Appendix V5-6P

Imniagut Lake Fisheries Assessment, Doris North Project, 2014

MAC RESOURCES

Memorandum

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To: John Roberts, VP Environmental Affairs
Jill Turk, Environmental Coordinator
Sharleen Hamm, Project Manager

From: Fraser Ross (B.Sc., R.P.Bio.)

Cc: April Hayward (Ph.D.), Project Manager
Marc Wen (M.Sc., R.P.Bio.), Partner in Charge

Subject: **Imniagut Lake Fisheries Assessment, Doris North Project, 2014**

GLOSSARY AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

CCME	Canadian Council of Ministers of the Environment
CPUE	Catch-per-unit-effort
DELTs	Deformities, Erosion, Lesions, or Tumors
ERM	ERM Consultants Canada Ltd.
FL	Fork Length
RISC	Resources Information Standards Committee
TMAC	TMAC Resources Inc.
UTM	Universal Transverse Mercator

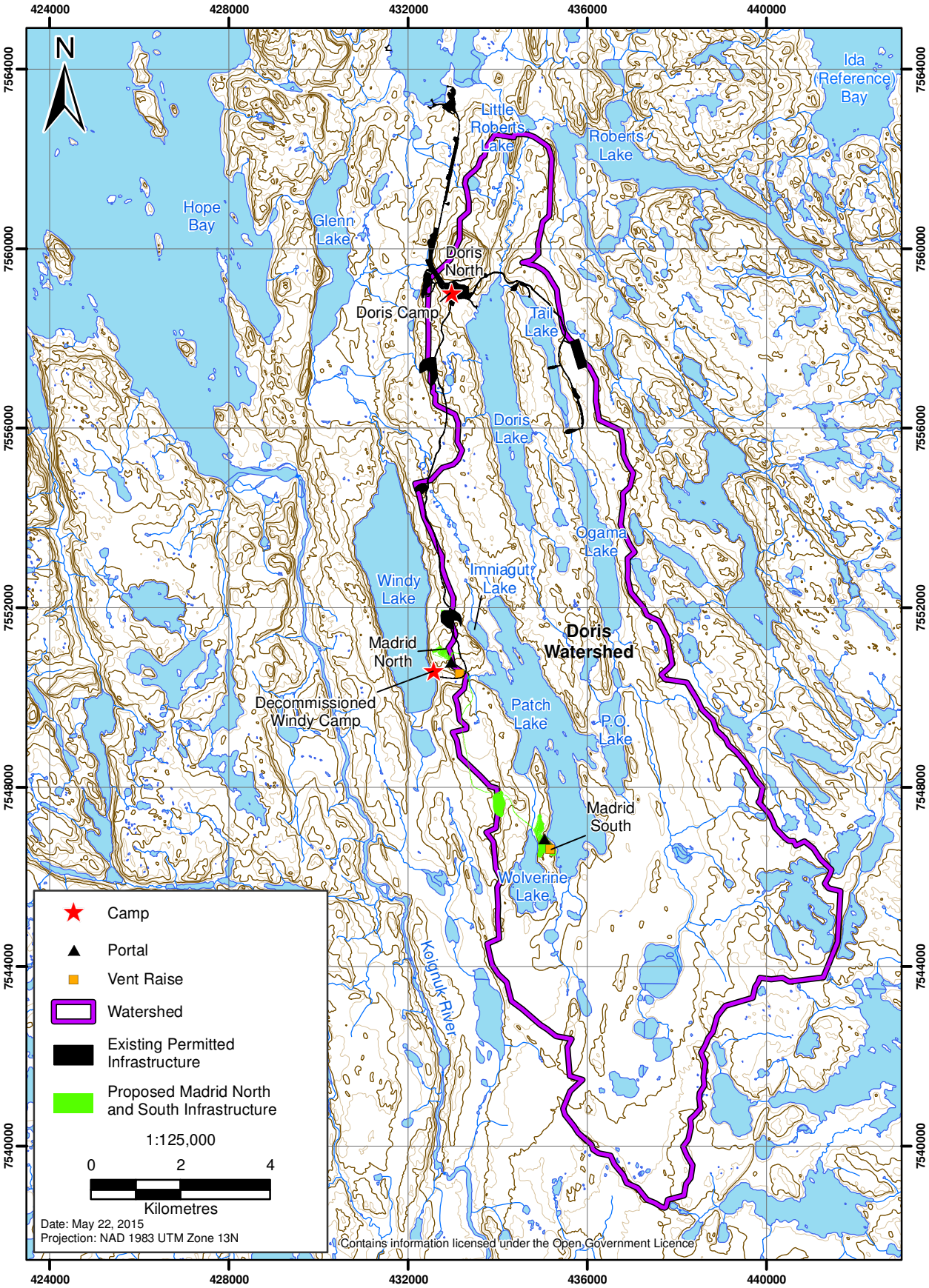
1. INTRODUCTION

ERM Consultants Canada Ltd. (ERM) conducted a fisheries assessment of Imniagut Lake, which is adjacent to existing and potential infrastructure in the Madrid area, at the request of TMAC Resources Inc. (TMAC) in the summer of 2014. This memorandum presents the results of the assessment.

Imniagut Lake is located in the Doris Creek watershed, 7 km south of Doris Camp and 500 m east of the Doris-Windy All Weather Road (Figure 1-1). The lake drains into Patch Lake, flowing through P.O. Lake, Ogama Lake, Doris Lake, and Little Roberts Lake before meeting the ocean at Roberts Bay. A 4 m waterfall between Doris Lake and Little Roberts Lake marks the upstream limit for anadromous fish.

Figure 1-1

Imniagut Lake and the Doris Creek Watershed, Doris North Project, 2014



Some biophysical attributes of Imniagut Lake have been sampled previously: physical limnology, water quality, sediment quality, phytoplankton, zooplankton, and benthic invertebrate sampling was conducted in 2009 (Rescan 2010a); a bathymetric survey was conducted in 2010 (Rescan 2011). Summer sampling in 2009 revealed that both temperature and dissolved oxygen profiles were stable throughout the water column; and although there was a slight decline in oxygen near the lake bottom, values remained above the Canadian Council of Ministers of the Environment (CCME) guidelines for early stage aquatic life (greater than 9.5 mg/L; CCME 2007). Under-ice dissolved oxygen profiles have not been collected; consequently, the extent to which the lake might experience fish winterkill due to depleted oxygen concentrations is uncertain.[1]

Imniagut Lake is adjacent to Patch Lake. The fish community in Patch Lake has been well documented, with fish community surveys conducted from 1995 to 1999 and from 2006 to 2009 (summarized in Rescan 2010b). Based on these studies, the fish community in Patch Lake is comprised of Lake Trout (*Salvelinus namaycush*), Lake Whitefish (*Coregonus clupeaformis*), Cisco (*Coregonus artedi*), and Ninespine Stickleback (*Pungitius pungitius*).

The objectives of the 2014 Imniagut Lake fisheries assessment were as follows:

- to determine fish presence and community composition in Imniagut Lake;
- to assess surface connectivity of Imniagut Lake to Patch Lake or any other fish-bearing waterbody; and
- to assess shoreline habitats in Imniagut Lake.

2. METHODOLOGY

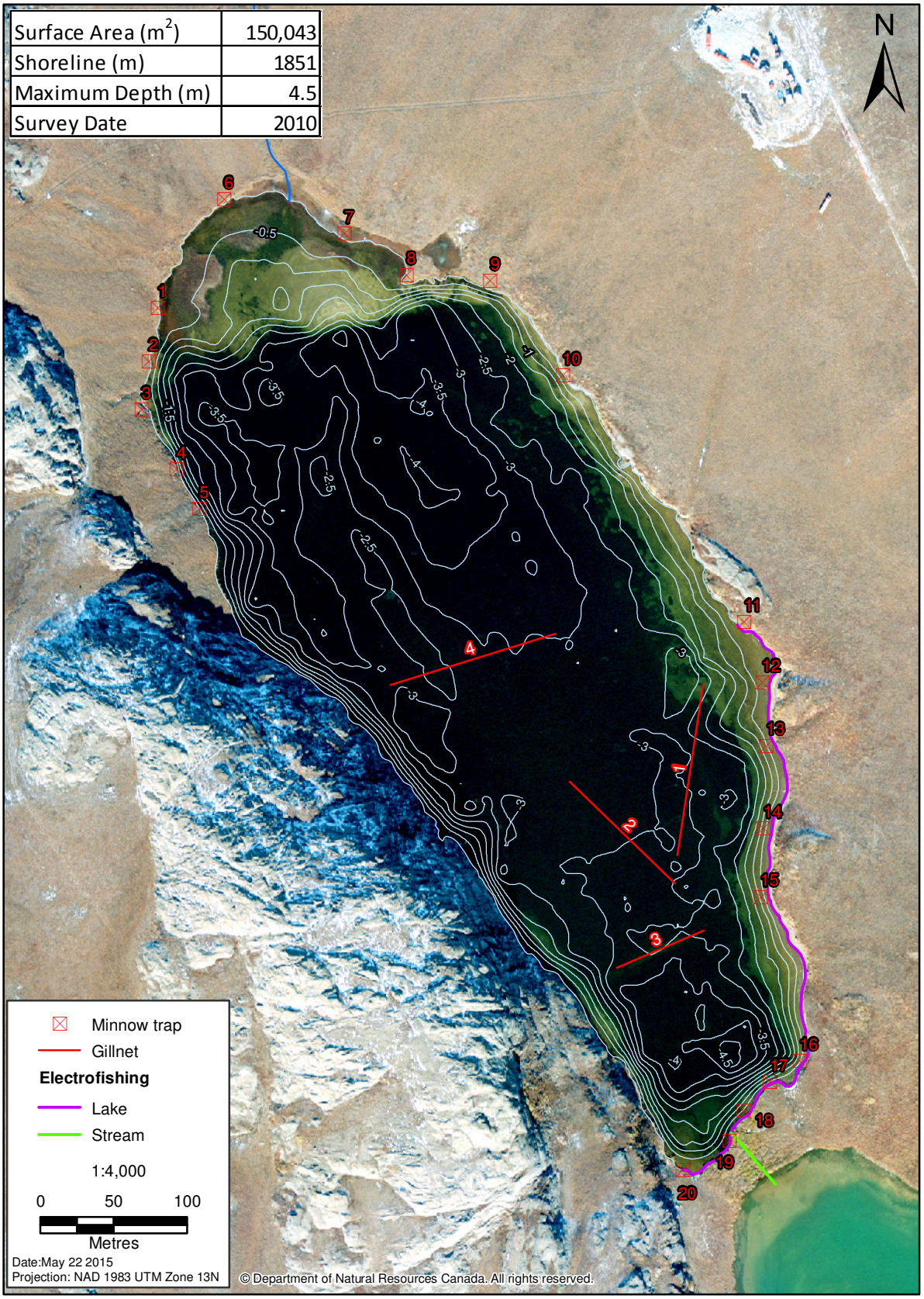
2.1 Fish Community Assessment

Minnow traps, gill nets, and an electrofisher were used to sample the fish community of Imniagut Lake in July and September, 2014 (Figure 2.1-1). All captured fish were identified to species and given a unique sample number. Fork Length (FL) was measured to the nearest 1 mm with a measuring board and wet weight was measured to the nearest 0.1 g using an electronic scale for a subsample of fish. Where parasites or deformities, erosion, lesions, or tumors (DELTs) were observed, this information was recorded for each captured fish.

[1] An attempt was made to collect under-ice temperature and dissolved oxygen profiles in 2009, but insufficient water depth prevented the collection of under-ice profiles at the sampling location. A bathymetric survey conducted in 2010 identified deeper areas of the lake, but under-ice sampling has not occurred in these areas. The results of the bathymetric survey suggest that Imniagut Lake has adequate water depth to provide overwintering fish habitat, with a maximum depth of 4.91 m and an average depth of 2.65 m.

Figure 2.1-1

Sampling Locations in Imniagut Lake, Doris North Project, 2014



2.1.1 Minnow Trapping

Cylindrical minnow traps (43 cm long, 23 cm in diameter, with 6.5 mm mesh, entrance diameter 3 cm) were employed to sample small-bodied fish (Figure 2.1-1). Traps were baited with dry commercial crab bait and immersed on July 11, 2014 for approximately 24 hours before retrieval the following day. Minnow trapping data were standardised as catch-per-unit-effort (CPUE), which was calculated as the number of fish captured per trap per 24 hours (Table 2.1-1).

Table 2.1-1. Catch-Per-Unit-Effort Calculations

Sampling Gear	CPUE Calculation
Electrofisher	*CPUE = number of fish caught * [100/(electrofishing effort, s)]*
Minnow trap	*CPUE = number of fish caught per trap *[(24 h / (set time, h)]*
Gill net	*CPUE = number of fish caught per net x [100 m^2/(total net area, m^2)] x [1 h/(set time, h)]*

CPUE = Catch-per-unit-effort

2.1.2 Gill Netting

A total of four gill nets were set on September 6th, 2014; two sinking gangs and two floating gangs were deployed (Figure 1-1). Each gill net consisted of a standard gang of six panels of different mesh sizes recommended by the Resources Information Standards Committee (25 mm, 76 mm, 51 mm, 89 mm, 38 mm and 64 mm; RISC 2001). Each panel was 15.2 m long, and the panels were sewn together to make a net that is 91.2 m long and 2.4 m deep. Nets were deployed by boat and set for up to two hours. Gill netting data were standardised as CPUE, which was calculated as the number of fish captured per 100 m^2 of net per hour (Table 2.1-1).

2.1.3 Electrofishing

Backpack electrofishing was conducted along the shoreline of Imniagut Lake and in the outflow that connects the lake to Patch Lake on July 12, 2014 (Figure 1-1). A crew leader operated a Smith-Root LR-24 and was accompanied by one dip netter. Anode ring diameter was 28 cm and dip net diameter was 21 cm with 3.2 mm mesh. A systematic sweep sampling approach was conducted; the lake shoreline was sampled between the water's edge to the maximum safe wading depth. In the outflow, the entire wetted width was sampled in an upstream direction from Patch Lake to Imniagut Lake. Electrofishing effort was not pre-determined because the primary objective was to determine whether fish were present in the lake and, if so, determine fish community composition. Electrofisher voltage (V), duty cycle (%) and frequency (Hz) settings were consistent among sites.

All captured fish were placed immediately in a holding tank for species identification, enumeration, and biological processing and then released back into the site once collection was complete. Electrofishing data were standardised as CPUE, which was calculated as the number of fish captured per 100 s of effort (Table 2.1-1).

2.2 Connectivity Assessment

The connectivity of Imniagut Lake to Patch Lake and other potentially fish-bearing waterbodies was assessed in the field on July 11, 2014, during high flows related to freshet. High flow

conditions allow fish to migrate between permanent waterbodies through ephemeral creeks that may be dry later in the summer. In some cases, freshet may be the only time of year that fish are able to migrate between adjacent waterbodies.

The locations of inflows and outflows were marked using a handheld GPS unit and representative photographs were taken. A visual assessment of the flow conditions was conducted and connectivity was assessed. Field crews followed inflows upstream until there was no longer a defined channel; outflows were assessed moving downstream until they connected with the next waterbody.

2.3 Habitat Assessment

Fish habitat was assessed through a visual survey of the shoreline and littoral zone of Imniagut Lake on July 11, 2014. The shoreline and littoral zone were grouped into habitat units of relatively homogenous substrate compositions using a handheld GPS unit. The substrate composition of each habitat unit was recorded as a percent of surface area (e.g., 50% boulder and 50% fines). Substrate types were defined by their average particle diameter: fines (less than 2 mm diameter), gravel (2 to 64 mm), cobble (64 to 256 mm), boulder (256 to 4,000 mm), and bedrock (greater than 4,000 mm). Emergent and submerged vegetation was also recorded when present. Inflows and outflows were identified and photographs were taken of representative habitat types.

3. RESULTS AND DISCUSSION

3.1 Fish Community Assessment

3.1.1 Minnow Trapping

A total of 20 minnow traps were set in the littoral zone of Imniagut Lake for 20 to 22 hours per trap, for a total effort of 420.1 hours. Ninespine Stickleback was the only species of fish captured in minnow traps, with a CPUE ranging from 0.0 to 230.2 fish/24 h (Table 3.1-1).

Minnow traps were deployed in two habitat types. One habitat type consisted of a mixture of fine sediments and aquatic vegetation; the other habitat type consisted of a mixture of bedrock, boulders, cobbles, and gravels (Figure 1-1). CPUE in habitats with a mixture of fine sediment and vegetation was 69.1 fish/24 h, whereas habitats with a mixture of large substrate had a lower CPUE of 2.0 fish/24 h. This suggests that Ninespine Stickleback prefer habitats dominated by fine sediment and vegetation.

Several fish were infested with a tapeworm parasite (thought to belong to the genus *Schistocephalus*). Infected fish had distended stomachs. Several free-living tapeworms were observed along the lake shoreline.

3.1.2 Gill Netting

No fish were captured in gill nets set in Imniagut Lake. A total of two sinking gangs were set for a combined total of 3.9 hours, and two floating gangs were set for a combined total of 3.7 hours (Table 3.1-2).

Table 3.1-1. Minnow Trap Data from Imniagut Lake, Doris North Project, 2014

Trap Number	Substrate Type	UTM Coordinates (Zone 13 W)		Date In	Date Out	Time In	Time Out	Duration (h)	Fish	
		Easting	Northing						Ninespine Stickleback	CPUE
1	Fines, aquatic vegetation	433352	7551635	11-Jul	12-Jul	12:37	9:00	20.4	71	83.7
2	Fines, aquatic vegetation	433346	7551598	11-Jul	12-Jul	12:42	9:05	20.4	32	37.7
3	Fines, aquatic vegetation	433341	7551565	11-Jul	12-Jul	12:43	9:10	20.4	196	230.2
4	Fines, aquatic vegetation	433365	7551524	11-Jul	12-Jul	12:44	9:15	20.5	2	2.3
5	Fines, aquatic vegetation	433380	7551498	11-Jul	12-Jul	12:45	9:20	20.6	35	40.8
6	Fines, aquatic vegetation	433397	7551708	11-Jul	12-Jul	12:53	9:25	20.5	90	105.3
7	Fines, aquatic vegetation	433480	7551685	11-Jul	12-Jul	12:58	9:30	20.5	11	12.9
8	Fines, aquatic vegetation	433522	7551657	11-Jul	12-Jul	13:00	9:35	20.6	5	5.8
9	Gravel, cobble, fines	433579	7551653	11-Jul	12-Jul	13:04	9:40	20.6	5	5.8
10	Gravel, cobble, fines	433629	7551588	11-Jul	12-Jul	13:06	10:50	21.7	0	0.0
11	Gravel, cobble, fines	433752	7551420	11-Jul	12-Jul	13:20	10:35	21.2	1	1.1
12	Gravel, cobble, fines	433765	7551379	11-Jul	12-Jul	13:26	10:40	21.2	1	1.1
13	Gravel, cobble, fines	433768	7551336	11-Jul	12-Jul	13:27	10:45	21.3	0	0.0
14	Gravel, cobble, fines	433766	7551280	11-Jul	12-Jul	13:29	10:50	21.3	5	5.6
15	Gravel, cobble, fines	433764	7551233	11-Jul	12-Jul	13:32	10:55	21.4	0	0.0
16	Gravel, cobble, fines	433791	7551121	11-Jul	12-Jul	13:34	11:00	21.4	2	2.2
17	Fines, aquatic vegetation	433770	7551107	11-Jul	12-Jul	13:38	11:05	21.4	1	1.1
18	Fines, aquatic vegetation	433752	7551088	11-Jul	12-Jul	13:41	11:10	21.5	23	25.7
19	Fines, aquatic vegetation	433743	7551067	11-Jul	12-Jul	13:42	11:15	21.5	197	219.6
20	Fines, aquatic vegetation	433711	7551047	11-Jul	12-Jul	13:47	11:20	21.5	56	62.4

Note: CPUE = Catch per unit effort (fish/trap/24 h)
The start and end times for trap removal were recorded; all times in between are estimates.

Table 3.1-2. Gill Net Data from Imniagut Lake, Doris North Project, 2014

Site Number	Set Number	Net Type	GPS No.	GPS No.	UTM Coordinates (Zone 13 W)		UTM Coordinates (Zone 13 W)		Date	Time In	Time Out	Duration (h)	Fish	
					Easting	Northing	Easting	Northing					No. Caught	CPUE
1	1	Sink	25	26	433708	7551262	433726	7551378	6-Sep-14	12:00	13:55	1:55	0	0.0
2	1	Float	27	28	433636	7551312	433709	7551242	6-Sep-14	12:40	14:20	1:40	0	0.0
3	1	Sink	29	30	433671	7551185	433731	7551210	6-Sep-14	14:10	16:10	2:00	0	0.0
4	1	Float	32	33	433518	7551378	433632	7551412	6-Sep-14	14:30	16:30	2:00	0	0.0

3.1.3 Electrofishing

An electrofishing survey along the southern shoreline of Imniagut Lake captured Ninespine Stickleback. A total of 27 Ninespine Stickleback were captured in 839 s of electrofishing effort (CPUE of 3.22 fish/100 s). Three Ninespine Stickleback were also captured during the electrofishing survey conducted in the outflow that connects Imniagut Lake to Patch Lake (CPUE of 3.33 fish/100 s). The presence of Ninespine Stickleback, along with the observed flow between the lakes and lack of barriers, suggests that Imniagut and Patch Lakes are connected.

3.2 Connectivity Assessment

A walking survey of the perimeter of Imniagut Lake was completed to identify the locations of inflows and outflows. Two inflows were identified, neither of which connect Imniagut Lake to fish-bearing waterbodies. A small, poorly defined channel flows into the northern end of the lake (Plate 3.2-1; Figure 1-1). This stream has a defined channel for several hundred metres, but it is not connected to other waterbodies. A second, short stream connects a small wetland to Imniagut Lake (Plate 3.2-2). The wetland has no inflows so it does not connect to upstream waterbodies. The inflow is approximately 20 m in length and less than 1 m in width. Water within the channel was shallow (0.05 to 0.42 m deep) but adequate to provide access between Imniagut Lake and the wetland. Given the small dimensions of the stream, it is expected that it would be dry for the majority of the open-water season.

Plate 3.2-1. A small, poorly defined channel enters the northern end of Imniagut Lake, July 11, 2014.

Plate 3.2-2. A small wetland northeast of Imniagut Lake, July 11, 2014.

Imniagut Lake has one outflow that discharges from the southern end of the lake and travels approximately 55 m before entering Patch Lake (Plate 3.2-3; Figure 2.1-1). The channel is poorly defined and braided, as it flows through a heavily vegetated area (primarily willows and grasses). It did contain sufficient water depth and volume during the site visit in July 2014 to permit the passage of small-bodied fish, as there were several channels that had greater than 10 cm water depth. It is expected that the outflow does provide seasonal access between Imniagut Lake and Patch Lake.

Plate 3.2-3. The outflow of Imniagut Lake drains into Patch Lake through a heavily vegetated, braided channel, July 11, 2014.

3.3 Habitat Assessment

The shoreline of Imniagut Lake was categorized based on the distribution of substrates and vegetation (Figure 3.3-1). The southwestern shoreline is dominated by steep bedrock; water depth drops quickly to 3 m along the length of this habitat unit (Plate 3.3-1). Along the northern end of the lake, the shoreline is dominated by fine sediment and dense riparian vegetation (primarily willows). Within this habitat unit, there is an expansive shallow shelf that contains submergent and emergent vegetation. A small wetland is adjacent to the lake within this habitat unit (Plate 3.2-2). The eastern shoreline is dominated by bedrock with an intermittent distribution of boulders (Plate 3.3-2). South of this habitat unit, the shoreline contains a mixture of boulders, cobbles, and gravels (Plate 3.3-3).

Plate 3.3-1. The steep western shoreline of Imniagut Lake is dominated by bedrock. July 11, 2014.

Plate 3.3-2. A habitat unit on the eastern shoreline is dominated by bedrock with intermittent boulder sections. July 11, 2014.

Figure 3.3-1

Shoreline Habitats in Imniagut Lake, Doris North Project, 2014

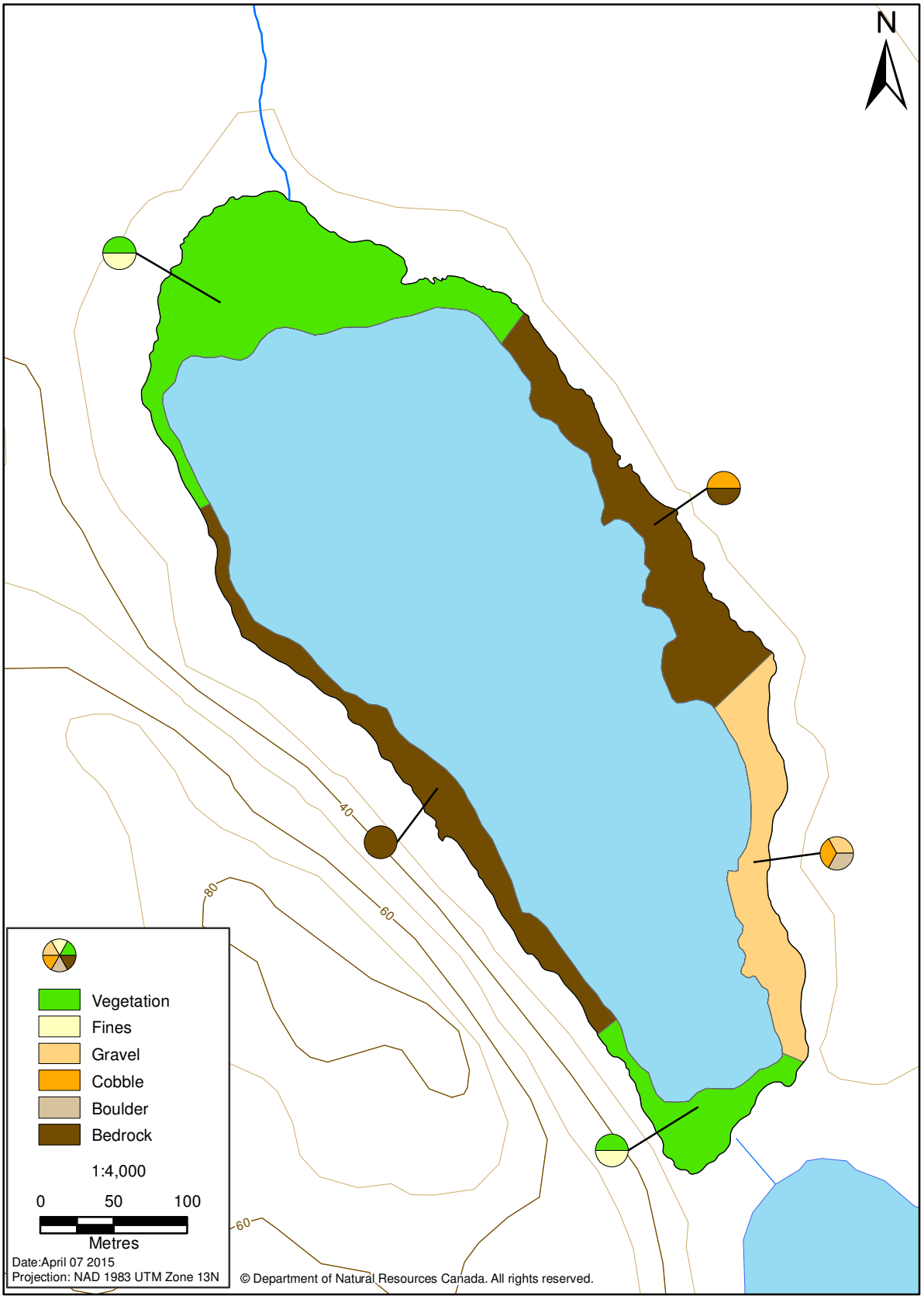


Plate 3.3-3. A habitat unit on the eastern shoreline is a mixture of boulders, cobbles, and gravels. July 11, 2014.

Along the western shoreline, the lake bed slopes more gradually than the steep western shore. The southern shoreline is dominated by fine sediment and dense riparian vegetation. The outflow of the lake discharges through this area, passing through dense willows before entering Patch Lake.

4. SUMMARY

4.1 Fish Community Assessment

The fish community in Imniagut Lake was sampled using three methods (minnow trapping, gill netting, and electrofishing), and in two seasons (summer and fall). The Ninespine Stickleback was the only species of fish captured in the lake. No fish were captured in gill nets; however, the total duration of gill net sets was 7.6 hours so additional effort would be required to confirm that no large-bodied fish inhabit the lake.

4.2 Connectivity Assessment

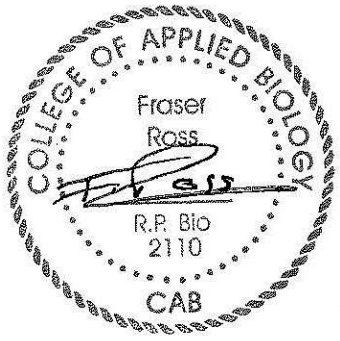
Two inflows to Imniagut Lake were identified; neither connect to upstream fish-bearing waterbodies. The outflow of Imniagut Lake flows through a densely vegetated channel before entering Patch Lake. In July, this channel provided connectivity between these lakes that could be used by small-bodied fish. This was confirmed by electrofishing, as Ninespine Sticklebacks were caught within the channel.

4.3 Habitat Assessment

The shoreline habitat of Imniagut Lake is composed of mixed substrates, with several habitat types represented: steep bedrock, gradually sloping mixture of boulders, cobbles, and gravels,

and areas dominated by fines and riparian vegetation. In addition, there is a shallow shelf of submergent and emergent vegetation at the north of the lake as well as a small wetland adjacent to the lake.

Prepared by:



Fraser Ross, B.Sc., R.P.Bio.
Consultant, Fisheries, ERM

Reviewed by:

Christopher Burns, B.Sc., R.P.Bio.
Senior Fisheries Biologist, ERM

April Hayward, Ph.D.
Project Manager, ERM

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