

Distribution, Habitat, and Population Structure of Nova Scotia

Brook Floater (*Alasmidonta varicosa*)

Final project report to the Nova Scotia Species at Risk Conservation Fund

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I Executive Summary

The Brook Floater (*Alasmidonta varicosa*) has been previously reported from 11 disjunct river and lake locations in Nova Scotia. Relatively little information has been available to date on individual population densities and numbers. The purpose of this study was to provide further information on the distribution, individual population size, and habitat features of this species in Nova Scotia. Brook Floater presence was reconfirmed in the Annapolis River, Wallace River, Salmon River (Guysborough County), St. Marys River, Gays River, Eden Lake and Lochaber Lake. No Brook Floaters were found or confirmed in the LaHave River, Bordens Lake (Guysborough County), or Mattatal Lake. Morphologically similar specimens found at Mattatal Lake during this study and previously identified as Brook Floaters are now suspect. A potential new site was located within the St. Marys River system at Black Brook, Pictou County. Where present, individual sample populations ranged in density from rare ($< 0.01/m^2$) to relatively abundant ($2.0/m^2$), and for Salmon River, St. Marys River and Wallace River calculated population size is potentially much larger than previously reported. UTM coordinates are provided for all qualitative survey locations for future sample plot surveys to track changes. Brook Floaters prefer a gravel substrate with fines, and are found where there are predominantly mixed-wood riparian zones with a wide variety of adjacent local land use practices. Long term trends in Brook Floater populations should be monitored through the use of permanent sample plots established on regionally representative rivers.

II Introduction

As a taxonomic group, freshwater mussels are one of the most threatened groups in North America, with nearly 70% of all species considered extinct, endangered, threatened or rapidly declining (Strayer and Ralley 1993, Martel *et al.* 2010). Reasons for these declines include sedimentation, pollution, riparian zone alterations, acid precipitation, loss of fish habitat, declining fish stocks, invasive species, climate change, and anthropogenic changes to watercourses (Martel *et al.* 2010).

Members of the genus *Alasmidonta* are among the most imperiled mussel fauna in North America. Of 13 species, 11 are endangered, threatened, extinct, or of concern (Williams *et al.* 1993). Three species are found in Canada, *Alasmidonta heterodon*, the Dwarf Wedge Mussel; *Alasmidonta undulata*, the Triangle Floater; and *Alasmidonta varicosa*, the Brook Floater, or Swollen Wedge Mussel (Williams *et al.* 1993). Only *A. undulata* and *A. varicosa* are found in Nova Scotia (Davis 2007).

Brook floaters are officially recognized as a species at risk in Canada and Nova Scotia. The Committee on the Status of Wildlife in Canada (COSEWIC) designated this species as “Special Concern” in 2009 based on a status assessment by Bredin and Martel (http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_brook_floater_0809_e.pdf). The authors of the status report found that Brook Floaters were found in 15 widely distributed watersheds throughout only Nova Scotia and New Brunswick, and represented only 1-5% of the available freshwater mussel fauna in their Canadian range. Brook Floater habitat was vulnerable to pollution, sedimentation and poor shoreline management practices associated with intensive agriculture and forestry practices, and increased shoreline alterations for residential and cottage development (COSEWIC 2009). Provincially, Brook Floaters and Triangle Floaters are designated as “yellow” species (sensitive to human activities and natural events) under the General Status Ranks of Wild Species assessment criteria.

Brook Floater occurrences in Nova Scotia and New Brunswick represent approximately 8% of the species global range (COSEWIC 2009). Nova Scotia records for this species were first published by Athearn and Clarke (1962) who documented this species in the Wallace, St. Mary’s, Annapolis, and Stewiacke rivers. Subsequent investigations by the Nova Scotia Museum of Natural History, the Nova Scotia Department of Natural resources, and the authors of the status report have documented the persistence, or loss of historical populations, and identified new occurrences. These findings are found in Davis 2007, COSEWIC 2009, and Martel *et al.* 2010.

Bredin and Martel (COSEWIC 2009) report that mussel surveys between 1998 and 2007 resulted in four new Brook Floater sites in Mattatall Lake, Gays River, Salmon River and Bordens Lake; and range extensions within the Annapolis and St. Marys Rivers.

To date very little information is available for this species beyond distribution and presence/absence data for Nova Scotia. Bredin and Martel (COSEWIC 2009) summarize known information on sampling effort and number of live individuals found at survey sites; however, there is little information available on population densities, structure and size, or morphological variation between populations.

With this in mind the objectives of this study were to:

1. Expand field survey coverage for all currently known Brook Floater populations.
2. Quantify population densities, and calculate population size and structure at all known Brook Floater locations.
3. Describe habitat characteristics, georeference all populations, and map the total extent of known populations and survey areas.

4. Establish long term monitoring plots at each Brook Floater site using EMAN protocols developed by Andre Martel.
5. Prepare a report in the form of a BSc. Biology Honours Thesis for St. Francis Xavier University.
6. Forward sample specimens collected to Nova Scotia Museum of Natural History

III Methodology

Brook floater survey sites were based on information from Bredin and Martel (COSEWIC 2009), Nova Scotia Museum of Natural History records, and information from prior surveys completed by the Nova Scotia Department of Natural Resources. Wherever possible, sampling sites for this project were placed as close as possible to previously reported sites. Once on site, a 100 m bank to bank reach was selected (based on an initial qualitative survey) and later georeferenced (UTM, NAD 27) using coordinates from Google Earth (December 2010). These coordinates designate survey centers of the permanent sample plots. All surveys were in water ≤ 1 m deep.

Qualitative surveys using a glass bottom viewing bucket were used to establish presence or absence of mussels. If Brook Floaters were found a more rigorous quantitative survey was completed. At each quantitative sampling location, 1 m² quadrats were randomly placed along transects spaced 2 m apart that spanned the full bank width and covered a 100 m reach. Within each quadrat sampled, all mussels were located using a glass-bottomed viewing bucket, collected, identified, and measured before being returned to the quadrat. Total length (to the nearest 0.1 mm) was measured using electronic callipers.

Percent surface substrate composition within each quadrat was qualitatively assessed and recorded. Substrate clast size ranged from fines (silt, sand), gravel, cobble, boulder, to bedrock. No excavation or substrate screening was done to locate mussels below the visible surface.

Valves from dead brook floaters were collected and forwarded to the Nova Scotia Museum of Natural History. Person search hours were recorded for each site.

For qualitative surveys catch per unit effort (CPUE) was calculated as number of Brook Floaters found per person search hour (psh). All densities and lengths were recorded as mean values plus/minus (\pm) standard error (S.E.). Axis values for histograms of Brook Floater maximum length distribution appear in a "European style" with commas rather than decimals.

Surveys and collections were made under the authority of a DFO License to Fish (for Educational Purposes), SG-GNS-09-142, issued from the Antigonish office (contact: Mr. Paul

Boyd); and a separate authority issued by the Nova Scotia Museum of Natural History in Halifax (contact: Mr. Andrew Hebda, Curator of Zoology).

IV Results

During the summer 2009 12 qualitative and 7 quantitative surveys for Brook Floaters (*Alasmidonta varicosa*) were conducted throughout Nova Scotia with the intent of (1) reconfirming known locations, and searching out previously unreported populations (2) quantifying local population demographics, (3) better understanding habitat and impacts of land use practices, and (4) establishing long term monitoring stations. Objectives 1 and 4 were successful, but unfortunately there is little meaningful data for objectives 2 and 3 because of the physical loss of data following the field season. One of the critical pieces of missing information was the actual number of 1 m² quadrats sampled at each site. Where possible these data were inferred from density calculations and number of known individuals observed and measured. In all cases where quantitative sampling occurred, at least 45 quadrats were sampled. Despite these difficulties there is no reason to suspect that these data are not correct, only incomplete. All specimens collected were deposited with the Nova Scotia Museum of Natural History.

IVa Brook Floater Locations

Brook Floater populations in Nova Scotia had previously been reported by Bredin and Martel (COSEWIC 2009). Their report recognizes populations in the Annapolis River, Gays River, Wallace River, LaHave River, Salmon River (Guysborough County), St. Mary's River system (including Lochaber Lake and Eden Lake), Bordens Lake (Guysborough County) and Mattatall Lake.

Surveys from this study confirm the presence of Brook Floaters in the Annapolis River, Gays River, Wallace River, Salmon River, East and North Branch St. Marys River, Lochaber Lake* and Eden Lake. No living or dead specimens were located in the LaHave River, Bordens or Mattatall Lake.

*Dead specimen only

Annapolis River

The single sampling site surveyed in the Annapolis River was upstream of the train trestle where it crosses the river in Middleton, and downstream of the highway that links the TCH 101 and Highway 1 (Figure 1). The qualitative sampling site began 80 m upstream from the railway

trestle and extended approximately 150 m upstream adjacent to Riverside Park. Total mussel density (all species) was $\geq 300/\text{m}^2$ in several locations at this site. Eastern Elliptio (*Elliptio complanata*) comprised $> 90\%$ of the observed mussels, with lesser amounts of Alewife Floater (*Anodonta implicata*), and the occasional Brook Floater. Very high bacterial counts from agricultural runoff and raw sewage from a failed sewage treatment facility on Slokum Brook pre-empted the survey, and on the advice of local health officials survey time spent in the water was kept to a minimum.

Five Brook Floater specimens (CPUE = 2.22) were found in a single midstream sand lens (1 m x 5 m) approximately 20 m downstream of the Slokum Brook outflow (Figure 1).



Figure 1. Aerial view of qualitative survey area (white oval) in Annapolis River, Middleton, King's County. Red star indicates approximate location of 5 Brook Floaters in sand lens.

LaHave River

Although Bredin and Martel (COSEWIC 2009) report Brook Floaters at multiple sites on the LaHave River, none were found at three sites surveyed for this study. Two of the three sites surveyed (sites 2 and 3) were based on coordinates of known Brook Floater locations reported by Bredin and Martell (COSEWIC 2009). Poor visibility, accessibility and survey success may

have been the result of recent rains that contributed to high water levels and tannic water. Eastern Elliptio were found at all three sites (Figure 2) in low densities, $< 0.42 \pm 0.17/m^2$.

Water depth and substrate composition varied widely across the three sites, ranging from < 0.15 m deep and primarily gravel, to > 1.5 m deep with boulder and bedrock.



Figure 2. Aerial view of Brook Floater survey sites on the LaHave River near Bridgewater. Survey area was contained within boundaries of the circles. No Brook Floaters were found although Bredin and Martell (COSEWIC 2009) reported finding specimens at sites 2 and 3.

A qualitative survey at site 1 (CPUE 0; 1.5 psh) covered approximately $650 m^2$ (13 m x 50 m). This site was not previously surveyed by Bredin and lies adjacent to a small locally maintained picnic area between Highway 10 and the river. Water levels were ≤ 50 cm and substrate was primarily cobble.

Site 2 (CPUE 0; 1.5 psh) was surveyed upstream of the bridge on the west side of the river. Total qualitative survey area was $1000 m^2$ (10 m x 100 m). Water depth in the river restricted surveys to a 10 m strip along the bank, and substrate varied from sand/silt to cobble.

Site 3 was immediately upstream of the bridge at Wentzells Falls and had confirmed reports of Brook Floaters in the past Bredin and Martel (COSEWIC 2009). A bank to bank quantitative survey (48 m x 12 m, 576 m²) revealed no Brook Floaters, however, survey conditions were poor from dark coloured deep water; consequently, the survey was shortened because of visibility problems. Water depth and substrate varied widely across the river, ranging from < 0.15 m and gravel, to > 1.5 m and boulder and bedrock.

Gays River

One live Brook Floater was found during a preliminary qualitative survey at site 1 (Figure 3). A quantitative survey at the same location did not reveal any more individuals. Other qualitative surveys at sites 2, 3, and 4 failed to detect Brook Floaters (Total 9.25 psh) . Eastern Elliptio was the only mussel species found with a combined density across all sites of $1.02 \pm 0.22/m^2$.



Figure 3. Aerial view of Gays River, Colchester County Brook Floater survey sites. Surveys occurred within the boundaries of the ovals.

Mattatall Lake

Nova Scotia Museum records indicate that Brook Floaters were collected at this site in the past. No Brook Floaters were found during a 2.5 psh qualitative survey; however, three specimens of a mussel previously thought to be *A. varicosa* were observed during this survey. Comparisons

between the Mattatall Lake mussels and confirmed Brook Floater collections at the museum suggest a misidentification of supposed Brook Floater mussels from this lake in the past.



Figure 4. Aerial view of Mattatall Lake with mussel survey site indicated by red oval. No Brook Floaters were located.

Wallace River

Wallace River is the only Gulf of St. Lawrence drainage known to have a population of Brook Floaters, although it is believed to be small (~ 200 individuals; COSEWIC 2009). Three sites were surveyed on this river. Sites 1 and 2 were qualitatively surveyed with viewing buckets; Site 3 was quantitatively sampled. No Brook Floaters were found at Site 1 (2 psh), however, Site 2 (2 psh) produced valves from two different Brook Floaters (CPUE 0; dead), and Site 3 produced three live Brook Floaters with a mean length of 62.52 ± 0.33 mm (Figure 6). Eastern Elliptio, and Eastern Pearlshell (*Margaritifera margaritifera*) were found at all three sites in low numbers. Mean total mussel density for all surveyed areas was $0.46/\text{m}^2 \pm 0.08$. Mean densities for Eastern Elliptio and Eastern Pearlshell were $0.25/\text{m}^2 \pm 0.06$ and $0.19/\text{m}^2 \pm 0.04$ respectively. Brook Floater density at Site 3 was $0.03/\text{m}^2 \pm 0.02$, and comprised 6.5% of the total mussel population for all sites combined. The calculated BF population for the 100 m reach at Site 3 (100 m x 32 m) is 96. The mean length of BF (n = 3) was 62.52 ± 0.33 mm.



Figure 5. Aerial view of three freshwater mussel survey sites for the Wallace River indicated by red ovals.

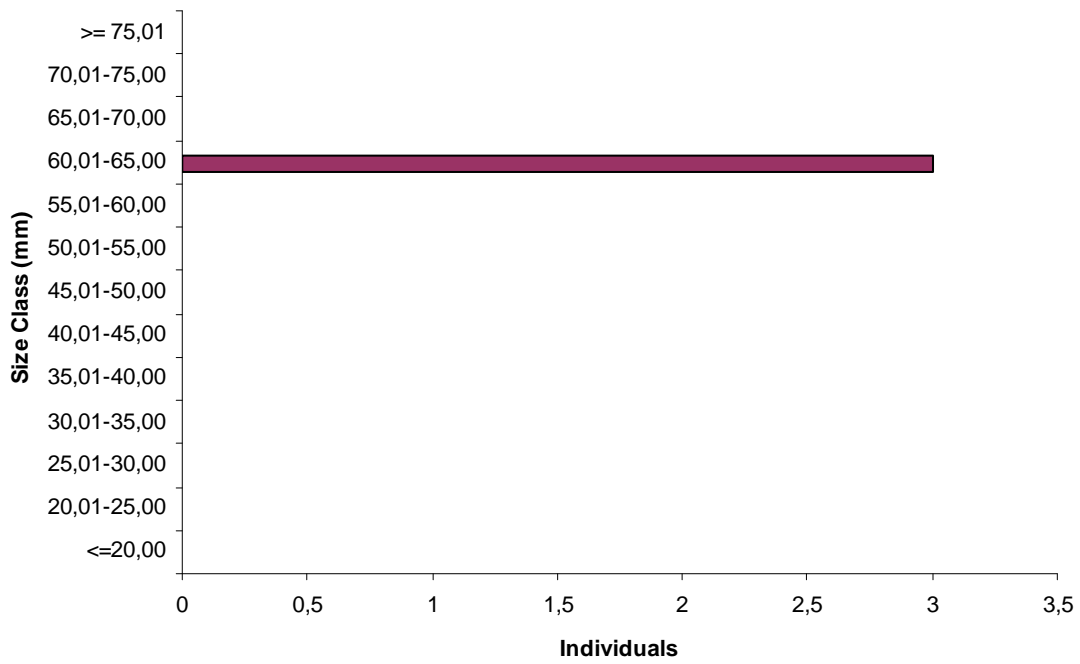


Figure 6. Size class distribution of the 3 live Brook Floaters found at Site 3 in the Wallace River.

Salmon River (Guysborough County)

The Salmon River survey location is downstream from the outflow of North Branch Lake in the Ogden Round Wilderness Area (Figure 7). This site was chosen because Brook Floaters were previously found at this site by M. Pulsifer (DNR Regional Biologist, Antigonish). Four species of freshwater mussels were found at this site during a 100 m reach quantitative survey, Brook Floaters, Eastern Elliptios, Eastern Pearlshell, and Eastern Floater (*Pyganodon cataracta*).

Total mussel density for this site was $29.54/m^2 \pm 6.91$. Eastern Pearlshells were the dominant species, accounting for 92.7% of the total mussel population counted. Brook Floaters were the second most abundant species at this site ($n = 19$). Densities for the four individual species were: Brook Floater $1.46/m^2 \pm 0.46$; Eastern Elliptio $0.38/m^2 \pm 0.18$; Eastern Pearlshell $27.38/m^2 \pm 6.49$ and Eastern Floater $0.31/m^2 \pm 0.85$. Based on site densities and area of reach (100 m x 14 m, 1400 m²) the calculated Brook Floater population was 2044.

Mean lengths by species were: Brook Floater 53.32 mm ± 1.21 ; Eastern Elliptio 61.70 mm ± 9.07 ; Eastern Pearlshell 68.77 mm ± 0.40 , and Eastern Floater 72.06 mm ± 4.94 .

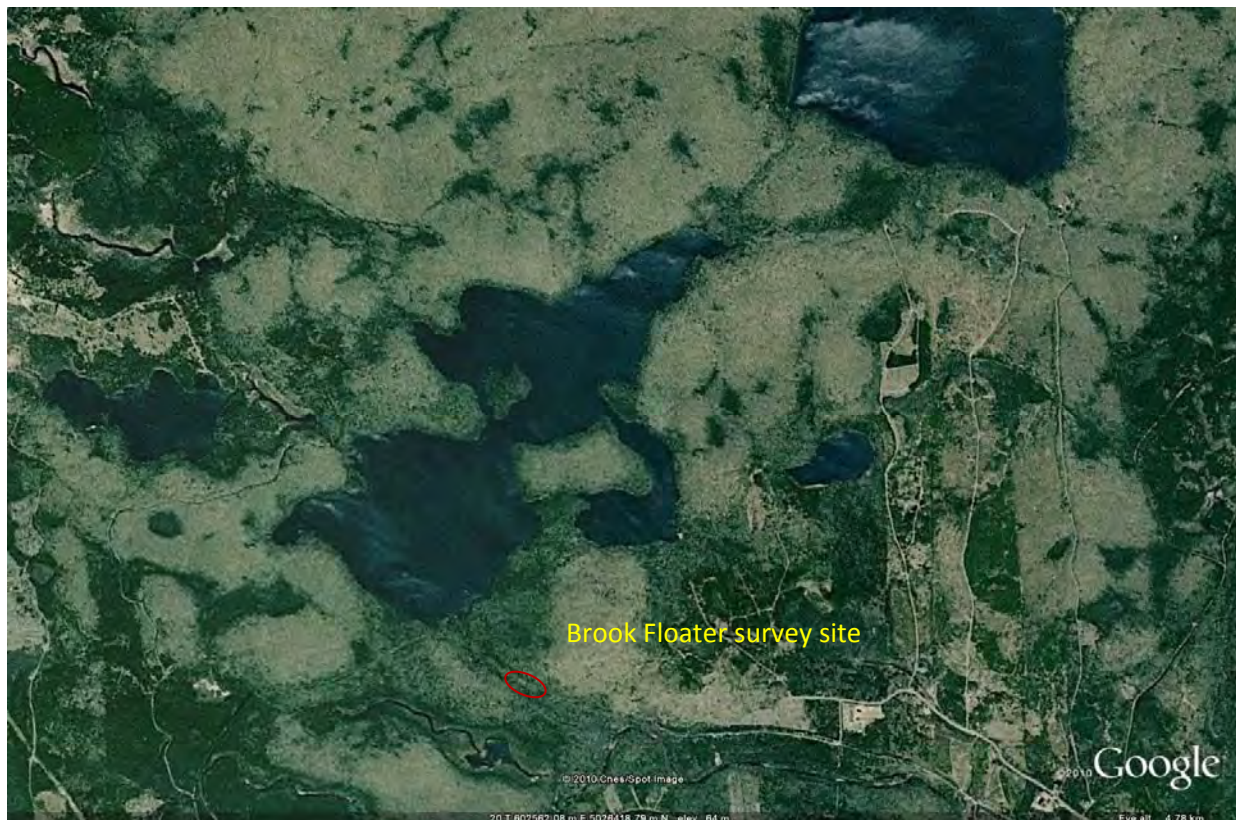


Figure 7. Aerial view of North Branch Lake, Guysborough County, and Salmon River survey location shown as red oval.

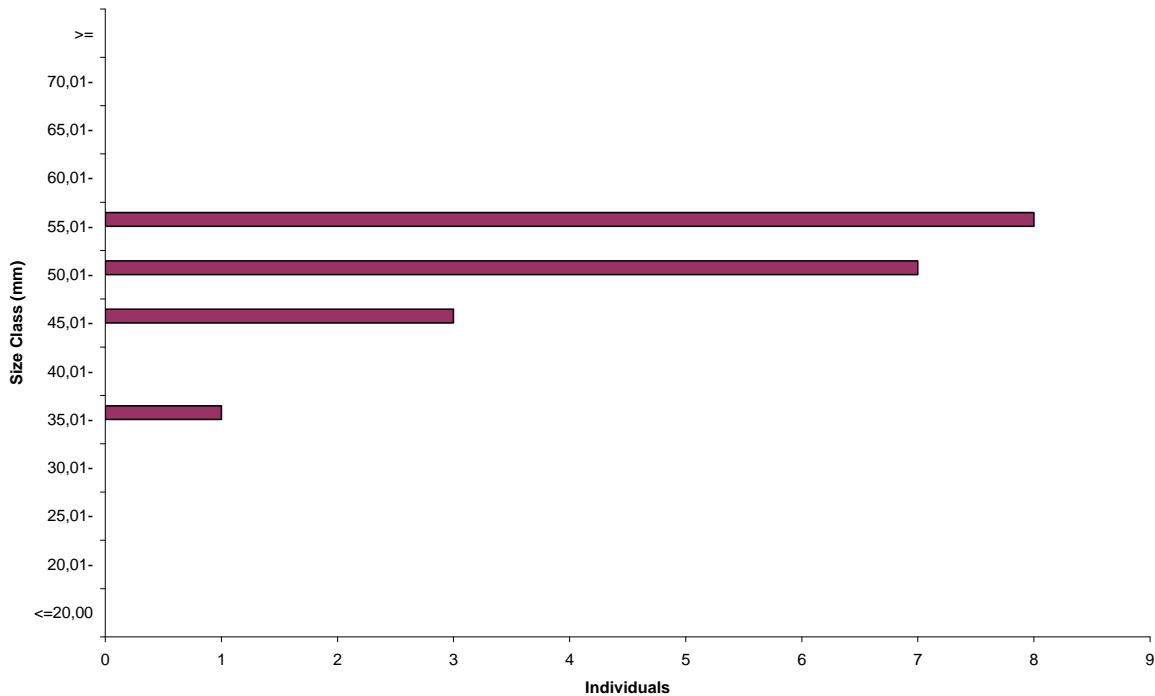


Fig 8. Size class distribution of Brook Floaters in Salmon River. Mean length was 54.32 +/- 1.21 mm.

East Branch St. Mary's River

The St. Mary's River watershed has the largest number of known Brook Floater sites to date. Three sites have been previously identified on the East Branch St. Mary's River, four sites on the North Branch St. Mary's River, and one site on the Main Branch St. Mary's River (COSEWIC 2009). In this study, two sites were surveyed on the East Branch, one quantitatively (Site 1), the other qualitatively (Site 2).

Site 1 is approximately 2.5 km downstream from the outflow of Eden Lake (Figure 9). Five mussel species were present at this site (Brook Floater, Eastern Elliptio, Eastern Pearlshell, Eastern Floater, Alewife Floater). Total mussel density within the 100 m reach based on quadrats (n = 45) was $4.89 \pm 0.85/m^2$. Eastern Pearlshells were the most abundant single species at $2.33 \pm 0.49/m^2$, with a mean length of 74.65 ± 1.00 mm. Brook Floaters were the second most abundant mussel at this site (n=90), comprising 41.6 % of the total observed sample, with a sample density of $2.00/m^2 \pm 0.47$. Mean length (mm) for this species was 57.28 ± 1.06 (Figure 11). The remaining three species were found at much lower densities ($< 0.30/m^2$ each) and collectively accounted for $< 12\%$ of the total sampled mussel population. Based upon the density of Brook Floaters within the 45 quadrats of the survey reach (100 m x 18 m, 1800 m^2) the calculated population size within this sample plot was 3600.



Figure 9. Aerial view of Brook Floater survey Site 1 location on East River St. Mary's below Eden Lake.



Figure 10. Aerial view of Brook Floater survey Site 2 location on the East River St. Mary's, below Site 1.

Site 2 was immediately downstream of a bridge that replaced an older structure in 2006 (Figure 10). A qualitative survey for 1.5 person-hours failed to find any Brook Floaters (CPUE 0), and total mussel presence was very low.

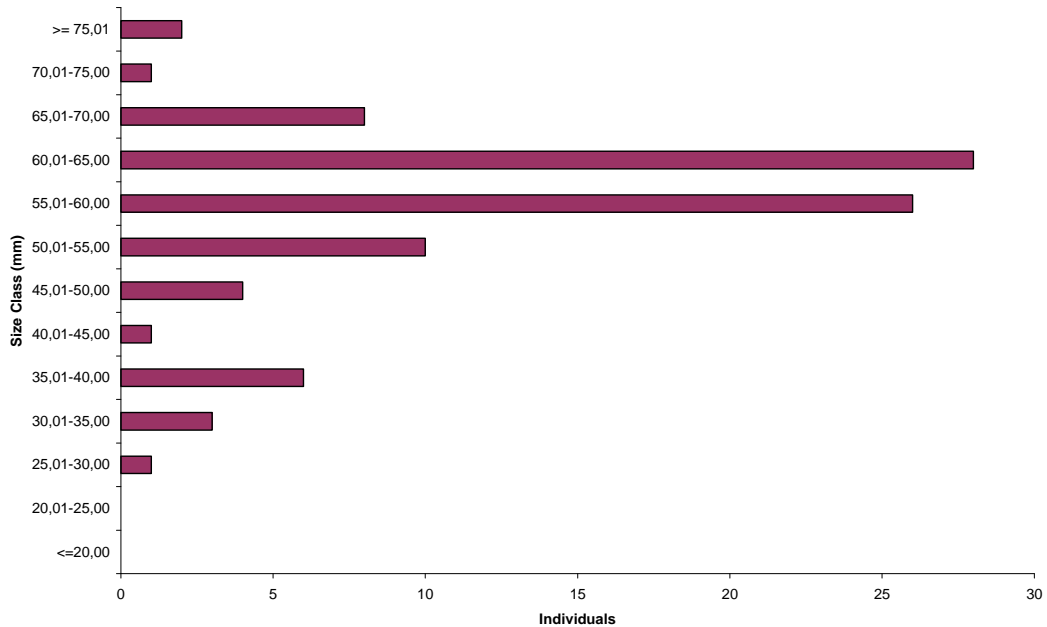


Fig 11. Size class distribution of Brook Floaters at site 1 in East Branch, St. Mary's River. Mean length for 90 specimens was 57.28 +/- 1.06 mm.

North Branch St. Mary's River

The North Branch St. Marys River flows south from Lochaber Lake, and has several Brook Floater sites. Site selection for this project was based on accessibility. At the nearest access point (Figure 12) a qualitative survey revealed a Brook Floater within 0.16 person-hours. A subsequent quantitative survey of 50 random 1 m² quadrats resulted in three species of mussel at this site, Brook Floater, Eastern Elliptio and Eastern Pearlshell. Total mussel density was 3.18 ± 0.47/m². Eastern Pearlshells were the dominant species, accounting for 96.2% of the total mussel population sampled (density = 3.06 ± 0.46/m²). Densities for Brook Floaters and Eastern Elliptios were 0.14 ± 0.08/m² and 0.06 ± 0.03/m² respectively. Brook Floaters comprised 4.4 % (n = 7) of the total sampled mussel population and mean length for the seven Brook Floaters measured was 54.14 ± 2.41 mm (Figure 13). The Brook Floater population estimate for the sample plot (100 m x 12 m; 1200 m²) was 168.



Figure 12. Aerial view of freshwater mussel survey location for North Branch St. Mary's River near Aspen, Guysborough County. Survey area is within red oval.

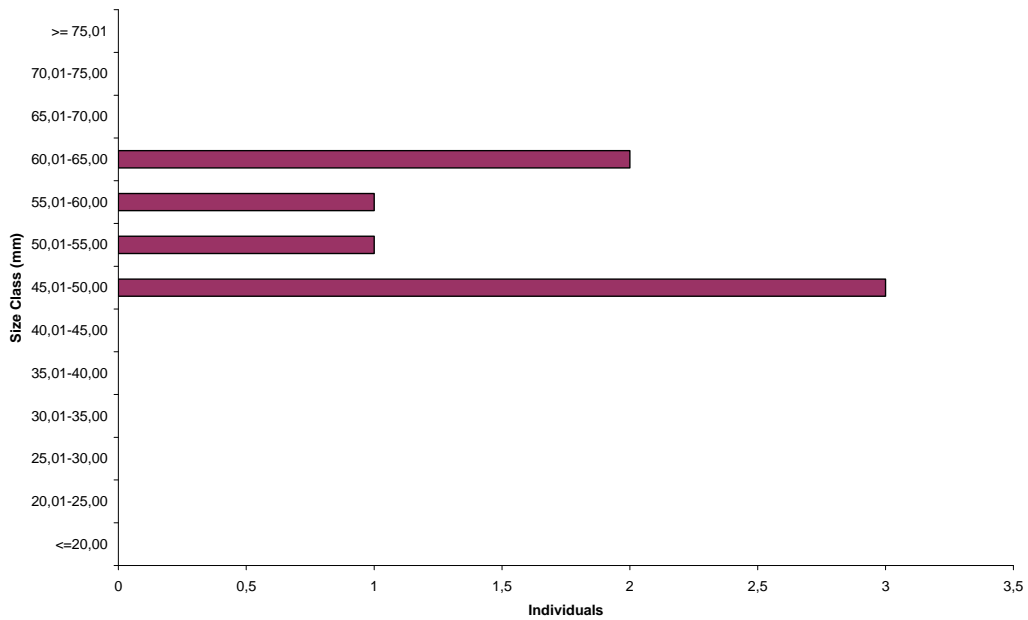


Figure 13. Size class distribution of Brook Floaters in North Branch, St. Mary's River. Mean length was 54.14 +/- 2.41 mm.

Eden Lake

Eden Lake, Pictou County, was the only lake quantitatively surveyed. This lake empties into the East Branch St. Mary's River. The survey area was on the north-west shore adjacent to cottages and a boat dock. There is no image of the sample site, and the exact location is unknown at this time because of the loss of data. Similarly, there is no record of how far out into the lake samples were taken, or the number of quadrats actually sampled.

Mussel density was much higher than in the East Branch St. Mary's River with $43.00 \pm 13.81/\text{m}^2$. Eastern Elliptio was the dominant species, accounting for 89.7% of the total sample population and with a density of $38.57 \pm 13.30/\text{m}^2$. Eastern Floaters and Alewife Floaters were present in low densities, $3.86 \pm 1.42/\text{m}^2$ and $1.28 \pm 0.75/\text{m}^2$ respectively. Brook Floaters were reconfirmed at this site with a sampled density of $0.13 \pm 0.01/\text{m}^2$. Four valves were found along the shoreline within the 100 m sample area.

Black Brook (Pictou County)

Black Brook was a potentially new location for Brook Floater located via a qualitative survey. This brook is a tributary of the East Branch St. Mary's River near the community of East River St. Marys. A single Brook Floater valve was found by a salmon habitat restoration crew. Subsequently, two qualitative surveys totaling 2.75 ph (CPUE 0) failed to find any further evidence of Brook Floaters. There is no image of the sample site, and the exact location is unknown at this time because of the loss of data.

Lochaber Lake

There are several records of Brook Floater shells being found in Lochaber Lake, particularly along the northern shore near where the North River St. Mary's enters at the north end of the lake (Figure 14).

A 1.3 p-h qualitative survey using viewing buckets was conducted at the north end of the lake. Two Brook Floater valves from different individuals were located along the shore, but no live Brook Floaters were found (CPUE 0).

Live Eastern Lampmussel (*Lampsilis radiata*), Eastern Elliptio, and Eastern Floater were commonly found at this site, despite poor viewing conditions from suspended sediments and rapidly deepening water only a few meters from shore.



Figure 14. Aerial view of qualitative freshwater mussel survey site denoted by red oval at Lochaber Lake, Antigonish County.

Borden's Lake (Guysborough County)

Brook Floaters had previously been reported from Borden's Lake in Guysborough County (DNR 2002), and subsequently been included in the COSEWIC (2009) assessment and status report by Bredin and Martell. Follow-up surveys for this study failed to find any Brook Floaters following a 2 person-hour qualitative survey using viewing buckets (CPUE 0). The exact location of the 2002 DNR survey could not be found through archived records so it remains unclear whether the original DNR data was correct, or Brook Floaters are restricted in their distribution in this lake and a different area was surveyed for this study. Habitats surveyed for this study (Figure 15) were not considered "typical" Brook Floater habitat because of the absence of sands and gravels, and the predominance of cobble.

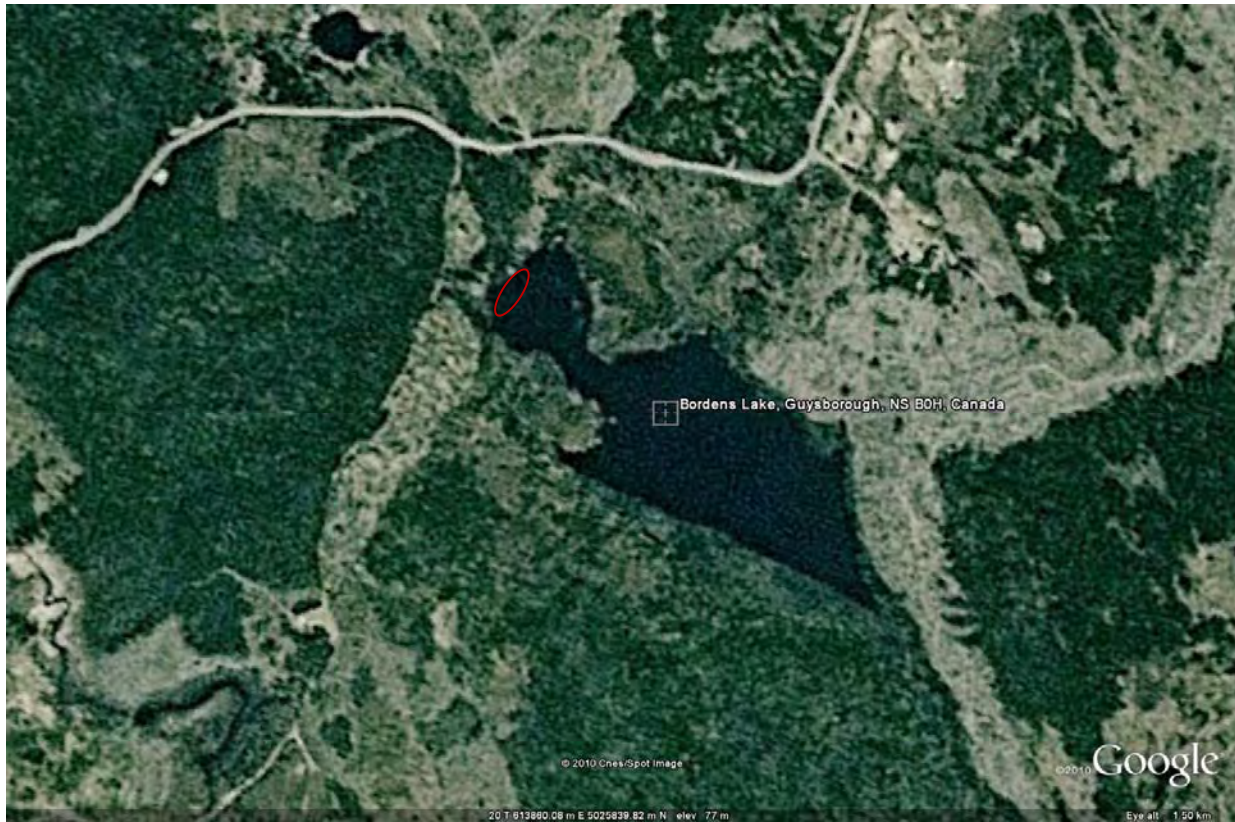


Figure 15. Aerial view of freshwater mussel survey site denoted by red oval at Borden's Lake, Guysborough County, near inflow from Godfry Brook.

IVb Substrate Composition

Ocular estimates of the relative percentage of bedrock, boulder, cobble, gravel and fines were taken for all quadrats. Table 1 below indicates that Brook Floaters are most commonly found in predominantly gravel and sandy substrates, or where sands and gravels occur interstitially between boulder and cobble.

Table 1. Substrate composition (mean % +/- S.E.) of common species averaged over all sites and locations.

	Bedrock	Boulder	Cobble	Gravel	Fines
Brook Floater	0.00 +/- 0.00	12.61 +/- 1.78	20.04 +/- 1.90	41.01 +/- 2.52	25.34 +/- 1.79
Eastern Pearlshell	0.00 +/- 0.00	8.30 +/- 0.63	27.99 +/- 0.81	56.92 +/- 1.15	6.30 +/- 0.55

Eastern Elliptio	0.00 +/- 0.00	11.55 +/- 1.62	22.99 +/- 2.04	28.56 +/- 2.53	36.45 +/- 3.39
Eastern Floater	0.00 +/- 0.00	3.84 +/- 2.41	26.15 +/- 5.13	48.46 +/- 8.61	18.46 +/- 5.97

IVc Surrounding Habitat and Land Use Practices

A qualitative assessment of surrounding land use types and uses was made at each site (Table 2). With the exception of the Annapolis River site all others were adjacent to forest land. The predominant forest cover type within riparian zones adjacent to survey sites was mixed-wood. Brook Floater survey sites occurred in a wide variety of land use settings, ranging from protected conservation areas, to managed forest, to intensive agricultural and recreational areas.

Table 2. Summary of riparian conditions surrounding study sites.

Site	Brook Floater Density (mussels/m ²)	General Land Type	Riparian Forest Type	Proximity to Nearest Road	Land Use
East Branch	2.00	Forested	Mixed-wood	< 60 m	Agricultural, forest
Salmon River	1.46	Forested, valley, floodplain	Softwood	750 m	Protected Wilderness
North Branch	0.14	Forested,	Mixed-wood	< 50 m	Forestry
Wallace River	0.03	Forested, Valley	Mixed-wood	400 m	Residential
Gay's River	-	Forested, grassland, floodplain	Mixed-wood	300 m	Agricultural, residential
LaHave River	-	Forested	Mixed-wood	< 50 m	Recreational, residential
Annapolis River	Unknown	Grassland, floodplain	Mixed-wood	100 m	Agricultural, residential

IVd Sample Plot Locations

All mussel survey sites were georeferenced for future monitoring using UTM coordinates. Table 3 below provides UTM coordinates for each survey site center obtained from Google Earth (December 2010). Quantitative surveys extended 50 m upstream and downstream from these center points. Qualitative surveys occurred at or near these coordinates.

Table 3. Georeferenced (UTM) coordinates for all survey sites.

System	Site No.	Survey Type	Coordinates
<i>Riverine Sites</i>			
Annapolis River	1	Qualitative	336717E 4977894N
LaHave River	1	Qualitative	375928E 4920947N
	2	Qualitative	376187E 4918726N
	3	Quantitative	370800E 4924588N
Gays River	1	Qualitative	469869E 4986842N
	2	Quantitative	469416E 4986680N
	3	Qualitative	470334E 4987418N
	4	Qualitative	470530E 4987418N
Wallace River	1	Qualitative	456051E 5066573N
	2	Qualitative	455974E 5067044N
	3	Quantitative	456678E 5064356N
Salmon River	1	Quantitative	601978E 5025318N
St. Marys River (North Branch)	1	Quantitative	574053E 5019140N
St. Marys River (East Branch)	1	Quantitative	558451E 5026710N
	2	Qualitative	565137E 5026259N
Black Brook	1	Qualitative	No Coordinates
<i>Lake Sites</i>			

Mattatal Lake	1	Qualitative	463754E 5060799N
Eden Lake	1	Quantitative	No Coordinates
Lochaber Lake	1	Qualitative	577152E 5034498N
Borden Lake	1	Qualitative	613685E 5025985N
Total	19	12 Qualitative	
		7 Quantitative	

V Discussion

The quality of this report is diminished with the loss of some key specific data, amongst other things, the number of quadrats actually sampled at each of the quantitative survey sites. However, for readers who may be concerned with the statistical validity of the data presented here, it is safe to say that with the random sampling protocol used, between 45 and 100 quadrats were sampled at each quantitative survey site. Additionally, there were very serious communications issues between the student researcher (Samantha Marshall) working with the St. Mary's River Association, and her project supervisor (Mark Pulsifer). In the end the student researcher did not complete her requirements for an Honours Thesis and degree. This report is a compilation of results from an incomplete draft version of results from Ms. Marshall. That being said, this project was successful in meeting several objectives.

When sampling for freshwater mussels timing of surveys, (and a healthy dose of serendipity) is critical for good data. Water depth and clarity are important factors that influenced results in this study. No Brook Floaters were found in the LaHave River and only one specimen was located in the Gays River which was likely the result of searching in a relatively restricted area because of inaccessibility to other sites due to high water. Brook Floaters had been previously located at both of these sites by Bredin (COSEWIC 2009). Similar difficulties were encountered at Lochaber Lake, which were further compounded by a high suspended sediment load impeding visibility. Visibility was also affected by cloud cover which made searching more difficult. This was most evident when surveying in dark coloured water, in dark substrate, or substrate shaded by riparian vegetation. Surveys within the Annapolis River system were compromised due to a high bacterial count that made it unsafe to spend extended periods of time in the water.

One of the primary objectives of this study was to gather data on Brook Floater densities and population sizes based on sampling within 100 m reaches. Bredin and Martel (COSEWIC 2009)

estimated population sizes in seven of the known Brook Floater sites in Nova Scotia based on area of occupancy and abundance. Poor sampling results in this study restricted the number of locations where a direct comparison between their estimated population sizes for entire systems could be compared to the results of this study for 100 m reaches; however, comparisons could be made for the St. Mary's River (East and North Branches), and Salmon River. Bredin and Martel (COSEWIC 2009) estimate a population range within the St. Mary's River, and Salmon River systems between 1000 – 5000, and 100 – 500 respectively. In comparison, calculations of Brook Floater numbers within 100 m sampling reaches for this study for the East and North Branches of the St. Mary's River were 3600 and 168 respectively; with the Salmon River sampling plot contributing an additional 2044 to the provincial population estimate. In both these instances the rigorous sampling protocols used in this study indicate, or at least suggest that there are considerably more Brook Floaters in these systems than previously reported. Similarly, results from this study would suggest that there are more Brook Floaters in the Wallace River system than previously estimated. The calculated population estimate for a 100 m survey plot for this study was 96, as compared to Bredin and Martel's (COSEWIC 2009) estimate of 233 for the entire system. These data should still be interpreted cautiously because of the variability in habitat, patchiness of mussel occurrences, and limitations of specific sampling protocols.

Results from Mattatal Lake in Colchester County were puzzling. Brook Floaters had previously been reported from this lake by Ross Hall, a retired DNR biologist with considerable experience surveying for freshwater mussels. These data were later reported in the COSEWIC (2009) Assessment and Status Report for this species. Hall accompanied the survey team to Mattatal Lake in 2009 to serve as a guide for this follow-up study and assisted with surveys. Water levels were very high from recent rains; however, two specimens were found that were similar to what Hall had previously identified as Brook Floaters. A closer examination and comparison between confirmed Brook Floaters and these two specimens suggests that Hall may have been mistaken in his identification. The Mattatal Lake specimens are less robust overall with a more delicate shell, they lack the prominent "ridge" that defines the Brook Floater and the overall shape is more ovoid than the typical kidney shape. Because mussels can be morphologically "plastic" depending on habitat it is inappropriate to say that these specimens are not Brook Floaters without further surveys and examination. Specimens have been left with the Nova Scotia Museum of Natural History for further clarification by experts there.

Bredin and Martel (COSEWIC 2009) report that the majority of Brook Floater locations occur in running water, with some exceptions. Brook Floaters have been previously identified from Eden Lake and Lochaber Lake, and this study reconfirmed their presence. In all riverine sites sampled Brook Floaters were found where expected, in sand and gravel bars or lenses, or in some cases in sands and gravels that accumulated between larger clasts such as large cobble or

boulder. Occular assessments of substrate composition showed that Brook Floaters preferred, on average, sites that had a surface substrate composition > 65% sand and gravel. Brook Floater occurrences in lake sites are more difficult to predict because the relative absence of strong current means that preferred sediments are likely found *in situ*, and as a result Brook Floaters may be restricted in their distribution. No live Brook Floaters were found in Lochaber Lake, although valves from dead individuals are regularly found in areas where sediments are atypical for this species.

Like all freshwater mussels, Brook Floaters are prone to disturbance from land use practices that can either impact habitat directly, or affect their fish hosts. Because mussels are sedentary and cannot escape the effects of pollution or sedimentation they are vulnerable to upstream disturbances. In this study Brook Floater populations were found adjacent to a variety of land use practices ranging from agriculture to forestry to residential and recreation. One of the obvious keys to long term habitat stability and population success has to be riparian integrity. A stable riparian zone that is appropriate in width and structure maintains water temperature and light regime, and prevents erosion and siltation. Intact forested sites tended to have more robust Brook Floater populations than sites surrounded by agricultural activities.

Long term trends in Brook Floater populations should be monitored through the use of permanent sample plots such as those initiated in this study. Regionally representative rivers with multiple permanent survey plots should be established to document population changes at five year intervals. This study indicates that some populations may be much higher than previously thought. Effective monitoring and surveys would clarify this.

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