Prepared For:

GHD

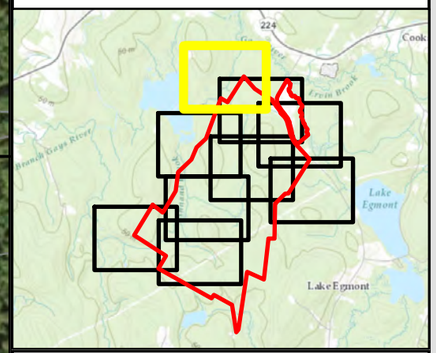
Figure 9I

Antrim Gypsum Project

Detailed Habitat Assessment Results

Antrim, NS

- Flat
- Riffle-Run
- Run
- Field Delineated Watercourse
- NSTDB Mapped Watercourse
- WC Mosaic
- Field Delineated Wetland
- NSECC Wetland Inventory
- Project Area
- Aquatic Study Area



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

0 50 100 200 m

1:4,000

Scale when printed @ 11" x 17"

Drawn By: AS
Reviewed By: MJ

Project #: 22-630
Date: 2024-03-06

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Document Name: 240213_Habitat_Results

APPENDIX B: PRIORITY SPECIES LIST

Antrim Gypsum Mine - Priority Species List
ACCDC Rankings: June 2022

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
			Mammals			
Alces alces americana	Moose	S1	0	0	Endangered	Moose are herbivores who live in boreal and mixed-wood forests. They are often found where there is an abundance of food (twigs, stems, and foliage of young deciduous trees and shrubs). In spring, islands and peninsulas are often used by cows when giving birth. In summer, access to wetlands (and aquatic vegetation) is important.
Glaucomys volans	Southern Flying Squirrel	S3S4	Not at Risk	No Status	0	Southern Flying Squirrel occurs in southern Nova Scotia in an area roughly bounded by the South Mountains in the north, the Gaspereau Valley (Kentville) to the west, the New Ross area in north-east Lunenburg County to the south and Kejimkujik National Park in the west. Southern Flying Squirrel selected forests with American beech, eastern hemlock, red oak, white ash and white pine. Nest trees (dead or alive) also tend to be larger in diameter than trees without nests (COSEWIC Assessment and Status Report).
Myotis lucifugus	Little Brown Myotis	S1	Endangered	Endangered	Endangered	Little Brown Myotis is one of the few bat species that uses buildings and other anthropogenic structures (e.g., bat boxes, bridges, and barns) to roost (particularly for maternity roosting), but it will also use cavities of canopy trees, foliage, tree bark, crevices on cliffs, and other structures.
Myotis septentrionalis	Northern Myotis	S1	Endangered	Endangered	Endangered	Northern Myotis may hibernate in cooler sections of a cave. Northern Myotis will generally return to the same hibernaculum, but not always in consecutive years. Northern Myotis roost singly or in small groups and favour tree roosts (under raised bark and in tree cavities and crevices), but they can also be found in anthropogenic structures (e.g., under shingles). Northern Myotis' maternity roosts are strongly associated with forest cover, streams, and tree characteristics (e.g., species, height, diameter, age, and decay). Females prefer to roost in tall, large diameter trees in early- to mid-stages of decay. Maternity colonies in Nova Scotia were generally in larger-than-average trees. Males generally roost alone under raised bark or within cavities of trees in mid-stages of decay.
Pekania pennanti	Fisher	S3	0	0	0	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.

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Perimyotis subflavus	Tricolored Bat	S1	Endangered	Endangered	Endangered	Tri-colored Bat often select the deepest part of caves or mines where temperature is the least variable, have strong humidity level preferences, and use warmer walls than other species. They have been recorded within any one hibernacula, possibly because they tend to hibernate solitarily (i.e., not in clusters) in the deepest sections of the caves/mines. Tri-colored Bats exhibit high fidelity to hibernacula. Roosts provide thermal regulation, shelter from weather and predation, and can be sites for social interaction. Individuals may switch roosts regularly and therefore, may use a network of roosts in a roosting area. The tendency to switch roosts may depend on species, sex, age, reproductive status, and roost type.
Sorex maritimensis	Maritime Shrew	S3				Often found in marshes and wet meadows The most favoured habitat is the edges of freshwater swamps and marshes which have become overgrown with tangled grass and rushes.
Sorex palustris	American Water Shrew	S3S4				Mostly aquatic, the water shrew lives beneath the overhanging banks and in rock crevices along the edges of swiftly flowing mountain streams. Rhododendron and yellow birch are usually the dominant vegetation in these areas.
Synaptomys cooperi	Southern Bog Lemming	S3				They are often found in sphagnum bogs and low moist places, but they are also found in grasslands, mixed deciduous/coniferous forests, spruce-fir forests, freshwater wetlands, marshes, and meadows. They prefer areas with a thick mat of herbaceous and shrubby vegetation.
Avifauna						
Bucephala clangula	Common Goldeneye	S1?B,SUN,SUM	0	0	0	Winters in Nova Scotia along the coast. Generally migrates late in fall and early in spring. Males tend to winter farther north than females. Found in shallow coastal bays, estuaries that offer good foraging sites: sand, gravel, rock and boulder substrates supporting mollusks and crustaceans. In the interior, wintering flocks gather on large lakes and rivers as far north as open water occurs. Breeds between April and July (Audubon and The Cornell Lab)
Buteo lagopus	Rough-legged Hawk	S3S4	0	0	0	Common across Nova Scotia during nonbreeding (winter). Spends the winter in open country, including grasslands, coastal prairies, marshes, farmland and dunes. In tree-covered areas they hunt over open bogs and other clearings. Breeds mostly on tundra, in areas having cliffs for nest sites; some breed along northern edge of coniferous forest zone. Rough-legged Hawks breed in open country of the arctic, both in North America and Eurasia. Breeds between April and July. May mate for life (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Calcarius lapponicus	Lapland Longspur	S3S4B, S5M	0	0	0	They winter in vast agricultural fields that are often devoid of other birdlife in that season in southern area, and head up to the tundra to breed in the summer. Breeds between April and July (Cornell Lab, Audubon).
Calidris canutus	Red Knot	S2?B,SUM	Special Concern/ Endangered/ Endangered	Not on Schedule 1/Not on Schedule 1/Not on Schedule 1	Endangered	Red Knots migrate through Nova Scotia along the coast in the summer and fall. Adults in faded breeding plumage are observed in July and August, while juveniles are mainly seen from August to October. Red Knots use different habitats during the breeding, wintering, and migration seasons. In the Arctic, they nest in extremely barren habitats, such as windswept ridges, slopes, or plateaus. Nesting sites are usually located in dry, south-facing locations, near wetlands or lakes, where the young are led after hatching. Red Knots generally feed in damp or barren areas that can be as far as 10 km from the nest. Migratory stopovers and wintering grounds are vast coastal zones swept by tides twice a day, usually sandflats but sometimes mudflats. In these areas, the birds feed on molluscs, crustaceans, and other invertebrates. The species also frequents peat-rich banks, salt marshes, brackish lagoons, mangrove areas, and mussel beds.
Calidris minutilla	Least Sandpiper	S3S4B	0	0	0	Common migrant (generally in flocks) in Nova Scotia. In Nova Scotia, Least Sandpipers are known to nest in sand dunes. During migration they stop on coastal mudflats, rocky shorelines and inland habitats including wet meadows, flooded fields, and muddy edges of lakes, ponds and ditches. On the coast they usually avoid sandy beaches and wide-open tidal flats, preferring narrow tidal creeks and the edges of salt marshes. Breeds between April and July (Audubon and The Cornell Lab).
Calidris pusilla	Semipalmated Sandpiper	S1B,SUM	0	0	0	Common migrant in Nova Scotia. Migrates in flocks (adults before juveniles). May make very long nonstop flights between major feeding areas on migration. Semipalmated Sandpipers nest in low tundra, usually not far from marshes or ponds (both dry upland habitats with sufficient vegetation cover). In preparation for migration, they gather into flocks in shallow-water mudflats or lakeshores. Migrating birds stop over at sewage ponds, ephemeral wetlands (rain pools), beaches, inlets, estuaries, tidal mudflat, sandbars and freshwater impoundments with shallow margins (edges of lakes and marshes). Breeds between April and July (Audubon and The Cornell Lab).
Cardellina canadensis	Canada Warbler	S1B	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.

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Cardellina pusilla	Wilson's Warbler	S2S3	0	0	0	Found in thickets along wooded streams, moist tangles, low shrubs, willows, alders. Breeds in thickets, second-growth, bogs, or in alder and willow groves near streams and ponds. In migration and winter, occurs from hot lowland thickets up to cool mountain woods; always in scrubby overgrown clearings and thin woods, not in the interior of dense forest. Breeds between April and July (Cornell Lab, Audubon).
Cathartes aura	Turkey Vulture	S3S4B, S4S5M	0	0	0	In past was not surveyed/very rare to see Turkey Vultures in Nova Scotia, but as the climate warms they are now sighted across the province (MBBA and Nova Scotia Bird Society). Look for Turkey Vultures as they soar high over open areas. They are particularly noticeable along roadsides and at landfills. At night, they roost in trees, on rocks and other high secluded spots. Most common over open or semi-open country (including mixed farmland, forest, rangeland and even small offshore islands), especially within a few miles of rocky or wooded areas providing secure nesting sites. Generally avoids densely forested regions. Breeds between April and July (Audubon and The Cornell Lab)
Charadrius vociferus	Killdeer	S2S3B, S5N,S5M	0	0	0	Favours fields, sandbars, lawns, river banks, coastal estuaries, mudflats and shores. Often found on open ground, such as pastures, plowed fields and large lawns, even at a great distance from water. This species does well in areas disturbed by humans and is commonly spotted on roads, lawns, airports, parking lots, golf courses, fields and in gravel areas. Most successful nesting areas have some shallow water closeby or other good feeding area for the chicks. Generally the vegetation in fields inhabited by Killdeer is no taller than one inch. You can find Killdeer near water, but unlike many other shorebirds, they are also common in dry areas. Spring migration is very early, returning to some northern areas in February or March. Breeds between March and July (Audubon and The Cornell Lab).
Chlidonias niger	Black Tern	S3N	0	0	0	Uncommon migrant and breeder in Nova Scotia; has mainly been seen in Cumberland County. Migrants turn up in many sorts of wetland habitats: sewage lagoons, river edges, lakes, marshes, lagoons, beaches and over open ocean waters, even far out to sea. Black Terns nest in large freshwater wetlands, usually in dense marshes on the edges of shallow lakes associated with open prairies or northern forests (sometimes in rice fields or on river islands). Breeds in scattered colonies between April and July (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Chordeiles minor	Common Nighthawk	S3?N,SUM	Special Concern	Threatened	Threatened	Common Nighthawk breeds in a range of open and partially open habitats, including forest openings and post-fire habitats, prairies, bogs, and rocky or sandy natural habitats, as well as disturbed areas. It is also found in settled areas that meet its habitat needs, those with open areas for foraging and bare or short-cropped surfaces for nesting. The species use of a wide range of habitats makes it difficult to estimate trends in habitat availability, except in urban habitats, where their main nesting sites – flat graveled roofs – are disappearing.
Chroicocephalus ridibundus	Black-headed Gull	S2M	0	0	0	Most of this species in Nova Scotia likely comes from Iceland (followed by a sudden growth of the Icelandic nesting population in the 1930s). In winter, found primarily along seacoasts, estuaries and protected bays (generally rare on fresh waters well inland). Breeds along lakes, rivers, bogs, moors, grasslands, swamps and coastal marshes. Usually nests in colonies, sometimes in isolated pairs. Breeds in scattered colonies between April and July (Audubon and The Cornell Lab).
Coccothraustes vespertinus	Evening Grosbeak	S1B, S4M	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	S3M	0	0	0	Black-billed Cuckoos are birds of woodlands and thickets, including aspen, poplar, birch, sugar maple, hickory, hawthorn and willow. They tend to occur more frequently in larger and denser woodlands than the Yellow-billed Cuckoo. On their wintering grounds, they live in forest, woodlands and scrub. A long-distance migrant, going to South America for the winter. Migrates at night; sometimes heard calling in flight overhead at night during the spring. During migration, they seek any kind of dense vegetation cover (e.g. young trees or tall shrubs). Common breeder in Nova Scotia. Breeds mostly in deciduous thickets and shrubby places, often on the edges of woodland or around marshes. Also in second growth of mixed deciduous-coniferous woods, or along their brushy edges. Breeds between April and July (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Contopus cooperi	Olive-sided Flycatcher	S3B	Special Concern	Threatened	Threatened	Olive-sided Flycatcher has been widely observed in open coniferous or mixed coniferous forests, often located near water or wetlands with the presence of tall snags or trees from which the species sallies for prey and advertises its territory. Mature conifer stands within patchy landscapes influenced by natural disturbance (e.g., recent burns) support the highest densities of Olive-sided Flycatcher. Nests are generally placed toward the tip of coniferous branches (although other tree types have been used).
Contopus virens	Eastern Wood-Pewee	S3B, S5M	Special Concern	Special Concern	Vulnerable	The Eastern Wood-pewee is mostly associated with the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in forest stands of intermediate age and in mature stands with little understory vegetation. During migration, a variety of habitats are used, including forest edges, early and successional clearings.
Coturnicops noveboracensis	Yellow Rail	S2S3B, S4S5M	Special Concern	Special Concern	0	Yellow rail is distributed along northern Nova Scotia. Nesting Yellow Rails are typically found in marshes dominated by sedges, true grasses, and rushes, where there is little or no standing water (generally 0-12 cm water dept), and where the substrate remains saturated throughout the summer. They can be found in damp fields and meadows, on the floodplains of rivers and streams, in the herbaceous vegetation of bogs, and at the upper levels (drier margins) of estuarine and salt marshes. Nesting habitats usually have a dry mat of dead vegetation from previous growing seasons. A greater diversity of habitat types is used during migration and winter than during the breeding season. In winter, the rails are known to use coastal wetlands and rice fields. (COSEWIC Assessment and Status Report).
Dolichonyx oryzivorus	Bobolink	S3B	Special Concern	Threatened	Vulnerable	Bobolink has nested in forage crops (e.g., hayfields and pastures dominated by a variety of species, such as clover, Timothy, Kentucky Bluegrass, and broadleaved plants). The Bobolink occurs in various grassland habitats including wet prairie, graminoid peatlands and abandoned fields dominated by tall grasses, remnants of uncultivated virgin prairie (tall-grass prairie), no-till cropland, small-grain fields, restored surface mining sites and irrigated fields in arid regions. It is generally not abundant in short-grass prairie, Alfalfa fields, or in row crop monocultures (e.g., corn, soybean, wheat), although its use of Alfalfa may vary by region.

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Empidonax traillii	Willow Flycatcher	S1B	0	0	0	Uncommon breeder throughout mainland Nova Scotia, not Cape Breton (MBBA, as of July 2021). In winter, they use shrubby clearings, pastures and woodland edges often near water. Migrates relatively late in spring and early in fall. Breeds in thickets of deciduous trees and shrubs, especially willows, or along woodland edges. Often near streams or marshes and may be found in drier habitats than the Alder Flycatcher. Breeds between April and July (Audubon and The Cornell Lab).
Euphagus carolinus	Rusty Blackbird	S3B	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.
Falco sparverius	American Kestrel	S3N	0	0	0	Breeds in Nova Scotia but also can be a permanent resident. American Kestrels favor open areas with short ground vegetation and sparse trees (e.g. meadows, wood edges, grasslands, deserts, parks, farm fields, cities and suburbs). When breeding, kestrels need access to at least a few trees or structures that provide appropriate nesting cavities. American Kestrels are attracted to many habitats modified by humans, including pastures and parkland, and are often found near areas of human activity including towns and cities. In winter, females may occupy open habitats more so than males. Breeds between April and July (Audubon and The Cornell Lab).
Gallinago delicata	Wilson's Snipe	S3B,S3N,S3M	0	0	0	Common across Nova Scotia during breeding and also known as a permanet resident in the southern areas of the province. Wilson’s Snipes can be found in all types of wet, marshy settings, including wet fields, bogs, fens, swamps, wet meadows and along muddy edges of rivers and ponds. They avoid areas with tall, dense vegetation, but need patches of cover to hide in and to provide a safe lookout for predators. During the breeding season they are mainly found around fresh marshes and bogs, shrubby streamsides and northern tundra. Breeds between April and July (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
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	S3B	0	0	0	Baltimore Orioles are often very common in open woods and groves in summer. Found in open woods, riverside groves, elms, shade trees. Breeds in deciduous or mixed woodland, generally in open woods or edges rather than interior of dense forest. May be common in trees in towns (Audubon). Breeds between April and July (Audubon and The Cornell Lab).
Ixobrychus exilis	Least Bittern	S3S4B	Threatened	Threatened	0	The Least bittern has been observed in every Province in Canada. However, it is only probable to be located in Nova Scotia. The Least Bittern breeds strictly in marshes dominated by emergent vegetation surrounded by areas of open water. Most breeding grounds in Canada are dominated by cattails, but breeding also occurs in areas with other robust emergent plants and in shrubby swamps. The presence of stands of dense vegetation is essential for nesting because the nests of Least Bittern sit on platforms of stiff stems. The nests are almost always within 10 m of open water. This small heron prefers large marshes that have relatively stable water levels throughout the nesting period. Needs for wintering habitat are less specific, and appear to be met by a wide variety of wetlands—not only emergent marshes like those used for breeding, but also brackish and saline swamps (Environment Canada Recovery Strategy)
Lanius borealis	Northern Shrike	SUB	0	0	0	They occur in open but brushy habitats, and on calm, sunny days they may sit up on utility wires, bushes, and trees (Cornell Lab).Nests are usually placed in a low tree or large shrub, often in spruce or willow, usually 6-15' above the ground. Breeds between April and July (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Limnodromus griseus	Short-billed Dowitcher	S3B	0	0	0	Common migrant in Nova Scotia that prefers coastal habitats. Migrants are opportunistic in their choice of habitat, turning up in man-made environments such as impoundments, sewage ponds and flooded farm fields as well as in muddy margins of rivers, lakes and bays. Migrants also rest on rocky and sandy shorelines (beaches) and occasionally feed in such places, but they forage mostly where there is a fine muddy bottom covered by a few inches of water (pond edges, mudflats and tidal marshes). Breeds far north, mostly in open bogs, marshes and edges of lakes within coniferous forest zone. Breeds between April and July (Audubon and The Cornell Lab).
Limosa haemastica	Hudsonian Godwit	S2B	Threatened	Not on Schedule 1	0	Hudsonian Godwit occurs regularly during breeding or migration in all three territories and in provinces from British Columbia to Québec, as well as occasionally in the fall in all of the Atlantic provinces. Hudsonian Godwit breeds in wetland habitats (sedge meadows and muskeg) in sub-Arctic and Boreal regions. It uses a wide variety of habitats on migration, including freshwater marshes, saline lakes, flooded fields, shallow ponds, coastal wetlands and mudflats (COSEWIC Assessment and Status Report).
Loxia curvirostra	Red Crossbill	S2B	0	0	0	Found throughout the entire province year-round. Red Crossbills can be found in conifer forests and groves, and breeds in pines (predominately), spruce, hemlock, Douglas-fir, or other evergreens. Breeding occurs from April to July (The Cornell Lab, Audubon)
Mareca strepera	Gadwall	S3B,S4 S5M	0	0	0	Not common in Nova Scotia but there have been recent confirmed sightings, based on the distrbution list by county in this file (MBBA, as of July 2021) - Found in lakes, ponds and marshes. They choose well-vegetated wetlands for foraging and concealing themselves. Gadwall breed mainly in prairie potholes (small ponds scattered throughout the Great Plains and Canadian prairies, hence why they are uncommon in Nova Scotia). Will also breed on tundra, deltas and wetlands in boreal forests farther north. Equally important for breeding are adjacent uplands with vegetation to conceal nests and ducklings. Breeds between April and July (but compared to most ducks, nesting begins rather late) (Audubon and The Cornell Lab)

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Mimus polyglottos	Northern Mockingbird	S3B,S5M	0	0	0	Year-round resident throughout Nova Scotia, less common in Cape Breton. Found year-round in areas with open ground and shrubby vegetation (e.g. dense, low shrubs - hedges, fruiting bushes and thickets). When foraging on the ground, it prefers grassy areas, rather than bare spots. Common places include roadsides, parkland, cultivated land, suburban areas, woodland edges and in second-growth habitat at low elevations. Breeds between April and July (Audubon and The Cornell Lab).
Molothrus ater	Brown-headed Cowbird	S3B	0	0	0	Found in farms, fields, prairies, wood edges, river groves. Favors open or semi-open country at all seasons. In winter often concentrates in farmland, pastures, or cattle feedlots. More widespread in breeding season, in grassland, brushy country, forest edges, even desert, but tends to avoid dense unbroken forest. Breeds between April and July, and lays eggs in nests of other birds (Audubon and The Cornell Lab).
Myiarchus crinitus	Great Crested Flycatcher	S2S3B, SUM	0	0	0	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).
Numenius borealis	Eskimo Curlew	SUB	Endangered	Endangered	0	This species have not been recorded in Nova Scotia since 2007. On spring and fall migration, a wide variety of habitats was used historically, including both inter-tidal and terrestrial habitats, the latter including anthropogenic landscapes. As on the breeding areas, the Eskimo Curlew commonly used ericaceous heathland on fall migration in southern Quebec, Labrador, Newfoundland and the Maritime Provinces. On spring migration, they were found in tallgrass and eastern mixed grass prairies, often in areas that had been recently burned or disturbed by grazing bison, and in cultivated fields. (COSEWIC Assessment and Status Report).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Numenius phaeopus hudsonicus	Whimbrel	S3S4N	0	0	0	Common migrant in Nova Scotia. Migrating whimbrels feed mostly on tidal mudflats and sandflats; they also forage in saltmarshes, lagoons, estuaries and on reefs and rocky shorelines where small crabs are available. When not feeding, Whimbrels roost in flocks in marshes, meadows, fields, dunes and oyster beds, as well as on small islands and even in mangrove trees. Migrating Whimbrels are known to also use coastal tundra and heath in Alaska and Canada. North American Whimbrels breed in subarctic and alpine tundra and taiga, nesting in drier upland environments (heath) or (mainly) wetter lowlands with grasses, sedges, mosses, lichens, small shrubs and stunted trees. Breeds between April and July (The Cornell Lab and eBird).
Oxyura jamaicensis	Ruddy Duck	S3M	0	0	0	Uncommon in Nova Scotia during migration. Only a few confirmed sightings in Cumberland and Antigonish county (MBBA, as of July 2021) - Migration extends over a considerable period in both spring and fall. Migrating Ruddy Ducks stop in a variety of habitats, mainly on large, permanent wetlands, ponds, marshes, lakes and reservoirs. About 86 percent of the breeding population is concentrated in the prairie pothole region of south-central Canada, hence why they are uncommon in Nova Scotia. Breeds between April and July (Audubon and The Cornell Lab)
Passerella iliaca	Fox Sparrow	S2S3M	0	0	0	Found year round in Cape Breton, and throughout the migration season (late March and early November) in the rest of the province. Migrates at night. Found in wooded areas, undergrowth, brush. Breeds in brushy areas including woodland edges and clearings, streamside thickets, scrubby second growth, stunted coastal forest. Winters in similar habitats, also in brushy fields, chaparral, well-vegetated suburbs and parks. Breeds from April to July (The Cornell Lab, Audubon)
Passerina cyanea	Indigo Bunting	S3S4	0	0	0	This species favors brushy edges rather than unbroken forest. Indigo Buntings breed in brushy and weedy areas. They're common on the edges of woods and fields; along roads, streams, rivers, and powerline cuts; in logged forest plots, brushy canyons, and abandoned fields where shrubby growth is returning. They are also in clearings within deciduous woods, edges of swamps. Breeds between April and July (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Perisoreus canadensis	Canada Jay	S2B, SUM	0	0	0	Year-round resident throughout Nova Scotia and commonly referred to as the Gray Jay. No regular migration. On rare occasions, small invasions of Canada Jays will move a short distance out of boreal forest in winter. Prefers boreal and subalpine forests across northern North America, usually where black or white spruce trees are common (also aspen, white birch, balsam fir, sugar maple, jack pine, red spruce, eastern white cedar, etc.). Found in various kinds of coniferous and mixed forest, but rarely occurs where there are no spruce trees. Mated pairs stay together all year and defend permanent territories. Breeding and nesting for this species begins very early, during late winter, with breeding grounds still snow-covered. Breeds until, approximately, July (Audubon and The Cornell Lab).
Petrochelidon pyrrhonota	Cliff Swallow	S1B	0	0	0	Breeds throughout Nova Scotia. A long-distance migrant that migrates in flocks, traveling by day. Typically nests in colonies, sometimes with hundreds of nests crowded close together. These colonies are close to a water source, open fields or pastures for foraging, and a source of mud for nest building. Nest site is usually on vertical surface with some overhead shelter. Natural sites were on cliffs. Most sites today are on the sides of buildings, under bridges, in culverts or similar places. They now live in grasslands, towns, broken forest and river edges, but avoid heavy forest and deserts (e.g. open to semi-open land, farms, river bluffs and lakes). Still unaccountably scarce or missing in some seemingly suitable areas. Breeds between April and July (Audubon and The Cornell Lab).
Phalacrocorax carbo	Great Cormorant	S2B				Habitat is mainly over shallow waters close to shore, especially in sheltered bay areas. Nests on rocky sea cliffs of coasts and islands. In recent years, as population has increased, has been found in winter on large rivers inland. Breeds throughout the year, but mostly spring to late summer (April to August) (Audubon and The Cornell Lab)
Pheucticus ludovicianus	Rose-breasted Grosbeak	S1B				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)

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Picoides arcticus	Black-backed Woodpecker	SXM				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	S2S3M				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	S1B				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)
Pluvialis dominica	American Golden-Plover	S3S4B, S5M				Uncommon migrant across Nova Scotia. Found in prairies, mudflats and shores (tundra in the summer). During migration, usually found on short-grass prairies, flooded pastures, plowed fields and, less often, on shorelines, mudflats and beaches (also found in disturbed areas - airports, golf courses and tilled farmland for example). Breeds on Arctic tundra, especially in low vegetation on rocky slopes. Breeds between April and July (Audubon and The Cornell Lab).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Pluvialis squatarola	Black-bellied Plover	S1?B,SUM				Migrates through Nova Scotia. Found in mudflats, open marshes and beaches (tundra in the summer). Nesting occurs in drier tundra, often more barren ridges above lowland lakes and rivers (sometimes in lower wet tundra near coast). In winter, found mostly on open sand beaches and tidal flats. During migration will often stop in short-grass prairie or plowed fields, especially during high tides, when mudflats are underwater. In some places, they forage on rocky shorelines. Black-bellied Plovers roost together at high tide and overnight on beaches, saltmarshes and sometimes upland habitats such as farm fields. Most migrate along coast or over sea, but numbers stop over regularly at some inland sites. Breeds between April and July (Audubon and The Cornell Lab).
Podiceps auritus pop. 2	Horned Grebe - Western population	S3				The Horned Grebe winters on the coast of Nova Scotia. It has been observed on lakes, rivers and marshes. Some birds follow coastlines as part of their migration. Horned Grebes generally winter in marine habitats, mainly estuaries and bays. Birds are found in greatest numbers in coastal habitats, including areas that offer some degree of protection. Some birds winter on inland lakes and rivers in areas where the minimum temperature in January is higher than -1°C (Species art Risk Public Registry)
Poecile hudsonicus	Boreal Chickadee	S2S3B				Year-round resident throughout Nova Scotia. Occasional small southward invasions in fall, with a few appearing south of breeding range (similar to Black-capped Chickadees invasions). Boreal Chickadees inhabit mostly mature coniferous forests (sometimes mixed forests), usually spruce and balsam fir, often near water. During late fall and winter irruptions, they tend to be found mostly in areas dominated by coniferous trees. Occurs in low stunted spruces as far North as treeline (e.g. spruce bogs). May mate for life, the birds remaining together all year. Nests in a hole in a tree, either a natural cavity or one they created (or from another species). Breeds between April and July (Audubon and The Cornell Lab).
Pooecetes gramineus	Vesper Sparrow	S2S3B, S2S3N				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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Rallus limicola	Virginia Rail	S3B				Breeds across Nova Scotia, but more common in the northern region. Nests in a variety of marshy situations, mostly fresh, but also brackish marshes near the coast. Where this species and Sora breed in same marshes, Virginia Rail typically nests in drier spots. Often moves into salt marshes in winter. During migration, sometimes found in odd spots, even city streets. Virginia Rails occupy shallow (sometimes deeper) freshwater wetlands with tall stands of cattails and rushes (need areas with standing water typically less than 6 inches deep with a muddy bottom). They are most common in wetlands with 40–70% coverage of tall emergent vegetation, mixed with open water, mudflats and areas with matted vegetation. During the nonbreeding season, Virginia Rails use similar habitat, but may venture into more open areas. Breeds between April and July (Audubon and The Cornell Lab).
Riparia riparia	Bank Swallow	S3S4				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	S3B, S5N, S5M				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 pinus	Pine Warbler	S2B, SUM				Pine Warblers live in pine or mixed pine-deciduous forest. Also sometimes in cedar or cypress. Various spottings throughout Nova Scotia, generally in the southern portion of the province. Breeds April to July (The Cornell Lab, Audubon)
Setophaga striata	Blackpoll Warbler	S2S3M				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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Setophaga tigrina	Cape May Warbler	S3M				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	S3N, SUM				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).
Spatula clypeata	Northern Shoveler	S3				Migrates through all parts of Nova Scotia, except Cape Breton (uncommon for this species to breed in Nova Scotia). Migratory period is quite prolonged in both spring and fall, with many birds moving late in spring and early in fall. Northern Shovelers use shallow wetlands with submerged vegetation during the breeding season, nesting along the margins and in the neighboring grassy fields. Outside of the breeding season they forage in saltmarshes, estuaries, lakes, flooded fields, wetlands, agricultural ponds and wastewater ponds (and fields in vicinity of shallow water) with extensive muddy margins, including stagnant or polluted waters not much favored by other ducks. Pair formation begins in winter and continues during spring migration. Breeds between April and July (Audubon and The Cornell Lab)
Spatula discord	Blue-winged Teal	S1S2B, SUM				Found mainly in fresh ponds and marshes. In summer they use shallow freshwater marshes and ponds in open country, as well as brackish marshes near coast. In migration and winter they forage and stop in any kind of shallow waters, whether inland or coastal. Flocks in migration are sometimes seen over ocean, many miles offshore. They are flightless during their late summer molt, and they spend this time in prairie potholes or large marshes. Blue-winged Teal nest among grasses or herbaceous vegetation. Pair formation begins in early winter and continues during spring migration. Breeds between April and July (Audubon and The Cornell Lab)

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Spinus pinus	Pine Siskin	S2S3B				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)
Sterna paradisaea	Arctic Tern	S2B				Common on-shore in Nova Scotia for the breeding season and common off-shore during migration. At sea for most of year, in wide variety of situations, but seems to spend most time over cold waters and well offshore. Rarely found inland. They tend to migrate offshore although some individuals may migrate overland. They forage over streams, ponds, lakes, estuaries and the open ocean. Nests in colonies (sometimes with other tern species), sometimes in isolated pairs (in treeless areas with little to no ground cover (coastal tundra), in open boreal forests and on undisturbed small islands and barrier beaches). Breeds between April and July (Audubon and The Cornell Lab).
Toxostoma rufum	Brown Thrasher	S3S4B, S4S5M				Not common and rarely seen in Nova Scotia, with no recorded sightings in Cape Breton (MBBA, as of July 2021). In eastern North America, Brown Thrashers nest in thickets, brush, shubbery, hedgerows, forest edges and overgrown clearings in deciduous forest. On rare occasions they breed in backyards and gardens with shrubs and hedges (but in general - areas of dense low growth, especially thickets around edges of deciduous or mixed woods, shrubby edges of swamps or undergrowth in open pine woods). Breeds between April and July (Audubon and The Cornell Lab).
Tringa flavipes	Lesser Yellowlegs	S2S3B, S4S5M				Common migrant throughout Nova Scotia. Occurs widely in migration, including coastal estuaries, salt and fresh marshes, mudflats, shores/edges of lakes and ponds; typically more common on freshwater habitats. Often in same places as Greater Yellowlegs, but may be less frequent on tidal flats. Wetland habitats ranging from tidal flats to sewage ponds to flooded fields; often in the company of other shorebird species. Breeds in open boreal forests and meadows interspersed with marshes and bogs. Breeds between April and July (Audubon and The Cornell Lab).
Tringa melanoleuca	Greater Yellowlegs	S3B, S5M				Common migrant in Nova Scotia (migrates in flocks). During migration and throughout the winter, Greater Yellowlegs use a wide variety of fresh and brackish wetlands, including mudflats, estuaries, beaches, marshes, lake and pond edges, wet meadows, sewage ponds and flooded agricultural fields. Breeds in boggy and marshes places within northern coniferous forest. Breeds between April and July (Audubon and The Cornell Lab).

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Tyrannus tyrannus	Eastern Kingbird	S3B, SUM				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	S3B				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	S2B, 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).
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.

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Chrysemys picta picta	Eastern Painted Turtle	S4	Special Concern	Special Concern	0	Eastern Painted Turtle is found in New Brunswick, Nova Scotia, and the Atlantic coastal states east of the Appalachian Mountains. Painted Turtles occupy slow moving, relatively shallow and well-vegetated wetlands (e.g., swamps, marshes, ponds, fens, bogs, and oxbows) and water bodies (e.g., lakes, rivers, creeks, and streams) with abundant basking sites and organic substrate. These turtles are found in association with submergent aquatic plants, which are used for cover and feeding. The species is semi-tolerant of human-altered landscapes and may occasionally be found occupying urban ponds and lands subject to anthropogenic disturbance (e.g., farm ponds, impoundments, water treatment facilities). Suitable nesting habitat includes open, often south-facing, and sloped areas with sandy-loamy and/or gravel substrate usually within 1200 m of aquatic active season habitats. Painted Turtles overwinter in shallow water with deep sediment (COSEWIC Assessment and Status Report).
Glyptemys insculpta	Wood Turtle	S2	Threatened	Threatened	Threatened	Wood Turtles are strongly associated with meandering, shallow rivers with sand, gravel, and/or cobble bottoms; these rivers are typically clear, with moderate current and frequent oxbows. Wood Turtles hibernate aquatically in streams and rivers (October to April, depending on location). Overwintering sites are usually on the bottom of deep pools, often with fallen debris that provides structure and prevents dislodging during high flow events. Found throughought the Province with concentrations in Guysborough and Annapolis Counties. Local plants include alders, chokecherry, hawthorn and mixed wood stands of deciduous and coniferous trees. Females lay their eggs in sandy bars along rivers and other gravel areas (driveways, roadsides, borrow pits) in June.
Hemidactylium scutatum	Four-toed Salamander	S3	0	0	0	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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Anguilla rostrata	American Eel	S3B	Threatened	Not on Schedule 1	0	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).
Alosa pseudoharengus	Alewife	S3N	0	0	0	A marine fish that uses freshwater sreams for spawning, and is now landlocked in many inland lakes. They have been known to enter Grand, Shudenacadie Lake, as well as Fletcher Run and Rawdon rivers. In the Maritime provinces, spawning commences in May and continues until late in June (Scott and Crossman, 1973).
Culaea inconstans	Brook Stickleback	S5	0	0	0	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	0	0	0	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	S3	Endangered	Not on Schedule 1	0	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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Morone saxatilis pop. 2	Striped Bass - Bay of Fundy population	S2S3B, S2S3N	Endangered	Not on Schedule 1	0	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 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 (landlocked)	Atlantic Salmon (landlocked)	S2S3B, S2S3N				Found in Grand Lake and Lake Charlotte, Halifax Co. In the autumn they move into rocky shallows to prepare for spawning, in the winter they can be found throughout the lake, and in the spring they often occur in surface waters. As water warms up, salmon will retire to the cooler waters. Spawning occurs in the fall (Scott and Crossman, 1973).
Salmo salar pop. 6	Atlantic Salmon - Nova Scotia Southern Upland population	S1S2				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	S1				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)
Invertebrates						
Bombus bohemicus	Ashton Cuckoo Bumble Bee	S1	Endangered	Endangered	Endangered	Currently, nothing is known about the mating and overwintering habitat requirements for the Gypsy Cuckoo Bumble Bee. Overwintering habitat for bumble bees in Ontario may include rotting logs, leaf litter and mulch, burrows in soil, and garden compost. Forage habitat includes the plant species mentioned below as well as other flowering plants which bloom early spring (e.g. Willow) to late autumn (e.g. Goldenrod). Forage habitat occurs in old fields, grasslands, dunes, alvars, woodlands (especially in the spring) and road sides.

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Bombus suckleyi	Suckley's Cuckoo Bumble Bee	SH	Threatened	Not on Schedule 1	0	Suckley's Cuckoo Bumble Bee occurs in most Canadian ecozone including the Atlantic Maritimes. Suckley's Cuckoo Bumble Bee occurs in diverse habitats including open meadows and prairies, farms and croplands, urban areas, boreal forest, and montane meadows. Records are from sea level to 1200 m although the species could potentially occur at higher elevations where its host(s) occur. In the early spring, hosts typically establish nests in abandoned underground rodent burrows or other dry natural hollows; because Suckley's Cuckoo Bumble Bee is a nest parasite these same host residence sites also serve as its habitat. Adults have been recorded feeding on pollen and nectar from many flowers (COSEWIC Assessment and Status Report).
Bombus terricola	Yellow-banded Bumble Bee	S3	Special Concern	Special Concern	Vulnerable	Habitat generalist within open coniferous, deciduous and mixed-wood forests, wet and dry meadows and prairie grasslands, meadows bordering riparian zones, and along roadsides, urban parks, gardens and agricultural areas, subalpine habitats and more isolated natural areas.
Coccinella transversoguttata	Transverse Lady Beetle	SH	Special Concern	Special Concern	Endangered	The Transverse Lady Beetle is reported to be a habitat generalist occurring within agricultural areas, suburban gardens, parks, coniferous forests, deciduous forests, prairie grasslands, meadows, sand dune edges and riparian areas.
Coccinella transversoguttata richardsoni	Transverse Lady Beetle	SH	Special Concern	Special Concern	0	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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
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.)
Molluscs						
Alasmidonta undulata	Triangle Floater	S2S3	0	0	0	They prefer small, steady-flowing streams close to headwaters. It is sometimes found in lakes or ponds, and most often found in gravelly sand, mud, or between large stones. (Vermont Atlas, 2021a)
Alasmidonta varicosa	Brook Floater	S3	Special Concern	Special Concern	Threatened	Found in rivers, streams, and lakes. They prefer watercourses with a moderate to high water flow with rocks, cobble and sand-pocket areas and may also be found in certain lakes in Nova Scotia. They are typically found clustered in sand-pocket areas behind boulders and stream banks, likely as a means of protection in high-flow velocity. The Brook Floater occurs in a relatively small number of rivers, including the Annapolis, LaHave, Gays, Wallace, East St. Marys and Salmon Rivers in Nova Scotia.
Margaritifera margaritifera	Eastern Pearlshell	S2	0	0	0	The mussels live buried or partly buried in coarse sand and fine gravel in clean, oligotrophic, fast-flowing and unpolluted rivers and streams (Skinner et al., 2003).
Strophitus undulatus	Creeper	S3				Shallow freshwater. Riffles, moderate-low gradient, creek, pool (Nature Serve Explorer, 2021).
Vascular Plants						
Acer saccharinum	Silver Maple	S1	0	0	0	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	0	0	0	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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Agalinis purpurea var. parviflora	Small-flowered Purple False Foxglove	S2S3	0	0	0	Sandy soils of stream and lake margins, bogs, and barren (NatureServe, 2021)
Agalinis tenuifolia	Slender Agalinis	S1	0	0	0	Anthropogenic (man-made or disturbed habitats), brackish or salt marshes and flats, fresh tidal marshes or flats, meadows and fields, woodlands https://gobotany.nativeplanttrust.org/species/agalinis/tenuifolia/; Exotic to Nova Scotia, http://www.accdc.com/webranks/NSall.htm.
Ageratina altissima	White Snakeroot	S1S2	0	0	0	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	0	0	0	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?	0	0	0	Wet meadows, rocky or gravelly stream banks and lake shores. Flowering June to August (Flora North America).
Allium schoenoprasum var. sibiricum	Wild Chives	S1?	0	0	0	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?	0	0	0	DISTRIBUTION NOT KNOWN IN NS. Dry soil in upland woods. Flowering early June (Flora North America).
Amelanchier fernaldii	Fernald's Serviceberry	S2S3	0	0	0	Thickets, open barrens, shores, and ravines. Occurs mostly in calcareous areas. Grows in riparian and shrub wetlands (Nature Serve Explorer, nd). Flowers June - August (Munro, Newell & Hill, 2014).
Amelanchier nantucketensis	Nantucket Serviceberry	S1	0	0	0	Found in disturbed habitats such as roadsides, fields, sand plains, riparian meadows and barrens (Munro, Newell & Hill, 2014). Bloom time April to May (Missouri Botanical Garden, nd)
Amelanchier spicata	Running Serviceberry	S3S4	0	0	0	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)

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Andersonglossum boreale	Northern Wild Comfrey	S1	0	0	0	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	0	0	0	Grows in swamps, meadows, in ditches and along streams. Flowers late May until September. Very abundant in northern Cape Breton (Munro, Newell & Hill, 2014)
Antennaria parlinii	Parlin's Pussytoes	S2	0	0	0	Found in dry soils of pine and oak forests, pastures, oldfields, and rocky banks. Flowers in June or July. Only known from along the LaHave River (Bridgewater), the Halfway River (Hants County) and from several Kings County locations. More recently found along the Kennetcook River, Hants County and East Branch River John, Pictou County (Munro, Newell and Hill, 2014).
Antennaria parlinii ssp. fallax	Parlin's Pussytoes	S2	0	0	0	Found in dry soils of pine and oak forests, pastures, oldfields, and rocky banks. Flowers in June or July. Only known from along the LaHave River (Bridgewater), the Halfway River (Hants County) and from several Kings County locations. More recently found along the Kennetcook River, Hants County and East Branch River John, Pictou County (Munro, Newell and Hill, 2014).
Antennaria rosea	Rosy Pussytoes	S1	0	0	0	The rosy-coloured flowers are distinctive and like no others of the genus in NS. It has very recently been confirmed at Cape d'Or (Munro, Newell and Hill, 2014).
Antennaria rosea ssp. arida	Rosy Pussytoes	S1	0	0	0	The rosy-coloured flowers are distinctive and like no others of the genus in NS. It has very recently been confirmed at Cape d'Or (Munro, Newell and Hill, 2014)
Asplenium viride	Green Spleenwort	S3	0	0	0	Limestone and other basic rocks (Flora of North America).
Barbarea orthoceras	American Yellow Rocket	S1	0	0	0	It inhabits ice-scoured river shores on high-pH bedrock or till, and on wet talus in the subalpine zone.

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Bartonia virginica	Yellow Bartonia	S3S4	0	0	0	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.
Betula michauxii	Michaux's Dwarf Birch	S3	0	0	0	Limited to peat bogs. It flowers later than many, in July and August. Scattered localities from Brier Island, Digby Co., east to Guysborough, Cape Breton and Inverness counties (Munro, Newell & Hill, 2014).
Bidens beckii	Water Beggarticks	S3S4	0	0	0	Found in shallows of sluggish streams and ponds. Flowers during August and September. Scattered throughout but more abundant from Pictou northward. (Munro, Newell and Hill, 2014).
Bidens hyperborea	Estuary Beggarticks	S2S3	0	0	0	Its habitat is limited to estuarine conditions. Flowers in August. Reported from River Philip and known from Antigonish and Inverness counties (Munro, Newell and Hill, 2014).
Boehmeria cylindrica	Small-spike False-nettle	S2S3	0	0	0	Understory herb of moist deciduous forests in Nova Scotia. Flowers from July - September.Elsewhere found in swamps. locally very abundant on the LaHave R fromNew Germany to Bridgewater , local on the Annapolis R atKingston and there's one record from the ShubenacadieWildlife Park (Munro, Newell & Hill, 2014)
Botrychium lanceolatum	Triangle Moonwort	S2S3	0	0	0	Kentville Ravine (Kings County); Colchester, Cumberland and a few sites in western Cape Breton. Rare where found and of limited distribution in the Northern counties. Found where there are fertile soils on wooded hillsides. Bogs, fens, forests, meadows, fields, swamps and edges of wetlands. This species releases its spores later than most moonworts (July to August) (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Botrychium lanceolatum ssp. angustisegmentum	Narrow Triangle Moonwort	S2S3	0	0	0	Kentville Ravine (Kings County); Colchester, Cumberland and a few sites in western Cape Breton. Rare where found and of limited distribution in the Northern counties. Found where there are fertile soils on wooded hillsides. Bogs, fens, forests, meadows, fields, swamps and edges of wetlands. This species releases its spores later than most moonworts (July to August) (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).

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Botrychium lunaria	Common Moonwort	S1	0	0	0	Known from Conrad's Beach, Halifax County and from New Campbellton and Indian Brook in northern Cape Breton. Found on open slopes, sand or gravel; shores and meadows. Basic soils. Anthropogenic habitats (man-made or disturbed habitats), fields and edges of wetlands. Spores are produced throughout the summer (Go Botany and Munro et al., 2014).
Botrychium lunaria var. lunaria	Moonwort Grapefern	S1	0	0	0	Known from Conrad's Beach, Halifax County and from New Campbellton and Indian Brook in northern Cape Breton. Found on open slopes, sand or gravel; shores and meadows. Basic soils. Anthropogenic habitats (man-made or disturbed habitats), fields and edges of wetlands. Spores are produced throughout the summer (Go Botany and Munro et al., 2014).
Botrychium simplex	Least Moonwort	S2S3	0	0	0	Scattered locations from Yarmouth County to Cape Breton: Cedar Lake (Digby-Yarmouth border), West Berlin (Queens County), Petpeswick and in Antigonish, Victoria and Inverness Counties. Reported from various habitats, usually involving damp or mossy streambanks or lakeshores. Also anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: occurs primarily in open sites, including prairies, wetlands, and abandoned mine sites. Spores produced in late May and June (Minnesota DNR, Go Botany and Munro et al., 2014).
Botrychium simplex var. simplex	Least Moonwort	S2S3	0	0	0	Scattered locations from Yarmouth County to Cape Breton: Cedar Lake (Digby-Yarmouth border), West Berlin (Queens County), Petpeswick and in Antigonish, Victoria and Inverness Counties. Reported from various habitats, usually involving damp or mossy streambanks or lakeshores. Also anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: occurs primarily in open sites, including prairies, wetlands, and abandoned mine sites. Spores produced in late May and June (Minnesota DNR, Go Botany and Munro et al., 2014).
Bromus latiglumis	Broad-Glumed Brome	S2	0	0	0	Floodplain (River or stream floodplains), forest, shores of rivers or lakes (Go Botany)
Cardamine dentata	Toothed Bittercress	S1	0	0	0	rare species of calcareous swamps and fens
Cardamine maxima	Large Toothwort	S2	0	0	0	rich, moist forests. Floodplain (river or stream floodplains), forests, talus and rocky slopes
Cardamine parviflora	Small-flowered Bittercress	S3	0	0	0	Flowers early, from April to August. Dry, shady ledges, exposed soils; sandy substrates. Bay of Fundy counties, from Brier Island to Cape d'Or. Central and northern Cape Breton.

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Carex adusta	Lesser Brown Sedge	S2S3	0	0	0	dry open forest or recent clearings (cutblocks) on acidic, gravelly soils. Frequent after fire. Flowering and fruting from June to September (Munro, Newell & Hill, 2014)
Carex grisea	Inflated Narrow-leaved Sedge	S1	0	0	0	floodplain forest and deciduous woods (Munro, Newell & Hill, 2014)
Carex houghtoniana	Houghton's Sedge	S2S3	0	0	0	sandy soils, along roadsides. Sandy disturbed area.
Carex lupulina	Hop Sedge	S3	0	0	0	Found in muck soils, in forests, swamps, swales and intervales. Flowers and fruits in June (Munro, Newell & Hill 2014)
Carex normalis	a Sedge	S1	0	0	0	Open, often wet, woods, thickets, meadows and roadsides. Fruiting early summer (Flora of North America, nd)
Carex peckii	White-Tinged Sedge	S2?	0	0	0	Dry or mesic slopes, mixed deciduous forests, rocky outcrops, old quarry. Flowering and fruiting from May - mid-July. So far known from White Rock, Kings Co., Rhodes Co., Lunenburg Co. and Halifax and the Pennants area, Halifax Co. (DAL herbarium only) (Munro, Newell & Hill 2014)
Carex pensylvanica	Pennsylvania Sedge	S1?	0	0	0	Grows in dry, rocky soils as in dry open woodlands. Flowers and fruits produced early to mid-May (Munro, Newell & Hill 2014)
Carex plantaginea	Plantain-Leaved Sedge	S1	0	0	0	Rich, moist, deciduous or mixed deciduous-evergreen forests, on slopes along streams or along edges of moit depressions, southward in mountain gorges. Fruiting in spring (Flora of North America, nd)
Carex rosea	Rosy Sedge	S3	0	0	0	Grows in dry soils beneath deciduous forests and thickets. Flowers from May to early July.
Carex scirpoidea ssp. scirpoidea	Scirpuslike Sedge	S2S3	0	0	0	Moist alpine meadows, stream banks, and open rocky slopes, thin and rocky soils, rock outcrops, and talus slopes. Flowers June - August (DNR WA, nd)
Carex vacillans	Estuarine Sedge	S1S3	0	0	0	Saline, brackish shores, swales, salt and intertidal marshes. Fruiting in June to August (Flora of North America).
Carex viridula ssp. brachyrrhyncha	Greenish Sedge	S1	0	0	0	Found along river and lake shores (Go Botany).
Carex viridula var. elatior	Greenish Sedge	S1	0	0	0	Moist to wet fens and runnels, on lime-rich soils. Fruiting in July-August (Flora North America).
Carex viridula var. saxilittoralis	Greenish Sedge	S1	0	0	0	Moist to wet, exposed shores and limestone barrens. Fruiting July-August (Flora North America).

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Caulophyllum thalictroides	Blue Cohosh	S2S3	0	0	0	Shade-tolerant, restricted to river floodplain deciduous forests. Appears in April, until beginning of June. A wide and patchy distribution over the northern portion of the province from Annapolis River to River Denys in Cape Breton (Munro, Newell & Hill, 2014).
Cerastium arvense ssp. strictum	Matted Field Chickweed	S1?	0	0	0	flowers May until frost.cliffs, talus slopes, quarries, rocky beaches, coastal headlands, and in high-pH and serpentine communities. Compacted soils, especially on moist lawns and other arable land
Ceratophyllum echinatum	Prickly Hornwort	S3	0	0	0	Marshes. A plant more typical of the shallows of acidic water bodies than its congener.
Cochlearia tridactylites	Limestone Scurvy-grass	S1	0	0	0	Summer-flowering. Brackish or calcareous soils. Little White Island and Big White Island, Halifax County represent the only confirmed localities yet.
Coleataenia longifolia	Long-leaved Panicgrass	S3S4	0	0	0	Marshes, meadows and fields, shores of rivers or lakes (GO Botany).
Coleataenia longifolia ssp. longifolia	Coastal Plain Panicgrass	S3S4	0	0	0	Marshes, meadows and fields, shores of rivers or lakes (GO Botany).
Comandra umbellata ssp. umbellata	Bastard's Toadflax	S2	0	0	0	Found in swamps and bogs, rich mesic sites, dry, sandy or rocky soils, savannas, early successional forests. Flowers March - August (Flora of North America, nd)
Conioselinum chinense	Chinese Hemlock-parsley	S3	0	0	0	Found in treed swamps, mossy coniferous forest, seepy coastal slopes. Flowers from August to October. Common on Saint Paul Island and infrequent elsewhere (Munro, Newell & Hill, 2014).
Conopholis americana	American Cancer-root	S2	0	0	0	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?	0	0	0	Anthropogenic (man-made or disturbed habitats), forest edges, meadows and fields, shrublands or thickets. Flowers in June (GoBotany, nd).
Crataegus succulenta	Fleshy Hawthorn	S3S4	0	0	0	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	0	0	0	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).

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Cuscuta cephalanthi	Buttonbush Dodder	S2?	0	0	0	Flowers during August and September. Low-lying coastal areas, often seen parsitizing Symphyotrichum novi-begii.Anthropogenic (man-made or disturbed habitats), meadows and fields, shores of rivers or lakes, swamps
Cyperus lupulinus ssp. macilentus	Hop Flatsedge	S1	0	0	0	Various well-drained, open places. Fruiting summer (Flora North America).
Cypripedium parviflorum var. makasin	Small Yellow Lady's-Slipper	S2	0	0	0	Mesic to wet fens, prairies, meadows, thickets, open coniferous, and mixed forest. Flowering in May to August (Flora of North America).
Cypripedium reginae	Showy Lady's-Slipper	S2	0	0	0	Found at Meander River in Hants Co., Musquodoboit River Valley, Halifax Co. Lives in alkaline swamps and bogs. Flowers from June to August (Munro, et al. 2014).
Diphasiastrum complanatum	Northern Ground-cedar	S3S4	0	0	0	Infrequent, scattered through the Cobequid hills southwest to the Annapolis Valley and east to Cape Breton. Deciduous forests and brushy hillsides spreading out into abandoned fields. Anthropogenic (man-made or disturbed habitats) habitats, forest edges, forests, meadows and fields. Flowers from July to October (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Diphasiastrum sitchense	Sitka Ground-cedar	S3S4	0	0	0	Has been observed in Kings County to Northern Victoria County. Commonly found on alpine and subalpine barrens or wooded slopes in Northern Nova Scotia. Also found in anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: somewhat rare but widespread ground-cedar hybrid that frequently occurs in the absence of its parents. No sources that state specific flowering time, most likely during the general growing season in Nova Scotia: June to September (Go Botany and Munro et al., 2014).
Diphasiastrum x sabinifolium	Savin-leaved Ground-cedar	S3?	0	0	0	Has been observed in Kings County to Northern Victoria County. Commonly found on alpine and subalpine barrens or wooded slopes in Northern Nova Scotia. Also found in anthropogenic habitats (man-made or disturbed habitats), meadows and fields. Subspecies: somewhat rare but widespread ground-cedar hybrid that frequently occurs in the absence of its parents. No sources that state specific flowering time, most likely during the general growing season in Nova Scotia: June to September (Go Botany and Munro et al., 2014).
Elatine americana	American Waterwort	S1	0	0	0	Brackish or salt marshes and flats, lacustrine (in lakes or ponds), riverine (in rivers or streams), shores of rivers or lakes

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Eleocharis erythropoda	Red-stemmed Spikerush	S1	0	0	0	Non-calcareous or calcareous fresh or brackish shores. Fruiting occurs in the summer (Flora North America).
Eleocharis flavescens	Pale Spikerush	S3	0	0	0	Bogs, brackish or salt marshes and flats, floodplain (river or stream floodplains), marshes, shores of rivers or lakes, wetland margins (edges of wetlands) (Go Botany).
Eleocharis flavescens var. olivacea	Bright-green Spikerush	S3	0	0	0	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).
Eleocharis ovata	Ovate Spikerush	S2S3	0	0	0	Grows on muddy streamsides, streambeds, and lakeshores often in subisding water. Fruiting from May through October. (Munro, et al. 2014).
Empetrum atropurpureum	Purple Crowberry	S2S3	0	0	0	Alpine or subalpine zones, mountain summits and plateaus, ridges or ledges
Empetrum eamesii	Pink Crowberry	S3	0	0	0	flower early, producing fruit from July until frost. Habitat includes sands and gravels of headlands, bogs and barrens. Recently found at South Canoe Lake a Corema community on granite.Collected from Halifax to Peggys Cove and in northern Cape Breton, with both subspecies having similar distribution in the province
Epilobium lactiflorum	White-flowered Willowherb	S1?	0	0	0	Alpine or subalpine zones, cliffs, balds or ledges, shores of rivers or lakes (GoBotany, nd).
Epilobium strictum	Downy Willowherb	S3	0	0	0	Scattered through throughout Cape Breton Island, infrequently elsewhere - Found in bogs and other peatlands - Flowers July to September (Munro, Newell & Hill, 2014)
Equisetum palustre	Marsh Horsetail	S1	0	0	0	A single collection each from Kings County and Halifax Counties. Found in edges of wetlands, marshes, swamps and shores of rivers or lakes. Flowers in summer (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Equisetum pratense	Meadow Horsetail	S3S4	0	0	0	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).
Erigeron philadelphicus	Philadelphia Fleabane	S2S3	0	0	0	Habitats include fields, meadows and springy slopes. Not common, scattered stations from Digby and Cumberland counties to central Cape Breton. Flowers from June to August (Munro, Newell & Hill, 2014).

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Erigeron philadelphicus var. philadelphicus	Philadelphia Fleabane	S2S3	0	0	0	Habitats include fields, meadows and springy slopes. Not common, scattered stations from Digby and Cumberland counties to central Cape Breton. Flowers from June to August (Munro, Newell & Hill, 2014).
Eriophorum gracile	Slender Cottongrass	S3	0	0	0	Grows in wet peat and inundated shores. Flowers and fruits during early summer. (Munro, et al. 2014).
Eriophorum gracile ssp. gracile	Slender Cottongrass	S3	0	0	0	Grows in wet peat and inundated shores. Flowers and fruits during early summer. (Munro, et al. 2014).
Euphrasia farlowii	Farlow's Eyebright	S1S3	0	0	0	Dry, grassy habitats on sandstone or limestone barrens, rocks, ledges, sandy beaches. http://beta.floranorthamerica.org/Euphrasia_farlowii
Fagus grandifolia	American Beech	S3S4	0	0	0	Forests
Fallopia scandens	Climbing False Buckwheat	S3S4	0	0	0	Uncommon and local, from Digby to Richmond counties on the northern side of the province - Grows on low ground in riparian zones - Flowers mid-August to October (Munro, Newell & Hill, 2014)
Festuca prolifera	Proliferous Fescue	S1S2	0	0	0	Alpine or subalpine zones, cliffs, balds, or ledges, talus and rocky slopes (Go Botany).
Festuca prolifera var. prolifera	Proliferous Fescue	S1S2	0	0	0	Proliferous fescue is a rare alpine species found only in Maine and New Hampshire, where it forms mats on cliffs, seeps and in ravines https://gobotany.nativeplanttrust.org/species/festuca/prolifera/.
Fimbristylis autumnalis	Slender Fimbry	S1	0	0	0	Moist to wet sands, peats, slits, or clays primarily of disturbed, sunny ground such as seeps, ditches, savanna, stream banks, reservoir drawdowns, and pond shores (Flora of North America)
Fragaria vesca	Woodland Strawberry	S3S4	0	0	0	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	0	0	0	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).

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Fraxinus nigra	Black Ash	S1S2	Threatened	Not on Schedule 1	Threatened	Black ash is typically found in poorly drained areas that are often seasonally flooded. It is most common on peat and muck soils, but also grows on fine sands over sands and loams. Although this species can tolerate still semi-stagnant conditions, there is a preference for swampy woodland stream and river banks with moving water. It is often associated with species such as Red maple, Speckled alder, Balsam poplar, and Black spruce. The species is shade intolerant, and seedlings, saplings and sprouts tend to regenerates only in partially opened forest canopies.
Fraxinus pennsylvanica	Red Ash	S1	0	0	0	Flowers May - June. Found in riparian and upland forest and shelter belts (Minnesota Wildflowers, nd)
Galium aparine	Common Bedstraw	S3S4	0	0	0	Composts, ballast and waste soils. Flowers from May until July (Munro, Newell & Hill, 2014)
Gentianella amarella ssp. acuta	Northern Gentian	S1	0	0	0	Open and forested river banks, subalpine gullies and brook sides, occurring in regions of high-pH bedrock and/or till.
Geocaulon lividum	Northern Comandra	S3S4	0	0	0	Damp sands and other sterile soils, especially in acid or peaty sites. Flowers from late May to early August (Munro, Newell & Hill, 2014)
Geranium bicknellii	Bicknell's Crane's-bill	S3	0	0	0	Colonizes recently burned or cleared land; recently exposed lakeshores. Flowers from late June to July (Munro, Newell & Hill, 2014)
Goodyera pubescens	Downy Rattlesnake-Plantain	S2S3	0	0	0	Forms in large colonies in woodlands and thickets. Flower in July and August (Munro, et al., 2014).
Goodyera repens	Lesser Rattlesnake-plantain	S3S4	0	0	0	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).
Hedeoma pulegioides	American False Pennyroyal	S2S3	0	0	0	Found in coastal areas in stony soils on open sites. Most common on the hills surrounding the Annapolis Valley and scattered in Colchester and Cumberland counties; infrequent elsewhere. Flowers in August
Hepatica americana	Round-lobed Hepatica	S2	0	0	0	Local and rare at Bridgewater, New Minas, Windsor, Pictou, Stewiacke, Antigonish and at a couple of North Mountain sites. Recently discovered along the Cogmagun River, Hants Co. Long known from along the St. Andrews River. Populations at Wolfville and St. Croix appear to be extirpated. Grows in dry, mixed deciduous forests. Flowers in April (Munro, Newell & Hill, 2014)
Hieracium paniculatum	Panicled Hawkweed	S3S4	0	0	0	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).

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Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Hordeum brachyantherum	Meadow Barley	S1	0	0	0	Grows in pastures and along streams and lake shores (Flora of North America).
Hordeum brachyantherum ssp. brachyantherum	Meadow Barley	S1	0	0	0	Grows in pastures and along streams and lake shores (Flora of North America).
Hudsonia ericoides	Pinebarren Golden Heather	S2	0	0	0	Late May to early in July. Sand barrens and other areas where the soil is dry and rocky, as at Jack Pine barrens at Williams Lake, Halifax Co. Ranges from Shelburne to Halifax counties along the Atlantic shore and known from several localities through the centre of the Annapolis Valley. Only a single Cape Breton locality.
Humulus lupulus var. lupuloides	Common Hop	S1?	0	0	0	Anthropogenic (man-made or disturbed habitats), floodplain (river or stream floodplains), forests, shrublands or thickets
Huperzia selago	Northern Firmoss	S1?	0	0	0	Limited to the northern half of the province, as far west as Brier Island, Digby County. Many localities clustered about the Bay of Fundy, inland to the south-facing slopes of the Cobequids and along the slopes of northern Cape Breton. Grows in rock crevices along streams and moist ravines. Anthropogenic habitats (man-made or disturbed habitats), cliffs, balds, or ledges, forests, meadows and fields, shores of rivers or lakes. Flowers from summer to early fall (Minnesota Environment and Natural Resources Trust Fund, Go Botany and Munro et al., 2014).
Hylodesmum glutinosum	Large Tick-trefoil	S2	0	0	0	Anthropogenic (man-made or disturbed habitats), cliffs, balds, or ledges, forest edges, forests, ridges or ledges, talus and rocky slopes. Flowers June to August
Hypericum majus	Large St John's-wort	S2S3	0	0	0	Flowers July to September. Wet or dry open soil.wet or dry open soil in bogs, marshes, ditches, meadows, woodlands, and other damp habitats.[4] It prefers elevations between 0–1,200 m Widely scattered locations. Until recently, only known from Halifax area and Big Baddeck, Victoria County, and thought to be historic.
Hypericum x dissimulatum	Disguised St. John's-wort	S2S3	0	0	0	Wet mucky soils in lacustrine habitats. Historically collected from Digby to Halifax Co. with a single specimen from each of Pictou and Guysborough counties (Munro, Newell & Hill, 2014).
Juncus alpinoarticulatus	Northern Green Rush	S2	0	0	0	Fen, fresh tidal marsshes or flats, marshes, meadows and fields, shores of rivers or lakes. Fruiting mid summer to fall (Go Botany).

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Juncus anthelatus	Greater Poverty Rush	S1?	0	0	0	Exposed or partially shaded sites in moist or seasonally wet sandy or clay soils. Flowering and fruiting in spring (Flora North America).
Juncus caesariensis	New Jersey Rush	S3	Special Concern	Special Concern	Vulnerable	New Jersey Rush is reported from 16 bogs and fens on the coastal plain of southeastern Cape Breton Island, Nova Scotia. These sites ranged from the Gracieville/Point Michaud area in the south, northeastwards along the coast to Fourchu Bay, a distance of approximately 50 km. Populations also occurred as much as 20 km inland (vicinity of Loch Lomond). The frequent association of this species with animals and lightly used all-terrain-vehicle trails on the edges of bogs and fens suggests a possible dependence on some level of disturbance for the maintenance of open habitat. These disturbances would reduce competition from other species. Seasonal flooding of New Jersey Rush habitats would also prevent the establishment of many species including shrubs.
Juncus greenei	Greene's Rush	S2	0	0	0	Found only on sandy soils and in dune hollows. Flowers and fruits produced from June through October. (Munro, et al., 2014).
Juncus stygius ssp. americanus	Moor Rush	S3	0	0	0	Wet moss, bogs and bog-pools. Flowering and fruiting in mid to late summer.
Juncus subcaudatus	Woods-Rush	S3S4	0	0	0	Conifer woods and spruce swamps, where substrate is soggy. Flowers and fruits produced from July through October. (Munro, et al. 2014).
Koeleria spicata	Narrow False Oats	S3S4	0	0	0	Grows in rocky soils on outcrops, cliffs, streamsides. Flowers and fruits from June through August (Munro, et al., 2014).
Lactuca hirsuta	Hairy Lettuce	S2S3	0	0	0	Grows in dryish soils in open forest and cut-overs. Scattered in the western part of NS. Flowers from July through September (Munro, Newell & Hill, 2014).
Limosella australis	Southern Mudwort	S3S4	0	0	0	Only on muddy shores or gravels of ponds, lakes and rivers along the coast. Flowers late June to October (Munro, Newell & Hill, 2014)
Liparis loeselii	Loesel's Twayblade	S3S4	0	0	0	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	0	0	0	Bogs, meadows and fields, swamps, wetland margins (edges of wetlands) (Go Botany).
Luzula parviflora ssp. melanocarpa	Black-fruited Woodrush	S3S4	0	0	0	uncommon in damp coniferous or mixed woods, cool ravines and banks (Hinds, 2000)

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Lysimachia minima	Chaffweed	S1	0	0	0	Its habitat is typically described as sandy or muddy soil that is prone to temporary standing water, such as pond edges and low ground in old fields. Flowers April - September (Minnesota Wildflowers, nd). Can also be found in man-made or disturbed habitats (GoBotany, nd)
Lysimachia quadrifolia	Whorled Yellow Loosestrife	S1	0	0	0	Anthropogenic (man-made or disturbed habitats), grassland, woodlands, fens, moist prairies (GoBotany, n.d.). Flowers from July - August (LBJ Wildflower Centre, nd).
Malaxis monophyllos	White Adder's-mouth	S1	0	0	0	Found in Fens, ridges or ledges, swamps with northern white-cedar. Flowering in summer (GoBotany).
Malaxis monophyllos var. brachypoda	North American White Adder's-mouth	S1	0	0	0	Found in swamps and bogs. Flower in summer (Flora fo North America).
Mononeuria groenlandica	Greenland Stitchwort	S3	0	0	0	peak flowering time of two weeks in the middle of July,[4] although it does flower anywhere between June to August. isolated and elevated areas. Thin coarse soil or in cracks of acidic rock on open rocky alpine and sub-alpine areas. Sometimes forming large masses in the appropriate habitat.
Montia fontana	Water Blinks	S1	0	0	0	Seepy slopes and rills, wet or brackish shores. Flowers June - September Found on the Northwest Arm Halifax (1883), Brier Island, Digby Co.; Port Hawkesbury, Inverness Co. Abundant on the east side of Burke Brook, Advocate, Cumberland Co. (Munr, Newell and Hill, 2014).
Nabalus racemosus	Glaucous Rattlesnakeroot	S1	0	0	0	Favours calcareous riverbanks, shores and damp prairies (Maine Department of Agriculture, Conservation & Forestry, nd).
Neottia bifolia	Southern Twayblade	S3	0	0	0	Bogs and swamps (Go Botany)
Nuphar microphylla	Small Yellow Pond-lily	S3S4	0	0	0	Ponds, lakes, sluggish streams, sloughs, ditches and occasionally tidal waters. Flowers summer - early fall (Flora of North America, nd)
Oenothera fruticosa	Narrow-leaved Evening Primrose	S2S3	0	0	0	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)

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Oenothera fruticosa ssp. tetragona	Narrow-leaved Evening Primrose	S2S3	0	0	0	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	0	0	0	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).
Oreojuncus trifidus	Highland Rush	S3	0	0	0	Grows in a number of habitat types, especially in alpine environments. Found on cliffs and ledges, fellfields, tundra, meadows. The soils may be dry to moist, calcareous and acidic (Wikipedia).
Osmorhiza longistylis	Smooth Sweet Cicely	S2S3	0	0	0	Intervale soils where fertility is high; deciduous forests. Flowers Late June to July. Scattered along the North Mountain in Annapolis and Kings counties to Cumberland Cobequids, infrequent in Cape Breton (Munro, Newell and Hill, 2014)
Oxybasis rubra	Red Goosefoot	S2S3	0	0	0	moist, disturbed soils such pond and lake shores, river and creek banks, and mud flats. Flowers July to September
Oxybasis rubra var. rubra	Red Goosefoot	S2S3	0	0	0	In New York, Red Pigweed has been found along the coast in wet interdunal swales, stony beaches, and the shores of coastal ponds, as well as amongst ship ballast and waste places (New York Natural Heritage Program 2010). Salt marshes (Clemants 1992). Salt marshes and brackish soil (Gleason and Cronquist 1991). Waste ground, shores, and river banks (Voss 1985).
Oxytropis campestris var. johannensis	Field Locoweed	S2	0	0	0	Ice-scoured river shores in regions of high-pH bedrock and/or till, on ledge, cobble, and gravel substrate. Calcareous rock ledges, gravel, and outcrops near rivers and bays. Variety reported to be relatively common in Newfoundland and Quebec. Also known from from 7 occurrences in Maine, all on the St. John River.
Packera paupercula	Balsam Groundsel	S3S4	0	0	0	Confined to calcareous or gypsum soils, on cliffs, talus and outcrops. Flowers in July. Abundant where found but local to Hants Co. north to northern Inverness Co. (Munro, Newell & Hill, 2014).
Packera paupercula var. paupercula	Balsam Groundsel	S3S4	0	0	0	Confined to calcareous or gypsum soils, on cliffs, talus and outcrops. Flowers in July. Abundant where found but local to Hants Co. north to northern Inverness Co. (Munro, Newell & Hill, 2014).

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Panicum dichotomiflorum ssp. puritanorum	Spreading Panicgrass	S1?	0	0	0	Flowering and fruiting from June through October
Parnassia parviflora	Small-flowered Grass-of-Parnassus	S1S2	0	0	0	Rocky seeps. Flowers August to September (Jepson Herbarium, 2021)
Persicaria amphibia var. emersa	Long-root Smartweed	S3?	0	0	0	Bloom on moist soil and are terrestrial-adapted. Flower June - September (Flora of North America)
Persicaria arifolia	Halberd-leaved Tearthumb	S3	0	0	0	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	0	0	0	Low thickets, swamps, bogs, moist shorelines, clearings, recent burns, cultivated ground. Flowering July - October (Flora of North America, nd)
Persicaria pensylvanica	Pennsylvania Smartweed	S3S4	0	0	0	Moist, disturbed places, ditches, riverbanks, cultivated fields, shorelines of ponds and reservoirs. Flowers May - December (Flora of North America, nd)
Pilea pumila	Dwarf Clearweed	S3				Usually grows in cool shady habitats as found on forested slopes of maple-beech, in the centre of the Province. Flowers from July - October. So far only known from West Branch, Pictou Co.; Little River, near Brookfield, Halifax Co.; and along the Herbert River, Hants Co. at Woodville.
Piptatheropsis canadensis	Canada Ricegrass	S3				Dry sandy or gravelly soil. Open woods clearings, pine plantations, barrens, wooded slopes. Fruiting season-July (Minnesota Wildflowers).
Plantago rugelii	Rugel's Plantain	S3				Grows in anthropogenic (man-made or disturbed habitat), grassland, meadows, fields (GoBotany, nd)
Platanthera flava var. herbiola	Pale Green Orchid	S2				Known from a variety of habitats: sandy, gravelly or peaty shorelines of lakes or streams; bogs, swamps and meadows. Found along the Tusket River, Yarmouth Co., Medway River, Queens County and north to Kings and Colchester Co. (Kemptown) (Munro, Newell & Hill, 2014).
Platanthera grandiflora	Large Purple Fringed Orchid	S3				Found in north-central and Southwestern NS. Favours wet meadows and riparian habitiats. Flowers in July.

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Platanthera hookeri	Hooker's Orchid	S3				Scattered in most of the province, local in the southwestern counties. So far absent from the eastern shore. Grows in open dry forests of mixed conifers. Flower appear from May to August (Munro, et al., 2014).
Platanthera huronensis	Fragrant Green Orchid	S1S2				No good record found. Habitat are known from streamsides, in wetlands, even forests. Flowers throughout the summer (Munro, et al., 2014).
Platanthera obtusata	Blunt-leaved Orchid	S3S4				Fens, Forests, Meadows field and swamps
Podostemum ceratophyllum	Horn-leaved Riverweed	S1				Medium to fast flowing river bottoms with ledge, cobble or sand substrate (GoBotany, nd)
Polygala sanguinea	Blood Milkwort	S3				Previously documented throughout the central/ northern mainland, usually in scant populations - Prefers acidic or run-out soil as found in fallow fields or brushlands - Flowers from late June into October (Munro, Newell & Hill, 2014)
Polygonum aviculare ssp. buxiforme	Box Knotweed	S2S3				Roadsides, vacant lots, sidewalks, packed and nondrifting sands, borders of marshes and dunes. Flowering July - December (Flora of North America, nd)
Polygonum aviculare ssp. neglectum	Narrow-leaved Knotweed	S3?				Found in disturbed areas. Flowers June - November (Flora of North America, nd)
Polygonum oxyspermum	Sharp-fruit Knotweed	S2S3				Collected from Shelburne and Queens counties, east to Strait of Canso; Bras d'Or Lakes to northern Cape Breton - Found in damp sands and gravels on the coast - Terminally deciduous ocreae with prominent persistent veins; smooth achenes without tubercles (Munro, Newell & Hill, 2014)
Polygonum oxyspermum ssp. raii	Ray's Knotweed	S2S3				Collected from Shelburne and Queens counties, east to Strait of Canso; Bras d'Or Lakes to northern Cape Breton - Found in damp sands and gravels on the coast - Ocreae are scarcely veined and nearly all deciduous; the achenes are roughened and sometimes tubercled (Munro, Newell & Hill, 2014)
Polypodium appalachianum	Appalachian Polypody	S3				Nova Scotia distrbiution still remains unclear. Habitat is restricted to cliffs, rocky slopes, balds, ridges or ledges and talus. No sources that state specific spore production time, most likely during the general growing season in Nova Scotia: June to September (Go Botany and Munro et al., 2014).

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Potamogeton polygonifolius	oblong-leaved pondweed	S1				Occurs in almost any wet or semi-wet oligotrophic and/or acidic habitat so long as flow is not too rapid. It may be found in lakes, slow-flowing rivers, ponds, ditches, seeps and among bog mosses (Wikipedia).
Potentilla canadensis	Canada Cinquefoil	S2S3				Found on dry rock barrens and other open areas. Flowers in June. (Munro, Newell & Hill, 2014)
Potentilla litoralis	Coastal Cinquefoil	S1				Coastal beaches (sea beaches), meadows and fields, ridges or ledges (GoBotany, nd). Flowering in the summer (Floras of Nova Scotia, 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)
Rhinanthus minor ssp. groenlandicus	Little Yellow Rattle	S1				Grows on disturbed, compacted soils as on roadsides, abandoned fields and the like. Flowers from mid-June through July (Munro, Newell & Hill, 2014)
Ribes americanum	Wild Black Currant	S1				Look for this shrub on shady slopes and in bottomland thickets where soils are fertile. Reported here from Truro and Windsor areas (Munro, Newell & Hill, 2014). Flowers May to June (Minnesota Wildflower, nd)
Rosa acicularis	Prickly Rose	S1				Found in thickets and rocky shaded slopes on acidic soil. Reported only from Beaverbank, Halifax Co. Flowers mid-June to July (Munro, Newell & Hill, 2014)
Rosa acicularis ssp. sayi	Prickly Rose	S1				Across its range, it grows in a wide variety of forested and open habitats, with a wide variety of soil and moisture conditions. Flowers in the spring (Schori, 2003)
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)
Sagina nodosa	Knotted Pearlwort	S3				Flowers from July to September. Coastal cliffs, sand flats and dune slopes. Cliffs, balds, or ledges, coastal beaches (sea beaches), meadows and fields, ridges or ledges Scattered from Annapolis to Guysborough counties. Nova Scotia Plants by Munro, Newell & Hill (2014).

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Salix glauca var. cordifolia	Beautiful Willow	S1				Sand and cobbles among granitic boulders, sandy alluvium, on exposed eskers, scree slopes, Sphagnum bogs, Empetrum heaths, snowbeds. Flowers late May - early July (Flora of North America, nd)
Salix myrtillifolia	Blueberry Willow	S1				Reed bogs, fens, stream banks, subalpine spruce thickets, Pinus contorta woods, sand dunes, coal spoils. Flowers early May - late July (Flora of North America, nd)
Salix pedicellaris	Bog Willow	S3				Grows in acidic substrate as in bogs; nutrient-rich marshes and in sphagnous lacustrine habitats. Flowers from May - July. Queens County, occasionally seen along Sharpe Brook in Kings County. Collections from South Branch, Stewiacke River, Colchester Co., Black River fen, Inverness Co. and several Queens Co. localities are recent. (Munro, Newell & Hill, 2014)
Salix sericea	Silky Willow	S3				Low-lying ground as in riparian zones. Flowers in late March until May. Rare and only reported from western NS. Parr Lake and Lake Fanning, Yarmouth Co.; Queens and Lunenburg counties to Halifax County,. (Munro, Newell & Hill, 2014)
Salix serissima	Autumn Willow	S1				Fens, meadows and fields, swamps (GoBotany, nd). Also found in brackish marshy strands, marly lakeshores, treed bogs, gravelly stream banks, lakeshores. Flowers from early June to early July (Flora of North America, nd).
Samolus parviflorus	Seaside Brookweed	S3				Prefers wet places, shallow water, often on tidal shores.It can also be found in brackish or salt marshes and flats, fresh tidal marshes or flats, riverine (in rivers or streams), swamps (GoBotany, nd; Newell, L. 1977)
Saxifraga cernua	Nodding Saxifrage	S1				Imperfectly drained moist areas (near creeks and lakeshores, on moist ledges and in exposed dry sites); acidic, or calcareous, or nitrophilous (often near Thule sites and human habitation), or circum-neutral. Spring to summer flowering time (Aiken et al. 2007)
Saxifraga oppositifolia ssp. oppositifolia	Purple Mountain Saxifrage	S1				Arctic and alpine tundra, mountain ledges, rock crevices, calcareous gravel, raised beach ridges. Flowers spring - summer (Flora of North America, nd)
Sceptridium dissectum	Dissected Moonwort	S3				Frequent in the southwestern counties and scattered eastward to Cape Breton. Not abundant but often seen. Generally in sandy, gravelly, grassy or open soils. Spores from September to November (Munro et al., 2014).
Solidago hispida	Hairy Goldenrod	S1?				Grows in wooded banks and rocky shores. Infrequent, occasionally seen from Yarmouth to Colchester counties (Munro, Newell & Hill, 2014).
Solidago hispida var. hispida	Hairy Goldenrod	S1?				Grows in wooded banks and rocky shores. Infrequent, occasionally seen from Yarmouth to Colchester counties (Munro, Newell & Hill, 2014).

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Solidago rugosa var. sphagnophila	Cedar-swamp Goldenrod	S1S3				Frequents waste soils, forests and fallow fields. Flowers late in August through September. Common throughout the province (Munro, Newell & Hill, 2014).
Sparganium androcladum	Branching Bur-Reed	S1				Found in lakes, ponds, rivers ro streams or the shore of rivers or lakes (Go Botany).
Spiranthes ochroleuca	Yellow Ladies'-tresses	S3?				Located in the western half of the province, northwest to Hants Co. Found in driest sand barrens, roadsides, and fields. Autumn-flowering from Sept-Oct (Munro, et al., 2014).
Stellaria humifusa	Saltmarsh Starwort	S2S3				Flowers from June to August. Limited to saltmarshes. Cumberland, Colchester and along the Atlantic coast from Halifax to Cape Breton County. It is possibly more common than the collections indicate.
Stellaria longifolia	Long-leaved Starwort	S3				Flowers appear from May until July. Damp grassy habitats, in sandy or mucky soils. moist habitat, including meadows, marshes, and roadsides.Locally abundant along the Salmon River at Truro and Kemptown, Colchester Co.; along the Musquodoboit and Stewiacke rivers; Isle Haute
Symphyotrichum boreale	Boreal Aster	S3				Favours lacustrine gravels, streamsides and edges of peatlands. Flowers during August and September . Scattered from Yarmouth to Cape Breton uncommon (Munro, Newell & Hill, 2014).
Symphyotrichum ciliolatum	Fringed Blue Aster	S3				Favours open fields, lawns and edges. Flowers during August and September. Scattered from Hants and Colchester counties to Cumberland, Pictou and Inverness counties (Munro, Newell & Hill, 2014).
Symphyotrichum undulatum	Wavy-leaved Aster	S3				Favours edges of fields and forests. Flowers during August and September. Scattered about Lunenburg Co, Queens, Hants, Kings, and Halifax (Munro, Newell & Hill, 2014).
Thalictrum confine	Northern Meadow-rue	S1				Alluvial or shingly calcareous shores and talus. Flowers June - July (Flora of North America, nd)
Toxicodendron vernix	Poison Sumac	S1				Usually found in swamps or marshes. Flowers from May to July. Only known in Telfer Lake and Apple Tree Lake in Queens county (Munro, Newell & Hill, 2014)
Trichostema dichotomum	Forked Bluecurls	S1				Relatively new to Nova Scotia. Found in anthropogenic/disturbed habitats, grasslands, meadows and fields, sandplains and barrens (GoBotany, nd). Flowers from August to October (Peterson & McKenny, 1968).
Triosteum aurantiacum var. aurantiacum	Orange-fruited Tinker's Weed	S3				Dry-mesic to mesic forests, woodlands, and forest borders

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Utricularia ochroleuca	Yellowish-white Bladderwort	S1				Shallow (generally <30cm) acidic waters. Flowers June - September (Jepson Herbarium, 2021)
Vaccinium boreale	Northern Blueberry	S3S4				Grows on the windswept headlands and barrens. Flowering late spring–early summer.Scattered at several Cape Breton localities, rare on the mainland.
Vaccinium uliginosum	Alpine Bilberry	S3				Wide tolerance of moisture and fertility, but generally acidic soils. bedrock outcrops, alpine thickets. Flowers in June. Ranges from Halifax and Digby along the east coast to Baleine; northern Cape Breton.
Vallisneria americana	Wild Celery	S2S3				Locally abundant: Shortts Lake, Colchester Co. Along the Musquodoboit River, Halifax Co.; Lake Killarney, Cumberland Co. Reported from northern Cape Breton. Found only in quiet waters. Flowers from July to October. (Munro, et al. 2014).
Verbena hastata	Blue Vervain	S3S4				Limited to mucky fertile soils, as along floodplains. Flowers during August - September (Munro, Newell & Hill, 2014)
Veronica catenata	Pink Water-Speedwell	S1				Shores of rivers or lakes, wetland margins (edges of wetlands) (GoBotany, nd). Flowers May - September (Minnesota Wildflowers, nd)
Viola sagittata	Arrow-Leaved Violet	S3S4				Sterile woods, clearing and fields. Flowers April - May (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).
Lichen						
Anzia colpodes	Black-foam Lichen	S3	S3	Threatened	Threatened	Anzia colpodes requires mature deciduous tree habitats with high humidity and high light levels. The required humidity is supplied by wetlands, nearby brooks, lakes or by the host's position on upland slopes above a water body. Host tree trunks are usually free of dense undergrowth and the lichen usually occurs at or above the height of the undergrowth (in swamps and fens). A few of the Anzia collections from are reported to be from the canopy of Red Maple trees. Recent searches have found that A. colpodes occurs from 20 cm above the ground to 2 m up the tree trunks.

Antrim Gypsum Mine - Priority Species List
ACCDC Rankings: June 2022

McCallum Environmental Ltd.

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Erioderma mollissimum	Graceful Felt Lichen	S1	S1	Endangered	Endangered	As of January 2012, Vole Ears Lichen was known from two populations at 29 sites along the Atlantic Coast of Nova Scotia totaling 153 adults and 23 juveniles. Vole Ears Lichen is often found in, or very near to, wetlands. It is found at the following specific sites: Blandford, Bon Mature Lake, Canada Hill/Mackenzies Barren, Clyde River Road1, Clyde River Road2, Duck Hole, Four Mile Brook, Fresh Water Brook, Haley Lake, Johnstons Pond, Jones Harbour, Jordan River, Lake John Road, Martin Brook, Misery Lake, Misery Lake Brook, Oakhill, Port L'Herbert, Pumpkinvine Brook, Robarts Pond, Robs Lake, Thomas Radall, Provincial Park, and Tidney.
Erioderma pedicellatum	Boreal Felt Lichen	S1	S1	Endangered	Endangered	The existing boreal felt lichen occurs within 25 km of the sea coast at an elevation of up to 300 m above sea level and they are found in forested habitats with low open crown closure. Boreal Felt Lichens are typically found in balsam fir stands, on north-facing trunks of mature and overmature trees. Habitat preference for boreal felt lichen is cool and moist and remains relatively constant throughout the year. They are often located on or at the base of slopes with northern or northeastern exposure.
Fuscopannaria leucosticta	White-rimmed Shingle Lichen	S3	S3	Not on Schedule 1	0	The second subpopulation in Nova Scotia occurs mainly on the east coast of southwestern Nova Scotia (in Shelburne and Queens counties), with sporadic sites throughout the eastern mainland. Common understorey associates of Fuscopannaria leucosticta include ferns in the genus Osmundastrum, hollies, and ash, with peat mosses dominating the ground cover in depressions and feathermosses dominating on hummocks.Fuscopannaria leucosticta grows on the bark of Red Maple trees in Nova Scotia (COSEWIC Assessment and Status Report).

Antrim Gypsum Mine - Priority Species List
ACCDC Rankings: June 2022

McCallum Environmental Ltd.

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Pannaria lurida	Wrinkled Shingle Lichen	S2S3	S2S3	Threatened	Threatened	The Wrinkled Shingle Lichen colonizes mature deciduous trees, most often Red Maple that grow near, but not usually within, imperfectly drained habitats. Hence, this lichen is found on trees close to the edge of treed swamps or floodplains. The Wrinkled Shingle Lichen most frequently inhabits sites near imperfectly drained, humid habitats dominated by deciduous trees. Such sites are close to the edge of treed swamps or riparian floodplains, or are at the base of moderate to steep slopes. A few occurrences are known from upland hardwood stands at the tops of slopes that are less than 100m in elevation. Only two occurrences are within a few kilometres of the coast. Canopy density is moderately open. The lichen grows on the rough bark of mature trees, mainly on the more sun-exposed sides. Red maple is the main host species, with poplar the second most frequent species. It is also known from Black and White Ash, Sugar Maple, Red Oak and American Beech.
Pannaria lurida ssp. russellii	Wrinkled Shingle Lichen	S2S3	S2S3	Threatened	Threatened	The Wrinkled Shingle Lichen colonizes mature deciduous trees, most often Red Maple that grow near, but not usually within, imperfectly drained habitats. Hence, this lichen is found on trees close to the edge of treed swamps or floodplains. The Wrinkled Shingle Lichen most frequently inhabits sites near imperfectly drained, humid habitats dominated by deciduous trees. Such sites are close to the edge of treed swamps or riparian floodplains, or are at the base of moderate to steep slopes. A few occurrences are known from upland hardwood stands at the tops of slopes that are less than 100m in elevation. Only two occurrences are within a few kilometres of the coast. Canopy density is moderately open. The lichen grows on the rough bark of mature trees, mainly on the more sun-exposed sides. Red maple is the main host species, with poplar the second most frequent species. It is also known from Black and White Ash, Sugar Maple, Red Oak and American Beech.
Pectenia plumbea	Blue Felt Lichen	S3	S3	Special Concern	Vulnerable	The Blue Felt Lichen is usually found on the trunks of old broad-leaved trees growing in moist habitats or close to streams and lake margins. This lichen occurs in coastal suboceanic areas but also some distance inland in damp valleys. It prefers cool, humid woodlands that may be mixed coniferous/hardwood or dominated by deciduous trees. The Blue Felt Lichen seems to prefer mature deciduous trees, particularly maple, ash and yellow birch. At its northerly limit of distribution in Nova Scotia, the Blue Felt Lichen has once been found on moss-covered rocks.

Antrim Gypsum Mine - Priority Species List
ACCDC Rankings: June 2022

McCallum Environmental Ltd.

Scientific Name	Common Name	SRank	COSEWIC	SARA	NSESA	Habitat Description
Peltigera hydrothyria	Eastern Waterfan	S1	S1	Threatened	Threatened	Eastern Waterfan grows attached to rocks at or below water level in clear, cool, partially shaded streams. Small waterfalls, exposed boulders and sinuous stream configurations create quiet or protected backwaters where the lichen grows outside the main current. In summer, this lichen is often partially or completely exposed during low water flow periods. Partial shade may be needed to help keep humidity high and temperatures low during summer months.
Sclerophora peronella (Atlantic pop.)	Frosted Glass-whiskers (Atlantic population)	S3S4	S3S4			This lichen has only been collected in two localities in Nova Scotia. It was observed on Cape Breton Island, in two forests in Inverness County. 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).

APPENDIX C: ACCDC REPORT

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

DATA REPORT 7222: Lake Egmont, NS

Prepared 23 March 2022
by J. Pender, Data Manager

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
LkEgmontNS_7222ob.xls	Rare or legally-protected Flora and Fauna in your study area
LkEgmontNS_7222ob100km.xls	A list of Rare and legally protected Flora and Fauna within 100 km of your study area
LkEgmontNS_7222msa.xls	Managed and Biologically Significant Areas in your study area

1.2 RESTRICTIONS

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

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

1.3 ADDITIONAL INFORMATION

The accompanying Data Dictionary provides metadata for the data provided.

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

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

Animals (Fauna)
John Klymko
Zoologist
(506) 364-2660
john.klymko@accdc.ca

Data Management, GIS
James Churchill
Conservation Data Analyst / Field Biologist
(902) 679-6146
james.churchill@accdc.ca

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

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

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

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

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

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

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

2.0 RARE AND ENDANGERED SPECIES

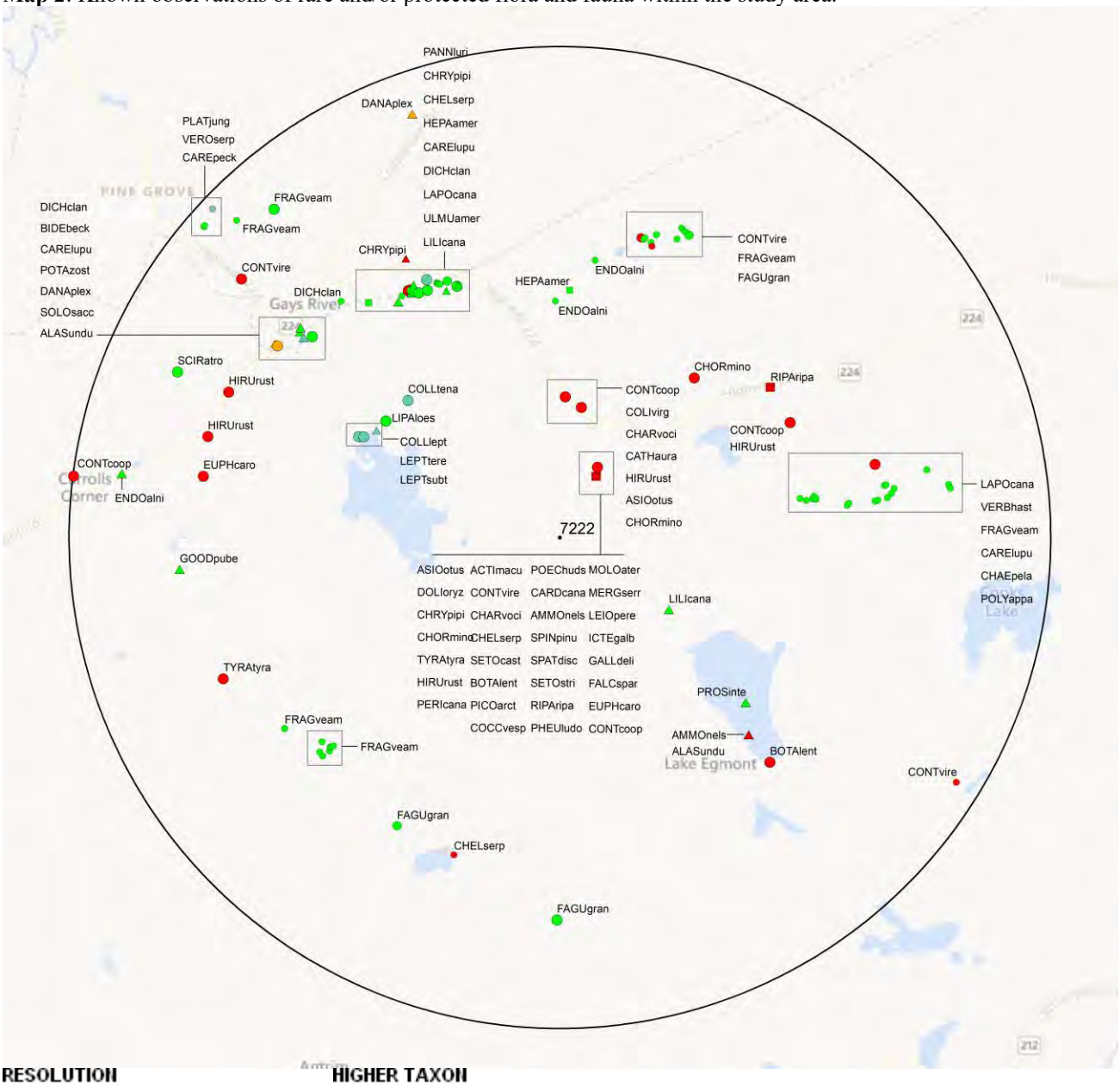
2.1 FLORA

The study area contains 81 records of 19 vascular, 7 records of 7 nonvascular flora (Map 2 and attached: *ob.xls), excluding 'location-sensitive' species.

2.2 FAUNA

The study area contains 112 records of 34 vertebrate, 4 records of 2 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

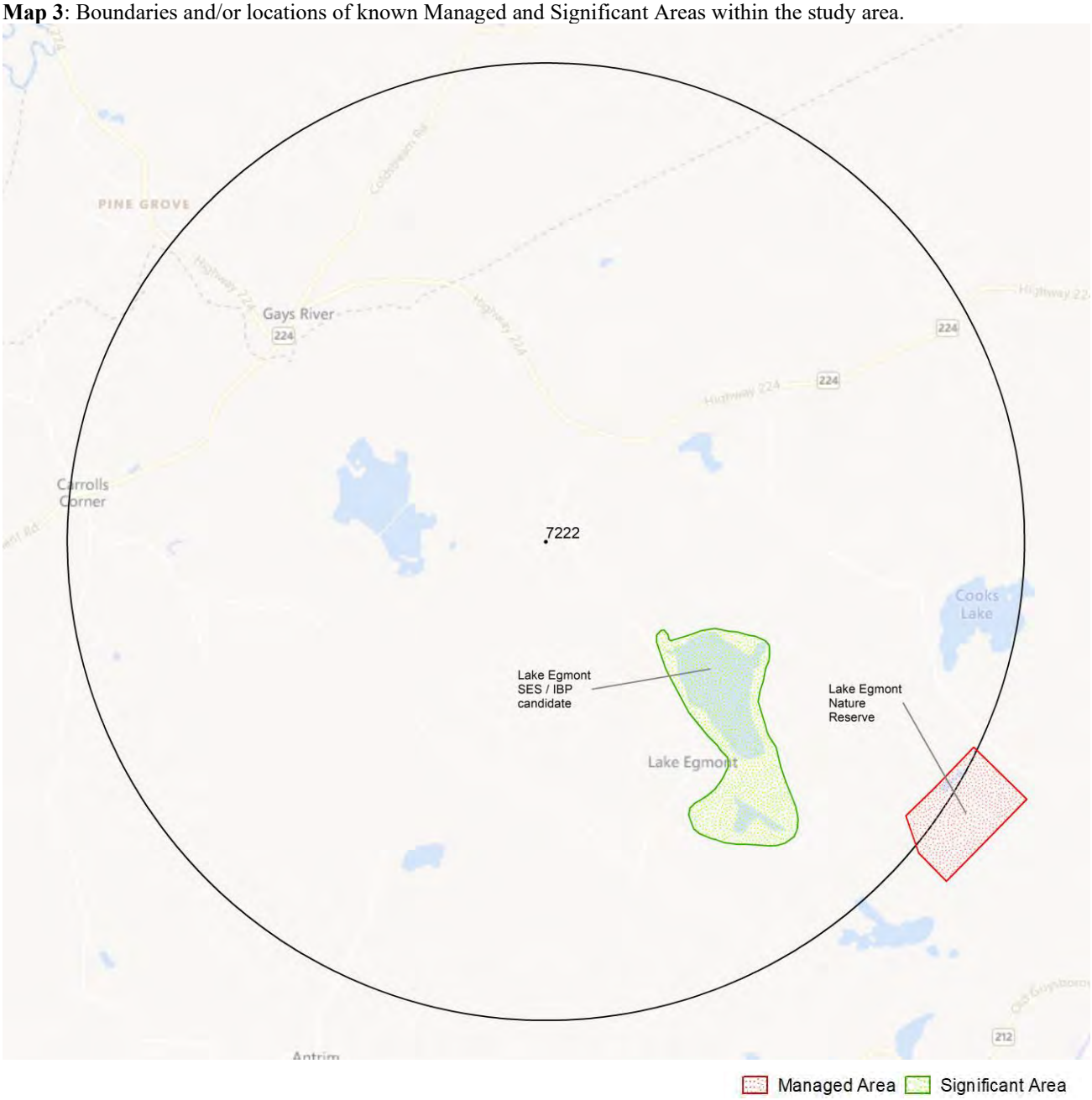
3.1 MANAGED AREAS

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

3.2 SIGNIFICANT AREAS

The GIS scan identified 1 biologically significant site in the vicinity of the study area (Map 3 and attached file: *msa.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	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened	Threatened	S2S3	1	3.0 ± 0.0
N	*Platydictya jungermannioides*	False Willow Moss				S2?	1	4.9 ± 0.0
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2S3	1	2.3 ± 0.0
N	*Solorina saccata*	Woodland Owl Lichen				S3	1	3.3 ± 2.0
N	*Enchylium tenax*	Soil Tarpaper Lichen				S3S4	1	2.1 ± 0.0
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S3S4	1	2.2 ± 0.0
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3S4	1	2.2 ± 0.0
P	*Scirpus atrovirens*	Dark-green Bulrush				S1	1	4.2 ± 0.0
P	*Proserpinaca intermedia*	Intermediate Mermaidweed				S1S2	1	2.5 ± 0.0
P	*Hepatica americana*	Round-lobed Hepatica				S2	14	2.5 ± 7.0
P	*Lilium canadense*	Canada Lily				S2	2	1.3 ± 1.0
P	*Carex peckii*	White-Tinged Sedge				S2?	1	4.8 ± 0.0
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S2S3	1	3.9 ± 1.0
P	*Laportea canadensis*	Canada Wood Nettle				S3	9	2.6 ± 0.0
P	*Carex lupulina*	Hop Sedge				S3	5	2.6 ± 0.0
P	*Potamogeton zosteriformis*	Flat-stemmed Pondweed				S3	3	3.4 ± 0.0
P	*Polypodium appalachianum*	Appalachian Polypody				S3	1	4.0 ± 0.0
P	*Bidens beckii*	Water Beggarticks				S3S4	1	3.4 ± 0.0
P	*Fagus grandifolia*	American Beech				S3S4	3	3.3 ± 0.0
P	*Endotropis alnifolia*	alder-leaved buckthorn				S3S4	3	2.4 ± 0.0
P	*Fragaria vesca ssp. americana*	Woodland Strawberry				S3S4	23	2.9 ± 0.0
P	*Veronica serpyllifolia*	Thyme-Leaved Speedwell				S3S4	1	4.8 ± 0.0
P	*Ulmus americana*	White Elm				S3S4	1	2.9 ± 1.0
P	*Verbena hastata*	Blue Vervain				S3S4	5	2.5 ± 0.0
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	1	2.1 ± 0.0
P	*Dichanthelium clandestinum*	Deer-tongue Panic Grass				S3S4	5	2.8 ± 0.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Colinus virginianus*	Northern Bobwhite	Endangered	Endangered			1	1.4 ± 0.0
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2B	5	0.7 ± 7.0
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Endangered	S2S3B,S1M	1	3.3 ± 0.0
A	*Dolichonyx oryzivorus*	Bobolink	Threatened	Threatened	Vulnerable	S3B	5	0.7 ± 7.0
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Endangered	S2B	3	0.7 ± 7.0
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	3	0.7 ± 10.0
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S3B	11	0.7 ± 7.0
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Endangered	S3B	1	0.7 ± 7.0
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Threatened	Threatened	S3B	7	0.7 ± 7.0
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S3B	5	0.7 ± 7.0
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern	Vulnerable	S3B,S3N,S3M	4	0.7 ± 7.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	10	0.7 ± 7.0
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	7	0.7 ± 10.0
A	*Ammospiza nelsoni*	Nelson's Sparrow	Not At Risk			S3S4B	2	0.7 ± 7.0
A	*Molothrus ater*	Brown-headed Cowbird				S2B	1	0.7 ± 7.0

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Asio otus*	Long-eared Owl				S2S3	2	0.7 ± 7.0
A	*Cathartes aura*	Turkey Vulture				S2S3B,S4S5M	1	1.4 ± 0.0
A	*Icterus galbula*	Baltimore Oriole				S2S3B,SUM	2	0.7 ± 7.0
A	*Perisoreus canadensis*	Canada Jay				S3	1	0.7 ± 7.0
A	*Poecile hudsonicus*	Boreal Chickadee				S3	1	0.7 ± 7.0
A	*Spinus pinus*	Pine Siskin				S3	2	0.7 ± 7.0
A	*Spatula discors*	Blue-winged Teal				S3B	1	0.7 ± 7.0
A	*Charadrius vociferus*	Killdeer				S3B	8	0.7 ± 7.0
A	*Tyrannus tyrannus*	Eastern Kingbird				S3B	4	0.7 ± 7.0
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	2	0.7 ± 7.0
A	*Falco sparverius*	American Kestrel				S3B,S4S5M	5	0.7 ± 7.0
A	*Gallinago delicata*	Wilson's Snipe				S3B,S5M	4	0.7 ± 7.0
A	*Setophaga striata*	Blackpoll Warbler				S3B,S5M	1	0.7 ± 7.0
A	*Picoides arcticus*	Black-backed Woodpecker				S3S4	1	0.7 ± 7.0
A	*Botaurus lentiginosus*	American Bittern				S3S4B,S4S5M	5	0.7 ± 7.0
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B,S4S5M	2	0.7 ± 7.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	2	0.7 ± 7.0
A	*Leiothlypis peregrina*	Tennessee Warbler				S3S4B,S5M	1	0.7 ± 7.0
A	*Mergus serrator*	Red-breasted Merganser				S3S4B,S5M,S5N	1	0.7 ± 7.0
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Endangered	S2?B,S3M	2	3.5 ± 0.0
I	*Alasmidonta undulata*	Triangle Floater				S2S3	2	2.8 ± 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	No
Emydoidea blandingii	*Blanding's Turtle - Nova Scotia pop.*	Endangered	Vulnerable	No
Glyptemys insculpta	**Wood Turtle**	**Threatened**	**Threatened**	**YES**
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.	Special Concern	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.

# recs	CITATION
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20	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2015. Atlantic Canada Conservation Data Centre Fieldwork 2015. Atlantic Canada Conservation Data Centre, # recs.
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1	eBird. 2020. eBird Basic Dataset. Version: EBD_relNov-2019. Ithaca, New York. Nov 2019, Cape Breton Bras d'Or Lakes Watershed subset. Cornell Lab of Ornithology.
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1	Manthorne, A. 2019. Incidental aerial insectivore observations. Birds Canada.
1	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2013.
1	NS DOE. 1991-1992. Nova Scotia Protected Areas database. Nova Scotia Department of Environment.
1	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.

5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 28704 records of 145 vertebrate and 1346 records of 66 invertebrate fauna; 7266 records of 271 vascular, 3249 records of 181 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	1	96.8 ± 1.0	NS
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	197	3.2 ± 0.0	NS
A	*Myotis septentrionalis*	Northern Myotis	Endangered	Endangered	Endangered	S1	17	9.6 ± 0.0	NS
A	*Perimyotis subflavus*	Tricolored Bat	Endangered	Endangered	Endangered	S1	17	9.6 ± 0.0	NS
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay of Fundy population	Endangered	Endangered		S1	36	8.8 ± 0.0	NS
A	*Salmo salar pop. 6*	Atlantic Salmon - Nova Scotia Southern Upland population	Endangered			S1	37	20.1 ± 0.0	NS
A	*Charadrius melodus melodus*	Piping Plover melodus subspecies	Endangered	Endangered	Endangered	S1B	632	36.0 ± 0.0	NS
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1B	64	38.2 ± 0.0	NS
A	*Dermochelys coriacea pop. 2*	Leatherback Sea Turtle - Atlantic population	Endangered	Endangered		S1S2N	2	70.0 ± 5.0	NS
A	*Morone saxatilis pop. 2*	Striped Bass - Bay of Fundy population	Endangered			S2S3B,S2S3N	4	8.8 ± 0.0	NS
A	*Melanerpes erythrocephalus*	Red-headed Woodpecker	Endangered	Threatened		SNA	1	57.7 ± 0.0	NS
A	*Protonotaria citrea*	Prothonotary Warbler	Endangered	Endangered		SNA	1	63.1 ± 0.0	NS
A	*Icteria virens*	Yellow-Breasted Chat	Endangered	Endangered		SNA	5	27.8 ± 0.0	NS
A	*Colinus virginianus*	Northern Bobwhite	Endangered	Endangered			3	1.4 ± 0.0	NS
A	*Antrostomus vociferus*	Eastern Whip-Poor-Will	Threatened	Threatened	Threatened	S1?B	12	10.4 ± 7.0	NS
A	*Asio flammeus*	Short-eared Owl	Threatened	Special Concern		S1B	14	43.7 ± 0.0	NS
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2	1220	2.2 ± 0.0	NS
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2B	1651	0.7 ± 7.0	NS
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Endangered	S2S3B,S1M	351	3.3 ± 0.0	NS
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S2S3M	52	36.1 ± 0.0	NS
A	*Acipenser oxyrinchus*	Atlantic Sturgeon	Threatened			S2S3N	7	8.8 ± 0.0	NS
A	*Dolichonyx oryzivorus*	Bobolink	Threatened	Threatened	Vulnerable	S3B	716	0.7 ± 7.0	NS
A	*Hydrobates leucorhous*	Leach's Storm-Petrel	Threatened			S3B	73	38.6 ± 0.0	NS
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	567	31.4 ± 0.0	NS
A	*Anguilla rostrata*	American Eel	Threatened			S3N	49	8.8 ± 0.0	NS
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened		SHB	2	70.4 ± 7.0	NS
A	*Melanerpes lewis*	Lewis's Woodpecker	Threatened	Threatened		SNA	1	59.2 ± 0.0	NS
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened		SUB	36	7.1 ± 0.0	NS
A	*Salmo salar pop. 12*	Atlantic Salmon - Gaspe - Southern Gulf of St. Lawrence population	Special Concern			S1	28	69.2 ± 50.0	NS
A	*Passerculus sandwichensis princeps*	Ipswich Sparrow	Special Concern	Special Concern		S1B	5	40.8 ± 0.0	NS
A	*Bucephala islandica*	Barrow's Goldeneye	Special Concern	Special Concern		S1N,SUM	5	82.2 ± 2.0	NS
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Endangered	S2B	236	0.7 ± 7.0	NS
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern	Special Concern		S2S3M	5	40.4 ± 0.0	NS
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern population	Special Concern	Special Concern	Endangered	S2S3N,SUM	54	38.6 ± 0.0	NS
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	135	0.7 ± 10.0	NS
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S3B	1177	0.7 ± 7.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Endangered	S3B	958	0.7 ± 7.0	NS
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Threatened	Threatened	S3B	438	0.7 ± 7.0	NS
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S3B	872	0.7 ± 7.0	NS
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern	Vulnerable	S3B,S3N,S3M	680	0.7 ± 7.0	NS
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern		S3N,SUM	5	65.3 ± 0.0	NS
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	903	0.7 ± 7.0	NS
A	*Phocoena phocoena*	Harbour Porpoise	Special Concern			S4	4	44.6 ± 0.0	NS
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern	Special Concern		S4	185	0.7 ± 10.0	NS
A	*Calidris subruficollis*	Buff-breasted Sandpiper	Special Concern	Special Concern		SNA	3	40.7 ± 0.0	NS
A	*Zonotrichia querula*	Harris's Sparrow	Special Concern			SNA	1	43.3 ± 0.0	NS
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1?B,SUN,SUM	5	40.0 ± 0.0	NS
A	*Fulica americana*	American Coot	Not At Risk			S1B	12	28.5 ± 7.0	NS
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Not At Risk	Special Concern	Vulnerable	S1B,SUM	89	47.1 ± 0.0	NS
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk			S2	2	60.6 ± 0.0	NS
A	*Aegolius funereus*	Boreal Owl	Not At Risk			S2?B,SUM	8	14.0 ± 7.0	NS
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3	2	25.4 ± 100.0	NS
A	*Hemidactylium scutatum*	Four-toed Salamander	Not At Risk			S3	29	11.9 ± 0.0	NS
A	*Megaptera novaeangliae*	Humpback Whale	Not At Risk			S3	1	78.5 ± 0.0	NS
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B	296	9.4 ± 7.0	NS
A	*Sialia sialis*	Eastern Bluebird	Not At Risk			S3B	60	9.1 ± 0.0	NS
A	*Buteo lagopus*	Rough-legged Hawk	Not At Risk			S3N	1	47.5 ± 0.0	NS
A	*Accipiter gentilis*	Northern Goshawk	Not At Risk			S3S4	136	9.7 ± 7.0	NS
A	*Glaucomys volans*	Southern Flying Squirrel	Not At Risk			S3S4	6	80.4 ± 10.0	NS
A	*Lagenorhynchus acutus*	Atlantic White-sided Dolphin	Not At Risk			S3S4	6	56.0 ± 2.0	NS
A	*Ammospiza nelsoni*	Nelson's Sparrow	Not At Risk			S3S4B	149	0.7 ± 7.0	NS
A	*Calidris canutus rufa*	Red Knot rufa subspecies - Tierra del Fuego / Patagonia wintering population	E,SC	Endangered	Endangered	S2M	154	32.6 ± 0.0	NS
A	*Morone saxatilis*	Striped Bass	E,SC			S2S3B,S2S3N	8	11.0 ± 0.0	NS
A	*Gadus morhua*	Atlantic Cod	E,SC,DD			SNR	2	66.8 ± 0.0	NS
A	*Alces alces americana*	Moose			Endangered	S1	96	13.9 ± 3.0	NS
A	*Uria aalge*	Common Murre				S1?B	1	41.1 ± 0.0	NS
A	*Passerina cyanea*	Indigo Bunting				S1?B,SUM	21	14.3 ± 7.0	NS
A	*Oxyura jamaicensis*	Ruddy Duck				S1B	1	40.9 ± 0.0	NS
A	*Gallinula galeata*	Common Gallinule				S1B	8	59.6 ± 7.0	NS
A	*Myiarchus crinitus*	Great Crested Flycatcher				S1B	23	22.8 ± 7.0	NS
A	*Mimus polyglottos*	Northern Mockingbird				S1B	45	39.4 ± 7.0	NS
A	*Toxostoma rufum*	Brown Thrasher				S1B	15	40.6 ± 7.0	NS
A	*Charadrius semipalmatus*	Semipalmated Plover				S1B,S4M	826	32.6 ± 0.0	NS
A	*Calidris minutilla*	Least Sandpiper				S1B,S4M	575	32.6 ± 0.0	NS
A	*Anas acuta*	Northern Pintail				S1B,SUM	28	14.3 ± 7.0	NS
A	*Vireo gilvus*	Warbling Vireo				S1B,SUM	28	20.5 ± 0.0	NS
A	*Vespertilionidae sp.*	bat species				S1S2	189	2.5 ± 0.0	NS
A	*Pooecetes gramineus*	Vesper Sparrow				S1S2B,SUM	43	19.6 ± 7.0	NS
A	*Vireo philadelphicus*	Philadelphia Vireo				S2?B,SUM	54	8.8 ± 0.0	NS
A	*Alca torda*	Razorbill				S2B	17	90.5 ± 0.0	NS
A	*Fratercula arctica*	Atlantic Puffin				S2B	22	80.9 ± 7.0	NS
A	*Empidonax traillii*	Willow Flycatcher				S2B	25	9.4 ± 7.0	NS
A	*Molothrus ater*	Brown-headed Cowbird				S2B	141	0.7 ± 7.0	NS
A	*Spatula clypeata*	Northern Shoveler				S2B,SUM	15	9.4 ± 7.0	NS
A	*Mareca strepera*	Gadwall				S2B,SUM	30	30.6 ± 7.0	NS
A	*Piranga olivacea*	Scarlet Tanager				S2B,SUM	34	29.0 ± 7.0	NS
A	*Calidris alba*	Sanderling				S2N,S3M	421	32.6 ± 0.0	NS
A	*Asio otus*	Long-eared Owl				S2S3	25	0.7 ± 7.0	NS
A	*Rallus limicola*	Virginia Rail				S2S3B	30	14.3 ± 7.0	NS
A	*Rissa tridactyla*	Black-legged Kittiwake				S2S3B	8	61.7 ± 0.0	NS
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B	322	7.0 ± 0.0	NS

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A	*Phalacrocorax carbo*	Great Cormorant				S2S3B,S2S3N	68	35.7 ± 7.0	NS
A	*Cathartes aura*	Turkey Vulture				S2S3B,S4S5M	25	1.4 ± 0.0	NS
A	*Setophaga pinus*	Pine Warbler				S2S3B,S4S5M	19	39.2 ± 0.0	NS
A	*Bucephala clangula*	Common Goldeneye				S2S3B,S5N,S5M	142	29.4 ± 7.0	NS
A	*Icterus galbula*	Baltimore Oriole				S2S3B,SUM	74	0.7 ± 7.0	NS
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	78	35.2 ± 0.0	NS
A	*Numenius phaeopus hudsonicus*	Whimbrel				S2S3M	81	34.9 ± 0.0	NS
A	*Phalaropus fulicarius*	Red Phalarope				S2S3M	3	40.4 ± 0.0	NS
A	*Perisoreus canadensis*	Canada Jay				S3	563	0.7 ± 7.0	NS
A	*Poecile hudsonicus*	Boreal Chickadee				S3	710	0.7 ± 7.0	NS
A	*Spinus pinus*	Pine Siskin				S3	510	0.7 ± 7.0	NS
A	*Salvelinus fontinalis*	Brook Trout				S3	65	10.6 ± 0.0	NS
A	*Salvelinus namaycush*	Lake Trout				S3	2	10.6 ± 0.0	NS
A	*Synaptomys cooperi*	Southern Bog Lemming				S3	1	87.2 ± 0.0	NS
A	*Pekania pennanti*	Fisher				S3	5	55.7 ± 0.0	NS
A	*Calcarius lapponicus*	Lapland Longspur				S3?N,SUM	3	46.9 ± 0.0	NS
A	*Spatula discors*	Blue-winged Teal				S3B	112	0.7 ± 7.0	NS
A	*Charadrius vociferus*	Killdeer				S3B	553	0.7 ± 7.0	NS
A	*Tringa semipalmata*	Willet				S3B	905	9.4 ± 7.0	NS
A	*Sterna paradisaea*	Arctic Tern				S3B	62	39.4 ± 7.0	NS
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	83	6.5 ± 0.0	NS
A	*Tyrannus tyrannus*	Eastern Kingbird				S3B	249	0.7 ± 7.0	NS
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S3B	456	0.7 ± 7.0	NS
A	*Alosa pseudoharengus*	Alewife				S3B	31	8.8 ± 0.0	NS
A	*Somateria mollissima*	Common Eider				S3B,S3M,S3N	600	31.2 ± 7.0	NS
A	*Tringa melanoleuca*	Greater Yellowlegs				S3B,S4M	941	17.5 ± 0.0	NS
A	*Falco sparverius*	American Kestrel				S3B,S4S5M	368	0.7 ± 7.0	NS
A	*Gallinago delicata*	Wilson's Snipe				S3B,S5M	695	0.7 ± 7.0	NS
A	*Setophaga striata*	Blackpoll Warbler				S3B,S5M	128	0.7 ± 7.0	NS
A	*Cardellina pusilla*	Wilson's Warbler				S3B,S5M	97	13.4 ± 7.0	NS
A	*Pinicola enucleator*	Pine Grosbeak				S3B,S5N,S5M	139	9.2 ± 0.0	NS
A	*Setophaga tigrina*	Cape May Warbler				S3B,SUM	198	19.4 ± 7.0	NS
A	*Branta bernicla*	Brant				S3M	2	75.6 ± 0.0	NS
A	*Pluvialis squatarola*	Black-bellied Plover				S3M	705	32.6 ± 0.0	NS
A	*Arenaria interpres*	Ruddy Turnstone				S3M	307	32.6 ± 0.0	NS
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	733	32.6 ± 0.0	NS
A	*Calidris melanotos*	Pectoral Sandpiper				S3M	119	36.1 ± 0.0	NS
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	538	31.3 ± 0.0	NS
A	*Chroicocephalus ridibundus*	Black-headed Gull				S3N	7	31.2 ± 7.0	NS
A	*Picoides arcticus*	Black-backed Woodpecker				S3S4	190	0.7 ± 7.0	NS
A	*Loxia curvirostra*	Red Crossbill				S3S4	203	9.4 ± 7.0	NS
A	*Botaurus lentiginosus*	American Bittern				S3S4B,S4S5M	261	0.7 ± 7.0	NS
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B,S4S5M	564	0.7 ± 7.0	NS
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	748	0.7 ± 7.0	NS
A	*Leiothlypis peregrina*	Tennessee Warbler				S3S4B,S5M	559	0.7 ± 7.0	NS
A	*Passerella iliaca*	Fox Sparrow				S3S4B,S5M	109	9.7 ± 7.0	NS
A	*Mergus serrator*	Red-breasted Merganser				S3S4B,S5M,S5N	138	0.7 ± 7.0	NS
A	*Calidris maritima*	Purple Sandpiper				S3S4N	43	27.5 ± 0.0	NS
A	*Lanius borealis*	Northern Shrike				S3S4N	1	21.2 ± 0.0	NS
A	*Morus bassanus*	Northern Gannet				SHB	15	38.9 ± 0.0	NS
A	*Aythya americana*	Redhead				SHB	2	43.0 ± 0.0	NS
A	*Leucophaeus atricilla*	Laughing Gull				SHB	9	38.5 ± 0.0	NS
A	*Progne subis*	Purple Martin				SHB	5	41.1 ± 0.0	NS
A	*Eremophila alpestris*	Horned Lark				SHB,S4S5N,S5M	9	13.4 ± 7.0	NS
I	*Bombus bohemicus*	Ashton Cuckoo Bumble Bee	Endangered	Endangered	Endangered	S1	24	10.6 ± 5.0	NS
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Endangered	S2?B,S3M	300	3.5 ± 0.0	NS
I	*Danaus plexippus plexippus*	Monarch	Endangered	Special Concern		S2?B,S3M	1	55.3 ± 0.0	NS

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I	*Gomphurus ventricosus*	Skillet Clubtail	Endangered	Endangered		SH	2	19.0 ± 0.0	NS
I	*Barnea truncata*	Atlantic Mud-piddock	Threatened	Threatened		S1	1	56.3 ± 1.0	NS
I	*Bombus suckleyi*	Suckley's Cuckoo Bumble Bee	Threatened			SH	1	39.3 ± 5.0	NS
I	*Alasmidonta varicosa*	Brook Floater	Special Concern	Special Concern	Threatened	S3	13	5.7 ± 0.0	NS
I	*Bombus terricola*	Yellow-banded Bumble Bee	Special Concern	Special Concern	Vulnerable	S3	81	8.8 ± 5.0	NS
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern		Endangered	SH	8	48.6 ± 2.0	NS
I	*Cicindela formosa*	Big Sand Tiger Beetle				S1	1	91.1 ± 1.0	NS
I	*Erora laeta*	Early Hairstreak				S1	1	48.3 ± 1.0	NS
I	*Pachydiplax longipennis*	Blue Dasher				S1	4	39.4 ± 0.0	NS
I	*Atlanticoncha ochracea*	Tidewater Mucket				S1	10	97.5 ± 1.0	NS
I	*Polygonia comma*	Eastern Comma				S1?	19	45.9 ± 0.0	NS
I	*Polygonia satyrus*	Satyr Comma				S1?	7	41.5 ± 5.0	NS
I	*Euphyes bimacula*	Two-spotted Skipper				S1S2	1	74.7 ± 0.0	NS
I	*Boloria chariclea*	Arctic Fritillary				S1S2	3	62.9 ± 2.0	NS
I	*Somatochlora brevicincta*	Quebec Emerald				S1S2	1	31.8 ± 0.0	NS
I	*Tharsalea dospassosi*	Maritime Copper				S2	34	79.9 ± 0.0	NS
I	*Satyrium acadica*	Acadian Hairstreak				S2	13	48.1 ± 2.0	NS
I	*Neurocordulia michaeli*	Broad-tailed Shadowdragon				S2	19	65.5 ± 0.0	NS
I	*Coenagrion resolutum*	Taiga Bluet				S2	2	32.1 ± 1.0	NS
I	*Margaritifera margaritifera*	Eastern Pearlshell				S2	129	5.7 ± 0.0	NS
I	*Pantala hymenaea*	Spot-Winged Glider				S2?B	7	44.7 ± 1.0	NS
I	*Nymphalis l-album*	Compton Tortoiseshell				S2S3	17	30.9 ± 2.0	NS
I	*Aglais milberti*	Milbert's Tortoiseshell				S2S3	18	34.0 ± 2.0	NS
I	*Aglais milberti milberti*	Milbert's Tortoise Shell				S2S3	3	90.8 ± 0.0	NS
I	*Lanthus vernalis*	Southern Pygmy Clubtail				S2S3	7	79.6 ± 0.0	NS
I	*Somatochlora kennedyi*	Kennedy's Emerald				S2S3	3	44.7 ± 1.0	NS
I	*Williamsonia fletcheri*	Ebony Boghaunter				S2S3	4	81.7 ± 0.0	NS
I	*Stylurus scudderi*	Zebra Clubtail				S2S3	6	8.6 ± 0.0	NS
I	*Alasmidonta undulata*	Triangle Floater				S2S3	31	2.8 ± 0.0	NS
I	*Strophiona nitens*	Chestnut Bark Long-horned Beetle				S3	2	46.2 ± 0.0	NS
I	*Hippodamia parenthesis*	Parenthesis Lady Beetle				S3	1	46.0 ± 0.0	NS
I	*Naemia seriata*	Seaside Lady Beetle				S3	13	40.2 ± 0.0	NS
I	*Chilocorus stigma*	Twice-stabbed Lady Beetle				S3	3	49.8 ± 0.0	NS
I	*Monochamus marmorator*	Balsam Fir Sawyer				S3	1	93.0 ± 0.0	NS
I	*Trachysida aspera*	Rough Flower Longhorn Beetle				S3	1	38.6 ± 0.0	NS
I	*Astylopsis sexguttata*	Six-speckled Long-horned Beetle				S3	1	33.0 ± 0.0	NS
I	*Satyrium calanus*	Banded Hairstreak				S3	64	18.0 ± 2.0	NS
I	*Callophrys lanoraieensis*	Bog Elfin				S3	20	33.6 ± 2.0	NS
I	*Strymon melinus*	Gray Hairstreak				S3	12	48.8 ± 1.0	NS
I	*Phanogomphus descriptus*	Harpoon Clubtail				S3	4	78.6 ± 0.0	NS
I	*Ophiogomphus aspersus*	Brook Snaketail				S3	6	56.2 ± 0.0	NS
I	*Ophiogomphus mainensis*	Maine Snaketail				S3	13	62.0 ± 0.0	NS
I	*Ophiogomphus rupinsulensis*	Rusty Snaketail				S3	36	8.6 ± 0.0	NS
I	*Epitheca princeps*	Prince Baskettail				S3	17	21.3 ± 0.0	NS
I	*Somatochlora forcipata*	Forcipate Emerald				S3	4	44.7 ± 1.0	NS
I	*Enallagma vernale*	Vernal Bluet				S3	6	29.9 ± 1.0	NS
I	*Strophitus undulatus*	Creeper				S3	6	90.2 ± 0.0	NS
I	*Polygonia interrogationis*	Question Mark				S3B	159	11.3 ± 0.0	NS
I	*Cecropterus pylades*	Northern Cloudywing				S3S4	18	48.6 ± 0.0	NS
I	*Amblyscirtes hegon*	Pepper and Salt Skipper				S3S4	32	18.0 ± 2.0	NS
I	*Cupido comyntas*	Eastern Tailed Blue				S3S4	21	43.0 ± 1.0	NS
I	*Argynnis aphrodite*	Aphrodite Fritillary				S3S4	35	28.7 ± 2.0	NS
I	*Polygonia faunus*	Green Comma				S3S4	19	18.5 ± 5.0	NS

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I	*Oeneis jutta*	Jutta Arctic				S3S4	7	44.7 ± 2.0	NS
I	*Aeshna clepsydra*	Mottled Darner				S3S4	12	9.2 ± 1.0	NS
I	*Aeshna constricta*	Lance-Tipped Darner				S3S4	21	9.2 ± 1.0	NS
I	*Boyeria grafiana*	Ocellated Darner				S3S4	9	50.8 ± 1.0	NS
I	*Gomphaeschna furcillata*	Harlequin Darner				S3S4	7	19.2 ± 0.0	NS
I	*Somatochlora franklini*	Delicate Emerald				S3S4	2	44.7 ± 1.0	NS
I	*Nannothemis bella*	Elfin Skimmer				S3S4	15	36.1 ± 0.0	NS
I	*Amphiagrion saucium*	Eastern Red Damsel				S3S4	2	39.8 ± 1.0	NS
I	*Icaricia saepiolus*	Greenish Blue				SH	4	47.2 ± 2.0	NS
I	*Polygonia gracilis*	Hoary Comma				SH	2	39.6 ± 2.0	NS
N	*Erioderma mollissimum*	Graceful Felt Lichen	Endangered	Endangered	Endangered	S1	33	20.0 ± 0.0	NS
N	*Erioderma pedicellatum (Atlantic pop.)*	Boreal Felt Lichen - Atlantic pop.	Endangered	Endangered	Endangered	S1	512	20.0 ± 0.0	NS
N	*Peltigera hydrothyria*	Eastern Waterfan	Threatened	Threatened	Threatened	S1	87	16.9 ± 0.0	NS
N	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened	Threatened	S2S3	123	3.0 ± 0.0	NS
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened	Threatened	S3	41	14.4 ± 0.0	NS
N	*Fuscopannaria leucosticta*	White-rimmed Shingle Lichen	Threatened			S3	8	26.5 ± 0.0	NS
N	*Pectenia plumbea*	Blue Felt Lichen	Special Concern	Special Concern	Vulnerable	S3	204	14.4 ± 0.0	NS
N	*Sclerophora peronella (Atlantic pop.)*	Frosted Glass-whiskers (Atlantic population)	Special Concern	Special Concern		S3S4	28	22.1 ± 0.0	NS
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	15	25.4 ± 0.0	NS
N	*Fissidens exilis*	Pygmy Pocket Moss	Not At Risk			S3	14	27.0 ± 0.0	NS
N	*Chaenotheca servitii*	Flexuous Golden Stubble	Data Deficient			S1	1	57.9 ± 1.0	NS
N	*Aloina brevirostris*	Short-Beaked Rigid Screw Moss				S1	1	56.4 ± 2.0	NS
N	*Sematophyllum demissum*	a Moss				S1	1	31.3 ± 2.0	NS
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				S1	1	58.0 ± 0.0	NS
N	*Blennothallia crispa*	Crinkled Jelly Lichen				S1	1	60.4 ± 0.0	NS
N	*Umbilicaria vellea*	Grizzled Rocktripe Lichen				S1	1	55.1 ± 5.0	NS
N	*Usnea perplexans*	Powdered Beard Lichen				S1	1	68.5 ± 0.0	NS
N	*Scytinium dactylinum*	Brown-buttoned Jellyskin Lichen				S1	1	99.7 ± 0.0	NS
N	*Lathagrium cristatum*	Fingered Jelly Lichen				S1	3	59.9 ± 0.0	NS
N	*Ephebe perspinulosa*	Thread Lichen				S1	1	99.7 ± 1.0	NS
N	*Fuscopannaria praetermissa*	Moss Shingles Lichen				S1	1	61.9 ± 0.0	NS
N	*Scytinium schraderi*	Wrinkled Jellyskin Lichen				S1	1	30.3 ± 0.0	NS
N	*Lichina confinis*	Marine Seaweed Lichen				S1	4	55.0 ± 0.0	NS
N	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S1	1	37.8 ± 0.0	NS
N	*Sticta limbata*	Powdered Moon Lichen				S1	4	75.5 ± 3.0	NS
N	*Leptogium hibernicum*	Hibernia Jellyskin Lichen				S1	1	66.1 ± 0.0	NS
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S1	4	60.3 ± 0.0	NS
N	*Bryoria nitidula*	Tundra Horsehair Lichen				S1	2	58.5 ± 0.0	NS
N	*Hypogymnia hultenii*	Powdered Honeycomb Lichen				S1	15	38.2 ± 0.0	NS
N	*Calypogeia neogaea*	Common Pouchwort				S1?	1	53.8 ± 0.0	NS
N	*Aloina rigida*	Aloe-Like Rigid Screw Moss				S1?	4	51.8 ± 0.0	NS
N	*Imbribryum muehlenbeckii*	Muehlenbeck's Bryum Moss				S1?	2	80.0 ± 0.0	NS
N	*Conardia compacta*	Coast Creeping Moss				S1?	1	74.0 ± 2.0	NS
N	*Tortula obtusifolia*	a Moss				S1?	3	33.0 ± 0.0	NS
N	*Didymodon tophaceus*	Olive Beard Moss				S1?	1	60.3 ± 0.0	NS
N	*Paludella squarrosa*	Tufted Fen Moss				S1?	3	50.9 ± 0.0	NS
N	*Physcomitrium immersum*	a Moss				S1?	1	87.0 ± 0.0	NS
N	*Schistostega pennata*	Luminous Moss				S1?	1	42.5 ± 0.0	NS
N	*Syntrichia ruralis*	a Moss				S1?	1	33.6 ± 0.0	NS
N	*Melanelia culbersonii*	Appalachain Camouflage Lichen				S1?	1	79.6 ± 0.0	NS

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N	*Arrhenopterum heterostichum*	One-sided Groove Moss				S1S2	2	56.4 ± 2.0	NS
N	*Mnium thomsonii*	Thomson's Leafy Moss				S1S2	1	61.1 ± 2.0	NS
N	*Plagiothecium latebricola*	Alder Silk Moss				S1S2	2	78.9 ± 3.0	NS
N	*Platydictya confervoides*	a Moss				S1S2	1	60.5 ± 0.0	NS
N	*Sematophyllum marylandicum*	a Moss				S1S2	2	23.7 ± 6.0	NS
N	*Timmia megapolitana*	Metropolitan Timmia Moss				S1S2	3	64.5 ± 0.0	NS
N	*Tortula mucronifolia*	Mucronate Screw Moss				S1S2	1	84.3 ± 3.0	NS
N	*Pseudotaxiphyllum distichaceum*	a Moss				S1S2	2	51.7 ± 0.0	NS
N	*Haplocladium microphyllum*	Tiny-leaved Haplocladium Moss				S1S2	1	36.7 ± 5.0	NS
N	*Enchylium bachmanianum*	Bachman's Jelly Lichen				S1S2	1	60.3 ± 0.0	NS
N	*Placidium squamulosum*	Limy Soil Stipplescale Lichen				S1S2	1	31.7 ± 6.0	NS
N	*Peltigera ponojensis*	Pale-bellied Pelt Lichen				S1S2	1	69.0 ± 0.0	NS
N	*Pilophorus cereolus*	Powdered Matchstick Lichen				S1S2	1	65.5 ± 3.0	NS
N	*Rhizoplaca subdiscrepans*	Scattered Rock-posy Lichen				S1S2	1	81.2 ± 1.0	NS
N	*Parmotrema reticulatum*	Netted Ruffle Lichen				S1S2	5	92.8 ± 0.0	NS
N	*Parmeliella parvula*	Poor-man's Shingles Lichen				S1S2	12	24.6 ± 0.0	NS
N	*Lecanora polytropa*	a lichen				S1S3	1	63.0 ± 1.0	NS
N	*Heterodermia galactophylla*	Branching Fringe Lichen				S1S3	1	81.4 ± 0.0	NS
N	*Xylopsora friesii*	a Lichen				S1S3	2	47.4 ± 0.0	NS
N	*Stereocaulon grande*	Grand Foam Lichen				S1S3	1	58.5 ± 0.0	NS
N	*Stereocaulon intermedium*	Pacific Brain Foam Lichen				S1S3	2	45.8 ± 0.0	NS
N	*Anacamptodon splachnoides*	a Moss				S2	2	45.8 ± 30.0	NS
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S2	2	26.9 ± 3.0	NS
N	*Sphagnum subnitens*	Lustrous Peat Moss				S2	1	44.3 ± 2.0	NS
N	*Usnea flavocardia*	Blood-splattered Beard Lichen				S2	1	55.3 ± 4.0	NS
N	*Cystocoleus ebeneus*	Rockgossamer Lichen				S2	2	46.5 ± 0.0	NS
N	*Hypotrachyna catawbiensis*	Powder-tipped Antler Lichen				S2	1	80.8 ± 0.0	NS
N	*Nephroma arcticum*	Arctic Kidney Lichen				S2	1	54.6 ± 1.0	NS
N	*Nephroma resupinatum*	a lichen				S2	11	25.8 ± 1.0	NS
N	*Placynthium flabellosum*	Scaly Ink Lichen				S2	1	11.8 ± 17.0	NS
N	*Riccardia multifida*	Delicate Germanderwort				S2?	1	24.9 ± 0.0	NS
N	*Anomodon viticulosus*	a Moss				S2?	1	74.9 ± 5.0	NS
N	*Weissia muhlenbergiana*	a Moss				S2?	4	61.1 ± 1.0	NS
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S2?	2	45.7 ± 2.0	NS
N	*Ptychostomum pendulum*	Drooping Bryum				S2?	1	56.4 ± 2.0	NS
N	*Drepanocladus polygamus*	Polygamous Hook Moss				S2?	4	31.3 ± 2.0	NS
N	*Dicranum condensatum*	Condensed Broom Moss				S2?	1	68.3 ± 0.0	NS
N	*Ditrichum rhynchostegium*	a Moss				S2?	1	46.0 ± 1.0	NS
N	*Grimmia anomala*	Mountain Forest Grimmia				S2?	1	95.5 ± 1.0	NS
N	*Kiaeria starkei*	Starke's Fork Moss				S2?	1	32.8 ± 10.0	NS
N	*Orthotrichum anomalum*	Anomalous Bristle Moss				S2?	1	66.2 ± 2.0	NS
N	*Philonotis marchica*	a Moss				S2?	2	44.6 ± 0.0	NS
N	*Platydictya jungermannioides*	False Willow Moss				S2?	1	4.9 ± 0.0	NS
N	*Saelania glaucescens*	Blue Dew Moss				S2?	1	69.5 ± 0.0	NS
N	*Cyrtomnium hymenophylloides*	Short-pointed Lantern Moss				S2?	2	42.9 ± 5.0	NS
N	*Platylomella lescurii*	a Moss				S2?	4	38.7 ± 0.0	NS
N	*Phylliscum demangeonii*	Black Rock-wafer Lichen				S2?	1	71.5 ± 0.0	NS
N	*Oxyrrhynchium hians*	Light Beaked Moss				S2S3	4	9.4 ± 25.0	NS
N	*Platydictya subtilis*	Bark Willow Moss				S2S3	1	78.9 ± 3.0	NS
N	*Scorpidium revolvens*	Limprichtia Moss				S2S3	2	50.9 ± 0.0	NS

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N	*Moelleropsis nebulosa*	Blue-gray Moss Shingle Lichen				S2S3	62	14.6 ± 0.0	NS
N	*Moelleropsis nebulosa ssp. frullaniae*	Blue-gray Moss Shingle Lichen				S2S3	3	23.5 ± 0.0	NS
N	*Ramalina thrausta*	Angelhair Ramalina Lichen				S2S3	13	16.0 ± 0.0	NS
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2S3	52	2.3 ± 0.0	NS
N	*Usnea ceratina*	Warty Beard Lichen				S2S3	1	71.0 ± 0.0	NS
N	*Usnea hirta*	Bristly Beard Lichen				S2S3	2	46.9 ± 0.0	NS
N	*Usnea rubicunda*	Red Beard Lichen				S2S3	4	38.1 ± 0.0	NS
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S2S3	15	32.2 ± 0.0	NS
N	*Usnocetraria oakesiana*	Yellow Band Lichen				S2S3	9	41.6 ± 0.0	NS
N	*Cladonia incrassata*	Powder-foot British Soldiers Lichen				S2S3	1	83.7 ± 0.0	NS
N	*Cladonia mateocyatha*	Mixed-up Pixie-cup				S2S3	3	47.0 ± 5.0	NS
N	*Cladonia parasitica*	Fence-rail Lichen				S2S3	3	40.5 ± 0.0	NS
N	*Chaenotheca gracilenta*	a lichen				S2S3	1	46.7 ± 0.0	NS
N	*Scytinium tenuissimum*	Birdnest Jellyskin Lichen				S2S3	8	33.0 ± 0.0	NS
N	*Melanohalea septentrionalis*	Northern Camouflage Lichen				S2S3	1	68.2 ± 0.0	NS
N	*Myelochroa aurulenta*	Powdery Axil-bristle Lichen				S2S3	4	40.2 ± 0.0	NS
N	*Parmelia fertilis*	Fertile Shield Lichen				S2S3	8	45.4 ± 0.0	NS
N	*Hypotrachyna minarum*	Hairless-spined Shield Lichen				S2S3	1	30.6 ± 0.0	NS
N	*Parmeliopsis ambigua*	Green Starburst Lichen				S2S3	3	47.9 ± 0.0	NS
N	*Racodium rupestre*	Rockhair Lichen				S2S3	3	41.2 ± 1.0	NS
N	*Umbilicaria polyphylla*	Petalled Rocktripe Lichen				S2S3	1	86.0 ± 2.0	NS
N	*Usnea cavernosa*	Pitted Beard Lichen				S2S3	2	68.5 ± 0.0	NS
N	*Usnea mutabilis*	Bloody Beard Lichen				S2S3	1	68.6 ± 0.0	NS
N	*Fuscopannaria sorediata*	a Lichen				S2S3	6	41.2 ± 1.0	NS
N	*Stereocaulon condensatum*	Granular Soil Foam Lichen				S2S3	3	75.7 ± 0.0	NS
N	*Physcia subtilis*	Slender Rosette Lichen				S2S3	1	18.0 ± 0.0	NS
N	*Dimelaena oreina*	Golden Moonglow Lichen				S2S3	2	51.8 ± 0.0	NS
N	*Cladonia coccifera*	Eastern Boreal Pixie-cup Lichen				S2S3	3	9.5 ± 4.0	NS
N	*Cladonia deformis*	Lesser Sulphur-cup Lichen				S2S3	3	78.2 ± 4.0	NS
N	*Cladonia phyllophora*	Felt Lichen				S2S3	2	97.9 ± 4.0	NS
N	*Usnea flammea*	Coastal Bushy Beard Lichen				S2S3	1	63.0 ± 1.0	NS
N	*Ephemerum serratum*	a Moss				S3	4	27.0 ± 0.0	NS
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S3	9	27.0 ± 0.0	NS
N	*Anomodon tristis*	a Moss				S3	10	39.3 ± 15.0	NS
N	*Sphagnum contortum*	Twisted Peat Moss				S3	3	54.5 ± 0.0	NS
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S3	3	41.0 ± 0.0	NS
N	*Rostania occultata*	Crusted Tarpaper Lichen				S3	1	93.3 ± 0.0	NS
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	25	16.9 ± 0.0	NS
N	*Solorina saccata*	Woodland Owl Lichen				S3	10	3.3 ± 2.0	NS
N	*Fuscopannaria ahlneri*	Corrugated Shingles Lichen				S3	92	15.8 ± 0.0	NS
N	*Heterodermia squamulosa*	Scaly Fringe Lichen				S3	79	32.2 ± 0.0	NS
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	27	26.4 ± 0.0	NS
N	*Leptogium milligranum*	Stretched Jellyskin Lichen				S3	7	21.5 ± 3.0	NS
N	*Nephroma bellum*	Naked Kidney Lichen				S3	8	27.3 ± 5.0	NS
N	*Placynthium nigrum*	Common Ink Lichen				S3	2	33.0 ± 0.0	NS
N	*Platismatia norvegica*	Oldgrowth Rag Lichen				S3	1	48.0 ± 0.0	NS
N	*Punctelia appalachensis*	Appalachian Speckleback Lichen				S3	99	84.5 ± 0.0	NS
N	*Viridothelium virens*					S3	2	45.6 ± 2.0	NS
N	*Ephebe lanata*	Waterside Rockshag Lichen				S3	2	11.8 ± 17.0	NS
N	*Phaeophyscia adiastola*	Powder-tipped Shadow Lichen				S3	1	46.0 ± 0.0	NS

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N	*Phaeophyscia pusilloides*	Pompom-tipped Shadow Lichen				S3	10	23.5 ± 7.0	NS
N	*Peltigera collina*	Tree Pelt Lichen				S3	12	22.7 ± 0.0	NS
N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3?	2	60.4 ± 0.0	NS
N	*Calliergon giganteum*	Giant Spear Moss				S3?	1	51.9 ± 3.0	NS
N	*Drummondia prorepens*	a Moss				S3?	1	67.8 ± 5.0	NS
N	*Elodium blandowii*	Blandow's Bog Moss				S3?	6	41.8 ± 7.0	NS
N	*Mnium stellare*	Star Leafy Moss				S3?	3	55.7 ± 0.0	NS
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S3?	1	54.3 ± 0.0	NS
N	*Sphagnum riparium*	Streamside Peat Moss				S3?	2	25.6 ± 0.0	NS
N	*Cladonia stygia*	Black-footed Reindeer Lichen				S3?	5	21.8 ± 0.0	NS
N	*Anomodon rugelii*	Rugel's Anomodon Moss				S3S4	1	85.7 ± 0.0	NS
N	*Dichelyma capillaceum*	Hairlike Dichelyma Moss				S3S4	3	35.3 ± 3.0	NS
N	*Dicranum leioneuron*	a Dicranum Moss				S3S4	1	73.3 ± 0.0	NS
N	*Encalypta ciliata*	Fringed Extinguisher Moss				S3S4	2	84.3 ± 3.0	NS
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	1	69.5 ± 0.0	NS
N	*Splachnum ampullaceum*	Cruet Dung Moss				S3S4	2	26.3 ± 0.0	NS
N	*Thamnobryum alleghaniense*	a Moss				S3S4	7	76.8 ± 0.0	NS
N	*Tomentypnum nitens*	Golden Fuzzy Fen Moss				S3S4	2	46.5 ± 2.0	NS
N	*Schistidium agassizii*	Elf Bloom Moss				S3S4	2	36.0 ± 0.0	NS
N	*Hylocomiastrum pyrenaicum*	a Feather Moss				S3S4	1	47.7 ± 0.0	NS
N	*Enchylium tenax*	Soil Tarpaper Lichen				S3S4	7	2.1 ± 0.0	NS
N	*Sticta fuliginosa*	Peppered Moon Lichen				S3S4	72	18.6 ± 0.0	NS
N	*Arctoparmelia incurva*	Finger Ring Lichen				S3S4	63	37.0 ± 0.0	NS
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S3S4	10	2.2 ± 0.0	NS
N	*Leptogium acadiense*	Acadian Jellyskin Lichen				S3S4	26	18.2 ± 0.0	NS
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3S4	19	2.2 ± 0.0	NS
N	*Cladonia floerkeana*	Gritty British Soldiers Lichen				S3S4	3	58.8 ± 0.0	NS
N	*Vahliella leucophaea*	Shelter Shingle Lichen				S3S4	10	75.9 ± 0.0	NS
N	*Heterodermia speciosa*	Powdered Fringe Lichen				S3S4	44	19.1 ± 0.0	NS
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S3S4	72	14.8 ± 4.0	NS
N	*Melanohalea olivacea*	Spotted Camouflage Lichen				S3S4	3	68.5 ± 0.0	NS
N	*Parmeliopsis hyperopta*	Gray Starburst Lichen				S3S4	3	67.2 ± 0.0	NS
N	*Parmotrema perlatum*	Powdered Ruffle Lichen				S3S4	11	40.8 ± 0.0	NS
N	*Peltigera hymenina*	Cloudy Pelt Lichen				S3S4	2	58.8 ± 2.0	NS
N	*Sphaerophorus fragilis*	Fragile Coral Lichen				S3S4	7	37.0 ± 0.0	NS
N	*Coccocarpia palmicola*	Salted Shell Lichen				S3S4	717	14.4 ± 0.0	NS
N	*Physcia caesia*	Blue-gray Rosette Lichen				S3S4	2	63.0 ± 1.0	NS
N	*Physcia tenella*	Fringed Rosette Lichen				S3S4	6	42.9 ± 0.0	NS
N	*Anaptychia palmulata*	Shaggy Fringed Lichen				S3S4	116	9.7 ± 3.0	NS
N	*Evernia prunastri*	Valley Oakmoss Lichen				S3S4	29	20.1 ± 0.0	NS
N	*Heterodermia neglecta*	Fringe Lichen				S3S4	124	20.0 ± 0.0	NS
P	*Clethra alnifolia*	Coast Pepper-Bush	Endangered	Threatened	Vulnerable	S2	2	47.3 ± 0.0	NS
P	*Juglans cinerea*	Butternut	Endangered	Endangered		SNA	12	42.4 ± 0.0	NS
P	*Fraxinus nigra*	Black Ash	Threatened		Threatened	S1S2	477	5.2 ± 0.0	NS
P	*Liatris spicata*	Dense Blazing Star	Threatened	Threatened		SNA	3	38.0 ± 0.0	NS
P	*Bartonia paniculata ssp. paniculata*	Branched Bartonia	Threatened	Threatened		SNA	1	45.3 ± 10.0	NS
P	*Lilaeopsis chinensis*	Eastern Lilaeopsis	Special Concern	Special Concern	Vulnerable	S3	16	91.6 ± 1.0	NS
P	*Isoetes prototypus*	Prototype Quillwort	Special Concern	Special Concern	Vulnerable	S3	13	62.4 ± 0.0	NS
P	*Floerkea proserpinacoides*	False Mermaidweed	Not At Risk			S2S3	5	41.9 ± 7.0	NS
P	*Acer saccharinum*	Silver Maple				S1	11	95.2 ± 0.0	NS
P	*Osmorhiza depauperata*	Blunt Sweet Cicely				S1	1	82.7 ± 5.0	NS
P	*Andersonglossum boreale*	Northern Wild Comfrey				S1	5	57.3 ± 1.0	NS
P	*Cochlearia tridactylites*	Limestone Scurvy-grass				S1	8	89.4 ± 0.0	NS
P	*Lobelia spicata*	Pale-Spiked Lobelia				S1	10	45.1 ± 7.0	NS

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P	*Hudsonia tomentosa*	Woolly Beach-heath				S1	2	92.9 ± 7.0	NS
P	*Ribes americanum*	Wild Black Currant				S1	4	30.5 ± 1.0	NS
P	*Fraxinus pennsylvanica*	Red Ash				S1	13	8.3 ± 0.0	NS
P	*Persicaria careyi*	Carey's Smartweed				S1	1	20.0 ± 3.0	NS
P	*Phytolacca americana*	Common Pokeweed				S1	1	40.8 ± 0.0	NS
P	*Montia fontana*	Water Blinks				S1	1	47.8 ± 1.0	NS
P	*Lysimachia quadrifolia*	Whorled Yellow Loosestrife				S1	1	57.0 ± 0.0	NS
P	*Ranunculus pensylvanicus*	Pennsylvania Buttercup				S1	31	75.1 ± 0.0	NS
P	*Amelanchier nantucketensis*	Nantucket Serviceberry				S1	1	89.9 ± 1.0	NS
P	*Salix myrtillifolia*	Blueberry Willow				S1	1	11.1 ± 0.0	NS
P	*Salix serissima*	Autumn Willow				S1	2	11.1 ± 0.0	NS
P	*Carex garberi*	Garber's Sedge				S1	4	45.5 ± 0.0	NS
P	*Carex laxiflora*	Loose-Flowered Sedge				S1	1	86.9 ± 1.0	NS
P	*Carex plantaginea*	Plantain-Leaved Sedge				S1	4	42.3 ± 0.0	NS
P	*Carex prairea*	Prairie Sedge				S1	2	96.3 ± 1.0	NS
P	*Carex viridula var. saxilittoralis*	Greenish Sedge				S1	5	55.1 ± 2.0	NS
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S1	2	90.8 ± 0.0	NS
P	*Scirpus atrovirens*	Dark-green Bulrush				S1	5	4.2 ± 0.0	NS
P	*Juncus vaseyi*	Vasey Rush				S1	3	45.8 ± 0.0	NS
P	*Trillium grandiflorum*	White Trillium				S1	3	96.3 ± 1.0	NS
P	*Malaxis monophyllos var. brachypoda*	North American White Adder's-mouth				S1	5	72.2 ± 10.0	NS
P	*Spiranthes casei var. casei*	Case's Ladies'-Tresses				S1	1	87.5 ± 0.0	NS
P	*Elymus hystrix*	Spreading Wild Rye				S1	12	11.9 ± 1.0	NS
P	*Adiantum pedatum*	Northern Maidenhair Fern				S1	10	40.4 ± 1.0	NS
P	*Equisetum palustre*	Marsh Horsetail				S1	1	93.2 ± 5.0	NS
P	*Botrychium lunaria*	Common Moonwort				S1	8	41.0 ± 0.0	NS
P	*Selaginella rupestris*	Rock Spikemoss				S1	1	56.6 ± 0.0	NS
P	*Solidago hispida*	Hairy Goldenrod				S1?	2	44.0 ± 7.0	NS
P	*Suaeda rolandii*	Roland's Sea-Blite				S1?	5	57.6 ± 2.0	NS
P	*Carex pensylvanica*	Pennsylvania Sedge				S1?	3	19.7 ± 3.0	NS
P	*Bolboschoenus robustus*	Sturdy Bulrush				S1?	2	90.9 ± 5.0	NS
P	*Allium schoenoprasum*	Wild Chives				S1?	5	39.3 ± 10.0	NS
P	*Allium schoenoprasum var. sibiricum*	Wild Chives				S1?	1	40.6 ± 7.0	NS
P	*Crocanthemum canadense*	Long-branched Frostweed			Endangered	S1S2	2	54.3 ± 1.0	NS
P	*Cypripedium arietinum*	Ram's-Head Lady's-Slipper			Endangered	S1S2	291	53.5 ± 0.0	NS
P	*Sanicula odorata*	Clustered Sanicle				S1S2	9	30.2 ± 10.0	NS
P	*Draba glabella*	Rock Whitlow-Grass				S1S2	2	84.9 ± 0.0	NS
P	*Proserpinaca intermedia*	Intermediate Mermaidweed				S1S2	1	2.5 ± 0.0	NS
P	*Anemone virginiana var. alba*	Virginia Anemone				S1S2	5	40.6 ± 7.0	NS
P	*Carex haydenii*	Hayden's Sedge				S1S2	3	40.9 ± 1.0	NS
P	*Platanthera huronensis*	Fragrant Green Orchid				S1S2	1	49.6 ± 10.0	NS
P	*Calamagrostis stricta ssp. stricta*	Slim-stemmed Reed Grass				S1S2	1	92.3 ± 7.0	NS
P	*Carex vacillans*	Estuarine Sedge				S1S3	2	52.2 ± 0.0	NS
P	*Zizia aurea*	Golden Alexanders				S2	38	32.5 ± 1.0	NS
P	*Antennaria parlinii ssp. fallax*	Parlin's Pussytoes				S2	13	31.5 ± 7.0	NS
P	*Rudbeckia laciniata*	Cut-Leaved Coneflower				S2	15	45.4 ± 7.0	NS
P	*Rudbeckia laciniata var. laciniata*	Cut-Leaved Coneflower				S2	7	81.5 ± 0.0	NS
P	*Arabis pycnocarpa*	Cream-flowered Rockcress				S2	1	72.8 ± 0.0	NS
P	*Cardamine maxima*	Large Toothwort				S2	1	95.3 ± 0.0	NS
P	*Hudsonia ericoides*	Pinebarren Golden Heather				S2	127	44.0 ± 7.0	NS
P	*Desmodium canadense*	Canada Tick-trefoil				S2	22	39.3 ± 5.0	NS

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P	*Hylodesmum glutinosum*	Large Tick-trefoil				S2	19	49.4 ± 0.0	NS
P	*Conopholis americana*	American Cancer-root				S2	3	90.6 ± 1.0	NS
P	*Anemonastrum canadense*	Canada Anemone				S2	8	40.1 ± 0.0	NS
P	*Hepatica americana*	Round-lobed Hepatica				S2	62	2.5 ± 7.0	NS
P	*Ranunculus sceleratus*	Cursed Buttercup				S2	22	38.2 ± 0.0	NS
P	*Galium boreale*	Northern Bedstraw				S2	7	62.3 ± 1.0	NS
P	*Gratiola neglecta*	Clammy Hedge-Hyssop				S2	4	27.0 ± 2.0	NS
P	*Dirca palustris*	Eastern Leatherwood				S2	65	11.3 ± 1.0	NS
P	*Carex gynocrates*	Northern Bog Sedge				S2	2	11.1 ± 0.0	NS
P	*Carex pellita*	Woolly Sedge				S2	12	32.2 ± 10.0	NS
P	*Carex livida*	Livid Sedge				S2	13	31.6 ± 0.0	NS
P	*Juncus greenei*	Greene's Rush				S2	6	30.1 ± 1.0	NS
P	*Allium tricoccum*	Wild Leek				S2	29	53.8 ± 0.0	NS
P	*Lilium canadense*	Canada Lily				S2	112	1.3 ± 1.0	NS
P	*Cypripedium parviflorum var. pubescens*	Yellow Lady's-slipper				S2	22	35.4 ± 7.0	NS
P	*Cypripedium parviflorum var. makasin*	Small Yellow Lady's-Slipper				S2	10	54.5 ± 0.0	NS
P	*Cypripedium reginae*	Showy Lady's-Slipper				S2	50	10.4 ± 7.0	NS
P	*Platanthera flava var. flava*	Southern Rein Orchid				S2	1	80.3 ± 7.0	NS
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S2	11	54.0 ± 0.0	NS
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S2	14	51.5 ± 1.0	NS
P	*Bromus latiglumis*	Broad-Glumed Brome				S2	33	27.9 ± 0.0	NS
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S2	20	28.1 ± 0.0	NS
P	*Elymus wiegandii*	Wiegand's Wild Rye				S2	21	31.2 ± 0.0	NS
P	*Festuca subverticillata*	Nodding Fescue				S2	13	32.5 ± 5.0	NS
P	*Cryptogramma stelleri*	Steller's Rockbrake				S2	3	64.4 ± 0.0	NS
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2?	3	69.9 ± 0.0	NS
P	*Rumex persicarioides*	Peach-leaved Dock				S2?	1	85.8 ± 0.0	NS
P	*Crataegus submollis*	Quebec Hawthorn				S2?	6	19.6 ± 7.0	NS
P	*Carex peckii*	White-Tinged Sedge				S2?	4	4.8 ± 0.0	NS
P	*Thuja occidentalis*	Eastern White Cedar			Vulnerable	S2S3	955	14.5 ± 7.0	NS
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2S3	32	39.2 ± 5.0	NS
P	*Bidens hyperborea*	Estuary Beggarticks				S2S3	2	92.3 ± 0.0	NS
P	*Erigeron philadelphicus*	Philadelphia Fleabane				S2S3	2	32.3 ± 1.0	NS
P	*Lactuca hirsuta*	Hairy Lettuce				S2S3	3	29.4 ± 7.0	NS
P	*Impatiens pallida*	Pale Jewelweed				S2S3	2	26.5 ± 0.0	NS
P	*Caulophyllum thalictroides*	Blue Cohosh				S2S3	81	9.1 ± 1.0	NS
P	*Boechera stricta*	Drummond's Rockcress				S2S3	12	44.2 ± 0.0	NS
P	*Draba arabisans*	Rock Whitlow-Grass				S2S3	13	84.9 ± 0.0	NS
P	*Stellaria humifusa*	Saltmarsh Starwort				S2S3	7	40.8 ± 0.0	NS
P	*Oxybasis rubra*	Red Goosefoot				S2S3	4	55.1 ± 2.0	NS
P	*Hypericum majus*	Large St John's-wort				S2S3	8	38.2 ± 0.0	NS
P	*Hypericum x dissimulatum*	Disguised St. John's-wort				S2S3	3	34.8 ± 0.0	NS
P	*Empetrum atropurpureum*	Purple Crowberry				S2S3	5	43.8 ± 7.0	NS
P	*Euphorbia polygonifolia*	Seaside Spurge				S2S3	1	99.7 ± 3.0	NS
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S2S3	11	10.6 ± 7.0	NS
P	*Hedeoma pulegioides*	American False Pennyroyal				S2S3	16	14.0 ± 5.0	NS
P	*Oenothera fruticosa ssp. tetragona*	Narrow-leaved Evening Primrose				S2S3	7	40.6 ± 7.0	NS
P	*Polygala polygama*	Racemed Milkwort				S2S3	1	45.8 ± 1.0	NS
P	*Polygonum aviculare ssp. buxiforme*	Box Knotweed				S2S3	8	40.6 ± 7.0	NS
P	*Polygonum oxyspermum ssp. raii*	Ray's Knotweed				S2S3	1	82.7 ± 1.0	NS
P	*Polygonum oxyspermum*	Sharp-fruit Knotweed				S2S3	1	41.1 ± 0.0	NS
P	*Rumex triangulivalvis*	Triangular-valve Dock				S2S3	11	29.9 ± 0.0	NS

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P	*Primula mistassinica*	Mistassini Primrose				S2S3	16	34.6 ± 1.0	NS
P	*Anemone quinquefolia*	Wood Anemone				S2S3	14	11.8 ± 0.0	NS
P	*Caltha palustris*	Yellow Marsh Marigold				S2S3	7	43.7 ± 0.0	NS
P	*Potentilla canadensis*	Canada Cinquefoil				S2S3	5	28.9 ± 5.0	NS
P	*Salix pellita*	Satiny Willow				S2S3	8	15.5 ± 2.0	NS
P	*Tiarella cordifolia*	Heart-leaved Foamflower				S2S3	222	5.1 ± 0.0	NS
P	*Agalinis purpurea var. parviflora*	Small-flowered Purple False Foxglove				S2S3	2	80.8 ± 0.0	NS
P	*Boehmeria cylindrica*	Small-spike False-nettle				S2S3	2	10.5 ± 0.0	NS
P	*Carex adusta*	Lesser Brown Sedge				S2S3	9	23.1 ± 7.0	NS
P	*Carex capillaris*	Hairlike Sedge				S2S3	1	79.8 ± 0.0	NS
P	*Carex comosa*	Bearded Sedge				S2S3	4	42.9 ± 0.0	NS
P	*Carex houghtoniana*	Houghton's Sedge				S2S3	5	19.8 ± 1.0	NS
P	*Carex hystericina*	Porcupine Sedge				S2S3	5	66.4 ± 1.0	NS
P	*Eleocharis ovata*	Ovate Spikerush				S2S3	9	55.3 ± 0.0	NS
P	*Scirpus pedicellatus*	Stalked Bulrush				S2S3	7	8.9 ± 0.0	NS
P	*Vallisneria americana*	Wild Celery				S2S3	3	15.1 ± 1.0	NS
P	*Najas gracillima*	Thread-Like Naiad				S2S3	2	48.2 ± 0.0	NS
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S2S3	14	3.9 ± 1.0	NS
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S2S3	28	8.8 ± 1.0	NS
P	*Potamogeton friesii*	Fries' Pondweed				S2S3	10	40.3 ± 5.0	NS
P	*Woodsia glabella*	Smooth Cliff Fern				S2S3	2	58.2 ± 1.0	NS
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S2S3	8	15.8 ± 5.0	NS
P	*Botrychium simplex*	Least Moonwort				S2S3	5	38.8 ± 0.0	NS
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S2S3	6	35.4 ± 7.0	NS
P	*Potamogeton pulcher*	Spotted Pondweed			Vulnerable	S3	3	31.4 ± 2.0	NS
P	*Angelica atropurpurea*	Purple-stemmed Angelica				S3	1	30.3 ± 0.0	NS
P	*Conioselinum chinense*	Chinese Hemlock-parsley				S3	3	36.9 ± 0.0	NS
P	*Hieracium robinsonii*	Robinson's Hawkweed				S3	3	38.0 ± 1.0	NS
P	*Iva frutescens*	Big-leaved Marsh-elder				S3	33	56.6 ± 0.0	NS
P	*Senecio pseudoarnica*	Seabeach Ragwort				S3	27	40.4 ± 0.0	NS
P	*Symphyotrichum boreale*	Boreal Aster				S3	5	24.8 ± 5.0	NS
P	*Symphyotrichum undulatum*	Wavy-leaved Aster				S3	7	41.7 ± 7.0	NS
P	*Symphyotrichum ciliolatum*	Fringed Blue Aster				S3	20	10.9 ± 0.0	NS
P	*Betula michauxii*	Michaux's Dwarf Birch				S3	30	21.3 ± 0.0	NS
P	*Betula pumila*	Bog Birch				S3	3	10.1 ± 0.0	NS
P	*Cardamine parviflora*	Small-flowered Bittercress				S3	13	53.1 ± 0.0	NS
P	*Palustricodon aparinoides*	Marsh Bellflower				S3	38	31.1 ± 0.0	NS
P	*Mononeuria groenlandica*	Greenland Stitchwort				S3	75	14.9 ± 0.0	NS
P	*Sagina nodosa*	Knotted Pearlwort				S3	38	37.2 ± 1.0	NS
P	*Sagina nodosa ssp. borealis*	Knotted Pearlwort				S3	10	52.2 ± 0.0	NS
P	*Stellaria longifolia*	Long-leaved Starwort				S3	12	13.1 ± 0.0	NS
P	*Ceratophyllum echinatum*	Prickly Hornwort				S3	12	31.4 ± 0.0	NS
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S3	65	41.9 ± 7.0	NS
P	*Viburnum edule*	Squashberry				S3	2	68.2 ± 0.0	NS
P	*Crassula aquatica*	Water Pygmyweed				S3	1	74.6 ± 0.0	NS
P	*Empetrum eamesii*	Pink Crowberry				S3	93	43.8 ± 7.0	NS
P	*Vaccinium uliginosum*	Alpine Bilberry				S3	3	57.7 ± 1.0	NS
P	*Halenia deflexa*	Spurred Gentian				S3	3	70.6 ± 0.0	NS
P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	12	64.0 ± 3.0	NS
P	*Myriophyllum verticillatum*	Whorled Water Milfoil				S3	3	33.1 ± 0.0	NS
P	*Epilobium strictum*	Downy Willowherb				S3	6	22.6 ± 0.0	NS
P	*Polygala sanguinea*	Blood Milkwort				S3	23	31.8 ± 5.0	NS
P	*Persicaria arifolia*	Halberd-leaved Tearthumb				S3	15	9.7 ± 0.0	NS
P	*Plantago rugelii*	Rugel's Plantain				S3	10	28.0 ± 0.0	NS
P	*Primula laurentiana*	Laurentian Primrose				S3	10	90.1 ± 0.0	NS

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P	*Samolus parviflorus*	Seaside Brookweed				S3	9	44.0 ± 5.0	NS
P	*Pyrola minor*	Lesser Pyrola				S3	2	59.1 ± 0.0	NS
P	*Anemone virginiana*	Virginia Anemone				S3	17	32.1 ± 7.0	NS
P	*Cephalanthus occidentalis*	Common Buttonbush				S3	6	47.2 ± 0.0	NS
P	*Galium labradoricum*	Labrador Bedstraw				S3	79	7.6 ± 0.0	NS
P	*Salix pedicellaris*	Bog Willow				S3	55	20.6 ± 0.0	NS
P	*Salix sericea*	Silky Willow				S3	1	21.8 ± 1.0	NS
P	*Saxifraga paniculata ssp. laestadii*	Laestadius' Saxifrage				S3	4	82.3 ± 7.0	NS
P	*Lindernia dubia*	Yellow-seeded False Pimperel				S3	38	48.9 ± 0.0	NS
P	*Laportea canadensis*	Canada Wood Nettle				S3	56	2.6 ± 0.0	NS
P	*Pilea pumila*	Dwarf Clearweed				S3	7	22.6 ± 0.0	NS
P	*Viola nephrophylla*	Northern Bog Violet				S3	10	27.2 ± 1.0	NS
P	*Carex bebbii*	Bebb's Sedge				S3	25	44.9 ± 0.0	NS
P	*Carex castanea*	Chestnut Sedge				S3	26	9.8 ± 0.0	NS
P	*Carex cryptolepis*	Hidden-scaled Sedge				S3	13	11.1 ± 0.0	NS
P	*Carex eburnea*	Bristle-leaved Sedge				S3	10	26.4 ± 0.0	NS
P	*Carex hirtifolia*	Pubescent Sedge				S3	53	10.7 ± 7.0	NS
P	*Carex lupulina*	Hop Sedge				S3	45	2.6 ± 0.0	NS
P	*Carex rosea*	Rosy Sedge				S3	40	20.0 ± 0.0	NS
P	*Carex swanii*	Swan's Sedge				S3	3	40.3 ± 0.0	NS
P	*Carex tenera*	Tender Sedge				S3	11	31.1 ± 0.0	NS
P	*Carex tribuloides*	Blunt Broom Sedge				S3	15	11.9 ± 0.0	NS
P	*Carex tuckermanii*	Tuckerman's Sedge				S3	34	48.4 ± 0.0	NS
P	*Carex atratiformis*	Scabrous Black Sedge				S3	3	86.7 ± 0.0	NS
P	*Eleocharis nitida*	Quill Spikerush				S3	10	38.0 ± 5.0	NS
P	*Eleocharis flavescens var. olivacea*	Bright-green Spikerush				S3	5	20.4 ± 0.0	NS
P	*Eriophorum gracile*	Slender Cottongrass				S3	13	39.4 ± 7.0	NS
P	*Coeloglossum viride*	Long-bracted Frog Orchid				S3	3	59.6 ± 0.0	NS
P	*Cypripedium parviflorum*	Yellow Lady's-slipper				S3	545	49.3 ± 0.0	NS
P	*Neottia bifolia*	Southern Twayblade				S3	108	17.9 ± 0.0	NS
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	112	10.9 ± 0.0	NS
P	*Platanthera hookeri*	Hooker's Orchid				S3	24	48.2 ± 0.0	NS
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S3	6	44.9 ± 0.0	NS
P	*Piptatheropsis canadensis*	Canada Ricegrass				S3	8	20.0 ± 3.0	NS
P	*Poa glauca*	Glaucous Blue Grass				S3	8	49.4 ± 1.0	NS
P	*Potamogeton praelongus*	White-stemmed Pondweed				S3	8	34.3 ± 5.0	NS
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3	6	37.0 ± 0.0	NS
P	*Potamogeton zosteriformis*	Flat-stemmed Pondweed				S3	15	3.4 ± 0.0	NS
P	*Asplenium viride*	Green Spleenwort				S3	12	67.5 ± 7.0	NS
P	*Dryopteris fragrans*	Fragrant Wood Fern				S3	15	51.7 ± 7.0	NS
P	*Sceptridium dissectum*	Dissected Moonwort				S3	7	67.0 ± 1.0	NS
P	*Polypodium appalachianum*	Appalachian Polypody				S3	17	4.0 ± 0.0	NS
P	*Persicaria amphibia var. emersa*	Long-root Smartweed				S3?	2	8.9 ± 0.0	NS
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S3?	15	37.1 ± 1.0	NS
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3?	7	43.8 ± 0.0	NS
P	*Bidens vulgata*	Tall Beggarticks				S3S4	7	37.2 ± 0.0	NS
P	*Erigeron hyssopifolius*	Hyssop-leaved Fleabane				S3S4	24	28.2 ± 0.0	NS
P	*Hieracium paniculatum*	Panicled Hawkweed				S3S4	19	63.0 ± 0.0	NS
P	*Bidens beckii*	Water Beggarticks				S3S4	9	3.4 ± 0.0	NS
P	*Packera paupercula*	Balsam Groundsel				S3S4	92	29.6 ± 5.0	NS
P	*Packera paupercula var. paupercula*	Balsam Groundsel				S3S4	1	55.3 ± 0.0	NS
P	*Atriplex glabriuscula var. franktonii*	Frankton's Saltbush				S3S4	15	64.3 ± 0.0	NS

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P	*Shepherdia canadensis*	Soapberry				S3S4	101	50.5 ± 7.0	NS
P	*Vaccinium boreale*	Northern Blueberry				S3S4	4	36.4 ± 0.0	NS
P	*Vaccinium cespitosum*	Dwarf Bilberry				S3S4	60	40.9 ± 0.0	NS
P	*Vaccinium corymbosum*	Highbush Blueberry				S3S4	2	38.2 ± 0.0	NS
P	*Fagus grandifolia*	American Beech				S3S4	247	3.3 ± 0.0	NS
P	*Bartonia virginica*	Yellow Bartonia				S3S4	25	21.8 ± 7.0	NS
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S3S4	5	46.0 ± 1.0	NS
P	*Nuphar microphylla*	Small Yellow Pond-lily				S3S4	4	66.4 ± 0.0	NS
P	*Persicaria pensylvanica*	Pennsylvania Smartweed				S3S4	32	19.6 ± 7.0	NS
P	*Fallopia scandens*	Climbing False Buckwheat				S3S4	28	30.3 ± 0.0	NS
P	*Rumex pallidus*	Seabeach Dock				S3S4	1	34.4 ± 0.0	NS
P	*Pyrola asarifolia*	Pink Pyrola				S3S4	10	20.1 ± 50.0	NS
P	*Endotropis alnifolia*	alder-leaved buckthorn				S3S4	167	2.4 ± 0.0	NS
P	*Amelanchier spicata*	Running Serviceberry				S3S4	15	54.7 ± 3.0	NS
P	*Crataegus succulenta*	Fleshy Hawthorn				S3S4	1	38.6 ± 0.0	NS
P	*Fragaria vesca ssp. americana*	Woodland Strawberry				S3S4	68	2.9 ± 0.0	NS
P	*Fragaria vesca*	Woodland Strawberry				S3S4	1	91.9 ± 0.0	NS
P	*Galium aparine*	Common Bedstraw				S3S4	25	38.1 ± 0.0	NS
P	*Geocaulon lividum*	Northern Comandra				S3S4	13	50.2 ± 0.0	NS
P	*Limosella australis*	Southern Mudwort				S3S4	21	36.0 ± 5.0	NS
P	*Veronica serpyllifolia*	Thyme-Leaved Speedwell				S3S4	77	4.8 ± 0.0	NS
P	*Ulmus americana*	White Elm				S3S4	71	2.9 ± 1.0	NS
P	*Verbena hastata*	Blue Vervain				S3S4	205	2.5 ± 0.0	NS
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S3S4	13	28.3 ± 0.0	NS
P	*Viola selkirkii*	Great-Spurred Violet				S3S4	5	45.9 ± 4.0	NS
P	*Symplocarpus foetidus*	Eastern Skunk Cabbage				S3S4	3	48.3 ± 0.0	NS
P	*Carex argyrantha*	Silvery-flowered Sedge				S3S4	7	69.9 ± 1.0	NS
P	*Triglochin gaspensis*	Gasp ├⌐ Arrowgrass				S3S4	21	58.8 ± 0.0	NS
P	*Juncus acuminatus*	Sharp-Fruit Rush				S3S4	5	10.9 ± 0.0	NS
P	*Juncus subcaudatus*	Woods-Rush				S3S4	24	8.9 ± 1.0	NS
P	*Luzula parviflora ssp. melanocarpa*	Black-fruited Woodrush				S3S4	5	62.6 ± 0.0	NS
P	*Goodyera repens*	Lesser Rattlesnake-plantain				S3S4	7	55.8 ± 0.0	NS
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	7	2.1 ± 0.0	NS
P	*Platanthera obtusata*	Blunt-leaved Orchid				S3S4	8	28.2 ± 1.0	NS
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3S4	26	40.6 ± 7.0	NS
P	*Alopecurus aequalis*	Short-awned Foxtail				S3S4	23	5.8 ± 0.0	NS
P	*Dichanthelium clandestinum*	Deer-tongue Panic Grass				S3S4	156	2.8 ± 0.0	NS
P	*Panicum philadelphicum*	Philadelphia Panicgrass				S3S4	13	48.9 ± 0.0	NS
P	*Koeleria spicata*	Narrow False Oats				S3S4	17	22.9 ± 0.0	NS
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S3S4	15	78.3 ± 0.0	NS
P	*Equisetum pratense*	Meadow Horsetail				S3S4	16	29.3 ± 0.0	NS
P	*Diphasiastrum complanatum*	Northern Ground-cedar				S3S4	14	45.7 ± 1.0	NS
P	*Diphasiastrum sitchense*	Sitka Ground-cedar				S3S4	2	47.1 ± 5.0	NS
P	*Huperzia appressa*	Mountain Firmoss				S3S4	18	36.4 ± 7.0	NS
P	*Sceptridium multifidum*	Leathery Moonwort				S3S4	10	22.8 ± 10.0	NS
P	*Botrychium matricariifolium*	Daisy-leaved Moonwort				S3S4	7	41.0 ± 0.0	NS
P	*Viola canadensis*	Canada Violet				SH	2	41.9 ± 7.0	NS
P	*Greeneochloa coarctata*	Small Reedgrass				SH	1	48.7 ± 6.0	NS

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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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APPENDIX B: STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE: FISH COLLECTION

1 PURPOSE

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

2 SCOPE

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

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

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

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

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

3 PERMITTING

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

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

4 SAFETY

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

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

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

5 FISH COLLECTION METHODS - THEORY

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

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

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

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

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

5.1 Electrofishing

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

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

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

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

Photo 1: Example of an electrofishing crew in action

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

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

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

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

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

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

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

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

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

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

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

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

5.2 Minnow Traps

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

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

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

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

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

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

5.3 Eel Pots

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

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

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

5.4 Fyke Nets

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

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

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

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

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

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

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

5.5 Seines

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

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

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

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

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

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

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

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

6 MATERIALS

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

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

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

7 FISH COLLECTION METHODS – PROCEDURES

7.1 Planning: Before You Leave

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

7.2 Electrofishing

7.2.1 Site Setup

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

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

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

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

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

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

7.2.2 Surveying

1. The survey should be completed in an upstream direction. Start at the most downstream point of the sampling site and work your way upstream. Once in the reach, the backpack operator will release the emergency shut off switch on the electrofishing unit. The operator must always give a verbal indication to, and receive a verbal acknowledgement from, all crew before commencing each sweep.
2. The electrofisher operator must say aloud "Power On" each time they begin electrofishing. Begin the first sweep by shocking water at the designated starting point.
3. The netter should be positioned downstream of the operator, approximately 2-3 m apart. The netter should set the pole net flush with the bed of the stream and perpendicular to flow.
4. Continue sweeping the anode ring wading from one bank to the other, always in line with the pole net, thus sampling a "lane" of the stream. When fishing undercut banks or log jams, fish can be drawn out by inserting the uncharged anode, switching it on and then pulling the anode out and away. Creating currents using the anode ring or dip-nets can often assist with pulling stunned fish out of complex structure when using this technique. When the opposite bank is reached, both the machine operator and pole netter move upstream 2–3 m and begin fishing again. Continue fishing until the entire sample reach has been fished.
   Note: If you get water in waders or gloves, or it begins to rain hard enough to saturate clothing, ***STOP WORK*** *immediately and get dry clothing. Never reach into the water in vicinity of an electrode, even if rubber gloves are being worn. To further prevent electrical shock, never touch an electrode while the circuit is energized, even while wearing rubber gloves and waders.*

5. Transfer captured fish to live wells where they can be held until the completion of the electrofishing pass. Keep the live well in a shaded area. When fish are held for a longer period of time, particularly during warm conditions, regularly change the water maintain water quality.
6. Record pass details (seconds of electrofishing, voltage, and frequency) on the Fish Collection Tracking Sheet. Reset the elapsed time counter for each pass.
7. Process the captured fish (refer to Section 8). Once processed, return captured fish to watercourse/ waterbody, outside of the barricaded reach (if using barrier nets).
8. Repeat steps 1-8 until the required number of passes have been completed. The number of passes required will depend on the type of survey (qualitative or quantitative) being employed.
   a. For a **qualitative, open-site survey,** one pass should be sufficient, unless crew members note a high number of fish that evaded capture. In that case, perform a second or third pass to obtain greater species representation. For all qualitative electrofishing surveys, crews should aim for at least 300 seconds of effort (i.e. minimum effort).
   b. In **quantitative, closed-site surveys,** a minimum of three passes should be performed. The requirement for additional passes is determined by the total catch on the last run. If the catch on the last run is <20% of the catch on the first pass and <50% of the catch of the previous pass, no additional passes are required. If no fish are captured or observed on the first two passes, the third pass is not necessary.
9. At the conclusion of all electrofishing surveys, inspect all equipment and note any problems requiring correction. Disconnect the battery and all attachments. Batteries must be charged at the

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

7.3 Trapping and Netting

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

7.3.1 Site Setup

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

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

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

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

7.3.2 Trap/Net Deployment (Day 1)

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

7.3.3 Trap/Net Retrieval (Day 2)

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

7.3.4 Seining

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

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

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

8 FISH PROCESSING

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

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

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

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

9 REPORTING

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

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

10 REFERENCES

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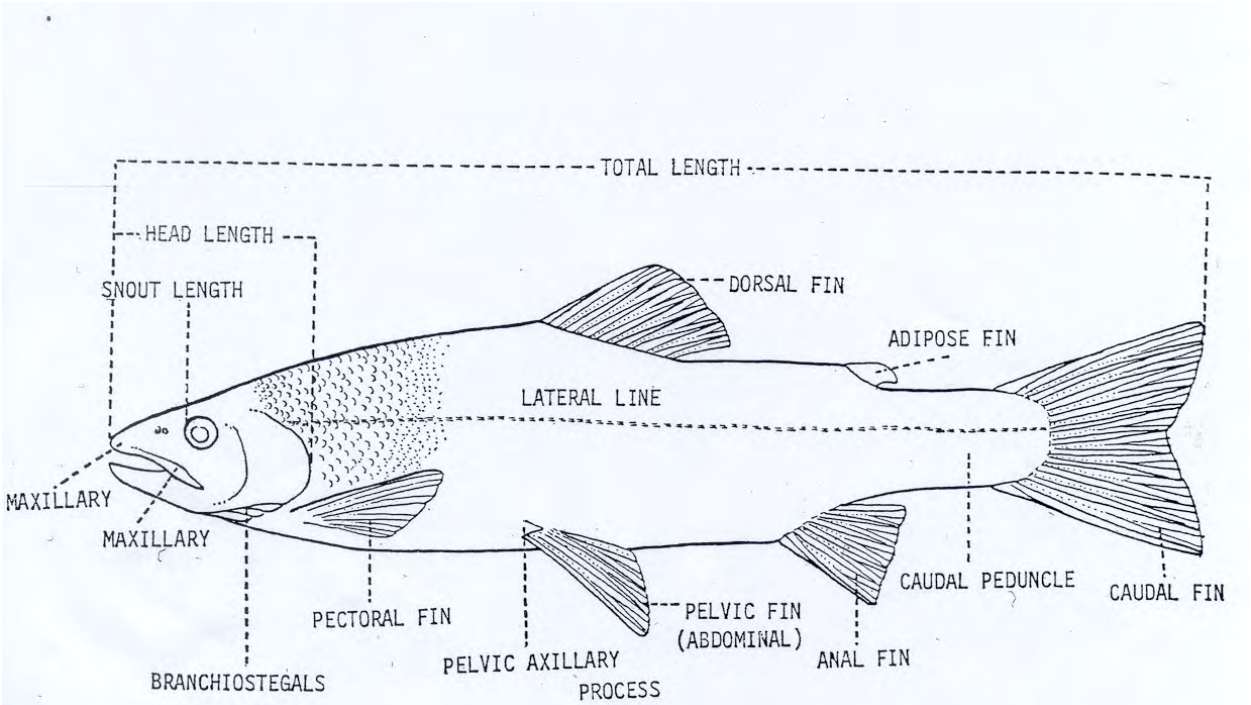
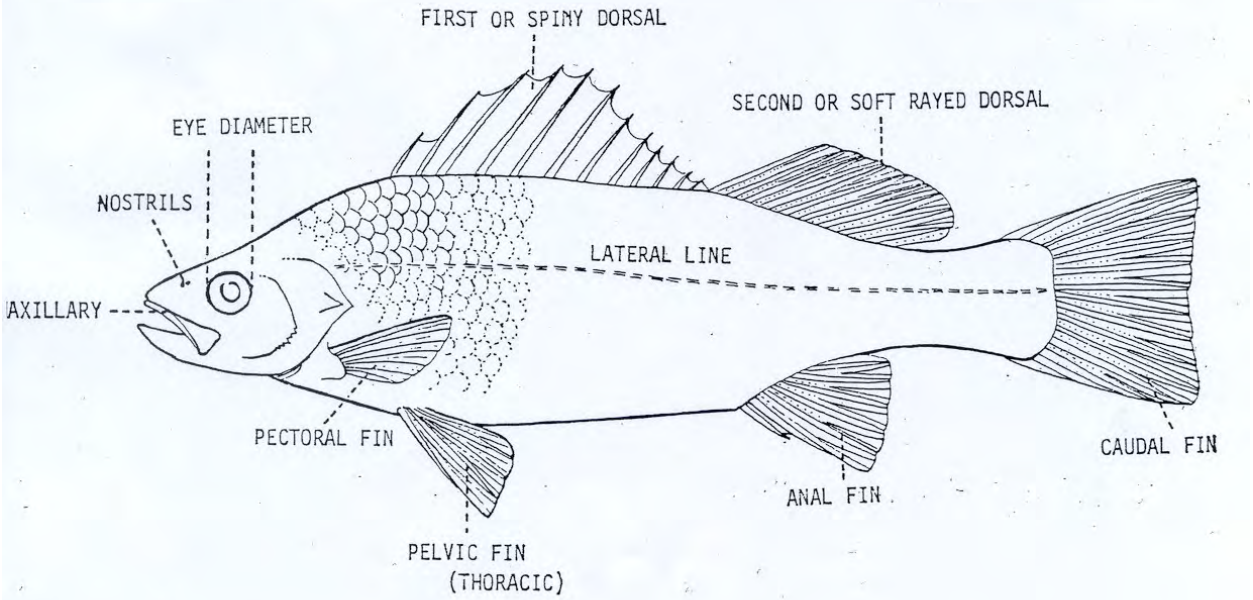
Appendix A: Anatomical Features of Fish


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


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

Appendix B: Fish Species Codes & Definitions

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

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

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

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

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

SECTION 6.0. FISH FACTS

THIS SECTION CONTAINS:

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

6.1. Understanding Fish

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

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

Eyes and Sight

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

Gills

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

Nostrils and Smell

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

Lateral Line (line along the side of the body)

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

Mouth

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

Fins

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

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

Scales

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

Ears

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

6.2. Habitat Requirements

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

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

Trout and salmon require very special conditions for:

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

In general, salmonids require streams that have:

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

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

Temperature

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

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

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

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

Shade

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

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

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

Oxygen

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

Gravel and Stream Bottom

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

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

Stream flow

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

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

Barriers to swimming up and downstream

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

Clean Water

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

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

Cover/Shelter

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

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

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

the current.

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

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

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

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

6.3. FACTS ON FISH

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

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

Atlantic Salmon (Salmo salar)

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

Physical Characteristics

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

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

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

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

Salmon finished spawning (kelts): very dark in colour

Facts on Salmon

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

Atlantic salmon are mentioned in the Magna Carta.

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

Most grilse are male.

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

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

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

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

Salmon Sizes

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

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

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

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

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

Distribution

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

Natural History

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

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

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

Fishing Facts

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

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

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

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

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

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

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

More Facts on Salmon

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

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

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

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

Brook trout (Salvelinus fontinalis)

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

Physical Characteristics

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

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

Facts on Brook Trout

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

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

It can be seen today in the Nova Scotia Museum.

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

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

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

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

Distribution

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

Natural History

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

Fishing facts

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

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

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

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

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

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

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

Brown Trout (Salmo trutta)

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

Physical Characteristics

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

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

Facts on Brown Trout

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

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

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

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

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

Distribution

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

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

Fishing Facts

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

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

Natural History

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

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

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

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

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

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

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

Rainbow Trout (Oncorhynchus mykiss)

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

Facts on Rainbow Trout

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

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

Physical Characteristics

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

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

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

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

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

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

(6 lb).

Distribution

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

Natural History

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

Fishing Facts

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

The flesh is tasty and may be prepared many ways.

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

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

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

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

Smallmouth bass (Micropterus dolomieui)

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

Physical Characteristics

The smallmouth bass has the following characteristics:

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

Facts about Smallmouth Bass

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

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

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

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

Distribution

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

Natural History

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

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

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

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

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

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

Fishing Facts

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

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

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

Striped Bass (Morone saxatalis)

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

Physical Characteristics

Striped bass have the following characteristics:

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

Striped bass have been recorded as large as

Facts about Striped Bass

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

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

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

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

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

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

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

Distribution

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

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

Natural History

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

Fishing Facts

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

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

It is not fished commercially in Nova Scotia.

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

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

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

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

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

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

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

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

Alewife (Alosa pseudoharengus)

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

Physical Characteristics

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

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

• Gasperaux entering freshwater are often copper-tinged

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

Facts on Alewife

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

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

• The eye is relatively large and has an obvious eyelid

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

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

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

probably include the blueback herring as well.

Distribution

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

Fishing Facts

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

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

Natural History

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

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

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

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

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

American Eel (Anguilla rostrata)

Physical Characteristics

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

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

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

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

Fishing Facts

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

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

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

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

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

Distribution

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

Natural History

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

Facts about Eels

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

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

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

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

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

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

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

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

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

American Shad (Alosa sapidissima)

Physical Characteristics

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

Facts on Fishing

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

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

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

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

Distribution

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

Natural History

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

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

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

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

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

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

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

Brown bullhead (Ictalurus nebulosus)

Physical Characteristics

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

The following can also identify the bullhead:

• A thick rounded body, heaviest toward the front

• A broad, large, somewhat flattened head

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

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

Facts about Bullheads

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

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

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

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

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

blotches and the belly is cream coloured

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

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

Distribution

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

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

Natural History

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

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

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

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

Rainbow smelt (Osmerus mordax)

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

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

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

Physical Characteristics

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

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

Distribution

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

Fishing Facts

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

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

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

Natural History

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

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

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

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

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

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

White Perch (Morone americana)

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

Facts about White Perch

The oldest known white perch lived 17 years.

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

Physical Characteristics

The white perch has the following characteristics:

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

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

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

Distribution

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

Fishing Facts

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

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

Natural History

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

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

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

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

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

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

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

Yellow perch (Perca flavescens)

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

Physical Characteristics

The yellow perch has the following characteristics:

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

Facts about Yellow Perch

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

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

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

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

Distribution

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

Facts about Yellow Perch

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

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

Natural History

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

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

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

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

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

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

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

White Sucker (Catostomus commersoni)

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

Fishing Facts

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

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

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

Physical Characteristics

The white sucker has the following characteristics:

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

spots on the sides

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

Distribution

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

Facts about Suckers

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

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

Natural History

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

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

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

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

sand and gravel shallow areas with moderate currents.

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

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

Appendix D: Fish Collection Tracking Sheet

Fish Collection Tracking Sheet

McCallum Environmental Ltd.

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

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

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

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

Revisions to Electrofisher settings required?

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

ELECTROFISHING (Electrofishing must proceed in an upstream direction)

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

TRAPPING & NETTING

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

Fish Collection Tracking Sheet

McCallum Environmental Ltd.

Individual Fish Measurements

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

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

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

STANDARD OPERATING PROCEDURE: DETAILED FISH HABITAT ASSESSMENT – STREAMS

1 PURPOSE

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

2 SCOPE

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

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

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

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

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

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

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

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

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

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

3 SAFETY

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

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

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

4 FISH HABITAT ASSESSMENT - THEORY

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

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

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

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

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

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

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

5 MATERIALS

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

6 FISH HABITAT ASSESSMENT METHODS – PROCEDURES

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

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

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

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

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

6.1 Planning: Before You Leave

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

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

6.2 Field Procedure

6.2.1 Site Setup

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

6.2.2 Transects

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

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

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

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

6.2.3 Between Transects

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

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

6.2.4 Reach Assessment

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

7 REFERENCES

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8 GLOSSARY

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

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

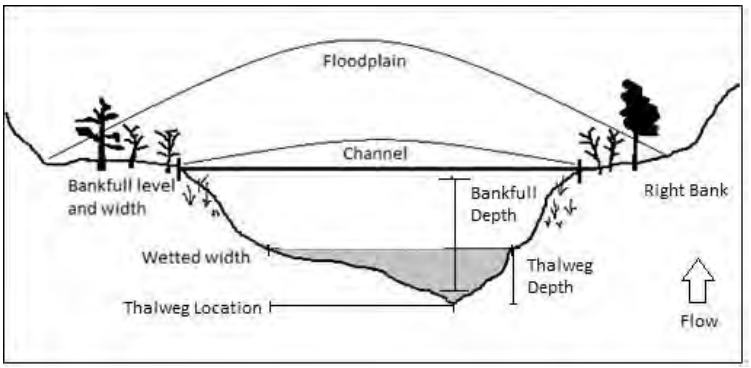


Image 1: Components of a channel cross-section

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

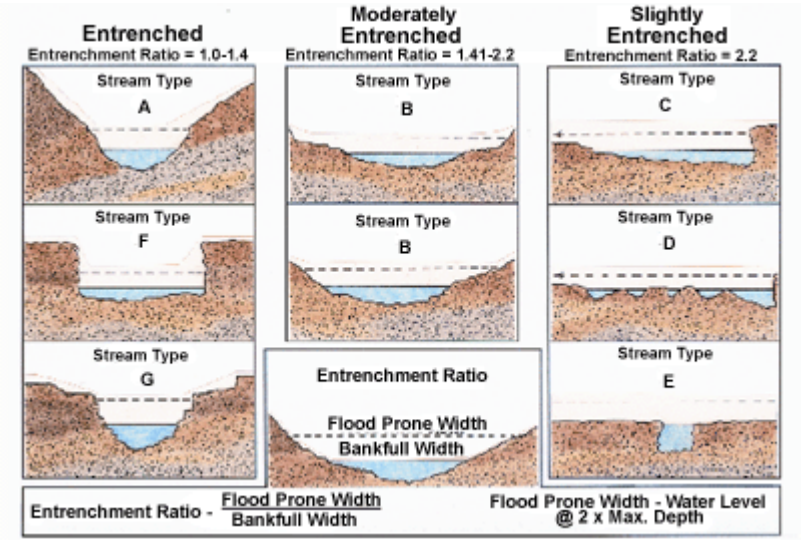


Image 2: Degrees of entrenchment (the term "entrenched" equates to "highly entrenched" for the purposes of this SOP. Source: https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=1259)

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

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

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

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

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

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

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

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

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

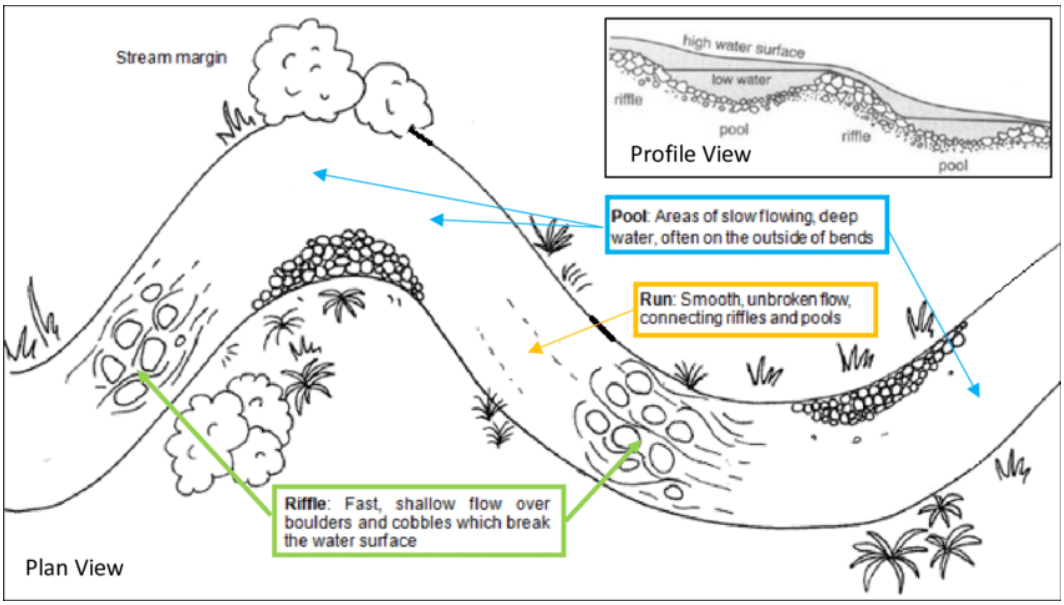


Image 3: A typically riffle-run-pool sequence within a stream (Source: https://www.researchgate.net/figure/Elements-of-a-river-reach-pool-riffle-and-run_fig13_322765638)

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

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

Image 4: A cascade

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

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

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

Image 6: A flat

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

Image 8: A boulder-bed

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

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

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

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

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

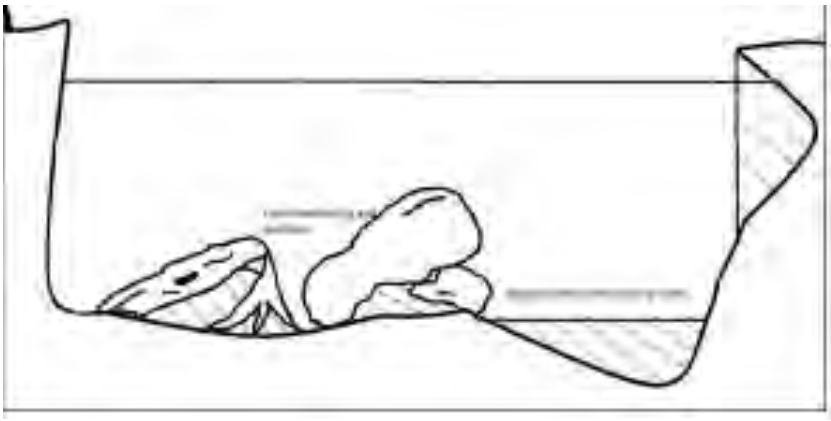


Image 11: Example of cover types within a transect (Source: NSHSI, 2018)

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.

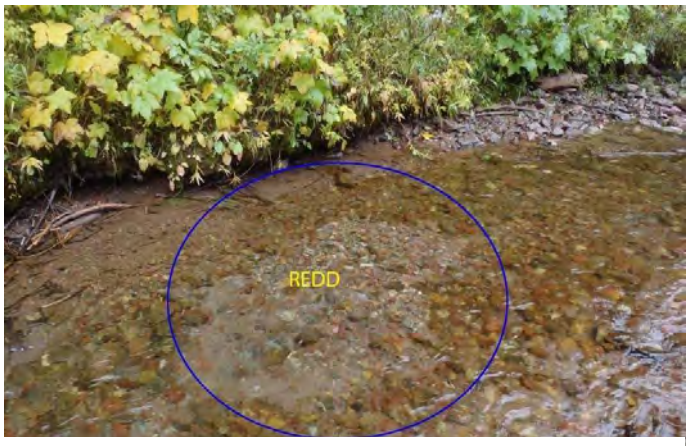


Image 12: A salmonid redd (Source: https://www.tu.org/blog/redd-surveys-shaping-priorities-in-michigans-pere-marquette/)

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:

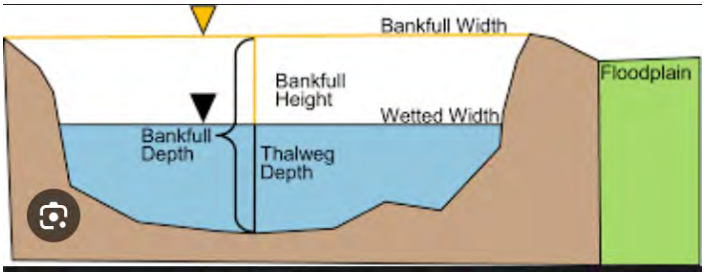
Detailed Fish Habitat Assessment - Streams

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 C: PHOTO LOG

Photo 1: WC 1 Reach 1

Photo 2: WC 1 Reach 2

Photo 3: WC 1 Reach 3

Photo 4: WC 1 Reach 4

Photo 5: WC 1 Reach 5

Photo 6: WC 1 Reach 6

Photo 7: WC 1 Reach 7

Photo 8: WC 1 Reach 8

Photo 9: WC 1 Reach 9

Photo 10: WC 1 Reach 10

Photo 11: WC 1 Reach 11

Photo 12: WC 1 Reach 12

Photo 13: WC 1 Reach 13

Photo 14: WC 1 Reach 14

Photo 15: WC2 Reach 1

Photo 16: WC3 Reach 1

Photo 17: WC3 Reach 2

Photo 18: WC4 Reach 1

Photo 19: WC5 Reach 1

Photo 20: WC6 Reach 1

Photo 21: WC7 Reach 1

Photo 22: WC7 Reach 2

Photo 23: WC8 Reach 1

Photo 24: WC8 Reach 2

Photo 25: WC9 Reach 1

Photo 26: WC9 Reach 2

Photo 27: WC9 Reach 3

Photo 28: WC9 Reach 4

Photo 29: WC10 Reach 1

Photo 30: WC11 Reach 1

Photo 31: WC11 Reach 2

Photo 32: WC12 Reach 1

Photo 33: WC12 Reach 2

Photo 34: WC12 Reach 3

Photo 35: WC14 Reach 1

Photo 36: WC15 Reach 1

Photo 37: WC16 Reach 1

Photo 38: WC17 Reach 1

Photo 39: WC18 Reach 1

Photo 40: WC19 Reach 1