



*Treasury Metals
Revised EIS Report
Goliath Gold Project
April 2018*



APPENDIX Q

FISHERIES AND FISH HABITAT

NOTE TO READER APPENDIX Q

In April 2015, Treasury Metals submitted an Environmental Impact Statement (EIS) for the proposed Goliath Gold Project (the Project) to the Canadian Environmental Assessment Agency (the Agency) for consideration under the Canadian Environmental Assessment Act (CEAA), 2012. The Agency reviewed the submission and informed Treasury Metals that the requirements of the EIS Guidelines for the Project were met and that the Agency would begin its technical review of the submission. In June 2015, the Agency issued a series of information requests to Treasury Metals regarding the EIS and supporting appendices (referred to herein as the Round 1 information requests). The Round 1 information requests included questions from the Agency, other federal and provincial reviewers, and members of Indigenous communities, as well as interested stakeholders. As part of the Round 1 information request process, the Agency requested that Treasury Metals consolidate the responses to the information requests into a revised EIS for the Project.

Appendix Q to the original EIS (Fisheries and Habitat) presented baseline fisheries data from field investigations conducted by DST in 2012 and 2013. These studies focused on areas where it was felt that additional baseline information would be helpful in assessing potential effects of the Project, or potential offsetting measures. Baseline fisheries data were also collected by Klohn Crippen Berger in 2010 and 2011, and the results presented in Appendix G to the original EIS. Since submission of the original EIS, Treasury Metals has been refining their understanding of fish and fish habitat in the study area, as well as collecting additional baseline field data. As part of the work to respond to the Round 1 information requests, Treasury Metals has consolidated the available baseline fisheries information that have been relied on in assessing the effects of the Project on fish and fish habitat into a single document entitled Summary Fisheries Baseline Report (2011–2016), which has been included as Appendix Q to the revised EIS. Appendix Q (Summary Fisheries Baseline Report (2011–2017)) to the revised EIS replaces Appendix Q to the original EIS, and incorporates all of the relevant fisheries information from Appendix G to the original EIS. The information presented in this appendix was used to describe baseline fish and fish habitat conditions (Section 5.8.4 of the revised EIS) and in the assessment of effects of the Project on fish and fish habitat (Section 6.14 of the revised EIS).

As part of the process to revise the EIS, Treasury Metals has undertaken a review of the status for the various appendices. The status of each appendix to the revised EIS has been classified as one of the following:

- **Unchanged:** The appendix remains unchanged from the original EIS, and has been re-issued as part revised EIS.
- **Minor Changes:** The appendix remains relatively unchanged from the original EIS, and has been re-issued with relevant clarification.
- **Major Revisions:** The appendix has been substantially changed from the original EIS. A re-written appendix has been issued as part of the revised EIS.

- **Superseded:** The appendix is no longer required to support the EIS. The information in the original appendix has been replaced by information provided in a new appendix prepared to support the revised EIS.
- **New:** This is a new appendix prepared to support the revised EIS.

The following table provides a listing of the appendices to the revised EIS, along with a listing of the status of each appendix and their description.

List of Appendices to the Revised EIS		
Appendix	Status	Description
Appendix A	Major Revisions	Table of Concordance
Appendix B	Unchanged	Optimization Study
Appendix C	Unchanged	Mining Study
Appendix D	Major Revisions	Tailings Storage Facility
Appendix E	Minor Changes	Traffic Study
Appendix F	Major Revisions	Water Management Plan
Appendix G	Superseded	Environmental Baseline
Appendix H	Minor Changes	Acoustic Environment Study
Appendix I	Unchanged	Light Environment Study
Appendix J	Minor Changes	Air Quality Study
Appendix K	Minor Changes	Geochemistry
Appendix L	Superseded	Geochemical Modelling
Appendix M	Minor Changes	Hydrogeology
Appendix N	Unchanged	Surface Hydrology
Appendix O	Superseded	Hydrologic Modeling
Appendix P	Unchanged	Aquatics DST
Appendix Q	Major Revisions	Fisheries and Habitat
Appendix R	Major Revisions	Terrestrial
Appendix S	Major Revisions	Wetlands
Appendix T	Unchanged	Socio-Economic
Appendix U	Minor Changes	Heritage Resources
Appendix V	Major Revisions	Public Engagement
Appendix W	Unchanged	Screening Level Risk Assessment
Appendix X	Major Revisions	Alternatives Assessment Matrix
Appendix Y	Unchanged	EIS Guidelines
Appendix Z	Unchanged	TML Corporate Policies
Appendix AA	Major Revisions	List of Mineral Claims
Appendix BB	Unchanged	Preliminary Economic Assessment
Appendix CC	Unchanged	Mining, Dynamic And Dependable For Ontario's Future
Appendix DD	Major Revisions	Indigenous Engagement Report

List of Appendices to the Revised EIS		
Appendix	Status	Description
Appendix EE	Unchanged	Country Foods Assessment
Appendix FF	Unchanged	Photo Record Of The Goliath Gold Project
Appendix GG	Minor Changes	TSF Failure Modelling
Appendix HH	Unchanged	Failure Modes And Effects Analysis
Appendix II	Major Revisions	Draft Fisheries Compensation Strategy and Plans
Appendix JJ	New	Water Report
Appendix KK	New	Conceptual Closure Plan
Appendix LL	New	Impact Footprints and Effects

EXECUTIVE SUMMARY

Treasury Metals Inc. (TMI) is a Canadian gold exploration and development company focused on its 100% owned high-grade Goliath Gold Project (the Project), situated in the Kenora/Dryden Mining District of northwestern Ontario. The Project is located adjacent to the village of Wabigoon, Ontario, approximately 20 km east of the city center of Dryden or 330 km west of the city of Thunder Bay.

Baseline investigations of fish and fish habitat, including background information review and field investigations, were conducted by Klohn Crippen Berger Ltd. (KCB) in 2010 and 2011 and by DST Consulting Engineers Inc. (DST) in 2012 and 2013. This information was presented in reports by the respective firms. Additional fish sampling was conducted by TMI staff in 2014. C. Portt and Associates (C. Portt) conducted reconnaissance level investigations at a number of locations and side-scan sonar investigations of Keplyn's Bay on Wabigoon Lake and an unnamed bay of Thunder Lake in 2016. This report consolidates the relevant fish and fish habitat information from previous reports and documents the additional fish and fish habitat baseline information acquired by TMI in 2014 and C. Portt and Associates in 2016.

Based on the current project design, there will be direct impacts by the project to two tributaries of Blackwater Creek. There are also predicted to be project effects on some of the tributaries that flow into the east side of Thunder Lake. These watercourses and the bays of Thunder Lake and Wabigoon Lake that receive these watercourses constitute the Local Study Area for fish and fish habitat while the Regional Study Area includes Thunder Lake and Wabigoon Lake.

The study area is in the English River watershed, which is tributary to the Winnipeg River and in the Nelson River primary watershed. Thunder Lake has a coldwater fish community that includes lake trout and Wabigoon Lake has a coolwater fish community that does not. Both lakes have diverse fish communities that include a number of species that are sought recreationally and/or consumed by humans. There are also eight active tourist outfitters operating on Wabigoon Lake which receives enhanced management and supports an active sport fishery focused on Walleye and Muskellunge angling. There are no at-risk fish species in the Regional Study Area.

Blackwater Creek flows to Keplyn's Bay of Wabigoon Lake. A portion of this bay has been cut off by the railway and flow from this isolated portion into Keplyn's Bay in via culverts under the railway. This isolated area functions as a coastal wetland and is likely to provide good spawning and nursery habitat for a number of fish species that are present in Wabigoon Lake including Northern Pike and possibly Muskellunge. The ability of fish to pass through the culverts beneath the railway, however, has not been assessed and if they are barriers to fish passage that would reduce the habitat value of this area.

Blackwater Creek and its tributaries are low gradient watercourses with predominantly clay and silt substrates. There is extensive beaver activity along the main branch of the creek and its tributaries. The resident fish community is dominated by Northern Redbelly Dace and Finescale Dace (*Phoxinus* spp.), Brook Stickleback and Pearl Dace -- species that are typical of these systems. There is no known walleye spawning habitat in Blackwater Creek. There are two areas of potential White Sucker spawning habitat where gravel is associated with road crossings. Eggs thought to be from White Sucker were collected from these in 2011 and spawning White Sucker were observed at one of the locations. It is not known if those White Sucker originated from Wabigoon Lake or from a stream-resident population, although the investigators did note that there were a number of beaver dams between the spawning locations and Wabigoon Lake that would impede upstream

fish migration. In 2017, no White Sucker were captured in a fyke net set in Blackwater Creek during the White Sucker spawning period nor were any observed at the two potential spawning locations. The benthic invertebrate community in Blackwater Creek was dominated by chironomids at most sites.

Little Creek and Hoffstrom's Bay Tributary drain to Hoffstrom's Bay of Thunder Lake. There is wetland habitat along the lake shore at the mouths of these watercourses that are suitable for Northern Pike spawning. Their catchments are entirely within the area of glaciolacustrine deposits and, like Blackwater Creek, they are low gradient watercourses with predominantly silt and clay substrates and with beaver activity. Their fish communities are dominated by *Phoxinus* spp., Brook Stickleback and Pearl Dace.

Thunder Lake Tributary 2 drains to the next bay north of Hoffstrom's Bay. There is wetland habitat adjacent to the lake that is suitable for Northern Pike spawning. Thunder Lake Tributary 2 and Thunder Lake Tributary 3 flow through a former Tree Nursery and there is a dam on each that blocks upstream fish migration. On Tributary 2 there is also a falls downstream from the dam that is a complete barrier to upstream fish migration. These two streams flow through an area of glacial outwash that is predominantly sand and their substrate reflect this. There are short areas of cobble and boulder substrate below the dam on Tributary 3 and below the falls on Tributary 2 that are suitable for White Sucker and Walleye spawning. No fish were captured in a fyke net set in Thunder Lake Tributary 2, downstream from the confluence with Thunder Lake Tributary 3, during the White Sucker spawning period in 2017 and no White Sucker were observed when the potential spawning areas were examined. The resident fish community in these streams is dominated by Fathead Minnow, Pearl Dace, *Phoxinus* spp. and Brook Stickleback. The benthic invertebrate community in these two watercourses had a higher percentage of Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa) than the samples from Blackwater Creek.

Total mercury concentrations in the forage fish samples collected in the Local Study Area Creek ranged from 0.027 mg/kg wet weight to 0.123 mg/kg wet weight. The mean total mercury concentration in dorsal muscle from Walleye from Thunder Lake was 0.120 and the mean mercury concentration in dorsal muscle from Walleye from Wabigoon Lake was 0.220 mg/kg wet weight. The total mercury concentration in dorsal muscle from the one Sauger tested, which was from Thunder Lake, was 0.473 mg/kg wet weight.

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1. INTRODUCTION

Treasury Metals Inc. (TMI) is a Canadian gold exploration and development company focused on its 100% owned high-grade Goliath Gold Project (the Project), situated in the Kenora/Dryden Mining District of northwestern Ontario. The Project is located adjacent to the village of Wabigoon, Ontario, approximately 20 km east of the city center of Dryden or 330 km west of the city of Thunder Bay.

The Project Area consists largely of two historic properties, the “Thunder Lake Property”, previously owned by Teck-Corona and the “Laramide Property”, located partially within both the Hartman and Zealand townships. The properties have a total area of approximately 4,881 hectares, comprised of 4,064 hectares of 137 unpatented land claims and 19 patented land claims for the remainder. Treasury holds the entire project subject to specific royalties on 13 of the patented land parcels. The site can be readily accessed year round from Highway 17 and from multiple public secondary roads that extend north from the highway, including Anderson Road, Maggrah Road and Tree Nursery Road. An overview of the project area is provided in Figure 1.

The Project was expected to require the completion of federal and provincial environmental assessments and permits prior to development. To support ongoing drilling activities and project permitting, TMI retained Klohn Crippen Berger Ltd. (KCB) in 2010 and 2011 and DST Consulting Engineers Inc. (DST) in 2012 and 2013, to gather baseline fish and fish habitat data and to submit environmental reports summarizing data collection. Additional fish sampling was conducted by TMI staff in 2014. C. Portt and Associates (C. Portt) conducted reconnaissance level investigations at a number of locations and side-scan sonar investigations of Keplyn’s Bay on Wabigoon Lake and an unnamed bay of Thunder Lake in 2016.

The 2010-2011 baseline investigations were reported in KCB (2012) and the 2012 baseline investigations were documented in DST (2014). The 2014 fish sampling by TMI and the 2016 work by C. Portt has not been previously reported.

Based on the current project design (Figure 1), there will be direct impacts by the project to two tributaries of Blackwater Creek referred to as Tributary 1 and Tributary 2. There are predicted project effects to the tributaries to Thunder Lake referred to as Unnamed Tributary 2 and Unnamed Tributary 3; the Tree Nursery Ponds on these watercourses are expected to provide water to the project. Hoffstrom’s Bay Tributary and Little Creek (formerly Unnamed Thunder Lake Tributary 4) may also be affected. These watercourses and the bays of Thunder Lake and Wabigoon Lake that receive these watercourses are the Local Study Area for fish and fish habitat while the Regional Study Area includes Thunder Lake and Wabigoon Lake (Figure 2).

This report consolidates the relevant fish and fish habitat information from previous reports and documents the additional fish and fish habitat baseline information acquired by TMI in 2014 and C. Portt and Associates in 2016. Where appropriate, quality control/quality assurance checks of the data in the earlier reports by checking original field or laboratory records. Some data have been reinterpreted based on the opinion of the author and some data and analyses presented previously have been omitted, based on the author’s assessment of relevance.

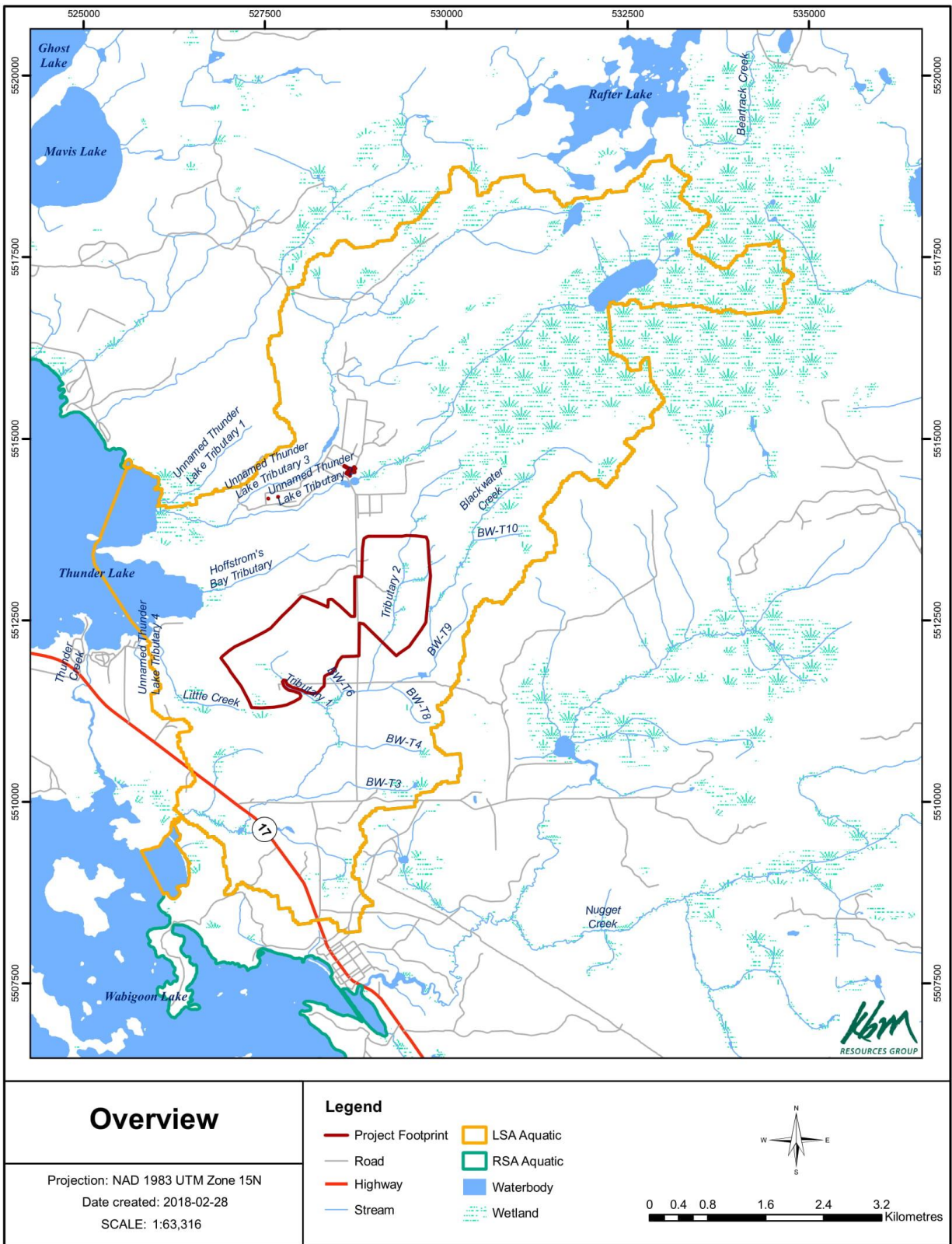


Figure 1. The project site and surrounding area.

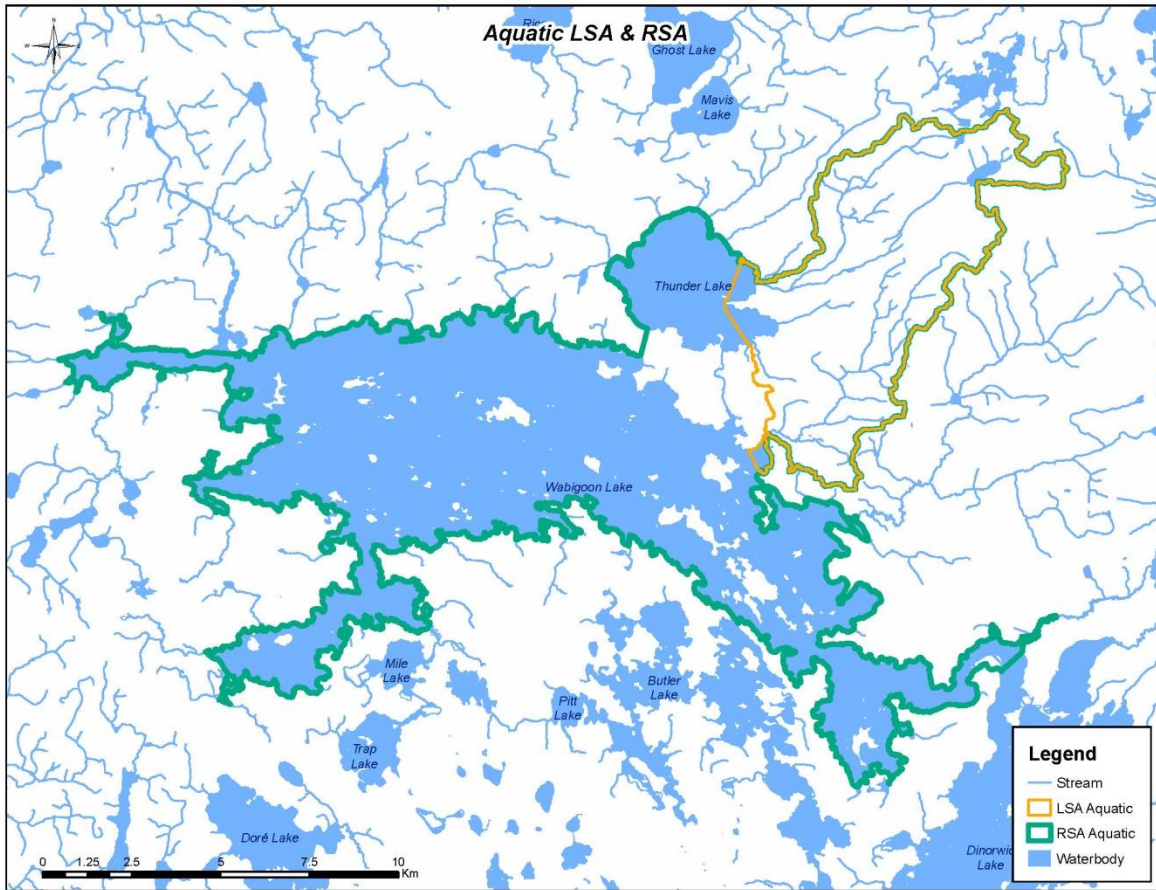


Figure 2. The Local Study Area (LSA) and Regional Study Area for fish and fish habitat.

1.1 Overview of Fisheries Investigations

The original Project Study Area, delineated by KCB, was the area within an approximately 10 km radius centered on the site of the proposed mine. Fisheries investigations conducted in 2010 and 2011 by KCB examined, to varying degrees, all of the principal watercourses within the study area that, at that time, it was thought could potentially be affected by the project. The two receiving waterbodies, Thunder Lake and Wabigoon Lake, were also examined in the vicinity of the mouths of the creeks draining from the study area.

The 2012 and 2013 fisheries investigations, conducted by DST, focused on Blackwater Creek and unnamed Thunder Lake Tributary 2 and unnamed Thunder Lake Tributary 3, as well as Hoffstrom’s Bay of Thunder Lake and Keplyn’s Bay of Wabigoon Lake..

In August of 2016, C. Portt, assisted by TMI staff, conducted side-scan sonar surveys of Keplyn’s Bay at the mouth of Blackwater Creek and in the bay which that the Thunder Lake Tributary 2 flows into. Reconnaissance of Blackwater Creek and the Thunder Lake Tributary 2 was also conducted at

that time. In the spring of 2017, White Sucker spawning investigations were conducted by C. Portt, assisted by TMI staff on Blackwater Creek and Thunder Lake Tributary 2 and Tributary 3.

2. Background Information

2.1 Overview

The study area is in the English River watershed, which is tributary to the Winnipeg River and in the Nelson River primary watershed (OMNR 2012b). The project site is located within the Lake Wabigoon Ecoregion (Ecoregion 4S) which extends from the northern portion of the Lake of the Woods east to Lac Seul and Dryden. The climate in ecoregion 4S is cool and dry with warm, moist summers and cold winters. The vegetation of ecoregion 4S is predominantly mixed forest (25%), sparse forest including peat lands (24%), and coniferous forest (14%). Water makes up about 24% of the area. This ecoregion is within the Lower English River Section in the Boreal Forest Region.

The project is within Fisheries Management Zone 5 (FMZ 5, OMNR 2012a). Fisheries management zones are geographic regions characterized by similar ecological, physical, social, and economic attributes (OMNR 2010). Lakes in FMZ 5 can be broadly classified as coldwater and coolwater based on their fish communities (OMNR 2012b). The principal defining feature of the coldwater fish community in FMZ 5 is the presence of lake trout, which are dependent upon coldwater, and therefore deep, well-oxygenated habitat. There are two large lakes within the study area; Thunder Lake has a coldwater fish community that includes lake trout and Wabigoon Lake has a coolwater fish community that does not.

2.2 Thunder Lake

Thunder Lake is a coldwater lake and has a surface area of 1,123 ha, a mean depth of 11.1 m, and a maximum depth of 23.5 m (OMNRF Fish ON-Line accessed April 26, 2017, <https://www.gisapplication.lrc.gov.on.ca/FishONLine>). It supports a coldwater fish community including populations of Lake Trout, Lake Whitefish and Lake Cisco and also populations of coolwater species including Walleye, Northern Pike, Yellow Perch and Smallmouth Bass. A list of fish species documented to occur in Thunder Lake is presented in Table 1. Thunder Lake drains to Wabigoon Lake via Thunder Creek. Water levels in Thunder Lake are controlled by a small dam at the head of Thunder Creek in Aaron Provincial Park.

Table 1. Fish species present in Thunder Lake. Source: Compiled from MNRF files in KCB (2012)

Common name	Scientific name
Lake Trout	<i>Salvelinus namaycush</i>
Lake Whitefish	<i>Coregonus clupeaformis</i>
Cisco	<i>Coregonus artedii</i>
Walleye	<i>Sander vitreus</i>
Sauger	<i>Sander canadensis</i>
Northern Pike	<i>Esox lucius</i>
Smallmouth Bass	<i>Micropterus dolomieu</i>
Yellow Perch	<i>Perca flavescens</i>
Burbot	<i>Lota lota</i>
Rock Bass	<i>Ambloplites rupestris</i>

White Sucker	<i>Catostomus commersonii</i>
Trout Perch	<i>Percopsis omiscomaycus</i>
Johnny Darter	<i>Etheostoma nigrum</i>
Mottled Sculpin	<i>Cottus bairdii</i>
Deepwater sculpin ¹	<i>Myoxocephalus thompsonii</i>

1. First reported in 2015. (D. Brunner, MNRF biologist. Personal communication with C. Portt. May 1, 2017).

The east shore of Thunder Lake is largely undeveloped in comparison to the remaining shoreline of the lake which is dominated by private homes, seasonal camps and public campgrounds (DST, 2014). The east end of Thunder Lake consists of two shallow (less than 2 m deep) sandy bays separated by a bedrock point (DST, 2014). Cobble and boulder shoals extending out from the bedrock point between the two bays and from the island off that point (Figure 3) are known lake trout and lake whitefish spawning areas and may also be walleye spawning areas although this has not been confirmed (D. Brunner, MNRF biologist. Personal communication with C. Portt. April 27, 2017). Other areas of potential lake trout and lake whitefish spawning habitat have been identified by MNRF based on the presence of coarse substrate but spawning has not been confirmed (D. Brunner, MNRF biologist, personal communication with C. Portt. April 27, 2017).

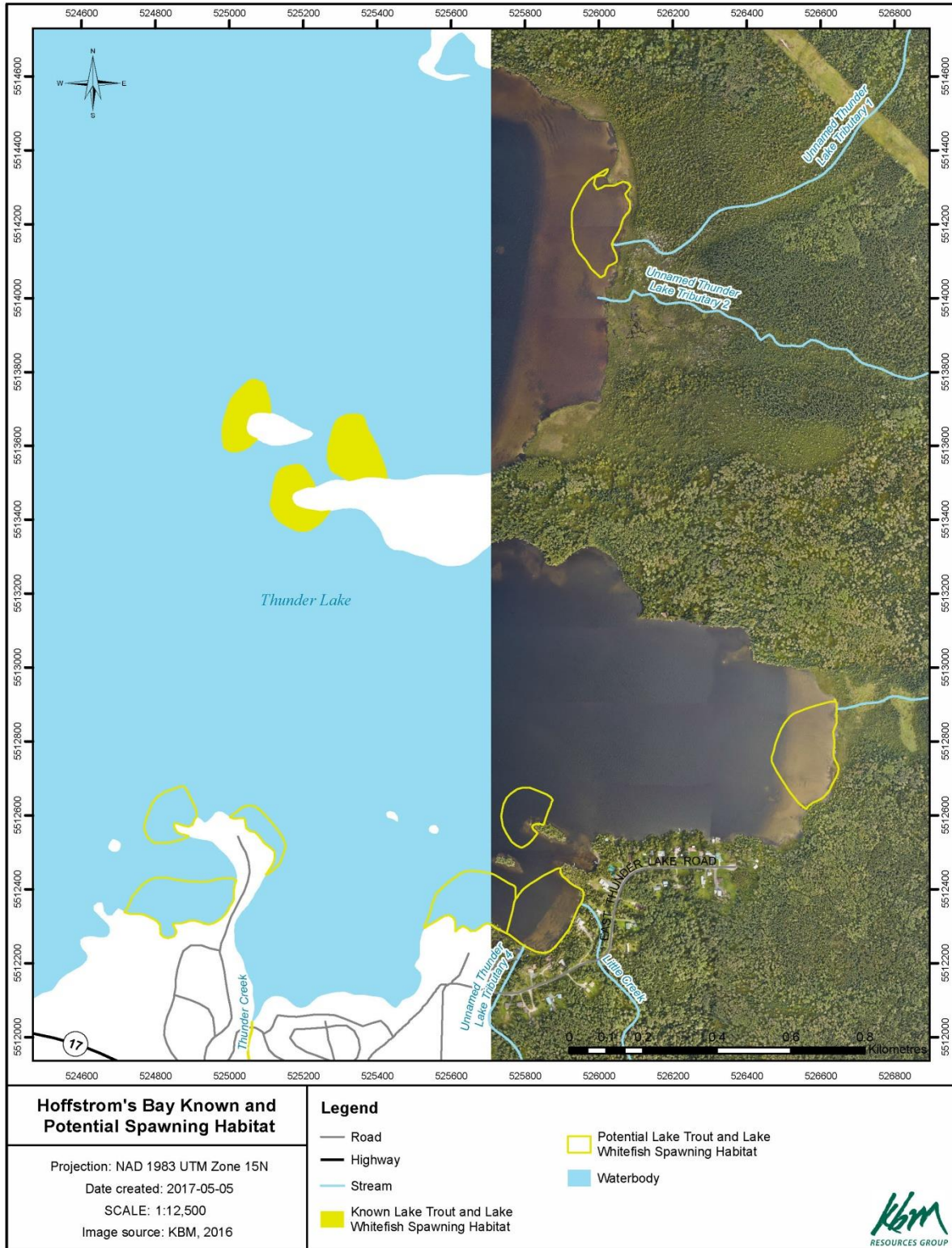


Figure 3. Locations of known and potential Lake Trout and/or Lake Whitefish spawning habitat (Source: Source: MNRF, in DST, 2014 and), and D. Brunner, MNRF biologist, personal communication with C. Portt, April 27, 2017).

2.3 Wabigoon Lake

Wabigoon Lake is a coolwater lake with a surface area of 9,922 ha, a mean depth of 6.1 m and a maximum depth of 14.6 m (OMNRF Fish ON-Line accessed April 26, 2017 <https://www.gisapplication.lrc.gov.on.ca/FishONLine>). A list of fish species in Wabigoon Lake, compiled by KCB from MNR files, is provided in Table 3.2.1. The lake has an irregular shoreline that is 204 km in length including islands; this in combination with the generally shallow depth results in a high proportion of littoral zone (OMNR 2013b). The shallow, turbid and highly productive water of Wabigoon Lake is uncharacteristic of FMZ 5. The water level of Wabigoon Lake is controlled by a dam at the outflow into the Wabigoon River in Dryden, Ontario. Water Levels range between 368.5 m and 369.23 m ASL annually (OMNR 2013b). Changing water levels due to the dam have caused erosion along the shoreline of Wabigoon Lake releasing sediments that contribute to the turbidity of the lake (D. Brunner, MNR biologist, personal communication with C. Portt. April 27, 2017).

Table 2. Fish species present in Wabigoon Lake (Source: MNR files including 2015 broad scale data).

Common name	Scientific name
Lake Whitefish	<i>Coregonus clupeaformis</i>
Cisco	<i>Coregonus artedii</i>
Walleye	<i>Sander vitreus</i>
Sauger	<i>Sander canadensis</i>
Northern Pike	<i>Esox lucius</i>
Muskellunge	<i>Esox masquinongy</i>
Smallmouth Bass	<i>Micropterus dolomieu</i>
Black Crappie	<i>Pomoxis nigromaculatus</i>
Yellow Perch	<i>Perca flavescens</i>
Burbot	<i>Lota lota</i>
Rock Bass	<i>Ambloplites rupestris</i>
White Sucker	<i>Catostomus commersonii</i>
Longnose Sucker	<i>Catostomus catostomus</i>
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>
Trout-perch	<i>Percopsis omiscomaycus</i>
Johnny Darter	<i>Etheostoma nigrum</i>
Mottled Sculpin	<i>Cottus bairdii</i>
Emerald Shiner	<i>Notropis atherinoides</i>
Mimic Shiner	<i>Notropis volucellus</i>
Fathead Minnow	<i>Pimephales promelas</i>
Spottail Shiner	<i>Notropis hudsonius</i>
Logperch	<i>Percina caprodes</i>
Nine-spine Stickleback	<i>Pungitius pungitius</i>

Wabigoon Lake is in close proximity to the communities of Dryden and Wabigoon Ontario, and there are a number of private homes and seasonal camps along its shoreline particularly along the Trans-Canada Highway and other road accessible areas. There are also eight active tourist outfitters operating on Wabigoon Lake (OMNR 2013b). Wabigoon Lake is also one of six Specially Designated

Waters in FMZ 5 and receives enhanced management and supports an active sport fishery focused on Walleye and Muskellunge angling (OMNR 2013b).

There are two fish sanctuaries on Wabigoon Lake that were created to protect spawning Walleye and Sauger that use known spawning areas. One of these is the around Christie Island, which is west of the outlet of Blackwater Creek. The other is in Nugget Creek and the area of Wabigoon Lake at the its mouth. Walleye are also known to spawn in Thunder Creek, which flows from Thunder Lake to Wabigoon Lake (D. Brunner, MNRF biologist, personal communication with C. Portt. April 27, 2017). Potential muskellunge spawning areas, identified by MNRF based on the habitat are presented in Figure 4.

3. Surficial Geology

The surficial geology of the Study Area is shown in Figure 5. The southern portion of the study area consists of relatively flat, silty clay glaciolacustrine deposits from postglacial Lake Agassiz (Roed 1980), through which a number of bedrock knobs protrude. Most of the Blackwater Creek watershed and the watersheds of the more southerly Thunder Lake tributaries are within this glaciolacustrine plain. One tributary to Blackwater Creek, which enters downstream from the proposed mine infrastructure, originates in a kame moraine that is within the glaciolacustrine plain. Areas of glaciofluvial outwash deposits with sandy soils occur north and east of the glaciolacustrine plain. Blackwater Creek originates in the more easterly of these, as do several branches of Hughes Creek, to the east. The lower reaches of the Thunder Lake Tributary 2 and most of Thunder Lake Tributary 3 flow through the more northerly outwash area. From the Tree Nursery ponds upstream, Thunder Lake Tributary 2 flows within an area of organic deposits that have developed over glaciolacustrine clays and are mostly associated with the Lola Lake peatland.

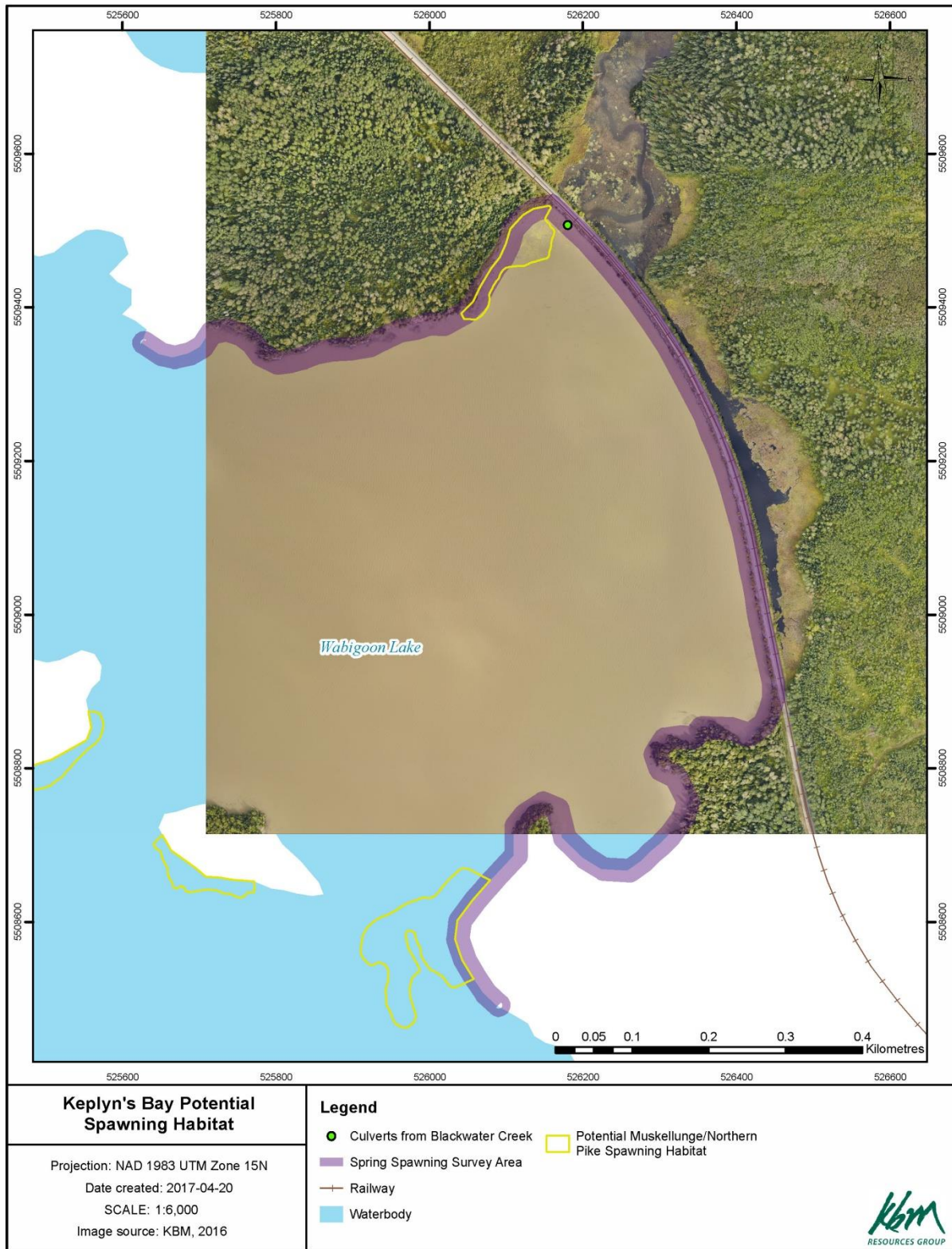


Figure 4. Potential Muskellunge and Northern Pike spawning habitat in and adjacent to Keplyn's Bay, Lake Wabigoon. Source: MNR, in DST, 2014.

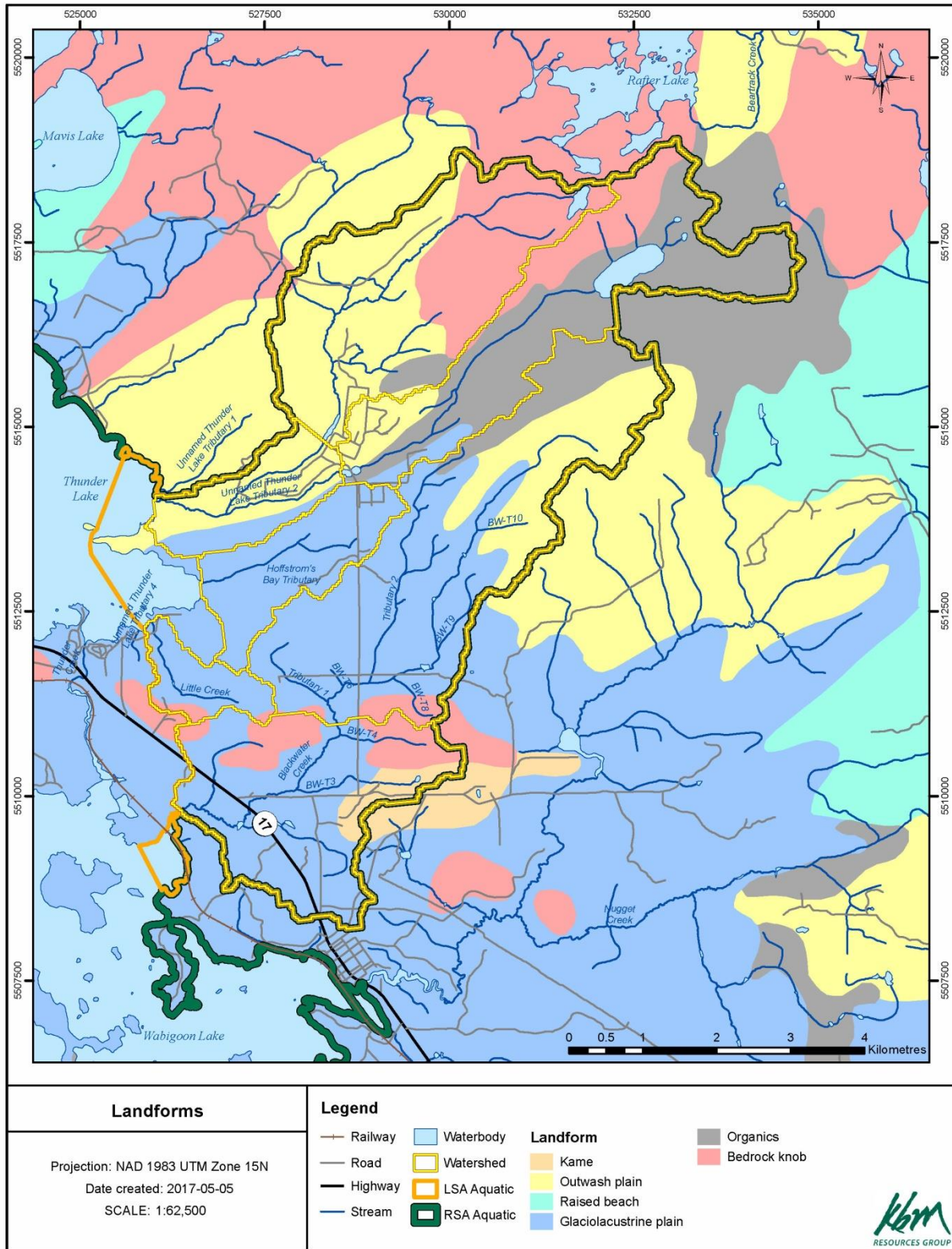


Figure 5. Surficial geology of the local study area and surroundings. Source: Ontario Ministry of Northern Development and Mines. Northern Ontario Engineering Geology Terrain Study.

4. Habitat Characterization

4.1 Methods

4.1.1 2010/2011 Habitat Characterization

Fish habitat data collected during the 2010 and 2011 studies (KCB, 2012) included information on:

- Channel and pond dimensions (i.e., channel widths, wetted widths, pond bathymetry);
- Dominant substrate (i.e., silt, sand, gravel, cobble, boulder);
- Bank features, (i.e., vegetative cover, stability);
- Habitat features, (i.e., pools, riffles, aquatic vegetation, instream cover);
- Barriers to fish movements including permanent (chutes, falls, gradient) and temporary (beaver dams, sediment wedges, channel discontinuity); and
- Water quality, (i.e., specific conductance, conductivity, turbidity, salinity, DO and pH).

Channel widths and wetted widths were measured to the nearest 0.1 m with a measuring tape at selected stream cross sections. Dominant bed material in streams and lacustrine habitats was determined by visually assessing substrate at sampling locations. If more than one bed material was present in large quantities, both materials were recorded. Vegetation on stream and lacustrine banks was visually assessed and recorded. Bank stability was assessed by noting undercut, vertical, slumping or eroding bank features present at each site. Habitat features were visually assessed, described and quantified.

Bathymetry surveys were conducted for the Tree Nursery Ponds on Thunder Lake Tributaries 2 and 3 and the portion of Wabigoon Lake that is upstream from the railway at the outlet of Blackwater Creek. Water depths were mapped using a Garmin 300C depth finder connected to a Garmin GPS while the habitat was traversed by canoe in an irregular grid. Depth readings were recorded to the nearest 0.1 m, recording every second where there were rapid changes in water depth (e.g., a deep trench) and every two to five seconds in other areas. Recorded depth values were interpolated in ArcMap using inverse distance weighting to create bathymetric maps.

In situ water quality measurements, as identified in the bulleted list above, were taken with an YSI 600 multi-parameter water quality meter for each of the lacustrine habitats where bathymetry was assessed. *In situ* water quality was measured at random locations within each sampling location, but was generally taken when there was a noticeable change in depth and, in ponds, near the pond outlet.

4.1.2 2012/2013 Habitat Characterization

Fish habitat mapping was conducted in the Hoffstrom's Bay area of Thunder Lake and Keplyn's Bay of Wabigoon Lake in conjunction with the 2013 spring spawning survey. Field staff from DST and TMI conducted visual surveys of the two bays and documented fish habitat characteristics such as substrate, evidence of aquatic vegetation, and depth. Locations of fish habitat features were

recorded using a hand-held GPS. A series of photographs were also taken to document the observed conditions. An AquaVu underwater camera system was used to confirm substrate types.

4.1.3 2016 Habitat Characterization

C. Portt, accompanied by TMI staff, conducted reconnaissance level assessments of Blackwater Creek and its tributaries at several locations on August 3 and 4, 2016. Portions of Thunder Lake Tributary 2 were also examined on August 3, 2016. Reconnaissance level assessments of Keplyn's Bay of Wabigoon Lake and the bay that Thunder Lake Tributary 2 discharges to on Thunder Lake were conducted by C. Portt, accompanied by TMI staff, on August 3 and 4, 2016, respectively. A Humminbird 899ci HD sonar unit was used to record geo-referenced side-scan sonar data of the inner portion of both bays. The primary objective was to determine if there were areas of coarse substrate present that had not been identified in the 2013 visual surveys. The side-scan images were processed using ReefMaster software (ver. 1.8) to create a single georeferenced side-scan mosaic of the area examined. Coarse substrates were clearly visible and easily differentiated from the surrounding fine-grained substrates. The georeferenced side-scan image data were imported into GIS software (QGIS version 2.8.5), and the one previously unidentified coarse substrate shoal was delineated.

4.2 Habitat Characterization Results

4.2.1 Blackwater Creek

Aerial photography of the Blackwater Creek watershed is provided in Appendix A. As discussed previously, Blackwater Creek originates in an area of glaciofluvial outwash and flows southwest across a glaciolacustrine plain, discharging into Keplyn's Bay of Wabigoon Lake. The main creek is 10.4 km long and has several tributaries. Most of the watershed is within the flat, silty-clay glaciolacustrine plain with low relief and very little bedrock, gravel, cobble, or boulder substrate. KCB (2012) described the habitat in Black Creek, dividing it into four separate reaches with the breaks between reaches 2, 3, and 4 located at road crossings. The three upstream reaches described by KCB (2012) are very similar and are discussed as one reach (Reach 2) below. The location of the break between Reach 1 and 2 and the locations of areas where coarse substrate has been observed are presented in Figure 6.

4.2.1.1 Reach 1

Reach 1 is the portion of Keplyn Bay that was separated from Wabigoon Lake by the construction of the railway. Based on field observations by C. Portt on August 3, 2016, flow from Blackwater Creek is conveyed under the railway by at least two corrugated steel pipes that are in the 1.25 m – 2 m diameter range (Figure 7). KCB (2012) stated that this connection "likely precludes fish migration from Wabigoon Lake into Blackwater Creek, although the extent of fish exclusion remains uncertain." DST (2013) indicated that fish passage through the culverts was possible. Under the conditions observed on August 3, 2016, it appeared that fish would be able to move freely through the culverts. It is possible, however, that during periods of high flow the culverts are a barrier to upstream fish migration due to high velocities.

The water velocities in this reach are low and most of the reach can be characterized as sheltered coastal wetland habitat (Figure 8). It supports dense beds of submergent and emergent vegetation, including wild rice, pondweed, milfoil, sedges, and horsetail (KCB, 2012). The maximum depth,

determined during a bathymetric survey in 2011, is 2.6 m and depth decreases with distance upstream (Figure 9; KCB, 2012). The substrates are soft organics (KCB, 2012). On August 7, 2011, the dissolved oxygen concentration was 8.22 mg/L at 0.3 m depth and 0.39 mg/L at 2.0 m depth (KCB, 2012). Given the dense aquatic vegetation, night-time oxygen depletion is to be expected during the summer when aquatic vegetation is abundant and may also occur during the winter. The riparian vegetation is dense and dominated by mixed forest of alder and spruce (KCB, 2012).

Many schools of minnows and many juvenile fish were observed here in August 2011, during the KCB field investigations (KCB, 2012). Potential Northern Pike spawning habitat (flooded grasses and sedges) is common in this reach (KCB, 2012). Based on the habitat characteristics, if fish are able to pass through the culverts into this area in the spring, Reach 1 may provide spawning and nursery habitat for a number of species that are present in Wabigoon Lake and spawn in wetlands, including Northern Pike and Muskellunge.

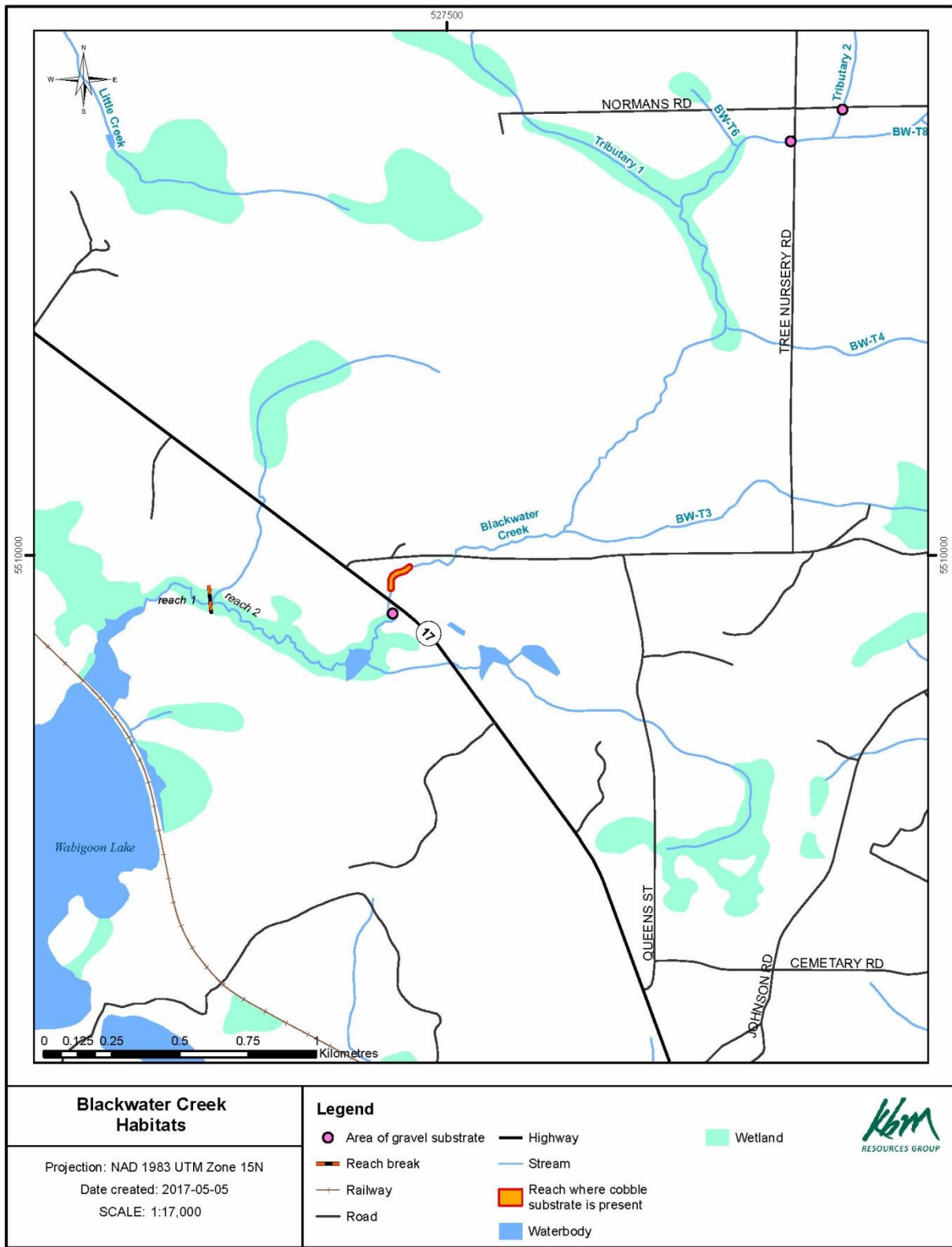


Figure 6. Break between Reaches 1 and 2 and locations where coarse substrate was observed in Blackwater Creek.



Figure 7. Upstream end of culverts underneath the railway that convey water from Blackwater Creek into Keplyn's Bay. August 3, 2016.



Figure 8. The sheltered habitat (Blackwater Creek Reach 1) upstream from the railway culverts that convey the flow from Blackwater Creek into Keplyn's Bay of Lake Wabigoon. (August 3, 2016).

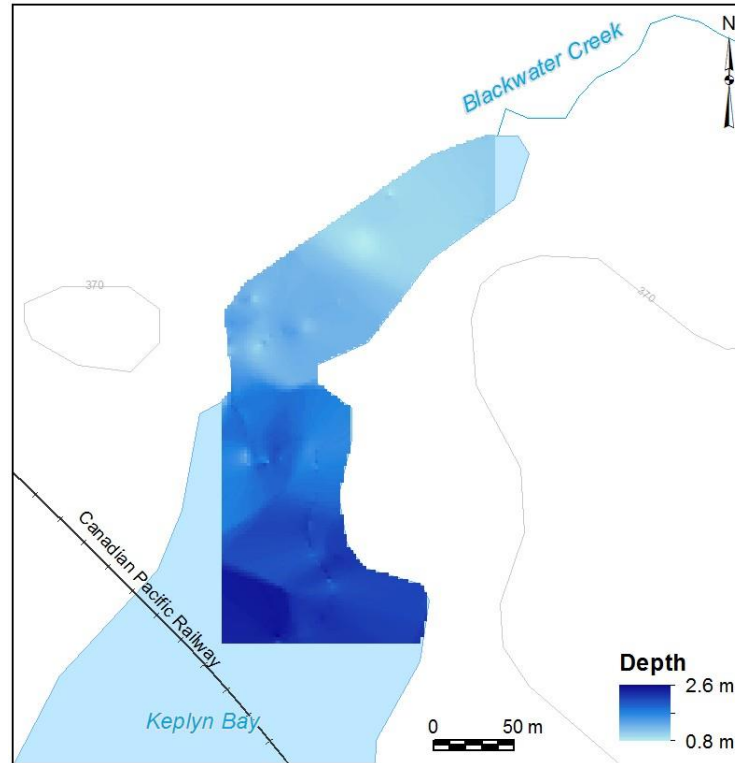


Figure 9. Bathymetry at Blackwater Creek outlet to Wabigoon Lake, August 7, 2011 [Source: KCB, 2012].]

4.2.1.2 Reach 2

The remainder of Blackwater Creek is low gradient stream habitat punctuated by active and inactive beaver dams and ponds. The creek channel is sinuous, which is consistent with the low gradient. The stream habitat is a sequence of runs and pools and there are several beaver ponds present. Only one riffle was observed downstream from Highway 17 by KCB (2012), and it is thought to have been created by gravel from the highway. Further upstream, riffle-like habitat is created where the stream flows over active or abandoned beaver dams.

Consistent with the surficial geology, the substrates are primarily fine silt and clay. Three areas of gravel, each located downstream from road crossings, were observed during the 2011 field investigations (Figure 6; KCB, 2012). The gravel at all of three locations is thought to have originated from road construction and maintenance. A reach with cobble substrate was identified during electrofishing between Anderson Road and Highway 17 in 2012 (DST, 2013; Figure 6; Figure 10). The cobble reach is at a pipeline crossing and is thought to have been placed there during the reconstruction of the creek channel through the right-of-way.

Channel width decreases with distance upstream. Wetted width of the main branch during field investigations in 2011 was approximately 3.5 m downstream from Highway 17, 0.5 – 2.5 m between Highway 17 and Norman Road, and generally less than 1 m upstream from Norman Road (KCB, 2012).

The effect of past and current beaver activity is evident in the pattern of riparian vegetation that alternates between dense willows and alders, open 'beaver meadows' with dense grasses and

sedges, and active beaver ponds. Woody debris is plentiful, in part as a consequence of beaver activity.

No permanent obstructions to fish passage were identified during the field investigations (KCB, 2012) although beaver dams can be impediments and create temporary barriers to upstream movement, depending on flows.



Figure 10. Constructed channel of Blackwater Creek through the pipeline right-of-way. August 4, 2016.



Figure 11. Blackwater Creek flowing through a beaver meadow approximately 650 m south of Normans Road. August 3, 2016.



Figure 12. Blackwater Creek immediately upstream from Normans Road. August 3, 2016.



Figure 13. Blackwater Creek immediately downstream from Normans Road. August 3, 2016.



Figure 14. Blackwater Creek flowing through a beaver meadow approximately 1.2 km upstream from Normans Road. August 4, 2016.

4.2.1.3 Tributary 1 of Blackwater Creek

Blackwater Creek Tributary 1 is of particular interest because a section of it will be directly affected by the project. A large beaver pond was present on Tributary 1 (Site 6), when it was examined in 2011 (KCB, 2012). Many trees were flooded and dead trees and fallen logs were present throughout the pond. The maximum depth of the pond was visually estimated to be approximately 2.5 m. On August 3, 2011, dissolved oxygen concentrations ranged from 13.2 mg/L near the surface (0.3 m) to 2.13 mg/L at 1.3 m depth. Minnow captures were high in this pond. There was no longer an active dam at this site when it was visited by C. Portt on August 3, 2016.

4.2.1.4 Tributary 2 of Blackwater Creek

A portion of Tributary 2 of Blackwater Creek will also be directly affected by the project. This tributary was examined at three locations by C. Portt on August 3-4, 2016. Tributary 2 is conveyed beneath Normans Road in two corrugated steel pipes. Width was 1 – 2 m and the maximum depth was approximately 0.5 m. The substrate upstream and downstream from the culverts is fine, with the exception of some gravel apparently originating from the road. Tributary 2 approximately 8 m downstream from Normans Road is shown in Figure 17.

Based on aerial photography (Appendix A), there is one beaver pond on Tributary 2, approximately 800 m upstream from Norman's Road (Figure 18). The colony did not appear to be active when observations were made on August 4, 2016.

A forestry road crosses Tributary 2 approximately 1.25 km upstream from Normans Road. The creek is conveyed beneath the road in a corrugated steel pipe that is approximately 300 mm in diameter (Figure 19). This corrugated steel pipe is likely a barrier to upstream fish movement under some flow conditions. The substrate upstream and downstream from the crossing is fine sand and silt. The width varies from 1 – 2 m and maximum depth is approximately 0.5 m. The riparian vegetation is dense (Figure 20), as it is at many locations along this tributary.



Figure 15. Remnants of a beaver pond located on Blackwater Creek tributary 1 immediately upstream from Normans Road. August 3, 2016.



Figure 16. Blackwater Creek Tributary 1 flowing across Normans Road. August 3, 2016.



Figure 17. Blackwater Creek Tributary 2 immediately downstream from Normans Road. August 3, 2016.



Figure 18. Beaver pond on Blackwater Creek Tributary 2. August 4, 2016.

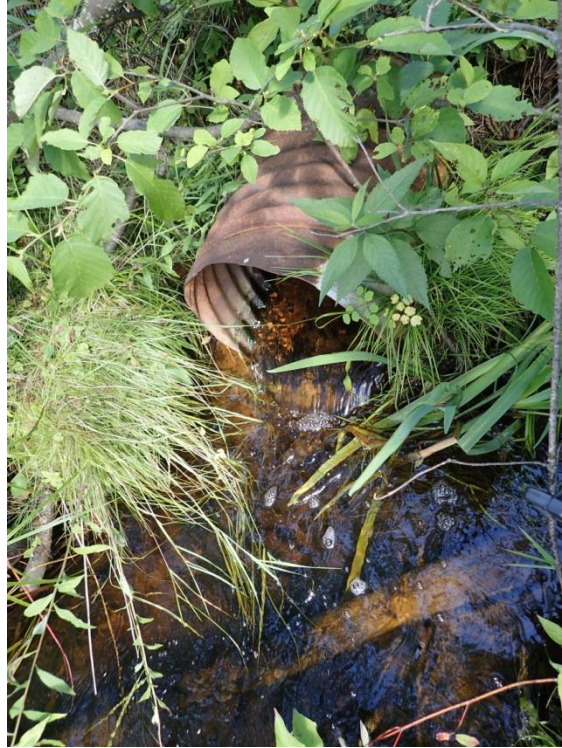


Figure 19. Corrugated steel pipe conveying Blackwater Creek Tributary 2 beneath a forestry road approximately 1.25 km upstream from Normans Road.



Figure 20. Looking upstream at Blackwater Creek Tributary 2 from the forestry road that crosses it approximately 1.25 km upstream from Normans Road.

4.2.1.5 Blackwater Creek Summary

What has been referred to as Reach 1 is the portion of Keplyn's Bay that was separated from Wabigoon Lake by construction of the railway. It is a coastal wetland and is considered to be important fish habitat. It is not known if fish are able to pass through the culverts beneath the railway under spring flow conditions. If they can, then this area is likely to be important spawning habitat for a number of species that occur in Wabigoon Lake, including Northern Pike, a number of forage species, and possibly Muskellunge.

The upstream reaches (2, 3 and 4) of Blackwater Creek are dominated by clay and silt substrates. The only areas of gravel substrate that have been identified are at road crossings. There is extensive beaver activity, and riparian vegetation ranges from dense shrub thickets to open 'beaver meadows'. The channel decreases in size with distance upstream. No permanent barriers to fish migration were observed on the main branch but beaver dams may act as temporary barriers. A culvert on Tributary 2 is probably a barrier to upstream fish migration under some flow conditions. Based on the paucity of coarse substrate it is unlikely that Walleye spawn in Blackwater Creek. No spawning run of White Sucker has been observed but a small number of spawning White Sucker, which may or may not have been stream-resident, were observed at one location (see section 6.1.1).

4.2.2 Thunder Lake Tributaries

Five streams flow into Thunder Lake along its eastern shore (Figure 21). They are referred to as Unnamed Thunder Lake Tributary 1, Unnamed Thunder Lake Tributary 2, Hoffstrom's Bay Tributary, Little Creek, and Unnamed Thunder Creek Tributary 4. A branch of Unnamed Thunder Lake Tributary 2 is referred to as Unnamed Thunder Lake Tributary 3. These tributaries were described at a number of locations by KCB (2012). Additional habitat information for Thunder Lake Tributary 2 and Thunder Lake Tributary 3 was acquired at electrofishing sites sampled in 2012 (DST, 2014) and during a site visit by C. Portt in August, 2016.

4.2.2.1 Unnamed Thunder Lake Tributary 1

Tributary 1 flows through the sandy soils of the outwash plain north of the local study area (KCB, 2012). Iron precipitates were observed at several points in the watershed of Tributary 1, indicating groundwater discharge (KCB, 2012). The outlet of is densely vegetated with marsh vegetation (KCB, 2012).

4.2.2.2 Unnamed Thunder Lake Tributary 2

Aerial photography of the Unnamed Thunder Lake Tributary 2 watershed is provided in Appendix A. Tributary 2 has a north branch, referred to as Thunder Lake Tributary 3, and both branches have ponds on them within the former tree nursery. Tributary 2 flows through the sandy soils of the outwash plain (KCB, 2012). Iron precipitates were observed at several points in the watershed of Tributary 2, indicating groundwater discharge (KCB, 2012).

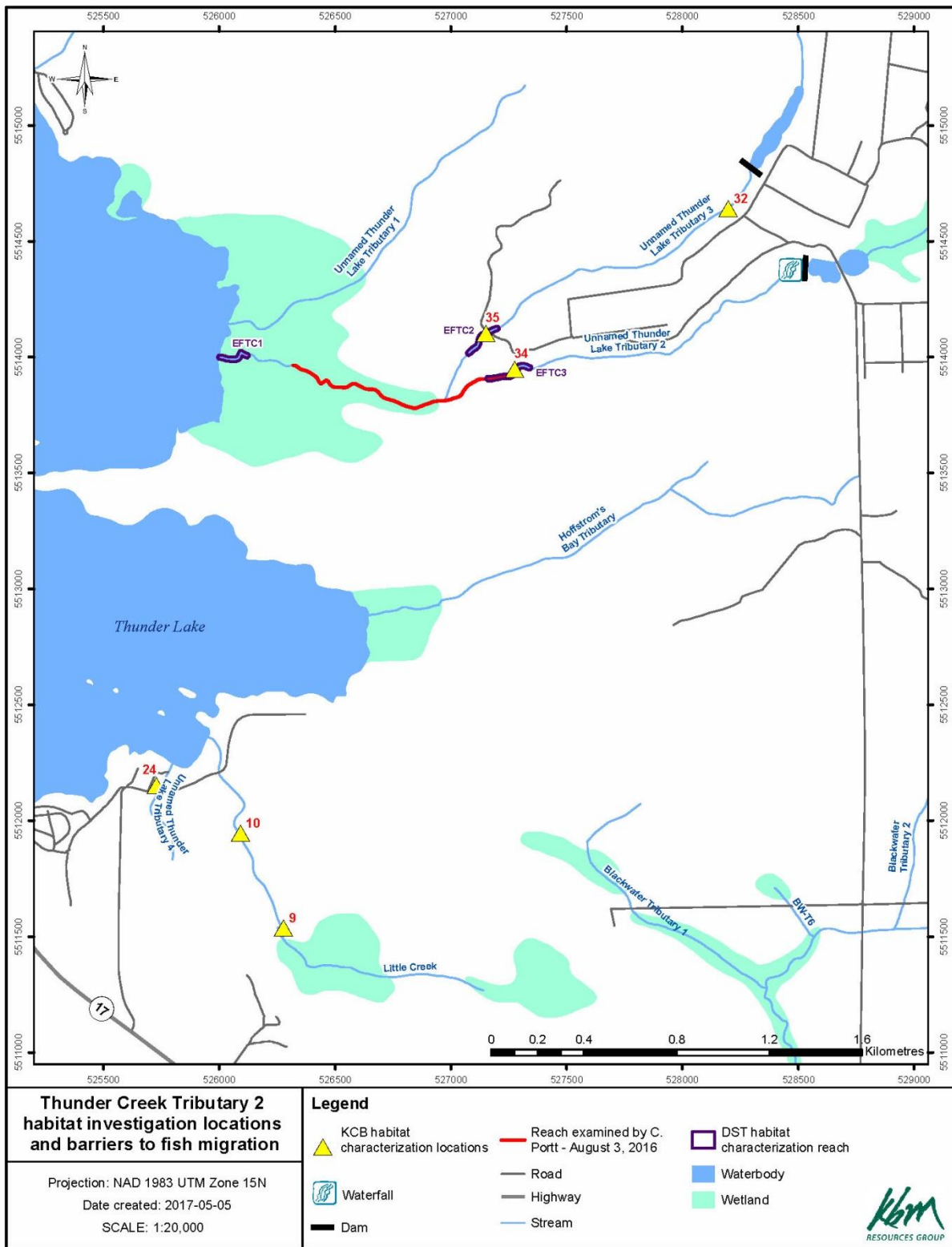


Figure 21. Locations on Thunder Lake tributaries where habitat was characterized.

The outlet of Unnamed Thunder Lake Tributary 2 is densely vegetated with marsh vegetation and is considered to be potential Northern Pike spawning habitat (KCB, 2012). DST (2012) characterized an electrofishing site located just upstream from Thunder Lake (EFBW1, Figure 21) as having dense bank vegetation and substrate of 100% fines. Many schools of juvenile fish were observed in the bay of Thunder Lake that receives Tributary 2 (KCB, 2012).

C. Portt examined Tributary 2 from the edge of the wetland adjacent to Thunder Lake upstream to the confluence with Thunder Lake Tributary 3 on August 3, 2016 (Figure 21). The substrate is fine silts and sands over this entire reach. The stream is sinuous and consists primarily of runs and deeper pools (Figure 22). The channel becomes braided after it enters the wetland adjacent to Thunder Lake (Figure 23). No potential Walleye or White Sucker spawning habitat was observed in this reach, nor were there any barriers to fish migration. In contrast to Blackwater Creek, no active or recently abandoned beaver dams were observed.

Thunder Lake Tributary 2 was described at site 34 by KCB (2012; Figure 21). At that location, it has a bankfull width of approximately 1.5 m to 3.0 m and a wetted width of 1.5 m to 2.5 m. The substrate is dominated with fine sand with no gravel, cobble or boulders present. The morphology of the channel is an irregular meander and unconfined. There is both large woody debris and fine woody debris present and pools that are approximately 0.65 m deep. No potential Walleye or White Sucker spawning habitat was observed. The riparian vegetation is dominated by grasses and alders where the stream crossed the hydro transmission corridor.



Figure 22. Thunder Lake Tributary 2 a short distance downstream from the confluence of the north and south branches. August 3, 2016.



Figure 23. One channel in the braided reach of Thunder Lake Tributary 2 after it enters the wetland that is adjacent to Thunder Lake. August 3, 2016.

C. Portt examined Thunder Lake Tributary 2 from the hydro transmission corridor downstream to the confluence with Thunder Lake Tributary 3 on August 3, 2016 (Figure 21). The substrate is fine silts and sands over this entire reach and the channel is a series of runs and pools (Figure 24). No potential Walleye or White Sucker spawning habitat was observed nor were there any barriers to fish migration.

Thunder Lake Tributary 2 flows through the south Tree Nursery ponds which are maintained by a concrete dam at their downstream end. This area was described by KCB (2012) and was examined by C. Portt on August 3, 2016. Approximately 20 m downstream from the dam, there is a series of fractured bedrock cascades with an estimated descent of 4 - 5 m in total. At the downstream end of these there is a falls with a vertical drop of approximately 1.7 m which is a complete barrier to upstream fish migration (Figure 25). Boulder and cobble substrate extends for approximately 40 m downstream from the falls, at which point the substrates become fine sands and silts once again. Based on the field observations, this reach of coarse substrate is the only potential Walleye spawning location on the south branch of Thunder Lake Tributary 2 between the waterfall and Thunder Lake. This section is also potential White Sucker spawning habitat. The dam at the downstream end of the Tree Nursery ponds creates a near-vertical drop of approximately 2 m which is a complete barrier to upstream fish migration (Figure 26).

The bathymetry of the south Tree Nursery Ponds is illustrated in (Figure 27). The mean depth is 1.4 m and the maximum depth is 3.1 m (KCB, 2012). Dissolved oxygen concentrations, determined on August 3, 2011, ranged from 2.4 mg/L at 1.8 m depth to 12.12 mg/L at 0.3 m depth (KCB, 2012).



Figure 24. Thunder Lake Tributary 2 upstream from the confluence with Thunder Lake Tributary 3. August 3, 2016.



Figure 25. Falls on Thunder Lake Tributary 2. August 3, 2016.



Figure 26. Dam at the downstream end of the tree nursery ponds on Thunder Lake Tributary 2. August 3, 2016.

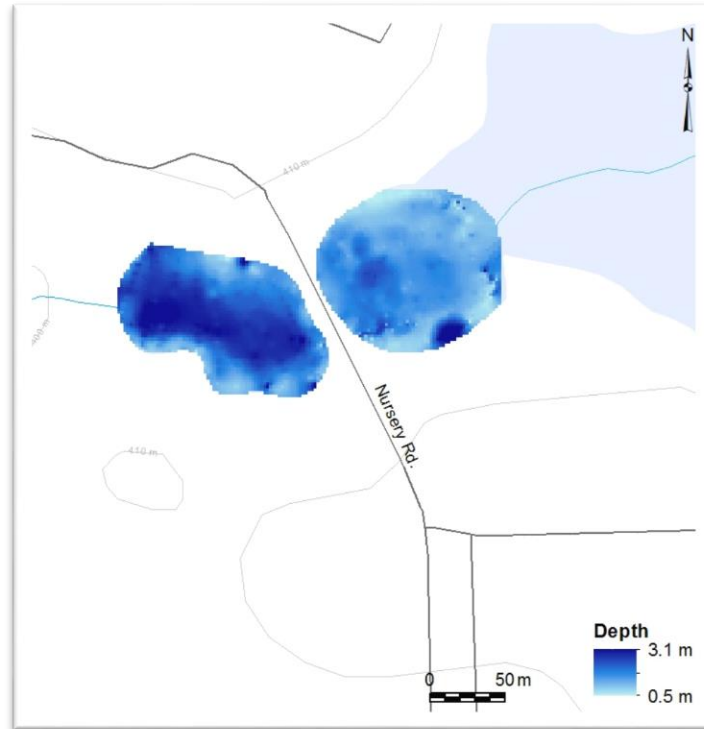


Figure 27. Bathymetry of ponds at Tree Nursery on Thunder Lake Tributary 2. Source: KCB, 2012.

4.2.2.3 Thunder Lake Tributary 3

Thunder Lake Tributary 3 was described at two locations by KCB (2012). At Site 35 (Figure 21), it had a bankfull width of 1.5 m to 2.5 m with a wetted width of 1.5 m to 2.0 m. The substrate was fines, with no gravel, cobble or boulders present. The banks were sloped and deeper pools (i.e., up to 1.5 m) were present with large woody debris. The riparian vegetation was dominated by alders and grasses. Farther upstream (Site 32, Figure 21), the North Branch had deeply incised valley walls with silty, very fine sandy banks and large clumps of woody debris. The riparian vegetation was dominated with grasses and alder with the upland area dominated with spruce, white, and red pine.

DST (2013) characterized the habitat at electrofishing site EFTC2 on Thunder Lake Tributary 3 immediately upstream from the hydro corridor (Figure 21). At that location, the substrate was mainly bedrock overlain by cobble, fines and a small amount of gravel. The bedrock feature underlying this reach may correspond to the bedrock outcrop downstream from the Tree Nursery ponds on the south branch (see Section 4.2.2.2).

A dam on Thunder Lake Tributary 3 creates the north Tree Nursery pond. The dam is a complete barrier to upstream fish migration KCB (2012) and there is an area of cobble boulder substrate immediately downstream from it (Figure 28; Figure 24). This area of coarse substrate is potential Walleye and White Sucker spawning habitat. Based on the bathymetric survey conducted by KCB (2012), the maximum depth of the north Tree Nursery pond is 3.5 m and the average depth is 1.6 m (Figure 29). On August 5, 2011, dissolved oxygen ranged from 0.23 mg/L at 2.9 m depth to 8.49 mg/L at 0.3 m depth.



Figure 28. Dam at the downstream end of the Tree Nursery ponds on Thunder Lake Tributary 3. April 24, 2017.

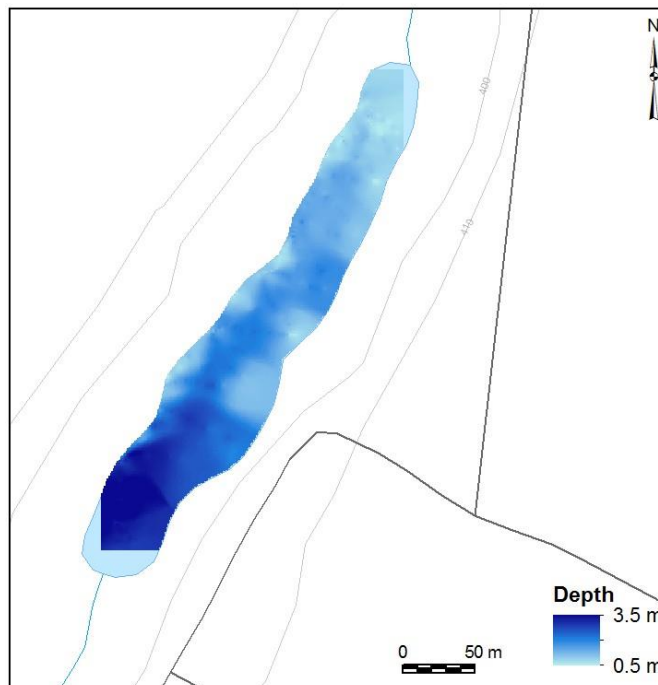


Figure 29. Bathymetry of the pond on the north branch of Thunder Lake tributary 2. (Source: KCB, 2012).

4.2.2.4 Hoffstrom's Bay Tributary

The outlet of Hoffstrom's Bay Tributary is densely vegetated with marsh vegetation and is considered potential northern pike spawning habitat (KCB, 2012). Many schools of juvenile fish were observed there during the field work (KCB, 2012). The watercourse has not been characterized in detail.

4.2.2.5 Little Creek

Little Creek flows into Thunder Lake south of Hoffstrom's Bay. It was characterized at two locations by KCB (2012; Figure 21). Beaver activity was evident at Site 48 (Figure 21), upstream of the stream outlet in 2011. Further upstream, past Site 10 (Figure 21), there was a pond created by a large beaver dam. Bathymetry was not conducted in this pond due to the dense reeds (KCB, 2012). Immediately downstream of this beaver dam was a marsh with dense reeds > 2 m in height. The dissolved oxygen concentration in this pond, taken from the shore on August 6, 2011, was 4.8 mg/L at 0.3 m depth (KCB, 2012). It can be expected that dissolved oxygen was low at greater depths, as it was in the other beaver ponds where dissolved oxygen profiles were determined at depth.

4.2.2.6 Unnamed Thunder Lake Tributary 4

Unnamed Thunder Lake Tributary 4 was examined at Site 24 (Figure 21) by KCB (2012; Figure 21), where extensive beaver activity and stagnant standing water was observed.

4.2.3 East Bays of Thunder Lake

Fish habitat in Hoffstrom's Bay was described and mapped by DST (2014; Figure 30). The peninsula that forms the north shore of Hoffstrom's Bay is dominated by a generally rocky shoreline composed of a mix of bedrock, cobble and gravel with small areas of sparse aquatic vegetation. At the western end of the peninsula there is a large area of rock and cobble that has been identified as one of several areas where habitat improvement work was conducted by OMNR to enhance Lake Whitefish spawning habitat (DST 2014; Figure 30).

At the head of Hoffstrom's Bay a large area has been flooded by beaver activity (DST, 2014). The area upstream of the beaver dam is dominated by aquatic vegetation, coarse woody debris and a mix of willow (*Salix* sp.) and alder (*Alnus* Sp.) shrubs around the margins. The shoreline in front of the dam is mostly sandy and silty with sparse submergent aquatic vegetation (Figure 30). Potential Northern Pike spawning habitat is present in meadow marsh and shore fen communities at the mouth of the Hoffstrom's Bay tributary (KCB, 2012), however DST (2014) indicated that the beaver dam across the mouth of the stream prevented fish access to the potential spawning area.

Most of the northwest facing inlets along the south shore of the bay are similar and have sandy/silty substrates, sparse aquatic vegetation and sandy shorelines (DST, 2014). Other areas along the south shore are a mix of rock and sparse aquatic vegetation similar to those observed on the north shore. The peninsula that forms the southwest boundary of the study area has a large area of boulders and cobble that has been also been identified as a habitat improvement area (DST, 2014; Figure 3).

There are four small islands in Hoffstrom's Bay. The three smallest islands are predominantly rocky and have very little aquatic vegetation (DST, 2014). The largest island has a rocky shoreline with sparse aquatic vegetation and coarse woody debris (DST, 2014). The northwest tip of the large island has a large bedrock cobble shoal extending northwest into deeper water (KCB, 2012).

As reported in Section 2.2, cobble and boulder shoals extending out from the bedrock point and island on the east end of Thunder Lake are known spawning habitat for Lake Trout and Lake Whitefish and potential Walleye spawning habitat (D. Brunner, MNRF Biologist. Personal communication with C. Portt, April 27, 2017). Other areas of coarse substrate are considered potential spawning habitats for those species but spawning has not been confirmed.

The bay which Thunder Lake Tributaries 1 and 2 flow into is separated from Hoffstrom's Bay by the peninsula described above. With the exception of one shoal of boulder and cobble (Figure 30), that was mapped using side-scan Sonar on August 4, 2016, the substrate in this bay is composed of sand and silt. There are extensive emergent reed beds and scattered beds of submergent vegetation in the inner portion of the bay. Potential northern pike spawning habitat is present in meadow marsh and shore fen communities associated with the mouth of Tributary 2 and a young-of-the-year northern pike was observed in this bay in 2011 (KCB, 2012).

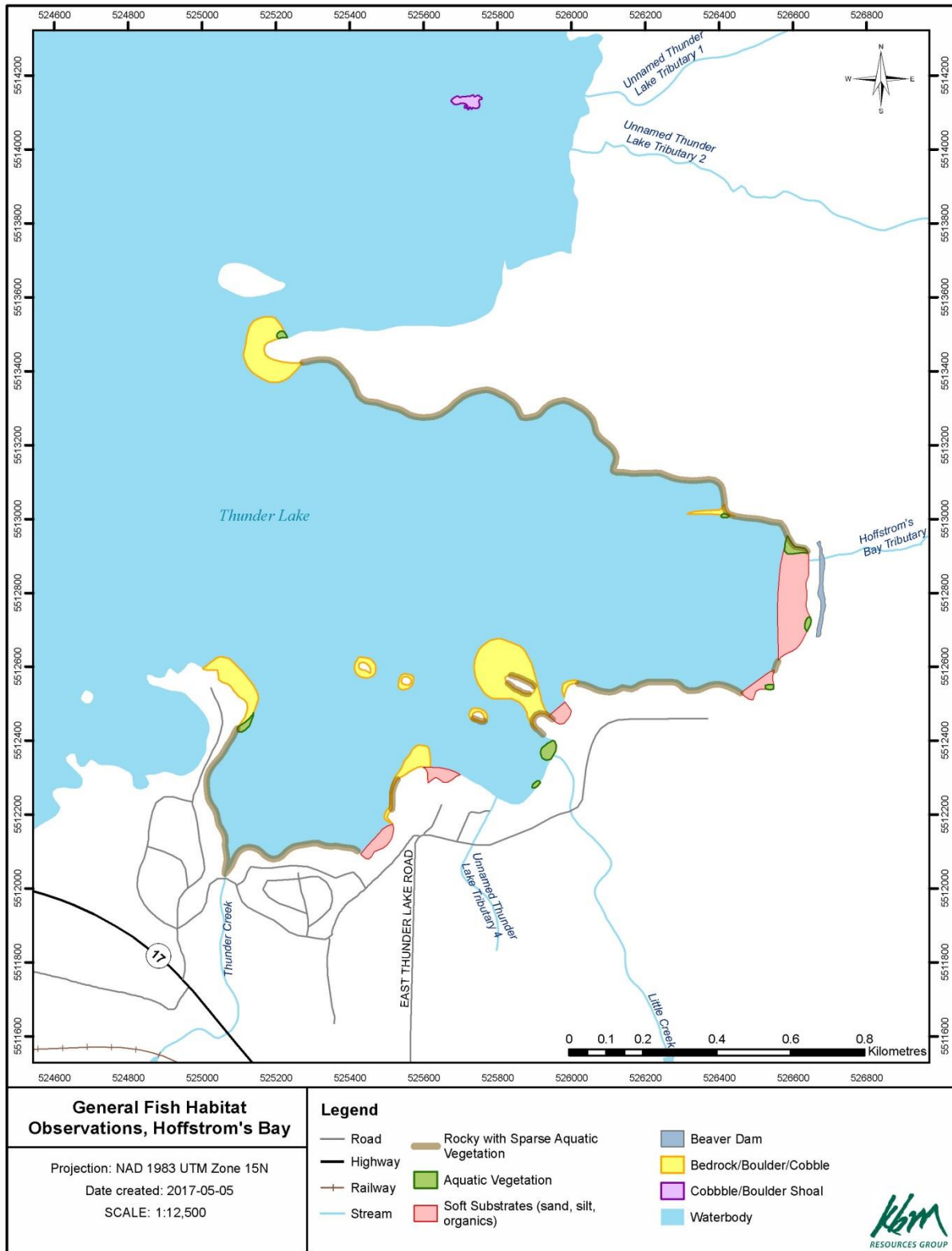


Figure 30. Fish habitat characterization. Hoffstrom's Bay, Thunder Lake. Source: DST, 2014.

4.2.4 Keplyn's Bay of Wabigoon Lake

The information from the observational survey of littoral zone habitat completed in Keplyn's Bay on May 22, 2013, is presented in Figure 31. The North and South shorelines of Keplyn's Bay are mainly composed of sand, silt and gravel. The rail causeway that forms the East shore of the bay is composed of rip-rap and boulder cobble. A side-scan sonar survey of the east end of Keplyn's Bay on August 3, 2016, did not identify any additional coarse substrate.

Nearly all of the bay has a soft bottom composed of a mix of sand, silt, gravel and organic material with sparse submergent vegetation (DST, 2013). The bay is generally flat and shallow with a maximum recorded depth of 4.9 m (DST, 2013). In the northeast corner of the bay near the inflow of Blackwater Creek there is a large area of aquatic vegetation and another is present on the southwest corner at the entrance to the bay (DST, 2013). Submergent vegetation was also observed across the head of the bay during the August 3, 2016, site visit (C. Portt, personal observation).

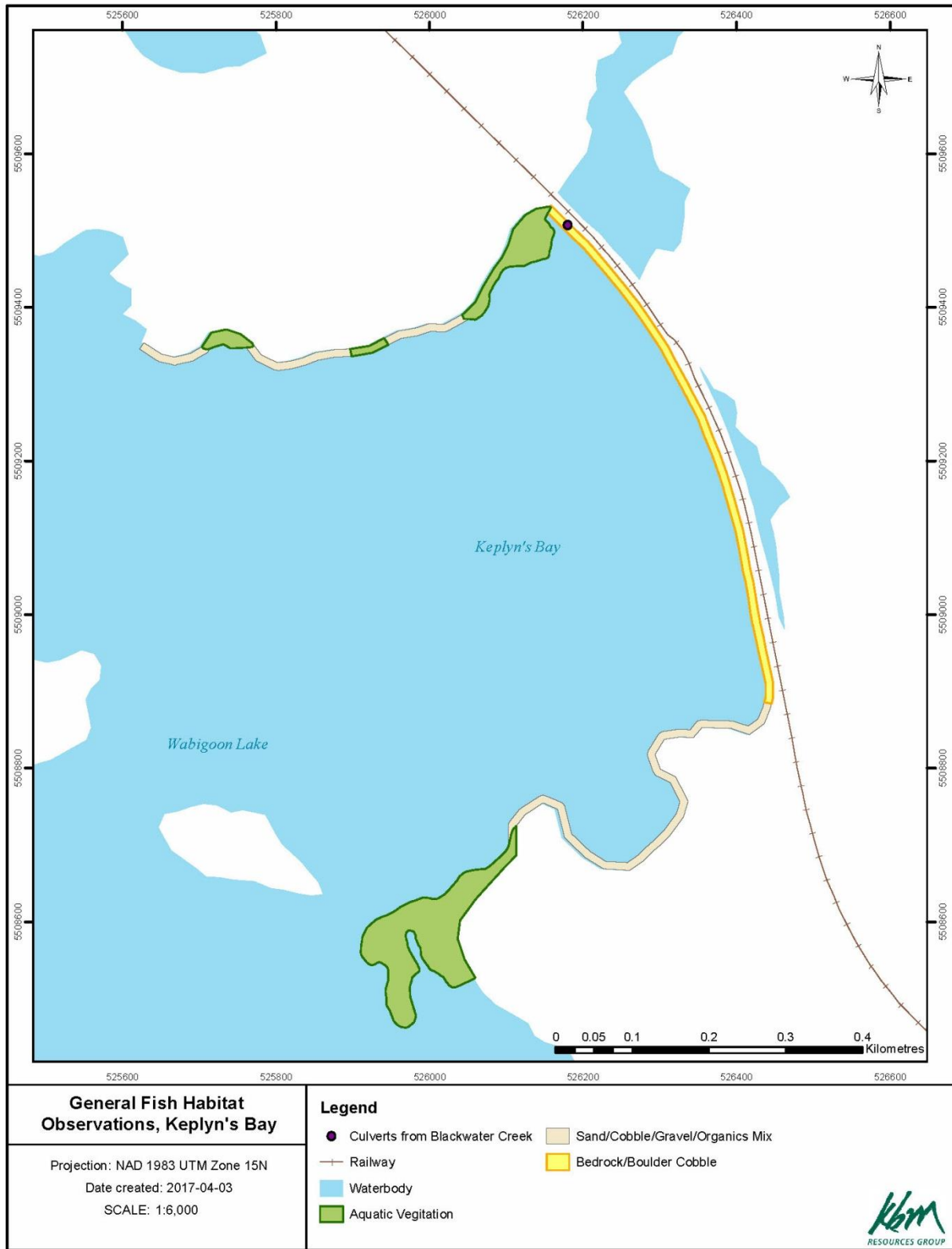


Figure 31. Fish habitat observations in Keplyn's Bay, Lake Wabigoon. Source: DST, 2014.

5. Fish Sampling

5.1 Fish Sampling Methods

5.1.1 Overview

Fish sampling was conducted in the fall of 2010 and in 2011 by KCB (KCB, 2012), in 2012 by DST, (DST, 2014) and by TMI in 2014. The sampling focused on Blackwater Creek and Thunder Lake Tributaries 2 and 3, which flow through the former Tree Nursery ponds. Limited sampling was conducted near the mouths of some of the watercourses in Thunder Lake and Wabigoon Lake.

Sampling was conducted in Hughes Creek and Nugget Creek by KCB in 2010 and 2011 (KCB, 2012) because it was thought at the beginning of baseline data collection that portions of the project infrastructure could be located within the Hughes Creek watershed; with the current project design, this is not the case. Therefore the Hughes and Nugget Creek data are not included in this report, nor is fish sampling data from Thunder Creek that was collected by KCB (2012). The Thunder Creek sampling was done to support possible fish habitat offsetting for the project in Thunder Creek; Thunder Creek is no longer considered a potential offsetting location.

Fish sampling gear included standard Gee-type minnow traps, backpack electrofishing, seining and gill netting. Descriptions of the gear are provided in Table 3. Each sampling location was allocated a site number, and geo-referenced using a handheld GPS. Most sites were photographed (upstream and downstream). In 2011 and 2012, fork length (mm) or total length (mm) was recorded, depending on species, and weights to nearest 0.01 gram were recorded for a representative sub-set (approximately 20%) of the fish captured. The remaining fish were grouped by species into size categories of 1 cm to 5 cm, 5 cm to 10 cm, or 10 cm to 15 cm and counted but weights were not recorded. In 2012, captured fish were identified to species, or genus in the case of *Phoxinus*, and the length of all or a sub-sample of the catch was determined to the nearest mm. Weight was determined to the nearest gram for some catches. In 2014 fish were identified and enumerated.

Table 3. Equipment Specifications for Fish Sampling

Equipment	Specifications/Model	Other
Minnow Trap	Standard wire, 2 opening	Baited with dry cat or dog food
Electrofisher	Smith-Root Model LR24	400 Volts to 500 Volts
Seine Net	30 m x 1 m with 1/8" stretched mesh	N/A
Gill Net – small mesh river index (SMRI)	5 panel, 13 mm to 38 mm stretched mesh. Each panel 0.9 m deep and 2.5 m long. Total length 12.5 m	Suitable to target small bodied fish such as young-of-year, juvenile sport fish and forage fish
Kick Net	500 µm mesh, D-Net	Used for kick and sweep

5.1.2 Minnow traps

Minnow traps were baited with dry cat or dog food and set over-night at representative sites in the streams and ponds in the LSA. Locations were geo-referenced and the set and lift dates and times were recorded. In 2010 and 2011, multiple traps were often set at one location. In 2012 and 2014 each trap that was set was assigned a unique location code. The fish captured in each trap were identified to species or, in the case of the two *Phoxinus* species (northern redbelly dace and finescale dace) to genus, and enumerated.

5.1.3 Electrofishing

Electrofishing was conducted in August 2011 and October 2011 in Blackwater Creek, Hughes Creek, Thunder Creek and Thunder Lake Tributary 2 (west of the Tree Nursery) using a Smith-Root LR24 electrofisher (KCB, 2013). Electrofishing was conducted by a two-person crew walking upstream; one crew member operated the electrofisher and the other collected the stunned fish with dip net. The coordinates of the sampling locations were determined using a handheld GPS and the times when electrofishing began and ended at each location were recorded. Each fish captured was identified to species. For some individuals, length was determined to the nearest millimetre and weight was determined to the nearest 0.01 g. In some cases, only a sub-sample of the catch were measured or individuals were assigned a size category. KCB (2013) reported that the fine substrate in Blackwater Creek and sections of Hughes Creek made electrofishing a less effective method than minnow trapping or seining. In 2011, following several attempts, electrofishing was abandoned and minnow trapping and seining were used as the main collection techniques.

In 2012, electrofishing was conducted in late June at one location in Blackwater Creek, two locations in unnamed Thunder Lake Tributary 2 and one location in unnamed Thunder Lake Tributary 3 (DST, 2014). The sampling site boundaries were selected using the Ontario Stream Assessment Protocol (OSAP; Stanfield, 2007)) methodology where possible. The electrofishing methodology followed the OSAP Standard Single Pass Survey methodology. Prior to electrofishing, the water temperature and conductivity were taken in order to properly calibrate the settings on the electrofisher. The coordinates of the upstream and downstream ends of the sampled reaches were determined using a handheld GPS.

Table 4. Electrofisher settings, effort (electroseconds) and the length of the sampling stations sampled in 2012 (DST, 2014).

Sampling location	voltage (v)	frequency (hz)	electro-seconds	station length (m)
Blackwater Creek	375	30	472	137
Thunder Lake Tributary 2 EFTC-1	450	30	850	151
Thunder Lake Tributary 3 EFTC-2	350	30	500	51
Thunder Lake Tributary 2 EFTC-3	375	30	353	48

In 2012, the habitat in the electrofished reaches was characterized using the OSAP Rapid Assessment Methodology. The data collected included substrate, depth, in-stream morphology, cover and bank stability. All data was collected using the point transect method with 6 - 10 evenly spaced transects perpendicular to the flow of the stream at each site (i.e. one transect every 4 to 10 meters, depending on the length of the site). At six approximately equidistant points along each transect depth and point substrate particle size were measured and cover and maximum particle size measurements were assessed within a visualized 30 cm ring around each point. At each transect the stability of both banks were categorized as eroding bank, vulnerable bank, protected bank, or deposition zone.

5.2 Fish Sampling Results

5.2.1 Blackwater Creek

The results of fish sampling conducted in Blackwater Creek and its tributaries are summarized in Table 5 and the sampling locations are shown in **Figure 32**. In total, 8,182 fish were captured. The most abundant and widely distributed taxa were the *Phoxinus* species (63% of the total catch), Brook Stickleback (22% of the total catch), and Pearl Dace (10% of the total catch). Fathead Minnow was captured less frequently and in lower numbers (2% of total catch). White Sucker (1% of the total catch) were more common in catches from the downstream reaches of Blackwater Creek and 59 of the 80 individuals captured were in a single minnow trap at location MINN3 (Table 3). A single Burbot was captured on two occasions between Highway 17 and Anderson Road. One Yellow Perch was captured in a gill net set in the bay/wetland habitat upstream from the railway at the outlet of Blackwater Creek. There were 42 cyprinids captured that were not identified to species; 17 of these were identified as “shiners”.

Phoxinus spp. dominated the catches in Tributary 1 (78% of total catch), followed by Brook Stickleback (34% of total catch) and Pearl Dace (18% of total catch). Fathead Minnow were also present (2% of total catch) and there were 11 fish captured that were identified as “shiners”. No White Sucker were captured in Tributary 1.

Four taxa were identified in catches from Blackwater Creek Tributary 2. *Phoxinus* spp. dominated the catches (48% of total catch), followed by Pearl Dace (11.6% of total catch) and Brook Stickleback (8.5% of total catch). Two White Sucker were captured by seining in Tributary 2 at Anderson Road (Location 12), on the same date as spawning was observed there (refer to Section 6.1.1). In addition, there were 11 fish captured that were identified as “shiners”. Catches were lower in the upper reaches of Tributary 2. No *Phoxinus* spp. were captured upstream of BWF32 and there was no catch in 16 of the 24 minnow traps sets starting at location BWF31 and going upstream.

5.2.2 Thunder Lake tributaries

The results of fish sampling conducted in the Thunder Lake tributaries are summarized in Table 6 and the sampling locations are shown in Figure 32. Catches at some locations at or near the mouths of the creeks reflect the lake fish community. For example, Yellow Perch were the most abundant species in the catches at the mouth of the Hoffstrom’s Bay tributary (site 50) and at the mouth of Tributary 1 (site 49) but, like Rock Bass and Mottled Sculpin, were not caught at any of the sampling sites further from the lake. In the Hoffstom’s Bay Tributary proper only *Phoxinus*, pearl dace and brook stickleback were captured while in Little Creek only Fathead Minnow, *Phoxinus* spp and Brook Stickleback were captured.

Most of the sampling effort was on Thunder Lake Tributary 2 and Thunder Lake Tributary 3. A single Pearl Dace was captured at the electrofishing site at the mouth of Tributary 2. A total of nine species were captured in Thunder Lake Tributary 2 between the dam at the Tree Nursery ponds and the confluence with Thunder Lake Tributary 3. Pearl dace and *Phoxinus* spp. were the most abundant species. Only five species were captured in the Tree Nursery ponds, where Fathead Minnow, Brook Stickleback, Pearl Dace and *Phoxinus* spp. were all common and two Iowa Darter were captured. Only Pearl Dace were captured in a short (2 hr) gill net set in the former tree nursery pond.

Thirteen fish species were captured Tributary 3. Catches were dominated by Pearl Dace, *Phoxinus* spp., Brook Stickleback, and Fathead Minnow. No fish were captured in two short gill net sets (1.6 hr and 0.4 hr) in the former tree nursery pond.

Table 5. Fish catches in Blackwater Creek and its tributaries. Sampling locations are arranged in order, from downstream to upstream, and are shown in Figure 32. Gear types are gill net (GN), minnow traps (MT), and electrofishing (EF).

Watercourse	Gear	Set Date	Sample/ Location ID	Number of traps	<i>Phoxinus</i> spp.	Brook Stickleback	Pearl Dace	Fathead Minnow	White Sucker	Shiner sp.	Cyprinid sp.	Burbot	Yellow Perch
Blackwater Creek	GN	August 07, 2011	25	na									1
	EF	August 04, 2011	58	na		24			2				
	EF	August 04, 2011	61	na	1	67	35		7	1	25		
	MT	2012	BW1	1									
	MT	2012	BW2	1		4							
	EF	June 26, 2012	EFBW1	na		7	4		1				1
	MT	June 2012	MINN22	1									
	MT	June 2012	MINN21	1									
	EF	August 03, 2011	28	na		4	27						1
	MT	August 08, 2011	28	1	38		23	17	3				
	MT	August 03, 2011	28	2	57		28		1				
	MT	May 10, 2011	28	2	10	8	1			3			
	MT	June 2012	MINN23										
	MT	2012	BW3	1	5		2						
	MT	August 08, 2011	30	6	339	11	30	33	1	2			
	MT	August 07, 2011	53	2	13	1	10		1				
	MT	August 07, 2011	59	2	9	2		1					
	MT	June 2012	MINN1	1		1							
	MT	August 07, 2011	66	3	6	2	1						
	MT	June 2012	MINN2	1		1							
	MT	June 2012	MINN3	1	177	1	25		59				
	MT	June 2012	MINN4	1	33								
	MT	June 2012	MINN5	1	10	3	2		1				
	MT	August 08, 2011	65	5	715	73	58	32					
	MT	August 07, 2011	64	2	186	27	7	27	1				
	MT	November 16, 2010	11	2		3							
	MT	May 10, 2011	11	2									
	MT	August 03, 2011	11	2									
	MT	June 2012	MINN18	1	27	26	29						
	MT	June 2012	MINN17	1									
	KS	May 10, 2011	1	na					0				
	MT	November 15, 2010	1	2		1							
	MT	August 03, 2011	1	2	50	51	116						
	MT	May 10, 2011	1	2	135	31	5	17	1				
	MT	June 2012	MINN19	1	2	4							
	MT	June 2012	MINN20	1	2	7	1						
MT	June 2012	MINN13	1	28	4								
MT	June 2012	MINN16	1	110	1								
MT	November 17, 2010	13	2		10								
MT	May 10, 2011	13	2	238	168	1							
MT	August 03, 2011	13	2	158	3								
MT	June 2012	MINN14	1	69									
MT	June 2012	MINN15	1	88									
MT	2012	BW4	1	165	9	3							

Watercourse	Gear	Set Date	Sample/ Location ID	Number of traps	<i>Phoxinus</i> spp.	Brook Stickleback	Pearl Dace	Fathead Minnow	White Sucker	Shiner sp.	Cyprinid sp.	Burbot	Yellow Perch
	MT	November 16, 2010	7	2	168	8	18						
	MT	2012	BW10	1			2						
	MT	2012	BW11	1	16	795	5						
	MT	November 16, 2010	8	2		3							
	MT	2012	BW12	1									
	MT	2012	BW13	1									
	MT	June 2012	MINN21	1	0								
Blackwater Creek Trib BT-1	MT	May 10, 2011	29	2	2	33	1						
Blackwater Creek Trib BT-3	MT	May 10, 2011	27	na									
Blackwater Creek Trib BT-4	MT	May 10, 2011	26	1									
Blackwater Creek Tributary 1	MT	June 2012	MINN6	1	0	6	4						
	MT	June 2012	MINN7	1	0	16	129						
	MT	June 2012	MINN8	1	133		119						
	MT	May 12, 2011	6	2	75	75		1					
	MT	August 08, 2011	6	6	99		19						
	MT	November 15, 2010	6	1	51	12	3	18					
	MT	May 10, 2011	6	2	194	108	28			11			
	MT	August 03, 2011	6	9	1480	7	2	31					
		Sub-total		23	2032	224	304	50	0	11			
Blackwater Creek Tributary 2	MT	November 16, 2010	12	2	25	41	7						
		May 10, 2011	12	2	53	38	2						
		August 03, 2011	12	2	78	44	5						
	SN	May 10, 2011	12	na					2				
	MT	May 22, 2014	BWF8A	1	0	0	0						
	MT	2012	BW5	1	4	3	2						
	MT	2012	BW9	1	2	2							
	MT	2012	BW8	1	2	1							
	MT	May 22, 2014	BWF7A	1	0	0	0						
	MT	July 03, 2014	BWF43	1	0	1	2						
	MT	2012	BW6	1	5	10							
	MT	July 03, 2014	BWF34	1	0	0	9						
	MT	August 06, 2011	63	2	49	25	12						
	MT	July 03, 2014	BWF35	1	0	2	4						
	MT	July 03, 2014	BWF36	1	0	1	26						
	MT	2012	BW7	1	5	4	4						
	MT	July 03, 2014	BWF37	1	0	1	0						
	MT	July 03, 2014	BWF38	1	0	2	0						
	MT	May 22, 2014	BWF6A	1	0	2	1						
	MT	July 03, 2014	BWF39	1	2	10	0						
MT	May 29, 2014	BWF13	1	0	1	3							
MT	July 03, 2014	BWF40	1	9	2	15							
MT	July 03, 2014	BWF41	1	0	1	6							
MT	July 03, 2014	BWF42	1	0	1	0							

Watercourse	Gear	Set Date	Sample/ Location ID	Number of traps	<i>Phoxinus</i> spp.	Brook Stickleback	Pearl Dace	Fathead Minnow	White Sucker	Shiner sp.	Cyprinid sp.	Burbot	Yellow Perch
	MT	June 19, 2014	BWF33	1	44	0	1						
	MT	May 29, 2014	BWF12	1	22	5	6						
	MT	June 19, 2014	BWF32	1	5	1	1						
	MT	May 29, 2014	BWF11	1	1	0	2						
	MT	May 29, 2014	BWF10	1	0	8	0						
	MT	June 19, 2014	BWF31	1	0	0	0						
	MT	June 19, 2014	BWF30	1	0	0	0						
	MT	May 29, 2014	BWF9	1	0	1	0						
	MT	May 22, 2014	BWF4A	1	0	0	0						
	MT	June 19, 2014	BWF29	1	0	0	2						
	MT	June 19, 2014	BWF28	1	0	0	0						
	MT	June 19, 2014	BWF27	1	0	0	0						
	MT	June 19, 2014	BWF26	1	0	0	0						
	MT	June 19, 2014	BWF25	1	0	3	1						
	MT	May 22, 2014	BWF5A	1	0	0	0						
	MT	June 04, 2014	BWF24	1	0	0	2						
	MT	June 04, 2014	BWF23	1	0	0	0						
	MT	June 04, 2014	BWF22	1	0	0	0						
	MT	June 04, 2014	BWF21	1	0	0	0						
	MT	June 04, 2014	BWF20	1	0	0	0						
	MT	June 04, 2014	BWF19	1	0	0	0						
	MT	June 04, 2014	BWF18	1	0	0	0						
	MT	June 04, 2014	BWF17	1	0	0	0						
	MT	May 29, 2014	BWF16	1	0	1	0						
	MT	May 29, 2014	BWF15	1	0	3	0						
	MT	May 29, 2014	BWF14	1	0	0	0						
	MT	May 22, 2014	BWF3A	1	0	2	0						
	MT	May 22, 2014	BWF1A	1	0	1	0						
	MT	May 22, 2014	BWF2A	1	0	0	0						
		Sub-total		56	306	217	113		2				
Total				152	5195	1834	851	177	80	17	25	2	1
% of total catch					63	22	10	2	1	<0.5	<0.5	<0.5	<0.5

Table 6. Fish catches in Thunder Lake tributaries. Sampling locations are arranged in order, from downstream to upstream, and are shown in Figure 32. Gear types are gill net (GN), minnow traps (MT), electrofishing (EF) and seine (SN).

Watercourse/ Waterbody	Gear	Set Date	Sample/ Location ID	Number of traps	Fathead Minnow	<i>Phoxinus</i> spp.	Brook Stickleback	Pearl Dace	Yellow Perch	Shiner sp.	White Sucker	Central Mudminnow	Blacknose Shiner	Creek Chub	Iowa Darter	Rock Bass	Trout- Perch	Mottled Sculpin	Cottus sp.	Cyprinid sp.	Burbot
Pond	MT	August 06, 2011	62	2		52															
Hoffstrom's Bay Tributary	MT	August 06, 2011	49	5					6	20						1		1			
	SN	August 06, 2011	49	0				1	27												
		August 06, 2011	49	0				7	39							1					
	MT	May 12, 2011	36	2			1														
	MT	November 15, 2010	2	2																	
		May 11, 2011	2	2			28	10													
	MT	November 15, 2010	3	2			3														
			Total	13		28	14	8	72	20						2		1			
Thunder Lake Tributary 1	MT	August 06, 2011	50	5			1		36	11		5									
Thunder Lake Tributary 2 - main Branch	EF	June 25, 2012	EFTC1					1													
Thunder Lake Tributary 2	EF	August 05, 2011	34	0	5	5	1	7				4									
		June 25, 2012	EFTC3				5					1									1
	MT	August 05, 2011	34	5		12	3	32			1	1									
		May 11, 2011	34	2		2					3										
	MT	2012	TC15	1		38							1								
	MT	May 10, 2011	31	1				2													
	MT	2012	TC14	1	6	4	2				1		8		1						
			Total	10	11	61	11	42		5	6	9		1							1
Thunder Lake Tributary 3	EF	August 05, 2011	35	0				6			5	9							1	1	
		June 25, 2012	EFTC2																		
	MT	August 05, 2011	35	4		10	2	4	4	1	5						2				
		May 11, 2011	35	2			20	1				2						1			
	A	June 14, 2011	32	0																	
	MT	May 10, 2011	32	1				11							1						
	MT	2012	TC18	1								2									
	MT	2012	TC17	1			1	4													
	GN	August 05, 2011	54	0																	
	MT	August 05, 2011	54	5	24	66	5	98			2										
	A	June 14, 2011	55	0																	
	GN	August 05, 2011	55	0																	
	MT	2012	TC7	1	1	3	47	6						3							
	MT	2012	TC6	1	4	5		3													
MT	2012	TC5	1																		
MT	2012	TC4	1	19	5	9	2						3								

Watercourse/ Waterbody	Gear	Set Date	Sample/ Location ID	Number of traps	Fathead Minnow	<i>Phoxinus</i> spp.	Brook Stickleback	Pearl Dace	Yellow Perch	Shiner sp.	White Sucker	Central Mudminnow	Blacknose Shiner	Creek Chub	Iowa Darter	Rock Bass	Trout- Perch	Mottled Sculpin	Cottus sp.	Cyprinid sp.	Burbot
	MT	2012	TC2	1																	
	MT	2012	TC3	1			5	9													
	MT	2012	TC1	1				2													
	MT	2012	TC16	1	43	12	3	10													
			Total	22	91	101	92	156		1	12	13		6	1		2	1	1	1	
Thunder Lake Tributary 2 nursery ponds	MT	2012	TC13	1	1	1	9	1													
	MT	2012	TC12	1	1																
	MT	2012	TC11	1	38	7	1														
	MT	2012	TC10	1	3	4															
	MT	2012	TC9	1																	
	GN	August 03, 2011	4&5					38													
	MT	November 15, 2010	4&5	2	1			26													
		May 10, 2011	4&5	2	77	5	42														
		August 03, 2011	4&5	2		34	1	22													
		May 11, 2011	4&5	2			75								2						
	MT	June 2012	MINN10	1	5	2	4	11													
	MT	June 2012	MINN11	1		1	3	2													
	MT	June 2012	MINN9	1	5	6		1													
	MT	June 2012	MINN12	1	36	3	3														
			Total	17	167	63	138	101							2						
Little Creek	MT	November 16, 2010	10	2																	
	MT	August 05, 2011	9	10		20	4														
		November 16, 2010	9	2	106	41	8														
		November 16, 2010	48	2																	
			Total	16	106	61	12														
Thunder Lake Tributary 4	MT	May 11, 2011	24	2																	
Total number all Thunder Lake Tributary locations				87	375	366	268	307	108	32	17	24	9	6	4	2	2	2	1	1	1

6. Spawning Investigations

6.1 Spawning Investigations Methods

6.1.1 2011 Spawning Surveys

The 2011 spawning surveys coincided with spring Walleye (*Stizostedion vitreum*) and White Sucker (*Catostomus commersonii*) spawning (KCB, 2012). Kick and sweep fish-egg surveys were conducted in May 10, 2011, and visual surveys were conducted at night with spotlights on May 11, 2011. In Blackwater Creek, the surveys focused on areas where gravel had been observed, mainly the washouts from culvert installations at road crossings. Both types of surveys were conducted at fish sampling location 5 on the main branch of Blackwater Creek and at fish sampling location 12 on Tributary 2 of Blackwater Creek (Figure 32). One site on Hughes Creek and one site on Thunder Creek were examined as reference locations to confirm that the timing of the surveys was correct.

Kick and sweep surveys consisted of moving upstream, walking backwards, with a standard kick net with 500 µm mesh held facing upstream. The substrate was disturbed using a kicking motion to dislodge any eggs present so that they would be carried into the net by the water current. The area covered ranged from a 2 m by 1 m grid to a 20 m by 1 m grid, depending on the amount of gravel present. Sampling took from 0.5 minutes to 2 minutes per site. If eggs were collected, a sub-sample was retained for measurement to confirm species identification. Spotlight surveys were conducted by a two-person team with waders and spotlights. Areas of suitable areas habitat in the riffles and rapids (on the reference creeks) were searched for spawning fish. Approximately 30 minutes (1 person-hour) was spent searching each site. The Walleye's reflective eyes are conspicuous under a spotlight and clearly distinguish them from other fish species.

6.1.2 2013 Spawning Surveys

6.1.2.1 Blackwater Creek

A spring spawning survey was conducted in Blackwater Creek on May 24, 2013, when water temperatures ranged between 14 °C and 20 °C. The survey was completed on foot and field staff visually inspected the stream for the presence of spawning fish from Anderson Road downstream to where Blackwater Creek enters the large wetland near its mouth. No fish exhibiting spawning behavior or other evidence of fish spawning were observed during the survey.

6.1.2.2 Hoffstrom's Bay and Keplyn's Bay

Visual surveys for fish exhibiting spawning behaviour was conducted in the Hoffstrom Bay area of Thunder Lake and Keplyn's Bay of Wabigoon Lake on May 23 and June 5, 2013. The surveys were conducted during daylight hours. Field staff completed a search of each bay to identify potential spawning habitat and used an AquaVu underwater camera system to search for spawning fish.

6.1.3 2017 Spawning Investigations

The 2017 spawning investigations included deploying fyke nets in Blackwater Creek and Thunder Lake Tributary 2, daytime and night-time spawning surveys in Blackwater Creek where coarse substrate occurs and at known White Sucker spawning locations in watercourses not affected by the project, daytime examination of areas where coarse substrate occurs downstream of dams on Thunder Lake Tributary 2 and Tributary 3, and an examination of Blackwater Creek to assess the possible influence of beaver dams on fish passage from Highway 17 downstream to Wabigoon Lake.

Fyke nets were deployed from May 8 to May 16, 2017, in Blackwater Creek (Location Fyke 1 on Figure 32) and in Thunder Lake Tributary 2 (Location Fyke 2 on Figure 32). Both nets were constructed of 1.5 inch square mesh with a single tunnel and they were set with the opening facing downstream and a wing extended to each bank (Figure 33, Figure 34). Water temperature was taken at the time of net deployment and when the nets were checked on May 9 and 10 with a Hach HQ30D water quality meter. A temperature logger (Onset WaterTemp Pro V2) was deployed at the net on Blackwater Creek on May 9 and at the net on Thunder Lake Tributary 2 on May 10. The loggers remained in place until the nets were removed. The nets were checked on May 9, 10, 12, 15 and 16 to determine if fish had been captured.

In the Blackwater Creek watershed, spawning surveys were conducted at two locations where coarse substrate was identified during the 2011 field investigations. One location is on the main branch of Blackwater Creek at the Tree Nursery Road crossing (fish sampling location 5; Figure 32) and the second is just downstream from where Anderson Road crosses Tributary 2 (fish sampling location 12; Figure 32). These locations were examined during the day and at night on May 10, as was Thunder Creek at a known White Sucker spawning location below a falls that is located just upstream from Highway 17, and Hughes Creek immediately downstream from Anderson Road. A short reach of Thunder Tributary 3 with coarse substrate that is immediately downstream from a dam on the former tree nursery was examined during the day on May 9 and a short reach of Thunder Lake Tributary 2 with coarse substrate, which is also immediately downstream of a dam on the former tree nursery, was examined during the day on May 11.

On May 10, 2017, a reach of Blackwater Creek between Highway 17 and where the creek begins to be influenced by water levels in Wabigoon Lake was examined to assess the potential influence of beaver dams in this reach on fish passage.



Figure 33. Fyke net on at location Fyke 1 on Blackwater Creek (refer to Figure 32). May 9, 2017.



Figure 34. Fyke net at location Fyke 2 on Thunder Lake Tributary 2 (refer to Figure 32) on May 10, 2017.

6.2 Spawning survey results

6.2.1 2011 Spawning Surveys

KCB (2012) states that White Sucker spawning was observed at Site 1 on Blackwater Creek and Site 12 on Blackwater Creek Tributary 2 (Figure 32; KCB, 2012) during the May 2011 surveys but gives no indication of the number of fish seen. No fish spawning was observed during the spotlight surveys at these locations on May 11, 2011, however, on the same night approximately 75 White Sucker were observed at a spawning site in Hughes Creek (KCB, 2012). Two White Sucker eggs were collected at Site 1 and ten White Sucker eggs (identified based on egg size) were collected at Site 12 in kick and sweep samples collected on May 10, 2011 (Figure 32; KCB, 2012). At the spawning location on Hughes Creek, 58 White Sucker eggs and 12 Walleye eggs were collected in kick and sweep samples. The observed spawning activity in Blackwater Creek was restricted to road crossings where gravel associated with the road construction and culvert installations provided suitable spawning substrate.

6.2.2 2013 Spawning Surveys

6.2.2.1 Blackwater Creek

No spawning fish were observed during the spring spawning survey conducted in Blackwater Creek on May 24, 2013. The water temperature during that survey, ranged from 14°C to 20°C.

6.2.2.2 Hoffstrom's Bay, Thunder Lake

The water temperature during the 2013 spawning surveys ranged from 10°C to 15°C on May 23rd, and from 12°C to 19°C on June 5. No spawning fish were observed during the survey.

6.2.2.3 Keplyn's Bay, Wabigoon Lake

The water temperature ranged from 9°C to 12°C during the spawning survey conducted in Keplyn's Bay on May 22, 2013. No spawning fish were observed.

6.2.3 2017 Spawning Investigations

The water temperature was 8.2°C in Blackwater Creek and 8.5°C in Thunder Lake Tributary 2 on May 9, 2017, when the fyke nets were deployed. Water temperature ranged from 6.4°C to 15.6°C in Blackwater Creek and from 5.5°C to 14.1°C in Thunder Lake Tributary 2, during the period when temperatures were logged. No fish were captured in either of the fyke nets.

No White Sucker or evidence of the substrate having been disturbed were observed in Blackwater Creek or in Blackwater Creek Tributary 2 when those locations were examined during the day on May 10. Approximately 25 adult White Sucker were observed in a pool downstream from the falls on Thunder Creek, located just upstream from Highway 17, that day but none were observed in Hughes Creek. An estimated 150 – 200 adult White Sucker were observed exhibiting spawning behavior at the Thunder Creek location at 21:50 on the night of May 10. Approximately 20 fish fled from the potential spawning habitat on Hughes Creek below Anderson Road when the light was shone on the area at approximately 10:30 on May 10. It is likely that these were White Sucker but mist rising from the water impaired visibility and they could not be identified with certainty. No

White Sucker, or other fish, were observed at the Blackwater Creek location or the Blackwater Creek Tributary 2 location which were examined after Hughes Creek on the night of May 10.

No White Sucker or other fish were observed in the areas of coarse substrate downstream from dams on Thunder Lake Tributary 2 and Tributary 3, which were examined for White Sucker during the day on May 9 and May 11, respectively.

Four active beaver dams were observed on Blackwater Creek downstream from Highway 17 on May 10, 2017, and it is thought that there was one more dam between the point where the creek was first accessed and the highway. Three of these appeared to be barriers to large fish (such as adult White Sucker) under the prevailing flow conditions. Another large beaver dam, which also appeared impassable to large fish, was present on Blackwater Creek just upstream from the first Anderson Road crossing (at approximately fish sampling location MINN23; Figure 32).

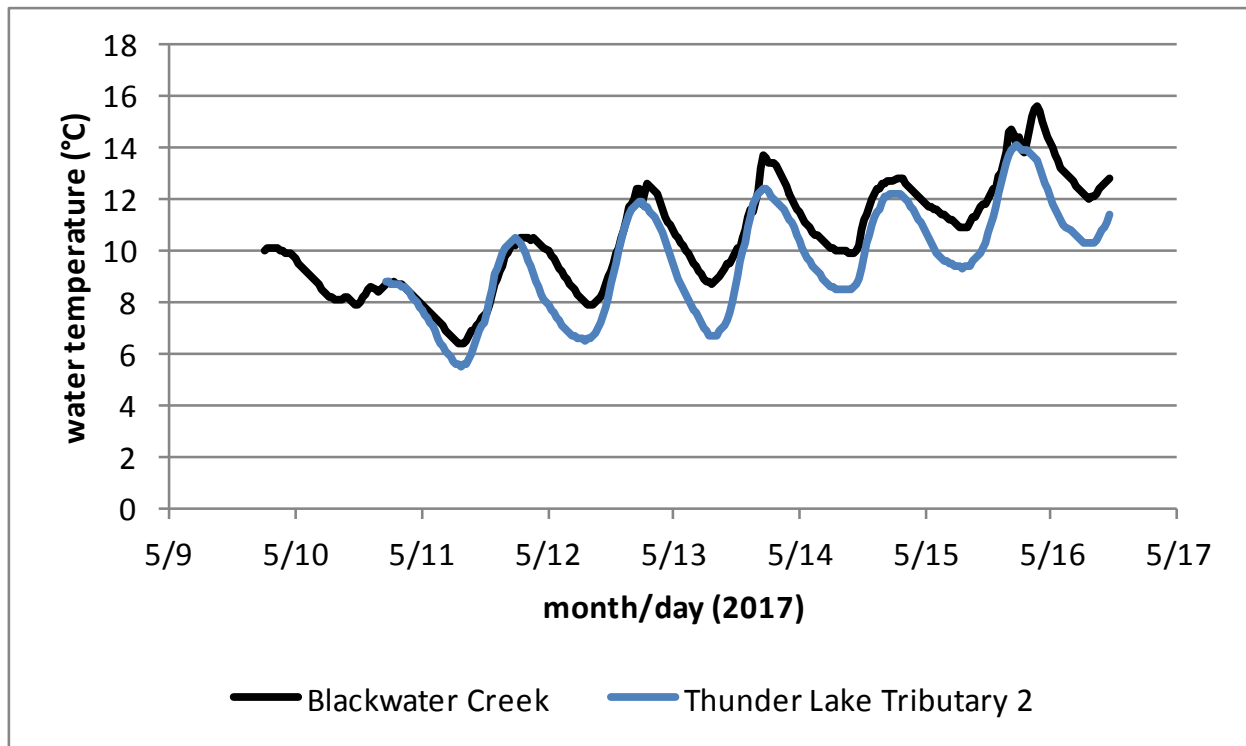


Figure 35. Water temperature in Blackwater Creek and Thunder Lake Tributary 2 while fyke nets were deployed in May, 2017. Refer to Figure 32 for locations

7. Benthic Invertebrates

7.1 Methods

7.1.1 2011 Benthic Invertebrate Sampling

Benthic invertebrate sampling was conducted on October 16 and 17, 2011, at one location in Blackwater Creek Tributary 1 (Site 6), at three locations on the main branch of Blackwater Creek (Sites 13, 65, 28) and at one location in the wetland at the mouth of Blackwater Creek (Site 23; KCB, 2012). The sampling locations are shown in Figure 36.

All stream reaches were characterized as slow and muddy, and impractical for kick-net sampling. At each site, three replicate samples were collected along a linear transect using a Ponar grab. For each sample, the Ponar was carefully dropped into stream bottom substrates and the sample material and captured invertebrates were rinsed into a sample collection bucket and sieved through 500 µm mesh. Large substrates were discarded and any non-benthos animals (e.g., fish) were released unharmed at the point of capture. Captured benthic invertebrates and accompanying substrates were placed in wide-mouth mason jars and preserved in 95% ethanol for shipment to the taxonomic laboratory.

Benthic invertebrate samples were shipped to ALS in Winnipeg for extraction, sorting, taxonomy, and enumeration. Upon arrival at the laboratory, a biological stain was added to each sample to increase sorting efficiency. Samples were then rinsed in a 250 µm sieve with clean water. The retained sample material was examined under a stereo microscope at 10X magnification and the benthic organisms present were extracted. A senior taxonomist enumerated and identified the benthic organisms to the lowest practical level using taxonomic keys. Members of the Family Chironomidae were identified to the family level, but specimens were retained for future identification to the genus or species level, should this be required. The majority of tubificid worms were identified to family level.

The number of individuals, number of taxa, percent Ephemeropter, Plecoptera and Trichoptera (EPT taxa), percent oligochaete worms and percent chironomids were calculated for each sample and the means of these indices were calculated for each sampling location.

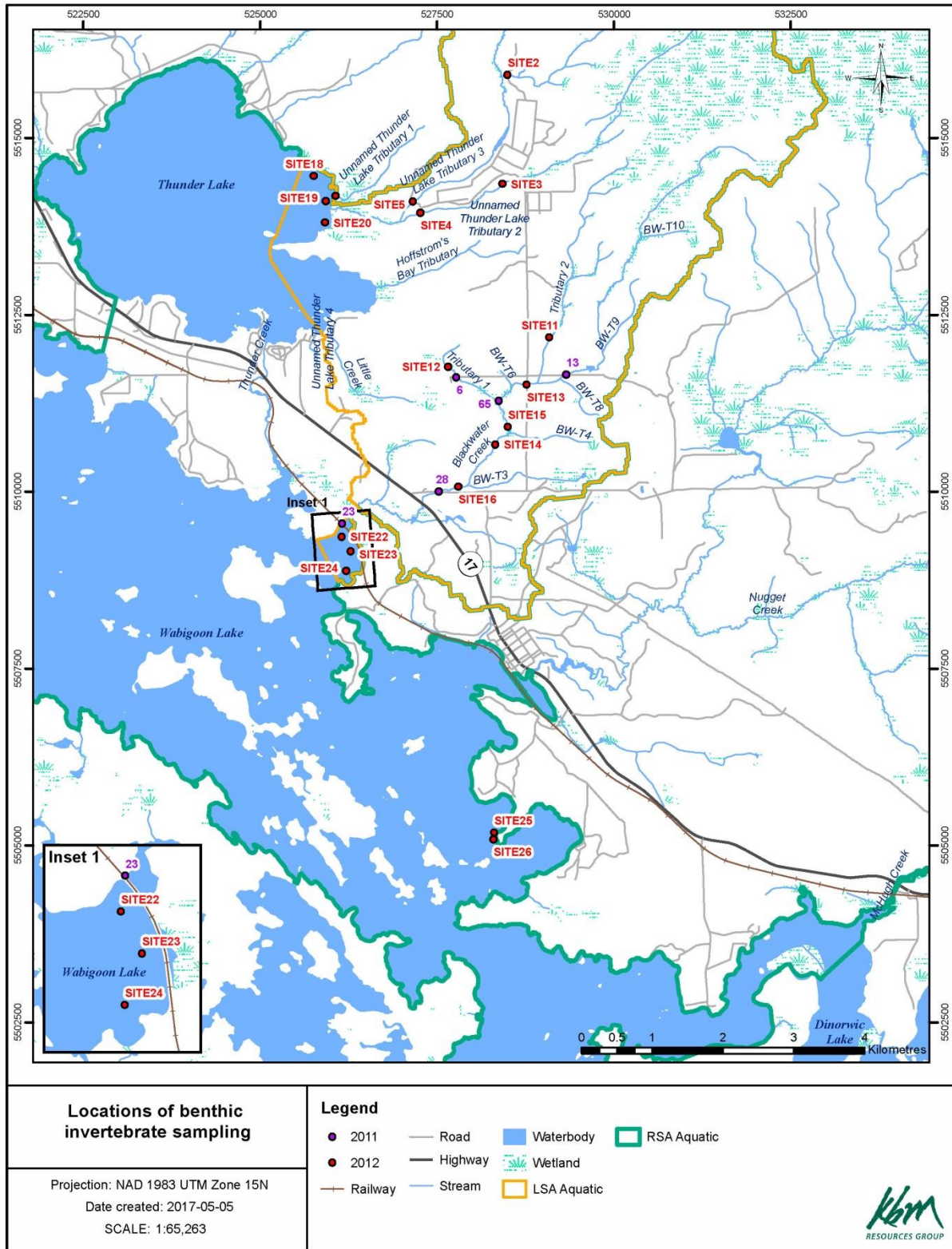


Figure 36. Benthic invertebrate sampling locations.

7.1.2 2012 Benthic Invertebrate Sampling

Benthic invertebrate samples were collected from 19 locations within the Project study area on October 22 and October 23, 2012 (Figure 36). Samples were collected from Blackwater Creek, Thunder Lake Tributary 2 and Thunder Lake Tributary 3, the bay of Thunder Lake that Tributary 2 drains to, and two locations in Wabigoon Lake -- one near the mouth of Blackwater Creek and the other approximately 5 km south west of the Blackwater Creek mouth. The lake samples were collected for possible use as 'before' stations in future monitoring and were not intended to characterize existing habitat quality in Wabigoon Lake or Thunder Lake.

The stream samples were collected using the Ontario Benthos Biomonitoring Network (OBBN) travelling kick and sweep method. Two riffles and one pool were sampled at each location. In each riffle and pool, the substrate was kicked to disturb the sediment and the dislodged material was collected by sweeping a 500 µ mesh D-net near the bottom of the creek. The substrate was kicked in a zigzagging pattern for 10 minutes. The collected samples were reduced in the field using a 500 µ mesh sieve to remove excess sediment and debris and the three samples collected at each site were combined. The reduced, combined sample was placed in laboratory supplied containers and preserved in 10% formalin.

At the lake locations, composite samples were collected using a Ponar grab, with each composite sample consisting of the material from three grabs combined. The samples were reduced in the field using a 500 µ mesh sieve to remove excess sediment and debris and the retained material was preserved in 10% formalin. As per Metal Mining Effluent Regulation guidelines, benthic invertebrate samples were collected at the same locations as sediment samples, to better correlate habitat with benthic invertebrate community characteristics. During the sample collection, the boat was anchored at the bow and stern to reduce movement. Three locations were sampled in Wabigoon Lake near the mouth of Blackwater Creek, two locations were sampled at the Wabigoon Lake Reference Site, and four locations were sampled in Thunder Lake.

The preserved benthic samples were sent to ALS Environmental, a certified laboratory, for benthic invertebrate sorting and identification to family level. A number of metrics were calculated including: taxon richness, relative abundance, percent Ephemeroptera, Plecoptera, Tricoptera (EPT), percent oligochaete worms and percent chironomids were calculated for each sample.

7.2 Results

7.2.1 2011 Benthic Invertebrate sampling

The 2011 benthic invertebrate metrics are summarized in Table 7 and the raw data are provided in Appendix B. The mean number of individuals in the 2011 benthic invertebrate samples ranged 26 to 200. The samples from the Blackwater Creek sites were composed primarily of oligochaete worms and chironomids with few or, at site 13, no EPT taxa. This is consistent with the low gradient habitat with fine substrates and, at least in the beaver ponds, low dissolved oxygen concentrations. The sample from location 23, where Blackwater Creek enters Wabigoon Lake, had the most taxa and EPT taxa accounted for 13.6% of the sample. The lake/wetland habitat at that location is quite different than the stream habitats at the other locations.

Table 7. Summary indices (mean of three samples) for benthic invertebrate samples collected in Blackwater Creek in 2011. Refer to Figure 36 for the sampling locations.

	Site				
	13	6	65	28	23
Mean # individuals	26	107	200	141	94
Mean # of taxa per sample	4	7	11	12	15
Mean % oligochaetes per sample	64	40	35	10	7
Mean % chironomids per sample	34	26	45	56	54
Mean % EPT taxa per sample	0.0	0.1	1.4	1.0	13.6

7.2.2 2012 Benthic Invertebrate Sampling

The 2012 benthic invertebrate metrics for the Blackwater Creek sites are provided in Table 8, which also provides the substrate particle size data. The raw benthic invertebrate data are provided in Appendix B. The number of individuals in the samples ranged 147 to 568 and the number of taxa ranged from 9 to 23. The samples were composed primarily of chironomids at Sites 11, 13, 14 and 15. More than 80 % of the sample at site 12 was composed of fingernail clams belonging to the family Pisiidae. Hydropsychid caddisflies were abundant at site 16, where they accounted for 50% of the sample. Silt was the dominant particle size at locations 11 and 12. Sand accounted for 78 percent – 79 percent of the sediment at sites 13 and 14. At sites 15 and 16 sand accounted for 48 percent and 40 percent of the samples, respectively, with both silt and clay also present.

Table 8. Summary indices and substrate particle size for benthic invertebrate samples collected in Blackwater Creek in 2012. Refer to Figure 36 for the sampling locations.

Site	11	12	13	14	15	16
Number of individuals	196	147	329	277	568	206
Number of taxa	15	9	21	18	23	15
% oligochaetes	21	3	5	10	5	5
% Chironomids	64	7	57	55	63	21
% EPT taxa	1	1	3	1	5	50
% Pisiidae	7	82	1	1	1	1
% Gravel (>2mm)	0.61	29.9	4.85	2.32	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	26.2	12.7	78.4	78.7	47.9	39.8
% Silt (0.063mm - 4um)	48.5	37.9	12.4	14.5	34.6	32.6
% Clay (<4um)	24.8	19.5	4.28	4.44	17.5	27.7

The 2012 benthic invertebrate data for the Thunder Lake Tributary 2 and Thunder Lake Tributary 3 sites are summarized in Table 9, which also provides substrate particle size data. The raw benthic invertebrate data are provided in Appendix B. The number of individuals in the samples ranged 156 to 2744. The number of taxa in the samples was, on average, higher than in Blackwater Creek and ranged from 23 to 31. Chironomids and EPT taxa accounted for most of the samples, with EPT taxa dominant at two sites and chironomids dominant at the other two. Fingernail clams were most abundant in the sample where there was the most gravel, as was the case in the samples from Blackwater Creek. Sand was the dominant particle size class in three of the samples and the fourth was 78 % gravel.

The greater percentage of EPT taxa in Thunder Lake Tributaries 2 and 3, relative to Blackwater Creek, suggests better habitat conditions are present in the former. This is consistent with less beaver activity (and thus fewer ponds with low dissolved oxygen) and may also reflect the finer substrates in Blackwater Creek, which is underlain by lacustrine deposits, compared to Thunder Lake Tributaries 2 and 3 which are underlain by outwash deposits .

Table 9. Summary indices and substrate particle size for benthic invertebrate samples collected in Tributary 2 and Tributary 3 of Thunder Lake in 2012. Refer to Figure 36 for the sampling locations.

Site	2	3	4	5
Number of individuals	156	2744	249	357
Number of taxa	23	22	31	27
% oligochaetes	3.8	0.2	12.9	0.3
% Chironomids	28.2	46.9	24.5	68.9
% EPT taxa	52.6	32.4	46.6	19.0
% Pisiidae	0.0	13.3	3.2	2.2
% Gravel (>2mm)	3.53	77.8	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	72.2	21.8	84.3	91.6
% Silt (0.063mm - 4um)	22.1	0.23	12.8	6.65
% Clay (<4um)	2.2	0.16	2.91	1.78

8. Fish Tissue Metals Analysis

Forage fish were collected from Blackwater Creek and submitted for metals analysis in 2011. Forage fish were collected from Blackwater Creek and Thunder Lake tributary 2 and submitted for metals analysis in 2012. Tissue samples from Walleye and one Sauger from Thunder Lake and Walleye from Wabigoon Lake were collected and submitted for metals analysis in 2012.

8.1 Methods

8.1.1 2011 Forage Fish Collections

Small-bodied (forage) fish were collected for metal analysis by seine netting in May, 2011, and by minnow trapping using standard "Gee" style minnow traps baited with cat food pellets in August, 2011 (KCB, 2012). Sample locations (Figure 37) were on Blackwater Creek Tributary 1 (Site 6), Blackwater Creek Tributary 2 (Site 12), and on Blackwater Creek (Site 28;). The coordinates of the sampling locations were determined by handheld GPS.

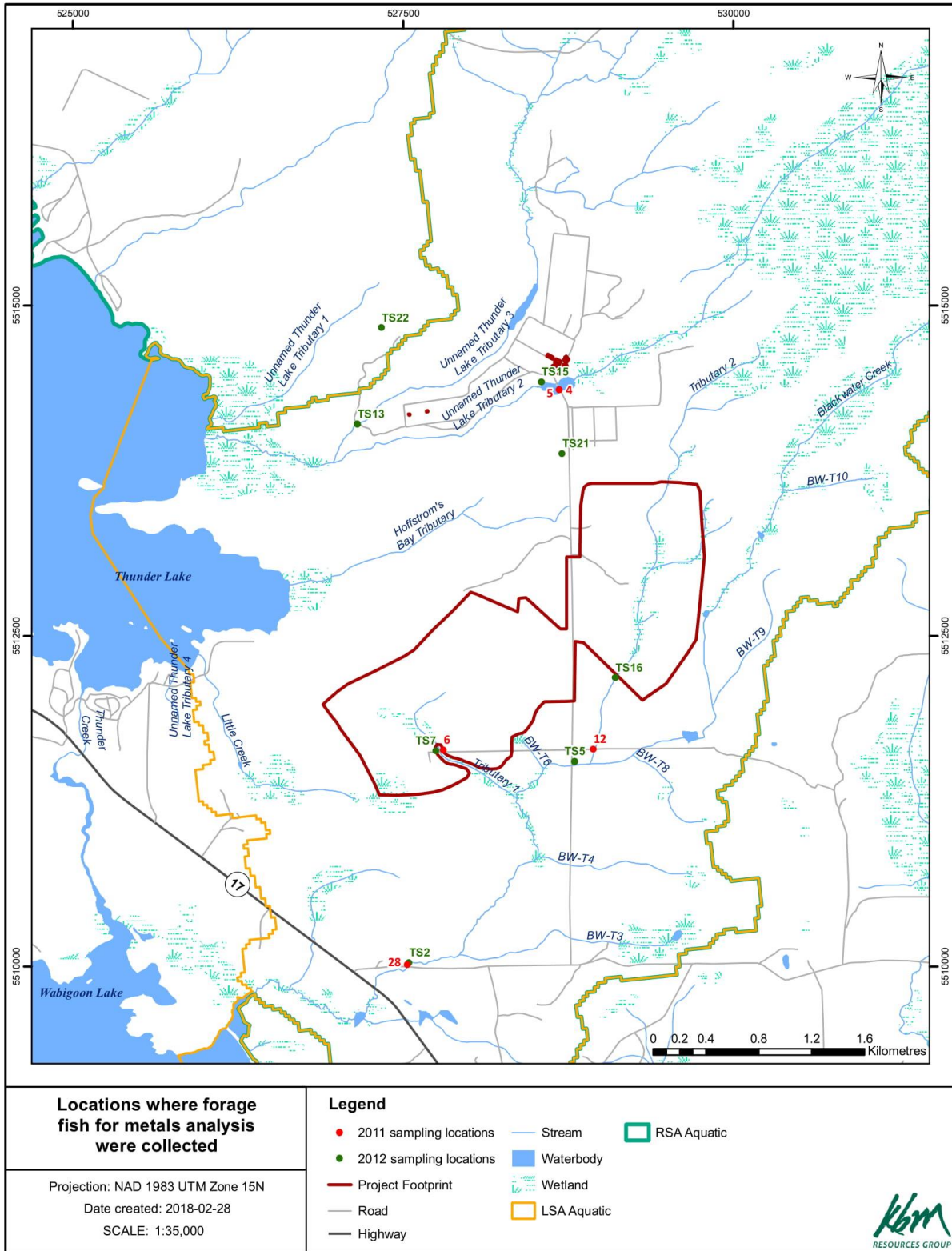


Figure 37. Locations where forage fish samples for metals analysis were collected.

Composite samples consisted of 10 individuals per sample of the dominant species in the catches, except for two White Suckers which were analyzed individually. The fish in each sample were measured and weighed and the samples were placed in plastic bags and frozen and stored in a standard freezer prior to shipping to ALS Laboratories for analysis.

8.1.2 2012 Forage Fish Collections

Overnight sets of standard “Gee” style traps baited with dog food pellets were used to collect small-bodied fish for tissue analysis from eight locations during the period June 25-27, 2012 (DST, 2013). As in 2011, samples were collected from Blackwater Creek Tributaries 1 and 2 and further downstream on Blackwater Creek (Figure 37). Samples were also collected from Blackwater Creek between Tributary 1 and Tributary 2 (TS2), from the Tree Nursery Pond on the south branch of Unnamed Thunder Lake Tributary 2 (TS15), from the north branch of that tributary (TS22), and from an isolated pond along the Tree Nursery Road (TS21). The coordinates of the sampling locations were determined by handheld GPS. Composite samples from each location were composed of multiple individuals of one or two species. The individuals in each sample were identified to species, or genus in the case of the two Phoxinus species, and their total length and fork length were measured to the nearest millimeter. The samples were packaged in plastic bags and frozen and stored in a standard freezer prior to shipping to ALS Laboratories for metals analysis.

8.1.3 Walleye and Sauger Tissue Sampling 2012

Tissue samples were collected from 11 Walleye caught by angling in Hoffstrom’s Bay of Thunder Lake on September 4, 2012. Tissue samples were collected from 30 Walleye and one Sauger captured in Keplyn’s Bay of Wabigoon Lake on September 5 and 6, 2012. Two of the fish captured in Keplyn’s Bay were caught in short-set gill net sets and the rest were caught by angling.

Total length, fork length, weight and sex were determined for each fish. An approximately 50g section of skinless, boneless dorsal muscle tissue was removed from each fish. Each muscle sample was placed in a sealed plastic bag and frozen and stored in a standard freezer prior to shipping to ALS Laboratories for metals analysis. Otoliths were removed from all but one of the fish; a dorsal spine was removed from the fish for which otoliths were not obtained. The structures were aged by Jon Tost of Great Lakes Environmental with one year being assigned for each annulus observed.

8.1.4 Laboratory Methods

Metals analysis was conducted by ALS Laboratories following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, with addition of hydrogen peroxide. Analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

8.2 Results

8.2.1 Metals Concentrations in Forage Fish

The forage fish sampling locations are shown in Figure 37 and the species composition and mercury concentrations are presented in Table 10. The analysis results for all metals are provided in Appendix C. The lengths of the individual fish in the 2012 samples are also provided in Appendix C.

Total mercury concentrations in the forage fish samples ranged from 0.027 mg/kg to 0.123 mg/kg. The total mercury concentrations were lowest in the samples from the Tree Nursery ponds and Blackwater Creek Tributary 1. The highest concentrations were in samples from the Blackwater Creek at Anderson Road and Blackwater Creek Tributary 2. When the same species was sampled at the same general locations in both years, the results were similar. For example, the total mercury concentration *Phoxinus* spp. from Blackwater Creek Tributary 1 was 0.043 mg/kg wet weight in the 2011 sample and 0.045 mg/kg wet weight in the 2012 sample.

8.2.2 Metals concentrations in Walleye and Sauger collected from Thunder and Wabigoon Lakes

The total mercury concentration was determined in muscle tissue samples taken from 11 Walleye from Thunder Lake and from 30 Walleye and one Sauger from Wabigoon Lake. Total length, age and mercury concentration are summarized in Table 11. The data for individual fish are provided in Appendix C. It should be noted that in DST (2013) the mercury concentrations were not associated with the correct individuals. The mercury results presented in Appendix C were taken from the original laboratory reports and matched with the fish numbers (and associated lengths and weights) in spreadsheets prepared from the field sheets, cross-checked against the fish numbers (and lengths and ages) present on the aging bench sheets. Plots of total length versus age and total mercury concentration versus total length are presented in Figure 38 and

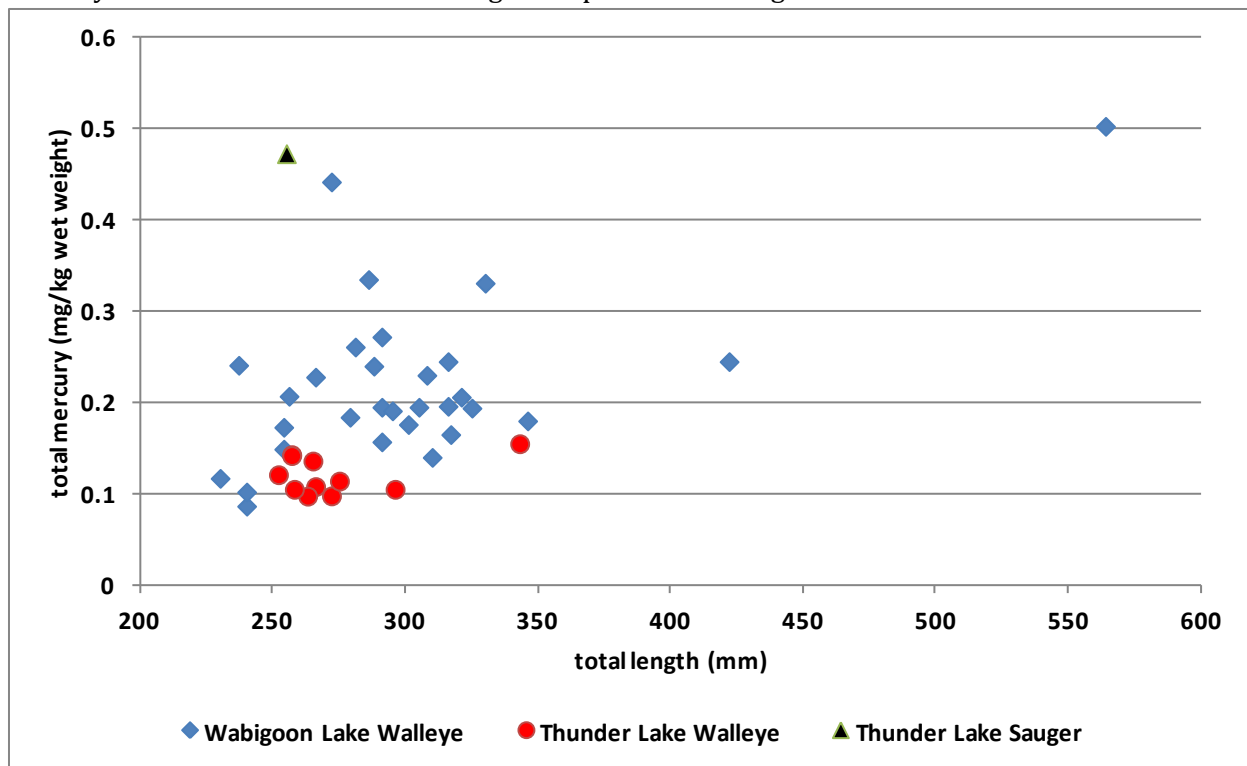


Figure 39. Plot of muscle total mercury concentration versus total length for Walleye from Thunder Lake and Walleye and one Sauger from Wabigoon Lake.

respectively. All of the sampled Walleye from Thunder Lake were between 250 mm and 350 mm in total length and were either one (n=10) or two (n=1) years of age. The age of Walleye from Wabigoon Lake ranged from one to ten years and all but two were less than 350 mm in total length (Figure 38).

Total mercury concentrations were, on average, lower and were less variable in Walleye from Thunder Lake than in Walleye of a similar size from Wabigoon Lake (Figure 39). There were too few large walleye captured to generate reliable mercury concentrations standardized for length. The mercury concentration for the one sauger that was captured from Thunder Lake was higher than the values for any of the Thunder Lake walleye. At 10+ years of age, the Sauger was considerably older than the Walleye from Thunder Lake and its mercury concentration was similar to that of the 10-year-old Walleye from Wabigoon Lake.

Table 10. Collection location and year, species composition and mercury concentration of samples of forage fish collected in 2011 (KCB, 2012) and 2012 (DST, 2013). Refer to Figure 37 for sampling site locations.

Location	Sampling site	Year	Species				total mercury (mg/kg wet weight)
			Pearl Dace	<i>Phoxinus</i> spp.	White Sucker	Fathead Minnow	
Blackwater Creek at Anderson Road	28	2011		10			0.082
	28	2011	10				0.105
	TS-2	2012	2		3		0.111
Blackwater Creek Tributary 1	6	2011				10	0.025
	6	2011		10			0.043
	TS-7	2012		12			0.045
Blackwater Creek at Tree Nursery Road	TS-5	2012		8			0.088
Thunder Lake Tributary 3	TS-13	2012		3			0.098
Thunder Lake Tributary 2 Tree Nursery pond	4 and 5	2011	10				0.033
	4 and 5	2011		10			0.027
	TS-15	2012	5	8			0.030
Blackwater Creek Tributary 7	12				1		0.064
	12	2011			1		0.092
	TS-16	2012	4	1			0.123
isolated pond beside Tree Nursery Road	TS-21	2012		9			0.057
Unknown	TS-22	2012	5				0.067

Table 11. The number of individual sampled and summary statistics for total length, age, and total mercury concentration in muscle samples from Walleye and Sauger captured in Thunder Lake and Wabigoon Lake in September, 2012.

Waterbody		Thunder Lake	Wabigoon Lake	
species		Walleye	Sauger	Walleye
number of individuals sampled		11	1	30
total length (mm)	mean	273	255	301
	minimum	252	255	230
	maximum	343	255	564
age (years)	mean	1	10	4
	minimum	1	na	2
	maximum	2	na	10
mercury concentration (mg/kg wet weight)	mean	0.120	0.473	0.220
	minimum	0.0975	na	0.0865
	maximum	0.155	na	0.503

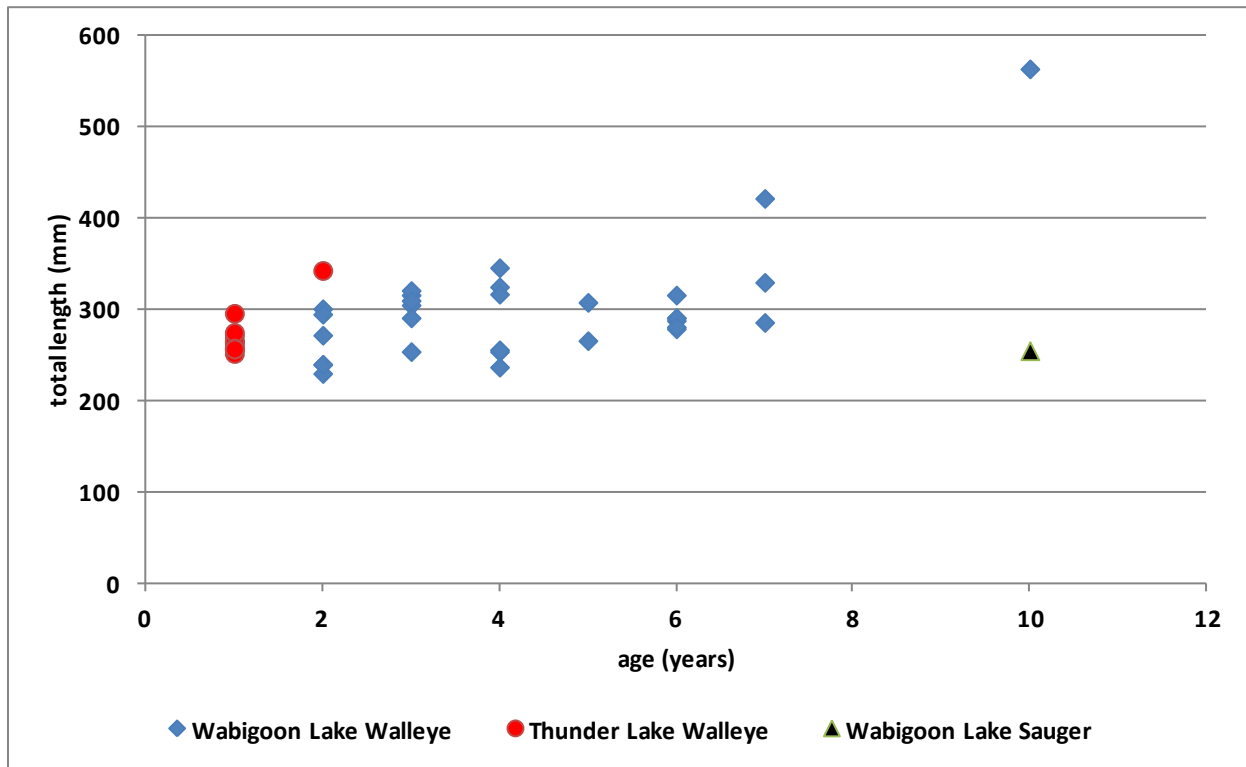


Figure 38. Plot of total length versus age for Walleye from Thunder Lake and Walleye and one Sauger from Wabigoon Lake.

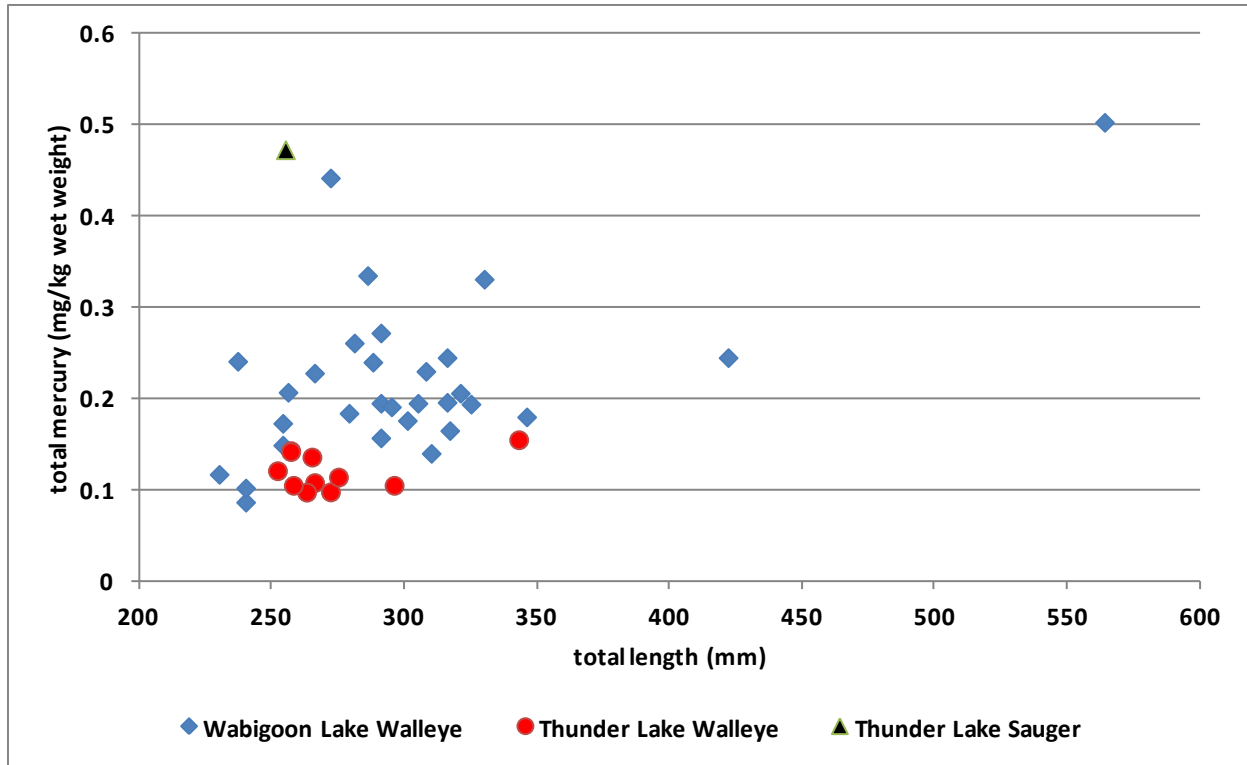


Figure 39. Plot of muscle total mercury concentration versus total length for Walleye from Thunder Lake and Wabigoon Lake and one Sauger from Wabigoon Lake.

9. References

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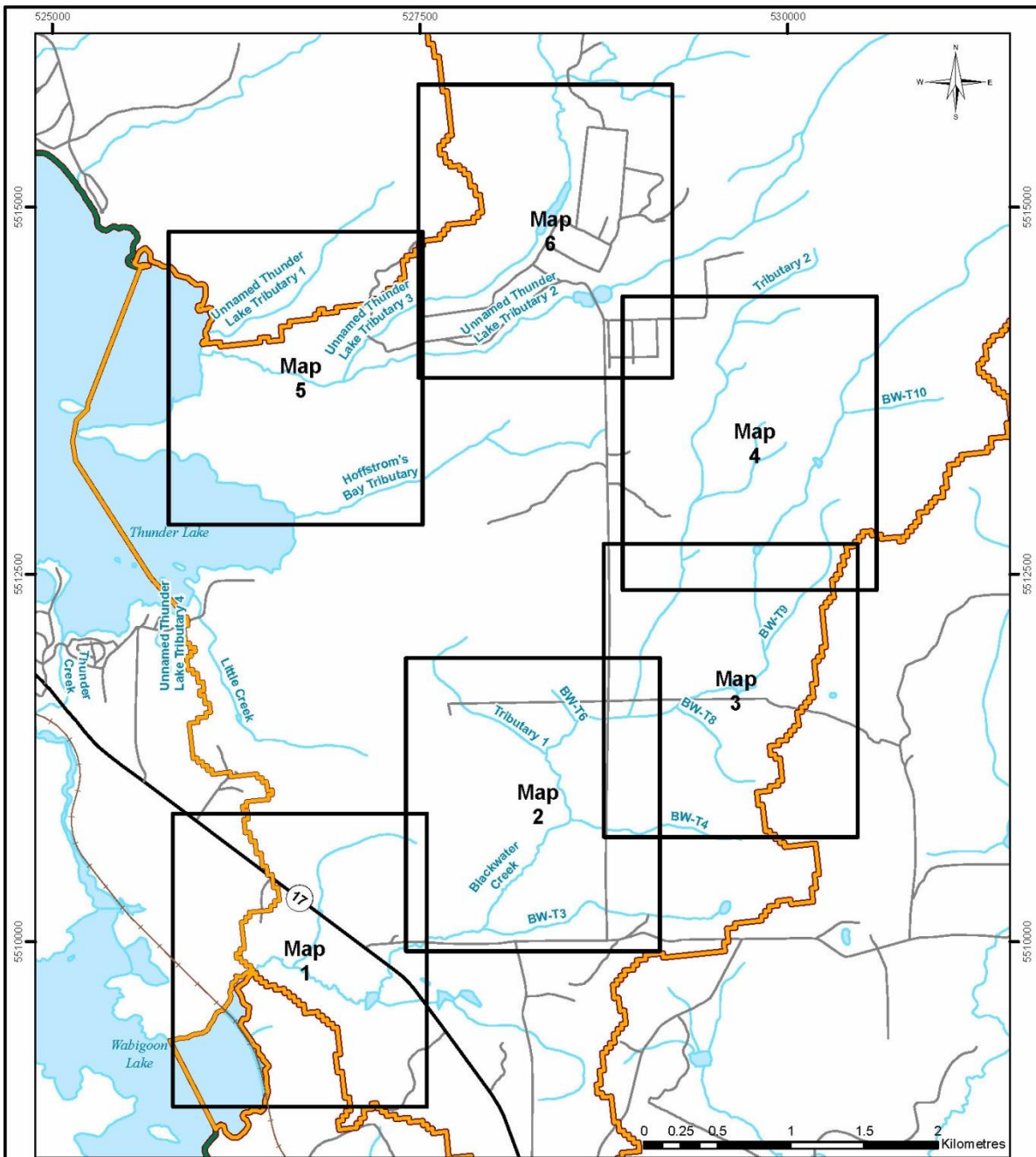
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Appendix A – Aerial Photography of the Blackwater Creek and Thunder Lake Tributary 2



**Beaver Observations
Key Map**

Projection: NAD 1983 UTM Zone 15N
 Date created: 2017-05-05
 SCALE: 1:34,355

Legend

- Index Tile
- Railway
- Road
- Highway
- Stream
- Waterbody
- LSAquatic
- RSAquatic



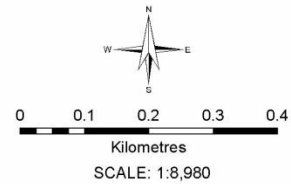


**Aerial View of
Blackwater Creek
Map 1**

Projection: NAD 1983 UTM Zone 15N
Date created: 2017-05-05
Imagery: KBM, 2016

Legend

-  Railway
-  Stream



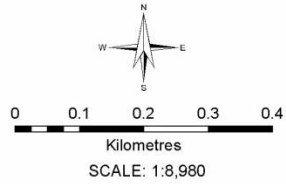


**Aerial View of
Blackwater Creek
Map 2**

Projection: NAD 1983 UTM Zone 15N
 Date created: 2017-05-05
 Imagery: KBM, 2016

Legend

— Stream



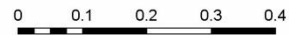


**Aerial View of
Blackwater Creek
Map 3**

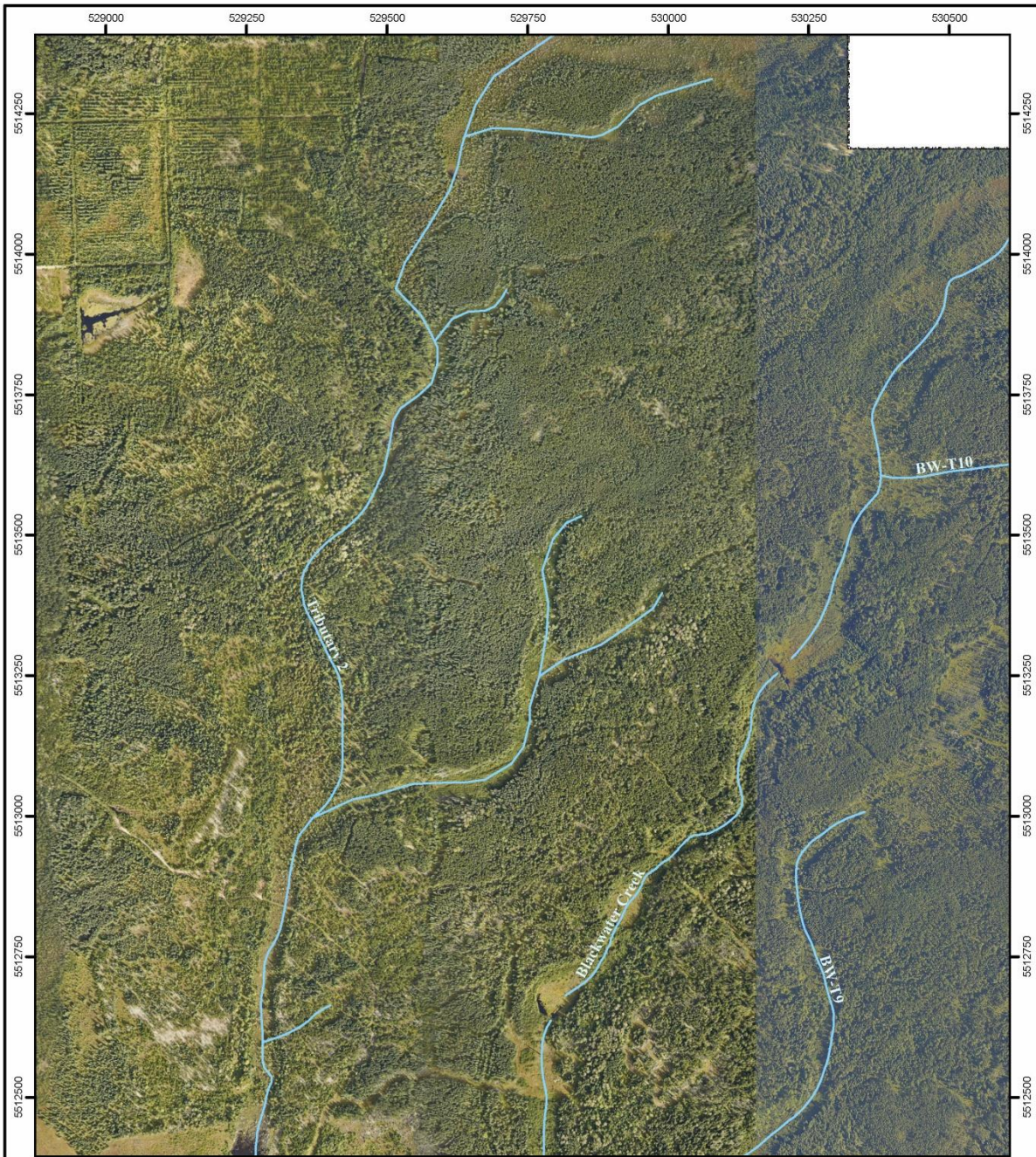
Projection: NAD 1983 UTM Zone 15N
Date created: 2017-05-05
Imagery: KBM 2016, KBM 2010

Legend

— Stream



Kilometres
SCALE: 1:8,980



**Aerial View of
Blackwater Creek
Map 4**

Projection: NAD 1983 UTM Zone 15N
Date created: 2017-05-05
Imagery: KBM 2016, KBM 2010

Legend

— Stream



0 0.1 0.2 0.3 0.4

Kilometres

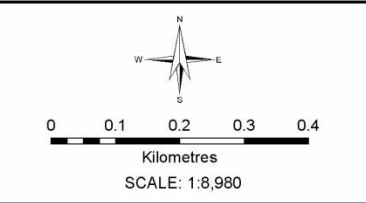
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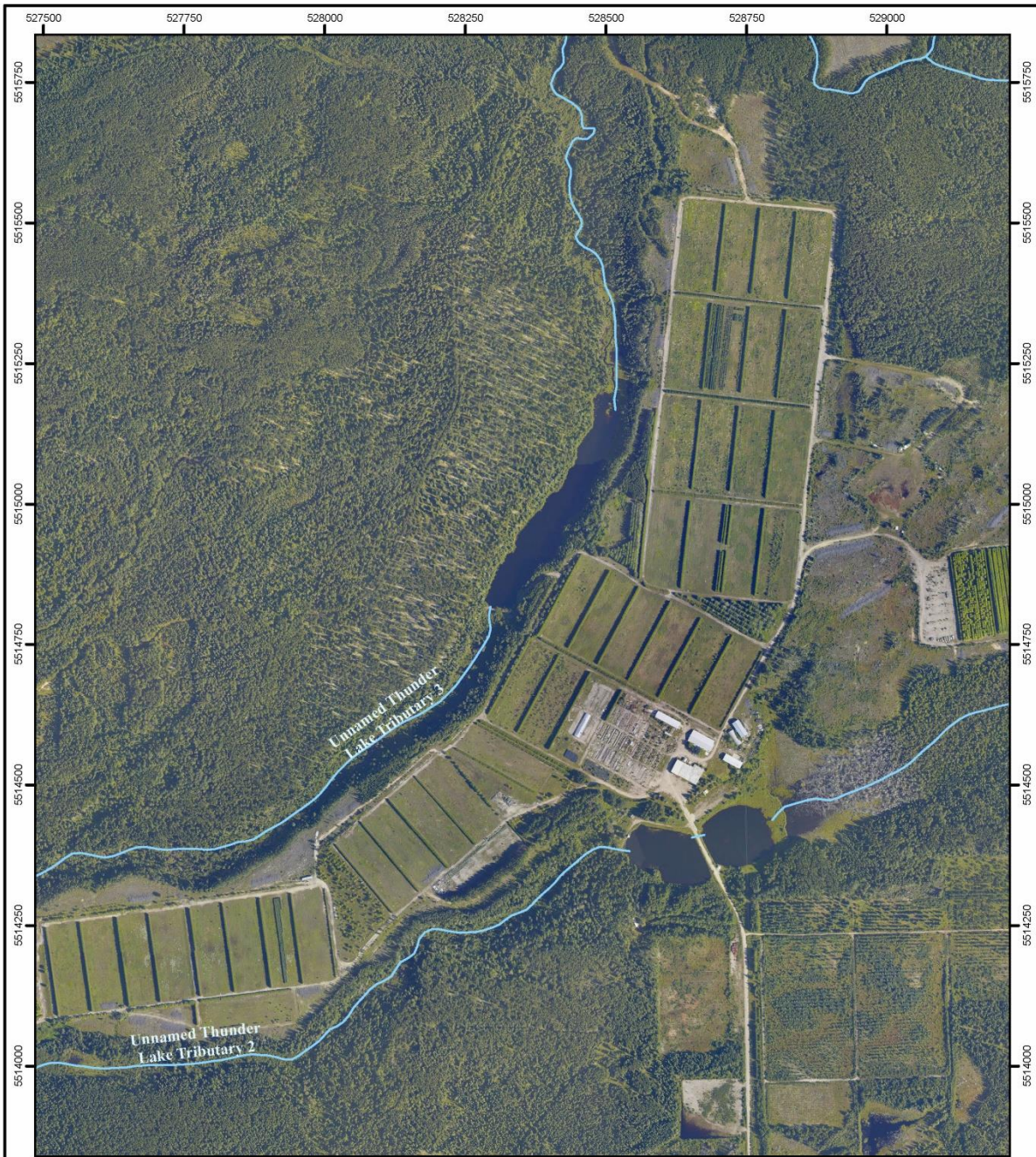


**Aerial View of
Thunder Lake Tributary 2
Map 5**

Projection: NAD 1983 UTM Zone 15N
Date created: 2017-05-05
Imagery: KBM, 2016

Legend
— Stream

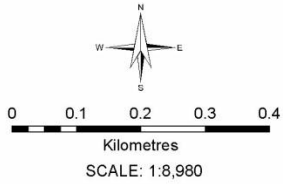




**Aerial View of
Thunder Lake Tributary 2
Map 6**

Projection: NAD 1983 UTM Zone 15N
Date created: 2017-05-05
Imagery: KBM, 2010

Legend
— Stream



APPENDIX B - Benthic Invertebrate Identification and Enumeration

Table B1. Benthic invertebrate identification and enumeration for samples collected in Blackwater Creek in 2011. Refer to Figure 36 for locations.																			
				Site #	65	65	65	23	23	23	13	13	13	6	6	6	28	28	28
				Sub-sample	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Class	Order	Family	Genus	Species															
ANNELIDA	HIRUDINEA	ERPOBDELLIDAE	<i>Dina</i>	<i>sp.</i>												1			
ANNELIDA	HIRUDINEA	ERPOBDELLIDAE	<i>Nepheleopsis</i>	<i>obscura</i>													1		
ANNELIDA	HIRUDINEA	GLOSSIPHONIIDAE	<i>Glossiphonia</i>	<i>complanata</i>											1	1			
ANNELIDA	HIRUDINEA	GLOSSIPHONIIDAE	<i>Helobdella</i>	<i>stagnalis</i>											1	1			
ANNELIDA	HIRUDINEA	GLOSSIPHONIIDAE	<i>Placobdella</i>	<i>sp.</i>				1	1										
ANNELIDA	OLIGOCHAETA	LUMBRICULIDAE	<i>Lumbriculus</i>	<i>sp.</i>							2								
ANNELIDA	OLIGOCHAETA	NAIDIDAE	<i>Dero</i>	<i>sp.</i>	2		2	1		1	3	1	14				3		5
ANNELIDA	OLIGOCHAETA	NAIDIDAE	<i>Nais</i>	<i>sp.</i>	6		7	1	1	8	2		1				7	5	4
ANNELIDA	OLIGOCHAETA	NAIDIDAE	<i>Slavina</i>	<i>appendiculata</i>						2									
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	unidentified	with hair setae	5		16		5						41		1		3
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	unidentified	without hair setae	31	27	55	1	2		2		4	12	150	4	3	3	2
ARACHNOIDEA	ARANEAE		unidentified	spider	4														3
ARACHNOIDEA	TROMBIDIFORMES		unidentified	nymph						1									
ARACHNOIDEA	TROMBIDIFORMES	LIMNESIIDAE	<i>Limnesia</i>	<i>sp.</i>	4	4													
ARACHNOIDEA	TROMBIDIFORMES	MIDEOPSIDAE	<i>Mideopsis</i>	<i>sp.</i>						1									
CRUSTACEA	AMPHIPODA	GAMMARIDAE	<i>Crangonyx</i>	<i>sp.</i>						1									
CRUSTACEA	AMPHIPODA	HYALELLIDAE	<i>Hyalella</i>	<i>azteca</i>						1			1						1
GASTROPODA	BASOMMATOPHORA	ANCYLIDAE	<i>Ferrissia</i>	<i>sp.</i>						1									
GASTROPODA	BASOMMATOPHORA	PLANORBIIDAE	<i>Armiger</i>	<i>crista</i>				1											
GASTROPODA	BASOMMATOPHORA	PLANORBIIDAE	<i>Gyraulus</i>	<i>sp.</i>				1		4									
GASTROPODA	NEOTAENIOGLOSSA	HYDROBIIDAE	<i>Amnicola</i>	<i>sp.</i>				20	3	20									
GASTROPODA	NEOTAENIOGLOSSA	HYDROBIIDAE	unidentified	too young to ID							1								
GASTROPODA	PROSOBRANCHIA	VALVATIDAE	<i>Valvata</i>	<i>tricarinata</i>						1									
INSECTA			unidentified	terrestrial									1						
INSECTA	COLEOPTERA	DYTISCIDAE	<i>Hydroporus</i>	<i>sp.</i>				1	2	1									
INSECTA	COLEOPTERA	HALIPLIDAE	unidentified	adult	1														
INSECTA	COLLEMBOLA	ISOTOMIDAE	<i>Isotomurus</i>	<i>tricolor</i>	1	1	2										1	1	
INSECTA	COLLEMBOLA	SMINTHURIDAE	<i>Sminthurides</i>	<i>sp.</i>	1														
INSECTA	DIPTERA		unidentified	pupa	2	2											2		1
INSECTA	DIPTERA	CERATOPOGONIDAE			1		7	1	1	2				5	4	1	26	28	40
INSECTA	DIPTERA	CHAOBORIDAE	<i>Chaoborus</i>	<i>sp.</i>	10	1													
INSECTA	DIPTERA	CHIRONOMIDAE			109		282	27	59	67	5		42	18	35	7	42	145	67
INSECTA	DIPTERA	PTYCHOPTERIDAE	<i>Ptychoptera</i>	<i>sp.</i>										1	4	4			
INSECTA	DIPTERA	SARCOPHAGIDAE	unidentified														2		1
INSECTA	DIPTERA	TABANIDAE	<i>Chrysops</i>	<i>sp.</i>	1	1													
INSECTA	EPHEMEROPTERA		unidentified	damaged					1	1									
INSECTA	EPHEMEROPTERA	CAENIDAE	<i>Caenis</i>	<i>sp.</i>		1	1	5	8	21								2	1
INSECTA	HOMOPTERA		unidentified	terrestrial														1	
INSECTA	PLECOPTERA		unidentified	too young to					1										

Table B1. Benthic invertebrate identification and enumeration for samples collected in Blackwater Creek in 2011. Refer to Figure 36 for locations.																			
				Site #	65	65	65	23	23	23	13	13	13	6	6	6	28	28	28
				Sub-sample	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
			nymph	ID															
INSECTA	TRICHOPTERA	HYDROPTILIDAE	<i>Oxyethira</i>	sp.	1		3												
INSECTA	TRICHOPTERA	LEPTOCERIDAE	<i>Leptocerus</i>	sp.						1									
INSECTA	TRICHOPTERA	LIMNAPHILIDAE	<i>Anabolia</i>	sp.														1	
INSECTA	TRICHOPTERA	LIMNAPHILIDAE	<i>Hydatophylax</i>	sp.															1
INSECTA	TRICHOPTERA	PHRYGANEIDAE	<i>Ptilostomis</i>	sp.				1							1				
INSECTA	TRICHOPTERA	POLYCENTROPODIDAE	<i>Polycentropus</i>	sp.			1	1		1									
PELECYPODA	VENEROIDA	PISIIDAE	<i>damaged</i>					1											
PELECYPODA	VENEROIDA	PISIIDAE	<i>Pisidium</i>	sp.										29	1		3	1	
PELECYPODA	VENEROIDA	PISIIDAE	<i>Sphaerium</i>	sp.													2		1
PELECYPODA	VENEROIDA	PISIIDAE	unidentified	Too young to ID		8				1							7	4	3

Table B2. Benthic invertebrate identification and enumeration for samples collected by DST in 2012. Refer to Figure 36 for locations.																						
Watercourse/waterbody				Blackwater Creek				Thunder Lake				Wabigoon Lake				Thunder Lake Tributary 2						
Site				11	12	13	14	15	16	17	18	19	20	22	23	24	25	26	2	3	4	5
Date sampled (October, 2012)				22	22	22	22	22	22	23	23	23	23	22	22	22	22	22	22	22	22	22
Class	Order	Family	Comment																			
GASTROPODA	NEOTAENIOGLOSSA	HYDROBIIDAE								9	3	8	5	4	2						1	
ANNELIDA	HIRUDINEA	ERPOBDELLIDAE				4	1					1								10		
		GLOSSIPHONIIDAE					1														3	
	OLIGOCHAETA	LUMBRICULIDAE							1					2							1	
		NAIDIDAE			1	1	1	4	4	1	2	1		62	5	1			1	2	30	1
		TUBIFICIDAE		41	4	15	26	25	5	3	28	3	7	36	2	2	1	1	5	4	1	
ARACHNOIDEA	ARANEAE		unidentified spider								9										1	
	ORBATIDA		unidentified	1																		
	TROMBIDIFORMES										2			2								
			unidentified nymph			1						1							1			
		ARRENURIDAE				1				2					1							
		HYGROBATIDAE		1		12	13	5	5													
		LEBERTIIDAE				1		1			6		1									
		LIMNESIIDAE								4												
		SPERCHONIDAE		2															1			3
		UNIONICOLIDAE		1						2				4			2					
COELENTERATA		HYDRIDAE						1														
CRUSTACEA	AMPHIPODA	HYALELLIDAE			2			10	8	1		29	9	44								
	CLADOCERA					2	3	1	2		2		1	4	5	1	7					
	COPEPODA	CALANOIDA				2	4		2		1	1	22		3							
		CYCLOPOIDA		5	4	50	42	9	18		15			12	2	2	14	3	4			1
		HARPACTICOIDA		5							5											
	OSTRACODA			44	2	3	3		5	6	10									1		
GASTROPODA	BASOMMATOPHORA	ANCYLIDAE												56								
		LYMNAEIDAE										6	15							1		
		PHYSIDAE									2											
		PLANORBIIIDAE						1		4		2	3									
	PROSOBRANCHIA	VALVATIDAE								3		7	5		3	1						
INSECTA	COLEOPTERA		unidentified								1											
		DYTISCIDAE																		2		
		ELMIDAE					1	47	24	4		1				2			1	84	2	1
		HALIPLIDAE		1							1										1	
	COLLEMBOLA	HYPOGASTRURIDAE		1																		
		ISOTOMIDAE									5									2		1
	DIPTERA		unidentified pupa			1	1	1														
		CERATOPOGONIDAE		3	3	74	60	72	6	10	24	2	1	2	3				2	40	3	10
		CHAOBORIDAE								1						1	70	26				
		CHIRONOMIDAE		125	10	186	153	358	43	115	228	63	38	884	58	53	28	31	44	1288	61	246
		EMPIDIDAE					1				2									48		1
		PSYCHODIDAE					1												1			
		PTYCHOPTERIDAE				2	1															

Table B2. Benthic invertebrate identification and enumeration for samples collected by DST in 2012. Refer to Figure 36 for locations.																						
Watercourse/waterbody			Blackwater Creek					Thunder Lake				Wabigoon Lake					Thunder Lake Tributary 2					
Site			11	12	13	14	15	16	17	18	19	20	22	23	24	25	26	2	3	4	5	
Date sampled (October, 2012)			22	22	22	22	22	22	23	23	23	23	22	22	22	22	22	22	22	22	22	
		SIMULIDAE			1					1									8	6	6	
		TABANIDAE			2	3	3											3		2	2	
		TIPULIDAE		1	4	12	8	3	4	1	4							8		6	5	
	EPHEMEROPTERA	BAETIDAE																7	44	6	11	
		CAENIDAE			1			2	21	8		4	9	2		3						
		EPHEMERIDAE								25		1	1	28	19	21	210	102				
		HEPTAGENIIDAE																	10	23	1	
		LEPTOPHLEBIIDAE		2		9	3	24	26	6									4	1		
	HEMIPTERA	CORIXIDAE		1													1					
		SALDIDAE						1												2		
	HOMOPTERA		unidentified terrestrial			2			1		5							1		1		
	HYMENOPTERA		terrestrial															3			1	
	LEPIDOPTERA		unidentified			1																
		NOCTUIDAE																			1	
		PYRALIDAE						1														
	MEGALOPTERA	SIALIDAE								2						1	6	3				
	ODONATA - ZYGOPTEA	CALOPTERYGIDAE						1														
	ODONATA-ANISOPTERA	AESHNIDAE		1																	4	
		CORDULEGASTRIDAE																			2	
		CORDULIIDAE		1			1															
		GOMPHIDAE								1										2	3	
	PLECOPTERA		unidentified nymph															3		8	4	
		CAPNIIDAE																25	44	17	12	
		LEUCTRIDAE																3	8	14		
		PERLODIDAE																4	14	7	4	
		TAENIOPTERYGIDAE																10		3	7	
	TRICHOPTERA	DIPSEUDOPSIDAE										1									1	
		GLOSSOSOMATIDAE																			16	
		HYDROPSYCHIDAE							56						1					602	4	
		HYDROPTILIDAE						1													4	
		LEPIDOSTOMATIDAE				1												25	16	7	16	
		LEPTOCERIDAE			1					3		7	4				4	3				
		LIMNEPHILIDAE						1			1							2	4	4	1	
		MOLANNIDAE											5									
		PHILOPOTAMIDAE																	144	2	3	
		PHRYGANEIDAE				1		2													1	
		POLYCENTROPODIDAE																3		3	4	
PELECYPODA	VENEROIDA	PISIIDAE		14	121	2	2	4	2	46	90	18	47	6	5	5	2	3		364	8	8
TURBELLARIA	TRICLADIDA												1									

APPENDIX C - METALS ANALYSES

Table C.1. Fork and total length of forage fish in samples collected for metals analysis in 2011.

Site	Species	Fork length (mm)	Total length (mm)
TS2	Pearl Dace	106	115
TS2	Pearl Dace	86	92
TS2	White Sucker	110	117
TS2	White Sucker	105	110
TS2	White Sucker	98	105
TS5	Phoxinus spp.	61	66
TS5	Phoxinus spp.	75	82
TS5	Phoxinus spp.	62	68
TS5	Phoxinus spp.	51	55
TS5	Phoxinus spp.	58	62
TS5	Phoxinus spp.	47	50
TS5	Phoxinus spp.	74	79
TS5	Phoxinus spp.	60	65
TS7	Phoxinus spp.	72	76
TS7	Phoxinus spp.	62	67
TS7	Phoxinus spp.	55	60
TS7	Phoxinus spp.	62	67
TS7	Phoxinus spp.	65	68
TS7	Phoxinus spp.	55	59
TS7	Phoxinus spp.	62	67
TS7	Phoxinus spp.	65	70
TS7	Phoxinus spp.	62	65
TS7	Phoxinus spp.	57	60
TS7	Phoxinus spp.	48	52
TS7	Phoxinus spp.	58	62
TS13	Phoxinus spp.	77	82
TS13	Phoxinus spp.	68	72
TS13	Phoxinus spp.	58	62
TS15	Pearl Dace	84	95
TS15	Pearl Dace	88	92
TS15	Phoxinus spp.	72	77
TS15	Pearl Dace	76	82
TS15	Pearl Dace	82	86
TS15	Pearl Dace	69	73
TS15	<i>Phoxinus spp.</i>	64	68
TS15	<i>Phoxinus spp.</i>	68	73
TS15	<i>Phoxinus spp.</i>	61	66
TS15	<i>Phoxinus spp.</i>	58	64

Site	Species	Fork length (mm)	Total length (mm)
TS15	<i>Phoxinus spp.</i>	60	65
TS15	<i>Phoxinus spp.</i>	55	59
TS15	<i>Phoxinus spp.</i>	58	62
TS16	Pearl Dace	70	75
TS16	Pearl Dace	68	73
TS16	Pearl Dace	62	66
TS16	<i>Phoxinus spp.</i>	68	73
TS16	Pearl Dace	59	60
TS21	<i>Phoxinus spp.</i>	71	76
TS21	<i>Phoxinus spp.</i>	76	80
TS21	<i>Phoxinus spp.</i>	84	90
TS21	<i>Phoxinus spp.</i>	66	70
TS21	<i>Phoxinus spp.</i>	66	72
TS21	<i>Phoxinus spp.</i>	79	85
TS21	<i>Phoxinus spp.</i>	65	70
TS21	<i>Phoxinus spp.</i>	69	73
TS21	<i>Phoxinus spp.</i>	67	72
TS22	Pearl Dace	90	96
TS22	Pearl Dace	88	96
TS22	Pearl Dace	90	97
TS22	Pearl Dace	73	79
TS22	Pearl Dace	70	77

Table C.2. Species, total and fork lengths, weight, sex, age and mercury concentration in dorsal muscle for Walleye and Sauger collected from Thunder and Wabigoon Lakes.

Lake	Fish #	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Age (years)	Total mercury concentration (mg/kg wet weight)
Thunder	F32	Walleye	238	252	114	f	1	0.121
Thunder	F40	Walleye	240	257	120	m	1	0.143
Thunder	F41	Walleye	244	257	125	u	1	0.142
Thunder	F39	Walleye	245	258	120	m	1	0.105
Thunder	F34	Walleye	248	263	120	m	1	0.0975
Thunder	F37	Walleye	250	265	135	f	1	0.136
Thunder	F36	Walleye	255	272	140	m	1	0.0978
Thunder	F38	Walleye	260	275	165	f	1	0.114
Thunder	F35	Walleye	282	296	205	m	1	0.105
Thunder	F33	Walleye	326	343	345	f	2	0.155
Thunder	F31	Walleye	254	266	130	m	1	0.108
Wabigoon	F17	Sauger	235	255	106	f	10	0.473
Wabigoon	F18	Walleye	215	230	84	m	2	0.117
Wabigoon	F21	Walleye	212	237	85	f	4	0.241
Wabigoon	F16	Walleye	227	240	105	m	2	0.0865
Wabigoon	F5	Walleye	228	240	106	u	2	0.102
Wabigoon	F2	Walleye	238	254	105	m	4	0.149
Wabigoon	F26	Walleye	237	254	100	f	3	0.173
Wabigoon	F29	Walleye	237	256	100	f	4	0.207
Wabigoon	F1	Walleye	248	266	125	m	5	0.228
Wabigoon	F23	Walleye	251	272	125	m	2	0.442
Wabigoon	F11	Walleye	260	279	140	m	6	0.184
Wabigoon	F9	Walleye	264	281	170	f	6	0.261
Wabigoon	F10	Walleye	269	286	180	f	7	0.335
Wabigoon	F13	Walleye	271	288	175	f	6	0.24
Wabigoon	F6	Walleye	239	291	117	u	3	0.157
Wabigoon	F7	Walleye	274	291	180	m	6	0.272
Wabigoon	F8	Walleye	274	291	200	m	6	0.195
Wabigoon	GN1	Walleye	274	295	190	f	2	0.191
Wabigoon	F19	Walleye	280	301	180	m	2	0.176
Wabigoon	F25	Walleye	284	305	220	f	3	0.195
Wabigoon	F3	Walleye	295	308	235	f	5	0.23
Wabigoon	F30	Walleye	288	310	235	m	3	0.14
Wabigoon	F12	Walleye	297	316	220	f	6	0.245

Lake	Fish #	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Age (years)	Total mercury concentration (mg/kg wet weight)
Wabigoon	F22	Walleye	293	316	250	m	3	0.196
Wabigoon	F20	Walleye	292	317	215	f	4	0.165
Wabigoon	F28	Walleye	298	321	225	f	3	0.206
Wabigoon	F14	Walleye	303	325	290	m	4	0.194
Wabigoon	F4	Walleye	309	330	295	f	7	0.331
Wabigoon	F24	Walleye	319	346	325	f	4	0.18
Wabigoon	F27	Walleye	394	422	715	f	7	0.245
Wabigoon	GN3	Walleye	530	564	1900	f	10	0.503

INSERT PDFS OF METALS ANALYSES ONCE THIS IS CONVERTED TO PDF.