Stewardship Plan to Protect and Restore the Atlantic salmon (*Salmo salar*) Habitat in the Cocagne River

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Developing a Stewardship Plan to protect and Restore the Atlantic salmon (*Salmo salar*) Habitat in the Cocagne River

1.1 Background

In the last 20 years, The Southeastern Anglers Association (SAA) has become important stewards of the protection and enhancement of the Atlantic salmon and its habitat in multiple rivers of southeastern New Brunswick. Completing a stewardship program to protect and restore the Atlantic salmon habitat in the Cocagne River is the first step before implementing important stewardship programs in the near future. It is only with great participation and interest from our members, landowners, local communities and partners that this project will become an important tool to work with.

In March 2013, the Southeastern Anglers Association completed its stewardship program entitled "Developing a stewardship plan to protect and restore the Atlantic salmon habitat in the Cocagne River" and submitted it to Environment Canada's Habitat Stewardship Program. In the meantime, because we thought this was a great program that yielded a very valuable tool, we reapplied for the grant, but this time for the Cocagne River. Shortly after, we received news that the project "Developing a stewardship plan to protect and restore the Atlantic salmon habitat in the Cocagne River" was approved. Building on the plan developed for the Bouctouche River, we were able to prepare this up-to-date, helpful andvaluable stewardship plan for the Cocage River.

The preparation of this document includes a literature review that gathers relevant information available about the Cocagne River. We have attempted to identify all the documentary sources and knowledge available to write up this plan. These sources include many publications from government, university published and unpublished research papers, exclusive consultants, reports from non-governmental organizations, community groups, personal communications from experts and other sources believed to be reliable and relevant (i.e., SAA members, staff and local residents). No field work has been undertaken for this document.

1.2 Purpose of the Project

In 2010, COSEWIC designated the Atlantic salmon with the status of Special Concern in the Designable Units (DU) 12 Gaspé and Gulf of Saint Lawrence, which encompasses the Cocagne River. It is mentioned in the COSEWIC assessment and status report that the lowest abundance of Atlantic salmon in the DU 12 during the last 3 generations was in 1999. Based on the data from the Miramichi River and other smaller rivers in the Gulf of Saint Lawrence, adult populations were higher in the late 1980's and early 1990's than in the past decade. We recognize that the Miramichi accounts for the majority of salmon populations in the DU but the smaller rivers flowing into the Northumberland Strait (which includes the Cocagne River) have appeared to indicate the same decline in Atlantic salmon populations (DFO and MRNF, 2009).

In 1998, legislative authority under the Fisheries Act, sanctioned by Fisheries and Oceans Canada, closed all Southeastern New Brunswick lakes, rivers, and streams draining into the Gulf of Saint Lawrence and Northumberland Strait south of Point Escuminac down to the New Brunswick/Nova Scotia border to Atlantic salmon fisheries. Multi-annual assessment of Atlantic salmon provided supporting evidence of low spawning escapement in all of these waterways and led to the complete closure of all Atlantic salmon fisheries.

It is well cited in various literature that the specific causes of decline of Atlantic salmon population in the Southern Gulf of Saint-Lawrence in the last 30 years are unknown, but might be a result of a combination of numerous threats (DFO and MRNF, 2009; COSEWIC, 2010). Because Atlantic salmon require rivers and streams that are generally clear, cool and well-oxygenated for reproduction and also for their first few years of their life, many suggested that threats such has recreational and aboriginal fishing, agriculture, forestry and urbanization have contributed to the problem.

This project will also bring importance to the strain of Atlantic salmon that migrate and rear in the smaller rivers flowing into the Southern Gulf of Saint Lawrence. The Bouctouche River is located approximately 16 km north of the Cocagne River and has been designated as an indicator for all other smaller rivers that drain into the Northumberland Strait by DFO. The Bouctouche River has an average population of

approximately 250 adult salmon and its conservation requirements were established to be 281 large spawners and 172 small spawners (Atkinson *et al*., 1998; Atkinson *et al.*, 2004). Although there are no estimates of the numbers of adult salmon abundance in the Cocagne River, it probably has less adult salmon because it is smaller. However, a review of Atkinson (2004) and Melanson *et al*. (1999) suggests that although the Cocagne River is smaller than the Bouctouche, the abundance of small salmon is on average two to four times higher in the Cocagne River than in the Bouctouche. Although the Cocagne River strain of Atlantic salmon does not account for a big percentage of the COSEWIC DU 12 when compared with bigger rivers such as the Miramichi it seems to consist of good habitat for Atlantic salmon rearing and is importance to our communities and our heritage.

1.3 Coordination of the project

In 1994-1995, the SAA drafted up its first plan to protect and enhance the Atlantic salmon and its habitat in many small rivers of Southeastern New Brunswick. This was realized thanks to the Recreational Fisheries development agreement between the Province of New Brunswick and Fisheries and Oceans Canada that encouraged the development of projects that would further enhance sport fishery in the region. Studies on habitat and angling management were necessary on all rivers of our territory so that we could determine what strategies needed to be implemented to assure the long-term sustainability of the Atlantic salmon and Brook trout stocks. After all study results were considered, the primary focus of the SAA since 1997 has been monitoring, habitat restoration and promoting good stewardship of our natural resources. In 2010, the SAA prepared a strategic plan that would outline specific, measurable and time focused objectives, working towards the SAA mission and goals for the next 5 years.

In the last 20 years, a total of 1.7 million dollars was attributed to the SAA to accomplish a variety of projects. It wouldn’t have been possible to realize these projects without the many good partnerships we developed over the years.

The SAA has become important stewards in protecting and enhancing the Atlantic salmon and its habitat in some rivers of Southeastern New Brunswick. We feel that we are in need of a new vision and we think that looking back and analyzing past activities

could help us achieve this. Completing this stewardship plan to protect and restore the Atlantic salmon habitat in the Cocagne River is the next step before implementing important stewardship projects in the near future. It is only with interest and participation of our members, landowners, local communities and partners that this project will become an efficient tool to work on stewardship programs at a watershed and sub-watershed level in the future.

The primary objective of this project will be to engage the SAA and other partners in developing a stewardship plan. Based on the knowledge gathered, 4 sites will be identified to protect or restore for the Atlantic salmon habitat in the Cocagne River. The plan will include recommendations on high priority areas where specific actions will be identified to facilitate future habitat stewardship projects for the Atlantic salmon. Afterwards, potential actions will be elaborated and these will become key elements that will be integrated into the stewardship program.

The project coordinator will involve several partners for input before writing up the stewardship plan. It will include recommendations on how the specific actions will be undertaken. Communication strategies, landowner enrollment, details on actions (ex. Permit application, restoration work, etc.), timeline and financial requirements will be some of the key subjects developed during the creation of the plan. During the course of the project, we will assure that the good partnership between all parties involved remains present.

2 Overview Description of the Cocagne Watershed

2.1 Geography

The Cocagne River is located in Kent County, Southeastern New Brunswick. All waters from the Cocagne flow into the Northumberland Strait drainage, which is part of the Gulf of Saint Lawrence's bigger ecosystem. The Cocagne watershed is situated in the coastal plain of the lowlands of the eastern New Brunswick, where the slope of the land towards the sea is not very noticeable. The Cocagne watershed presents altitudes varying from 0 m to 150 m above sea-level.

The Cocagne watershed covers a surface of approximately 400 km² (Gauvin *et al.*, 2009). The headwaters of the Cocagne River are found in the Gallagher Ridge region and origin from the Canaan bog. On the north side of the river, the principal tributaries are the North Branch of the Cocagne River, Shaw, Butler, Meadow and Murray Brooks (Gauvin *et al.*, 2009). On the south side of the river, the principal tributaries consist of the des Ormeaux, Dupuis, Babineau, Cormier, François, little Goguen and Anguille River. Other smaller watersheds such as the Goguen and Howard brooks, whereas some waterways drain directly into the Northumberland Strait such as the Malcontents brook (Gauvin *et al.*, 2009).

2.2 Bathymetry and Hydrology

The estuary is relatively shallow with an average water depth of 4 m and 6 to 7 m in the channels. The Cocagne River has weak to moderate water flow, is short and not very deep, typical of New Brunswick's east coast. The river has an average rate of water flow of 4.6 m^3/s in normal weather and 49 m^3/s during large rain events. The slope of the river is on average 0.5% (Gauvin *et al.*, 2009).

2.3 Geology

During the last glaciations, the Cocagne River was mostly covered by glaciers. Over time, these glaciers melted and receded revealing the landscape that we see today. This phenomenon has also left important clay deposits along the Southeastern New Brunswick coastline. The receding glaciers caused the rise of sea levels which in returned caused the deposition of a layer of marine sediments of 1 to 2 m on lands. The Cocagne

watershed has an orientation southwestern/north-eastern, which partly improves the drainage of the grounds and tributaries found in this one.

A report produced by Agriculture Canada in 1992 “Soil Regions Chipman, Minto and Hartcourt in New Brunswick” gives a good overview of the soil compositions for the concerned area;

> “*The bedrock geology is simple. In almost the whole survey area, thin deposits of unconsolidated materials are underlain by horizontally bedded Pennsylvanian sandstones. The parent material of rich soils is well-sorted marine influence outwash sand, more than 1m deep. It is free of coarse fragments, but sometimes it has some gravel and cobbles of Pennsylvanian sandstone origin.”(Rees et al. 1992)*

2.4 Climate and Temperature

All Kent County communities are influenced by a modified continental climate, which is typical of the Maritime region. Our climate is influenced primarily by the east air masses, which are provided by the central zones of Canada. These atmospheric currents are modified by the frequent inflow of humid air coming from the Atlantic. The average number of degree-days is usually higher for the inland than in the coastal area. The influence of the oceanic air tends to bring short periods of milder temperature during winter and foggy periods during summer. The precipitation is typical of the climate in the Maritimes and is fairly distributed throughout the year (Agriculture NB, 1976). January is usually the coldest month, July being the hottest. Storms are unpredictable, summer like winter; and the fog is frequent especially along coasts (Arsenault *et al.*, 1976).

2.5 Land Use

The Cocagne watershed has a population of more than 2500 residents and most reside along the shores of the river and the coastline. Numerous permanent and seasonal residences compose several little communities and four rural communities, namely Notre-Dame, Macdougall settlement, Saint-Antoine and Cocagne. Forestry and agriculture are the two major land uses found in the watershed. Logging in the Cocagne

watershed started around the 1800's and the river was used to carry the wood to shipbuilding factories. In the 1940's and 1950's the area was intensively logged for the paper industry. Logging still takes place nowadays in many areas in the watershed. The Agricultural sector is diversified in the Cocagne watershed. In 2006, there were 12 active horticultural farms and 8 active animal farms found within the limits of the watershed. The horticultural operations consist mostly of apple orchards, whereas animal production consists mostly of cattle ranching (Gauvin *et al*., 2009). The economy of the area depends on the natural resources and the goods and services, which the area can offer for the neighbouring areas considering its proximity to the municipalities of Moncton, Dieppe, and Shédiac.

Recreational fishing has always been a popular activity for the residents of the Cocagne watershed. It is therefore an important activity from an economic and social perspective (Gauvin *et al*., 2009).

2.6 Human Impact

Before the arrival of European settlers, the rivers were composed of many characteristics such as numerous pools, undercut banks, loose gravel in spawning grounds, an abundance of food sources and good water quality. All of these characteristics provided good fish habitat for the various stages in the life cycle of fish and other stream organisms. With the arrival of the European settlers in the mid 1600's, we started seeing changes made to the landscape to accommodate survival and even bigger changes were seen when the Industrial revolution developed in the late 1800's. The availability of nutritious food, for both local and trading purposes, contributed to the economic growth of the Maritime's coastal regions.

Due to evolution, cumulative impacts associated with urbanisation and poor land use have resulted in serious deterioration of the aquatic ecosystem. Removal of vegetation along the streams, improper agriculture and forestry practices, road development, barriers, improper waste management, improper uses of pollutants, over harvesting, etc., are some of the actions responsible for bringing adverse physical and chemical changes to the aquatic ecosystem of the region.

3 Threats to Atlantic salmon in the Cocagne River

The cumulative effects of improper activities along our rivers have contributed to the lost of fish habitat and has led to a decline in fish populations in the region. It was mentioned in the SAA's first written report that "fish stocks are below normal levels" (J LeBlanc *et al*., 1995).

3.1 Low marine survival

Low marine survival is well discussed and researched among Atlantic salmon populations throughout the Gulf of Saint Lawrence. It is believed to be the cause of reduced returns to many rivers such has the Cocagne River and has resulted in stocks falling well below the designated conservation limits.

Five hypotheses were described in the Conservation status report, Atlantic Salmon in Atlantic Canada and Québec: Part II Anthropogenic Considerations. These Five hypotheses are: higher than presumed natural mortality after Greenland Fishery, predation by birds and marine mammals, altered oceanographic conditions leading to changes in immigration routes, marine survival is 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 (DFO and MRNF, 2009). It is really important that studies and research continue to better understand the factors mentioned in these hypotheses.

3.2 Estuaries- Adaptation of Marine Life and Predation

Knowledge of salmonid life in the early pre-marine phase is relatively limited. The Atlantic salmon's dwell period in the estuary is relatively brief, generally lasting only one or two tidal cycles. In estuaries, schools of smolts reside in and are usually displaced with the surface current and movement influenced by the tide and the direction of the water flow. During this migration from the river to the estuary, the diet of Atlantic salmon smolts changes. Feeding conditions and early marine growth have been postulated to be critical to overall marine survival and year-class strength for Atlantic salmon. Many physiological changes, which are essential for seawater entry, occur in smolts during the downstream migration, and further changes take place in response to

seawater transfer. These physiological responses may be a critical part of the adaptive process to ocean conditions. Perhaps one of the greatest values of the estuary to these young salmon is the abundance of food that enables them to double or even triple in size before migrating to sea. Size is one of the best defenses against predation. So estuaries are essential to the very survival of these fish (Stefansson *et al.*, 2003). As for Atlantic salmon adults, a small minority of these will feed as they enter their native river. They will mainly travel in the estuary to attain freshwater to spawn. Predators such as seals and human could influence their survival.

Four hypotheses to estuarine life survivors were identified in the Conservation status report, Atlantic salmon in Atlantic Canada and Québec: Part II Anthropogenic Considerations. These four hypotheses are: 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 adults returning (DFO and MRNF, 2009). It is really important that studies and research continue to better understand the factors mentioned in these hypotheses.

3.3 Low Spawning Escapement for Atlantic salmon in Freshwater

Multi-annual assessments of Atlantic salmon provided supporting evidence of the low spawning escapement in the Bouctouche River which serves as an indicator for all other smaller rivers that drain into the Northumberland Strait. In 1998, it led to the total closure of all fisheries for Atlantic salmon in the many rivers south of the Miramichi River down to the Nova Scotia border. Fisheries and Oceans Canada have assessed relative abundance of juvenile Atlantic salmon yearly since 1974. The results show that juvenile density in the past three decades has been at least stable and demonstrating no significant trends, but that juvenile abundance remains low. Higher densities in recent years, particularly in the Bouctouche and Cocagne River, may be influenced by the closure of all salmon harvesting in 1998 (Atkinson, 2004).

The low spawning escapement is probably reflected by the lower adult returns and lower carrying capacity of the habitat. It has been shown to be directly caused by many improper human activities throughout the years. The following paragraphs describe potential causes of the decline of the Atlantic salmon in the Cocagne River that we have

identified and which should be examined and for which mitigation measures should be taken following a proper stewardship plan.

3.3.1 Impacts on freshwater habitat from human activities

3.3.1.1 Habitat alteration

Habitat alteration is a common problem on the Cocagne River. Changing land-use patterns, particularly land development and land clearing for urbanization, agriculture and forestry operations, created a number of conditions affecting spawning and rearing habitat. Increasing urban development and population growth resulted in land clearings and infrastructure construction such as roads and buildings. These activities and structures have altered and disrupted the hydrology process in nearby streams, directly affecting the water and habitat quality. The succeeding paragraphs will explain how each human activity may have altered water and habitat quality.

3.3.1.1.1 Agriculture

Agricultural activities have impacted the geomorphology and the riparian zone of surrounding water courses. The extent and the type of farming usually determine the type of problems we could encounter. Farmers could have realigned or piped streams along their fields to improve workability. Livestock using the streams could cause water contaminations, bank erosion and siltation in the stream. Improper land use of crops and farm operation could contribute to an overload of sediments, which could in return, create disruption in natural hydrological processes. Sediment overload, over-widening, shallow water depths and lack of resting pools are all signs of habitat fragmentation and poor habitat quality caused by agricultural operations.

3.3.1.1.2 Forestry

The history of forestry activities has had a long-term detrimental impact on some sections of the Cocagne River. In favor of economic growth, this industry has had an impact on the geomorphology and on the riparian zones in many sections of the river. The most important negative impact of past forestry practices is increased sedimentation. Clear cutting, improper road construction and log driving brought changes to the buffer zone

and the morphology of the watercourse. Many streams show section without adequate temperature, depth or resting pools.

3.3.1.1.3 Urbanization

Urban development has directly impacted the entire watersheds' water flow pattern in many ways. Channel realignment, dredging, infrastructures for waste water and water supply and street and road construction have interfered with the hydrogeomorphology of the watercourses present on affected sites and also further downstream. Improper control of storm water runoff from new or old developments can carry contaminants from developed areas into nearby streams and rivers and cause morphological changes to the stream bed. In many of these cases, the soils are impervious (hardened) due to development. As more areas are covered with surfaces that don't let the precipitation percolate into the soil, the storm water flows directly into nearby waterways. Over a short period of time these increases in water level increase and can cause habitat destruction where diversions or healthy buffer zones are not well established (Fisheries and Oceans, 2006).

3.3.1.1.4 Transportation infrastructure

Issues with transportation infrastructure are most notable when dealing with watercourse crossing and the variety of choices available for proponents. For example, culvert installation needs to be properly planned so the culvert does not impair ecosystem function. Inadequate safeguards, poor roadway maintenance, improperly installed culverts, unstable bridge abutments, improper road ditching, can increase the input of sediments into streams, exceeding the capacity of the hydraulic process to move and sort the fine particles.

Problems with culverts occur when they are improperly installed. In such case, the culvert may erode the stream banks or streambeds downstream and lead to deposition of sediments that can cause imbalances in hydrological processes. If the problems persist for many years the culvert becomes perched, blocking fish migration and filling pools with sediments downstream. Also, causeways can restrict the water flow and change the hydrological processes permanently.

3.3.1.1.5 Industrial activities and mines

No major industries or mines are presently active in the Cocagne watershed. Preventative measures should be considered before any future developments takes place.

3.3.1.2 Water quality

3.3.1.2.1 Sedimentation

A common problem found in the Cocagne River is excessive input of silt and sand to nearby streams. Causes range from improper installation or maintenance of transportation infrastructure to poor agricultural practices, all-terrain vehicle trails and fording sites, poor forest harvesting practices and dredging. All of these can increase the input of sediments into streams, exceeding the capacity of the hydraulic process to move and sort the fine particles. It is noted in many reviewed documents that the movement of the normal bed load is a natural process which sorts and migrates substrates, usually without disrupting processes in the life cycle of salmon. Thereby excessive input of silt and sand may stress, suffocate or trap alvins and disrupt the macro invertebrate populations which are the primary food source of juvenile salmon.

3.3.1.2.2 Nutrient regime alteration

Nutrients from common sources such as crop fertilization, poorly maintained septic systems, and municipal lagoons can result in serious impacts to fish habitat. These can form serious endocrine-disrupting compounds that can compromise the survival of salmon at sea (Fairchild *et al.,* 2002). No evidence of high sub-lethal contaminants and nutrients were recorded in the freshwater portions of the Cocagne River. Sources of highly disrupted compounds and nutrients should be monitored in estuaries where land use influence, such as municipal waste, private septic systems and agriculture activities are more prevalent.

3.3.1.2.3 Contaminants and pathogens

Higher counts of *E. coli* and fecal coliform can be found in some section of the river. Sources are probably municipal lagoons, faulty septic systems or agricultural run-off. The correlation between nutrient levels and pathogen load should be monitored because research suggests that the presence of nutrients may also encourage the proliferation of aquatic pathogens (Fisheries and Oceans, 2006)

3.3.1.3 Ecosystem imbalance

An imbalanced ecosystem occurs when the relative numbers of one too many components of a natural community is unstable. When the ecosystem becomes in imbalance, competition between organisms or species, in which the strength of one is lowered by the presence of another, starts to affect populations. Limited supply of at least one resource (such as food, water, and territory) used by both may start depleting the population of one of the organisms. The causes of ecosystem imbalances can be related to the introduction of new species, the sudden death of some species, natural hazards or man-made causes.

When an aquatic ecosystem becomes imbalanced, certain signs such as the overabundance of one species (or the depletion of another), eutrophication, and poor water quality become apparent.

3.3.1.4 Climate change

Climate change is one of the most important environmental issues of our time and should be brought up. Climate change is defined as a long-term shift in climate measured by changes in temperature, precipitation, wind and other indicators, and should be considered in having an impact on our ecosystems. Ocean and freshwater habitats for Atlantic salmon have been affected by global scale phenomena, such as climate change. It brought changes to precipitation and temperature patterns, affecting the ocean ecosystem, migration routes of salmon as well as salmon habitat quality in rivers and streams.

It is stated that

> "*In Canada, many parts of the coast have been shown to have significant sensitivity to sea-level rise and associated storm impacts. Areas with the highest sensitivity include parts of the Atlantic coast, especially in the southern Gulf of Saint Lawrence, including sections of the New Brunswick Gulf coast. In this region, sea level is already rising, with demonstrable impacts" (Environment Canada, 2006)*

3.3.1.5 Poaching and Illegal Fishing

By-catch of Atlantic salmon continues to be a common problem throughout the Cocagne River despite existing federal regulation that prohibit the retention of any

salmon caught as by-catch during commercial fishing, recreational fishing or illegal poaching.

- Commercial Fishery

  Since 1984, the Department of Fisheries and Oceans states that any Atlantic salmon caught in the Maritime Provinces by by-catch in fisheries directed to other species must be returned to the water. (DFO and MRNF, 2009). Even with modified gear (prohibition of gill nets), it is evident that some fisheries still catch salmon accidentally.

- Recreational Fishery

  Since 1998, legislative authority under the Fisheries Act sanctioned by Fisheries and Oceans Canada, closed all of Southeastern New Brunswick, including the Cocagne River for Atlantic salmon fishery. Since then, no retention of Atlantic salmon has been allowed but the by-catch from other recreational fisheries such as Brook trout could have a small impact on the salmon population. The type of fishing gear used (ex. barbed hook) and improper handling of salmon caught could have an impact, especially during black salmon and smolts runs in spring and early summer.

- Poaching

  Poaching has the greatest potential of illegally catching adult salmon but also holds the greatest potential for disturbing the habitat with the methods used. Poaching occurs in both marine and freshwater habitats and the intensity varies throughout the regions and years. The methods vary from gigging, and gill nets used to sweep pools.

4 Vision for a Stewardship Plan for the Cocagne River

4.1 Objectives.

The main objective of this project will be to engage the SAA and other partners in developing a stewardship plan to protect and restore the Atlantic salmon habitat in the Cocagne River. The plan will include recommendations on high priority areas where specific actions will be identified to facilitate future habitat stewardship projects for the Atlantic salmon. Afterwards, the actions will become key elements that will be elaborated in the stewardship plan. It will include recommendations on how the specific actions will be brought forward. Communication strategies, landowner enrolment, details on actions (ex. permits, labor), timeline and financial acquisitions required are some of the key subjects developed.

Through years of experience, the SAA has realized that for a project to be well delivered and to move forward quickly, adequate sources of support are needed. Undertaking a watershed project takes a great deal of preparation and time to complete properly and effectively.

4.1.1 Input from Focus Group Meeting-Identifying issues of local concern

On January 27th 2014, the SAA organized an afternoon of discussion on Atlantic salmon in the Cocagne River. 12 people participated to the event. The list of participants and notes from discussions can be found in the Annexe A. Here are some of major points concerns and comments discussed during this event.

- There is no (or very scarce) data available on the salmon population of the Cocagne River.
- Not enough cooperation from DFO and First Nations with community groups.
- Water levels seem to be diminishing.
- Poaching is still an important problem for Atlantic salmon.

- Improper forestry operations could affect Atlantic salmon, but overall, the Cocagne River seems to have good habitat.

4.2 Goals

The primary goals of this project will be to engage the SAA and other partners in utilizing this stewardship plan to develop projects to protect and restore the Atlantic salmon habitat in the Cocagne River. Based on the knowledge gathered, 4 sites (sections of the Cocagne watershed) have been identified and actions have been developed to help elaborate future stewardship projects.

4.2.1 Sites to be restored and protected in the Cocagne Watershed

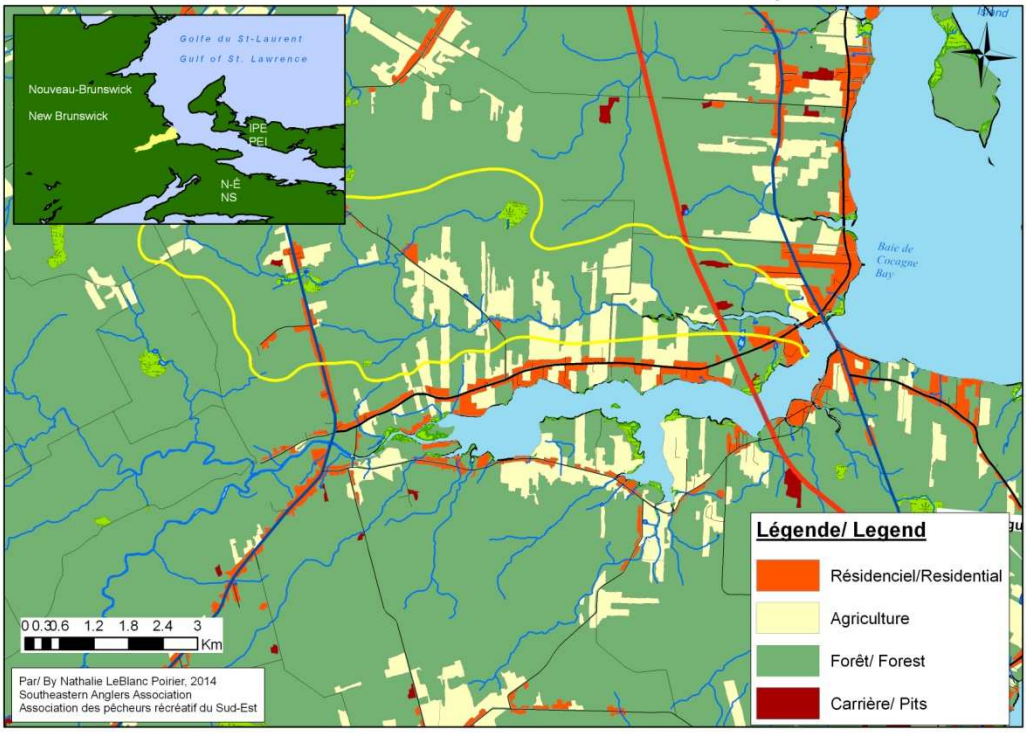
Based on the knowledge gathered, here are the 4 sites identified. Concerns and action items have been identified for each site to help protect or restore the Atlantic salmon and their habitat in the Cocagne River. Details on specific stewardship actions identified and how progress will be evaluated will be described in the following sections of this plan.

4.2.2 Murray Brook

4.2.2.1 Location

The head waters of Murray brook are found in a marsh along route 115 between the villages of Saint-Antoine and Notre-Dame and empties into the Cocagne estuary on route 535 which makes it approximately 10 km long.

Utilisation du territoire - Ruisseau Murray
Murray Brook - Land use



4.2.2.2 Land use and surrounding landowners

The majority of the Murray brook is bordered by agricultural lands (active and inactive fields, pastures, hay lands, and orchards). There are a few forested areas, but these are scarce and fragmented. There are not many residences close the brook except where it crosses route 115 and Murray road. There is a quarry located on the Saint-Martin-de-Kent road. This open pit is causing important sedimentation issues since its owners have hit an underground freshwater source while digging a trench to drain the quarry. The trench now brings a large quantity of sediments into Murray brook.

4.2.2.3 Human impact

The main risks of disturbance to the watercourse could be attributed to inappropriate agricultural practices and improper management of quarries. There are also numerous water impoundment structures on Murray brook. Some culverts found along the brook are improperly designed and/or installed and cause problems to fish passage and sediment movements.

4.2.2.4 Water quality

There is 1 station that was monitored for the Water Classification Program (WCP) from 2001 to 2013 on Murray brook. This site is located roughly 20 m downstream from the culvert on the Saint-Martin-de-Kent road.

4.2.2.4.1 Bacteriological parameters

E coli was recorded at this site monthly in 2001 and 2007-2012 for the WCP. *E. coli* was high for this site as majority of samples were over 200 MPN/100 ml which is the threshold for healthy aquatic life. In 2010, July and August values of 2300 MPN/100 ml were recorded.

4.2.2.4.2 Chemical and Physical parameters

Water temperature was monitored once a month between July and October from 2000-2012 for the WCP. Water temperature never exceeded 23^{o}C (the threshold temperature for Atlantic salmon survival). The highest water temperature recorded was July 2001 and was just a little over 20 ^{o}C.

Dissolved oxygen was also monitored monthly from 2001 to 2012 (except in 2003 and 2007). The majority of DO levels remained over 7 mg/L, which is the recommended threshold for aquatic life. In 2006 and 2008, the July and August sampled showed low DO values that could adversely affect salmon

pH values at this site were recorded in 2001, 2007 (July only), 2008 (August only), 2009 and 2012. Almost all samples exceeded a pH of 7.00, the average pH being just a little under 8.00.

Conductivity was measured from 2001 to 2012 (except in 2003). In 2001, conductivity was on average approximately 200 µs for the summer and decreased gradually to 120 µs in 2009. After 2009, the average conductivity increased gradually to reach an approximate average of 200 µs in 2011 and 2012.

4.2.2.4.3 .Granulometry

A grain size study was conducted in Murray brook at the water quality site located roughly 20m downstream from the culvert on the Saint-Martin-de-Kent road. The granulometry analysis showed that the three samples taken constituted of 14.93%, 12.06% and 16.44% fine sediments (under 2 mm). It is recommended that fine sediments of less than 2mm make up less than 20-30% of the total substrate for salmon reproduction.

4.2.2.5 Habitat quality

Changes in water quality and habitat quality were evaluated with an invertebrate study on Murray brook in 2003, 2004, 2005, 2008 and 2010. The protocol used for the study is the Rapid Assessment developed by the NB Dept of Environment and Local Government and Eastern Charlotte Waterways. This study can detect changes in habitat water quality by using various indexes calculated by using invertebrate abundance and diversity.

On Murray brook this study revealed that indicator taxa abundance and diversity remained stable through the years indicating that water and habitat quality had remained unchanged.

4.2.2.6 Concerns and stewardship actions of the site

Concerns	***Actions***

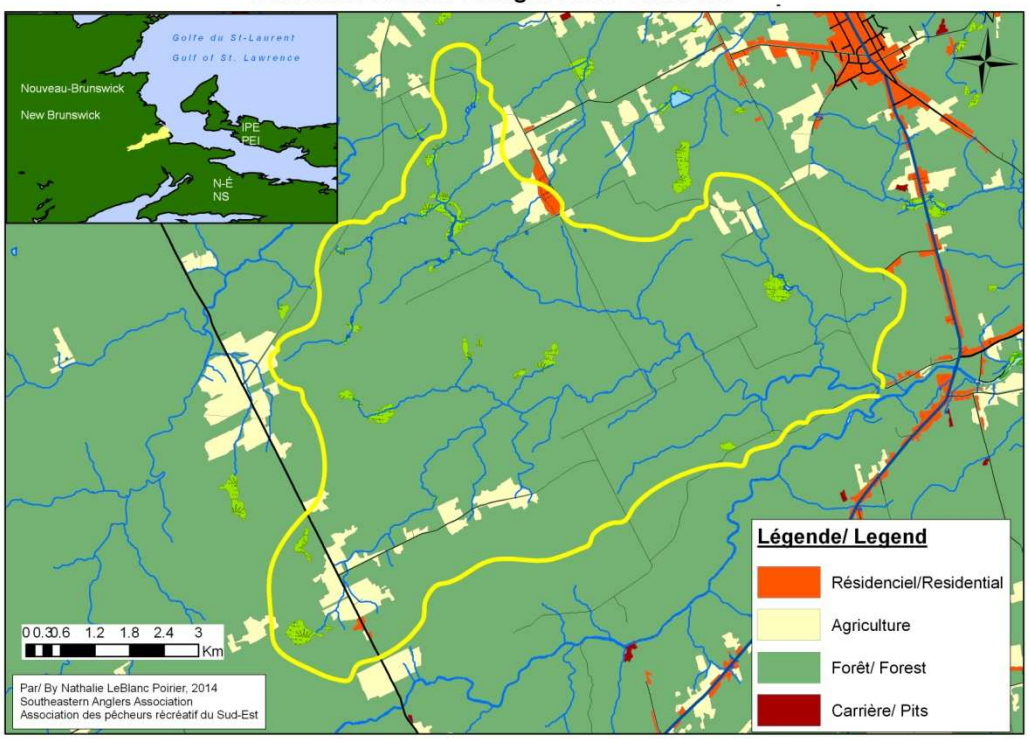
Urbanization: Residential development near the river	-Promoting Best Management Practices (BMP'S) for urban developments -Habitat restoration projects: Riparian zone, tree planting, instream structures -Outreach and Education
Damages caused by poor agricultural practices	-Promoting BMP's for agricultural operations -Habitat restoration projects: Riparian zone, tree planting, instream structures -Outreach and Education
Influence of quarries located near watercourse (siltation)	-Promoting Best Management Practices (BMP'S): - Habitat restoration projects: Riparian zone, tree planting, instream structures -Outreach and Education
Improper/Inefficient culverts	-Work with Government officials to change culverts -Address and solve problem by using modern restoration techniques (ex. Baffles or water retention wall to ameliorate fish passage)

4.2.3 Northwest branch

4.2.3.1 Location

The Northwest Branch of the Cocagne River is approximately 15 km long. Its headwaters are located close to Gladeside on route 490. An important tributary, Meadow brook, joins the Northwest Branch of the Cocagne River in Alexandrina. Meadow brook is approximately 7 km long and its headwaters are located in Saint-Damien.

Utilisation du territoire - Branche Nord-ouest de la rivière Cocagne
Northwest Branch Cocagne River- Land use



4.2.3.2 Land use and surrounding landowners

The Northwest Branch of the Cocagne River and Meadow brook are located in heavily forested areas where there is intensive logging activity, mostly conducted by private companies. There are only a few residences and fields in proximity of the watercourse in Gladeside on route 490 and in Saint-Damien.

4.2.3.3 Human impact

Forestry practices have the potential to adversely impact the Northwest Branch of the Cocagne River. Also, numerous secondary dirt roads that are used by logging

companies are found within this area. The poor maintenance of these dirt roads is the cause of large sediment inputs during rain events. These rivers are also heavily impacted by numerous fording sites found along ATV and logging trails.

4.2.3.4 Water quality

One site is monitored on the Northwest Branch of the Cocagne River for the WCP. The site is located at the end of Alexandrina road which is located close to the town of Notre-Dame.

4.2.3.4.1 Bacteriological parameters

Testing from the WCP in 2000, 2001, and 2008-2012 has shown that levels of *E coli* were in majority under the recommended threshold of 200 MPN/100 ml. However certain samples, especially in August, had values higher than 200 MPN/100 ml, and the 2011 sample even had more than 1000 MPN/100 ml.

4.2.3.4.2 Chemical and physical parameters

Water temperature was monitored monthly from 2000 to 2012 (except in 2002, 2003 and 2007). The temperature at this site never exceeded 23^{o}C, the average for the month of July and August being approximately 19 and 17 ^{o}C, respectively.

DO was also monitored monthly for the WCP from 2000-2012 (except in 2002, 2003, 2006 and 2007). Almost all samples taken had DO levels over 7 mg/L which is the recommended threshold for aquatic life, except two samples taken in July and August of 2008. Averaging across years, the average DO levels for September would be around 9 mg/L.

pH measurements were recorded from 2000 to 2001, 2008 to 2009 and in 2012. The majority of measurements were between 7.00 and 8.00 which is acceptable for the Atlantic salmon. Two samples taken in July and August of 2008 had pH values of 6.4 and 6.2, respectively.

Conductivity from 2000 to 2001 and from 2004 to 2005 was stable with values ranging between 80 µs and 140 µs on average across all months. In 2008, the conductivity was on average approximately 50 µs and follows a gradual increasing trend until 2012 where it averages more than 120 µs for the whole summer. It seems that

something has been increasing the conductivity of the Northwest Branch of the Cocagne River in recent years.

4.2.3.5 Granulometry

A study was conducted in 1996 at two sites on the Northwest Branch of the Cocagne River using modified Whitlock-Vibert boxes to assess substrate composition. The results indicated that the proportion of fine sediment smaller than 2mm of these two sites were 8.9% and 2.5%, which is adequate for Atlantic salmon reproduction. However, since these results were obtained almost 20 years ago, we suggest that the substrate composition at this site should be reevaluated in the near future using the same techniques as the ones used in recent years.

4.2.3.6 Habitat quality

To assess water and habitat quality, freshwater macroinvertebrates were sampled following Environment Canada's Canadian Aquatic Biomonitoring Network (CABIN) procedure. This program will help us detect changes in water and habitat quality by examining the composition of the communities of various aquatic insects and biological indicators. This study revealed that indicator taxa abundance and diversity remained stable through the years indicating that water and habitat quality had remained unchanged.

4.2.3.7 Concerns and stewardship actions of the site

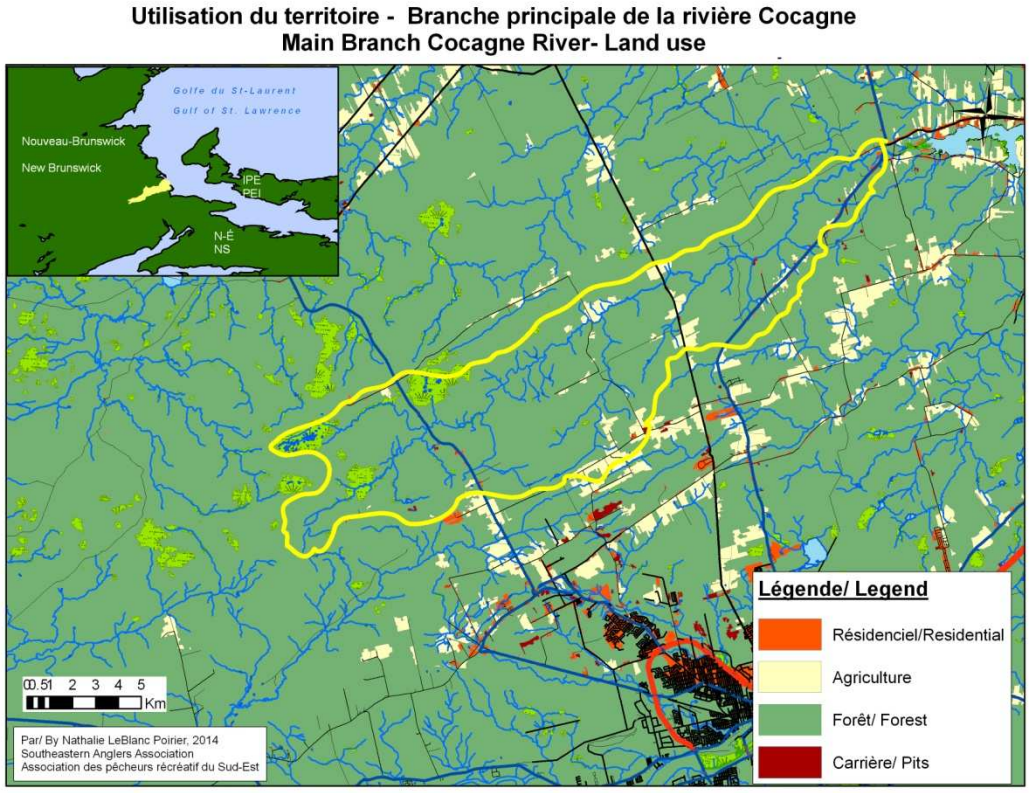
Concerns	***Actions***
ATV fording sites	-Establish partnerships with the ATV clubs -Promoting BMP's to ATV clubs -Habitat restoration work: bank and channel stabilization with rocks. -Outreach and Education
Secondary roads infrastructure	-Establish partnerships with the Provincial government to mitigate unpaved road erosion problems -Promoting BMP's relating to transportation and roads to government and private sector (forestry companies) -Habitat restoration projects: Riparian zone enhancement, check dams construction, or sediment traps to reduce sediment inputs.

Damages caused by mismanaged forestry practices (siltation and poor buffer zone)	-Promoting Best Management Practices (BMP'S): Forestry -Habitat restoration projects: Riparian zone, tree planting, instream structures -Outreach and Education
Other	Protection of Pristine areas

4.2.4 Main Cocagne River

4.2.4.1 Location

The main Cocagne River is approximately 43 km long. Its headwaters are found in the Gallagher Ridge region and origin from the Canaan bog.



4.2.4.2 Land use and surrounding landowners

The Main Cocagne River can be divided into three sections with different types and intensity of land use. First, there is the residential section found between Route 535 and 115. Most of the residents and agricultural operations are found within this section and these account for a large proportion of the land use found on both the North and South side of the river. Two rural communities are found within this section, namely Cocagne and Notre-Dame

The second section is found between route 115 and 490. There are very few residences in this section and no agricultural operations to the best of our knowledge. There are intensive forestry activities along the river in this section. Aerial pictures reveal that there are very few parcels of forest along the river in this section that have never been harvested. Adequate buffer zones seem to have been kept in most harvested plots.

The third section is located between route 490 and the bog where the headwaters of the Main Cocagne River are found, approximately 4 km west of route 126 in Gallagher Ridge. The great majority of this section is composed of natural forests and pristine riparian habitats. There a very few habitations found along the river in this section and there is only one active farm, which ranches cattle, located on Victoria road. Aerial pictures reveal that there are a few plots in which forestry operations have been conducted.

4.2.4.3 Human impact

Forestry operations could have the biggest impact on this section, although this latter would probably be relatively small. Although the Main Cocagne River has very few parcels with forestry operations, aerial pictures reveal that some of its tributaries have had recent logging activity near them.

4.2.4.4 Water quality

Three water quality sites monitored for the WCP in 2001 are found along the Main Cocagne River. Station 1 is located on route 115 off of Poirier Office road. Station 2 is located on route 490, and station 3 is located close to the headwaters on route 126.

4.2.4.4.1 Bacteriological parameters

Station 1 was monitored for *E. coli* from 2007 to 2012. *E. coli* generally stayed under the recommended 200 MPN/100 ml except for July and August of 2010 and 2011 where values as high as 1900 MPN/100 ml were detected.

Station 2 was monitored for *E. coli* from 2000 to 2001 and from 2007 to 2012. In 2000 and 2001 *E. coli* reading exceeded 200 MPN/100 ml in August of 2000 and in July, August September and October of 2001. The years 2007-2012 followed the same trend as Station 1 with August of 2010 and 2011 showing values as high as 2400 MPN/100 ml.

Station 3 was monitored the same years as station 2. Levels of 1200 MPN/100 ml were detected in July of 2001. Afterwards this station followed the same trend as the two others although the values were not as high. 2011 had the highest *E. coli* reading with approximately 520 MPN/100 ml.

4.2.4.4.2 Chemical and Physical parameter

Water temperature was monitored from 2004 to 2012 at station 1, from 2000 to 2012 (except 2002 and 2003) at station 2, and from 2000 to 2012 (except 2002-2007) at station 3. Water temperature at station 1 was almost always under 23^{o}C except for two occasions in July 2004 and 2008. The same trend was observed at the two other stations. Water temperature seems to be adequate for Atlantic salmon the majority of the time in the Main Branch of the Cocagne River.

DO was monitored from 2004 to 2012 (except 2003) at station 1, from 2000 to 2012 (except 2002, 2003 and 2007) at station 2 and from 2000 to 2012 (except 2002-2007) at station 3. All stations had DO levels under the recommended 7 mg/L in the months of July and August in 2008. This could be caused by the high water temperatures obsevered that year since DO levels in water are inversely correlated with water temperature. Station 1 was also just under the recommended over 7 mg/L in August of 2006. Station 2 followed the same trend but also had low DO levels in September of that same year. Station 3 had levels lower than 7 mg/L in July of 2001, 2008 and 2010.

pH was measured between 2006 and 2012 (except in 2010 and 2011) at station 1, in 2000, 2001, 2009 and 2012 at station 2 and 3. Station 1 and 2 had pH readings mostly around 7.00 which is adequate for the Atlantic salmon. Station 3, which is closer to the headwaters, had on average, slightly more acidic waters.

Conductivity was assessed from 2004-2012 at station 1, from 2000-2012 (except 2002 and 2003) at station 2 and from 2000-2001 and 2008-2012 at station 3. At all stations for all years and months, the conductivity was relatively low with an average of 60-70 µs and highest values (only recorded in June and July of 2011) of close to 120 µs.

4.2.4.4.3 Granulometry

Only station 1 has been assessed for substrate composition. This assessment was conducted in 2005. The three samples taken at this site showed 7.42%, 3.51% and 7.10% of fine sediments under 2 mm. Substrate compositions at this site seems to be adequate for the Atlantic salmon.

4.2.4.5 Habitat quality

Freshwater invertebrate studies have been conducted in Station 1 and 3 in 2003, 2004, 2005, 2008 and 2010. The protocol used for the study is the Rapid Assessment developed by the NB Dept of Environment and Local Government and Eastern Charlotte Waterways. This study revealed that indicator taxa abundance and diversity remained stable through the years indicating that water and habitat quality had remained unchanged.

4.2.4.6 Concerns and stewardship actions of the site

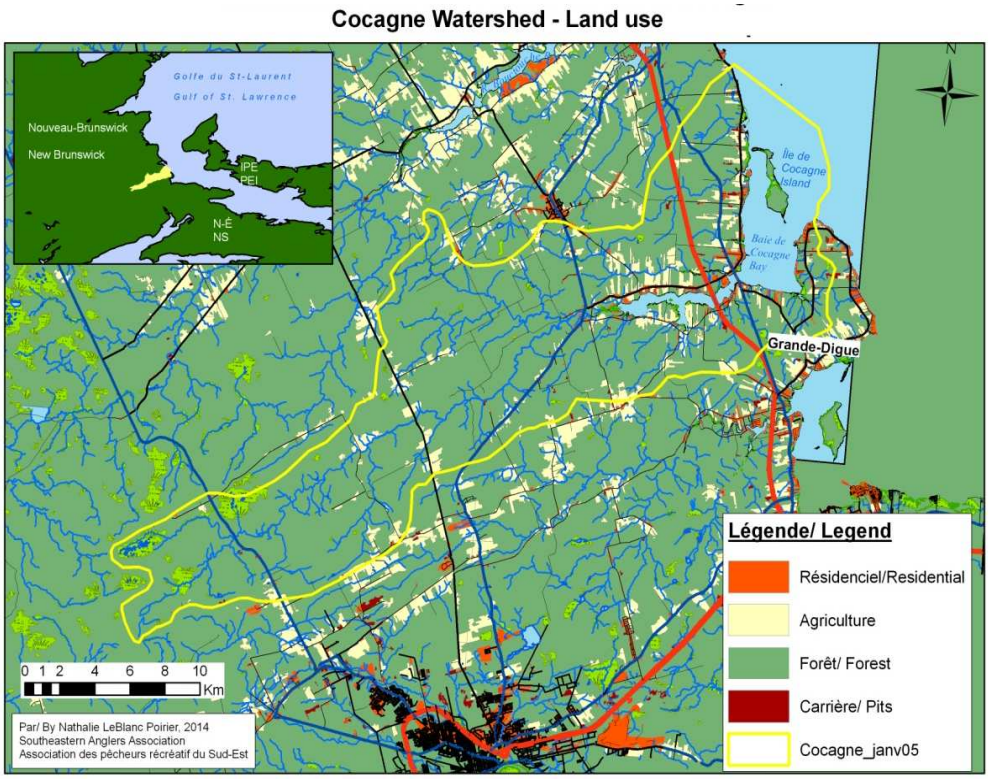
Concerns	***Actions***
Agriculture practices (Cattle access, poor buffer zone and contamination from fields)	-Promoting (BMP'S): Agriculture -Outreach and Education
Damages caused poor mismanaged forestry practices	-Promoting Best Management Practices (BMP'S): Forestry -Habitat restoration projects: Riparian zone, tree planting, instream structures -Outreach and Education

4.2.5 Entire Cocagne Watershed

4.2.5.1 Location

The Cocagne River is located in Kent County, Southeastern New Brunswick. All waters from the Cocagne flow into the Northumberland Strait drainage, which is part of the Gulf of Saint Lawrence's bigger ecosystem. The Cocagne watershed is situated in the coastal plain of the lowlands of the eastern New Brunswick, where the slope of the land towards the sea is easy and not very noticed. The Cocagne watershed presents altitudes varying from 0m to 150m above sea-level.

The Cocagne watershed covers a surface of approximately 400 km² (Gauvin *et al.*, 2009). The headwaters of the Cocagne River are found in the Gallagher Ridge region and origin from the Canaan bog. On the North side of the river, the principal tributaries are the North Branch of the Cocagne River, Shaw, Butler, Meadow and Murray Brooks (Gauvin *et al.*, 2009). On the south side of the river, the principal tributaries consist of the des Ormeaux, Dupuis, Babineau, Cormier, François, little Goguen and Anguille river..Other smaller watersheds such as the Goguen and Howard brooks, whereas some waterways drain directly into the Northumberland Strait such as the Malcontents brook (Gauvin *et al.*, 2009).



4.2.5.2 Land use and surrounding landowners

The majority of the watershed is covered in natural, pristine forested areas especially the upper parts of the Main Cocagne and the Northwest branch.

Forestry activities are found almost throughout the whole watershed but are most predominant in the middle section where they make up for a significant proportion of total land use.

Agricultural activities are mostly found along the main branch of the Cocagne River between route 535 and 115, in the communities of Cocagne, Whites Settlement, Notre-Dame and Cocagne-Nord. There are also numerous agricultural activities along the coastline in the communities of Côte-d'Or, Breau-village, Cormierville and Bar-de Cocagne and all along the Murray brook.

Important residential areas include the town of Cocagne, Notre-Dame and the outcrops of the town of Saint-Antoine. The Town of Cocagne is located near the estuary and the town of Notre-dame is located in the section of the Main Cocagne River.

4.2.5.3 Water quality

There are 6 water quality sites that are presently monitored for the WCP in the Cocagne River watershed by the SAA. Results and details concerning water quality assessments can be found in various reports from the SAA and KWC.

4.2.5.4 Bacteriological parameters

Across all years and months all sites showed as much acceptable levels of E. coli as non acceptable levels (over threshold of 200 MPN/100 ml). During July and August of 2010, all sites had very high levels *E.coli*, even reaching 2400 MPN/100 ml in Murray brook. During those two months, the data shows that the further the sites were from the headwaters, the more *E. coli* they had. As this seems to be a onetime event, it could be related to climatological factors such as increased frequency of rain events during that year other than direct anthropological factors. This would also explain why this spike in *E. coli* has been detected all over the watershed.

4.2.5.4.1 Chemical and Physical parameters

The water temperature was below 23°C for the great majority of samples. Murray brook has the coldest waters, averaging around 17 °C in July, and never exceeded 23°C. The Northwest Branch also never exceeded 23°C. Its average water temperature in July would be close to 20°C. All other sites exceeded 23°C in July of 2004 and 2008. In general, the rivers of the Cocagne watershed have water which is at an acceptable temperature for the Atlantic salmon.

In general all sites show good oxygenation of the water with the great majority of DO samples being 7 mg/L. However, all sites also showed levels of DO lower than7 mg/L in August and September of 2006 and July and August of 2008. This could be related to air and water temperature since DO in water is inversely related to water temperature.

4.2.5.4.2 Granulometry

Fine sediments of less than 2mm in diameter can be detrimental to salmon health and reproduction if these represent more than 20% of substrate composition. In the Cocagne watersheds, none of the sites sampled for granulometric analysis showed proportions of fine sediments of less than 2mm higher than 20%. The substrate composition of the Cocagne River therefore seems adequate for Atlantic salmon health and reproduction. Therefore, efforts should be taken to preserve the river in this way. Sedimentation caused by agricultural, forestry or other anthropogenic sources should be assessed further and mitigation actions should be developed and carried out.

4.2.5.5 Habitat quality

The assessment of habitat and water quality through indicator taxa suggested that for all sites habitat and water quality remained stable through the years.

Concerns and stewardship actions of the site

Concerns	***Actions***
Agriculture practices (Cattle access, poor buffer zone and contamination from fields)	-Promoting BMP's: for agricultural operations -Outreach and Education -Restoration of riparian areas/banks
Damages caused by mismanaged forestry practices (siltation and	-Promoting BMP's: for forestry operations

poor buffer zone)	-Habitat restoration projects: Riparian zone amelioration, in-stream structures, sediment trapping -Outreach and Education
Urbanization **(Town of Cocagne and Notre-Dame Future development and municipal waste treatment)**	-Promoting BMP's for Urbanization, Contact and work with municipal government, planning commissions and landowners -Outreach and Education
Roads infrastructure	-Establish partnerships with the Provincial government to mitigate unpaved road erosion problems -Promoting BMP's relating to transportation and roads to government and private sector (forestry companies) -Habitat restoration projects: Riparian zone enhancement, check dams construction, or sediment traps to reduce sediment inputs.
Fording sites	-Establish partnerships with the ATV clubs -Promoting BMP's to ATV clubs -Habitat restoration work: bank and channel stabilization with rocks. -Outreach and Education
Low abundance of adult and juvenile Atlantic salmon	-Broodstocking with Cocagne River strain. -Promoting best angling practices -Identify and protect important salmon habitat
Few natural areas protected	Protect pristine areas such as large parcels of undeveloped land.

4.3 Details on Specific Stewardship Actions

Restoration and protection tools

The SAA has always chosen a holistic approach to preserve, protect and enhance any recreational fishing species such as the Atlantic salmon and their habitat by monitoring and protecting whole watersheds. Aquatic habitat conservation issues are often surrounded by a complex combination of economic development and land use activities, and are not always easily resolved.

The SAA will undertake steps to complete the preparation of a few actions proposed per year. Writing proposals, talking to landowners, enrolling volunteers, training staff appropriately for the projects, gathering materials, applying for required permits, promotion, education and then actually doing the groundwork will be some of the tasks at hand. If funding is approved for the projects, the SAA has always employed a project coordinator and the appropriate staff. The projects moves faster and better if good coordination is in place.

Our ultimate goal is to promote actions that will protect pristine areas and to conduct and support activities that will create healthier and more environmentally, socially and economically viable ecosystems for the surrounding communities. In the following paragraphs we will elaborate on the actions identified to reach this goal.

4.3.1 Protect Pristine Areas

Protected areas have long been known as one of the most effective tools for the preservation of natural capital, its biodiversity and the complex interactions amongst the elements of all ecosystems. Sufficient high-quality habitat is of utmost importance for the survival of all fish and wildlife populations, and essential for the maintenance of ecosystems on which all beings depend for their survival. As New Brunswickers and Canadians, we have a profound attachment to the wilderness, which is rooted in our collective history and heritage. This aspect has been an important driving force behind the creation of the SAA in 1993.

There are many tools and programs to protect pristine areas. These range from ownership and management of various types of formal protected areas by organisations

such as Nature Conservancy of Canada to the negotiation of voluntary agreements with private landowners such as restrictive covenants.

These pristine areas would primarily be created for the purpose of conservation. Management activities may include interventions such as habitat restoration and investigative research projects on habitat species status.

These types of actions will mainly require staff, volunteers and stakeholders for their elaboration. Writing funding proposal, talking to land owners, enrolling volunteers, promotion, education and legal advice could be some of the tasks necessary before signing purchases or obtaining landowner easements. Financial requirements will be project dependent. Coordination, legal advice and land purchasing could become cost associated with the project but will be out valued by the volunteer time given, the easements and agreements created, and the ecological value of the areas protected.

Here are some of the steps that could be followed:

1-Site identification and selection

The establishment of a protected pristine area begins with the identification and selection of a parcel of land that is minimally affected by anthropogenic activities and of ecological importance to important species such as the Atlantic salmon. This process would involve the creation of partnerships with other non-profit organizations, governments, Aboriginal people, landowners and stakeholders that have an interest in the areas chosen for protection.

2-Feasibility assessments

The second step would be to conduct a series of feasibility assessments. These include an ecosystem assessment and a strategic environmental assessment to evaluate the environmental condition of the candidate site and the impact that its protection would have on the environment. In addition, public and stakeholder consultations would be conducted to determine the feasibility of turning a candidate site into a protected pristine area. The results of these ecological, social and economic assessments will help determine the boundaries and the various options available for protection, and develop the agreement with the landowners..

3-Securement and agreement

Once a candidate site is selected, the type of protected area will determine the tools available for securing land and waters. For example, the Nature Conservancy of Canada, can secure parcels of land through purchase, donation or transfer. Individual landowners can secure parcels of land by agreement, easement, or transfer. Legal advice will be important during this step to protect the pristine areas identified.

4.3.2 Promoting Best Management Practices (BMP's)

Any projects should start by encouraging and educating landowners and decision makers on the values of applying best management practices to all of their land use projects. The best remediation option for numerous non-point source pollution problems is to promote BMP's. Landowners and decision makers applying BMP's will help re-establish the hydrology of nearby watercourses, and consequently their health.

The ultimate goal of promoting BMP's is to get all concerned parties (stakeholders) to work cooperatively in choosing practices that are more environmentally sound for the health of the watershed. Partnership agreements and funding from other programs will be required to continue promoting BMP's and accomplish restoration projects. A 10% financial requirement should be allocated for the promotion of BMP's in every project.

The following paragraphs will describe BMP's for each land use activity and how actions could be taken on.

4.3.2.1 Agriculture

Poor agricultural practices are one of the largest land use problem contributing to habitat and water quality issues in the Cocagne River. The SAA has worked in the past with local farmers and the Department of Fisheries, Agriculture and Aquaculture of NB to promote BMP's to farmers and has conducted extensive restoration projects. Through great partnerships and funding opportunities many issues have been resolved. There is still a will from local farmers to participate in efforts that favor the environmental health

of our watershed, but financial restrains and developing proper partnerships with governing authorities are still important obstacles.

Here is a list of BMP's that can be applied in the agricultural sector;

- Agricultural management practices
    - Nutrient management
    - Integrated pest management
    - Proper pesticide use
    - Develop an irrigation water management plan
    - Organic production
- Vegetation and tillage practices
    - Reduced soil erosion from rainwater and wind by slowing the velocity of runoff water, increasing infiltration and establishing vegetation and tree cover in and around fields.
    - Commonly used practices include conservation tillage, contour farming, strip cropping, filter strips, field borders, cover crops, crop rotation, crop row orientation, windbreak installation and pasture management.
- Structural practices
    - Agricultural waste management system
    - Runoff management system, wetland development
    - Terraces, water and sediment control basins or diversions
    - Livestock exclusions (fencing)
    - Grade stabilization structures
    - Grassed waterways
    - Stream bank protection

4.3.2.2 Forestry

Forestry is still viable economically for the area. Logging activities mostly creates issues during heavy periods of rain which contributes to habitat and water quality degradation in the Cocagne River. Partnerships with landowners, private companies local woodlot Marketing boards and the Department of Natural resources NB should be

established. New funding programs should be found to continue promoting BMP's and to accomplish restoration projects that relate to forestry issues.

Here is a list of BMP's that can be applied in the forestry sector;

- Road construction and Maintenance
    - Erosion and sediment controls
    - Skid trail maintenance
    - Access road maintenance
    - Erosion controls on landings
    - Stream crossing erosion control
    - Filter strip sediment control
- Harvesting
    - Selective cutting instead of clear cutting
    - Riparian zone protection
    - Adequate buffer zones along waterways
- Reforestation
    - Mechanical site preparation
    - Seedling plantation
- Pesticide use
    - Reduce pesticide use
    - Opt for organic pesticides

4.3.2.3 Urban development and recreational activities

Numerous permanent and seasonal residences compose several little communities and two municipalities in the Cocagne River watershed. With commuting distance in some areas, less than 30 minutes from Moncton smaller communities have began to expand in the last decade. . The SAA should continue promoting BMP's that relate to urbanization and be more involved with projects regarding urban development planification. Partnerships with landowners, local service district, municipalities and the Kent planning commission should be established.

- Here is a list of BMP's that can be applied in the urbanization and recreational activities sectors;

Road construction and Maintenance

- Erosion and sediment controls
- Access roads maintenance
- Erosion controls on landings
- Stream crossing erosion control
- Filter strip sediment control
- Street and roads cleaning

Recreational activities

- Maintenance for ATV's trails
- Reduce sediment inputs from secondary roads
- Reduce the number of ATV stream crossings
- Ameliorating stream crossing (ex. Installing a rocks path in the stream)

- Suburb and sub-division developments
  - Minimizing directly connected impervious areas
  - Promote urban forestry
  - Detention and retention ponds
  - Porous pavement
  - Vegetative filter swales and strips
  - Manage storm water runoff during heavy rainfall events.

- Waste water (septic systems and municipalities infrastructure)
  - Proper facilities
  - Promote good housekeeping practices
  - Illicit discharge detection and elimination

4.3.3 Promoting best angling practices

The by-catch from other recreational fisheries such as Brook trout could have a small impact on the Atlantic salmon population. Promotion and education strategies should be taken to support BMP's for recreational fishing. The type of fishing gear used (ex. barbed hooks) and improper handling of fish especially during black salmon and

smolt runs in the spring and early summer could have a negative impact on Atlantic salmon populations,.

Here are a few BMP's the SAA promotes:

1. Fishing regulations

We suggest that all anglers should inform themselves about the specific regulations in place in the area that they plan to fish. In many cases rules can even vary within the same river. The regulations on the species allowed to be caught, the bag limits, and the retention sizes are all subject to changes each season.

2. Practice catch and release

Give the fish a chance to live. Use techniques supported by catch-and-release adepts, such as using a circle hooks which is less likely not to get into the fish's gut or gills and improves its chances of survival upon release. The use of barbless hooks is also recommended when practicing catch and release.

3. Consider when to fish

What's the water temperature like? This is especially important when fishing for coldwater species like trout and salmon. These species have a decreased chance of survival after being released when the water becomes warm because warm water contains less dissolved oxygen than cold water. When water temperatures are high, consider other fishing opportunities that will have less impact on Atlantic salmon.

4. Choose tackle wisely

Choose the right size hooks and line strength for the fish species you are going to target. If you intend to release your fish, remember that fish caught on flies or lures with single barbless hooks have the best chance of surviving. Replace treble hooks with single barbless hooks. If you're fishing with bait, get rid of your conventional hooks and start using circle and barbless hooks. If you decide to fish with bait and conventional hooks, set the hook quickly to avoid deep-hooking fish. Deeply hooked fishes have a good chance of fatality because of internal organs tearing while you are landing them.

5: Pack out everything you pack in

The point is, be particular about bagging all your detritus and bringing it home with you for recycling and composting, if possible. If you're really committed to protecting the environment, pick-up somebody else's trash as well.

4.3.4 Habitat restoration projects

Poor physical habitat quality has been caused by multiple factors that were discussed in the paragraphs above. .Past habitat assessments revealed numerous issues in the watershed that can often be attributed to poor land use and riparian zone degradation. The SAA could use numerous restoration techniques or a combination of techniques to deal with riparian and aquatic habitat issues. The first step would be to address land use problems by promoting best management practices. The second would be to design and build habitat restoration structures that help improve the ecological recovery of Atlantic salmon habitat.

More extensive planning will be involved if habitat restoration projects are undertaken by the SAA. Writing funding proposals, talking to landowners, enrolling volunteers, training staff appropriately for the project, gathering materials, applying for required permits, project promotion, education and carrying out the restoration work could be some of the tasks at hand. Financial requirements will be project-dependant. Some projects could require thousands to hundreds of thousands of dollars depending on staff, materials and heavy machinery requirements.

Here are some of the proposed projects that the SAA could undertake in the future to ameliorate Atlantic salmon habitat in the Cocagne River.

4.3.4.1 Livestock fencing

The first step of a restoration project is to identify and get rid of the source of the problem. Where cattle cause problems in streams, the restoration project will first require to exclude the livestock from the riparian zone. The SAA has worked on projects that teach and demonstrate the importance of the riparian area for good water quality and fish habitat. Thanks to several financial sources, 11 local farmers, and the help of volunteers, we have been able to restore over 20 km of riparian zone along the rivers of the region. Today, we are proud to re-visit the restored sites and discover healthy habitats supporting a rich diversity of organisms. The SAA should continue promoting the exclusion of

livestock from nearby streams because it generates important benefits for the health of the habitat.

Benefits of livestock fencing

1. *Increased bank and stream channel stability*
2. *improved water quality*
3. *improved herd health*
4. *Reduced of sediment, E. coli and nutrients inputs into the streams.*

Stabilized fording sites

Watering livestock at rivers is often the only practical option for producers who sometimes need to cross waterways themselves with their farm equipment. Providing safe watering areas, and crossings for livestock and farm equipment all the while reducing their negative impact on water and habitat quality effects is a critical task.. In the past, the SAA has stabilized fording sites at both watering locations for livestock as well as crossings for farm equipment. To stabilize a fording site, the approaches to the waterway must be properly aligned and hardened with rocks, and the stream bottom is stabilized with hard rock to prevent erosion and rutting (Cormier, 2008; Harris *et al*., 2012).

Benefits of stabilized fording sites:

1. *Reduced stream bank erosion*
2. *Improved herd health*
3. *Improved aquatic habitat availability*
4. *Reduced risk of stream contamination from faulty equipment or from equipment becoming stuck in a stream*

4.3.4.2 <u>Bank Stabilization</u>

Bank stabilization is used to raise a severely or moderately eroding stream bank that is lacking riparian zone vegetation. Several techniques can be used to stabilize banks, to reduce erosion and prevent sediment and nutrients from being introduced into a watercourse. Techniques such as Back sloping, Rock armoring and Crib walls are some successful techniques used by other groups in the Province of New Brunswick. More recently, Bioengineering has become an acceptable and successful technique for river restoration. Bioengineering is the use of living materials and ecologically designed concepts to restore or enhance a degraded section of a stream or a riparian zone.

Willow is a key tree species used in Bioengineering efforts by the other groups. This pliable tree grows rapidly and can be propagated from cuttings. Its root growth is thick and readily holds soil materials in place and can act as a filter, keeping fine sediments from entering into the streams. Willow is often used in bioengineering techniques such as the construction of fascines and wattles. The mature trees will provide shade to the stream and offer terrestrial habitats to other riparian dependent species. These restoration techniques and more can be found in the "Ecological restoration of degraded aquatic habitats: A watershed approach" published by Fisheries and Oceans.

Benefits of bioengineering techniques:

1. *Reduces sediment being introduced to watercourse*
2. *Enhances fish habitat*
3. *Maintains the riparian habitat*
4. *Preserves topsoil*
5. *Reduces green house gas emissions by reducing CO^2 output from bared soils*

4.3.4.3 Tree planting

Clearly the end goal of all bank stabilization efforts is the reestablishment of the natural riparian vegetative community. Not only does the riparian zone have innumerable biological roles in the aquatic community, it is nature's way of permanently stabilizing stream banks. Whenever possible, the first thing we do is plant native trees in the riparian zone. Most times, however, erosion is proceeding at such a rate that young trees do not have a chance to grow. Methods of bank stabilization should be used before to allow planted trees the opportunity to thrive enough to be able to take over the job of naturally stabilizing the bank.

Benefits of planting trees

1. *Increased site biodiversity*
2. *Stabilization of eroding stream banks through increased root mass*
3. *Decrease in sediment and nutrient transfer to streams by root absorption*
4. *Reduced run-off rate through increased site surface water retention*
5. *Moderated stream temperatures provided by increased shade cover*
6. *Increased fish cover and habitat*
7. *Increased aquatic food source through falling organic debris*
8. *Reduced carbon emissions as a result of reduction in bare topsoil and through uptake from vegetation*

4.3.4.4 Instream restoration structures: Digger logs, Rock sills and Tree deflectors

The SAA started using instream structures such as Digger logs, Rock sills and Tree deflectors in the summer of 1997. Digger logs and tree deflectors work best in small watercourses with either a sandy or silt substrate and in conjunction with a fencing/planting program to rehabilitate the riparian zone at the same time. Sites restored using these techniques now have better habitats for all life stages of the Atlantic salmon and other fish species. The SAA is still interested in continuing to apply these techniques were needed. These techniques and more can be found in the "Ecological restoration of degraded aquatic habitats: A watershed approach" published by Fisheries and Oceans.

Benefits of instream restoration structures:

1. *Increased fish habitat availability*
2. *Increased stream channel stability*
3. *Improved substrate and water conditions for fish including increased dissolved oxygen and temperature*
4. *Reduced ice jams risk*

4.3.5 Broodstocking with Cocagne River Strain

Once habitat is restored or protected, stocking with Atlantic salmon broodstock could be used to help increase the population. Brood stock management involves manipulating environmental factors to increase survival and development. Such conditioning can ensure the sustainability of a particular fish stock. This would help sustain optimum juvenile salmon stocks and meet conservation requirements.

The biggest challenge with broodstocking will be catching mature adult fish from the Cocagne River. Methodologies frequently used are: Trap nets, angler's by-catches or pool seining. Permits will be required to manipulate fish. Depending on the methodology used, it could be quite time consuming and costly. Financial requirements could range from $2,000 for anglers by-catch or pool seining to $10,000 for trap net operations. Good partnerships and volunteer time could lower these costs significantly.

4.3.6 Fish Hatchery

The SAA has used the Miramichi fish hatchery facilities in the past, for hatching and rearing Atlantic salmon broodstoock, especially for the early life stages. This program was active from 1996 to 1999 until the hatchery became privatized. This methodology has proven to be successful in the South and Main Branch of the Bouctouche River and could be applied in the Cocagne. For subsequent years, electrofishing data showed that the survival of stocking juvenile (adipose clip) was successful. Financial requirements could range from $5,000 to $10,000, depending on life stage required.

4.3.7 Salmon instream or streamside incubators

This methodology consists of baskets (various materials are presently used) that are usually buried in gravel fit for spawning at selected sites in early fall. The baskets are then filled with fertilized eggs from recently caught adult spawners immediately after fertilization and water hardening. In springtime, the fingerlings can swim out of the baskets and find suitable habitat nearby.

This methodology is presently being tested by The Friends of the Kouchibouguacis and Fundy National Park in New Brunswick. If hatching success is consistently high with these methods, their ease of installation and low cost could make them a viable alternative to stocking approaches. Financial requirements could range from $1,000 to $3,000 depending on the number of sites chosen and staff needed to rear adult fish.

4.3.8 Community Outreach

Community outreach should become an important activity of every action/project that will be undertaken. A key component of outreach programs is to provide resourceful information to all age classes of the community. The SAA should have ressources available in-house and on the Internet and be ready and able to provide face to face outreach to landowners and groups of interest. In addition to delivering services, outreach should be used as an educational tool to promote awareness of existing services and data. The Community Outreach Programs should be evaluated yearly, depending on ongoing projects, community interests and/or environmental concerns. The outreach program could consist of individual tools or be a combination of several ones. The SAA could find

volunteers, staff or communication firms to help us deliver outreach programs. A 10% financial requirement should be allocated for outreach in every project proposed for financial assistance.

Here is a list of outreach tools that we used or researched:

- Annual meeting
- Increase the number of SAA members
- Focus group discussions
- Educational and/or hands-on workshops
- Informative placements on BMP's or related information
- Informative pamphlets (previously published and new design)
- Fish friend programs in schools
- Presentations (schools, anglers, nature clubs, surrounding residents, etc.)
- Informational kiosks (local events, farmer's markets, fishing/hunting events)
- SAA Website (links to other partners)
- Facebook page
- Newsletters
- Interpretation signs/signage placed near restoration sites
- Day camp and/or fishing derby for children
- Educational games for children (done during presentations, camps, kiosks)
- Promotional tools for anglers and possibly for children (ex. Barbless hooks, thermometers, etc.) along with descriptive cards explaining why and how to use them.
- Mail-outs (surveys, educational references etc.) could be given/mailed with the newsletters

4.4 Program evaluation

Program evaluation will benefit the species and habitat that we are trying to preserve by improving our ability to monitor changes and evaluate our the success of our efforts. It will also benefit stakeholders and partners, by providing information or assist with decision-making.

Here is a list of monitoring/evaluation programs that should be considered when assessing the long term results of projects undertaken. Approximate financial requirements for each program can be found in the appendix.

4.4.1 CAMP (Community Aquatic Monitoring Program)

The Community Aquatic Monitoring Program (CAMP) offers guidance for community-based groups monitoring the health and marine productivity of their local aquatic ecosystem. Through monitoring protocols with DFO, we are maintaining a science-based approach program for assessing the health of our estuary. Scientific procedures applied to monitoring programs require that each site in the estuary be sampled multiple times each year. From May through September, community group members and staff sample 5 stations monthly in the Cocagne estuary. Aquatic organisms are captured with beach seines, identified and later released. The data collected helps monitor the health of the Cocagne estuary and consist of:

- The identification of fish and crustacean species
- The count of fish and crustaceans individuals
- General aquatic vegetation profiles,
- Water and sediment samples,
- Physical and chemical parameters (water temperature, salinity and dissolved oxygen).

With this information, scientists working with government agencies and universities can undertake nutrient analyses, organic loading assessments, and assess changes in the aquatic community structure. In return, this tool can help identify the factors negatively affecting the health of our estuaries.

More on the C.A.M.P. program can be found at the following site: http://www.glf.dfo-mpo.gc.ca/Gulf/CAMP.

4.4.2 CABIN (Canadian Aquatic Biomonitoring Network) invertebrate sampling

Biomonitoring methods are used to enhance or compliment chemical and physical water quality monitoring by using the presence, richness and abundance of organisms (invertebrates) living at the site as an indication of the ecosystems condition. Biomonitoring does not identify the cause of impairment but rather provides an assessment of ecosystem health.

For more information on the CABIN program please visit: http://ec.gc.ca/rcba-cabin/

4.4.3 Electrofishing

Electrofishing devices use electricity to stun the fish so that they can be caught to determine abundance, density, and species composition of a site. When done correctly, electrofishing results in no permanent harm to the fish, which return to their natural state in as little as two minutes after being stunned. There are two methods that can be used for elecrtofishing:

1st method: Diminishing return with open sites, which allows the calculation of different fish species densities and percent habitat saturation. All fish captured can be counted, identified and measured depending on the intent of the survey.
2nd method: Spot check, which determines the presence or absence of fish in a particular area. All fish captured can be counted, identified and measured depending on the intent of the survey.

4.4.4 Water quality

Since the year 2000, water quality has been measured almost year in the Cocagne River. The same 6 sites are visited every month, from May/June to October/November to measure physical, chemical and bacteriological parameters. The physical parameters monitored consist of water temperature,. The chemical parameters monitored consist of

dissolved oxygen, salinity, conductivity Ph, and nitrates. The bacteriological parameters monitored consist of *E.coli* counts and total coliforms.

This is a cost-effective long-term water quality-monitoring program that we are now able to apply to detect changes, positively or negatively affecting our streams in our watershed.

4.4.5 Stream surveys

Stream surveys are conducted to determine possible contamination sources that may have potential impacts on water quality. All man-made objects or alterations that are visible from the stream bank are described/noted, inspected, photographed and marked with a GPS and are considered as potential pollution sources. Examples of potential contamination sources are culverts, pipes, agricultural soils, forestry clear cuttings, septic tanks, treatment plants, garbage, dumps, any manure leaching, etc. Incoming streams, freshwater sources, sedimentation hot spots, log jams and active or inactive beaver dams are also recorded.

Through this visual survey, we are able to better understand possible factors affecting fish habitat quality and overall stream health and prepare remediation plans if needed.

4.4.6 Redd counts

Female Atlantic salmon excavate nests in gravel substrate to deposit their eggs. Once one or more males externally fertilize them, she covers these with gravel. These nests are called redds. A redd count is done by counting all visible redds observed during a spawning season in an area known to contain salmon. These numbers can then be used as an indicator of the abundance of salmon spawning in a given stream.

4.4.7 Sedi-bacs: Measuring sedimentation

This method is used to determine the amount of sediment deposited into a stream. Sedi-bacs are placed in the stream and recovered after a set period of time. The sediments collected are then rinsed-out, dried, sieved and weighed to determine the quantity of sediments and grain sizes.

This type of survey can be used to compare the normal amount of sediment deposition along a streambed compared to the amount of sediments deposited during major weather (rain) events.

Large amounts of sediment deposited onto a streambed in a short period of time can indicate problematic hot spots. These hot spots can be created from improper drainage ditch construction, lack of stream bank vegetation, poor agricultural/forestry operations, and many other anthropogenic activities. Areas with loads of fine sediments that cover larger substrate, limit the locations where the Atlantic salmon can spawn and results in a degraded fish habitat.

5 Conclusion

This stewardship plan will become the groundwork on which we will center the deliverables of future projects involving the Atlantic salmon. Completing this stewardship plan to protect and restore the Atlantic salmon habitat in the Cocagne River is the first step towards stewardship projects in the near future. This document will be an important tool that will help us prepare projects and work hand in hand with our members, landowners, local communities and partners.

The preparation of this document includes a literature review that gathers relevant information available about the Cocagne River. We have attempted to identify all the available documentary sources and knowledge available to write up this plan within such a short period of time. No field verification was attempted for this document.

This will be an on-going working document. Actions will be re-appraised every 1-3 years to monitor progress and adjust according to the results. Priorities could change yearly depending on ethics, financial resources and partnerships.

The SAA will progress with the following values and goals in mind:

- *The involvement and partnership of landowners will be the key to achieve successful outcomes.*
- *The SAA will ensure that good communication with stakeholders involve is included at all levels when ongoing enhancement efforts will be developed.*
- *The SAA will strive to keep the highest level of ongoing communication, education, and awareness within the local communities to ensure that people are involved and informed of our activities and successes.*
- *The SAA will encourage good stewardship and ensure that it is recognized and promoted to all local communities and partners.*

Our goals will be:

- *Implement and support ongoing communication, education, and awareness activities that promote good stewardship in order to protect and enhance Atlantic salmon habitat in the Cocagne River.*
- *Restore and protect fish habitat and surrounding ecosystems.*
- *Manage and maintain a viable Atlantic salmon population in the Cocagne River through strong stakeholders collaboration and devotion.*

The next step will be to review actions identified in this document and setting more concrete goals, objectives and strategies for upcoming years. Communications strategies, landowner's enrolment, details on actions (ex. permits, labor, and materials), timeline and financial acquisition required would be some of the key subjects to be developed.

We are grateful that this project was realized. Focus group participants pointed out that it is important to protect the strain of Atlantic salmon that migrate and rear in the smaller rivers flowing in the Southern Gulf of Saint Lawrence. The Cocagne River strain of Atlantic salmon does not account for a big percentage of the COSEWIC DU 12 if compare with bigger rivers such as the Miramichi but are of great value to our communities and our heritage, and the health of our aquatic ecosystems.

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Annexe A. Notes from the focus groups meeting on the future of the Atlantic salmon in the Cocagne River, held on January 27th, 2014.

Participants present: Raoul Maillet, Rhéal Robichaud, Raoul Gaudet, Scott Douglas, Denis Léger, Jean-Paul Daigle, Bob Flack, Gérald Robichaud, Gerry Mazerolle, Donald Alexander, Nathalie LeBlanc-Poirier, and Charles Comeau.

Question 1. A reflection of the past and present status of Atlantic salmon in the Cocagne River in comparison with other rivers draining into the Gulf of St.-Lawrence.

A commercial Alewife (*Alosa pseudoharengus*) fisherman suggested that from his experience and what he has seen on the Cocagne River, Atlantic salmon abundances seems to be increasing slightly, Brook trout abundance seems to be decreasing at a fast rate and Striped bass (*Morone saxatilis*) abundance seems to have increased exponentially in the last few years. He also says that after the construction of the new bridge, there has been more eelgrass.

Numerous participants present agreed that the overall habitat and health of the Cocagne River has changed through the years but is still generally good, compared to other rivers of New Brunswick.

Question 2. What are the causes of the decline of the Atlantic salmon population on the Cocagne River?

Poaching was designated as an important factor by many participants. A local Alewife fisherman said that although he doesn't participate in poaching activities (which many acknowledged was true) he gets regularly judged and called a poacher because Alewife fisherman were known to keep everything they found in their box nets. He stated that he does not think that commercial fisherman are the cause the largest poaching problems on the river. Denis Léger, a local Provincial enforcement officer stated that individuals often cause bigger poaching problems that commercial fisherman. According to him, one individual can hurt a population of fish considerably in only one night of

poaching. He also stated that it is very difficult to because enforce the law properly on all rivers of Southeastern NB because his department is short-staffed. However, all agreed that poaching is becoming less of a problem since it is an older mentality and that many local residents who were long-time poachers are now deceased.

Certain participants suggested that improper fishing techniques, such as the use of treble hooks, improper line size, and the use of barbed hooks also causes considerable mortality of Atlantic Salmon.

Many participants believed that the explosion in Striped bass abundance observed in recent years negatively affected Atlantic salmon populations. They believe that Striped bass are opportunistic eaters that will prey on anything including salmon juveniles and smolts. Some have also mentioned an increase in blue heron abundance that prey on all types of fish. A commercial Alewife fisherman has also indicated that he observed seals coming high up the river, almost up to the tidal waters line. He also indicated that he has caught a few large rainbow trouts (*Oncorhynchus mykiss*) in recent years.

Certain participants have expressed that the water levels in many rivers have dropped considerably in the last decades.

Some participants have said that they rarely see freshwater mussels in the Cocagne which indicate good water quality.

Numerous participants think that improper forestry practices are the cause of numerous problems that could negatively affect the Atlantic salmon, such as sedimentation problems, decreased canopy cover, and machinery in streams. One participant mentioned seeing large-scale clear-cutting operations on the Cocagne River. Mr. Denis Léger confirmed that although 95% of private forestry companies follow regulations some companies (and individuals) often do not respect these, for example by not leaving a 30 m buffer zone in riparian areas.

One important point that came out is that we don’t have any data on the adult salmon population of the Cocagne River, which makes it hard to say if the population is

actually in decline and to find causes for this decline. One participant also suggested that we don't know how many salmon the Cocagne River can sustain because of this lack of data.

Some participants have suggested that not enough data on Atlantic salmon populations is collected by the DFO and made available to the public. Scott Douglas, an Aquatic biologist with the DFO rectified this point by stating that the juvenile salmon stocks of Southeast rivers of NB (At least the Bouctouche River which is used as an indicator for the other rivers) are assessed yearly by a DFO using electrofishing and that all data and results are readily available on the Internet.

Mr. Douglas also mentioned that electrofishing is not a priority for DFO, but that priorities are determined from pressures coming from groups like the SAA.

Question 3. What actions/projects would you like to see done to improve the Atlantic salmon habitat and/or population in the Cocagne River?

Some people suggested that reopening a catch-and-release season in the Cocagne would be a good idea. It would increase the number of responsible anglers in the river, which in return would discourage poaching operations. Also, anglers fishing the sections of the river that would be catch-and-release would also have to use single barbless hooks.

Some people were against stocking programs, which they think rarely work and are a waste of time and money. However some people were in favor of stocking programs. We (the SAA) talked about the stocking programs we had in the 1990's, and which many acknowledge generated few improvements in Atlantic salmon abundance.

Annexe B. Financial acquisition for Evaluation programs

Water Quality cost for Cocagne (per month)

Employees
2 people × 8 hours @ 18$/hour = **$288.00**
(4 hours each in the field, 4 hours of data entry and 4 hours in lab)
Total: $288.00

Mileage
160 km @ $0.41/km = **$65.60**
(37 kms @ $0.41/km) × 2= **$30.34**
Total: **$95.94**

Field Equipment
YSI (model 85): **$1771.37**
PH meter (pHep by Hanna): **$87.30**
GPS (Garmin, etrex 20): **$219.99**
Waders, 2 pairs: **$250.00**
Tape measure (50m): **$25.00**
Sterile bottles for water samples (6 a month): **$3.30** (at $0.55 each, 200 bottles for $110.00)
Total: $2356.96
Subsequent year total: $ 3.30 (per month)

Laboratory Equipment (in-house)
Sealer: **$4000.00**
Quanti-trays (6 a month): **$8.42** (at $1.40 each, 100 trays for $140.25)
Nitrate kits (for 6 samples): **$14.00** ($28.00 a kit, does 12 samples)
Colilert (e-coli reagent): **$39.60** for 6 samples ($132.00 for 20 tests)
Pipettes: **$0.60** for 6 samples ($25.00 for 250 pipettes)
Colorimeter (smart 3): **$999.00**
Distilled water: **$5.00**
Incubator: **$623.00**
UV lamp: **$126.67**
Spray bottle for distilled water: **$3.00**
Total: $5819.29
Subsequent year total: $ 67.62 (per month)

Total Cost = $14 379.48 (in house)
Subsequent year total: $ 454.86 (per month)

Data aquisition (per site, per month)
Temperature and Dissolved Oxygen

Employees
2 people × 3 hours at $18/hour) × 3 visits = $324.00
Total: $324.00

Mileage
Dependant on site location, (at least 60 kms)
60kms @ $0.41/km × 3 visits = $73.80 (minimum)
Total: $73.80 (minimum)

Equipment
-VEMCO minilog llT submersible temperature data logger (10 year battery life): $275.00
-VEMCO field reader: $750.00
-HOBO dissolved oxygen data logger: $1250.00
(3 year factory replaceable battery, 6 month lifespan on DO cap)
-software for HOBO dissolved oxygen logger: $99.00

Total with VEMCO: $ 1422.80 + (mileage dependant)
Total with HOBO: $ 1746.80 +(mileage dependant, does not include DO replacement cap)

Stream Survey (per site)

Employees
3 people × 8 hours at 18$/hour = $432.00 (max, can be done with 2 people, in 4 hours)
Total: $432.00

Mileage
50+ km at $0.41/km = $20.50 (minimum)
Total: **$20.50** (minimum)

Field Equipment
Field sheet, pencil, clipboard: $5.00
Metal meter stick: $7.50
YSI (model 85): $1771.37
pH meter (pHep by Hanna): $87.30
GPS (Garmin, etrex 20): $219.99
Waders, 3 pairs: $375.00+
Flow meter (optional): $500.00
Hand level or surveying equipment: $120.00 (hand level), $650.00 (surveying equipment)
Waterproof camera: $250.00
Hip Chain (ChainMan II): $110.00
Measuring tape (50m+): $25.00
Total: $3471.16 – $4001.16 (includes optional equipment)
Subsequent year total: $0 - $380.00 (if waders need to be replaced yearly)

Total cost: $3923.66 - $4453.66 + (mileage dependant)
Total cost subsequent years: $452.50 - $832.50

Community Aquatic Monitoring Program (CAMP)

Employees
2-3 people × 8 hours each at $18/hour = $288.00 - $432.00
Total: $288.00 - $432.00

Mileage
50 kms at $0.41/km = $20.50
Total: $20.50

Equipment
-YSI (model 85): $1771.37
-Waders (2 pairs): $250.00
-Beach seine, aerated bin: $1320.00
-Small cooler, ice packs: $10.00
-Clipboard, string/twine, ziplock bags: $10.00
-Dip nets (2-4):$10.00
-Vegetation quadrant: $5.00
-Underwater viewing bathyscope: $88.79
-Fish identification guide/book: $30.00
-Garden trowel (for sediment sample collection): $17.00

Total: $3512.16
Subsequent year/month total: $0

Total Cost: $3820.66 - $3964.66 + (mileage dependant)
Total cost subsequent year: $308.50 - $452.50 + (mileage dependant)

Partners
-DFO
-CSGSL (Coalition du sud du gulf de St-Laurent)

Electrofishing (per site)

Employees
3 people × 4 hours at $18/h= $216.00
Total: $ 216.00

Mileage
Dependant on site
Atleast 50 kms at $0.41/km = $20.50
Total: $20.50+

Equipment
-Electrofishing backpack: $9988.00
-Battery for electrofisher: $636.00
-Battery charger: $272.00
-Waders (3 pairs): $375.00+
-2 lightweight electrofishing nets: ($156.00 x 2) = $312.00
-2 buckets: $20.00
-GPS (Garmin, etrex 20): $219.99

Total: $11 822.99
Subsequent year total: $ 375.00

Certification
-full training (field and online), price for NGO's: $375.00 per person
-refresher (field only), price for NGO's: $200.00
Total: $575.00
Subsequent year total: $ 0-$375.00 (dependant on staff)

Total Cost: $ 12 634.49
Total cost subsequent years: $611.50 – $986.50+ (for additional mileage)

Partners
-DFO

Redd counts (per day)

Employees
2 people × 8 hours at 18$/hour = $288.00
Total: $288.00

Mileage
Dependant on site
50+ km @ $0.41/km = $20.50 (minimum)
Total: **$20.50** (minimum)

Field Equipment
Underwater viewing bathyscope: $88.79
Waders, 2 pairs**:** $250.00+
GPS (Garmin, etrex 20): $219.99
Total: $558.78
Subsequent year total: $250.00

Total cost of project: $867.28 + (for mileage)
Total cost for project, subsequent years: $558.50

Partners
New Brunswick Aquatic Data Warehouse

Methodology
Document can be found on SAA's database.

Sedi-Bacs:**Measuring Sedimentation (persite)**

Employees
2 people (field portion) × 4 hours at $18/hour = $144.00 (max) × 15 visits (max) =$2160.00
1 person (lab) × 1 hour at $18/hour = $18.00 X 15 samples (max) = $270.00
Total: $2430.00

Mileage
Dependant on site location (at least 60 kms per trip)
Visit each site up to 3 times a month for up to 5 months
15 visits, 60kms+/visit at $0.41/km
Total: $369.00 (minimum)

Field Equipment
-GPS (Garmin, etrex 20): $219.99
-Bucket, 4L (10 for $27.50): $2.75
-Mesh bags to hold gravel: $1.00
-Gravel: $5.00 (or less)
-2 pairs of waders: $250.00+
Total: $478.74
Subsequent year total: up to $255.00 (possibly $0)

Laboratory Equipment
-Oven (to dry sediment): $894.80 (smallest)
-Muffle furnace (to burn organic content): $1426.73 (cheapest)
-Seives (set of 6): $171.90
-sieve shaker : $1374.02
-Scale: $286.49 – $638.31
-Ceramic hearth plate (to remove excess water before drying): $277.32
-Paint brush (for sediment removal from sieve): $2.00
-Mortar and pestle (to break apart dried sediment): $5.00
-6 beakers (12 for $50.00): $25.00
Total: $4463.26
Subsequent year total: $0

Total Cost: $7741.00+ (mileage dependant)
Total cost subsequent year: $2799.00 - $3054.00+ (mileage dependant)

Partners
-Université de Moncton

Invertebrate sampling, CABIN protocol (per site)

Employees
(3-4 people for 4 hours) @ $18/hour = $216.00 - $288.00 (in field)
Total: $216.00 - $288.00

Mileage
Dependant on site location

Equipment
-Paper, clipboard, pencils, markers, calculator, waterproof labels, labelling tape: $30.00
-Duct tape, ziplock bags, batteries: $15.00
-Small emergency tool kit (optional): $30.00
-GPS (Garmin etrex 20) : $219.99
-Camera (waterproof) : $250.00
-Densiometer (optional) : $130.00
-Meter stick, tape measure (30m+), small ruler (30cm): $32.00
-Surveying equipment, tent pegs: $650.00
-Cooler, ice packs, sample bottles: $30.00
-YSI (model 85): $1771.37
-pH meter (pHep by Hanna): $87.30
-Kicknet (can sometimes be borrowed from CRI): $170.00
-Stopwatch: $20.00
-Squeeze bottle, tweezers/spoon, white tray: $10.00
-Bucket: $10.00
-Sieve: $55.00
-Formalin and formalex: $10.00 (4L)
-Waders (2 pairs atleast): $250.00
-Life jacket: $25.00
-Throw bag (50 feet), first aid kit: $45.00
-Rubber boots, rain gear (optional): $50.00
-Rubber/neoprene gloves, protective goggles/glasses (1 pair): $5.00
Total: $3685.66 (without options), **$3895.66**
Subsequent year total (per sample**): $40.00** approx.

Laboratory
-BioTech Taxonomy (NB), **sorting and identification of invertebrates**: $230.00/sample
-UNB/CRI/BMI (NB):
Sorting and identification: $300.00 (family level), $400.00 (genus level)
Identification only (pre-sorted samples): $125.00 (order level), $175.00 (family level), $250.00 (genus level)
Total: $230.00 (average price)

Total Cost: $4131.66 - $4413.66+ (does not include mileage)
Total cost subsequent years: $702.00 - $774.00+ (does not include mileage)

Partners

-CRI (Canadian River Institute)
-Coalition pour la viabilité du sud du Golfe du Saint-Laurent (Coalition-SGSL).