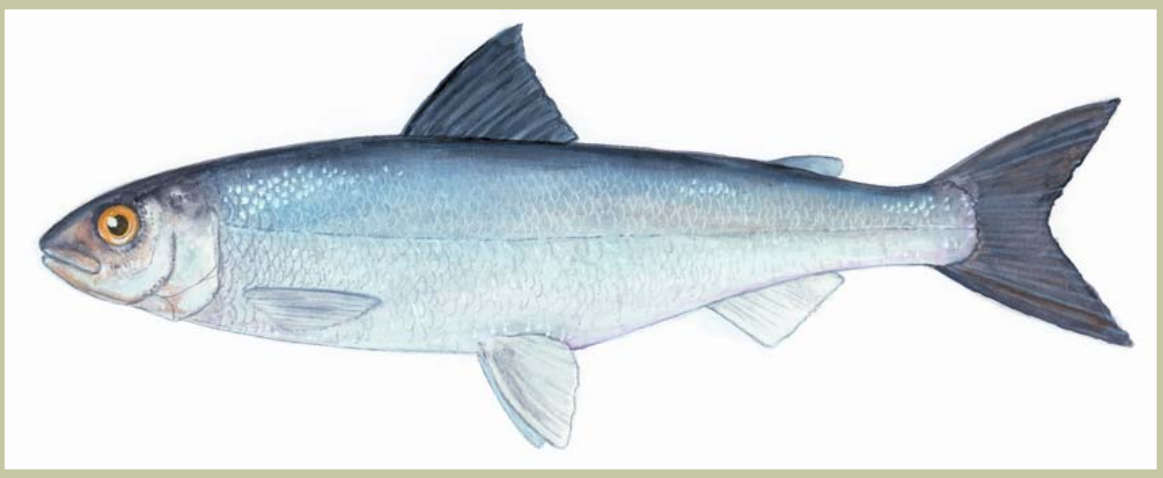
Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Atlantic Whitefish (*Coregonus huntsmani*) in Canada

Atlantic Whitefish



December 2006

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

About the Species at Risk Act Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the Species at Risk Act and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

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December 2006

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Additional copies:

You can download additional copies from the SARA Public Registry (http://www.sararegistry.gc.ca/)

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DECLARATION

This recovery strategy for the Atlantic whitefish has been prepared in cooperation with the jurisdictions described in the preface. Fisheries and Oceans Canada has reviewed and accepts this document as its recovery strategy for the Atlantic whitefish as required by the *Species at Risk Act*.

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 set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the Atlantic whitefish and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. The Minister will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

Under the *Species at Risk Act*, the responsible jurisdiction for the Atlantic whitefish is Fisheries and Oceans Canada. Atlantic whitefish occur only in Nova Scotia, and the government of Nova Scotia also cooperated in the production of this recovery strategy.

AUTHORS

This document was prepared based on advice from the Atlantic Whitefish Conservation and Recovery Team.

The Atlantic Whitefish Conservation and Recovery Team (AWCRT), hereafter referred to as ‘the Recovery Team’, was formed in the fall of 1999 in response to concerns regarding the survival of the Atlantic whitefish in Nova Scotia. Successful recovery is dependent on a transparent and inclusive approach that is acceptable to a variety of community interests; therefore the Recovery Team draws membership from all sectors that have an interest in protecting the species. The Recovery Team is thus comprised of tri-partite government members: the Department of Fisheries and Oceans (DFO), Nova Scotia Department of Natural Resources (NSDNR), and Nova Scotia Department of Agriculture and Fisheries (NSDAF), as well as their clients, industry, and stakeholders.

Meetings are held at least once a year. Members of the Recovery Team when this and the 2002 Recovery Strategy was developed are listed below. Key functions of the Recovery Team include:

- advise DFO on the development of a recovery strategy and action plan;
- coordinate Recovery Team member/organization involvement in recovery actions including environmental, biological, technical and social (educational and stewardship) program initiatives, and;
- communicate recovery activities to others.

Membership:

Member Organization	**Current and past members**
Bluenose Coastal Action Foundation	Cook, Brooke
Bridgewater – Public Service Commission	Feener, Larry Fox, Mike
Canadian Association of Smallmouth Anglers	Weare, Mark
Dalhousie University	Cook, Adam Hasselman, Danc
DesBrisay Museum	Selig, Gary
DFO, Science - Diadromous Fish (Maritimes)	Bradford, Rod Davison, Bev Longard, David Longue, Philip Marshall, Larry (former co-chair) O'Neil, Shane O'Reilly, Patrick Whitelaw, John
DFO, Fisheries Management (Maritimes)	Burton, Clifford Manderville, Darin Marshall, Ian (current chair) Purdy, Jeff Stevens, Greg Sweeney, Anne
DFO, Species at Risk Coord. Office (Maritimes)	Barnes, Bob (former co-chair) Cullen, Lynn Loch, John (former acting co-chair) McPherson, Arran

	Querbach, Kirsten Robichaud-LeBlanc, Kim
DFO, Oceans - Habitat Management (Maritimes)	Hamilton, Anita Schaefer, Heidi Wheaton, Thomas
DFO, Communications (Maritimes)	Myers, Carl McKinnon, Chastity
DFO, Policy and Economics (Maritimes)	Rudd, Murray
Environment Canada	Davidson, Kevin
Hebbville Village Commission	Barkhouse, Murray
Native Council of Nova Scotia	Martin, Tim
Nova Scotia Dept. of Agriculture and Fisheries	LeBlanc, Jason
Nova Scotia Dept of Environment & Labour	Green, Bob Helmer, Leif
Nova Scotia Dept. of Natural Resources	Elderkin, Mark
Nova Scotia Museum of Natural History	Gilhen, John (current co-chair) Hebda, Andrew
Nova Scotia Power Corporation	Burgess, Carys Meade, Ken
Petite Rivière Watershed Advisory Group	Bell, Doug Brown, Wally
South Shore Naturalists	Bryant, David Comolli, Jill Smith, Judith
Tusket River Environmental Protection Assoc.	Dukeshire, Danny Patten, Patrick

ACKNOWLEDGMENTS

This recovery strategy has been developed through the cooperative effort of the Atlantic Whitefish Conservation and Recovery Team (AWCRT). In the development of such, this

document draws heavily on a draft National recovery strategy prepared by Doug Rowland on behalf of the AWCRT in 2001. DFO is grateful to the Recovery Team and Mr. Rowland and the many individuals who provided information and advice contributing to the development of this document. We also thank Dave Longard of DFO Science and Stanley Johnston of DFO Oceans for preparing the maps in this document. Furthermore, Fisheries and Oceans Canada wishes to recognize the invaluable input provided by the broader interested public in the consultation process (see Appendix III for a record of consultations).

ENVIRONMENTAL CONSIDERATIONS

Environmental considerations must be incorporated into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The recovery planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The environmental considerations for this strategy are summarized as follows:

This recovery strategy will benefit the environment by promoting the recovery of the Atlantic whitefish. Although a major challenge facing the recovery of Atlantic whitefish is the lack of general knowledge about the species biology, its abundance and habitat requirements, as well as assessing the impact of identified threats and appropriate measures to mitigate these threats, the potential for the strategy to inadvertently lead to adverse effects on other species was considered. Re-introduction of the species into watersheds other than the Tusket and Petite rivers could have ecological consequences. Negative consequences to other recreational fisheries and/or species will be mitigated to the extent possible and socio-economic costs fully estimated in a subsequent Action Plan. Potential impacts are expected to be site-specific and strategies to address impacts will be developed in advance of taking recovery actions. The environmental risks associated with re-introductions were concluded to be activities that outweigh the consequences of inaction.

RESIDENCE

SARA defines residence as: "*a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating*" **[SARA S2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted when available on the SARA public registry: http://www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

The Atlantic whitefish, although presently land-locked, is an anadromous fish by nature, and is under the jurisdiction of the federal government. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered or threatened species. The Atlantic whitefish was listed as endangered under SARA in June 2003. Fisheries and Oceans Canada – Maritimes Region, led the development of this recovery strategy. The proposed strategy meets SARA requirements in terms of content and process (Sections 39-41). It was developed in cooperation or consultation with (see Appendix III for full record of consultations), as appropriate:

EXECUTIVE SUMMARY

The Atlantic whitefish, *Coregonus huntsmani* (Scott 1987), is an endemic[1] Canadian species known historically only in the Tusket River and Petite Rivière watersheds in southwestern Nova Scotia[2] (Figure 1). Once an anadromous species, it is now believed to be extirpated from the Tusket River (Figure 2) and entirely land-locked within three small semi-natural lakes (1600 total hectares) in the upper Petite Rivière drainage (Figure 3). Atlantic whitefish are not found anywhere else in the world and the exact size of the remaining population is not known.

The species has historically supported fisheries in the Tusket and Petite watersheds and is the sole representative of a unique lineage of whitefish in North America; it is therefore an important component of biodiversity in Canada. A pronounced population decline in recent decades resulted in the species being assessed as "endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC in 1984; this status was re-confirmed by COSEWIC in 2000).

Knowledge of which environmental/ecological factors have contributed to the decline and continued low abundance of Atlantic whitefish is imprecise. However, acidification of the aquatic habitat as a result of acid rain has occurred throughout the known range for the species, fish habitat has been altered as a result of human land and watercourse use (in particular the construction and operation of dams and associated fishways) and non-indigenous fish predators (including smallmouth bass and chain pickerel) have been introduced illegally into the watersheds. These factors, as well as unregulated, excessive harvesting in the past, are believed to be the principle contributing factors to the species' decline.

In June 2003, Canada passed its *Species at Risk Act* (SARA). SARA was created to prevent Canadian wildlife species from becoming extinct and to help species at risk recover to sustainable levels. With the coming into force of SARA, the Atlantic whitefish, recognized as being threatened with imminent extinction, was automatically listed as *Endangered* under Schedule 1 of SARA, which requires legal protection and mandatory recovery plans for listed species.

Protection under the Act prohibits the killing, harming, harassing, capturing or taking of individuals and also makes it illegal to damage or destroy their residence and provides protection for critical habitat once identified in a recovery strategy or action plan. While the state of knowledge on habitat requirements of Atlantic whitefish is increasing as new scientific evidence becomes available, it is currently not possible to identify critical habitat for Atlantic whitefish and thus it will wait to be designated at a later stage in an action plan. Appendix II however includes a list of research and monitoring activities that collectively, constitute a schedule of studies which describes the activities that are needed to help define the critical habitat for this species.

[1] Appendix I provides a Glossary of Terms
[2] The former distribution of the species (e.g., prior to the arrival of Europeans in the 1600s) is unknown.

Although the prohibitions associated with SARA protect Atlantic whitefish, SARA however enables recovery strategies to exempt persons engaging in certain activities from these general prohibitions. In November 2004, DFO Maritimes Region hosted a Regional Advisory Process review to assess the level of mortality that would not jeopardize the survival or recovery of the species. The conclusion from the meeting was that there are no indications that current human activities within the Petite Rivière drainage pose a threat to the survival of Atlantic whitefish; however there may not be scope for further harm arising from new activities or proposed changes to existing activities. Furthermore, there is no certainty that harm from current human activities will remain low once smallmouth bass have become established in the Petite Rivière drainage. The allowable harm assessment could not address whether current activities jeopardize the recovery of Atlantic whitefish largely owing to a lack of prior knowledge concerning the biology of the species outside the current area of known occupancy. These can only become known as recovery actions are implemented.

A key requirement under this new legislation is the development of recovery strategies which detail the specific steps that need to be taken in order to protect and recover the species. This recovery strategy has been prepared in cooperation with the Atlantic Whitefish Conservation and Recovery Team (AWCRT). Fisheries and Oceans Canada (DFO), the Nova Scotia Department of Natural Resources (NSDNR), and the Nova Scotia Department of Agriculture and Fisheries (NSDAF) have legislative responsibilities for recovery of this species.

This recovery strategy identifies the goal, objectives and recommended strategies that are believed necessary to protect and recover Atlantic whitefish. In brief, the goal of the recovery strategy is to:

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

The supporting objectives outline the need to:

i. Conserve, protect and manage the species and its habitat;
ii. Increase the number and range of viable populations;
iii. Increase understanding of the species and its habitat, and;
iv. Increase public involvement and acceptance.

Given their unique attributes, the imminent danger of Atlantic whitefish becoming extinct adds weight to the importance of implementing recovery. Some of the specific initiatives for recovery have already begun. Extending the range of Atlantic whitefish is an important component of recovery for this species. Efforts to extend the species’ range by establishing back-up populations are currently underway. As part of a three-year trial project, captive reared Atlantic whitefish have already been released into Anderson Lake, near Burnside, Dartmouth, Nova Scotia, in November 2005 and April 2006. As the success of this introduction will not be known for several years, from this point forward this Recovery Strategy will focus its consideration on the historic populations, and will discuss the recovery efforts at Anderson Lake specifically in Section 2.8.

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INTRODUCTION

Atlantic whitefish are found only in Nova Scotia, Canada and occur in the wild as a single population distributed among three small, connected, semi-natural lakes. They are presently at critically low levels, assessed as “endangered” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and protected under the federal *Species at Risk Act* (SARA).

The Atlantic whitefish is a member of the salmon and trout family Salmonidae. This fish was historically referred to as Acadian whitefish, Sault whitefish, round whitefish, and common whitefish (Edge and Gilhen 2001). It appears dark green or blue on its back with silvery sides and a silvery to white underbelly. They possess a deeply forked tail and an adipose fin (Figure 4). The fish has been used by humans for food and have been angled for recreational purposes (Scott and Scott 1988).

Atlantic whitefish can be distinguished from other whitefish species by their genetic structure (Bernatchez et al. 1991; Murray 2005) and physical characteristics (Edge et al. 1991; Hasselman 2003). Thought to represent the sole living representative of the early form of whitefishes (Smith and Todd 1992), the species represents a unique component of the local, national and global biodiversity.

First described by Huntsman (1922), the Atlantic whitefish is a Canadian endemic species known historically to occur in the Tusket River and Petite Rivière in southwestern Nova Scotia (Scott 1987; Edge and Gilhen 2001) (Figure 1). An anadromous (sea-going) population was reported from the Tusket River (Figure 2) (Edge and Gilhen 2001); however, there is no documented record of a fall run in the Petite Rivière (Bradford et al. 2004a). Since the construction of the dams on the Petite Rivière Atlantic whitefish have been documented downstream in both the freshwater and marine portions of the watershed (Figure 3) (Edge and Gilhen 2001). It is presumed that these fish somehow passed downstream over the Hebbville dam, and were able to tolerate marine conditions.

Declining numbers in both the Tusket River and Petite Rivière watersheds in recent decades (Edge 1984b) and a global distribution restricted to two river drainages, resulted in the Atlantic whitefish being assessed as “endangered” by COSEWIC in 1984, the first fish species in Canada to be so designated. Re-assessment of the species status by COSEWIC in 2000 concluded that a remnant anadromous population may exist in the Tusket, that the land-locked Petite Rivière population continues to persist, and that there is uncertainty concerning the status of any anadromous run to the Petite Rivière. A continued decline in abundance, an absence of mitigation of threats identified in the previous assessment, and new threats (Edge and Gilhen 2001) were cited in support of the designation of the species status as “endangered”.

Information acquired since the 2000 COSEWIC assessment confirmed the existence of the land-locked population in the Petite Rivière, casts uncertainty on the existence of an

anadromous run to that river (Bradford et al. 2004a) and indicates that the species has been extirpated from the Tusket River (the last confirmed specimen was captured in 1982 (Edge 1984a)). The species range is currently restricted within the 16km^2 aggregate area of three small semi-natural lakes (Hebb, Milipsigate and Minamkeak) within the Petite Rivière (Figure 3) (Bradford et al. 2004a; DFO 2004a).

Canadians recognize that our natural heritage is an integral part of our national identity and history, as well as part of the world's heritage. We further recognize that wildlife (including fish) has value in and of itself as well as being valued for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons. Therefore, when a species becomes at risk, as is clearly the case with Atlantic whitefish, both Canada and Nova Scotia have responsibilities through their respective conservation mandates to protect, conserve, and recover the species. These jurisdictions have determined that preparation of a recovery strategy for Atlantic whitefish is the appropriate first formal step to meeting these responsibilities.

In summary, the Atlantic whitefish is found only in Nova Scotia, recognized to be of considerable evolutionary significance, at risk of extinction from several threats, and in need of immediate recovery actions. Intended to provide a common direction to be followed by participating parties, the purpose of this document is to lay out a strategy for the recovery of the Atlantic whitefish by setting a goal and objectives to arrest or reverse the decline of the species and identifying the main areas of activities to be undertaken.

1 BACKGROUND

1.1 Status

1.1.1 Canadian Status

COSEWIC Assessment Summary

Common	**name**:	Atlantic	whitefish
Scientific	**name**:	*Coregonus*	*huntsmani*
Status:			Endangered
Occurrence:		Nova	Scotia.

Reason for Designation: This species, endemic to Nova Scotia, is found only in the Tusket[1] and Petite Rivière watersheds. It continues to decline because of habitat loss and degradation caused by acidification, hydroelectric dams, introductions of exotic species, and incidental fishing.

Status History: Designated Endangered in April 1984. Status re-examined and confirmed in November 2000. Last assessment based on an updated status report.

[1] subsequently considered extirpated from the Tusket River (Bradford et al. 2004a)

1.1.2 Global Status

In 1996 the Atlantic whitefish was globally assessed as V*ulnerable* by the World Conservation Union (IUCN). It is listed in the IUCN Red Book with the designation VU D2, which implies the species is not endangered but facing a high risk of extinction in the wild in the medium-term future [3]. The 1996 designation indicated that the population is very small and is characterized by an acute restriction in its area of occupancy.

1.2 Distribution

1.2.1 Global Range

The Atlantic whitefish is endemic to Nova Scotia, meaning that it is found nowhere else in the world. In Nova Scotia it was historically found only in the Tusket and Petite

[3] This assessment was based on IUCN criteria, which differs from the criteria used by COSEWIC; and inaccurately identifies the distribution of the species as being the Great Lakes region of North America.

Rivière watersheds, and their adjacent estuaries and bays (Figure 1). This species was extirpated from the Tusket River system sometime after 1982 (Bradford et al. 2004a).

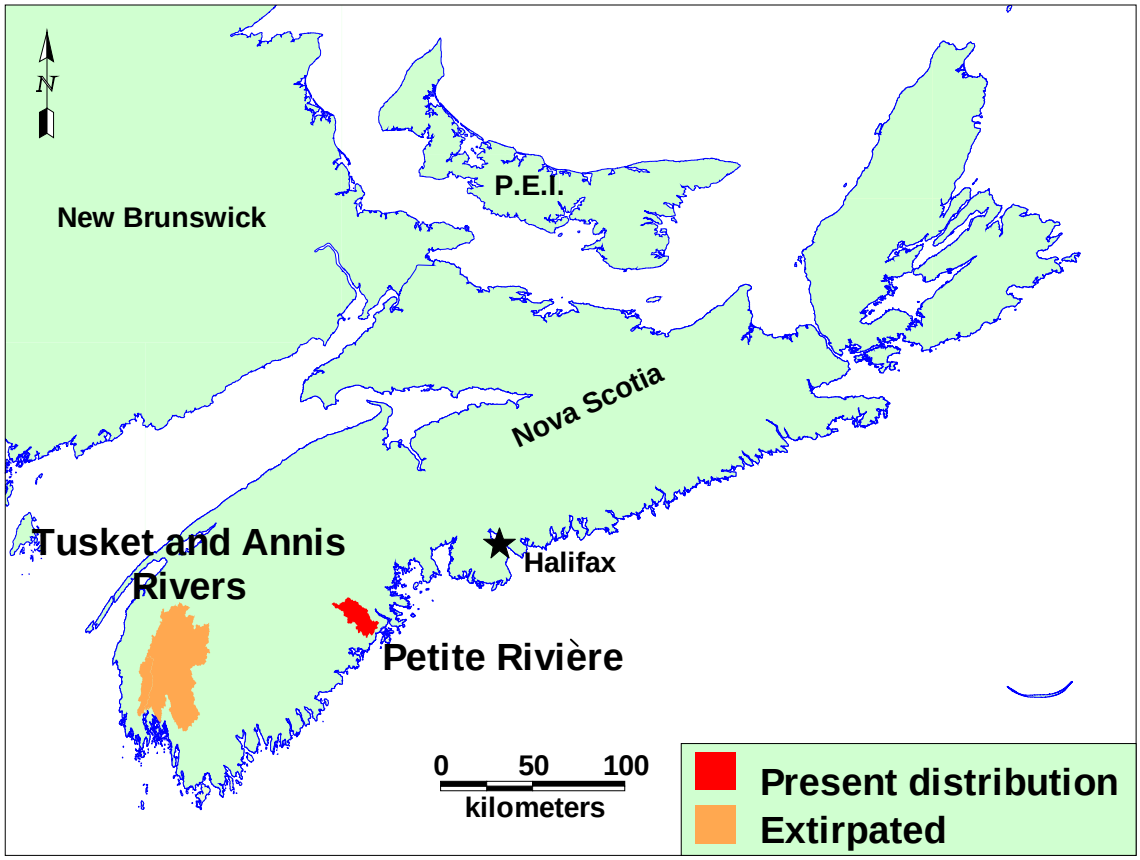

Figure 1. Map showing the historical Canadian watershed distribution of Atlantic whitefish. [4]

Despite extensive commercial and recreational fisheries in fresh and coastal waters throughout Nova Scotia, as well as extensive province-wide fish surveys, Atlantic whitefish populations have not been reported outside these two watersheds. Isolated captures of specimens identified as Atlantic whitefish were reported at the mouth of the Sissiboo River in southwestern Nova Scotia in 1919 (Scott and Scott 1988), at Halls Harbour on the Minas Channel in 1958 (Edge and Gilhen 2001) and in the LaHave Estuary in 1995 and 1997 (Edge and Gilhen 2001). These specimens may have been members of the Tusket or Petite populations.

1.2.2 Tusket River Watershed

The Tusket River population of Atlantic whitefish appears to have been entirely anadromous. They have not been recorded in the watershed since 1982. The population is now considered to be extirpated (Bradford et al. 2004a).

[4] 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.

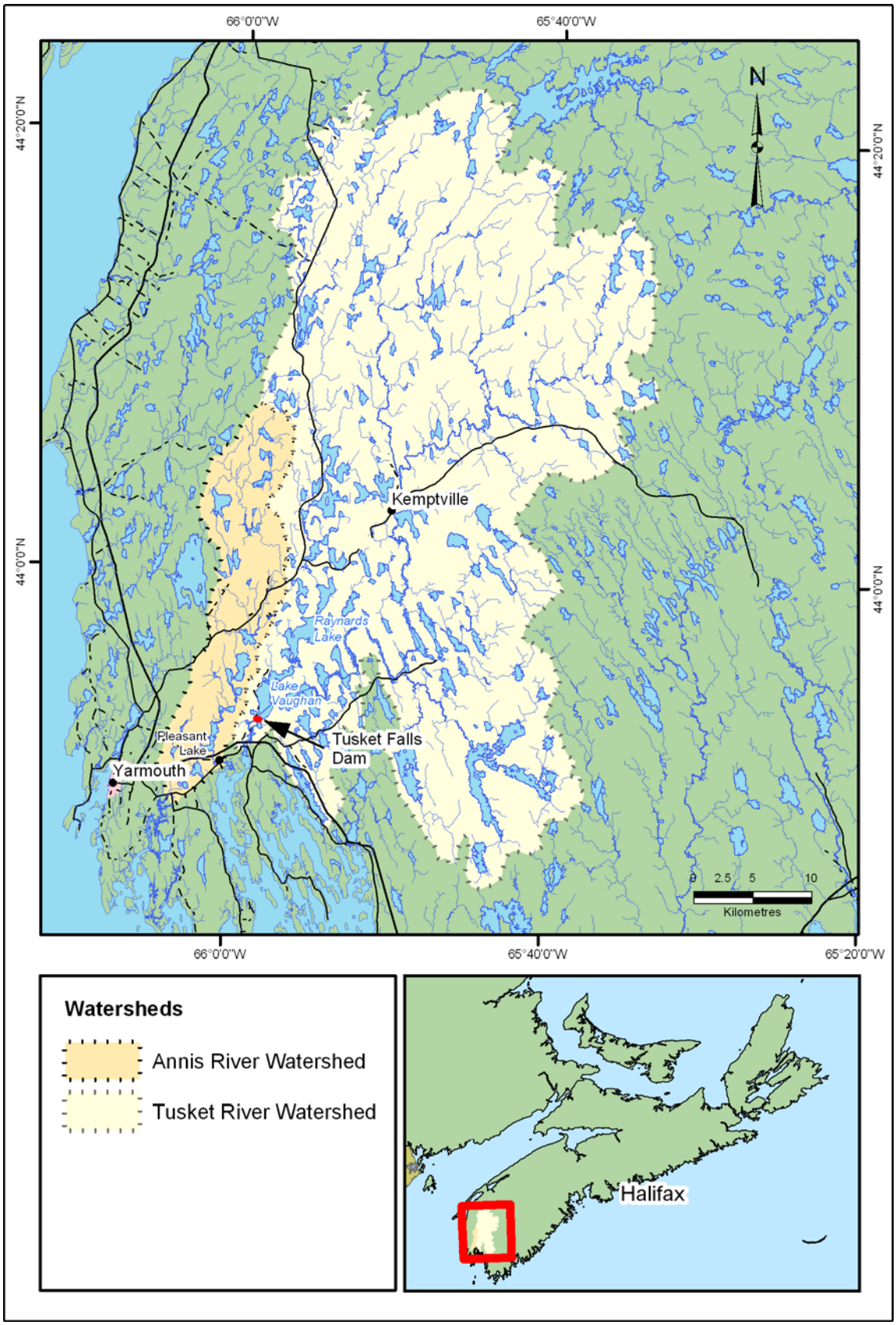

Figure 2. Tusket-Annis rivers watershed and estuary.

Occurrences were recorded in the non-tidal lower portions of both the Tusket River and the Annis River, as well as in the estuary that these two rivers share. Individuals have also been reported in Yarmouth Harbour located several kilometers to the west of the Tusket River (Figure 2). There is no information concerning the distance ascended by Atlantic whitefish in either the Tusket or Annis rivers (Bradford et al. 2004a; Figure 2).

1.2.3 Petite Rivière Watershed

The Petite Rivière system supports a significant resident Atlantic whitefish population distributed among three lakes: Minamkeak, Milipsigate and Hebb (Edge and Gilhen 2001; Figure 3). The lakes, which collectively cover a surface area of barely more than 16.0 km^2, cannot be accessed from the sea since the dam at Hebbville (Figure 3) is a complete barrier to upstream fish passage. The first confirmed specimen of Atlantic whitefish was found at the outlet from Milipsigate Lake in 1923 (Piers 1927).

There is no documented record of an anadromous run of Atlantic whitefish on the Petite Rivière prior to or after the construction of the dams on the Petite system. Since the construction of the dams, there have been reported occurrences of Atlantic whitefish below the lakes in Fancy Lake, and in the tidal portions of the Petite Rivière (Figure 3). As resident populations were not found in any recent surveys of the lakes below the dams (Bradford et al. 2004a), it is presumed that these fish somehow passed or were swept over the Hebbville dam and moved from there into downstream areas. There is no evidence to document this movement over the dam, including when or at what age Atlantic whitefish might pass over it. Specimens, that are also likely strays from the lake-resident population (Bradford et al. 2004a), have been captured in the LaHave River estuary (Edge and Gilhen 2001) which lies to the east of the Petite Rivière (Figure 3).

The presence of Atlantic whitefish in Minamkeak Lake has particular significance in light of the 1903 diversion of this lake from the Medway River (Figure 3) to the Petite Rivière (Edge and Gilhen 2001). Recent surveys showed that Atlantic whitefish are not resident within the Medway River, including the sub-drainage into which Minamkeak once drained (Bradford et al. 2004a). Presence of Atlantic whitefish in Minamkeak Lake is likely a consequence of colonization from Milipsigate and Hebb lakes sometime after the diversion (Bradford et al. 2004a).

1.3 Legal Protection

Atlantic whitefish are listed under Schedule 1, Part 2 of the *Species at Risk Act* (SARA) and therefore, the SARA provisions against the killing, harming, harassing, capturing or taking of individuals (SARA Section 32), and the damage or destruction of residence (SARA Section 33) apply.

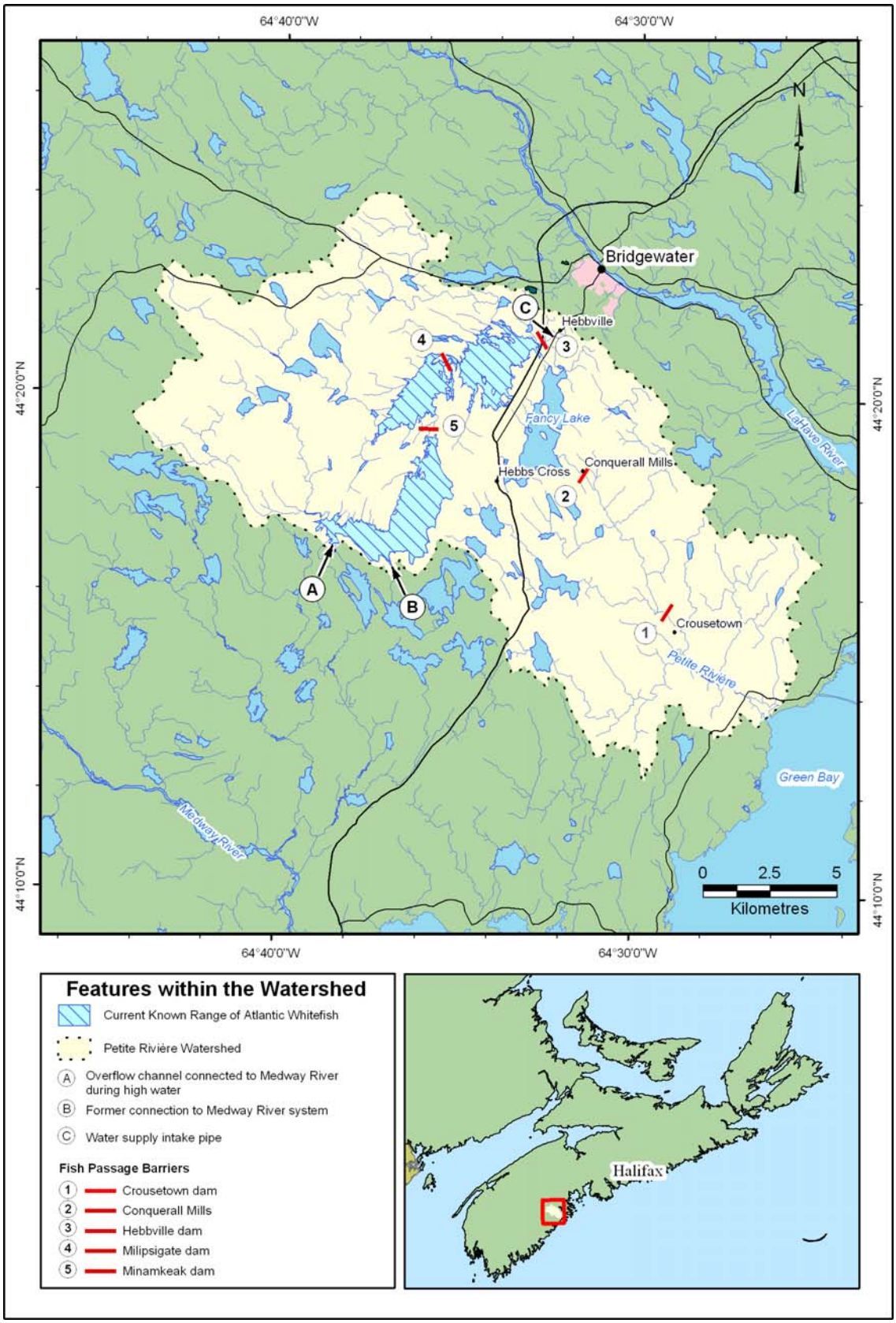

Figure 3. Petite Rivière watershed and Green Bay estuary.

In addition to SARA, the *Fisheries Act* and its supporting regulations have direct and/or indirect application to Atlantic whitefish. The *Fisheries Act* protects fish and fish habitat, whilst its supporting regulations (the Fishery (General) Regulations (F(G)R's), the Maritime Provinces Fishery Regulations (MPFR's), the Atlantic Fishery Regulations, 1985 (AFR's), and the Aboriginal Communal Fishing Licences Regulations (ACFLR's)) provide the tools to protect, conserve and manage fisheries.

With respect to fisheries, three of the most important regulatory provisions are;

a) section 6 of the MPFR's which prohibits the retention or possession of Atlantic whitefish,
b) section 6 of the F(G)R's which provides for the issue of variation orders to close any fishing season set out in regulations, and;
c) section 22 of the F(G)R's which provides for the issue of licence conditions.

After discussions with stakeholders, DFO and the Province have agreed to implement additional management measures on the Petite Rivière to protect Atlantic whitefish, primarily from incidental capture. By variation order, all angling is now prohibited annually from April 1 to June 30 in the inland waters of Minamkeak, Milipsigate and Hebb lakes (Figure 3), including the thoroughfares joining them. Commencing in 2005, only unbaited lures and artificial flies (no bait) are permitted during the open angling season from July 1 to September 30. One commercial gaspereau gill net licence holder in the estuary of the Petite Rivière was required, by licence condition, to relocate his fishing gear.

With respect to the protection of fish and fish habitat, some important regulatory provisions of the *Fisheries Act* include:

a) section 20 - 22 which deal with requirements for fish passage and the construction of fish-ways;
b) section 32 which prohibits the destruction of fish by means other than fishing unless authorized by the Minister;
c) section 35(2) which prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized by the Minister, and;
d) section 36(3) which prohibits the deposition of deleterious substances into waters frequented by fish.

These sections of the *Fisheries Act* are administered by DFO, with the exception of section 36 which is administered by Environment Canada.

The Atlantic whitefish and its habitat are also protected by provincial legislation including the 1998 Nova Scotia *Endangered Species Act* and the 1994-95 Nova Scotia *Environment Act*. Minamkeak, Milipsigate and Hebb lakes form the water supply for the town of Bridgewater, and as such they will receive environmental protection as a designated 'Protected Water Area' under the provincial *Environment Act*. This type of designation involves a combination of regulations and best management practices which are rolled-out through a 'Source Water Protection Plan' and will address all

activities in the watershed that could impact water quality (e.g., forestry, agriculture, road construction, recreational use, mining, etc.). The only fishery known to or likely to capture Atlantic whitefish in these three lakes is the recreational angling fishery which has either been closed or significantly modified to eliminate the likelihood of harm.

1.4 General Biology and Description

1.4.1 Physical Description

The Atlantic whitefish is a member of the salmon and trout family (Salmonidae) (Scott and Scott 1988) and belongs to the whitefish subfamily Coregoninae. It appears salmon-like, with silvery sides, a silvery white underbelly, and a back that is dark bluish-black or dark green (Figure 4). There are no spots or upper body markings. It has a deeply forked caudal (tail) fin and an adipose fin (small, fleshy fin between dorsal and caudal fins, typical of salmonids).

Scott and Scott (1988) describe Atlantic whitefish as having between 91 and 100 scales along the lateral line, a terminal mouth (lower and upper jaws equal) and small but well developed teeth.

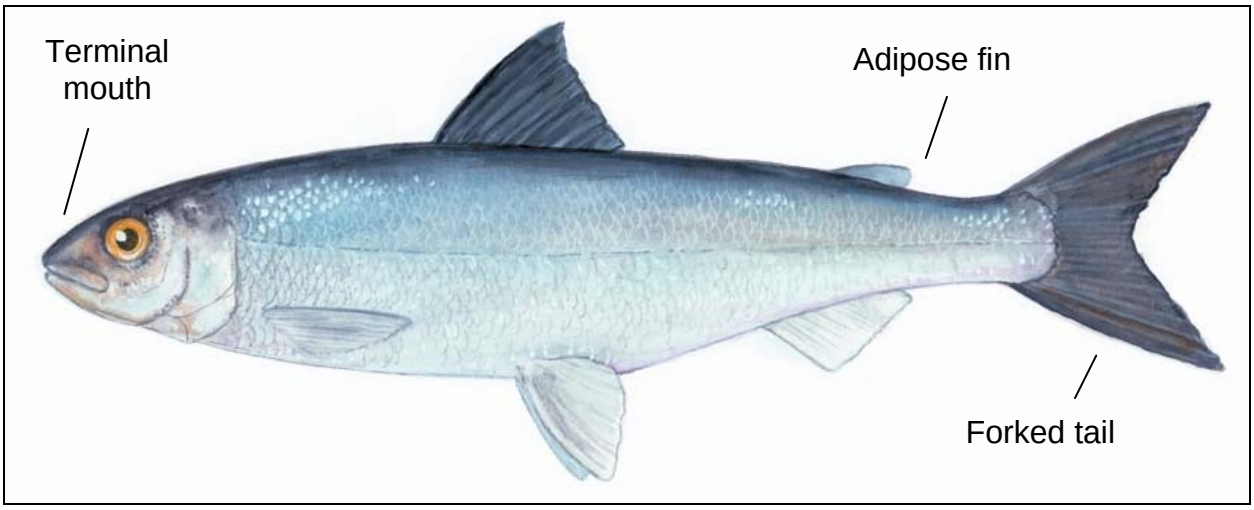

Figure 4. Schematic depicting an adult Atlantic whitefish.

While growth of the species in the wild has not been studied, anadromous specimens from the Tusket River are known to have been larger than the landlocked Petite Rivière individuals. Records suggest adults can reach 50 cm (20 in) in length and up to 3.63 kg (8 lb.) in weight (Edge and Gilhen 2001). However, anadromous adults typically average 38 cm (15 in) while the smaller landlocked individuals range 20 to 25 cm (8-10 in) (Bradford 2000).

1.4.2 Common and Scientific Name

The common name Atlantic whitefish was employed by Scott (1967) and Scott and Crossman (1973) in reference to its regular occurrence in salt water off Yarmouth County, Nova Scotia, and its upstream fall migration in the Tusket River (Scott 1987). Originally described as *Coregonus canadensis* by Scott (1967) the species name *canadensis* was found to be already in use. Hence the name *Coregonus huntsmani* was recommended by Scott in 1987 in honour of the late Dr. A.G. Huntsman, noted Canadian marine biologist, who was aware of the presence of an unusual whitefish in Nova Scotia waters at least as early as 1921 (Huntsman 1922). The species was also referred to in the past as Acadian whitefish, Sault whitefish, round whitefish, and common whitefish.

1.4.3 Distinguishing Traits

Atlantic whitefish can be recognized on the basis of their external appearance. The species can be distinguished from most other salmonids by its larger scales. Additional features are used to distinguish Atlantic whitefish from the lake whitefish, *C. clupeaformis*, which is a common species in Nova Scotian lakes. The number of lateral line scales differs (average of 93.8 in Atlantic whitefish versus an average of 76.6 in lake whitefish), as does the number of vertebrae (average of 65.3 in Atlantic whitefish versus 60.6 in lake whitefish), the mouth shape (near- terminal for Atlantic whitefish, sub-terminal for lake whitefish), and Atlantic whitefish have small teeth while lake whitefish do not (Edge et al. 1991; Hasselman 2003). Genetically, Atlantic whitefish differ from both lake whitefish and cisco (Bernatchez et al. 1991; Murray 2005).

The distinguishing external traits of the Atlantic whitefish are published annually in the Nova Scotia Angler's Handbook, along with a request for members of the public to contact authorities with suspected sightings of the species. Additionally, habitat stewardship initiatives within the Petite Rivière area have included production and distribution of a handbook and brochure which provides information on the Petite Rivière watershed and the endangered Atlantic whitefish.

1.4.4 Life History

Little is known about the life history of Atlantic whitefish and what is known relates primarily to adults.

Anadromous population

The Atlantic whitefish was anadromous (sea-going) in the Tusket River (Figure 2); and, despite the lack of recorded evidence, they likely occurred historically in Petite Rivière as well (Figure 3). Individuals on the Tusket were known to occur in the estuary and sea waters in the summer, migrate into freshwater in the early fall (around September), move upstream in October and November with spawning probably occurring in the late fall or winter, overwinter, and return to the sea in the spring (Edge and Gilhen 2001). Specimens captured in the Tusket River during October and November had well developed gonads but had not yet spawned while specimens collected in May and June

had poorly developed gonads (Edge and Gilhen 2001). Neither specific locations nor characteristics of the spawning habitat of the anadromous Atlantic whitefish population that once existed in the Tusket watershed are known (Bradford et al. 2004a).

Atlantic whitefish specimens captured in the marine environment contained shrimp, amphipods, fish and marine worms (Edge 1987).

Lake resident population

Spawning of the landlocked population in the Petite Rivière lakes also probably occurs in early winter. Neither specific locations nor characteristics of the spawning habitat of the land-locked Atlantic whitefish are known. Fish occurring in Minamkeak, Milipsigate and Hebb lakes are genetically identical (Murray 2005). No eggs or larvae have been collected from the wild. A single juvenile was sampled from an aggregation of Atlantic whitefish of similar size on one occasion in June 2000 in Hebb Lake (Hasselman 2003). The paucity of information on these life stages precludes any understanding of age structure and mortality rates.

Adults feed on a wide variety of aquatic organisms. Stomach analyses of specimens from the landlocked Petite Rivière population indicated a diet that includes aquatic insects and small fish but not benthic organisms (Edge and Gilhen 2001).

As mentioned previously, it is possible that Atlantic whitefish are swept over the Hebbville dam since there is nothing to prevent their downstream passage. However, these fish that do pass over this dam, are not able to re-join the lake resident population since there is no upstream fish passage provided. Furthermore, while there have been records of Atlantic whitefish below the Hebbville dam, there is no evidence to indicate that these fish represent a viable population (Bradford et al. 2004a).

1.4.5 Habitat Requirements

Little is known of the habitat requirements of Atlantic whitefish. Spawning, nursery, and rearing ground locations and preferences are not known, and migration areas are not understood. In the Tusket population, adults were frequently caught in the estuary. Lake resident Atlantic whitefish appear to be more prevalent in warmer surface waters than are lake whitefish. Recent field and laboratory research indicates that the species can tolerate full sea water from an early stage of development (DFO unpublished data).

1.5 Population Size and Trends

While there is insufficient information available at this time to enable accurate quantitative estimates of the Atlantic whitefish populations' sizes and trends in the Tusket and Petite watersheds, the following general qualitative comments can be made.

1.5.1 Tusket River Population

Once abundant, the Tusket River population apparently declined rapidly in the 1940s and 1950s, likely a result of the combined effects of construction and operation of the Tusket hydro-electric facility, poaching, and river acidification (Gilhen 1977; Bradford et al. 2004a). The decline continued; by the 1970s it was a novelty for one specimen to be taken in a season by a gaspereau fisherman. The last confirmed specimen captured on the Tusket River was in 1964 (Edge et al. 1991; Bradford et al. 2004a). No individuals have been observed or captured in any of the years of fishway monitoring since 1995 (Bradford et al. 2004a). It is believed that this population no longer exists (Edge and Gilhen 2001; Bradford et al. 2004a).

On the adjacent Annis River, catch also decreased over time, to the point that by the late 1970s a combined catch of fewer than ten individuals per year in the gaspereau fishery was typical (Edge and Gilhen 2001). There are no reports of Atlantic whitefish being captured in the Annis River since 1982 (Edge and Gilhen 2001; Bradford et al. 2004a).

1.5.2 Petite Rivière Population

There are anecdotal reports of Atlantic whitefish in the Petite Rivière watershed as early as the 1870s (Edge and Gilhen 2001). The recent trend for the Petite Rivière lake resident population is uncertain as there is no population estimate for the lakes. There have been records of Atlantic whitefish occurring below the Hebbville dam since its construction; however, a research trapnet set in the estuary during autumn 1999 and spring 2000 failed to capture a single Atlantic whitefish (Bradford et al. 2004a). Therefore, the presence of a viable anadromous population of Atlantic whitefish below the Hebbville dam is unlikely, or it exists below the level of detection currently possible.

1.6 Threats and Limiting Factors

Modification of the Tusket River and Petite Rivière watersheds through human activities has altered their physical habitat, hydrography and water chemistry. Species abundance has also been affected by past over-harvesting. Past and present significant threats, limiting factors, and habitat alterations include (in no particular order) (Bradford et al. 2004b; DFO 2004b):

- construction and operation of hydroelectric dams and water supply impoundments;
- acidification of habitat resulting from acid rain;
- land use practices, in particular agriculture and forestry;
- Historical fishing activities, and;
- introduction and spread of non-native fish species which may pose competitive or predation risks (e.g., smallmouth bass, chain pickerel).

While the threats faced by Atlantic whitefish in the two watersheds (Tusket and Petite) exhibit common traits, the significance of the threats varies between the two systems (DFO 2004b). In the Tusket, habitat alteration and inadequate fish passage due to

hydroelectric dam construction and operation, acidification, chain pickerel and smallmouth bass predation, and over-harvesting are identified as the most significant threats. By contrast, the Petite Rivière is better buffered and thus less affected by acidification; however the construction and operation of water supply facilities and predation by smallmouth bass are identified as the most significant factors threatening the population.

These threats have been recently reviewed during a DFO Regional Advisory Process meeting to evaluate the level of mortality that would not jeopardize the survival or recovery of Atlantic whitefish and to identify the potential sources of human-induced harm. In support of this review, factors potentially resulting in mortality of Atlantic whitefish as a result of human activities were considered (Bradford et al. 2004b). The conclusions of this meeting are summarized in a Status Report (DFO 2004a) and in section 2.7 of this document. The scope for the harm assessment documented in the Status Report (DFO 2004a) was limited to the area of known occupancy (i.e., the three Petite Rivière lakes).

1.6.1 Hydroelectric Development and Water Supply Impoundment

The construction and operation of hydroelectric dams and water supply impoundments have transformed lake and riverine habitat to reservoir habitat; the resulting fluctuating water level regimes have altered the original habitat and the dams have either blocked or impeded fish passage. A chronology of hydroelectric generation on the Tusket and Petite rivers in relation to fish passage and habitat requirements can be found in Bradford et al. 2004b.

Atlantic whitefish migration in the Tusket River is thought to have been limited by the Tusket River dams and past seasonal closures of the fish ladders (Edge and Gilhen 2001). The fish ladders were closed annually in the fall interrupting or preventing the Atlantic whitefish fall spawning migration. The damming of the Tusket River at Tusket Falls (Figure 2) in 1929 interfered with the migratory movement of the Atlantic whitefish for many years. Although a fishway, originally constructed of timber, was built in 1930, and rebuilt in 1941 due to decay, the structure was considered unsatisfactory and a new fishway was constructed in 1949. Additional improvements and changes were made to the fishways at both the Main Diversion Dam (Lake Vaughn) and the Powerhouse Dam (Tusket Falls) in the 1960s and 70s to facilitate downstream passage for diadromous species (e.g., salmon and gaspereau), improve the overall efficiency of the fishways for fish migration, and reduce mortality associated with fish passing through the turbines. In the 1980s and 90s ongoing studies with DFO and other stakeholders on the Tusket River focused on manipulation of operation schedules and maintenance flows to coincide with migratory movements of fish. Changes were mostly associated with attempts to improve upstream and downstream passage for Atlantic salmon and gaspereau. Since 2003 the Powerhouse fish ladder operating period has been extended to the end of December to accommodate any possible remnant Atlantic whitefish spawning migrations. Monitoring devices were also installed in an attempt to confirm the presence or absence of Atlantic whitefish in the Tusket River system. No Atlantic

whitefish have been observed migrating through this monitoring device (NSPI 2003), and the species is now considered extirpated from the Tusket River system. Were Atlantic whitefish re-established on the Tusket River, the existing fishway should be suitable providing operations accommodated its migration times.

In the Petite Rivière system, waterbodies have been impounded and diverted for various reasons since the late 1790s; those in the upper watershed now constitute the Town of Bridgewater water supply. The construction of a hydroelectric dam at the foot of Hebb Lake as early as 1901 effectively blocked any upstream migration of fishes beyond this point. Dams without fish ladders presently obstruct the Petite Rivière at the outlets of Minamkeak, Milipsigate and Hebb lakes (Figure 3). While it is not known if adult anadromous Atlantic whitefish migrated to these lakes to spawn prior to the existence of the dams, the Hebbville dam now eliminates any likelihood of upstream migration to the lakes, including any individuals attempting to rejoin the population after having fallen over the dam. Fish passage is also impeded at the former dam site at Conquerall Mills, around an existing dam at Crousetown; and, is impeded or blocked at the dams at Milipsigate and Minamkeak lakes (Figure 3). A brief description of each barrier to fish passage on the Petite Rivière is provided in Table 1 below.

Table 1: Descriptions of barriers to fish passage in the Petite Rivière (adapted from Conrad 2005).

Dam	**Description**
Crousetown	A 2.4 m high timber dam located at a former sawmill site. The dam includes a run-around type of fishway constructed from loose native stone that is considered to be inefficient for fish passage.
Conquerall	The dam at the former Conquerall Mills hydro site was partially dismantled, allowing a 9 m space between the remaining concrete abutments. The resulting short series of rapids constitutes a 1.2 m drop which may present a small in-stream barrier to Atlantic whitefish passage upstream.
Hebbville	The Town of Bridgewater water supply storage dam at Hebb Lake consists of a concrete flow-control structure and a long rock and earth fill berm. This berm is several hundred meters long and ends at a large pond. The pond is supplied by steady seepage through the berm and is drained by way of a meandering outlet channel and 1.5 m diameter culvert, finally emptying into the main channel of the river about 60 m downstream of the main concrete flow control structure. Other than the spillway, no fish passage is provided at this dam.
Milipsigate	A concrete dam structure operated by the Town of Bridgewater for flow regulation purposes. Other than the spillway, no fish passage is provided at this dam.
Minamkeak	The uppermost storage dam for the Town of Bridgewater and is used for flow regulation purposes. Other than the spillway, no fish passage is provided at this concrete dam structure.

1.6.2 Acidification

Acidification may be another limiting factor for Atlantic whitefish. The rivers most affected by acidification in Nova Scotia are in the Southern Upland Region, which include the Petite and Tusket, where a combination of hard-rock geology, inadequately buffered soils and prevailing weather patterns have resulted in severe acidification of the rivers and lakes. The Tusket is more affected by acid rain than the Petite. While research on the effect of low pH on various life stages of Atlantic whitefish is underway, the impacts may be comparable to those of other salmonids. Acid toxicity has been identified as a major factor in low wild salmon abundance in Southern Upland rivers (DFO 2000), for example. Data from Clair et al. (2004) indicate that the Petite Rivière as well as portions of the Tusket River possess sufficient buffering capacity for Atlantic whitefish survival (Bradford et al. 2004b).

1.6.3 Land Use Practices

Land use practices can contribute to aquatic habitat degradation. Sectors such as agriculture, residential development and forestry undertake land-based activities in the Petite and Tusket watersheds. While there are no studies linking these activities specifically to effects on Atlantic whitefish, it can be inferred that should common activities not be properly mitigated, they could result in effects to fish and fish habitat.

In the upper reaches of the Petite Rivière watershed, agricultural activities have introduced bacterial contaminants and silt into watercourses. The majority of farming in the area occurs in the upper reaches of the natural watershed boundary of the Petite Rivière lakes and accounts for 2.5% of the land in the natural watershed (Kendall and Llewellyn 2001). Although farming in the area is on the decline and lands formerly used for farming are growing over, common farming practices involve raising livestock in small numbers and using manure to fertilize hay fields (Kendall and Llewellyn 2001). No large scale pesticide or herbicide application is known to occur, however concerns were raised by Kendall and Llewellyn (2001) about the application of manure on fields near watercourses, and the practice of watering livestock directly in watercourses. Manure in waterways is a concern since it can increase bacterial counts and decrease pH levels; however, in the Petite Rivière watershed levels are not thought to pose significant detrimental effect on the water supply (Llewellyn et al. 2000).

With respect to forestry, Sayah (1999, cited by Llewellyn et al. 2000) noted overlaps between clear cut areas and waterbodies within the natural watershed boundary of the Petite Rivière drainage. Forestry activities including roads, skidding trails, and clear cuts can cause accelerated soil erosion and siltation that can lead to a reduction in the productivity of the aquatic ecosystem and affect the rate and quantity of water runoff. All these factors can be harmful to fish habitat and lethal to fish (Birtwell 1999). Clear cutting has not, however, been reported directly surrounding the three lakes where Atlantic whitefish are found (Kendall & Llewellyn 2001). Under the *Nova Scotia Forest*

Act (1989), there are Wildlife Habitat and Watercourses Protection Regulations which specify various requirements to protect watercourses that fall within forested areas (e.g., leaving buffer zones around watercourses). It is not known whether Atlantic whitefish have any particular sensitivity that would not accommodate forestry activities when undertaken according to the provincial guidelines and regulations. Generally, there is no indication of non-compliance in current forestry practices around the three lakes where Atlantic whitefish are currently found.

1.6.4 Historical Fishing Activities

Past harvesting practices, including poaching and incidental captures, may have been a factor in the decline of Atlantic whitefish populations. Atlantic whitefish were reportedly fished in the Tusket system prior to the 1960s and in the Petite Rivière until recently. Captured primarily by gill and dip nets, and occasionally by angling, the fish were used for human consumption, reportedly supporting a minor sport fishery and yielding a good food fish of fine flavour. They may also have been utilized for other purposes including bait for lobster traps and fertilizer (Scott and Scott 1988 and P. Longue, DFO 2001 personal communication).

Atlantic whitefish were once very abundant in the Tusket and Annis Rivers. Prior to 1940, it was reportedly not uncommon to catch 200 in a net when fishing for gaspereau on the Tusket River (Bradford et al. 2004a). The accumulation of Atlantic whitefish in the upper pools of the Tusket hydro facility fish ladders facilitated poaching in the 1950s. (Gilhen 1977; Scott and Scott 1988). Similarly, on the Annis River, incidental catches of 50 to 100 individuals during the gaspereau fishery was common as late as 1970.

In the Petite Rivière system, a small angling fishery around Milipsigate and Hebb lakes may have existed as early as 1870s (Edge and Gilhen 2001). Atlantic whitefish were reported as occasional bycatch in the May-June gaspereau fishery in the Petite estuary. There have been no legal directed or bycatch fisheries for the species, since at least 1978. Section 6 of the *Maritime Provinces Fishery Regulations* which specifically prohibits the retention or possession of Atlantic whitefish came into effect in 1993.

1.6.5 Interactions with Non-native Fish Species

Non-indigenous fish predators threaten Atlantic whitefish. Smallmouth bass (*Micropterus dolomieu)* and chain pickerel (*Esox niger*) have been identified as possible threats to Atlantic whitefish (Edge and Gilhen 2001). Smallmouth bass has been introduced into both systems, and chain pickerel are found in the Tusket system. The introduction and increasing range of smallmouth bass in both watersheds is also of concern, in particular the presence of this species in Minamkeak Lake, one of the three upper lakes of the Petite watershed which collectively support the only significant remaining population of Atlantic whitefish. The relationship of these introduced species to Atlantic whitefish is not well understood, but may pose competitive and predation risks (Bradford et al. 2004b).

CRITICAL HABITAT

Critical habitat as defined under section 2 of SARA is 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*".

While the state of knowledge on habitat requirements of Atlantic whitefish is increasing as new scientific evidence becomes available, it is currently not possible to identify critical habitat for this species and thus critical habitat for Atlantic whitefish is not identified in this recovery strategy and will wait to be designated at a later stage in an action plan. As set out in SARA, if information is inadequate to identify critical habitat within the recovery strategy, a schedule of studies must be prepared. Such a schedule, when implemented, will yield new information to enable the species' critical habitat to be described.

Appendix II includes a list of research and monitoring activities that collectively, constitute a schedule of studies. This schedule of studies describes the activities that are needed to define the critical habitat for this species. Despite not being able to identify critical habitat for Atlantic whitefish at this time, the following description of the habitat fundamental to the survival of the species may be useful in a future description of its critical habitat.

Atlantic whitefish, known historically to occur in the Tusket and Petite rivers, no longer exist outside of the Petite Rivière drainage. Life-cycle closure is achieved by fish resident within Hebb, Milipsigate and Minamkeak lakes (Figure 3). Species survival, and ultimately recovery, is therefore wholly contingent on the continued viability of this population whose global area of occupancy is now confined to approximately 16km^2 of semi-natural lake habitat. While there are no indications that current human activities pose a threat to the survival of Atlantic whitefish, or that habitat quality within the lakes is inadequate, there is no scope for a further decline in either the abundance or the distribution of this species and the habitat it occupies (DFO 2004a).

2 RECOVERY

For Atlantic whitefish, survival and recovery have specific meanings that are clearly defined as follows:

Survival is ensuring that Atlantic whitefish continue to exist in the wild in Nova Scotia. This includes continued existence within their current known habitat, but also elsewhere in established populations. Additional populations are required for survival purposes to reduce the risk of extinction should some accidental or random event result in the extirpation of the existing population in the Petite Rivière Lakes.

Recovery requires enabling anadromy, and range extension outside the Petite Rivière lakes. Recovery also inherently requires that survival is achieved. Options for achieving anadromy include the repatriation of the anadromous run to the Tusket River, the

promotion of anadromy on the Petite Rivière, or the promotion of anadromy elsewhere. Range extension also requires additional freshwater resident populations.

RECOVERY FEASIBILITY

The recovery of Atlantic whitefish is both biologically and technically feasible.

2.1.1 Biological Feasibility

The underlying basis for their decline in geographic range, and the concurrent loss of anadromy of the Atlantic whitefish was most likely past human interference, particularly with migration. For the past 20 years, federal fisheries regulations have prohibited fishing of Atlantic whitefish, however before this, there was minimal protection aimed specifically at this species. Despite these factors, the species has survived. Atlantic whitefish are therefore likely to respond positively to recovery efforts aimed at mitigating and correcting past human interference, including fish passage improvements to encourage anadromy, and recent fisheries regulations that provide added protection for this species.

The Recovery Team has confidence that the Atlantic whitefish is biologically capable of survival in areas beyond its current range including estuarine and marine habitats. Atlantic whitefish can adapt to new freshwater and marine environments: they naturally colonized Minamkeak Lake and there is historical evidence of their presence in estuaries. This, along with recent field and laboratory research that indicates the species can tolerate full sea water from an early stage of development (DFO unpublished data), supports that restoration of anadromy is feasible. Atlantic whitefish can tolerate capture and removal from the wild, and transportation to facilities where they survive for several years in captivity. Atlantic whitefish can also be cultured. This species is expected to respond relatively rapidly to recovery actions given that their approximate age at first maturity is 3 years.

The biological feasibility of Atlantic whitefish recovery also depends upon their continued survival within their current environment. The Petite Rivière drainage is naturally buffered from acid rain, and the lakes receive added protection as a municipal water supply. Water quality is not considered to pose either a current or future threat to the survival of Atlantic whitefish in the Petite Rivière, provided current water management practices continue.

2.1.2 Technical Feasibility

Recovery of the species requires stability in the current population (i.e., survival), reestablishment of the anadromous form, and expansion beyond the current range. To achieve these aspects of recovery, it must be technically feasible to move Atlantic whitefish from one area to another, and to grow and reproduce the species in captivity. Wild Atlantic whitefish have been successfully moved into captive breeding facilities indicating that moving the species into areas beyond its current range is technically

possible. The facilities and expertise also exist to grow Atlantic whitefish in captivity. Captive breeding techniques have been developed at the Mersey Biodiversity Facility that allows the species to be spawned and reared in abundance in captivity. It is also possible to effectively mimic the spawning practice in the wild by reconditioning wild-caught fish to spawn more than once.

Recovery is also technically feasible because the known human induced threats that impact Atlantic whitefish have the potential to be mitigated (e.g., see Allowable Activities section 2.7). These activities are also subject to regulation by federal, provincial and municipal governments. For example, more recent federal fisheries regulations offer added protection to Atlantic whitefish by providing greater flexibility to adjust seasons and gear types in fisheries directed at other species. This flexibility will benefit Atlantic whitefish by reducing their vulnerability to incidental catch and it is expected they will respond well to this added protection.

A support network to implement and adhere to recovery measures is also required for recovery to be technically feasible. Local non-government organizations and community groups, industries that operate in Atlantic whitefish habitat, as well as provincial and municipal governments support the recovery of Atlantic whitefish and are members of the Recovery Team. The Atlantic whitefish is also listed as an endangered species under the Nova Scotia Endangered Species Act. This listing should facilitate the implementation of recovery actions between federal and provincial governments.

As mentioned above with respect to the biological feasibility of recovery, the remaining population of Atlantic whitefish may have survived due to the refuge provided by the dams on the Petite Rivière. There are some concerns that restoring open migration routes on this system could actually pose a risk to recovery. The Recovery Team maintains that restoring free access to the ocean on the Petite Rivière is key to promoting anadromy which is a positive outcome both within the context of survival and recovery. Although a precautionary approach to providing fish passage is required, this approach is technically feasible. Implementation of fish passage would have to include controls to exclude undesirable species (e.g., non-native fish), security to prevent poaching, and monitoring facilities to study and respond to the movements of Atlantic whitefish, and the abundance, movements and ecological effects of the other species in this system.

2.2 Recovery Goal

The goal of the Atlantic whitefish recovery strategy is to: *Achieve stability in the current population of Atlantic whitefish in Nova Scotia, reestablishment of the anadromous form, and expansion beyond its current range.*

2.3 Recovery Objectives

Creating and maintaining the necessary conditions to achieve a viable population of Atlantic whitefish in Nova Scotia will be accomplished by implementing the following prioritized recovery objectives:

Objective 1: Conserve, protect and manage the species and its habitat.

Objective 2: Increase the number and range of viable populations.

Objective 3: Increase understanding of the species and its habitat.

Objective 4: Increase public involvement and acceptance.

Following each objective is a set of non-prioritized strategies that, when implemented, will contribute to the fulfillment of their corresponding objective. These strategies are designed to provide sufficient detail to facilitate the application of SARA, and to assist the next step of recovery planning, which is the development of recovery action plans.

The four recovery objectives and their respective strategies are as follows:

Objective 1: Conserve, protect and manage the species and its habitat.

Rationale: The Atlantic whitefish in the Petite Rivière system are all that remains of this species in the wild. The survival of this species depends on the protection of remaining wild fish, and the habitat that they occupy (i.e., three semi-natural lakes in the Petite Rivière watershed). Conservation, protection and management of the species and its habitat will also be required in any range extension to ensure the species survival and progress towards recovery.

Strategies:

a) Address emergent threats to survival.
- initiate contingency planning to deal effectively with these threats, and;
- develop and implement mitigation measures to reduce, control or eliminate emergent threats (e.g., measures to control invasion of non-indigenous species).

b) Develop and implement mitigation measures to minimize human-induced harm to the species and its habitat.

c) Ensure regulatory compliance.
- enforcement of regulations to protect whitefish and their habitat;
- report instances of non compliance, and;

- assess adequacy of enforcement (i.e., are regulations being adequately applied to protect whitefish and their habitat, and adjust as appropriate).

d) Develop and implement watershed and site specific habitat quality management and protection.

Objective 2: Increase the number and range of viable populations

Rationale: In the wild, Atlantic whitefish currently exist only in the Petite Rivière. Recovery of this species must entail more than simply the survival of what remains in the Petite Rivière. The recovery of this species requires enabling anadromy, and range extension outside the Petite Rivière lakes. Recovery also inherently requires that survival is achieved. Options for achieving anadromy include the repatriation of the anadromous run to the Tusket River, promotion of anadromy on the Petite Rivière, or promotion of anadromy elsewhere. Range extension also requires additional freshwater resident populations. Any change in their current habitat could seriously threaten the survival of Atlantic whitefish (e.g., random event, accidental spill, etc.); therefore, the survival of this species also depends on the establishment of viable populations in locations beyond its current range.

Strategies:

a) Work toward establishing viable anadromous runs. Assess the feasibility of the following options.
   - repatriation of an anadromous run to the Tusket system, and;
   - establishment of anadromous populations elsewhere including the Petite Rivière.

b) Maintain the infrastructure and expertise to support captive rearing and re-introduction.

c) Develop a decision support tool to direct fish releases into available and appropriate habitat (balance biological and socio-economic considerations).

d) Plan and execute fish releases in selected watersheds and/or lakes (select donor stock - transplanted wild fish vs. captive reared) in accordance with Introduction and Transfer Guidelines.

e) Plan and support habitat conservation, protection, and possibly restoration in areas selected for releases. In areas with sea access, this will involve protection and management measures from the location of release, and into estuarine and coastal areas.

Objective 3: Increase understanding of the species and its habitat.

Rationale: The current state of knowledge about the basic biology and ecology of Atlantic whitefish and its habitat requirements is limited. Pressing research concerns include the lack of a quantitative population estimate for this species, the potential impacts of introduced species on the remaining wild population of Atlantic whitefish, and the paucity of basic information on habitat use and preferences by life stage. More understanding is required to support survival and recovery efforts, threat assessments, and the application of the SARA prohibitions that protect the species and its habitat (including any potential residence and/or critical habitat identified).

Strategies:

a) Implement scheduled quantitative assessments of species status (information is required to assess threats, manage broodstock, evaluate effectiveness of actions).

b) Develop and undertake research programs to identify habitat requirements (freshwater, estuarine and coastal), including studies to define critical habitat (see section 1.7), and to determine if the residence concept applies to Atlantic whitefish.

c) Continue research to address knowledge gaps including, but not limited to, genetics, health (including disease and parasites), nutrition, life cycle history, behavior, and physiology.

d) Assess the degree of risk posed by current and emergent threats.

***Objective 4*:** Increase public involvement and acceptance.

Rationale: Unlike many other endangered species, the Atlantic whitefish does not currently have a high level of charismatic appeal, and is not particularly well known among the general public. Increasing the level of stakeholder concern and sense of responsibility for the survival and recovery of this species is critical to ensuring the success of recovery efforts. This will be a particular challenge when considering the repatriation or introduction of this endangered species into water bodies. Communication and education are important tools for promoting recovery efforts with both stakeholders and the general public.

Strategies:

a) Develop a general communications plan.

b) Develop a strategy to encourage public support for survival and recovery actions.

c) Encourage stewardship initiatives aimed at conserving, protecting and managing the species and its habitat. Involve local groups to the extent possible (e.g., Aboriginal, recreational and commercial fishers, shoreline property owners,

volunteer-based and non-government organizations, industry, the community at large) that have interest in the aquatic resources in the watersheds and estuaries.

d) Promote Recovery Team meetings as opportunity for communication and collaborations among all team members.

2.4 Performance Indicators

Measurable performance indicators will be a critical component of the recovery action plan for the Atlantic whitefish to gauge the extent to which recovery activities are successful in contributing to the stated recovery goal for the species. An ongoing assessment of the efficacy of actions undertaken within a recovery initiative as part of the action planning process will be critical to ensuring both intelligent use of resources as well as the greatest likelihood of species recovery.

2.5 Identification of Knowledge Gaps

Significant progress has been achieved since the formation of the Recovery Team in 1999 in addressing knowledge gaps of importance to recovery planning and recovery strategy implementation. Information is now available or forthcoming from current activities for the following:

- phylogenetic status, historic and current range and status of the species;
- genetic health of the remaining members of the species;
- accurate field identification of living specimens using external characters;
- genetic markers to support enforcement efforts and future assessments of species distribution;
- captive breeding and rearing protocols;
- life-history stage specific assessments of susceptibility to acid (rain) toxicity; thermal preferences, and salinity tolerance;
- trophic position of Atlantic whitefish residing in lakes;
- degree of threat to survival and recovery posed by invasive species;
- effects of current human activities on Atlantic whitefish survival;
- fish passage requirements around dams, and;
- feasibility of establishing additional freshwater resident populations using seed stock reared in captivity.

Although the above acquired information will possibly improve the likelihood that the recovery actions will be successful, the adequacy of the existing information base is uncertain. Recovery of the species can only be realized through range extension into the marine realm (i.e., anadromy), and into freshwater habitat not currently occupied by the species. There is no existing information on the life history of Atlantic whitefish anywhere other than within the Petite Rivière lakes. As new information is acquired, the Recovery Team must use an adaptive management approach to ensure survival of the species within existing habitat, and to ensure the success of range expansion into the

marine realm and additional freshwater sites. Knowledge gaps that must be addressed as recovery implementation continues to unfold include:

Monitoring
- quantitative assessment of population size, age composition and age at maturity, and growth and mortality;
- effects of current human activities on Atlantic whitefish survival, and;
- fish passage requirements.

Captive Rearing
- nutritional, husbandry, and space requirements to maintain Atlantic whitefish in captivity, and;
- likelihood that domestication selection will occur within Atlantic whitefish spawned and reared in captivity.

Habitat
- determination of specific habitat requirements as they relate to spawning, incubation, rearing and thermal refugial requirements;
- seasonal area of occupancy of Atlantic whitefish;
- identification and mapping of residences and critical habitat, and;
- assessment of habitat suitability within candidate stocking sites.

For details on specific activities that target the key knowledge gaps in the habitat requirements and identification of critical habitat for Atlantic whitefish view the 'Schedule of Studies' to identify critical habitat in Appendix II.

2.6 Development of Action Plans

Recovery action plans are the documents that lay out how recovery strategies are to be implemented. Action plans take recommendations from the recovery strategy, either individually or collectively, and chart out who needs to be involved and to what extent in carrying out the proposed activities.

Following the approval of this recovery strategy under SARA and posting on the Public Registry, a recovery Action Plan for the Atlantic whitefish will be developed within two years. In the interim, many of the strategies in this document can be acted on and therefore, recovery implementation will be an ongoing activity that can occur in the absence of any formal action plan. Furthermore, the Strategy recognizes the need for adaptive management; as new information becomes available, the actions for recovery may be modified.

2.7 Activities Permitted by the Recovery Strategy

As set out in subsection 83(4) of the *Species at Risk Act*, a person can engage in an otherwise prohibited activity if the activity is permitted by a recovery strategy and the person is authorized under an Act of Parliament to engage in that activity.

A Regional Advisory Process (RAP) meeting was convened in November 2004 to assess the level of mortality that would not jeopardize the survival or recovery of the species. Participants included DFO scientists and fisheries managers, the provincial departments of Agriculture and Fisheries, and Natural Resources, scientists from academia and representatives from the Recovery Team. The products of this review are formal documents which provide the conclusions of the meeting (DFO 2004a), along with the Proceedings which provide details of the discussions generated in review of the working papers (DFO 2004b).These documents are available on the Department of Fisheries and Oceans website, under the Canadian Science Advisory Secretariat (CSAS) at:

http://www.dfo-mpo.gc.ca/csas/Csas/status/2004/SSR2004_052_e.pdf

Discussions during the review indicate that there are no estimates of abundance for Atlantic whitefish; status and trends is limited to an analysis of relative indicators of spatial occupancy (i.e., change in geographic distribution over time). Potential sources of mortality and aggregate harm, their relative rank effect by activity, alternatives to current human activities, and feasible measures to minimize impact of activities on Atlantic whitefish are presented in DFO 2004b and included fishing activities, habitat effects due to barriers to fish passage, water extraction, urbanization, eutrophication, and scientific collections.

The conclusion from the meeting was that there are no indications that current human activities (as above) within the Petite Rivière drainage pose a threat to the survival of Atlantic whitefish, however there may not be scope for further harm arising from new activities or proposed changes to existing activities because they may jeopardize the survival and recovery of the species (DFO 2004a). A scientific review of activities and any new information will be undertaken every 5 years to ensure that the survival or recovery of the species is not jeopardized. In accordance with subsection 83(4) of SARA, the recovery strategy permits the operation of the Hebb Lake Dam that is authorized pursuant to subsection 6(4) of the *Navigable Waters Protection Act*, R.S.C., 1985, c. N-22.

Should new activities or changes to existing activities be anticipated, an assessment of their impact on the survival and recovery of Atlantic whitefish will be undertaken.

The allowable harm assessment could not address whether current activities jeopardize the recovery of Atlantic whitefish as recovery for this species is defined as an increase in area of occupancy. Consequently, the lack of prior knowledge concerning the threats to the species outside its current area of known occupancy precludes that assessment at this time. This recovery strategy accordingly presents several options to achieve recovery (range extension); the feasibility of each option has not been determined (see Objective 2; page 27).

2.8 Recovery Effort Underway: Fish releases into Anderson Lake

The Recovery Team identified the need to establish back-up populations of Atlantic whitefish to minimize its risk of extinction. In 2004, a DFO Science workshop was held to examine decision criteria for introducing this species into a watercourse beyond its existing range, and to develop a "decision support tool" to guide the decision making process (DFO 2004c). This decision support tool was subsequently screened by a technical committee of the Recovery Team. Anderson Lake, near Burnside, in Dartmouth, Nova Scotia, was considered an acceptable candidate site according to the criteria of the tool.

On November 4, 2005, 1500 Atlantic whitefish reared at DFO's Mersey Biodiversity Facility were released into Anderson Lake as part of a three-year trial project. A second release of 750 fish occurred on April 24, 2006 and a third release of another 750 fish is scheduled to occur during the fall of 2006. In addition, a number of young-of-the-year fish was also released in April and May of 2006. DFO staff will monitor the whitefish in Anderson Lake to determine the success of the introductions.

With respect to legal protection, the SARA legislation discussed in Section 1.3 applies to the Atlantic whitefish found in Anderson Lake, as does the *Fisheries Act*. Section 6 of the Maritime Provides Fishery Regulations (MPFRs) also applies, however no additional protection measures (e.g., variation orders) were deemed necessary in this lake. DFO held consultations with the owners of the land surrounding Anderson Lake (see Appendix III) prior to the releases. As well, DFO signed Working Agreements with the land owners to facilitate a cooperative approach to avoiding or mitigating any potential negative effects potentially resulting from possible future development activities around the lake.

2.9 Anticipated Conflicts or Challenges

As has been illustrated throughout this document, a major challenge facing the recovery of Atlantic whitefish is the lack of general knowledge about the species biology, its abundance and habitat requirements, as well as assessing the impact of identified threats and appropriate measures to mitigate these threats (Section 2.5).

Some of the anticipated conflicts or challenges facing the recovery of Atlantic whitefish include the following dependant on recovery actions taken:

- (re)-introduction of the species into watersheds other than the Tusket and Petite rivers could be ecologically and socially problematic. From both ecological and management perspectives, there could be negative consequences to other recreational fisheries or resource values;
- water control changes could impact stakeholders;
- fishery regulatory changes could impact stakeholders, particularly recreational fishers;

- predators and competitors such as smallmouth bass and chain pickerel may be difficult to control. The implications of the introduction of these species are not well understood and effective methods of control have not been identified. Furthermore, smallmouth bass are a popular sport fish and their presence in a watershed is not necessarily viewed by all interest groups as negative, and;
- obtaining the financial resources and technical and scientific expertise required for timely implementation of all aspects of the recovery initiative may be problematic. It is acknowledged that there is significant demand from a wide variety of interests in our society for public and private sector funding for initiatives. Furthermore, the existing workload for many of the key contributors to this initiative is substantial.

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APPENDIX I – Glossary of Terms

Anadromous
Migrating from sea to fresh water to spawn

Action Plan
Action plans are the second part of a two-part recovery planning process. The first part, which is the recovery strategy, describes scientific baseline information about the species, its critical habitat and threats, as well as establishing objectives that will assist its survival and recovery. These recovery strategies are implemented through action plans, which outline the measures needed to meet the objectives set out in recovery strategies, and indicate when they are to take place.

Biodiversity
The variety of life in all its forms, levels and combinations, including ecosystem, species, and genetic diversity (IUCN, UNEP and WWF, 1991).

COSEWIC
Committee On the Status of Endangered Wildlife in Canada. A body of Canadian government, academic and non-academic government experts which assess species at risk of extinction nationally

Endangered
a species facing imminent extirpation or extinction

Endemic
restricted to a region or a part of a region, e.g., an island or country

Extinct
a species that no longer exists

Extirpated
As used in text, locally extinct species

Mitigation
Measures to reduce, prevent, or correct impacts.

Morphological
Related to the measurable characters (body shape, form, proportions) of an organism.

Non-indigenous species
Those species that have been transported through human activities from their native ranges into new ecosystems where they did not evolve. Synonymous to ‘introduced species’.

Phylogenetic
Study of the evolutionary relatedness among various groups of organisms.

Telemetry
The automatic measurement and transmission of data from remote sources, by radio or other means, for recording and analysis.

Trophic
The position that an organism occupies in a food chain.

APPENDIX II – Schedule of Studies to Identify Critical Habitat

In the absence of sufficient, long-term studies on habitat use to identify the critical habitat of Atlantic whitefish within this recovery strategy, SARA requires under section 41 (1c.1) that a 'Schedule of Studies' be prepared. The following research activities in Table 2 target key knowledge gaps on the habitat requirements of this species. Accompanying each activity is an assessment of the overall priority (recovery or survival), potential partners, and estimated timing. It is hoped the implementation of the following schedule will yield information that will allow for the description of critical habitat for this species. It is important to note that activities outlined in this schedule are subject to priorities and budgetary constraints of the participating jurisdictions and organizations. Consequently, these activities may not necessarily be completed within the timelines established below. It should also be noted that it may be possible to designate critical habitat under Section 58 of SARA before the end of the timeline indicated in Table 2.

Table 2. Schedule of studies to identify critical habitat for Atlantic whitefish, including research activities, level of priority, possible partners, start date and estimated timing.

RESEARCH ACTIVITIES	**PRIORITY**	**START DATE**	**ESTIMATED TIMING**				
	SURVIVAL OR RECOVERY	(FISCAL YEAR)	05/ 06	06/ 07	07/ 08	08/ 09	09/ 10
Re-evaluate the spatial and temporal distribution of Atlantic whitefish in the Petite Rivière watershed for all life history stages: - the population within the 3 lakes (Minamkeak, Hebb and Milipsigate) - the anadromous component contingent on the provision for fish passage Bathymetrically map the 3 lakes to identify and delineate potential critical habitat	Survival Recovery	1999 ongoing	x	x	x	x	x

RESEARCH ACTIVITIES	PRIORITY	START DATE	ESTIMATED TIMING				
	SURVIVAL OR RECOVERY	(FISCAL YEAR)	05/ 06	06/ 07	07/ 08	08/ 09	09/ 10
Conduct radio telemetry studies to identify: - seasonal foraging areas - thermal refugia - spawning habitat - rearing habitat - seasonal migration (both landlocked and anadromous forms)	 Survival Survival Survival Survival Survival/ Recovery	2005	x	x	x	x	x
Conduct biological collection of prey species in the Petite Rivière watershed to: - assess spatial and temporal distribution within the 3 lakes - evaluate relative contribution to Atlantic whitefish life history stages	 Survival Survival	2005 ongoing	x	x	x		
Evaluate the factors inhibiting / limiting anadromy in the Petite Rivière watershed which include: - physical barriers to fish passage - physiological constraints on anadromy	 Recovery Recovery	2003 ongoing	x	x	x	x	x

Potential partners could include: Atlantic Whitefish Conservation and Recovery Team, Dalhousie University, Nova Scotia Department of Agriculture and Fisheries, Bluenose Coastal Action Foundation, Bridgewater Public Service Commission, Nova Scotia Museum of Natural History

APPENDIX III – Record of Consultations

The Atlantic whitefish is an aquatic species under the federal jurisdiction of Fisheries and Oceans Canada. There are few people in Canada with scientific, traditional or local knowledge of this species as its known historical distribution is limited to two watersheds in southwest Nova Scotia, and its present distribution is now limited to three small connected semi-natural lakes in the Petite Rivière watershed (Minamkeak, Milipsigate and Hebb lakes). An attempt to establish a back-up population of hatchery-reared Atlantic whitefish is also underway in Anderson Lake, N.S.; however, the success of this endeavor has yet to be determined.

To assist in the development of this recovery strategy, DFO brought together a group of experts and representatives from multiple levels of government (federal, provincial, municipal), environmental non-government organizations, academia, and industry groups. Specific members of the Atlantic Whitefish Conservation and Recovery Team and their affiliations can be found on pages v - vi of this recovery strategy.

Comments on the proposed recovery strategy were sought from all members of the Recovery Team. The strategy was also reviewed by relevant provincial government Directors from the province of Nova Scotia.

Recreational anglers were surveyed in preparation for the Atlantic whitefish Allowable Harm Assessment (Bradford et al. 2004a). This assessment, summarised in Section 2.7 (Allowable Activities) of this strategy, was subject to a full peer review through the Canadian Science Advisory process (DFO 2004a).

Communications regarding Atlantic whitefish were made regularly with the Yarmouth/ Shelburne County Gaspereau Advisory Committee and the Queens/ Lunenburg County Gaspereau Advisory Committee, and particularly during the formation of the Recovery Team. These advisory committees are chaired by DFO and deal with the commercial and recreational gaspereau fisheries.

Provincial Recreational Fisheries Advisory Councils (RFAC) held public consultations over the past four years in the RFAC 3 area (Lunenburg and Halifax counties) on all initiatives that restricted angling in an attempt to prevent harm to Atlantic whitefish. Those initiatives included the delayed opening (June 30 instead of April 1) of the angling season in the waters of Minamkeak, Milipsigate and Hebb lakes, the extension of that angling closure to an unnamed tributary to facilitate enforcement, the prohibition on using bait from July 1 to September 30 in those same lakes and tributary, and the stocking initiative in Anderson Lake. Attendees included representatives from local river, angling and wildlife associations, and other interested individuals. DFO regularly attends the RFAC meetings and is provided with Minutes of the meetings. The province's representative on the Atlantic Whitefish Conservation and Recovery Team provided regular updates of these consultations to recovery team members.

Acadia First Nations elders from three Reserves were interviewed in an attempt to gain an understanding of the status, trend and recovery considerations for Atlantic whitefish from the local Aboriginal Community. Two elders reported having caught Atlantic whitefish in the 1940s-50s in areas known to be occupied by Lake whitefish (Bradford et al. 2004a). Other general communication efforts regarding Atlantic whitefish have been made with First Nations People since the establishment of the Recovery Team in 1999.

Discussion between DFO and the owners of land surrounding Anderson Lake occurred between June 2003 and November 2005 prior to the release of Atlantic whitefish into Anderson Lake. DFO and the two landholders have signed Working Agreements which will guide a cooperative approach to development activities around the lake, and will aim to mitigate any potential harm to Atlantic whitefish.

No comments were received during the 60-day SARA public registry comment period.