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BIOPHYSICAL BASELINE REPORT
Shaw Middleton Sand Pit Project
Middleton, NS

April 29, 2025

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April 29, 2025

Mr. Glen Merkley
GHD Limited

Dear Mr. Merkley,

Re: Biophysical Baseline Report
Shaw Middleton Sand Pit Project, Middleton, NS

Attached is the Biophysical Baseline Report prepared for the Shaw Middleton Sand Pit Project, Middleton, NS.

The report documents our observations, findings, and conclusions.

We trust this to be satisfactory at this time. Once you have had an opportunity to review this correspondence, please contact us to address any questions you may have.

Thank you,

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EXECUTIVE SUMMARY

McCallum Environmental Ltd. (MEL), now Strum Consulting, was retained to complete the terrestrial (habitat, flora, fauna, and avifauna) and aquatic (wetlands, fish, and fish habitat) biophysical surveys for the proposed Shaw Middleton Sand Pit Project (the Project), located in Middleton, Nova Scotia (NS). This report is intended to support the preparation and submission of a provincial Environmental Assessment Registration Document (EARD) with Nova Scotia Environment and Climate Change (NSECC).

Biophysical surveys have been completed with the key objectives of facilitating avoidance of effects where practicable, understanding potential project interactions, and to support regulatory applications in the future as needed. 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 the desktop and field evaluations completed in 2023.

Project Areas

The Project Area (PA) is situated on private land comprised of the following entire and partial PIDs: 05286968, 05194030, 05313861, 05059688, 05058334, 05313853, 05310834, 05286984, 05286976, 05291455, and 05291448. The PA is approximately 109.55 ha in size, which includes 89.29 ha of disturbed area (i.e., clear-cutting).

The PA is surrounded by disturbed clear-cut areas, young-middle age mixedwood forests, agricultural land, and two treed swamps. One wetland contains an associated watercourse with a portion of open water.

Note that select fish and fish habitat field programs (electrofishing and trapping) and avifauna field programs were conducted both within and in proximity to the PA. The locations of these surveys outside of the PA have direct connectivity to surface water features (for aquatic surveys) within the PA, additionally, these locations were chosen for their access and safety considerations for field teams. Studies completed outside of the PA may be beneficial for future monitoring.

Vascular Plants, Lichens, and Vegetation Communities

Vascular plant, lichen, and vegetation community surveys (i.e. habitat surveys) took place in 2023. All surveys consisted of meandering transects across the PA and within targeted locations. Prior to undertaking field assessments, desktop research was conducted.

A total of 145 vascular plants were observed, including four Species of Conservation Interest (SOCI). No rare lichens were observed. Terrestrial habitats were dominated by clearcut within the PA, with some smaller areas of spruce-hemlock or spruce-pine forests, and wetland habitat.

Fauna

Wildlife surveys were completed opportunistically throughout the suite of biophysical surveys. Particular attention was paid to Species at Risk (SAR) and SOCI species. All observations were identified and recorded by biologists experienced in recognition of wildlife tracks, scat, and browse.

As there were no Abandoned Mine Openings (AMOs) present within the PA, and no other suitable bat hibernacula, AMOs on crown land within 5 km of the PA were visited and checked for suitable bat hibernacula habitat. Only AMOs directly accessible from public roads were assessed.

The PA is not within mainland moose core habitat and there is no suitable habitat for mainland moose within the PA, therefore dedicated mainland moose surveys were not conducted.

Surveys were not completed on the one identified watercourse within the PA, as surveys took place before watercourse delineation was completed, in order to meet the optimal seasonal window. It was the intention for the surveys to be completed three times, however, the field schedule was interrupted by the forest fires in May and June 2023. In consultation with Mark McGarrigle, Species at Risk Biologist at Nova Scotia Natural Resources (NSNR), a desktop exercise was used to map potential wood turtle habitat within the PA using detailed stream habitat descriptions collected during fish habitat surveys.

No priority species fauna was observed during any field surveys.

Avifauna

Prior to conducting field surveys, a preliminary desktop survey design was developed to target suitable habitat for avifauna species or groups of interest. Avifauna surveys included migration (spring and fall), breeding, and common nighthawk. Survey point count locations were established within and adjacent to the PA, should post-construction avifauna monitoring be required.

Four avifauna SAR were observed: common nighthawk (*Chordeiles minor*), evening grosbeak (*Coccothraustes vespertinus*), olive-sided flycatcher (*Contopus cooperi*), and eastern wood-pewee (*Contopus virens*). Four avifauna SOCI were observed: bay-breasted warbler (*Setophaga castanea*), pine warbler (*Setophaga pinus*), pine siskin (*Spinus pinus*), and red crossbill (*Loxia curvirostra*). Avian biophysical surveys resulted in the observation of 1,433 individuals, representing 74 bird species.

Wetlands

Wetlands were identified via meandering transects throughout the PA. Functional assessment using the Wetland Ecosystems Services Protocol – Atlantic Canada (WESP-AC) evaluation technique was followed. Two wetlands were identified totalingy approximately 4.8 hectares (ha) in area.

The two identified wetlands are located along the southern edge of the PA and can be characterized as mixedwood treed swamps. Neither of these wetlands are classified as Wetlands of Special Significance (WSS).

Fish and Fish Habitat

Fish and Fish Habitat was first assessed from a desktop perspective, to better understand the potential for fisheries resources within the PA. Watercourses were identified and delineated via meandering transects. Electrofishing took place under DFO fishing license #341208; trapping was conducted to supplement electrofishing efforts. Water quality measurements were recorded for each watercourse reach delineated; lastly, detailed fish habitat surveys were completed.

One field identified watercourse was observed within the PA. This watercourse continues west beyond the PA, eventually draining into the Nictaux River. This watercourse originates in a field delineated open water area within a wetland. Fishing occurred within the watercourse (outside of the PA), and the following species were caught: threespine stickleback (*Gasterosteus aculeatus*), creek chub (*Semotilus atromaculatus*), northern redbelly dace (*Chrosomus eos*), and brook trout (*Salvelinus fontinalis*). No fish were caught within the PA, however, given the direct connectivity to downstream fisheries resources, all delineated surface water features within the PA are also considered fisheries resources.

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ACCDC	Atlantic Canadian Conservation Data Centre
ACPF	Atlantic Coastal Plain Flora
AMO	Abandoned Mine Opening
ATV	All-Terrain Vehicle
CM	Centimeters
CONI	Common nighthawk
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch Per Unit Effort
CWS	Canadian Wildlife Services
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
EARD	Environmental Assessment Registration Document
EC	Environment Canada
ECCC	Environment and Climate Change Canada
ELC	Ecological Land Classification
FBP	Functional Benefit Product
FEC	Forest Ecosystem Classification for Nova Scotia
FACW	Facultative Wetland
FAC	Facultative
GIS	Geographic Information System
GPS	Global Positioning System
HA	Hectares
IBA	Important Bird Area
IH	Intolerant Hardwood Forest Group
KM	Kilometer
MBBA	Maritime Breeding Bird Atlas
MBS	Migratory Bird Sanctuary
MTRI	Mersey Tobeatic Research Institute
NS	Nova Scotia
NSNR	Nova Scotia Natural Resources
NSECC	Nova Scotia Environment and Climate Change
NSESA	Nova Scotia Endangered Species Act
NSTDB	Nova Scotia Topographic Database
OBL	Obligate
PC	Point Count
PID	Property Identification Number
SAR	Species at Risk
SARA	Species at Risk Act
SH	Spruce Hemlock Forest Group
SMP	Special Management Practices
SOCI	Species of Conservation Interest
SOP	Standard Operating Procedure

SP	Spruce Pine Forest Group
SRank	Status rank
SS	Shrub Swamp Group
TDS	Total Dissolved Solids
TH	Tolerant Hardwood Forest Group
UTM	Universal Transform Mercator
WAM	Wet Areas Mapping
WESP-AC	Wetland Ecosystem Services Protocol – Atlantic Canada
WSS	Wetland of Special Significance
WC	Watercourse
WC	Wet Coniferous Forest Group
WL	Wetland

1.0 INTRODUCTION

McCallum Environmental Ltd. (MEL), now Strum Consulting, was retained to complete the terrestrial (vegetation communities, flora, fauna, and avifauna) and aquatic (wetlands, fish, and fish habitat) biophysical surveys for the proposed Shaw Middleton Sand Pit Project (the Project), located in Middleton, Nova Scotia (NS). This report is intended to support the preparation and submission of a provincial Environmental Assessment Registration Document (EARD) with Nova Scotia Environment and Climate Change (NSECC).

Biophysical surveys have been completed with the key objectives of facilitating avoidance of effects where practicable, understanding potential project interactions, and to support regulatory applications in the future as needed. 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 the desktop and field evaluations completed in 2023 within the Project Area (PA).

1.1 Background

The Project is a sand pit located in Middleton, Annapolis County, Nova Scotia, located approximately 4 km southeast of Middleton in Annapolis County, Nova Scotia (Drawing 1, Appendix A). Strum was retained by GHD to conduct biophysical surveys to support a EARD submission to develop a sand pit.

1.2 Regulatory Context

The Nova Scotia *Environment Act* and Environmental Assessment Regulations regulate provincial environmental assessments. The proposed Project will likely require a provincial environmental assessment registration as it is considered a *Class I* undertaking under Schedule A of the Nova Scotia Environmental Assessment Regulations.

The Project has potential to interact with flora and fauna species, as well as their habitats, that may be protected under several federal and provincial legislations as well as regulatory guidelines. Surveys were designed to detect species that may be listed in these documents. Legislation that may direct resource development and conservation of flora and fauna include:

Federal Legislation

- *Species At Risk Act, S.C. 2002, c. 29* (SARA)
- *Migratory Birds Convention Act, S.C. 1994, c.22*

Provincial Legislation

- *Wildlife Act, R.S.N.S 1989, c. 504*
- *The Endangered Species Act, S.N.S., 1998, c.11* (ESA)
- *The Environment Act, S.N.S., 1994-95, c. 1*

The Project is also driven by policies, guidelines, and standards that provide guidance on the development of the Project and the survey design. These guidance/policies include:

- Nova Scotia Wetland Conservation Policy (NSECC, 2019)
- The Guide to Addressing Wildlife Species and Habitat in an EA Registration Document (NSECC, 2009)
- Various Nova Scotia Natural Resources (NSNR) Special Management Practices (SMP) and Environment and Climate Change Canada (ECCC) Species at Risk Management Plans.

In Nova Scotia, wetlands are protected under the Activities Designation Regulation of the *Environment Act* and the Wetland Conservation Policy (NSECC, 2019). The *Environment Act* defines a wetland as:

> *"Land referred to as a marsh, swamp, fen, or bog that either periodically or permanently has water table at, near, or above the land surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation, and biological activities adapted to wet conditions".*

Nova Scotia's Wetland Conservation Policy (NSECC, 2019) applies to all freshwater and certain tidal wetlands with the objectives to prevent net loss of wetland area or function, promote wetland protection and net gain, and enhance impact mitigation efforts. Under this policy and the *Environment Act*, approvals are required to alter wetlands, with certain exceptions (e.g., wetlands with area <100 m^2, specific linear developments). The policy also provides a mechanism for the province to designate Wetlands of Special Significance (WSS), which may include wetlands known to support at-risk species. Species, and their residences, with legal protection under the federal SARA include those listed as extirpated, endangered, or threatened. These same protections apply to endangered and threatened species listed under the ESA. These legally protected species are referred to as Species at Risk (SAR). These legal protections are not afforded to SARA Special Concern and ESA Vulnerable listed species (e.g., blue felt lichen (*Pectenia plumbea*), which are referred to as Species of Conservation Interest (SOCI). Protection for these species may be managed under other policies, such as the At-risk Lichens – Special Management Practices (NSNR, 2018).

The 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. 1994-95, c. 1, s. 1*.) Therefore, it is necessary to understand what watercourses and water resources are present within the PA prior to Project development.

The 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".*

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 report focuses on surface water features in the context of fish habitat provision.

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".

Under the *Fisheries Act*, activities which result in the death of fish or the harmful alteration, disruption or destruction (HADD) of fish habitat are prohibited. Under Sections 34.4(2) and 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 HADD of fish habitat.

On July 21, 2023, a meeting was held between Strum and NSNR in order to review proposed and in place biophysical methodology.

1.3 Assessment Spatial Boundaries

The PA is situated on private land comprised of the following entire and partial PIDs: 05286968, 05194030, 05313861, 05059688, 05058334, 05313853, 05310834, 05286984, 05286976, 05291455, and 05291448 (Drawing 1, Appendix A). The PA is surrounded by disturbed clear-cut mixed-wood forest, young-middle age mixedwood forests, and agricultural land.

The PA itself mainly consists of open (e.g., clear-cut) habitat, forest, and two treed swamps, one tree swamp contains a watercourse and small open water feature. The western-most boundary of the PA is approximately 950 m east of the Nictaux River.

The PA is approximately 109.55 ha in size, which includes 89.29 ha of disturbed area (i.e., clear-cutting).

Note that select fish and fish habitat field programs (electrofishing and trapping) and avifauna field programs were conducted both within and in proximity to the PA. The locations of these surveys outside of the PA considered direct connectivity to surface water features (for aquatic surveys) within the PA, and access and safety considerations for field teams.

2.0 BASELINE PROGRAM METHODOLOGY

This section details the following key aspects of the biophysical baseline methodologies:

- Terrestrial: habitat, vascular plants, lichens, wildlife, and avifauna.
- Aquatic: wetlands, fish, and fish habitat.

2.1 Terrestrial Assessments

Biophysical field studies for the Project began in May 2023 and continued until September 2023. The field studies were focused on highlighting the ecological linkages within the PA, as well as with the surrounding habitats. The biophysical field assessments and timing are outlined in Table 2.1.

Table 2.1: Biophysical Assessment Components and Timing

Survey		Date
Vegetation Community and Classification (i.e., habitat surveys)		July 6, 2023
Vascular Plant Surveys	Early botany	June 23, 2023
	Late botany	September 27, 2023
Lichen Survey		August 17, 2023
Wildlife Surveys	Incidental observations	Opportunistically throughout all biophysical surveys
	Wood Turtle	Desktop study based on fish habitat assessment data
Avifauna Surveys	Spring migration	May 11 & 24, 2023
	Breeding bird	June 8 & July 6, 2023
	Nightjar Surveys	June 9 & July 5, 2023
	Fall migration	August 25, September 14, October 18, 2023
Wetland and Watercourse Delineations and Assessments		June 20-22 & June 27, 2023
Fish and Fish Habitat Assessments		July 11 – 14, 2023

2.1.1 Priority Species

Assessment of wildlife, vegetation, and habitat was completed based on the requirements outlined in the NSECC Guide to Addressing Wildlife Species and Habitat in an EA Registration Document (NSECC, 2009). The priority species list was created in accordance with this guide and outlined below; it is used for the following purposes:

- To identify which targeted surveys were required based on species and habitats available within the PA.
- To identify key detection times for targeted surveys.
- To inform field staff of priority species which may be encountered during biophysical surveys.

2.1.1.1 Development of a Priority Species List

In support of the assessment of priority species occurrence and use of the PA, a priority species list was created prior to commencing field assessments. The purpose of the priority species list is to identify a broad list of species that have the potential to be present within the PA. Priority species include 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 Centre (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 SARA and/or the ESA.

Development of a priority species list for flora and fauna 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. ESA – All species listed as Endangered, Threatened, or Vulnerable.
3. ACCDC Conservation Rank – All species designated as S1, S2, or S3.

Additionally, invertebrates listed under ESA, 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 ESA required open water habitat and no open water habitat is present inside the PA, this species was not carried forward to the final list.

The compilation of a priority species list is habitat driven, rather than observation driven. 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 is 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. The priority species list is referenced across the various biophysical assessments (Appendix B). See Table 2.2 for status rank definitions (ACCDC, 2025) across multiple regulatory levels.

Table 2.2: 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.
ESA	**Endangered**	A species facing imminent extirpation or extinction.
ESA	**Threatened**	A species likely to become endangered if limiting factors are not reversed.
ESA	**Vulnerable**	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
ESA	**Extirpated**	A species that no longer exists in the wild in the Province but exists in the wild outside of the Province.
ESA	**Extinct**	A species that no longer exists.
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.

Protection	Status	Definition
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		
Protection	**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.

2.1.1.2 Additional Desktop Priority Species Review

Several sources were used to supplement the desktop priority species list. These sources are described herein and include observations-based datasets (i.e., ACCDC report) and proximal datasets [e.g., provincial abandoned mine openings (AMO) database, boreal felt lichen (*Erioderma pedicellatum*) predictive habitat]. Proximal datasets are those that provide information that may support the understanding of priority species in proximity to an area. For example, AMOs may support bat hibernacula, but this dataset does not represent known bat hibernacula or observations of the species.

The ACCDC houses a comprehensive biodiversity database for Atlantic Canada, including conservation status ranks, which is updated regularly. ACCDC reports provide important supplementary, observation-driven data sources including sightings of priority species recorded within 5 km and 100 km. An ACCDC report was prepared for the PA on May 23, 2023 (Appendix C).

NSNR has classified several species as ‘location sensitive’, meaning that ACCDC is not permitted to provide specific location data for these species in their reports. Location sensitive species in Nova Scotia include black ash (*Fraxinus nigra*), Blanding’s turtle (*Emydoidea blandingii*), wood turtle (*Glyptemys insculpta*), peregrine falcon populations (*Falco peregrinus,*

pop.1), and any bat hibernaculum. If any of these species are present within 5 km of the PA, the ACCDC report will simply identify that they are present. If noted in the ACCDC report, Strum will consult with NSNR to obtain additional information on the observation.

Additional datasets reviewed during the desktop review for priority species included:

- Lichen databases, included those provided by the Mersey Tobeatic Research Institute (MTRI), that were assessed to identify potential for priority lichen species including vole ears (*Erioderma mollissimum*) and boreal felt lichen
- Provincial government records of AMOs were reviewed as AMOs that are uncapped and unflooded may provide bat hibernacula (NSNR, 2024a)
- The NSNR significant species and habitats database (NSNR, 2024d)
- Maritime Breeding Bird Atlas (MBBA)
- Canada Wildlife Service Migratory Bird Sanctuary (MBS)
- Canada Important Bird Area (IBA)
- SARA critical habitat layers
- SARA recovery strategies
- Fisheries and Oceans Canada (DFO) critical habitat mapping
- Atlantic salmon atlas
- Freshwater fish species distribution records
- Provincial Landscape Viewer – Atlantic Coastal Plain Flora (ACPF) Buffer, Lynx Buffer, Marten Range Patches 2019, Marten Range Patches 2030, Marten Habitat Management Zones, Mainland Moose Concentration Areas
- Provincial Special Management Practice layers – wood turtle, vole ears lichen, mainland moose (*Alces alces americana*), etc.

2.1.2 Habitat

The following are the desktop and field methodologies used during the habitat surveys (herein referred to as vegetation community surveys). The purpose of defining the vegetation communities within the PA is to determine what communities are present, what habitats and species they can support, and if unique or rare habitats are present (i.e., areas to target during other biophysical surveys).

2.1.2.1 Desktop Review

Prior to completing field assessments, several geospatial datasets were reviewed to inform the vegetation community surveys:

- PA spatial boundary
- Nova Scotia forestry inventory (NSNR, 2021a)
- Nova Scotia wetland inventory (NSNR, 2021c)
- Nova Scotia Topographic Database (NSTDB)
- Ecological Land Classification (ELC)
- Nova Scotia old forestry policy polygons
- Aerial imagery

These datasets allowed the surveyors to, at a high-level, identify potential areas of interest, particularly wetland features which often reflect changes in vegetation community structures.

2.1.2.2 Field Survey

Vegetation community surveys took place during wetland and watercourse delineation (June 20-22 & June 27, 2023) and on July 6, 2023, in conjunction with breeding bird surveys. Avian survey points are laid out strategically to target unique habitat types, therefore vegetation community surveys were completed in conjunction with avian surveys. This timing was selected as it facilitates proper detection and characterization of the vegetation communities and allows the findings to guide other, later surveys (i.e., targeted locations for late botany surveys). Surveys were completed by a Strum biologist walking meandering transects during wetland and watercourse delineation and at designated habitat points (HP) (Drawing 2, Appendix A). The Nova Scotia Forest Ecosystem Classification System (FEC, Keys et al., 2023) was used to classify vegetation communities found within the PA. Additionally, Natural Landscapes of Maine was used to help define non-forested wetland communities (Gawler & Cutko, 2018).

All vegetation community types encountered within the PA were georeferenced using a handheld Garmin GPSMAP 64s unit, and the following information was recorded:

- Dominant tree, shrub, and herbaceous species
- Presence of disturbance
- Anthropogenic (e.g., cut block)
- Natural (e.g., windthrow)
- None
- Representative photographs
- Vegetation community and classification (as per FEC guidelines)

Both wetland and upland vegetation communities were assessed, acknowledging that additional wetland information will be recorded during detailed wetland evaluations. The surveys were intended to locate and record the diversity of vegetation types that exist within the PA, and not to delineate the boundaries of these communities.

2.1.3 Vascular Plants

Desktop and field survey methodologies were implemented prior to conducting the vascular plant survey program and these survey methodologies are discussed below.

2.1.3.1 Desktop Review

Prior to undertaking the field assessment, a detailed desktop review of known vascular plant observations and potential habitat for rare plants within the PA was conducted. The desktop review process involved a review of the ACCDC database results (Appendix C), mapped wetland habitat, results of the vegetation community identification and classification (Section 3.1.1.2), and the priority species list (Appendix B).

Additional geospatial databases were reviewed for information pertaining to vascular plant community assemblages. These databases include ACPF Group Buffers (NSNR, 2024c) and the ecological land classifications of Nova Scotia (Neily et al., 2017). The desktop review process informs field surveyors if there is an increased likelihood of priority vascular plant species and where they may be expected (e.g., landscape characteristics).

2.1.3.2 Field Survey

Dedicated vascular plant surveys were completed early (June 23, 2023) and late (September 27, 2023) in the growing season (June 1 to September 30) to capture plant species with different flowering periods. Surveys were completed within the PA by Strum biologists Mark MacDonald and Emma Halupka. All suitable habitats, as identified within the field, were surveyed. Additionally, incidental vascular plant observations, particularly priority species, were recorded throughout the suite of other biophysical surveys conducted in 2023. Habitats particularly supportive of SAR species, especially black ash (*Fraxinus nigra*), were thoroughly searched; this included low-lying wet areas with appropriate hydrological regimes.

Meandering transects were completed on foot, and all major habitat types were assessed to create a species list of vascular species and community assemblages observed within the PA, along with georeferenced locations of priority vascular flora species (Drawing 3, Appendix A). All encountered vascular plant species were identified. If a species could not be identified in the field, detailed photographs were taken to capture diagnostic features, and, if required, specimens were collected and preserved for identification out of the field. Specimens were only collected if they were abundant on the site and were not collected if only one or two individuals were observed. All priority species observed were georeferenced, counted (when possible), photographed, and a description of their habitat was recorded. If specimens were present in tufts or in large numbers (e.g., counting was not reasonable), the areas that contained large numbers of that species were measured (e.g., 10 m x 10 m). The following literature were the primary references used during the field surveys and identification process:

- Roland's Flora of Nova Scotia (Roland et al., 1998)
- Nova Scotia Plants (Munro et al., 2014)
- Flora of New Brunswick (H. Hinds, 2000)
- Go Botany (NPT, 2024)
- Field Manual of Michigan Flora (Voss & Reznicek, 2012)
- Sedges of Maine (Arsenault et al., 2013)
- Grasses and Rushes of Maine (Mittelhauser et al., 2019)
- Mosses of Eastern North America Vol. 1 & 2 (Crum & Anderson, 1981)
- Mosses and Liverworts of Britain and Ireland – a Field Guide (Atherton et al., 2010)
- Common Mosses of the Northeast and Appalachians (Mcknight et al., 2013)

All plant species were reviewed to determine if they are a member of the ACPF group or invasives.

2.1.4 Lichens

The following are the desktop and field survey methodologies implemented during the lichen survey program.

2.1.4.1 Desktop Review

Prior to the field assessment, a detailed desktop review of known lichen observations and potential habitat for rare lichens within the PA was conducted. The desktop review process involved a review of the following:

- The Priority Species List (Appendix B)
- ACCDC database results (Appendix C)
- NSNR predictive habitat mapping for boreal felt lichen (2010)
- MTRI vole ears and extant blue felt lichen GIS databases (MTRI, 2019)
- NSNR forest inventory GIS database (NSNR, 2021a)

The desktop review process informs field surveyors if there is an increased likelihood of priority lichen species and where they may be expected. The forest inventory GIS database helps predict forest characteristics, including age, which are more suitable for lichens. While the specific habitat requirements for each priority lichen species varies, many require mature to old growth forests; stand age is one of the greatest determinants of the presence of many rare epiphytic lichens (R. T. McMullin et al., 2008).

2.1.4.2 Field Survey

All suitable lichen habitats within the PA, as identified within the field (guided by the desktop review), were surveyed on August 17, 2023, by Strum lichenologist Cole Vail. Meandering transects were completed on foot and targeted mature trees appropriate for hosting priority lichen species, supported by the preliminary habitat assessment and points (Drawing 3, Appendix A). These trees were visually inspected, focusing on tree trunks, branches, and twigs. Any identified priority species lichens were clearly marked with flagging tape.

The following information was collected for any priority lichen species identified during field surveys, along with photographs, and any other relevant information:

- Surveyor name
- Weather condition
- Survey condition
- General site location
- Date
- Scientific name
- Count (# of thalli)
- Size of thallus or thalli
- Habitat (host tree and general habitat – including within a wetland or upland)
- Location (waypoint in UTM NAD83)
- Height of the specimen

- Direction that the specimen is facing
- Any relevant comments

If a lichen specimen could not be readily identified in the field, photos and/or specimens were collected and identified later. Specimens were only collected if they were abundant on site and were not collected if only one or two individuals were observed. If necessary, collected samples were inspected via microscope and standard chemical spot tests in accordance with Brodo *et al.* (2001), to determine the species. The following literature was referenced during the surveys and identification process:

- The Macrolichens of New England (J. Hinds & Hinds, 2007)
- Lichens of North America (Brodo et al., 2001)
- Keys to Lichens of North American – Revised and Expanded (Brodo, Sharnoff, & Sharnoff, Keys to Lichens of North America - Revised and Expanded, 2016)
- Microlichens of the Pacific Northwest – Volume 1 – Key to The Genera (McCune & Geiser, 2017)
- Microlichens of the Pacific Northwest – Volume 2 – Key to the Species (McCune & Geiser, 2017)
- Common Lichens of Northeastern North America(T. McMullin & Anderson, 2014)
- The Lichens of Great Britain and Ireland (Smith, Aptroot, Coppins, Fletcher, Gilbert, James, & Wolseley, 2016)

Through the lichen survey, a list of common lichens was recorded with focus on macrolichens (i.e., foliose, fruticose, and squamulose), along with georeferenced locations of priority lichen species.

2.1.5 Fauna

Desktop and field survey methodologies were implemented during the wildlife survey program and these methodologies are discussed below.

2.1.5.1 Desktop Review

Prior to undertaking the terrestrial field assessments, a detailed desktop review of known fauna observations and potential habitat was undertaken within the PA and to support survey design. The following databases were reviewed:

- Priority species list (Appendix B)
- ACCDC report (Appendix C)
- NSNR Significant Habitat layers
- SARA Critical Habitat layers
- Government records of AMOs (NSNR, 2024a)
- SARA Recovery Strategies
- Special Management Practice Zone (SMPZ).

Additionally, NSNR is consulted regarding location sensitive species if recorded in the ACCDC report, as well as the presence of species' core habitat in relation to the PA.

2.1.5.2 Field Surveys

Wildlife surveys were completed opportunistically throughout the suite of biophysical surveys. Particular attention was paid to SAR and SOCI species. These surveys help to understand which species are present within the PA and how they could potentially interact with the Project. All observations were identified and recorded by biologists experienced in recognition of wildlife tracks, scat, and browse, resulting in a comprehensive fauna species list. Wildlife habitat availability was assessed concurrently with other biophysical surveys, within wetland and upland habitat. The following literature was referenced during the surveys and identification process:

- Mammal Tracks & Signs: A Guide to North American Species (Elbroch, 2019)
- A Field Guide to Animal Tracks (Murie, 2005)
- Dragonflies and Damselflies of the East (Paulson, 2012); and
- Tracking & the Art of Seeing (Rezendes, 1999)

Based on the desktop review, specialized surveys were deemed necessary to target specific priority species known, or having the potential, to exist within the PA and surrounding area (e.g., priority species list, ACCDC report and/or the presence of suitable habitat). Specialized surveys were designed for wood turtles. Where a priority species was identified during surveys, additional effort was made in the field to understand the habitat at the sighting location and evaluate its suitability to support the species' survival and life cycle requirements. Refer to the following subsections for additional details on specialized surveys.

Bat Field Surveys

There are seven species of bats documented in Nova Scotia, of which four are resident species that reside in the province year-round and three are migratory species that overwinter in the southern United States. Resident species include the little brown myotis (*Myotis lucifugus*), northern myotis (Myotis septentrionalis), tri-colored bat (*Perimyotis subflavus*), and big brown bat (*Eptesicus fuscus*). Migratory species include the Eastern red bat (*Lasiurus borealis*), hoary bat *(Lasiurus cinereus*), and silver-haired bat *(Lasionycteris noctivagans*).

Three resident species (the little brown myotis, northern myotis, and tri-colored bat) are protected federally and provincially under SARA and the ESA. These three species were added to the ESA as "Endangered" on July 11, 2013, and were declared "Endangered" under Schedule 1 of SARA on November 26, 2014. The designation under SARA and the ESA was driven by the emergence of white-nose syndrome (a disease caused by the fungus *Geomyces destructans*), which was first detected in Canada in 2010 and led to a 90% population decline in Nova Scotia by 2013 (COSEWIC, 2013). All three migratory bat species were listed by COSEWIC in May 2023 as "Endangered" (COSEWIC, 2023). The big brown bat is not listed under either SARA or the ESA.

Standalone bat surveys were not considered to be necessary within the PA, as no AMOs were located within it. Instead, AMOs on crown land within 5 km of the PA were checked for their conditions. Only AMOs directly accessible from public roads were assessed. AMOs can provide bat habitat, especially if they are open and unflooded. During all biophysical surveys, Strum biologists recorded any evidence of caves, open wells, cavities in mature trees, rock outcrops or other potential hibernacula or maternity roosting habitats, or any incidental observations of bats themselves. If a hibernaculum was observed, additional surveys (e.g., acoustic monitoring) would be completed.

Mainland Moose Surveys

Mainland moose (*Alces alces americana*) is listed as Endangered by the ESA and considered critically imperiled (S1) by the ACCDC. The ACCDC report notes the nearest mainland moose observation as 13.9 km away from the PA (ACCDC, 2023; Appendix C). The PA was confirmed as not overlapping with Mainland Moose Core Habitat (pers. comm. Sarah Spencer, NSNR SAR Biologist, January 23, 2024) identified in the Recovery Plan for the Moose *(Alces alces americana*) in Mainland Nova Scotia (NSNR, 2021b). Core habitat has been identified as areas that currently provide life cycle requirements of mainland moose and/or are expected to contain biophysical attributes for life cycle requirements over the next 30 years (NSNR, 2021b). Mainland moose forage in habitats that are dominated by regenerative forests and cutovers. Mature forested stands can provide areas for winter and summer cover, and areas of open water features provide calving and aquatic feeding areas in the summer months (NSNR, 2021b). Review of aerial imagery shows the forest within the PA was not comprised of all stages (NSNR, 2021a), dominated instead by mostly clearcut areas.

As the PA is not within the mainland moose core habitat, and there is no potential habitat for mainland moose in parts of the PA, dedicated mainland moose surveys were not conducted.

Herpetofauna Surveys

Field surveys were planned but not conducted for wood turtles within the PA due to extenuating circumstances caused by forest fires that occurred in May and June 2023. Wood turtles are a priority fauna species that was determined as having potential to be within the PA based on desktop analyses. The NS SMPZ review identified a wood turtle SMPZ buffer 700 m outside the PA. The wood turtle is listed as Threatened under SARA and ESA.

According to the Recovery Strategy, wood turtles require water with sufficient flow and sufficient depth to provide them with ice-free, well-oxygenated water throughout the winter (ECCC, 2020). In Ontario, wood turtles hibernate in water with an average depth of 91 ± 34.8 cm, approximately 123.3 cm from the shore (ECCC, 2020). Wood turtles tend to hibernate wherever instream structures such as boulders or root-wads provide some cover, and rarely hibernate outside of the main channel of a watercourse, as they require well oxygenated water throughout the winter (pers. comm., M. Pulsifer, January 2021).

Wood turtles nest in well-drained gravelly soil on the banks of inhabited watercourses. While some may be attracted to gravelly roadsides for nesting, this habitat is considered unsuitable

due to the danger presented to emerging hatchlings. To support egg incubation, soils need to be well-drained, with a southern aspect, and free of vegetation. This habitat is typically present as sand or gravel bars in depositional areas of dynamic, natural watercourses (ECCC, 2020).

Opportunistic observations for all turtle species and their suitable habitat were documented through all field programs, particularly wetland and watercourse evaluations. All herpetofauna incidental observations were recorded during field surveys.

It was the intention for three rounds of surveys to be completed, as outlined in the Wood Turtle *(Glyptemys insculpta)* Standardized Water-Based Survey Protocol (Ikanawtiket Environmental Inc, 2018). However, these were interrupted by the forest fires in May and June 2023. By the time it was safe to return to the woods, the window for turtle surveys had closed. Instead of completing surveys, a desktop exercise to map potential wood turtle habitat within the PA was completed in consultation with Mark McGarrigle (Species at Risk Biologist, NSNR), using detailed stream habitat descriptions collected for fish habitat surveys.

2.1.6 Avifauna

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

2.1.6.1 Desktop Review

A review of the Canada IBA database, ACCDC report, MBBA, old forest GIS database, and Canada Wildlife Service (CWS) MBS was completed to support bird survey design. The Nova Scotia Provincial Landscape Viewer was also reviewed to determine whether the PA is within, or adjacent to special features, such as protected areas. To ensure the PA is not located within any ecologically sensitive regions, the following databases were also reviewed:

- NSNR Significant Habitats
- Protected Areas/Parks and Wildlife Management Areas
- SARA Critical Habitat GIS layers
- SARA Recovery strategies
- Special Management Practice (SMPs) layers

2.1.6.2 Field Survey Design

Prior to conducting field surveys, a preliminary desktop survey design was developed to target suitable habitat for avifauna species or groups of interest (e.g., breeding birds, nightjar, owls, etc.). Survey methods were consistent with the guidelines stated in CWS (ECCC-CWS, 2022), CWS (2018), EC CWS (2007a), and EC CWS (2007b). These documents provided instructions in the following areas: survey site selection, survey location spacing, number of point counts, survey duration, and season selection.

Based on desktop review, CWS guidelines, The Guide to Addressing Wildlife Species and Habitat in an EA Registration Document (NSECC, 2009), and results from the priority species list and the ACCDC report, the following avifauna survey types were selected:

- Spring and fall migration point count (PC) surveys
- Breeding bird PC surveys and area searches
- Nightjar surveys

Winter surveys are not required or recommended by any guidelines or in regulatory meetings. Shorebird and waterfowl specific surveys were not completed since PCs during spring migration, breeding bird, and fall migration surveys included fields, wetlands, and watercourses within the PA where these bird groups would be detected if they were present. Owl surveys were not completed but were likely to be observed during Nightjar surveys. PC coverage within the PA adequately recorded raptor presence, negating the need for raptor-specific surveys in the avifauna baseline field program. In addition to this, surveyors incidentally report raptor and large stick nest observations during all, non-avian field surveys.

To determine suitable avifauna survey locations the following databases were used within GIS to encompass all habitat types and project infrastructure within the PA:

- Aerial imagery (provided by Google Earth)
- NSNR Forest Inventory
- NSECC Depth-to-Water (DTW) Model
- NSECC Wet Areas Mapping (WAM) and Flow Accumulation
- NSNRR Wetland Inventory
- NSTDB which includes road, watercourse, and topography layers
- Province of Nova Scotia Geographic Data Directory – Canopy Height Model (CHM).

Spring and Fall Migration and Breeding Bird Surveys

The following section outlines methodologies (i.e., PC surveys) employed during spring, fall, and breeding season surveys.

A total of 10 PCs were selected in representative habitats within and adjacent to the PA. These surveys are not species-specific, as avifauna species have different habitat requirements for breeding and migratory purposes, therefore a representative number of all major habitats were targeted. PC locations were spaced a minimum of 250 m depending on the complexity of habitat types and to reduce, and hopefully eliminate, the risk of double-counting individuals, as recommended in Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (ECCC-CWS, 2007).

PCs were selected as the preferred method for avian usage surveys due to the large extent of the PA and they provide identification of a broad range of species while minimizing the possibility of double-counting individuals. Attempts were made to establish PCs within and adjacent to the PA, should post-construction avifauna monitoring be required. Survey design primarily focused on both habitat and area coverage. PC locations were selected based on the desktop habitat review and were spread throughout and surrounding the PA to provide representative coverage for the diversity of habitats identified. It is Strum's understanding that PC locations provided representative sampling of avifauna habitats. A map of survey locations

is provided as Drawing 4 (Appendix A). Based on this design, the maximum number of PCs were placed within the PA while maintaining the 250 m minimum distance apart.

Note that there are three PC locations outside of the PA boundary due to changes to the boundary after the 2023 field season. These three PCs were brought forward into the avian baseline report to represent the habitat diversity that the survey design targeted with all 10 original PC locations (Drawing 4, Appendix A).

Nightjar Surveys

The common nighthawk (*Chordeiles minor*; ACCDC S3B) is listed as Special Concern by SARA/ COSEWIC and Threatened by ESA. The common nighthawk prefers to nest in gravelly substrates and is best detected while this species is foraging for insects shortly after sunset (MBBA, 2008). Based on desktop analysis and reconnaissance surveys, the PA does contain suitable habitat for the common nighthawk, such as barren areas with low shrub cover, open forests, developed areas (e.g., agricultural fields), clearcut areas, and other disturbed areas (Birds Canada, 2022; COSEWIC, 2018a).

The eastern whip-poor-will (*Antrostomus vociferus*; ACCDC S1?B) is listed as Threatened by SARA/ESA and Special Concern by COSEWIC. The eastern whip-poor-will uses a mixture of open lands for foraging and wooded areas for nesting and perching (Birds Canada, 2022). Examples of suitable habitat for eastern whip-poor-will include shrubbed wetlands, clearcuts, agricultural fields, rock or sand barrens with scattered trees, savannahs, burned areas, conifer plantations, and various types of forests at early stages of succession or edges of dense forest with similar ground-level structure. This species is found in habitat with moderate tree, shrub, and herbaceous cover (ECCC, 2018a).

Both the common nighthawk and eastern whip-poor-will are included in the functional bird group 5 (nocturnal raptors; refer to Section 2.1.6.3 for the list of functional bird groups) and were targeted for the nightjar surveys.

Potential suitable breeding and foraging habitat for common nighthawk and eastern whip-poor-will, such as roadside/gravel areas, clearcut and disturbed areas, wetland, and forested areas (Birds Canada, 2022; ECCC, 2018a; MBBA, 2008), were selected as PC locations both within the PA and the area bordering the PA. A minimum of 1.5 km spacing (with a maximum distance of approximately 2 km) was used to provide adequate coverage of the area while minimizing overlapping observations (i.e., hearing the same individual at multiple locations). Four nightjar PC locations were selected in the preliminary desktop review (Drawing 4, Appendix A). All nightjar PC locations were on public roadsides and in open areas (e.g., clearcuts or cultivated lands/agricultural fields) with proximity to the PA. Nightjar PCs on roads and open areas with wide visibility also alleviates safety concerns for the surveyor during crepuscular and nocturnal surveys.

2.1.6.3 Field Surveys

Survey locations determined in the desktop survey design were visited and adjusted if required. A breakdown of survey type, time of year, and survey rationale is described in Table 2.3. Survey dates were selected to provide representative coverage of important stages of avifauna ecology and to comply with the requirements for a Class I undertaking under Section 9(1) of the Nova Scotia Environmental Assessment Regulations. As an example, by spreading out survey dates the widest variety of migrating birds will be observed. Effort was made to spread rounds across survey periods (e.g., spring migration, breeding bird, and fall migration) to represent that entire period.

Table 2.3: Avian Surveys Completed within the PA

Survey Type	Survey Rounds	Survey Locations	Dates	Rationale	Reference for Survey Dates and Methods
Spring migration	2	10 PCs	May 2023	Bird species begin to migrate back to Canada to breed this time of year. Resident species may begin to breed on March 30. Surveying during this time period will detect any early nesters and the beginning of spring migration.	Nesting Periods – Government of Canada (ECCC, 2018a)
Breeding bird	2	10 PCs	Early June to early July 2023	June is peak breeding season in Nova Scotia. Different species breed on different schedules, therefore, spreading surveys out within June allow for greater chances to detect species. Early July will likely catch late breeders.	Maritimes Breeding Bird Atlas (2023)
Fall migration	3	10 PCs	Late August to October 2023	Bird species begin to migrate south for the winter months from late August to September. Survey rounds began in late August and extended into late October to accommodate three survey rounds and potential early/late migrants.	Maritimes Breeding Bird Atlas (2023)
Nightjar	2	4 nightjar PCs	Early June to early July 2023	To understand the use of the land within and surrounding the PA by common nighthawk and Eastern whip-poor-will. Suitable habitat for both species is found within and adjacent to the PA. Based on ACCDC, common nighthawk have been observed 1.5 (± 0.00) km away from the PA and no Eastern whip-poor-will have been observed 14.3 (± 7) km away from the PA.	Birds Canada (2022) ACCDC (2023 Project report)

Habitat descriptions at each PC were recorded and each field-verified PC location was georeferenced by a handheld Garmin GPS. General observations including temperature, visibility, wind speed, date, and start and end time were also recorded during each survey. Bearings were recorded for priority species observed during dedicated survey periods and incidentally.

Bird species were identified and assigned functional bird groups to understand how each group uses the PA. These functional groups include:

1. **Waterfowl**: Ducks, geese, or other large aquatic birds, especially when regarded as game.
2. **Shorebirds**: Waders, from the Order Charadriiformes.
3. **Other waterbirds**: Includes seabirds (i.e., marine birds), grebes (Order Podicipediformes), loons (Order Gaviiformes), Ciconiiformes (i.e., storks, herons, egrets, ibises, spoonbills, etc.), pelicans (Order Pelicaniformes), flamingos (Order Phoenicopteriformes), Gruiformes (i.e., cranes and rails), kingfishers, and dippers (the only family of passerines considered waterbirds).
4. **Diurnal Raptors**: Birds within the families Accipitridae (i.e., hawks, eagles, buzzards, harriers, kites, and old-world vultures), Pandidonidae (i.e., osprey), Sagittariidae (i.e., secretary bird), Falconidae (i.e., falcons, caracaras, and forest falcons), Cathartidae (i.e., new world vultures), and one species from the Order Strigiformes (i.e., hawk owl).
5. **Nocturnal Raptors**: Birds of the Order Strigiformes (i.e., owls; with exception of the hawk owl, which is a diurnal species of owl).
6. **Passerines**: Any bird of the Order Passeriformes, which includes more than half of all bird species. This is with exception of the dippers, which are a passerine considered a waterbird.
7. **Other Landbirds**: Birds within the Orders Galliformes (i.e., quail, pheasant, and grouse), Columbiformes (i.e., pigeons and doves), Cuculiformes (i.e., cuckoos), Caprimulgiformes (i.e., nighthawks and whip-poor-wills), Apodiformes (i.e., swifts and hummingbirds), and Piciformes (i.e., woodpeckers, flickers, and sapsuckers).

Survey methods varied for each survey type are described in detail below.

Spring and Fall Migration Surveys

Spring and fall migration surveys consisted of PC surveys as shown in Drawing 4 (Appendix A). Two rounds of spring migration surveys were completed on May 11, 2023, and May 24, 2023. Three rounds of fall migration surveys were completed on August 25, 2023, September 14, 2023, and October 18, 2023. Survey rounds were separated by a minimum of 10 days. Survey round, date, location, and weather conditions are listed in Tables 2.4 and 2.5.

A total of 10 PC locations were surveyed during spring and fall migration seasons (Drawing 4, Appendix A). Total effort for both spring and fall migration PC surveys was 200 minutes for spring migration and 300 minutes for fall migration. Surveys began at, or within half an hour of sunrise and effort was made to complete surveys by 10 am. Each PC was surveyed for a

duration of 10 minutes. At each PC, a handheld Garmin GPS unit was used to geo-reference the location. During each survey, weather conditions (i.e., temperature, wind speed, precipitation, and visibility) were monitored and bird observations were recorded at three distance categories: within a 50 m radius, 50 to 100 m radius, and outside the 100 m radius.

All birds identified (auditory and/or visual) were recorded by species, including age and sex if known. Breeding behaviour and fly-overs will also documented (e.g., altitude and flight direction). Surveys are not conducted in wind speeds over three on the Beaufort scale (12-19 km/hr), when noise levels make it difficult to hear or distinguish bird calls, or in rain that is more than a light drizzle (EC CWS, 2007b). Incidental observations, those observed outside PC locations or outside allocated survey time, were recorded for novel (e.g., not observed during any other survey) and priority species (SAR or SOCI) or species displaying breeding or other noteworthy behaviour(s).

During the dedicated bird surveys, habitat descriptions were recorded by surveyors for field verification of the desktop review.

Table 2.4: Spring and Fall Migration PC Locations and Habitat Field Descriptions

PC ID	Coordinates*		Surveyor Habitat Field Notes and Aerial Imagery Notes
	Easting	Northing	
1	340042.4	4976415.9	Dirt road. Mature mixedwood forest. Hardwood dominant. Sandy/silty soil.
2	340271.8	4976128.7	Dirt road. Empty agricultural field to West of point. East is expansive fresh clearcut with few pockets of mixedwood trees and large retention trees. Intact mixedwood forest close-by/surrounding PA where not cut. Sandy/silty soil.
3	339906.8	4975737.8	Upland bank from watercourse with small riparian and shrubbed/treed swamp. Mature mixedwood forest surrounding. Close to edge of clearcut (edge habitat).
4	340533.0	4976589.4	On road/old ATV trail. Mature mixedwood forest, softwood dominant. Well-defined shrub layer. Close to edge of clearcut (edge habitat). Sandy/silty soil.
5	341205.1	4976455.8	On logging dirt road. Middle of fresh clearcut with few little pockets of mixed wood trees and large retention trees. Sandy/silty soil.
6	341364.6	4976832.7	In fresh clear-cut. Few small mixed wood pockets of trees and large retention trees. Sandy/silty soil. Intact mixedwood forest surrounding the PA/clear-cut.
7	340788.3	4976260.3	On dirt logging road. Middle of fresh clearcut with few little pockets of mixedwood trees and large retention trees. Sandy/silty soil.
8	341520.2	4976218.5	Edge of one of the larger mixedwood pockets within the clearcut. Slightly softwood dominant. Intact mixedwood nearby (at edge of PA). Edge habitat.
9	341673.8	4975969.2	In mature mixed wood forest that is close to the clearcut edge (edge habitat). PC is on edge of treed swamp. Grass and moss herbaceous layer.

PC ID	Coordinates*		Surveyor Habitat Field Notes and Aerial Imagery Notes
	Easting	Northing	
10	341059.5	4975805.6	Edge of small swamp (Wetland 1) with large pine trees and open water. Mixedwood surrounding. Edge of clearcut nearby (edge habitat).

*Coordinates are listed in NAD83 UTM Zone 20N

Table 2.5: Spring and Fall Migration Survey Dates and Weather Conditions

Survey Round	Date	Temperature (°C)	Wind (Beaufort Scale)	Precipitation
Spring Migration				
Round 1	May 11, 2023	6 - 8	1	0
Round 2	May 24, 2023	3 - 11	0	0
Fall Migration				
Round 1	August 25, 2023	10-14	0	0
Round 2	September 14, 2023	20-22	0-2	0
Round 3	October 18, 2023	20	0	0

Weather conditions represent the entire survey (surveyors recorded weather conditions at the start and end of each survey). Precipitation scale is as follows: 0 = none, 1 = drizzle, and 2 = light/moderate. Wind scale (Beaufort scale) is as follows: 0 = <1 km/hr, 1 = 1-5 km/hr, 2 = 6-11 km/hr, and 3 = 12-19 km/hr. Survey rounds were completed and spread out as feasible based on travel and weather conditions.

Breeding Bird Surveys

Two rounds of breeding bird surveys were completed in June and July 2023 at PCs 1-10. The 10 PCs surveyed during this season occurred at the same locations for the spring and fall migration surveys. The total effort for both breeding bird PC survey rounds was 200 minutes. Rounds were separated by a minimum of 10 days. Survey round, date, location, and weather conditions are listed in Table 2.6.

The methods for breeding bird surveys mirror those described for spring and fall migration PC surveys in terms of suitable conditions and data recording, with the addition of area searches and surveying for breeding evidence within the PA. Area searches are recommended by CWS during the breeding season to visit more habitat types and/or search habitats more thoroughly for species use during the breeding season (EC CWS, 2007b).

Qualified biologists conducted the area searches between PC locations during the morning breeding bird survey or after the morning survey in different areas. Meandering, non-standardized transects were completed, focusing on new habitats or habitat with notable high activity. All bird observations were recorded in the same manner as the PC location method but with a focus on novel species, priority species, and breeding evidence. Area searches do not require standardized effort (EC CWS, 2007b), but GPS tracks were recorded. Area searches were approximately 60 to 75 minutes in length. In total, approximately 300 minutes of area searches were completed during breeding bird surveys (Drawing 4, Appendix A).

To understand breeding bird activity within and adjacent to the PA, the breeding status of all bird species observed during breeding bird surveys was also recorded. The surveyor documented bird behaviour observed, including distraction display, carrying food, and carrying

nesting material. The MBBA has various breeding evidence codes that are used to determine the breeding status based on field observations (MBBA n.d.). The following are examples of the breeding status indicators described in Atlassing for Species at Risk in the Maritime Provinces (see MBBA, 2008 to view all breeding status indicators and definitions):

- **Observed** - species observed in its breeding season.
- **Possible** - species observed during breeding season in suitable nesting habitat or singing males or breeding calls heard, in suitable nesting habitat during breeding season.
- **Probable** – male and female pair observed in suitable nesting habitat during nesting season, agitated behavior or anxiety calls of an adult.
- **Confirmed** – copulation, nest building (including adult carrying nesting material), adult carrying food, distraction display, courtship display or territorial behaviour between two individuals, behavior indicating active nest, nest containing eggs, recently fledged young (nidicolous species), or downy young (nidifugous species), including incapable of sustained flight.

Table 2.6: Breeding Bird Survey Dates and Weather Conditions

Survey Round	Date	Temperature (°C)	Wind (Beaufort Scale)	Precipitation
Round 1	June 8, 2023	8 - 15	0 - 1	0
Round 2	July 6, 2023	16 - 20	0 - 1	0

Weather conditions represent the entire survey (surveyors recorded weather conditions at the start and end of each survey). Precipitation scale is as follows: 0 = none, 1 = drizzle, and 2 = light/moderate. Wind scale (Beaufort scale) is as follows: 0 = <1 km/hr, 1 = 1-5 km/hr, 2 = 6-11 km/hr, and 3 = 12-19 km/hr. Survey rounds were completed and spread out as feasible based on travel and weather conditions.

Nightjar Surveys

Targeted surveys were selected for nightjars because these species are not reliably detected during the breeding bird PC surveys due to their crepuscular nature (Birds Canada, 2022). Protocols were based on ECCC-CWS recommendations from a previous wind power project (Birds Canada, 2022; pers. comm. Mark McGarrigle, Species at Risk Biologist, NSNR, May 5, 2022; pers. comm. Stephen Zwicker, Environmental Assessment Coordinator, ECCC-CWS, June 3, 2022) and, as a result, playback recordings were not used, and the Canadian Nightjar Survey Protocol by Birds Canada (2022) was implemented into the field program. Nightjars are crepuscular and the best time to detect these species, particularly common nighthawk, is while they are foraging for insects shortly after sunset (MBBA, 2008).

The 2022 protocol by Birds Canada recommends one survey round, however NSNR prefers two rounds (May 2022, pers. comm. Mark McGarrigle, Species at Risk Biologist, NSNR). Two dedicated survey rounds for nightjars were conducted on June 9, 2023, and July 5, 2023, at four PC locations (Drawing 4, Appendix A). These dates were selected because common nighthawk and eastern whip-poor-will tend to breed between early June and late July in the Maritimes (MBBA, 2023). Survey timing started within seven days on either side of a full moon (due to potential for eastern whip-poor-will observations; Birds Canada 2022) and surveys were completed between one hour before sunset and two hours after sunset when nightjars

are most active (pers. comm. Stephen Zwicker, Environmental Assessment Coordinator, ECCC-CWS, June 3, 2022). Combined nightjar surveys resulted in a total of 48 minutes of effort.

Nightjar surveys consisted of a six-minute passive surveying period at each nightjar PC location (hereafter CONI PC). This survey did not employ call playback or use of flashlights, as per survey protocol by Birds Canada (2022). Nightjar PCs were on roads and in open areas (e.g., cultivated lands/agricultural fields and clear-cut areas) spread throughout and outside the PA. As per survey protocol, effort was made to choose PC locations with little noise and surveys were completed between June 15 and July 15 (Birds Canada, 2022). Surveys were not conducted in wind speeds greater than Beaufort scale three, when rain was heavier than a light drizzle, or if noise levels were high enough to affect the surveyor's hearing. Site conditions and data recorded included weather conditions, cloud cover, time effort, number of cars passing by, and if the moon was visible. All individual nightjar observations were recorded, including behaviours such as vocalizations or wing booms, as well as the sex, distance to surveyor, bearing, and time the observation occurred (e.g., what type of observation or behaviour was observed when; Birds Canada, 2022). Any other bird species observed during the nightjar surveys were also recorded as incidentals.

Note that during the nightjar surveys, an opportunistic turtle survey was conducted along the survey route (between nightjar PCs) in which roadsides and water crossings under roads were surveyed for turtles or turtle nesting activity while travelling between survey locations. Any turtle observations were recorded from this effort.

Table 2.7: Nightjar PC Locations and Habitat Field Descriptions

Nightjar PC ID	Coordinates (NAD 83 UTM 20)		Surveyor Habitat Field Notes
	Easting	Northing	
1	339778.17	4975901.37	Clear cut area. Dirt logging road nearby. Large retention trees in proximity.
2	340362.51	4977522.25	Dirt Road. Hardwood surrounding road and grassy fields.
3	341935.02	4976592.15	Dirt Road. Quarry (off-site)/forested area. Surrounded by hardwood and mixedwood.
4	342059.67	4974509.09	Next road by grassy field and shrubby roadsides. Surrounded by mixedwood and hardwood patches.

Table 2.8: Nightjar Survey Dates and Weather Conditions

Survey Round	Date	Temperature (°C)	Wind (Beaufort Scale)	Precipitation	Surveyor Notes
Round 1	June 9, 2023	13	0	0	Moderate noise. Slight car noise in distance and low spring peeper noise. The noise did not negatively impact the survey.
Round 2	July 5, 2023	18 - 21	0 - 1	0	No Noise.

Weather conditions represent the entire survey (surveyors recorded weather conditions at the start and end of each survey). Precipitation scale is as follows: 0 = none, 1 = drizzle, and 2 = light/moderate. Wind scale (Beaufort scale) is as follows: 0 = <1 km/hr, 1 = 1-5 km/hr, 2 = 6-11 km/hr, and 3 = 12-19 km/hr.

2.2 Aquatic Assessments

The following subsections outline the methods undertaken to assess wetlands, surface water, and fish and fish habitat.

2.2.1 Wetlands

A desktop review and field survey were implemented during the wetland survey program, these methods are discussed below.

2.2.1.1 Desktop Review

A desktop review of available topographic maps, provincial databases, and aerial photography was completed to aid in the determination and assessment of wetland habitat in the PA. Predicted wetland areas were identified from the NSNR Wetland Inventory Database (NSNR, 2021c); predicted watercourses were identified from the NSTDB watercourse layer (version dated December 18, 2020). The WAM database (version dated December 2007), the provincial flow accumulation data set (version dated May 2007) and LiDAR data (various dates) was reviewed to identify potential un-mapped wetlands. The predictive WSS layer, provided by NSECC, was consulted for the presence of expected and potential WSS within the PA (NSECC, June 2020).

2.2.1.2 Wetlands of Special Significance

The Wetland Conservation Policy was developed by NSECC (NSECC, 2019). Its mandate is to provide a framework for the conservation of wetlands. Furthermore, it provides a framework for the identification of WSS. According to NSECC (NSECC, 2019; p.11-12), the following criteria define WSS:

- All salt marshes.
- Wetlands that are within or partially within a designated Ramsar site, Provincial Wildlife Management Area (Crown and Provincial lands only), Provincial Park, Nature Reserve, Wilderness Areas or lands owned or legally protected by non-government charitable conservation land trusts.

- Intact or restored wetlands that are project sites under the North American Waterfowl Management Plan and secured for conservation through the Nova Scotia Easter Habitat Joint Venture (NS-EHJV).
- Wetlands known to support at-risk species as designated under the federal SARA or the ESA.
- Wetlands in designated protected water areas as described within Section 106 of the *Environment Act*.

A province-wide framework for determination of WSS using Wetland Ecosystem Services Protocol - Atlantic Canada (WESP-AC) has recently been developed. Among the wetland characteristics, functions, and services to be considered during the process are whether the area:

- Supports a significant species or species assemblages (e.g., coastal plain flora)
- Supports high wildlife biodiversity
- Has significant hydrologic value
- Has high social or cultural importance

A framework for determination of WSS designation based on functional benefit using the Wetland Ecosystem Services Protocol – Atlantic Canada (WESP-AC) has recently been developed and implemented by NSECC in August 2021. A Functional WSS Interpretation Tool automatically assesses the subject wetland based on the WESP-AC functional results. The grouped functions in Section 3.2.1.2 are used to calculate a “Functional Benefit Product” (FBP). The FBP is categorized into scores of “low”, “moderate” and “high”. The thresholds for these categories are calibrated by WESP-AC assessments across Nova Scotia. These categories are used to create WSS determination rules. The grouped functions are further combined into “supergroups” for habitat (Aquatic Habitat and Transition Habitat) and support (Hydrologic Support, Water Quality Support and Aquatic Support) functions. The wetland is determined to be a WSS if certain ‘high’ or combination of ‘moderate and ‘high’ scores are satisfied within these supergroups.

NSECC has also developed a WSS predictive GIS layer (pers. comm., NSECC Wetland Specialist, September 2020), which was consulted during the desktop evaluation for wetlands prior to field delineations by Strum. The layer overlies mapped wetlands with protected areas layers, and rare species observations from ACCDC, among other attributes. According to NSECC, this WSS GIS layer is intended to be used as a planning tool and should be interpreted as potential WSS, as it incorporates all ACCDC priority species observations which fall within NSECC mapped wetlands, regardless of the species’ ranking or status, positional accuracy of the data points, observation date, etc.

Final WSS designation will be determined by NSECC with guidance from data collected through Project field surveys and wetland assessment presented herein. The Project team will engage with NSECC to discuss WSS designation on a site-specific basis through the permitting process.

2.2.1.3 Field survey

Meandering transects were completed within the PA to identify wetland habitat from June 20 - 23, 2023. Desktop review results showing topographic trends and habitat types guided survey routes. Wetland delineation and assessment took place within the growing season (June 1 to September 30). Wetland delineation was conducted in accordance with the Corps of Engineers Wetland Delineation Manual (Environmental Laboratory, 1987) and the Regional Supplement to the United States Army Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (United States Army Corps of Engineers 2011). In each wetland, vegetation, hydrology, and soils data were recorded at both wetland and upland data points on either side of the wetland boundary in accordance with the Army Corps of Engineers Wetland Delineation Manual (Environmental Laboratory, 1987). Wetland classes were determined using the Canadian Wetland Classification System (NWWG, 1997).

In keeping with the Army Corps of Engineers methodologies for wetland delineation, three criteria are required for a wetland determination to be made:

- Presence of hydrophytic (water loving) vegetation
- Presence of hydrologic conditions that result in periods of flooding, ponding, or saturation during the growing season
- Presence of hydric soils

Wetland boundaries were recorded using a handheld Garmin GPS unit, with sub-5 m accuracy. All watercourses observed within the boundaries of the wetland were mapped and assessed. The delineated wetlands were flagged with pink flagging tape and Wetland Data Determination Forms were completed in and adjacent to wetlands identified to confirm wetland/upland conditions and boundaries. Wetland functional assessments were completed for each wetland identified within the PA using the WESP-AC wetland evaluation technique within the growing season. The WESP-AC process involves the completion of three forms: a desktop review portion that examines the landscape level aerial conditions in which the wetland is situated, and two field forms identifying biophysical characteristics of the wetland (field form) and stressors within the wetland (stressors form).

Additionally, a Strum-designed rapid functional assessment field form was completed, which contained information on wetland type, dominant vegetation types, landform, water flow, and landscape position. The form also contains information on saturation, groundwater, and the presence of ponded water; notes will be made on the level of ground irregularity, water movement, vegetation patterns, fish presence, priority species and/or habitat presence, vegetated buffer, and canopy cover. This assessment is completed in addition to the WESP-AC functional assessment.

Hydrophytic Vegetation Methodology

Hydrophytic vegetation is defined as the total macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanent or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present

(Environmental Laboratory, 1987). Hydrophytic vegetation should be the dominant plant type in wetland habitat (Environmental Laboratory, 1987).

Dominant plant species observed at each data point location were classified according to their indicator status (probability of occurrence in wetlands), in accordance with the Nova Scotia Wetland Indicator Plant List. Further relevant information was reviewed in Flora of Nova Scotia (Zinck, 1998; Munro, Newell, and Hill, 2014).

If the majority (greater than 50%) of the dominant vegetation at a data point is classified as obligate (OBL), facultative wetland (FACW), or facultative (FAC) (excluding FAC-), then the location of the data point is considered to be dominated by hydrophytic vegetation. The prevalence index (PI) was used to calculate and determine positive hydrophytic vegetation indicators.

Wetland Hydrology Methodology

Wetland habitat, by definition, has a water table at, near, or above the land surface or that is saturated with water either periodically or permanently. To be classified as a wetland, a site should have at least one primary indicator or two secondary indicators of wetland hydrology. Examples of primary indicators of wetland hydrology include water marks, drift lines, sediment deposition, and water-stained leaves. Examples of secondary indicators of wetland hydrology include oxidized root channels, dry season water table, and stunted or stressed plants.

Each area of expected wetland habitat was assessed for signs of hydrology through observations across the area and assessment of soil pits at each data point.

Hydric Soils Methodology

A hydric soil is defined as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA, NRCS, 2003). Indicators that a hydric soil is present include the following: soil colour (gleyed soils and soils with bright mottles and/or low matrix chroma), aquic or preaquic moisture regime, reducing soil conditions, sulfidic material (odour), soils listed on the hydric soils list, iron and manganese concretions, organic soils (histosols), histic epipedon, high organic content in surface layer in sandy soils, and organic streaking in sandy soils.

A soil pit was completed at each data point location. These pits were excavated to a maximum depth of 50 cm or refusal. The soil in each was then examined for hydric soil indicators. The matrix colour and mottle colour (if present) of the soil were determined using Munsell Soil Colour Charts.

Wetland Functional Assessment

Wetland functional assessments were completed for each wetland within the PA using the Wetland Ecosystem Services Protocol – Atlantic Canada (WESP-AC) evaluation technique.

The WESP-AC process involves the completion of three forms; a desktop review portion (office form) that examines the landscape level aerial conditions in which the wetland is situated, and two field forms identifying biophysical characteristics of the wetland (field form) and stressors within the wetland (Stressors Form), if any. The process serves as a rapid method for assessing individual wetland functions and values. WESP-AC addresses 17 specific functions that wetlands may provide (Table 2.9).

The specific wetland functions are individually allocated into grouped wetland functions and measured for “function” and “benefit” scores. Wetland function relates to what a wetland does naturally (i.e., water storage), whereas wetland benefits are benefits of the function, whether it is ecological, social, or economic. The highest functioning wetlands are those that have both high function and benefit scores for a given function. WESP-AC enables a comparison to be made between individual wetlands within the province to gain a sense of the importance each has in providing ecosystem services.

Table 2.9: WESP-AC Wetland Function Parameters

Grouped Wetland Function	Specific Wetland Functions
Hydrologic Function	Surface Water Storage
Aquatic Support	Aquatic Invertebrate Habitat
	Stream Flow Support
	Organic Nutrient Export
	Water Cooling
Water Quality	Sediment Retention & Stabilization
	Phosphorus Retention
	Nitrate Removal & Retention
	Carbon Sequestration
Aquatic Habitat	Anadromous Fish Habitat
	Resident Fish Habitat
	Waterbird Feeding Habitat
	Waterbird Nesting Habitat
	Amphibian and Turtle Habitat
Terrestrial Habitat	Songbird, Raptor, & Mammal Habitat
	Pollinator Habitat
	Native Plant Habitat

In addition to the grouped wetland functions above, WESP-AC also measures the following grouped functions, however these are only evaluated by their benefit scores:

- Wetland Condition
- Wetland Risk.

The following individual functions are assessed to determine the benefit scores associated with each wetland:

- Public Use & Recognition
- Wetland Sensitivity
- Wetland Ecological Condition
- Wetland Stressors

For each wetland evaluated, WESP-AC process calculates the overall score for the seven grouped wetland functions and the 17 specific wetland functions listed in Table 2.9 above. One score each is provided for function and benefit. Scores are ranked as 'Lower', 'Moderate', or 'Higher', allowing for analysis of the wetland as compared to baseline wetland scores in Nova Scotia. A 'Higher' WESP-AC score means that wetland has a greater capacity to support those processes as compared to other wetlands in the province. A 'Higher' WESP-AC score in both the function and benefits category means the wetland supports the natural ecosystem functions and provides services potentially important to society.

A summary of the WESP-AC results is provided in Appendix D. The raw WESP-AC Excel files can be provided to the NSECC Wetland Specialist(s) upon request.

The WESP-AC functional evaluation technique recognizes that, in many cases, delineation of entire wetlands where they extend beyond the PA is not always feasible (e.g., property ownership) or necessary to complete an appropriate assessment (Adamus, 2021). Instead, WESP-AC permits the delimitation of an Assessment Area (AA), defined as the wetland or portion of wetland physically assessed in the field, while the Office Form considers the broader landscape characteristics and functions that extend beyond the AA and/or PA.

2.2.2 Surface Water, Fish and Fish Habitat

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 Aquatic Study Area prior to the construction of the Project.

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 Aquatic Study Area to support the description of fish habitat and determine effects to regulated watercourses which may require provincial approval.

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 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. In addition to the above-mentioned definition and in accordance with the Guide to Altering Watercourses (NSECC, 2015), the watercourse parameters listed in this document were used to aid in determining the presence of a watercourse.

The following desktop and field survey methodologies were implemented during the surface water, fish, and fish habitat survey programs and are discussed below.

2.2.2.1 Desktop Review

The goal of the desktop evaluation was to identify the location of watercourses and waterbodies (i.e., potential fish habitat features) within, or in proximity to, the PA based on mapped systems, topography, and satellite imagery. An assessment of where the PA lies within primary and secondary watersheds was also conducted (Drawing 5, Appendix A). Prior to completing the field evaluation, Strum reviewed all topographically mapped watercourses and waterbodies, provincial flow accumulation data, and depth to water table mapping to identify potential surface water features within the PA (Drawing 6, Appendix A).

Information on confirmed and potential fish presence within the PA and surrounding surface water features was collected from the following sources:

- ACCDC Report (Appendix C)
- NSNR Significant Species and Habitats database
- Aquatic Species at Risk Map (DFO, 2025)
- Fisheries and Oceans Stock Status Reports (Gibson et al., 2003)
- Description of Selected Lake Characteristics and Occurrence of Fish Species in 781 Nova Scotia Lakes (Alexander et al., 1986)
- Nova Scotia Salmon Atlas (iBookfishing, 2022)
- Freshwater Fish Species Distribution Records (Nova Scotia, 2019)
- Nova Scotia Department of Fisheries and Aquaculture (NSDFA) Lake Inventory Maps
- Canadian Rivers Institute (CRI) inland fish distribution maps
- Local angler database (Fishbrain, N.D.)

2.2.2.2 Field Surveys

The Aquatic Study Area (Drawing 7, Appendix A) was established to identify watercourses (i.e., fish habitat) that may be directly or indirectly affected by the Project. The following surveys were completed throughout the Aquatic Study Area:

- Watercourse delineation
- Fish collection through electrofishing and trapping
- In-situ water quality measurements
- Detailed fish habitat assessment

Watercourse Delineation

Watercourse delineation and site drainage characterizations were completed throughout the PA in conjunction with wetland delineation and evaluation.

During the field evaluations, Strum used NSECC guidance on watercourse determinations to identify watercourses (NSECC, 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
- 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-5m accuracy). All features were characterized through detailed fish habitat assessments.

Fish habitat is described in the context of any aquatic feature which is contiguous with a fish bearing stream, whether it is located within a watercourse, wetland, or waterbody. Throughout this report, this will primarily be described in the context of watercourses, however the term ‘open water’ will be used.

Open water features were identified as components of linear watercourses (e.g., ponds) that were 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 2 m depth, <8 ha in size, and had less than 50% vegetative cover following guidance from the Army Corps of Engineers wetland delineation manual (Environmental Laboratory, 1987). All wetlands

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

Fish Surveys: Electrofishing

Electrofishing was conducted within three survey locations in the Aquatic Study Area: WC2 and WC3 (Drawing 7, Appendix A). Aquatic field surveys took place outside of the PA, in downstream habitat due to accessibility. A nearby road allowed the field crew to safely enter the woods with an electrofisher and all necessary gear. Data collected from downstream reaches represents what would be observed upstream due to similar habitats. Sampling reaches of approximately 100 m, if possible, and not restricted by watercourse length, were selected as representative habitats with potential to support fish along a section of a watercourse. The goal of the two pass, open site electrofishing surveys, was to determine fish species presence and to estimate relative abundance within the Aquatic Study Area. Fish collection was completed under Fisheries and Oceans Canada Fishing License # 341208.

Electrofishing was completed using guidance from the Strum SOP for Fish Collection (Appendix E). The methods and data collection forms outlined in the SOP were developed using the following sources:

- A review of fish sampling methods commonly used in Canadian freshwater habitats (Portt et al., 2006)
- New Brunswick (NB) Aquatic Resources Data Warehouse, the NB Department of Natural Resources and Energy, and the NB Wildlife Council (2006)
- DFO's Interim Policy for the Use of Backpack Electrofishing Units (DFO, 2003)

DFO'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.

Standardized data collection forms developed by the NB Aquatic Resources Data Warehouse, the NB Department of Natural Resources and Energy, and the NB Wildlife Council (2006) were adapted for use for field data collection during electrofishing surveys. Field data collected included the physical and chemical parameters of the electrofishing site, electrofishing methods and settings, and results of electrofishing surveys.

Fish were sampled within open sites (i.e., without the use of barrier nets) using a Halltech Battery Backpack Electrofisher (HT-2000) with unpulsed direct current (DC). A two pass approach was used and an open site was employed to ensure the greatest likelihood of capturing any fish present and estimate relative abundance. 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, a 5-gallon plastic bucket that contains ambient stream water. The live well was kept out of the sun and 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 (per Section 1.5 of the fish license #341208). At the conclusion of the pass, fish in the live well were identified to species and measured for length and weight. After recuperating from the electrofishing shock, all fish were released back into the sampled reach.

Details of the electrofishing locations and survey dates are presented in Table 2.10. Electrofishing locations are shown in Drawing 7 (Appendix A) and representative photographs of each electrofishing reach are provided in Appendix F.

Table 2.10: Electrofishing Survey Details

Electrofishing Location	Stream Order	Survey Dates	Upstream Coordinates (UTM)		Downstream Coordinates (UTM)		Reach Length (m)
			Easting	Northing	Easting	Northing	
WC2	1	July 12, 2023	339775	4975676	339698	4975649	100
			339990	4975733	339892	4975710	100
WC3	1	July 14, 2023	339905	4976484	339925	4976430	100

Fish Surveys: Trapping

Trapping was conducted in conjunction with electrofishing surveys to capture and record fish presence within WC2 and Open Water A on July 11 and 12, 2023. Minnow traps and eel pots were used to capture and record fish presence, as water levels at the time of assessment were insufficient to deploy other, larger trap types (e.g. fyke nets). Minnow traps have an effective catch range of body depths approximately 6-50 mm. Eel pots have an effective catch range of body depths approximately 10 – 80 mm. Baited minnow traps and eel pots were set in pools with sufficient water depths to cover the traps, left overnight, and collected the following day.

Details of fish collection locations, survey dates, and traps deployed are provided in Table 2.11. Trap locations are shown on Drawing 7 (Appendix A).

Table 2.11: Trapping Details

Water-	Site	UTM		Survey Dates	Traps Deployed	
Open Water A	Site 1	341060	4975850	July 11-12, 2023	MT	2
	Site 2	341046	4975791	July 11-12, 2023	MT	2
	Site 3	341021	4975799	July 11-12, 2023	MT	2
	Site 4	341032	4975809	July 11-12, 2023	EP	1
WC1	Site 1	339791	4975683	July 12-13, 2023	MT	2
	Site 2	339812	4975710	July 12-13, 2023	MT	2
	Site 3	339856	4975708	July 12-13, 2023	MT	2
	Site 4	339878	4975713	July 12-13, 2023	MT	2
	Site 5	338814	4975710	July 12-13, 2023	EP	1
	Site 6	339856	4975709	July 12-13, 2023	EP	1

Water Quality Measurements

In-situ water quality measurements were recorded for each watercourse reach delineated through detailed habitat assessments. Water quality measurements were collected using a calibrated Myron Ultrapen DO Pen Probe and Hannah Combo pH/Conductivity/TDS Probe at the time of the sampling event/survey.

Fish Habitat Characterization

Detailed fish habitat surveys were completed by Strum biologists for fish habitat features. Fish habitat characterization was completed using guidance from the Strum SOP for Fish Habitat Assessments in the lotic environment (Appendix G).

To support fish habitat assessments, watercourses within the Aquatic Study Area were 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. 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.

For each reach (i.e., homogenous section of watercourse), 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 factors (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 150 m in total length, six 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 lentic fish habitat characterizations for open water features could not be completed due to wading conditions brought on by deep water and muck substrates. Instead, the general habitat type was described and measurements of depth, substrate, velocity (where possible), vegetative cover and width were recorded and validated with aerial image interpretation. This also applies to watercourses with unsafe wading conditions.

Detailed fish habitat surveys were performed on watercourses and waterbodies predicted to have direct or indirect effects from the Project, WC1, WC2, WC3 and associated open water feature (Open Water A), as shown on Drawing 7 (Appendix A).

3.0 EXISTING CONDITIONS

3.1 Terrestrial Environment

Habitat and vegetation community assessments as well as surveys for vascular plants and lichens were completed to determine potential impacts to species or their specific habitat which may be protected under legislation.

3.1.1 Vegetation Community Classification

The desktop review and field results for the vegetation community assessment completed within the PA are provided in the following sections. Vegetation community assessments were completed to address key topics regarding species habitat as discussed in The Guide to Addressing Wildlife Species and Habitat in an EA Registration Document (NSECC, 2009).

3.1.1.1 Desktop Results

The PA is in the Valley and Central Lowlands Ecoregion (600) and the Annapolis Valley (610) ecodistrict (NSNR, 2019). The Valley and Central Lowlands ecoregion is mostly sheltered from coastal climatic influences, translating to an early spring and hotter summers. The growing season is extended in this ecoregion, and mean annual precipitation ranges between 1100 and 1300 mm. The total area of this ecoregion is 4065 km^2 or approximately 7.4% of the province (Neily et al., 2017).The Annapolis Valley ecodistrict is kept warm as it is sheltered by both the North and South Mountains from the stronger oceanic influences of the Bay of Fundy (Neily et al., 2017). The Annapolis Valley ecodistrict is rarely more than 11km in width and reaches just over 140km in length. It extends from Boot Island in the Minas Basin to portions of Digby County, within St. Mary's Bay (Neily et al., 2017). This ecodistrict is dominated by agricultural lands, being the most intensely farmed ecodistrict in the province. Early successional forests of aspen (*Populus spp.*), red maple (*Acer rubrum*), white ash *(Fraxinus americana)*, grey and white birch *(Betula populifolia, Betula papyrifera)* occur on farmlands that have reverted to forest cover (Neily et al., 2017). Late successional forests of red spruce (*Picea rubens*), white pine (*Pinus strobus*), and hemlock (*Tsuga canadensis*) on zonal sites are rare in the Annapolis Valley ecodistrict. Black spruce (*Picea mariana),* and red maple forests are still common on the wet soils unsuitable for farming. White pine, red pine (*Pinus resinosa*), and red oak (*Quercus rubra*) are also common on dry, coarse sandy soils. (Neily et al., 2017).

No Old Forest polygons are present within the PA (NSNR, 2024b). NSNR forestry polygons (2022) identified that the PA is composed of softwood, hardwood, and mixed wood stands (Drawing 2, Appendix A). The closest Nova Scotia Old Forestry Policy polygon is 867 m east of the PA.

The PA is not located in any protected or conservation areas within federal, provincial, or municipal jurisdiction. Drawing 8 (Appendix A) shows the PA and surrounding significant habitats and conservation areas. The Nova Scotia Provincial Landscape Viewer (NSNR, 2024c) and desktop review identified the following:

- Torbrook Nature Reserve is located 2.3 km south of the PA
- The Cloud Lake Wilderness Area is located 7.1 km south of the PA

The Provincial Landscape Viewer was reviewed to identify the land cover within the PA (Table 3.1; Drawing 2).These estimations are based on the NSNR Forest Inventory (NSNR, 2021a).

Table 3.1: Land Cover Types within the Project Area and their Respected Percent Cover as Determined by the Provincial Landscape Viewer and NSNR Forest Inventory

Habitat Type[1]	Area (ha)	Approximate Percentage of PA (%)
Hardwood Forests	9.84	9%
Softwood Forest	1.27	1%
Mixedwood Forests	10.29	9%
Disturbed	87.38	80%
Wetland	0.72	1%
Total PA	109.55	100.0

[1]Includes wetlands from provincial forestry layer (NSNR 2021) and does not include field delineated wetlands.

Via desktop review, the habitat in the PA mainly consists of disturbed area (87.38 ha, 80% of the PA), mixedwood forest (10.29 ha, 9% of the PA), and hardwood forest (9.84 ha, 9 %).

Hardwood is dominant in the southern and northern portions of the PA. The disturbed area comprises a majority of the site, leaving a margin of forest surrounding the clear-cut center. Mapped wetland habitat in the PA equates to 0.72 ha. Two mapped wetlands are present in the southern part of the PA. Refer to Section 3.2.1 for additional details on wetlands.

3.1.1.2 Field Results

The field survey found the PA is comprised of a mosaic of softwood dominated stands and disturbed areas. Disturbed portions of the PA include a road and a large, cleared, forestry operations area. A softwood dominated stand is situated within the center of the PA, remained after harvesting operations. See Table 3.2 and Drawing 2 (Appendix A) for vegetation communities and corresponding HPs.

Table 3.2: Vegetation Community Groups and Vegetation Types within the PA

Community Type	Vegetation Group	Vegetation Type (VTs)	HP	Classification Source
Upland & Wetland Communities	Spruce-Hemlock Forest Group	SH1 – Red maple / Hay-scented fern / Wood sorrel	HP3	FEC
	Spruce Pine Forest Group	SP4 – Hemlock / Pin cushion moss / Needle carpet	HP4	FEC
	Anthropogenic	Clearcut	HP1, HP2, HP5	N/A
	Wet Deciduous Group	WD3	HP6	FEC

The vegetation groups and vegetation types identified within the PA are described in detail within the following subsections.

3.1.1.3 Vegetation Community and Classification – Upland Communities

The following subsections outline the vegetation communities observed within the PA.

Spruce-Hemlock Forest Group (SH)

The Spruce-Hemlock Forest Group is primarily composed of vegetation types with a range of slope positions. Most sites are non-rocky, though surface stoniness varies. Soils in this Forest Group are mainly derived from glacial till deposits. This group represents mid to late successional softwood VTs. Red spruce, hemlock, and white pine are the dominant trees.

SH1 – Hemlock / Pin Cushion Moss / Needle Carpet

The SH1 is a late successional VT with an overstory dominated by hemlock. It can also contain scattered red spruce, white pine and/or yellow birch. Hemlock dominance persists due to its ability to shade out other trees once established in the canopy. Resultant of the long-lived and shade-tolerant nature of hemlock, this VT will develop old forest characteristics. Hurricanes and/or fires may periodically renew this VT at a stand-level. The shrub layer is primarily regenerating conifers, especially hemlock, red spruce, and balsam fir (*Abies balsamea)*. Herb cover can be diverse, but coverage is usually low. Typical species include evergreen wood fern (*Dryopteris intermedia*), rose twisted stalk (*Streptopus lanceolatus*), and starflower (*Lysimachia borealis*). The SH1 vegetation type was observed in one location within the PA, HP3, a remaining forest stand within the clear cut.

Spruce Pine Forest Group (SP)

The Spruce-Pine forest group consists of vegetation types that are associated with nutrient poor soils which are often related to forest disturbances (Neily et al., 2023). Conifer species, primarily spruce and pine, are often dominant within this forest group. As a result of the nutrient poor acidic soils, ericaceous species are also often present within this group (Keys et al., 2023). One vegetation type within this group was observed within the PA, SP4.

SP4 – White pine / Blueberry / Bracken

The SP4 vegetation type (VT) can be an early to mid-successional VT that typically occurs on dry to moist, nutrient poor sites. White pine is the dominant overstory tree, and the deep roots of this species can allow it to access moisture during drier periods of time (Neily et al., 2023). This VT is typical following a stand-replacing disturbance such as fire, and a dense shrub layer is usually present. Species such as lambkill (*Kalmia angustifolia*), velvet-leaf blueberry (*Vaccinium myrtilloides*), and lowbush blueberry (*Vaccinium angustofolium*) are often prevalent. A herbaceous layer is composed of a low diversity of species, and an extensive bryophyte cover is typical. The SP4 VT was observed at one different locations within the PA: HP4

Anthropogenically Influenced

Clearcut

The vegetation community classification guides used in the field focus on natural communities and do not describe human-disturbed landscapes as they are often dynamic and unpredictable. Vegetation communities in disturbed landscapes such as cutblocks were categorized into the clearcut group. It is important to note these communities as they are widespread throughout the PA, making up a majority of the landscape, and speak to the level of disturbance found in the area. The community structure usually varies but is often dominated by species such as woolgrass (*Scirpus cyperinus*), soft rush (*Juncus effusus*), bent grasses (*Agrostis* spp.) and a variety of different members of the aster family (*Asteracea*). Only upland communities were found within the clearcut area. HP 1, 2, & 5 were located within the clearcut.

3.1.1.4 Vegetation Community and Classification – Wetland Communities

The following subsections outline the wetland vegetation communities.

Wet Deciduous Forest Group (WD)

The Wet-Deciduous forest group consists of vegetation types that are characterized by water at or near the ground surface for most of the growing season (Neily et al., 2023). Deciduous species, primarily red maple and white ash, are often dominant within this forest group. As a result of the moderate or high nutrient availability in soils, the presence of white ash being indicative of elevated richness (Neily et al., 2023). The understory of this group are usually composed of regenerating tree species, speckled alder *(Alnus incana)*, winterberry (*Ilex verticillata*), and mountain holly (*Ilex mucronata,* (Neily et al., 2023). One vegetation type within this group was observed within the PA, WD3.

WD3 – Red maple / Sensitive Fern – Lady Fern/ Sphagnum

The WD3 VT can occur at a variety of successional stages with an overstory dominated by red maple. It can also contain scattered white as sugar maple and/or yellow birch, among other species. Hurricanes and other wind-events may periodically renew this VT at a stand-level. The shrub layer is primarily regenerating canopy species, balsam fir, beaked hazelnut, and wild raisin. Herb cover can be diverse, but coverage is usually low. Typical species include sensitive fern (*Onoclea sensibilis*), lady fern (*Athyrium filix-femina*), and dwarf raspberry (*Rubus pubescens*). The WD3 vegetation type was observed in one location within the PA, HP6.

3.1.1.5 Vegetation Community and Classification Summary

The PA is comprised of VTs within the Spruce-Pine Forest Group (SP), the Spruce-Hemlock Forest Group (SH), a clearcut group, and Wet Deciduous Forest Group (WD). VTs informed field surveys for rare vascular and nonvascular species. The vegetative communities identified within the PA are common in the surrounding landscape and the province. Though the habitat communities were not delineated in the field, the HPs recorded provide a representative overview demonstrating the diversity of VTs that exist within the PA.

3.1.2 Vascular Plants

The following sections outline the results from the desktop review and the field surveys completed within the PA.

3.1.2.1 Desktop Results

The ACCDC reports the presence of 224 records of 32 vascular plant species within 6 km of the PA. The ACCDC report also states that there are observations of black ash (*Fraxinus nigra*) near the PA. Communication with NSNR in January 2023 confirmed that there are no black ash observations within the PA (S. Spencer, NSNR SAR Biologist, Personal Communications, June 26, 2023). In addition, Ms. Spencer stated that the closest location of core habitat for black ash to the PA is 2.5 km northwest of the PA.

There are no ACPF buffers within the PA, with the closest buffers located 1.7 km north and 1.8km south of the PA near Route 201 and Nictaux River, respectively.

Two SAR vascular plants were identified as having been found within 6 km of the PA during desktop review: dense blazing star (*Liatris spicata,* SARA/COSEWIC Threatened, SNA) and eastern white cedar (*Thuja occidentalis, ESA* Vulnerable, S2S3). Refer to the ACCDC report (Appendix C) for a full list of SOCI vascular plants.

3.1.2.2 Field Results

A total of 145 vascular plant species were observed within the PA during botany surveys, wetland delineation, and incidentally. None of the vascular plants identified are classified as SAR, however, four are SOCI. The four SOCI identified (Drawing 9, Appendix A) can be found below:

- Hop sedge (*Carex lupulina,* ACCDC S3)
- American beech (*Fagus grandifolia*, ACCDC S3S4)
- White elm (*Ulmus americana*, ACCDC S3S4)
- Meadow horsetail (*Equisetum pratense*, ACCDC S3S4)

Within the PA, 5.5% of the observed vascular plant species comprised of exotics (n=8), 94.5% (n=137) were native. A list of all plants observed can be found in Appendix H.

As discussed in Section 3.1.1, the PA consists primarily of intact and regenerating softwood dominated forested communities and wetlands with disturbed sites consisting of the dirt road and cleared areas. Hydrophytic vegetation was present in wetlands (Section 3.2.1). The disturbed habitats (e.g., cleared areas) consisted primarily of herbaceous pioneer species, with many of the exotic species being confined to the edges of the dirt roads.

3.1.2.3 Priority Vascular Plants

Observation details of the four priority vascular plant species identified within the PA are outlined in Table 3.3 (Drawing 9, Appendix A).

Table 3.3: Summary of Priority Vascular Plant Observations within the PA

Scientific Name	Common Name	COSEWIC	SARA	ESA	S-Rank	No. of Observation Locations within the PA	No. of Individuals Within the PA
Carex lupulina	Hop sedge	-	-	-	S3	2	2
Fagus grandifolia	American beech	-	-	-	S3S4	1	10
Ulmus americana	White elm	-	-	-	S3S4	2	2
Equisetum pratense	Meadow horsetail	-	-	-	S3S4	1	1

The descriptions of the species and locations within the PA for these species are described below:

Hop sedge

Hop sedge, while variable in size, has an inflorescence that may reach 40 cm tall. It has 1-2 staminate spikes, with pistillate spikes composed of cylinders of up to 80 flowers (Munro et al., 2014). It flowers and fruits in June and grows in the borders of wet woods and along swampy shores (H. Hinds, 2000). Both observations are within proximity to each other in WL1.

American beech

This species, common in mature woods, often exhibits black warty cankers caused by beech bark disease, an insect-fungus complex composed of the beech scale insect (*Cryptococcus fagisuga*) and the fungus *Nectria galligena* (H. Hinds, 2000). A healthy tree would have a smooth elephant grey bark – and the sharply toothed leaves are often retained during winter; the tree has cigar shaped winter buds, providing a distinguishing feature (H. Hinds, 2000). One observation of this species was found within 20 m north of WL1.

White elm

The white elm is common on alluvial soils such as flood plains but can also be found in rich, wet upland and hardwood forests (H. Hinds, 2000*).* While many mature trees have succumbed to dutch elm disease, scattered populations still occur. These trees have doubly serrate leaves that are 15 cm at maturity on unwinged branchlets (Hinds, 2000). Two observations of this species were found within WL1 and 20 m north of WL1.

Meadow horsetail

Meadow horsetail is a solitary annual fern that can be either fertile or sterile. The greenish-white stems (up to 50 cm in length) are black in the basal portions. This species grows in moist woods or meadows, in sun or partial shade. While not common, the fertile stems shed their spores from late April to early July (Cody & Britton, 1989). One observation of this species was found within WL1.

3.1.3 Lichens and Bryophytes

The following sections outline the results from the lichen desktop review and the field surveys completed within the PA.

3.1.3.1 Desktop Results

The ACCDC report (Appendix C) documented six priority lichen species within 5 km of the PA. All six species identified are SOCI:

- Black-footed reindeer lichen (*Cladonia stygia*, S3?)
- Eyed mosshorns woollybear lichen (*Polychidium muscicola*, S1)
- Powdered fringe lichen (*Heterodermia speciosa*, S3S4)
- Scaly ink lichen (*Placynthium flabellosum*, S2)
- Shelter shingle lichen (*Vahliella leucophaea*, S3S4)
- Waterside rockshag lichen (*Ephebe lanata,* S3)

No predicted boreal felt lichen polygons are present within the PA, with the closest predicted polygon occurring 42 km to the southeast of the PA. According to the MTRI databases, no extant boreal felt lichen populations are within 50 km and the closest vole ears lichen population is located over 50 km away.

The ACCDC report (Appendix C) documented seven priority bryophyte species within 5 km of the PA. All seven species identified are SOCI:

- Biddlecome's pouncewort (*Cololejeunea biddlecomiae*, S2?)
- Yew-leaved pocket moss (*Fissidens taxifolius,* S3)
- Rock veilwort (*Metzgeria conjugata*, S3?)
- Light beaked moss (*Oxyrrhynchium hians*, S2S3)
- Bark willow moss (*Platydictya subtilis*, S2S3)
- Delicate germanderwort (*Riccardia multifida*, S2?)
- *Thamnobryum alleghaniense* (S3S4)

3.1.3.2 Field Results

During the field surveys, 26 lichen species were observed within the PA. No SOCI or SAR lichens were observed.

The PA consists of both disturbed and intact habitat. Intact habitat is dominated by softwood and wetlands. Many of the priority lichens in Nova Scotia prefer mature forested communities, often in association with wetlands, lakes, and watercourses. The habitat that provides the greatest potential to support priority lichen species is within proximity of watercourses, wetlands, as well as steeply sloped portions in the southern section of the PA. Wetland and adjacent upland habitat provide mature forested communities consisting of softwood and hardwood species. Some portions of the site provide the appropriate tree maturity, bark texture, and pH for a suite of priority cyanolichens such as blue felt lichen (*Pectenia plumbea*), or the calicioid frosted glass-whiskers (*Sclerophora peronella*).

There were 12 bryophyte species observed within the PA throughout vascular plant surveys, lichen surveys, and incidentally during other biophysical surveys. No priority bryophyte species were identified in the PA.

3.1.3.3 Priority Lichens

No priority lichen or bryophyte species were observed within the PA during the field surveys.

3.1.4 Vegetation Community Classification, Vascular Plants and Lichens Summary

The PA consists of wetlands, watercourses, mature and regenerative forest stands. During the plant and lichen surveys, 145 vascular plants, 26 lichens, and 12 bryophyte species were identified within the PA. Four SOCI vascular plants were observed. No SAR vascular plants were identified. No priority lichens or bryophytes were observed.

3.1.5 Fauna

The following sections outline the results from the desktop review and the field surveys completed within the PA.

3.1.5.1 Desktop Results

There are no documented NSNR significant habitats within the PA; the closest significant habitat is located approximately ~1.35 km Northeast of the PA (Drawing 8, Appendix A). The closest abandoned mine opening (AMO; ID# TOR-6-045) is located 223 m south of the PA (Drawing 8, Appendix A).

No priority mammal species were listed within 5 km of the PA by the ACCDC (Appendix C). The PA does not overlap mainland moose core habitat. NSNR confirmed that the Project does not overlap with any other core or critical habitat layers including bat species, and wood turtle (S. Spencer, SAR Biologist, NSNR, June 2023). The closest core habitat for wood turtle is located 2.5 km northwest of the PA.

The silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cincereus*) have been observed together in two locations, 1.3 km southwest and 2.7 km northeast from the PA (ACCDC, 2023; Appendix C). No AMOs are located within the PA; the closest AMO (AMO; ID# TOR-6-045) is located 230 m South of the PA (NSNR, 2017) and is flooded.

The ACCDC report notes the nearest observations of snapping turtle (*Chelydra serpentina,* COSEWIC/SARA Special Concern, ESA Vulnerable, ACCDC S3), and eastern painted turtle (*Chrysemys picta picta*, COSEWIC Special Concern, ESA Special Concern, ACCDC S4) were documented approximately 1 km southwest of the PA, near Nictaux River. An observation of blanding's turtle (*Emydoidea blandingii*, COSEWIC, SARA Endangered, ESA Endangered) was 2.2 km away from the PA (ACCDC, 2023; Appendix C). This observation may be inaccurate; blanding's turtle within Nova Scotia is concentrated in the southern part of the province, in and around Kejimkujik National Park (Parks Canada, 2012). This distribution is the most isolated population within the species' range. NSNR was unable to confirm the identification of the observation, and herpetology experts at the MTRI were unable to confirm

the validity of the observation (Brad Tom, Wildlife Biologist, MTRI, Personal Communications, August 2023)

Wood turtle observations have been recorded 1km northwest and 1km south of the PA (S. Spencer, SAR Biologist, NSNR, June 2023).

3.1.5.2 Field Results

Mammals

Wildlife species, including mammals, were assessed through incidental wildlife observations, and recorded within the PA during all biophysical surveys. Refer to Table 3.4 for all incidental mammal observations confirmed either visually or by sign (scat, tracks, etc.).

Table 3.4: Confirmed Mammalian Species within the PA

Scientific Name	Common Name	COSEWIC	SARA	ESA	S-Rank
Odocoileus virginianus	White tailed deer	-	-	-	S5
Tamiasciursus hudsonicus	American red squirrel	-	-	-	S5

Bats

No bat observations or identification of potential hibernacula were identified within the PA during the field survey program. All bat species found within Nova Scotia have a provincial S-Rank of S1 or SUB, S1M. All are listed as Endangered under SARA and ESA (ECCC, 2018). Mature forested stands do exist within the PA and could provide roosting habitat. However, no evidence of roosting was observed during the biophysical surveys in 2023. Mature forested stands are targeted by many bat species for roosting as older forests tend to provide a higher density of snags, and foraging habitat in a closed canopy (ECCC, 2018) .

The foraging needs of each species is dependent on sex and species. Little brown myotis and tri-colored bat tend to forage more frequently in open habitats, such as ponds and roads or forests with open canopies. The northern myotis have a preference for roosting in trees; however, the habitat preferences of females may vary according to their reproductive status (Garroway & Broders, 2008). Females appear to prefer shade tolerant deciduous trees over coniferous trees, whereas males roost alone in coniferous or mixed-stands in mid-decay stages (Broders & Forbes, 2004). Northern myotis are also non-migratory and are typically associated with the little brown myotis during hibernation, being found in caves or abandoned mines (Moseley, 2007).

A large opening in forest canopy is present in the center portion of the PA because of recent forestry operations. None of the AMOs checked outside of the PA provided suitable hibernacula as they were all flooded or filled.

Priority Herpetofauna

No turtle signs were observed within the PA during biophysical surveys.

As wood turtle surveys could not be completed due to forest fires in 2023, habitat suitability was assessed from a desktop perspective using detailed habitat notes from fish habitat surveys. Representative photos are provided in Appendix F, corresponding to locations provided in Drawing 10 (Appendix A).

Only one watercourse, WC1, is located within the PA and may contain suitable habitat for wood turtle's life cycle. Habitat potential is based on review of known preferred overwintering, nesting and general habitat for each species. The desktop exercise also includes identifying potential habitat for snapping turtle, eastern painted turtle, wood turtle and Blanding's turtle. There were 13 points of interest identified during the desktop exercise using watercourse characterization data collected during fish and fish habitat surveys (Section 3.2.2). Descriptions of habitat observed at the 13 points of interest are presented in Table 3.5, along with commentary on their potential for turtle habitat.

Table 3.5: Summary of Turtle Habitat Suitability Study

Point of Interest	Dominant Substrate	Water Velocity	Riparian and Instream Habitat Descriptions	Suitable Nesting and Overwintering Habitat Available
1	Muck	<0.05 m/s	Riparian wetland, shallow flat water. Closed canopy. Vegetated and muck riparian edge.	No suitable overwintering or nesting available habitat. Marginal general habitat.
2	Sand, muck, gravel	<0.05 m/s	Riparian wetland, shallow riffle – run habitat with flat areas and small pools. Closed canopy and no bank or entrenchment.	
3	Gravel	<0.05 m/s	Riparian wetland, shallow flat water. Closed canopy and no bank or entrenchment.	
4	Muck	<0.05 m/s	Riparian wetland, riffle run habitat. Instream vegetation. Closed canopy and no bank or entrenchment.	
5	Muck	<0.05 m/s	Riparian wetland, riffle run habitat. Shallow pooling. Closed canopy and no bank or entrenchment.	
6	Muck	<0.05 m/s	Riparian wetland, riffle run habitat. Shallow pooling. Closed canopy and no bank or entrenchment.	
7	Sand, gravel, cobble	<0.05 m/s	Riparian wetland, riffle-run habitat, instream vegetation. Closed canopy and no bank or entrenchment.	
8	Sand, gravel, cobble	<0.05 m/s	Riparian wetland, shallow pooling. Closed canopy.	

Point of Interest	Dominant Substrate	Water Velocity	Riparian and Instream Habitat Descriptions	Suitable Nesting and Overwintering Habitat Available
9	Muck	<0.05 m/s	Riparian wetland, low entrenchment of stream banks.	
10	Muck	<0.05 m/s	Riparian wetland, coarse woody debris present.	
11	Gravel, cobble, rubble	0.05-0.26 m/s	Riparian wetland, channel widens, riffle-run – pool habitats. Closed canopy.	Marginal general habitat.
12	Sand, gravel, cobble	0.05-0.26 m/s	Riparian wetland, riffle- run – pool habitats. Channel is moderately entrenchment. Vegetated banks. Closed Canopy.	Marginal overwintering habitat available in shallow pool.
13	Sand, gravel	0.05-0.26 m/s	Riparian wetland, channel is moderately entrenched, no suitable turtle banks for nesting or sun exposure.	Marginal general habitat, overwintering habitat available in shallow pool.

Wood Turtle

Wood turtles are medium-sized, semi-aquatic turtles, which are found in eastern North America (ECCC, 2020). This species is typically found in forested areas; however, they require aquatic habitats such as clear, freshwater perennial streams to support different life stages.

Overwintering habitat includes sites with a mean water depth of 91 cm in a variety of microhabitats including submerged logs, overhanging banks or resting on the bottom of a pool (ECCC, 2020). Most individuals overwinter within deeper areas of their main inhabited stream or side channel of a watercourse with well oxygenated water flowing at a rate to prevent freezing to the substrate (ECCC, 2020).

Preferred nesting habitat includes sand/gravel banks along a river where there is sun exposure. This turtle species is the most terrestrial of all freshwater turtles in Canada (ECCC, 2020). Wood turtle general habitat includes areas that provide thermoregulation, foraging, mating, and movement opportunities. Wood turtles use wetlands and moderate to slow-moving clear-water streams, in-stream deep pools, and sand/gravel bars for thermoregulation, foraging, mating, movement, and nesting (ECCC, 2020).

The results of the desktop habitat exercise demonstrate that there is low potential for overwintering and nesting habitat for wood turtles within the PA. Watercourse 1 may provide suitable general habitat for wood turtles such as foraging or movement, however, overwintering and nesting habitat is limited due to the prevalence of mucky riparian edges, shallow pools and poor sun exposure (Photo log, Appendix F). The remaining PA is comprised of a mix of softwood dominant forest and disturbed areas, with hardwood forest inclusions along the edges of the PA. Although wood turtles often occupy terrestrial habitats, they require access to

water daily for several vital functions such as thermoregulation (ECCC, 2020). These areas may provide foraging and movement opportunities but are considered poor habitat due to the reduced availability of aquatic habitat and thermal conditions.

Snapping Turtle

Snapping turtles (COSEWIC/SARA, Vulnerable; ESA, Special Concern; ACCDC, S3) use a variety of habitats; however, they are the most aquatic of the turtle species present in Nova Scotia and preferred habitat is slow-moving water with a soft mud bottom and dense aquatic vegetation. Nesting typically occurs in sand or gravel banks in proximity to water with sparse vegetation cover (Branchaud & Ribeyron, 2020). Hibernation sites are aquatic environments (e.g., lentic, lotic, and mud) where water will not freeze to the bottom, the substrate is a thick layer of mud, and other cover (e.g., large woody debris) is present (Branchaud & Ribeyron, 2020).

The open water portion in WC1 may provide suitable overwintering habitat for snapping turtles. The open water is composed of mucky detritus substrate, abundant aquatic vegetation and has a water depth greater than 1 m. No snapping turtles were observed within the PA during any of the biophysical surveys. Refer to Section 3.2.2.2 for more information on habitat characteristics of WC1.

Eastern Painted Turtle

Eastern painted turtles (COSEWIC/SARA/ESA, Special Concern; ACCDC, S4) are primarily found throughout the southwestern and central parts of Nova Scotia. Eastern painted turtles typically inhabit areas with shallower, and slower moving waters with a soft bottom (NCC, 2023). In addition, they are known to be found basking in habitats with abundant rocks and logs (COSEWIC, 2018a). Nesting typically occurs in habitats with sand or gravel, forest clearings, meadows, and fields with areas of high sun exposure (COSEWIC, 2018a). Suitable habitat for eastern painted turtles is available in the open water portion in WC1.

Blanding's Turtle

Blanding's turtle (COSEWIC/SARA/ESA, Endangered; ACCDC, S1), while primarily an aquatic species, will often make extensive movements during the active season (ECCC, 2016). They generally prefer eutrophic conditions, in waterbodies less than 2 m deep and holding a soft organic substrate with abundant emergent or subsurface aquatic vegetation (ECCC, 2016). The species primarily nests in open areas such as beaches, shorelines, meadows, rock outcrops, and anthropogenic sites (ECCC, 2016). An observation in the ACCDC report (Appendix C) may be inaccurate. NSNR was unable to confirm the identification of the observation, and herpetology experts at the MTRI were unable to confirm the validity of the observation (Personal Communications, Brad Tom, Wildlife Biologist, MTRI, August 2023). The Nova Scotia Blanding's Turtle population is concentrated in and adjacent to Kejimkujik National Park (ECCC, 2016).

3.1.6 Avifauna

The following sections outline the results from the desktop review and the avifauna field surveys completed.

3.1.6.1 Desktop Results

The ACCDC (Appendix C) identified 11 avian SAR and 20 SOCI within 5 km of the PA (Drawing 8, Appendix A). The SAR birds observed by the ACCDC within 5 km are:

- Bank swallow (*Riparia riparia*; SARA/COSEWIC Threatened)
- Barn swallow (*Hirundo rustica*; SARA Threatened, COSEWIC Special Concern)
- Bobolink (*Dolichonyx oryzivorous*; SARA Threatened, COSEWIC Special Concern)
- Canada warbler (*Cardellina canadensis;* SARA Threatened, COESWIC Special Concern)
- Common nighthawk (*Choredeiles minor*; SARA/COSEWIC Special Concern)
- Eastern wood-pewee (*Contopus virens*; SARA/COSEWIC Special Concern)
- Evening grosbeak (*Coccothraustes vespertinus*; SARA/COSEWIC Special Concern)
- Olive-sided flycatcher (*Contopus cooperi*; SARA/COSEWIC Special Concern)
- Chimney swift (*Chaetura pelagica*; SARA/COSEWIC Threatened)
- Red-headed woodpecker (*Melanerpes erythrocephalus;* SARA Threatened, COSEWIC Endangered)
- Rusty blackbird (*Euphagus carolinus*; SARA/COSEWIC Special Concern)

Eastern wood-pewee, olive-sided flycatcher, evening grosbeak, and common nighthawk were observed during the biophysical surveys conducted within the PA and will be discussed in Section 3.1.6. The ACCDC reported Canada warbler and rusty blackbird within 5 km of the PA. However, neither were found during any of the Project surveys which can likely be attributed to the lack of wetland habitat and the abundance of upland forest that has been clear-cut within the PA. The ACCDC bobolink observation is likely a result of agricultural land (e.g., farm fields), older regenerating developed land, and natural fields/meadows in and around the PA. The ACCDC chimney swift observation can likely be attributed to the farm fields, large rivers, and anthropogenic structures surrounding the PA. However, there is no appropriate habitat for bobolink or chimney swift in the PA due to the recent disturbance (clear-cutting) on the site. Recent forest activity (June 2023) has left pockets of trees around the PA that exclusively support various passerines and woodpeckers, including flycatchers. The PA has been drastically altered, decreasing the habitat usage for most birds. Avifauna that prefer edge-like habitat (e.g. flycatchers) will still be present in and around the PA. Bobolink and chimney swift habitat is scarcely present within the PA (i.e., habitat that would contain tracts of undisturbed tall grass, sedge, and rush herbaceous species). ACCDC noted barn and bank swallows within 5 km of the PA. No barn or bank swallows were observed during the biophysical surveys conducted in the PA.

Based on desktop analysis, there are no protected parks, wilderness areas, nature reserves, game sanctuaries, IBAs, migratory bird sanctuaries, or significant habitat related to birds within the PA. The Project is within the MBBA square 20LQ47.

One nature reserve is within six km of the PA, the Torbrook Nature Reserve is approximately 2.6 km north from the PA. The nearest Provincially Protected Area Parks and Wildlife Management Area is the Cloud Lake Wilderness Area located approximately 7 km south of the PA. The closest Important Bird Area (IBA) to the PA is the Southern Bight of the Minas Basin IBA (NS020), which is approximately 50 km east from the PA. This section will continue with information regarding these areas as well as the results from the MBBA square.

Further desktop analysis revealed no projects (research or development) or other significant areas near the PA.

Torbrook Nature Reserve

The Torbrook Nature Reserve is approximately 152 ha and represents one of the few relatively undisturbed forest patches of old growth red spruce and eastern hemlock in the area (Province of Nova Scotia 2013; Drawing 8, Appendix A). The area was protected due to the abundance of old growth mature hardwood and mixed wood, with some mature softwood occurring within the Annapolis County.

Although the PA includes mixed wood and hardwood forest, the habitat differs from the habitat within this nature reserve due to the young age and disturbed nature (clear-cut) of the forest within the PA.

Cloud Lake Wilderness Area

The Cloud Lake Wilderness Area is the closest Protected Area/Parks and Wildlife Management Area to the PA, located approximately 7 km south of the PA. Cloud Lake Wilderness Area is located south of Greenwood, Annapolis County (Province of Nova Scotia n.d.; Drawing 8, Appendix A). This wilderness area protects 15,802 hectares of woodland, lakes and river within Nova Scotia's South Mountain Rolling Plain natural landscape and is part of the LaHave and Nictaux river watersheds.

Although the PA contains mixed wood forest, the forest cover in the Cloud Lake Wilderness Area is made up of mixed wood and mature coniferous forest, comprised of red spruce, red and white pine, yellow birch, red and sugar maple and other species not related to the composition of the PA. Moreover, the PA is different due to the young age and disturbed nature (clear-cut) of the forests.

Southern Bight of the Minas Basin Important Bird Area (NS020)

The closest IBA to the PA is the Southern Bight of the Minas Basin IBA (NS020).

The Southern Bight of the Minas Basin IBA (IBA NS020) is approximately 22,192 ha in size and is situated in the Bay of Fundy near Wolfville, Nova Scotia. The Southern Bight of the Minas Basin is a large tidal embayment, including the Avon River, comprised of intertidal mudflats and river channels with varying substrates. Various habitat types, including beaches, tidal rivers/estuaries, saltmarshes, mudflats, and sandflats line the coastline depending on the tide level. The famous Bay of Fundy drastic tide levels is the reason for the change in habitat

types along the coastline depending on the time of day (IBA Canada n.d.). The Southern Bight of the Minas Basin is an important foraging spot for a variety of shorebirds and waterfowl during migration periods (e.g., geese, ducks, plovers, sandpipers, etc.). The high abundance of amphipods in the mud attracts one to two million shorebirds in the mudflats at the head of the Bay of Fundy (including this IBA and adjacent IBAs) before fall migration. The high abundance of food source is estimated to attract 50 to 95% of the world's population of semipalmated sandpipers (*Calidris pusilla*), as well as many other species of shorebirds. Thousands of shorebirds and waterfowl species are also observed using this bay as a stopover area during spring migration (IBA Canada n.d.).

The Southern Bight of the Minas Basin IBA is a proposed Hemispheric Shorebird Reserve, under the Western Hemisphere Shorebird Reserve Network. Concerns and threats for this site include anthropogenic use and disturbance on the beaches that line the coastline, as well as pollution and pesticide exposure due to developed and agricultural lands surrounding this IBA (IBA Canada n.d.). The PA is approximately 15 km away from any inlet/bay or coastline and does not represent the habitats within the Southern Bight of the Minas Basin IBA.

Maritime Breeding Bird Atlas

One MBBA square (20LQ47) encompasses the entirety of the PA (results are provided in Appendix I). Observations within this square are listed below:

- The first atlas has 32 confirmed breeders.
- The second atlas has 40 possible, 21 probable, and 26 confirmed breeders.
    - Of these breeding species, there were nine SAR:
        - Eastern wood-pewee (*Contopus virens*),
        - Olive-sided flycatcher (*Contopus cooperi*),
        - Common nighthawk (*Chordeiles minor*),
        - Bobolink (*Dolichonyx oryzivorus*),
        - Canada warbler (*Cardellina canadensis*),
        - Chimney swift (*Chaetura pelagica*),
        - Barn swallow (*Hirundo rustica*),
        - Bank swallow (*Riparia riparia*),
        - Evening grosbeak (*Occothraustes vespertinus*)
- SOCI observations within these MBBA squares (or SAR recorded with no breeding evidence) are presented in Appendix I.

The 20LQ47 MBBA summary square had common nighthawk observations, with observations of breeding evidence recorded (T, 2nd code). The common nighthawk is reported to be within 1.5 (± 0) km of the PA by ACCDC.

3.1.6.2 Avian Survey Results

The following subsections outline the results of the point count surveys (spring migration, breeding season, fall migration, and nightjar surveys) and all incidental observations. Note that incidental observations will not be included in the dedicated bird survey sections and will be included in a separate section.

ACCDC breeding bird status qualifiers were used to determine whether a species is a priority species, based on the time of year in which the species was observed. If a species has only one seasonal ranking, such as S3B, it was considered a SOCI regardless of the time of year it was observed. However, if the species had an alternate ranking, such as a S-Rank of S2S3B, S5N, the species was considered a priority species if observed during the breeding season. Outside of breeding season, this species was not considered a priority species.

Spring Migration

During spring migration PC surveys, a total of 339 individuals representing 44 species (this number does not include unknowns) were observed during dedicated surveys.

Two avian species at risk (SAR) (eastern wood-pewee and evening grosbeak) and one avian SOCI (red crossbill, *Loxia curvirostra*) were identified during the 2023 spring migration surveys (Drawing 9, Appendix A; Table 3.6).

Passerines comprised 92.92% of the species observed, followed by other landbirds (6.49%) and waterfowl (0.59%). These percentages include unknown individuals that were identified to the level of bird group (e.g., passerines). American robin (n=39) and American goldfinch (n=32) were the most abundant species observed. All species, their abundance, and observed PC locations are presented in Table 3.6.

All species identified are native species in this region of Nova Scotia. Typical and common habitat to support these species is present within the PA and surrounding landscape.

During spring migration, the PC locations with the highest number of individuals and species observed were PCs 1, 2 and 4 (Drawing 4, Appendix A). PC 2 had 45 individuals representing 20 species and both PC 1 (representing 25 species) and PC 4 (representing 22 species) had 44 individuals. All three PCs represent different habitat types, with PC 1 being next to a road edge beside a portion of hardwood and mixed wood forest, PC 2 being located next to a cultivated agricultural field and recently cleared hardwood forest and PC4 being located within mixed wood forest that was recently cleared for the Project. All of these PC locations are examples of edge habitat due to PC 1 being close to a road, PC 2 at the edge of cultivation and where cleared forest starts, and PC 4 being recently cleared mixed wood forest. At PC 6, most of the birds, besides sparrows, American robins, and palm warblers, sounded like they were in the pockets of trees left in the clearcut.

The higher number of species and individuals at these locations is likely due to this habitat variability and structure (e.g., vegetation height differences provided by edge habitat). This would attract a variety of species, especially passerines, piciformes, and other land birds.

There were no observations of probable and no observations of confirmed breeding behaviour during the spring migration surveys (MBBA, n.d.).

Table 3.6: Individual Abundance and Species of Birds Observed During Spring Migration Surveys

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
EAWP	**Eastern wood-pewee**	***Contopus virens***	**SC**	**V**	**S3S4B**	**1**	**-**	**4**	**6**
EVGR	**Evening grosbeak**	***Coccothraustes vespertinus***	**SC**	**V**	**S3S4B, S3N**	**4**	**-**	**1, 4, 9, 10**	**6**
RECR	**Red crossbill**	***Loxia curvirostra***	**-**	**-**	**S3S4**	**3**	**-**	**1, 2, 8**	**6**
AMCR	American crow	*Corvus brachyrhynchos*	-	-	S5	5	-	1, 6, 8, 9	6
AMGO	American goldfinch	*Carduelis tristis*	-	-	S5	32	-	1, 2, 4, 7, 8, 9, 10	6
AMRE	American redstart	*Setophaga ruticilla*	-	-	S5B	4	-	3, 4, 10	6
AMRO	American robin	*Turdus migratorius*	-	-	S5B, S3N	39	-	1, 2, 3, 4, 5, 6, 7, 8, 10	6
BBWA	Bay-breasted warbler	*Setophaga castanea*	-	-	S3S4B, S4S5M	1	-	3	6
BAWW	Black-and-white warbler	*Mniotilta varia*	-	-	S5B	11	-	1, 3, 4, 6, 8, 9, 10	6
BLBW	Blackburnian warbler	*Dendroica fusca*	-	-	S4B	2	-	1, 3	6
BCCH	Black-capped chickadee	*Poecile atricapilla*	-	-	S5	8	-	1, 2, 3, 4	6
BTBW	Black-throated blue warbler	*Setophaga caerulescens*	-	-	S5B	3	-	3, 4, 10	6
BTNW	Black-throated green warbler	*Dendroica virens*	-	-	S5B	8	-	1, 3, 4, 7, 9	6
BLJA	Blue jay	*Cyanocitta cristata*	-	-	S5	17	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
BHVI	Blue-headed vireo	*Vireo solitarius*	-	-	S5B	7	-	1, 2, 3, 4, 6, 7	6
BRCR	Brown creeper	*Certhia americana*	-	-	S5	5	-	1, 3, 4, 8	6
CAGO	Canada goose	*Branta canadensis*	-	-	SUB, S4N, S5M	2	-	3	1
CHSP	Chipping sparrow	*Spizella passerina*			S4B, S5M	2	-	2, 6	6
COGR	Common grackle	*Quiscalus quiscula*	-	-	S5B	2	-	6	6
CORA	Common raven	*Corvus corax*	-	-	S5	2	-	4, 5	6
COYE	Common yellowthroat	*Geothlypis trichas*	-	-	S5B	4	-	4, 9, 10	6
DEJU	Dark-eyed junco	*Junco hyemalis*	-	-	S4S5	9	-	2, 5, 6, 7, 8, 10	6
GCKI	Golden-crowned kinglet	*Regulus satrapa*	-	-	S5	2	-	3	6

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
HAWO	Hairy woodpecker	*Picoides villosus*	-	-	S5	4	9 females	7, 8, 9	7
HETH	Hermit thrush	*Catharus guttatus*	-	-	S5B	6	-	1, 2, 9, 10	6
LEFL	Least flycatcher	*Empidonax minimus*	-	-	S4S5B, S5M	13	-	1, 2, 3, 4, 8, 9, 10	6
MODO	Mourning dove	*Zenaida macroura*	-	-	S5	5	-	1, 2, 4	7
NAWA	Nashville warbler	*Vermivora ruficapilla*	-	-	S4B, S5M	1	-	10	6
NOFL	Northern flicker	*Colaptes auratus*	-	-	S5B	8	-	1, 2, 3, 4, 7, 9	7
NOPA	Northern parula	*Parula americana*	-	-	S5B	18	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
NOWA	Northern waterthrush	*Parkesia noveboracensis*	-	-	S4B, S5M	4	-	1, 3, 9, 10	6
OVEN	Ovenbird	*Seiurus aurocapilla*	-	-	S5B	24		1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
PAWA	Palm warbler	*Dendroica palmarum*	-	-	S5B	11	-	6, 7, 8, 9	6
PUFI	Purple finch	*Carpodacus purpureus*	-	-	S4S5B, S3S4N, S5M	4	-	1, 7, 10	6
RBNU	Red-breasted nuthatch	*Sitta canadensis*	-	-	S4S5	3	-	2, 9, 10	6
REVI	Red-eyed vireo	*Vireo olivaceus*	-	-	S5B	14	-	1, 2, 3, 4, 5, 6, 7, 9, 10	6
RTHU	Ruby-throated hummingbird	*Archilochus colubris*	-	-	S5B	1	-	9	6
SOSP	Song sparrow	*Melospiza melodia*	-	-	S5B	12	-	2, 3, 5, 6, 7, 8, 9, 10	6
SWSP	Swamp sparrow	*Melospiza georgiana*	-	-	S5B	1	-	3	6
WBNU	White-breasted nuthatch	*Sitta carolinensis*	-	-	S4	5	-	1, 3, 4, 7	6
WTSP	White-throated sparrow	*Zonotrichia albicollis*	-	-	S4S5B, S5M	6	-	2, 3, 5, 6, 7	6
YBFL	Yellow-bellied flycatcher	*Empidonax flaviventris*	-	-	S4B, S5M	4	-	1, 2, 3	6
YBSA	Yellow-bellied sapsucker	*Sphyrapicus varius*	-	-	S5B	10	-	1, 2, 3, 4, 7, 9, 10	7
YRWA	Yellow-rumped warbler	*Dendroica coronata*	-	-	S5B	12	-	1, 3, 7, 9, 10	6
Total Number of Individuals				**339**	**Total Number of Species (does not include unknowns)**				**44**

Incidental observations not included (those observed outside of point count locations). All individuals recorded were adults. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://www.accdc.com/webranks/NSvert.htm (December 2023). "-" represents no federal designation.

Breeding Season

During breeding bird PC surveys, a total of 410 individuals representing 56 species were observed.

Two avian SAR (eastern wood-pewee and olive-sided flycatcher) and two avian SOCI (bay-breasted warbler, *Setophaga castanea,* and red crossbill; Table 3.7; Drawing 9, Appendix A) were observed during the breeding bird surveys.

Passerines comprised 91.71% of the species observed, followed by other landbirds (6.83%), diurnal raptor (0.49%) waterfowl (0.49%), other waterbirds (0.24%), and nocturnal raptors (0.24%). American robin (n=53) and ovenbird (n=35) were the most abundant species observed. There was active forestry within 150 m of most PC locations, making it difficult to hear birds in some sections. Most of the birds, besides sparrows, American robins, and palm warblers, sounded like they were in the pockets of trees left in the clearcut. All the species identified are native species in this region of Nova Scotia and the province in general. Typical and common habitat to support these species is present within the PA and surrounding landscape. All species, their abundance and observed PC locations, are listed in Table 3.7.

During breeding season, the PC locations with the highest number of individuals and species observed were PCs 3 and 8 (Drawing 4, Appendix A). PC 8 had 48 individuals representing 24 species and PC 3 had 45 individuals representing 25 species. Both PCs represent different habitat types, with PC 8 being located within recently cleared softwood and hardwood forest, and PC 3 being near a closed, mixed wood swamp area in the south of the Project (within wetland 1 and next to Open Water A). Both of these PC locations are situated in edge habitat, where PC 8 is a recently cleared (2023) open area with a few scattered patches of standing trees (a.k.a. “wildlife trees”) and PC 3 is a closed, mixed wood swamp and forest that transition to a small bit of open water.

The higher number of species and individuals at these locations is likely due to this habitat variability and structure (e.g., vegetation height differences provided by edge habitat). This would attract a variety of species including passerines, woodpeckers, raptors, waterfowl, and shorebirds.

There were no observations of probable or confirmed breeding behaviour during the breeding bird surveys (MBBA, n.d.).

All other species observed during the breeding bird surveys are considered possible breeders due to observing them in suitable nesting habitat during the breeding season (Table 3.7; MBBA, n.d.).

Table 3.7: Individual Abundance and Species of Birds Observed During Breeding Bird Surveys

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
EAWP	**Eastern wood-pewee**	***Contopus virens***	**SC**	**V**	**S3S4B**	**7**	**-**	**2, 3, 4, 6, 8**	**6**
OSFL	**Olive-sided flycatcher**	***Contopus cooperi***	**SC**	**T**	**S3B**	**1**	**-**	**5**	**6**
BBWA	**Bay-breasted warbler**	***Setophaga castanea***	**-**	**-**	**S3S4B, S4S5**	**1**	**-**	**10**	**6**
RECR	**Red Crossbill**	***Loxia curvirostra***	**-**	**-**	**S3S4**	**1**	**-**	**8**	**6**
ALFL	Alder flycatcher	*Empidonax alnorum*	-	-	S5B	1	-	3	6
AMCR	American crow	*Corvus brachyrhynchos*	-	-	S5	5	-	2, 3, 5, Area Search	6
AMGO	American goldfinch	*Carduelis tristis*	-	-	S5	15	-	1, 2, 3, 7, 8, 9, Area Search	6
AMRE	American redstart	*Setophaga ruticilla*	-	-	S5B	5	-	1, 3, 8, 9, 10	6
AMRO	American robin	*Turdus migratorius*	-	-	S5B, S3N	53	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Area Search	6
BDOW	Barred Owl	*Strix varia*	-	-	S5	1	-	9	5
BEKI	Belted kingfisher	*Megaceryle alcyon*	-	-	S4S5B	1	-	3	3
BAWW	Black-and-white warbler	*Mniotilta varia*	-	-	S5B	10	-	1, 2, 3, 4, 6, 9	6
BLBW	Blackburnian warbler	*Setophaga fusca*	-	-	S4B, S5M	1	-	8	6
BCCH	Black-capped chickadee	*Poecile atricapilla*	-	-	S5	13	-	2, 3, 4, 5, 7, 8, 9, 10, Area Search	6
BTBW	Black-throated blue warbler	*Setophaga caerulescens*	-	-	S5B	6	-	1, 3, 4, 6, Area Search	6
BTNW	Black-throated green warbler	*Dendroica virens*	-	-	S5B	9	-	3, 4, 6, 8, 10	6
BLJA	Blue jay	*Cyanocitta cristata*	-	-	S5	8	-	5, 6, 9, 10, Area Search	6
BHVI	Blue-headed vireo	*Vireo solitarius*	-	-	S5B	4	-	6, 8, 9	6
BOWA	Bohemian waxwing	*Bombycilla garrulus*	-	-	S5N	1	-	8	6
BRCR	Brown creeper	*Certhia americana*	-	-	S5	6	-	3, 8, 9, 10	6
CAGO	Canada goose	*Branta canadensis*	-	-	SUB, S4N, S5M	2	-	9	1
CEDW	Cedar waxwing	*Bombycilla cedrorum*	-	-	S5B	5	-	2, 3, 7, 8	6

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
CSWA	Chestnut-sided warbler	*Setophaga pensylvanica*	-	-	S5B	2	-	Area Search	6
CHSP	Chipping sparrow	*Spizella passerina*	-	-	S4B, S5M	3	-	2, 10	6
COGR	Common grackle	*Quiscalus quiscula*	-	-	S5B	1	-	5	6
CORA	Common raven	*Corvus corax*	-	-	S5	1	-	4	6
DEJU	Dark-eyed junco	*Junco hyemalis*	-	-	S4S5	13	-	2, 5, 6, 7, 10, Area Search	6
DOWO	Downy woodpecker	*Dryobates pubescens*	-	-	S5	1	-	9	7
GCKI	Golden-crowned kinglet	*Regulus satrapa*	-	-	S5	1	-	Area Search	6
HAWO	Hairy woodpecker	*Picoides villosus*	-	-	S5	1	-	8	7
HETH	Hermit thrush	*Catharus guttatus*	-	-	S5B	15		1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
LEFL	Least flycatcher	*Empidonax minimus*	-	-	S4S5B, S5M	23	-	1, 2, 3, 4, 6, 8, 9, 10	6
MAWA	Magnolia warbler	*Dendroica magnolia*	-	-	S5B	1	-	Area Search	6
MERL	Merlin	*Falco columbarius*	-	-	S5B	1	-	Area Search	4
MODO	Mourning dove	*Zenaida macroura*	-	-	S5	12	-	1, 2, 3, 4, 5, 7, 9, 10	7
NOFL	Northern flicker	*Colaptes auratus*	-	-	S5B	5	-	2, 3, 5, 8	7
NOPA	Northern parula	*Parula americana*	-	-	S5B	24		1, 2, 3, 4, 5, 6, 8, 9, 10, Area Search	6
NOWA	Northern waterthrush	*Parkesia noveboracensis*	-	-	S4B, S5M	2	-	9, 10	6
OVEN	Ovenbird	*Seiurus aurocapilla*	-	-	S5B	35	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Area Search	6
PAWA	Palm warbler	*Dendroica palmarum*	-	-	S5B	9	-	5, 6, 7, 8	6
PUFI	Purple finch	*Carpodacus purpureus*	-	-	S4S5B, S3S4N, S5M	3	-	3, 9, 10	6
RBNU	Red-breasted nuthatch	*Sitta canadensis*	-	-	S4S5	7	-	5, 6, 8, 9, 10	6
REVI	Red-eyed vireo	*Vireo olivaceus*	-	-	S5B	25		1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
RTHA	Red-tailed hawk	*Buteo jamaicensis*	-	-	S5	1	-	5	4
RWBL	Red-winged blackbird	*Agelaius phoeniceus*	-	-	S4B	2	-	4, 9	6
RCKI	Ruby-crowned kinglet	*Regulus calendula*	-	-	S4B,S5M	1	-	5	6

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
RTHU	Ruby-throated hummingbird	*Archilochus colubris*	-	-	S5B	2	-	1	6
RUGR	Ruffed Grouse	*Bonasa umbellus*	-	-	S5	2	-	1, 3	7
SOSP	Song sparrow	*Melospiza melodia*	-	-	S5B	12	-	2, 5, 6, 7	6
TRES	Tree swallow	*Tachycineta bicolor*	-	-	S4B	20	-	4, 5, Area Search	6
WBNU	White-breasted nuthatch	*Sitta carolinensis*	-	-	S4	2	-	3, Area Search	6
WTSP	White-throated sparrow	*Zonotrichia albicollis*	-	-	S4S5B, S5M	11	-	2, 4, 5, 6, 7, 8	6
WIWR	Winter wren	*Troglodytes troglodytes*	-	-	S5B	1	-	Area Search	6
YBFL	Yellow-bellied flycatcher	*Empidonax flaviventris*	-	-	S4B, S5M	2	-	6, 8	6
YBSA	Yellow-bellied sapsucker	*Sphyrapicus varius*	-	-	S5B	6	-	3, 4, 5, 8, 10	7
YRWA	Yellow-rumped warbler	*Dendroica coronata*	-	-	S5B	7	-	3, 5, 6, 10	6
Total Number of Individuals				**410**	**Total Number of Species**				**56**

incidental observations not included (those observed outside of point count locations). All individuals recorded were adults. Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://www.accdc.com/webranks/NSvert.htm (March 2024). "- "represents no federal designation. "Area Search" under the PC Locations column represents a species observed during the area searches conducted after the morning PC surveys.

Fall Migration

During fall migration PC surveys, a total of 670 individuals representing 54 species (this number does not include unknowns) were observed, including one avian SAR (eastern wood-pewee) and two avian SOCI (pine warbler and pine siskin (*Spinus pinus*) (Drawing 9, Appendix A). All species, their abundance, and observed PC locations are listed in Table 3.8.

Passerines were the most abundant bird group and comprised 79.55% of the species observed, followed by waterfowl (13.58%), other landbirds (5.97 %), diurnal raptors (0.75%), and nocturnal raptors (0.15%). These percentages include unknown individuals that were identified to the level of bird group (e.g., diurnal raptors). American robin (n=138) and Canada goose (n=91) were most abundant species observed. There was a large group (n=50) of American robins seen and heard over 100 m away from PC 2, concentrated around edges of clearcut and moving around together (probable migratory behaviour). There were also three groups of Canada geese (n=75) heard and seen flying west over 100 m away from PC2, again displaying probable migratory behaviour.

All species identified are native species in this region of Nova Scotia, with the exception of European starling. Typical and common habitat to support these species is present within the PA and surrounding landscape.

During fall migration, the PC locations with the highest number of individuals and species observed were PCs 2 and 8 (Drawing 4, Appendix A). PC 2 had 176 individuals representing 17 species (not including unknowns) and PC 8 had 98 individuals representing 23 species. PC 2 and 8 represent different habitat types, with PC 2 being located next to a cultivated agricultural field and recently cleared hardwood forest and PC 8 within a recently cleared (2023) open area next to a few scattered patches of standing trees (a.k.a. “wildlife trees”). Notably, observers at PC2 recorded 77 Canada geese and 55 American robin, making up the majority of the findings at PC2 and demonstrating probable migratory behaviour. These are both examples of edge habitat, since both PCs represent an open area surrounded by forest edges or patches. The higher number of species and individuals at these locations is likely due to this habitat variability and structure (e.g., vegetation height differences provided by edge habitat). This correlates with what was observed during the breeding season.

There was one observation of probable breeding behaviour during the fall migration surveys:

- A male and female black-and-white warbler at PC 8 (probable breeding behavior [MBBA, n.d.]).

Table 3.8: Individual Abundance and Species of Birds Observed During Fall Migration Surveys

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
EAWP	**Eastern wood-pewee**	***Contopus virens***	**SC**	**V**	**S3S4B**	**2**	**-**	**1, 2**	**6**
PISI	**Pine siskin**	***Spinus pinus***	**-**	**-**	**S3**	**6**	**-**	**8, 10**	**6**
PIWA	**Pine warbler**	***Setophaga pinus***	**-**	**-**	**S2S3B, S4S5M**	**1**	**-**	**9**	**6**
AMCR	American crow	*Corvus brachyrhynchos*	-	-	S5	13	-	1, 2, 3, 5, 7, 9	6
AMGO	American goldfinch	*Carduelis tristis*	-	-	S5	45	-	2, 3, 4, 5, 6, 7, 8, 9, 10	6
AMKE	American kestrel	*Falco sparverius*	-	-	S3B	2	-	6	4
AMRE	American redstart	*Setophaga ruticilla*	-	-	S5B	2	-	10	6
AMRO	American robin	*Turdus migratorius*	-	-	S5B, S3N	138	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
BAEA	Bald eagle	*Haliaeetus leucocephalus*	-	-	S5	1	-	1	4
BDOW	Barred owl	*Strix varia*	-	-	S5	1	-	1	5
BAWW	Black-and-white warbler	*Mniotilta varia*	-	-	S5B	7	1 female, 1 male and female couple	3, 8, 9, 10	6
BLBW	Blackburnian warbler	*Dendroica fusca*	-	-	S4B	1	Female or juvenile male	3	6
BCCH	Black-capped chickadee	*Poecile atricapilla*	-	-	S5	63	-	2, 3, 4, 5, 6, 7, 8, 9, 10	6
BLPW	Blackpoll warbler	*Dendroica striata*	-	-	S3S4B	1	Male	3	6
BTBW	Black-throated blue warbler	*Setophaga caerulescens*	-	-	S5B	1	Male	4	6
BTNW	Black-throated green warbler	*Dendroica virens*	-	-	S5B	1	-	8	6
BLJA	Blue jay	*Cyanocitta cristata*	-	-	S5	66	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	6
BHVI	Blue-headed vireo	*Vireo solitarius*	-	-	S5B	4	-	3, 8, 10	6
BRCR	Brown creeper	*Certhia americana*	-	-	S5	4	-	1, 3, 8, 9	6
CAGO	Canada goose	*Branta canadensis*	-	-	SUB, S4N, S5M	91	-	1, 2, 3, 8	1

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
CEDW	Cedar waxwing	*Bombycilla cedrorum*	-	-	S5B	4	-	1, 8	6
CHSP	Chipping sparrow	*Spizella passerina*			S4B, S5M	1	-	3	6
CORA	Common raven	*Corvus corax*	-	-	S5	12	-	1, 3, 6, 9, 10	6
COYE	Common yellowthroat	*Geothlypis trichas*	-	-	S5B	4	-	2, 7, 10	6
DEJU	Dark-eyed junco	*Junco hyemalis*	-	-	S4S5	20	-	1, 2, 3, 4, 5, 6, 7, 10	6
DOWO	Downy woodpecker	*Dryobates pubescens*	-	-	S5	1	-	8	7
EUST	European starling	*Sturnus vulgaris*	-	-	SNA	4	-	1	6
GCKI	Golden-crowned kinglet	*Regulus satrapa*	-	-	S5	6	-	2, 3, 6, 8	6
HAWO	Hairy woodpecker	*Picoides villosus*	-	-	S5	7	-	3, 5, 6, 7, 8, 9	7
HETH	Hermit thrush	*Catharus guttatus*	-	-	S5B	1	-	4	6
LEFL	Least flycatcher	*Empidonax minimus*	-	-	S4S5B, S5M	1	-	4	6
MAWA	Magnolia warbler	*Dendroica magnolia*	-	-	S5B	1	Female	4	6
MERL	Merlin	*Falco columbarius*	-	-	S5B	1	-	6	4
MODO	Mourning dove	*Zenaida macroura*	-	-	S5	6	-	2, 5, 6, 7, 10	7
NAWA	Nashville warbler	*Vermivora ruficapilla*	-	-	S4B, S5M	3	-	4, 7, 10	6
NOCA	Northern cardinal	*Cardinalis cardinalis*	-	-	S4	2	-	1, 3	6
NOFL	Northern flicker	*Colaptes auratus*	-	-	S5B	18	-	2, 4, 5, 6, 7, 8, 9, 10	7
NOPA	Northern parula	*Parula americana*	-	-	S5B	1	-	8	6
OVEN	Ovenbird	*Seiurus aurocapilla*	-	-	S5B	4	-	4, 9	6
PAWA	Palm warbler	*Dendroica palmarum*	-	-	S5B	10	-	2, 4, 6, 7, 8, 9, 10	6
PIWO	Pileated woodpecker	*Dryocopus pileatus*	-	-	S5	3	-	2, 3, 6	7
PUFI	Purple finch	*Carpodacus purpureus*	-	-	S4S5B, S3S4N, S5M	3	-	1, 4, 9	6
RBNU	Red-breasted nuthatch	*Sitta canadensis*	-	-	S4S5	17	-	1, 2, 3, 4, 6, 7, 8, 10	6

Code	Common Name	Scientific Name	SARA	ESA	S-Rank	#	Sex / Age	PC Observations	Group
REVI	Red-eyed vireo	*Vireo olivaceus*	-	-	S5B	18	-	1, 3, 5, 6, 8, 9, 10	6
RTHA	Red-tailed hawk	*Buteo jamaicensis*	-	-	S5	1	-	8	4
RIPH	Ring-necked pheasant	*Phasianus colchicus*	-	-	SNA	1	-	4	7
SOSP	Song sparrow	*Melospiza melodia*	-	-	S5B	42	-	2, 3, 4, 5, 6, 7, 8, 9, 10	6
SWSP	Swamp sparrow	*Melospiza georgiana*	-	-	S5B	1	-	10	6
VEER	Veery	*Catharus fuscescens*	-	-	S4B	1	-	7	6
WBNU	White-breasted nuthatch	*Sitta carolinensis*	-	-	S4	3	-	8, 10	6
WTSP	White-throated sparrow	*Zonotrichia albicollis*	-	-	S4S5B, S5M	12	-	2, 3, 4, 6, 7	6
WWCR	White-winged crossbill	*Loxia leucoptera*	-	-	S4S5	1	-	3	6
YBSA	Yellow-bellied sapsucker	*Sphyrapicus varius*	-	-	S5B	5	1 Juvenile	3, 4, 6, 7, 10	7
YRWA	Yellow-rumped warbler	*Dendroica coronata*	-	-	S5B	5	-	5, 6, 8, 9, 10	6
Total Number of Individuals				**670**	**Total Number of Species (does not include unknowns)**				**54**

Incidental observations not included (those observed outside of point count locations). Bird group is coded as: 1 = waterfowl; 2 = shorebirds; 3 = other waterbirds (i.e., that are not waterfowl or shorebirds); 4 = diurnal raptors; 5 = nocturnal raptors; 6 = passerines (excluding dippers), and 7 = other landbirds. Bolded species are priority species. Bolded and underlined species are SAR. ACCDC rankings retrieved from: http://www.accdc.com/webranks/NSvert.htm (March 2024). "-"represents no federal designation

Nightjar Surveys

The PA does contain suitable habitat for the common nighthawk and the Eastern whip-poor-will. Examples of suitable habitat for common nighthawk include open bogs/wetlands, open forests, grasslands, barren areas with low shrub cover, clearcut areas, quarries, or other disturbed areas (COSEWIC, 2018a). Examples of suitable habitat for Eastern whip-poor-will include shrubbed wetlands, clearcuts, agricultural fields, rock or sand barrens with scattered trees, savannahs, burned areas, conifer plantations, and various types of forests at early stages of succession or edges of dense forest with similar ground-level structure. This species is found in habitat with moderate tree, shrub, and herbaceous cover (ECCC, 2018b).

In total, eight nightjars (common nighthawk) were observed during two rounds of surveys. There was a slight car noise in the distance from all CONI PC locations, making it more difficult to hear all the birds. Seven nightjars (common nighthawk) were observed during nightjar survey Round 1 (five within 100 m of the observer and two further than 100 m from the observer). Two common nighthawk were observed doing aerial displays during the first round of Nightjar Surveys. One nightjar (common nighthawk) was observed flying overhead further than 100 m from the observer, going south, during nightjar survey Round 2. Two common nighthawks were recorded at PC CONI 1, two common nighthawks were recorded at PC CONI 2, three more were recorded at PC CONI 3, and one was recorded at PC CONI 4. Low spring peeper noise was heard at CONI PC locations 2, 3, and 4.

Other avian species were observed during nightjar survey Round 1 and include:

- One eastern wood-pewee approximately 300 m east of PC CONI 1 located by recently cleared mixed-wood forest in patch of uncleared ‘wildlife trees’ (Drawing 2, Appendix A).
- One yellow warbler (*Setophaga petechia*), one veery (*Catharus fuscescens*), and one eastern wood-pewee heard calling approximately 50 m east of PC CONI 2.

There was one novel species observed during the nightjar surveys compared to the spring/fall migration and breeding bird surveys (yellow warbler).

Incidentals

Incidental observations include those made during dedicated bird surveys (i.e., observation outside of point count time or survey location) and those made during non-bird related surveys (e.g., wetland delineation, botany, etc.).

There were no avian incidental observations during the dedicated avian survey program. There were a few incidental bird species recorded during other biophysical baseline survey types and will be listed below. There were no novel species observed incidentally during other biophysical baseline survey types. All incidental birds were also observed during the dedicated bird surveys.

Incidentals during a wetland and watercourse delineations (June 29, 2023):

- Two eastern-wood pewees heard around Wetland 1 and Watercourse 1.

All species identified are native species in this region of Nova Scotia. Typical and common habitat to support these species is present within the PA and surrounding landscape.

The only avian SAR observed during these incidental observations were the eastern wood-pewees observed during the early wetland and watercourse surveys. One was heard within the PA, located by WC 1 and WL1 near the southwestern border of the PA. One other eastern-wood pewee was recorded outside the PA during the 2023 wetland and watercourse delineations, approximately 430 m south of the Project. Note that all avian SAR observation locations can be viewed in Drawing 9 (Appendix A).

3.1.6.3 Priority Avifauna Species

ACCDC breeding bird status qualifiers were used to determine whether a species is a priority species, based on the time of year in which the species was observed. If a species has only one seasonal ranking, such as S3B, it was considered a SOCI regardless of the time of year it was observed. However, if the species had an alternate ranking, such as a S-Rank of S2S3B, S5N, the species was considered a priority species if observed during the breeding season. Outside of breeding season, this species was not considered a priority species.

Refer to Drawing 9, Appendix A for all avian SAR observations. Note that the PC survey data above reflects the PC(s) at which each avian SAR or SOCI were observed, and Drawing 9 is a map that reflects where the observation is precisely located based on surveyor data (i.e., distance and direction recorded).

Species at Risk

Four avian SAR and four avian SOCI were observed during surveys throughout the dedicated survey period in 2023. The SAR, its habitat requirements, and the habitat present within the PA, are described below.

All the avian SAR observations (eastern wood-pewee, olive-sided flycatcher, evening grosbeak, and common nighthawk) within the PA are associated with edge habitat, open areas, as well as wetlands and watercourses. The number of SAR (especially eastern wood-pewee and olive-sided flycatcher) can be directly attributed to the presence of edge habitat in and around the PA. Although clear-cut habitat is not suitable breeding/nesting habitat for flycatchers, they commonly will sit on the edges of clear-cuts for foraging. The PA consists of a large clear-cut area with patches of trees throughout. The forested edge adjacent to cleared area represents edge habitat [a variety in habitat and variation in vegetation structure (e.g., height), which attract a variety of bird species, not just flycatchers]. Further information on species at risk observed within the PA will be included in this section and refer to Drawing 9 (Appendix A) for all avian SAR observations.

Eastern wood-pewee

The eastern wood-pewee (listed as Special Concern by SARA/COSEWIC, Vulnerable by ESA, and ranked by ACCDC as S3S4B) is a small-sized bird belonging to the passerine group. There is suitable foraging and breeding habitat for this species within the PA. The species is known to nest and forage at high canopy levels in areas associated with clearings and forest edges. Eastern wood-pewees are mostly associated with the mid-canopy layer of forest clearings and edges of wetlands and deciduous and mixed forests. They are most abundant in intermediate age and mature forest stands (COSEWIC, 2012a). Preferred habitats include riparian areas by rivers, open/semi-open mature forest, treed swamps, bogs, meadows, cut blocks, quarries, transmission lines, barrens, and burned forests. The preference of edge habitat is strongly associated with their foraging needs and behaviour. The most significant threat to this species is the loss and/or degradation of habitat (COSEWIC, 2012a).

All eastern wood-pewee observations within the PA are associated with edge habitat around the sand pit site or the watercourse and wetland in the southwest of the PA. Out of all the biophysical surveys completed for the Project (beyond just the avifauna surveys), 15 eastern wood-pewee were recorded in and around the PA, all findings were generally associated with clear-cut areas or wetlands along the southern boundary of the PA. Seven eastern wood-pewee were recorded within the PA, three are located by WC1 and WL1 near the southwestern border of the PA. Eight eastern wood-pewee were recorded outside of the PA near roads, cultivated land, mixed wood forest, and clear-cut edges.

All eastern wood-pewee observation locations, including the incidental observations during the early botany surveys, can be viewed in Drawing 9 (Appendix A).

Olive-sided flycatcher

The olive-sided flycatcher (listed as Special Concern by SARA/COSEWIC, Threatened by ESA, and ranked by ACCDC as S3B) is small to medium-sixed bird belonging to the passerine group. There is suitable foraging and breeding habitat for this species within the PA. The olive-sided flycatcher is typically found in edge habitat within softwood and mixed wood forests for breeding habitat. This species inhabits open forest, often near water or wetlands that contain tall snags or trees (COSEWIC, 2018b). This species prefers areas with tall trees or snags adjacent to or within open areas to perch on for foraging. Preferred habitats include riparian areas by rivers, open/semi-open mature forest, treed swamps, bogs, cutblocks, barrens, meadows, and burned forests. The most significant threat to this species is the loss and/or degradation of habitat (COSEWIC, 2018b).

In all of the surveys completed for the Project so far, only one individual olive-sided flycatcher was seen and heard flying northeast overhead at PC5 (~ 60 m southeast of PC 6) and over 100 m away from the observer during the Breeding Bird Surveys. The olive-sided flycatcher was recorded approximately 150 m northeast in a treeline on the edge of a clearcut section (seen singing in one of the little tree pockets left in clearcut).

Evening Grosbeak

Evening grosbeak (*Coccothraustes vespertinus.*) is listed as Special Concern by COSEWIC and SARA, is listed as Vulnerable by ESA, and is ranked by ACCDC as S3S4B, S3N. The evening grosbeak is generally associated with older coniferous and mixed forests, partial cutting of mature stands also maintains habitat for this species (MBBA, 2008). Evening grosbeak are documented by ACCDC and the MBBA as present in the vicinity of the PA, and suitable habitat may be available for this species within the PA based on desktop review (i.e., mixed wood forests, clear cut edges, roadside clearings). The ACCDC report states this species has been identified within 1.9 ± 0 km of the PA (Appendix C). In addition, Evening grosbeak has been observed within the region displaying breeding evidence (MBBA, n.d.; Appendix I).

In all the surveys completed for the Project so far, four individual evening grosbeaks were recorded during the Spring Migration Surveys. One was heard flying overhead ~ 50 m away in the forest (~20-30 m) at PC1 and another was heard ~ 50 m away in the forest (~20-30 m) at PC9. One more was heard right by PC10 (less than 20-30 m away) in a forested area and the fourth one was heard within 20 m of PC4 in forested habitat.

Common Nighthawk

Common nighthawk (*Chordeiles minor*) is listed as Special Concern by COSEWIC and Threatened by the SARA and ESA and ranked by ACCDC as S3B. Common nighthawk prefer to nest in gravelly substrates and are best detected while foraging for insects shortly after sunset (MBBA, 2008). Common nighthawk are documented by ACCDC and the MBBA as present in the vicinity of the PA, and suitable habitat may be available for this species within the PA based on desktop review and the field results (i.e., harvested areas, roadside clearings). The ACCDC report states this species has been identified within 1.5 ± 0 km of the PA (Appendix C). In addition, common nighthawk has been observed within the region displaying breeding evidence (MBBA, n.d.; Appendix I).

Two dedicated evening surveys for the common nighthawk were conducted during their breeding season on June 9 and July 5, 2023. The survey dates coincide with breeding season for common nighthawk and were limited to two evening surveys to limit disturbance to breeding species. Targeted surveys for this species were selected because they are not reliably detected during the seasonal PC surveys due to their crepuscular nature (Saskatchewan Ministry of Environment, 2015). Four common nighthawk PCs (CONI PC), CONI1, CONI2, CONI3, and CONI4, were surveyed by a qualified ornithologist. Surveys were conducted one hour before sunset and ended 30 minutes after sunset (Saskatchewan Ministry of Environment, 2015; MBBA, 2008).

CONI1 is situated 680 m west of the PA on a gravel farm road. CONI2 is located on a dry-weather resource road approximately 900 m north of the PA. CONI3 is located on an unnamed resource road, adjacent to an existing quarry and 230 m east of the PA. CON 4 is located on Torbrook Road, a paved road, approximately 1.5 km south of the PA. CONI PC locations were selected within appropriate habitat, and in order to provide coverage of the entire PA as

common nighthawk can be heard from 800 m away (Saskatchewan Ministry of Environment, 2015). From the chosen central location there is a maximum distance of 1500 m to the PA boundary. CONI PC locations were selected because they are on gravel roads, with roadside gravel clearings suitable for nesting habitat, and can safely be accessed from a vehicle during nocturnal surveys (MBBA, 2008). CONI PCs were distanced by 800 m to provide coverage, while avoiding overlapping observations (i.e., hearing the same individual at multiple locations; Saskatchewan Ministry of Environment, 2015).

At each CONI PC location, surveys consisted of a three-minute passive surveying period, followed by three minutes of alternating 30-seconds call-playback of the conspecific common nighthawk call and 30-seconds of silent passive surveying as per survey protocol by Saskatchewan Ministry of Environment (2015). The MBBA Species at Risk Atlassing Guide states that common nighthawk are territorial, therefore using call-playback methods may increase the probability of observations (MBBA, 2008). Any observations of common nighthawk were recorded, including the number of individuals heard, sex, distance, bearing, dominant habitat that the bird is observed within, bird behaviour, and whether the bird is observed during the allotted survey time or not. Any other birds observed during the survey time were recorded.

Two common nighthawks were recorded at PC CONI1, two common nighthawks were recorded at PC CONI2, three more were recorded at PC CONI3, and one was recorded at PC CONI4. All of the PC CONI locations are at least 200 m outside the PA and are adjacent to edge habitats with stand heterogeneity (i.e. roads, quarries, forest patches and/or recently clear-cut forest).

Species of Conservation Interest

Across all survey seasons, a total of four avian SAR and four avian SOCI was observed (Drawing 9, Appendix A). Note that certain bird species are considered SOCI during certain seasons due to their ACCDC SRank, as explained throughout field results. The species of conservation interest and the survey season/type when they were observed are as follows:

- Pine warbler (Fall Migration 2023)
- Pine siskin (Fall Migration 2023)
- Bay-breasted warbler (Breeding Bird Surveys 2023)
- Red crossbill (Spring Migration 2023 & Breeding Bird Surveys 2023)

3.1.6.4 Assessment of Avifauna Habitat

The PA provides a range of habitats suitable for a variety of bird species with different habitat requirements. There are expansive areas of open habitat that provide foraging and breeding habitat for certain species (e.g., raptors and passerines). Forests and shrub-dominated areas with stand heterogeneity (i.e., stands with different height classes) provide suitable habitat for foraging and breeding for many passerine species. Open habitat transitioning into forested habitat also provides edge habitat that various species use for foraging (e.g., swallows and flycatchers).

Overall, survey locations in open areas (e.g., clear-cut area) with forested edges had the highest individual and species counts. The higher number of species and individuals at these locations is likely due to this habitat variability and structure (e.g., vegetation height differences provided by edge habitat). This would attract a variety of species (passerines, woodpeckers, raptors, waterfowl, and shorebirds).

There were a couple of observations of migratory behaviour or general migratory patterns noted within the PA during the spring migration, breeding bird, or fall migration surveys (e.g., specific direction or migratory areas/corridors), listed as follows:

- Three small groups of Canada geese travelling together at PC 2 [number of individuals (n) = 75] were observed during fall migration surveys.
- One large group of American robins (n=40) gathered around the edge of recently cleared forest at PC 2.

3.2 Aquatic Environment

Wetland and watercourse surveys, including fish and fish habitat assessments, were completed and are discussed below.

3.2.1 Wetlands

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

3.2.1.1 Desktop Review

A review of the NSECC Wetlands Inventory Database identified one mapped wetland, classified as a swamp, within the southeast corner of the PA (Drawing 6, Appendix A). The wetland and boundary were field verified during wetland surveys. No other NSECC wetlands are located within the PA.

The Wet Areas Mapping database identifies areas within the PA that have saturation ranges varying from 0 to 10.0 m below the ground surface. The area surrounding the provincially mapped swamp shows saturation ranges from 0.51 m to 2.0 m below surface. Saturation close to the surface (0 – 0.10 m) is also found in the north and southwest portions of the PA where there are depressions following a hillslope (Drawing 6, Appendix A).

No NSECC predicted WSS are located within the PA. The closest predicted WSS (ID# 17787) is a swamp along the Nictaux River, located approximately 2.8 km southwest of the PA.

3.2.1.2 Field Surveys

Two wetlands were identified within the PA (Drawing 7, Appendix A). One of the wetlands identified within the PA was the NSECC mapped wetland that was identified during the desktop review. The boundaries of this wetland were adjusted in the field as necessary. A summary of wetlands, and their characteristics are provided in Table 3.9. Representative photos are provided in Appendix F.

Table 3.9: Wetland Characteristics

Wetland	Wetland Type	Wetland Size (Ha)	Water Flow Path	Landform	Landscape Position	Hydric Soil Indicator	Hydrological Conditions	Dominant Vegetation
1[1]	Mixed-wood treed swamp	3.9686	Outflow	Hillslope	Stream Floodplain	Histosol	Surface water, high water table, saturation, inundation visible on aerial imagery, drainage patterns, water-stained leaved, Saturation visible on Aerial Imagery drainage patterns, geomorphic position	**Herbs***: Osmundastrum cinnamomeum, Dryopteris cristata, Onoclea sensibilis* **Shrubs**: *Alnus incana. Fraxinus americana, Tsuga canadansis, Betula aleghaniensis* **Trees:** *Larix laricina, Picea mariana, Abies balsamea, Betula aleghaniensis, Fraxinus americana*
2[1]	Mixed-wood treed swamp	0.8502	Isolated	Flat	Terrene	Histosol	Surface water, High water table, water-stained leaved	**Herbs**: *Carex disperma, Osmundastrum cinnamomeum, Acer rubrum, Onclea sensibilis, Maianthemum canadense, Lysimachia borealis* **Shrubs**: *Alnus incana, Fraxinus americana, Tsuga canadansis, Betula aleghaniensis* **Trees**: *Alnus incana*, *Tsuga canadansis, Betula aleghaniensis, Fraxinus americana, Ilex verticilata, Acer rubrum*

[1] Field delineated wetlands extend beyond the PA boundary

In total, the two wetlands account for approximately 4.8 ha, which comprises approximately 4.4% of the PA. Both wetlands are classified as mixedwood treed swamps. Wetland type classifications are guided by The Canadian Wetland Classification System (1997). Both wetlands continue beyond the PA. WL1 accounts for 82% of the total wetland area in the PA. Both wetlands are located along the southern edge. No other wetland type was identified within the PA.

The dominant tree species within WL1 and WL2 include red maple, white ash, black spruce, and balsam fir. Both wetlands have a notable shrub layer of speckled alder and white birch. The soil type identified in both wetlands was histosol.

Swamps are wetlands that are characterized by the dominance of tall woody perennial vegetation that often exceeds 30% cover (NWWG, 1997). These wetland types are often forested (dominated by trees with a high canopy cover) and/or have extensive shrub cover and consist of soils which can either be mineral or organic (NWWG, 1997). This wetland type is common within Nova Scotia and can either be stand-alone or found within wetland complexes (often along the outer edges).

Wetland Functional Analysis

The following subsections summarize the results of the WESP-AC functional assessments and the WESP-AC WSS Interpretation Tool for the two wetlands within the PA. Detailed results can be found in the summary tables provided in Appendix D.

WESP-AC Grouped Wetland Function Results

Hydrologic Group

The Hydrologic Group evaluates the effectiveness of a wetland to store or delay the downslope movement of surface water. However, the model does not account for wetland size, and in turn, does not account for larger wetlands having the ability to store more water than smaller wetlands. Wetlands that have the highest functions within this group include those that do not have surface water outlets, and instead, are isolated from flowing surface water. See Table 3.10 for each wetland's function and benefit score.

Table 3.10: Hydrologic Group Score Category

Function	Benefit		
	Lower	Moderate	Higher
Lower	None	None	None
Moderate	None	WL 1 and WL2	None
Higher	None	None	None

WL1 and WL2 scored moderately for both function and benefit for the Hydrology Group. WL1 has a relatively low elevation change throughout the wetland and contains an outlet watercourse (WC1). This likely results in a longer flow path and delay of downslope movement of surface water. WL2 is an isolated mixedwood tree swamp with no surface water connections, allowing it to efficiently store water.

Water Quality Group

The water quality group is compiled from four different functions: sediment retention and stabilization; phosphorus retention; nitrate removal; and carbon sequestration. The main function of this group is to evaluate the wetland's potential to intercept, retain, and filter sediments, particulates, and organic matter. Similar to the hydrologic group, the wetlands that have the highest functions in this regard include those that do not have a surface water outlet and instead are isolated from flowing surface water. The model does not account for wetland size, and as such, larger wetlands do not necessarily score higher for water purification than small wetlands, although size may factor into this function (Table 3.11).

Table 3.11: Water Quality Group WESP-AC Results

Function	Benefit		
	Lower	Moderate	Higher
Lower	None	None	None
Moderate	None	None	WL1
Higher	None	WL2	None

WL1 received moderate function and higher benefit scores, which indicates it is able to efficiently retain and filter sediments. WL2 scored higher in function with a moderate benefit score. Both wetlands are adjacent to unvegetated slopes where surface water runoff is likely to be more rapid, thus providing greater benefit in their ability to trap sediments.

Aquatic Support Group

The aquatic support group comprises four individual functions: stream flow support; aquatic invertebrate habitat; organic nutrient export; and water cooling. The main function of this group is to determine the wetland's ability to support ecological stream functions that promote habitat health, therefore wetlands lying adjacent to or containing flowing water score higher than those that do not (i.e. isolated wetlands). Additionally, headwater wetlands are crucial for supporting stream flow during the dry season by contributing to water flow via groundwater input and storage capacity (Table 3.12).

Table 3.12: Aquatic Support Group WESP-AC Results

Function	Benefit		
	Lower	Moderate	Higher
Lower	None	None	None
Moderate	WL2	None	None
Higher	WL1	None	None

WL1 scored higher for function and lower for benefit and WL2 scored moderate for function and lower for benefit. WL1 is associated with WC1 and Open Water A, offering a wider variety of microhabitats for invertebrates. The presence of these aquatic features likely allows for greater water cooling and the export of organic nutrients, providing greater aquatic functions than WL2.

Aquatic Habitat Group

The aquatic habitat group is compiled from five different functions: anadromous fish habitat; resident fish habitat; amphibian and turtle habitat; waterbird feeding habitat; and waterbird nesting habitat. Wetlands that have the highest functions within this group include those that are adjacent to or contain flowing water (Table 3.13).

Table 3.13: Aquatic Habitat Group

Function	Benefit		
	Lower	Moderate	Higher
Lower	WL2	None	None
Moderate	None	WL 1	None
Higher	None	None	None

WL1 received moderate function and benefit scores, as there is ponded and flowing water present within the wetland that could provide habitat for herpetofauna, waterbirds, or fish. WL2 scored lower for both function and benefit in this group because it is isolated.

Transition Habitat Group

The transition habitat group comprises of three different functions: songbird, raptor, and mammal habitat; native plant habitat and pollinator habitat. The main function of the collective group is to evaluate the wetland's ability to support healthy habitat for birds, mammals, and native plants (Table 3.14).

Table 3.14: Transition Habitat Group WESP-AC Results

Function	Benefit		
	Lower	Moderate	Higher
Lower	None	None	None
Moderate	WL2	None	None
Higher	None	WL1	None

WL1 scored higher for function and moderate for benefit and WL2 scored moderate for function and lower for benefit. Wetlands within the PA provide habitat that supports a variety of flora and fauna. Both wetlands are more than 500 m from the nearest road or population centre, providing greater support to plants, songbirds, or mammal species through natural forest cover. Lower or moderate benefit scores suggest that these wetlands perform these benefits at the same or lower rate to other wetlands within the surrounding area.

Wetland Condition

Wetland Condition refers to the integrity or health of a wetland as defined by its vegetative composition and richness of native species. Scores are derived from the similarity between the wetlands being evaluated and reference wetlands of the same type and landscape setting (Adamus, 1996).

Wetland condition rank within the PA is higher, indicating that both wetlands contain a relatively successful level of vegetative community health and species diversity (see Appendix D). High scoring wetlands may have greater ecological integrity, microhabitats, species diversity, etc., while lower scoring wetlands may indicate that they have lost their function and integrity due to historical natural or anthropogenic impacts.

Wetland Risk

Wetland Risk takes sensitivity and stressors into account by averaging the two. Sensitivity is the lack of intrinsic resistance and resilience of the wetland to anthropogenic or naturally caused stress (Niemi *et al*., 1990).

The functional assessment tool uses five metrics to measure sensitivity: abiotic resistance, biotic resistance, site fertility, availability of colonizers, and growth rate. Stress relates to the degree to which the wetland is or has recently been anthropogenically altered in a way that degrades natural condition and/or function. The model applies four stress groups: hydrologic stress, water quality stress, fragmentation stress, and general disturbance stress. Wetlands that are highly resilient may have Lower risk scores despite their exposure to multiple stressors. Additionally, wetlands exposed to fewer threats, but with low resilience may have high risk scores. Wetland resilience is tied to multiple factors, such as size, proximity to natural land cover, and presence of invasive species.

WL1 and WL2, scored higher for wetland risk, meaning they are generally exposed to pre-existing stressors (e.g., road development, forest harvesting, and agriculture land development) and/or may be less resilient and susceptible to change.

Functional Assessment Summary

WESP-AC is a quantitative decision-making tool, but its results must be used qualitatively to form conclusions around wetland functions. The highest functioning wetlands are those that have both higher function and higher benefit scores. While higher benefit or function scores were calculated for various wetlands, no wetland scored higher in all grouped benefits and functions.

Scores ranged from higher to lower for both wetlands. WL1 scored higher in function for the aquatic support and transitional habitat groups and higher in benefits for the water quality group, as it is associated with a watercourse and open water feature, providing a unique range of functions and benefits. WL2 scored lower to moderate in aquatic support, aquatic habitat and transitional habitat groups because it is an isolated wetland offering less variety of habitat and overall aquatic support.

WESP-AC WSS Interpretation Tool

The results generated from the WESP-AC Interpretation tool are presented Table 3.15 and Table 3.16.

None of the wetlands within the PA are classified as a functional WSS.

Table 3.15: WESP-AC WSS Interpretation Tool Results

Wetland ID	Function-Benefit Product (FBP)										Conclusion
	Support Supergroup – Hydrologic		Support Supergroup – Water Quality Support		Support Supergroup – Aquatic Support		Habitat Supergroup – Aquatic Habitat		Habitat Supergroup – Transition Habitat		
	FBP Score	FBP Score Category	FBP Score	FBP Score Category	FBP Score	FBP Score Category	FBP Score	FBP Score Category	FBP Score	FBP Score Category	
1	16.70	Low	28.73	Low	22.30	Low	21.47	Low	65.26	Low	Not a WSS
2	35.37	Low	27.52	Low	1.61	Low	1.43	Low	20.86	Low	Not a WSS

Table 3.16: Functional Wetland Determination Results

Wetland	Habitat Rule Satisfied?	Support Rule Satisfied	Habitat/Support Rule Hybrid Satisfied?	Conclusion
1	No	No	No	Not a WSS
2	No	No	No	Not a WSS

Wetlands of Special Significance

As part of a qualitative wetland assessment, along with a review of the current (June 2020) NSECC predictive WSS layer, each wetland was reviewed to assess potential for WSS designation.

No wetlands within the PA are present within any of the following special habitats: Ramsar Sites; Provincial Wildlife Management Areas; Provincial Parks; Nature Reserves; Wilderness Areas; Lands owned or legally protected by non-governmental charitable conservation land trusts; intact or restored wetlands under the North American Waterfowl Management Plan; and protected water areas, which would result in the designation of a WSS. The nearest protected area is Torbrook Nature Reserve, which is 3.5 km south of the PA.

No functional WSS were identified through the WESP-AC WSS Interpretation Tool.

No wetlands were identified as potential WSS based on the presence of a SAR species.

Wetland Hydrology

Wetland hydrology is dependent on the wetland type and its position on the landscape. Within the PA, swamps are the only type of wetland observed (n=2).

Water table fluctuations in swamps are often greater than that of other wetlands, particularly if there is a watercourse connection. Isolated swamps are on average drier than most other wetland types, with a water table below the surface for the majority of the year (Warner & Rubec, 1997). Swamps may function as groundwater recharge or discharge systems depending on their position in the landscape and association with other hydrologic features (e.g., watercourses).

The PA is located in the Annapolis watershed (1DC-3), which empties into the Bay of Fundy.

The hydrologic gradient of the PA is to the southwest and originates from Open Water A within WL1. Open Water A is fed from groundwater inputs and surface water runoff from adjacent hillslopes. The water flows through WC1 and eventually drains into the Nictaux River, outside the PA WL1 and WL2 are not hydrologically connected. WL2 is an isolated swamp that is likely fed by groundwater inputs.

WL1 and WL2 are located along the southern edge of the PA, separated from the remainder of the PA by a sandy glacial deposit. The remainder of the site has little surficial hydrology, likely due to the sandy substrate, which allows any standing water to quickly drain resulting in the dry landscape observed.

3.2.2 Fish and Fish Habitat

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

3.2.2.1 Desktop Review

The PA is situated entirely within the Annapolis primary watershed (1DC) and the Annapolis River secondary watershed (1DC-3) (Drawing 5, Appendix A). No mapped watercourses or waterbodies were identified within the PA; however, an unnamed tributary commences approximately 77 m west of the southwestern edge of the PA and flows northwest towards the Nictaux River (this watercourse is herein referred to as WC1).

The topographical high within the Aquatic Study Area is situated in the eastern corner. Within the PA, surface water drains from this topographic high in both northerly and westerly directions. Northern flow is directed towards a tributary to the Annapolis River (herein referred to as WC4), while western flow drains to the Nictaux River. A small amount of surface flow is generated eastward, which similarly is directed toward Bald Hill Brook, which is an Annapolis River tributary. Bald Hill Brook, WC4, and the Nictaux River drain into the Annapolis River, which is situated approximately 3 km north of the PA. A natural ravine in the south of the PA causes surface water to drain and collect at its base. All surface water originating from the PA is eventually directed north towards the Annapolis River which flows into the Annapolis Basin and eventually the Bay of Fundy (Drawing 6, Appendix A).

The priority species list (Appendix B) was used to identify the following priority fish species that may occur within the PA: Atlantic sturgeon (*Acipenser oxyrinchus,* COSEWIC threatened, S2S3N), Atlantic salmon – Southern Upland population (*Salmo salar;* COSEWIC endangered; S1), American eel (*Anguilla rostrata;* COSEWIC threatened, S3N), brook stickleback (*Culaea inconstans*; S3), lake trout (*Salvelinus namaycush*; S3), brook trout (*Salvelinus fontinalis;* S3), northern pearl dace (*Margariscus nachtriebi;* S3), and striped bass – Bay of Fundy population (*Morone saxatilis* pop. 2; COSEWIC endangered, S2S3B, S2S3N).

The ACCDC report identified two species located within 5 km of the PA: American eel and brook trout. The Aquatic Species at Risk Map (DFO, 2025) was reviewed, and no critical habitat or species listed under the SARA were identified within the Annapolis River secondary watershed. Brook floater (*Alasmidonta varicosa;* SARA Special Concern) are noted as “found (or potentially found)” within the Annapolis River 3 km north of the PA (DFO, 2025).

American eel was identified within the ACCDC report within 2.2 km of the PA. As a catadromous species, eel spend the majority of their lives in freshwater, moving to the Sargasso Sea to spawn (Scott & Crossman, 1973). American eel distribution encompasses all freshwater watercourses that have connectivity to the Atlantic Ocean (COSEWIC, 2012). The abundance and distribution of American eel has diminished over the last century due to human impacts within freshwater habitat (COSEWIC, 2012). American eel populations are ranked as S3N by the ACCDC and are listed as threatened by COSEWIC; they are not currently listed under SARA or ESA.

Brook trout were identified by the ACCDC report within 5.1 km of the PA. This species is ubiquitous in freshwater systems throughout the province. Trout populations in general are affected by habitat loss, over exploitation, competition, and illegal introductions (NSDAF,

2005). Brook trout populations are ranked as S3 by the ACCDC and have not been assessed by COSEWIC, nor are they listed under SARA or ESA.

The Nova Scotia Significant Species and Habitat database did not identify any significant species or habitat within the Aquatic Study Area. The Aquatic Species at Risk map did not identify any SAR or critical habitat within the Aquatic Study Area.

The Nova Scotia freshwater fish species distribution records (Nova Scotia, 2019), Description of Selected Lake Characteristics and Occurrence of Fish Species in 781 Nova Scotia Lakes (Alexander et al., 1986) and the Canadian Rivers Institute (CRI) inland fish distribution maps were reviewed, and 14 additional fish species were identified within the Annapolis River primary watershed (1DC). These species include:

- White sucker (*Catostomus commersonii;* S5)
- Smallmouth bass (*Micropterus dolomieu*: SNA)
- Alewife (*Alosa pseudoharengus*; S3B)
- American shad (*Alosa sapidissima*; S5B)
- Common shiner (*Luxilus cornutus*; S5)
- Creek chub (*Semotilus atromaculatus;* S5)
- Golden shiner (*Notemigonus crysoleucas*; S4)
- Banded killifish (*Fundulus iaphanous*; S5)
- Mummichog (*Fundulus heteroclitus*; S5)
- Threespine stickleback (*Gasterosteus aculeatus;* S5)
- Ninespine stickleback (*Pungitius pungitius;* S5)
- Brown bullhead (*Ameiurus nebulosus;* S5)
- Brown trout (*Salmo trutta*; SNA)
- Rainbow trout (*Oncorhynchus mykiss*; SNA)
- White perch (*Morone americana,* S5)
- Yellow perch (*Perca flavescens,* S5)

FISHBRAIN is a mobile application which gives fishers the ability to log fish captured at geographically referenced locations. Using this resource, it was found that fish caught and logged in the Nictaux River included striped bass and American shad (Fishbrain, N.D.).

3.2.2.2 Field Results

Watercourse Delineation

One field identified watercourse, WC1, and one waterbody, Open Water A, were delineated and characterized within the PA. Two additional watercourses were identified outside the PA but within the Aquatic Study Area, WC2, and WC3 (Drawing 7, Appendix A):

- WC1 originates from Open Water A, travels through WL1, and continues west beyond the PA before draining into WC2 (a tributary to the Nictaux River). Direct connectivity to the Nictaux River was field verified.

- Open Water A is a waterbody that is present within WL1 and is the upstream headwater/extent of WC1. The open water is situated along the southern boundary of the PA.
- WC2 originates southwest of the PA. It flows north towards WC1, which drains into WC2, then flows west, eventually flowing into Nictaux River. WC2 was delineated and connectivity to the Nictaux River was field verified during the detailed habitat assessment.
- WC3 originates in a wetland in the northwest portion of the Aquatic Study Area. WC3 flows north, eventually joining Nictaux River. WC3 was delineated within the extent of the Aquatic Study Area during the detailed habitat assessment.

Refer to Fish Habitat Characterization for physical descriptions of the aquatic features identified within the Aquatic Study Area. No additional watercourses or waterbodies were delineated within the PA. Representative photographs of each aquatic feature are provided in Appendix F.

Fish Surveys: Electrofishing Results

The results of qualitative electrofishing surveys are presented in Table 3.18. Relative abundance has been expressed through Catch Per Unit Effort (CPUE) calculated as the number of fish captured per 100 seconds of electrofishing effort.

Table 3.18: Summary of Electrofishing Efforts within the Aquatic Study Area

Site	Survey Date	Fish Species Collected	Catch Per Species	Total Catch	Total Effort (seconds)	CPUE (fish/100 seconds)
WC2 Reach A	July 12, 2023	threespine stickleback, creek chub, brook trout	3 5 1	10	499.8	2.00
		threespine stickleback, creek chub, brook trout	2 1 1	4	435.6	0.92
WC2 Reach B	July 12, 2023	--	--	0	363	0
				0	373.7	0
WC3	July 14, 2023	--	--	0	317.9	0
				0	312.2	0
WC1 site 1	July 12, 2023	threespine stickleback, creek chub, brook trout	3 5 2	9	935.5	0.96
WC1 site 2	July 12, 2023	threespine stickleback, creek chub, brook trout	2 1 1	4	736.2	0.54

Electrofishing surveys completed on July 12 and 14, 2023 resulted in the capture of three species and 14 individual fish within one of the three survey locations, WC2 Reach A. A total of five threespine stickleback, six creek chub, and two brook trout were captured, resulting in a CPUE of 2.00 and 0.92 for Pass 1 and Pass 2, respectively. No fish were captured in WC2, Reach B or WC3.

Fish Surveys: Trapping Results

The results of trapping efforts in Open Water A and WC2 are presented in Table 3.19. Relative abundance has been expressed through CPUE per trap type and per species.

Table 3.19: Summary of Trapping Efforts within the Aquatic Study Area

Waterbody ID	Survey Date	Fish Species Collected	Total Catch	Total Catch Per Trap Type[1]	Total Effort Per Trap Type (hours)	CPUE (per trap hour)
WC2	July 12-13, 2023	threespine stickleback, creek chub, northern redbelly dace	89 8 4	MT1 - 62 MT2 - 38 MT3 - 0 MT4 - 1 EP1 - 0 EP2 - 0	MT – 84.85 EP – 42.86	MT- 1.19 EP- 0
Open Water A	July 11-12, 2023	None	0	MT- 0 EP- 0	MT – 60.62 hrs EP – 20.58 hrs	MT- 0 EP- 0

[1]MT = minnow trap, EP = eel pot

Over the 82.20 hours of trapping within Open Water A, no fish were caught or observed. Over 127.71 hours of trapping within WC2, 101 fish were caught in three of the four minnow traps. These species included threespine stickleback, with the highest abundance (89 individuals), creek chub (8 individuals), and northern redbelly dace (4 individuals). No fish were captured in eel pots. Refer to Drawing 7 (Appendix A) for site locations within WC2 and Open Water A.

Fish Species Observed

Table 3.20 presents a summary of fish species captured through all electrofishing and trapping surveys within the Aquatic Study Area (priority species are **bolded**) and displayed on Drawing 7. Representative photographs of each species captured are presented in Appendix F.

Table 3.20: Fish Species Captured within the Aquatic Study Area

Common Name	Scientific Name	COSEWIC/SARA/ ESA/S-Rank	Total Catch		Length Range (mm)	Watercourse		
			Total #	% Catch		Open Water A	WC2	WC3
Northern redbelly dace	*Chrosomus eos*	S5	4	3.4%	55-60		X	
Creek chub	*Semotilus atromaculatus*	S5	14	12.1%	50-110		X	
Threespine stickleback	*Gasterosteus aculeatus*	S5	94	81.7%	39-65		X	
Brook trout	***Salvelinus fontinalis***	**S3**	**3**	**2.6%**	80-170		X	
Total Individuals			115					

As a result of fishing efforts (i.e., all electrofishing and trapping surveys) completed within the Aquatic Study Area, a total of four species were captured:

- brook trout (S3)
- creek chub (S5)
- northern redbelly dace (S5)
- threespine stickleback (S5)

Species diversity is considered moderate in the context of a first order stream within Nova Scotia. In total, 115 fish were captured across three survey locations, all within WC2. Threespine stickleback accounted for the vast majority of fish captured, accounting for 81.7% of the total catch for all fishing efforts. Creek chub was caught less frequently, comprising about 12% of the total capture. Approximately 6% of all fish caught were made up of northern redbelly dace (3.4%) and brook trout (2.6%). Of the four species capture, only brook trout (S3) is considered a priority fish species. During fish collection, both juvenile and adult brook trout were captured within WC2.

Water Quality

Water quality results are reported and discussed as they relate 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 Freshwater Aquatic Life (FWALs). In-situ water quality measurements recorded during detailed habitat surveys in July 2023 are provided in Table 3.21.

Table 3.21: Summary of In-situ Water Quality Measurements during Detailed Habitat Surveys

Site	Reach #	Sampling Date	Water Temp (ºC)	pH	Conductivity (µS/cm)	TDS (mg/L)
WC1	1	July 11, 2023	20.4	5.7	132	81
	2	July 11, 2023	19.4	5.9	128	70
	3	July 11, 2023	20.0	6.2	100	59
WC2	1	July 12, 2023	19.0	6.8	136	76
	2	July 12, 2023	19.5	6.4	117	64
	3	July 12, 2023	20.6	6.9	116	61
WC3	1	July 13, 2023	14.6	7.6	62	27
	2	July 13, 2023	15.4	6.3	101	50

Values in bold indicate parameters recorded as below CCME guidelines for the protection of aquatic life, including: pH levels below 5.0 (CCREM, 1987).

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

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 (Raleigh, 1982). The thermal preference class (as defined by Coker et al., 2001) for brook trout is classified as cold, meaning preferred summer water temperatures fall below 19°C (Hasnain, 2012).

Creek chub thrive in temperature ranges between 12-24 degrees but can sustain themselves in isolated pools in streams up to 28 degrees (McMahon, 1982). Northern redbelly dace is a hardy fish and can survive in a range of temperatures. They require areas with groundwater interactions that allow surrounding waters to gradually cool providing a more stable habitat where breeding can occur within 21-28 degrees (Stasiak, 2006).

Recorded summer water temperatures are considered suitable for the local fish community.

pH

CCME FWALs establish that a range of pH from 6.5 to 9.0 is suitable for supporting fish populations 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.

Brook trout tolerate acidic conditions particularly well, compared with other species. They have been known to survive at pH 3.5 in laboratory settings (Daye & Garside, 1975). Raleigh proposed an optimal pH range for brook trout as 6.5-8.0, with a tolerance range of 4.0-9.5 (Raleigh, 1982).

Other fishes within the local fish community including threespine stickleback, can tolerate low levels of pH (4-5.5; COSEWIC, 2011). Creek chub prefer pH ranges between 6-9 but can survive in waters with pH as low as 5.4 (McMahon, 1982). Northern redbelly dace is a hardy fish and can survive in a variety of pH that other fish cannot tolerate (Stasiak, 2006).

The pH range for aquatic features sampled within the PA was between 5.7-7.6, with an average pH of 6.48. All measurements, except for three (6.8 and 6.9 in WC2 and 7.6 in WC3) fall outside of the CCME guidelines (<6.5) but are not considered limiting to the local fish community.

Conductivity and Total Dissolved Solids

Conductivity is a measure of water's capacity to conduct an electrical current. 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 target) as part of its Environmental Performance Water Quality Index (ECCC, 2011).

Total Dissolved Solids (TDS) is a measurement of inorganic salts, organic matter, and other dissolved materials in water. Conductivity is correlated to TDS as 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. A study by Weber-Scannell & Duffy (2007) reported a variety of studies that evaluated the effect of elevated TDS on freshwater aquatic invertebrates. These studies reported the commencement of effect at 499 mg/L, with most effects not observed until >1000 mg/L. With fish, research is limited, but preliminary studies reported in Weber-Scannell and Duffy (2007) demonstrated survival rates of salmonid embryos to elevated TDS (38% survival when exposed to 2229 mg/L for brook trout, and 35% survival when exposed to 1395 mg/L).

Conductivity and TDS are often used as baseline for comparison with background measurements. Major changes in this parameter could indicate that a discharge or some other source of pollution has entered the aquatic resource. Conductivity and TDS levels measured within the PA (100-136 µS/cm and 27-81 mg/L, respectively) are considered acceptable for aquatic life.

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 3.22. These summary tables have been prepared using data collected during watercourse delineation, detailed habitat surveys, fishing surveys and water quality surveys. Suitable habitat requirements were pulled from Appendix J. Fish habitat characteristics of waterbodies are provided in Table 3.23. Linear watercourse reaches and waterbodies are presented on Drawing 7 (Appendix A) and representative photos are presented in Appendix F.

The subsections following these tables describe fish habitat within each aquatic feature identified in the Aquatic Study Area and provide an assessment of the baseline habitat quality 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. All delineated surface water features within the PA (watercourses and waterbodies) are considered fisheries resources.

Table 3.22: Physical Characteristics of Watercourses within the Aquatic Study Area

Watercourse	Reach	Stream Order	Flow Type[1]	Reach Characteristics										Fish Support[7]				
				Channel Width (m)[2]	Wetted Width (m)[2]	Reach Length (m)	Dominant Habitat Type	Other Habitats Present	Slope (%)[3]	Velocity Range (m/s)	Depth range (m)[2]	Dominant Substrate[4]	Cover types[5]	Confirmed Species[6]	Suitable Habitat			
															Spawning	YOY	Juvenile	Adult
1	1	1	E	1-3	0.6-0.9	90.7	Flat	-	<1	<0.05	0.03-0.09	Muck	AP	None	NRD, 3SB	NRD, 3SB	NRD, 3SB	NRD, 3SB
	2	1	I	1.6-3	0.8-1.6	424.9	Riffle-run	Flat, Pool	1	<0.05	0-0.25	Cobble, Gravel, Muck	AP, IN		BKT, 3SB, CRC, NRD	BKT, 3SB, CRC, NRD	BKT, 3SB, CRC, NRD	BKT, 3SB, CRC, NRD
	3	1	P	1.5-3.9	0.6-1.7	407.0	Riffle-run	Pool	2	0.05-0.26	0-0.32	Rubble, Cobble, Gravel, Sand	AP, IN		BKT, 3SB, CRC, NRD	BKT, 3SB, CRC, NRD	BKT, 3SB, CRC, NRD	BKT, 3SB, CRC, NRD
2	1	1	I	1.5-4	0.8-2.1	387.0	Riffle-run	Pool	1	0.05-0.15	0-0.26	Boulder, cobble, rubble, gravel	AP, IN	CRC, BKT, 3SB, NRD	NRD, 3SB, BKT	BKT, NRD, CRC	BKT, NRD, CRC	BKT, NRD, CRC
	2	1	P	2.3-5.3	0.5-3	561.0	Riffle-run	Pool	1	0.05-0.24	0-0.42	Gravel, Sand, Cobble	AP. IN		BKT, NRD, 3SB, CRC	BKT, NRD, 3SB, CRC	BKT, NRD, 3SB, CRC	BKT, NRD, 3SB, CRC
	3	1	P	3.4-4.4	1.1-3.7	266.0	Riffle-run	--	1	0.06-0.13	0.04-0.34	Cobble, Gravel	AP, IN		BKT, NRD, 3SB	BKT, CRC	BKT, CRC	BKT
3	1	1	I	1.2-2.6	0.5-1	286.0	Riffle-run	Flat	1	0.05-0.12	0-0.23	Muck, Sand	AP, IN	None	NRD, 3SB	BKT	BKT, CRC	BKT
	2	1	P	3.3	2.6	26.0	Riffle-run	--	1	<0.05	0.14-0.34	Muck, Sand	AP, IN		NRD, 3SB	BKT	BKT, CRC	BKT

[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 € – A watercourse that flows during snowmelt and rainfall runoff periods only (AT, 2009).
[2]Ranges are provided for reaches measured through multiple transects.
[3]Slopes were estimated based on overall habitat type (DFO, 2012).
[4]Dominant substrates are described as any substrate that made up more than 30% along any transect within the reach.
[5]Cover Types = AP = aquatic vegetation (submergent and/or emergent vegetation); IN = instream objects/in situ cover within the streambed in the form of fallen trees, submerged logs, rocks, boulders, undercut banks, and accumulated debris; O = overhead cover from riparian vegetation overhanging the stream
[6] Species codes: brook trout (BKT), creek chub (CRC), northern redbelly dace (NRD), threespine stickleback (3SB)

Table 3.23: Physical Characteristics Waterbodies within the Aquatic Study Area

Waterbody ID	Waterbody area (m²)	Waterbody length (m)	Waterbody width (m)	Transect	Depth Range (m)[1]	Dominant Substrate[2]	Vegetation	Cover (%)[3]	Fish Support[5]					
									Confirmed Species	Probable Species[4]	Suitable Habitat			
											Spawning	YOY	Juvenile	Adult
Open Water	1,294.8	39.3	58.2	1	>1	Muck/Detritus	*Alnus incana*, *Onoclea sensibilis*, *Typha latifolia* and *Carex intumescens*	85	None	NRD, 3SB	NRD, 3SB	NRD, 3SB	NRD, 3SB	NRD, 3SB

[1]Depth measurements were assumed due to safety and accessibility
[2]Dominant substrate was visually estimated or was estimated from the bank.
[3]Cover is calculated as a sum of all available cover types present (large woody debris, boulders, overhanging vegetation, emergent vegetation, and submergent vegetation
[4] Presence of fish species extrapolated from downstream reach based on direct aquatic connectivity, confirmed species presence and habitat suitability.
[5] Species codes: Brook trout (BKT), Creek Chub (CRC), Northern redbelly dace (NRD), Threespine stickleback (3SB)

Watercourse 1

WC1 is a first order stream that originates as drainage from Open Water A. The watercourse flows west for approximately 580 m prior to exiting the southwestern side of the PA, where it eventually drains into the Nictaux River (Drawing 7, Appendix A). The watercourse was delineated into three reaches during the detailed habitat assessment.

Reach 1 is ephemeral and the dominant habitat type is a flat. This reach extends for 91 m through WL1. The channel is slightly entrenched and not well defined. Channel and wetted width range from 1-3 m and 0.6-0.9 m, respectively, and water depths range between 0.3-0.9 m. Woody debris, emergent and submergent vegetation provide instream cover throughout the watercourse. The mucky substrate and slow-moving water observed throughout this reach provides suitable habitat for all life stages of northern redbelly dace and threespine stickleback. No barriers to fish movement were observed between Open Water A and WC1.

The remaining two reaches (Reaches 2 and 3) were both characterized as a series of higher gradient riffle-runs. Reach 2 was characterized as intermittent and is 425 m long. Flat and pool habitats were also identified. Reach 2 is dominated by cobble, gravel, and muck substrates with a channel and wetted widths of 1-3 m and 0.8-1.6 m, respectively. Water depths range from 0-25 cm. Reach 3 is characterized as perennial and is 407 m long. Pool habitat was also identified. Reach 3 was slightly wider, with channel and wetted widths of 1.5-3.9 m and 0.6-1.7 m, respectively. The dominant substrate within this reach was rubble, cobble, gravel, and sand with water depths ranging between 0-32 cm. Reach 2 is slightly entrenched with similar cover types as Reach 1, consisting of woody debris, and emergent and submergent vegetation. Reach 3 is moderately-highly entrenched, with cover consisting of undercut banks, woody debris, and emergent vegetation. Within these reaches, suitable habitat is found for all life stages of brook trout, creek chub, northern redbelly dace, and threespine stickleback.

WC1 is considered a fisheries resource due to its connectivity with WC2, which is known to contain four species of fish based on trapping and electrofishing results.

Open Water A

Open Water A is a small body of water approximately 0.13 ha in size, located near the southern edge of the PA (Drawing 7, Appendix A). Open Water A is contained entirely within WL1 and is highly vegetated. Moderate to high instream cover was observed throughout the entire pond in the form of submergent and emergent vegetation. The average depth in the open water was estimated to be over 1 m deep. Measurements were unable to be taken due to accessibility and safety concerns. Open Water A provides suitable habitat for all life stages of northern redbelly dace and threespine stickleback due to its mucky substrate and instream cover.

Open Water A is considered a fisheries resource due to its connectivity with WC1. Although the upstream extent of WC1 is characterized as ephemeral, there is seasonal connectivity with WC2, which is fish bearing.

Watercourse 2

WC2 is a first order stream that originates in the southwest portion of the Aquatic Study Area and eventually flows into Nictaux River. WC2 was delineated into three reaches during the detailed habitat assessment.

Reach 1 was characterized as intermittent and is 387 m long. The dominant habitat type identified was riffle-run, however, pool habitat was also present. Reach 1 ranged from slightly entrenched to highly entrenched. The dominant substrates in Reach 1 are boulder, cobble, rubble, and gravel. Channel and wetted widths range from 1.5-4 m and 0.8-2.1 m respectively. Water depths ranged from 0-0.26 m. The cover types present in Reach 1 include undercut banks, emergent and submergent vegetation, and woody debris. Within this reach, suitable habitat is available for all life stages of northern redbelly dace and brook trout, spawning habitat for threespine stickleback, and YOY, juvenile, and adult habitat for creek chub.

Reach 2 and Reach 3 are both perennial, riffle-run habitats. Reach 2 is 561 m long and pool habitat is also present. Reach 2 was predominantly highly entrenched, and the dominant substrates are cobble, gravel, and sand. Channel and wetted widths range from 2.3-5.3 m and 0.5-3.0 m respectively. Water depths range from 0-0.42 m. Cover types in Reach 2 include undercut banks, emergent, and submergent vegetation and woody debris. Within Reach 2, suitable habitat is found for all life stages of brook trout, creek chub, northern redbelly dace, and threespine stickleback. Reach 3 is 266 m long and is highly entrenched. Channel and wetted widths range from 3.4-4.4 m and 1.1-3.7 m respectively. Water depths range from 0.04-0.34 m. Dominant substrates are gravel and cobble, and cover types include undercut banks, emergent, and submergent vegetation and woody debris. Reach 3 provides suitable habitat for all life stages of brook trout and spawning habitat for northern redbelly dace and threespine stickleback. Suitable habitat for YOY and juvenile creek chub is also present.

WC2 is a fisheries resource. Trapping and electrofishing results revealed the presence of four fish species within the watercourse.

Watercourse 3

WC3 originates from a wetland in the northwest portion of the Aquatic Study Area and eventually flows into Nictaux River. WC3 was delineated into two reaches during the detailed habitat assessment.

Reach 1 is characterized as intermittent, riffle-run habitat. Reach 1 is 490 m long and slightly entrenched. The dominant substrates include muck and sand. Channel and wetted widths range from 1.2-2.6 m and 0.5-1 m respectively. Water depths range from 0-0.23 m. Cover types in Reach 1 include emergent and submergent vegetation and woody debris. Suitable spawning habitat is present for northern redbelly dace and threespine stickleback. Suitable habitat for YOY, juvenile, and adult brook trout habitat is present, as well as suitable juvenile creek chub habitat.

Reach 1 measurements could not be collected when wading conditions became unsafe due to water depths and unstable substrate. Photos were taken, but no measurements could be recorded. In this section, WC3 is perennial with a flat habitat type. Pools are also present. This section extends for 215 m. The watercourse is slightly to moderately entrenched, with abundant instream and emergent vegetation. Some woody debris is present. The dominant substrate is muck. Depths exceeded what is safely wadeable, which is typically >1 m.

Reach 2 is perennial with a riffle-run habitat type. Reach 2 is 96 m long and moderately entrenched. The dominant substrates are muck and sand. Channel and wetted widths are 3.3 m and 2.6 m respectively. Water depths range from 0.14 m to 0.34 m. Cover types included emergent and submergent vegetation and woody debris. Suitable habitat for YOY, juvenile, and adult brook trout habitat is present, as well as suitable juvenile creek chub habitat.

WC3 is a fisheries resource due to its connectivity with the Nictaux River. Although the upstream extent of the watercourse disappears underground intermittently as it flows through a wetland, suitable fish habitat for known species within the Aquatic Study Area is present in the majority of the watercourse.

4.0 CONCLUSIONS

This report documents the biophysical surveys that took place within and adjacent to the PA in 2023.

Vascular Plants, Lichens, and Habitat

Vascular plant, lichen and vegetation community surveys (i.e. habitat surveys) took place in 2023. All surveys consisted of meandering transects across the PA and within targeted locations. Prior to undertaking field assessments, desktop research was conducted.

A total of 145 vascular plants were observed, including four SOCI. No rare lichens were observed. Terrestrial habitats were dominated by clearcut within the PA, with some smaller areas of spruce-hemlock or spruce-pine forests, and wetland habitat.

Fauna

Wildlife surveys were completed opportunistically throughout the suite of biophysical surveys. Particular attention was paid to SAR and SOCI species. All observations were identified and recorded by biologists experienced in recognition of wildlife tracks, scat, and browse.

As there were no AMOs present within the PA, and no other suitable bat hibernacula, AMOs on crown land within 5 km of the PA were visited and checked for suitable bat hibernacula habitat. Only AMOs directly accessible from public roads were assessed.

The PA is not within mainland moose core habitat and there is no suitable habitat for mainland moose within the PA, therefore dedicated mainland moose surveys were not conducted.

It was the intention for herpetofauna field surveys to be repeated three times, however, the field schedule was interrupted by the forest fires in May and June 2023. In consultation with Mark McGarrigle, Species at Risk Biologist at NSNR, a desktop exercise was used to map potential turtle habitat within the PA using detailed stream habitat descriptions collected for fish habitat surveys.

No priority species fauna was observed during any field surveys.

Avifauna

Prior to conducting field surveys, a preliminary desktop survey design was developed to target suitable habitat for avifauna species or groups of interest. Avifauna surveys included migration (spring and fall), breeding, and common nighthawk. Survey point count locations were established within and adjacent to the PA, should post-construction avifauna monitoring be required.

Four avifauna SAR were observed: common nighthawk, evening grosbeak, olive-sided flycatcher, and eastern wood-pewee. Four avifauna SOCI were observed: bay-breasted warbler, pine warbler, pine siskin, and red crossbill. Avian biophysical surveys resulted in the observation of 1,433 individuals, representing 74 bird species.

Wetlands

Wetlands were identified via meandering transects throughout the PA. Functional assessment using the WESP-AC evaluation technique was followed. Two wetlands were identified totaling approximately 4.8 ha in area.

The two identified wetlands are located along the southern edge of the PA and can be characterized as mixedwood treed swamps. Neither of these wetlands are classified as WSS.

Fish and Fish Habitat

Fishing efforts confirmed the presence of four fish species in proximity to the PA, including brook trout, creek chub, northern redbelly dace, and threespine stickleback. A total of 115 fish were captured across two electrofishing and one trapping location in WC1, while no fish were captured through trapping efforts in the field delineated open water. Threespine stickleback made up the vast majority of individuals captured. No water quality limitations were identified during field surveys.

Detailed fish habitat assessments revealed that the highly vegetated, wetland flats of the field delineated open water (the headwater to WC1) and the uppermost reach of WC1 provide limited habitat suitability for the local fish community but may support the various life stages of northern redbelly dace and threespine stickleback. Suitable habitats for all documented species and life stages are provided in WC1 as watercourse complexity improves downstream. Though no fish were captured in the field delineated open water, there were no limitations to fish passage identified that would restrict movement between WC1 and Open Water A. As such, both surface water features identified within the PA are considered fisheries resources).

5.0 STATEMENT OF QUALIFICATIONS AND LIMITATIONS

This Report (the "Report") has been prepared by Strum Consulting ("Consultant") for the benefit of GHD Limited ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations, and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental, or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental, or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

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Should additional information become available, Strum requests that this information be brought to our attention immediately so that we can re-assess the conclusions presented in this report. This report was prepared by Mark MacDonald, MScF, Senior Project Manager and Terrestrial Lead, and was reviewed by Shaun Allain, BSc., EP., Group Manager Environmental Assessment & Approvals.

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APPENDIX A
DRAWINGS

Shaw Middleton Sand Pit Project, Middleton, NS

Project Location

N

Highway 201

Nictaux

Nictaux River

Nictaux Falls Rd

Nictaux Falls

Torbrook Rd

Torbrook West

Torbrook

East Torbrook Rd

0 300 600 900 1,200 m

Project Area

Utilities (line)

Existing Pipeline

Existing Transmission Lines

Transportation

Road

Unpaved Road

Water Features

Mapped Stream

Mapped Lakes and Rivers

Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: Esri Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:20,000	Drawing #: 1
Drawn By: P. Opra	
Checked By: S. Allain	

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Shaw Middleton Sand Pit Project, Middleton, NS

Habitat

HP1
HP2
HP3
HP4
HP5
HP6

N

0 200 400 600 800 m

Project Area
Habitat Points

Forested Land (Type)
Softwood
Mixedwood
Hardwood
Old Growth

Utilities (line)
Existing Transmission Lines

Transportation
Road
Unpaved Road

Water Features
Mapped Stream
Mapped Lakes and Rivers
Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS, Google

Date: 20250424	Project #: 24-10016
Scale: 1:10,000	Drawing #: 2
Drawn By: P. Opra	
Checked By: S. Allain	

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Shaw Middleton Sand Pit Project, Middleton, NS

Lichen and Flora

N

0 200 400 600 800 m

Project Area

Lichen Transect

Botany Transect

Clear Cut Area

Utilities (line)

Existing Transmission Lines

Transportation

Road

Unpaved Road

Water Features

Mapped Stream

Mapped Lakes and Rivers

Mapped Wet Areas

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250424	Project #: 24-10016
Scale: 1:10,000	Drawing #: 3
Drawn By: P. Opra	
Checked By: S. Allain	

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Avifauna Methodology

N

CONI2
PC6
PC4
CONI3
PC1
PC5
PC7
PC8
PC2
PC9
CONI1
PC10
PC3
CONI4
Torbrook West
Nictaux Falls

0 200 400 600 800 m

Project Area
Avifauna PC Locations
Nightjar PC Locations
Breeding Bird Area Search

Utilities (line)

Existing Pipeline
Existing Transmission Lines

Transportation

Road
Unpaved Road

Water Features

Mapped Stream
Mapped Lakes and Rivers
Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: Google Maps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:13,000	Drawing #: 4
Drawn By: P. Opra	
Checked By: S. Allain	

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Watersheds

N

0 4 8 12 16 km

Project Area

Annapolis River Primary Watershed Boundary

Annapolis River Secondary Watershed Boundary

Transportation

Highway

Road

Unpaved Road

Water Features

Mapped Stream

Mapped Indefinite Stream

Mapped Lakes and Rivers

Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:280,000	Drawing #: 5
Drawn By: P. Opra	
Checked By: S. Allain	

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Aquatic Desktop Review

Drains to Annapolis River

Nictaux River

Nictaux Falls

Torbrook West

N

0 200 400 600 800 m

Depth to water table (cm)

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

Project Area

Flow Accumulation

Utilities (line)

- Existing Pipeline
- Existing Transmission Lines

Transportation

- Road
- Unpaved Road

Water Features

- Mapped Stream
- Mapped Lakes and Rivers
- Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCGC, ISA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:15,000	Drawing #: 6
Drawn By: P. Opra	
Checked By: S. Allain	

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Aquatic Methods and Results

N

WC3

WL 1

WL 2

WC1

WC2

Reach A

Reach B

1 2 3 4 5 6

1 2 3 4

0 150 300 450 600 m

Project Area

Aquatic Study Area

Trapping Location

Detailed Habitat

Reach 1

Reach 2

Reach 3

Electrofishing Reaches

Field Assessed Watercourse

Field Delineated Open Water

Field Delineated Wetlands

Utilities (line)

Existing Transmission Lines

Transportation

Unpaved Road

Water Features

Mapped Stream

Mapped Lakes and Rivers

Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCGC, ISA Canada, CNWI, HERE, Garmin, USGS

Date: 20250311	Project #: 24-10016
Scale: 1:7,000	Drawing #: 7
Drawn By: P. Opra	
Checked By: S. Allain	

GHD

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Shaw Middleton Sand Pit Project, Middleton, NS

Desktop Results

N

Melvern Square

Greenw Squa

Spa Springs

Gates Mountain

South Greenwood

Wilmot

Meadowvale

East Tremont

Tremont

South Farmington

Brooklyn

South Tremont

Torbrook Mines

Nictaux

Torbrook

Brickton

Nictaux West

Nictaux Falls

Torbrook West

North Williamston

Torbrook Nature Reserve

South Williamston

East Inglisville

Nictaux South

West Inglisville

Inglisville

Bloomington

Cloud Lake Wilderness Area

0 1 2 3 4 km

Project Area

Abandoned Mine Openings

ACCDC Pt. Data

Vertebrate Fauna

Nonvascular Flora

Vascular Flora

Invertebrate Fauna

Old Growth

Wood Turtle SMP 200m Buffer

Type of Existing Protection

Nature Reserve

Wilderness Area

Significant Species and Habitats

Species at Risk

Utilities (line)

Existing Pipeline

Existing Transmission Lines

Transportation

Highway

Road

Unpaved Road

Water Features

Mapped Stream

Mapped Lakes and Rivers

Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:70,000	Drawing #: 8
Drawn By: P. Opra	
Checked By: S. Allain	

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Observed Priority Species

N

Red Crossbill

Red Crossbill

Pine Siskin

Pine Siskin

Red Crossbill

Red Crossbill

Pine Warbler

Pine Siskin

White Elm

Hop Sedge

Meadow Horsetail

Hop Sedge

White Elm

WC1

WL 1

WL 2

Brook Trout

0 150 300 450 600 m

Project Area

Freshwater Fish

Vascular Plant

Vertebrate

Field Assessed Watercourse

Field Delineated Wetlands

Field Deliniated Open Water

Utilities (line)

Existing Transmission Lines

Transportation

Unpaved Road

Water Features

Mapped Stream

Mapped Lakes and Rivers

Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:7,000	Drawing #: 9
Drawn By: P. Opra	
Checked By: S. Allain	

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Shaw Middleton Sand Pit Project, Middleton, NS

Turtle Habitat Suitability Study

GHD

N

WL 2

WC1

1 2 3 4 5 6 7 8 9 10 11 12 13

WL 1

0 100 200 300 400 m

Project Area

Wood Turtle Habitat Points

Field Assessed Watercourse

Field Delineated Wetlands

Utilities (line)

Existing Transmission Lines

Transportation

Unpaved Road

Water Features

Mapped Stream

Mapped Lakes and Rivers

Mapped Wetlands

Coordinate System: NAD83 UTM Zone 20N

Sources: ESRI Basemaps, GeoNOVA, SNSIS, NSNRR, ACCDC, IBA Canada, CNWI, HERE, Garmin, USGS

Date: 20250310	Project #: 24-10016
Scale: 1:5,000	Drawing #: 10
Drawn By: P. Opra	
Checked By: S. Allain	

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APPENDIX B
PRIORITY SPECIES LIST

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
VASCULAR PLANTS						
Acer saccharinum	Silver Maple	S1	-	-	-	Generally found near flowing water and in wetlands. In Nova Scotia, it has been found along the Cornwallis River, Kings Co. (Munro, Newell & Hill, 2014).
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)
Ageratina 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)
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 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
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)
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).
Bromus latiglumis	Broad-Glumed Brome	S2	-	-	-	Floodplain (River or stream floodplains), forest, shores of rivers or lakes (Go Botany)
Carex grisea	Inflated Narrow-leaved Sedge	S1	-	-	-	floodplain forest and deciduous woods (Munro, Newell & Hill, 2014)
Carex houghtoniana	Houghton's Sedge	S2S3	-	-	-	sandy soils, along roadsides. Sandy disturbed area.

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
Carex normalis	a Sedge	S1	-	-	-	Open, often wet, woods, thickets, meadows and roadsides. Fruiting early summer (Flora of North America, nd)
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 rosea	Rosy Sedge	S3	-	-	-	Grows in dry soils beneath deciduous forests and thickets. Flowers from May to early July.
Carex viridula ssp. brachyrrhyncha	Greenish Sedge	S1	-	-	-	Found along river and lake shores (Go Botany).
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).
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).
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).
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).
Fagus grandifolia	American Beech	S3S4	-	-	-	Forests
Fimbristylis autumnalis	Slender Fimbry	S1	-	-	-	Moist to wet sands, peats, slits, or clays primarily of disturbed, sunny round 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.
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).
Hieracium paniculatum	Panicled Hawkweed	S3S4	-	-	-	Mixed forest on dryish soils, especially oak.Occasional from Yarmouth east to Kings and Halifax counties. Common about Kentville and at Keji.Flowers August and September (Munro, Newell & Hill, 2014).
Humulus lupulus var. lupuloides	Common Hop	S1?	-	-	-	Anthropogenic (man-made or disturbed habitats), floodplain (river or stream floodplains), forests, shrublands or thickets

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
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.
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).
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).
Neottia bifolia	Southern Twayblade	S3	-	-	-	Bogs and swamps (Go Botany)
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)
Panicum dichotomiflorum ssp. puritanorum	Spreading Panicgrass	S1?	-	-	-	Flowering and fruiting from June through October
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)
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 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).

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
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)
Polygonum aviculare ssp. neglectum	Narrow-leaved Knotweed	S3?	-	-	-	Found in disturbed areas. Flowers June - November (Flora of North America, nd)
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)
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)
Rudbeckia laciniata	Cut-Leaved Coneflower	S2	-	-	-	Grows in wet fertile soils along the edge of swamps, swales or streams. Often colonial. Flowers in August. Common in Kings Co., isolated colonies from Annapolis and Cumberland counties to Guysborough (Munro, Newell & Hill, 2014).
Rumex triangulivalvis	Triangular-valve Dock	S2S3	-	-	-	Grows in moist areas and disturbed habitats, meadows and fields (GoBotany, nd)
Salix pellita	Satiny Willow	S2S3	-	-	-	Found in riparian habitats. Flowers May and June (Munro, Newell & Hill, 2014)
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.
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).
Verbena hastata	Blue Vervain	S3S4	-	-	-	Limited to mucky fertile soils, as along floodplains. Flowers during August - September (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)
Zizia aurea	Golden Alexanders	S2	-	-	-	Found in meadows, shores, thickets and wooded swamps. Flowers May and June. Occasionally reported in: Pomquet and South River, Antigonish County, Upper Musquodoboit, Halifax County (Munro, Newell and Hill, 2014).
LICHENS						
Erioderma pedicellatum	Boreal Felt Lichen	S1	Endangered	Endangered	Endangered	The existing boreal felt lichen occurs within 25 km of the seacoast 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

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
						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.
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						
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.
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.
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).
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

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
						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).
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).
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).
Chordeiles minor	Common Nighthawk	S3B	Special Concern	Special Concern	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

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
						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	Special Concern	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.
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.
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.
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).
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

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
						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).
Myiarchus crinitus	Great Crested Flycatcher	S1B	-	-	-	Uncommon breeder throughout mainland Nova Scotia, not Cape Breton (MBBA, as of July 2021). Migrates mostly at night. Breeds mainly in deciduous forest or mixed forest, but avoids pure stands of conifers. May be found in either continuous deep forest or in more open wooded areas, around edges of clearings or abandoned orchards. Dead snags and dying trees are important sources of the cavities they need for nesting (will even search out cavities in old orchards and in woody urban areas like parks, cemeteries and golf courses). If there are enough trees, they will claim territories in pastures, along streams and rivers, and in swamps and wetlands. 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).
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 semiopen 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). Favours 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

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
						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).
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, conifers in summer. Usually breeds in northern coniferous forest, in thick stands of spruce and fir. They are preators 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 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)
Sialia sialis	Eastern Bluebird	S3B	-	-	-	Uncommon breeder throughout Nova Scotia. In the north, arrives quite early in spring, and lingers late in fall. These birds live in semi-open country with scattered trees, but with little understory and sparse ground cover. Original habitats probably included open, frequently burned pine savannas, beaver ponds, mature (but open) woods and forest clearings/openings. Today, they are most common along pastures, roadsides, agricultural fields, suburban parks, backyards and golf courses. Breeds between April and July (Audubon and The Cornell Lab).
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 occurs in many kinds of semi-open areas, woodland edges, weedy fields. Breeding occurs from April to July (The Cornell Lab, Audubon)
Sturnella magna	Eastern Meadowlark	SHB	Threatened	Threatened	-	Eastern meadowlark currently occurs in only a few scattered areas, and it does not seem to breed regularly in Nova Scotia. Easterm Meadowlark is mos common in native grasslands, pastures and savannahs. It also uses a wide variety of other anthropogenic grassland habitats, hayfields, weedy meadows, young orchards, golf courses, restored surface mines, grassy roadside verges, young oak plantations, grain fields, herbaceous fencerows, and grassy airfields. Eastern meadowlarks occasionally nest in row crop fields such as corn and soybean, but these are considered low quality habitat (COSEWIC Assessment and Status Report).

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
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 treeline, 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 treetos (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).
FISH						
Acipenser oxyrinchus	Atlantic Sturgeon	S2S3N	Threatened	No Status	-	Atlantic sturgeon occurs south along the coast of Nova Scotia and the Bay of Fundy. Important habitats for Atlantic Sturgeon appear to be a river with access to the sea, preferably with deep channels, an estuary with relatively warm, mesohaline conditions and a coastal shelf region. Atlantic Sturgeon spawn in freshwater over rocky gravel substrate in 1 - 3 m deep water with a strong current, and under waterfalls and in deep pools with hard, clay bottoms (COSEWIC Assessment and Status Report).
Anguilla rostrata	American Eel	S3N	Threatened	No Status	-	During their oceanic migrations, eels occupy salt water and in their continental phase (growth in continental waters), they use all salinity zones. In freshwater habitats, preferred habitat can be found in both lentic and lotic waters including all waters extending from the high-water mark down to at least 10 m depth for all reaches currently or formerly used by the American Eel (COSEWIC Assessment and Status Report).
Culaea inconstans	Brook Stickleback	S3	-	-	-	Inhabits clear, cold, densely vegetated waters of small streams and spring-fed ponds and is found along the swampy margins of beach ponds of larger lakes. They are tolerant of salt water for short periods of time. Spawning occurs in shallow water from late April to July, depending on the water temperature (Scott and Crossman, 1973)
Margariscus nachtriebi	Northern Pearl Dace	S3	-	-	-	Cool, clear headwater streams in the south, bog drainage streams, ponds and small lakes in the north, and in stained, peaty waters of beaver ponds. Spawning occurs in clear water over sand or gravel in weak or moderate current (Scott and Crossman 1973).
Morone saxatilis	Striped Bass	S2S3B, S2S3N	Endangered	Not on Schedule 1	-	The natural range of Striped Bass covers the Atlantic coast of North America. The southern Gulf of St. Lawrence DU occurs in the southern Gulf of St. Lawrence, primarily on the east coast of New Brunswick, but also part of the coast of Nova Scotia. The Bay of Fundy DU occurs in the Bay of Fundy. There is one confirmed spawning population in the Shubenacadie River, NS, and one has been extirpated from the Annapolis River, NS (COSEWIC Assessment and Status Report).
Morone saxatilis pop. 2	Striped Bass - Bay of Fundy population	S2S3B,S2S3N	Endangered	Not on Schedule 1	-	Shubenacadie River, Saint John River (historically), and Annapolis River (historically). In most Striped Bass populations, spawning, incubation and early larval development occur in fresh or slightly brackish waters. The Shubenacadie River population, however, spawns in a section of its major tributary, the Stewiake

Scientific Name	Common Name	S-Rank	COSEWIC	SARA	ESA	Habitat Description
						River,affected by a tidal bore. At the juvenile and adult stages, Striped Bass use coastal and estuarine habitats and saltwater systems. Eelgrass plays an important role for several species of fish at different stages of their life cycle, including the Striped Bass for rearing, feeding and sheltering. Young and adult Striped Bass populations undertake a fall migration to estuaries or freshwater habitats to overwinter (see Dispersal and Migration section). This behaviour is considered to enable them to avoid the low winter ocean temperatures. Wintering and spawning sites do not necessarily overlap in distribution or occur in the same drainage (COSEWIC Assessment and Status Report).
Salmo salar pop. 6	Atlantic Salmon - Nova Scotia Southern Upland population	S1	Endangered	No Status	-	Southern Upland Atlantic Salmon typically spend two to four years in freshwater as juveniles before migrating to the north Atlantic Ocean. After staying at sea for one to three years, adults return to freshwater to spawn. Rivers that support Atlantic Salmon are generally clear, cool and well-oxygenated, with gravel, cobble and boulder substrates.
Salvelinus fontinalis	Brook Trout	S3	-	-	-	Most common in cool well-oxygenated waters of lakes and streams. In autumn, brook trout move into smaller, shallower streams and require free passage along streams to move between areas of use. Spawning occurs from October - early December (Gilhen, 1974)
INVERTEBRATE						
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.
Coccinella transversoguttata richardsoni	Transverse Lady Beetle	SH	Special Concern	Special Concern	-	The Canadian range of the Transverse Lady Beetle stretches from St. John's, Newfoundland and Labrador, west to Vancouver Island. The Transverse Lady Beetle is a habitat generalist and known to occur within agricultural areas, suburban gardens, parks, coniferous forests, deciduous forests, prairie grasslands, meadows, and riparian areas. The Transverse Lady Beetle can also be found in a wide variety of non-agricultural vegetation including birch, pine, spruce, maple, mountain ash, poplar, willow, sage, cherry, alder, thistles, grasslands, and scruff pea plants along the edge of sand dunes. Overwintering adults tend to aggregate in well ventilated microhabitats such as under stones, rock crevices, in grass tussocks, in leaf litter, or in tree bark (COSEWIC Assessment and Status Report).
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, river banks, 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

Atlantic Canada Conservation Data Centre
Centre de données sur la conservation du Canada atlantique

DATA REPORT 7690: Middleton, NS

Prepared 31 May 2023
by C. Robicheau, 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
MiddletonNS_7690ob.xls	Rare or legally-protected Flora and Fauna in your study area
MiddletonNS_7690ob100km.xls	A list of Rare and legally protected Flora and Fauna within 100 km of your study area
MiddletonNS_7690msa.xls	Managed and Biologically Significant Areas in your study area
MiddletonNS_7690ff_py.xls	Rare Freshwater Fish in your study area (DFO database)

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
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sean.blaney@accdc.ca

Animals (Fauna)
John Klymko
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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
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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

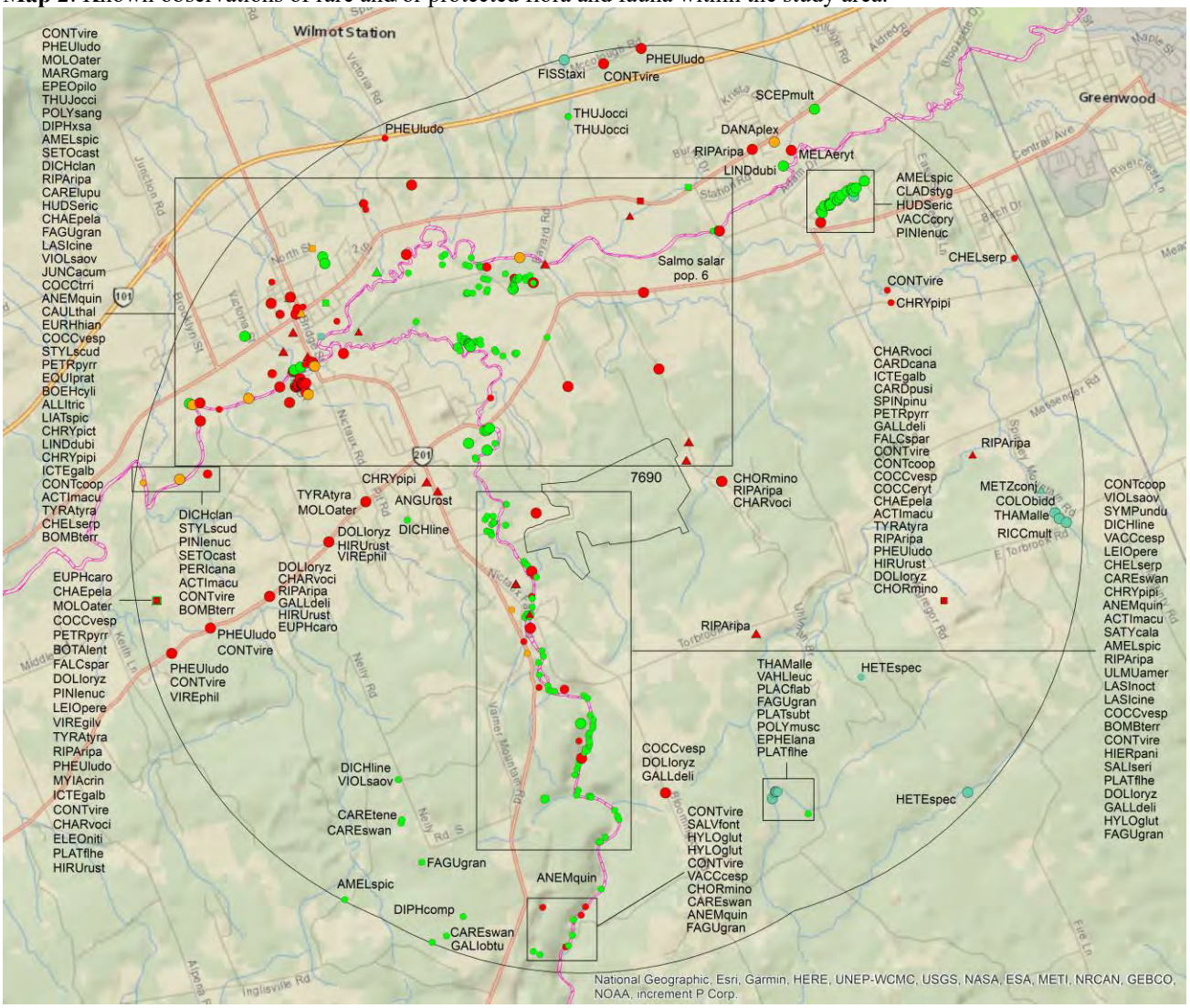
2.1 FLORA

The study area contains 224 records of 32 vascular and 17 records of 13 nonvascular flora (Map 2 and attached: *ob.xls), excluding 'location-sensitive' species.

2.2 FAUNA

The study area contains 511 records of 38 vertebrate and 17 records of 7 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.



RESOLUTION

- 4.7 within 50s of kilometers
- 4.0 within 10s of kilometers
- 3.7 within 5s of kilometers
- 3.0 within kilometers
- 2.7 within 500s of meters
- 2.0 within 100s of meters
- 1.7 within 10s of meters

HIGHER TAXON

- vertebrate fauna
- invertebrate fauna
- vascular flora
- nonvascular flora

3.0 SPECIAL AREAS

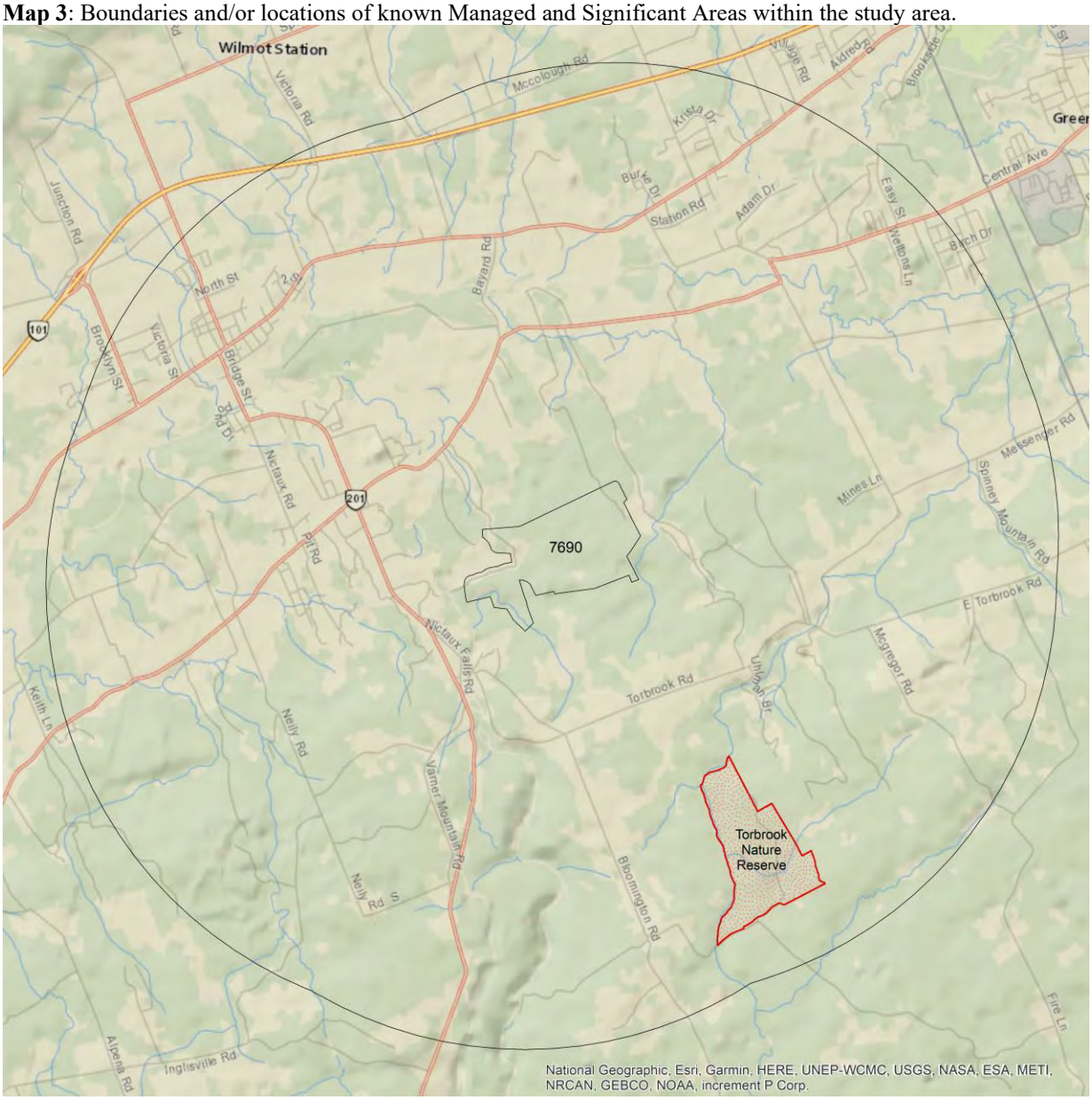
3.1 MANAGED AREAS

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

3.2 SIGNIFICANT AREAS

The GIS scan identified no biologically significant sites in the vicinity of the study area (Map 3 and attached file: *sa*.xls).

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	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S1	2	4.2 ± 0.0
N	*Placynthium flabellosum*	Scaly Ink Lichen				S2	1	4.2 ± 0.0
N	*Cololejeunea biddlecomiae*	Biddlecome's Pouncewort				S2?	1	5.6 ± 0.0
N	*Riccardia multifida*	Delicate Germanderwort				S2?	1	5.8 ± 0.0
N	*Oxyrrhynchium hians*	Light Beaked Moss				S2S3	1	4.3 ± 5.0
N	*Platydictya subtilis*	Bark Willow Moss				S2S3	1	4.2 ± 0.0
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S3	1	5.8 ± 0.0
N	*Ephebe lanata*	Waterside Rockshag Lichen				S3	2	4.1 ± 0.0
N	*Metzgeria conjugata*	Rock Veilwort				S3?	1	5.5 ± 0.0
N	*Cladonia stygia*	Black-footed Reindeer Lichen				S3?	1	5.0 ± 0.0
N	*Thamnobryum alleghaniense*	a Moss				S3S4	2	4.2 ± 0.0
N	*Vahliella leucophaea*	Shelter Shingle Lichen				S3S4	1	4.2 ± 0.0
N	*Heterodermia speciosa*	Powdered Fringe Lichen				S3S4	2	3.8 ± 0.0
P	*Liatris spicata*	Dense Blazing Star	Threatened	Threatened		SNA	1	4.3 ± 0.0
P	*Hudsonia ericoides*	Pinebarren Golden Heather				S2	23	2.3 ± 0.0
P	*Hylodesmum glutinosum*	Large Tick-trefoil				S2	14	2.4 ± 0.0
P	*Allium tricoccum*	Wild Leek				S2	21	1.9 ± 0.0
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S2	14	2.0 ± 0.0
P	*Thuja occidentalis*	Eastern White Cedar			Vulnerable	S2S3	47	3.0 ± 0.0
P	*Caulophyllum thalictroides*	Blue Cohosh				S2S3	12	2.7 ± 0.0
P	*Anemone quinquefolia*	Wood Anemone				S2S3	19	1.3 ± 0.0
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2S3	1	5.9 ± 0.0
P	*Boehmeria cylindrica*	Small-spike False-nettle				S2S3	1	4.3 ± 0.0
P	*Symphyotrichum undulatum*	Wavy-leaved Aster				S3	9	1.5 ± 0.0
P	*Polygala sanguinea*	Blood Milkwort				S3	2	4.9 ± 0.0
P	*Salix sericea*	Silky Willow				S3	3	2.8 ± 0.0
P	*Lindernia dubia*	Yellow-seeded False Pimperel				S3	3	4.4 ± 0.0
P	*Carex lupulina*	Hop Sedge				S3	1	4.9 ± 3.0
P	*Carex swanii*	Swan's Sedge				S3	4	1.3 ± 0.0
P	*Carex tenera*	Tender Sedge				S3	1	4.8 ± 0.0
P	*Eleocharis nitida*	Quill Spikerush				S3	1	5.9 ± 7.0
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	5	1.5 ± 0.0
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3?	1	4.8 ± 0.0
P	*Hieracium paniculatum*	Panicled Hawkweed				S3S4	2	1.5 ± 0.0
P	*Vaccinium cespitosum*	Dwarf Bilberry				S3S4	5	1.3 ± 0.0
P	*Vaccinium corymbosum*	Highbush Blueberry				S3S4	1	4.7 ± 0.0
P	*Fagus grandifolia*	American Beech				S3S4	6	1.8 ± 0.0
P	*Amelanchier spicata*	Running Serviceberry				S3S4	9	1.7 ± 0.0
P	*Ulmus americana*	White Elm				S3S4	2	1.7 ± 0.0
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S3S4	7	1.5 ± 0.0
P	*Juncus acuminatus*	Sharp-Fruit Rush				S3S4	2	4.9 ± 2.0
P	*Dichanthelium clandestinum*	Deer-tongue Panic Grass				S3S4	4	3.8 ± 0.0
P	*Equisetum pratense*	Meadow Horsetail				S3S4	1	1.8 ± 0.0
P	*Diphasiastrum complanatum*	Northern Ground-cedar				S3S4	1	5.5 ± 0.0
P	*Sceptridium multifidum*	Leathery Moonwort				S3S4	1	5.7 ± 0.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Melanerpes erythrocephalus*	Red-headed Woodpecker	Endangered	Threatened		SNA	1	5.1 ± 0.0
A	*Lasiurus cinereus*	Hoary Bat	Endangered			SUB, S1M	6	1.8 ± 0.0
A	*Lasionycteris noctivagans*	Silver-haired Bat	Endangered			SUB,S1M	2	1.8 ± 0.0
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2B	22	1.2 ± 1.0
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Endangered	S2S3B,S1M	289	4.2 ± 0.0
A	*Anguilla rostrata*	American Eel	Threatened			S3N	1	2.2 ± 0.0
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Endangered	S2B	2	4.5 ± 0.0
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	10	1.5 ± 1.0
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S3B	11	3.6 ± 0.0
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Endangered	S3B	1	4.4 ± 7.0
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Special Concern	Threatened	S3B	4	1.5 ± 0.0
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Special Concern	Threatened	S3B	3	0.9 ± 0.0
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Vulnerable	S3B	19	3.6 ± 0.0
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern	Vulnerable	S3B,S3N,S3M	10	1.9 ± 0.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	32	1.3 ± 0.0
A	*Chrysemys picta*	Painted Turtle	Special Concern	Special Concern		S4	2	4.2 ± 0.0
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	13	1.5 ± 0.0
A	*Myiarchus crinitus*	Great Crested Flycatcher				S1B	1	5.9 ± 7.0
A	*Vireo gilvus*	Warbling Vireo				S1B,SUM	1	5.9 ± 7.0
A	*Vireo philadelphicus*	Philadelphia Vireo				S2?B,SUM	2	3.6 ± 0.0
A	*Molothrus ater*	Brown-headed Cowbird				S2B	3	3.1 ± 0.0
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B	3	4.2 ± 0.0
A	*Icterus galbula*	Baltimore Oriole				S2S3B,SUM	5	4.3 ± 0.0
A	*Perisoreus canadensis*	Canada Jay				S3	1	5.1 ± 0.0
A	*Spinus pinus*	Pine Siskin				S3	2	4.4 ± 7.0
A	*Salvelinus fontinalis*	Brook Trout				S3	1	5.1 ± 0.0
A	*Charadrius vociferus*	Killdeer				S3B	6	1.5 ± 0.0
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	1	4.4 ± 7.0
A	*Tyrannus tyrannus*	Eastern Kingbird				S3B	9	3.1 ± 0.0
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	22	2.5 ± 0.0
A	*Falco sparverius*	American Kestrel				S3B,S4S5M	3	4.4 ± 7.0
A	*Gallinago delicata*	Wilson's Snipe				S3B,S5M	5	3.7 ± 0.0
A	*Cardellina pusilla*	Wilson's Warbler				S3B,S5M	1	4.4 ± 7.0
A	*Pinicola enucleator*	Pine Grosbeak				S3B,S5N,S5M	4	4.5 ± 0.0
A	*Botaurus lentiginosus*	American Bittern				S3S4B,S4S5M	3	5.9 ± 7.0
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B,S4S5M	2	3.2 ± 0.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	6	1.5 ± 0.0
A	*Leiothlypis peregrina*	Tennessee Warbler				S3S4B,S5M	2	1.3 ± 0.0
I	*Epeoloides pilosulus*	Macropis Cuckoo Bee	Endangered	Endangered	Endangered	S1	2	5.0 ± 5.0
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Endangered	S2?B,S3M	1	5.1 ± 0.0
I	*Bombus terricola*	Yellow-banded Bumble Bee	Special Concern	Special Concern	Vulnerable	S3	3	2.1 ± 0.0
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern		Endangered	SH	1	4.7 ± 2.0
I	*Margaritifera margaritifera*	Eastern Pearlshell				S2	1	3.4 ± 0.0
I	*Stylurus scudderi*	Zebra Clubtail				S2S3	8	4.1 ± 0.0
I	*Satyrium calanus*	Banded Hairstreak				S3	1	1.8 ± 0.0

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**	**YES**
Emydoidea blandingii	**Blanding's Turtle - Nova Scotia pop.**	**Endangered**	**Endangered**	**YES**
Glyptemys insculpta	**Wood Turtle**	**Threatened**	**Threatened**	**YES**
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.		Vulnerable	No
Bat hibernaculum or bat species occurrence		**[Endangered][1]**	**[Endangered][1]**	**YES**

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.

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1	Amiro, P.G. 1998. Atlantic Salmon Inner Bay of Fundy SFA 22 & part of 23. DFO Sci. SSR D3-12.
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1	White, S. 2019. Notable species sightings, 2018. East Coast Aquatics.

5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 67333 records of 163 vertebrate and 2626 records of 80 invertebrate fauna; 18494 records of 328 vascular and 5167 records of 247 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	*Coregonus huntsmani*	Atlantic Whitefish	Endangered	Endangered	Endangered	S1	147	52.5 ± 1.0	NS
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	758	1.8 ± 0.0	NS
A	*Myotis septentrionalis*	Northern Myotis	Endangered	Endangered	Endangered	S1	108	1.8 ± 0.0	NS
A	*Perimyotis subflavus*	Tricolored Bat	Endangered	Endangered	Endangered	S1	206	1.8 ± 0.0	NS
A	*Emydoidea blandingii*	Blanding's Turtle	Endangered	Endangered	Endangered	S1	10325	2.2 ± 0.0	NS
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay of Fundy population	Endangered	Endangered		S1	122	7.9 ± 50.0	NS
A	*Salmo salar pop. 6*	Atlantic Salmon - Nova Scotia Southern Upland population	Endangered			S1	15	31.3 ± 1.0	NS
A	*Eubalaena glacialis*	North Atlantic Right Whale	Endangered	Endangered		S1	1	61.8 ± 50.0	NS
A	*Charadrius melodus melodus*	Piping Plover melodus subspecies	Endangered	Endangered	Endangered	S1B	758	64.6 ± 0.0	NS
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1B	57	39.7 ± 0.0	NS
A	*Dermochelys coriacea pop. 2*	Leatherback Sea Turtle - Atlantic population	Endangered	Endangered		S1S2N	6	68.3 ± 0.0	NS
A	*Morone saxatilis pop. 2*	Striped Bass - Bay of Fundy population	Endangered			S2S3B,S2S3N	4	18.8 ± 1.0	NS
A	*Lamna nasus*	Porbeagle Shark	Endangered			SNR	1	30.4 ± 0.0	NS
A	*Lasiurus cinereus*	Hoary Bat	Endangered			SUB, S1M	68	1.8 ± 0.0	NS
A	*Lasionycteris noctivagans*	Silver-haired Bat	Endangered			SUB,S1M	18	1.8 ± 0.0	NS
A	*Lasiurus borealis*	Eastern Red Bat	Endangered			SUB,S1M	8	33.3 ± 0.0	NS
A	*Rangifer tarandus pop. 2*	Caribou - Atlantic-Gasp├⌐sie population	Endangered	Endangered	Extirpated	SX	2	88.7 ± 5.0	NB
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Threatened	Endangered	S1B	9	50.9 ± 7.0	NS
A	*Asio flammeus*	Short-eared Owl	Threatened	Special Concern		S1B	32	54.5 ± 7.0	NS
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2	1127	1.5 ± 1.0	NS
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2B	1717	1.2 ± 1.0	NS
A	*Thamnophis saurita*	Eastern Ribbonsnake	Threatened	Threatened	Threatened	S2S3	2496	19.8 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Endangered	S2S3B,S1M	1849	4.2 ± 0.0	NS
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S2S3M	163	55.6 ± 0.0	NS
A	*Acipenser oxyrinchus*	Atlantic Sturgeon	Threatened			S2S3N	12	64.4 ± 0.0	NS
A	*Hydrobates leucorhous*	Leach's Storm-Petrel	Threatened			S3B	23	60.7 ± 0.0	NS
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	1109	45.2 ± 0.0	NS
A	*Anguilla rostrata*	American Eel	Threatened			S3N	406	2.2 ± 0.0	NS
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened		SHB	18	19.3 ± 7.0	NS
A	*Ixobrychus exilis*	Least Bittern	Threatened	Threatened		SUB	11	86.7 ± 0.0	NB
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened		SUB	63	14.3 ± 7.0	NS
A	*Antrostomus vociferus*	Eastern Whip-Poor-Will	Special Concern	Threatened	Threatened	S1?B	12	14.3 ± 7.0	NS
A	*Passerculus sandwichensis princeps*	Ipswich Sparrow	Special Concern	Special Concern		S1B	2	62.2 ± 0.0	NS
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern		S1N,SUM	31	51.6 ± 1.0	NS
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Endangered	S2B	352	4.5 ± 0.0	NS
A	*Balaenoptera physalus*	Fin Whale	Special Concern	Special Concern		S2S3	5	73.4 ± 0.0	NB
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern	Special Concern		S2S3M	15	12.6 ± 0.0	NS
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern population	Special Concern	Special Concern	Endangered	S2S3N,SUM	37	14.6 ± 4.0	NS
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	803	1.5 ± 1.0	NS
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S3B	1446	3.6 ± 0.0	NS
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Endangered	S3B	1158	4.4 ± 7.0	NS
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Special Concern	Threatened	S3B	804	1.5 ± 0.0	NS
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Special Concern	Threatened	S3B	1354	0.9 ± 0.0	NS
A	*Dolichonyx oryzivorus*	Bobolink	Special Concern	Threatened	Vulnerable	S3B	1532	3.6 ± 0.0	NS
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern	Vulnerable	S3B,S3N,S3M	929	1.9 ± 0.0	NS
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern		S3N,SUM	53	8.8 ± 10.0	NS
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	1516	1.3 ± 0.0	NS
A	*Phocoena phocoena*	Harbour Porpoise	Special Concern			S4	42	30.2 ± 6.0	NS
A	*Phocoena phocoena pop. 1*	Harbour Porpoise - Northwest Atlantic Population	Special Concern			S4	4	16.6 ± 3.0	NS
A	*Chrysemys picta*	Painted Turtle	Special Concern	Special Concern		S4	152	4.2 ± 0.0	NS
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	1104	1.5 ± 0.0	NS
A	*Anarhichas lupus*	Atlantic Wolffish	Special Concern	Special Concern		SNR	1	86.1 ± 0.0	NS
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1?B,SUN,SUM	20	34.8 ± 0.0	NS
A	*Fulica americana*	American Coot	Not At Risk			S1B	20	41.6 ± 7.0	NS
A	*Chlidonias niger*	Black Tern	Not At Risk			S1B	6	86.2 ± 0.0	NB
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Not At Risk		Vulnerable	S1B,SUM	495	9.1 ± 0.0	NS
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk			S2	4	60.4 ± 0.0	NS
A	*Aegolius funereus*	Boreal Owl	Not At Risk			S2?B,SUM	2	68.0 ± 7.0	NB
A	*Lynx canadensis*	Canada Lynx	Not At Risk		Endangered	S2S3	14	69.1 ± 5.0	NB
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3	2	66.4 ± 0.0	NB
A	*Hemidactylium scutatum*	Four-toed Salamander	Not At Risk			S3	44	23.5 ± 0.0	NS
A	*Megaptera novaeangliae*	Humpback Whale	Not At Risk			S3	7	26.3 ± 0.0	NS
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B	252	48.6 ± 7.0	NS
A	*Sialia sialis*	Eastern Bluebird	Not At Risk			S3B	167	9.8 ± 7.0	NS
A	*Buteo lagopus*	Rough-legged Hawk	Not At Risk			S3N	6	60.8 ± 0.0	NS
A	*Accipiter gentilis*	Northern Goshawk	Not At Risk			S3S4	131	7.0 ± 0.0	NS
A	*Glaucomys volans*	Southern Flying Squirrel	Not At Risk			S3S4	17	45.1 ± 5.0	NS
A	*Lagenorhynchus acutus*	Atlantic White-sided Dolphin	Not At Risk			S3S4	3	86.7 ± 0.0	NS
A	*Ammospiza nelsoni*	Nelson's Sparrow	Not At Risk			S3S4B	235	9.8 ± 7.0	NS
A	*Calidris canutus rufa*	Red Knot rufa subspecies	E,SC	Endangered	Endangered	S2M	888	55.6 ± 0.0	NS
A	*Calidris canutus*	Red Knot	E,SC	E,T		S2M	2	91.2 ± 0.0	NS
A	*Morone saxatilis*	Striped Bass	E,SC			S2S3B,S2S3N	25	34.5 ± 0.0	NS
A	*Gadus morhua*	Atlantic Cod	E,SC,DD			SNR	5	59.1 ± 0.0	NS

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A	*Salmo salar*	Atlantic Salmon	E,T,SC			S1B,S1N	8	33.6 ± 0.0	NS
A	*Odobenus rosmarus pop. 5*	Atlantic Walrus - Nova Scotia - Newfoundland - Gulf of St Lawrence population	X			SX	1	43.8 ± 5.0	NS
A	*Alces alces americana*	Moose			Endangered	S1	141	13.9 ± 0.0	NS
A	*Alces alces*	Moose				S1	26	27.7 ± 0.0	NS
A	*Picoides dorsalis*	American Three-toed Woodpecker				S1?	3	72.6 ± 0.0	NB
A	*Uria aalge*	Common Murre				S1?B	12	21.1 ± 0.0	NS
A	*Passerina cyanea*	Indigo Bunting				S1?B,SUM	60	24.3 ± 7.0	NS
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1B	8	86.2 ± 0.0	NB
A	*Oxyura jamaicensis*	Ruddy Duck				S1B	58	41.6 ± 7.0	NS
A	*Gallinula galeata*	Common Gallinule				S1B	22	28.1 ± 7.0	NS
A	*Myiarchus crinitus*	Great Crested Flycatcher				S1B	72	5.9 ± 7.0	NS
A	*Cistothorus palustris*	Marsh Wren				S1B	28	28.1 ± 7.0	NS
A	*Mimus polyglottos*	Northern Mockingbird				S1B	144	9.8 ± 7.0	NS
A	*Toxostoma rufum*	Brown Thrasher				S1B	30	14.5 ± 0.0	NS
A	*Charadrius semipalmatus*	Semipalmated Plover				S1B,S4M	2381	26.3 ± 0.0	NS
A	*Calidris minutilla*	Least Sandpiper				S1B,S4M	1874	32.6 ± 0.0	NS
A	*Anas acuta*	Northern Pintail				S1B,SUM	61	16.4 ± 0.0	NS
A	*Vireo gilvus*	Warbling Vireo				S1B,SUM	61	5.9 ± 7.0	NS
A	*Vespertilionidae sp.*	bat species				S1S2	398	1.8 ± 0.0	NS
A	*Pooecetes gramineus*	Vesper Sparrow				S1S2B,SUM	56	7.5 ± 0.0	NS
A	*Vireo philadelphicus*	Philadelphia Vireo				S2?B,SUM	64	3.6 ± 0.0	NS
A	*Alca torda*	Razorbill				S2B	38	26.4 ± 0.0	NS
A	*Fratercula arctica*	Atlantic Puffin				S2B	37	64.5 ± 0.0	NS
A	*Empidonax traillii*	Willow Flycatcher				S2B	73	16.8 ± 7.0	NS
A	*Molothrus ater*	Brown-headed Cowbird				S2B	268	3.1 ± 0.0	NS
A	*Spatula clypeata*	Northern Shoveler				S2B,SUM	157	28.1 ± 7.0	NS
A	*Mareca strepera*	Gadwall				S2B,SUM	198	28.1 ± 7.0	NS
A	*Piranga olivacea*	Scarlet Tanager				S2B,SUM	80	6.8 ± 0.0	NS
A	*Calidris alba*	Sanderling				S2N,S3M	2181	55.6 ± 0.0	NS
A	*Martes americana*	American Marten			Endangered	S2S3	28	20.2 ± 0.0	NS
A	*Asio otus*	Long-eared Owl				S2S3	23	50.9 ± 7.0	NS
A	*Rallus limicola*	Virginia Rail				S2S3B	56	9.8 ± 7.0	NS
A	*Rissa tridactyla*	Black-legged Kittiwake				S2S3B	18	37.4 ± 0.0	NS
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B	346	4.2 ± 0.0	NS
A	*Phalacrocorax carbo*	Great Cormorant				S2S3B,S2S3N	48	15.3 ± 0.0	NS
A	*Cathartes aura*	Turkey Vulture				S2S3B,S4S5M	367	7.6 ± 0.0	NS
A	*Setophaga pinus*	Pine Warbler				S2S3B,S4S5M	55	7.0 ± 0.0	NS
A	*Bucephala clangula*	Common Goldeneye				S2S3B,S5N,S5M	254	18.3 ± 13.0	NS
A	*Icterus galbula*	Baltimore Oriole				S2S3B,SUM	153	4.3 ± 0.0	NS
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	333	55.5 ± 0.0	NS
A	*Numenius phaeopus*	Whimbrel				S2S3M	7	55.4 ± 0.0	NS
A	*Numenius phaeopus hudsonicus*	Whimbrel				S2S3M	357	49.4 ± 0.0	NS
A	*Phalaropus fulicarius*	Red Phalarope				S2S3M	5	65.0 ± 0.0	NB
A	*Perisoreus canadensis*	Canada Jay				S3	596	5.1 ± 0.0	NS
A	*Poecile hudsonicus*	Boreal Chickadee				S3	433	9.8 ± 7.0	NS
A	*Spinus pinus*	Pine Siskin				S3	621	4.4 ± 7.0	NS
A	*Salvelinus fontinalis*	Brook Trout				S3	163	5.1 ± 0.0	NS
A	*Sorex maritimensis*	Maritime Shrew				S3	2	33.2 ± 0.0	NS
A	*Synaptomys cooperi*	Southern Bog Lemming				S3	24	60.4 ± 0.0	NS
A	*Pekania pennanti*	Fisher				S3	22	12.3 ± 0.0	NS

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A	*Calcarius lapponicus*	Lapland Longspur				S3?N,SUM	22	32.8 ± 0.0	NS
A	*Spatula discors*	Blue-winged Teal				S3B	174	9.8 ± 7.0	NS
A	*Charadrius vociferus*	Killdeer				S3B	771	1.5 ± 0.0	NS
A	*Tringa semipalmata*	Willet				S3B	1257	25.8 ± 7.0	NS
A	*Sterna paradisaea*	Arctic Tern				S3B	49	71.6 ± 0.0	NB
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	79	4.4 ± 7.0	NS
A	*Tyrannus tyrannus*	Eastern Kingbird				S3B	368	3.1 ± 0.0	NS
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	715	2.5 ± 0.0	NS
A	*Alosa pseudoharengus*	Alewife				S3B	16	34.5 ± 0.0	NS
A	*Somateria mollissima*	Common Eider				S3B,S3M,S3N	832	9.8 ± 7.0	NS
A	*Tringa melanoleuca*	Greater Yellowlegs				S3B,S4M	2325	15.6 ± 0.0	NS
A	*Falco sparverius*	American Kestrel				S3B,S4S5M	330	4.4 ± 7.0	NS
A	*Gallinago delicata*	Wilson's Snipe				S3B,S5M	612	3.7 ± 0.0	NS
A	*Setophaga striata*	Blackpoll Warbler				S3B,S5M	84	19.3 ± 7.0	NS
A	*Cardellina pusilla*	Wilson's Warbler				S3B,S5M	157	4.4 ± 7.0	NS
A	*Pinicola enucleator*	Pine Grosbeak				S3B,S5N,S5M	102	4.5 ± 0.0	NS
A	*Setophaga tigrina*	Cape May Warbler				S3B,SUM	135	10.6 ± 7.0	NS
A	*Branta bernicla*	Brant				S3M	24	53.7 ± 0.0	NS
A	*Pluvialis squatarola*	Black-bellied Plover				S3M	2500	55.6 ± 0.0	NS
A	*Arenaria interpres*	Ruddy Turnstone				S3M	897	55.6 ± 0.0	NS
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	2473	33.4 ± 0.0	NS
A	*Calidris melanotos*	Pectoral Sandpiper				S3M	474	45.2 ± 0.0	NS
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	1674	45.2 ± 0.0	NS
A	*Chroicocephalus ridibundus*	Black-headed Gull				S3N	10	43.8 ± 0.0	NS
A	*Picoides arcticus*	Black-backed Woodpecker				S3S4	90	12.6 ± 7.0	NS
A	*Loxia curvirostra*	Red Crossbill				S3S4	351	9.8 ± 7.0	NS
A	*Sorex albibarbis*	Eastern Water Shrew				S3S4	3	85.1 ± 1.0	NB
A	*Botaurus lentiginosus*	American Bittern				S3S4B,S4S5M	340	5.9 ± 7.0	NS
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B,S4S5M	557	3.2 ± 0.0	NS
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	1070	1.5 ± 0.0	NS
A	*Leiothlypis peregrina*	Tennessee Warbler				S3S4B,S5M	324	1.3 ± 0.0	NS
A	*Passerella iliaca*	Fox Sparrow				S3S4B,S5M	67	16.8 ± 7.0	NS
A	*Mergus serrator*	Red-breasted Merganser				S3S4B,S5M,S5N	217	9.8 ± 7.0	NS
A	*Calidris maritima*	Purple Sandpiper				S3S4N	232	8.8 ± 10.0	NS
A	*Lanius borealis*	Northern Shrike				S3S4N	44	53.6 ± 0.0	NS
A	*Morus bassanus*	Northern Gannet				SHB	89	14.6 ± 0.0	NS
A	*Aythya americana*	Redhead				SHB	5	91.3 ± 0.0	NB
A	*Leucophaeus atricilla*	Laughing Gull				SHB	10	60.6 ± 0.0	NB
A	*Progne subis*	Purple Martin				SHB	31	21.6 ± 7.0	NS
A	*Eremophila alpestris*	Horned Lark				SHB,S4S5N,S5M	36	7.4 ± 0.0	NS
I	*Bombus bohemicus*	Ashton Cuckoo Bumble Bee	Endangered	Endangered	Endangered	S1	23	5.9 ± 0.0	NS
I	*Epeoloides pilosulus*	Macropis Cuckoo Bee	Endangered	Endangered	Endangered	S1	2	5.0 ± 5.0	NS
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Endangered	S2?B,S3M	1181	5.1 ± 0.0	NS
I	*Danaus plexippus plexippus*	Monarch	Endangered	Special Concern		S2?B,S3M	5	36.7 ± 0.0	NS
I	*Barnea truncata*	Atlantic Mud-piddock	Threatened	Threatened		S1	8	62.6 ± 0.0	NS
I	*Bombus suckleyi*	Suckley's Cuckoo Bumble Bee	Threatened			SH	3	81.6 ± 5.0	NB
I	*Alasmidonta varicosa*	Brook Floater	Special Concern	Special Concern	Threatened	S3	2	62.5 ± 0.0	NS
I	*Bombus terricola*	Yellow-banded Bumble Bee	Special Concern	Special Concern	Vulnerable	S3	334	2.1 ± 0.0	NS
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern		Endangered	SH	5	4.7 ± 2.0	NS
I	*Gomphurus ventricosus*	Skillet Clubtail	Special Concern	Endangered		SH	1	90.9 ± 1.0	NS
I	*Cicindela formosa*	Big Sand Tiger Beetle				S1	1	45.6 ± 1.0	NS
I	*Erora laeta*	Early Hairstreak				S1	2	66.5 ± 2.0	NS

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I	*Ophiogomphus anomalus*	Extra-Striped Snaketail				S1	8	76.7 ± 0.0	NS
I	*Pachydiplax longipennis*	Blue Dasher				S1	17	45.2 ± 0.0	NS
I	*Atlanticoncha ochracea*	Tidewater Mucket				S1	11	84.6 ± 1.0	NS
I	*Polygonia comma*	Eastern Comma				S1?	20	41.2 ± 0.0	NS
I	*Polygonia satyrus*	Satyr Comma				S1?	7	66.2 ± 2.0	NS
I	*Boloria chariclea*	Arctic Fritillary				S1S2	2	72.8 ± 2.0	NS
I	*Somatochlora brevicincta*	Quebec Emerald				S1S2	1	98.5 ± 1.0	NS
I	*Tharsalea dospassosi*	Maritime Copper				S2	3	34.6 ± 1.0	NS
I	*Satyrium acadica*	Acadian Hairstreak				S2	5	88.9 ± 5.0	NB
I	*Coenagrion resolutum*	Taiga Bluet				S2	13	63.9 ± 0.0	NS
I	*Margaritifera margaritifera*	Eastern Pearlshell				S2	65	3.4 ± 0.0	NS
I	*Pantala hymenaea*	Spot-Winged Glider				S2?B	5	72.8 ± 0.0	NB
I	*Nymphalis l-album*	Compton Tortoiseshell				S2S3	26	54.2 ± 2.0	NS
I	*Aglais milberti*	Milbert's Tortoiseshell				S2S3	16	33.8 ± 2.0	NS
I	*Aglais milberti milberti*	Milbert's Tortoise Shell				S2S3	1	93.7 ± 0.0	NB
I	*Somatochlora kennedyi*	Kennedy's Emerald				S2S3	6	85.3 ± 0.0	NS
I	*Somatochlora williamsoni*	Williamson's Emerald				S2S3	7	15.2 ± 0.0	NS
I	*Williamsonia fletcheri*	Ebony Boghaunter				S2S3	4	72.4 ± 0.0	NS
I	*Enallagma geminatum*	Skimming Bluet				S2S3	4	55.0 ± 0.0	NS
I	*Stylurus scudderi*	Zebra Clubtail				S2S3	27	4.1 ± 0.0	NS
I	*Alasmidonta undulata*	Triangle Floater				S2S3	29	77.7 ± 0.0	NS
I	*Strophiona nitens*	Chestnut Bark Long-horned Beetle				S3	2	15.2 ± 0.0	NS
I	*Lebia ornata*	Ornate Harp Ground Beetle				S3	1	64.9 ± 0.0	NS
I	*Hippodamia parenthesis*	Parenthesis Lady Beetle				S3	7	54.3 ± 0.0	NS
I	*Disonycha pensylvanica*	Pennsylvania Flea Beetle				S3	1	39.0 ± 0.0	NS
I	*Chrysochus auratus*	Dogbane Leaf Beetle				S3	7	75.0 ± 0.0	NB
I	*Naemia seriata*	Seaside Lady Beetle				S3	55	15.8 ± 0.0	NS
I	*Pachyrhinus elegans*	Elegant Broad-nosed Weevil				S3	1	67.0 ± 0.0	NS
I	*Chilocorus stigma*	Twice-stabbed Lady Beetle				S3	25	52.8 ± 0.0	NS
I	*Myzia pullata*	Streaked Lady Beetle				S3	4	74.1 ± 0.0	NB
I	*Iphthiminus opacus*	Cloudy Darkling Beetle				S3	2	75.2 ± 0.0	NB
I	*Monochamus marmorator*	Balsam Fir Sawyer				S3	2	76.0 ± 0.0	NB
I	*Trachysida aspera*	Rough Flower Longhorn Beetle				S3	1	84.4 ± 0.0	NB
I	*Dicerca tenebrosa*	Dark Jewel Beetle				S3	2	34.7 ± 0.0	NS
I	*Dicerca tuberculata*	Swollen Jewel Beetle				S3	1	99.0 ± 9.0	NS
I	*Astylopsis sexguttata*	Six-speckled Long-horned Beetle				S3	1	92.2 ± 0.0	NB
I	*Satyrium calanus*	Banded Hairstreak				S3	49	1.8 ± 0.0	NS
I	*Callophrys lanoraieensis*	Bog Elfin				S3	22	47.7 ± 0.0	NS
I	*Strymon melinus*	Gray Hairstreak				S3	18	37.9 ± 2.0	NS
I	*Phanogomphus descriptus*	Harpoon Clubtail				S3	4	95.9 ± 0.0	NB
I	*Ophiogomphus aspersus*	Brook Snaketail				S3	13	78.0 ± 0.0	NS
I	*Ophiogomphus mainensis*	Maine Snaketail				S3	13	49.1 ± 0.0	NS
I	*Ophiogomphus rupinsulensis*	Rusty Snaketail				S3	18	54.3 ± 1.0	NS
I	*Epitheca princeps*	Prince Baskettail				S3	9	59.8 ± 1.0	NS
I	*Somatochlora forcipata*	Forcipate Emerald				S3	7	48.5 ± 1.0	NS
I	*Enallagma vernale*	Vernal Bluet				S3	2	87.3 ± 1.0	NS
I	*Polygonia interrogationis*	Question Mark				S3B	147	12.6 ± 1.0	NS
I	*Lepturopsis biforis*	Two-spotted Long-horned Beetle				S3S4	2	63.6 ± 0.0	NS
I	*Cecropterus pylades*	Northern Cloudywing				S3S4	9	88.9 ± 5.0	NB
I	*Amblyscirtes hegon*	Pepper and Salt Skipper				S3S4	6	53.7 ± 2.0	NS
I	*Cupido comyntas*	Eastern Tailed Blue				S3S4	41	12.6 ± 0.0	NS
I	*Argynnis aphrodite*	Aphrodite Fritillary				S3S4	35	12.6 ± 0.0	NS
I	*Polygonia faunus*	Green Comma				S3S4	31	12.6 ± 1.0	NS
I	*Oeneis jutta*	Jutta Arctic				S3S4	25	61.9 ± 0.0	NS

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I	*Aeshna clepsydra*	Mottled Darner				S3S4	34	10.3 ± 1.0	NS
I	*Aeshna constricta*	Lance-Tipped Darner				S3S4	31	41.2 ± 0.0	NS
I	*Boyeria grafiana*	Ocellated Darner				S3S4	21	23.1 ± 0.0	NS
I	*Gomphaeschna furcillata*	Harlequin Darner				S3S4	40	23.6 ± 0.0	NS
I	*Somatochlora franklini*	Delicate Emerald				S3S4	5	48.5 ± 1.0	NS
I	*Erythrodiplax berenice*	Seaside Dragonlet				S3S4	6	75.4 ± 0.0	NS
I	*Nannothemis bella*	Elfin Skimmer				S3S4	32	25.8 ± 0.0	NS
I	*Sympetrum danae*	Black Meadowhawk				S3S4	6	50.9 ± 0.0	NS
I	*Enallagma vesperum*	Vesper Bluet				S3S4	24	13.0 ± 0.0	NS
I	*Amphiagrion saucium*	Eastern Red Damsel				S3S4	9	64.1 ± 0.0	NB
I	*Icaricia saepiolus*	Greenish Blue				SH	1	67.4 ± 2.0	NS
I	*Chlosyne nycteis*	Silvery Checkerspot				SH	8	49.7 ± 2.0	NS
I	*Polygonia gracilis*	Hoary Comma				SH	1	92.2 ± 7.0	NB
I	*Eristalis brousii*	Hourglass Drone Fly				SX	1	63.9 ± 0.0	NS
N	*Erioderma mollissimum*	Graceful Felt Lichen	Endangered	Endangered	Endangered	S1	16	49.7 ± 1.0	NS
N	*Erioderma pedicellatum (Atlantic pop.)*	Boreal Felt Lichen - Atlantic pop.	Endangered	Endangered	Endangered	S1	13	52.0 ± 0.0	NS
N	*Peltigera hydrothyria*	Eastern Waterfan	Threatened	Threatened	Threatened	S1	831	55.0 ± 0.0	NS
N	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened	Threatened	S2S3	291	14.5 ± 0.0	NS
N	*Pannaria lurida ssp. russellii*	Wrinkled Shingle Lichen	Threatened	Threatened		S2S3	1	62.9 ± 0.0	NS
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened	Threatened	S3	188	8.1 ± 0.0	NS
N	*Fuscopannaria leucosticta*	White-rimmed Shingle Lichen	Threatened			S3	96	25.2 ± 0.0	NS
N	*Heterodermia squamulosa*	Scaly Fringe Lichen	Threatened			S3	137	7.0 ± 0.0	NS
N	*Pectenia plumbea*	Blue Felt Lichen	Special Concern	Special Concern	Vulnerable	S3	607	10.4 ± 0.0	NS
N	*Sclerophora peronella (Atlantic pop.)*	Frosted Glass-whiskers (Atlantic population)	Special Concern	Special Concern		S3S4	31	14.3 ± 3.0	NS
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	41	46.7 ± 4.0	NS
N	*Fissidens exilis*	Pygmy Pocket Moss	Not At Risk			S3	18	8.2 ± 0.0	NS
N	*Aloina brevirostris*	Short-Beaked Rigid Screw Moss				S1	2	77.7 ± 2.0	NS
N	*Homalotheciella subcapillata*	Few-haired Moss				S1	1	59.3 ± 0.0	NS
N	*Orthotrichum gymnostomum*	Aspen Bristle Moss				S1	1	15.6 ± 0.0	NS
N	*Orthotrichum pallens*	Pale Bristle Moss				S1	1	61.6 ± 0.0	NS
N	*Seligeria calcarea*	Chalk Brittle Moss				S1	3	84.0 ± 0.0	NB
N	*Seligeria diversifolia*	a Moss				S1	1	63.1 ± 0.0	NB
N	*Sematophyllum demissum*	a Moss				S1	1	46.6 ± 1.0	NS
N	*Tetrodontium brownianum*	Little Georgia				S1	7	69.4 ± 0.0	NB
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				S1	1	60.7 ± 0.0	NS
N	*Blennothallia crispa*	Crinkled Jelly Lichen				S1	1	83.2 ± 0.0	NS
N	*Umbilicaria vellea*	Grizzled Rocktripe Lichen				S1	2	69.9 ± 1.0	NB
N	*Usnea perplexans*	Powdered Beard Lichen				S1	1	71.7 ± 0.0	NS
N	*Heterodermia leucomela*	Elegant Fringe Lichen				S1	1	93.9 ± 0.0	NS
N	*Scytinium dactylinum*	Brown-buttoned Jellyskin Lichen				S1	2	8.1 ± 0.0	NS
N	*Flavoparmelia baltimorensis*	Rock Greenshield Lichen				S1	1	65.3 ± 0.0	NS
N	*Lathagrium cristatum*	Fingered Jelly Lichen				S1	6	68.1 ± 1.0	NB
N	*Ephebe hispidula*	Dryside Rockshag Lichen				S1	1	14.1 ± 0.0	NS
N	*Ephebe perspinulosa*	Thread Lichen				S1	2	9.6 ± 0.0	NS
N	*Fuscopannaria praetermissa*	Moss Shingles Lichen				S1	1	72.3 ± 0.0	NS
N	*Parmotrema perforatum*	Perforated Ruffle Lichen				S1	46	62.3 ± 0.0	NS
N	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S1	9	4.2 ± 0.0	NS
N	*Pseudevernia consocians*	Common Antler Lichen				S1	1	80.9 ± 0.0	NS
N	*Spilonema revertens*	Rock Hairball Lichen				S1	4	21.1 ± 0.0	NS
N	*Sticta limbata*	Powdered Moon Lichen				S1	12	49.5 ± 0.0	NS
N	*Lathagrium fuscovirens*	Crumpled Rock Tarpaper Lichen				S1	2	55.7 ± 0.0	NS

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N	*Dermatocarpon miniatum*	Common Stippleback Lichen				S1	4	10.1 ± 0.0	NS
N	*Leptogium hibernicum*	Hibernia Jellyskin Lichen				S1	1	73.3 ± 0.0	NS
N	*Hypotrachyna horrescens*	Hairy-spined Shield Lichen				S1	1	88.2 ± 0.0	NS
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S1	11	17.0 ± 0.0	NS
N	*Hypogymnia hultenii*	Powdered Honeycomb Lichen				S1	3	89.0 ± 0.0	NS
N	*Calypogeia neogaea*	Common Pouchwort				S1?	3	53.6 ± 0.0	NS
N	*Jubula pennsylvanica*	a liverwort				S1?	4	55.7 ± 0.0	NS
N	*Aloina rigida*	Aloe-Like Rigid Screw Moss				S1?	3	76.4 ± 0.0	NS
N	*Brachythecium erythrorrhizon*	Taiga Ragged Moss				S1?	1	96.6 ± 0.0	NB
N	*Imbribryum muehlenbeckii*	Muehlenbeck's Bryum Moss				S1?	2	54.9 ± 0.0	NS
N	*Cirriphyllum piliferum*	Hair-pointed Moss				S1?	2	8.5 ± 0.0	NS
N	*Conardia compacta*	Coast Creeping Moss				S1?	2	69.0 ± 1.0	NB
N	*Tortula obtusifolia*	a Moss				S1?	1	62.8 ± 0.0	NB
N	*Didymodon tophaceus*	Olive Beard Moss				S1?	2	83.2 ± 0.0	NS
N	*Grimmia anodon*	Toothless Grimmia Moss				S1?	4	60.9 ± 3.0	NS
N	*Homomallium adnatum*	Adnate Hairy-gray Moss				S1?	2	55.2 ± 0.0	NS
N	*Meesia triquetra*	Three-ranked Cold Moss				S1?	3	51.6 ± 0.0	NS
N	*Paludella squarrosa*	Tufted Fen Moss				S1?	3	83.4 ± 0.0	NS
N	*Physcomitrium immersum*	a Moss				S1?	9	6.4 ± 0.0	NS
N	*Schistostega pennata*	Luminous Moss				S1?	2	91.9 ± 0.0	NS
N	*Timmia norvegica*	a moss				S1?	3	69.3 ± 0.0	NB
N	*Trichodon cylindricus*	Cylindric Hairy-teeth Moss				S1?	3	6.4 ± 0.0	NS
N	*Plagiomnium ellipticum*	Marsh Leafy Moss				S1?	1	7.5 ± 0.0	NS
N	*Syntrichia ruralis*	a Moss				S1?	1	94.8 ± 0.0	NB
N	*Enchylium limosum*	Lime-loving Tarpaper Lichen				S1?	2	83.1 ± 0.0	NS
N	*Euopsis granatina*	Lesser Rockbud Lichen				S1?	1	17.0 ± 1.0	NS
N	*Scytinium intermedium*	Forty-five Jellyskin Lichen				S1?	1	83.3 ± 4.0	NS
N	*Melanelia culbersonii*	Appalachain Camouflage Lichen				S1?	1	83.9 ± 0.0	NS
N	*Peltigera malacea*	Veinless Pelt Lichen				S1?	2	73.7 ± 1.0	NB
N	*Peltigera venosa*	Fan Pelt Lichen				S1?	1	87.2 ± 0.0	NB
N	*Metzgeria crassipilis*	Hairy Veilwort				S1S2	1	98.5 ± 0.0	NS
N	*Porella pinnata*	Pinnate Scalewort				S1S2	3	23.0 ± 0.0	NS
N	*Reboulia hemisphaerica*	Purple-margined Liverwort				S1S2	3	16.1 ± 0.0	NS
N	*Arrhenopterum heterostichum*	One-sided Groove Moss				S1S2	3	49.2 ± 5.0	NS
N	*Brachythecium turgidum*	Thick Ragged Moss				S1S2	3	34.2 ± 3.0	NS
N	*Dicranoweisia crispula*	Mountain Thatch Moss				S1S2	1	76.4 ± 0.0	NB
N	*Didymodon rigidulus*	Rigid Screw Moss				S1S2	12	55.8 ± 0.0	NS
N	*Didymodon ferrugineus*	Rusty Beard Moss				S1S2	2	69.7 ± 0.0	NB
N	*Hygrohypnum montanum*	a Moss				S1S2	2	68.0 ± 1.0	NB
N	*Hypnum pratense*	Meadow Plait Moss				S1S2	2	33.9 ± 3.0	NS
N	*Mnium thomsonii*	Thomson's Leafy Moss				S1S2	1	73.1 ± 2.0	NS
N	*Tortula acaulon*	Cuspidate Earth Moss				S1S2	7	5.9 ± 0.0	NS
N	*Plagiothecium latebricola*	Alder Silk Moss				S1S2	4	70.4 ± 1.0	NB
N	*Platydictya confervoides*	a Moss				S1S2	1	73.6 ± 0.0	NS
N	*Sematophyllum marylandicum*	a Moss				S1S2	1	56.0 ± 0.0	NS
N	*Timmia megapolitana*	Metropolitan Timmia Moss				S1S2	2	92.7 ± 1.0	NS
N	*Tortula mucronifolia*	Mucronate Screw Moss				S1S2	3	60.9 ± 3.0	NS
N	*Syntrichia papillosa*	a Moss				S1S2	2	15.6 ± 0.0	NS
N	*Pseudotaxiphyllum distichaceum*	a Moss				S1S2	2	28.4 ± 4.0	NS
N	*Hamatocaulis vernicosus*	a Moss				S1S2	4	51.8 ± 0.0	NS
N	*Haplocladium microphyllum*	Tiny-leaved Haplocladium Moss				S1S2	1	31.9 ± 3.0	NS

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N	*Rhynchostegium serrulatum*	Dark Beaked Moss				S1S2	1	82.3 ± 2.0	NS
N	*Enchylium bachmanianum*	Bachman's Jelly Lichen				S1S2	2	58.2 ± 0.0	NS
N	*Sclerophora amabilis*	Collared Glass-whiskers Lichen				S1S2	3	30.9 ± 0.0	NS
N	*Cladonia sulphurina*	Greater Sulphur-cup Lichen				S1S2	7	78.4 ± 0.0	NB
N	*Peltigera ponojensis*	Pale-bellied Pelt Lichen				S1S2	6	73.7 ± 1.0	NB
N	*Pilophorus cereolus*	Powdered Matchstick Lichen				S1S2	2	54.2 ± 3.0	NS
N	*Rhizoplaca subdiscrepans*	Scattered Rock-posy Lichen				S1S2	2	64.6 ± 0.0	NS
N	*Parmotrema reticulatum*	Netted Ruffle Lichen				S1S2	12	23.0 ± 0.0	NS
N	*Parmeliella parvula*	Poor-man's Shingles Lichen				S1S2	1	89.2 ± 0.0	NS
N	*Chaenotheca hygrophila*	a lichen				S1S3	9	39.6 ± 0.0	NS
N	*Umbilicaria polyrhiza*	Ballpoint Rocktripe Lichen				S1S3	1	94.8 ± 0.0	NS
N	*Lecanora polytropa*	a lichen				S1S3	8	36.7 ± 1.0	NS
N	*Heterodermia galactophylla*	Branching Fringe Lichen				S1S3	4	84.3 ± 0.0	NS
N	*Xylopsora friesii*	a Lichen				S1S3	1	69.9 ± 1.0	NB
N	*Peltigera neckeri*	Black-saddle Pelt Lichen				S1S3	1	75.7 ± 5.0	NB
N	*Usnea fragilescens*	Inflationary Beard Lichen				S1S3	2	41.3 ± 0.0	NS
N	*Usnea chaetophora*	Articulated Beard Lichen				S1S3	2	47.9 ± 0.0	NS
N	*Stereocaulon intermedium*	Pacific Brain Foam Lichen				S1S3	11	9.5 ± 0.0	NS
N	*Anacamptodon splachnoides*	a Moss				S2	4	17.9 ± 0.0	NS
N	*Scorpidium scorpioides*	Hooked Scorpion Moss				S2	3	90.8 ± 0.0	NB
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S2	2	9.4 ± 0.0	NS
N	*Sphagnum subnitens*	Lustrous Peat Moss				S2	4	68.0 ± 0.0	NS
N	*Scorpidium cossonii*	CossonΓÇÖs Hook Moss				S2	1	89.7 ± 1.0	NB
N	*Cystocoleus ebeneus*	Rockgossamer Lichen				S2	4	17.0 ± 0.0	NS
N	*Hypotrachyna catawbiensis*	Powder-tipped Antler Lichen				S2	45	46.7 ± 4.0	NS
N	*Scytinium imbricatum*	Scaly Jellyskin Lichen				S2	4	57.0 ± 0.0	NB
N	*Nephroma arcticum*	Arctic Kidney Lichen				S2	2	69.4 ± 0.0	NS
N	*Nephroma resupinatum*	a lichen				S2	12	8.3 ± 0.0	NS
N	*Placynthium flabellosum*	Scaly Ink Lichen				S2	7	4.2 ± 0.0	NS
N	*Cololejeunea biddlecomiae*	Biddlecome's Pouncewort				S2?	1	5.6 ± 0.0	NS
N	*Moerckia flotoviana*	Flotow's Ruffwort				S2?	1	83.6 ± 0.0	NS
N	*Riccardia multifida*	Delicate Germanderwort				S2?	5	5.8 ± 0.0	NS
N	*Anomodon viticulosus*	a Moss				S2?	8	39.4 ± 0.0	NS
N	*Weissia muhlenbergiana*	a Moss				S2?	6	22.3 ± 0.0	NS
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S2?	8	31.9 ± 0.0	NS
N	*Ptychostomum pendulum*	Drooping Bryum				S2?	1	77.7 ± 2.0	NS
N	*Drepanocladus polygamus*	Polygamous Hook Moss				S2?	9	9.4 ± 0.0	NS
N	*Pseudocampylium radicale*	Long-stalked Fine Wet Moss				S2?	3	33.9 ± 3.0	NS
N	*Climacium americanum*	American Tree Moss				S2?	10	55.8 ± 0.0	NS
N	*Dicranum condensatum*	Condensed Broom Moss				S2?	6	33.9 ± 3.0	NS
N	*Ditrichum rhynchostegium*	a Moss				S2?	5	58.7 ± 1.0	NS
N	*Fissidens bushii*	Bush's Pocket Moss				S2?	17	8.4 ± 0.0	NS
N	*Fontinalis hypnoides*	a moss				S2?	1	60.9 ± 0.0	NS
N	*Fontinalis sullivantii*	Sullivant's Water Moss				S2?	4	52.2 ± 0.0	NS
N	*Grimmia olneyi*	a Moss				S2?	10	55.8 ± 0.0	NS
N	*Grimmia anomala*	Mountain Forest Grimmia				S2?	1	65.7 ± 1.0	NS
N	*Hygrohypnum bestii*	Best's Brook Moss				S2?	6	13.3 ± 0.0	NS
N	*Orthotrichum anomalum*	Anomalous Bristle Moss				S2?	6	15.6 ± 0.0	NS
N	*Philonotis marchica*	a Moss				S2?	1	55.8 ± 0.0	NS
N	*Physcomitrium collenchymatum*	a Moss				S2?	1	34.2 ± 0.0	NS
N	*Platydictya jungermannioides*	False Willow Moss				S2?	3	69.7 ± 0.0	NB
N	*Rhytidium rugosum*	Wrinkle-leaved Moss				S2?	2	69.5 ± 1.0	NB
N	*Saelania glaucescens*	Blue Dew Moss				S2?	2	76.4 ± 0.0	NB
N	*Tortella fragilis*	Fragile Twisted Moss				S2?	1	69.3 ± 0.0	NB
N	*Anomobryum julaceum*	Slender Silver Moss				S2?	4	63.1 ± 0.0	NB

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N	*Rauiella scita*	Smaller Fern Moss				S2?	16	55.6 ± 0.0	NS
N	*Cyrtomnium hymenophylloides*	Short-pointed Lantern Moss				S2?	7	69.3 ± 0.0	NB
N	*Platylomella lescurii*	a Moss				S2?	13	25.1 ± 0.0	NS
N	*Phylliscum demangeonii*	Black Rock-wafer Lichen				S2?	6	17.0 ± 0.0	NS
N	*Oxyrrhynchium hians*	Light Beaked Moss				S2S3	6	4.3 ± 5.0	NS
N	*Platydictya subtilis*	Bark Willow Moss				S2S3	6	4.2 ± 0.0	NS
N	*Plagiomnium rostratum*	Long-beaked Leafy Moss				S2S3	10	29.3 ± 3.0	NS
N	*Scorpidium revolvens*	Limprichtia Moss				S2S3	3	83.4 ± 0.0	NS
N	*Moelleropsis nebulosa*	Blue-gray Moss Shingle Lichen				S2S3	15	22.7 ± 0.0	NS
N	*Moelleropsis nebulosa ssp. frullaniae*	Blue-gray Moss Shingle Lichen				S2S3	4	83.4 ± 0.0	NS
N	*Ramalina thrausta*	Angelhair Ramalina Lichen				S2S3	12	51.5 ± 1.0	NS
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2S3	73	19.3 ± 0.0	NS
N	*Usnea ceratina*	Warty Beard Lichen				S2S3	4	50.7 ± 0.0	NS
N	*Usnea rubicunda*	Red Beard Lichen				S2S3	8	44.1 ± 0.0	NS
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S2S3	28	36.8 ± 0.0	NS
N	*Usnocetraria oakesiana*	Yellow Band Lichen				S2S3	19	9.1 ± 1.0	NS
N	*Catinaria atropurpurea*	a lichen				S2S3	1	79.2 ± 0.0	NS
N	*Cladonia incrassata*	Powder-foot British Soldiers Lichen				S2S3	2	69.4 ± 0.0	NS
N	*Cladonia mateocyatha*	Mixed-up Pixie-cup				S2S3	4	39.6 ± 0.0	NS
N	*Cladonia parasitica*	Fence-rail Lichen				S2S3	2	66.3 ± 1.0	NS
N	*Scytinium tenuissimum*	Birdnest Jellyskin Lichen				S2S3	4	69.2 ± 1.0	NS
N	*Melanohalea septentrionalis*	Northern Camouflage Lichen				S2S3	4	72.2 ± 0.0	NS
N	*Myelochroa aurulenta*	Powdery Axil-bristle Lichen				S2S3	6	48.3 ± 0.0	NS
N	*Parmelia fertilis*	Fertile Shield Lichen				S2S3	8	20.0 ± 0.0	NS
N	*Hypotrachyna minarum*	Hairless-spined Shield Lichen				S2S3	6	21.5 ± 0.0	NS
N	*Parmeliopsis ambigua*	Green Starburst Lichen				S2S3	2	49.9 ± 2.0	NS
N	*Racodium rupestre*	Rockhair Lichen				S2S3	3	58.0 ± 0.0	NS
N	*Umbilicaria polyphylla*	Petalled Rocktripe Lichen				S2S3	1	49.9 ± 2.0	NS
N	*Usnea cavernosa*	Pitted Beard Lichen				S2S3	5	45.3 ± 0.0	NS
N	*Usnea mutabilis*	Bloody Beard Lichen				S2S3	4	71.6 ± 0.0	NS
N	*Fuscopannaria sorediata*	a Lichen				S2S3	11	58.3 ± 0.0	NS
N	*Stereocaulon condensatum*	Granular Soil Foam Lichen				S2S3	11	9.2 ± 0.0	NS
N	*Stereocaulon subcoralloides*	Coralloid Foam Lichen				S2S3	1	71.8 ± 1.0	NB
N	*Dimelaena oreina*	Golden Moonglow Lichen				S2S3	1	48.8 ± 0.0	NS
N	*Hypotrachyna revoluta*	Granulating Loop Lichen				S2S3	6	52.0 ± 2.0	NS
N	*Cetraria arenaria*	Sand-loving Icelandmoss Lichen				S2S3	33	7.4 ± 0.0	NS
N	*Cladonia coccifera*	Eastern Boreal Pixie-cup Lichen				S2S3	1	9.5 ± 0.0	NS
N	*Cladonia deformis*	Lesser Sulphur-cup Lichen				S2S3	11	55.0 ± 3.0	NS
N	*Cladonia phyllophora*	Felt Lichen				S2S3	2	39.9 ± 4.0	NS
N	*Hypotrachyna afrorevoluta*	Pustulate Revolute Loop Lichen				S2S3	3	48.1 ± 1.0	NS
N	*Usnea flammea*	Coastal Bushy Beard Lichen				S2S3	2	52.0 ± 0.0	NS
N	*Ephemerum serratum*	a Moss				S3	7	13.5 ± 0.0	NS
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S3	15	5.8 ± 0.0	NS
N	*Anomodon tristis*	a Moss				S3	18	16.0 ± 0.0	NS
N	*Sphagnum contortum*	Twisted Peat Moss				S3	8	9.4 ± 0.0	NS
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S3	6	32.5 ± 0.0	NS
N	*Rostania occultata*	Crusted Tarpaper Lichen				S3	9	8.4 ± 0.0	NS
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	54	9.6 ± 0.0	NS
N	*Solorina saccata*	Woodland Owl Lichen				S3	18	68.1 ± 1.0	NB

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N	*Fuscopannaria ahlneri*	Corrugated Shingles Lichen				S3	44	22.6 ± 0.0	NS
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	37	56.9 ± 0.0	NS
N	*Leptogium milligranum*	Stretched Jellyskin Lichen				S3	36	9.3 ± 0.0	NS
N	*Nephroma bellum*	Naked Kidney Lichen				S3	7	72.0 ± 9.0	NS
N	*Placynthium nigrum*	Common Ink Lichen				S3	2	69.9 ± 1.0	NB
N	*Punctelia appalachensis*	Appalachian Speckleback Lichen				S3	164	9.5 ± 0.0	NS
N	*Viridothelium virens*	a lichen				S3	7	40.8 ± 0.0	NS
N	*Ephebe lanata*	Waterside Rockshag Lichen				S3	14	4.1 ± 0.0	NS
N	*Phaeophyscia adiastola*	Powder-tipped Shadow Lichen				S3	25	10.1 ± 0.0	NS
N	*Phaeophyscia pusilloides*	Pompom-tipped Shadow Lichen				S3	9	8.6 ± 0.0	NS
N	*Peltigera collina*	Tree Pelt Lichen				S3	6	27.9 ± 0.0	NS
N	*Metzgeria conjugata*	Rock Veilwort				S3?	4	5.5 ± 0.0	NS
N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3?	3	13.1 ± 0.0	NS
N	*Calliergon giganteum*	Giant Spear Moss				S3?	3	9.7 ± 0.0	NS
N	*Drummondia prorepens*	a Moss				S3?	9	21.7 ± 0.0	NS
N	*Elodium blandowii*	Blandow's Bog Moss				S3?	6	7.5 ± 0.0	NS
N	*Mnium stellare*	Star Leafy Moss				S3?	3	77.0 ± 1.0	NS
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S3?	4	68.5 ± 0.0	NB
N	*Sphagnum riparium*	Streamside Peat Moss				S3?	4	23.0 ± 0.0	NS
N	*Cladonia stygia*	Black-footed Reindeer Lichen				S3?	18	5.0 ± 0.0	NS
N	*Anomodon rugelii*	Rugel's Anomodon Moss				S3S4	11	8.7 ± 0.0	NS
N	*Dichelyma capillaceum*	Hairlike Dichelyma Moss				S3S4	8	50.1 ± 3.0	NS
N	*Dicranum leioneuron*	a Dicranum Moss				S3S4	1	77.9 ± 0.0	NB
N	*Encalypta ciliata*	Fringed Extinguisher Moss				S3S4	3	66.3 ± 1.0	NS
N	*Encalypta procera*	Slender Extinguisher Moss				S3S4	8	17.0 ± 0.0	NS
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	4	21.1 ± 0.0	NS
N	*Splachnum ampullaceum*	Cruet Dung Moss				S3S4	4	32.5 ± 0.0	NS
N	*Thamnobryum alleghaniense*	a Moss				S3S4	41	4.2 ± 0.0	NS
N	*Tomentypnum nitens*	Golden Fuzzy Fen Moss				S3S4	4	51.9 ± 0.0	NS
N	*Schistidium agassizii*	Elf Bloom Moss				S3S4	6	12.4 ± 0.0	NS
N	*Hylocomiastrum pyrenaicum*	a Feather Moss				S3S4	4	8.7 ± 0.0	NS
N	*Bryoria pseudofuscescens*	Mountain Horsehair Lichen				S3S4	18	41.2 ± 0.0	NB
N	*Enchylium tenax*	Soil Tarpaper Lichen				S3S4	7	36.7 ± 0.0	NS
N	*Sticta fuliginosa*	Peppered Moon Lichen				S3S4	59	19.3 ± 0.0	NS
N	*Arctoparmelia incurva*	Finger Ring Lichen				S3S4	30	13.3 ± 0.0	NS
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S3S4	27	8.4 ± 0.0	NS
N	*Leptogium acadiense*	Acadian Jellyskin Lichen				S3S4	46	9.9 ± 0.0	NS
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3S4	33	9.1 ± 0.0	NS
N	*Felipes leucopellaeus*	a lichen				S3S4	7	35.0 ± 0.0	NS
N	*Cladonia floerkeana*	Gritty British Soldiers Lichen				S3S4	8	58.5 ± 0.0	NS
N	*Vahliella leucophaea*	Shelter Shingle Lichen				S3S4	29	4.2 ± 0.0	NS
N	*Heterodermia speciosa*	Powdered Fringe Lichen				S3S4	110	3.8 ± 0.0	NS
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S3S4	234	20.4 ± 0.0	NS
N	*Melanohalea olivacea*	Spotted Camouflage Lichen				S3S4	8	33.6 ± 0.0	NS
N	*Parmeliopsis hyperopta*	Gray Starburst Lichen				S3S4	4	52.0 ± 0.0	NS
N	*Parmotrema perlatum*	Powdered Ruffle Lichen				S3S4	62	36.4 ± 0.0	NS
N	*Peltigera hymenina*	Cloudy Pelt Lichen				S3S4	1	53.5 ± 1.0	NS
N	*Sphaerophorus fragilis*	Fragile Coral Lichen				S3S4	1	99.7 ± 3.0	NS
N	*Sclerophora peronella*	Frosted Glass-whiskers Lichen				S3S4	21	28.8 ± 0.0	NS
N	*Coccocarpia palmicola*	Salted Shell Lichen				S3S4	157	22.6 ± 0.0	NS
N	*Physcia caesia*	Blue-gray Rosette Lichen				S3S4	4	54.2 ± 0.0	NS
N	*Physcia tenella*	Fringed Rosette Lichen				S3S4	3	74.8 ± 0.0	NB

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N	*Anaptychia palmulata*	Shaggy Fringed Lichen				S3S4	324	9.0 ± 0.0	NS
N	*Evernia prunastri*	Valley Oakmoss Lichen				S3S4	42	9.8 ± 0.0	NS
N	*Heterodermia neglecta*	Fringe Lichen				S3S4	130	9.6 ± 1.0	NS
P	*Rhynchospora macrostachya*	Tall Beakrush	Endangered	Endangered	Endangered	S1	57	63.6 ± 0.0	NS
P	*Clethra alnifolia*	Coast Pepper-Bush	Endangered	Threatened	Vulnerable	S2	177	49.5 ± 0.0	NS
P	*Sabatia kennedyana*	Plymouth Gentian	Endangered	Endangered	Endangered	S2S3	1	88.9 ± 0.0	NS
P	*Fraxinus nigra*	Black Ash	Threatened		Threatened	S1S2	895	3.6 ± 0.0	NS
P	*Hydrocotyle umbellata*	Water Pennywort	Special Concern	Special Concern	Endangered	S2	86	59.5 ± 2.0	NS
P	*Eleocharis tuberculosa*	Tubercled Spike-rush	Special Concern	Special Concern	Vulnerable	S2	1	87.2 ± 0.0	NS
P	*Lachnanthes caroliniana*	Redroot	Special Concern	Special Concern	Vulnerable	S2	1483	60.2 ± 0.0	NS
P	*Lophiola aurea*	Goldencrest	Special Concern	Special Concern	Vulnerable	S2	846	55.0 ± 0.0	NS
P	*Lilaeopsis chinensis*	Eastern Lilaeopsis	Special Concern	Special Concern	Vulnerable	S3	154	72.6 ± 0.0	NS
P	*Scirpus longii*	Long's Bulrush	Special Concern		Vulnerable	S3	570	50.3 ± 0.0	NS
P	*Isoetes prototypus*	Prototype Quillwort	Special Concern	Special Concern	Vulnerable	S3	7	15.2 ± 0.0	NS
P	*Floerkea proserpinacoides*	False Mermaidweed	Not At Risk			S2S3	38	33.8 ± 1.0	NS
P	*Acer saccharinum*	Silver Maple				S1	34	39.7 ± 0.0	NS
P	*Toxicodendron vernix*	Poison Sumac				S1	42	68.8 ± 0.0	NS
P	*Osmorhiza depauperata*	Blunt Sweet Cicely				S1	1	54.6 ± 5.0	NS
P	*Antennaria rosea ssp. arida*	Rosy Pussytoes				S1	1	45.4 ± 0.0	NS
P	*Nabalus racemosus*	Glaucous Rattlesnakeroot				S1	24	67.1 ± 0.0	NS
P	*Andersonglossum boreale*	Northern Wild Comfrey				S1	5	42.5 ± 0.0	NS
P	*Turritis glabra*	Tower Mustard				S1	3	39.3 ± 0.0	NS
P	*Lobelia spicata*	Pale-Spiked Lobelia				S1	7	61.4 ± 7.0	NS
P	*Silene antirrhina*	Sleepy Catchfly				S1	5	9.3 ± 0.0	NS
P	*Hudsonia tomentosa*	Woolly Beach-heath				S1	1	96.7 ± 0.0	NB
P	*Callitriche hermaphroditica*	Northern Water-starwort				S1	7	76.2 ± 0.0	NB
P	*Elatine americana*	American Waterwort				S1	3	94.1 ± 0.0	NB
P	*Astragalus robbinsii var. minor*	Robbins' Milkvetch				S1	32	45.4 ± 0.0	NS
P	*Gentianella amarella ssp. acuta*	Northern Gentian				S1	3	90.3 ± 0.0	NB
P	*Ribes americanum*	Wild Black Currant				S1	13	69.5 ± 1.0	NS
P	*Trichostema dichotomum*	Forked Bluecurls				S1	9	57.9 ± 0.0	NS
P	*Fraxinus pennsylvanica*	Red Ash				S1	56	46.7 ± 0.0	NS
P	*Polygonum achoreum*	Leathery Knotweed				S1	4	28.1 ± 10.0	NS
P	*Persicaria careyi*	Carey's Smartweed				S1	1	99.9 ± 5.0	NB
P	*Phytolacca americana*	Common Pokeweed				S1	3	40.2 ± 0.0	NS
P	*Podostemum ceratophyllum*	Horn-leaved Riverweed				S1	4	36.6 ± 0.0	NS
P	*Montia fontana*	Water Blinks				S1	2	49.7 ± 0.0	NS
P	*Lysimachia minima*	Chaffweed				S1	1	59.2 ± 0.0	NS
P	*Lysimachia quadrifolia*	Whorled Yellow Loosestrife				S1	1	91.0 ± 0.0	NS
P	*Clematis occidentalis*	Purple Clematis				S1	16	69.6 ± 0.0	NB
P	*Ranunculus pensylvanicus*	Pennsylvania Buttercup				S1	5	76.5 ± 0.0	NB
P	*Amelanchier nantucketensis*	Nantucket Serviceberry				S1	1	79.5 ± 1.0	NS
P	*Agalinis tenuifolia*	Slender Agalinis				S1	1	99.6 ± 0.0	NS
P	*Scrophularia lanceolata*	Lance-leaved Figwort				S1	5	12.3 ± 1.0	NS
P	*Carex digitalis*	Slender Wood Sedge				S1	5	60.3 ± 0.0	NS
P	*Carex garberi*	Garber's Sedge				S1	3	89.7 ± 0.0	NB
P	*Carex granularis*	Limestone Meadow Sedge				S1	1	98.6 ± 5.0	NB
P	*Carex laxiflora*	Loose-Flowered Sedge				S1	6	25.8 ± 7.0	NS
P	*Carex ormostachya*	Necklace Spike Sedge				S1	7	26.6 ± 5.0	NS
P	*Carex plantaginea*	Plantain-Leaved Sedge				S1	6	68.8 ± 0.0	NB
P	*Carex prairea*	Prairie Sedge				S1	3	44.3 ± 1.0	NS
P	*Carex tincta*	Tinged Sedge				S1	9	75.2 ± 0.0	NB
P	*Carex viridula var. saxilittoralis*	Greenish Sedge				S1	1	54.1 ± 0.0	NS
P	*Carex grisea*	Inflated Narrow-leaved				S1	4	94.4 ± 0.0	NB

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P	*Carex saxatilis*	Russet Sedge				S1	14	92.5 ± 0.0	NB
P	*Eleocharis erythropoda*	Red-stemmed Spikerush				S1	7	78.0 ± 0.0	NB
P	*Fimbristylis autumnalis*	Slender Fimbry				S1	3	68.1 ± 0.0	NS
P	*Scirpus atrovirens*	Dark-green Bulrush				S1	3	76.6 ± 0.0	NS
P	*Blysmopsis rufa*	Red Bulrush				S1	1	96.7 ± 0.0	NB
P	*Schoenoplectus torreyi*	Torrey's Bulrush				S1	10	50.9 ± 0.0	NS
P	*Iris prismatica*	Slender Blue Flag				S1	1	34.3 ± 100.0	NS
P	*Sisyrinchium fuscatum*	Coastal Plain Blue-eyed-grass				S1	6	41.9 ± 1.0	NS
P	*Juncus secundus*	Secund Rush				S1	3	34.7 ± 0.0	NS
P	*Juncus vaseyi*	Vasey Rush				S1	5	82.5 ± 0.0	NB
P	*Triantha glutinosa*	Sticky False-Asphodel				S1	4	89.7 ± 0.0	NB
P	*Trillium grandiflorum*	White Trillium				S1	3	44.4 ± 1.0	NS
P	*Malaxis monophyllos var. brachypoda*	North American White Adder's-mouth				S1	6	36.9 ± 0.0	NS
P	*Spiranthes casei var. casei*	Case's Ladies'-Tresses				S1	3	47.3 ± 0.0	NS
P	*Dichanthelium xanthophysum*	Slender Panic Grass				S1	10	61.6 ± 0.0	NS
P	*Elymus hystrix*	Spreading Wild Rye				S1	8	79.8 ± 0.0	NS
P	*Torreyochloa pallida var. pallida*	Pale False Manna Grass				S1	2	15.5 ± 1.0	NS
P	*Graphephorum melicoides*	Purple False Oats				S1	6	71.0 ± 0.0	NB
P	*Adiantum pedatum*	Northern Maidenhair Fern				S1	25	34.3 ± 100.0	NS
P	*Dryopteris goldieana*	Goldie's Woodfern				S1	1	72.8 ± 1.0	NS
P	*Equisetum palustre*	Marsh Horsetail				S1	4	44.1 ± 5.0	NS
P	*Selaginella rupestris*	Rock Spikemoss				S1	45	77.6 ± 0.0	NS
P	*Solidago hispida*	Hairy Goldenrod				S1?	4	95.6 ± 1.0	NB
P	*Suaeda rolandii*	Roland's Sea-Blite				S1?	7	62.3 ± 0.0	NS
P	*Carex pensylvanica*	Pennsylvania Sedge				S1?	1	71.9 ± 10.0	NS
P	*Carex rostrata*	Narrow-leaved Beaked Sedge				S1?	1	82.2 ± 0.0	NB
P	*Bolboschoenus robustus*	Sturdy Bulrush				S1?	1	39.2 ± 5.0	NS
P	*Juncus anthelatus*	Greater Poverty Rush				S1?	1	6.2 ± 0.0	NS
P	*Allium schoenoprasum*	Wild Chives				S1?	12	26.2 ± 0.0	NS
P	*Allium schoenoprasum var. sibiricum*	Wild Chives				S1?	4	47.1 ± 7.0	NS
P	*Panicum dichotomiflorum ssp. puritanorum*	Spreading Panicgrass				S1?	6	61.1 ± 0.0	NS
P	*Huperzia selago*	Northern Firmoss				S1?	1	36.7 ± 1.0	NS
P	*Crocanthemum canadense*	Long-branched Frostweed			Endangered	S1S2	151	6.4 ± 0.0	NS
P	*Cypripedium arietinum*	Ram's-Head Lady's-Slipper			Endangered	S1S2	308	72.8 ± 1.0	NS
P	*Sanicula odorata*	Clustered Sanicle				S1S2	9	34.4 ± 2.0	NS
P	*Ageratina altissima*	White Snakeroot				S1S2	56	47.0 ± 0.0	NS
P	*Draba glabella*	Rock Whitlow-Grass				S1S2	14	36.7 ± 1.0	NS
P	*Proserpinaca intermedia*	Intermediate Mermaidweed				S1S2	4	32.1 ± 2.0	NS
P	*Carex haydenii*	Hayden's Sedge				S1S2	13	51.1 ± 1.0	NS
P	*Platanthera huronensis*	Fragrant Green Orchid				S1S2	9	50.9 ± 10.0	NS
P	*Calamagrostis stricta ssp. stricta*	Slim-stemmed Reed Grass				S1S2	1	94.2 ± 7.0	NS
P	*Woodsia alpina*	Alpine Cliff Fern				S1S2	12	67.1 ± 0.0	NB
P	*Selaginella selaginoides*	Low Spikemoss				S1S2	9	69.5 ± 0.0	NB
P	*Euphrasia farlowii*	Farlow's Eyebright				S1S3	2	95.9 ± 0.0	NS
P	*Zizia aurea*	Golden Alexanders				S2	21	87.9 ± 0.0	NS
P	*Antennaria parlinii ssp. fallax*	Parlin's Pussytoes				S2	36	48.9 ± 0.0	NS
P	*Rudbeckia laciniata*	Cut-Leaved Coneflower				S2	28	9.8 ± 7.0	NS
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S2	17	47.6 ± 0.0	NS
P	*Cardamine maxima*	Large Toothwort				S2	27	13.0 ± 4.0	NS

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P	*Hudsonia ericoides*	Pinebarren Golden Heather				S2	155	2.3 ± 0.0	NS
P	*Desmodium canadense*	Canada Tick-trefoil				S2	17	45.1 ± 7.0	NS
P	*Hylodesmum glutinosum*	Large Tick-trefoil				S2	41	2.4 ± 0.0	NS
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S2	28	45.4 ± 0.0	NS
P	*Conopholis americana*	American Cancer-root				S2	100	8.4 ± 0.0	NS
P	*Anemonastrum canadense*	Canada Anemone				S2	25	12.8 ± 0.0	NS
P	*Hepatica americana*	Round-lobed Hepatica				S2	63	10.6 ± 0.0	NS
P	*Ranunculus sceleratus*	Cursed Buttercup				S2	3	93.2 ± 0.0	NB
P	*Galium boreale*	Northern Bedstraw				S2	9	47.9 ± 0.0	NS
P	*Comandra umbellata*	Bastard's Toadflax				S2	1	96.7 ± 0.0	NB
P	*Gratiola neglecta*	Clammy Hedge-Hyssop				S2	15	77.3 ± 0.0	NB
P	*Dirca palustris*	Eastern Leatherwood				S2	70	70.8 ± 13.0	NS
P	*Carex chordorrhiza*	Creeping Sedge				S2	2	86.0 ± 0.0	NB
P	*Carex pellita*	Woolly Sedge				S2	3	95.6 ± 0.0	NB
P	*Carex livida*	Livid Sedge				S2	3	69.8 ± 10.0	NS
P	*Juncus greenei*	Greene's Rush				S2	2	85.6 ± 0.0	NS
P	*Juncus alpinoarticulatus ssp. americanus*	Northern Green Rush				S2	6	78.1 ± 0.0	NB
P	*Allium tricoccum*	Wild Leek				S2	136	1.9 ± 0.0	NS
P	*Lilium canadense*	Canada Lily				S2	39	30.7 ± 7.0	NS
P	*Cypripedium parviflorum var. pubescens*	Yellow Lady's-slipper				S2	30	40.4 ± 5.0	NS
P	*Cypripedium parviflorum var. makasin*	Small Yellow Lady's-Slipper				S2	16	26.8 ± 0.0	NS
P	*Cypripedium reginae*	Showy Lady's-Slipper				S2	35	64.9 ± 1.0	NB
P	*Platanthera flava var. flava*	Southern Rein Orchid				S2	19	57.4 ± 7.0	NS
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S2	28	2.0 ± 0.0	NS
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S2	13	46.5 ± 0.0	NS
P	*Bromus latiglumis*	Broad-Glumed Brome				S2	1	98.5 ± 2.0	NB
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S2	41	39.1 ± 0.0	NS
P	*Elymus wiegandii*	Wiegand's Wild Rye				S2	3	91.2 ± 0.0	NB
P	*Festuca subverticillata*	Nodding Fescue				S2	10	46.5 ± 1.0	NS
P	*Piptatheropsis pungens*	Slender Ricegrass				S2	15	13.8 ± 0.0	NS
P	*Cryptogramma stelleri*	Steller's Rockbrake				S2	6	63.2 ± 0.0	NB
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2?	3	68.1 ± 0.0	NS
P	*Rumex persicarioides*	Peach-leaved Dock				S2?	1	74.2 ± 0.0	NS
P	*Crataegus submollis*	Quebec Hawthorn				S2?	6	76.9 ± 1.0	NS
P	*Carex peckii*	White-Tinged Sedge				S2?	5	75.0 ± 0.0	NB
P	*Thuja occidentalis*	Eastern White Cedar			Vulnerable	S2S3	437	3.0 ± 0.0	NS
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2S3	18	34.0 ± 1.0	NS
P	*Bidens hyperborea*	Estuary Beggarticks				S2S3	1	96.7 ± 0.0	NB
P	*Erigeron philadelphicus*	Philadelphia Fleabane				S2S3	14	36.7 ± 0.0	NS
P	*Eutrochium dubium*	Coastal Plain Joe Pye Weed				S2S3	2	70.5 ± 0.0	NS
P	*Lactuca hirsuta*	Hairy Lettuce				S2S3	5	54.3 ± 1.0	NS
P	*Impatiens pallida*	Pale Jewelweed				S2S3	13	36.6 ± 0.0	NS
P	*Caulophyllum thalictroides*	Blue Cohosh				S2S3	65	2.7 ± 0.0	NS
P	*Draba arabisans*	Rock Whitlow-Grass				S2S3	42	36.4 ± 0.0	NS
P	*Boechera stricta*	Drummond's Rockcress				S2S3	25	36.4 ± 0.0	NS
P	*Stellaria humifusa*	Saltmarsh Starwort				S2S3	16	46.7 ± 1.0	NS
P	*Oxybasis rubra*	Red Goosefoot				S2S3	8	90.5 ± 1.0	NB
P	*Hypericum majus*	Large St John's-wort				S2S3	8	64.7 ± 0.0	NS
P	*Hypericum x dissimulatum*	Disguised St. John's-wort				S2S3	6	57.0 ± 0.0	NS
P	*Empetrum atropurpureum*	Purple Crowberry				S2S3	1	93.7 ± 7.0	NS
P	*Euphorbia polygonifolia*	Seaside Spurge				S2S3	12	75.7 ± 3.0	NS
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S2S3	12	51.6 ± 1.0	NS
P	*Hedeoma pulegioides*	American False Pennyroyal				S2S3	62	27.9 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
P	*Oenothera fruticosa ssp. tetragona*	Narrow-leaved Evening Primrose				S2S3	22	55.6 ± 0.0	NS
P	*Polygala polygama*	Racemed Milkwort				S2S3	45	22.6 ± 0.0	NS
P	*Polygonum aviculare ssp. buxiforme*	Box Knotweed				S2S3	6	25.8 ± 7.0	NS
P	*Polygonum oxyspermum ssp. raii*	Ray's Knotweed				S2S3	4	77.6 ± 1.0	NS
P	*Rumex triangulivalvis*	Triangular-valve Dock				S2S3	18	44.8 ± 1.0	NS
P	*Primula mistassinica*	Mistassini Primrose				S2S3	11	88.0 ± 0.0	NB
P	*Anemone quinquefolia*	Wood Anemone				S2S3	57	1.3 ± 0.0	NS
P	*Caltha palustris*	Yellow Marsh Marigold				S2S3	22	13.0 ± 0.0	NS
P	*Amelanchier fernaldii*	Fernald's Serviceberry				S2S3	1	61.6 ± 7.0	NS
P	*Potentilla canadensis*	Canada Cinquefoil				S2S3	10	54.1 ± 0.0	NS
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2S3	9	5.9 ± 0.0	NS
P	*Salix pellita*	Satiny Willow				S2S3	20	14.2 ± 7.0	NS
P	*Tiarella cordifolia*	Heart-leaved Foamflower				S2S3	43	41.1 ± 0.0	NS
P	*Agalinis purpurea var. parviflora*	Small-flowered Purple False Foxglove				S2S3	5	89.7 ± 1.0	NB
P	*Boehmeria cylindrica*	Small-spike False-nettle				S2S3	57	4.3 ± 0.0	NS
P	*Carex adusta*	Lesser Brown Sedge				S2S3	5	73.4 ± 0.0	NB
P	*Carex capillaris*	Hairlike Sedge				S2S3	25	45.4 ± 0.0	NS
P	*Carex comosa*	Bearded Sedge				S2S3	12	20.8 ± 1.0	NS
P	*Carex houghtoniana*	Houghton's Sedge				S2S3	9	55.7 ± 0.0	NS
P	*Carex hystericina*	Porcupine Sedge				S2S3	10	7.5 ± 1.0	NS
P	*Carex longii*	Long's Sedge				S2S3	1	79.1 ± 10.0	NS
P	*Carex scirpoidea*	Scirpuslike Sedge				S2S3	6	86.5 ± 0.0	NB
P	*Eleocharis ovata*	Ovate Spikerush				S2S3	13	44.7 ± 0.0	NS
P	*Scirpus pedicellatus*	Stalked Bulrush				S2S3	13	92.3 ± 0.0	NB
P	*Vallisneria americana*	Wild Celery				S2S3	33	57.3 ± 0.0	NS
P	*Juncus ranarius*	Seaside Rush				S2S3	1	96.7 ± 0.0	NB
P	*Najas gracillima*	Thread-Like Naiad				S2S3	22	60.6 ± 0.0	NS
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S2S3	106	8.4 ± 0.0	NS
P	*Spiranthes casei*	Case's Ladies'-Tresses				S2S3	2	64.7 ± 0.0	NS
P	*Spiranthes casei var. novaescotiae*	Case's Ladies'-Tresses				S2S3	4	6.9 ± 0.0	NS
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S2S3	17	16.0 ± 1.0	NS
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S2S3	8	76.8 ± 0.0	NB
P	*Potamogeton friesii*	Fries' Pondweed				S2S3	8	41.5 ± 2.0	NS
P	*Cystopteris laurentiana*	Laurentian Bladder Fern				S2S3	1	85.6 ± 1.0	NB
P	*Woodsia glabella*	Smooth Cliff Fern				S2S3	68	67.4 ± 0.0	NB
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S2S3	14	36.7 ± 1.0	NS
P	*Botrychium simplex*	Least Moonwort				S2S3	3	49.3 ± 1.0	NS
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S2S3	7	37.5 ± 7.0	NS
P	*Potamogeton pulcher*	Spotted Pondweed			Vulnerable	S3	28	44.8 ± 0.0	NS
P	*Angelica atropurpurea*	Purple-stemmed Angelica				S3	3	84.4 ± 1.0	NB
P	*Conioselinum chinense*	Chinese Hemlock-parsley				S3	38	45.5 ± 0.0	NS
P	*Hieracium robinsonii*	Robinson's Hawkweed				S3	16	74.5 ± 0.0	NB
P	*Iva frutescens*	Big-leaved Marsh-elder				S3	59	49.0 ± 0.0	NS
P	*Senecio pseudoarnica*	Seabeach Ragwort				S3	1	93.4 ± 0.0	NS
P	*Symphyotrichum boreale*	Boreal Aster				S3	15	55.7 ± 0.0	NS
P	*Symphyotrichum undulatum*	Wavy-leaved Aster				S3	158	1.5 ± 0.0	NS
P	*Symphyotrichum ciliolatum*	Fringed Blue Aster				S3	27	36.1 ± 1.0	NS
P	*Alnus serrulata*	Smooth Alder				S3	700	54.0 ± 0.0	NS
P	*Betula michauxii*	Michaux's Dwarf Birch				S3	56	56.9 ± 0.0	NS
P	*Betula pumila*	Bog Birch				S3	2	96.7 ± 0.0	NB
P	*Cardamine parviflora*	Small-flowered Bittercress				S3	15	16.8 ± 7.0	NS
P	*Palustricodon aparinoides*	Marsh Bellflower				S3	20	16.9 ± 1.0	NS

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P	*Lobelia kalmii*	Brook Lobelia				S3	8	89.7 ± 1.0	NB
P	*Mononeuria groenlandica*	Greenland Stitchwort				S3	141	50.9 ± 0.0	NS
P	*Sagina nodosa*	Knotted Pearlwort				S3	30	53.7 ± 3.0	NS
P	*Sagina nodosa ssp. borealis*	Knotted Pearlwort				S3	1	79.9 ± 5.0	NS
P	*Stellaria longifolia*	Long-leaved Starwort				S3	5	68.1 ± 0.0	NB
P	*Ceratophyllum echinatum*	Prickly Hornwort				S3	15	40.1 ± 0.0	NS
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	36	78.8 ± 0.0	NS
P	*Viburnum edule*	Squashberry				S3	15	71.3 ± 0.0	NB
P	*Crassula aquatica*	Water Pygmyweed				S3	1	99.3 ± 0.0	NS
P	*Empetrum eamesii*	Pink Crowberry				S3	5	85.5 ± 0.0	NS
P	*Halenia deflexa*	Spurred Gentian				S3	11	84.4 ± 1.0	NB
P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	28	14.0 ± 0.0	NS
P	*Myriophyllum verticillatum*	Whorled Water Milfoil				S3	11	79.3 ± 0.0	NB
P	*Utricularia resupinata*	Inverted Bladderwort				S3	18	55.1 ± 0.0	NS
P	*Epilobium strictum*	Downy Willowherb				S3	14	45.2 ± 3.0	NS
P	*Polygala sanguinea*	Blood Milkwort				S3	29	4.9 ± 0.0	NS
P	*Persicaria arifolia*	Halberd-leaved Tearthumb				S3	20	39.6 ± 0.0	NS
P	*Plantago rugelii*	Rugel's Plantain				S3	8	16.0 ± 1.0	NS
P	*Primula laurentiana*	Laurentian Primrose				S3	80	13.4 ± 0.0	NS
P	*Samolus parviflorus*	Seaside Brookweed				S3	57	72.7 ± 0.0	NS
P	*Pyrola minor*	Lesser Pyrola				S3	6	39.1 ± 7.0	NS
P	*Anemone virginiana*	Virginia Anemone				S3	14	69.9 ± 0.0	NS
P	*Cephalanthus occidentalis*	Common Buttonbush				S3	1966	48.9 ± 0.0	NS
P	*Salix pedicellaris*	Bog Willow				S3	97	29.9 ± 0.0	NS
P	*Salix sericea*	Silky Willow				S3	144	2.8 ± 0.0	NS
P	*Saxifraga paniculata ssp. laestadii*	Laestadius' Saxifrage				S3	51	45.4 ± 0.0	NS
P	*Lindernia dubia*	Yellow-seeded False Pimperel				S3	25	4.4 ± 0.0	NS
P	*Laportea canadensis*	Canada Wood Nettle				S3	41	8.3 ± 0.0	NS
P	*Pilea pumila*	Dwarf Clearweed				S3	12	50.5 ± 0.0	NS
P	*Viola nephrophylla*	Northern Bog Violet				S3	21	54.8 ± 1.0	NS
P	*Carex bebbii*	Bebb's Sedge				S3	24	72.3 ± 0.0	NS
P	*Carex castanea*	Chestnut Sedge				S3	3	89.1 ± 0.0	NS
P	*Carex cryptolepis*	Hidden-scaled Sedge				S3	19	51.1 ± 3.0	NS
P	*Carex eburnea*	Bristle-leaved Sedge				S3	18	68.9 ± 0.0	NB
P	*Carex hirtifolia*	Pubescent Sedge				S3	16	79.9 ± 0.0	NS
P	*Carex lupulina*	Hop Sedge				S3	70	4.9 ± 3.0	NS
P	*Carex rosea*	Rosy Sedge				S3	50	9.2 ± 0.0	NS
P	*Carex swanii*	Swan's Sedge				S3	83	1.3 ± 0.0	NS
P	*Carex tenera*	Tender Sedge				S3	10	4.8 ± 0.0	NS
P	*Carex tribuloides*	Blunt Broom Sedge				S3	20	9.6 ± 0.0	NS
P	*Carex tuckermanii*	Tuckerman's Sedge				S3	45	74.9 ± 0.0	NS
P	*Carex atratiformis*	Scabrous Black Sedge				S3	5	82.7 ± 0.0	NS
P	*Eleocharis nitida*	Quill Spikerush				S3	21	5.9 ± 7.0	NS
P	*Eleocharis flavescens var. olivacea*	Bright-green Spikerush				S3	13	30.8 ± 0.0	NS
P	*Eleocharis quinqueflora*	Few-flowered Spikerush				S3	9	89.4 ± 0.0	NB
P	*Eriophorum gracile*	Slender Cottongrass				S3	9	13.6 ± 1.0	NS
P	*Coeloglossum viride*	Long-bracted Frog Orchid				S3	16	41.1 ± 0.0	NS
P	*Cypripedium parviflorum*	Yellow Lady's-slipper				S3	583	44.8 ± 7.0	NS
P	*Neottia bifolia*	Southern Twayblade				S3	76	16.8 ± 0.0	NS
P	*Platanthera flava*	Southern Rein-Orchid				S3	37	48.6 ± 0.0	NS
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	37	33.8 ± 1.0	NS
P	*Platanthera hookeri*	Hooker's Orchid				S3	31	16.2 ± 1.0	NS
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	16	1.5 ± 0.0	NS
P	*Piptatheropsis canadensis*	Canada Ricegrass				S3	15	55.7 ± 0.0	NS

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P	*Poa glauca*	Glaucous Blue Grass				S3	26	36.5 ± 0.0	NS
P	*Stuckenia filiformis*	Thread-leaved Pondweed				S3	7	47.4 ± 7.0	NS
P	*Potamogeton praelongus*	White-stemmed Pondweed				S3	13	45.4 ± 1.0	NS
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3	7	34.4 ± 1.0	NS
P	*Potamogeton zosteriformis*	Flat-stemmed Pondweed				S3	14	42.4 ± 1.0	NS
P	*Asplenium viride*	Green Spleenwort				S3	33	66.9 ± 0.0	NB
P	*Dryopteris fragrans*	Fragrant Wood Fern				S3	80	66.3 ± 0.0	NS
P	*Sceptridium dissectum*	Dissected Moonwort				S3	9	9.1 ± 1.0	NS
P	*Polypodium appalachianum*	Appalachian Polypody				S3	46	6.5 ± 0.0	NS
P	*Persicaria amphibia var. emersa*	Long-root Smartweed				S3?	43	48.4 ± 0.0	NS
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S3?	46	6.9 ± 0.0	NS
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3?	14	4.8 ± 0.0	NS
P	*Bidens vulgata*	Tall Beggarticks				S3S4	4	74.8 ± 0.0	NS
P	*Erigeron hyssopifolius*	Hyssop-leaved Fleabane				S3S4	88	67.6 ± 0.0	NB
P	*Hieracium paniculatum*	Panicled Hawkweed				S3S4	51	1.5 ± 0.0	NS
P	*Bidens beckii*	Water Beggarticks				S3S4	42	39.4 ± 0.0	NS
P	*Packera paupercula*	Balsam Groundsel				S3S4	90	73.5 ± 0.0	NS
P	*Atriplex glabriuscula var. franktonii*	Frankton's Saltbush				S3S4	17	34.2 ± 0.0	NS
P	*Shepherdia canadensis*	Soapberry				S3S4	113	54.4 ± 0.0	NS
P	*Vaccinium boreale*	Northern Blueberry				S3S4	2	64.2 ± 0.0	NS
P	*Vaccinium cespitosum*	Dwarf Bilberry				S3S4	106	1.3 ± 0.0	NS
P	*Vaccinium corymbosum*	Highbush Blueberry				S3S4	19	4.7 ± 0.0	NS
P	*Fagus grandifolia*	American Beech				S3S4	776	1.8 ± 0.0	NS
P	*Bartonia virginica*	Yellow Bartonia				S3S4	25	30.3 ± 0.0	NS
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S3S4	76	44.1 ± 1.0	NS
P	*Decodon verticillatus*	Swamp Loosestrife				S3S4	189	48.7 ± 0.0	NS
P	*Nuphar microphylla*	Small Yellow Pond-lily				S3S4	7	44.7 ± 0.0	NS
P	*Persicaria pensylvanica*	Pennsylvania Smartweed				S3S4	34	10.2 ± 0.0	NS
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	20	8.3 ± 0.0	NS
P	*Rumex pallidus*	Seabeach Dock				S3S4	3	55.8 ± 0.0	NS
P	*Pyrola asarifolia*	Pink Pyrola				S3S4	14	36.7 ± 1.0	NS
P	*Endotropis alnifolia*	alder-leaved buckthorn				S3S4	133	41.1 ± 0.0	NS
P	*Amelanchier spicata*	Running Serviceberry				S3S4	73	1.7 ± 0.0	NS
P	*Fragaria vesca ssp. americana*	Woodland Strawberry				S3S4	28	45.7 ± 0.0	NS
P	*Fragaria vesca*	Woodland Strawberry				S3S4	13	38.6 ± 0.0	NS
P	*Galium aparine*	Common Bedstraw				S3S4	32	34.8 ± 2.0	NS
P	*Geocaulon lividum*	Northern Comandra				S3S4	11	15.2 ± 1.0	NS
P	*Limosella australis*	Southern Mudwort				S3S4	7	76.6 ± 0.0	NS
P	*Ulmus americana*	White Elm				S3S4	112	1.7 ± 0.0	NS
P	*Verbena hastata*	Blue Vervain				S3S4	130	11.9 ± 0.0	NS
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S3S4	82	1.5 ± 0.0	NS
P	*Viola selkirkii*	Great-Spurred Violet				S3S4	11	36.7 ± 1.0	NS
P	*Symplocarpus foetidus*	Eastern Skunk Cabbage				S3S4	62	40.3 ± 0.0	NS
P	*Carex argyrantha*	Silvery-flowered Sedge				S3S4	29	34.4 ± 2.0	NS
P	*Sisyrinchium atlanticum*	Eastern Blue-Eyed-Grass				S3S4	114	36.2 ± 0.0	NS
P	*Triglochin gaspensis*	Gasp ├⌐ Arrowgrass				S3S4	16	64.9 ± 0.0	NB
P	*Juncus acuminatus*	Sharp-Fruit Rush				S3S4	13	4.9 ± 2.0	NS
P	*Juncus subcaudatus*	Woods-Rush				S3S4	15	12.0 ± 2.0	NS
P	*Luzula parviflora ssp. melanocarpa*	Black-fruited Woodrush				S3S4	13	19.3 ± 7.0	NS
P	*Goodyera repens*	Lesser Rattlesnake-plantain				S3S4	24	6.3 ± 0.0	NS
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	15	36.7 ± 1.0	NS
P	*Platanthera obtusata*	Blunt-leaved Orchid				S3S4	18	45.1 ± 10.0	NS
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3S4	54	30.4 ± 0.0	NS
P	*Alopecurus aequalis*	Short-awned Foxtail				S3S4	9	12.0 ± 0.0	NS

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P	*Dichanthelium clandestinum*	Deer-tongue Panic Grass				S3S4	294	3.8 ± 0.0	NS
P	*Coleataenia longifolia*	Long-leaved Panicgrass				S3S4	1631	54.8 ± 0.0	NS
P	*Panicum philadelphicum*	Philadelphia Panicgrass				S3S4	35	8.6 ± 0.0	NS
P	*Koeleria spicata*	Narrow False Oats				S3S4	34	45.4 ± 0.0	NS
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S3S4	36	21.1 ± 0.0	NS
P	*Lorinseria areolata*	Netted Chain Fern				S3S4	64	69.2 ± 0.0	NS
P	*Equisetum pratense*	Meadow Horsetail				S3S4	12	1.8 ± 0.0	NS
P	*Diphasiastrum complanatum*	Northern Ground-cedar				S3S4	15	5.5 ± 0.0	NS
P	*Diphasiastrum sitchense*	Sitka Ground-cedar				S3S4	2	54.9 ± 1.0	NS
P	*Huperzia appressa*	Mountain Firmoss				S3S4	50	35.7 ± 0.0	NS
P	*Sceptridium multifidum*	Leathery Moonwort				S3S4	15	5.7 ± 0.0	NS
P	*Botrychium matricariifolium*	Daisy-leaved Moonwort				S3S4	11	44.3 ± 10.0	NS
P	*Bidens discoidea*	Swamp Beggarticks				SH	1	59.1 ± 0.0	NS
P	*Viola canadensis*	Canada Violet				SH	1	75.8 ± 0.0	NS
P	*Dichanthelium meridionale*	Matting Witchgrass				SH	1	63.9 ± 10.0	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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755	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.
734	Toms, Brad. 2012. Atlantic Coastal Plain Flora records, 2011. Mersey-Tobiatic Research Institute, 1109 recs.
727	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2014. Atlantic Canada Conservation Data Centre Fieldwork 2014. Atlantic Canada Conservation Data Centre, # recs.
685	Paquet, Julie. 2019. Atlantic Canada Shorebird Survey ACSS database for 2019. Environment Canada, Canadian Wildlife Service.
681	Benjamin, L.K. (compiler). 2007. Significant Habitat & Species Database. Nova Scotia Dept Natural Resources, 8439 recs.
648	Brooks, Delaney. 2023. Port of Saint John Waterbird Survey since 2019. Nature NB.
622	Cameron, E. 2008. Canadian Gypsum Co. survey 2007-08. Conestoga-Rovers & Assoc., 623 recs.
583	Churchill, J.L. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2018. Atlantic Canada Conservation Data Centre, 907 recs.
485	Newell, R.E. 2000. E.C. Smith Herbarium Database. Acadia University, Wolfville NS, 7139 recs.
442	McNeil, J.A. 2019. Blanding's Turtle records, 2017. Mersey Tobeatic Research Institute, 372 recs.
413	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2015. Atlantic Canada Conservation Data Centre Fieldwork 2015. Atlantic Canada Conservation Data Centre, # recs.
406	Belliveau, A.G. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
405	Scott, F.W. 2002. Nova Scotia Herpetofauna Atlas Database. Acadia University, Wolfville NS, 8856 recs.
398	Brazner, John. 2022. Clearcut Transect Study. Nova Scotia Department of Natural Resources and Renewables Wildlife Division.

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394	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.
376	Clayden, S. Digitization of Wolfgang Maass Nova Scotia forest lichen collections, 1964-2004. New Brunswick Museum. 2018.
373	Belliveau, A.G. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 10695 recs.
372	McNeil, J.A. 2018. Blanding's Turtle records, 2018. Mersey Tobeatic Research Institute, 372 recs.
366	Churchill, J.L. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre, 2318 recs.
365	Churchill, J.L. 2019. Atlantic Canada Conservation Data Centre Fieldwork 2019. Atlantic Canada Conservation Data Centre.
353	Wildlife Division. 2021. Fraxinus nigra records assembled to define and model habitat. Nova Scotia Department of Natural Resources and Renewables.
352	Eaton, S. 2014. Nova Scotia Wood Turtle Database. Environment and Climate Change Canada, 4843 recs.
351	Chapman, C.J. 2019. Atlantic Canada Conservation Data Centre 2019 botanical fieldwork. Atlantic Canada Conservation Data Centre, 11729 recs.
316	Toms, Brad. 2011. Atlantic Coastal Plain Flora records 2010. Mersey-Tobiatic Research Institute, 1074 recs.
311	Blaney, C.S.; Mazerolle, D.M.; Oberndorfer, E. 2007. Fieldwork 2007. Atlantic Canada Conservation Data Centre. Sackville NB, 13770 recs.
306	McNeil, J.A. 2015. Blandings Turtle (Emydoidea blandingii), Eastern Ribbonsnake (Thamnophis sauritus), and Snapping Turtle (Chelydra serpentina) sightings, 2015. Mersey Tobeatic Research Institute.
304	Staicer, C. 2021. Additional compiled Nova Scotia Species at Risk bird records, 2005-2020. Dalhousie University.
300	McNeil, Jeffie. 2022. Wood Turtle GPS Tracking data, 2021. Mersey Tobeatic Research Institute.
297	Mazerolle, D.M. 2017. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
294	Benjamin, L.K. (compiler). 2012. Significant Habitat & Species Database. Nova Scotia Dept Natural Resources, 4965 recs.
292	Hicks, Andrew. 2009. Coastal Waterfowl Surveys Database, 2000-08. Canadian Wildlife Service, Sackville, 46488 recs (11149 non-zero).
292	Staicer, Cindy. 2023. 2022 SAR Bird ARU occurrences. Dalhousie University, 379 records.
286	Chapman-Lam, C.J. 2021. Atlantic Canada Conservation Data Centre 2020 botanical fieldwork. Atlantic Canada Conservation Data Centre, 17309 recs.
277	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.
272	Belliveau, A.G. 2021. E.C. Smith Herbarium and Atlantic Canada Conservation Data Centre Fieldwork 2021. E.C. Smith Herbarium.
262	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.
255	Mazerolle, D.M. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
249	Smith, D. 2013. Personal communication concerning Anguilla rostrata trapping results in Kejimkujik NP, NS. Winter 2013. Pers. comm.
247	McNeil, Jeffie. 2022. 2021 Turtle Records. Mersey Tobeatic Research Institute.
247	McNeil, Jeffie. 2023. 2022 Turtle Records. Mersey Tobeatic Research Institute.
234	Brazner, J. 2016. Nova Scotia Forested Wetland Bird Surveys. Nova Scotia Department of Lands and Forestry.
229	Blaney, C.S.; Mazerolle, D.M. 2008. Fieldwork 2008. Atlantic Canada Conservation Data Centre. Sackville NB, 13343 recs.
228	Belland, R.J. Maritimes moss records from various herbarium databases. 2014.
224	Clayden, S.R. 1998. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 19759 recs.
220	Toms, B. 2018. Bat Species data from www.batconservation.ca for Nova Scotia. Mersey Tobeatic Research Institute, 547 Records.
218	Westwood, A., Staicer, C. 2016. Nova Scotia landbird Species at Risk observations. Dalhousie University.
212	Blaney, C.S.; Mazerolle, D.M. 2009. Fieldwork 2009. Atlantic Canada Conservation Data Centre. Sackville NB, 13395 recs.
210	Toms, Brad & Pepper, Chris; Neily, Tom. 2022. Nova Scotia lichen database [as of 2022-04]. Mersey Tobeatic Research Institute.
206	Klymko, J. 2018. Maritimes Butterfly Atlas database. Atlantic Canada Conservation Data Centre.
205	McNeil, Jeffie. 2023. Ribbonsnake records from 2022. Mersey Tobeatic Research Institute.
202	Blaney, C.S. & Mazerolle, D.M. 2011. 2011 botanical surveys in Kejimkujik National Park. Atlantic Canada Conservation Data Centre, 820 recs.
198	iNaturalist. 2018. iNaturalist Data Export 2018. iNaturalist.org and iNaturalist.ca, Web site: 11700 recs.
194	Churchill, J.L. 2022. Atlantic Canada Conservation Data Centre Fieldwork 2022. Atlantic Canada Conservation Data Centre.
191	Belliveau, A.G. 2018. E.C. Smith Herbarium and Atlantic Canada Conservation Data Centre Fieldwork 2018. E.C. Smith Herbarium, 6226 recs.
190	McNeil, J.A. 2019. Blanding's Turtle records, 2019. Mersey Tobeatic Research Institute.
190	McNeil, J.A. 2019. Eastern Painted Turtle trapping records, 2019. Mersey Tobeatic Research Institute.
187	Manthorne, A. 2014. MaritimesSwiftwatch Project database 2013-2014. Bird Studies Canada, Sackville NB, 326 recs.
184	Blaney, C.S. 2020. Sean Blaney 2020 field data. Atlantic Canada Conservation Data Centre, 4407 records.
183	East Coast Aquatics Inc. 2023. Year 3 (2022) Wood Turtle Monitoring Hwy 104 Sutherlands River To Antigonish.
182	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2003.
181	Riley, J. 2020. Digby County lichen observations. Pers. comm. to J.L. Churchill.
175	Brunelle, P.-M. (compiler). 2009. ADIP/MDDS Odonata Database: data to 2006 inclusive. Atlantic Dragonfly Inventory Program (ADIP), 24200 recs.
175	Staicer, Cindy. 2023. 2022 SAR Bird field occurrences from the Landbirds at Risk Project, NS. Dalhousie University, 446 records.
169	Stantec. 2014. Energy East Pipeline Corridor Species Occurrence Data. Stantec Inc., 4934 records.
168	Munro, Marian K. Tracked lichen specimens, Nova Scotia Provincial Museum of Natural History Herbarium. Atlantic Canada Conservation Data Centre. 2019.
159	Stewart, J.I. 2010. Peregrine Falcon Surveys in New Brunswick, 2002-09. Canadian Wildlife Service, Sackville, 58 recs.
155	Belliveau, A.G. 2014. Plant Records from Southern and Central Nova Scotia. Atlantic Canada Conservation Data Centre, 919 recs.
154	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.
153	McNeil, J.A. 2014. Blandings Turtle (Emydoidea blandingii) and Snapping Turtle (Chelydra serpentina) sightings, 2014. Mersey Tobeatic Research Institute.
151	Riley, J. 2019. Digby County lichen observations. Pers. comm. to J.L. Churchill, 50 recs.
147	McNeil, J.A. 2011. Ribbonsnake (Thamophis sauritus) sightings, 2010. Parks Canada, 148 recs of 70+ individuals.
138	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2013.
137	Nature Trust of New Brunswick. 2021. Nature Trust of New Brunswick site inventory data submitted in April 2021. Nature Trust of New Brunswick, 2189 records.

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136	Wallace, S. 2020. Stewardship Department species occurrence data on NTNB preserves. Nature Trust of New Brunswick.
133	Parks Canada. 2010. Specimens in or near National Parks in Atlantic Canada. Canadian National Museum, 3925 recs.
132	Amirault, D.L. & Stewart, J. 2007. Piping Plover Database 1894-2006. Canadian Wildlife Service, Sackville, 3344 recs, 1228 new.
130	Chapman-Lam, C.J. 2022. Atlantic Canada Conservation Data Centre 2021 botanical fieldwork. Atlantic Canada Conservation Data Centre, 15099 recs.
130	Keddy, C.J. 1989. Habitat securement for redroot, golden crest and Long's bulrush in Ponhook Lake, NS. World Wildlife Fund (Canada), 131 recs.
126	Staicer, Cindy. 2022. 2021 Landbird Species at Risk observations. Dalhousie University.
124	Hagerman, Christianne. 2022. Wisqoq and Eastern White Cedar field work. E.C. Smith Herbarium, Acadia University.
122	Benjamin, L.K. 2009. NSDNR Fieldwork & Consultants Reports. Nova Scotia Dept Natural Resources, 143 recs.
122	McNeil, Jeffie. 2022. Ribbonsnake records, 2021. Mersey Tobeatic Research Institute.
121	McNeil, J.A. 2020. Snapping Turtle and Eastern Painted Turtle records, 2020. Mersey Tobeatic Research Institute.
111	Berrigan, L. 2019. Maritimes Marsh Monitoring Project 2013, 2014, 2016, 2017, and 2018 data. Bird Studies Canada, Sackville, NB.
110	Wilhelm, S.I. et al. 2011. Colonial Waterbird Database. Canadian Wildlife Service, Sackville, 2698 sites, 9718 recs (8192 obs).
109	Clayden, S.R. 2007. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, download Mar. 2007, 6914 recs.
109	Mazerolle, D.M. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 13515 recs.
109	McNeil, J.A. 2020. Blanding's Turtle records, 2020. Mersey Tobeatic Research Institute.
103	e-Butterfly. 2019. Export of Maritimes records and photos. McFarland, K. (ed.) e-butterfly.org.
99	Gallop, John. 2023. Species at Risk and Species of Conservation Interest records. McCallum Environmental.
98	Sollows, M.C,. 2008. NBM Science Collections databases: mammals. New Brunswick Museum, Saint John NB, download Jan. 2008, 4983 recs.
96	Belliveau, A.G. & Churchill, J.L.; Anderson, F.; Brooks, F. 2023. Lichen Inventory of Blue Rocks, NS. E.C. Smith Herbarium.
96	Churchill, J.L. 2021. Atlantic Canada Conservation Data Centre Fieldwork 2021. Atlantic Canada Conservation Data Centre.
95	Breen, A. 2019. 2019 Atlantic Whitefish observations. Coastal Action, 95 recs.
95	Epworth, W. 2016. Species at Risk records, 2014-2016. Fort Folly Habitat Recovery Program, 38 recs.
95	McNeil, J.A. 2019. Eastern Painted Turtle trapping records, 2017. Mersey Tobeatic Research Institute.
94	Belliveau, A. 2013. Rare species records from Nova Scotia. Mersey Tobeatic Research Institute, 296 records. 296 recs.
94	NatureServe Canada. 2019. iNaturalist Maritimes Butterfly Records. iNaturalist.org and iNaturalist.ca.
92	Richardson, Leif. 2018. Maritimes Bombus records from various sources. Richardson, Leif.
90	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.
86	Neily, T.H. 2017. Nova Scotia lichen records. Mersey Tobeatic Research Institute.
80	Hubley, Nicole. 2022. Monarch (Danaus plexippus) records submitted to MTRI from the 2021 field season. Mersey Tobeatic Research Institute.
80	Porter, Caitlin. 2021. Field data for 2020 in various locations across the Maritimes. Atlantic Canada Conservation Data Centre, 3977 records.
79	Herman, T.B. & Power, T.D., Eaton, B. 1995. Population status of Blanding's Turtle (Emydoidea blandingii) in Nova Scotia. Can. Field-Nat., 109: 182-191. 79 recs.
79	McMullin, R.T. 2022. Maritimes lichen records. Canadian Museum of Nature.
78	e-Butterfly. 2016. Export of Maritimes records and photos. Maxim Larrivee, Sambo Zhang (ed.) e-butterfly.org.
76	iNaturalist. 2020. iNaturalist butterfly records selected for the Maritimes Butterfly Atlas. iNaturalist.
76	Parks Canada. 2021. Species at Risk observations from 2019-2020 in Kejimkujik National Park and Historic Site. Parks Canada, 76 records.
75	Benjamin, L.K. (compiler). 2001. Significant Habitat & Species Database. Nova Scotia Dept of Natural Resources, 15 spp, 224 recs.
74	Brazner, John; MacKinnon, Frances. 2020. Relative conservation value of Nova Scotia's forests: forested wetlands as avian biodiversity hotspots. Canadian Journal of Forest Research, 50(12): 1307-1322. dx.doi.org/10.1139/cjfr-2020-0101.
71	Blaney, C.S. 2019. Sean Blaney 2019 field data. Atlantic Canada Conservation Data Centre, 4407 records.
70	Birds Canada. 2022. Maritimes Swiftwatch project data for 2022. Pers. comm., 155 records.
70	McNeil, J.A. 2019. Snapping Turtle records, 2019. Mersey Tobeatic Research Institute.
70	Roland, A.E. & Smith, E.C. 1969. The Flora of Nova Scotia, 1st Ed. Nova Scotia Museum, Halifax, 743pp.
68	McNeil, J.A. 2017. Updates to Blanding's Turtle database, 1984-2014. Mersey Tobeatic Research Institute.
65	Cameron, R.P. 2009. Cyanolichen database. Nova Scotia Environment & Labour, 1724 recs.
64	Klymko, John. 2022. Atlantic Canada Conservation Data Centre zoological fieldwork 2021. Atlantic Canada Conservation Data Centre.
64	Zinck, M. & Roland, A.E. 1998. Roland's Flora of Nova Scotia. Nova Scotia Museum, 3rd ed., rev. M. Zinck; 2 Vol., 1297 pp.
63	McNeil, J.A. 2013. Ribbonsnake (Thamnophis sauritus) sightings, 2012 . Parks Canada, 63 records of 26+ individuals.
63	Roland, A.E. 1976. The Coastal Plain Flora of Kejimkujik National Park. Parks Canada Report, 238 pp.
62	Blaney, C.S; Korol, J.B.; Crowell, I. 2023. 2022 AC CDC Botany program field data. Atlantic Canada Conservation Data Centre, 5293 records.
61	Blaney, C.S. 2017. Atlantic Canada Conservation Data Centre Fieldwork 2017. Atlantic Canada Conservation Data Centre.
60	Benedict, B. Connell Herbarium Specimens (Data) . University New Brunswick, Fredericton. 2003.
60	Bryson, I.C. 2020. Nova Scotia flora and lichen observations 2020. Nova Scotia Environment, 139 recs.
60	McLean, K. 2020. Species occurrence records from Clean Annapolis River Project fieldwork in 2020. Clean Annapolis River Project, 206 records.
59	Staicer, C. & Bliss, S.; Achenbach, L. 2017. Occurrences of tracked breeding birds in forested wetlands. , 303 records.
56	Bagnell, B.A. 2001. New Brunswick Bryophyte Occurrences. B&B Botanical, Sussex, 478 recs.
54	Blaney, C.S. 2000. Fieldwork 2000. Atlantic Canada Conservation Data Centre. Sackville NB, 1265 recs.
54	LaPaix, R.W.; Crowell, M.J.; MacDonald, M.; Neily, T.D.; Quinn, G. 2017. Stantec Nova Scotia rare plant records, 2012-2016. Stantec Consulting.
54	Layberry, R.A. & Hall, P.W., LaFontaine, J.D. 1998. The Butterflies of Canada. University of Toronto Press. 280 pp+plates.
53	Churchill, J.L. 2020. Atlantic Canada Conservation Data Centre Fieldwork 2020. Atlantic Canada Conservation Data Centre, 1083 recs.

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53	Neily, T.H. & Pepper, C.; Toms, B. 2018. Nova Scotia lichen database [as of 2018-03]. Mersey Tobeatic Research Institute.
52	Belliveau, A.G., Churchill, J.L. 2019. Compilation of flora and fauna observation records from Isle Haute, Nova Scotia. Acadia University; Atlantic Canada Conservation Data Centre, 522 recs.
52	Cowie, F. 2007. Electrofishing Population Estimates 1979-98. Canadian Rivers Institute, 2698 recs.
52	Richardson, D., Anderson, F., Cameron, R, McMullin, T., Clayden, S. 2014. Field Work Report on Black Foam Lichen (Anzia colpodes). COSEWIC.
50	Neily, T.H. 2019. Tom Neily NS Bryophyte records (2009-2013). T.H. Neily, Atlantic Canada Conservation Data Centre, 1029 specimen records.
47	Feltham, Carter. 2022. Monarch (Danaus plexippus) and Milkweed MTRI records from the 2022 Field Season. Mersey Tobeatic Research Institute.
47	Neily, T.H. & Pepper, C.; Toms, B. 2020. Nova Scotia lichen database [as of 2020-03-18]. Mersey Tobeatic Research Institute.
46	Blaney, C.S. 2018. Atlantic Canada Conservation Data Centre Fieldwork 2018. Atlantic Canada Conservation Data Centre.
45	Bayne, D.M. 2007. Atlantic Coastal Plain Flora record, 2004-06. Nova Scotia Nature Trust. Pers. comm. to C.S. Blaney, 57 recs.
45	MacDonald, E.C. 2018. Piping Plover nest records from 2010-2017. Canadian Wildlife Service.
44	McLean, K. 2019. Wood Turtle observations . Clean Annapolis River Project.
40	Cameron, E. 2007. Canadian Gypsum Co. survey 2005-07. Dillon Consulting Ltd, 40 recs.
38	Mazerolle, D.M. 2020. Atlantic Canada Conservation Data Centre botanical fieldwork 2019. Atlantic Canada Conservation Data Centre.
38	Sollows, M.C. 2009. NBM Science Collections databases: molluscs. New Brunswick Museum, Saint John NB, download Jan. 2009, 6951 recs (2957 in Atlantic Canada).
37	Newell, R.E. 2019. Crocanthemum canadense records compiled for provincial status report. pers. comm. from Ruth Newell to AC CDC.
36	McNeil, J.A. 2017. Eastern Ribbonsnake (Thamnophis sauritus) sightings, 2017. Mersey Tobeatic Research Institute, 36 recs.
36	Tsehtik, M.; Leblanc, M.; Creaser, T. 2020. Coastal Action: 2020 Species at Risk Data. Coastal Action, 40 records.
35	Benjamin, L.K. 2012. NSDNR fieldwork & consultant reports 2008-2012. Nova Scotia Dept Natural Resources, 196 recs.
35	Blaney, C.S.; Spicer, C.D.; Popma, T.M.; Hanel, C. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 2252 recs.
35	East Coast Aquatics Inc. 2021. Species at Risk records from Spicer North Mountain Quarry Expansion Environmental Assessment. East Coast Aquatics, 44 records.
35	Roland, A.E. 1980. Checklist of Vascular Plants of Kejimkujik National Park in Lichens, Liverworts, Mosses and Flowering Plants of Kejimkujik National Park. Roland, A.E. (ed.) Parks Canada Report, pp. 52-140, 160 pp.
34	Blaney, C.S.; Spicer, C.D.; Rothfels, C. 2004. Fieldwork 2004. Atlantic Canada Conservation Data Centre. Sackville NB, 1343 recs.
33	LaPaix, Rich. 2022. Rare species observations, 2018-2022. Nova Scotia Nature Trust.
33	McNeil, J.A. 2018. Wood Turtle records, 2018. Mersey Tobeatic Research Institute, 68 recs.
33	Mersey Tobetic Research Institute. 2021. 2020 Monarch records from the MTRI monitoring program. Mersey Tobetic Research Institute, 72 records.
32	Atlantic Canada Conservation Data Centre. 2020. Cape LaHave Island observations from August 2020. Atlantic Canada Conservation Data Centre, 605 records.
32	Klymko, J.J.D. 2018. 2017 field data. Atlantic Canada Conservation Data Centre.
31	Blaney, C.S.; Spicer, C.D. 2001. Fieldwork 2001. Atlantic Canada Conservation Data Centre. Sackville NB, 981 recs.
31	Jobin, C. & Clow, A., Van Dijk, J. 2019. Eastern Waterfan data, Mount Allison Fundy Field Camp 2019. Chapman, C.J. (ed.) Fundy National Park and Mount Allison University, 31 recs.
30	Amirault, D.L. & McKnight, J. 2003. Piping Plover Database 1991-2003. Canadian Wildlife Service, Sackville, unpublished data. 7 recs.
30	Frittaion, C. 2012. NSNT 2012 Field Observations. Nova Scotia Nature Trust, Pers comm. to S. Blaney Feb. 7, 34 recs.
30	Phinney, L. 2019. Little Brown Myotis maternal colony counts and birdSAR, 2019. Mersey Tobeatic Research Institute.
28	Blaney, C.S. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 1042 recs.
27	McAlpine, D.F. New Brunswick Museum bee specimens. New Brunswick Museum. 2013.
26	Benedict, B. Connell Herbarium Specimen Database Download 2004. Connell Memorial Herbarium, University of New Brunswick. 2004.
26	Erskine, A.J. 1999. Maritime Nest Records Scheme (MNRS) 1937-1999. Canadian Wildlife Service, Sackville, 313 recs.
26	McLean, K. 2020. Wood Turtle observations . Clean Annapolis River Project.
25	Burnie, B. 2013. 2013 Scirpus longii field data. Mount Saint Vincent University, 51 recs.
25	Honeyman, K. 2019. Unique Areas Database, 2018. J.D. Irving Ltd.
25	Kennedy, Joseph. 2010. New Brunswick Peregrine records, 2009. New Brunswick Dept Natural Resources, 19 recs (14 active).
25	McNeil, J.A. 2019. Snapping Turtle records, 2017. Mersey Tobeatic Research Institute.
24	Bayne, D.M., Cameron, R.C. 2014. 2014 Lichen records near Little Bon Mature Lake, Queens NS. NS Department of Natural Resources.
24	Belliveau, A.G. 2021. New Black ash site records near Kentville, NS. Acadia University, 47 records.
24	Broders, H.G. 2006. Unpublished data. , 24 recs.
24	Patrick, A.; Horne, D.; Noseworthy, J. et. al. 2017. Field data for Nova Scotia and New Brunswick, 2015 and 2017. Nature Conservancy of Canada.
24	Speers, L. 2008. Butterflies of Canada database: New Brunswick 1897-1999. Agriculture & Agri-Food Canada, Biological Resources Program, Ottawa, 2048 recs.
23	Haughian, Sean. 2021. Update to lichen data from 2017-2021. Nova Scotia Museum.
23	Hinds, H.R. 1986. Notes on New Brunswick plant collections. Connell Memorial Herbarium, unpubl, 739 recs.
23	McLean, K. 2019. Species At Risk observations. Clean Annapolis River Project.
22	Breen, A. 2018. 2018 Atlantic Whitefish observations. Coastal Action.
22	Klymko, J.J.D.; Robinson, S.L. 2012. 2012 field data. Atlantic Canada Conservation Data Centre, 447 recs.
22	Nelly, T.H. 2006. Cypripedium arietinum in Hants Co. Pers. comm. to C.S. Blaney. 22 recs, 22 recs.
21	Envirosphere Consultants Ltd., Strum. 2023. SAR records from three Environmental Assessments in Nova Scotia. Envirosphere Consultants Ltd., Strum, 48 records.
21	MacKinnon, D.S. & O'Brien, M.K.H.; Cameron, R.P. 2002. Fieldwork 2000. Dept of Environment & Labour, Protected Areas Branch, 252 recs.
21	Riley, J. 2023. Rare and at Risk lichens and plants near Goldsmith Lake, NS. Pers. comm. to J.L. Churchill.
20	MacDonald, E.C. 2018. CWS Piping Plover Census, 2010-2017. Canadian Wildlife Service, 672 recs.
20	O'Grady, Sally. 2010. Water Pennywort in Kejimkujik National Park, 2010. Parks Canada, 20 shapefiles.
20	Richardson, D., Anderson, F., Cameron, R, Pepper, C., Clayden, S. 2015. Field Work Report on the Wrinkled Shingle lichen (Pannaria lurida). COSEWIC.

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19	Ferguson, D.C. 1954. The Lepidoptera of Nova Scotia. Part I, macrolepidoptera. Proceedings of the Nova Scotian Institute of Science, 23(3), 161-375.
19	Neily, T.H. & Pepper, C.; Toms, B. 2020. Nova Scotia lichen database [as of 2020-05-25]. Mersey Tobeatic Research Institute, 668 recs.
19	NS DNR. 2017. Black Ash records from NS DNR Permanent Sample Plots (PSPs), 1965-2016. NS Dept of Natural Resources.
19	Porter, C.J.M. 2014. Field work data 2007-2014. Nova Scotia Nature Trust, 96 recs.
19	Thomas, A.W. 1996. A preliminary atlas of the butterflies of New Brunswick. New Brunswick Museum.
18	Basquill, S.; Sam, D. 2019. Crocanthemum canadense observations near Greenwood, NS, 2015-2019. pers. commun. from Nova Scotia Department of Lands and Forestry to AC CDC, 18 recs.
18	Basquill, S.P. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre, Sackville NB, 69 recs.
18	Basquill, S.P., Porter, C. 2019. Bryophyte and lichen specimens submitted to the E.C. Smith Herbarium. NS Department of Lands and Forestry.
18	Benjamin, L.K. 2011. NSDNR fieldwork & consultant reports 1997, 2009-10. Nova Scotia Dept Natural Resources, 85 recs.
18	Chapman, C.J. 2018. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. Atlantic Canada Conservation Data Centre, 11171 recs.
18	Epworth, W. 2012. Species at Risk records, 2009-11. Fort Folly Habitat Recovery Program, 162 recs.
17	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.
17	Haughian, S.R. 2018. Description of Fuscopannaria leucosticta field work in 2017. New Brunswick Museum, 314 recs.
17	Manthorne, A. 2019. Incidental aerial insectivore observations. Birds Canada.
17	Nature Conservancy of Canada. 2022. NCC Field data for Nova Scotia. Nature Conservancy of Canada.
16	Holder, M. 2003. Assessment and update status report on the Eastern Lilaeopsis (Lilaeopsis chinensis) in Canada. Committee on the Status of Endangered Wildlife in Canada, 16 recs.
16	Hunsinger, J. 2021. Species at Risk records from Medway Community Forest Cooperative monitoring plots and baited game cameras, 2019-2020. Medway Community Forest Cooperative, 16 records.
16	Klymko, J.J.D.; Robinson, S.L. 2014. 2013 field data. Atlantic Canada Conservation Data Centre.
16	Nussey, Pat & NCC staff. 2019. AEI tracked species records, 2016-2019. Chapman, C.J. (ed.) Atlantic Canada Conservation Data Centre, 333.
16	Wallace, Shaylyn. 2023. Painted Turtle and Snapping Turtle records since 2015. New Brunswick Department of Energy and Resource Development.
15	Basquill, S.P. 2011 vascular plant field data. Nova Scotia Department of Natural Resources, 37 recs.
15	Cameron, R.P. 2018. Degelia plumbea records. Nova Scotia Environment.
15	Cowie, Faye. 2007. Surveyed Lakes in New Brunswick. Canadian Rivers Institute, 781 recs.
15	Klymko, J.J.D. 2012. Odonata specimens & observations, 2010. Atlantic Canada Conservation Data Centre, 425 recs.
15	Oldham, M.J. 2000. Oldham database records from Maritime provinces. Oldham, M.J; ONHIC, 487 recs.
14	Blaney, C.S.; Mazerolle, D.M. 2011. Fieldwork 2011. Atlantic Canada Conservation Data Centre. Sackville NB.
14	McNeil, J.A. 2018. Snapping Turtle records, 2018. Mersey Tobeatic Research Institute.
14	Neily, T.H. 2013. Email communication to Sean Blaney regarding Listera australis observations made from 2007 to 2011 in Nova Scotia. , 50.
14	New Brunswick Department of Natural Resources and Energy Development. 2023. Wood turtle records from 2016-2021. New Brunswick Department of Natural Resources and Energy Development, 637 records.
14	Pepper, C. 2013. 2013 rare bird and plant observations in Nova Scotia. , 181 records.
13	Blaney, C.S.; Spicer, C.D.; Mazerolle, D.M. 2005. Fieldwork 2005. Atlantic Canada Conservation Data Centre. Sackville NB, 2333 recs.
13	G.Proulx, R. Newell, A. Mills, D. Bayne. 2018. Selaginella rupestris records, Digby Co. Nova Scotia Lands and Forestry, 1387601 recs.
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13	Nova Scotia Nature Trust. 2014. Ladyslipper records from Saint Croix Nova Scotia, JLC Ed. Nova Scotia Nature Trust.
13	Wilhelm, S.I. et al. 2019. Colonial Waterbird Database. Canadian Wildlife Service.
12	Askanas, H. 2016. New Brunswick Wood Turtle Database. New Brunswick Department of Energy and Resource Development.
12	Basquill, S.P. 2012. 2012 rare vascular plant field data. Nova Scotia Department of Natural Resources, 37 recs.
12	Caissie, A. Herbarium Records. Fundy National Park, Alma NB. 1961-1993.
12	Hill, N.M. 2021. Observation of Carex haydenii and black ash near Marshy Hope and Ponhook Lake. pers. comm.
12	McAlpine, D.F. 1998. NBM Science Collections: Wood Turtle records. New Brunswick Museum, Saint John NB, 329 recs.
12	Sabine, D.L. Bombus terricola specimens in Dwayne Sabine's personal collection. pers. comm. 2022.
12	Sollows, M.C. 2008. NBM Science Collections databases: herpetiles. New Brunswick Museum, Saint John NB, download Jan. 2008, 8636 recs.
12	Toms, Brad. 2011. Species at Risk data from 2011 field surveys. Mersey Tobeatic Research Institute, 17 recs.
12	Tranquilla, L. 2015. Maritimes Marsh Monitoring Project 2015 data. Bird Studies Canada, Sackville NB, 5062 recs.
12	Wissink, R. 2000. Rare Plants of Fundy: maps. Parks Canada, 20 recs.
11	Adams, J. & Herman, T.B. 1998. Thesis, Unpublished map of C. insculpta sightings. Acadia University, Wolfville NS, 88 recs.
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11	Bryson, I. 2020. Nova Scotia and Newfoundland rare species observations, 2018-2020. Nova Scotia Environment.
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11	Hall, R.A. 2001. S.. NS Freshwater Mussel Fieldwork. Nova Scotia Dept Natural Resources, 178 recs.
11	Hall, R.A. 2003. NS Freshwater Mussel Fieldwork. Nova Scotia Dept Natural Resources, 189 recs.
11	Holder, M.L.; Kingsley, A.L. 2000. Kinglsey and Holder observations from 2000 field work.
11	Kennedy, Bob. 2021. Results of Oct 15 & 16 Field Trip. Nova Scotia Wild Flora Society.
11	LaPaix, R.W.; Crowell, M.J.; MacDonald, M. 2011. Stantec rare plant records, 2010-11. Stantec Consulting, 334 recs.
11	Neily, T.H. & Pepper, C.; Toms, B. 2013. Nova Scotia lichen location database. Mersey Tobeatic Research Institute, 1301 records.

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11	Ogden, K. Nova Scotia Museum butterfly specimen database. Nova Scotia Museum. 2017.
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10	Benjamin, L.K. 2009. Boreal Felt Lichen, Mountain Avens, Orchid and other recent records. Nova Scotia Dept Natural Resources, 105 recs.
10	Bredin, K.A. 2001. WTF Project: Freshwater Mussel Fieldwork in Freshwater Species data. Atlantic Canada Conservation Data Centere, 101 recs.
10	Nature Trust of New Brunswick. 2022. Nature Trust of New Brunswick 2022 staff and volunteer observations of species occurence data. Nature Trust of New Brunswick.
10	Neily, T. H. 2018. Lichen and Bryophyte records, AEI 2017-2018. Tom Neily; Atlantic Canada Conservation Data Centre.
10	Parker, M.S.R. 2011. Hampton Wind Farm 2010: significant floral/faunal observations. , 13 recs.
10	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.
9	Blaxley, Megan; Vinson, Neil. 2020. Peltigera hydrothyria records from a tributary of Lake Brook, Fundy National Park. Chapman-Lam, Colin J. (ed.) Fundy National Park, 9.
9	Brunelle, P.-M. (compiler). 2010. ADIP/MDDS Odonata Database: NB, NS Update 1900-09. Atlantic Dragonfly Inventory Program (ADIP), 935 recs.
9	Edsall, J. 2007. Personal Butterfly Collection: specimens collected in the Canadian Maritimes, 1961-2007. J. Edsall, unpubl. report, 137 recs.
9	Hinds, H.R. 1999. Connell Herbarium Database. University New Brunswick, Fredericton, 131 recs.
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9	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2014.
9	Pepper, C. 2021. Rare bird, plant and mammal observations in Nova Scotia, 2017-2021.
9	Sabine, D.L. 2005. 2001 Freshwater Mussel Surveys. New Brunswick Dept of Natural Resources & Energy, 590 recs.
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8	Cameron, R.P. 2009. Nova Scotia nonvascular plant observations, 1995-2007. Nova Scotia Dept Natural Resources, 27 recs.
8	Canadian National Collection of Insects Arachnids, and Nematodes Bombus specimen database export. Government of Canada. 2022.
8	Goltz, J.P. 2012. Field Notes, 1989-2005. , 1091 recs.
8	Hinds, H.R. 1992. Rare Vascular Plants of Fundy National Park. , 10 recs.
8	King, Katie; Jean, Samuel. 2021. Black ash observations near Booklyn, NS. E.C. Smith Herbarium.
8	Klymko, J. 2019. Atlantic Canada Conservation Data Centre zoological fieldwork 2018. Atlantic Canada Conservation Data Centre.
8	McAlpine, D.F. 1998. NBM Science Collections databases to 1998. New Brunswick Museum, Saint John NB, 241 recs.
8	Voscort, L. Bombus terricola specimens collected during MSc research in southwestern Nova Scotia. Acadia University. 2022.
8	Wissink, R. 2006. Fundy National Park Digital Database. Parks Canada, 41 recs.
7	Blaney, C.S.; Mazerolle, D.M.; Klymko, J; Spicer, C.D. 2006. Fieldwork 2006. Atlantic Canada Conservation Data Centre. Sackville NB, 8399 recs.
7	Boyne, A.W. & Grecian, V.D. 1999. Tern Surveys. Canadian Wildlife Service, Sackville, unpublished data. 23 recs.
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7	Kennedy, Joseph. 2010. New Brunswick Peregrine records, 2010. New Brunswick Dept Natural Resources, 16 recs (11 active).
7	Ogden, J. NS DNR Butterfly Collection Dataset. Nova Scotia Department of Natural Resources. 2014.
7	Sollows, M.C. Export of New Brunswick Museum butterfly records for the Maritimes provinces. New Brunswick Museum. 2016.
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6	Brazner, J.; Hill, N. 2018. Plant observations along the Cornwallis River, Nova Scotia. Nova Scotia Department of Lands and Forestry.
6	Bredin, K.A. 2002. NS Freshwater Mussel Fieldwork. Atlantic Canada Conservation Data Centere, 30 recs.
6	Cameron, R.P. 2013. 2013 rare species field data. Nova Scotia Department of Environment, 71 recs.
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6	Matthew Smith. 2010. Field trip report from Avon Caving Club outlining the discovery of Cyrpipedium arietinum and Hepatica nobilis populations. Public Works and Government Services Canada.
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6	Nova Scotia Nature Trust. 2022. Ram's Head Lady Slipper observations from 2015 and 2019. , 6 records.
6	Patrick, Allison. 2021. Animal and plant records from NCC properties from 2019 and 2020. Nature Conservancy Canada.
6	Popma, T.M. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 113 recs.
6	Riley, Johnathan. 2023. Wisqoq north of Kejimkujik National Park. Pers. comm. Municipality of the District of Digby, 6 records.
6	Rock, J. 2020. Atlantic Canada Piping Plover field surveys: Nesting pairs by beach, 2018-2020. Environment and Climate Change Canada - Canadian Wildlife Service, 216 records.
6	Speers, L. 2001. Butterflies of Canada database. Agriculture & Agri-Food Canada, Biological Resources Program, Ottawa, 190 recs.
6	Toms, Brad. 2022. Non-Lichen Observations from Lichen SMP and NCC Property Searches. Mersey Tobeatic Research Institute.
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5	Christie, D.S. 2000. Christmas Bird Count Data, 1997-2000. Nature NB, 54 recs.
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5	Klymko, J. Butterfly records at the Nova Scotia Museum not yet accessioned by the museum. Atlantic Canada Conservation Data Centre. 2017.
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5	McKendry, Karen. 2016. Rare species observations, 2016. Nova Scotia Nature Trust, 19 recs.
5	Neily, T.H. Tom Neily NS Sphagnum records (2009-2014). T.H. Neily, Atlantic Canada Conservation Data Centre. 2019.
5	Pohl, G.P. Specimen data from Northern Forest Research Centre. Northern Forest Research Centre. 2022.

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4	Anon. Dataset of butterfly records for the Maritime provinces. Museum of Comparative Zoology, Harvard University. 2017.
4	Cameron, R.P. 2009. Erioderma pedicellatum database, 1979-2008. Dept Environment & Labour, 103 recs.
4	Cody, W.J. 2003. Nova Scotia specimens of Equisetum pratense at the DAO herbarium in Ottawa. , Pers. comm. to C.S. Blaney. 4 recs.
4	Edsall, J. 2001. Lepidopteran records in New Brunswick, 1997-99. , Pers. comm. to K.A. Bredin. 91 recs.
4	Forsythe, B. 2006. Cypripedium arietinum at Meadow Pond, Hants Co. Pers. comm. to C.S. Blaney. 4 recs, 4 recs.
4	Hennigar, Briana; Gow, Jonas. 2023. Bank Swallow Nesting Site in Waterville. The Jijuktu'kwejk Watershed Alliance.
4	Hughes, Cory. 2020. Atlantic Forestry Centre Coccinella transversoguttata collections. Canadian Forest Service, Atlantic Forestry Centre.
4	Klymko, J.J.D. 2011. Insect fieldwork & submissions, 2010. Atlantic Canada Conservation Data Centre. Sackville NB, 742 recs.
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4	NatureServe Canada. 2018. iNaturalist Butterfly Data Export . iNaturalist.org and iNaturalist.ca.
4	Newell, R. & Neily, T.; Toms, B.; Proulx, G. et al. 2011. NCC Properties Fieldwork in NS: August-September 2010. Nature Conservancy Canada, 106 recs.
4	Olsen, R. Herbarium Specimens. Nova Scotia Agricultural College, Truro. 2003.
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4	Powell, B.C. 1967. Female sexual cycles of Chrysemy spicta & Clemmys insculpta in Nova Scotia. Can. Field-Nat., 81:134-139. 26 recs.
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4	Toms, B. 2016. Email list of four GPS locations of Golden Crest (Lophiola aurea) from the previously documented site on Molega Lake, NS. Mersey Tobeatic Research Institute, 4 records.
3	Amiro, Peter G. 1998. Atlantic Salmon: Inner Bay of Fundy SFA 22 & part of SFA 23. Dept of Fisheries & Oceans, Atlantic Region, Science Stock Status Report D3-12. 4 recs.
3	Belliveau, A.G. E.C. Smith Herbarium Specimen Database 2019. E.C. Smith Herbarium, Acadia University. 2019.
3	Benedict, B. Connell Herbarium Specimens, Digital photos. University New Brunswick, Fredericton. 2005.
3	Bradford, R. 2004. Coregonus huntsmani locations. Dept of Fisheries & Oceans, Atlantic Region, Pers. comm. to K. Bredin. 4 recs.
3	Cameron, R.P. 2011. Lichen observations, 2011. Nova Scotia Environment & Labour, 731 recs.
3	Cameron, R.P. 2014. 2013-14 rare species field data. Nova Scotia Department of Environment, 35 recs.
3	Doubt, J. 2013. Email to Sean Blaney with Nova Scotia records of Fissidens exilis at Canadian Museum of Nature. pers. comm., 3 records.
3	Epworth, W. 2013. Species at Risk records, 2013. Fort Folly Habitat Recovery Program, 27 recs.
3	Hill, N.M., Myra, M. 2017. Email to Sean Blaney regarding rich intervale flora on Nictaux River. Fern Hill Institute, 3 records.
3	Hope, P. 2002. Field survey of Goodyera pubescens population at Kejimkujik National Park. Kejimkujik National Park, 3 recs.
3	LaPaix, R.W. 2014. Trans-Canada Energy East Pipeline Environmental Assessment, Records from 2013-14. Stantec Consulting, 5 recs.
3	Mersey Tobeatic Research Institute. 2022. Nova Scotia Bobolink observations. pers. comm. to J. Churchill.
3	Mills, Pamela. 2008. Clethra alnifolia at Mudflat Lake. Nova Scotia Dept of Natural Resources, Wildlife Div. Pers. comm. to D.M. Mazerolle, 4 recs.
3	Nash, Vicky. 2018. Hammond River Angling Association Wood Turtle observations. Hammond River Angling Association, 3 recs.
3	Newington, Nina. 2023. Anzia colpodes at Beal's Brook, NS. Pers. comm. to J. Churchill.
3	Nova Scotia Department of Lands and Forestry. 2018. Wood Turtle observations in, or near, the cornwallis River watershed. NS DLF, pers. comm. to AC CDC.
3	Plissner, J.H. & Haig, S.M. 1997. 1996 International piping plover census. US Geological Survey, Corvallis OR, 231 pp.
3	Riley, J. 2020. Digby County Pannaria lurida observations. Pers. comm. to J.L. Churchill.
3	Sabine, M. 2016. NB DNR staff incidental Black Ash observations. New Brunswick Department of Natural Resources.
3	Staicer, C. 2013. Personal communication concerning Hirundo rustica nesting in and around Kejimkujik NP, NS. Pers. comm.
3	Watts, Todd. 2021. Todd Watts rare species data 2021. Peskotomakuti First Nation at Skutik, 152 records.
3	White, S. 2019. Notable species sightings, 2018. East Coast Aquatics.
3	WIlliams, M. Cape Breton University Digital Herbarium. Cape Breton University Digital Herbarium. 2013.
2	Anon. 2017. Export of Maritimes Butterfly records. Global Biodiversity Information Facility (GBIF).
2	Bagnell, B.A. 2003. Update to New Brunswick Rare Bryophyte Occurrences. B&B Botanical, Sussex, 5 recs.
2	Basquill, S.P. 2018. Various specimens, NS DNR field work. NS Department of Natural Resources, 10.
2	Bateman, M.C. 2001. Coastal Waterfowl Surveys Database, 1965-2001. Canadian Wildlife Service, Sackville, 667 recs.
2	Belliveau, A.G. 2020. Email to Colin Chapman on new NS locations for Allium tricoccum. Chapman, C.J. (ed.) Acadia University.
2	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2000.
2	Bishop, G. 2012. Field data from September 2012 Anticosti Aster collection trip. , 135 rec.
2	Blaney, C.S. 1999. Fieldwork 1999. Atlantic Canada Conservation Data Centre. Sackville NB, 292 recs.
2	Brunelle, P.-M. 2009. NS Power odonata records for Mersey, Tusket & Sissiboo systems. Nova Scotia Power, 218 recs.
2	Cameron, R.P. 2012. Additional rare plant records, 2009. , 7 recs.
2	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.
2	Clayden, S.R. 2020. Email to Sean Blaney regarding Pilophorus cereus and P. fibula at Fidele Lake area, Charlotte County, NB. pers. comm., 2 records.
2	Emma Vost. 2022. Bank swallow colony and broad-winged hawk sightings in Bridgetown, NS. Personal communication, 4.
2	Gilhen, J., Jones, A., McNeil, J., Tanner, A.W. 2012. A Significant Range Extension for the Eastern Ribbonsnake, Thamnophis sauritus, in Nova Scotia, Canada. The Canadian Field-Naturalist, 126(3): 231-233.
2	Goltz, J.P. 2001. Botany Ramblings April 29-June 30, 2001. N.B. Naturalist, 28 (2): 51-2. 8 recs.
2	Hicklin, P.W. 1995. The Maritime Shorebird Survey Newsletter. Calidris, No. 3. 6 recs.
2	Hill, N.M. 2013. email communications to Sean Blaney and David Mazerolle regarding the discovery of Listera australis populations at Black River Lake and Middlewood. , 2.
2	Hill, N.M. 2019. Observation of Crocanthemum canadense near Auburn, Annapolis Co. NS on May 29, 2019. Fern Hill Institute, 2 recs.
2	Hinds, H.R. 2000. Rare plants of Fundy in Rare Plants of Fundy: maps. Wissink, R. (ed.) Parks Canada, 2 recs.

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2	Kennedy, B. & Cron, C.; Patriquin, D. 2018. Email to Sean Blaney on observations of Trichostema dichotomum at Shingle Lake, Nova Scotia. , 2 records.
2	Klymko, J.J.D. 2012. Insect field work & submissions. Atlantic Canada Conservation Data Centre, 852 recs.
2	Lock, A.R., Brown, R.G.B. & Gerriets, S.H. 1994. Gazetteer of Marine Birds in Atlantic Canada. Canadian Wildlife Service, Atlantic Region, 137 pp.
2	Manning, I. 2020. Peregrine Falcon nest site observations. pers. comm. to J. Churchill.
2	Marshall, L. 1998. Atlantic Salmon: Southwest New Brunswick outer-Fundy SFA 23. Dept of Fisheries & Oceans, Atlantic Region, Science. Stock Status Report D3-13. 6 recs.
2	Mazerolle, David. 2021. Botanical fieldwork 2019-20200. Parks Canada.
2	Mills, P. 2016. Email communication to S. Blaney, re: Scirpus longii at Upper Great Brook, Queens Co. NS. NS DNR, 2 recs.
2	Misc. rare species records gathered by NSDNR staff or communicated to NSDNR and forwared to ACCDC
2	Munro, M. 2003. Caulophyllum thalictroides & Carex hirtifolia at Herbert River, Brooklyn, NS. , Pers. comm. to C.S. Blaney. 2 recs.
2	Munro, M. 2003. Dirca palustris & Hepatica nobilis var. obtusa at Cogmagun River, NS. , Pers. comm. to C.S. Blaney . 2 recs.
2	NatureServe Canada. 2018. iNaturalist Maritimes Butterfly Records. iNaturalist.org and iNaturalist.ca.
2	Neily, T.H. & Pepper, C.; Toms, B. 2015. Nova Scotia lichen location database [as of 2015-02-15]. Mersey Tobeatic Research Institute, 1691 records.
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2	Newell, R.E. 2006. Rare plant observations in Digby Neck. Pers. comm. to S. Blaney, 6 recs.
2	Perrin, J., Russel, J. 1912. Catalogue of Butterflies and Moths, Mostly Collected in the Neighborhood of Halifax and Digby, Nova Scotia. Proceedings and Transactions of the Nova Scotian Institute of Science, 12(3), 258-290.
2	Phillips, B. 2017. Emails to John Klymko regarding Eastern Waterfan (Peltigera hydrothyria) occurrences in Fundy National Park. Fundy Biosphere Reserve, 3 recs.
2	Porter, Caitlin. 2020. Observations for 26 EcoGifts sites in southwest New Brunswick. Atlantic Canada Conservation Data Centre, 1073 records.
2	Porter, K. 2013. 2013 rare and non-rare vascular plant field data. St. Mary's University, 57 recs.
2	Proulx, V.D. 2002. Selaginella rupestris sight record at Centreville, Nova Scotia. Virginia D. Proulx collection, 2 recs.
2	Robinson, S.L. 2014. 2013 Field Data. Atlantic Canada Conservation Data Centre.
2	Scott, F.W. 1988. Status Report on the Southern Flying Squirrel (Glaucomys volans) in Canada. Committee on the Status of Endangered Wildlife in Canada, 2 recs.
2	Shafer, A.B.A., D.T. Stewart. 2006. A Disjunct Population of Sorex dispar (Long-Tailed Shrew) in Nova Scotia. Northeastern Naturalist, 13(4): 603-608.
2	Sheffield, C.S. 2004. The Rare Cleptoparasitic Bee Epeoloides pilosula (Hymenoptera: Apoidea: Apidae) Discovered in Nova Scotia, Canada, with Distributional Notes
2	Shortt, R. Connell Herbarium Black Ash specimens. University New Brunswick, Fredericton. 2019.
2	Vinson, Neil. 2020. Email - additional Peltigera hydrothyria records, Fundy National Park. Chapman-Lam, Colin J. (ed.) Fundy National Park, 2.
2	Webster, R.P. 2004. Lepidopteran Records for National Wildlife Areas in New Brunswick. Webster, 1101 recs.
2	Webster, R.P. Atlantic Forestry Centre Insect Collection, Maritimes butterfly records. Natural Resources Canada. 2014.
2	Wong, Sarah. 2020. Two Chimney Swift observation made by Sarah Wong. pers. comm. to Sean Blaney.
2	Wong, Sarah. 2021. Chimney Swift observations, Beverly Lake, NS. pers. comm.
1	Allan Smith. 2011. Cedar stand location at South Williamston. Abitibi Bowater, 1 Rec.
1	Amirault, D.L. 2003. 2003 Peregrine Falcon Survey. Canadian Wildlife Service, Sackville, unpublished data. 7 recs.
1	Amirault, D.L. 2005. 2005 Peregrine Falcon Survey. Canadian Wildlife Service, Sackville, unpublished data. 27 recs.
1	Amiro, Peter G. 1998. Atlantic Salmon: Southern Nova Scotia SFA 21. Dept of Fisheries & Oceans, Atlantic Region, Science. Stock Status Report D3-11. 1 rec.
1	Anderson, Frances. 2022. Heterodermia squamulosa record near Lunenburg, NS. pers. comm.
1	Arsenault, R. 2009. Goodyera pubescens record in Kejimkujik National Park. Pers. comm. to C.S. Blaney, 1 rec.
1	Austin-Smith, P. 2014. 2014 Common Nighthawk personal communication report, NS. NS Department of Natural Resources.
1	Basquill, S. P. 2008. Nova Scotia Dept of Natural Resources.
1	Basquill, S.P. 2004. C. americana and Sedum sp records, 2002. Pers. comm. to C.S. Blaney. 2 recs, 2 recs.
1	Basquill, S.P. 2012. 2012 Bryophyte specimen data. Nova Scotia Department of Natural Resources, 37 recs.
1	Basquill, S.P.; Quigley, E. 2006. New Minuartia groenlandica record for NS. Pers. comm. to C.S. Blaney, Oct 6, 1 rec.
1	Basset, I.J. & Crompton, C.W. 1978. The Genus Suaeda (Chenopodiaceae) in Canada. Canadian Journal of Botany, 56: 581-591.
1	Bayne, D.Z. 2014. 2014 rare species observations from southwest Nova Scotia. Nova Scotia Department of Natural Resources, 46 recs.
1	Belliveau, A. & Toms, B. 2012. Email regarding Lophiola aurea (Goldencrest) location on Molega Lake, NS. Mersey Tobeatic Research Institute, 3 records.
1	Benjamin, L.K. 2003. Cypripedium arietinum in Cogmagun River NS. Pers. comm. to S. Blaney, 1 rec.
1	Berg, L. 2020. Canada Warbler observations, Birch Lake, NS. pers. comm. to J. Churchill.
1	Bernard, Laurel. 2013. Email to Sean Blaney regarding Listera australis at Lake Rossignol. Nature Conservancy of Canada, 1.
1	Blaney, C.S. Miscellaneous specimens received by ACCDC (botany). Various persons. 2001-08.
1	Bredin, K.A. 2000. NB & NS Bog Project, fieldwork. Atlantic Canada Conservation Data Centre, Sackville, 1 rec.
1	Breen, A. 2017. 2017 Atlantic Whitefish observation. Coastal Action.
1	Brooks, Fiona. Erioderma mollissimum records in Lunenburg County, NS. Pers. comm., 2 records.
1	Brown, Constance Lynn. 2023. Wood turtle records for New Brunswick. University of New Brunswick. Pers. comm., 2 records.
1	Brunton, Dan. 2022. Record of Isoetes prototypus near Sand Lake, NS. pers. comm.
1	Cameron, R.P. 2017. 2017 rare species field data. Nova Scotia Environment, 64 recs.
1	Catling, P.M. 2001. Bog Elfin records in NB, 1939-95. Eastern Cereal & Oilseed Research Centre, Ottawa, Pers. comm. to K.A. Bredin. 11 recs.
1	Chapman-Lam, Colin J. 2022. Atlantic Canada Conservation Data Centre 2022 contracted project work. Atlantic Canada Conservation Data Centre.
1	Chapman, Cody. Unreported Species at Risk Records across Nova Scotia. Chapman, Cody, 5 records.

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1	Clayden, S.R. 2020. Email regarding Blue Felt Lichen (Pectenia plumbea) occurrences in New Brunswick, from Stephen Clayden to Sean Blaney. pers. comm., 2 records.
1	Clayden, S.R.; Goltz, J.P. 2018. Emails to Sean Blaney on occurrence of Polygonum douglasii at Big Bluff, Kings Co., New Brunswick. pers. comm., 1 record.
1	Cook, K. 2016. Wood Turtle record. Pers comm. to Nova Scotia Department of Lands and Forestry.
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APPENDIX D
WESP-AC RESULTS

Table 1: WESP-AC Results - Specific Function Scores for All Assessed Freshwater Wetlands

Wetland ID	1		2	
	Function Score	Benefits Score	Function Score	Benefits Score
Water Storage & Delay (WS)	4.13	4.04	6.38	5.54
Stream Flow Support (SFS)	1.66	2.70	0.00	0.00
Water Cooling (WC)	6.21	0.18	0.00	0.00
Sediment & Toxicant Retention & Stabilization (SR)	3.16	9.15	2.17	2.46
Phosphorus Retention (PR)	1.59	9.02	2.31	2.50
Nitrate Removal & Retention (NR)	2.61	10.00	10.00	4.67
Carbon Sequestration (CS)	3.27	N/A	1.43	N/A
Organic Nutrient Export (OE)	7.26	N/A	7.25	N/A
Anadromous Fish Habitat (FA)	0.00	0.00	0.00	0.00
Resident & Other Fish Habitat (FR)	0.00	0.00	0.00	0.00
Aquatic Invertebrate Habitat (INV)	4.15	4.76	6.99	0.54
Amphibian & Turtle Habitat (AM)	4.93	5.16	2.28	1.86
Waterbird Feeding Habitat (WBF)	6.97	5.00	0.00	0.00
Waterbird Nesting Habitat (WBN)	5.66	5.00	0.00	0.00
Songbird, Raptor, & Mammal Habitat (SBM)	8.89	10.00	5.60	5.00
Pollinator Habitat (POL)	8.54	3.33	5.21	3.33
Native Plant Habitat (PH)	3.49	6.05	1.08	4.18
Public Use & Recognition (PU)	N/A	1.82	N/A	1.29
Wetland Sensitivity (Sens)	N/A	10.00	N/A	10.00
Wetland Ecological Condition (EC)	N/A	7.10	N/A	6.52
Wetland Stressors (STR) (higher score means more)	N/A	7.18	N/A	7.43
Average Function/Benefit	4.27	5.29	2.96	2.88

NOTE: A score of 0 does not mean the function or benefit is absent from the wetland. It means only that this wetland has a capacity that is equal or less than the lowest-scoring one, for that function or benefit, from among all the NS calibration wetlands that were assessed previously.

Table 2: WESP-AC Results - Grouped Function Scores for All Assessed Freshwater Wetlands

WL ID	HYDROLOGIC Group		WATER Quality Group		AQUATIC SUPPORT Group		AQUATIC Habitat Group		TRANSITIONAL Habitat Group		WETLAND CONDITION		WETLAND RISK		WSS1
	Function	Benefits	Function	Benefits	Function	Benefits	Function	Benefits	Function	Benefits	Function	Benefits	Function	Benefits	
1	4.13	4.04	2.96	9.70	6.04	3.69	5.24	4.10	7.83	8.23	7.10	Higher	8.59	Higher	No
2	6.38	5.54	6.99	3.94	5.40	0.36	1.37	1.11	4.78	4.58	6.52	Higher	8.72	Higher	No
Average Score	5.26	4.79	4.98	6.82	5.72	2.00	3.31	2.58	6.20	6.40	6.81	Higher	8.66	Higher	
Average Rating*	Moderate	Moderate	Moderate	Higher	Higher	Lower	Moderate	Moderate	Moderate	Moderate	Higher	Higher	Higher	Higher	

*Average group rating calculated based on the Nova Scotia normalized reference values in the WESP-AC tool.

APPENDIX E
STANDARD OPERATING PROCEDURES – FISH COLLECTION

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) (now Strum Consulting) 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 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℃
- Weather conditions
  - Moderate rain (enough to soak through clothing)
  - thunder and lightening
  - extreme heat (above 30℃)
- 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 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).

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

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.

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).

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

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℃, 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℃.***

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 400 seconds of 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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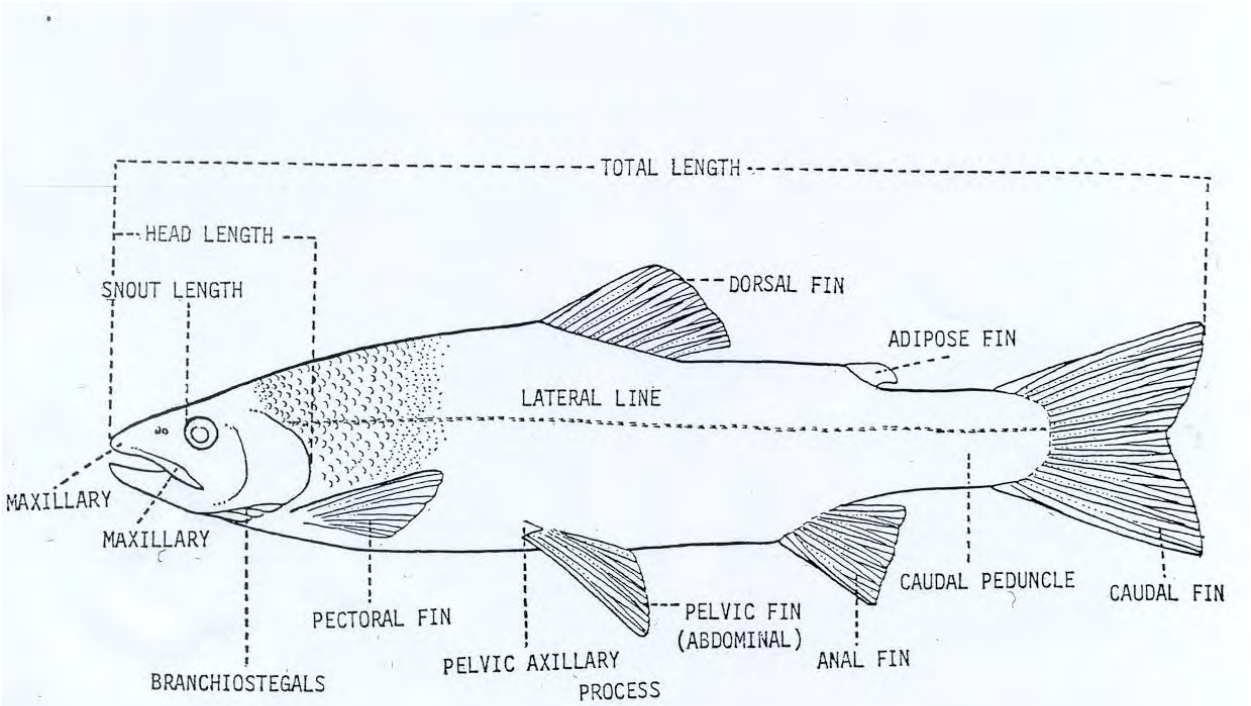
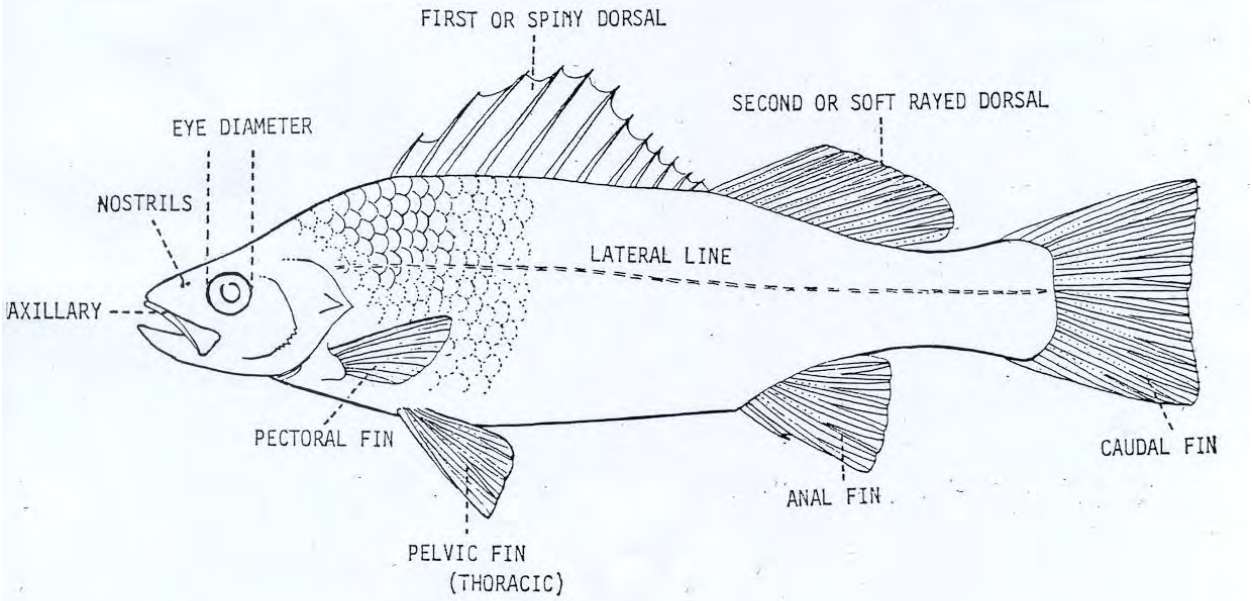
Appendix A: Anatomical Features of Fish


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

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 than 22ºC ***	**# 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

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 F
PHOTO LOG

Photo 1: Point #1 – Upstream extent of WC1. Mucky substrate and low flow conditions are not characteristic of potential wood turtle habitat. July 11, 2023.

Photo 2: Point #2 – Sand, muck, and gravel substrate. Low flow conditions. Not characteristic of potential wood turtle habitat. July 11, 2023.

Photo 3: Point #3 – Gravel substrate. Low flow conditions are present. The riparian zone may provide suitable foraging habitat for wood turtles. July 11, 2023.

Photo 4: Point #4 – Muck substrate and low flow conditions are not characteristic of potential wood turtle habitat. July 11, 2023.

Photo 5: Point #5 – Muck substrate and low flow conditions are not characteristic of potential wood turtle habitat. July 11, 2023.

Photo 6: Point #6 – Muck substrate and low flow conditions are not characteristic of potential wood turtle habitat. July 11, 2023.

Photo 7: Point #7 – Sand, gravel, and cobble substrate. Low flow conditions are present. The riparian zone may provide suitable foraging habitat for wood turtles. July 11, 2023.

Photo 8: Point #8 – Sand, gravel, and cobble substrate. Low flow conditions are present. The riparian zone may provide suitable foraging habitat for wood turtles. July 11, 2023.

Photo 9: Point #9 – Muck substrate and low flow conditions are not characteristic of potential wood turtle habitat. July 11, 2023.

Photo 10: Point #10 – Muck substrate and low flow conditions are not characteristic of potential wood turtle habitat. July 11, 2023

Photo 11: Point #11 – Gravel, cobble, and rubble substrate. Low flow conditions are present. The riparian zone may provide suitable foraging habitat for wood turtles. July 11, 2023

Photo 12: Point #12 – Sand, gravel, and cobble substrate. Low flow conditions are present. The riparian zone may provide suitable foraging habitat for wood turtles. July 11, 2023.

Photo 13: Point #13 – The downstream extent of the watercourse before it exits the Study Area. Sand and gravel substrate. Low flow conditions are present. The riparian zone may provide suitable foraging habitat for wood turtles. July 11, 2023.

Photo 14: Representative photo of WL1

Photo 15: Representative photo of WL2

Photo 16: Representative photo of WL3

Photo 16: Representative photo of WL4.

Photo 17: Open Water A.

Photo 18: WC1R1.

Photo 19: WC1R2.

Photo 20: WC1R3.

Photo 21: Brook trout caught during electrofishing in WC1.

Photo 22: Creek chub caught during electrofishing in WC1.

Photo 23: Threespine caught during trapping in WC1.

Photo 24: Northern redbelly dace caught during trapping in WC1.

APPENDIX G
STANDARD OPERATING PROCEDURES – FISH HABITAT ASSESSMENT

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) (now Strum Consulting) 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
- 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)
- 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 0).

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 0 – 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.

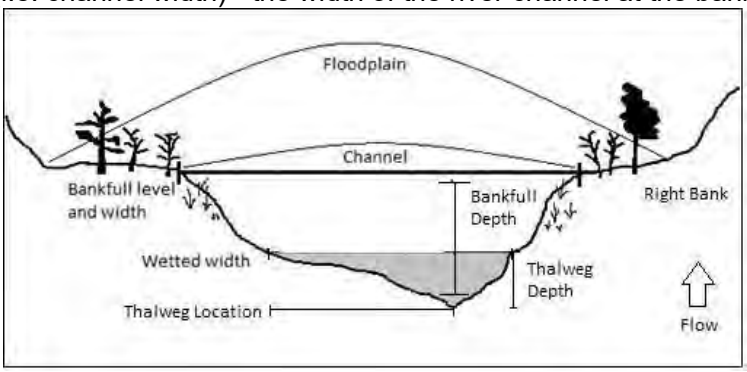


Image 1: Components of a channel cross-section

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.

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).

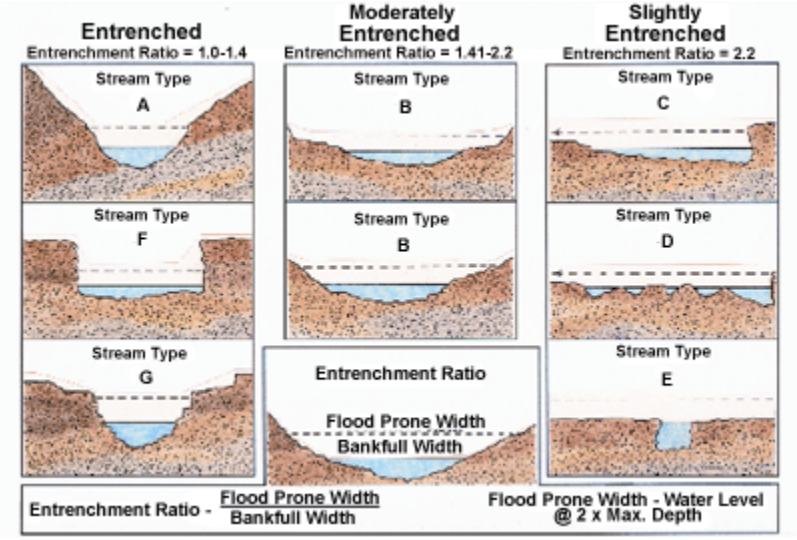


Image 2: Degrees of entrenchment (the term "entrenched" equates to "highly entrenched" for the purposes of this SOP. Source:

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:

- **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).

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

- **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.

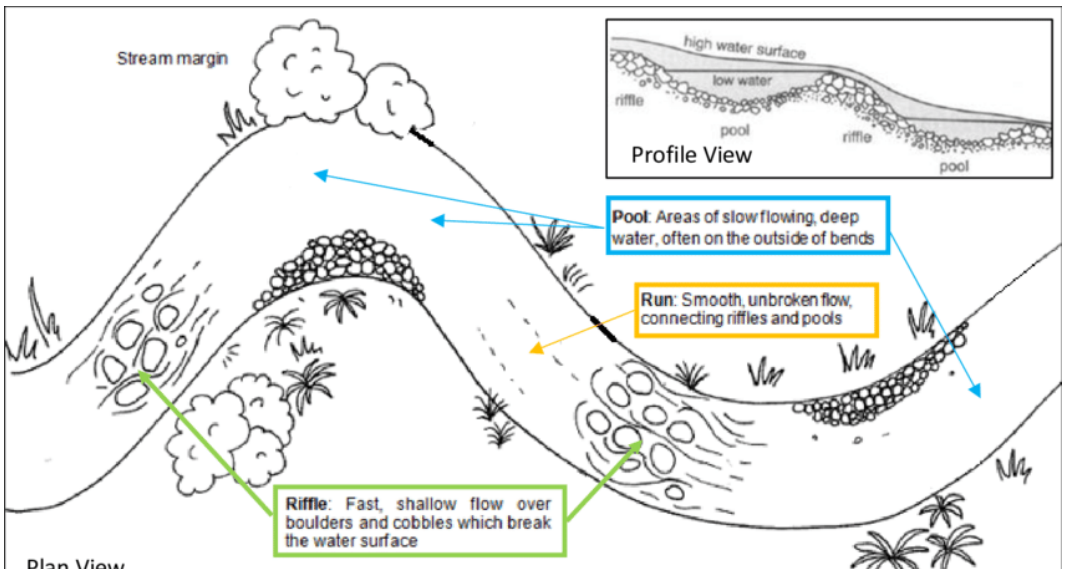


Image 3: A typically riffle-run-pool sequence within a stream (Source: https://www.researchgate.net/figure/Elements-of-a-river-reach-pool-riffle-and-run_fig13_322765638)

- **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 steep 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)

- **t –** 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.

- **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

Image 8: A boulder-bed

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).

- **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., coarse, 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).

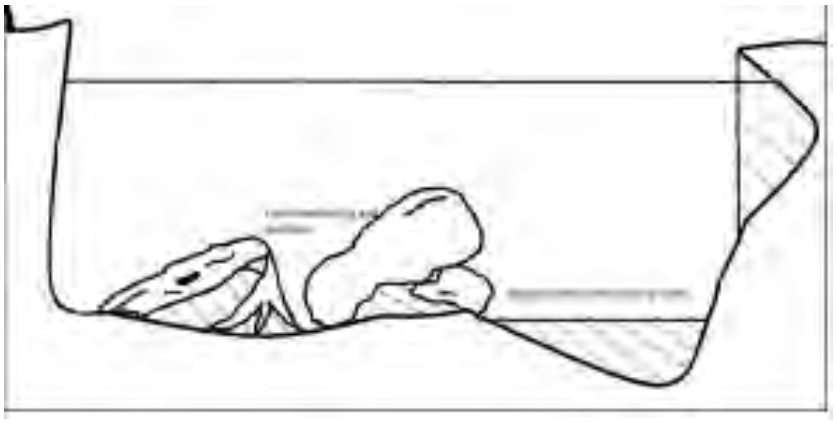


Image 11: Example of cover types within a transect (Source: NSHSI, 2018)

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.

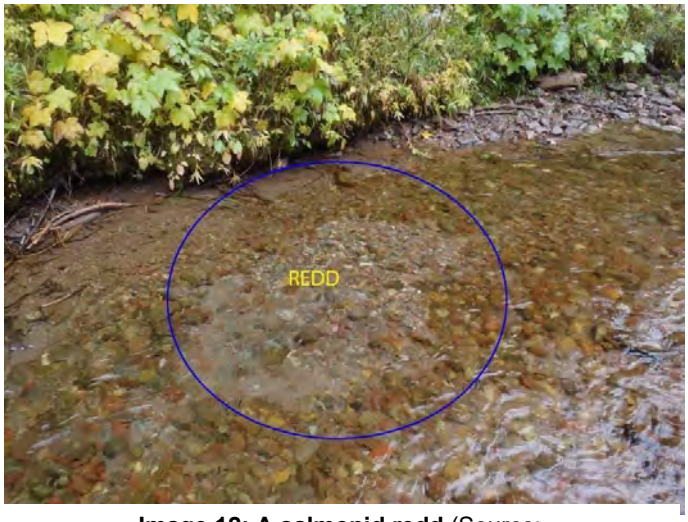


Image 12: A salmonid redd (Source: https://www.tu.org/blog/redd-surveys-shaping-priorities-in-michigans-pere-marquette/)

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:

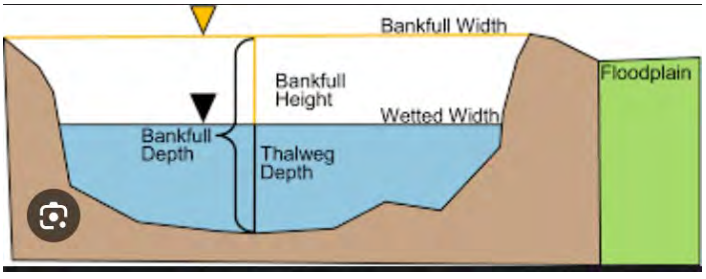
Detailed Fish Habitat Assessment - Streams

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 H
PLANT LIST

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
VASCULAR PLANTS						
Dryopteris intermedia	Evergreen Wood Fern	S5	0	0	0	No
Solidago rugosa	Rough-stemmed Goldenrod	S5	0	0	0	No
Acer rubrum	Red Maple	S5	0	0	0	No
Abies balsamea	Balsam Fir	S5	0	0	0	No
Pteridium aquilinum	Bracken Fern	S5	0	0	0	No
Populus tremuloides	Trembling Aspen	S5	0	0	0	No
Lysimachia borealis	Northern Starflower	S5	0	0	0	No
Doellingeria umbellata	Hairy Flat-top White Aster	S5	0	0	0	No
Maianthemum canadense	Wild Lily-of-The-Valley	S5	0	0	0	No
Veronica officinalis	Common Speedwell	SNA	0	0	0	0
Pinus strobus	Eastern White Pine	S5	0	0	0	No
Symphyotrichum lateriflorum	Calico Aster	S5	0	0	0	0
Fraxinus americana	White Ash	S4	0	0	0	No
Viburnum cassinoides	Northern Wild Raisin	S5	0	0	0	0
Acer spicatum	Mountain Maple	S5	0	0	0	No
Oclemena acuminata	Whorled Wood Aster	S5	0	0	0	No
Equisetum sylvaticum	Woodland Horsetail	S5	0	0	0	No
Onoclea sensibilis	Sensitive Fern	S5	0	0	0	No
Chrysosplenium americanum	American Golden Saxifrage	S5	0	0	0	No
Geum rivale	Water Avens	S5	0	0	0	No
Geum aleppicum	Yellow Avens	S5	0	0	0	No
Alnus incana	Speckled Alder	S5	0	0	0	No
Carex crinita	Fringed Sedge	S5	0	0	0	No
Clematis virginiana	Virginia Clematis	S5	0	0	0	No
Rubus idaeus	Red Raspberry	S5	0	0	0	Yes
Glyceria striata	Fowl Manna Grass	S5	0	0	0	No
Mitella nuda	Naked Bishop's-Cap	S4S5	0	0	0	No

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
Fragaria virginiana	Wild Strawberry	S5	0	0	0	Yes
Quercus rubra	Northern Red Oak	S5	0	0	0	No
Rubus pubescens	Dwarf Red Raspberry	S5	0	0	0	No
Cornus canadensis	Bunchberry	S5	0	0	0	No
Vaccinium angustifolium	Late Lowbush Blueberry	S5	0	0	0	0
Calamagrostis canadensis	Bluejoint Reed Grass	S5	0	0	0	No
Lonicera canadensis	Canada Fly Honeysuckle	S5	0	0	0	No
Persicaria sagittata	Arrow-leaved Smartweed	S5	0	0	0	No
Galium palustre	Common Marsh Bedstraw	S5	0	0	0	No
Larix laricina	Tamarack	S5	0	0	0	No
Lycopus uniflorus	Northern Water Horehound	S5	0	0	0	No
Impatiens capensis	Spotted Jewelweed	S5	0	0	0	No
Ilex verticillata	Common Winterberry	S5	0	0	0	No
Osmundastrum cinnamomeum	Cinnamon Fern	S5	0	0	0	No
Coptis trifolia	Goldthread	S5	0	0	0	No
Clintonia borealis	Yellow Bluebead Lily	S5	0	0	0	No
Rubus canadensis	Smooth Blackberry	S5	0	0	0	No
Picea rubens	Red Spruce	S5	0	0	0	No
Rubus allegheniensis	Alleghaney Blackberry	S5	0	0	0	No
Nabalus trifoliolatus	Three-leaved Rattlesnakeroot	S5	0	0	0	No
Aralia nudicaulis	Wild Sarsaparilla	S5	0	0	0	No
Arceuthobium pusillum	Eastern Dwarf Mistletoe	S5	0	0	0	No
Carex trisperma	Three-seeded Sedge	S5	0	0	0	No
Carex leptalea	Bristly-stalked Sedge	S5	0	0	0	No
Carex brunnescens	Brownish Sedge	S5	0	0	0	No
Dryopteris carthusiana	Spinulose Wood Fern	S5	0	0	0	No
Viola cucullata	Marsh Blue Violet	S5	0	0	0	0
Parathelypteris noveboracensis	New York Fern	S5	0	0	0	No

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
Mitchella repens	Partridgeberry	S5	0	0	0	No
Linnaea borealis	Twinflower	S5	0	0	0	No
Betula populifolia	Gray Birch	S5	0	0	0	No
Gaultheria procumbens	Eastern Teaberry	S5	0	0	0	No
Comptonia peregrina	Sweet-fern	S5	0	0	0	No
Apocynum androsaemifolium	Spreading Dogbane	S5	0	0	0	No
Vaccinium myrtilloides	Velvet-leaved Blueberry	S5	0	0	0	0
Tsuga canadensis	Eastern Hemlock	S4	0	0	0	0
Solidago flexicaulis	Zigzag Goldenrod	S5	0	0	0	No
Plantago major	Common Plantain	SNA	0	0	0	No
Bidens frondosa	Devil's Beggarticks	S5	0	0	0	No
Typha latifolia	Broad-leaved Cattail	S5	0	0	0	0
Solidago canadensis	Canada Goldenrod	S4S5	0	0	0	No
Spiraea alba	White Meadowsweet	S5	0	0	0	No
Epipactis helleborine	Helleborine	SNA	0	0	0	No
Corylus cornuta	Beaked Hazel	S5	0	0	0	No
Scirpus cyperinus	Common Woolly Bulrush	S5	0	0	0	No
Osmunda regalis	Royal Fern	S5	0	0	0	No
Carex folliculata	Northern Long Sedge	S5	0	0	0	No
Fagus grandifolia	**American Beech**	**S3S4**	0	0	0	No
Ulmus americana	**White Elm**	**S3S4**	0	0	0	0
Pinus resinosa	Red Pine	S4S5	0	0	0	No
Kalmia angustifolia	Sheep Laurel	S5	0	0	0	No
Thelypteris palustris	Eastern Marsh Fern	S5	0	0	0	0
Rhododendron canadense	Rhodora	S5	0	0	0	No
Epigaea repens	Trailing Arbutus	S5	0	0	0	No
Carex lupulina	**Hop Sedge**	**S3**	0	0	0	No
Solanum dulcamara	Bittersweet Nightshade	SNA	0	0	0	No

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
Epilobium coloratum	Purple-veined Willowherb	S4	0	0	0	No
Acer saccharum	Sugar maple	S5	0	0	0	No
Tussilago farfara	Coltsfoot	SNA	0	0	0	Yes
Solidago gigantea	Giant Goldenrod	S5	0	0	0	No
Solidago bicolor	White Goldenrod	S5	0	0	0	No
Cornus sericea	Red Osier Dogwood	S5	0	0	0	No
Rosa multiflora	Multiflora Rose	SNA	0	0	0	Yes
Chelone glabra	White Turtlehead	S5	0	0	0	Yes
Glyceria canadensis	Canada Manna Grass	S5	0	0	0	No
Dryopteris cristata	Crested Wood Fern	S5	0	0	0	No
Populus grandidentata	Large-toothed Aspen	S5	0	0	0	No
Betula papyrifera	Paper Birch	S5	0	0	0	No
Symphyotrichum puniceum	Purple-stemmed Aster	S5	0	0	0	0
Acer pensylvanicum	Striped Maple	S5	0	0	0	Yes
Cypripedium acaule	Pink Lady's-Slipper	S5	0	0	0	No
Maianthemum racemosum	Large False Solomon's Seal	S4S5	0	0	0	No
Medeola virginiana	Cucumber Root	S5	0	0	0	Yes
Orthilia secunda	One-sided Wintergreen	S5	0	0	0	No
Oxalis montana	Common Wood Sorrel	S5	0	0	0	No
Moneses uniflora	One-flowered Wintergreen	S4S5	0	0	0	No
Toxicodendron radicans	Poison Ivy	S5	0	0	0	0
Cornus alternifolia	Alternate-leaved Dogwood	S5	0	0	0	No
Monotropa uniflora	Convulsion-Root	S5	0	0	0	No
Alnus alnobetula	Green Alder	S5	0	0	0	No
Ribes lacustre	Bristly Black Currant	S5	0	0	0	No
Iris versicolor	Harlequin Blue Flag	S5	0	0	0	No
Chamaenerion angustifolium	Fireweed	S5	0	0	0	No
Trillium cernuum	Nodding Trillium	S4	0	0	0	0

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
Lysimachia arvensis	Scarlet Pimpernel	SNA	0	0	0	No
Astragalus sp.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Epifagus virginiana	Beechdrops	S4	0	0	0	No
Prunus serotina	Black Cherry	S5	0	0	0	No
Salix sp.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Urtica dioica	Stinging Nettle	S4	0	0	0	0
Arisaema triphyllum	Jack-in-the-pulpit	S5	0	0	0	No
Circaea alpina	Small Enchanter's Nightshade	S5	0	0	0	No
Chimaphila umbellata	Common Pipsissewa	S4	0	0	0	No
Dryopteris marginalis	Marginal Wood Fern	S5	0	0	0	No
Dennstaedtia punctilobula	Eastern Hay-Scented Fern	S5	0	0	0	No
Melilotus albus	White Sweet-clover	SNA	0	0	0	Yes
Ranunculus repens	Creeping Buttercup	SNA	0	0	0	Yes
Polystichum acrostichoides	Christmas Fern	S5	0	0	0	No
Lycopodium	Running Clubmoss	S5	0	0	0	Yes
Dendrolycopodium dendroideum	Round-branched Tree-clubmoss	S5	0	0	0	No
Equisetum pratense	**Meadow Horsetail**	**S3S4**	0	0	0	No
Comarum palustre	Marsh Cinquefoil	S5	0	0	0	No
Carex disperma	Two-seeded Sedge	S5	-	-	-	No
Carex intumescens	Bladder Sedge	S5	-	-	-	No
Athyrium filix-femina	Common Lady Fern	S5	-	-	-	No
Dryopteris campyloptera	Mountain Wod Fern	S5	-	-	-	No
Carex stricta	Tussock Sedge	S5	-	-	-	No
Matteuccia struthiopteris	Ostrich Fern	S5	-	-	-	No
Cornus canadensis	Bunchberry	S5	-	-	-	No
Scirpus spp.	Bulrush sp.	SNA	-	-	-	No
Ranunculus acris	Common Buttercup	SNA	-	-	-	No
Astragalus sp.	NA	NA	NA	NA	NA	NA

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
Salix sp.	NA	NA	NA	NA	NA	NA
LICHENS						
Hypogymnia vittata	Slender Monk's Hood Lichen	S4	-	-	-	-
Hypogymnia krogiae	Freckled Tube Lichen	S5	-	-	-	-
Hypogymnia physodes	Monk's hood Lichen	S5	-	-	-	-
Parmeliella triptophylla	Black-bordered Shingles Lichen	S5	-	-	-	-
Pyxine sorediata	Mustard Lichen	S5	-	-	-	-
Parmelia sulcata	Hammered Shield Lichen	S5	-	-	-	-
Parmelia squarrosa	Bottlebrush Shield Lichen	S5	-	-	-	-
Hypogymnia incurvoides	Lattice Tube Lichen	S4S5	-	-	-	-
Evernia mesomorpha	Boreal Oakmoss Lichen	S5	-	-	-	-
Collema furfuraceum	Blistered Tarpaper Lichen	S5	-	-	-	-
Collema subflaccidum	Tree Tarpaper Lichen	S5	-	-	-	-
Peltigera aphthosa	Common Freckle Pelt Lichen	S5	-	-	-	-
Peltigera canina	Dog Lichen	S5	-	-	-	-
Ricasolia quercizans	Smooth Lung Lichen	S5	-	-	-	-
Dolichousnea longissima	Methuselah's Beard Lichen	S4	-	-	-	-
Usnea dasopoga	Fishbone Beard Lichen	S5	-	-	-	-
Cladonia macilenta	Lipstick Powderhorn Lichen	S4S5	-	-	-	-
Cladonia verticillata	Ladder Lichen	S5	-	-	-	-
Cladonia uncialis	Thorn Lichen	S5	-	-	-	-
Cladonia stellaris	Star-tipped Reindeer Lichen	S5	-	-	-	-
Platismatia glauca	Varied Rag Lichen	S5	-	-	-	-
Stereocaulon dactylophyllum	Finger Foam Lichen	S5	-	-	-	-
Stereocaulon saxatile	Rock Foam Lichen	S4	-	-	-	-
Dibaeis baeomyces	Pink Earth Lichen	S5	-	-	-	-
Arctoparmelia centrifuga	Ripple Ring Lichen	S5	-	-	-	-
Lobaria pulmonaria	Lungwort Lichen	S5	-	-	-	-

Scientific Name	Common Name	S-Rank	COSEWIC	*SARA*	*ESA*	Invasive (Yes/No)
BRYOPHYTES						
Sphagnum central	Central peat moss	S4	-	-	-	-
Sphagnum austinii	Austin's peat moss	S5	-	-	-	-
Sphagnum rubellum	Red peat moss	S5	-	-	-	-
Pleurozium schreberi (Schreber's moss)	Red-stemmed feather moss	S5	-	-	-	-
Hylocomium splendens (stairstep moss)	Stairstep moss	S5	-	-	-	-
Sphagnum capillifolium	Northern peatmoss	S5	-	-	-	-
Neckera pennata	Feathery neckera moss	S5	-	-	-	-
Sphagnum angustifolium	Narrowleaf peatmoss	S5	-	-	-	-
Sphagnum girgensohnii	Green peat moss	S5	-	-	-	-
Ulota crispa	Crisped pincushion moss	S5	-	-	-	-
Polytrichum commune	Common haircap moss	S5	-	-	-	-
Bazzania tribolata	Three-lobed whipwort	S5	-	-	-	-

NOTE: Priority species are **bolded**.

APPENDIX I
MARITIME BREEDING BIRD ATLAS SQUARE

ATLAS DES OISEAUX NICHEURS DES MARITIMES
BREEDING BIRD ATLAS

Square Summary (20LQ47)

#species (1st atlas)				#species (2nd atlas)				#hours		#pc done	
poss	prob	conf	total	poss	prob	conf	total	1st	2nd	road	offrd
0	0	32	32	40	21	26	87	40	58.3	15	3

Region summary (#16: Annapolis Valley - Digby Neck)

#squares	#sq with data		#species		#pc done	target #pc
	1st	2nd	1st	2nd		
78	69	75	154	175	888	292

Target number of point counts in this square: 12 road side, 3 off road (2 in Mature coniferous, 1 in Mature deciduous). Please try to ensure that each off-road station is located such that the entire 100m radius circle is within the prescribed habitat.

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Canada Goose		FY	2	46	Northern Harrier			49	44	Short-eared Owl †			2	0
Wood Duck			18	34	Sharp-shinned Hawk			31	25	North Saw-whet Owl			7	26
American Wigeon			5	9	Northern Goshawk			23	24	Common Nighthawk †		T	43	42
American Black Duck		FY	59	72	Red-should Hawk †			0	0	Whip-poor-will ‡			1	1
Mallard	NE	P	18	50	Broad-winged Hawk		H	27	33	Chimney Swift †		H	39	32
Blue-winged Teal			14	13	Red-tailed Hawk	FL	D	57	64	Ruby-thr Hummingbird	ON	FY	62	89
Northern Shoveler ‡			1	2	Virginia Rail †			7	6	Belted Kingfisher		H	55	60
Northern Pintail			4	2	Sora		S	17	25	Yellow-bellied Sapsucker		NY	37	37
Green-winged Teal			21	20	Common Gallinule †			1	2	Downy Woodpecker	ON	AE	65	85
Ring-necked Duck			24	30	American Coot †			1	1	Hairy Woodpecker	NY	D	63	78
Common Eider §			4	9	Killdeer	FL	FY	68	45	Black-back Woodpecker			4	12
Hooded Merganser			7	25	Spotted Sandpiper		A	57	45	Northern Flicker		FY	78	94
Common Merganser			21	20	Willet			17	16	Pileated Woodpecker		H	44	73
Red-breast Merganser			2	6	Upland Sandpiper †			1	0	American Kestrel		H	49	37
Gray Partridge			14	0	Wilson's Snipe		D	49	45	Merlin			14	46
Ring-necked Pheasant	NE	S	59	70	American Woodcock		D	49	49	Olive-sided Flycatcher †		S	37	41
Ruffed Grouse		S	62	76	Herring Gull §			14	28	Eastern Wood-Pewee		S	62	68
Spruce Grouse			26	13	Great Black-backed Gull §			23	32	Yellow-bellied Flycatcher		S	24	44
Wild Turkey †			0	1	Roseate Tern ‡§			1	0	Alder Flycatcher		S	57	94
Common Loon			33	53	Common Tern ‡§			1	1	Least Flycatcher		S	57	84
Pied-billed Grebe ‡			2	10	Arctic Tern ‡§			1	1	Eastern Phoebe		CF	17	45
Double-crest Cormorant §			11	24	Black Guillemot ‡§			5	10	Gr Crested Flycatcher			10	9
Great Cormorant ‡§			1	1	Rock Pigeon		H	46	58	Eastern Kingbird	NE	S	52	41
American Bittern			24	17	Mourning Dove	ON	T	55	94	Blue-headed Vireo		S	56	90
Great Blue Heron §			26	26	Black-billed Cuckoo		S	5	16	Warbling Vireo †			1	6
Cattle Egret ‡			0	0	Eastern Screech-Owl ‡			0	1	Red-eyed Vireo		S	71	92
Turkey Vulture ‡¤			1	16	Great Horned Owl	FL	T	40	32	Gray Jay			42	34
Osprey		H	24	32	Barred Owl		NY	40	64	Blue Jay	FL	FY	75	96
Bald Eagle ¤		H	21	50	Long-eared Owl †			1	1	American Crow	NY	FY	81	96

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Maritimes Breeding Bird Atlas - Summary Sheet for Square 20LQ47 (page 2 of 2)

SPECIES	Code		%		SPECIES	Code		%		SPECIES	Code		%	
	1st	2nd	1st	2nd		1st	2nd	1st	2nd		1st	2nd	1st	2nd
Common Raven		D	73	93	North Waterthrush		S	34	40	White-throat Sparrow		A	75	98
Horned Lark †			2	2	Black-white Warbler	FL	CF	75	92	White-crown Sparrow ‡			0	1
Tree Swallow	NY	AE	82	84	Tennessee Warbler			49	12	Dark-eyed Junco		A	78	94
Bank Swallow §	ON	H	65	29	Nashville Warbler		S	31	52	Scarlet Tanager †			15	10
Cliff Swallow §		H	36	28	Mourning Warbler			17	9	Northern Cardinal		S	8	33
Barn Swallow	NY	NE	81	77	Common Yellowthroat		A	78	97	Rose-breast Grosbeak	FL	P	56	54
Black-capp Chickadee	AY	AE	75	98	American Redstart	ON	A	84	96	Indigo Bunting			7	4
Boreal Chickadee			43	46	Cape May Warbler			14	1	Bobolink	ON	S	63	52
Red-breast Nuthatch		S	66	84	Northern Parula		A	66	98	Red-wing Blackbird	NE	FY	68	80
White-breast Nuthatch	ON	S	34	54	Magnolia Warbler		S	66	89	Eastern Meadowlark †			5	0
Brown Creeper			30	36	Bay-breasted Warbler			23	25	Rusty Blackbird †			33	16
House Wren †			1	1	Blackburnian Warbler		S	49	61	Common Grackle	NE	FY	76	90
Winter Wren		S	40	61	Yellow Warbler	NE	NE	76	94	Brown-head Cowbird			60	22
Golden-crown Kinglet			62	74	Chestn-sided Warbler		CF	66	94	Baltimore Oriole	NY		31	22
Ruby-crown Kinglet			66	48	Blackpoll Warbler			2	9	Pine Grosbeak			15	6
Eastern Bluebird †			10	14	Black-thr Blue Warbler			33	48	Purple Finch		FY	72	90
Veery		A	68	77	Palm Warbler		S	30	56	House Finch †			14	5
Bicknell's Thrush †			0	0	Yellow-rumped Warbler		CF	78	93	Red Crossbill †			20	17
Swainson's Thrush		S	49	80	Black-thr Green Warbler		A	71	94	White-winged Crossbill			34	29
Hermit Thrush		S	65	92	Canada Warbler †		S	44	37	Pine Siskin		H	55	36
Wood Thrush †			13	1	Wilson's Warbler	FL		10	8	American Goldfinch		FY	76	93
American Robin	NE	CF	91	98	Chipping Sparrow	NE	FY	60	62	Evening Grosbeak		T	53	45
Gray Catbird	ON	A	60	68	Vesper Sparrow †			5	6	House Sparrow	ON	S	73	32
Northern Mockingbird †			17	10	Savannah Sparrow		S	53	70					
Brown Thrasher †			1	6	Nelson's Sh.-tail Sparrow			14	18					
European Starling	ON	AE	81	86	Fox Sparrow			0	1					
Bohemian Waxwing ‡			1	0	Song Sparrow	NE	FY	85	98					
Cedar Waxwing		S	69	92	Lincoln's Sparrow			7	20					
Ovenbird		A	71	96	Swamp Sparrow		S	43	70					

This list includes all species found during the Maritimes Breeding Bird Atlas (1st atlas: 1986-1990, 2nd atlas: 2006-2010) in the region #16 (Annapolis Valley - Digby Neck). Underlined species are those that you should try to add to this square (20LQ47). They have not yet been reported during the 2nd atlas, but were found during the 1st atlas in this square or have been reported in more than 50% of the squares in this region during the 2nd atlas so far. "Code" is the code for the highest breeding evidence for that species in square 20LQ47 during the 2nd and 1st atlas respectively. The % columns give the percentage of squares in that region where that species was reported during the 2nd and 1st atlas (this gives an idea of the expected chance of finding that species in region #16). Rare/Colonial Species Report Forms should be completed for species marked: § (Colonial), ‡ (regionally rare), † (rare in the Maritimes) or ¤ (rare in the Maritimes, documentation only required for confirmed records). Current as of 25/01/2024. An up-to-date version of this sheet is available from http://www.mba-aom.ca/jsp/summaryform.jsp?squareID=20LQ47?lang=en

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APPENDIX J
LIFE CYCLE AND HABITAT CHARACTERISTICS OF FISH SPECIES

Common Name	Scientific Name	S-Rank	Status	Kanno & Beazley, 2004		Life Cycle			Stage	Habitat Description	Depth (m)	Velocity (m/s)	Substrate	Cover	Optimal Growth Temp (°C)*
				Disturbance tolerance	Temperature regime	Age of Maturity	Life Span	Spawning Period							
Brook Trout	*Salvelinus fontinalis*	S3	-	Intolerant	Coldwater	3 years (average), range of 1-4 years	5 years	October-November	Spawning,	Eddy, plunge/trench/debris/pools, steady/flat, riffle, run, rapids	0.1-0.3	0.01-0.9	S/G/C	R, W	14.2
									YOY	Eddy, plunge/trench/debris/pools, steady/flat, riffle, rapids	0.1-0.7	0.02-0.4	Gr/C/R/B	Aq, S, W	
									Juvenile	Eddy, plunge/trench/debris/pools, steady/flat, riffle, run, rapids	0.2->2.0	0.01-1.5	Si/S/G/C/R/B	Aq, R, S, U, W	
									Adult	Eddy, plunge/trench/debris/pools, steady/flat, riffle, run, falls, rapids	0.06-1.1	0.01-0.5	Gr/C/R/B	Aq, R,S, U, W	
									Overwintering	Eddy, plunge/trench/debris/pools	<0.5	<0.15	S/Si	S, U	
Northern redbelly dace	*Chrosomus eos*	S5	-	Intermediate	Coldwater	1 year	3-4 years	Two or more spawning periods during spring and summer	spawning	Sluggish spring fed streams also in lakes and bogs. beaver ponds filled with a constant supply of cool groundwater. Dark tea coloured water. Pools/ flats	-	slow	Si, M/D	Aq, R, W, U	17-24
									YOY						
									Juvenile						
									Adult						
									overwintering						
Threespine stickleback	*Gasterosteus aculeatus*	S5	-	Intermediate	Coolwater	1-2 years	5 years (8 years max in a lab)	April – July	Spawning	April-June they construct a nest on the bottom, in relatively shallow areas, very rarely attached to plants. They make a depression up to 14 × 10 cm to which they bring plant materials. Pools	0.1-0.6	0.03-0.2	Cl/M/S/Gr/Bo/M	Aq/R	16-18
									YOY	Pools/slow waters	0.1-1.0	0.1-1.0	Cl/S/M		
									Juvenile/Adult		0.1-0.6	0.03-0.2	Cl/M/S/Gr/M	AP, W	

Common Name	Scientific Name	S-Rank	Status	Kanno & Beazley, 2004		Life Cycle			Stage	Habitat Description	Depth (m)	Velocity (m/s)	Substrate	Cover	Optimal Growth Temp (°C)*
				Disturbance tolerance	Temperature regime	Age of Maturity	Life Span	Spawning Period							
Creek Chub	*Semotilus atromaculatus*	**S5**	-	Tolerant	Coolwater	2-4 years	5-7 years	April-July as water temps approach 14° C	Spawning	Large streams, construct nest in shallow areas above and bellow riffles. Riffles, run, pools	>1m-2m	20-60cm/sec	Gr	Aq, R, S, U, W	12-24
									YOY	small, clear, streams, and brooks, sometimes shore waters of small lakes, Riffles, run, pools		<10cm/sec	Gr		
									Juvenile	Quiet waters of beaver ponds, bog ponds, small lakes or quiet pool-like expansions of streams, Riffles, run, pools		.60cm/sec	Gr/Si/M		
									Adult	deep pool and abundant cover, access to larger warmer streams within 5km		-	Gr		

Notes: *Optimal Growth Temperature from Hasnain et al., 2010

Substrate types: Cl = Clay (Mud), M = Muck (Detritus), Si = Silt, S = Sand, G = Gravel, C = Cobble, R = Rubble, B = Boulder, Be = Bedrock

Cover Types: AP = aquatic plants (submergent and/or emergent); IN = instream objects/in situ cover within the streambed in the form of fallen trees, submerged logs, rocks, boulders, undercut banks, and accumulated debris; O = overhead cover from riparian vegetation overhanging the stream Information collected from the following sources: Scott and Crossman, 1973; Gilhen, 1974; Raleigh, 1982; Coad et al., 1995; Grant and Lee, 2004; Kanno and Beazley, 2004; NSDFA, 2005; McCarthy et al., 2006; Brown et al., 2009; Hasnain et al., 2010; Hokanson et al., 2011; COSEWIC, 2012; COSEWIC, 2014; Fuller et al., 2019; Eakins, 2023; Twomey, 1984; Trial et. al., 1983; New Jersey Fish & Wildlife, 2022; Alaska Department of Fish and Game, N/A .