St. Mary's River Association Recovery Strategy

Prepared for
St. Mary's River Association

by

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EXECUTIVE SUMMARY

The decline in the Atlantic salmon population over the past few decades has prompted the St. Mary's River Association (SMRA) to alter its focus from that of an angler organization to a river based conservation organization. With this shift in focus and approach the SMRA began to invest significant resources into the development of an ecosystem based integrated watershed management plan that would benefit the entire river and see salmon populations return to sustainable levels able to support their native and non-native community needs in addition to their biological role. This work really started gaining momentum in the early 2000's with the hiring of an Executive Director and the development of the "Healthy Rivers, Vibrant Community" program. The subsequent years saw many studies being completed, knowledge gaps identified and mitigated, which led to an important understanding of the scope of the river's issues and its potential. As this multi-year program drew to a close and the SMRA prepared for the next step, the federal government Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended listing Atlantic salmon of the Southern Upland, including the St. Mary's River, as an endangered species. The St. Mary's River Association, concerned about the pace of the salmon decline and the timeframe for the development of a government based recovery plan, felt that it was necessary to initiate their own process to act upon their progress to date. As such the "next step" was a program to develop and implement a recovery strategy for the St. Mary's River. The recovery strategy was developed in three phases: literature review, consultation, and plan development. The aim of the strategy is to develop a collaborative, feasible, holistic ecosystem based solutions that will return the river to a state that it can support an ecologically healthy and self-sustaining salmon population, able to meet the needs of the native and non-native communities. Following plan development the aim is to transition immediately into plan adoption and implementation. The plan is intended to complement the government based recovery plan as it comes online.

The initial phase involved an extensive review of the literature that had been generated before and during the "Healthy River, Vibrant Communities" program. These data had been generated by DFO in monitoring and studying the St. Mary's River and other similar systems within Nova Scotia, by the St. Mary's River Association in 20 years or work on the river, and by the scientific community. This phase was somewhat simplified as DFO had embarked on a similar literature review for their recovery potential assessment (RPA) that they were required to complete as part of the endangered species listing process.

The second phase of the recovery strategy was a consultation phase, where various stakeholders were asked about their concerns and thoughts on the problems faced and solutions for salmon in the St. Mary's River. During these consultations many issues were raised and discussed but key concerns were engagement of the public, involvement of various levels of government, and the native community in the recovery process; the pros and cons of stock enhancement; public's access to the various fisheries; management issues; the role of predation

control in recovery; and respect of native treaty rights as well as for the integrity of the fish and the ecosystem.

The recovery strategy was developed by taking the information gathered from the first two phases and exploring those issues identified as impacting the St. Mary's River. A comprehensive and integrative solution was then developed to address these issues. Issues that were identified were salmon survival, water chemistry (pH, metals), temperature, watershed connectivity and access, predation, hydrology, habitat, aquaculture and stocking. The proposed solution involves a multifaceted approach that aims to, wherever possible, maximize production and minimize losses.

One of the main aspects of the solution is to increase the amount of available high quality habitat through improvements to culverts and increases in habitat restoration efforts. Improvements to culverts will increase access (currently estimated that only 1/3 of the existing culverts are fully passable) and habitat connectivity and promote fish movement through the watershed. Increases in habitat restoration will be targeted to optimize habitat, exploit cold water refuge areas and promote aquatic connectivity within the watershed. Funding applications have been submitted to several agencies in an effort to start this work this summer (2013). Two other key aspects of the solution are the development of a predator control program and a population enhancement (stocking) program. Both of these programs carry a degree of risk and valid scientific opposition, as such they will need to be carefully designed to obtain regulatory approval and minimize the negative impacts to existing wild salmon. As such these programs will have to go through a design and approval phase before on-the-ground work can begin. The plan recommends implementing these initial phase as soon as possible. Other aspects of the recovery plan are advocacy, fisheries management, dialogue with industry, chemical mitigation, and monitoring program expansion. Another key aspect is the need to develop partnerships with other fisheries groups, industry and government agencies to advocate for policies and management guidelines that will protect habitat and salmon populations both during and after their recovery. Open dialogue, as opposed to strict opposition, with industries such as aquaculture and the oil and gas industry has the potential to minimize industrial impacts and potentially gain technical and/or financial benefits. Mitigation would like be spread out over time and space to treat only those areas of the watershed that have issues and some potential for recovery.

The plan outlined in this document has a degree of flexibility that will make it palatable to most key stakeholders. The various aspects of the plan are feasible, and scientifically defensible. Most importantly this plan, if implemented effectively, can lead to the healthy and self-sustaining population described in the strategy objective. Implementation of the plan and working towards recovery will certainly require a good deal of compromise and investment in terms of time, finances and human resources. However, these investments will pay off for the community and the province for years to come.

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1.0 INTRODUCTION

In the late 1970's a few individuals who were interested in the betterment of the St. Mary's River started an informal committee to work toward this goal. Membership quickly grew from the few individuals to a few hundred, and the committee was formally incorporated under the Societies Act on November 9, 1979, as the St. Mary's River Association (SMRA). From the beginning, the Association wanted to be more than simply an angling group and wished to encompass objectives that would be dedicated to the preservation and wise use of the St. Mary's River as the community's most important resource. To meet these objectives, over the last three decades, the Association has conducted its own research, monitoring and management initiatives, as well as collaborating with government and non-governmental agencies on a wide range of projects and initiatives.

Through the 1980's, the SMRA evaluated salmon enhancement methods and participated in the St. Mary's River Forestry/Wildlife Project, assisted in a St. Mary's River Management Plan, and funded a dependency survey of the local communities on the St. Mary's River. Between 1990 and 2000 the Association developed a community-based management plan for the salmon fishery, began habitat enhancement within the basin, and assisted with fish and environment monitoring in the watershed. Since 2000 the organization has been active with habitat restoration, land protection and stewardship and continued monitoring and participating in management of the fisheries of the river.

Today, the general mission of the St. Mary's River Association remains the same as it was in the 1970's; to work collaboratively to preserve the fishery and promote sustainable use of the river for all stakeholders. However in recent years the methods have shifted to expand the organization into a greater role as a conservation group that utilizes the latest scientific and management principles. As such, the association has tried to adopt a more progressive management approach, moving beyond single species management to more of an ecosystem management or holistic approach. With this change in approach, the SMRA is trying to understand and influence the fundamental processes that shape the ecosystem and the services the community receives, in an attempt to ensure sustainable interactions between the river ecosystem and all of the stakeholders.

A major development in this new approach came with the launch of the Healthy Rivers, Vibrant Communities program, where the association invested resources into understanding what was known and what was not about how the river ecosystem worked and how the various stakeholders interacted with the river. An integrated watershed management strategy was to be the outcome of this program.

However, as this program was developing, the Atlantic salmon (*Salmo salar*) populations within the St. Mary's River, and throughout the Southern Upland, continued their rapid decline

that had begun in the mid 1990's. The Southern Upland is essentially the portion of mainland Nova Scotia that drains into the Atlantic Ocean proper, it excludes almost all lands that drain into the Gulf of St. Lawrence or the Bay of Fundy. These declines prompted the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to investigate listing of Atlantic salmon within the Southern Upland as an endangered species under the federal Species at Risk Act (SARA). As this process of listing salmon under SARA has continued, the integrated watershed management plan has morphed into a recovery strategy for the Atlantic salmon of the St. Mary's River. The objective of this strategy is to develop and implement holistic ecosystem-based solutions that are inclusive of all stakeholders and that will return the river to natural state that can support needs of all users.

2.0 STUDY AREA[1]

The St. Mary's River drains 1,350 sq. km of land and is comprised of three principle branches, the East, West and North branches, which combine to form the Main Branch extending to the estuary (Figure 1). The West Branch is ~56 km long with a drainage area of 470 km^2, the East Branch is ~27 km long with a drainage area of 389 km^2, and the North Branch is ~27 km long with a drainage area of 82 km^2. The North Branch flows into the East Branch near the community of Aspen (45°18'23"N, 62°03'49"W). The Main Branch, at the confluence of the East and West Branches (45°15'20"N, 62°03'48"W) just downstream from Glenelg Lake, is ~19 km long and drains into the estuary at the head of tide, regarded to be at the Highway 7 Bridge in Sherbrooke (Hart-Buckland Nicks, 1995). There are approximately 130 lakes within the watershed ranging in size from <5 ha to 3 km^2 (Lochaber Lake). The largest lakes in the watershed are Lochaber, Lochiel, Eden and Archibald's Mills lakes, all on the East and North branches. The West Branch is notable by an absence of large lakes on the mainstem. There are 16 settlements in the St. Mary's River watershed with an estimated total population within the St. Mary's Municipal district of 2,587 people.

Cultural History

Prior to European contact, the St. Mary's River was used by the Miq'maq First Nation for sustenance and inland travel, taking advantage of its long length to penetrate the interior. The St. Mary's River area was originally settled by the French who built Fort St. Marie (1654), from which the river took its name, and changed hands to the British in 1669. The watershed remained relatively lightly exploited until the 19th Century. A valuable commercial salmon fishery, tall stands of pine, and rich soil attracted Irish settlers in the early 1800's. Through the 19th century the watershed was an important part of the regional economics, contributing its forests to England as lumber and the Atlantic salmon to the tables of Europe and elsewhere.

[1] Adapted from material available on St. Mary's River Association Website. http://stmarysriverassociation.com

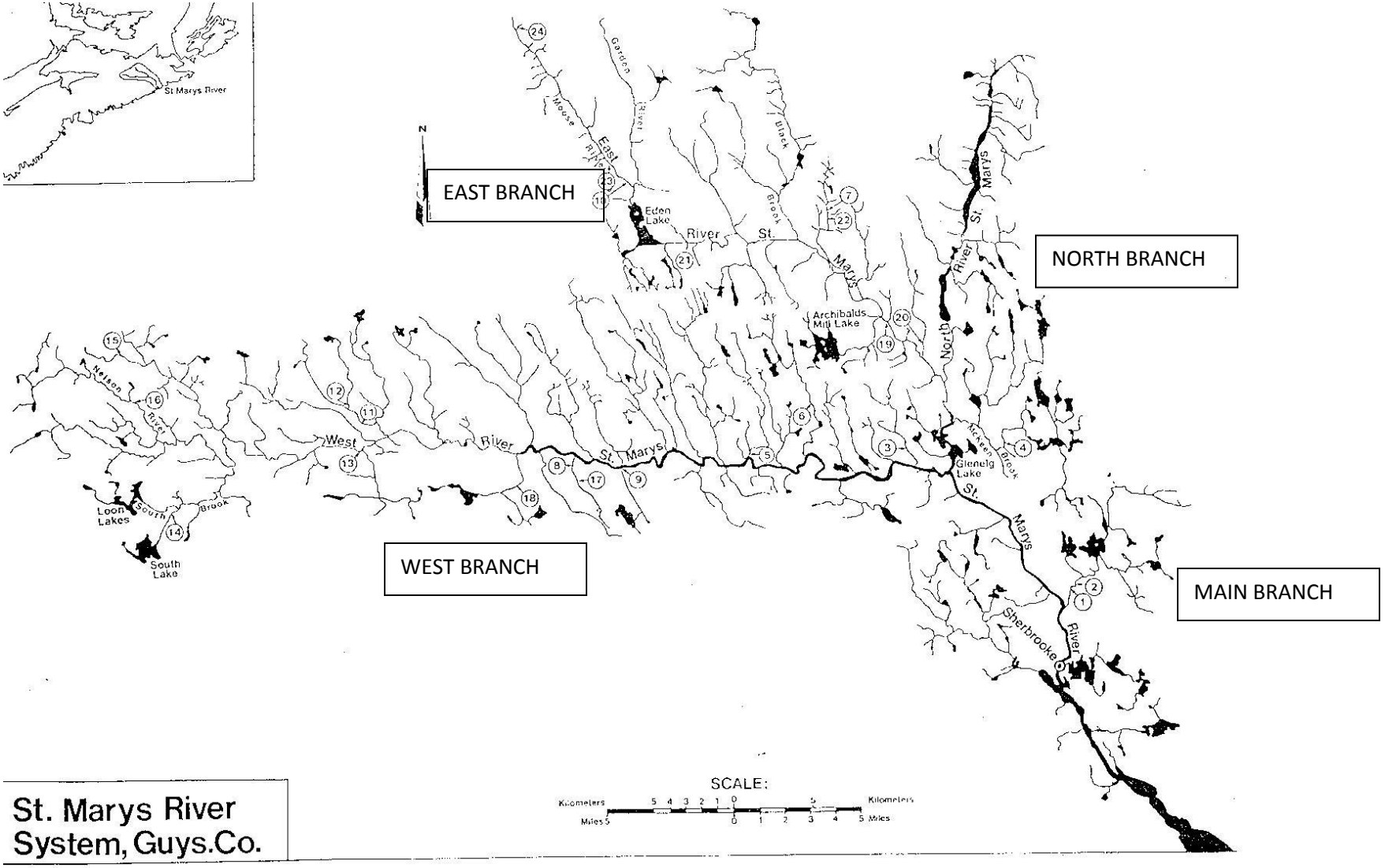

Figure 1: St. Mary's River watershed illustrating four "branches" of river. Circled numbers are electrofishing sites.

The St. Mary's River has a long history of log drives to deliver logs from the headwaters to the estuary for shipment elsewhere. The river was also used to power sawmills and as a transportation route for people, as well as providing an abundant source of food in the form of fish. By mid-1800 the effects of exploitation on the river was apparent. Veith (1868) comments the St. Mary's river salmon fishery was second to none in Nova Scotia but had declined to almost nothing due to spearing and netting of salmon, and the use of the watershed and river for the export of logs and lumber. Knight (1867) also blames mill dams as being very abundant on most rivers of the Province, and preventing access to upstream areas by anadromous fishes.

In 1969, a large-scale historical restoration project began in which a local village was recreated representing period of the latter half of the 19th century. Today, the Sherbrooke Village, a part of the Nova Scotia Museum system, remains the greatest tourist draw within the St. Mary's River watershed. The watershed is lightly settled with the primary industries being tourism, forestry and agriculture. Industrial forestry also takes place with the wood being taken out of the watershed for processing, primarily as pulp.

Geology

The St. Mary's River predominately drains a landscape, which, geologically, originated on a continent apart from North America, likely either Africa or South America. About 400 million years ago this fragment of landmass, which presently comprises much of southeast Nova Scotia, collided with eastern North America and was "welded" onto the North American continent. This fragment, called the "Meguma Terrane" differs geologically from other areas of the province and is composed primarily of sandstones and shale. The geological groundwork is interrupted by faults and these faults control the drainage patterns within the watershed. However, unlike most of the other watersheds within the Southern Uplands, the St. Mary's River is also influenced by the other major landmass of the Nova Scotia Mainland - the "Avalon Terrane". The difference in rock composition between these two landmasses has a major influence on the water chemistry of the St. Mary's River as the limestone within the Avalon Terrane has significant buffering capacity whereas the shale of the Megume Terrane does not provide significant buffering capacity.

Forests and Landscapes

The landscape of the watershed was historically Acadian Forest made up of red spruce, yellow birch, balsam fir, sugar maple, red pine, eastern white pine, eastern hemlock and American beech. It has been converted over time through manual and mechanized agriculture and forestry operations to a landscape with slopes dominated by softwoods and large clearings for agriculture in the flat river valley bottoms. The landscapes vary from rolling hills to relatively steep terrains and from treed to barrens. Wetlands are dispersed throughout the watershed. Small patches of the original Acadian Forest have remained intact, most of which are protected either by provincial law or by the Nova Scotia Nature Trust.

Fish and Wildlife

The St. Mary's River watershed is used by a wide variety of fish and wildlife. Approximately 20 species of fish are documented to occur in the lakes and rivers of the basin, including the recreationally pursued Atlantic salmon, brook trout, gaspereau (alewife), American eel, rainbow smelt, and yellow perch. Coarse fish, such as white sucker and minnows are also abundant. Wildlife within the area include that typical of northern Nova Scotia (whitetail deer, black bear, coyote, raccoon, etc.) as well as a wide variety of bird species. The St. Mary's River is also known to be home to the mainland moose and the Wood turtle - both provincially recognized species-at-risk.

3.0 METHODS

The methodology employed in the development of this strategy involved two phases. The first phase was a literature review and the second phase was a series of consultations with various stakeholders. The recovery strategy was developed by taking the information gathered from these two phases and exploring what was known and what was uncertain about the issues these phases identified as impacting salmon and the St. Mary's River. Once the extent and nature of the issues were made clear, a comprehensive and integrative solution was developed to address these issues.

3.1 LITERATURE REVIEW[1]

The initial phase involved an extensive review of the literature. The primary sources of literature that were used were studies that had been generated as part of programs run by the St. Mary's River Association, including the "Healthy River, Vibrant Communities" program (2005-present). Other important programs included salmon enhancement programs (1981-1982; 1989), St. Mary's River Forestry/Wildlife Project (1984-1992), River Specific Atlantic Salmon Management Plan (1985-1994), the Dependency Survey (1988), Habitat restoration program (1989-2008), Liming Project (1998), and a project looking at the abundance and ecology of Wood turtles within the St. Mary's River watershed (2003-2007).

The salmon enhancement program in 1981-1982 saw a streamside incubator and semi-natural rearing pond used to enhance the survival of juvenile Atlantic salmon from the egg to parr stage. Approximately 50,000 eggs were incubated and juveniles reared and later released. As part of this program, the St. Mary's River Association collaborated with the Department of

[1] Adapted from material available on St. Mary's River Association Website. http://stmarysriverassociation.com

Fisheries and Oceans to enforce fishery regulations and surveillance for poachers. The Salmon enhancement project in 1989 had members of the St. Mary's River Associated collected broodstock and participated in juvenile releases into the river of hatchery raised salmon.

The St. Mary's River Forestry/Wildlife Project (1984-1992) was a joint initiative of federal and provincial governments, Stora Forest Industries, Scott Maritimes Ltd., Canadian Institute of Forestry, and St. Mary's River Association. The objective of this project was to develop methods to manage forestry and wildlife together. The association was interested in this initiative with the idea that integrating forestry and wildlife management would lead to better land use practises which in turn would benefit the river through more effective and beneficial land-water interactions that would create healthy river environment for salmon Participating groups conducted joint studies and operational trials to develop practical and effective guidelines and procedures to be used in the planning and operations of forest management. This process has led to the development of high standards for integrated resource management that provincial Department of Natural Resources has adopted and have been implementing.

In 1985 the St. Mary's River Association proposed a river-specific Atlantic salmon management project as a pilot study for a river-specific approach to salmon management in Atlantic Canada. Such a management document was produced in 1988. The objective of this management plan was to *"optimize Atlantic salmon from all segments of the St. Mary's River in order to provide all user groups with maximum benefits."* This program required research and monitoring to obtain the information to meet the objective, but the principle funding source was removed in 1994 and the project changed to become a community-based management plan renamed as the St. Mary's River Resource Management Model. This plan built on the objectives and information derived from the previous River Specific Atlantic Salmon Management Plan from 1988. The objective of the St. Mary's River Resource Management Model was "*to develop a management plan for the St. Mary's River to achieve the maximum sustainable benefit from the fisheries resource, based upon information that is specific to the river and upon a system of decision-making that is shared between members of the local community, user groups and government agencies*". Within this project the St. Mary's River Association collaborated with the Department of Fisheries and Oceans, often carrying the costs, to conduct research and monitoring on Atlantic salmon of the river, in the context of river-specific management. The results of this 1985-1995 river management work was a management strategy, detailed fisheries management plan, and a blueprint for community-based management plan.

With the Dependency Survey (1988), Hurley Fisheries Consulting was retained by St. Mary's River Association to conduct a survey of the uses by people of the St. Mary's River. The study was intended as an examination of the socio-economic relationships of residents and visitors to the river. The results provided baseline data for the development of a river-specific management plan for salmon stocks and so was part of the above River Specific Atlantic Salmon Management Plan.

The Habitat restoration program saw riverbank stabilization of eroding banks at various sites throughout the watershed for almost 20 years. This work has involved placement of large rock material using heavy machinery along stretches of eroding river-bank. Habitat restoration of smaller streams (particularly using digger logs) has been conducted since 1993 with increasing frequency in recent years.

The 1998 Liming project added approximately 50 tonnes of limestone cobble at two locations within the St. Mary's River in order to assess the feasibility and effectiveness of liming the river to increase the low pH of the stream water.

The Wood turtle project in the mid 2000's involved collaboration between Nova Scotia Department of Natural Resources and St. Francis Xavier University, the St. Mary's River Association in a five year study of the Wood turtle, a provincial species-at-risk, within the watershed. This research was aimed at determining the population size of the turtles within the watershed and to determine basic ecology and behaviour of the local population. The rationale for undertaking this project was part the association's movement to an ecosystem based, integrated watershed management approach. Wood turtles were chosen because they have a "species of special concern" designation, there is a sizable local population with sentimental value within the community and because they are an edge species that live in both the aquatic and terrestrial ecosystems. This last reason makes them a good indicator species for land-water interactions that impact the health of the river and thus salmon.

Building upon the management plan program, The Healthy Rivers, Vibrant Community Program was launched in 2005. The aim of this new program was to update and implement the management plan program's recommendations that had been put off due to logistical constraints. With the launch of this new program, the St. Mary's River Association sought to incorporate the most progressive scientific and management principles, while working to identify and close knowledge gaps. Specific projects launched under this new program included: collaborations with university researchers on movement and predation patterns present within the St. Mary's River; studies on the hydrology, channel changes, connectivity, and water chemistry; workshops on salmon stock enhancement; recreational usage, creel, and social perception surveys; as well as stream, lake, and estuary assessments.

In addition to these in-house sources, other important sources of literature that were consulted included studies that DFO had generated by monitoring and studying the St. Mary's River as well as other similar systems within Nova Scotia; and a subset of related academic studies that had been generated by the scientific community. This phase was made somewhat simpler as DFO had embarked on a similar literature review for their recovery potential assessment (RPA) that they had to complete as part of the endangered species listing process.

3.2 CONSULTATION

The second phase of the recovery strategy was a consultation phase, in which various stakeholders were asked about their concerns and thoughts on the problems faced by, and solutions for, salmon in the St. Mary's River. The St. Mary's River Association has worked since their inception with federal and provincial fisheries agencies on management issues and required data collection for appropriate management. Management issues include determining annual fisheries regulations and required assessment research to determine conservation and allocation requirements. As part of the required data collection the Association has always been a principal player in the sampling of juvenile, smolt, and adult Atlantic salmon within the St. Mary's River. This working relationship and the Association's grassroots organization allowed for frank and honest discussions with stakeholders.

Stakeholders consulted included the Nova Scotia Department of Fisheries and Aquaculture (Inland Fisheries Division), the Department of Fisheries and Oceans, the Nova Scotia Salmon Association, the Atlantic Salmon Federation, Paqtnkek First Nation, as well as members of the general public. Stakeholders were consulted through ½ day meetings where the project's objectives and approach were outlined, the stakeholders concerns and suggestions for recovery were voiced, and potential strategies and resources were debated. All meetings were followed by subsequent correspondence with one or more of the attendees. The general public was consulted through a public meeting in Sherbrooke with approximately 40 attendees on October 4, 2012. A month long opportunity for submissions of ideas and concerns followed this meeting. During all of these consultations many issues were raised and discussed, but the common key concerns were (i) engagement of the public, various levels of government, and the native community in the recovery process; (ii) the pros and cons of stock enhancement; (iii) the public's access to the various fisheries; (iv) management issues; (v) the role of predation control in recovery; and (vi) respect of native treaty rights as well as for the integrity of the fish and the ecosystem.

Specific topics that were discussed in the public consultation were the need to involve and work with the First Nation community, the need to engage the public and get the community involved in the recovery process, and the need to improve assessment methods. Members of the public also felt that any recovery plan would need to have political involvement from all levels of government (municipal, provincial and federal), and that recovery would have to involve a stock enhancement program. Several individuals expanded on this sentiment, expressing need for this enhancement program to have a well thought out business plan and their desire for that business case to be made within this recovery strategy document. This certainly was considered in the development of stock enhancement program recommendations but was beyond the scope of this document. People at this public meeting also raised concerns over hydrology (low water) in the river and concerns over land use practices

The meeting with representatives from the Nova Scotia Department of Fisheries and Aquaculture, Inland Fisheries Division, took placed on September 26th, 2012 and emphasized that any recovery plan must allow for maintenance of access to fishing opportunities. Provincial representatives were supportive of stock enhancement in principle, but did express that the department's logistical constraints would prohibit them from providing substantial assistance with a stocking program to the St. Mary's River.

During the meeting with representatives from the Department of Fisheries and Oceans on October 10th, 2012, the need for the department to work within the context of their legal and procedural obligations to the *Species-At-Risk Act* was identified. Informal discussions identified that management options are very limited at this point in time, that a short term predator control program may have some potential that could be investigated, and that a stock enhancement program more intensive that the existing live gene banking would not likely be supported at this time. It was emphasized that although this did not necessarily prohibit the St. Mary's River Association from pursuing this option, that any program would still require federal "live-release" and transfer approvals and so would have to meet and be defensible to the department's rigorous standards.

The meetings with Paqtnkek Fisheries Officer on January 14th, 2013 and the Band Council on January 29th, 2013 was extremely productive. The Band Council was, in principle, supportive of the ideas and general outline of the recovery strategy. They expressed their concern over the existing management policies and procedures, their appreciation at being asked to participate in this recovery strategy, and the need for treaty rights to be respected. In particular the right to be consulted and the right for their food, social and ceremonial needs to be met were discussed.

4.0 ISSUES

The literature review and the consultations have identified the following factors as affecting salmon abundance in the St. Mary's River: freshwater and at sea mortality, water chemistry (primarily acidity), elevated summer temperatures, watershed connectivity and access, predation, hydrology and habitat (especially with respect to climate change), and aquaculture and stock enhancement. Management issues were also addressed as a concern by many parties during the consultation phase.

The problem facing the St. Mary's River salmon populations can most simply be defined as a low abundance relative to conservation targets (Figure 2). The underlying causes of this low abundance have been long debated, but are related to the issues identified above. Much argument can be, and has been, made about the validity of the abundance estimates, the causes of declines and the usage of abundance estimates in the application of management policies. However, these estimates have been adopted by governing organizations (DFO, Committee on the Status of Endangered Wildlife in Canada or COSEWIC) as the official population estimates

for the St. Mary's River. Effort could be put into attempting to disprove these estimates, but as there is little disagreement about the trend that these estimates show (significant declines), and as the efforts required to change the regulating agencies collective mind would be substantial with low probability of success, it is recommended that efforts be placed into facilitating recovery as opposed to arguing procedure with the regulators.

The issues facing the St. Mary's River are certainly many and diverse. However, there is one overarching issue that has been generally accepted as the leading cause of declines in salmon abundance. This issue is at-sea mortality, which increased significantly in mid-1990. It was at this time that salmon abundance estimates reported in DFO annual reports began to demonstrate an exponential decline (Figure 2). The effects of at-sea mortality were examined in the RPA documents by DFO that were peer reviewed by the scientific community. These documents illustrate that at-sea mortality for the St. Mary's River populations is the limiting factor, which is to say that at sea mortality rates currently limit the maximum potential population growth. Furthermore projections indicate that this level of at-sea mortality will limit the population to such an extent that the largest achievable natural self-sustaining population would still deposit fewer eggs than is required to meet the conservation target for the system (7.4 million eggs). The precise cause for increased marine mortality is not known, so a solution is difficult to develop. This issue is not limited to the St. Mary's River, as it affects all Atlantic salmon populations to some extent. The scope and logistics of researching and mitigating this issue puts it beyond the ability of the St. Mary's River Association to address in a significant way. In fact, it is quite arguably beyond the ability of the federal government to understand or address in a significant manner. As such, it is the recommendation of the authors that this issue should be put aside by the St. Mary's River Association, which instead should invest efforts into issues that can be addressed. The Association shouldn't be ignorant of the issue, but rather should look into trying to offset marine mortality through changes to the freshwater portion of the life history while keeping informed on developments in the at-sea mortality component as determined by larger organizations.

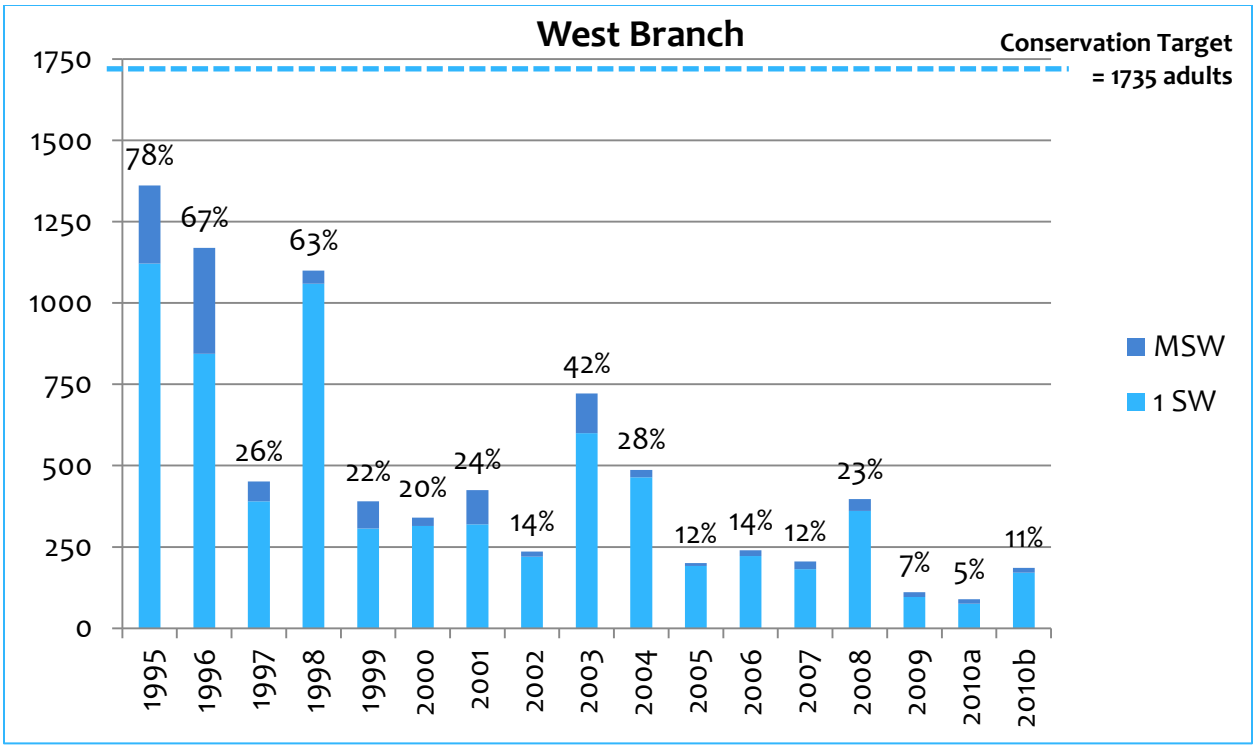

Figure 2: The decline in abundance estimates of multi-sea winter fish (MSW) and single sea winter fish (1 SW) for the West Branch of the St. Mary's River. Population estimates are expressed as the percentage of conservation target for the number of returning adults. In 2010 the Mark-Recapture method was not completed due to logistical constraints so there were two estimates generated, one that utilized historic recapture rates (2010a) and the other using LaHave River population estimates as a guide (2010b).

Freshwater survival of Atlantic salmon in this drainage has been estimated annually through a cooperative venture between DFO and the St. Mary's River Association. Estimates are generated with the use of models that take into account numerous factors including data provided by anglers and data collected from electrofishing mark recapture studies electrofishing. Correlation analysis between abundance estimates generated for the St. Mary's River and abundance estimates generated for the LaHave River, which is the index river for the Southern Upland Region, found that a significant correlation exists between the two populations, with the St. Mary's River abundance estimates in recent years being on average a half of the abundance estimates for the LaHave River. On occasion, when data was lacking, this index correlation was used to generate an abundance estimate for the St. Mary's River.

Between 1990 and 2006 approximately 30 different watercourses (West Branch: 16, East Branch: 11, Main Branch: 2, North Branch: 1) within the St. Mary's River watershed were assessed 249 times using the electrofishing / mark-recapture method and the results reported by the St. Mary's River Association and DFO in its annual reports. In general, these assessments demonstrate that juvenile densities are relatively low with parr densities ranging between from 0 parr/100m^2 to 46 parr/100m^2, with an overall average of 5.5 parr/100m^2. In comparison, assessments done in the West River system in Antigonish (a very healthy system that is exceeding its conservation requirements) by St. Francis Xavier University and DFO – Gulf Region Habitat Division had densities ranging between from 10 parr/100m^2 to 212 parr/100m^2,

with an overall average of 63.1 parr/100m^2 (K. Hunter Thesis, in prep) Differences between the two systems probably rule out direct comparison but this does provide a framework for fish densities during a similar time period.

The overall average salmon densities (fry and parr together) in these 249 assessments was 18.6 fish/100m^2, with similar numbers being found in the East and West Branches, 18.5 fish/100m^2 (N=129) and 19.3 fish/100m^2 (N=108), respectively. The North Branch and tributaries of the Main Branch had lower overall densities of 7.4 fish/100m^2 and 7.6 fish/100m^2, respectively although there were relatively few assessments done on these branches (North Branch N=3; Main Branch N=9). Both fry densities (Figure 3) and total parr densities (Figure 4) have been declining in recent years.

When comparing the different branches for juvenile productivity it may be seen that four of the top 10 producing watercourses (densities >5.5 parr/100m^2) are within the West Branch, three in the East Branch, two in the Main Branch, and one in the North Branch. If productivity across all 30 watercourses is considered there is no discernible correlation between branch and productivity ($r = 0.08$). From this it may be concluded that restrictions on productivity are not confined to a single region of the watershed and conversely all branches have the productive juvenile habitat. When autocorrelations were evaluated for select tributaries to determine if juvenile densities from a given year can predict subsequent years populations, only Big Meadow Brook on the East Branch showed a significant correlation ($r =1.0$) between fry and parr densities, which may only be a function of low n values for Big Meadow Brook (N=3). The other four tributaries all had r values of <0.45. This lack of correlation indicates a high degree of year-to-year variability. Although the cause of this high degree of variance is unknown it is likely that stochastic events such as extreme temperatures, droughts and floods are playing a significant role. Declines in juvenile populations are also associated with declines in adult returns. Lower adult return rates coupled with an increase in the relative number of grilse (decrease in MSW salmon) likely results in a decrease in overall egg deposition, due to a decrease in both the number of spawners and the fecundity of those spawners (smaller adults carry fewer eggs to deposit). However, no recent information has been obtained on spawning success rates, egg mass sizes, and overwinter survival of eggs and so a decrease in egg deposition has not been corroborated but is likely.

A review of catch returns and a preliminary study by Mitchell (unpublished) suggest that the brook trout (*Salvelinus fontinalis*) populations within the St. Mary's River are relatively healthy and stable. There is only a limited dataset for non-salmonid fishes (Gray et al. 1978); as such it is hard to draw concrete conclusions about these species. A number of these species, including American eel, yellow perch, white suckers, sea lamprey, American shad, sticklebacks, and gaspereau, are known to be present in the watershed. Generally these populations are all assumed to be healthy although anecdotally several of these species, notably the gaspereau seem

to be down. Preliminary analysis done by DFO suggests similar declines in many other minnow and shiner populations over the past few decades. Similar trends have been noted in other watersheds throughout the province.

Other species of note within the watershed that should be considered in the development of any large scale restoration strategy are Striped bass, Wood turtles, and several species of freshwater mussels such as the brook floater and the yellow lamp mussel, all of which have a COSEWIC or provincial designation as a species of concern. Striped bass seem, at least anecdotally, to be increasing. The impact that the return of this natural predator may have on salmon populations is unknown. There is currently an assessment underway to establish the status of Striped bass populations within the province. Wood turtle and freshwater mussel populations have been assessed as stable by provincial regulators. Most other species that rely on the watershed and thus could be affected by a recovery strategy, such as amphibians, birds, and small mammals have not been extensively assessed, but are generally assumed to have stable populations.

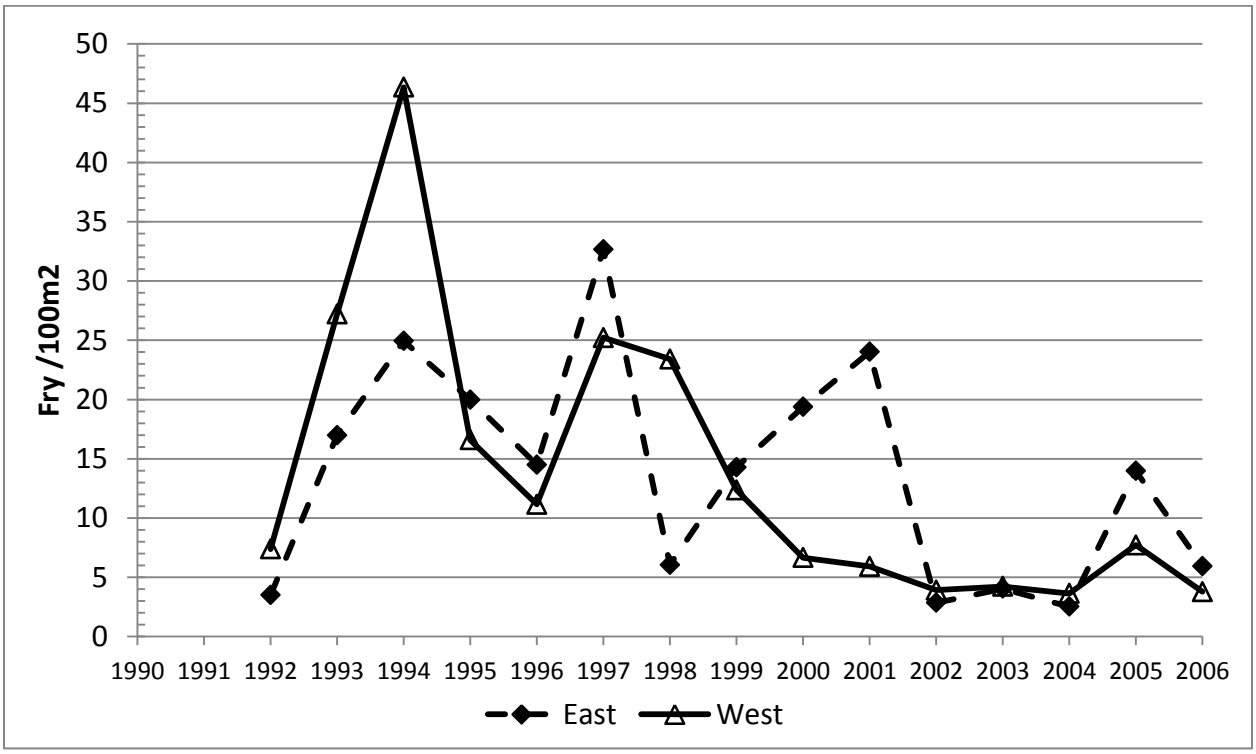

Figure 3: The decline in abundance estimates of fry densities (fry/100m^2) for the East and West Branches of the St. Mary's River.

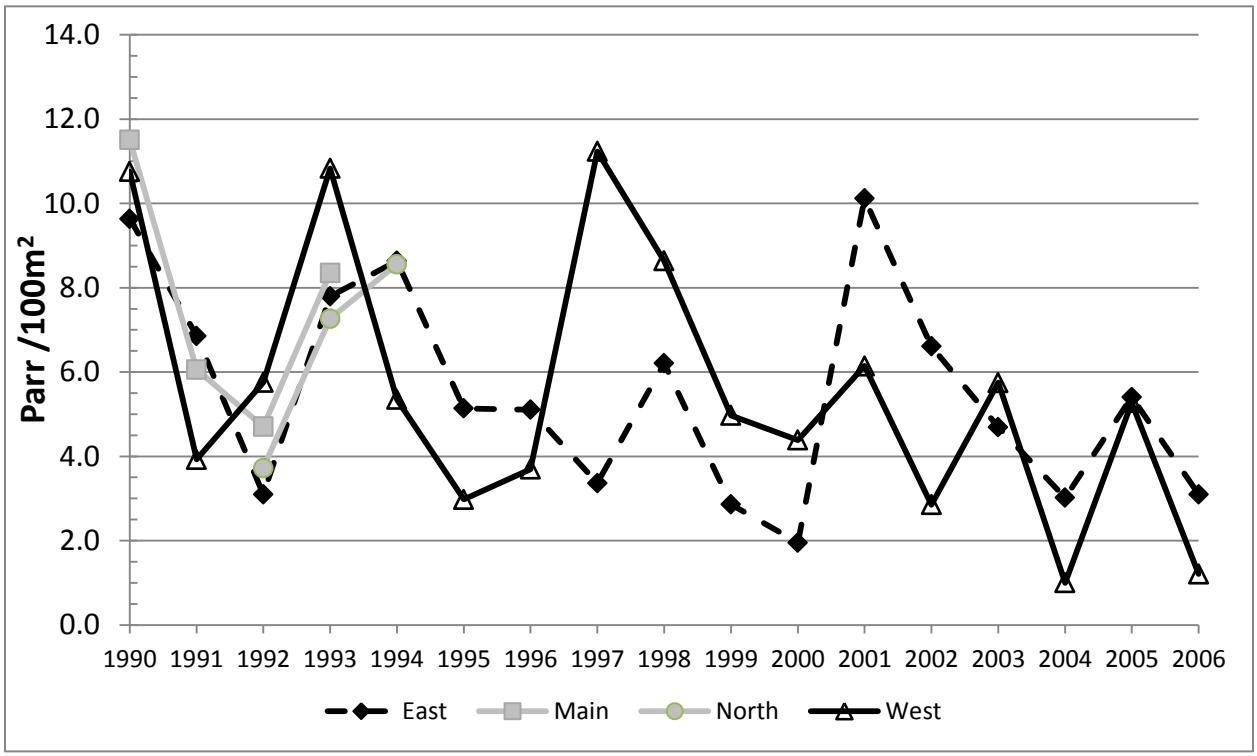

Figure 4: The decline in abundance estimates of parr densities (parr/100m^2) for the four branches of the St. Mary's River.

No aquatic invasive species likely to impact upon salmon are known to exist within the St. Mary's River watershed. The impacts that invasive species can have on native fish population dynamics are significant (e.g., chain pickerel and smallmouth bass). Mitchell (2012) showed fundamental shifts in lake fish communities due to the presence of chain pickerel in lakes close to the St. Mary's River, and work outside of the province has indicated the smallmouth bass can also have significant predation effects on native fish. Effort must be made to ensure that these species are not introduced into this watershed to prevent this potential risk.

Water Chemistry

When evaluating water chemistry a number of parameters can be considered. In the Southern Upland of Nova Scotia, the parameters that usually are of greatest concern for fish are acidity, aluminum concentration, other metals concentrations (such as cadmium, copper, and lead), and nutrient availability. Previous work by the St. Mary's River Association and monitoring work done by provincial and federal departments have examined the role that each of these parameters plays in the St. Mary's River Watershed.

Acidification is a problem throughout much of the Southern Upland. This in turn leads to elevated aluminum levels (Clair, 2012), which have a compounded toxicity effect upon salmonids. pH sampling has identified that, unlike most of the Southern Upland, acidification is less of a concern in the St. Mary's River (Figure 3). Ideal water for salmonids should be

circumneutral, with levels under 6.2 being considered harmful (Kroglund and Staurnes, 1999). Young juveniles (egg, alevin, and fry) and salmon undergoing smoltification are the most sensitive to acidification (Dill et al. 2002). Using these criterions, the West Branch is considered as having some pH depression issues (as it is mostly in the mid-5 range, with approximately 1/3 of the sub-watersheds at or below pH 5). Generally speaking the East and North Branches, which make up ~45% of the watershed's habitat, typically have acceptable pH levels (East Branch: typically in the mid-6 range, with some watersheds in the high 5 range; North Branch: typically around 7). As the higher pH of the East Branch tends to compensate the low pH of the West Branch, the Main Branch generally has acceptable pH levels (typically low 6 ranges), although depending on relative rainfall and discharge between the major branches the Main Branch can occasionally dip low enough to be of concern, especially if these acidity events coincide with the timing of the smolt run. A more detailed analysis on the specifics frequencies and distribution on acidity issues are outlined in Mitchell (2011a).

Currently the extent of effects caused by elevated dissolved aluminum concentrations is not clearly understood because until recently it was believed that aluminum levels in Nova Scotia were mitigated by naturally occurring high organic carbon content in the waters of the province (LaCroix, 1989). Aluminum levels are linked to acidification and naturally high concentrations in bedrock of the Southern Upland. Based on the results of a preliminary study by Mitchell (2011), it is unlikely that aluminum toxicity is a major concern to salmon in the St. Mary's River. However, work by Clair (2012) has recently suggested that many of the previous assumptions about aluminum levels and toxicity are incorrect and aluminum may represent a serious issue in the province's waterways. Given the potential ramification suggested by Clair's work, further investigation into aluminum concentrations in the St. Mary's River is warranted. If aluminum levels are found to be a concern, then the recommended approach from researchers in Norway (B. Finstad, pers. comm.) is to treat the acidity issue first then attempt to treat aluminum by adding dissolved organic carbon to induce flocculation. However the feasibility of this approach in the St. Mary's River would have to be validated.

The effect of other metals and nutrient availability in the St. Mary's River was investigated in a study and review conducted by Mitchell in 2011. He concluded that most water quality variables were not likely of concern, but that cadmium, copper, and lead warranted further investigation. While these three metals were at levels below standards set for human consumption, errors and inconsistencies in reporting methods did not allow for a definitive conclusion about whether or not existing levels posed any sort of threat to fish populations. This study suggested nutrient levels were not elevated,

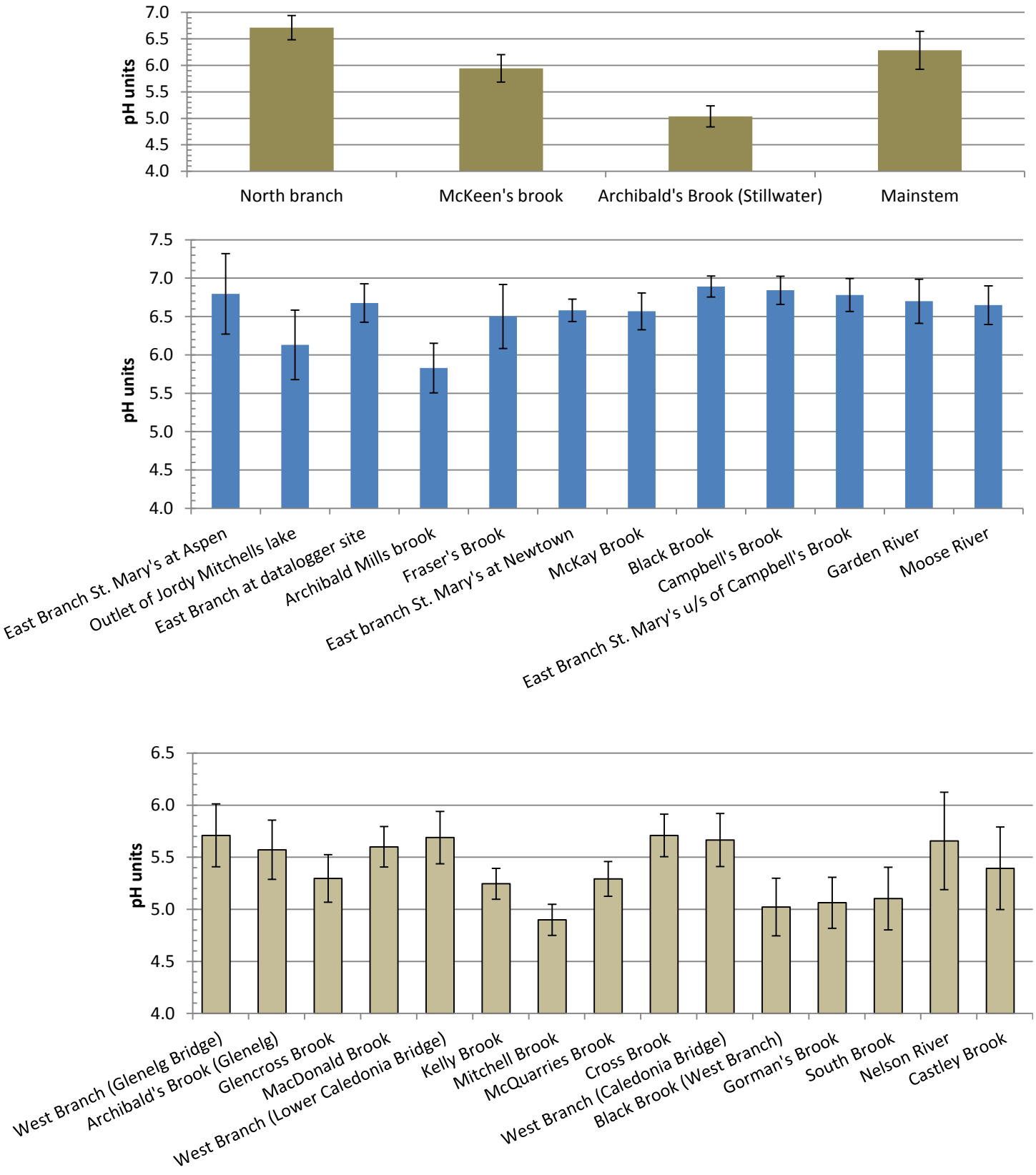

Figure 5: A) Mean pH of four index sites sampled on approximately weekly basis between March and November 2009. North branch monitoring site is at Data logger site near Fishers Mills. McKeen's Brook monitoring site is at Highway 7 Bridge crossing of brook. Archibald's Brook (Stillwater) monitoring site is at Highway 7 Bridge crossing of brook. Mainstem monitoring site is opposite the SMRA interpretive Centre. B) Mean pH of selected tributaries and the mainstem along the East Branch St. Mary's River between March and October 2009. C) Mean pH of selected tributaries and the mainstem along the West Branch St. Mary's River between April and October 2009. All Error bars = SD.

Access

A study conducted by Mitchell (2009) assessed the fish passage potential of ninety-nine culverts throughout thewatershed. That study identified that approximately 2/3 of these culverts were at least partially impassible for fish as evaluated using standard measures published in the literature. The study also concluded that passage issues typically occurred lower in the watershed and that although those culverts with passage issues affected all species, smaller fish were differentially impaired. Based on this work it has been concluded that the St. Mary's River is a highly fragmented watershed with significant habitat connectivity issues. Similar work by Clean Annapolis River Project, in association with DalTech, has identified that this result is typical of many watershed throughout the province. The technical report also provided prescriptions for eight high priority culverts that likely could be easily remediated and would open up significant amount of habitat. It is recommended that access and connectivity be a high priority in implementing the recovery plan.

Temperature

Air temperature data collected from Environment Canada weather station at Stillwater on the Main Branch of the St. Mary's River indicates that in recent years there has been slow and steady increase in the maximum, mean, and minimum temperatures during July and August, the warmest months of the year (Figure 6). This corresponds with the period of time when adult salmon return to the river and when river discharge is typically at its lowest flow. The result of high temperature and low flow can result in elevated water temperatures that often approach and exceed the upper thermal limit for salmonids. Warmer water also has a lower oxygen saturation level and can result in water with oxygen levels depressed below the requirement of salmonids. During these periods of thermal stress and hypoxia salmon often must seek thermal refuge areas in order to survive. Even if water temperatures do not reach lethal levels, elevated water temperatures have been documented to negatively affect salmonid populations. For example it has been demonstrated that increased temperatures influence the timing of smolt migration (Jonsson and Ruud-Hansen, 1985) and can negatively affect salmonid productivity (Power and Power, 1994). Climate change analysis by Vasseur and Catto (2008) predict that temperatures will continue to increase and water flow is likely to decrease in the coming decades.

From the habitat assessment work conducted by Dr. Mitchell for the St. Mary's River Association it is clear that there are many areas of cold water refuge and areas of temperature concern throughout the watershed. A significant portion of these trouble spots and refuge spots have been identified through surveys and planning completed to date (Mitchell 2010, Mitchell 2011a, Mitchell 2011b), however the list is not complete. As such any attempt to address temperature issues within the St. Mary's River will also need to include more stream surveys and thermal monitoring.

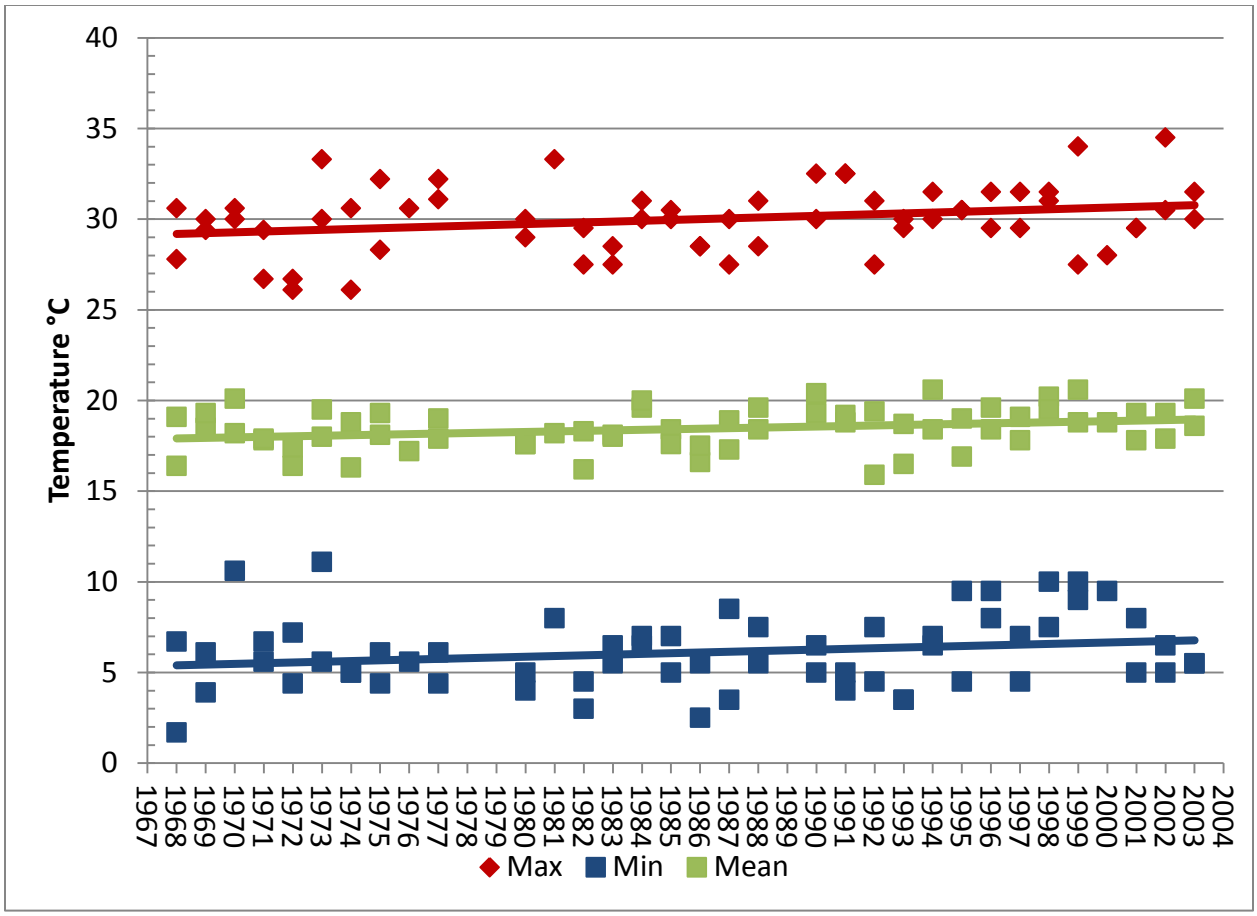

Figure 6: The increase in maximum, minimum and mean (average) air temperature at Stillwater, Nova Scotia between 1967 and 2004.

Hydrology / Habitat

Low flows, flooding, and ice formation have been identified as a concern within the St. Mary's River watershed dating back to the 1950's and were among the first concerns raised during the public consultation. Despite prevalent claims of increases in extreme hydrological events and that change to discharge are likely to occur, Mitchell (2009a) found that currently there is "no clear indication of a linear change over time in mean annual flow or variation in flow, nor significant correlations with the North Atlantic Oscillation Index". However, Mitchell did note that while not measurable increasing as of yet, there is a high degree of variability in flow in the watershed and that the river is considered a "flashy" system with a wide range in flows throughout the watershed. Accepted scientific climate change predictions (Vasseur and Catto, 2008) lend credence to possibility of increases in this variability in the coming decades.

Habitat degradation has been well documented throughout the watershed with stream surveys conducted by Mitchell (2010b; 2011b; 2011c), and by respected provincial groups and individuals such Amy Weston and Bob Rutherford with the Nova Scotia Salmon Association's NSLC Adopt-A-Stream Program. These surveys also identified numerous areas which had good habitat characteristics or had the potential to become good salmon habitat. Habitat degradation

has resulted from numerous historic and current practises within and adjacent to the watercourse, including forestry operations, agricultural operations, rural development, and transportation infrastructure. Efforts have been made by the St. Mary's River Association and the Nova Scotia Nature Trust to preserve and protect key areas of the riparian zone, but more will need to be done in the working landscape portions of the watershed to offset aquatic habitat damage.

As a result of these concerns over hydrologic and habitat degradation a long standing priority within the St. Mary's River Association has been the remediation of degraded habitat and associated effects on hydrology. Flow control mechanisms have also been considered in the past, but the analysis and literature review by Mitchell in 2009 examining the hydrology of the St. Mary's River found that these mechanisms are not a viable option for remediating. As a result the remaining option for addressing hydrologic and habitat concerns within the St. Mary's will be to develop a comprehensive and specific restoration outline that will define restoration steps to remediate degraded habitat and offsetting or ameliorating hydrologic concerns. As land use practises impact upon aquatic habitat restoration work will also need to be done with governments, industry and public to educate and find common ground on this issue.

Predation and Competition

Predation of seals and birds on salmonids was identified in the consultation phase as a concern and mentioned as a possible cause of the decline in salmon populations. No conclusive evidence has been found to confirm these concerns, although there have been relatively few predator population estimates and studies on salmonids predation rates within Nova Scotia. Regional level (Atlantic Provinces) estimates by DFO and the National Bird Survey of Canada do suggest increases in the seal and fish-eating bird populations, providing possible support to the idea of predator limitation. Another possible piece of evidence are the numerous anecdotal reports of declines in smaller "bait" fishes, which, if substantiated, could result in a disproportionate predation on salmonids. Despite this, the data that exists for predation rates in Nova Scotia and a recent salmon tracking and predation study conducted on the St. Mary's River by a Ph.D. candidate at Dalhousie University did not seem to suggest that predation rates were significantly outside of normal range for most species (Halfyard et al., In Press).

Even though this evidence does not suggest predation limitation, mathematical modelling work conducted as part of the COSEWIC mandated recovery potential assessment (RPA) by DFO suggests that temporary relief from predation pressure could significantly increase salmonid production. Perhaps as a result of this modelling work, DFO personnel suggested during the consultation phase, the possibility of culls could be investigated. Due to the high mobility of seals, it is likely that nothing can be done at the watershed level about this predator; however the Association might want to consider cooperating with provincial and interprovincial organizations on this matter. Disruption of piscivorous bird feeding or culls timed with key life stages (such as smolt migration) might be a viable strategy to provide a degree of predation relief and thus a boost to salmon populations during these critical recovery years.

Predation on salmon by humans through legal and illegal activities has had an impact upon salmonid populations in Nova Scotia. The significance of this impact has been highly debated and disputed in technical reports, presentations, and public meetings. Regardless, the continuing effects and impacts of this fishing have been mostly eliminated as the salmon fishery has been closed for the past number of years. This of course does not eliminate illegal activities, and so the recovery strategy will need to address this issue through education and public awareness.

Competition between salmon and other fish species within the St. Mary's River is not currently a major concern. The degree of interspecies competition between salmon and other non-invasive species does not appear to limit salmon populations in a significant manner in Nova Scotia. However, one native species, Striped bass, have been at very low abundance for the last number of decades but have started to increase in numbers recently. The possible impacts of the return of Striped bass in large numbers upon salmon populations are not known, and so should be monitored closely in the coming years. Invasive species, notably smallmouth bass and chain pickerel, can have negative impacts on salmonids, but these species do not currently exist within the watershed. Efforts have been made by regulatory authorities and should be supported to ensure that these species are not introduced into the St. Mary's River, especially as these fish are located nearby in waterways of adjacent watersheds.

Aquaculture/Stock Enhancement

Currently there are no finfish aquaculture facilities operating within or adjacent to the St. Mary's River watershed. Stock enhancements activities have not been undertaken in the St. Mary's River since the early 1990's, with the exception of a small gene banking program that was operated in the mid 2000's. It is generally accepted that these and other historic stock enhancement were operated at such a small scale relative to existing populations at the time to not have had any lasting impact upon the salmon population within the St. Mary's River.

It is well established within the literature that stocking enhancement programs have the potential to threaten the health of wild fish populations through alterations to the gene pool if proper diligence and rigour is not maintained within the enhancement program. As such, current DFO policy is against the use of stock enhancement except where it can be demonstrated that the benefits outweigh the risks. This policy has resulted in limitations on stock enhancement programs within Nova Scotia. Currently most stock enhancement programs are run on historically stocked rivers such as the Margaree River, on rivers exceeding their carrying capacity or deemed to be extirpated, or on rivers where the populations are in severe risk of becoming extirpated (ex. gene banking program being run to preserve unique genetic stock of the Inner Bay of Fundy rivers).

Similar to stock enhancement, aquaculture can also represent a threat to wild fish stocks with the potential for fish farm escapees affecting the genetic integrity of wild fish and as a

vector for disease, predators and parasites. Although much debate surrounds the degree to which these impacts occur, the basis of the potential for impact has been substantiated in numerous scientific studies and government reports. As a result these two issues, stock enhancement and aquaculture, are connected through similar areas of concern (disease, genetic effects, etc.) and as any restoration prescriptions involving weighing the pros and cons of one will need to consider the pros and cons of the other as well.

Management

Several parties during the consultation phase identified historical management of salmon and government policy and practises implemented within the St. Mary's, and within Nova Scotia, as an area of concern and a possible impediment to restoration success. Specific areas of concern included decisions with regard to pool closures and season restrictions, lack of assessments and scientific study, and non-meaningful consultation with native communities. Regulatory authorities have had a strong working relationship with the St. Mary's River Association and have been very helpful in the formulation of this strategy and document. This relationship will have to be maintained and developed in order to constructively address these areas of concern as the recovery strategy moves forward.

Another aspect of management that was identified during the consultation phase as a major concern was the connection between the public's ability to fish and their interest in supporting recovery activities through activism, volunteering, and financial and in-kind support. It was made clear by several groups during consultation phase that efforts will need to be made to provide (maintain and if possible expand) angling opportunities and to engage the public as well as the key stakeholders in the process.

5.0 RESTORATION PRESCRIPTIONS

The current low salmon population levels are likely a result of a combination of all of the previously identified factors, thus all will have to be examined and considered in any recovery plan. Some of these underlying causes (e.g., at-sea mortality) are too large of scale to be adequately addressed by local or regional associations such as the SMRA, while others are not feasible to be fully mitigated (acidity). Thus, the approach recommended here is to address those issues within the scope of the association's ability, while attempting to maximize river-specific productivity and minimize losses. The multifaceted approach proposed involves addressing areas of connectivity and access, restoring habitat, controlling predation , actively participating in management/advocacy, enhancing stocks , and monitoring water chemistry and salmon status Cost estimates have been provided as rough guidelines only for an initial benchmark of 10 years . Actual costs and timelines will extend beyond this benchmark and may vary considerable due to a wide variety of socioeconomic variables. Specific and more detailed budgets and timelines

will need to be generated for each individual program within the strategy as they are developed and implemented

The priority within the St. Mary's River system is to increase access and connectivity for salmon. Current estimates indicate that 1/2 to 2/3 of all culverts have passage issues. This drastically reduces the amount of available habitat for adult spawners and for rearing juveniles. Techniques to be used will include (i) requesting that Nova Scotia Transportation and Infrastructure Renewal replace culverts, (ii) making modifications to existing culverts, using standard and known methods, to enhance passage and passage efficiency, and (iii) clearing debris from existing culverts. This program is slated to begin this summer (2013) with two culvert enhancements on MacQuarries Brook and Jordan's Brook (a tributary to McLoed's Lake) which if successful should provide a new low cost tool for culvert mitigation. A cohesive plan of identifying and mitigating priority culverts needs to be developed this summer, so as to ensure the programs continuation in 2014. Use of partners' organization (NSSA, CARP, DalTech) will assist in this initiative, however regulators must be willing to consider "outside of the box" solutions and actively participate in the partnership to avoid unnecessary road blocks. The association will respect the regulators right to govern, but recognize the need to limit red tape bureaucracy and unnecessary delay to novel projects due in large part to their novelty.

There are an estimated 2000 culverts in the St. Mary's River watershed. Using the work by Mitchell (2010a) as a guide ~50% of these would have passage issues. Preliminary estimates indicate that perhaps as many as 10-20% of those culverts could not be mitigated and would need replacement, while the remainder could be mitigated at least temporarily at a lower cost. Given a projected cost of $50,000 per replacement and $5,000 per mitigation, the estimated costs associated with this program, without concomitant monitoring would be $7.5 million for the replacements and $4.25 million for the mitigations. A monitoring program could be implemented as a research project for a post-graduate engineering student or Ph.D. student, in which case the estimated cost for monitoring would likely be ~$50,000. The total estimated cost for complete culvert mitigation is $11.8 million and would likely take 30-50 years to complete. Although these figures seem daunting, selection of only priority culverts would drastically reduce these figures and it is anticipated that the effects of culvert mitigations and replacements would begin to be felt immediately by the fish community. Careful selection and treatment of problem culverts, and those with the greatest amount of suitable habitat upstream, would likely result in best return on investment by maximizing accessible habitat in the first few years of the program. Full exploitation of new habitat is estimated to take several years dependent upon the size and location of the novel habitat.

The next highest priority is to increase the quality of the salmon habitat within the watershed. The St. Mary's River Association is planning on continuing their restoration efforts this summer (2013), however the present restoration program needs to be significantly expanded in a well thought out and organized manner to ensure the quickest returns and optimal use of resources. Restoration should be conducted such that efforts from one year build on the previous

years. As such the important aspects of this priority will be the development of a comprehensive habitat restoration outline and the implementation of a methodical program of large scale restoration (larger streams, but also increased number of areas restored in a given year). Previous stream and lake survey work should be used as the initial guide for this initiative. Given the known connection between habitat degradation and increased water temperatures (Poole and Berman, 2001), this restoration program will need to try to take advantage of as many of the known cold water refuge areas as possible, while remediating the known areas of summer thermal stress. Novel temperature restoration techniques should be tested and implemented in conjunction with traditional restoration techniques. It is also recommended that this habitat restoration plan include a riparian zone enhancement program. Once again "outside of the box" solutions need to be considered and regulators need to be willing to entertain these ideas.

These first two priorities should initially be targeted at high value areas that are low cost, high yield, and have the opportunity to provide numerous ecological services. It is the recommendation of this report that select tributaries (such as those being considered this summer) be targeted first. The next highest value areas would be the North Branch and the northern tributaries and streams of the East Branch. These waterways typically have excellent water quality but suffer from habitat degradation due to historic development, agriculture (fields extending to stream without riparian areas retained) and logging. As such they mirror the systems that drain into the Gulf, which showed extremely positive responses to habitat restoration initiatives. Due to the similarity to the Gulf it is expected that these populations can be expected to undergo very high production once the physical habitat is restored (unlike the West Branch, depressed pH is not an issue here and will not exert a negative effect on the salmon). These watercourses of the East and North Branch also have many lakes that provide flow refuge as well as temperature and predator refuge (for the deeper lakes) for juveniles and spawners (limits mortalities, decreases energy spent thereby allowing more energy to go into egg production).

An early priority within this program is the development and implementation of the comprehensive habitat restoration outline. Several funding applications had been previously drafted for Shell and RBC funding programs to bring in a respected restoration consulting company like Parish Geomorphic to develop this outline for the West Branch and see its initiation. Based on these applications preliminary costs estimates were ~$50,000 for the West Branch alone, so an anticipated $125,000 should cover the planning and program initiation for the entire system. Although expensive, past consultation with DFO indicated this would be the best approach for implementing a large scale mainstem restoration program. Smaller tributary planning and restoration implementation can be developed in conjunction with the expertise at NSLC Adopt-A-Stream Program. Based on past success and budgets it is estimated that the cost of restoration is ~$8/$m^2$ of habitat. Given that there is ~3,100,000m^2 of habitat, and taking into consideration the aforementioned planning costs it is estimated that restoration of the habitat within the watershed would cost ~$25 million. Similar to the culvert mitigations the effects of

restoration efforts would begin to be utilized by the fish community immediately, however based on current research into ecosystem response to restoration efforts, the full effects of restoration will not occur until 3-5 years post restoration (B. Taylor, pers. comm.) with the full effects translating to changes to the salmonid populations over the subsequent life cycle.

Predator control and invasive species management is another important aspect of the recovery strategy. Predator control is contrary to ecosystem management principles adopted by the St. Mary's River Association; however modelling associated with the RPA and Halfyard et al. (in press) research indicates that some form of this type of control has the potential to have a positive effect on salmon. As such it is the recommendation of this strategy that avian predation control should be investigated. Seal predation control is likely too difficult for the St. Mary's River Association and so should be left to DFO or other broader reaching organization. It is important to recognize that killing one species to benefit another is highly contentious and will put the St. Mary's River Association in prominence within the media and conservation organizations. The decision to proceed with predator control will also require a major public relations management campaign if the SMRA is to maintain a reputation as a conservation organization. Currently there are no invasive fish species within the St. Mary's River. This needs to be maintained through collaboration with the provincial governments and other partner organizations. An education campaign on the dangers of invasive species and what private citizens can do about to prevent the spread needs to be developed and initiated. This campaign has already begun with talks at the Antigonish Public Library in April 2012. Striped bass, a native species whose abundance is increasing, will likely have an effect on salmon populations. Little is known on what the outcome of this effect will be. It is recommended that role of Striped bass be investigated to develop an effective strategy for salmon recovery.

The aviation predator control and the Striped bass studies could both be implemented as research projects for graduate students, in which case the estimated cost would likely be ~$50,000/project. It is anticipated that these projects would likely take 5 years to complete. Predator control program implementation could begin upon the studies completion and would likely incur additional start-up costs as well as an annual budget likely on the order of $10,000/year. This is a very rough estimate as the nature of the predation control program is undetermined and so costs difficult to estimate. Costs given are estimated based on running a comprehensive field program for several months during the summer. The education and outreach campaign costs should be minimal, ~$10,000 to cover meetings and travel should be sufficient for the duration of the 10 year program. Based on these estimates the total cost of a predation control and invasive species management program would be roughly $225,000.

Stock enhancement program will have to be developed to offset the limitation caused by at-sea mortality. Current DFO policy does not advocate the use of stock enhancement as a restorative tool and so DFO personnel, as regulators of stocking, would have to be convinced of the importance and viability of any such program in order for it to proceed. Beginning a

program immediately is not a viable option as recommended safe stocking levels are less than 20-25% of existing population levels (Margaree stocking levels; Clement et al. 2007). At the current levels this would be a not be cost effective on the St. Mary's River (maximum increase in populations from 10% of conservation targets to 12% of conservation targets at a significant financial and biological cost). It is recommended that work should begin immediately on the development of a "safe" enhancement program (short term, small scale, stream side incubators are generally considered the best options) and that evidence supporting the programs legitimacy be gathered to convince DFO for future implementation.

Enhancement programs will need to be minimal impact in their design. Streamside incubators combined with carefully designed broodstock collection and husbandry protocols show the most promise for a program that minimizes risk. This approach has been successful in the Mulgrave Lakes area (NS) and in Maine. Expertise to guide the development of the necessary protocols resides within the province, at federal and provincial hatcheries, and within academia. Many of the potential genetic constraints are already known as they were outlined in the RPA process. This information will have to be utilized and partnerships developed if the program is to have success. Only careful design and rigid protocols will convince regulators of the benefits, and minimization of risk, as enhancement programs. Currently such programs are not palatable to DFO due to concern over potential impacts to wild salmon stocks. A business plan will also need to be developed in conjunction with scientific evidence supporting the program to convince government officials that this is viable restoration tool.

A significant obstacle that must be overcome before any stock enhancement program can be implemented is that current populations are an insufficient source for broodstock. Proper design dictates that broodstock utilized in an enhancement program must come from the system it is augmenting. Therefore, there is a need to first boost production in rivers by other measures (increasing access, habitat augmentation, and predator control) in order to allow removal of broodstock with minimal risk to the population. Full-scale implementation of the program would only begin once it is safe and cost-effective, that is only after other restoration strategies have bolstered populations to a higher percentage of conservation targets (70-80% is suggested as a discussion point for a possible target). It is recommended that a pilot scale project on a smaller sub-watershed that has a sustainable population be developed, ideally within the initial 10 year span of this strategy.

Based on work by Christman et al. (2012) the cost of operating a stream side incubator based enhancement program is ~$42,500/year to run a program at 6 sites. Based on their productivity and the egg requirements, and likely stocking densities for the St. Mary's River, this would scale to ~$1.75 million to fully augment the St. Mary's River populations. If this program was run for a 10 year span, which is typically of many "enhancement for recovery" programs, the total costs would be ~$17.5 million.

Policy development and advocacy (fisheries management considerations, land use considerations, etc.) should be addressed during this period of salmon angling closures. This will establish firm criterion on when and how the fishery can be reopened, as well as promote healthy interactions between stakeholders that should assist in minimizing losses of habitat and of individual salmon. This must be done collaboratively with native groups, other partners, the public, regulators, government officials, and industry. Native groups have legal rights which must be respected. The public's interest drives government policy and is the purpose of restoration strategy. It is suggested that while salmon closures remain in place other fishing opportunities be explored within the St. Mary's River (trout, Striped bass). Regulators and government officials have legal obligations and rights to manage and so need to be included. Other partners have vested interest in the river, which must be respected. Industry has the potential to provide both the most help and the most harm, depending on practices used, and so must be involved in discussions. In partnering with industry, partnership agreements are recommended so that both the SMRA and the industry's role are defined and that the right to independent opinion and critique is maintained. Dialogue and open communication with respectable aquaculture companies should be considered in conjunction with effective lobbying which will require formalized partnerships with larger organization like Atlantic Salmon Federation to effect positive regulation change. Good relationships with these companies may realize other benefits, such as financial support, wild-strain of salmonids for stocking programs, genetic and rearing expertise, as well as information on near shore biology and hydrology that will benefit conservation efforts. Estimated costs for this program should be minimal, ~$10,000 to cover meetings and travel for the duration of the 10 year program

Water chemistry is a relatively low priority in the recovery strategy. Acidified streams should be treated with watershed or catchment liming. Daniels (2012) work on projected costs and scope of lime dosers indicates that this is not a viable option for the St. Mary's River. Concentrations of some metals (aluminum, cadmium, copper and lead) need to be more firmly established. Some sort of flocculation treatment might be necessary, but feasibility of this and the exact nature of this remediation need to be further developed once metal levels are more firmly established. Based on Daniels' work it is estimated the costs for this entire program would run an estimated ~$20,000/year for at least 10 years for a total estimated cost of ~$200,000.

The assessment and monitoring program that generates population abundance estimates must be maintained in its current form of yearly electrofishing/ mark-recapture studies. As the recovery strategy develops this assessment and monitoring program will need to be expanded to capture the changes in sub-populations and different life history phases, both as an indicator of recovery and as a metric of restoration activities. Other species, such as benthic invertebrates, predators and species of concern (Wood turtles); will need to be periodically monitored to ensure they are not being adversely affected by the recovery strategy. Adaptive management should be used throughout the recovery strategy. The cost of additional assessment and monitoring is

estimated to have equipment and start-up costs of ~$25,000 and annual costs of ~$25,000/year at least 10 years for a total estimated cost of ~$275,000.

6.0 SUMMARY

Due to the number and complex nature of the issues currently facing the St. Mary's River and its salmon populations, a multi-faceted solution is required to facilitate restoration and recovery. The restoration prescription involves initially focusing on maximizing productivity by bolstering the quality and quantity of high quality habitat through increases in aquatic connectivity and restoration of habitat within and adjacent to the stream. Losses may be mitigated through improvements to water quality, increasing protection from predation, and stock enhancement. Special care will have to be taken in designing these programs to ensure a primary mandate of protection and preservation of wild stock genetic diversity. Current examples of success that have been documented and validated with a rigorous scientific process will have to be emulated to ensure that this primary mandate is met. Concomitant with programs to increase production and reduce loss there will have to be scientific studies, outreach and education programs and monitoring to ensure the goals of this recovery strategy are being addressed in a legitimate and meaningful manner.

Successful implementation and completion of this recovery strategy will represent a significant investment in human, equipment and financial resources from numerous different stakeholders (governments, native communities, volunteer organizations, and members of the public), but will yield many benefits to the communities and people of Guysborough and throughout Nova Scotia. The program will require an estimated investment of just under $55.25 million and will take several decades to realize. Although taken on the whole these are substantial and daunting figures when amortized over the life of the program and the years of residual benefits this does not represent overly taxing costs. Additional cost savings and benefits will be realized by operating this program as a partnership with many different stakeholders being invited to participate in the program. By running the program as a partnership the SMRA will be able to take advantage of local knowledge and resources and at the same time build capacity in the rural areas of Nova Scotia. Success of this program will represent restoration of significant portion of the province (2.4% of total land mass; and ~5.8% of the endangered Southern Upland) and is something that would be of worldwide significance in terms of its leadership in restoration ecology and its demonstration of the potential to impact to the environment in a positive and meaningful way.

This program is feasible despite its high costs, because although the overall program is complex and costly, its individual programs do not require the generation of new knowledge in order to complete and can be implemented independently on a variety of scales. Certainly there

are elements and aspects that must be determined in each program, but the underlying technology and basic capacity required to achieve success is already present within the St. Mary's River Association, and the potential partners around the province. In some areas the report still does call for innovation and novel techniques, but these have incorporated mainly as a cost and time saving approach. For example it is more cost effective and timely to mitigate the passage issues on many culverts than it is to replace all of them. The independence of the individual programs also means that they can be run simultaneously on several different sub watersheds or on pilot level scales. This will represent a significant cost saving, or at least will allow for the deferral of costs, as generally the reason for the high overall program costs stems from repeating lost cost projects over the sub watershed scale to encompass the large overall area of the watershed. Running the programs on different scales and simultaneously will allow for comparisons to be made that will increase knowledge and understanding of these systems and how they respond to recovery. For example the East and West Branches have significantly different characteristics that lend themselves to testing a wide variety of recovery techniques, and because some of tributaries are more significantly acid impacted than others there is an opportunity for comparison of these tributaries to learn how they affect salmon populations and how they respond to various restoration techniques. This knowledge can then be to facilitate recovery in other portions of the watershed and in other areas of the province.

Another major advantage of this program is the lack of one overarching issue within the freshwater environment. The lack of one overarching issue means that there is no single fundamental limiting factor in the freshwater environment that must be overcome in order to realize any level of success. The multifaceted nature of the problems means that many different approaches can be developed and utilized simultaneous to achieve synergistic results that will lead to success in a timelier and ultimately more efficient manner. This is different than most areas of the Southern Uplands which have an overarching acidity issue, since the St. Mary's isn't plagued to the same degree much of the program is not contingent on addressing acidity before other beneficial actions such as restoration can be attempted.

Other advantages that make the St. Mary's and this recovery strategy feasible are connected with the position of the St. Mary's River within the Southern Upland. The St. Mary's River watershed represents a sizable proportion of the Southern Upland and provincial land mass. The St. Mary's River has the position of having among the highest historic salmon returns based on reported angling catches. The watershed straddles the edge of the Southern Upland and so is less affected by many of the water chemistry and development concerns throughout much of the other portions of the Southern Upland. Lastly and perhaps most significantly the St. Mary's River Association has proven themselves capable and leaders through the compilation of an immense amount of river specific data and has developed many productive working relationships that can be used to support a recovery initiative.

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