Species at Risk Act
Management Plan Series

Management Plan for the Brook Floater (Alasmidonta varicose) in Canada

Brook Floater (Alasmidonta varicosa)

2018

Canada

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Cover photo: Southeastern Anglers Association; Tina Sonier, Darlene Elward and Valérie Martin

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the Species at Risk Act (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for species listed as special concern. They are also required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans is the competent federal Minister for the Brook Floater as per Section 65 of SARA. In preparing this management plan, the competent minister has considered, as per Section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this management plan has been prepared in cooperation with many individuals, organizations and government agencies as per section 66(1) of SARA.

Fisheries and Oceans Canada has prepared a federal management plan that meets the content and process requirements under SARA Sections 65, 66, 68 and 69.

As stated in the preamble to SARA, success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and measures set out in this management plan and will not be achieved by Fisheries and Oceans Canada, or any other party alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this management plan for the benefit of the Brook Floater and Canadian society as a whole.

A SARA management plan includes conservation measures to ensure that a species of special concern does not become threatened or endangered. These conservation measures support the management objectives identified in the management plan. Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of participating jurisdictions and organizations.

Acknowledgements

Fisheries and Oceans Canada would like to acknowledge the many individuals that contributed with valuable information and advice in the initial development of this document. In particular, the participants who attended the 2014 Brook Floater workshop provided genuine and enthusiastic contributions to the development of this management plan for the Brook Floater. In addition, many valuable comments were offered by individuals participating in the consultation process. See Appendix B for the full Record of Cooperation and Consultation in the development of this management plan.

Executive summary

The Brook Floater (Alasmidonta varicosa) is a freshwater mussel listed as Special Concern under the Species and Risk Act (SARA) in 2013. This listing triggers the development of a management plan which identifies the measures needed to conserve the species in order to prevent further declines, range loss or worsened status due to human activities. The general prohibitions of SARA do not apply to species of Special Concern, and there is no requirement to identify or protect critical habitat.

Populations of Brook Floater are endemic to North America and are found from Georgia (United States) to New Brunswick (NB) and Nova Scotia (NS) (Canada). The species is considered a medium sized mussel, distinctly kidney shaped, with a relatively smooth shell. The Canadian population is estimated to contain between 23,000-34,000 individuals, distributed within watersheds in the provinces of New Brunswick and Nova Scotia. The Brook Floater is found in the following 15 watersheds: the St. Croix, Magaguadavic, Petitcodiac, Southwest Miramichi, Kouchibouguacis, Bouctouche, Shediac and Scoudouc Rivers in New Brunswick, and the Salmon (Guysborough County), St. Marys, Wallace, French River (Mattatall Lake), Gays, Annapolis and LaHave Rivers in Nova Scotia. Seven of these occurrences in NB and two in NS were found due to increased survey efforts in the last 15 years. The discovery of new sites in Canada and the declining number of Brook Floaters in the United States adds even more global significance to the Canadian population of the Brook Floater.

Threats to the Canadian Brook Floater population are related primarily to habitat alteration and reduced water quality. Threats of highest concern for the Brook Floater include poor agricultural and forestry practices, whereas threats of medium concern include dam operations, residential development and stream crossing by all-terrain vehicles (ATVs). Mining effluents, road construction and introduction of non-native invasive species are considered threats of low concern.

The overall objective of this management plan is to maintain a viable, self-sustaining Brook Floater population in Canada at current and new locations. Conservation measures are to be implemented under four broad strategies: 1) Protection - Conserve the quality and quantity of Brook Floater habitat; 2) Management - Mitigate threats to the Brook Floater and its habitat; 3) Research and Monitoring - Improve knowledge of the Brook Floater in Canada; and 4) Outreach and Communication - Promote education and awareness of the Brook Floater and efforts to conserve the species and its habitat.

This management plan contains an Implementation Schedule that identifies partners and timelines for each outlined conservation measure. Fisheries and Oceans Canada (DFO) will continue to work cooperatively with other jurisdictions, First Nations and Indigenous organizations, stakeholders and interested parties on the conservation of the Brook Floater.

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1. COSEWIC[1] species assessment information

Date of assessment: April 2009

Common name (population): Brook Floater

Scientific name: Alasmidonta varicosa

COSEWIC status: Special Concern

Reason for designation: A medium-sized freshwater mussel that is confined to 15 widely scattered watersheds in Nova Scotia and New Brunswick. This mussel was never abundant, usually representing only 1-5% of the total freshwater mussel fauna present. The habitat is subject to impacts (shoreline development, poor agricultural practices, and other water quality issues) with potential cumulative degradation on larger stretches of rivers. Populations appear to have been lost from two historic locations, although new populations have been found recently. Because this mussel has disappeared from approximately half of its US locations, the Canadian population now represents an important global stronghold for the species.

Canadian occurrence: New Brunswick, Nova Scotia

COSEWIC status history: Designated Special Concern in April 2009. Assessment based on a new status report.

2. Species status information

The Brook Floater has been assigned various domestic and international at-risk status designations, which are summarized below and in Table 1.

Canadian designation status:

The Brook Floater (Alasmidonta varicosa) was assessed in Canada as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2009. A Special Concern designation means that a wildlife species may become threatened or endangered because of a combination of biological characteristics and identified threats. In 2013, the Brook Floater was listed as Special Concern under Schedule 1 of the Species at Risk Act (S.C. 2002, c.29) (SARA), which triggered the requirement for the development and implementation of a management plan. This management plan was prepared in accordance with section 65 of SARA and aims to identify the conservation measures needed to ensure that the Brook Floater does not become

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada

further at risk. The automatic prohibitions of SARA (sections 32 and 33) do not apply to species of Special Concern, and there is no requirement to identify or protect critical habitat.

The New Brunswick Department of Natural Resources (NBDNR) listed the Brook Floater under the NB Species at Risk Act as special concern in 2013 (New Brunswick Department of Natural Resources 2015).

The Nova Scotia Department of Natural Resources (NSDNR) listed the Brook Floater under the Endangered Species Act as threatened in 2013 (Nova Scotia Department of Natural Resources 2015).

The Atlantic Canada Conservation Data Centre (ACCDC) ranked the species as an S1S2 - subnational rank of critically imperiled (S1) to imperiled (S2) species in both New Brunswick (NB) and Nova Scotia (NS) (Atlantic Canada Conservation Data Centre 2015).

Global and United States designation:

NatureServe, an international network of biological data inventories, assigned a global status of G3 (vulnerable) to the Brook Floater, and in Canada it has the status of N2 (nationally imperiled) (NatureServe 2016). The Brook Floater is ranked as critically imperiled (S1) in 10 of the 17 States in which it occurs and possibly extirpated (SH or SX) in two other states in the United States (US) (COSEWIC 2009; NatureServe 2016). The Brook Floater has been petitioned for listing under the Endangered Species Act in US, but it is not listed at this time (U.S Fish and Wildlife Service 2016).

Table 1. Summary of existing status designations assigned to the Brook Floater at the national (Canadian designations) and international levels.

Jurisdiction	Authority/Organization	Year(s) assessed and/or listed	Status/Description
Canada	Species at Risk Act	2013	Schedule 1: Special Concern
Canada	COSEWIC	2009	Special Concern
Province of New Brunswick (NB)	NB Species at Risk Act	2013	Special Concern
Province of Nova Scotia (NS)	NS Endangered Species Act	2013	Threatened
Atlantic Canada	The Atlantic Canada Conservation Data Centre (ACCDC)	2010	S1S2 - subnational rank of critically imperiled (S1) to imperiled (S2) species in both NB and NS

Jurisdiction	Authority/Organization	Year(s) assessed and/or listed	Status/Description
Canada	NatureServe	2013	N2 (nationally imperiled)
United States	NatureServe	2011	Critically imperiled (S1) in 10 of the 17 States in which it occurs; possibly extirpated (SH or SX) in two other states
International	NatureServe	2011	Global: G3-Vulnerable

3. Species information

The following sections provide a summary description of the species and its needs. Further details on the Brook Floater can be found in the "COSEWIC Assessment and Status Report on the Brook Floater Alasmidonta varicosa in Canada (COSEWIC 2009)" and in Jacques Whitford Stantec Limited (2012).

Taxonomy

Class: Bivalvia
SubClass: Palaeoheterodonta
Order: Unionoida
Superfamily: Unionoidea
Family: Unionidae
Subfamily: Unioninae
Tribe: Alasmidontini
Genus: Alasmidonta
Species: A. varicosa (Lamarck 1819)

3.1 Species description

Freshwater mussels belong to the order Unionoida and the superfamily Unionoidea, which comprises six families. Together they comprise a group of ecologically important macroinvertebrates known for their ability to filter water while partially buried in the bottom of rivers and lake systems.

Conservation of the Canadian population of Brook Floater is important for the global maintenance and persistence of the species, since approximately 60 – 80 extirpations of about 150 known sites have been recorded in the southern and central areas of its range in the US (COSEWIC 2009).

3.1.1 Anatomy and morphology

The description below is taken from Clarke (1981) and Nedeau (2008). The Brook Floater's shell can be up to 70mm long, 40mm high and 30mm wide. The ventral margin of the shell is slightly curved, giving the Brook Floater a distinctive kidney-shaped shell. The shell is relatively smooth, with short grooves and ridges perpendicular to the growth lines. The posterior ridge is inflated and rounded. The periostracum[2] (the shell exterior) varies in colour from yellow-green-brown-black, with extensive rays visible in most individuals. The nacre[2] (the shell interior) is bluish-white, sometimes with an olive or pink tint. The pseudocardinal (hinge[2]) teeth are not easily identifiable. The foot is usually the striking colour of cantaloupe. The Brook Floater has the habit of relaxing its abductor muscles and opening its valves when removed from the water (Figure 1).

Figure 1. Adult Brook Floater. External view of the shell morphology and the cantaloupe colour foot. Specimen found in the Bouctouche river (source: Southeastern Anglers Association; Photo credit: Tina Sonier, Darlene Elward and Valérie Martin).

3.1.2 Biology

This section is focused on the current state of knowledge on the biology of the Brook Floater population in Canada and on general information on freshwater mussels.

Reproduction

Information specific to Brook Floater life cycle requirements are not well known; the information on reproduction described here is generally applicable to most freshwater mussel species (Figure 2). Generation time for the Brook Floater is thought to be 10 years (COSEWIC 2009). The average age for samples from Canadian subpopulations was between 7-14 years old (Jacques Whitford Stantec Limited 2012). Mussels are considered broadcast spawners, with males releasing large amounts of sperm into the

[2] Periostracum – the outer parchment-like paper of a shell; Nacre, the pearly inner layer in mussel species; Hinge, the structure that joins the two halves of a bivalve shell at the dorsal margin.

water column, and females siphoning the sperm in through their filter-feeding mechanism to complete fertilization internally (Strayer et al. 2004; COSEWIC 2009). The fertilized eggs develop into larvae which remain inside the female mussels until environmental conditions are favorable, usually in early spring. The freshwater mussel larvae are called glochidia. To complete the larval development and metamorphose into juveniles, thousands and sometimes millions of glochidia are released by the females and subsequently attach to a host fish for several days or months. These glochidia have the appearance of miniature mussels with hooking mechanisms that enable them to attach to host fish (Bauer 1987; Jansen and Hanson 1991; Nedeau 2008).

Little is known regarding the host fish for Brook Floaters in the wild. Experimental infections conducted in laboratories in the US suggested that Blacknose Dace (Rhynichthys atratus), Longnose Dace (Rhynichthys cataractae), Golden Shiner (Notemigonus crysoleucas), Pumpkinseed Sunfish (Lepomis gibbosus), Slimy Sculpin (Cottus cognatus), and Yellow Perch (Perca flavescens) could serve as host fish for the Brook Floater (Wicklow and Richards 1995; Nedeau 2008). All these species occur in NB and NS freshwater bodies and may be potential hosts for the Brook Floater. In Canada, Ninespine Stickleback (Pungitius pungitius) has been confirmed carrying a Brook Floater glochidium in a study conducted in the Kouchibouguacis River, NB (Beaudet 2006), indicating that this species can also be a potential host for Brook Floater glochidia.

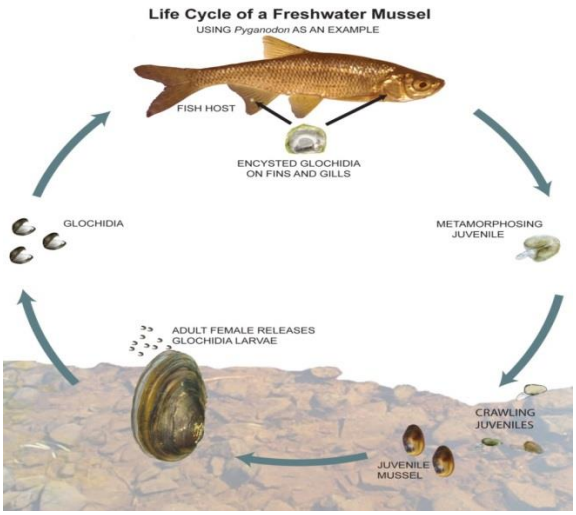

Figure 2. Freshwater mussel life cycle. Note the sessile (adult) and dispersion phase (glochidia) of mussels. Using Pyganodon as an example. Source: Martel et al. 2010. Freshwater Mussels (Bivalvia: Margaritiferidae, Unionidae) of the Atlantic Maritime Ecozone. In Species Diversity in the Atlantic Maritime Ecozone. Edited by D.F. McAlpine and I.M. Smith (2010)

Ecological role

Freshwater mussels are considered important indicators of the health of a watercourse (Williams et al. 1993; Baisley 2010). They are an important component of food webs, filtering both water and sediment. Mussels are omnivorous filter-feeders, removing zooplankton, algae, bacteria and detritus from the water column, and possibly dissolved organic material. Freshwater mussels improve habitat conditions for other species by physically stabilizing and modifying the sediment (through living organisms and spent shells), increasing food availability and altering the nutrient composition of the environment (Vaughn et al. 2008).

3.2 Populations and distribution

Distribution

Current distribution

The Brook Floater is endemic to northeastern North America, extending from northeastern Georgia through the eastern US into southern NB and mainland NS (Figure 3).

A gap in the distribution occurs between northern New Hampshire-southern Maine, resulting in a division of the Brook Floater's range into northern and southern zones (Figure 3). The species has disappeared from about half of the known locations in the US.

The Canadian Brook Floater is known to occur in 15 watersheds in eastern Canada: the St. Croix, Magaguadavic, Petitcodiac, Southwest Miramichi, Kouchibouguacis, Bouctouche, Shediac and Scoudouc watersheds in NB, and the Salmon River (Guysborough County), St. Marys, Wallace, French (Mattatall Lake), Gays, Annapolis and LaHave watersheds in NS (Table 2). Distribution is disjunctive within each province, with little potential for movement between these areas given their distance from each other (COSEWIC 2009).

Recent survey efforts

A number of surveys were conducted in recent years in various watersheds in both provinces; the results of these surveys are outlined below:

<u>New Brunswick</u> (Figure 4):

Miramichi River: Surveys undertaken by the Miramichi River Environmental Assessment Committee (MREAC) in 2009 and 2010 discovered two additional sites with Brook Floater on tributaries of the Miramichi River – NB (Taxis and Barnaby Rivers) that were not previously identified in the COSEWIC report (Baisley 2010).

Petitcodiac River: The presence of Brook Floater in the Petitcodiac River watershed, NB (Little River) was re-confirmed during the summer of 2015 (M. Hanson – pers. Comm. 2015).

Shediac Bay: In the summer of 2015, 14 sites in the Shediac Bay Watershed were surveyed and no brook floater mussels were found (Hébert 2016).

Three watersheds along mid-eastern coast: In 2015, the Southeastern Anglers Association surveyed three watersheds: Bouctouche, Chockpish and Cocagne. A total of 3 Brook Floaters were found in the Bouctouche River (Elward 2015).

Nova Scotia (Figure 5):

Various watersheds throughout Nova Scotia: The St. Marys River Association and the NS Department of Natural Resources conducted a survey throughout NS in 2009 with the intent of reconfirming known locations of Brook Floater. This study confirmed the presence of Brook Floaters in the Annapolis River, Gays River, Wallace River, Salmon River (Guysborough County), East and North Branch St. Marys River, Lochaber Lake (dead specimen only) and Eden Lake. No living or dead specimens were located in the LaHave River, Borden's or Mattatall Lake (Marshall and Pulsifer 2010).

Historical records

Presence of Brook Floater was not confirmed in three rivers where they historically occurred: the Stewiacke River (NS) and the Aroostook and Renous Rivers (NB) (COSEWIC 2009) (Figures 4 and 5).

Population

Trend data are unavailable for the Canadian Brook Floater population. Increased survey efforts over the past 15 years have, however, led to refining population estimates within NB and NS.

The size of the global Brook Floater population is not clearly known. The Brook Floater in Canada is only found in NB and NS, representing approximately 8% of the species current global geographic range. In NB, Brook Floater numbers are estimated to be between 15,000 and 22,000, with a total Canadian population range of approximately 23,000 to 34,000 individuals. In NS, numbers of individuals are estimated to be between 8,000 and 12,000 (COSEWIC 2009).

A qualitative assessment has found that in the five areas (Petitcodiac, Southwest Miramichi, Shediac, Annapolis and St. Marys Rivers) with the largest concentrations of individuals, the number of individuals has been stable or a new occurrence has been confirmed, with observed recruitment (Jacques Whitford Stantec Limited 2012).

Table 2. List of watersheds and water bodies in NB and NS where Brook Floaters have been found (black dots in Figures 4 and 5).

Canadian distribution	Watersheds	Water bodies within watersheds where Brook Floater is found	Sites where the Brook Floater is found (black dots in Figures 4 and 5)
New Brunswick	St. Croix	St.Croix River	5
	Magaguadavic	Magaguadavic River	1
	Petitcodiac	Petitcodiac, North and Little Rivers	14
	Southwest Miramichi	Miramichi Northwest*, Miramichi Southwest, Cains and Renous ** Rivers	8
	Kouchibouguacis	Kouchibouguacis River	10
	Bouctouche	Bouctouche and South Branch Bouctouche Rivers and Luke Brook	8
	Shediac	Shediac River, Weisner Brook	8
	Scoudouc	Scoudouc River	2
Eastern Nova Scotia	Salmon (Guysborough County)	Salmon River, Borden's Lake	2
	St. Marys River	East River St. Marys, Lochaber and Eden Lakes	9
Central – Northern Nova Scotia	Wallace	Wallace River	2
	French River	Mattatall Lake	1
	Gays	Stewiacke** and Gays Rivers	2
South-West Nova Scotia	Annapolis	Annapolis River	7
	LaHave	LaHave River	2

*Partial shell in midden (see legend in Figure 4)
**Historical record (see legend in Figures 4 and 5)

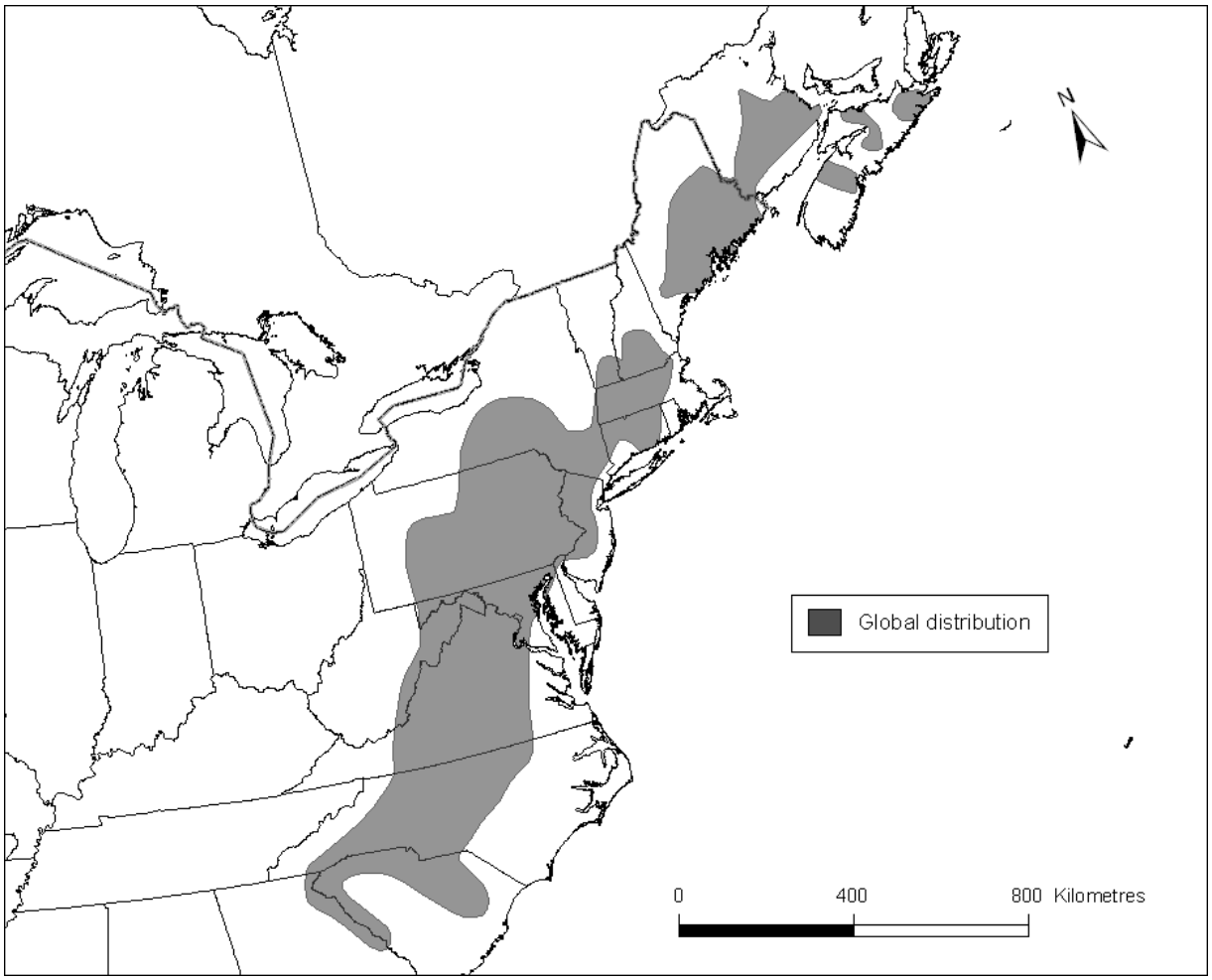

Figure 3. Global distribution of the Brook Floater showing its range from North-Eastern Georgia, through Eastern USA, to Central Nova Scotia and Southern half of New Brunswick (source: COSEWIC 2009).

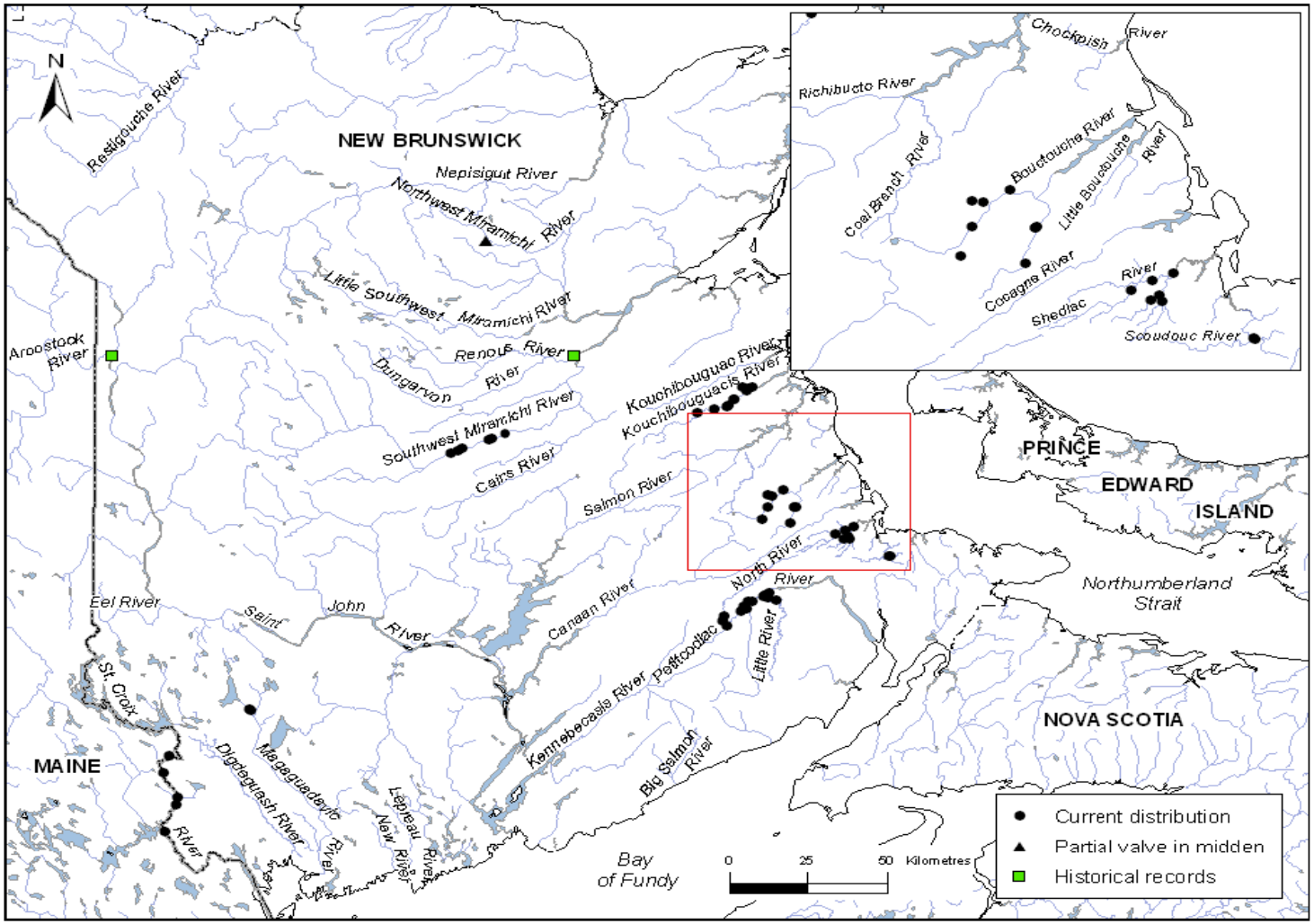

Figure 4. Map of New Brunswick showing the Brook Floater occurrences until 2009 and the historical records (green square, prior to 1980), as well as a partial valve (partial shell) from a midden (deposit of shells or other food debris from muskrats) (black triangle) (Source: COSEWIC 2009).

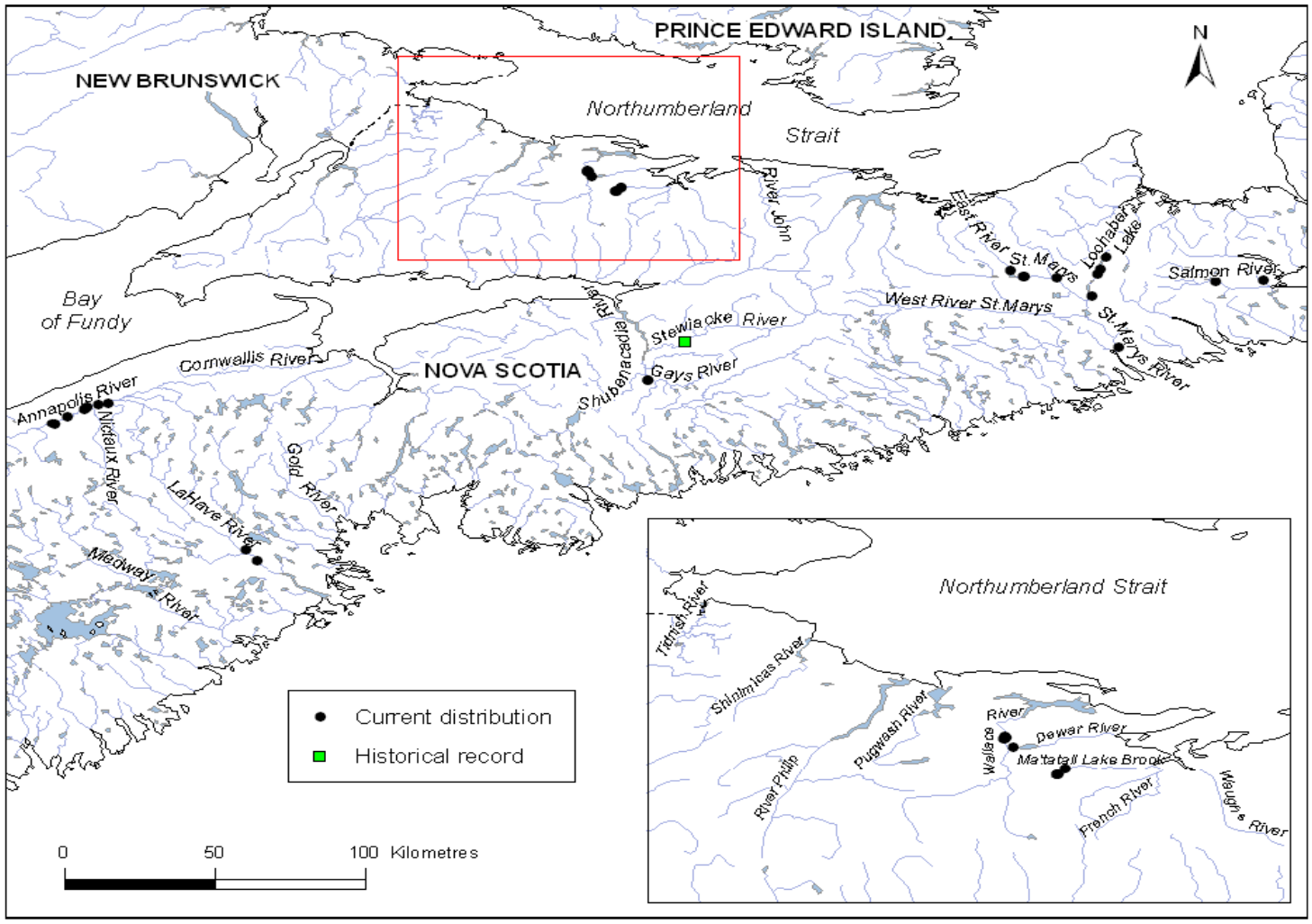

Figure 5. Map of Nova Scotia showing the Brook Floater occurrences until 2009 and the historical records (green square, prior to 1980) (Source: COSEWIC 2009).

3.3 Needs of the Brook Floater

3.3.1 Habitat needs

The habitat requirements of the Brook Floater are not well understood. Important habitat features appear to be bottom substrate (type and size), water flow, and water quality. Brook Floaters are found in rivers, streams, and lakes, indicating a tolerance of a range of watercourse widths, depths and flow rates. The species seems to prefer watercourses with a moderate to high water flow and a rocky bottom with cobble and sand pockets (Athearn and Clarke 1962; Sabine 2006; Baisley 2010), however, they are also found in Canada in lake environments with little to no water flow (COSEWIC 2009). They are typically found clustered in sand pocket areas behind boulders, rocky outcrops and stream banks, likely as a means of protection in high flow velocity environments (Sabine 2006; Nedeau 2008). Brook Floaters prefer low calcium environments (an indicator of nutrient-poor water) and a pH greater than 5.4 (COSEWIC 2009).

3.3.2 Biological needs

As described in Section 3.1.2 of this document, Brook Floaters need a host fish to complete their life cycle; however, there is little information available on which fish species are hosts for the Brook Floater in the wild. In Canada, the only information on host fish used by Brook Floaters is that of Beaudet, collected in the Kouchibouguacis River, NB where the subpopulation of Brook Floaters is small (Beaudet 2006). Beaudet reported only one glochidium of the Brook Floater on a single Ninespine Stickleback (Pungitius pungitius) (Beaudet 2006).

3.3.3 Limiting factors

North America has the highest diversity of freshwater mussels in the world with about 300 known taxa (William et al. 1993). Although diverse and widespread on this continent, over 70% of freshwater mussels are considered to be endangered, threatened or quickly declining (William et al. 1993). One of the limiting factors for the Brook Floater is the lack of public knowledge about freshwater mussels in general, which contributes to the decline of many species, including the Brook Floater. Increasing public awareness of the existence of freshwater mussels, in particular the Brook Floater, will contribute to the implementation of conservation measures to help maintain a stable population in Canada.

Brook Floater glochidia are dependent upon their host fish in order to complete aspects of their life cycle. As a result, any impact to fish assemblages (such as a reduction in numbers, or displacement resulting from non-native species) will have an impact on Brook Floater recruitment in subsequent years.

Brook Floaters are relatively stationary in their movements once they reach the adult stage. They often rely on their muscular foot for minor adjustments to accommodate feeding or seasonal changes in the water level. Their primary means of dispersal is

during the glochidial stage of development through the attachment to host fish species (Jacques Whitford Stantec Limited 2012). A decrease in host fish populations in association with an increase of barriers for migration for these fish could compromise successful dispersal of Brook Floaters.

Fluctuating water levels in rivers where Brook Floaters are found is also another limiting factor. Brook Floaters are vulnerable to prolonged exposure to low water, warm water temperatures and low dissolved oxygen since they cannot disperse to areas with more favorable conditions. During low water flow periods, mussel mortality could occur due to dehydration, thermal stress and exposure to predation (Nedeau 2008).

The genetic descriptions of unionid species (molluscs of the family Unionidae) along the North Atlantic Slope drainage basins (area drained by streams flowing into the Atlantic Ocean, from the St. John River in Maine to the York River in Virginia, US) suggest that these populations are distinct biogeographic "islands" of diversity (COSEWIC 2009), with each population being on its own evolutionary trajectory. Until molecular data show otherwise, it is prudent to assume that the Canadian Brook Floater population is similarly fragmented. As occurrences tend to be clustered within a small reach of a tributary, it is unlikely that these fragmented subpopulations would recolonize watersheds if resident individuals were lost (COSEWIC 2009).

Although identified as a "global stronghold for the species", the abundance of the Canadian Brook Floater population is usually less than 5% of the total of freshwater mussels present in a watercourse (COSEWIC 2009). Because their method of fertilization depends on close proximity of individuals, their limited density likely impacts reproductive success (COSEWIC 2009). Groups with a low number of adults and/or low number of young or individuals of the same age are all signs of low reproductive success (Nedeau 2008).

Natural predation could also be a limiting factor for the Brook Floater. The common Muskrat (Ondatra zibethicus), the North American River Otter (Lontra canadensis), the Raccoon (Procyon lotor), the American Mink (Neovison vison) and freshwater turtles are known to prey on freshwater mussels. Muskrats in particular are widespread throughout the Brook Floater's range in NB and NS; however, there is no specific information on the relationship of this natural predator and impacts on Brook Floater mussel beds.

Muskrats are predominantly herbivorous but can eat freshwater mussels, especially if suitable aquatic vegetation is not available (i.e. in winter months) or where high muskrat densities co-occur with mussels. Although Brook Floater shells have been found in muskrat middens (Hanson and Locke 2001; COSEWIC 2009), there is no evidence of selective predation on the Brook Floater. Studies suggest that muskrat prey selection is generally based on abundance of freshwater mussel species and sometimes size of prey, but other factors such as season, availability of vegetation and type of habitat also affect prey selection (Neves and Odom 1989; Tyrrell and Hornback 1998).

Negative impacts of muskrat predation on endangered freshwater mussel species have been observed, notably in populations where abundance is precariously low (Zahner-Meike and Hanson 2001). Muskrat predation on the Brook Floater is, however, generally viewed as a relatively minor limiting factor (Neves and Odom 1989). The most important cause of decline in many North American freshwater mussel populations, including the Brook Floater, has been attributed to water quality degradation and habitat loss (see section 4 on threats).

4. Threats

4.1 Threat assessment

An assessment of existing and potential threats to the Brook Floater population in Canada is presented in Table 3 and discussed further in Section 4.2. This assessment was informed by COSEWIC's species status assessment (COSEWIC 2009) and DFO Science Advice (DFO 2014). The identified threats negatively impact the species or its habitat and appropriate management may be needed to ensure that the Brook Floater does not become threatened or endangered. The concern assigned to the various threats are relative to each other, and will be used to inform the prioritization of conservation measures based on our current limited knowledge of these threats and their impact on the population.

The threat of highest concern is related to agricultural and forestry management practices, which can lead to increased sediment loads, pesticide dispersion and changes in nutrient concentrations in watersheds where Brook Floaters are found. Threats of medium concern include: operation of hydroelectric facilities, which can result in issues with habitat availability and suitability, and river drawdown; residential development, which can cause degradation and clearing of riverside vegetation; and ATV stream crossings, which can degrade stream and river beds. The level of knowledge (i.e. degree of evidence) associated with a particular threat is reflected in its associated causal certainty (see column heading definitions in the footnotes below Table 3 for further details on these ranking criteria).

The threats identified in Table 3 are considered to impact habitat as well as individual Brook Floaters.

Table 3. Threat assessment for the Brook Floater.

Threat	Level of concern[3]	Extent[4]	Occurrence[5]	Frequency[6]	Severity[7]	Causal certainty[8]
Agricultural and forestry practices	High	Widespread	Current	Continuous	Moderate	Medium
Dam operations (river drawdown)	Medium	Localized	Current	Seasonal	Moderate	Medium
Residential development	Medium	Localized	Current	Continuous	Moderate	Low
Stream crossing by all-terrain vehicles	Medium	Localized	Current	Continuous	Moderate	Low
Mining effluents	Low	Localized	Anticipated	Unknown	Low	Medium
Road construction practices (fish passage issues)	Low	Localized	Current	Continuous	Low	Low
Introduction of non-native invasive species (molluscs, fish)	Low	Unknown	Anticipated	Continuous	Low	Medium

[3] Level of concern: signifies that managing the threat is of High, Medium or Low concern (relative ranking) for the conservation of the species. This criterion considers the assessment of all the information in the table.

[4] Extent: refers to whether threat information relates to: Localized (a specific site or narrow portion of the species' Canadian range); Widespread (the whole distribution or large portion of the species' Canadian range); or Unknown (insufficient information to determine the extent of the threats).

[5] Occurrence: indicates whether the threat is: Historic (contributed to decline but no longer affecting the species); Current (affecting the species now); Anticipated (may affect the species in the future); or Unknown (it is not known whether the threat is currently occurring, but it is a viable threat).

[6] Frequency: describes the temporal extent of the threat over the course of the year: Seasonal (the threat only occurs at certain times of the year); Recurrent (occurs repeatedly); Continuous (it is constant); or Unknown (no information is available about the frequency).

[7] Severity: reflects the population-level effect: High (very large population-level effect); Moderate (medium population-level effect); or Low (minimal population-level effect).

[8] Causal certainty: reflects the degree of evidence that is known for the threat and how it affects the population: High (there is substantial scientific evidence of a causal link where the impact to populations is understood qualitatively); Medium (there is scientific evidence linking the threat to stresses on the population); Low (there is a plausible link with limited evidence that the threat has stressed the population); or Unknown (the strength of evidence linking the threat to the survival and recovery on the population is unknown due to the lack of information about the species and/ or the threat).

4.2 Description of threats

4.2.1 Threats affecting habitat (change, loss and degradation) and directly affecting individuals.

Agricultural and forestry management practices

Agricultural and forestry practices, where not well managed, have the potential to cause sediment disruption, pesticide dispersion, and changes in nutrient concentrations in aquatic environments. The effects of these habitat modifications on the Brook Floater are described below.

The Brook Floater and its habitat are potentially impacted by poor agricultural practices such as uncontrolled river access by cattle (COSEWIC 2009). Open access to stream crossings by livestock can cause direct mortality to mussels through trampling of mussel beds. It can also lead to habitat degradation and loss through trampling surrounding vegetation thus increasing siltation, and from nutrient enrichment from livestock manure.

Sediment alteration/disruption: There is substantial evidence that sedimentation is a major contributor to the decline of the Brook Floater population in Canada. COSEWIC links this threat to poor land use practices (such as poor agricultural and forestry practices) (COSEWIC 2009). These activities occur in the majority of water bodies in NB and NS where Brook Floaters can be found and if not well managed can lead to impacts to the Brook Floater's habitat. The impact of these threats on freshwater mussels is well known (Richter et al. 1997); therefore, a high level of concern was assigned to this threat. Sedimentation in a watercourse has multiple consequences for freshwater mussels. Sediment suspended in the water column impacts light penetration, decreases food availability and impacts the ability of mussels to filter feed, leading to a moderate severity impact at the population level. Increased sediment loads can change the composition, depth, width, or stability of the watercourse (Box and Mossa 1999). Additionally, the increase in turbidity and change in light penetration caused by sedimentation can impact the reproductive success of freshwater mussels. These environmental alterations can affect the host fish assemblage, as well as the ability of female mussels to notice the presence of host fish through their shadow in the water column or the release of chemical substances by the host fish (Haag et al. 1995; Box and Mossa 1999).

Change in nutrient concentrations: In addition to sedimentation, poor agricultural and forestry practices can also contribute to increased nutrient runoff, eutrophication and an increase of pesticide and fertilizer dispersion in the aquatic environment where Brook Floaters are found. Changes in nutrient concentrations can be caused by different events, such as severe rainfall which results in surface runoff from agricultural lands, causing eutrophication of watercourses (COSEWIC 2009). Increased nutrient loads have been shown to negatively impact mussel species richness (Metcalfe-Smith et al. 2003).

Poor forestry practices can lead to increased pesticide dispersion, erosion of access and logging roads and increased annual runoff through compaction and vegetation removal near watercourses (Box and Mossa 1999). Forested riparian areas act as a buffer to minimize land use impacts (Lowrance et al. 1984). All Brook Floater sites in Canada occur in forested and/or agricultural landscapes and, consequently, associated practices can influence the surrounding watercourses. A threat assessment for each site is necessary in order to prioritize locations and prescribe site-specific management actions.

Dam operations (river drawdown - water level fluctuations)

Richter et al. (1997) identified eastern mussel species as "… more severely affected by altered nutrient impacts from hydroelectric impoundments and agricultural runoff". COSEWIC also identified dam operations and associated impoundments as a threat to the Brook Floater. Dam operation has been assessed as a threat of medium concern for the Brook Floater in this management plan because this threat is current and seasonal, increasing fluctuations in summer temperatures and water levels. There is substantial scientific evidence related to the effects of dam operations (especially drawdown) on mussels (Samad and Stanley 1986; Tucker et al. 1997; Howells et al. 2000; Tetzloff 2001; Burlakova and Karatayev 2008). Currently, four of the 15 watersheds known to have Brook Floaters also have dams (COSEWIC 2009). Two rivers are influenced by multiple dams. This is the case of the St. Croix and Magaguadavic Rivers, which are influenced by dams in areas occupied by the Brook Floater, with potential cumulative effects. The Magaguadavic River dam also operates with extreme water level fluctuations, especially in hot, dry years (COSEWIC 2009). The Annapolis and LaHave Rivers also have dams; however, these are not located in proximity to known Brook Floater occurrences.

In addition to dam operations, impoundments can have significant effects on freshwater mussels in stretches of a watercourse both upstream and downstream of the dam. In addition to habitat fragmentation, other effects related to the operation of dams include increased turbidity, colder temperatures, changes in water flow patterns (height and duration), altered chemical composition, sedimentation, changes to the physical structure of the watercourse and alteration of the food web (Baxter 1977). Freshwater fish, including species that are potential host fish for Brook Floater glochidia, are similarly negatively affected by fluctuations in hydrological regimes (Travnichek and Maceina 1994).

Changing flow patterns in a watercourse result in decreased mussel density and body condition and increased parasitism (possibly resulting from decreased body condition) (Galbraith and Vaughn 2010). There is also the potential for the Brook Floater to be exposed above the water line if water levels are extremely low, leading to desiccation and direct mortality or increased predation.

Residential development (riparian area degradation, discharge of sewage effluents)

Residential development is classified as a threat of medium concern for the Brook Floater in this management plan because it is both current and localized and there is some scientific evidence indicating how this activity affects Brook Floaters. Although COSEWIC assessed residential development as the second most important threat, it is assessed as a medium level of concern here because there is insufficient evidence about the likelihood of harm to mussels. Increased residential development was identified as an imminent threat especially around three lakes where the species occurs in NS – Lochaber, Eden and Mattatall Lakes (COSEWIC 2009). The degradation and clearing of riverside vegetation associated with suburban development has been shown to reduce the size of freshwater mussel populations and inhibit recruitment (Brainwood et al. 2006).

Another consequence of increased residential development is the discharge of sewage effluents. COSEWIC identified four locations (two each in NB and in NS) as being potentially impacted by effluent discharge from sewage treatment plants (COSEWIC 2009). In addition to nutrients (nitrogen, phosphorous, other organic matters) and bacteria found in municipal wastewater effluents, pharmaceuticals and personal care products are also becoming a concern to the health of aquatic species and ecosystems (Canadian Council of Ministers of the Environment 2006). Gagné et al. 2006 demonstrated that pharmaceuticals and personal care products found in municipal waste water discharge have the potential to cause adverse effects on the immune system of freshwater mussels.

Stream crossing by all-terrain vehicles (riparian area degradation)

Stream crossing by all-terrain vehicles (ATVs) is assessed as a threat of medium concern for Brook Floater in this management plan because this threat is current and localized and there is some scientific evidence to determine the impact of the activity on the Brook Floater.

Use of ATVs in rivers can cause direct mortality of individuals and habitat loss, in particular by crushing mussel beds and disturbing surrounding habitat when crossing rivers (Jacques Whitford Stantec Limited 2012). Activities related to stream crossing by ATVs, development of commercial or residential areas, or other structures and road access can lead to erosion, siltation, loss or degradation of riparian areas, or alteration of the water temperature, water chemistry and light regime of a watercourse (Clinton 2011).

Stream crossings by ATVs, in combination with residential development, are localized at a number of sites along rivers, especially in four watersheds in NB where Brook Floaters can be found (Shediac, Scoudouc, Bouctouche and Kouchibouguacis Rivers); the effects of these activities can be cumulative, leading to the degradation of large sections of these rivers.

Mining effluents (discharge of industrial effluent)

This threat is considered a low concern because the likelihood of a spill affecting the population of Brook Floater in Canada is low. Based on the most current knowledge, there is only one Brook Floater location downstream of a lead-zinc mine in Gays River (COSEWIC 2009). In addition, federal and provincial legislation governing mining operations exist and ensure that these activities are monitored. Effluents must comply with standards for acceptable water quality, ensuring the preservation of aquatic ecosystems. On the other hand, these standards are not developed specifically for freshwater mussels and there is evidence that juvenile mussels would be particularly susceptible to toxic effluents if a spill did occur (Layzer and Madison 1995; Newton et al. 2003; Wicklow 2004).

Road construction practices (fish passage issues)

The construction of small roads often requires the installation of drainage canals, ditches or culverts. Poor installation and maintenance of these canals can lead to inadequate fish passage, creating significant barriers to the free movement of fish upstream and downstream of barrages, which has the potential to affect dispersal of glochidia by host fish (Baxter 1977). The maintenance and dispersal of the Brook Floater depend on the presence and unhindered movement of host fish.

The current level of concern related to fish passage issues has been assessed as low since it is not possible to clearly identify the causal certainty until more information is available to confirm the host fish of the Brook Floater in Canada. There is a substantial amount of knowledge to evaluate habitat connectivity in watersheds that support Brook Floaters. Barriers to fish movement could eventually be considered a high level of concern in the future when information about the host fish is available.

Introduction of non-native invasive species (molluscs and fish)

The introduction of non-native and invasive species (molluscs and fish) can pose serious threats to ecological functions and to the integrity of Brook Floater habitat (Martel et al. 2010). The level of concern was assessed as low since the likelihood of establishment of exotic species is not known at this time and there is no registry of non-native mussels in sites where Brook Floaters are found. There is, however, evidence of non-native fish species introductions, which could potentially affect Brook Floater host fish in Canada and elsewhere.

Non-native, invasive, or introduced fish species: Chain Pickerel (Esox niger) and Smallmouth Bass (Micropterus dolomieui) are present and spreading throughout a number of lakes and rivers in the Maritimes Provinces. These fish prey on a variety of smaller fish; this could potentially increase the predation pressure on the Brook Floater host fish, though the host fish have not yet been clearly identified. Even with prohibitions against the translocation of live fish in both provinces, Smallmouth Bass was introduced

in NB near the Miramichi River system in 2008 (DFO 2009) and in NS rivers continuously since 1942 (McNeill 1995). The full impact of the potential presence of this species on Brook Floaters is not well understood at this time. Smallmouth Bass are known to be present in Mattatall Lake and pose an imminent threat to small fish, which are potential hosts of the Brook Floater.

Non-native, invasive mussel species: The introduction of Dreissenid[9] molluscs such as Zebra Mussel (Dreissena polymorpha) and Quagga Mussels (Dreissena bugenis) is a potential threat to freshwater mussels in NB and NS. There is substantial scientific evidence demonstrating that non-native mussel species can negatively affect native mussel populations. Unionid mussels such as the Brook Floater are adversely affected by Dreissenids through direct colonization, reduction of available habitat, changes in the biotic environment or a reduction in food sources (MacIsaac 1996). Zebra Mussels are also known to alter the nutrient cycle in aquatic habitats, affecting other molluscs and fish species. Since its introduction in the Great Lakes in 1986, Zebra Mussel colonization has resulted in the decline and regional extirpation of freshwater mussel populations in lakes and river systems across North America (Schloesser et al. 1996). The Zebra Mussel and the Quagga Mussel have been introduced in the St. Lawrence River as well. One of the most disturbing and direct consequences of the invasion of these two species is the local extirpation of native freshwater mussel populations. A survey developed by Nalepa et al. (1996) in Lake St. Clair showed that in 1986 (before the first Zebra Mussel became established), 18 species were found in the lake and by 1994 only 5 species remained. There is no evidence that Dreissenids are currently found (neither Zebra nor Quagga Mussels) in NB (Sabine - pers. comm. 2015) and NS waters (Hebda - pers. comm. 2015).

4.3 Knowledge gaps

The lack of information on the biology of the species, population estimates, habitat quality, use and characteristics does not directly threaten survival of the Brook Floater. Addressing these gaps may, however, represent the best opportunity to inform and improve management of the species and its habitat. Knowledge gaps that should be addressed to enable better management of the Brook Floater are identified and discussed below.

Identification of new Brook Floater sites: COSEWIC identified a number of potential survey sites where searching for new occurrences of the Brook Floater should be undertaken (COSEWIC 2009); therefore, increasing survey efforts to identify additional sites would be beneficial. Searching for Brook Floater shells in muskrat middens could help confirm presence of the species and provide insights on natural predation. Priority for survey work was identified, in particular, for rivers that flow into the Bay of Fundy (Digdeguash, Lepreau, New and Big Salmon Rivers). Recent discovery of Brook

[9] Dreissenids: General term used to define small freshwater mussels belonging to the family Dreissenadae.

Floaters in two tributaries of the Miramichi River confirms the need for further survey effort in this watershed as well (Baisley and Bredin 2009; Baisley 2010).

Population estimates and trends: The species is a relatively recent discovery in both NB (1948) and NS (1921) (Sabine 2006). There is limited data quantifying abundance, range and number of individuals. Trend detection is limited to qualitative population assessment using presence-absence data. The lack of information on population abundance and trends is not specific to the Brook Floater but pertains to all freshwater mussel communities. The low search effort, lack of experts in the field and difficulties in species identification also contribute to this knowledge gap. The quantitative assessment of Brook Floater in current sites would help understand population trends, recruitment and juvenile abundance. This information is also important to measure progress in achievement of the management plan objective.

Biology of the species: Limited basic biological information specific to the Brook Floater in Canadian waters is available; however, most is inferred from other closely related freshwater mussel species. The identification of host fish species, aspects of fertilization (timing, habitat conditions), and timing of glochidial release are important in order to develop actions related to monitoring, assessment and threat mitigation. More precise information on which fish species in Canada are hosts for Brook Floater glochidia will also contribute to knowledge of the biological needs for the species, as well as in establishing the extent of risk posed by some threats.

Habitat characteristics, including water quality: Characteristics of habitats used by the Brook Floater are generally known (moderate to fast flowing water, clean water, rocky and sandy bottom). There is a need to identify specific habitat characteristics, such as optimal flow velocity for glochidial dispersal and survival and optimum bottom type and depth. A better understanding of specific habitat needs may assist in developing more precise management measures. Additionally, information on water quality requirements, such as pH levels, water hardness, temperature and turbidity is incomplete; this information would assist in assessment of threats, planning surveys to identify new occurrences, determining Brook Floater tolerance to environmental changes and the timing and location for applying mitigation measures.

The risk posed by threats: The risk associated with some threats (mechanism and degree of impact) to the Brook Floater is not clearly understood, notably due to a lack of scientific evidence. The effect of introducing non-native fish species to rivers where the Brook Floater is found and the impacts to potential host fish is unknown. Although it appears that activities such as residential development and ATV stream crossings can affect the Brook Floater and its habitat, research would provide a better understanding of the risk posed by these threats which could inform the implementation of targeted monitoring and conservation efforts. The risk posed by fish passage issues (poor installation and maintenance of culverts) is not completely understood because there is no confirmation of the host fish species for Brook Floater glochidia in Canada. Based on US studies, there is an indication that the host will be a small fish, but research is required to confirm which fish species plays this role for the Canadian population. The

host fish has an important role in the conservation of Brook Floaters. It is also important to determine if limitations to fish passage pose a risk to host fish movements, restricting effective dispersal of Brook Floater glochidia to suitable habitat.

Aboriginal Traditional Knowledge (ATK): There is currently no information available regarding Aboriginal Traditional Knowledge on the Brook Floater. The gathering and sharing of information related to ATK regarding Brook Floater would be beneficial to determine the importance of the species for First Nations people and to foster stewardship initiatives.

5. Management objective

The overall objective of the management plan is to:

Maintain a viable, self-sustaining Brook Floater population in Canada at current and new locations (including historical sites should they become naturally re-established)**.**

Due to insufficient quantitative historical and current abundance, distribution and life history information, specific population and distribution objectives could not be developed for the Brook Floater at this time. The management objective is intended to ensure that the Brook Floater does not become threatened or endangered due to habitat degradation or destruction. The aim is to conserve the habitat where the species currently exists and where new occurrences are discovered, including areas where the Brook Floater naturally re-establishes to historical locations. The focus of the management plan is to encourage measures that help the Brook Floater to be self-sustaining in Canada, where management intervention is not required to ensure its continued existence. The potential of re-establishing the Brook Floater in locations of presumed former occurrence was considered during the development of this plan, but such measures are not warranted at this time.

6. Broad strategies and conservation measures

This management plan includes four broad strategies and related conservation measures to maintain and prevent the further decline of the Canadian Brook Floater population.

The conservation measures are presented in the following four broad strategies:

Broad strategy 1: protection - conserve the quality and quantity of Brook Floater habitat

Broad strategy 2: management - mitigate threats to the Brook Floater and its habitat

Broad strategy 3: research and monitoring - improve knowledge of the Brook Floater in Canada

Broad strategy 4: outreach and communication - promote education and awareness of the Brook Floater and efforts to conserve the species and its habitat

Section 6.1 and 6.2 provide an overview of measures already completed and underway, as well as those that have yet to be implemented, respectively. The conservation measures to be implemented are summarized in an Implementation Schedule in Section 6.3, which prioritizes actions and identifies leads, partners and timelines, to the extent possible at this time.

6.1 Measures already completed or currently underway

6.1.1 Broad strategy 1 and 2: protection and management

The following existing federal and provincial laws and regulations can directly or indirectly contribute to the conservation of the Brook Floater in Canada:

Federal

Canada's Fisheries Act (R.S.C. 1985, c. F-14) and its regulations, which are administered by DFO and delegated authorities, provide direct protection for the Brook Floater and its unknown host fish. The Act currently prohibits activities that result in serious harm to fish that are part of a Commercial, Recreational or Aboriginal Fishery (CRA), or the fish that support such a fishery. It also prohibits the deposition of deleterious substances into waters frequented by fish or in any place under any condition.

The federal Aquatic Invasive Species Regulations were introduced pursuant to the Fisheries Act in 2015, providing a suite of regulatory tools that can be used to prevent the introduction of and manage the spread of aquatic invasive species, contributing to the protection of species such as the Brook Floater that can be impacted by invasive species.

Provincial

Provincial legislation and regulations provide additional protection for the Brook Floater and its habitat. Some of these legal tools do not offer direct protection for the Brook Floater, but they may provide measures that would avoid or minimise the impact of potential activities on Brook Floater habitat.

New Brunswick:
The Brook Floater was listed as Special Concern in 2013 under the NB Species at Risk Act. Although there is no conservation plan or measures currently in place for the Brook

Floater, the Act requires that a management plan outlining appropriate actions be prepared or adopted if one exists that satisfies legal requirements.

The Watercourse and Wetland Alteration Regulation permit program established under the Clean Water Act helps maintain Brook Floater habitat quality by protecting surface water resources from the effects of activities such as construction projects, uncontrolled landscaping and forestry activities, installation of dams and water obstructions.

The Crown Lands and Forests Act provides protection to Brook Floater habitat quality by governing forestry activities on provincial crown land through the establishment of standards, criteria and procedures for forest management.

Nova Scotia:

The NS Endangered Species Act identified the Brook Floater as a Threatened species in 2013. Although there are currently no measures in place under this Act, this legislation provides for the designation, protection, recovery and other relevant aspects of conservation for listed species.

NS has enacted the Wildlife Habitat and Watercourses Protection Regulations (1989), established under Section 40 of the Forests Act, to protect water quality and the riparian zone. This regulation includes measures to avoid or mitigate some of the identified threats for Brook Floaters and their habitat.

Designation Regulations (1995) were created under Section 66 of the Environment Act to protect surface water from human influences. The Environmental Assessment Regulations pursuant to the Environment Act require projects to undergo environmental assessments if they are likely to cause significant environmental impacts to freshwater habitat.

Other initiatives

A preliminary Recovery Potential Assessment (RPA) was completed to evaluate the feasibility of maintaining the Brook Floater in Canada and to identify strategic directions to be included in this management plan (Jacques Whitford Stantec Limited 2012). The RPA concluded that the maintenance or recovery potential for the Brook Floater is high. Proposed measures and actions to address threats to the species were also identified.

Environment and Climate Change Canada maintains several national freshwater monitoring programs, including the Canadian Aquatic Biomonitoring Network (CABIN). The objective of CABIN is to undertake monitoring to assess the health of freshwater ecosystems in Canada. The program is based on a network approach that promotes inter-agency collaboration and data-sharing to achieve consistent and comparable reporting on freshwater quality and aquatic ecosystem conditions in Canada. The CABIN program has developed a database containing information that can be used to understand Brook Floater habitat conditions and general presence of aquatic organisms (including fish and benthic macroinvertebrates).

6.1.2 Broad strategy 3: research and monitoring

Several projects and surveys have been undertaken since the preparation of the COSEWIC status report, providing new insights on the Brook Floater in Canada. Selected published reports from these initiatives are listed in Section 8 - References (Baisley and Bredin 2009; Marshall and Pulsifer 2010; Baisley 2010).

6.1.3 Broad strategy 4: outreach and communication

The Shediac Bay Watershed Association and the Southeastern Anglers Association in NB developed an information sheet on the importance of freshwater mussels in watershed ecosystems and key threats to their habitat. A section of this information sheet focuses on the Brook Floater, describing the importance of the species and threats to its survival. The two groups also developed a bookmark summarizing best management practices for land users in order to maintain and improve habitat quality in rivers, emphasizing freshwater mussels. The Southeastern Anglers Association developed a Stewardship Plan for the Brook Floater in the Bouctouche, Chockpish, Little Bouctouche and Cocagne watersheds. These communication products were funded by the Habitat Stewardship Program for Species at Risk and by the NB Wildlife Trust Fund.

The NB Department of Natural Resources developed a fact sheet, providing information and guidance on how to avoid the introduction of the Zebra Mussel in NB. This fact sheet is available to the public at the following link zebra mussels fact sheet.

6.2 Additional measures to be implemented

6.2.1 Broad strategy 1: protection - conserve the quality and quantity of Brook Floater habitat

Habitat quality maintenance and/or enhancement are essential for the conservation of existing Brook Floaters. To ensure the consideration of Brook Floater habitat during near-water project reviews (i.e. road construction, residential development, use of land for agriculture and forestry, mining and dam installation and operation), the following measures will be pursued:

I – Develop and share a map of Brook Floater distribution and information on the species with federal, provincial and other regulators to enhance consideration of the Brook Floater and its habitat during project reviews. Proposals for projects near water are reviewed by provincial and federal departments, based on existing regulations. These reviews ensure that serious harm to fish and fish habitat is avoided or mitigated.

II - Emphasize the importance of implementing and promoting compliance with existing regulations to help maintain Brook Floater subpopulations. Applying provincial legislation to conserve riparian zones is an example of measures to maintain habitat and population stability, preventing erosion and siltation as well as maintaining water temperature for the Brook Floater.

III - Continue implementation of existing provincial/federal water quality and habitat conservation regulations and guidelines in areas where the Brook Floater is found. Although these guidelines have been in place for some time, continued efforts to improve awareness and compliance will help ensure that recommended procedures are uniformly implemented to protect the Brook Floater.

6.2.2 Broad strategy 2: management – mitigate threats to the Brook Floater and its habitat

A number of management approaches aimed at addressing threats to the Brook Floater will contribute to the maintenance and/or recovery of the species.

IV – Engage groups to develop habitat stewardship projects in locations where the Brook Floater is found. Encouraging stewardship projects to improve the quality of and/or maintain Brook Floater habitat and the potential host fish species habitat can help the conservation of multiple species. First Nations and Indigenous organizations, communities and non-government organizations (NGOs) are encouraged to lead conservation and stewardship projects with the potential support of the Aboriginal Fund for Species at Risk (AFSAR), the Habitat Stewardship Program (HSP) and other federal (e.g., Environmental Damages Fund) or provincial environmental funding programs (e.g., NB Wildlife Trust Fund and NS Habitat Conservation Fund).

V - Provide guidance to local community groups and organizations while planning and implementing project activities for the Brook Floater that would reduce threats to the species and its habitat. This guidance can be provided by existing project funding request reviews through AFSAR and HSP programs or other federal and provincial environmental funds.

VI - Apply existing best management practices for agricultural and forestry activities, residential development and ATV use in areas of Brook Floater habitat. As agricultural and forestry practices have been identified as a threat of high concern for the Brook Floater, encouraging agricultural and forestry practitioners to apply best management practices for their activities will contribute to threat mitigation. Several sources of information on beneficial land use practices for agricultural and forestry activities are available from federal and provincial departments. The need to develop additional best practices for municipal residential development and ATV use around watercourses will be evaluated.

VII - Consider the Brook Floater in design options for fish passage and dam installation and operation. Fish passage issues and drawdown caused by dam operations are threats to the Brook Floater and the host fish. Ensuring that the species and its habitat requirements are considered when designing new fish passage and dam constructions, including mitigation measures to maintain habitat quality and quantity, especially in locations where the Brook Floater is found, will help mitigate these threats.

6.2.3 Broad strategy 3: research and monitoring - improve knowledge of Brook Floater in Canada

Overall abundance and distribution of the Brook Floater in Canada is not completely known. Additional effort is required to collect population data (e.g. subpopulation size, estimate of area occupied in the watercourse, age structure of the subpopulation) at all locations and watercourses identified in the 2009 COSEWIC report as potentially suitable for the Brook Floater; this will allow for refined conservation objectives (i.e. population size and distribution). Identification or confirmation of host fish species and a better understanding of the Brook Floater's life cycle and habitat requirements, as well as water quality parameters, would help guide conservation efforts, survey work and mitigation measures.

VIII - Determine Brook Floater distribution and population estimates at existing sites using standard protocols (qualitative surveys). The acquisition of information on species distribution and a population estimate can be undertaken at existing sites by determining age structure and occupancy within the watercourse. Once this information is collected, a strategy will be developed to understand and monitor population dynamics (increases and decreases in abundance through time, natural mortality rates, fecundity, productivity, etc.) by conducting surveys at a minimum of 5-10 year intervals using standard protocols.

IX - Determine the presence/absence of the Brook Floater at potential sites identified in the COSEWIC report. The COSEWIC Assessment and Status Report identified several potential sites for the Brook Floater. Undertaking presence/absence surveys for the Brook Floater in these watercourses will provide a better understanding of population distribution. An analysis of muskrat middens, where present, could help confirm the local presence of the Brook Floater if shells or shell fragments are identified and could also provide insights on natural mortality from muskrat predation.

X - Collect information on life cycle requirements of the Brook Floater in Canada. There are several knowledge gaps related to the Brook Floater's life cycle. Studies are needed to identify the host fish species, timing of fertilization and glochidial release, factors promoting optimum reproduction, dispersal patterns and the factors affecting survival rates of larvae, young and adults. Such studies will help identify potential conservation measures required to meet the management plan objective.

XI - Collect information on habitat requirements of the Brook Floater in Canada. Studies to better define the habitat requirements of the Brook Floater, such as watercourse width, depth, bottom type and flow rates/patterns, water quality parameters (i.e. pH, water hardness, temperature and conductivity) would be beneficial.

XII - Gather and share Aboriginal Traditional Knowledge (ATK) on the Brook Floater and its habitat in Canada. Addressing this knowledge gap would help determine the importance of the species for Indigenous peoples and foster stewardship initiatives.

XIII - Gather information on threats to the Brook Floater and its habitat. While identifying the host fish for Brook Floater glochidia, information on the extent of habitat fragmentation will be obtained. Assess if fragmentation restricts Brook Floater distribution by the blockage of fish passage to potential host fish. This will also help in understanding the potential risk of unintentionally enhancing access for invasive species, if fish passage improvements at a particular site are considered.

XIV – Gather information on the potential impact of non-native invasive fish species on the Brook Floater and its host fish species. Currently, there is no evidence of non-native freshwater mussels species in the waterbodies where the Brook Floater occurs, but there is evidence of the presence of non-native fish species (Smallmouth Bass). A more detailed evaluation of the potential impact of non-native invasive fish species on the Brook Floater will be possible once more information on the host fish for the Brook Floater glochidia have been determined.

XV – Develop a landowner and land user (agriculture and forestry) database in areas where residential development, agriculture and forestry are identified as a threat to the Brook Floater. This would help increase understanding of the potential impacts of land use activities and identify groups or individuals that could potentially participate in mitigation measures.

6.2.4 Broad strategy 4: outreach and communication - promote education and awareness of the Brook Floater and efforts to conserve the species and its habitat

Freshwater mussels represent a group of species that are relatively little known by the general public. Improving knowledge and awareness of the Brook Floater is, therefore, key to achieving the objectives of this management plan. Such actions complement many of the measures recommended in this document.

XVI - Promote education and awareness of local communities located near Brook Floater habitat about the existence of the species and the importance of key watersheds as habitat for the species in partnership with First Nations and Indigenous organizations and NGOs. Various First Nations and Indigenous organizations and NGOs are well positioned to develop outreach strategies and educational materials to promote stewardship with the support of partners.

XVII - Develop and share outreach materials (posters, pamphlets, newsletters, web based information and social media) to help increase public awareness of the Brook Floater, its status and role in maintaining water quality, the main threats to its survival as well as mitigation measures and stewardship initiatives to conserve the species and its habitat.

XVIII - Distribute existing information from federal and provincial sources on best management practices for agriculture, forestry and residential development to practitioners of these activities to help increase awareness of the Brook Floater and its habitat.

XIX - Encourage the responsible use of ATVs and inform users about the impacts of unsuitable stream crossing practices on the Brook Floater and its habitat, as well as measures to mitigate this threat. Increase awareness of ATV users and associations about existing NB and NS provincial guidelines and regulations for the responsible use of ATVs.

XX - Assess the effectiveness of outreach and education efforts by developing and implementing a survey of landowners, residents and ATV users. Evaluate survey results to gauge knowledge on the existence of the Brook Floater and how to conserve its habitat. The result of this measure will help inform future outreach and education efforts.

6.3 Conservation measures and implementation schedule

A Conservation Measures and Implementation Schedule has been developed (Table 4) to present measures and track progress in achieving the management objective for the Brook Floater. This schedule outlines prioritized conservation measures which will lead to effective implementation. Leads, partners and timelines necessary for successful implementation are included to the extent possible.

Successful management of the Brook Floater is not dependent on the actions of any single jurisdiction; rather, it requires the commitment and cooperation of many different constituencies. Fisheries and Oceans Canada encourages all Canadians to contribute to conservation of the Brook Floater by participating in measures outlined in this management plan. Where appropriate, partnerships with specific organizations and sectors will provide the necessary expertise and capacity to carry out identified measures. If your agency or organization is interested in participating in any of the outlined conservation measures, you can learn how to get involved by accessing the Species at Risk Public Registry or contacting the Species at Risk Gulf Region office of DFO at glf-sara-lep@dfo-mpo.gc.ca.

Explanation of column headings in Table 4

Table 4 is laid out so that each conservation measure listed in the table is first grouped under one of the four broad strategies of this management plan. Additional columns outline the priority, threats or concerns addressed, participating agencies and timelines.

Conservation Measure: The activities or actions that should be taken to implement the management plan are summarized and organized according to the four broad strategies identified above. Further details related to each measure are provided in Section 6.2.

Priority: Priority levels (low, medium or high) are assigned to reflect the direct contribution that a conservation measure will make toward addressing the stated threat or limitation and thus the degree to which the activity is expected to contribute to achieving the management objective for the Brook Floater. It does not take into account the priorities and budgetary constraints of the participating jurisdictions and organizations, but may be used to inform decisions on funding as well as DFO's departmental and conservation priorities.

- High priority measures are those considered most likely to have an immediate and/or direct influence on meeting the management objective for the Brook Floater and are thus considered to be most urgently needed. In some cases, a high priority action may be an essential precursor to another measure that contributes to the management of the species.

- Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of Brook Floater subpopulations.

- Low priority measures will likely have an indirect or gradual influence on reaching the management objective, but are nonetheless considered important contributions to advancing the knowledge base and/or public involvement in, and acceptance of, measures required for Brook Floater management.

Responsibilities: The Lead and Partners columns identify the jurisdictions, organizations and other parties currently or potentially involved in completing the stated conservation

measures. This management plan is also intended to encourage other groups to become involved, therefore, future partnerships may not be completely captured within this document at the time of its publication. In some cases, the organizations or parties that may become involved in the future have yet to be determined.

Timeline: The Timeline column indicates the estimated timeline for completion of the conservation measure from the date of publication of this management plan.

Below is a list of parties/groups and acronyms used in Table 4.

AAFC: Agriculture and Agri-Food Canada
AC: Academia
AOCs: Aboriginal Organizations and Communities
DFO: Department of Fisheries and Oceans Canada
ECCC: Environment and Climate Change Canada
IND: Industry
MUN: Municipalities
NGOs: Non-Government Organizations
NRCan: Natural Resources Canada
NSFA: Nova Scotia Federation of Agriculture
PNB: Province of New Brunswick (Department of Natural Resources – NBDNR; Department of Environment and Local Government – NBDELD; Department of Agriculture, Aquaculture and Fisheries - NBDAAF).
PNS: Province of Nova Scotia (Department of Agriculture – NSDA; Department of Natural Resources – NSDNR; Department of Environment – NSDE)
TBD: To be determined

Table 4. Implementation Schedule for the Brook Floater outlining conservation measures to be taken by DFO and its partners. Where more than one participant appears, they are listed in alphabetical order.

Conservation measure	Priority	Threats or concerns addressed	Responsibilities		Timeline
			Lead	Partners	
Broad strategy 1: protection					
I - Share a map of Brook Floater distribution and information on the species with municipal, provincial and federal regulators.	High	Agricultural, forestry and residential development practices; ATV stream crossings, road construction practices and mining.	DFO	AAFC ECCC MUN NSFA PNB PNS	1 year, repeated as new information becomes available
II - Enhance awareness among agencies and regulators about the importance of implementing and promoting compliance with existing regulations to maintain Brook Floater subpopulations in NB and NS watersheds.	High	Agricultural, forestry and residential development practices; ATV stream crossings, road construction practices and mining.	DFO	AAFC ECCC MUN NSFA PNB PNS	2 to 5 years
III – Continue implementation of existing provincial and federal water quality and habitat conservation regulations and guidelines, which will contribute to maintenance of the Brook Floater and its habitat. Evaluate the need for additional measures that could benefit the Brook Floater.	Medium	Agricultural, forestry and residential development practices; ATV stream crossings; road construction practices; mining effluents and introduction of non-native invasive species.	AAFC DFO ECCC NSFA PNB PNS	AOC NGOs	Ongoing, followed by periodic review
Broad strategy 2: management					
IV - Engage groups and organizations to develop conservation and stewardship projects for the preservation of aquatic ecosystems benefitting the Brook Floater and other species (multiple species approach) in locations where the species is found.	High	Agricultural, forestry and residential development practices; ATV stream crossings; road construction practices; mining effluents; dam operations and introduction of non-native invasive species.	DFO ECCC	AOCs MUN NGO NSFA PNB PNS	Ongoing
V - Provide guidance to groups and organizations in local communities on the implementation of	High	Agricultural, forestry and residential development practices; ATV stream crossings; road	DFO ECCC	AOCs NGOs PNB PNS	Ongoing

Conservation measure	Priority	Threats or concerns addressed	Responsibilities		Timeline
			Lead	Partners	
stewardship project activities for the reduction of threats to the Brook Floater and its habitat.		construction practices; mining effluents; dam operations and introduction of non-native invasive species.			
VI - Encourage agricultural and forestry practitioners, and residential developers to apply best management practices for their activities in locations where Brook Floaters are known to occur.	High	Agricultural, forestry and residential development practices; road construction practices.	NGOs MUN PNB PNS	DFO IND NRCan NSFA	Ongoing
VII - Consider the Brook Floater and the host fish when new or modifications to fish passage and dam infrastructures are being proposed, especially where the Brook Floater is known to occur.	Medium	Fish passage issues, dam operations; introduction of non-native invasive species; road construction practices.	DFO PNB PNS	IND	Ongoing
Broad strategy 3: research and monitoring					
VIII - Monitor Brook Floater population size and distribution. a) Conduct qualitative surveys using standard protocols to determine population age structure and occupancy at existing locations. b) Based on results of qualitative surveys in 'a', develop a survey strategy and periodically monitor population dynamics using quantitative standard protocols.	High	Refine management objectives (acquire information about population size and distribution).	AC AOCs NGOs	DFO PNB PNS	a) 2-5 years b) 5 to 10 year intervals
IX - Undertake presence/absence surveys for the Brook Floater in watercourses identified by COSEWIC as potential habitat for the species (e.g. examine muskrat middens near suitable habitat for Brook Floater shells).	High	Confirmation of new subpopulations and/or sites in Canada.	AC AOCs NGOs	DFO PNB PNS	2 to 5 years
X - Undertake studies to	High	Address knowledge	AC	AOCs	2 to 5 years

Conservation measure	Priority	Threats or concerns addressed	Responsibilities		Timeline
			Lead	Partners	
obtain information on life cycle requirements of the Brook Floater in Canada including identifying host fish species.		gaps to better understand threats identified in this management plan and how to mitigate them.		DFO NGOs PNB PNS	
XI - Undertake studies to collect information on habitat requirements of the Brook Floater, including water quality requirements.	High	Address knowledge gaps to better understand threats identified in this management plan and how to mitigate them.	AC	AOCs DFO NGOs PNB PNS	2 to 5 years
XII- Gather and share Aboriginal Traditional Knowledge (ATK) on Brook Floater and its habitat.	Medium	Address knowledge gaps related to ATK on Brook Floater and its habitat.	AOCs	AC DFO	TBD
XIII - Gather information on habitat fragmentation at existing Brook Floater sites.	Low	Address knowledge gaps related to habitat fragmentation (road construction practices/ fish passage issues).	AC	AOCs DFO NGOs PNB PNS	> 5 years
XIV- Evaluate the potential impact of non-native invasive fish species on the Brook Floater and its host fish species.	Low	Address knowledge gaps and potential threat related to the effects of non-native invasive fish species on Brook Floater populations.	AC PNB PNS	DFO NGO's	> 5 years
XV - Develop a landowner and land user database in areas where residential development and poor land use practices are identified as an imminent threat to the Brook Floater and its habitat.	Low	Poor agricultural, forestry, residential development, and road construction practices.	DFO MUN PNB PNS	AOCs IND NGOs	2 to 5 years
Broad strategy 4: outreach and communication					
XVI - Promote awareness of the Brook Floater and its conservation needs to local communities in partnership with First Nation and Indigenous organizations and NGOs.	High	Agricultural, forestry and residential development practices; ATV stream crossings; road construction practices; introduction invasive species.	AOCs NGOs	DFO, ECCC NSFA PNB PNS	Ongoing
XVII - Develop and share outreach material related to the Brook Floater as a species at risk, its role in maintaining water quality, its main threats and appropriate mitigation measures as well	Medium	Agricultural, forestry and residential development practices; ATV stream crossings; road construction practices; mining effluents; dam operations and	AOCs NGOs	DFO ECCC NSFA PNB PNS	Ongoing

Conservation measure	Priority	Threats or concerns addressed	Responsibilities		Timeline
			Lead	Partners	
as appropriate stewardship initiatives to conserve the species and its habitat.		introduction of invasive species.			
XVIII - Distribute existing federal or provincial materials on best management practices for agriculture and forestry practitioners and residential developers.	Medium	Agricultural, forestry and residential development practices; road construction practices.	DFO MUN PNB PNS	AOCs NGOs NRCan NSFA	3 years
XIX - Enhance awareness of ATV users about the impact of unsuitable stream crossings on the Brook Floater and its habitat and ensure that users are aware of existing NB and NS provincial guidelines and regulations.	Medium	ATV stream crossings.	DFO PNB PNS	AOCs MUN NGOs	2 to 5 years, repeated as needed
XX - Survey landowners, residents and ATV users to assess the effectiveness of outreach and education efforts aimed at conserving the Brook Floater and its habitat. Use results to inform future outreach and education efforts.	Medium	Agricultural, forestry and residential development practices; ATV stream crossings; road construction practices; mining effluents; dam operations and introduction of invasive species.	AOCs NGOs	DFO PNB PNS	>5 years

7. Measuring progress

Reporting on implementation of this management plan will be done by assessing progress towards achieving the broad strategies and conservation measures outlined above. The implementation of this management plan will be monitored on a regular basis and will be assessed within five years after the final version has been published to the Species at Risk Public Registry.

The performance indicators below identify the broad strategies and how progress towards achieving them will be evaluated in the future. These indicators will also be used to evaluate whether the conservation measures identified in Table 4 are adequate for their purpose of maintaining the quality and quantity of Brook Floater habitat at 2015 levels and locations.

Broad strategy 1: protection

Progress towards Broad Strategy 1- Protection will be evaluated both in the short- and long-term by achieving the following:

- measures have been taken to promote continued awareness of and compliance with existing regulations to maintain quality and quantity of Brook Floater habitat

Broad strategy 2: management

Progress towards Broad Strategy 2- Management will be evaluated in the short-term and on an ongoing basis by achieving the following:

- measures have been taken to reduce threats to the Brook Floater and its habitat in Canada

Broad strategy 3: research and monitoring

Progress towards Broad Strategy 3- Research and Monitoring will be evaluated in the short-term and on an ongoing basis by achieving the following:

- measures have been taken to address knowledge gaps focusing on high and medium priorities related to the Brook Floater's life cycle and habitat requirements required to support conservation efforts

- measures have been taken to better understand Brook Floater population dynamics and distribution

Broad strategy 4: outreach and communication

Progress towards Broad Strategy 4 – Outreach and Communication will be measured in the short-term and on an ongoing basis by achieving the following:

- measures have been taken to promote awareness and stewardship actions to conserve the Brook Floater and its habitat in Canada

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Appendix A. Effects on the environment and other species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (2010), SARA recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that the management plan may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

The potential for the Brook Floater management plan implementation to inadvertently lead to adverse effects on other species was considered. However, as the recommended conservation measures are limited to non-intrusive actions such as monitoring the population, promoting awareness and voluntary stewardship activities, it was concluded that this management plan will not entail any significant adverse effects.

The Brook Floater and other freshwater mussels play a key role in maintaining water quality and they are efficient indicators of healthy ecosystems. Implementation of the conservation measures outlined in this management plan would likely have additional ecological benefits that will reduce habitat degradation and fragmentation. These ecological benefits range from providing ecological services, such as water filtration and purification, providing food for other organisms, including fish, creating habitat for other organisms, stabilizing stream bottom or providing an important environment for algae and insect larvae to attach. Implementation of the conservation measures outlined in this management plan would equally benefit other aquatic species, such as freshwater mussels that overlap the geographic distribution of the Brook Floater (e.g. Eastern Pearl Shells (Margaritifera margaritifera), Eastern Elliptio (Elliptio complanata), as well as host fish and other native species of fish that share the same ecosystem). Terrestrial species which occasionally use watercourses where the Brook Floater is found during a portion of their life cycle may also benefit from measures proposed in this management plan (i.e., Wood Turtle (Glyptemys insculpta) - currently listed under SARA as Threatened).

Appendix B. Record of cooperation and consultation

Management plans are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties and others as outlined in SARA section 39. A two-day workshop was held in Moncton, NB on March 20-21, 2014 to seek input and advice on the conservation measures required to reduce the threats to the Brook Floater and its habitat. Information on participation is included below.

Table 5. Brook Floater Management Plan workshop attendee list, March 20 and 21, 2014.

Attendee	Affiliation
Federal departments	
Amirault-Langlais, Diane	Parks Canada Agency/ Kouchibouguac
Bastien-Daigle, Sophie	DFO Gulf Region/ Species at Risk Regional Management
Corkum, Jessica	DFO Maritimes / Species at Risk Management Division
Maillet, Josette	DFO Gulf/ Aquatic Species at Risk Program
Ouellette, Marc	DFO Gulf Region
Robichaud, Guy	DFO Gulf/ Fisheries Protection Program
Rondeau, Amélie	DFO Gulf/ Aquatic Species at Risk Program
Province of New Brunswick	
Lusk, Stewart	NB Department of Natural Resources
Non-government organizations	
Collins, Harry	MREAC Watershed Group
Donelle, Remi	Shediac Bay Watershed Association
Doucet, Anita	Les Ami(e)s de la Kouchibouguacis
Gallant, Samuel	Les Ami(e)s de la Kouchibouguacis
LeBlanc Poirier, Nathalie	Southeastern Anglers Association

The draft management plan was also reviewed by relevant DFO representatives in the National Capital Region, Gulf Region and Maritimes Region.

In addition, consultation on the draft management plan occurred through letters sent to First Nations and Indigenous Organizations in NB and NS, relevant federal agencies, NB and NS provincial government representatives, as well as various stakeholders (NGOs, academics, and industry groups in NB and NS) during the period of January to March 2016. All comments received during this consultation period were considered and addressed as appropriate in this version of the document.

Additional stakeholder, Indigenous, and public input was sought through the publication of the proposed management plan on the Species at Risk Public Registry for a 60-day public comment period. Comments received informed the final document.