Species at Risk Act
Action Plan Series

Action Plan for the Atlantic Whitefish (Coregonus huntsmani) in Canada

Atlantic Whitefish

2018

Canada

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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 action plans for species listed as Extirpated, Endangered, and Threatened for which recovery has been deemed feasible. They are also required to report on progress five years after the publication of the final document on the Species at Risk (SAR) Public Registry.

Under SARA, one or more action plan(s) provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines what needs to be done to achieve the population and distribution objectives (previously referred to as recovery goals and objectives) identified in the recovery strategy, including the measures to be taken to address the threats and monitor the recovery of the species, as well as the proposed measures to protect critical habitat that has been identified for the species. The action plan also includes an evaluation of the socio-economic cost of the action plan and the benefits to be derived from its implementation. The action plan is considered one in a series of documents that are linked and should be taken into consideration together. Those being the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, the recovery strategy, and one or more action plans.

The Minister of Fisheries and Oceans is the competent minister under SARA for the Atlantic Whitefish and has prepared this action plan to implement the recovery strategy, as per s. 47 of SARA. To the extent possible, it has been prepared in cooperation with the Atlantic Whitefish Conservation and Recovery Team (AWCRT) which is comprised of relevant federal and provincial government departments: Fisheries and Oceans Canada (DFO), Nova Scotia Department of Fisheries and Aquaculture (NSDFA), and the Nova Scotia Department of Natural Resources (NSDNR), as well as, municipal government, industry, academia, interested stakeholders, environmental non-government organizations and Aboriginal Peoples including the Bluenose Coastal Action Foundation (BCAF), Public Service Commission of Bridgewater (PSCB), Dalhousie University, Native Council of Nova Scotia (NCNS), Maritime Aboriginal Peoples Council (MAPC), Nova Scotia Museum of Natural History (NSM), Nova Scotia Power Incorporated (NSPI), the South Shore Naturalists, Nature Nova Scotia, and the Mersey Tobeatic Research Institute (MTRI). Parks Canada Agency (PCA) and Nova Scotia Environment (NSE) also provide support to the AWCRT. Input was provided by the above outlined groups and any others, including the broader interested public during the consultation process, as per s. 48(1) of SARA (Appendix C).

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan and will not be achieved by DFO, or any other

jurisdiction alone. All Canadians are invited to join in supporting and implementing this action plan for the benefit of the Atlantic Whitefish and Canadian society as a whole.

Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

This action plan has been developed by DFO through the cooperative effort of the multi-stakeholder/multi-interest Atlantic Whitefish Conservation and Recovery Team (AWCRT; the 'Recovery Team') (Appendix A). In the development of such, this document draws heavily on the Recovery Strategy for the Atlantic Whitefish (Coregonus huntsmani) in Canada (DFO 2006a; DFO 2018), the minutes of the semi-annual meetings of the Recovery Team, 2002-2011, as well as the Recovery 'Activity Table' updated annually by the Recovery Team since 2007. DFO is grateful to former DFO employee and AWCRT co-chair Dr. Larry Marshall who prepared the initial draft of this action plan under contract, and the Recovery Team for their dedicated efforts in providing information, expertise, and perspectives contributing to the development of this document. DFO also wishes to recognize the input provided by the broader interested public in the consultation process. See Appendix C for the Record of Cooperation and Consultation.

Executive summary

The Atlantic Whitefish, Coregonus huntsmani (Scott 1987), is globally unique and therefore a significant component of Canada's biodiversity. The species was historically found in only two watersheds in southwestern Nova Scotia, Canada: the Tusket River in Yarmouth County and the Petite Rivière in Lunenburg County. Currently the only wild self-sustaining population of Atlantic Whitefish exists largely restricted within three small, interconnected, semi-natural lakes in the upper Petite Rivière drainage area (DFO 2018). This action plan addresses the species' entire global distribution with the intent of implementing the overall recovery goal of the recovery strategy, which is to: "Achieve stability in the current population of Atlantic Whitefish in Nova Scotia, re-establishment of the anadromous form, and expansion beyond its current range".

This action plan addresses all four broad strategies within the recovery strategy (DFO 2018):

i) conserve, protect and manage the species and its habitat
ii) increase the number and range of viable populations
iii) address knowledge gaps relating to the species and its habitat
iv) increase public involvement in, and acceptance of, measures required for the species survival and recovery

Current threats to be addressed in conserving Atlantic Whitefish in the Petite Rivière include: the appropriate management of lake water levels, including drawdowns and removals for domestic use, interaction with illegally introduced aquatic invasive species (i.e., Smallmouth Bass (Micropterus dolomieu) and Chain Pickerel (Esox niger)), and inadequate fish passage at barrier sites. The threat of acidification from construction and excavation activities (e.g., road construction, quarries, and mining) is also to be addressed in conserving Atlantic Whitefish in the Petite Rivière Lakes. Potential threats to be considered in any new or expanded population could include: habitat alteration and inadequate fish passage due to hydroelectric dams and their operation, acidification, interactions with non-native invasive fish species (e.g., Smallmouth Bass and Chain Pickerel), and by-catch in recreational angling and other fisheries (DFO 2009).

The population of Atlantic Whitefish and its habitat within its current three lake distribution in the Petite Rivière is expected to benefit from recreational angling fishery management measures implemented over the past decade, environmental protection offered by the designation of the Petite lakes as a Watershed Protected Water Area in 2006, and the recent identification of the Petite lakes as critical habitat. Further details on these protection measures and the identified critical habitat are provided in the amended recovery strategy (see DFO 2018).

Re-establishing the anadromous form and expanding the species range is contingent upon the availability of life-stages of fish, in numbers that can establish genetically and ecologically viable populations. Technologies for Atlantic Whitefish captive-breeding

have been developed to assist towards this end. The DFO Science-led captive-breeding program for Atlantic Whitefish, however, concluded in the spring of 2012. The continued commitment and cooperation of the AWCRT and other partners will be needed to identify viable mechanisms and potential partnering opportunities and arrangement to implement the recovery measures required to expand the range of Atlantic Whitefish and achieve the distribution objective for this species.

Key activities already undertaken include:

- provision of fish passage at Hebb Lake Dam to ensure survival of the wild lake-resident population and begin to provide the conditions to promote anadromy on the Petite Rivière.
- monitoring of regulatory compliance
- developing and documenting the Atlantic Whitefish captive-breeding technology
- release of captive-bred Atlantic Whitefish into a new waterbody outside the Petite Lakes (i.e., Anderson Lake) and monitoring of these releases for signs of survival and reproduction success, i.e., to assess the feasibility of using the progeny of wild-caught adults bred in captivity to establish lake-resident populations
- ongoing maintenance of an active Recovery Team

Key outlined recovery measures include (priority not necessarily implied by order):

- sharing the documented Atlantic Whitefish captive-breeding techniques and methodologies that have been successfully developed by DFO Science (2000-2012) and used to date
- identifying alternative viable mechanisms to support future introduction needs.
- Assessing the status of the existing population within the three Petite Rivière lakes
- pursuing opportunities for fish passage improvements to identified impediments in the Petite Rivière watershed
- establishing an additional population(s) of anadromous Atlantic Whitefish in suitable riverine habitat, particularly watersheds within the western portion of Nova Scotia's Southern Upland eco-region, and including consideration of the Tusket River
- developing and implementing management approaches to mitigate or eliminate the threat posed by Smallmouth Bass and Chain Pickerel
- using best management practices, contingency and remediation plans to limit environmental impact effects from any new construction or excavation activities that could expose acid-generating slates to air and surface runoff within the Petite Rivière Lakes
- undertaking the studies outlined in the critical habitat Schedule of Studies contained in the recovery strategy to refine the current identification of critical habitat and identify any additional areas of critical habitat
- continuing to monitor Atlantic Whitefish in Anderson Lake to evaluate the status and condition of the species in that location

In total, the action plan proposes 26 recovery measures contained within 15 approaches. Narratives detailing each measure to be taken are included.

Success in the recovery of Atlantic Whitefish is not solely dependent on the actions of any single jurisdiction; rather it requires the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan. Accordingly, this action plan contains an Implementation Schedule which is organized on the basis of who will conduct or be a key participant in the activity. Table 1 identifies the recovery measures to be led by Fisheries and Oceans Canada (DFO), in cooperation with other relevant partners, whereas Table 2 identifies the recovery measures that are either collaborative efforts with other partner organizations or jurisdictions or that could be undertaken voluntarily by other parties but to which DFO could participate in a supporting capacity. Organizations interested in participating in one of these measures, are asked to please contact the Species at Risk Management Division, Maritimes Region, by email or phone at 1-866-891-0771.

Adopting an adaptive management approach to recovery for Atlantic Whitefish will be essential to ensure the survival of the species within its existing habitat, the success of range expansion efforts, and to address existing and any new emergent threats. Implementation of this action plan requires monitoring the response of the species to recovery actions as they are implemented and assessments of the effectiveness of recovery measures undertaken. Methods that will be used for such are either built directly into or included, where appropriate, with the proposed recovery measures. While the implementation of this action plan is anticipated to benefit the environment by promoting the recovery of the Atlantic Whitefish, the potential for effects on other species were also considered (Appendix B). SARA requires that the implementation of an action plan and its ecological and socio-economic impacts be assessed and reported on five years after the plan comes into effect. A review of activities and progress towards recovery will be undertaken at that time to ensure any new information or changing conditions are taken into account. DFO will continue to work cooperatively with the Recovery Team and any other stakeholders, Aboriginal Peoples and interested parties towards the recovery of Atlantic Whitefish.

An evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation was completed. The evaluation showed that many of the measures included in the action plan represent a continuation of current activities or commitments of the DFO and/or other groups into the foreseeable future; therefore these measures are unlikely to result in additional costs over and above what is already planned. However, certain measures, such as efforts to establish Atlantic Whitefish anadromy in the Petite Rivière watershed and potential range expansion, would require additional investments. Establishing anadromy within the Petite watershed would require the construction of fish passage facilities at several locations, which could cost hundreds of thousands of dollars. Precise costs associated with range expansion cannot be determined until further details are developed in the form of an operational plan and a viable mechanism to support range expansion activities is identified.

If fully implemented, it is anticipated that this action plan will benefit Atlantic Whitefish as well as other species (e.g., Gaspereau (Alosa sp.), Brook Trout (Salvelinus fontinalis), Atlantic Salmon (Salmo salar)). Additionally, as Canadians have been shown to value the conservation and preservation of species in and of themselves, it is anticipated that this action plan will result in additional non-market benefits to Canadians (e.g., higher bequest[1] and existence values[2]).

[1] Bequest value: value current generation places on maintaining or preserving an asset or resource, such as an endangered species, so that it is available for future generations.
[2] Existence value: value reflecting the benefit people receive from simply knowing that a particular asset or environmental resource, such as an endangered species, exists.

Table of contents

List of tables and figures

Tables

Figures

1. Recovery actions

1.1 Context and scope of the action plan

The scope of this action plan is to present the recovery measures necessary to address the Atlantic Whitefish's entire global distribution by addressing all four of the broad strategies and corresponding approaches identified in the recovery strategy, and seeks to build on previous and ongoing activities that address these objectives.

The Atlantic Whitefish, Coregonus huntsmani (Scott 1987), is globally unique and phylogenetically distinct and therefore a significant component of Canada's biodiversity. The species is endemic to Nova Scotia, Canada and limited to the western portion of the Southern Upland eco-region (Figure 1). Although considered to be an anadromous species by nature, the wild population is currently largely restricted within three small interconnected semi-natural freshwater lakes (1,600 total hectares/16 km^2) in the upper Petite Rivière drainage area; namely Milipsigate Lake, Minamkeak Lake, and Hebb Lake (referred to within this document as 'the Petite lakes') (DFO 2018). These lakes form the water supply for the town of Bridgewater and could not be accessed from the sea until the recent provision in 2012 of fish passage at Hebb Lake Dam located at the foot of the Petite lakes. The species historical range also included the Tusket River (in Yarmouth County) and is expected to have extended to other watersheds in Nova Scotia (DFO 2009). Captive-reared Atlantic Whitefish have been released into a new freshwater waterbody in Nova Scotia, Anderson Lake, in Dartmouth, but individuals here are not yet known to be reproducing successfully.

The Amended Recovery Strategy for the Atlantic Whitefish (Coregonus hunstmani) in Canada (DFO 2018) is published on the SAR Public Registry and sets out the broad strategies and approaches needed for the species recovery. This action plan builds upon those identified approaches and addresses the species' entire global distribution in an attempt to achieve the overall goal of the recovery strategy, namely to:

> "Achieve stability in the current population of Atlantic Whitefish in Nova Scotia, reestablishment of the anadromous form, and expansion beyond its current range."

Accordingly, this action plan outlines recovery measures to address the four broad strategies and the 15 corresponding approaches that are identified in the recovery strategy. The four prioritized broad strategies identified for the recovery of Atlantic Whitefish in Canada are:

i. conserve, protect and manage the species and its habitat
ii. increase the number and range of viable populations
iii. address knowledge gaps relating to the species and its habitat

iv. increase public involvement in, and acceptance of, measures required for the species survival and recovery

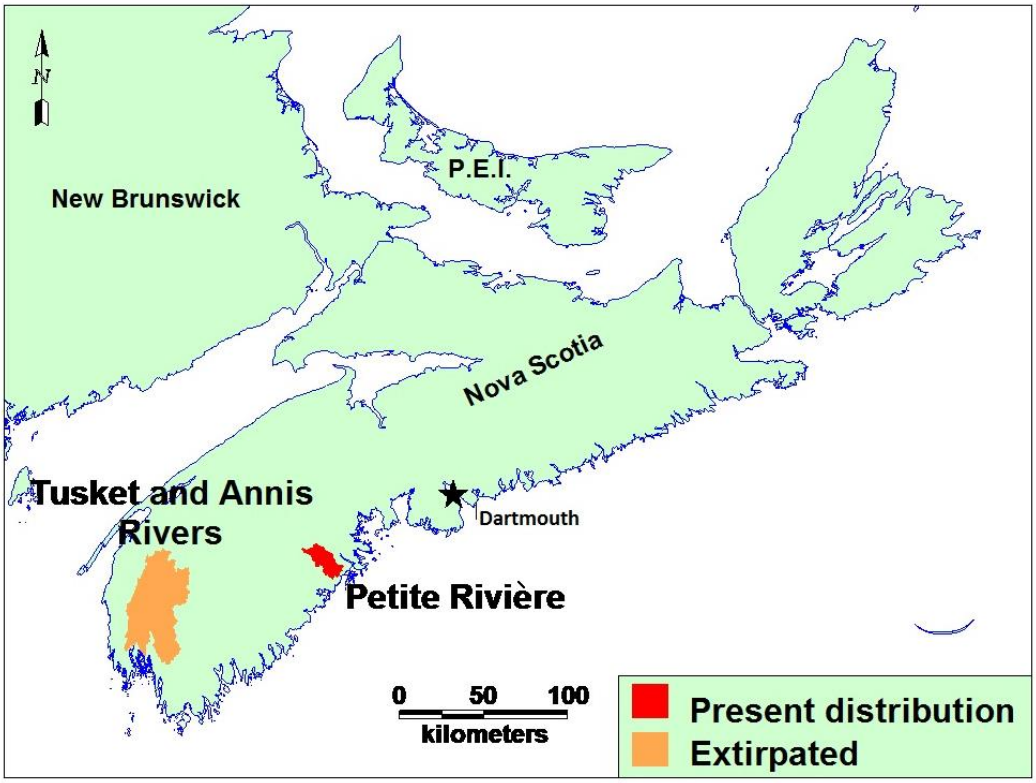

Figure 1. Present and known historical Canadian watershed distribution of Atlantic Whitefish[3]. The general location of Anderson Lake is indicated by a star.

A previous draft action plan focused solely on fish passage improvements on the Petite Rivière was developed after several years of work, as indicated by an 'Action Plan Statement' published on the SAR Public Registry. In September 2009 this 'chapter' approach to action planning (i.e., incremental approach to producing the action plan, preparing chapters that focus on individual themes or threats, for example, until all elements are addressed) was set aside for Atlantic Whitefish in favour of a single concise and all-encompassing document that takes into account all measures required to meet the broad strategies for the recovery strategy. This action plan seeks to build upon those efforts, where appropriate. Although fish passage has recently been constructed at Hebb Lake Dam, its effectiveness for Atlantic Whitefish is yet to be evaluated. The additional measures required to fully implement fish passage on the Petite Rivière are incorporated where appropriate into this document (see Recovery Measures #4 and #15 in Section 1.2.1).

[3] All map images derived from the Nova Scotia Topographic Database (NSTDB) and used by permission of Service Nova Scotia. Maps intended for illustrative purposes only.

1.2 Measures to be taken and implementation schedule

1.2.1 Measures to be taken

This section of the document outlines the measures to be taken to promote the recovery of Atlantic Whitefish. These are the recovery measures required to address each stated approach in the recovery strategy. The rationale associated with the establishment of each broad strategy is outlined in the recovery strategy. To maximize consistency with the recovery strategy, the recovery measures are organized in the same order as the corresponding objectives and approaches presented in that document. The associated narrative below provides additional detail on each of the recovery measures outlined and linked to the subsequent Implementation Schedules in Section 1.2.2 which additionally identifies the corresponding partners and timelines.

Broad strategy 1:
Conserve, protect and manage the species and its current habitat.

Approach 1.1; address emergent threats to survival.

1) Monitor Atlantic Whitefish introductions in Anderson Lake.

Among the first recovery efforts identified to conserve the species and minimize its risk of extinction was to attempt to create a back-up population. Accordingly, experimental releases of captive-reared Atlantic Whitefish were released into Anderson Lake by DFO between 2005 and 2008. A final small allotment of fish was released in 2012 from the remaining captive-bred Atlantic Whitefish that were held at the Mersey Biodiversity Facility following its closure. These releases served the dual goal of evaluating the feasibility of using captive-reared fish to establish successfully reproducing lake-resident populations of Atlantic Whitefish outside of the Petite lakes (details of this action are outlined in the recovery strategy) and in doing so, hopefully successfully introducing the species into a new waterbody, thus conserving the species from risk of extinction. Annual monitoring between 2006 and 2010 provided evidence of survival, body growth and some maturing fish but no young-of-the-year have been observed to date (Bradford et al. 2015). Continued monitoring is required to fully evaluate the outcomes of this introduction and to determine whether a self-sustaining population has been established. The success of these introductions will help secure the survival of this species. Monitoring will be accomplished by trap netting in the late fall (November – December) for evidence of survival and reproduction. Additional introductions into Anderson Lake may be desirable in order to achieve self-sustainability (see Recovery Measure #13a) and, if/when established, the status of this new population should be assessed (see Recovery Measure #17).

2) Strengthen and enforce provincial regulations and enforce SARA general prohibitions to reduce the spread of non-native species.

In November 2010, the Province of Nova Scotia amended its Fisheries and Coastal Resources Act to authorize the making of regulations to prohibit the possession of live fish in Nova Scotia (except under certain conditions). The Live Fish Possession Regulations come into effect on April 1, 2013 and are intended to protect native fish species by directly targeting the unauthorized introduction of invasive fish species into provincial waters. Implementing the amendments and monitoring their effectiveness will be important for a number of Atlantic Whitefish recovery efforts in the Petite Rivière and with any current or future Atlantic Whitefish introductions into additional waterbodies. Furthermore, enforcing the SARA general prohibitions against harm to Atlantic Whitefish should be applied in cases where the alleged offence of an unauthorized introduction of an invasive fish species is proven (see also Recovery Measure #8 for reporting and evaluating incidents of non-compliance).

3) Document, evaluate, and address threat of aquatic invasive species (i.e., Smallmouth Bass and Chain Pickerel) in the Petite Rivière.

Surveys of Smallmouth Bass on Minamkeak, Milipsigate, and Hebb Lakes (e.g., nests, distribution, and evidence of reproduction) have been conducted annually by the Nova Scotia Department of Fisheries and Aquaculture (NSDFA) and the Bluenose Coastal Action Foundation (BCAF) from 2007 to 2013 (BCAF 2015). Results from these surveys indicate that Smallmouth Bass are currently present and reproducing in all three lakes (BCAF 2015). It was also recently confirmed (2013) that there are Chain Pickerel in at least two of the upper lakes in the Petite Rivière (Hebb and Milipsigate). The Recovery Team has concerns about the spread of Smallmouth Bass and newly confirmed presence of Chain Pickerel and their likely continued spread given their documented negative impact on lake communities, including other species of fish and the entire aquatic ecosystem complex. A compilation of current Smallmouth Bass survey results into a technical report is being drafted by the NSDFA. The Recovery Potential Assessment (RPA; DFO 2009) and Recovery Team determined that the potential for survival of Atlantic Whitefish would be higher if the abundance of Smallmouth Bass and Chain Pickerel within the Petite lakes is mitigated (e.g., eliminated or appropriately reduced to minimize negative impacts) and if further spread of Chain Pickerel is also prevented. Accordingly, DFO established a 3-year agreement with the NSDFA on a boat-electrofishing program (2014-2016) (see Section 2.10 of the recovery strategy (DFO 2018) for more details on the boat-electrofishing efforts to date) and will continue to provide advice, technical support and collaborate with partners as required to continue to monitor the status of both invasive species (i.e., Smallmouth Bass and Chain Pickerel) in the Petite lakes, compile the Smallmouth Bass survey information and the boat-electrofishing results into reports (see Recovery Measure #20) and review these reports (see Recovery Measure #22) to further evaluate and implement next steps and mitigation options which are important to the continued survival of Atlantic Whitefish. This includes effective use of existing regulatory framework and management tools (see Recovery Measure #2) to reduce the threat and direct removals to control

their numbers, such as using an electrofishing boat to remove any Smallmouth Bass or Chain Pickerel from the system, removals of individuals of both species intercepted in the fish trap at the Hebb Lake Dam fish passage facility (Robichaud-LeBlanc and Fenton 2011; Robichaud-LeBlanc and O'Neil 2013) as well as any Smallmouth Bass or Chain Pickerel intercepted via other monitoring and sampling methods. This could also include any new tools or mechanisms needed to ensure Atlantic Whitefish survival and availability for future recovery efforts.

4) Monitor the fish passage facility constructed at Hebb Lake Dam to determine fish usage.

A series of dams constructed over the past centuries within the Petite Rivière system either blocked or continues to impede fish passage at five locations between the Petite lakes and the estuarine/marine environment (descriptions of the five main impediments to Atlantic Whitefish passage on the Petite Rivière can be found in the recovery strategy). The dam at the most downstream of the Petite lakes, Hebb Lake Dam, effectively blocked any upstream migration beyond this point. Atlantic Whitefish individuals that occasionally fell over the Hebb Lake Dam could not return to the lakes where reproduction occurs and therefore this represented a potentially significant loss of productivity to a species of small population size.

The effective use of the fish passage facility at Hebb Lake Dam in conjunction with the provision of fish passage at other existing barriers on the watershed would also promote the conditions thought to be favorable for enabling anadromy of Atlantic Whitefish on the Petite Rivière as per the recovery strategy and as further detailed in Recovery Measure #14. There is broad agreement by the Recovery Team that establishing fish passage at Hebb Lake Dam represents a significant step towards ensuring the survival of the wild Atlantic Whitefish population within the Petite lakes. Considerable effort has been expended to date to provide the basis for developing priorities for the provision of fish passage on the Petite Rivière including i) preparation of the Petite Rivière Fish Passage Plan for Atlantic Whitefish: Discussion Document for a SARA Action Plan (Schaefer et al. 2006), and ii) the Petite Rivière Fish Passage Plan for Atlantic Whitefish – Workshop (DFO 2006b).

Collaboration to date between DFO, Nova Scotia Power Inc., and the Public Service Commission of Bridgewater (PSCB) resulted in the commencement of construction in the spring of 2011 of a fish passage facility at the Hebb Lake Dam. The facility was completed in spring 2012 and commissioned in fall 2012. The installation of a monitoring trap in the Hebb Lake Dam fish passage facility helps address a number of key questions related to the effectiveness of such facilities for Atlantic Whitefish, as well as for other fish species. Monitoring also helps answer a number of biological questions (such as habitat use, population size, movement and migration timing, biological characteristics and condition) related to Atlantic Whitefish and other fish species. The presence of the monitoring trap also provides the opportunity to control the passage of all fish species, particularly the numbers of individuals per species entering the lake (e.g., an escapement target for alewife has been recommended in a phased

precautionary approach – see Robichaud-LeBlanc and O'Neil 2013) and/or prohibit entry of unwanted (e.g., invasive) fish species such as Smallmouth Bass and Chain Pickerel.

A Working Group of the Recovery Team was established and assisted DFO in developing an interim monitoring plan for the first year of implementation (Robichaud-LeBlanc and Fenton 2011) which was updated in 2013 to accommodate phase 2 of the plan (Robichaud-LeBlanc and O'Neil 2013). Monitoring at the Hebb Dam fish passage facility has been undertaken by BCAF from 2012 to present and results are published in their annual reports which can be found on their website (BCAF 2015). Additional details on efforts to date related to the construction and monitoring of the Hebb Dam fish passage facility can be found in Section 2.10 of the recovery strategy (DFO 2018). Continued DFO collaboration with the PSCB is required through all aspects related to the operation of the fish passage facility, including its efficacy for Atlantic Whitefish, and providing advice and technical support as required in implementing with partners (e.g., BCAF) ongoing monitoring and operation control protocols.

5) Work collaboratively with regulators on lake management and flow regimes in the Upper Petite lakes.

The Petite lakes serve as the municipal water supply for the Town of Bridgewater. The system is managed as a run-of-the-river operation and, other than for dam maintenance and construction/upgrades, the PSCB only manages minor variations in water levels for the purpose of public health and safety (i.e., property and personal safety) that could be adversely impacted by flood conditions.

The Town has recently reviewed their water relicensing requirements with Nova Scotia Environment (NSE) and determined that their 100 year old structures (network of dams and berms) were not meeting the Canadian Dam Safety Guidelines. Effective reconstruction of dam sections was identified as needed in situations where overtopping due to storm events could result in dam failure with potential significant negative results downstream to property and public safety. The PSCB consulted extensively with the Recovery Team and DFO on options to address dam upgrade needs while considering possible impacts to the Atlantic Whitefish population. The required work was undertaken during 2011 and is now completed. The PSCB installed automated lake level monitors at each dam site to provide real time lake level data for all three Petite lakes that may help in coordinating lake levels with Atlantic Whitefish migration timing. It is anticipated that the dam upgrades and the installation of water level monitors will result in an improved capacity to maintain water levels important to protect Atlantic Whitefish habitat.

Continued collaborations with the PSCB are required to ensure lake management and flow regimes are maintained within water levels appropriate for the protection of Atlantic Whitefish habitat, including water levels and flow through the fish passage facility. This could include advice from DFO on the identification of a range of water levels prior to the Atlantic Whitefish spawning season and during the species fall migration window,

and the review of any proposed work by all regulators to ensure that it will be done in a manner that would not result in significant impacts to the species critical habitat.

Approach 1.2; develop and implement mitigation to minimize human-induced harm to the species and its habitat.

6) Manage licensed recreational angling fisheries to ensure impacts to Atlantic Whitefish are minimized or eliminated.

Angling for species such as Brook Trout (Salvelinus fontinalis) and Smallmouth Bass continues on Minamkeak, Milipsigate and Hebb Lakes and along the lower Petite Rivière but with season and gear restrictions designed to minimize any Atlantic Whitefish by-catch in the recreational angling fisheries (see the Legal Protection section of the recovery strategy for details). An additional reduction to the angling season (from July 1 - October 31 to July 1 - September 30) on the Petite lakes was implemented in 2011 to further reduce the risk to pre-spawning Atlantic Whitefish in the fall. The continued review and management of recreational angling fisheries on the Petite Rivière is particularly important as efforts progress to establishing anadromy of Atlantic Whitefish in this watershed. Promoting immediate release of incidentally caught Atlantic Whitefish and educating anglers on best handling practices would be important in enhancing the species survival. Furthermore, continuing to use existing mechanisms to gather incidental capture information and exploring further ways to collaborate with the Province on gathering this information will help evaluate the impact of this activity as recovery efforts progress. Additional measures to reduce incidental capture of Atlantic Whitefish in recreational fisheries in any new areas (e.g., Anderson Lake) may also be required.

Approach 1.3; ensure regulatory compliance.

7) Apply new and existing regulatory frameworks and management tools to protect Atlantic Whitefish and their habitat including in new areas where Atlantic Whitefish are released.

Various regulations and land use management practices are in place to protect Atlantic Whitefish and their habitat, with a current focus on the Petite lakes. For example, DFO fishery officers from the local Liverpool detachment have been active on the Petite Rivière watershed in recent years, dedicating a significant proportion of their efforts to the enforcement and public awareness of regulations to protect Atlantic Whitefish. These efforts have been expanded to include Anderson Lake and they should be expanded in new areas where Atlantic Whitefish are released.

Under the Fisheries Act, the Fisheries Protection Program (FPP) reviews projects that may impact fish that are part of a commercial, recreational, and/or Aboriginal fishery or to fish that support such a fishery to assess compliance with the Fisheries Act and SARA.

The Petite lakes have also been protected since 2006 by a Protected Water Area designation under the Nova Scotia Environment Act. As part of this designation, regulations[4] are in place which address activities in the watershed that could impact water quality (e.g., activities associated with agriculture, forestry, road construction, commercial, industrial, residential and recreational development, and certain aspects of mining).

The effective use and enforcement of the existing and amended regulatory framework and tools described above as well as any new regulatory tools (e.g., potential Wilderness Protected Area designation as outlined in Recovery Measure #11 and SARA critical habitat) will be important for the continued survival of Atlantic Whitefish.

8) Report and evaluate incidents of non-compliance.

There have been few reports of non-compliance against Atlantic Whitefish and their habitat to date. Furthermore there have been no direct violations to the species or its habitat under the Fisheries Act or SARA and few indirect violations associated with closed areas due to the presence of Atlantic Whitefish. Suspicious activities or alleged infractions can be reported directly to DFO's Conservation and Protection (C&P) Office at (902) 354-6030 or to Crime Stoppers at 1-800-222-TIPS (8477). Environmental emergencies in the Petite Rivière watershed can be reported to 1-800-565-1633 where information is then directed to the appropriate authority either within DFO and/or to another government department if necessary. Response to habitat-related incidents are evaluated based on each situation but may vary from site remediation to charges under the Fisheries Act or SARA. Information received on incidents of non-compliance to Atlantic Whitefish individuals is subsequently recorded, analyzed, and investigated. A timely response, as well as high visibility patrols and investigations resulting from receiving information have proven to be an asset to the protection of Atlantic Whitefish. Current practices will be evaluated and adapted as necessary to accommodate changing conditions.

Approach 1.4; develop and implement watershed and site specific habitat quality management and protection.

9) Use best management practices, and contingency and remediation plans with any new construction or excavation activities within the Petite lakes to maintain water quality within parameters known to support Atlantic Whitefish.

There are new highway construction works currently planned in the vicinity of the Petite lakes and watershed, and the potential for future mining and quarry excavation activities. Acid run-off from construction and excavation activities (e.g., mines and quarries) can pose a threat to fish and fish habitat by impacting the water quality in the lakes and creating an acidic environment. The lands around the Petite lakes, and a

[4] Link to Town of Bridgewater Public Service Commission Watershed Protected Area including regulations: https://www.bridgewater.ca/town-services/water-services-psc/watershed-protected-area

large proportion of the Petite Rivière watershed, are underlain by geological rock formations made up of greywacke and slates. Activities that expose acid-generating slates to air and surface runoff may pose a threat to the Atlantic Whitefish and its habitat in the Petite lakes if not properly mitigated or remediated. Collaboration with the Nova Scotia Departments of Transportation and Infrastructure Renewal (NSTIR) and Natural Resources (NSDNR), Bridgewater Public Service Commission (BPSC), and regulators (e.g., Nova Scotia Environment) is required to ensure development proposals for excavation activities within the Petite Rivière watershed use best management practices and include contingency and remediation plans for dealing with this potential threat.

10) **Engage land users and owners in the Petite Rivière watershed to minimize negative impacts of their activities on Atlantic Whitefish and become involved in the activities of the Recovery Team.**

The Minamkeak, Milipsigate, and Hebb Lakes and the waterways that connect these lakes, as well as the fish passage facility at Hebb Lake Dam, are identified as critical habitat for Atlantic Whitefish in the recovery strategy (DFO 2018). In addition, a land mass larger than the total area of the lakes, but less than one-half the lakes' watershed, is designated a 'Watershed Protected Area'. The PSCB is an active member of the Recovery Team and manages activities under its control in a manner largely consistent with the well-being of Atlantic Whitefish. Landowners will need to continually minimize any potential negative impacts of their activities on the lake-resident Atlantic Whitefish population. Efforts are required to engage all land users to participate and become engaged in the implementation of the action plan and the activities of the Recovery Team to ensure their activities are not in contravention of federal or provincial regulations, including SARA critical habitat provisions.

11) **Support the NSE in establishing the lands around the Petite lakes as a 'Wilderness Area'.**

The Nova Scotia Environment (NSE), Protected Areas Branch, has had recent success in partnering with municipalities for Wilderness Area designation of town water supply lands. Protecting naturally functioning ecosystems is complementary to the objective of protecting water quality. Subsequently, planners with the NSE identified Bridgewater's water supply as a potential candidate for joint wilderness-water supply protection. A Wilderness Area designation could potentially provide additional protection for the endangered Atlantic Whitefish population, by precluding development of shorelines, brooks, and wetlands that surround the lakes. Commercial resource development activities on these public lands (e.g., mining, forestry) would also have greater restrictions within the lands captured by the Wilderness Protected Area designation. The implementation of this Recovery Measure will further support the implementation of Recovery Measure #10. Since the fall of 2008, NSE has initiated discussions with various potential partner organizations to determine the support of the designation, including a presentation to Recovery Team members in November 2009 and October 2011. DFO and Recovery Team members will continue to facilitate discussions with

NSE on the benefits of this potential designation and assist this effort where possible with the provision of necessary support and information.

Broad strategy 2:
Increase the number and range of viable populations.

Range expansion involves establishing additional self-sustaining freshwater resident populations outside the Petite lakes and viable anadromous populations in several watersheds in the Nova Scotia Southern Uplands eco-region, including the Petite Rivière. Range expansion is contingent upon the availability of life-stages of fish in numbers that can establish viable populations. Range expansion should proceed using an adaptive management approach. Socio-economic, ecological, and management criteria should be considered when selecting candidate sites.

Approach 2.1; document and identify the knowledge and means to support range expansion needs.

12) Identify viable mechanisms to support range expansion.

a) Share the documented captive-breeding methodologies.

Expertise and culture techniques for Atlantic Whitefish captive-breeding were developed and improved at the DFO Mersey Biodiversity Facility from 2000 until its closure in 2012. Documentation of the methodologies developed at the Mersey Biodiversity Facility was accomplished in 2015 and reported in a Culture Handbook (Whitelaw et al. 2015). This report has been shared with the Recovery Team. The sharing of these documented methodologies with any new potential partners will inform future initiatives.

b) Develop options for future range expansion initiatives.

The continued commitment and cooperation of the AWCRT and other partners will be needed to identify viable mechanisms and potential partnering opportunities and arrangements to implement the recovery measures required to expand the range of Atlantic Whitefish and achieve the distribution objective.

Approach 2.2; establish Atlantic Whitefish populations in locations beyond their current range.

The implementation and success of fish introductions is contingent upon the successful implementation of Recovery Measure #12.

13) Identify priority locations for introduction initiatives.

a) Evaluate potential lakes and riverine locations for introduction efforts.

For existing locations (i.e., Anderson Lake) monitoring should be undertaken where Atlantic Whitefish have already been introduced to confirm the population status and identify whether a self-sustaining population has been established (see Recovery Measure #1). Depending on the outcomes of this monitoring, additional introductions into Anderson Lake could be considered.

Expanding the range of Atlantic Whitefish is likely to require additional efforts to introduce populations in lakes and rivers. Establishing additional lake populations would provide a contingency in the event of a catastrophic event in the Petite Rivière watershed. Other lakes outside the Petite Rivière should also be evaluated and considered for freshwater lake-resident introductions.

Riverine introduction initiatives should also be pursued to create anadromous populations including that of the existing population in the Petite Rivière. Advice from the RPA (DFO 2009) suggests that establishing several Atlantic Whitefish populations in different watersheds will increase the probability that the species will be self-sustaining in the long term. A 'Decision Support Tool' (DST) to guide decisions on Atlantic Whitefish freshwater introduction sites was developed by DFO in 2004 (DFO 2004). This tool considers socio-economic, ecological, and management criteria in the selection of candidate sites. Similar criteria are needed to guide the selection of candidate rivers for the establishment of anadromous Atlantic Whitefish populations and should be developed to ensure there is a good understanding of current and future factors within candidate watersheds (e.g., habitat quality, barriers to fish passage, invasive fish species). A recent PhD thesis has increased knowledge on the evaluation of habitat suitability for translocation of Atlantic Whitefish and thereby enhanced decision making capabilities for identifying priority locations (Cook 2012).

b) Evaluate and continue to undertake water quality monitoring on the Tusket and Petite Rivière watersheds.

The Bluenose Coastal Action Foundation has collected water quality data (e.g., temperature, conductivity, total dissolved solids, salinity, dissolved oxygen and pH) on the Petite Rivière for many years. Water quality data has also been collected by Nova Scotia Power Inc. on the Tusket system. These data should be assessed for significant trends and used in both developing criteria to select riverine release locations and also in evaluating influence of water quality on Atlantic Whitefish recovery. Water quality monitoring on the Petite Rivière and Tusket watersheds should continue and collection protocols should be reviewed and revised as required to address information needs to support recovery efforts.

14) Develop and implement operational plans for range expansion activities.

Before undertaking introduction activities at any selected new location, either freshwater or riverine, a site-specific operational plan must be in place. It is also recommended that trial efforts be attempted prior to larger scale introduction efforts to answer research questions and test logistics. In areas with sea access, plans must encompass all areas

from the location of release, and into estuarine and coastal areas. All plans should minimally address the following:

- regulatory considerations:
  - ensure that conservation, protection, and potential restoration needs are met for the species and its habitat
  - permits and/or authorizations required with respect to all anticipated human interactions and on-going activities
  - if populations are successfully established, critical habitat identification and protection for these new areas must be considered and the appropriate steps taken
- logistical needs (e.g., availability of desired life-stage in numbers needed, availability of a secure niche for trials, availability of local group to partner/collaborate with)
- desired knowledge outcomes of any trial research efforts (e.g., scope for harm, estimates of resources required to implement larger scale re-introduction efforts)
- monitoring needs and protocols
- performance indicators
- adaptive management practices and measures to ensure sustainable populations, new critical habitat, and success of recovery efforts.
- public engagement and stewardship: in addition to the regulatory considerations, communication with and engagement of resource users and land owners upfront creates support for recovery measures and helps minimize the impact of human activities on Atlantic Whitefish and their habitat

Approach 2.3; enable the Petite Rivière population to become anadromous.

15) Pursue opportunities for implementation of fish passage at Crousetown Dam and improvements to other impediments in the Petite Rivière.

The existing population of Atlantic Whitefish is largely restricted within the Petite lakes. The RPA indicates that the potential for survival of this population may be higher if anadromy is established in this watershed. A series of dams along the main stem of the watershed and between the three headwater lakes blocked or continue to impede fish passage. Improving fish passage at all impediments would help create the conditions to allow anadromy. The importance of improving fish passage on the Petite Rivière and measures taken to date, including the construction of a fish passage facility at Hebb Lake Dam, are highlighted in Recovery Measure #4 and in the recovery strategy (DFO 2018).

Although Hebb Lake Dam is the first dam at the foot of the Petite lakes, a dam without adequate fish passage downriver at Crousetown further restricts fish that might descend to and return from the estuarine/marine environment. The Crousetown Dam is the first impediment to fish passage that Atlantic Whitefish would face when moving upstream in the watershed and was identified by the Recovery Team as one of the highest priority

sites for improving fish passage (DFO 2006b). Significant efforts have been undertaken by DFO for several years to advance fish passage at the privately owned Crousetown Dam, but these have been challenged by issues of ownership, liability, and opportunities for funding. DFO continues to seek opportunities to advance this important project and work towards establishing all necessary fish passage improvements on the Petite Rivière system.

Fish passage is also impeded at two other locations between Petite lakes. Improving fish passage at these sites would facilitate the exchange of Atlantic Whitefish individuals among the distinct lakes with the potential benefit of increased opportunity for genetic interaction and greater availability of a diversity of habitat. Restoring connectivity between the lakes would also provide access to and from the river and tidal waters for all members of the species irrespective of their lake of origin. Preliminary functional designs for fish passage at each barrier location on the Petite Rivière were produced in 2005 by an engineer hired by DFO (Conrad 2005) thereby allowing for further benefits to survival and recovery of Atlantic Whitefish to be added with time. Additionally, the BPSC, as part of a recent comprehensive review of dam safety (outlined in Recovery Measure #5) have implemented the required upgrades that will facilitate some fish passage at the current lake reservoir operating levels. These recent upgrades to their structures will not interfere with future plans to develop fish passage facilities within the municipal water supply area of the Petite Rivière watershed. Given the current presence and ongoing concerns with the continued spread of Smallmouth Bass and Chain Pickerel in the Petite Rivière system, any fish passage improvements should consider the need to restrict passage of these aquatic invasive species.

Broad strategy 3:
Address knowledge gaps relating to the species and its habitat.

Approach 3.1; implement scheduled quantitative assessments of species status.

16) Monitor and assess the status of the existing population of Atlantic Whitefish in the Petite lakes.

The absolute abundance of wild Atlantic Whitefish is unknown but is considered to be low (DFO 2009; COSEWIC 2010). A variety of techniques to confirm the continued presence of Atlantic Whitefish within the Petite lakes have been undertaken in the past decade (DFO 2009) but these have not been effective in assessing their abundance in these lakes. The recovery strategy has identified a ‘watershed specific abundance target’ of 1,275 mature individuals as the interim population objective for the species (DFO 2018). To assess survival, recovery and status with respect to a watershed abundance target it is proposed that at a minimum, monitoring activities should aim to i) establish whether Atlantic Whitefish continue to produce new individuals annually in Minamkeak Lake, ii) determine the response of Atlantic Whitefish in Hebb and Milipsigate Lake to the presence of Smallmouth Bass and Chain Pickerel, and iii) assess the response of Atlantic Whitefish to invasive species control measures.

Regardless of the platform used, monitoring is required to evaluate survival (continued presence and reproductive success) and progress toward recovery, as well as establishing an estimate of population size.

17) Monitor and, once established, assess the status of new populations of Atlantic Whitefish.

As efforts progress towards establishing additional populations of Atlantic Whitefish, these introductions will need to be monitored to evaluate their success and eventually have their status assessed once established as self-sustaining. This would include assessing the status of Atlantic Whitefish in Anderson Lake (in addition to the monitoring outlined in Recovery Measure #1) once they become established as a self-sustaining population. This measure will be important for future COSEWIC assessments of the species status and will also assist in measuring progress towards achieving the population and distribution objectives of the recovery strategy.

Approach 3.2; develop and undertake research programs to identify habitat requirements (freshwater, estuarine, and coastal), including a determination of the applicability of the residence concept to Atlantic Whitefish and studies to refine or identify new areas of critical habitat.

18) Undertake habitat research activities outlined in the Schedule of Studies section of the Recovery Strategy.

Atlantic Whitefish survival depends upon its continued production within Minamkeak, Milipsigate, and Hebb Lakes and thus, this habitat is considered necessary for its survival (DFO 2009). The fish passage facility at the Hebb Dam was constructed to provide passage of Atlantic Whitefish and therefore is required for both the species current survival and future recovery. Accordingly, these three lakes, as well as the fish passage facility at Hebb Lake Dam, are identified as critical habitat in the recovery strategy (DFO 2018). However, i) the utilization of the various habitats within these lakes by the different life history stages of Atlantic Whitefish is not well understood, ii) the characteristics of suitable spawning habitat are not known, and iii) the habitat preferences of Atlantic Whitefish are not well understood. The habitat requirements for this species in rivers, estuaries, and the marine environment are also largely unknown and these areas may be required for the species subsequent recovery. As activities to enable anadromy and extend the species' range are implemented, particularly implementation of fish passage on the Petite Rivière, studies that would contribute to our understanding of how Atlantic Whitefish use the lower lakes, river, estuary, and coastal zone are required to determine if additional areas of critical habitat are found in relevant riverine, estuarine, and marine habitat areas. Hence, investigations outlined in the Schedule of Studies of the recovery strategy (DFO 2018) should yield information important to proposals for refinement of the identified critical habitat and potential additions to habitat necessary for recovery. See the recovery strategy (DFO 2018) for details on the identified critical habitat and the research activities outlined in the Schedule of Studies.

19) Re-evaluate the applicability of the SARA residence concept for Atlantic Whitefish.

During the 2009 RPA, it was noted that the available information indicates that the residence concept and hence its definition under SARA does not apply to Atlantic Whitefish. However, national level guidance and criteria for determining the applicability of the residence concept for aquatic species has more recently been finalized (DFO 2015), and the concept for Atlantic Whitefish will require re-consideration, once further information is acquired on the precise features as well as location and use of such features that support the species habitat functions.

Approach 3.3; continue to conduct research to address knowledge gaps including, but not limited to, genetics, health (including disease and parasites), nutrition, life cycle history, behaviour, and physiology.

20) Complete reports on existing research studies, data collection, and monitoring work.

The state of knowledge about the basic biology and ecology of Atlantic Whitefish has increased but is limited. Although reports on some activities have recently been published (e.g., Anderson Lake releases [Bradford et al. 2015] and Atlantic Whitefish captive-breeding methodology [Whitelaw et al. 2015]), a number of other activities that have been undertaken in recent years have not yet been fully documented and made available to all participants supporting survival and recovery efforts. A focus on providing the results of recent undertakings would increase the understanding of the species and assist in decisions related to future efforts. These would include reports on the scope for interaction between Atlantic Whitefish and aquatic invasive species (i.e., Smallmouth Bass and Chain Pickerel) as well as the results of the 3-year (2014-2016) collaborative boat-electrofishing program, trophic position of wild lake-resident populations of Atlantic Whitefish, physiological ecology of Atlantic Whitefish, and documenting the results of acoustically tagged Atlantic Whitefish released in the lower Petite Rivière in 2007. Documenting the efforts and outcomes of the Hebb Dam fishway monitoring during the first five years of operation (2012-2017) would also be valuable. It would also be important to publish the Decision Support Tool developed by DFO in 2004 to assess candidate lakes for introductions.

21) Plan and undertake research studies as new gaps in knowledge important for recovery become apparent.

Additional research and monitoring activities have been outlined in the RPA (DFO 2009) and the recovery strategy (DFO 2018). As recovery efforts progress, future studies may need to be planned and undertaken to address new gaps in knowledge as they become apparent.

Approach 3.4; assess the degree of risk posed by current and emergent threats.

22) Review Smallmouth Bass documented survey results (i.e., report) and results of the 3-year boat-electrofishing program for both Smallmouth Bass and Chain Pickerel in the area of the Petite Lakes to evaluate appropriate next steps and future mitigation options.

See Recovery Measure #3 for background on this recovery measure; the report on the documented Smallmouth Bass survey results within the Petite lakes should provide insight to the degree to which Smallmouth Bass are a threat to the habitat and survival/recovery of the resident Atlantic Whitefish populations in the Petite lakes. This report, in conjunction with information on the occurrence of Chain Pickerel in the area of the Petite lakes, including the results of the 3-year boat-electrofishing program, would provide insights to assist in the development, selection, and implementation of appropriate next steps and future mitigation options.

Broad strategy 4: Increase public involvement in, and acceptance of, measures required for the species survival and recovery.

Approach 4.1; develop a communication plan.

23) Finalize an adaptive communication plan.

Compared to other endangered species, the Atlantic Whitefish was not particularly well known and did not generate a high level of interest among the general public when it was included in Schedule 1 when SARA was proclaimed in 2003. The species uniqueness and highly restricted distribution heightens the need for increasing the level of stakeholder and public concern and sense of responsibility for the survival and recovery of this species because it is both crucial to ensuring the species survival within its current three lake distribution and necessary to ensure the success of ongoing and planned recovery efforts. A Communications Subcommittee of the Recovery Team was founded early on to identify, explore, and lead outreach, communication, and education opportunities. Since, this Subcommittee has effectively pursued and exploited most opportunities within their sphere and respective areas of influence (a summary of key communication activities and outcomes undertaken during the February 2007 to February 2012 time period are outlined in the first 5-year progress report on recovery strategy implementation (DFO 2016)); details on specific products, events, etc. are outlined in the Activity Table maintained by the Recovery Team and are available upon request from the Species at Risk Management Division, Maritimes Region, by email or by phone at 1-866-891-0771), and much success was achieved, but the Subcommittee still needs to develop a shared adaptive communication plan. This comprehensive plan will be an increasingly important tool to promote collaboration, avoid duplication, adapt to new information and techniques, and guide appropriate communication efforts. This is particularly important to support efforts and collaborations towards establishing anadromy on the Petite Rivière and expanding the species range to new areas.

Approach 4.2; develop a strategy to encourage public support for survival and recovery actions.

24) Implement the communication plan and seek opportunities to inform the public.

As outlined above and detailed in the Activity Table maintained by the Recovery Team, members and other groups have sought out numerous opportunities to promote the uniqueness and raise awareness of the endangered Atlantic Whitefish within the Petite lakes, and their conservation needs and recovery efforts. Recovery Team members are encouraged to continue to seek out opportunities to inform the local community and expand their audience; this will be particularly important as recovery efforts progress towards establishing anadromy on the Petite and range extension into new areas. The implementation of Recovery Measure #25 will assist in identifying appropriate tools and opportunities.

Approach 4.3; encourage partnering and stewardship initiatives aimed at conserving, protecting, and managing the species and its habitat.

25) Encourage a partnered approach and identify stewardship opportunities for stakeholders.

The principle external funding source used to support Atlantic Whitefish stewardship initiatives has to date been the federal government's Habitat Stewardship Program for Species at Risk (e.g., the Atlantic Whitefish Recovery Project undertaken by the Bluenose Coastal Action Foundation). Two other federal funding programs directly involved in the protection and recovery of species at risk are the Interdepartmental Recovery Fund and the Aboriginal Fund for Species at Risk. The federal Recreational Fisheries Conservation Partnerships Program may also provide funding opportunities to those interested in undertaking activities to restore fisheries habitat. Funding opportunities also exist within the Nova Scotia Salmon Association's Adopt-a-Stream program, Environment and Climate Change Canada's Environmental Damages Fund and EcoAction Community Funding Program. Government agencies are to continue providing advice and assistance to 'stewards' in identifying stewardship opportunities to support the conservation, protection, and management of Atlantic Whitefish and their habitat within both their current as well as in expanded or new areas.

Approach 4.4; promote Recovery Team meetings as opportunities for communication and collaboration among all team members.

26) Continue to hold regular meetings of the Recovery Team.

The Atlantic Whitefish Conservation and Recovery Team was first formed in 1999 and meetings were held twice annually. In addition, subcommittees or working groups are occasionally assembled around specific tasks. Spring meetings generally communicate

and co-ordinate plans relevant to the coming field season; fall meetings attempt to relate progress on projects/programs conducted subsequent to the spring meeting and discuss next steps. Spring and fall meetings of the Recovery Team should continue to share information and ideas on current and planned recovery measures as well as discussing any emergent issues. Terms of Reference for the Recovery Team have been developed. Recovery Team membership and a summary of the team's key functions are outlined in the recovery strategy.

1.2.2 Implementation schedule

The Implementation Schedule presented in Table 1 and 2 outlines the recovery measures identified in Section 1.2.1 by responsible party, including, where available, proposed methodology for monitoring, as well as the priority of each measure, the threat(s) or concern(s) to the species being addressed under each broad strategy, and the status and timeline within which the measure will be accomplished. To facilitate linkages, the recovery measures described in both tables are organized in the same numerical order as the corresponding measures presented in the preceding narrative section.

These recovery measures are meant to outline what needs to be done to achieve the population and distribution objectives for the Atlantic Whitefish. The measures presented in this action plan are meant to refine the recovery planning process by identifying activities that can be used to guide not only activities to be undertaken by DFO, but also those for which other jurisdictions, organizations, and individuals committed to Atlantic Whitefish recovery have a role to play. This action plan builds upon many successful activities already underway (conducted by DFO or by other organizations), while at the same time recognizing that other measures need to be undertaken or enhanced. DFO will continue to assess the feasibility and effectiveness of recovery measures and work cooperatively with the multi-stakeholder Atlantic Whitefish Conservation and Recovery Team, who act as an expert advisory body providing information and guidance to DFO, and other interested parties towards the recovery of Atlantic Whitefish. In addition, where appropriate, DFO seeks to engage with organizations or individuals and enter into a Conservation Agreement under s. 11 of SARA to implement the relevant conservation measures.

Success in the recovery of this species is not solely dependent on the actions of any single jurisdiction; rather it requires the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan. DFO strongly encourages all Canadians to participate in the conservation of Atlantic Whitefish through undertaking priority recovery measures outlined in this action plan.

Table 1 identifies the recovery measures to be led by DFO, in cooperation and consultation with other agencies, organizations, and individuals as appropriate, to support the recovery of Atlantic Whitefish. As all Canadians are invited to join in supporting and implementing this action plan for the benefit of the Atlantic Whitefish and

Canadian society as a whole, Table 2 identifies the recovery measures that would support the recovery of Atlantic Whitefish that could be undertaken by DFO in collaboration with other organizations or jurisdictions, or those measures that could be undertaken voluntarily by other jurisdictions, groups, and individuals interested in participating in the recovery of this species. If your organization is interested in participating in one of these measures, please contact the Species at Risk Management Division, Maritimes Region, by email or by phone at 1-866-891-0771.

Table column headings:

Recovery Measures: The “Recovery Measures” column lists the activities or actions that will be taken to implement the recovery strategy, including those to achieve the population and distribution objectives and address the threat(s) or concern(s) to the species. They are linked directly to the broad strategies and approaches provided in the recovery strategy and are relevant to the geographic scope of the action plan. Where appropriate, it includes the method for monitoring the recovery measure.

Partners: The "Partners" column lists the jurisdictions, organizations, and other parties currently or potentially involved in completing the stated recovery measures. The relevant DFO sectors involved in either a leading or supporting role are identified as appropriate. This action plan is also intended to encourage other groups to become involved and these future partnerships may not be completely captured within this document.

Below is a list of acronyms used in the Implementation Schedule (Tables 1 and 2):

BCAF	Bluenose Coastal Action Foundation
DFO	Fisheries and Oceans Canada
ENGO	Environmental Non-Government Organization
NSDFA	Nova Scotia Department of Fisheries and Aquaculture
NSDNR	Nova Scotia Department of Natural Resources
NSE	Nova Scotia Environment
NSPI	Nova Scotia Power Incorporated
NSTIR	Nova Scotia Department of Transportation and Infrastructure Renewal
PSCB	Public Service Commission of Bridgewater
SWNS	Southwest Nova Scotia

Priority: Priority levels (low, medium, or high) are assigned to reflect the direct contribution a recovery measure is expected to have on addressing the stated threat or concern under the relevant broad strategy, and thus the degree to which the activity is expected to contribute to the survival or recovery of Atlantic Whitefish. 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 departmental and conservation priorities.

- High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the recovery objective for Atlantic Whitefish and are thus considered to be most urgently needed to ensure the species survival or of highest importance for the species' recovery. In some cases, a high priority action may need the completion of another stated high priority action before it can be accomplished.
- Medium priority measures may have a less immediate or less direct influence on reaching the recovery objectives, but are still important for recovery of the population.
- Low priority recovery measures will likely have an indirect or gradual influence on reaching the recovery objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of Atlantic Whitefish.

Threats or concerns addressed: The "Threats or Concerns Addressed" column includes the main threat to the survival or recovery of the species or concern being addressed by the stated recovery measure associated under the relevant broad strategy.

Status: The "Status" column reflects whether an activity has been initiated, with two status categories:

- Not started
- Underway

Timelines: The "Timeline" column refers to the estimated approximate timeline to completion from the date of publication of this action plan:

- Short: < 2 years
- Medium: 2-5 years
- Long-term: > 5 years
- Continuous (i.e., the activity will be ongoing over time)

Table 1. Recovery measures for Atlantic Whitefish to be led by Fisheries and Oceans Canada.

#	Recovery measures	Priority	Threats orconcerns addressed	Status / Timeline
Broad strategy 1: conserve, protect, and manage the species and its habitat.				
	Approach 1.1: address emergent threats to survival.			
1	Monitor the Atlantic Whitefish introduced to Anderson Lake to determine if a self-sustaining population has resulted.	High	Extinction of the species	Underway / Continuous
Broad strategy 2: increase the number and range of viable populations.				
	Approach 2.1: document and identify the knowledge and means to support range expansion needs.			
12	Identify viable mechanisms to support range expansion. a) Sharing the documented supporting methodologies	High	Absence of anadromy / Range expansion	Underway / Continuous
	Approach 2.2: establish Atlantic Whitefish populations in locations beyond their current range.			
13	Identify priority locations for introduction initiatives. a) Evaluate potential lakes and riverine locations for introduction efforts	High	Range expansion	Underway / 2-5 yrs
Broad strategy 3: address knowledge gaps relating to the species and its habitat.				
	Approach 3.1: implement scheduled quantitative assessments of species status.			
16	Monitor and assess the status of the existing population of Atlantic Whitefish in Minamkeak, Milipsigate, and Hebb Lakes.	High	Extinction of the species	Underway / 2-5 yrs
17	Monitor and, once established, assess the status of new populations of Atlantic Whitefish.	High	Range expansion	Not started / Continuous
	Approach 3.2: develop and undertake research programs to identify habitat requirements (freshwater, estuarine, and coastal), including a determination of the applicability of the residence concept to Atlantic Whitefish and studies to refine and identify new			

#	Recovery measures	Priority	Threats orconcerns addressed	Status / Timeline
	areas of critical habitat.			
18	Undertake the habitat research activities outlined in the Schedule of Studies section of the recovery strategy.	High	Lack of knowledge of habitat characteristics / Destruction of habitat	Underway / 2-5 yrs
19	Re-evaluate the applicability of the SARA “residence” concept to Atlantic Whitefish.	Low	Destruction of residence	Not Started / 2-5 yrs

Table 2. Collaborative recovery measures for Atlantic Whitefish to be undertaken jointly by Fisheries and Oceans Canada and its partners**.**

#	Recovery measures	Partners	Priority	Threats or concerns addressed	Status / Timeline
Broad strategy 1: conserve, protect and manage the species and its habitat.					
	Approach 1.1: address emergent threats to survival.				
2	Strengthen and enforce provincial regulations to reduce the spread of non-native species such as Smallmouth Bass (Micropterus dolomieu) and Chain Pickerel (Esox niger).	NSDFA; DFO	High	Competition and predation by non-native species	Underway / Continuous
3	Document, evaluate and address threats posed by aquatic invasive species (i.e., Smallmouth Bass and Chain Pickerel) in the Petite lakes: a) Gather and analyse data regarding the life history, ecology, status, and spawning areas of Smallmouth Bass present in Minamkeak, Milipsigate, and Hebb Lakes on the Petite Rivière and compile information into a report (Recovery Measure #20). Also, gather and review information on the occurrence of Chain Pickerel in the area of the Petite lakes and the effectiveness of the current 3-year boat-electrofishing program. b) Evaluate next steps and future options for mitigating threats and propose recommended solutions. c) Develop and implement management approaches to mitigate or eliminate the threat to Atlantic Whitefish depending on the outcome of 3(a) and informed by 3(b).	ENGO (e.g., BCAF); NSDFA; DFO	High	Competition and predation by non-native species	Underway / a) < 2 yrs b) < 2 yrs c) 2-5 yrs
4	Monitor the fish passage facility constructed at the Hebb Lake Dam to determine fish usage.	NSPI; PSCB; ENGO (e.g., BCAF); DFO	High	Loss of individuals from population	Underway / < 2 yrs
5	Work collaboratively with regulators on establishing lake level management and appropriate flow regimes to protect Atlantic Whitefish critical habitat.	PSCB; DFO	Medium	Damage to or loss of habitat	Underway / < 2 yrs
	Approach 1.2: develop and implement mitigation measures to minimize human-induced harm to the species and its habitat.				
6	Continue to review and manage licensed recreational angling fisheries to ensure that impacts to Atlantic Whitefish are minimized or eliminated.	NSDFA; DFO	Medium	Harm to or loss of individuals	Underway / Continuous

#	Recovery measures	Partners	Priority	Threats or concerns addressed	Status / Timeline
				from population	
	Approach 1.3: ensure regulatory compliance.				
7	Continue to apply new and existing regulatory framework and management tools to protect Atlantic Whitefish and its habitat, including in new areas where Atlantic Whitefish are released.	PSCB; DFO	High	Harm to or loss of individuals from population / damage or destruction of habitat	Underway / Continuous
8	Report and evaluate incidents of non-compliance.	NGOs; General public; DFO	Medium	Harm to or loss of individuals from population / damage or destruction of habitat	Underway / Continuous
	Approach 1.4: develop and implement watershed and site specific habitat quality management and protection.				
9	Use best management practices, and contingency and remediation plans with any new construction or excavation activities within the Petite lakes to maintain water quality within parameters known to support Atlantic Whitefish.	NSTIR, NSDNR, PSCB, NSE, EC, Recovery Team members	High	Damage or destruction of habitat from land-based sources	Underway / Continuous
10	Engage all land users and landowners in the Petite Rivière watershed (e.g., forest harvest industries, public water supply utilities and other resource-users) to: a) minimize the potential negative impacts of their activities on Atlantic Whitefish and their habitat through development and implementation of best practices b) become actively involved in implementation of the action plan and activities of the Recovery Team	PSCB; land resource users; DFO	a) Medium b) Low	Impacts to habitat from land-based sources	Underway / 2-5 yrs
11	Support the Protected Areas Branch, Nova Scotia Environment (NSE), in its proposal to explore the concept of establishing the public lands around Minamkeak, Milipsigate, and Hebb lakes as a provincial 'Wilderness Area'.	Recovery Team members; NSE; DFO	Medium	Impacts to habitat from land-based	Underway / < 2 yrs

#	Recovery measures	Partners	Priority	Threats or concerns addressed	Status / Timeline
				sources	
Broad strategy 2: increase the number and range of viable populations.					
	Approach 2.1: document and identify the knowledge and means to support range expansion needs.				
12	Identify viable mechanisms to support range expansion. b) Develop options for future range expansion initiatives	Recovery Team members; DFO	High	Absence of anadromy / Range expansion	Underway / 2-5 yrs
	Approach 2.2: Establish Atlantic Whitefish populations in locations beyond their current range.				
13	Identify priority locations for range expansion initiatives. b) Evaluate and continue to undertake water quality monitoring on the Tusket and Petite Rivière watersheds	NSPI (on Tusket); BCAF (on Petite)	Medium (for both the Tusket and Petite)	Acidification	Underway / Continuous
14	Develop and implement operational plans for range expansion activities.	Recovery Team members; DFO	High	Extinction of the species / Range expansion	Underway / 2-5 yrs
	Approach 2.3: enable the Petite Rivière population to become anadromous.				
15	Pursue opportunities for implementation of fish passage at the Crousetown Dam and improvements to other impediments in the Petite Rivière.	PSCB; ENGO; DFO	High	Impediments to fish passage	Underway / 2-5 yrs
Broad strategy 3: address knowledge gaps relating to the species and its habitat.					
	Approach 3.3: continue research to address knowledge gaps including, but not limited to genetics, health (including diseases and parasites), nutrition, life cycle history, behaviour, and physiology.				
20	Complete reports on existing results of research studies, data collection, and monitoring work relating to Atlantic Whitefish.	ENGO; Academia; DFO	Medium	Lack of knowledge documentation	Underway / < 2 yrs

#	Recovery measures	Partners	Priority	Threats or concerns addressed	Status / Timeline
21	Plan and undertake research studies and monitoring programs as new gaps in knowledge important for recovery become apparent.	ENGOs; NSDFA; Academia; DFO	Medium	Lack of knowledge	Not started but as required
	Approach 3.4: assess the degree of risk posed by current and emergent threats.				
22	Review documented results of the Smallmouth Bass surveys in Minamkeak, Milipsigate, and Hebb Lakes (Recovery Measure #3a) upon its completion in conjunction with the reported efforts and outcomes of the 3-year invasive species boat-electrofishing program to evaluate results for implementation of Recovery Measure 3c.	NSDFA; ENGO (e.g., BCAF); DFO	High	Competition and predation by non-native species	Underway / < 2 yrs
Broad strategy 4: increase public involvement in, and acceptance of, measures required for the species survival and recovery					
	Approach 4.1: develop a communications plan.				
23	Finalize an adaptive communications plan to address relations (within the Recovery Team and with the general public) on current and future Atlantic Whitefish issues and recovery efforts using the Communications Subcommittee of the Recovery Team.	Recovery Team Communi-cations Sub-committee members; DFO	Medium	Absence of a communication tool	Underway / < 2 yrs
	Approach 4.2: develop a strategy to encourage public support for survival and recovery actions.				
24	Seek opportunities to implement the communications plan (Recovery Measure #26) and inform the public.	Recovery Team members	Low (Petite lakes) Medium/ High (expanded Petite and new populations)	Limited public awareness/ knowledge	Underway / Continuous

#	Recovery measures	Partners	Priority	Threats or concerns addressed	Status / Timeline
	Approach 4.3: encourage partnering and stewardship initiatives aimed at conserving, protecting and managing the species and its habitat.				
25	Encourage a partnered approach to conserving, protecting, and managing Atlantic Whitefish and their supporting habitat and identify stewardship opportunities for stakeholders.	ENGOs; industry, Academia, NSDFA; Aboriginal Peoples; Recovery Team members; DFO	Low (Petite lakes) Medium/ High (expanded Petite and new populations)	Limited public involvement	Underway / Continuous
	Approach 4.4: promote Recovery Team meetings as opportunities for communication and collaborations among all team members.				
26	Continue to hold and encourage participation to regular meetings of the Recovery Team (e.g., spring and fall meetings).	Recovery Team members; DFO	High	Survival and recovery	Underway / Continuous

1.3 Critical habitat

1.3.1 Identification of the species' critical habitat

Critical habitat is defined under s. 2 of SARA as the “habitat necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species”.

Habitat of aquatic species at risk is further defined under s. 2(1) of SARA as:

> “…spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced”.

Critical habitat for Atlantic Whitefish is identified to the extent possible in the recovery strategy (DFO 2018). The recovery strategy also contains details about the identified critical habitat including its geographical location and biophysical functions, features, and attributes.

The Schedule of Studies provided in the recovery strategy outlines the research activities required to identify any additional areas of critical habitat, and to better describe the current identification of critical habitat. Depending on the results of this work, additional critical habitat, or changes to the current description of critical habitat, will be included in future amendments to the recovery strategy.

1.3.2 Examples of activities likely to result in destruction of critical habitat

Examples of activities likely to result in the destruction of critical habitat are outlined in the recovery strategy (DFO 2018).

1.4 Proposed measures to protect critical habitat

Under SARA, critical habitat for aquatic species not found in a place mentioned in s. 58(2) of that Act must be legally protected within 180 days after it is identified in a recovery strategy or action plan. For Atlantic Whitefish critical habitat, it is anticipated that this will be accomplished through the making of a SARA Critical Habitat Order as required by s. 58(4) and (5) of SARA, which will invoke the s. 58(1) prohibition against the destruction of the identified critical habitat.

2. Socio-economic evaluation

2.1 Background

In Canada, Atlantic Whitefish have been listed as an endangered species under the List of Wildlife Species at Risk (Schedule 1) of SARA since June 2003. As such, the species

benefits from legal protections and mandatory recovery requirements which are administered by DFO[5]. Atlantic Whitefish are also protected under the Fisheries Act with supporting regulations providing the tools to protect, conserve, and manage fisheries. Additional protections are afforded through provincial legislation such as the Nova Scotia Endangered Species Act and the Nova Scotia Environment Act. Additional detail on how each of these pieces of legislation work to protect Atlantic Whitefish is provided in the recovery strategy (DFO 2006a and 2018).

In addition to existing legislative and regulatory protections, Atlantic Whitefish has benefited from directed research and recovery efforts. A Recovery Team for the species has existed since 1999, which pre-dates the listing of the species under SARA by several years. This team currently consists of individuals from various levels of government, industry, Aboriginal groups, and environmental organizations (see Appendix A), but has also included academia, community groups, and others. Efforts by the Recovery Team have been instrumental in increasing the understanding of the species and its habitat, as well as raising public awareness and fostering community involvement in recovery initiatives.

A brief summary of the recovery progress and activities completed to date is available on the Atlantic Whitefish species profile page of the SAR Public Registry. A more detailed account of the progress on implementation of the recovery strategy is provided in the Report on the Progress of Recovery Strategy Implementation for the Atlantic Whitefish (Coregonus huntsmani) in Canada for the Period 2007-2012 (DFO 2016). As noted in Section 1.2.2 of this action plan, progress has been possible as a result of successful collaborations between many different groups. Continued recovery efforts are dependent upon continuation of such partnerships. Recovery measures for which DFO has been identified as the appropriate lead organization are listed in Table 1; measures which will require collaborative efforts by DFO and its partners are provided in Table 2, with anticipated partner groups identified.

2.2 **Methodology**

SARA requires the responsible federal minister to undertake “an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation” (SARA s. 49(1)(e), S.C. 2002, c. 29). This section of the action plan identifies the anticipated socio-economic impacts of the proposed measures listed in Tables 1 and 2. For the purposes of this evaluation, it is assumed that the action plan is fully implemented within the specified timelines. The analysis only considers costs and benefits which are incremental to the baseline (e.g., costs/benefits associated with new activities or enhancements to existing activities that are above-and-beyond what is part of current practice or formal commitments). Costs and benefits that are real or reasonably expected to occur are included while those of a highly speculative or uncertain nature are not. An order-of-magnitude estimate of potential costs and benefits

[5] For more information, see: Government of Canada (2003). Species at Risk Act, A Guide.

is provided where sufficient information is available to provide an evaluation. Otherwise, a qualitative statement regarding potential impacts is provided.

Costs and benefits associated with the identification of critical habitat for the Atlantic Whitefish are not considered in this evaluation. A detailed analysis of the incremental impacts will be completed as part of the regulatory process associated with the SARA s. 58(4) Ministerial Order (see Section 1.4).

2.3 **Costs of implementation**

Many measures listed in Tables 1 and 2 represent a continuation of the current activities or commitments of DFO and/or other groups into the foreseeable future. Unless there is an indication that these activities would cease in the absence of this action plan they are considered to be a continuation of the baseline. It is assumed that these activities would carry no incremental costs.

Implementation of some measures could require larger investments. Efforts to establish anadromy in the Petite Rivière watershed, including the construction of fish passage facilities at several additional locations, would require investments in the range of several hundred thousand dollars[6]. Costs associated with construction would be short-term in nature, although costs associated with maintenance and monitoring activities may be incurred over a longer time frame.

Additional investment would also be required in order to fulfil the elements of the Atlantic Whitefish recovery strategy associated with range extension. Both new introductions and re-introductions (i.e., to the Tusket-Annis rivers) would require the identification of a viable mechanism to support introduction needs (i.e., Recovery Measure #12b). Until such a mechanism is identified, it is not possible to identify the associated costs. Furthermore, specific range expansion activities would require an operational plan as described in Recovery Measure #14. Until the details of proposed range extension activities are known in greater detail, precise cost estimates cannot be provided. However, it is reasonable to assume that stocking and subsequent monitoring at any new location is likely to cost tens of thousands of dollars, with the cost varying by the size of the stocked area. Monitoring would require a longer-term investment in order to determine the success of new introductions, although it is likely that time-frames for monitoring would be known before any releases of fish would occur.

It may also cost tens of thousands of dollars annually to complete some of the research and monitoring initiatives included in this action plan. This includes completion of a set of critical habitat research studies noted in the amended recovery strategy (DFO 2018), operation and monitoring at the Hebb Lake Dam fish passage facility, and the development of protocols to monitor the status of the populations that reside within the Petite lakes. It is anticipated that the critical habitat research studies would be

[6] Note: This excludes all costs associated with construction of the new fish passage facility at Hebb Lake Dam, as this work is considered part of the baseline.

completed by DFO within a five year period and therefore represent a short-term cost. Monitoring at the Hebb Lake Dam fish passage facility may require a longer-term investment, though costs, and the intensity of monitoring activities, could be expected to decrease once fish migration timing and usage at the facility is understood and strategic monitoring needs are established. Abundance studies on the Petite lakes would be required every few years, requiring an intermittent long-term investment by DFO.

Other measures may require small scale investments by DFO, industry (e.g., NSPI), environmental groups (e.g., BCAF), or other organizations in order to enhance current capabilities. Examples include potential costs associated with travel to and/or facilitation of meetings, monitoring activities at Anderson Lake, and a possible peer review session for the invasive species reports (i.e., Smallmouth Bass surveys and results of boat-electrofishing program).

Costs associated with the implementation of certain measures cannot be estimated based on available information. For example, it is not possible to identify potential impacts to stakeholders in areas where Atlantic Whitefish introductions may occur as the sites have yet to be determined and the project yet to be designed (see Recovery Measure #14). Similarly, costs associated with future mitigation of the threat posed by invasive species (i.e., Smallmouth Bass and Chain Pickerel) (see Recovery Measure #22) cannot be determined at this time. Until further details emerge on these and other measures, the full cost of implementation cannot be estimated.

2.4 **Benefits of implementation**

Implementation of this action plan will represent an important step towards the recovery of Atlantic Whitefish and the overall goal of the recovery strategy by stabilizing the current population, re-establishing anadromy, and expanding the species' range. An assessment of the contribution of individual measures to recovery is provided in the 'Threats or Concern Addressed' column of Tables 1 and 2.

Other species are likely to benefit from the initiatives contained within this plan. Many species (e.g., Gaspereau (Alosa sp.), Brook Trout, Atlantic Salmon (Salmo salar)) would benefit from improved fish passage, the mitigation of threats posed by invasive species, and various research/monitoring efforts (see Appendix B). Long-term benefits may also accrue to recreational and commercial fisheries which target these species if productivity is enhanced. Even greater benefits are possible if, in the long-term, Atlantic Whitefish were to recover to a point that the population could support a recreational fishery. Furthermore, related species could benefit indirectly from research activities which enhance the understanding of Atlantic Whitefish.

Many of the benefits derived from biodiversity conservation, including the protection and recovery of species at risk, are non-market commodities that are difficult to quantify. The Act recognizes that "wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological, and scientific reasons" (SARA Preamble, S.C. 2002, c.

29). A review of the literature confirms that Canadians value the preservation and conservation of species in and of themselves. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2008). Self-sustaining and healthy ecosystems, with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians.

2.5 Distributional impacts

As discussed in Section 1.2.2, implementation of this action plan will require collaboration among many organizations and groups which have participated in previous Atlantic Whitefish recovery efforts. This includes contributions from various levels of government, non-governmental organizations, Aboriginal groups, industry, universities, and others. It is also anticipated that new groups will become involved in future recovery initiatives as a direct outcome of the actions of Broad Strategy 4. Probable participants for each measure are noted in Tables 1 and 2. However, at this time it is not possible to determine the extent to which each of these groups will contribute (financially or otherwise) to this plan. Likewise, precise benefits to individual groups cannot be estimated at this time, but are discussed broadly in Section 2.4.

3. Measuring progress

The performance indicators presented in the associated recovery strategy provide a way to define and measure progress toward achieving the population and distribution objectives. This information is essential for scientists, partners, and the public to learn and adapt their activities over time.

Reporting on implementation of the action plan (under s. 55 of SARA) will be done after five years by assessing progress towards completing the recovery measures identified.

Reporting on the ecological and socio-economic impacts of the action plan (under s. 55 of SARA) will be done by assessing the results of monitoring the recovery of the species and its long term viability, and by assessing the implementation of the actionplan.

4. Associated plans

No other action plans related to Atlantic Whitefish have been published or submitted for inclusion in the SAR Public Registry. However, various other plans and documents are associated with the implementation of the recovery measures outlined in the action plan, as listed below.

- A discussion document entitled Petite Rivière Fish Passage Plan for Atlantic Whitefish: Discussion Document for a SARA action plan (Schaefer et al. 2006) was evaluated and supported by the Atlantic Whitefish Conservation and Recovery Team and formed the basis of a direction forward to improving

fish passage on the Petite Rivière as described in the associated recovery measures outlined in this action plan. Functional designs for fish passage at Crousetown and Hebb Lake Dams were produced for DFO in 2005 (Conrad 2005). Subsequent revisions to the Hebb Lake fishway design plans were developed by a consultant in consultation with DFO (Sikumiut Environmental Management Ltd 2010).

- Plans for dam upgrades in the Petite Rivière watershed for the Public Service Commission of Bridgewater were developed by a consultant (Sikumiut Environmental Management Ltd 2011).
- An interim plan to address immediate monitoring needs and operation control protocols at the newly constructed Hebb Lake Dam fish passage facility has been developed by DFO in collaboration with a Working Group of the Recovery Team, for implementation during the fall 2011 – winter/spring 2012 season (Robichaud-LeBlanc and Fenton 2011). The interim plan has been revised in 2013 to take into account the results of monitoring in 2012 and the qualitative review conducted by DFO Science of the risks of passing diadromous fish and other river-resident fish above Hebb Dam (Robichaud-LeBlanc and O'Neil 2013). An adaptive long-term monitoring plan will be developed to accommodate changing requirements as information is acquired regarding the survival and recovery of Atlantic Whitefish and additional fish passage facilities are constructed on the Petite Rivière.

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Appendix A. Atlantic Whitefish Conservation and Recovery Team

Organization	Active members
Bluenose Coastal Action Foundation	Nodding, Brooke Breen, Andrew Longue, Philip Hiltz, Tim
Bridgewater – Public Service Commission	Hood, Larry
DFO, Science	Showell, Mark
DFO, Fisheries Management	Stevens, Greg
DFO, Species at Risk Management Division	Robichaud-LeBlanc, Kim Burbidge, Chris(topher)
DFO, Fisheries Protection Program	Delaney, Leanda
DFO, Conservation and Protection	Wolfe, William Burgess, Roland
DFO, Communications	MacLean, Melanie
DFO, Policy and Economics	MacIntosh, Robert
Native Council of Nova Scotia	Stevens, Jeff
Nova Scotia Dept. of Fisheries and Aquaculture	LeBlanc, Jason
Nova Scotia Museum of Natural History	Gilhen, John (co-Chair)
Nova Scotia Power Corporation	Nicolas, Jean-Marc
Maritime Aboriginal Peoples Council	McNeely, Joshua
Nature Nova Scotia	Comolli, Jill

Appendix B. Effects on the environment and other species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals[7] (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 [8](FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of action plans may 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 action plan itself, but are also summarized below in this statement.

While the implementation of this action plan is anticipated to benefit the environment by promoting the recovery of the Atlantic Whitefish, the potential for effects on other species were also considered. The plan will call for the management on the Petite Rivière of new lake levels resultant of dam and spillway refurbishment that may affect fish including Atlantic Whitefish and their habitat. The restoration of fish passage on the Petite Rivière will likely benefit biodiversity in general by reopening habitat to other native diadromous species. Management and controlled passage of native and non-native invasive species intercepted at proposed fish passage facilities may be required to address the spread of illegally introduced Smallmouth Bass and Chain Pickerel within the Petite Rivière watershed and the potential return to headwater lakes of historical native species such as American eel (Anguilla rostrata), and gaspereau. The interaction between species repatriated to the lakes and the lake resident form of Atlantic Whitefish is currently un-assessed but may pose either a threat or a benefit to resident Atlantic Whitefish populations. Protocols for the control of both native and non-native invasive species required to mitigate against any inadvertent impacts have been developed by DFO in consultation with the Province of Nova Scotia and a Working Group of the Recovery Team (Robichaud-LeBlanc and Fenton 2011; Robichaud-LeBlanc and O'Neil 2013).

The effects of introducing Atlantic Whitefish to select lakes of limited biodiversity in anticipation of developing rescue populations is thought to outweigh unperceived harmful effects. Repatriation of Atlantic Whitefish to the Tusket watershed or their

[7] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[8] https://www.ec.gc.ca/dd-sd/default.asp?Lang=En&n=CD30F295-1

introduction to other riverine habitat within their presumed historical distribution is not expected to impact the biodiversity and habitat of those watersheds. Running candidate lakes and rivers through established decision criteria will assist in evaluating any potential impacts prior to introductions.

Overall, ensuring the survival and recovery of Atlantic Whitefish will require an adaptive management approach and best management practices to avoid activities in certain locations and during critical times in their life cycle. Taking the above noted mitigation measures into account, it is concluded that the benefits of the implementation of this action plan outweigh any adverse effects that may result.

Appendix C. Record of cooperation and consultation

The Atlantic Whitefish is an aquatic species under the federal jurisdiction of DFO. It has a highly restricted range, historically found in only two watersheds in southwestern Nova Scotia, Canada; the Tusket River and Petite Rivière. Its present distribution is largely limited to three small lakes in the Upper Petite Rivière system. As such, there are few people in Canada with scientific, traditional or local knowledge of this species.

To assist in the recovery of this species and the development of this action plan, DFO drew upon the expertise of the long-standing multi-stakeholder Atlantic Whitefish Conservation and Recovery Team. Active members involved in the development and review of this action plan can be found in Appendix A.

The draft action plan was also reviewed by DFO sector representatives in both Maritimes and National Capital Regions and relevant Nova Scotia provincial governments, including but not limited to, the Department of Natural Resources, the Department of Fisheries and Aquaculture, the Department of Transportation and Infrastructure Renewal, and the Department of Agriculture. All comments received during these reviews were considered and addressed as appropriate.

Aboriginal peoples have representation on the Recovery Team and their input was sought through the Recovery Team process. The draft action plan was also circulated more broadly to all regional First Nations and other Aboriginal groups to provide an opportunity for additional input into the document. No comments were received during this review phase.

All additional comments received on the proposed action plan during the 60-day public registry comment period (June 9 – August 8, 2016) were considered and addressed as appropriate in the final version of the document.