

# Hermit Lake Arctic Grayling Investigation and Restoration Planning



## **Prepared For**

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## EXECUTIVE SUMMARY

The Hermit Lake area has been a long-known fishing location for angling and harvest of Arctic grayling by community members of Teslin. However, since 1995 the presence of grayling in Hermit Lake and Creek outlet has been declining, and in recent years there has been an apparent absence of fish in the lake. The field assessments undertaken during 2020 were intended to build upon similar assessments completed during 2018. Specifically, the 2020 assessment aimed to assess the fish habitat quality in Hermit Lake at different times of year and to assess fish habitat quality in Hermit Creek from Hermit Lake downstream to Nisutlin Bay (Teslin Lake).

Dissolved oxygen and temperature profiles collected in Hermit Lake documented suitable conditions during the spring and summer; however, low dissolved oxygen levels during the months were low and are not expected to allow for Arctic grayling to overwinter within the lake. An assessment of the fish habitat quality in Hermit Creek indicated that conditions do not appear to be suitable for grayling to migrate upstream from Teslin Lake into Hermit Lake. This is due to low flow and many impediments to upstream migration, including areas of subsurface flow. Dissolved oxygen profiles were also collected in two additional small lakes nearby—Second Lake and an unnamed lake—which were also known to have Arctic grayling present as recently as 1999. Both lakes also had low dissolved oxygen levels during the winter months which may not allow for fish to successfully overwinter.

The combination of poor winter fish habitat quality in Hermit Lake and the presumed inability for grayling to migrate into Hermit Lake from Teslin Lake appears to prohibit the successful restoration of grayling to the watershed.



## ACKNOWLEDGEMENTS

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## ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
DO	Dissolved Oxygen
CPUE	Catch Per Unit Effort
EDI	Environmental Dynamics Inc.
TTC	Teslin Tlingit Council
YG	Yukon Government



## 1 INTRODUCTION

The Hermit Lake area has been a long-known location for Teslin locals and Teslin Tlingit Council (TTC) citizens to angle for and harvest Arctic grayling (*Thymallus arcticus*). The outlet of Hermit Lake was historically known as a popular fishing location, however; since 1995, community members have observed reduced grayling populations and in recent years there has been an apparent lack of fish present in the Hermit Lake area (White Mountain Environmental Consultants 1999, EDI Environmental Dynamics Inc 2018). Investigations completed in May of 1999 observed a large amount of beaver activity in the wetland area upstream of Hermit Lake, which was suggested to be diverting the flow of water into the Fox Creek drainage instead of Hermit Creek. However, a thorough ground investigation of this area during May of 2018 indicated that although there is beaver activity on Fox Creek to the north of Hermit Lake, there is a height of land—containing mature forest—separating the two watersheds. Based upon these observations, it does not appear as though streamflow from the Fox Creek watershed has entered Hermit Lake in recent history.

Gillnetting was carried out in Hermit Lake as part of the 1999 investigations with an average catch per unit effort (CPUE) of 2.34 grayling/hour and an average grayling length of 384 mm. Grayling were also observed upstream of the lake but were crowded/trapped in small habitats along the flow margins. Second Lake, which lies above the wetland area above Hermit Lake in the Fox Creek watershed, was also sampled during the investigation. Significant numbers of grayling were captured in a short amount of time, and were observed to be in the midst of spawning at the time of sampling (White Mountain Environmental Consultants 1999).

Investigations in 2018 by EDI included the area upstream and downstream of Hermit Lake. Field crews walked the wetland area upstream of Hermit Lake and observed this drainage to have a very small channel with minimal flow, resulting in a lack of suitable grayling habitat upstream of Hermit Lake. Unlike the sampling event in 1999, there were no fish observed in any portion of Hermit Creek above Hermit Lake. In the first 125 meters downstream of the Hermit Lake outlet field crews observed some suitable habitat in the form of pockets of gravel substrate in the channel, although no fish were observed. The remaining stretch of creek between Hermit Lake and the Sawmill road culvert was traversed and found to be poorly defined and challenging to locate at the time of sampling. Field crews observed areas of minimal flow, subsurface flow, and large amounts of woody vegetation within the channel, making it appear unlikely that fish passage could be achieved. Electrofishing in Hermit Creek downstream of the Sawmill road culvert (i.e. the lower 250 m of the creek) during September 2018 captured a small number of young-of-the-year Arctic grayling (as well as burbot (*Lota lota*) and slimy sculpin (*Cottus cognatus*)), suggesting that spawning likely occurred in the lower reaches of Hermit Creek during 2018. In addition to stream investigations and electrofishing, three gillnet sets were deployed in Hermit Lake to record fish presence or absence. No fish were captured during netting and no fish activity was observed (EDI Environmental Dynamics Inc 2018).

To understand the current lack of grayling within the Hermit Creek watershed, more information on stream morphology, habitat availability and water quality was needed. Investigation and sampling efforts in 2020 intended to answer remaining questions on what happened to the stock of grayling in Hermit Creek and if there are restoration efforts that could be executed to restore the population.





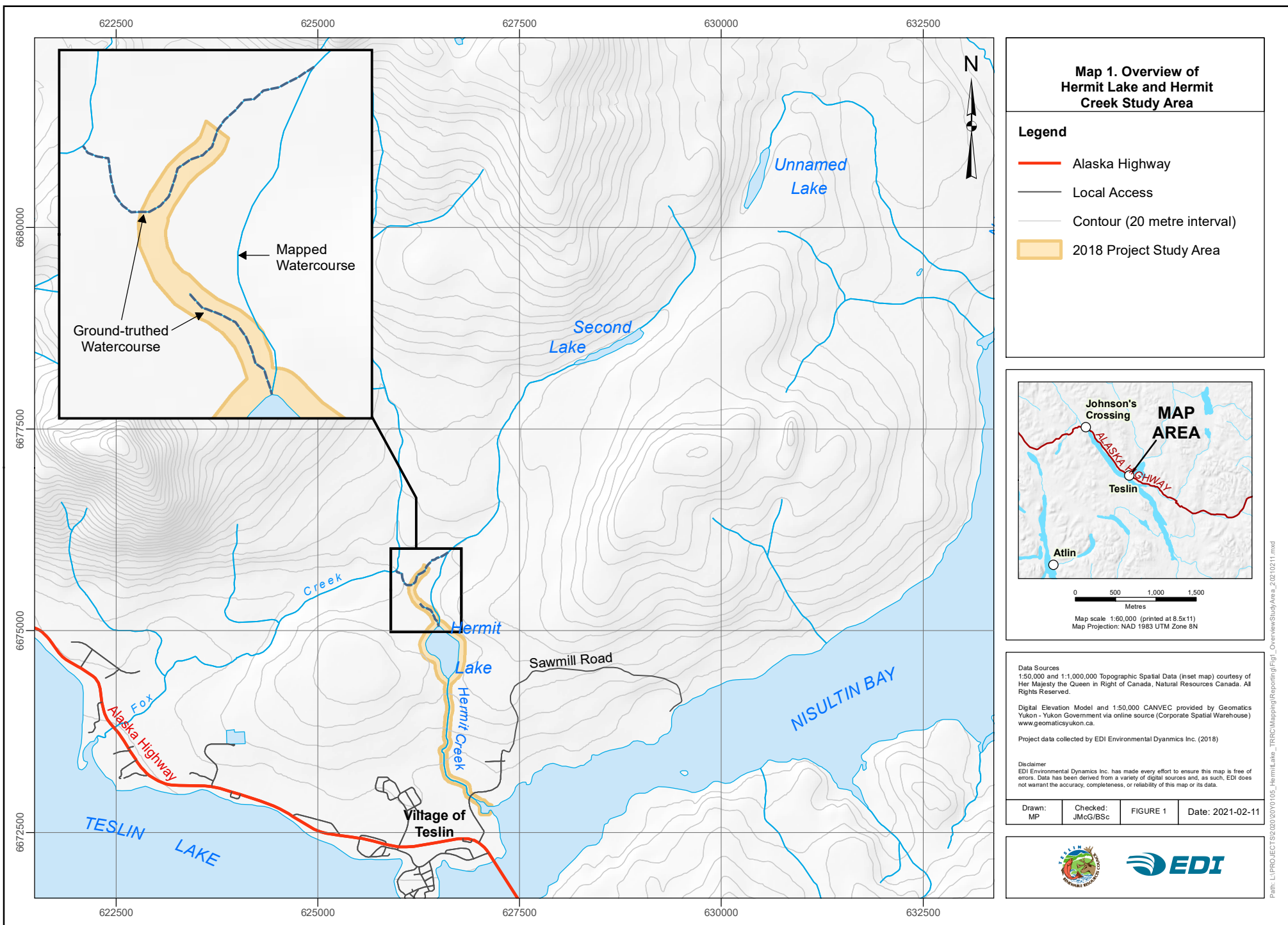
## 1.1 OBJECTIVES OF THE 2020 PROJECT

The 2020 Hermit Creek project objectives were as follows:

- Collect additional information on fish presence in the Hermit Creek watershed, habitat suitability and potential methods of Arctic grayling restoration in the watershed.
- Work with project stakeholders to discuss potential methods of Arctic grayling restoration which may include, but not be limited to habitat improvements to Hermit Creek and/or the outlet of Hermit Lake.
- Prepare a technical report summarizing the results of the project including recommendations for restoration of the Arctic grayling population in the Hermit Creek watershed.

## 1.2 STUDY AREA OVERVIEW

The Hermit Lake area is located immediately to the north of the Village of Teslin (Map 1). Access to the lake is provided by an ATV trail located in the northern part of the Sawmill subdivision. Hermit Lake has an area of approximately 15 hectares and a maximum depth of approximately 8 m.





## 2 METHODS

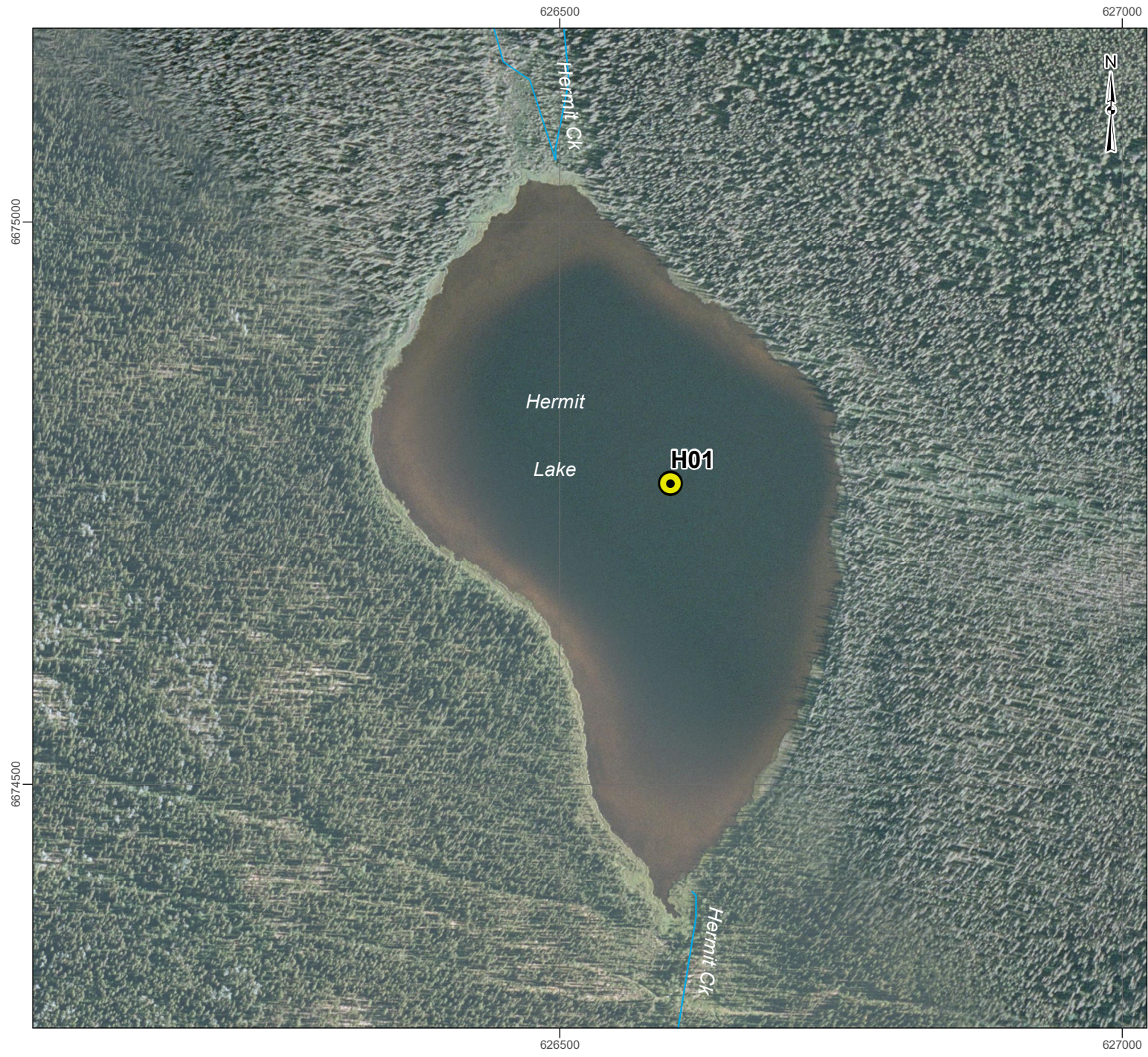
### 2.1 DISSOLVED OXYGEN PROFILES

Dissolved oxygen (DO) and temperature profiles were collected on Hermit Lake during 2020 (March, May and August) and 2021 (February); profiles were also collected at Second Lake during March 2020 and February 2021. Profiles were collected using a YSI ProPlus optical dissolved oxygen meter and an ice auger was used to drill holes in the ice during the winter sampling events. To match the winter profile locations, field crews used a zodiac to collect the summer DO profiles. Temperature and DO levels were recorded at set intervals from the surface of the lake to the bottom. Data recorded in the field from each site were entered into excel and transformed into profiles, with ranges of 0 – 15°C (Temperature) and 0 – 10 mg/L (Dissolved Oxygen) to allow for consistent comparisons between sampling events.

### 2.2 STREAM INVESTIGATIONS


Stream investigations were intended to provide information on fish passage potential and creek morphology in Hermit Creek. Field investigations of Hermit Creek and Hermit Lake were conducted on May 15 and September 9, 2020. The May 15 investigations included a stream walk from the outlet of Hermit Lake to approximately 500 meters downstream of Hermit Lake, as well as the stretch of creek from the Sawmill culvert to the outlet of Hermit Creek into Teslin Lake. The September 9<sup>th</sup> investigations included stream walks: a) from the downstream end of the Sawmill road culvert to the outlet of Hermit Creek, b) from the upstream end of the culvert to approximately 570 meters upstream, c) from the outlet of Hermit Lake to 200 meters downstream. Field crews took visual assessments/observations of flow, culvert condition, instream and terrestrial vegetation, potential barriers to fish passage, substrate and visually identified any fish if present.

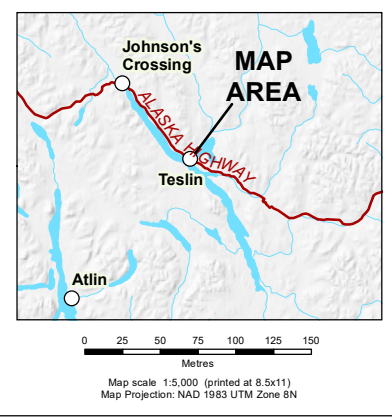




## Map 2. Dissolved Oxygen Sampling Sites on Hermit Lake

### Legend

-  Dissolved Oxygen Sampling Site



**Data Sources**  
 1:50,000 and 1:1,000,000 Topographic Spatial Data (inset map) courtesy of Her Majesty the Queen in Right of Canada, Natural Resources Canada. All Rights Reserved.

Imagery provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) [www.geomatics.yukon.ca](http://www.geomatics.yukon.ca).

Project data collected by EDI Environmental Dynamics Inc. (2018)

**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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## 3 RESULTS AND DISCUSSION

### 3.1 DISSOLVED OXYGEN AND TEMPERATURE PROFILES

#### 3.1.1 HERMIT LAKE

Dissolved oxygen profiles collected at Hermit Lake on March 27, 2020 and February 23, 2021 showed similar results with overall low dissolved oxygen (below 3.0 mg/L) throughout the water column and water temperatures between 2 and 4 °C (Figure 1, top left and bottom right). These profiles were collected at the deepest spot in Hermit Lake and field crews did not observe any areas signs of inflow or different ice conditions that may indicate different conditions in different parts of the lake.

Dissolved oxygen can be a limiting factor and can determine fish presence or absence in small lakes like Hermit Lake. Low oxygen levels over a period of time have been shown to cause lethal and/or physiological and behavioural effects, especially in young fish (CCME 1999). Late winter dissolved oxygen levels in the lake were quite low (maximum of 2.78 mg/L in 2020 and 2.71 mg/L in 2021). These levels are below the Canadian Water Quality Guideline for the Protection of Aquatic life of 6.5 mg/L in cold water (CCME Canadian Council of Ministers of the Environment 1999). While these guidelines are known to be conservative, the levels found in the late winter are well below this guideline. Interestingly, a recent study found that adult and juvenile Arctic grayling exhibited both increased ventilation rate and increased incidence of surface movement as dissolved oxygen concentrations dropped to 4 mg/L and speculated that 4.0 mg/L was a critical threshold for winter survival (Davis et al. 2019). Using this threshold, grayling overwintering would not be possible in Hermit Lake during the late winter of 2020 and 2021.

Dissolved oxygen profiles collected at Hermit Lake during the spring (May 15) and summer (August 20) 2020 found considerable different conditions compared to the winter months (Figure 1) with much higher dissolved oxygen levels. During the spring sampling event, dissolved oxygen levels were relatively high within the upper 2.5 m of the water column and decreased to low levels—similar to the winter—within the lower 2 m of the water column. The water temperature profile also showed evidence of stratification during this sampling event with temperatures over 11 °C at the surface, a rapid change within the thermocline at a depth of 2.0 to 2.5 m and a gradual decline to just above 3 °C near the bottom. The summer sampling event was completed at a slightly deeper location within the lake and showed high levels of dissolved oxygen within the upper 4.0 m, followed by a rapid reduction down towards 5.0 m, followed by very low dissolved oxygen within the lower 3 m of the water column. The water temperature profile during the late summer did not show stratification and temperatures decreased only slightly below the surface temperature of just over 14 °C.

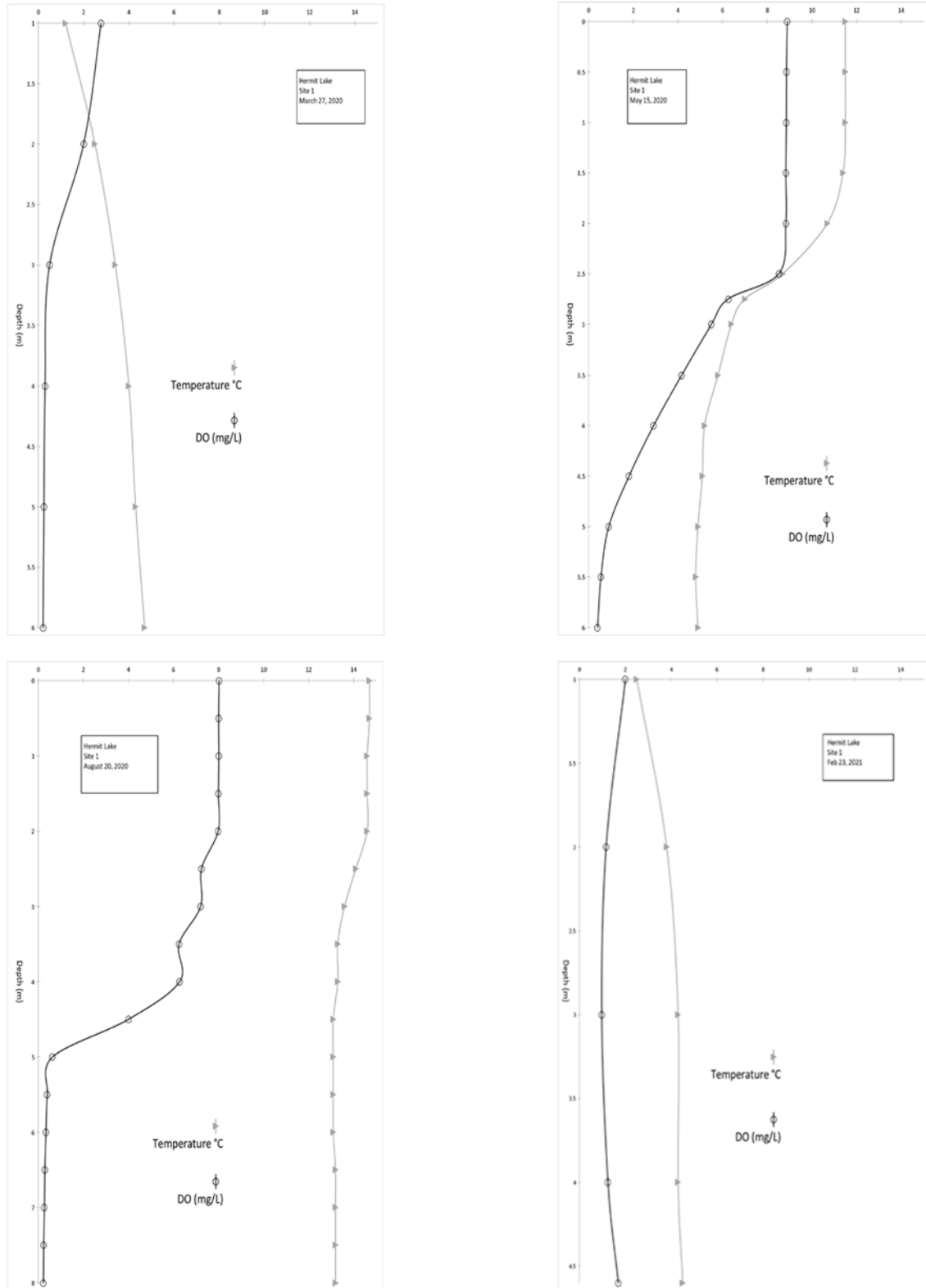


Figure 1. Dissolved oxygen profiles in Hermit Lake between March 27, 2020 and February 23, 2021.



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### 3.1.2 SECOND LAKE AND UNNAMED LAKE

Dissolved oxygen and temperatures were collected at Second Lake and an unnamed lake to provide perspective on the Hermit Lake data. Both of these lakes were also known to have Arctic grayling present as recently as 1999. However, the winter profiles collected at both lakes during the winter of 2020 and 2021 (Figure 2) recorded very low dissolved oxygen levels (below 3 mg/L) similar to that of Hermit Lake. Based upon these observations, the status of Arctic grayling within both of these lakes is also questionable. Due to summer access constraints, neither of these lakes were investigated during the summer months during the current assessment and it is therefore not possible to theorize what may have changed in these lakes over time.

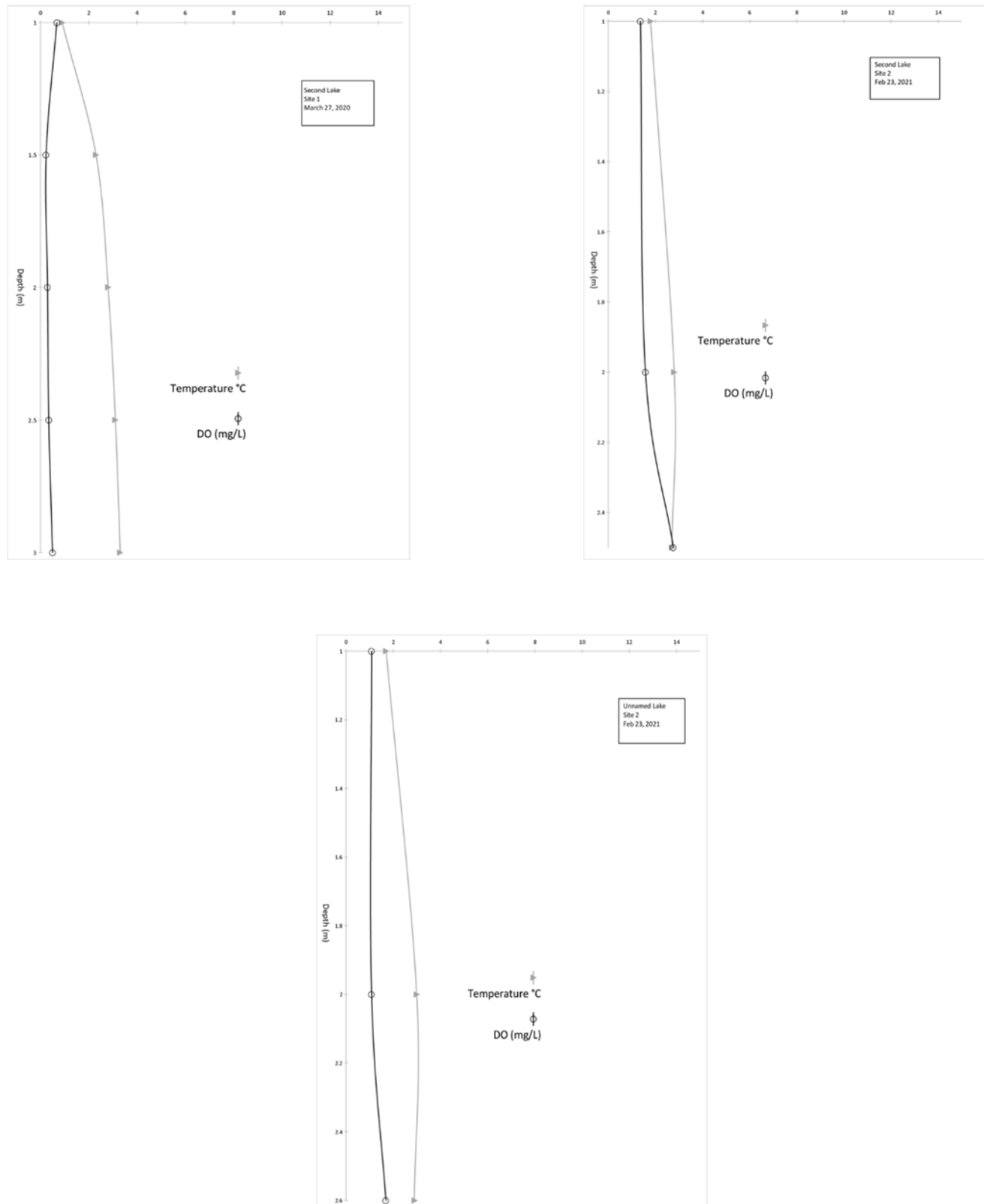


Figure 2. Dissolved oxygen profiles recorded between March 27, 2020 and February 23, 2021 in Second Lake (top) and Unnamed Lake (bottom).





## 3.2 STREAM INVESTIGATION RESULTS

### 3.2.1 MAY 15, 2020

The first of two planned field investigations of the Hermit Creek area was conducted on May 15, 2020. The field crew started the investigation by walking downstream from the outlet of Hermit Lake. At the time of the investigation, the crew noted that there was no defined outlet at the south end of the lake and that flow was minimal (Photo 1 in Appendix A). The crew continued to walk downstream for 500 meters before ending the first portion of the investigation. They noted that there was a large amount of instream woody debris and that substrate was many composed of fines and organics. Flows were limited during this time (Photo 2 in Appendix A) suspected to be between 1 – 10 L/sec. As the crew moved further downstream, the stream was found to frequently go subsurface. No fish were observed in the creek or lake.

The second portion of the May 15 investigation included the portion of the stream between the Sawmill Road culvert and the outlet of Hermit Creek into Teslin Lake. At the time of the investigation, the Sawmill Road culvert appeared to be plugged with ice, but flow was observed at the downstream end (Photo 2 in Appendix A). The field crew continued to walk downstream of the culvert to an old bridge, observing natural woody debris throughout the creek channel and substrate consisting of fines and cobble. No fish were observed during the creek walk and the crew noted that the old bridge could be a potential impediment to upstream fish passage.

### 3.2.2 SEPTEMBER 9, 2020

On September 9, 2020, a field crew walked the majority of Hermit Creek downstream of Hermit Lake in an upstream direction. Between the Sawmill Road culvert and Teslin Lake, it was noted that water flow was higher than previously observed during the 2018 investigation at the time of year. Habitat downstream of the old bridge was deemed to be good with some cover and instream vegetation for juvenile fish (Photo 3 in Appendix A); one juvenile pike was observed in the channel. Flow proceeded to be subsurface under the old bridge although fish passage was observed to be possible in high water conditions (Photo 4 in Appendix A). The crew noted that removal of the old bridge would help to improve habitat and upstream fish passage potential across a broader range of flow levels. Habitat upstream of the bridge included a poorly defined channel that extended to the Sawmill road culvert, with fish passage still a possibility although habitat quality was deemed to be poor. At the time of the investigation, the Sawmill Road culvert was back watered allowing for fish to pass through to the upstream end (Photo 5 in Appendix A).

Surface flow remained consistent for the first 100 meters above the Sawmill Road culvert until the creek passed under powerlines where it branched off into shallow braids, taking on the characteristics of a wetland area (Photo 6 in Appendix A). Between 230 and 360 meters upstream from the culvert, the creek had inconsistent concentrated flow, often going subsurface and was likely unpassable by fish. At 390 meters upstream the creek reverted to a more defined channel with concentrated flow until approximately 480 meters. At this point the creek was shallow and flow was spread out (Photo 7 in Appendix A) with no presence of



pools, posing a challenge for fish passage. The field crew continued to walk until 570 meters upstream of the Sawmill Road culvert where the creek continued to have concentrated flow. The substrate of the creek was composed of fines and sands throughout. No fish were observed between the Sawmill Road culvert and the end of the survey at 570 m upstream.

The outlet of the Hermit Lake was found to be poorly defined at the time of the field assessment (Photo 8 in Appendix A) and there was no noticeable flow until after an ATV bridge approximately 30 meters downstream of the lake (Photo 9 in Appendix A). Habitat quality increased below the ATV bridge to about 200 meters downstream, where there were pockets of substrate including fines and some rocks (Photo 10 in Appendix A).

The stream channel at the outlet of Hermit Lake is poorly defined and flow seems to be percolating through instream vegetation and organics. A 200-meter stretch of creek downstream of the lake outlet provides some potential spawning habitat in the form of pockets of gravel-bed material, but no fish have been observed during any of the sampling events. Even if fish were present in the lake it would be difficult for fish to access the lower habitat during the observed flow conditions. The majority of Hermit Creek upstream of the Sawmill road culvert provides little habitat for fish and includes several impediments to upstream fish passage (i.e., subsurface flow) that could prevent fish passage between the culvert and Hermit Lake.

### 3.3 SUMMARY AND DISCUSSION OF RESTORATION OPTIONS

The Arctic grayling population within Hermit Lake is no longer present and this appears to be related to winter conditions within the lake and/or conditions in the creek. Winter conditions in the past two years indicate that grayling would not be able to overwinter in the lake. Annual migration into the lake from Teslin Lake would be very difficult given the low flow volumes and impediments in the creek between the Sawmill Road and Hermit Lake.

Information on fish presence suggests that conditions were different in the past and there was a sustainable grayling population for many years. Either fish migrated up to the lake in the spring on an annual basis and/or they were able to overwinter in the lake consistently. Field investigations, as well as a review of available aerial imagery, did not reveal why conditions may have changed; however, it is suspected that the flow amounts into and out of the lake have been reduced. Past investigations indicated that the highwater mark of the lake and outlet was notably higher before 1999 and it was speculated that beaver dams in the inlet stream diverted part of the flow into the Fox Creek watershed (White Mountain 1999). The 2018 investigation did not find any evidence of this; therefore, the reasons for the apparent change are unknown (EDI 2018).

It is also interesting that Second Lake and the unnamed lake to the northeast had poor water quality conditions in the winter. Further assessment of Arctic grayling presence in these areas may be warranted to determine if they are still present in these areas in the summer.

Methods of restoring grayling or access to Hermit Lake were considered during the conduct of this project. Options such as stream channel modification (i.e. removing impediments) to improve fish access up to the lake or improvement of spawning habitats were contemplated. However, given limited flow volume is the key issue causing the impediments to migration, such improvements are not warranted or possible.



If winter fish habitat conditions were consistently suitable within Hermit Lake, options could be explored to reintroduce grayling to the lake. However, the poor overwintering conditions observed within the lake and the poor-quality habitat throughout much of Hermit Creek would preclude efforts to reintroduce a sustainable population.



## 4 CONCLUSION

The absence of Arctic grayling in Hermit Lake and the creek upstream of Sawmill Road continues to be evident. This is explained by poor water quality in Hermit Lake during the late winter and the access constraints in Hermit Creek. This investigation has confirmed that something has changed (including flow levels) in the Hermit Lake watershed in the past 20 years; however, there is no clear explanation of how or why such a change has occurred. Unfortunately, there currently does not appear to be any clear actions that can be taken that will restore fish use of this area. There may be merit to investigate Second and the other lake to the northeast during the open water season to determine if Arctic grayling are still present in these areas during the spring and summer months.



## 5 REFERENCES

- CCME Canadian Council of Ministers of the Environment. 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Dissolved Gas Supersaturation. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba. 7 pp.
- Davis, M.N., McMahon, T.E., Webb, M.A.H., Ilgen, J.E., Hitch, A.T., Jaeger, M.E., and Cutting, K.A. 2019. Winter Survival, Habitat Use, and Hypoxia Tolerance of Montana Arctic Grayling in a Winterkill-Prone Lake. *Transactions of the American Fisheries Society* 148(4):843–856. DOI: 10.1002/tafs.10176
- EDI Environmental Dynamics Inc. 2018. Hermit Creek Arctic Grayling Habitat Assessment. Whitehorse YT.
- White Mountain Environmental Consultants, P. 1999. Fisheries Investigations into the Hermit Lake Drainage, An Assessment of Arctic Grayling Stocks, 1999. Teslin, YT. 5 pp.



## APPENDIX A    PHOTOGRAPHS



Photo 1. Downstream view of the outlet of Hermit Lake on May 15, 2020.



Photo 2. Downstream end of the Sawmill road culvert on May 15, 2020.





Photo 3. Downstream view of Hermit Creek outlet into Teslin Lake on September 9, 2020.



Photo 4. Upstream view of old bridge near the outlet of Hermit Creek on September 9, 2020.





Photo 5. View of Sawmill road culvert from the upstream end looking downstream on September 9, 2020.



Photo 6. Hermit Creek approximately 200 meters upstream of the Sawmill culvert on September 9, 2020.





Photo 7. Hermit Creek 480 meters upstream of the Sawmill road culvert on September 9, 2020.



Photo 8. Outlet of Hermit Lake on September 9, 2020.





Photo 9. Upstream view of flow under the ATV bridge downstream of Hermit Lake on September 9, 2020.



Photo 10. Upstream view of Hermit Creek approximately 200 meters downstream of Hermit Lake on September 9, 2020.