

V. Discussions and Conclusions

A. Water Classification

The Water Classification Program, upon ratification, will become one of the HRAA's most valuable management tools. This program has already helped to shape the nature in which we approach watershed management. The Provisional Water Classification divided the watershed into 22 eco-reaches including seven main stem sites, nine major tributaries and six minor tributaries. Using the information in the WCD and the knowledge of staff and volunteers, the HRAA has performed research, restoration, and follow up monitoring on many of these sites, positively influencing the entire system in the process. We have also been able to identify the areas that are in the most need of our attention, and those that need to be protected so that their pristine conditions can remain a sustainable, viable part of the natural ecosystem.

Once government has ratified the Water Classification of the Hammond River, it will be attached to the Regulation as a Schedule. This means that these sites will be protected from certain land use practices and development according to their class. The highest level of protection will be that assigned to an A class eco-reach. This will facilitate in protection measures that the HRAA will be undertaking in the future. However, in the meantime, special attention will be paid to the six eco-reaches that fall under the B and C category, with efforts being made to improve conditions on these watercourses so that they too, achieve A class limits. Once a B or C class watercourse starts attaining A class limits, a petition can be made to government to have the eco-reach classification upgraded.

From 2009-2010, the top priority of the HRAA in regards to water classification, will be to improve the conditions on the three C Class Brooks: Scoodic Brook, Bradley Brook and Palmer Brook. If the major issues on these brooks can be addressed, and monitoring performed to show that conditions have improved to a higher class, the HRAA can update the Water Classifications prior to the ratification in 2010. Once the improvements have been made to these brooks, the HRAA will move on to restore the B class Brooks. These brooks include one main stem site, in the Mill Brook region, and two major tributaries: Salt Springs Brook and South Stream Brook. All of these sites are heavily impacted by agricultural land use. Working with landowners on these brooks is believed to be the best chance of restoring them to A Class levels.

In recent years, the Hammond River Angling Association, supported by DENV and other partners, has performed a series of studies to establish an overall picture of water quality and habitat suitability of the C class brooks.

Some of the research performed is listed below, all corresponding data can be found in the appendices.

I. Bradley Brook

- A. 3 km of stream habitat assessments
- B. Water sampling for Metals, Chemistry, Nutrients, Bacteria, and Nitrates
- C. *E. coli* monitoring at three sites for a duration of 5 weeks
- D. Identification of point source water contamination
- E. Sediment studies
- F. Electrofishing Surveys

II. Soodic Brook

- A. 3 km of stream sweeps
- B. Water sampling on upper and lower reaches of the brook for Metals, Chemistry, Nutrients, Bacteria, and Nitrates
- C. *E. coli* monitoring at two sites for a duration of 5 weeks
- D. Identification of point source water contamination
- E. Sediment studies
- F. Electrofishing Surveys

III. Palmer Brook

- A. 5 km of stream sweeps
- B. Water sampling on upper and lower reaches of the brook for Metals, Chemistry, Nutrients, Bacteria, and Nitrates
- C. Identification of point source water contamination
- D. Sediment studies
- E. *E. coli* monitoring at two sites for a duration of 5 weeks
- F. Drogue studies
- G. Electrofishing Surveys on five sites

Through these studies, the HRAA identified major environmental issues on each of the brooks. On Soodic Brook, the results showed extremely high *E-coli* levels sourced to a cattle field. Bradley Brook had a variety of contaminants sourcing back to poor riparian zones combined with residential properties. The final area of concern is a significant industrial region undergoing rapid development on Palmer Brook, resulting in significant sediment loading.

Details of the current issues facing these streams are outlined below:

I. Bradley Brook

- A. Excessive garbage and potentially harmful run-off
- B. Sporadic *E. coli* levels, although average was within the B class limits in 2007
- C. Numerous private properties backing on the stream with various types of land misuse creating threats to stream health.
- D. Rumors have circulated that waste water management companies have been seen dumping the waste from their trucks into this brook. This would explain the high *E. coli* content and the degrading water quality. These conditions, coupled with the numerous beaver dams along the brook, are resulting in pools of stagnant water along certain sections of the brook.

II. Scoodic Brook

- A. Excessive sedimentation and run-off in 2006. This brook feeds directly into Sherwood's Pool, an important salmon pool
- B. Pristine water quality and habitat conditions exist in the upper reaches but excessive *E. coli* levels in lower reaches. Average *E. coli* level at one site does not even qualify Scoodic as a C Class Brook (Average : 592 *E. coli*/100ml over 7 weeks of testing) *
- C. Field crews identified a farm that allows cows to access the brook. This is believed to be the major source of *E. coli*.
- D. Industrial garage adjacent to brook stores large amounts of salt, as well as heavy machinery on site. Poses a huge threat to stream health.

III. Palmer Brook

- A. Palmer Brook has had increased development in the area impacting its water quality for the last few years
- B. Sediment studies identified that some specific sections of the brook are unable to sustain juvenile salmon eggs through the winter because of excessive sediment loading
- C. Sediment loading is obvious during any rain event, when the brook runs brown. Sources of sediment include: runoff from gravel pits, large scale clear-cuts with feeder streams running through them, and violations of the 30 meter setbacks from wetlands and waterways. While some landowners are buying in to the HRAA message and working to correct land issues, others are still ignoring the problems on their land and continuing to contribute to sediment loading.

**Water Classification E. coli Limits Are:*

A Class: E. coli levels will be naturally occurring

B Class: E. coli levels will be <200 per 100ml of water

C Class: E. coli levels will be between 200 and 400 per 100 ml of water



Figure 107. Renforth construction worked with HRAA staff and DENV to re-establish a degraded gravel pit reducing large flows of sediment to Palmer Brook. Photo on the left shows the Renforth pit in February of 2008 and the photo on the right show the same location in July 2008. A settling pond and standpipe was installed to regulate water runoff and prevent the sedimentation of Palmer Brook. *Photos S. Campbell.*

The HRAA will perform a significant amount of work on Palmer, Bradley and Scoodic Brooks in 2009, in order to improve the conditions of these brooks prior to ratification. Each of the brooks has numerous problems, requiring various restoration projects.

Bradley Brook

Bradley Brook is in a highly developed residential region. In previous years, the HRAA has performed stream sweeps assessing the overall condition of the brook. To date, the HRAA assessed a total of three kilometers of Bradley Brook. In 2009, the HRAA will engage the residents of Bradley Brook through community events, and offer landowners assistance in cleanup efforts on problem sites.

The HRAA will host an information session to encourage best management practices around the brook. The residents will also be assisted through local garbage and recycling pickup days organized by the HRAA. This will promote a sense of stewardship

toward the brook and prevent further dumping. All residents participating in the event will be rewarded for their help through a gift of a maple tree. To ensure proper planting techniques, HRAA will be responsible for planting the tree in the brook's riparian zone.

The HRAA will begin in the spring engaging landowners on Bradley Brook through information sessions explaining the issues on the brook and how they can help. Following the meeting, a community-specific newsletter will be developed to further engage landowners and help promote plans for a local spring clean up. On the clean-up days, volunteers and HRAA staff will sort garbage and recyclables in association with a localized waste management crew, with whom the HRAA will be partnering. The waste management crew will be hired to manage the disposal of most of the garbage. During this time, hazardous waste products will also be collected in pick-up trucks and taken to the Household Hazardous Waste Facility at Crane Mountain.

As households complete the spring clean up they will receive a red maple tree as a sign of appreciation for cooperation in the clean-up project. The red maple is well known for its ability to withstand severe flooding during peak water levels and during the summer months their large canopy casts much needed shade on the brook. The trees will be planted by HRAA around the brook; the trees will stabilize the soil and help decrease water temperatures. The trees will also serve as a reminder of the good deeds done for the brook.

During this interaction with Bradley Brook landowners, we will attempt to gain information about other concerns facing the brook, primarily the issue of illegal waste water dumping. We will provide landowners with contact information for the Department of the Environment and other appropriate officials for reporting illegal activity around the brook. We hope to instill a sense of stewardship in these landowners, knowing that the brook will benefit if those around it value it.

Scoodic Brook

Scoodic Brook is the second C class brook. Through stream assessments the major area of concern found on the brook was a beef producer's farming practices, although various other smaller issues were also identified. The HRAA will begin efforts to restore the brook by assisting the local landowner to restrict cattle's access to the brook. This effort will require moving fences that currently run through the brook and installing an alternate water source for the cattle. The restriction of cattle access will actually increase the health of the cattle and decrease the bacterial content of the brook.

Meetings will commence with the landowner early in the spring to establish a system to meet the watering needs. In preparation for this, the HRAA will work with the NB Department of Environment officials to ensure all regulations are met. In order for the issue of cattle in the brook to be resolved, a low maintenance watering system will be installed with the co-operation of the landowner as per the Environment officials' guidance. To ensure the new system is not causing runoff of mud from the high traffic watering area, the HRAA will install recycled rubber matting from the NB Tire Stewardship Program. The matting will decrease the mud, thus decreasing the sedimentation of the brook.

Once an alternate watering source is in place, the fencing will be corrected to DENV Standards. Currently, the fencing in place crosses the brook in several locations allowing the cattle to access the water. HRAA crews will begin placing cedar post at an agreed-upon setback, to restrict the cattle from moving freely through the brook. The removal of the cattle from this stream will have

2 immediate positive impacts: 1) decrease the bacterial content in the water, and 2) studies prove that cattle production increases with a clean water supply and hooves remaining dry (Frank Moore et al, 2000). This is a mutually beneficial arrangement, improving cattle production while enhancing the conditions of the brook.

For all three of the C class brooks, the post-work monitoring will be comprised primarily of *E. coli* sampling. In order to meet DENV standards, we will sample once weekly, above and below each work site, for a minimum of five weeks. After five weeks, the average is taken and if it is below C class levels, the classification should be reviewed and re-assigned accordingly. If at any time during the five weeks, there is a spike in the *E. coli* levels at any site, it should be investigated immediately. The plans that have been coordinated for each of these sites are based on the information we have collected in past years. However, new problems are arising all the time and even though we may correct the existing problems, there could be new issues that we are not aware of. *E. coli* sampling results are available within 24 hours of processing, so the HRAA should be well equipped to deal with any new issues that may come up and be able to source them fairly effectively. All sampling should take place during normal conditions, preferably in the summer months, when bacterial spikes are more likely to occur.

When these brooks have been restored and are achieving A or B class levels, the HRAA will turn its attention to the restoration of the B class brooks and the protection of the A class brooks. The B class eco-reaches are generally believed to have water quality issues relating to agricultural land use and poor riparian zones. These sites will be dealt with in more detail in the Watershed Management section.

The development of a comprehensive monitoring plan for all brooks is going to be a key initiative relating to Water Classification. It is crucial to verify that the eco-reaches are attaining the levels that were assigned to them. Identifying sites that are not meeting the appropriate levels, and the reasons behind it, will become the next major initiative that HRAA uses to protect the watershed.

The monitoring plan will require benthic and water quality sampling at seven or eight sites each year. With a full benthic assessment taking place this year, the rapid assessment technique can be used in subsequent sampling and compared back to the 2008 baseline data. Within a three year period, all 22 eco-reaches should be sampled and the results compared to previous results and Water Classification standards. Where discrepancies are identified, more detailed assessments will be carried out, in the form of stream habitat assessments. These assessments have proved to be the best method of identifying issues within specific eco-reaches. By getting out and walking these stretches of water, we are able to observe conditions that maps and aerial photos don't show. Habitat assessments also provide good baseline data that can be checked back to on a regular basis.

The HRAA will work closely with landowners, stakeholders and the Department of the Environment over the next year to come to agreements on final classifications for all of the eco-reaches. Throughout these public outreach efforts we will try to ensure that each eco-reach is eligible for the highest possible classification. The actual classification that is proposed to government will depend on the current condition of the brook and the position of local stakeholders and landowners. The HRAA will encourage that the highest applicable rating is assigned to each eco-reach but will work with the public to help ensure that everyone is satisfied with the outcome of this program.

Palmer Brook

Palmer Brook has undergone considerable restoration in recent years, but still runs brown during rain events. Efforts will be made to continue talks and work with the landowners of the Palmer Brook region. The efforts within some parts of the industrial area of Palmer are evident, showing signs of continual improvement, but there is much still to be done. Two of the four major landowners with sediment problems have made large scale improvements to their operations, reducing and controlling sediment run-off successfully. HRAA wants to promote that success and continue working with landowners directly.

HRAA also has a funding proposal in place to help all of the landowners restore their properties to a state that will prevent further sediment loading and facilitate in the restoration of the brook. The following work is slated for 2009-2010, pending project approval. Since the project is aimed at restoring fish habitat, the work will focus on improving fish passage and habitat conditions, while positively impacting the overall water quality of the stream.

Palmer Brook Restoration includes three major activities:

1. Replacement of a culvert on Colton Brook

Currently, Colton Brook, the main tributary to Palmer has two culverts that are undersized and over-sloped. The HRAA will remove these 900 mm culverts and replace them with culverts that meet current standards according to drainage calculations.

The culverts are on a private dirt road leading to a gravel pit. This landowner has previously expressed interest in this project and will be re-engaged upon project approval.

2. Stream Cleanup with Removal of Barriers to Fish Passage

Extensive development around Palmer Brook and its main tributary, Colton Brook, has resulted in the dieback and destruction of the riparian zone and the deterioration of water quality. As a result, significant amounts of organic and inorganic materials are being deposited into the brook. This accumulation has created barriers to the passage of fish in both inward and outward migration. This creates a great concern in regards to Atlantic salmon and the requirement of all fish species to move throughout various habitats to find suitable resources and spawning conditions. Allowing fish free passage throughout the system also helps to maintain genetic biodiversity.

The HRAA will perform a full assessment of the quality of habitat along with stream characteristics along 10km of Palmer Brook and 5km of Colton Brook through stream habitat assessments. HRAA will also remove all barriers to fish passage, as they are located and inorganic debris.

3. Restoration of development-damaged sites

The HRAA will continue its efforts in stabilization of the sites at Renforth Pit and the Hammond River Industrial Park using various trees and shrub. The planting will be designed and monitored by a Forest Technician and performed. The planting will not only stabilize the surrounding soil and reduce the sediment transportation but will decrease the overall volume of water during rain events.

Crews will commence planting in the early spring following ground thaw. This will allow the trees and shrubs to take root over the course of the summer and stabilize the banks to their full potential. The planting will mimic a natural succession of the land and the surrounding naturally vegetated land. As the summer progresses crews will return to the planting site, and tend to the trees as required.

The HRAA, with the help of landowners create a showcase within the region demonstrating beneficial management practices and corrective techniques to create a spark within the community promoting the responsible land use. The chronic sedimentation of Palmer Brook from this site has been an ongoing issue but with the help of the HRAA, it will be rectified.

C. Fisheries Management

For the last number of years, the primary assessment tool that the HRAA has been able to effectively and consistently put to good use is the Juvenile Density Survey. This project has been funded every year from 2005-2009 by the Wildlife Trust Fund, with support from other funding bodies as well. In addition to the data that HRAA has been collecting, we have access to historical density data collected by government agencies since 1979. In 2008, we were able to replicate most of the historical sites and start comparing the historical numbers to current densities.

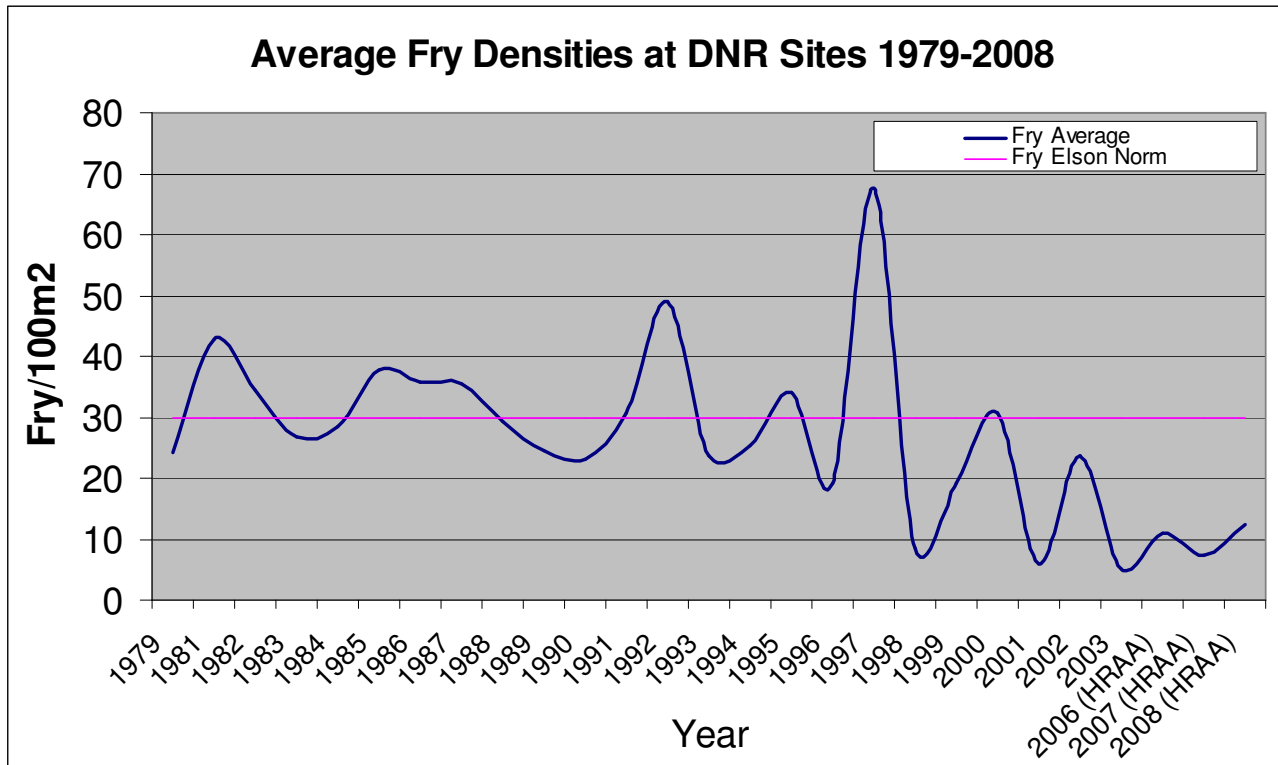


Figure 108. Average fry densities at the historical sites from 1979-2008. For each given year the average of was taken of all assessed sites. This could be from one to five sites, depending on the year. A clear decline in average fry densities is evident following the huge spike in 1997.

Figure 108 is a graph of the average fry densities at these sites between 1979 and 2008, and illustrates an alarming trend. Throughout the eighties and early nineties, the average fry density hovered around the Elson norm for fry. Then in 1997, there was a huge spike in fry numbers followed by a steady decline. The fry average now hovers around 10 fry/100m². This is about 1/3 of the historical average. Historical parr densities are very sporadic and no clear trend is evident from these numbers. Please refer to Appendix A for all electrofishing data.

In 2008, HRAA field crews electro-fished 19 sites, four of which were historical sites. Including these sites in

all future density surveys is going to be a crucial part of monitoring the juvenile populations. In 2008, parr densities for all but one of the 19 sites were less than 40 parr/100m² (Elson Norm) and were therefore considered low. The highest density recorded for parr was on South Stream at 59.6 parr/100 m². The next highest was 21.7 parr/100m² on Hanford Brook. The average parr density for the

system was 9.8 parr/100m. This is significantly lower than the Elson Norm, which is used as a standard for healthy salmon populations. However, the overall parr density is up from 4.4 parr/100m² in 2007.

The highest density of fry, in 2008, was found in Hanford Brook at 34.5 fry/100m². This was the only site to achieve Elson Norms for fry this year. However, Germaine Brook was extremely close at 29.6 fry/100m², as was Brawley Brook at 27.0 fry /100m². The average density of fry across all sites in 2008 was 11.8/100m², down from 16.9/100m² in 2007.

Of the 4 DFO sites that were replicated, Hanford Brook had the highest density of both parr and fry. This is consistent with historical numbers, as are the low numbers at the Smithtown and French Village bridge sites. The numbers at Burke's Farm are down from DFO records but remain consistent with the HRAA findings since 2005. Unfortunately, a bridge replacement at Hillsdale Bridge kept us from accessing this site which is, historically, one of the highest performing sites for juvenile salmon.

Atlantic salmon were identified in all but two sites: Palmer Brook 1 and Scoodic Brook. Brook Trout were not identified in any of the main stem sites and were lacking at three tributary sites: Salt Springs Brook 1, Germaine Brook 2, and Palmer Brook 1. The average density of each species was calculated using the numbers from all 17 closed sites. Blacknose dace had the highest average density at 35.0/100m². The next highest was salmon fry at 11.8/100m², followed by brook trout at 11.1/100 m². Creek chub had an average density of 10.6/100m², followed by salmon parr at 9.8/100m² and slimy sculpin at 5.6/100m². All other species averaged a density of less than 5.0/100m² (Figure 109).

According to Elson Norms, the juvenile salmon densities across most sites in the Hammond River are considered low. Of the 19 sites only three sites either achieved or came close to reaching the Elson Norm in regards to fry density. The parr numbers are even lower, with only one site, South Stream, achieving the Elson Norm. Although the average parr density increased to 9.8 parr/100m² up from 4.4 in 2007, if South Stream is removed from that equation the average drops to 6.7parr/100m². Trout densities also seem low, with most sites having less than 20 trout per 100m². These findings suggest that the Hammond's salmonids are not thriving and therefore support a strategy of continued stocking efforts in areas with good fish habitat and low fish densities.

Stocking unfed fry has minimal impact on the system and is considered to be the most beneficial stocking method available at this time. Parr stocking is also considered to be advantageous to the salmon population and may be recommended for the next cycle of stocking. Parr are more likely to have a negative impact on wild salmon and other fish species. Results of the juvenile salmon density surveys will be used again this year to inform appropriate stocking areas for parr stocking.

Even though salmon densities are not achieving Elson Norms, it should be noted that salmon fry have one of the highest average densities across the watershed according to the 2008 numbers, second only to Blacknose Dace. Brook trout come in at third highest, followed by Creek Chub, and salmon parr have the 5th highest density, beating out the remaining 13 species. This suggests that Atlantic salmon are still a very relevant species in the Hammond River.

The following is a list of recommendations for stocking and electro-fishing methods in 2009 and into the future:

- HRAA’s program continues to monitor the 5 historical sites surveyed by authorities in the past. Methods for analyzing this data to determine long term survival rates for differing life stages in these areas can be helpful in calculating appropriate stocking levels on a site-specific basis
- Stocking continues at the unfed fry stage
- Parr stocking re-commences during the next cycle with experimental sites to assess wild and hatchery survival rates
- Closed site linear regression method is continued on all tributary sites and whenever possible on main stem sites
- Presence/absence surveys be limited to main stem sites, where nets can’t be accommodated

There has been a noticeable shift in the density of juvenile salmon through the recent years of stocking. Although there was only one site that reached the Elson norm in regards to fry populations and one in parr populations, there was an obvious shift of the

fry populations of 2007 advancing to the parr stage in 2008. With the continued efforts of stocking fry, a less detrimental impact to the ecosystem than parr, the Hammond River Angling Association looks to continue its efforts to increase juvenile salmon populations. Electro-fishing sites studied in 2008 will be revisited in 2009 and HRAA hopes also to continue on historical DFO sites started in 2008, and attempt to perform closed sites whenever possible.

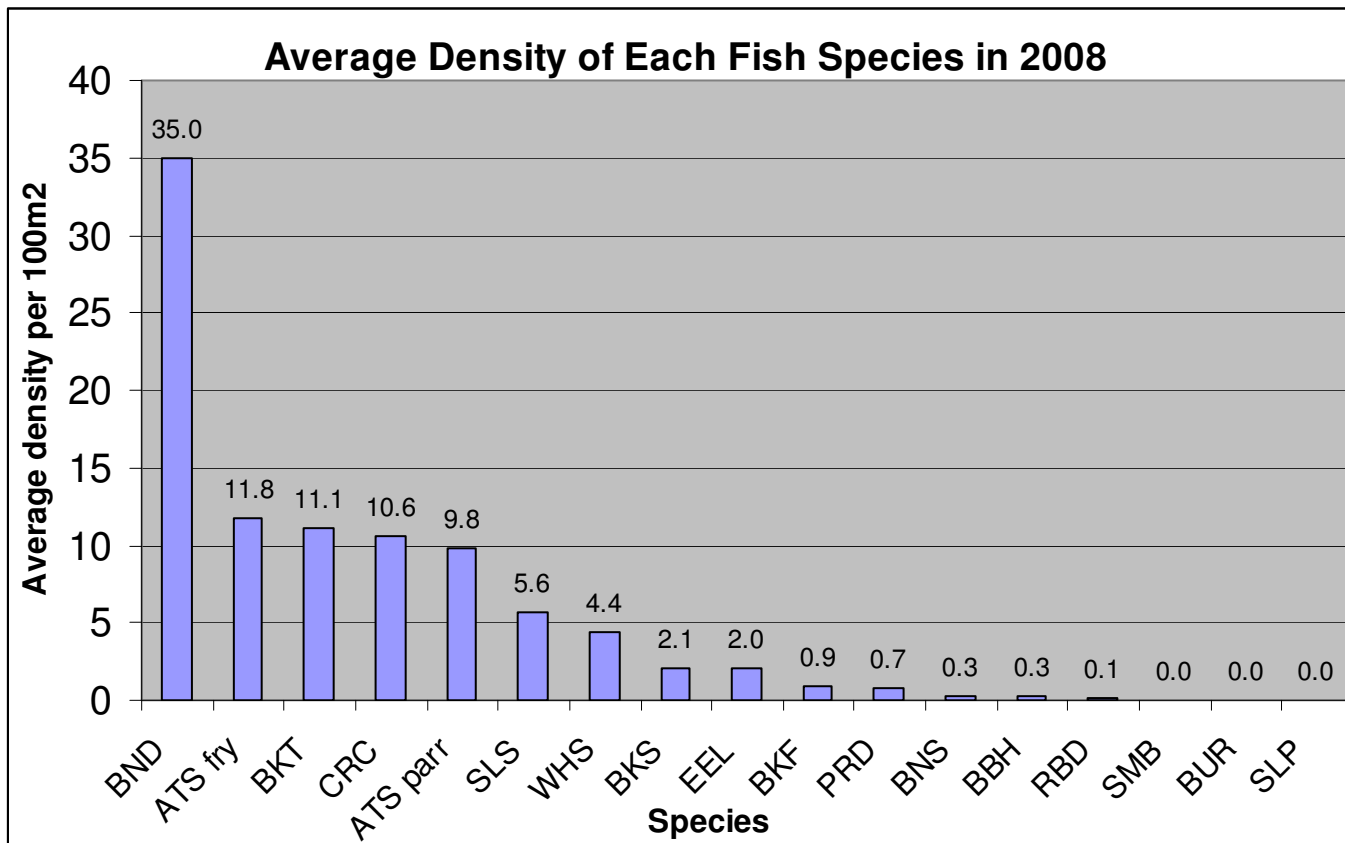


Figure 109. Bar graph depicting the average density of each species identified in the Hammond River Watershed during 2008 electro-fishing surveys.

The HRAA has other assessment tools at its disposal, including redd counts, visual counts and swim or dive

throughs. The visual counts and dive throughs have been developed in the last three years and the techniques have improved significantly since 2006. In 2008, we were able to assess far more pools and identified nearly 4 times as many mature salmon as we had in the previous two years. The plan for furthering this method in 2009 will include the incorporation of a mark/recapture component. At present, this seems like the best chance of assessing the adult population since there is no in stream structure required for this method.

Working with DFO, HRAA staff and volunteers have determined that a mark/recapture technique is the most appropriate method of assessment for the Hammond River. The mark/recapture method of assessment will be a multi-phased project. The first phase will take place during the annual broodstock collection on Palmer Brook in late August. HRAA staff, DFO officials and volunteers will seine the pool in Palmer Brook and Rod Price will remove fish one by one in order to choose broodstock and to allow time to tag fish that are being released. HRAA will ensure that there is at least one expert available at this time to train HRAA staff in tagging methods. Fish that are not collected for broodstock will be placed in a tag box, tagged with a light coloured carlin clip, measured, sexed and then released back into the pool.

The next tagging effort will take place in mid September. This may take place on Palmer Brook if there are believed to be enough fish holding there. In early October there will be one final tagging event planned. Throughout these three collections, the HRAA will tag between 50 and 100 fish. Site locations will be chosen carefully to ensure that these numbers can be reached within these efforts. Visual assessments will be performed by HRAA field crews in the days prior to tagging to monitor numbers and choose appropriate sites.

The higher the number of tagged fish and the more fish we target for recapture, the more accurate the count will be. To ensure that high quality data is gathered from the primary mark/recapture efforts, there will be a visual assessment of known salmon pools subsequent to tagging and directly prior to recapture. Swim-throughs will be conducted on various pools throughout the Hammond River to assess where fish are holding. As crews move through the pools they will tabulate a count and establish a ratio of grilse to salmon. High density areas will then be targeted for recapture efforts. We are confident that this method will provide HRAA with the much needed adult count that has been lacking for so long.

Another valuable resource that we have available to us is the vast amount of historical data we have from redd counts. The majority of this data was collected by John Blenis and Tom Pettigrew, who did a run in canoes, annually, from the Hillsdale Bridge down to the Silver Hill pool. This data has been compiled in a graph in Appendix B. However, conditions in the last several years have prevented any kind of redd count from being performed. It is essential that this count recommences, especially the Hillsdale run. Once there is a good idea of numbers in regards to returning spawners, redds, and juveniles, a more complete picture of the Hammond River salmon population can be drawn. Once this is in place, more informed decisions can be made about how to protect, restore and enhance this population of fish.

C. Watershed Management

As with any watershed in a developed country, the Hammond River has been a sought after region for many years, by all walks of life, for both recreation and development. The valleys of the river contain rich fertile soil, and are known for their high productivity. Since the early days of pioneer development and farming in the Hammond River valley, settlers have known this region to be special. As New Brunswick became a populated province, so too, did these valleys. Many of the primary settlers were farmers. The farming community of earlier days was unaware of the ramifications of poor riparian zones, as their crops grew best in these lowlands. As time moved on it was discovered that many of the practices of old were out-dated and, at times, harmful to the environment. However, with much of the farming trade's knowledge having been passed from generation to generation, it has become difficult to prevent further degradation.

With the increase in farming, so too came increased urban development, people began looking outside of large cities to build homes and subdivisions. Many of the housing units developed along the river system were looking to take advantage of the picturesque water frontage. As the trend developed towards the dream home, many poor practices were developed. Trees, shrubs and grasses became heavily cut back and manicured using herbicides and pesticides causing the silent loss of many creatures. The riparian zones became weak along these regions, causing the banks to give way, releasing sediment into the watercourse.

As technology progressed, so did the industrial age as more large-scale operations began to appear in the watershed. These operations have large footprints, and engulf large tracts of land. With much of the land around these industrial developments becoming compact or paved, water runoff became, and, continues to be, an issue. Many wetlands and flood plains have been filled in and paved, no longer capable of absorbing runoff. The input of water into the brooks and the Hammond River itself has increased, causing large scale, prolonged flood events. Meanwhile, groundwater absorption has diminished, posing potentially disastrous conditions for the 1000's of dwellings in the watershed that rely on wells for the water needs.

Since the creation of The Hammond River Angling Association, one of the primary goals of the organization has been to work with local landowners to increase the health of the riparian zones, knowing that these areas dictate the health of aquatic habitat. Through years of experience, the association has come to learn many ways of restoring the riparian zones and has developed a strong working relationship with many farmers, residents, and now, industrial developers. The Hammond River Angling Association is in a constant state of adaptation as the watershed is rapidly changing. New methods and technology are being developed on an annual basis to remain an effective watershed restoration resource. There are still many key areas of concern throughout the watershed, which the HRAA continues to address through both new and time-tested techniques and with the cooperation of volunteers and landowners, these issues will be remediated.

Table 1: Priorities within watershed management based on classification and known hazards, on an eco-reach basis.

Priority listing of watershed management			
Level	Eco-reach	Areas of Concern	Issues
1	Palmer Brook	Palmer Brook industrial, Confluence, Colton Brook	Erosion, runoff/sedimentation, E. coli.
2	Scoodic Brook	Scoodic brook lower 1km	Salt storage, cattle access, erosion
3	Bradley Brook	Bradley Brook as a whole, Jenny Langstroth final 1 km	E coli. Pollutants, dumping, erosion, landuse
4	Salt Springs Brook	Bill Titus Property	erosion, sedimentation, landuse, corridor resources
5	South Stream Brook	From XTR through confluence	Cattle access, landuse, sedimentation, dumping
6	Mill Brook Region	All	landuse, erosion
7	Tabor	Bridge replacement, mouth of scoodic, sherwoods pool	sedimentation and erosion, landuse
8	French Village	Deephole road, Duffy's field	erosion, sedimentation, landuse
9	HRAA	Steele's field,	erosion, sedimentation, landuse
10	Germaine Brook	Fowlers farm off germaine brook rd	Landuse, erosion
11	Fowler Brook	2 km to confluence	Brine line, PCS mine, Chamber #1, FORD,
12	Hanford Brook	All including tribs, with an emphasis on Porter Brook	Erosion, landuse, unknown trib hazard
13	Markhamville	All	landuse, erosion, dumping
14	cusacks	All	landuse, erosion, dumping
15	Smithtown	All	Development, landuse, erosion
16	North Branch	All	development, mines, landuse
17	Brawley Brook	All	development, landuse, dumping
18	Bater Brook	All	over-cutting, development,
19	McGonagle Brook	All	Landuse, cattle restriction
20	Mill Brook	All	Landuse
21	Donnelly Brook	All	landuse
22	Titus Brook	All	landuse

**Priority is based on classification rating and known issues within each given reach

The 22 eco-reaches have been prioritized according to their classifications and current conditions. The C class reaches are the top priority, followed by the B class reaches. Refer to table 1 for the full list of eco-reaches and their priority status, as well as details on the specific sites, and corresponding issues to be addressed.

Within the watershed, three tributaries have been designated as “C” class watercourses. These reaches are Palmer Brook, Scoodic Brook and Bradley Brook. All three brooks have a series of issues degrading the water quality, ranging from industrial development runoff to cattle access. Considerable work has been performed on these three brooks in an attempt to decrease the negative impacts on the brooks and improve the water quality. There are more details regarding these brooks in the Water Classification section of the Discussion.

In addition to the three C class brooks, there are also three B class brooks. While the problems on these brooks are not as serious, there are still water quality concerns that the HRAA can help remediate. Most of the issues can be attributed to weakened riparian zones. The next three brooks on the priority list are the B class reaches.

Salt Springs Brook is the fourth reach on the priority scale, with a weakened riparian zone in the lower stretches degrading it to a “B” classification. Key areas of concern found along this reach have been isolated around the former Titus farm. Historically, the land has been used for agricultural purposes, but the current owners are moving away from this and the fields are now being allowed to develop naturally. The primary concern is still sedimentation caused by erosion, although conditions will start to improve with this correction of land use. Increased water velocities in recent years have caused large scale erosion to occur, in addition to adding sediment to the brook.

Another major concern in this part of the watershed is the possible development of salt dome caverns for the storage of natural gas. HRAA staff and volunteers have, and will continue, to carefully monitor this situation. The Quality of Life Initiative is a local group protesting the project. HRAA is keeping in touch with them and with Corridor Resources, the company proposing the project. It is still in the very early phases and any developments will be followed closely. Corridor Resources continues to work toward the creation of the chambers, and further monitoring will continue.

South Stream Brook is the fifth priority. The upper reaches of the brook remain largely untouched with some agricultural use but strong buffers still intact along the brook. As the brook reaches Barnesville, near the XTR, the brook begins to see more development. Housing can be seen in close proximity to the brook, with one foundation situated on the edge of the bank. Several houses have accumulated large piles of garbage on their properties, creating a potential threat to the brook. HRAA will develop a plan to assist landowners through education and resources to remove hazards and restore properties. Stream habitat assessments will also help to monitor success of efforts with landowners.

The brook moves through a long stretch of healthy forested riparian zone, well shaded and sustainable. Another area of concern is a high concentration of farm fields, consisting of both hay cultivation and cattle grazing. In order to optimize the hay output, much of the riparian zone has been stripped. Considerable erosion has occurred because of the lack of strong rooting vegetation. These fields are essentially barren and pose a continual risk of further erosion and habitat degradation.

Cattle fields are located on both the east and west banks of the brook, with connecting cattle crossings. The crossings are not well managed or restricted and the cattle were often seen wandering through the water, unchecked. Severe spikes in *E. coli*. are thought to have originated from these locations. The crossings have also caused channeling along the banks at each crossing moving both sediment and fecal matter. These areas should be addressed through landowner communications and the development of assistance programs, such as riparian fencing combined with planting and planned cattle crossings.

The Mill Brook region of the Hammond River was classified as a “B” class eco-reach, thus making it a priority for restoration. It is the only main stem site that is not designated as an A class watercourse. One of the limiting factors in classification of Mill Brook region was the high spikes in *E. coli*. Since the testing of 1998, a shift has occurred in the farming within this reach. The area

was once used predominantly for cattle grazing and has now shifted to the cultivation of crops and hay. Through further water testing, it may be possible to upgrade the classification to an “A” class. Until this can be verified, the HRAA should continue water sampling and working with local landowners. Other notable issues in this region are land use and erosion. The poor riparian zones have caused severe erosion and sedimentation of the river. Development of a working relationship between HRAA and landowners is strongly recommended, coupled with education and public outreach programs.

Although the region of Tabor Bridge, on the Hammond River, has achieved the classification of “A”, there are a number of concerns to be addressed within this reach. One of the areas of major concern is the salmon pool known as Sherwood’s Pool. This pool has been in a state of disrepair caused by years of stripping vegetation from the riparian zone. Attempts to repair and stabilize the



Figure 110. In late summer of 2008 contractors began to replace the Tabor Bridge. Photo shown of strong fall flooding taken following heavy rain events of late October 2008. Monitoring was conducted by HRAA staff and DENV to limit the impact of the construction on the river. *Photo T. Benjamin.*

banks have been made on multiple occasions by HRAA. However, all efforts have failed and the erosion continues. With new understanding of bank stability and hydraulics, the HRAA will develop a restoration plan for the Sherwood’s Pool.

Sherwood’s Pool is the location of highest risk however, it is not the only pool on this reach that has become degraded. The pool at the mouth of Scoodic Brook is only metres upstream of Sherwood’s Pool. This pool, too, has been reduced in quality because of riparian zone vegetation removal. Once Sherwood’s Pool has been restored, efforts should be made to proceed to this pool. Restoration of these sites will require continued talks with the landowners, constant maintenance, and full participation of membership to ensure a successful result.

Another major concern arose in the summer of 2008. Construction began to replace the bailey bridge above Tabor Bridge Pool. The site of construction is regarded as an ecologically sensitive site, containing a large Atlantic salmon pool and unique rock features. With construction in such a valuable region, it has caused a great deal of discontent amongst watershed enthusiasts and the greater community at large (Figure 151). HRAA

began monitoring the site and developing contacts with the proper officials to assist those working on the site. This will allow HRAA

to have some minor level of control. Staff and volunteers worked tirelessly monitoring the on goings of the operation and consulting those responsible when issues arose. HRAA will continue to monitor the replacement efforts on the Tabor Bridge Pool and the removal of the former bailey bridge.

The eighth reach on the priority list, is that of French Village on the main stem of Hammond River. This reach is well known for its productive salmon pools however, its riparian zone is degraded and posing a significant risk to the health of the aquatic habitat. Two key areas of concern have been isolated, Duffy's field and Deep Hole Road. These areas have been extensively worked and left in a weakened state. Duffy's field is comprised of hay, cultivated twice annually. This has limited the growth of any substantial vegetation, leaving the banks weak and at risk of severe erosion. The Duffy's have been a long time partner with HRAA, allowing staff and volunteers to create buffers and plant trees and shrub in these areas. Due to limited funding and lower priority, the Duffy's field has received minimal planting. It is strongly recommended HRAA continue to work with the Duffy's to develop an action plan to restore the riparian zone through natural planting methods. In the fields, there are several large ponds and low dips. These should be developed as wetlands to help minimize the impact of seasonal flooding and create habitat.

Beginning at the French Village Covered Bridge, the Deep Hole Road extends through to the Deep Hole. Formally extracted for topsoil, the parcel of land surrounding the Deep Hole Road has minimal vegetation. The vegetation is unable to stabilize the soil to the degree required to withstand the high water velocities and ice break-up. The road itself has been further degraded by a steady flow of traffic, tearing deeper into the soil creating large trenches and holes. With the disturbance of the soil, sediment begins to seep into the river. It is suggested HRAA develop a contact with the landowner to strategize a solution. Possible partnerships could be pursued and a road created through the field, using crushed stone as to prevent trenching and holes. The remaining field should be replanted in native riparian trees and shrubs to reduce the negative effects of the road system and stabilize the eroding banks.

One of the priorities of HRAA for many years has been the HRAA and Steele's field (Figure 111). Through many years of restoration work, the HRAA has been able to reclaim a high percentage of eroding fields. With a considerable amount of staff and volunteer work, this field has enabled the HRAA eco-reach to drop to a priority level of nine. There are still regions where erosion is creating sharp angles in the banks.



Figure 111. A group of high school students volunteering time and energy to help plant thousands of sapling trees in the HRAA field, spring 2008. *Photo G. Sayer*

With the severe nature of the erosion, the river channel is beginning

to shift toward the field, creating large pools. Continued partnership with the Steele family is recommended to further the success of riparian zone and reduce erosion.

Located just above the field is a well-known salmon pool, Crowley's Pool. The adjacent bank is currently in a state of degradation, posing a significant risk toward the pool. The bank is at a severe turn on the river and sits at an almost vertical angle. It is virtually bare, and large chunks of soil are stripped from the banks and deposited into the pool below, annually. This soil generally settles to the bottom, resulting in the infilling of the pool. This single bank has become a sight of great concern to many, with much of the erosion occurring within the last 3 years. Potential restoration techniques will be researched for this site, as the bank will require major work, not just simply trees and shrubs.

Germaine Brook, located in Upham, is our tenth eco-reach priority. Germaine Brook is known for its abundant salmon populations and redds. It is because of these two factors that this reach is prioritized as number ten. Most of Germaine Brook is pristine and untouched, with vast stretches of prime nursery areas. However, along the Fowler farm, sections of the banks are beginning to erode into the brook. Work should continue with the Fowlers to create a vegetated buffer zone that is restricted from cultivation. Planting of riparian tree and shrub species will be conducted to ensure a strong sustainable buffer is created and regular monitoring continued to ensure optimal survival.



Figure 112. In the summer of 2001 staff and volunteers worked tirelessly to clean a dumpsite along the Markhamville reach, removing truckloads of waste.

Although Fowler Brook is reasonably healthy, there exists a significant risk to this stream's habitat. Fowler Brook is located near the headquarters for the Cassidy Lake division of PCS, a large-scale potash mine. The mine currently has a brine line system running directly under and adjacent to Fowler Brook. PCS has a history of brine spills in this area, with one causing massive fish die off in the eighties. Although the technology has improved since that time, there is still a great concern that another large brine spill may occur. Since an incident in the winter of 2009, when a small spill occurred at chamber one, the HRAA has become increasingly concerned with the maintenance of the brine line and the monitoring procedures. Communication will continue with PCS to ensure monitoring is adequate and HRAA continues to be notified promptly of spills and other related issues. Near chamber one, a small water crossing exists. Currently vehicles pass freely through the brook causing varying degrees of damage. HRAA will recommend that PCS create a crossing here to prevent further siltation.

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Previous experience of HRAA and DNR staff, indicates that the water quality of Porter Brook, a major tributary to the Hanford Brook is a major concern. HRAA staff found there to be no fish

present during an electro-fishing study of 2006 and talks with DNR staff reiterated these findings. Water quality issues have not been conclusively identified, but should be investigated further in order to pinpoint potentially negative sources. Speculation is that poor farming practices upstream are causing the issues noted downstream. The current conditions on Hanford Brook are good, though there is considerable fear that its water quality will deteriorate due to the influences of Porter Brook. Once the primary concern has been identified, HRAA will partner with the landowner to create a strategy to correct the issue. Until which time, HRAA will continue to monitor Hanford and Porter Brooks to note any changes.

The headwaters of the Hammond River are found in Markhamville, a small farming community. Through Markhamville, the majority of the land use is dominated by agriculture. Many of the fields contain very little vegetation and erosion has been noted throughout the region. For the most part, water velocities in this region remain low, causing much less impact than some of the lower reaches. Another major concern is that of illegal dumping. Due to the remote nature of Markhamville, illegal dumping occurs on a regular basis. Most of the illegal dumping is thought to occur on the properties of the offenders. Public outreach is the most effective way of dealing with illegal dumping. HRAA will create partnerships with landowners, assisting in riparian zone restoration to reduce erosion and garbage removal to instill stewardship.

The Cusack's Bridge reach of the main stem remains in good condition, as most of its riparian zone is comprised of forested land. Small isolated sections of erosion have been noted. Therefore, landowners will be pursued and encouraged to develop or increase buffers. In addition, isolated properties have been found to be illegally dumping their waste over the banks of their residences. These landowners will be consulted and non-compliance will result in a report to the illegal dumping hotline, and if applicable, the unsightly premises act can also be pursued.

The Smithtown eco-reach is in good condition, although most of the river is surrounded by agricultural land. The majority of the banks surrounding the river are very shallow, allowing the water to pass over them with little erosion. However, where the bank slope is steep, erosion is beginning to take place. The erosion is limited to a few areas, though a timely repair is required, as these areas pose a high risk of developing into large-scale problems. Public outreach geared toward farmers should continue along with planting in fields to establish a strong buffer of trees and shrubs. This area has also seen an increase in development in recent years, with many new houses and communities being built. Monitoring of these activities will continue with efforts being made to work with



Figure 113. Bater Brook riddled with blown down trees following an over harvesting of timber. Photo A. White

developers to protect the best interest of the river system. Volunteers have been a great resource, providing information on activities occurring within the local communities. Volunteer involvement will continue to be a valuable tool for monitoring well into the future.

The North Branch of the Hammond River is a remote location with little development or housing. This reach is at risk of becoming degraded by industrial activities. There is already a brine line running through the region with a second currently under construction. The actual installation of this 2nd pipe is a major concern to the HRSS since much of the activity is scheduled throughout the winter and spring months. Therefore, the risk of siltation and interference with egg incubation is much higher. This project will continue to be carefully monitored throughout 2009. There is also a silica mine in the North Branch drainage area that has had leaching issues in recent years. While strong relationships with PCS have been established over the years, there has been virtually no contact with the silica mine, and this should be remedied in the near future.



Figure 114. Donnelly Brook remains pristine but, any changes in the current land use this brook will be at risk of becoming degraded. *Photo S. Prosser*

Priority number seventeen is the Brawley Brook reach. The land surrounding Brawley Brook currently is forest, but these conditions are being threatened by increased development in the area. The area, which the brook passes through has become increasingly urbanized with residential development. Large tracts of land are being converted from forest to housing communities. HRAA will continue to monitor these sites, ensuring all laws are abided and the well being of the brook and river is protected. Stream habitat assessments conducted in previous years found there to be a great deal of illegal dumping taking place. The majority of the garbage removed is attributed to passersby's, throwing garbage over the bridge. Stream habitat assessments will continue on Brawley Brook and garbage will continue to be removed. An emphasis will be placed on the education of local landowners to create stewards of the brook. The presence of the HRAA should be felt within this community to fully engage landowners.

The Bater Brook area is very similar to the Brawley Brook watershed. Much of its riparian area is forest, but an increase in development is resulting in the clearing of large parcels of the landscape. Monitoring of the Bater Brook development will continue. HRAA will also establish contacts with developers to determine the plans and offer suggestions and assistance while working around the watershed. The riparian zone around the brook is highly sensitive to cutting, previous tree harvesting has left portions of the riparian zone blown down. HRAA will work to ensure future harvesting operations around the brook are aware of the ramifications of minimal stocking of residuals.

While the majority of McGonagle Brook runs through forested land, the entire lower portion runs through grazing fields. Work has been done to isolate the cattle from the stream but with spring flooding the fencing is often destroyed. Therefore, HRAA will return on an annual basis to ensure the fencing is still in place and the cattle cannot access the brook. With much of the brook passing through the open fields the water temperature fluctuates regularly. HRAA has and will continue to plant trees along the brook to both stabilize the banks and reduce water temperatures.

The final three priority locations are Mill Brook, Donnelly Brook and Titus Brook. These three brooks are currently in pristine conditions with few problems. The three share on common concern, land use. With any changes in the current land use these brooks are at risk of becoming degraded. A monitoring and protection plan will be put in place to ensure these brooks continue to be healthy and productive. Also further studies will be conducted to create a baseline data on the stream habitat, through stream habitat assessments.

The plans for each of these eco-reaches will be implemented within the next five years, according to available resources, funding and time constraints. The HRAA team will work to continue creating stewards of the river throughout all of the communities in the watershed, while building relationships with developers, residents and businesses alike. There is no question that more issues will continue to arise over this time, but HRAA will be better equipped to deal with these challenges, thanks to the plans and clear directions that are laid out in this Management Plan. Public outreach will continue to be an important part of the HRAA mandate, as will restoration and protection within the watershed. Thank you to all who helped in the creation of this document.

VI. Glossary of Terms

Algae bloom- A sudden burst of nutrients within a water body allowing algae to flourish, often reducing dissolved oxygen levels in the water, posing a hazard to aquatic inhabitants.

Alkalinity: is a measure of water's capacity to neutralize an acid and resist changes in pH. Alkalinity measures the amount of alkaline compounds in the water, such as carbonate, bicarbonates, and hydroxide. (New Brunswick Department of the Environment Analytical Service Laboratory, 1999)

“As it naturally occurs”: referring to a watercourse which displays physical, chemical and biological characteristics that are not affected or are only minimally or temporarily affected by human activity (New Brunswick Department of Environment, 1999)

Bailey bridge- A pre-fabricated bridge often used by military personnel as a temporary crossing; few can still be found crossing the Hammond in its upper reaches.

Benthic Invertebrates: Aquatic insects and other invertebrates that spend part or all of their life cycle in or on the bottom of a watercourse and are capable of being seen without magnification (New Brunswick Department of Environment, 1999)

Brine: salt or seawater, in most cases within the Hammond River it is derived from potash through “brine lines” which run throughout the watershed.

Broodstock- Collection of sexually mature salmon and grilse from a salmon pool. These fish are then sent to Mactaquac where they are spawned and released to the river again and the juveniles are reared streamside.

Dissolved oxygen- The amount of oxygen absorbed into a given medium, in our case water. This measurement indicates the overall quality of environment for aquatic inhabitants.

Drainage Area: The contours of the land running from high points to low points through which water travels. It is at the lowest point of these areas where streams and rivers often form.

***E. coli* (*Escherichia coli*):** this bacteria is frequently used as an indicator for bacteria and possible pathogen contamination of inland and coastal water (McNeely, R.N. *et al.*, 1979).

Eco-reach: A section of the river system divided for ease of classification. The division was made in 1998 using bridges as land marks and naming the reaches accordingly.

Electro-fish: The use of electrical current to temporarily demobilize fish allowing a sample to be taken of a given fish population. This methodology is widely used throughout the scientific community and has proven to be very successful at HRAA.

Embeddedness: the degree that larger particles, such as boulders, rubble, or gravel, are surrounded or covered by fine sediment (Hunter, 1991).

Fecal Coli form: A group of bacteria within the coli form family specific to the intestinal tract of warm blooded animals and humans. Presence of fecal coliforms is an indicator of fecal pollution (New Brunswick Department of the Environment Analytical Service Laboratory, 1999)

Ford(s): Locations at which crossing of a river or stream has historically taken place. The water level is typically low and the crossing is preferred to be at 90° to the water as to reduce detrimental effects.

Fry: a recently-hatched fish, one which has fully absorbed its yolk sac and can now hunt and consume live food

GIS: Geographical Information System. Widely used mapping software used to document work HRAA has performed. This has been a highly valuable tool in the creation of maps depicting the locations of streams and work performed.

Habitat: the total environment required by plants and animals to sustain all its life functions. Habitat requirements of fish include food, space, shelter, and water quality (Department of Fisheries and Oceans, 1988)

Median Substrate: the materials making up the streambed; usually described as bedrock, boulder, cobble, gravel, sand or silt (Department of Fisheries and Oceans, 1988)

Overhanging Cover: is vegetation that hangs over a waterway and provides shade, cover, food and a breeding place for aquatic insects

Parr: juvenile fish, one preparing to leave the fresh waters of its home.

pH- The measure of the acidity or basicity of a given solution. All aquatic inhabitants have a tolerance to pH levels most often near the 7.00 reading

Point Source: pollution discharged directly into the environment, usually through a discharge pipe. Includes industrial and commercial process effluent, and collected human wastes (New Brunswick Department of Environment, 1999)

Pool: water of considerable depth for the size of the stream; pools generally have slowly flowing water and a smooth surface but they often have a swift, turbulent area where the water enters them (Department of Fisheries and Oceans, 1988)

Presence/absence- Electro-fishing assessment used to determine essentially the presence or absence of fish species within a given area. Often used to determine the probability of a given habitat to be assessed further.

Redd: the gravel nest which salmonids lay their eggs in (Department of Fisheries and Oceans, 1988)

Riffle: shallow water with a rapid current and surface flow broken by gravel or rubble (Department of Fisheries and Oceans, 1988)

Riparian Areas: land adjacent to a stream or other body of water (Smith, 1992)

Rip Rap: a foundation or wall made of broken rock and/or logs (Department of Fisheries and Oceans, 1988)

Run: moderate to rapid current flow in a deeper, narrower channel than a riffle; the depth and materials found in runs make them excellent cover locations for salmonids (Department of Fisheries and Oceans, 1988)

Sedimentation: deposition of eroded soil material on the streambed (Department of Fisheries and Oceans, 1988)

Silvics- the study of forests and their ecology, including the application of soil science, botany, zoology, etc. to forestry

Smolt: This is the stage where Salmonid becomes physiologically adapted to saltwater and begins its trek to its salt water environment.

Stakeholder: individual or an organization who has a direct and/or indirect interest in the watershed (Eastern Charlotte Waterways Inc., 1999)

Substrate- The composition of the stream bed.

Tannin- Binding agent found in many plants and trees. This agent breaks down into water during defoliation of trees and often changes water a deep brown “cola” colour.

Three sweep regression- Method of electro-fishing where a section of stream is isolated by two barrier nets and three passes are made through the given area to determine the overall fish density.

Tolerant hardwoods- Hardwood trees that can thrive under the canopy/cover of surrounding trees prior to being opened up to full sunlight. These trees often have large canopies and are able to shade large amounts of the surrounding ground. These trees tend to be a much longer lived tree species, far exceeding the non-tolerant species.

Total Kjeldahl Nitrogen (TKN): represents the nitrogen equivalent to the sum of ammonia and organic nitrogen. TKN levels are important for assessing the amount of nitrogen available for biological activities (New Brunswick Department of the Environment Analytical Service Laboratory, 1999)

TP (Total Phosphorus): phosphorus originates from weathering of bedrock, decomposition of organic matter, domestic sewage, phosphate from detergents, and drainage from fertilized land. (New Brunswick Department of the Environment Analytical Service Laboratory, 1999)

Turbid- The cloudiness created within water as suspended particles become active (like smoke in the air). Often seen in areas with large scale erosion.

Water Classification: A technical and administrative procedure that can be used to manage water by setting goals for use and protection. Rivers, tributaries, and lakes or segments of rivers are placed into categories based on the desired level of protection (Eastern Charlotte Waterways Inc., 1999)

Watershed: an area of land from which water drains downhill into a body of water such as a lake or river. A watershed is comprised of hills, valleys, lakes, streams, rivers and smaller tributaries (Fergus Lea *et al.* 1990).

Water Velocity: a measurement of speed recorded as distance traveled over time (eg. feet or meters per second) (Department of Fisheries and Oceans, 1988)

Zippin- Program used following electro-fishing data collection to determine fish densities on a per 100 metres square standard. This program allows data from many samples to be compared on a standard basis.

Riparian Zone Rating System

Rating the health of the riparian zones surrounding a given eco-reach helps HRAA to correlate readings such as dissolved oxygen, water temperatures and fish density. The health of the riparian helps stabilize the overall health of the water and the fish populations that inhabit the given reach. Ratings range from excellent to poor helping HRAA to prioritize summer riparian restoration projects.

Excellent- The riparian zone is well vegetated with 80% or greater of the banks comprised of trees and shrubs. Minimal erosion is present (<10%) and the banks are stable.

Good- The riparian zone is heavily vegetated with 79%- 60% of the banks comprised of more shrubs than trees casting shade across 60% of the reach during mid day sun. Erosion surrounding the site is isolated to a few locations (11% - 25%).

Fair- The riparian zone is vegetated with 59% - 40% of the banks comprised of shrubs and few trees, casting less than 60% shade on the reach during mid day sun. Erosion is occurring during peak water flow times (26% - 49%). These areas should be monitored closely to ensure they do not deteriorate further.

At Risk- The current condition of the riparian zone falls within the good to fair rating. However increased degradation that may reduce the riparian rating at an expedited rate. These sites are typically found in areas under high development pressure and agricultural land.

Poor- The riparian zone has little to no trees or shrubs covering less than 39% of the bank covered in trees or shrubs, the water has minimal vegetative cover. Erosion occurs frequently with greater than 50% of the banks eroding.

VII. References

Department of Fisheries and Oceans. December 1988. A Guide for Fish Habitat Improvement. Gulf Region, Science Branch, Fish Habitat and Enhancement Division, P.O. Box 5030 Moncton, New Brunswick, E1C 9B6.

Eastern Charlotte Waterways Inc. 1999. Water Classification Guidebook. 17 Main Street, St. George, New Brunswick, E0G 2Y0.

Fergus Lea, P.E, T. Landry and B. Fortier. 1990. Comprehensive planning for lake watersheds. Maine Department of Environmental Protection.

Hunter Christopher. 1991. Better Trout Habitat: A Guide to Stream Restoration and Management. Island Press, Suite 300, 1718 Connecticut Avenue, NW, Washington, DC.

McNeely, R.N. *et al.* 1979. Water Quality Source Book, A Guide to Water Quality Parameters. Environment Canada, Inland Water Directorate, Water Quality Branch, Ottawa, Ont.

New Brunswick Department of the Environment, 1999. Overview of the Water Classification Regulation. Environmental Planning Section, P.O. Box 6000, Fredericton, New Brunswick.

New Brunswick Department of the Environment Analytical Service Laboratory, 1999. Unpublished description of *B Parameters.

Smith Robert. 1992. Elements of Ecology. 3rd Edition. Addison-Wesley Educational Publishers, Inc.

Perley, Moses Henry, 1852. Reports on Sea and River of New Brunswick. J. Simpson, Printer to the Queen's Most Excellent Majesty. Fredericton, New Brunswick

Institute for Resources, Environment and Sustainability, University of British Columbia, Certificate Programs. 2006. Accessed on March 2, 2009. <http://www.ires.ubc.ca/academic/certificate/index.html>