Community-University Research for Recovery Alliance

RESEARCH REPORT

# St. Pauls Inlet: a biological re-assessment of zooplankton and fish populations within an estuarine system in Western Newfoundland

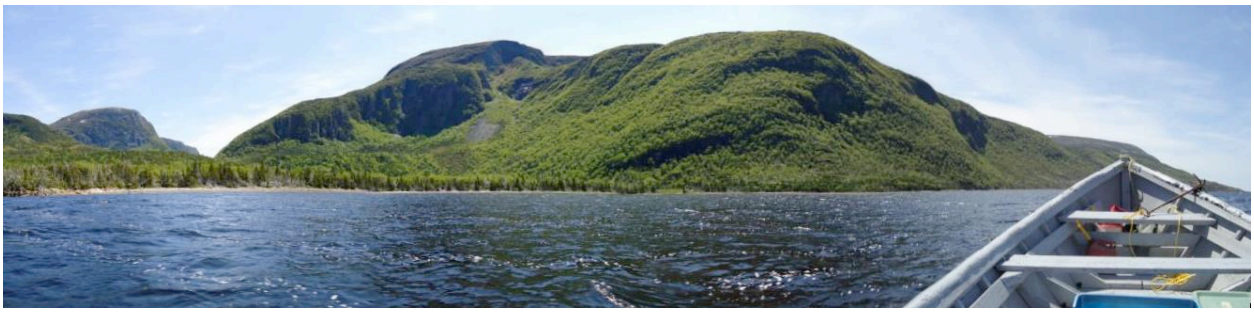
Report by Erin N. Stevens, Ryan Melanson, and Christine Campbell

*This report is adapted from the following theses:*

Zooplankton composition in western Newfoundland and Labrador - A comparison of brackish water and estuarine sites
*A thesis by Erin N. Stevens*
*in fulfillment of the requirements*
*of the degree of Master of Science (Biology)*
*at Memorial University of Newfoundland*

and

Nearshore Fish Populations within St. Pauls Inlet, an estuarine system in western Newfoundland.
*A thesis by Ryan L. Melanson*
*in fulfilment of the requirements*
*of the degree of Bachelor of Science (Honours)*
*at Memorial University of Newfoundland, Grenfell Campus.*



## Introduction

St. Pauls Inlet is a fjord-type estuary on the western coast of insular Newfoundland. It has been classified as a marine area of interest by the Canadian Parks and Wildlife Society (Rao et al. 2009). The inlet can be defined as an estuarine system in that it is a semi-enclosed coastal body of water with a free connection to the sea and within which the sea water is measurably diluted with fresh water (Pritchard 1967). The area is also characteristic of fjordal landscapes as a result of the glacial sculpting which occurred in western Newfoundland approximately 12, 000 years ago (Rogerson 1983).

Estuaries are dynamic aquatic systems with changes in salinity, temperature, oxygen and turbidity due both to tidal influences and freshwater flow. River inflow can result in input of organic matter and nutrients and occasionally freshwater zooplankton from upstream (Nielsen and Anderson 2002). Estuaries are often associated with some of the highest productivity on the planet and are of great importance to nutrient cycling at the land-sea boundary (Knox 1986).

St. Pauls Inlet is an ecologically and economically important area within the confines of Gros Morne National Park. It is the only body of brackish water within the park boundaries. This distinguishing feature was detailed in the initial study of the inlet in 1979 by Carter & MacGregor. This initial study examined aspects of the inlet ranging from the hydrological aspects such as salinity, temperature, and turbidity to the species of organisms within the inlet. No other studies have been done on the inlet since that published report.

The objective of the recent research done on the inlet was to determine some of the water body's current biodiversity. A Master's project on zooplankton species was undertaken during the summers of 2009 and 2010. Zooplankton are microscopic animals that float in the water; the majority are crustaceans (related to crabs, lobsters, etc), and can serve as a food source for a variety of aquatic organisms including pelagic fish.

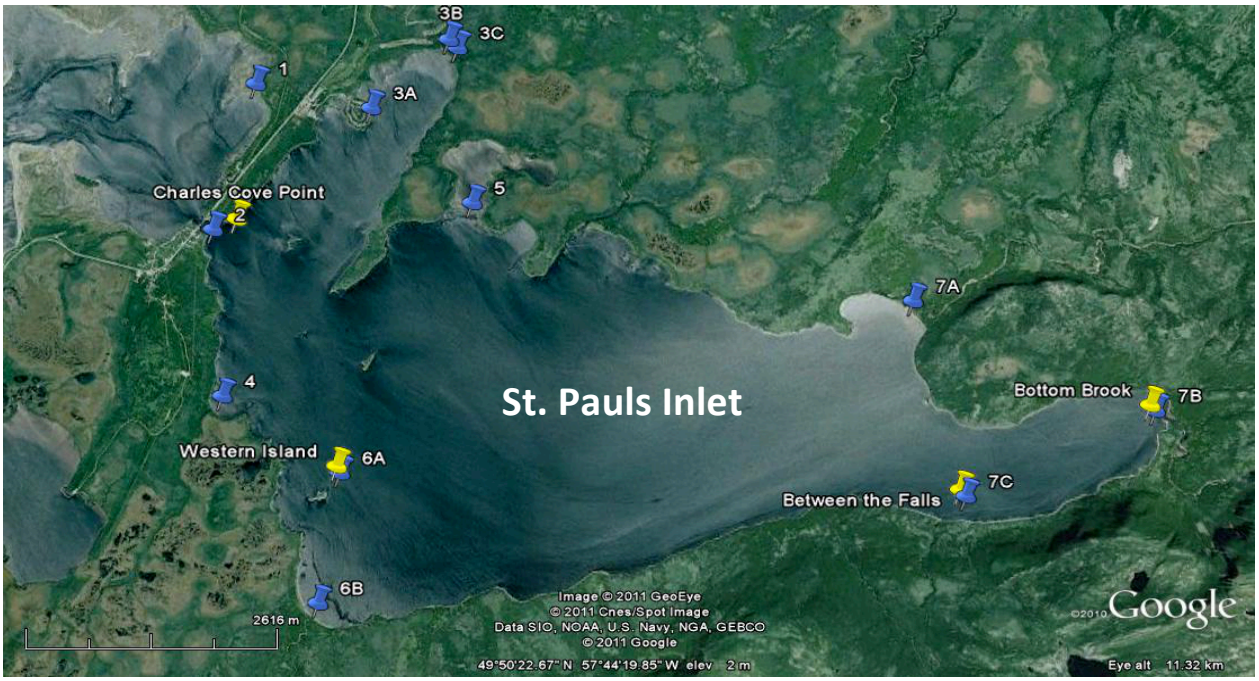


Figure 1: Sampling locations for both fish (blue placeholders) and zooplankton (yellow placeholders) in and around St. Pauls Inlet.

An additional Honours project was done in the summer of 2010 to determine the diversity of near-shore fish species in the inlet.

The initial study in 1979 detailed a moderate diversity of organisms compared to more marine environments. A total of 31 species of zooplankton were identified, including 13 different species of copepods and 18 miscellaneous zooplankton species. Carter and MacGregor also identified 23 species of near-shore fish.

Both current projects seek to compare the present diversity in the inlet with the study done by Carter and MacGregor in 1979. All sampling was carried out with considerable input from local boat owners. Biological data from St. Pauls were also examined in order to place the inlet in a regional context, in terms of comparisons with other sites in Newfoundland and Labrador.

These projects are a subcomponent of the overall interdisciplinary Community – University Research for Recovery Alliance (CURRA) project focusing on Newfoundland's west coast marine ecosystems and fishing communities. CURRA researchers define recovery as a vibrant future for people, communities, and their natural environment. In determining fish and zooplankton abundance and species composition in St. Pauls Inlet we can add to our knowledge of the inlet including its potential to contribute to the larger marine ecosystem.

**Methodology**

St. Pauls Inlet, pictured above (Fig. 1), has a surface area of 30 $km^2$. The inlet is 11 km long and is 6 km at its widest point, with an opening of only 80 m at the western end which allows sea water to enter the inlet. Due to the small size of the entrance, there is a significant tidal velocity at the mouth of the inlet. The freshwater input is from a total of 24 streams or rivers with St. Pauls

River (aka Bottom Brook) being the largest inflow. The inlet is characterized by shallow depths of 1-3 m on the western portion of the inlet extending into the bay. The eastern portion of the inlet has steep slopes, typical of fjords, with a depth of 36 m in the center. The substrate within St. Pauls Inlet has been produced by highly variable glacial scouring. There are steeply sloping rock beaches as well as shallow, coarse sandy beaches. The inlet opens up into St. Pauls Bay which is a shallow water bay having depths of less than 3 m and sandy bars. A 6 m deep trench leads from the inlet through the bay into the Gulf of St. Lawrence.

**Salinity**
Salinity was tested at all sites in 1 m depth intervals using a portable handheld meter

**Fish Methodology**
Sampling was performed during the month of August 2010 with a total of 7 sites sampled: 6 within St. Paul's Inlet as well as one location along St. Paul's Bay. Sites were chosen to include a potential range of salinities as well as for ease of access. One site was within the bay to examine the more saline bay habitat, another was selected at the mouth of the inlet, and the rest of the 5 sites were at locations in the inlet ranging from close to the mouth to the far end at Bottoms Brook. The remaining 5 sites were selected in order to sample over a possible salinity gradient within the inlet. Due to substrate types and weather, not all sites were sampled with the same frequency nor were all sites sampled with the same gear.

Three different types of gear were used during sampling: 10 m beach seine, minnow traps, and multi-paneled gill nets. Multiple gear types were used to accurately represent fish fauna since sizes of fish caught differs between gear types (Methven and Schneider 1998).

In all samples, captured fish were removed from the trapping gear and placed in a large pail of inlet water to be removed individually for species identification. Taxonomic identification was based on Robins et al. (1986) and Scott and Scott (1988). Once fish were processed they were returned to the inlet unharmed.

Analyses were performed which allowed for identifying patterns in species assemblages or groups. These analyses were done to compare the sites within the inlet as well as to compare St. Pauls Inlet with three other similarly sampled sites in Newfoundland and Labrador: Bonne Bay (Currie et al. 2009), Gilbert Bay (Wroblewski et al. 2007), and Trinity Bay (Methven et al. 2001). Sites were grouped (or clustered) together by looking at the numbers of species in common between sites (determined using calculated similarity coefficients and cluster analysis).

**Zooplankton Methodology**
Zooplankton were sampled weekly during the months of July & August in 2009 and during the months of June, July, and August in 2010. A total of four sites were selected within St. Pauls inlet. Similar to the fish sampling method, sites were selected based on an assumption concerning the range of salinity as well as accessibility. They were also selected to accord with sites sampled previously by Carter and MacGregor (1979).

The zooplankton samples were taken using tow nets lowered from a dory. Horizontal tows were taken to collect a composite sample of the water column and vertical tows to collect the organisms throughout the water column. Two different sized mesh nets (63 μm and 500 μm) were used for the horizontal tows, whereas the vertical tows used a net with an 80 μm mesh net. The mesh size of the tow nets differed in order to

collect a range in the size of organisms. The vertical tows were taken down to the bottom of the water column as well as approximately half way through the water column. Horizontal tows were typically 2 two minutes in length and had a flow meter attached to adequately estimate the volume of water filtered through the nets.

The zooplankton taken with the nets were taken back to the field station where they were preserved in 70% ethanol in sterile scintillation vials. They were then counted under a microscope and identified to the lowest taxonomic group possible using a variety of sources and dichotomous keys (Bradford-Grieve 1999; Johnson and Allen 2005).

Similar to the fish methodology, cluster analysis was performed to assess the distribution of zooplankton species within the inlet. The data from St. Pauls Inlet were also compared with the previous biological study done by Carter and MacGregor in 1979, and with samples obtained from another brackish-water system in Lake Melville, Labrador.

**Results**

The 1979 Carter and MacGregor study indicated that the inlet had a longitudinal salinity gradient due to the tidal influx at the mouth of the inlet as well as freshwater input from the many streams and rivers throughout the inlet. They also determined that there was a *halocline* or vertical gradient of salinity in the inlet with colder more saline water at the bottom of the water column and warmer, fresher water floating on top. In contrast, the data collected in this present study do not indicate any marked longitudinal salinity gradient nor does there appear to be a noticeable vertical salinity gradient.

**Fish Results**

Fifteen species representing 9 families of fish were collected from St. Pauls Inlet in 2010. Six of the 15 species accounted for 98% of the total fish sampled: 60% *Pungitius pungitius* (Ninespine stickleback), 18% *Gasterosteus aculeatus* (Threespine stickleback), 7% *Gasterosteus wheatlandi* (Blackspotted stickleback), 7% *Apeltes quadracus* (Fourspine stickleback), 4% *Tautogolabrus adspersus* (Cunner), and 2% *Myoxocephalus octodecemspinosus* (Longhorn sculpin). Sites 2 and 4 had the highest number of species, with ten and seven species respectively. The statistical analysis indicated no distinct species clusters within the inlet, with all sites exhibiting similar species composition with about 40% similarity

Differences were observed between these 2010 results and the Carter and MacGregor study of 1979. The 1979 study of the inlet identified 11 species not seen in 2010; however, there were 3 species in 2010 that were not found in 1979. In addition, there was only a single tentative identification of P. *pungitius* in 1979, whereas the current 2010 study found that *P. pungitius* was the most abundant fish collected. When compared to the other regional sites (Figure 2), St. Pauls Inlet is shown to be somewhat distinct in regards to species composition.

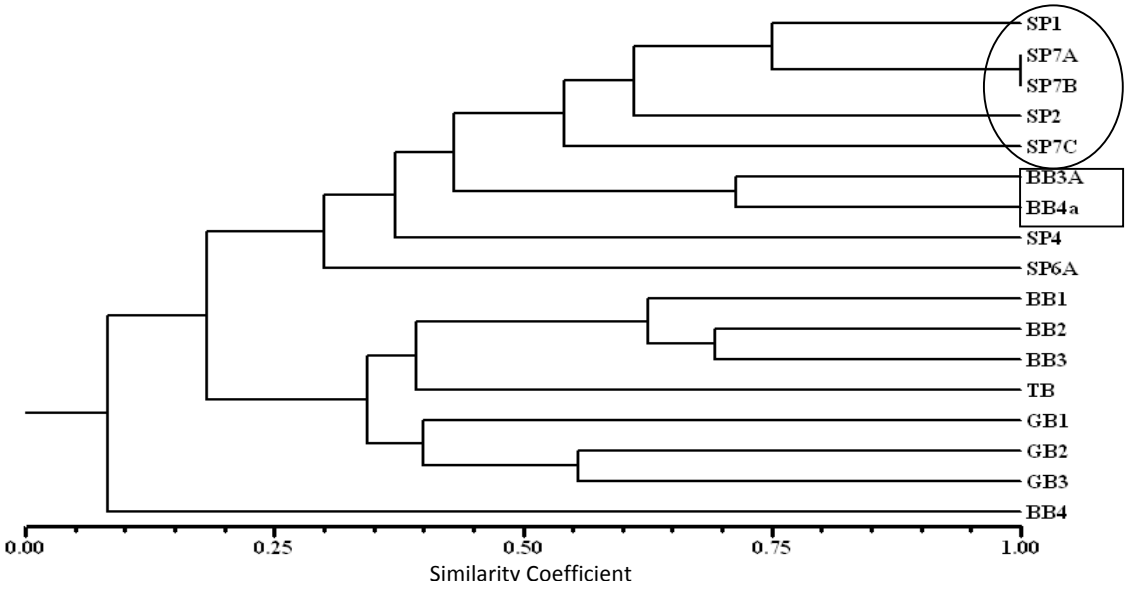



Figure 2: Cluster analysis of fish species composition based on site. SP = St. Pauls Inlet, BB = Bonne Bay, TB = Trinity Bay, and GB# = Gilbert Bay. St. Paul's sites cluster as a relatively distinct group, along with 2 estuarine sites – BB3a, BB4a – from Bonne Bay.

**Zooplankton Results**

The current study identified 16 different zooplankters with four species accounting for 95% of organisms collected: (45% *Acartia hudsonica*, 36% *Temora longicornis,* 9% *Evadne nordmanni,* 5% *Podon leuckarti*. These percentages do not include zooplankton juvenile stages (nauplii and copepodites) as they are difficult to identify to species level. As in the fish study, the statistical analysis did not indicate any strong clustering of species at sites. There did not appear to be any real biogeographical grouping in the inlet by species of zooplankton (Fig. 3).



A total of 18 zooplankters that were identified in 1979 were not seen in the 2009-2010 sampling. In addition, there were 2 species that were found in 2010 that were not seen in 1979: *Microstella norvegica* (0.3% of organisms) and *P. leuckarti* (5% of organisms). One of the most abundant species found in 1979 was the large marine copepod *Calanus finmarchicus*, of which only one specimen was found in 2009-2010. Figure 4 indicates that St. Pauls Inlet is distinct in zooplankton species assemblages compared with Lake Melville in Labrador, another regional brackish-water site (2007 data).

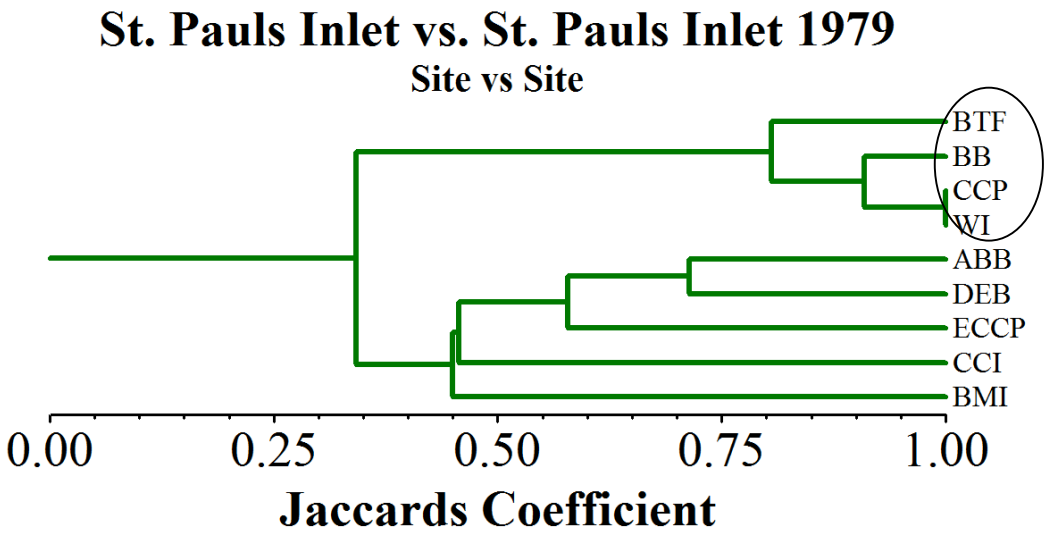



Figure 3: Cluster analysis of zooplankton species composition comparing St. Pauls Inlet 2010 (circled) to St. Pauls Inlet 1979. (BTF = Between the Falls, BB = Bottom Brook, WI = Western Island, CCP – Charles Cove Point; ABB = Bottom Brook 1979; DEB = Eastern Brook 1979, ECCP = Charles Cove Point 1979, and BMI = Middle Inlet 1979.)

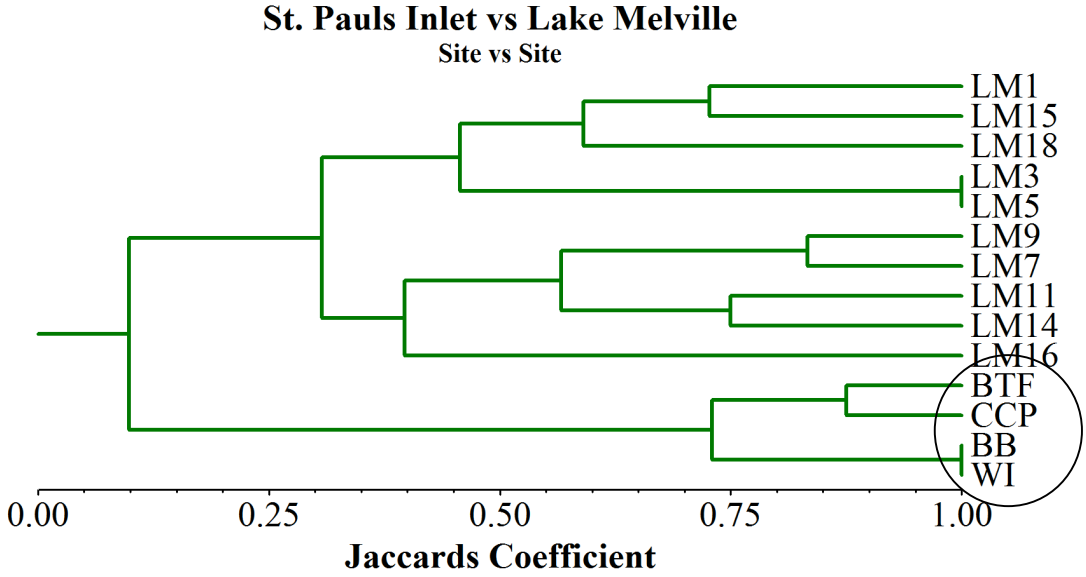



Figure 4: Cluster analysis of zooplankton species composition comparing St. Pauls Inlet to Lake Melville (LM). The SPI sites cluster together, indicated by the circle. (BTF = Between the Falls, BB = Bottom Brook, WI = Western Island, CCP – Charles Cove Point)

**Discussion**

St. Pauls Inlet has all the indications of an estuarine system; it cannot be classified simply as a marine or freshwater system. Although there is no apparent longitudinal salinity gradient across the inlet, there is some stratification. However, the stratification is not pronounced nor is it present at all sites. Both the fish and zooplankton communities in St. Paul's Inlet can be classified as estuarine (Johnson and Allen 2005: Currie et al. 2009).

The species richness of near-shore fish in St. Paul's Inlet is within the range of values found in other studies of estuarine systems in Newfoundland and Labrador. Although there are fewer species collected in this study compared to the 1979 study, this may be due to sampling methods including the duration of the tows, and time of day the samples were taken. In fact, the occurrence of three previously unknown species, *Apeltes quadracus* (Fourspine stickleback), *Gasterosteus wheatlandi* Blackspotted stickleback), and *Urophycis tenuis* (White hake), may be due to increased shallow-water sampling done in this current study. The fish species seemed to be found throughout the inlet with no visible grouping.

As the salinity across the inlet was not highly variable, the zooplankton do not show any distinct species groupings across the inlet. Zooplankton species composition within the inlet appears to be distinctively estuarine. In comparing the inlet to Lake Melville, another brackish-water system, there are distinct groupings indicating only about 10% similarity. This is most likely due to the other regional site being much bigger with much larger salt and freshwater influx. This influx brought in freshwater or marine organisms which were not seen in St. Pauls Inlet.

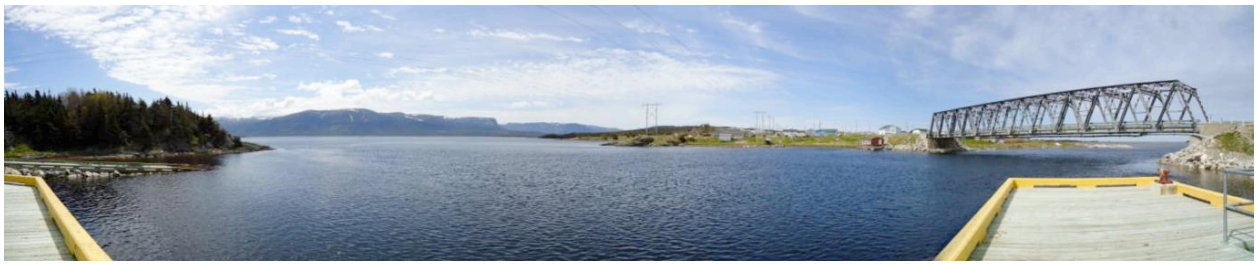
The inlet has also changed compared to the 1979 study in that there were different and more species found in 1979 compared to the present day. This may be due to differences in sampling type, location, time of day, or sampling effort. The species composition could have also been altered due to changes in human interaction with the inlet and the food web within. The community surrounding the inlet has changed in many ways during the last few decades. St. Pauls Inlet used to have a herring fishery that collapsed in the 1970s and the lobster fishery has decreased substantially (a 64% decrease since 1988). The population of the town has decreased from 450+ residents to 290 (2009 census). Although the town has decreased in population there is now more traffic through the area due to the park being incorporated in the 1970s and increasing tourist activity in the area (Kukac, 2009). Any of these, or some other unknown changes to the area surrounding the inlet could have affected the species within.

Hopefully the examinations within these combined studies provide a new framework for future research endeavours. Possible future research could include:

- A more thorough re-evaluation of St. Pauls Inlet to include flora and fauna that were not sampled in these studies.
- A more in-depth look at surrounding bodies of water to include St. Pauls Bay, Gulf of St. Lawrence, and the streams or rivers that flow into the inlet.
- Examination of nutrient availability and resultant zooplankton and fish productivity as it might contribute to commercial fisheries.

This research was funded through the Community-University Research for Recovery Alliance (CURRA) at Memorial University. The CURRA is funded by the Social Science and Humanities Research Council of Canada (SSHRC) and Memorial University, with additional financial and in-kind support from numerous community partners and groups. The Institute of Biodiversity, Ecosystem Science and Sustainability (IBES) and Parks Canada provided financial support for the research outlined in this report.

**Special thanks to town of St. Paul's residents Craig Payne and Willis Payne as without their assistance this research would not have been possible.**



**Community-University Research for Recovery Alliance (CURRA)**
**202 Elizabeth Avenue, Memorial University**
**St. John's, NL, A1C 5S7**
**Telephone: 709-864-7551**
**www.curra.ca**

Zooplankton photographs are courtesy of Ross Hopcroft www.arcodive.org
Landscape photographs are courtesy of Erin Stevens

CURRA

MEMORIAL UNIVERSITY

IBES
Institute for Biodiversity Ecosystem Science & Sustainability

Parks Canada Parcs Canada

Canada

# References


Bradford-Grieve, J. M. (1999). Fiches d'identification du zooplancton. Conseil international pour l'exploration de la mer. Vol. 18.

Carter, J. A. and C. D. MacGregor. (1979). Marine inventory of St. Paul's Inlet, Gros Morne National Park. Halifax, N.S., Martec Limited.

Currie, J. J., J. S. Wroblewski, D. A. Methven, and R. G. Hooper. (2009). Near Shore Fish Fauna of Bonne Bay, a Fjord within Gros Morne National Park, Newfoundland, Community-University Research for Recovery Alliance (CURRA), MUN.

Johnson, W. S. and D. M. Allen (2005). Zooplankton of the Atlantic and Gulf Coasts: a guide to their identification and ecology. Johns Hopkins University Press.U.S.A.

Knox, G. A. (1986). Estuarine ecosystems: a systems approach. CRC Press. U.S.A.

Methven, D. A. and D. C. Schneider (1998). Gear-independent patterns of variation in catch of juvenile Atlantic cod (*Gadus morhua*) in coastal habitats. Canadian Journal of Fisheries and Aquatic Sciences 55: 1430-1442.

Methven, D. A., R. L. Haedrich, and G. A. Rose. (2001). The fish assemblage of a Newfoundland estuary: Diel, monthly and annual variation. Estuarine Coastal and Shelf Science 52: 669-687.

Nielsen, T. G. and C. M. Andersen (2002). Plankton community structure and production along a freshwater-influenced Norwegian fjord system."Marine Biology 141: 707-724.

Pritchard, D. W. (1967). "What is an estuary: physical viewpoint?" American Association for the Advancement of Science. 85: 3-4.

Rao, A., L. Outhouse, and D. Gregory. (2009). Special marine areas in Newfoundland and Labrador. Canadian Parks and Wilderness Society - Newfoundland and Labrador Chapter. St. John's, NL

Robins, C. R., G. C. Ray, J. Douglas, and R. Freund. (1986). A field guide to Atlantic Coast fishes of North America. Houghton Mifflin. U.S.A.

Rogerson, R. J. (1983). Geological evolution. *In* Biogeography and ecology of the Island of Newfoundland. Editor: G. R. South. Dr. W. Junk Publishers. The Hague.

Scott, W. B. and M. G. Scott (1988). Atlantic fishes of Canada. University of Toronto Press in cooperation with the Minister of Fisheries and Oceans and the Canadian Govt. Pub. Centre, Supply and Services Canada.

Wroblewski, J. S., L. K. Kryger-Hann, D. A. Methven, and R. L. Haedrich. (2007). The fish fauna of Gilbert Bay, Labrador: a marine protected area in the Canadian subarctic coastal zone. Journal of the Marine Biological Association of the United Kingdom 87: 575-587.