

Haines Junction Candidate Stocked Lake Investigations



Prepared For

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22Y0129
Version: 1
April 2023



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EXECUTIVE SUMMARY

In 2022 the Alsek Renewable Resource Council (ARRC) expressed interest in developing a stocked lake in the Haines Junction area to provide additional fishing opportunities to local anglers and ease pressure on wild fish populations. Stocked lakes must meet certain criteria to be included to reduce potential harm to native ecosystems. These criteria include a winter dissolved oxygen concentration of greater than 4 mg/L, no connectivity between waterbodies, no fish present, and existing access.

Based on a desktop review conducted previously by EDI, and fish and fish habitat investigations by the Yukon Government, 8 lakes were identified for addition to the stocked lake program by the ARRC. In March 2022, an overwintering habitat investigation was conducted to determine if winter dissolved oxygen concentrations in the 8 lakes were suitable for fish (i.e., <4 mg/L). The investigations identified that none of the lakes selected possessed dissolved oxygen concentrations that would allow fish to survive the winter. As such, these lakes were removed as potential candidates for the stocked lake program.

Given these results, the ARRC identified a cluster of 6 lakes near the north end of Aishihik Lake as potential candidates. In September 2022, fish and fish habitat investigations were conducted in the 6 lakes to provide information regarding connectivity to other waterbodies, fish presence and identify any existing access to the lakes. The investigation revealed the presence of northern pike in Five Mile Lake, as well as potential connectivity between Five Mile Lake, Unnamed Lake A, Unnamed Lake B and Martens Lake. As such, these lakes were removed from the list. No fish were caught in Duck Lake, and did not have any connection to other waterbodies, however, winter dissolved oxygen concentrations were well below the 4 mg/L threshold for the stocked lake program as documented during March 2023.

The results from the investigations conducted in 2022 and 2023 indicate that there are no lakes near the Village of Haines Junction or Aishihik Lake that are suitable candidates for entry into the stocked lake program based upon the criteria considered.



ACKNOWLEDGEMENTS

John Trotter and Gary Darbyshire from the ARRC, and Levi Graham and Mathew Brown from CAFN assisted with fieldwork for the candidate stocked lakes overwintering and fish habitat investigations.

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1 INTRODUCTION

EDI Environmental Dynamics Inc. (EDI) was retained by the Alsek Renewable Resource Council (ARRC) to assist in developing a stocked lake in the Haines Junction area. The overarching objective of this project was to provide additional fishing opportunities to local anglers and to ease pressure on wild fish populations in the Haines Junction area.

To be eligible for the stocked lake program, there are several criteria that must be met including:

- A minimum overwintering dissolved oxygen value of greater than 4.0 mg/L,
- No connectivity to other waterbodies or risk of connection during flood events,
- Existing access and safe access trails,
- No other fish species present.

Using these criteria, EDI conducted investigations in several lakes in the Haines Junction and Aishihik Lake areas to identify potential lakes for the Yukon Government's stocked lake program. This report describes the methods and results from the 2022 and 2023 candidate stocked lake investigations.



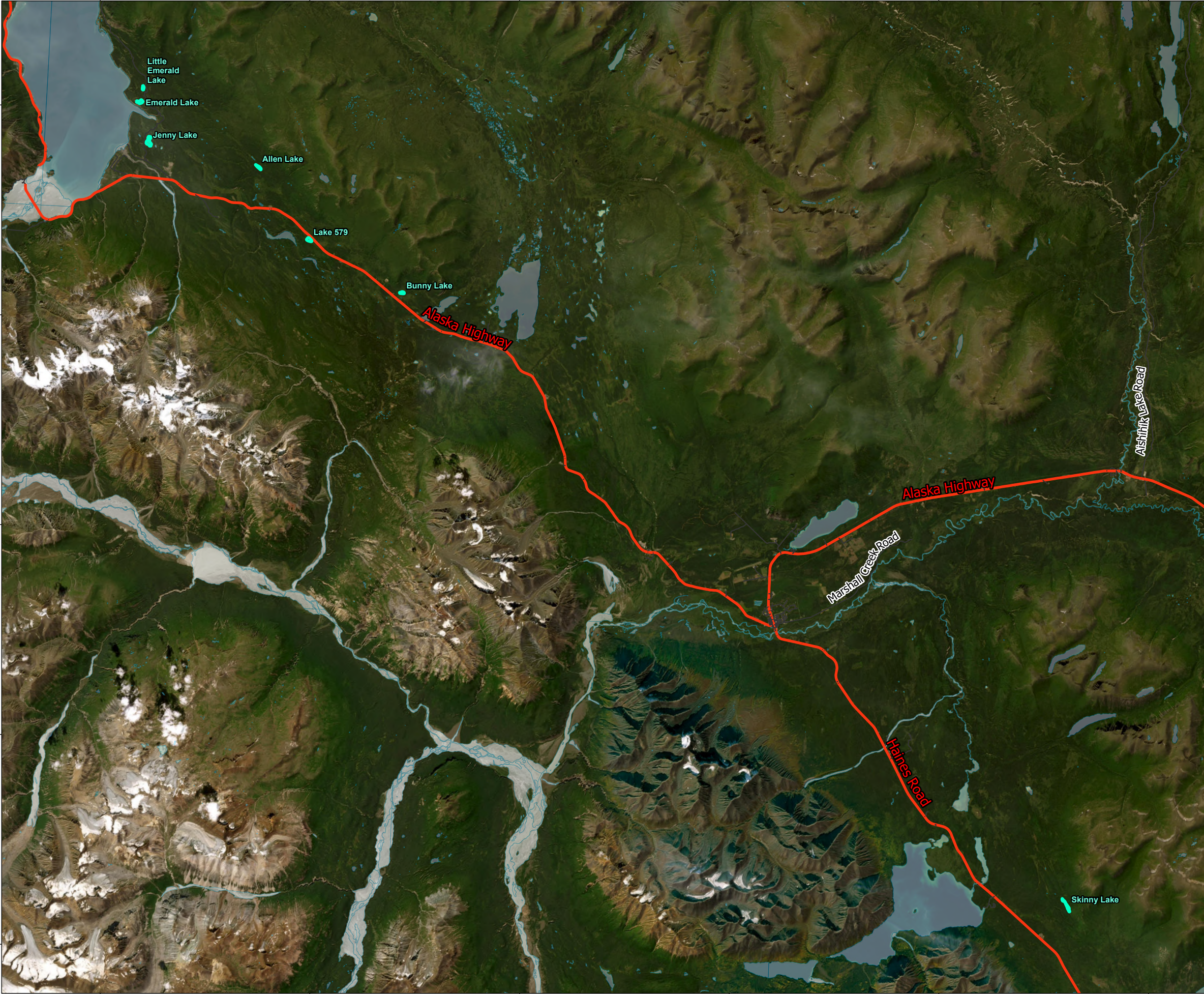
2 CANDIDATE LAKE DETERMINATION

In 2017, EDI completed a desktop exercise to identify potential candidate lakes for stocking and rank the candidates based on accessibility, connectivity, and distance to First Nations settlement land (FNSL) (EDI Environmental Dynamics Inc. 2017). In March 2018, Environment Yukon visited seven candidate lakes in the Snag Junction area and four in the Kloo Lake area. Investigations were completed to determine overwintering habitat suitability and collect dissolved oxygen-temperature profiles of the lakes. All of the lakes in the Kloo Lake area contained poor levels of dissolved oxygen and were unsuitable overwintering habitat for fish (Barker 2018).

A list of candidate lakes was compiled from the previous desktop analysis to identify potential stocked lakes in the Haines Junction area. The candidate lakes were identified by the ARRC and vetted by the CAFN as an initial list of the best candidate lakes to investigate (Table 1, Map 1).

Table 1. List of candidate stocked lakes visited during March 2022 overwintering habitat investigation.

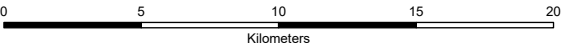
Name	Location (Decimal Degrees)	
	Latitude	Longitude.
Unnamed Lake (Bunny Lake)	60.955285	-138.018274
Lake 579	60.986046	-138.142697
Allen Lake	61.031862	-138.216057
Jenny Lake	61.046936	-138.361372
Emerald Lake	61.069116	-138.374473
Unnamed Lake (Emerald Lake 2)	60.078107	-138.373538
Unnamed Lake (Moose Meadows Lake)	60.734104	-137.348604
Unnamed Lake (Gun Range Pond)	60.738085	-137.438193



Candidate stocked lakes visited during
March 2022

Legend

- Primary Road
- Secondary Road
- Waterbody
- Candidate Stocked Lakes



Map Scale = 1:275,000 (printed on 11 x 17)
Map Projection: NAD 1983 UTM Zone 8N

Data Sources

- Inset Basemap. National Geographic World Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
- Main Basemap. World Imagery: Earthstar Geographics

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2.1 2022 OVERWINTERING HABITAT INVESTIGATION

2.1.1 METHODS

Overwintering habitat investigations were completed over March 21–23, 2022 at 8 candidate lakes in the Haines Junction area (Table 1). The sampling was conducted in partnership with the AARC and the Champagne and Aishihik First Nation (CAFN). Each candidate lake was visited, and dissolved oxygen-temperature profiles were collected in each lake. Dissolved oxygen decreases in lakes overwinter through the decomposition of biotic material (vegetation and microbes). The decomposition process consumes oxygen which can be reduced to levels low enough for lakes to become anoxic and cause fish kills. (Davis et al. 2020). In most instances the winter oxygen-limiting period ends with the breakup of lake ice in spring (Barica and Mathias 1979).

The candidate lakes were visited in late winter (March) (Table 1) when values of dissolved oxygen are generally lowest. Ice and snow cover prevent oxygenation of lake water by diffusion and aeration, reduce convective mixing, and reduce the amount of light available for photosynthesis and the production of oxygen by submersed vegetation (Welch and Kalff 1974, Terzhevik et al. 2009).

Holes were drilled at what appeared to be the deepest part each lake with a gas-powered ice auger. Dissolved oxygen and water temperature were measured at 1-meter intervals from the ice-water interface to the lake bottom using a YSI Pro SOLO water quality probe. Multiple holes were drilled in the larger candidate lakes (Jenny and Emerald lakes) as the extent of winter hypoxia in larger lakes may be more heterogeneous due to inflows (Guenther and Hubert 1991, Baehr and DeGrandpre 2002).

Levels of dissolved oxygen were compared to the Canadian Council of Ministers of the Environment (CCME) freshwater dissolved oxygen guidelines for the protection of aquatic life (CCME Canadian Council of Ministers of the Environment 1999). The CCME guidelines indicate a dissolved oxygen value of 9.5 mg/L for early life stages or 6.5 mg/L for other life stages. Additionally, Yukon Government suggests a minimum overwinter dissolved oxygen value of greater than 4.0 mg/L for candidate stocked lakes (Yukon Government 2022).

2.1.2 RESULTS

The majority of the lakes visited during March 2022 had levels of dissolved oxygen levels <1.0 mg/L through the entire water column (Table 2). Only Emerald Lake and Unnamed Lake (Emerald Lake #2) had dissolved oxygen levels that were above 1.0 mg/L in the first few meters of the water column. However, levels of dissolved oxygen in these lakes were still low (<4.0 mg/L) and dropped rapidly to below 1.0 mg/L within a few meters of water depth. Additionally, most of the lakes investigated were characteristically shallow (<6 m deep). As part of the stocking program the Yukon Government prefers lakes >10.0 m deep, however, shallower lakes have been stocked in the past when overwintering conditions were favorable (Yukon Government, 2019). Yukon Government also suggests that overwinter levels of dissolved oxygen should be



above 4.0 mg/L for consideration in the stocked lakes program. As such, none of the candidate lakes visited are likely to provide suitable conditions for fish overwintering survival in a fish stocking program.

Table 2. Candidate stocked lakes temperature-dissolved oxygen profile data from March 2022 overwintering habitat suitability investigations.

Water Depth (m)	Temperature (°C)	Dissolved Oxygen		Comments
		Percent Saturation (%)	mg/L ¹	
Bunny Camp Lake				
0.0	1.3	3.1	0.44	Ice Surface
1.0	0.9	2.0	0.28	
1.8	2.0	1.6	0.27	Lake Bottom
Lake 579				
0.0	0.6	4.0	0.57	Ice Surface
1.0	0.6	2.0	0.29	
1.5	1.1	1.5	0.22	Lake Bottom
Allen Lake				
0.0	0.5	4.7	0.67	Ice Surface
1.0	0.8	2.7	0.38	
2.0	2.7	2.4	0.32	
3.0	3.7	2.2	0.29	
4.0	4.4	2.1	0.27	
5.0	4.7	1.7	0.21	Lake Bottom
Jenny Lake (hole #1) ²				
0.0	1.9	4.9	0.67	Ice Surface
1.0	1.7	2.2	0.30	
2.0	3.5	1.8	0.24	
3.0	4.1	1.6	0.21	
4.0	4.6	1.4	0.19	
4.05	4.6	1.4	0.17	Lake Bottom
Emerald Lake (hole #2) ²				
0.0	0.4	22.6	3.23	Ice Surface
1.0	0.8	20.6	2.93	
2.0	2.5	18.2	2.46	
3.0	3.4	15.0	2.00	
4.0	3.7	8.2	1.08	
5.0	3.9	2.2	0.29	



Water Depth (m)	Temperature (°C)	Dissolved Oxygen		Comments
		Percent Saturation (%)	mg/L ¹	
6.0	4.5	2.0	0.19	
7.0	4.1	1.3	0.16	
8.0	4.3	1.2	0.15	
8.9	4.6	1.1	0.14	Lake Bottom
Emerald Lake 2				
0.0	0.2	17.7	2.55	Ice Surface
1.0	0.7	13.2	1.87	
2.0	2.5	11.2	1.52	
3.0	3.8	4.5	0.59	
4.0	4.4	2.8	0.34	
5.0	4.5	1.5	0.20	
5.75	5.0	1.4	0.18	Lake Bottom
Moose Meadows Lake				
0.0	0.8	2.0	0.28	Ice Surface
1.0	0.9	1.6	0.23	
1.2	1.0	1.4	0.20	Lake Bottom
Gun Range Pond				
0.0	1.0	4.0	0.56	Ice Surface
1.0	1.0	2.2	0.31	
2.0	3.1	2.1	0.27	
2.75	4.4	1.9	0.25	Lake Bottom

¹ All measurements of dissolved oxygen were below 4.0 mg/L.

² While multiple holes and dissolved oxygen-temperature profiles were recorded results from the other profiles were very similar, and as such, only one profile is presented here.

2.2 2022 FISH AND FISH HABITAT ASSESSMENT

Given the lakes identified in Table 1 were deemed unsuitable, the ARRC expressed interest in investigating the suitability of a cluster of 6 lakes (Table 3, Map 2) near the north end of Aishihik Lake as potential candidate lakes.

In addition to suitable winter dissolved oxygen concentrations, stocked lakes require no connectivity to other waterbodies or risk of connection during flood events, existing access and safe access trails, and no other fish species present. To confirm potential connectivity of the candidate lakes (Table 3), a combination of aerial drone surveys and ground truthing were utilized. Drone surveys were conducted using a DJI Mavic 2 drone



flown by a certified operator. The area between each lake were flown to identify any potential connectivity between the lakes. If any indicators (e.g., wetted, or historical stream channels, ponds, marshes, or riparian vegetation) were identified, the area was visited on foot to confirm conditions.

A combination of fish sampling methods including snorkel surveys, beach seining and angling were used to determine the presence and/or absence of fish in the candidate lakes. Details of each method are provided in the following sections.

Table 3. List of candidates stocked lakes visited during September 2022 fish and fish habitat investigation

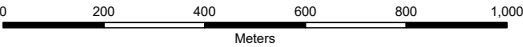
Name	Location (Decimal Degrees)	
	Latitude	Longitude.
Duck Lake	61.666028	-137.426453
Martens Lake	61.642336	-137.371400
Five Mile Lake	61.648788	-137.390345
Unnamed Lake A	61.658880	-137.401830
Unnamed Lake B	61.654152	-137.414778
Unnamed Lake C	61.652291	-137.370279



Candidate Stocked lakes visited during
September 2023

Legend

Secondary Road



Map Scale = 1:15,000 (printed on 11 x 17)
Map Projection: NAD 1983 UTM Zone 8N

Data Sources

- Inset Basemap. National Geographic World Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
- Main Basemap. World Imagery: Maxar

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Checked:
A. MacPhail

Map 2

Date: 2023-04-04





2.2.1 METHODS

2.2.1.1 Snorkel Surveys

Snorkel surveys were conducted by experienced individuals following Resource Inventory Standards Committee (RISC) standards (BC Environment and Resources Inventory Committee 1997). A single individual wearing a dry suit, mask, and snorkel completed surveys by floating through the identified survey area attempting to identify fish (by species) and count all individuals observed. Snorkel surveys were used to rapidly collect information on fish presence and habitat use (Table 4). Information collected during snorkel surveys includes the date, start location and time, end location and time, estimate of the area surveyed, description of the habitat units surveyed, and weather and survey viewing conditions. Snorkel survey locations are provided in **Error! Reference source not found..**

Table 4. September 2022 Snorkeling effort and sampling locations

Site	Location	Date	Number of Surveyors	Survey Description
SN-01	North end of Duck Lake (Start: 61.66959098°, -137.4330144°) (End: 61.6655906°, -137.4295398°)	September 28 th , 2022	1	Surveyed from the northwest corner of Duck Lake to the approximate middle of lake. Water was clear at the time of the survey providing suitable survey conditions.
SN-02	South end of Duck Lake (Start: 61.66352235°, -137.422799°) (End: 61.66265442°, -137.4227845°)	September 28 th , 2022	1	Surveyed the southwest corner of Duck Lake. Water was clear at the time of the survey providing suitable survey conditions.

2.2.1.2 Beach Seining

Beach seining was conducted following RISC Standards using a fine (2 mm) mesh seine net measuring 1.5 m deep by 10.0 m long with one weighted line and one floating line (BC Environment and Resources Inventory Committee 1997). A total of 8 and 2 seine hauls were completed in Duck Lake and Five Mile Lake, respectively. The area sampled varied depending on site-specific conditions including water depth, flow, accessibility, substrate, and the presence of debris. Sampled area (length, width and depth) was estimated at each site and ranged from 20 m² to 90 m² (Table 5; Map 3). Information collected at each site included date/time, weather conditions, wave direction (if applicable), substrate, seine haul quality, and seine haul dimensions (length, average width and depth).

**Table 5. September 2022 beach seining effort and sampling locations.**

Site	Date	Location	Coordinates (Decimal Degrees)		Sampled area (m2)
			Latitude	Longitude	
BS-1	September 27th, 2022	Duck Lake	61.66918838	-137.4326809	36
BS-2	September 27th, 2022	Duck Lake	61.6692265	-137.4329251	45
BS-3	September 27th, 2022	Duck Lake	61.6695155	-137.4331246	45
BS-4	September 27th, 2022	Five Mile Lake	61.65538467	-137.3905939	90
BS-5	September 27th, 2022	Five Mile Lake	61.65551821	-137.3908783	90
BS-6	September 27th, 2022	Duck Lake	61.66325936	-137.4219977	38
BS-7	September 27th, 2022	Duck Lake	61.66317561	-137.4217325	30
BS-8	September 27th, 2022	Duck Lake	61.66311496	-137.4215303	43
BS-9	September 28th, 2022	Duck Lake	61.66300756	-137.4211498	20
BS-10	September 28th, 2022	Duck Lake	61.66283198	-137.4208668	24

2.2.1.3 Angling

Angling was conducted following RISC standards (BC Environment and Resources Inventory Committee 1997). Angling generally targets adult and sub-adult visual feeders. The crew used a combination of fly fishing using a variety of flies to target fish within Duck Lake. Angling was conducted at three locations on Duck Lake (Table 6, **Error! Reference source not found.**). Information collected at each site included location, date, start/end time, sampling effort, catch, and weather conditions.

Table 6. September 2022 angling effort and sampling locations.

Site	Date	Location	Start Coordinates (Decimal Degrees)		End Coordinates (Decimal Degrees)		Number of Anglers	Angling Time (hrs)
			Latitude	Longitude	Latitude	Longitude		
AG-1	September 27 th , 2022	Duck Lake	61.669241	-137.4329	61.66488	-137.4295	1	1.0
AG-2	September 28 th , 2022	Duck Lake	61.668246	-137.4304	61.663333	-137.4226	1	1.5
AG-3	September 28 th , 2022	Duck Lake	61.66301	-137.4214	61.66468	-137.4295	1	0.5



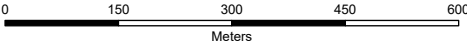
September 2023 Fish Sampling Locations

Legend

Secondary Road

Fish Sampling

- Angling
- Beach Seining
- Summer Dissolved Oxygen Profile
- Winter Dissolved Oxygen Profile
- Snorkel Surveys



Map Scale = 1:10,000 (printed on 11 x 17)
Map Projection: NAD 1983 UTM Zone 8N

Data Sources

- Inset Basemap. National Geographic World Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
- Main Basemap. World Imagery: Maxar

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2.2.2 RESULTS

2.2.2.1 Connectivity Between Lakes

Aerial drone surveys conducted between the lakes on the south side of the Aishihik Lake road (Martens Lake, Five Mile Lake, Unnamed Lake A and Unnamed Lake B) suggest at certain times of the year (i.e., during freshet) there could be some connectivity between the lakes. No connectivity was identified at the time of the survey, however, without further assessment it can't be ruled out that there is connectivity between the lakes at certain times of the year.

On the north side of the Aishihik Lake road, there appeared to be no connectivity between Duck Lake and any of the lakes on the south side of the road. There was an unwetted area approximately 400 metres (m) in length between the south end of Duck Lake and the Aishihik Lake Road with no culvert connecting the north and south side of the road. At the north end Duck Lake, minimal wetted habitat (small depressions filled with groundwater) with little to no fish value was observed. This transitions to an open forest before descending into a small marsh north of Duck Lake. The small marsh sits approximately 28 metres in elevation below Duck Lake, and there is no wetted fish habitat between the two waterbodies. As such, connectivity between Duck Lake and the small marsh is highly unlikely. Representative photographs of the area are provided in Appendix A.

2.2.2.2 Fish Presence/Absence

Fish sampling results are presented in Table 7. Two juvenile northern pike were caught via beach seining in Five Mile Lake. Given the suspected connectivity between the Five Mile Lake, Martens Lake, Unnamed Lake A and Unnamed Lake B, it was assumed that northern pike may be present within these waterbodies at certain times of the year. Stocked lake candidates require no other fish species present, as such, no further effort was applied in Martens Lake, Unnamed Lake A, or Unnamed Lake B.

No fish were caught in Duck Lake via beach seining or angling. Snorkel surveys identified an abundance of invertebrates, but no fish were observed.

Table 7. Summary of Effort and Species Captured in Duck Lake and Five Mile Lake, September 2022

Sampling Method	Number of Sites	Total Effort	Species	Total Individuals Captured
Duck Lake				
Angling	3	2.95 hrs	N/A	0
Beach seining	8	280 m ²	N/A	0
Snorkel Survey	2	1.8 hrs	N/A	0
Five Mile Lake				
Beach seining	2	180 m ²	Northern pike	2



2.2.3 DUCK LAKE TEMPERATURE AND DISSOLVED OXYGEN PROFILE

2.2.3.1 September 2022

A temperature and dissolved oxygen profile for the deepest part of Duck Lake from September 2022 is provided below in Table 8. Dissolved oxygen ranged from 70.3 to 74.0 % (8.47 to 8.93 mg/L) within the water column and temperature was steady around 7.2 to 7.3 °C.

Table 8. Duck Lake temperature-dissolved oxygen profile data from September 2022

Water Depth (m)	Temperature (°C)	Dissolved Oxygen		Comments
		Percent (%)	mg/L	
Duck Lake				
0	7.3	74	8.93	Water Surface
1	7.3	73.8	8.9	
2	7.3	73.3	8.84	
3	7.2	72.6	8.77	
4	7.2	72	8.7	
5	7.2	70.3	8.47	
6	7.2	3.7	0.44	Lake Bottom- Mud

2.2.3.2 March 2023

Following the methods outlined in Section 2.1.1, a follow up sampling event was conducted in Duck Lake in March 2023 to verify winter dissolved oxygen concentrations. Dissolved oxygen levels were all <3.0 mg/L through the water column in Duck Lake (Table 9) indicating unsuitable conditions for fish overwintering.



Table 9. Duck Lake temperature-dissolved oxygen profile data from March 2023

Water Depth (m)	Temperature (°C)	Dissolved Oxygen		Comments
		Percent (%)	mg/L ¹	
DO-1				
1	0.8	13.6	1.97	
2	2.6	11.6	1.25	
3	3.7	5.5	0.73	
4	4.4	3.5	0.46	
5	4.5	4.2	0.55	Lake Bottom- Mud
DO-2				
1	0.7	18.6	2.68	
2	2.7	16.6	2.28	
3	3.4	11.3	1.5	Lake Bottom- Mud
DO-3				
1	1.6	13.5	1.9	
2	3.2	9.9	1.34	
3	3.7	7.1	0.93	
4	3.7	8.3	1.09	Lake Bottom- Mud



3 SUMMARY

The results from the investigations conducted in 2022 and 2023 indicate that there are no lakes near the Village of Haines Junction or Aishihik Lake that are suitable candidates for entry into the stocked lake program based upon the criteria used to assess the lakes. Although Duck Lake met most of the required criteria, the winter dissolved oxygen concentrations were unsuitable for fish overwintering.



4 REFERENCES

- Baehr, M.M. and DeGrandpre, M.D. 2002. Under-Ice CO₂ and O₂ Variability in a Freshwater Lake. *Biogeochemistry* 61(1):95–113. DOI: 10.1023/A:1020265315833
- Barica, J. and Mathias, J.A. 1979. Oxygen Depletion and Winterkill Risk in Small Prairie Lakes Under Extended Ice Cover. *Journal of the Fisheries Research Board of Canada* 36(8):980–986. DOI: 10.1139/f79-136
- Barker, O. 2018. Evaluation of Candidate Stocked Lakes in Kluane Region. Environment Yukon Fish and Wildlife Branch. Note to File.
- CCME Canadian Council of Ministers of the Environment. 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Dissolved Oxygen (Freshwater). Canadian Council of Ministers of the Environment, Winnipeg, Manitoba Canada. 6 pp. (<http://ceqg-rcqe.ccme.ca/download/en/177>)
- Davis, M.N., McMahon, T.E., Cutting, K.A., and Jaeger, M.E. 2020. Environmental and climatic factors affecting winter hypoxia in a freshwater lake: evidence for a hypoxia refuge and for re-oxygenation prior to spring ice loss. *Hydrobiologia* 847(19):3983–3997. DOI: 10.1007/s10750-020-04382-z
- EDI Environmental Dynamics Inc. 2017. Yukon Stocked Lake Program: Potential Lake Identification Project. Prepared for the Yukon Fish and Wildlife Enhancement Trust Fund, Whitehorse, Yukon. 12 pp.
- Guenther, P.M. and Hubert, W.A. 1991. Factors influencing dissolved oxygen concentrations during winter in small Wyoming reservoirs. *Great Basin Naturalist* 51(3):5.
- Terzhevik, A., Golosov, S., Palshin, N., Mitrokhov, A., Zdorovenov, R., Zdorovenova, G., Kirillin, G., Shipunova, E., and Zverev, I. 2009. Some features of the thermal and dissolved oxygen structure in boreal, shallow ice-covered Lake Vendyurskoe, Russia. *Aquatic Ecology* 43(3):617–627. DOI: 10.1007/s10452-009-9288-x
- Welch, H.E. and Kalff, J. 1974. Benthic Photosynthesis and Respiration in Char Lake. *Journal Fisheries Research Board of Canada* 31(609–620):13.
- Yukon Government, Department of Environment. 2019. Angler's Guide to Yukon Stocked Lakes.
- Yukon Government, Department of Environment. 2022. Yukon Stocked Lakes Program Overview and Candidate Lakes. Yukon Territory. Presented to the Alsek Renewable Resource Council (ARRC). February 2022 presentation.



APPENDICES



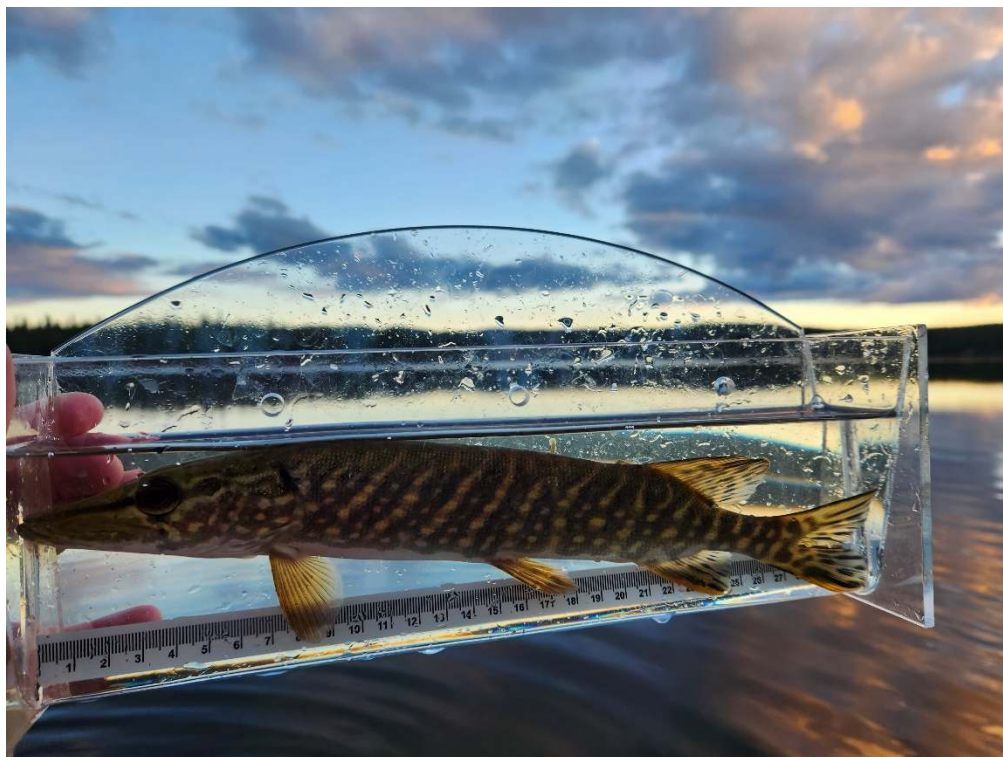
APPENDIX A PHOTOGRAPHS



Appendix Photo A-1. Auguring a hole in the ice to investigate fish overwintering conditions at Jenny Lake (March 22, 2022).



Appendix Photo A-2. Overwintering habitat investigation at Emerald Lake #2 (March 22, 2022).



Appendix Photo A-3. Juvenile Northern Pike caught in Five Mile Lake (September 7, 2022).



Appendix Photo A-4. Benthic invertebrates caught in Duck Lake (September 7, 2022).



Appendix Photo A-5. Upland forest habitat found between Duck Lake and small marsh to the north (September 7, 2022).



Appendix Photo A-6. Ground conditions at the south end of Duck Lake (September 7, 2022).



Appendix Photo A-7. Aerial view looking at Duck Lake (top left) and Unnamed Lake A (bottom right; (September 7, 2022)



Appendix Photo A-8. Typical shoreline conditions found in Duck Lake (September 7, 2022).



Appendix Photo A-9. Duck Lake looking south (September 7, 2022).