Six Mile Brook Pit Expansion Project - Fish and Fish Habitat 2023 Biophysical Baseline Report

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EXECUTIVE SUMMARY

McCallum Environmental Ltd. (MEL) was retained by S.W. Weeks Construction Limited (S.W. Weeks; the Proponent) to prepare baseline biophysical reports, including fish and fish habitat surveys, for the proposed Six Mile Brook Pit Expansion Project (the Project), which is a sand and gravel pit located in Six Mile Brook, Nova Scotia. These assessments are to support the preparation and submission of the provincial EARD.

Fish and fish habitat surveys have been completed with the key objectives of facilitating avoidance of fish habitat where practicable, understanding the potential project interactions with fish and fish habitat, and to support fish and fish habitat regulatory applications. This was achieved by completing a review of background desktop resources in combination with field studies to identify potential environmental constraints and sensitivities.

This report outlines the methods and results of field evaluations completed within the Six Mile Brook Study Area in 2023. The field program involved four main tasks, including:

- Baseline field delineation of watercourses, waterbodies and wetlands;
- Fish community surveying through electrofishing and trapping;
- Detailed fish habitat characterization of aquatic features with potential to be directly and indirectly affected by Project development; and,
- In-situ water quality sampling.

Baseline delineation resulted in the identification of seven watercourses (WC1-WC7), four small waterbodies (beaver ponds), and three wetland mosaics.

Water quality measurements were recorded in-situ during baseline delineation and fish habitat surveys. Water quality parameters measured are considered suitable for cold-water species (e.g., salmonids). Recorded summer temperatures (late July and early August) ranged from 15°C to 20°C, and the lowest pH recorded was 5.21 (WL5).

Fish community surveys (electrofishing and trapping) resulted in a total of three species and 78 individual fish captured. Juvenile (including young of year) and adult Atlantic salmon, juvenile (including young of year) and adult brook trout, and juvenile brown trout were all confirmed present in Six Mile Brook. Young of year and adult brook trout were confirmed in WC3. No fish were captured in WC1 or WC4 through trapping and electrofishing efforts. Atlantic salmon (COSEWIC Special Concern, S1) and brook trout (S3) are both considered priority species.

Detailed fish habitat surveys within selected watercourses were conducted using standard methodologies to gather key measurements such as reach length, reach wetted and bankfull width, stream substrate composition, water depths, water velocities, and cover. The data was used to determine the overall habitat suitability based on measured stream substrate, water depths, and water velocities (habitat parameters) for each fish species identified within the Study Area. Fish habitat in open water and wetland mosaic features were described generally from their riparian areas due to unsafe boating and wading conditions.

Overall, all but one delineated aquatic feature (WC4) was assessed as a fisheries resource (i.e., fish habitat). Fish habitat within the Study Area primarily provides suitable habitat for adult brook trout, but lacks the morphological and substrate complexity to support other life stages of salmonids (including spawning). Potential salmonid (salmon and trout) spawning habitat is expected to be limited to the lower reaches of

WC3 and Six Mile Brook. The multiple beaver dams present on WC1 and WC3 may act as obstacles to fish passage through these systems, particularly when water levels are seasonally low.

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1 INTRODUCTION

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The objective of the fish and fish habitat species surveys was to:

- Identify species and habitat usage with a focus on Species at Risk (SAR) and Species of Conservation Interest (SOCI) within and surrounding the Study Area (the Study Area was designed to include the maximum extent of expected impacts (and in consideration of property ownership)).

The biophysical surveys completed by MEL took place within the EA Study Area, which borders Stillman Road to the south, and is within 300 m of Four Mile Brook Rd to the east. The Study Area includes the entirety of PIDs 65173437, 00834622, and 00834721 as well as the northern portion of PID 00834739 and a 100 m buffer on a mapped watercourse, south of the proposed expansion. The EA Study Area is 96.9 ha in size, which includes 36.3 ha of disturbed area (historic and current pit), as indicated in Figure 1. One electrofishing survey and one fish habitat survey took place outside the Study Area to provide greater context to species activity in the area.

The results of these surveys will be carried forward in the EARD to evaluate the Project's effect to fish and fish habitats.

1.1 Regulatory Context

The Nova Scotia *Environment Act* requires that an approval from NSECC be obtained before any watercourses or water resource can be altered, including the flow of water (Environment Act c.1, s.1, 1994-95). Therefore, it is necessary to understand what watercourses and water resources are present within the Study Area prior to the pit expansion.

The Nova Scotia Environment Act (2006) defines a watercourse as:

> "the bed and shore of every river, stream, lake, creek, pond, spring, lagoon or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and all groundwater".

Using this guidance, watercourses have been identified and described throughout the Study Area to support descriptions of fish habitat.

The federal Fisheries Act defines fish as "(a) parts of fish, (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;", and fish habitat as "waters frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas".

Within the Fisheries Act, activities which result in the harmful alteration, disruption or destruction (HADD) of fish habitat are prohibited. Under Section 35(2) of the Act, authorization may be granted for a proposed work, undertaking or activity that may, respectively, result in the death of fish or the harmful alteration, disruption or destruction of fish habitat.

Throughout this report, fish habitat is described in the context of watercourses as defined above. While groundwater is included in the regulatory definition of a watercourse under the Environment Act, this section focuses on surface water features in the context of fish habitat provision.

2 BASELINE SURVEY METHODOLOGY

The following desktop and field survey methodologies were implemented during the baseline fish and fish habitat survey program and are discussed below.

2.1 Desktop Review

The goal of the desktop evaluation was to identify the location of potential fish habitat features (i.e., watercourses and waterbodies) within or in proximity to the Study Area based on mapped systems, topography, and satellite imagery. Prior to completing the field evaluation, MEL reviewed all NSTDB mapped watercourses and waterbodies, provincial flow accumulation data, and depth to water table mapping to identify potential surface water features within and surrounding the Study Area (Figure 1, Appendix A).

An assessment of where the Study Area lies within primary and secondary watersheds was also conducted (Figure 2, Appendix A).

A priority species list was used to identify priority fish species that may occur in the Study Area (Appendix B). The purpose of the priority species list is to identify a broad list of species that have the potential to be present within the Study Area. Priority species include Species of Conservation Interest (SOCI) that are not listed species under provincial or federal legislation (i.e., Committee on the Status of Endangered Wildlife in Canada [COSEWIC] species and/or Atlantic Canada Conservation Data Center [ACCDC] S1, S2 and S3 species or any combination thereof (i.e., S3S4 is considered a SOCI)), and Species at Risk (SAR) which are listed under the Species at Risk Act (SARA) and/or the Nova Scotia Endangered Species Act (NSESA).

Development of a priority species list for lichen, vascular plants, avifauna, and wildlife was completed based on a compilation of listed species from the following sources:

1. COSEWIC and SARA – All species listed as Endangered, Threatened, or of Special Concern;
2. NSESA – All species listed as Endangered, Threatened, or Vulnerable; and,
3. ACCDC Conservation Rank – All Species designated as S1, S2, or S3.

Additionally, invertebrates listed under NSESA, COSEWIC and SARA as described above, were included in the development of the priority species list.

The priority species list was first narrowed by broad geographic area and then further narrowed by identifying specific habitat requirements for each species. For example, if a listed species on the NSESA required open water habitat and no open water habitat is present inside the Study Area, this species was not carried forward to the final list.

The compilation of a priority species list is habitat driven, rather than observation driven (e.g., ACCDC report of Maritime Breeding Bird Atlas [MBBA]). This is based on the recognition that observation-based datasets are not comprehensive lists of species in any given area. As such, the information provided by observation driven sources are supplementary to the priority species list, rather than forming the basis of the list.

A single desktop priority species list was developed for all seasons for the Project using the methodology provided above. The seasonality of mobile species is not used to screen species into, or out of, the priority

species list. All field staff reviewed the desktop evaluation for priority species prior to commencing field work to ensure they were familiar with the priority species identification and their status ranks. See Table 2-1 for status rank definitions across multiple regulatory levels.

Table 2-1. Status Ranks Definitions

Protection	Status	Definition
COSEWIC	**Extinct**	A wildlife species that no longer exists.
COSEWIC	**Extirpated**	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere
COSEWIC	**Endangered**	A wildlife species facing imminent extirpation or extinction
COSEWIC	**Threatened**	A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction
COSEWIC	**Special Concern**	A wildlife species that may become threated or endangered because of a combination of biological characteristics and identified threats.
COSEWIC	**Data Deficient**	A category that applies when the available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction.
COSEWIC	**Not at Risk**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
SARA	**Extirpated**	Species which no longer exist in the wild in Canada but exist elsewhere in the wild.
SARA	**Endangered**	Species facing imminent extirpation of extinction.
SARA	**Threatened**	Species which are likely to become endangered if nothing is done to reverse the factors leading to their extirpation or extinction.
SARA	**Special Concern**	Species which may become threatened or endangered because of a combination of biological characteristics and identified threats.
NSESA	**Endangered**	A species facing imminent extirpation or extinction.
NSESA	**Threatened**	A species likely to become endangered if limiting factors are not reversed.
NSESA	**Vulnerable**	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
NSESA	**Extirpated**	A species that no longer exists in the wild in the Province but exists in the wild outside of the Province.
NSESA	**Extinct**	A species that no longer exists.

Protection	Status	Definition
ACCDC	**SX**	**Presumed Extirpated** - Species or community is believed to be extirpated from the province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
ACCDC	**S1**	**Critically Imperiled** - Critically imperiled in the province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.
ACCDC	**S2**	**Imperiled** - Imperiled in the province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
ACCDC	**S3**	**Vulnerable** - Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
ACCDC	**S4**	**Apparently Secure** - Uncommon but not rare; some cause for long-term concern due to declines or other factors.
ACCDC	**S5**	**Secure** - Common, widespread, and abundant in the province.
ACCDC	**SNR**	**Unranked** - Nation or state/province conservation status not yet assessed.
ACCDC	**SU**	**Unrankable** - Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
ACCDC	**SNA**	**Not Applicable** - A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
ACCDC	**S#S#**	**Range Rank** - A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).
ACCDC	**Not Provided**	Species is not known to occur in the province.
ACCDC	**Breeding Status Qualifiers**	
ACCDC	**Qualifier**	**Definition**
ACCDC	**B**	Breeding - Conservation status refers to the breeding population of the species in the province.
ACCDC	**N**	Nonbreeding - Conservation status refers to the non-breeding population of the species in the province.
ACCDC	**M**	Migrant - Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the province.

Additional information on confirmed and potential fish presence within the Study Area and surrounding surface water features was collected from the following sources:

- ACCDC Report (as presented in Appendix C);
- NSDNRR Significant Species and Habitats database (2023);
- Aquatic Species at Risk Map (Fisheries and Oceans Canada, 2019);
- Fisheries and Oceans Stock Status Reports (Gibson, Amiro, and Robichaud-LeBlanc, 2003);
- Description of Selected Lake Characteristics and Occurrence of Fish Species in 781 Nova Scotia Lakes (Alexander, Kerekes, and Sabean, 1986);
- Nova Scotia Salmon Atlas (2023);
- Freshwater Fish Species Distribution Records (NSDFA, 2019);
- Fish Hatchery Stocking Records (NSDFA, 2018);
- Sportfish Angler Records (NSDFA, 2021); and
- Nova Scotia Department of Fisheries and Aquaculture (NSDFA) Lake Inventory Maps (n.d.).

2.2 Field Surveys

Fish and fish habitat surveys (Figures 3A-C, Appendix A) were performed to identify water features within the Study Area that support fish and fish habitat. The following field surveys were completed within the Study Area:

- Watercourse and wetland delineation (Section 2.2.1);
- Fish collection (Sections 2.2.2 and 2.2.3);
- Fish habitat characterization (Section 2.2.4); and,
- In-situ water quality measurements (Section 2.2.5).

The following subsections describe the components of the fish and fish habitat field surveys.

2.2.1 Watercourse and Wetland Delineation

Watercourse was completed throughout the Study Area in conjunction with wetland delineation and evaluation in June 2023.

During the field evaluations, McCallum used NSECC guidance on watercourse determinations to identify watercourses (NSE, 2015). The following parameters were used to define watercourses:

- Presence of a mineral soil channel;
- Presence of sand, gravel and/or cobbles evident in a continuous pattern over a continuous length with little to no vegetation;

- Indication that water has flowed in a path or channel for a length of time and rate sufficient to erode a channel or pathway;
- Presence of pools, riffles or rapids;
- Presence of aquatic animals, insects or fish; and,
- Presence of aquatic plants.

According to guidance provided by NSECC, any surface feature that meets two of the criteria above meets the definition of a provincially regulated watercourse. The source and sink of each system were verified in field. Any identified watercourses were flagged in the field with blue flagging tape and mapped using a Garmin GPSMAP 64s unit (capable of sub-five m accuracy). Note that Six Mile Brook was not field delineated as the topographic watercourse line was found to be accurate in the field.

Open water features such as beaver ponds and flooded wetlands were frequently encountered along watercourses during field delineation. All open water features identified were components of linear watercourses that are more accurately represented graphically by polygon files rather than lines. From a regulatory perspective, open water features are defined as watercourses by the Environment Act. Features referred to as open water habitats were typically less than two m depth, <8 ha in size, and had less than 50% vegetative cover following guidance from the Army Corps of Engineers wetland delineation manual (United States Army Corps of Engineers, 2009). The term wetland (WL) mosaic is used to describe habitats where a watercourse disperses widely into vegetated wetland habitat as unconsolidated flow and undefined channel within a wetland boundary. These habitats provide ephemeral or perennial fish access, depending on the contribution of flow from the associated watercourse. In both cases, these features were mapped by walking the outer-most flooded boundary.

Watercourses identified within the Study Area were characterized and data such as weather, watercourse identification information, stream order, flow type, entrenchment, gradient, and water quality parameters were recorded. Measurement of substrate types, cover, description of riparian habitat, and physical channel measurements (depth, wetted, and bankfull widths) were also recorded. Detailed fish habitat assessments are described in Section 3.2.3.

All wetlands delineated within the Study Area were reviewed to confirm the presence of fish or fish habitat within the, and if so, the extent (m^2) of fish habitat available.

2.2.2 Fish Surveys: Electrofishing

Electrofishing was conducted within the three primary drainage systems of the Study Area: the watercourse to the northwest (WC4), the watercourse to the southeast (WC3), and Six Mile Brook which lies just south of the Study Area (Figures 3A-C, Appendix A). The goal of these electrofishing surveys was to determine fish community composition and to estimate the relative abundance of fish within the Study Area's aquatic features. Fish collection was completed under Fisheries and Oceans Canada Fishing License # SG-RHQ-23-001A. Sampling reaches of approximately 100 m were established, if possible and not restricted by watercourse length, and inclusive of representative habitat types within each aquatic feature. The two surveys within the Study Area were closed sites (i.e., with barrier nets at the upstream and downstream extents of the reach), while the Six Mile Brook site was open (i.e., without barrier nets) due to inefficiencies associated with closing a larger watercourse.

Electrofishing was completed using guidance from a MEL Standard Operating Procedure (SOP) for Fish Collection (Appendix D).

Fisheries and Oceans Canada's Interim Policy for the Use of Backpack Electrofishing Units (2003) was reviewed and followed by all members of the electrofishing crew. This document provides a detailed list of standard equipment, safety, training, and emergency response procedure requirements for electrofishing. Each electrofishing crew consisted of two individuals, one of which (the crew lead) was a qualified person as defined under the DFO Interim Electrofishing Policy.

Fish were sampled using a Halltech Battery Backpack Electrofisher (HT-2000) with unpulsed direct current (DC). The operator waded upstream to eliminate the effects of turbidity caused by bottom sediment and probed the anode into fish habitat within the site. A second crew member walked behind the operator to net any stunned fish using a D-frame landing net (1/8" mesh). If fish were captured, they were held in a live well containing ambient stream water and an aerator (i.e., bubbler), and the live well was kept out of the sun. Captured fish were checked regularly for signs of stress, in addition, water temperatures were monitored during electrofishing surveys to prevent fishing in water greater than 22˚C (as per fish license conditions). At the conclusion of the pass, fish in the live well were identified to species and measured for length and weight. After recuperating, all fish were released back into the sampled reach. One pass was performed for Six Mile Brook outside of the Study Area (open site), while multiple passes were performed for WC3 and WC4 (closed sites) within the Study Area.

Details of the electrofishing locations and survey dates are provided in Table 2-2. Electrofishing locations are shown on Figures 3A-3C (Appendix A).

Table 2-2. Electrofishing Survey Details

Electrofishing Location	Stream Order	Survey Dates	Upstream Coordinates (UTM)		Downstream Coordinates (UTM)		Reach Length (m)
			Easting	Northing	Easting	Northing	
Six Mile Brook	3	August 2, 2023	507729	5048145	507835	5048114	111
WC3	2	August 2, 2023	507713	5048437	507694	5048349	101
WC4	1	August 3, 2023	507247	5049515	507274	5049423	106

2.2.3 Fish Surveys: Trapping

Trapping was conducted to supplement fish community data in ponded, open water features where electrofishing could not be performed due to water depths or unsafe wading conditions. Both minnow traps and eel pots were deployed to target both small and larger-bodied fish; minnow traps have an effective catch range of body depths approximately 6 - 50 mm, while eel pots have an effective catch range of 10 – 90 mm. These traps allow fish to swim inside through funnels that guide them from a large opening near the outside of the trap to a narrow opening close to the center of the trap. Both minnow traps and eel pots were baited with dog food and set in multiple groupings around a single location with sufficient water depths to cover the traps. All traps were set overnight and collected the following day.

Details of trapping locations, survey dates, and traps deployed are provided in Table 2-2. Trap locations are shown on Figure 3A (Appendix A).

Table 2-2. Trapping Survey Details

Trapping Location	Trap Site	Survey Dates	UTM Coordinates		Traps Deployed
			Easting	Northing	
Open Water C: present within WL5	Group 1	July 27-28, 2023	507716	5048605	1 Eel Pot, 4 Minnow Traps
	Group 2	July 27-28, 2023	507685	5048621	2 Minnow Traps
	Group 3	July 27-28, 2023	507711	5048639	1 Eel Pots, 2 Minnow Traps
Open Water E: present within WL1	Group 1	August 2-3, 2023	507435	5048852	1 Eel Pots, 2 Minnow Traps
	Group 2	August 2-3, 2023	507442	5048852	2 Minnow Traps
	Group 3	August 2-3, 2023	507471	5048846	1 Eel Pots, 2 Minnow Traps
	Group 4	August 2-3, 2023	507471	5048852	2 Minnow Traps

2.2.4 Fish Habitat Characterization

Fish habitat characterization was completed by MEL biologists in July and August of 2023. Detailed fish habitat surveys were completed in aquatic features with drainage areas in proximity to the planned pit expansion area (and therefore potentially affected by Project development; Figure 1, Appendix A). Fish habitat characterization was completed using guidance from the MEL Standard Operating Procedure for Fish Habitat Assessments in the lotic environment (Appendix E).

To support fish habitat assessments, each surveyed watercourse was delineated into individual reaches defined by discrete homogeneous units (e.g., riffle, run, pool, flat, etc.) as determined in the field in an upstream to downstream direction. Each habitat type contains discrete substrate types, water depth, and velocity ranges which have been determined using the described biological 'preferences' outlined in Grant and Lee (2004), whenever possible. In smaller, first-order streams, habitat types were often found to be extremely short and variable. For efficiency in the field, when individual habitat types were less than five meters in overall length, they were grouped together into one reach containing multiple smaller habitat units. The upstream and downstream ends of each reach were recorded with handheld GPS device. Watercourses selected for detailed habitat evaluations are shown on Figures 3A-3C (Appendix A).

For each reach, a detailed fish habitat survey was completed which included water quality measurements, designation of substrate and cover types, riparian habitat descriptions, and barrier assessments. Cross-sectional measurements (transects) were established to describe morphological (e.g., channel and wetted widths, bank heights) and flow characteristics (e.g., velocities and depths) within the reach. Transect measurements were recorded at every 25 m length of reach – for example, if a reach was 100 m in total

length, four transects were established within the reach. If multiple habitat types (<5 m in length) were grouped together to form a reach, transects were established within each habitat type represented within the reach. The number of transects and transect locations were selected and modified as needed in the field based on specific habitat features observed, or limitations related to access, wadeability, and safety concerns.

Traditional fish habitat characterizations for open water features and wetland mosaics could not be completed due to unsafe boating and wading conditions brought on by shallow water and deep muck substrates. Instead, these fish habitat features were described more generally from the safety of the riparian edges. Substrate types and vegetation cover were described for each feature, and when possible, representative depth measurements were taken from the riparian edge.

2.2.5 Water Quality Measurements

In-situ water quality measurements were recorded in aquatic features during baseline delineation and detailed habitat assessments. These water quality measurements were collected using a calibrated YSI Multi-Probe water quality instrument (or equivalent) or a combination of a Myron Ultrapen DO Pen Probe and Hannah Combo pH/Conductivity/TDS Probe at the time of the sampling event/survey. Locations of water quality measurements coincide with fish collection locations and habitat reaches (Figures 3, Appendix A).

3 EXISTING CONDITIONS

The following sections outline the fish and fish habitat findings from the desktop review and field survey.

3.1 Desktop Review

The Study Area is situated entirely within the East/Middle/West Pictou primary watershed (1DP) and the West River Pictou secondary watershed (1DP-1) (Figure 2, Appendix A). The Study Area is located within the Six Mile Brook drainage system, a smaller tributary located in the northwestern corner of the watershed which flows in a general southeasterly direction to the West River Pictou, which eventually empties into the Northumberland Strait to the north. Six Mile Brook is fed by numerous smaller first and second-order headwater tributaries. No named waterbodies were identified within the Six Mile Brook drainage area. The only waterbodies identified within or in proximity to the Study Area through desktop review were the on-site settling ponds which service the existing pit (Figure 1, Appendix A).

The topographical high within the Study Area generates a division of flow along two sides of the existing pit, with surface water on the northwestern side of the Study Area draining southwest and surface water on the northeastern side draining southeast. All surface water originating from the Study Area is eventually captured by Six Mile Brook.

Six Mile Brook enters the southwestern extent of the Study Area from the west. The brook flows southeast for approximately 400 m before exiting the Study Area south. One unnamed, first order watercourse (field verified as a first-second order watercourse and subsequently referred to as WC3), was identified within the Study Area through desktop review. The watercourse is located east of the existing pit and flows south under Stillman Road before discharging into Six Mile Brook.

The ACCDC report (Appendix C) identified four priority fish species within 10 km of the Study Area: alewife (*Alosa pseudoharengus;* S3B); Atlantic sturgeon (*Acipenser oxyrinchus;* COSEWIC Threatened, S2S3N), Gaspe-Southern Gulf of St. Lawrence population Atlantic salmon (*Salmo salar;* COSEWIC Special Concern, S1), and brook trout (*Salvelinus fontinalis;* S3). The priority species list (Appendix B) identified two additional priority species as potentially present including American eel (*Anguilla rostrata;* COSEWIC threatened, S3N) and northern pearl dace (*Margariscus nachtriebi*; S3).

The Nova Scotia freshwater fish species distribution records (NSDFA, 2019), fish hatchery stocking records (NSDFA, 2018), and sportfish angler records (NSDFA, 2021) were reviewed, and no records were found for water features within the Study Area. However, records for the distribution and stocking datasets exist for West River, which Six Mile Brook flows into. Distribution records include nine species: chain pickerel (*Esox niger*), white perch (*Morone americana*), white sucker (*Catostomus commersonii*), mummichog (*Fundulus heteroclitus*), alewife, brook trout, American eel (*Anguilla rostrata*), golden shiner (*Notemigonus crysoleucas*), and ninespine stickleback (*Pungitius pungitius*). Stocking records include 24 records of brook trout stocking in West River. The Aquatic Species at Risk Map (DFO, 2023) was reviewed, and no critical habitat or species listed under SARA were identified within the West River Pictou secondary watershed.

3.2 Field Results

Seven field identified watercourses (WC1-WC6, and Six Mile Brook (WC7), four small waterbodies (beaver ponds), and three wetland mosaics were delineated and characterized within the Study Area (Figure 4, Appendix A):

- WC1 is an unnamed, first-second order stream which drains the existing on-site settling ponds and flows southeast through WL1, eventually emptying into Open Water C (in WL5) which flows into WC3 along the eastern boundary of the Study Area.
- WC2 is an unnamed, first order tributary to WC1 flowing north to south.
- WC3 is a topographically mapped first-second order stream which originates from the northern extent of WL5 within the Study Area. The watercourse flows south through WL5, exiting the Study Area at Stillman Road and emptying into Six Mile Brook.
- WC4 is an unnamed, first order stream which originates north of the Study Area and flows south, eventually dispersing just north of the existing pit into upland habitat.
- WC5 and WC6 are two unnamed, first order ephemeral tributaries to Six Mile Brook located in the southwest corner of the Study Area.
- WC7 is the portion of Six Mile Brook contained with the Study Area. Six Mile Brook enters the Study Area at the southwestern corner and flows southeast for approximately 400 m before existing the Study Area to the south.
- Wetland Mosaics A, B and Open Water C are all located along WC3 within the confines of WL5. Open Water C is ponded as a result of beaver dams. These aquatic features represent the extent of potential fish habitat within WL5.
- Wetland Mosaic D and Open Water E, F, and G are all located along WC1 within the confines of WL1. Similarly, Open Water E, F, and G have all been formed from beaver dams along WC1. These aquatic features represent the extent of potential fish habitat within delineated wetlands.

Refer to Section 3.2.3 for physical descriptions of the water features identified within the Study Area. Representative photographs of each water feature are provided in Appendix F.

3.2.1 Fish Surveys

The following sections outline the results of electrofishing and fish trapping efforts undertaken.

3.2.1.1 *Electrofishing*

The results of electrofishing surveys are presented in Table 3-1. Relative abundance has been expressed through Catch Per Unit Effort (CPUE) calculated as the number of fish captured per 300 seconds of electrofishing effort.

Table 3-1. Summary of Electrofishing Efforts undertaken.

Site	Survey Date	Fish Species Collected		Catch per Species	Total Catch	Total Effort (seconds)	CPUE (fish caught/ 300 seconds)
		Common Name	Scientific Name				
Six Mile Brook	August 2nd, 2023	Brook Trout	*Salvelinus fontinalus*	13	47	1173.8	12.01
		Atlantic Salmon	*Salmo salar*	33			
		Brown Trout	*Salmo trutta*	1			
WC3	August 3rd, 2023	Brook Trout	*Salvelinus fontinalus*	31	31	2663.4	3.49
WC4	August 3rd, 2023	N/A	N/A	N/A	0	1207.4	0

During electrofishing surveys, Six Mile Brook had the highest diversity and abundance of catch, with three species observed, and 47 individual fish caught. Six Mile Brook also had the highest CPUE of all three electrofishing locations at 12.01. Thirty-one (31) individual fish of a single species were caught in WC3, resulting in a CPUE of 3.49. No fish were caught during the electrofishing survey in WC4, resulting in a CPUE of 0. Refer to Figures 3A-3C (Appendix A) for electrofishing locations.

3.2.1.2 *Trapping*

The results of trapping efforts are presented in Table 3-2. Relative abundance has been expressed through CPUE.

Table 3-2. Summary of Trapping Efforts undertaken.

Waterbody ID	Site	Survey Date	Fish Species Collected		Total Effort Per Site (hours)	Total Catch	CPUE
			Common Name	Scientific Name			
Open Water C	Group 1	July 27th, 2023	N/A	N/A	22.92	0	0

	Group 2	July 27th, 2023	N/A	N/A	22.92	0	0
	Group 3	July 27th, 2023	N/A	N/A	22.92	0	0
Open Water E	Group 1	August 2nd, 2023	N/A	N/A	23.75	0	0
	Group 2	August 2nd, 2023	N/A	N/A	23.75	0	0
	Group 3	August 2nd, 2023	N/A	N/A	23.75	0	0
	Group 4	August 2nd, 2023	N/A	N/A	23.75	0	0

No fish were caught between the seven groups of traps deployed within Open Water C and E. A total of 163.76 hours of trapping was conducted across the seven trapping groups. Refer to Figures 3A-3C (Appendix A) for fish trapping locations.

3.2.1.3 *Fish Species Observed*

Table 3-3 presents a summary of fish species captured through all electrofishing and trapping surveys, listed in order of abundance. Individual data for fish captured at each sampling site are presented in Appendix G, and representative photographs of each species captured are presented in Appendix F.

Table 3-3. Fish Species Captured

Common Name	Scientific Name	SARA, COSEWIC, NSESA	SRank	Total Catch		Length range (mm)		System			
				Total Number	Percent Catch		Six Mile Brook (WC7)	WC3	WC4	Open Water C	Open Water E
Brook Trout	*Salvelinus fontinalis*	-	S3	44	56.4 %	48-170	X	X	-	-	-
Atlantic Salmon	*Salmo salar*	COSEWIC – Special Concern	S1	33	42.3 %	46-131	X	-	-	-	-
Brown Trout	*Salmo trutta*	-	SNA	1	1.3 %	69	X	-	-	-	-
Total				78	Total Species		3	1	0	0	0

As a result of fishing efforts (i.e., all electrofishing and trapping surveys) undertaken, a total of three species were captured:

- Atlantic salmon (*Salmo salar*; COSEWIC Special Concern, S1);
- Brook trout (*Salvelinus fontinalis*; S3); and,
- Brown trout (*Salmo trutta*; SNA).

In total, 78 individual fish were captured across two survey locations. Brook trout was the most commonly captured, accounting for 56.4% of the total catch for all fishing efforts with juvenile and adult life stages present within both WC3 and Six Mile Brook. Atlantic salmon (juvenile and adults) was the most abundant species in Six Mile Brook, while only one juvenile brown trout was captured in the system. Fish capture results (particularly the presence of young-of-year fish) suggest that all three species are successfully spawning in Six Mile Brook. Brook trout young-of-year captured in WC3 would suggest this species could also be spawning within this tributary. Atlantic salmon and brook trout are both considered priority fish species.

No fish were captured through trapping efforts within Open Water C and E. It is likely that the multiple beaver dams present along WC1 and WC3 are impeding fish passage into the upper reaches of these systems, particularly during seasonally low water levels. However, these beaver dams are not considered complete barriers to fish and as such these aquatic features are still considered to provide fish habitat, despite the lack of catch. No fish were captured in WC4, which was suspected based on a lack of connectivity to any downgradient, fish-bearing system. Fish habitat characteristics of these systems are further described in Section 3.2.3.

3.2.2 Water Quality

Water quality results are reported and discussed as it relates to the chemical characteristics required for suitable fish habitat. Where applicable, water quality sampling results are evaluated against the CCME Guidelines for the Protection of Aquatic Life (FWALs). In-situ water quality measurements recorded during detailed habitat surveys in July and August 2023 are provided in Table 3-4. Note that the dissolved oxygen (DO) probe was malfunctioning at the time of assessment, and as such no DO measurements have been provided.

Table 3-4. Summary of In-situ Water Quality Measurements recorded during field studies.

Site	Reach #	Sampling Date	Water Temp (℃)	pH	Conductivity (µS/cm)
WC1	1	July 27, 2023	19.8	5.46	45
	2	August 3, 2023	16.8	6.62	72
WC2	1	August 3, 2023	17.5	6.61	98
WC3	1	July 27, 2023	18.3	5.65	135
	2	July 28, 2023	20.5	5.46	71
	2 to 3	August 2, 2023	19.4	5.46	56
	3	July 28, 2023	20.4	6.09	43

	4	July 28, 2023	-	-	-
WC4	1	August 3, 2023	15.1	5.99	41
	1	August 3, 2023	15.2	6.54	69
	2	August 3, 2023	15.2	6.01	45
	3	August 3, 2023	-	-	-
Six Mile Brook	1	August 2, 2023	16.8	6.32	45
Open Water C	N/A	July 27, 2023	20.3	5.21	95

These results are discussed as they relate to fish habitat quality in the following sections.

3.2.2.1 *Temperature*

Water temperature affects the metabolic rates and biological activity of aquatic organisms, thus influencing the use of habitat by aquatic biota. There are no CCME guidelines related to temperature and aquatic biota. Temperature preferences of fish vary between species, as well as with size, age, and season.

Salmonids are cold-water fish species, meaning they require cold water to live and reproduce (Bowlby et al., 2013). The thermal preference class (as defined by Coker et al., 2001) for both Atlantic salmon and brook trout is classified as cold, meaning preferred summer water temperatures fall below 19°C (Hasnain et al., 2010). Brown trout can tolerate slightly higher temperatures are considered tolerant of cold/cool thermal regimes (Hasnain et al., 2010).

The results shown in Table 3-4 provide a snapshot of temperatures from mid-summer (late July and early August 2023) for most watercourses. Throughout the areas where temperatures were recorded, temperatures ranged from 15.1°C in WC4 to 20.5°C in WC3. All recorded temperatures are considered suitable and generally non-limiting for salmonid species.

3.2.2.2 *pH*

CCME FWALs establish that a range of pH from 6.5 to 9.0 is suitable within freshwater habitat. Kalff (2002) indicates that the loss of fish populations is gradual and depends on fish species, but decline is evident when pH is <6.5. Kalff (2002) further states that a 10-20% species loss is apparent when pH <5.5.

Compared to other salmonids, brook trout can tolerate acidic conditions particularly well, and have been documented to. survive at pH 3.5 in laboratory settings (Daye and Garside, 1975). Raleigh (1982) proposed an optimal pH range for brook trout as 6.5-8.0, with a tolerance range of 4.0-9.5. Significant mortality of Atlantic salmon fry, which is considered the most sensitive salmon life stage to acidity, occurs at pH 5.0 (Farmer, 2000). Brown trout reproduction is similarly adversely affected at pH levels below 5.0 (Buffam et al., 2021).

The pH range for sampled aquatic features was 5.21 in WL5 to 6.62 in WC1, with an average pH of 5.95. Out of the 12 pH measurements shown in Table 3-4, three exhibited pH levels within CCME recommended range for freshwater aquatic life (6.5-9). However, no measurements recorded in-situ during fishing surveys and habitat assessments exhibited pH levels so low (<5.0) as to expect to cause harm to the eggs and fry of salmonid species (CCREM, 1987). As such, pH levels are considered suitable for salmonid productivity in select surface water features.

3.2.2.3 *Conductivity*

Conductivity is the measure of water's capacity to conduct an electrical current and is correlated to total dissolved solids (TDS) which is a measurement of inorganic salts, organic matter, and other dissolved materials in water. This is because increases in the mineral and salt content of water will increase its capacity to carry a charge. Toxicity in fish can be achieved through large increases in salinity, changes in the ionic composition of the water and toxicity of individual ions. Environment Canada has established a freshwater conductivity target of 500 µS/cm (conductivity must not exceed the target) as part of its Environmental Performance Water Quality Index (EC, 2011). No conductivity measurements recorded during in-situ field studies reached or exceeded the Environment Canada Water Quality Index target. The highest recorded conductivity was found in WC3 at 135 µS/cm.

Conductivity and TDS are often used as baseline for comparison with background measurements. Major changes in these parameters could indicate that a discharge or some other source of pollution has entered the aquatic resource. Conductivity levels measured within select surface water features are considered acceptable for aquatic life.

3.2.3 Assessment of Fisheries Resources

A summary of key fish habitat characteristics within each linear watercourse surveyed, and the fish species and life stages they support, is presented in Table 3-5. Fish habitat characteristics of waterbodies are provided in Table 3-6. These summary tables have been prepared using data collected during watercourse delineation, detailed habitat surveys, fishing surveys and water quality surveys. Detailed fish habitat measurements are presented in Appendix H. Delineated linear watercourse reaches and waterbodies are presented on Figure 4 (Appendix A), and representative photos are presented in Appendix F.

The subsections following these tables describe fish habitat within each freshwater feature identified in the Study Area and provides an assessment of the baseline quality of the habitat in relation to fish species and their life stages. The results of fish habitat characterizations and fish surveys have been used to define which water features provide habitat for fish (i.e., "Fisheries Resources"), and which do not.

Fisheries resources are defined as those regulated watercourses which provide viable fish habitat and are accessible to fish at any time of the year. All delineated, linear watercourses are considered provincially regulated watercourses as defined by NSECC guidance (NSE, 2015), but not all provincially regulated watercourses are necessarily considered fisheries resources. Provincially regulated watercourses may contain a bed and bank, but if inaccessible to fish based on certain features which would prevent fish from accessing the watercourse (e.g., presence of a permanent barrier, hydrological isolation from downgradient, fish-bearing systems) are not considered a fisheries resource.

Note that WC5, WC6, and WC7 (the perennial Six Mile Brook and two ephemeral tributaries; Figure 4, Appendix A) did not receive detailed fish habitat characterization on account of these systems being geographically distant from the planned pit expansion area and potential Project impacts. All three systems are considered fisheries resources.

Table 3-5. Fish Habitat Characteristics and Species Life Cycle Provisions of Select Watercourses within the Study Area

Watercourse	Reach	Stream Order	Flow Type[1]	Reach Characteristics									Fish Support[6]					
				Channel Width (m)[2]	Wetted Width (m)[2]	Reach Length (m)	Dominant Habitat Type	Other Habitats Present	Average Velocity (m/s)	Average Depth (m)	Dominant Substrate	Average Cover (%)[3]	Confirmed Species	Probable Species[5]	Suitable Habitat			
															Spawning	YOY	Juvenile	Adult
1	1	1	P	1.2-5	0.8-5	138	Run	Riffle, Pool	<0.05	0.19	Muck/ Detritus	AQ (15), OH (8), CC (73)	-	BKT	-	-	-	BKT
	1B	1	P	1.0-1.6	0.8-1.5	62	Run	Riffle	<0.05	0.10	Muck/ Detritus	AQ (2), OH (23), CC (53)			-	-	-	BKT
	2	2	P	1.2-15	0.7-2.2	201	Run	None	<0.05	0.27	Muck/ Detritus	AQ (10), OH (8), CC (22)			-	-	-	BKT
2	1	1	P	0.4-1.8	0.2-1.4	204	Run	Riffle	<0.05	0.10	Muck/ Detritus	OH (10), CC (58)	-	BKT	-	-	-	BKT
3	1	1	I	1.2-2.7	0.4-1.75	226	Flat	None	<0.05	0.11	Muck/ Detritus	AQ (4), OH (15). CC (53)	BKT	ATS, BKT, BNT	-	-	-	BKT
	2	3	P	1.7-2.8	1.3-2.5	113	Run	None	0.14	0.26	Muck/ Detritus	IN (3), AQ (7), OH (20), CC (55)			-	-	-	BKT
	2B	3	P	3.1	2.3	12	Run	None	<0.05	0.23	Muck/ Detritus	OH (15), CC (90)			-	-	-	BKT
	3	3	P	1.6-4.4	1.5-4	326	Riffle-Run	Pool	0.45	0.19	Gravel, Muck/ Detritus	IN (5), AQ (2), OH (8), CC (38)			ATS, BKT, BNT	ATS, BKT, BNT	ATS, BKT, BNT	BKT, BNT
	4	3	P	2.4	2	46	Rapid	None	0.62	0.17	Boulder	OH (1), CC (65)			-	ATS	ATS, BKT, BNT	-
4	1	1	P	2.6-3.5	1.3-2.2	154	Rapid	Riffle	0.20	0.06	Boulder	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	1	P	2.0-3.6	0-2	126	Riffle	Rapid	0.13	0.03	Gravel	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Watercourse	Reach	Stream Order	Flow Type[1]	Reach Characteristics									Fish Support[6]						
				Channel Width (m)[2]	Wetted Width (m)[2]	Reach Length (m)	Dominant Habitat Type	Other Habitats Present	Average Velocity (m/s)	Average Depth (m)	Dominant Substrate	Average Cover (%)[3]	Confirmed Species	Probable Species[5]	Suitable Habitat			
															Spawning	YOY	Juvenile	Adult
	3	1	I	2.2-4.3	0	80	Flat	None	0	0	Cobble	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[1]Perennial (P) – A stream that flows continuously throughout the year, Intermittent (I) – Streams that go dry during protracted rainless periods when percolation depletes all flow, Ephemeral (E) – A watercourse that flows during snowmelt and rainfall runoff periods only (AT, 2009).
[2]Ranges are provided for reaches measured through multiple transects.
[3]Cover categories include instream (IN: within the streambed in the form of large woody debris, boulders, undercut banks); overhanging (OH: riparian cover overhanging the stream within 1 m of surface; and aquatic vegetation (AQ: submergent and emergent vegetation within the stream), and canopy cover (CC; proportion of stream that is shaded by riparian vegetation).
[4]Probable species presence determined for watercourses based on direct aquatic connectivity with another fisheries resource with confirmed species presence and habitat suitability
[5]Species codes: Atlantic salmon (ATS), brook trout (BKT), brown trout (BNT).

Table 3-6. Fish Habitat Characteristics and Species Life Cycle Provisions of Select Waterbodies within the Study Area

Waterbody ID	Area (m²)	Average Depth (m)	Dominant Substrate	Dominant Vegetation	Cover (%)[1]	Fish Support[3]					
						Confirmed Species	Probable Species[2]	Suitable Habitat			
								Spawning	YOY	Juvenile	Adult
Open Water C (WL5)	12,705	>1	Muck/ Detritus	*Typha latifolia*	50	-	BKT	-	-	-	BKT
Open Water E (WL1)	2,045	1	Muck/ Detritus	*Typha latifolia*	25	-	BKT	-	-	-	BKT
Open Water F (WL1)	127	1	Muck/ Detritus	*Typha latifolia*	60	-	BKT	-	-	-	BKT
Open Water G (WL1)	138	1	Muck/ Detritus	*Typha latifolia*	60	-	BKT	-	-	-	BKT
WL Mosaic A (WL5)	461	0.14	Muck/ Detritus	*Onoclea sensibilis*	70	-	BKT	-	-	-	-
WL Mosaic B (WL5)	165	0.07	Muck/ Detritus	*Typha latifolia*	50	-	BKT	-	-	-	-
WL Mosaic D (WL1)	1,213	0.42	Muck/ Detritus	*Typha latifolia*	60	-	BKT	-	-	-	BKT

[1]Cover is approximated from the waterbody edge and estimated s a sum of all available cover types present (overhanging vegetation, aquatic vegetation, woody debris).
[2]Probable species presence determined for watercourses based on direct aquatic connectivity with another fisheries resource with confirmed species presence and habitat suitability.
[3]Species codes: Atlantic salmon (ATS), brook trout (BKT), brown trout (BNT).

3.2.3.1 *Watercourse 1, Watercourse 2, and Associated Waterbodies*

WC1 is a first-second order stream that is sourced from the existing on-site settling ponds and flows southeast through WL1. From the outlet of the settling ponds, WC1 quickly disperses into a wetland mosaic (D) before rechannelizing. The watercourse continues southeast through WL1, where it varies between channelized and ponded habitats (Open Water E, F, and G) as a result of multiple beaver dams on the system. WC2 is a first order tributary to WC1 which collects upland drainage and seeps from WL2, eventually flowing south through WL1 to connect to WC1.

WC1 composes three homogenous, slightly entrenched fish habitat reaches. All are defined as slow runs which located between the multiple small waterbodies. Reach 1 and Reach 1B (a side channel) contain other microhabitats (<5 m in length) including riffles and pools. Channel widths range from 1 to 15 m, which generally expand towards its downstream end. All three reaches are dominated by muck (i.e., organic) substrates, which is characteristic of a wetland stream. Minor cover is provided by sporadic aquatic and overhead vegetation within the channelized reaches, with the stream becoming increasingly less shaded as it opens through WL1 towards its downstream end.

Wetland Mosaic D is characterized by sporadic, unconsolidated flow through dense, marsh-like (cattail) vegetation. Open Water E, F, and G are small, ponded features with similar characteristics, having formed as a result of beaver dams. Aquatic vegetation is dominated by cattail but is significantly less dense than that present in Wetland Mosaic D. Thick muck is the dominant substrate throughout, and water depths average approximately 1 m.

No fish were captured in WC1 through fish collection efforts; however, based on the confirmed presence of brook trout within WC3, it is conservatively assumed that fish may access this system. The multiple beaver dams likely impose an obstacle to fish passage but are unlikely to be complete barriers to all fish species and life stages. WC1 and its associated waterbodies provide suitable habitat for adult brook trout, who may be found across all substrate types and within low velocity habitats for foraging opportunities and refuge. The watercourse lacks the substrate, velocity/depth, and cover complexity to support other life stages of the species (spawning and juvenile rearing).

WC2 is characterized as a 204 m long, low velocity and slightly entrenched run with sparse riffle habitat. As the watercourse enters WL1, flow goes underground for approximately 4 m before resurfacing. The watercourse is well shaded but provides little diversity in cover, and substrates are dominated by muck. Similar to WC1, the watercourse provides potential foraging opportunities for adult brook trout but is unlikely to support any other life stage.

3.2.3.2 *Watercourse 3 and Associated Waterbodies*

WC3 is a topographically mapped first-second order stream which originates from Wetland Mosaic A at the northern extent of WL5. The watercourse continues to flow south through WL5, dechannelizing into WL Mosaic B and then again into the largest open water feature in the Study Area (C). The watercourse rechannlizes as WL5 narrows, then travels south through upland habitat and exits the Study Area at Stillman Road. WC3 is a direct tributary to Six Mile Brook.

Wetland Mosaic A is a small, wetted area of WL5 with water diffused through heavy vegetation. Water is relatively shallow throughout (average 14 cm) and highly obscured by sensitive fern and emergent vegetation. Substrate is comprised entirely of muck.

Reach 1 of WC3 extends from the outlet of Wetland Mosaic A to Open Water C (and includes Wetland Mosaic B). The reach is described as an intermittent, low velocity flat, with channel widths ranging between 1.2 and 2.7 m. Average water depth is 11 cm and muck dominates the substrate. Sporadic instream aquatic

vegetation and overhanging vegetation provide some cover for the stream, which is mostly shaded. Within the reach there are multiple, short areas where the channel becomes undefined or flow goes underground, which likely pose as barriers to fish passage during dryer periods. Wetland Mosaic B is characteristically similar to Wetland Mosaic A but smaller in area and shallower.

Open Water C is a large, flooded area of WL5 that has inundated as a result of beaver activity. Remaining snags would suggest that the wetland was a former treed swamp that has transitioned to more marsh-like characteristics as a result of the impoundment. Water depths exceed 1 m throughout the pond and muck dominates the substrate.

The outlet of Open Water C forms from two branches of WC3, denoted as Reach 2 (the primary channel) and Reach 2B. The two reaches share similar habitat characteristics and are described as runs. Muck dominates the substrate and along with aquatic and overhanging vegetation, undercut banks provide minor amounts of instream cover.

Reach 3 begins near the southern tip of WL5, where the channel gains gradient through upland habitat. The reach is described as a series of moderate velocity riffles and runs with smaller pools providing micro-habitats throughout the reach. Substrate is dominated by both muck and gravels, and a cover is provided by a combination of undercut banks, aquatic and overhanging vegetation. Reach 3 contains the Stillman Road crossing; a corrugated metal pipe of approximately 1.6 m in diameter. The bottom is slightly rusted but intact, and no visible fish passage impediments were noted. The last 46 m of WC3 (Reach 4, before emptying into Six Mile Brook), is a higher gradient, high velocity rapid dominated by boulder substrates.

Electrofishing conducted within Reach 3 of WC3 resulted in the captured of both juvenile (including young-of-year) and adult brook trout, which is a likely indication that successful spawning is occurring within the stream. No fish were captured through trapping efforts within Open Water C, which may be a result of the beaver dam on the system. Fish passage is further impeded through Reach 1 by multiple underground and dechannelized sections of watercourse. Still, the upper reaches of WC3 (1, 2, and 2B) and Open Water C may provide foraging and refuge opportunities for adult brook trout. The habitat complexity, water depths, velocities, and gravel substrates documented in Reach 3 are considered to support all life stages of brown and brook trout, and the spawning and juvenile rearing of Atlantic salmon (should they enter the watercourse from Six Mile Brook). No suitable adult salmon habitat in the form of deep (> 1 m) pools were documented within the watercourse. Reach 4 provides suitable habitat for young of year and juvenile salmon, but the higher velocities are considered prohibitive for young of year trout. Older juvenile brown and brook trout, however, are likely to withstand these velocities.

3.2.3.3 *Watercourse 4*

WC4 is an unnamed, first order stream which originates north (outside) of the Study Area and flows south as a slightly-moderately entrenched channel through upland habitat. The watercourse is perennial with intermittent sections, with its most downstream reach (3) completely dry during the on-site assessment.

The watercourse was delineated into three reaches that transition from higher to lower gradient (rapid, riffle, then flat). Channel widths range from 2 to 4.3 m and at the time of assessment, water depths were shallow throughout. Substrate is composed of a rocky mixture with dominant substrates changing with habitat types.

The watercourse ends in a gravel washout in upland habitat at its downstream extent and does not rechannelize. As no connection to any potentially fish-bearing system was noted, the watercourse is not

considered a fisheries resource. This is supported by the results of electrofishing which resulted in no capture after 1207.4 seconds of effort.

4 SUMMARY

This baseline fish and fish habitat report was prepared as baseline information in anticipation of an EARD for the Six Mile Brook Pit Expansion Project. The report presents the methods and findings of fish and fish habitat studies conducted within the Study Area in 2023. It is anticipated that this information will support the registering of a provincial EARD by understanding the potential project interactions with fish and fish habitat, and to facilitate regulatory permitting for impacts to fish and fish habitat wherever necessary.

Seven watercourses, four small waterbodies and three wetland mosaics were delineated within the Study Area. All watercourses, waterbodies, and wetland mosaics, with the exception of WC4, have been assessed as fisheries resources.

Fish community sampling within the Study Area confirmed the presence of three species: Atlantic salmon, brook trout, and brown trout (of which Atlantic salmon and brook trout are considered priority species). Fish habitat within the Study Area is largely limited in overall provisioning – most watercourses and waterbodies may support adult life stages of brook trout, and the multiple beaver dams present on WC1 and WC3 may serve as obstacles to fish passage. Potential salmonid spawning and rearing habitat is limited to Six Mile Brook and the lower reaches of WC3.

5 LIMITATIONS

The following limitations regarding fish and fish habitat data collection and interpretation are acknowledged:

- Field methods (fish surveys and fish habitat characterization) have been completed by qualified professionals based upon commonly accepted practices in environmental consulting. However, a single assessment may not define the absolute status of fish habitat within the Study Area. Watercourses are highly dynamic systems and conditions and characteristics may change over the lifetime of this Project, either naturally or through non-Project related anthropogenic influences (e.g., climate change). External influencing factors are not considered in this report.

- GPS coordinates taken in the field using handheld Garmin GPS units have inherent accuracy limitation between 3 to 5 m. Watercourse lines, polygons, and observation points identified in this document are based upon these GPS readings and limited by this positional accuracy.

- There is inherent subjectivity in fish habitat characterization (e.g., % substrate composition), which may cause discrepancies between assessors. However, all Project assessors are qualified personnel trained in fish habitat characterization and thus minor differences should not influence conclusions and analysis based upon the collected information.

- All reasonable assessment programs will involve an inherent risk that some site conditions or characteristics may not be detected during surveys. While multi-faceted and targeted surveys are completed to mitigate this risk, reports and analysis on such investigations will be based on reasonable interpretation from representative field sample points, supporting desktop interpretation and professional judgment.

6 CLOSING

This report has considered relevant factors and influences pertinent within the scope of the assessment and has completed and provided relevant information in accordance with the methodologies described herein.

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APPENDIX A : FIGURES

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FIGURE 1

Desktop Hydrology Review

Six Mile Brook Quarry Expansion

Pictou County, NS

Flow Accumulation
NSTDB Mapped Watercourse
NSTDB Contour Line (5 m)

Depth to Saturation

0 - 0.10m
0.11 - 0.50m
0.51 - 2.00m
Mapped Waterbody (NSTDB)
NSECC Wetland Inventory
Proposed Quarry Expansion Area
Historic Workings To Be Remediated Prior IA Expiration June 2024
Pit Floor Currently In use
Area To Be Remediated As Part of EA
Study Area

Six Mile Brook

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 125 250 500 m

1:10,000 Scale when printed @ 11" x 17"

Drawn By: AS
Reviewed By: MM

Project Number: 22-624
Date: 2023-12-19

McCallum Environmental Ltd.

5050000
5049500
5049000
5048500
5048000
5047500

506000 506500 507000 507500 508000 508500 509000

Document Name: 231219_SixMile_EARD_DesktopHydrology

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FIGURE 2

Primary and Secondary Watersheds

Six Mile Brook Quarry Expansion

Pictou County, NS

East River Pictou
Middle River Pictou
West River Pictou
East/Middle/West (Pictou) Primary Watershed (1DP)
Study Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 2.5 5 10 Km

1:250,000 Scale when printed @ 11" x 17"

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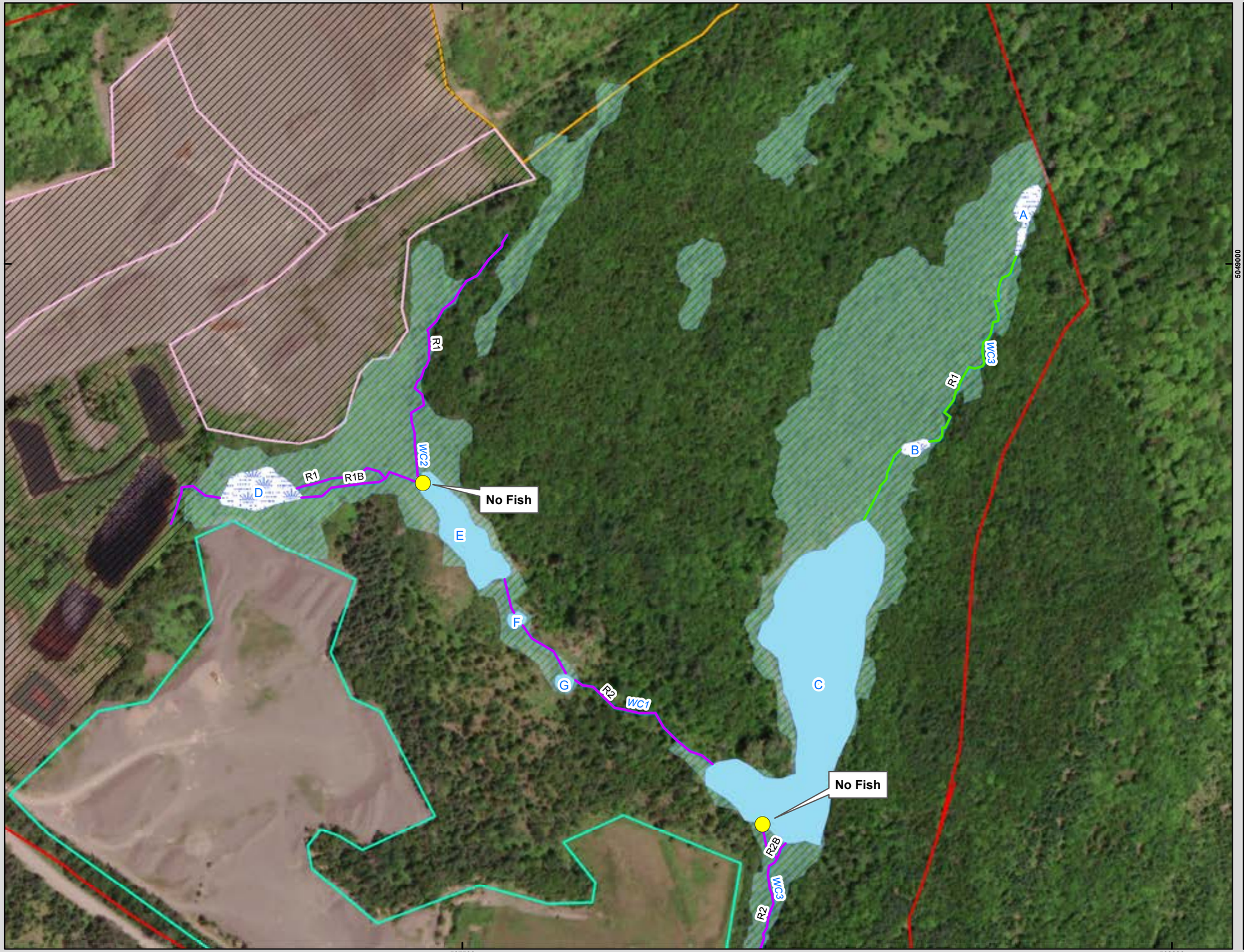
FIGURE 3A

Fish and Fish Habitat Methods and Results

Six Mile Brook Quarry Expansion

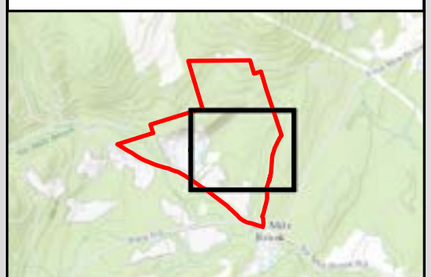
Pictou County, NS



Trapping Location (Grouping)

Habitat Type

- Flat
- Run
- Open Water (Beaver Pond)
- Wetland Mosaic
- Field Delineated Watercourses
- Field Delineated Wetlands
- Proposed Quarry Expansion Area
- Historic Workings To Be Remediated Prior IA Expiration June 2024
- Pit Floor Currently In use
- Area To Be Remediated As Part of EA
- Study Area



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Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

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1:2,500

Scale when printed @ 11" x 17"

Drawn By: AS
Reviewed By: MM

Project Number: 22-624
Date: 2023-12-19

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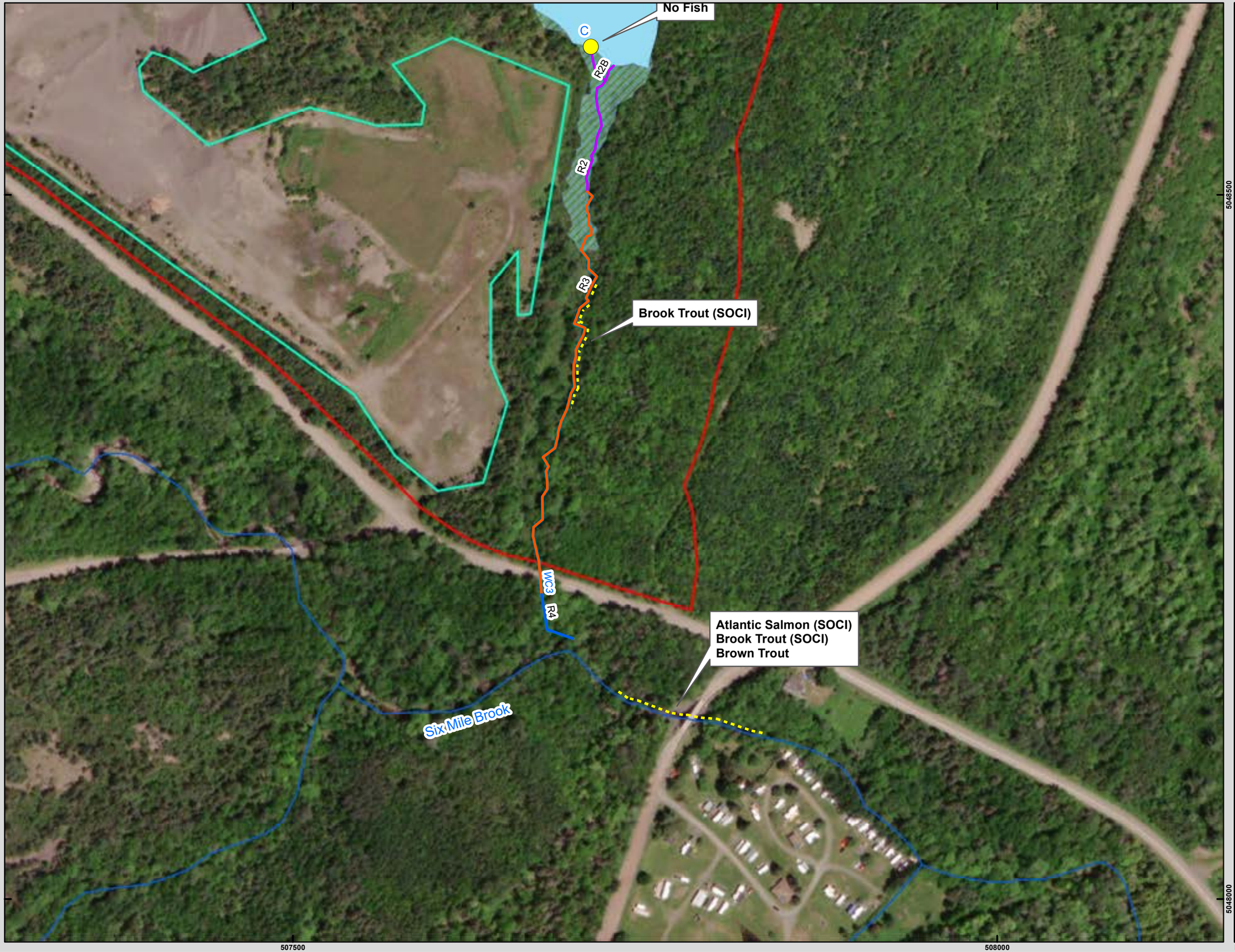
Document Name: 231219_SixMile_EARD_FishSurveyResults



Prepared For:

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FIGURE 3B

Fish and Fish Habitat Methods and Results

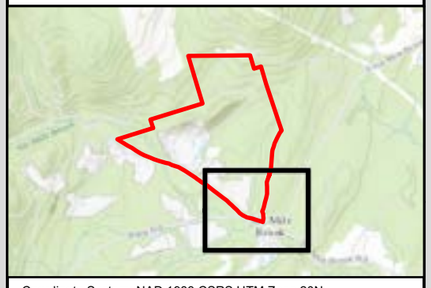
Six Mile Brook Quarry Expansion

Pictou County, NS

- Trapping Location (Grouping)
- Electrofishing Reach

Habitat Type

- Rapid
- Riffle-Run
- Run
- Field Delineated Watercourses
- NSTDB Mapped Watercourse
- Open Water (Beaver Pond)
- Field Delineated Wetlands
- Historic Workings To Be Remediated Prior IA Expiration June 2024
- Study Area
- NSTDB Mapped Watercourse



Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 25 50 100 m

1:2,500

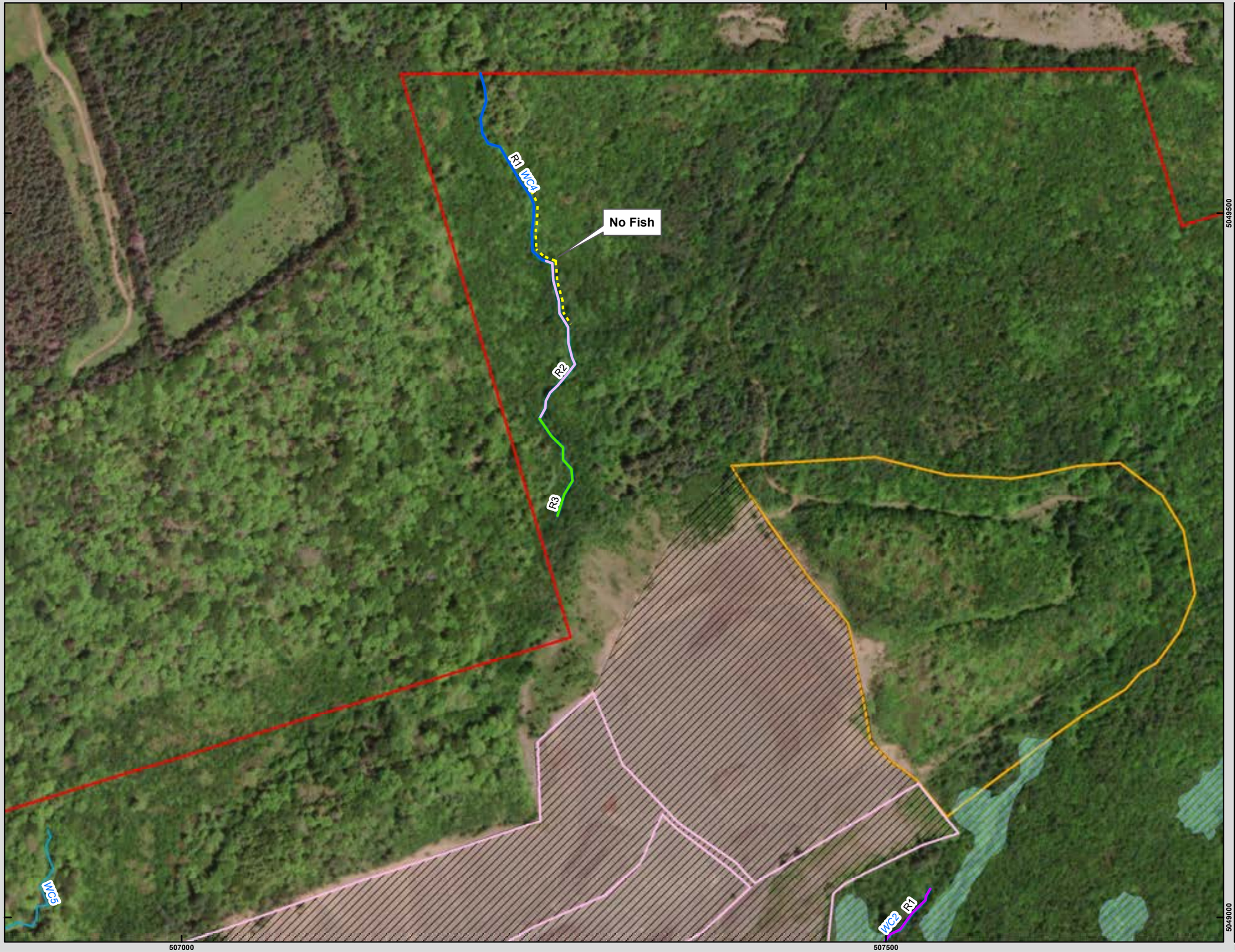
Scale when printed @ 11" x 17"

Drawn By: AS
Reviewed By: MM

Project Number: 22-624
Date: 2023-12-19

McCallum Environmental Ltd.

Document Name: 231219_SixMile_EARD_FishSurveyResults



Prepared For:

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FIGURE 3C

Fish and Fish Habitat Methods and Results

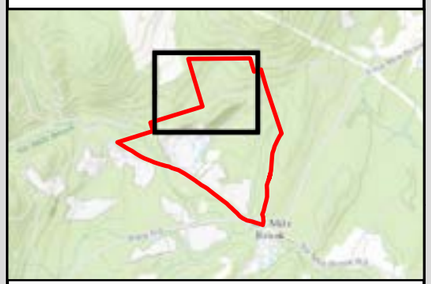
Six Mile Brook Quarry Expansion

Pictou County, NS

Electrofishing Reach

Habitat Type

- Flat
- Rapid
- Riffle
- Run
- Field Delineated Watercourses
- Field Delineated Wetlands
- Proposed Quarry Expansion Area
- Pit Floor Currently In use
- Area To Be Remediated As Part of EA
- Study Area



Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 25 50 100 m

1:2,500 Scale when printed @ 11" x 17"

Drawn By: AS
Reviewed By: MM

Project Number: 22-624
Date: 2023-12-19

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Document Name: 231219_SixMile_EARD_FishSurveyResults

Prepared For:

WEEKS

FIGURE 4

Wetland and Watercourse Field Results

Six Mile Brook Quarry Expansion

Pictou County, NS

WC4
WC5
WC6
WC7
WC2
WC1
WC3
Six Mile Brook
WL1
WL2
WL3
WL4
WL5
A
B
C
D
E
F
G

5049500
5049000
5048500

506500
507000
507500
508000

- Field Delineated Watercourses
- NSTDB Mapped Watercourse
- Open Water (Beaver Pond)
- Wetland Mosaic
- Field Delineated Wetlands
- Proposed Quarry Expansion Area
- Historic Workings To Be Remediated Prior IA Expiration June 2024
- Pit Floor Currently In use
- Area To Be Remediated As Part of EA
- Study Area

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 75 150 300 m

1:6,000

Scale when printed @ 11" x 17"

Drawn By: AS
Reviewed By: MM

Project Number: 22-624
Date: 2023-12-19

McCallum Environmental Ltd.

Document Name: 231219_SixMile_EARD_WL and WC

APPENDIX B: PRIORITY SPECIES LIST

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
			VASCULAR PLANTS			
Agalinis purpurea	Purple False-Foxglove	S2S3	-	-	-	Bogs, calcareous and mafic fens, open floodplain swamps, depression ponds, interdune swales, tidal freshwater marshes and swamps; more numerous in a variety of wet to mesic, open, disturbed habitats, including old fields, clearings, and roadsides. Flowers in late summer to early fall (Digital Atlas of Virginia Forest, nd).
Agalinis purpurea var. parviflora	Small-flowered Purple False Foxglove	S2S3	-	-	-	Sandy soils of stream and lake margins, bogs, and barren (NatureServe, 2021)
Agalinis tenuifolia	Slender Agalinis	S1	-	-	-	Anthropogenic (man-made or disturbed habitats), brackish or salt marshes and flats, fresh tidal marshes or flats, meadows and fields, woodlands https://gobotany.nativeplanttrust.org/species/agalinis/tenuifolia/ ; Exotic to Nova Scotia, http://www.accdc.com/webranks/NSall.htm.
Ageratina altissima var. altissima	White Snakeroot	S1S2	-	-	-	Grows in moist soils at the edge of fields and forests. Flowers late summer, August and September. Known from Mill Brook, McGahey Brook and a brook near Refugee Cove, all in Cape Chignecto Provincial Park; older collection from Antigonish County. (Munro, Newell and Hill, 2014)
Allium schoenoprasum	Wild Chives	S1?	-	-	-	Wet meadows, rocky or gravelly stream banks and lake shores. Flowering June to August (Flora North America).
Allium schoenoprasum var. sibiricum	Wild Chives	S1?	-	-	-	Wet meadows, rocky or gravelly stream banks and lake shores. Flowering June to August (Flora North America).
Allium tricoccum var. burdickii	Narrow-leaved Wild Leek	S1?	-	-	-	DISTRIBUTION NOT KNOWN IN NS. Dry soil in upland woods. Flowering early June (Flora North America).
Amelanchier fernaldii	Fernald's Serviceberry	S2S3	-	-	-	Thickets, open barrens, shores, and ravines. Occurs mostly in calcareous areas. Grows in riparian and shrub wetlands (Nature Serve Explorer, nd). Flowers June - August (Munro, Newell & Hill, 2014).
Amelanchier spicata	Running Serviceberry	S3S4	-	-	-	Man-made or disturbed habitats, cliffs, balds, ledges, forest edges, grassland, meadows and fields, woodlands (GoBotany, nd). Flowers in the spring (NC State Extension, nd)

Andersonglossum boreale	Northern Wild Comfrey	S1	-	-	-	A generalist. along the borders of woods and thickets, along trails and pathways through woods, and within upland deciduous woods. It appears to prefer circumneutral or even calcareous areas. The soils are usually sandy or rocky (New York Natural Heritage Program 2005). Rare in open woods and roadsides (Rhoads and Block 2000). Borders, openings, and clearings or under dense shade in coniferous or mixed woods (fir, cedar, spruce, pine, birch, aspen, and occasionally beech and maple), especially in sandy or rocky soil (Voss 1996). Uplands woods (Gleason & Cronquist 1991). Rich woods and thickets (Fernald 1970). flowers of this plant begin to appear mid-May and persist into early July
Anemone virginiana	Virginia Anemone	S3	-	-	-	Calcareous and slate ledges along streams. Intervals and thickets of same. Flowers in early July (Munro, Newell & Hill, 2014)
Anemone virginiana var. alba	Virginia Anemone	S1S2	-	-	-	Calcareous and slate ledges along streams. Intervals and thickets of same. Flowers in early July (Munro, Newell & Hill, 2014)
Angelica atropurpurea	Purple-stemmed Angelica	S3	-	-	-	Grows in swamps, meadows, in ditches and along streams. Flowers late May until September. Very abundant in northern Cape Breton (Munro, Newell & Hill, 2014)
Antennaria parlinii	Parlin's Pussytoes	S2	-	-	-	Found in dry soils of pine and oak forests, pastures, oldfields, and rocky banks. Flowers in June or July. Only known from along the LaHave River (Bridgewater), the Halfway River (Hants County) and from several Kings County locations. More recently found along the Kennetcook River, Hants County and East Branch River John, Pictou County (Munro, Newell and Hill, 2014).
Antennaria parlinii ssp. fallax	Parlin's Pussytoes	S2	-	-	-	Found in dry soils of pine and oak forests, pastures, oldfields, and rocky banks. Flowers in June or July. Only known from along the LaHave River (Bridgewater), the Halfway River (Hants County) and from several Kings County locations. More recently found along the Kennetcook River, Hants County and East Branch River John, Pictou County (Munro, Newell and Hill, 2014).
Asplenium viride	Green Spleenwort	S3	-	-	-	Limestone and other basic rocks (Flora of North America).

Atriplex glabriuscula var. franktonii	Frankton's Saltbush	S3S4	-	-	-	confined to indigenous salt marsh and beach habitats. t is very common in northern areas, such as the Northumberland Strait region and along Cape Breton's northern coasts. Occasionally seen elsewhere as near Truro and Halifax.
Barbarea orthoceras	American Yellow Rocket	S1	-	-	-	It inhabits ice-scoured river shores on high-pH bedrock or till, and on wet talus in the subalpine zone.
Bartonia virginica	Yellow Bartonia	S3S4	-	-	-	Flowers July to September. Dry barrens, sandy or peaty soils, bogs, lakeshores. Common in the southwestern counties becoming scarcer east to Annapolis and Halifax; St. Peter's area of Cape Breton.
Bidens beckii	Water Beggarticks	S3S4	-	-	-	Found in shallows of sluggish streams and ponds. Flowers during August and September. Scattered throughout but more abundant from Pictou northward. (Munro, Newell and Hill, 2014).
Bidens vulgata	Tall Beggarticks	S3S4	-	-	-	Widely tolerant of habitats, from waste urban ground to dykelands. Scattered from Kings and Cumberland counties to Pictou. Reported to be common at Truro. Flowers through late summer (Munro, Newell & Hill, 2014).
Botrychium lanceolatum	Triangle Moonwort	S2S3	-	-	-	Kentville Ravine (Kings County); Colchester, Cumberland and a few sites in western Cape Breton. Rare where found and of limited distribution in the Northern counties. Found where there are fertile soils on wooded hillsides. Bogs, fens, forests, meadows, fields, swamps and edges of wetlands. This species releases its spores later than most moonworts (July to August) (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Botrychium lanceolatum ssp. angustisegmentum	Narrow Triangle Moonwort	S2S3	-	-	-	Kentville Ravine (Kings County); Colchester, Cumberland and a few sites in western Cape Breton. Rare where found and of limited distribution in the Northern counties. Found where there are fertile soils on wooded hillsides. Bogs, fens, forests, meadows, fields, swamps and edges of wetlands. This species releases its spores later than most moonworts (July to August) (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).

Botrychium simplex	Least Moonwort	S2S3	-	-	-	Scattered locations from Yarmouth County to Cape Breton: Cedar Lake (Digby-Yarmouth border), West Berlin (Queens County), Petpeswick and in Antigonish, Victoria and Inverness Counties. Reported from various habitats, usually involving damp or mossy streambanks or lakeshores. Also anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: occurs primarily in open sites, including prairies, wetlands, and abandoned mine sites. Spores produced in late May and June (Minnesota DNR, Go Botany and Munro et al., 2014).
Botrychium simplex var. simplex	Least Moonwort	S2S3	-	-	-	Scattered locations from Yarmouth County to Cape Breton: Cedar Lake (Digby-Yarmouth border), West Berlin (Queens County), Petpeswick and in Antigonish, Victoria and Inverness Counties. Reported from various habitats, usually involving damp or mossy streambanks or lakeshores. Also anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: occurs primarily in open sites, including prairies, wetlands, and abandoned mine sites. Spores produced in late May and June (Minnesota DNR, Go Botany and Munro et al., 2014).
Bromus latiglumis	Broad-Glumed Brome	S2	-	-	-	Floodplain (River or stream floodplains), forest, shores of rivers or lakes (Go Botany)
Caltha palustris	Yellow Marsh Marigold	S2S3	-	-	-	Restricted to the Northumberland coast, majority found in Inverness county. Grows in open or treed swamps, alder marshes and meadows. Flowers in early June. Restricted to the Northumberland coastal plain: Mabou, Northeast Margaree, Margaree River, Terre Noir. St. Josephdu-Moine, Cheticamp, Pleasant Bay area, all of Inverness County. North shore of Merigomish Island, Pictou County represents the only mainland collection to date
Cardamine dentata	Toothed Bittercress	S1	-	-	-	rare species of calcareous swamps and fens
Cardamine maxima	Large Toothwort	S2	-	-	-	rich, moist forests. Floodplain (river or stream floodplains), forests, talus and rocky slopes
Carex adusta	Lesser Brown Sedge	S2S3	-	-	-	dry open forest or recent clearings (cutblocks) on acidic, gravelly soils. Frequent after fire. Flowering and fruting from June to September (Munro, Newell & Hill, 2014)

Carex digitalis	Slender Wood Sedge	S1	-	-	-	Generally found in forested habitats: deciduous or mixed deciduous (but focus on richer areas -moist slopes) over a variety of soils. Only found in Keji park at this time. Fruits in early summer. (Munro, Newell & Hill, 2014)
Carex digitalis var. digitalis	Slender Wood Sedge	S1	-	-	-	Generally found in forested habitats: deciduous or mixed deciduous (but focus on richer areas -moist slopes) over a variety of soils. Only found in Keji park at this time. Fruits in early summer. (Munro, Newell & Hill, 2014)
Carex grisea	Inflated Narrow-leaved Sedge	S1	-	-	-	floodplain forest and deciduous woods (Munro, Newell & Hill, 2014)
Carex hirtifolia	Pubescent Sedge	S3	-	-	-	calcareous regions in thickets, deciduous forests and floodplains, forest openings (Illinois Wildflowers, nd). Scattered around the lowlands in the central counties as at Shubenacadie and Brookfield. Also along the Meander and Herbert rivers, Hants Co (Munro, Newell & Hill, 2014)
Carex houghtoniana	Houghton's Sedge	S2S3	-	-	-	sandy soils, along roadsides. Sandy disturbed area.
Carex hystericina	Porcupine Sedge	S2S3	-	-	-	*note: resembles the more common C. lurida, but for the presence of many nerves on the perigynia, extending to the orifice. Habitat: seeps, marshes and shoreline fens. Fruits in late spring to mid-summer. Orange listed (Minnesota Wildflowers, nd)
Carex normalis	a Sedge	S1	-	-	-	Open, often wet, woods, thickets, meadows and roadsides. Fruiting early summer (Flora of North America, nd)
Carex pellita	Woolly Sedge	S2	-	-	-	Wet soils in fields, meadows and marshes, especially in calcareous regions under successional conditions. Flowering and fruiting from May - August. Known only from East River of Pictou, Pictou Co. (Munro, Newell & Hill 2014)
Carex pensylvanica	Pennsylvania Sedge	S1?	-	-	-	Grows in dry, rocky soils as in dry open woodlands. Flowers and fruits produced early to mid-May (Munro, Newell & Hill 2014)
Carex plantaginea	Plantain-Leaved Sedge	S1	-	-	-	Rich, moist, deciduous or mixed deciduous-evergreen forests, on slopes along streams or along edges of moit depressions, southward in mountain gorges. Fruiting in spring (Flora of North America, nd)
Carex rosea	Rosy Sedge	S3	-	-	-	Grows in dry soils beneath deciduous forests and thickets. Flowers from May to early July.

Carex scirpoidea ssp. scirpoidea	Scirpuslike Sedge	S2S3	-	-	-	Moist alpine meadows, stream banks, and open rocky slopes, thin and rocky soils, rock outcrops, and talus slopes. Flowers June - August (DNR WA, nd)
Carex vacillans	Estuarine Sedge	S1S3	-	-	-	Saline, brackish shores, swales, salt and intertidal marshes. Fruiting in June to August (Flora of North America).
Carex viridula ssp. brachyrrhyncha	Greenish Sedge	S1	-	-	-	Found along river and lake shores (Go Botany).
Carex viridula var. elatior	Greenish Sedge	S1	-	-	-	Moist to wet fens and runnels, on lime-rich soils. Fruiting in July-August (Flora North America).
Carex viridula var. saxilittoralis	Greenish Sedge	S1	-	-	-	Moist to wet, exposed shores and limestone barrens. Fruiting July-August (Flora North America).
Caulophyllum thalictroides	Blue Cohosh	S2S3	-	-	-	Shade-tolerant, restricted to river floodplain deciduous forests. Appears in April, until beginning of June. A wide and patchy distribution over the northern portion of the province from Annapolis River to River Denys in Cape Breton (Munro, Newell & Hill, 2014).
Cerastium arvense ssp. strictum	Matted Field Chickweed	S1?	-	-	-	flowers May until frost.cliffs, talus slopes, quarries, rocky beaches, coastal headlands, and in high-pH and serpentine communities. Compacted soils, especially on moist lawns and other arable land
Ceratophyllum echinatum	Prickly Hornwort	S3	-	-	-	Marshes. A plant more typical of the shallows of acidic water bodies than its congener.
Coleataenia longifolia	Long-leaved Panicgrass	S3S4	-	-	-	Marshes, meadows and fields, shores of rivers or lakes (GO Botany).
Coleataenia longifolia ssp. longifolia	Coastal Plain Panicgrass	S3S4	-	-	-	Marshes, meadows and fields, shores of rivers or lakes (GO Botany).
Comandra umbellata ssp. umbellata	Bastard's Toadflax	S2	-	-	-	Found in swamps and bogs, rich mesic sites, dry, sandy or rocky soils, savannas, early successional forests. Flowers March - August (Flora of North America, nd)
Conioselinum chinense	Chinese Hemlock-parsley	S3	-	-	-	Found in treed swamps, mossy coniferous forest, seepy coastal slopes. Flowers from August to October. Common on Saint Paul Island and infrequent elsewhere (Munro, Newell & Hill, 2014).

Conopholis americana	American Cancer-root	S2	-	-	-	Reported from the western half of the province - Parasitic plant found in trees, particularly oaks and other deciduous trees - Flowers April to July (Munro, Newell & Hill, 2014)
Crataegus submollis	Quebec Hawthorn	S2?	-	-	-	Anthropogenic (man-made or disturbed habitats), forest edges, meadows and fields, shrublands or thickets. Flowers in June (GoBotany, nd).
Crataegus succulenta	Fleshy Hawthorn	S3S4	-	-	-	Forest edges, forests, meadows and fields. Also found in abandoned farmland, along streams and in forest openings. Flowers in late spring (Natural Resources Canada, nd).
Crataegus succulenta var. succulenta	Fleshy Hawthorn	S3S4	-	-	-	Forest edges, forests, meadows and fields. Also found in abandoned farmland, along streams and in forest openings. Flowers in late spring (Natural Resources Canada, nd).
Cuscuta cephalanthi	Buttonbush Dodder	S2?	-	-	-	Flowers during August and September. Low-lying coastal areas, often seen parsitizing Symphyotrichum novi-begii.Anthropogenic (man-made or disturbed habitats), meadows and fields, shores of rivers or lakes, swamps
Cyperus lupulinus ssp. macilentus	Hop Flatsedge	S1	-	-	-	Various well-drained, open places. Fruiting summer (Flora North America).
Cypripedium parviflorum var. makasin	Small Yellow Lady's-Slipper	S2	-	-	-	Mesic to wet fens, prairies, meadows, thickets, open coniferous, and mixed forest. Flowering in May to August (Flora of North America).
Desmodium canadense	Canada Tick-trefoil	S2	-	-	-	Flowers in late July. Riparian, open forests. average to moist sandy or rocky soil; prairies, along shores, along roads, railroads, open woods. Kejimkujik Park to the Pictou County rivers. Rare from Annapolis to Colchester Co.
Dichanthelium linearifolium	Narrow-leaved Panic Grass	S3	-	-	-	Soils both dry and sandy. Flowers and fruiting from July to October (Munro, et al., 2014).
Diphasiastrum complanatum	Northern Ground-cedar	S3S4	-	-	-	Infrequent, scattered through the Cobequid hills southwest to the Annapolis Valley and east to Cape Breton. Deciduous forests and brushy hillsides spreading out into abandoned fields. Anthropogenic (man-made or disturbed habitats) habitats, forest edges, forests, meadows and fields. Flowers from July to October (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Diphasiastrum sitchense	Sitka Ground-cedar	S3S4	-	-	-	Has been observed in Kings County to Northern Victoria County. Commonly found on alpine and subalpine barrens or wooded slopes in Northern Nova Scotia. Also found in anthropogenic habitats (man-made or disturbed habitats),

						meadows and fields. Subspecies: somewhat rare but widespread ground-cedar hybrid that frequently occurs in the absence of its parents. No sources that state specific flowering time, most likely during the general growing season in Nova Scotia: June to September (Go Botany and Munro et al., 2014).
Diphasiastrum x sabinifolium	Savin-leaved Ground-cedar	S3?	-	-	-	Has been observed in Kings County to Northern Victoria County. Commonly found on alpine and subalpine barrens or wooded slopes in Northern Nova Scotia. Also found in anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: somewhat rare but widespread ground-cedar hybrid that frequently occurs in the absence of its parents. No sources that state specific flowering time, most likely during the general growing season in Nova Scotia: June to September (Go Botany and Munro et al., 2014).
Eleocharis flavescens	Pale Spikerush	S3	-	-	-	Bogs, brackish or salt marshes and flats, floodplain (river or stream floodplains), marshes, shores of rivers or lakes, wetland margins (edges of wetlands) (Go Botany).
Eleocharis flavescens var. olivacea	Bright-green Spikerush	S3	-	-	-	Bogs, cold springs, dry stream banks, lake and pond margins, maritime mud flats, marshes, moist meadows, swamps. Fruiting summer-winter (June-November) (Flora North America).
Elymus hystrix	Spreading Wild Rye	S1	-	-	-	Meander River and Five Mile River, Hants Co, and East River of Pictou Co. Wooded lowlands and terraces. Fruiting from June to August (Munro, et al., 2014).
Epilobium lactiflorum	White-flowered Willowherb	S1?	-	-	-	Alpine or subalpine zones, cliffs, balds or ledges, shores of rivers or lakes (GoBotany, nd).
Equisetum pratense	Meadow Horsetail	S3S4	-	-	-	Known to be in several streams in Hants, Colchester and Cumberland counties, in addition to Victoria and Inverness Counties. Uncommon and limited to alluvial thickets, pastures and treed streamsides, including gravelly bars. Flowers mid to late spring (Minnesota Environment and Natural Resources Trust Fund and Munro et al., 2014).
Euphrasia farlowii	Farlow's Eyebright	S1S3	-	-	-	Dry, grassy habitats on sandstone or limestone barrens, rocks, ledges, sandy beaches. http://beta.floranorthamerica.org/Euphrasia_farlowii
Fagus grandifolia	American Beech	S3S4	-	-	-	Forests
Fallopia scandens	Climbing False Buckwheat	S3S4	-	-	-	Uncommon and local, from Digby to Richmond counties on the northern side of the province - Grows on low ground in riparian

						zones - Flowers mid-August to October (Munro, Newell & Hill, 2014)
Fimbristylis autumnalis	Slender Fimbry	S1	-	-	-	Moist to wet sands, peats, slits, or clays primarily of disturbed, sunny ground such as seeps, ditches, savanna, stream banks, reservoir drawdowns, and pond shores (Flora of North America)
Fragaria vesca	Woodland Strawberry	S3S4	-	-	-	Forming dense patches in shady forests, ravines. Flowers in June. A white-berried form of this species persists in a number of locations within the province: White Rock, Wolfville, Grand Pré and Barrington. (Munro, Newell & Hill, 2014).
Fragaria vesca ssp. americana	Woodland Strawberry	S3S4	-	-	-	Forming dense patches in shady forests, ravines. Flowers in June. A white-berried form of this species persists in a number of locations within the province: White Rock, Wolfville, Grand Pré and Barrington. (Munro, Newell & Hill, 2014).
Fraxinus nigra	Black Ash	S1S2	Threatened	No Status	Threatened	Black ash is typically found in poorly drained areas that are often seasonally flooded. It is most common on peat and muck soils, but also grows on fine sands over sands and loams. Although this species can tolerate still semi-stagnant conditions, there is a preference for swampy woodland stream and river banks with moving water. It is often associated with species such as Red maple, Speckled alder, Balsam poplar, and Black spruce. The species is shade intolerant, and seedlings, saplings and sprouts tend to regenerates only in partially opened forest canopies.
Fraxinus pennsylvanica	Red Ash	S1	-	-	-	Flowers May - June. Found in riparian and upland forest and shelter belts (Minnesota Wildflowers, nd)
Galium aparine	Common Bedstraw	S3S4	-	-	-	Composts, ballast and waste soils. Flowers from May until July (Munro, Newell & Hill, 2014)
Gentianella amarella ssp. acuta	Northern Gentian	S1	-	-	-	Open and forested river banks, subalpine gullies and brook sides, occurring in regions of high-pH bedrock and/or till.
Goodyera repens	Lesser Rattlesnake-plantain	S3S4	-	-	-	Shady, moist, coniferous or mixed woods, on mossy or humus-covered ground. Sometimes it is found in bogs or cedar swamps. Flowering early July-early September (Flora North America).

Hepatica americana	Round-lobed Hepatica	S2	-	-	-	Local and rare at Bridgewater, New Minas, Windsor, Pictou, Stewiacke, Antigonish and at a couple of North Mountain sites. Recently discovered along the Cogmagun River, Hants Co. Long known from along the St. Andrews River. Populations at Wolfville and St. Croix appear to be extirpated. Grows in dry, mixed deciduous forests. Flowers in April (Munro, Newell & Hill, 2014)
Hordeum brachyantherum	Meadow Barley	S1	-	-	-	Grows in pastures and along streams and lake shores (Flora of North America).
Hordeum brachyantherum ssp. brachyantherum	Meadow Barley	S1	-	-	-	Grows in pastures and along streams and lake shores (Flora of North America).
Humulus lupulus var. lupuloides	Common Hop	S1?	-	-	-	Anthropogenic (man-made or disturbed habitats), floodplain (river or stream floodplains), forests, shrublands or thickets
Huperzia appressa	Mountain Firmoss	S3S4	-	-	-	Also known as Huperzia appalachiana. In Nova Scotia, known from the Fundy coast, Cumberland County (McAlese Brook and Moose River) and Kings County (Amethyst Cove). Also a collection from Clyburne Brook, Victoria County. Found on damp acidic granite as on talus slopes or exposed cliffs. Alpine or subalpine zones, cliffs, balds, or ledges, mountain summits and plateaus, ridges or ledges. Flowers from summer to early fall (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Huperzia selago	Northern Firmoss	S1?	-	-	-	Limited to the northern half of the province, as far west as Brier Island, Digby County. Many localities clustered about the Bay of Fundy, inland to the south-facing slopes of the Cobequids and along the slopes of northern Cape Breton. Grows in rock crevices along streams and moist ravines. Anthropogenic habitats (man-made or disturbed habitats), cliffs, balds, or ledges, forests, meadows and fields, shores of rivers or lakes. Flowers from summer to early fall (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Hylodesmum glutinosum	Large Tick-trefoil	S2	-	-	-	Anthropogenic (man-made or disturbed habitats), cliffs, balds, or ledges, forest edges, forests, ridges or ledges, talus and rocky slopes. Flowers June to August

Hypericum x dissimulatum	Disguised St. John's-wort	S2S3	-	-	-	Wet mucky soils in lacustrine habitats. Historically collected from Digby to Halifax Co. with a single specimen from each of Pictou and Guysborough counties (Munro, Newell & Hill, 2014).
Juncus alpinoarticulatus	Northern Green Rush	S2	-	-	-	Fen, fresh tidal marsshes or flats, marshes, meadows and fields, shores of rivers or lakes. Fruiting mid summer to fall (Go Botany).
Juncus anthelatus	Greater Poverty Rush	S1?	-	-	-	Exposed or partially shaded sites in moist or seasonally wet sandy or clay soils. Flowering and fruiting in spring (Flora North America).
Juncus caesariensis	New Jersey Rush	S3	Special Concern	Special Concern	Vulnerable	New Jersey Rush is reported from 16 bogs and fens on the coastal plain of southeastern Cape Breton Island, Nova Scotia. These sites ranged from the Gracieville/Point Michaud area in the south, northeastwards along the coast to Fourchu Bay, a distance of approximately 50 km. Populations also occurred as much as 20 km inland (vicinity of Loch Lomond). The frequent association of this species with animals and lightly used all-terrain-vehicle trails on the edges of bogs and fens suggests a possible dependence on some level of disturbance for the maintenance of open habitat. These disturbances would reduce competition from other species. Seasonal flooding of New Jersey Rush habitats would also prevent the establishment of many species including shrubs.
Juncus stygius ssp. americanus	Moor Rush	S3	-	-	-	Wet moss, bogs and bog-pools. Flowering and fruiting in mid to late summer.
Kalmia procumbens	Alpine Azalea	S1	-	-	-	Alpine or subalpine zones, ridges or ledges
Laportea canadensis	Canada Wood Nettle	S3	-	-	-	Limited to fertile loam or alluvium in deciduous forests and within floodplains. Flowers from July to September (Munro, Newell & Hill, 2014)
Lindernia dubia	Yellow-seeded False Pimperel	S3	-	-	-	Riparian, muddy streamsides, drained ponds. Flowers from late June until frost (Munro, Newell & Hill, 2014)
Liparis loeselii	Loesel's Twayblade	S3S4	-	-	-	Cool, moist ravines, bogs, or fens, wet peaty or sandy meadows, and exposed sand along edges of lakes, often colonizing previously open and disturbed habitats during early and middle stages of reforestation. Flowering May-August (Go Botany).

Lorinseria areolata	Netted Chain Fern	S3S4	-	-	-	Bogs, meadows and fields, swamps, wetland margins (edges of wetlands) (Go Botany).
Luzula parviflora ssp. melanocarpa	Black-fruited Woodrush	S3S4	-	-	-	uncommon in damp coniferous or mixed woods, cool ravines and banks (Hinds, 2000)
Lysimachia quadrifolia	Whorled Yellow Loosestrife	S1	-	-	-	Anthropogenic (man-made or disturbed habitats), grassland, woodlands, fens, moist prairies (GoBotany, n.d.). Flowers from July - August (LBJ Wildflower Centre, nd).
Malaxis monophyllos	White Adder's-mouth	S1	-	-	-	Found in Fens, ridges or ledges, swamps with northern white-cedar. Flowering in summer (GoBotany).
Malaxis monophyllos var. brachypoda	North American White Adder's-mouth	S1	-	-	-	Found in swamps and bogs. Flower in summer (Flora fo North America).
Mononeuria groenlandica	Greenland Stitchwort	S3	-	-	-	peak flowering time of two weeks in the middle of July,[4] although it does flower anywhere between June to August. isolated and elevated areas. Thin coarse soil or in cracks of acidic rock on open rocky alpine and sub-alpine areas. Sometimes forming large masses in the appropriate habitat.
Neottia bifolia	Southern Twayblade	S3	-	-	-	Bogs and swamps (Go Botany)
Nuphar microphylla	Small Yellow Pond-lily	S3S4	-	-	-	Ponds, lakes, sluggish streams, sloughs, ditches and occasionally tidal waters. Flowers summer - early fall (Flora of North America, nd)
Oenothera fruticosa	Narrow-leaved Evening Primrose	S2S3	-	-	-	Scattered from Yarmouth to the Northumberland Strait - Found in dry open soil habitats such as old fields, edges of thickets and roadsides - Flowers from June to August (Munro, Newell & Hill, 2014)
Oenothera fruticosa ssp. tetragona	Narrow-leaved Evening Primrose	S2S3	-	-	-	Scattered from Yarmouth to the Northumberland Strait - Found in dry open soil habitats such as old fields, edges of thickets and roadsides - Flowers from June to August (Munro, Newell & Hill, 2014)
Ophioglossum pusillum	Northern Adder's-tongue	S2S3	-	-	-	Known from Yarmouth and Digby Counties; scattered east to Halifax and Amherst; a single Cape Breton record from George River. Found in sterile soils, swamps and sandy or cobbly lakeshores. Anthropogenic habitats (man-made or disturbed habitats), marshes, meadows, fields and edges of wetland margins. Spores produced May to August (Go Botany and Munro et al., 2014).

Osmorhiza longistylis	Smooth Sweet Cicely	S2S3	-	-	-	Intervale soils where fertility is high; deciduous forests. Flowers Late June to July. Scattered along the North Mountain in Annapolis and Kings counties to Cumberland Cobequids, infrequent in Cape Breton (Munro, Newell and Hill, 2014)
Oxybasis rubra	Red Goosefoot	S2S3	-	-	-	moist, disturbed soils such pond and lake shores, river and creek banks, and mud flats. Flowers July to September
Oxybasis rubra var. rubra	Red Goosefoot	S2S3	-	-	-	In New York, Red Pigweed has been found along the coast in wet interdunal swales, stony beaches, and the shores of coastal ponds, as well as amongst ship ballast and waste places (New York Natural Heritage Program 2010). Salt marshes (Clemants 1992). Salt marshes and brackish soil (Gleason and Cronquist 1991). Waste ground, shores, and river banks (Voss 1985).
Packera paupercula	Balsam Groundsel	S3S4	-	-	-	Confined to calcareous or gypsum soils, on cliffs, talus and outcrops. Flowers in July. Abundant where found but local to Hants Co. north to northern Inverness Co. (Munro, Newell & Hill, 2014).
Packera paupercula var. paupercula	Balsam Groundsel	S3S4	-	-	-	Confined to calcareous or gypsum soils, on cliffs, talus and outcrops. Flowers in July. Abundant where found but local to Hants Co. north to northern Inverness Co. (Munro, Newell & Hill, 2014).
Panicum dichotomiflorum ssp. puritanorum	Spreading Panicgrass	S1?	-	-	-	Flowering and fruiting from June through October
Parnassia parviflora	Small-flowered Grass-of-Parnassus	S1S2	-	-	-	Rocky seeps. Flowers August to September (Jepson Herbarium, 2021)
Persicaria amphibia var. emersa	Long-root Smartweed	S3?	-	-	-	Bloom on moist soil and are terrestrial-adapted. Flower June - September (Flora of North America)
Persicaria arifolia	Halberd-leaved Tearthumb	S3	-	-	-	Found inf shaded swamps, ponds, tidal marshes along rivers, wet ravine in forests. Flowers July - October (Flora of North America, nd)
Persicaria careyi	Carey's Smartweed	S1	-	-	-	Low thickets, swamps, bogs, moist shorelines, clearings, recent burns, cultivated ground. Flowering July - October (Flora of North America, nd)

Persicaria pensylvanica	Pennsylvania Smartweed	S3S4	-	-	-	Moist, disturbed places, ditches, riverbanks, cultivated fields, shorelines of ponds and reservoirs. Flowers May - December (Flora of North America, nd)
Pilea pumila	Dwarf Clearweed	S3	-	-	-	Usually grows in cool shady habitats as found on forested slopes of maple-beech, in the centre of the Province. Flowers from July - October. So far only known from West Branch, Pictou Co.; Little River, near Brookfield, Halifax Co.; and along the Herbert River, Hants Co. at Woodville.
Piptatheropsis canadensis	Canada Ricegrass	S3	-	-	-	Dry sandy or gravelly soil. Open woods clearings, pine plantations, barrens, wooded slopes. Fruiting season-July (Minnesota Wildflowers).
Piptatheropsis pungens	Slender Ricegrass	S2	-	-	-	Sandy dry forests and savannas on dunes and plains, usually with aspen, oak, jack pine, and/or red pine; rocky forests and summits; rock barrens (Reznicek, Voss & Walters, 2011).
Plantago rugelii	Rugel's Plantain	S3	-	-	-	Grows in anthropogenic (man-made or disturbed habitat), grassland, meadows, fields (GoBotany, nd)
Platanthera hookeri	Hooker's Orchid	S3	-	-	-	Scattered in most of the province, local in the southwestern counties. So far absent from the eastern shore. Grows in open dry forests of mixed conifers. Flower appear from May to August (Munro, et al., 2014).
Platanthera huronensis	Fragrant Green Orchid	S1S2	-	-	-	No good record found. Habitat are known from streamsides, in wetlands, even forests. Flowers throughout the summer (Munro, et al., 2014).
Platanthera obtusata	Blunt-leaved Orchid	S3S4	-	-	-	Fens, Forests, Meadows field and swamps
Podostemum ceratophyllum	Horn-leaved Riverweed	S1	-	-	-	Medium to fast flowing river bottoms with ledge, cobble or sand substrate (GoBotany, nd)
Polygala sanguinea	Blood Milkwort	S3	-	-	-	Previously documented throughout the central/ northern mainland, usually in scant populations - Prefers acidic or run-out soil as found in fallow fields or brushlands - Flowers from late June into October (Munro, Newell & Hill, 2014)
Polygonum aviculare ssp. buxiforme	Box Knotweed	S2S3	-	-	-	Roadsides, vacant lots, sidewalks, packed and nondrifting sands, borders of marshes and dunes. Flowering July - December (Flora of North America, nd)

Polygonum aviculare ssp. neglectum	Narrow-leaved Knotweed	S3?	-	-	-	Found in disturbed areas. Flowers June - November (Flora of North America, nd)
Polypodium appalachianum	Appalachian Polypody	S3	-	-	-	Nova Scotia distrbiution still remains unclear. Habitat is restricted to cliffs, rocky slopes, balds, ridges or ledges and talus. No sources that state specific spore production time, most likely during the general growing season in Nova Scotia: June to September (Go Botany and Munro et al., 2014).
Potamogeton polygonifolius	oblong-leaved pondweed	S1	-	-	-	Occurs in almost any wet or semi-wet oligotrophic and/or acidic habitat so long as flow is not too rapid. It may be found in lakes, slow-flowing rivers, ponds, ditches, seeps and among bog mosses (Wikipedia).
Ranunculus pensylvanicus	Pennsylvania Buttercup	S1	-	-	-	Found in wet fields, ditches, marshes, along shores. Flowers June - August (Minnesota Wildflowers, nd)
Ranunculus sceleratus	Cursed Buttercup	S2	-	-	-	Anthropogenic (man-made or disturbed habitats), fresh tidal marshes or flats, marshes, swamps (GoBotany, n.d.). Flowers May - September (Minnesota Wildflowers, nd)
Ranunculus sceleratus var. sceleratus	Cursed Buttercup	S1S2	-	-	-	Ponds, riverbanks. Flowers from April - June, October (Jepson Herbarium, 2021)
Rhinanthus minor ssp. groenlandicus	Little Yellow Rattle	S1	-	-	-	Grows on disturbed, compacted soils as on roadsides, abandoned fields and the like. Flowers from mid-June through July (Munro, Newell & Hill, 2014)
Rosa acicularis ssp. sayi	Prickly Rose	S1	-	-	-	Across its range, it grows in a wide variety of forested and open habitats, with a wide variety of soil and moisture conditions. Flowers in the spring (Schori, 2003)
Rumex triangulivalvis	Triangular-valve Dock	S2S3	-	-	-	Grows in moist areas and disturbed habitats, meadows and fields (GoBotany, nd)
Salix glauca var. cordifolia	Beautiful Willow	S1	-	-	-	Sand and cobbles among granitic boulders, sandy alluvium, on exposed eskers, scree slopes, Sphagnum bogs, Empetrum heaths, snowbeds. Flowers late May - early July (Flora of North America, nd)
Salix myrtillifolia	Blueberry Willow	S1	-	-	-	Reed bogs, fens, stream banks, subalpine spruce thickets, Pinus contorta woods, sand dunes, coal spoils. Flowers early May - late July (Flora of North America, nd)
Salix serissima	Autumn Willow	S1	-	-	-	Fens, meadows and fields, swamps (GoBotany, nd). Also found in brackish marshy strands, marly lakeshores, treed bogs,

						gravelly stream banks, lakeshores. Flowers from early June to early July (Flora of North America, nd).
Samolus parviflorus	Seaside Brookweed	S3	-	-	-	Prefers wet places, shallow water, often on tidal shores.It can also be found in brackish or salt marshes and flats, fresh tidal marshes or flats, riverine (in rivers or streams), swamps (GoBotany, nd; Newell, L. 1977)
Sanicula odorata	Clustered Sanicle	S1S2	-	-	-	Found only on fertile alluvial soils and on intervales. Flowers during July and August. Found at Five Mile River, Hants County, Cornwallis River, Kings County, West River, Pictou County, Salmon River, Colchester County and Southwest Margaree River, Inverness County (Munro, Newell and Hill, 2014).
Saxifraga cernua	Nodding Saxifrage	S1	-	-	-	Imperfectly drained moist areas (near creeks and lakeshores, on moist ledges and in exposed dry sites); acidic, or calcareous, or nitrophilous (often near Thule sites and human habitation), or circum-neutral. Spring to summer flowering time (Aiken et al. 2007)
Saxifraga oppositifolia ssp. oppositifolia	Purple Mountain Saxifrage	S1	-	-	-	Arctic and alpine tundra, mountain ledges, rock crevices, calcareous gravel, raised beach ridges. Flowers spring - summer (Flora of North America, nd)
Sceptridium dissectum	Dissected Moonwort	S3	-	-	-	Frequent in the southwestern counties and scattered eastward to Cape Breton. Not abundant but often seen. Generally in sandy, gravelly, grassy or open soils. Spores from September to November (Munro et al., 2014).
Solidago hispida	Hairy Goldenrod	S1?	-	-	-	Grows in wooded banks and rocky shores. Infrequent, occasionally seen from Yarmouth to Colchester counties (Munro, Newell & Hill, 2014).
Solidago hispida var. hispida	Hairy Goldenrod	S1?	-	-	-	Grows in wooded banks and rocky shores. Infrequent, occasionally seen from Yarmouth to Colchester counties (Munro, Newell & Hill, 2014).
Solidago rugosa var. sphagnophila	Cedar-swamp Goldenrod	S1S3	-	-	-	Frequents waste soils, forests and fallow fields. Flowers late in August through September. Common throughout the province (Munro, Newell & Hill, 2014).
Sparganium androcladum	Branching Bur-Reed	S1	-	-	-	Found in lakes, ponds, rivers ro streams or the shore of rivers or lakes (Go Botany).

Spiranthes lucida	Shining Ladies'-Tresses	S2S3	-	-	-	Few Know locations in central NS. Grows in alluvial soils and damp rocky shores. Found in thickets and meadows. Flowers appear in early July (Munro, et al., 2014).
Symphyotrichum boreale	Boreal Aster	S3	-	-	-	Favours lacustrine gravels, streamsides and edges of peatlands. Flowers during August and September . Scattered from Yarmouth to Cape Breton uncommon (Munro, Newell & Hill, 2014).
Symphyotrichum ciliolatum	Fringed Blue Aster	S3	-	-	-	Favours open fields, lawns and edges. Flowers during August and September. Scattered from Hants and Colchester counties to Cumberland, Pictou and Inverness counties (Munro, Newell & Hill, 2014).
Thalictrum confine	Northern Meadow-rue	S1	-	-	-	Alluvial or shingly calcareous shores and talus. Flowers June - July (Flora of North America, nd)
Thuja occidentalis	Eastern White Cedar	S2S3	-	-	-	Found in riparian areas along streams, in swamps, along lakeshores, in woodland forests and in old pastures. It is shade-tolerant and typically occurs in cool, moist habitats that are nutrient rich. It does best in moderate drainage conditions that are neither too wet nor dry. Eastern White Cedar is typically observed in cool, moist shaded areas.
Tiarella cordifolia	Heart-leaved Foamflower	S2S3	-	-	-	Alluvial soils, deciduous forests even stony roadsides. Flowers mid-May to mid-June (Munro, Newell & Hill, 2014)
Toxicodendron vernix	Poison Sumac	S1	-	-	-	Usually found in swamps or marshes. Flowers from May to July. Only known in Telfer Lake and Apple Tree Lake in Queens county (Munro, Newell & Hill, 2014)
Trichostema dichotomum	Forked Bluecurls	S1	-	-	-	Relatively new to Nova Scotia. Found in anthropogenic/disturbed habitats, grasslands, meadows and fields, sandplains and barrens (GoBotany, nd). Flowers from August to October (Peterson & McKenny, 1968).
Triosteum aurantiacum var. aurantiacum	Orange-fruited Tinker's Weed	S3	-	-	-	Dry-mesic to mesic forests, woodlands, and forest borders
Utricularia ochroleuca	Yellowish-white Bladderwort	S1	-	-	-	Shallow (generally <30cm) acidic waters. Flowers June - September (Jepson Herbarium, 2021)
Verbena hastata	Blue Vervain	S3S4	-	-	-	Limited to mucky fertile soils, as along floodplains. Flowers during August - September (Munro, Newell & Hill, 2014)
Veronica catenata	Pink Water-Speedwell	S1	-	-	-	Shores of rivers or lakes, wetland margins (edges of wetlands) (GoBotany, nd). Flowers May - September (Minnesota Wildflowers, nd)

Viola nephrophylla	Northern Bog Violet	S3	-	-	-	Cool, mossy sites: bogs, streamsides and wet woods. Flowers May - July (Munro, Newell & Hill, 2014)
Viola sagittata var. ovata	Arrow-Leaved Violet	S3S4	-	-	-	Open woods and thickets, disturbed ground, roadsides, powerline rights-of-way. Flowers April - June (Flora of North America, nd)
Woodsia glabella	Smooth Cliff Fern	S2S3	-	-	-	Mainland Nova Scotia has a single locality in Jeffers Brook, Cumberland County. The remainder of known sites are in Northern Nova Scotia: Big Southwest Brook, Lockhart Brook, and on Sky Glen Mountain. A very rare fern, only found on vertical cliffs or streamside (e.g. cliffs, balds, or ledges, ridges or ledges). Spores produced in summer to early fall (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
LICHENS						
Anzia colpodes	Black-foam Lichen	S3	Threatened	Threatened	Threatened	Anzia colpodes requires mature deciduous tree habitats with high humidity and high light levels. The required humidity is supplied by wetlands, nearby brooks, lakes or by the host's position on upland slopes above a water body. Host tree trunks are usually free of dense undergrowth and the lichen usually occurs at or above the height of the undergrowth (in swamps and fens). A few of the Anzia collections from are reported to be from the canopy of Red Maple trees. Recent searches have found that A. colpodes occurs from 20 cm above the ground to 2 m up the tree trunks.
Erioderma pedicellatum	Boreal Felt Lichen	S1	Endangered	Endangered	Endangered	The existing boreal felt lichen occurs within 25 km of the sea coast at an elevation of up to 300 m above sea level and they are found in forested habitats with low open crown closure. Boreal Felt Lichens are typically found in balsam fir stands, on north-facing trunks of mature and overmature trees. Habitat preference for boreal felt lichen is cool and moist and remains relatively constant throughout the year. They are often located on or at the base of slopes with northern or northeastern exposure.

Pectenia plumbea	Blue Felt Lichen	S3	Special Concern	Special Concern	Vulnerable	The Blue Felt Lichen is usually found on the trunks of old broad-leaved trees growing in moist habitats or close to streams and lake margins. This lichen occurs in coastal suboceanic areas but also some distance inland in damp valleys. It prefers cool, humid woodlands that may be mixed coniferous/hardwood or dominated by deciduous trees. The Blue Felt Lichen seems to prefer mature deciduous trees, particularly maple, ash and yellow birch. At its northerly limit of distribution in Nova Scotia, the Blue Felt Lichen has once been found on moss-covered rocks.
Peltigera hydrothyria	Eastern Waterfan	S1	Threatened	Threatened	Threatened	Eastern Waterfan grows attached to rocks at or below water level in clear, cool, partially shaded streams. Small waterfalls, exposed boulders and sinuous stream configurations create quiet or protected backwaters where the lichen grows outside the main current. In summer, this lichen is often partially or completely exposed during low water flow periods. Partial shade may be needed to help keep humidity high and temperatures low during summer months.
Sclerophora peronella (Atlantic pop.)	Frosted Glass-whiskers (Atlantic population)	S3S4	Special Concern	Special Concern	-	Collections from Nova Scotia were on exposed heartwood of living red maple trees growing in old-growth hardwood stands. Frosted Glass-whiskers grows on old deciduous trees, usually on the exposed heartwood of living trunks and more rarely on bark, in humid and rather shaded situations. This arboreal lichen is often associated with old-growth forests in coastal regions, but it is also found in open forests, in clearings, and on the margins of old deciduous forests (COSEWIC Assessment and Status Report).

MAMMALS						
Alces alces	Moose	S1	-	-	Endangered	Moose are herbivores who live in boreal and mixed-wood forests. They are often found where there is an abundance of food (twigs, stems, and foliage of young deciduous trees and shrubs). In spring, islands and peninsulas are often used by cows when giving birth. In summer, access to wetlands (and aquatic vegetation) is important.

Lasionycteris noctivagans	Silver-haired Bat	S1M, SUB	-	-	-	Most commonly found in boreal or coniferous and deciduous forests near bodies of water. Summer day roosts are typically under loose bark in trees such as, willows, maple, ash and dead trees. Maternity colonies can be found in cavities in these trees. Uncommonly, they use human structures (garages, sheds, etc). During the winter, these bats have been found in caves and other rocky areas that provide shelter, in tree cavities, and in buildings.
Lasiurus borealis	Eastern Red Bat	S1M, SUB	-	-	-	Lives in forests, forest edges, and hedgerows. It roosts among foliage, usually in deciduous trees, but sometimes roosts in coniferous trees. Rare in heavily urbanized areas.
Lasiurus cinereus	Hoary Bat	S1M, SUB	-	-	-	They prefer deciduous and coniferous trees at the edge of clearings, but have been found in trees in heavy forests, open wooded glades, and shade trees along urban streets and in city parks.
Myotis lucifugus	Little Brown Myotis	S1	Endangered	Endangered	Endangered	Little Brown Myotis is one of the few bat species that uses buildings and other anthropogenic structures (e.g., bat boxes, bridges, and barns) to roost (particularly for maternity roosting), but it will also use cavities of canopy trees, foliage, tree bark, crevices on cliffs, and other structures.
Myotis septentrionalis	Northern Myotis	S1	Endangered	Endangered	Endangered	Northern Myotis may hibernate in cooler sections of a cave. Northern Myotis will generally return to the same hibernaculum, but not always in consecutive years. Northern Myotis roost singly or in small groups and favour tree roosts (under raised bark and in tree cavities and crevices), but they can also be found in anthropogenic structures (e.g., under shingles). Northern Myotis' maternity roosts are strongly associated with forest cover, streams, and tree characteristics (e.g., species, height, diameter, age, and decay). Females prefer to roost in tall, large diameter trees in early- to mid-stages of decay. Maternity colonies in Nova Scotia were generally in larger-than-average trees. Males generally roost alone under raised bark or within cavities of trees in mid-stages of decay.
Pekania pennanti	Fisher	S3	-	-	-	They are often found in deciduous and mixedwood forest stands in the forested region. They can also be found in wetland vegetation types including shrubby swamps, shrubby bogs, and marshes. There is a higher likelihood to find them in harvested stands compared to naturally regenerating stands of similar age.

Perimyotis subflavus	Tricolored Bat	S1	Endangered	Endangered	Endangered	Tri-colored Bat often select the deepest part of caves or mines where temperature is the least variable, have strong humidity level preferences, and use warmer walls than other species. They have been recorded within any one hibernacula, possibly because they tend to hibernate solitarily (i.e., not in clusters) in the deepest sections of the caves/mines. Tri-colored Bats exhibit high fidelity to hibernacula. Roosts provide thermal regulation, shelter from weather and predation, and can be sites for social interaction. Individuals may switch roosts regularly and therefore, may use a network of roosts in a roosting area. The tendency to switch roosts may depend on species, sex, age, reproductive status, and roost type.
Sorex maritimensis	Maritime Shrew	S3	-	-	-	Often found in marshes and wet meadows The most favoured habitat is the edges of freshwater swamps and marshes which have become overgrown with tangled grass and rushes.
Sorex palustris	American Water Shrew	S3S4	-	-	-	Mostly aquatic, the water shrew lives beneath the overhanging banks and in rock crevices along the edges of swiftly flowing mountain streams. Rhododendron and yellow birch are usually the dominant vegetation in these areas.
Synaptomys cooperi	Southern Bog Lemming	S3	-	-	-	They are often found in sphagnum bogs and low moist places, but they are also found in grasslands, mixed deciduous/coniferous forests, spruce-fir forests, freshwater wetlands, marshes, and meadows. They prefer areas with a thick mat of herbaceous and shrubby vegetation.

HERPETOFAUNA

Chelydra serpentina	Snapping Turtle	S3	Special Concern	Special Concern	Vulnerable	They are common in southwestern Nova Scotia and less common on the northeastern mainland. Although Snapping Turtles occupy a wide variety of habitats, the preferred habitat for this species is characterized by slow-moving water with a soft mud bottom and dense aquatic vegetation. Established populations are most often found in ponds, marshes, swamps, peat bogs, shallow bays, river and lake edges, and slow-moving streams. turtles appear to prefer the following characteristics for their hibernacula: water shallow enough to let the turtle reach the surface to breathe, but deep enough so the water will not freeze to the bottom; a location that is likely to freeze over later in the season and thaw earlier in the spring; a thick layer of mud in which the turtle can bury itself; and additional submerged cover, such as a floating mat of vegetation, roots, stumps, branches or logs, a muskrat dwelling or an overhanging bank.
Chrysemys picta picta	Eastern Painted Turtle	S4	Special Concern	Special Concern	-	Eastern Painted Turtle is found in New Brunswick, Nova Scotia, and the Atlantic coastal states east of the Appalachian Mountains. Painted Turtles occupy slow moving, relatively shallow and well-vegetated wetlands (e.g., swamps, marshes, ponds, fens, bogs, and oxbows) and water bodies (e.g., lakes, rivers, creeks, and streams) with abundant basking sites and organic substrate. These turtles are found in association with submergent aquatic plants, which are used for cover and feeding. The species is semi-tolerant of human-altered landscapes and may occasionally be found occupying urban ponds and lands subject to anthropogenic disturbance (e.g., farm ponds, impoundments, water treatment facilities). Suitable nesting habitat includes open, often south-facing, and sloped areas with sandy-loamy and/or gravel substrate usually within 1200 m of aquatic active season habitats. Painted Turtles overwinter in shallow water with deep sediment (COSEWIC Assessment and Status Report).

Glyptemys insculpta	Wood Turtle	S2	Threatened	Threatened	Threatened	Wood Turtles are strongly associated with meandering, shallow rivers with sand, gravel, and/or cobble bottoms; these rivers are typically clear, with moderate current and frequent oxbows. Wood Turtles hibernate aquatically in streams and rivers (October to April, depending on location). Overwintering sites are usually on the bottom of deep pools, often with fallen debris that provides structure and prevents dislodging during high flow events. Found throughought the Province with concentrations in Guysborough and Annapolis Counties. Local plants include alders, chokecherry, hawthorn and mixed wood stands of deciduous and coniferous trees. Females lay their eggs in sandy bars along rivers and other gravel areas (driveways, roadsides, borrow pits) in June.
Hemidactylium scutatum	Four-toed Salamander	S3	-	-	-	Four-toed salamanders have specialized habitat requirements which require suitable breeding wetlands within or adjacent to mature forests. They prefer mature, mesic forests with dense canopy cover to preserve body moisture, an abundance of downed woody debris for cover and foraging opportunities, and vernal pools, ponds, bogs, shallow marshes, or other fishless bodies of water for nesting and larval success. Wooded wetlands such as seepage swamps or cedar swamps with many moss mats are ideal. Male adults can be located under leaves, bark, and logs in the upland forest, while females are most often found during the breeding season nesting in moss mats which overhang pools of water. (Harding 1997).

AVIFAUNA						
Accipiter cooperii	Cooper's Hawk	S1?B,SUN,SUM	-	-	-	Not common in Nova Scotia but does breed in the province. Found in mature forest, open woodlands, wood edges and river groves. Nests in coniferous, deciduous and mixed woods, typically those with tall trees and with openings or edge habitat nearby. Also found among trees along rivers through open country, and increasingly in suburbs and cities where tall trees exist for nesting (e.g., parks, open fields and even backyards with feeders). Breeds between April and July (Audubon and The Cornell Lab)
Accipiter gentilis	Northern Goshawk	S3S4	-	-	-	Found in coniferous and mixed forests. Generally restricted to wooded areas (along riparian corridors) but may be in relatively open woods or along edges. Often more common as a breeding bird in mixed woods (e.g., mature and old-growth forests with more than 60% closed canopy). In the East, goshawks seek out nest sites in mixed-hardwood forests where beeches, birch, hemlock and maples dominate. Goshawks often build nests near breaks in the canopy, such as a forest trail, road or opening created by a downed tree and prefer sites with a creek, pond or lake nearby. Breeds between April and July. May mate for life (Audubon and The Cornell Lab).
Actitis macularius	*Spotted Sandpiper*	S3S4	Spotted Sandpiper	-	-	Common near fresh and saltwater. Habitat includes pebbly lake shores, ponds, and stream sides (and seashores in the winter). Spotted Sandpipers spend the winter along the coasts of North America. During migration and winter, this species is found along the coast on mudflats, beaches, and breakwaters (also found in inland habitats such as sewage ponds and irrigation ditches). Breeds near the edge of fresh water in a wide variety of settings, including lakes, ponds, rivers, and streams (in either open or wooded country). Breeding territories generally need to have a shoreline, a semi-open area for the nest and patches of dense vegetation to conceal the

						chicks. Breeds between April and July (Audubon and The Cornell Lab).
Aegolius funereus	*Boreal Owl*	S2?B,SUM	-	-	-	Year-round resident, mainly in Cape Breton (MBBA, as of July 2021). Does not migrate regularly, but is nomadic and moves outside of range when prey is scarce. Boreal Owls occur in stands of spruce, aspen, poplar, birch and fir in the boreal forest (muskeg, mixed-wood and conifer forests). They also occur in high elevation mountains with subalpine forests in Canada. In the winter, they forage in spruce-fir forests where uncrusted snow under the trees facilitates access to prey. In spring, they often forage in clearcuts and agricultural fields where small mammals are easier to locate. Beginning in late winter or early spring, male sings at night to defend territory and attract a female (Audubon and The Cornell Lab).K
Anas acuta	Northern Pintail	S1B,SUM	-	-	-	Found in marshes, prairies, fresh ponds, lakes and salt bays. Summers in wide variety of open habitats, including prairies, farmland, northern tundra and near bodies of water. Breeds in seasonal wetlands, open areas with short vegetation, wet meadows, grasslands and crop fields. During the nonbreeding season they use flooded and dry agricultural fields, lakes, reservoirs, estuaries, saltmarshes, freshwater and brackish wetlands and bays. Pintails also use different habitats depending on time of day (e.g. tend to forage in wetlands during the day). Breeds between April and July (Audubon and The Cornell Lab)
Antrostomus vociferus	Eastern Whip-Poor-Will	S1?B	Threatened	Threatened	Threatened	Roughly 50% of home ranges consisted of open habitats, used primarily for foraging. Common habitat choices include rock or sand barrens with scattered trees, savannahs, old burns or other disturbed sites in a state of early to mid-forest succession, or open conifer plantations. Accordingly, pine

						(barrens and plantations), oak (barrens and savannahs), and aspen and birch (early to mid-succession) are common tree species associations. Individuals will often feed in nearby shrubby pastures or wetlands where perches, and power-line and roadway corridors are also occupied. Other necessary habitat elements are thought to involve ground-level vegetation and woodland size. Areas with little ground cover are preferred.
Asio flammeus	Short-eared Owl	S1B	Threatened	Special Concern	-	Short-eared Owls breed primarily in well-drained grasslands near coastal wetlands. In areas with extensive coastlines, some caution is warranted in summarizing breeding habitat as inland marshes and bogs are less frequently monitored and thus may be under-represented in assessments of breeding habitat (COSEWIC Assessment and Status Report).
Asio otus	Long-eared Owl	S2S3	-	-	-	Known to breed throughout Nova Scotia. They occur at elevations ranging from near sea level to above 6,500 feet. May be nomadic at times, moving about in response to changing food supplies. Favored habitat includes dense trees for nesting and roosting and open country (e.g. grasslands and shrublands) for hunting. Inhabits a wide variety of such settings, including forest with extensive meadows to groves of conifers or deciduous trees. Generally, avoids unbroken forest. Known to be an early breeder. Breeds between April and July (Audubon and The Cornell Lab).
Botaurus lentiginosus	American Bittern	S3S4B, S4S5M	-	-	-	Found in marshes and reedy lakes. Breeds in freshwater marshes, mainly large, shallow wetlands with a large amount of tall marsh vegetation (cattails, grasses and sedges) and areas of open shallow water. Sometimes feeds in dry grassy fields. They are rarely seen out in the open, prefers vegetation

						cover. Breeds between April and July (Audubon and The Cornell Lab)
Branta bernicla	Brant	S3M	-	-	-	Found throughout all of Nova Scotia during migration (winter to spring breeding season). Most migrating and wintering Brant in eastern North America use coastal waters, especially lagoon systems behind barrier beaches, where eelgrass, sedges, and algae are plentiful. When not feeding, Brant roost on mudflats, barrier islands and sand spits near their foraging areas. Breeds between April and July (Audubon and The Cornell Lab)
Bucephala islandica	Barrow's Goldeneye	S1N, SUM	Special Concern	Special Concern	-	Lakes and ponds. They are usually in coniferous or aspen woodlands (elevations of up to about 6,100 feet). They favor shallower waters than Common Goldeneyes. In winter, they live in coastal waters and rivers. Breeds on cold inland waters, such as small lakes, rivers, beaver ponds, mostly in forested country but also in open terrain. In winter they are mainly on shallow, protected coastal waters, such as bays and estuaries. May winter far inland on lakes and rivers, even in very cold regions where hot springs keep water open. Barrow's Goldeneye wintering habitat extends along the shores of the Atlantic provinces.
Buteo lagopus	Rough-legged Hawk	S3N	-	-	-	Common across Nova Scotia during nonbreeding (winter). Spends the winter in open country, including grasslands, coastal prairies, marshes, farmland and dunes. In tree-covered areas they hunt over open bogs and other clearings. Breeds mostly on tundra, in areas having cliffs for nest sites; some breed along northern edge of coniferous forest zone. Rough-legged Hawks breed in open country of the arctic, both in North America and Eurasia. Breeds between April and July. May mate for life (Audubon and The Cornell Lab).
Calcarius lapponicus	Lapland Longspur	S3?N,SUM	-	-	-	They winter in vast agricultural fields that are often devoid of other birdlife in that season in southern area, and head up to

						the tundra to breed in the summer. Breeds between April and July (Cornell Lab, Audubon).
Cardellina canadensis	Canada Warbler	S3B	Special Concern	Threatened	Endangered	Forest undergrowth, shady thickets. Breeds in mature mixed hardwoods of extensive forests and streamside thickets. Prefers to nest in moist habitat: in luxuriant undergrowth, near swamps, on stream banks, in rhododendron thickets, in deep, rocky ravines and in moist deciduous second-growth.
Cardellina pusilla	Wilson's Warbler	S3B,S5M	-	-	-	Found in thickets along wooded streams, moist tangles, low shrubs, willows, alders. Breeds in thickets, second-growth, bogs, or in alder and willow groves near streams and ponds. In migration and winter, occurs from hot lowland thickets up to cool mountain woods; always in scrubby overgrown clearings and thin woods, not in the interior of dense forest. Breeds between April and July (Cornell Lab, Audubon).
Cathartes aura	Turkey Vulture	S2S3B,S4 S5M	-	-	-	In past was not surveyed/very rare to see Turkey Vultures in Nova Scotia, but as the climate warms, they are now sighted across the province (MBBA and Nova Scotia Bird Society). Look for Turkey Vultures as they soar high over open areas. They are particularly noticeable along roadsides and at landfills. At night, they roost in trees, on rocks and other high secluded spots. Most common over open or semi-open country (including mixed farmland, forest, rangeland and even small offshore islands), especially within a few miles of rocky or wooded areas providing secure nesting sites. Generally avoids densely forested regions. Breeds between April and July (Audubon and The Cornell Lab)
Charadrius vociferus	Killdeer	S3B	-	-	-	Favors fields, sandbars, lawns, riverbanks, coastal estuaries, mudflats and shores. Often found on open ground, such as pastures, plowed fields and large lawns, even at a great distance from water. This species does well in areas disturbed by humans and is commonly spotted on roads, lawns, airports, parking lots, golf courses, fields and in gravel areas. Most successful nesting areas have some shallow water close by or

						other good feeding area for the chicks. Generally the vegetation in fields inhabited by Killdeer is no taller than one inch. You can find Killdeer near water, but unlike many other shorebirds, they are also common in dry areas. Spring migration is very early, returning to some northern areas in February or March. Breeds between March and July (Audubon and The Cornell Lab).
Chordeiles minor	Common Nighthawk	S3B	Special Concern	Threatened	Threatened	Common Nighthawk breeds in a range of open and partially open habitats, including forest openings and post-fire habitats, prairies, bogs, and rocky or sandy natural habitats, as well as disturbed areas. It is also found in settled areas that meet its habitat needs, those with open areas for foraging and bare or short-cropped surfaces for nesting. The species use of a wide range of habitats makes it difficult to estimate trends in habitat availability, except in urban habitats, where their main nesting sites – flat graveled roofs – are disappearing.
Coccothraustes vespertinus	Evening Grosbeak	S3B,S3N, S3M	Special Concern	Special Concern	Vulnerable	Evening Grosbeak breeding habitat generally includes open, mature mixedwood forests, where fir species and/or White Spruce are dominant, and Spruce Budworm is abundant. Outside the breeding season, the species seems to depend largely on seed crops from various trees such as firs and spruces in the boreal forest but is also attracted to ornamental trees that produce seeds or fruit, and bird feeders stocked with sunflower seeds.
Coccyzus erythropthalmus	Black-billed Cuckoo	S3B	-	-	-	Black-billed Cuckoos are birds of woodlands and thickets, including aspen, poplar, birch, sugar maple, hickory, hawthorn and willow. They tend to occur more frequently in larger and denser woodlands than the Yellow-billed Cuckoo. On their wintering grounds, they live in forest, woodlands and scrub. A long-distance migrant, going to South America for the winter. Migrates at night; sometimes heard calling in flight overhead at night during the spring. During migration, they seek any kind of dense vegetation cover (e.g., young trees or tall shrubs). Common breeder in Nova Scotia. Breeds mostly in

						deciduous thickets and shrubby places, often on the edges of woodland or around marshes. Also in second growth of mixed deciduous-coniferous woods, or along their brushy edges. Breeds between April and July (Audubon and The Cornell Lab).
Contopus cooperi	Olive-sided Flycatcher	S3B	Special Concern	Threatened	Threatened	Olive-sided Flycatcher has been widely observed in open coniferous or mixed coniferous forests, often located near water or wetlands with the presence of tall snags or trees from which the species sallies for prey and advertises its territory. Mature conifer stands within patchy landscapes influenced by natural disturbance (e.g., recent burns) support the highest densities of Olive-sided Flycatcher. Nests are generally placed toward the tip of coniferous branches (although other tree types have been used).
Contopus virens	Eastern Wood-Pewee	S3S4B	Special Concern	Special Concern	Vulnerable	The Eastern Wood-pewee is mostly associated with the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in forest stands of intermediate age and in mature stands with little understory vegetation. During migration, a variety of habitats are used, including forest edges, early and successional clearings.
Coturnicops noveboracensis	Yellow Rail	SUB	Special Concern	Special Concern	-	Yellow rail is distributed along northern Nova Scotia. Nesting Yellow Rails are typically found in marshes dominated by sedges, true grasses, and rushes, where there is little or no standing water (generally 0-12 cm water dept), and where the substrate remains saturated throughout the summer. They can be found in damp fields and meadows, on the floodplains of rivers and streams, in the herbaceous vegetation of bogs, and at the upper levels (drier margins) of estuarine and salt marshes. Nesting habitats usually have a dry mat of dead vegetation from previous growing seasons. A greater diversity of habitat types is used during migration and winter than during the breeding season. In winter, the rails are known to

						use coastal wetlands and rice fields. (COSEWIC Assessment and Status Report).
Dolichonyx oryzivorus	Bobolink	S3B	Special Concern	Threatened	Vulnerable	Bobolink has nested in forage crops (e.g., hayfields and pastures dominated by a variety of species, such as clover, Timothy, Kentucky Bluegrass, and broadleaved plants). The Bobolink occurs in various grassland habitats including wet prairie, graminoid peatlands and abandoned fields dominated by tall grasses, remnants of uncultivated virgin prairie (tall-grass prairie), no-till cropland, small-grain fields, restored surface mining sites and irrigated fields in arid regions. It is generally not abundant in short-grass prairie, Alfalfa fields, or in row crop monocultures (e.g., corn, soybean, wheat), although its use of Alfalfa may vary by region.
Empidonax traillii	Willow Flycatcher	S2B	-	-	-	Uncommon breeder throughout mainland Nova Scotia, not Cape Breton (MBBA, as of July 2021). In winter, they use shrubby clearings, pastures and woodland edges often near water. Migrates relatively late in spring and early in fall. Breeds in thickets of deciduous trees and shrubs, especially willows, or along woodland edges. Often near streams or marshes and may be found in drier habitats than the Alder Flycatcher. Breeds between April and July (Audubon and The Cornell Lab).
Euphagus carolinus	Rusty Blackbird	S2B	Special Concern	Special Concern	Endangered	Breeding habitat is characterized by coniferous-dominated forests adjacent to wetlands, such as slow-moving streams, peat bogs, sedge meadows, marshes, swamps and beaver ponds. On migration, the Rusty Blackbird is primarily associated with wooded wetlands. In winter, it occurs primarily in lowland forested wetlands, cultivated fields and pecan groves. Suitable habitat for the species appears to be decreasing on its breeding range and wintering grounds, due mainly to the loss and degradation of wetlands by human activities.

Fulica americana	American Coot	S1B				The American Coot inhabits a wide variety of freshwater wetlands including prairie potholes, coastal bays, ponds, swamps, marshes, suburban parks, sewage ponds and large lakes (the two main features of their habitat include heavy stands of emergent aquatic vegetation along some portion of a shoreline and some depth of standing water within that vegetation). Seasonal wetlands are used during years of high water, while drought years cause breeding to be limited to permanent wetlands. Migrants sometimes are seen out at sea, quite far from land. Breeds between April and July (Audubon and The Cornell Lab).
Falco sparverius	American Kestrel	S3B,S4S5M	-	-	-	Breeds in Nova Scotia but also can be a permanent resident. American Kestrels favor open areas with short ground vegetation and sparse trees (e.g., meadows, wood edges, grasslands, deserts, parks, farm fields, cities and suburbs). When breeding, kestrels need access to at least a few trees or structures that provide appropriate nesting cavities. American Kestrels are attracted to many habitats modified by humans, including pastures and parkland, and are often found near areas of human activity including towns and cities. In winter, females may occupy open habitats more so than males. Breeds between April and July (Audubon and The Cornell Lab).
Gallinago delicata	Wilson's Snipe	S3B,S5M	-	-	-	Common across Nova Scotia during breeding and also known as a permanent resident in the southern areas of the province. Wilson’s Snipes can be found in all types of wet, marshy settings, including wet fields, bogs, fens, swamps, wet meadows and along muddy edges of rivers and ponds. They avoid areas with tall, dense vegetation, but need patches of cover to hide in and to provide a safe lookout for predators. During the breeding season they are mainly found around fresh marshes and bogs, shrubby streamside’s and northern tundra. Breeds between April and July (Audubon and The Cornell Lab).

Gallinula galeata	Common Gallinule	S1B	-	-	-	Common Gallinules use freshwater and brackish marshes, ponds and lakes that have a mix of submerged, floating, and emergent aquatic vegetation and are open water year-round. They also use artificial aquaculture ponds, rice fields, sewage lagoons and urban stormwater retention ponds. May be on more open ponds with less marsh cover or on still, slow-moving waters. Found with American Coot in many places but requires more marsh growth. Breeds between April and July (Audubon and The Cornell Lab).
Haemorhous purpureus	Purple Finch	S3S4N, S4S5B, S5M	-	-	-	Found throughout the entire province year-round. Purple finches can be found in woods, groves, suburbs. Breeds mostly in coniferous and mixed woods, both in forest interior and along edges. In migration and winter, found in a wide variety of wooded and semi-open areas, including forest, suburbs, swamps, and overgrown fields. Breeding occurs from April to July (The Cornell Lab, Audubon)
Hirundo rustica	Barn Swallow	S3B	Special Concern	Threatened	Endangered	Barn Swallows forage over a wide range of open and semi-open habitats including natural and anthropogenic grasslands, other farmland, open wetlands, open water, savannah, tundra, highways and other cleared right-of-ways, and cities and towns. They avoid forested regions and high mountains. Barn Swallows throughout the world have adapted to nesting in or on human structures, including buildings, barns, bridges, culverts, wells and mine shafts. Use of natural nest sites such as caves or rock cliffs with crevices or ledges protected by overhangs is rarely reported. Nocturnal roosts are typically in reed or cane beds or other dense vegetation, usually in or near water.
Icterus galbula	Baltimore Oriole	S2S3B,SUM	-	-	-	Baltimore Orioles are often very common in open woods and groves in summer. Found in open woods, riverside groves, elms, shade trees. Breeds in deciduous or mixed woodland, generally in open woods or edges rather than interior of dense

						forest. May be common in trees in towns (Audubon). Breeds between April and July (Audubon and The Cornell Lab).
Ixobrychus exilis	Least Bittern	SUB	Threatened	Threatened		The Least bittern has been observed in every Province in Canada. However, it is only probable to be located in Nova Scotia. The Least Bittern breeds strictly in marshes dominated by emergent vegetation surrounded by areas of open water. Most breeding grounds in Canada are dominated by cattails, but breeding also occurs in areas with other robust emergent plants and in shrubby swamps. The presence of stands of dense vegetation is essential for nesting because the nests of Least Bittern sit on platforms of stiff stems. The nests are almost always within 10 m of open water. This small heron prefers large marshes that have relatively stable water levels throughout the nesting period. Needs for wintering habitat are less specific, and appear to be met by a wide variety of wetlands—not only emergent marshes like those used for breeding, but also brackish and saline swamps (Environment Canada Recovery Strategy)
Lanius borealis	Northern Shrike	S3S4N	-	-	-	They occur in open but brushy habitats, and on calm, sunny days they may sit up on utility wires, bushes, and trees (Cornell Lab).Nests are usually placed in a low tree or large shrub, often in spruce or willow, usually 6-15' above the ground. Breeds between April and July (Audubon and The Cornell Lab).
Limnodromus griseus	Short-billed Dowitcher	S3M	-	-	-	Common migrant in Nova Scotia that prefers coastal habitats. Migrants are opportunistic in their choice of habitat, turning up in man-made environments such as impoundments, sewage ponds and flooded farm fields as well as in muddy margins of rivers, lakes and bays. Migrants also rest on rocky and sandy shorelines (beaches) and occasionally feed in such places, but they forage mostly where there is a fine muddy bottom covered by a few inches of water (pond edges, mudflats and tidal marshes). Breeds far north, mostly in open bogs, marshes

						and edges of lakes within coniferous forest zone. Breeds between April and July (Audubon and The Cornell Lab).
Limosa haemastica	Hudsonian Godwit	S2S3M	Threatened	-	-	Hudsonian Godwit occurs regularly during breeding or migration in all three territories and in provinces from British Columbia to Québec, as well as occasionally in the fall in all of the Atlantic provinces. Hudsonian Godwit breeds in wetland habitats (sedge meadows and muskeg) in sub-Arctic and Boreal regions. It uses a wide variety of habitats on migration, including freshwater marshes, saline lakes, flooded fields, shallow ponds, coastal wetlands and mudflats (COSEWIC Assessment and Status Report).
Loxia curvirostra	Red Crossbill	S3S4	-	-	-	Found throughout the entire province year-round. Red Crossbills can be found in conifer forests and groves, and breeds in pines (predominately), spruce, hemlock, Douglas-fir, or other evergreens. Breeding occurs from April to July (The Cornell Lab, Audubon)
Mimus polyglottos	Northern Mockingbird	S1B	-	-	-	Year-round resident throughout Nova Scotia, less common in Cape Breton. Found year-round in areas with open ground and shrubby vegetation (e.g. dense, low shrubs - hedges, fruiting bushes and thickets). When foraging on the ground, it prefers grassy areas, rather than bare spots. Common places include roadsides, parkland, cultivated land, suburban areas, woodland edges and in second-growth habitat at low elevations. Breeds between April and July (Audubon and The Cornell Lab).
Molothrus ater	Brown-headed Cowbird	S2B	-	-	-	Found in farms, fields, prairies, wood edges, river groves. Favors open or semi-open country at all seasons. In winter often concentrates in farmland, pastures, or cattle feedlots. More widespread in breeding season, in grassland, brushy country, forest edges, even desert, but tends to avoid dense unbroken forest. Breeds between April and July, and lays eggs in nests of other birds (Audubon and The Cornell Lab).

Passerella iliaca	Fox Sparrow	S3S4B, S5M	-	-	-	Found year round in Cape Breton, and throughout the migration season (late March and early November) in the rest of the province. Migrates at night. Found in wooded areas, undergrowth, brush. Breeds in brushy areas including woodland edges and clearings, streamside thickets, scrubby second growth, stunted coastal forest. Winters in similar habitats, also in brushy fields, chaparral, well-vegetated suburbs, and parks. Breeds from April to July (The Cornell Lab, Audubon)
Passerina cyanea	Indigo Bunting	S1?B,SUM	-	-	-	This species favors brushy edges rather than unbroken forest. Indigo Buntings breed in brushy and weedy areas. They're common on the edges of woods and fields; along roads, streams, rivers, and powerline cuts; in logged forest plots, brushy canyons, and abandoned fields where shrubby growth is returning. They are also in clearings within deciduous woods, edges of swamps. Breeds between April and July (Audubon and The Cornell Lab).
Perisoreus canadensis	Canada Jay	S3	-	-	-	Year-round resident throughout Nova Scotia and commonly referred to as the Gray Jay. No regular migration. On rare occasions, small invasions of Canada Jays will move a short distance out of boreal forest in winter. Prefers boreal and subalpine forests across northern North America, usually where black or white spruce trees are common (also aspen, white birch, balsam fir, sugar maple, jack pine, red spruce, eastern white cedar, etc.). Found in various kinds of coniferous and mixed forest, but rarely occurs where there are no spruce trees. Mated pairs stay together all year and defend permanent territories. Breeding and nesting for this species begins very early, during late winter, with breeding grounds still snow-covered. Breeds until, approximately, July (Audubon and The Cornell Lab).

Petrochelidon pyrrhonota	Cliff Swallow	S2S3B	-	-	-	Breeds throughout Nova Scotia. A long-distance migrant that migrates in flocks, traveling by day. Typically nests in colonies, sometimes with hundreds of nests crowded close together. These colonies are close to a water source, open fields or pastures for foraging, and a source of mud for nest building. Nest site is usually on vertical surface with some overhead shelter. Natural sites were on cliffs. Most sites today are on the sides of buildings, under bridges, in culverts or similar places. They now live in grasslands, towns, broken forest and river edges, but avoid heavy forest and deserts (e.g. open to semi-open land, farms, river bluffs and lakes). Still unaccountably scarce or missing in some seemingly suitable areas. Breeds between April and July (Audubon and The Cornell Lab).
Pheucticus ludovicianus	Rose-breasted Grosbeak	S3B	-	-	-	Look for these birds in forest edges and woodlands. Rose-breasted Grosbeaks breed in moist deciduous forests, deciduous-coniferous forests, thickets, and semi open habitats. They gravitate toward second-growth woods, suburban areas, parks, gardens, and orchards, as well as shrubby forest edges next to streams, ponds, marshes, roads, or pastures. They favor edges or openings with combination of shrubs and tall trees, rather than unbroken forest. Breeds from April to July (The Cornell Lab, Audubon)
Picoides arcticus	Black-backed Woodpecker	S3S4	-	-	-	Known throughout Nova Scotia year-round. Not strictly migratory but may move around in response to changing conditions (e.g. destruction of habitat). Eastern birds occasionally stage southward irruptions in winter, with scattered individuals showing up well south of breeding range. Habitat includes boreal forests of firs and spruces (pine, Douglas-fir, hemlock, tamarack and spruce, especially spruce bogs). Favors areas of dead or dying trees (coniferous and deciduous) and may concentrate at burned or flooded areas with many standing dead trees. Frequents lowlands in the

						North and mountains in the West. Breeds between April and July (Audubon and The Cornell Lab).
Pinicola enucleator	Pine Grosbeak	S3B, S5N, S5M	-	-	-	Found throughout the province year-round. Pine grosbeaks can be found in conifers; in winter, other trees. Breeds in open coniferous forest, especially of spruce and fir. In winter often found in deciduous trees (especially fruiting trees), also in groves of pines and other conifers. Breeding occurs from April to July (The Cornell Lab, Audubon).
Piranga olivacea	Scarlet Tanager	S2B, SUM	-	-	-	These birds can be found in oak forests in summer, but they often remain out of sight as they forage in the leafy upper branches. Nest site is in tree (usually deciduous), typically 20-30' above ground. Found in forests and shade trees (especially oaks). Breeds mostly in deciduous forest, predominately oaks but also in maple, beech, mixed pine-oak woods, and coniferous woods dominated by pine or hemlock. Breeding Scarlet Tanagers prefer large forest tracts with large trees. During spring and fall they use similar forest habitats as well as open spaces such as parks and gardens. Breeds between April and July (The Cornell Lab, Audubon)
Poecile hudsonicus	Boreal Chickadee	S3	-	-	-	Year-round resident throughout Nova Scotia. Occasional small southward invasions in fall, with a few appearing south of breeding range (similar to Black-capped Chickadees invasions). Boreal Chickadees inhabit mostly mature coniferous forests (sometimes mixed forests), usually spruce and balsam fir, often near water. During late fall and winter irruptions, they tend to be found mostly in areas dominated by coniferous trees. Occurs in low stunted spruces as far North as treeline (e.g. spruce bogs). May mate for life, the birds remaining together all year. Nests in a hole in a tree, either a natural cavity or one they created (or from another species). Breeds between April and July (Audubon and The Cornell Lab).

Pooecetes gramineus	Vesper Sparrow	S1S2B, SUM	-	-	-	Vesper Sparrows breed in open areas with short, sparse grass, areas where there are a few taller plants for use as song perches, and scattered shrubs including, old fields, pastures, weedy fencelines and roadsides, hayfields, and native grasslands. Can be found in meadows, fields, prairies, roadsides, open grassy or weedy fields. May be in weedy roadsides, gravel pits, stubble fields, grassy areas just above sandy beaches. Breeds from April to July (The Cornell Lab, Audubon).
Rallus limicola	Virginia Rail	S2S3B	-	-	-	Breeds across Nova Scotia, but more common in the northern region. Nests in a variety of marshy situations, mostly fresh, but also brackish marshes near the coast. Where this species and Sora breed in same marshes, Virginia Rail typically nests in drier spots. Often moves into salt marshes in winter. During migration, sometimes found in odd spots, even city streets. Virginia Rails occupy shallow (sometimes deeper) freshwater wetlands with tall stands of cattails and rushes (need areas with standing water typically less than 6 inches deep with a muddy bottom). They are most common in wetlands with 40–70% coverage of tall emergent vegetation, mixed with open water, mudflats and areas with matted vegetation. During the nonbreeding season, Virginia Rails use similar habitat, but may venture into more open areas. Breeds between April and July (Audubon and The Cornell Lab).
Riparia riparia	Bank Swallow	S2B	Threatened	Threatened	-	As with other swallow species, migratory stopover points are usually centred on large marshes where birds roost at night and disperse to forage throughout the day. There is little information available for Bank Swallows in terms of the importance of area requirements of these disparate habitats and their proximity to each other.
Setophaga castanea	Bay-breasted Warbler	S3S4B,S4S5M	-	-	-	Bay-breasted warblers are found in woodlands and conifers in summer. Usually breeds in northern coniferous forest, in thick

						stands of spruce and fir. They are predators of spruce budworm and are abundant in spruce forests during outbreaks. Where spruce is not found, will nest in deciduous or mixed second-growth woods of birches, maples, firs, and pines. Breed from April to July, typically in the latter half of the breeding window (The Cornell Lab, Audubon)
Setophaga pinus	Pine Warbler	S2S3B,S4 S5M	-	-	-	Pine Warblers live in pine or mixed pine-deciduous forest. Also sometimes in cedar or cypress. Various spottings throughout Nova Scotia, generally in the southern portion of the province. Breeds April to July (The Cornell Lab, Audubon)
Setophaga striata	Blackpoll Warbler	S3B,S5M	-	-	-	The blackpoll warbler can be found in conifers; broadleaf trees in migration. Breeds in low northern spruce forest. In migration, moves through forests, parks and gardens, they stop over in scrubby thickets and mature evergreen and deciduous forests. Found in the southern half of Nova Scotia during migration and the northern half during the breeding season. Breeding occurs from April to July (The Cornell Lab, Audubon).
Setophaga tigrina	Cape May Warbler	S3B,SUM	-	-	-	The Cape May Warbler can be found in spruce forest; other trees in migration. Breeds in spruce forest, especially during spruce budworm outbreaks, either in pure stands or mixed with firs or other trees, generally in more open woods or near the forest edge. During migration often favors conifers, but also forages in deciduous trees and thickets. Breeding occurs from April to July (The Cornell Lab, Audubon)
Spinus pinus	Pine Siskin	S3	-	-	-	Found throughout the province year-round. Pine Siskins can be found in conifers, mixed woods, alders, weedy areas. Breeds mostly in coniferous and mixed woods, often around edges or clearings; sometimes in deciduous woods, isolated conifer groves. In migration and winter, many kinds of semi-open areas, woodland edges, weedy fields. Breeding occurs from April to July (The Cornell Lab, Audubon)

Toxostoma rufum	Brown Thrasher	S1B	-	-	-	Not common and rarely seen in Nova Scotia, with no recorded sightings in Cape Breton (MBBA, as of July 2021). In eastern North America, Brown Thrashers nest in thickets, brush, shrubbery, hedgerows, forest edges and overgrown clearings in deciduous forest. On rare occasions they breed in backyards and gardens with shrubs and hedges (but in general - areas of dense low growth, especially thickets around edges of deciduous or mixed woods, shrubby edges of swamps or undergrowth in open pine woods). Breeds between April and July (Audubon and The Cornell Lab).
Tringa solitaria	Solitary Sandpiper	S3S4M, SUB	-	-	-	Common migrant in Nova Scotia. A long-distance migrant that mostly migrates alone and at night. They are rarely seen on mudflats or saltmarshes with other shorebirds and will frequent areas with little water in almost any setting, from inner city to forest interior (e.g. fields, ditches, swamps, wooded wetlands at higher elevation, etc.). This bird often stops at lakes, ponds, or streams similar to their nesting habitat (areas with bog habitat and spruce trees), especially where there are extensive muddy margins. Breeds between April and July (Audubon and The Cornell Lab).
Turdus migratorius	American Robin	S3N, S5B	-	-	-	Common in most of Nova Scotia as a year-round resident and for breeding in the very Northern part of the province (mainly Cape Breton). This species occupies many habitat types, such as lawns, farmland, fields, and city parks, as well as in more wild places like woodlands, forests, mountains up to near tree line, recently burned forests and tundra. During winter many robins move to moist woods where berry-producing trees and shrubs are common. Males arrive first in the breeding season. Nests where there are trees and mud for nest-making material. Breeds between April and July (Audubon and The Cornell Lab).
Tyrannus tyrannus	Eastern Kingbird	S3B	-	-	-	Common breeder throughout Nova Scotia. A long-distance migrant that uses many habitats and migrates in flocks. Unlike many of the migratory songbirds, kingbirds may travel mostly

						by day. The Eastern Kingbird usually breeds in fields with scattered shrubs and trees, in orchards and along forest edges (also clearings, roadsides, parks, newly burned forest, beaver ponds, golf courses and urban environments with tall trees and scattered open spaces). It is drawn to water, often nesting densely in trees that overhang rivers or lakes. In summer, requires open space for hunting. Often common around edges of marshes, farmland and native tallgrass prairie. Breeds between April and July (Audubon and The Cornell Lab).
Vireo gilvus	Warbling Vireo	S1B,SUM	-	-	-	Occurs in deciduous and mixed woods, aspen groves, poplars, shade trees. Breeds in open deciduous or mixed woodland; also in orchards, shade trees of towns (Audubon). They stay high in deciduous treetops (Cornell Lab). Breeds between April and July (Audubon and The Cornell Lab).
Vireo philadelphicus	Philadelphia Vireo	S2?B,SUM	-	-	-	Occurs in second growth; poplars, willows, alders. Breeds in deciduous and mixed woodlands, especially near their edges, or in the young growth of overgrown pastures. Also nests in willows and alders along streams, lakes, and ponds. Breeds between April and July (Audubon).
INVERTEBRATE						
Bombus bohemicus	Ashton Cuckoo Bumble Bee	S1	Endangered	Endangered	Endangered	Currently, nothing is known about the mating and overwintering habitat requirements for the Gypsy Cuckoo Bumble Bee. Overwintering habitat for bumble bees in Ontario may include rotting logs, leaf litter and mulch, burrows in soil, and garden compost. Forage habitat includes the plant species mentioned below as well as other flowering plants which bloom from early spring (e.g., Willow) to late autumn (e.g., Goldenrod). Forage habitat occurs in old fields, grasslands, dunes, alvars, woodlands (especially in the spring) and road sides.
Bombus suckleyi	Suckley's Cuckoo Bumble Bee	SH	Threatened	Not on Schedule 1	-	Suckley's Cuckoo Bumble Bee occurs in most Canadian ecozone including the Atlantic Maritimes. Suckley's Cuckoo Bumble Bee occurs in diverse habitats including open

						meadows and prairies, farms and croplands, urban areas, boreal forest, and montane meadows. Records are from sea level to 1200 m although the species could potentially occur at higher elevations where its host(s) occur. In the early spring, hosts typically establish nests in abandoned underground rodent burrows or other dry natural hollows; because Suckley's Cuckoo Bumble Bee is a nest parasite these same host residence sites also serve as its habitat. Adults have been recorded feeding on pollen and nectar from many flowers (COSEWIC Assessment and Status Report).
Bombus terricola	Yellow-banded Bumble Bee	S3	Special Concern	Special Concern	Vulnerable	Habitat generalist within open coniferous, deciduous and mixed-wood forests, wet and dry meadows and prairie grasslands, meadows bordering riparian zones, and along roadsides, urban parks, gardens and agricultural areas, subalpine habitats and more isolated natural areas.
Coccinella transversoguttata	Transverse Lady Beetle	SH	Special Concern	Special Concern	Endangered	The Transverse Lady Beetle is reported to be a habitat generalist occurring within agricultural areas, suburban gardens, parks, coniferous forests, deciduous forests, prairie grasslands, meadows, sand dune edges and riparian areas.
Danaus plexippus	Monarch	S2?B,S3M	Endangered	Special Concern	Endangered	The breeding habitat of the Eastern and Western populations in Canada is confined to where milkweeds grow, since leaves of these plants are the sole food of the caterpillars. The different species of milkweeds grow in a variety of environments, including meadows in farmlands, along roadsides and in ditches, open wetlands, dry sandy areas, short and tall grass prairie, riverbanks, irrigation ditches, arid valleys, and south-facing hillsides. Milkweeds are also often planted in gardens. The Monarch is known to breed on native milkweeds within their natural ranges. The most commonly used other sources of nectar are goldenrods (Solidago spp.), asters (Doellingeria, Eurybia, Oclemena, Symphyotrichum and Virgulus), the introduced Purple Loosestrife (Lythrum

						salicaria), and various clovers (Trifolium spp. and Melilotus spp.)

APPENDIX C: ACCDC REPORT

DATA REPORT 7620: Six Mile Brook, NS

Prepared 7 March 2023
by J. Pender, Conservation Data Analyst

CONTENTS OF REPORT

Map 1. A 100 km buffer around the study area

1.0 PREFACE

The Atlantic Canada Conservation Data Centre (AC CDC; www.accdc.com) is part of a network of NatureServe data centres and heritage programs serving 50 states in the U.S.A, 10 provinces and 1 territory in Canada, plus several Central and South American countries. The NatureServe network is more than 30 years old and shares a common conservation data methodology. The AC CDC was founded in 1997, and maintains data for the jurisdictions of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Although a non-governmental agency, the AC CDC is supported by 6 federal agencies and 4 provincial governments, as well as through outside grants and data processing fees.

Upon request and for a fee, the AC CDC queries its database and produces customized reports of the rare and endangered flora and fauna known to occur in or near a specified study area. As a supplement to that data, the AC CDC includes locations of managed areas with some level of protection, and known sites of ecological interest or sensitivity.

1.1 DATA LIST

Included datasets:

Filename	Contents
SixMileBkNS_7620ob.xls	Rare or legally-protected Flora and Fauna in your study area
SixMileBkNS_7620ob100km.xls	A list of Rare and legally protected Flora and Fauna within 100 km of your study area
SixMileBkNS_7620msa.xls	Managed and Biologically Significant Areas in your study area

1.2 RESTRICTIONS

The AC CDC makes a strong effort to verify the accuracy of all the data that it manages, but it shall not be held responsible for any inaccuracies in data that it provides. By accepting AC CDC data, recipients assent to the following limits of use:

a) Data is restricted to use by trained personnel who are sensitive to landowner interests and to potential threats to rare and/or endangered flora and fauna posed by the information provided.
b) Data is restricted to use by the specified Data User; any third party requiring data must make its own data request.
c) The AC CDC requires Data Users to cease using and delete data 12 months after receipt, and to make a new request for updated data if necessary at that time.
d) AC CDC data responses are restricted to the data in our Data System at the time of the data request.
e) Each record has an estimate of locational uncertainty, which must be referenced in order to understand the record's relevance to a particular location. Please see attached Data Dictionary for details.
f) AC CDC data responses are not to be construed as exhaustive inventories of taxa in an area.
g) The absence of a taxon cannot be inferred by its absence in an AC CDC data response.

1.3 ADDITIONAL INFORMATION

The accompanying Data Dictionary provides metadata for the data provided.

Please direct any additional questions about AC CDC data to the following individuals:

Plants, Lichens, Ranking Methods, All other Inquiries
Sean Blaney
Senior Scientist / Executive Director
(506) 364-2658
sean.blaney@accdc.ca

Animals (Fauna)
John Klymko
Zoologist
(506) 364-2660
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Data Management, GIS
James Churchill
Conservation Data Analyst / Field Biologist
(902) 679-6146
james.churchill@accdc.ca

Billing
Jean Breau
Financial Manager / Executive Assistant
(506) 364-2657
jean.breau@accdc.ca

Questions on the biology of Federal Species at Risk can be directed to AC CDC: (506) 364-2658, with questions on Species at Risk regulations to: Samara Eaton, Canadian Wildlife Service (NB and PE): (506) 364-5060 or Julie McKnight, Canadian Wildlife Service (NS): (902) 426-4196.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in New Brunswick, please contact Hubert Askanas, Energy and Resource Development: (506) 453-5873.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in Nova Scotia, please contact Donna Hurlburt, NS DLF: (902) 679-6886. To determine if location-sensitive species (section 4.3) occur near your study site please contact a NS DLF Regional Biologist:

Western: Emma Vost
(902) 670-8187
Emma.Vost@novascotia.ca

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Eastern: Elizabeth Walsh
(902) 563-3370
Elizabeth.Walsh@novascotia.ca

For provincial information about rare taxa and protected areas, or information about game animals, fish habitat etc., in Prince Edward Island, please contact Garry Gregory, PEI Dept. of Communities, Land and Environment: (902) 569-7595.

2.0 RARE AND ENDANGERED SPECIES

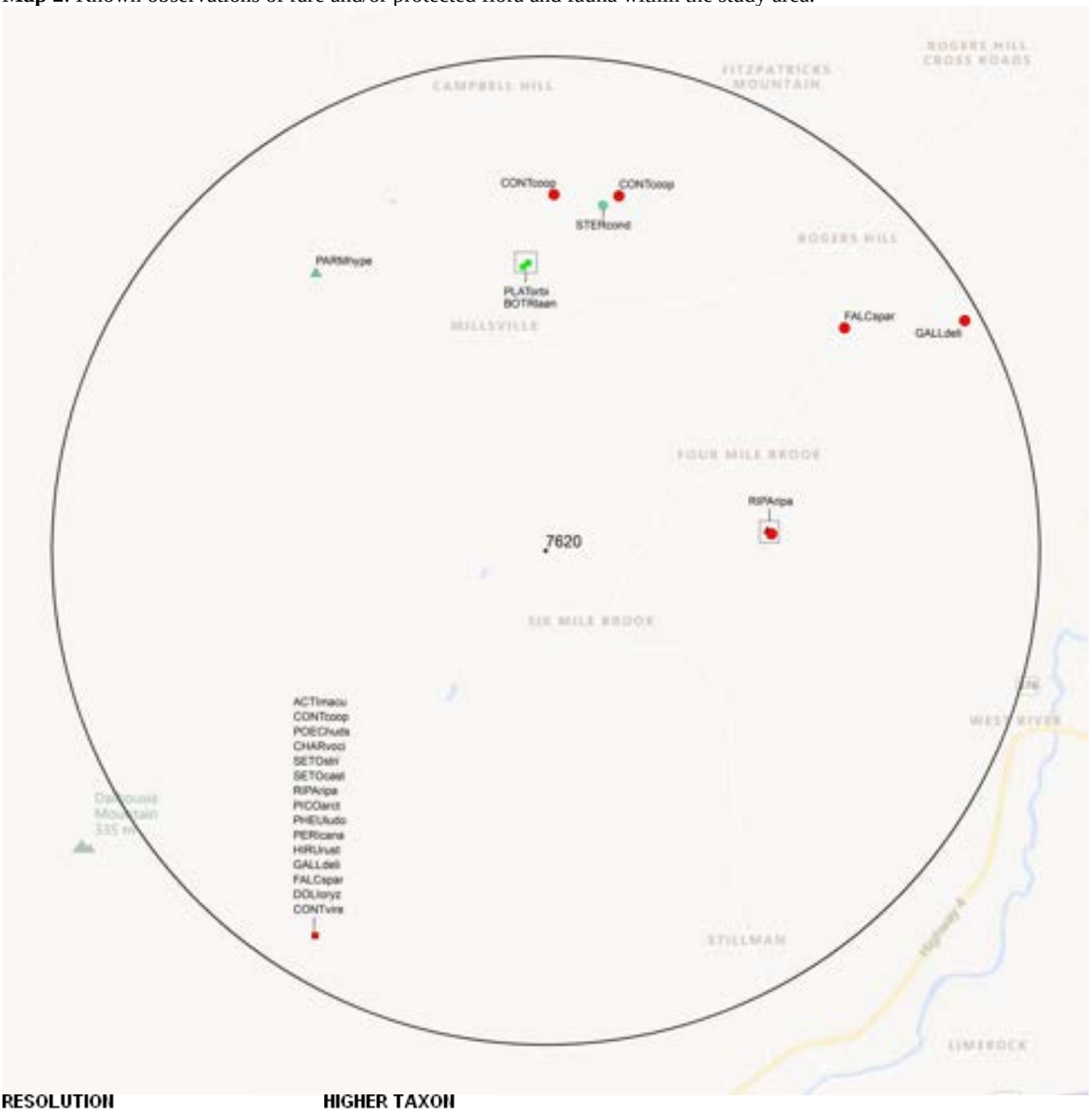
2.1 FLORA

The study area contains 2 records of 2 vascular and 2 records of 2 nonvascular flora (Map 2 and attached: *ob.xls), excluding 'location-sensitive' species.

2.2 FAUNA

The study area contains 24 records of 15 vertebrate and no records of invertebrate fauna (Map 2 and attached data files - see 1.1 Data List), excluding 'location-sensitive' species. Please see section 4.3 to determine if 'location-sensitive' species occur near your study site.

Map 2: Known observations of rare and/or protected flora and fauna within the study area.



3.0 SPECIAL AREAS

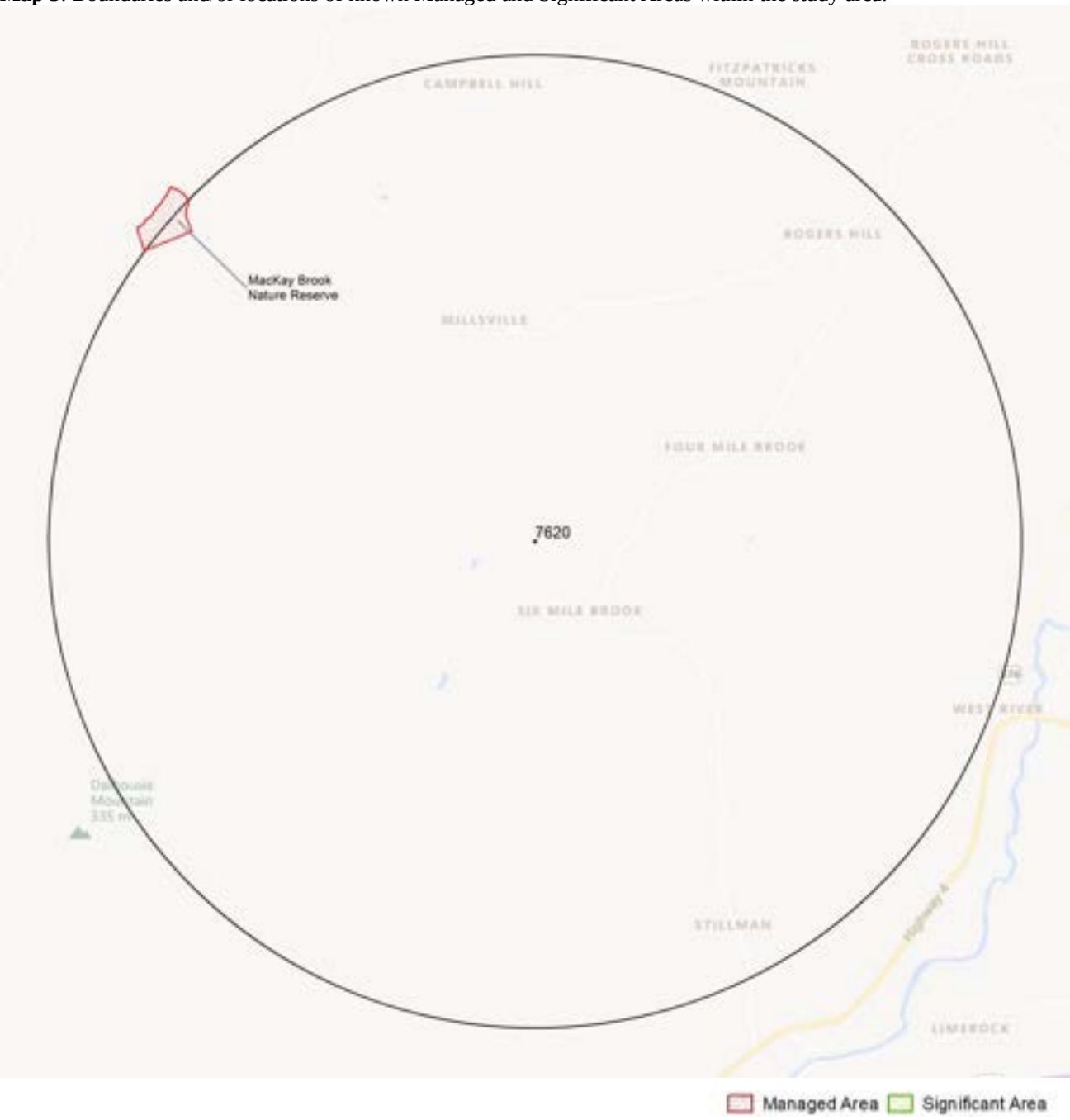
3.1 MANAGED AREAS

The GIS scan identified 1 managed area in the vicinity of the study area (Map 3 and attached file: *msa.xls).

3.2 SIGNIFICANT AREAS

The GIS scan identified no biologically significant sites in the vicinity of the study area (Map 3).

Map 3: Boundaries and/or locations of known Managed and Significant Areas within the study area.



4.0 RARE SPECIES LISTS

Rare and/or endangered taxa (excluding “location-sensitive” species, section 4.3) within the study area listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record). [P] = vascular plant, [N] = nonvascular plant, [A] = vertebrate animal, [I] = invertebrate animal, [C] = community. Note: records are from attached files *ob.xls/*ob.shp only.

4.1 FLORA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
N	*Stereocaulon condensatum*	Granular Soil Foam Lichen				S2S3	1	3.5 ± 0.0
N	*Parmeliopsis hyperopta*	Gray Starburst Lichen				S3S4	1	3.7 ± 1.0
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S2S3	1	2.9 ± 0.0
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3S4	1	2.9 ± 0.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2B	3	2.3 ± 0.0
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S3B	1	4.5 ± 7.0
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S3B	3	3.6 ± 0.0
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Vulnerable	S3B	1	4.5 ± 7.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	2	4.5 ± 7.0
A	*Perisoreus canadensis*	Canada Jay				S3	1	4.5 ± 7.0
A	*Poecile hudsonicus*	Boreal Chickadee				S3	2	4.5 ± 7.0
A	*Charadrius vociferus*	Killdeer				S3B	1	4.5 ± 7.0
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	1	4.5 ± 7.0
A	*Falco sparverius*	American Kestrel				S3B,S4S5M	2	3.8 ± 0.0
A	*Gallinago delicata*	Wilson's Snipe				S3B,S5M	2	4.5 ± 7.0
A	*Setophaga striata*	Blackpoll Warbler				S3B,S5M	1	4.5 ± 7.0
A	*Picoides arcticus*	Black-backed Woodpecker				S3S4	1	4.5 ± 7.0
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B,S4S5M	2	4.5 ± 7.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	1	4.5 ± 7.0

4.3 LOCATION SENSITIVE SPECIES

The Department of Natural Resources in each Maritimes province considers a number of species "location sensitive". Concern about exploitation of location-sensitive species precludes inclusion of precise coordinates in this report. Those intersecting your study area are indicated below with "YES".

Nova Scotia

Scientific *Name*	Common Name	SARA	Prov Legal Prot	Known within the Study Site?
Fraxinus nigra	Black Ash		Threatened	No
Emydoidea blandingii	*Blanding's Turtle - Nova Scotia pop.*	Endangered	Endangered	No
Glyptemys insculpta	Wood Turtle	Threatened	Threatened	No
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.		Vulnerable	No
Bat hibernaculum or bat species occurrence		[Endangered][1]	[Endangered][1]	No

1 *Myotis lucifugus* (Little Brown Myotis), *Myotis septentrionalis* (Long-eared Myotis), and *Perimyotis subflavus* (Tri-colored Bat or Eastern Pipistrelle) are all Endangered under the Federal Species at Risk Act and the NS Endangered Species Act.

4.4 SOURCE BIBLIOGRAPHY

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
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1	Canadian Wildlife Service. 2019. Canadian Protected and Conserved Areas Database (CPCAD). December 2019. ECCC.https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html.
1	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2014.
1	Munro, Marian K. Tracked lichen specimens, Nova Scotia Provincial Museum of Natural History Herbarium. Atlantic Canada Conservation Data Centre. 2019.

5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 48611 records of 135 vertebrate and 1032 records of 60 invertebrate fauna; 6009 records of 257 vascular and 2571 records of 137 nonvascular flora (attached: *ob100km.xls).

Taxa within 100 km of the study site that are rare and/or endangered in the province in which the study site occurs (including “location-sensitive” species). All ranks correspond to the province in which the study site falls, even for out-of-province records. Taxa are listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record).

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	95	9.6 ± 0.0	NS
A	*Myotis septentrionalis*	Northern Myotis	Endangered	Endangered	Endangered	S1	90	52.1 ± 1.0	PE
A	*Perimyotis subflavus*	Tricolored Bat	Endangered	Endangered	Endangered	S1	5	61.0 ± 5.0	NS
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay of Fundy population	Endangered	Endangered		S1	22	21.3 ± 0.0	NS
A	*Salmo salar pop. 6*	Atlantic Salmon - Nova Scotia Southern Upland population	Endangered			S1	31	37.2 ± 0.0	NS
A	*Charadrius melodus melodus*	Piping Plover melodus subspecies	Endangered	Endangered	Endangered	S1B	2603	18.1 ± 0.0	NS
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1B	22	87.0 ± 0.0	NS
A	*Morone saxatilis pop. 2*	Striped Bass - Bay of Fundy population	Endangered			S2S3B,S2S3N	2	77.6 ± 0.0	NS
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Threatened	Endangered	S1B	1	80.8 ± 7.0	NS
A	*Asio flammeus*	Short-eared Owl	Threatened	Special Concern		S1B	9	18.1 ± 7.0	NS
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2	4461	9.5 ± 5.0	NS
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2B	2461	2.3 ± 0.0	NS
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Endangered	S2S3B,S1M	639	9.8 ± 7.0	NS
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S2S3M	370	43.8 ± 0.0	NS
A	*Acipenser oxyrinchus*	Atlantic Sturgeon	Threatened			S2S3N	2	64.5 ± 0.0	NS
A	*Hydrobates leucorhous*	Leach's Storm-Petrel	Threatened			S3B	44	87.9 ± 7.0	NS
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	1427	15.6 ± 0.0	NS
A	*Anguilla rostrata*	American Eel	Threatened			S3N	67	35.5 ± 0.0	NS
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened		SUB	36	9.8 ± 0.0	NS
A	*Salmo salar pop. 12*	Atlantic Salmon - Gaspe - Southern Gulf of St. Lawrence population	Special Concern			S1	47	5.6 ± 0.0	NS
A	*Antrostomus vociferus*	Eastern Whip-Poor-Will	Special Concern	Threatened	Threatened	S1?B	7	67.7 ± 7.0	NS
A	*Passerculus sandwichensis princeps*	Ipswich Sparrow	Special Concern	Special Concern		S1B	1	91.9 ± 0.0	NS
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern		S1N,SUM	13	20.6 ± 0.0	NS
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Endangered	S2B	269	12.9 ± 7.0	NS
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern	Special Concern		S2S3M	11	55.0 ± 0.0	NS
A	*Morone saxatilis pop. 1*	Striped Bass - Southern Gulf of St. Lawrence population	Special Concern			S2S3N	1	77.0 ± 1.0	NS
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern population	Special Concern	Special Concern	Endangered	S2S3N,SUM	24	58.7 ± 0.0	PE
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	79	10.3 ± 0.0	NS
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S3B	1552	4.5 ± 7.0	NS
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Endangered	S3B	1095	6.5 ± 7.0	NS
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Threatened	Threatened	S3B	374	6.5 ± 7.0	NS
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S3B	1249	3.6 ± 0.0	NS
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Vulnerable	S3B	1331	4.5 ± 7.0	NS
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern	Vulnerable	S3B,S3N,S3M	779	6.5 ± 7.0	NS
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern		S3N,SUM	9	79.5 ± 0.0	NS
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	1254	4.5 ± 7.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Phocoena phocoena*	Harbour Porpoise	Special Concern			S4	1	88.8 ± 5.0	PE
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	61	19.0 ± 1.0	NS
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1?B,SUN,SUM	2	8.6 ± 7.0	NS
A	*Fulica americana*	American Coot	Not At Risk			S1B	17	14.1 ± 7.0	NS
A	*Chlidonias niger*	Black Tern	Not At Risk			S1B	1	90.0 ± 0.0	NS
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Not At Risk	Special Concern	Vulnerable	S1B,SUM	25	65.9 ± 0.0	PE
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk			S2	1	65.2 ± 0.0	NS
A	*Aegolius funereus*	Boreal Owl	Not At Risk			S2?B,SUM	14	12.6 ± 0.0	NS
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3	1	66.4 ± 100.0	NS
A	*Hemidactylium scutatum*	Four-toed Salamander	Not At Risk			S3	8	30.2 ± 0.0	NS
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B	489	9.8 ± 7.0	NS
A	*Sialia sialis*	Eastern Bluebird	Not At Risk			S3B	62	13.6 ± 0.0	NS
A	*Buteo lagopus*	Rough-legged Hawk	Not At Risk			S3N	4	60.7 ± 0.0	PE
A	*Accipiter gentilis*	Northern Goshawk	Not At Risk			S3S4	139	8.6 ± 7.0	NS
A	*Lagenorhynchus acutus*	Atlantic White-sided Dolphin	Not At Risk			S3S4	3	65.1 ± 0.0	NS
A	*Ammospiza nelsoni*	Nelson's Sparrow	Not At Risk			S3S4B	284	17.8 ± 7.0	NS
A	*Calidris canutus rufa*	Red Knot rufa subspecies	E,SC	Endangered	Endangered	S2M	477	15.6 ± 0.0	NS
A	*Morone saxatilis*	Striped Bass	E,SC			S2S3B,S2S3N	4	58.4 ± 1.0	NS
A	*Alces alces americana*	Moose			Endangered	S1	133	5.8 ± 0.0	NS
A	*Picoides dorsalis*	American Three-toed Woodpecker				S1?	8	72.0 ± 7.0	NS
A	*Passerina cyanea*	Indigo Bunting				S1?B,SUM	16	42.8 ± 0.0	NS
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1B	1	79.3 ± 7.0	NS
A	*Oxyura jamaicensis*	Ruddy Duck				S1B	12	67.8 ± 7.0	NS
A	*Gallinula galeata*	Common Gallinule				S1B	12	13.8 ± 7.0	NS
A	*Myiarchus crinitus*	Great Crested Flycatcher				S1B	15	8.6 ± 7.0	NS
A	*Cistothorus palustris*	Marsh Wren				S1B	1	89.5 ± 3.0	NB
A	*Mimus polyglottos*	Northern Mockingbird				S1B	38	18.1 ± 7.0	NS
A	*Toxostoma rufum*	Brown Thrasher				S1B	10	18.1 ± 7.0	NS
A	*Charadrius semipalmatus*	Semipalmated Plover				S1B,S4M	1723	16.0 ± 0.0	NS
A	*Calidris minutilla*	Least Sandpiper				S1B,S4M	1063	15.6 ± 0.0	NS
A	*Anas acuta*	Northern Pintail				S1B,SUM	60	34.5 ± 0.0	NS
A	*Vireo gilvus*	Warbling Vireo				S1B,SUM	20	20.3 ± 7.0	NS
A	*Vespertilionidae sp.*	bat species				S1S2	77	5.6 ± 0.0	NS
A	*Pooecetes gramineus*	Vesper Sparrow				S1S2B,SUM	57	12.9 ± 7.0	NS
A	*Vireo philadelphicus*	Philadelphia Vireo				S2?B,SUM	83	23.3 ± 0.0	NS
A	*Fratercula arctica*	Atlantic Puffin				S2B	3	87.5 ± 0.0	NB
A	*Empidonax traillii*	Willow Flycatcher				S2B	19	23.2 ± 7.0	NS
A	*Molothrus ater*	Brown-headed Cowbird				S2B	183	6.5 ± 7.0	NS
A	*Spatula clypeata*	Northern Shoveler				S2B,SUM	32	54.8 ± 7.0	NS
A	*Mareca strepera*	Gadwall				S2B,SUM	78	33.4 ± 0.0	NS
A	*Piranga olivacea*	Scarlet Tanager				S2B,SUM	14	9.8 ± 7.0	NS
A	*Calidris alba*	Sanderling				S2N,S3M	937	18.1 ± 0.0	NS
A	*Asio otus*	Long-eared Owl				S2S3	34	23.7 ± 0.0	NS
A	*Rallus limicola*	Virginia Rail				S2S3B	51	20.3 ± 7.0	NS
A	*Rissa tridactyla*	Black-legged Kittiwake				S2S3B	1	30.7 ± 0.0	NS
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B	319	8.6 ± 7.0	NS
A	*Phalacrocorax carbo*	Great Cormorant				S2S3B,S2S3N	215	36.9 ± 7.0	PE
A	*Cathartes aura*	Turkey Vulture				S2S3B,S4S5M	8	68.0 ± 0.0	PE
A	*Setophaga pinus*	Pine Warbler				S2S3B,S4S5M	15	8.6 ± 7.0	NS
A	*Bucephala clangula*	Common Goldeneye				S2S3B,S5N,S5M	173	15.8 ± 13.0	NS
A	*Icterus galbula*	Baltimore Oriole				S2S3B,SUM	61	9.8 ± 7.0	NS
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	163	16.0 ± 0.0	NS
A	*Numenius phaeopus hudsonicus*	Whimbrel				S2S3M	211	22.1 ± 0.0	NS
A	*Perisoreus canadensis*	Canada Jay				S3	583	4.5 ± 7.0	NS
A	*Poecile hudsonicus*	Boreal Chickadee				S3	946	4.5 ± 7.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Spinus pinus*	Pine Siskin				S3	531	6.5 ± 7.0	NS
A	*Salvelinus fontinalis*	Brook Trout				S3	66	5.6 ± 0.0	NS
A	*Salvelinus namaycush*	Lake Trout				S3	2	47.5 ± 0.0	NS
A	*Pekania pennanti*	Fisher				S3	6	17.3 ± 0.0	NS
A	*Calcarius lapponicus*	Lapland Longspur				S3?N,SUM	3	79.4 ± 0.0	NS
A	*Spatula discors*	Blue-winged Teal				S3B	321	6.5 ± 7.0	NS
A	*Charadrius vociferus*	Killdeer				S3B	752	4.5 ± 7.0	NS
A	*Tringa semipalmata*	Willet				S3B	1960	9.8 ± 7.0	NS
A	*Sterna paradisaea*	Arctic Tern				S3B	51	72.8 ± 7.0	NS
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	129	8.6 ± 7.0	NS
A	*Tyrannus tyrannus*	Eastern Kingbird				S3B	365	6.5 ± 7.0	NS
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	835	4.5 ± 7.0	NS
A	*Alosa pseudoharengus*	Alewife				S3B	24	5.6 ± 0.0	NS
A	*Somateria mollissima*	Common Eider				S3B,S3M,S3N	341	27.9 ± 11.0	NS
A	*Tringa melanoleuca*	Greater Yellowlegs				S3B,S4M	2368	15.6 ± 0.0	NS
A	*Falco sparverius*	American Kestrel				S3B,S4S5M	560	3.8 ± 0.0	NS
A	*Gallinago delicata*	Wilson's Snipe				S3B,S5M	1050	4.5 ± 7.0	NS
A	*Setophaga striata*	Blackpoll Warbler				S3B,S5M	101	4.5 ± 7.0	NS
A	*Cardellina pusilla*	Wilson's Warbler				S3B,S5M	101	16.3 ± 7.0	NS
A	*Pinicola enucleator*	Pine Grosbeak				S3B,S5N,S5M	117	9.8 ± 7.0	NS
A	*Setophaga tigrina*	Cape May Warbler				S3B,SUM	320	6.5 ± 7.0	NS
A	*Branta bernicla*	Brant				S3M	8	77.7 ± 0.0	NS
A	*Pluvialis squatarola*	Black-bellied Plover				S3M	2032	18.1 ± 0.0	NS
A	*Arenaria interpres*	Ruddy Turnstone				S3M	872	18.1 ± 0.0	NS
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	1685	16.0 ± 0.0	NS
A	*Calidris melanotos*	Pectoral Sandpiper				S3M	173	18.1 ± 0.0	NS
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	1023	18.1 ± 0.0	NS
A	*Chroicocephalus ridibundus*	Black-headed Gull				S3N	15	72.2 ± 0.0	NS
A	*Picoides arcticus*	Black-backed Woodpecker				S3S4	183	4.5 ± 7.0	NS
A	*Loxia curvirostra*	Red Crossbill				S3S4	153	6.5 ± 7.0	NS
A	*Sorex palustris*	American Water Shrew				S3S4	6	63.8 ± 0.0	PE
A	*Botaurus lentiginosus*	American Bittern				S3S4B,S4S5M	474	6.5 ± 7.0	NS
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B,S4S5M	672	4.5 ± 7.0	NS
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	895	4.5 ± 7.0	NS
A	*Leiothlypis peregrina*	Tennessee Warbler				S3S4B,S5M	690	6.5 ± 7.0	NS
A	*Passerella iliaca*	Fox Sparrow				S3S4B,S5M	73	19.1 ± 0.0	NS
A	*Mergus serrator*	Red-breasted Merganser				S3S4B,S5M,S5N	104	9.8 ± 7.0	NS
A	*Calidris maritima*	Purple Sandpiper				S3S4N	30	22.1 ± 0.0	NS
A	*Lanius borealis*	Northern Shrike				S3S4N	4	74.8 ± 0.0	PE
A	*Morus bassanus*	Northern Gannet				SHB	43	26.0 ± 4.0	NS
A	*Aythya americana*	Redhead				SHB	3	96.8 ± 0.0	PE
A	*Leucophaeus atricilla*	Laughing Gull				SHB	4	90.2 ± 0.0	NS
A	*Progne subis*	Purple Martin				SHB	8	74.1 ± 7.0	NS
A	*Eremophila alpestris*	Horned Lark				SHB,S4S5N,S5M	8	56.6 ± 7.0	PE
I	*Bombus bohemicus*	Ashton Cuckoo Bumble Bee	Endangered	Endangered	Endangered	S1	32	31.5 ± 5.0	NS
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Endangered	S2?B,S3M	114	5.4 ± 0.0	NS
I	*Barnea truncata*	Atlantic Mud-piddock	Threatened	Threatened		S1	1	71.8 ± 1.0	NS
I	*Bombus suckleyi*	Suckley's Cuckoo Bumble Bee	Threatened			SH	1	38.7 ± 5.0	NS
I	*Alasmidonta varicosa*	Brook Floater	Special Concern	Special Concern	Threatened	S3	16	45.3 ± 0.0	NS
I	*Bombus terricola*	Yellow-banded Bumble Bee	Special Concern	Special Concern	Vulnerable	S3	116	10.3 ± 5.0	NS
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern		Endangered	SH	7	7.6 ± 2.0	NS
I	*Gomphurus ventricosus*	Skillet Clubtail	Special Concern	Endangered		SH	1	88.5 ± 0.0	NS
I	*Erora laeta*	Early Hairstreak				S1	1	76.2 ± 0.0	PE
I	*Atlanticoncha ochracea*	Tidewater Mucket				S1	1	96.8 ± 0.0	NS
I	*Polygonia satyrus*	Satyr Comma				S1?	16	34.4 ± 5.0	NS
I	*Euphyes bimacula*	Two-spotted Skipper				S1S2	2	38.2 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
I	*Boloria chariclea*	Arctic Fritillary				S1S2	1	33.6 ± 2.0	NS
I	*Tharsalea dospassosi*	Maritime Copper				S2	76	18.6 ± 1.0	NS
I	*Satyrium acadica*	Acadian Hairstreak				S2	15	16.7 ± 2.0	NS
I	*Neurocordulia michaeli*	Broad-tailed Shadowdragon				S2	26	42.4 ± 0.0	NS
I	*Coenagrion resolutum*	Taiga Bluet				S2	50	49.3 ± 1.0	PE
I	*Margaritifera margaritifera*	Eastern Pearlshell				S2	154	5.8 ± 0.0	NS
I	*Pantala hymenaea*	Spot-Winged Glider				S2?B	1	77.3 ± 1.0	NS
I	*Nymphalis l-album*	Compton Tortoiseshell				S2S3	9	19.0 ± 2.0	NS
I	*Aglais milberti*	Milbert's Tortoiseshell				S2S3	16	19.0 ± 2.0	NS
I	*Aglais milberti milberti*	Milbert's Tortoise Shell				S2S3	3	51.7 ± 0.0	NS
I	*Lanthus vernalis*	Southern Pygmy Clubtail				S2S3	8	53.6 ± 0.0	NS
I	*Somatochlora kennedyi*	Kennedy's Emerald				S2S3	2	79.9 ± 1.0	PE
I	*Somatochlora williamsoni*	Williamson's Emerald				S2S3	12	82.7 ± 0.0	PE
I	*Williamsonia fletcheri*	Ebony Boghaunter				S2S3	4	50.6 ± 0.0	NS
I	*Stylurus scudderi*	Zebra Clubtail				S2S3	4	78.0 ± 0.0	NS
I	*Alasmidonta undulata*	Triangle Floater				S2S3	19	41.3 ± 0.0	NS
I	*Astyleiopus variegatus*	Variegated Long-horned Beetle				S3	1	95.8 ± 0.0	NS
I	*Naemia seriata*	Seaside Lady Beetle				S3	1	70.9 ± 0.0	NS
I	*Chilocorus stigma*	Twice-stabbed Lady Beetle				S3	1	73.0 ± 0.0	PE
I	*Monochamus marmorator*	Balsam Fir Sawyer				S3	2	38.5 ± 0.0	NS
I	*Satyrium calanus*	Banded Hairstreak				S3	3	20.4 ± 2.0	NS
I	*Callophrys lanoraieensis*	Bog Elfin				S3	6	36.8 ± 0.0	NS
I	*Phanogomphus descriptus*	Harpoon Clubtail				S3	4	58.8 ± 1.0	NS
I	*Ophiogomphus aspersus*	Brook Snaketail				S3	4	76.1 ± 0.0	NS
I	*Ophiogomphus mainensis*	Maine Snaketail				S3	14	39.2 ± 0.0	NS
I	*Ophiogomphus rupinsulensis*	Rusty Snaketail				S3	55	53.0 ± 0.0	NS
I	*Epitheca princeps*	Prince Baskettail				S3	11	50.7 ± 0.0	NS
I	*Somatochlora forcipata*	Forcipate Emerald				S3	3	73.6 ± 1.0	PE
I	*Enallagma vernale*	Vernal Bluet				S3	4	58.8 ± 1.0	NS
I	*Strophitus undulatus*	Creeper				S3	6	78.2 ± 1.0	NS
I	*Polygonia interrogationis*	Question Mark				S3B	48	16.7 ± 2.0	NS
I	*Cecropterus pylades*	Northern Cloudywing				S3S4	27	7.7 ± 0.0	NS
I	*Amblyscirtes hegon*	Pepper and Salt Skipper				S3S4	12	16.7 ± 2.0	NS
I	*Cupido comyntas*	Eastern Tailed Blue				S3S4	3	43.3 ± 0.0	NS
I	*Argynnis aphrodite*	Aphrodite Fritillary				S3S4	23	22.8 ± 100.0	NS
I	*Polygonia faunus*	Green Comma				S3S4	18	19.0 ± 2.0	NS
I	*Oeneis jutta*	Jutta Arctic				S3S4	8	39.8 ± 0.0	NS
I	*Aeshna clepsydra*	Mottled Darner				S3S4	4	80.6 ± 1.0	NS
I	*Aeshna constricta*	Lance-Tipped Darner				S3S4	28	16.8 ± 1.0	NS
I	*Boyeria grafiana*	Ocellated Darner				S3S4	11	51.7 ± 0.0	NS
I	*Gomphaeschna furcillata*	Harlequin Darner				S3S4	3	70.8 ± 0.0	PE
I	*Somatochlora franklini*	Delicate Emerald				S3S4	6	59.9 ± 1.0	NS
I	*Nannothemis bella*	Elfin Skimmer				S3S4	3	94.3 ± 1.0	NS
I	*Sympetrum danae*	Black Meadowhawk				S3S4	7	71.8 ± 1.0	NS
I	*Amphiagrion saucium*	Eastern Red Damsel				S3S4	2	23.8 ± 0.0	NS
I	*Sphaerophoria pyrrhina*	Violaceous Globetail				SH	1	39.1 ± 5.0	NS
I	*Icaricia saepiolus*	Greenish Blue				SH	3	20.1 ± 2.0	NS
I	*Polygonia gracilis*	Hoary Comma				SH	2	19.0 ± 2.0	NS
N	*Erioderma mollissimum*	Graceful Felt Lichen	Endangered	Endangered	Endangered	S1	30	67.4 ± 0.0	NS
N	*Erioderma pedicellatum (Atlantic pop.)*	Boreal Felt Lichen - Atlantic pop.	Endangered	Endangered	Endangered	S1	523	56.0 ± 0.0	NS
N	*Peltigera hydrothyria*	Eastern Waterfan	Threatened	Threatened	Threatened	S1	34	8.7 ± 0.0	NS
N	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened	Threatened	S2S3	24	68.1 ± 1.0	NS
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened	Threatened	S3	33	40.5 ± 0.0	NS
N	*Fuscopannaria leucosticta*	White-rimmed Shingle Lichen	Threatened			S3	6	60.4 ± 0.0	NS
N	*Heterodermia squamulosa*	Scaly Fringe Lichen	Threatened			S3	8	77.4 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
N	*Pectenia plumbea*	Blue Felt Lichen	Special Concern	Special Concern	Vulnerable	S3	170	15.0 ± 0.0	NS
N	*Sclerophora peronella (Atlantic pop.)*	Frosted Glass-whiskers (Atlantic population)	Special Concern	Special Concern		S3S4	25	63.8 ± 0.0	NS
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	7	60.7 ± 1.0	NS
N	*Fissidens exilis*	Pygmy Pocket Moss	Not At Risk			S3	6	37.3 ± 0.0	NS
N	*Chaenotheca servitii*	Flexuous Golden Stubble	Data Deficient			S1	1	52.9 ± 1.0	NS
N	*Erioderma pedicellatum*	Boreal Felt Lichen	E,SC		Endangered	S1	1	67.3 ± 0.0	NS
N	*Tetrodontium brownianum*	Little Georgia				S1	1	98.3 ± 0.0	NS
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				S1	1	53.1 ± 0.0	NS
N	*Blennothallia crispa*	Crinkled Jelly Lichen				S1	1	98.7 ± 0.0	NS
N	*Cladonia brevis*	Short Peg Lichen				S1	1	95.7 ± 4.0	PE
N	*Scytinium schraderi*	Wrinkled Jellyskin Lichen				S1	1	62.3 ± 0.0	NS
N	*Lichina confinis*	Marine Seaweed Lichen				S1	2	90.5 ± 2.0	NS
N	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S1	1	48.4 ± 0.0	NS
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S1	2	47.7 ± 0.0	PE
N	*Hypogymnia hultenii*	Powdered Honeycomb Lichen				S1	9	91.2 ± 0.0	NS
N	*Calypogeia neogaea*	Common Pouchwort				S1?	1	90.0 ± 0.0	NS
N	*Aloina rigida*	Aloe-Like Rigid Screw Moss				S1?	2	50.4 ± 0.0	NS
N	*Brachythecium erythrorrhizon*	Taiga Ragged Moss				S1?	2	91.5 ± 0.0	PE
N	*Campylostelium saxicola*	a Moss				S1?	2	75.9 ± 0.0	PE
N	*Tortula obtusifolia*	a Moss				S1?	3	36.4 ± 2.0	NS
N	*Didymodon tophaceus*	Olive Beard Moss				S1?	2	98.6 ± 4.0	NS
N	*Schistostega pennata*	Luminous Moss				S1?	1	98.1 ± 0.0	NS
N	*Enchylium limosum*	Lime-loving Tarpaper Lichen				S1?	2	73.8 ± 0.0	PE
N	*Scytinium intermedium*	Forty-five Jellyskin Lichen				S1?	2	77.5 ± 4.0	NS
N	*Arrhenopterum heterostichum*	One-sided Groove Moss				S1S2	1	91.5 ± 1.0	NS
N	*Plagiothecium latebricola*	Alder Silk Moss				S1S2	1	94.7 ± 3.0	NS
N	*Seligeria donniana*	Donian Beardless Moss				S1S2	1	99.5 ± 3.0	NS
N	*Sematophyllum marylandicum*	a Moss				S1S2	1	92.2 ± 6.0	NS
N	*Timmia megapolitana*	Metropolitan Timmia Moss				S1S2	3	49.9 ± 0.0	NS
N	*Pseudotaxiphyllum distichaceum*	a Moss				S1S2	2	95.5 ± 0.0	NS
N	*Haplocladium microphyllum*	Tiny-leaved Haplocladium Moss				S1S2	1	55.5 ± 5.0	NS
N	*Placidium squamulosum*	Limy Soil Stipplescale Lichen				S1S2	1	51.5 ± 6.0	NS
N	*Cladonia labradorica*	Labrador Lichen				S1S2	1	100.0 ± 0.0	NS
N	*Peltigera ponojensis*	Pale-bellied Pelt Lichen				S1S2	1	15.6 ± 0.0	NS
N	*Pilophorus cereolus*	Powdered Matchstick Lichen				S1S2	1	81.0 ± 3.0	NS
N	*Parmeliella parvula*	Poor-man's Shingles Lichen				S1S2	14	73.6 ± 0.0	NS
N	*Heterodermia galactophylla*	Branching Fringe Lichen				S1S3	2	61.6 ± 0.0	NS
N	*Peltigera neckeri*	Black-saddle Pelt Lichen				S1S3	2	70.7 ± 0.0	NS
N	*Stereocaulon grande*	Grand Foam Lichen				S1S3	1	51.0 ± 0.0	NS
N	*Anacamptodon splachnoides*	a Moss				S2	1	94.7 ± 3.0	NS
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S2	2	98.1 ± 3.0	NS
N	*Sphagnum subnitens*	Lustrous Peat Moss				S2	1	93.6 ± 2.0	NS
N	*Scytinium imbricatum*	Scaly Jellyskin Lichen				S2	1	85.3 ± 4.0	NS
N	*Nephroma resupinatum*	a lichen				S2	2	87.7 ± 0.0	NS
N	*Placynthium flabellosum*	Scaly Ink Lichen				S2	1	78.5 ± 17.0	NS
N	*Anaptychia crinalis*	Hanging Fringed Lichen				S2	2	95.7 ± 4.0	PE
N	*Riccardia multifida*	Delicate Germanderwort				S2?	2	71.7 ± 0.0	NS
N	*Anomodon viticulosus*	a Moss				S2?	1	50.6 ± 5.0	NS
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S2?	3	30.6 ± 2.0	NS

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N	*Drepanocladus polygamus*	Polygamous Hook Moss				S2?	4	82.3 ± 0.0	PE
N	*Ditrichum rhynchostegium*	a Moss				S2?	1	47.2 ± 0.0	PE
N	*Kiaeria starkei*	Starke's Fork Moss				S2?	1	91.5 ± 10.0	NS
N	*Philonotis marchica*	a Moss				S2?	3	29.6 ± 0.0	NS
N	*Platydictya jungermannioides*	False Willow Moss				S2?	3	71.1 ± 0.0	NS
N	*Saelania glaucescens*	Blue Dew Moss				S2?	1	27.3 ± 0.0	NS
N	*Cyrtomnium hymenophylloides*	Short-pointed Lantern Moss				S2?	1	27.3 ± 0.0	NS
N	*Platylomella lescurii*	a Moss				S2?	1	95.4 ± 0.0	NS
N	*Oxyrrhynchium hians*	Light Beaked Moss				S2S3	1	68.7 ± 25.0	NS
N	*Platydictya subtilis*	Bark Willow Moss				S2S3	3	75.9 ± 0.0	PE
N	*Moelleropsis nebulosa*	Blue-gray Moss Shingle Lichen				S2S3	58	54.9 ± 0.0	NS
N	*Moelleropsis nebulosa ssp. frullaniae*	Blue-gray Moss Shingle Lichen				S2S3	3	73.5 ± 0.0	NS
N	*Ramalina thrausta*	Angelhair Ramalina Lichen				S2S3	15	36.1 ± 0.0	NS
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2S3	81	49.3 ± 0.0	PE
N	*Usnea ceratina*	Warty Beard Lichen				S2S3	1	91.2 ± 0.0	NS
N	*Usnea rubicunda*	Red Beard Lichen				S2S3	2	38.9 ± 0.0	NS
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S2S3	7	36.0 ± 6.0	NS
N	*Cladonia incrassata*	Powder-foot British Soldiers Lichen				S2S3	1	71.9 ± 0.0	NS
N	*Cladonia parasitica*	Fence-rail Lichen				S2S3	1	64.1 ± 1.0	NS
N	*Scytinium tenuissimum*	Birdnest Jellyskin Lichen				S2S3	16	39.1 ± 0.0	NS
N	*Melanohalea septentrionalis*	Northern Camouflage Lichen				S2S3	2	89.8 ± 0.0	PE
N	*Myelochroa aurulenta*	Powdery Axil-bristle Lichen				S2S3	1	37.2 ± 0.0	NS
N	*Parmelia fertilis*	Fertile Shield Lichen				S2S3	10	27.7 ± 0.0	NS
N	*Hypotrachyna minarum*	Hairless-spined Shield Lichen				S2S3	1	85.8 ± 0.0	NS
N	*Parmeliopsis ambigua*	Green Starburst Lichen				S2S3	4	17.3 ± 1.0	NS
N	*Fuscopannaria sorediata*	a Lichen				S2S3	6	60.6 ± 0.0	NS
N	*Stereocaulon condensatum*	Granular Soil Foam Lichen				S2S3	10	3.5 ± 0.0	NS
N	*Physcia subtilis*	Slender Rosette Lichen				S2S3	1	79.0 ± 0.0	NS
N	*Cladonia coccifera*	Eastern Boreal Pixie-cup Lichen				S2S3	2	52.4 ± 1.0	NS
N	*Cladonia deformis*	Lesser Sulphur-cup Lichen				S2S3	2	79.2 ± 0.0	PE
N	*Ephemerum serratum*	a Moss				S3	2	19.7 ± 3.0	NS
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S3	2	8.1 ± 0.0	NS
N	*Anomodon tristis*	a Moss				S3	3	77.8 ± 0.0	NS
N	*Sphagnum contortum*	Twisted Peat Moss				S3	4	90.3 ± 4.0	NS
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S3	3	74.1 ± 0.0	NS
N	*Rostania occultata*	Crusted Tarpaper Lichen				S3	5	66.9 ± 0.0	PE
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	17	50.9 ± 2.0	NS
N	*Solorina saccata*	Woodland Owl Lichen				S3	7	64.0 ± 0.0	NS
N	*Fuscopannaria ahlneri*	Corrugated Shingles Lichen				S3	87	16.9 ± 0.0	NS
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	28	47.4 ± 0.0	NS
N	*Leptogium milligranum*	Stretched Jellyskin Lichen				S3	9	51.0 ± 0.0	NS
N	*Nephroma bellum*	Naked Kidney Lichen				S3	8	30.4 ± 0.0	NS
N	*Placynthium nigrum*	Common Ink Lichen				S3	4	51.4 ± 0.0	NS
N	*Platismatia norvegica*	Oldgrowth Rag Lichen				S3	1	97.3 ± 0.0	NS
N	*Ephebe lanata*	Waterside Rockshag Lichen				S3	2	48.4 ± 0.0	NS
N	*Phaeophyscia adiastola*	Powder-tipped Shadow Lichen				S3	4	52.6 ± 0.0	PE
N	*Phaeophyscia pusilloides*	Pompom-tipped Shadow Lichen				S3	12	6.0 ± 0.0	NS
N	*Peltigera collina*	Tree Pelt Lichen				S3	16	29.2 ± 0.0	NS

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N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3?	1	46.9 ± 0.0	PE
N	*Calliergon giganteum*	Giant Spear Moss				S3?	1	78.9 ± 2.0	PE
N	*Elodium blandowii*	Blandow's Bog Moss				S3?	2	7.0 ± 3.0	NS
N	*Mnium stellare*	Star Leafy Moss				S3?	1	91.5 ± 1.0	NS
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S3?	1	92.8 ± 0.0	NS
N	*Sphagnum riparium*	Streamside Peat Moss				S3?	2	79.0 ± 0.0	NS
N	*Cladonia stygia*	Black-footed Reindeer Lichen				S3?	5	76.0 ± 0.0	NS
N	*Encalypta procera*	Slender Extinguisher Moss				S3S4	5	76.6 ± 0.0	NS
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	1	27.3 ± 0.0	NS
N	*Splachnum ampullaceum*	Cruet Dung Moss				S3S4	2	67.2 ± 0.0	NS
N	*Thamnobryum alleghaniense*	a Moss				S3S4	3	76.2 ± 0.0	NS
N	*Tomentypnum nitens*	Golden Fuzzy Fen Moss				S3S4	2	81.5 ± 0.0	PE
N	*Schistidium agassizii*	Elf Bloom Moss				S3S4	2	83.9 ± 0.0	NS
N	*Hylocomiastrum pyrenaicum*	a Feather Moss				S3S4	1	99.5 ± 3.0	NS
N	*Bryoria pseudofuscescens*	Mountain Horsehair Lichen				S3S4	17	53.6 ± 0.0	PE
N	*Enchylium tenax*	Soil Tarpaper Lichen				S3S4	7	47.4 ± 0.0	NS
N	*Sticta fuliginosa*	Peppered Moon Lichen				S3S4	52	16.0 ± 1.0	NS
N	*Arctoparmelia incurva*	Finger Ring Lichen				S3S4	10	83.5 ± 0.0	NS
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S3S4	14	28.5 ± 0.0	NS
N	*Leptogium acadiense*	Acadian Jellyskin Lichen				S3S4	28	21.1 ± 0.0	NS
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3S4	36	50.0 ± 0.0	NS
N	*Vahliella leucophaea*	Shelter Shingle Lichen				S3S4	9	54.8 ± 0.0	NS
N	*Heterodermia speciosa*	Powdered Fringe Lichen				S3S4	20	16.6 ± 3.0	NS
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S3S4	35	52.4 ± 0.0	NS
N	*Melanohalea olivacea*	Spotted Camouflage Lichen				S3S4	6	16.6 ± 3.0	NS
N	*Parmeliopsis hyperopta*	Gray Starburst Lichen				S3S4	5	3.7 ± 1.0	NS
N	*Parmotrema perlatum*	Powdered Ruffle Lichen				S3S4	1	84.4 ± 0.0	NS
N	*Peltigera hymenina*	Cloudy Pelt Lichen				S3S4	1	82.5 ± 1.0	NS
N	*Coccocarpia palmicola*	Salted Shell Lichen				S3S4	733	40.3 ± 0.0	NS
N	*Physcia tenella*	Fringed Rosette Lichen				S3S4	8	53.4 ± 0.0	PE
N	*Anaptychia palmulata*	Shaggy Fringed Lichen				S3S4	61	35.2 ± 0.0	NS
N	*Evernia prunastri*	Valley Oakmoss Lichen				S3S4	32	8.0 ± 5.0	NS
N	*Heterodermia neglecta*	Fringe Lichen				S3S4	57	13.1 ± 0.0	NS
P	*Fraxinus nigra*	Black Ash	Threatened		Threatened	S1S2	452	9.0 ± 0.0	NS
P	*Bartonia paniculata ssp. paniculata*	Branched Bartonia	Threatened	Threatened		SNA	1	44.6 ± 10.0	NS
P	*Lilaeopsis chinensis*	Eastern Lilaeopsis	Special Concern	Special Concern	Vulnerable	S3	17	70.9 ± 0.0	NS
P	*Isoetes prototypus*	Prototype Quillwort	Special Concern	Special Concern	Vulnerable	S3	13	60.7 ± 0.0	NS
P	*Floerkea proserpinacoides*	False Mermaidweed	Not At Risk			S2S3	3	32.7 ± 7.0	NS
P	*Acer saccharinum*	Silver Maple				S1	1	96.9 ± 20.0	PE
P	*Nabalus racemosus*	Glaucous Rattlesnakeroot				S1	1	96.9 ± 20.0	PE
P	*Cochlearia tridactylites*	Limestone Scurvy-grass				S1	5	95.0 ± 0.0	NS
P	*Lobelia spicata*	Pale-Spiked Lobelia				S1	6	49.7 ± 7.0	NS
P	*Stellaria crassifolia*	Fleshy Stitchwort				S1	1	92.4 ± 5.0	PE
P	*Hudsonia tomentosa*	Woolly Beach-heath				S1	55	28.3 ± 7.0	NS
P	*Callitriche hermaphroditica*	Northern Water-starwort				S1	6	91.3 ± 0.0	PE
P	*Elatine americana*	American Waterwort				S1	1	78.9 ± 0.0	NS
P	*Ribes americanum*	Wild Black Currant				S1	2	38.6 ± 5.0	NS
P	*Fraxinus pennsylvanica*	Red Ash				S1	6	60.4 ± 0.0	NS
P	*Persicaria careyi*	Carey's Smartweed				S1	1	52.3 ± 3.0	NS
P	*Ranunculus pensylvanicus*	Pennsylvania Buttercup				S1	31	53.8 ± 0.0	NS
P	*Salix myrtillifolia*	Blueberry Willow				S1	1	69.1 ± 0.0	NS
P	*Salix serissima*	Autumn Willow				S1	2	69.1 ± 0.0	NS
P	*Carex alopecoidea*	Foxtail Sedge				S1	2	87.5 ± 0.0	NS
P	*Carex garberi*	Garber's Sedge				S1	4	22.7 ± 0.0	NS
P	*Carex ormostachya*	Necklace Spike Sedge				S1	1	94.8 ± 1.0	NB

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P	*Carex plantaginea*	Plantain-Leaved Sedge				S1	4	32.3 ± 0.0	NS
P	*Carex prairea*	Prairie Sedge				S1	1	82.5 ± 0.0	PE
P	*Carex tincta*	Tinged Sedge				S1	4	87.5 ± 1.0	NS
P	*Carex viridula var. saxilittoralis*	Greenish Sedge				S1	4	92.2 ± 0.0	NS
P	*Carex grisea*	Inflated Narrow-leaved Sedge				S1	6	77.2 ± 0.0	NS
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S1	15	21.6 ± 0.0	NS
P	*Scirpus atrovirens*	Dark-green Bulrush				S1	2	62.7 ± 0.0	NS
P	*Blysmopsis rufa*	Red Bulrush				S1	1	93.9 ± 5.0	PE
P	*Iris prismatica*	Slender Blue Flag				S1	2	73.3 ± 1.0	NS
P	*Juncus vaseyi*	Vasey Rush				S1	4	27.2 ± 0.0	NS
P	*Malaxis monophyllos var. brachypoda*	North American White Adder's-mouth				S1	3	90.5 ± 1.0	NS
P	*Elymus hystrix*	Spreading Wild Rye				S1	4	31.1 ± 1.0	NS
P	*Potamogeton nodosus*	Long-leaved Pondweed				S1	1	97.0 ± 5.0	NS
P	*Adiantum pedatum*	Northern Maidenhair Fern				S1	1	39.6 ± 1.0	NS
P	*Solidago hispida*	Hairy Goldenrod				S1?	1	51.9 ± 7.0	NS
P	*Suaeda rolandii*	Roland's Sea-Blite				S1?	1	82.0 ± 2.0	NS
P	*Carex pensylvanica*	Pennsylvania Sedge				S1?	3	54.6 ± 3.0	NS
P	*Carex rostrata*	Narrow-leaved Beaked Sedge				S1?	1	96.8 ± 5.0	PE
P	*Bolboschoenus robustus*	Sturdy Bulrush				S1?	2	49.7 ± 7.0	NS
P	*Allium schoenoprasum*	Wild Chives				S1?	4	17.3 ± 3.0	NS
P	*Allium schoenoprasum var. sibiricum*	Wild Chives				S1?	1	40.2 ± 7.0	NS
P	*Cypripedium arietinum*	Ram's-Head Lady's-Slipper			Endangered	S1S2	13	50.5 ± 0.0	NS
P	*Sanicula odorata*	Clustered Sanicle				S1S2	4	6.2 ± 10.0	NS
P	*Ageratina altissima*	White Snakeroot				S1S2	2	77.8 ± 1.0	NS
P	*Proserpinaca intermedia*	Intermediate Mermaidweed				S1S2	1	73.0 ± 0.0	NS
P	*Anemone virginiana var. alba*	Virginia Anemone				S1S2	5	30.3 ± 5.0	NS
P	*Parnassia parviflora*	Small-flowered Grass-of-Parnassus				S1S2	1	60.5 ± 1.0	NS
P	*Carex haydenii*	Hayden's Sedge				S1S2	4	38.5 ± 1.0	NS
P	*Platanthera huronensis*	Fragrant Green Orchid				S1S2	5	57.8 ± 10.0	NS
P	*Calamagrostis stricta ssp. stricta*	Slim-stemmed Reed Grass				S1S2	26	73.9 ± 0.0	PE
P	*Carex vacillans*	Estuarine Sedge				S1S3	3	87.5 ± 0.0	NS
P	*Zizia aurea*	Golden Alexanders				S2	47	21.8 ± 1.0	NS
P	*Antennaria parlinii ssp. fallax*	Parlin's Pussytoes				S2	4	10.9 ± 0.0	NS
P	*Rudbeckia laciniata*	Cut-Leaved Coneflower				S2	25	18.5 ± 0.0	NS
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S2	1	95.1 ± 0.0	NS
P	*Hudsonia ericoides*	Pinebarren Golden Heather				S2	3	93.9 ± 5.0	PE
P	*Desmodium canadense*	Canada Tick-trefoil				S2	20	19.9 ± 0.0	NS
P	*Anemonastrum canadense*	Canada Anemone				S2	1	37.2 ± 0.0	NS
P	*Hepatica americana*	Round-lobed Hepatica				S2	27	5.3 ± 0.0	NS
P	*Galium boreale*	Northern Bedstraw				S2	7	60.8 ± 5.0	NS
P	*Comandra umbellata*	Bastard's Toadflax				S2	51	83.8 ± 5.0	NS
P	*Gratiola neglecta*	Clammy Hedge-Hyssop				S2	5	44.9 ± 0.0	NS
P	*Dirca palustris*	Eastern Leatherwood				S2	5	68.5 ± 7.0	NS
P	*Carex chordorrhiza*	Creeping Sedge				S2	1	87.8 ± 1.0	PE
P	*Carex gynocrates*	Northern Bog Sedge				S2	2	69.1 ± 0.0	NS
P	*Carex pellita*	Woolly Sedge				S2	12	19.2 ± 0.0	NS
P	*Carex livida*	Livid Sedge				S2	14	51.9 ± 0.0	NS
P	*Juncus greenei*	Greene's Rush				S2	7	62.5 ± 1.0	NS
P	*Juncus alpinoarticulatus ssp.*	Northern Green Rush				S2	7	90.7 ± 3.0	PE

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
	americanus								
P	*Luzula spicata*	Spiked Woodrush				S2	1	77.3 ± 0.0	NS
P	*Allium tricoccum*	Wild Leek				S2	8	18.3 ± 0.0	NS
P	*Lilium canadense*	Canada Lily				S2	109	5.8 ± 6.0	NS
P	*Cypripedium parviflorum var. pubescens*	Yellow Lady's-slipper				S2	37	17.8 ± 7.0	NS
P	*Cypripedium reginae*	Showy Lady's-Slipper				S2	68	12.3 ± 0.0	NS
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S2	8	16.2 ± 0.0	NS
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S2	13	9.2 ± 5.0	NS
P	*Bromus latiglumis*	Broad-Glumed Brome				S2	33	35.1 ± 0.0	NS
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S2	19	42.0 ± 0.0	NS
P	*Elymus wiegandii*	Wiegand's Wild Rye				S2	20	11.4 ± 0.0	NS
P	*Festuca subverticillata*	Nodding Fescue				S2	5	68.5 ± 1.0	NS
P	*Cryptogramma stelleri*	Steller's Rockbrake				S2	1	80.6 ± 0.0	NS
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2?	7	13.9 ± 1.0	NS
P	*Rumex persicarioides*	Peach-leaved Dock				S2?	5	68.9 ± 5.0	PE
P	*Crataegus submollis*	Quebec Hawthorn				S2?	6	36.4 ± 5.0	NS
P	*Carex peckii*	White-Tinged Sedge				S2?	3	34.3 ± 0.0	NS
P	*Thuja occidentalis*	Eastern White Cedar			Vulnerable	S2S3	937	59.4 ± 0.0	NS
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2S3	18	9.9 ± 0.0	NS
P	*Bidens hyperborea*	Estuary Beggarticks				S2S3	3	72.1 ± 0.0	NS
P	*Erigeron philadelphicus*	Philadelphia Fleabane				S2S3	5	48.5 ± 5.0	NS
P	*Lactuca hirsuta*	Hairy Lettuce				S2S3	3	72.0 ± 5.0	PE
P	*Impatiens pallida*	Pale Jewelweed				S2S3	3	48.4 ± 0.0	NS
P	*Caulophyllum thalictroides*	Blue Cohosh				S2S3	58	18.2 ± 0.0	NS
P	*Boechera stricta*	Drummond's Rockcress				S2S3	8	28.0 ± 0.0	NS
P	*Stellaria humifusa*	Saltmarsh Starwort				S2S3	10	70.0 ± 1.0	PE
P	*Oxybasis rubra*	Red Goosefoot				S2S3	9	18.2 ± 0.0	NS
P	*Hypericum majus*	Large St John's-wort				S2S3	24	53.2 ± 0.0	NS
P	*Hypericum x dissimulatum*	Disguised St. John's-wort				S2S3	5	61.8 ± 1.0	NS
P	*Empetrum atropurpureum*	Purple Crowberry				S2S3	5	91.5 ± 5.0	PE
P	*Euphorbia polygonifolia*	Seaside Spurge				S2S3	13	42.4 ± 1.0	PE
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S2S3	9	41.7 ± 0.0	NS
P	*Hedeoma pulegioides*	American False Pennyroyal				S2S3	7	20.3 ± 5.0	NS
P	*Oenothera fruticosa ssp. tetragona*	Narrow-leaved Evening Primrose				S2S3	3	18.6 ± 7.0	NS
P	*Polygonum aviculare ssp. buxiforme*	Box Knotweed				S2S3	5	20.7 ± 0.0	NS
P	*Polygonum oxyspermum ssp. raii*	Ray's Knotweed				S2S3	4	90.3 ± 5.0	PE
P	*Rumex triangulivalvis*	Triangular-valve Dock				S2S3	7	54.4 ± 0.0	NS
P	*Primula mistassinica*	Mistassini Primrose				S2S3	16	29.5 ± 0.0	NS
P	*Anemone quinquefolia*	Wood Anemone				S2S3	20	41.7 ± 0.0	NS
P	*Caltha palustris*	Yellow Marsh Marigold				S2S3	53	35.5 ± 0.0	NS
P	*Amelanchier fernaldii*	Fernald's Serviceberry				S2S3	3	86.2 ± 5.0	NS
P	*Potentilla canadensis*	Canada Cinquefoil				S2S3	1	58.3 ± 5.0	NS
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2S3	1	94.8 ± 1.0	NB
P	*Salix pellita*	Satiny Willow				S2S3	5	44.7 ± 0.0	NS
P	*Tiarella cordifolia*	Heart-leaved Foamflower				S2S3	222	9.3 ± 0.0	NS
P	*Agalinis purpurea var. parviflora*	Small-flowered Purple False Foxglove				S2S3	12	14.8 ± 0.0	NS
P	*Boehmeria cylindrica*	Small-spike False-nettle				S2S3	2	78.8 ± 0.0	NS
P	*Carex adusta*	Lesser Brown Sedge				S2S3	6	39.0 ± 0.0	NS
P	*Carex capillaris*	Hairlike Sedge				S2S3	1	96.0 ± 0.0	NS
P	*Carex comosa*	Bearded Sedge				S2S3	6	44.6 ± 7.0	NS
P	*Carex houghtoniana*	Houghton's Sedge				S2S3	5	54.5 ± 1.0	NS
P	*Carex hystericina*	Porcupine Sedge				S2S3	7	19.2 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Eleocharis ovata*	Ovate Spikerush				S2S3	7	17.9 ± 0.0	NS
P	*Scirpus pedicellatus*	Stalked Bulrush				S2S3	7	42.9 ± 0.0	NS
P	*Vallisneria americana*	Wild Celery				S2S3	7	52.6 ± 1.0	NS
P	*Juncus ranarius*	Seaside Rush				S2S3	1	95.8 ± 25.0	PE
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S2S3	2	74.4 ± 1.0	NS
P	*Spiranthes casei var. novaescotiae*	Case's Ladies'-Tresses				S2S3	2	85.2 ± 0.0	PE
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S2S3	22	16.7 ± 5.0	NS
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S2S3	11	74.9 ± 0.0	PE
P	*Potamogeton friesii*	Fries' Pondweed				S2S3	19	36.1 ± 5.0	NS
P	*Woodsia glabella*	Smooth Cliff Fern				S2S3	1	56.5 ± 1.0	NS
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S2S3	9	2.9 ± 0.0	NS
P	*Botrychium simplex*	Least Moonwort				S2S3	3	29.1 ± 0.0	NS
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S2S3	7	12.1 ± 0.0	NS
P	*Potamogeton pulcher*	Spotted Pondweed			Vulnerable	S3	3	51.8 ± 2.0	NS
P	*Angelica atropurpurea*	Purple-stemmed Angelica				S3	8	43.3 ± 0.0	NS
P	*Conioselinum chinense*	Chinese Hemlock-parsley				S3	3	6.7 ± 5.0	NS
P	*Hieracium robinsonii*	Robinson's Hawkweed				S3	3	12.6 ± 7.0	NS
P	*Senecio pseudoarnica*	Seabeach Ragwort				S3	15	40.2 ± 7.0	NS
P	*Symphyotrichum boreale*	Boreal Aster				S3	59	40.2 ± 7.0	NS
P	*Symphyotrichum ciliolatum*	Fringed Blue Aster				S3	20	19.5 ± 0.0	NS
P	*Betula michauxii*	Michaux's Dwarf Birch				S3	32	57.6 ± 0.0	NS
P	*Betula pumila*	Bog Birch				S3	35	69.5 ± 0.0	NS
P	*Cardamine parviflora*	Small-flowered Bittercress				S3	4	93.5 ± 0.0	NS
P	*Palustricodon aparinoides*	Marsh Bellflower				S3	36	6.1 ± 0.0	NS
P	*Mononeuria groenlandica*	Greenland Stitchwort				S3	2	82.6 ± 0.0	NS
P	*Sagina nodosa*	Knotted Pearlwort				S3	9	91.9 ± 0.0	NS
P	*Sagina nodosa ssp. borealis*	Knotted Pearlwort				S3	9	90.7 ± 0.0	NS
P	*Stellaria longifolia*	Long-leaved Starwort				S3	18	15.3 ± 0.0	NS
P	*Ceratophyllum echinatum*	Prickly Hornwort				S3	13	42.0 ± 0.0	NS
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	99	15.4 ± 0.0	NS
P	*Viburnum edule*	Squashberry				S3	3	5.3 ± 0.0	NS
P	*Crassula aquatica*	Water Pygmyweed				S3	6	86.0 ± 5.0	PE
P	*Empetrum eamesii*	Pink Crowberry				S3	12	68.6 ± 5.0	PE
P	*Halenia deflexa*	Spurred Gentian				S3	1	86.7 ± 1.0	NS
P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	5	50.8 ± 2.0	NS
P	*Myriophyllum verticillatum*	Whorled Water Milfoil				S3	2	42.3 ± 0.0	NS
P	*Epilobium strictum*	Downy Willowherb				S3	48	38.1 ± 5.0	NS
P	*Polygala sanguinea*	Blood Milkwort				S3	20	9.0 ± 0.0	NS
P	*Persicaria arifolia*	Halberd-leaved Tearthumb				S3	30	38.4 ± 0.0	NS
P	*Plantago rugelii*	Rugel's Plantain				S3	7	13.3 ± 0.0	NS
P	*Samolus parviflorus*	Seaside Brookweed				S3	22	55.3 ± 0.0	NS
P	*Pyrola minor*	Lesser Pyrola				S3	2	12.4 ± 0.0	NS
P	*Anemone virginiana*	Virginia Anemone				S3	28	19.9 ± 1.0	NS
P	*Galium labradoricum*	Labrador Bedstraw				S3	103	41.1 ± 0.0	NS
P	*Salix pedicellaris*	Bog Willow				S3	55	23.9 ± 7.0	NS
P	*Salix sericea*	Silky Willow				S3	1	90.5 ± 1.0	NS
P	*Lindernia dubia*	Yellow-seeded False Pimperel				S3	46	13.0 ± 0.0	NS
P	*Laportea canadensis*	Canada Wood Nettle				S3	46	13.1 ± 0.0	NS
P	*Pilea pumila*	Dwarf Clearweed				S3	29	36.8 ± 6.0	NS
P	*Viola nephrophylla*	Northern Bog Violet				S3	10	12.1 ± 1.0	NS
P	*Carex bebbii*	Bebb's Sedge				S3	20	28.1 ± 0.0	NS
P	*Carex castanea*	Chestnut Sedge				S3	26	62.6 ± 0.0	NS
P	*Carex cryptolepis*	Hidden-scaled Sedge				S3	13	41.8 ± 0.0	NS
P	*Carex eburnea*	Bristle-leaved Sedge				S3	33	47.4 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Carex hirtifolia*	Pubescent Sedge				S3	44	12.7 ± 0.0	NS
P	*Carex lupulina*	Hop Sedge				S3	30	6.6 ± 0.0	NS
P	*Carex rosea*	Rosy Sedge				S3	20	5.3 ± 0.0	NS
P	*Carex tenera*	Tender Sedge				S3	8	6.3 ± 1.0	NS
P	*Carex tribuloides*	Blunt Broom Sedge				S3	12	19.2 ± 2.0	NS
P	*Carex tuckermanii*	Tuckerman's Sedge				S3	12	6.8 ± 0.0	NS
P	*Eleocharis nitida*	Quill Spikerush				S3	4	83.5 ± 7.0	NS
P	*Eleocharis flavescens var. olivacea*	Bright-green Spikerush				S3	7	41.7 ± 0.0	NS
P	*Eleocharis quinqueflora*	Few-flowered Spikerush				S3	1	97.0 ± 3.0	PE
P	*Eriophorum gracile*	Slender Cottongrass				S3	14	38.3 ± 10.0	NS
P	*Schoenoplectus americanus*	Olney's Bulrush				S3	1	77.3 ± 0.0	NS
P	*Coeloglossum viride*	Long-bracted Frog Orchid				S3	1	64.7 ± 0.0	NS
P	*Cypripedium parviflorum*	Yellow Lady's-slipper				S3	26	12.2 ± 0.0	NS
P	*Neottia bifolia*	Southern Twayblade				S3	25	28.6 ± 0.0	NS
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	132	9.0 ± 0.0	NS
P	*Platanthera hookeri*	Hooker's Orchid				S3	17	50.5 ± 0.0	NS
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	4	18.1 ± 7.0	NS
P	*Piptatheropsis canadensis*	Canada Ricegrass				S3	9	45.5 ± 1.0	NS
P	*Poa glauca*	Glaucous Blue Grass				S3	1	96.0 ± 0.0	NS
P	*Stuckenia filiformis*	Thread-leaved Pondweed				S3	7	81.1 ± 0.0	PE
P	*Potamogeton praelongus*	White-stemmed Pondweed				S3	43	17.7 ± 1.0	NS
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3	6	12.9 ± 7.0	NS
P	*Potamogeton zosteriformis*	Flat-stemmed Pondweed				S3	16	43.3 ± 0.0	NS
P	*Asplenium viride*	Green Spleenwort				S3	9	62.5 ± 7.0	NS
P	*Dryopteris fragrans*	Fragrant Wood Fern				S3	7	26.3 ± 7.0	NS
P	*Sceptridium dissectum*	Dissected Moonwort				S3	6	11.6 ± 5.0	NS
P	*Polypodium appalachianum*	Appalachian Polypody				S3	13	12.8 ± 0.0	NS
P	*Persicaria amphibia var. emersa*	Long-root Smartweed				S3?	3	65.2 ± 0.0	NS
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S3?	13	25.1 ± 0.0	NS
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3?	14	20.5 ± 0.0	NS
P	*Bidens vulgata*	Tall Beggarticks				S3S4	5	29.7 ± 0.0	NS
P	*Erigeron hyssopifolius*	Hyssop-leaved Fleabane				S3S4	36	56.6 ± 0.0	NS
P	*Hieracium paniculatum*	Panicled Hawkweed				S3S4	6	10.1 ± 0.0	NS
P	*Bidens beckii*	Water Beggarticks				S3S4	13	25.9 ± 0.0	NS
P	*Packera paupercula*	Balsam Groundsel				S3S4	75	20.0 ± 0.0	NS
P	*Atriplex glabriuscula var. franktonii*	Frankton's Saltbush				S3S4	7	27.0 ± 2.0	NS
P	*Vaccinium boreale*	Northern Blueberry				S3S4	4	90.7 ± 0.0	NS
P	*Vaccinium cespitosum*	Dwarf Bilberry				S3S4	54	26.7 ± 0.0	NS
P	*Vaccinium corymbosum*	Highbush Blueberry				S3S4	1	96.4 ± 3.0	PE
P	*Fagus grandifolia*	American Beech				S3S4	213	5.6 ± 1.0	NS
P	*Bartonia virginica*	Yellow Bartonia				S3S4	1	90.5 ± 7.0	NS
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S3S4	2	40.7 ± 1.0	NS
P	*Decodon verticillatus*	Swamp Loosestrife				S3S4	1	89.3 ± 0.0	PE
P	*Nuphar microphylla*	Small Yellow Pond-lily				S3S4	3	12.7 ± 2.0	NS
P	*Persicaria pensylvanica*	Pennsylvania Smartweed				S3S4	22	12.1 ± 0.0	NS
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	46	13.1 ± 0.0	NS
P	*Rumex pallidus*	Seabeach Dock				S3S4	2	76.6 ± 0.0	NS
P	*Pyrola asarifolia*	Pink Pyrola				S3S4	16	23.3 ± 0.0	NS
P	*Endotropis alnifolia*	alder-leaved buckthorn				S3S4	284	41.1 ± 0.0	NS
P	*Amelanchier spicata*	Running Serviceberry				S3S4	13	10.0 ± 2.0	NS
P	*Crataegus succulenta*	Fleshy Hawthorn				S3S4	5	80.4 ± 5.0	PE
P	*Fragaria vesca ssp. americana*	Woodland Strawberry				S3S4	68	23.1 ± 1.0	NS
P	*Fragaria vesca*	Woodland Strawberry				S3S4	1	62.7 ± 0.0	NS
P	*Galium aparine*	Common Bedstraw				S3S4	16	39.1 ± 4.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Geocaulon lividum*	Northern Comandra				S3S4	17	57.4 ± 0.0	NS
P	*Limosella australis*	Southern Mudwort				S3S4	45	52.0 ± 1.0	PE
P	*Ulmus americana*	White Elm				S3S4	87	6.3 ± 2.0	NS
P	*Verbena hastata*	Blue Vervain				S3S4	210	5.4 ± 0.0	NS
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S3S4	4	70.3 ± 1.0	PE
P	*Viola selkirkii*	Great-Spurred Violet				S3S4	4	64.7 ± 0.0	NS
P	*Symplocarpus foetidus*	Eastern Skunk Cabbage				S3S4	19	92.7 ± 0.0	NB
P	*Carex argyrantha*	Silvery-flowered Sedge				S3S4	1	57.2 ± 5.0	PE
P	*Triglochin gaspensis*	Gasp ├ Arrowgrass				S3S4	24	90.5 ± 0.0	NS
P	*Juncus acuminatus*	Sharp-Fruit Rush				S3S4	3	64.1 ± 0.0	NS
P	*Juncus subcaudatus*	Woods-Rush				S3S4	19	19.6 ± 5.0	NS
P	*Luzula parviflora ssp. melanocarpa*	Black-fruited Woodrush				S3S4	5	57.6 ± 0.0	NS
P	*Goodyera repens*	Lesser Rattlesnake-plantain				S3S4	9	43.0 ± 1.0	PE
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	23	43.5 ± 5.0	PE
P	*Platanthera obtusata*	Blunt-leaved Orchid				S3S4	6	65.6 ± 1.0	NS
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3S4	39	2.9 ± 0.0	NS
P	*Alopecurus aequalis*	Short-awned Foxtail				S3S4	26	33.1 ± 1.0	NS
P	*Dichanthelium clandestinum*	Deer-tongue Panic Grass				S3S4	119	59.9 ± 0.0	NS
P	*Panicum philadelphicum*	Philadelphia Panicgrass				S3S4	11	53.0 ± 0.0	NS
P	*Koeleria spicata*	Narrow False Oats				S3S4	9	20.3 ± 0.0	NS
P	*Equisetum pratense*	Meadow Horsetail				S3S4	10	30.1 ± 0.0	NS
P	*Diphasiastrum complanatum*	Northern Ground-cedar				S3S4	12	28.3 ± 0.0	NS
P	*Diphasiastrum sitchense*	Sitka Ground-cedar				S3S4	7	31.8 ± 5.0	NS
P	*Huperzia appressa*	Mountain Firmoss				S3S4	7	30.8 ± 5.0	NS
P	*Sceptridium multifidum*	Leathery Moonwort				S3S4	23	19.9 ± 0.0	NS
P	*Botrychium matricariifolium*	Daisy-leaved Moonwort				S3S4	17	12.4 ± 10.0	NS
P	*Viola canadensis*	Canada Violet				SH	1	32.7 ± 7.0	NS

5.1 SOURCE BIBLIOGRAPHY (100 km)

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

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236	Blaney, C.S & Spicer, C.D.; Popma, T.M.; Basquill, S.P. 2003. Vascular Plant Surveys of Northumberland Strait Rivers & Amherst Area Peatlands. Nova Scotia Museum Research Grant, 501 recs.
226	Neily, T.H. 2017. Nova Scotia lichen records. Mersey Tobeatic Research Institute.
225	MacDonald, E.C. 2018. Piping Plover nest records from 2010-2017. Canadian Wildlife Service.
209	eBird. 2014. eBird Basic Dataset. Version: EBD_relNov-2014. Ithaca, New York. Nov 2014. Cornell Lab of Ornithology, 25036 recs.
208	Newell, R.E. 2000. E.C. Smith Herbarium Database. Acadia University, Wolfville NS, 7139 recs.
199	Blaney, C.S.; Mazerolle, D.M. 2012. Fieldwork 2012. Atlantic Canada Conservation Data Centre, 13,278 recs.
187	Chapman, C.J. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 11171 recs.
185	Scott, F.W. 2002. Nova Scotia Herpetofauna Atlas Database. Acadia University, Wolfville NS, 8856 recs.
177	Island Nature Trust. 2016. Farmland birds project. Mader, Shannon (ed.) .
170	Bryson, I. 2013. Nova Scotia rare plant records. CBCL Ltd., 180 records.
169	MacDonald, E.C. 2018. CWS Piping Plover Census, 2010-2017. Canadian Wildlife Service, 672 recs.
168	Brunelle, P.-M. (compiler). 2009. ADIP/MDDS Odonata Database: data to 2006 inclusive. Atlantic Dragonfly Inventory Program (ADIP), 24200 recs.
166	Blaney, C.S.; Mazerolle, D.M.; Hill, N.M. 2011. Nova Scotia Crown Share Land Legacy Trust Fieldwork. Atlantic Canada Conservation Data Centre, 5022 recs.
165	Newell, R.E. 2005. E.C. Smith Digital Herbarium. E.C. Smith Herbarium, Irving Biodiversity Collection, Acadia University, Web site: http://luxor.acadiau.ca/library/Herbarium/project/. 582 recs.
155	Klymko, J. 2018. Maritimes Butterfly Atlas database. Atlantic Canada Conservation Data Centre.
147	Bryson, I.C. 2020. Nova Scotia flora and lichen observations 2020. Nova Scotia Environment, 139 recs.
144	Mazerolle, D.M. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 13515 recs.
142	Catling, P.M., Erskine, D.S. & MacLaren, R.B. 1985. The Plants of Prince Edward Island with new records, nomenclatural changes & corrections & deletions, 1st Ed. Research Branch, Agriculture Canada, Ottawa, Publication 1798. 22pp.
137	Pepper, C. 2021. Rare bird, plant and mammal observations in Nova Scotia, 2017-2021.
135	Pronych, G. & Wilson, A. 1993. Atlas of Rare Vascular Plants in Nova Scotia. Nova Scotia Museum, Halifax NS, I:1-168, II:169-331. 1446 recs.
130	Chapman-Lam, C.J. 2022. Atlantic Canada Conservation Data Centre 2021 botanical fieldwork. Atlantic Canada Conservation Data Centre, 15099 recs.
128	Pepper, C. 2013. 2013 rare bird and plant observations in Nova Scotia. , 181 records.
127	MacDonald, Haley. 2022. Updates to Fraxinus nigra observations on NCC Docherty's Brook property. Nature Conservancy of Canada.
121	LaPaix, R.W.; Crowell, M.J.; MacDonald, M. 2011. Stantec rare plant records, 2010-11. Stantec Consulting, 334 recs.
120	Amirault, D.L. & McKnight, J. 2003. Piping Plover Database 1991-2003. Canadian Wildlife Service, Sackville, unpublished data. 7 recs.
111	Richardson, Leif. 2018. Maritimes Bombus records from various sources. Richardson, Leif.
110	Belliveau, A.G. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
109	Burke, Lindsey. 2022. Species data recorded during the 2021 season at Prince Edward Island National Park. Parks Canada.
109	Neily, T.H. & Pepper, C. 2020. Nova Scotia SMP lichen surveys 2020. Mersey Tobeatic Research Institute.
100	Klymko, J.J.D. 2012. Insect fieldwork & submissions, 2011. Atlantic Canada Conservation Data Centre. Sackville NB, 760 recs.
100	Toms, B. 2018. Bat Species data from www.batconservation.ca for Nova Scotia. Mersey Tobeatic Research Institute, 547 Records.
97	Cameron, R.P. 2009. Cyanolichen database. Nova Scotia Environment & Labour, 1724 recs.
91	Burns, L. 2013. Personal communication concerning bat occurrence on PEI. Winter 2013. Pers. comm.
88	Canadian Wildlife Service, Dartmouth. 2010. Piping Plover censuses 2007-09, 304 recs.
87	McNeil, J.A. 2018. Wood Turtle records, 2018. Mersey Tobeatic Research Institute, 68 recs.
83	Chapman-Lam, C.J. 2021. Atlantic Canada Conservation Data Centre 2020 botanical fieldwork. Atlantic Canada Conservation Data Centre, 17309 recs.
80	Blaney, C.S.; Spicer, C.D. 2001. Fieldwork 2001. Atlantic Canada Conservation Data Centre. Sackville NB, 981 recs.
78	Nature Conservancy of Canada. 2022. NCC Field data for Nova Scotia. Nature Conservancy of Canada.
75	Blaney, C.S. 2000. Fieldwork 2000. Atlantic Canada Conservation Data Centre. Sackville NB, 1265 recs.
75	Cameron, R.P. 2011. Lichen observations, 2011. Nova Scotia Environment & Labour, 731 recs.
73	Neily, T.H. & Pepper, C.; Toms, B. 2020. Nova Scotia lichen database [as of 2020-03-18]. Mersey Tobeatic Research Institute.
72	Staicer, C. & Bliss, S.; Achenbach, L. 2017. Occurrences of tracked breeding birds in forested wetlands. , 303 records.
69	Berrigan, L. 2019. Maritimes Marsh Monitoring Project 2013, 2014, 2016, 2017, and 2018 data. Bird Studies Canada, Sackville, NB.
68	Blaney, C.S.; Mazerolle, D.M. 2008. Fieldwork 2008. Atlantic Canada Conservation Data Centre. Sackville NB, 13343 recs.
68	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2013. Atlantic Canada Conservation Data Centre Fieldwork 2013. Atlantic Canada Conservation Data Centre, 9000+ recs.
63	Klymko, John. 2022. Atlantic Canada Conservation Data Centre zoological fieldwork 2021. Atlantic Canada Conservation Data Centre.
62	Blaney, C.S.; Mazerolle, D.M.; Oberndorfer, E. 2007. Fieldwork 2007. Atlantic Canada Conservation Data Centre. Sackville NB, 13770 recs.
62	Cameron, R.P. 2009. Erioderma pedicellatum database, 1979-2008. Dept Environment & Labour, 103 recs.
62	Manthorne, A. 2014. MaritimesSwiftwatch Project database 2013-2014. Bird Studies Canada, Sackville NB, 326 recs.
61	Arsenault, M. 2019. Cormorant colony nest counts. PE Department of Communities, Land, and Environment.
61	Ayles, P. 2006. Prince Edward Island National Park Digital Database. Parks Canada, 179 recs.
61	Glen, W. 1991. 1991 Prince Edward Island Forest Biomass Inventory Data. PEI Dept of Energy and Forestry, 10059 recs.
60	Mazerolle, D.M. 2017. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
57	Munro, Marian K. Tracked lichen specimens, Nova Scotia Provincial Museum of Natural History Herbarium. Atlantic Canada Conservation Data Centre. 2019.
57	Toms, Brad & Pepper, Chris; Neily, Tom. 2022. Nova Scotia lichen database [as of 2022-04]. Mersey Tobeatic Research Institute.

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56	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2013.
52	Blaney, C.S.; Spicer, C.D.; Popma, T.M.; Hanel, C. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 2252 recs.
52	Roland, A.E. & Smith, E.C. 1969. The Flora of Nova Scotia, 1st Ed. Nova Scotia Museum, Halifax, 743pp.
50	Blaney, C.S.; Mazerolle, D.M.; Klymko, J; Spicer, C.D. 2006. Fieldwork 2006. Atlantic Canada Conservation Data Centre. Sackville NB, 8399 recs.
50	iNaturalist. 2018. iNaturalist Data Export 2018. iNaturalist.org and iNaturalist.ca, Web site: 11700 recs.
48	eBird. 2021. eBird Basic Dataset. Version: EBD_relOct-2020. Ithaca, New York. Oct 2020, Prince Edward Island Bird SAR subset. Cornell Lab of Ornithology.
47	Churchill, J.L. 2020. Atlantic Canada Conservation Data Centre Fieldwork 2020. Atlantic Canada Conservation Data Centre, 1083 recs.
47	Zinck, M. & Roland, A.E. 1998. Roland's Flora of Nova Scotia. Nova Scotia Museum, 3rd ed., rev. M. Zinck; 2 Vol., 1297 pp.
45	Staicer, C. 2021. Additional compiled Nova Scotia Species at Risk bird records, 2005-2020. Dalhousie University.
44	Blaney, C.S. 2020. Sean Blaney 2020 field data. Atlantic Canada Conservation Data Centre, 4407 records.
44	Neily, T.H. & Pepper, C.; Toms, B. 2015. Nova Scotia lichen location database [as of 2015-02-15]. Mersey Tobeatic Research Institute, 1691 records.
44	Nussey, Pat & NCC staff. 2019. AEI tracked species records, 2016-2019. Chapman, C.J. (ed.) Atlantic Canada Conservation Data Centre, 333.
43	Benjamin, L.K. 2012. NSDNR fieldwork & consultant reports 2008-2012. Nova Scotia Dept Natural Resources, 196 recs.
42	Erskine, D. 1960. The plants of Prince Edward Island, 1st Ed. Research Branch, Agriculture Canada, Ottawa., Publication 1088. 1238 recs.
41	Curley, F.R. 2005. PEF&W Collection 2003-04. PEI Fish & Wildlife Div., 716 recs.
41	Nova Scotia Nature Trust. 2013. Nova Scotia Nature Trust 2013 Species records. Nova Scotia Nature Trust, 95 recs.
40	Patrick, Allison. 2021. Animal and plant records from NCC properties from 2019 and 2020. Nature Conservancy Canada.
39	Staicer, Cindy. 2022. 2021 Landbird Species at Risk observations. Dalhousie University.
38	Pulsifer, M.D. 2002. NS Freshwater Mussel Fieldwork. Nova Scotia Dept Natural Resources, 369 recs.
37	Blaney, C.S. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 1042 recs.
37	PEI National Park. 2019. SAR and Bombus records from PEI NP from the 2019 field season. Moody, Allison (ed.) PEI National Park, 158 recs.
36	Hall, R.A. 2001. S.. NS Freshwater Mussel Fieldwork. Nova Scotia Dept Natural Resources, 178 recs.
36	Hall, R.A. 2003. NS Freshwater Mussel Fieldwork. Nova Scotia Dept Natural Resources, 189 recs.
34	Porter, C.J.M. 2014. Field work data 2007-2014. Nova Scotia Nature Trust, 96 recs.
33	Blaney, C.S. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2018. Atlantic Canada Conservation Data Centre.
33	iNaturalist. 2020. iNaturalist butterfly records selected for the Maritimes Butterfly Atlas. iNaturalist.
32	Belliveau, A.G. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 10695 recs.
30	Belland, R.J. Maritimes moss records from various herbarium databases. 2014.
30	Chapman, C.J. 2019. Atlantic Canada Conservation Data Centre 2019 botanical fieldwork. Atlantic Canada Conservation Data Centre, 11729 recs.
30	Parks Canada. 2021. PEI National Park 2020 Species at Risk records. Parks Canada, 40 records.
30	Tims, J. & Craig, N. 1995. Environmentally Significant Areas in New Brunswick (NBESA). NB Dept of Environment & Nature Trust of New Brunswick Inc, 6042 recs. https://doi.org/10.1037/arc0000014.
29	Benjamin, L.K. (compiler). 2001. Significant Habitat & Species Database. Nova Scotia Dept of Natural Resources, 15 spp, 224 recs.
29	Neily, T.H. 2010. Erioderma Pedicellatum records 2005-09. Mersey Tobiatic Research Institute, 67 recs.
28	Sharkie, R., MacQuarrie, K., Fraser, M. 2003. A Floral Inventory of the Western Section of Prince Edward Island National Park and adjacent Crown lands. Parks Canada Agency, v + 106 pp.
27	Sollows, M.C,. 2008. NBM Science Collections databases: mammals. New Brunswick Museum, Saint John NB, download Jan. 2008, 4983 recs.
26	Belliveau, A.G. 2021. E.C. Smith Herbarium and Atlantic Canada Conservation Data Centre Fieldwork 2021. E.C. Smith Herbarium.
26	Popma, T.M. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 113 recs.
25	Blaney, C.S.; Spicer, C.D.; Mazerolle, D.M. 2005. Fieldwork 2005. Atlantic Canada Conservation Data Centre. Sackville NB, 2333 recs.
25	MacQuarrie, K.E., H. Schaefer, and K. Schoenrank. 1999. A Floral inventory of the Western Area, Greenwich, Prince Edward Island National Park. Parks Canada Agency, Parks Canada Technical Reports in Ecosystem Science, No 021.
25	Pepper, Chris. 2012. Observations of breeding Canada Warbler's along the Eastern Shore, NS. Pers. comm. to S. Blaney, Jan. 20, 28 recs.
24	Layberry, R.A. & Hall, P.W., LaFontaine, J.D. 1998. The Butterflies of Canada. University of Toronto Press. 280 pp+plates.
23	Belliveau, A.G. 2020. E.C. Smith Herbarium and Atlantic Canada Conservation Data Centre Fieldwork 2019, 2020. E.C. Smith Herbarium.
23	Blaney, C.S.; Spicer, C.D.; Rothfels, C. 2004. Fieldwork 2004. Atlantic Canada Conservation Data Centre. Sackville NB, 1343 recs.
23	MacDonald, M. 2008. PEI Power Corridor Floral Surveys, 2004-08. Jacques Whitford Ltd, 2238 recs (979 rare).
22	Anderson, Frances; Neily, Tom. 2010. A Reconnaissance Level Survey of Calciphilous Lichens in Selected Karst Topography in Nova Scotia with Notes on Incidental Bryophytes. Mersey Tobeatic Research Institute.
22	Archibald, D.R. 2003. NS Freshwater Mussel Fieldwork. Nova Scotia Dept Natural Resources, 213 recs.
22	Powell, B.C. 1967. Female sexual cycles of Chrysemy spicta & Clemmys insculpta in Nova Scotia. Can. Field-Nat., 81:134-139. 26 recs.
21	Chapman, C.N. (Cody). 2020. Nova Scotia Black Ash (Fraxinus nigra) field observations by Confederacy of Mainland Mi'kmaq. Forestry Program, Confederacy of Mainland Mi'kmaq.
21	Tranquilla, L. 2015. Maritimes Marsh Monitoring Project 2015 data. Bird Studies Canada, Sackville NB, 5062 recs.
20	Cameron, R.P. 2018. Degelia plumbea records. Nova Scotia Environment.
20	Grandtner, M.M. 1971. Ecological Study of the Interior Dunes of West Brackley Beach, Prince Edward Island National Park. Parks Canada, 1: 70. 41 recs.
20	LaPaix, Rich. 2022. Rare species observations, 2018-2022. Nova Scotia Nature Trust.
20	Neily, T.H. 2019. Tom Neily NS Bryophyte records (2009-2013). T.H. Neily, Atlantic Canada Conservation Data Centre, 1029 specimen records.
19	Haughian, Sean. 2021. Update to lichen data from 2017-2021. Nova Scotia Museum.
19	Klymko, J.J.D.; Robinson, S.L. 2012. 2012 field data. Atlantic Canada Conservation Data Centre, 447 recs.
19	NS DNR. 2017. Black Ash records from NS DNR Permanent Sample Plots (PSPs), 1965-2016. NS Dept of Natural Resources.
18	Cameron, R.P. 2014. 2013-14 rare species field data. Nova Scotia Department of Environment, 35 recs.

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18	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2014.
18	Neily, T. H. 2018. Lichen and Bryophyte records, AEI 2017-2018. Tom Neily; Atlantic Canada Conservation Data Centre.
18	Neily, T.H. 2012. 2012 Erioderma pedicellatum records in Nova Scotia.
17	LaPaix, R.W.; Crowell, M.J.; MacDonald, M.; Neily, T.D.; Quinn, G. 2017. Stantec Nova Scotia rare plant records, 2012-2016. Stantec Consulting.
17	McMullin, R.T. 2022. Maritimes lichen records. Canadian Museum of Nature.
17	NatureServe Canada. 2019. iNaturalist Maritimes Butterfly Records. iNaturalist.org and iNaturalist.ca.
16	Adams, J. & Herman, T.B. 1998. Thesis, Unpublished map of C. insculpta sightings. Acadia University, Wolfville NS, 88 recs.
16	Cameron, R.P. 2013. 2013 rare species field data. Nova Scotia Department of Environment, 71 recs.
16	Canadian Wildlife Service, Atlantic Region. 2010. Piping Plover censuses 2006-09. , 35 recs.
16	e-Butterfly. 2016. Export of Maritimes records and photos. Maxim Larrivee, Sambo Zhang (ed.) e-butterfly.org.
16	Gilhen, J. 1984. Amphibians & Reptiles of Nova Scotia, 1st Ed. Nova Scotia Museum, 164pp.
16	McNeil, J.A. 2016. Blandings Turtle (Emydoidea blandingii), Eastern Ribbonsnake (Thamnophis sauritus), Wood Turtle (Glyptemys insculpta), and Snapping Turtle (Chelydra serpentina) sightings, 2016. Mersey Tobeatic Research Institute, 774 records.
15	Belliveau, A. 2013. Rare species records from Nova Scotia. Mersey Tobeatic Research Institute, 296 records. 296 recs.
15	Chaput, G. 2002. Atlantic Salmon: Maritime Provinces Overview for 2001. Dept of Fisheries & Oceans, Atlantic Region, Science Stock Status Report D3-14. 39 recs.
15	Ogden, J. NS DNR Butterfly Collection Dataset. Nova Scotia Department of Natural Resources. 2014.
14	Churchill, J.L. 2019. Atlantic Canada Conservation Data Centre Fieldwork 2019. Atlantic Canada Conservation Data Centre.
14	Ferguson, D.C. 1954. The Lepidoptera of Nova Scotia. Part I, macrolepidoptera. Proceedings of the Nova Scotian Institute of Science, 23(3), 161-375.
14	Hagerman, Christianne. 2022. Wisqoq and Eastern White Cedar field work. E.C. Smith Herbarium, Acadia University.
14	Phinney, Lori; Toms, Brad; et. al. 2016. Bank Swallows (Riparia riparia) in Nova Scotia: inventory and assessment of colonies. Merset Tobeiatc Research Institute, 25 recs.
14	Richardson, D., Anderson, F., Cameron, R, McMullin, T., Clayden, S. 2014. Field Work Report on Black Foam Lichen (Anzia colpodes). COSEWIC.
14	Spicer, C.D. & Harries, H. 2001. Mount Allison Herbarium Specimens. Mount Allison University, 128 recs.
14	Toms, Brad. 2022. Non-Lichen Observations from Lichen SMP and NCC Property Searches. Mersey Tobeatic Research Institute.
13	Belliveau, A.G. 2014. Plant Records from Southern and Central Nova Scotia. Atlantic Canada Conservation Data Centre, 919 recs.
13	Robinson, S.L. 2015. 2014 field data.
13	Westwood, A., Staicer, C. 2016. Nova Scotia landbird Species at Risk observations. Dalhousie University.
13	Wilhelm, S.I. et al. 2019. Colonial Waterbird Database. Canadian Wildlife Service.
12	Basquill, S.P. 2010. Plant data from Prince Edward Island National Park Forest Community Plots. Atlantic Canada Conservation Data Centre, 150 records.
12	Doucet, D.A. 2009. Census of Globally Rare, Endemic Butterflies of Nova Scotia Gulf of St Lawrence Salt Marshes. Nova Scotia Dept of Natural Resources, Species at Risk, 155 recs.
12	McMullin, R.T.; van Miltenburg, N.; Atkinson, K.-L.; Ayles, P. 2022. A Provisional List of the Lichens and Allied Fungi of Prince Edward Island National Park. Canadian Museum of Nature, 37 pp.
12	Plissner, J.H. & Haig, S.M. 1997. 1996 International piping plover census. US Geological Survey, Corvallis OR, 231 pp.
12	Spicer, C.D. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 211 recs.
11	Downes, C. 1998-2000. Breeding Bird Survey Data. Canadian Wildlife Service, Ottawa, 111 recs.
11	Klymko, J. 2021. Atlantic Canada Conservation Data Centre zoological fieldwork 2020. Atlantic Canada Conservation Data Centre.
11	McLelland, Don. 2021. Orchid observations on PEI. Don McLelland. Pers. comm. to C.S. Blaney.
11	Oldham, M.J. 2000. Oldham database records from Maritime provinces. Oldham, M.J; ONHIC, 487 recs.
11	White, S. 2018. Notable species sightings, 2016-2017. East Coast Aquatics.
10	Basquill, S.P. 2012. 2012 rare vascular plant field data. Nova Scotia Department of Natural Resources, 37 recs.
10	Bateman, M.C. 2001. Coastal Waterfowl Surveys Database, 1965-2001. Canadian Wildlife Service, Sackville, 667 recs.
10	Churchill, J.L.; Walker, J. 2017. Species at Risk Surveys at Correctional Services Canada Properties in Nova Scotia and New Brunswick. Atlantic Canada Conservation Data Centre.
10	Goltz, J.P. & Bishop, G. 2005. Confidential supplement to Status Report on Prototype Quillwort (Isoetes prototypus). Committee on the Status of Endangered Wildlife in Canada, 111 recs.
10	Klymko, J.J.D. 2016. 2015 field data. Atlantic Canada Conservation Data Centre.
10	McMullin, R.T. 2015. Prince Edward Island's lichen biodiversity and proposed conservation status in a report prepared for the province of PEI. Biodiversity Institute of Ontario Herbarium, University of Guelph, 776 records.
10	Zahavich, J. 2018. Canada Warbler and Olive-sided Flycatcher records 2018. Island Nature Trust, 14 recs.
10	Zahavich, J.L. 2020. Canada Warbler, Olive-sided Flycatcher and Eastern Wood-Pewee observations, Prince Edward Island, 2017-2019. Island Nature Trust.
9	Benjamin, L.K. 2011. NSDNR fieldwork & consultant reports 1997, 2009-10. Nova Scotia Dept Natural Resources, 85 recs.
9	Blaney, C.S. 2019. Sean Blaney 2019 field data. Atlantic Canada Conservation Data Centre, 4407 records.
9	Blaney, C.S.; Mazerolle, D.M. 2011. Fieldwork 2011. Atlantic Canada Conservation Data Centre. Sackville NB.
9	Cameron-MacMillan, Maureen. 2020. Northern Goshawk Nests in Eastern Nova Scotia, as of November, 2020. Nova Scotia Department of Lands and Forestry.
9	Cameron, R.P. 2005. Erioderma pedicellatum unpublished data. NS Dept of Environment, 9 recs.
9	Cameron, R.P. 2006. Erioderma pedicellatum 2006 field data. NS Dept of Environment, 9 recs.
9	Cameron, R.P. 2017. 2017 rare species field data. Nova Scotia Environment, 64 recs.
9	O'Neil, S. 1998. Atlantic Salmon: Northumberland Strait Nova Scotia part of SFA 18. Dept of Fisheries & Oceans, Atlantic Region, Science. Stock Status Report D3-08. 9 recs.
9	Stewart, J.I. 2010. Peregrine Falcon Surveys in New Brunswick, 2002-09. Canadian Wildlife Service, Sackville, 58 recs.
9	Webster, R.P. Atlantic Forestry Centre Insect Collection, Maritimes butterfly records. Natural Resources Canada. 2014.
8	Cameron, R.P. 2012. Rob Cameron 2012 vascular plant data. NS Department of Environment, 30 recs.
8	Curley, F.R. 2007. PEF&W Collection. PEI Fish & Wildlife Div., 199 recs.
8	Klymko, J.J.D.; Robinson, S.L. 2014. 2013 field data. Atlantic Canada Conservation Data Centre.

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8	MacArthur, M.E.L. 1976. An Ecological Study of the Greenwich Sand Dune System, M.Sc. Thesis. Department of Biology, Acadia University, Wolfville NS, 98 recs.
8	MacQuarrie, K.E., H. Schaefer, and K. Schoenrank. 2001. A Floral inventory of the Central and Schooner Pond Areas of Greenwich, Prince Edward Island National Park. Parks Canada Agency, Parks Canada Technical Reports in Ecosystem Science, No 030.
8	Manthorne, A. 2019. Incidental aerial insectivore observations. Birds Canada.
8	Mersey Tobetic Research Institute. 2021. 2020 Monarch records from the MTRI monitoring program. Mersey Tobetic Research Institute, 72 records.
8	Porter, Caitlin. 2021. Field data for 2020 in various locations across the Maritimes. Atlantic Canada Conservation Data Centre, 3977 records.
7	Basquill, S.P. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre, Sackville NB, 69 recs.
7	Belland, R.J. 2012. PEI moss records from Devonian Botanical Garden. DBG Cryptogam Database, Web site: https://secure.devonian.ualberta.ca/bryo_search.php 748 recs.
7	Benjamin, L.K. 2009. Boreal Felt Lichen, Mountain Avens, Orchid and other recent records. Nova Scotia Dept Natural Resources, 105 recs.
7	Brazner, J. 2016. Nova Scotia Forested Wetland Bird Surveys. Nova Scotia Department of Lands and Forestry.
7	Cameron, B. 2006. Hepatica americana Survey at Scotia Mine Site in Gays River, and Discovery of Three Yellow-listed Species. Conestoga-Rovers and Associates, (a consulting firm), october 25. 7 recs.
7	Harding, R.W. 2008. Harding Personal Insect Collection 1999-2007. R.W. Harding, 309 recs.
7	Hill, N.M. 1994. Status report on the Long's bulrush Scirpus longii in Canada. Committee on the Status of Endangered Wildlife in Canada, 7 recs.
7	Hubley, Nicole. 2022. Monarch (Danaus plexippus) records submitted to MTRI from the 2021 field season. Mersey Tobeatic Research Institute.
7	Hughes, Cory. 2020. Atlantic Forestry Centre Coccinella transversoguttata collections. Canadian Forest Service, Atlantic Forestry Centre.
7	Klymko, J. Dataset of butterfly records at the New Brunswick Museum not yet accessioned by the museum. Atlantic Canada Conservation Data Centre. 2016.
7	McLelland, Don. 2022. Orchid records for Prince Edward Island. Pers. comm.
7	Neily, T.H. & Pepper, C.; Toms, B. 2020. Nova Scotia lichen database [as of 2020-05-25]. Mersey Tobeatic Research Institute, 668 recs.
7	Neily, T.H. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. T.H. Neily, Atlantic Canada Conservation Data Centre.
7	Neily, Tom. 2020. Lichen surveys for PEI Forested Landscapes Priority Place. Chapman, C.J. (ed.) Atlantic Canada Conservation Data Centre, 158 records.
7	Robinson, S.L. 2011. 2011 ND dune survey field data. Atlantic Canada Conservation Data Centre, 2715 recs.
7	Sabine, D.L. 2013. Dwaine Sabine butterfly records, 2009 and earlier.
7	Taylor, B.R., and Tam, J.C. 2012. Local distribution of the rare plant Triosteum aurantiacum in northeastern Nova Scotia, Canada. Rhodora, 114(960): 366-382.
6	Blaney, C.S.; Mazerolle, D.M. 2009. Fieldwork 2009. Atlantic Canada Conservation Data Centre. Sackville NB, 13395 recs.
6	Doucet, D.A. 2007. Lepidopteran Records, 1988-2006. Doucet, 700 recs.
6	Gallop, John. 2021. Sheet Harbour rare lichen observations. McCallum Environmental.
6	Hall, R. 2008. Rare plant records in old fieldbook notes from Truro area. Pers. comm. to C.S. Blaney. 6 recs, 6 recs.
6	Kelly, G. 2005. Fraxinus nigra. Dept of Agricuture, Fisheries, Aquaculture & Forestry. Pers. comm. to C.S. Blaney, Mar. 2, 11 recs.
6	Mazerolle, D.M. 2020. Atlantic Canada Conservation Data Centre botanical fieldwork 2019. Atlantic Canada Conservation Data Centre.
6	Neily, T.H. Tom Neily NS Sphagnum records (2009-2014). T.H. Neily, Atlantic Canada Conservation Data Centre. 2019.
6	Spicer, C.D. 2004. Specimens from CWS Herbarium, Mount Allison Herbarium Database. Mount Allison University, 5939 recs.
6	Stevens, C. 1999. Cam Stevens field data from PEI vegetation plots. Sent along with specimens to C.S. Blaney. UNB masters research project, 732 recs.
6	White, S. 2019. Notable species sightings, 2018. East Coast Aquatics.
5	Amirault, D.L. 1997-2000. Unpublished files. Canadian Wildlife Service, Sackville, 470 recs.
5	Blaney, C.S. 2017. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
5	Bryson, I. 2020. Nova Scotia and Newfoundland rare species observations, 2018-2020. Nova Scotia Environment.
5	Daury, R.W. & Bateman, M.C. 1996. The Barrow's Goldeneye (Bucephala islandica) in the Atlantic Provinces and Maine. Canadian Wildlife Service, Sackville, 47pp.
5	Dibblee, R.L. 1999. PEI Cormorant Survey. Prince Edward Island Fisheries, Aquaculture & Environment, 1p. 21 recs.
5	Erskine, A.J. 1999. Maritime Nest Records Scheme (MNRS) 1937-1999. Canadian Wildlife Service, Sackville, 313 recs.
5	Feltham, Carter. 2022. Monarch (Danaus plexippus) and Milkweed MTRI records from the 2022 Field Season. Mersey Tobeatic Research Institute.
5	Giberson, D. 2008. UPEI Insect Collection. University of Prince Edward Island, 157 recs.
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APPENDIX D : FISH COLLECTION SOP

STANDARD OPERATING PROCEDURE: FISH COLLECTION

1 PURPOSE

The purpose of this document is to provide standard methods for fish collection techniques performed by McCallum Environmental Ltd. (MEL) employees and subconsultants in freshwater habitats.

2 SCOPE

This document provides standards for data collection and measurements, and gives details on a limited range of fish collection methodologies/gear for linear watercourses and littoral habitats of open water areas (i.e. ponds, lakes), including:

- Electrofishing
- Minnow traps
- Eel pots
- Fyke nets
- Seine nets

Subject to study design, these sampling techniques can provide both qualitative information (i.e. species presence, community composition, and relative abundance) and quantitative information (i.e. population estimates) on fish species within freshwater habitats. A clear understanding of the purpose of the sampling program will help define the fish trapping methodology that is needed.

It is important to note that all gear types have certain limitations, including but not limited to catch selectivity and sampling efficacy. The best fish collection studies will employ variety of gear types to sample as many habitat types as possible, thus ensuring the widest possible range of fish species and sizes are collected. A summary of gear types (i.e. sampling methodologies) presented within this document and their limitations are provided in Section 5. There are several resources that provide greater detail and a wider range of procedures for fish collection - see Portt et al. (2006) for a comprehensive review of fish sampling methods in freshwater habitats.

It is also important that all field staff understand the habitat preferences of fish expected to be encountered within the study area. All field staff should have a general understanding of the biology and habitat preferences of anticipated fish species and age groups. This knowledge can greatly improve the sampling efficiency of the field crew and provides important information for gear selection. Detailed information on the biology of fishes in Nova Scotia can be found in Scott and Crossman (1973), McPhail and Lindsey (1970), and the Nova Scotia Adopt A Stream Manual (2005). Fact sheets for common freshwater fish species have been provided in Appendix C.

3 PERMITTING

Before engaging in any fish collection survey, MEL must apply for, and obtain a Licence to Fish Finfish for Scientific Purposes, issued by Fisheries and Oceans Canada (DFO). This is required under the provisions of the Fisheries Act, and any fishing completed without a permit can be subject to criminal charges under the Act. Project managers must ensure proper notification is provided to DFO as outlined in the licence, and must confirm that there are no variation orders in effect which may limit fish sampling methods.

All field staff must read and understand the conditions of the fishing licence and are required to have a hard copy of the licence on hand during all fish collection surveys.

4 SAFETY

The following documents provide important safety considerations and Personal Protective Equipment (PPE) for this type of work, and should be consulted before proceeding with any fish collection survey:

- MEL HSE Policy;
- MEL Remote Work Policy; and,
- Fisheries and Oceans Canada's Interim Policy for the Use of Backpack Electrofishing Units (2003)

The following sections provide important information pertaining to the prevention and avoidance of injury to personnel and fish during fish collection surveys. Unique safety considerations that apply to each fishing method are outlined in Sections 5.1 through 5.5, and procedures outlined in Section 6.0 contain safety checks and emergency response protocols to be followed by all field crew members.

5 FISH COLLECTION METHODS - THEORY

Gear types used for sampling can be divided into two categories: active and passive. Active gear includes those that are moved through the water either by machine or with human power (e.g. electrofishing). Passive gear is usually set and left stationary for a period of time (e.g. minnow traps).

Although gear will be selected prior to the field survey, the surveyors will exercise their judgment in using any combination of gear types to ensure that all habitat types are surveyed within the watercourse reaches or waterbodies of interest.

Certain criteria assist in selection of appropriate gear types. These criteria can include, for example, the overall objective of the fish collection survey, anticipated fish species to be encountered, and in-field limitations such as the physical characteristics of the watercourse/waterbody being surveyed. Fish mortality is also an issue that must be considered, with preference for non-lethal or low-mortality methods wherever possible. Gear types known to have high mortality rates (e.g. gill nets) are not proposed for use as part of MEL fish collection efforts at this time.

Certain limitations may restrict the use of a particular gear type to a lake, a stream, or a particular habitat type. For example, electrofishing is effective in shallow areas of with higher velocity but cannot be used efficiently in deep open waters. Site accessibility, substrate, vegetation, time constraints, size, and accessibility of the habitat of the lake or stream may further affect deployment of each gear type. The best results are obtained by using a variety of gear types to sample as many habitat types as possible, thus ensuring the widest possible range of fish species and sizes are collected.

Many factors affect fish sampling. These include water depth, conductivity, water clarity, water temperature, water velocity, fish size and behavior. The effects these factors have on sampling efficiency vary, and many of the factors are interrelated. Efficacy and limitations of specific gear types are summarized in Table 1.

5.1 Electrofishing

Electrofishing is the technique of passing electric current through the water to attract and stun fish, thus facilitating their capture. This SOP pertains to backpack electrofishing only. It is most useful in streams

and rivers, but can also be used to sample shallow littoral areas of lakes. The deeper and wider a sampling area, the more likely fish will be able to avoid capture.

The electrofishing unit is essentially a portable transformer carried on the back of the operator (like a backpack), with probes, controls, and gauges. An electrical current is produced by the unit and is passed through the water from the cathode (negatively (-) charged probe) to the anode (positively (+) charged probe). This current produces an electric field in the water that will affect any fish in a variety of ways depending on where the fish is situated in relation to the electrical field (flight, attraction, or stun). It is also influenced by environmental conditions such as flow rate and conductivity, and the size of the fish present.

Electrofishing is the preferred MEL method for fish collection. Ideally, electrofishing reaches will be free of safety or navigation hazards such as abundant woody debris, deep pools, unstable substrate, or high flow. Although larger fish are typically more easily stunned, electrofishing can be effective at capturing all species and sizes of fish.

Photo 1: Example of an electrofishing crew in action

Electrofishing can be used to determine both qualitative metrics (i.e. determining species presence, diversity, or relative abundance) and quantitative metrics (i.e. estimating population size, absolute abundance), depending on the characteristics of the habitat and the overall objective of the survey. Electrofishing procedures presented in Section 7.2 outline techniques for both qualitative and quantitative surveys. Quantitative surveys (i.e. the depletion method) is the preferred procedure and should be completed whenever site conditions allow.

The depletion method (also known as the “Zippin” method, see Zippin, 1958) is a suitable method for population estimates when the stream is very small, it is expedient to collect all data within a short time

period such as one day, and the population being estimated is relatively small (roughly less than 2,000 individuals). This type of freshwater habitat is typical of what MEL biologists encounter throughout Nova Scotia's landscape, especially within headwater inland systems.

The depletion method requires that an adequate number of fish be removed on each sampling pass so that measurably fewer fish are available for capture and removal on a subsequent pass. The number of passes required generally depends on the capture result of each pass; however, a minimum of three passes is generally recommended. Two passes may be sufficient if the second catch is < 10% of the first, and if catches have not declined in the first three sweeps then additional passes are required until catches are < 25% of that in the initial pass.

The following conditions must be met for accurate depletion method estimates:

1. Emigration and immigration by fish during the sampling period must be negligible. This is accomplished by installing barrier nets at both upstream and downstream ends of the electrofishing reach.
2. All fish within a specified sample group must be equally vulnerable to capture during a pass.
3. Vulnerability to capture of fish in a specified sample group must remain constant for each pass (e.g. fish do not become more wary of capture).
4. Collection effort and conditions which affect collection efficiency, such as water clarity, must remain constant. To minimize error, the amount of effort used on each pass should be as constant as possible.

The depletion method is ineffective when more individuals are caught in the second or third passes than were caught in previous passes. This may be particularly problematic for streams containing low numbers of fish. In addition, the depletion method can only be used when barrier nets can be effectively deployed to reduce fish movement. When sampling reaches where blocking nets are not practical (i.e. large rivers), a qualitative survey (single pass without the use of barrier nets) should be performed, which will allow an estimate of relative abundance (Catch Per Unit Effort, known as CPUE).

Electrofishing must be done with a minimum crew size of two people: a "crew leader" and the other "crew members". The crew leader must be a qualified person and be certified to conduct backpack electrofishing surveys. The crew leader is responsible for the instruction of all other crew members. At least one crew member must have up-to-date Standard First Aid and CPR training.

Unsafe working conditions that may cause one to halt electrofishing operations (this list is not exhaustive and the final decision is generally left to the crew leader):

- Temperature
  - Electrofishing cannot be conducted in water temperatures >22°C
- Weather conditions
  - Moderate rain (enough to soak through clothing)
  - thunder and lightening
  - extreme heat (above 30°C)
- Dark water, deep water, fast flowing waters
  - unsure footing
  - inability to properly see substrate and/or fish
  - difficult to net fish efficiently and safely

- Stream conditions
  - thick, hidden, difficult vegetation and other debris in site
  - in-stream or overhanging vegetation

If any of these situations arise, the team must stop to evaluate conditions, and determine whether it is safe to proceed with electrofishing surveys. All crew members will work as a group to discuss and evaluate options to proceed with the survey. The final decision to proceed, delay, or forego the survey will be left to the crew leader. The crew leader must contact the Project Manager within 24 hours if a survey is delayed or skipped due to safety concerns.

5.2 Minnow Traps

Minnow traps are small, wire or plastic enclosures used to trap live fish. They are typically circular and slightly tapered towards the ends, with inward facing funnels at each end. The opening size for most minnow traps is 3 – 5 cm in diameter, with a standard mesh size of 6 - 8 mm, giving it an effective catch range of body depths approximately 6 - 50 mm. Small fish can swim inside through funnels that guide them from the large opening near the outside of the trap to the narrow opening close to the centre of the trap. Once inside it is difficult for the animal to locate the opening and escape.

Minnow traps consist of two wire baskets held together by a clip. The baskets are interlocked and the clip is inserted to hold the two halves together. The trap is attached with rope to a fixed object to it can be retrieved, and is positioned either on the bottom or suspended at a particular depth. Minnow traps are set with bait, which is discussed further in Procedures (Section 7).

Photo 2: Typical metal minnow trap (Source: https://dynamicaquasupply.com/products/minnow-trap-gee-style-1-8-mesh)

Minnow traps are also size selective and are best suited for sampling juvenile fish or adults of small species. They are most commonly used in littoral habitat and low velocity streams, especially within areas that may be difficult to sample with nets or electrofishing, such as deep areas, or habitats with abundant aquatic vegetation or woody debris. Water depth must be sufficient to submerge the trap entrances. As for

all trap and net types, the length of set time for minnow traps should account for activity levels of fish at various times of the day (daylight, dusk, overnight, and dawn). Generally, traps should be set for approximately 24 hours (set on the first day and retrieved the following day). Traps may be re-deployed on successive days, provided they are checked once per 24 hours. If minnow trapping is completed to supplement electrofishing efforts, shorter set times may be suitable (to be determined on a project-by-project basis).

Minnow traps provide a qualitative metric of abundance (i.e. relative abundance), with effort expressed in terms of catch per trap per length of time set (CPUE).

5.3 Eel Pots

Eel pots are similar to minnow traps in that they allow fish into an opening in a rigid metal trap. MEL's eel pots are rectangular and are available in a variety of lengths (2-5 ft). A single, inward facing funnel (6.5 - 8 cm opening) is located at one end of the trap, through which small and medium sized fish can swim inside through. This longer funnel guides the fish from the large opening near the outside of the trap to the narrow opening situated closer to the opposite end of the trap. This end of the trap acts like a door which can be opened to retrieve trapped fish and to install bait. A bungee cord and hook keep this door closed when the trap is set. With a wire mesh size of 1-2 cm, the effective catch range of eel pots are fish with body depths of 10 - 80 mm. The trap is attached with rope to a fixed object to it can be retrieved, and is positioned on the bottom substrate.

Photo 3: Typical metal eel pot (Source: https://ketchamsupply.com/product/eel-trap/)

This sample method is selective towards small-medium sized fishes, and can be deployed wherever water depth allows the opening of the eel pot to be submerged. Eel pots target slightly larger fish which may be excluded from the minnow trap; however as a larger trap, it is typically deployed in larger, deeper pools or littoral zones without many obstructions, whereas minnow traps can be selected to sample small watercourses where other methods cannot be used. Pots should be set for approximately 24 hours (set on the first day and retrieved the following day). Traps may be re-deployed on successive days, provided they are checked once per 24 hours. If trapping is completed to supplement electrofishing efforts, shorter set times may be suitable (to be determined on a project-by-project basis). Eel pots can provide a qualitative metric of abundance (i.e. relative abundance), with effort expressed in terms of catch per trap per length of time set (CPUE).

5.4 Fyke Nets

A fyke net is a type of hoop net which traps fish inside mesh enclosures. The mesh is supported by a series of rigid hoops, which become smaller towards the back of the net. The opening of the trap contains a D-shaped hoop, and all subsequent hoops are round. The fyke net is characterized by “wings” which lead fish to the fyke net opening. The wings are short lengths of mesh with float (on the top, with buoys) and lead (on the bottom, weighted) lines that are attached to the lateral margins of the first hoop and extended at a 45º angle to the opening of the trap.

Fish that enter the fyke net pass through constrictions called tunnels. The tunnels are cones of mesh that are attached to the hoops, so that when the net is set and the hoops are separated the narrow end of the tunnel points to the rear. Usually there are multiple tunnels per net which get smaller towards the back of the net. Fyke nets are normally not baited, relying instead on the wings to guide fish into them. Fyke nets are accessed at the posterior end, where the mesh that extends beyond the last hoop is closed by a drawstring.

Fyke nets can be set in littoral and stream habitats in water that is deeper or shallower than the height of the hoops, as long as the tunnels are submerged. These nets are difficult to set where the bottom is

Photo 4: Example of a fyke net installation in an open waterbody

uneven, such as among boulders, and where there is dense vegetation or an abundance of other obstructions such as logs or stumps. In littoral habitats, fyke nets should be installed perpendicular to the shoreline, with the posterior end of the net positioned farthest offshore. In stream setting, the net is normally set with the opening facing upstream. One of the main drawbacks of a fyke net in stream environments is that debris can collect in or damage the net, reducing catch efficiency.

Fyke nets are size and species selected – they tend to target larger bodied fish as smaller fish like juvenile salmonids and forage fish may escape through the mesh (2 cm openings), and are more likely to capture roaming species than sedentary species. When deployed, fyke nets should remain in place for approximately 24 hours (set on the first day and retrieved the following day). Fyke nets may be re-deployed on successive days, provided they are checked once per 24 hours. If netting is completed to

supplement electrofishing efforts, shorter set times may be suitable (to be determined on a project-by-project basis). Nets can provide a qualitative metric of abundance (i.e. relative abundance), with effort expressed in terms of catch per trap per length of time set (CPUE).

5.5 Seines

Seine nets (which also double as barrier nets for use during electrofishing surveys) consist of a length of fine mesh strung between a positively buoyant line (the float line) and a negatively buoyant line (the lead line) that is pulled through the water to encircle fish. Typical seines used in research are made of a woven (also called knotless) nylon mesh with small (in our case, 1/8th inch) openings. This SOP pertains only to seines used through wading, though they may also be deployed from a boat.

Seines can be used in both littoral habitat and slackwater areas of larger rivers, but generally cannot be used in moderate-fast currents. Seines are normally only used in water depths that are less than two thirds the depth of the seine, so that the lead line remains on the bottom and the float line remains at the surface as the net is pulled forward. Seining is easiest over smooth bottoms with no debris or obstructions, which may cause the net to lift off the bottom substrate, causing a loss of fish.

The simplest deployment technique involves two people, one on each end of the seine. One person stays fixed at the shore, while the second person wades through the water with the seine in a smooth arc. The seine haul ends by bringing the two ends of the seine together and pulling the net forward so that the encircled fish end up in the mesh that is between the lead and float lines.

Photo 5. Example of seining within riverine habitat
(Source: https://commons.wikimedia.org/wiki/File:Seining_for_wild_fish.jpg)

Efficiency varies widely among species, with benthic species being less susceptible to capture than mid-water species. Smaller individuals are more susceptible than large individuals, which may avoid capture by swimming out of the path of the seine. Qualitative abundance estimates can be expressed in terms of catch per haul if all hauls are similar, whereas more quantitative abundance estimates can be expressed as catch per unit area seined (e,g, catch per m^2).

Table 1. Efficacy and limitations of gear types (adapted from Portt el al. 2006)

Gear	Limitations			Survey Objective			Units
	Depth	**Habitat**	**Selectivity**	**Presence**	**Relative Abundance**	**Absolute Abundance**	
Electrofishing	Limited to safe wading depths for backpack; <2 m for boat. Only requires enough water to submerge the anode ring and tail.	Cannot conduct in water >22°C, or in the rain. Currents must be low enough to safely wade. High turbidity, vegetation, woody debris, soft substrate, and low conductivity decreases efficiency. Efficiency lower in large streams than in small streams.	Capture efficiency greater for large individuals. Benthic species are easy to overlook.	✓	✓	✓	CPUE (effort = electrofishing seconds) or catch per square m
Minnow Traps	Requires depths sufficient to submerge trap (>15cm). Not suitable for extremely shallow water.	Limited to low velocity habitat.	Limited to small-bodied fish (6 - 50 mm).	✓	✓		CPUE (effort = trap time in hours)
Eel Pots	Requires depths sufficient to submerge interior funnel (>20cm) along the entire length of the trap. Not suitable for extremely shallow water.	Limited to low velocity habitat.	Limited to small/moderate bodied-fish (10 - 80 mm).	✓	✓		CPUE (effort = trap time in hours)

Gear	Limitations			Survey Objective			Units
	Depth	**Habitat**	**Selectivity**	**Presence**	**Relative Abundance**	**Absolute Abundance**	
Fyke Nets	Requires depths sufficient to submerge interior funnel (>20 cm). Not suitable for extremely shallow water.	Limited to low-moderate velocity habitats with limited amounts of debris.	High selectivity for roaming species (vs. sedentary). Good for intercepting fish during migration. Effective catch range 20 mm + body depth.	✓	✓		CPUE (effort = net time in hours)
Seines	Limited to safe wading depths. Ideal water depths are less than 1/2 – 2/3 depth of the seine, so that the lead line can rest on the substrate, while the float line remains above water.	Limited to stream or littoral habitat with small, rocky substrate and limited obstructions.	Benthic species less catchable than mid-water species. Smaller individuals more susceptible than large individuals.	✓	✓	✓	CPUE (effort = number of hauls) or catch per square m

6 MATERIALS

The materials and equipment required to safely perform fish capture surveys in the field are listed below. The list is inclusive of all materials required to perform any fish capture survey (electrofishing, trapping, and netting).

- Electrofishing Kit
  - backpack electrofisher in Pelican case
  - anode pole and ring
  - cathode tail
  - batteries and battery charger
  - gloves (long-armed, lineman's gloves)
  - polarized sunglasses
  - long-handled landing net
  - wader repair kit
- Traps and nets
  - minnow traps
  - eel pots
  - fyke nets
  - seine nets (i.e. barrier nets)
  - rope
  - rebar or stakes to aid in setup
- Fish Processing Kit
  - clear tupperware with ruler
  - plexiglass fish viewer
  - electronic balance scale (including calibration weights and extra batteries)
  - spring scale (and extra batteries)
  - live-well buckets (plastic, 5-gallon)
  - small dip net
- Additional Equipment
  - standard MEL PPE
  - Required PPE for electrofishing:
    - Leak-free chest waders with wading belt
    - Wide brimmed hat
    - Polarized sunglasses
    - Long-armed gloves/linesman gloves
  - first aid kit
  - personal flotation device if deemed necessary based on site characteristics
  - field sheets on write-in-the-rain paper ("Fish Collection Tracking Sheet", Appendix D)
  - fish ID books, identification key
  - pencils
  - multi-parameter water quality instrument (YSI or equivalent)
  - GPS
  - hand sanitizer
  - flagging tape
  - measuring tape

- meter stick
- phone or digital camera
- **hard copy of DFO fishing licence**

7 FISH COLLECTION METHODS – PROCEDURES

7.1 Planning: Before You Leave

1. Review detailed written scope provided to you by the Project Manager. This will identify priority deliverables, timelines, and budget allowed for each task. Detailed methods will be provided in this scope (i.e. # of traps required, set time required, etc).
2. Identify the crew supervisor/operator and crew members. The crew supervisor must have an Electrofishing Crew Leader Certification and proper training for the use of the electrofisher and safety procedures. The primary responsibility of the crew supervisor is to ensure the safety of all crew members. Their secondary responsibility is to direct the survey. A field team must consist of a minimum of 2 people, and all crew members are responsible for working in a safe manner, bearing mind that any action can affect the safety of other crew members.
3. Determine the location(s) of the survey, size of area to be surveyed and easiest access to the site based on the work scope provided by the Project Manager. Sample design should be verified by the Project Manager.
4. Prepare site maps and GPS units as required.
5. Ensure that all personal safety equipment and field gear are in good working order. Check the electrofisher unit and traps for any obvious signs of damage. Ensure all traps and nets have clear markings on them identifying the licence number, a contact person, and an emergency contact number.
6. Fill out a field tracking sheet. Have all crew members review and sign off on the field tracking sheet.

7.2 Electrofishing

7.2.1 Site Setup

1. Ensure that all personal safety equipment is in good working order and remove all jewelry including watches, necklaces or rings before commencing electrofishing.
2. Assign roles for the following:
   - electrofisher operator
   - primary netter
   - secondary netter (if third crew member is available)
3. Prepare the workstation for the survey by laying out the first aid kit(s) and other equipment to ensure fast and easy access. Set-up any equipment to be used for processing fish.
4. Measure a 100 m survey reach along the contours of the stream channel, marking the beginning and end of the survey reach with flagging tape and take GPS waypoints. For “closed” sites, install the barrier nets at the downstream extent, and then upstream extent of the reach, ensuring that the lead line is placed firmly against the bottom substrate and that the nets cover the entire channel width. This is not required for larger streams greater than the width of the barrier nets (on average > 7 m across); however, whenever possible, adjust the downstream and upstream extent locations of reaches to allow for use of barrier nets (try to find a narrow channel section). For

larger streams, a qualitative, single-pass survey using an open-site methodology should be employed.

5. Take representative photos of the following:
    - Looking upstream
    - Looking downstream
    - Right bank (downstream orientation)
    - Left bank (downstream orientation)
    - Substrate
    - Any distinct physical features
6. Sketch a rough drawing of the site on the Fish Collection Tracking Sheet, noting any distinct physical features of the site (barriers, pools, braiding etc.), and discuss any potential safety hazards with all crew members. Discuss how to proceed through the survey reach.
7. Record the site identifier information, general site conditions (air temperature, weather, previous precipitation), and physical characteristics of the reach (widths, depths, substrate, habitat types, etc) on the Fish Collection Tracking Sheet.
8. Measure and record temperature, conductivity (SPC, CON), total dissolved solids (TDS), pH, dissolved oxygen (DO), and salinity (SAL) on the Fish Collection Tracking Sheet.

    Note: If performing multi-pass surveys, water temperature must be recorded at the beginning of each pass. ***Electrofishing cannot be conducted in water >22°C.***

9. Assemble the electrofishing unit.
    - With the main power switch in the OFF position, and emergency shut off switch pressed down, plug the anode and cathode into their proper connectors located on the bottom of the Pelican case and install the battery
    - Ensure the tilt switch is turned on
    - Reset the 'elapsed time' counter
    - Check that emergency releases are in good working order
    - Set a low output voltage (100 or 150V) and frequency (40 or 60Hz) to start
    - Ensure that the audible safety tone and light are working
    - Keep the emergency shut off switch pressed down when entering the stream
10. Outside of the closed survey reach, test the voltage and frequency settings and adjust if necessary. Voltage and frequency may need to be changed to get a desired response. In general, lower frequencies are safer for larger fish than higher frequencies. If the unit is not producing satisfactory results, try increasing the frequency a few levels before increasing the output voltage. Only increase the output voltage one-step at a time, releasing the anode pole switch to change the electrofisher output frequency and/or voltage levels.

    Note: Observe fish closely. In general, if it takes more than 5 seconds for a fish to recover it may have been shocked too much. If it takes more than 15 seconds for a fish to recover it was definitely shocked too much; therefore reduce the frequency or output voltage. Another common indication of an excessive voltage setting is "burn marks" on fish caused by the triggering of pigment cells in the flesh and visible as dark discolorations. Burn marks are temporary, but when observed the voltage should be decreased. The voltage should only be increased if fish are consistently in the fright zone and are not completely stunned.

7.2.2 Surveying

1. The survey should be completed in an upstream direction. Start at the most downstream point of the sampling site and work your way upstream. Once in the reach, the backpack operator will release the emergency shut off switch on the electrofishing unit. The operator must always give a verbal indication to, and receive a verbal acknowledgement from, all crew before commencing each sweep.
2. The electrofisher operator must say aloud "Power On" each time they begin electrofishing. Begin the first sweep by shocking water at the designated starting point.
3. The netter should be positioned downstream of the operator, approximately 2-3 m apart. The netter should set the pole net flush with the bed of the stream and perpendicular to flow.
4. Continue sweeping the anode ring wading from one bank to the other, always in line with the pole net, thus sampling a "lane" of the stream. When fishing undercut banks or log jams, fish can be drawn out by inserting the uncharged anode, switching it on and then pulling the anode out and away. Creating currents using the anode ring or dip-nets can often assist with pulling stunned fish out of complex structure when using this technique. When the opposite bank is reached, both the machine operator and pole netter move upstream 2–3 m and begin fishing again. Continue fishing until the entire sample reach has been fished.
   Note: If you get water in waders or gloves, or it begins to rain hard enough to saturate clothing, ***STOP WORK*** *immediately and get dry clothing. Never reach into the water in vicinity of an electrode, even if rubber gloves are being worn. To further prevent electrical shock, never touch an electrode while the circuit is energized, even while wearing rubber gloves and waders.*
5. Transfer captured fish to live wells where they can be held until the completion of the electrofishing pass. Keep the live well in a shaded area. When fish are held for a longer period of time, particularly during warm conditions, regularly change the water maintain water quality.
6. Record pass details (seconds of electrofishing, voltage, and frequency) on the Fish Collection Tracking Sheet. Reset the elapsed time counter for each pass.
7. Process the captured fish (refer to Section 8). Once processed, return captured fish to watercourse/ waterbody, outside of the barricaded reach (if using barrier nets).
8. Repeat steps 1-8 until the required number of passes have been completed. The number of passes required will depend on the type of survey (qualitative or quantitative) being employed.
   a. For a **qualitative, open-site survey,** one pass should be sufficient, unless crew members note a high number of fish that evaded capture. In that case, perform a second or third pass to obtain greater species representation. For all qualitative electrofishing surveys, crews should aim for at least 300 seconds of effort (i.e. minimum effort).
   b. In **quantitative, closed-site surveys,** a minimum of three passes should be performed. The requirement for additional passes is determined by the total catch on the last run. If the catch on the last run is <20% of the catch on the first pass and <50% of the catch of the previous pass, no additional passes are required. If no fish are captured or observed on the first two passes, the third pass is not necessary.
9. At the conclusion of all electrofishing surveys, inspect all equipment and note any problems requiring correction. Disconnect the battery and all attachments. Batteries must be charged at the

end of each day's use to maintain the life expectancy and all equipment must be thoroughly dried and stored in the appropriate manner.

7.3 Trapping and Netting

As previously stated, fish collection surveys are most effective when using a variety of gear types to sample as many habitat types as possible. Efforts should be made to supplement electrofishing surveys with other fishing techniques (trapping and netting) when the watercourse reach or portions of the reach being surveyed are not suitable for electrofishing (i.e. non-wadeable, deeper pools, high concentration of woody debris). Trapping and netting are also the preferred method for the open water habitats (e.g. ponded wetlands) and littoral habitats of lakes, where electrofishing tends to be inefficient. The types of traps and nets suitable for each survey depends largely on physical habitat characteristics of the watercourse or waterbody and the fish species anticipated to inhabit them. However, the main objective for netting and trapping should be to set the most diverse combination of traps and nets possible. The habitat limitations and selectivity of each trap type are summarized in Table 1.

7.3.1 Site Setup

Note: if trapping/nettings occurs within the same survey reach as electrofishing, combine all data onto one Fish Collection Tracking Form. Trapping/netting completed within a watercourse/waterbody without electrofishing requires its own tracking form.

1. Ensure that all traps and nets are in good working order (no tears and holes). Ensure all passive traps that are to be left unattended have an identification tag (licence number, contact name and emergency contact number) attached.
2. Select suitable locations within the watercourse/waterbody for deployment that are accessible by wading. Consider the physical characteristics of the habitat being surveyed, the fish species anticipated to be present, and the likelihood of fish to congregate in certain areas based on the species and time of year. Plan to distribute traps so they will be independent of each other. Target in-stream habitats such as:
    - Areas with suitable water depths for trap deployment
    - Slack-water areas (particularly in rivers)
    - Potential refuge/cover areas, including snags, deep pools, highly vegetated areas, and undercut banks
    - Off-channel habitats, side channels, and backwaters
3. If considering seining, identify any possible snags, large substrate, deep areas, or other safety hazards which may impede the survey. Discuss and mitigate with all crew members. Only seine if it is safe and appropriate to do so.
4. When trap/net locations are confirmed, take a GPS waypoint and a water depth reading of each location. Record the UTM coordinates and water depth for each trap/net on the Fish Collection Tracking Sheet.
5. Sketch a rough drawing of the site on the Fish Collection Tracking Sheet, noting any distinct physical features of the site (barriers, pools, braiding etc.), and discuss any potential safety hazards with all crew members.

6. Record the site identifier information, general site conditions (air temperature, weather, previous precipitation), and physical characteristics of the watercourse/waterbody (when applicable) on the Fish Collection Tracking Sheet.
7. Measure and record temperature, conductivity (SPC, CON), total dissolved solids (TDS), pH, dissolved oxygen (DO), and salinity (SAL).
8. Proceed with trap/net deployment or seining (if conditions allow).

Note: As standard practice, all passive traps and nets (minnow traps, eel pots, and fyke nets) should be set for approximately 24 hours. The involves setting traps/nets on one day, and retrieving traps the following day them the following day. Traps may be re-deployed on successive days, provided they are checked once per 24 hours. If trapping is completed to supplement electrofishing efforts, shorter set times may be suitable (to be determined on a project-by-project basis).

7.3.2 Trap/Net Deployment (Day 1)

1. If deploying minnow traps or eel pots, place bait in inner compartment, bearing in mind various mesh sizes so the bait stays inside the traps. Possible bait includes dry or wet cat/dog food, or Cheetos. Ensure rope is attached to each minnow trap/eel pot and tie the other end to a stationary object. Identify the stationary object with flagging tape. This will assist in locating the traps and will also prevent the trap from floating away.
2. If deploying fyke nets, face the opening upstream if in riverine habitat, or perpendicular to the shoreline if in an open waterbody with the opening facing the shore. Fix the wings in place using stakes driven into the substrate, or rope attached to stationary objects to achieve a 45º angle to the opening of the trap. Ensure that the lead line lays flat on the bottom substrate – this can be ensured by placing rocks along the bottom edge of the wings. Ensure that each funnel is open and not twisted to allow for the passage of fish to the back of the net. Tie off the posterior drawstring and extend the traps back so that each segment is fully extended and the hoops are upright. To maintain this position, the posterior end of the trap may need to be fixed in place – this can be achieved with a stake, stick, rope, rock or other heavy object.
3. Ensure all entries into the traps and nets are submerged.
4. Record deployment time on the Fish Collection Tracking Sheet.
5. Take photos of each trap setup.

7.3.3 Trap/Net Retrieval (Day 2)

1. If multiple traps are used, retrieve in the order they are deployed, one at a time. Record retrieval time for each trap/net on the Fish Collection Tracking Sheet. Set times and retrieval times can be rounded to the closest 5-minute interval.
2. Deposit fish captured into a live well.
3. Process captured fish (refer to Section 8).
4. Rinse the traps/nets clean after all of the fish have been released. Allow the traps/nets to dry once the field survey is complete.
5. If re-deploying traps, follow outlines in Section 7.3.2.

7.3.4 Seining

1. Attach a pole (stake, rebar, etc.) to each end of the seine and used as a handle. The lead line should be attached to the bottom of the pole, which is kept on or at the substrate. An alternate method is to tie a loop in each end of the lead line and place it over the operators' feet that are

closest to the net, and to hold the float line in the hand closest to the net. The bottom line is pulled forward by the operator's leg.

2. With one crew member staying stationary on the shore/bank holding one end of the seine, the other crew member drags the other end of the net into the water by wading in a perpendicular line to the shore, keeping the lead line on the bottom substrate and the float line at the water's surface.
3. Once almost all of the net has been pulled into the water, the wading crew member arcs back to the shoreline/bank, creating an arc shape with the net. The wading operator then pulls their end of the net back to the shoreline, lining up parallel to the stationary operator.
4. To retrieve the net, pull the net to shore with one person on each end of the net. The float and lead lines should be pulled in together at a slow, even pace. Do not pull too quickly, as this could cause the float line to become submerged and possibly allow fish to escape over the net. If the float line is pulled in ahead of the lead line, the flow of water will be downward causing the lead line to lift off the bottom, allowing fish to escape underneath the net.
5. As the net approaches shore, the lead line should be kept on the bottom and the float line should be lifted slightly to stop fish from jumping out of the net. The entire net should be pulled onto the shore and the catch quickly transferred into live wells and processed.

8 FISH PROCESSING

Fish should be handled as little as possible and processed quickly. The water quality of the live wells should be maintained as close as possible to the fish's natural habitat, and should be kept out of direct sunlight. Monitor condition of fish on a regular basis to ensure the temperature and oxygen levels in the well are adequate, and replace water if fish show signs of stress (i.e. gasping at surface, frantic swimming, lethargy, rapid gill movements, etc.). Note that these processing procedures do not include anesthetic. Gentle pressure should be used to immobilize fish on the measuring board - ensure that this pressure remains slight and is not focused on the eye area or the operculum.

1. Prepare the onshore workstation to commence the processing of captured fish. Layout/assemble all equipment from the Fish Processing Kit. Level the electronic balance scale and calibrate prior to use.
2. If fish have been captured through multiple gear types, process fish from each gear type one at a time. This is necessary to infer qualitative abundance data for each method of fish collection.
3. Any crew member involved in fish handling procedures will ensure that hands are free of chemical contaminants (i.e. insect repellent, sunscreen) prior to any handling of fish. If additional surveys are to take place in the same day, crew members must sanitize hands prior to handling fish from different areas in order to minimize the risk of disease transfer.
4. Prepare the live well (fish captured during electrofishing should be actively placed in a live well during sampling), ensuring that water is refreshed regularly, especially on warm days. Prepare multiple live wells and separate fish species if predation within the well is likely to occur (i.e. American eel captured with other fish species).
5. On the Fish Collection Tracking Sheet under Individual Fish Measurements (Appendix D), assign each fish captured with a number starting from 1, and continue numbering for each fish (1, 2, 3…) captured within a particular survey site. Photograph each individual fish with the fish number in the photograph (or photograph the fish number prior to photographing the fish). Record the collection method - if electrofishing with multiple passes, record what pass the fish was captured during (e.g. Pass 1), or if captured with a trap or net, record the gear type and ID if using multiples of the same type (e.g. MT1). Gear type codes are presented on the Fish Collection

Tracking Sheet. Record the fish species using the 3-letter codes provided in Appendix B. If species is unknown, record with a "U".

6. Measure and record the total length (TL, mm), fork length (FL, mm), weight (in grams), and life stage (if known). See Appendix B for terms and definitions:
    - Small fish (<500g) are to be weighed with the electronic balance scale, measuring to with +/- 0.01g.
    - Large fish (>500g) are to be weighed on a spring scale using a tared mesh net.
7. Note whether or not the adipose fin is clipped, as this will indicate that the fish is from a hatchery. Watch for burn marks and note any other pertinent observations. Note any mortalities, and overall condition. Appendix A provides anatomical features and morphological definitions for fish.
8. Return captured fish to the habitat area. In the case of multi-pass electrofishing surveys, captured fish may should be returned outside and downstream of the barrier nets so as to avoid being double counted.

9 REPORTING

Reporting and data management requirements will be communicated to the field crew by the Project Manager. At a minimum, the following parameters must be communicated to the Project Manager for submission to DFO under Appendix A of the License to Fish for Scientific Purposes:

- Dates of the fishing activity
- Fishing location (waterbody, county and province)
- Gear type used
- Number of fish caught by species
- Life stage of fish caught by species
- Number of fish sampled/tagged by species if applicable
- Fate of fish by species:
    - Number released alive
    - Number of incidental mortalities
    - Number retained alive
    - Number of retained mortalities.

10 REFERENCES

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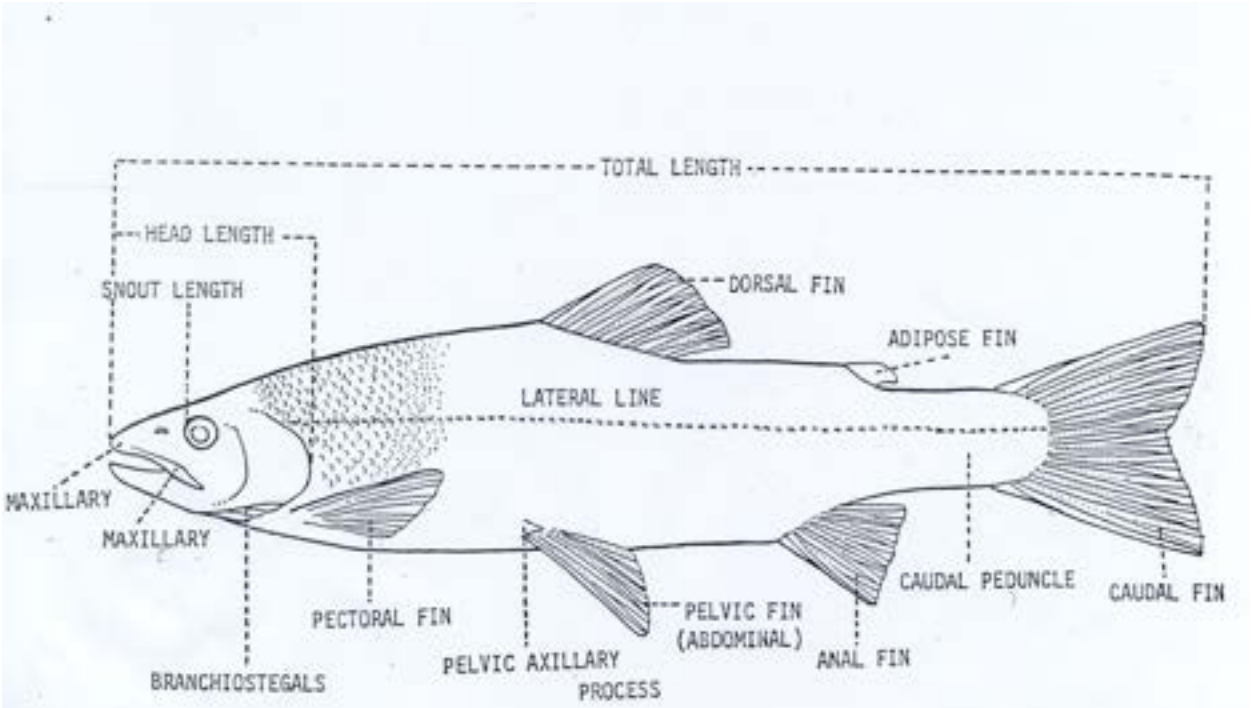
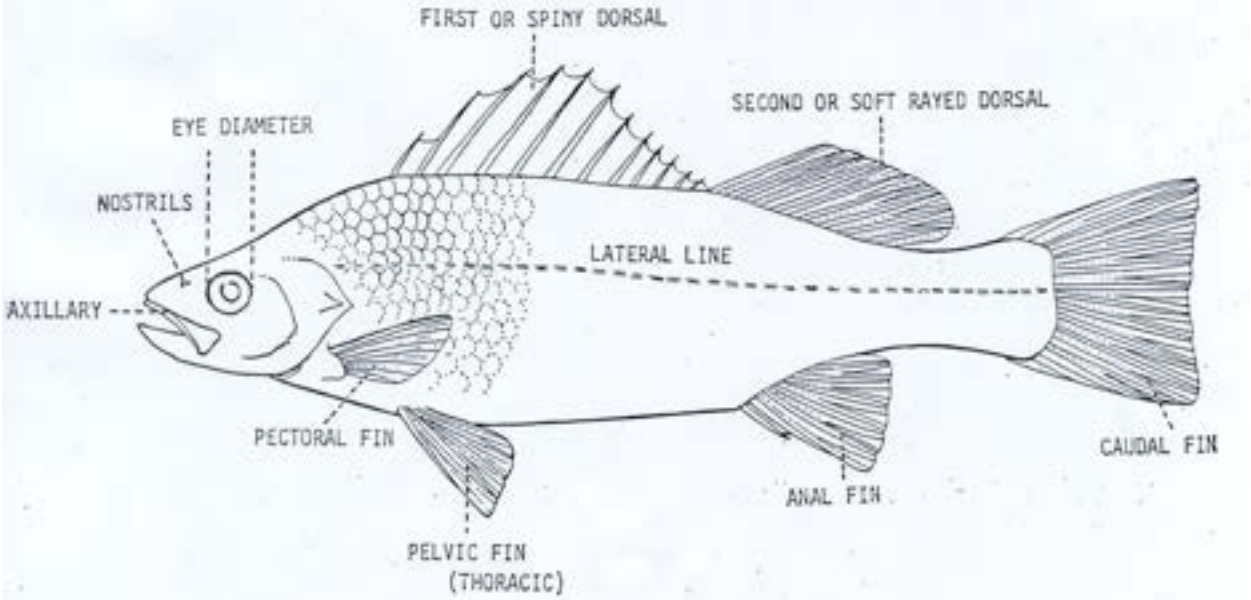
Appendix A: Anatomical Features of Fish


TOTAL LENGTH
HEAD LENGTH
SNOUT LENGTH
DORSAL FIN
ADIPOSE FIN
LATERAL LINE
MAXILLARY
MAXILLARY
PECTORAL FIN
PELVIC FIN
(ABDOMINAL)
CAUDAL PEDUNCLE
CAUDAL FIN
BRANCHIOSTEGALS
PELVIC AXILLARY
PROCESS
ANAL FIN


FIRST OR SPINY DORSAL
SECOND OR SOFT RAYED DORSAL
EYE DIAMETER
NOSTRILS
LATERAL LINE
AXILLARY
PECTORAL FIN
CAUDAL FIN
ANAL FIN
PELVIC FIN
(THORACIC)

Appendix B: Fish Species Codes & Definitions

Code	Species Name	Code	Species Name
ALE	Alewife (*Alosa pseudoharengus*)	LKC	Lake chub (*Couesius plumbeus*)
EEL	American eel (*Anguilla rostrata*)	LKT	Lake trout (*Salvelinus namaycush*)
AMS	American shad (*Alosa sapidissima*)	LWF	Lake whitefish (*Coregonus clupeaformis*)
ARC	Arctic char (*Salvelinus alpinus*)	LLS	Landlocked salmon (*Salmo salar*)
ATS	Atlantic salmon (*Salmo salar*)	LNS	Longnose sucker (*Catostomus catostomus*)
AST	Atlantic sturgeon (*Acipenser oxyrhynchus*)	MUM	Mummichog (*Fundulus heteroclitus*)
ATC	Atlantic tomcod (*Microgadus tomcod*)	MUS	Muskellunge (*Esox masquinongy*)
BKF	Banded killifish (*Fundulus diaphanus*)	9SB	Ninespine stickleback (*Pungitius pungitius*)
BND	Blacknose dace (*Rhinichthys atratulus*)	NRD	Northern redbelly dace (*Chrosomus eos*)
BNS	Blacknose shiner (*Notropis heterolepis*)	PLD	Pearl dace (*Semotilus margarita*)
BSS	Blackspotted stickleback (*Gasterosteus wheatlandi*)	PSF	Pumpkinseed Sunfish (*Lepomis gibbosus*)
BLH	Blueback herring (*Alosa aestivalis*)	RBS	Rainbow smelt (*Osmerus mordax*)
BKS	Brook stickleback (*Culaea inconstans*)	RBT	Rainbow trout (*Salmo gairdneri*)
BKT	Brook trout (*Salvelinus fontinalis*)	RSF	Redbreast sunfish (*Lepomis auritus*)
BBH	Brown bullhead (*Ictalurus nebulosus*)	RWF	Round whitefish (*Prosopium cylindraceum*)
BNT	Brown trout (*Salmo trutta*)	SLP	Sea lamprey (*Petromyzon marinus*)
BUR	Burbot (*Lota lota*)	SST	Shortnose sturgeon (*Acipenser brevirostrum*)
CHP	Chain pickerel (*Esox niger*)	SLS	Slimy sculpin (*Cottus cognatus*)
CSH	Common shiner (*Notropis cornutus*)	SMB	Smallmouth bass (*Micropterus dolomieui*)
CRC	Creek chub (*Semotilus atromaculatus*)	SPL	Splake (*S. namaycush x S. fontinalis*)
FLF	Fallfish (*Semotilus corporalis*)	STB	Striped bass (*Morone saxatilis*)
FHM	Fathead minnow (*Pimephales promelas*)	3SB	Threespine stickleback (*Gasterosteus aculeatus*)
FSD	Finescale dace (*Chrosomus neogaeus*)	WHP	White perch (*Morone americana*)
4SB	Fourspine stickleback (*Apeltes quadracus*)	WHS	White sucker (*Catostomus commersoni*)
GSH	Golden shiner (*Notemigonus crysoleucas*)	YLP	Yellow perch (*Perca flavescens*)
GLF	Goldfish (*Carassius auratus*)		

Total Length: the distance from the most anterior part of the head to the tip of the tail when the fin lobes of the tail are pressed together. This is the only length measurement collected for fish without forked tails such as banded killifish.

Fork length: measured from the most anterior part of the head to the median caudal fin rays (fork of tail). This measurement is only appropriate for fork tailed fish such as trout and salmon.

CPUE: Catch per unit effort = catch (fish) / survey effort (time).

Appendix C: Fish Fact Sheets for Common Freshwater Species (Source: NSSA, 2005)

SECTION 6.0. FISH FACTS

THIS SECTION CONTAINS:

- Some notes on fish anatomy
- Habitat requirements of salmon and trout
- Fish facts on many Nova Scotia fish species

6.1. Understanding Fish

A woman wrote the very first published fishing manual nearly 500 years ago. Dame Juliana Berners, prioress of the Benedictine convent near St. Albans, England hand wrote the treatise f Fishing with an Angle in 1496. The boll included advice on how to construct a two-section rod and where the best places were to fish

This first section contains information on the anatomy of fish. Although different species of fish vary, what is described here is a general description of a trout or salmon.

Eyes and Sight

As with the eyes of mammals, fish eyes serve a number of purposes: to find food, to watch for enemies and other dangers, and to navigate perhaps even during ocean migrations. The pupil bulges outward to take in a wider field of vision, and although the eyes are set on the side of the head, they have all-around vision, giving the fish stereoscopic vision in a forward direction. The lens of the fish eye can move in and out like a camera lens. Trout and salmon appear to have the ability to see well into air and have good vision in semi-darkness. They respond strongly to sudden changes in light intensity (which would usually indicate danger), especially if they are within a closed environment from which they are unable to escape.

Gills

Fish gills are composed of two basic parts: the gill covers and the gill filaments. The gill covers protect very delicate threads or **filaments** that are located in cavities on either side of the head. A special pump called the **brachial pump** maintains a flow of water over the gills. When the mouth closes, water passes through the gills and out through the gill covers which open. The gill filaments are richly supplied with blood vessels that pick up oxygen out of the water. Carbon dioxide is released as a waste product. More activity increases the need for oxygen and this results in a corresponding increase in the opening and closing of the mouth and gills.

Nostrils and Smell

Trout and salmon have a well-developed sense of smell. It is believed that they use this ability to seek out and recognize the chemical characteristics of their home streams for spawning. This sense is sometimes helpful in avoiding predators. Fish breathe through their gills and mouth, not their nose.

Lateral Line (line along the side of the body)

There is a row of special scales with small holes along each side of the fish's body called the **lateral line**. The system is connected to a series of nerve endings can detect changes in pressure, sound, and movement. The lateral line helps to warn the fish of the approach of predators and search for prey.

Mouth

The mouth is used to catch and hold food of various types; but food is not chewed before being swallowed. The mouth is also important for breathing or respiration. Water is constantly taken in through the mouth and forced out over the gill filaments through the gills. This fish receives its oxygen by moving water over its gills.

Fins

Most fish have two sets of paired fins: the pelvic and pectoral fins, and four single fins: dorsal, caudal, anal and adipose. Some fins are spiny (although not on salmon or trout). Spines can be used for protection or for sexual display.

- The dorsal and anal fins are used for maintaining vertical balance and achieving quick changes in direction.
- The pelvic and pectoral fins are used for horizontal or lateral balance and resting.
- The adipose fin is small and fleshy on trout, salmon and whitefish and we don't know its purpose. Fishery managers, to identify certain stocks of fish or indicate that a fish is tagged, often clip it off.
- The caudal or tail fin is the most important fin as it is used to propel the fish through water by the flexing of strong muscles along the sides of the body. The caudal fin is also used by the female salmonids and male smallmouth bass to move gravel and scoop out the nests (redds) in which eggs are deposited.

Scales

The body surface skin of the fish, except for the head and fins, is protected by overlapping scales that grow in regular patterns and by an outer coating of mucus, which protects the fish from disease. Growth of the scales is continuous and takes place around the perimeter of each scale. Growth is more rapid in summer than in winter, thus, growth rings (looking somewhat similar to those of trees) of summer are farther apart than those of winter, and indicate the age and life history of the fish. When fish are sick or stressed, the rings are closer together. Rings spaced more apart indicate healthy growth and environmental conditions.

Ears

Fish do not have external ears but they can detect sound with an inner ear and labyrinth that function as organs of balance as well as hearing. Low frequency sounds can also be detected in the water by the lateral line system.

6.2. Habitat Requirements

If you know what a fish needs in a stream in order to survive, it is a natural progression to determine where and what is in need of protection or rehabilitation. This section will concentrate primarily on the needs of trout and salmon (referred to as **salmonids** by biologists). These fish can be found in many different habitats in our part of the world. Because they often have to cope with severe and varying conditions they can be remarkably resilient in habitat use, in feeding, growth and reproduction. Despite the fact that these fish adapt to change well they can be highly sensitive, environmentally "fussy" fishes; particularly in the "egg" and "young" stages.

The habitat requirements for fish are the things they need to live. As we learned in the first section, this is a combination of water, food, space, and cover. In this next section we'll look at the important habitat requirements of fish. Even within one species different habitat combinations are required for nursery areas, feeding and spawning. Understanding habitat will help you to better determine the health of the stream, its potential for trout and salmon and other fish, and the locations most likely to benefit from rehabilitation and enhancement.

Trout and salmon require very special conditions for:

- Successful **spawning** (the production of eggs)
- The development and hatching of eggs
- Growth and survival for their young
- Feeding

In general, salmonids require streams that have:

- **Temperatures** that are fairly cool
- **Shade**; there should be trees and shrubs along the bank of the stream
- Water with lots of **oxygen**
- Clean **gravel** of different sizes on the stream bottom
- Sufficient **flow of water**
- No major **physical obstructions** which will stop them from moving up or downstream
- **Cover** or places to hide when it gets too hot and to hide from predators
- **Clear water** so they can see insects to feed on
- **The right combination of habitats** for different parts of their life cycle
- Lots of small insects and animals for **food**

Let's look at each one of these in turn.

Temperature

Salmonids need much cooler water than other fish such as perch, bass, gaspereau or suckers. For example, if water temperature rises much above 20 - 25·C, for very long, most salmonids, especially in early stages, will become seriously stressed or will die. On the other hand, many species of bass, suckers and perch for example, thrive in much higher temperatures. Young trout and salmon prefer a water temperature between 15 and 18·C. Brook trout will die if the water temperature rises above 22 C. (72 degrees F.) for more than several consecutive days; rainbow and brown trout will die if it's hotter than 24·C. (75 degrees F.). Fish can adapt to a gradual change in temperature, but sudden drastic changes can shock and kill them.

Also, fish are cold blooded which means that their body temperature varies according to the temperature of the surrounding water. The warmer it gets, the faster their metabolism gets so they need more oxygen. The problem is that warmer water holds less oxygen.

Temperature also affects the growth and reproduction of fish. Fish lay eggs only at certain temperatures. Most salmonids prefer cooler temperatures: salmon, brown trout, brook trout and lake trout spawn during the late autumn and early winter; rainbow trout prefer the warmer temperatures from mid-April to late June. Temperature is also a major factor in the timing of fish migrations.

The temperature of a stream is regulated by springs, shade, and the stream width to depth ratio. Most streams begin as springs bubbling out of the ground. The spring water comes from snow melt and rain water that percolated into the soils of the surrounding hillsides the previous week, day, month, or year. Sometimes because of human activity the amount of rainwater that goes deep down into the soil is reduced, not allowing the water table to be replenished. This can cause springs to dry up, so that water levels in rivers decrease and water temperatures increase. Many streams come from lakes and their water is warmer when it enters the stream. In these streams even more care must be taken to make sure that the water doesn't get too hot.

Shade

The amount of shade along a stream is very important. Too much shading in a stream reduces the growth of instream plants (algae). This will mean less food for insects, and in turn less food for fish. In some places it can also make spring-fed streams too cool for salmonids, which prefer 16-17 C. temperatures for growth.

Too little shading encourages heating of the stream and raised temperatures. The percent of shading needed varies from stream to stream and depends upon the amount of spring water available to cool the stream, the stream's width and depth, and human land use activity in the area. There is a balance in all these and the optimum appears to be about 60% shade during

the peak of the day. In general, most streams don't have enough shade. A narrow, deep river channel also maintains cooler water temperatures by having less surface exposed to the air. Where width greatly increases, the shallow water is then highly susceptible to heating by direct contact with the air. Even in well-shaded streams, the water temperature follows the air temperature very closely if pools are poorly developed and the channel is wide and shallow. Direct sunlight warms things up even more, as everyone knows; it's cooler in the shade.

Oxygen

Trout and salmon that live in streams require high levels of **dissolved oxygen** (the amount of oxygen contained in the water). Fish are extremely sensitive to any decrease in the available supply of oxygen and can suffocate very quickly if they are forced to endure a low level for even a short period of time. Young fish or breeding fish have even greater oxygen requirements. Eggs lying in the gravel take in oxygen through their shell. A lowered level of oxygen may result in a delay in the development of the embryo and the hatching. These low levels can be caused by increases in temperature, excessive nutrients and silt which all can deplete oxygen. Moving water adds oxygen to the stream. The faster the water moves, the more oxygen goes in.

Gravel and Stream Bottom

For successful egg-laying, salmonids require clean, stable gravel of 1-10 cm in diameter, depending on size of the adult fish. The gravel must be clean and loose, so that water can flow through the gravel to provide each egg with enough oxygen, and so that waste products emitted by the eggs (such as carbon dioxide and ammonia) will flow away from the egg. The gravel must contain different sized stones. Smaller gravel is used for egg laying, larger stones are needed for many of the insects which live in the water, and boulder sizes are needed to ensure spaces for fish to hide and over-winter.

The best bottom for a trout and salmon stream is a mixture of gravel, rubble, rock, and boulder with a liberal sprinkling of sunken logs and stumps. The rock/gravel bottom, especially in riffles and runs, offers the best habitat for insects that the fish eat. This mixture should have very little sand and silt in it. You should be able to pick up the surface stones without exposing sand or silt and see insects on them.

Stream flow

Nova Scotia is known for extreme changes in the amount of water that flows in streams. In the spring the water often flows high because of winter snow melt and spring rains. This is called the **spring freshet** or flood. In the hot weather of summer many streams experience droughts and have very little water flowing through them. This is extremely hard on salmon and trout. The best streams have flows without these extremes. It is especially important to have enough water flowing in the normal low flow period of late August and September to provide adequate nursery areas for young fish. It is also important during the winter, so that

embryos and alvins do not freeze. Human activity in the watershed can result in higher freshets, lower summer and winter flows, and excessive ice formation.

Barriers to swimming up and downstream

During migrations between the ocean and the spawning and rearing sites in lakes and rivers, an unobstructed path is necessary for adults. Fry and juveniles also move to different habitats, as they grow older, so they require access up and down the stream and into side-channels and tributaries. Obstructions such as logjams, hydro power dams, and poorly installed culverts are especially damaging to the migrations of salmonids unless provisions for passage are made.

Clean Water

Clean, clear water is very important to trout and salmon. The water must be clear enough to permit the sunlight to reach the stream bottom where important plants and algae grow. These plants and algae are important food sources for many of the insects upon which trout and salmon feed. Also, high concentrations of solids such as silt in the water can damage the fragile breathing systems of insects and fish.

While some fish, such as suckers, locate food chiefly by smell or feel, trout and salmon need to see their food. Therefore, they feed and grow better in clear water. Water quality is critical during the spawning, incubation, and hatching periods. Heavy sedimentation can smother eggs in gravel and easily destroy them.

Cover/Shelter

Stream salmonids require cover such as undercut banks, logs, spaces under large rocks and boulders, overhanging trees and plants, and deep pools. This cover is used for feeding, hiding, resting, and over wintering. Additionally, overhanging plants shade the river to help control stream temperatures.

Fish spend a lot of time hiding from various predators, whether these predators be the web-footed, clawed, four-footed, or the two legged kind. Their hiding locations are commonly called areas of shelter. Shelter is critical to a fish's survival in a stream and various sizes of trout or salmon require different ranges of shelter. Ideally, most fish like to be protected or sheltered on three sides. This often means on the top, one side and bottom (e.g. an undercut bank). They also require a shelter that is a snug fit and not too roomy. Therefore, a fish will select a shelter that is close-fitting to its body size.

A shelter should break the water flow so that a "dead-space" or slow current area is created near it. A popular misconception is that salmonids like to swim against heavy currents. On the contrary, they prefer to rest where they don't have to exert themselves too much. As unlikely as it may seem, there are many "dead-spaces" among swift currents. Even the most torturous rapids will have holding areas as long as there is a structure that acts as a buffer to

the current.

Fry not only prefer the shallow, slow margins of a stream, but also seek shelter that conceals them. In the shallows, woody debris such as branches, twigs, and small fallen tree limbs can provide many nooks and crannies for small fish. Where this material is absent, jumbles of large sticks and small boulders can also provide good shelter areas. Larger, older trout look for more substantial cover in the deeper areas of the stream. Undercut banks, log-jams, stumps, and boulders all offer hiding spaces for the larger fish.

Relatively shallow water can also be a holding location as long as the surface is riffled, which masks the presence of the fish. Weed beds composed of healthy aquatic plants provide additional cover for young and adult alike.

To add variety to the shelter equation, shelter can be species-specific to a certain degree. Brown trout and brook trout prefer areas with overhead cover and therefore select the margins and edges of the stream. Rainbow trout, however, are not as selective and often position themselves in mid-river if a suitable shelter or current break is available. Salmon parr prefer the cover of broken water surface (e.g. on riffles) and spaces under rocks in riffle areas.

There is an approach to assessing salmonid habitats presented in section 9 which provides additional information on the specific needs and when you need to undertake restoration.

6.3. FACTS ON FISH

The next section contains fact sheets on the following fish species found in Nova Scotia:

Atlantic Salmon
Brook Trout
Brown Trout
Rainbow Trout
Smallmouth Bass
Striped Bass
Alewife
American Eel
American Shad
Brown Bullhead
Rainbow Smelt
White Perch
Yellow Perch
White Sucker

Atlantic Salmon (Salmo salar)

One of the best-known members of the salmonid family is the Atlantic salmon which is also known as: grilse, grilt, fiddler; landlocked salmon, ouananiche and grayling (all for landlocked fish); black salmon, slink, kelt (all for post-spawning fish); smolt, parr, Kennebec salmon, and Sebago salmon.

Physical Characteristics

Salmon can vary in colour depending on the water they're in, their age, and sexual activity. In fact there are so many different physical looks in the life of a salmon that it can be confusing. What follows are some of the common colour characteristics:

Salmon in saltwater: blue, green or brown on the back and silvery on the sides and belly. On the upper body you can find several x-shaped black spots.

Salmon in freshwater: bronze-purple in colour and sometimes with reddish spots on the head and body.

Spawning males: these fish develop a hooked lower jaw (kype)

Salmon finished spawning (kelts): very dark in colour

Facts on Salmon

The name salar comes from the Latin "salio" whish means to leap. The Atlantic salmon can make leaps 3.7 m (12 ft) high and 5 m (16.3 ft) long!

Atlantic salmon are mentioned in the Magna Carta.

In the wild about 1 in 10 young salmon survive to become smolts and in many rivers fewer than 1 in 25 of those will return to spawn.

Most grilse are male.

Biologists can "read" the scales of salmon to determine how old they are, how many years they spent in fresh water, how many years they spent at sea and at what ages they spawned.

Young salmon (parr) in freshwater: 8 to 11 dark bars on the side with a red spot between each one.

Young salmon leaving fresh water for the sea (smolts): silvery in colour and usually about 12 to 20 cm (5-8 in) long.

Atlantic salmon can be easily confused with both brown trout and rainbow trout. However there are several characteristics that can help you distinguish the different species. Rainbow trout have a rows of spots on the tail (caudal) fin that is not found in salmon and brown trout have a reddish colouring on the adipose fin (the small fin in front of the tail on top of the body). Some of the different characteristics can be observed on the following pages in the line drawings.

Salmon Sizes

Sea-run salmon - can be as big as 1.5 m (59 in) and 36 kg (79 lb) but most are 9 kg (20 lb) or less.

Biggest known fish ever caught in Canada: a 25.1 kg (55 lb) fish caught in the Grand Cascapedia River, Quebec.

After two winters at sea: 2.7 to 6.8 kg (6-15 lb).

After one winter at sea (grilse): 1.4 to 2.7 kg (3-6 lb)

Landlocked Atlantic - 0.9 to 1.8 kg (2-4 lb). However a 16.1 kg (35.5 lb) specimen was taken in Sebago Lake, Maine over 50 years ago.

Distribution

Atlantic salmon are native to the North Atlantic Ocean and coastal rivers and can be found on both sides of the ocean including parts of Russia, Portugal, Iceland, and Greenland. In Canada and the U.S. they can be found from Northern Quebec and Labrador to the Connecticut River. Due to over fishing and the destruction of habitat, salmon no longer can be found in much of its original range and the numbers of fish have seriously declined. As an example, since the late 1800's, there has been no salmon in Lake Ontario. Landlocked populations of Atlantic salmon exist in some lakes of eastern North America, particularly in Newfoundland, Labrador and Quebec.

Natural History

Atlantic salmon spend part of their life feeding and growing during long migrations in the sea, and then return to reproduce in the fresh water stream where they hatched. This type of pattern, moving from the sea to freshwater, is described as being **anadromous**.

Atlantic salmon that are ready to spawn begin moving up rivers from spring through fall. These spawning runs are surprisingly consistent and occur at the same time each year for each river. Salmon populations are often spoken of as "early run" or "late run". Salmon travel long distances, as much as 500 km (312 mi) upstream and are known for their ability to leap small waterfalls and other obstacles. During this journey, the salmon does not eat, though it rises readily to an artificial fly. Landlocked salmon living in lakes move up into tributary streams to spawn.

Spawning occurs during October and November usually in gravel-bottom riffles at the head or tail of a pool. The female looks for places where the water is seeping down into clean gravel. Spawning occurs in the evening and at night. The female digs a nest **(redd)** 15-35 cm (6-14 in) deep in the gravel by turning on her side, flipping her tail upward and pulling the gravel up until a hole is excavated. She then usually moves upstream and repeats the whole process. After the female and male spawn in the redd the 5-7 mm eggs are buried with gravel by the female and the whole process is repeated several times until the female has shed all of her eggs. Females produce an average of 1500 eggs per kilogram of body weight (700 eggs/lb). After spawning the adults (now called kelts) usually drop downstream to rest in a pool. Contrary to some stories, adults do not die after spawning. Exhausted and thin, they often return to sea immediately before winter or remain in the stream until spring. Some will survive to spawn a second time but few survive to spawn 3 or more times.

Fishing Facts

The Atlantic salmon has been prized for centuries, both commercially and for sport. However, dam construction in rivers has blocked access to many spawning streams and siltation has destroyed many others.

In addition pollution, acid rain, over fishing and poaching have all contributed to a drastic decline in ·Canada's Atlantic salmon stocks.

Today, except for small fisheries in Quebec and Labrador, ·Canada's commercial fishery is closed. Recreational fisheries are very closely regulated, and "hook and release" angling is increasingly promoted.

Through salmon enhancement programs biologists and local community groups are working to restore the production potential of many salmon rivers.

Salmon eggs develop slowly (about 110 days) over the winter while water flowing through the nest keeps the eggs clean and oxygenated. In most of our rivers the eggs survive quite well and are protected from freezing or silt. The eggs hatch in the spring, usually April, and the young salmon (alvins) remain buried in the gravel for up to 5 weeks while they absorb the large yolk sac. It's at this stage that many young fish are lost. Over the winter silt and sand often move

into the nest and can trap the young fish. If they make it through this stage, the young salmon that emerge are about 2.5 cm (1 in) long in May or June.

During this freshwater stage before they migrate to sea they are known as parr. Salmon parr are territorial and feed during the day. They eat mainly water insects but will also eat other invertebrates when available. Young salmon usually live in shallow riffle areas 25 to 65 cm (10-26 in) deep that have gravel, rubble, rock, or boulder bottoms. Salmon parr may be eaten by many kinds of predators including trout, eels, other salmon, mergansers, kingfishers, mink and otter. During their first winter the parr stay under rocks on the bottom of the stream.

More Facts on Salmon

Salmon have been reared in hatcheries for decades to provide smolts for river stocking programs.

Today they are commercially farmed in large ocean pens, a rapidly growing industry in Atlantic Canada.

After two or three (but anywhere from 2 to 8) years in fresh water salmon parr turn into smolts and prepare for life in salt water. In the spring, these parr become slimmer and turn silvery. During the spring run-off, as water temperatures rise, smolts form schools and migrate downstream at night. It is during this downstream migration that smolts "learn" or become imprinted with the smell or other features of their particular river.

At sea salmon are known to travel long distances. Many salmon from Maritime rivers travel as far as the western coast of Greenland where the waters are rich in food. Here, salmon grow rapidly, feeding on crustaceans and other fishes such as smelt, alewives, herring, capelin, mackerel, and cod. Salmon will stay at sea for one or more years. The salmon will spend only one year at sea are smaller and called grilse when they return to freshwater to spawn. At sea, salmon are eaten by cod, pollack, swordfish, tunas and sharks but have been known to live to 11 years.

Brook trout (Salvelinus fontinalis)

This salmonid is also called speckled trout, brook charr, brookie, lake trout, square tail, sea-trout, Eastern brook trout, native trout, coaster, and breac.

Physical Characteristics

The brook trout is a handsome fish. Like salmon, their colour varies depending on the water they are in and their sexual activity. Here are some of the common characteristics:

Adult in freshwater: green to dark brown and black on the back and sides. Light-coloured wavy lines on upper back, dorsal fin and upper part of the caudal (tail) fin. Red spots surrounded by blue halos and many light spots are usually present on the sides. The belly is lighter, white to yellow in females, or reddish in males. The leading edges of the lower fins have a bright white border followed by a black border and reddish coloration.

Facts on Brook Trout

Larger brook trout that live in northern waters sometimes eat small mammals such as mice, shrews and voles.

A 61 cm (24 in.) sea-run trout that weighed 3.4 kg (7.5 lb) was caught in Halifax ·County Nova Scotia in 1871.

It can be seen today in the Nova Scotia Museum.

During spawning: colours intensify and males can become a deep orange-red on the belly.

Adult in saltwater: silvery on the sides and dark blue or green on the back. Pale red spots may be visible on the sides as well as the white leading edge on the fins. When returning from the sea these trout regain their freshwater colours.

Young brook trout or parr: 8 to 10 dark vertical bars (called parr marks) on the sides.

The largest "brookie" on record was taken in Ontario in 1915 weighing 14.5 lb (6.6 kg) and 34 in (86 cm) long. Brookies in Nova Scotia typically range from 15-35 cm (6-14 in) long.

Distribution

The brook trout is native to eastern North America from the Atlantic seaboard to Massachusetts, south along the Appalachian Mountains, west to Minnesota and north to Hudson Bay. It is found in a range of waters from tiny ponds to large rivers, lakes, and salt-water estuaries. Its popularity as a sport fish has resulted in brook trout introductions throughout the world. Widely distributed throughout the Maritimes, brook trout are our most sought-after freshwater fish.

Natural History

Brook trout prefer cool clear waters of 10 to 18·C with a lot of cover. Usually they live in spring-fed streams with many pools and riffles where they can use undercut banks, submerged objects such as large rocks and stumps, deep pools, and shelter from overhanging vegetation as hiding places. Brook trout are meat-eaters (carnivorous). They eat mostly water and land insects but will take anything they can swallow. Larger trout will eat leeches, small fish, mollusks, frogs, and salamanders.

Fishing facts

The brook trout is the most popular sport fish in the Atlantic Provinces. It is taken with spinning tackle, live bait or flies.

Unfortunately many natural populations of brook trout in Nova Scotia have declined. They are vulnerable to over fishing and human practices that affect their habitat. For example, siltation can smother developing eggs, dams can block access to spawning areas, or the loss of trees along a stream bank can reduce shade and cause summer water temperatures to get too high.

Brook trout have been reared in hatcheries for over a hundred years. Hatchery trout are widely stocked in natural waters to supplement "wild" populations or to introduce the brook trout to new areas. Sometimes trout are stocked in small ponds or lakes near urban areas to provide "put and take" sport fisheries.

Brook trout in Nova Scotia spawn in October and November in shallow, gravelly areas of streams where there is a clean bottom and good water flows. Spring-fed headwaters are ideal but they'll also spawn in the gravel-bottomed areas of lakes where spring waters occur. The female digs a nest (redd) 10-15 cm (4-6 in) deep in the gravel with her body. After the eggs have been laid and fertilized, they are covered and left to develop slowly over the winter. A 25 cm (10 in) female trout can produce about 500 three to five mm eggs. Water flowing through the redds keeps the eggs clean and oxygenated. Hatching occurs in the spring and the larvae (alvins) remain still and undisturbed in the gravel while they absorb the large yolk-sac.

Young trout (fry) emerge from the gravel at a length of 2.5-3.5 cm and begin feeding on aquatic

insects. They prefer shallow areas where the temperatures are 11-15·C and where rubble (rocks of 10-40 cm (4-16 in)) on the stream bottom provides cover. At the end of their first year, brook trout in Nova Scotia are 5-10 cm (2-4 in) long. Their growth depends very much on local conditions. Brook trout living in larger rivers and lakes would probably be 25 or 30 cm (10-12 in) at age 3, but those in small streams might only reach a length of 15 cm (6 in). Trout usually mature at three years old and rarely live past age 5.

Some populations of brook trout migrate to sea for short periods. They move downstream in the spring or early summer and remain in estuarine areas where there's lots of food. After about 2 months they return to freshwater. Brook trout probably migrate to sea in response to crowded conditions, low food supplies, or unfavourable temperatures in their home waters. Some over-winter in estuaries, and there are shore movements along our coast. Not all fish in a population migrate nor do they necessarily go every year. Sea-run brook trout live longer and grow larger than strictly freshwater trout. Brook trout predators include mergansers, herons, kingfishers, mink, owls, osprey, otter, perch, eels, and other trout.

Brown Trout (Salmo trutta)

The brown trout is also a salmonid and is known as German brown trout, German trout, Lochleven trout, European brown trout, or brownie.

Physical Characteristics

"Brownies" get their name from the brown or golden brown on their backs. Here are some of their other characteristics:

- their sides are silvery and bellies are white or yellowish • dark spots, sometimes encircled by a pale halo, are plentiful on the back and sides
- spotting also can be found on the head and the fins along the back
- rusty-red spots also occur on the sides
- the small top fin in front of the tail has a reddish hue
- sea-run brown trout have a more silvery coloration and the spotting is less visible.

Facts on Brown Trout

Apart from moving upstream to spawn, adults tend to stay at the same station in a river with very little movement to other areas of the stream areas. They can be found at these stations day after day, even year after year!

The closest relative of the brown trout is the Atlantic Salmon (Salmo salar). The brown trout's name (Salmo trutta) means salmon trout.

The largest brown trout ever taken was hooked recently in Arkansas, U.S weighing just over 40 pounds.

They closely resemble Atlantic salmon and rainbow trout but the salmon has no red coloration on the adipose fin and the rainbow trout has distinct lines of black spots on the tail. Young brown trout (parr) have 9-14 dark narrow parr marks along the sides and some red spotting along the lateral line.

Brown trout can grow to be quite large, especially sea-run fish. Brown trout weighing up to 31 kg (68 lb) have been recorded in Europe and a specimen weighing 13 kg (28.5 lb) was caught in Newfoundland. Typically they range from 2.3 to 3.2 kg (5-7 lb) but reach 5.9 kg (13 lb) in Guysborough Harbour.

Distribution

Brown trout naturally occur throughout Europe and western Asia. They range from Finland south to North Africa, west to Iceland and as far east as Afghanistan. Introduced throughout the world, they were first placed in Canadian waters in 1890. Today they are well established in rivers, lakes and coastal areas in much of North America and are found in all Canadian provinces except Manitoba, Prince Edward Island, and the Northwest Territories. Sea-run populations occur in Atlantic Canada and Quebec.

Brown trout are well established in several Nova Scotia watersheds. They are no longer being stocked in areas that they inhabit. Nova Scotia brown trout come from German and Lochleven (Scotland) ancestral stocks.

Fishing Facts

Brown trout prefer very similar habitats to our native brook trout except that they can tolerate slightly higher temperatures. They often use the lower reaches of rivers and streams where it is unsuitable for brook trout.

Biologists thought the brown trout out-competed and displaced the native brook trout and stocking programs were discontinued.
Brown trout do live longer and grow larger than brook trout. They have become quite popular with anglers and are caught in estuaries with lures and streamer-type flies. There is no commercial fishery.

Natural History

Brown trout prefer cool clear rivers and lakes with temperatures of 12-19.C. They are wary and elusive fish that look for cover more than any other salmonid. In running waters they hide in undercut banks, instream debris, surface turbulence, rocks, deep pools and shelter from overhanging vegetation. Brown trout are meat-eaters (carnivorous). They eat insects from water and land, and take larger prey such as worms, crustaceans, mollusks, fish, salamanders, and frogs as their size increases.

Brown trout spawn in the fall and early winter (October to February) at the same time or later than brook trout. They return to the stream where they were born, choosing spawning sites that are spring-fed headwaters, the head of a riffle or the tail of a pool. Selected sites have good water flows through the gravel bottom. The female uses her body to excavate a nest (redd) in the gravel. She and the male may spawn there several times. A 2.3 kg (5 lb) female produces about 3400 golden coloured eggs that are 4-5 mm in diameter. Females cover their eggs with

gravel after spawning and the adults return downstream. The eggs develop slowly over the winter, hatching in the spring. A good flow of clean well-oxygenated water is necessary for successful egg development.

After hatching the young fish (alvins) remain buried in the gravel and take nourishment from their large yolk-sacs. By the time the yolk-sac is absorbed, water temperatures have warmed to 7-12◦C. The fish (now known as fry) emerge from the gravel and begin taking natural food.

Brown trout fry are aggressive and establish territories soon after they emerge. They are found in quiet pools or shallow, slow flowing waters where older trout are absent. They grow rapidly and can reach a size of 165 mm (6.5 in) in their first year.

Yearling brown trout move into cobble and riffle areas. Adults are found in still deeper waters and are most active at night. They are difficult to catch and are best fished at dusk. Brown trout living in streams grow to about 1.8 kg (4 lb) but lake residents and sea-run fish grow larger. Most mature in their third to fifth year and many are repeat spawners.

In sea-run populations, brown trout spend 2-3 years in freshwater then migrate downstream to spend 1 or 2 growing seasons in coastal waters near the river mouth. There they feed on small fishes and crustaceans. Most return to their home streams to spawn but some straying occurs. Brown trout live up to 14 years and can spend as long as 9 years in the sea.

Rainbow Trout (Oncorhynchus mykiss)

This member of the salmonid family is also called Steelhead, Kamloops trout, steelhead trout, silver trout, or coast rainbow trout.

Facts on Rainbow Trout

The largest rainbow trout was caught in Alaska in 1970 and weighed 19.10 kg (42 lb).

The rainbow trout is commonly used as a laboratory animal for water quality testing.

Physical Characteristics

Like most other members of the salmonid family, the appearance of rainbow trout varies.

Adults in freshwater: colour varies from metallic blue to green or yellow-green to brown on the back becoming silvery on the sides and light on the belly. Many small black spots cover the head, back, sides and fins, and spots on the tail are in obvious rows. The adipose fin (small fin in front of the tail on the back) has a black border. Mature fish have a distinctive rosy stripe along the side that extends from the gill cover to the caudal fin.

Adults in saltwater: sea-run rainbow trout (steelheads) are more silvery in colour, may lack the rosy stripe, and show less spotting on the sides.

Young rainbow trout (parr): have 5-13 well-spaced dark parr marks on the sides and show less spotting on the body than adults.

Rainbow trout may look very similar to Atlantic salmon and brown trout, but can be distinguished by the regular rows of spots on the tail, the lack of any coloured spots and the absence of red in the adipose fin.

Rainbow trout can grow as big as 25.8 kg (57 lb) but in Nova Scotia usually grow up to 2.7 kg

(6 lb).

Distribution

Rainbow trout are actually native to the eastern Pacific Ocean and fresh waters of western North America. They naturally ranged from Mexico to Alaska and inland to the Rockies. However, they have been widely introduced throughout the world, and now occur across central North America to the eastern coast. Rainbow trout were first introduced to Atlantic Canada in the late 1800's. Today they are stocked in rivers and lakes throughout Nova Scotia and are known to reproduce in the Bras d'Or Lake watershed.

Natural History

Different populations of rainbow trout may have very different life history patterns. Rainbow trout may live in lakes or ponds, they may be stream dwellers or they may spend part of their lives at sea before returning to freshwater (anadromous) to reproduce.
They prefer water temperatures of 12-18·C and do well in clear, cool, deep lakes or cool, clear, moderately-flowing streams with abundant cover and deep pools. They spawn in the spring (usually from March to May in Atlantic Canada) in small tributaries of rivers, or in inlets or outlets of lakes. Rainbow trout usually home to the streams where they hatched.

Fishing Facts

A popular sport fish, rainbow trout are fished with wet and dry flies, lures or natural bait.

The flesh is tasty and may be prepared many ways.

Rainbow trout have been reared in hatcheries for decades to support stocking programs. They are also reared commercially in ponds for food and for sport, and more recently in salt water pens.

Spawning occurs in shallow riffles with gravel bottoms. The female uses her body to dig a nest (redd) in the gravel. One or two males will spawn with her in the nest, after which she buries the fertilized eggs. She repeats this process until all her eggs are used. Most female rainbow trout produce about 1,000-4,000 eggs. The eggs are 3-5 mm in diameter and hatch in 4-7 weeks depending on the temperature. In another 3-7 days the young absorb the yolk sac and emerge from the gravel.

The young of lake-dwelling fish may move into the lake by the end of their first summer. Some stay in a tributary up to 3 years before entering the lake. Young rainbow trout seek cover and prefer slow- moving shallow stream areas where rubble, rocks, instream debris and undercut banks provide shelter. Older trout move into faster and deeper stream waters. Rainbow trout that migrate to sea (steelheads) spend from 1-4 years in freshwater before they transform into smolts to prepare for life in salt water. Rainbow trout smolts lose their parr markings and become silvery. They migrate to sea in spring and remain there for a few months to several years before they return to fresh water.

Rainbow trout take a wide variety of foods, but in freshwater they eat mainly insects, crustaceans, snails, leeches, and other fish if available. At sea they eat mainly fish, crustaceans, and squid. Rainbow trout growth varies widely depending on their habitat, diet and life history pattern. Generally fish that go to sea or live in large productive lakes, grow largest and live longer. Rainbow trout usually mature at ages 3 to 5 at sizes that range from 15-40 cm (6-16 in) long. Many will spawn repeatedly. Rainbow trout can live to 11 years.

Smallmouth bass (Micropterus dolomieui)

This fish, a member of the sunfish family is also called northern smallmouth bass, smallmouth black bass, black bass, and brown bass.

Physical Characteristics

The smallmouth bass has the following characteristics:

- A robust, slightly laterally compressed fish
- Its colour varies from brown, golden brown, olive to green on the back becoming lighter to golden on the sides and white on the belly
- It has 8-15 narrow, vertical bars on the sides and dark bars on the head that radiate backwards from the eyes
- Its head is relatively large, with a large red, orange, or brown eye
- Its lower jaw protrudes
- Its two dorsal fins are joined; the front one is spiny and the second one has 1 spine followed by soft rays
- Its pelvic fins sit forward on the body below the pectoral fins
- Three spines border the front of the anal fin and a single spine is found on each pelvic fin
- Young fish have more distinct vertical bars or rows of spots on their sides and the caudal or tail fin is orange at the base followed by black and then white

Facts about Smallmouth Bass

Some male smallmouth bass return to the same nest year after year; over 85% of them build their nest within 138 m (150 yd) of where they nested in earlier years.

The world record smallmouth bass was caught in Kentucky, U.S.A. in 1955 and weighed 5.4 kg (11.9 lb). It measured 68.6 cm (27 in) long and 54.9 cm (21.7 in) in girth.

They have been seen "sunning" in pools with water temperatures of 26.7· C.

Smallmouth bass can reach over 4 kg (9 lb) in parts of central Canada but usually don't exceed 1.1 kg (2.5 lb) in Nova Scotia.

Distribution

The smallmouth bass is a freshwater fish originally found in lakes and rivers of eastern and central North America. As a result of widespread introductions, it now ranges from southern Nova Scotia and New Brunswick, south to Georgia, west to Oklahoma, north to Minnesota, west to North Dakota and east from southern Manitoba to Quebec. It also occurs in a few areas of western North America and has been introduced in Europe, Asia, and Africa.

Natural History

Smallmouth bass prefer clear, quiet waters with gravel, rubble, or rocky bottoms. They live in mid-sized, gentle streams that have deep pools and abundant shade, or in fairly deep, clear lakes and reservoirs with rocky shoals. Smallmouth bass tend to seek cover and avoid the light. They hide in deep water, behind rocks and boulders, and around underwater debris and crevices. Smallmouth bass prefer temperatures of 21-27· C. As temperatures fall, they become less active and seek cover in dark, rocky areas. In the winter they cease feeding, remain inactive on the bottom, staying near warm springs when possible.

Spawning takes place from late May to July in shallow (usually 0.3-0.9 m (1-3 ft) deep) protected areas of lakes and rivers, when the water temperature is 16 to 18· C. The male prepares a nest on a sandy, gravel or rocky bottom by cleaning an area 0.3 to 1.8 m (1-6 ft) in diameter. He defends the nest from other males and attracts a series of females into the nest to spawn. After spawning the female leaves and the male remains to guard the nest and fan the eggs. Females usually produce from 5,000 to 14,000 eggs, depending on their size. The eggs are from 1.2-2.5 mm in diameter and stick to stones in the bottom of the nest.

The young are about 5.8 mm long when they hatch in 4-10 days depending on the temperature. Hatching success can vary a lot. Sudden changes in temperature or water level can cause the eggs to die from shock or cause the male to abandon the nest, leaving it open for predators. After hatching, the male remains with the young for another 3-4 weeks while they absorb the yolk sac and begin to leave the nest.

Young fish tend to stay in quiet, shallow areas with rocks and vegetation. They begin feeding on plankton (tiny organisms suspended in the water), and switch to larger prey like water insects, amphibians, crayfish, and other fish as they grow. (Crayfish are native to New Brunswick but are not found in Nova Scotia). Two-year old bass are about 12.7 cm (5 in) long.

Older bass prefer rocky, shallow areas of lakes and rivers and retreat to deeper water at high water temperatures. Most bass do not travel great distances and those in streams spend all season in the same pool. Smallmouth bass mature at ages 3-6 when they are about 17 to 28 cm (6.7-11 in) long. Males usually mature a year earlier than females. They are known to live 15 years.

Some smallmouth bass predators are yellow perch, sunfishes, catfishes, white suckers and turtles.

Fishing Facts

Smallmouth bass are a fish of great sporting quality that have been popular with anglers since the early 1800's.

This popularity led to widespread introductions and the culture of smallmouth bass. It was harvested commercially until the 1930's but over-fishing led to its restriction as a sport fish.

Smallmouth bass can be taken with wet or dry flies, by trolling or casting with live bait or lures, or still fishing with crayfish, minnows or frogs.

Striped Bass (Morone saxatalis)

Other common names for this fish include: striper bass, striped sea bass, and striper.

Physical Characteristics

Striped bass have the following characteristics:

- A long, laterally compressed fish
- Its colour is olive green to blue or black on the back; the sides are pale to silvery (sometimes with brassy reflections); its belly is white
- It has 7-8 dark horizontal stripes on the sides
- Both eyes and mouth are relatively large and the lower jaw protrudes
- The pelvic fins sit forward on the body below the pectoral fins
- The first dorsal fin (on the back) is spiny and the second has one spine followed by several soft rays
- A single spine lies at the front of each pelvic fin and three short spines precede the anal fin
- Young often lack stripes and have 6-10 dusky bars on the sides

Striped bass have been recorded as large as

Facts about Striped Bass

A striped bass weighing 28.6 kg (62.9 lb) was caught near Reversing Falls in the Saint John River, New Brunswick in 1979.

The world record (angling) striped bass weighed 35.6 kg (78 lb) was caught at Atlantic City, New Jersey in 1982.

A striped bass tagged and released in the Saint John River, New Brunswick was recaptured 36 days later in Rhode Island, U.S.A. 805 km (503 mi) away! (22.4km/day 14 mi/day)

After fertilization striped bass eggs swell to about three times their original diameter to a size of 3.6 mm.

Surveys show the average striped bass angler on the Annapolis River, Nova Scotia spends about 50 hours on each fish caught.

56.7 kg (124.7 lb) North Carolina, 1891). However most striped bass caught are 13.6 kg (30 lb) or less.

The short (less than half the fin length) anal fin spines and body stripes distinguish striped bass from white perch, the other member of the temperate bass family found in Maritime waters. The white perch lacks stripes and 2 of its anal spines are longer than half the fin length.

Distribution

The striped bass is a coastal species found in rivers, estuaries, and inshore waters of eastern North America from the St. Lawrence River and southern Gulf of St. Lawrence to northern Florida, as well as the northern coast of the Gulf of Mexico. It was introduced on the Pacific coast of North America over 100 years ago, where it now ranges from California to southern British Columbia. Striped bass have been introduced and become established in some landlocked lakes in the southern and central U.S.

Striped bass have been introduced to parts of Europe and Asia.

Natural History

Striped bass is a schooling fish, living in the sea and returning to fresh water to spawn (anadromous). It is most common in steady-flowing, turbid rivers that have low slopes and large estuaries. During their saltwater life many striped bass make long sea migrations. However not all fish migrate and some populations do not migrate at all. Some fish remain in the estuary of their home rivers.

Fishing Facts

Historically valued both for food and for sport, stocks of striped bass have been declining since the 1970's. This is probably due to a combination of over fishing, habitat destruction, pollution and natural population cycles.

The striped bass is becoming a popular sport fish in ·Canadian waters and can be caught by casting, trolling, jigging, and fly fishing. They are fished in the surf or along shorelines and estuaries wherever schools of small food fishes are found and best fishing is often in the evening at high tide. Striped bass can be fished with live bait, lures (bucktails, Rapalas), plugs and poppers (skipping bugs). Bait success depends on the location and feeding habits of bass at the time but gaspereau, eels and worms are popular.

It is not fished commercially in Nova Scotia.

Striped bass spawn in May and June after moving upriver the previous fall, usually at water temperatures of 14 to 22· C. The length of this journey can vary from a long journey inland to just above the head of tide. Striped bass sometimes spawn in brackish water.

Striped bass produce many eggs. In fact, more than three million have been recorded for a 22.7 kg (50 lb) female! About 100,000 eggs is more typical of bass in our rivers. Striped bass spawn near the water surface in water 0.3-6.1 m (1-20 ft) deep. The eggs have a large oil globule and

are semi-buoyant. Ideally the current that prevents them from getting silted over and smothered on the bottom carries them along. The eggs hatch in 2-3 days depending on the temperature (15-18.6◦C).

Newly hatched fish are about 5 mm long. After absorbing yolk-sac, they feed on zooplankton (tiny invertebrates suspended in the water).

Striped bass are carnivores and take progressively larger prey as they grow. They eat a variety of invertebrates such as insect larvae, marine worms, and crustaceans as well as many kinds of schooling fishes, especially herring and gaspereau.
Adults feed most actively just after sunset and just before dawn and can be seen moving in with the tide, rolling and flashing as they feed on smaller fish. Canadian striped bass grow fairly rapidly and can be 14.5 cm (5.7 in) at age 1. They usually mature at age 3-6 years when they are about 34-53 cm (13.4-21.7 in) long. Males usually mature a year earlier than females, but do not live as long. Striped bass can live to 31 years.

Other fish such as Atlantic tomcod, Atlantic cod, silver hake and larger striped bass eat small striped bass. Adult striped bass have few predators except humans.

Young striped bass form schools and spend their first two or three years in the lower reaches of rivers and in estuaries, preferably where there is a sand and gravel bottom and some current. After this period, many leave their home waters and make long sea migrations along the Atlantic coast. Striped bass populations from North Carolina to the Bay of Fundy are typically migratory and travel in large schools moving north in the summer and south in the winter. They probably return to their home rivers when they reach sexual maturity and are ready to spawn, however mature fish do not necessarily return every year to spawn. In general, most migrating striped bass are female. Some of the large striped bass caught along the Maritime coasts probably originate from U.S. rivers.

Striped bass populations go through cycles. Every so many years the young-of-the-year offspring survive in particularly high numbers and become what is called a dominant year class in the population. Year class success is probably determined in the first two months of life and may be related to environmental conditions during this period.

Alewife (Alosa pseudoharengus)

Common names for the alewife are gaspereau, river herring, sawbelly, or kiack.

Physical Characteristics

The alewife is a member of the herring family. Here are some things to look for:

• A slender, laterally compressed fish coloured greyish-green on the back, and silvery on the sides and belly

• Gasperaux entering freshwater are often copper-tinged

• A single black spot is present on each side, just behind the head

Facts on Alewife

Alewife eggs, or roe, are canned and sold as a delicacy.

Despite the many thousands of eggs laid by spawning alewife very few offspring actually survive. In some populations as few as three young-of-the-year fish migrate downstream for each female that spawned.

• The eye is relatively large and has an obvious eyelid

• A row of scales, known as scutes, form a sharp edge along the mid-line of the belly which is how the alewife came to be called "sawbelly".

The alewife in Nova Scotia is usually 25-30 cm (10-12 in) long and weighs up to 340 gr (12 oz). There is no lateral line.

Another species known as the blueback herring is very difficult to distinguish from the alewife. They inhabit the same watersheds and have similar natural histories. Many reports of alewife

probably include the blueback herring as well.

Distribution

The alewife is found in rivers and lakes along the eastern coast of North America from Newfoundland to North Carolina and the adults live in coastal marine waters 56-110 m (180-350 ft) deep. Landlocked populations exist in several Ontario and New York lakes. Since the Welland Canal was built in 1824, the alewife has spread throughout the Great Lakes.

Fishing Facts

During the spawning runs commercial fishermen set large trap nets or enclosures called weirs in coastal rivers and estuaries to catch migrating alewives. Major Canadian fisheries are on the Shubenacadie, Miramichi, and Saint John Rivers.

The catch is used for fishmeal, lobster bait, pet food or it is smoked, canned, salted or pickled. Although tasty, alewives are not favoured locally for human consumption due to their large number of bones.

Natural History

In the Maritimes the alewife spends most of its life growing in salt water feeding mainly on zooplankton, tiny invertebrates, that live in the water column. Each spring from April to July large runs of adult alewives migrate up coastal rivers to spawn in freshwater lakes, ponds and streams (this movement from sea to freshwater makes the alewife an anadromous fish).

Alewives also spawn in brackish water. Like trout and salmon, alewives use their sense of smell to return to the streams and lakes where they hatched or near by watersheds. Female alewives usually begin spawning at age 4, repeat spawn each following year and may live to be 10. Male alewives often mature a year earlier than females. About 75% of alewives entering Nova Scotia rivers are repeat spawners. Alewives can move into coastal areas in late winter but will not migrate into fresh water until river temperatures begin to warm. Males enter the river first. Alewives only migrate into freshwater during daylight hours. However spawning occurs at night and can occur in standing, slow moving or fast mid-river water. A single female can lay as many as 200,000 eggs.

After spawning the adults begin the downstream migration to the sea within a few days.

Alewife eggs are about 1mm in diameter and are left to lie on the bottom or float with the current. Depending on the water temperature, the eggs hatch in about a week. After the yolk-sac is absorbed the tiny, larval fish stay near the spawning grounds preferring shallow, warm and sandy areas. They feed on tiny species of zooplankton. From August to October young-of-the-year, (sizes from 32-152 mm (1.25-6 in) migrate downstream in large groups or schools to live in estuaries and coastal areas. Adults over winter at sea in the George's Bank, Gulf of Maine or Nantucket Shoals and as far south a Florida. Alewives can live at least 10 years.

Alewives are eaten by many species of fish and birds including striped bass, salmonids, smallmouth bass, eels, perch, bluefish, weakfish, terns and gulls.

American Eel (Anguilla rostrata)

Physical Characteristics

The American eel has a long snake-shaped body. It has no pelvic fins and the fins along the top of the body are continuous. The body is covered with mucus, which is where the expression "slippery as an eel" comes from. Their colour changes as they grow up and there are different names for eels at these different stages.

"Glass eels" are young eels approaching the shore at sea. Their bodies are transparent with a distinct black eye.

"Elvers" are eels that are just adapting to fresh water and are greyish-green in colour.

"Yellow eels" are adults in freshwater. Their colour varies from yellowish to greenish to olive-brown, being darker on the back and lighter on the belly.

Fishing Facts

Commercial fishermen harvest silver and yellow eels with many kinds of gear including weirs, traps, otter trawls, nets, handlines, eel pots and spears.

Eels are sold for human consumption and as bait for other fisheries. Many are shipped fresh or frozen to Europe where they are considered a delicacy and served smoked or jellied.

Elvers have been harvested for use in pond culture and grow-out operations. The American eel is caught by recreational fishermen.

"Silver, bronze, or black eels" are sexually mature eels which darken to a bronze-black hue on the back with silver underneath.

American eels can grow to a size of 1270 mm (50 in) and weigh up to 4.5 kg (10 lb).

Distribution

American eels are found in freshwater streams and rivers, brackish coastal waters and the Atlantic Ocean of eastern North America from southern Greenland and Labrador to the Gulf of Mexico and northern South America. It is the only member of the freshwater eel family found in North America and is wide spread in the Maritime Provinces.

Natural History

The American eel goes on long oceanic migrations to reproduce. Unlike fish such as Atlantic salmon and alewife that return to freshwater to spawn, eels are catadromous, which means they spend most of their lives in freshwater lakes and streams, returning to sea to spawn. No one has ever seen American eels spawn but it is believed to occur in the Sargasso Sea, east of the Bahamas.

Facts about Eels

Eels do not become definitely male or female until they are 20-25 cm (8-10 in) long!

What sex an eel becomes is thought to be partly determined by environmental conditions such as crowding and food abundance.

In areas (southern U.S.) where food abundance and water temperatures favour rapid growth rates, a higher percentage of male eels are found. In cooler areas, such as Nova Scotia, where eels grow more slowly but reach an overall larger size, there tends to be more females. This is an advantage since larger females produce more eggs and can contribute more offspring.

Eels can absorb oxygen through their skin and can travel overland particularly in damp, rainy weather.

Spawning occurs from February through April and hatching probably occurs within a few days. The tiny transparent eel larvae (known as leptocephali), only a few millimetres long, drift with ocean currents to the coastal areas of North America. They grow rapidly until the fall.

Once they are between 8-12 months old and about 55-65 mm (2.1- 2.6 in) long they transform into glass eels. At this stage, eels actively migrate toward freshwater. As they enter brackish and freshwater they begin to develop colour and are known as elvers. Elvers and glass eels reach the Maritime coasts in April and May. At first the elvers are active at night and rest near the bottom during the day. They may stay in estuaries for some time moving up and downstream with the tide as they physiologically prepare to live in fresh water. When elvers begin to migrate upstream they become active during the day and are thought to use the current and the odour of brook water to find their way. This upstream migration can take several years with distances as far as 1000 km (600 mi) involved.

Elvers eat aquatic insects, small crustaceans and fish parts. After a year in freshwater elvers are about 127 mm long (5 in). Following this stage, eels enter a growth phase lasting many years in which they are known as yellow eels. Some eels do not migrate upstream as elvers but

remain instead to live in estuaries. Yellow eels are most active at night and spend the day concealed in vegetation or burrowed in the bottom. Their diet includes insect larvae, fish, crabs, worms, clams, and frogs. They also feed on carrion and are able to tear pieces off food items too large to be swallowed whole.

In late summer and fall some adult American eels in eastern Canada begin their spawning migration to the Sargasso Sea. During this time they change to the "silver eel" stage and become sexually mature. Males can mature at age 3 but females mature later usually at ages 4-7. However eels can spend up to 40 years in fresh water. Female eels produce from 0.5 to 4.0 million eggs. It appears that all eels die after spawning. Adult eels are eaten by larger fish such as sharks, haddock, and swordfish and also by gulls and bald eagles.

American Shad (Alosa sapidissima)

Physical Characteristics

The American shad, like the alewife (gasperau), is a member of the herring family and has the following characteristics:

Facts on Fishing

American shad were much more abundant in the past. During the 1800's a thriving fishery for shad existed along the Atlantic coast supporting an annual catch as high as 23,000 tons (50 million pounds). Today small commercial fisheries exist but numbers have greatly declined due to over-fishing and changes in our rivers. Dams often block access to vast areas of spawning habitat. Even where fishways provide access, many young shad may not survive the downstream migration.

Shad are fished commercially in rivers during the spawning runs. The eggs (roe) are most desirable so large numbers of mature females are taken. The flesh is sold fresh and salted. Shad are angled and considered a fine game fish.

- Slender and silvery-coloured with a blue-green metallic hue on the back
- Has a black spot, similar to the alewife, located on the side, just behind the head - on the shad, this spot is followed by several smaller dark spots
- The eye has an obvious eyelid
- A row of scales known as scutes form a sharp "sawbelly" edge along the midline of the belly
- There is no lateral line

American shad can grow to 76 cm (30 in) and weigh 6.8 kg (15 lb). However, adults found in Canadian rivers are usually 45 to 50 cm (18-20 in) long and weigh from 1.4 to 2.7 kg (3-6 lb).

Distribution

American shad are anadromous (moving from the sea to freshwater) fish found along the Atlantic coast of North America from Newfoundland to Florida. Large spawning runs used to occur in the Shubenacadie and Annapolis rivers (also Saint John, Petitcodiac and Miramichi) but they are found in many Maritime coastal rivers. They have been introduced along the Pacific coast and now range from Alaska to California.

Natural History

The American shad lives for several years at sea before returning to spawn in the stream where it hatched. Shad avoid cold temperatures and prefer to stay in water 8·C or warmer. Water temperature and currents determine much of their migration and behaviour.

Each spring, schools of shad, using their sense of smell, begin to migrate up coastal rivers and tributaries when water temperatures reach 12·C.

Spawning in the Maritimes occurs during June and July in water temperatures of 13-20·C. Migration stops in temperatures over
20·C. American shad do not usually travel as far upstream as the alewife. They spawn in rivers at night in mid-water in streams with a wide range of bottom types. The eggs are about 3 mm across and drift along with the current to hatch in 8-12 days depending on the temperature.

A female can produce anywhere from 60,000-600,000 eggs but shad in Canadian rivers usually produce about 130,000 eggs. Many shad in the Maritimes are repeat spawners, however shad in southern populations die after spawning.

Young shad spend their first summer in the river feeding on insects and crustaceans. They swim near the bottom in water as deep as 3.7 to 4.9 m (12-16 ft) but at night they are found near the surface. When they migrate to sea in the fall, they have grown to a size of 7.5 to 12.5 cm (3-5 in). They migrate to the sea as temperatures in the river drop.

At sea, shad live in schools and move according to the bottom temperatures, seeking areas that are 7-13· C. They stay near the bottom during the day, dispersing at night to all depths. Immature and spawned-out adults remain offshore in areas like the Bay of Fundy until winter, when they move farther out to sea in order to stay in preferred water temperatures. At sea they eat zooplankton (tiny invertebrates that live in the water), small bottom crustaceans, and occasionally small fish. Most shad mature at age 4 or 5 when they are about 48-53 cm (19-21 in) long. Shad can live up to 13 years.

Although not a major food source for other animals, shad are eaten at sea by seals, sharks, blue-fin tuna, kingfish, and porpoises. Young shad in freshwater are eaten by bass, American eels, and birds.

Brown bullhead (Ictalurus nebulosus)

Physical Characteristics

Nova Scotia's only member of the freshwater catfish family is easy to identify with its distinctive sets of whisker-like formations around the mouth. These are called barbels and the bullhead has four pairs.

The following can also identify the bullhead:

• A thick rounded body, heaviest toward the front

• A broad, large, somewhat flattened head

• Sharp, saw-toothed, spines at the base of the dorsal and pectoral fins. These spines can be "locked" in an erect position.

• The tail or caudal fin is square and there is an adipose fin (small fin on the back in front of the tail)

Facts about Bullheads

The spines at the base of the dorsal and pectoral fins can be "locked" into an erect position. This is thought to help protect the bullhead against predators, making it much harder to swallow.

Brown bullheads take many kinds of bait and can be easily caught by anglers. They are best fished with worms at dusk.

The flesh of the brown bullhead is very tasty. They are reared commercially in the southern U.S.

Brown bullheads are extremely resistant to pollution. In areas of heavy pollution they can be the only fish species present.

• Its colour is dark brown to olive green on the back ; its sides are sometimes mottled with dark

blotches and the belly is cream coloured

• There are no scales but the skin has many taste glands

In Nova Scotia it seldom grows more than 30 cm (1 ft) long and 0.5 kg (1 lb) in weight. Bullheads weighing as much as 2.7-3.6 kg (6-8 lb) have been caught in Ontario.

Distribution

The brown bullhead is found in the fresh waters of eastern and central North America, from the Maritime Provinces to Florida, and westward to southern Saskatchewan, Missouri, and Texas. It occurs across southern Canada from Saskatchewan to the Maritimes. The brown bullhead has been introduced to western North America and Europe.

In Atlantic Canada the brown bullhead exists only in New Brunswick and mainland Nova Scotia.

Natural History

Brown bullheads usually live on the bottom in the shallow, weedy, mud-bottomed areas of lakes or large slow-moving streams. They tolerate higher water temperatures and lower oxygen levels than many other fish species.

They feed on the bottom at night, using their barbels to search for food. They eat a variety of foods including insects, fish eggs, leeches, mollusks, crayfish, worms, algae, plants, and small fishes. Young bullheads feed mainly on insects and plankton (tiny organisms suspended in the water).

Bullheads spawn in the late spring when water temperatures approach 21·C. One or both parents excavate a shallow nest in a protected area of mud or sandy bottom. Spawning occurs in the daytime and several thousand cream coloured eggs are deposited in the nest. The parents care for the eggs by fanning them with their fins and physically stirring them up. After hatching, the young catfish are jet black and resemble tadpoles. They swim in a "school" and are protected by their parents for several weeks until they are about two inches long.

The brown bullhead usually matures at age 3 and lives for 6-8 years. The chain pickerel and other members of the pike and perch families eat them.

Rainbow smelt (Osmerus mordax)

Other common names are Atlantic rainbow smelt, smelt, American smelt, freshwater smelt, Atlantic smelt, leefish, and frost fish.
This fish is one of two members of the smelt family found in Atlantic Canada. The other member found here is capelin.

Facts about Smelt Freshly caught smelt smell very much like cucumber! No doubt this feature is responsible for the common name "smelt". This odour disappears after preservation or freezing.

Males smelt are more abundant on the spawning grounds than females. This is probably because they can spawn up to 8 consecutive nights but females may spawn only 3 or 4 nights.

Physical Characteristics

The rainbow smelt is a small slender fish that grows to about 25 cm (10 in). It has the following characteristics:

- Olive-green on the back, becoming lighter on the sides
- Sides have a purple, pink and blue iridescence especially when freshly caught
- The belly is silvery
- Relatively large mouth with fang-like teeth and a protruding lower jaw
- The caudal (or tail) fin is deeply forked
- An adipose fin (small fin in front of the caudal fin on the top) is present
- The lateral line is incomplete
- Spawning males are covered on the head, body and fins with tiny bumps (nuptial tubercles)
- Smelt in freshwater are darker becoming almost black on the back

Distribution

The rainbow smelt is found in rivers and coastal areas of eastern North America from Labrador to New Jersey and on the west coast from Vancouver Island around Alaska to the Arctic Ocean. Landlocked populations also occur in lakes and ponds throughout the Atlantic region. They have been introduced in the Great Lakes and have increased their range to other Ontario drainages through unauthorized introductions.

Fishing Facts

Smelt are fished commercially and for sport. Winter fishing for smelt is a popular sport. Anglers take them on lines through the ice, using worms as bait. In spring, anglers dipnet or seine them in the spawning tributaries.

Commercial fisherman catch them in box nets, bag nets, gillnets or by trawling.

The largest Maritime fishery occurs in the Miramichi estuary. Smelt are sold fresh or frozen and are very tasty.

Natural History

The rainbow smelt is a schooling fish, which grows and matures in shallow coastal waters and migrates up freshwater streams to spawn (anadromous). Smelt move into estuaries in the fall and begin to move up the streams after the spring thaw.

Spawning occurs from February-June usually at water temperatures from 4-10·C). Smelt do not necessarily return to the stream of their birth to spawn, especially if there are other nearby streams. Smelt in landlocked lakes swim up tributary streams or in some cases spawn along the shoreline. Spawning occurs at night in fast moving water. Several males spawn with one female. The fertilized eggs become sticky and attach to the bottom, sometimes forming a thick layer. One female can produce as many as 93,000 eggs. After spawning the adults return to the estuary during the day but may return upstream to spawn again on subsequent nights. Some fish die after spawning. The rest leave freshwater after spawning to spend the summer in coastal waters.

Smelt eggs are about 1mm in diameter and take anywhere from 11-29 days to hatch, depending on the temperature. Smelt fry are 5 to 6 mm long when they hatch and drift downstream to brackish water. They use water depth for cover and feed near the surface at night. Young smelt feed on plankton (tiny organisms suspended in the water), and may grow to 5 cm (2in) by August.

Older fish eat larger invertebrates and other fish. Smelt grow most rapidly in their first year and can tolerate increasing amounts of saltwater, as they get older. They prefer temperatures of 6-14· C and stay close to shore, seeking cover in eelgrass beds or below the water.

Smelts in the Miramichi average 13.9 cm (5.3 in) at age 2, and 20.6 cm (8.1 in) by age 5, southern populations grow faster. Smelt in small landlocked lakes may only reach a length of 10.2 cm (4 in). Smelt usually mature at age 2 in the Maritimes and can live to age 17. Females live longer and grow larger than males.

Smelt are eaten by bluefish, striped bass, salmonids as well as birds, and harbour seals.

White Perch (Morone americana)

Oddly enough, the white perch is actually a member of the bass family and is not a true perch. Other common names for the white perch are silver perch, sea perch, silver bass, narrow-mouthed bass, and bass perch.

Facts about White Perch

The oldest known white perch lived 17 years.

The world angling record for white perch is a 2.15 kg (4.7 lb) fish taken in Messalonskee Lake, Maine in 1949.

Physical Characteristics

The white perch has the following characteristics:

- A deep, thin body that slopes up steeply from the eye to the beginning of the dorsal fin
- Colours which can be olive, grey-green, silvery-grey, dark brown or black on the back becoming a lighter green on the sides and silvery-white on the belly
- The pelvic and anal fins (both on the belly) are sometimes rosy coloured
- Like all members of the bass family it has two dorsal fins on the back and the pelvic fins sit forward on the body below the pectoral fins
- The first dorsal fin has nine spines but the second one is soft rayed • there are three spines at the front of the anal fin, and a single spine precedes the second dorsal fin and each pelvic fin
- It has many small sharp teeth
- Its scales are relatively large and the lateral line is complete

It can grow to 48.3cm (19 in) and 2.72 kg (6 lb).

It is very similar in shape to the striped bass, also found in our waters. The white perch has a deeper, less rounded body than the striped bass. The anal fin spines of the striped bass are less than one-half the fin length, but the second and third anal spines in the white perch are greater than this.

Distribution

White perch are found in fresh and brackish waters along the Atlantic coast from the southern Gulf of St. Lawrence to North Carolina and inland along the upper St. Lawrence River to the lower Great Lakes. It is present in all three Maritime Provinces.

Fishing Facts

The white perch has very tasty flesh and where it grows large enough can be a popular sport fish. They are caught on bait (worms, small minnows) lures, or streamer-type flies.

White perch are fished commercially in Chesapeake Bay, U.S. and the lower Great Lakes.

Natural History

White perch is a fish that can live in fresh or salt water and does best when summer water temperatures reach 24·C. In the Maritimes, it occurs mostly in freshwater lakes and ponds. Sea-run populations are found in some coastal rivers and estuaries.

Spring spawning takes place when water temperatures are 11-16·C, late May-late July in shallow water over many kinds of bottom. Males and females each spawn several times and the tiny 0.9 mm eggs become sticky after fertilization and attach to vegetation and bottom materials. White perch are quite prolific; a 25 cm (10 in) female can produce 247,700 eggs.

The length of time for hatching depends on the water temperature. When the water is cooler, hatching takes longer (4-4.5 days at 15·C versus about 30 hours at 20·C). Newly hatched white perch are 2.3 mm long and feed on plankton (tiny organisms in the water). They grow rapidly and can reach 65 mm (2.5 in) by late summer.

Growth rates of white perch vary among regions and populations. Few studies have been done on Maritime populations. Most perch in our waters are less than 15 cm (6 in). Larger pan-sized white perch that weigh 225 to 450 g (0.5-1 lb) are taken in some Nova Scotia lakes. Lake Ontario fish can reach 33.5 cm (13.2 in) and 780 g (1.72 lb). Even larger sizes have been reported in some U.S. waters.

White perch in lakes are known to feed both during the day and at night. Fresh and saltwater populations move to surface (or inshore) waters at night, retreating to deeper water during the

day. They perch eat mostly aquatic insect larvae when they are small. As they grow, many kinds of fish such as smelt, yellow perch, killifish, and other white perch are eaten. They usually mature at 3 years and live 5-7 years.

White perch are thought to compete with some game fishes for food. In some places a lack of harvesting, either by anglers or other species of fish, can lead to large populations of stunted, small white perch. Smallmouth bass, chain pickerel, and large trout will eat white perch.

Yellow perch (Perca flavescens)

This, the only true member of the perch family in Nova Scotia, is also called perch, lake perch, and American perch.

Physical Characteristics

The yellow perch has the following characteristics:

- Its colour is black-green, to olive, to golden brown on the back and extending down the sides in tapered bars
- The rest of the sides are yellowish becoming grey to white on the belly
- It has two dorsal fins (on the back), the first one has 13-15 sharp spines, the second has only one spine followed by soft rays
- The pelvic fins with one spine sit forward on the belly almost directly below the pectoral fins
- The pectoral fins are amber-coloured and transparent whereas the pelvics are yellow to white and opaque
- Eyes are yellow to green
- The scales feel rough to the touch
- The colour of a spawning male fish intensifies; its lower fins can become orange to bright red.
- Young yellow perch are first transparent, then silvery or pale green

Facts about Yellow Perch

Occasionally yellow perch are found with the unusual colouring of grey-blue or red and the absence of dark bars on the side.

The yellow perch has been called "a good bold-biting fish" "the most extravagantly handsome of fishes" "a ravager of all smaller fish" and "bait-stealing little devils".

Students studying the anatomy of bony fishes most often use the yellow perch.

The yellow perch can grow to 1.9 kg (4.2 lb) but in Nova Scotia it does not exceed 30 cm (12 in) and 450 g (1 lb).

Distribution

Yellow perch can be found in freshwater of North America from Nova Scotia south along the Atlantic coast to Florida, west from Pennsylvania to Missouri, northwest to Montana, north to Great Slave Lake, southwest to James Bay and east to New Brunswick and Nova Scotia. It has been introduced widely in the south and western U.S.and has spread to southern British Columbia. Yellow perch cannot be found in Prince Edward Island, Cape Breton Island or Newfoundland. It is occasionally found in brackish water along the Atlantic coast.

Facts about Yellow Perch

The yellow perch is fished both for sport and for food. Anglers can catch them in summer and winter with fish or worms as bait. Yellow perch have been fished commercially in Canada for over a hundred years and are sold both fresh and frozen. The flesh is white and tasty.

Yellow perch are sometimes infected with the broad tapeworm (Diphyllobothrium latum) that can be transmitted to humans if the flesh is improperly cooked.

Natural History

The yellow perch is a schooling, shallow water fish that can adapt to a wide variety of warm or cool habitats. They are found in large lakes, small ponds, or gentle rivers but is most abundant in clear, weedy lakes that have muck, sand, or gravel bottoms. They prefer summer temperatures of 21-24· C. Yellow perch feed on aquatic insects, crustaceans, and a variety of fishes and their eggs.

Spawning occurs from April through July, but usually during May in Nova Scotia, at water temperatures of 9-12·C. The adults move into shallow areas of lakes or up into tributary streams. Males are first to arrive and the last to leave. Yellow perch spawn at night or in early morning, most often in areas where there is debris or vegetation on the bottom.

The female perch sheds her eggs in a long jelly-like spiral or accordion-folded strand. Several males fertilize the eggs during spawning. The egg mass can be as much as 2.1 m (7 ft) long, 51-102 mm (2-4 in) wide and weigh 0.9 kg (2 lb)!

Females produce an average of 23,000 eggs but have been known to shed up to 109,000 eggs. The egg masses are semi-buoyant and attach to the vegetation or bottom material. They receive no parental care and can be cast ashore during storms or eaten by predators. Yellow perch eggs are 3.5 mm in diameter and hatch in 8-21 days, depending on the temperature. Newly hatched perch are about 5 mm long.

Young perch grow quickly and remain near the shore during their first summer, swimming in large schools that often include other species. Perch in Nova Scotia waters do not grow as large as those living in the warmer, larger, or more productive habitats of central Canada. In general northern populations grow more slowly but live longer, and females grow faster than males.

Adults move in schools farther offshore than the young. They move between deeper and shallow water in response to changing food supplies, seasons, and temperatures. Perch feed in the morning and evening, taking food in open water or off the bottom. At night they rest on the bottom. Yellow perch remain active and feed during the winter.
Yellow perch can outbreed and out-feed speckled trout or other fish in a lake. This can sometimes lead to an overpopulation of small, stunted fish (less than 15 cm (6 in).

Other fish such as smallmouth bass, chain pickerel, and lake trout eats yellow perch. Birds like mergansers, loons, kingfishers and gulls also take them.

White Sucker (Catostomus commersoni)

This fish, the only member of the sucker family found in Nova Scotia, is also called the common sucker, common white sucker, eastern sucker, sucker, black sucker, mud sucker, mookie and muckie.

Fishing Facts
The flesh of the white sucker is bony but can be very tasty, particularly when hot-smoked.

Young suckers are sold as bait but there is little other commercial interest in the species. Suckers should not be used as bait in lakes that do not already contain suckers.

White suckers are not a popular sport fish but they can be caught on wet flies, small spinners and small hooks baited with dough balls or worms.

Physical Characteristics

The white sucker has the following characteristics:

- A torpedo-shaped fish distinguished by its sucker-like mouth located on the underside of its blunt, rounded snout
- Its mouth has thick lips covered with little fleshy bumps (papillae)
- Its colour varies from grey to coppery brown to almost black on the back and upper sides, becoming lighter on the lower sides to white on the belly
- During spawning, the darkness on the back intensifies and the body becomes more golden in colour
- Spawning males develop coarse bumps (nuptial tubercles)on the anal fin and lower tail (caudal) fin
- It has relatively large scales, one dorsal fin, no adipose fin and the lateral line is complete
- Young white suckers from 5 to 15 cm (2-6 in) in length usually have three large dark

spots on the sides

They can grow to 63 cm (25 in) and more than 3.2 kg (7 lb) but reach about 46 cm (18 in) in Nova Scotia.

Distribution

The white sucker is a North American species found in freshwater lakes and streams from Labrador south to Georgia, west to Colorado and north through Alberta and British Columbia to the Mackenzie River delta. In Canada, it is absent from Newfoundland, eastern Labrador, Prince Edward Island, south-western British Columbia and much of the far north.

Facts about Suckers

Spawning migrations of white suckers can be numerous and very dense - 500 have been known to swim upstream past a single point in 5 minutes.

Although examining the growth rings on their scales ages most fish, this method is not always reliable for suckers older than 5 years. They are best aged using sections of their pectoral fin rays.

Natural History

The white sucker can adapt to a wide range of environmental conditions but generally lives in the warm, shallow waters of lakes and quiet rivers. They prefer summer temperatures of 24·C. In streams they are most abundant in pool areas with ample underwater debris, streamside vegetation, and water depth to provide cover.

In lakes they are usually found in the upper 6.2-9.2 m (20-30 ft) of water, moving to shallows to feed. They are bottom feeders that browse the bottom, sucking in aquatic insects, small clams, and snails, and then spitting out the inedible sand and gravel. They feed mostly at dawn and dusk, and are active year round.

White suckers spawn in the spring (May and June), migrating upstream to spawning areas (small streams and tributaries) when water temperatures are 10-18·C. Suckers typically spawn in shallow gravel riffles where the water is up to 30 cm (1 ft) deep and where the speed is moderate. Lake populations of white suckers with limited access to streams will occasionally spawn on gravel shoals where there are waves. Although some spawning occurs in daytime, most takes place at sunrise and sunset. One female spawns with several males. Females usually produce 20,000-50,000 eggs, but can produce up to 139,000 eggs. Suckers do not build a nest, but scatter their eggs, which stick to the bottom, or drift downstream and attach elsewhere.

The eggs hatch in 8 to 11 days, depending on the temperature (10-15· C). The young remain in the gravel for 1or 2 weeks and then migrate downstream at a size of 12 to 17 mm. Sometimes only 3% of white sucker eggs survive to this stage. Young suckers in lakes are found along shorelines with sand or gravel bottoms. In streams they prefer

sand and gravel shallow areas with moderate currents.

At first white suckers do not feed on the bottom. Their mouth is at the end of their snout, and they feed near the surface of the water on plankton (tiny organisms suspended in the water). When they grow to about 16-18 mm (0.6-0.7 in), their mouths shift to the underside of the head and they begin taking food from the bottom. White suckers grow most rapidly during their first year and can reach a length of 17.9 cm (7 in) by age 1. Growth rates vary considerably in different areas, but in all populations females grow more rapidly than males, reach larger sizes, and live longer. They usually mature at ages 5 to 8, and males mature a year earlier than females. Suckers can live up to 17 years.

Although there is evidence that suggests that the white sucker can compete for food with other sport fish, they can be a major food item in the diet of other fish such as Atlantic salmon, brook trout, pike and bass. Birds and mammals also eat them.

Appendix D: Fish Collection Tracking Sheet

Fish Collection Tracking Sheet

McCallum Environmental Ltd.

Pre-Job General Information		
Project:	Project Number:	Task:
Date:	Personnel:	WC/WB ID:
Weather:	Precipitation (past 24 hours):	Reach ID:

Site Characteristics **Photos taken of the site?** ☐ **Yes (US, DS, LB, RB, Substrate)**

Stream Type (% Surface Area)		**Water Quality Measurements**	
Riffle		pH	
Run		SAL (ppt)	
Pool		CON (µS/cm)	
Other (specify)		SPC (µS/cm)	
Substrate (% Surface Area)		TDS (mg/L)	
Bedrock		DO (%, mg/L)	
Boulder (>25 cm)		* Temp measurements are recorded below	
Rubble (14-25 cm)			
Cobble (3-13 cm)		**Physical Measurements (average over reach)**	
Gravel (0.2-3 cm)		Bankfull width (cm)	
Sand (0.06-2 mm)		Wetted Width (cm)	
Silt (<0.006 mm)		Depth (cm)	
Muck/Detritus		Length of Reach (m)	
Clay/Mud		Velocity (estimate)	

Fish Caught? (if so, list species)
Add any commentary or observations from survey effort.

Revisions to Electrofisher settings required?

Sketch of Site: Include flow direction, locations of habitat features/cover ex. Large boulders, large woody debris, overhanging vegetation, and undercut banks

ELECTROFISHING (Electrofishing must proceed in an upstream direction)

Method Used: ☐ Depletion ☐ CPUE		**Pass 1**	**Pass 2**	**Pass 3**
Site Set-up: ☐ Open ☐ Closed	**Effort (seconds)**			
Upstream Waypoint:	**Voltage**			
Downstream Waypoint:	**Frequency**			
Water visibility: ☐ Good ☐ Fair ☐ Poor	**Water temp (°C)**			
***Measure Temperature at Beginning of each pass**	**Air Temp (°C)**			
***DO NOT Electrofish if water temp is greater than22ºC ***	**# of Fish Caught**			
*** Do NOT Electrofish if temperature is greater than 22ºC**				

TRAPPING & NETTING

Gear Used: ☐ Fyke Nets (#__) ☐ Minnow Traps (#__) ☐ Eel Pots (#__) ☐ Seine		**Bait:**
Locations and Depths (UTM, cm):		**Time In (hr):**
		Time Out (hr):

Fish Collection Tracking Sheet

McCallum Environmental Ltd.

Individual Fish Measurements

Pre-Job General Information		
Project:	Project Number:	Task:
Date:	WC/WB ID:	Reach ID:

Individual Fish Measurements – Photograph EACH individual – with enough detail to confirm ID if required								
Capture Method*	Fish ID #	Species Code	Fork Length (mm)	Total Length (mm)	Weight (g)	Age/Age Class	Mark observed? State type and tag # if poss.	Comments (e.g. parasites, lesions, net marks, dead, etc)

*PASS(#) = Electrofishing, MT = Minnow Trap, EP = Eel Pot, FN = Fyke Net, SN = Seine

APPENDIX E : FISH HABITAT ASSESSMENT SOP

STANDARD OPERATING PROCEDURE: DETAILED FISH HABITAT ASSESSMENT – STREAMS

1 PURPOSE

The purpose of this document is to provide standard methods for detailed fish habitat assessments performed by McCallum Environmental Ltd. (MEL) employees and subconsultants in lotic, freshwater habitats.

2 SCOPE

This document provides standards for data collection for detailed fish habitat assessments and describes a limited range of field-based measures for linear watercourses (i.e. lotic systems).

Fish habitat is inherently difficult to measure and quantify directly. Therefore, this Standard Operating Procedure (SOP) incorporates measures that evaluate specific features that are characteristics of, or inherent to a function of fish habitat and can indicate the extent to which a particular fish habitat characteristic or function is provided within a stream. This SOP aims to provide procedures for detailed fish habitat assessments which may be modified depending on the requirements and scope of a particular project.

Measures are habitat variables that can be quantified directly, or if not, visually estimated in the field. This SOP aims to incorporate measures of fish habitat with the following criteria, whenever possible:

- Quantifiable – habitat variables can be measured numerically, or when not possible, visual-based methods are standardized to the maximum practical extent.
- Rapid – habitat variables can be measured within the expected time frame of assessment (1/2 – 1 day per watercourse depending on watercourse size).
- Repeatable – a clear protocol for taking measurements can be described such that different users taking the measurement on the site would arrive at similar conclusions.
- Sensitive – changes or impacts to the stream would result in changes/impacts in the habitat variable. Variables are responsive to changes in the stream system.

It is important to note that the methods outlined in the SOP are best suited for previously mapped watercourses. MEL defines watercourses based on guidance from Nova Scotia Environment (NSE, 2015). The following parameters were used to define watercourses:

- Presence of a mineral soil channel;
- Presence of sand, gravel and/or cobbles evident in a continuous patter over a continuous length with little to no vegetation;
- Indication that water has flowed in a path or channel for a length of time and rate sufficient to erode a channel or pathway;
- Presence of pools, riffles or rapids;
- Presence of aquatic animals, insects or fish; and,
- Presence of aquatic plants.

According to the guidance provided by Nova Scotia Environment and Climate Change (NSECC), any surface feature which meets two of the criteria above meets the definition of a regulated watercourse. In MEL's experience, many first-order, headwater streams which meet the criteria of a regulated

watercourse in Nova Scotia are not represented on topographic mapping or through provincial GIS layers. As such, it is critical that a general reconnaissance of watercourses within a study area is completed prior to undertaking detailed fish habitat assessments as outlined in this SOP.

It is also important to note that many rivers and stream comprise areas of "open water" – areas where the watercourse takes on more pond-like conditions, often caused by beaver dams or other natural or anthropogenic obstructions. "Open water" areas are defined in this SOP as areas of stillwater, or a flat, wide portion of a watercourse with no visible current. The scope of this SOP for fish habitat assessment in streams includes open water habitat up to a maximum depth of 2 m. For open water areas with depths greater than 2 m, fish habitat assessments procedures for lentic areas (ponds and lakes) should be followed. However, the decision of whether to apply lotic or lentic fish habitat assessments to open water areas depend on several other factors, including overall goals of the survey, and will ultimately be at the discretion of the Project Manager. For example, when a watercourse exceeds wadeable depth (generally 1m), a variance on the procedure for describing habitat may be prescribed, based on factors such as accessibility and water velocity, as they can affect the ability to complete measurements from a boat. Procedures for fish habitat assessments in lentic systems are outlined in a separate SOP.

Prior to conducting fish habitat assessments, all field staff should acquire knowledge on the habitat preferences of fish expected to be encountered within a particular freshwater system. All field staff should possess a general understanding of the biology and habitat preferences of anticipated local fish species and age classes. This knowledge will provide important context to empirical habitat assessments and will help field crews identify unique habitat features in the field. Detailed information on the biology of fishes in Nova Scotia can be found in Scott and Crossman (1973), McPhail and Lindsey (1970), and the Nova Scotia Adopt A Stream Manual (2005).

3 SAFETY

The MEL HSE Program outlines important safety considerations and Personal Protective Equipment (PPE) for this type of work, particularly the working near water section.

A daily Field Work Tracking Sheet and Vehicle Inspection Form, along with the End of Day form must be completed via SiteDocs and signed by all crew members as per MEL HSE Program. All crew members must follow MEL's Checking In/Out Policy when entering/exiting the field.

Water levels can change dramatically and can be hazardous to those working in large river flows. Field crews should not enter watercourses with swift water or dangerous currents. Discuss any potential safety concerns when completing the Field Work Tracking Sheet with the entire field crew, and before entering any streams, and adjust the hazard assessment through the day as necessary to reflect conditions and hazards.

4 FISH HABITAT ASSESSMENT - THEORY

Field approaches to fish habitat assessments and evaluations are incredibly varied. The selection of appropriate habitat assessment tools or evaluation methods is determined by the questions you wish to answer about a particular system. Depending on survey objectives, a variety of methods may be employed. Overall, fish habitat assessments are site-specific and methods must be tailored to the freshwater habitats being investigated.

The measurable features outlined in this SOP are based on the following general attributes that are important in influencing fish habitat within a given stream. These include:

- channel dimensions, gradient, and velocities
- channel substrate size and type
- habitat complexity and cover
- riparian vegetation cover and structure
- anthropogenic alterations or disturbance

The methods outlined in this SOP and the field sheet (Detailed Fish Habitat Assessment – Streams", Appendix A, herein referred to as "field sheet") were derived from the following sources:

- The Nova Scotia Fish Habitat Assessment Protocol: A Field Methods Manual for the Assessment of Freshwater Fish Habitat (2018);
- DNR / DFO – New Brunswick Stream Habitat Inventory Datasheets;
- Standard Methods Guide for the Classification and Quantification of Fish Habitat in Rivers of Newfoundland and Labrador for the Determination of Harmful Alteration, Disruption and Destruction of Fish Habitat (2012);
- Reconnaissance (1:20,000) Fish and Fish Habitat Inventory (2001);
- The US EPA Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish (1999); and,
- The Canadian Aquatic Biomonitoring Network Field Manual, Wadeable Streams (2012).

Specific stream terminology is used and referred to throughout the procedures outlined in Section 6. Definitions of specific terms and associated acronyms, as well as diagrams and calculations are provided in a Glossary at the end of the document (Section 8).

For larger river systems (typically 3rd order streams and over), detailed, low-elevation aerial imagery can be interpreted to support habitat descriptions post-field. This technique is particularly useful when habitat complexity increases or water depths/flows reduce wadeability. In addition, aerial imagery interpretation is helpful when assessing areas that have been historically altered through anthropogenic activities, such as freshwater systems that have been ditched or diverted, which are difficult to delineate in the field.

5 MATERIALS

- standard MEL PPE
- chest waders with wading belt
- polarized safety glasses (useful for reducing glare)
- field sheets on write-in-the-rain paper, or electronic forms on tablet
- pencils
- multi-parameter water quality instrument (YSI or equivalent)
- GPS
- velocity meter
- measuring tape and meter stick (2 m length)
- phone or digital camera

6 FISH HABITAT ASSESSMENT METHODS – PROCEDURES

A watercourse, as defined in Section 2, is bound by distinct downstream and upstream endpoints when delineated in the field. MEL biologists typically identify unnamed, linear watercourses with dual alphabetical letters starting with first-order, headwater streams. Following completion of delineation, lettered watercourses are assigned watercourse numbers. When first order streams combine, the second order stream will be designated with a new number, unless flow is substantially disproportionate across headwater streams (i.e., one first-order stream contributes the vast majority of flow to the second order stream).

A reach is length of stream comprising one homogenous habitat type (i.e., a run). Reaches are numbered from an upstream – downstream orientation. Larger streams comprising variable habitat types are therefore divided into multiple reaches. In smaller, first-order streams, major habitat types may be so short as to not warrant the continuous establishment of very small reaches. For efficiency in the field, when individual habitat types are small in overall length (<5 m), they may be lumped together into one reach.

A **transect** is a particular location within a reach where a cross-sectional survey is performed. A transect is line across a stream perpendicular to the flow and along which measurements are taken (e.g., velocities, depths, substrates, cover, etc.), so that morphological and flow characteristics along the line are described from bank to bank. Transects are numbered from an upstream-downstream orientation. For the purposes of this SOP, one transect is to be completed for every 25 m length of reach (e.g. if a run is 150 m in length, 6 transects would be established along the run). If multiple habitat types have been lumped together (< 5 m in length) to form a reach, a transect must be established within each habitat type represented within the reach. However, the amount of transects and transect locations may be shifted slightly or altered during the field assessment based on specific habitat features observed, or access, wadeability, and safety concerns.

The watercourses to be surveyed will be defined by the Project Coordinator – these may comprise an entire watercourse, or a section of a watercourse.

The procedures outlined in Section 6 include both reach-scale and transect-scale data collection – measurements are taken repeatedly at cross-sections (predominantly quantitative measurements), whereas other measurements are based on reach averages (predominantly qualitative, visual-based assessments). Generally speaking, a detailed habitat assessment for streams involves walking the length of the watercourse chosen for assessment from the upstream extent to downstream extent, establishing reaches for each change in habitat type, and stopping to take specific cross-sectional measurements along the length of each reach.

6.1 Planning: Before You Leave

1. Review detailed written scope provided to you by the Project Coordinator. This will identify priority deliverables, timelines, and budget allowed for each task. Detailed methods should be provided in this scope (i.e., watercourses to be surveyed and extent of surveying needed along each watercourse).

2. Determine your field crew – fish habitat assessments should be completed with a crew size of two people.
3. Determine the location(s) of the survey, size of area to be surveyed and easiest access to the site based on the work scope provided by the Project Coordinator.
4. Complete a review of available data from watercourse delineation surveys. If fish collection surveys have been completed, review the results of those surveys prior to commencing field work. A desktop review of fish species distribution records should be conducted if no fish collection surveys have been completed.
5. Print field sheets and/or prepare tablets and prepare site maps and GPS units as required.
6. Complete safety forms/procedures as per MEL HSE Program.

6.2 Field Procedure

6.2.1 Site Setup

1. It is preferable to begin surveys at the top (upstream end) of the watercourse to be surveyed as reaches and transects are to be numbered in an upstream-downstream orientation.
2. Record general survey data including Project name, date, crew member names, and watercourse identification information.
3. Begin to establish a reach. Identify the habitat type present. If smaller (<5 m in length) habitat types are to be lumped together, identify all present. Record the upstream boundary coordinate (for smaller reaches the upstream and downstream coordinates can likely be established at the same time). For longer reaches, when the downstream end can't be seen from the upstream end, the downstream boundary coordinate can be recorded once the entire reach has been surveyed.
4. Describe and record general reach characteristics including habitat and flow type. If the stream is dynamic in flow (e.g., perennial stream with intermittent sections), use the comment section to describe the flow regime.
5. Measure and record water quality parameters, including temperature, conductivity (SpC), total dissolved solids (TDS), pH, dissolved oxygen (DO). Record turbidity based on a visual assessment of the watercourse if not included as a parameter on the water quality meter (refer to Section 8 – Glossary).

6.2.2 Transects

Record the GPS location (waypoint) of each transect surveyed. Identify each transect with a sequential number from upstream to downstream and the associated reach number (i.e., Reach 2 Transect 4 of Watercourse 1 can be labelled WC1R2T4). A transect must be established for every 25 m of a particular habitat type (reach). If smaller habitat types (< 5 m in length) have been lumped together into a single reach, a transect must be established within each habitat type represented.

1. Record the habitat type being surveyed.
2. Begin measuring the channel cross-section from the left bank looking downstream. Pin the measuring tape into the banks and record the bankfull width on the field sheet. Keep the measuring tape in this position for the duration of cross-section measurements.
3. Measure and record wetted width (if the watercourse is dry the wetted width is 0 m).
4. Record 3 depth and velocity measurements. Starting at the left bank, use the meter stick and the velocity meter to determine the depth of the water and water velocity at equal distances cross the

wetted portion of the cross-section (at ¼, ½, and ¾ wetted width). Velocity measurements should be taken at approximately 0.6 water depth.

5. Measure thalweg depth, this is the deepest spot along the transect.
6. Record a bank height measurement from the thalweg location, this measurement is taken from the top of the water to the taut measuring tape.
7. Record substrate types and % composition (this needs to add up to 100%). This estimate should taken from 50 cm upstream and downstream of the transect tape.
8. Record cover along the transect (%) (see Section 8 to break down each cover type further):
    a. Instream: Within the streambed in the form of large woody debris, boulders, undercut banks
    b. Overhead: Riparian cover overhanging the stream within 1m of the surface
    c. Shade: Canopy cover
    d. Aquatic Vegetation: Submergent and emergent vegetation
9. Note the amount of entrenchment of the channel as Highly entrenched, Moderately Entrenched, Somewhat Entrenched, or Not Entrenched.
10. Take representative photos at each transect of the following:
    a. Looking upstream
    b. Looking downstream
    c. Substrate

6.2.3 Between Transects

1. Once transect measurements are complete begin walking to the next transect location.
2. Note, waypoint, and photograph any unique habitat features or observations, including any information that will aid in producing an accurate description of fish habitat and barriers found throughout the watercourse (the following list in non-exhaustive):
    - Areas of upwelling or groundwater seeps
    - Areas of subterranean flow or discontinuous channel
    - Gravel or point bars
    - Braids
    - Debris jams
    - Ice scarring
    - Beaver dams
    - Back channels or off-channel habitats
    - Islands
    - Potential spawning areas or evidence of spawning (e.g. redds)
    - Any fishing challenges.

    In the comments section, record relevant dimensional information of habitat features such as height, width, length, depth, or information on activity, connectivity, or any other notes that may aid in the description of the habitat features.
3. Note, waypoint, and photograph any culverts or other crossing if identified. Record the culvert type (e.g., corrugated metal pipe, concrete box, etc.), dimensions, and describe the general condition of the culvert (e.g., crushed, rusted, hung, etc.).
4. Once the next transect is reached, repeat procedures outlined in Section 6.2.2.

6.2.4 Reach Assessment

1. For the entire reach, identify the dominant riparian vegetation (Grass, Shrub, Coniferous Forest, Deciduous Forest, Mixed Forest, Wetland, or None). Describe any stressors found within the riparian area (i.e., agriculture, forestry roads, intake pipes, etc.)
2. For the entire reach, estimate the percentage of riverbank with active erosion and record it on the field sheet.
3. For the entire reach, estimate the percent stream shade and record it on the field sheet.

7 REFERENCES

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8 GLOSSARY

Bankfull Level – the level of water flow in a river just before it spills over the banks into the floodplain. The bankfull level can be identified by changes in bank angle, vegetation, and soils.

Bankfull Width (i.e. channel width) - the width of the river channel at the bankfull level.

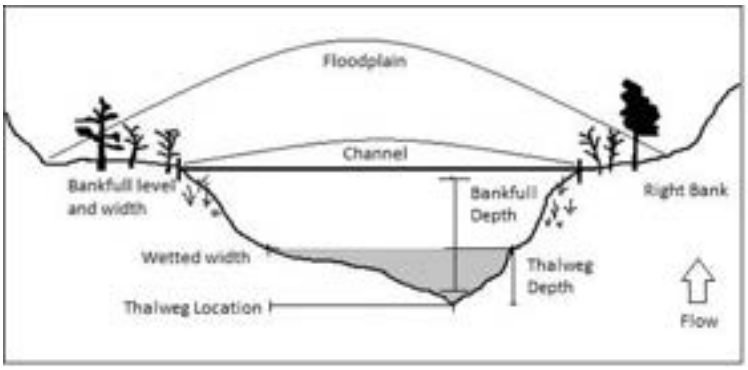


Image 1: Components of a channel cross-section

Embeddedness - refers to the degree larger substrate is surrounded by finer sand and silt material that fills in spaces between the individual rocks. Highly embedded substrate limits spawning and rearing success of fish, reduces habitat for benthic macroinvertebrates, and impairs a river's ability to form a thalweg and transport material. A stain line on the rock may indicate the level of burial and aid in the estimation. Note: Bedrock would be recorded as unembedded. Sandy or organic substrate is recorded as completely embedded because it is embedded within itself.

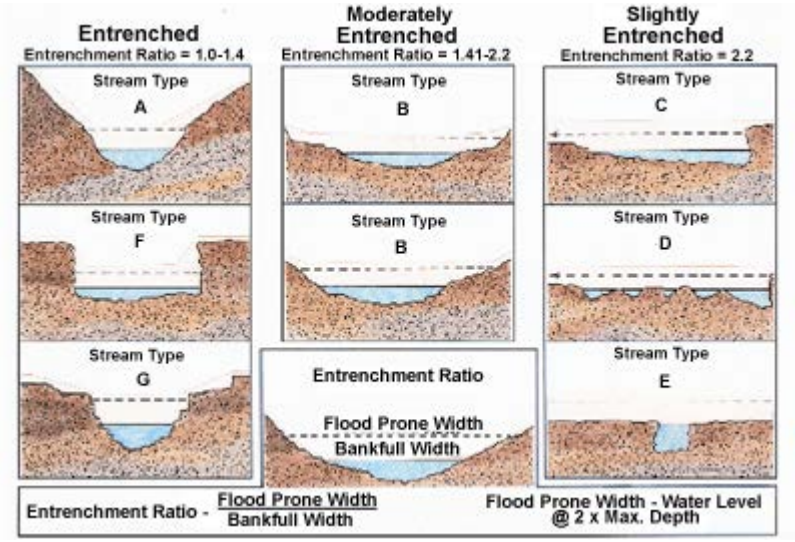


Image 2: Degrees of entrenchment (the term "entrenched" equates to "highly entrenched" for the purposes of this SOP. Source: https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=1259)

Entrenchment - the vertical containment of a stream, or the disconnection of the channel from a floodplain. A stream may also be entrenched by the use man-made berms. In streams that are highly entrenched, overbank flooding occurs less frequently than less entrenched streams. For the purposes of this SOP, entrenchment is qualitatively described in the field through a visual assessment, and is categorized as one of the following: Highly Entrenched (HE), Moderately Entrenched (ME), Slightly Entrenched (SE), or Not Entrenched (NE). "Not Entrenched" streams are typically associated with streams areas that have no defined channel (see "Habitat Types" for description).

Erosion - an area of slumping displaying a loss of bank material. Do not confuse an eroded band with undercut bank. While eroding forces create undercut banks these banks tend to remain stable due to an established root system.

Flow Type – refers to the presence of flowing water within a stream on a temporal scale. For the purposes of this SOP, streams are categorized into the following flow types (source: AT, 2009):

- **Perennial (P) -** A stream that flows continuously throughout the year.
- **Intermittent (I) -** Streams that go dry during protracted rainless periods when
- percolation depletes all flow.
- **Ephemeral (E) -** A watercourse that flows during snowmelt and rainfall runoff periods only.

Any watercourse or watercourse reach may have components of each flow type. For instance, perennial, with intermittent sections.

Gradient - The slope of the stream, or rate of vertical drop per unit of length of the channel bed (presented as a percentage). The following is a simple desktop method using Google Earth to determine stream gradient. This method will not be as precise as a direct field survey but should provide a good estimate of stream gradient:

Habitat type - a categorical description of the types of aquatic environments within a stream. Habitat types that are commonly encountered include:

Image 3: A riffle (Source: http://smallstreamreflections.blogspot.com/2017/05/in-riffles.html)

- **Riffle** - a shallow and fast section of stream with, often within a series of pools and runs. Water flow is agitated and surface is broken by rocky substrate, which appears turbulent. Substrate is coarse (gravel – cobble dominated).
- **Pool** – a deep and slow section of river, generally occurring near the corners of meanders, or created by the vertical force of water falling down over logs or boulders. Pools have a rounded bottom and may comprise the full or partial width of the stream. For the purposes of this SOP, a pool is defined as having a minimum residual depth of 20 cm.
- **Run** - an area of stream characterized by moderate current, continuous, smooth surface and depths greater than riffles. Runs are stretches of the stream, typically downstream of pools and riffles, where stream flow and current are moderate.

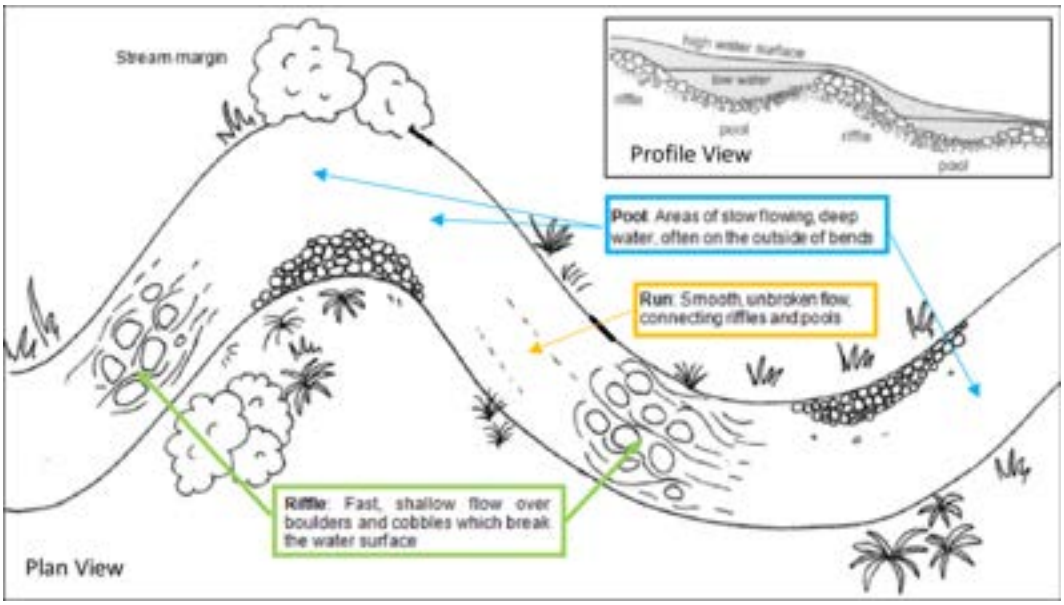


Image 3: A typically riffle-run-pool sequence within a stream (Source: https://www.researchgate.net/figure/Elements-of-a-river-reach-pool-riffle-and-run_fig13_322765638)

- **Rapids** – area of steeper gradient with irregular and rapid flows, often with turbulent white waters. Deeper than riffles, with substrate being extremely coarse (large cobble – boulder).

- **Chute/Falls/Cascade –** Significant white water present. Can be an area of channel constriction, usually due to bedrock instructions. Associated with a rapid change in stream gradient with most water free-falling over a vertical drop or series of drops.

Image 4: A cascade

- **Step-pool** – a series of staircase like pools which occur in steeper channel sections. Each pool has a defined step made of larger substrate, followed by a drop into a pool.

Image 5: Step-pool habitat (Source: https://www.researchgate.net/figure/Artificial-step-pool-sequence-in-the-Mala-Raztoka-Brook_fig6_277075982)

- **Flat –** associated with low gradient streams, water is very smooth (flow is not obvious), and substrate often comprises organic matter, mud, and sand. Area characterized by low velocity and near-uniform flow; differentiated from pool habitat by high channel uniformity.

Image 6: A flat

- **Boulder-bed –** area characterized by a significant occurrence of large boulders as a result of glacial till deposits. Water may be visible between boulders or heard flowing subsurface depending on the time of year of the survey. Channel dimensions may be obscured. Boulders may be bare or have vegetation cover (typically mosses or alders).

Image 8: A boulder-bed

- **No defined channel (NDC)–** typically occurring in small headwater streams, these areas are more accurately characterized as general drainage, with poorly or no defined channel banks and substrates largely comprised of organic forest soils. Water flow is diffusely spread out (i.e. sheet flow). Often associated with wetland habitat. NDCs may have diffused standing water during higher seasonal flow periods, or may be completely dry and lacking surface water of any kind, but may act as a connection between defined channels upstream and downstream.

Image 9: An area of a stream with NDC during high flow

Image 10: An area of a stream with NDC during low flow

The following table provides additional detail to aid in identificaiton of habitat types (McCarthy, Grant, and Scruton, 2006).

Habitat Type	Habitat Parameter	Description
Fast Water	**Mean Water Velocity** **Stream Gradient**	**> 0.5m/s** **Generally > 4%.**
Rapid	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Considerable white water[1] present. > 0.5 m/s < 0.6 m Usually dominated by boulder (Coarse[2]) and rubble (Medium[2]) with finer substrates (Medium and Fine[2]) possibly present in smaller amounts. Larger boulders typically break the surface. Generally 4-7%
Falls/ Chute/ Cascade	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Mainly white water present. The dominating feature is a rapid change in stream gradient with most water free-falling over a vertical drop or series of drops. > 0.5 m/s Variable and will depend on degree of constriction of stream banks. Dominated by bedrock and/or large boulders (Coarse). > 7% and can be as high as 100%.
Run	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Relatively swift flowing, laminar[3] and non-turbulent. > 0.5 m/s > 0.3 m Predominantly gravel, cobble and rubble (Medium) with some boulder (Coarse) and sand (Fine) in smaller amounts. Typically < 4% (exception to gradient rule of thumb)
Moderate Water	**Mean Water Velocity** **Stream Gradient**	**0.2-0.5m/s** **>1 and < 4%**
Riffle	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Relatively shallow and characterized by a turbulent surface[4] with little or no white water. 0.2 – 0.5 m/s < 0.3 m Typically dominated by gravel and cobble (Medium) with some finer substrates present, such as sand (Fine). A small amount of larger substrates (Coarse) may be present, which may break the surface.[5] Generally >1 and < 4%
Steady/ Flat	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Relatively slow-flowing, width is usually wider than stream average and generally has a flat bottom. 0.2 - 0.5 m/s >0.2 m Predominantly sand and finer substrates (Fine) with some gravel and cobble (Medium). > 1 and < 4%
Slow Water	**Mean Water Velocity** **Stream Gradient**	**Generally < 0.2m/s (some eddies can be up to 0.4m/s).** **< 1%.**
Plunge / Trench / Debris Pools	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Generally caused by increased erosion near or around a larger, embedded object in the stream such as a rock or log or created by upstream water impoundment resulting from a complete, or near complete, channel blockage. These pool types may be classified as an entire reach (e.g., pools greater than 60% of the stream width) or as sub-divisions of a fast water habitat. < 0.2 m/s > 0.5 m depending on stream size (e.g., may be shallower in smaller systems). Highly variable (i.e., course, medium or fine substrates) Generally < 1%
Eddy	General Description Mean Water Velocity Mean Water Depth Substrate Stream Gradient	Relatively small pools caused by a combination of damming and scour; however scour is the dominant forming action. Formation is due to a partial obstruction to stream flow from boulders, roots and/or logs. Partial blockage of flow creates erosion near obstruction. It is typically < 60% of the stream width and hence will be a sub-division of a faster-water habitat type (e.g., Run with 20% eddies). Typically < 0.4 m/s, but can be variable. > 0.3 m. May vary depending on obstruction type, orientation, streambed and bank material and flows experienced. Predominantly sand, silt and organics (Fine) with some gravels (Medium) in smaller amounts. Variable

[1] White water is present when hydraulic jumps are sufficient to entrain air bubbles which disturb the water surface and reduces visibility of objects in the water.

[2] Coarse, Medium and Fine substrate types are classified according to the Standard Methods Guide for the Classification/Quantification of Lacustrine Habitat in Newfoundland and Labrador (Bradbury *et al.* 2001).

[3] Laminar describes the surface of the water as smooth and glass-like with no reduced visibility of objects in the water.

[4] Turbulence is present if there are local patches of white water or if water movement disturbs a portion of the surface.

[5] Pocket water often constitutes an important component of riffles in Newfoundland and Labrador and is characterized by a predominance of larger substrates (e.g., boulders) breaking the surface. The result is a riffle with many eddies around the boulders.

Instream Cover - includes large woody debris, undercut banks, unembedded large substrate, aquatic vegetation, deep pools, and overhanging vegetation within 1 m of the water's surface. These features provide valuable refuge and resting areas for fish. As the instream features become embedded by fine silt and sand, cover for fish is reduced. To be considered viable instream cover for this assessment, areas must be obscured from the surface by the cover element itself (boulder, LWD, vegetation, bank).

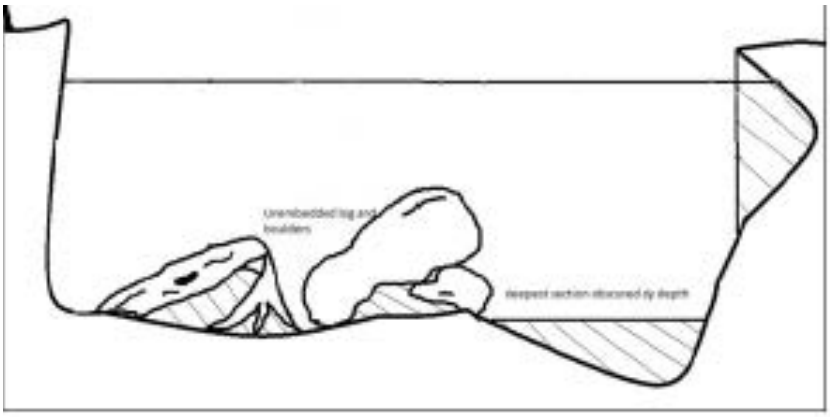


Image 11: Example of cover types within a transect (Source: NSHSI, 2018)

The following terms may be used to guide the description and identification of cover. Bolded cells indicate categories of in-stream cover, specifically.

Large Woody Debris	Fallen trees, logs and stumps, root wads, and piles of branches within or along the edges of streams.
Boulders	Large substrate under which fish can hide. Refuge for fish must be provided between the boulder and the channel bottom (i.e. a boulder that is complete embedded does not provide in-stream cover).
Undercut Banks	An undercut bank occurs when the river cuts into the bank, removing rocks and soil while leaving some portion of the bank overhanging the river. Undercut banks generally are stabilized by the presence of vegetation and roots that hold the topsoil intact.
Deep Pools	To assess whether pool depth provides cover, hold your boot above the bottom of the pool to what would be equivalent to residual depth of the pool. If you cannot see your boot, you can consider that area as instream cover.
Overhanging vegetation	Riparian cover overhanging the stream. Note: overhanging over must be within 1 m of the water's surface to count towards in-stream cover.
Emergent vegetation	Aquatic plants growing above or extending above the water surface (e.g. cattails, sedges, grasses, rushes)
Submergent vegetation	Aquatic plants that grow entirely below the water surface (e.g., elodea, bladderwort, pipewort, potamogeton), and includes numerous mosses and macroalgae)

Riparian Area – strip of land adjacent to watercourses which plays an important role in stream productivity and overall function. For the purposes of this SOP, the riparian area is considered all ground within 10 m from the bank's edge.

Redd – salmonid spawning nests. Characterized as circular to oblong patches of recently cleaned, gravel-cobble-sized substrate that contrasts the surrounding substrate. Redds typically have a depression from the surrounding substrate and may have a 'mound' on the downstream end of the disturbance. If identified, redds would be measured, photographed and their location recorded on GPS.

Image 12: A salmonid redd (Source: https://www.tu.org/blog/redd-surveys-shaping-priorities-in-michigans-pere-marquette/)

Stream Order - the hierarchical ordering of streams based on the degree of branching. It is a simple quantitative method to categorize stream segments based on their relative position within the drainage basin. Stream order provides a general indication of stream size, stream function and energy sources. Determine the stream order by labeling the first stream at the head of the watershed as 1 and increasing the order by 1 each time two streams of the same order join until you reach the watercourse/watercourse reach being assessed.

Stream Shade – this is the canopy cover created by riparian vegetation above the stream. Midday sun is the most direct and influential on stream temperatures, so shade estimates should be made between 10:00 am and 2:00 pm, when possible.

Substrate Types – The following table may be used to aid in identification of substrate types (from DFO 2012).

Bedrock	Continuous solid rock exposed by the scouring forces of the river/stream
Boulder	Rocks ranging from 25cm to >1 m in diameter
Rubble	Rocks ranging from 14-25 cm in diameter
Cobble	Rocks ranging from 3-13 cm in diameter
Gravel	Small stones ranging from 2mm to 3 cm in diameter
Sand	Grains ranging from 0.06 to 2 mm in diameter, frequently found along stream margins or between rocks and stones.
Silt	Very fine sediment particles, usually <0.06 mm in diameter
Muck/detritus	Organic material from dead organisms (plant and/or animal)
Clay/mud	Find deposits between rocks and covering other substrates

Transect - A line across a stream perpendicular to the flow and along which measurements are taken, so that morphological and flow characteristics along the line are described from bank to bank. For the purposes of this SOP, “transect” and “cross section” are used interchangeably.

Watercourse - Any provincially regulated watercourse as defined by NSE guidance (2015).

Watercourse Reach - A length of stream characterized by a single habitat type (e.g. a run). Complex streams will comprise many reaches. In smaller, first-order streams, major habitat types may be so short as to not warrant the continuous establishment of very small reaches. When individual habitat types are small in overall length (<5 m), they may be lumped together into one reach.

Wetted Width – the width of the stream that contains water at the time of the assessment.

Turbidity - The concentration of suspended sediments and particulate matter in the water. Measure of the relative clarity of a liquid. If not measured, turbidity is to be visually assessed and recorded based on the following codes:

- T (Turbid) - very turbid or muddy appearance, objects visible to 15 cm depth
- M (Moderately Turbid) - cloudy, objects visible to 45 cm depth
- L (Lightly Turbid) - occasionally cloudy, objects visible to 1 m
- C (Clear)

APPENDIX A

Detailed Fish Habitat Assessment – Streams

Detailed Fish Habitat Assessment - Streams

General Survey Data			
Project:	Project #:	Date:	Surveyors:
Watercourse #:	Reach #:		
Reach Boundary Coordinates: U/S_____ D/S_____			

Water Quality		
Temperature (℃):	pH:	Dissolved Oxygen (mg/L):
Conductivity:	TDS:	Turbidity (T, M, L, C, or NTU):

Reach Characteristics	
Habitat Type:	Does reach include other habitat types < 5 m in length? ☐ If yes select all below Riffle ☐ Run ☐ Flat ☐ Pool ☐ Cascade ☐ Step ☐ Eddy ☐ Debris Pool ☐ Other ☐ (_____)
Flow Type*: Perennial ☐ Intermittent ☐ Ephemeral ☐ Describe flow regime:	

Banks and Riparian Area	
Riparian Description (include potential stressors i.e., agriculture, forestry roads, intake pipes, etc.):	Stream shade (%):
Dominant Veg: Grass ☐ Shrub ☐ Coniferous Forest ☐ Deciduous Forest ☐ Mixed-wood Forest ☐ Wetland ☐ None ☐ Describe:	Bank Erosion (%):

Notable Features		Culvert
Underground flow ☐ No defined channel ☐ Island ☐ Braids ☐ Falls ☐ Redd ☐ Spawning gravels ☐ Groundwater ☐ Beaver Dam ☐ Debris jam ☐ Gravel bars ☐	Other ☐ _____ Comments (location, dimensions, connectivity, etc.): **Fishing Challenges?**	US Waypoint: DS Waypoint: Type: Diameter or H/W (m): Length (m): Condition:

Flow		
	Perennial	A stream that flows continuously throughout the year
	Intermittent	Streams that go dry during protracted rainless periods when percolation depletes all flow
	Ephemeral	A watercourse that flows during snowmelt and rainfall runoff periods only

Substrate Types	
Bedrock (Be)	Continuous solid rock
Boulder (Bo)	25cm to >1 m
Rubble (Ru)	14-25 cm
Cobble (Co)	3-13 cm
Gravel (Gr)	2mm to 3 cm
Silt (Si)	Very fine sediment particles
Muck/detritus (M/D)	Organic material
Clay/mud (C/M)	Fine mineral material

Cover types	
In-stream	Within the streambed in the form of large woody debris, boulders, undercut banks
Overhead	Riparian cover overhanging the stream within 1 m of surface
Shade	Canopy cover
Aquatic Vegetation	Submergent and emergent

Date: Location: Assessor:

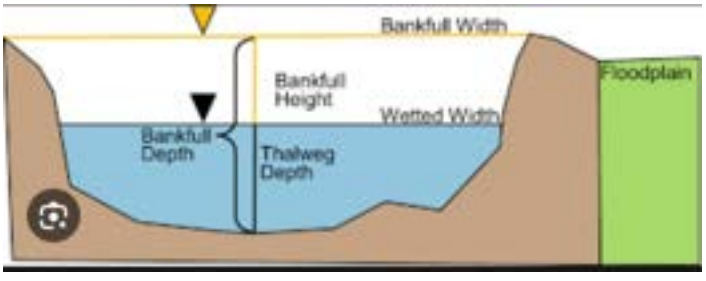
Detailed Fish Habitat Assessment - Streams

Note: Transect measurements are to be taken every **25 m** of a single habitat type (i.e. reach). If minor habitat types (<5 m in length) have been lumped into the overall reach, take representative transect measurements at each habitat type present. Depth and Velocity measurements are taken from left bank to right bank – looking downstream; measured in m or m/s.

Transect Measurements			
Transect #:	Easting:	Northing:	Bank Height (m)*:
Habitat Type:	Wetted Width (m):		Bankfull Width (m):
Depth ¼:	Depth ½:		Depth ¾:
Velocity ¼:	Velocity ½:		Velocity ¾:
Thalweg Depth (m)		Entrenchment:	
Substrate (needs up to 100%): Be _____ Bo_____ Ru_____ Co_____ Gr_____ Si_____ M/D _____C/M_____			
Cover types (%): In-stream_____ Overhead _____ Shade _____ Aquatic Veg _____ Specific cover:			
Notes:			

Transect Measurements			
Transect #:	Easting:	Northing:	Bank Height (m)*:
Habitat Type:	Wetted Width (m):		Bankfull Width (m):
Depth ¼:	Depth ½:		Depth ¾:
Velocity ¼:	Velocity ½:		Velocity ¾:
Thalweg Depth (m)		Entrenchment:	
Substrate (needs up to 100%): Be _____ Bo_____ Ru_____ Co_____ Gr_____ Si_____ M/D _____C/M_____			
Cover types (%): In-stream_____ Overhead _____ Shade _____ Aquatic Veg _____ Comments:			
Notes:			

Transect Measurements			
Transect #:	Easting:	Northing:	Bank Height (m)*:
Habitat Type:	Wetted Width (m):		Bankfull Width (m):
Depth ¼:	Depth ½:		Depth ¾:
Velocity ¼:	Velocity ½:		Velocity ¾:
Thalweg Depth (m)		Entrenchment:	
Substrate (needs up to 100%): Be _____ Bo_____ Ru_____ Co_____ Gr_____ Si_____ M/D _____C/M_____			
Cover types (%): In-stream_____ Overhead _____ Shade _____ Aquatic Veg _____ Comments:			
Notes:			
Photos: Downstream ☐ Upstream ☐ Left Bank ☐ Right Bank ☐ Substrate			



Date: Location: Assessor:

APPENDIX F : PHOTOLOG

Photo 1: Representative Photo of WC1

Photo 2: Representative Photo of WC2

Photo 3: Representative Photo of WC3

Photo 4: Representative Photo of WC4

Photo 5: Representative Photo of WL Mosaic A

Photo 6: Representative Photo of WL Mosaic B

Photo 7: Representative Photo of WL Mosaic D

Photo 8: Representative Photo of Open Water E

Photo 9: Representative Photo of Open Water F

Photo 10: Representative Photo of WL1 Open Water G

Photo 11: Representative Photo of Open Water C

Photo 12: Atlantic salmon (*Salmo salar*)

Photo 13: Brook trout (*Salvelinus fontinalis*)

Photo 14: Brown trout (*Salmo trutta*)

APPENDIX G : INDIVIDUAL FISH MEASUREMENTS

Table 1. Individual Fish Measurements

Data Entry	Date	Sampling site	Capture Method (identify Pass # or Trap Type #)	Fish ID Number	Species Code	Common name	Scientific name	Fork length (mm)	Total length (mm)	Weight (g)	Alive/ dead?	Notes (i.e. parr marks, other marks/tags, parasites, injuries, etc)
KF	230802	Six Mile Brook	Pass 1	1	BKT	brook trout	Salvelinus fontinalus	140	145	30.1	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	2	BKT	brook trout	Salvelinus fontinalus	67	70	2.6	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	3	ATS	Atlantic salmon	Salmo salar	55	60	2.21	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	4	ATS	Atlantic salmon	Salmo salar	47	50	0.6	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	5	ATS	Atlantic salmon	Salmo salar	56	60	1.3	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	6	ATS	Atlantic salmon	Salmo salar	57	61	2.42	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	7	ATS	Atlantic salmon	Salmo salar	48	50	1.08	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	8	ATS	Atlantic salmon	Salmo salar	66	72	3.12	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	9	ATS	Atlantic salmon	Salmo salar	57	60	1.57	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	10	BNT	brown trout	Salmo trutta	64	69	2.29	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	11	BKT	brook trout	Salvelinus fontinalus	68	71	2.14	Dead	YOY
KF	230802	Six Mile Brook	Pass 1	12	BKT	brook trout	Salvelinus fontinalus	156	162	23.46	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	13	BKT	brook trout	Salvelinus fontinalus	131	135	21.54	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	14	BKT	brook trout	Salvelinus fontinalus	76	80	5.1	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	15	ATS	Atlantic salmon	Salmo salar	117	121	18.24	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	16	BKT	brook trout	Salvelinus fontinalus	84	90	4.81	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	17	BKT	brook trout	Salvelinus fontinalus	156	162	57.64	Alive	Adult
KF	230802	Six Mile Brook	Pass 1	18	ATS	Atlantic salmon	Salmo salar	57	60	1.42	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	19	ATS	Atlantic salmon	Salmo salar	56	60	2.47	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	20	BKT	brook trout	Salvelinus fontinalus	144	151	18.51	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	21	BKT	brook trout	Salvelinus fontinalus	143	149	19.74	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	22	ATS	Atlantic salmon	Salmo salar	115	120	21.1	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	23	BKT	brook trout	Salvelinus fontinalus	135	140	27.6	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	24	BKT	brook trout	Salvelinus fontinalus	116	120	15.24	Alive	Parr
KF	230802	Six Mile Brook	Pass 1	25	ATS	Atlantic salmon	Salmo salar	51	56	1.34	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	26	ATS	Atlantic salmon	Salmo salar	51	55	0.99	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	27	ATS	Atlantic salmon	Salmo salar	51	54	1.41	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	28	ATS	Atlantic salmon	Salmo salar	52	56	1.67	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	29	BKT	brook trout	Salvelinus fontinalus	72	77	4.07	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	30	ATS	Atlantic salmon	Salmo salar	55	60	3.49	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	31	ATS	Atlantic salmon	Salmo salar	57	62	2.52	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	32	ATS	Atlantic salmon	Salmo salar	64	69	2.49	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	33	ATS	Atlantic salmon	Salmo salar	66	71	2.64	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	34	ATS	Atlantic salmon	Salmo salar	53	58	1.12	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	35	ATS	Atlantic salmon	Salmo salar	46	49	0.71	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	36	ATS	Atlantic salmon	Salmo salar	46	51	1.41	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	37	ATS	Atlantic salmon	Salmo salar	60	64	2.34	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	38	ATS	Atlantic salmon	Salmo salar	66	70	2.71	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	39	ATS	Atlantic salmon	Salmo salar	52	55	1.49	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	40	ATS	Atlantic salmon	Salmo salar	59	64	3.02	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	41	ATS	Atlantic salmon	Salmo salar	46	51	1.62	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	42	ATS	Atlantic salmon	Salmo salar	46	50	1.14	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	43	ATS	Atlantic salmon	Salmo salar	54	60	2.14	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	44	ATS	Atlantic salmon	Salmo salar	43	46	1.39	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	45	ATS	Atlantic salmon	Salmo salar	56	60	2.41	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	46	ATS	Atlantic salmon	Salmo salar	44	49	1.29	Alive	YOY
KF	230802	Six Mile Brook	Pass 1	47	ATS	Atlantic salmon	Salmo salar	52	56	2.36	Alive	YOY
KF	230803	WC3	Pass 1	1	BKT	brook trout	Salvelinus fontinalus	80	85	3.81	Alive	YOY
KF	230803	WC3	Pass 1	2	BKT	brook trout	Salvelinus fontinalus	75	81	2.84	Alive	YOY
KF	230803	WC3	Pass 1	3	BKT	brook trout	Salvelinus fontinalus	64	69	2.85	Alive	YOY
KF	230803	WC3	Pass 1	4	BKT	brook trout	Salvelinus fontinalus	163	170	47.72	Alive	Adult
KF	230803	WC3	Pass 1	5	BKT	brook trout	Salvelinus fontinalus	69	75	3.74	Alive	YOY
KF	230803	WC3	Pass 1	6	BKT	brook trout	Salvelinus fontinalus	72	75	5.34	Alive	YOY
KF	230803	WC3	Pass 1	7	BKT	brook trout	Salvelinus fontinalus	62	70	4.59	Alive	YOY
KF	230803	WC3	Pass 1	8	BKT	brook trout	Salvelinus fontinalus	75	80	6.07	Alive	YOY
KF	230803	WC3	Pass 1	9	BKT	brook trout	Salvelinus fontinalus	70	76	4.78	Alive	YOY
KF	230803	WC3	Pass 1	10	BKT	brook trout	Salvelinus fontinalus	55	61	2.46	Alive	YOY
KF	230803	WC3	Pass 1	11	BKT	brook trout	Salvelinus fontinalus	53	58	2.35	Alive	YOY
KF	230803	WC3	Pass 1	12	BKT	brook trout	Salvelinus fontinalus	72	79	3.39	Alive	YOY
KF	230803	WC3	Pass 1	13	BKT	brook trout	Salvelinus fontinalus	43	48	1.04	Alive	YOY
KF	230803	WC3	Pass 1	14	BKT	brook trout	Salvelinus fontinalus	64	71	3.54	Alive	YOY
KF	230803	WC3	Pass 1	15	BKT	brook trout	Salvelinus fontinalus	56	60	2.04	Alive	YOY
KF	230803	WC3	Pass 1	16	BKT	brook trout	Salvelinus fontinalus	73	79	4.82	Alive	YOY
KF	230803	WC3	Pass 1	17	BKT	brook trout	Salvelinus fontinalus	144	152	33.56	Alive	Adult
KF	230803	WC3	Pass 1	18	BKT	brook trout	Salvelinus fontinalus	90	97	16.65	Alive	Parr
KF	230803	WC3	Pass 2	1	BKT	brook trout	Salvelinus fontinalus	54	59	2.87	Alive	YOY
KF	230803	WC3	Pass 2	2	BKT	brook trout	Salvelinus fontinalus	97	101	12.63	Alive	Parr
KF	230803	WC3	Pass 2	3	BKT	brook trout	Salvelinus fontinalus	74	80	3.84	Alive	YOY
KF	230803	WC3	Pass 2	4	BKT	brook trout	Salvelinus fontinalus	73	80	5.2	Alive	YOY
KF	230803	WC3	Pass 2	5	BKT	brook trout	Salvelinus fontinalus	53	58	1.34	Alive	YOY
KF	230803	WC3	Pass 2	6	BKT	brook trout	Salvelinus fontinalus	74	80	6.13	Alive	Parr
KF	230803	WC3	Pass 2	7	BKT	brook trout	Salvelinus fontinalus	79	84	5.87	Alive	Parr
KF	230803	WC3	Pass 2	8	BKT	brook trout	Salvelinus fontinalus	77	82	4.78	Alive	YOY
KF	230803	WC3	Pass 2	9	BKT	brook trout	Salvelinus fontinalus	64	70	407	Alive	YOY
KF	230803	WC3	Pass 2	10	BKT	brook trout	Salvelinus fontinalus	125	132	27.34	Alive	Parr
KF	230803	WC3	Pass 3	1	BKT	brook trout	Salvelinus fontinalus	142	148	26.48	Alive	Adult
KF	230803	WC3	Pass 3	2	BKT	brook trout	Salvelinus fontinalus	60	66	2.61	Alive	YOY
KF	230803	WC3	Pass 3	3	BKT	brook trout	Salvelinus fontinalus	72	76	4.59	Alive	Parr

APPENDIX H : DETAILED FISH HABITAT DATA

Table 1. General Reach Information, Part 1.

Detailed Fish Habitat Assessment	Reach #1	Reach #1	Reach #2	Reach #3	Reach #4	Reach #1	Reach #2	Reach #3	Reach #1	Reach #2
General Survey Data										
Project Name	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook	Six Mile Brook
Project #	23-767	23-767	23-767	23-767	23-767	23-767	23-767	23-767	23-767	23-767
Date	230727	230727	230728	230728	230728	230803	230803	230803	230803	230803
Surveyors	KF, MS	KF, MS	KF, MS	KF, MS	KF, MS	KF, MS	KF, MS	KF, MS	KF, MS	KF, MS
Watercourse #	WC3	WC1	WC3	WC3	WC3	WC4	WC4	WC4	WC2	WC1
Culvert # (if applicable)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Reach #	1	1	2	3	4	1	2	3	1	2
Upstream Coordinates	507885, 5049004	507317, 5048837	507718, 5048578	507708, 5048491	507686, 5048198	507223, 5049604	507252, 5049465	507259, 5049356	507542, 5049029	507455, 5048847
Downstream Coordinates	507787, 5048823	507445, 5048847	507706, 5048515	507679, 5048214	507696, 5048187	507252, 5049465	507259, 5049356	507273, 5049285	507474, 5048845	507673, 5048649
Water Quality										
Water Quality Measured (Y/N)	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Temperature (C)	18.3	19.8	20.5	20.4	-	15.1	15.2	-	17.5	16.8
pH	5.65	5.46	5.46	6.09	-	5.99	6.01	-	6.61	6.62
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	135	45	71	43	-	41	45	-	98	72
TDS (mg/L)	-	-	-	-	-	-	-	-	-	-
Turbidity (T, M, L, C, or NTU)	Moderately Turbid	Moderately Turbid	Moderately Turbid	Moderately Turbid	Moderately Turbid	Clear	Clear	-	-	-
If Applicable NTU units	-	-	-	-	-	-	-	-	-	-
Reach Characteristics										
Habitat Type	Flat	Riffle-Run	Run	Riffle-Run	Rapid	Rapid	Riffle	Flat	Pool	Run
Flow Type (P, I, E)	Intermittent	Perennial	Perennial	Perennial	Perennial	Perennial	Perennial	Intermittent	Perennial	Perennial
Describe flow regime	heavy rains recently may contribute to heavy flow	flows consistently	flows consistently	flows consistently	flows consistently	flows consistently	flows consistently until R2T2	completely dry	always flowing. feed by wetland	flows consistently
Does reach include other habitat types? (<5m in	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No
If applicable, include all habitat types included in reach (Riffle, Run, Flat, Pool, Cascade, Step,		pool		pool		Riffle	Rapid		Riffle	
Banks and Riparian Area										
Riparian Description (include potential stressors i.e., agriculture, forestry roads, intake pipes, etc.)						fire with 20 years, might be man made watercourse based on sterile features	fire with 20 years, might be man made watercourse based on sterile features	fire with 20 years, might be man made watercourse based on sterile features	surronded by a wetland that seeps into WC multiple times. gravel quarry only 50m or so from WC.	
Dominant Riparian Veg. (Check one)										
Grass										
Shrub										
Coniferous Forest										
Decididuous Forest						Yes	Yes	Yes		
Mixed-wood Forest										
Wetland	Yes	Yes	Yes	Yes	Yes				Yes	Yes
None										
Riparian Area Description										
Notes										
General notes on reach. Ex. Where does it start (outside of SA? In a WL?). Where does it go?	flows into open water created by a beaver dam DS, can not wade transects due to depth and substrate					starts outside SA, FLOWS UNOBSTRUCTED THROUGHT THE SA, NO WETLANDS AROUND WC	no notes expect it runs dry halfway through reach	ends into a washedout area, gravel every where. no signs of it rechanneling again.	starts at edge of WL2, first 25m discontinuous and flooded, not fish hab really	

Table 2. Transect Information Part 1

Assessors	Survey Date	Watercourse	Reach #	Transect #	Waypoint		Habitat Type	Bank Height (m)	Thalweg Depth (m)	Width (m)		Depths and Velocities						Entrenchment	Substrate types (add up to 100%)	Cover types (% of EACH instream, overhead, shade, aquatic vegetation)	Notes on Transect
					Easting	Northing				Wetted	Bankfull	1/4 Depth (m)	1/4 Vel (m/s)	1/2 Depth (m)	1/2 Vel (m/s)	3/4 Depth (m)	3/4 Vel (m/s)				
KF, MS	230727	WC3	1	1	507874	5048982	Flat	0.23	0.18	1.65	2.3	0.15	<0.05	0.1	<0.05	0.13	<0.05	Not entrenched	100 muck	20 emergent veg, 15 overhang veg, 60 shade	flooded on both sides, sensitive fern in stream.
KF, MS	230727	WC3	1	2	507872	5048955	Flat	0.19	0.12	1.75	2.5	0.1	<0.05	0.1	<0.05	0.08	<0.05	Not entrenched	100 muck	5 emerg, 25 over, 50 shade	flooded on both sides, sensitive fern in stream.
KF, MS	230727	WC3	1	3	507862	5048933	Flat	0.23	0.09	1.2	1.8	0.05	<0.05	0.04	<0.05	0.06	<0.05	Slightly entrenched	100 muck	5 emerg, 15 over, 40 shade	more channelized
KF, MS	230727	WC3	1	4	507843	5048913	Flat	0.19	0.14	0.8	1.2	0.11	<0.05	0.12	<0.05	0.08	<0.05	Slightly entrenched	100 muck	5 emerg, 5 over, 80 shade	poor habitst
KF, MS	230727	WC3	1	5	507838	5048885	Flat	0.19	0.13	1.2	2.7	0.13	<0.05	0.12	<0.05	0.06	<0.05	Slightly entrenched	100 muck	2 emerg, 5 over, 90 shade	poor habitat
KF, MS	230727	WC3	1	6	507804	5048864	Flat	0.23	0.17	1	1.2	0.15	<0.05	0.15	<0.05	0.07	<0.05	Slightly entrenched	100 muck	2 emerg, 10 over, 60 shade	main channel downstream of multiple braids that all flow towards open water portion
KF, MS	230727	WC3	1	7	507794	5058843	Flat	0.18	0.29	0.4	1.3	0.12	<0.05	0.06	<0.05	0.27	<0.05	Slightly entrenched	100 muck	20 over, 40 shade	riparian veg changing to more rushes
KF, MS	230727	WC3	1	8	507787	5048823	Flat	0.15	0.25	1.5	2.4	0.07	<0.05	0.24	<0.05	0.08	<0.05	Slightly entrenched	100 muck	30 over, 10 shade	becomes large open water after this transect
KF, MS	230727	WC1	1	1	507317	5048837	Pool	N/A	0.3	5	5	0.15	<0.05	0.32	<0.05	0.17	<0.05	Slightly entrenched	50 muck, 50 silt	80 emerg, 10 over, 70 shade	back jammed from dense cattails made large pool couldn't run tape across
KF, MS	230727	WC1	1	2	508325	5048833	Riffle	0.22	0.16	0.8	1.2	0.15	<0.05	0.13	<0.05	0.11	<0.05	Slightly entrenched	50 muck, 50 gravel	10 emerg, 10 over, 25 shade	heavy flow coming from back jammed pool
KF, MS	230727	WC1	1	3	507342	5048842	Run	0.17	0.3	1.2	1.6	0.25	<0.05	0.27	<0.05	0.19	<0.05	Slightly entrenched	90 muck, 10 gravel	10 emerg, 10 over, 90 shade	within WL mosaic, cannot follow one watercourse, extremely confusing with cattails
KF, MS	230727	WC1	1	4	507364	5048847	Run	0.11	0.26	2.1	1.5	0.24	<0.05	0.19	<0.05	0.21	<0.05	Slightly entrenched	100 muck	10 emerg, 10 over, 90 shade	within WL mosaic, cannot follow one watercourse, extremely confusing with cattails
KF, MS	230727	WC1	1	5	507383	5058841	Riffle	0.13	0.23	1.2	1.5	0.22	<0.05	0.21	<0.05	0.11	<0.05	Slightly entrenched	100 muck	5 over, 90 shade	seems all channels have converged just upstream
KF, MS	230727	WC1	1	6	507401	5048846	Run	0.17	0.2	1.2	1.4	0.14	<0.05	0.18	<0.05	0.1	<0.05	Slightly entrenched	100 muck	10 over, 70 shade	
KF, MS	230727	WC1	1	7	507427	5048851	Riffle	0.11	0.19	0.9	1.2	0.1	<0.05	0.14	<0.05	0.16	<0.05	Not entrenched	100 muck	10 emer, 20 over, 80 shade	
KF, MS	230727	WC1	1	8	507443	5048850	Run	0.09	0.46	2.5	3.1	0.33	<0.05	0.28	<0.05	0.13	<0.05	Slightly entrenched	80 muck, 20 sand	5 emerg, 15 over, 70 shade	downstream of two channels, AA and AAB
KF, MS	230727	WC1	1B	7	507425	5048843	Run	0.15	0.25	1.5	1.6	0.2	<0.05	0.23	<0.05	0.1	<0.05	Slightly entrenched	40 muck, 60 sand	2 emerg, 15 over, 30 shade	on B channel - original channel
KF, MS	230727	WC1	1B	6	507408	5048844	Run	0.06	0.09	1.1	1.6	0.03	<0.05	0.08	<0.05	0.04	<0.05	Slightly entrenched	100 muck	15 over, 50 shade	on B channel - original channel
KF, MS	230727	WC1	1B	5	507387	5048837	Riffle	0.22	0.13	0.8	1	0.05	<0.05	0.08	<0.05	0.09	<0.05	Slightly entrenched	80 muck, 20 gravel	5 emerg, 40 ofer, 80 shade	on B channel - original channel
KF, MS	230728	WC3	2	1	507718	5048578	Run	0.17	0.29	1.5	1.8	0.2	<0.05	0.22	<0.05	0.23	<0.05	Slightly entrenched	20 gravel, 10 cobble, 70 muck	2 emerg, 20 over, 60 shade	downstream of beaver dam, multiple channels at first then flows into this channel
KF, MS	230728	WC3	2B	1	507724	5048588	Run	0.18	0.3	2.3	3.1	0.17	<0.05	0.28	<0.05	0.25	<0.05	Slightly entrenched	15 gravel, 85 muck	15 over, 90 shade	on b channel, immediately connects into main channel
KF, MS	230728	WC3	2	2	507716	5048559	Run	0.22	0.44	1.3	1.7	0.14	<0.05	0.16	<0.05	0.31	<0.05	Slightly entrenched	80 muck, 20 silt	20 emerg, 20 over, 40 shade	hard to establish banks with vegetation in WL
KF, MS	230728	WC3	2	3	507712	5048538	Run	0.23	0.44	2.5	2.5	0.36	<0.05	0.4	0.211	0.26	0.32	Slightly entrenched	40 gravel, 20 sand, 40 muck	10 under, 20 over, 80 shade	up to now either to slow for flow or to much veg
KF, MS	230728	WC3	2	4	507706	5048515	Run	0.13	0.43	2.4	2.8	0.39	0.396	0.22	0.232	0.17	0.172	Slightly entrenched	10 gravel, 30 san, 5 silt, 55 muck	5 emer, 20 over, 40 shade	
KF, MS	230728	WC3	3	1	507708	5048491	Riffle	0.1	0.4	1.9	2.2	0.09	0.209	0.2	0.209	0.34	0.554	Slightly entrenched	30 gravel, 30 sand, 40 muck	5 emerg, 10 over, 30 shade	
KF, MS	230728	WC3	3	2	507705	5048469	Run	0.09	0.32	1.6	2	0.17	0.335	0.22	0.281	0.28	0.436	Slightly entrenched	30 gravel, 30 sand, 40 muck	5 emerg, 15 over, 10 shade	
KF, MS	230728	WC3	3	3	507707	5048451	Run	0.16	0.47	1.9	2.1	0.4	0.17	0.28	0.307	0.17	0.328	Slightly entrenched	20 gravel, 20 sand, 20 silt, 40 muck	5 emerg, 20 over, 25 shade	
KF, MS	230728	WC3	3	4	507708	5048427	Run	0.22	0.32	1.9	2.4	0.29	0.605	0.25	0.508	0.17	0.508	Slightly entrenched	35 gravel, 10 sand, 5 silt, 50 muck	5 emerg, 5 over, 15 shade	
KF, MS	230728	WC3	3	5	507712	5048403	Riffle	0.17	0.24	1.7	1.8	0.23	0.723	0.22	0.524	0.17	0.462	Slightly entrenched	20 cobble, 20 gravel, 10 sand, 50 muck	10 over, 30 shade, 50 undercut banks	
KF, MS	230728	WC3	3	6	507698	5048378	Run	0.12	0.25	1.5	1.6	0.1	0.657	0.2	0.601	0.2	0.151	Slightly entrenched	20 cobble, 20 gravel, 10 sand, 50 muck	5 over, 10 shade	large uprooted trees from fiona
KF, MS	230728	WC3	3	7	507696	5048347	Riffle	0.11	0.23	2	2.6	0.2	0.357	0.17	0.315	0.15	0.843	Slightly entrenched	10 cobble, 60 gravel, 30 muck	7 over, 10 shade	DS of large tree jam from Fiona
KF, MS	230728	WC3	3	8	507688	5048323	Riffle	0.17	0.2	2.4	2.5	0.13	0.098	0.13	0.594	0.08	0.921	Slightly entrenched	30 cobble, 30 gravel, 10 sand, 10 boulder, 20 muck	2 over, 5 under, 80 shade	
KF, MS	230728	WC3	3	9	507684	5048296	Riffle	0.13	0.27	2.4	2.65	0.25	0.494	0.24	0.521	0.18	0.394	Slightly entrenched	60 gravel, 20 sand, 20 muck	5 over, 80 shade	
KF, MS	230728	WC3	3	10	507675	5048273	Run	0.27	0.13	3	3.4	0.11	0.211	0.12	0.499	0.08	0.542	Slightly entrenched	50 gravel, 30 sand, 20 muck	5 over, 70 shade	

Table 3. Transect Information, Part 2

Assessors	Survey Date	Watercourse	Reach #	Transect #	Waypoint		Habitat Type	Bank Height (m)	Thalweg Depth (m)	Width (m)		Depths and Velocities						Entrenchment	Substrate types (add up to 100%)	Cover types (% of EACH instream, overhead, shade, aquatic vegetation)	Notes on Transect
					Easting	Northing				Wetted	Bankfull	1/4 Depth (m)	1/4 Vel (m/s)	1/2 Depth (m)	1/2 Vel (m/s)	3/4 Depth (m)	3/4 Vel (m/s)				
KF, MS	230728	WC3	3	11	507676	5048248	Run	0.16	0.25	2.3	2.6	0.19	0.504	0.14	0.515	0.12	0.492	Slightly entrenched	10 cobble, 40 gravel, 40 sand, 10 muck	10 over, 50 shade	
KF, MS	230728	WC3	3	12	507679	5048214	Pool	0.13	0.32	4	4.4	0.28	0.184	0.23	0.801	0.13	0.085	Moderately entrenched	15 boulder, 10 rubble, 20 cobble, 25 gravel, 30 sand, 10 muck	2 over, 40 shade	
KF, MS	230728	WC3	4	1	507684	5048233	Rapid	0.11	0.22	2	2.4	0.15	0.848	0.21	0.535	0.16	0.473	Slightly entrenched	50 boulder, 30 rubble, 20 cobble	1 over, 65 shade	
KF, MS	230803	WC4	1	1	507223	5049584	Rapid	0.34	0.12	2	2.9	0.1	1.667	0.09	1.667	0.05	1.667	Moderately entrenched	40 boulder, 25 rubble, 25 cobble, 10 gravel	0 cover, 80 shade	
KF, MS	230803	WC4	1	2	507213	5049560	Riffle	0.12	0.1	1.3	2.9	0.05	0.286	0.08	0.286	0.03	0.286	Slightly entrenched	15boulder, 20 rubble, 40 cobble, 20 gravel, 5 sand	0 cover, 90 shade	
KF, MS	230803	WC4	1	3	507221	5049538	Rapid	0.41	0.13	2.2	3.5	0.08	0.25	0.1	0.25	0.06	0.25	Moderately entrenched	20 boulder, 40 rubble, 25 cobble, 15 gravel	0 cover, 90 shade	
KF, MS	230803	WC4	1	4	507238	5049520	Rapid	0.34	0.11	1.6	2.6	0.05	0.125	0.05	0.125	0.06	0.125	Moderately entrenched	20 boulder, 20 rubble, 10 cobble, 50 gravel	0 cover, 90 shade	
KF, MS	230803	WC4	1	5	507250	5049500	Rapid	0.35	0.1	1.3	3.2	0.05	0.2	0.08	0.2	0.07	0.2	Slightly entrenched	60 boulder, 20 rubble, 20 cobble	5 boulder, 90 shade	
KF, MS	230803	WC4	1	6	507251	5049474	Rapid	0.29	0.11	2	3.3	0.03	0.182	0.05	0.182	0.07	0.182	Slightly entrenched	20 boulder, 20 rubble, 5 cobble, 35 gravel, 20 sand	o cover, 80 shade	
KF, MS	230803	WC4	2	1	507262	5049453	Riffle	0.17	0.07	2	3.6	0.03	0.286	0.03	0.286	0.04	0.286	Slightly entrenched	5 rubble, 20 cobble, 50 gavelr, 25 sand	0 cover, 90 shade	**efish good here**
KF, MS	230803	WC4	2	2	507270	5049427	Rapid	0.35	0.08	1.5	2.3	0.03	0.182	0.05	0.182	0.05	0.182	Slightly entrenched	40 boulder, 30 rubble, 10 cobble, 10 gravel	0 cover, 90 shade	
KF, MS	230803	WC4	2	3	507277	5049402	Riffle	0.34	0.08	1.3	2	0.04	0.04	0.04	0.04	0.05	0.04	Moderately entrenched	10 boulder, 20 rubble, 40 cobble, 30 gravel	o cover, 80 shade	**starts to run dry after R2t2**
KF, MS	230803	WC4	2	4	507263	5049377	Riffle	0.4	0	0	2.3	0	0	0	0	0	0	Moderately entrenched	10 boulder, 20 rubble, 40 cobble, 30 gravel	0 cover, 80 shade	**completely dry**
KF, MS	230803	WC4	3	1	507261	5049345	Flat	0.6	0	0	4.3	0	0	0	0	0	0	Moderately entrenched	15 boulder, 20 rubble, 40 cobble, 20 gravel, 5 sand	0 cover, 70 shade	**completely dry**
KF, MS	230803	WC4	3	2	507274	5049330	Flat	0.32	0	0	2.6	0	0	0	0	0	0	Slightly entrenched	10 boulder, 10 rubble, 40 cobble, 30 gravel, 20 sand	0 cover, 90 shade	**completely dry**
KF, MS	230803	WC4	3	3	507278	5049308	Flat	0.52	0	0	2.2	0	0	0	0	0	0	Moderately entrenched	10 boulder, 10 rubble, 40 cobble, 30 gravel, 20 sand	0 cover, 90 shade	**completely dry**
KF, MS	230803	WC2	1	1	507522	5049007	Run	0.11	0.11	1.4	1.8	0.05	<0.05	0.09	<0.05	0.05	<0.05	Not entrenched	100 muck	o cover, 90 shade	**slightly flooded into WL, discontinuous before this**
KF, MS	230803	WC2	1	2	507510	5048992	Riffle	0.25	0.12	0.4	0.8	0.11	0.112	0.11	0.112	0.04	0.112	Slightly entrenched	100 muck	2 over, 60 shade	**small section transitions into riffle for 5m**
KF, MS	230803	WC2	1	3	507494	5048970	Run	0.13	0.14	0.7	0.9	0.1	0.125	0.12	0.125	0.07	0.125	Slightly entrenched	100 muck	0 over, 40 shade	
KF, MS	230803	WC2	1	4	507476	5048949	run	0.1	0.14	0.9	1.2	0.1	<0.05	0.08	<0.05	0.12	<0.05	Slightly entrenched	20 boulder, 80 muck	10 over, 40 shade	
KF, MS	230803	WC2	1	5	507469	5048926	Run	0.2	0.13	0.4	0.7	0.08	<0.05	0.1	<0.05	0.1	<0.05	Slightly entrenched	100 muck	5 over, 50 shade	
KF, MS	230803	WC2	1	6	507463	5048903	Run	0.15	0.09	0.75	0.9	0.04	<0.05	0.05	<0.05	0.05	<0.05	Slightly entrenched	100 muck	10 over, 50 shade	
KF, MS	230803	WC2	1	7	507464	5048881	Run	0.2	0.24	0.2	0.4	0.13	<0.05	0.19	<0.05	0.22	<0.05	Slightly entrenched	100 muck	40 over, 50 shade	
KF, MS	230803	WC2	1	8	507469	5048862	Run	0.15	0.14	0.4	0.6	0.1	<0.05	0.13	<0.05	0.12	<0.05	Slightly entrenched	100 muck	10 over, 80 shade	
KF, MS	230803	WC1	2	1	507466	5048845	Run	0.12	0.38	2.1	2.2	0.11	<0.05	0.24	<0.05	0.12	<0.05	Not entrenched	100 muck	30 over, 30 shade	
KF, MS	230803	WC1	2	2	507487	5048832	Run	0.2	0.48	1.4	1.4	0.25	<0.05	0.22	<0.05	0.33	<0.05	Slightly entrenched	100 muck	20 over, 20 shade	**flooded on both sides use aerial for full flooded extent**
KF, MS	230803	WC1	2	3	507500	5048815	Run	0.03	0.66	1.6	1.6	0.34	<0.05	0.56	<0.05	0.23	<0.05	Slightly entrenched	100 muck	10 over, 10 shade	**flooded on both sides use aerial for full flooded extent**
KF, MS	230803	WC1	2	4	507512	5049798	Run	0.04	0.78	2.1	2.1	0.29	<0.05	0.7	<0.05	0.35	<0.05	Slightly entrenched	100 muck	20 emerg, 20 shade	**flooded on both sides use aerial for full flooded extent**
KF, MS	230803	WC1	2	5	507526	5048766	Run	0.05	0.3	1.3	1.3	0.13	<0.05	0.21	<0.05	0.08	<0.05	Slightly entrenched	100 muck	50 emerg, 50 shade	**large open water upstream of beaver dam, wadeable about 75cm deep throughout.**
KF, MS	230803	WC1	2	6	507545	5048738	Run	0.08	0.21	1.7	1.8	0.26	<0.05	0.27	<0.05	0.23	<0.05	Slightly entrenched	50 muck 50 sand	15 emer, 15 shade	**downstream of beaver dam and small open water**
KF, MS	230803	WC1	2	7	507559	5048724	Run	0.14	0.33	1.4	1.5	0.29	<0.05	0.21	<0.05	0.17	<0.05	Slightly entrenched	100 muck	5 over, 10 emerg, 15 shade	
KF, MS	230803	WC1	2	8	507584	5048700	Run	0.16	0.27	1.1	1.3	0.22	<0.05	0.26	<0.05	0.17	<0.05	Slightly entrenched	100 muck	5 emer, 5 over, 10 shade	**downstream of beaver dam, and small open water**
KF, MS	230803	WC1	2	9	507605	5048685	Run	0.04	0.41	0.7	1.2	0.35	<0.05	0.4	<0.05	0.22	<0.05	Slightly entrenched	60 muck, 40 sand	over 20, shade 40	
KF, MS	230803	WC1	2	10	507633	5048682	Run	0.09	0.27	1.7	15	0.24	<0.05	0.22	<0.05	0.21	<0.05	Slightly entrenched	100 muck	5 over, 25 shade	**downstream of beaver dam, and small open water**
KF, MS	230803	WC1	2	11	507650	5048664	Run	0.04	0.32	2.1	2.1	0.27	<0.05	0.31	<0.05	0.28	<0.05	Slightly entrenched	60 muck, 40 sand	15 emer, 5 over, 20 shade	**downstream of beaver dam, and small open water**
KF, MS	230803	WC1	2	12	507669	5058651	Run	0.05	0.43	2.2	2.2	0.4	<0.05	0.38	<0.05	0.36	<0.05	Slightly entrenched	60 muck, 40 sand	5 emerg, 5 shade	

Table 4. Notable Features

Surveyors	Survey Date	WC #	Reach #	Feature Type	Waypoint		Comments
					Easting	Northing	
KF, MS	230727	3	1	Underground flow	507871	5048966	until 507873, 5048956. goes under recently uprooted tree and is lost. slightly rechannels DS of debris
KF, MS	230727	3	1	No defined channel	507847	5048917	5x5 m of multiple small brainds, that go slightly underground at portion <1m rechannelizes after 5 m
KF, MS	230727	3	1	No defined channel	507818	5048868	15 m of undefined braids thatare fed from the upland adjacent to wetland. all flow towards large open water
KF, MS	230803	4	2	Other	507272	5049391	runs dry, no more water downstream of this point
KF, MS	230803	2	1	Underground flow	507477	5048943	runs underground for 4 m

Table 5. Culvert Information

WC #	Reach #	US Waypoint		DS Waypoint		Material	Shape	Dimensions				Condition
		Easting	Northing	Easting	Northing			Diameter (m)	Height (m)	Width (m)	Length (m)	
WCAC	3	507673	5048234	507679	5048216	Corrugated Metal Pipe (Annular)	Circular	1.6	-	-	-	slight rust on bottom still intact

Table 6. Wetland Mosaic Information

Survey Date	Surveyors	Water Course Name	WC #	Stream Order	General Characteristics						Water Quality						Measurement check #	Width (m)	Depth (m)	Velocity (m/s)
					Habitat Type	Reach Length (m)	Gradient (%)	Veg/Water Ratio	Substrate	Vegetation	Temperature	pH	Dissolved Oxygen	Conductivity	TDS	Turbidity (T,M, L, C or NTU)				
230727	KF, MS	WL Mosaic B	3	1	Flat	30	<1	80/20	muck	catails	18.3	5.65	-	135	-	-	1	10	0.03	0
230727	KF, MS	WL Mosaic B	3	1	Flat	30	<1	80/20	muck	catails	18.3	5.65	-	135	-	-	2	10	0.08	0
230727	KF, MS	WL Mosaic B	3	1	Flat	30	<1	80/20	muck	catails	18.3	5.65	-	135	-	-	3	10	0.1	0
230727	KF, MS	WL Mosaic B	3	1	Flat	30	<1	80/20	muck	catails	18.3	5.65	-	135	-	-	4	10	0.09	0
230727	KF, MS	WL Mosaic D	1	1	Run	55	<1	80/20	muck	catails	-	-	-	-	-	-	1	10	0.24	0
230727	KF, MS	WL Mosaic D	1	1	Run	55	<1	80/20	muck	catails	-	-	-	-	-	-	2	10	0.58	0
230727	KF, MS	WL Mosaic D	1	1	Run	55	<1	80/20	muck	catails	-	-	-	-	-	-	3	10	0.26	0
230727	KF, MS	WL Mosaic D	1	1	Run	55	<1	80/20	muck	catails	-	-	-	-	-	-	4	10	0.6	0
2307278	KF, MS	WL Mosaic A	3	1	Flat	50	<1	70/30	muck	sensitive fern	-	-	-	-	-	-	1	14	0.12	0
2307278	KF, MS	WL Mosaic A	3	1	Flat	50	<1	70/30	muck	sensitive fern	-	-	-	-	-	-	2	14	0.08	0
2307278	KF, MS	WL Mosaic A	3	1	Flat	50	<1	70/30	muck	sensitive fern	-	-	-	-	-	-	3	14	0.16	0
2307278	KF, MS	WL Mosaic A	3	1	Flat	50	<1	70/30	muck	sensitive fern	-	-	-	-	-	-	4	14	0.2	0