

# **HISTORY AND DISTRIBUTION OF LAKE WHITEFISH, *COREGONUS CLUPEAFORMIS* (MITCHILL, 1818), IN NOVA SCOTIA AND NEW BRUNSWICK, CANADA, WITH SUPPLEMENTARY NOTES ON REGIONAL COREGONIDS**

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## **ABSTRACT**

Lake Whitefish (*Coregonus clupeaformis*) occur in the Canadian Maritime Provinces of New Brunswick and Nova Scotia and were first described regionally in the 1850s in the Saint John River. However, no early observations of the species were known in Nova Scotia prompting

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extensive Lake Whitefish stocking through Canada's earliest federally run hatcheries. From 1878-1901, nearly 80 million Lake Whitefish fry were introduced to Nova Scotia and New Brunswick, but all attempted introductions were thought to have failed. From 1964 onward, Lake Whitefish discoveries were reported in Nova Scotia, but not until 1990 were these populations demonstrated to be native. Due to the distinct genetic lineage and eastern distribution of maritime Lake Whitefish populations, we argue that they originated from a distinct glacial refugium. The goal of this review is to provide baseline data on origin, distribution, and history of Lake Whitefish throughout the Maritimes that will facilitate continued research, help identify undocumented populations, and support the conservation of those so far known. As invasive species spread, climates warm, and new recreational fisheries develop, the resilience of Lake Whitefish populations should become a management consideration among the region's small yet distinct eastern assemblage of native cold-water fishes.

Keywords: Hatchery stocking, zoogeography, native species, continental shelf refugia, post-glacial dispersal

## INTRODUCTION

The genus *Coregonus* is the most speciose within the family Salmonidae and has a northern circumpolar distribution (Bernatchez 1995) that includes freshwater, euryhaline, and anadromous ciscoes and whitefishes (Scott and Crossman 1973, Svårdson 1979, Bernatchez *et al.* 2010). This diverse group of fishes is highly adaptable with noted variations in diet, spawning habitat, and use of marine waters, even among conspecifics. In North America, 18 coregonid species are recognized of which the Lake Whitefish (*Coregonus clupeaformis* Mitchill, 1818) may be the most well known and widely distributed, ranging from the Lake Erie and Michigan basins in the south to the northern tributaries of Alaska (Scott and Crossman 1973). From this western point, the Lake Whitefish occurs as far east as the Atlantic coast of Nova Scotia (Bernatchez and Dodson 1991). Lake Whitefish is most common in deep, well oxygenated, oligotrophic lakes (Wood 2016), but it is also found in rivers, estuaries, and on occasion marine waters, particularly in the coastal tributaries of Hudson Bay and Arctic Ocean drainages (Scott and Crossman 1973). Among North American coregonids, the Lake Whitefish is one of three species native to the Canadian Maritime Provinces (MP; Fig 1). In northern New Brunswick (NB), Lake Whitefish occur alongside the Round Whitefish (*Prosopium cylindraceum* Pallas, 1784) while in Nova

Scotia (NS) the only other coregonid is the critically endangered and endemic Atlantic Whitefish (*Coregonus huntsmani*) (Scott 1967, Edge and Gilhen 2001). Due to the morphological plasticity and diversity of the genus *Coregonus* across the Holarctic, and difficulties in distinguishing member species (Scott and Scott 1988), the eastern-most natural distribution of Lake Whitefish has only recently been defined (Bernatchez and Dodson 1990, 1991, Edge and Gilhen 2001).

Lake Whitefish have been documented and described in NB since the 1850s, largely in the Saint John River Basin (Perley 1852). Although, the absence of early records in NS suggested that no Coregonids were known prior to 1919 (Vldykov and McKenzie 1935). This perceived absence of whitefish in NS and limited distribution in NB coupled with the high value of Lake Whitefish as a commercial food species elsewhere in Canada incentivised intensive stocking efforts across the MP (Pope 1879). These stocking efforts and the introduced fish were not successful, and Lake Whitefish supplementation programs in the MP were abandoned as early as the turn of the 20th century. Nearly 125 years after stocking was first attempted, native populations of Lake Whitefish were discovered in NS and its native ancestry in the MP has since been confirmed (Bernatchez and Dodson 1990, 1991). Despite this discovery, our knowledge of local distribution, basic ecology, and conservation status of Lake Whitefish is lacking. Furthermore, the persistence of several Lake Whitefish populations in NS has not been confirmed in over 20 years, and in many more locations far more time has elapsed since the most recent survey or report. In NB, documented Lake Whitefish disappearances have been left unexamined. These data gaps in both provinces have remained despite the known impacts of climate change and invasive species introduction that threaten native cold-water fishes region-wide (Curry and Gautreau 2010).

To inform future study of Lake Whitefish in the MP, this review compiles all available data on the Lake Whitefish including post glacial distribution, historical stocking efforts, population ancestry, and present occurrence in NS and NB. These data have been assembled into a series of tables and maps detailing the timing and magnitude of documented introductions while reporting the spatial distribution of stocked and native populations, the latter of which were identified both prior to and after the stocking occurred. Round Whitefish and Atlantic Whitefish are also described regionally when required to

better understand Lake Whitefish history, distribution, and identification. While the presented data are comprehensive of what is known regarding Lake Whitefish and reported to date, a significant time gap exists between this writing (2025) and even the most recent partial surveys (Murray 2005, Nova Scotia Department of Fisheries and Aquaculture [NSDFA], unpubl. data). Therefore, modern persistence of identified populations in most locations and particularly in NS is almost entirely unknown. Though, in the absence of alternative data sources, these data must be considered accurate until updated assessments become available. The goal of this review is to provide baseline data to assist all future study and exploration of Lake Whitefish in the MP and we encourage future authors to confirm and update the species occurrence here presented alongside their findings.

### **Description of the Study Area**

This review focuses on lakes of the Canadian MPs (including NS and NB) but omits Prince Edward Island (PEI; Fig 2, 3) due to its lack of suitable habitat and absence of Lake Whitefish occurrence or stocking. The MPs that support whitefishes occupy a temperate coastal ecozone characterized by mild winters and cool summers with mean annual monthly temperatures raging from -2 to 15.5°C in coastal regions (Webb and Marshall 1999) and with less seasonal temperature moderation as one travels inland. Lakes in Nova Scotia are usually small, shallow, and oligotrophic, often appearing darkly stained or tannic due to a high humic concentration drawn from organic material decay in wetland soils (Davis and Browne 1996). These darkly stained tannic waters are synonymous with low pH (Kerekes *et al.* 1982) resulting from the production of natural, dissolved organic acids. These conditions were in many regions exacerbated by the effects of acid rain in the 1970s (Clair *et al.* 2007) which eroded the natural buffering capacity of the soil. Darkly stained lakes subject to limited light penetration frequently establish shallow thermoclines that maintain cold-water refugia even within confined or shallow basins (Heiskanen *et al.* 2015).

In NS, the northwestern portion of the province, including much of Cape Breton, is composed of sedimentary rock such as limestone that is more easily weathered to provide a buffer against acidity (Davis and Browne 1996). In southwestern and eastern regions, shallow granite and shale bedrock covered with thin acidic soils provide little buffering capacity and low pH ( $\leq 4.5$ ) is often reported in these

regions susceptible to acidification (Shilts 1981, Clair *et al.* 2007, Curry and Gautreau 2010). Low pH is linked to impacts to aquatic ecosystems (Kerekes *et al.* 1982), including declines in native salmonids (Watt 1987), reductions in inland and anadromous fishes (White 1992) and loss of species diversity (Kelso *et al.* 1986), and thus it may also impact Lake Whitefish (Edge 1987, Goodchild 2001). Freshwater obligate and euryhaline fish diversity is low throughout NS (Curry 2007), resulting in limited interspecific competition amongst native species. This condition may have left native fishes of the MP vulnerable to predation and competition by aquatic invasive species such as Smallmouth Bass (*Micropterus dolomieu* Lacépède, 1802) and Chain Pickerel (*Esox niger* Lesueur, 1818), particularly in the south of the province where warm water invasives are most prevalent (LeBlanc 2010).

Similar environmental conditions exist in NB including low pH and the lack of natural buffering capacity in the southwest of the province (Clair *et al.* 2007). However, Lake Whitefish have much greater access to large rivers, deep basins, and interconnected lake systems in NB than are available in NS. In some of these larger systems such as the Saint John River, dams now block migration routes and fish passage. NB has a higher diversity of freshwater obligate fishes than NS (Curry 2007) but has also fostered more warm water invasive species of which many are regarded as key sportfish throughout inland lakes, the Saint John, and the Saint Croix rivers complicating management. The Saint John River where Lake Whitefish were first reported in the MP has a large estuary with saltwater measurable 70 km upstream from the river mouth (Carter and Dadswell 1983) and possibly offers refuge to Lake Whitefish away from freshwater obligate invasive species concentrated further upstream (Zelman *et al.* 2023).

### Nomenclature

Hebda (2019) reported several names used to describe the Lake Whitefish, but across historical literature of the MP only a small number are repeated. Gizzard-fish is used by Perley (1851) and Smith (1969) in reference to the thick walled and gizzard-like stomach of the Lake Whitefish. The French name Poisson Pointu (English: sharp fish) is also reported by Perley (1851) and was used by early Acadian fishers that pursued the species in both Lake Témiscouata, Québec, and the Madawaska River, NB. This name likely describes the small, tapered head or pointed fins of the species because Lake Whitefish

possess no rigid spines. The Sault Whitefish (*Coregonus labradoricus* Richardson, 1836) is used by Cox (1896a) and Piers (1924) and suggested a northern form or sub-species of the Lake Whitefish. Despite these differences in early naming conventions, Lake Whitefish in the MP are the same as those occurring throughout the rest of North America despite some meristic differences (Edge 1987, Edge *et al.* 1991, Hasselman 2003, Hasselman *et al.* 2009), and the identification of localized dwarf forms (Fenderson 1964). Following discoveries of phenotypic plasticity of the species relating to gill raker and lateral line scale counts, the species which occurs across North America was eventually consolidated into *Coregonus clupeaformis* and the suggestion of subspecies was abandoned (Gilhen 1974).

Modern vernacular in the MP often refers to the species simply as “whitefish”, offering no distinction between the Lake Whitefish and the Round Whitefish that occupy an overlapping distribution in northern New Brunswick. Reference to the Round Whitefish within available records would likely be minimal because this planktivorous species is almost never caught by anglers, although, Maine once supported a recreational spring river fishery for the species (J. Wood, unpubl. data).” In contrast, the Atlantic Whitefish in Nova Scotia is commonly referred to specifically due to their conservation status (DFO 2006, 2018, COSEWIC 2010, COSEWIC 2022) and longstanding awareness campaigns. In French “Grand Corégone” is most common in and refers to the Lake Whitefish specifically.

### Whitefish Morphology

Scott and Crossman (1973) state that the genus *Coregonus* is “taxonomically, the most perplexing of all Canadian freshwater fishes”, a statement mostly relating to the difficulty of identifying cisco species due to high variability in gill raker counts and morphology, but the identification of whitefish in the MP has similarly resulted in considerable confusion (Edge and Gilhen 2001). Whitefish are subject to pronounced morphological variation (Fig 1; Svårdson 1979, Edge 1987, Edge *et al.* 1991) and diagnostic features such as gill raker number and length, and lateral line scale count can vary widely (Lindsey 1981, Edge 1987, Edge *et al.* 1991). Individual size and growth rate can also change based on environment, mode of feeding, and habitat that varies by individual lake (Scott and Crossman 1973, Goodchild 2001). In addition to broad intraspecies variation of the

genus *Coregonus*, three species of whitefish are present in the MP that are of note for local identification purposes (Fig 1).

Lake Whitefish and Atlantic Whitefish are the only two coregonids found in NS (Edge 1987, Edge *et al.* 1991). At present, Atlantic Whitefish are only known to persist in Hebb Lake, Minamkeak Lake, and Millipsigate Lake at the head of the Petite Rivière watershed, Lunenburg County (DFO 2018). Following the likely extirpation of this species from the Tusket and Annis rivers, it no longer overlaps spatially with Lake Whitefish in NS (Edge 1984, 1987, Edge and Gilhen 2001). In the neighbouring province of NB, the Atlantic Whitefish is absent, but the Round Whitefish occupies an overlapping distribution with Lake Whitefish in the north of the province. There it is found in the Saint Croix River Basin, and upper Saint John River basin through Madawaska and Victoria Counties (Scott and Crossman 1959, Gautreau and Curry 2020, DNRED unpubl. data) in addition to Restigouche County in the Restigouche River basin (Gautreau and Curry 2020, DNRED unpubl. data). Characteristics for identifying the Lake Whitefish and distinguishing among the species pairs in each respective province are as follows.

Lake Whitefish (Fig 1) have large clearly defined cycloid scales and a straight and clearly visible lateral line expressing 70-85 scales in most populations of the MP (Edge 1987). However, lateral line scale counts may be as high as 90 among populations in the upper Saint John River basin (Hasselman 2003). The body is coloured greenish grey dorsally, changing to silver-grey on the sides, and fading to a white ventral surface (Kerekes 1975, Goodchild 2001). The body is deepest just before the dorsal fin (Scott and Crossman 1973) and is slightly laterally compressed (Scott 1967). The dorsal fin is small, pointed, and soft rayed, and an opaque adipose fin is present along with a deeply forked and dark grey caudal fin. The pectoral fins, the mid-ventral abdominal fins, and the anal fin can range in colour from dark grey to faded yellow and are also soft-rayed. Lake Whitefish have a pointed overhung snout with a slightly sub-terminal mouth. Small teeth are present in juveniles, but no teeth are expressed by adults (Goodchild 2001). The maxillary extends to the anterior edge of the eye/pupil (Scott and Crossman 1973). During spawning, nuptial tubercles develop in both sexes but are most pronounced in males (Goodchild 2001). Additional morphometric and meristic counts for Lake Whitefish in the MP have been reported in detail by Edge



(1987), Edge *et al.* (1991), and Hasselman (2003). While regionally the species can grow to 62 cm FL and 4.5 kg, as reported from the largest of 130 Lake Whitefish sampled in the Saint John River by Dadswell (1975), it generally maintains a relatively small average size in the MP (< 50 cm; Lanman 1874, Smith 1952, Dadswell 1975).

In contrast, the Atlantic Whitefish (Fig 1), which is only found in NS, has a terminal mouth with small well-developed teeth on the premaxillaries, vomer, palatines, dentary, and tongue that are expressed in juveniles and retained as adults (Scott and Crossman 1973, Edge and Gilhen 2001, Hasselman 2003). In comparison to the Lake Whitefish, the snout of the Atlantic Whitefish is rounded, but its inferior lower jaw renders this character hard to reliably distinguish from a true sub-terminal position (Hasselman 2003). The elongate body is slightly laterally compressed (Scott and Crossman 1973) and sports similar colouration to the Lake Whitefish with silvery sides and a dark back (Edge and Gilhen 2001). Lateral line scales counts are perhaps the most reliable external identifying feature because the Atlantic Whitefish never expresses fewer than 88 lateral line scales (typically 91-100) which separates it from all Nova Scotian populations of Lake Whitefish (Edge 1987, 1991, Edge and Gilhen 2001, Goodchild 2001, Hasselman 2003). While not observable in live specimens, Atlantic Whitefish also have 64-67 vertebrae as compared to the 58-64 of the Lake Whitefish (Edge 1987, Edge *et al.* 1991, Edge and Gilhen 2001) and these counts have been proven a reliable discriminatory character by taxonomists (Hasselman 2003).

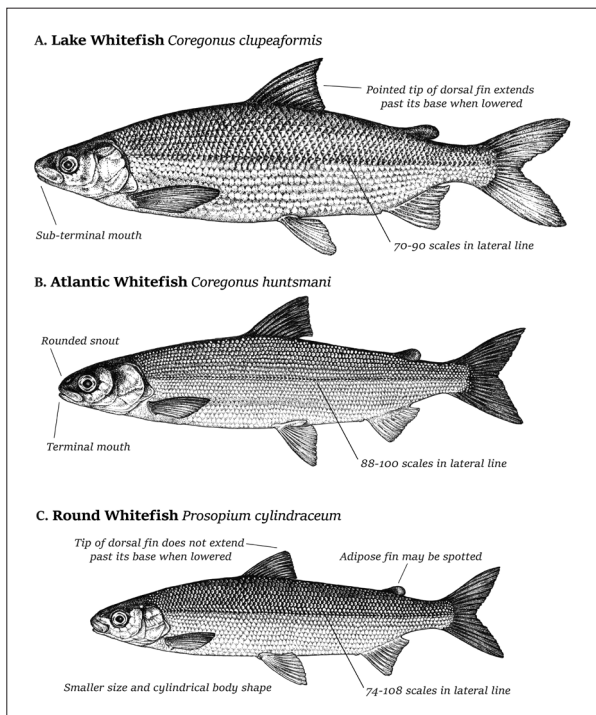
The Round Whitefish by comparison (Fig 1) is generally small (20-30 cm total length) but can occasionally exceed 40 cm (J. Wood, observation), it has a long slender body that is cylindrical in cross section and is green to bronze along the back, silver laterally, and white along the ventral side (Scott and Crossman 1973). Scales are well defined with dark borders and 74-108 lateral line scales are present, thus overlapping with counts for Lake Whitefish (Scott and Crossman 1973). The fins are pale amber in colour, but the dorsal and caudal fin can take on a sooty black shade and the adipose may appear brown and spotted providing a useful identification character (Scott and Crossman 1973). When depressed, the tip of the dorsal fin does not extend past its posterior base as it does in Lake Whitefish (Gautreau and Curry 2020). Parr of the Round Whitefish are often spotted.



Dwarf forms of the Lake Whitefish were identified in at least 22 lakes in Maine by Fenderson (1964), 28 by Edge (1987, Edge *et al.* 1991), and updated to 29 by Wood (2016) who has since documented an additional population in Glazier Lake in 2017 for a total of 30 (J. Wood unpubl. data). Some of these populations occur as sympatric pairs of dwarf and normal populations. All occurrences of the dwarf form so far documented in Maine are reported in the Allagash, Aroostook, and St. Francis River drainages of the Saint John River basin and were thought to be exclusive to those systems. Though in the province of Québec, a dwarf population does exist in Lake Témiscouata (Edge 1987, Edge *et al.* 1991) where it occurs in sympatry with the standard form yet maintains reproductive isolation (Fenderson 1964, Kirkpatrick and Selander 1979, Bernatchez and Dodson 1990, 1991). An additional dwarf population likely exists in Scots Lake, Halifax County, Nova Scotia as described by Semple (1973, NSDFA unpubl. data; mean fork length 21.1 cm, mature at age 1-3). This finding might suggest that the purported distribution of dwarf whitefish supposedly occurring only in the upper reaches of the Saint John River basin could be a product of survey effort which is far greater in Maine than in the adjacent MPs. These dwarf Lake Whitefish are generally indistinguishable morphologically from a small Lake Whitefish apart from having more numerous and tightly packed gill rakers (Bernatchez *et al.* 2010) and an earlier age of spawning maturity (generally maturing at age 1-2; Edge 1987, Edge *et al.* 1991). Behaviorally, the two forms differ in swimming depth and burst acceleration (Rogers *et al.* 2002). In NB, Glazier Lake and Beau Lake (mostly encompassed in the Province of Québec) which border the northwest corner of the province both support the dwarf form, and a sympatric pair is confirmed to occur in Beau Lake (J. Wood unpubl. data updating Wood 2016). A lack of thorough assessment in other areas precludes the description of dwarf populations that might occur in the MP.

## METHODS

Lake Whitefish in the MP have a disjointed history that includes naturalist accounts and stocking reports from the mid to late 1800s followed by modern surveys and literature from the late 1900s with sparse data available in between. As a result, available literature forms



**Fig 1** Scientific illustration of the three whitefish species found in the Canadian Maritime Provinces including a) the Lake Whitefish (*Coregonus clupeaformis*) [dwarf and normal forms], b) the Atlantic Whitefish (*Coregonus huntsmani*), and c) the Round Whitefish (*Prosopium cylindraceum*). Illustrations by E.M.T Bateman.

no clear link between introduced and native origin populations or past and present distribution critical for managers and ongoing research efforts (Mandrak *et al.* 2023). In this review, we 1) compiled reports of the early occurrence and distribution of Lake Whitefish in the MP reported prior to the onset of stocking, 2) provided a detailed account of the stocking efforts and all locations stocked throughout NS and NB, 3) summarized data for Lake Whitefish population ancestry and origin where available, and 4) identified the current distribution of Lake Whitefish populations in the MP inclusive of suspected locations. Where necessary for species identification and progression of the historical narrative, data from Round Whitefish and Atlantic Whitefish are included, but these data are not comprehensive for

the region. The methods used to compile and display these data for this review are as follows.

### **Historical Distribution**

Pre-stocking occurrence data for Lake Whitefish is only available for NB as the species was not discovered in NS until several decades after stocking concluded. To summarize Lake Whitefish presence in NB, early naturalist writings, fisheries observations, and distributional notes that pre-dated the first years of stocking (1879 in NS and 1886 in NB) were compiled. Within these documents, possible confusion exists between Lake Whitefish and Round Whitefish as the latter species was never identified overtly in historical literature. Fortunately, modern surveys demonstrate species overlap only in the northern portion of the province (Saint John River, Saint Croix River, and Restigouche River basins; Gautreau and Curry 2020, NBDNRED unpubl. data) and therefore, mistaken or unspecified Coregonid identity by early naturalists was deemed largely inconsequential. Furthermore, early accounts of “whitefish” occurring naturally in NB only overlapped with stocking that occurred in Grand Lake, Queens County, on the Saint John River which supports an irrefutable and formerly abundant native population (Perley 1851, Smith 1970), thereby simplifying our assessment of population ancestry. The Round Whitefish is not known from Grand Lake, Queens County, or elsewhere in the lower Saint John River.

### **Stocking History**

Lake Whitefish stocking records were transcribed from the annual Department of Marine and Fisheries reports from 1878 (Pope 1879) to 1901 (Sutherland 1902) and crosschecked with summary tables that were similarly extracted by Bradford and Mahaney (2004). These records were first tabulated by year and stocking location (Table 1, 2) and then merged to form a stocking summary by lake detailing the range of years stocked, the total number of stocking years, and the total number of Lake Whitefish released (Table 3, 4). A second data frame was then created to provide details on each stocked location by province. These tables include county and watershed data extracted from provincial data layers on Google Earth Pro, latitude and longitude extracted from Google Earth Pro, lake depth extracted from provincial lake map databases when available, and lake area calculated using lake polygon layers for NS and NB in Arc GIS Pro

(ESRI 2024). Once summarised, stocked lakes were mapped using GIS and then compared with reconstructed maps of the Laurentide ice sheet to examine post glacial zoogeography (see supplementary data in Dalton *et al.* 2023).

In addition to the stocking history of Lake Whitefish, the recent history of provincially led hatchery introductions of trout (Brook Trout [*Salvelinus fontinalis* Mitchell, 1814], and Rainbow Trout [*Oncorhynchus mykiss* Walbaum, 1792]) within known whitefish lakes was also compiled. Comprehensive data for Brown Trout (*Salmo trutta* Linnaeus, 1758) stocking in the MP is tabulated in Andrews *et al.* (2025), but there is no overlap between provincially led introductions of this species and Lake Whitefish populations. Extensive stocking records for trout exist in federal reports going back to the mid 1800s (see Andrews *et al.* 2025), but for the purpose of this review only the more recent provincial stocking records were used (NSDFA, unpubl. data). These records extended back to 1976 in both NS and NB and provided a satisfactory though incomplete assessment of possible hatchery effects on native Lake Whitefish populations. Provincial hatchery stocking records were summarized by lake to detail the number of years stocked, the number of hatchery reared trout released, and the species. Concurrently, the presence of invasive species including Chain Pickerel or Smallmouth Bass in each lake was also noted from provincial databases in both NS and NB where available.

### **Lake Whitefish Ancestry and Origin**

The ancestry and origin of Lake Whitefish in the MP has long been a topic of debate. This is particularly true in NS where the species was not identified in provincial waters until long after stocking efforts had concluded which initially implied an introduced origin. To report on Lake Whitefish ancestry and origin, we collected all available literature relating to morphometric and genetic analysis comparing Lake Whitefish populations within the MP to western Lake Whitefish populations that sourced regional hatcheries. Surveyed lakes, sampled fish, and reported ancestry from genetic analysis were cross referenced against reported stocking locations to assess possible origin and these data were entered into lake summary tables (Table 5, 6). Genetic data for Lake Whitefish populations in NB were sparse compared to NS, but accounts of occurrence pre-dating stocking coupled with limited stocking overlap served to confirm population ancestry in this region.

**Table 1** Complete summary of Lake Whitefish (*Coregonus clupeaformis*) fry stocking in Nova Scotia including annual stocking details for each lake by year and county, the number of fry released during each stocking event, and the source hatchery of the stocked fish. Lake Whitefish introduced to Nova Scotia were sent from either the Newcastle or Sandwich Hatcheries in Ontario. The Sandwich Hatchery sourced Lake Whitefish eggs from Lake Erie and the Detroit River and often sent stock to the Newcastle Hatchery, though in early years it is possible that some whitefish eggs at the Newcastle Hatchery were sourced from Lake Ontario. All Lake Whitefish arriving from Ontario were received by the Bedford Hatchery in Halifax, Nova Scotia from which whitefish were stocked in local lakes or in some instances transferred to other hatcheries for distribution.

Lake Name	County	Stocking Year	Number Released	Stocked Fish Origin	Source
Beeler's Lake	Annapolis	1892	300,000	Sandwich, ON	Tupper 1893
Beeler's Lake	Annapolis	1893	300,000	Sandwich, ON	Tupper 1894
George Lake	Annapolis	1891	250,000	Sandwich, ON	Tupper 1892
La Rose Lake	Annapolis	1896	500,000	Newcastle and Sandwich, ON	Davies 1897
Milford (Pits) Lake	Annapolis	1889	200,000	Sandwich, ON	Tupper 1890
Paradise Lake	Annapolis	1891	500,000	Sandwich, ON	Tupper 1892
Paradise Lake	Annapolis	1892	300,000	Sandwich, ON	Tupper 1893
Paradise Lake	Annapolis	1893	300,000	Sandwich, ON	Tupper 1894
Paradise Lake	Annapolis	1894	1,000,000	Sandwich, ON	Costigan 1895
Paradise Lake	Annapolis	1896	250,000	Newcastle and Sandwich, ON	Davies 1897
Paradise Lake	Annapolis	1897	1,200,000	Sandwich, ON	Davies 1898
Paradise/Round Hill Lakes (Upper/lower Wrights)	Annapolis	1898	700,000	Sandwich, ON	Davies 1899
Paradise Lake	Annapolis	1899	700,000	Sandwich, ON	Davies 1900
Paradise Lake	Annapolis	1900	500,000	Sandwich, ON	Davies 1901
Paradise Lake	Annapolis	1901	500,000	Sandwich, ON	Sutherland 1902
Round Hill Lake (Upper/Lower Wrights Lake)	Annapolis	1890	250,000	Sandwich, ON	Tupper 1891
Round Hill Lake (Upper/Lower Wrights Lake)	Annapolis	1893	300,000	Sandwich, ON	Tupper 1894
Round Hill Lake (Upper/Lower Wrights Lake)	Annapolis	1896	500,000	Newcastle and Sandwich, ON	Davies 1897
Lochaber Lake	Antigonish	1889	300,000	Sandwich, ON	Tupper 1890
Lochaber Lake	Antigonish	1894	700,000	Sandwich, ON	Costigan 1895

Table 1 Cont'd

Lake Name	County	Stocking Year	Number Released	Stocked Fish Origin	Source
Lochaber Lake	Antigonish	1901	500,000	Sandwich, ON	Sutherland 1902
St Joseph's Lake	Antigonish	1894	1,000,000	Sandwich, ON	Costigan 1895
St Joseph's Lake	Antigonish	1895	500,000	Sandwich, ON	Costigan 1896
Folly Lake	Colchester	1878	20,000	Newcastle, ON	Pope 1979
Haines & Porters Lake	Digby	1895	800,000	Sandwich, ON	Costigan 1896
Goshen Lake	Guysborough	1899	200,000	Sandwich, ON	Davies 1900
Goshen Lake	Guysborough	1900	500,000	Sandwich, ON	Davies 1901
Governor's Lake	Halifax	1887	150,000	Newcastle, ON	Foster 1888
Governor's Lake	Halifax	1889	200,000	Sandwich, ON	Tupper 1890
Grand Lake	Halifax	1878	120,000	Newcastle, ON	Pope 1979
Grand Lake	Halifax	1887	750,000	Newcastle, ON	Foster 1888
Grand Lake	Halifax	1888	1,400,000	Sandwich, ON	Tupper 1889
Grand Lake	Halifax	1889	500,000	Sandwich, ON	Tupper 1890
Grand Lake	Halifax	1890	500,000	Sandwich, ON	Tupper 1891
Grand Lake	Halifax	1891	500,000	Sandwich, ON	Tupper 1892
Grand Lake	Halifax	1892	300,000	Sandwich, ON	Tupper 1893
Grand Lake	Halifax	1893	300,000	Sandwich, ON	Tupper 1894
Hubley's Lake	Halifax	1887	150,000	Newcastle, ON	Foster 1888
Hubley's Lake	Halifax	1889	200,000	Sandwich, ON	Tupper 1890
Hubley's Lake	Halifax	1891	250,000	Sandwich, ON	Tupper 1892
Hubley's Lake	Halifax	1892	300,000	Sandwich, ON	Tupper 1893
Hubley's Lake	Halifax	1893	300,000	Sandwich, ON	Tupper 1894
Lake Thomas	Halifax	1893	300,000	Sandwich, ON	Tupper 1894
Lake William	Halifax	1893	300,000	Sandwich, ON	Tupper 1894

Lily Lake	Halifax	1878	10,000	Newcastle, ON	Pope 1979
Sandy Lake	Halifax	1878	10,000	Newcastle, ON	Pope 1979
Sandy Lake	Halifax	1886	50,000	Newcastle, ON	Foster 1887
Sandy Lake	Halifax	1887	750,000	Newcastle, ON	Foster 1888
Sandy Lake	Halifax	1888	700,000	Sandwich, ON	Tupper 1889
Sandy Lake	Halifax	1889	200,000	Sandwich, ON	Tupper 1890
Sandy Lake	Halifax	1890	500,000	Sandwich, ON	Tupper 1891
Sandy Lake	Halifax	1891	250,000	Sandwich, ON	Tupper 1892
Sandy Lake	Halifax	1894	300,000	Sandwich, ON	Costigan 1895
Sandy Lake	Halifax	1895	200,000	Sandwich, ON	Costigan 1896
Sandy Lake	Halifax	1896	250,000	Newcastle and Sandwich, ON	Davies 1897
Sandy Lake	Halifax	1897	1,400,000	Sandwich, ON	Davies 1898
Sandy Lake	Halifax	1900	200,000	Sandwich, ON	Davies 1901
Williams Lake	Halifax	1887	900,000	Newcastle, ON	Foster 1888
Williams Lake	Halifax	1888	700,000	Sandwich, ON	Tupper 1889
Williams Lake	Halifax	1889	200,000	Sandwich, ON	Tupper 1890
Williams Lake	Halifax	1890	500,000	Sandwich, ON	Tupper 1891
Williams Lake	Halifax	1891	250,000	Sandwich, ON	Tupper 1892
Williams Lake	Halifax	1892	300,000	Sandwich, ON	Tupper 1893
Williams Lake	Halifax	1897	1,400,000	Sandwich, ON	Davies 1898
Williams Lake	Halifax	1898	200,000	Sandwich, ON	Davies 1899
Williams Lake	Halifax	1901	200,000	Sandwich, ON	Sutherland 1902
Neal's/Nelson Lake	Halifax	1887	150,000	Newcastle, ON	Foster 1888
Lake Ainsley	Inverness	1895	1,000,000	Sandwich, ON	Costigan 1896
Lake Ainsley	Inverness	1896	500,000	Newcastle and Sandwich, ON	Davies 1897
Lake Ainsley	Inverness	1898	700,000	Sandwich, ON	Davies 1899
Lake O'Law (First Lake)	Inverness	1896	1,000,000	Newcastle and Sandwich, ON	Davies 1897
Lake O'Law (First Lake)	Inverness	1898	700,000	Sandwich, ON	Davies 1899
Lake O'Law (First Lake)	Inverness	1899	800,000	Sandwich, ON	Davies 1900
Lake O'Law (First Lake)	Inverness	1900	800,000	Sandwich, ON	Davies 1901



Table 1 Cont'd

Lake Name	County	Stocking Year	Number Released	Stocked Fish Origin	Source
Lake O'Law (First Lake)	Inverness	1901	1,000,000	Sandwich, ON	Sutherland 1902
Aylesford Lake	Kings	1890	250,000	Sandwich, ON	Tupper 1891
Gaspereau Lake	Kings	1889	200,000	Sandwich, ON	Tupper 1890
Gaspereau Lake	Kings	1892	300,000	Sandwich, ON	Tupper 1893
Lake George	Kings	1893	300,000	Sandwich, ON	Tupper 1894
Loon Lake	Kings	1893	300,000	Sandwich, ON	Tupper 1894
McPherson's Lake	Pictou	1899	50,000	Sandwich, ON	Davies 1900
McPherson's Lake	Pictou	1900	500,000	Sandwich, ON	Davies 1901
McPherson's Lake	Pictou	1901	500,000	Sandwich, ON	Sutherland 1902
Kejimikujik Lake*	Queens	~1900	-	-	Veilleux 1964
Minard Lake*	Queens	~1900	-	-	Kerekes 1975
Lake Rossignol	Queens	1889	500,000	Sandwich, ON	Tupper 1890, Veilleux 1964
Milton Lake (Lake Milo)	Yarmouth	1895	500,000	Sandwich, ON	Costigan 1896
Brazil Lake	Yarmouth	1899	800,000	Sandwich, ON	Davies 1900
Brazil Lake	Yarmouth	1900	500,000	Sandwich, ON	Davies 1901
Brazil Lake	Yarmouth	1901	500,000	Sandwich, ON	Sutherland 1902

\* 500,000 Lake Whitefish eggs were sent to an auxiliary hatchery in the village of Kempt, Nova Scotia in 1889 (Tupper 1890) and likely released as fry in 1890. These were reported to have been released in Minard Lake and Kejimikujik Lake (Veilleux 1964, Kerekes 1975) but the numbers introduced and whether these two locations represent the full extent of the introductions from the Kempt Hatchery is unknown.

Note: In 1889 the Auxiliary hatchery in Lochaber, Nova Scotia was also sent a shipment of 120,000 Lake Whitefish eggs, but the destinations of the fry resulting from this transfer are unknown and therefore are not listed above.

**Table 2** Detailed stocking history of New Brunswick lakes with Lake Whitefish (*Coregonus clupeaformis*) fry conducted by the Department of Marine and Fisheries from 1886 to 1901. Lake Whitefish eggs were sourced from the Newcastle and Sandwich hatcheries in Ontario that were primarily collected from Lake Erie and the Detroit River, though some broodstock could have originated from Lake Ontario in earlier years. Table includes the name of each stocked waterbody, county, stocking year, the number of fry released as well as hatchery origin and source document. The hatchery in Sandwich Ontario sourced its Lake Whitefish eggs from the Detroit River, but also sent whitefish eggs to the Newcastle Hatchery on the shores of Lake Ontario. All Lake Whitefish fry in New Brunswick were received and distributed by the Saint John River Hatchery located at Rapides des Femmes, Victoria County.

Lake Name	County	Year	Number Released	Origin	Source
German Town Lake	Albert	1896	320,000	Sandwich, ON	Davies 1897
Jones Lake	Carleton	1891	180,000	Sandwich, ON	Tupper 1892
Jones Lake	Carleton	1892	140,000	Sandwich, ON	Tupper 1893
Jones Lake	Carleton	1893	320,000	Sandwich, ON	Tupper 1894
Jones Lake	Carleton	1894	240,000	Sandwich, ON	Costigan 1895
Lakeville and Summerville Lakes (Williamstown Lake)	Carleton	1886	650,000	Newcastle, ON	Foster 1887
Lakeville Lake (Williamstown Lake)	Carleton	1888	466,662	Sandwich, ON	Tupper 1889
Lakeville Lake (Williamstown Lake)	Carleton	1889	350,000	Sandwich, ON	Tupper 1890
Lakeville Lake (Williamstown Lake)	Carleton	1890	300,000	Sandwich, ON	Tupper 1891
Lakeville Lake (Williamstown Lake)	Carleton	1893	320,000	Sandwich, ON	Tupper 1894
Lakeville Lake (Williamstown Lake)	Carleton	1894	240,000	Sandwich, ON	Costigan 1895
Lakeville Lake (Williamstown Lake)	Carleton	1896	240,000	Sandwich, ON	Davies 1897
Chamcook Lake	Charlotte	1887	400,000	Newcastle, ON	Foster 1888
Foster Lake	Charlotte	1889	350,000	Sandwich, ON	Tupper 1890
Foster Lake	Charlotte	1891	240,000	Sandwich, ON	Tupper 1892
Foster Lake	Charlotte	1892	220,000	Sandwich, ON	Tupper 1893
Foster Lake	Charlotte	1893	320,000	Sandwich, ON	Tupper 1894
Foster Lake	Charlotte	1898	640,000	Sandwich, ON	Davies 1899
Foster Lake	Charlotte	1899	240,000	Sandwich, ON	Davies 1900
Foster Lake	Charlotte	1897	320,000	Sandwich, ON	Davies 1898

Table 2 Cont'd

Lake Name	County	Year	Number Released	Origin	Source
Lake Utopia	Charlotte	1892	220,000	Sandwich, ON	Tupper 1893
Mohanneous River/Mohannes Stream	Charlotte	1900	320,000	Sandwich, ON	Davies 1901
Byran (Byram's) Pond	Madawaska	1893	120,000	Sandwich, ON	Tupper 1894
Byran (Byram's) Pond	Madawaska	1894	120,000	Sandwich, ON	Costigan 1895
Byran (Byram's) Pond	Madawaska	1896	240,000	Sandwich, ON	Davies 1897
Grand Lake	Queen's	1899	320,000	Sandwich, ON	Davies 1900
Washademoak Lake	Queen's	1899	320,000	Sandwich, ON	Davies 1900
Beaulieu (Baulieu/Bolieu's) Pond	Victoria	1899	240,000	Sandwich, ON	Davies 1900
Beaulieu (Baulieu/Bolieu's) Pond	Victoria	1900	240,000	Sandwich, ON	Davies 1901
Beaulieu (Baulieu/Bolieu's) Pond	Victoria	1901	240,000	Sandwich, ON	Sutherland 1902
Long Lake	Victoria	1887	300,000	Newcastle, ON	Foster 1888
Long Lake	Victoria	1889	300,000	Sandwich, ON	Tupper 1890
Long Lake	Victoria	1893	160,000	Sandwich, ON	Tupper 1894
Long Lake	Victoria	1894	240,000	Sandwich, ON	Costigan 1895
Long Lake	Victoria	1895	720,000	Sandwich, ON	Costigan 1896
Long Lake	Victoria	1896	560,000	Sandwich, ON	Davies 1897
Long Lake	Victoria	1897	320,000	Sandwich, ON	Davies 1898
Long Lake	Victoria	1901	240,000	Sandwich, ON	Sutherland 1902
Meadow Lake	Victoria	1887	300,000	Newcastle, ON	Foster 1888
Pond at Hatchery	Victoria	1899	320,000	Sandwich, ON	Davies 1900
Pond at Hatchery	Victoria	1900	120,000	Sandwich, ON	Davies 1901
Pond at Hatchery	Victoria	1901	400,000	Sandwich, ON	Sutherland 1902
Portage Lake	Victoria	1887	300,000	Newcastle, ON	Foster 1888
Portage Lake	Victoria	1889	200,900	Sandwich, ON	Tupper 1890

Portage Lake	Victoria	1891	180,000	Sandwich, ON	Tupper 1892
Portage Lake	Victoria	1892	140,000	Sandwich, ON	Tupper 1893
Rapids Des Femmes	Victoria	1888	155,582	Sandwich, ON	Tupper 1889
Tomlinson Lake	Victoria	1888	155,554	Sandwich, ON	Tupper 1889
Baldhead Lake	York	1897	320,000	Sandwich, ON	Davies 1898
Baldhead Lake	York	1898	320,000	Sandwich, ON	Davies 1899
Baldhead Lake	York	1899	240,000	Sandwich, ON	Davies 1900
Baldhead Lake	York	1900	320,000	Sandwich, ON	Davies 1901
Baldhead Lake	York	1901	320,000	Sandwich, ON	Sutherland 1902
Forest Lake	York	1900	560,000	Sandwich, ON	Davies 1901
Foster Lake	York	1901	320,000	Sandwich, ON	Sutherland 1902
Harvey Lake	York	1888	466,662	Sandwich ON	Tupper 1889
Harvey Lake	York	1889	350,000	Sandwich, ON	Tupper 1890
Harvey Lake	York	1890	700,000	Sandwich, ON	Tupper 1891
Harvey Lake	York	1891	480,000	Sandwich, ON	Tupper 1892
Harvey Lake	York	1892	440,000	Sandwich, ON	Tupper 1893
Harvey Lake	York	1893	560,000	Sandwich, ON	Tupper 1894
Harvey Lake	York	1894	320,000	Sandwich, ON	Costigan 1895
Harvey Lake	York	1895	480,000	Sandwich, ON	Costigan 1896
Harvey Lake	York	1896	320,000	Sandwich, ON	Davies 1897
Harvey Lake	York	1897	320,000	Sandwich, ON	Davies 1898
Harvey Lake	York	1898	320,000	Sandwich, ON	Davies 1899
Harvey Lake	York	1899	320,000	Sandwich, ON	Davies 1900
Harvey Lake	York	1900	320,000	Sandwich, ON	Davies 1901
Harvey Lake	York	1901	320,000	Sandwich, ON	Sutherland 1902
Lake George	York	1892	220,000	Sandwich, ON	Tupper 1893
Lake George	York	1893	240,000	Sandwich, ON	Tupper 1894
Lake George	York	1894	320,000	Sandwich, ON	Costigan 1895
Lake George	York	1895	480,000	Sandwich, ON	Costigan 1896
Lake George	York	1896	320,000	Sandwich, ON	Davies 1897

Table 2 Cont'd

Lake Name	County	Year	Number Released	Origin	Source
Lake George	York	1897	320,000	Sandwich, ON	Davies 1898
Lake George	York	1898	640,000	Sandwich, ON	Davies 1899
Lake George	York	1899	240,000	Sandwich, ON	Davies 1900
Lake George	York	1900	320,000	Sandwich, ON	Davies 1901
Lake George	York	1901	320,000	Sandwich, ON	Sutherland 1902
Maguadavic Lake	York	1887	400,000	Newcastle, ON	Foster 1888
Maguadavic Lake	York	1888	933,324	Sandwich ON	Tupper 1889
Maguadavic Lake	York	1889	350,000	Sandwich, ON	Tupper 1890
Maguadavic Lake	York	1890	700,000	Sandwich, ON	Tupper 1891
Maguadavic Lake	York	1891	240,000	Sandwich, ON	Tupper 1892
Oromocto Lake	York	1888	622,216	Sandwich ON	Tupper 1889
Oromocto Lake	York	1889	350,000	Sandwich, ON	Tupper 1890
Oromocto Lake	York	1890	300,000	Sandwich, ON	Tupper 1891
Oromocto Lake	York	1891	240,000	Sandwich, ON	Tupper 1892
Oromocto Lake	York	1892	220,000	Sandwich, ON	Tupper 1893
Oromocto Lake	York	1893	320,000	Sandwich, ON	Tupper 1894
Oromocto Lake	York	1894	320,000	Sandwich, ON	Costigan 1895
Oromocto Lake	York	1895	240,000	Sandwich, ON	Costigan 1896
Oromocto Lake	York	1896	320,000	Sandwich, ON	Davies 1897
Oromocto Lake	York	1897	320,000	Sandwich, ON	Davies 1898
Oromocto Lake	York	1898	320,000	Sandwich, ON	Davies 1899
Oromocto Lake	York	1899	240,000	Sandwich, ON	Davies 1900
Oromocto Lake	York	1900	320,000	Sandwich, ON	Davies 1901
Oromocto Lake	York	1901	320,000	Sandwich, ON	Sutherland 1902
Skiff Lake	York	1887	400,000	Newcastle, ON	Foster 1888

Skiff Lake	York	1889	350,000	Sandwich, ON	Tupper 1890
Yoho Lake	York	1892	220,000	Sandwich, ON	Tupper 1893
Yoho Lake	York	1893	240,000	Sandwich, ON	Tupper 1894
Yoho Lake	York	1894	320,000	Sandwich, ON	Costigan 1895
Yoho Lake	York	1895	240,000	Sandwich, ON	Costigan 1896
Yoho Lake	York	1896	320,000	Sandwich, ON	Davies 1897
Yoho Lake	York	1897	320,000	Sandwich, ON	Davies 1898
Yoho Lake	York	1898	320,000	Sandwich, ON	Davies 1899
Yoho Lake	York	1899	320,000	Sandwich, ON	Davies 1900
Yoho Lake	York	1900	320,000	Sandwich, ON	Davies 1901
Yoho Lake	York	1901	320,000	Sandwich, ON	Sutherland 1902
Pond at Hatchery (Grand Falls)	-	1895	240,000	Sandwich, ON	Costigan 1896
Private Waters	-	1897	240,000	Sandwich, ON	Davies 1898
Saint John River at Hatchery	-	1891	60,000	Sandwich, ON	Tupper 1892
Saint John River at Hatchery	-	1894	320,000	Sandwich, ON	Costigan 1895

**Table 3** Summary of lakes stocked with Lake Whitefish (*Coregonus clupeaformis*) fry in the Province of Nova Scotia including water body name, county, primary and secondary watershed, latitude, longitude, depth (m), and surface area (ha). Stocking details are also listed including the initial and final year of stocking, number of years stocked, and the total number of Lake Whitefish fry released during the stocking period.

Water body Name	County	Primary Watershed	Secondary Watershed	Latitude	Longitude	Depth (m)	Surface Area (ha)	Initial Year of Stocking	Final Year of Stocking	# of Years Stocked	Number Stocked
Beeler's Lake	Annapolis	Annapolis River	Lequille River	44.652	-65.519	3	20.1	1892	1893	2	600,000
George Lake	Annapolis	Herring Cove/Medway River	Medway River	44.578	-65.190	-	79	1891	1891	1	250,000
La Rose Lakes	Annapolis	Annapolis River	Annapolis River	44.713	-65.441	5	53.8	1896	1896	1	500,000
Milford (Pits/Pitts) Lake	Annapolis	Mersey River	Mersey River	44.588	-65.407	6	19.7	1889	1889	1	200,000
Paradise Lake*	Annapolis	Annapolis River	Annapolis River	44.764	-65.170	9	396.4	1891	1901	10	5,250,000*
Round Hill Lake*	Annapolis	Annapolis River	Annapolis River	44.727	-65.365	-	18.8/37	1890	1896	3	1,050,000*
(Upper/Lower Wrights Lake)											
Lochaber Lake	Antigonish	St Mary's River	St Mary's River	45.422	-62.029	52.4	307.2	1889	1901	3	1,500,000
St Joseph's Lake	Antigonish	South/West	West River	45.536	-62.080	6	19.9	1894	1895	2	1,500,000
Folly Lake	Cumberland	Salmon/Debert Rivers	Folly River	45.540	-63.546	33.5	78.9	1878	1878	1	20,000
Haines Lake	Digby	Sissiboo/Bear River	Sissiboo River	44.514	-65.807	7	66.7	1895	1895	1	800,000
Porters Lake	Digby	Sissiboo/Bear River	Sissiboo River	44.493	-65.808	7	326.7	1895	1895	1	



Goshen Lake	Guysborough	Country Harbour	Country Harbour River	45.377	-61.978	8	12.1	1899	1900	2	700,000
Governor's Lake	Halifax	Sackville River	Nine Mile River	44.643	-63.701	11	105.2	1887	1889	2	350,000
Grand Lake	Halifax	Shubenacadie/ Stewiacke River	Shubenacadie River	44.910	-63.600	45	1841	1878	1893	8	4,370,000
(Shubenacadie Grand)											
Hubley's Lake	Halifax	Sackville River	Woodens River	44.647	-63.829	14	255.3	1887	1893	5	1,200,000
(Hubley Big Lake)											
Lake Thomas	Halifax	Shubenacadie/ Stewiacke River	Shubenacadie River	44.798	-63.609	14	111	1893	1893	1	300,000
Lake William	Halifax	Shubenacadie/ Stewiacke River	Shubenacadie River	44.767	-63.586	28	339	1893	1893	1	300,000
Lily Lake	Halifax	Sackville River	Shore Direct	44.743	-63.638	41.2	5	1878	1878	1	10,000
Neal's/Neilson Lake	Halifax	-	-	-	-	-	-	1887	1887	1	150,000
Sandy Lake	Halifax	Sackville River	Sackville River	44.735	-63.701	19	74.5	1878	1900	12	4,810,000
Williams Lake	Halifax	Sackville River	Shore Direct	44.620	-63.593	20	34.1	1887	1901	9	4,650,000
Lake Ainsley	Inverness	Margaree River	Margaree River	46.127	-61.174	18	5,735.8	1895	1898	3	2,200,000
Lake O'Law (Frist Lake)	Inverness	Margaree River	Margaree River	46.277	-60.960	30	27.1	1896	1901	5	4,300,000
Aylesford Lake	Kings	Gaspereau River	Gaspereau/ Black River	44.947	-64.662	12	532	1890	1890	1	250,000
Gaspereau Lake	Kings	Gaspereau River	Gaspereau/ Black River	44.965	-64.548	-	2,202.9	1889	1892	2	500,000
Lake George	Kings	Gaspereau River	Gaspereau/ Black River	44.935	-64.699	9	153	1893	1893	1	300,000
Loon Lake	Kings	Gaspereau River	Gaspereau/ Black River	44.898	-64.669	6	69.6	1893	1893	1	300,000

Table 3 Cont'd

Water body Name	County	Primary Watershed	Secondary Watershed	Latitude	Longitude	Depth (m)	Surface Area (ha)	Initial Year of Stocking	Final Year of Stocking	# of Years Stocked	Number Stocked
McPherson's Lake	Pictou	East/Middle/West River	East River Pictou	45.468	-62.545	13.4	13.4	1899	1901	3	1,050,000
Kejimikujik Lake**	Queens	Mersey River	Mersey River	44.383	-65.250	17	2,600	-	-	-	-
Minard Lake**	Queens	Mersey River	Mersey River	44.425	-65.168	6	121.3	-	-	-	-
Lake Rossignol	Queens	Mersey River	Mersey River	44.213	-65.148	-	15,105.2	1889	1889	1	500,000
Brazil Lake	Yarmouth	Tusket River	Annis River	44.008	-65.998	11	99.7	1898	1901	4	2,500,000
Milton Lake (Lake Milo)	Yarmouth	Tusket River	Ohio Millstream Brook	43.861	-66.115	10	58.7	1895	1895	1	500,000

\* An additional 700,000 Lake Whitefish fry were reported stocked in Paradise/Round Hill Lakes that were not included within the presented totals.

\*\* 500,000 Lake Whitefish eggs were sent to an auxiliary hatchery in the village of Kempt, Nova Scotia in 1889 (Tupper 1890) and likely released as fry in 1890. These were reported to have been distributed to Minard Lake and Kejimikujik Lake (Veilleux 1964, Kerekes 1975) but the numbers introduced and whether these two locations represent the extent of the introductions from the Kempt Hatchery is unknown.

**Table 4** Summary of lakes stocked with Lake Whitefish (*Coregonus clupeaformis*) fry in the Province of New Brunswick including water body name, county, primary and secondary watershed, latitude, longitude, depth (m), and surface areas (ha). Stocking details are also listed including the initial and final year of stocking, number of years stocked, and the total number of Lake Whitefish fry released during the stocking period.

Water body Name	County	Primary Watershed	Secondary Watershed	Latitude	Longitude	Depth (m)	Surface Area (ha)	Initial Year of Stocking	Final Year of Stocking	# of Years Stocked	Number Stocked
Germantown Lake	Albert	Petitcodiac Composite	South Channel	45.674	-64.803	-	-	1896	1896	1	320,000
Jones Lake	Carleton	-	-	-	-	-	-	1891	1894	4	740,000
Lakeville/ Sommerville Lake	Carleton	Saint John River Basin Composite	Big Presque Isle Stream	46.315	-67.700	3.7	1733	1886	1896	6	2,566,662
(Williamstown Lake)											
Chamcook Lake	Charlotte	West Fundy Composite	Bocabec River Composite	45.145	-67.091	41.91	338.6	1887	1887	1	400,000
Foster Lake	Charlotte	St. Croix River Basin	Canoose Stream Composite	45.317	-67.231	-	48.5	1889	1901	7	1,870,000
Lake Utopia	Charlotte	West Fundy Composite	Magaguadavic River	45.176	-66.793	28.35	1387.9	1892	1892	1	220,000
Mohaneeus River/ Mohaneeus Stream	Charlotte	St. Croix River Basin	Canoose Stream Composite	45.151	-67.325	-	-	1900	1900	1	320,000
Byram's Pond	Madawaska	-	-	-	-	-	-	1893	1896	3	480,000
Grand Lake	Queens	Saint John River Basin	Jemseg River	45.957	-66.033	30.5	17067.2	1899	1899	1	320,000

Table 4 Cont'd

Water body Name	County	Primary Watershed	Secondary Watershed	Latitude	Longitude	Depth (m)	Surface Area (ha)	Initial Year of Stocking	Final Year of Stocking	# of Years Stocked	Number Stocked
Washademoak	Queens	Saint John River Basin	Washademoak Creek	45.794	-65.969	30	3122.8	1899	1899	1	320,000
Beaulieu Pond	Victoria	-	-	-	-	-	-	1899	1901	3	720,000
Long Lake	Victoria	Saint John River Basin	Tobique River	47.031	-66.895	27.4	989	1887	1901	8	2,840,000
Meadow Lake	Victoria	-	-	-	-	-	-	1887	1887	1	300,000
Pond at Hatchery (Grand Falls)	Victoria	Saint John River Basin	Boutot Brook Composite	47.007	-67.732	-	-	1899	1901	3	840,000
Portage Lake	Victoria	-	-	-	-	-	-	1887	1892	4	820,900
Rapids Des Femme Pond/Creek	Victoria	Saint John River Basin	Boutot Brook Composite	47.007	-67.743	-	-	1888	1888	1	155,582
Tomlinson Lake	Victoria	Saint John River Basin	Aroostook River	46.711	-67.761	-	9.75	1888	1888	1	155,554
Baldhead Lake	York	-	-	-	-	-	-	1897	1901	5	1,520,000
Forest Lake	York	-	-	-	-	-	-	1900	1901	2	880,000
Harvey Lake	York	West Fundy Composite	Magaguadavic River	45.747	-67.028	13.6	695.6	1888	1901	14	5,716,662
Lake George	York	Saint John River Basin	Pokiok Stream	45.817	-67.047	5.15	691.5	1892	1901	10	3,420,000
Magaguadavic Lake	York	West Fundy Composite	Magaguadavic River	45.704	-67.200	10.69	2623.8	1887	1891	5	2,623,324

Oromocto Lake	York	Saint John River Basin	Oromocto River	45,586	-67,004	13.72	4047.3	1888	1901	14	4,452,216
Skiff Lake	York	St Croix River Basin	Spednic Lake	45,822	-67,527	17.68	627.26	1887	1889	2	750,000
Yoho Lake	York	Saint John River Basin	Oromocto River	45,781	-66,861	13.69	126	1892	1901	10	2,940,000

Note: Since the time of stocking Germantown Lake has been drained to restore wetland.

The classification of the Atlantic Whitefish as a separate species from the Lake Whitefish forms a key point of intersection in NS. Therefore, we also compiled all early observations of the Atlantic Whitefish, including those which occurred prior to its initial classification. These data include morphometric and meristic analyses to the point of distinction of the Atlantic Whitefish to more clearly outline and distinguish early Lake Whitefish discoveries.

### **Current Distribution**

Based on available data, the assessment of Lake Whitefish distribution was approached differently in each province. In NS, several surveys conducted from the mid to late 1900s identified Lake Whitefish incidentally as the species was initially suspected to be absent from the province. Following recognition of the species in NS, surveys to procure samples for morphological studies often reported novel populations expanding evidence of occurrence. In a small number of locations, these historical reports were supplemented by modern surveys by the NSDFA and verified angler captures. Many locations where Lake Whitefish are reported in NS have been left un-surveyed since their first discovery. Without new data these locations must be considered current.

In NB, most available data on species distribution resulted from reports in the historical literature and records of occurrence spanning from 1958-1987 kept by the New Brunswick Department of Natural Resources and Energy Development (NBDNRED). Due to a lack of recent surveys in many locations outside of lakes bordering the State of Maine, these records must also be considered current. While reporting on the distributions of Lake Whitefish in both provinces using historical data, we acknowledge that inaccuracies are possible where un-surveyed populations may no longer persist following the impacts of invasive species, acidification, and dams in several locations.

### **Lake Whitefish Stocking in Canada**

In 1865 Samuel Wilmot began his first experiments in fish culture, and one year later in 1866, he built what would become Ontario's first fish hatchery in Newcastle on the shores of Lake Ontario near its confluence with Wilmot Creek (Smith 1875, Lasenby *et al.* 2001, Morrison and Peiman 2021). The hatchery supported Wilmot's early attempts to restore Atlantic Salmon (*Salmo salar* Linnaeus, 1758)

in Lake Ontario. Then after receiving federal support in 1867, the Newcastle Hatchery became Canada's first federal fish hatchery in 1868 (Prince 1906, note that Ontario, Québec, NS, and NB had only joined to form Canada through confederation in 1867 at which time the federal government gained jurisdiction over fisheries). Following confederation, Samuel Wilmot was given the title of fisheries overseer by the Minister of Marine and Fisheries in 1868 and was charged with operating the Newcastle Hatchery (McCullough 2003, Knight 2007, Morrison and Peiman 2021). The Newcastle Hatchery was born of Wilmot's efforts to recover Atlantic Salmon locally, but federal interests were to sustain commercial fisheries of which the Lake Trout (*Salvelinus namaycush*, Walbaum, 1792) and Lake Whitefish were the most valuable species (Evermann and Goldsborough 1907, Knight 2007). Wilmot successfully hatched Lake Whitefish in 1867 and 1868 (Prince 1906, Lasenby *et al.* 2001), and in accordance with federal interest he began propagating Lake Whitefish at the Newcastle hatchery in 1871 (Knight 2007). To support these efforts, Wilmot built a Lake Whitefish hatchery in Sandwich, Ontario on the shores of the Detroit River in 1875-76 (Whitcher 1876, Prince 1906, Lasenby *et al.* 2001, Knight 2007) and further enlarged the Newcastle Hatchery (Prince 1906). The Sandwich Hatchery sourced its eggs from wild spawning fish harvested by the Bois Blanc Island and Fighting Island Fisheries in the Detroit River (Prince 1906, Whitcher 1878). Using this nearby source, the Sandwich Hatchery became a prolific supplier of Lake Whitefish eggs and fry that were generally transferred from this location in February in the eyed stage for broader distribution and hatching (Prince 1906).

### **Whitefish Stocking in Nova Scotia**

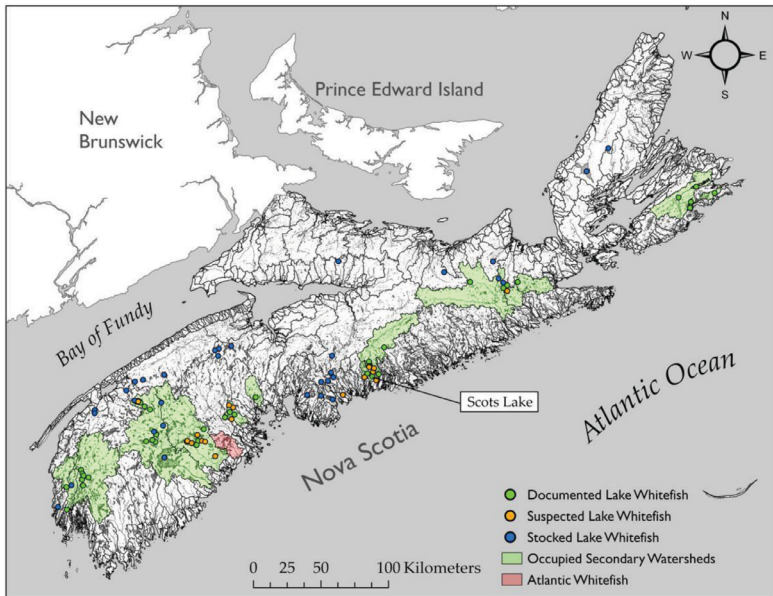
On 1 July 1876, Samuel Wilmot was appointed Superintendent of Fish Culture in Canada (McCullough 2003, Knight 2007, Morrison and Peiman 2021) and in that year he opened NS's first fish hatchery in Bedford along the Sackville River to support the propagation of Atlantic Salmon (Whitcher 1876). Despite the intended purpose of the Bedford Hatchery (Wilmot 1978), it immediately began to receive shipments of Lake Whitefish eggs from Ontario in 1877 (Pope 1879). The early shipments of Lake Whitefish eggs arrived from Newcastle by rail (likely via Sandwich), though later shipments often arrived directly from the Sandwich hatchery. From 1877 to 1901, the Bedford Hatchery received shipments totalling 42,230,000 Lake Whitefish



eggs from both the Newcastle Hatchery and the Sandwich Hatchery. These eggs were then hatched and distributed by rail to accessible locations throughout the province (Bradford and Mahaney 2004). Many of these locations were near the City of Halifax, and along the western and northern shores of NS (Pope 1879, Bradford and Mahaney 2004; Fig 2).

At the onset of this intensive stocking effort, James. C. Pope, the Minister of Marine and Fisheries at the time, made his intentions in NS clear, stating that by “*extending the operations to the hatching of both whitefish and salmon trout [Lake Trout]*”, “*the great number and extent of the inland lakes of this Province now useless and of no value whatever, as they contain few, if any, commercial fish, and it appears a very desirable object to stock, if possible, these lakes with those valuable fish. By doing so the value of the fisheries of Nova Scotia would largely increase, and an extensive inland fishery would be created which would afford remunerative employment and a partial means of subsistence to hundreds of people living at a distance from the seacoast.*” (Pope 1879, page 375-376). Lake Whitefish were of further interest in NS as the province was suspected to be devoid of the species (Evermann and Smith 1894, Perley 1852, Lanman 1874, Evermann and Smith 1896, Piers 1924) and Pope (1879) clearly saw Lake Whitefish as a desirable addition in the interest of supporting the local economy.

In the first year of stocking (1878), Lake Whitefish were only introduced to (Shubenacadie) Grand, Lily, and Sandy lakes, Halifax County, and Folly Lake, Colchester County (Pope 1879; Table 1). Stocking was again recorded in Sandy Lake in 1886 (Foster 1887; Table 1) after which the extent and number of introductions increased sharply. When Lake Whitefish stocking efforts increased, introductions were first reported in Halifax County near the Bedford Hatchery in 1887 and 1888 during which 2,850,000 (Foster 1888) and 2,800,000 (Tupper 1889) fry were released respectively. In 1889, 500,000 Lake Whitefish eggs were transferred to an auxiliary hatchery in Kempt, Queens County that was reported to have been owned by a local fishing club (Kerekes 1975, Edge 1987), and 120,000 eggs were sent to a second auxiliary hatchery in Lochaber, Antigonish County (Tupper 1890). These eggs were likely hatched as fry for distribution in 1890. The fate of those supplied to the Lochaber hatchery was unrecorded, but those sent to Kempt were reported stocked in Kejimikujik Lake



**Fig 2** Map of Lake Whitefish (*Coregonus clupeaformis*) stocking and present distribution in Nova Scotia, Canada. The watershed highlighted in red is the Petite Riviere and is currently (2025) the only region known to support Nova Scotia's endemic populations of Atlantic Whitefish (*Coregonus huntsmani*) within Hebb, Minamkeak, and Milipsigate lakes following their likely extirpation in the Tusket and Annis Rivers in the south of the province. Scots Lake, Halifax County, Nova Scotia supports a suspected dwarf Lake Whitefish population.

and possibly Minard Lake (Veilleux 1964). Details regarding these releases are sparse and there is little information to suggest if other lakes were stocked near Kejimikujik or Lochaber or how many Lake Whitefish may have been released (Table 1, 3, 5). While Veilleux (1964) mentions stocking of Lake Whitefish in Lake Rossignol, possibly in reference to the Kempt hatchery, this lake was also reported stocked with 500,000 fry by the Bedford Hatchery in 1889 (Tupper 1890; Table 1, 3) and it is unclear whether these records represent two distinct stocking events or present duplicated information.

In subsequent years, introductions were recorded in the counties of Annapolis, Antigonish, Kings, and Queens until 1894; thereafter adding Digby, Yarmouth, and Inverness Counties in 1895, and Pictou County in 1900. Following 17 years of stocking in Nova Scotia (1878, 1886-1901), Lake Whitefish fry had been distributed to at least 33 lakes. Among these, Paradise Lake, Annapolis County, was the most

heavily stocked, receiving >5,250,000 fry cumulatively over the course of ten consecutive years of stocking (1891-1901, Table 1, 3). Short-lived fisheries for Lake Whitefish were reported in some systems in years shortly after stocking (Murray 2005), but the excitement around the species and their potential to support the local economy faded as quickly as did the catches. All efforts to create self sustaining populations of Lake Whitefish in NS were reported to have “*utterly failed*” (Piers 1924, page 1; see also Murray 2005) and no further attempts were made to stock the species in NS after 1901.

Lasenby *et al.* (2001) remarks that at the time of stocking in the late 1800s that Lake Whitefish and Lake Herring (i.e. *Cisco* sp.) were not distinguished as separate species and both were given the name *Coregonus albus*. The Great Lakes hatcheries that shipped “Lake Whitefish” to the MP and beyond are home to five extant species of *Cisco*, though as many as eight species were historically described in the Great Lakes within this taxonomically complex group (Eshenroder *et al.* 2016). Any number of these species could have been introduced to the MP under the guise of “Whitefish”. However, no subsequent captures have confirmed whether this species mixing occurred. Lake Whitefish and *Cisco* spawning runs known in the lower Detroit River near the Sandwich Hatchery collapsed by the early 1900s due to overfishing, pollution (Hartman 1972), and destruction of habitat following construction of the Livingstone Shipping Channel (Roseman *et al.* 2007). Following this collapse, 1910 was reported as the last year of Lake Whitefish propagation at the Sandwich hatchery during which time eggs were probably sourced from waters further afield (Lasenby *et al.* 2001). The Lake Whitefish which spawned in the Detroit River was reported as destroyed in 1900 due to siltation and smothering of their spawning shoals (Trautman 1957).

### **Nova Scotia Post-Stocking Whitefish Surveys and Observations**

It was not until 1919, 18 years after Lake Whitefish stocking had ceased in NS, that the first whitefish was recorded in the province. At this time two coregonids were reported captured from the mouth of the Sissiboo River, Digby County, and were initially identified as Round Whitefish (Vladykov and Mckenzie 1935). But these were almost undoubtedly the first records of the Atlantic Whitefish, later known from the Tusket and Annis rivers to the south (Bradford *et al.* 2004). On 9 May 1923, Piers (1924) reported a whitefish angled at the

spillway of the dam located at the outlet of Milipsigate Lake, near the town of Bridgewater, Lunenburg County. Piers (1924) first referred to the specimen as “*a variant of Coregonus labradoricus*” suggesting a purported northwestern form of Lake Whitefish, but the specimen possessed a high lateral line scale count and differences in form that separated it from other Coregonids. Following further assessment, that specimen was recognized as the first identified Atlantic Whitefish and not the Lake Whitefish, which was then only regionally known from the province of NB (Piers 1924, Gilhen 1974).

A subsequent account of *C. clupeaformis* (Lake Whitefish) captured from the Tusket River, Yarmouth County, on 10 April, 1951 (Smith 1952) was also revealed to be an Atlantic Whitefish as reported in Scott and Crossman (1973), Leim and Scott (1966), Scott (1967), and later confirmed by meristic and morphometric analysis by Edge (1987, Edge *et al.* 1991). As a result, the occurrence of Lake Whitefish in Yarmouth and Lunenburg Counties as described by Dymond (1947), Livingstone (1953), and Smith (1952) were incorrect due to misidentification, and all instances were similarly Atlantic Whitefish (Edge 1987, Edge *et al.* 1991). Leim and Day (1959) also report a Lake Whitefish that was likely a misidentified Atlantic Whitefish captured in saltwater from a wharf in Wedgeport, NS, on 8 July 1954, and another similar misidentification was reported in Halls Harbour, NS, on 31 May 1958 in fully marine water (Edge 1987, Edge *et al.* 1991).

The first true observations of Lake Whitefish in NS were reported from 8-11 July 1964 during a survey of Kejimikujik Lake (Veilleux 1964). Collected Lake Whitefish were captured using a 5 cm stretch mesh gill net set at depths ranging from 3-14 m (Veilleux 1964). At the time and still today (2025), it is unclear if these captures from Kejimikujik Lake represent a native population of Lake Whitefish, or rather if they resulted from a surviving stocked population (see Table 1). Edge (Edge 1987, Edge *et al.* 1991) notes that Lake Whitefish were stocked in Kejimikujik National Park by a fishing club, and Veilleux (1964) confirms that both Kejimikujik Lake, Lake Rossignol located downstream, and the nearby Minard Lake were stocked ~75 years prior to the 1964 surveys (stocking almost certainly occurred in 1890, Tupper 1890) with fish sourced from a small auxiliary hatchery in Kempt, NS (transferred from the Bedford hatchery, Tupper 1890, Veilleux 1964, Kerekes 1975, Table 1). During subsequent surveys of park waters from 1970-1972 (Note that Kejimikujik National Park was

established in 1969), Lake Whitefish were confirmed in Mountain, Peskowsk, and Cobrielle lakes that were never reported stocked (Kerekes 1975; species confirmed by W.B. Scott; Table 1). Lake Whitefish were also reported in 1974 in Minard Lake just outside park boundaries (Gilhen 1974). Within the park, Kerekes (1975) notes that only Kejimikujik and Mountain Lake are deep enough to meet the cold-water habitat requirements of Lake Whitefish, and the species was suspected to move from deep waters in Mountain Lake to access Peskowsk and Cobrielle during cooler water periods. Spawning was noted in Mountain Lake in December and the maximum size of the species among fish captured in Kejimikujik National Park was reported as 30 cm (250 g; Veilleux 1964, Kerekes 1975).

The confirmation of Lake Whitefish in NS both in and around Kejimikujik National Park prior to its official designation (Veilleux 1964) was realized too late to be included in "The Freshwater Fishes of Canada" by Scott and Crossman (1973), as this seminal text on the freshwater fishes and their distribution in Canada only mentions observations of Atlantic Whitefish in NS. Perhaps ironically, that same year (1973) would begin a flurry of Lake Whitefish discoveries across the province. Semple (1973) reported Lake Whitefish in Scots Lake/ Scots Pond, Halifax County in that year which is located distant from any stocking location, and the identified population was documented in detail, including their spawning period, maturation, and size. Smith (1974) reported the occurrence of Lake Whitefish in Pringle Lake, Guysborough County, following surveys in 1973 (later confirmed by Ives 1975, Alexander *et al.* 1986), but the proximity of this lake to Goshen Lake (1.5 km) that was stocked in 1899 and 1890 (Davies 1900, 1901, Table 1) leaves questions regarding their origin. Subsequent lake surveys in 1973, also revealed Lake Whitefish in Narrow Lake (Ives 1975, confirmed by Alexander *et al.* 1986) which could still present a nearby transfer from Goshen Lake (9.5 km away) but is situated in a separate watershed. Lake surveys conducted from 1964-1981 by Alexander *et al.* (1986) also include 13 Lake Whitefish confirmations among 781 survey locations that were identified from 1964-1980 (which overlap with some previously described such as by Veilleux 1964). Further occurrence of Lake Whitefish in the Mira River (see also Goodchild 2001) was relayed to the author (D.R. Alexander) by J. Gilhen, a former curator of the Nova Scotia Museum of Natural History.

Due to frequent prior misidentifications of Lake Whitefish in the region (see Piers 1924, Smith 1952, Dymond 1947, Livingstone 1953, Leim and Day 1959), samples collected by Alexander *et al.* (1986) from Pringle Lake were sent to the Royal Ontario Museum for comparison to the Atlantic Whitefish (then referred to as the “Acadian Whitefish”) which had been collected in 1973 (see Scott 1967, Edge 1987, Edge *et al.* 1991). In this instance, the species had not been misidentified, and the collected specimens were indeed Lake Whitefish, representing the easternmost occurrence of this species described at the time (Alexander *et al.* 1986). Alexander *et al.* (1986), however, wrote with uncertainty regarding whether the collected (and now confirmed) Lake Whitefish were native to NS or resulted from unreported hatchery introductions or subsequent private introductions (see also Edge 1987, Edge *et al.* 1991) because historical reports had made no prior indication of their natural occurrence in the province. Despite these concerns, several of the lakes sampled by Alexander *et al.* (1986) and reported to contain Lake Whitefish such as Chezzetcook Lake, Halifax County, Eden Lake, Pictou County, and Little Mushamush Lake, Lunenburg County, were all far removed from any documented stocking locations (Tables 1, 3).

Even following the discovery of several populations of Lake Whitefish by the late 1980s, the species remained largely unknown in NS. Scott and Crossman (1988) only stated that the Lake Whitefish occurs “*less commonly in some Nova Scotia lakes*”, and a book published by J. Gourlay (1995) intending to highlight non-traditional freshwater sport fishes in NS makes no mention of the species at all. Evidently, Lake Whitefish never became a focal point of the NS fishery or economy as Pope (1879) had envisioned over a century prior, but scientific interest was growing regarding the origin of Lake Whitefish in NS. In years to follow, researchers began to study Lake Whitefish in more detail, first comparing their morphometrics and meristics to those of Atlantic Whitefish (Edge 1987, Edge *et al.* 1991, Hasselman 2003, Hasselman *et al.* 2009), and later by assessing population ancestry using genetic methods (Bernatchez and Dodson 1990, Bernatchez *et al.* 1996). Through these studies, additional lakes in NS were surveyed to collect samples of the two Coregonid species for comparison (Bradford *et al.* 2004).

The most interesting lakes documented to support Lake Whitefish are perhaps those at the headwaters of the Tusket River. Lake Whitefish



were confirmed in Ogden, Parr, Petes, Mink, and Kempt Back lakes by Bradford *et al.* (2004) and are suspected to have remained in those lakes separate from the river-dwelling Atlantic Whitefish until the extirpation of the latter species in ~1982 (Bradford *et al.* 2004). Bradford *et al.* (2004) also suggests that some unverified local reports of Lake Whitefish in the Annis and Tusket rivers may have been Atlantic Whitefish. The status of Lake Whitefish in any part of the Tusket River is currently unknown (last reported during surveys in 2002) following the introduction of Chain Pickerel (first reported in Snare Lake in 1948; NSDFA unpubl. data) and acidification of surface waters in NS (Watt 1987, White 1992). Recently in 2017, a Lake Whitefish was captured for the first time during a routine survey of Conrod Lake, Halifax County (Table 5; NSDFA unpubl. data). Conrod Lake lies adjacent to Chezzetcook Lake where the species was found in 1974 (Alexander *et al.* 1986) and near Scots Lake where Lake Whitefish were described in 1973 (Semple 1973) and re-confirmed by NSFDA in 2008 (NSFDA unpubl. data). A Lake Whitefish was also confirmed in Big Lake Mushamush, Lunenburg County, NS for the first time in 2025 (Table 5).

Following survey efforts spanning 60 years from 1964 to present (2025), Lake Whitefish have so far been identified in 42 lakes in NS spanning 16 secondary watersheds (Fig 2; Table 5). Collection of these data revealed populations distributed from Porcupine Lake, Yarmouth County to Salmon River, Cape Breton County (Table 5). Known Lake Whitefish populations have a clustered distribution exclusive to Atlantic facing watersheds of NS (Fig 2) and Lanman (1874) noted that Lake Whitefish are not observed in any systems draining into the Gulf of St Lawrence. This is likely a product of their glacial refuges and post-glacial colonization routes (Edge 1987, Schmidt 1986, Dalton *et al.* 2023) and closely mirrors the distribution of Lake Trout in the MP described by Warner *et al.* (2023), although this species regionally is found in far fewer confirmed locations. The continued existence of Lake Whitefish in the south of NS is uncertain as this region remains the epicenter of invasive species spread and acidification of surface waters, along with being one of the least studied regions of the province. White (1992) suggested that Lake Whitefish inhabit too few lakes to determine their pH tolerance in NS based on surveys conducted in 1983 and 1987, but following the loss of salmonids from southern NS due in part to acidification (Watt *et al.* 1983, Watt 1987), impacts



to both Lake Whitefish and Atlantic Whitefish are possible. Lake Whitefish typically spawn in late fall and winter in streams or over cobble/gravel lake shoals (Whitaker and Wood 2021), a time of year when pH levels are most alkaline (Watt *et al.* 1983, Edge and Gilhen 2001). At this time early developmental stages may be most sensitive to acidification both during incubation and immediately post-hatch (Edge 1987), but the emergence of larvae in spring (Whitaker and Wood 2021) may provide some temporal ecological buffer to low pH.

### **Whitefish Stocking in New Brunswick**

Bradford and Mahaney (2004) report that 196 million Lake Whitefish fry hatched from eggs sourced from “*federal hatcheries on the lower Great Lakes*” were reared and released in waters across Canada from 1878-1914. Of these, 37,470,900 eggs (nearly 20% of the total produced) were sent to NB to hatch and be released over a period of 16 years spanning 1886-1901 (Table 2). Lake Whitefish were the only Coregonid stocked in NB (apart from possibly mistaken Ciscoes; Lasenby *et al.* 2001), and Lake Whitefish eggs sent to NB were received by the “Saint John River hatchery” located at Rapide des Femmes 5 km downstream from Grand Falls. The hatchery building and associated dam had been constructed in the summer of 1879 and was opened by Samuel Wilmot in October 1879 (Pope 1879). This site was ideal for receiving and distributing Lake Whitefish eggs and fry as Samuel Wilmot described that “*the railway runs through the property only a few yards from the hatchery*” and from this point, eggs and fry could be transported along the Saint John River by means of boat, rail, or road (Pope 1879). Like the Bedford hatchery in NS, the Saint John River hatchery at Grand Falls was constructed with the intention of producing Atlantic Salmon for release directly into the Saint John River. Within nine years of establishment and only one year into the whitefish stocking program, the output of Lake Whitefish at this establishment would greatly outnumber all other species including Atlantic Salmon.

The first point of introduction of hatchery reared Lake Whitefish to NB was in Lakeville/Sommerville Lake (Williamstown Lake), Carleton County, where 650,000 Lake Whitefish fry were released in 1886 (Table 2; Fig 3), but in the following year stocking quickly expanded to include lakes in Charlotte, Victoria, and York counties in regions south of the Saint John River. Stocking was recorded in Madawaska County in 1893, adding Albert County in 1896.

**Table 5** Observations of Lake Whitefish (*Coregonus clupeaformis*) in the Province of Nova Scotia including lake name, county, primary and secondary watershed, latitude, longitude, depth (m), surface area (ha), years of observation, ancestry (stocked or native) and data source. When lakes are indicated as stocked it does not rule out the possibility of a pre-existing native population. Lakes with a native ancestry marked as “?” are native populations that could have received unreported introductions of Lake Whitefish from nearby stocked lakes. Shallow lakes may be occupied during cold water periods by populations residing in deeper connected waters.

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
Boot Lake	Annapolis	Mersey River	Mersey River	44.570	-65.383	6.0	102.8	2001-2002	No*	-	Hasselman 2003
Eleven Mile Lake	Annapolis	Mersey River	Mersey River	44.530	-65.292	2.1	226.3	1975	No*	-	Alexander <i>et al.</i> 1986
Fisher Lake*	Annapolis	Mersey River	Mersey River	44.548	-65.344	6.0	394.8	-	No*	-	Located between Boot and Eleven Mile Lake
Geier Lake*	Annapolis	Mersey River	Mersey River	44.577	-65.396	-	20.0	-	No*	-	Located between Liverpool Head and Boot Lake
Liverpool Head Lake	Annapolis	Mersey River	Mersey River	44.581	-65.404	6.9	13.2	1975	No*	-	Alexander <i>et al.</i> 1986
Milford (Pitts/Pitts) Lake	Annapolis	Mersey River	Mersey River	44.586	-65.405	6.3	20.0	1975	Yes	-	Alexander <i>et al.</i> 1986
Grand Lake	Cape Breton	Salmon/Mira River	Gerratt Brook	45.957	-59.956	-	148.6	1980	No	Yes	Alexander <i>et al.</i> 1986
Hardy Lake	Cape Breton	Salmon/Mira River	Shore Direct	45.864	-60.195	-	24.9	1956	No	Yes	NSDFA, Unpublished data
MacIntyres Lake	Cape Breton	Salmon/Mira River	Shore Direct	45.902	-60.185	12.8	71.7	1973, 2000-2002	No	Yes	Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009

MacLeods Lake	Cape Breton	Salmon/Mira River	Shore Direct	45.886	-60.181	-	73.9	2000-2002	No	Yes	Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009
Mira River	Cape Breton	Salmon/Mira River	Mira River	46.003	-60.129	-	3,237.6	1983, 2000-2002	No	Yes	John Gilhen observation in Edge 1987; Bernatchez and Dodson 1990; Edge <i>et al.</i> 1991; Hasselman 2003; Bradford <i>et al.</i> 2004b; Hasselman <i>et al.</i> 2009
Salmon River	Cape Breton	Salmon River and Mira	Mira River	45.935	-60.302	-	-	1982	No	Yes	Edge 1987; Edge <i>et al.</i> 1991, connected to Mira River
Eight Island Lake	Guy's-borough	Country Harbour	Country Harbour River	45.351	-61.962	10.1	91.3	-	No	-	Connected to Pringle Lake
G Lake	Guy's-borough	Country Harbour	Country Harbour	45.357	-61.974	10.0	18.7	1985	No	?	NS Dept of Inland Fisheries
Narrow Lake	Guy's-borough	New Harbour / Salmon River	Salmon River	45.397	-61.849	11.0	24.4	1973	No	?	Ives 1975, Alexander <i>et al.</i> 1986
Pringle Lake	Guy's-borough	Country Harbour	Country Harbour River	45.377	-61.949	26.0	58.3	1973	No	?	Smith 1974; Ives 1975; Alexander <i>et al.</i> 1986; Edge 1987, 1991
Big Shaw Lake	Halifax	Musquodoboit River	Musquodoboit River	44.968	-63.112	10.0	82.0	2000-2004	No	Yes	Murray 2005
Chezzetcook Lake	Halifax	Musquodoboit River	Chezzetcook River	44.773	-63.222	18.3	296.0	1974	No	-	Alexander <i>et al.</i> 1986; Bradford <i>et al.</i> 2004b

Table 5 Cont'd

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
Conrod Lake	Halifax	Musquodoboit River	Chezzetcook River	44.776	-63.258	29.6	134.9	2017	No	-	NS Dept of Inland Fisheries
Gibraltar Lake	Halifax	Musquodoboit River	Musquodoboit River	44.862	-63.252	16.0	85.4	2000-2004	No	Yes	Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009
Long Bridge Lake*	Halifax	Musquodoboit River	Chezzetcook River	44.787	-63.208	-	85.	-	No	-	Connected to Chezzetcook Lake
Moose Lake*	Halifax	Musquodoboit River	Musquodoboit River	44.843	-63.251	7.6	15.4	-	No	-	Connected to Gibraltar Lake
Morris Lake**	Halifax	Sackville River	Cow Bay River	44.650	-63.496	12.8	175.9	1999	No	-	Unconfirmed angler report in Bradford <i>et al.</i> 2004b
Petepeswick Lake*	Halifax	Musquodoboit River	Chezzetcook River	44.770	-63.193	-	297.5	-	No	-	Connected to Chezzetcook Lake
Pace(s) Lake*	Halifax	Musquodoboit River	Little River, Petepeswick Inlet	44.815	-63.212	51.2	302.7	-	No	-	Connected to Scots Lake
Scots Lake/ Scots Pond	Halifax	Musquodoboit River	Little River, Petepeswick Inlet	44.791	-63.180	18.0	15.0	1973	No	Yes	Sample 1973, Murray 2005
Thompson Lake*	Halifax	Musquodoboit River	Chezzetcook River	44.768	-63.295	-	48.8	-	No	-	Connected to Conrod Lake

Big Mushamush Lake	Lunenburg	Gold River	Mushamush River	44.492	-64.554	25.0	1,078	2025	No	Yes	Dr. A. Spares pers comm and photo
Caribou Lake	Lunenburg	Gold River	Mushamush River	44.526	-64.549	50.0	268.5	1982, 2000-2002	No	-	Edge 1987; Hasselman 2003; Hasselman <i>et al.</i> 2009
Little Mushamush Lake	Lunenburg	Gold River	Mushamush River	44.510	-64.505	13.0	438.7	1980	No	Yes	Alexander <i>et al.</i> 1986; Edge 1987; Edge <i>et al.</i> 1991; Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009
Millet Lake	Lunenburg	Gold River	Middle River (Lunen Co.)	44.627	-64.309	26.0	66.9	1983, 2000	No	Yes	NSDFA, unpublished data
Shingle Lake	Lunenburg	Herring Cove/Medway	Medway River	44.408	-64.789	14.0	468.2	2000	No	Yes	Hasselman 2003; Bradford <i>et al.</i> 2004b; Murray 2005; Hasselman <i>et al.</i> 2009
Sucker Lake	Lunenburg	Gold River	Mushamush River	44.489	-64.593	9.0	30.3	2013	No	-	Verified Angler Report
West Whale Lake*	Lunenburg	Gold River	Mushamush River	44.571	-64.557	-	159.6	-	No	-	Connected to Little Mushamush Lake
Whale Lake*	Lunenburg	Gold River	Mushamush River	44.569	-64.541	-	395.8	-	No	-	Connected to Little Mushamush Lake
Eden Lake	Pictou	St. Mary's River	St. Marys River	45.401	-62.299	16.5	223.4	1975, 2000-2002	No	Yes	Alexander <i>et al.</i> 1986; Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009

Table 5 Cont'd

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
Annis Lake	Queens	Herring Cove/ Medway	Medway River	44.329	-64.839	18.0	80	-	No	-	Edge 1987; Edge <i>et al.</i> 1991
Beavertail Basin*	Queens	Herring Cove/ Medway	Medway River	44.329	-64.803	13.3	220.0	-	No	-	Part of Molega Lake
Beavertail Lake*	Queens	Herring Cove/ Medway	Medway River	44.329	-64.785	3.0	71.6	-	No	-	Part of Molega Lake
Cameron / Beartrap Lakes*	Queens	Herring Cove/ Medway	Medway River	44.320	-64.945	-	121.2	-	-	-	(Note: Winter only) Connected to Little Ponhook Lake
Cobrielle (Coblielle) 1986 Lake	Queens	Mersey River	Mersey River	44.310	-65.230	6.3	131.8	1971-72	No	?	Kerekes 1975; Alexander <i>et al.</i>
Kejmkujuk Lake	Queens	Mersey River	Mersey River	44.383	-65.250	19.2	2,435.0	1964	Yes	?	(Note: winter only) Veilleux 1964;
Little Ponhook Lake	Queens	Herring Cove/ Medway	Medway River	44.301	-64.851	14.0	79.2	2001-2004	No	Yes	Alexander <i>et al.</i> 1986 Hasselman 2003, Bradford <i>et al.</i> 2004b; Murray 2005; Hasselman <i>et al.</i> 2003
Minard Lake	Queens	Mersey River	Mersey River	44.425	-65.168	5.8	111.9	1974	Yes	?	Kerekes 1975; Alexander <i>et al.</i> 1986
Mountain Lake	Queens	Mersey River	Mersey River	44.316	-65.260	14.3	136.6	1971-72	No	?	Kerekes 1975; Alexander <i>et al.</i> 1986
Molega Lake*	Queens	Herring Cove/ Medway	Medway River	44.367	-64.843	15.0	2085	-	No	-	Connected to Shingle Lake

Peskowesk Lake	Queens	Mersey River	Mersey River	44.316	-65.283	13.0	685.0	1972	No	-	Kerkes 1975; Alexander <i>et al.</i> 1986 (Note: winter only)
Ponhook Lake*	Queens	Herring Cove/ Medway	Medway River	44.313	-64.898	-	1729.2	-	No	-	Connected to Little Ponhook Lake
Salters Lake**	Queens	Herring Cove/ Medway	Medway River	44.229	-64.676	-	50.5	~2000	No	-	Angler report in Bradford <i>et al.</i> 2004b
St. Mary Bay (Ponhook Lake)*	Queens	Herring Cove/ Medway	Medway River	44.328	-64.938	-	115.0	-	No	-	Connected to Little Ponhook Lake
Carleton River	Yarmouth	Tusket River	Tusket River	44.113	-65.914	-	-	~2003	No	-	Hasselman 2003
Kempt Back Lake	Yarmouth	Tusket River	Tusket River	44.064	-65.844	18.0	278.5	1986, 2002	No	Yes	Bradford <i>et al.</i> 2004b; Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009
Lake George	Yarmouth	Tusket River	Salmon River	43.995	-66.044	-	1161.2	1982-1983	No	-	Edge 1987; Edge <i>et al.</i> 1991
Mink Lake	Yarmouth	Tusket River	Tusket River	44.010	-65.891	16.0	145.0	1952, 1983, 1999, 2001-2002	No	Yes	Bradford <i>et al.</i> 2004b; Hasselman 2003; Murray 2005; Hasselman <i>et al.</i> 2009
Ogden Lake	Yarmouth	Tusket River	Tusket River	44.049	-65.902	19.9	297.3	2002	No	-	Bradford <i>et al.</i> 2004b
Parr Lake	Yarmouth	Tusket River	Tusket River	44.089	-65.900	9.4	257.8	1986	No	-	Bradford <i>et al.</i> 2004b
Petes Lake	Yarmouth	Tusket River	Tusket River	44.076	-65.890	-	108.0	2002	No	-	Bradford <i>et al.</i> 2004b

Table 5 Cont'd

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
Porcupine Lake	Yarmouth	Tusket River	Annis River	43.845	-66.032	12.2	147.0	2002	No	-	Bradford <i>et al.</i> 2004b

Lake Name\* Lakes directly connected to water where Lake Whitefish are verified, having a high likelihood of also containing Lake Whitefish  
Lake Name\*\* Lakes where Lake Whitefish have been reported by unverified sources.  
Stocked\* Lakes directly connected to waters where Lake Whitefish were stocked.



**Table 6** Observation of Lake Whitefish (*Coregonus clupeaformis*) in the Province of New Brunswick including lake name, county, primary and secondary watershed, latitude, longitude, depth (m), surface area (ha), year of observation, ancestry (stocked or native) and data source. All major water bodies connected to the lower Saint John River are assumed to have native Lake Whitefish populations." It is unknown whether the Lake Whitefish population in most lakes persist following their last year of observation.

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
Beechwood Dam	Carleton	Saint John River Basin	Muniac Stream	46.543	-67.668	-	-	1958	No*	Yes	Smith 1979
Beechwood Headpond	Carleton	Saint John River Basin	Composite Muniac Stream	46.615	-67.712	-	-	1958	No*	Yes	NB Power
Black's Harbour	Charlotte	West Fundy Composite	Pocologan River	45.054	-66.800	-	-	1958	No	-	Edge 1987
Digdeguash Lake	Charlotte	West Fundy Composite	Composite Magaguadavic River	45.219	-66.917	19.8	407.5	1993	No	Yes	Saia 1995
Kerr(s) Lake	Charlotte	West Fundy Composite	Bocabec River	45.217	-67.023	12.0	73.0	1945-1950	No	Yes	Smith 1952, Edge 1987
Darling's Lake	Kings	Saint John River Basin	Kennebecasis River	45.501	-65.864	5	400.0	1851	No*	Yes	Perley 1852
Nerepis River	Kings	Saint John River Basin	Nerepis River	45.378	-66.259	-	-	Pre-1852	No*	Yes	Perley 1852
Saint John River	Kings	Saint John River Basin	Black Brook Composite	45.451	-66.131	-	-	Pre-1874	No*	Yes	Lanman 1874

Table 6 Cont'd

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
Sherwood Lake	Kings	West Fundy Composite	Musquash River	45.307	-66.396	-	226.4	1973, 1998	No	Yes	Atlantic Canada Conservation Data Center
Beau Lake	Madawaska/Québec	Saint John River Basin	Rivière Baker-Brook Composite	47.299	-69.050	-	668.0	Pre-1914, 2024	No	Yes	Kendall 1914, Author observation
First (Green) Lake	Madawaska	Saint John River Basin	Green River	47.638	-68.276	16.8	466.0	1972	No	Yes	Meth 1973
Glazier Lake	Madawaska	Saint John River Basin	Rivière Baker-Brook Composite	47.233	-69.011	35.9	453.2	Pre-1907	No	Yes	Evermann & Goldsborough 1907
Green River (Davis Mill)	Madawaska	Saint John River Basin	Green River	47.350	-68.136	-	-	Pre-1969	No	Yes	Smith 1969
Lac Baker (Baker Lake)	Madawaska	Saint John River Basin	Rivière Baker-Brook Composite	47.368	-68.699	35.7	564.1	1942	No	-	Meth 1973, Edge 1987
Madawaska River	Madawaska	Saint John River Basin	Madawaska River	47.365	-68.324	-	-	Pre-1851	No	Yes	Perley 1851, Lanman 1874
Second Falls Head Pond (Green River Reservoir)	Madawaska	Saint John River Basin	Green River	47.467	-68.231	-	61.7	Pre-1969, 1973	No	Yes	Smith 1969; NBDNRED unpubl. data; Environment Canada 2002

Third (Green) Lake	Madawaska	Saint John River Basin	Green River	47.772	-68.373	17.7	100.0	1939, 1983	No	-	Meth 1973, Edge 1987, NBDNRED unpubl. data
Logan Lake	Northumberland	Miramichi River Basin	Northwest Miramichi	47.093	-66.706	-	85.5	-	No	Yes	NBDNRED unpubl. data
Serpentine Lake	Northumberland	Saint John River Basin	Tobique River	47.130	-66.863	24.4	495.3	Pre-1973	No	-	Meth 1973
Belleisle Bay	Queens	Saint John River Basin	Belleisle Creek	45.592	-65.931	33.5	2,337.6	Pre-1972	No*	Yes	Meth 1972
Grand Lake (Saint John River)	Queens	Saint John River Basin	Jemseg River	45.957	-66.033	30.5	17,067.0	Pre-1851, 2017	Yes	Yes	Perley 1851; Bernatchez and Dodson 1990, Author observation
Maquapit Lake	Queens	Saint John River Basin	Jemseg River	45.907	-66.194	-	1843.2	-	No*	Yes	Atlantic Canada Conservation Data Center
Saint John River	Queens	Saint John River Basin	Swan Creek Composite	45.811	-66.126	-	-	Pre-1851	No*	Yes	Perley 1851, Adams 1873
Salmon River	Queens	Saint John River Basin	Jemseg river	46.251	-65.834	-	-	1969	No*	Yes	Smith 1970
Washademoak Lake	Queens	Saint John River Basin	Washademoak	45.776	-65.994	-	3,349.8	1987	No	Yes	NBDNRED, unpubl. data
McDougall Lake	Restigouche	Restigouche River Basin	Kedgwick River	47.907	-67.726	-	298.2	1969, 2014	No	-	NBDNRED, unpubl. data
Saint John River	Saint John	Saint John River Basin	Grand Bay Composite	45.268	-66.068	-	-	Pre-1874	No*	Yes	Lanman 1874
West Branch Reservoir (Halls Lake)*	Saint John	West Fundy Composite	Musquash River	45.216	-66.376	-	437.9	-	No	-	Connected to West Branch (Musquash) Reservoir (South)

Table 6 Cont'd

Lake Name	County	Primary Watershed	Secondary Watershed	Lat	Long	Depth (m)	Surface area (ha)	Whitefish Observations	Stocked	Native	Source
West Branch (Musquash) Reservoir (South)	Saint John	West Fundy Composite	Musquash River	45.190	-66.366	-	110.9	1972, 1973	No	-	NBDNRED unpubl. data
Saint John River	Sunbury	Saint John River Basin	Swan Creek Composite	45.881	-66.523	-	-	Pre-1851	No*	Yes	Perley 1851, Meth 1872
Long Lake	Victoria	Saint John River	Tobique River	47.031	-66.895	27.4	989.0	1973	Yes	-	NBDNRED unpubl. data
Tobique River Lakes (undefined)	Victoria	Saint John River Basin	Tobique River	-	-	-	-	Pre-1873	No*	Yes	Adams 1873
Tobique River Reservoir	Victoria	Saint John River Basin	Tobique River	46.795	-67.677	-	421.1	1979	Yes	Yes	NBDNRED unpubl. data
Trousers Lake	Victoria	Saint John River Basin	Tobique River	47.011	-66.959	18.3	1008.5	1964, 1972, 1983	No	Yes	Meth 1973, Edge 1987, NBDNRED unpubl. data
East Grand Lake	York	St Croix River Basin	Forest City Stream	45.737	-67.798	36.6	6,503.3	1969, 1984, 2010	No	Yes	Edge 1987; Bernatchez and Dodson 1990; Wood 2016
Mactaquac Dam	York	Saint John River Basin	Indian Brook Composite	45.955	-66.865	-	-	1969	No*	Yes	Smith 1970, Murray 2005

Mactaquac Headpond	York	Saint John River Basin	Baker Brook Composite	45.926	-67.072	-	5,483.4	Pre-1851, 1977	No*	Yes	Perley 1851; NBDNRED publ. data
Oromocto Lake	York	Saint John River Basin	Oromocto River	45.585	-67.010	-	4047.3	1997	No	Yes	NBDNRED unpubl. data
Oromocto River Mouth	York	Saint John River Basin	Oromocto River	45.851	-66.481	-	-	1971	No*	Yes	Meth 1972
Palfrey Lake*	York	St Croix River Basin	Spednic Lake	45.650	-67.480	-	726.4	-	No	Yes	Connected to Spednic Lake
Spednic Lake	York	St. Croix River Basin	Spednic Lake	45.597	-67.529	16.5	6,968.3	1972, 2007	No	Yes	NBDNRED unpubl. data, Wood 2016
Wauklahegan Lake	York	St. Croix River Basin	Spednic Lake	45.606	-67.369	-	353.4	-	No	Yes	Atlantic Canada Conservation Data Center

Lake Name\* Lakes directly connected to water where Lake Whitefish are verified, having a high likelihood of also containing Lake Whitefish

Note:

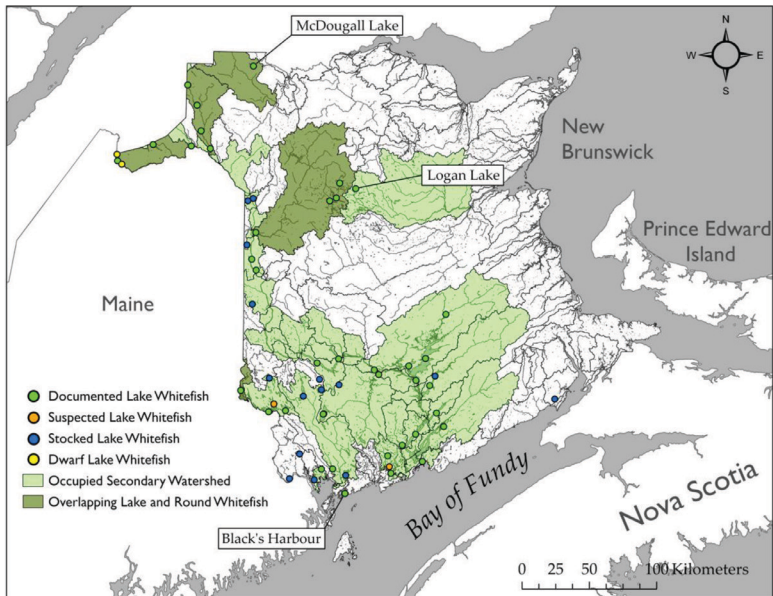
Tobique River Lakes are not defined, but likely include Trousers Lake and Long Lake, Victoria County and Serpentine Lake, Northumberland County, but could include other attached basins.

McDougall Lake and the possible occurrence in Logan Lake (NBDNRED unpubl. data) in the River Basin of the Northwest Miramichi are the only locations to support Lake Whitefish in NB that do not drain to the Atlantic Ocean.

Stocking was generally focused on large lakes in the southwest of the province with Lake George, Oromocto Lake, and Harvey Lake receiving over 3 million Lake Whitefish fry each before the whitefish stocking program ended in 1901 (Table 2).

### **New Brunswick Post-Stocking Whitefish Surveys**

Lake Whitefish were first noted in NB by Perley (1851) in the Madawaska River at the falls near this tributary's confluence with the Saint John River. In this location, Perley (1851) reported that Lake Whitefish could be captured in summer but were commonly harvested in autumn and served as a winter staple for both the First Nations and French colonists (Perley 1851, 1852, Adams 1873, Lanman 1874, Piers 1924, Meth 1973). In this region of the upper Saint John River, the species was pursued nearly to the point of its destruction (Cox 1896b). Lake Whitefish were also documented in the Tobique Lakes connected to the Saint John River by Adams (1873), but no mention of specific lakes was made. The species was captured in spring in Grand Lake of the Saint John River and in the river's main stem between Grand Lake (Jemseg River) and the City of Fredericton (Perley 1851, Evermann and Goldsborough 1907). In these systems, Lake Whitefish appeared in shallow lake margins during cooler water periods, though were reported to occupy deeper water in summer (Perley 1851, Adams 1873). While Perley (1851) makes passing mention of Lake Whitefish in the downstream reaches of the Saint John River, Lanman (1874) describes its occurrence through the "*whole extent*" of that system. Perley (1852) and Lanman (1874) even describe the capture of Lake Whitefish in the Saint John Harbour in spring. Here, Lake Whitefish occurrence was likely supported by high volumes of freshwater causing a local reduction in surface salinity during the annual freshet for which that system is known (Newton and Burrell 2015). Cox (1893) and Meth (1972) also mention Lake Whitefish occurrence downstream in autumn, though not necessarily to the harbour mouth. Further collections of Lake Whitefish from the lower Saint John River are held by the Royal Ontario Museum, the Canadian Museum of Nature, and the New Brunswick Museum of Natural History archived within the collection of fishes (NB Museum of Natural History, online data portal). These observations are also supported by Dadswell (1975) who reported that the entire population occupies the inshore estuary in autumn and spends the summer in



**Fig 3** Map of Lake Whitefish (*Coregonus clupeaformis*) stocking and present distribution in New Brunswick, Canada. The overlapping range of Round Whitefish (*Prosopium cylindraceum*) is indicated but is not comprehensive of their distribution. Lake Whitefish and Round Whitefish co-occur in McDougall Lake and together with Logan Lake are the only Lake Whitefish populations outside of an Atlantic-draining watershed. Black's Harbour marks the occurrence of a Lake Whitefish observation in non-estuarine marine waters.

Belleisle Bay which has a salinity ranging 2.5-4.6 ppt through much of its 33 m deep basin (Andrews *et al.* 2020).

Lake Whitefish were also reported in both Darlings' Lake in Kennebecasis Bay and the Nerepis River branching from the main stem of the Saint John River at Grand Bay (Fig 3). The Nerepis River likely supported a spawning migration based on the descriptions made by Perley (1852). Adams (1873) suggested that the Saint John River may host both a freshwater obligate form of the Lake Whitefish and another which inhabited the estuary, though subsequent reports and analysis by Adams (1873) suggest no difference between these types other than colouration. Despite this conclusion, Edge (1987) confirms the capture of a Lake Whitefish in Black's Harbour, NB in 1958 in fully marine waters (see also Leim and Day 1959, Scott and Crossman 1957, Edge 1987; Fig 3). Scott and Crossman (1959) also report a Lake Whitefish captured between 18-27 m depth in

the lower Saint John River by Dadswell (1975), a region below the halocline with salinities measuring ~20 ppt (Carter and Dadswell 1983). Lake Whitefish are known to form anadromous populations (Dadswell 1975, Morin *et al.* 1981) and there is high likelihood that this behaviour is also present in the estuary of the Saint John River that receives significant tidal exchange from the Bay of Fundy. As surface temperatures cooled in Saint John River in autumn (mid September-October), Lake Whitefish were observed to seek tributary streams to spawn, an activity primarily conducted at night (Perley 1851, 1852, Lanman 1874).

In later years, Lake Whitefish were also reported from Beau Lake (Kendall 1914) in the upper reaches of the Saint John River (most of which occurs in Québec), and while Lake Whitefish presence in the adjoining Glazier Lake was falsely reported by Evermann and Goldsborough (1907) in reference to Kendall (1903), it was later confirmed in 1972 by Meth (1973); DDT levels in Lake Whitefish were simultaneously reported as 0.220-0.252 ppm in that location in 1972. Smith (1969) mentions the occurrence of Lake Whitefish in the Green River, and it was later confirmed upstream in the First and Third Green River lakes (Keachie and Cote 1973). Lac Baker was also reported to support the species (Meth 1973, Hyatt 1970 in Meth 1973). When the Saint John River began to be developed for hydropower, Lake Whitefish were observed at both the Beechwood Generating Station and the Mactaquac Generating Station following their respective completion dates in 1957 and 1968 (Smith 1979; Table 7, 8). By 1990, catches of Lake Whitefish in the bypass facility at Beechwood Dam had dwindled to zero (Beaumaster *et al.* 2020), while catches declined even more precipitously at Mactaquac (Smith 1979, Ingram 1980; Table 7, 8). At that location, the number of observed Lake Whitefish dropped from 2,440 fish in 1968 (Smith 1970; he states 2,351 fish) to just 15 in 1971 (Meth 1973, Smith 1979, Ingram 1980), and from 2005-present (2025), not a single Lake Whitefish has been captured or observed at the dam.

Smith (1970) reports that Lake Whitefish arriving to the Mactaquac facility did so in late October and November, consistent with an upstream spawning migration that was “*usually still in progress when collection facilities were closed for the season*”. This observation simultaneously explained the lack of consistent fish lift captures of Lake Whitefish in autumn and the most likely reason for their



disappearance (Smith 1970, 1979; Table 8). When present, Lake Whitefish were observed in the fish lift starting in October and this pattern of autumn captures was consistent through later years (Table 7, 8). Initially it was suspected that Lake Whitefish blocked by the Mactaquac Dam re-routed to the Keswick River (Meth 1974). Gravid fish were also captured near the mouth of Oromocto River located 35 km downstream (Meth 1972), but this location possibly supported a separate population which has not been observed since and was never verified. A similarly timed spawning migration was also intercepted in Salmon River, a tributary at the upstream end of Grand Lake, Queens County in 1969 (Smith 1970), that was also first and last reported in 1971 and 1972 respectively (Meth 1972, 1974).

Most early accounts of Lake Whitefish originated from the Saint John River basin which undoubtedly supported the region's largest population, but Lake Whitefish in NB were not exclusive to that watershed. Kendall (1903) described the Lake Whitefish broadly from the St. Croix River but provided no specifics on inhabited lakes. In 1950, specimens of Lake Whitefish were collected in a 5.1 cm stretched mesh gill net set at the bottom of Kerr Lake, Charlotte County, at a depth of 7.5 m (Smith 1952), suggesting for the first time in regional literature that the species might also occur outside of the Saint John and St. Croix River basins.

Among records of Lake Whitefish in NB, two reports are of note. The first being reports of Lake Whitefish in the Restigouche River (see Cox 1893, Scott and Crossman 1959) and in McDougall Lake, Restigouche County (NBDNRED unpubl. data; Fig 3). These observations could have been misidentified Round Whitefish known to occupy the region or might represent Lake Whitefish originating from a different glacial refugium than those elsewhere in the MP (i.e., the Mississippian glacial refuge; Curry 2007, Curry and Gautreau 2010). The second report is that of the occurrence of Lake Whitefish in Logan Lake in the headwaters of the Miramichi River basin (NBDNRED unpubl. data; Fig 3). Logan Lake similarly does not match the post-glacial distribution of the species in the MP that typically occur only in Atlantic-facing watersheds. However, Lake Whitefish in this location may have been separated from populations in the Tobique River watershed (Huntsman 1953) during post-glacial isostatic rebound. If the record from Logan Lake is correct, this populations may provide important clues regarding regional zoogeography and post-glacial dispersal of the inland fishes of NB.

Table 7 Lake Whitefish (*Coregonus clupeaformis*) captured in the fish lift of the Beechwood Dam on the Saint John River, New Brunswick. The Beechwood Dam was completed in 1957 following which a small number of Lake Whitefish were reported annually until the year 2000 when catches declined to zero. Catches are listed by month within the operational period of the fish lift each year alongside a catch per unit effort of fish/day and the information source when data is available.

Year	Start of Operation	May	June	July	Aug	Sept	Oct	Nov	End of Operation	Total Days	Total Whitefish	CPUE	Source
1957	14-Jun	-	0	0	0	0	0	0	30-Nov	153	0	0.00	Smith 1979
1958	01-Jun	-	0	0	0	0	1	0	21-Nov	173	1	0.01	Smith 1979
1959	20-May	2	0	0	0	0	0	0	23-Nov	187	2	0.01	Smith 1979
1960	20-May	0	0	0	0	0	1	2	22-Nov	186	3	0.02	Smith 1979, Ingram 1960
1961	12-Jun	-	0	0	0	0	2	1	21-Nov	162	3	0.02	Smith 1979, Ingram 1961
1962	02-Jun	-	1	0	0	0	10	0	12-Nov	163	11	0.07	Smith 1979, Ingram 1962
1963	30-May	0	2	0	0	0	2	0	19-Nov	173	4	0.02	Smith 1979, Ingram 1963
1964	21-May	0	3	0	0	8	6	0	25-Nov	188	17	0.09	Smith 1979
1965	17-May	0	1	0	0	0	1	0	17-Nov	184	2	0.01	Smith 1979
1966	26-May	0	2	0	0	0	0	0	14-Nov	172	2	0.01	Smith 1979
1967	02-Jun	-	0	0	0	0	0	0	20-Nov	171	0	0.00	Smith 1979
1968	15-May	1	1	0	0	0	0	0	18-Nov	187	2	0.01	Smith 1979
1969	05-Jun	0	0	0	0	0	0	0	04-Nov	152	0	0.00	Smith 1979
1970	02-Jun	-	0	0	0	0	0	0	12-Nov	163	0	0.00	Smith 1979
1971	01-Jun	-	0	0	1	2	0	0	08-Nov	160	3	0.02	Smith 1979
1972	16-May	0	1	0	0	0	0	0	31-Oct	168	1	0.01	Ingram 1981
1973	16-May	0	0	0	0	0	0	0	31-Oct	168	0	0.00	Ingram 1981
1974	16-May	0	0	0	0	0	0	0	31-Oct	168	0	0.00	Ingram 1981
1975					No Data					-	-	-	

1976	16-May	0	4	0	0	0	0	0	0	31-Oct	168	4	0.02	Ingram 1981
1977	20-Jun	-	0	0	1	1	0	0	0	03-Nov	136	2	0.01	Ingram 1987
1978	12-Jun	-	0	2	0	2	0	0	-	31-Oct	141	5	0.04	Ingram 1987
1979	14-Jun	-	2	1	0	0	1	0	0	01-Nov	140	4	0.03	Ingram 1987
1980	10-Jun	-	1	0	1	1	0	0	0	04-Nov	147	3	0.02	Ingram 1987
1981	10-Jun	-	0	0	0	0	1	1	0	11-Nov	154	1	0.01	Ingram 1987
1982	14-Jun	-	0	0	0	0	0	3	0	03-Nov	142	3	0.02	Ingram 1987
1983	30-Jun	No Whitefish Data								27-Oct	119	-	-	-
1984	03-Jul									29-Oct	118	-	-	-
1985	25-Jun									30-Oct	127	-	-	-
1986	30-Jun									16-Oct	108	-	-	-
1987	02-Jun									30-Oct	150	-	-	-
1988	28-Jun									31-Oct	125	-	-	-
1989	28-Jun									30-Oct	124	-	-	-
1990	21-Jun	-	0	0	0	0	0	0	0	09-Oct	110	0	0.00	Beaumaster <i>et al.</i> 2020
1991	24-Jun	-	0	0	0	0	0	0	0	17-Oct	115	0	0.00	Beaumaster <i>et al.</i> 2020
1992	06-Jul	-	-	0	0	0	0	0	0	07-Oct	93	0	0.00	Beaumaster <i>et al.</i> 2020
1993	12-Jul	-	-	0	0	0	0	0	0	18-Oct	98	0	0.00	Beaumaster <i>et al.</i> 2020
1994	18-Jul	-	-	0	0	0	0	0	0	10-Nov	115	0	0.00	Beaumaster <i>et al.</i> 2020
1995	26-Jul	-	-	5	0	0	0	0	0	27-Oct	93	5	0.05	Beaumaster <i>et al.</i> 2020
1996	24-Jul	-	-	0	0	0	0	0	0	05-Nov	104	0	0.00	Beaumaster <i>et al.</i> 2020
1997	24-Jul	-	-	0	0	0	0	0	0	30-Oct	98	0	0.00	Beaumaster <i>et al.</i> 2020

Table 7 Cont'd

Year	Start of Operation	May	June	July	Aug	Sept	Oct	Nov	End of Operation	Total Days	Total Whitefish	CPUE	Source
1998	30-Jun	-	0	0	0	2	0	-	30-Oct	122	2	0.02	Beaumaster <i>et al.</i> 2020
1999	22-Jun	-	0	1	0	0	0	0	03-Nov	134	1	0.01	Beaumaster <i>et al.</i> 2020
2000	15-Jul	-	-	0	0	0	0	0	14-Nov	122	0	0.00	Beaumaster <i>et al.</i> 2020
2001	28-Jun	-	0	0	0	0	0	0	07-Nov	132	0	0.00	Beaumaster <i>et al.</i> 2020
2002	16-Jul	-	-	0	0	0	0	0	06-Nov	113	0	0.00	Beaumaster <i>et al.</i> 2020
2003	11-Jul	-	-	0	0	0	0	0	13-Nov	125	0	0.00	Beaumaster <i>et al.</i> 2020
2004	30-Jun	-	0	0	0	0	0	0	10-Nov	133	0	0.00	Beaumaster <i>et al.</i> 2020
2005	08-Jul	-	-	0	0	0	0	-	08-Oct	92	0	0.00	Beaumaster <i>et al.</i> 2020
2006	05-Jul	-	-	0	0	0	0	0	06-Nov	124	0	0.00	Beaumaster <i>et al.</i> 2020
2007	05-Jul	-	-	0	0	0	0	0	01-Nov	119	0	0.00	Beaumaster <i>et al.</i> 2020
2008	09-Jul	-	-	0	0	0	0	-	27-Oct	110	0	0.00	Beaumaster <i>et al.</i> 2020
2009	23-Jun	-	0	0	0	0	0	0	06-Nov	136	0	0.00	Beaumaster <i>et al.</i> 2020
2010	23-Sep	-	-	-	-	0	0	0	03-Nov	41	0	0.00	Beaumaster <i>et al.</i> 2020

[illegible]

**Table 8** Lake Whitefish (*Coregonus clupeaformis*) recorded in the fish lift of the Mactaquac Dam on the Saint John River, New Brunswick. The Mactaquac Dam was completed in 1968 following which catches of Lake Whitefish that arrived during their upstream spawning migration in October and November rapidly declined. While the arrival of this species was noted in the fish lift, there are no accounts that the captured whitefish were transported upstream of the dam by the fish lift. Spawning tributaries that likely occurred upstream were almost certainly impacted from flooding of the Mactaquac Headpond where the water level was increased by 40 m.

Year	Start of Operation	May	June	July	Aug	Sept	Oct	Nov	End of Operation	Total Days	Total Whitefish	CPUE	Source
1968	14-May	0	0	0	2	16	1,264	1,158	21-Nov	191	2440	12.77	Smith 1979
1969	16-May	0	0	0	0	1	319	842	25-Nov	193	1162	6.02	Smith 1979
1970	20-May	0	0	0	0	0	439	136	18-Nov	182	575	3.16	Smith 1979
1971	22-May	0	0	0	0	0	5	10	16-Nov	178	15	0.08	Smith 1979
1972	21-May	0	0	0	0	0	15	2	17-Nov	180	17	0.09	Ingram 1980
1973	17-May	0	0	0	0	0	3	0	15-Nov	182	3	0.02	Ingram 1980
1974	21-May	0	0	0	0	1	44	25	13-Nov	176	70	0.40	Ingram 1980
1975	20-May	0	0	0	0	0	74	39	14-Nov	178	113	0.63	Ingram 1980
1976	13-May	0	0	0	3	0	2	0	29-Nov	200	5	0.03	Ingram 1980
1977	16-May	0	0	0	0	0	18	-	31-Oct	168	18	0.11	Ingram 1985
1978	16-May	0	0	0	0	0	90	-	31-Oct	168	90	0.54	Ingram 1985
1979	16-May	0	0	0	0	0	184	-	31-Oct	168	184	1.10	Ingram 1985
1980	16-May	0	0	0	0	0	17	-	31-Oct	168	17	0.10	Ingram 1985
1981	16-May	0	0	0	0	0	5	-	31-Oct	168	5	0.03	Ingram 1985
1982	16-May	0	0	0	0	0	49	-	31-Oct	168	49	0.29	Ingram 1985
1983	16-May	0	0	0	0	0	0	-	30-Oct	167	0	0.00	Ingram 1990
1984	16-May	0	0	0	0	5	12	-	30-Oct	167	17	0.10	Ingram 1990
1985	16-May	0	0	0	0	0	17	-	30-Oct	167	17	0.10	Ingram 1990
1986	01-May	0	0	0	0	0	67	-	30-Oct	182	67	0.37	Ingram 1990
1987	01-May	0	0	0	0	0	68	-	30-Oct	182	68	0.37	Ingram 1990
1988	01-May	0	0	0	0	0	14	-	30-Oct	182	14	0.08	Ingram 1990

1989	04-Jun	-	0	0	0	0	1	6	-	18-Oct	136	7	0.05	MGS Fishway
1990	14-May	0	0	0	0	0	0	3	-	25-Oct	164	3	0.02	unpubl data MGS Fishway
1991	01-Jun	-	0	0	1	0	0	16	-	28-Oct	149	17	0.11	unpubl data MGS Fishway
1992	24-May	0	0	0	0	0	0	64	-	26-Oct	135	64	0.47	unpubl data MGS Fishway
1993	10-May	0	0	0	0	0	0	-	-	29-Sep	142	0	0.00	unpubl data MGS Fishway
1994	03-Jun	-	0	0	0	0	0	613	-	25-Oct	144	613	4.26	unpubl data MGS Fishway
1995	29-May	0	0	0	0	0	0	16	-	26-Oct	150	16	0.11	unpubl data MGS Fishway
1996	27-May	0	0	0	0	0	0	1	-	11-Oct	137	1	0.01	unpubl data MGS Fishway
1997	18-Jun	-	0	0	0	0	0	0	-	23-Oct	127	0	0.00	unpubl data MGS Fishway
1998	19-May	0	0	0	0	0	0	2	-	26-Oct	160	2	0.01	unpubl data MGS Fishway

Table 8 Cont'd

Year	Start of Operation	May	June	July	Aug	Sept	Oct	Nov	End of Operation	Total Days	Total Whitefish	CPUE	Source
1999	10-May	0	0	0	0	0	14	-	25-Oct	168	14	0.08	MGS Fishway
2000	20-May	0	0	0	0	0	12	-	26-Oct	159	12	0.08	unpubl data MGS Fishway
2001	18-May	0	0	0	0	0	3	-	31-Oct	166	3	0.02	unpubl data MGS Fishway
2002	18-May	0	0	0	0	0	5	-	31-Oct	166	5	0.03	unpubl data MGS Fishway
2003	22-May	0	0	0	0	0	0	-	20-Oct	151	0	0.00	unpubl data MGS Fishway
2004	21-Jun	-	0	0	0	0	1	-	21-Oct	122	1	0.01	unpubl data MGS Fishway
2005	20-May	0	0	0	0	0	0	-	13-Oct	146	0	0.00	unpubl data MGS Fishway
2006	16-May	0	0	0	0	0	0	-	26-Oct	163	0	0.00	unpubl data MGS Fishway unpubl data



2007	23-May	0	0	0	0	0	0	0	0	0	-	19-Oct	149	0	0.00	MGS Fishway unpubl data
2008		No Data												-	-	MGS Fishway unpubl data
2009	16-May	0	0	0	0	0	0	0	0	0	-	09-Oct	146	0	0.00	MGS Fishway unpubl data
2010	04-May	0	0	0	0	0	0	0	0	0	-	04-Oct	153	0	0.00	MGS Fishway unpubl data
2011	25-May	0	0	0	0	0	-	-	-	-	-	26-Jul	62	0	0.00	MGS Fishway unpubl data
2012	14-May	0	0	0	0	0	0	0	0	0	-	16-Oct	155	0	0.00	MGS Fishway unpubl data
2013	10-May	0	0	0	0	0	0	0	0	0	-	09-Oct	152	0	0.00	MGS Fishway unpubl data
2014	17-May	0	0	0	0	0	0	0	0	0	-	24-Oct	160	0	0.00	MGS Fishway unpubl data
2015	11-May	0	0	0	0	0	0	0	0	0	-	22-Oct	164	0	0.00	MGS Fishway unpubl data
2016	13-May	0	0	0	0	0	0	0	0	0	0	07-Nov	178	0	0.00	MGS Fishway unpubl data



### **Morphometrics and Meristics of Whitefish in the Maritime Provinces**

Edge (1987, Edge *et al.* 1991) was the first author to produce a detailed morphometric comparison between the Atlantic Whitefish and the Lake Whitefish in NS (n=6 populations), NB (n=5 populations), Québec, and Maine, and to further document intraspecific variation amongst the latter species. This analysis of meristic characters by Edge (1987, Edge *et al.* 1991) within NS and NB identified specimens from Mira River (Salmon River branch), NS and Kerr Lake, NB as distinct based on low lateral line scale counts. Edge (1987) also noted high gill rakers counts in Lake Whitefish collected from Pringle Lake, NS (mean 30.9), possibly due to a planktivorous diet, but observed that Lake Whitefish from the Mira River had low gill raker counts that may indicate benthic feeding. Following this assessment, Edge (1987) suggested that based on gill raker counts most population from NS and NB seemed to group separately. Lake Whitefish from the Mira River were also suggested as “*sufficiently distinct to be described as a subspecies*” due to lower lateral line scale (64-75, mean 70.1) and gill raker counts (20-24, mean 22.6) when compared to other assessed populations (Edge 1987, Edge *et al.* 1991, Goodchild 2001). The genus *Coregonus*, however, is known for its phenotypic plasticity, particularly in gill raker number and form (Loch 1974, Svårdson 1979, Lindsey 1981) that, while hereditary, can be strongly influenced by habitat type and foraging strategy within a few generations (Lindsey 1981). Therefore, these characters have been considered unreliable for differentiating populations (Goodchild 2001). Upon further assessment, the Mira River population of Lake Whitefish has demonstrated no genetic difference from other NS populations (Bernatchez and Dodson 2001, Goodchild 2001) despite apparent morphological differences.

When describing all three Maritime Coregonids, Hasselman (2003) reports that a combination of the length of the longest gill rakers, the lateral line scale count, and the pectoral fin length was able to correctly distinguish among the various species. Detailed morphometrics and meristics for the three species examined are found in Hasselman (2003). Morphometric analysis by Hasselman (2003, Hasselman *et al.* 2009) also identified distinctive phenotypic variation in Lake Whitefish populations between Kerr Lake, NB and three other populations that included Lake George, Mira River in NS, and Saint John River

in NB. Murray (2005) noted high  $F_{st}$  values between Lake Whitefish populations in Maritime drainages. Conversely, Lake Whitefish in the Saint John River, NB (sampled at Mactaquac Dam) and the Mira River, NS were found to have the least genotypic differentiation but the greatest phenotypic differences (Murray 2005).

### **Ancestry of Whitefish in the Maritime Provinces**

Atlantic Whitefish and Round Whitefish have always been considered native to NS and NB respectively due to a lack of historical stocking and the endemic nature of the former species, but the ancestry of Lake Whitefish was not so clear. Following detailed meristic analysis of multiple Lake Whitefish populations by Edge (1987, Edge *et al.* 1991, Hasselman 2003, Hasselman *et al.* 2009), questions remained about whether the Lake Whitefish observed in NS were native to the province or remnants of past stocking efforts (see also Curry and Gautreau 2010). As recently as 1996, Davis and Browne (1996) wrote without evidence that the Lake Whitefish was an introduced species in NS, and to a degree it was, but these statements disregarded several studies already addressing the local origin and ancestry of this species.

Bernatchez and Dodson (1990) used restriction-fragment length polymorphism in mitochondrial DNA to study several populations of Lake Whitefish in Maine, NS, and NB. Their findings first made a distinction between western Lake Whitefish that dispersed from a Mississippian glacial refuge following glacial retreat at the end of the Pleistocene epoch and those arriving from a probable, isolated Atlantic refugium. They suspected that those populations from the Atlantic refugium now occupy waters ranging from Maine's Allagash Basin through to Cape Breton, NS. The Atlantic glacial refugium likely encompassed an unglaciated plain around the present-day Hudson and Susquehanna River basins (Schmidt 1986; Fig 4). Initial hypotheses perceived that the only region of overlap between these two clonal groups (Atlantic and Mississippian) was the Allagash Basin of the Saint John River drainage in Maine where sympatric populations from two glacial refuges exist (Bernatchez and Dodson 1990, Bernatchez *et al.* 1996; Fig 4). In this overlapping region, Lake Whitefish suspected to have originated from the western (Mississippian) assemblage appeared to exhibit only a normal size phenotype, while those thought to originate from the eastern (Atlantic)

assemblage appeared to exhibit either a normal or a dwarf phenotype that occasionally formed a sympatric pair. Bernatchez and Dodson (1990) theorised that these dwarf and normal phenotype pairs (see also Fenderson 1964) developed through sympatric speciation in the Allagash Basin while remaining reproductively isolated within individual lakes. In NB, these dwarf/normal pairs are only known in Beau Lake in the upper Saint John River on the Maine/NB/Québec border, but they may also occur in Glazier Lake where only the dwarf form is identified (Wood 2016; J. Wood unpubl data). Based on the degree of sequence divergence, it was suggested as a conservative estimate that Lake Whitefish in the MP suspected to have originated from an Atlantic refugium last shared a common ancestor with Lake Whitefish from the Mississippian (western) group 150,000 years ago (Bernatchez and Dodson 1990). This timespan is considered a relatively recent divergence among Lake Whitefish clades (Bernatchez and Dodson 1991).

Bernatchez and Dodson (1991) corrected their previous findings for the MP after characterising four distinct assemblages of Lake Whitefish identifiable across North America which they described as the Beringian (i.e., Yukon/Alaska origin), Mississippian, Atlantic, and Acadian lineages. Among these, Lake Whitefish in NS, NB, some parts of southern Québec, and the northeastern USA through to New England (Bodaly *et al.* 1992) comprised a unique clade based on the analysis of mitochondrial DNA. This group of Lake Whitefish was deemed to be the “Acadian” lineage by Bernatchez and Dodson (1991; to avoid confusion with the Atlantic Whitefish [*Coregonus huntsmani*] once known as the “Acadian Whitefish” we will use the term “Scotian” or “Scotian lineage” to describe this eastern group of Lake Whitefish [*Coregonus clupeaformis*] occurring in the MP throughout the remainder of this article). Within this re-evaluation, Bernatchez and Dodson (1991) found no evidence of the “Scotian” haplotype identified in the MP in other lakes known to have been sourced from the Atlantic refugium (e.g. Lake Champlain, New York State; Bernatchez and Dodson 1994). Furthermore, these new data suggested that Lake Whitefish from the Mississippian refugium only overlapped with those from the Atlantic refugium in the lower St. Lawrence River and Eastern Québec (Fig 4) but Bernatchez and Dodson (1991) reported no overlap between the Mississippian and the “Scotian” lineages. Previous reports of overlapping clades in

the Allagash Basin were thus more likely the intersection of the Atlantic and “Scotian” groups that only meet in Northern Maine and Québec (Bernatchez and Dodson 1991, Pigeon *et al.* 1997, Mee *et al.* 2015). The “Scotian” assemblage of Lake Whitefish thus constitutes a distinct group native to the MP and neighbouring eastern regions (Bernatchez and Dodson 1991, 1994, Bernatchez and Wilson 1998) which has maintained reproductive isolation from other Lake Whitefish groups from discrete glacial origins even when found in sympatry in eastern lakes (Lu and Bernatchez 1998, 1999, COSEWIC 2008).

Identifying a distinct “Scotian” group of Lake Whitefish was an important first step in re-defining the origin of Lake Whitefish in the MP, but Bernatchez and Dodson (1990, 1991) only examined Grand Lake, in Queens County, NB, and Mira River, in Cape Breton, NS during their analysis. Murray (2005), however, was the first to consider the possible implications of historical stocking and to discuss the introduction of Ontario-origin (Detroit River) Lake Whitefish to the MP. Murray (2005) assayed 13 Lake Whitefish populations (12 in NS and 1 in NB; Fig 2, Table 5, 6) using 11 microsatellite loci and included samples from Lake Ontario (a possible stocking source) and MacAlpine Lake, Nunavut, as two representatives of the Mississippian lineage. This study demonstrated that Lake Whitefish sampled from the MP were more closely related to each other within the range of the proposed “Scotian” lineage than to the Mississippian group, mirroring findings by Bernatchez and Dodson (1990, 1991). Based on these results, Murray (2005) concluded that stocking had been unsuccessful (see also Piers 1924), but apart from Grand Lake, Queens County, NB, which supported a significant native population prior to being stocked, population ancestry had not actually been assessed in stocked waters. Lakes within and adjacent to Kejimikujik National Park (likely stocked in 1890) and those near Goshen Lake in Guysborough County (stocked in 1899 and 1900) that could retain stocked genetics were missed (Davies 1900, 1901; Table 1). Though possibly apart from a slim possibility in these regions, there is little chance that any stocked whitefish remained in NS to be sampled (Fig 2).

### **Glacial Refuges and Origin of the “Scotian” Lineage of Lake Whitefish**

Following on the findings of (Bernatchez and Dodson 1991) it was hypothesised that the “Scotian” lineage of Lake Whitefish found in the MP and Maine arrived from eastern continental shelf areas that

remained above sea level and ice free during the last glacial maxima (Fulton and Andrews 1987, Bodaly *et al.* 1992). Evidence for this hypothesised eastern origin is robust in part because the known distribution of the “Scotian” Lake Whitefish (Fig 2, 3, 4) is concentrated in and nearly exclusive to eastern draining watersheds of the MP. Three possible eastern refugia are described by Curry (2007) and include: 1) a southern Georges Banks Refugium (Whitmore *et al.* 1967, Shaw 2006), 2) a Sable Island Banks or “Scotian” Refugium (Catling *et al.* 1985, Davis and Browne 1996, 1998, Mandrak *et al.* 2023), and 3) a Northeastern Grand Banks Refugium east of Newfoundland (NFLD; Schmidt 1986, Curry and Gautreau 2010; Fig 4). Among these regions, the Northeastern Grand Banks of NFLD is often suggested as being the most likely origin for many eastern fishes (Schmidt 1986, Bernatchez and Dodson 1991, Curry 2007, Curry and Gautreau 2010; Fig 4), but the precise post-glacial origin for some species is still subject to some debate and we believe it is incorrect for the whitefish occurring in the MP. A fourth region, the Atlantic Glacial Coastal refugium (i.e., Atlantic Refugium) which overlapped with present day Cape Cod and occurred next to Georges Bank (Curry 2007; Fig 4) is not included here because Lake Whitefish distinct from the “Scotian” lineage have been identified separately as having originated from this refugium and occur sparsely in central Maine but not as far as the MPs (Bernatchez and Dodson 1991).

Tangential to the three regions described, it has also been postulated that a glacially de-watered continental shelf could have presented a near continuous land mass as a possible refuge (Wright 1989). However, modern assessment has led to the hypothesis that ice extending to and even past the continental shelf edge was possible (Dalton *et al.* 2020, 2023). For simplicity of argument, we will assume three discrete refugia as potential Lake Whitefish sources for the MP. Dalton *et al.* (2020, 2023) provides extensive and robust geochronological data sets regarding ice cover of modern landforms, but little data is presented describing ice extent beyond those coastlines. Furthermore, the presence of significant ice streams along the Laurentian and Fundian channels (Piper and MacDonald 2001, Shaw 2006, Shaw *et al.* 2006; Fig 4) would have roughly split a continuous land mass into the three isolated refuges (Georges Bank, Sable Island “Scotian”, and Grand Banks) as previously described.

Beginning in the south, clear evidence suggests that Georges Bank remained ice free during the Wisconsin glacial maximum. This evidence includes fine lacustrine sediments characteristic of freshwater habitats and glacial moraines which provide evidence of ice margin contact on the western edge of the bank (Pratt and Schlee 1969). These data complement the discovery of numerous fossils teeth of both Mastodon and Mammoth (*M. americanum*, and *Mammuthus* sp; Whitmore *et al.* 1967) dredged from the sea floor indicating the presence of numerous large herbivores. The existence of such large mammals at sufficient abundance to leave discoverable fossils suggest that forests and grasslands once covered Georges Bank. Therefore, sufficient freshwater was available to support vegetation growth and probably freshwater obligate fishes until Georges Bank became inundated by rising sea levels. To the north, the Northeastern Banks of NFLD also remained ice free based on evidence from geochronological data (Dalton *et al.* 2023) and probably provided refuge to some salt tolerant and anadromous fishes that dispersed widely from this location (Bernatchez and Dodson 1991, Curry 2007, Curry and Gautreau 2010). However, the occurrence of Lake Whitefish from the “Scotian” lineage or Atlantic Whitefish seems unlikely in either of these refugia.

During glacial retreat beginning 18,000 years before present (BP; Curry 2007), both the Northeastern Grand Banks of NFLD and Georges Bank would have been isolated from NS (Fig 4). Both regions were separated from the MP by significant expanses of cold and seasonally stratified marine waters (de Vernal *et al.* 2000) and partially blocked by significant streams of calving glacial ice (Shaw 2006). Calving glaciers formed ice streams that flowed rapidly seaward from the North American continent during glacial retreat (Shaw 2006). These glaciers extended to the ocean floor in a then shallow sea, and their seaward displacement carved both the Laurentian Channel to the north of NS and the Fundian Channel to the south, sending huge plumes of sediment and ice into continental shelf waters (Shaw 2006, Dalton *et al.* 2020, 2023). To the south of NS, Georges Bank was flooded between 11,000-8,000 years BP during which a shallow sea in the Gulf of Maine began to widen (Grant 1970). Thus, any freshwater obligate fishes on Georges Bank would have had to navigate low salinity surface waters of an otherwise hypersaline ocean to reach the mainland (Curry 2007). The closest landmass would have



been the northeastern United States. At this point, and if successful, whitefish would most likely overlap with fishes of the Atlantic Coastal Refugium, but fishes from that refugium probably did not disperse as far as the MP (Curry 2007). Lake Whitefish and in particular the anadromous Atlantic Whitefish are tolerant to salt water (Scott and Crossman 1973), but dispersal from Georges Bank fails to explain why neither is found in the Northeastern United States that would have been far closer and more easily accessible.

The Northeastern Grand Banks most often provides the favoured hypothesis for an eastern Lake Whitefish refugium (Bernatchez and Dodson 1991, Curry 2007, Curry and Gautreau 2010), but is subject to similarly puzzling disjunctions in fish distribution. No whitefish species or freshwater obligate fishes of any type are native to the island of NFLD (Curry 2007), which was not only the closest colonizable landmass, but one with an enormous abundance of suitable lakes. Atlantic Whitefish by comparison only occupy southern NS where Lake Whitefish populations are also numerous. This distribution begs explaining how these species (particularly the Atlantic Whitefish) could have bypassed so much available habitat in both NFLD and NS only to take up residence further south while avoiding lakes draining to the Southern Gulf of St Lawrence. In contrast, Arctic Char (*Salvelinus alpinus*, Linnaeus, 1758) that did originate from the Northeastern Grand Banks refugium occur on NFLD but have not been found in NS (Bernatchez and Dodson 1991, Brunner *et al.* 2001, Salisbury *et al.* 2019). This absence occurs even though Arctic Char would have been the most well adapted to disperse through cold marine waters that abounded during glacial retreat (Scott and Crossman 1973). Notably, some assessments of the Northeastern Banks as a suitable refuge for Lake Whitefish had assumed that the species was introduced to NS and therefore not native to the province (Curry and Gautreau 2010) or had uncertain distribution (Mandrak *et al.* 2023), a conclusion that may have led to overlooked distributional clues.

Following this assessment, a “Scotian” group of Lake Whitefish is perhaps more likely to have survived in proglacial lakes in a Scotian Shelf refugium ahead of the ice front (Shaw 2006; Fig 4). Upon glacial retreat, these lakes would have been transported onto the eastern Maritime coast following the forebulge and topography over which the retreating ice front passed (Dadswell 1974), probably avoiding the need for marine migration. This avenue of colonization would

support the exclusive occurrence of Lake Whitefish in the eastern facing watersheds of NS, and the distribution of endemic populations of Atlantic Whitefish on that shore (DFO 2018). The distribution of “Scotian” Lake Whitefish is also identical to that of genetically distinct Lake Trout which occur exclusively in the MP and northern Maine (Warner *et al.* 2023, 2024). Since Lake Trout have the lowest salinity tolerance of the genus *Salvelinus* (Scott and Crossman 1973), marine colonization routes would have been extremely unlikely for this species, suggesting that it probably also shared the Scotian Shelf refugium with the two NS Coregonid species which would have served as suitable prey in fresh water.

In NB, the “Scotian” lineage of Lake Whitefish also reached river basins spanning from the Saint John River to the St. Croix River (Fig 4). To arrive at these locations, Lake Whitefish likely passed over NS and through the Bay of Fundy as glacial melt water transgressed in proglacial lakes over the land that was depressed approximately 200 m from its present elevation upon glacial retreat (Quinlan and Beaumont 1982, Dalton *et al.* 2023). The Bay of Fundy, which had cleared of ice between 13,000 -12,500 years BP (Fader 2005), initially posed a marine barrier to Lake Whitefish movement. Isostatic rebound then outpaced sea level rise causing the bay to drain between 13,000-9,500 years BP (Grant 1971, Fader *et al.* 1977, Fader 2005), probably initially the bay became a freshwater lake fed by melting ice on the western Fundy shore (Stea and Mott 1998, Shaw *et al.* 2002). Near 11,000 years BP, sea level rise caused the gradual return of marine waters to the bay which would soon provide a pathway for whitefish to enter NB through a rising but still brackish Bay of Fundy (Grant 1970, Shaw 2006). Migrating whitefish would have then met the Saint John River along the NB coastline which formed its present-day southern connection to the Bay of Fundy near 8,000 years BP (Curry 2007).

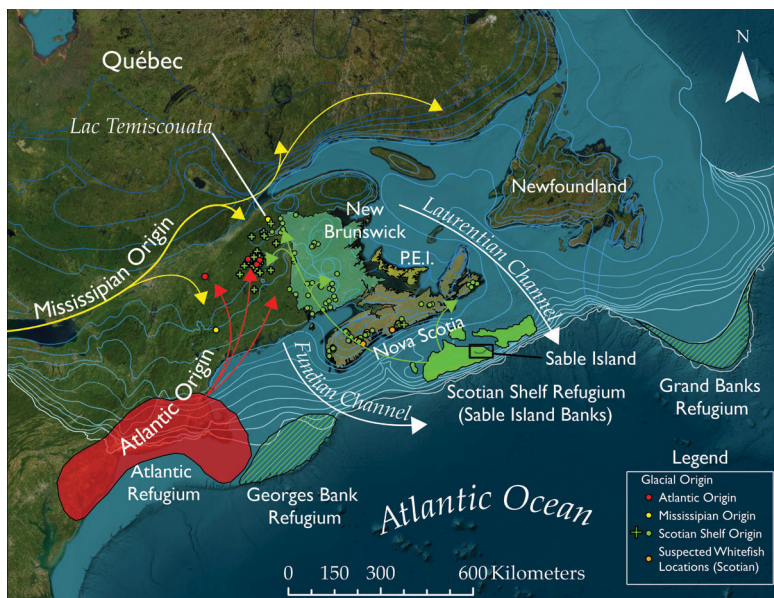
Near 9,500 years BP, eustatic sea level rise started to rapidly outpace isostatic rebound, and by 7,000 years BP the Bay of Fundy was once again flooded with cold sea water (Fader 2005). Rising sea levels re-established the marine barrier to whitefish migration, once again separating NS and NB while widening of the Gulf of Maine (Grant 1970). Under this timeline, Lake Whitefish which dispersed into the Saint John River near 8,000 years BP would have had approximately 3,000-4,000 years to follow on the heels of the retreating glacial ice

in proglacial lakes to arrive in headwater lakes of the upper Saint John River. Proglacial lakes were one of the most effective means of widespread post-glacial dispersal of fishes during the Wisconsin glacial retreat throughout the Holarctic (Segerstråle 1957, Dadswell 1972, Dadswell 1974). Isostatic rebound and dewatering of the land mass from 6,000 years BP to present (Curry 2007) would have provided the mechanism to transport Lake Whitefish to the upper Saint John River and Maine's Allagash Basin (deglaciated between 14,500–11,000 years BP; Borns *et al.* 2004) where they are now found isolated in deep lake basins.

Reflecting further, Atlantic Whitefish were found exclusively in watersheds draining to the Atlantic Ocean but survive only in the Petite Rivière, Lunenburg County (Bradford *et al.* 2004). This restricted distribution is surprising, because the anadromous life cycle and greater adaptation of this species to salt water should have provided more opportunity for it to disperse. Some authors have suggested that the Atlantic Whitefish may have sought refuge in a small deglaciated corner of southern NS (Edge 1987), but there is no data that suggests this hypothesized refuge existed (Dalton *et al.* 2023). Conversely, Atlantic Whitefish probably originated from a similar “Scotian” refugium as did the Lake Whitefish (Curry and Gautreau 2010). In contrast to the eastern origin of other coregonids of the MP, the Round Whitefish in NB arrived from the Mississippian glacial refugium (Morgan *et al.* 2018), once situated in the upper Mississippi valley where most of the freshwater obligate fishes in the MP and central North America originated (Dadswell 1972, Curry 2007, Curry and Gautreau 2010).

## Diet

Lake Whitefish diet can vary considerably by lake and in NS has been reported to include Cladocera plankton (Pringle Lake, Guysborough County, NS; Edge 1987), benthic organisms including amphipods, diptera larvae, isopods, sphaeriid clams (Lake George, Annapolis County, and Mira River Cape Breton County NS; Edge 1987), and gastropods (Saint John River; Dadswell 1975). Gilhen (1974) reported that Lake Whitefish are bottom feeders that graze on insect larvae and gastropods while occasionally capturing small fishes, including small Rainbow Smelt (*Osmerus mordax* Mitchell, 1814) when present (J. Wood unpubl. data). All Lake Whitefish captured during winter sampling in East Grand Lake on the Maine/NB border in 2024/25



**Fig 4** Map of the optimal 25,000-year (calibrated age before present) ice margin extracted from supplementary files in Dalton *et al.* (2023) showing the hypothesised ice edge in 1,000-year increments during retreat and the possible glacial refugia hypothesised to have existed in eastern North America during Wisconsin Glaciation. These locations include the Grand Banks and Georges Banks refugia (green hatched polygon), the Scotian Shelf Refugium (Sable Island Banks; solid green polygon) and the Atlantic refugium (red polygon) which was located near modern day Cape Cod and the mouth of the Hudson River. Arrows emanating from the Mississippian Refuge (yellow), Atlantic Refuge (red), and the Scotian Shelf Refugium (green) show the hypothesised colonization routes of Lake Whitefish so far identified in the Canadian Maritime Provinces and State of Maine. Round points matching the colours of source refugia indicate documented Lake Whitefish populations with likely or known origin, while suspected populations are marked as orange circles. Dwarf Lake Whitefish likely originating from the Scotian Shelf Refugium are marked as a green “+”.

had juvenile Alewife ~4.5 cm in their stomachs (M. Warner unpubl. data). In NB, Dadswell (1975) reported that adult Lake Whitefish in the Saint John River were benthic carnivores preying largely on gastropods while juveniles are planktivorous until a size of 20 cm. Dadswell (1975) observed the most feeding and highest gut fullness from October-June, suggesting greater feeding in the colder months and found other food items to include amphipods, insect larvae, and fish eggs at this time. Differences in diet and food resource competition are thought to be responsible for divergence in gill raker counts

observed across circumpolar Lake Whitefish populations (Loch 1974, Svårdson 1979, Lindsey 1981) and diet evidently varies with prey availability and lake.

### **Recreational Fishing Regulations**

#### *Nova Scotia*

Goodchild (2001) reported that there was no catch or retention limit for Lake Whitefish in NS for the 1998 season. From 2002 to present (2025), there appears to be no targeted fishery, yet recreational angling regulations in NS allow a daily bag and possession limit of 8 Lake Whitefish with seasons corresponding to open seasons for recognized sportfish that span from April 1 to Sept 30 (Nova Scotia Anglers Handbook 2025). All lakes are open to summer angling, but Sucker Lake, Lunenburg County, and Pringle Lake, Guysborough County, are the only lakes reported to sustain Lake Whitefish that are open to winter fishing. There is no length restriction applied for retaining Lake Whitefish in NS and the species has been reported as only a minor recreational species in the province (Goodchild 2001). This lack of angler interest combined with limited winter fishing opportunities in NS may have in-part reduced the ability to determine regional Lake Whitefish distribution.

#### *Atlantic Whitefish*

Following a federal Species at Risk Act (SARA) listing as endangered in 2003 (Bradford *et al.* 2004; the first species listing under SARA), the Atlantic Whitefish found exclusively in NS has become highly protected within its remaining native range. As a result, no fishing is permitted in Hebb, Minamkeak, or Milipsigate lakes, Lunenburg County. Furthermore, Atlantic Whitefish cannot be targeted or retained by recreational anglers and must be released immediately if captured accidentally (Nova Scotia Anglers Handbook 2025).

#### *New Brunswick*

In NB regulations pertaining to “whitefish” do not distinguish between Lake Whitefish and Round Whitefish, and neither species is considered a sportfish. As a result, the recreational fishing season opens in accordance with the designated sportfish seasons in both inland and tidal waters across all recreational fishing areas and closes on Sept 15th. Anglers in NB have a daily bag and possession limit of 8 “whitefish”, but within a slot size ranging from 10-70 cm total

length. This length limit encompasses the entire adult size range for both whitefish species in the province. The sole exception to these regulations is on boundary waters shared with the State of Maine where fishing is permitted for “whitefish” during both the summer and winter sportfishing seasons during which the daily bag and possession limit is three without length restrictions. NB also supports a recreational fishery for whitefish in waters designated as tidal (i.e., lakes, bays, and portions of tidally influenced inland waters where no sportfishing licence is required). These tidally influenced waters supporting Lake Whitefish are exclusive to the downstream reaches and tributary lakes of the Saint John River. The daily bag and possession limit for whitefish in these designated waters is five whitefish without length limitations (New Brunswick Regulations Summary 2025).

### *Round Whitefish*

No distinction is made between Round Whitefish and Lake Whitefish in NB and this species is included within daily limits and length restrictions of the latter species. There appears to be no fishery for this species anywhere in NB and there are no reports of accidental captures by anglers.

### **Overlap with Introduced Species**

Bolstering Atlantic Salmon (landlocked and anadromous populations) and Brook Trout (*Salvelinus fontinalis* Mitchell, 1815) populations in provincial waters has been the central goal of federal and provincial run hatcheries since their initial establishment in the MP (Whitcher 1876). As interest in the potential of new species introductions to the MP developed, stocking efforts quickly expanded to include the Lake Whitefish (Pope 1879), Lake Trout (Warner *et al.* 2023), Brown Trout (*Salmo trutta* Linnaeus, 1758; Andrews *et al.* 2025), Rainbow Trout (*Oncorhynchus mykiss* Richardson, 1836), Smallmouth Bass (*Micropterus dolomieu* Lacepède, 1802; Leblanc 2010), Chain Pickerel (*Esox niger* Lesueur, 1818; Adams 1873, Mitchell *et al.* 2012), Muskellunge (*Esox musquinongy* Mitchell, 1824; Zelman *et al.* 2023) and, on rare occasions, Rainbow Smelt. Directed releases were conducted in many accessible waters with little information on the ecosystems to which they were introduced or impacts that may result (Warner *et al.* 2023, Andrews *et al.* 2025). It is unlikely that pre-occurrence of any native fishes, particularly the little-known and widely undocumented Coregonids, was considered by hatcheries



in early years. Stocking efforts were politically driven by seeking to win public favour by satiating demand for stocked trout and salmon while attempting to create exciting new fisheries or bolster existing ones (Andrew *et al.* 2025). The continued deficit of information on native species distributions and interaction persists across the MP to the present day while stocking efforts continue.

The impacts of stocked trout over Lake Whitefish populations are unknown, but both Lake Whitefish and Atlantic Whitefish have seemingly thrived in systems with low fish diversity and low trout abundance (Edge 1987, Edge and Gilhen 2001, Bradford *et al.* 2015). When surveyed by Edge (1987), Brook Trout were not captured in the lakes of the Petite Rivière with Atlantic Whitefish, nor were they found in any lake of the Mushamush River watershed in NS that seem to support a high number of Lake Whitefish lakes. However, Brook Trout do exist in both the Mushamush and Petite Riviere watershed at low abundance and have been stocked in Fancy Lake in the latter (Edge and Gilhen 2001). An examination of provincial stocking records in NS from 1976-2021 reveals that 25 of the 40 confirmed Lake Whitefish lakes and 14 of the 18 suspected Lake Whitefish lakes (62.5% and 77.7% respectively) have been stocked with at least one species of trout (Brook Trout or Rainbow Trout). Brown Trout may have also arrived naturally to some locations (Andrews *et al.* 2025). Eleven of these whitefish lakes (6 known and 5 suspected) were stocked with Brook Trout as recently as 2021 (Table 9). Among recently stocked locations, Eden Lake, a 223-hectare lake in Pictou County, was stocked with 174,672 Brook Trout from 1976-2021 with unknown effect (Table 9). There is no recent account of Lake Whitefish from this lake, nor were they located in Pringle Lake or Narrow Lake following surveys by NSDFA in 2024. These two locations were planted with 23,941 and 89,426 Brook Trout respectively within the assessed period.

In NB, provincial stocking records maintained from 1976-2023 document similar introductions of Brook Trout in 10 of 40 known and one of two suspected Lake Whitefish habitats (counting the main Saint John River as one location and omitting marine observations; Table 10). Among these locations, Lac Baker was stocked with 185,500 Brook Trout over 28 years with the most recent introduction occurring in 2023 (Table 10). Across reported Lake Whitefish locations, Lake Trout, Brown Trout, landlocked Atlantic Salmon, and Splake (Brook Trout x Lake Trout hybrid) were also introduced. Again, an examination of

historic stocking records would likely reveal a much greater number of introductions. The impacts or effects of these introductions are unknown due to a lack of survey in Lake Whitefish supporting waters.

In Maine, the introduction of landlocked Rainbow Smelt has been linked to the broadscale collapse of Lake Whitefish populations (Wood 2016). Where Lake Whitefish population declines have occurred, Wood (2016) notes that recruitment failure can go unnoticed because adults continue to appear common due to their long lifespan (30-45 years). Feeding pelagically, Rainbow Smelt may prey on larval whitefish with the greatest effects reported in small lakes with low habitat complexity (Evans and Loftus 1987, Loftus and Huntsman 1986). Some lines of thought suggest that complex habitats such as those available in East Grand Lake on the border of Maine and NB may serve to protect young whitefish amidst its deep basins and boulder-strewn substrate. Similarly in the Mira River in Cape Breton, NS, Lake Whitefish do not appear to be affected by co-occurrence with smelt (Edge 1987, Goodchild 2001) but smelt in this system may tend towards anadromy rather than remaining in freshwater. Although in some systems food competition between Rainbow Smelt and larval Lake Whitefish may be more impactful than direct predation because introduced smelt are known to transform zooplankton communities (Evans and Loftus 1987). Resilient Lake Whitefish populations may benefit from habitat complexity that offers cover and greater food resources for juvenile whitefish or support more diverse fish communities maintaining possible predator controls on smelt (Whitaker and Wood 2021).

The detrimental effects of Rainbow Smelt on Atlantic Whitefish were apparently learned during an attempt to safeguard the endangered and endemic coregonid in Anderson Lake near Halifax, NS. Here Atlantic Whitefish was introduced to a small and highly protected lake within the confines of a Canadian Forces Base (CFB-Halifax) between 2005-2012 (Bradford *et al.* 2015). Landlocked Rainbow Smelt were identified within the lake prior to stocking Atlantic Whitefish, but at the time young Rainbow Smelt were deemed a beneficial pelagic food source (Bradford *et al.* 2015). After extensive efforts to monitor the introduced population failed, piscivorous Brook Trout and Rainbow Smelt were suggested to have had a negative effect on survival and reproduction (Bradford *et al.* 2015). Efforts to rear Atlantic Whitefish in Anderson Lake were abandoned in 2012 (Bradford



*et al.* 2015) and no subsequent attempts have yet been made to introduce the species outside of their remaining native distribution in the Petite Rivière watershed.

Invasive Chain Pickerel and Smallmouth Bass are most prevalent in the lakes of southern NS (Nova Scotia Anglers Handbook 2024; Leblanc 2010, Mitchell *et al.* 2012) and are reported in 21 of the confirmed and nine of the suspected Lake Whitefish lakes in that province (Table 9). These invasives also overlap with the SARA listed Atlantic Whitefish. Smallmouth Bass were first confirmed in Milipsigate Lake in 2000 (LeBlanc 2010) and are now found in all three lakes containing the species (DFO 2024). Chain Pickerel were identified in both Hebb and Milipsigate Lakes in May 2013 (DFO 2018). Because of the overlap of these invasives within the world's last remaining habitats of the Atlantic Whitefish, eradication options such as rotenone application cannot be attempted, and electrofishing must be used to regulate predator populations (DFO 2018).

In NB, Smallmouth Bass are found in 23 of the 40 confirmed Lake Whitefish waters while Chain Pickerel are found in 22 (Table 10). The two suspected whitefish locations are invaded by both species (Table 10). Lake Whitefish in the Saint John River are faced with additional threats from Muskellunge (*Esox masquinongy* Mitchell, 1824) introduced in a headwater lake in the 1970s (Zelman *et al.* 2023) and more recently Largemouth Bass (*Micropterus salmoides* Cuvier, 1828) (Culberson *et al.* in press) which are also found in St. Croix River watershed on the Maine/NB border.

## DISCUSSION

The occurrence of Lake Whitefish in the MP is exclusive to watersheds draining to the Atlantic Ocean (Goodchild 2001) apart from single occurrences in Restigouche and Miramichi counties that drain into the Gulf of St. Lawrence. While several authors describe genetically distinct “Scotian” whitefish as originating from a Northeastern Grand Banks Refugium, a more likely origin was perhaps nearer to Sable Island (see Shaw 2006) where numerous endemic terrestrial species persist today (e.g. COSWIC 2014). This pattern of distribution contrasts with many other freshwater obligate species occurring in the MP that likely survived Wisconsin glaciation in either an Atlantic or Mississippian glacial refugium and arrived from the southwest (Fig 4).



Narrow Lake	Guysborough	Confirmed	1977	2021	25	89,426	BT	-	-	-
Pringle Lake	Guysborough	Confirmed	1976	2021	11	23,941	BT	-	-	-
Big Shaw Lake	Halifax	Confirmed	-	-	-	-	-	-	-	-
Chezetcook Lake	Halifax	Confirmed	1981	2008	6	11,672	BT	Present	2012	-
Conrod Lake	Halifax	Confirmed	1979	2017	33	146,933	BT	Present	2012	-
Gibraltar Lake	Halifax	Confirmed	-	-	-	-	-	-	-	-
Long Bridge Lake	Halifax	Suspected	1979	2017	29	101,513	BT	Present	2012	-
Moose Lake	Halifax	Suspected	-	-	-	-	-	-	-	-
Morris Lake	Halifax	Suspected	1987	2021	18	31,491	BT	Present	1975	Present
Petepeswick Lake	Halifax	Suspected	1981	2017	26	78,855	BT	Present	2012	-
Paces Lake	Halifax	Suspected	1984	2019	27	103,208	BT	-	-	-
Scots Lake/	Halifax	Confirmed	1998	2019	15	39,877	BT	-	-	-
Scots Pond										
Thompson Lake	Halifax	Suspected	1993	1996	3	1,483	BT	-	-	-
Big Mushamush Lake	Lunenburg	Confirmed	1976	1977	2	1,199	BT	Present	1994	-
Caribou Lake	Lunenburg	Confirmed	1976	2013	23	130,611	BT	Present	2005	-
Little Mushamush Lake	Lunenburg	Confirmed	1976	2012	20	83,887	BT	Present	1999	-
Millet Lake	Lunenburg	Confirmed	1976	2021	9	6,950	BT	-	-	-
Shingle Lake	Lunenburg	Confirmed	-	-	-	-	-	Present	1995	-
Sucker Lake	Lunenburg	Confirmed	1990	2021	31	132,528	BT, RT	Present	1996	-
West Whale Lake	Lunenburg	Suspected	-	-	-	-	-	-	-	-
Whale Lake*	Lunenburg	Suspected	-	-	-	-	-	-	-	-
Eden Lake	Pictou	Confirmed	1976	2021	42	174,672	BT	-	-	-
Annis Lake	Queens	Confirmed	1976	2001	19	82,842	BT	Present	2001	-
Beavertail Basin	Queens	Suspected	1984	1999	8	43,101	BT	Present	2001	-

Table 9 Cont'd

Water Body Name	County	Status	First Year Stocked	Last Year Stocked	# of Years Stocked	Total Stocked	Species	Smallmouth Bass	Year Reported	Chain Pickerel	Year Reported
Beavertail Lake	Queens	Suspected	1984	1999	8	See Beavertail Basin	BT	Present	2001	-	-
Cameron / Beartrap lakes	Queens	Suspected	1976	2021	12	See Ponhook	BT	Present	1995	-	-
Cobrielle (Cobrielle) Lake	Queens	Confirmed (Winter)	-	-	-	-	-	-	-	Present	2023
Kejimikujik Lake	Queens	Confirmed	-	-	-	-	-	-	-	Present	2018
Little Ponhook Lake	Queens	Confirmed	1977	2016	19	38,144	BT	Present	2001	-	-
Minard Lake	Queens	Confirmed	1976	1977	2	883	BT	-	-	-	-
Mountain Lake	Queens	Confirmed	-	-	-	-	-	-	-	Present	2023
Molega Lake	Queens	Suspected (Winter)	1976	2021	14	75,335	BT	Yes	2001	-	-
Peskowesk Lake	Queens	Confirmed	-	-	-	-	-	-	-	Present	2018
Ponhook Lake	Queens	Suspected	1976	2021	12	20,320	BT	Yes	1995	-	-
Salters Lake	Queens	Suspected	1984	1984	1	1,001	BT	-	-	-	-
St. Mary Bay (Ponhook Lake)	Queens	Suspected	1976	2021	12	See Ponhook	BT	Yes	1995	-	-
Carleton River	Yarmouth	Confirmed	-	-	-	-	-	Yes	1994	-	-
Kempt Back Lake	Yarmouth	Confirmed	1976	1998	9	49,225	BT	Yes	1998	-	-
Lake George	Yarmouth	Confirmed	-	-	-	-	-	Yes	2001	-	-
Mink Lake	Yarmouth	Confirmed	1976	2009	22	48,993	BT	Yes	1994	-	-
Ogden Lake	Yarmouth	Confirmed	1976	1995	9	9,999	BT	Yes	1989	-	-
Parr Lake	Yarmouth	Confirmed	1976	1977	2	1,853	BT	Yes	1989	-	-

Petes Lake	Yarmouth	Confirmed	-	-	-	-	Yes	1989	-	-
Porcupine Lake	Yarmouth	Confirmed	-	-	-	-	-	-	Present	1977

MacIntyres Lake: Rainbow Trout stocking constitutes 2,544 of the total number of trout introduced.  
Sucker Lake: Rainbow Trout stocking constitutes 117,804 of the total number of trout introduced.

**Table 10** Summary of Brook Trout (*Salvelinus fontinalis*; BT) stocking in water bodies where Lake Whitefish (*Coregonus clupeaformis*) are confirmed or suspected in the province of New Brunswick. Brook Trout stocking in many locations was initiated by the Department of Marine and Fisheries in the late 1800s, but only stocking conducted by the province from 1976 – 2024 and recoded by the New Brunswick Department of Natural Resources and Energy Development is reported. Stocking in many locations occurred long prior to this time and in some locations may have involved other species such as Brown Trout (*Salmo trutta*; see Andrews et al. 2025). Displayed data includes water body name, county, first and last year stocked, number of years stocked, total number stocked and species. No Rainbow Trout (*Oncorhynchus mykiss*) were documented to have been stocked in these waterbodies during the listed period, however, escaped Rainbow Trout now occur and reproduce in the Mactaquac and Beechwood headpond. Splake, a hybrid between a Brook Trout and Lake Trout (*Salvelinus namaycush*) and Brook Trout x Arctic Char (*Salvelinus alpinus*) were stocked in Grand Lake, Queens County and both Oromocto Lake and Grand Lake Queens County have also been supplemented with Landlocked Salmon.

Lake Name	County	Status	First Year Stocked	Last Year Stocked	# of Years Stocked	Total Stocked	Species	Chain Pickerel	Smallmouth Bass
Beechwood Dam	Carleton	Confirmed	-	-	-	-	-	Present	Present
Beechwood Headpond	Carleton	Confirmed	-	-	-	-	-	Present	Present
Black's Harbour	Charlotte	Confirmed	-	-	-	-	-	-	-
Digdeguash Lake	Charlotte	Confirmed	-	-	-	-	-	Present	Present
Kerr(s) Lake	Charlotte	Confirmed	-	-	-	-	-	-	-
Darling's Lake	Kings	Confirmed	-	-	-	-	-	Present	Present
Nerepis River	Kings	Confirmed	-	-	-	-	-	Present	Present
Saint John River	Kings	Confirmed	-	-	-	-	-	Present	Present
Sherwood Lake	Kings	Confirmed	-	-	-	-	-	-	-
Beau Lake	Madawaska/ Province of	Confirmed	-	-	-	-	-	-	-
	Québec								
First (Green) Lake	Madawaska	Confirmed	1976	2001	15	50,648	Brook Trout	-	-
Glazier Lake	Madawaska	Confirmed	1987	2007	4	8,850	Brook Trout	-	In watershed

Green River (Davis Mill)	Madawaska	Confirmed	-	-	-	-	-	-	In watershed
Lac Baker (Baker Lake)	Madawaska	Confirmed	1979	2024	29	188,400	Brook Trout	-	In watershed
Madawaska River	Madawaska	Confirmed	-	-	-	-	-	-	-
Second Falls Head	Madawaska	Confirmed	-	-	-	-	-	-	-
Pond (Green River Reservoir)	Madawaska	Confirmed	1987	2003	6	13,836	Brook Trout	-	-
Third (Green) Lake	Northumberland	Confirmed	-	-	-	-	-	-	-
Logan Lake	Queens	Confirmed	1977	1989	4	37,113	Brook Trout	Present	Present
Serpentine Lake	Queens	Confirmed	1980	2015	19	133,866	Brook Trout	Present	Present
Belleisle Bay (Saint John River)	Queens	Confirmed	-	-	-	-	-	Present	Present
Grand Lake	Queens	Confirmed	1977	1989	4	37,113	Brook Trout	Present	Present
Maquapit Lake	Queens	Confirmed	-	-	-	-	-	Present	Present
Saint John River	Queens	Confirmed	-	-	-	-	-	Present	Present
Salmon River	Queens	Confirmed	-	-	-	-	-	Present	Present
Washademoak Lake	Queens	Confirmed	-	-	-	-	-	Present	Present
McDougall Lake	Restigouche	Confirmed	2000	2024	19	40,835	Brook Trout	-	-
Saint John River	Saint John	Confirmed	-	-	-	-	-	Present	Present
West Branch Reservoir	Saint John	Suspected	1976	1980	5	21,351	Brook Trout	Present	Present
(Halls Lake)*	Saint John	Confirmed	-	-	-	-	-	Present	Present
West Branch (Musquash) Reservoir (South)	Saint John	Confirmed	-	-	-	-	-	Present	Present
Saint John River	Sunbury	Confirmed	-	-	-	-	-	Present	Present
Long Lake	Victoria	Confirmed	-	-	-	-	-	-	-

Table 10 Cont'd

Lake Name	County	Status	First Year Stocked	Last Year Stocked	# of Years Stocked	Total Stocked	Species	Chain Pickerel	Smallmouth Bass
Tobique River	Victoria	Confirmed	-	-	-	-	-	-	-
Lakes (undefined)									
Tobique River	Victoria	Confirmed	-	-	-	-	-	-	Present
Reservoir									
Trousers Lake	Victoria	Confirmed	1976	2000	12	32,323	Brook Trout	-	-
East Grand Lake	York	Confirmed	-	-	-	-	-	Present	Present
Mactaquac Dam	York	Confirmed	-	-	-	-	-	Present	Present
Mactaquac	York	Confirmed	1978	1990	10	53,068	Brook Trout	Present	Present
Headpond									
Oromocto Lake	York	Confirmed	1976	1978	3	24,755	Brook Trout	Present	Present
Oromocto River	York	Confirmed	-	-	-	-	-	Present	Present
Mouth									
Palfrey Lake*	York	Suspected	-	-	-	-	-	Present	Present
Spednic Lake	York	Confirmed	-	-	-	-	-	Present	Present
Wauklahagan Lake	York	Confirmed	-	-	-	-	-	Present	Present

The precise identity of the "Tobique River Lakes" is not defined but likely include Trousers Lake, Long Lake, and Serpentine Lake  
Lake Name\* Lakes directly connected to water where Lake Whitefish are verified, having a high likelihood of also containing Lake Whitefish



Within the distinctly eastern distribution of the “Scotian” Lake Whitefish, populations have been steadily discovered since initial observations were made in Kejimikujik Lake by Veilleux (1964), and several more populations are likely to exist regionally. This is particularly true in NS where Lake Whitefish have never been a priority species for sport fisheries or research. Lakes supporting known Lake Whitefish populations are often nestled in un-surveyed and interconnected lake chains that could easily host several additional populations (Table 5). For example, Lake Whitefish were only discovered in Conrod Lake, Halifax County by the NSDFA in 2017 (Fig 5), but this lake is directly connected to Chezzetcook Lake where Whitefish were confirmed in 1974 (Alexander *et al.* 1986; Table 5). Lake Whitefish presence in adjacent waters including Thompson, Petepeswick, and Long Bridge lakes is likely (Table 5), as are several more in the un-surveyed lakes of Guysborough County. Even though many of these lakes are developed, it is not uncommon for Lake Whitefish to evade detection (Edge and Gilhen 2001) due to their adherence to deep lake basins, a brief winter spawning period, and a diet of plankton and benthic macroinvertebrates minimizing the chance for incidental capture by anglers. In Kerr Lake, NB, Smith (1952) noted that Lake Whitefish had avoided detection by local anglers for years, and it was not until a suitably sized gill net was deployed at appropriate lake depths that individuals of the species were captured. The lesser extent of eastern facing watersheds in NB may leave fewer regions to investigate, though lakes between the Saint John and Saint Croix River watersheds, particularly the Lepreau and Magaguadavic drainages are potential candidates for future sampling.

The repeated discovery of new Lake Whitefish populations, particularly in NS, has not resulted in the species becoming more well studied. Since distinctions were made between the Lake Whitefish and the Atlantic Whitefish by Scott (1967) and the general question of Lake Whitefish origin in the MP was addressed, research interest has stagnated. Anglers in NS are generally unaware of the occurrence of Lake Whitefish in the province, and both research and public interest in NB (apart from lakes along the Maine border) remains similarly sparse. Once abundant populations in the Saint John River appear to have declined dramatically as evidenced by plummeting captures at the Mactaquac and Beechwood dams (Table 7). Lake Whitefish could also be extirpated from the Mactaquac Headpond following



**Fig 5** Photo of a Lake Whitefish (36.2 cm Fork Length) captured in Conrod Lake, Halifax County, Nova Scotia on 23 August 2017. The photographed specimen was the only individual captured and was taken in a 5 cm square mesh gill net set on the bottom along a slope extending from 9-15 m deep during an overnight set. Bottom temperature along this depth range was 6.4-11.0°C. A thermocline was measured at 14 m and dissolved oxygen below the thermocline was 9.46-8.79 mg/l from 14-29.5 m; pH ranged from 4.90-5.0. The maximum depth of Conrod Lake was 29.6 m where water temperature was recorded as 5.4°C (NSDFA, unpubl. data).

obstruction of upstream passage by the Mactaquac Dam and flooding of potential spawning habitat, but this was never assessed prior to or following construction of the Mactaquac Dam. Spawning runs by Lake Whitefish in the lower Saint John River may also be highly reduced, but the extent of any declines or even their continued occurrence have not been investigated. Following initial surveys in the MP, no Lake Whitefish-specific assessments have been completed, perhaps with the sole exception of border lakes which include East Grand Lake of the St. Croix River drainage and Beau and Glazier lakes of the Saint John River that have received periodic assessment by the State of Maine (Whitaker and Wood 2021).

At present, data regarding the persistence or abundance of Lake Whitefish in the MP is unavailable in nearly all locations. While retention limits have generally remained high, angler interest in Lake Whitefish is low, and perhaps due to lack of interest alone retention could be deemed inconsequential. Low angler retention in the MP might only provide superficial relief to Lake Whitefish populations while threats unrelated to harvest could be more critical to long term population survival. Introductions of native and non-native fishes have re-shuffled species distributions and unknowingly superimposed new

competitors and predators over pre-existing Lake Whitefish populations with unknown consequences. Edge (1984) relates that the effects of Brook Trout introductions on Atlantic Whitefish populations are also unknown, but the former could be a detrimental competitor throughout the MP due to the magnitude and scope of the stocking effort.

Similarly, Warner (1965) reported that in the NB-adjacent waters of Maine, Lake Whitefish suffered from the introduction of landlocked Atlantic Salmon and Rainbow Smelt. The State of Maine has raised serious concerns regarding the decline and disappearance of many of its Lake Whitefish populations, drawing links to the re-distribution of otherwise native fishes such as Rainbow Smelt (Whitaker and Wood 2021). Until competitive interactions between native Lake Whitefish and introduced but otherwise native species are confirmed and quantified, stocking any species over known Lake Whitefish populations should be considered with utmost caution or avoided entirely. Simultaneously, warmwater invasive species continue to spread through waters of the MP. Lake Whitefish are susceptible to predation like other soft rayed Maritime species, but the tendency for Lake Whitefish to occupy cold bathypelagic waters and potentially reach an adult size refuge (Whitaker and Wood 2001) may somewhat prolong their persistence in invaded systems. As warmwater invaders spread, Lake Whitefish may someday remain as Nova Scotia's only native cold-water lacustrine species.

Dams have been noted as an impediment to the recovery of the anadromous Atlantic Whitefish in the Petite Rivière watershed, NS (DFO 2006, 2018, COSEWIC 2010). Regarding Lake Whitefish, impoundments could provide a trade-off by increasing the volume of available cold-water refuge in exchange for impacting the integrity of shallow spawning habitat. Lake Whitefish persist in Conrod Lake, NS despite the presence of a small dam and fishway that inevitably increased water levels within the lake. However, there is no documented need for passage by Lake Whitefish at this location. Large runs of Lake Whitefish seemingly vanished along with their spawning habitats in the Saint John River, but it is unreported if other dams such as the Madawaska Dam or the Tobique Narrows Dam (Huntsman 1953) had similar effect upstream. Spawning runs in unimpeded tributaries of the Saint John River such as Salmon and Nerepis Rivers must now bypass lumber processing and historical mining operations, but no recent surveys indicate if these spawning migrations persist.

Much study is needed to determine not only the state and conservation status of Lake Whitefish in all MP waters, but first and foremost, to determine simply whether many of the populations described in this review can still be found at all.

This is the first review to compile a complete list of historical Lake Whitefish stocking locations, known and suspected Lake Whitefish lakes, and provide details on overlap between Lake Whitefish, stocked trout, and other prevalent invasive species in the MP. Following this compilation of data and identification of the gaps therein, we can conclude that examinations of Lake Whitefish populations and their continued occurrence region wide are greatly needed. Lake Whitefish populations are disappearing across Maine adjacent to our study area, prompting actions outlined in a 2001 management plan and updated in a 2016 status assessment (Wood 2016). Such actions are not possible in the MP where data on Lake Whitefish populations are not available. Many locations such as Kejimikujik Lake, NS are now on the invasion front for Chain Pickerel, and while all other native species have been carefully monitored by park staff and university researchers during an ensuing and precipitous post-invasion decline (Boyachek 2024), Lake Whitefish in Kejimikujik National Park have remained completely unassessed since the formation of the park. Once Lake Whitefish are gone from park waters, no data will be available apart from perhaps scales remaining in lake sediment cores that could be used to genetically determine whether the species was native to the park to inform restocking if such an option exists in the future. The intent of this review is to provide baseline data and background information necessary to inform future studies of Lake Whitefish in NS and NB. Nationally, this species is identified as a distinct group in the MP found nowhere else in North America, while regionally this species is worth studying and protecting as it forms a distinct component of the region's small but unique cold-water fish assemblage.

### **Future Questions**

1. Do undescribed Lake Whitefish populations still occur in Nova Scotia and/or New Brunswick? Several un-surveyed lakes exist that have direct connections with those supporting confirmed populations. Some of these suspected lakes are listed in Table 5, but this list is unlikely exhaustive. Other populations may exist in lakes of Atlantic-facing watersheds in both provinces, particularly in Guysborough County, NS.

2. What is the origin of Lake Whitefish in Kejimikujik National Park? Stocking in this location was noted by Kerekes (1975) and Edge (1987), but no explanation exists as to why introductions may have been successful in this region and nowhere else in the MP. If Lake Whitefish within the park are native, they will be important to describe before these populations are potentially lost to invasive Chain Pickerel.
3. Do Lake Whitefish persist in all lakes identified in this review (Table 2, 5)? Invasive species, stocking of native species, hydro-electric dams, reduced water quality, warming and acidification of surface waters have broadly impacted lakes and rivers of the MP with unknown consequences for Lake Whitefish.
4. Do any stocked Lake Whitefish populations with genetics from the Detroit River persist in NS? Minard Lake near Kejimikujik National Park might be a key candidate for investigation.
5. How has the introduction of hatchery-reared Brook Trout, Brown Trout, and Rainbow Trout impacted Lake Whitefish populations in the Maritime Provinces?
6. Apart from border waters where retention limits have been amended, is a daily bag and possession limit of 8 whitefish sustainable now or if fisheries develop in NS and NB?
7. How do Lake Whitefish in the lower Saint John River use the estuary? And are they a truly anadromous population as suggested by captures in both the Saint John Harbour and at Black's Harbour, New Brunswick?
8. How do Lake Whitefish in the Mira River, NS, use the estuary? And like those in the Saint John River, are they a salt-tolerant anadromous population?
9. Where do Lake Whitefish in any Maritime population spawn, and what considerations must be met to protect those spawning habitats if needed?
10. Do the Lake Whitefish which occur in McDougall and Logan Lakes of the Restigouche and Miramichi River watersheds, NB, originate from the Atlantic glacial refugium?

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