

# **2018 Tay River Chinook Salmon Access Investigation**

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## ABSTRACT

This report details the results of the 2018 Tay River Chinook Salmon Access Investigation project. The project objectives were to determine the presence or absence of Chinook salmon (*Onchorynchus tshawytscha*) in the Tay River, estimate the Chinook production potential of the system and investigate the feasibility of modifying the identified barrier to allow Chinook salmon passage into the system.

Sampling for the presence of juvenile Chinook was conducted on the lower Tay River in June 2018. Gee trapping and beach seining yielded a total of 670 juvenile fish, none of which were juvenile Chinook. eDNA sampling occurred at 5 separate sites on the Tay River. Six eDNA samples were collected in June and six in August. All twelve samples tested negative for the presence of Chinook. In addition to the sampling regime an aerial survey to look for the presence of spawning adult salmon was conducted on August 24 over the upper 72 km of the Tay River drainage. No spawning Chinook were observed. The results of the 2018 samplings and aerial survey of the Tay River indicated Chinook were not present in the system.

The production potential of the Tay River system was estimated using a freshwater habitat area model based on the meta-analysis of the known production of 25 Chinook stocks. The estimated annual maximum sustained yield (Smsy) of Chinook salmon for the Tay River system based on this model was 6,820.

During the August 2018 survey of the Tay River the entire drainage was over flown at low level by helicopter. The identified velocity barrier located 4 km upstream from the confluence with the Pelly River was the only probable barrier to adult salmon migration identified on the Tay River. This velocity barrier constricts the river from an average width of approximately 25 m upstream of the canyon to a width of approximately 2.5 m at the identified chute. The velocity chute descends approximately 1.5 m over a declivity of 4 m. The water through the chute and in the pool below is air entrained; hence impairing the ability of migrating salmon to either leap above the cascade or swim through it. The conclusions of the 2018 Tay River Chinook Salmon Access Investigation project are that Chinook salmon are absent in the system and reason for the absence is the identified velocity barrier.

## 1.0 INTRODUCTION

The Yukon River Salmon Agreement is a bilateral treaty based agreement between the US and Canada with a goal of co-managing, restoring and conserving Yukon River Salmon. The Yukon River Panel is a 12 member body with equal representation from both countries and was formed to implement the Yukon River Salmon Agreement. Under the aegis of this agreement a Restoration and Enhancement (R&E) fund was established to provide funding for the restoration, conservation and enhancement of Canadian origin salmon. The Yukon River Panel (YRP) manages the R&E fund. The YRP has developed a list of mid-term and long-term priorities for the R&E fund. One of the mid-term priorities is to restore fish access to spawning and rearing habitat. The 2018 Tay River Chinook Access project is directed at meeting that priority.

### *Background*

Three years of Chinook radio telemetry studies were conducted on the upper Yukon River over the period 2002 through 2004. The radio telemetry studies in 2003 and 2004 included comprehensive aerial surveys of all possible drainages and tributaries, including the Pelly River, that could contain Yukon River Chinook spawning populations (Mercer 2005, Mercer and Eiler 2004, Osborne et al. 2003). Two complete surveys were conducted each year during the assumed peak spawning period. It was noted by the researchers that the Tay River was one of the larger drainages within the Pelly River system and appeared to contain suitable Chinook spawning and rearing habitat, however no radio tagged Chinook were recorded in the Tay River watershed during 4 surveys over two years. All the other larger tributaries within the Pelly system (Blind Creek, Ross River, McMillan River) contained radio tagged Chinook in both years of the study (Figure 3). The lack of radio tagged Chinook in the Tay River system led the telemetry researchers to conduct a more detailed aerial investigation of the lower reaches of the system during the final aerial survey in 2004. This investigation indicated that a possible impediment to salmon migration (velocity barrier) was located approximately 4 km upstream of the mouth of the Tay River drainage (Mercer and Eiler 2004). The presence of the barrier was a plausible explanation for the absence of radio tagged Chinook in the system.

With the knowledge of this possible barrier and the emphasis by the R&E fund on restoration projects it was decided to investigate the Chinook restoration and enhancement potential of the Tay River system. An aerial reconnaissance survey of the Tay River system was conducted by Metla Environmental Inc. (MEI) in October, 2015. This survey re-affirmed the presence of the possible barrier as well as supported the probable existence of significant Chinook spawning and rearing habitat in the system.

A proposal to investigate the presence/absence of Chinook salmon in the Tay River system as well as the feasibility of providing Chinook access into the system was submitted to the Yukon River Panel (YRP) Restoration and Enhancement Fund in 2017. The 2017 proposal was not accepted but it was suggested to re-submit a proposal with a reduced scope for 2018. The 2018 proposal had the primary objective of determining the presence or absence of Chinook salmon in the system. The 2018 proposal was submitted with the support and involvement of the Selkirk First Nation (SFN).

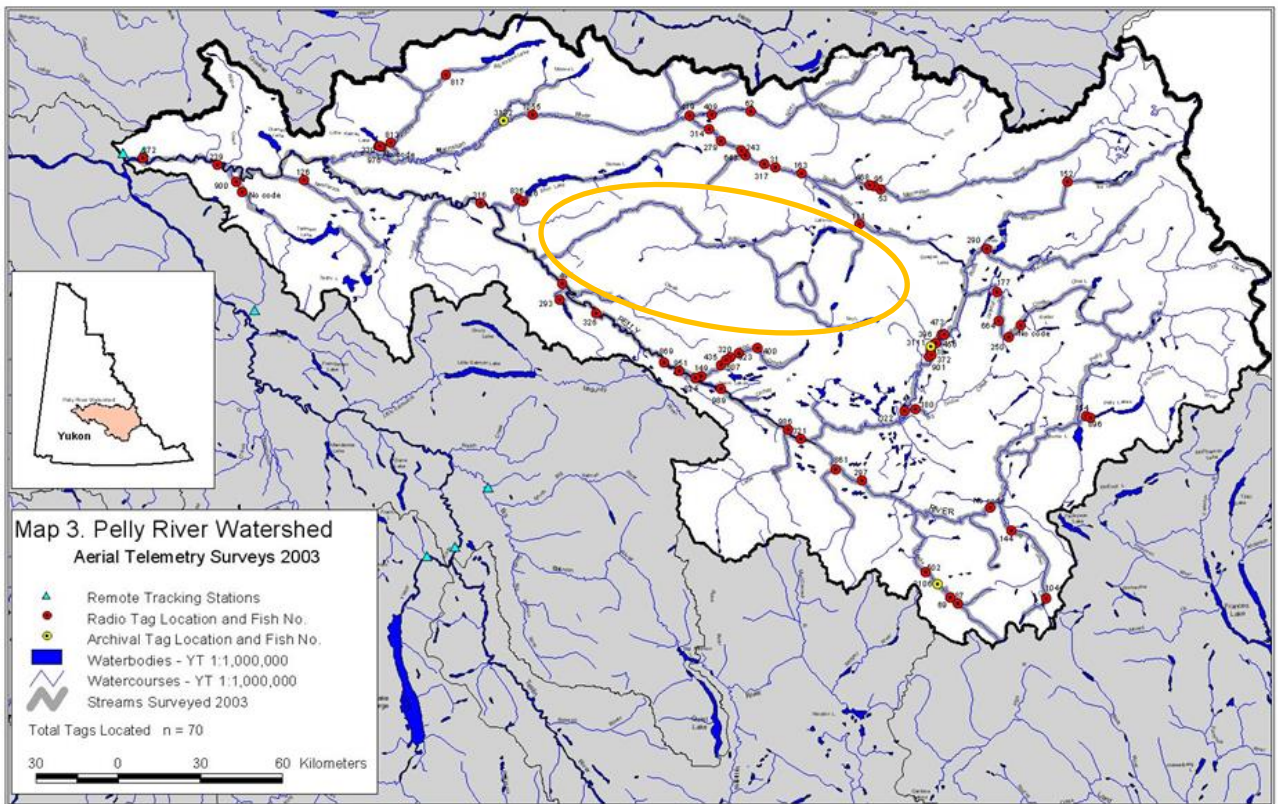


Figure 1. Location of radio tagged Chinook salmon located in the Pelly River system in 2003.  
Note: Tay River drainage outlined in yellow.

### *Study Area*

The Tay River is a tributary of the Pelly River in the upper Yukon River drainage (Figure 2). It is the third largest tributary within the Pelly River watershed with an area of approximately 3,840 km<sup>2</sup> (Figure 3). There are 3 lakes at the headwaters of the system. Tay Lake is the largest of these with a surface area of approximately 1,015 Ha. The total length of the Tay River from Tay Lake to the Pelly River confluence is approximately 195 km. Elevation rises from 848 m at the river mouth to 1,131m at Tay Lake, resulting in an approximate mean gradient of 2.3m/km.

The Water Board of Canada operated a hydrometric survey station near the mouth of the Tay River for 6 years over the period 1990 – 1995 (Water Survey of Canada). During this period the mean monthly discharge rate ranged from a high of 71.0 meters<sup>3</sup>/second in June to a low of 4.0 meters<sup>3</sup>/second in March, (Appendix 1(a) and (b)).

The Tay River watershed is remote with no road access to any point in the drainage.



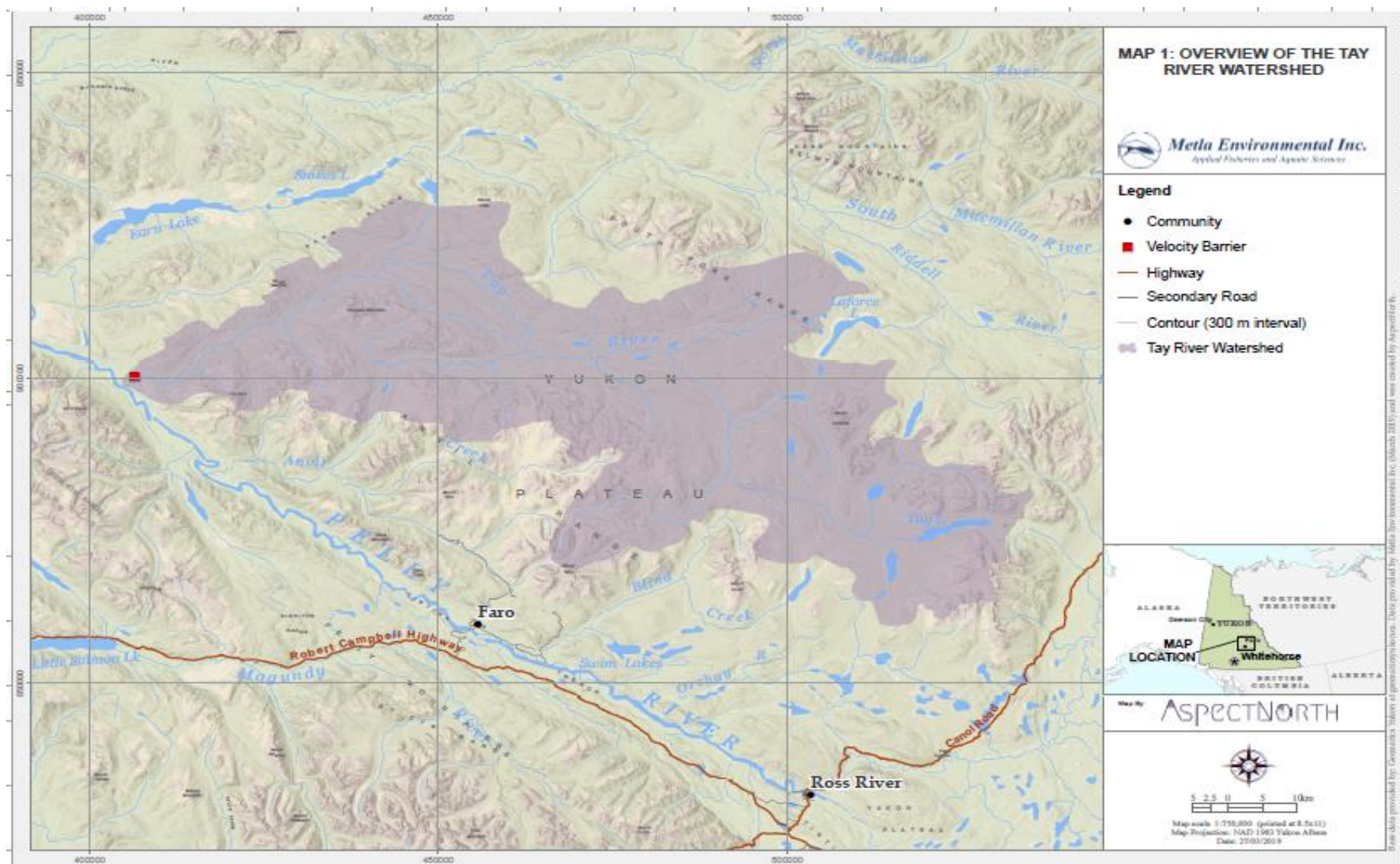


Figure 2. Tay River drainage in the Pelly River watershed.

## 2. OBJECTIVES

The specific objectives of the 2018 Tay River Chinook Salmon Access Investigation project were to:

1. Determine the presence or absence of Chinook salmon in the system.
2. Quantify the potential Chinook production of the Tay River system using existing production models as they apply to the upper Yukon River watershed.
3. Conduct an engineering pre-assessment to identify options to improve the passage of Chinook salmon into the system.
4. Prepare a summary report detailing the results of the project. .

## 3. METHODS

### *Determining Presence of Chinook salmon in the system.*

Three methods were used to investigate the occurrence of Chinook salmon in the Tay River system. These included juvenile Chinook sampling using conventional methods, environmental DNA (eDNA) sampling and aerial surveying to look for the presence of spawning adults.

Based on the known biology of juvenile Yukon River Chinook it would be reasonable to assume age 0+ juvenile Chinook would be found rearing in the lower reaches of the Tay River drainage if Chinook salmon were present in the system (Daum and Flannery 2009), Bradford et al. 2001, Bradford 2006, Bradford et al. 2009, DFO 2017). The river morphology of the lower Tay River has characteristics that are typical of high quality juvenile Chinook rearing habitat (Mossop and Bradford, 2006). Based on current knowledge of the Yukon River juvenile Chinook life history it is probable that age 0+ or age 1+ juvenile Chinook salmon would be rearing in the upper Yukon River system from mid-May through to April the following year (Bradford et al. 2009).

Sampling for the presence of juvenile Chinook salmon was conducted on the Tay River during the period June 17 through June 21, 2018. Two MEI biologists and a technician from SFN conducted the sampling. Access to the sampling area was via floatplane from Whitehorse to an un-named lake (62°41'36.55"N; 133°49'50.50"W) located approximately 30 km upstream from the confluence of Tay and Pelly rivers (Figure 3). Equipment and supplies had to be transported by foot approximately 500m from the lake to the Tay River. A 3.5 m inflatable boat and 6 hp motor were used to navigate on the river and to access the sampling sites.

### *Conventional Chinook sampling*

Sampling methods used were Gee traps baited with salmon roe and beach seining (Figures 4 and 5). A total of 6 Gee traps were set over a period of 48 hours at 12 separate sites. The 12 sites were located between the stations N 62°69'19.8", W 133°85'94.0" and N 62°70'43.4", W 133°82'56.4"; a distance of approximately 4 river km. Gee traps were set at locations that incorporated woody debris and were deemed preferred juvenile Chinook habitat.



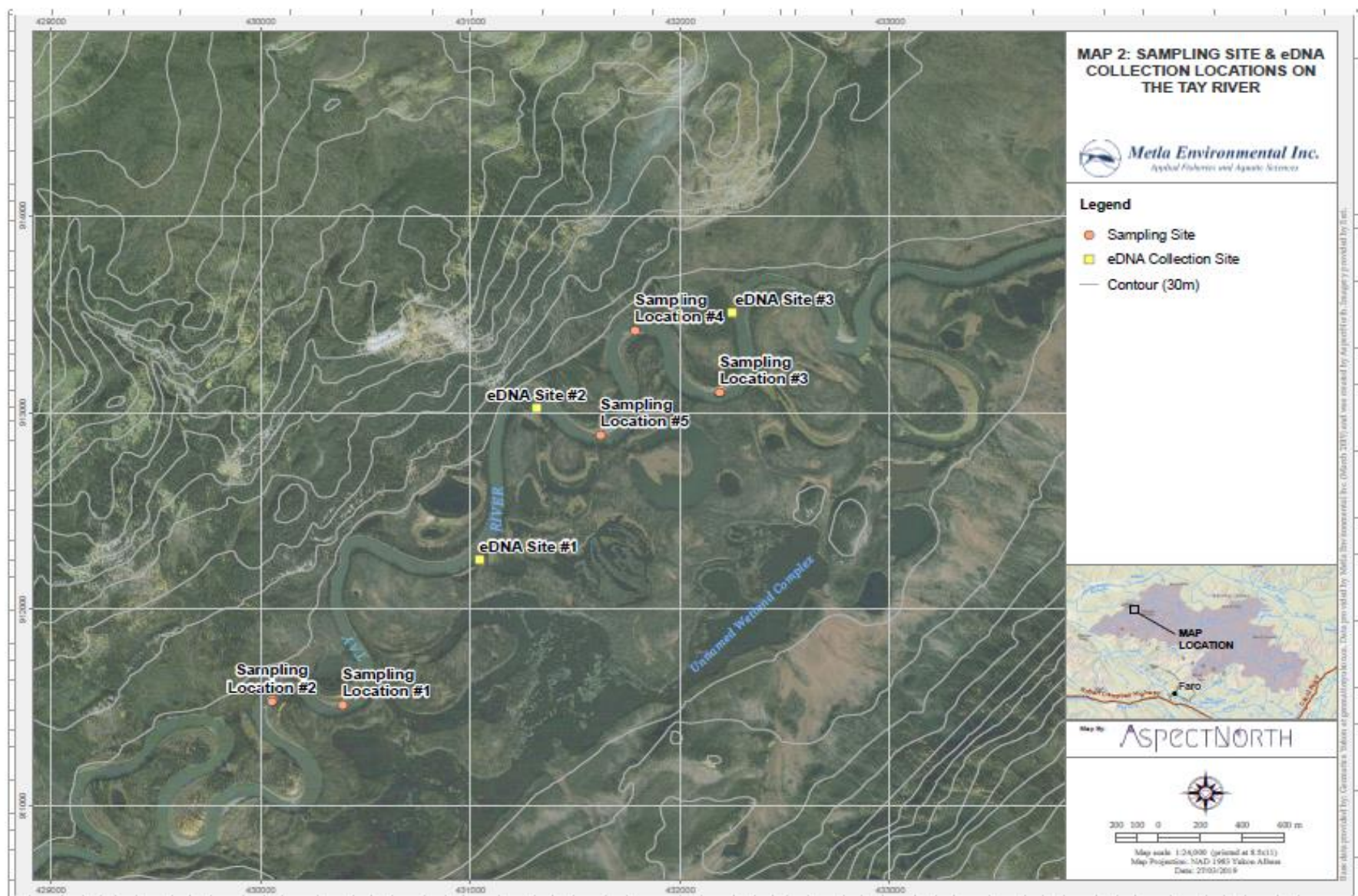


Figure 3. Location of sampling sites on the lower Tay River, June 2018.

Beach seining occurred at 5 sites (Figure 3). The beach seine used was 10 m long x 1.5 m deep with 3 mm mesh. At each seining site replicate sets were conducted. All fish species captured were identified, enumerated and released alive.



Figure 4. Location of baited Gee trap in woody debris, eDNA site 3, Tay River 2108.



Figure 5. Beach seining at site 3 Tay River 2018.



## *eDNA sampling*

eDNA sampling methods provide an efficient, non-invasive and highly effective method to assess Chinook salmon occurrence and distribution in aquatic systems. eDNA can be more cost effective and accurate compared to traditional biotic inventory methods. The advantages of eDNA methods also include:

- a) ability to allow post-hoc examination of samples, for multiple species, after collection;
- b) reduced disturbance (i.e. stress/mortality) to target taxa;
- c) reduced cost compared with traditional biotic inventory.

As species move through the water DNA from the organism is shed exogenously and will be suspended in the aquatic habit. eDNA is collected in water samples taken from the aquatic habitat. eDNA methods use a polymerase chain reaction (qPCR) analysis technique to extract, amplify and detect the DNA of the organism(s) targeted. The use of eDNA techniques has been demonstrated to be an effective method for detecting the presence or absence of Chinook salmon in the Yukon River system (Hobbes and Kanary, 2016).

The eDNA sampling protocol used for the 2018 Tay River project was based on the 2017 BC Ministry of Environment - *Environmental DNA Protocol for Freshwater Aquatic Ecosystems Version 2.2* (Hobbs 2017). The eDNA sample collection protocol for all sample sites involved the use of an extended pole to hold the sample container and to preclude the sampler from entering the water and causing potential contamination. Strict disinfection and cross contamination protocol was used at each site. The water samples were collected in 1 liter Nalgene bottles. All eDNA water samples collected were stored on ice in a cooler and were processed within 24 hours. Each one liter sample was filtered onto a 45 µm cellulose membrane using a Nalgene Polypropylene Analytical Test Filter Funnel. The samples were filtered using a hand held vacuum pump and Erlenmeyer vacuum flask as detailed by Hobbs (2017). The filters were removed using forceps and placed in a coin envelope. Each envelope was labelled with project ID, sample site and date. The coin envelopes from each site were placed in a Ziploc bag containing silica bead desiccant. The filtered eDNA samples were shipped via courier to the Hebling microbiology Lab at University of Victoria for analysis.

eDNA samples were collected at 3 sites on the lower Tay River on June 18 and 19 (Figure 3). Two replicates were taken at each of these 3 sites. In addition to the 3 sites on the lower Tay River, eDNA was also collected at 2 sites (site #4 and #5) on the upper Tay River (Figure 6). Access to the upper Tay River was by helicopter on August 24. Three replicate samples were obtained from site #4 and also from site #5. This resulted in a total of 12 eDNA samples collected from the Tay River in 2018.

As well as the eDNA samples collected on the Tay River, two replicate eDNA samples were collected on June 22 from a stream<sup>1</sup> where rearing juvenile Chinook were known to be present. Two replicates of distilled water samples corresponding to the June and August eDNA sampling events were also filtered and sent for analysis. These “control” samples were collected and analyzed as per the eDNA sampling protocol detailed by Hobbs (2017). The rationale for the “control” samples is to test for both type I (false positive) and type II (false negative) errors.

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<sup>1</sup> These eDNA samples were collected at Wolf Creek located with the city limits of Whitehorse, YT. Hatchery age 1+ juvenile Chinook are introduced annually into this stream.

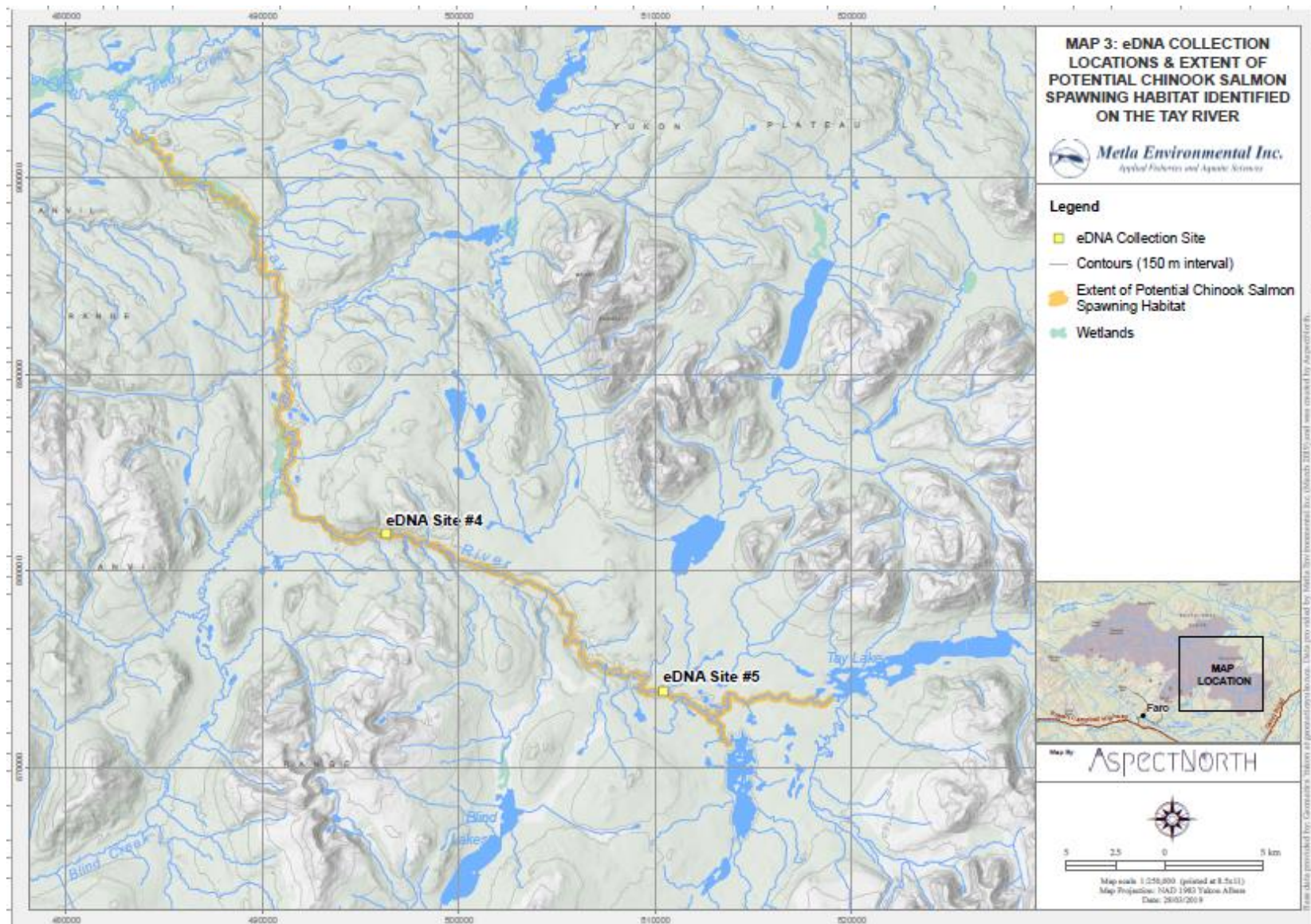


Figure 6. eDNA collection sites on the upper Tay River, 2018.

One negative control sample (distilled or deionized water) per processing event is recommended. Quality control to monitor for contamination of field and lab procedures is another rationale for sample replication.

All the eDNA samples collected were analyzed for both Chinook salmon and Grayling (*Thymallus arcticus*). Since Grayling were confirmed to be present in the Tay River system, this analysis provided an additional indicator for evidence of type II errors.

### ***Aerial survey***

On August 24 2018, a Bell Long Ranger helicopter was chartered from Whitehorse for an aerial reconnaissance of the Tay River. An MEI biologist and the Fish and Wildlife officer from SFN conducted the survey. The objectives of the aerial survey were to:

- a) Conduct an over flight of the suspected Tay River fish passage barrier and to take pictures and video of the site;
- b) Determine if there was a site to land a helicopter at or near the barrier;
- c) Survey the Tay River from its mouth to Tay Lake to locate spawning chinook salmon; and
- d) Collect two e-DNA samples near the headwater lakes and upstream of the Teddy Creek confluence; the area considered as probable Chinook spawning habitat (Figure 6).

The survey included an aerial reconnaissance of the velocity barrier and a low level overflight of the entire drainage. The survey continued upstream at approximately 80-90 knots/hr enroute to the e-DNA sampling sites and Tay Lake. During the low level flight the surveyors were attentive to any secondary evidence of spawning fish such the presence of predators/scavengers. General stream conditions were noted; specifically, where potential spawning gravels were located. The 70 km section from Teddy Creek junction to the outlet of Tay Lake exhibited discontinuous sections of gravel substrate the could be potential Chinook salmon spawning habitat (Figure 6). This area was surveyed at a slower speed of approximately 50 knots/hr.

### ***Potential Chinook production of the Tay River system using habitat models.***

The potential Chinook production of the Tay River system was quantified using a habitat based model (Parken et al. 2006). This habitat model uses the area (km<sup>2</sup>) of a drainage to estimate the Chinook salmon maximum sustained annual yield (Smsy). The model is based on regression analysis of systems with known Chinook Smsy production. It is recognized that this type of modelling has limitations. However, it is the model best suited for data limited systems and/or estimating potential Chinook production. The parameters developed by Parken (2006) are detailed in Appendix 2. The model makes predictions based on stream and ocean type stocks as well as northern and southern stocks. The regression model for the northern stream stocks used for estimating the potential Tay River production was:

$$(\ln y) = 2.95 + (0.694 * \ln x) + (0.30 / 2)$$

Where y = Smsy and x = watershed area. The watershed area of the Tay River drainage used in the model was derived from digital mapping data and was calculated to be 3,840 km<sup>2</sup>.

As well as the Parken model, a regression was developed using the published Smsy values of 10 northern Chinook stocks. These Smsy values were obtained from data presented by Parken



(2006). Two of these northern Chinook stocks included the Salcha and Chena rivers, both which are tributaries of the Yukon River in Alaska. This regression allowed comparison of the Tay River potential production with other northern Chinook stocks that have empirical Smsy production values.

### ***Engineering pre-assessment of velocity barrier***

A reconnaissance of the velocity barrier was conducted on August 24 in conjunction with the aerial survey and eDNA collection. No suitable landing site was located near the barrier however, an exposed gravel bar located approximately 150 upstream from the site could potentially serve as a helipad under certain water conditions. The assessment did not involve empirical measurements of the hydrological characteristics at the barrier. Information collected was based on visual estimation from the helicopter and sub interpretation and subsequent examination of a suite of 20 photos and several minutes of video.

## **4. RESULTS**

### ***Gee trapping and beach seining***

The Gee trapping results are presented in Appendix 3. The 6 Gee traps were set for a total soak time of approximately 50 hours. A total of 2 fish were captured over this period; one juvenile pike (*Esox Lucius*) and one sculpin (*Cottus cognatus*).

The beach seining results are presented in Appendix 4. Beach seining occurred at 6 sites (Figure 3). The number of beach seine “sets” at each site ranged from one through four, and was determined by the suitable seining area at each site. A total of 16 beach seine sets were completed. A combined total of 672 fish were captured in the beach seine sets. Juvenile longnose suckers (*Catostomus catostomus*) were numerically the most abundant fish caught with 607 captured. A total of 50 juvenile Grayling were captured. Fifteen slimy sculpins were also captured.

### ***eDNA analysis***

The results of the 2018 Tay River eDNA analysis are presented in Table 1 and Appendix 5. All 12 of the Tay River samples were negative for Chinook DNA. Both of the Wolf Creek samples yielded positive results for Chinook. The 2 eDNA samples from Wolf Creek also yielded positive results for Grayling, as expected. All 3 control samples (distilled water) yielded negative results for both Grayling and Chinook. Ten of the 12 Tay River samples yielded positive results for Grayling.

Based on the criteria outlined in Hobbs (2016) the eDNA results confirm the absence of Chinook salmon in the Tay River system in 2018. The two false negative results (type II error) for Grayling in the Tay River eDNA results may be the result of several factors. The Grayling eDNA marker has weaker sensitivity than the Chinook marker (Jessica Round, Univ. of Victoria Microbiology Lab; personal comm.). The presence of a false negative underscores the reason for a sampling regime incorporating at least 2 replicates at each site. However the 10/12 positive results for Grayling in the Tay River samples affirms the veracity of the overall eDNA results.

Table 1. eDNA results for Tay River, Wolf Creek and controls, 2018.

<b>Collection Location</b>	<b>Chinook Frequency</b>	<b>Lab Call</b>	<b>Biologist Call</b>	<b>Grayling Frequency</b>	<b>Lab Call</b>	<b>Biologist Call</b>
Tay River	0/8	N	N	0/8	N	N
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	7/8	Y	Y
Tay River	0/8	N	N	0/8	N	N
Tay River	0/8	N	N	7/8	Y	Y
Wolf Creek	8/8	Y	Y	7/8	Y	Y
Wolf Creek	8/8	Y	Y	8/8	Y	Y
Control	0/8	N	N	0/8	N	N
Control	0/8	N	N	0/8	N	N
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	8/8	Y	Y
Tay River	0/8	N	N	8/8	Y	Y
Control	0/8	N	N	0/8	N	N

Note: Y = tested positive for taxa; N = tested negative for taxa

### ***Potential Chinook salmon production from Tay River system.***

Based on the Parken (2006) habitat model the estimated Smsy of Chinook salmon from the Tay River is 6,820 (90% CI , 5,251 – 8,388). Using a regression from the published Smsy values of 10 northern Chinook stocks (Parken 2006), yielded a slightly lower Smsy point estimate of 6,302. These values are illustrated in Figure 7.

For comparison, the Salcha and Chena rivers in the Yukon drainage in Alaska have watershed areas of 5,620 km<sup>2</sup> and 4,515 km<sup>2</sup> respectively. The freshwater habitat areas of these two rivers are similar to the Tay River system of 3,840 km<sup>2</sup>. The published Smsy estimates for the Salcha and Chena rivers are 3,939 and 3,621 (Parken 2006). This suggests that the estimated Smsy for the Tay River, both for the Parken model estimate and the regression estimate may be biased high. The escapement goals for the Salcha River (3,300 – 6,500) and the Chena (2,800 – 5,700) (cited in Stub and Tyers, 2016) indicate both these systems are significant Chinook producers.

Actual Chinook production from a given system is dependent on many independent factors related to habitat quality and variables affecting inter – annual variation in production. However the above estimated Smsy values and escapement goals can be used as indicators for other data limited systems such as the Tay River and can be tested and refined as new stock-recruitment data become available.

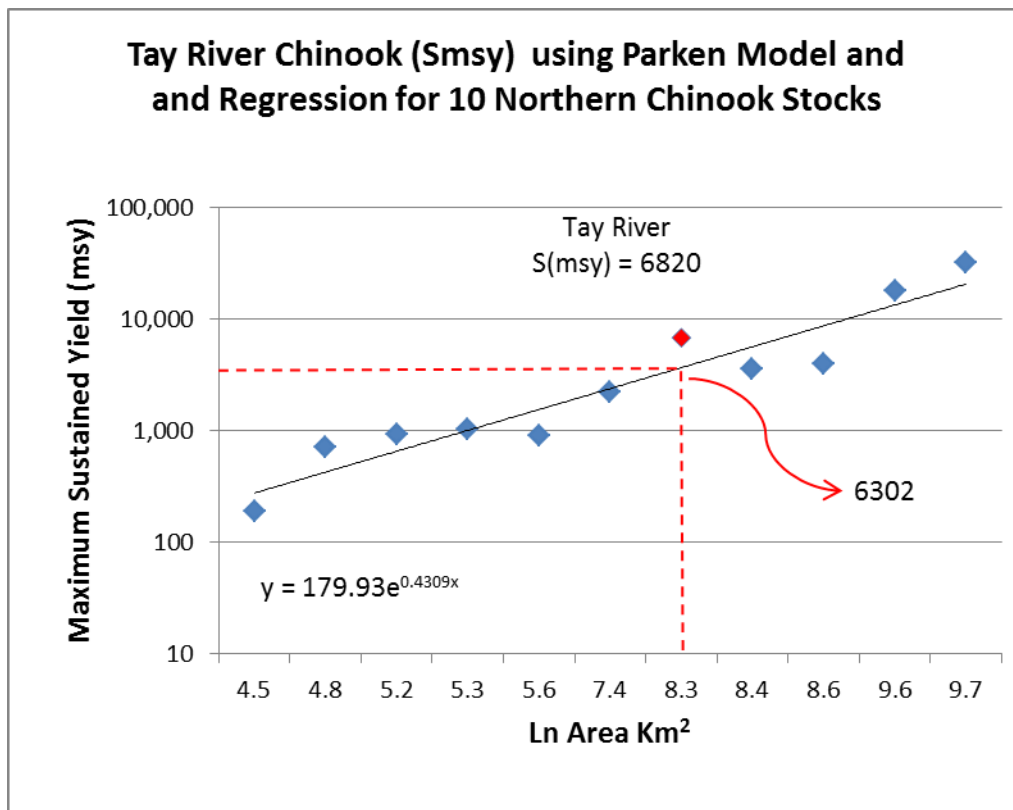


Figure 7. Smsy production estimates based on Parken (2006) model (6,820) and regression of 10 northern Chinook stocks with published Smsy values (6,302).

### *Aerial survey*

Viewing conditions were considered good throughout the aerial survey. No spawning Chinook salmon were observed in the upper Tay River during the 2018 aerial survey. No spawning redds, either recent or relict were observed. The surveyors were attentive to secondary evidence of spawning salmon such as the presence of eagles and bears but none were noted.

### *Engineering pre-assessment of velocity barrier*

There was no detailed quantitative engineering/hydrological assessment made of the velocity barrier in 2018. A suite of pictures and videos of the velocity barrier was obtained during the August aerial survey. The visual observations indicated that the river constricts from a width of approximately 25 m above the canyon to a constriction of approximately 2.5 at the velocity chute (Figure 8).

At the water level encountered during the survey it was estimated the velocity chute descends approximately 1.5 m over a declivity of 4 m. The grade of the declivity was estimated at 30%. Significant air entrainment was observed in the water flowing through the chute and at the base of the barrier. Air entrainment can be a significant impediment to the ability of adult salmonids to reach maximum burst swimming speeds (Stuart 1962). It is possible Chinook cannot pass the identified barrier due to a combination of the velocity of the water within the chute and air entrainment in the water in the chute and the downstream pool. A qualitative assessment of the barrier by a DFO engineer indicated that modifying the barrier by widening the channel and

thereby reducing the velocity and turbulence is technically feasible and is within the scope of salmon range extension projects that DFO has engaged in (Allan Jonssen, DFO SEP Vancouver; personal comm.). By blasting out approximately 12 m<sup>3</sup> of the rock outlined in yellow in Figure 8 the flow velocity at the barrier would be reduced. As well, air entrainment in and at the base of the chute would decrease as a result of the more laminar flow.



Figure 8. Velocity barrier on lower Tay River.  
Note: Scale is approximate.

## DISCUSSION

The results of the 2018 field work on the Tay River indicate Chinook salmon were absent from the system. Conventional fish sampling methods can be inconclusive regarding the presence of a particular taxa in an aquatic system. However, eDNA is a powerful and definitive biotic inventory tool for establishing the presence or absence of Chinook salmon in aquatic habitats. Additional eDNA sampling in subsequent years would unambiguously determine if the absence of Chinook in the system is consistent over time. The radio telemetry studies described above also suggest that Chinook salmon were absent in 2003 and 2004. The single identified velocity barrier 4 km upstream from the mouth of the Pelly River is the probable cause for the absence of Chinook salmon.

Several factors affect swimming burst speed and leaping success of adult salmon. These include water velocity, turbulence in the take-off pool, the depth of the take-off pool, the ratio of pool depth to fall height, and where the leap is initiated (Stuart 1962). Burst swim speeds of Chinook



range from 3.3 m/sec. to 6.9 m/sec with a maximum endurance of approximately 10 seconds (Powers and Orsborn 1985). The weight of the evidence indicates that Chinook salmon are currently excluded from the system as a result of the velocity barrier. Reducing the velocity and increasing the laminar flow at the barrier should allow returning adult salmon access to the Tay system.

The potential Tay River Chinook production estimates presented above are based on a simple habitat area approach that makes few assumptions. Uncertainty arises from these estimates due to random variability and variations in growth, survival, distribution, and reproduction as well as relationships between salmon abundance, habitat capacity, and nutrient levels. Subjective professional evaluation suggests the Tay River contains significant high quality juvenile Chinook rearing habitat. Spawning habitat is more difficult to assess both in terms of quantity and quality without more detailed investigation.

It is the view of the project proponents<sup>2</sup> that due to its relatively large size and probable spawning and rearing habitat, the Tay River system may offer one of the better opportunities to significantly and measurably increase Chinook production in the upper Yukon River system. The increase in Chinook production would be accomplished by providing and/or improving access for Chinook salmon into the system and the development of a self-sustaining anadromous run of Chinook. The Tay River Chinook access project is consistent with the Salmon Management Plan that has been developed by the SFN.

As well as the 2018 Tay River project activities reported above, the project proponents have consulted with the Yukon Environmental and Socio-economic assessment Board (YESAB) to provide an opportunity for pre-proposal discussions. The project proponents have also consulted with Yukon Territorial Government Department of Environment to introduce the Tay River Chinook Access Project and obtain feedback on issues that would need to be addressed in the YESAB proposal. As well, MEI and SFN made a presentation of the Tay River project to the Government of Canada Northern Affairs Faro Mine Remediation Project Team. The Government of Canada funds this project and is leading the design of the remediation plan and regulatory processes. This presentation informed the Team of the Tay River project and outlined how the project could be used to offset real and perceived Chinook habitat degradation and production loss associated with the past Faro mine operations. These consultations are ongoing.

In order for the Tay River project to move forward the following objectives are suggested for 2019. The barrier modification and introduction (range extension) of Chinook salmon into the Tay River system will trigger a YESAB review. A primary objective in 2019 will be to prepare and submit a YESAB proposal and conduct further research/data collection pursuant to the YESAB review instructions. The secondary objectives for 2019 would be:

- a) Conduct field work in the system and provide data and information related to requirements and recommendations after the YESAB review of the project.
- b) Collect information on Traditional Knowledge on the Tay River system as it relates to traditional use fisheries and specifically Chinook salmon.
- c) Conduct detailed engineering work on the barrier to determine the methods and approximate cost for blasting a fish passageway.
- d) Continue discussions with Federal authorities overseeing the Faro mine rehabilitation project with a view to secure additional funding for the project.

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<sup>2</sup> Proponents are the Selkirk First Nation and Metla Environmental Inc.



## **ACKNOWLEDGEMENTS**

The Selkirk First Nation supported and assisted with the 2018 Tay River project. Anniesia Heger of SFN and Peter Etherton (MEI) assisted with the Lower Tay River sampling activities. Mr. Etherton also conducted the August aerial survey and eDNA collection and processing. Eugene Alfred of SFN collaborated on all aspects of the project and assisted with the presentation to the Faro Mine Remediation team. Jane Wilson (MEI) provided logistical support to the project as well as literature and report reviewing.

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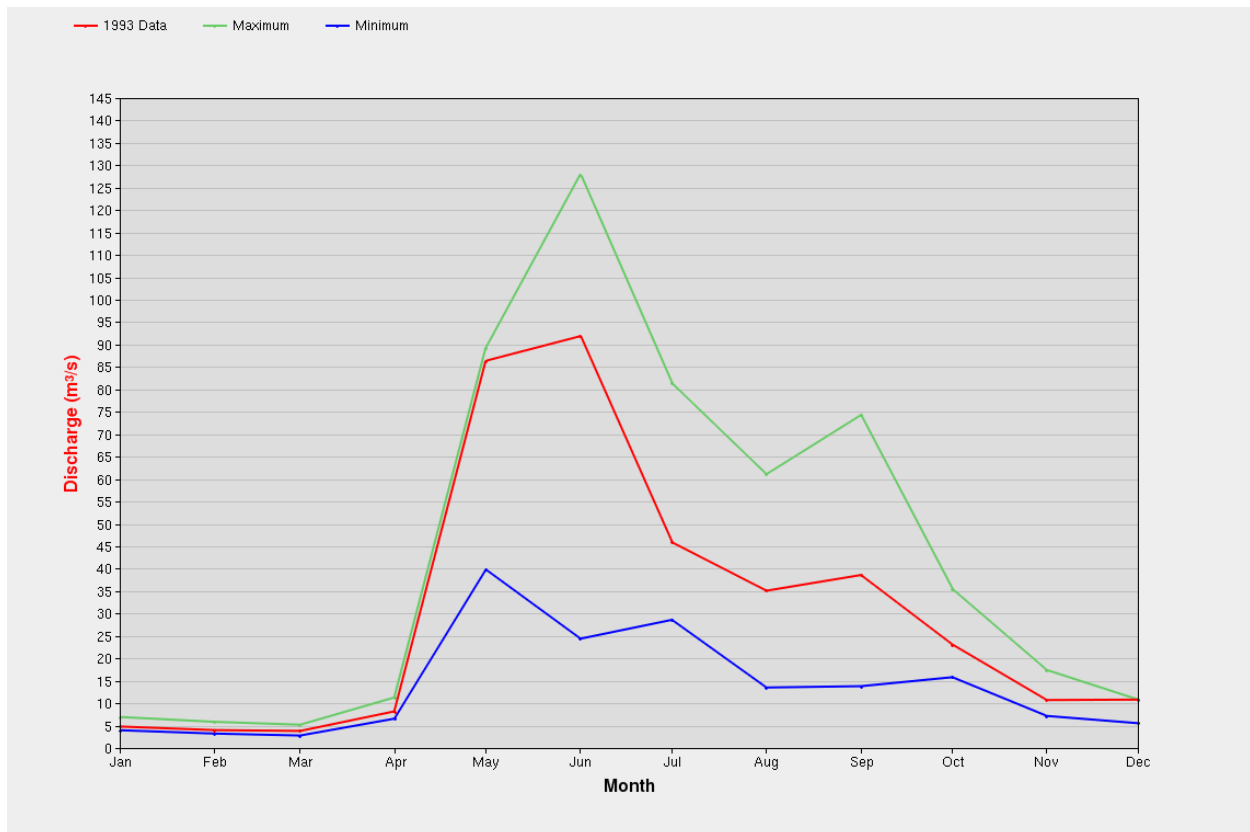
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Appendix 1 (a). Mean monthly discharge (m<sup>3</sup>/hour) at the Tay River hydrometric station, 1990 -1995.  
Station location: 62° 34' 41" N; 34° 14' 18" W. Source: Water Survey of Canada.

This table provides monthly mean value for a station.													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1995	3.97	3.22	2.79	8.05	39.8	24.4	28.6	31.7	51.7	20.6	7.16	6.46	19.1
1994	6.22	4.53	4.28	11.3	56.3	64.8	28.8	13.5	13.8	16.6	7.96	5.53	19.5
1993	4.79	4.00	3.81	8.19	86.4	91.9	45.9	35.1	38.6	23.1	10.7	10.8	30.4
1992	6.92	5.84	5.20	7.04	55.7	128	67.6	33.9	33.2	15.8	11.4	7.25	31.5
1991	4.93	4.03	3.80	6.56	89.3	58.0	81.4	61.1	68.3	35.5	17.4	10.0	36.9
1990	-	-	-	-	73.5	58.7	35.2	25.7	74.3	29.2	11.4	7.00	-
Mean	5.37	4.32	3.98	8.23	66.8	71.0	47.9	33.5	46.7	23.5	11.0	7.84	27.5
Max	6.92	5.84	5.20	11.3	89.3	128	81.4	61.1	74.3	35.5	17.4	10.8	36.9
Min	3.97	3.22	2.79	6.56	39.8	24.4	28.6	13.5	13.8	15.8	7.16	5.53	19.1

Appendix 1(b). Tay River maximum and minimum mean monthly discharge (m<sup>3</sup>/hour), 1990 - 1995; and 1993 mean monthly discharge at the Tay River hydrometric station.





Appendix 2. Summary of parameters used for the hhabitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia (Parken et al, 2006).

Table 5. Summary of  $\ln \hat{a}$ ,  $\hat{b}$ ,  $\hat{\sigma}^2$ , adjusted  $R$ , and ANOVA F-test results for regression habitat-models to predict Smsy and Srep stocks stratified by north and south areas.

Statistic	Smsy Habitat Model		Srep Habitat Model	
	North <sup>A</sup>	South	North	South
$\ln \hat{a}$	2.95	4.64	4.01	5.81
Standard Error	0.60	0.83	0.56	0.78
CV	20%	18%	14%	13%
t-value	4.92	5.57	7.18	7.45
p-value	<0.001	<0.001	<0.001	<0.001
$\hat{b}$	0.694	0.579	0.683	0.561
Standard Error	0.08	0.11	0.08	0.10
CV	12%	18%	12%	18%
t-value	8.30	5.50	8.78	5.63
p-value	<0.001	<0.001	<0.001	<0.001
$\hat{\sigma}^2$	0.30	0.26	0.26	0.23
Adjusted $r^2$	0.85	0.73	0.86	0.74
ANOVA P-value	<0.001	<0.001	<0.001	<0.001

<sup>A</sup>Using the north area regression parameters to estimate Smsy (y) from watershed area (x) in equation 3 gives

$$(\ln y) = 2.95 + (0.694 * \ln x) + (0.30 / 2) .$$

Appendix 3. Gee trapping results on lower Tay River, 2018.

Set #	Trap #	Time Set <i>June 18</i>	Time pulled <i>June 19</i>	Total hrs set	Captures	Species
1	1	11:55	11:00	23 h 5 m	0	
	2	11:50	11:10	23 hr 20 m	0	
	3	11:45	11:20	23 h 35 m	0	
	4	11:30	11:35	24 hr 5 min	0	
	5	11:30	11:45	24 h 15 m	0	
	6	11:20	12:00	24 h 40 m	0	
2	7	14:40	15:55	25 h 15 m	1	slimy sculpin
	8	14:45	16:00	25 h 15 m	0	
	9	14:50	16:05	25 h 15 m	0	
	10	15:00	16:10	25 h 10 m	0	
	11	15:10	16:15	25 h 5 m	0	
	12	15:20	16:20	25 h	1	juvenile pike

Note: Gee traps set between coordinates: N 62°69'19.8" , W 133°85'94.0" and N 62°70'43.4", W 133°82'56.4"

Appendix 4. Beach seine results lower Tay River, 2018.

Site	Set #	Total number fish captured	Grayling	Suckers	Sculpins	Comments
Site 1	1	1	1			15 cm
	2	0				
	3	0				
	4	7	6		1	grayling @ ~2.5 cm
Site 2	1	621	21	600		Grayling and suckers @ ~2 - 3cm
Site 3	1	16	10		6	Juvenile Grayling ~ 3cm
	2	6	3		3	Juvenile Grayling ~ 3cm
	3	0				
Site 4	1	7	5		2	Juvenile Grayling ~ 3cm
	2	1		1		
	3	3	1		2	Juvenile Grayling ~ 3cm
Site 5	1	0				
	2	0				
	3	1			1	
Site 6	1	6	2	4		Grayling and suckers @ ~2 - 3cm
	2	3	1	2		Grayling @ 5 cm
<b>Total</b>	16	672	50	607	15	

Appendix 5. eDNA results for Tay River, Wolf Creek and control samples.

Collection date	Collection Location	Site ID #	Collection Time	Easting	Northing	Test for ONTS and THAR	DPN	Amplifiable DNA Frequency	Amplifiable DNA Call	ONTS Frequency	Lab Call	Biologist Call	THAR Frequency	Lab Call	Biologist Call
18-Jun-18	Tay River	1	15:30	133.8478	62.6965	Y	10	4/4	Y	0/8	N	N	0/8	N	N
18-Jun-18	Tay River	1	15:30	133.8478	62.6965	Y	3	4/4	Y	0/8	N	N	8/8	Y	Y
19-Jun-18	Tay River	2	9:45	133.8432	62.70346	Y	2	4/4	Y	0/8	N	N	8/8	Y	Y
19-Jun-18	Tay River	2	9:45	133.8432	62.70346	Y	6	4/4	Y	0/8	N	N	7/8	Y	Y
19-Jun-18	Tay River	3	10:00	133.8246	62.70763	Y	8	4/4	Y	0/8	N	N	0/8	N	N
19-Jun-18	Tay River	3	10:00	133.8246	62.70763	Y	9	4/4	Y	0/8	N	N	7/8	Y	Y
26-Jun-18	Wolf Creek	n/a	14:25	134.935	60.61039	Y	5	4/4	Y	8/8	Y	Y	7/8	Y	Y
26-Jun-18	Wolf Creek	n/a	14:25	134.935	60.61039	Y	4	4/4	Y	8/8	Y	Y	8/8	Y	Y
26-Jun-18	Control	n/a	16:00	n/a	n/a	Y	7	0/4	N	0/8	N	N	0/8	N	N
26-Jun-18	Control	n/a	16:00	n/a	n/a	Y	1	0/4	N	0/8	N	N	0/8	N	N
24-Aug-18	Tay River	4	9:30	132.5722	62.4311	Y	7	4/4	Y	0/8	N	N	8/8	Y	Y
24-Aug-18	Tay River	4	9:30	132.5722	62.4311	Y	4	4/4	Y	0/8	N	N	8/8	Y	Y
24-Aug-18	Tay River	4	9:30	132.5722	62.4311	Y	1	4/4	Y	0/8	N	N	8/8	Y	Y
24-Aug-18	Tay River	5	10:03	132.2986	62.35917	Y	5	4/4	Y	0/8	N	N	8/8	Y	Y
24-Aug-18	Tay River	5	10:03	132.2986	62.35917	Y	6	4/4	Y	0/8	N	N	8/8	Y	Y
24-Aug-18	Tay River	5	10:03	132.2986	62.35917	Y	2	4/4	Y	0/8	N	N	8/8	Y	Y
24-Aug-18	Control	n/a	11:00	n/a	n/a	Y	3	0/4	N	0/8	N	N	0/8	N	N

Note: ONTS = Chinook salmon (*Oncorhynchus tshawytscha*)

THAR = Grayling (*Thymallus arcticus*)