Conservation Status Report, Atlantic Salmon in Atlantic Canada and Québec: Part II– Anthropogenic Considerations

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Québec Ministère des Ressources naturelles et de la Faune

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Abstract

This document is a continuation of the assessment of the conservation status of Atlantic salmon (*Salmo salar* L.) which began with 'Species Information' in 'Conservation Status Report, Atlantic Salmon in Atlantic Canada and Québec: Part I – Species Information' (DFO and MRNF 2008). It addresses the anthropogenic considerations relevant to the conservation of Atlantic salmon, i.e., threats, existing protection, potential conservation targets, and significance of Atlantic salmon in Canada, and was assembled from text drafted by DFO and Québec Provincial Atlantic salmon fisheries and habitat managers, economists and personnel in Aboriginal fisheries. Most elements of the document were reviewed in the presence of contributors, and 'external' scientists during a workshop held in March of 2007 (DFO 2007a).

Highlights include:

- a general discussion of 16 categories of threats potentially limiting to Atlantic salmon in Eastern Canada and a first attempt at a semi-quantitative evaluation of the degree of harm by each threat in terms of salmon affected and spawners lost within each of 28 Conservation Units;
- evidence that the most wide-ranging habitat threats to Atlantic salmon originate from transportation infrastructure, agriculture, forestry and mining operations, and Municipal waste water discharge, and that the Maritime Provinces are the most severely impacted;
- summary recovery efforts in place for the unlisted (*Species at Risk Act*, SARA) but severely depleted populations of Atlantic salmon in the outer Bay of Fundy (NS) and Southern Upland (NS) as well as the SARA-listed inner Bay of Fundy populations;
- summary proposals for species rebuilding and habitat restoration as embodied in: a draft policy for the conservation of wild Atlantic salmon, an Atlantic salmon Endowment Fund, an Implementation Plan addressing Resolutions and Agreements of the North Atlantic Salmon Conservation Organization (NASCO), and governance and regulatory reform for aquaculture management; and
- evidence that more than 40,000 Aboriginal Peoples in more than 50 communities through Atlantic Canada and Québec can be said to be dependent on the traditional values of the Atlantic salmon resource.

Résumé

Le présent document est la suite de l'évaluation de l'état de la conservation du saumon atlantique (*Salmo salar* L.) présentée dans la rubrique « Renseignements sur l'espèce » du « Rapport sur l'état de la conservation du saumon atlantique au Canada atlantique et au Québec : Partie I - Renseignements sur l'espèce » (MPO et MNRF 2008). Il traite des facteurs anthropiques qui entrent en ligne de compte dans la conservation du saumon atlantique, à savoir les menaces pesant sur l'espèce, les mesures de protection mises en place et les objectifs de conservation possibles, ainsi que de l'importance du saumon atlantique au Canada. Il est issu d'une ébauche établie par des gestionnaires des pêches et de l'habitat du saumon atlantique, des économistes et des membres du personnel responsable de la gestion des pêches autochtones au MPO et au gouvernement du Québec. La plupart de ses éléments ont été soumis à un examen en présence de leurs auteurs et de scientifiques externes au cours d'un atelier tenu en mars 2007 (MPO 2007a).

Faits saillants du document

- analyse générale des 16 catégories de menaces pouvant constituer une limite pour le saumon atlantique de l'est du Canada et première tentative d'évaluation semi-quantitative du degré de dommage pouvant être dû à chaque menace, en l'occurrence du nombre de saumons touchés et de reproducteurs perdus dans chacune des 28 unités de conservation;
- information montrant que les menaces les plus étendues qui pèsent sur l'habitat du saumon atlantique viennent de l'infrastructure du transport, de l'agriculture, de la foresterie, de l'industrie minière et du rejet d'eaux usées municipales, et que ce sont les provinces Maritimes qui en pâtissent le plus;
- résumé des initiatives de rétablissement concernant le saumon atlantique des populations de l'avant-baie de Fundy (N.-É.) et du bas-plateau sud (N.-É.), qui ne sont pas inscrites sur la liste de la *Loi sur les espèces en péril* (LEP) mais qui sont gravement décimées, et des populations de l'arrière-baie de Fundy qui, elles, figurent sur la liste de la LEP;
- résumé des propositions de rétablissement de l'espèce et de restauration de son habitat s'inscrivant dans le cadre de l'ébauche de politique pour la conservation du saumon atlantique sauvage, du Fonds de dotation pour le saumon atlantique, du plan de mise en œuvre des résolutions et accords de l'Organisation pour la conservation du saumon de l'Atlantique Nord ainsi que des initiatives de gouvernance et de réforme réglementaire en matière de gestion de l'aquaculture;
- information montrant que plus de 40 000 Autochtones dans plus de 50 communautés du Canada atlantique et du Québec peuvent être considérés comme dépendant des valeurs traditionnelles associées au saumon atlantique.

1.0 Introduction

With the full impact of the *Species at Risk Act* (SARA) now being felt by the responsible Federal agencies, the DFO Species at Risk Secretariat developed in 2004 a prioritized list of aquatic species for which there were indications of declining abundance and which had, to that point, not been addressed through the full purview of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). For a few of these species the Secretariat funded the development of a 'Conservation Status Report' (see terms of Reference, Appendix1). Following nearly two decades of decline in abundance, Atlantic salmon (*Salmo salar* L.) were identified as a conservation concern requiring a Conservation Status Report (CSR).

This document is a continuation of the assessment of the conservation status of Atlantic salmon which began with 'Species Information' in 'Conservation Status Report, Atlantic salmon in Atlantic Canada and Québec: Part I – Species Information' (DFO and MRNF 2008). It addresses the anthropogenic considerations relevant to the conservation of Atlantic salmon, i.e., threats, existing protection, potential conservation targets, and significance of Atlantic salmon in Canada (Sections 2-5 in Appendix 1) and was assembled from text drafted by DFO and Québec Provincial Atlantic salmon fisheries and habitat managers, economists and personnel in Aboriginal fisheries. Most elements of the document were reviewed in the presence of contributors, and 'external' scientists during a workshop held in March of 2007 (DFO 2007a) [2].

'Threats to the species' are addressed summarily within the text; threats relevant to each of the identified Conservation Units (CUs) (DFO and MRNF 2008) are where possible, addressed in Appendix 2. Social/cultural, Aboriginal, and economic significances of the species are intended to provide background for any economic assessment of the impacts as a consequence of any prescribed reductions in harm. Peer reviewed information on the economic significance was not available at the time of publication but is to appear in a separate document published by DFO Policy and Economics Branch.

2.0 Threats to the Species

In the context of their identification and management for species at risk, a 'threat' is, "An activity or process (both natural and anthropogenic) that has caused, is causing, or may cause harm, death, or behavioral changes to a species at risk or the destruction, degradation, and/or impairment of its habitat to the extent that population-level effects occur" (Environment Canada 2006). In essence, it is an activity that imposes a 'stress' on a species-at-risk population which contributes to or perpetuates its decline, or limits its recovery. The elevated marine mortality and subsequent declining returns experienced by Atlantic salmon in recent years are, then, stresses caused by unknown (but hypothesized) threats.

2.1 Limiting Factors, Threats (Domestic and International), and Management Measures

[2] Because of the magnitude of this undertaking and the limitation of resources, these components of the CSR were, like those of Part I (DFO and MRNF 2008), based on information internal to the responsible jurisdictions for Atlantic salmon in Eastern Canada. While most elements were reviewed in workshop by non-partisan experts, affected jurisdictions, stakeholders (industry and non-government organizations) and Aboriginal Peoples were not consulted, thereby precluding publication of this document as a DFO 'Science Advisory Report'.

The decline in abundance of Atlantic salmon common to all areas of Eastern North America stimulated two intensive reviews by DFO, one following the exceptional low return of salmon in 1997 (DFO 1998) and a second workshop in June 2000 (O'Neil *et al* 2000, and Cairns 2001). In the report edited by Cairns (2001) background to the Dalhousie workshop (O'Neil *et al* 2000), regional biologists identified and evaluated 62 possible threats and research initiatives, which could lead to a better understanding of the more significant threats and possible interventions to arrest the decline in or stress on Atlantic salmon. The plausibility of each threat was evaluated for salmon originating in 18 areas of Eastern Canada and the Northeastern United States (U.S.). The 10 leading hypotheses for the decline included:

- Freshwater life: one hypothesis related to the reduction of juvenile survival due to inter- and intra-specific competition;
- Estuarine life: four hypotheses specifically related to: fish predation on smolts, bird and seal predation on smolts, density-dependent effects in fresh water influencing subsequent survival at sea, and seal predation on returning adults; and,
- Marine life: five hypotheses specifically related to: higher than presumed natural mortality after the Greenland fishery, predation by birds and marine mammals, altered oceanographic conditions leading to changes in migration routes, marine survival decreasing because cooler waters have altered the temperature-mediated balance between predators and prey, and again, density-dependent effects in fresh water have influenced subsequent survival at sea.

The fresh water and their watersheds, the estuaries, and the marine areas that comprise salmon habitat also provide valuable economic opportunities in a wide range of non-fishery-related sectors, such as urban development, transportation, forestry, agriculture, energy (hydroelectric dams, oil and gas), aquaculture, provision of drinking water, mining, and others. Productive habitat in Atlantic Canada faces growing pressures from human activities that threaten the capacity to sustain wild Atlantic salmon populations over the long term. In addition, competing uses pose a challenge for maintaining healthy, abundant, productive, and accessible habitat for Atlantic salmon and other species. Further, there is a concern that habitat accessibility and productivity can deteriorate from the many small, incremental, and often unidentified impacts that accumulate over time. Finally, ocean and freshwater habitat of Atlantic salmon can be affected by global-scale phenomena, such as climate change through, for example, changing precipitation and temperature patterns affecting the ocean ecosystem, migration routes of salmon, as well as salmon habitat in rivers and streams.

Factors addressed in the following section pertain specifically to anthropogenic threats, specifically those sources of mortality or harm that are either 'permitted' or 'un-permitted' by agencies and which can be managed, prevented, or mitigated mostly in Canada but in a few cases internationally, for example, bolstering the *Clean Air Act* or reducing atmospheric carbon emissions. Narratives emphasize the breadth of coverage, with the exception of a few examples, rather than depth of treatment. Threats specific to each of Canada's Atlantic salmon Conservation Units (CUs) (Figure 1) [see DFO and MRNF (2008) for derivation of CUs] have been noted under 'status' (DFO and MRNF 2008) and are also highlighted in Appendix 2 of this report.

2.1.1 Directed Salmon Fishing and Management Measures

Beginning with the closure of interceptory drift net fisheries in 1967, salmon fisheries in Eastern Canada moved away from mixed stock marine fisheries towards Aboriginal, Native-food and

recreational salmon fisheries on river-specific stocks within estuaries and fresh water that are estimated or presumed to be at or near conservation limits. In some areas, exceptions have been made to allow retention fisheries on stocks that have been subjected to enhancement activities, where new habitat has been opened up and stocks are considered to still be in a colonization phase, for example, the Exploits and Terra Nova rivers in insular Newfoundland. Fisheries are principally managed on a river-specific basis and, in the few areas where retention of the dominant egg-bearing size group is allowed, harvests are closely controlled. The management objective is to maintain the spawning escapement in each river above the conservation limit. Management measures to control undesired consequences of the fisheries are user specific. Harvests by all users in Canada totaled 148t in 2008, only 3t more than the average of the previous 10 years but less than 10% of any landings reported 1960 – 1978 (ICES 2009).

Aboriginal and Food Fisheries

In Eastern Canada, Aboriginal and food fisheries take place subject to agreements or through licences issued to Aboriginal groups (see Sections 3.3.1 and 5.4 for additional details). The licences generally stipulate gear, season, and catch limits. Most of these fisheries take place in fresh water or in estuaries close to river mouths. Although the reports of harvests are incomplete, the fisheries often impact river-specific stocks. In large areas of Eastern Canada, Aboriginal harvests of Atlantic salmon have been curtailed due to concern about stock status.

Gill nets are the most common gear for fishing in estuaries, but in some locations such as the Miramichi and other Gulf New Brunswick rivers, there has been a concerted effort to promote the use of trapnets rather than gill nets to allow the selective harvest of small (1SW) salmon and the unharmed release of large (MSW) salmon and other incidental catches.

Some of the Aboriginal and food fisheries of Labrador take place in what are considered to be coastal waters. These fisheries have moved closer to river mouths and likely harvest few salmon from other than local rivers. Reporting rates in this fishery are very high, upwards of 85% compliance in the completion of fishing logbooks. In 2006, to reduce the overall catch of 2SW and older fish in these fisheries, a number of additional measures were introduced: maximum mesh size of 114 mm and a monitoring program to initiate in-season closures that coincide with peak runs of large salmon. The estimated harvest in all Aboriginal Peoples' food fisheries in 2008 was 62.4t, the highest of 19 years of record (ICES 2009).

Recreational Fisheries

The harvest in recreational fisheries in 2008 totaled 43,301 small and large salmon (approximately 83 t) and remained among the lowest of a 35 year time series (ICES 2009). Small salmon represented 93% of the harvest, in large part a function of catch-and-release recreational fisheries in the Maritimes and insular Newfoundland. All (100%) of the effort and catch occurs in fresh water and is therefore river specific. Licenses are required to fish recreationally and fishing is generally restricted to fly fishing with daily and seasonal limits. All salmon harvested are required to be tagged. Recreational fisheries vary by area from complete closures of all fisheries to the retention of both small and large salmon.

The compliance of licensed recreational anglers is considered to be very good. Recent efforts to verify the compliance of anglers in Nova Scotia to the regulations indicate that the compliance rate was in the order of 95% (DFO 2007b). Management measures intended to achieve/promote the objective of meeting or exceeding conservation limits are summarized below:

In the Maritime Provinces (NS, NB, and PEI), in many areas, large salmon generally contribute the majority of the egg deposition:

- Based on previous status and expected returns of salmon, management plans for each Salmon Fishing Area are set before the season to increase the likelihood of achieving conservation requirements on a river specific basis where possible;
- Many rivers in the Maritime Provinces are closed to retention fisheries of any size due to low stock abundance;
- Retention of salmon larger than or equal to 63 cm is not permitted;
- Daily retention limits of zero, one, or two small salmon per day depend on river or area specific management plans;
- Where salmon fishing is permitted, maximum daily catch limits are four fish per day unless otherwise specified;
- For the LaHave River, NS, continuation or closure of the fishery is based on a review of early July returns.

In Québec, the dominant egg-bearing size group is the large salmon:

- Management rules for each zone are set before the season in order to reach the conservation limit on each river;
- All harvests of salmon, regardless of size, must be reported within 48 hours;
- On rivers where large salmon can be retained, if the first fish retained is a large salmon, then fishing must cease for the day. A daily maximum of two fish retained per day is allowed;
- In the northern zone, each river has its own set of regulations as most of these rivers are difficult to access and effort is lower than in the southern rivers;
- In the southern zone, where approximately 90% of the fishing effort takes place, fisheries are closed on rivers where populations are small; of the open rivers, more than 50% are restricted to the retention of small salmon only. On the remaining rivers where large salmon retention is allowed, river-specific in-season assessments are conducted. If the number of fish observed during the in-season assessment is less than the number which would provide a high probability of meeting conservation by the end of the season, then retention fishing for large salmon is prohibited.

In Newfoundland, the dominant egg-bearing size group is small salmon (with the exception of rivers in the southwest coast of the island where eggs are contributed by both small and large salmon):

- Retention of large salmon is prohibited;
- A river classification system is used to establish river-specific season retention limits by variation order for small salmon. The classification system considers the size of the river and its previous status relative to conservation to set the specific season retention limits from zero to a maximum of 6 fish per year;
- Daily retention limits of two small salmon (on Class I, II and III rivers; none on Class IV rivers) and maximum catch and release limit of four fish;

- Barbless hooks are mandatory.

In Labrador, eggs are contributed by both small and large salmon; the large salmon component is proportionately high in females and important to total egg depositions:

- Retention of large salmon is permitted on a limited number of rivers;
- On nine rivers of Southern Labrador crossed by the Trans-Labrador highway, retention of large salmon is prohibited and the seasonal retention for small salmon is limited to two fish;
- On other rivers in Labrador, there is maximum season retention of four fish of which only one may be a large salmon. These remaining rivers are often remote, difficult to access and have low overall recreational fishing effort;
- Barbless hooks are mandatory.

Catch and release fisheries

The practice of catch and release has increased in frequency in the recreational fisheries of Canada. In 2008, this accounted for 58,004 (22, 891 large and 35, 113 small) salmon representing about 57% of the total number caught and released as well as those retained (ICES 2009). There is some mortality (ICES op cit) but under the right conditions, catch and release angling is considered to be an effective conservation and management tool (DFO 1998). Water temperature and handling during release are factors which affect the survival rate of released fish. Numerous studies on the stress and mortality associated with catch and release have been conducted and form the basis for the estimates of incidental mortality and the environmental criteria under which catch and release recreational fisheries are allowed (Dempson *et al* 2002).

- The mortality rate assumed for catch and release fish in Eastern Canada ranges from 3% to 10%. These losses are considered in the assessment of the attainment of conservation.
- In Newfoundland and Labrador, barbless hooks are mandatory for salmon. In Nova Scotia, barbless hooks are mandatory for the entire season when fishing for salmon in rivers open only to hook and release fishing and, are mandatory for parts of the season in rivers open to retention. In Southwest New Brunswick, there are no provisions for barbless hooks as there are no open seasons for salmon while in Gulf New Brunswick barbless hooks are mandatory only for certain rivers and in specific seasons[3]. In Québec, there is no mandatory provision for barbless hooks but the ministry invites fishers that regularly return salmon to the water to use a barbless hook[4].
- Environmental protocols have been used in Newfoundland and Labrador to close rivers to recreational fishing when the water temperature is equal to or greater than 22ºC on two consecutive days, as measured in mid-afternoon. During the period 1975 to 1999, 28% of the rivers have been closed annually, resulting in the loss of 35 to 65% of the number of potential fishing days available in some Newfoundland areas. (Dempson *et al* 2001). Closures of rivers for environmental reasons were high through 2004, but fewer rivers were affected during the period 2005 – 2007.
- Intermittent closures to recreational fishing have been in place as required on the Miramichi River in response to warm water and low water conditions during July and August. There are no formal environmental criteria in place and decisions are based on

[3] http://www.nasco.int/pdf/2009%20papers/nac(09)4.pdf
[4] http://www.mrnf.gouv.qc.ca/english/publications/online/wildlife/salmon-regulations/index.asp

observed exceptional mortalities of fish (not all due to angling) and concerns for their increased vulnerability to illegal fishing activities.

- To reduce hook and release mortalities in Nova Scotia, rivers are either closed by July 15 or are closed mid-season during the warm water period (July 15-August 31).

Domestic Commercial Fisheries

Commercial fisheries for Atlantic salmon in Canadian waters, which as recently as 1980 yielded a harvest of 2,412t (ICES 2009), have been closed since 2000. This was the result of a general license reduction initiated in the Maritime Provinces in 1972 and continued after 1984, when the commercial fisheries of the New Brunswick, Nova Scotia, Prince Edward Island, as well as portions of Québec were closed. Further reductions were introduced through the late 1980s and early 1990s, leading to a moratorium on commercial salmon fishing for insular Newfoundland in 1992, followed by a moratorium in 1998 for Labrador and in 2000 for Québec, which completed the closure of all commercial fisheries for Atlantic salmon in Eastern Canada.

Non-domestic Fisheries

Salmon of Canadian origin are captured in the marine fisheries of St. Pierre and Miquelon and at West Greenland.

St. Pierre et Miquelon (France) There are no salmon producing rivers on the islands of St. Pierre and Miquelon. Reported harvests of salmon in the marine gill net fishery have ranged between 1.5 and 3.6t per year over the past 12 years (ICES 2009). All adult age groups of salmon are harvested in the fishery. In the context of total harvests, the fishery is small but it is a mixed stock and interception fishery.

A recent genetic analysis of a sample of the catches from 2004 indicated that 98% of the fish were of Canadian origin (ICES 2006). As this fishery occurs in a marine area adjacent to the south coast of Newfoundland, it likely has an impact on stocks of this area and the Maritime Provinces.

West Greenland The fishery at West Greenland harvests fish of North American and European origin and is, therefore, a mixed-stock interception fishery. The salmon caught in that fishery are mostly (>90%) non-maturing 1SW salmon, most of which are destined to return to home waters as multi-sea-winter (2SW primarily) fish. Fish from all multi-sea-winter producing areas of Eastern Canada are intercepted in this fishery. In the past ten years, the continent of origin of the harvested fish has been predominantly North American. In 2008 the fishery, which is conducted for local consumption, had a reported harvest of 8,000 fish of North American origin in 2008, second highest of the previous 10 years (ICES 2009).

Illegal Harvests

Illegal harvests of Atlantic salmon, commonly referred to as poaching, occur in both marine and fresh waters to varying degrees throughout Atlantic Canada. Poaching in marine waters is more frequent in waters around Newfoundland and Labrador and Québec lower north shore than elsewhere and is most frequently carried out using illegal gillnets, and also using otherwise-legal fishing gear (such as bait nets) that have been modified or set so as to increase the bycatch of salmon (DFO 2007b). Poaching in inland waters is carried out by a variety of means, including jigging and sweeping of pools by nets (DFO 2007b).

Numerous management measures have been put in place to reduce the potential for poaching. These include:

- The installation, upkeep, and monitoring of protection barriers in large guarded headwater pools which limit the upstream access of salmon in order to protect fish from poaching in remote upriver sections which are difficult to patrol. The province of New Brunswick, in collaboration with communities and conservation organizations, maintains six such facilities in four rivers. In the province of Québec, stakeholders operate and maintain such facilities. Salmon are released to continue their short migration upstream to spawning areas in early fall when conditions do not favor poaching;
- Closure of sections or entire rivers to fishing activities under low water conditions when salmon are concentrated in a reduced number of holding pools and opportunities for illegal activities are high;
- The targeting of enforcement activities on organized and largely illegal fishing activities motivated by illegal catch and sale of wild salmon. This effort includes Aboriginal, Federal and Provincial enforcement personnel in the establishment of joint patrols and exchange of information;
- The use of programs such as 'dial-a-poacher' and 'crime-stoppers' to solicit information from the public which can lead to the arrest and prosecution of violators;
- The investment by local watershed associations towards the purchase, installation, and monitoring of video cameras at key pools and public announcements of these monitoring devices to deter illegal fishing activities and assist in prosecutions;
- Efforts to increase deterrence by seeking the most severe penalties possible for convictions for salmon poaching. As an added deterrent, details of convictions are published in local newspapers and on the government web sites. Convicted individuals are increasingly asked to make restitution to local conservation organizations;
- Facilitation of and support for numerous watershed stewardship groups which promote local awareness of and compliance with salmon conservation measures. In some instances employees of these groups perform compliance monitoring; and
- Development and distribution of education and awareness products such as restaurant placemats, school presentations, and radio advertisements to promote compliance.

2.1.2 Bycatch of Salmon in Domestic Fisheries for Other Species

Aboriginal Fisheries

In Ungava, the principle fishers are Inuit residents of Nunavik. Salmon is not the most abundant or popular species among fishers of Ungava rivers and estuaries. Other species sought include brook trout (*Salvelinus fontinalis*), Arctic charr (*Salvelinus alpinus*), lake whitefish (*Coregonus clupeaformis*), round whitefish (*Prosopium cylindraceum*), lake trout (*Salvelinus namaycush*), and northern pike (*Esox lucius*). Salmon are vulnerable to these fisheries and significant numbers are taken and reported, particularly from the estuarial fisheries for these species.

In estuarial and coastal waters of Labrador in 2006, salmon for food, social, and ceremonial purposes were obtained as bycatch within the framework of other fisheries, Arctic charr in particular (ICES (2007). Once the allowance of salmon was captured in each of those fisheries, they were to be either terminated or moved to areas not frequented by salmon. For example, the Nunatsiavut Government communal fishery was provided an allowance of seven salmon for the

fishing season after which nets had to be moved to areas where only charr had been historically caught (ICES 2007). The Labrador resident subsistence fishery, in which most of the fishers are Aboriginal, had a catch limit of four salmon per requested licence within a season limit of 50 trout and charr. After the capture of four salmon, fishers' nets were to be removed from the water (ICES 2007).

There are no reported bycatches of salmon from any other Aboriginal fisheries in Eastern Canada.

Recreational Fisheries

Fisheries for brook trout, striped bass *(Morone saxatilis)* and shad *(Alosa sapidissima*) in rivers in which Atlantic salmon populations have been designated as 'endangered' and listed in Schedule 1 of Canada's SARA in some cases have been limited through modified seasons or gear restrictions to limit the risk of impact on Atlantic salmon. To minimize or eliminate overlap with adult Atlantic salmon in declining but unlisted populations, fisheries for species co-existing with salmon are generally restricted by season, location, and occasionally gear variation orders.

Specific measures currently in place that have reduced or eliminated salmon bycatch include:

- Variation orders that exclude fishing for brook trout, even with flies-only gear, in locations at times when adult salmon are expected to be present;
- Regulations that forbid the retention of juvenile salmon;
- Variation orders for striped bass on the Saint John River that restrict recreational gear to floating bass plugs;
- Exclusion of fisheries with any expected bycatch of adult salmon or significant bycatch of juvenile salmon in the SARA listed inner Bay of Fundy (iBoF) rivers of Nova Scotia and New Brunswick and, as well, the investment of additional resources in conservation and protection efforts to safeguard the life stages residing in and returning to fresh water.

Commercial Fisheries (Near Shore and Distant)

Since 1984 in the Maritime Provinces and in insular Newfoundland, any Atlantic salmon caught as bycatch in fisheries directed to other species must be returned to the water. Information provided to ICES (2004) suggested that there are some fisheries still with the potential to catch salmon incidentally, but that there was no evidence of significant bycatch of salmon in any of the fisheries surveyed.

Specific measures currently in place that have reduced the amount of salmon bycatch (DFO 2007b) include:

- The moratorium on the groundfish fishery in Eastern Canada in 1992 has reduced a large amount of gear which historically captured salmon;
- Various measures in Newfoundland to minimize bycatch in the bait and pelagic fisheries include: restricting fishing times or implementing closures in areas with high salmon abundance, and restrictions on how and where nets are set;
- Gaspereau trapnet fisheries in the Miramichi River (New Brunswick) have been delayed to minimize the unnecessary handling of Atlantic salmon bycatch;
- Estuary American shad fisheries in the Saint John River (New Brunswick) are closed when salmon are present.

2.1.3 Salmon Fisheries Impacts on Salmon Habitat

No cases appear to have been documented wherein salmon fisheries have been investigated for their adverse impact on salmon habitat. Thus, categorical assessments of 'low', 'uncertain', and 'not applicable' threats are attributed to each of the Aboriginal, recreational, commercial and illegal fisheries (Appendix 2).

Aboriginal

Most Aboriginal fisheries are conducted within estuaries or the lower portion of rivers; fisheries in coastal areas of Labrador, and in estuaries would not be expected to impact salmon habitat. In-river fisheries utilizing trapnets held in place by stakes, piles, or anchors, fixed gill nets, and tangle nets (light seines) would be expected to have a 'low' or 'uncertain' impact on the bottom and ultimately on Atlantic salmon. It is conceivable, however, that bottom resting gear types and active seining can be disruptive to a small area of benthic organisms, and that the exhaust from outboard motors used to transport installers of the gear and fishers to and from the devices would detract from the water quality. Fisheries based on recreational methods are discussed below.

Recreational

Recreational fisheries for Atlantic salmon in Eastern Canada utilize feathered hooks (flies) and in themselves would have little if any impact on habitat. Casting of the flies to prospective salmon lies is done by anglers on shore, in a boat/canoe and, perhaps most frequently, wading in the river shallows. Outboard motors do not enhance the water quality, and anchors to fix the boat location would have a small disruptive effect on bottom fauna. Wading fishermen could as well physically disturb/impact bottom fauna. However, none of these scenarios have been assessed.

Commercial

All commercial salmon fisheries are closed and therefore of no impact on salmon habitat.

Illegal

Illegal fisheries have the greatest potential to disturb salmon habitat. Poachers' methods include: sweeping of salmon holding areas with crude and heavily weighted bottom dragging seines and gill nets, corralling/entrapment of fish with the aid of uprooted rock barriers and, occasionally, explosives.

2.1.4 Mortality Associated with Water Use

Power Generation

Ruggles (1980) identified the following unnatural conditions created by dams that can threaten anadromous salmonid populations: passage over spillways, passage through turbines, flow patterns in both rivers and impoundments, exposure to atmospheric gas saturation, concentrated pollutants, predators, water temperatures, disease organisms, and increased vulnerability to exploitation from angling.

Dams equipped with hydroelectric generating facilities entrain and impinge downstream migrating Atlantic salmon. Entrainment occurs when downstream migrants pass through turbines and die or are injured by direct contact with turbine runners, turbulence, or pressure changes. Impingement occurs when a fish comes in contact with a screen, a trash rack, or debris at the intake, causing bruising, de-scaling, and other injuries. Impingement, if prolonged, repeated, or occurring at high velocities also causes mortality. Fay *et al* (2006) note that entrainment mortality for salmonids can range between 10-30% at hydroelectric dams depending upon fish

length (juvenile versus adult), turbine type, runner speed, and head (EPRI 1992). Passage through turbines can also lead to indirect mortality from increased predation and disease (Odea 1999). Where multiple dams exist, the losses of downstream migrating smolts from turbine entrainment are often cumulative and biologically significant. Because of their larger size, turbine mortality of kelts is expected to be significantly greater than 10 to 30% (FERC 1997).

Mortality of salmon in hydropower generation plants, although mitigatable by fish by passes and water management, can pose a significant threat to the persistence of Atlantic salmon in the impacted river. This threat is particularly high during low marine survival episodes and in low productivity areas.

2.1.5 Habitat Alterations

The Fisheries Act of Canada defines fish habitat as, "Spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes". Fisheries and Oceans does not authorize works or undertakings (projects) but rather authorizes the negative impacts on fish and fish habitat associated with works or undertakings, where these impacts are deemed acceptable and subject to compensation. The regulation of works or undertakings associated with land and water uses resides with Provincial or Municipal level governments.

The habitat protection and pollution prevention provisions of the *Fisheries Act* provide the Minister of Fisheries and Oceans with the following powers:

- The authority to require the construction, maintenance, and operation of fish passage facilities at obstructions in rivers; to remove unused obstructions to fish passage; and to require a sufficient flow of water at all times below an obstruction for the safety of fish and the flooding of spawning grounds;
- The authority to prohibit the destruction of fish by any means other than fishing;
- The authority to modify, restrict, or prohibit any work or undertaking which is likely to result in the harmful alteration, disruption or destruction of fish habitat; and
- The authority to prohibit the deposit of deleterious substances of any type in water frequented by fish (Environment Canada responsibility).

Municipal Waste Water

Environment Canada has responsibility for administration and enforcement of Section 36 of the *Fisheries Act* (prohibition of the deposition of deleterious substances of any type in waters frequented by fish). Point source Municipal (and industrial) waste water entering some salmon rivers in Maine is known to be impaired due to contamination by mercury, PCBs, dioxin, bacteria, viruses, added nutrients, and reduced dissolved oxygen (Fay *et al* 2006). No documentation was sought, but it is expected the same impairments may exist in urbanized/industrialized watersheds of Eastern Canada. No consequences of such impairments were noted by Fay *et al* (2006).

In Canada, recent studies have indicated that exposure of juvenile salmon to a range of sub-lethal concentrations of contaminants in fresh water, including endocrine-disrupting chemicals found in waste water and pesticides, may compromise survival of salmon at sea (Fairchild *et al* 2002). Sources of such compounds range from agriculture, sewage effluents, and industrial effluents. In addition, chemical pollution from chlorinated organic compounds, which are widely distributed

in the North Atlantic Ocean, has been proposed as a complementary factor affecting the sea survival of Atlantic salmon (Scott 2001). The limited studies to date have examined a minute number of the vast variety of chemicals currently being utilized and introduced. Actions associated with contaminants and their effects on Atlantic salmon include:

- National Pesticide Program launched in 2002 by DFO to address issues pertaining to the biological impacts of pesticides on aquatic ecosystems; and
- provision of information and scientific advice to the Pest Management Regulatory Agency which determines whether a pesticide should be registered. Chronic effects have been added to the criteria used by the regulatory agency in their evaluation.

Sedimentation and Silting

The impacts of sedimentation and silting on Atlantic salmon have been addressed in 4.1 of the 'Conservation Status Report, Atlantic Salmon in Atlantic Canada and Québec: Part I – Species Information' (DFO and MRNF 2008). There it is noted that the movement of normal bedload is a natural process which sorts and migrates substrates usually without disrupting processes in the life cycle of salmon. However, road construction with inadequate safeguards, poor roadway maintenance, improperly installed culverts, unstable bridge abutments, improper road ditching, poor agricultural processes, all terrain vehicle trails and fords, poor forest harvesting practices, and dredging can increase the input of sediments to streams that exceed the capacity of the hydraulic process to move and sort the materials, thereby stressing, suffocating, or entrapping (alevins) Atlantic salmon and disrupting, as well as adversely impacting, the benthic macro invertebrate populations on which juvenile salmon forage.

Pulp and Paper Mills

While overall improvements in the receiving environments have occurred since updated Federal regulations were passed in 1992, two cycles of Environmental Effects Monitoring results show clearly that mill effluents still affect the local receiving environments at a number of locations across Canada (McMaster *et al* 2006). There is, however, no recent research on the effects of these effluents on salmon, or more specifically Atlantic salmon even though there is a wide literature on the effects on other laboratory and caged salmonids (Orrego *et al* 2006). There are also recent reviews on pulp and paper mill effluent characteristics (Hewitt *et al* 2006) and effects (McMaster *et al* 2006) that can be of assistance in describing the current situation in Canada. Multiple compounds in pulp and paper effluents affect sex steroid production in fish. These bioactive substances originate from wood and are liberated during pulp digestion (Hewitt *et al* 2006). Pulp and paper mill effluents have provided perhaps one of the best cases in Canada of endocrine disruption in fish, with effects showing alterations in reproductive function downstream of effluents (McMaster 2001).

The link between pulp and paper effluents and endocrine disrupting effects is of concern for Atlantic salmon, as the environmental estrogen, 4-nonylphenol, has been linked to historical population declines in Atlantic salmon, however in that case, due to forest spraying (Fairchild *et al* 1999). Reductions in smolt weight and plasma IGF-1 levels have been demonstrated in the laboratory for both 4-nonylphenol and estrogen exposures (Arsenault *et al* 2004). While these effects are not on the reproductive system, they are ecologically significant for salmon populations, as reduced size and growth as postsmolts has been linked to reduced survival to adult. IGF-1 concentration has been proposed as an indicator for high quality smolts (Beckman *et al* 1999). Exposure to sources of endocrine active compounds during parr smolt transformation has the potential to interfere with the complex hormonal changes and rapid growth involved with

parr smolt transformation (Dickhoff 1993; Hogasen 1998). For Atlantic salmon, a caging study in the Miramichi River showed a general trend of better feeding and growth in smolts caged at sites with fewer known anthropogenic inputs, of which pulp and paper mill effluent was a major contributor at the time (2001 and 2002) (Jardine *et al* 2005). Exposure to low concentrations (1 to 10 ppb) of a mix of two endocrine active substances (4-nonylphenol and atrazine, a herbicide) in fresh water has been shown to affect Atlantic salmon smolts biochemically, and then to cause significant mortality after transfer to sea water (Moore *et al* 2003).

While there is no definitive study showing links between pulp and paper mills and Atlantic salmon survival, the potential for effects from endocrine disrupting substances should not be ignored. Pulp and paper mills are known to contribute endocrine active chemicals to the aquatic environment, and endocrine active chemicals are known to affect salmon smolts.

Obstructions

This section includes reservoirs and tidal installations for hydroelectric power generation, which alter behavior & ecosystems.

Hydropower dams and other such obstructions are typically constructed in river reaches with moderate to high underlying gradients, which if free-flowing are highly valuable as Atlantic salmon spawning, nursery, and adult resting habitat.

As noted in Section 3.1 of the 'Conservation Status Report, Atlantic Salmon in Atlantic Canada and Québec: Part I – Species Information' (DFO and MRNF 2008), obstructions can severely reduce the productive habitat and production of salmon. Low head and surmountable dams, at the very least, delay upstream migration until such time as water discharges are adequate for salmon to leap the obstruction. Higher dams equipped with fish passage have varying passage efficiencies; 100% being very uncommon (Fay *et al* 2006). Even when upstream passage is available and adults are able to pass above dams and successfully negotiate impoundments to upriver areas for reproduction, the impoundments behind these dams can delay or prevent smolt emigration, increase the energetic costs of smolt movements, and dependent on discharge conditions can result in increased predation (NRC 2004).

In addition to direct loss of productive habitat from flooding, dams also alter natural river hydrology and geomorphology, interrupt natural sediment and debris transport processes, and alter natural temperature regimes (Ruggles and Watt 1975; Wheaton *et al* 2004). These impacts can adversely change aquatic community composition and affect the entire aquatic ecosystem structure and function. Existing riverine aquatic communities upstream of a dam site are typically replaced by lacustrine communities following construction.

Regulation of stream flows at hydropower projects (daily or seasonal store and draw, daily peaking, and cycling, etc.) can also adversely affect salmon through stranding, redd dewatering, increased predation, interference with spawning or migratory behavior, increased embeddedness of spawning substrates, and compromised invertebrate production (Hunter 1992). In addition, trapping of gravel in impoundments and release of clear water downstream of dams can cause the removal of smaller, mobile grains from beds below dams, leaving only progressively coarser substrates. This process, termed armoring, may result in gravels becoming too coarse for use by spawning salmon (Kondolf 2000). Habitat and aquatic communities in reaches immediately below dams can also be affected due to the unnatural funneling of flows to particular segments of

the dam (powerhouse or penstocks) at the expense of adjacent segments and associated habitat, or due to the depth of the water intake (for example, deep/cold versus surface/warm).

Water Extractions

Water withdrawals for agricultural, mining, or other industrial purposes can directly impact Atlantic salmon spawning and rearing habitat (Fay *et al* 2006). They have the potential to expose or reduce salmon habitat and contribute to more variation and higher water temperatures. Adequate water quantity and quality are critical to all life stages of Atlantic salmon, especially adult migration and spawning, fry emergence, and smolt emigration (Section 3.1 in DFO and MRNF 2008). Survival of eggs, fry, and juveniles are also mediated by stream flow. Juvenile salmon, present in the stream throughout the year, are adapted to survive high flows by seeking refuge in the substrate. However, low flows can constrain available habitat and limit populations. During summer and winter low flows, juvenile salmon survival is directly related to discharge (Gibson 1993; Cunjak 1988; Cunjak 1996), with better survival in years with higher flows during these seasons (Ghent and Hanna 1999). As a result, water withdrawals have the potential to limit carrying capacity and reduce parr survival. Withdrawals may also dewater redds and reduce egg survival, impede adult migration; and extend smolt emigration by reducing spring discharge.

Urbanization (Altered Hydrology)

Changing land-use patterns, particularly development and land clearing for agriculture and as a result of forestry operations, create a number of conditions that may affect spawning and rearing habitat. Increased development and population growth results in land clearing and construction of infrastructure such as roads and buildings. These activities and structures can alter or disrupt the hydrological process in the system which can result in declines in water and habitat quality (Booth *et al* 2002). For example, increasing the amount of impervious surface (paved roads and parking lots) in a watershed can alter hydrologic regimes, increase erosion, and increase pollutant loads entering streams and rivers.

Land management activities, particularly land clearing for agriculture, development, and timber harvest, have the potential to impact geomorphological and riparian processes (Boyer *et al* 2003; NRC 2004). Seasonal river flow patterns are responsible for maintaining the habitat structure within the river channel. The volume and timing of high flows facilitate effective sediment transport, cleansing fine sediment from juvenile and spawning habitat, building gravel bars, and maintaining diversity in channel morphology. The geomorphologic process of sediment transport and deposit are critical to maintaining productive Atlantic salmon habitat (Hill *et al* 1991; Leopold *et al* 1992; McBain and Thrush 1997).

The construction of new roads increases access into relatively undisturbed and previously inaccessible areas. Roads are often built in association with logging, agriculture, and the development of homes or industrial or commercial projects. Roads can alter many ecological functions and characteristics including the pattern of runoff and surface water flow, sedimentation, increased nutrient loading, and chemical contaminants (Trombulak and Frissell 2000). Depending on a large number of factors, the effects of roads on the ecological health of a landscape can be quite severe (Trombulak and Frissell 2000). Roads and their requisite ditches result in a direct and increased rate of transfer of sediment and other material to waterways. Some road placements, as well as bridges, can directly alter the development and maintenance of hydraulically balanced stream channels. Changes in land cover as well as land and water use can also result in excessive nutrient enrichment.

Infrastructure (Roads, Culverts and Fish Passage)
Associated with increased human population growth, agriculture, and forestry activities and development are increased infrastructure needs including road construction and resource demands such as increased water use and water pollution control and treatment. As a migratory species, Atlantic salmon must be able to access spawning and rearing habitat and safely migrate back to the ocean in a timely manner in order to complete their life cycle. Lack of habitat connectivity affects the abundance and distribution of Atlantic salmon populations. Man-made barriers (for example, improperly installed culverts) can fragment Atlantic salmon habitat.

To reduce costs, corrugated metal culverts are frequently installed at road crossings rather than bridges. Bridges with openings less than the natural high flow stream width increase velocities and create hydraulic conditions that can delay or block fish passage, as well as alter or disrupt habitat above and below an improperly designed and installed bridge. Improperly placed or designed culverts create barriers to fish passage through hanging outfalls, increased water velocities, or insufficient water velocity and depth within the culvert. Culverts can also degrade upstream and downstream habitat quality and food production as a result of damming, scouring, and deposition of sediments (Bates 2003). Gibson *et al* (2005) suggest that culverts create more passage barriers to fish passage than other structures.

Aquaculture Siting
Salmon aquaculture has the potential to interact with wild salmon in many ways (DFO 1999), but sites are often chosen to avoid sensitive habitats and are operated in a manner to minimize environmental effects (DFO 2007b).

Aquaculture facilities were in general sited in accordance with protocols described for two zones in Eastern Canada: Zone I (largely encompassing CUs 1, 2, 3, 4 (east coast of the Northern Peninsula, only), 7, 8, and 25-28); and Zone II (the remaining CUs) (Porter 1992). Siting in Zone I is to be consistent with the maintenance of existing genetic integrity, that is, siting at locations >30km from the estuary of a Class 1 river (unaffected by introductions and transfers of salmon). Siting in Zone II is unrestricted with respect to distance but, like Zone I, forbids the use of viable non-indigenous species and reproductively viable Atlantic salmon stocks non-indigenous to the North American Commission Area and encourages the use of broodstock based on local or nearby stocks to the site (Porter 1992). The protocols strongly endorse cages or facilities that minimize escapes, that is, to minimize the risk of escaped fish from entering watercourses where wild fish populations spawn which may result in increased competition for habitat and food supplies.

Jurisdiction for the regulation of aquaculture is shared between the Federal and Provincial governments (DFO 2007b). At the Federal level, all aquaculture sites must undergo a review for potential fish habitat effects under Section 35 of the *Fisheries Act*. The review includes evaluation of information on the size, type, and proposed practices of the farm combined with specific features of the site such as the benthic fish habitat present, water depth, and currents. The *Fisheries Act* review is intended to assess the risk that the project poses to fish habitat and to ensure that all appropriate measures are in place to avoid and minimize fish habitat effects. Provinces are responsible for licensing aquaculture operations, providing tenure on Crown Lands for aquaculture activities, regulating activities related to fish health management, disease monitoring and surveillance, environmental performance, escape prevention, siting, waste management, and ensuring the orderly development of aquaculture (DFO 2007b).

The vast majority of marine fish farm sites also require a screening level environmental assessment under the *Canadian Environmental Assessment Act*[5] (CEAA) (DFO 2007b). This environmental assessment must be completed prior to the issuance of a formal approval under the *Navigable Waters Protection Act*[6] (NWPA), or a subsection 35(2) authorization under the *Fisheries Act*. The CEAA screening examines the potential environmental effects of the project on the natural environment, including the impacts on wild fish stocks, wildlife, and their habitats. Also considered are the potential cumulative effects of the project and other existing or proposed projects in the area that may have similar effects. A determination is made as part of the environmental assessment as to whether the project is likely to cause significant adverse environmental effects, taking into consideration all appropriate mitigation measures. Implementation of mitigation measures is often required as part of environmental management plans and through adherence to Provincial regulations for fish health, escapes prevention, sea lice monitoring, and waste discharge. Only those projects that are unlikely to cause significant adverse environmental effects, taking into account mitigation measures, are allowed to proceed through the issuance of Federal approvals under the NWPA or the *Fisheries Act.*

Siting also considers the risk of transmission of disease and parasites from caged farmed fish to migrating wild salmon, as there is evidence to suggest that the presence of intensive aquaculture can attract wild salmon either through the presence of fish themselves and abundant food supplies (DFO 1999). Risk of disease transmission may now be reduced, however, as a result of the recent implementation of Canada's National Aquatic Animal Health Program (NAAHP), a science-based regulatory program designed to help protect Canada's aquatic resources from the introduction or spread of infectious disease (DFO 2007b).

There is, as well, evidence that intensive aquaculture may also cause salmon to alter migratory behaviour (Amiro 2001). Many predators of Atlantic salmon such as seals can also be attracted to aquaculture facilities and may, in turn, result in an increased rate of predation of wild fish in the area (Cairns and Meerburg 2001).

The effects of the release of organic matter and therapeutants into the ecosystem from aquaculture operations and the potential effect(s) these may have on wild salmon populations can vary by location (Carey and Pritchard 1995; Cabello 2006). However, the majority of the aquaculture industry has made substantial progress in minimizing these outputs, converting to more environmentally friendly products, and researching the impacts of aquaculture on wild fish populations.

Agriculture/Forestry/Mining

Pesticides used for agriculture, forestry, and other land use practices can include insecticides, fungicides, and herbicides. Of these, insecticides are generally the most toxic to Atlantic salmon, followed by fungicides and herbicides (Maine Technical Advisory Committee 2002). Improper applications of pesticides can also introduce harmful toxins into receiving watersheds.

The use of pesticides may have direct or indirect adverse effects to Atlantic salmon or their habitats. Direct effects occur when Atlantic salmon and the chemical come in direct contact (Norris *et al* 1991). Indirect effects result from chemically induced modifications to habitat or non-target organisms (for example, food sources). Pesticide effects on salmonids may range from acute (leading to sudden mortality), to chronic (leading to increased cumulative mortality).

[5] See http://laws.justice.gc.ca/en/c-15.2/text.html for text of the CEAA.
[6] See http://laws.justice.gc.ca/en/N-22/text.html for text of the NWPA.

Effects on aquatic life depend primarily on the concentration and duration of exposure. Specific effects of pesticides on Atlantic salmon are influenced by factors such as concentration, toxicity, water quality (for example, pH, temperature, conductivity, alkalinity), and stream flow.

Many anthropogenic activities associated with or directly the result of forestry and agriculture can cause sedimentation. Clearing vegetation near watercourses or permitting livestock to enter streams and rivers can allow runoff to transport silt into watercourses. The degree to which fine sediments surround coarse substrates within the streambed is referred to as embeddedness (Sylte and Fischenich 2002). Anthropogenic sedimentation loading can lead to increased embeddedness of spawning and incubation substrates. Permeability, a measure of water flow through substrate, is reduced in embedded spawning gravels leading to lower dissolved oxygen rates and greater concentrations of metabolic wastes around incubating eggs (Moring 1982; Tappel and Bjornn 1983; Chapman 1988; Kondolf and Wilcock 1996; and Kondolf 2000), and presumably increased mortality of eggs.

Mining impacts Atlantic salmon both directly and indirectly. Blasting can directly kill fish and destruct fish habitat. It can also disrupt groundwater patterns, which in turn influence groundwater fed water courses and their associated habitats. Effluents discharged from mines can impact salmon by altering water quality, for example, changing temperature, pH, increasing suspended particulate matter, and introducing heavy metals into the water. The flow of effluents can also indirectly alter downstream erosion patterns and alter hydrology. Another significant threat from mining is water extraction from either ground or surface water, the impacts of which are site specific. Metal mining specifically impacts habitat because of the required tailing impoundment area. To help mitigate these impacts requires that a portion of a water body be isolated, settled, and treated before the flow is returned into the main water body. These diversions and impoundments can reduce available fish habitat and impact water quality.

Municipal, Provincial, and Federal Dredging

Many human activities in or near aquatic habitats re-suspend bottom sediments and create turbid conditions that differ in scope, timing, duration, and intensity from non-impacted areas. Dredging of navigation channels is a direct source of bottom disturbance. Re-suspension events after dredging or in developed areas negatively influence habitat and fish during storms, freshets, or tidal flows. Concentrations of re-suspended sediments vary among dredge and sediment types and the environmental conditions at the time of dredging (McLellan *et al* 1989; Herbich and Brahme 1991; Hayes *et al* 2000).

2.1.6 Shipping, Transport, and Noise

Salmon are exposed to shipping through some of their time at sea. In general, vessel noise can cause fish to change their depth (Hawkins 1993.) One observer noted, however, that salmon seem to avoid ships and their noise (Hawkins and Johnstone 1978). Sea surface trawl experiments in the last number of years suggest that catches of salmon postsmolts increased when vessels towed in an arc such that the path of the trawl net was separate from that of the ship noise and its wake (Short pers. comm.[7]).

Shipping can indirectly impact fish when spills occur. These can introduce contaminants into the water which harm fish and potentially disrupt behaviour. The degree of impact depends on the containment, volume, location, and timing.

[7] B. Short, DFO St. John's, NL.

Introduction of invasive species from the exchange of ballast water could also indirectly impact Atlantic salmon, however, no examples were noted in the literature examined.

2.1.7 Fisheries on Prey of Salmon

Atlantic salmon prey on many different species throughout their marine residency (Section 4.2 in DFO and MRNF 2008). This diversity is suggested as a means through which salmon maximize their foraging behaviour and, as a result, are unlikely to have a singular dependence on any one forage species (Lear 1972; Ritter 1989; Jacobsen and Hansen 2001). Among the known prey species, some of which are fished commercially, for example, capelin *(Mallotus villosus)*, herring (*Clupea harengus*), shrimp (*Pandalus borealis)*, some are noted to be at low abundance (herring), while others currently are at high abundance (shrimp). The status of one principal prey species, sandlance ***(****Ammodytes* spp.*)*, is undetermined, but its presence is widespread across the marine range of salmon. Indicators of the status of the principal prey species of salmon might be condition or size at age of adult salmon. This is because these parameters can be affected by food supply. Across the range of salmon, fish condition and size at age have increased during the same period that marine survival has decreased. This observation could indicate that forage is not currently limiting the growth or survival of salmon. An alternate view could be that prey abundance is scarce in specific areas or times when salmon are migrating, and predator selection has resulted in a survival release of the larger individuals. However, the size distribution of surviving adult salmon does not indicate a threshold or truncated distribution typical of size selective predation. Therefore, prey abundance may not be a current threat to Atlantic salmon population persistence.

2.1.8 Aquaculture (Salmon and Other Species)

This section includes escapes from fresh water, marine facilities, disease, parasites, and competition.

Jurisdiction for the regulation of aquaculture is shared between the federal and provincial governments. The role of the Federal government is to manage aquaculture so that it is environmentally sustainable, socially responsible, and economically viable. This includes the development of assessment tools for aquaculture, the review of licensing applications under the CEAA, the research of wild/farmed interactions, the development of national programs concerning fish health, and the enforcement of provisions under the *Fisheries Act.* The provinces license operations, provide tenure for aquaculture sites (except in PEI where DFO issues leases on behalf of that Province), regulate activities such as escape prevention, compliance, siting, waste management, and undertakes research and development (DFO 2009a). A comprehensive description of aquaculture activities in Canada and details on topics such as authorities, regulation, and enforcement of aquaculture operations can be found at www.dfo-mpo.gc.ca/aquaculture .

Interactions between wild and farmed salmon have been the subject of a large number of reports, scientific publications, and international symposia and workshops. In 1999, DFO sponsored a workshop to review the issue of interactions among wild and farmed Atlantic salmon and to recommend ways of minimizing risks to wild salmon (DFO 1999). The major issues examined during that review and the subsequent recommended actions are summarized below.

Improving Containment

The concern to wild stocks of escapes from the industry is the potential interactions which may result, including inter-breeding and subsequent loss of fitness, competition for food and space, disruption of breeding behaviour, and others (Cairns 2001).

Farm-origin salmon, including juvenile salmon that have escaped from hatcheries which supply the grow-out industry, were reported in 14 rivers in New Brunswick and Nova Scotia since the aquaculture industry began in 1979 (DFO 1999). Escaped farmed salmon have been observed periodically in the spawning stocks of some iBoF rivers.

In Newfoundland, escapees (adults and smolt) from the Bay d'Espoir area on the south coast of the island, where the only salmon farming occurs, have been found in the nearby Conne River (DFO 1999; Dempson *et al* 1998; Dempson and Power 2004; Dempson *et al* 2004).

An annual indicator of losses from the southwest New Brunswick and Maine (U.S.) production areas may be inferred from the monitoring done by the Atlantic Salmon Federation at a fish ladder in the Magaguadavic River (New Brunswick) since 1992. Escapees were highest in 1994 at over 1,100 fish, but declined such that numbers ranged from 16 to 124, 2001-2005 (Jones *et al* 2006). Assuming constant mortality of escaped farmed salmon across years, these observations suggest that improvements in containment have occurred. Concurrently, wild salmon counts to the Magaguadavic River have dropped to less than 10 fish, 2002-2005, after having exceeded 290 fish as recently as 1992 (Jones *et al* 2006). Isolated incidents of farmed fish escaping have been documented, and particularly important losses from storm damage or more recently vandalism in southwest New Brunswick in 2005 are known. The incidence of escaped farmed salmon among wild fish in eastern North American rivers has as well been summarized in Morris *et al* (2008).

The use of more exotic species (for example, rainbow trout) in and around salmon rivers could pose a problem with escapes into the wild; rainbow trout may displace salmon by competing with salmon for foraging opportunities in fresh water (and perhaps saltwater); there also may be competition for spawning habitat.

Identifying and Controlling Disease

Maintaining healthy farmed fish ultimately reduces the potential risk of disease transfer between wild and farmed fish. The transfer of live fish represents the highest risk of introducing exotic diseases into a new area. Existing Federal and Provincial regulations and policies have helped reduce the risk of the introduction of exotic diseases in Canada (DFO 2007b). Also, Canada, through international agreements such as the UN Convention on Biological Diversity, the UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks, and NASCO's Agreement on Adoption of a Precautionary Approach, is obligated to take appropriate actions to minimize the potential negative impacts of aquaculture on wild salmon stocks.

Based on the available information, it is uncertain what threat to the persistence of wild Atlantic salmon is posed for stocks in the vicinity of salmon farming operations, and it is unlikely that wild salmon stocks that are distant from farmed salmon are affected unless utilising the area of salmon farming for migration. The accumulation of all of the above factors can occur and has been observed to occur in wild salmon populations in the vicinity of even small farmed salmon operations. The degree to which these factors can be controlled and mitigated is uncertain.

2.1.9 Fish Culture/Stocking

This section includes non-commercial fish culture, including private, NGO, and government.

Population supplementation through artificial breeding and rearing has been a standard tool to enhance Atlantic salmon fisheries for over a century. Increased reliance on this tool emerged from the impact of acidification on the vulnerable Southern Upland of Nova Scotia. The method appeared to be viable through to the 1980s. However, with the downturn in marine survival for both natural and enhanced wild populations in the 1990s, even the wild portion of enhanced stocks began to perform poorly without explanation. Bypassing marine mortality was attempted with limited success (Dempson *et al* 1999). In several cases, enhancement could no longer offset the decreased productivity attributed to low marine survival and the wild populations declined. In many rivers, there is no suitable population size of wild adult salmon to conduct genetically safe enhancement practices, and federally funded enhancement activities have ceased. Limited private and Provincial enhancement activities have continued or have been initiated on selected rivers where the risks to wild salmon populations are minimal, for example the Sackville River.

Supplementation programs that increase the probability of persistence of the residual wild salmon populations while maintaining genetic diversity, reducing domestication, and reducing loss of fitness have taken precedence over historic enhancement activities.

Live Gene Banking to Preserve Stocks

Establishment of live (within facilities) and living (instream) gene banks (LGBs) for the remaining wild populations of the Southern Upland have been initiated and are being assessed as an appropriate management option for these rivers. The program emphasis has shifted from smolt rearing to adult rearing from wild selected parr or smolts. These priority activities are expected to continue while there are residual wild salmon populations remaining to protect. The effectiveness of this procedure to enhance the genetic and numeric persistence of remnant populations is being evaluated. In the previous five years, there has essentially been no permitted exploitation of wild salmon in any fisheries in the Southern Upland area rivers.

2.1.10 Scientific Research

Mortality associated with scientific research (capturing, collecting, handling or holding) of Atlantic salmon is not deemed to be detrimental to robust salmon populations. However, loss of potential adult salmon in small populations, especially those 'listed' under SARA could be harmful to population recovery. Under the *Fisheries Act*, a scientific permit is required to fish for, capture, or kill any Atlantic salmon for scientific purposes. Section 73 of the SARA requires a permit to fish for, capture directly, incidentally kill, or harass any listed species (an iBoF salmon). If the mortality is incidental to a licensed activity and will not affect the recovery of the species, then a permit may be issued for the licensed activity. In the case of iBoF salmon, no permits for incidental mortality have been issued because to date there is no indication that there are any fish available for incidental mortality. A scientific permit can be issued to directly fish for, capture, kill, harass, or disturb the residence or habitat of a listed species if the research benefits the recovery of the species. In both cases, the Regional Director of Science acting on behalf of the Minister provides a recommendation to management on the risk of the activity to a salmon population and its ecosystem, and assesses the benefits for recovery associated with the research. Scientific research permits provide the only mechanism to allow research that is likely to cause harm to a fish but benefits the potential for recovery.

The largest portion of research is focused on population assessments and today entails the enumeration of juveniles by electrofishing, pre-smolt and smolt in rotary screw traps, and the live capture of adults in nets and traps installed within counting fences and fishways. The deleterious effects of electrofishing on individual fish are well established (Snyder 2003) but, as

argued by Fay *et al* (2006), impacts only a very small portion of the population and in all likelihood can be regarded as compensatory, that is, contributes to enhanced survival of those remaining. Traps for smolts and adults have been designed for relatively 'passive' capture and holding free of entanglement. All operations minimize handling as much as possible, avoid chemical anesthetics as much as possible, and cease operation and handling at, depending on life stage, physiological stressful water temperatures. Research that requires direct mortality is generally conducted on fish obtained from the LGB or their progeny and is incidental to the persistence of the LGB and hence to population persistence. Therefore, the threat posed by research is generally mitigated by recovery actions that research activities seek to improve.

2.1.11 Military Activities

Military training activities conducted by the Department of National Defense, as well as those activities in support of training (construction and maintenance of infrastructure), can have varied effects on fish, including Atlantic salmon. Training activities have the potential to directly harm fish through such actions as the crossing of watercourses (fording), whereby a vehicle driving on the substrate could crush and kill eggs or juveniles present in the substrate. This outcome could also occur during an exercise that would require a large scale crossing of soldiers on foot.
Military exercises using explosives could lead to direct mortality if used too close to watercourses with fish present. The same is possible for unknown experimental chemicals which in the past included 'Agent Orange'.

Support activities also have the potential for impact. Many military training areas have numerous roadways, and these roadways would require bridge or culvert installations and maintenance, ditching, and road resurfacing and grading. These activities could lead to the deposit of sediment into nearby watercourses. Temporary bridges used during exercises may have a similar result, as they would be on the edges of the watercourse and may require some preparation work. Undersized culverts have the potential to prevent upstream migration of adults during spawning, and could impact populations present.

Large scale activities may also lead to the deposit of sediment in a nearby watercourse. For example, maneuvers using tracked and wheeled vehicle on slopes can cause wide-spread rutting of the terrain. Spring runoff and rain events can cause these ruts to wash silt laden water down slope and into nearby waters.

Large military bases proximate to Atlantic salmon producing waters in Atlantic Canada are Goose Bay and Gander in Labrador, St Johns', insular Newfoundland, Greenwood and Shearwater in Nova Scotia, Gagetown in New Brunswick, and Valcartier and Bagotville in Québec.

2.1.12 Air Pollutants

Sulphur-dioxide (SO_2) emissions (from metal smelting, coal-fired electrical utilities) and nitrous oxide (NO_x) emissions (combustion) are the principal acidifying pollutants transported over long distances and falling as acids in the precipitation in Nova Scotia. This acid precipitation has affected a complex of rivers in the Southern Upland area of Eastern Nova Scotia (DFO 2000).

Approximately 75% of the wet sulphate deposition in Southern Nova Scotia is from United States sources; 25% is from Canadian sources. North American emissions of SO_2 peaked in the early 1970s with reductions implemented due to health and environment concerns.

There is evidence that, despite a reduction in sulphate depositions of about one-third since the mid-1980s, the pH in Southern Upland rivers has not recovered at rates observed in other areas (DFO 2000). In many rivers slow recovery is expected because of the effect of natural organic acids and low levels of natural buffering. Recoveries of elements like calcium (necessary for growth of fish) are expected to take fifty to one hundred years in these rivers. Increased H+ ion concentrations, coupled with the low concentrations of Ca++, are responsible for the mortality of salmon in acidified rivers of Nova Scotia. The combination of geochemistry, weather patterns, thin soils, and low acid neutralizing capacity has caused severe acidification of most of the 65 rivers in the Southern Upland of Nova Scotia. By 1989 salmon were extirpated from 14 rivers and populations had declined by 90% in another 20 rivers. Population simulation analysis indicated that, at those acidity levels and 5% marine survival, only seven of 47 rivers on the Southern Upland were expected to be self sustaining (DFO 2000). Since that analysis, pH has not improved and marine survival of wild salmon in the LaHave River, the index river for this area, has averaged only 3%.

Efforts to Reduce Emissions

The Eastern Canadian provinces and New England (U.S.) governors adopted a work plan in June 1998 that called for further national emission reductions of 50% of sulfur dioxide and 20-30% of nitrogen oxides beyond current commitments. Québec had already committed, as a first step, to reducing its emissions to 40% below its current SO_2 cap by the year 2002.

The 'Canada-Wide Acid Rain Strategy for Post-2000' was approved in October 1998 by 26 Federal, Provincial, and Territorial ministers of environment and of energy. Commitments in the strategy included aggressive pursuit of SO_2 emission reductions in key areas of the U.S. and establishment of targets and schedules for further SO_2 emission reductions in Ontario, Québec, New Brunswick, and Nova Scotia (Anon. 1998).

Liming to Neutralize Acidity and Restore Habitat Productive Capacity

DFO (2000) reviewed a number of approaches for neutralizing the effects of acidity in streams in the Southern Upland of Nova Scotia. The usual neutralizing substance is limestone, and effective treatment requires a release of lime proportional to the discharge and acidity of the water that is to be neutralized. Potential liming compounds differ in theoretical neutralizing capacities, solubility in water, ease and safety of handling, and cost.

While several trial liming projects have been attempted in Nova Scotia, one stands out. In 2005, the Nova Scotia Acid Rain Campaign Committee (Nova Scotia Salmon Association and Atlantic Salmon Federation) selected the West River Sheet Harbour watershed as a demonstration site for mitigating the effects of acid rain through the application of lime with mechanical dosers. There, at a cost of more than $250,000, they upgraded an access road, ran power and phone lines, and installed a Norwegian-built 50-tonne capacity lime doser some 30 km upriver of the ocean. Over the course of the first full year of operation, the doser was calibrated to automatically release sufficient powdered lime to raise the pH at the river mouth to 5.5. Monitoring through 2008 suggests increases in the abundance of aquatic invertebrates[8].

Based on the cumulative affects and extirpations, the estimated time to recovery for affected drainages, and the large area affected, acidification remains a significant threat to the Southern

[6] http://thechronicleherald.ca/Science/9009058.html

Upland CU and possibly to a lesser degree CUs in Southern and Southeast Newfoundland (Table 1).

2.1.13 Introductions of Non-Native or Invasive Species

There are several non-indigenous species of freshwater fish which have become established in a large number of wild salmon watersheds in New Brunswick and Nova Scotia. The species of most concern include smallmouth bass (*Micropterus dolomieui*), and species in the pike family (chain pickerel *Esox niger* and muskellunge *Esox masquinongy*). These species are potentially both competitors and predators of juvenile Atlantic salmon. Introductions are generally the result of directed and illegal transfers of live fish between watersheds. With few exceptions, once established, it is nearly impossible to eradicate them and prosecution of illegal transfer activity is difficult. Actions specific to invasive species control include:

- proposed introductions and transfers of non-native species are evaluated by Provincial committees, and a risk analysis is conducted to determine if the activity can proceed taking account of containment methods and disease;
- communication and education activities to inform the public on the consequences of invasive species, and actions to take to reduce the potential for unintentional transfer; and
- where possible, eradication (cf. Connell *et al* 2002).

Even with these measures in effect, based on the history of illegal introductions and the biological traits of the species already introduced and the limited success in curtailing their expansion, the introduction of non-native species into existing salmon habitat represents a real and expanding threat to the persistence of salmon in the affected and adjacent drainages.

2.1.14 International High Seas Targeted

Through the auspices of NASCO, salmon catches in Greenland, 1998-2007 have averaged 19t (ICES 2009; 26t in 2008). There is some suggestion that sales for local consumption are largely unmonitored and possibly more extensive than reported. Evidence, however, of low market value for the product, a single government clearing house for access to international markets, international agreements (NASCO), and the logistics of hiding a significant ‘food fishery’ all suggest that declines in reported and estimated unreported landings (~10t) are consistent with economic times and fishery management measures (Cairns 2001).

There are, as well, ongoing suggestions that unreported fisheries harvest salmon in the offshore zone, especially outside the 200 nautical mile Economic Exclusion Zone (Cairns 2001). Vessels that could potentially prosecute a modern-day unreported salmon fishery include the Pacific fleet that formerly fished very long (up to 60 km) drift-nets (banned from the world's oceans by United Nations resolution in 1992), those flying flags of convenience in pursuit of tuna in the Atlantic Ocean, and ‘pirate’ vessels operating outside any regulatory or monitoring system (Cairns 2001).

Meerburg (1994) could find no direct evidence to support the above hypotheses. Further, with the low price of salmon, a pirate drift-net fishery for salmon in the Northwest Atlantic would be economically viable only if catch rates were high, which, based on their incidence in demersal and mid-water trawl fisheries in waters off Newfoundland and Labrador, is unlikely to be true (Dempson *et al* 1998). Spares *et al* (2007) contend however, that more Canadian salmon than are currently acknowledged migrate to the Irminger Sea and to the east of the Faroes. This supports

earlier suppositions by Dadswell (2000) that Canadian Atlantic salmon, particularly those destined to older sea ages, are taken in a ghost fishery on the high seas.

In some parts of the Northeast Atlantic, herring, mackerel, and postsmolt salmon have overlapping distributions during part of the year; leading to suggestions that herring and mackerel trawl and purse-seine fisheries could in untargeted fashion take significant numbers of salmon (ICES 1999, 2000). Salmon might therefore be an undetected component of North Atlantic trawl fisheries for shrimp, capelin, and other pelagic species.

Based on this conflicting information, it is impossible to determine if high seas fisheries represent a real and current threat to the persistence of Atlantic salmon in Canada. However, no nation or international agency associated with Atlantic salmon has provided information to support this hypothesis.

2.1.15 Ecotourism and Recreation

To date, no scientific documentation has been found of the threats imposed by recreational boaters, rafters, divers, floaters, swimmers, or shore based observers. Experience suggests that, within a normal range, the above activities result in little more than a temporary change in the salmon's lie. Indeed, it has been the experience that not even repeated sweeps of a pool with an electrofishing boat deterred an escaping 1SW salmon from taking the fly of an angler within minutes of the cessation of electrofishing (Marshall pers. comm.)[9]. Higher powered and larger craft could only frequent main stem and larger rivers where there would be ample opportunity for salmon to seek alternate cover or lies until the disturbance subsided.

2.1.16 Ecosystem and Climate Change

Climate change has been identified as an important source of aquatic disturbance on a global scale by possibly altering species composition and dominance in aquatic ecosystems. Greene and Pershing (2007) indicate that recent changes in climate in the late 1980s have resulted in an enhanced outflow of low-salinity waters from the Arctic through the Labrador Sea, enhancement of stratification on the Northwest Atlantic shelf, greater phytoplankton production in the fall, greater abundance of small planktonic copepods, and a decrease in abundance of older life stages.

The impacts of climate are expected to be manifested in both the freshwater and marine environments. From 1990–2100, mean surface air temperature is projected to increase by 1.4 to 5.8ºC, with more rapid warming in the Northern regions of North America (IPCC 2001). In Atlantic Canada, a 2 to 6°C increase is expected in the next century, with increases in air temperature expected to be greatest in Western New Brunswick and Québec, and lowest in Labrador. The responses of Atlantic salmon populations across its range in Eastern Canada are uncertain but they are expected to differ across the latitudinal range.

Changes in temperatures, salinities, currents, and species composition and distribution (including predators and prey of salmon) are all anticipated as a result of climate change. In combination, these factors will impact on Atlantic salmon production and survival in fresh water and at sea. The population trajectories associated with these changes are difficult to model as the anticipated conditions are outside the range of values observed in the relatively short time frame during which salmon have been studied.

[9] L. Marshall, formerly DFO Science, Bedford Institute of Oceanography, Dartmouth NS.

Marine and estuarine conditions are believed to exert important influences on Atlantic salmon, their ecology and survival. Climate induced changes, for example in sea surface temperature and salinity, may be some of the key factors affecting natural salmon mortality through changes in the distribution of plankton assemblages and associated dependent prey species, as well as predators (Cairns 2001). Regardless, projecting stock-specific effects of climate change on Atlantic salmon will be problematic owing to differences in stock characteristics and local geography. To date, three approaches have been used to draw inferences: physiological approaches, empirical approaches using local weather and climate data related to salmon population dynamics, and distributional approaches linking projected climate change effects to presumed changes in fish species distributions. A brief summary of several of these approaches for Atlantic salmon is provided by Wrona *et al* (2005).

2.2 List of Threats

Threats relevant to each of the 28 proposed CUs (Figure 1) are highlighted in Appendix 2. DFO Science, Habitat, and Fisheries and Aquaculture Management sectors and regional equivalents in the Province of Québec have each contributed. Each potential source of mortality was assessed with respect to the proportion of salmon in the entire CU that would be affected, and the time frame in which salmon had been or were about to be vulnerable to the threat. Possible management alternatives to mitigate the threats are proposed.

While there may be some inconsistencies between jurisdictions in the provision of details, it is evident that threats in the southern CUs outnumber those of more northern CUs. It is, as well, evident that conventional management options to increase abundance in the south are few, and that options do remain for the few threats in the more northern CUs. Management measures are consistent with the NASCO agreement on the management of fisheries, on the protection and restoration of Atlantic salmon habitat, and on the management of aquaculture and introductions and transfers.

2.3 Degree of Harm from Each Threat

An assessment of harm or loss to the potential spawning population resultant of each threat to the salmon in each of the 28 proposed CUs is also included in Appendix 2. Again, it is evident that harm in the southern CUs exceeds those of more northern CUs.

2.4 Aggregate Total Harm or Mortality from Threats

Cairns (2001) noted that it is very improbable that the decline in Atlantic salmon is due to any single cause, and factors contributing to a decline are likely to have acted in a cumulative manner. Aggregates of harm for the traditional permitted threats of directed fishing, bycatch, and habitat alterations are included in Appendix 2. Directed fishing and habitat alterations are considered in many CUs to have a ‘medium’ effect on populations; air pollution (acid rain) is an issue of concern in CUs 5 and 6 (Newfoundland, Southeast and South coasts), 15 (Nova Scotia Southern Upland), and 17 (Southwest New Brunswick). ‘Ecosystem change’ as an un-permitted threat was largely viewed from the perspective of freshwater issues; only overseers of CUs bordering the Bay of Fundy took into account the marine phase of the salmon’s life cycle and accorded unexplained marine mortality as a significant threat.

A semi-quantitative assessment of the impact of habitat-related threats to salmon is summarized by salmon CUs (Table 1). The most wide-ranging habitat threats to Atlantic salmon originate

from transportation infrastructure, agriculture, forestry and mining operations, and Municipal waste water discharge. The least severely threat-impacted areas are in Québec (CUs 18-28) and Newfoundland and Labrador (CUs 1-8). Conversely, the Maritime Provinces (CUs 9-17) are the most severely threat-impacted with several threats affecting > 30% of salmon or a loss of > 30% of spawners (Table 1; Appendix 2). Salmon of CU 15 (the Southern Upland) are severely impacted by acid rain which has caused the loss of populations in several of the 65 rivers within the CU. In combination with the persisting low marine survival (ecosystem change) common to CUs 13-17, in particular, acid rain is threatening the loss of the majority of the remaining salmon populations within that area (Amiro 2000; DFO 2000).

2.5 Assessment of Cross-Jurisdictional Authorities in Relation to Threats

Regulations are made under the authority of the Federal *Fisheries Act*. The Federal Department of Fisheries and Oceans (DFO) is the main authority for regulations concerning management of Atlantic salmon except in Québec where the Provincial government has been delegated the authority. All people fishing for Atlantic salmon must be authorized by a license. The Atlantic Provinces are responsible for licensing recreational freshwater fisheries for Atlantic salmon. The Federal government licenses all Aboriginal fisheries for Atlantic salmon.

Management and Licensing Authority by Province (DFO 2007b)

Province	Management Responsibilities For Atlantic Salmon	Authority
Newfoundland Labrador	Federal government manages the marine and freshwater fisheries and licensing of Aboriginal fisheries and the Nanatsiavut government licenses its Inuit domestic fishery. Province is responsible for licensing of the recreational harvest in fresh water and requires the use of tags for the Recreational Fishery.	Fishery (General) Regulations, Newfoundland Fishery Regulations, Aboriginal Communal Fishing License Regulations Wildlife Regulations – Newfoundland/Labrador Labrador Inuit Land Claim Agreement
New Brunswick, Nova Scotia, Prince Edward Island	Federal government manages marine and freshwater fisheries and licensing of Aboriginal fisheries. Provinces license recreational harvest in fresh water and require the use of tags for sport caught salmon.	Fishery (General) Regulations, Maritime Provinces Fishery Regulations, Aboriginal Communal Fishing License Regulations General Angling Regulations – N.B. Fishing Regulations – N.S. Angling Regulations – P.E.I.
Québec	The Province manages and licenses the harvest and requires the use of tags for sport caught salmon.	Fishery (General) Regulations, Aboriginal Communal Fishing License Regulations Québec Fishery Regulation

(Note: A *National Parks Act* fishing license is required in a National Park)

The *Fisheries Act* also has provisions for habitat protection. This extends to levying penalties for destruction of fish or fish habitat, and includes provisions for habitat restoration by a guilty

party. The *Fisheries Act* is considered to be the most powerful environmental legislation in Canada concerning fish and the protection and restoration of fish habitat.

Additional Federal environmental legislation of significance for protecting habitat, whether freshwater or marine, is included in the CEAA (used to assess proposed projects which could affect habitat (for example, dams, mines, and aquaculture sites), and the *Oceans Act* (provides a means to deal with at-sea pollution and protection of sensitive marine habitat). Environment Canada is responsible for administering Section 36 of the *Fisheries Act* and is therefore responsible for dealing with issues related to deleterious substances.

IBoF Atlantic salmon are also provided protection under the SARA and the Canadian *National Park Act*.

Federal environmental legislation is also supplemented by legislation under Provincial authority (above) aimed at preventing water pollution and habitat destruction by various activities such as the petroleum industry, logging, transportation, and pulp and paper.

Habitat Issues, Federal Authority, Areas of Applications and Legislation (DFO 2007b)

HABITAT ISSUES	RESPONSIBLE AUTHORITIES	AREAS OF APPLICATION	LEGISLATION
Prevention and destruction of fish and fish habitat, deposit of substance harmful to fish	Department of Fisheries and Oceans and Environment Canada	Any work near water: logging, mining, transportation corridors, construction, factory, farm and Municipal effluent. Requirement for fish passage and submission of construction plans.	*Fisheries Act* (applies throughout Canada including private property – no area is exempt)
Prevention of at-sea pollution, and protection of sensitive marine areas	Department of Fisheries and Oceans, Parks Canada, Natural Resource Canada, Transport Canada, and Environment Canada	Ship pollution (such as ballast water and waste oil), oil and gas activities. Sets aside marine areas to protect species and ecological sensitive areas.	*Oceans Act*
A requirement for environmental assessments of projects	Canadian Environmental Assessment Agency	Any project with potential to cause adverse environmental effects: mines, aquaculture, dams, transportation corridors, pipelines, etc.	*Canadian Environmental Assessment Act*
Prevents species from extinction; provisions for recovery and sound management	Department of Fisheries and Oceans, Parks Canada, and Environment Canada	Inner Bay of Fundy Atlantic salmon	*Species at Risk Act* *National Parks Act*
Deal with the effects of Acid Rain	Environment Canada	Atlantic coast of Nova Scotia	The Canada-wide Acid Rain Strategy for Post-2000 Canada-U.S. Air Quality Agreement

2.6 Early Identification of 'Principal Stakeholders' in Relation to Threats

Atlantic salmon are fished for food, social, and ceremonial purposes by more than 50 First Nations and other Aboriginal communities in Atlantic Canada and Québec (Section 5.4). For

both coastal and inland Aboriginal people, salmon have been and continue to be important culturally as a food source. Working with First Nations and other Aboriginal organizations is an essential part of salmon management and restoration.

Atlantic salmon has been of considerable importance to all Canadians living in Atlantic Canada and Québec. Prior to the 1980s, this heritage was perhaps more focused on commercial salmon fisheries (although subsistence uses were common and important throughout the region from the time of their arrival). However, with the recent downturns in abundance of some stocks, the focus now is more on community level conservation as well as on the related high value recreational fisheries and the socio-economic opportunities they provide. The growing acceptance of catch and release fisheries has also permitted the co-existence of both a fishery and maximization of escapements. The recreational fishing industry for wild Atlantic salmon in Atlantic Canada and Québec contributed upwards of $58 million in 2005 to local and Provincial economies (DFO 2007c) and sustained thousands of jobs, primarily in rural and remote areas where there is limited opportunity to establish viable, alternative industries. This is, however, only 65% and 40% of respective estimated expenditures in 2000 (DFO 2003) and 1995 (DFO 1997), when Atlantic salmon were in greater abundance.

3.0. Existing Protection

3.1 Legislation

Section 91 of the *Constitution Act, 1867* assigns exclusive legislative authority over 'sea coast and inland fisheries' to the Federal government. The Minister of Fisheries and Oceans exercises this authority under the *Fisheries Act* and regulations. The Minister retains the authority and accountability for the protection and sustainable use of fisheries resources and their habitat. The Minister's authority includes the discretion and 'power' necessary to regulate access to the resource, impose conditions on harvesting, and enforce regulations. However, management authority was delegated to the Province of Québec in 1922 for the waters under the Province's jurisdiction. DFO remains responsible for and applies the *Fisheries Act* provision for the conservation and protection of fish habitat in watercourses in the Province of Québec but accedes to the Province on delivery of some aspects of this responsibility.

Although the primary constitutional responsibility to manage and conserve salmon is Federal, Provincial governments (as part of their authority relating to property rights under Section 92 of *Constitution Act, 1867*) also have important authorities in relation to the harvesting of salmon in inland waters. Licences for recreational salmon angling are issued by Provincial governments. Provincial governments collect fees for these licences, and have enacted Provincial regulations setting conservation measures such as angler licensing and requirements for tagging harvested fish. Furthermore, Provincial and Municipal governments have their own important constitutional authorities with respect to land, water, environment, and waste disposal. Therefore, the responsibility for conservation of salmon, and in particular for compliance with related management measures, while led by DFO, is shared with other levels of government.

The legal context for management of wild Atlantic salmon is also defined by court decisions respecting Aboriginal and treaty rights. Existing Aboriginal and treaty rights are recognized and affirmed in Section 35 of the *Constitution Act, 1982*. In its 1990 decision in *R. v. Sparrow*, the Supreme Court of Canada held that the recognition and affirmation of existing Aboriginal rights in the *Constitution Act, 1982*, means that any infringement of such rights must be justified. As

described in more detail below, DFO seeks to manage fisheries in a manner consistent with the decision of the Supreme Court of Canada in *R. v. Sparrow* and subsequent court decisions. Specifically, DFO is committed to managing fisheries such that Aboriginal fishing for food, social and ceremonial purposes has priority over other fisheries once conservation has been met.

3.2 Existing Status Designations (Domestic and International)

Historically the Atlantic salmon could be found throughout the North Atlantic, ranging in the Western Atlantic from Québec's Ungava region southward to New York State, and in the Eastern Atlantic from the Arctic Circle southward to Portugal. There is an abundance of scientific information on recent status (ICES 2006), some publications on past occurrence (MacCrimmon and Gots 1979; Parrish *et al* 1998), and a volume of information posted by the World Wildlife Fund (WWF 2001) on the status of 2,005 salmon bearing rivers in Northeast and Northwest Atlantic nations employing The World Conservation Union (IUCN) Red List for Species (ICUN 2000) and commissioned specialists. There is, however, a general lack of up-to-date 'national' jurisdiction-reviewed official 'status designations'.

Designations: Atlantic salmon:

IUCN: LR/lc (lower risk/least concern 1996)

Distribution: Argentina [int], Australia [int], Belgium, Canada, Chile [int], Czech Republic [RE]. Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Greenland, Iceland, Ireland, Italy, Latvia, Lithuania, Netherlands, New Zealand [int], Norway, Poland, Portugal, Russian Federation, Slovakia, Spain, Sweden, Switzerland [RE], United Kingdom, and United States where 'int' = introduced; 'RE' = extirpated/restored?

Inner Bay of Fundy Atlantic salmon DU:

COSEWIC: Endangered (May 2001, April 2006)
SARA Endangered, Schedule 1 (June 2003)

Gulf of Maine (GOM) Distinct Population Segment (DPS)

USFWS Endangered (Dec 18, 2000)

Atlantic salmon – Great Lakes population

Committee on the Status of Species at Risk in Ontario (COSSARO) Extirpated (2003)

Atlantic salmon – Lake Ontario population

COSEWIC Extirpated (April 2006)

3.3 Existing Management Measures (Complementary to Section 2)

When pronounced declines in abundance were observed in the 1980s, a wide range of management measures were introduced for conservation purposes. The closures in 1972 of strategic intercepting and terminal commercial fisheries were expanded in 1984 to include all the commercial fisheries of the Maritime Provinces and portions of Québec. Also in 1984, the mandatory catch and release of all large salmon was introduced to the recreational fisheries of the Maritime Provinces and insular Newfoundland. These measures had the effect of increasing returns and spawning escapements of salmon in the Maritime Provinces with subsequent responses in juvenile production.

In contrast, overall escapements to Newfoundland were not consistent with 'plan' expectations. The failure of most stocks to rebuild in subsequent years to anticipated levels following the management measures of 1984 resulted in further reductions and eventually moratoria on commercial salmon fisheries in 1992 for insular Newfoundland, in 1998 for Labrador, and in 2000 for all commercial fisheries in Eastern Canada. Since then, more restrictive management measures have been introduced in an attempt to compensate for declining survival and salmon abundance, including reduced daily and season bag limits, mandatory catch and release of large salmon and in some cases all sizes of salmon, and in large portions of the Maritimes the total closure of the recreational fisheries. Several Aboriginal community fisheries have been severely reduced and, in some cases, voluntarily suspended.

Salmon are harvested only in recreational and Aboriginal fisheries and as bycatch in one fishery in Labrador. Fisheries are principally managed on a river-specific basis. The management of retention fisheries for Atlantic salmon is governed by the status of the river-specific stocks. In rivers where retention is permitted, harvests are regulated by tagging or quotas and catch reporting.

Fisheries on the age groups of Atlantic salmon are managed based on the fork length of the fish; small salmon have a fork length less than 63cm; large salmon are of fork length equal to or greater than 63cm. These length classes represent predominantly one-sea-winter salmon in the small category, and multi-sea-winter and repeat spawners (both one-sea-winter and multi-sea-winter) in the large category.

A distinction is made between harvests and catches. Harvest represents fish which are retained in the legal fisheries. Catches include fish which are retained as well as those released alive as in catch and release recreational fisheries.

Any Atlantic salmon caught as bycatch in other fishing gear or fisheries (excepting one fishery in Labrador) cannot be retained and must be returned to the water.

3.3.1 Aboriginal and Food Fisheries

In 1990, the Supreme Court of Canada affirmed the Aboriginal priority rights over other fisheries to fishing for food, social, and ceremonial purposes. Atlantic salmon are fished by more than 50 First Nations and other Aboriginal communities in Eastern Canada (5.4). Fishing is generally subject to agreements or licenses which may stipulate gear, season, and catch limits. Harvests are required to be reported collectively by each Aboriginal user group. Due to conservation considerations, many Aboriginal communities in the south either cannot or do not exercise their rights to fish for salmon.

Since 2004, food fishery arrangements have been developed with the Labrador Inuit Association (now Nunatsiavut Government), the Innu First Nation, and the Labrador Metis Nation. These fisheries occur in traditional areas for example, bays and estuaries close to river mouths, and in near-shore areas of coastal Labrador. Considering that the fishery occurs away from the headland areas where the commercial fishery historically took place, there is minimal interception of non-local origin salmon stocks.

Since 2000, a licensed Labrador resident (all resident inclusive) subsistence fishery has taken place in the Lake Melville and Southern Labrador areas. Residents are permitted to retain a

maximum of four salmon of any size as a bycatch while fishing for trout and charr using fixed gill nets of specified size. Retained salmon are required to be tagged along with a requirement to complete and return a logbook to DFO following the closure of the fishery.

Since 2000, the Canadian Aboriginal and food fishery harvests have varied between 42 and 62.4t annually, with less than 50% by number of the harvested fish being large salmon (ICES 2009). These fisheries occur principally in rivers and estuaries except in Labrador where about 20% of the harvests occur in coastal (marine) areas.

3.3.2 Commercial Fisheries

Commercial exploitation of salmon was continually reduced through gear, season, location, and license transfer regulations until a general license reduction program was initiated in 1972. Conservation measures initiated in 1972 continued in 1984 when the commercial fisheries of New Brunswick, Nova Scotia, Prince Edward Island, as well as portions of Québec were closed. Further reductions were introduced through the late 1980s and early 1990s, leading to a moratorium on commercial salmon fishing for insular Newfoundland in 1992, followed by a moratorium in 1998 for Labrador, and culminating with the closure of all commercial fisheries for Atlantic salmon in Eastern Canada in 2000.

3.3.3 Recreational Fisheries

Licenses are required for all persons fishing recreationally for Atlantic salmon. All recreational fisheries occur in rivers with restrictions on gear. The fisheries are also regulated by seasons as well as daily and seasonal bag limits. The daily and seasonal bag limits vary by and within provinces, within areas and by river. The maximum season limit is eight small salmon (no large salmon) in New Brunswick and parts of Nova Scotia. In Newfoundland, retention limits range from a seasonal limit of six fish to catch and release based on a river classification system. In those rivers of Southern Labrador crossed by the Trans Labrador Highway, a seasonal retention limit of two small salmon and no retention of large salmon is applied. Where large salmon can be retained in Québec and Labrador, the maximum limit is seven fish of any size in Québec and four fish in Labrador (of which only one could be a large salmon). All retained salmon must be tagged. Provincial licence and guide requirements for Atlantic salmon anglers in Atlantic Canada are summarized in Table 2.

The reporting frameworks for harvests and catches in the recreational fisheries vary by province. In Québec, all retained fish must be reported to river authorities within 48 hours of harvest, but the reporting of catch and release fish is voluntary. In Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and New Brunswick, a reporting stub is issued with each license, and all anglers are requested to record catches and return the license stub to authorities at the end of the fishing season.

The practice of catch and release has increased in the recreational fisheries of Canada. In 1984, it became mandatory for anglers to release all large salmon in the Maritime Provinces and Newfoundland. In recent years, anglers have been required to release all salmon on some rivers and, on others, anglers voluntarily release caught fish. In recent years, some provinces have introduced catch and release only licenses.

3.4 Recovery Measures Currently In Place

"In the context of species-at-risk conservation, recovery is the process by which the decline of an endangered, threatened, or species of special concern is arrested or reversed and threats removed or reduced to improve the likelihood of the species persistence in the wild" (National Recovery Working Group 2005). The iBoF populations are the only listed (endangered) sea-run Atlantic salmon populations in Eastern Canada to which the term 'recovery measures' are truly applicable and which have in fact undergone the process of planning, documenting, and implementing priority actions to reduce their risk of extinction (DFO 2008).

3.4.1 Inner Bay of Fundy, CU 16

The iBoF Atlantic salmon populations are considered a 'Designatable Unit' (DU) by COSEWIC (2006). The entire iBoF DU exists within Eastern Canada. It includes all rivers draining into the Bay of Fundy, between and including the Mispec River (northeast of the Saint John River in New Brunswick) and Pereaux River (Minas Basin in Nova Scotia). Adult Atlantic salmon are reported to have inhabited from 32 to 50 rivers in that area. IBoF Atlantic salmon are a distinct genetic component of the anadromous species that possess unique life history traits. They are presently at critically low levels, listed as endangered by COSEWIC and protected under the Federal SARA.

All commercial fisheries for Atlantic salmon in the Bay of Fundy were closed after the 1984 season. Other local commercial gear that was known or suspected of having occasionally caught salmon incidentally (for example, shad and gaspereau gillnets, herring weirs, herring seiners) remain open, although since 1984 all salmon caught incidentally in such fisheries are required by regulation to be released, dead or alive. Recreational fisheries for salmon on iBoF rivers have been closed since 1990, except on the Gaspereau River which remained open for recreational and food fisheries until 1994, closed in 1995, then was re-opened under agreements in 1996 and 1997 with a much shorter catch and release only angling season and a limited food fishery. Since 1998 the river has been closed to fishing.

Interestingly, an allowable harm assessment for these populations in 2004 concluded that any level of human-induced harm could jeopardize survival or recovery of the stock complex (DFO 2004; O'Boyle 2003). Thus, the harmful activities and their potential impacts on iBoF salmon were reviewed only in so much as to provide an evaluation framework for fisheries managers (Amiro 2004; O'Boyle 2003).

Guided by Sections 73(2) and (3) of the SARA, fisheries managers were able to justify the issuance of SARA Allowable Harm Permits for scientific research relating to the conservation and enhancement of the species' chances of survival in the wild. They concluded that with closures of directed salmon fisheries, the suppressed state of iBoF salmon, and the mandatory release and likely high survival of any incidentally caught salmon in non-salmon commercial and recreational gear, the likelihood of harm to iBoF salmon would be remote. The Department also noted that, in the absence of known impacts by the on-going aquaculture industry in the Western Bay of Fundy on iBoF salmon (DFO 1999), and in consideration of efforts by the hydroelectric industry to minimize harm with improved fish passage and bypass facilities on the Gaspereau River, it was at that time socially and economically impractical to eliminate all human interaction with the species. DFO for its part directed SARA project funding towards additional enforcement and compliance, habitat monitoring, and public education and awareness programs regarding iBoF salmon, particularly with respect to the SARA prohibitions against killing, harming, capturing, taking, etc. of fish and their habitat, and support of LGB facilities.

Thus, existing fisheries and hydro electric generation within the iBoF and the aquaculture industry in the Western Bay of Fundy continued mindful of the prohibitions of SARA. Managers remain cognizant of the impact of existing activities, those for which new information is becoming available, and the possible necessity for re-assessment of harm on salmon populations being expanded by LGB activities. Proposed new activities having potential for harming iBoF salmon will of necessity be assessed on a case-by-case basis.

The main recovery measure, aside from fisheries management initiatives, was then the implementation in 1998 of live gene banking from three biodiversity facilities. This is credited with halting the decline of the Salmon, Pt. Wolfe, and Upper Salmon river populations in New Brunswick, and the Stewiacke and Gaspereau river populations in Nova Scotia, at least through to the smolt stage. Surplus juvenile production from the facilities has as well been released as contingencies to several rivers whose populations had been extirpated.

An assessment by COSEWIC (2006) evaluated several reviews (including Cairns 2001 and National Recovery Team 2002) that attempted to list and prioritize threats responsible for the decline and concluded that the leading marine considerations were (in no particular order): 1) interactions with farmed and hatchery salmon (e.g., competition with escapees for food, parasite and disease outbreaks, and modified predator interactions); 2) ecological community shifts (e.g., increased predator abundances and lack of or reduced forage species); 3) depressed population phenomena (e.g., lack of recruits to form effective schools); 4) environmental shifts (e.g., temperature shifts depressing ocean productivity and altered migration routes leading to decreased survival); 5) fisheries (e.g., excessive illegal and/or incidental catches of salmon); and 6) the possibility of cumulative and/or synergic interactions among these and other threats.

COSEWIC (2006) also concluded that the leading freshwater considerations were (in no particular order): 1) depressed population phenomena (as a result of abnormal behaviour due to low abundance or because of inbreeding depression); 2) changes in environmental conditions (climate changes leading to premature smolt emigration or decreasing freshwater productivity, and atmospheric changes increasing ultraviolet radiation and its impacts); and 3) contaminants.

Because it has been shown that existing freshwater habitat is no more limiting in its ability to produce smolts than it may have been 15 years prior to listing, investigations pertinent to recovery of iBoF salmon have principally been focused on direct and indirect impacts of the ocean ecosystem. Efforts have included the tracking of salmon migration patterns, feeding areas and prey, interaction with aquaculture sites, parasite loads, and presence of disease organisms during their first summer months as postsmolts. Technology is now being developed to ascertain their whereabouts during the subsequent fall and winter months and most importantly, the potential to determine or hypothesize the probable cause of their fate at sea. To date, there is no information to suggest the benefits of different management regimes, for example, the Fundy Isles aquaculture industry, herring and mackerel *(Scomber scombrus)* trawl fisheries, or the growing abundance of grey and harbor seals.

3.4.2 Outer Bay of Fundy Rivers, CU 17

The principal rivers of the outer Bay are the St. Croix (international boundary), Digdeguash, Magaguadavic, and Saint John. Abundance in all rivers declined in the early 1980s. The Saint John River, the only one which had a commercial fishery, has been closed to commercial fishing for Atlantic salmon since 1984. The recreational fisheries, mostly on the Saint John, were closed to retention fisheries for large salmon in 1985 and to retention of small salmon since the early 1990s.

Aboriginal fisheries on the Saint John operated under various quotas (up to 3,700 fish total) through the early 1990s, but were voluntarily discontinued in 1997. Hook and release fisheries, which were allowed intermittently on the Saint John through the mid 1990s, were essentially closed by 1998. By this date all other rivers in the outer Bay were closed to fishing.

Outer Fundy rivers had over a century of supplemental stocking from Federal hatcheries and, since 1968, from the Saint John River's Mactaquac facility. Most stocking was to the Saint John River and consisted of upwards of 300,000 'quality' smolts reared from eggs of May - early June, late June - early July, and late July - early August adults collected at Mactaquac, as well as opportunistic collections (early-run preferred) from the Nashwaak and Hammond rivers. In the 1980s, accelerated rearing of smolts was implemented to increase the quality of the product and (it was hypothesized) increase the proportion of two-sea-winter fish. In the 1990s, NB Power as well contributed to the improvement of upstream passage facilities for salmon at the Beechwood and Tobique hydroelectric dams.

Despite the preceding measures, stocks declined precipitously through the 1990s in the Saint John and other outer Bay rivers and prompted the need for proactive 'recovery' measures. First steps were taken in 2000, when smolt production at Mactaquac was decreased in favour of the captive rearing of mature adults for release back to their river or tributary of origin. This practise utilized the collection of river or tributary specific wild juveniles (pre-smolts and smolts), few of which would survive at sea to contribute to egg depositions, in order to increase spawning escapements in specific tributaries, maximize the use of wild returning spawners to spawn naturally, and minimize the loss of genetic diversity frequently associated with fish culture practices.

An LGB program was as well initiated by stakeholders, including the aquaculture industry, in 1996 with what was believed to be the last vestiges of the wild Magaguadavic River population (Carr *et al* 2004). Also, the St. Croix population, which had been largely extirpated by the early 1950s (Bair and Rounsefell 1951) and had sporadically had the salmon population supported and was the recipient of Saint John and Penobscot river fish (juveniles, smolts and adults) since at least the 1970s, facilitated by the St. Croix International Waterway Commission and assisted by both DFO and the Maine Atlantic Salmon Commission. Recent emphasis has been on the the capture and retention of naturalized returning adults by the Commission, collection and hatching of eggs by DFO, and the rearing and early release of juveniles to the prime production areas by the Waterway Commission from returning naturalized adults.

As well, in 2000, on the Saint John River, stakeholders accessing public and private funding sources initiated as their own recovery measure an assessment and plan to address the absence of downstream passage facilities (targeted at smolts) at the three major dams on the river. While the goal has yet to be met, their efforts did result in a prioritization of dams that should receive fish passage, the design of a facility at Tobique Narrows that would optimize safety, benefits and costs, and provide options for operational research and assessment. The plans resulted in renewed field assessments of conditions and specific occurrences of water spill or turbine passage, and were the basis for a risk assessment of the proposed facility to yield measurable benefits at current low levels of marine survival and habitat constrained juvenile production.

3.4.3 Southern Upland Rivers of Nova Scotia, CU 15

Acid rain has had a major destructive impact in many of Canada's lakes and rivers. Nova Scotia is the most heavily impacted province in Canada in terms of the proportion of fish habitat that

has been damaged by acid rain. The geological area known as the Southern Upland is the main area impacted (DFO 2000).

At least 65 rivers within the Southern Upland historically maintained salmon populations. Rivers of the Southern Upland region are generally organic-acid stained, of lower productivity, and, when combined with acid precipitation, can result in acidic conditions toxic to salmon. As of 1986, there were 20 rivers that were partially acidified (main-river annual mean pH between 4.7 and 5.0), and at least 14 rivers were heavily acidified (pH < 4.7) and had lost their population of Atlantic salmon. There is evidence that, despite reduction in sulphate depositions through the 1990s, acidity in Southern Upland rivers has not been reduced at rates observed in other geographic areas. Juvenile monitoring in recent years suggests that population extirpations have doubled in the 15 years since 1986, and that most populations are critically low (DFO 2000).

Management options proposed in 2000 to protect remaining stocks included: liming to neutralize river acidity and restore some habitat production capacity; stocking of hatchery-reared fish to increase salmon returns, live gene banking to preserve stocks and support future restoration, and restricting exploitation (DFO 2000). Principal recommendations were to support Canada's position to negotiate a further 50% reduction in sulfate emission limits in Eastern Canada and the United States, and develop a recovery plan for Southern Upland salmon to prevent further loss of stocks and to hasten their recovery (DFO 2000).

As a result, DFO Regional Science initiated live gene banking and captive adult rearing of a few severely depleted stocks Southern Upland stocks to minimize the loss of genetic diversity. This was accommodated (along with iBoF salmon) in the two Nova Scotia hatcheries returned to the Department after their failed public divestitures. As well, exploitation which had already been reduced by the closure of the commercial fishery in 1984, was further reduced by the closure of most recreational fisheries as a result of reduced marine survival (except for those few rivers which had been supported by hatchery stocking under divestiture), and a recovery plan (Ritter 2000) was drafted by DFO with input from stakeholders and the Province of Nova Scotia.

Stakeholders, with leadership from the Nova Scotia Salmon Association, planned and funded the installation in late 2005 of a lime doser on the West River Sheet Harbour, principally under the banner of a demonstration project. Strapped for personnel and financial resources to operate the re-acquired and unfunded Nova Scotia hatcheries (renamed biodiversity facilities), without the capacity to initiate and conduct habitat science which had been lost to 'Program Review', and without a Federal mandate to indulge in the liming of rivers, Regional Science failed to implement much of the proposed investigative science proposed within the draft Recovery Plan. A collaborative study with Environment Canada resulting in forecasts of 50-100 years for recovery of pH (Clair *et al* 2004) did suggest, however, the level of commitment that would be required to effect recovery if marine survival were to increase.

4.0 Potential Conservation Targets

Stock status of Atlantic salmon is currently evaluated in the context of abundance and attainment of river-specific conservation requirements. The objective is to maintain spawning escapements above the conservation requirements. In the Maritime Provinces, the conservation limit is an egg deposition rate of 240 eggs per 100 m^2 of fluvial habitat, and this rate is expected to maximize freshwater production. In Newfoundland, a deposition rate of 240 eggs per 100 m^2 of fluvial area is used, with an additional requirement of 368 eggs per ha of pond area, or 105 eggs per ha of pond area in the Northern Peninsula. The recently recommended conservation limit for Labrador

is 190 eggs per 100 m^2; the conservation target remains at 240 eggs per m^2 (Reddin *et al* 2006). In Québec, a set of parameters is used in varying circumstances to determine the number of eggs necessary to optimize harvest potential of adults. The egg requirements are 168 eggs per 100 m^2 of units of productive habitat.

Conservation limits in terms of two-sea-winter salmon have also been defined for Eastern Canada (O'Connell *et al* 1997) and are used in the development of the catch advice and risk analysis for mixed stock marine fisheries at West Greenland and in Canada. The management objective is to maintain the spawning escapement in each river above the conservation limit. Management measures to control undesired consequences of the fisheries are user specific.

4.1 Goal of Conservation Measures

The goal of conservation measures for Atlantic salmon in Canada, as was recently drafted for an updated policy for the conservation of wild Atlantic Salmon (DFO 2009a), is, "To maintain and restore healthy and diverse salmon populations and their habitat, for the benefit and enjoyment of the people of Canada in perpetuity". Key elements are 'conservation' and 'sustainable use and benefits'. As resource management agencies, DFO and MRNF are committed to the sustainable use and benefit of wild salmon resources, that is, the use of biological resources in a way and at a rate that does not lead to their long-term decline, but rather maintains the potential for future generations to meet their needs and aspirations (DFO 2009a). However, both agencies recognize that sustainability can only be achieved through protection of the biological foundation, that is, the protection, maintenance, and rehabilitation of genetic diversity, species, and ecosystems to sustain biodiversity, and the continuance of evolutionary and natural production processes.

To achieve the outcome, DFO and MRNF indicate that three objectives must be fulfilled:

1. Safeguard the genetic diversity of wild Atlantic salmon;

2. Maintain habitat and ecosystem integrity; and

3. Manage fisheries for sustainable use and benefits.

Principles by which the objectives should be guided include:

1. Conservation of wild Atlantic salmon, their genetic diversity, and their habitats is the highest priority in resource management decision making.

2. Resource management decisions will consider biological, social, and economic consequences; they will reflect best science including Aboriginal Traditional Knowledge (ATK) and local knowledge, and they will maintain the potential for future generations to meet their needs and aspirations.

3. Resource management decisions will be made in an open, transparent, and inclusive manner.

4. Conservation initiatives will be optimized by actively engaging Provincial governments, First Nations and other Aboriginal organizations, volunteers, and other stakeholders in the development, implementation, promotion, maintenance of, and compliance with management decisions, while DFO maintains its legislative authority towards the conservation of Atlantic salmon and its habitat.

It is suggested (DFO 2009a) that implementation of such a plan should lead to:

- Healthy, diverse, and abundant wild salmon populations for future generations;
- Sustainable fisheries to meet the needs of First Nations and other Aboriginal organizations and contribute to the current and future prosperity of all Canadians; and
- Inclusion of ecosystem values in management decisions.

4.2 New and Proposed Species Rebuilding and Habitat Restoration Strategies

The Government of Canada has been working towards the implementation of important policies and strategies for maintenance and recovery of wild Atlantic salmon in Canada. These policies and strategies include: 1) Canada's Policy for the Conservation of Wild Atlantic Salmon – the modernization of a 20-year-old policy to reflect current directions and strategies concerning stewardship and ecosystem-based integrated management approach; 2) an Atlantic Salmon Endowment Fund – a $30 million grant to the Atlantic Salmon Conservation Foundation, the financial interest from which is to help achieve healthy and sustainable wild Atlantic salmon and its habitat; and 3) governance and regulatory reform (risk management framework) for aquaculture management (DFO 2007b).

Canada's Policy for Conservation of Wild Atlantic Salmon (2009a [draft][10]) is likely to embrace strategies adapted from those of Canada's Policy for Conservation of Wild Pacific Salmon (DFO 2005). The proposed strategies to safeguard the genetic diversity of wild Atlantic salmon, maintain habitat and ecosystem integrity, and manage fisheries for sustainable use and benefits are:

- Assessment and monitoring of population status;
- Conservation and protection of Atlantic salmon habitat;
- Inclusion of ecosystem values and monitoring;
- Integrated fisheries management planning;
- Program delivery; and
- Performance review.

The first three strategies are likely to influence the conservation and management of Atlantic salmon stocks in Canada over the long term. In the interim, management measures described previously (Section 3.3) will continue. As a part of the usual course of managing wild Atlantic salmon stocks in Canada, adjustments will be made to address the circumstances associated with individual stocks and stock groupings.

Also proposed is an overhaul of the *Fisheries Act*; the federal law that governs the management of fisheries and the protection of fish habitat in Canada. The changes being considered (DFO 2007b) will:

- Require for the first time the consideration of a precautionary approach to conserve aquatic resources;
- Put in place a science-based ecosystem approach to fisheries management;
- Introduce provisions concerning aquatic invasive species, and

[10] Canada's Policy for Conservation of Wild Atlantic Salmon was released in August, 2009, and can be found at http://www.dfo-mpo.gc.ca/fm-gp/policies-politiques/wasp-pss/wasp-psas-2009-eng.htm. The draft version was available during the development of this document.

- Enhance the approach in dealing with and enforcing fish habitat provisions.

The proposed overhaul of the Act was presented in the Canadian Parliament in late 2006 and released to the public for consultation in 2007. There are a number of stages that the proposed changes must go through (incomplete in 2009) before coming into force. After this process, there will be an implementation stage when some components of the revised Act would go into effect immediately and others involving new regulations would be phased in. The new Act will direct Canadian government decisions and activities over the longer term in several areas involving management of fisheries, and restoration and protection of habitat. Details of the proposed new *Fisheries Act* can be viewed at www.dfo-mpo.gc.ca.

The following sections are intended to provide a description of more specific initiatives that have recently been or will be implemented to influence the conservation and management of Atlantic salmon (DFO 2007b). These measures are in addition to the usual or 'routine' actions that are taken and are meant to address significant stocks or groups of stocks or areas.

4.2.1 Management of Fisheries

Integrated management planning that incorporates the biological, economic, and social factors for sustainable fisheries has been used in Canada for several years. This process will continue and much emphasis is placed on increasing the stakeholders, aboriginal, and provincial participation in planning and shared delivery of plans (DFO 2007 b). Management measures are reviewed annually and in most situations throughout the year. This structured, systematic, and inclusive approach to management plans applies the principles of risk management and the precautionary approach. It also uses the methodology outlined in NASCO's Decision Structure (NASCO 2002) to aid the Council and Commissions of NASCO and relevant authorities in implementing the precautionary approach for the management of North Atlantic salmon fisheries. The following will be new or additional actions in the integrated management of wild Atlantic salmon stocks.

Catch Data

Unreported catch in Canada is significant compared to reported catch. Significant resources have been committed in recent years to deal with poaching and expanding and improved catch reporting systems. There were questions concerning the validity of the estimates of unreported catch and to a lesser degree, the reported catch. Canada was to undertake improvements in catch data reporting, with emphasis on validating unreported catch. Examinations have begun on past catch, catch and release, and unreported catch estimates as provided to ICES. A review was to be done on reporting methodology for weakness in reliability and consistency and, based on findings, implement, where possible, changes to reporting methodology to improve reliability and consistency in reporting of catch, including unreported catch (DFO 2007b).

Coastal and Bycatch Fisheries

Additional measures were introduced in 2006 to reduce the catch of 2SW fish in coastal areas of Labrador. These included prohibition of larger mesh nets (maximum mesh size of 4.5 inches), and a monitoring program for peak runs of large salmon and in-season closures based on the data. The effectiveness of these measures was to be evaluated and adjustments were to be made if a further reduction in the catch of 2SW salmon was warranted (DFO 2007b).

Recognizing the ICES advice concerning the West Greenland fishery since 2006 (no fishery), Canada consults with the NASCO parties on the applicability of 2006 measures (maximum 20

tonnes internal subsistence) in subsequent years. This was to be based on an agreed framework of indicators which were to be used in identifying any significant change in the previously provided multi-annual advice (DFO 2007b).

As a result, enforcement activities will be maintained and efforts will continue to improve the effectiveness of enforcement measures to thwart illegal fishing. Enforcement activities, violations, prosecutions, and penalties will be summarized annually and there will be continued effort to increase the severity of the penalties related to illegal fishing.

4.2.2 Protect and Restore Salmon Habitat

Habitat efforts outlined in Section 3 will continue. In many cases these efforts include a collaborative approach that integrates the roles and responsibilities governments (Federal, Provincial, and Municipal) and that of key partners such as First Nations, non-government organizations such as the Atlantic Salmon Federation, watershed groups, universities, and industries. One important action in 2007 was the establishment of the Atlantic Salmon Endowment Fund and the granting of $30M to the Atlantic Salmon Conservation Foundation (ASCF). The ASCF, at arm's-length from government, has invested the $30M grant. The income earned on the investment will be used to fund projects that help watershed and community organizations working on a range of wild Atlantic salmon habitat, enhancement, monitoring and conservation initiatives

Other programs include the continuation of the Nova Scotia Adopt-A-Stream program administered by the Nova Scotia Salmon Association and designed to help community-based volunteer organizations carry out projects to restore fish habitat and increase fish populations; and, continued enforcement of provisions of the *Fisheries Act* and, where necessary, seeking of important monetary penalties for destruction of fish or fish habitat. Habitat-related work is as well carried out by stakeholders with funding available from various sources, such as the *Environmental Damages Fund*[11], *New Brunswick Wildlife Trust Fund*[12] and the *Habitat Stewardship Program*[13].

Acid Rain

The Canada-Wide Acid Rain Strategy for Post-2000 included commitments of SO_2 emission reductions in key areas such as Ontario, Québec, New Brunswick, and Nova Scotia. Ontario, a significant Canadian source of emissions, has embarked on a plan to significantly reduce SO_2 emissions by 2010 and further reductions by 2015 (a possible 46% reduction from 1994 levels). This plan includes elimination of a number of coal fired electrical generation plants. In Québec, strategies are also in place to reduce emissions from the mining and smelting industry (a significant source). A 50% reduction in emissions by 2010 has been targeted in Québec. Despite almost halving Canadian SO_2 emissions since 1980, without further significant reductions of SO_2 emissions from the U.S., the acid rain problem in Eastern Canada will not be resolved. Unfortunately, power providers in the U.S. are expected to build the equivalent of 280 coal fired electricity generating plants (500 megawatt) between 2003 and 2030 (Hawkins *et al* 2006).

[11] See "http://www.ec.gc.ca/edf-fde/default.asp?lang=En&n=C5BAD261-1" for program details.
[12] See "http://www.nbwtf.ca/eindex.asp" for program details.
[13] See "http://www.cws-scf.ec.gc/hsp-pih/" for program details.

Anticipated actions include: 1) the Nova Scotia Acid Rain Campaign (NS Salmon Association and Atlantic Salmon Federation) will monitor the effectiveness of the targeted liming project on the West River Sheet Harbour at achieving the conservation objectives related to increased salmon and trout freshwater production; 2) promotion of acid rain as an issue for NASCO attention; and 3) the promotion and dissemination and exchange of information about acid rain impacts and ways to reduce its effects.

4.2.3 Manage Aquaculture

Introductions and Transfers

Discussion will continue between the Canada Food Inspection Agency (CFIA), DFO and the Introduction and Transfer Committees (ITCs) to develop a revised model for cooperative delivery for I&T management. Proposed amendments to Canada's Health of Animal Regulations under the *Health of Animals Act* will further strengthen the I&T process and bring the significant resources and expertise of the CFIA to aquatic animal health management. CFIA will have the authority and expertise to undertake risk assessments for diseases of international and national concern and to issue import and domestic movement permits from a fish health perspective for proposed shipments, while ITCs will focus primarily on genetic and ecological impacts, but also on local fish health issues that are outside the mandate of CFIA, associated with the release and transfer of aquatic animals.

Fish Health

Amendments to Canada's Health of Animals Regulations scheduled for 2010/2011 will allow for the full implementation of the National Aquatic Animal Health Program (NAAHP). CFIA will be responsible for managing aquatic animal disease risks associated with trade in finfish, molluscs and crustaceans based on new zonation schemes, surveillance and monitoring programs, and disease control and contingency plans. DFO Science will be responsible for disease research, diagnostic services as well as providing scientific advice. When implemented, the program will provide a robust disease management regime for wild and cultured fish populations in Canadian waters. Complimentary to these efforts is the opening of new Aquatic Veterinary Diagnostic Facilities serving New Brunswick and Newfoundland and Labrador.

Containment Codes

Components of a comprehensive containment strategy include provisions for cage design and moorings, inspection and audit programs, contingency plans in the event of breaches, and annual reporting. For governments, the integration of codes with regulatory frameworks ensures a consistent application of best management practices by the industry.

Newfoundland and Labrador has a code of Containment for the Culture of Salmonids and includes it as a condition of the finfish-culture licence. In addition, DFO and the New Brunswick Department of Agriculture and Aquaculture (NBDAA) have recently developed a *Southwest New Brunswick Breach of Containment Governance Document.* This document is meant to compliment the work of the New Brunswick Salmon Growers Association (NBSGA) *Code of Containment for Cultured Atlantic Salmon in Marine Net Pens in New Brunswick.* Together these documents provide aquaculturists operating in Southwest New Brunswick with a clear and concise statement of their obligations respecting breaches and recaptures of farmed fish. As such, aquaculturists will be required to apply for written permission under the Federal *Fisheries Act* and the *Federal Species at Risk Act* to conduct any recapture activities. Such permissions, if granted, will be accompanied by the provision for reporting requirements and gear requirements should such an event occur.

Bay Management
Bay management is an effective tool for areas with high concentration of aquaculture sites and compliments production policies of which site fallowing and crop rotation are critical elements. The approach promotes healthier ecosystems and benefits to farmed and wild stocks.

In New Brunswick, the Bay of Fundy is divided into a number of separate management areas and within each, only farmed salmon born in the same year are raised within the same management area, thus reducing the incidence of parasites or pathogens from being transmitted to disease-free incoming smolts. New strategies are dependent on new science.

Science
Aquaculture is an industry based on the knowledge of engineers, environmental scientists, oceanographers, ecologists, habitat biologists, marine biologists, health scientists, and socio-economists, governments, academics, and industry. In 2007, DFO created a new Center for Integrated Aquaculture Science (CIAS) to lead and implement an integrated aquaculture research program that will leverage DFO expertise on aquaculture science across the department, and generate scientific knowledge in support of future policies and management decision. The CIAS continues to develop its strategy for implementing the integrated research aquaculture program.

Sharing information
Governments and industry will continue to update websites, meet special interest groups on a regular basis, and address specific issues as they arise.

4.2.4 Marine Survival

Oceanic influences on salmon growth, behaviour, and survival are complex and difficult to study because of the large temporal and spatial scales over which they operate and the dynamic nature of the marine environment in both time and space. Linking variations in salmon returns to changes in the aquatic ecosystems requires costly large-scale monitoring programs. Efforts are needed nationally and internationally to collaborate and cost share with interested parties in the conduct of a comprehensive Northwest Atlantic-wide survey to collect information on migration patterns, distribution, and possible factors that affect the status of salmon.

Canada is committed to NASCO's SALSEA program (steered by The International Atlantic Salmon Research Board, IASRB) to link research, information and data gathering systems on Atlantic salmon in estuarine, coastal, and marine areas across the North Atlantic. The Canadian government committed $100K to the SALSEA research program in 2007–2008, and in 2008-2009, 24 ship days (valued at $0.5M) for Canadian and USA scientists to conduct a pelagic ecosystem survey, including postsmolts in the Northwest Atlantic, ostensibly the Labrador Sea under the umbrella of SALSEA- North America[14]. As well, the DFO Minister has appointed a representative to inform, promote, and be an advocate for the SALSEA program in Canada, and to focus upon the need for public and private participation in this important international Atlantic salmon research to identify the causes and the possible solutions to low survival at sea. A report on the findings of the research strategy to the North American Commission of NASCO and the IASRB is expected in 2009-2010.

[14]See: http://www.nasco.int/sas/salseaamerica_rs.htm

Additionally, Canada will continue the research on early marine migration and survival of smolts, postsmolts, and kelts using acoustic telemetry. These projects represent close collaboration between DFO, the Atlantic Salmon Federation, the Province of Québec, and universities and will be enhanced by the new Oceans Tracking Network initiative.

Canada will also promote links between NASCO's SALSEA program and similar programs underway in the North Pacific on Pacific salmon. Such opportunities will be available when Canada participates in the North Pacific Anadromous Fish Commission (NPAFC) annual meetings, scientific meetings, and exchanges. This will also include promoting joint meetings or exchanges like the proposed joint NASCO/NPAFC meeting in 2011[15].

4.2.5 Invasive Species

There are several non-indigenous species of freshwater fish which have become established in New Brunswick and Nova Scotia and potentially can compete with or prey upon juvenile Atlantic salmon, among them, smallmouth bass, rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), chain pickerel, and muskellunge. These introductions were generally the result of directed and illegal transfers of live fish between watersheds. Didymo (*Didymosphenia geminate*), an invasive algae originating in New Zealand is established in Southern Québec and, while a concern, has not yet been shown to interfere with salmon production[16].

Actions specific to invasive species control include: risk analysis assessments of proposed introductions and transfers by I&T committees to determine if the activity can proceed taking account of containment methods and disease; communication and education activities to inform the public on the consequences of invasive species and actions to reduce the potential for unintentional transfer, and consultations and development of an action plan to address invasive species (2006-2011).

4.3 Recommended Actions and Recovery Schedule

Actions prescribed within the draft salmon policy's strategies 'to maintain and restore healthy and diverse salmon populations and their habitat, for the benefit and enjoyment of the people of Canada in perpetuity' (Section 4.2 and DFO 2009a) are as follows:

1. Assessment and monitoring of population status:
    - develop criteria to assess populations within CUs[17] and identify benchmarks to represent biological status; and
    - monitor and assess status of populations within those CUs.

2. Conservation and protection of Atlantic salmon habitat:
    - administer habitat protection provisions of the *Fisheries Act*;
    - monitor and assess habitat health and status;
    - identify salmon habitat needs and priorities; and
    - promote and support linkages to develop an integrated data system for watershed management.

[15]See: http://www.nasco.int/sas/pdf/sag_papers/sag_09_9.pdf
[16]See: www.mddep.gouv.qc.ca/eau/eco_aqua/didymo/didymo-en.pdf
[17] In the absence of the recently defined CUs, the draft 'Policy' (DFO 2009a) begun in 2005 continued to utilize the existing Salmon Management Areas (SFAs 1-23 and Q1-11)

3. Inclusion of ecosystem values and monitoring:
   - identify indicators to use in monitoring the status of freshwater ecosystems;
   - identify indicators to use in monitoring the status of salmon's marine ecosystems; and
   - integrate climate, freshwater, and ocean information into wild Atlantic salmon management processes.

4. Integrated fisheries management planning:
   - develop multi-year integrated fisheries management plans for wild Atlantic salmon; and
   - approval of integrated fisheries management plans.

5. Program delivery:
   - Assess and monitor the status of populations;
   - Plan and monitor annual fisheries;
   - Collaborate on river specific/ watershed multi-year approaches; and
   - Plan and implement habitat management activities.

6 Performance review:
   - Conduct post-season review of annual management plans; and
   - Conduct regular reviews of the success of the Wild Atlantic Salmon Conservation Policy.

Such recommendations are general in nature, and the success could well vary according to the goal and information base available. The Recovery Strategy for the iBoF Atlantic salmon populations, for example, is more specific and identifies the following five recovery objectives and approaches, the latter being more equivalent to actions, which in many cases have been implemented. In this case the overarching goal (there are, as well, five-year and long term targets) is to, "Re-establish wild self-sustaining populations as required to conserve the genetic characteristics of the remaining anadromous iBoF Atlantic salmon" (DFO 2009b).

Conserve iBoF salmon genetic characteristics and re-establish self-sustaining populations to iBoF rivers:
- provide salmon with appropriate genetic characteristics for re-colonization of iBoF rivers designated for recovery;
- conserve the genetic characteristics of the residual populations from the Chignecto Bay and the Minas Basin [10 populations named]; and
- use Live Gene Bank strategies to conserve iBoF genetic characteristics and re-establish self-sustaining populations to iBoF rivers.

Identify and remedy threats limiting survival and recovery of iBoF salmon in the marine environment:
- determine marine habitat quality, quantity, and use by iBoF salmon populations;
- preserve and recover marine habitat;
- identify and evaluate marine threats that could limit iBoF survival and recovery; and
- reduce or mitigate marine threats that could limit iBoF salmon survival and/or recovery.

Identify and remedy threats limiting survival and recovery of iBoF salmon in the freshwater environment:
- continue to review and determine habitat quality, quantity, and use by iBoF salmon populations;

- preserve and recover freshwater habitat;
- identify and evaluate freshwater habitat threats that could limit iBoF salmon survival and recovery; and
- reduce or mitigate freshwater threats that could limit iBoF salmon survival and recovery.

Assess population status, sustainability, and recovery feasibility:

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

Communicate and increase the general awareness of the status and recovery of iBoF salmon:

- involve governments, First Nations and other Aboriginal organizations, stakeholders, industry and the general public in the planning and conduct of recovery initiatives, and
- communicate with the relevant stakeholders on the status of recovery efforts in a manner that demonstrates how their behaviours can affect recovery.

Recovery schedules, like COSEWIC assessments, tend to gravitate toward three-generation time frames. From a practical perspective, progress towards a recovery goal should be reviewed using a series of performance measures within five years of the development of an action plan and in every subsequent five-year period. In the case of the iBoF salmon, the reviews should: 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 (DFO 2009b).

4.4 Other Studies Needed

Cairns (2001) documented 62 hypotheses potentially contributory to the decline of pre-fishery abundance estimates of Atlantic salmon. The hypotheses applied to all life stages and invoked fisheries, aquaculture, disease, predation, life history, and chemical, physical/biological and thermal environments. Based on a ranking system, the leading hypothesis related to freshwater (2) and to estuarine and marine life (10). A workshop attended by some 30 national and international experts to address the hypotheses (O'Neil *et al* 2000) re-affirmed that higher mortality was occurring after the salmon leave their rivers and is seemingly common to all North American Atlantic salmon spawning populations – often coupled with local factors in some freshwater and near shore areas (O'Neil *et al* 2000).

Of 15 research activities developed to investigate declining returns and categorized as 'essential' at the workshop (O'Neil *et al* 2000), the front runners in order of importance were: 1) freshwater conditioning (for subsequent survival of smolts at sea); 2) coastal field studies on the distribution of salmon; 3) marine field studies on the distribution of salmon; 4) salmon distribution models; and 5) estimation of survival rates with technology.

It was proposed that finding evidence to explain the decline in survival would have to build on and expand historical time series of data from freshwater areas and aggressively research the marine areas. The more probable factors were reduced smolt quality, adverse estuarine conditions, increased predation in the marine environment, and changes in ocean migration patterns, some of which could be linked to climate or oceanographic conditions (O'Neil *et al*

2000). The theme is essentially the same for salmon of the Baltic, Atlantic, and Pacific, that is, the priority area for research is to improve understanding of salmon migration patterns, distribution, and habitat utilization at sea (NPAFC 2002).

Independent of the Canadian effort to identify and gain funding to investigate the causes of the decline, the IASRB (steered by NASCO) through SALSEA proposed efforts in 2004 to ascertain and implement the research necessary to address declining populations in the Northeast Atlantic. Their strategy originally consisted of a logical sequence of investigations within four work packages involving: 1) preliminary work; 2) a focus on the early period at sea, the inshore zone, and the role of freshwater factors on survival; 3) off shore investigations; and 4) communications background to the fund raising for SALSEA.

Full funding was secured from the European Union 7th Framework, the Atlantic Salmon Trust and the 'Total Fund' in 2007 for a revised approach for 2008 through 2011 (ICES 2008). The revision entitled 'SALSEA-Merge' has the overall objectives of merging genetic and ecological investigations to advance understanding of stock specific migration and distribution patterns and overall ecology of the marine life of Atlantic salmon. Through the foregoing, there is an expectation to gain insight into the factors resulting in recent significant increases in marine mortality.

SALSEA-Merge will assemble and analyze data on the oceanographic and biological characteristics of the marine habitat of postsmolts in addition to obtaining biological material from three cruises scheduled for 2008 and 2009 (ICES 2008). Significantly, material from marine salmon surveys carried out over the past two decades, such as archived tissues for genetic stock identification to river or region of origin, salmon scales, and tag recovery information, will form a major input to the project. SALSEA-Merge work packages were revised with two packages being focused on the development of genetic identification methodology and genetic identification of stock origin of samples taken at sea. Two other work packages will deal with ecology data acquisition and analyses, both historical and contemporary. A fifth package will merge and analyze genetic, biological, and oceanographic data into models for stock specific distribution and migration patterns, integrated with patterns of growth, dietary differences, and oceanographic conditions (ICES 2008).

The research strategy of SALSEA-North America consists of three inter-related activities which build on existing index rivers programs in eastern North America[18]. Research activities are linked to the overall marine SALSEA research program advocated by NASCO and variously involve the three Atlantic DFO regions, the province of Québec, personnel from the State of Maine and USA NOAA. The activities include:

- Monitoring of life history parameters, feeding, disease status, parasite communities, and overall marine mortality at 16 index rivers in eastern North America and as well, sampling at West Greenland (including revamped sampling under SALSEA West Greenland;
- Acoustic tracking of salmon smolts and kelts from some index rivers past in-river, estuarial, near-shore and off-shore acoustic receiving stations, and
- Marine capture surveys involving the sampling of the upper column pelagic ecosystem during the period corresponding to the early post-smolt phase (primarily August) of Atlantic salmon.

[18] http://www.nasco.int/sas/salseaamerica_rs.htm

5.0 Significance of the Species

5.1 Scientific (Endemicity and Worldwide Status)

Atlantic salmon were historically found throughout the North Atlantic, ranging in the Western Atlantic from Québec's Ungava southward to New York State and in the Eastern Atlantic from the Arctic Circle southward to Portugal (Section 2.2 in DFO and MRNF 2008). It has been suggested on the basis of reconstructed climate cycles that the abundance of Atlantic salmon in North America is the lowest it has been in 300 years (Condron *et al* 2002). In the last 30 or more years, most salmon populations have undergone significant declines, the most dramatic being the 80% plus decline in the estimated abundance of non-maturing North American fish frequenting West Greenland waters (ICES 2006). Many populations are teetering on the brink of extinction or have already been lost.

Parrish *et al* (1998) reviewed available information to develop maps showing the current status of wild sea-run Atlantic salmon within their endemic range. They indicate that in Europe, salmon have been extirpated in Southern and Central England, several regions of Portugal and Spain, coastal Northern France, Belgium, Netherlands, Germany and Switzerland and in the Southern Baltic, Denmark, Germany, Poland, Lithuania, Latvia, Estonia, and Russia. Restoration is being attempted in a few rivers of Germany, France, Spain, and Switzerland.

In North America, populations in Connecticut, Rhode Island, Massachusetts, New Hampshire, Southern Maine, the St. Croix River Me/NB, and some rivers of the upper north and south shore St. Lawrence, Québec have been extirpated (Parrish *et al* 1998), although attempts are being made at restoration. Indeed the species' range has generally contracted and fragmented over the last century and a half, particularly where human activity is concentrated.

In 2001, the World Wildlife Fund reported that of 2,005 rivers in 19 countries which historically had salmon producing rivers and for which the population status could be determined, 15% had lost their populations (extinct), 12% had nearly lost their population (critical), 20% of populations were 'endangered', 10% were 'vulnerable' and 43% were 'healthy' (WWF 2001). Approximately 90% of the healthy populations were within Norway, Ireland, Iceland, and Scotland. Summary analyses for the 19 countries were handicapped by the fact that only 154 river populations in Canada were accorded known status. Of those rivers populations, 11% were classified as extinct, 39% were deemed critical, 7% were labeled as endangered, 14% were termed vulnerable, and only 29% were assessed as being healthy.

5.2 Ecological (Top Predator, Significant Prey Items)

Cairns (2006) provides the following in his review of predator-prey and competitive inter-specific interactions document that also formed the basis of Section 4.2 in DFO and MRNF (2008).

Fresh water**:** Juvenile Atlantic salmon are opportunistic predators of aquatic invertebrates, especially those drifting at the surface. The most important prey are insects at the larval, nymph, or adult stage. Major prey groups include Ephemeroptera, Plecoptera, Trichoptera, Chironomiidae, and Coleoptera. Parr in the Miramichi River consume Atlantic salmon eggs at the time of spawning (Cunjak and Therrien 1998). Some prey of juvenile salmon are terrestrial organisms that fall into the stream (allochthonous food) and some are of aquatic origin (autochthonous food). Isotope studies on the Catamaran Brook in New Brunswick indicate that

most (85%) food in headwater reaches is allochthonous, but that allochthonous sources contribute only 36-52% of food in downstream areas (Doucett *et al* 1996).

During their downstream migration, smolts eat aquatic invertebrates including Tricoptera, Ephemenoptera, Plecoptera, Simuliidae, and Culicidae. Johnson *et al* (1996) found that invertebrates of terrestrial origin were the main food sources for wild and hatchery-reared smolts trapped at dams on the Merrimack River.

Marine**:** Marine-phase Atlantic salmon are primarily pelagic and mid-water. Postsmolts eat mostly invertebrates as they pass through estuaries, although diet may vary greatly among sites and among years. Diet often includes a substantial component of terrestrial insects, as well as crustaceans and small fish. Postsmolt diet in coastal waters includes sand lance and other small fish, various fish larvae, euphausiids, amphipods, copepods, and crab larvae. Piscivory is the main feeding mode for postsmolts of 25 cm or more (Hislop and Shelton 1993). Fish, particularly capelin, sand lance, and herring, are the principal foods of marine-phase salmon in waters off Eastern Canada (Lear 1972; Reddin 1985). Other foods include small fish (including *Paralepis* spp.) and crustaceans (particularly amphipods), for example, squid (*Branchioteuthis riisei).* In the Northeast Atlantic, invertebrates play a greater role in salmon diet than they do in the northwest Atlantic (Jacobsen and Hansen 2000). Diet includes amphipods, euphausiids, herring, capelin, redfish larvae, blue whiting, lantern fish, sprat, cod, smelt, and *Paralepis* spp.

A small minority of returning adults feed as they enter their native rivers; diet is exclusively fish. In the case of early-run salmon, diet may include outgoing smolts (Sturlaugsson 2000). The position of salmon in the freshwater and marine ecosystems was addressed in Section 4.3 of DFO and MRNF (2008).

5.3 Social and Cultural

For a thousand years, the Atlantic salmon (*Salmo salar* L.*)* has occupied a salient position in the history of Eastern North America (Dunfield 1985). Originally a food source with both social and ceremonial purposes for Aboriginal people (Section 3.3), it became an increasingly important factor in both the domestic and commercial life of the developing colonies. Commercial salmon fisheries in Canada remained important to rural economies of the Maritime Provinces through the 1960s and through the 1980s elsewhere. The salmon as well provided an important recreational outlet for sportsmen and evolved as a principal object of intellectual and scientific investigations. It is a heritage of Atlantic Canada and Québec, an important indicator of environmental quality, an object of respect, a target of eco-tourism, and has a unique intrinsic value. North Atlantic-wide, the species has a significant cultural and economic value for which substantial public interest and support exists, particularly because of the association between salmon and pristine natural environment Wilzbach *et al* (1998).

The recent downturns in abundance of some stocks, however, have led to a focus on community level conservation as well as on the related high value recreational fisheries and the socio-economic opportunities they provide. The growing acceptance of catch and release recreational fisheries has permitted the co-existence of both a fishery and maximization of escapements, thereby sustaining thousands of jobs primarily in rural and remote areas where there is limited opportunity to establish viable, alternative industries.

5.4 Aboriginal

For both coastal and inland Aboriginal people, Atlantic salmon have been and continue to be important culturally as a food source. Resource management processes and decisions are in accordance with any treaties or agreements entered into between Canada as well as Québec and First Nations and other Aboriginal organizations such that allocations and Aboriginal fishing for food, social, and ceremonial purposes has priority over other fisheries where conservation requirements have been met. In total, more than 40,000 Aboriginal people in more than 50 communities through most Salmon Conservation Units of Eastern Canada can be said to be dependent on the traditional values of the Atlantic salmon resource

First Nations and other Aboriginal communities with fishing agreements, arrangements or licenses[1] for Atlantic salmon in Eastern Canada. 2006-2007.

Province	Aboriginal Community	CU's subject to Agreements	Province	Aboriginal Community	CU's subject to Agreements
Newfoundland & Labrador:	▪ Nunatsiavut Gov't ▪ Innu Nation ▪ Labrador Metis Nation ▪ Miawpukek Mi'kamawey Mawi'omi	1, 2 1, 2 3 6 4 - 8	Nova Scotia	▪ Pictou Landing ▪ Paq'tnkek ▪ Waycobah ▪ Wagmatcook ▪ Eskasoni ▪ Membertou ▪ Chapel Island ▪ Millbrook ▪ Indian Brook ▪ Acadia ▪ Annapolis Valley ▪ Glooscap ▪ Bear River ▪ Netukulimkewe'l Commission	12 12 12, 13 12, 13 12, 13 12, 13 12, 13 12, 15 12, 15 15 15 15 12 - 15 12 - 16
New Brunswick	▪ Pabineau ▪ Eel River Bar ▪ Madawaska ▪ Esgenoopetitj ▪ Eel Ground ▪ Metepenagiag ▪ Elsipogtog ▪ Buctouche ▪ Indian Island ▪ Peoples' Council ▪ Fort Folly ▪ Oromocto ▪ St. Mary's ▪ Kingsclear ▪ Woodstock ▪ Tobique	9 9 9 10 10 10 10 10 10 9, 10, 16, 17 16 17 17 17 17 17	Quebéc	▪ Listiguj ▪ Gesgapegiag ▪ Gespeg ▪ Essipit ▪ Betsiamites Innu ▪ Uashat mak Mani-Utenam ▪ Ekuanitshit ▪ Nutashquan ▪ Montagnais Unamen Shipu ▪ Montagnais Pakua Shipu ▪ Inuit of Nunavik	18 18 19 24 24 25 25 25 26 26 28
PEI	▪ Abegweit ▪ Lennox Island ▪ Native Council	11 11 11			

[1] Agreements include voluntary suspension of fishing where conservation requirements are not being met.

Numbers of salmon identified as the requirement for each community are privileged information but in terms of numbers of salmon (small and large) are estimated to be in the vicinity of 30,000 fish.

The legal context for management of wild Atlantic salmon is defined by court decisions respecting Aboriginal and treaty rights. Existing Aboriginal and treaty rights are recognized and affirmed in Section 35 of the *Constitution Act, 1982*. In its 1990 decision in *R. v. Sparrow*, the Supreme Court of Canada held that the recognition and affirmation of existing Aboriginal rights in the *Constitution Act, 1982* means that any infringement of such rights must be justified. As described in more detail in DFO (2009a; App. 1), the Department seeks to manage fisheries in a manner consistent with the decision of the Supreme Court of Canada in *R. v. Sparrow* and subsequent court decisions.

5.5 Economic

[Section being prepared under separate cover by DFO Policy and Economics Branch]

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Table 1. Summary assessment of threats to Atlantic salmon (in terms of salmon affected and lost to habitat alterations) in Atlantic salmon Conservation Units of Atlantic Canada and Québec (DFO and MRNF 2008).

Dark shading highlights >30% of salmon affected; light shading is 5-30% affected, and no shading is <5% affected-often not applicable unassessed, uncertain.

Atlantic Salmon Conservation Unit	Number of salmon rivers [b]	Salmon Affected : Spawners Lost												
		Regulated Habitat Alterations										Other		
		Municipal waste water	Industrial effluents (pulp & paper, etc.)	Hydroelectric & water storage dams	Water extraction	Urbanization (hydrology)	Transportation Infrastructure (roads culverts & fish passage)	Aquaculture siting	Agriculture forestry mining	Dredging	**Cumulative**	Shipping transport	Air pollutants/acid rain	Ecosystem change
1. North Labrador	28	L:L	L:L	L:L	L:L	L:L	L:L	L:L	L:L	L:L	**L:L**	L:L	L:L	LU:LU
2. Lake. Melville Labrador	20	L:L	L:L	L:L	L:L	L:L	M:M	L:L	L:L	L:L	**U:U**	L:L	L:L	LU:LU
3. South Labrador	41	L:L	L:L	L:L	L:L	L:L	M:M	L:L	L:L	L:L	**U:U**	L:L	- : -	LU:LU
4. NE Coast NF	127	M:M	L:L	M:M	L:L	L:L	M:M	L:L	M:M	L:L	**U:U**	L: -	- : -	LU:LU
5. SE Coast NF	49	L:L	L:L	L:L	L:L	L:L	M:M	L:L	M:M	L:L	**U:U**	U:U	MU:MU	LU:LU
6. South Coast NF	55	L:L	- :L	M:M	L:L	L:L	L:L	M:M	L:L	L:L	**U:U**	- : -	MU:MU	LU:LU
7. SW Coast NF	40	L:L	L:L	L:L	L:L	L:L	U:U	L:L	M:M	L:L	**U:U**	- : -	- : -	LU:LU
8. NW Coast NF	34	L:L	L:L	L:L	L:L	L:L	L:L	L:L	L:L	L:L	**L:L**	L:L	- : -	LU:LU
9. Northern NB	15	L:L	L:L	LM:LM	L:L	L:L	M:M	N/A	M:M	L:L	**M:M**	U:U	L:U	LU:LU
10. Central NB	25	LM:L	L:L	L:L	L:L	L:L	M:M	N/A	LM:L	L:L	**M:M**	U:U	L:U	LU:LU
11. PEI	5	L:L	N/A	MH:MH	L:L	L:L	MH:MH	L:L	MH:MH	L:L	**MH:MH**	U:U	U:U	LU:LU
12. NE NS	33	LM:LM	L:L	L:L	L:L	L:L	M:M	N/A	L:L	L:L	**M:M**	U:U	U:U	LU:LU
13. CB East Highlands	8	M:L	U:U	L:L	L:L	H:U	H:U	H:U	H:U	L:L	**U:U**	H:U	L:L	H:U
14. CB East Lowlands	21	H:U	U:U	L:L	L:L	H:U	H:U	H:U	H:U	L:L	**MH:U**	H:U	L:L	H:U
15. Southern Upland NS	65	H:U	L:L	H:M	U:U	H:U	H:U	U:U	H:U	L:L	**H:U**	L:L	H:H	H:U
16. IBoF NS/NB	37	H:U	L:L	M:L	U:U	H:U	H:U	H:U	H:U	L:L	**H:M**	L:U	L:L	H:H
17. OBoF NB	17	H:U	H:U	H:M	MH:U	H:U	H:U	M:U	H:U	L:L	**H:M**	H:U	U:U	H:H

Table 1 cont'd

Atlantic Salmon Conservation Unit	Number of salmon rivers [b]	Salmon Affected : Spawners Lost												
		Regulated Habitat Alterations										Other		
		Municipal waste water	Industrial effluents (pulp & paper, etc.)	Hydroelectric & water storage dams	Water extraction	Urbanization (hydrology)	Transportation Infrastructure (roads culverts & fish passage)	Aquaculture siting	Agriculture forestry mining	Dredging	**Cumulative**	Shipping transport	Air pollutants/acid rain	Ecosystem change
18. Chaleur Bay PQ	5	L:L	L:L	N/A	L:L	L:L	L:L	N/A	L:L	- : -	**L:L**	- : -	L:L	L:L
19. Gaspé Peninsula PQ	10	U:U	U:U	N/A	N/A	L:L	L:L	U:U	U:U	- : -	**L:L**	U:U	U:U	U:U
20. Lower St. Lawrence N. Shore Gaspé PQ	9	L:L	N/A	L:L	L:L	L:L	L:L	N/A	L:L	- : -	**L:L**	- : -	L:L	L:L
21.Appalachian Region PQ	0													
22. Québec City Region PQ	3	L:L	U:U	U:U	U:U	U:U	L:L	U:U	U:U	U:U	**U:U**	U:U	U:U	M:M
23. Saguenay-Lac Saint Jean PQ	4	L:L	U:U	U:U	U:U	U:U	M:U	U:U	-: -	U:U	**U:U**	U:U	U:U	H:L
24. Upper North Shore PQ	12	N/A	N/A	L:L	L:L	N/A	N/A	N/A	UL:UL	N/A	**- : -**	N/A	N/A	U:U
25. Middle North Shore PQ	17	N/A	N/A	L:L	N/A	N/A	N/A	N/A	UL:UL	N/A	**- : -**	N/A	N/A	U:U
26. Lower North Shore PQ	21	N/A	N/A	L:L	N/A	N/A	N/A	N/A	N/A	N/A	**- : -**	N/A	N/A	U:U
27. Anticosti PQ	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	U:U	N/A	**- : -**	N/A	N/A	U:U
28. Ungava PQ	4	L:L	N/A	N/A	L:L	L:L	L:L	L:L	L:L	L:L	**L:L**	U:U	U:U	U:U

a- Where 'salmon affected' symbol 'L' is < 5% of salmon in CU are affected; 'M' is 5-30% are affected, 'H' is >30% are affected and 'U' is uncertain; 'salmon lost' symbol 'L' is < 5% of salmon spawners in CU are lost; 'M' is 5-30% are lost, 'H' is >30% are lost and 'U' is uncertain; N/A = Not Applicable and "-" = Not Assessed.

b- Provisional

Table 2.General provincial licence and guide requirements for Atlantic salmon anglers in Atlantic Canada.

Province	Licence to angle salmon in:		Guide/Outfitter Requirement for Non-residents	Access		Other Regulations
	Inland Waters	*Tidal Waters*		*Private Waters*	*Public Waters*	
NL	Required for all anglers. A family licence holder's children under the age of 18 are permitted to angle under the family licence.	Not required, but any salmon caught must be released.	Required when fishing in scheduled salmon waters or in non-scheduled salmon waters more than 800 m from a provincial highway without being accompanied by a direct relative who is a resident of the province.	No	Yes	n/a
NB	Required for all anglers.	Not required, but any salmon retained must be tagged. .	Required when fishing for sea-run Atlantic salmon or when angling for any species on Atlantic salmon waters after a designated date.	Yes	Yes	Only anglers who reside year round in the province can apply to fly fish in Crown Reserve Waters at a fee of $40.25 per day.
NS	Required for all anglers.	Required for all anglers	Not required	No	Yes	n/a
PEI	Required for all anglers.	Required for all anglers	Not required	Yes	Yes	n/a
QC	Required for all anglers. A salmon licence holder's spouse and children under the age of 18 are permitted to angle under the holder's licence.	Not required, but any salmon retained must be tagged.	Required when fishing north of the 52nd parallel or east of the Saint-Augustin River.	Yes	Yes	A salmon fishing licence is required to fish for every species of fish in a salmon river.

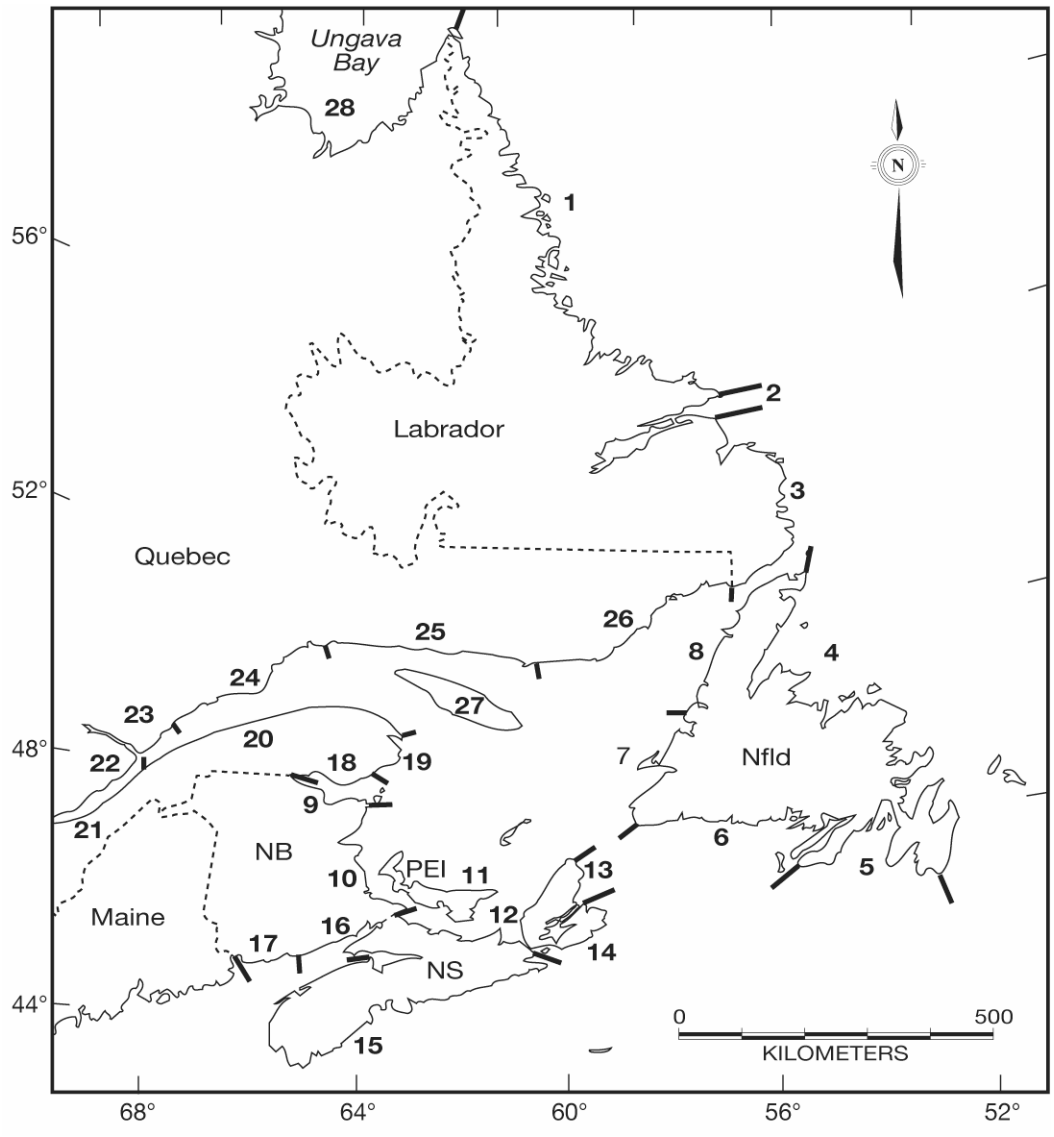

Figure 1. Proposed Conservation Units (CUs) for Atlantic salmon of Eastern Canada (DFO and MRNF 2008).

Appendix 1. Conservation Status Report - Terms of Reference (2004)

Context

DFO Species Priority List

What:

- DFO priority list based on biological and socio-economic information

How:

- DFO and other jurisdictions (possibly through CCFAM) would identify priorities for assessment through general status, COSEWIC Priorities etc.

Why:

- Identification of species requiring conservation measures
- DFO staff (potentially in partnership with other jurisdictions) would develop Conservation Status Reports that would form the basis of a COSEWIC status report, allowable harm assessment and recovery strategy
- Allows for the development of annual/regional species work plans to maintain equitable division of labour

Conservation Status Report

What:

- Conservation Status Reports that would form the basis of a COSEWIC status report, allowable harm assessment and recovery strategy
- DFO and not SARA language used
- DFO would subsequently submit COSEWIC status report for consideration (potential for no submission)

How:

- DFO initiates an Assessment (see content below)
- Assessment is reviewed through Advisory Processes (which includes stakeholder participation)
- Enables DFO to implement pre-emptive management measures prior to listing
- Increases transparency & stakeholder involvement in process
- Integrates the SARA process into normal DFO operations
- DFO would use the outcome of this assessment to consult with stakeholders and implement management measures (if possible)

Why:

- Provides ample lead-time to consult with our stakeholders
- DFO would have the information required to prepare for listing
- Provides better info to COSEWIC
- Potentially prevent unnecessary listings
- Decreases duplication of effort

Document Development

This species was identified as a conservation concern through a previous Science peer-review. The species status report was developed by (name) and was reviewed on (date) in (place) (cite CSAS documents).

Drafting of this document was begun on (date) by (DFO or consultant) using existing jurisdictional information. A peer-review meeting was held (date) with representatives from affected jurisdictions, stakeholders (industry, NGOs) and Aboriginal Peoples, to gather further information and discussion. Proceedings of the RAP were published on (date). Comments were incorporated into the present document.

Contents of Conservation Status Report (CSR) — Component 1

Note: The following contains required content of

- COSEWIC status report
- Allowable Harm Assessment Framework
- SARA Recovery Strategy or Action Plan

1. Species Information

Summary introduction of species and rationale for conducting CSR for that species (i.e., rationale and basis for reviewing the conservation status of the species at this time)

1.1 Description of Species

1.1.1 Name and Classification
1.1.2 Morphological Description
1.1.3 Genetic Description
1.1.4 Ecologically Significant Units (if applicable)

1.2 Distribution

1.2.1 Global Range
1.2.2 Canadian Range

1.3 Habitat Considerations

1.3.1 Habitat Requirements
1.3.2 Habitat Trends
1.3.3 Habitat Protection/ Ownership
1.3.4 Identification of Crucial Habitat (if possible at this point)
1.3.5 Studies Required to Identify Crucial Habitat (if needed)
1.3.6 Identification of Residence (where applicable)

1.4 Biology

1.4.1 Life Cycle and Reproduction
1.4.2 Predation (identify main predators)
1.4.3 Physiology (e.g. depth, temperature requirements)
1.4.4 Dispersal/Migration
1.4.5 Inter-specific Interactions
1.4.6 Adaptability

1.5 Population Size, Trends, and Uncertainty

1.5.1 Search Effort (data sources sought/considered)
1.5.2 Abundance
1.5.3 Recent/historical Trends (including natural fluctuation)
1.5.4 Potential for Recovery (including recovery feasibility)
1.5.5 Rescue Effect

1.6 Scope for Harm

1.6.1 Present/recent species trajectory?
1.6.2 Present/recent species status?
1.6.3 Expected order of magnitude/target for recovery?

1.6.4 Expected general time frame for recovery to the target?
1.6.5 Is there scope for harm/mortality to the species that will not impede recovery?
1.6.6 What is the maximum harm/mortality that will not impede recovery?

2. Threats to the species

2.1 Limiting Factors and Threats (domestically and internationally)

2.1.1 List of threats (including real or potential mortality/harm)
2.1.2 Degree of harm from each threat
2.1.3 Aggregate total harm/mortality from threats and compare to allowable harm to determine what level of mitigation is needed

2.2 Assessment of Cross-Jurisdictional Authorities in relation to Threats

2.3 Early Identification of 'Principal Stakeholders' in relation to Threats

3. Existing Protection

3.1 Legislation
3.2 Existing Status Designations (domestically and internationally)
3.3 Recovery Measures Currently In Place

4. Potential Conservation Targets

4.1 Goal of Conservation Measures
4.2 Proposed Species Rebuilding/Habitat Restoration Strategy
4.3 Recommended Actions/Recovery Schedule
4.4 Other Studies Needed

5. Significance of the Species

5.1 Scientific (endemicity, worldwide status…)
5.2 Ecological (top predator, significant prey item…)
5.3 Social/Cultural
5.4 Aboriginal
5.5 Economic

<u>Implementation/Management Considerations</u>

- Once the Conservation Status Report has been drafted, a socio-economic analysis of the contents of the assessment (e.g. proposed conservation targets) is initiated (in consultation with other jurisdictions as needed).

- A regional or national peer-review meeting (RAP/NAP) is planned and convened to review the assessment. This meeting includes clients, Sectors, First Nations, and jurisdictions.

- Proceedings and Part 1 of the Conservation Status Report are produced.

- Science (National Headquarters) formally informs operational sectors on outcome of Allowable Harm Assessment (AHA) (Phases 1 & 2).

- DFO Sectors and other jurisdictions (as required) determine how AHA can be implemented (through integrated management plans, MPAs, mitigation measures and alternative activities to be considered). Includes how to partition harm amongst competing activities.

- Socio-economic analysis and consideration are developed on AHA implementation and impacts of listing.

- Sectoral perspectives are integrated into draft management approach including intent to send status report to COSEWIC.

- Communications strategy is produced (DFO species management strategy and communications plan).

Contents of Conservation Status Report (CSR)— Component 2 —Socio-Economic Report[19]

***Note* This part will be peer-reviewed in a NAP type meeting with all stakeholders/partners included. The results will be combined with Part 1 to produce the final Conservation Status Report.**

Background:
Methodology, assumptions, limitations
- Identification and description of base case
- Allowable harm assessment/(Fisheries) Management scenarios
- Listing prohibitions; recovery actions

Accounts (As Relevant – All may not apply)

1. Fishing:

a. Commercial fishing sector impacts (Dependence, economic viability and income support)
- Total number of fishers
    - number of licences, permits, enterprises, vessels, persons employed
- Identification of fisheries where there is by-catch
- % of income attributed to species (dependency)
    - Crew members affected
- Geographical distribution of affected licence holders
- Income Support: number of EI recipients by area; average amount awarded by area
- Price trends (landed price and market price per pound by area)
- Fishing enterprises (number, revenue, costs)
- Other sources of income

b. Recreational fishing sector impacts
- Total landings, by area
- Profile of activities affected (employment, value)

c. Processing Sector
- Plants processing species
    - Quantity processed
    - Location (geographical distribution)
    - Cod as a percentage of total processed (dependency, viability)
    - Value added
    - Employment, EI

2. First Nations impacts
- Fishing (Communal licences, FSC allocations
- Employment, income
- Economic development impacts

[19] The socio-economic component of these terms of reference was prepared before the method and approach of conducting socio-economic evaluations relevant to species management under the Species at Risk Act had been finalized. Consequently the scope and approach for the socio-economic report will not be completed as noted in the terms of reference and the timeline for the review has not been finalized.

3. **Impacts to other industries** (This may require partnering with provinces for information)
    - E.g., Agriculture, mining, electricity, oil and gas, tourism etc.
        - Activity, production and viability, revenue, wages, employment, costs and net returns

4. **Habitat Enhancements**

5. **Social Impacts**
    - Community Profiles (employment, demographic trends etc.)
    - Regional development

6. **Government**
    - Sectors (Federal, Provincial, Municipal)
    - Revenues (e.g. taxes), costs (e.g. science)

Departmental Recommendation/Proposed Action Plan

- Decision is made on whether to send a species status report to COSEWIC
- If yes, DFO implements management measures prior to COSEWIC listing
- Relevant Sectors consult with jurisdictions, Wildlife Management Boards (WMBs), First Nations, and clients as required
- Implementation of management approach includes promoting stewardship and developing tools/process/system to monitor success or the impact of management measures

Appendix 2. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in Conservation Units of Atlantic Canada and Québec.

The contents of this Appendix represent a first attempt by Federal and Provincial biologists, fisheries managers, and habitat managers in Eastern Canada to provide a semi-quantitative overview of the relevance of listed threats and evaluation of effects on Atlantic salmon in Conservation Units within their jurisdictions. The framework for the Appendix was developed at the Second Workshop on the Conservation Status of Atlantic Salmon in Eastern Canada, 6-9 March 2007 (DFO. 2007a). Several of the participants at that workshop were contributors to this Appendix; others are acknowledged within the Credits of this document. Changes in personnel since the report's inception and varying interpretations of information being sought outside of a workshop environment led to some inconsistencies in its completion. Notable among them is the deletion of rows, particularly in Québec, absence of entries in the 'Proportion of salmon' and 'Effect on population' columns and the term 'Not Applicable', all of which are taken as being 'Not Applicable' to the Conservation Unit under consideration. The absence of entries in cells within the 'Management Alternatives/Mitigation' column are taken to mean that no *new* actions are possible/have yet been assessed/deemed practical, etc. The bounds of the terms Low, Medium, and High, < 5%, 5% to 30%, and > 30%, respectively, are provided in the opening header for each of the Conservation Units and in many cases, the term 'Uncertain', is used to convey the uncertainty of any estimates. CU 21 is omitted as the region lacks salmon.

Appendix 2. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 1, North Labrador.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 1**	**Source (*with examples*)**	**Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/Time Frame Historic (H) Current (C) Potential (P)**	**Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation *(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**High –** for 2SW salmon **Low –** for 1SW salmon; tendency to locate fisheries in estuaries so as to minimize impact on interception of mixed stocks	**C** **C**	**High** **Low**	Restrictions on opening and closing dates Restrictions on mesh size
	Recreational: retention and release	**Low –** effort restricted to fishing camps; access is low due to remote locations	**C**	**Low**	
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland/St. Pierre – Miquelon)	**Low** – 2SW salmon only	**C**	**Low**	Reductions in domestic fisheries in those areas
	Illegal (poaching)	**Low** – availability of salmon through FSC precludes poaching	**C**	**Low**	
	CUMULATIVE EFFECT	**MEDIUM–HIGH**	**C**	**MEDIUM–HIGH –** concern more associated with 2SW than 1SW stocks	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low–** incidental catch prohibited	
	Commercial near-shore			**Low –** incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 1 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low**	
	Commercial	**Low**	**C**	**Low**	
	Illegal	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment)	**Low**	**H C P**	**Low**	Fish Screen Guidelines, Section 32 enforcement, regional water withdrawal guideline development
Habitat Alterations	Municipal waste water treatment facilities	**Low**– very small human population	**C P**	**Low**	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low**– few operations	**C P** (sawmills)	**Low**	Best management practices
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low** –no current operations	**P**	**Low**	HADDs for new projects have to be mitigated or have compensation
	Water extractions	**Low** –small number of operations	**C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low** –small human population	**P**	**Low**	Project redesign
	Infrastructure (roads/ culverts) (fish passage)	**Low** –only roads are in towns	**C P**	**Low**	Existing regulations – more monitoring
	Aquaculture siting	**Low** – no current operations	**P**	**Low**	
	Agriculture/forestry/mining, etc.	**Low** – one major mine, some small scale forestry	**C P**	**Low**	Enforcement/monitoring of existing suite of regulations, compensations; where required
	Municipal, Provincial and Federal dredging	**Low** –no current work	**P**	**Low**	

Conservation Unit 1 cont'd

Habitat Alterations	CUMULATIVE EFFECT	**LOW**		**LOW**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Low** – very little shipping except from one mine	**C P**	**Low**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.				
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and, genetic introgression				
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication				
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	Conduct live sampling only
Military Activities	Field operations, shooting ranges				
Air Polluants	Acid rain	**Not Assessed – Low** – no industry (except for 1 mine) here or up-wind of this area	**P**	**Low – Not Assessed**	

Conservation Unit 1 cont'd

UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private Companies and public-at-large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain** –some rivers in this area are moderately impacted by low water levels, warm water temperatures	**C P**	**Low – Uncertain** – affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 2, Lake Melville, Labrador.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 2**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Medium-High** (2SW fish) **Low** (1SW fish)	**CP** **CP**	**Medium–High** (2SW fish) **Low** (1SW fish)	Catches are expected to decline in future years due to negotiated fishing areas
	Recreational: retention and release	**Low**	**C**	**Low**	
	Commercial (domestic)	**Not Applicable** – all commercial fisheries closed			
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**C**	**Low**	Reductions in domestic fisheries in those areas
	Illegal (poaching)	**Low-Medium**	**C**	**Low-Medium**	
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM**	Increased monitoring by Aboriginal guardians of FSC fisheries
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low–** incidental catch prohibited	
	Commercial near-shore			**–** incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 2 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low**	
	Commercial	**Low**	**C**	**Low**	
	Illegal	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low**	**C P H**	**Low** – major system is dammed; no sea-run salmon up that far	Fish Screen Guidelines; Section 32 enforcement, regional water withdrawal guideline development
Habitat Alterations	Municipal waste water treatment facilities	**Low** – small human population	**H C P**	**Low**	Ensure current projects and future developments meet standards, current update of the one major system
	Pulp and paper mills	**Low**– few operations	**C P** (sawmills)	**Low**	Best management practices, restoration of one old site
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low**	**C P**	**Low –** potentially much greater	HADDs for new projects have to be mitigated or have compensation
	Water extractions	**Low -** small number of operations	**C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low –** small human population	**P**	**Low**	Project redesign
	Infrastructure (roads/culverts) (fish passage)	**Medium** – one major highway	**C P**	**Medium** – causeway across main river in area	Existing regulations – more monitoring
	Aquaculture siting	**Low** – no current operations	**P**	**Low**	
	Agriculture/forestry/mining, etc.	**Low** – only some small projects	**H C P**	**Low**	Enforcement/monitoring of existing suite of regulations
	Municipal, Provincial and Federal dredging	**Low** –no current work; one private operation (mining)	**P**	**Low**	Follow regulations in place

Conservation Unit 2 cont'd

Habitat Alterations	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Low** – some shipping, contamination around airport but being cleaned up (not near water)	**C P H**	**Low**	Not applicable
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.				
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression				
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication				
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	Conduct live sampling only
Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Low – Not Assessed**	**C P**	**Low**	Not applicable

Conservation Unit 2 cont'd

UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change; changes in relative predator and prey abundances, disease	**Low-Uncertain** – some rivers in this area are moderately impacted by low water levels and warm water temperatures	**C P**	**Low – Uncertain** –affect on salmon populations is unknown	.

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 3, South Labrador.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 3**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Medium** (2SW fish) **Low** –1SW fish; tendency to locate fisheries in estuaries (to minimize impact on interception of mixed stocks)	**C** **C**	**Medium** (2SW fish) **Low** (1SW fish)	Restrictions on opening and closing dates Restrictions on mesh size
	Recreational: retention and release	**Medium**	**OVER-REPRESENTATION**	**Medium**	Recent reduction in harvest prompted by increased access due to Trans-Labrador Highway
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**C**	**Low**	Reductions in domestic fisheries in those areas
	Illegal (poaching)	**Medium**	**C**	**Medium**	Increased enforcement with collaborative agreement with Provincial government Presence of Aboriginal guardians and monitors
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM**	Increase management and enforcement measures in place
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low –** incidental catch prohibited	
	Commercial near-shore			**Low –**incidental catch prohibited	

Conservation Unit 3 cont'd

Bycatch of Salmon in Fisheries for Other Species	Commercial distant				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low**	
	Commercial	**Low**	**C**	**Low**	
	Illegal	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low**	**C P H** – nothing in the foreseeable future	**Low**	Fish Screen Guidelines, Section 32 enforcement; regional water withdrawal guideline development
Habitat Alterations	Municipal waste water treatment facilities	**Low –** small human population	**H C P**	**Low**	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low** – few operations	**H C P** (sawmills)	**Low**	Best management practices; follow current regulations
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low** – no current operations	**P**	**Low**	HADDs for new projects have to be mitigated or have compensation
	Water extractions	**Low** – small number of operations	**C P**	**Low**	Must meet regulations in place/ monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low** – small human population	**P**	**Low**	Project redesign; existing regulation monitoring
	Infrastructure (roads/culverts) (fish passage)	**Medium –** recent and ongoing road construction, many water crossings	**C P**	**Medium**	Existing regulations – more monitoring; enforcement
	Aquaculture siting	**Low –** no current operations	**P**	**Low**	

Conservation Unit 3 cont'd

Habitat Alterations	Agriculture/forestry/mining, etc.	**Low**	**H C P**	**Low** – ongoing forestry with higher potential	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low** – no current work	**P**	**Low**	Follow regulations in place
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Low** – little shipping	**H C P**	**Low – Not Assessed**	Not applicable
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.				
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression				
Fish Culture / Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication				
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	Conduct live sampling only
Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Not Assessed**		**Not Assessed**	Not applicable

Conservation Unit 3 cont'd

UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain** –some rivers are moderately impacted by low water levels and warm water temperatures	**C P**	**Low–Uncertain** –affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 4, Northeast Coast NF.

Potential Sources of Mortality/Harm permitted and Un-permitted Activities **Conservation Unit 4**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal				
	Recreational: retention and release	**Medium**	**C**	**Medium**	Reductions in retention fisheries, increase use of catch and release measures, direct effort controls, season modifications, closures, environmental protocols
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland/St. Pierre – Miquelon)	**Low**	**C**	**Low**	Reductions in domestic fisheries in those areas
	Illegal (poaching)	**Medium**	**C**	**Medium–**increased enforcement in conjunction with DFO and Provincial enforcement officers; initiated stewardship initiatives with three local groups; changed enforcement strategies for more targeted efforts	Continued use of compliance monitors on selected watersheds including Aboriginal guardians
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM**—many initiatives in place in recent years	New 5-year Integrated Fisheries Management Plan with major elements including river classification and adaptive management strategy

Conservation Unit 4 cont'd

Bycatch of Salmon in Fisheries for Other Species	Aboriginal				
	Recreational			**Low –** incidental catch prohibited	
	Commercial near-shore	**Low**	**C**	**Low–** incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal				
	Recreational				
	Commercial	**Low** (eel fishery)	**C**	**Low**	
	Illegal				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Medium**	**C**	**Medium**	New technology being developed for smolt in potential restoration of Rattling Brook (Exploits River)
Habitat Alterations	Municipal waste water treatment facilities	**Medium –** many communities including urban centers	**H C P**	**Medium**	Ensure current projects and future developments meet standards; many capital improvements
	Pulp and paper mills	**Low** – one major paper mill, many sawmills	**H C P**	**Low**	Best management practices; continue with improvements and research, monitoring
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Medium –** one large river heavily involved; one smaller river (Rattling Brook) dewatered	**H C P**	**Medium**	HADDs for new projects, i.e., mitigation or compensation Restoration work, e.g., Rattling Br; examine policy on existing facilities Continue with tech. improvements; fishways on Exploits River
	Water extractions	**Low**	**H C P**	**Low**	Must meet regulations in place/ monitoring, develop regional guidelines

Conservation Unit 4 cont'd

Habitat Alterations	Urbanization (altered hydrology)	**Low** – main urban areas have little affect on salmon habitat	**H C P**	**Low**	Project redesign/existing regulation; monitoring
	Infrastructure (roads/culverts) (fish passage)	**Medium** – recent and ongoing road construction, many water crossings	**H C P**	**Medium**	Existing regulations – more monitoring/enforcement
	Aquaculture siting	**Low**	**P**	**Low** – several mussel operations, low effect on salmon	Choose locations carefully; monitoring; following guidelines and best practices
	Agriculture/forestry/mining, etc.	**Medium** – heavy resource use area	**H C P**	**Medium**	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low** – some small projects	**H C P**	**Low**	Follow regulations in place; mitigations and compensations as required
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Not Assessed** – some shipping	**H C P**	**Not Assessed**	Not applicable
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Low**	**C**	**Low**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression				
Fish Culture/ 7Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication				

Conservation Unit 4 cont'd

Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	Live sampling only
Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Not Assessed** – some industry	**C P**	**Not Assessed**	Not applicable
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain –** some rivers in this area are moderately impacted by low water levels and warm water temperatures	**C P**	**Low – Uncertain –** affect on salmon populations is unknown	.

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 5, Southeast Coast NF.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 5**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal				
	Recreational: retention and release	**Low – Medium –** (season open from June 1 to September 7). Moderate effort on some rivers.	**C**	**Low – Medium**	Reductions in retention fisheries; increase use of catch and release measures; direct effort controls; season modifications; closures; environmental protocols
	Commercial (domestic)	**N/A –** all commercial fisheries closed			
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**H**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Low**	**C**	**Low –** increased enforcement in conjunction with DFO and Provincial enforcement officers; began stewardship initiatives with local groups; changed enforcement strategies for more targeted efforts	Continued use of compliance monitors on selected watersheds, including Aboriginal guardians
	CUMULATIVE EFFECT	**LOW – MEDIUM**	**C**	**LOW – MEDIUM**	New 5-year Integrated Fisheries Management Plan with major elements including river classification and adaptive management strategy

Conservation Unit 5 cont'd

Bycatch of Salmon in Fisheries for Other Species	Aboriginal				
	Recreational			– incidental catch prohibited	
	Commercial near-shore			– incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT				
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Applicable** – no directed Aboriginal fisheries in this CU		**None**	
	Recreational	**Uncertain**		**Uncertain** – but expected to be nil	
	Commercial				
	Illegal	**Uncertain**		**Uncertain**	
	CUMULATIVE EFFECT	**NONE**		**NONE**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low** – some heavy industry	**C P H**	**Low** – some potential effect on salmon	Compensation and mitigation – guidelines; best management practices; Fish Screen Guidelines; monitoring.
Habitat Alterations	Municipal waste water treatment facilities	**Low** – few communities	**H C P**	**Low**	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low**	**Not Applicable**	**Low**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low** – a few small projects	**H C P**	**Low**	HADDs for new projects have to be mitigated or have compensation
	Water extractions	**Low** – some for proposed heavy industry	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low** – only small communities	**H C P**	**Low**	Project redesign/existing regulations - monitoring

Conservation Unit 5 cont'd

Habitat Alterations	Infrastructure (roads/culverts) (fish passage)	**Medium**	**H C P**	**Medium** – near shore heavy industry	Existing regulations – more monitoring/ enforcement
	Aquaculture siting	**Low** – several mussel operations	**P**	**Low** – low effect on salmon	Choose locations carefully; monitoring; follow guidelines and best practices
	Agriculture/forestry/mining, etc.	**Medium**	**H C P**	**Medium** – potential mineral processing, past mining/processing	Enforcement/monitoring of existing suite of regulations, compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**H C P**	**Low** - some current work in relation to heavy industry	Follow regulations in place, mitigations and compensations as required, minimize amount
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain** – potential for impacts owing to high shipping activities in Placentia Bay	**C**	**Uncertain** – impacts on populations are uncertain	Work with Loma – integrated management
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Uncertain**	**C**	**Uncertain**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low – Uncertain** – no directed salmonid aquaculture activities	**C P**	**Low – Uncertain** – no current evidence of escaped farmed salmon in this area, but low numbers of steelhead (rainbow) trout have been found in some rivers; at least one established population of rainbow (Shalloway Pond Brook)	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Uncertain**		**Uncertain**	

Conservation Unit 5 cont'd

Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low** – minimal removals for scientific purposes.	
Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Medium –Uncertain –** historically, rivers in this area demonstrated moderately low mean alkalinities and thus were potentially sensitive to acidification damage; rivers generally of mean pH values 5.5 to around 6.0	**H P**	**Medium – Uncertain –** current information is lacking.	

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain –** some rivers in this area are moderately impacted by low water levels and warm water temperatures	**C P**	**Low – Uncertain –** affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 6, South Coast, NF.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 6**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal				
	Recreational: retention and release	**Low – Medium**	**C**	**Low –Medium**	Reductions in retention fisheries, increase use of catch and release measures, direct effort controls, season modifications, closures, environmental protocols
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland/St. Pierre – Miquelon)	**Low**		**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Medium**		**Medium –** increased enforcement in conjunction with DFO and Provincial enforcement officers; initiated stewardship initiatives with local groups; changed enforcement strategies for more targeted efforts	Continued use of compliance monitors on selected watersheds, including Aboriginal guardians
	CUMULATIVE EFFECT	**LOW – MEDIUM**		**LOW – MEDIUM** – many initiatives in place in recent years	New 5-year Integrated Fisheries Management Plan with major elements including river classification and adaptive management strategy

Conservation Unit 6 cont'd

Bycatch of Salmon in Fisheries for Other Species	Aboriginal				
	Recreational			– incidental catch prohibited	
	Commercial near-shore	**Low** (eel fishery)	**C**	**Low –** incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal				
	Recreational	**Low**		**Low**	
	Commercial				
	Illegal				
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low**	**C H P**	**Low**	Fish Screen Guidelines; Section 32 enforcement; regional water withdrawal guideline development
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**H C P**	**Low** – few communities	Ensure current projects and future developments meet standards
	Pulp and paper mills		**H C P** (sawmills)	**Low** – few operations	Current regulations and best management practices
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Medium –** one large project, some change to Bay characteristics	**H C P**	**Medium**	HADDs for new projects have to be mitigated or have compensation; monitoring present mitigations; enforcement of present regulatory suite
	Water extractions	**Low –** some light industry and communities	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines

Conservation Unit 6 cont'd

Habitat Alterations	Urbanization (altered hydrology)	**Low** – only small communities	**H C P**	**Low**	Project redesign; existing regulation - monitoring
	Infrastructure (roads/ culverts) (fish passage)	**Low** – few new roads or other projects	**H C P**	**Low**	Existing regulations – more monitoring/enforcement
	Aquaculture siting	**Medium –** substantial finfish sites	**H C P**	**Medium –** Potential fouling of marine habitat. Water quality issues	Choose locations carefully; up front and continuing research; environmental effects monitoring; follow regulations and best practices
	Agriculture/forestry/mining, etc.	**Low**	**H C P**	**Low** – extensive past forestry as well as some past mining	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**P**	**Low**	Follow regulations in place; mitigations and compensations as required; minimize amount
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Not Assessed**	**C H P**	**Not Assessed**	Not applicable
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Uncertain**	**C**	**Uncertain**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low - Uncertain –** directed salmonid aquaculture activities occur in this CU; evidence of escaped farmed salmon has been documented in several rivers; higher numbers of escaped steelhead (rainbow) trout have been found, with sporadic occurrences of steelhead in a variety of rivers along the south coast with additional captures at sea	**C P**	**Medium – Uncertain –** potential exists for greater interactions owing to substantive expansion of aquaculture industry into Fortune Bay	

Conservation Unit 6 cont'd

Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Uncertain**		**Uncertain**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low** – minimal removals for scientific purposes	
Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Medium – Uncertain**	**H P**	**Medium – Uncertain** – historically, rivers in this area demonstrated low mean alkalinities with average pH values often < 5.5 and were among the most sensitive of all of insular Newfoundland; current information is lacking	

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private Companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain** – -some rivers in this area are periodically impacted by low water levels and warm water temperatures	**C P**	**Low – Uncertain** – affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 7, Southwest Coast NF.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 7**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal				
	Recreational: retention and release	**Medium**	**C**	**Medium**	Reductions in retention fisheries; increase use of catch and release measures; direct effort controls; season modifications; closures, environmental protocols
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland/ St. Pierre – Miquelon)	**Low**	**C**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Medium**	**C**	**Medium** – increased enforcement in conjunction with DFO and Provincial enforcement officers; initiated stewardship initiatives with three local groups; changed enforcement strategies for more targeted efforts	Continued use of compliance monitors on selected watersheds, including Aboriginal guardians
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM –** many initiatives in place in recent years	New 5-year Integrated Fisheries Management Plan, with major elements including river classification and adaptive management strategy

Conservation Unit 7 cont'd

Bycatch of Salmon in Fisheries for Other Species	Aboriginal				
	Recreational	**Low**	**C**	**Low –** incidental catch prohibited	
	Commercial near-shore			**Low –** incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal				
	Recreational				
	Commercial	**Low** (eel fishery)	**C**	**Low**	
	Illegal				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low**	**C H P**	**Low**	Fish Screen Guidelines; Section 32 enforcement; regional water withdrawal guideline development
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**H C P**	**Low** – small communities, one urban center	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low**	**H C P**	**Low** – one paper mill, little interaction with river	Current regulations, monitoring of best practices
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low**	**H C P**	**Low** – some small projects	HADDs for new projects have to be mitigated or have compensation. Monitoring present mitigations, enforcement of present regulatory suite
	Water extractions	**Low**	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low**	**H C P**	**Low** – mostly small communities; one urban center	Project redesign; existing regulation - monitoring

Conservation Unit 7 cont'd

Habitat Alterations	Infrastructure (roads/culverts) (fish passage)	**Uncertain**	**H C P**	**Uncertain** – cabin and resort development	Existing regulations – more monitoring/enforcement
	Aquaculture siting	**Low**	**H C P**	**Low** – some mussel activity	Choose locations carefully; monitoring; follow regulations and best practices
	Agriculture/forestry/mining, etc.	**Medium**	**H C P**	**Medium** – extensive agriculture, past and present forestry, past mining	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**P**	**Low**	Follow regulations in place; mitigations and compensations as required, minimize amount
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Not Assessed**	**C H P**	**Not Assessed**	Not applicable
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.				
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression				
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication				
Scientific Research	Government, university, community and Aboriginal groups				

Conservation Unit 7 cont'd

Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Not Assessed**	**C H P**	**Not Assessed**	Not applicable
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain**	**C P**	**Low – Uncertain**– some rivers in this area are moderately impacted by low water levels and warm water temperatures; affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 8, Northwest Coast NF.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 8**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal				
	Recreational: retention and release	**Medium**	**C**	**Medium**	Reductions in retention fisheries; increase use of catch and release measures; direct effort controls; season modifications; closures; environmental protocols
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland/ St. Pierre – Miquelon)				
	Illegal (poaching)	**Medium**	**C**	**Medium –** increased enforcement in conjunction with DFO and Provincial enforcement officers; initiated stewardship initiatives with local groups; changed enforcement strategies for more targeted efforts	Continue use of compliance monitors on selected watersheds, including Aboriginal guardians
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM –** many initiatives in place in recent years	New 5-year Integrated Fisheries Management Plan with major elements including river classification and adaptive management strategy

Conservation Unit 8 cont'd

Bycatch of Salmon in Fisheries for Other Species	Aboriginal				
	Recreational	**Low**	**C**	**Low –** incidental catch prohibited	
	Commercial near shore			– incidental catch prohibited	
	Commercial distant				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal				
	Recreational				
	Commercial	**Low -** (eel fishery)	**C**	**Low**	
	Illegal				
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low**	**C H P**	**Low**	Fish Screen Guidelines; Section 32 enforcement; regional water withdrawal guideline development
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**H C P**	**Low** – few communities	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low –** (sawmills)		**Low** – few operations	Current regulations; monitoring of best practices
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low**	**H C P**	**Low** – some small projects	HADDs for new projects have to be mitigated or have compensation; monitoring of present mitigations; enforcement of present regulatory suite
	Water extractions	**Low**	**H C P**	**Low** – some for light industry	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low**	**H C P**	**Low** – mostly small communities	Project redesign; existing regulation - monitoring

Conservation Unit 8 cont'd

Habitat Alterations	Infrastructure (roads/culverts) (fish passage)	**Low**	**H C P**	**Low** – few new roads or other projects	Existing regulations – more monitoring/enforcement
	Aquaculture siting	**Low**	**H C P**	**Low** – onshore hatchery	Choose locations carefully; monitoring; follow regulations and best practices
	Agriculture/forestry/mining, etc.	**Low**	**H C P**	**Low** – ongoing forestry	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**P**	**Low**	Follow regulations in place; mitigations and compensations as required; minimize amount
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Low –** Not Assessed	**P**	**Low –** Not Assessed	Not applicable
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.				
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression				
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication				
Scientific Research	Government, university, community and Aboriginal groups				

Conservation Unit 8 cont'd

Military Activities	Field operations, shooting ranges				
Air Pollutants	Acid rain	**Not Assessed**	**P**	**Not Assessed**	Not applicable
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae				
International High Seas Targeted	Flags of convenience?				
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival				
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain**	**C P**	**Low – Uncertain –** some rivers in this area are moderately impacted by low water levels and warm water temperatures; affect on salmon populations is unknown.	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 9, Northern NB.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 9**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Low**	**C**	**Low**	Control harvest through agreements between DFO and First Nations
	Recreational: retention and release	**Low**	**C**	**Low –** 1SW retention only	Encourage the use of catch and release measures
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**H C**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Low**	**C**	**Low** – increased enforcement in conjunction with DFO and Provincial enforcement officers; increased stewardship initiatives with local groups; changed enforcement strategies for more targeted efforts	Continue use of compliance monitors on selected watersheds, including Aboriginal guardians
	CUMULATIVE EFFECT	**LOW – MEDIUM**	**C**	**LOW – MEDIUM**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low –** all bycatch mandatory release	
	Recreational	**Low**	**C**	**Low –** all bycatch mandatory release	
	Commercial near-shore	**Low**	**C**	**Low –** all bycatch mandatory release	

Conservation Unit 9 cont'd

Bycatch of Salmon in Fisheries for Other Species	Commercial distant	**Low**	**C**	**Low**	None apparent
	CUMULATIVE EFFECT	**LOW**		**LOW**	None apparent
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**C**	**Low**	None apparent
	Recreational	**Low**	**C**	**Low**	None apparent
	Commercial	**Not Applicable –** all commercial fisheries closed			
	Illegal	**Low**	**C**	**Low**	None apparent
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	None apparent
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low – Medium**	**H C**	**Low**	Thermal generation stations in Dalhousie and Belledune, NB, must comply with conditions of operating license and Section 22 of the *Fisheries Act*
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**H C P**	**Low** – few communities	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low**	**H C**	**Low –** pulp and paper mills comply with pulp and paper effluent regulations	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low** – **Medium**	**H C P**	**Low – Medium**	Must comply with Sections 22 and 35 of the *Fisheries Act*.
	Water extractions	**Low**	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low**	**H C P**	**Low** – only small communities	Project redesign/existing regulation - monitoring
	Infrastructure (roads/culverts) (fish passage)	**Medium**	**H C P**	**Medium** – many non compliant culverts	More monitoring/enforcement of existing regulations
	Aquaculture siting	**Not Applicable**			

Conservation Unit 9 cont'd

Habitat Alterations	Agriculture/forestry/mining, etc.	**Medium**	**H C P**	**Medium** – potential mineral processing; past mining/ processing	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**H C P**	**Low**	Follow regulations in place; mitigations and compensations as required; minimize amount
	CUMULATIVE EFFECT	**MEDIUM**	**H C P**	**MEDIUM**	None apparent
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**H C P**	**Uncertain**	None apparent
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Uncertain**	**H C**	**Uncertain**	None apparent
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low**		**Low**	Fish Health regulations; Introduction and Transfer regulation
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low**		**Low**	Must comply with Introduction and Transfers guidelines.
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low** – minimal removals for scientific purposes.	None apparent
Military Activities	Field operations, shooting ranges	**Not Applicable**			
Air Pollutants	Acid rain	**Low**	**H P**	**Uncertain**	None apparent

Conservation Unit 9 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Uncertain**		**Uncertain**	Increase monitoring and enforcement activities Conduct education programs
International High Seas Targeted	Flags of convenience?	**Uncertain**		**Uncertain**	None apparent
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Medium**	**H C P**	**Low**	Conduct education programs Increase enforcement activities
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain**	**C P**	**Low – Uncertain**; some rivers in this area are moderately impacted by low water levels and warm water temperatures; affect on salmon populations is unknown.	None apparent

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 10, Central NB.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 10**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Low**	**H C**	**Low**	Control harvest through agreements between DFO and First Nations
	Recreational: retention and release	**Low**	**H C**	**Low** – 1SW retention only	Encourage the use of catch and release measures
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**H C**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Low**	**H C**	**Low –** increased enforcement in conjunction with DFO and Provincial enforcement officers; increased stewardship initiatives with local groups; changed enforcement strategies for more targeted efforts	Continue use of compliance monitors on selected watersheds, including Aboriginal guardians
	CUMULATIVE EFFECT	**LOW – MEDIUM**	**C**	**LOW – MEDIUM** – many initiatives in place in recent years to reduce mortality	.
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low** – all bycatch mandatory release	
	Recreational	**Low**	**C**	**Low** – all bycatch mandatory release	
	Commercial near shore	**Low**	**C**	**Low** – all bycatch mandatory release	

Conservation Unit 10 cont'd

Bycatch of Salmon in Fisheries for Other Species	Commercial distant	**Low**	**C**	**Low**	None apparent
	CUMULATIVE EFFECT	**LOW**		**LOW**	None apparent
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**H C**	**Low**	None apparent
	Recreational	**Low**	**H C**	**Low**	None apparent
	Commercial	**Not Applicable**			
	Illegal	**Low**	**H C**	**Low**	None apparent
	CUMULATIVE EFFECT	**LOW**		**LOW**	None apparent
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortalities, entrainment, stranding)	**Low –** very small number of dams	**H C**	**Low**	
Habitat Alterations	Municipal waste water treatment facilities	**Low – Medium**	**H C P**	**Low –** some systems inadequate; occasional system failures	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low**	**H C P**	**Low –** pulp and paper mills comply with pulp and paper effluent regulations	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low**	**H C P**	**Low**	Very low number of facilities
	Water extractions	**Low**	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low**	**H C P**	**Low**	Project redesign; existing regulation - monitoring
	Infrastructure (roads/culverts) (fish passage)	**Medium**	**H C P**	**Medium** – many non compliant culverts	Existing regulations; more monitoring/enforcement
	Aquaculture siting	**Not Applicable**			

Conservation Unit 10 cont'd

Habitat Alterations	Agriculture/forestry/mining, etc.	**Low – Medium**	**H C P**	**Low –** clear-cutting, sedimentation	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**H C P**	**Low**	Follow regulations in place; mitigations and compensations as required; minimize amount
	CUMULATIVE EFFECT	**MEDIUM**	**H C P**	**MEDIUM**	None apparent
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**H C P**	**Uncertain**	None apparent
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Uncertain**	**H C P**	**Uncertain**	None apparent
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low**	**H C P**		Fish Health regulations; Introduction and Transfer regulations
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low**	**H C P**	**Low**	Must comply with Introduction and Transfer guidelines
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low** – minimal removals for scientific purposes.	None apparent
Military Activities	Field operations, shooting ranges	**Not Applicable**			
Air Pollutants	Acid rain	**Low**	**H C P**	**Uncertain**	None apparent

Conservation Unit 10 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Low –** chain pickerel were found in Despres Lake in the Miramichi watershed; eradication was done in 2001	**H C P**	**Low**	Increase monitoring and enforcement activities Conduct education programs
International High Seas Targeted	Flags of convenience?	**Uncertain**		**Uncertain**	None apparent
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**H C P**	**Low**	Increase enforcement activities Conduct education programs
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain**	**C P**	**Low – Uncertain –** some rivers in this area are moderately impacted by low water levels and warm water temperatures; affect on salmon populations is unknown	None apparent

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 11, PEI.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 11**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Low**	**H C**	**Low**	Control harvest through agreements between DFO and First Nations
	Recreational: retention and release	**Low –** 1SW retention only	**H C**	**Low**	Encourage the use of catch and release measures
	Commercial (domestic)	**Not Applicable –** all commercial fisheries closed			
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**H C**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Low**	**H C**	**Low –** increased enforcement in conjunction with DFO and Provincial enforcement officers; initiated stewardship initiatives with three local groups; changed enforcement strategies for more targeted efforts	Continue use of compliance monitors on selected watersheds including Aboriginal guardians
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low –** all bycatch mandatory release	.
	Recreational	**Low**	**C**	**Low –** all bycatch mandatory release	
	Commercial near shore	**Low**	**C**	**Low –** all bycatch mandatory release	
	Commercial distant	**Low**	**C**	**Low**	None apparent

Conservation Unit 11 cont'd

Bycatch of Salmon in Fisheries for Other Species	CUMULATIVE EFFECT	**LOW**		**LOW**	None apparent
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**H C**	**Low**	None apparent
	Recreational	**Low**	**H C**	**Low**	None apparent
	Commercial	**Not Applicable**			
	Illegal	**Low**	**H C**	**Low**	None apparent
	CUMULATIVE EFFECT	**LOW**		**LOW**	None apparent
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Not Applicable**			
Habitat Alterations	Municipal waste water treatment facilities	**Low** small communities, two urban centers	**H C P**	**Low**	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Not Applicable –** no pulp and paper mills in this CU			
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems Dams constructed for purposes other than hydroelectric generation	**Not Applicable –** no generation in this CU **Medium – High**		**Medium – High**- habitat fragmentation (more than 600 dams constructed, fish passage barriers, ecosystem impacts)	
	Water extractions	**Low**	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low**	**H C P**	**Low** – mostly small communities, two urban center	Project redesign; existing regulation - monitoring

Conservation Unit 11 cont'd

Habitat Alterations	Infrastructure (roads/culverts) (fish passage)	**Medium** – **High**	**H C P**	**Medium – High –**many non-compliant culverts; sedimentation; fish passage barriers	Existing regulations; more monitoring/ enforcement
	Aquaculture siting	**Low**	**H C P**	**Low** – many mussel farms in eastern PEI	Choose locations carefully; monitoring; follow the PEI Shellfish Aquaculture Environmental Code of Practice
	Agriculture/forestry/mining, etc.	**Medium – High**	**H C P**	**Medium – High**– extensive agriculture; nutrient and pesticide loading, sedimentation	Enforcement/monitoring of existing suite of regulations, compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**H C P**	**Low**	Follow regulations in place; mitigations and compensations as required; minimize amount
	CUMULATIVE EFFECT	**MEDIUM – HIGH**		**MEDIUM – HIGH–** many fish killed due to pesticide spraying on crops, nutrient enrichment and anoxic events	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**H C P**	**Uncertain**	Follow Federal, Provincial and Municipal regulations
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Uncertain**	**H C P**	**Uncertain**	None apparent
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low**	**H C P**	**Low**	Fish Health regulations; Introduction and Transfer regulations

Conservation Unit 11 cont'd

Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low**	**H C P**	**Low**	Utilize native stock for enhancement
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	None apparent
Military Activities	Field operations, shooting ranges	**Not Applicable**			
Air Pollutants	Acid rain	**Uncertain**	**H C P**	**Uncertain**	None apparent

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Low –** presence of rainbow trout in certain rivers	**H C P**	**Low**	Increase monitoring and enforcement activities; conduct education programs
International High Seas Targeted	Flags of convenience?	**Uncertain**		**Uncertain**	None apparent
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**H C P**	**Low**	Increase enforcement activities; conduct education programs
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain –** habitat may favor exotic species	**C P**	**Low – Uncertain**, some rivers in this area are moderately impacted by low water levels and warm water temperatures; affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 12, North-eastern, NS.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 12**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Low**	**H C**	**Low**	Control harvest through agreements between DFO and First Nations
	Recreational: retention and release	**Low**	**H C**	**Low –** 1SW retention only	Encourage the use of catch and release measures
	Commercial (domestic)	**Not Applicable** – all commercial fisheries closed			
	High Seas (West Greenland/St. Pierre – Miquelon)	**Low**	**H C**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Low**	**H C**	**Low –** increased enforcement in conjunction with DFO and Provincial enforcement officers; initiated stewardship initiatives with local groups; changed enforcement strategies for more targeted efforts	Continue use of compliance monitors on selected watersheds including Aboriginal guardians
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW –** many initiatives in place in recent years	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low**	**C**	**Low –** all bycatch mandatory release	
	Recreational	**Low**	**C**	**Low –** all bycatch mandatory release	
	Commercial near shore	**Low**		**Low–** all bycatch mandatory release	

Conservation Unit 12 cont'd

Bycatch of Salmon in Fisheries for Other Species	Commercial distant	**Low**			None apparent
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	None apparent
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**H C**	**Low**	None apparent
	Recreational	**Low**	**H C**	**Low**	None apparent
	Commercial	**Not Applicable**			
	Illegal	**Low**	**H C**	**Low**	None apparent
	CUMULATIVE EFFECT	**LOW**		**LOW**	None apparent
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Not Applicable**			
Habitat Alterations	Municipal waste water treatment facilities	**Low – Medium**	**H C P**	**Low – Medium – s**ome inadequate facilities and occasional system failures	Ensure current projects and future developments meet standards
	Pulp and paper mills	**Low**	**H C P**	**Low –** pulp and paper mills comply with pulp and paper effluent regulations	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low**			None apparent
	Thermal generation station (entrapment, entrainment, temperature effects)	**Low**		**Low –** mitigation measures in place	
	Water extractions	**Low**	**H C P**	**Low**	Must meet regulations in place; monitoring; develop regional guidelines
	Urbanization (altered hydrology)	**Low**	**H C P**	**Low**	Project redesign; existing regulation - monitoring
	Infrastructure (roads/culverts) (fish passage)	**Medium**	**H C P**	**Medium –** many non-compliant culverts	Existing regulations; more monitoring/enforcement

Conservation Unit 12 cont'd

Habitat Alterations	Aquaculture siting	**Not Applicable**			
	Agriculture/forestry/mining, etc.	**Low**	**H C P**	**Low**	Enforcement/monitoring of existing suite of regulations; compensations where required
	Municipal, Provincial and Federal dredging	**Low**	**H C P**	**Low**	Follow regulations in place; mitigations and compensations as required; minimize amount
	CUMULATIVE EFFECT	**MEDIUM**		**MEDIUM**	None apparent
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**H C P**	**Uncertain**	None apparent
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Uncertain**	**H C P**	**Uncertain**	None apparent
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low**	**H C P**	**Low**	Fish Health regulations; introduction and transfer regulation
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low**	**H C P**	**Low**	None apparent
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low –** minimal removal for scientific purpose	None apparent
Military Activities	Field operations, shooting ranges	**Not Applicable**			
Air Pollutants	Acid rain	**Uncertain**	**H C P**	**Uncertain**	None apparent

Conservation Unit 12 cont'd

UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Low**	**H C P**	**Low**	Increase monitoring and enforcement activities; conduct education programs
International High Seas Targeted	Flags of convenience?	**Uncertain**		**Uncertain**	None apparent
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**H C P**	**Low**	Increase enforcement activities; conduct education programs
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low – Uncertain**	**C P**	**Low – Uncertain**; some rivers in this area are moderately impacted by low water levels and warm water temperatures; affect on salmon populations is unknown	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 13, Cape Breton East Highlands, NS.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 13**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**High** – Aboriginal harvests on several rivers; varies from year to year	**C**	**Medium** – Aboriginal harvests not well known but likely >5%, not always reported and outside of agreements	Increase enforcement by Aboriginal Fisheries Guardians
	Recreational: retention and release	**High –** all rivers open for hook and release; no retention	**C**	**Low** – mortality from hook and release thought to be <5%	
	Commercial (domestic)	**Low –** all are closed	**H**	**None –** closed	
	High Seas (West Greenland / St. Pierre – Miquelon)	**High –** all rivers in the CU produce 2SW salmon	**C**	**Low –** estimated catch of CU 13 non-maturing salmon in West Greenland fishery is low	
	Illegal (poaching)	**High** – all populations are exposed to illegal fishing	**C**	**Medium–** anecdotal information suggests it could be >5%	Increase enforcement; stewardship river watch programs; conservation education in schools
	CUMULATIVE EFFECT	**HIGH**		**MEDIUM**	See above
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**High** – all salmon migrate through areas fished for other species	**C**	**Uncertain** - most fisheries are marine based and research cruises and, with the exception of gillnets, sampling using similar gears indicates salmon are seldom caught	Determine bycatch of salmon in other fishery gear of CU 13

Conservation Unit 13 cont'd

Bycatch of Salmon in Fisheries for Other Species	Recreational	**High** – recreational fisheries for other species occur in most rivers of the CU	**C**	**Low –** bycatch of salmon is illegal; live release of incidental catch of salmon is effective	
	Commercial near-shore	**High** – bycatch of salmon is illegal; all salmon occupy near-shore environments for varying periods of time and at two principal stages, smolt and adult	**C**	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon in estuaries and in near-shore gear are low; main gear with potential for catch is gillnets; removal of pre-spawning salmon could have significant effects where abundance is low	Additional monitoring and enforcement of bycatch regulations in commercial fisheries known to have captured or have the potential to capture CU 13 salmon especially for gear that is known to have a high potential for mortality
	Commercial distant	**High** – all rivers in the CU produce distant migrating 2SW salmon.	**C**	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon in distant fisheries is low, but the numbers of salmon are also low so any removal of maturing salmon at sea could be significant	Advise commercial fisheries monitoring programs to report any Atlantic salmon observations and provide samples of mortalities
	CUMULATIVE EFFECT	**HIGH**		**UNCERTAIN**	See above
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**High**	**C**	**Low** - Aboriginal fisheries have limited habitat interaction	
	Recreational	**High**	**C**	**Low –** Gear is limited to fly fishing deployed by wading	
	Commercial	**None –** fisheries are closed	**H**	**None –** fisheries are closed	
	Illegal	**High –** illegal fishing could potentially occur in most rivers	**C**	**Low** – nets have limited habitat impacts	
	CUMULATIVE EFFECT	**HIGH**		**LOW**	

Conservation Unit 13 cont'd

Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low** – little known water use that causes mortality; limited hydroelectric development	**C**	**Low**	
Habitat Alterations	Municipal waste water treatment facilities	**Medium** – waste water discharge is generally into rivers or estuaries, but limited development	**C**	**Low –** limited Municipal development	
	Pulp and paper mills	**Uncertain**	**C**	**Uncertain**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low –** no hydroelectric development	**C**	**Low –** no hydroelectric development	
	Water extractions	**Low** – the proportion of habitat affected is unknown, but likely low	**C**	**Low** – the impact of water extraction/diversion on the production of salmon is unknown but likely low	
	Urbanization (altered hydrology)	**High** – most of the rivers have some form of development along their courses	**C**	**Uncertain** – effects unknown	Urban planning that incorporates hydrology
	Infrastructure (roads/culverts) (fish passage)	**High** – all rivers have structures of one form or another	**C**	**Uncertain**	Ensure compliance with construction and installation standards for fish habitat Conduct regular compliance monitoring and reporting Provide increased exposure and education for best design and construction practices

Conservation Unit 13 cont'd

Habitat Alterations	Aquaculture siting	**High** – most rivers flow into the Bras d'Or Lakes which has aquaculture sites	**H C P**	**Uncertain** – likely low	Determine the incidence of aquaculture escapes in salmon rivers proximate to salmon farms Therapeutic application of vaccines and treatment of infections of farmed salmon to control outbreaks of disease and parasites License sites away from wild salmon populations License only land-based fish culture operations
	Agriculture/forestry/mining, etc.	**High –** most watersheds have agriculture and forestry	**C P**	**Uncertain** – sediment run off and altered flow regimes can result which decreases fish survival at several stages; altered flows increases the vulnerability of fish during low flow events which are increasing with climate change; extent of habitat damage is undocumented	Increase education and awareness of best management practices Ensure compliance with best management practices for design, construction and operation of agricultural and forestry practices Increase monitoring and enforcement of/for correct habitat alteration procedures Habitat restoration and/or compensation for harmful alteration or destruction of fish habitat or its function Increase greenbelt applications including fencing for agriculture and no cut areas for forestry in prime habitats for fish On site filtering of contaminated water before release
	Municipal, Provincial and Federal dredging	**Low**	**C**	**Low**	Timing to reduce impact
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**High**– shipping in the Bras d'Or Lakes	**C**	**Uncertain** – salmon known to avoid low frequency noise	Conduct research on salmon behaviour with respect to sound Determine sound levels and distribution in Bras d'Or Lakes

Conservation Unit 13 cont'd

Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc	**Medium** – smelt are fished both commercially and recreationally in the Bras d'Or Lakes	**C**	**Uncertain** – kelt survival, adult salmon condition and smolt diet is uncertain in this CU	Conduct research to determine these parameter values
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**High** – most rivers flow into the Bras d'Or Lakes which has aquaculture sites	**H C P**	**Uncertain** – potentially high for small populations	Increase retention of farmed fish in cages through increased perform-ance based standards and controls and mandatory reporting of losses Treat effluents from fish culture operations Direct removal of farmed salmon at counting facilities Screeen all live gene bank salmon for farmed salmon Control or limit predators in the vicinity of fish farms Move to land based operation for salmonids Prevent fish's ability to reproduce if escape occurs
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low –** enhancement stocking discontinued	**H C P**	**Uncertain**	Ensure compliance with the fish culture genetic program and introductions and transfer protocols within government hatcheries Increased monitoring and enforcement of existing regulations for industry hatcheries on both escapes and distributions Ensure transparent operation of industry and government hatcheries
Scientific Research	Government, university, community and Aboriginal groups	**Low** – surveys are limited, periodically wide spread but only a fraction of the population of juveniles is affected	**C**	**Low** – non-lethal methods are generally used	Ensure research likely to benefit the recovery of the species Best handling practices
Military Activities	Field operations, shooting ranges	**Low**	**C**	**Low**	

Conservation Unit 13 cont'd

Air Pollutants	Acid rain	**Low** – few drainages are affected by acid precipitation	**C**	**Low** – most drainages in CU are not vulnerable to acid precipitation	Support enforcement of the *Clean Air Act* Precautionary management of the residual salmon rivers/stocks Mitigate key watersheds through liming to prevent extirpation of rare genetic stocks
UN-PERMITTED					
Introductions of Non-native / Invasive Species	Smallmouth bass, brown and rainbow trout, invertebrates, plants, algae	**High** – at least 30% of the drainages have at least one exotic fish species such as rainbow trout	**C**	**Uncertain** – but likely low, although long term effects are not known	Direct removals in selected drainages and facilities Increase regulations and enforcement concerning transfers of fish Increase or make mandatory harvests in all directed fisheries or bycatch of exotic fish species Increase education programs concerning the expansion of exotic species
International High Seas Targeted	Flags of convenience?	**High** – all drainages have or had distant migrating salmon	**C**	**Uncertain –** the extent and origin of un-permitted high seas salmon catch is unknown	Examine international fisheries for unreported catch of wild Atlantic salmon through international agreements and working groups
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low –** few if any activities in areas where interference is known	**C**	**Low**	Determine any potential for negative impacts and mitigate
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**High** – all drainages are vulnerable to low flow and high flow events as well as exposed to increased predation associated with increased fish, bird and mammal populations	**C**	**Uncertain** – modeling suggests high vulnerability	Direct research to address climate change and related ecosystem change issues on Atlantic salmon

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 14, Cape Breton East Lowlands, NS.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 14**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**High** – Aboriginal harvests on several rivers; varies from year to year	**C**	**Medium** – Aboriginal harvests, not well known but likely >5% , not always reported and outside of agreements	Increased enforcement by Aboriginal Fisheries Guardians
	Recreational: retention and release	**High** – all rivers open for hook and release; no retention	**C**	**Low** – mortality from hook and release thought to be <5%	
	Commercial (domestic)	**None** – all are closed	**H**	**None** – closed	
	High Seas (West Greenland/ St.Pierre – Miquelon)	**High** – all rivers in the CU produce 2SW salmon	**C**	**Low** – estimated catch of CU 14 non-maturing salmon in West Greenland fishery is thought to be low	
	Illegal (poaching)	**High** – all populations are exposed to illegal fishing	**C**	**Medium** – anecdotal information suggests it could be >5%	Increase enforcement Stewardship river watch programs Increase conservation education in schools
	CUMULATIVE EFFECT	**HIGH**		**MEDIUM**	See above
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**High** – all salmon migrate through areas fished for other species	**C**	**Uncertain** - most fisheries are marine based and research cruises and, with the exception of gillnets, sampling using similar gears indicates salmon are seldom caught	Determine bycatch of salmon in other fishery gear of CU14

Conservation Unit 14 cont'd

Bycatch of Salmon in Fisheries for Other Species	Recreational	**High** – recreational fisheries for other species occur in most rivers of the CU	**C**	**Low** - bycatch of salmon is illegal; live release of incidental catch of salmon is effective	
	Commercial near-shore	**High** – bycatch of salmon is illegal; all salmon occupy near-shore environments for varying periods of time and at two principal stages, smolt and adult	**C**	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon in estuaries and in near-shore gear are low; main gear with potential for catch is gillnets; removal of pre-spawning salmon could have significant effects where abundance is low	Additional monitoring and enforcement of bycatch regulations in commercial fisheries known to have captured or have the potential to capture CU 14 salmon especially for gear that is known to have a high potential for salmon mortality
	Commercial distant	**High** – all rivers in the CU produce distant migrating 2SW salmon	**C**	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon in distant fisheries is low, but the numbers of salmon are also low so any removal of maturing salmon at sea could be significant	Advise commercial fisheries monitoring programs to report any Atlantic salmon observations and provide samples of mortalities
	CUMULATIVE EFFECT	**HIGH**		**UNCERTAIN**	See above
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**High**	**C**	**Low –** Aboriginal fisheries have limited habitat interaction	
	Recreational	**High**	**C**	**Low –** gear is limited to fly fishing deployed by wading	
	Commercial	**Low –** fisheries are closed	**H**	**Low –** fisheries are closed	
	Illegal	**High –** illegal fishing could potentially occur in most rivers	**C**	**Low –** nets have limited habitat impacts	
	CUMULATIVE EFFECT	**HIGH**		**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**None** – no known water use that would cause mortality; one hydroelectric development that would not effect salmon	**C**	**Not Applicable**	

Conservation Unit 14 cont'd

Habitat Alterations	Municipal waste water treatment facilities	**High** – waste water discharge is generally into rivers or estuaries	**C**	**Uncertain –** some indication that waste water chemicals alter survival even at low exposure rates	Collection and tertiary treatment of waste water to reduce chemical effects
	Pulp and paper mills	**Uncertain**	**C**	**Uncertain**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**None –** no hydroelectric development that would effect salmon	**C**	**Not Applicable –** no hydroelectric development that would effect salmon	
	Water extractions	**Low** – the proportion of habitat effected is unknown, but likely low	**C**	**Low** – the impact of water extraction/diversion on the production of salmon is unknown but likely low	Flow releases to emulate natural flows
	Urbanization (altered hydrology)	**High** – most of the rivers have some form of development along their courses	**C**	**Uncertain** – effects unknown	Urban planning that incorporates hydrology
	Infrastructure (roads/culverts) (fish passage)	**High** – all rivers have structures of one form or another	**C**	**Uncertain**	Ensure compliance with construction and installation standards for fish habitat Conduct regular compliance monitoring and reporting Provide increased exposure and education for best design and construction practices
	Aquaculture siting	**High** – many rivers flow into the Bras d'Or Lakes which has aquaculture sites	**H C P**	**Uncertain –** likely low	Determine the incidence of aquaculture escapes in salmon rivers proximate to salmon farms Therapeutic application of vaccines and treatment of infections of farmed salmon to control outbreaks of disease and parasites License sites away from wild salmon populations License only land-based fish culture operations

Conservation Unit 14 cont'd

Habitat Alterations	Agriculture/forestry/mining, etc.	**High** – most watersheds have agriculture and forestry	**C P**	**Uncertain** – sediment run off and altered flow regimes can result which decreases fish survival at several stages and altered flows increases the vulnerability of fish during low flow events which are increasing with climate change; extent of habitat damage is undocumented	Increase education and awareness of best management practices Ensure compliance with best management practices for design, construction and operation of agricultural and forestry practices Increase monitoring and enforcement of/for correct habitat alteration procedures Habitat restoration and/or compensation for harmful alteration or destruction of fish habitat or its function Increase greenbelt applications including fencing for agriculture and no cut areas for forestry in prime habitats for fish On site filtering of contaminated water before release
	Municipal, Provincial and Federal dredging	**Low**	**C**	**Low**	Timing to reduce impact
	CUMULATIVE EFFECT	**MEDIUM – HIGH**		**UNCERTAIN**	See above
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**High –** shipping in the Bras d'Or Lakes	**C**	**Uncertain –** salmon known to avoid low frequency noise	Conduct research on salmon behaviour with respect to sound Determine sound levels and distribution in Bras d'Or Lakes
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Medium** – smelt are fished both commercially and recreationally in the Bras d'Or Lakes	**C**	**Uncertain** – kelt survival, adult salmon condition and smolt diet is uncertain in this CU	Conduct research to determine these parameter values

Conservation Unit 14 cont'd

Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**High** – most rivers flow into the Bras d'Or Lakes which has aquaculture sites	**H C P**	**Uncertain –** potentially high for small populations	Increase retention of farmed fish in cages through increased perform-ance based standards and controls and mandatory reporting of losses Treat effluents from fish culture operations Direct removal of farmed salmon at counting facilities Screen all live gene bank salmon for farmed salmon Control or limit predators in the vicinity of fish farms Move to land based operation for salmonids Prevent fish's ability to reproduce if escape occurs
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low –** enhancement stocking discontinued	**H C P**	**Uncertain**	Ensure compliance with the fish culture genetic program and introductions and transfer protocols within government hatcheries Increased regulation and enforcement of existing regulations for industry hatcheries on both escapes and distributions Ensure transparency of industry and government hatcheries
Scientific Research	Government, university, community and Aboriginal groups	**Low** – surveys are limited, periodically wide spread but only a fraction of the population of juveniles is affected	**C**	**Low** – non-lethal methods are generally used	Ensure research likely to benefit the recovery of the species Best handling practices
Military Activities	Field operations, shooting ranges	**Low**	**C**	**Low**	

Conservation Unit 14 cont'd

Air Pollutants	Acid rain	**Low** – few drainages are affected by acid precipitation	**C**	**Low** – most drainages in CU are not vulnerable to acid precipitation	Support enforcement of the *Clean Air Act* Precautionary management of the residual salmon rivers/stocks Mitigate key watersheds through liming to prevent extirpation of rare genetic stocks
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**High** – some of the drainages have at least one exotic fish species such as rainbow trout	**C P**	**Uncertain** – but likely low, although long term effects are not known	Direct removals in selected drainages and facilities Increase regulations and enforcement concerning transfers of fish Increase or make mandatory harvests in all directed fisheries or bycatch of exotic fish species Increase education programs concerning the expansion of exotic species
International High Seas Targeted	Flags of convenience?	**High** – all drainages have or had distant migrating salmon	**C**	**Uncertain –** the extent and origin of un-permitted high seas salmon catch is unknown	Examine international fisheries for unreported catch of wild Atlantic salmon through international agreements and working groups
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low –** few if any activities in areas where interference is known	**C**	**Low**	Determine any potential for negative impacts and mitigate
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**High** – all drainages are vulnerable to low and high flow events as well as exposed to increased predation associated with increased fish, bird and mammal populations	**C**	**Uncertain –** modeling suggests high vulnerability	Direct research to address climate change and related ecosystem change issues on Atlantic salmon

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 15, Southern Upland, NS.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 15**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Low** – limited to put-and-take rivers and by annual agreement to rivers where assessments indicate conservation has been met	**C**	**Low** – fishing agreements for this CU are dependent on in-season assessments which have precluded harvests for Aboriginal use since 2003	
	Recreational: retention and release	**High** – 11 of 65 rivers open for hook and release but four of these are the bulk of the residual populations in the CU	**C**	**Low** – hook and release season on residual populations (4) is three week duration and release survival is high, remainder is on put and take stocking	
	Commercial (domestic)	**None** – fishery closed	**H**	**None**	
	High Seas (West Greenland / St. Pierre – Miquelon)	**High** – all rivers in the CU produce 2SW salmon	**C**	**Low** – estimated catch of CU 15 non-maturing salmon in West Greenland and St. Pierre – Miquelon fishery is low	
	Illegal (poaching)	**High** – all populations are exposed to illegal fishing	**C**	**Uncertain** – reports, investigations and prosecutions for illegal fishing of salmon are low and therefore assume that the take is low, but the numbers of salmon are also low so any removal of pre-spawning salmon could be significant	Increase enforcement Stewardship river watch programs Increase conservation education in schools
	CUMULATIVE EFFECT	**HIGH**		**LOW – UNCERTAIN**	See above

Conservation Unit 15 cont'd

Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**High** – all salmon migrate through areas fished by Aboriginal Peoples for other species	**C**	**Low -** most Aboriginal fisheries are marine based and research cruises or sampling using similar gears indicates salmon are seldom if ever caught	All bycatch mandatory release
	Recreational	**High** – bycatch of salmon is illegal; recreational fisheries for other species occur in most rivers of the CU	**C**	**Low -** bycatch of salmon is illegal, some seasons are adjusted or closed to avoid bycatch, live release of incidental catch of salmon has been demonstrated to be effective	All bycatch mandatory release
	Commercial near-shore	**High** – bycatch of salmon is illegal; all salmon occupy near-shore environments for varying periods of time and at two principal stages, smolt and adult	**C**	**Uncertain** – reports, investigations and prosecutions for illegal fishing of salmon in estuaries and in near-shore gear are low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of pre-spawning salmon could be significant	Additional monitoring and enforcement of bycatch regulations in commercial fisheries known to have captured or have the potential to capture CU 15 salmon especially for gear that is known to have a high potential for mortality
	Commercial distant	**High** – all rivers in the CU produce distant migrating 2SW and 3SW salmon	**C**	**Uncertain** – reports, investigations and prosecutions for illegal fishing of salmon in distant fisheries is low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of maturing salmon at sea could be significant	Advise commercial fisheries monitoring programs to report any Atlantic salmon observations and provide samples of mortalities
	CUMULATIVE EFFECT	**HIGH**		**UNCERTAIN**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low** – marine based fisheries	**C**	**Low –** Aboriginal fisheries are generally marine and have limited habitat interaction	All bycatch mandatory release

Conservation Unit 15 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Recreational	**Low** – few rivers are open to recreational salmon fishing	**C**	**Low –** gear is limited to fly fishing deployed by wading or boat access	All bycatch mandatory release
	Commercial	**Not Applicable**	**C**	**Not Applicable**	All bycatch mandatory release
	Illegal	**Uncertain** – based on report rates proportion of salmon affected is likely low	**C**	**Uncertain** – based on reported cases impact is likely low	Additional monitoring to determine occurrence
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortalities, entrainment, stranding)	**High** – four of the largest river systems in the CU are dammed - Annapolis, Tusket, Mersey, East River Sheet Harbour and have variable fish passage efficiencies; LaHave River at Morgans Falls has louvered bypass and low mortality; bypass rates and turbine mortalities are not usually measured requiring the application of literature formula or values	**H C**	**Uncertain** – salmon population persistence has an increased sensitivity to low fish passage efficiency during low marine survival eras	Continue to improve fish passage efficiencies Operational management changes
Habitat Alterations	Municipal waste water treatment facilities	**High** – waste water discharge is generally into rivers and estuaries through which all salmon must pass	**C**	**Uncertain –** some indication that waste water chemicals alter survival even at low exposure rates	Collection and tertiary treatment of waste water to reduce chemical effects
	Pulp and paper mills	**Low** – one of 65 rivers affected, i.e. Mersey River	**C**	**Low –** river already affected by dams and/or waterfalls with no or ineffective fish passage; pH reduction due to acid precipitation has also impacted the area	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**High –** at least 30% of the drainage area of CU 15 historical salmon rivers have some form of altered flow; two rivers, Northwest and Indian, are in pen stocks with no habitat or passage	**C**	**Medium –** effects range from severe to limited	Improve fish passage facilities Spill regimes to match run timing of smolts and adults
	Water extractions	**Uncertain** – the proportion of habitat affected is unknown	**C**	**Uncertain** – the impact of water extraction/diversion on the production of salmon is unknown	Flow releases to emulate natural flows

Conservation Unit 15 cont'd

Habitat Alterations	Urbanization (altered hydrology)	**High** – most of the 65 known salmon rivers have some form of development along their courses	**C**	**Uncertain** – no known positive effects	Urban planning that incorporates hydrology
	Infrastructure (roads/culverts) (fish passage)	**High** – all rivers have structures of one form or another	**C**	**Uncertain** – most structures are installed under guidelines or following inspection; however, some do not comply and are under reassessment	Ensure compliance with construction and installation standards for fish habitat Conduct regular compliance monitoring and reporting Provide increased exposure and education for best design and construction practices
	Aquaculture siting	**Uncertain –** several aquaculture operations are sited in the CU and major expansions are planned – relative use of the affected marine habitat by the residual populations of wild salmon is unknown	**C P**	**Uncertain** – no known positive effects	Determine the incidence of aquaculture escapes in salmon rivers proximate to salmon farms Therapeutic application of vaccines and treatment of infections to farmed salmon to control outbreaks of disease and parasites License sites away from wild salmon populations License only land-based fish culture operations

Conservation Unit 15 cont'd

Habitat Alterations	Agriculture/forestry/mining, etc	**High –** most watersheds have agricultural and/or forestry	**C**	**Uncertain** – sediment run off and altered flow regimes can result which decreases fish survival at several stages and altered flows increases the vulnerability of fish during low flow events which are increasing with climate change; extent of habitat damage is undocumented	Increase education and awareness of best management practices Ensure compliance with best management practices for design, construction and operation of agricultural and forestry practices Increase monitoring and enforcement of/for correct habitat alteration procedures Habitat restoration and/or compensation for harmful alteration or destruction of fish habitat or its function Increased greenbelt applications including fencing for agriculture and no cut areas for forestry in prime habitats for fish On site filtering of contaminated water before release
	Municipal, Provincial and Federal dredging	**Low**	**C**	**Low**	Timing to reduce impacts
	CUMULATIVE EFFECT	**HIGH**		**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Low**	**C**	**Low**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Medium** – smelt are fished both commercially and recreationally throughout the CU	**C**	**Low** – kelt survival was tested and observed to be high out of the study estuary; adult salmon show increased condition and size indicating adequate ration; smolt diet is uncertain in this CU	

Conservation Unit 15 cont'd

Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behavior and migration, genetic introgression	**Low** – few salmon farming operations currently exist within the CU – plans are to increase salmon production – other mariculture operations occur throughout the CU e.g. scallop, mussel and some marine culture is land based and effluents are usually untreated	**C P**	**Uncertain** – observed incidence of escapes, infections and parasites are low in both marine and freshwater environments and in/on wild salmon returns; however, higher incidences were noted proximate to salmon farming sites – some infections and diseases are associated with salmon farming – predators are known to take escaped farmed salmon	Increase retention of farmed fish in cages through increased performance based standards and controls and mandatory reporting of losses Treat effluents from fish culture operations Direct removal of farmed salmon at counting facilities Screen all live gene bank salmon for farmed salmon Control or limit predators in the vicinity of fish farms Move to land based operation for salmonids Prevent fish's ability to reproduce if escape occurs
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low –** enhancement stocking discontinued in 2001 and now practiced almost exclusively on populations that are extirpated or healthy	**C**	**Uncertain –** the effects of straying from supportive breeding and rearing to residual low wild salmon populations are unknown, but impact is suspected to be inversely proportional to population abundance and distance from stock origins – only fish that are local to the CU are grown and released in the CU	Ensure compliance with the fish culture genetic program and introductions and transfer protocols within government hatcheries Increased monitoring and enforcement of existing regulations for industry hatcheries on both escapes and distributions Ensure transparent operation of industry and government hatcheries
Scientific Research	Government, university, community and Aboriginal groups	**Low** – surveys are limited but periodically wide spread; however, only a fraction of the population of juveniles is affected	**C**	**Low** – non-lethal methods are used wherever possible	Ensure research likely to benefit the recovery of the species Best handling practices
Military Activities	Field operations, shooting ranges	**Low** – rifle range and ordnance proximate to the Sackville R	**C**	**Low** – **Uncertain**	

Conservation Unit 15 cont'd

Air Pollutants	Acid rain	**High** – all drainages are affected by acid precipitation and recovery could be 30 to 50 years	**C**	**High** – drainages in CU15 are particularly vulnerable to acid precipitation and resulting pH is frequently lethal to salmon; about 50% of river populations are extirpated and the residual populations are critically low	Support enforcement of the *Clean Air Act* Precautionary manage the residual salmon rivers/stocks Mitigate key watersheds through liming to prevent extirpation of rare genetic stocks
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**High** – at least 30% of the drainages have at least one exotic fish species including chain pickerel, black bass and rainbow trout	**C**	**Uncertain** – long term effects are not known and expected to be negative	Direct removals in selected drainages and facilities Increase regulations and enforcement concerning transfers of fish Increase or make mandatory harvests in all directed fisheries or bycatch of exotic fish species Increase education programs concerning the expansion of exotic species
International High Seas Targeted	Flags of convenience?	**High** – all drainages have or had distant migrating salmon	**C**	**Uncertain** – the extent and origin of high seas salmon catch is unknown	Examine international fisheries for unreported catch of wild Atlantic salmon through international agreements and working groups
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low –** activities are infrequent and banned in areas where interference is likely to harm salmon	**C**	**Low**	Determine any potential for negative impacts and mitigate
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**High** – all drainages are vulnerable to low flow and high flow events as well as exposed to increased predation associated with increased fish, bird and mammal populations	C	**Uncertain** – modeling suggests high vulnerability	Direct research to address climate change and related ecosystem change issues on Atlantic salmon

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 16, Inner Bay of Fundy, NS and NB.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 16**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**None –** closed since 1991	**H**	**None**	
	Recreational: retention and release	**None –** closed since 1991	**H**	**None**	
	Commercial (domestic)	**None –** closed since 1984	**H**	**None**	
	High Seas (West Greenland / St. Pierre – Miquelon)	**High –** all rivers in the CU produce 2SW salmon	**C –** no tags recovered from distant fisheries for all but one stock	**Low –** estimated catch of CU 16 non-maturing salmon in West Greenland fishery is extremely low	Reductions to domestic food fisheries
	Illegal (poaching)	**High** – All populations are exposed to illegal fishing	**C** – Fishery Officer reports	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon are low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of pre-spawning salmon could be significant	Additional enforcement, especially in rivers where adult salmon are released from the live gene bank
	CUMULATIVE EFFECT	**HIGH**		**LOW**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Low** – Aboriginal fisheries management has initiated restrictions on salmon catches similar to DFO regulations	**C**	**Low** – small catches of salmon caught	

Conservation Unit 16 cont'd

Bycatch of Salmon in Fisheries for Other Species	Recreational	**High** – recreational fisheries for other species occur in most rivers of the CU; juveniles, smolts and adults have been reported captured during various fisheries; live release is mandatory	**C**	**Low** - bycatch of salmon is illegal, seasons are adjusted or closed to avoid bycatch, live release of incidental catch of salmon is effective	Additional monitoring and enforcement of bycatch regulations in recreational fisheries known to capture CU 16 salmon and known to have a high potential for live release
	Commercial near-shore	**Low** – limited gaspereau and low weir fisheries occur in near-shore and in some estuarial environments for varying periods of time exposing two principal stages, smolt and adult; shad gillnet fishery is closed	**C**	**Uncertain** – reports, investigations and prosecutions for illegal fishing of salmon in estuaries and in near-shore gear are low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of pre-spawning salmon could be significant	Additional monitoring and enforcement of bycatch regulations in commercial fisheries known to have captured or have the potential to capture CU 16 salmon and are known to have a high potential for live release Close a commercial fishery if salmon have been recently captured
	Commercial distant	**Low** – few rivers in the CU produce distant migrating 2SW and 3SW salmon	**H C –** low numbers tag recoveries from historical commercial fisheries indicate most stocks are not exposed to interceptory fisheries	**Uncertain** – reports, investigations and prosecutions for illegal fishing of salmon in distant fisheries including Newfoundland and coastal Nova Scotia is low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of maturing salmon at sea could be significant	Advise commercial monitoring programs to report any Atlantic salmon observations and provide samples of mortalities
	CUMULATIVE EFFECT	**HIGH**		**LOW**	Additional monitoring and enforcement of bycatch regulations in recreational and commercial fisheries known to have captured CU 16 salmon and are known to have a high potential for live release
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not applicable**	**H**	**None**	
	Recreational	**Not applicable**	**H**	**None**	
	Commercial	**Not applicable**	**H**	**None**	

Conservation Unit 16 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Illegal	**High –** based on report rates proportion of salmon affected is likely low	**C**	**Uncertain –** based on reported cases impact is likely low	Additional enforcement
	CUMULATIVE EFFECT	**NONE**		**NONE**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Medium** – hydroelectric dams occur on three rivers in the CU including the Gaspereau, Avon and St. Croix, some with no or ineffective fish passage	**H C**	**Low** – ineffective fish passage areas were long ago extirpated or had limited habitat available below natural barriers; fish passage improvements continue in the most affected river, Gaspereau River, Kings County. NS	Continue to improve fish passage efficiency Operational management changes
Habitat Alterations	Municipal waste water treatment facilities	**High** – waste water discharge is generally into rivers and estuaries	**C**	**Uncertain –** some indication that waste water chemicals alter survival	Tertiary treatment of all wastewater to reduce chemical effects
	Pulp and paper mills	**Low** – Halfway River, Kings Co. NS dammed to provide water	**C**	**Low -** fish passage only recently re-established but river was already extirpated	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Medium** – hydroelectric dams occur on three rivers in the CU including the Gaspereau, Avon and St. Croix, some with no or ineffective fish passage	**C**	**Low** – populations were extirpated long ago in two locations and fish passage improvements have been initiated and continue in the Gaspereau River	Improve fish passage facilities Spill regimes to match run timing of smolts and adults
	Water extractions	**Unknown**	**C**	**Uncertain** – the extent and impact of water extraction/ diversion on the production of salmon is unknown	Flow releases to emulate natural flows

Conservation Unit 16 cont'd

Habitat Alterations	Urbanization (altered hydrology)	**High –** many rivers have complete or partial fish passage resultant of water control structures in support of urban or agriculture flood relief; effective passage and delays in downstream and upstream migration limit populations in many rivers known to have provided salmon habitat and production e.g., Petitcodiac, Avon, Shepody, Great Village, Parrsboro, and Chiganois	**C P**	**Uncertain** – no known positive effects; possibility for long term meta-population reduction and loss of population resilience	Urban planning that incorporates hydrology Alternative flood control measures
	Infrastructure (roads/culverts) (fish passage)	**High** – all rivers have structures of one form or another	**C P**	**Uncertain**	Ensure compliance with construction and installation standards for fish habitat Conduct regular compliance monitoring and reporting Provide increased exposure and education for best design and construction practices
	Aquaculture siting	**High –** proximity of industry in a known marine habitat area; water is a vector for disease and parasites transmission	**C P**	**Uncertain** – exposure may not equal mortality; limited survival of escapes results in low straying to CU16 rivers	Therapeutic application of vaccines and treatment of infections of farmed salmon to control outbreaks of disease and parasites License sites away from wild populations License only land-based operations

Conservation Unit 16 cont'd

Habitat Alterations	Agriculture/forestry/mining, etc.	**High –** most watersheds have agricultural and forestry and many habitat deficiencies as the result of poor design, construction and operations have been noted	**C**	**Uncertain** – altered flow regimes, increased water temperatures and siltation can result from extensive cutting and poor operational practices which increases vulnerability of fish during increasing drought events associated with climate change	Increase education and awareness of best management practices Ensure compliance with best management practices for design, construction and operations Increase monitoring and enforcement of habitat procedures Habitat restoration and compensation for harmful alteration or destruction of fish habitat or its function Increase greenbelt applications including fencing for agriculture and no cut areas for forestry in prime habitats for fish On site filtering of contaminated water before release
	Municipal, Provincial and Federal dredging	**Low**	**C**	**Low**	Timing to reduce impact
	CUMULATIVE EFFECT	**HIGH**		**MEDIUM**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Low –** limited shipping in major estuaries	**C**	**Uncertain**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Medium** – smelt are fished both commercially and recreationally throughout the CU, herring are fished extensively throughout the CU and known marine habitat areas; commercial harvest of sand lance occurs outside Canadian waters but within the Bay of Fundy	**C**	**Unknown** – complete distribution of CU16 salmon in the marine habitat is unknown; returns of putatively local migrating salmon is too low to examine any condition factor	

Conservation Unit 16 cont'd

Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Medium** – observed incidence of escapes is low however some escapes migrate to CU 16 rivers and are known to have spawned leading to genetic introgression and loss of local fitness; predator attraction to escapes and collateral mortality of wild salmon in the marine habitat likely occurs	**C P**	**Uncertain** – threat to genetic diversity, increased transmission of once rare diseases, potential for increased parasite transmission, predator attraction and increased collateral mortality of proximate wild salmon	Increase retention of farmed fish in cages through increased perform-ance based standards and controls and mandatory reporting of losses Treat effluents from fish culture operations Direct removal of farmed salmon at counting facilities Screen all live gene bank salmon for farmed salmon Control or limit predators in the vicinity of fish farms Move to land based operation for salmonids Prevent fish's ability to reproduce if escape occurs
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Medium** – while marine survival is intolerably low the population is dependent on supportive rearing and breeding; all stocking is through a pedigree based live gene bank program designed to reduce the loss of diversity and fitness to the wild; commercial hatcheries operate within the CU growing imported salmon under strict retention licenses	**C**	**Uncertain** – completely neutral supportive rearing and breeding programs are not possible; escapes from hatcheries within the area or adjacent to the area or from salmon farms receiving products from these hatcheries have been reported; only three rivers have the opportunity (fishway or traps) to remove escapes and none have the ability to completely genetically identify escapes or external stock strays; funding for genetic identification is limited to live gene bank components	Ensure compliance with the fish culture genetic program and introductions and transfer protocols within government hatcheries Increased regulation and enforcement of existing regulations for industry hatcheries on both escapes and distributions Ensure transparency of industry and government hatcheries
Scientific Research	Government, university, community and Aboriginal groups	**High** – until marine survival rebounds almost all salmon in the CU are handled at some stage	**C**	**Low** – some delays, minimal mortality	Ensure research likely to benefit the recovery of the species Best handling practices
Military Activities	Field operations, shooting ranges	**Low** – limited military activity in the area	**H**	**Uncertain**	

Conservation Unit 16 cont'd

Air Pollutants	Acid rain	**Low** – most rivers are rich in base cations and have high acid neutralizing capacity; Avon and Gaspereau Rivers have some tributaries that are exceptions	**C**	**Low** – drainages in CU are not particularly vulnerable to acid precipitation and pH is generally suitable for salmon	Support enforcement of the *Clean Air Act* Precautionary manage the residual salmon rivers/stocks Lime key watersheds to prevent extirpation of rare genetic stocks

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Low** – some smallmouth bass, brown and rainbow trout are known in the CU	**H C**	**Uncertain** – bass noted as significant predator on juvenile/smolt populations in Eastern Canada	Direct removals in selected drainages and facilities Increase regulations and enforcement concerning transfers of fish Increase or make mandatory harvests in all directed fisheries or bycatch of exotic fish species Increase education programs on the expansion of exotic species
International High Seas Targeted	Flags of convenience?	**Low** – few distant migrating salmon but the extent and origin of high seas salmon catch are unknown	**C**	**Uncertain –** migration strategy-switching of CU 16 salmon may have been a viable alternative that is now unsuccessful?	
Ecotourism and Recreation	Private Companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**C**	**Uncertain**	Determine any potential for negative impacts and mitigate
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**High** – all drainages are vulnerable to low and high flow events as well as exposed to greater predation associated with increased fish, bird and mammal populations	**C**	**High –** marine survival and returns are less than 1% of past values	Direct research to address climate change and related ecosystem change issues on Atlantic salmon

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 17, Outer Bay of Fundy NB.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 17**	**Source** **(*with examples*)**	**Proportion of Salmon in CU Affected** **LOW < 5%,** **MEDIUM 5% to 30%,** **HIGH > 30%,** **UNCERTAIN**	**Cause/ Time Frame** **Historic (H)** **Current (C)** **Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Not Applicable** – closed in mid 90s	**H**	**None**	
	Recreational: retention and release	**Not Applicable** – closed in mid 90s	**H**	**None**	
	Commercial (domestic)	**Not Applicable** – closed since 1983	**H**	**None**	
	High Seas (West Greenland / St. Pierre – Miquelon)	**High** – all rivers in the CU produce 2SW salmon	**C –** occasional tag return	**Low**– estimated catch of CU 17 non-maturing salmon in West Greenland fishery is low	
	Illegal (poaching)	**High** – All populations are exposed to illegal fishing	**C –** Fishery Officer reports	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon are low and therefore one assumes that the take is low, but the numbers of salmon are also low so any removal of pre-spawning salmon could be significant	Additional enforcement, especially below Tobique Dam and adult release sites
	CUMULATIVE EFFECT	**HIGH**		**LOW**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**High** – a striped bass fishery downriver of Mactaquac Dam	**C**	**Low** – small catches of salmon caught	

Conservation Unit 17 cont'd

Bycatch of Salmon in Fisheries for Other Species	Recreational	**High** – bycatch of salmon is illegal; recreational fisheries for other species occur in most rivers of the CU; juveniles captured during trout fishery	**C**	**Low** – seasons are adjusted or closed to avoid bycatch, live release of incidental catch of salmon is effective	
	Commercial near-shore	**High** – shad and gaspereau fisheries and salmon occupy near-shore environments for varying periods of time and at two principal stages, smolt and adult; shad gillnet fishery is closed once the first adult salmon mortality occurs	**C**	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon in estuaries and in near-shore gear are low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of pre-spawning salmon could be significant	Close the commercial shad gillnet fishery once salmon have been captured at Mactaquac Dam or Nashwaak monitoring facilities
	Commercial distant	**High** – all rivers in the CU produce distant migrating 2SW and 3SW salmon.	**C**	**Uncertain –** reports, investigations and prosecutions for illegal fishing of salmon in distant fisheries is low and therefore one assumes that the take is low but the numbers of salmon are also low so any removal of maturing salmon at sea could be significant	Advise commercial fisheries monitoring programs to report any Atlantic salmon observations and provide samples of mortalities
	CUMULATIVE EFFECT	**HIGH**		**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Applicable**	**H**	**None**	
	Recreational	**Not Applicable**	**H**	**None**	
	Commercial	**Not Applicable**	**H**	**None**	
	Illegal	**High**	**C**	**Uncertain –** based on reported cases, impact is likely low	Additional monitoring to determine occurrence
	CUMULATIVE EFFECT	**LOW**		**UNCERTAIN**	

Conservation Unit 17 cont'd

Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**High** – three Canadian and one American dam(s) on the Saint John; one on the Magaguadavic, and one Canadian and one American on the St. Croix all with no or ineffective downstream fish passage	**H C**	**Medium** – estimated eggs lost to smolt mortality related to dams would be at least 10% of total estimated potential eggs deposited to the Saint John River	Improve downstream passage Operational management changes
Habitat Alterations	Municipal waste water treatment facilities	**High** – significant waste water discharge into the Saint John and St. Croix rivers and estuaries, also the Magaguadavic River at St. George	**C**	**Uncertain –** some indication that waste water chemicals alter survival	Collection and tertiary treatment of wastewater to reduce chemical effects especially at Saint John Harbour
	Pulp and paper mills	**High** – City of Saint John on the Saint John River and Woodland on the St. Croix	**C**	**Uncertain –** effect of pulp mill effluents on adult return and run timing, smolt migration and survival is unknown	Determine effluent effects on salmon Treat effluents Install stack scrubbers
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**High –** see above, water storage dams on Tobique reduce egg-to-smolt survival; effective passage and delays in upstream migration of returning adults	**C**	**Medium –** some probability that fish are diverted and spawn successfully elsewhere which can result in a loss of genetic diversity and a general loss of production due to under escapement	Manned operation of fishways Transport of specific stock to their tributary, i.e., Tobique
	Water extractions	**Medium** – **High** – Saint John and St. Croix rivers headwater impoundments and mills and some irrigation	**C**	**Uncertain** – the impact of water extraction/diversion on the production of salmon is unknown	Flow releases to emulate natural flows
	Urbanization (altered hydrology)	**High** – Fredericton, Saint John, etc	**C P**	**Uncertain** – no known positive effects	Urban planning that incorporates hydrology
	Infrastructure (roads/culverts) (fish passage)	**High** – all rivers have structures of one form or another	**C P**	**Uncertain**	Ensure compliance with construction and installation standards for fish habitat Conduct regular compliance monitoring and reporting Provide increased exposure and education for best design and construction practices

Conservation Unit 17 cont'd

Habitat Alterations	Aquaculture siting	**Medium –** water is a vector for disease and parasites transmission and proximity is a factor; the bulk of the NB aquaculture industry is sited in CU 17 and proximate to rivers representing 12 % of the CU's potential wild salmon production; expansion is planned	**C P**	**Uncertain** – exposure may not equal mortality	Determine the incidence of aquaculture escapes in salmon rivers proximate to salmon farms Therapeutic application of vaccines and treatment of infections of farmed salmon to control outbreaks of disease and parasites License sites away from wild salmon populations License only land-based fish culture operations
	Agriculture/forestry/mining, etc.	**High –** most watersheds have agricultural and forestry, in particular clear cutting on the Saint John, and on the Salmon and Nashwaak (tributaries of the Saint John), and significant potato farming on the upper Saint John and tributaries	**C**	**Uncertain** – altered flow regimes, increases water temperatures and siltation can result which increases vulnerability of fish during increasing low flow events associated with climate change	Increase education and awareness of best management practices Ensure compliance with best management practices for design, construction, and operation of agricultural and forestry practices Increase monitoring and enforcement of /for correct habitat alteration procedures Habitat restoration and/or compensation for harmful alteration or destruction of fish habitat or its function Increase greenbelt applications including fencing for agriculture and no cut areas for forestry in prime habitats for fish On site filtering of contaminated water before release
	Municipal, Provincial and Federal dredging	**Low**	**C**	**Low**	Timing to reduce impact
	CUMULATIVE EFFECT	**HIGH**		**MEDIUM**	

Conservation Unit 17 cont'd

Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**High –** exposure of the entire Saint John River population	**C**	**Uncertain**	Conduct research on salmon behaviour with respect to sound Determine effects of shipping and noise on salmon in Saint John Harbour
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c etc.	**Medium** – smelt are fished both commercially and recreationally throughout the CU	**C**	**Low** – condition of adult recruits has not appreciably changed indicating an adequate ration of food	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Medium** – observed incidence of escapes is low at Mactaquac/Nashwaak but high in both marine and freshwater environment for other outer rivers in CU (12%) proximate to the industry	**C P**	**Uncertain** – threat to genetic diversity, increased transmission of once rare diseases, potential for increased parasite transmission, predator attraction and collateral mortality of wild salmon within proximity	Increase retention of farmed fish in cages through increased performance based standards and controls and mandatory reporting of losses Treat effluents from fish culture operations Direct removal of farmed salmon at counting facilities Screen all live gene bank salmon for farmed salmon Control or limit predators in the vicinity of fish farms Move to land based operation for salmonids Prevent farmed fish from reproducing if escape occurs
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Medium –** St. Croix potentially high with stocking; hatchery escapes to Magaguadavic potentially harmful; indirect consequences of adult broodstock production at Mactaquac (Saint John River system) is unknown	**C**	**Uncertain –** potential influence of Mactaquac on 1SW population	Ensure compliance with the fish culture genetic program and introductions and transfer protocols within government hatcheries Increase monitoring and enforcement of existing regulations for industry hatcheries on both escapes and distributions Ensure transparent operation of industry and government hatcheries

Conservation Unit 17 cont'd

Scientific Research	Government, university, community and Aboriginal groups	**High** – handling at Mactaquac, Nashwaak, St. George and Milltown	**C**	**Low** – some delays, minimal mortality	Ensure research likely to benefit the recovery of the species; use of Best handling practices
Military Activities	Field operations, shooting ranges	**Low** – Nerepis (less than 5% of production), agent orange, etc	**H**	**Uncertain**	Gagetown clean up
Air Pollutants	Acid rain	**Uncertain** – possible detriment due to low pH on Canaan and Gaspereau tributaries of the Saint John	**C**	**Uncertain**	Support enforcement of the *Clean Air Act* Precautionary management of residual salmon rivers/stocks Mitigate key watersheds through liming to prevent extirpation of rare genetic stocks

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Introductions of Non-native / Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**High** – smallmouth bass, chain pickerel and muskellunge all expanding rapidly; rainbow trout less of a threat based on stock origin	**C**	**Uncertain** – bass and esocids noted as significant predator on juvenile/smolts. Saint John perhaps the most extreme case of invasive species on salmonid populations in Eastern Canada	Direct removals in selected drainages and facilities Increase regulations and enforcement concerning transfers of fish Increase or make mandatory harvests in all directed fisheries or bycatch of exotic fish species Increase education programs concerning the expansion of exotic species
International High Seas Targeted	Flags of convenience?	**High** – all drainages have or had distant migrating salmon	**C**	**Uncertain –** the extent and origin of high seas salmon catch is unknown	Examine international fisheries for unreported catch of wild Atlantic salmon through international agreements and working groups
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Uncertain**	**C**	**Uncertain**	Determine any potential for negative impacts and mitigate
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**High** – all drainages are vulnerable to low flow and high flow events as well as exposed to increased predation associated with increased fish, bird and mammal populations	**C**	**High –** marine survival and returns are less than 30% of past values	Direct research to address climate change and related ecosystem change issues on Atlantic salmon

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 18 (Zone Q1) Chaleur Bay, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 18**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Low**	**C**	**Low**	
	Recreational: retention and release	**Medium**	**C**	**Medium**	Increase use of catch and release measures
	Commercial (domestic)	**None** – commercial fisheries closed	**H**	**None**	
	High Seas (West Greenland/ St. Pierre – Miquelon)	**Uncertain**	**C**	**Uncertain**	
	Illegal (poaching)	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**None**	**C**	**None**	
	Recreational	**Not Assessed**	**C**	**Not Assessed**	
	Commercial near-shore	**Low**	**C**	**Low**	Not assessed
	Commercial distant	**Uncertain**	**C**	**Uncertain**	Not assessed
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 18 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Assessed**	**C**	**Not Assessed**	
	Recreational	**Not Assessed**	**C**	**Not Assessed**	
	Commercial	**Not applicable**	**C**	**Not applicable**	
	Illegal	**Not Assessed**	**C**	**Not Assessed**	
	CUMULATIVE EFFECT	**NOT ASSESSED**	**C**	**NOT ASSESSED**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**None**	**C**	**None**	
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**C**	**Low**	
	Pulp and paper mills	**Low**	**C**	**Low**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Not applicable**	**C**	**Not applicable**	
	Water extractions	**Low**	**C**	**Low**	
	Urbanization (altered hydrology)	**Low**	**C**	**Low**	
	Infrastructure (roads /culverts) (fish passage)	**Low**	**C**	**Low**	
	Aquaculture siting	**Not Applicable**	**C**	**Not Applicable**	
	Agriculture/forestry/mining, etc.	**Low**	**C**	**Low**	
	Municipal, Provincial and Federal dredging	**Not Assessed**	**C**	**Not Assessed**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 18 cont'd

Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Not Assessed**	**C**	**Not Assessed**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, Recreational, Aboriginal fisheries for species a, b, c etc.	**Low**	**C**	**Low**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low**	**C**	**Low**	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low**	**C**	**Low**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	
Military Activities	Field operations, shooting ranges	**Not Applicable**	**C**	**Not Applicable**	
Air Pollutants	Acid rain	**Low**	**C**	**Low**	

Conservation Unit 18 cont'd

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Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Low**	**C**	**Low**	
International High Seas Targeted	Flags of convenience?	**Not Assessed**		**Not Assessed**	
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**C**	**Low**	
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low**	**C**	**Low**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 19 (Zone Q2), Gaspé Peninsula, PQ.

Potential Sources of Mortality/harm Permitted and Un-permitted Activities **Conservation Unit 19**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Low**	**C**	**Low –** less than 20 salmon /year	
	Recreational: retention and release	**Medium**	**C**	**Low** – 55% of rivers (5/9) have catch and release measures; pre- and in-season management plans control exploitation based on status; large salmon fisheries authorized only where conservation limits (CL) are met or exceeded	
	Commercial (domestic)	**Not Applicable –** commercial fisheries closed	**H**	**Not Applicable**	
	High Seas (West Greenland / St. Pierre – Miquelon)	**Low**	**C**	**Low**	Reductions in internal use fisheries in those areas
	Illegal (poaching)	**Uncertain**	**C**	**Uncertain** – river management organizations have protection activities, education initiatives	
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Not Applicable**	**H**	**Not Applicable**	
	Recreational	**Low**	**C**	**Low**	
	Commercial near-shore	**Low–** not assessed	**C**	**Low** – not assessed	
	Commercial distant	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 19 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Applicable**		**Not Applicable**	
	Recreational	**Low**	**C**	**Low**	
	Commercial	**Not Applicable –** commercial fisheries closed		**Not Applicable**	
	Illegal	**Uncertain**	C	**Uncertain**	
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine morality, entrainment, stranding)	**Not Applicable**		**Not Applicable**	
Habitat Alterations	Municipal waste water treatment facilities	**Uncertain**	**C**	**Uncertain**	
	Pulp and paper mills	**Uncertain**	**H**	**Uncertain**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Not Applicable**	**C**	**Not Applicable**	
	Water extractions	**Not Applicable**	**C**	**Not Applicable**	
	Urbanization (altered hydrology)	**Low**	**C**	**Low**	
	Infrastructure (roads/culverts) (fish passage)	**Low**	**C**	**Low**	
	Aquaculture siting	**Uncertain**	**C**	**Uncertain**	
	Agriculture/forestry/mining, etc.	**Uncertain**	**C**	**Uncertain**	
	Municipal, Provincial and Federal dredging	**Not Assessed**		**Not Assessed**	
	CUMULATIVE EFFECT	**LOW**		**LOW**	

Conservation Unit 19 cont'd

Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**C**	**Uncertain**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Uncertain**	**C**	**Uncertain**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Uncertain**	**C**	**Uncertain –** increased frequency of rainbow trout being observed in salmon rivers	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Uncertain**	**H**	**Uncertain**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	
Military Activities	Field operations, shooting ranges	**Not Applicable**	**C**	**Not Applicable**	
Air Pollutants	Acid rain	**Uncertain**	**P**	**Uncertain**	

Conservation Unit 19 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Uncertain**	**C**	**Uncertain –** increased frequency of rainbow trout being observed in salmon rivers; Didymo algae has not yet been identified in the CU	
International High Seas Targeted	Flags of convenience?	**Not Assessed**	**C**	**Not Assessed**	
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**C**	**Low –** canoe and aquatic activities gaining popularity	
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Uncertain**	**C**	**Uncertain**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 20 (Zone Q3) Lower St. Lawrence N. Shore, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 20**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Not Applicable**	**C**	**Not Applicable**	
	Recreational: retention and release	**Medium**	**C**	**Medium**	Increase use of catch and release measures
	Commercial (domestic)	**Not Applicable –** commercial fisheries closed	**H**	**Not Applicable**	
	High Seas (West Greenland/St. Pierre – Miquelon)	**Uncertain**	**C**	**Uncertain**	
	Illegal (poaching)	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**MEDIUM**	**C**	**MEDIUM**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Not Applicable**	**C**	**Not Applicable**	
	Recreational	**Not Assessed**	**C**	**Not Assessed**	
	Commercial near-shore	**Low**	**C**	**Low**	Situation not assessed
	Commercial distant	**Uncertain**	**C**	**Uncertain**	Situation not assessed
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Assessed**	**C**	**Not Assessed**	
	Recreational	**Not Assessed**	**C**	**Not Assessed**	
	Commercial	**Not Assessed**	**C**	**Not Assessed**	

Conservation Unit 20 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Illegal	**Not Assessed**	**C**	**Not Assessed**	
	CUMULATIVE EFFECT	**NOT ASSESSED**	**C**	**NOT ASSESSED**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Not Assessed**	**C**	**Not Assessed**	
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**C**	**Low**	
	Pulp and paper mills	**Not Applicable**	**C**	**Not Applicable**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Low**	**C**	**Low**	
	Water extractions	**Low**	**C**	**Low**	
	Urbanization (altered hydrology)	**Low**	**C**	**Low**	
	Infrastructure (roads /culverts) (fish passage)	**Low**	**C**	**Low**	
	Aquaculture siting	**Not Applicable**	**C**	**Not Applicable**	
	Agriculture/forestry/mining, etc.	**Low**	**C**	**Low**	
	Municipal, Provincial and Federal dredging	**Not Assessed**	**C**	**Not Assessed**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 20 cont'd

Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Not Assessed**	**C**	**Not Assessed**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Low**	**C**	**Low**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Low**	**C**	**Low**	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Low**	**C**	**Low**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	
Military Activities	Field operations, shooting ranges	**Not Applicable**	**C**	**Not Applicable**	
Air Pollutants	Acid rain	**Low**	**C**	**Low**	

Conservation Unit 20 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Not Applicable**	**C**	**Not Applicable**	
International High Seas Targeted	Flags of convenience?	**Not Assessed**		**Not Assessed**	
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**C**	**Low**	
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Low**	**C**	**Low**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 22 (Zone Q5), Québec City Region, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 22**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	Not applicable		Not applicable	
	Recreational: retention and release	**Low – Medium**	**C**	**Low– Medium –** one river closed to Atlantic salmon fishing; post-release mortality is estimated at 10 to 15%	Mandatory release of large salmon on other rivers Grilse fishery only
	Commercial (domestic)	**Not applicable**	**H**	**Not Applicable**	
	High Seas (West Greenland/St. Pierre – Miquelon)	**Uncertain**	**C**	**Uncertain**	
	Illegal (poaching)	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**LOW – MEDIUM**		**LOW – MEDIUM**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Uncertain**	**C**	**Uncertain**	
	Recreational	**Low**	**C**	**Low**	
	Commercial near-shore	**Low –** very few salmon are reported captured by commercial fishing in CU 22	**C**	**Low**	
	Commercial distant	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Applicable**		**Not Applicable**	
	Recreational	**Low**	**C**	**Low**	

Conservation Unit 22 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Commercial	**Not Applicable**	**H**	**Not Applicable**	
	Illegal	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Low – Medium –** downstream migration protective structures have been installed at all generating stations since 2005	**C**	**Low – Medium –** there continues to be minor problems of impingement and mortality on certain rivers	Annual monitoring of downstream migration to assess the effectiveness of the protective structures
Habitat Alterations	Municipal waste water treatment facilities	**Low** – almost all Municipal waste is treated	**C**	**Low**	
	Pulp and paper mills	**Uncertain** – there is a pulp and paper mill on one river; the current impact of this mill on salmon is uncertain	**C**	**Uncertain**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Uncertain** – could cause problems during low velocity episodes; increase in water temperature	**C**	**Uncertain** – we have already closed one generating station in order to provide flow for a fish ladder	
	Water extractions	**Uncertain** – could cause problems during low velocity episodes	**C**	**Uncertain**	
	Urbanization (altered hydrology)	**Uncertain**	**C**	**Uncertain**	
	Infrastructure (roads/culverts) (fish passage)	**Low**	**C**	**Low**	
	Aquaculture siting	**Uncertain**	**C**	**Uncertain**	
	Agriculture/forestry/mining, etc.	**Uncertain –** increase in water temperature	**C**	**Uncertain**	
	Municipal, Provincial and Federal dredging	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**UNCERTAIN**	**C**	**UNCERTAIN**	

Conservation Unit 22 cont'd

Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**C**	**Uncertain**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Uncertain**	**C**	**Uncertain**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Uncertain –** most requests to stock rainbow trout within/proximate watersheds containing Atlantic salmon are refused	**C**	**Uncertain**	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Uncertain**	**C**	**Uncertain**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	
Military Activities	Field operations, shooting ranges	**Uncertain**	**C**	**Uncertain** no control of activities within military complex	
Air Pollutants	Acid rain	**Uncertain–** the waters of the watersheds of certain rivers are slightly acidic, without causing problems; the buffering capacity of the rivers is low and the pH of precipitation is roughly 4.5	**C**	**Uncertain**	

Conservation Unit 22 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Uncertain –** not known if there is inter-specific competition with rainbow trout; most requests to stock rainbow trout within the hydro graphic basin of Atlantic salmon rivers are refused	**C**	**Uncertain**	Research is being conducted to determine if there is inter-specific competition between Atlantic salmon and rainbow trout
International High Seas Targeted	Flags of convenience?	**Uncertain**	**C**	**Uncertain**	
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Uncertain**	**C**	**Uncertain**	
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Medium –** annual monitoring of water temperature on every salmon river; mid summer temperature is critical on some rivers and reaching 27^{o}C	**C**	**Medium** – low velocity episode during the summer and high velocity episode after reproduction; high occurrence of lesions and ulcerations with fungi on spawners in certain rivers	.

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 23 (Zone Q6), Saguenay-Lac Saint Jean, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 23**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Not Applicable**	**C**	**Not Applicable**	
	Recreational: retention and release	**Low** – permanent catch and release on every river	**C**	**Low**	
	Commercial (domestic)	**Not Applicable**		**Not Applicable**	
	High Seas (West Greenland/ St. Pierre – Miquelon)	**Uncertain**	**C**	**Uncertain**	
	Illegal (poaching)	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Uncertain**	**C**	**Uncertain**	
	Recreational	**Uncertain**	**C**	**Uncertain**	
	Commercial near-shore	**Uncertain**	**C**	**Uncertain**	
	Commercial distant	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**LOW**		**LOW**	
Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Not Applicable**	**C**	**Not Applicable**	
	Recreational	**Low**	**C**	**Low**	
	Commercial	**Not Applicable**	**C**	**Not Applicable**	
	Illegal	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	

Conservation Unit 23 cont'd

Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Not Applicable**	**C**	**Not Applicable**	
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**C**	**Low**	
	Pulp and paper mills	**Uncertain**	**C**	**Uncertain**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Uncertain**	**C**	**Uncertain**	
	Water extractions	**Uncertain**	**C**	**Uncertain**	
	Urbanization (altered hydrology)	**Uncertain**	**C**	**Uncertain**	
	Infrastructure (roads/culverts) (fish passage)	**Medium**	**C**	**Uncertain**	
	Aquaculture siting	**Uncertain**	**C**	**Uncertain**	
	Agriculture/forestry/mining, etc.	**Not assessed**	**C**	**Not assessed**	
	Municipal, Provincial and Federal dredging	**Uncertain**	**C**	**Uncertain**	
	CUMULATIVE EFFECT	**UNCERTAIN**	**C**	**UNCERTAIN**	
Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**C**	**Uncertain**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Uncertain**	**C**	**Uncertain**	

Conservation Unit 23 cont'd

Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Uncertain**	**C**	**Uncertain**	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Uncertain**	**C**	**Uncertain**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**C**	**Low**	
Military Activities	Field operations, shooting ranges	**Uncertain**	**C**	**Uncertain**	
Air Pollutants	Acid rain	**Uncertain**	**C**	**Uncertain**	
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Uncertain**	**C**	**Uncertain**	
International High Seas Targeted	Flags of convenience?	**Not Assessed**	**C**	**Not Assessed**	
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Uncertain**	**C**	**Uncertain**	
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease and natural disaster	**High –** exceptional flood in 1996	**C**	**Low**	Bank and bed consolidation program Fish stocking program

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 24 (Zone Q7), Upper North Shore, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 24**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Low –** Aboriginal fishing is carried out in only two rivers of the CU's 12 rivers	**C**	**Low**	
	Recreational: retention and release	**Low – Medium –** 5 of the 12 rivers of this CU are closed to salmon fishing	**C**	**Low –** only two rivers in this CU allow the retention of large salmon; the numbers retained are very low	Increase use of catch and release measures
	Illegal (poaching)	**Low** – great efforts are taken by the river managers of this CU to control poaching	**C**	**Low**	Additional protection efforts; additional education efforts
	CUMULATIVE EFFECT	**LOW – MEDIUM**		**LOW**	
Habitat Alterations	Hydroelectric power generation (dams and reservoirs): altered behavior and ecosystems	**Low**	**C P –** we expect an increase of this threat in the future	**Low**	Avoid construction of dams on salmon rivers Require promoters to include mitigation measures in their dam project to limit negative effects on fish habitat and mortality
	Water extractions	**Low**	**C**	**Low**	
	Forestry and mining	**Uncertain** – probably **Low**	**H C P**	**Uncertain –** probably **Low**	Use of mitigation measures

Conservation Unit 24 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Rainbow trout and algae	**Uncertain –** probably none at the present time (some occurrence of rainbow trout in salmon rivers of this CU)	**C** but mostly **P–** we expect an increase of this threat in the future	**Uncertain –** probably none at the present time	Use of measures to limit propagation of invasive species
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Uncertain**	**P**	**Uncertain**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 25 (Zone Q8), Middle North Shore, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 25**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Uncertain -** Aboriginal fishing is carried out in only four of the CU's 17 rivers	**C**	**Uncertain**	
	Recreational: retention and release	**Uncertain** – two of the CU's 17 rivers are closed to salmon fishing	**C**	**Uncertain**– all rivers except one allow retention of large salmons	Increase use of catch and release measures
	Illegal (poaching)	**Uncertain –** problematic; well known but difficult to eradicate because of the size of the territory	**C**	**Uncertain**	Additional protection efforts; additional education efforts
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Bycatch of Salmon in Fisheries for other species	Commercial near-shore	**Uncertain –** problematic; well known but difficult to eradicate because of the size of the territory	**C**	**Uncertain**	Use more selective methods of fishing to avoid salmon capture Additional protection efforts; additional education efforts
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Habitat Alterations	Hydroelectric power generation (dams and reservoirs): altered behavior and ecosystems	**Low**	**C P–** (we expect an increase of this threat in the future)	**Low**	Avoid construction of dams on salmon rivers Require promoters to include mitigation measures in their dam project to limit negative effects on fish habitat and mortality
	Forestry and mining	**Uncertain –** but probably **Low**	**H C P**	**Uncertain –** but probably **Low**	Use of mitigation measures

Conservation Unit 25 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Rainbow trout and algae	**Uncertain–** probably **None** at the present time; (some occurrence of rainbow trout in salmon rivers of this CU)	**C –** but mostly **P –** (we expect an increase of this threat in the future)	**Uncertain–** but probably **None** at the present times	Use of measures to limit propagation of invasive species
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Uncertain**	**P**	**Uncertain**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 26 (Zone Q9), Lower North Shore, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 26**	Source (*with examples*)	Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN	Cause/ Time Frame Historic (H) Current (C) Potential (P)	Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)	Management Alternatives/ Mitigation *(relative to existing actions)*
Directed Salmon Fishing	Aboriginal	**Uncertain –** Aboriginal fishing is carried out in only two of the 22 rivers in this CU	**C**	**Uncertain**	
	Recreational: retention and release	**Uncertain –** all rivers of this CU are opened to salmon fishing	**C**	**Uncertain –** all rivers allow retention of large salmon; this CU is mostly visited by non-residents and catch and release is used widely even if it is on a voluntary basis	Increase use of catch and release measures
	Illegal (poaching)	**Uncertain -** problematic; well known but difficult to eradicate because of the size and remoteness of the territory	**C**	**Uncertain**	Additional protection efforts; additional education efforts
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Bycatch of Salmon in Fisheries for other Species	Commercial near-shore	**Uncertain –** commercial near-shore fishing well implanted in this CU; problematic, well known but difficult to eradicate because of the size and remoteness of the territory	**C**	**Uncertain**	Use more selective methods of fishing to avoid salmon capture Additional protection efforts; additional education efforts
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	

Conservation Unit 26 cont'd

Habitat Alterations	Hydroelectric power generation (dams and reservoirs): altered behavior and ecosystems	**Low**	**C** and **P –** (we expect an increase in this threat in the future)	**Low**	Avoid construction of dams on salmon rivers Require promoters to include mitigation measures in their dam project to limit negative effects on fish habitat and mortality
UN-PERMITTED					
Introductions of Non-native / Invasive Species	Rainbow trout and algae	**Uncertain –** but probably **None** at the present time	**C –** but mostly **P** – (we expect an increase of this threat in the future)	**Uncertain –** but probably **None** at the present time	Use of measures to limit propagation of invasive species
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Uncertain**	**P**	**Uncertain**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 27 (Zone Q10), Anticosti, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 27**	**Source** (***with examples***)	**Proportion of Salmon in CU Affected** **LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame** **Historic (H) Current (C) Potential (P)**	**Effect on Population** **(LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation** ***(relative to existing actions)***
Directed Salmon Fishing	Recreational: retention and release	**Uncertain** but probably **Low –- Medium –** only 5 of 24 rivers in this CU are open to salmon fishing	**C**	**Low –** retention of large salmons forbidden in the rivers of this CU	Increase use of catch and release measures
	Illegal (poaching)	**Uncertain** but probably **Low –** great efforts are taken by the river managers of this CU to control poaching	**C**	**Uncertain –** but probably **Low**	Additional protection efforts; additional education efforts.
	CUMULATIVE EFFECT	**UNCERTAIN**		**UNCERTAIN**	
Habitat Alterations	Forestry and mining	**Uncertain**	**H C P**	**Uncertain**	Use of mitigation measures
UN-PERMITTED					
Introductions of Non-native/ Invasive Species	Rainbow trout and algae	**Uncertain –** but probably **None –** at the present time; (some occurrence of rainbow trout in salmon rivers of this CU)	**C–**but mostly **P**– (we expect an increase of this threat in the future)	**Uncertain –** but probably **None –** at the present time	Use of measures to limit propagation of invasive species
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Uncertain**	**P**	**Uncertain**	

Appendix 2 cont'd. Summary of threats to and rating of effects on recovery and/or persistence of Atlantic salmon in CU 28 (Zone Q11), Ungava, PQ.

Potential Sources of Mortality/Harm Permitted and Un-permitted Activities **Conservation Unit 28**	**Source (*with examples*)**	**Proportion of Salmon in CU Affected LOW < 5%, MEDIUM 5% to 30%, HIGH > 30%, UNCERTAIN**	**Cause/ Time Frame Historic (H) Current (C) Potential (P)**	**Effect on Population (LOW < 5% spawner loss, MEDIUM 5% to 30% spawner loss, HIGH > 30% spawner loss, UNCERTAIN)**	**Management Alternatives/ Mitigation *(relative to existing actions)***
Directed Salmon Fishing	Aboriginal	**Uncertain**	**C**	**Uncertain** – the Inuit catch level is unknown	Introduce monitoring of food fisheries
	Recreational: retention and release	**Low**	**C**	**Low**	Promote release as suggested by some outfitters
	Commercial (domestic)	**Not Applicable**	**H**	**Not Applicable**	
	High Seas (West Greenland/ St. Pierre – Miquelon)	**Not Assessed**	**P**	**Not Assessed –** little high seas fishing by Inuit	
	Illegal (poaching)	**Uncertain**	**C**	**Uncertain** – the isolation and size of rivers could favor poaching	Increase monitoring
	CUMULATIVE EFFECT	**UNCERTAIN**	**C**	**UNCERTAIN**	
Bycatch of Salmon in Fisheries for Other Species	Aboriginal	**Uncertain**	**C**	**Uncertain**	
	Recreational	**Uncertain**	**P**	**Uncertain**	
	Commercial near-shore	**Uncertain**	P	**Uncertain**	
	Commercial distant	**Uncertain**	P	**Uncertain**	
	CUMULATIVE EFFECT	**UNCERTAIN**	P	**UNCERTAIN**	

Conservation Unit 28 cont'd

Salmon Fisheries Impacts on Salmon Habitat	Aboriginal	**Low**	**C**	**Low**	
	Recreational	**Low**	**C**	**Low**	
	Commercial	**Low**	**C**	**Low**	
	Illegal	**Low**	**C**	**Low**	
	CUMULATIVE EFFECT	**LOW**	**C**	**LOW**	
Mortality Associated with Water Use	Power generation at dams and tidal facilities (turbine mortality, entrainment, stranding)	**Not Applicable**	**P**	**Not Applicable –** hydroelectric development however, continues to be a major threat given the hydropower potential	
Habitat Alterations	Municipal waste water treatment facilities	**Low**	**P**	**Low**	
	Pulp and paper mills	**Not Applicable**	**C**	**Not Applicable**	
	Hydroelectric power generation (dams and reservoirs, tidal power): altered behavior and ecosystems	**Not Applicable**	**P**	**Not Applicable** – hydroelectric development continues to be a major threat given the hydropower potential	
	Water extractions	**Low**	**C**	**Low** – the size of the rivers allows for water extractions	
	Urbanization (altered hydrology)	**Low**	**P**	**Low**	
	Infrastructure (roads and culverts) (fish passage)	**Low**	**P**	**Low**	
	Aquaculture siting	**Low**	**P**	**Low**	
	Agriculture/forestry/mining, etc.	**Low**	**P**	**Low**	
	Municipal, Provincial and Federal dredging	**Low**	**P**	**Low**	
	CUMULATIVE EFFECT	**LOW**	**P**	**LOW**	

Conservation Unit 28 cont'd

Shipping, Transport and Noise	Municipal, Provincial, Federal and private transport activities (including land and water based contaminants/ spills)	**Uncertain**	**P**	**Uncertain**	
Fisheries on Prey of Salmon (for example capelin, smelt, shrimp)	Commercial, recreational, Aboriginal fisheries for species a, b, c, etc.	**Uncertain**	**C**	**Uncertain**	
Aquaculture (salmon and other species)	Escapes from fresh water, marine facilities, disease, parasites, competition, effects on behaviour and migration, genetic introgression	**Uncertain**	**C**	**Uncertain** – very small aquaculture facility and production of Arctic charr in Kuujjuaq	
Fish Culture/ Stocking (non-commercial, including private, NGO, government)	Impacts on effective population size, over-representation of families, domestication	**Uncertain**	**C**	**Uncertain**	
Scientific Research	Government, university, community and Aboriginal groups	**Low**	**H**	**Low** – very little catch for scientific research in recent years	
Military Activities	Field operations, shooting ranges	**Uncertain**	**P**	**Uncertain**	
Air Pollutants	Acid rain	**Uncertain**	**P**	**Uncertain**	

Conservation Unit 28 cont'd

UN-PERMITTED

Introductions of Non-native/ Invasive Species	Smallmouth bass, chain pickerel, muskellunge, rainbow trout, invertebrates, plants, algae	**Uncertain**	**P**	**Uncertain**	
International High Seas Targeted	Flags of convenience?	**Not Assessed**		**Not Assessed**	
Ecotourism and Recreation	Private companies and public at large (water crafts, swimming, etc) effects on salmon behaviour and survival	**Low**	**C**	**Low**	
Ecosystem Change	Climate change, changes in relative predator and prey abundances, disease	**Uncertain**	**C**	**Uncertain**	