed redds and spawning chum salmon were enumerated, and their locations recoded using a GPS. Spawning surveys were directed by and data were collected and recorded on an iPad using the mapping application Avenza Pro. Survey data were later used to map the location of chum salmon redds observed during the 2019 project.

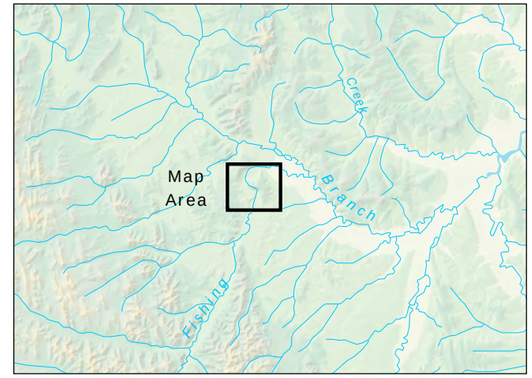
2.2 INSTREAM EGG INCUBATION

The project underwent a project review by the Yukon Environmental and Socio-economic Assessment Board during the summer of 2019, which was inclusive of the 2020 monitoring work for the project. Permits were issued by DFO for the 2019 work and included a Scientific Fish Collection License for the brood stock collection and spring monitoring event and an Introduction, Transplant and Transport (ITT) permit for the egg planting in the Fishing Branch River. The instream egg incubation (egg planting) component of the project involved the following components: site selection and preparation, brood stock collection, egg fertilization, egg deployment and spot velocity measurements.

2.2.1 SITE SELECTION AND PREPARATION

Using data collected during the four years of chum salmon habitat assessment, planting sites were chosen to focus on areas with high ground water influence including the main channel and side channels (Map 2). As well, sites close to or in the dewatered limit from 2017 were chosen to gather data on egg survival in this area. Sites were chosen with appropriately sized substrate and flow rates. The choices made for planting site locations were also sensitive to the abundance and close proximity of spawning chum salmon and natural redds.





Legend

- Instream Incubation Site
- Brood Stock Collection Site
- Department of Fisheries and Oceans Camp
- Upstream Extent of Wetted Channel (Date Noted)
- Reach Break

Instream incubation sites in the Fishing Branch River

Data sources

Digital Elevation Model and 1:1,000,000 National Topographic Database (NTDB) provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Project data displayed is site specific.

Aerial imagery provided by GroundTruth Exploration Ltd. (Collected June 2015)

This document is not an official land survey and the spatial data presented is subject to change.

0 500 1,000 1,500 2,000

Metres

Map Scale = 1:30,000 (printed on 11 x 17)
Map Projection: NAD 1983 UTM Zone 7N

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Vuntut Gwitchin First Nation

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At each of the planting sites, artificial redds were created by working/cleaning the substrate using hand tools to mimic natural red construction. The final step of site preparation was to move cleaned substrate to the sides of the deployment area, leaving a trench. It was within this trench that the Whitlock-Vibert boxes (WVBs), closed mesh bags and egg insertion pipes were placed during the egg deployment. After being planted into the stream, the incubation media were covered with the previously moved substrate and supplemented with additional stream substrate as needed. The GPS co-ordinates were collected for the egg planting sites and a rock with a unique combination of colored flagging tape was placed on each prepared site to facilitate relocation of the sites

2.2.2 BROOD STOCK COLLECTION

Brood stock was collected in the upper reaches of Fishing Branch River in an area known to dewater. All fish handled were collected by angling/snagging. Captured chum salmon were measured from nose to mid-eye and for fork length and sexed. Fish not suitable for brood stock (due to poor condition, lack of ripeness or spent) were released promptly; fish to be used for brood stock were temporarily placed in holding bags to allow for eggs and milt to be collected simultaneously.

2.2.3 EGG FERTILIZATION

When a sufficient number of males and females were captured to collect eggs and milt, each fish was carefully wiped dry and the eggs/milt placed in a new, dry plastic container. Collected eggs were enumerated by weight to obtain an estimate of the total number collected. Eggs and milt were placed in a clean dark cooler with an ice pack to keep cool until fertilization could take place.

Fertilization was done in batches with only enough eggs being fertilized for a single site or cluster of sites to reduce the amount of holding time of the fertilized eggs prior to being planted into the stream. Eggs were weighed to estimate the number required for each site. Milt from up to three males was used for each batch of eggs.

Egg fertilization was conducted near each egg planting site to reduce the amount of handling and transport into the stream. An umbrella was set up over the area to provide shelter from the rain/snow and sun during the fertilization and water hardening process. After being fertilized, the eggs were placed in a white bin to water harden and flush for 20 minutes before being loaded into the various incubation media for planting in the stream.

2.2.4 EGG DEPLOYMENT

Egg deployment at each site involved the use of three methods including WVBs, closed mesh bags and egg insertion pipes. The WVBs and closed mesh bags are used to provide a measure of hatching success and emergence success, respectively. The WVBs are a commercially available incubator, each of which was loaded with 175 to 200 fertilized eggs and buried in at the sites.

Two different sizes of closed mesh bags were used. One was a small mesh bag (approximately 30 cm x 15 cm) that is half circle in shape with zippers along the outer, round edge. The other was a larger mesh bag that is rectangular in shape and approximately 30 cm x 15 cm x 10 cm. Both bags were filled with substrate using a shovel and buried in the planting site. An egg insertion pipe was used to deploy a predetermined number of eggs into the bag to mimic natural conditions and provide a surrogate for monitoring the survival of eggs planted using an egg insertion pipes. Once the eggs were planted into the bag, the pipe was carefully removed, the zipper on the bag closed and the whole bag buried within the site. The mesh bags were constructed of fine mesh and were designed to hold rocks to allow for the fate of eggs/alevin to be determined following retrieval.

One to two egg insertion pipes were used at sites with an adequate number of eggs available to be planted and provided a more rapid method of planting eggs; however, the eggs are not contained and therefore obtaining a quantitative estimate of survival is not possible. The number of eggs planted using the pipes was dependent upon substrate conditions with larger, deeper amounts of substrate allowing for more eggs to be planted. Half of the eggs were placed into the pipe at a depth of approximately 25 cm below the surface of the bed, with the remainder deposited 5 to 10 cm closer to the bed surface.

Incubation media were marked with a color combination of flagging tape unique to each planting site and sketched onto a site plan to facilitate success monitoring. Following the placement of eggs at each site, previously cleaned substrate was piled into a mound to protect the eggs and mimic the construction of a natural chum redd.

2.2.5 SPOT VELOCITY MEASUREMENTS

Spot velocities were collected using a Swoffer velocity meter at all egg planting sites and at nine natural chum salmon redds. Natural redds measured were in close proximity to planting sites Velocity measurements were collected at 60% of the water depth, which is the standard for stream discharge measurements, and directly above bed, with the latter providing a more adequate representation of intra-substrate flow. The spot velocities were collected to determine what flow rates chum salmon are spawning in and if this is a limiting factor in site selection. This information will also be used to compare success rates of each planting site to if there is a correlation with flow rates.

2.3 TEMPERATURE MONITORING

Temperature loggers were deployed at each site during planting in 2019. Tidbit V2 loggers were programmed to record hourly water temperature data. Loggers were placed in the bags used for egg planting so they could easily be retrieved during spring monitoring.

2.4 REMOTE CAMERAS

Two remote field cameras were installed along the Fishing Branch River at the same locations used during the 2017/2018 habitat assessment project – approximately 100 m downstream of the brood stock collection

location and just downstream from FBR03 and FBR04. Both cameras were attached to trees along the riverbank using bungie cords and set up to take one photo every hour. Images from remote cameras during previous years of work on Fishing Branch River were helpful in determining the timing and extent of water in the area each season.

2.5 SUCCESS MONITORING

Success monitoring was conducted on April 28, 2020. The primary objective of this monitoring was to determine survival to the alevin stage (WVBs) and fry emergence (closed mesh bags). Egg planting media was also retrieved from the river at this time.

3 RESULTS AND DISCUSSION

3.1 AERIAL SURVEY

A full aerial survey was not completed during 2019, largely due to inclement weather and the associated poor visibility for accurately counting spawning chum and redds. Helicopter fuel limitations and the need to limit disturbance to bear viewing activities near the Bear Cave Mountain Eco-Adventures camp were also contributing factors in not being able to complete the survey. However, portions of the chum spawning area were surveyed on September 30, 2019, and it was found that the distribution of chum spawning redds was very similar to that of previous years. Five large clusters of spawning chum and redds were noted including: three large clusters near the foot of Bear Cave Mountain and the associated groundwater fed tributaries, one large cluster in the main channel of the river near the Bear Cave Mountain Eco-Adventures camp and one large cluster upstream of Bear Cave Mountain (Appendix A). This final cluster is of particular interest given it is in a location that has been known to become seasonally dewatered in previous years; an estimated 150 to 175 chum redds are located within this area. This cluster was also the location used as brood stock collection for this project as chum eggs naturally spawned in this area are not expected to survive.

3.2 INSTREAM EGG INCUBATION

The timing of brood stock collection and egg planting appeared to coincide with the middle of the chum salmon spawning period, late September and early October. Due to the number of chum salmon that spawn in Fishing Branch River, along with the long run time and multiple pulses of fish, timing is much easier to determine for collecting brood stock compared to other rivers with smaller run sizes. However, logistics to accessing Fishing Branch River does present a unique set of challenges with the collection of brood stock. Weather and mechanical delays are a regular occurrence when travel to/from Eagle Plains and Fishing Branch River.

3.2.1 SITE PREPARATION

Due to the lack of sedimentation and large substrate in the Fishing Branch River, site preparation did not take much time compared to other similar projects completed in different parts of the Yukon Territory. Two crew members prepared planting sites and collected additional substrate to cover the site, while two other crew members were enumerating and fertilizing the eggs to be planted at the site.

3.2.2 BROOD STOCK COLLECTION

Brood stock collection was done in the upper reaches of Fishing Branch River in the dewatered area identified during the 2016 and 2017 chum salmon habitat assessments. Brood stock collection was completed during the morning to allow for egg planting in the afternoon. A total of 48 chum salmon were captured. On the first day of brood stock collection (September 30, 2019), only one out of the 10 capture chum salmon was spent.

However, on the second day of brood stock collection (October 2, 2019), most fish were spent(i.e., 33 of the 38 captured chum salmon). During brood stock collection, large amounts of chum salmon were observed spawning in the upper area known to dewater in late winter; 150 to 175 redds were estimated in this area. Of the 48 captured chum, 34 (71%) were males. Males ranged from 590 to 700 mm in fork length with an average of 658 mm. Female fork lengths ranged from 605 to 700 mm and averaged 646 mm. A total of three females were live spawned for brood stock, with one involving a complete egg take and two being partial takes. A total of 4,991 eggs were collected and planted in Fishing Branch River. Milt was collected from a total of eight males with the milt or one to three males being used to fertilize each batch of eggs.

3.2.3 EGG FERTILIZATION AND DEPLOYMENT

A total of 4,991 eggs were planted in the Fishing Branch River during 2019 (Table 1). This total was below the initial target of 7,200 eggs and resulted from difficulties catching ripe females on the last day of brood stock collection. To enumerate the number of eggs collected a weight apportionment was used. This was done by removing most of the ovarian fluid, and then counting and weighing a subsample to determine the weight per egg. The total weight of all eggs collected was measured and the number of eggs collected was estimated.

Seven sites were planted with fertilized eggs in Fishing Branch River: two sites were in a groundwater tributary, one site in a main side channel, and four sites in the main stem of the river. The two sites in the groundwater tributary (GW01 and GW02, Table 1) were located in a previously documented area with year-round groundwater influence and consistent seasonal water temperature regimes. One of the sites in the main channel (FBR03, Table 1) was located just downstream of the dewatered limit documented in 2018. Sites contained a minimum of two WVBs and one closed mesh bag (large or small) with other sites containing both a small and large closed mesh bag. Site GW02 contained the most media used with the addition of two egg insertion pipes. This was done due to the number of eggs available and the previous spawning success documented in the area.

Table 1. Summary of egg planting in Fishing Branch River 2019.

River/Creek	Site	Whitlock-Vibert Boxes		Closed Mesh Bags		Egg Insertion Pipes		Total
		W-A	W-B	C-A (Large)	C-B (small)			
Groundwater Tributary	GW01	200	200	-	125	-	-	**525**
Groundwater Tributary	GW02	200	200	200	125	270	270	**1,265**
Fishing Branch River	FBR01	200	200	144	144	-	-	**688**
Fishing Branch River	FBR02	200	200	123	100	-	-	**623**
Fishing Branch River	FBR03	200	200	240	-	-	-	**640**
Fishing Branch River	FBR04	200	200	-	150	-	-	**550**
Fishing Branch River	FBR05	175	175	200	150	-	-	**700**
Total		**1,375**	**1,375**	**907**	**794**	**270**	**270**	**4,991**

3.2.4 SPOT VELOCITY MEASUREMENTS

Natural redd depths ranged from 0.13 to 0.63 m and velocities ranged from 0.03 to 0.67 m/sec. Planting site depths ranged from 0.12 to 0.42 m with velocities of 0.2 to 0.82 m/sec. The majority of the planting sites fall between the natural depth and velocity ranges (Table 2). One planting site is just below the natural redd depth range as well, a single planting site is higher than the natural redd velocity range. Although there is some variance in the depths and velocities at planting sites, each site was in close proximity to several natural redds and spawning chum salmon.

Table 2. Spot velocity measurements collected at all artificial redds and nine natural redds using a Swoffer velocimeter, September 30 and October 2, 2019.

River/Creek	Site	Depth (m)	Velocity Just Above Bed (m/s)	Velocity at 60% Depth (m/s)
Groundwater Tributary	GW01	0.4	0.17	0.2
Groundwater Tributary	GW01 - Natural Redd	0.6	0.14	0.03
Groundwater Tributary	GW01 - Natural Redd	0.63	0.08	0.05
Groundwater Tributary	GW02	0.41	0.11	0.2
Fishing Branch River	FBR01	0.26	0.25	0.45
Fishing Branch River	FBR01 - Natural Redd	0.3	0.29	0.52
Fishing Branch River	FBR01 - Natural Redd	0.22	0.24	0.42
Fishing Branch River	FBR02	0.42	0.49	0.82
Fishing Branch River	FBR02 - Natural Redd	0.18	0.37	0.51
Fishing Branch River	FBR03	0.42	0.2	0.41
Fishing Branch River	FBR04	0.42	0.18	0.23
Fishing Branch River	FBR05	0.12	0.57	0.63
Fishing Branch River	FBR05 - Natural Redd	0.5	0.39	0.59
Fishing Branch River	FBR05 - Natural Redd	0.17	0.48	0.56
Fishing Branch River	FBR05 - Natural Redd	0.13	0.55	0.6
Fishing Branch River	FBR05 - Natural Redd	0.25	0.51	0.67

3.3 TEMPERATURE MONITORING

Due to the groundwater input, the water of the Fishing Branch River has consistently warm temperatures through the winter months. Out of the five temperature monitors, only two dipped below 1°C throughout the monitoring period of October 3, 2019, to April 27, 2020; the five sites followed the same pattern until early January, with sites FBR02 and FBR05 having more exaggerated changes (Figure 1). Site FBR01 had the warmest average temperature, 4.6° C, throughout the monitoring period. The temperature of the groundwater channel at GW01 and GW02 was slightly below FBR01, with an average of 4.3°C, followed by FBR03 at 3.5°. Sites FBR02 and FBR05 had the coolest temperatures, with averages of 2.2 and 2.1°C, respectively, during the monitoring period. The temperature at FBR02 ranged between 1 to 4°C from October until the end of November, and then dropped down to 0.5°C by December 4, 2019, with a fluctuating, generally increasing, pattern to follow until April, 2020. On January 14, 2020, the temperature at FBR05 began to drop and reached 0.4°C on January 21, 2020, which is when the temperature at FBR02 began to rise. On March 21, 2020, the temperature at FBR05 reached its lowest at -3.8°C on March 29, 2020. During this time, a portion of the site may have been exposed to the air, as this was observed during the monitoring trip in late April. By April 18, 2020, the temperature at FBR05 was back up to 4.9°C and mirrored FBR02 and FBR03 for the remainder of the monitoring period.

Chum salmon egg development varies, with hatching occurring between 400 and 600 Accumulated Thermal Units (ATUs) and emergence occurring between 700 and 1000 ATUs (Tomaro et al. 2007). Temperature monitoring data suggest that development rates may also vary considerably throughout the Fishing Branch River (Figure 2). Sites FBR01, GW01 and GW02 reached 400 ATUs by the beginning of January, 2020, with FBR03 reaching 400 ATUs by late January. However, FBR02 and FBR04 and FBR05 reached 400 ATUs by mid April, 2020. The groundwater channel sites and FBR01 were reaching emergence stage ATUs before FBR02, FBR04 and FBR05 had reached hatching stage ATUs. Data collected at the warmer sites are consistent with published data on chum salmon development rates. However, the colder sites (FBR02, FBR04 and FBR05) are not consistent with known chum salmon development rates with development more advanced than would have been expected based upon water temperatures.

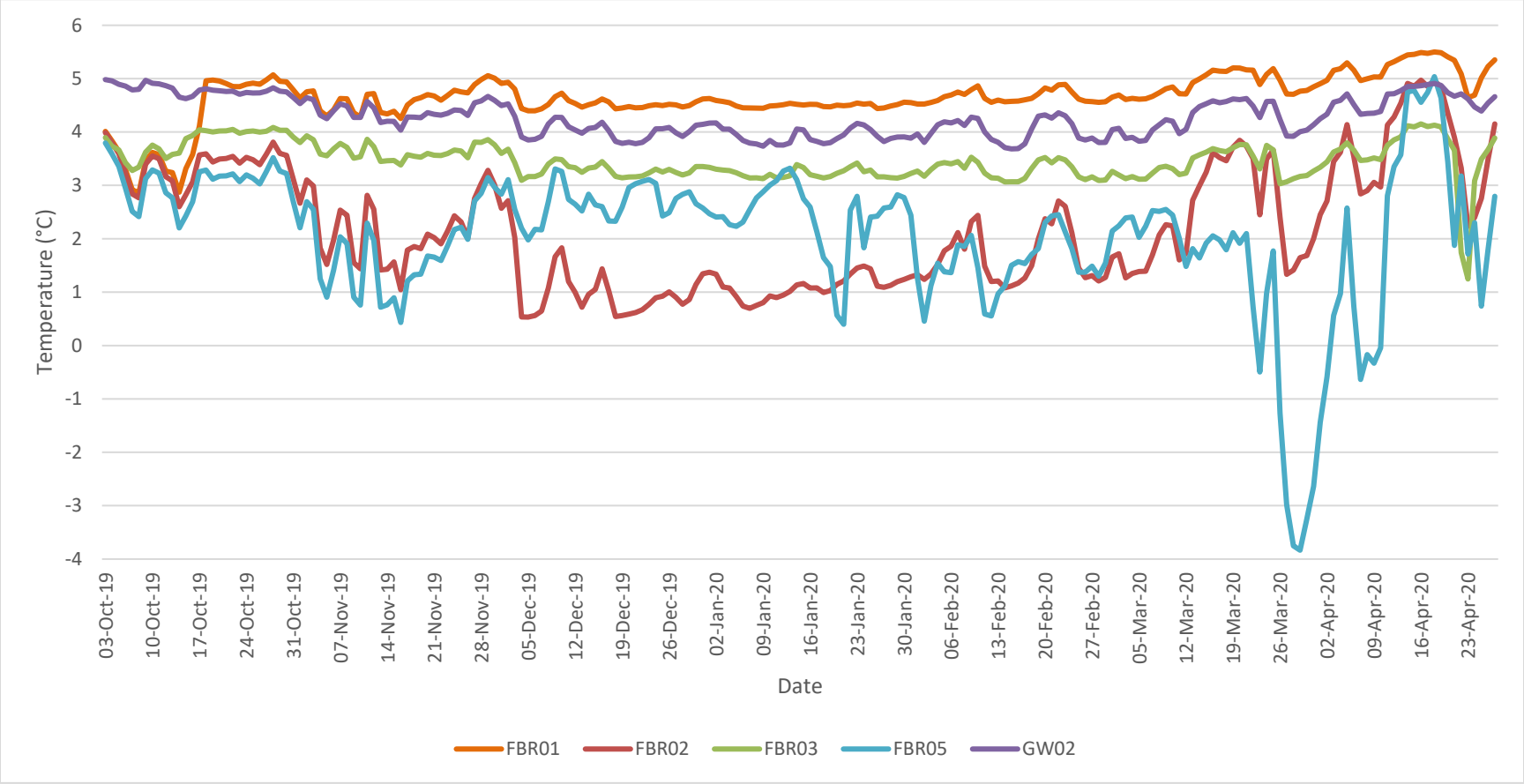

Figure 1. Water temperatures at egg planting sites in Fishing Branch River from October 3, 2019 to April 27, 2020.

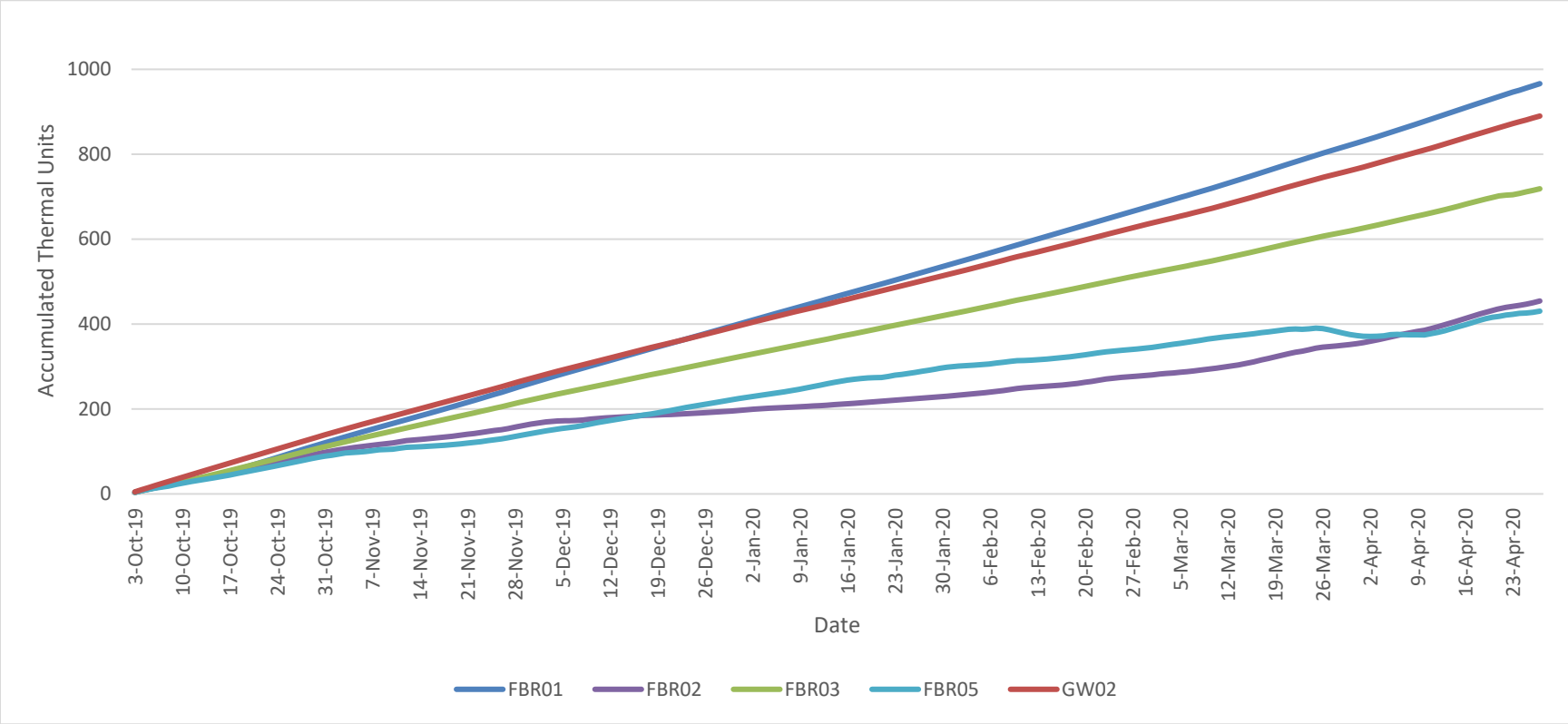

Figure 2. Accumulated Thermal Units (ATUs) from the Fishing Branch River planting sites.

3.4 REMOTE CAMERAS

Based on images from remote cameras, the site approximately 100 m downstream from the brood stock collection site on the Fishing Branch River became cut off from water flow on February 19, 2020. The river in this area is fed solely from groundwater discharge at a nearby spring during the winter months. On March 28, 2020, the river became dry at this location, with no more input from the groundwater discharge location (see photos in Appendix A). In mid April, 2020, a warm period occurred, with air temperatures reaching 14°C on April 15, and flowing water was present on April 22. By April 26, 2020, the river appears to be dry with frozen ice jams throughout the visible area. This is consistent with crew observations during the success monitoring trip, where the river was dry with small residual pools and large amounts of ice jams.

The remote camera just downstream from FBR03 and FBR04 became obstructed by snow shortly after being deployed and remained that way for most of the winter season. On April 18, 2020, the water level in the Fishing Branks River at this location appears to be comparable to water levels observed during success monitoring. By April 22, 2020, the river was flowing at moderate levels before declining again by April 27, 2020.

3.5 SUCCESS MONITORING

Success monitoring results are presented separately in the following sections for each individual site. Each site had varying success and conditions and therefore each site is presented and discussed individually.

Success monitoring was conducted on April 28, 2020. Monitoring trips are typically scheduled early in the development stage - when eggs are at the early alevin stage – to monitor the success of the WVBs. At this time, all dead eggs are counted and live alevin are released and the hatching success can be calculated. Due to the remoteness of the Fishing Branch River and the logistical challenges and associated cost of visiting the site, only one monitoring trip was done late in the season when the chum salmon would be close to emergence. During the monitoring trip, five of the 14 planted WVBs were completely empty (one WVB had three dead alevin left out of the original 200 planted). This could suggest that there was 100% hatching success and all the emergent fry had left the box; however, this cannot be confirmed. Additionally, five of the planted WVBs where not relocated. At FBR01, flagging from the boxes was found in the forest. It is believed the missing WVBs were either dug up by spawning chum salmon and washed away or they were dug up by grizzly bears.

Results were also variable for the closed mesh bags planted at each site. Several bags were found to have few dead eggs or signs of dead eggs and no signs of live or dead alevin and or fry. In one case, there was no sign of any eggs, alevin or fry. In cases where few emergent fry were discovered but the combined total of the fry/alevin and dead eggs did not equal the planted number of eggs, only the number of live fry/alevin was used to calculate the success rate. The remaining number of missing eggs may have been consumed by invertebrates found in the bag.

3.5.1 FBR01

Site FBR01 was in a primary side channel and had many spawning chum salmon throughout the channel at the time of brood stock collection and egg fertilization in September/October 2020 (Map 2). This site had two small bags planted with 144 eggs planted in each.

At the time of the success monitoring in April 2020, one of the bags had 16 live emergent fry and 55 dead eggs for an inferred hatching success of 11%. The other bag was found to have 74 dead eggs and no signs of living or dead alevin or emergent fry; therefore, the success rate could not be determined. Both bags at this location were found to have lots of fines and sand within the bag as well as invertebrates.

In April 2020, water velocity at FBR01 was consistent with velocities measured at nearby two natural redds. During monitoring, a visual assessment of the flow determined it was sufficient for egg survival and consistent with what would be expected at that time of year. This site was the warmest of all sites planted with eggs, with water staying above 4°C for the majority of the monitoring period. The ATU data suggest eggs planted at this site would have hatched between December 2019 and February 2020 and emergence would have occur between March 2020 and May 2020. This information fits with observations made during success monitoring in April 2020, when crew members found emergent fry in one of the bags and no signs of alevin present.

Photo 1. Large mesh bag planted at site FBR01 with sediment from the bag visible in the surrounding water.

Photo 2. An upstream view at FBR01 on April 27, 2020.

3.5.2 FBR02

Site FBR02 was located on the margin of the main channel on the opposite side of a groundwater fed channel (Map 2). In the fall of 2019, two bags, one small and one large, were placed at the site and planted with 100 and 123 eggs, respectively.

In April 2020, the small bag containing 100 eggs was found to be completely empty with no signs of dead or living eggs, alevin or fry; this has not been observed in similar projects at other rivers in the Yukon (EDI Environmental Dynamics Inc. 2017, 2019). Typically, there are signs of dead, rotting eggs within the bag even if a complete failure. Eggs may have been consumed by invertebrates. This bag was also found to be very clean and free of fines and sand. The larger bag was found to have 13 dead alevin and 27 live fry for an inferred emergence success of 22%. The large bag was found to have invertebrates, fines and organics collected in it. Visual assessment of flow in the area was sufficient for egg survival and consistent with what would be expected. Additionally, lots of chum fry were observed in side pools in the vicinity of FBR02.

Site FBR02 was one of the coldest sites planted during 2019/2020 and does not follow known development rate data available for chum salmon. Data collected at this site suggest eggs planted would not reach the hatching stage (400 ATUs) until April 2020. At the time of monitoring, this site reached 454.3 ATUs. However, during success monitoring, crews found live emergent fry at this site, at 246 ATUs less than required to reach the emergent stage. This has been seen in a similar project on Deadman Creek with Chinook salmon. It is believed eggs have a base rate of development when temperatures reach below 1.6°C and therefore hatching, and particularly fry emergence, can occur at far less ATUs than in a hatchery setting (EDI

Environmental Dynamics Inc. 2018c) where water temperatures are typically warmer than most natural Yukon river systems.

Photo 3. **Small bag planted at site FBR02 with very clean cobble.**

Photo 4. **Downstream view of site FBR02 on April 27, 2020.**

3.5.3 FBR03

Site FRB03 was located immediately downstream of the dewatered limit observed in 2018 (Map 2). At the time of egg planting, this site was just outside of the thalweg where flow was observed to be quite high. One large bag was placed in this location with 240 eggs. Flow rates measured at the site were consistent with other flow rates measured at various natural redds.

At the time of success monitoring in April 2020, the site was still wetted. A visual assessment of the flow determined it was lower than in the fall of 2019, but consistent with the expected flows given the time of year. During monitoring, the bag was found to be partially uncovered and containing a total of 11 fry, for an inferred emergence success rate of 7%. Minimal amounts of fines and large numbers of invertebrates were found within the bag.

Site FBR03 was one of the warmer sites, with water temperatures with a average temperatures staying above 3°C during the monitoring period. Temperature data suggest hatching would have occurred between late January and late March 2020, with emergence beginning in late April 2020. This is consistent with what was observed during success monitoring in late April, with crews finding live emergent fry. Furthermore, the results from this site are consistent with published chum salmon egg development data (Tomaro et al. 2007).

Photo 5. Large bag planted at site FBR03 with clean substrate.

Photo 6. Overview photo of FBR03 and FBR04 on April 27, 2020.

3.5.4 FBR04

Site FBR04 was located immediately downstream of FBR03 (Map 2). Similar to FBR03, this site was located just outside of the thalweg where flow rates were observed to be high. In the fall of 2019, one small bag was placed at FB04 with 150 eggs.

A visual assessment of the flow during success monitoring in April 2020 determined flows were suitable for egg incubation. During monitoring, the bag was partially exposed to the air. A total of 36 live fry and three dead alevin were counted within the bag, giving it an inferred emergence success rate of 24%. The bag was found to have moderate amounts of fine sediment built up and a moderate number of invertebrates present. No temperature logger was planted at FBR04; however, due to its close proximity to FBR03, it likely followed the same temperature regime detailed in the previous section.

Photo 7. Small bag planted at FBR04 with dead eggs visible in the bag.

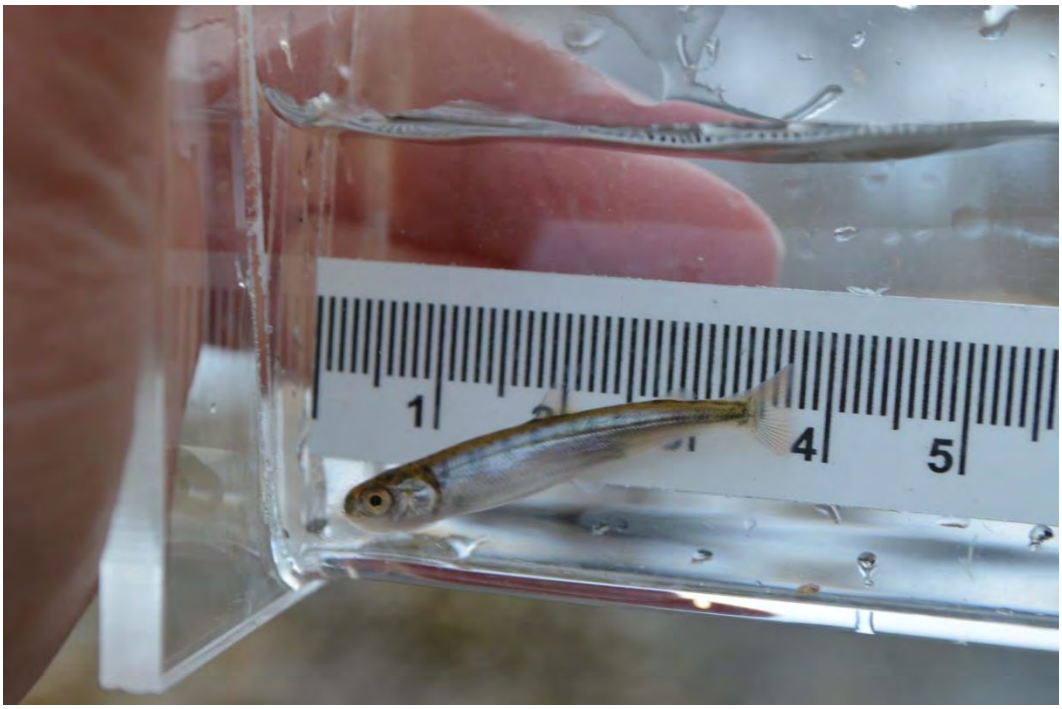

Photo 8. Chum salmon fry from the small bag at FBR04.

3.5.5 FBR05

Site FBR05 was located on the margin of the main channel close to an area with a large cluster of chum salmon redds (Map 2). During egg planting in fall 2019, several chum salmon were observed spawning in close proximity to the site. A large and small bag had been placed at this site with 200 and 150 eggs, respectively (although 50-70% of the eggs blew out of the large bag during planting). Water velocity measurements at FBR05 and surrounding natural redds were the highest out of all the velocity measurements during the fall of 2019.

During the success monitoring in April 2020, observations made through visual assessment indicated that flows were very low with the top portion of the site dry and minimal flow through the substrate. Even with the low flows, emergence at FBR05 was relatively high compared to other sites in 2020. The small bag was found to have two live alevin for an inferred emergence success of 1%.However, the large bag was found to have six live fry and 62 live alevin for an emergence success rate of 52%.

Water temperature data show that this site was the coldest out of all the sites planted in 2019, dropping below 0°C for several days in late March 2020. Similar to FBR02, this site was not consistent with known chum salmon development rate data (Tomaro et al. 2007). Temperature data collected at this site suggest eggs would not have hatch until mid April 2020, with emergence taking place sometime after that. Crews did find many live and dead alevin at this site, but they also found six live fry in one of the bags. At the time of monitoring, this site was at approximately 430 ATUs, which was 270 ATUs below when alevin would be expected to reach the emergent stage.

Photo 9. Upstream view at FBR05 with flagging visible at the planting site.

Photo 10. Image of the large and small bag planted at FBR05 after minimal amounts of substrate removed.

3.5.6 GW01

Site GW01 was located in a groundwater fed side channel that has been a large focus of project work during four years of ongoing chum habitat assessment and monitoring (EDI Environmental Dynamics Inc. 2018b) During egg planting in the fall of 2019, the water velocity measurement at the site and the number of natural redds had the lowest observed measurements out of all the sites. However, even with the low water velocity measurements, there were still large numbers of spawning chum salmon throughout the groundwater channel. One small bag was placed at GW01.

During the success monitoring in April 2020, water flows were visually assessed to be similar to conditions during planting. The one small bag at GW01 had a large amount fines and sand accumulated in it and had zero live alevin or fry. Lack of success at this site may be due to the amount of sediment built up in the bag. No temperature logger was planted at GW01; however, due to its close proximity to GW02, it likely followed the same temperature regime detailed in the next sections.

3.5.7 GW02

Site GW02 was located approximately 3 m downstream from GW01. Conditions observed during planting and monitoring were consistent with those at GW01, as explained in Section 3.5.6. In fall 2019, one large bag and one small bag were placed at GW02, with 200 and 125 eggs, respectively.

During success monitoring in April 2020, the large bag was found 100% exposed and rolled away from the planting site. It is believed this bag was dug up by a grizzly bear. The small bag was found to have large

amounts of fines and sands accumulated within it, and was, therefore, consistent with GW01. A total of 96 dead eggs were counted and 14 dead alevin, for an inferrred hatching success of 11%.

The water at the groundwater sites was the second warmest out of all the sites, staying above 3.5°C during the monitoring period. Temperature data suggest eggs planted at this site would have hatch between January and February 2020 and reached the emergent stage in mid March 2020. Due to the poor success at both GW01 and GW02, development stages based on temperature and ATU data could not be compared to results observed during success monitoring.

3.5.8 DEWATERED LIMIT INVESTIGATION

On April 28, 2020, field crews investigated the dewatered limit of the Fishing Branch River and walked upstream to the brood stock collection site (Map 2). Crew members chipped holes through the ice and dug into the river substrate to attempt to locate dead/frozen chum salmon eggs or alevin. Crews dug approximately 30 holes in various locations throughout the river, including areas identified to have spawning chum salmon during the aerial survey; however, they were unable to locate any eggs or alevin. Several residual pools with many dead and living slimy sculpin were observed. These pools ranged from 20 cm across to large pools 1 m across by 2.5 m long. It is likely that the high water flow event prior to the field visit may have contributed to the inability to locate and dead eggs of alevin within the seasonally dewatered area.

4 CONCLUSION

Whitlock-Vibert boxes and closed mesh bags are used to provide a measure of hatching success and emergence success, respectively. Due to the number of missing WVBs and the abnormal results from those that were found in the Fishing Branch River during 2019/2020, hatching success could not be accurately determined. Emergence success was quite variable across all sites, ranging from 0 to 52%, with higher success rates at sites in the main channel of the Fishing Branch River. High success rates in the main channel may be a result of higher water velocities, resulting in less build up of sediments and higher dissolved oxygen levels.

The project showed that catching brood stock within the area known to seasonally dewater and planting their eggs in areas where dewatering does not occur is a possible method to allow for these eggs to survive as opposed to not surviving due to dewatering. The project methods will require some refinement for future years to increase success. However, the presence of some sites with moderate to high survival is promising for increasing survival in subsequent years of the project. In future years of the project, the following items are recommended to be incorporated into the project:

- The use of WVBs should be discontinued due the inability to conduct regular site checks during the incubation period.
- The number of closed mesh bags should be increased to obtain more confidence in egg to fry survival at each site.
- The number of planting sites near the dewatered limit should be increased to further refine the understanding of how chum salmon eggs are affected by seasonal dewatering.
- More time and emphasis should be placed on investigating the late winter dewater limit to get a better understanding of the number of affected chum salmon redds and the implications for egg survival.
- A complete aerial survey of the portion of Fishing Branch River where chum salmon spawn should be done at the end of the spawning period. This will allow for a more accurate account of spawning distribution and relative distribution of redds after the completion of the spawning period

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APPENDIX A. PHOTOGRAPHS

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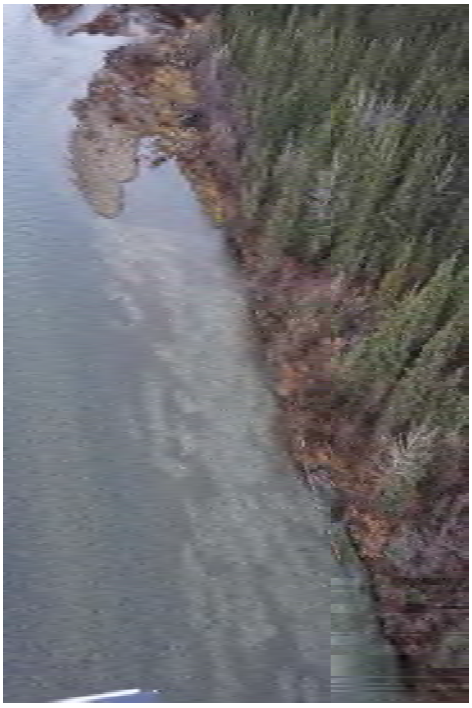

Photo 1. Large cluster of chum salmon redds near Bear Cave Mountain (FBR05).

Photo 2. Portion of a large cluster of chum salmon redds in the seasonally dewatered area where brood stock was collected.

Photo 3. Caleb Charlie with a male chum salmon.

Photo 4. Female Chum salmon used for brood stock collection.

Photo 5. Gathering length data during brood stock collection.

Photo 6. Fertilization process of collected chum salmon eggs.

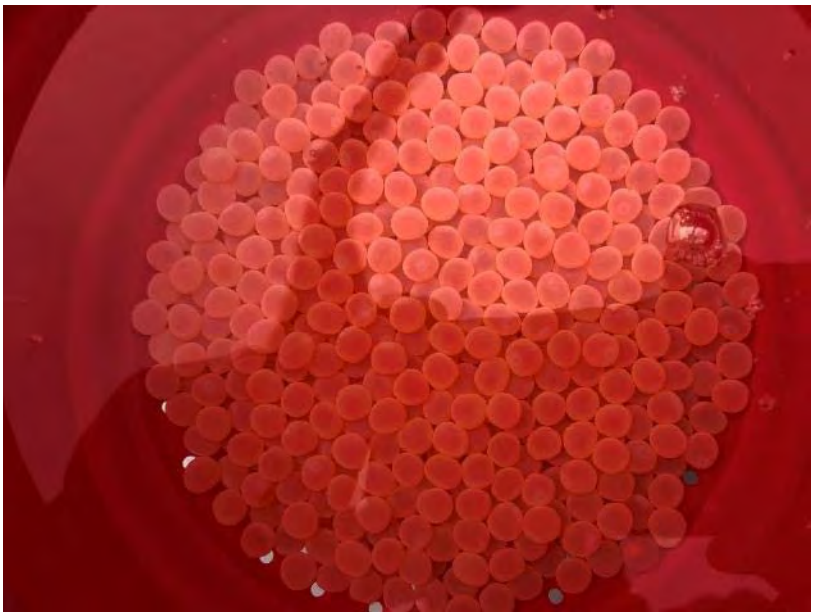

Photo 7. Water hardening of chum salmon eggs.

Photo 8. Fertilized chum salmon eggs ready to be planted, two Whitlock-Vibert Boxes and two containers for planting in closed mesh bags

Photo 9. Closing up the small mesh bag after egg insertion, with gathered rocks ready to cover the site.

Photo 10. Collecting spot velocity measurements at FBR01.

Photo 11. Large numbers of spawning chum salmon at FBR02.

Photo 12. Photo of several chum salmon fry from site FBR04.

Photo 13. Photo of several alevin from site FBR02.

Photo 14. Photo of a Whitlock-Vibert box from site FBR05 with lots of dead eggs.

Photo 15. Upstream view at the dewatered limit of Fishing Branch River on April 28, 2020.

Photo 16. Example of a small residual pool located in the dewatered area with two dead slimy sculpin, April 28, 2020.

Photo 17. Upstream photo of a hole dug into the substrate within the dewatered limit.

Photo 18. Aerial photo of the dewatered brood stock collection area where several spawning chum were observed.

Photo 19. Time lapse photo facing upstream when temperatures reach 14°C, April 15, 2020.

Photo 20. Time lapse photo taken April 22, 2020 with high flows.

Photo 21. Time lapse photo taken April 26, 2020 with no visible flow and large amounts of ice.