FINAL

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Atlantic salmon (*Salmo salar*), inner Bay of Fundy populations.

Atlantic salmon

(Inner Bay of Fundy populations)

April 2010

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/approach/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/).

Recovery Strategy for Atlantic salmon (*Salmo salar*), inner Bay of Fundy populations

[Final]

April 2010

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Additional copies:

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PREFACE

The Atlantic salmon is an anadromous fish and is under the jurisdiction of the federal government of Canada. The *Species at Risk Act*, section 37,requires the competent ministers to prepare recovery strategies together for a wildlife species listed as an Extirpated, Endangered or Threatened species. The Atlantic salmon, iBoF populations was listed as Endangered under SARA in June 2003. Fisheries and Oceans Canada, Maritimes Region, co-led the development of this recovery strategy with Parks Canada Agency who has jurisdiction for the species within Fundy National Park, in cooperation and consultation with many individuals, organizations and government agencies. IBoF salmon occur in the following provinces and their respective governments cooperated in the production of this recovery strategy:

- Nova Scotia
- New Brunswick

(see Authors for the list of Recovery Team members and Appendix V for the full record of consultations). The strategy meets SARA requirements in terms of content and process (sections 39-41).

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 (DFO) and Parks Canada Agency or any other party alone. This strategy provides advice to jurisdictions and organizations that may be involved or wish to become involved in the recovery of the species. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans and the Minister of Environment invite all responsible jurisdictions and Canadians to join DFO and Parks Canada Agency in supporting and implementing this strategy for the benefit of the iBoF Salmon and Canadian society as a whole. Fisheries and Oceans Canada and Parks Canada Agency will support implementation of this strategy to the extent possible, given available resources and overall responsibility for species at risk conservation.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new information. The competent ministers 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 competent ministers 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 Minister of Fisheries and Oceans Canada is the competent Minister with respect to aquatic species, other than individuals occurring in or on lands under the administration of Parks Canada Agency.

AUTHORS

This document was prepared by Fisheries and Oceans Canada (DFO) and the Parks Canada Agency with advice from the iBoF Atlantic Salmon Conservation and Recovery Team, but does not necessarily represent the views of its individual members, nor the official positions of the organizations with which they are associated.

The Inner Bay of Fundy Atlantic Salmon Conservation and Recovery Team, hereafter referred to as the 'Recovery Team', was formed in 2000 in response to concerns regarding the decline in iBoF Atlantic salmon and is comprised of relevant federal (DFO, Parks Canada Agency (PCA) and Environment Canada (EC)) and provincial (Nova Scotia and New Brunswick) government members as well as interested stakeholders and Aboriginal peoples from the inner Bay of Fundy area. Some members also participate in a Planning Group consisting of a number of focused sub-committees: Assessment and Monitoring, Freshwater and Marine Habitat, Genetics: Preservation and Restoration, Communications, and Aboriginal.

Meetings are typically held twice a year; spring and fall. Key functions of the Recovery Team include:

- advising DFO on the development of a recovery strategy and action plans;
- coordinating Recovery Team member/organization involvement in recovery actions including environmental, biological, technical and social (educational and stewardship) program initiatives; and
- facilitating discussion and communication on recovery activities.

Recovery Team Members

Members listed have a pertinent interest, knowledge or expertise associated with iBoF Atlantic salmon, represent a stakeholder organization, industry or government agency, have participated in at least one meeting during the 2005-2009 period and/or have contributed directly to the development of this document.

Co-chairpersons

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DFO acknowledges all participants in the Recovery Team and their dedicated efforts in providing information, expertise and perspectives in the development of this recovery strategy. The National Recovery Strategy prepared by the Recovery Team in 2002 (National Recovery Team 2002) provided the foundation for the development of this document. Much of the material presented in the background section of this report was taken from the documentation provided to the Committee on the Status of Endangered Wildlife in Canada for reassessing the ‘endangered’ listing of iBoF Atlantic salmon populations (COSEWIC 2006). The document was further revised as per SARA Recovery Strategy content requirements and updated with new information since the publication of the 2002 Plan. Specifically, recommendations provided by the Recovery Potential Assessment conducted in March 2008 (DFO 2008a) have been included. Additionally, DFO acknowledges the invaluable input provided by the broader interested public in the consultation process (see Appendix V for a record of consultations).

STRATEGIC ENVIRONMENTAL ASSESSMENT

A Strategic Environmental Assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. 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.

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 clearly benefit the environment by promoting the recovery of the iBoF Atlantic salmon populations with little negative effect on habitat or non target species. Exceptions could occur however, where, for example, the restoration of former riverine salmon habitat through the return of appropriate discharge and temperature regimes reversed or slowed a transition to warmer water ecosystems. Potentially adverse effects on the few residual iBoF Atlantic salmon populations may include their maintenance in Live Gene Banks within biodiversity facilities, the cross breeding of the last few individuals from several near-extirpated populations in which numbers are too small for the maintenance of individual populations, the introduction of residual populations to iBoF rivers now devoid of Atlantic salmon, and human induced mortality through research activities; all have been concluded to be environmental risks that are outweighed by 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/sar/recovery/residence_e.cfm

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EXECUTIVE SUMMARY

Atlantic salmon (*Salmo salar*) is an anadromous fish endemic to the northern temperate hemisphere. The "Atlantic salmon, inner Bay of Fundy (iBoF) populations" are considered a 'Designatable Unit' (DU) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2006). The entire iBoF DU exists within Eastern Canada. It includes all rivers draining into the inner Bay of Fundy, starting with the Mispec River (northeast of the Saint John River in New Brunswick) to the Pereaux River (northeast of the Annapolis River in Nova Scotia). Adult Atlantic salmon are reported to have inhabited from 32 to 42 rivers in that area (Figure 1). IBoF Atlantic salmon possess distinct genetic traits and unique life history characteristics compared to the remainder of the anadromous Atlantic salmon species. They are presently at critically low levels, listed and protected under Schedule 1, Part 2 of the federal *Species at Risk Act*.

The collective populations of iBoF Atlantic salmon (iBoF Salmon) may have numbered as many as 40,000 adults earlier in the 20th century, but were reduced to as few as 250 adults by 1999. Although the populations have historically fluctuated widely, since 1989 wild iBoF Salmon have declined to critically low abundance levels and are currently at imminent risk of extinction. COSEWIC assessed iBoF Salmon as "Endangered" in 2001. Documented declines in adult abundance have continued in the two main index rivers; declines are greater than 99% in the Stewiacke River, Nova Scotia, and are about 95% in the Big Salmon River, New Brunswick. Furthermore, recent juvenile population monitoring indicated that declines are widespread throughout the area. This DU was reassessed by COSEWIC in April 2006 and its Endangered status was re-confirmed. Persistence of the populations is currently maintained through a Live Gene Bank (LGB) program which is a pedigree-supported spawning and rearing program designed to minimize the loss of genetic diversity and fitness in the remnant populations. A Recovery Potential Assessment (RPA) for iBoF Salmon was conducted by DFO Science in March 2008 to summarize the current understanding related to the distribution, abundance, trends, extinction risk and current state of iBoF Salmon populations, as well as to provide information on habitat and threats (DFO 2008a).

The causes of the marked decline of Atlantic salmon throughout much of their range and the complete collapse in some locations, such as the iBoF, are not well understood. A growing body of evidence suggests that the sharp decline of iBoF Salmon is primarily due to low marine survival. Key threats responsible for the decline were identified in COSEWIC (2006) and reviewed in the iBoF Salmon RPA (DFO 2008a). Potential marine threats identified to date are (in no particular order): 1) interactions with farmed and hatchery salmon (competition with escapees for food, parasite and disease outbreaks and modified predator interactions), 2) ecological community shifts (increased predator abundance, and lack of or reduced forage species), 3) environmental shifts (temperature shifts depressing ocean productivity, and altered migration routes leading to decreased survival), 4) fisheries (excessive illegal and/or incidental catch), and 5) depressed population phenomena (lack of recruits to form effective schools), Threats to the species in the freshwater environment are thought to be historical and contemporary in nature and include (in no particular order): 1) changes in environmental conditions, 2) contaminants, 3) barriers to fish passage, and 4) depressed population phenomena.

The persistence of iBoF Salmon currently requires maintaining existing populations through the ongoing LGB program until the causes of low marine survival can be identified and remedied or alternative life history strategies can be identified, evaluated and supported. Correspondingly, the overarching recovery goal for iBoF Salmon is to:

> *re-establish wild, self-sustaining populations as required to conserve the genetic characteristics of the remaining anadromous iBoF Atlantic salmon.*

Because there are challenges to re-establishing iBoF Salmon populations in a large subset of rivers, and because there is a need for realistic benchmarks for evaluating recovery success in the short to medium term, both a five-year target and a long term target have been established for inner Bay of Fundy salmon populations. The five-year target sets out ambitious but achievable population and distribution objectives for the next five years. The five-year target was set at the conservation levels within the 10 rivers that currently contribute to the LGB program and would represent approximately a third of the measured accessible habitat. A longer term target for iBoF Salmon, should marine survival improve, has also been established. This target can be defined using both abundance and distribution components as recommended by the RPA. An abundance of 9,900 spawning adults (conservation level set for the DU and representing about 25% of the species' past abundance) was considered a reasonable abundance target by the RPA and a set of 19 rivers were selected for the distribution component of the target based on science-based criteria outlined in the RPA. This distribution component of the long term target represents greater than 85% of the measured accessible habitat and recognizes that efforts in more rivers will be important for long term population sustainability once marine survival improves. This long term target is not expected to be achieved in less than three generations.

Creating and maintaining the necessary conditions to conserve the genetic characteristics of iBoF Salmon and re-establish wild self-sustaining populations throughout the iBoF, will be accomplished by implementing the following five prioritized supporting recovery objectives:

1. Conserve iBoF Salmon genetic characteristics and re-establish self-sustaining populations to iBoF rivers.
2. Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the marine environment.
3. Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the freshwater environment.
4. Assess population status, sustainability, and recovery feasibility.
5. Communicate and increase the awareness of the status and recovery of iBoF Salmon.

Specific approaches within each of these objectives are outlined below. Implementing the recommended approaches will require close collaboration among governments, independent scientific experts, Aboriginal peoples, industry, other stakeholders and interested parties, and will be dependent on resource availability, among other factors.

A number of specific initiatives supporting the stated recovery objectives have already been completed, or are underway (see Section 2.8 Actions_Completed_or_Underway). These activities include the LGB program in operation since 1998, recent surveys to help determine the marine distribution of post-smolts during the fall and winter months, and the proposed restoration of tidal flow and fish passage on the Petitcodiac River. Although there remain a number of gaps in our knowledge about the iBoF Salmon, the primary objective of the recovery strategy remains focused on identifying the source(s) of the unusually high marine mortality and protecting the iBoF Salmon's genetic characteristics. Lists of 'high' and 'other' priority research and monitoring recommendations are outlined here-in.

Following the adoption of this recovery strategy under SARA, one or more action plans for the iBoF Salmon will be developed, with the first one within 4 years. Several priorities for action planning have been identified thus far however in the interim, many of the strategies in this document can be acted on immediately. Recovery implementation will be an ongoing activity that can occur in the absence of any formally adopted action plan.

Protection under SARA prohibits the killing, harming, harassing, capturing or taking of an endangered or threatened species. SARA however enables a recovery strategy to exempt certain activities from the general prohibitions of SARA if the activity is authorized under another Act of Parliament and does not jeopardize the survival or recovery of the species. The extinction risk of iBoF Salmon was reviewed during the RPA and it was concluded that there is scope for low levels of human-induced mortality without jeopardizing the survival or recovery of these populations. This recovery strategy adopts this conclusion and includes a list of activities exempted from the SARA prohibitions; these are detailed in Section 2.9 (Activities Permitted by the Recovery Strategy). All efforts to minimize the impact of human activities on this DU continue to be encouraged.

SARA also requires the protection of critical habitat once it is identified in a recovery strategy and/or action plan. This recovery strategy identifies critical habitat for iBoF Salmon in freshwater as specific freshwater habitat types found below complete natural barriers in the 10 LGB rivers (and their tributaries) identified in the five-year recovery target. Freshwater habitat types and uses are well known for Atlantic salmon. Accordingly, freshwater critical habitat in these rivers consists of riffles, runs and pools, which provide for the functions of those habitats (e.g., spawning, feeding, rearing, migration and overwintering). Examples of activities that could destroy freshwater critical habitat are described in Section 2.5.2 (Activities that are Likely to Destroy Freshwater Critical Habitat). Atlantic salmon also require marine habitats to complete a life cycle. However, habitat requirements for iBoF Salmon are not well known in the marine environment. In the absence of sufficient knowledge on the precise spatial and temporal use of the marine environment by the iBoF Salmon, marine critical habitat is not identified in this recovery strategy and will be developed at a later date in an action plan. A schedule of studies which lays out the key research activities necessary to help determine, identify and describe the marine critical habitat requirements for the species is provided.

This recovery strategy will benefit the environment by promoting the recovery of the iBoF Salmon populations with little negative effect on habitat or non target species. The greatest challenges to recovery may lie in developing and implementing effective mitigation measures for those anthropogenic threats that are currently preventing or limiting recovery.

Furthermore, this recovery strategy recognizes both local watershed and community efforts and knowledge, and Aboriginal knowledge and experience as being distinct and important in the recovery and protection of iBoF Salmon. Additionally, management measures will need to consider fisheries for Aboriginal food, social, and ceremonial (FSC) purposes.

SARA requires that progress toward the implementation of recovery strategies be reviewed at a minimum every 5 years. 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 and PCA will continue to assess the feasibility and effectiveness of recovery efforts and work cooperatively with stakeholders, Aboriginal people and other interested parties towards the recovery of iBoF Salmon.

INTRODUCTION

The Bay of Fundy is bounded by Maine, New Brunswick (NB) and Nova Scotia (NS), and has been suspected of harbouring at least two different population assemblages of Atlantic salmon since very early times (Perley 1852; Huntsman 1931a,b). One assemblage is now referred to as “outer Bay of Fundy salmon” and includes populations inhabiting rivers and streams in the western Bay of Fundy, like the Saint John River, NB. Within outer Bay of Fundy populations, returning adults are generally a mix of salmon that have spent one and two winters at sea before first returning to spawn and have relatively few previous spawners amongst them (DFO 1986; Marshall *et al.* 1998). Tag recovery information indicates that outer Bay of Fundy salmon migrate to the northwest Atlantic Ocean (Ritter 1989).

The second assemblage of salmon is referred to as “inner Bay of Fundy (iBoF) salmon” (Perley 1852). The entire iBoF area is identified as a Designatable Unit (DU) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2006) and encompasses all drainages from the Mispec River, NB to the Pereaux River, NS (Figure 1). Based on recreational catch reports, at least 32 rivers of the iBoF are known to have supported anadromous populations of Atlantic salmon (Amiro 2003) but another 10 rivers and streams within the iBoF are known to have produced salmon (National Recovery Team 2002, COSEWIC 2006). Except for the Gaspereau River, all iBoF Salmon populations have similar life history traits that differ from those of outer Bay of Fundy salmon. IBoF Salmon have been characterized as having a more localized migration (staying within the Bay of Fundy and the Gulf of Maine), earlier age at maturity, a greater dependence on repeat spawning for population stability, and until recently a higher survival between spawning events (Amiro 1987; Amiro and Jefferson 1996).

Based on an analysis of mitochondrial DNA, iBoF Salmon can be further partitioned into two groups of populations that are related to each other but distinctive from other salmon populations in North America and Europe. These groups appear to be geographically separated with one group inhabiting rivers flowing into the Minas Basin (i.e., the Minas Basin group) and the other inhabiting rivers of the adjacent Chignecto Bay and in New Brunswick (i.e., the Chignecto Bay group) (Verspoor *et al.* 2002). An exception among iBoF populations is the population of the Gaspereau River, NS, which possesses the same genetic uniqueness common to the Minas Basin group (Verspoor *et al.* 2002), but displays marine migratory patterns and life history traits similar to outer Bay of Fundy salmon (Amiro and Jefferson 1996; DFO 2001).

The iBoF assemblage was designated “endangered” by COSEWIC in 2001 (COSEWIC 2001) and listed under Canada’s *Species at Risk Act* as “endangered” in 2003. This status was reassessed and re-confirmed by COSEWIC in 2006. In response to concerns of acute declining abundances prompting fishery prohibitions and warranting immediate action, an iBoF Atlantic Salmon Conservation and Recovery Team was formed in 2000. A National Recovery Plan was prepared by the Recovery Team and approved by the Department of Fisheries and Oceans Canada (DFO) in 2002 (National Recovery Team 2002). With the coming into force of SARA in June 2003, the federal government (DFO for aquatic species at risk with Parks Canada Agency for individuals of the species found within Fundy National Park) is legally responsible for ensuring that specific steps are taken with respect to the recovery of listed species and that recovery strategies are prepared for extirpated, endangered or threatened species. As a result, DFO and PCA co-developed a 'SARA compliant' recovery strategy for the endangered iBoF Salmon.

Atlantic salmon of the IBoF rivers were and remain a culturally significant fish traditionally harvested by Aboriginal peoples for food, social and ceremonial purposes. In addition, iBoF rivers historically supported commercial and recreational salmon fisheries. The commercial fishery was closed in 1985 and there have been no recreational or Aboriginal fisheries since 1990 (except for the Gaspereau River which supported a limited recreational and food fishery until 1997). The species, regarded by the general public as a barometer of the health of the natural environment and seen by most people in Atlantic Canada as an important natural symbol, remains culturally significant to local communities around the inner Bay of Fundy.

In summary, iBoF Salmon are an ecologically and culturally significant species, genetically distinct, possessing a unique set of life history characteristics, composed of at least two distinct population segments and once occupied many iBoF rivers in both NS and NB. At risk of extinction, declared "endangered" by COSEWIC, and currently protected under SARA, the persistence of the population is presently maintained through the LGB program. Given their unique attributes and imminent extinction risk, the urgent need to implement the recovery of this species is apparent.

This document is intended to provide a strategy for the planning and implementation of recovery for iBoF Salmon. It defines the goal for recovery of the species and outlines objectives to achieve this goal. It identifies activities to be undertaken as well as areas where knowledge is lacking and further information is required. It also includes a description of the species and its needs, and identifies the threats to its survival and recovery.

1. BACKGROUND

1.1 COSEWIC Status

COSEWIC Assessment Summary

Common name: Atlantic salmon, Inner Bay of Fundy populations

Scientific name: *Salmo salar*

Status: Endangered

Occurrence: New Brunswick, Nova Scotia, Atlantic Ocean

Reason for Designation: These salmon represent a unique Canadian endemic; their entire biological distribution exists within Canada. Adult numbers are estimated to have declined by more than 95% in 30 years, and most rivers no longer have either adults or juveniles. In 2003, fewer than 100 adults are estimated to have returned to the 32 rivers known to have historically contained the species. There is no likelihood of rescue, as neighbouring regions harbour severely depressed, genetically dissimilar populations. The reasons for the collapse in adult abundances are not well understood. Reduced survival from smolt to adulthood in marine waters is thought to be a key factor. There are many possible causes of this increased mortality, including ecological community shifts; ecological/genetic interactions with farmed and hatchery Atlantic salmon; environmental shifts; and fisheries (illegal or incidental catch). Threats to the species in the freshwater environment are thought to be historical and contemporary in nature. Historical threats include loss and degradation of habitat (attributable to the construction of barriers to migration and logging); contemporary threats may include interbreeding with escaped farmed fish and environmental change (warmer temperatures, contaminants).

Status History: Designated Endangered in May 2001 and in April 2006. Last assessment based on an updated status report.

1.2 Distribution

1.2.1 Atlantic Salmon - Global Range

The range of natural anadromous Atlantic salmon is essentially the North Atlantic Ocean and adjacent rivers (DFO and NMRF 2008). WWF (2001) has suggested wild Atlantic salmon historically occupied 2,615 rivers worldwide. In Europe, Atlantic salmon have been found in rivers from Portugal to northwest Russia, as well as in the United Kingdom, Iceland and Greenland. In North America the species natural range extends into rivers bordering the northwest Atlantic Ocean from Ungava Bay, Canada in the north to Rhode Island’s Pawcatuck River, U.S. in the south. Recent status estimates however indicate that many southern populations in Europe and North America are now extirpated or in great decline (Parrish *et al.* 1998). Domestic strains of Atlantic salmon are now cultured for commercial aquaculture purposes in many temperate climates worldwide, including the Bay of Fundy (Gross 1998).

1.2.2 Atlantic Salmon - Canadian Range

The natural Canadian range of sea-run Atlantic salmon represents roughly one-third the area of the total global range, and extends northward from the St. Croix River (Canada-U.S. boundary) to the Ungava Bay of Québec, and westward into the St. Lawrence River up to the Jacques Cartier River near Québec City (Scott and Crossman 1973, MacCrimmon and Gots 1979; DFO and NMRF 2008) (Figure 1). There are by recent count 728 rivers in Atlantic Canada in which Atlantic salmon are or were present within the last half century (DFO and MNRF 2008). The status of Canadian Atlantic salmon populations was recently reviewed and it was noted that those from many rivers in the southern reaches of their Canadian range are now extirpated (Parrish *et al.* 1998).

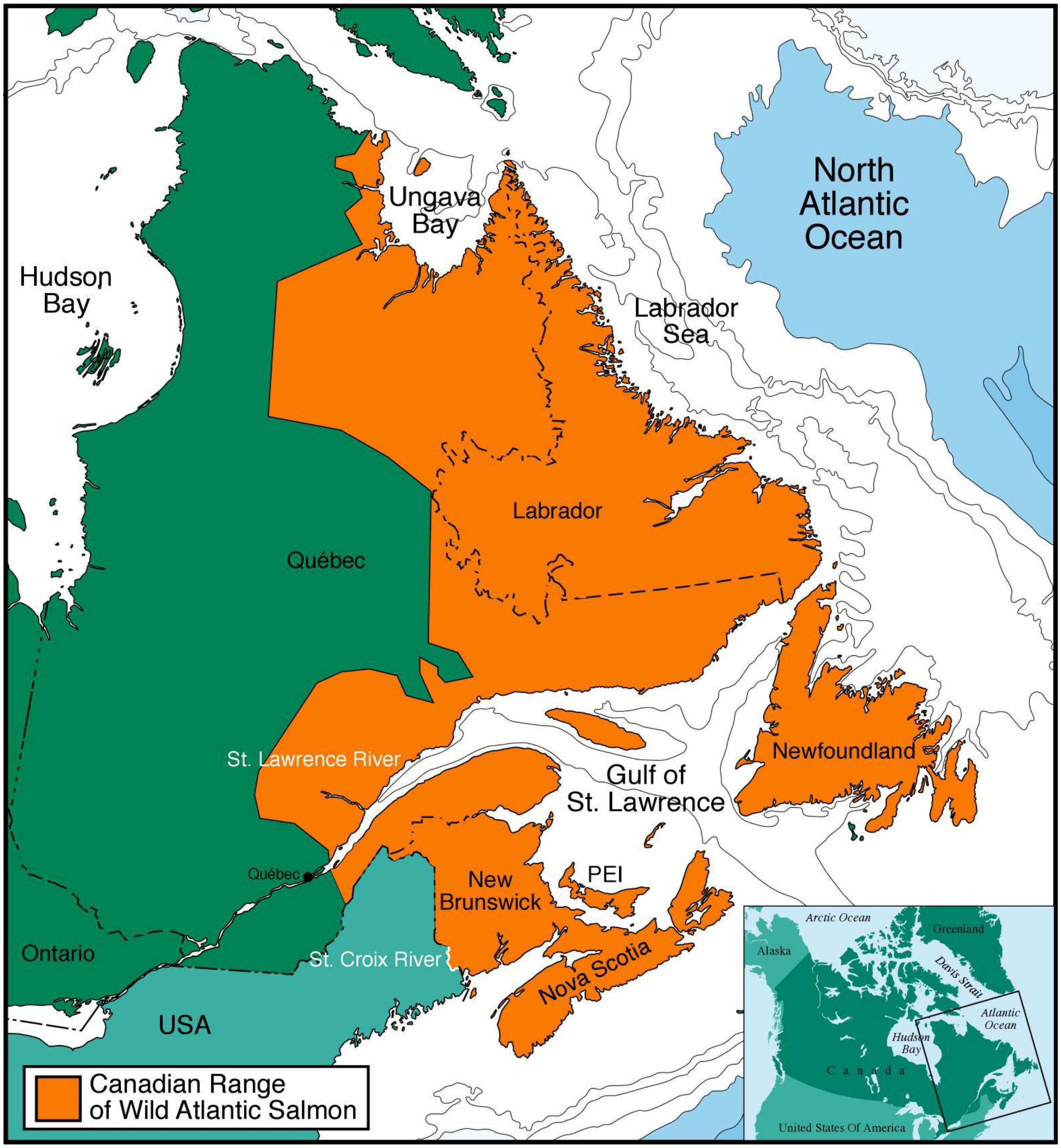

Figure 1. Natural Eastern Canadian range of wild Atlantic salmon.

1.2.3 IBoF Atlantic Salmon - Designatable Unit Range

IBoF Salmon populations are considered a 'Designatable Unit' by COSEWIC. The entire iBoF DU exists within Eastern Canada. It includes all rivers draining into the Bay of Fundy starting with the Mispec River (the first river northeast of the Saint John River, NB), and extending around the Bay to the Pereaux River (the first river northeast of the Annapolis River, NS) (as described on pages 15-16 *in* COSEWIC 2006). The extent of marine occupancy and occurrence includes at least the Bay of Fundy and outlying oceanic waters (COSEWIC 2006). The location of the iBoF Salmon DU[1] including the 50 rivers referred to in this document are displayed in Figure 2, however not all rivers and tributaries within the DU are shown on the map.

Recreational fishery data suggest that at least 32 iBoF rivers supported self sustaining salmon populations (Amiro 2003, COSEWIC 2006). Another 10 rivers and streams are reported to have produced salmon (National Recovery Team 2002, COSEWIC 2006) and these include the Avon River, NS and nine systems in NB: Memramcook, Weldon, Goose, Quiddy, Little Salmon, Tynemouth/ Bains Brook, Gardner, Emmerson and Mispec. Several additional rivers displayed in Figure 2 were sampled in 2000, 2002 and/or 2003 for the presence of juvenile salmon, but none were found (Gibson *et al.* 2003a; Figure 6). It is unknown if viable populations of salmon ever inhabited any of the small drainages between the Pereaux and Annapolis rivers or other unsampled drainages in the iBoF DU.

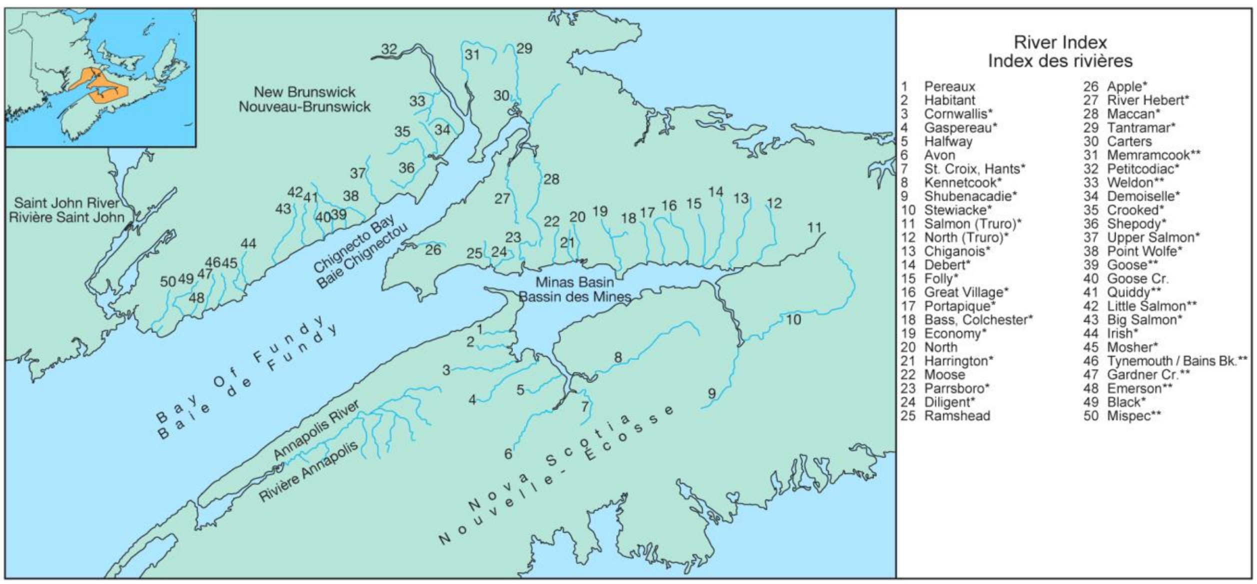

Figure 2. The location of the iBoF Salmon DU and the approximate location of the 50 iBoF rivers referred to in this document. Not all rivers and tributaries within the DU are represented. Recreational catch data suggests that 32 rivers (*) supported self-sustaining Atlantic salmon populations (Amiro 2003, COSEWIC 2006). Another 10 rivers and streams (**) are reported to have produced salmon (National Recovery Team 2002, COSEWIC 2006). The remaining rivers were sampled in 2000, 2002 and/or 2003 (see section 1.6 and Figure 6 of this document). Figure adapted from Gibson *et al.* (2003a).

1.3 Legal Protection and Resource Management

1.3.1 General

Both federal and provincial governments have legislative authorities to regulate different aspects of the fisheries resources in Canada. In June 2003, Canada's federal legislation to protect and

[1] The inner Bay of Fundy (iBoF) Atlantic salmon Designatable Unit is hereafter referred to as iBoF Salmon.

conserve species at risk in Canada, SARA, came into force. SARA is one component of a three-part federal strategy for the protection of wildlife species at risk. It builds on the federal-provincial-territorial *Accord for the Protection of Species at Risk* and activities administered by Environment Canada's 'Habitat Stewardship Program'. The Minister of Fisheries and Oceans is the 'competent minister' under SARA responsible for aquatic species at risk. The Minister of Environment acting for Parks Canada Agency is also a 'competent minister' with respect to individuals in or on federal lands that are administered by that Minister and that are national parks, national historic sites or other protected heritage areas, and thereby, the two government departments are jointly responsible for the delivery of the recovery program for iBoF Salmon.

1.3.2 Federal Authority

Under the *Constitution Act*, the federal government has exclusive legislative authority for the conservation of all fish stocks.

SARA applies to "aquatic species" wherever they are found within Canadian jurisdiction. An "aquatic species" means a wildlife species that is a fish or marine plant as defined in the *Fisheries Act* (see the Glossary for a definition of 'fish' under the *Fisheries Act*). IBoF Salmon are listed under Schedule 1, Part 2 of SARA and are therefore subject to the SARA provisions against the killing, harming, harassing, capturing or taking of individuals (section 32), and the damage or destruction of the species residence (section 33).

In addition to SARA, the *Fisheries Act* and its supporting regulations have direct and/or indirect application to iBoF Salmon. The *Fisheries Act* protects fish and fish habitat in all waters in the fishing zones of Canada, all waters in the territorial sea of Canada and all internal waters. The *Fisheries Act's* supporting regulations [the *Fishery (General) Regulations*, *the Maritime Provinces Fishery Regulations*, the *Atlantic Fishery Regulations, 1985*, and the *Aboriginal Communal Fishing Licences Regulation*] provide the tools to protect, conserve and manage fisheries.

The *Fisheries Act* has specific provisions that:

(a) make fish passage mandatory and require the construction of fish-ways (when deemed appropriate by the Minister) (section 20);
(b) prohibit the destruction of fish by means other than fishing, unless authorized (section 32);
(c) prohibit the harmful alteration, disruption or destruction of fish habitat, unless authorized (section 35); and
(d) prohibit the deposit of deleterious substances into waters frequented by fish unless regulated (section 36).

Under the regulations:

(a) commercial, recreational and Aboriginal Atlantic salmon fisheries have been closed since 1990 on all iBoF rivers except for the Gaspereau River. The Gaspereau River remained open for Atlantic salmon recreational and food fisheries until 1994, was closed in 1995 and re-opened with limited food fishery agreements and a shorter catch-and-release angling season in 1996 and 1997;
(b) the retention of incidentally caught salmon is strictly prohibited; and,

(c) it is illegal to release live fish into fish habitat without a federal licence. This is to minimize disease, genetic, ecological or other adverse affects to wild fish and their habitat(s).

The provisions of the *Fisheries Act* and supporting regulations are mostly administered by DFO. Environment Canada administers section 36 of this *Act* which pertains to the release of deleterious substances into waters frequented by fish. The Upper Salmon and Point Wolfe rivers, contained within the boundaries of Fundy National Park, are afforded additional protection by the *Canada National Parks Act* and related regulations which are administered by PCA.

The *Oceans Act* applies to waters of Canada extending from the low tide mark outward to 200 nautical miles which includes the Territorial Sea and the exclusive economic zone. While the *Oceans Act* itself affords little direct protection for iBoF Salmon, its regulation and order making powers generally provide for the protection and preservation of the marine environment and can be used for the creation of marine protected areas.

1.3.3 Provincial Authority

The provinces have exclusive legislative authority over matters dealing with property and civil rights and the management of public lands, including those pertaining to public fisheries, water and substrates. In both NS and NB the control of water rights are also areas of provincial responsibility. With respect to ownership of the riverbed, in NS and NB it is asserted to be owned by the crown (the province), however in NB, private land owners claim to have been granted riparian rights. The provinces regulate the terms and conditions of access to the recreational fisheries in freshwater. Similarly, the granting of special privileges to limit access to certain waters falls under provincial jurisdiction.

New Brunswick and Nova Scotia also have legislation regarding environmental protection, land use, riparian rights associated with water quantity and water quality, forest management, mining, aquaculture development, agriculture, and highway and infrastructure development.

The NB Department of Natural Resources, the NS Department of Fisheries and Aquaculture and the NS Department of Natural Resources administer their respective provincial natural resource management legislation and also support the federal *Fisheries Act*. Both provinces have environmental agencies (NS Department of Environment, NB Department of Environment) for delivery of their environmental legislation. Examples of provincial legislation that directly and indirectly afford protection to iBoF Salmon in NB include the *Endangered Species Act*, *Aquaculture Act*, *Clean Environment Act*, *Clean Water Act*, *Ecological Reserves Act*, *Crown Land and Forests Act*, *Pesticide Control Act* and the *Fish and Wildlife Act;* and, in Nova Scotia, the *Endangered Species Act*, *Fisheries and Coastal Resources Act*, *Wildlife Act*, *Environment Act* and *Angling Act*.

1.3.4 Aboriginal and Treaty Rights

Aboriginal and treaty rights of the Aboriginal peoples of Canada are recognized and protected under sections 25 and 35 of the *Constitution Act, 1982*. Aboriginal peoples play a role and are involved in the conservation of wildlife pursuant to SARA. The SARA preamble states that, "…

the roles of the Aboriginal peoples of Canada ... in the conservation of wildlife in this country are essential." Section 8.1 of SARA further obliges the Minister of Environment Canada to establish the National Aboriginal Council on Species at Risk (NACOSAR) whose role is to advise the Minister on the administration of SARA and to provide advice and recommendations to the Canadian Endangered Species Conservation Council (CESCC).

The Supreme Court of Canada, in its 1990 ruling in R. *v. Sparrow*, found that where an Aboriginal Right to fish for food, social and ceremonial (FSC) purposes is established, that right has priority over other users of the resource, after conservation needs have been met. In 1999, the Supreme Court of Canada in *R. v. Marshall* confirmed a treaty right to hunt, fish and gather in pursuit of a "moderate livelihood" for Mi'kmaq and Maliseet First Nations, based on local treaties signed in the eighteenth century.

On November 18, 2004, the Supreme Court of Canada in the 'Haida[2]' and 'Taku[3]' cases ruled that the Crown has a legal obligation to consult Aboriginal groups; and if appropriate, to accommodate their interests when the Crown has knowledge of a potential or established Aboriginal or Treaty right, and contemplates conduct that might adversely affect them.

1.3.5 Conservation Organizations

International management of wild Atlantic salmon is through the North Atlantic Salmon Conservation Organization (NASCO) with scientific support from the International Council for the Exploration of the Sea (ICES). Locally, stakeholder groups, such as the Atlantic Salmon Federation and provincial and watershed conservation organizations, invest considerable time and money towards Atlantic salmon conservation. Aboriginal peoples' natural life management authorities, groups and communities invest significant effort seeking support and involvement in protection, conservation, and recovery activities to help conserve and recover the Atlantic salmon and its habitat. These organizations, authorities, groups and communities have proven to be invaluable and essential to Atlantic salmon protection, conservation and recovery efforts.

1.3.6 Land Ownership

The lands through which the iBoF rivers flow are asserted to be owned either privately or by the respective provincial Crown. Exceptions to this are lands of the federal Crown which include National Parks, lands reserved for Aboriginal peoples, Department of National Defence properties, public works lands, national historic sites, and other such lands that belong to her Majesty in right of Canada. These lands may include the traditional ancestral homelands of the Mi'kmaq, Maliseet and Passamaquoddy Aboriginal peoples (Percy 2003), affirmed in the Royal Proclamation of 1763 and asserted as outstanding comprehensive claims (Native Communications Society of Nova Scotia 1987; Native Council of Nova Scotia 1993).

[2] *Haida Nation v. British Columbia (Minister of Forests*), 2004 Supreme Court of Canada 73
[3] *Taku River Tlingit First Nation v. British Columbia (Project Assessment Director*), 2004 Supreme Court of Canada 74

1.4 General Biology and Species Description

1.4.1 Name and Classification

Class:	Osteichthyes (Bony Fishes)	
Order:	Salmoniformes	
Family:	Salmonidae	
Species:	*Salmo salar* L.	
Designatable Unit (DU):	Inner Bay of Fundy Populations	
Common species names:	English:	Atlantic salmon
	French:	Saumon atlantique
	Mi'kmaq:	plamu
	Maliseet:	polam
	Others:	salmon, ouananiche (landlocked form), black salmon, grilse, kelt (Leim and Scott 1966)

1.4.2 Physical Description

The Atlantic salmon, 'the leaper' (Netboy 1968), has been called the king of fish (Dubé 1972), due primarily to its ability to ascend waterfalls. To date, no obvious morphological distinctions have been described for the iBoF Salmon. As a species, the Atlantic salmon is a medium-sized salmonid with a pointed head, well-developed teeth on both jaws, and a slightly forked caudal (tail) fin (Figure 3). Its large body is long and hydrodynamic.

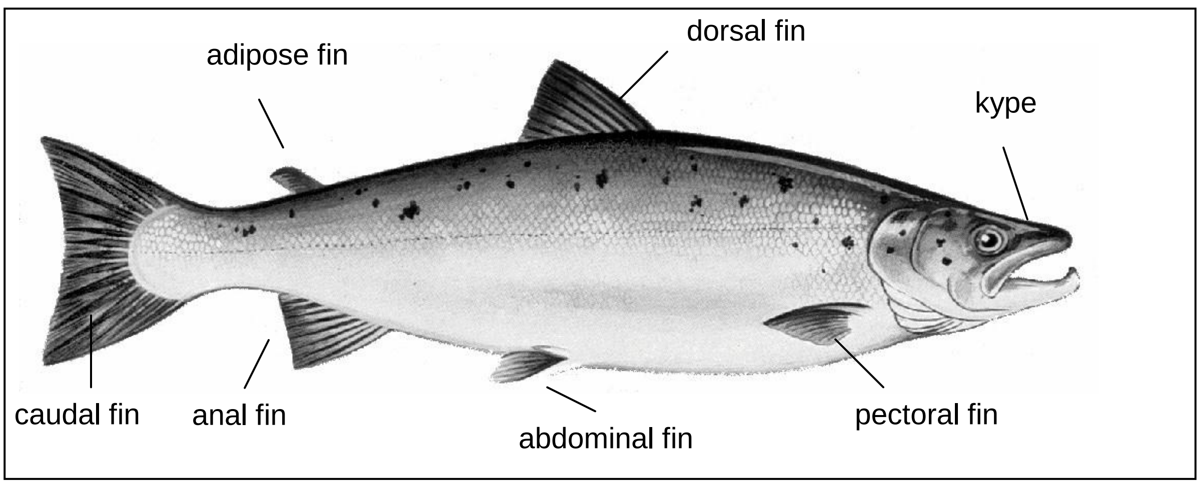

Figure 3. Line drawing of adult Atlantic salmon (adapted from Amiro 2003).

Salmon having spent one year at sea (i.e., grilse or ISW) average between 1.4-2.7 kg, whereas salmon that return after spending two years at sea (i.e., large salmon or MSW) average between 2.7-6.8 kg (Scott and Scott 1988). Few salmon live beyond 9 years of age in eastern Canada (Scott and Scott 1988). Atlantic salmon can vary in colour and physical appearance depending on water quality, age and spawning state. When living at sea, the lower half of the body and belly are silvery while the back varies through shades of brown, green and blue. Atlantic salmon have black fins and numerous black spots scattered along the dorsal upper half of the body.

Spawning salmon in freshwater become bronze-purple in colour, with reddish spots on the head and body. Males develop a pronounced hooked lower jaw (kype). After spawning, both sexes darken in coloration (hence the name ‘black salmon’). Young salmon (parr) in freshwater have 8-11 dark bars on their sides with a red spot between each one. Young salmon leaving freshwater for the sea (smolts) are silvery in colour and are usually about 12-15 cm in length.

1.4.3 Life History Characteristics

General

The biology of the Atlantic salmon is relatively well known (e.g., Scott and Crossman 1973, Baum 1997). Appendix II of this document provides a general summary of the species life cycle. The following section describes any known differences for the iBoF Salmon DU.

Specific to iBoF Salmon

Except for the Gaspereau River population, all iBoF Salmon populations have similar life history traits; these display differences from those of outer Bay of Fundy Salmon: a more localized migration, an earlier age at maturity, a high survival between annual spawning events, a dependence on repeat spawning for population stability and a distinct genetic profile (see section 1.4.5 of this document) (Amiro 2003).

Most iBoF parr change their physical appearance and their physiological condition in preparation for migration to the marine environment (i.e., smoltification) in the early spring after two years in freshwater, at a size probably similar to those fish outside the DU. Smolt migration is often later into the summer (including July) (Amiro 2003) compared to other Atlantic salmon populations. Recent monitoring on the Big Salmon River indicated that at least 70% of the smolts (wild origin or LGB origin - released as unfed fry) were age-2, and the majority were captured between mid May and mid June (Flanagan *et al.* 2006). Rather than migrating to waters off west Greenland, as do neighbouring outer Bay of Fundy Atlantic salmon (Ritter 1989), tagging, telemetry and trawling surveys indicate that iBoF post-smolts and adults remain within the Bay of Fundy and northern Gulf of Maine until October (Amiro 2003, Lacroix and Knox 2005, Lacroix *et al.* 2005), however there is no documentation of their over-wintering distribution or habitats. Almost all iBoF Salmon mature after one winter at sea and spawn in consecutive years with the majority of returns (two-thirds or more) being female (Amiro 2003). Based on a study of wild Big Salmon River smolt returns from 1966 through 1971 (Ritter 1989), marine survival ranged from 1.0% to 9.7% with a mean value of 6.0%. Big Salmon River data from 1965 to 1973 (Jessop 1975, Jessop 1986 in Amiro 2003), indicate a generation time for iBoF Salmon of 3.7 years based on an average 2.6 freshwater years (to smolt migration) and 1.1 marine years (to first adult maturity). Body size for female salmon averages 61.5 cm and egg production of all age classes averages 4,060 eggs. Although the majority of iBoF Salmon mature after one sea-winter, the relatively high across-year survival of females resulted in repeat-spawners contributing the majority of eggs in the Big Salmon River from 1965 to 1973 (Amiro 2003).

1.4.4 Habitat Requirements

Requirements in Freshwater

Atlantic salmon streams are generally clean, cool, well oxygenated, characterized by moderately low (2 m/km) to moderately steep (11.5 m/km) gradients (Elson 1975), and have bottom substrates composed of assorted gravel, cobble and boulder. Salmon prefer stable stream channels that develop natural riffles, rapids, pools and flats which are utilized during different life stages.

Parr growth occurs at temperatures above 7°C (Allen 1941). Good salmon streams have summer temperatures between 15° and 25°C (Elson 1975). Specific freshwater habitat requirements for iBoF Salmon are known and suitability indices exist for both summer (Morantz *et al.* 1987) and winter (Cunjak 1988).

Except in areas affected by localized pollution sources, water quality in iBoF rivers is good to excellent for Atlantic salmon production. Water quality surveys (Ashfield *et al.* 1993; Lacroix 1994) show that pH is generally greater than 6.0 in iBoF rivers, and therefore non-inhibiting to salmon reproduction and survival of early life stages.

Requirements in Marine Waters

Marine habitat requirements for iBoF Salmon are less well known than those for freshwater. The only available indicator of marine habitat quality for Atlantic salmon is temperature. The marine temperature preference for Atlantic salmon ranges between 1-13^{o}C, with high preference for 4-10^{o}C areas (Reddin 2006). The infusion of cold oceanic water into the Bay of Fundy and Gulf of Maine provides this temperature range (Petrie *et al.* 1996) and supports two of their principal prey species; sand lance (*Ammodytes americanus)* and euphausiids (Gordon and Dadswell 1984). These temperature conditions, together with tag recovery information (Amiro 1998), indicate that the Bay of Fundy and northern Gulf of Maine constitute marine habitat for iBoF Salmon.

1.4.5 Genetic Uniqueness

Atlantic salmon of the iBoF are unique. Mitochondrial DNA analysis identified a genetic haplotype unique to the Minas Basin (including the Gaspereau River) populations and a rare haplotype shared by salmon populations throughout iBoF rivers (Verspoor *et al.* 2002). Accordingly, the Minas Basin and Chignecto Bay (and westward) groupings of salmon populations, collectively known as iBoF Salmon, may be considered as two “evolutionary significant units” (ESUs) as defined by Waples (1991, 1995). While these two groups are related to each other they are distinct from other salmon populations in North America and Europe (Verspoor *et al.* 2002).

Atlantic salmon of the Gaspereau River, NS, unlike those in other rivers of the iBoF, possess the same genetic haplotye as those from the Minas Basin group, yet also displays a marine migratory pattern and life history traits more similar to other Atlantic coast populations, including outer Bay of Fundy Atlantic salmon (Amiro and Jefferson 1996; Ritter 1989). Whether these differences have a genetic basis is not known.

1.5 Cultural and Economic Significance

IBoF rivers historically supported economically and culturally significant Aboriginal, recreational and commercial Atlantic salmon fisheries.

1.5.1 Commercial Harvest

IBoF Salmon were harvested commercially within the Bay of Fundy from the 1800s until the closure of the commercial fishery in 1985. Annual landings averaged 1,061 salmon during 1970-1984. The principal licensed salmon fishery in the inner Bay was prosecuted with drift nets (gill nets tied to a drifting boat) within the Petitcodiac river estuary, Shepody Bay, Cumberland Basin (all within Chignecto Bay), Shubenacadie and Avon river estuaries, and the Minas Basin (Dunfield 1974). IBoF Salmon were also harvested in other coastal fisheries, principally weirs (trap nets constructed of pickets, brush and twine or wire) rimming the Bay of Fundy. Weir fishing primarily targeted herring but was frequently licensed for the retention of other species such as shad, bass, sturgeon and in the case of weirs in Kings and Colchester counties Nova Scotia (Minas Channel and Basin), salmon (Dunfield 1974). The curtailment of the commercial fishery for iBoF Salmon after the 1984 season was part of a Maritimes-wide government funded commercial salmon licence retirement program. This program had a number of specific objectives; among them, conservation of large salmon, recognition of the social and cultural importance of salmon fishing to Aboriginal people and recognition of the larger potential benefits to be generated from the recreational fishery.

1.5.2 Recreational Fisheries

Recreational fisheries for Atlantic salmon in iBoF rivers were altered to reduce exploitation in the years following the closure of the commercial fishery (i.e. 1985). Generally restricted to a fall season fishery most iBoF rivers opened in August and closed in October with mandatory release of large salmon (≥63.0 cm). Annual recreational catches for 24 iBoF rivers (Amiro 1990; Table 1) from 1970 to 1990 averaged 1,462 small salmon (<63.0 cm) (Amiro 2003; revised). Two rivers, the Big Salmon and Stewiacke, accounted for more than half of the historic recreational catch. Anglers were licensed to fish by artificial fly only and were subject to daily and seasonal catch limits. There have been no recreational or Aboriginal salmon fisheries since 1990, except for the Gaspereau River. The Gaspereau River remained open for angling and food fisheries until 1994, was closed in 1995, and re-opened with limited food fishery agreements and a shorter catch-and-release angling season in 1996 and 1997. Based on the value of an angled fish (DFO 1988) and average angling catch from 1970 to 1990, the iBoF recreational fishery for Atlantic salmon was estimated to have been worth more than a quarter of a million dollars annually (National Recovery Team 2002). However, another value for an angled fish (DFO 1988) or approach to estimating the worth of the fishery (Gardner Pinfold Consulting 1991) suggests a 60-400% greater value.

1.5.3 Economic Significance to Aboriginal Peoples

From a historic political perspective, securing trading relationships between the Mi'kmaq Aboriginal peoples and the English for natural resources was a significant goal of the treaty-making process along the Northeast Atlantic coast (Native Council of Nova Scotia 1993). The cod and salmon fisheries were so large and important to the parties that all pre-confederation treaties clearly used specific treaty language to identify fishing activities. Wording such as, "…to hunt, fish, and gather, as usual…" were deliberate points for negotiations in the treaties. The social, cultural and economic significance as well as the political leverage which the Atlantic salmon fisheries and other fishery resources played in the relationship building for peace, friendship and trade, was and remains important to this day. The 1985 Supreme Court of Canada (SCC) decision in *Simon versus The Queen* reaffirms the Treaty of 1752 as existing where hunting and fishing "as usual" were to continue. In 1999, the Marshall SCC decision on fishing "as usual" was interpreted to mean "and include trade for economic sufficiency". These two modern post-1982 SCC decisions further underscore the past and present importance of fishery resources to the Mi'kmaq and Maliseet people.

Historically, Mi'kmaq and Maliseet 'summer communities' were established and revisited in accordance with the usual time of salmon returns to the rivers and their relative abundance (Native Council of Nova Scotia 1993; Percy 2003). Best fishing sites were acquired and held by families having community stature. Sites were frequently traded like commodities but usually only in a larger subset of considerations.

Opportunities today for economic gain from Atlantic salmon in the inner Bay are extremely limited. However, recovery of salmon populations could offer the potential for commercial harvest or more likely, to service recreational fishing and ecotourism industries through the provision of lodging and guiding much as is offered by some Aboriginal peoples elsewhere in Atlantic Canada.

1.5.4 Cultural Significance to Aboriginal Peoples

Atlantic salmon remains socially and culturally the single most important fish to Aboriginal people of Atlantic Canada (Native Council of Nova Scotia 1993; Percy 2003). More than just a source of food, it is an important spiritual component of traditional family and community feasts. It is also a manifestation of a long history with fishery resources, relationship building, trade and other aspects of the distinctive cultural values. Always under a watchful eye because of its importance, the Mi'kmaq and Maliseet peoples came to view the abundance of Atlantic salmon as a barometer of the overall health of the waters and indicator of the abundance of other riverine aquatic life. Thus the recent loss of access to iBoF Salmon is viewed by Aboriginal peoples as impacting their cultural well-being and considered a serious setback to conservation practices.

1.5.5 Cultural Significance to Local Communities

Wild Atlantic salmon are highly prized by the recreational fisher and are valued by the general public as an indicator of healthy aquatic environments. The long-range oceanic migrations that are a characteristic of most wild Atlantic salmon populations have lodged their place in the minds of Canadians. The wild Atlantic salmon has a long history of cultural significance to local communities around the Bay of Fundy going well beyond its economic and recreational value. It has been a sign of the ritual of passing seasons, an emblematic creature that embodies mysterious knowledge, and a subject of artistic depiction and poetic expression. A leaping wild Atlantic salmon sits atop the crest on the NB coat of arms, for example, and was featured in the original design on NB conservation license plates thus emphasizing the importance of preserving this valuable resource for future generations. There are numerous non-government associations focused on the conservation and management of wild Atlantic salmon including the international Atlantic Salmon Federation which includes regional offices and affiliate organizations in both NS and NB, such as the Nova Scotia Salmon Association and the New Brunswick Salmon Council. Most Atlantic salmon rivers around the inner Bay area also have individual river associations whose mission is to further the conservation of salmonid species and their environment in their particular river.

1.6 Population Size and Trends

The historical population size of Atlantic salmon in iBoF rivers likely exceeded 40,000 adults earlier in the 20th century (COSEWIC 2006); abundance was reduced to as few as 250 adults by 1999. Given the low abundance in the two rivers in which adult returns are currently monitored (the Big Salmon and Gaspereau rivers) it is unlikely that abundance has subsequently increased. Although abundance has historically fluctuated widely, since 1989 wild iBoF Salmon have declined to critically low levels and are currently at risk of extinction. The Recovery Potential Assessment (RPA) concluded that population projections under current conditions indicate a very high probability that, without human intervention, iBoF Salmon will be extinct within 10 years (DFO 2008a).

The status of iBoF Salmon populations has typically been assessed using data from the two most studied rivers, the Big Salmon and Stewiacke. Recreational catch and effort data prior to the closure of these fisheries, electrofishing data from several rivers and adult fish counts on the Gaspereau River, NS, and Upper Salmon River, NB were also used to assess the species status.

The size of the Stewiacke River population was estimated to be between 1,100 and 6,700 returning adults during the 1960s and early 1970s (Gibson and Amiro 2003), with high variability from year to year (Figure 4). The estimated numbers of returns for the years 1997 to 2001 are less than 50 per year, and it is unlikely that more than four salmon returned to the Stewiacke River in 2001. Taken together, the annual abundance estimates indicate a decline of more than 99% between 1967 and 2000, with most of the decline occurring in the early and mid 1990s (about a 92% decrease from 1990 to 2000). An electrofishing survey in 2003 indicated that juvenile abundance has increased in this river as a result of the LGB program, although, based on adult counts in the Gaspereau and Big Salmon rivers, there is no evidence that increased juveniles have contributed to a marked increase in adult Atlantic salmon returns

(Gibson *et al.* 2004; Figure 6). Adult abundance is not presently being monitored in the Stewiacke River.

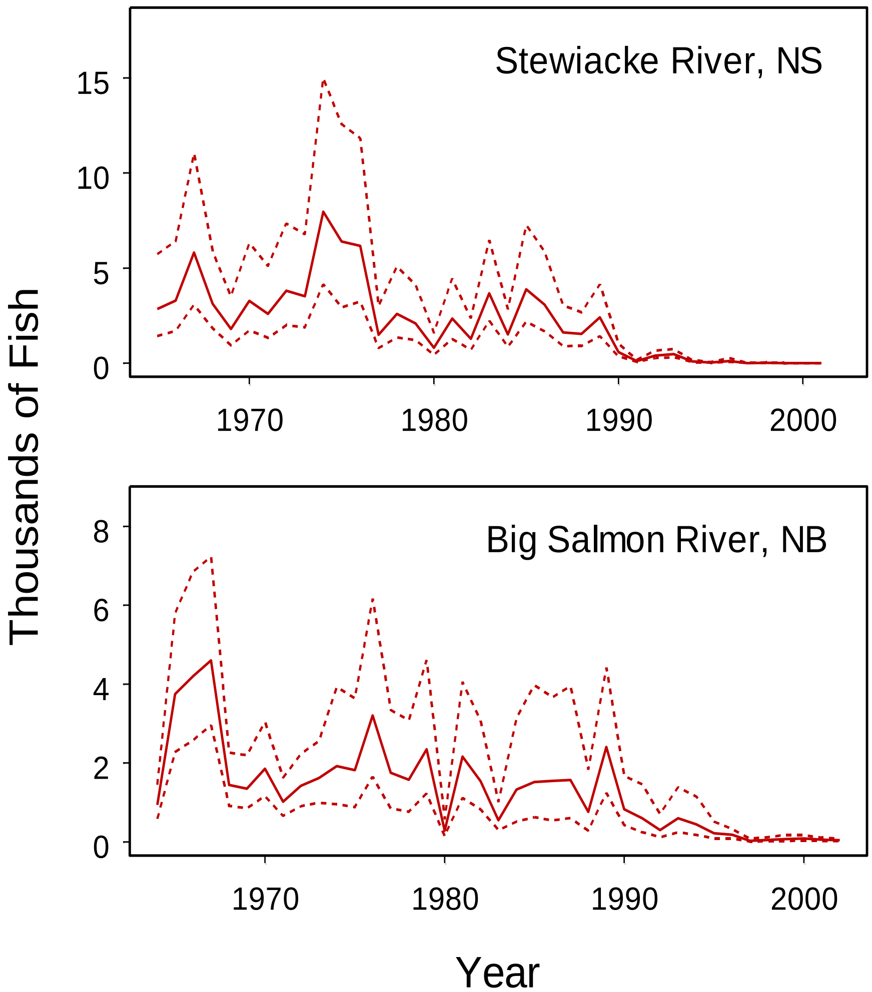

Figure 4. Estimated number of Atlantic salmon (solid lines) returning to two index iBoF rivers from 1965 to 2002 (adapted from Gibson and Amiro 2003 and Gibson *et al.* 2003a). The dashed lines indicate the uncertainty associated with the estimates.

The size of the Big Salmon River population was in the range of 1,000 to 4,000 salmon during the 1960s and early 1970s, but less than 100 fish are thought to have returned to this river since 1996 (Gibson *et al.* 2003b). Similar to the Stewiacke River, adult salmon population estimates show a decrease of between 92% and 97% over the 30-year time period from 1967 to 2000, with the majority of that decrease in the early 1990s (Gibson *et al.* 2003b). The number of adult salmon returning to the Big Salmon River in 2003 was estimated at only 21 fish (Gibson *et al.* 2004). Juvenile abundance in the Big Salmon River has, like that of the Stewiacke River, increased as a result of the LGB program (Figure 4).

The abundance of adult salmon has also been monitored in two other rivers: the Gaspereau and Upper Salmon. On the Gaspereau River, NS, adult abundance is monitored by counts at a fish ladder at the White Rock dam. In 2007, the number of salmon ascending this fish ladder was two, down from 102 in 1997. The number of adult salmon observed in the fall in the Upper Salmon River was recorded for 22 years between 1963 and 1994 (Amiro 2003). The highest recorded count was 1,200 fish in 1967 and 900 fish were counted in 1979. Counts from 1991 to 1994 did not exceed 50 fish in any year.

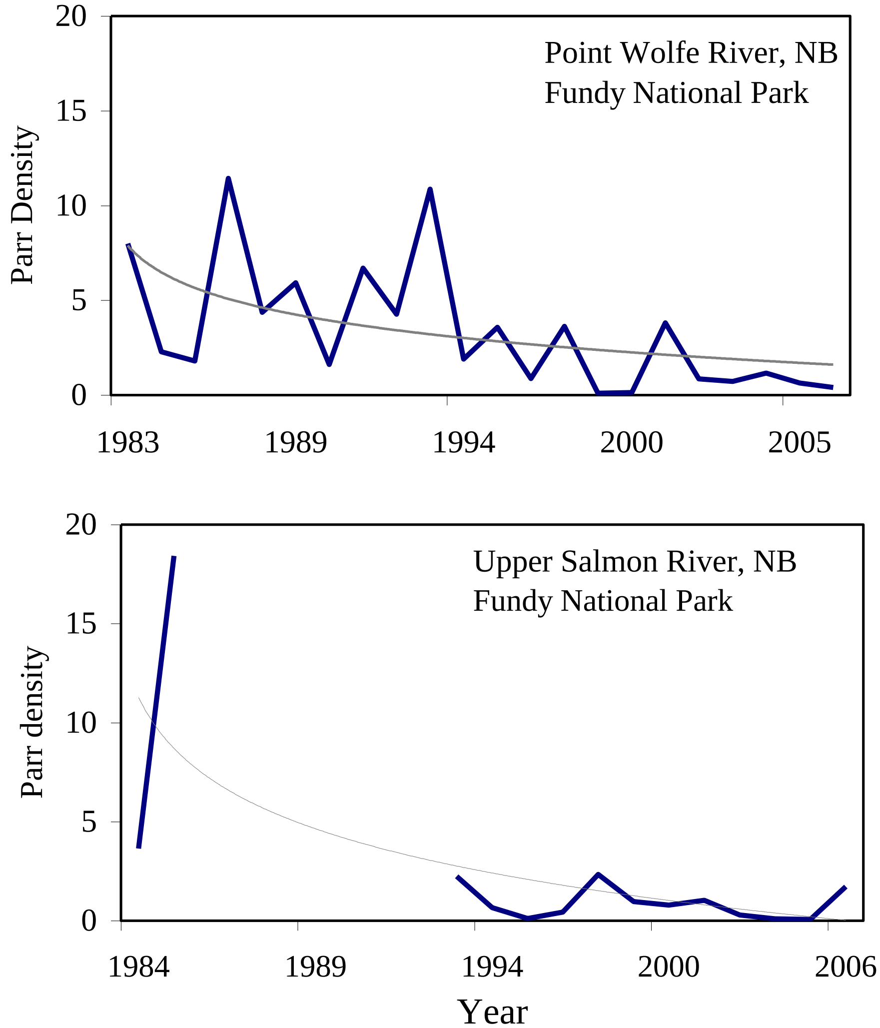

Figure 5: Densities of juvenile Atlantic salmon (parr/100m^2) in the Point Wolfe River (upper chart) and Upper Salmon River (lower chart), Fundy National Park, based on electrofishing at 6 permanent sites per river since the early 1980's (Parks Canada, unpublished data).

Abundance of Atlantic salmon in other iBoF rivers was typically assessed by electrofishing to monitor juvenile abundance. Electrofishing surveys in the Point Wolfe and Upper Salmon rivers have been carried out by Fundy National Park staff since the early 1980s; the longest continuous juvenile density time series for any iBoF system. Results of these surveys are shown in Figure 5 above. Recent range wide electrofishing surveys were carried out in iBoF rivers from 2000 to 2003 and are summarized by Gibson *et al.* (2003a, 2004). During 2002, a total of 246 sites were electrofished in 48 rivers (Figure 6). Fry were found in only four of 34 rivers without LGB support, and parr were found in only 12 of these rivers. Where salmon were present in rivers without LGB support, average densities of fry and parr were very low (Figure 6). During the 2003 survey, 112 sites were electrofished in 16 rivers. Salmon were captured in low densities in five of 10 rivers without LGB support. Densities are increasing in rivers with LGB support, but they remain low in many parts of these rivers. Salmon were not observed in seven rivers that had contained salmon in 2000. This suggests ongoing river-specific extirpations in rivers without LGB support. However, the sampling intensity in some of these rivers was low, and it is possible that salmon were present at very low abundance but were not detected.

While the overall prognosis for the iBoF adult population status is bleak, the increased abundance of juvenile salmon in rivers receiving LGB support (see section 2.7 of this document) indicates that this program has slowed or halted the decline of Atlantic salmon in these rivers. In the Big Salmon River, adult abundance from 2005 to 2007 remains very low, but is higher than it was during the period from 2001 to 2004. In 2003 and 2004, 43% and 35% respectively of the wild smolts migrating out of the Big Salmon River were progeny of salmon reproducing in the wild, indicating that salmon returning to this river do successfully reproduce. As such, the LGB program has potentially prevented the extirpation of salmon from some rivers, and has safeguarded against the loss of this distinct genetic lineage within salmon populations on the whole.

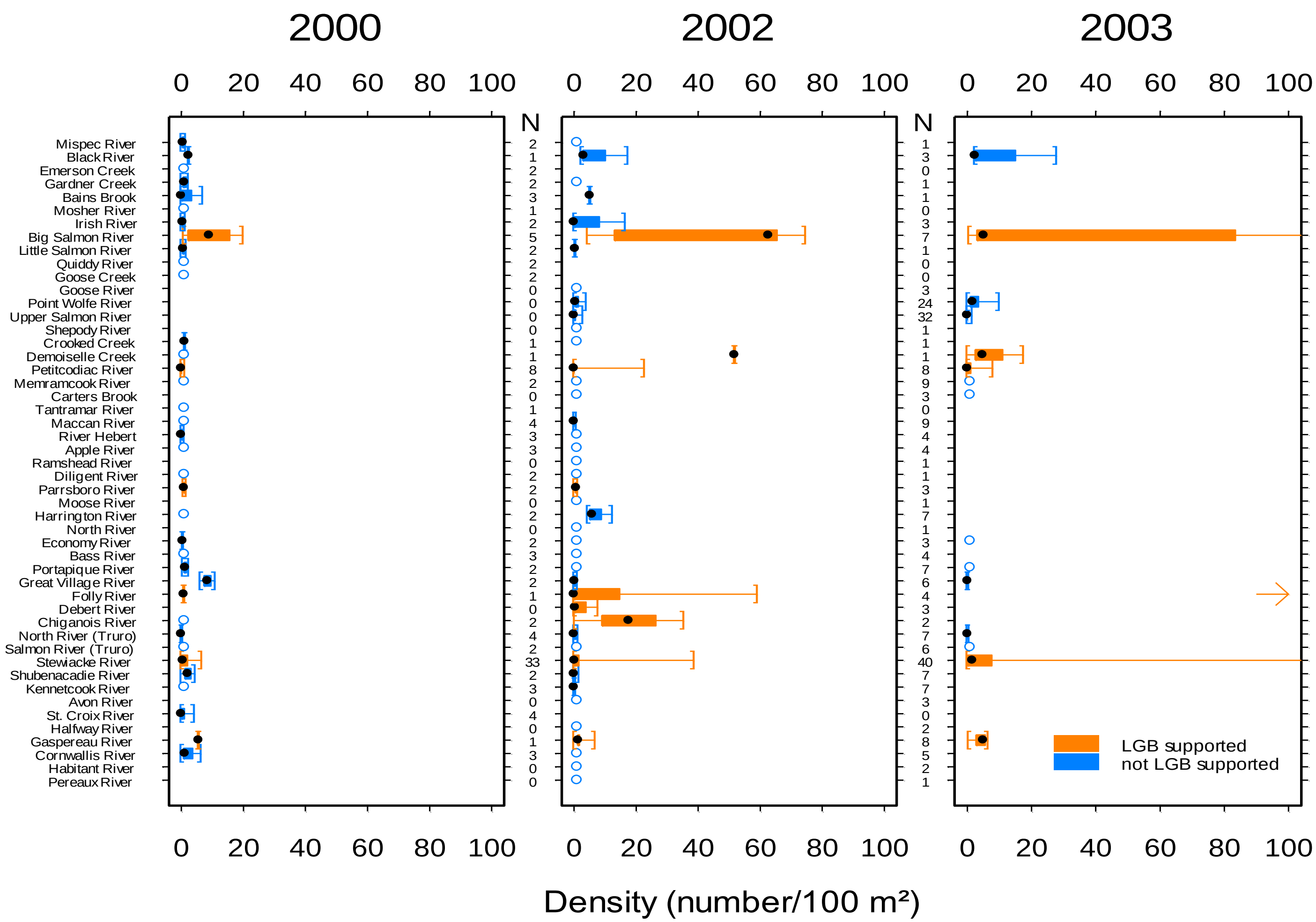

Figure 6. Densities of juvenile Atlantic salmon in inner Bay of Fundy rivers based on electrofishing during 2000, 2002 and 2003. The column "N" gives the number of electrofishing sites in each river in each year. The solid dot shows the median density (the middle value: half of the sites had equal or higher densities and half the sites had equal or lower densities). O's mark rivers in which salmon were not captured. The box shows the inter-quartile range: half the sites had densities within this range. The whiskers (lines with square brackets) are drawn to the minimum and maximum densities observed each year. LGB supported rivers are where juvenile Atlantic salmon had been released since 1996. Densities outside the range of the graph are marked with an arrow. Rivers with blank spaces were not electrofished in those years (from Gibson *et al.* 2004).

1.7 Threats[4]

1.7.1 Background

The factors that have caused the collapse of wild Atlantic salmon populations in the iBoF since the 1980s are not well understood. The decline in abundance of Atlantic salmon in all rivers around the iBoF at roughly the same time suggests common factors are acting on all iBoF Salmon populations. Analyses of population dynamic trends in some of the larger iBoF rivers found that increased marine mortality was primarily responsible for the decline (Trzcinski *et al.* 2004) and that this mortality continues to increase (Gibson *et al.* 2004).

1.7.2 Assessment of Threats

Assessment of threats responsible for the decline

It is challenging to separate the roles of historical and current impacts in the decline of iBoF Salmon. Atlantic salmon in the iBoF have experienced a long history of fishing (commercial, recreational and bycatch), habitat changes (e.g., poor forestry practices, barriers to salmon migration), chemical use in watersheds (e.g., agriculture), and other threats that have contributed to their decline and current status (COSEWIC 2006).

Key threats responsible for the decline were identified by COSEWIC (2006) and further reviewed at the March 2008 RPA for iBoF Salmon (DFO 2008a). Potential marine and freshwater threats described to date are (importance not implied by order):

Marine threats:

1. Aquaculture: interactions with farmed and hatchery salmon (e.g., genetic inbreeding, competition with escapees for food, parasite and disease outbreaks, and modified predator interactions);
2. Ecological community shifts (increased predator abundance; lack of or reduced forage species);
3. Environmental shifts (temperature shifts depressing ocean productivity; altered migration routes leading to decreased survival);
4. Fisheries (excessive illegal and/or incidental catches); and
5. Depressed population phenomena (lack of recruits to form effective schools).

Freshwater threats:

1. Changes in environmental conditions (e.g., climate changes leading to premature smolt emigration or decreasing freshwater productivity, and atmospheric changes increasing ultraviolet radiation and its impacts);
2. Contaminants;
3. Barriers to fish passage; and

[4] A definition of threat as utilized in this recovery strategy can be found in the Glossary of Terms in Appendix I of this document.

4. Depressed population phenomena (e.g., as a result of abnormal behaviour due to low abundance or because of inbreeding depression).

Cumulative or synergistic interactions among threats are likely, but unknown. Research on methods of prioritizing threats to iBoF Salmon is ongoing.

Assessment of threats to persistence and recovery

Model predictions, together with the extremely low return rates observed in both the Gaspereau and Big Salmon rivers (on opposite sides of the Bay of Fundy) indicate that the factor(s) limiting population recovery for iBoF Salmon act during the marine life stage and therefore have repercussions on a regional scale. Should marine survival return to healthier, pre-mid 1980s levels, then disturbances to freshwater habitat that affect the productive capacity of iBoF Salmon (e.g., rate and level of smolt production) will become the dominant factors in their recovery. For this reason, this recovery strategy addresses both regional marine and freshwater threats to iBoF Salmon populations, focusing on those that are most likely to limit persistence and recovery. These threats are summarized below and discussed in greater detail in the RPA document (DFO 2008a) and threats research document (Amiro *et al.* 2008). Mitigation measures and alternatives to address specific threats identified in this section were also reviewed at the RPA.

1.7.3 Marine Threats

Aquaculture: Interactions with farmed and hatchery salmon

The development of salmon farming in coastal areas of the Bay of Fundy and Gulf of Maine over the last 20 years may have increased the transmission of disease and parasites (e.g., infectious salmon anemia [ISA] virus, sea lice) to wild salmon. Some wild salmon intercepted near salmon farms in the Bay of Fundy have been ISA positive (Carr and Whoriskey 2002), whereas others have been clear of parasites or diseases (Lacroix and Knox 2005). Although evidence linking disease outbreaks with the recovery potential of iBoF Salmon is lacking, outbreaks of diseases and parasites in salmon farms have been linked to increased mortality of nearby wild salmon stocks in the northeast Atlantic (Johnsen and Jensen 1994, Grimnes and Jakobsen 1996; Finstad *et al.* 2000).

There is concern that the development of salmon farming has led or could lead to the loss of genetic fitness due to mixing of farmed escapees with wild salmon. At about the time that iBoF wild salmon were declining, the Atlantic salmon fish farming industry was rapidly growing in the Bay of Fundy (Amiro 1998, Chang 1998) and escapees of farmed Atlantic salmon into rivers began to be recorded (e.g., Carr *et al.* 1997; Stokesbury and Lacroix 1997; Lacroix and Stokesbury 2004). Because interbreeding is known to have a significant negative effect on the ability of salmon to survive in the wild, the extent and magnitude of the impacts of fish farming on iBoF Salmon needs to be determined given its potential to limit recovery.

The abundance of predators, such as seals and birds, near Atlantic salmon farms in the Bay of Fundy may be a source of post-smolt mortality (Lacroix *et al.* 2004) potentially limiting recovery of iBoF Salmon (Amiro 1998).

Ecological community shifts

Ecological changes in the Bay of Fundy or other marine habitat areas used by iBoF Salmon could potentially influence survival at sea; however such changes were not well documented during the period when the populations declined. One study evaluating factors affecting migration, growth and survival of young salmon in the Bay of Fundy and Gulf of Maine led to the conclusion that environmental conditions and food supply were not limiting during their first few months at sea (Choi *et al.* 2004). Given the large dietary range of post-smolts, it is unlikely that food limitations have had an important role in the populations' decline.

While not studied specifically for the iBoF Salmon, predation has been identified as a significant source of marine mortality in salmonids especially at the post-smolt stage shortly after leaving a river (Montevecchi *et al.* 2002; Hansen *et al.* 2003; Middlemas *et al.* 2003). Evidence regarding the importance of predation is however conflicting. For example, salmon were not observed in a Bay of Fundy survey of spiny dogfish stomach contents (P. Amiro, DFO, pers. comm.) even though this species is known to prey on post-smolt. (Lacroix and Knox 2005).

Environmental shifts

The largest increases in sea surface temperature around the globe have occurred in the North Atlantic, and a decrease in primary productivity has been attributed to these increases (Gregg *et al.* 2003). Environmental conditions in the ocean are known to influence salmon migration, growth, and survival. Temperature cycles have been linked with historical catches of adult salmon (Friedland *et al.* 2003) and it has been suggested that climate change may be a factor contributing to the current declines of Atlantic salmon in the North Atlantic, although the mechanisms are not clear. Nevertheless, a recent analysis of mortality of iBoF Salmon while at sea did not find correlations between either the North Atlantic Oscillation Index or sea-surface temperature.

It has also been suggested that changing environmental conditions may impact migration routes and decrease survival. Historically, many iBoF Salmon tag returns came from the Quoddy region in the Bay of Fundy, although recently few salmon appear to be entering this area. It is not known whether this difference is related to changing migration patterns, given that summer temperatures in the Bay of Fundy are thought to provide suitable habitat for salmon. Temperature is not known to have changed to an extent that would cause a major increase in iBoF Salmon mortality.

Fisheries: Marine-Estuarine

In the Bay of Fundy, salmon post-smolts have been intercepted by Atlantic herring (*Clupea harengus harengus*) weirs (Jessop 1976; Lacroix *et al.* 2004), although the harvest of salmon in herring weirs is prohibited and many herring weirs are no longer operational. In the remaining weirs, the numbers of salmon captured are small and the occurrences are low. Nonetheless, because of the low population sizes, the overall impact of even small amounts of by-catch remains uncertain.

Four marine fisheries in the Bay of Fundy were identified in one study as having a high potential of capturing salmon: gaspereau, shad, herring and mackerel gill net (Loch *et al.* 2004). Measures to minimize the risk of incidental catch and mortality of salmon have been developed (e.g., season and area restrictions, enforcement, live release). In addition, some existing and new commercial fisheries in the Bay of Fundy and Gulf of Maine, where iBoF Salmon post-smolts spend an extended period of time, could impact salmon. Records indicate that there is potential for salmon by-catch in high-head weirs and the recreational fishery for striped bass, although the extent of this impact is unknown.

Depressed population phenomena

It has been suggested that schooling behaviour acts as a predator defence for some marine fishes and reduces predation risk (Pitcher and Parrish 1993). Although the losses of post-smolts in coastal areas of the Bay of Fundy cannot be attributed directly to predators, the consistently low catches of post-smolts in individual trawl sets during surveys conducted in the Bay of Fundy and Gulf of Maine in 2001-2003 (Lacroix and Knox 2005), suggests they may have been too scarce to form large schools. It is not known whether iBoF Salmon populations historically formed schools, and, if so, there is no evidence to suggest that they have lost the ability to effectively school.

1.7.4 Freshwater Threats

Habitat Quality: Changes in environmental conditions

Habitat in spawning rivers is threatened by the effects of agriculture, urbanization, poor forestry practices, mining, road building and other factors related to human activities. Decreased smolt production due to habitat degradation, low pH, and temperature increases have been observed elsewhere, but overall impacts on iBoF Salmon have not been quantified. Nonetheless, the success of the LGB program in increasing the number of juvenile salmon in iBoF rivers (Gibson *et al.* 2004; Flanagan *et al.* 2006) indicates that freshwater habitat quality is sufficient to maintain populations despite ongoing degradation.

Habitat Quality: Contaminants

There has been increasing concern that pesticides and environmental contaminants may have an effect on the survival of Atlantic salmon in freshwater (e.g., NMFS 2005). A number of recent experiments have provided evidence of a negative association between exposure to various contaminants in freshwater and subsequent survival at sea (e.g., Moore *et al.* 2003; Waring and Moore 2004). Agricultural activities occur in many iBoF watersheds, especially those of the Petitcodiac, Stewiacke, Salmon, and Cornwallis rivers, resulting in the runoff of nutrients and pesticides. Research is recommended to determine whether the levels of pesticides and other contaminants (e.g., heavy metals, sewage) in iBoF habitat are influencing salmon survival.

Habitat Quality and Quantity: Barriers

Barriers exist on at least 25 major rivers around the Bay of Fundy. In the iBoF, causeway-dam type barriers on the Petitcodiac, Shepody, Avon, Great Village, Chignois and Parrsboro rivers are among the most substantial (Amiro *et al.* 2008a). Causeway-dams also exist on other watersheds in the inner Bay as well, for example on the Memramcook River. These barriers have caused or are thought to have caused a wide range of ecological effects on the rivers and their estuaries (Wells 1999).

Construction of the Petitcodiac River causeway in 1968 largely obstructed the passage of adult salmon and smolt and is estimated to have reduced the total iBoF Salmon production by at least 20 percent (National Recovery Team 2002, Locke *et al.* 2003). In turn, this decrease in production may have affected the persistence of the entire iBoF DU (Hutchings 2003), particularly if straying and mixing of wild salmon among rivers is important for population viability as suggested by Fraser *et al*. (2007).

Depressed Population Phenomena

Population genetic theory predicts that smaller populations are more likely to disappear than larger populations because there is little variability in their genetic makeup thereby rendering them less able to respond to environmental change and increasing susceptibility to inbreeding depression (Consuegra and Nielsen 2007). Re-colonization of rivers that have small populations with comparatively few individuals will almost certainly lead to low genetic variability (Elliot and Reilly 2003). The degree to which genetic diversity is lost and the associated potential for inbreeding, is dependent on the severity of population decline and its duration (Consuegra and Nielsen 2007).

Based on historical fluctuations in commercial landings as well as past construction of mill dams that block access to spawning areas, iBoF Salmon are thought to have survived through periods of low abundance in the past. It is of note, however, that historical population decreases are not thought to have been as severe as present declines, thus allowing for recovery following past periods of low abundance.

1.7.5 Threats from Local Conditions

The threats described above are those that may act on all iBoF populations in a manner that influences recovery. However, iBoF Salmon populations are also affected by local conditions which may act on populations within individual rivers and which could impact recovery if survival in the marine environment increases (Trczinski *et al.* 2004). Some mortality can occur when developments, e.g., hydroelectric, do not provide adequate facilities for fish passage or when fish do not use these facilities. Similarly, water management for power generation, water extraction for irrigation, flood control, commercial and domestic water supplies, and effluent discharges are in place in many iBoF rivers and impact salmon habitat. The Habitat Protection Provisions of the *Fisheries Act* are a tool used to avoid or minimize local effects to fish habitat.

2. RECOVERY

2.1 Recovery Feasibility

Modeling for iBoF Salmon indicates that annual marine survivals are now below those required for population replacement. The LGB program has been a principal activity used to support iBoF Salmon survivorship. The LGB is a captive breeding and rearing program designed to minimize the loss of genetic variation and fitness in the remnant populations. Analysis of the effects of the LGB program on population viability and recovery indicate that, although iBoF Salmon will rapidly become extinct without the LGB program, with the program in place, populations are expected to persist in the longer term, albeit at a low population size. Analysis further indicates that the recovery of iBoF Salmon is likely to be possible if there is an increase in marine survival. As noted elsewhere in this document, the causes of low marine survival are not well understood. It is possible that increased marine survival could occur if the sources of the severely increased marine mortality are discovered and remedied (reduced or mitigated), the causes of marine mortality naturally abate, or iBoF Salmon develop a successful life history strategy to increase survival in the present marine environment.

DFO is of the opinion that recovery may be feasible if research can advance the understanding of marine survival, and if implementation of appropriate mitigation measures can remedy factors most limiting recovery, or if successful alternative life history strategies can be identified, evaluated and supported[5]. Therefore, despite the uncertainty regarding the causes of low marine survival and hence recovery feasibility, DFO is of the opinion that it would be premature to conclude that recovery is not feasible without further effort to understand limiting factors. This recovery strategy will proceed in the interim on the premise that recovery is feasible. Feasibility will be reviewed based on the success of research and recovery efforts and understanding of limiting factors. In the meantime, population viability (i.e., survival) is dependent on the supportive rearing and breeding program, a function of the LGB.

2.1.1 Biological feasibility

The rich data series available for iBoF Salmon populations has been used to construct biological life history models. These models indicate that the population is not presently viable without the intervention of the LGB program, apparently because of very high rates of marine mortality. To date, the LGB program has been successful at collecting individuals from the residual native populations, adequately perfecting captive rearing techniques and ultimately increasing the abundance of juveniles in the wild. A recent DFO Science review (DFO 2008b) indicates that the LGB program is viable as a mechanism for contributing to the survival of the population, but that recovery will only be achievable if marine survival increases (see discussion below).

Freshwater habitat remains largely unchanged since the collapse of the population in the late 1980s and is not thought to be limiting the recovery of iBoF Salmon despite the ongoing threats of habitat degradation and loss. There appears to be an abundance of quality freshwater habitat

[5] This statement refers to the possibility of using Atlantic salmon with a certain set of behavioral, physiological, biochemical or morphological attributes that would allow for survival and successful reproduction in iBoF rivers

conducive to salmon reproduction and successful stocking of LGB progeny has proven that the freshwater habitat remains functional. Although the marine habitats occupied by iBoF Salmon, especially during the winter months, are less well know than those for freshwater, there is evidence that iBoF Salmon move throughout most of the Bay of Fundy during their marine phase (DFO 2008a). Temperature is currently the best indicator of marine habitat quality for iBoF Salmon, and although marine habitats occupied during the winter months remain unknown, habitat within an acceptable temperature range for Atlantic salmon and its principal prey species appears to be widely available for much of the year. Therefore, with the exception of low marine survival, which can be partially mitigated through the LGB program, life history characteristics and habitat attributes appear sufficient for population recovery to be biologically feasible.

2.1.2 Technical feasibility

The LGB program was initiated for iBoF Salmon in 1998, with the goal of preserving the remnant populations and remaining genetic diversity of the species. Technical expertise and infrastructure exists to operate the LGB program. DFO currently maintains LGBs at the Mactaquac (in NB), Coldbrook and Mersey (in NS) biodiversity facilities. The principal populations maintained are those of the Big Salmon, Stewiacke, and Gaspereau rivers as well as the Point Wolfe and Upper Salmon rivers within Fundy National Park and a few other iBoF rivers. Residual wild juvenile salmon have been successfully raised to maturity in captivity and their young have been observed to survive in the wild to become smolts at viable rates. Stocked LGB juveniles have been recaptured from the wild and raised to maturity, pedigree–based breeding has been conducted, and the resulting eggs incubated to rear a subsequent generation. The technical aspects of the program have been adequately resolved and a variety of life stages of iBoF Salmon have been held in captivity or released. Monitoring of juvenile salmon in the wild has confirmed that the population can be continued through this process of bypassing the marine phase of the life cycle. The program has been successful at increasing the abundance of juveniles in the wild and substantially reducing extinction risk.[6] However, the LGB program alone is not expected to achieve recovery of this population. Recovery will only be achieved if the causes of high marine mortality can be identified and remedied.

Success in population maintenance has allowed research to begin to explore sources of high marine mortality, and ultimately to evaluate what management measures are required to achieve recovery. Potential causes of high marine mortality are discussed elsewhere in this document and during the iBoF Salmon RPA. The RPA also discussed potential mitigation measures and alternatives to address specific threats which are described in the Science Advisory Report (DFO 2008a). Some of the factors potentially contributing to low marine survival may be remediable, while others may not. Many management measures will require collaboration between multiple agencies and groups. Some measures are already being implemented.

[6] Benchmarks have been set to evaluate the effectiveness of the LGB program (see Appendix III – LGB Evaluation Benchmarks). Further details on the captive breeding program and its activities can be found in the Actions Completed or Underway section of this Recovery Strategy (see page 42).

2.2 Recovery Goal

IBoF Salmon is currently dependent on supplementation from the LGB program for survival. Recovery would require identifying and remedying the causes of the low marine survival or identifying alternative life history strategies which could be evaluated and supported. Correspondingly, the overarching recovery goal for iBoF Salmon is to:

> *re-establish wild, self-sustaining populations as required to conserve the genetic characteristics of the remaining anadromous iBoF Atlantic salmon*

The RPA for iBoF Salmon (DFO 2008a) recommends that recovering populations in as many rivers as feasible will increase the probability that the iBoF Salmon population assemblage will become self-sustaining in the long term. Historically, the species inhabited at least 32 rivers around the inner Bay of Fundy (as supported by recreational catch data). However, to date salmon have virtually disappeared from those rivers not receiving LGB support. The RPA recommends that a large subset of the 32 rivers where Atlantic salmon have historically been caught be selected as a recovery distribution target based on scientific criteria, recognizing that there may be limitations to re-establishing populations in all 32 rivers, particularly in the short term. Given these limitations, this recovery strategy adopts population and distribution objectives that are considered ambitious but achievable for the next five years and describes a longer term target to strive for, should marine survival increase.

2.2.1 Five Year Target[7]

> *Conserve the genetic characteristics of the few remaining anadromous iBoF Atlantic salmon populations in order to progress towards re-establishing self-sustaining populations to their conservation levels[8] in the following 10 river systems that contribute to the LGB program: Gaspereau, Stewiacke, Debert, Folly, Great Village, Portapique, Economy, Upper Salmon, Point Wolfe and Big Salmon*

This target recognises that mortality of iBoF Salmon currently occurs primarily in the marine environment and thus short term persistence is contingent on the LGB program. This short term target represents approximately 33% of the measured accessible habitat and will be used to prioritize recovery efforts. It will also serve as a realistic benchmark to evaluate recovery success during the five year review of progress towards the implementation of this recovery strategy in 2014. Re-establishing self-sustaining populations in the above-noted ten rivers would be considered the minimum required to conclude that success had been achieved in attaining recovery goal.

[7] Paragraph 41(1)(d) of SARA requires that recovery strategies include "*a statement of the population and distribution objectives that will assist the recovery and survival of the species*…". The five year target presented in section 2.2.1 of this document is intended to constitute the statement of population and distribution objectives under SARA for this recovery strategy.

[8] The number of salmon required to produce an egg deposition of 2.4 eggs/m^2 of habitat, a value thought to optimize juvenile production in freshwater.

2.2.2 Long Term Target

As noted above, there are challenges to re-establishing iBoF salmon populations in a larger subset of rivers in the short term. Nonetheless, it is recognized that it would be desirable to do so in the longer term should marine survival increase, making more widespread recovery feasible. The following long term target has therefore been developed:

> *Conserve the genetic characteristics of the few remaining anadromous iBoF Atlantic salmon populations in order to re-establish self-sustaining populations of iBoF Atlantic salmon to a conservation level of 9,900 spawning adults distributed throughout the following 19 river systems: Gaspereau, Shubenacadie, Stewiacke, Salmon (Colchester), North (Colchester), Chiganois, Debert, Folly, Great Village, Portapique, Bass (Colchester), Economy, Harrington, Apple, Maccan, Petitcodiac, Upper Salmon, Point Wolfe and Big Salmon*

This target recognises that once marine survival rates for iBoF Salmon improve, recovery efforts in a greater number of rivers will become increasingly valuable for long term population self sustainability. The RPA recommends that a recovery target incorporate:

- abundance components for both specific rivers and the entire area where iBoF Salmon occur, and
- a distribution target for a set of specific rivers in which salmon would be recovered.

The RPA considers 9,900 spawning adults to be a reasonable abundance target for iBoF Salmon. This abundance target represents about 25% of the past abundance of salmon in this area, and about 100 times the current abundance of wild adults.

In identifying the distribution component of the target, the following six science-based criteria are outlined in the RPA to guide the selection of rivers that should be given the highest priority in recovery efforts. The first three criteria are considered to be the most important.

1. Represent each of the three unique subunits: Minas Basin, Gaspereau River, and Chignecto Bay.
2. Include rivers with large areas of habitat (>10% of the total measured area).
3. Include rivers with residual native populations that contribute to the LGB.
4. Represent local habitat variation within the Minas Basin and Chignecto Bay regions.
5. Include rivers with higher productivity per unit area and productive capacity.
6. Maintain metapopulation structure by increasing the number of rivers in which salmon are recovered.

Accordingly, all rivers that directly met criteria 1, 2, and 3 were included in the long-term distribution target for iBoF Salmon. Because the RPA advises that recovery of a greater number of rivers increases the probability of salmon becoming self sustaining, additional rivers were also included to address criterion 5 (e.g., rivers with productivities >100,000 parr and >15 parr per unit area). Although criteria 1, 2, 3 and 5 were the primary basis for identifying the selection of 19 rivers, rivers were also assessed against Criteria 4 and 6, which relate to local variation and metapopulation, respectively. Although there are no measures readily available to determine which rivers should be added based on these two criteria, the fact that greater than 85% of measured accessible habitat is included in the long term distribution target should help to ensure adaptation to local variation and metapopulation structure.

Both the abundance and distribution targets will be re-evaluated in five years and may be revised to take into account new information or changing conditions. It is difficult to specify an exact timeline for the long term target but it is not expected to be achieved in less than three generations. The generation time for iBoF Salmon is approximately 4 years (COSEWIC 2006).

2.3 Recovery Objectives and Approaches

Creating and maintaining the necessary conditions to conserve the genetic characteristics of iBoF Salmon and re-establish wild self-sustaining populations will be accomplished by implementing the following five prioritized objectives:

- **Objective 1**: *Conserve iBoF Salmon genetic characteristics and re-establish self-sustaining populations to iBoF rivers*.

- **Objective 2**: *Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the marine environment*.

- **Objective 3**: *Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the freshwater environment*.

- **Objective 4**: *Assess population status, sustainability, and recovery feasibility*.

- **Objective 5**: *Communicate and increase the general awareness of the status and recovery of iBoF Salmon*.

The recovery objectives are to be achieved through a number of associated approaches which provide both the direction and flexibility for achieving the desired recovery goals for iBoF Salmon. These approaches 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 action plans. Implementing the recommended approaches will require collaboration among governments, independent experts, Aboriginal peoples, industry, non-governmental and conservation organizations, other stakeholders and interested parties. Potential partners for each recommended approach, either individually or collectively, will be identified in the action plan(s).

Objective 1: *Conserve iBoF Salmon genetic characteristics and re-establish self-sustaining populations to iBoF rivers*.

Rationale: Numbers of wild Atlantic salmon in iBoF rivers have declined to critically low levels and are currently at risk of extinction. The RPA concluded that population projections under current conditions indicate a very high probability that, without human intervention, iBoF

Salmon will be extinct within 10 years (DFO 2008a). To date, the primary activity that has been used to conserve genetic diversity and fitness of iBoF Salmon has been the LGB program. Populations from ten rivers have been brought into LGBs and represent the last vestiges of the iBoF Salmon. These will be the first to be targeted for re-establishment to self-sustainability. The protection of these few residual populations is critical to recovery. Maintaining sufficient individuals through the use of the LGBs, which includes harbouring representative families in biodiversity facilities and the wild, and prescribing mating strategies for the production of fish for both release and retention, is believed necessary to minimize the loss of genetic variation and the accumulation of inbreeding, as well as to minimize the loss of fitness.

Approaches:

1. Provide salmon with appropriate genetic characteristics for re-colonization of iBoF rivers designated for recovery.
2. Conserve the genetic characteristics of the residual populations from the Chignecto Bay and the Minas Basin (specifically Gaspereau, Stewiacke, Debert, Folly, Great Village, Portapique, Economy, Upper Salmon, Point Wolfe and Big Salmon).
3. Use Live Gene Bank strategies to conserve iBoF genetic characteristics and re-establish self-sustaining populations in iBoF rivers.

Objective 2: *Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the marine environment*.

Rationale: Current marine survival rates for iBoF Salmon are the lowest on record. While it is known that iBoF Salmon do not migrate to the North Atlantic as do outer Bay of Fundy populations (with the exception of the Gaspereau River population) and that they appear to frequent the inner and outer Bay during their first summer at sea, nothing is known of their whereabouts during the subsequent fall and winter months (maturing grilse) and year (non-maturing grilse or potential repeat spawners). Identifying factors preventing or limiting recovery is then contingent upon determining the whereabouts of iBoF Salmon after their first months at sea.

Approaches:

1. Determine marine habitat quality, quantity and use by iBoF Salmon populations.
2. Preserve and recover marine habitat.
3. Identify and evaluate marine threats that could limit iBoF Salmon survival and/or recovery.
4. Reduce or mitigate marine threats that could limit iBoF Salmon survival and/or recovery.

Objective 3: *Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the freshwater environment*.

Rationale: The collective losses to the iBoF Salmon population have occurred principally at sea. The causative factor(s) and feasibility of overcoming these losses are currently unknown. Should marine survival increase, the freshwater habitat must be in sufficient quality and quantity to support increased returns of sea-run adults. Consequently, the freshwater habitat quality and quantity must continue to be assessed, protected, and where necessary rehabilitated. As well, freshwater habitat threats potentially limiting recovery must be identified and mitigated to ensure that freshwater habitat will not pose a limiting factor for self-sustainability should marine survival increase.

Approaches:

1. Continue to review and determine freshwater habitat quality, quantity and use by iBoF Salmon populations.
2. Preserve and recover freshwater habitat.
3. Identify and evaluate freshwater habitat threats that could limit iBoF Salmon survival and/or recovery.
4. Reduce or mitigate freshwater threats that could limit iBoF Salmon survival and/or recovery.

Objective 4: Assess population status, sustainability, and recovery feasibility.

Rationale: A measure of success for the recovery strategy is the self-sustainability of iBoF Salmon populations. An annual review of the activities undertaken as steps towards achieving the recovery targets will provide a means of monitoring the status of the respective recovery approaches. Because the life cycle of iBoF Salmon is approximately 5 years, a reassessment of recovery feasibility and a review of progress towards the recovery goal will be completed within 5 years and in every subsequent 5-year period.

Approaches:

1. Continue to review and update the annual status of populations where information is available.
2. Periodically, (as prescribed in the recovery strategy and companion action plan(s), i.e. every 5 years) evaluate recovery strategy success, review progress towards attaining self-sustainable populations, and assess the feasibility of recovery.

Objective 5: *Communicate and increase the general awareness of the status and recovery of iBoF Salmon***.**

Rationale: All levels of government, Aboriginal peoples, industry, non-government and conservation organizations, other stakeholders, and the general public need to be involved in activities that support the population's survival and recovery. In addition to raising general awareness, engaging stakeholders that directly or indirectly interact with the population will contribute to a successful recovery framework.

Approaches:

1. Involve governments, non-government and conservation organizations, other stakeholders, Aboriginal Peoples, industry and the general public in the planning and conduct of recovery initiatives.
2. Communicate with the relevant stakeholders on the status of recovery efforts in a manner that demonstrates how their behaviours can affect recovery.

2.4 Performance Indicators

Measurable performance indicators are an important component of the recovery evaluation for the iBoF Salmon populations. A review of progress towards a recovery goal should be completed within 5 years and in every subsequent five-year period to: 1) gauge the extent that recovery activities are successful in contributing to the stated recovery goal for the species; 2) measure the extent to which progress has been made towards the achievement of each of the objectives; and 3) provide feedback on what changes are required to improve effectiveness. The evaluations should be carried out using a series of performance measures including but not limited to those outlined in Table 1 below.

Table 1. List of general indicators of progress to assist in determining the extent that recovery is being achieved. Each set of indicators corresponds to a specific recovery objective.

Recovery Objectives	Indicators of Progress
1- Conserve iBoF Salmon genetic characteristics and re-establish self-sustaining populations to iBoF rivers.	• number of river populations persisting, with and without LGB support; • success in maintaining a full complement of year-classes, representative of the Chignecto Bay and Minas Basin (including Gaspereau River) populations in the LGB; • confirmation that loss of genetic diversity by the populations in the wild and in captivity relative to the diversity noted in the founder collection has been minimized; and • loss of adaptive traits by inbreeding / outbreeding depression or unintentional loss of distinct populations within a river has been mitigated.
2- Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the marine environment (see section 1.7.3 Marine Threats)	• extent that our understanding of ocean distribution and habitat use by iBoF Salmon has increased; • contribution of the research program towards the identification of threats that could be preventing or limiting recovery; and • success of mitigative measures for overcoming identified threats.
3- Identify and remedy anthropogenic threats limiting survival and/or recovery of iBoF Salmon in the freshwater environment (see section 1.7.4 Freshwater Threats)	• extent and status of the habitat inventory (i.e., amount, location and condition of freshwater habitat in all iBoF rivers); • extent to which habitat quality, in terms of salmon production capabilities, has been assessed; • success of mitigative measures for overcoming identified threats; and • confirmation that the quality and quantity of habitat (freshwater and marine) has been maintained.
4- Assess population status, sustainability, and recovery feasibility.	• annual status of populations where information is available; • non-genetic and non-habitat related threats identified; • non-genetic and non-habitat related threats reduced and mitigated; and • recovery strategy success, progress towards attaining self-sustainable populations, and the feasibility of recovery have been reviewed as indicated in the strategy.
5- Communicate and increase the general awareness of the status and recovery of	• governments, non-governement and conservation organizations, other stakeholders, Aboriginal Peoples, industry and the general

iBoF Salmon	public are involved in the planning and conduct of recovery initiatives. • relevant stakeholders are aware of how their actions potentially affect iBoF Salmon. • relevant stakeholders are clear on how the *Species at Risk Act* is being used to protect iBoF Salmon.

2.5 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*".

Atlantic salmon require a variety of both freshwater and marine habitats to complete a life cycle, and as a salmon grows to maturity, habitat requirements change. Freshwater habitat types and uses are well known for Atlantic salmon, however marine habitat requirements for iBoF Salmon are much less well known. Below are a description of freshwater critical habitat for iBoF Salmon and a schedule of studies to help define areas of marine critical habitat.

2.5.1 Freshwater Areas of Critical Habitat

In the case of iBoF Salmon, freshwater habitat is not limiting recovery at present (Amiro *et al.* 2008b). Not all iBoF Salmon freshwater habitat is critical because there is more freshwater habitat available than is required to achieve survival and recovery. As noted elsewhere in this document, the LGB program is essential to the current persistence of iBoF Salmon. Following this, freshwater habitats in the ten rivers that contain residual native populations and contribute to the LGB program are considered the most important to achieving the recovery objectives for this species. Accordingly, this recovery strategy identifies freshwater critical habitat for iBoF Salmon within those ten rivers.

The Gaspereau, Stewiacke, Debert, Folly, Great Village, Portapique, Economy, Upper Salmon, Point Wolfe and Big Salmon rivers contain freshwater critical habitat for iBoF Salmon. Freshwater critical habitat consists of riffles, runs and staging or holding pools found below complete natural barriers (i.e., waterfalls) in these ten rivers (and their tributaries) (Figure 7; Appendix IV). Riffles, runs and staging or holding pools found below complete natural barriers encompass a significantly large portion of the 10 rivers. Importantly, substantial portions of the Point Wolfe and Upper Salmon rivers are within the boundaries of Fundy National Park (FNP; Figure 7; Appendix IV). All parts of these rivers within FNP that are accessible to salmon are considered critical habitat. This is due to the fact that within FNP there is no accessible river habitat that does not meet the physical description of critical habitat.

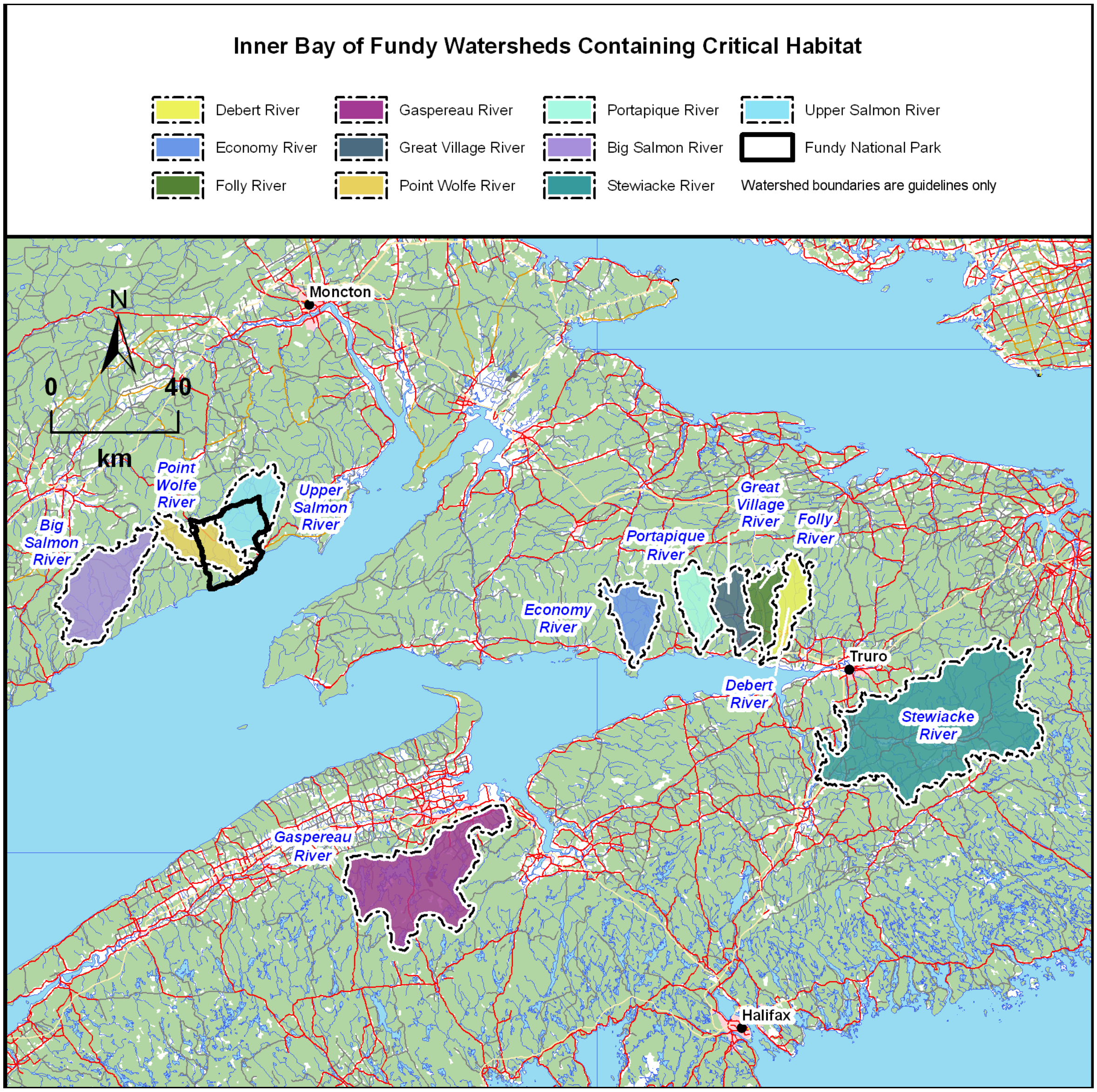

Figure 7. Location of inner Bay of Fundy watersheds containing critical habitat. For a detailed view of each watershed refer to Appendix IV. *Source*: Watershed boundaries were defined using contours, lakes and rivers from 1:50,000 National Topographic Database maps and are intended to be guidelines only.

What follows is a description of iBoF Salmon habitat preferences and requirements that are common for all types of freshwater habitat (i.e., temperature, gradient, etc). In addition, descriptions of the specific habitats found within the 10 rivers listed above that are considered to be critical (i.e., riffles, runs and pools) and their unique features are also provided. Access to and between critical habitat is an important determinate of growth, survival and lifetime reproductive success and therefore, connectivity between habitat types is also considered.

General Habitat Requirements

Atlantic salmon require several different habitats to complete a life cycle (Table 2). The major freshwater habitat types for Atlantic salmon serve as feeding, overwintering, spawning, early life-stage nursery and rearing habitats (Gibson 1993, Armstrong *et al*. 2003).

Atlantic salmon freshwater habitat preferences include streams that are generally clean, cool, and well oxygenated, characterized by moderately low (2 m/km) to moderately steep (11.5 m/km) gradients (Elson 1975), bottom substrates composed of assorted gravel, cobble and boulder, pH values greater than 5.5 (Amiro 2006) and low (<0.02%) silt loads (Julien and Bergeron 2006). Highest population densities and productivities are associated with rivers that have moderate summer temperatures (15° and 25°C) and moderate flows (Jones 1949, Elson 1974, Gibson 2002). Parr growth occurs at temperatures above 7°C (Allen 1941) and juveniles feed on invertebrate drift. Stream gradient is a good indicator of habitat quality, with optimal gradients ranging from 0.5 to 1.5% (Amiro 1993, Amiro *et al*. 2003). Salmon prefer stable stream channels that develop natural riffles, rapids, pools and flats which are utilized during different life stages.

Table 2. General descriptions of temporal and spatial freshwater habitat requirements for Atlantic salmon for eight life stages (adapted from Amiro *et al.* 2003).

Life Stage	Age from egg deposit (months)	Time		Freshwater Habitat		
		Start	Stop	Substrate	Locations	Function
Egg	0 to 6	Nov.	March	loose gravel and cobble	all river and tributaries	egg deposition and incubation
alevin	6 to 7	April	May	interstitial space in gravel and cobble	all river and tributaries	early development
Fry	8 to 12	May	April	gravel, cobble and boulder	all river and tributaries	1st year growth and overwintering
1+ parr	12 to 36	May	May	cobble and boulder	all river and tributaries	2nd year growth and overwintering
2+ parr	26 to 36	May	May	cobble and boulder	all river and tributaries	3rdthird year growth and overwintering
3+ &> parr	36 to 48+	May	May	cobble and boulder	all river and tributaries	growth and overwintering
smolt	28, 38 and 50	May	July	all	lower reaches	feeding and migration
adult	38, 50 and 62	Dec.	April	varied	all river – deeper water	staging for spawning and overwintering

Riffles –Spawning (redds), Early Life Stage Nursery

Riffles are characterized by shallow water, fast currents and a turbulent surface with gravel or boulder bottom. The location of these features varies as the sediments in the stream naturally move. Streams with about 70% riffle area appear to be optimum habitat (Poff and Huryn 1998).

Atlantic salmon deposit their eggs in excavated depressions called redds (De Gaudemar *et al.* 2000) which are typically found in riffles. Eggs are deposited in redds from late October to early December and are occupied until spring (roughly mid-May or June) when the fry emerge and begin feeding (Danie *et al.* 1984). Redds are typically about 2.3 to 5.7 m^2 in size, and consist of a raised mound of gravel or dome under which most of the eggs are located, and an upstream depression or 'pot' (De Gaudemar *et al.* 2000). Burial depths are about 10 to 15 cm and redds are typically constructed in water depths of 17 to 76 cm and velocities between 26 to 90 cm/s^2.

Redds protect eggs and alevins from disturbance, currents and predators. Eggs or alevins can be displaced into unfavourable habitat if not sheltered from currents. Redds protect eggs by causing water to move such that released eggs are captured. After being covered with gravel by the adult salmon, Redds provide small openings between gravel for water flow and oxygen for the incubation of the eggs and development of alevins prior to emerging from the redd as fry (Danie *et al.* 1984). The flow of water through the redds also removes waste. Figure 8 illustrates the downstream flow of water through the gravel and over the buried eggs.

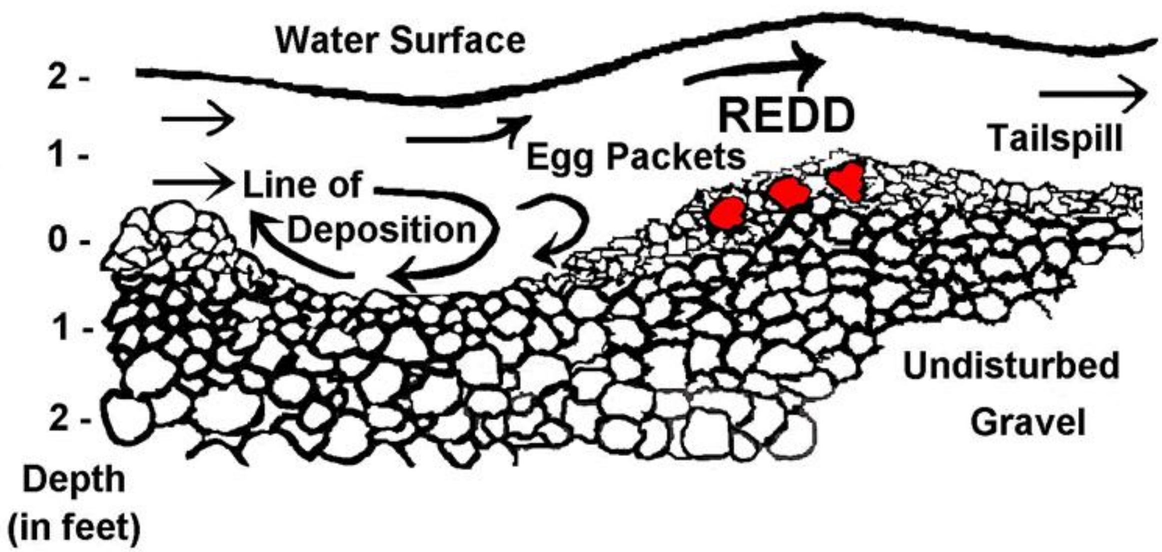

Figure 8. Typical redd in profile view and illustrating the flow of water through the gravel and over the buried eggs (Image courtesy of Washington State Department of Fish and Wildlife).

Runs – Feeding, Rearing and Migration

Runs are deeper than riffles and with a moderate to fast current, the run's surface is not as turbulent as the riffle and bottom materials are smaller gravel/cobble. When present, runs are typically between riffles and pools. Atlantic salmon parr are found in riffle-run areas typically with cobble and boulder and are often stationary, occupying territories associated with home stones (Heggenes 1990). Salmon parr use eddies and spaces around rocks or instream debris as shelter from currents which are used for feeding, growth, migration, shelter from currents and as cover for predator avoidance.

Pools – Feeding, Overwintering, Rearing

Deep, slow-moving water with a flat surface and sand or small gravel bottoms are characteristic of pools. Staging or holding pools are well documented for many rivers because they are favoured locations for salmon anglers, and many are identified on the 1:50,000 National Topographic Series maps. Although spawning does not occur until late fall, adult Atlantic salmon may enter the rivers in either the spring, summer or fall, and then typically remain in freshwater until they spawn. Ascension of rivers typically occurs in three phases, the second being a relatively long residency period (Bardonnet and Bagliniere 2000) that can range from about one month to over 6 months. During this time they stage in pools and these pools are used year after year. Adults may stay as long as 2 to 3 months in a single pool (Bardonnet and Bagliniere 2000).

Staging pools dissipate energy, provide cover and shelter from predators, provide low-flow areas that enable salmon to remain in freshwater without a large energy expenditure, and can also provide thermal refuges if the pools are fed by ground water.

Potential Additional Areas of Freshwater Critical Habitat

There remain some unanswered questions regarding the habitat used for spawning and by post-spawning salmon (kelts), and this will be addressed in further research (Table 3). Furthermore, the RPA states that if marine survival increases, recovery would be sensitive to the quantity and quality of freshwater habitat. Therefore, recovery efforts in a greater number of rivers may become increasingly important for long term population self sustainability, if marine survival increases. If in the future evidence is gathered suggesting that additional iBoF rivers would be essential for the survival and recovery of the species, the current definition of freshwater critical habitat for iBoF Salmon will be revisited. The Petitcodiac River for example, the largest of the iBoF rivers and estimated to have represented approximately 20% of the total iBoF Salmon production, may be given further consideration as containing potential critical habitat areas once the causeway is removed, if marine survival increases. As with the distribution target, critical habitat will be re-evaluated in five years and may be revised to take into account new information or changing conditions.

2.5.2 Activities that are Likely to Destroy Freshwater Critical Habitat

There are several types of freshwater critical habitat that each serves different functions to iBoF Salmon. A particular activity may be considered destruction in one type of habitat and not in another area because the activity may impact the two habitats differently. What follows are examples of activities that are likely to destroy freshwater critical habitat.

Infilling riffles, runs or pools (e.g., for the construction of watercourse crossings such as bridges, causeways, pipelines, etc.) would result in the permanent loss of the habitat features that support the unique function for iBoF Salmon in that area. Access between riffles, runs and pools must be maintained in a manner that does not have a detrimental impact on critical habitat. For example, installing a barrier (e.g., dam or culvert) without providing fish passage could result in the permanent loss of access to upstream habitat. Persistently dewatering a watercourse through water extraction or impoundment to the point that critical habitat becomes unable to serve its biological function for salmon or connectivity between areas of critical habitat is lost and is also considered destruction of critical habitat.

Any activity that changes the general water quality requirements of critical habitat (such as pH, suspended solids, temperature, etc) for sufficient frequency, duration and concentration such that it can no longer serve its biological functions for iBoF Salmon would be considered destruction. For example, persistent and excessive releases of deleterious substances from land based activities could increase suspended solids, alter pH or temperature to the point that the habitat is no longer functional for iBoF Salmon.

It is important to note that determining whether any particular activity will result in destruction of critical habitat would depend on the extent in time and space, intensity and specific nature of the activity, and the adequacy of associated mitigation measures. In many cases there are mitigation measures or best management practices that can be used in association with those activities described above which, if implemented properly, would allow these activities to occur without destroying critical habitat.

All habitat in inner Bay of Fundy rivers is protected under the *Fisheries Act*. IBoF Salmon in these rivers will continue to be protected by both the *Fisheries Act* and SARA. Habitat in FNP rivers not delineated as critical habitat are also offered protection by the *Canada National Parks Act* and regulated regulations.

2.5.3 Schedule of Studies to Identify Additional Areas of Critical Habitat

Critical habitat for the iBoF Salmon has been defined here-in for the freshwater environment of the species' life cycle. Notwithstanding this, it is possible that there exists additional areas of freshwater critical habitat and habitat in the marine environment that are also essential to the survival and recovery of the species. Potential marine areas of critical habitat are not identified in this recovery strategy because of uncertainty about the distribution and habitat use of iBoF Salmon in the marine environment. Although the RPA acknowledged that there is evidence that iBoF Salmon move throughout most of the Bay of Fundy during their marine phase, it concluded that the contribution that individual areas of marine habitat make to the persistence or recovery of populations cannot be determined at this time. Additional work must be completed in order to identify the spatial and temporal use of the marine environment by the iBoF Salmon throughout the year (particularly in winter). As set out in SARA, where information is inadequate to identify critical habitat within a recovery strategy, a schedule of studies must be prepared. The schedule of studies outlined in Table 3 below includes research activities that should help to determine whether additional areas of freshwater critical habitat exist and whether critical habitat areas exist within the marine distribution of iBoF Salmon. The RPA identified the determination of marine habitat use by iBoF Salmon as a high priority research recommendation and research on this issue has already begun. Completion of this work is proposed over the next 3 to 4 years (Table 3).

Table 3: Schedule of Studies outlining recommended research activities for the identification of critical habitat used by inner Bay of Fundy Atlantic salmon in Canada. These research activities will be incorporated into the action plan for this species.

Description of Activity	Outcome/Rationale	Timeline
Investigate habitat used for spawning and by post-spawning salmon (kelts) as well as freshwater and estuarine survival of kelts.	Identification of potential areas of estuarine and additional areas of freshwater critical habitat, and potential limiting factors in these habitats.	2008 – 2010
Investigate habitat used by salmon kelts for reconditioning, as well as the location and timing of mortality if it occurs.	Identification of areas of marine critical habitat and potential limiting factors. Repeat spawners are important for the recovery of iBoF Salmon.	2009– 2011
Investigate migration routes for iBoF post-smolts leaving the Bay of Fundy and summer habitat used by resident post-smolts in the BoF.	Identification of potential summer areas of marine critical habitat.	2009– 2012
Investigate marine foraging habitat used by salmon post-smolts and comparison to that used by salmon of outer BoF origin.	Identification of potential areas of marine critical habitat.	2009– 2011
Analyse existing marine distribution data for iBoF Salmon.	Identification of potential marine critical habitat areas for iBoF Salmon and linkage to environmental factors and habitat activities potentially limiting survival or recovery.	2009– 2011

Potential partners for the above activities could include but are not limited to Aboriginal communities and organizations, salmon conservation associations, watershed stewardship groups, provincial government agencies, universities, and industry.

2.6 Knowledge Gaps

The principal knowledge gap for iBoF Salmon recovery is the underlying cause(s) for the exceptionally low marine survival experienced by both post-smolts and post-spawners. Resolving this knowledge gap will involve determining the location of iBoF Salmon fall and over-wintering habitat and plausible causes of the change in at-sea survival or evidence of mortality. Knowledge of other factors that may limit recovery, including genetic effects of outbreeding depression, interactions with farmed and hatchery salmon, predation and food web shifts would also be expected to contribute toward the recovery of iBoF Salmon. Gaining such knowledge is an essential step in developing mitigative measures to remedy or minimize identified threats to iBoF Salmon in the marine environment and ultimately for re-establishing wild, self-sustaining populations.

Although there is considerable knowledge on the use of freshwater habitat by Atlantic salmon and freshwater habitat is currently not a factor limiting recovery, the present amount, location and condition of freshwater habitat for salmon should continue to be inventoried and monitored in a comprehensive manner for the iBoF rivers. There is also limited knowledge of the methodology/technology required to overcome concerns related to barriers and fish passage improvement scenarios on a site specific basis. Furthermore there is a gap in projects aimed at identifying and evaluating freshwater habitat threats and appropriate mitigation measures for addressing those threats.

A more comprehensive list of research and monitoring recommendations that would address gaps in our knowledge about the iBoF Salmon and the knowledge of which would be expected to contribute toward their recovery were prioritized during the RPA into 'high' and 'other' categories (DFO 2008a). Some of these activities are already underway. Others would be subject to the priorities and budgetary constraints of the participating jurisdictions and organizations. These lists are expected to evolve as knowledge improves.

Table 4. High priority research and monitoring recommendations

Topic	Recommendation
Habitat	Investigate marine habitat use, including spatial and temporal use of habitats throughout the year (particularly in winter) with an emphasis on identifying limiting factors.
Habitat	Identify which habitat factors are most limiting recovery and which mitigation options would provide the most effective improvement in habitat quantity or quality.
Habitat	Monitor storm and drought frequencies and trends.
Habitat	Update river flow information, develop instream flow needs model, and investigate cumulative effects of changing flow conditions.
Genetics	Study genetic effects of outbreeding depression (e.g., escaped farmed or straying from outside the DU).
Genetics	Collect quantitative genetic data and monitor introgression.
Aquaculture Impacts	Investigate interactions between wild and farmed salmon (including disease, attraction, etc.) in marine and freshwater environments, including documenting behaviour and fate of escaped salmon.
Predator Impacts	Identify specific predators and magnitude of predation levels in the Bay of Fundy.
Trophic Impacts	Effect of food web and other shifts in the Bay of Fundy on historical recruitment and recovery potential.
Barriers	Quantify restoration potential of various barrier removal and fish passage improvement scenarios and the methodology/technology that would be most effective.

Table 5. Other research and monitoring recommendations

Topic	Recommendation
Biology	Investigate salmon population dynamics.
Habitat	Inventory the present amount, location and condition of freshwater habitat for all iBoF rivers, and begin to quantify changes in habitat over time.
Habitat	Research the role that the distribution of different quality habitat units across a region or within a river has on population viability.
Barriers	Collect information on barriers

Barriers	Develop meta-population viability analysis modeling to investigate expected increases in productive capacity and population persistence that would result from removing particular barriers.
Barriers	Research impact of barriers on the loss in productivity in adjacent estuarine and coastal habitats and any potential impact of those losses on salmon production.
Modeling	Incorporate the potential genetic consequences of Live Gene Banking into the Population Viability Analysis (PVA).
Fisheries	Investigate and follow-up on any salmon catch (annually).
Contaminants	Survey to determine whether the levels of pesticides and other contaminants (e.g., heavy metals) in iBoF habitat are influencing salmon survival.
Modeling	Model changes in environmental/ecological conditions and human activities in the context of their cumulative effects on population viability.

In addition, SARA states that "*The Traditional Knowledge of the Aboriginal peoples of Canada should be considered in the assessment of which species may be at risk and in developing and implementing recovery measures*". Aboriginal Traditional Knowledge (ATK) gaps exist because of the lack of mechanisms for supporting Aboriginal peoples' involvement and the lack of a principled approach or protocols for acquiring ATK about the salmon from Aboriginal peoples. To help in achieving success of recovery goals and plans, efforts to include ATK should continue and should be drawn from affected Aboriginal organizations through supported and meaningful consultation throughout the recovery process. The knowledge learned and included in accordance with proper protocols, can provide useful guidance and demonstrate a best effort to include the Aboriginal peoples' worldviews about the iBoF Salmon in all elements of the recovery process.

2.7 Statement on 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. The plans must also demonstrate respect for, and take into account, the activities and approaches which Aboriginal peoples wish to undertake.

It is expected that one or more action plans for this species will be developed, each outlining steps to be taken to implement the goals and objectives identified in the recovery strategy for the species. The first action plan will be developed within 4 years of the posting of this strategy, or at an earlier date. Several priorities that have been identified thus far to be potentially considered during the action planning process include addressing marine critical habitat, the activities of the LGB program and modifications to the Petitcodiac River causeway.

In the interim, work can still begin and continue on many of the recommended approaches outlined in this document. Therefore, recovery implementation will be an ongoing activity that can occur in the absence of any formal action plan. Furthermore, the recovery strategy recognizes the need for adaptive management; as new information becomes available, the actions for recovery may be modified.

2.8 Actions Completed or Underway

2.8.1 Management Actions

Fisheries Restrictions

All commercial fisheries for Atlantic salmon in the Bay of Fundy were closed after the 1984 season. Recreational fisheries for Atlantic salmon in iBoF rivers were reduced in the years following the closure of the commercial fishery and subsequently closed since 1990 except for the Gaspereau River. The Gaspereau River remained open for recreational and food fisheries until 1994, was closed in 1995 and re-opened with limited food fishery agreements and a shorter catch-and-release only angling season in 1996 and 1997.

Habitat Management

A 'Salmon Presence Assessment Tool' (SPAT), that helps determine the chance of encountering a salmon at a specific site for use in decision making, has been developed. A database of restoration projects, including those in the iBoF, is being developed to facilitate and expedite selection of habitat compensation projects.

2.8.2 Research, Monitoring and Outreach Actions

Many iBoF Salmon research, monitoring, stewardship, outreach and recovery efforts have been initiated by government and non-government organizations over the past 20 or more years. The multi-stakeholder iBoF Atlantic Salmon Conservation and Recovery Team was first formed in 2000 and published a National Recovery Plan in 2002 (National Recovery Team 2002) that outlined the key issues facing the iBoF Salmon and the research and actions required to encourage recovery. Some of the actions proposed in that plan were completed; others are ongoing and are reflected in this recovery strategy. The determination of the cause(s) of the low survival at sea remains an urgent priority.

A summary of completed activities up to March 2008 and planned activities for April 2008 – March 2009 are summarized in a tabular format, referred to as 'The Activity Table'. The Activity Table provides key results and planned activities that are cross-referenced to the specific objectives and strategies outlined in this recovery strategy, and further linked to specific actions. This Activity Table is available online at the DFO Science web-site for the Maritimes Region [http://www.bio-iob.gc.ca/research/species_at_risk/ibof_salmon/Activities-Table-iBoF-Salmon-RS-Eng.pdf] or by request from the Maritimes Region Species-at-Risk Office. This Activity Table will be updated annually to reflect progress on ongoing activities and capture any new work being undertaken. The following provides the highlights of actions undertaken to date. The details are provided in the Activity Table.

Efforts to conserve iBoF genetic characteristics and re-establish self-sustaining populations

Conservation of the genetic characteristics of iBoF Salmon is currently taking place through the LGB program initiated in 1998. LGB salmon are currently maintained at DFO's Mactaquac (in

NB), Coldbrook and Mersey (in NS) salmon biodiversity facilities. Mating plans have been developed and employed to conserve the genetic characteristics of iBoF Salmon and to reduce the loss of genetic diversity. The genetic traits of individual salmon from the LGBs are determined and crosses are performed according to a specific mating scheme developed to ensure the fullest possible range of genetic families and unique inner Bay genetic characteristics are maintained, and to reduce the possibility of negative effects from inbreeding on the genetic structure of the iBoF Salmon. Monitoring levels of genetic variation to assess any loss of diversity over time is undertaken to ensure the genetic characteristics of the residual iBoF populations are conserved. A recent international review of the LGB program has supported the scientific protocols established to achieve this strategy (DFO 2008b).

Two principal activities have been associated with the LGB strategies:

1. The development, implementation, testing, and improvements to the LGB program by using specific collection, mating and release strategies to assess the success of LGB salmon introductions to designated rivers; and
2. The ongoing collections and distributions of various life stages of LGB salmon, and assessment of the status of populations in selected iBoF rivers.

The genetic makeup of salmon collected are being typed to determine the current composition of LGB salmon in these rivers and releases occur each year using the release strategy protocols. The first spawning of captive broodstocks was carried out in the fall of 2000, and the first releases of resulting juveniles were made in 2001.

Additional genetic research underway on iBoF Salmon includes the relative effects of inbreeding and outbreeding and the impacts of mate choice and other variables associated with the LGB program on the survival, growth and other fitness-associated traits.

Efforts to identify and remedy threats in the marine environment

Efforts to date focused on identifying and remedying threats limiting survival and/or recovery of iBoF Salmon in the marine environment have involved a range of activities, including:

- Literature and field studies to determine, assess and document the marine habitat quality, quantity and use by iBoF Salmon populations. To date, the habitat suitability of the BoF and Gulf of Maine regions have been mapped using 10-year average monthly temperatures.
- Surface trawling surveys and acoustic tagging experiments of post-smolts in the Bay of Fundy (BoF) and GoM to determine their distribution during fall and winter months at sea (Lacroix and Knox 2005; Lacroix 2008).
- Other studies are focused on developing electronic tags and tag release mechanisms to extend the range of data that can be collected from these types of projects.
- Analysis of historical scale patterns as a means of detecting changes in environmental effects or migration patterns.

Future plans include archiving all existing marine distribution data for iBoF post-smolts and an analysis of factors affecting their migratory behaviour, route(s) and habitat use(s). To this end, field work underway includes using acoustic tags attached to pre-spawning adults in the Big

Salmon River to monitor habitat use and time of river exit, in addition to a joint DFO-Parks Canada marine habitat use study. In this latter study, satellite tags, which record information on position, depth and temperature, are attached to post-spawning adults (kelts) in the Big Salmon River and Point Wolfe River. These tags are preset to pop-up to the water's surface 4-8 months later and transmit the data to an overhead satellite. The intent is to expand this program to NS rivers. Winter trawling surveys to capture live salmon in the marine environment and identify overwintering habitat of iBoF Salmon are also being proposed and may involve the development of more efficient trawling methods.

Potential threats have been evaluated by modelling iBoF Salmon population dynamics in the Big Salmon River as a case study (Trzcinski *et al.* 2004), by the development of electronic tagging methods, and by an assessment of the incidental effects of licensed fisheries on iBoF Salmon populations. Allowable harm assessment reviews have also allowed for an evaluation of potential threats to iBoF Salmon (Amiro 2004; DFO 2004).

Efforts to identify and remedy threats in the freshwater environment

Several studies have been undertaken to date to provide information on iBoF Salmon freshwater habitat use, quality, and quantity: stream habitat slopes have been classified and mapped in a Geographic Information System (GIS) format for 23 iBoF rivers (Amiro *et al.* 2003); a study on the habitat use by juvenile salmon has recently been completed (Gibson *et al.* 2008a); and tracking experiments have clarified habitat needs for juveniles and adult spawners. Other works documenting other types of habitat and use by iBoF Salmon are underway and include the development of a habitat survey database undertaken by Fort Folly's Habitat Recovery Program in 2002 to assess the suitability of habitat for juvenile Atlantic salmon in the Memramcook River and adjacent tributaries, culvert surveys and stream experiments to determine the effects of nutrient enrichment.

Ongoing freshwater habitat restoration activities will contribute to achieving the objectives and goals of this recovery strategy and efforts are regularly undertaken by government agencies and interested stakeholders. Work is currently underway to restore tidal flow and fish passage on the Petitcodiac River. An Environmental Impact Assessment (EIA) has been completed for the causeway between the City of Moncton and the Town of Riverview. The objective of the EIA was to examine and evaluate options to address a long-term solution to fish passage and other ecosystem issues (including tidal exchange, sediment transport and other physical processes and biophysical functions) related to the Petitcodiac River causeway. Opening the gates permanently and replacing the causeway with a partial bridge have been assessed as the best options to meet the objectives defined in the EIA. Implementation of the project is being accomplished in a three-stage strategy; stage 1) design, construction and communication prior to opening the existing gates; stage 2) open existing gates; and stage 3) construct the preferred structure. Stage 1 is near completion and stage 2 is to begin in the spring of 2010 with opening of the gates during the ice free season and monitoring for 2 years. Project details and the Environmental Impact Assessment Report are available online at http://www.gnb.ca/0099/petit/index-e.asp and http://www.petitcodiac.com/.

Additional projects underway to address threats in the freshwater environment include a trial of the upstream migration of adult salmon to the White Rock fishway on the Gaspereau River under controlled flow conditions, an inventory of culvert installations within the Maritimes region of DFO, and subsequent development of guidelines for their installation, and the assessment of the 243 aboiteaus within NS iBoF watersheds.

Efforts to assess population status, sustainability, and recovery feasibility.

Annual reviews of the status of iBoF Salmon populations have been extensive and there are long term data series for the two index iBoF rivers; the Big Salmon and Stewiacke. There is data for the Big Salmon River from 1951 to the present day and salmon abundance estimates have been provided for the Stewiacke River since 1965. Trends in the Stewiacke River have been analysed by Gibson and Amiro (2003). Adult abundance data is also available for annual updates and monitoring has been conducted on the Point Wolfe since 2000, the Upper Salmon River since 2002, and the Petiticodiac River since 2002 (Gibson *et al.* 2003a; Gibson *et al.* 2004). Salmon migration in the Gaspereau River has been monitored since 1920 at the White Rock fish ladder. Fundy National Park has been assessing juvenile populations in the Point Wolfe River and Upper Salmon River since 1982. Extensive inner Bay wide electrofishing surveys have been undertaken to estimate the abundance of juvenile Atlantic salmon in iBoF rivers in 2000, 2002 and 2003 (Gibson *et al.* 2003a; Gibson *et al.* 2004). The results of these surveys are detailed in the Population Size and Trends section of this recovery strategy.

Two different population viability analyses (PVA), one based on trends in the Stewiacke River population, and one based on the life history of the Big Salmon River population, have been undertaken to determine the likelihood that this designatable unit would become extinct in the absence of human intervention or a change in marine survival. Modelling that includes the LGB indicates there is a high probability that the population can be maintained through the LGB program. Additionally, low levels of human-induced mortality have little effect on the probability of extinction when the LGB is operating, even at very low levels of marine survival (Gibson *et al*. 2008b).

Data will continue to be collected and documented so that population status, sustainability, and recovery feasibility can be reassessed and periodically evaluated every 5 years as prescribed in the recovery strategy, and as recovery efforts proceed as new information becomes available.

Efforts to communicate and increase public awareness

Fostering the exchange of information and co-ordinating activities of mutual interest or concern to Atlantic salmon conservation and recovery programs in the Bay of Fundy/Gulf of Maine are important ongoing components of the recovery strategy. The continued involvement of governments, non-government and conservation organizations, other stakeholders, Aboriginal Peoples, industry, academia and the general public in the planning and undertaking of recovery initiatives will be critical to the success of the recovery strategy for iBoF Salmon.

Communication and general awareness has been accomplished by many government and non-government conservation groups through a variety of mechanisms including collaborative scientific projects such as the smolt wheel operation on the Big Salmon River, numerous public news and information broadcasts, brochures, school presentations, workshops and other communication methods. The inner Bay of Fundy Planning Group and the Recovery Team provide venues for discussing projects, direction, and needs for recovery and include all interested stakeholders.

A new project is planned in Fundy National Park which would partner with LGB operations and nearby schools to have surplus eggs from a scheduled in-park recovery project reared on site for staff, visitors and the community to view and become familiar with the recovery program. Interpretive presentations and panels are planned for both the in-park and classroom components.

2.8.3 Aboriginal Activities

The cultural value of the iBoF Salmon is extremely difficult, if not impossible, to measure. It can be stated that Atlantic salmon have been of significant importance to cultural identity of Aboriginal peoples, throughout the historic range of the animal. The importance of taking recovery and conservation measures is understood as an absolute necessity for Aboriginal peoples living in proximity of the inner Bay of Fundy and their commitment has been demonstrated by foregoing any harvest of iBoF Salmon for nearly two decades. Additional specific examples include those actions taken by the Fort Folly First Nation to involve its community and in particular, its youth in its iBoF Salmon recovery efforts. The Netukulimkewe'l Commission of Nova Scotia has undertaken voluntary suspension of community salmon harvesting in the Bay of Fundy. This group has also taken steps to raise awareness of the need to protect and conserve Atlantic salmon and its freshwater habitat. Through the recent formation of an iBoF Salmon Aboriginal Sub-committee within the Recovery Team, Aboriginal organizations have sought increased representation and engagement in the work of the Recovery Team and input into the development of this recovery strategy.

2.8.4 Activities by Local Community

Local community knowledge of the wild Atlantic salmon and their river habitat in the inner Bay of Fundy, as well as the stewardship activities undertaken by local watershed / conservation organizations and the general public are invaluable to the conservation and recovery of iBoF Salmon populations and their habitat. The continued participation by such groups in the activities of the Recovery Team will be important for the successful implementation of this recovery strategy.

The Habitat Stewardship Program (HSP; http://www.cws-scf.ec.gc.ca/hsp-pih/) has provided financial support to a variety of iBoF Salmon projects in the area over the last number of years, promoting direct involvement of a wide number of community groups and individuals involved in recovery and outreach efforts. Projects have included the delivery of a variety of community education and outreach activities including the production of outreach materials, and habitat recovery projects in various iBoF watersheds.

2.9 Activities Permitted by the Recovery Strategy

On June 1, 2004, it became illegal to kill, harm, harass, capture, or take any endangered or threatened species protected under SARA or to cause damage or destruction to the species' residence or any part of its critical habitat. Subsection 83(4) of SARA however enables recovery strategies, action plans and management plans to exempt persons engaging in certain activities from the general and critical habitat prohibitions under SARA. In order for this provision to apply, the activity must be authorized under another Act of Parliament.

The RPA for the iBoF Salmon was conducted in March 2008 to inform, among other scientific elements, the extinction risk of iBoF Salmon populations. Model results from this review and the conclusions drawn from the RPA suggest that "*under current conditions[*when the LGB is operating*], neither the probability of extinction nor the probability of recovery is very sensitive to low levels of human-induced mortality. However, if marine survival increased and iBoF Salmon began to recover, recovery would be sensitive to low levels of human-induced mortality*." In other words, there is currently scope for low levels of human-induced mortality without jeopardizing the survival or recovery of this species. The conclusions of the meeting (DFO 2008a) are available on the DFO's Canadian Science Advisory Secretariat (CSAS) website at: http://www.dfo-mpo.gc.ca/csas/csas/Publications/Pub_Index_e.htm.

The recovery strategy adopts the conclusion of the RPA and, in accordance with subsection 83(4) of SARA, exempts the following activities from the SARA prohibitions:

- Scientific conservation and recovery activities led by DFO and authorized by licence under Sections 52 and 56 of the *Fisheries (General) Regulations* and Section 4 of the *Fisheries Act* including:
  - the collection, retention and release of iBoF Salmon in support of the Live Gene Bank program and for conservation research;
  - the sampling, by methods including but not limited to electrofishing, angling, use of fyke nets and seine nets, in support of research, assessment of status or to determine the presence or absence of salmon.
- Electrofishing authorized by licence under Section 52 of the *Fisheries (General) Regulations*, conducted by qualified individuals for the purposes of enforcement, environmental emergencies, mitigation (i.e., a fish salvage or fish out) for compensation and restoration projects, or to fulfil the conditions of a *Fisheries Act* authorization or Letter of Advice.
- Research and recovery activities authorized by Parks Canada Agency and undertaken within Fundy National Park, NB that are authorized under the *Canada National Parks Act* (or another Act of Parliament):
  - Sampling and collection of iBoF Salmon by various methods, including but not limited to electrofishing, angling, use of fyke nets, rotary screw traps, counting fences and seining, in support of research and status assessment;
  - Tagging, tracking and release activities in support of the iBoF Salmon live gene bank program;
  - Habitat restoration and improvement activities in support of the conservation and recovery of iBoF Salmon.

These particular activities have been included as permitted activities in this recovery strategy because they are regularly conducted and are intended to improve understanding of iBoF Salmon, enhance their chances of survival in the wild and/or mitigate threats to their recovery..

Other new or existing activities considered likely to harm, harass, kill, capture or take iBoF Salmon may be permitted by the Minister of Fisheries and Oceans Canada under Section 73 or other similar provisions of SARA if relevant conditions can be met. Activities that will affect the iBoF Salmon within the limits of Fundy National Park may also be permitted pursuant to section 73 or other similar provisions of SARA by the Minister responsible for the Parks Canada Agency, if the relevant conditions are met. These conditions require that the activity must not jeopardize survival or recovery of the species, that all reasonable alternatives to the activity have been considered and that all feasible measures will be taken to minimize the impact of the activity on the species. Persons wishing to carry out any activity other than those permitted herein and expected to affect iBoF Salmon may apply to the Minister of Fisheries and Oceans Canada or the Minister responsible for the Parks Canada Agency (for watersheds within Fundy National Park) for a permit or agreement under section 73 of SARA. Such permits and agreements will only be issued if the conditions set out in SARA are met. SARA permit applications can be downloaded on the DFO Species at Risk website at http://www.dfo-mpo.gc.ca/species-especes. Persons wishing to carry out an activity within Fundy National Park should visit Parks Canada's online permit application system at http://www.pc.gc.ca/apps/RPS/.

Recovery strategy implementation must be reviewed within 5 years and every 5 years thereafter. A review of activities and any new information will be undertaken at that time to ensure that the survival or recovery of the species remains non-jeopardized. The Department of Fisheries and Oceans Canada will continue to assess the effectiveness of recovery efforts and work cooperatively with stakeholders to find further solutions to assist iBoF Salmon recovery.

2.10 Recovery Strategy Implementation and Significance to Aboriginal Peoples

To the Aboriginal peoples of the Bay of Fundy, the importance of recovering the iBoF Salmon is more than a feasibility exercise; it is of fundamental significance to the distinctive cultural heritage and tradition which the Mi'kmaq and Maliseet people have with salmon.

The Aboriginal peoples' worldview in which there is an interconnection and interdependence of all life forms, and ATK of the iBoF waters and salmon are important considerations for the recovery strategy and its implementation. ATK can, for example, provide commentary, experience, local knowledge and worldview about the causes, conditions, or current state of salmon. Western scientific views and perspectives are also necessary in order to gain for example, a better understanding of the threats and limiting factors to survival of the iBoF Salmon, but are viewed as being incomplete. This Aboriginal perspective is particularly important given the responsibilities vested by SARA in Aboriginal peoples to provide advice to the Minister on the implementation of the *Act*, and to ensure their inclusion in the various processes, including the development of and participation in action plans.

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APPENDIX I – GLOSSARY of TERMS

Aboriginal rights: Activities, practices, traditions and customs integral to an Aboriginal group and carried out prior to contact (First Nation) or effective control (Métis) by Europeans. Examples (e.g., harvesting [hunting, trapping, fishing, gathering] for food, social, ceremonial and sometimes commercial purposes).

Allele: One of several possible mutational states of a particular gene or locus (gene location).

Aquaculture: Farming of fish, shellfish and aquatic plants in fresh or salt water. Aquaculture products can be grown inland in freshwater recycling facilities, ponds, freshwater lakes and bays, or in the open ocean. The farmed aquatic animals and plants are fed and cared for to ensure optimum health and product quality. Once they have reached an appropriate size, they are harvested, processed, and then shipped to market. *Source: www.dfo-mpo.gc.ca/aquaculture/faq_e.htm#1a*

Anadromous fish: Fish that reproduce in freshwater and spend a part of their life in the marine environment.

Assemblage: Refers to a grouping or collection of populations that possess certain traits, and possibly genetic makeup, similarities.

Aboriginal Traditional Knowledge (ATK): The collective memory and holistic knowledge Aboriginal peoples communities have accumulated about wildlife species and their environment that is passed from one generation to another through oral traditions (including songs, stories, and spiritual teachings), observation of activities (including rituals, rites, ceremonies, and dance) and lived experience.

Broodstock: Adult fish captured or reared to provide gametes (i.e., eggs and sperm) for natural spawning, hatchery culture and stocking purposes.

Captive breeding: Mating of broodfish developed and maintained in captivity.

Conservation: The protection, maintenance, and rehabilitation of genetic diversity, species and ecosystems to sustain biodiversity and the continuance of evolutionary and natural production processes. For inner Bay of Fundy salmon the conservation requirement is an egg deposition rate of 2.4 eggs per m^2 of freshwater rearing habitat.

Designatable Unit: Approach adopted by COSEWIC to identify entities for status assessment of species under the Canadian *Species at Risk Act* based on established taxonomy, genetic evidence, range disjunction, and/or biogeographic distinction.

Density-dependent: Processes such as growth, survival and reproduction for which their rates change in response to variation in population density.

Diadromous fish: Fish that migrate between and spend parts of their life in both freshwater and the marine environment.

DNA: A type of nucleic acid that is localized within cell nuclei of complex organisms (including fish), and which is the molecular basis of heredity.

Electrofishing: The act of collecting salmon, generally juveniles, for determination of abundance, using an electrofisher.

Euphasiids: shrimp-like marine invertebrate animals also known as krill found throughout the Bay of Fundy and elsewhere.

Extirpation: The local extinction of a species or a genetically distinct population segment of that species in Canada, which occurs elsewhere.

Extinction: Loss of a species or a genetically distinct population segment of that species.

Fish: Fish under the *Fisheries Act* includes fish and parts of fish; shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals; and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

Fitness: The ability to survive and reproduce in a particular environment. In this document, the term "wild fitness" is used to denote the ability of wild salmon to survive and reproduce in their natural habitat.

Food, Social and Ceremonial (FSC) right: Refers to the 1990 Supreme Court of Canada landmark ruling in the *Sparrow* decision. The Court found that where an Aboriginal group has a right to fish for food, social and ceremonial purposes, it takes priority, after conservation, over other uses of the resource. The Supreme Court also indicated the importance of consulting with Aboriginal groups when their fishing rights might be affected.

Founder: A collection of individuals from which a population has been initiated or derived. In the context of the iBoF recovery program, founders for a given river-specific Live Gene Bank are individuals originally captured from the wild, from which all subsequent generations of salmon have descended.

Furunculosis: A bacterial disease of salmonids caused by the bacteria *Aeromonas salmonicida* usually characterized by boils (or furuncles) on the skin, haemorrhaging of body organs, and loss of appetite. Treatment by antibiotics is usually successful.

Gamete: Mature germ cell (sperm or egg) possessing a haploid chromosome set and capable of formation of a new individual by fusion with another gamete.

Gene Bank: A depository for fish and/or their gametes [see definition of gamete] that are genetically representative of a biological entity such as a stock or population. Under the recovery program for iBoF Salmon, live fish are being housed in fish culture facilities.

Gene: The fundamental physical unit of heredity that controls or influences one or more characters and is located on a particular chromosome.

Genetics: A branch of biology that deals with the heredity and variation of organisms and with the mechanisms by which these are affected.

Genetic diversity: The variation at the level of individual genes that provides a mechanism for population to adapt to their ever-changing environment.

GIS: Refers to a Geographic Information System which is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information; that is, data identified according to location.

Grilse: Informal term used to refer to an adult salmon less than 63 cm in fork length and which generally have spent only one winter at sea before returning to spawn for the first time; also referred to as small salmon or one-sea-winter (ISW) salmon.

Haplotype: The genetic constitution of an individual chromosome (i.e., a combination of alleles (see definition of allele) of closely linked loci (see definition of locus) that are found in a single chromosome and tend to be inherited together).

Hydrodynamics: The study of fluids in motion.

Inbreeding: The mating of closely related individuals.

Inbreeding depression: A loss or reduction in fitness that usually accompanies inbreeding in organisms.

Interbreeding: The mating within a narrow range or with closely related types or individuals.

Kelt: A spent or spawned-out salmon.

Large salmon: An adult salmon equal to or greater than 63 cm in fork length, which collectively generally comprise all adult salmon that have spent two or more winters at sea; also referred to as multi-sea-winter (MSW) salmon.

Life history traits: The various biological characteristics that portray the individual stock or population, e.g., incidence of precocious maturation among parr, smolt age and size, sea age at maturity, sex ratio for the different sea age classes.

Live Gene Bank (LGB): A captive breeding and rearing program undertaken for populations or species that are at imminent risk of extirpation in the wild, often designed to minimize the loss of genetic variation and the accumulation of inbreeding over time.

Lineage: A grouping of biological stocks that are genetically distinct from others and have evolved independently from other representatives of the same species.

Locus (*plural* loci): The position of a gene (or other significant sequence) on a chromosome.

Major Histocompatibility Complex (MHC): A large DNA sequence region or group of genes found in most vertebrate species.

Mark-recapture: An active field sampling technique which employs the marking of fish and subsequent recovery of some of the fish to estimate their abundance.

Microsatellite markers: Repetitive stretches of short sequences of DNA used as genetic markers to track inheritance in families.

Mitochondria (*sing.* Mitochondrion): Any of various round or long cellular organelles that are found outside the nucleus, produce energy for the cell through cellular respiration, and are rich in fats, proteins and enzymes.

Mitochondrial DNA (mtDNA): is DNA [see definition of DNA] that is located in mitochondria [see definition of mitochondria].

NACOSAR: Refers to the National Aboriginal Council on Species at Risk as legislated under SARA section 8.1. This committee, consisting of six representatives of the Aboriginal peoples of Canada selected by the Minister based upon recommendations from Aboriginal organizations, is tasked with advising the Minister of Environment Canada on the administration of SARA and to provide advice and recommendations to the Canadian Endangered Species Conservation Council.

North Atlantic Oscillation Index (NAOI): The North Atlantic Oscillation (NAO) is a large-scale pattern of natural climate variability that has important impacts on the weather and climate of the North Atlantic region. Although the NAO occurs in all seasons, it is during winter that it is particularly dominant. It controls the strength and direction of westerly winds and storm tracks across the North Atlantic. The NAO index is a measure of the strength of these winds.

Parr: Juvenile salmon stage between the fingerling stage and the smolt stage. Parr are often referred to by their age class as 0+ parr, 1+ parr, etc. See Appendix II for schematic and further description of this life stage.

Pedigree mating: the use of lineage information to prioritize and select candidates for spawning, and to determine which females will spawn with which males, so as to minimize inbreeding and loss of genetic variation through time.

pH: A measure of the acidity of the water.

Population (or river population): A group of interbreeding organisms that is relatively isolated from other such groups and is likely adapted to the local habitat.

Population dynamics: The combination of processes that determine the size and composition of a population and the study of changes over time and the factors influencing those changes.

Post-smolt: A juvenile salmon from the time that it departs the river as a smolt until it completes its first winter at sea, when it becomes a one-sea-winter salmon (see definition of 'grilse').

Post-spawner: A salmon that has spawned previously and has not yet returned to the river to spawn again.

Primary Production: The total amount of new organic matter produced by photosynthesis (process by which green plants transform light into energy).

Recovery Potential Assessment: A science evaluation framework used as a basis for decisions relating to the recovery planning of a species at risk.

Restoration: The re-establishment of populations of inner Bay of Fundy Atlantic salmon to self-sustaining levels in rivers which they once occupied.

Re-colonization: The process of re-seeding inner Bay of Fundy rivers with inner Bay of Fundy Atlantic salmon.

Sedimentation: The accumulation of solid fragments of material.

Sea-run salmon: Atlantic salmon that spend one or more winters at sea.

Self-sustaining: Used to refer to a population that is able to maintain itself over an extended period of time.

Smolt: Fully silvered juvenile salmon that has completed rearing in freshwater and which is capable of migrating seaward with physiological capability to survive transition from freshwater to salt water.

Smoltify: Physiological changes which a juvenile salmon undergoes in order to transform from a parr to a smolt.

Spawning: The reproductive ritual involving egg fertilization with male gametes and in the case of salmon in natural streams and rivers, the deposition of those eggs and male gametes into gravel riverbed nests called 'redds' [see Appendix II for further description of redd].

Species: A group of interbreeding natural populations that is reproductively isolated from other groups. *(Note, this definition is different than the broader definition of "species" used by COSEWIC to designate the biological entity at "risk", i.e., a "species" is any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.)*

Stakeholder: An individual, group or agency with a vested interest in the resource.

Stock (or biological stock): Any group of interbreeding organisms that is reproductively isolated from other groups of the same species.

Strain (or domestic strain): A group of individuals with a common ancestry that exhibit genetic, physiological, or morphological differences from other groups as a result of husbandry practices.

Synergistic: Working together in combined action.

Telemetry: The process of transmitting of data from remote sources, by radio or other means, for recording and analysis.

Tidal Barriers: Obstructions to tidal flows in rivers, streams and across marsh areas generally situated at the head of the Bay of Fundy, e.g., dykes, dams and causeways. Some of these structures are obstructing fish migration.

Threat: Any activity or process (both natural and anthropogenic) that has caused, is causing, or may cause harm, death, or behavioural changes to a species at risk or the destruction, degradation, and/or impairment of its habitat to the extent that population-level effects occur.

Wild Salmon: The offspring of salmon that have spawned naturally and for which the parents were also the product of natural spawning and lived continuously in the wild.

APPENDIX II – ATLANTIC SALMON LIFE CYCLE

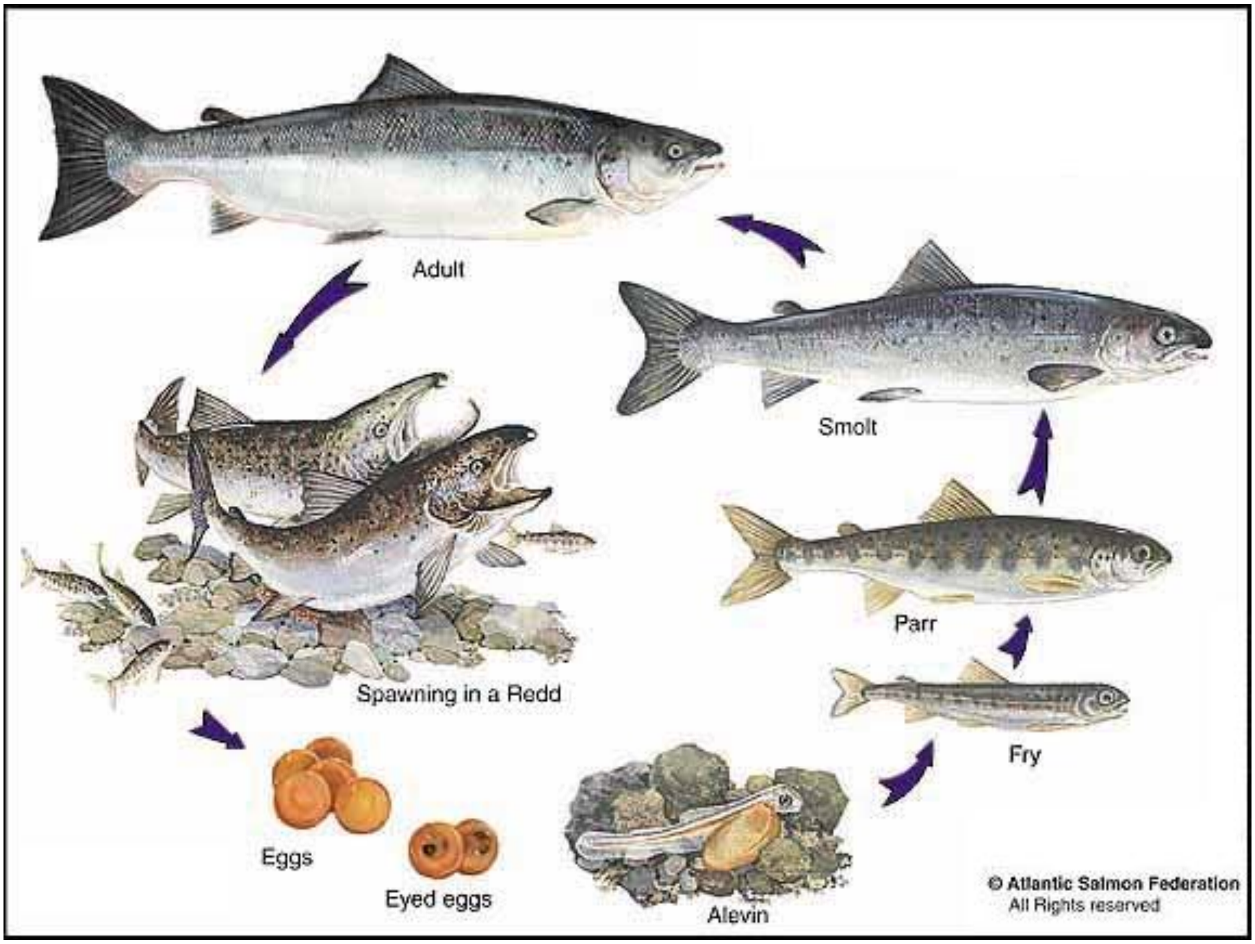


Illustration by J.O. Penanen, Atlantic Salmon Federation

The life cycle of the Atlantic salmon contains many stages. **Adults** spend part of their life feeding and growing during long migrations at sea, and then return to reproduce in the freshwater stream where they hatched. Atlantic salmon from eastern Canada typically migrate to feeding grounds off north-western Greenland. At maturity, they home to their river of origin. Straying rates are low, typically less than 5%. Atlantic salmon that are ready to spawn begin moving up rivers from spring through fall. Although the timing of river entry varies among populations as an adaptation to local conditions and a response to water levels, these spawning runs are surprisingly consistent occurring at the same time each year for each river. Canadian Atlantic salmon typically spawn during October and November, usually earlier in the north and later in the south. The nest site is chosen by the female, typically in a gravel-bottom at the head of riffles or tail of a pool, where she digs a nest pit called a '**redd'**. Males compete with each other for proximity to the female, and the dominant male and perhaps others release milt as she releases a portion of her eggs. Small, precociously mature parr may sneak into the nest and also release milt. The female covers the embryos with gravel and then digs another nest, repeating this process until she has released all her eggs. The **eggs**, averaging 1500 per kg of body weight, are large (5-7 mm) and contain a considerable quantity of yolk. After spawning, surviving adults, termed ‘**kelts’**, may return to sea immediately where they continue to grow until the next spawning season or remain in the river over winter and return to sea in the spring. The eggs develop in the nest during the winter and, depending upon temperature, usually hatch in April. The young remain buried in the gravel as ‘**alevins’**, absorbing the yolk sac until May or June. Young emerging salmon, called ‘**fingerlings’** or ‘**underyearlings’** are about 2.5 cm long. Older juveniles, termed ‘**parr’**, are territorial, occupy riffles where they feed on invertebrates and may remain in streams for 2-8 years (2-4 years in iBoF Salmon). After several years of freshwater growth, perhaps at 12-15 cm in length, the parr change physiologically into ‘**smolt’** and migrate to the ocean. Growth in the ocean is rapid, and individuals may mature after one sea-winter (1SW) as ‘**grilse’** or after two or more sea-winters (MSW) as ‘**large salmon**’. Salmon feed on a variety of prey including crustaceans and small fish.

APPENDIX III – LGB EVALUATION BENCHMARKS

The primary objectives of the iBoF Salmon Live Gene Bank (LGB) program are:

1. To minimize loss of genetic variation and the accumulation of inbreeding;
2. To minimize the loss of fitness.

Benchmarks have been set to evaluate the effectiveness of the LGB program at meeting its primary objectives. Those benchmarks are:

1. To retain (recover) one or more offspring from a minimum of 90% of high and medium priority parents, in every generation[9]. Offspring may be obtained from either captive or wild-exposed environments.
2. Fifty percent of offspring recovered from each generation should, where feasible, be obtained from native river habitat, having been exposed to natural selection from the fry stage through to either the late stage parr or smolt stage (addresses objective 2 above).
3. To minimize the reduction of gene diversity and allele richness to 2 and 4 percent per generation, respectively, when resources for fish culturing, wild collections, and genetic analyses are available[10].
4. To produce and release a sufficient number of juveniles into river habitat to yield enough individuals to permit recovery of a minimum of 200 late stage parr or smolts per year given (1) expected mortality through to the smolt stage and (2) the expected capture rate given proposed methods of sampling.[11]
5. Preservation and maintenance of the genetic diversity of the population will be accomplished partly through cryopreservation. The strategy proposed to accomplish this is to cryopreserve 100 high or medium priority LGB F1 salmon from each of Big Salmon and Stewiacke populations. Fertilization success with cryopreserved milt is not always successful so success for this strategy will be based on demonstration of fertilization in 80% or more of the matings in 5 test crosses. The evidence for success will be the production of 3 or more fertilized eggs per family using thawed cryopreserved milt.

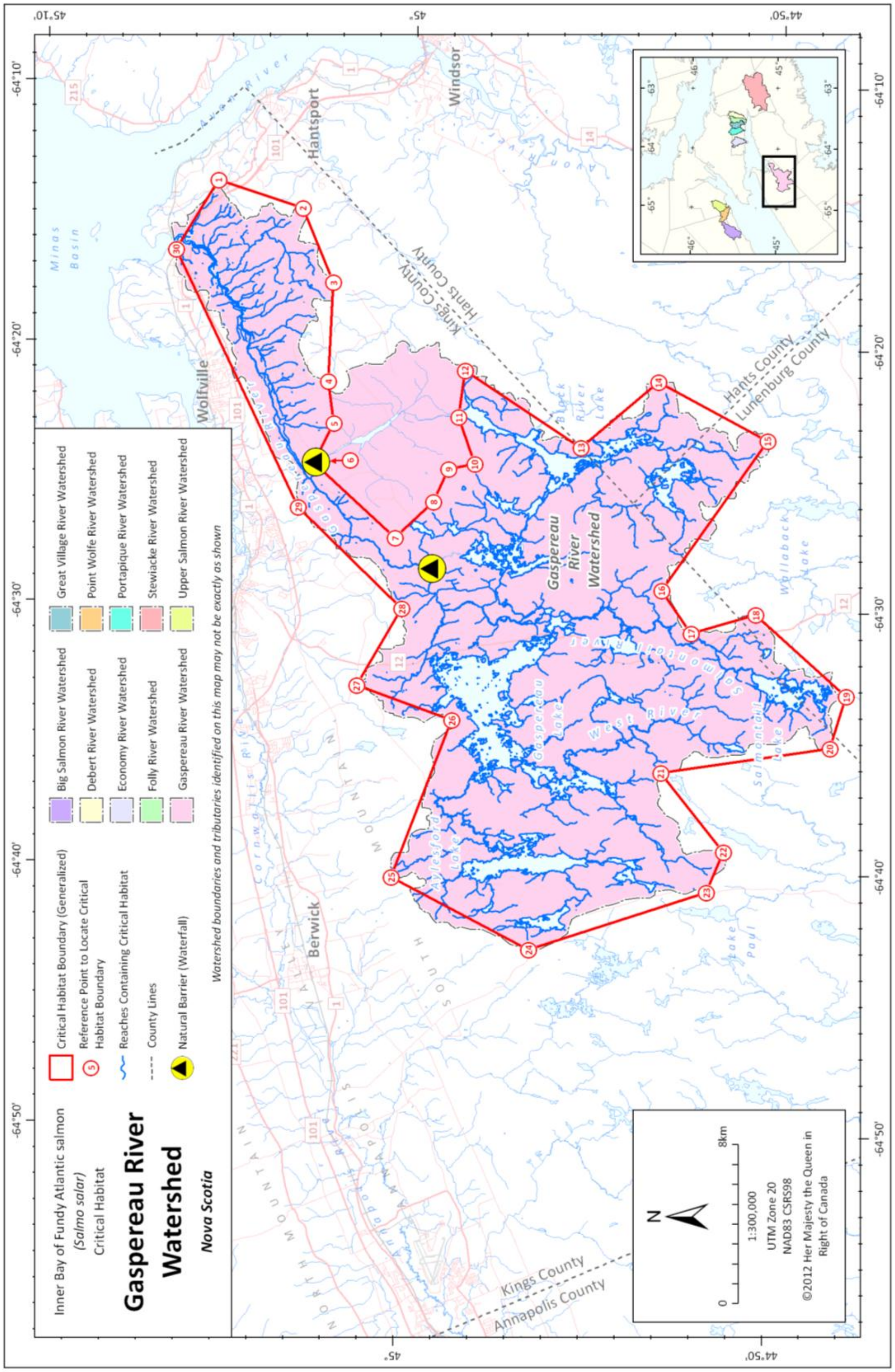
[9] High and medium priority salmon are defined as all individuals from full sib families of 3 or fewer individuals and the first representative from full sib families of 4 or larger (addresses objective 1 above).

[10] Gene diversity, defined as the likelihood that two variants of a given gene drawn at random from a population are different, and allele richness, defined as the number of different variants present in a population, adjusted for the possible differences in sample size, will be estimated using neutral molecular markers (microsatellites) and standard population genetic computations.

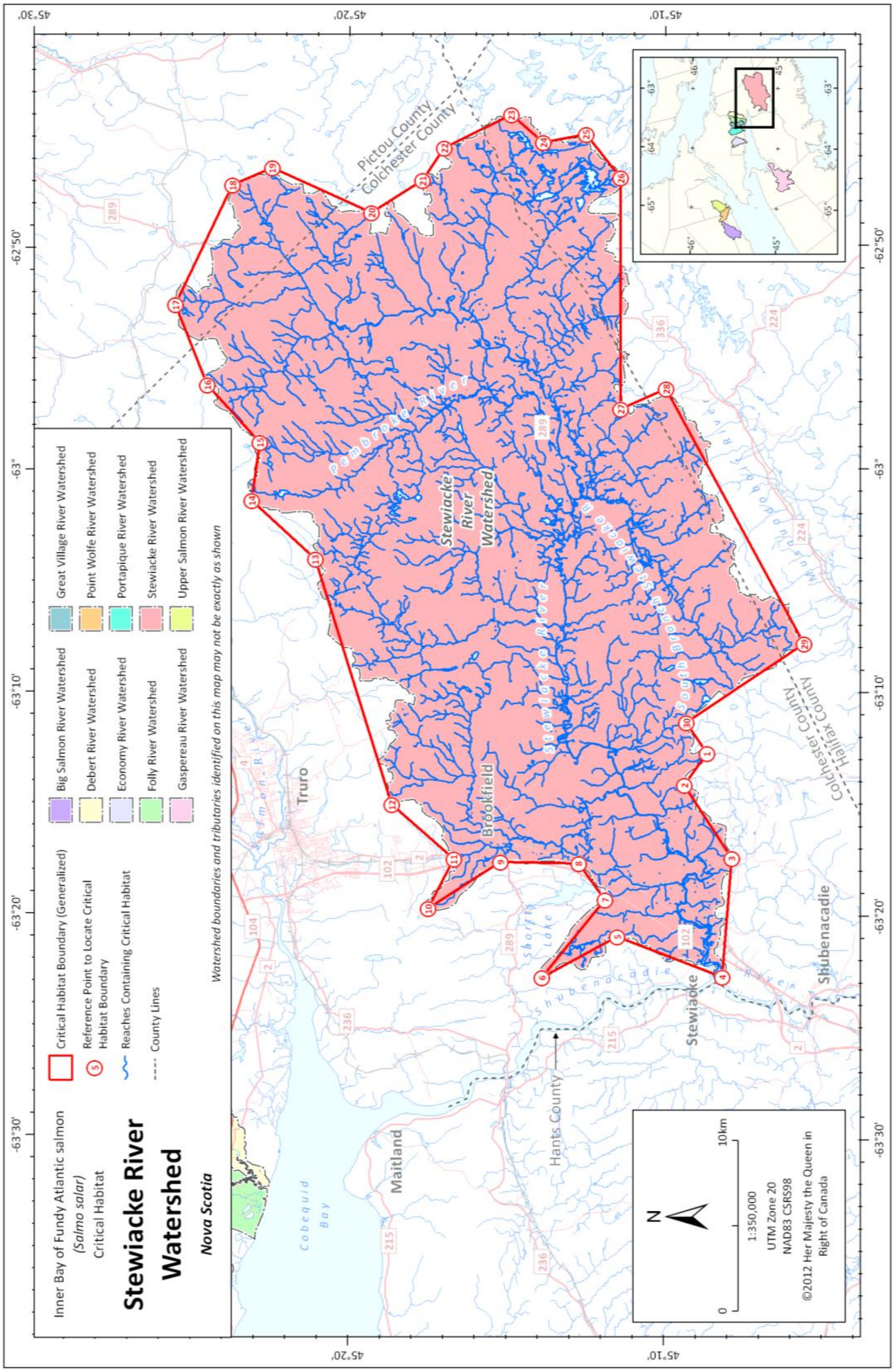
[11] Late stage parr captured from the wild can be substituted for smolts where (1) large gender biases exist and (2) smolt recovery operations cannot be performed.

APPENDIX IVa – Inner Bay of Fundy Watersheds Containing Critical Habitat

Gaspereau



Stewiacke


Inner Bay of Fundy Atlantic salmon
(Salmo salar)
Critical Habitat
Stewiacke River Watershed
Nova Scotia
Critical Habitat Boundary (Generalized)
Reference Point to Locate Critical Habitat Boundary
Reaches Containing Critical Habitat
County Lines
Big Salmon River Watershed
Debert River Watershed
Economy River Watershed
Folly River Watershed
Gaspereau River Watershed
Great Village River Watershed
Point Wolfe River Watershed
Portapique River Watershed
Stewiacke River Watershed
Upper Salmon River Watershed
Watershed boundaries and tributaries identified on this map may not be exactly as shown
Stewiacke River Watershed
Pembroke River
Stewiacke River
Truro
Brookfield
Stewiacke
Shubenacadie
Maitland
Cobequid Bay
Pictou County
Colchester County
Halifax County
Hants County
1:350,000
UTM Zone 20
NAD83 CSRS98
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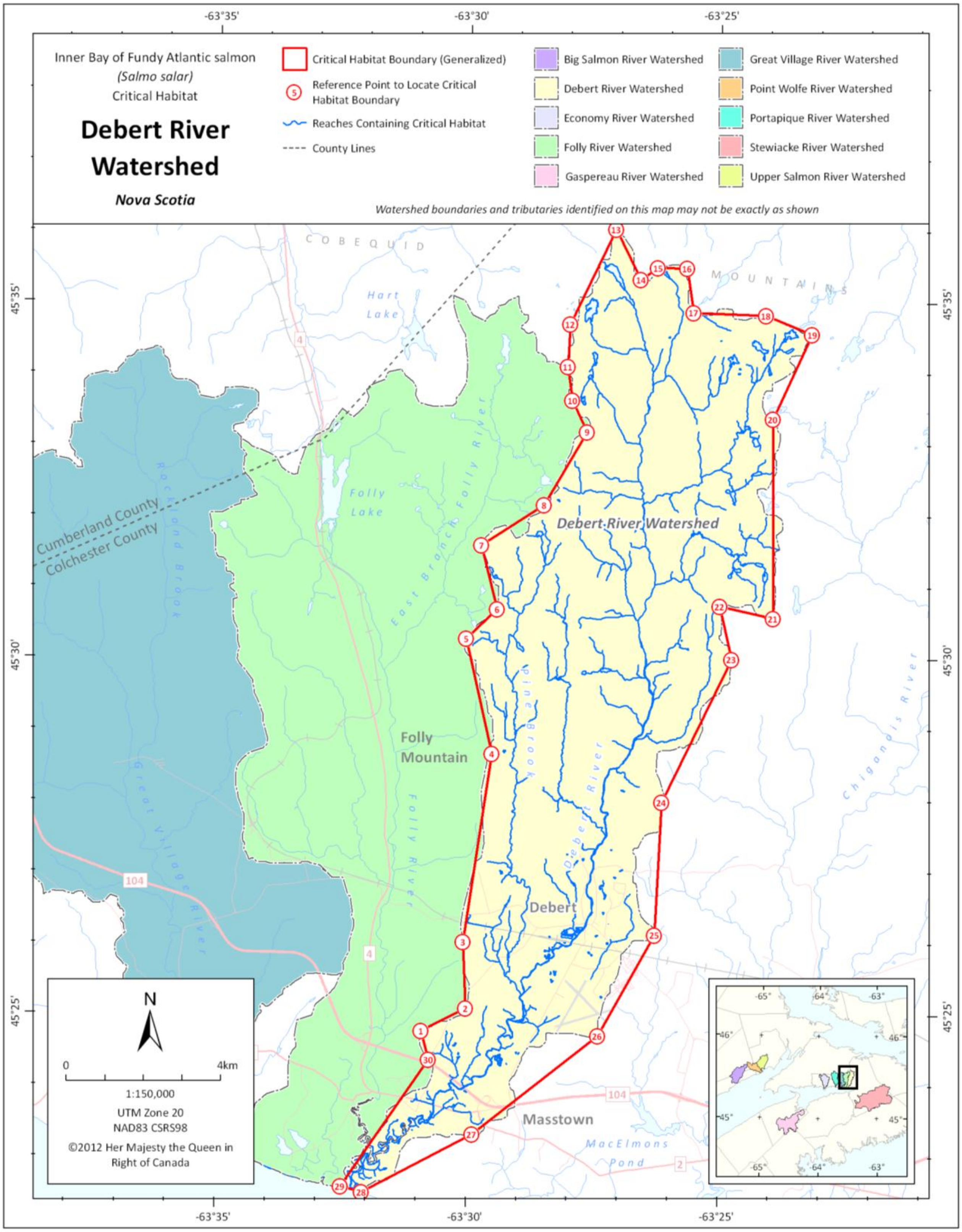
Debert



Inner Bay of Fundy Atlantic salmon
(Salmo salar)
Critical Habitat
Debert River Watershed
Nova Scotia
Critical Habitat Boundary (Generalized)
Reference Point to Locate Critical Habitat Boundary
Reaches Containing Critical Habitat
County Lines
Big Salmon River Watershed
Debert River Watershed
Economy River Watershed
Folly River Watershed
Gaspereau River Watershed
Great Village River Watershed
Point Wolfe River Watershed
Portapique River Watershed
Stewiacke River Watershed
Upper Salmon River Watershed
Watershed boundaries and tributaries identified on this map may not be exactly as shown
Debert River Watershed
Folly Mountain
Debert
Masstown
Cumberland County
Colchester County
Folly Lake
Hart Lake
1:150,000
UTM Zone 20
NAD83 CSRS98
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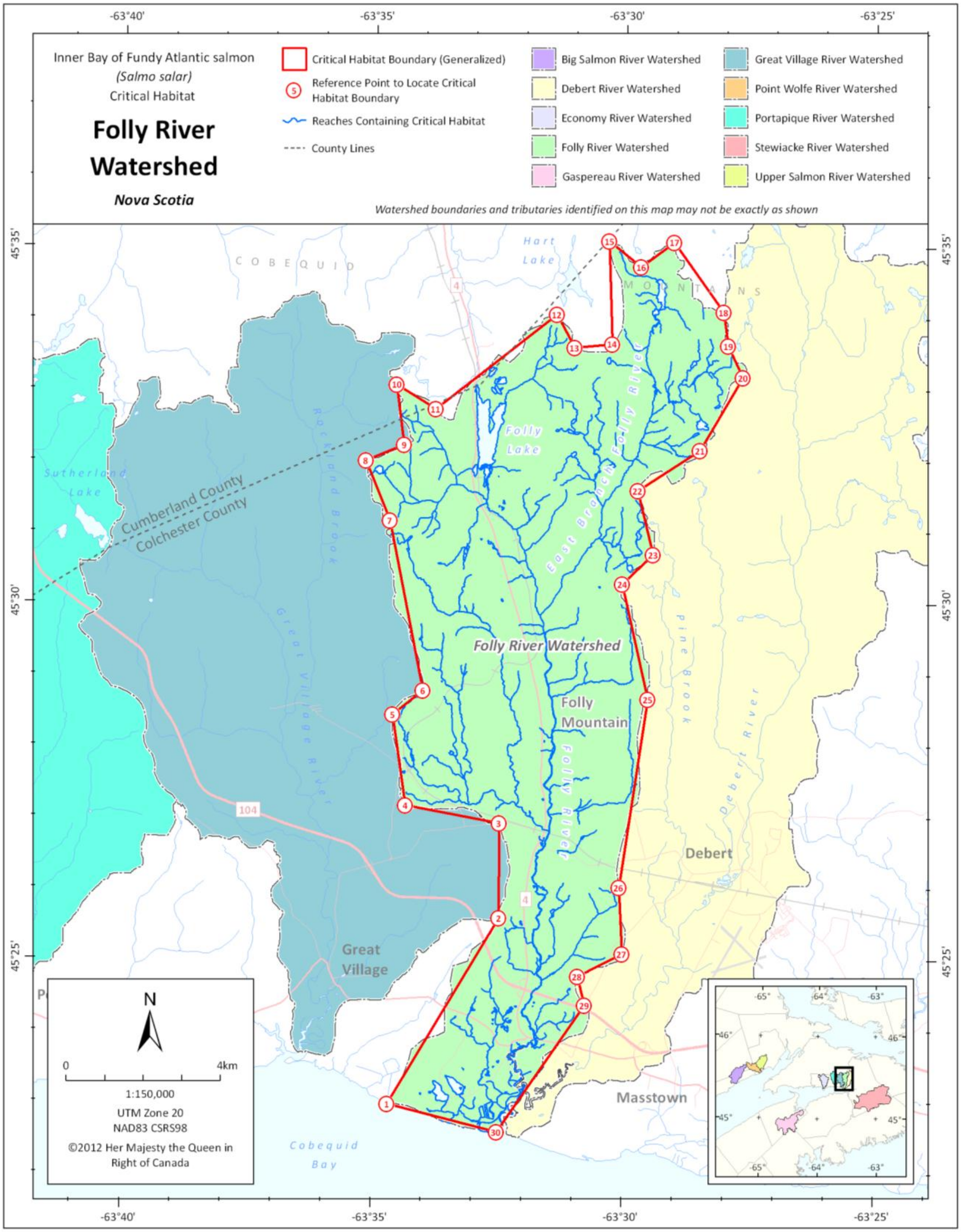
Folly


Inner Bay of Fundy Atlantic salmon
(Salmo salar)
Critical Habitat
Folly River Watershed
Nova Scotia
Critical Habitat Boundary (Generalized)
Reference Point to Locate Critical Habitat Boundary
Reaches Containing Critical Habitat
County Lines
Big Salmon River Watershed
Debert River Watershed
Economy River Watershed
Folly River Watershed
Gaspereau River Watershed
Great Village River Watershed
Point Wolfe River Watershed
Portapique River Watershed
Stewiacke River Watershed
Upper Salmon River Watershed
Watershed boundaries and tributaries identified on this map may not be exactly as shown
Cumberland County
Colchester County
Folly River Watershed
Folly Mountain
Folly Lake
Debert
Great Village
Masstown
Cobequid Bay
1:150,000
UTM Zone 20
NAD83 CSRS98
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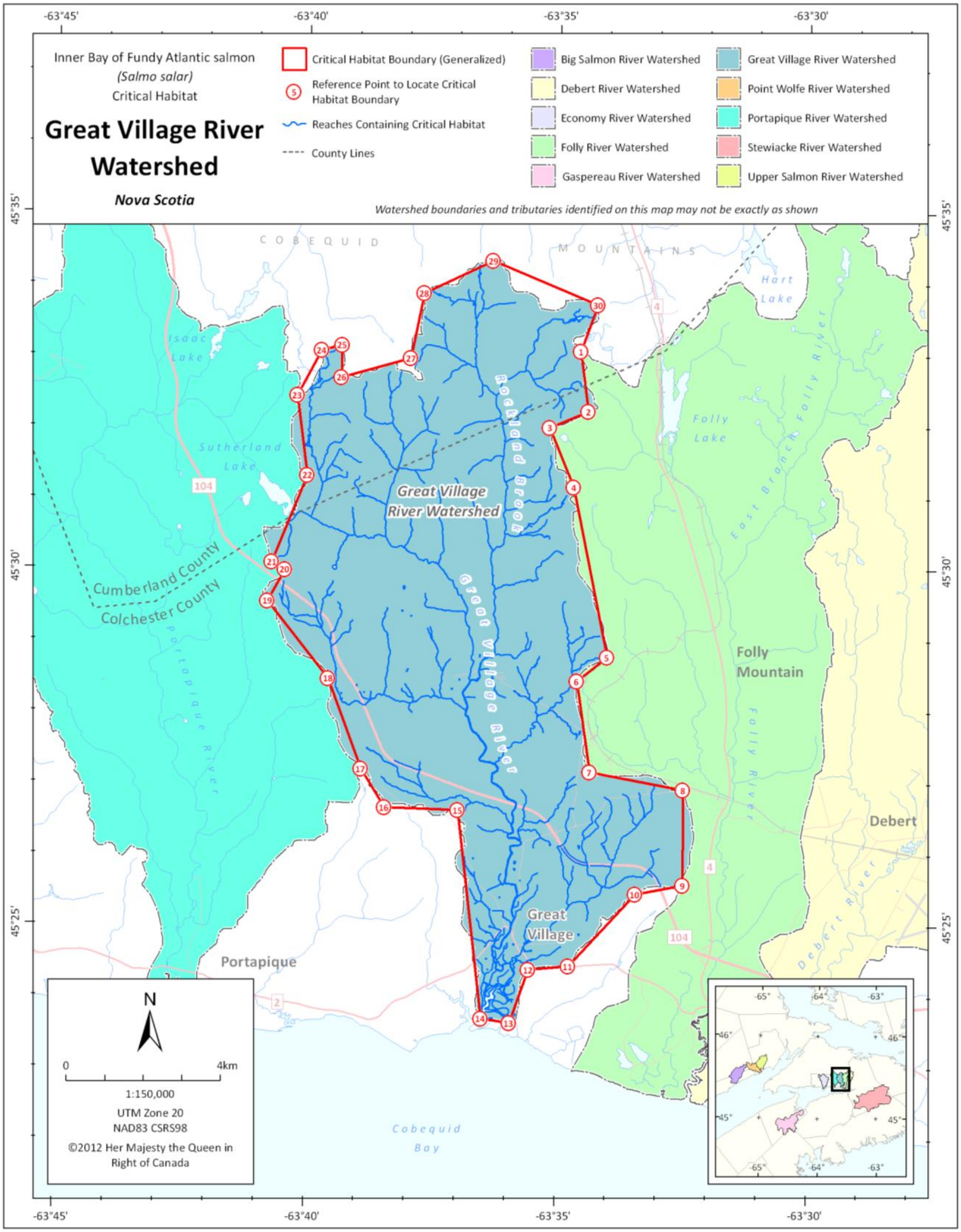
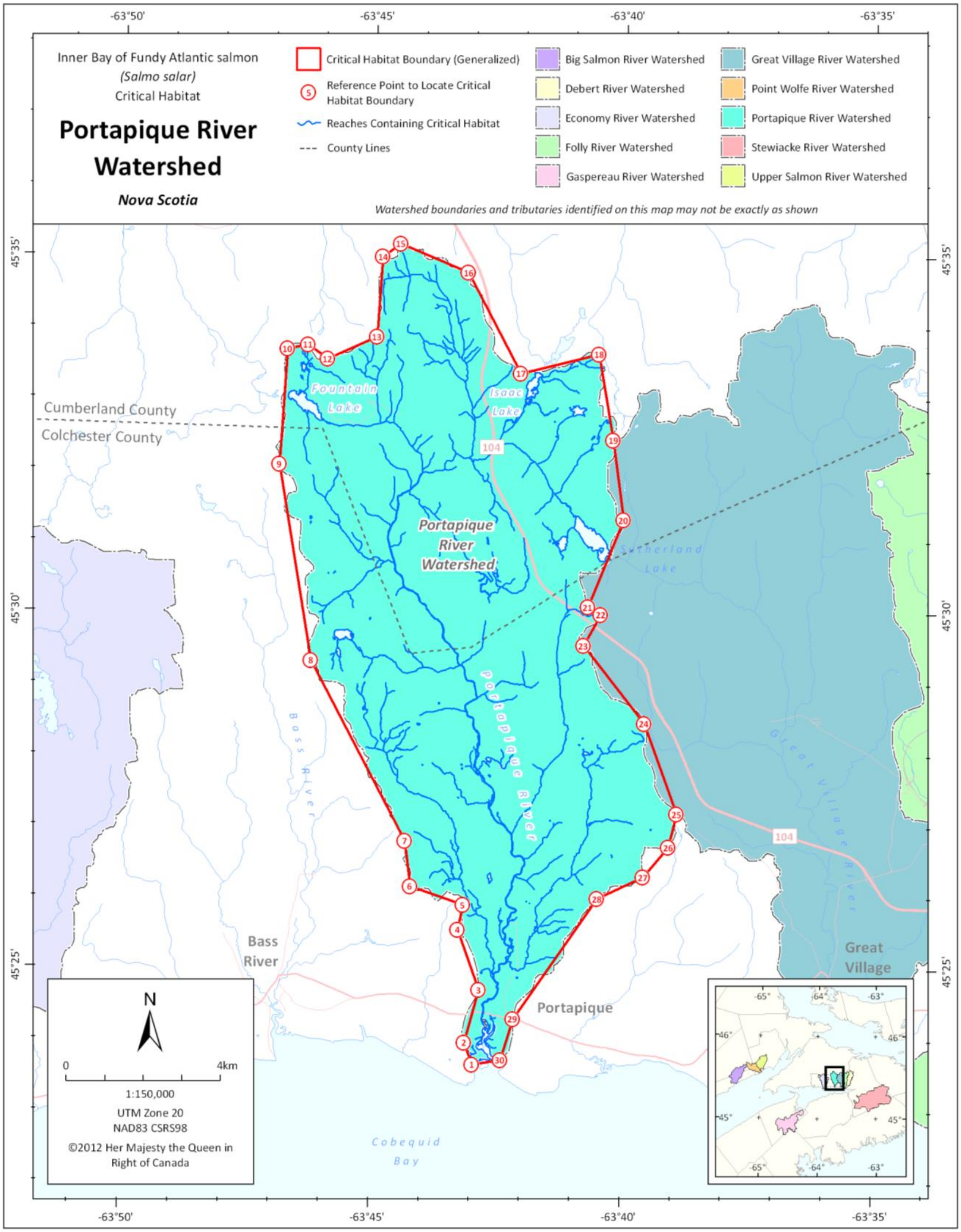
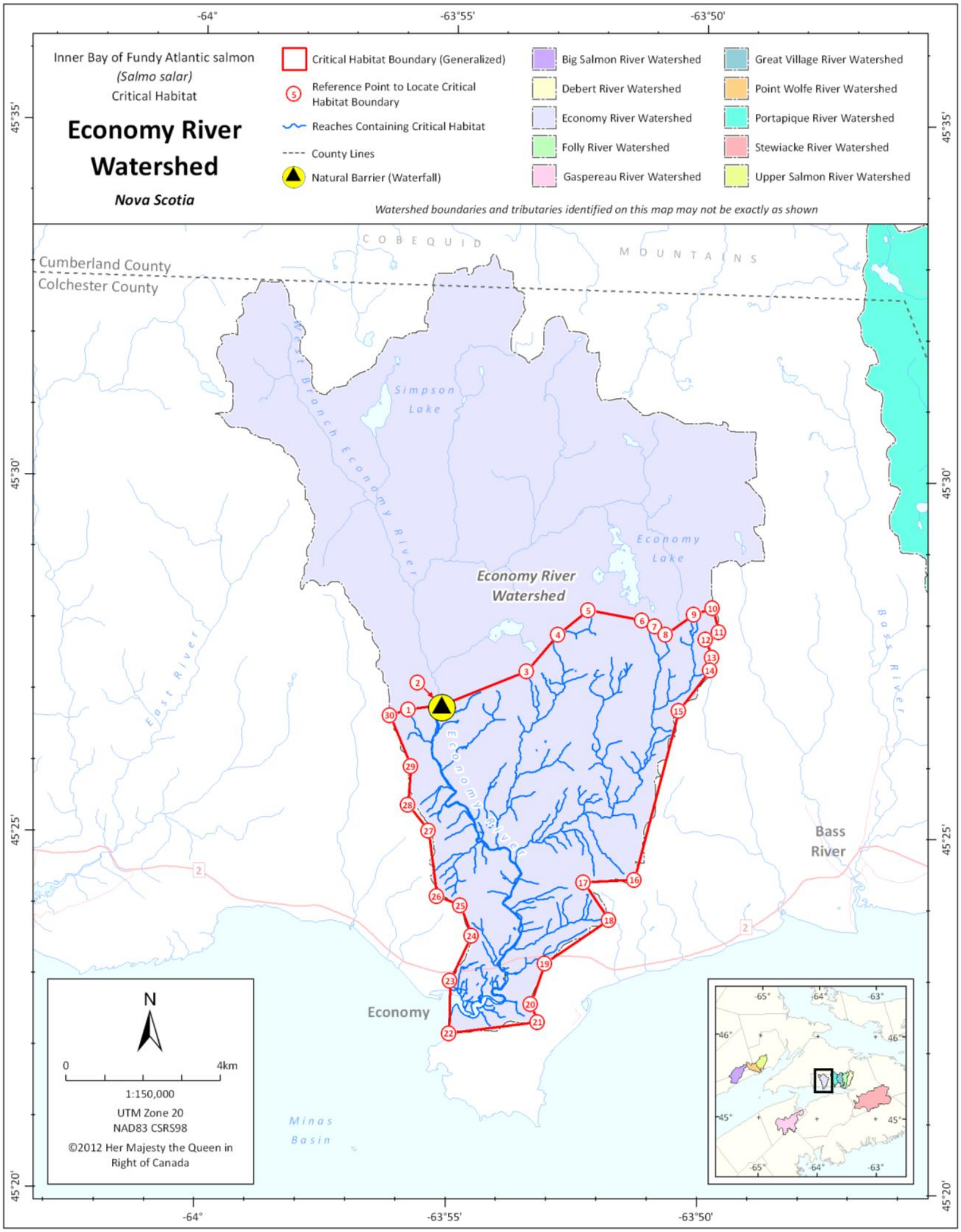
Great Village



Portapique


Inner Bay of Fundy Atlantic salmon
(Salmo salar)
Critical Habitat
Portapique River Watershed
Nova Scotia
Critical Habitat Boundary (Generalized)
Reference Point to Locate Critical Habitat Boundary
Reaches Containing Critical Habitat
County Lines
Big Salmon River Watershed
Debert River Watershed
Economy River Watershed
Folly River Watershed
Gaspereau River Watershed
Great Village River Watershed
Point Wolfe River Watershed
Portapique River Watershed
Stewiacke River Watershed
Upper Salmon River Watershed
Watershed boundaries and tributaries identified on this map may not be exactly as shown
Cumberland County
Colchester County
Fountain Lake
Isaac Lake
Portapique River Watershed
Sutherland Lake
Portapique River
Bass River
Great Village River
Bass River
Great Village
Portapique
Cobequid Bay
104
0
4km
1:150,000
UTM Zone 20
NAD83 CSRS98
©2012 Her Majesty the Queen in Right of Canada
-63°50'
-63°45'
-63°40'
-63°35'
45°35'
45°30'
45°25'

Economy



Inner Bay of Fundy Atlantic salmon
(Salmo salar)
Critical Habitat
Economy River Watershed
Nova Scotia
Critical Habitat Boundary (Generalized)
Reference Point to Locate Critical Habitat Boundary
Reaches Containing Critical Habitat
County Lines
Natural Barrier (Waterfall)
Big Salmon River Watershed
Debert River Watershed
Economy River Watershed
Folly River Watershed
Gaspereau River Watershed
Great Village River Watershed
Point Wolfe River Watershed
Portapique River Watershed
Stewiacke River Watershed
Upper Salmon River Watershed
Watershed boundaries and tributaries identified on this map may not be exactly as shown
Cobequid Mountains
Cumberland County
Colchester County
Simpson Lake
West Branch Economy River
Economy Lake
Economy River Watershed
East River
Economy River
Bass River
Economy
Minas Basin
1:150,000
UTM Zone 20
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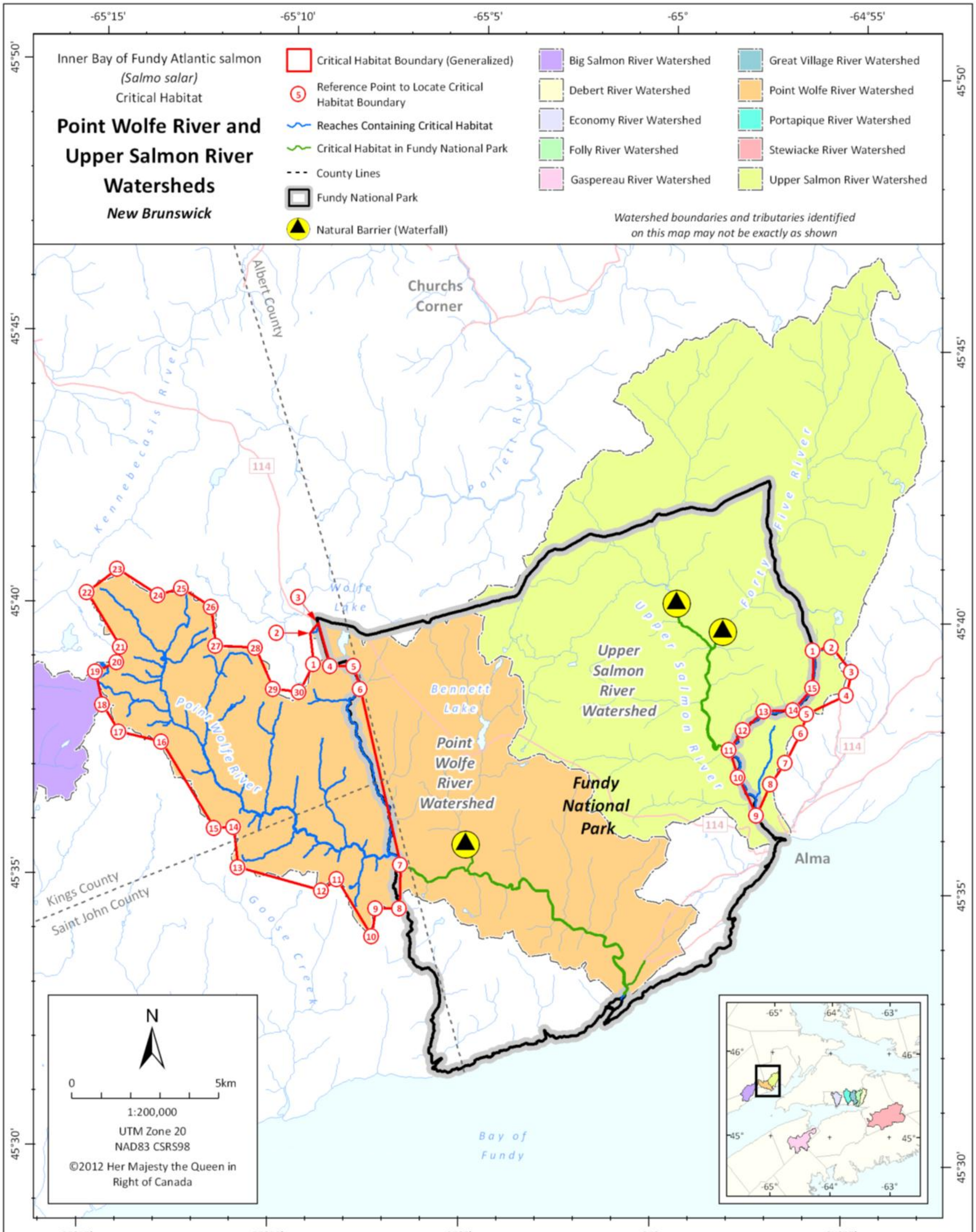
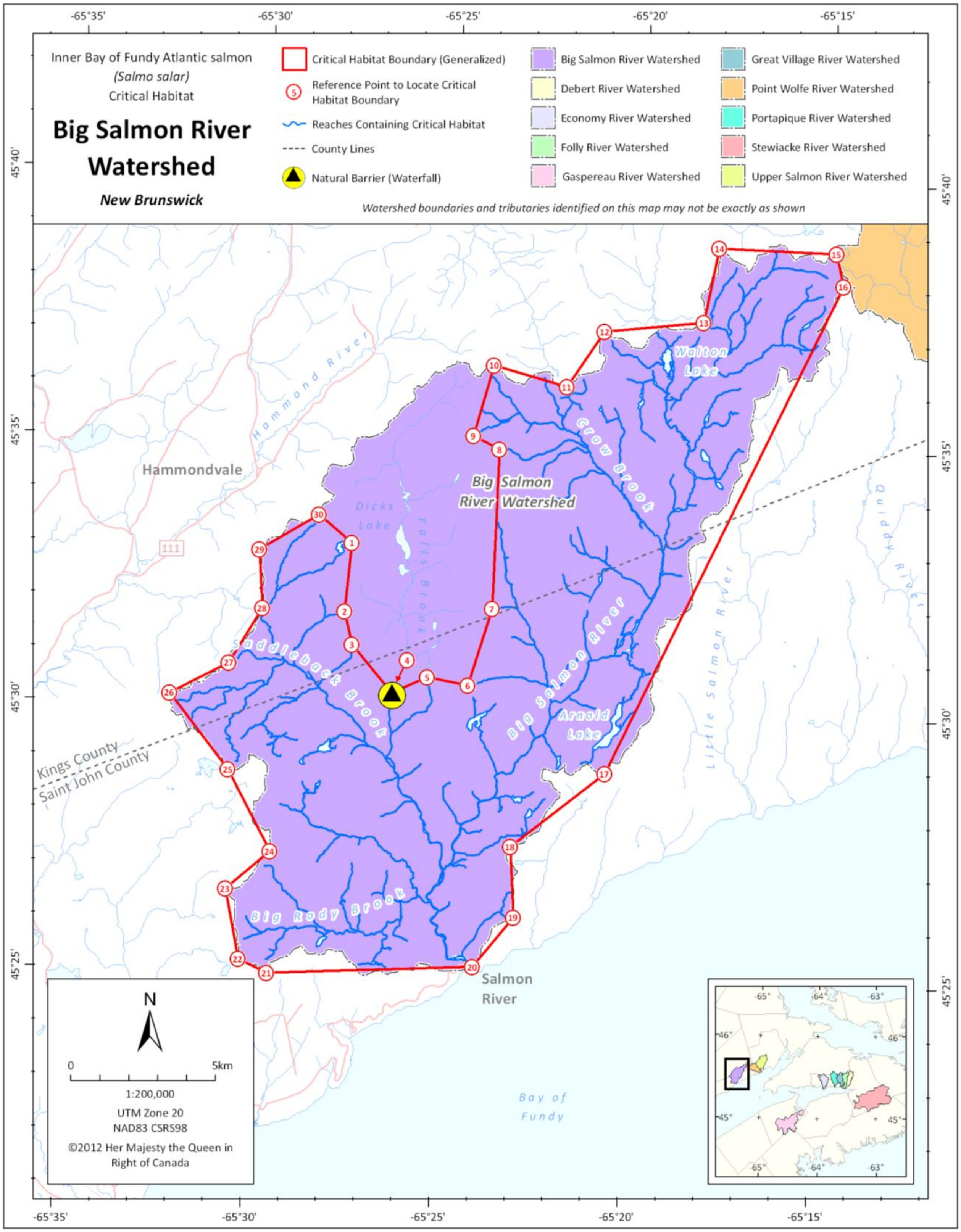
Point Wolfe and Upper Salmon



Big Salmon


Inner Bay of Fundy Atlantic salmon
(Salmo salar)
Critical Habitat
Big Salmon River Watershed
New Brunswick
Critical Habitat Boundary (Generalized)
Reference Point to Locate Critical Habitat Boundary
Reaches Containing Critical Habitat
County Lines
Natural Barrier (Waterfall)
Big Salmon River Watershed
Debert River Watershed
Economy River Watershed
Folly River Watershed
Gaspereau River Watershed
Great Village River Watershed
Point Wolfe River Watershed
Portapique River Watershed
Stewiacke River Watershed
Upper Salmon River Watershed
Watershed boundaries and tributaries identified on this map may not be exactly as shown
Hammondvale
Hammond River
Dicks Lake
Falls Brook
Big Salmon River Watershed
Crow Brook
Walton Lake
Saddleback Brook
Big Salmon River
Arnold Lake
Little Salmon River
Quiddy River
Big Rody Brook
Kings County
Saint John County
Salmon River
Bay of Fundy
1:200,000
UTM Zone 20
NAD83 CSRS98
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APPENDIX IV b - Coordinates of the Areas within which the iBoF Salmon Critical Habitat is found

	Coordinate Position	Latitude	Longitude
Gaspereau River Watershed			
	1	45° 05' 22" N	64° 13' 48" W
	2	45° 03' 04" N	64° 14' 50" W
	3	45° 02' 12" N	64° 17' 40" W
	4	45° 02' 17" N	64° 21' 27" W
	5	45° 02' 08" N	64° 23' 04" W
	6	45° 02' 40" N	64° 24' 34" W
	7	45° 00' 24" N	64° 27' 24" W
	8	44° 59' 23" N	64° 26' 00" W
	9	44° 58' 59" N	64° 24' 44" W
	10	44° 58' 17" N	64° 24' 32" W
	11	44° 58' 44" N	64° 22' 45" W
	12	44° 58' 35" N	64° 20' 57" W
	13	44° 55' 24" N	64° 23' 50" W
	14	44° 53' 20" N	64° 21' 17" W
	15	44° 50' 20" N	64° 23' 27" W
	16	44° 53' 09" N	64° 29' 14" W
	17	44° 52' 19" N	64° 30' 51" W
	18	44° 50' 35" N	64° 30' 06" W
	19	44° 48' 05" N	64° 33' 09" W
	20	44° 48' 30" N	64° 35' 09" W
	21	44° 53' 05" N	64° 36' 13" W
	22	44° 51' 20" N	64° 39' 11" W
	23	44° 51' 47" N	64° 40' 44" W
	24	44° 56' 34" N	64° 43' 04" W
	25	45° 00' 20" N	64° 40' 23" W
	26	44° 58' 47" N	64° 34' 21" W
	27	45° 01' 23" N	64° 33' 04" W
	28	45° 00' 11" N	64° 30' 06" W
	29	45° 03' 03" N	64° 26' 17" W
	30	45° 06' 29" N	64° 16' 28" W
Stewiacke River Watershed			
	1	45° 08' 44" N	63° 12' 46" W
	2	45° 09' 27" N	63° 14' 11" W
	3	45° 07' 56" N	63° 17' 27" W
	4	45° 08' 13" N	63° 22' 47" W

Coordinate Position	Latitude	Longitude
5	45° 11' 33" N	63° 20' 59" W
6	45° 13' 56" N	63° 22' 50" W
7	45° 11' 57" N	63° 19' 20" W
8	45° 12' 47" N	63° 17' 43" W
9	45° 15' 16" N	63° 17' 39" W
10	45° 17' 33" N	63° 19' 45" W
11	45° 16' 44" N	63° 17' 32" W
12	45° 18' 42" N	63° 15' 05" W
13	45° 21' 09" N	63° 04' 04" W
14	45° 23' 09" N	63° 01' 25" W
15	45° 22' 54" N	62° 58' 49" W
16	45° 24' 34" N	62° 56' 13" W
17	45° 25' 34" N	62° 52' 37" W
18	45° 23' 45" N	62° 47' 14" W
19	45° 22' 30" N	62° 46' 29" W
20	45° 19' 21" N	62° 48' 29" W
21	45° 17' 44" N	62° 47' 03" W
22	45° 17' 02" N	62° 45' 36" W
23	45° 14' 55" N	62° 44' 08" W
24	45° 13' 54" N	62° 45' 22" W
25	45° 12' 33" N	62° 45' 00" W
26	45° 11' 28" N	62° 46' 58" W
27	45° 11' 28" N	62° 57' 19" W
28	45° 10' 02" N	62° 56' 25" W
29	45° 05' 40" N	63° 07' 51" W
30	45° 09' 23" N	63° 11' 23" W

Debert River Watershed

1	45° 24' 46" N	63° 30' 54" W
2	45° 25' 05" N	63° 30' 01" W
3	45° 26' 01" N	63° 30' 04" W
4	45° 28' 40" N	63° 29' 31" W
5	45° 30' 17" N	63° 30' 02" W
6	45° 30' 42" N	63° 29' 26" W
7	45° 31' 35" N	63° 29' 45" W
8	45° 32' 09" N	63° 28' 30" W
9	45° 33' 11" N	63° 27' 39" W
10	45° 33' 38" N	63° 27' 57" W
11	45° 34' 06" N	63° 28' 03" W
12	45° 34' 42" N	63° 28' 00" W
13	45° 36' 02" N	63° 27' 05" W

Coordinate Position	Latitude	Longitude
14	45° 35' 20" N	63° 26' 36" W
15	45° 35' 30" N	63° 26' 15" W
16	45° 35' 29" N	63° 25' 40" W
17	45° 34' 52" N	63° 25' 33" W
18	45° 34' 50" N	63° 24' 06" W
19	45° 34' 34" N	63° 23' 10" W
20	45° 33' 22" N	63° 23' 57" W
21	45° 30' 35" N	63° 23' 56" W
22	45° 30' 45" N	63° 24' 59" W
23	45° 30' 00" N	63° 24' 45" W
24	45° 27' 59" N	63° 26' 08" W
25	45° 26' 08" N	63° 26' 16" W
26	45° 24' 42" N	63° 27' 23" W
27	45° 23' 19" N	63° 29' 52" W
28	45° 22' 30" N	63° 32' 04" W
29	45° 22' 35" N	63° 32' 29" W
30	45° 24' 22" N	63° 30' 45" W

Folly River Watershed

1	45° 22' 58" N	63° 34' 40" W
2	45° 25' 35" N	63° 32' 28" W
3	45° 26' 55" N	63° 32' 28" W
4	45° 27' 10" N	63° 34' 20" W
5	45° 28' 26" N	63° 34' 36" W
6	45° 28' 46" N	63° 34' 00" W
7	45° 31' 09" N	63° 34' 41" W
8	45° 32' 00" N	63° 35' 10" W
9	45° 32' 13" N	63° 34' 24" W
10	45° 33' 04" N	63° 34' 34" W
11	45° 32' 43" N	63° 33' 47" W
12	45° 34' 03" N	63° 31' 22" W
13	45° 33' 36" N	63° 31' 01" W
14	45° 33' 39" N	63° 30' 16" W
15	45° 35' 05" N	63° 30' 20" W
16	45° 34' 44" N	63° 29' 42" W
17	45° 35' 05" N	63° 29' 02" W
18	45° 34' 06" N	63° 28' 03" W
19	45° 33' 38" N	63° 27' 57" W
20	45° 33' 11" N	63° 27' 39" W
21	45° 32' 09" N	63° 28' 30" W
22	45° 31' 35" N	63° 29' 45" W

	Coordinate Position	Latitude	Longitude
	23	45° 30' 42" N	63° 29' 26" W
	24	45° 30' 17" N	63° 30' 02" W
	25	45° 28' 40" N	63° 29' 31" W
	26	45° 26' 01" N	63° 30' 04" W
	27	45° 25' 05" N	63° 30' 01" W
	28	45° 24' 46" N	63° 30' 54" W
	29	45° 24' 22" N	63° 30' 45" W
	30	45° 22' 35" N	63° 32' 29" W
Great Village River Watershed			
	1	45° 33' 04" N	63° 34' 34" W
	2	45° 32' 13" N	63° 34' 24" W
	3	45° 32' 00" N	63° 35' 10" W
	4	45° 31' 09" N	63° 34' 41" W
	5	45° 28' 46" N	63° 34' 00" W
	6	45° 28' 26" N	63° 34' 36" W
	7	45° 27' 10" N	63° 34' 20" W
	8	45° 26' 55" N	63° 32' 28" W
	9	45° 25' 35" N	63° 32' 28" W
	10	45° 25' 27" N	63° 33' 25" W
	11	45° 24' 26" N	63° 34' 44" W
	12	45° 24' 23" N	63° 35' 32" W
	13	45° 23' 38" N	63° 35' 54" W
	14	45° 23' 42" N	63° 36' 28" W
	15	45° 26' 37" N	63° 36' 58" W
	16	45° 26' 39" N	63° 38' 26" W
	17	45° 27' 11" N	63° 38' 54" W
	18	45° 28' 28" N	63° 39' 34" W
	19	45° 29' 33" N	63° 40' 47" W
	20	45° 29' 59" N	63° 40' 27" W
	21	45° 30' 05" N	63° 40' 42" W
	22	45° 31' 19" N	63° 40' 00" W
	23	45° 32' 26" N	63° 40' 13" W
	24	45° 33' 04" N	63° 39' 44" W
	25	45° 33' 08" N	63° 39' 20" W
	26	45° 32' 41" N	63° 39' 20" W
	27	45° 32' 57" N	63° 37' 57" W
	28	45° 33' 52" N	63° 37' 42" W
	29	45° 34' 20" N	63° 36' 19" W
	30	45° 33' 43" N	63° 34' 13" W

Coordinate Position	Latitude	Longitude
Portapique River Watershed		
1	45° 23' 39" N	63° 42' 57" W
2	45° 23' 58" N	63° 43' 06" W
3	45° 24' 42" N	63° 42' 49" W
4	45° 25' 33" N	63° 43' 15" W
5	45° 25' 54" N	63° 43' 09" W
6	45° 26' 09" N	63° 44' 12" W
7	45° 26' 47" N	63° 44' 19" W
8	45° 29' 19" N	63° 46' 13" W
9	45° 32' 04" N	63° 46' 53" W
10	45° 33' 41" N	63° 46' 44" W
11	45° 33' 45" N	63° 46' 20" W
12	45° 33' 33" N	63° 45' 56" W
13	45° 33' 52" N	63° 44' 57" W
14	45° 34' 59" N	63° 44' 51" W
15	45° 35' 10" N	63° 44' 30" W
16	45° 34' 46" N	63° 43' 08" W
17	45° 33' 22" N	63° 42' 05" W
18	45° 33' 38" N	63° 40' 31" W
19	45° 32' 26" N	63° 40' 13" W
20	45° 31' 19" N	63° 40' 00" W
21	45° 30' 05" N	63° 40' 42" W
22	45° 29' 59" N	63° 40' 27" W
23	45° 29' 33" N	63° 40' 47" W
24	45° 28' 28" N	63° 39' 34" W
25	45° 27' 11" N	63° 38' 54" W
26	45° 26' 43" N	63° 39' 04" W
27	45° 26' 18" N	63° 39' 34" W
28	45° 26' 00" N	63° 40' 28" W
29	45° 24' 18" N	63° 42' 08" W
30	45° 23' 43" N	63° 42' 23" W
Economy River Watershed		
1	45° 26' 46" N	63° 55' 50" W
2	45° 26' 50" N	63° 55' 09" W
3	45° 27' 19" N	63° 53' 29" W
4	45° 27' 50" N	63° 52' 52" W
5	45° 28' 11" N	63° 52' 16" W
6	45° 28' 02" N	63° 51' 11" W
7	45° 27' 58" N	63° 50' 56" W

Coordinate Position	Latitude	Longitude
8	45° 27' 51" N	63° 50' 43" W
9	45° 28' 08" N	63° 50' 10" W
10	45° 28' 13" N	63° 49' 47" W
11	45° 27' 53" N	63° 49' 39" W
12	45° 27' 47" N	63° 49' 55" W
13	45° 27' 32" N	63° 49' 47" W
14	45° 27' 21" N	63° 49' 50" W
15	45° 26' 47" N	63° 50' 26" W
16	45° 24' 24" N	63° 51' 17" W
17	45° 24' 21" N	63° 52' 18" W
18	45° 23' 50" N	63° 51' 47" W
19	45° 23' 13" N	63° 53' 03" W
20	45° 22' 38" N	63° 53' 20" W
21	45° 22' 24" N	63° 53' 11" W
22	45° 22' 13" N	63° 54' 57" W
23	45° 22' 58" N	63° 54' 56" W
24	45° 23' 36" N	63° 54' 31" W
25	45° 24' 01" N	63° 54' 45" W
26	45° 24' 09" N	63° 55' 13" W
27	45° 25' 04" N	63° 55' 24" W
28	45° 25' 25" N	63° 55' 49" W
29	45° 25' 58" N	63° 55' 46" W
30	45° 26' 41" N	63° 56' 12" W

Point Wolfe River Watershed

1	45° 38' 59" N	65° 09' 08" W
2	45° 39' 32" N	65° 09' 16" W
3	45° 39' 44" N	65° 09' 04" W
4	45° 38' 57" N	65° 08' 42" W
5	45° 38' 57" N	65° 08' 05" W
6	45° 38' 14" N	65° 08' 13" W
7	45° 35' 20" N	65° 06' 44" W
8	45° 34' 31" N	65° 06' 43" W
9	45° 34' 31" N	65° 07' 21" W
10	45° 34' 00" N	65° 07' 26" W
11	45° 35' 02" N	65° 08' 23" W
12	45° 34' 49" N	65° 08' 47" W
13	45° 35' 12" N	65° 10' 59" W
14	45° 35' 56" N	65° 11' 07" W
15	45° 35' 55" N	65° 11' 38" W
16	45° 37' 29" N	65° 13' 05" W

	Coordinate Position	Latitude	Longitude
	17	45° 37' 38" N	65° 14' 12" W
	18	45° 38' 08" N	65° 14' 39" W
	19	45° 38' 44" N	65° 14' 52" W
	20	45° 38' 55" N	65° 14' 18" W
	21	45° 39' 12" N	65° 14' 13" W
	22	45° 40' 11" N	65° 15' 08" W
	23	45° 40' 38" N	65° 14' 22" W
	24	45° 40' 10" N	65° 13' 16" W
	25	45° 40' 18" N	65° 12' 40" W
	26	45° 39' 59" N	65° 11' 52" W
	27	45° 39' 16" N	65° 11' 43" W
	28	45° 39' 15" N	65° 10' 41" W
	29	45° 38' 30" N	65° 10' 11" W
	30	45° 38' 27" N	65° 09' 30" W
Upper Salmon River Watershed			
	1	45° 39' 27" N	64° 56' 03" W
	2	45° 39' 32" N	64° 55' 34" W
	3	45° 39' 05" N	64° 55' 01" W
	4	45° 38' 39" N	64° 55' 08" W
	5	45° 38' 17" N	64° 56' 10" W
	6	45° 37' 56" N	64° 56' 19" W
	7	45° 37' 23" N	64° 56' 42" W
	8	45° 36' 59" N	64° 57' 05" W
	9	45° 36' 24" N	64° 57' 26" W
	10	45° 37' 05" N	64° 57' 56" W
	11	45° 37' 35" N	64° 58' 11" W
	12	45° 37' 58" N	64° 57' 50" W
	13	45° 38' 19" N	64° 57' 18" W
	14	45° 38' 21" N	64° 56' 31" W
	15	45° 38' 46" N	64° 56' 02" W
Big Salmon River Watershed			
	1	45° 33' 05" N	65° 27' 33" W
	2	45° 31' 48" N	65° 27' 41" W
	3	45° 31' 10" N	65° 27' 28" W
	4	45° 30' 18" N	65° 26' 22" W
	5	45° 30' 37" N	65° 25' 26" W
	6	45° 30' 28" N	65° 24' 21" W

Coordinate Position	Latitude	Longitude
7	45° 31' 55" N	65° 23' 46" W
8	45° 34' 54" N	65° 23' 41" W
9	45° 35' 09" N	65° 24' 24" W
10	45° 36' 29" N	65° 23' 54" W
11	45° 36' 07" N	65° 21' 57" W
12	45° 37' 10" N	65° 20' 59" W
13	45° 37' 23" N	65° 18' 21" W
14	45° 38' 47" N	65° 17' 59" W
15	45° 38' 44" N	65° 14' 51" W
16	45° 38' 08" N	65° 14' 39" W
17	45° 28' 54" N	65° 20' 39" W
18	45° 27' 29" N	65° 23' 06" W
19	45° 26' 10" N	65° 22' 58" W
20	45° 25' 13" N	65° 24' 00" W
21	45° 24' 59" N	65° 29' 28" W
22	45° 25' 14" N	65° 30' 14" W
23	45° 26' 33" N	65° 30' 38" W
24	45° 27' 16" N	65° 29' 29" W
25	45° 28' 46" N	65° 30' 39" W
26	45° 30' 11" N	65° 32' 17" W
27	45° 30' 46" N	65° 30' 43" W
28	45° 31' 48" N	65° 29' 53" W
29	45° 32' 54" N	65° 30' 00" W
30	45° 33' 36" N	65° 28' 27" W

APPENDIX V – RECORD OF CONSULTATIONS

The Atlantic salmon, inner Bay of Fundy (iBoF) populations is an anadromous fish under the federal jurisdiction of DFO. Parks Canada Agency has jurisdiction for the species within Fundy National Park and co-led the development of this recovery strategy. The entire iBoF area exists within Eastern Canada and includes all rivers draining into the Bay of Fundy from the Mispec River in New Brunswick to the Pereaux River in Nova Scotia. Because the range of the species encompasses two provinces and a federal park, and the breath of knowledge and expertise in relation to the species, broad engagement and consultations were sought in the development of the recovery strategy.

The iBoF Atlantic Salmon Conservation and Recovery Team played a key role in providing input into the recovery strategy. DFO Maritimes Region chaired this team of experts and representatives from multiple levels of government and well as stakeholder groups and Aboriginal peoples from the inner Bay of Fundy area. Specific members of the Recovery Team and their affiliations can be found on page vi of this recovery strategy. Input on this strategy was sought from all members of the Recovery Team.

In addition, the scientific elements of the strategy, namely sections 2.1 (recovery feasibility), 2.2 (recovery goal), 2.5 (critical habitat) and 2.9 (activities permitted by the recovery strategy) were informed through a full peer review organized by the Canadian Science Advisory Secretariat.

The strategy was also reviewed by DFO representatives in National Capital Regions and relevant provincial government representatives from Nova Scotia and New Brunswick. All comments received during this level of review were considered.

Aboriginal peoples were significantly engaged in the activities of the Recovery Team and formed an Aboriginal subcommittee to input into the recovery strategy. The final draft document was also circulated to relevant First Nations and Aboriginal communities to provide an opportunity for any additional input into this strategy. All comments received during this review were considered for incorporation into the document.

All comments received on the proposed recovery strategy during the 60-day public registry comment period (December 4, 2009 to February 2, 2010) were considered and addressed as appropriate in the final version of the document.