The Community Aquatic Monitoring Program (CAMP) for Measuring Marine Environmental Health in Coastal Waters of the southern Gulf of St. Lawrence: 2005 Overview

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by

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ABSTRACT

In 2003, department of Fisheries and Oceans (DFO) Gulf Region developed a monitoring program called the Community Aquatic Monitoring Program (CAMP) to help determine the ecological health of estuaries and coastal shorelines in the southern Gulf of St. Lawrence (sGSL). The primary goal of CAMP was to provide an outreach program for DFO to interact with community environmental groups. The monitoring aspect developed from this partnership was to test the hypothesis that a relationship exists between the health of an estuary or coastal shoreline and the diversity and abundance of finfish and crustacean species which inhabit the littoral or near shore zone. CAMP expanded the number of locations from 4 in its pilot year (Thériault et al. 2006) to 24 throughout the Maritime Provinces of Nova Scotia (NS), New Brunswick (NB) and Prince Edward Island (PEI) in 2004. Baseline sites, meaning sites at which 6 stations were sampled by day-time beach seining once a month from May to September inclusive, numbered 15 in 2004. In 2005, the number of locations totalled 21 of which 19 were considered as baseline. Each community environmental group adhered to the same sampling methodology and related protocols as outlined in Weldon et al. (2005). All species of finfish, crabs and shrimp collected were identified, separated into young of the year and adults, enumerated and then released. Habitat was also characterized by collecting information such as; water temperature, salinity, dissolved oxygen, % plant coverage and algae coverage and, once a year in September, collection of a substrate sample for measurement of grain size distribution, % moisture content and % organic content. This report summarizes baseline physical and biological data for the estuaries sampled in 2005. This year approximately half a million animals were processed and 30 different species were identified. In order to test the hypothesis that these data reflect environmental quality, several years of data will be required to detect temporal and spatial patterns that may exist. Ultimately it is hoped that this program will provide a simple method of characterizing estuarine health that community groups will find both useful and easy to apply.

RÉSUMÉ

En 2003, le Ministère des Pêches et Océans (MPO) de la Région du Golfe a mis au point un programme de surveillance intitulé Programme communautaire de surveillance aquatique (PCSA) afin d'évaluer la santé écologique des estuaires et des zones du littoral du sud du golfe du Saint-Laurent. Le PCSA se voulait surtout un programme d'extension permettant au MPO d'interagir avec les groupes environnementaux des collectivités. L'aspect de surveillance issu de ce partenariat vise à mettre à l'essai l'hypothèse qu'une relation existe entre la santé d'un estuaire ou d'une zone côtière et la diversité et l'abondance de poissons et de crustacés qui se trouvent dans la zone littorale ou côtière. Le PCSA est passé de 4 emplacements lors de l'année du projet pilote (Thériault et al. 2006) à 24 répartis partout dans les provinces Maritimes, soit la Nouvelle-Écosse (N.-É.), le Nouveau-Brunswick (N.-B.) et l'Île-du-Prince-Édouard (Î.-P.-É.) en 2004. Les emplacements principaux, soit les emplacements où on a effectué des prélèvements mensuels diurnes dans six stations, à l'aide de seines de plage, de mai à septembre, s'élevaient à 15 en 2004. En 2005, le nombre d'emplacements atteignait 21, dont 19 emplacements principaux. Chaque groupe environnemental communautaire a utilisé la même méthode d'échantillonnage et les protocoles connexes décrits par Weldon et al. (2005). Les individus de chaque espèce de poissons, de crabes et de crevettes capturés à l'aide d'une seine de plage ont été énumérés, identifiés, triés selon l'âge (jeunes de l'année et adultes) puis remis à l'eau. De plus, des données sur l'habitat de ces espèces ont été recueillies telles que; la température de l'eau, la salinité, la teneur en oxygène dissous et le pourcentage de recouvrement par les plantes et les algues une fois par mois. De plus, la taille du grain, le % de la teneur en eau et de la teneur en matières organiques du substrat ont été recueillies une fois par an, soit en septembre. Le présent rapport résume les données physiques et biologiques des emplacements principaux des estuaires étudiés en 2005. Cette année, près d'un demi-million d'animaux ont été comptés et 30 différentes espèces ont été identifiées. Pour pouvoir vérifier l'hypothèse selon laquelle ces données reflètent la qualité de l'environnement estuarien, plusieurs années de données devront être étudiées afin de détecter les tendances temporelles et spatiales qui pourraient exister. On espère que le programme s'avèrera une méthode simple de caractérisation de la santé estuarienne qui sera à la fois utile et facile à appliquer pour les groupes communautaires.

1.0 INTRODUCTION

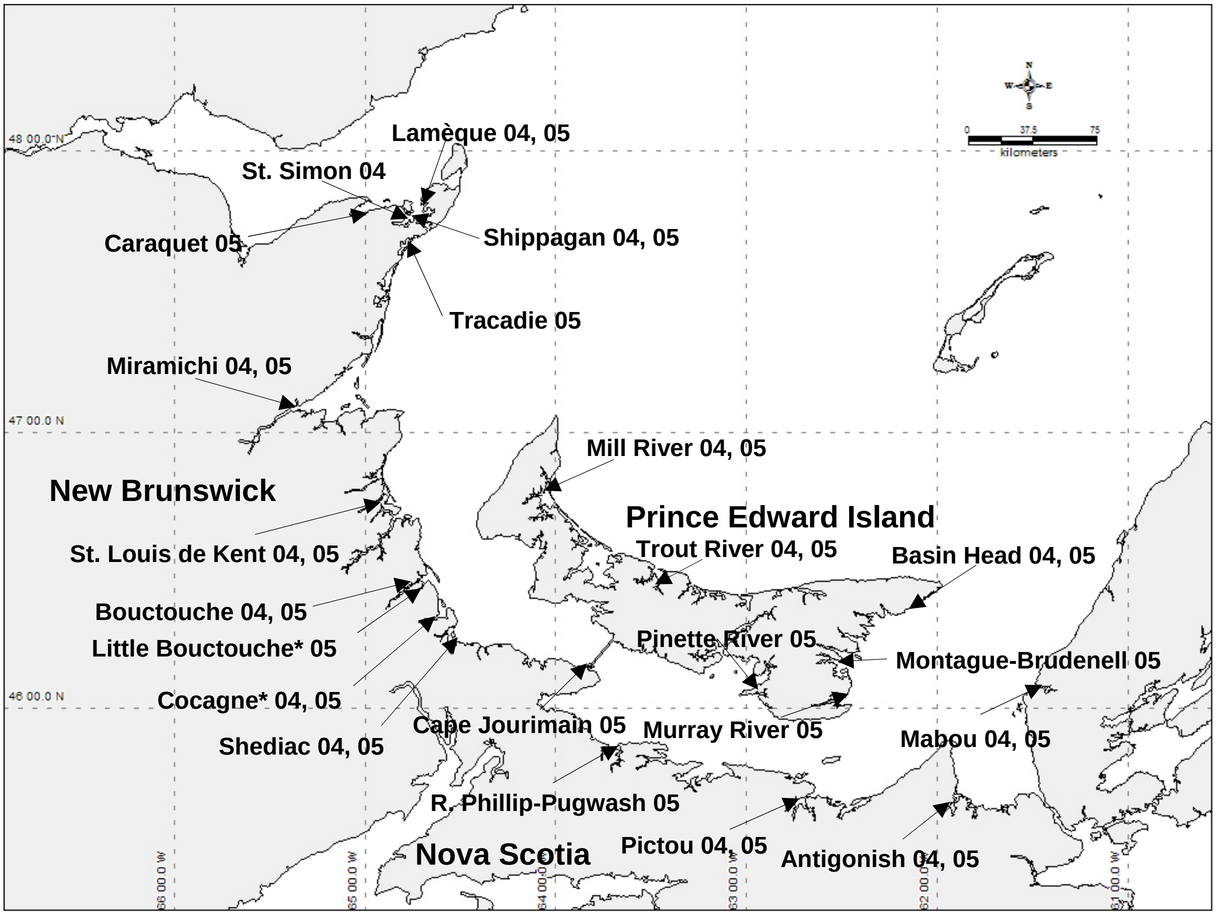
1.1 Background

In the Canada Oceans Strategy document (COS, 2002), Fisheries and Oceans Canada (DFO) established its commitment to work collaboratively with local stakeholders to "*establish marine environmental quality guidelines, objectives and criteria respecting estuaries, coastal waters and marine waters.*" During 2003 and 2004, the Stewardship and Aquatic Ecosystem Sections of DFO Gulf Region integrated their planning priorities to develop a practical monitoring program that would assist in determining the ecological health of estuaries in the southern Gulf of St. Lawrence (sGSL) as outlined in Canada's Stewardship Agenda (2003). The outcome was the development of the Community Aquatic Monitoring Program (CAMP) outlined in detail in the first report (Weldon et al. 2005). One of the aims of the program is to determine if a relationship exists between the health of an estuary and/or a coastal shoreline and the diversity and abundance of conspicuous invertebrate and fish species which utilize this ecosystem. One hypothesis being tested by CAMP is that an estuary which has been degraded by human activity may have fewer species and different abundance of individuals than a healthy, undisturbed estuary.

Methods and protocols to implement the CAMP approach were chosen after reviewing a wide variety of methods for evaluating estuarine health and population dynamics (Karr 1981, Methven et al. 2001, Whitfield and Elliot 2002). The 2004 field season expanded the CAMP program in all three provinces. This report will provide an overview of the CAMP results in 2005 and briefly discuss some of the similarities and differences with outcomes of the 2004 field season.

1.2 Where has CAMP taken place?

CAMP is a long term community aquatic monitoring program used to determine the ecological health of estuaries and coastal shorelines in the sGSL region. It was determined that to become a baseline location, an estuary or coastal shoreline would be sampled monthly during the spring and summer months (May - September) (5 times) at 6 chosen stations. This resulted in establishing eight sample estuaries in NB, three sample estuaries in NS and three sample estuaries in PEI in 2004. This expanded to nine in NB, four in NS and six in PEI in 2005 as illustrated on the map below.



* refers to locations that were sampled 4 of the 5 months (almost baseline)

Figure 1. CAMP baseline monitoring locations (2004 - 2005) for NB, NS and PEI. Each arrow shows the location of a baseline sampling estuary that includes six sample stations.

The CAMP program continues to involve several partnerships including DFO Oceans and Habitat Division, DFO Area offices, Universities, various environmental organizations and local estuary community watershed groups, all based throughout the Gulf Region.

The groups who participated in 2005 include:

New Brunswick

- Partenariat pour la gestion intégrée du bassin versant de la baie de Caraquet
- Coalition pour la viabilité de l'environnement des havres de Shippagan et les Îles Miscou et Lamèque
- L'association des bassins versants de la Grande et Petite rivière Tracadie
- Miramichi River Environmental Assessment Committee
- Friends of the Kouchibouguacis River
- Southeastern Anglers Association
- Pays de Cocagne Sustainable Development Group

- Shediac Bay Watershed Association
- Cape Jourimain Nature Centre

Prince Edward Island

- Mill River Watershed Improvement Committee
- Trout River Environmental Committee
- Basin Head Lagoon Ecosystem Conservation Committee
- Southeast Environmental Association
- Winter River Environmental Committee
- Montague Watershed Improvement Committee
- Students from the University of Prince Edward Island Biology Department

Nova Scotia

- Friends of the Pugwash Estuary
- Cumberland County Rivers Association
- Pictou County Rivers Association
- Pictou Harbour Environmental Protection Project
- Fresh Air Outdoor Adventure Society
- Mabou Harbour Coastal Management Planning Committee
- Students from the St. Francis Xavier University Biology Department and program in Integrated Studies in Aquatic Resources (ISAR).

Participation of community groups is a fundamental component of the CAMP program, as communities share the responsibility of volunteering their time to monitor estuaries and coastal shorelines in their area. As they often have several projects related to the estuary, their work is instrumental in demonstrating and initiating correct stewardship principles.

2.0. MATERIALS AND METHODS

Monthly daytime sampling was done from May to September for the original 14 sites began in 2004 as well as the 7 new sites added in 2005. Data on invertebrates and fish species, macrophytes, water quality and benthic substrate were collected at 126 baseline sampling stations throughout the provinces of NB, NS and PEI. In this report a site refers to the specific estuary or coastal location and a station refers to one of the 6 locations where beach seines sampled the shoreline community. A standardized beach seining method was used to collect and monitor the presence and abundance of estuarine species. Physical data included the use of a quadrat for vegetation cover, meter readings to record temperature, salinity and dissolved oxygen and a sediment collection. Detailed methodology and protocols are described in more detail in Weldon et al. (2004).

2.1 Training

The training program for CAMP participants takes place in May and is a combination of theory and practical sessions. The theory session includes an hour long presentation on CAMP which includes a background of the CAMP, an outline of the methodology, an introduction to the equipment, training on use of the field data collection sheets and an identification review to the species sampled during the field season. The training regime is modified according to the experience of past NGO coordinators and the need to train new employees and/or volunteers.

This practical field training involves learning the proper use of equipment, standardized techniques and proper identification of fish, crustaceans and plant species with an actual on-site beach seine collection. After a beach seining, the volunteers identify the contents of the beach seine while DFO trainers and NGO coordinators assist with verification and review.

2.2 Site Selection

In 2005, NGO's returned to the exact same estuary or coastal sites to repeat the sampling regime at the same stations of the past year. New baseline estuary sites were added in 2005 following protocols identical to those of the 2004 collections (Weldon et al. 2004).

2.3 Fish Identification

When difficulties with identification arose, groups could refer to the CAMP identification guide for clarification, or collect a specimen for identification. One option is to get the unknown back to the local Area Office or DFO HQ for identification. The unknown species would be put on ice and frozen or otherwise preserved upon return to the NGO field station. Guides such as Peterson Atlantic Coast Fishes and Atlantic Seashore field guides were made available and distributed to community groups to be used to assist with identification.

2.4 Macrophytes

A 50 cm x 50 cm quadrat, divided into four equal sub-quadrants, was used to estimate macrophyte percentage cover at each sample station. The quadrat was thrown three times, within the sample area. The data sheet was used to record the approximate percentages of the dominant plant and algae types. The use of this quadrat method was possible only when the water column was not turbid as wind and wave action stir up the sediment and makes the % coverage evaluation difficult.

Volunteers also included a general description of the sample area by taking notes of the overall dominant macrophyte present, their approximate cover in percent and location in reference to the shore.

2.5 Physical Measures

YSI meter model 85 was used to measure three physical components of water: temperature (± 0.1 C°), dissolved oxygen (± 0.3 mg/L) and salinity (± 0.1 ppt). Meter readings were taken either before or after the beach sweep. The YSI probe was submerged approximately at mid-depth in the center of the sample area.

Also in 2005, Vemco continuous temperature monitoring probes were deployed for most of the sampling season. This was done this first year by DFO personnel with NGO representative or Area Office coordinator assistance. For the most part, a boat was used to attach the probe one meter below the surface to a temporary channel marker. In other cases, the probe was attached to a fixed structure such as a wharf or dock 1 meter below the low water mark. Recovery was successful for about 75% of the probes.

2.6 Substrate

In September, a sample of benthic substrate was collected from each sample station to analyze moisture content, organic content and grain size of the sediment. Using a garden trowel, a sample of the surficial 10 cm layer was obtained from within the 225 m^2 area beach-seined, bagged and returned for freezing at -20˚C and stored for later analysis at the Gulf Fisheries Center. From each frozen sediment sample, a thawed portion (100 ± 20 grams) was removed and placed in an aluminum pan.

In the laboratory, moisture content was determined as the difference in weight before and after drying at 70°C for 24 h (standardized time). Organic content was calculated as the difference in weight before and after burning the sediments in a muffle furnace at 500°C for one hour (standardized time). (Note that the burning time was decreased to1 h from 3 h in 2005). Grain size distribution per sample was determined from 10 min shaking (standardized time) with a mechanical sieve shaker with six different sieve sizes: >2 mm (very coarse sand), >1 mm (coarse sand), >500 µm (medium sand), >250 µm (fine sand), >125 µm (very fine sand), >63 µm (coarse silt) and <63 µm (silt) (Higgins and Thiel 1988). The mean grain size (MGS) was then calculated from the cumulative frequency curves established with the grain size distribution.

2.7 Permits

Each group was able to apply on-line to acquire a sampling permit for scientific purposes. These are available from DFO Gulf region at the following location:

https://www.glf.dfo-mpo.gc.ca/fam-gpa/bssp-saps/s52/form-e.php?form_lgE=e

Those listed as part of the community group on the Section 52 permit are authorized to collect, count and release fish species commonly found in estuarine locations. The permit also allows them to collect and transfer species that require further identification.

3.0. RESULTS

Descriptive statistics were used to examine the CAMP data and determine the relative abundance and species richness for sampling sites in each of the Maritime Provinces.

The total abundance values were determined by adding the totals for each species for the 5 months sampled of the season at each CAMP estuary or coastal site. Species richness was calculated by determining the mean number of different species captured across all 6 stations located within a CAMP site, for each month sampled. In addition, the species richness was averaged for all 5 months for each baseline site. Presenting the data in this way allows for comparisons among all the estuary and coastal shoreline sample sites. Abundance of a particular species or grouped species of invertebrate or fish can be compared across sites and stations. This information is also available in graphic form on posters developed for each geographical region of the Northumberland Strait.

3.1 Fish and Crustaceans

For the 2005 sample season, a total of **417,790** fish and crustaceans were counted for eleven baseline (includes two almost baseline (4/5)) estuaries/coastal shorelines within NB, four within NS and six in PEI.

There were 30 different species of fish and crustaceans identified during the 2005 sample season, twenty-four of those species were fish and six were crustaceans (**Appendix 1**).

This section will discuss sampling results for sites with four to five complete months of sampling data. This includes the provinces of NB, NS, and PEI for the following 21 sites; Jourimain, Shediac, Cocagne (4 months), Little Bouctouche (4 months), Bouctouche, Saint Louis de Kent, Miramichi, Tracadie, Lamèque, Shippagan, and Caraquet (NB); River Phillip-Pugwash, Pictou, Antigonish, and Mabou (NS); and Mill River, Trout River, Basin Head, Pinette River, Murray River and Monteque-Brudenell Rivers (PEI).

The six common species of crustaceans were; grass shrimp (*Palaemonetes vulgaris*), sand shrimp (*Crangon septemspinosa)*, rock crab (*Cancer irroratus*), green crab (*Carcinus maenas*), lady crab (*Ovalipes ocellatus)* and mud crabs (*Xanthidae sp*.).

Interestingly, the most abundant fish and crustacean species were the same for New Brunswick, Nova Scotia, and Prince Edward Island. They were, in order of most abundant; sand shrimp (*Crangon septemspinosa*), both mummichog (*Fundulus heteroclitus*) and killifish (*Fudulus diaphanus*) grouped as *Fundulus* sp., 4-spine stickleback (*Apeltes quadracus*) and Atlantic silverside (*Menidia menidia*).

The ten most abundant species or species groups for each province/zone are graphed to show the abundance relationship among the three sections in New Brunswick, namely northeastern, central and southeastern sites (Fig. 2 - 4), Nova Scotia (Fig 5 & 5A) and Prince Edward Island sites (Fig. 6 & 6A). Within the 10 categories of species, the 'other' category pools the remaining less abundant species which sometimes represents large number of certain species at specific stations (eg. pipefish). The total number of species or species groups for the 5 months sampled is also graphed next to the total abundance graph. For each month, average species richness per beach seine haul was calculated across the six stations. The mean and 95 % confidence interval for these monthly estimates of species richness were plotted for each estuary or bay.

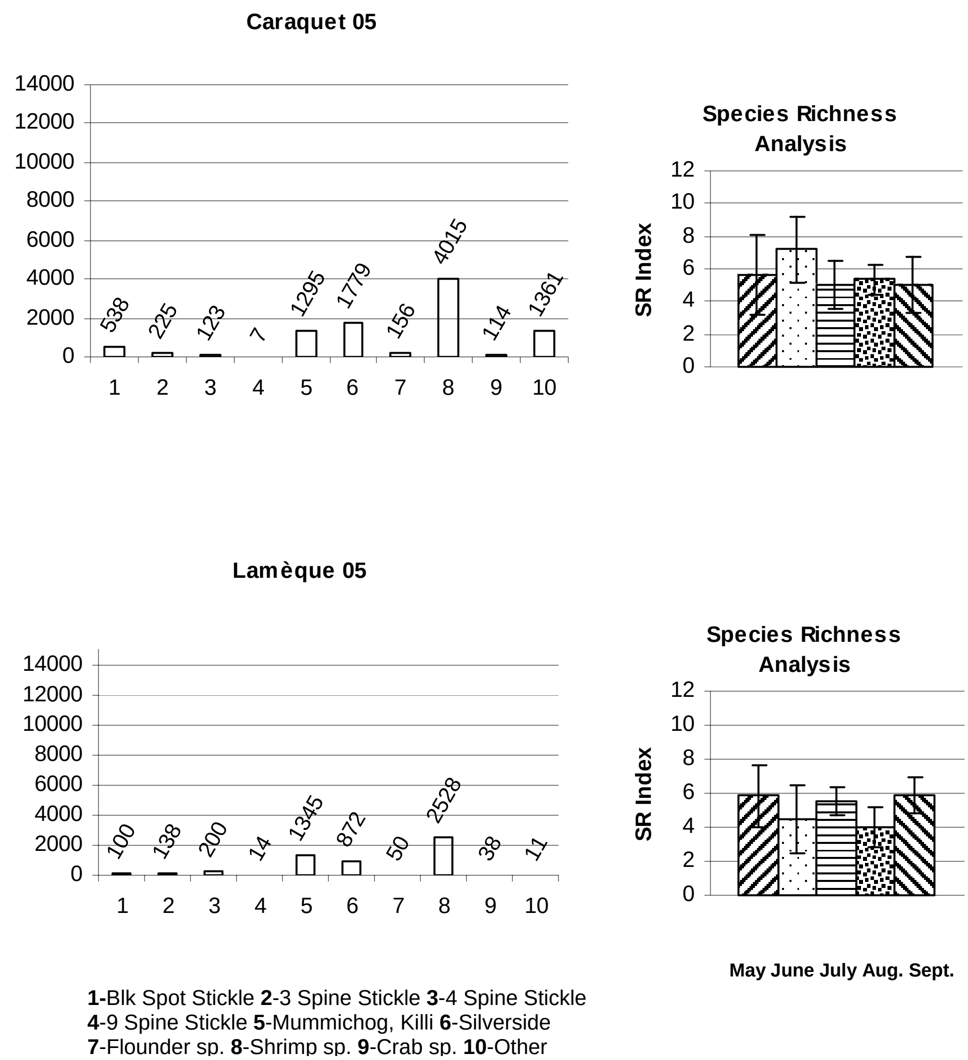


Figure 2. Total cumulative number of adult animals for the 10 most abundant species or species groups in Caraquet and Lamèque (NB) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

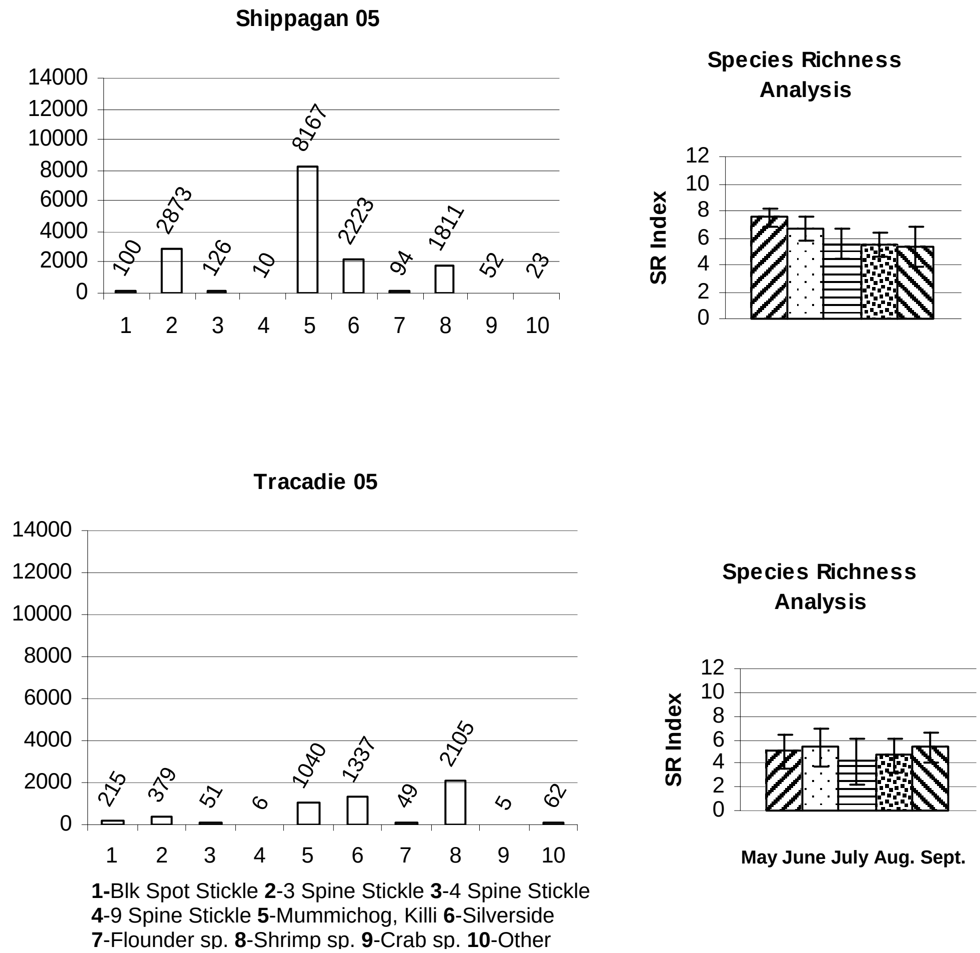


Figure 2A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Shippagan and Tracadie (NB) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

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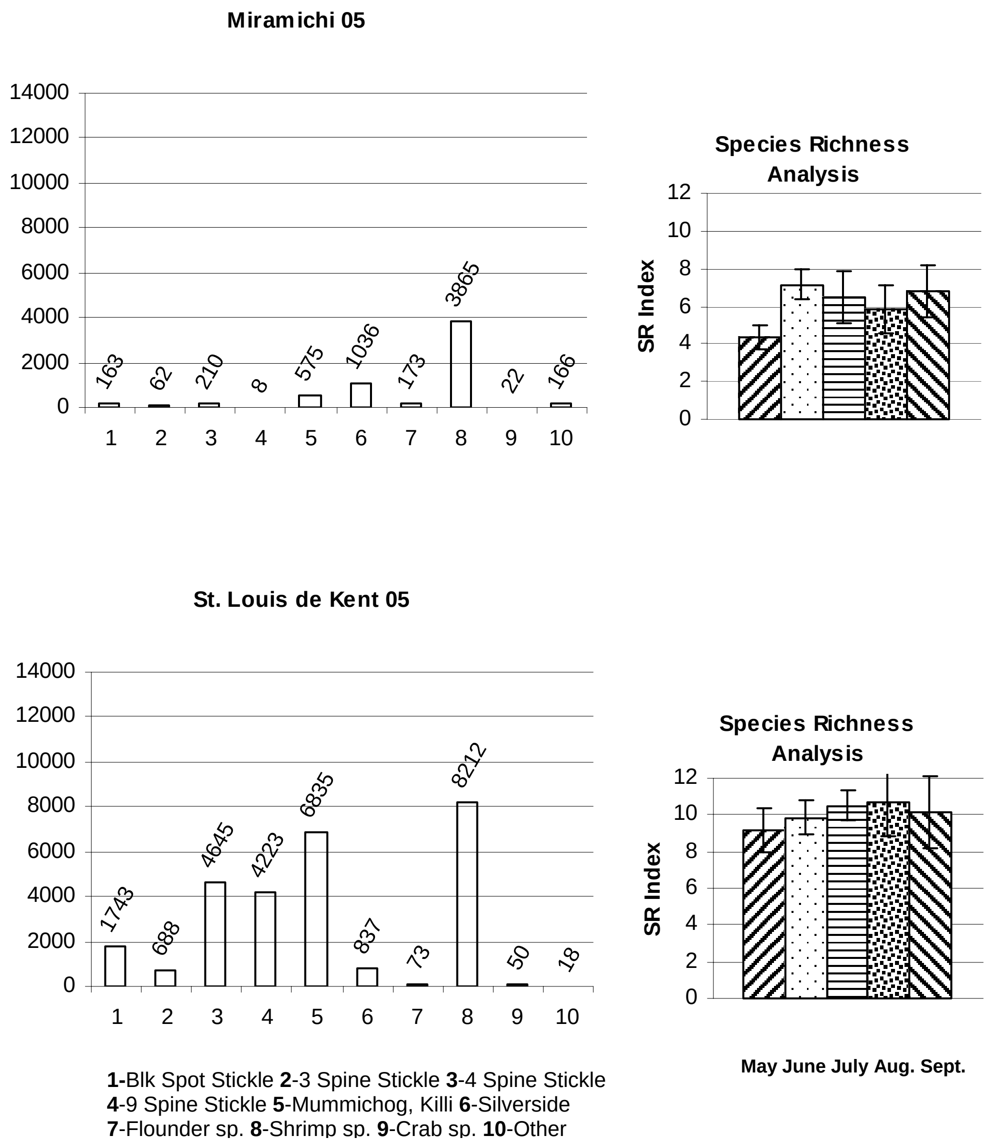

Figure 3. Total cumulative number of adult animals for the 10 most abundant species or species groups in Miramichi and St. Louis de Kent (NB) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

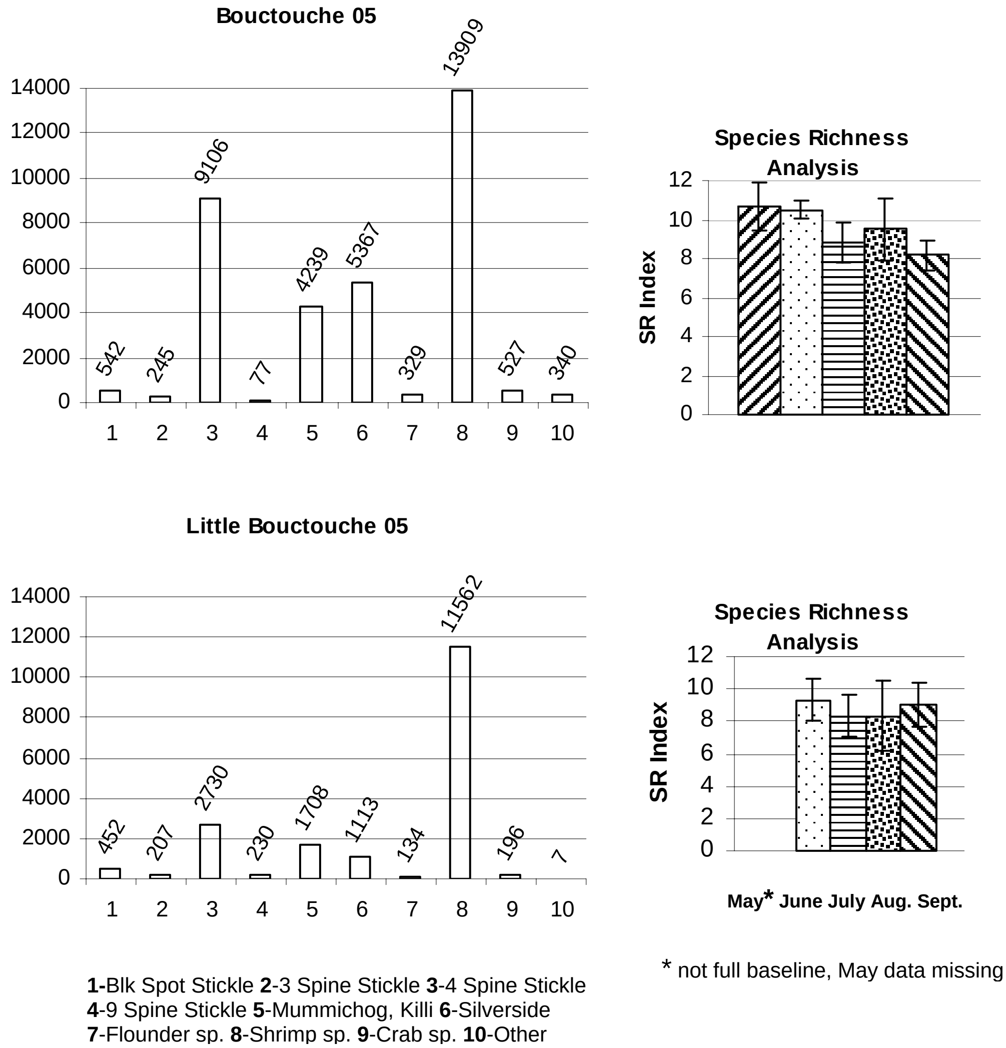

Figure 4. Total cumulative number of adult animals for the 10 most abundant species or species groups in Bouctouche and Little Bouctouche (NB) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

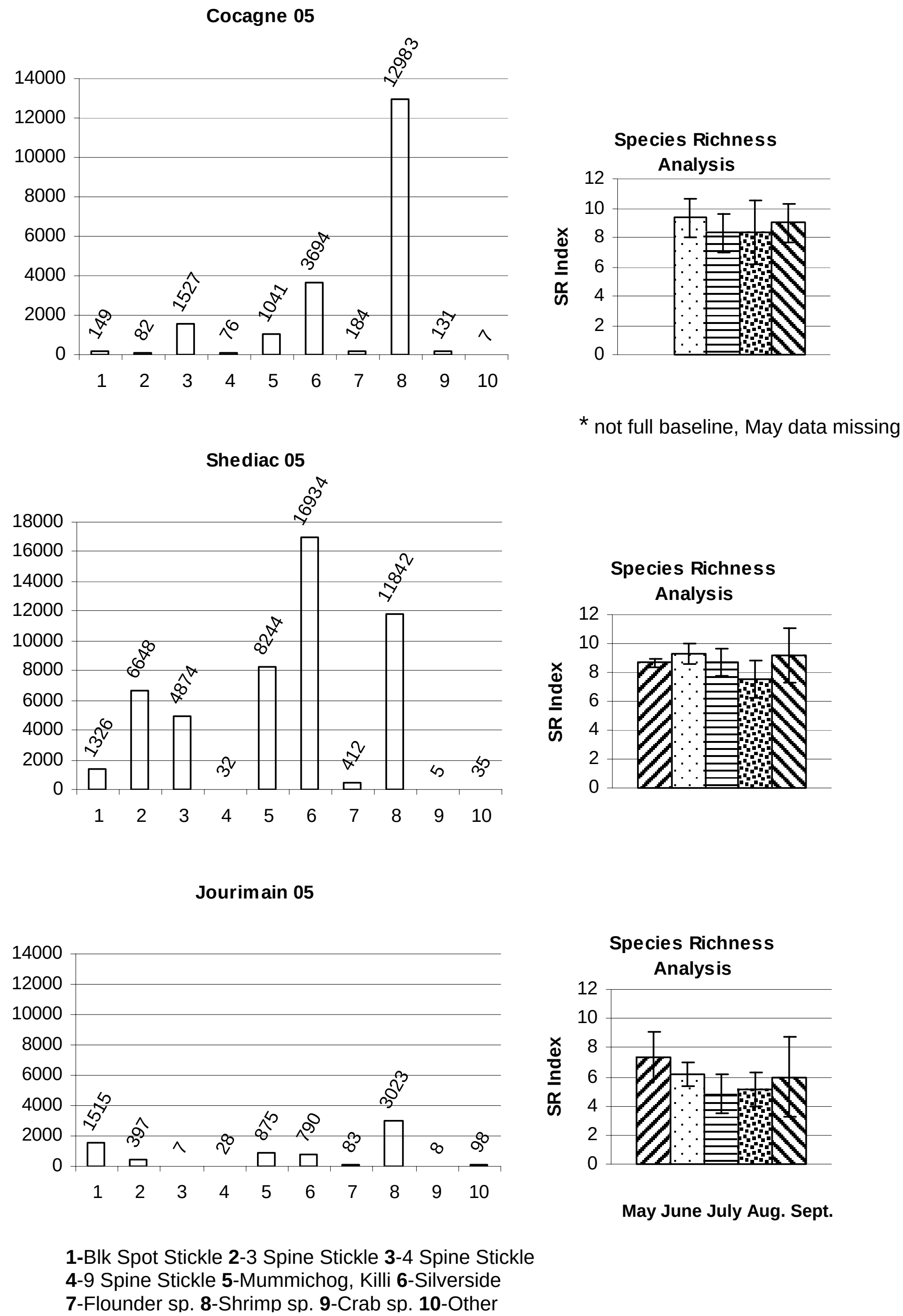

Figure 4A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Cocagne, Shediac and Cape Jourimain (NB) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

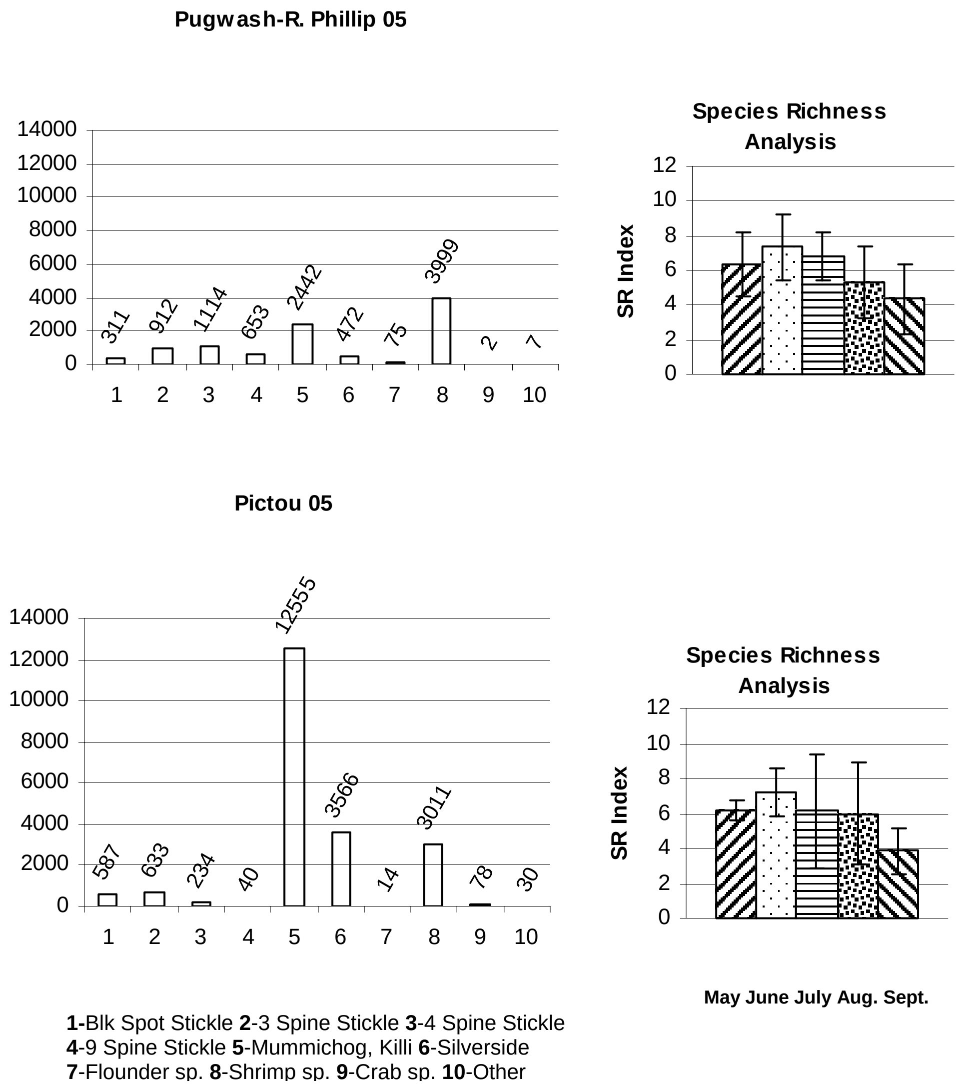

Figure 5. Total cumulative number of adult animals for the 10 most abundant species or species groups in Pugwash - R. Phillip and Pictou (NS) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

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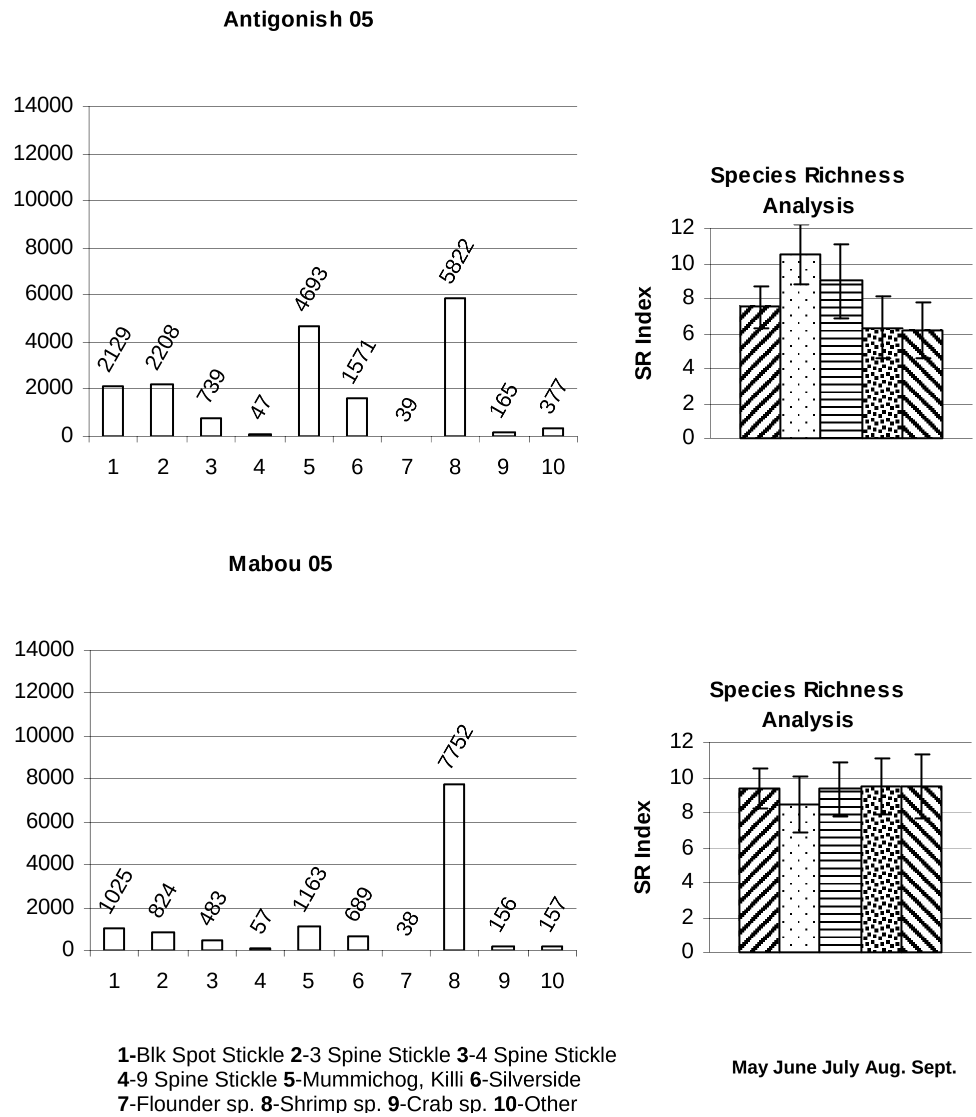


Figure 5A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Antigonish and Mabou (NS) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

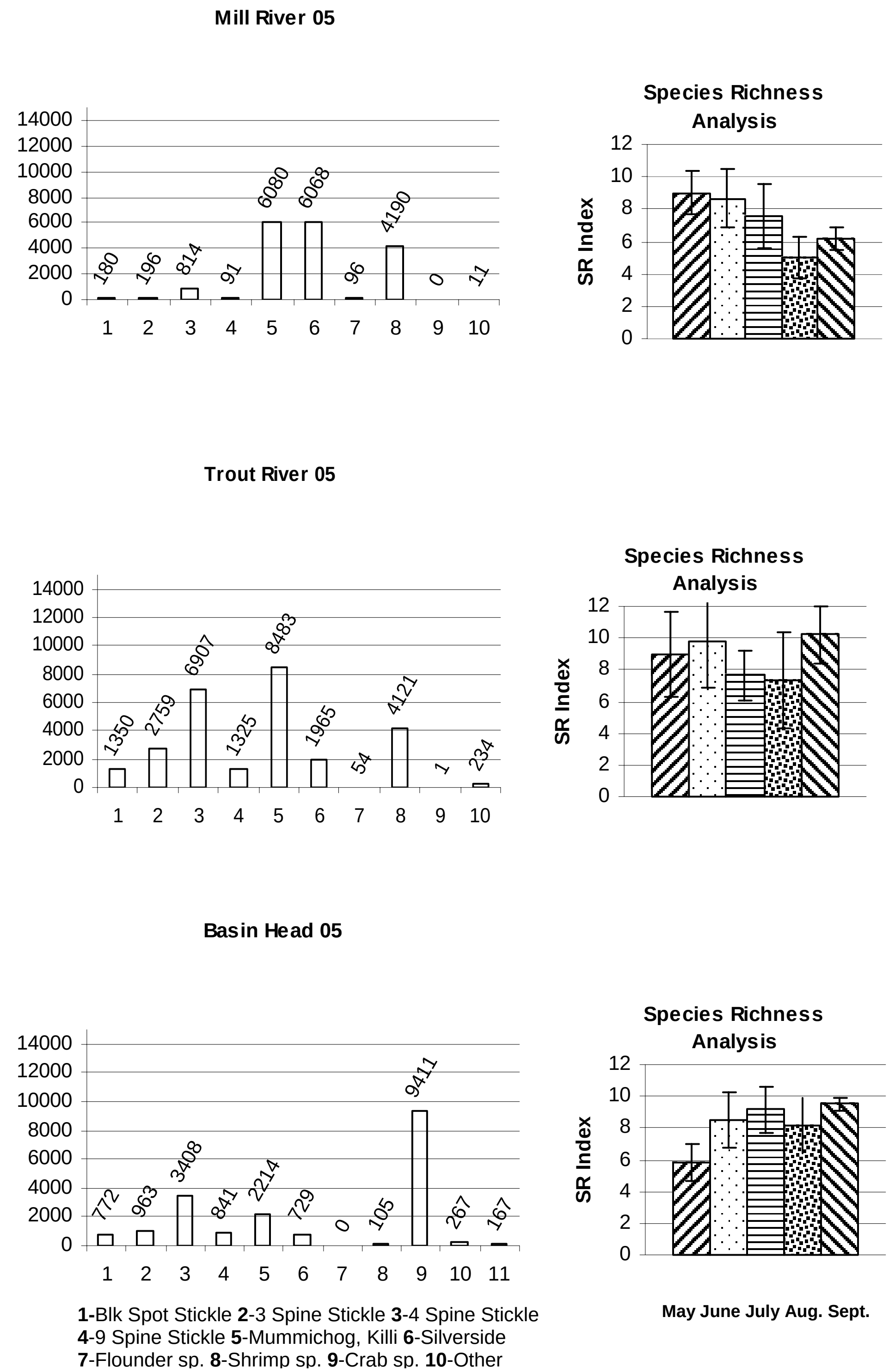


Figure 6. Total cumulative number of adult animals for the 10 most abundant species or species groups in Mill R., Trout R. and Basin Head (PEI) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

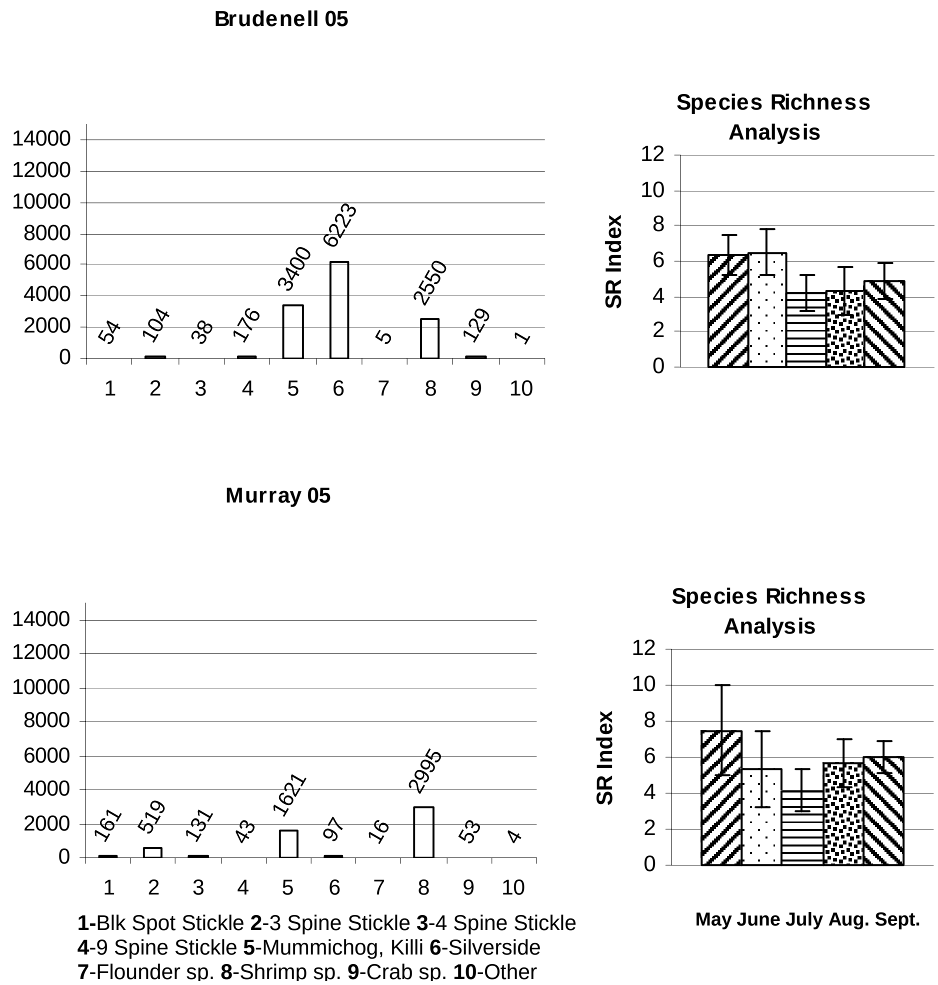


Figure 6A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Brudenell-Montague and Murray (PEI) sampled over 5 months in 2005. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

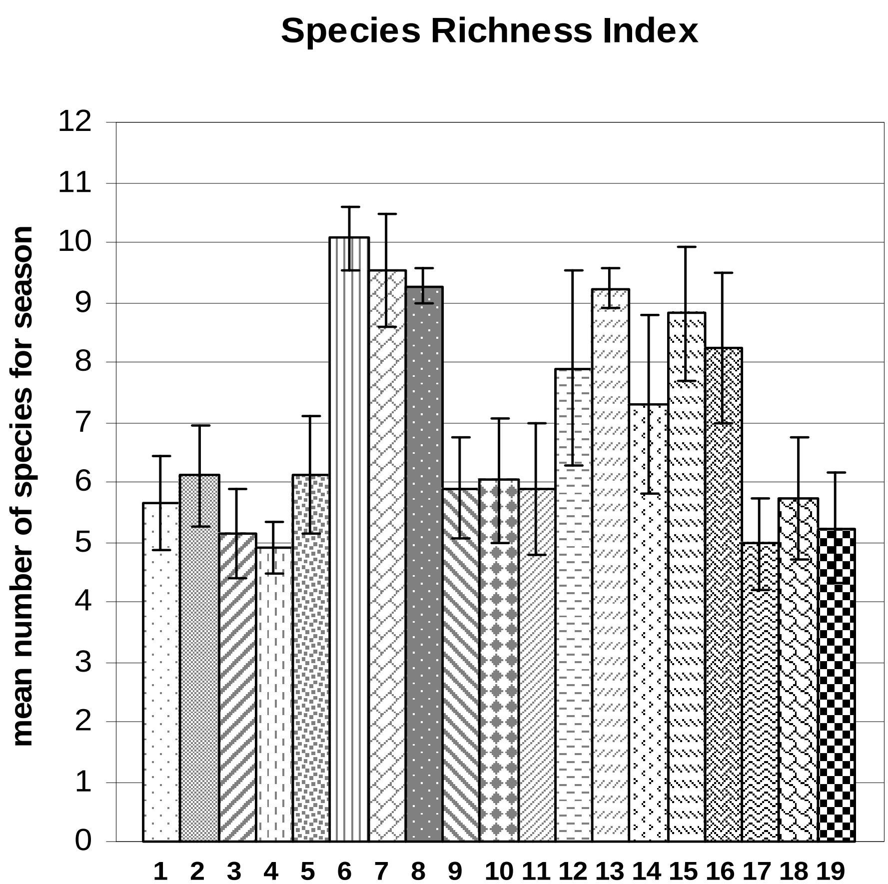
In northeastern NB (**Figures 2 & 2A**), the most abundant species in Caraquet, Lamèque, Shippagan and Tracadie were shrimp, mummichog and silverside. Sand shrimp were the most abundant at all locations except Shippagan where *Fundulus* sp. was the dominate species. The threespine stickleback counts were higher in Shippagan and Tracadie compared to the fourspine stickleback and the blackspotted stickleback. Caraquet had a greater abundance of blackspotted stickleback than the three and fourspine stickleback. As for Lamèque, the fourspine stickleback was the fourth most abundant species after the shrimp, the mummichog and the silverside. St. Simon location was not sampled in 2005 and Tracadie became a new baseline site. Mean species richness was generally higher in the spring and early summer samplings, though compared to the rest of the province, numbers were lower.

In central NB (**Figure 3**), Miramichi and St. Louis de Kent (Kouchibouguacis) were the only baseline locations in 2005. Baie du Village and the main Richibucto River were not sampled in 2005. St Louis de Kent generated totals much higher than the Miramichi. Sand shrimp had the dominant totals in both rivers. Silversides were the second most abundant in the Miramichi but ranked only 6th in the Kouchibouguacis system. The dominant stickleback in both systems was the fourspine. Striped bass were noticeably evident in the Miramichi and totalled 156 over the 5 months sampling. Mean species richness was highest in June in Miramichi and in August in St. Louis de Kent. The trend was for higher overall species richness in central NB when compared to northeast NB.

In southeastern NB (**Figure 4 & 4A**), Bouctouche, Cocagne and Shediac maintained baseline status. The Little Bouctouche and Cape Jourimain came onboard as new baseline sites. Jourimain is more of a coastal location compared to the estuaries associated with the others which might explain the lower abundance per species. Sand shrimp numbers were highest at all sites except Shediac where silversides dominated. Silverside adult abundance ranked 2nd in Cocagne, 3rd in Bouctouche and 4th in Cape Jourimain and Little Bouctouche. The fourspine stickleback was highest in abundance than the different sticklebacks in Bouctouche, Little Bouctouche and Cocagne. The threespine stickleback dominated in Shediac and the blackspotted had highest numbers of all sticklebacks in Cape Jourimain. Mean species richness was highest in May and June in Bouctouche, in June and September in the Little Bouctouche, in June and September in Cocagne, in June in Shediac and in May and June in Cape Jourimain. Mean species richness in the southeast was comparable to central NB.

In Nova Scotia (**Figure 5 & 5A**), Pictou, Antigonish and Mabou maintained baseline status. River Phillip-Pugwash became a baseline site in 2005. The groups were able to maintain a solid sampling schedule with regular assistance of biology students from St. Francis Xavier University. Sand shrimp were highest in numbers in all locations except Pictou where *Fundulus* sp. dominated. *Fundulus* sp. was second in dominance at all the other locations. For the 4 stickleback species, threespine dominate in Pictou and Antigonish, fourspine dominate in Pugwash-River Phillip and blackspotted dominate in Mabou. In Antigonish, sand lance numbers were high in the “other” category in June at station 6. There were no large fluctuations in mean species richness in Nova Scotia, generally a value of seven was most frequent for all locations.

In Prince Edward Island (**Figure 6 & 6A**), Basin Head, Trout River and Mill River maintained their baseline status in 2005. The Southeast Environmental Association (SEA), who was involved with the CAMP for 3 months in 2004, was able to achieve baseline status in 2005. Their locations also included the Pinette, Murray and Montague-Brudenell river estuaries. Compared to the other five locations in PEI, Trout River had the highest abundance of collected species overall. Sand shrimp were most abundant in Basin Head and Murray River. *Fundulus* sp. had the highest totals in the Trout, Pinette and Mill River estuaries. The Montague-Brudenell system saw silversides being the abundant species collected. For the 4 stickleback species, fourspine stickleback abundance was highest in Mill River, Trout River and Basin Head. The threespine stickleback abundance was highest in Pinette, Brudenell and Murray River locations. Mean species richness was highest in May and June in Mill River, June and September in Trout River and July and September in Basin Head. Values of 9 and 10 species were not uncommon in Basin Head and number of total species per beach seine haul were often equal or over 10 for Trout River. A value of 6 or less was the norm in the southeast section of the province. Values were highest in May in Murray and Pinette estuaries. In the Montague-Brudenell system, June had the highest mean species richness value, but only slightly more than May.



(NB) 1- St. Simon **2**- Shippagan **3**- Lamèque **4**-Tracadie **5**- Miramichi **6**- St. Louis de Kent **7**- Bouctouche **8-** Shediac **9**- Cape Jourimain **(NS) 10**- Pugwash -R. Phillip **11**- Pictou **12**- Antigonish **13**- Mabou **(PEI) 14-** Mill River **15**-Trout River **16**- Basin Head **17-** Pinette **18**- Murray R. **19-** Montague-Brudenell R.

Figure 7. The mean species richness with a confidence interval at ± 95% (n = 5 for each bar) for 19 baseline estuary locations in the Gulf of St. Lawrence over a 5 month period.

Figure 7 provides an average of all 6 sample stations, for all months for each of the 19 baseline estuaries or coastal shoreline locations. The species richness for all five months was averaged to arrive at the reference value shown in the graph. At this time the combined data provide a baseline reference point. When more information is available, environmental science personnel will examine the successive year data for patterns and trends.

In the province of New Brunswick, St. Louis de Kent had the highest average species richness for the five month sampling period at ~10.1 species ± 0.5227 (SD), followed closely by Bouctouche (~ 9.5) and Shediac (~9.3). The lowest average species richness was in Tracadie at ~ 4.9 species ± 0.4334.

In Nova Scotia, Mabou Harbour had the highest species richness value at ~ 9.2 ± 0.3212 (SD) and Pictou Harbour had the lowest at ~ 5.9 species ± 1.0952 (SD).

In PEI, Trout River had the highest mean species richness values at ~ 8.8 species ± 1.1177 (SD). The Pinette system has the lowest value at ~ 5.0 species ± 0.7656 (SD).

3.2 Macrophytes

The dominant vegetation type was submerged eelgrass beds. When possible, stations were chosen to include an eelgrass bed in the station sweep area, to have eelgrass growth in the vicinity or to have the potential to have eelgrass grow there. Normally the eelgrass bed was located in the outer 1/3rd or outer 1/5th of the sample sweep area. If a vegetation bed was present the number of fish and invertebrates collected was generally higher as more habitat for pelagic species were available. If the bottom type was sand dominated, less eelgrass was present. Sites with larger rocks are likely to include species of rockweed (usually *Fucus vesiculosus*). Other abundant macrophyte vegetation includes filamentous green algae (*Cladophora sp*.) and sea lettuce (*Ulva lactuca*). In northern NB and at a few NS sites hollow green weed (*Enteromorpha intestinalis*) was noticeable but not abundant. On occasion, volunteers have found pieces of kelp species (*Laminaria*) and green fleece (*Codium fragile*) pieces as floating wash-in by the net sweep. These species are usually attached by a holdfast in deeper water. Generally, upper estuary sites in the river system contain more eelgrass beds than the outer portion that is closer to the mouth or associated with a beach area. Vegetation type is important as it defines the variety of available habitats. Preference of YOY pelagics and juvenile crustaceans for protective cover from predators translates into greater numbers when vegetation is present.

Percent vegetation coverage was estimated using the sampling grid as described in Weldon et al. (2005). When this was not possible, volunteers estimated the overall vegetation cover by looking at the 225 m^2 of beach seine sweep. Very often the vegetation was farther out beyond the sweep area.

Table 1. Summary of the dominant bottom sediment type for each estuary location and the mean percent vegetation cover of individual stations (or range of mean percentage cover if more than one station). (total stations = 6, mean of 5 monthly samples for percentages)

N.B.	# Stations Mud	mean % Vegetation	# Stations Mud-Sand	mean % Vegetation	# Stations Sand	mean % Vegetation	# Stations Sand-Rock	mean % Vegetation	# Stations Rock	mean % Vegetation
Caraquet	0	0	1	15	2	0 - 5	2	0 - 10	1	20
Lamèque	1	30	4	0 - 50	1	10	0	0	0	0
Shippagan	0	0	0	0	4	0-5	2	0	0	0
Tracadie	0	0	1	15	5	0-5	0	0	0	0
Miramichi	2	0	1	0	2	0-5	1	0	0	0
St Louis	3	0 - 5	3	0 - 25	0	0	0	0	0	0
Bouctouche	1	0	3	0	2	0 - 10	0	0	0	0
Little Bouct.	0	0	1	5	4	0 - 10	1	5	0	0
Cocagne	1	10	1	5	3	0 - 5	1	0	0	0
Shediac	2	0 - 10	3	0 - 20	1	5	0	0	0	0
Jourimain	0	0	1	5	4	0 - 5	1	5	0	0
N.S.	# Stations Mud	mean% Vegetation	# Stations Mud-Sand	mean % Vegetation	# Stations Sand	mean % Vegetation	# Stations Sand-Rock	mean % Vegetation	# Stations Rock	mean % Vegetation
R.Phil-Pugw	2	0 - 20	1	0	3	0 - 30	0	0	0	0
Pictou	0	0	1	0 - 5	4	0 - 20	1	15	0	0
Antigonish	2	0 - 20	0	0	1	0	1	0	2	0 - 45
Mabou	2	30 - 55	1	30	0	0	1	0	2	0 - 10
P.E.I.	# Stations Mud	mean % Vegetation	# Stations Mud-Sand	mean % Vegetation	# Stations Sand	mean % Vegetation	# Stations Sand-Rock	mean % Vegetation	# Stations Rock	mean % Vegetation
Mill River	0	0	1	32	5	0 - 5	0	0	0	0
Trout River	1	0	2	0 - 40	2	0 - 25	0	0	0	0
Basin Head	0	0	1	0	5	0 - 10	1	0	0	0
Pinette	1	0	2	0 - 5	3	0 - 10	0	0	0	0
Murray	0	0	1	0	4	0 - 10	1	0	0	0
Mont.-Brud	0	0	0	0	6	0 - 30	0	0	0	0

The percent vegetation cover is presented as averages and/or best estimates for the range determined. The site with the most mud (3) and mud - sand sites (3) was in St. Louis de Kent. St. Louis has the smallest mean grain size at 0.18 ± 0.05 (SD) mm. The majority of the stations were characteristically sandy close to shore where beach seining occurred. Often the mud was farther offshore and was mostly sampled when the tide was out. In Nova Scotia, mud or mud - sand occurred in half the stations at all sites except Pictou. Prince Edward Island sites were dominated by sandy sites.

Percent vegetation cover is a qualitative measure because some is attached (eelgrass and rockweed) and some is floating as was observed with sea lettuce. The spring observations have lower values for vegetation but as a season progressed, the vegetation present generally increased.

The quadrat method described in Weldon et al. (2005) is effective when the water has not been stirred up. Volunteers find it difficult to get bottom profile information when wind and waves make observations more difficult. The use of a viewing bucket or waterscope was shown to volunteers but not made mandatory in 2005. The NGO's were instructed to make a detailed record of the characteristics of the bottom profile for each station in May so comparisons could be made as the season progressed. When each site was visited in the following months, volunteers were instructed to make entries in the data sheet that would approximate the vegetation cover as if they threw the quadrate. Comparing the 5 months of descriptive data inputs allows the data processor to get a good description of the site. This general description of the site does not provide reliable replicate data.

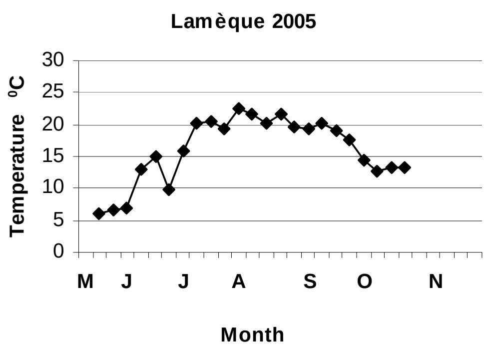
3.3 Physical Measures

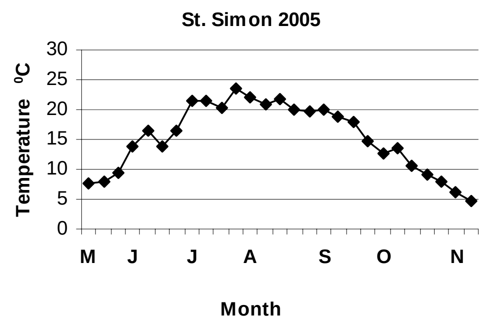
At each sample site and at every station, three physical parameters were measured. Readings for salinity, temperature and dissolved oxygen gave a monthly snapshot that provided an overview of seasonal change (**Tables 2 - 4**). The upper sample stations in each estuary had lower salinities and considerable fluctuation depending upon state of the tide, as expected. There was considerable variation in dissolved oxygen.

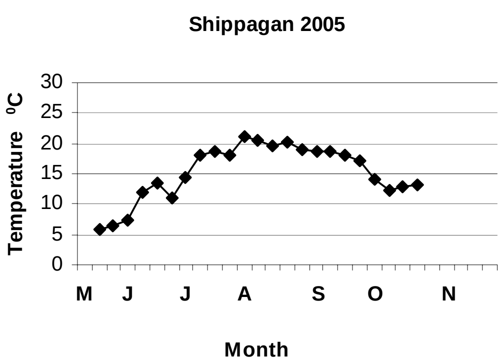
Table 2. Average monthly temperature (^{0}C ± S.D.) per site for the 2005 season (n = 6). (NA = not available)

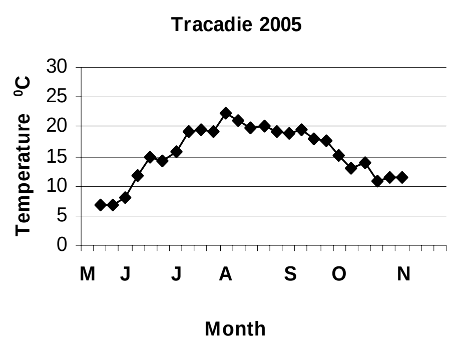
	Temp ^{0}C ± S.D.				
N.B.	May	June	July	Aug.	Sept.
Caraquet	**11.8 ± 3.1**	**19.1 ± 4.6**	**20.7 ± 0.5**	**18.0 ± 1.7**	**12.7 ± 0.3**
Lamèque	**7.7 ± 0.8**	**22.9 ± 0.9**	**22.3 ± 0.7**	**21.5 ± 1.0**	**12.2 ± 0.8**
Shippagan	**13.1 ± 2.1**	**20.4 ± 2.4**	**22.5 ± 2.1**	**20.4 ± 0.9**	**14.5 ± 0.8**
Tracadie	**9.1 ± 0.5**	**20.3 ± 1.3**	**22.2 ± 1.5**	**20.1 ± 2.3**	**12.9 ± 1.4**
Miramichi	**11.4 ± 0.7**	**22.0 ± 0.6**	**23.7 ± 2.3**	**22.0 ± 0.6**	**19.0 ± 0.3**
St Louis	**17.5 ± 1.8**	**24.4 ± 1.8**	**26.3 ± 1.8**	**20.7 ± 0.5**	**15.3 ± 0.7**
Bouctouche	**15.4 ± 3.0**	**20.7 ± 1.5**	**22.0 ± 1.3**	**23.5 ± 3.5**	**15.1 ± 0.2**
Little Bouct.	**NA**	**21.7 ± 1.8**	**22.7 ± 1.0**	**21.5 ± 0.6**	**15.7 ± 0.9**
Cocagne	**14.9 ± 2.2**	**24.0 ± 1.4**	**23.4 ± 3.3**	**21.4 ± 0.6**	**18.5 ± 4.1**
Shediac	**18.5 ± 2.6**	**21.6 ± 1.7**	**23.4 ± 1.6**	**23.5 ± 1.3**	**15.2 ± 0.2**
Jourimain	**10.2 ± 1.5**	**16.7 ± 1.2**	**18.3 ± 0.03**	**21.8 ± 0.8**	**14.4 ± 0.5**
N.S.					
R.Phil-Pugwash	**9.5± 1.5**	**15.1 ± 0.7**	**22.8 ± 3.3**	**23.6 ± 2.9**	**24.4 ± 4.6**
Antigonish	**7.9 ± 1.3**	**13.8 ± 0.59**	**20.3 ± 1.0**	**22.1 ± 1.1**	**19.3 ± 2.2**
Mabou	**10.2 ± 0.8**	**14.9 ± 1.4**	**21.7 ± 1.1**	**22.0 ± 1.4**	**15.6 ± 0.8**
Pictou	**8.7 ± 0.6**	**16.9 ± 1.3**	**20.2 ± 2.6**	**23.3 ± 1.4**	**18.2 ± 0.6**
P.E.I.					
Mill River	**10.8 ± 0.5**	**20.6 ± 0.8**	**23.8 ± 0.5**	**22.1 ± 1.1**	**14.97± 0.8**
Trout River	**15.1 ± 1.7**	**20.6 ± 1.1**	**21.9 ± 0.8**	**19.0 ± 0.3**	**14.68 ± 0.9**
Basin Head	**6.9 ± 0.7**	**11.4 ± 1.0**	**17.8 ± 0.6**	**19.8 ± 0.3**	**15.1 ± 0.5**
Pinette	**20.2 ± 0.7**	**20.1 ± 1.6**	**21.9 ± 0.2**	**14.0 ± 0.7**	**13.5 ± 6.8**
Murray	**20.4 ± 1.5**	**24.0 ± 1.5**	**22.8 ± 1.3**	**15.7 ± 0.5**	**9.8 ± 0.3**
Mont.-Brudenell	**16.2 ± 3.0**	**21.7 ± 1.8**	**22.4 ± 1.7**	**14.2 ± 0.8**	**10.2 ± 0.4**

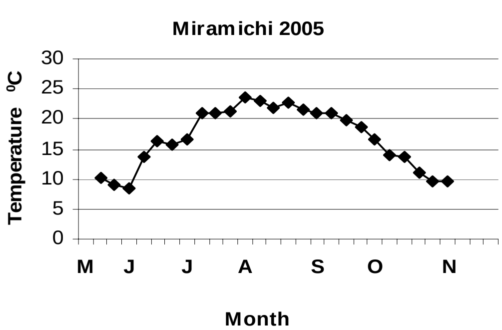
Each estuary has its own temperature characteristics. **Table 2** reflects the average temperature on the day of sampling of all sites on the estuary. There are individual differences depending on whether the sample site is inner, middle or outer estuary. Temperature was obviously related to increasing air temperatures as the season progressed; hence the warmest temperatures occurred in July and August. Outer estuary sample sites were generally cooler due to contact with cooler oceanic water from Northumberland Strait. Inner estuary sample stations are generally warmer later in the season as they are influenced by the warmer inland run-off waters of the estuary. In shallow waters of inner estuarine stations temperature variation will also reflect diurnal changes in air temperature. In 2005, Vemco continuous temperature minilog probes were inserted in selected estuaries. The loggers were set to record at hourly intervals and the graphed data represents weekly averages. The majority were recovered, but where data are missing, those probes were not recovered. The following graphs represent those weekly averages for those locations where probe information was downloaded.

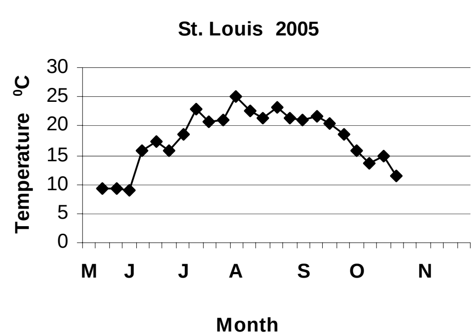


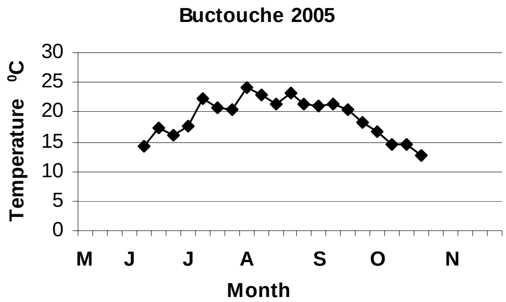


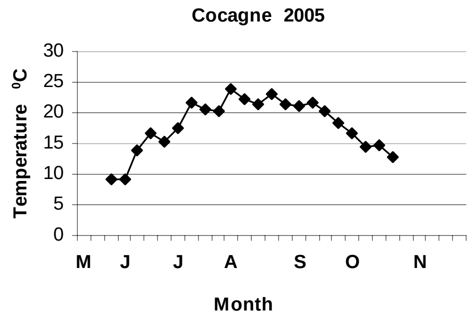


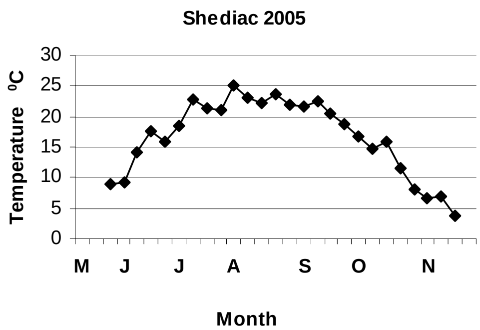


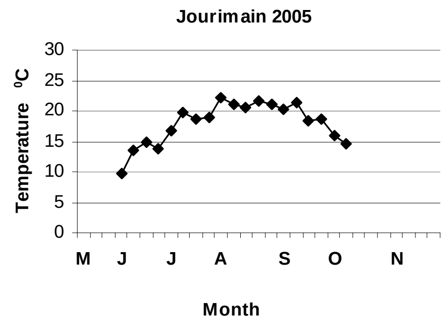




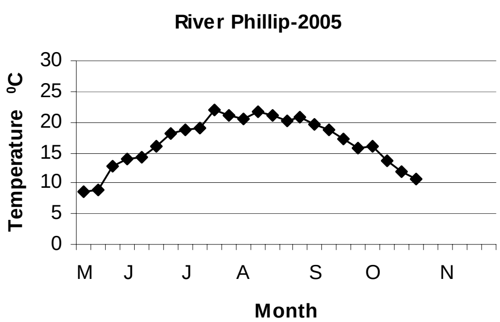


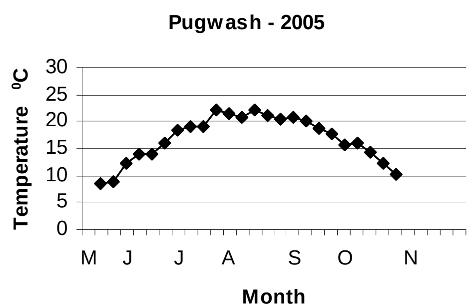


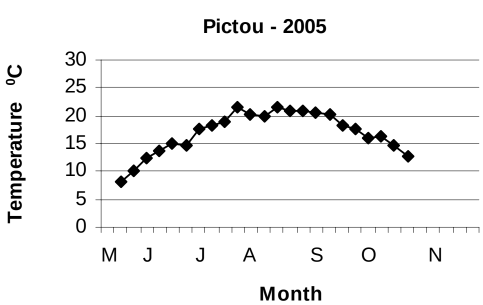


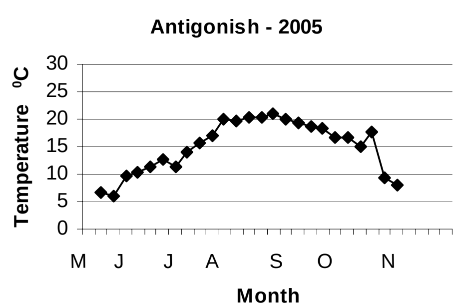


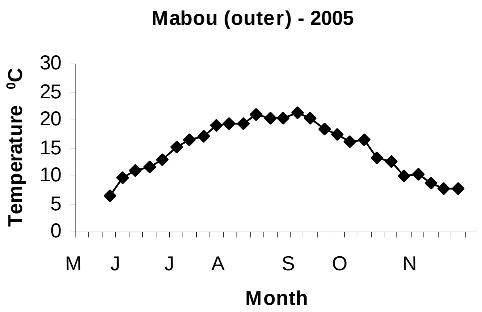
In New Brunswick, there was a slight drop in the average surface temperature in late June and late July in most locations.

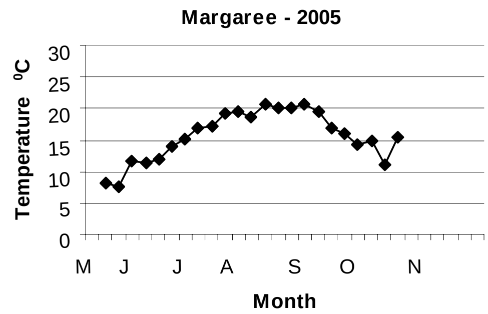




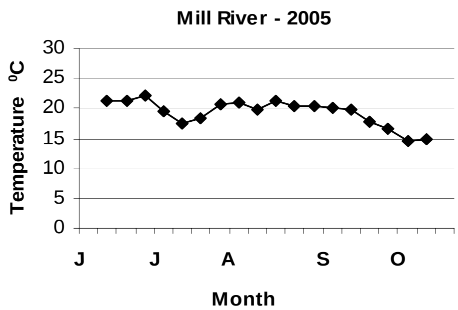


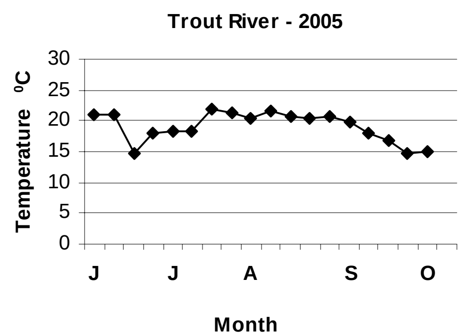


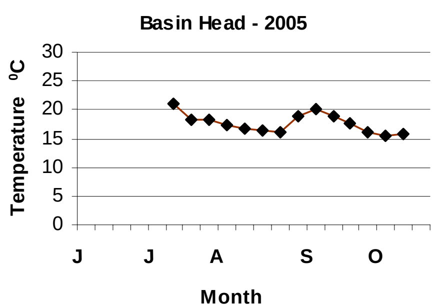


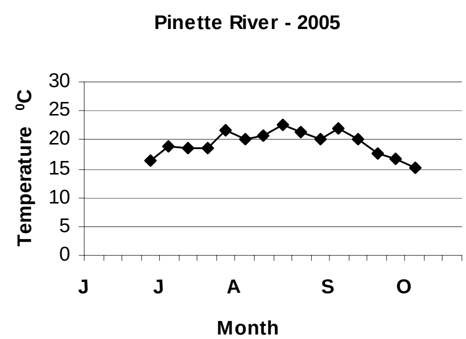


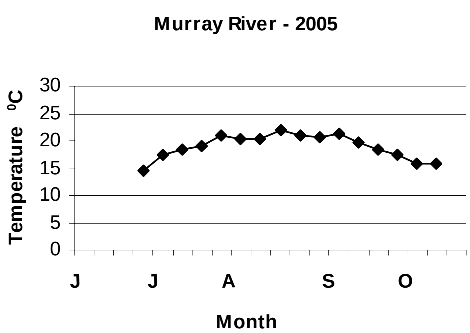
In Nova Scotia, the trend for an increase from spring to mid summer and a decrease from summer to fall was recorded. Most of the estuaries show a slight decrease in early August.

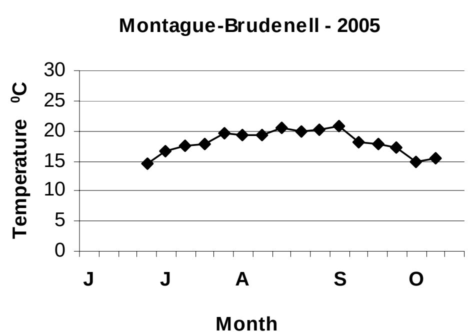












In Prince Edward Island, Basin Head which experiences less exchange with Northumberland Strait waters behaves quite differently from the other estuaries. Otherwise the other estuaries show the pattern of increases from spring to mid - August then a decline as air temperatures cool. There are fluctuations that probably relate to summer cooling and warming patterns related to weather conditions. Also, the temperature probes were put in the water later in PEI compared to NS and NB which explains in part the different patterns observed in PEI

Figure 8. Graphs representing the weekly mean temperature (^{0}C) determined from hourly readings from Vemco minilog temperature recorders for all sites involved in the 2005 sampling season for CAMP.

Table 3. Average monthly salinity (ppt ± S.D.) per location for the 2005 season (n = 6). (NA = not available)

	Salinity (ppt) ± S.D.				
N.B.	May	June	July	Aug	Sept
Caraquet	**20.6 ± 8.4**	**22.9 ± 1.2**	**23.7 ± 1.2**	**25.7 ± 1.0**	**26.6 ± 1.4**
Lamèque	**24.2 ± 6.2**	**25.2 ± 0.4**	**24.8 ± 1.9**	**25.6 ± 0.4**	**25.9 ± 1.3**
Shippagan	**27.6 ± 0.3**	**26.2 ± 0.5**	**25.9 ± 0.2**	**26.2 ± 1.7**	**26.4 ± 1.2**
Tracadie	**20.1 ± 4.1**	**23.8 ± 6.0**	**23.3 ± 2.9**	**24.5 ± 2.5**	**22.9 ± 2.7**
Miramichi	**0.9 ±1.2**	**9.6 ± 7.7**	**12.8 ± 7.7**	**13.5 ± 5.5**	**18.3 ± 7.2**
St Louis	**7.3 ± 2.2**	**14.6 ± 0.9**	**14.5 ± 1.1**	**19.3 ± 1.1**	**11.5 ± 1.3**
Bouctouche	**10.3 ± 4.2**	**22.5 ± 1.6**	**23.2 ± 0.7**	**23.3 ± 1.0**	**23.7 ± 0.9**
Little Bouct.	**NA**	**22.5 ± 2.0**	**23.9 ± 1.4**	**25.4 ± 1.0**	**22.7 ± 22.6**
Cocagne	**12.7 ± 2.3**	**25.5 ± 0.3**	**24.6 ± 1.9**	**26.8 ± 0.6**	**23.9 ± 5.0**
Shediac	**14.2 ± 4.3**	**23.9 ± 1.8**	**23.1 ± 0.6**	**25.9 ± 0.4**	**25 ± 0.6**
Jourimain	**24.9 ± 2.5**	**27.2 ± 0.2**	**27.2 ± 0**	**28.1 ± 0.3**	**27.8 ± 0.5**
N.S.					
R.Phil-Pugwash	**19 ± 4.2**	**22.3 ± 3.9**	**20.2 ± 2.6**	**26.6 ± 1.0**	**27.0 ± 1.6**
Antigonish	**22.7 ± 11.6**	**10.3 ± 9.3**	**20.3 ± 1.0**	**26.3 ± 3.5**	**23.1 ± 5.7**
Mabou	**13.2 ± 4.3**	**23.8 ± 4.0**	**21.7 ± 1.1**	**25.9 ± 0.9**	**15.1 ± 6.8**
Pictou	**14.1 ± 7.8**	**23.5 ± 2.7**	**22.8 ± 3.3**	**25.8 ± 1.7**	**27.3 ± 1.5**
P.E.I.					
Mill River	**10.6 ± 7.4**	**22.6 ± 0.8**	**21.6 ± 2.2**	**24.7 ± 1.6**	**23.2 ± 0.6**
Trout River	**14.5 ± 6.3**	**24.0 ± 2.1**	**22.9 ± 2.5**	**22.0 ± 5.7**	**24.3 ± 1.4**
Basin Head	**27.8 ± 1.5**	**28.9 ± 0.6**	**27.3 ± 0.7**	**27.3 ± 1.1**	**24.9 ± 1.8**
Pinette	**26.5 ± 0.5**	**27.1 ± 0.7**	**27.0 ± 04**	**26.2 ± 0.8**	**22.9 ± 5.8**
Murray	**27.6 ± 1.3**	**27.3 ± 1.0**	**27.0 ± 0.7**	**26.8 ± 0.5**	**25.0 ± 2.8**
Mont.-Brudenell	**28.9 ± 0.9**	**27.5 ± 0.3**	**26.5 ± 0.9**	**27.2 ± 0.3**	**26.3 ± 1.2**

Values for salinity (**Table 3**) varied extensively among sites, at different sampling times and within each estuary. However, when monthly averages were examined seasonal variations were not extreme. If the tide was just starting to recede in the upper estuary, the salinity would naturally be higher than if the tide had not come in yet due in part to greater influence from headwaters leaving the estuary. As much as possible, groups attempted to sample on a similar tide regime each month. Lower salinities are noted for St. Louis and Miramichi estuaries because they were sampled further up the estuary than other sites in NB. These two longer estuaries have lower salinities in the upper sites and higher salinities at the mouth; therefore the lower values indicated are reasonable as more input from headwater run-off can have a major influence. These higher ranges of salinity for St.-Louis de Kent and Miramichi can eventually cause problem when trying to compare the fish and crustacean community as fresh water carry different fish and crustaceans than salt water. The stations located more up river might be subject to changes in future sampling and moved downriver where the salinity is comparable to the other sites. In most cases, the salinities in May were lower than subsequent months.

Table 4. Average monthly dissolved oxygen (mg/l ± S.D.) per location for the 2005 season (n = 6). (NA = not available)

	Dissolved Oxygen (mg/l)±S.D.				
N.B.	May	June	July	Aug	Sept
Caraquet	**9.8 ± 0.9**	**8.9 ± 1.9**	**4.0 ± 2.7**	**7.8 ± 0.6**	**7.5 ± 0.3**
Lamèque	**10.2 ± 0.3**	**4.4 ± 2.1**	**6.7 ± 0.7**	**5.2 ± 1.4**	**8.4 ± 0.6**
Shippagan	**8.3 ± 1.6**	**6.8 ± 1.6**	**N/A**	**6.9 ± 0.8**	**10.8 ± 1.4**
Tracadie	**11.4 ± 0.6**	**8.8 ± 1.1**	**9.5 ± 2.1**	**8.7 ± 0.5**	**9.4 ± 1.8**
Miramichi	**11.1 ± 0.5**	**8.9 ± 0.9**	**8.2 ± 0.7**	**8.2 ± 0.6**	**8.9 ± 0.4**
St Louis	**9.3 ± 1.3**	**8.9 ± 1.1**	**11.3 ± 2.3**	**9.9 ± 1.8**	**8.3 ± 1.6**
Bouctouche	**8.9 ± 0.6**	**6.7 ± 0.4**	**6.7 ± 0.7**	**9.2 ± 0.6**	**9.2 ± 0.6**
Little Bouct.	**NA**	**6.8 ± 0.8**	**6.9 ± 1.2**	**5.5 ± 0.7**	**9.7 ± 2.1**
Cocagne	**8.8 ± 0.6**	**6.3 ± 0.7**	**7.9 ± 0.8**	**5.9 ± 1.2**	**9.9 ± 2.0**
Shediac	**7.8 ± 0.7**	**8.2 ± 1.9**	**8.5 ± 1.8**	**9.0 ± 2.5**	**6.9 ± 0.6**
Jourimain	**9.1 ± 0.3**	**8.7 ± 0.3**	**8.1 ± 0.3**	**7.3 ± 0.4**	**7.9 ± 0.4**
N.S.					
R.Phil-Pugwash	**10.1 ± 0.9**	**9.1 ± 0.7**	**9.0 ± 1.2**	**7.6 ± 0.4**	**7.9 ± 0.3**
Antigonish	**10.2 ± 0.8**	**9.3 ± 0.7**	**7.9 ± 0.6**	**7.3 ± 1.2**	**8.7 ± 1.3**
Mabou	**11.1 ± 0.8**	**10.7 ± 0.5**	**8.1 ± 0.6**	**7.2 ± 1.2**	**7.5 ± 1.6**
Pictou	**9.7 ± 3.6**	**8.3 ± 0.3**	**8.9 ± 5.3**	**6.3 ± 1.3**	**8.3 ± 2.1**
P.E.I.					
Mill River	**10.2 ± 1.4**	**8.2 ± 1.0**	**8.2 ± 3.6**	**7.1 ± 0.4**	**8.6 ± 1.5**
Trout River	**11.7 ± 0.6**	**8.5 ± 1.0**	**6.9 ± 0.7**	**5.5 ± 0.6**	**7.7 ± 1.8**
Basin Head	**10.3 ± 1.6**	**9.6 ± 0.8**	**7.1 ± 1.0**	**5.8 ± 1.4**	**8.2 ± 0.8**
Pinette	**7.6 ± 0.4**	**8.0 ± 0.6**	**6.4 ± 0.5**	**8.2 ± 0.4**	**9.3 ± 0.2**
Murray	**8.8 ± 0.7**	**8.5 ± 0.8**	**7.0 ± 1.3**	**8.0 ± 0.7**	**9.1 ± 0.4**
Mont.-Brudenell	**9.1 ± 0.6**	**7.2 ± 1.1**	**7.7 ± 1.4**	**7.9 ± 0.5**	**9.0 ± 0.5**

Dissolved oxygen values (**Table 4**) were generally highest in the spring sampling and decreased as the summer progressed. This can be tied to temperature as higher temperatures mean a lower capacity for water to hold oxygen. By September, many locations show a noticeable increase in DO again as the water temperature cooled and plant matter production decreased. There were noticeably lower levels of dissolved oxygen in Lamèque and Shippagan in the mid-summer (4.4 ± 2.1, 4.0 ± 2.7, 5.2 ± 1.4 (SD). Overall, at many stations, **Table 4** shows dissolved oxygen values that are higher in May and September than in the mid sampling months

3.4 Substrate

In September, one sediment sample was taken at every sample station at all baseline locations. The 2 dominant sediment types were sand, mud or a combination of both. Greater vegetation cover, which is related to bottom type, was generally observed in muddy areas.

This sediment analysis was completed in the fall by lab technicians at DFO Gulf region. A more detailed description of the procedure is included in Weldon et al. 2005.

Table 5. Summary of average % organic content (± S.D.), % moisture content (± S.D.), and mean grain size (MGS) for the baseline locations (n = 6).

	% Organic	% Moisture	mean Grain Size MGS (mm)
N.B.	**September**		
Caraquet	**0.98 ± 0.45**	**19.09 ± 7.34**	**0.57 ± 0.32**
Lamèque	**1.25 ± 0.28**	**20.12 ± 2.56**	**0.44 ± 0.35**
Shippagan	**1.40 ± 0.92**	**23.77 ± 2.65**	**0.28 ± 0.06**
Tracadie	**1.44 ± 0.33**	**25.68 ± 1.71**	**0.30 ± 0.08**
Miramichi	**1.35 ± 0.36**	**31.90 ± 12.04**	**0.28 ± 0.15**
St. Louis de Kent	**3.14 ± 2.24**	**33.13 ± 10.52**	**0.18 ± 0.05**
Bouctouche	**8.31 ± 8.61**	**43.00 ± 14.30**	**0.18 ± 0.05**
Little Bouctouche	**0.93 ± 0.39**	**28.53 ± 2.37**	**0.19 ± 0.05**
Cocagne	**0.73 ± 0.35**	**24.77 ± 2.58**	**0.29 ± 0.06**
Shediac	**1.20 ± 0.21**	**24.60 ± 3.33**	**0.38 ± 0.18**
Jourimain	**0.74 ± 0.56**	**23.97 ± 2.02**	**0.35 ± 0.08**
N.S.			
R. Phil - Pugwash	**2.58 ± 3.11**	**34.91 ± 16.54**	**0.22 ± 1.12**
Pictou	**1.80 ± 1.29**	**23.70 ± 9.78**	**Greater than 2mm**
Antigonish	**1.19 ± 0.63**	**23.70 ± 9.78**	**Greater than 2mm**
Mabou	**1.57 ± 0.87**	**24.51 ± 7.71**	**Greater than 2mm**
P.E.I.			
Mill River	**1.66 ± 0.44**	**29.27 ± 3.67**	**0.19 ± 0.05**
Trout River	**1.86 ± 0.53**	**29.57 ± 3.21**	**0.20 ± 0.04**
Basin Head	**2.44 ± 3.51**	**31.82 ± 13.59**	**0.23 ± 0.09**
Pinette	**2.45 ± 4.62**	**27.43 ± 14.06**	**0.38 ± 0.11**
Murray	**0.52 ± 0.29**	**19.03 ± 2.84**	**0.43 ± 0.14**
Mont.- Brudenell	**1.25 ± 0.29**	**21.88 ± 1.36**	**0.30 ± 0.06**

In New Brunswick, Bouctouche has the highest percent organic and percent moisture content compared to all other locations. High organic content and percent moisture appears to indicates a mud bottom. Bouctouche also had the second smallest average grain size. Murray River has the lowest percent organic and percent moisture contents and the sixth largest mean grain size. River Phillip/ Pugwash in NS and Pinette River in PEI have the highest value for percent organic content in there respective provinces. Basin Head and River Phillip / Pugwash have the highest percent moisture content in their provinces.

4.0 DISCUSSION

4.1 Fish and Crustaceans

In northeastern NB; shrimp, silverside and mummichog were the dominant species at all four locations (i.e. Caraquet, Lamèque, Shippagan and Tracadie) and in Shippagan the threespine stickleback was also dominant. *Fundulus* species (mummichog and killifish) dominated in Shippagan and shrimp species were most numerous in the other three locations. Sticklebacks show no trend of most abundant with each location having its own dominant species. The higher mean species richness values observed in the early spring and summer (May and June) compared to July and August may be the result of normal aggregative behaviour related to feeding and breeding and species moving into the estuaries after over wintering at sea (i.e. Atlantic Silverside) (Conover and Murawski 1982). As the season progresses, the populations of most small pelagics seem to disperse throughout the nearshore habitat though little research is available to substantiate this hypothesis.

In central New Brunswick, only two locations had full baseline status, Miramichi and St. Louis de Kent. The much larger totals for collected species in St. Louis probably reflects the differences in estuary site characteristics. Salinities are lower in St. Louis than other estuaries. One inner station will be moved farther out in 2006. Moving sites to more saline water will also be examined for the Miramichi in 2007. The ninespine stickleback was more abundant in the St. Louis estuary than anywhere else which does match with what is know of its salinity preference, i.e. they are more abundant in the freshwater dominant locations of estuaries (Scott and Scott 1988). The Kouchibouguacis River, located in St. Louis de Kent, is a much smaller estuary with sample stations characterized by having more vegetation than the more dominant sandy type sample stations in the Miramichi system. This is also evident in the species richness index which has higher values in St. Louis.

In southeastern NB; two new sites, the Little Bouctouche and Cape Jourimain joined as baseline locations to the three other baseline sites (i.e. Bouctouche, Cocagne and Shediac). Sand shrimp numbers were highest of all species in all locations except Shediac. Silversides were very abundant in one station in Shediac that was near a fish processing plant outflow pipe. This sample site produced very large numbers of silversides as they seem to prefer this nutrient rich environment. More information can be found in Theriault et al. (2006) in relation to this phenomenon. There was no distinct pattern for species richness in the southeast locations. Overall, species richness was greater than values determined for the northeast locations.

River Phillip and Pugwash were combined to form the new baseline site in Nova Scotia in 2005. The Margaree estuary was sampled once but could not maintain a volunteer base to continue. Mummichogs were found in highest numbers in Pictou while sand shrimp dominated totals in the other three locations. There was no pattern of total number dominance with the stickleback species. Presence of green crab was noted in all sites except River Phillip - Pugwash. The mean species richness was highest overall in Mabou, and lower in River Phillip/Pugwash and Pictou.

Three new locations in the southeast portion of Prince Edward Island were able to provide sufficient data to achieve baseline status in 2005. For three out of six sites, *Fundulus* sp., sand shrimp and silversides exhibited dominant numbers in 2005. As for the three other sites (i.e. Trout River, Basin Head and Murray River), Atlantic silverside did not come out as dominant but rather the threespine stickleback or the fourspine stickleback. The different trends of stickleback number domination at different locations may provide clues to estuary health in the future. Green crab was present in all southeast and east locations for all months except the Pinette River in August. The three new locations in the southeast part of the province showed lower mean species richness compared to remaining locations in the province maybe because the volunteers sampling these three new sites were not as experienced in identifying the species as the other community groups were.

4.2 Macrophytes

Overall, the station characteristics did not change much over the season, except for growth of the existing attached vegetation. The species of vegetation that were catalogued in May generally remained the same in September. There was the usual increase in vegetation density over the growth season. Mud bottom substrates where eelgrass dominated the outer edge of the sample area were where an increase in vegetation was most noticeable. One concern to NGO volunteers was the accumulation of unattached material in the beach seine at a sample location. Algae such as sea lettuce and eelgrass could hinder the effectiveness of collections by smothering fish before they could be counted and released. It also made it impossible to sweep a net in a limited number of locations in mid-summer. Later in the summer and early fall, sample areas that experienced less water movement or were in sheltered inlets had a tendency to collect larger amounts of sea lettuce and/or eelgrass debris which quickly made it difficult to haul the beach seine back to shore because of the large amount of vegetation increasing the weight of the beach seine. Many of the outer estuary or coastal sites were characterized by a dominant sandy/rocky substrate. Rockweed attached to rocks was the dominant species in these locations. Also present, especially later in the summer, were tufts of filamentous green algae. There were very few sites where no vegetation was present. In these instances a sandy bottom was the dominant substrate.

The methods used in the CAMP are qualitative and serve to describe the general state of vegetation at each site. Comparisons can then be made from year to year. To get a more accurate description of each site, a more labour intensive grid method could be used. At this point in time, the vegetation data determined by present CAMP methods has proven to be adequate.

4.3 Physical Measures

Physical measures were taken as part of the CAMP collection protocol. These recordings provide a monthly measure of changes that occur at sample sites. The same pattern of cooler temperatures in the spring, warming as the summer progressed and cooling off in the fall appears normal. Data from the temperature profilers provide an overview of the changes in estuary temperature over the sampling season. In New Brunswick, there was a slight drop in the weekly average in late June and late July. The other two provinces show no anomalies from a normal increase with warming air temperatures and a drop as it cools off in the fall.

In the upper estuary samples, salinity was lower as expected due to larger fresh water input. There is monthly variation. The dominant pattern is that early months have lower salinities for most locations, probably due to run-off related to spring snow melt. Middle sites in most locations vary in salinity and this probably can be attributed to the state of the tide. Incoming tides or rising tides bring in more salt water as compared to the increase in fresh water when the tide was receding.

Estuarine organisms require dissolved oxygen concentrations at adequate levels to survive. Trout and salmon for example prefer levels above 4 mg/l. Dissolved oxygen preferences for permanent estuary/coastal shoreline species are not well documented. The general pattern for oxygen levels in the estuary was higher quantities in the spring that subsequently dropped in the summer and increased again in the fall. In locations where there was more organic matter, such as near seafood processing plants, decomposition of organic matter could produce the lower oxygen levels recorded (Tchoukanova et al. 2003). Other processes that allow oxygen input in the water column include photosynthesis by plants and mixing from the air due to turbulence. Diurnal changes may also be a significant reflection of site health that the CAMP protocol is not catching

4.4 Substrate

The sediment samples collected in September 2005 were analyzed in late spring 2006. In New Brunswick, the sediments generally had low organic content; 1 to 1.5 percent at most sample locations in the estuaries. One site, Bouctouche, recorded an average organic content above 8 percent. Percent moisture content was close to 25 for most locations, with Bouctouche being the highest at 43%. In Nova Scotia, River Philip/Pugwash had the highest total organic content at 2.6 percent with the other sites less between 1.2 and 1.8 percent. Total percent moisture content was around 24% except the River Phillip – Pugwash site which had an average moisture content of 35%. Organic content ranged from 0.5 to 2.5 percent in Prince Edward Island. Percent moisture was around 30 in four locations and around 20 in the other two.

One general observation is that mud bottoms with characteristic small mean grain size had higher percent organic content and higher percent moisture content. The opposite patterns exist for sandy bottom locations.

5.0 CONCLUSION

The fundamental objective of the CAMP program is still to develop outreach for DFO stewardship staff to engage the coastal communities in learning more about their estuaries and bays. The initial goal of maintaining a monitoring program that is NGO friendly has been realized. Baseline data have been collected for two years from a wide range of estuaries and bays in the Gulf of St Lawrence.

Now we are able to test the hypothesis that animal assemblages might also tell us about the health of these areas. The relationships that have developed among the various partners have resulted in the maintenance of a strong baseline monitoring program. Baseline data have been collected for two years from estuaries and bays in the Gulf of St. Lawrence. The next steps for CAMP are now in the hands of the DFO and their associated university collaborators. The baseline data resulting from community efforts will be used to develop a tool for determining whether an estuary as a whole, or individual stations within an estuary have viable and sustainable biological communities that provide us with a good comprehension and indication of overall health of these estuaries. For example, can the absence or presence or abundance of particular species reflect particular environmental problems? Is it overall species diversity that provides the best single metric for estuarine health? When these and related questions have been addressed and the resulting conclusions have been returned to the participating community groups and the public at large, CAMP will have fulfilled its immediate objectives.

NGO’s anticipate that the data they have gathered will be useful in developing an authoritative tool to help them monitor the health and condition of their estuary. After one more year of baseline data, we hope to have enough data to begin developing such a tool. Subsequently, community groups will continue to monitor the health of their estuary / coastal shoreline using the CAMP. DFO will continue to supply necessary working materials and continue to assist with the training and coordination of the program. The community groups remain as the backbone relating to the success of the program. Community groups continue to be diligent in collecting the baseline data required.

The CAMP has already proven to be a popular method for gathering data for estuaries and coastal shorelines. From an initial group of four pilot estuaries in 2003, participation grew to 24 in 2004. Of the 24 involved in 2004, 15 achieved baseline status by completing the full five months of sampling (Weldon et al. 2005). In 2005, there were 21 locations sampled and, of these, 19 were able to maintain baseline status. The continued involvement of community groups illustrates that collecting data is important to the stewardship activities of the groups. DFO, working in conjunction with community groups, is providing an avenue for developing stewardship of local resources. As a vehicle for public education, CAMP has continued to have a positive impact. More than 80 individuals, including high school and university students, and interested members of the general public from teens to retirees were trained in the rudiments of fish and invertebrate identification and the basics of formal data collection for environment assessment. The involvement of non-professionals in CAMP activities has thus been a source of important public education and outreach on the part of DFO.

The goal of this second report is to provide a presentation and summary of the 2005 data related to temporal and geographic variation in species abundance and community structure. After three years of collections, researchers in the Aquatic Ecosystem of DFO will have enough baseline data to develop statistically sound indices related to estuary health and community structure. Primary data collection objectives of CAMP continue to be met. Many community groups now have the knowledge base to continue their assessments of environmental conditions and potential problems both within CAMP and by applying the approaches derived from CAMP to other locations.

Besides a commitment to quality data recording, the community groups realize they have only had to contribute resources for one day a month to acquire these data. The integrated approach provided by the University partners, DFO and certain funding agencies has helped guide the development of the CAMP to a direction that will maximize output goals from minimal input.

There is an expectation that more specialized science could easily be developed from the outcomes of the present CAMP data. As the Risk Analysis Model of watershed issues becomes more widely used, CAMP protocols and gathered information will become a key component in the overall management of a watershed.

The protocols established at the outset of the program have generally been adhered to, with adjustments being made to various protocols and methods that have improved the consistency of data acquisition.

ACKNOWLEDGEMENTS

This program was originally developed through the Oceans and Habitat Division, Oceans and Science Branch (OSB), Gulf Region DFO. Gulf region NGO’s remain onboard with tremendous enthusiasm for volunteers that oversee ecological programs across the region. Summer students, both employed and volunteering were an invaluable resource for data collection. Some funding for student salaries came from Interdisciplinary Studies in Aquatic Resources at St. Francis Xavier University, and grants to Dr. David Garbary from the Natural Sciences and Engineering Research Council of Canada. Other groups used portions of Environmental Trust funds to free up resources for the one day a month necessary to maintain the program.

After the initial set-up of the pilot stage by several of the authors, the continued support and consultation throughout the 2005 sampling season ensured that the program maintained strong links to the original concept.

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Appendix 1. List of Species Collected During the CAMP 2005

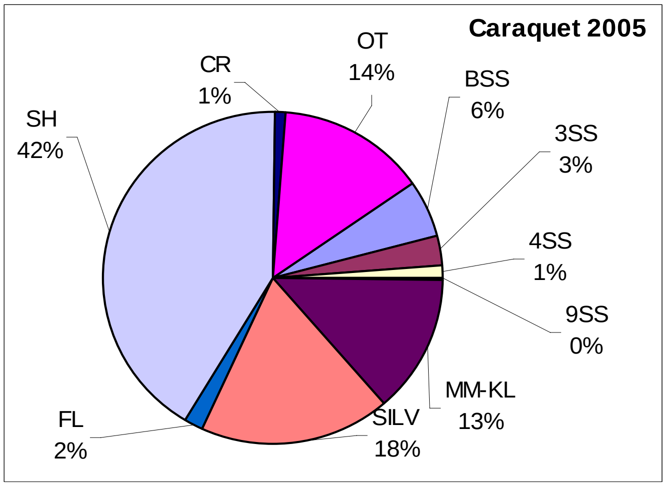
fish

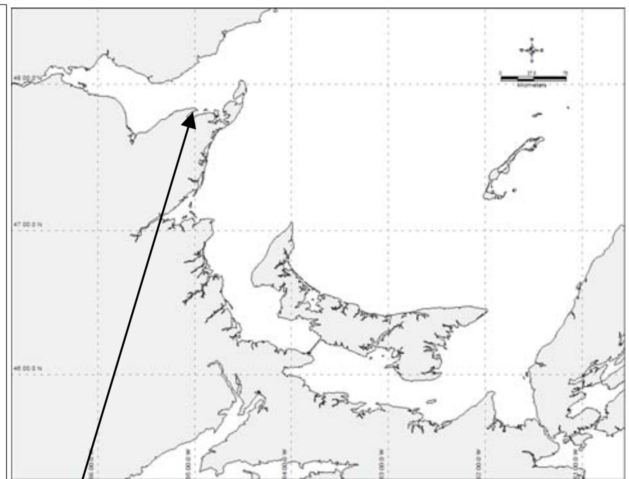
alewife (gaspereau) (*Alosa sp.***)**
American sand lance (*Ammodytes hexapterus***)**
Atlantic silverside (*Menidia menidia***)**
Atlantic tomcod (*Microgadus tomcod***)**
banded killifish (*Fundulus diaphanus***)**
black spotted stickleback (*Gasterosteus wheatlandi***)**
blueback herring (*Alosa aestivalis***)**
brook (speckled) trout (*Salvelinus fontinalis***)**
cunner (*Tautogolabrus adspersus***)**
fourspine stickleback (*Apeltes quadracus***)**
ninespine stickleback (*Pungitius pungitius***)**
northern pipefish (*Syngnathus fuscus***)**
mummichog (*Fundulus heteroclitus***)**
rainbow smelt (*Osmerus mordax***)**
rock gunnel (*Pholis gunnellus***)**
shorthorn sculpin (*Myoxocephalus scorpius***)**
silver rockling (*Gaidropsarus argentatus***)**
smooth flounder (*Pleuronectes putnami***)**
striped bass (*Morone saxatilis***)**
threespine stickleback (*Gasterosteus aculeatus***)**
white perch (*Morone americanus***)**
windowpane flounder (*Scophthalmus aquosus***)**
winter flounder (*Pseudopleuronectes americanus***)**
winter skate (*Raja ocellata***)**

crustaceans

grass shrimp
(*Hippolyte zostericola***)**
green crab
(*Carcinus maenas***)**
lady crab
(*Ovalipes ocellatus***)**
mud crabs
(*Xanthidae sp***.)**
rock crab
(*Cancer irroratus***)**
sand shrimp
(*Crangon septemspinosa***)**

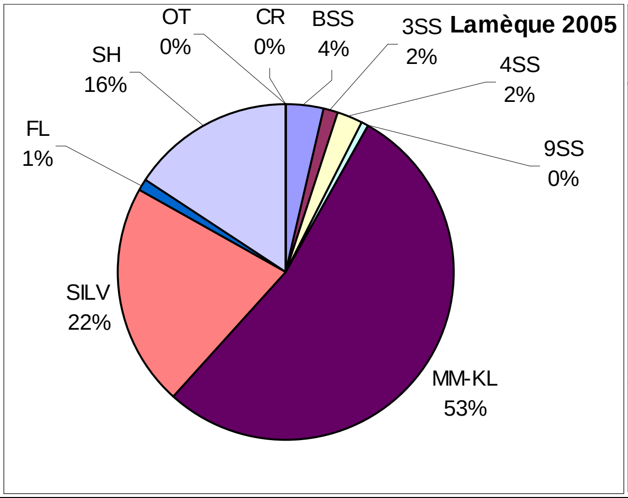
Appendix 2. Map of each Estuary/Coastal Shoreline Location Showing Sampling Sites plus a Pie Chart that Summarizes the Total Quantities of the Most Abundant Species for the 2005 Sampling Season

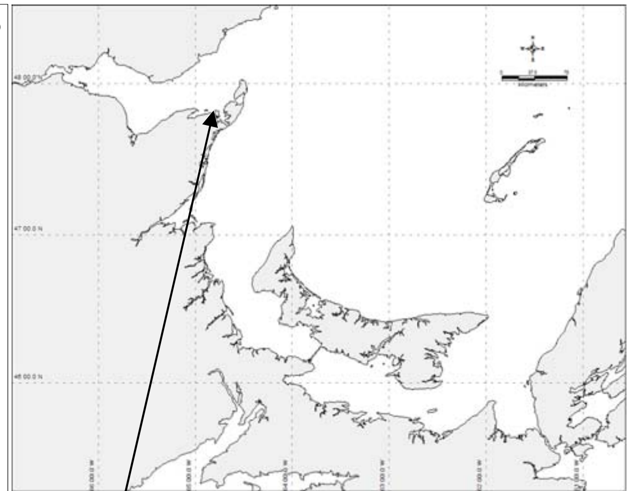




Black Spot Stickleback (BSS)	6%	Atlantic Silverside (SILV)	18%
3 Spine Stickleback (3SS)	3%	Flounder Species (FL)	2%
4 Spine Stickleback (4SS)	1%	Shrimp Species (SH)	42%
9 Spine Stickleback (9SS)	0.1%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	13%	Other Species (OT)	14%

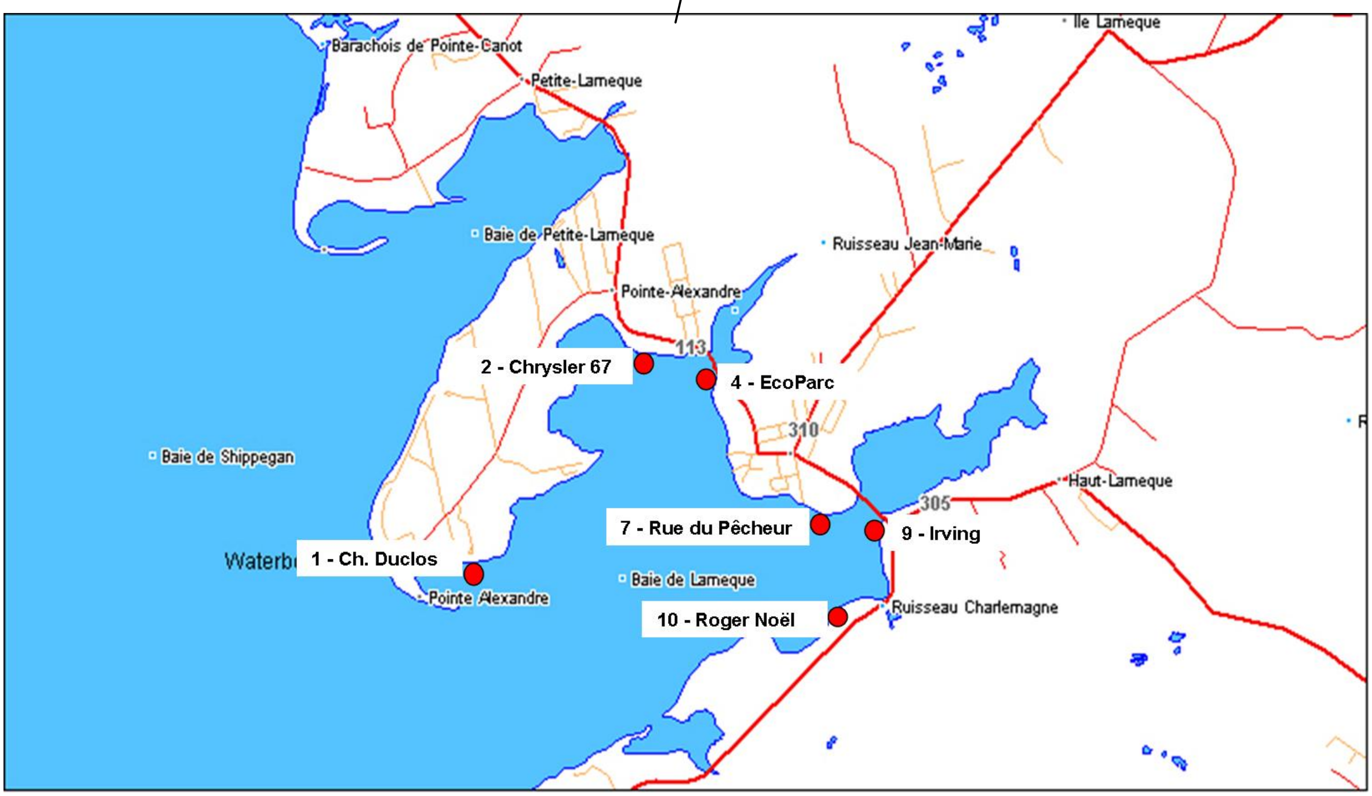
New Brunswick / Caraquet

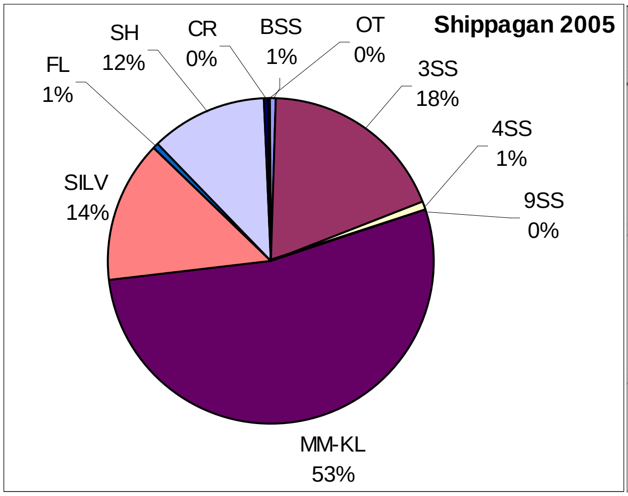


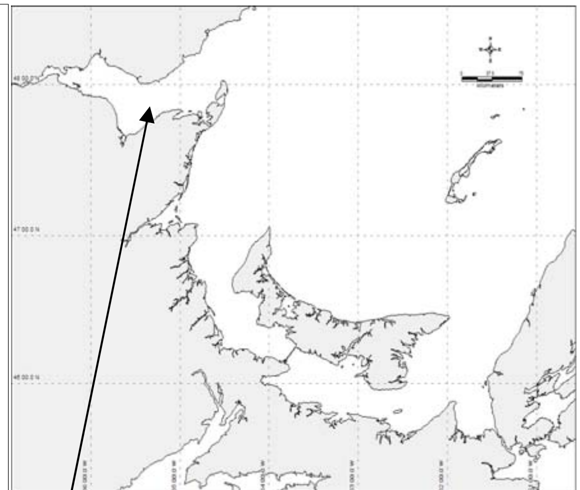


Black Spot Stickleback (BSS)	4%	Atlantic Silverside (SILV)	22%
3 Spine Stickleback (3SS)	2%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	3%	Shrimp Species (SH)	16%
9 Spine Stickleback (9SS)	0.3%	Crab Species (CR)	0%

New Brunswick / Lamèque

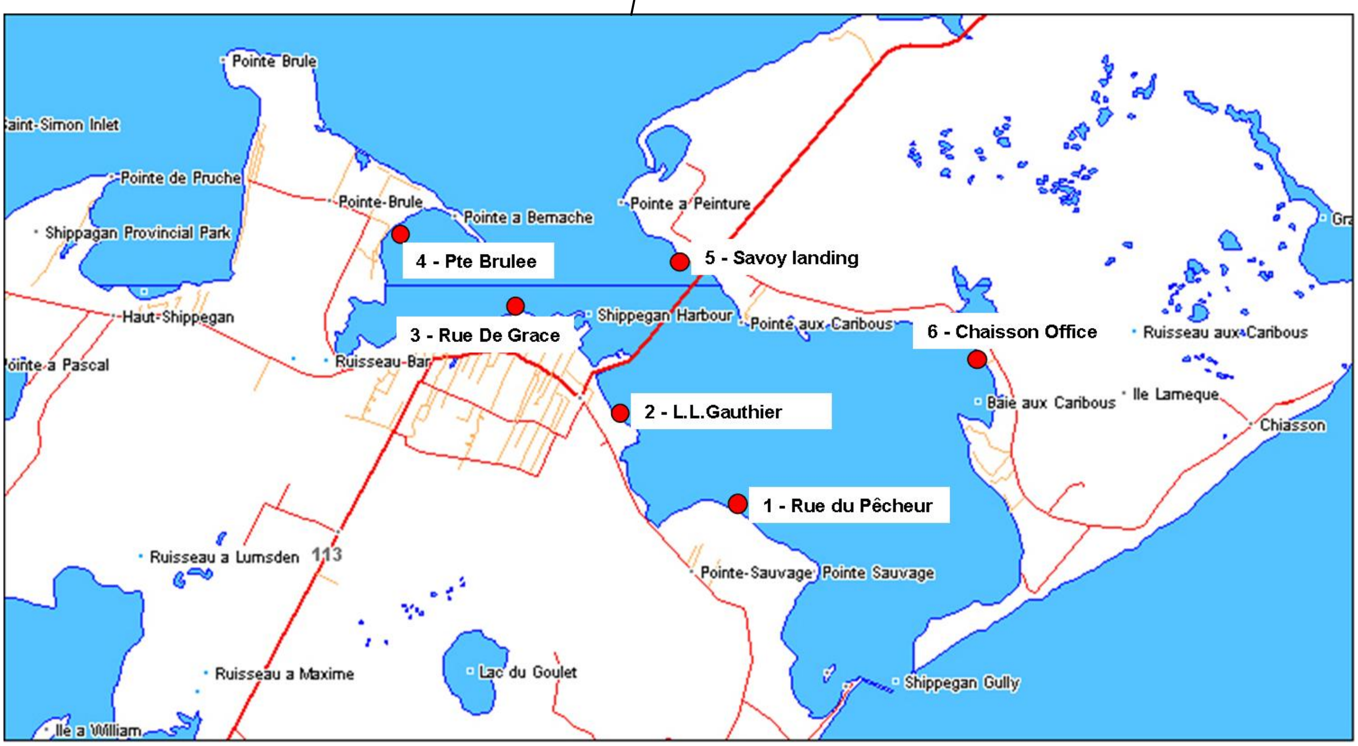


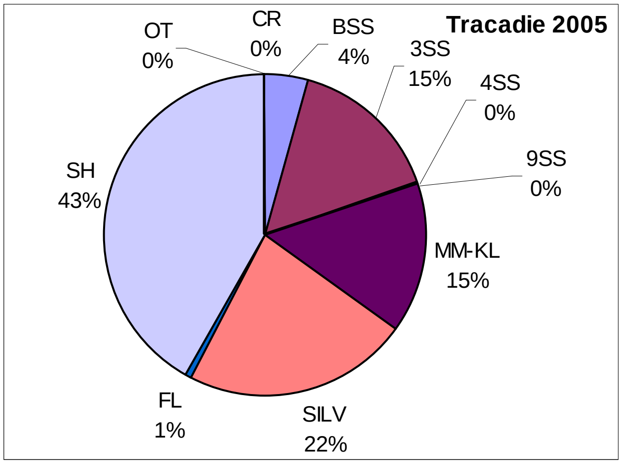


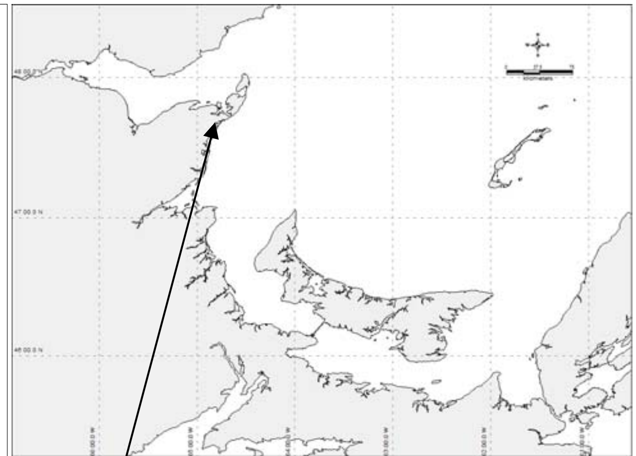


Black Spot Stickleback (BSS)	1%	Atlantic Silverside (SILV)	14%
3 Spine Stickleback (3SS)	19%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	1%	Shrimp Species (SH)	12%
9 Spine Stickleback (9SS)	0.1%	Crab Species (CR)	0.3%
Mummichog/Killifish (MM-KL)	53%	Other Species (OT)	0.2%

New Brunswick / Shippagan

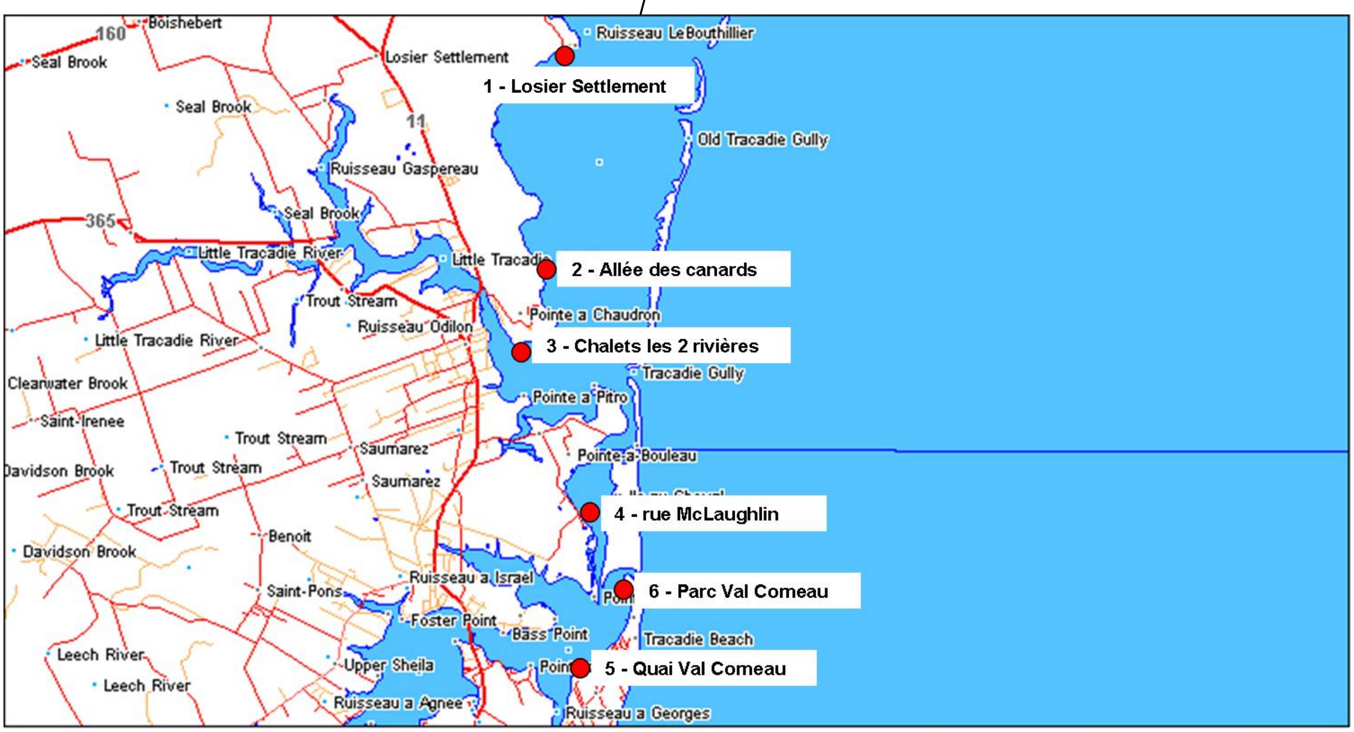


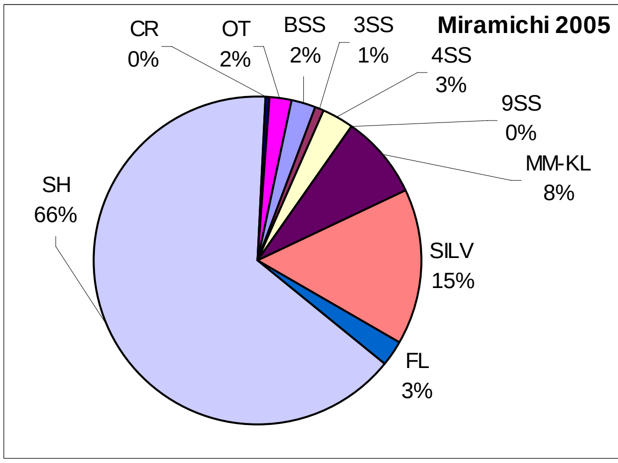


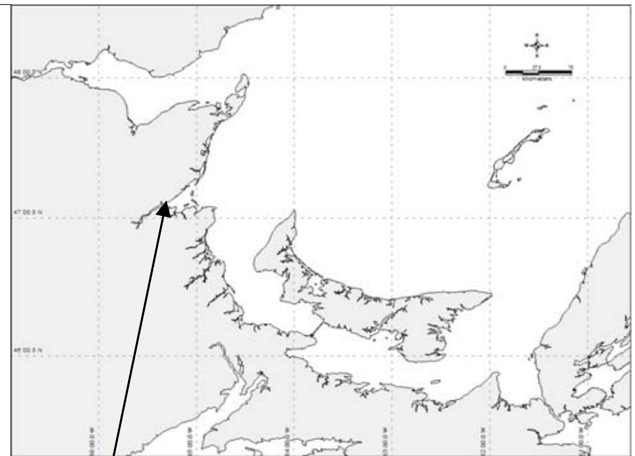


Black Spot Stickleback (BSS)	4%	Atlantic Silverside (SILV)	22%
3 Spine Stickleback (3SS)	15%	Flounder Species (FL)	0.7%
4 Spine Stickleback (4SS)	0.4%	Shrimp Species (SH)	42%
9 Spine Stickleback (9SS)	0.05%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	15%	Other Species (OT)	0%

New Brunswick / Tracadie

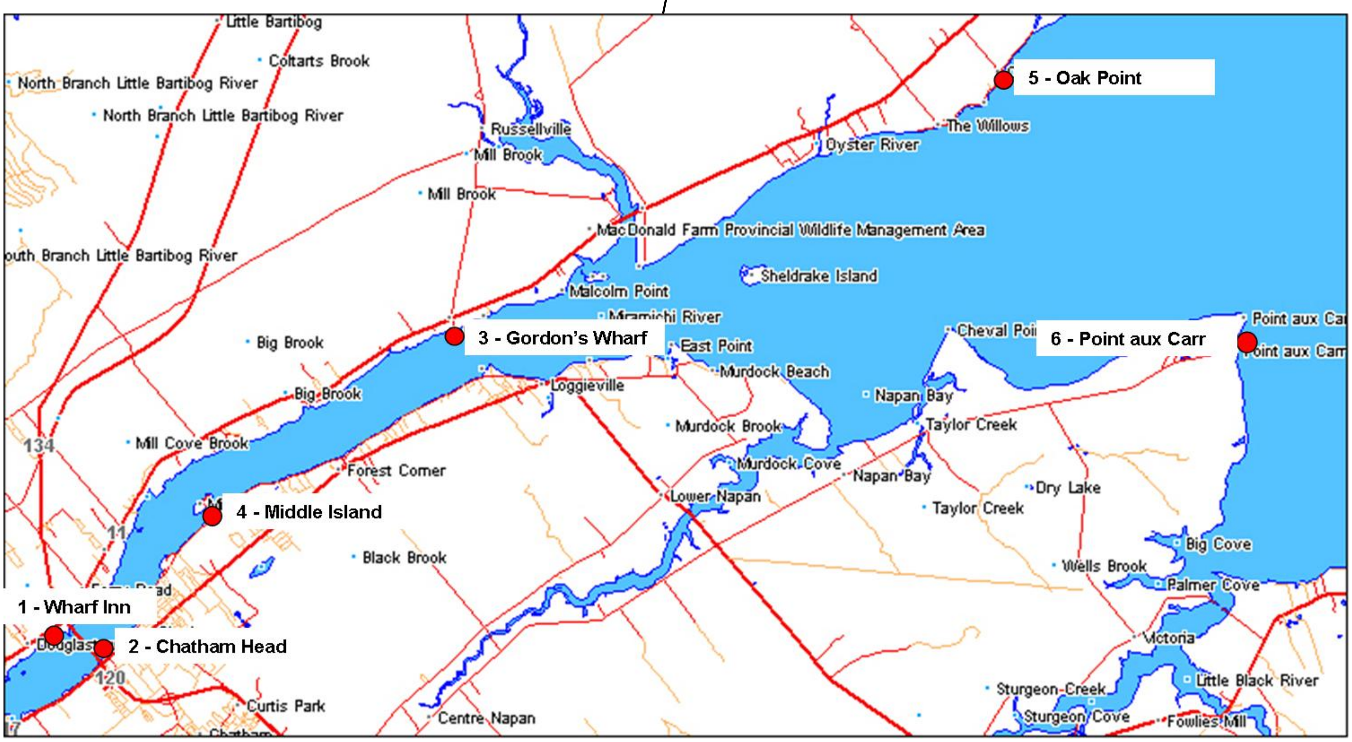


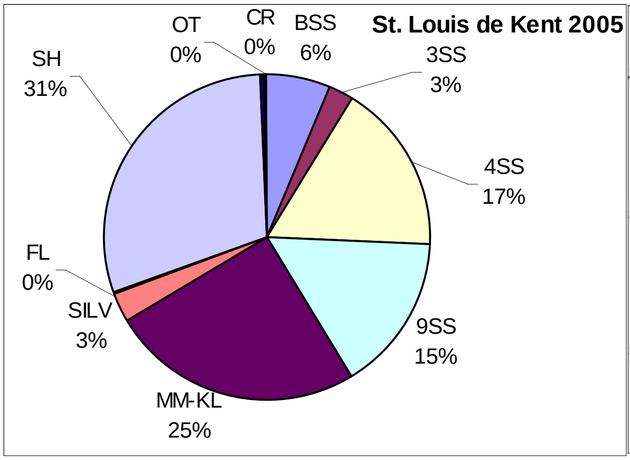


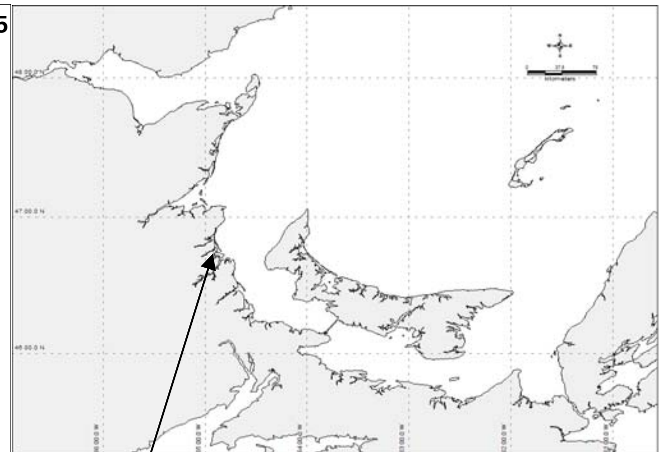


Black Spot Stickleback (BSS)	2%	Atlantic Silverside (SILV)	15%
3 Spine Stickleback (3SS)	1%	Flounder Species (FL)	3%
4 Spine Stickleback (4SS)	3%	Shrimp Species (SH)	66%
9 Spine Stickleback (9SS)	0.1%	Crab Species (CR)	0.3%
Mummichog/Killifish (MM-KL)	8%	Other Species (OT)	2%

New Brunswick / Miramichi

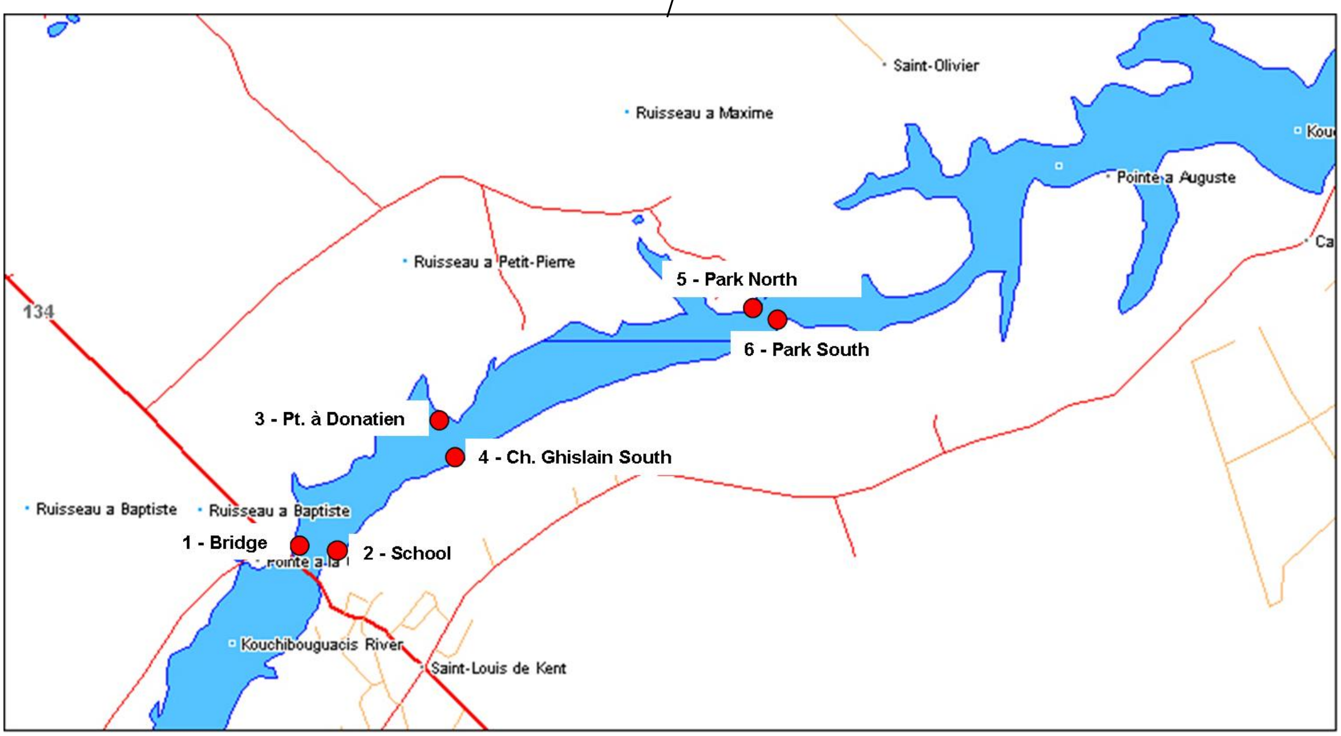


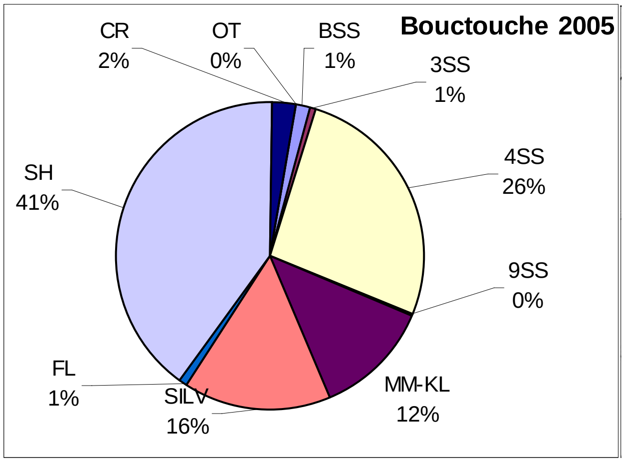


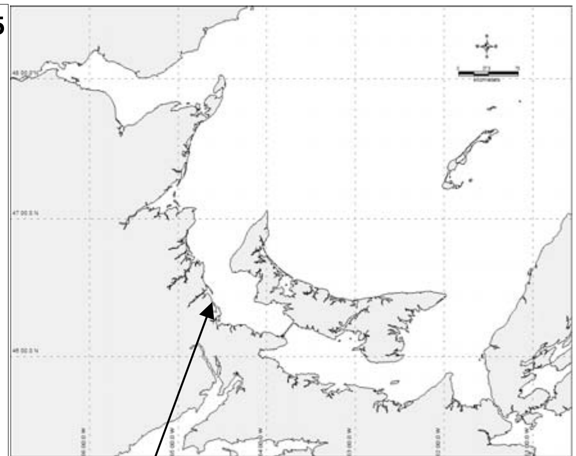


Black Spot Stickleback (BSS)	6%	Atlantic Silverside (SILV)	3%
3 Spine Stickleback (3SS)	3%	Flounder Species (FL)	0.3%
4 Spine Stickleback (4SS)	17%	Shrimp Species (SH)	30%
9 Spine Stickleback (9SS)	15%	Crab Species (CR)	0.2%
Mummichog/Killifish (MM-KL)	25%	Other Species (OT)	0.2%

New Brunswick / St. Louis de Kent

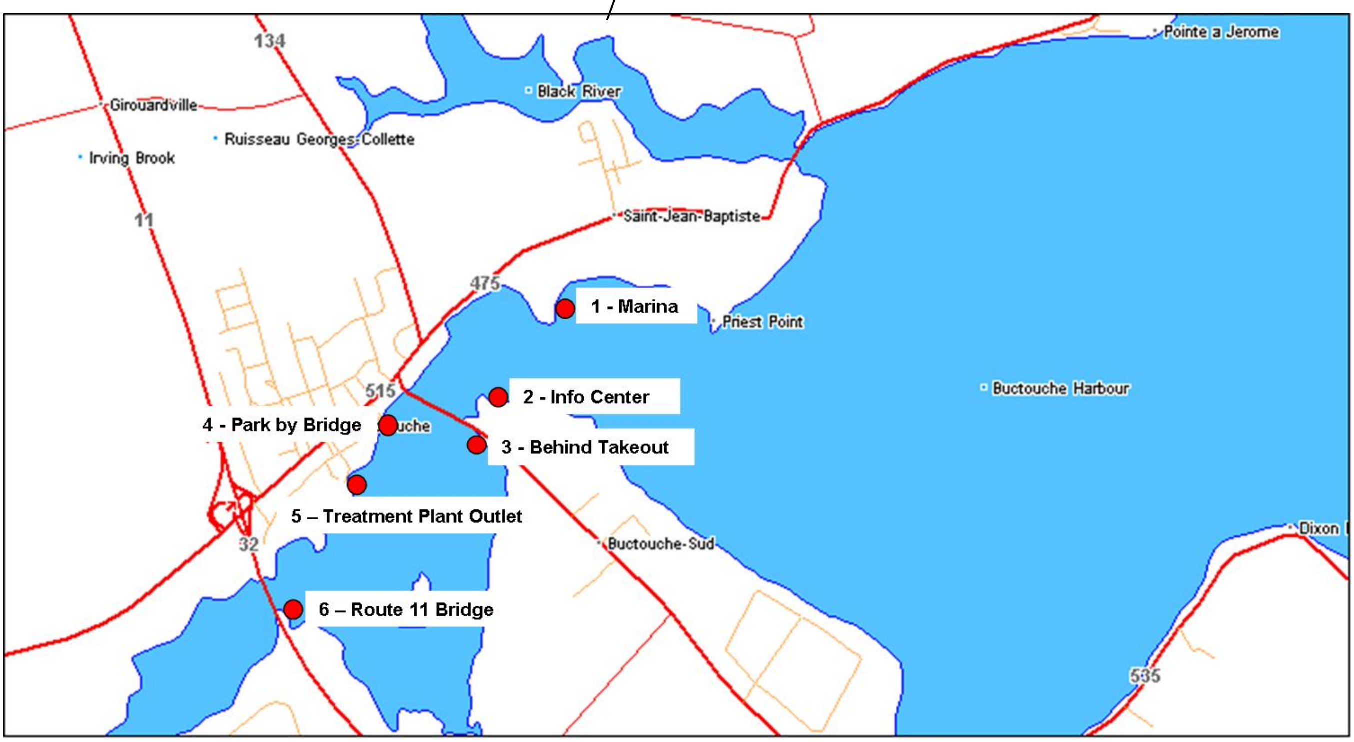


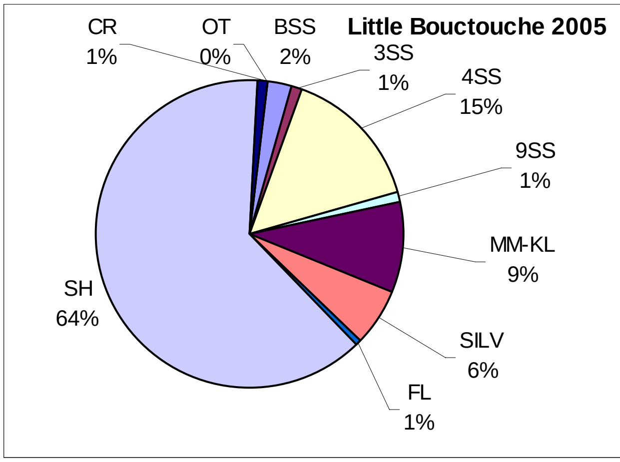


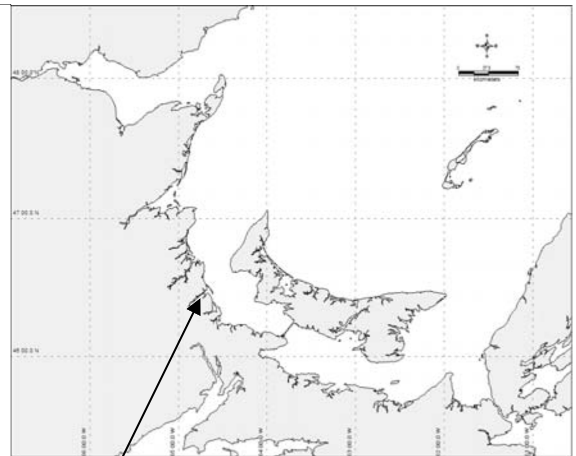


Black Spot Stickleback (BSS)	1%	Atlantic Silverside (SILV)	15%
3 Spine Stickleback (3SS)	1%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	26%	Shrimp Species (SH)	40%
9 Spine Stickleback (9SS)	0.2%	Crab Species (CR)	2%
Mummichog/Killifish (MM-KL)	12%	Other Species (OT)	0.04%

New Brunswick / Bouctouche



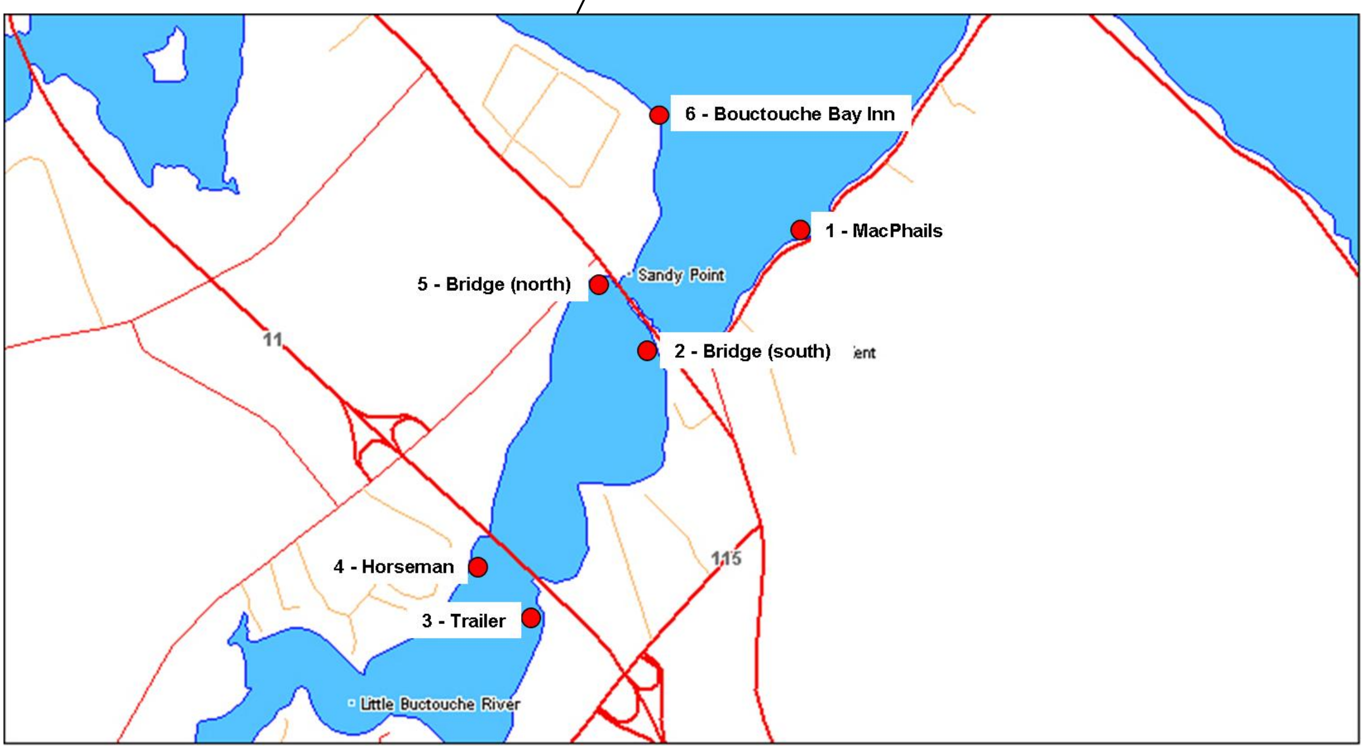


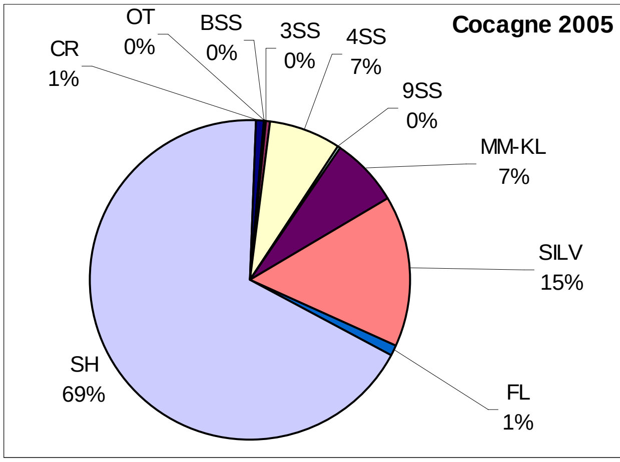


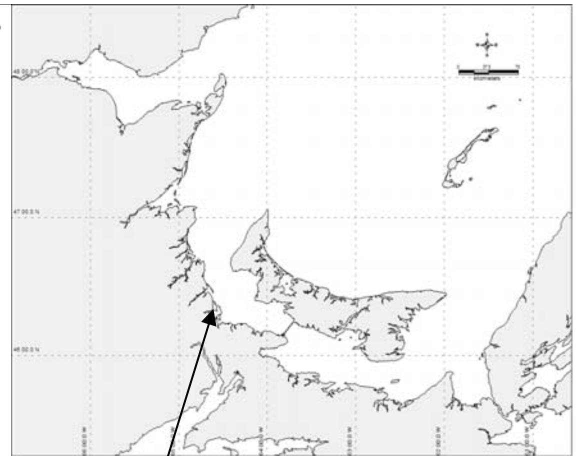
Black Spot Stickleback (BSS)	2%	Atlantic Silverside (SILV)	6%
3 Spine Stickleback (3SS)	1%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	15%	Shrimp Species (SH)	63%
9 Spine Stickleback (9SS)	1%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	9%	Other Species (OT)	0.04%

New Brunswick / Little Bouctouche*

* represents 4 months data



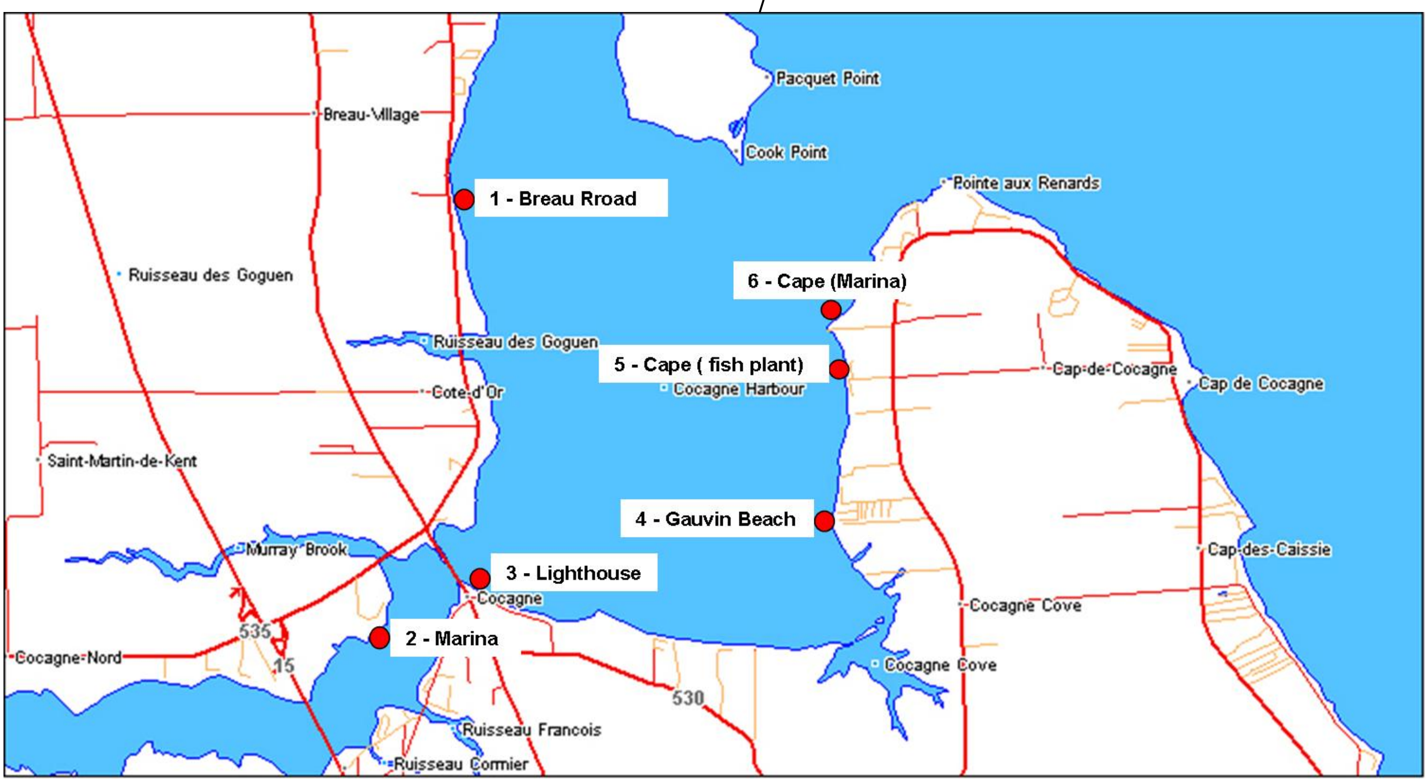


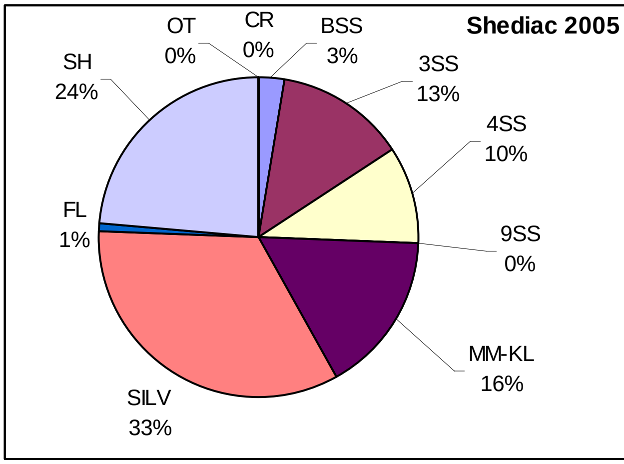


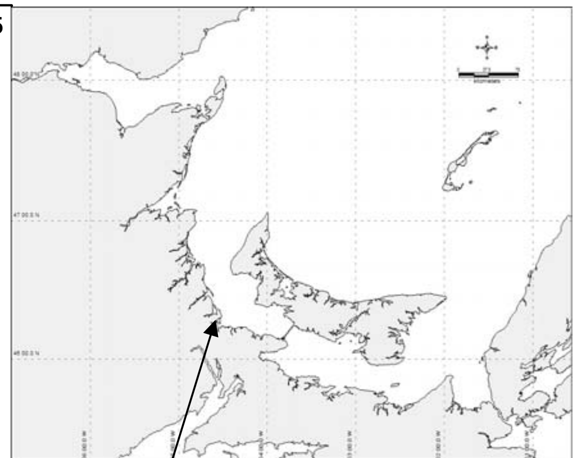
Black Spot Stickleback (BSS)	0.1%	Atlantic Silverside (SILV)	15%
3 Spine Stickleback (3SS)	0.3%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	7%	Shrimp Species (SH)	69%
9 Spine Stickleback (9SS)	0.3%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	7%	Other Species (OT)	0.02%

New Brunswick / Cocagne*

* represents 4 months data

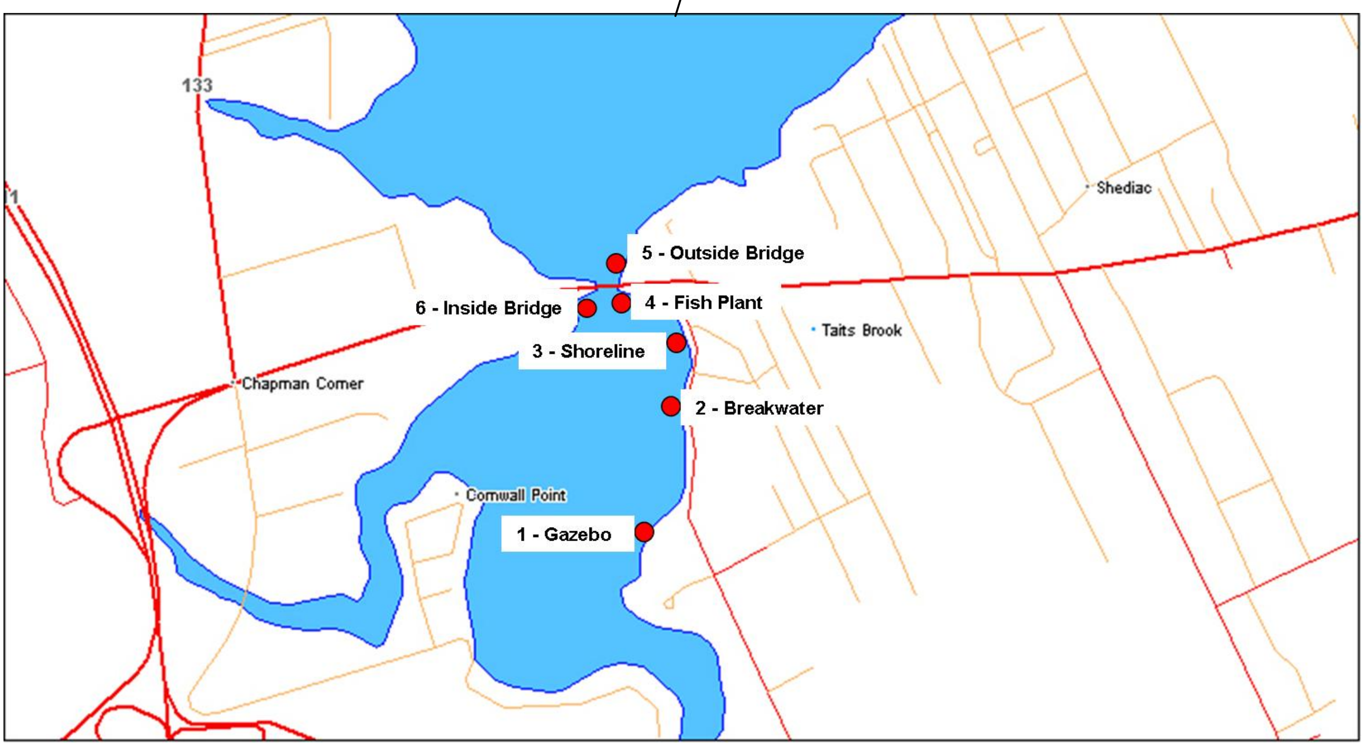


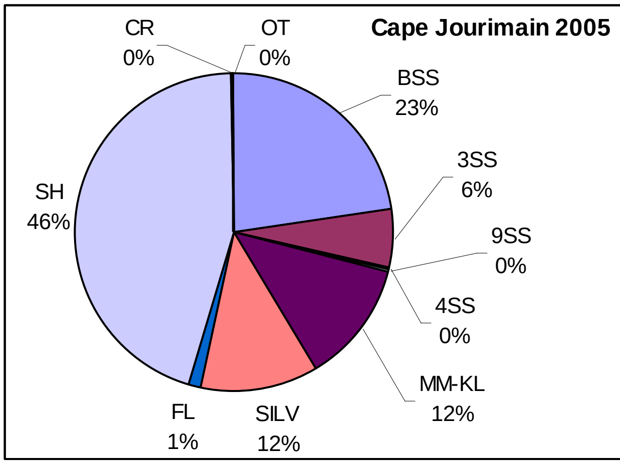


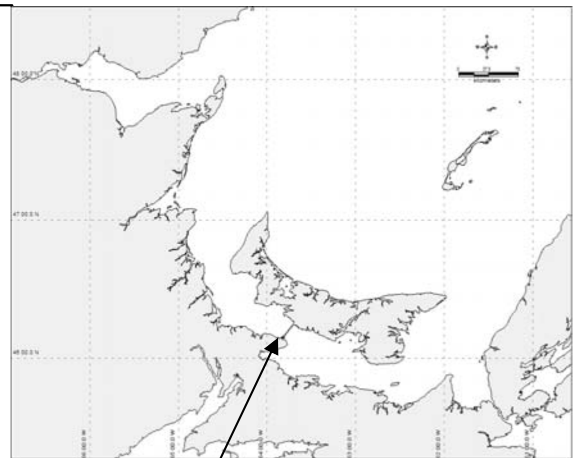


Black Spot Stickleback (BSS)	3%	Atlantic Silverside (SILV)	34%
3 Spine Stickleback (3SS)	13%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	10%	Shrimp Species (SH)	24%
9 Spine Stickleback (9SS)	0.06%	Crab Species (CR)	0.01%
Mummichog/Killifish (MM-KL)	16%	Other Species (OT)	0.1%

New Brunswick / Shediac

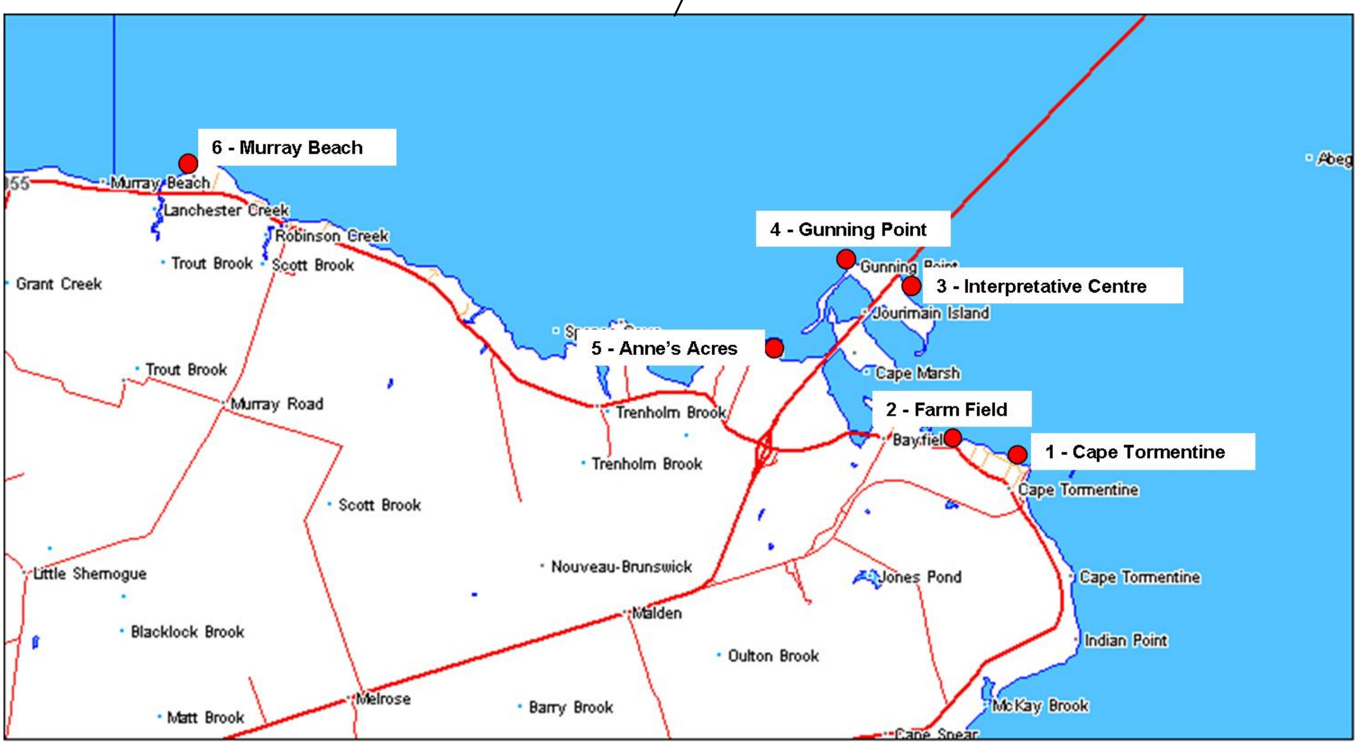


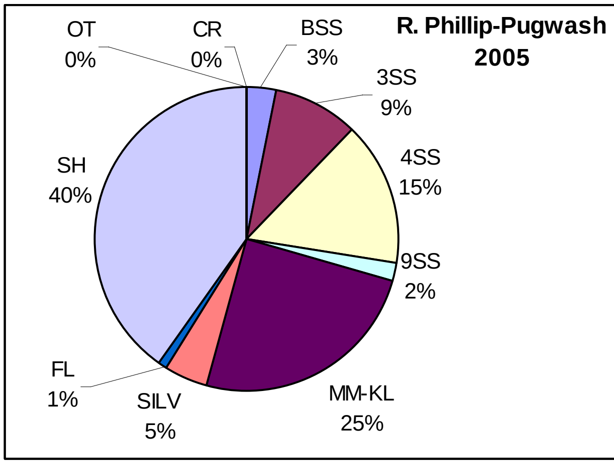


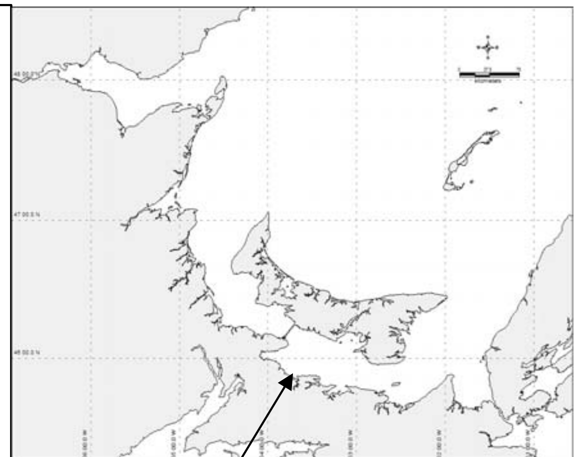


Black Spot Stickleback (BSS)	23%	Atlantic Silverside (SILV)	12%
3 Spine Stickleback (3SS)	6%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	0.1%	Shrimp Species (SH)	45%
9 Spine Stickleback (9SS)	0.4%	Crab Species (CR)	0.1%
Mummichog/Killifish (MM-KL)	12%	Other Species (OT)	0.1%

New Brunswick / Cape Jourimain

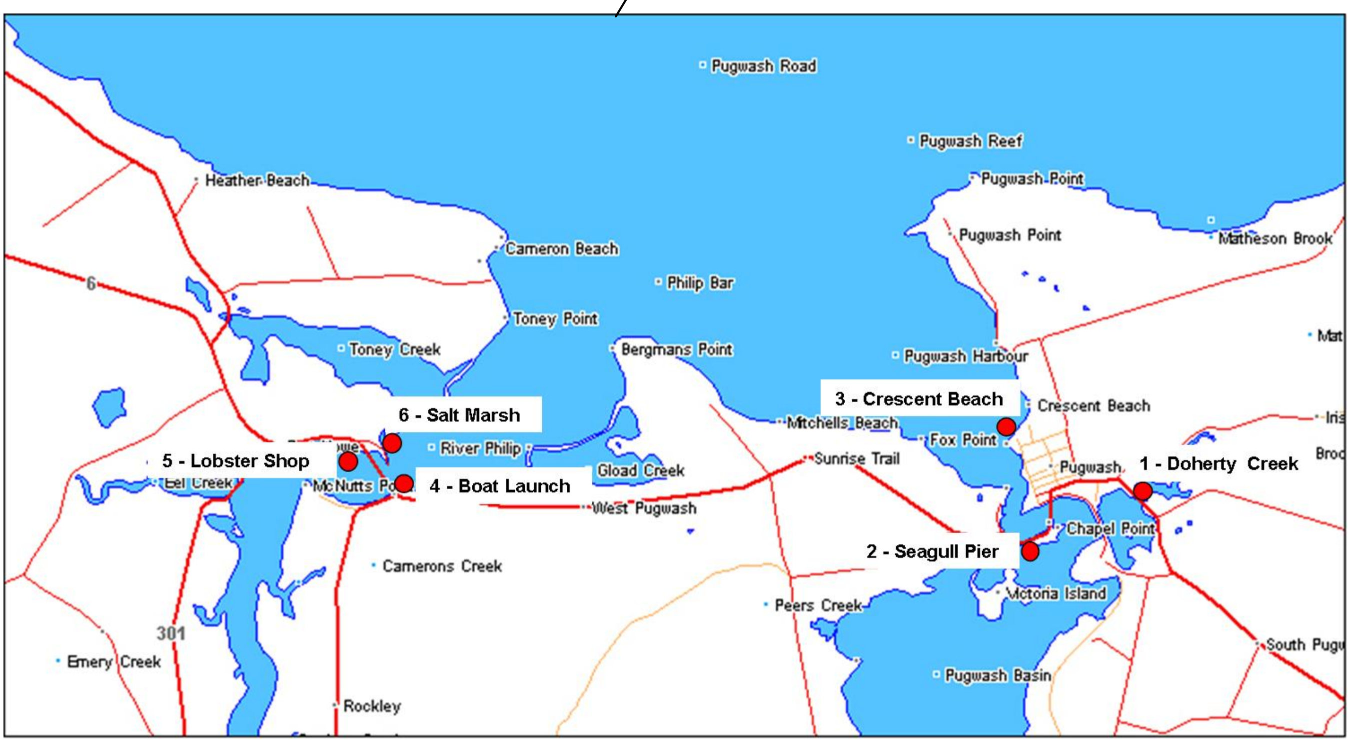


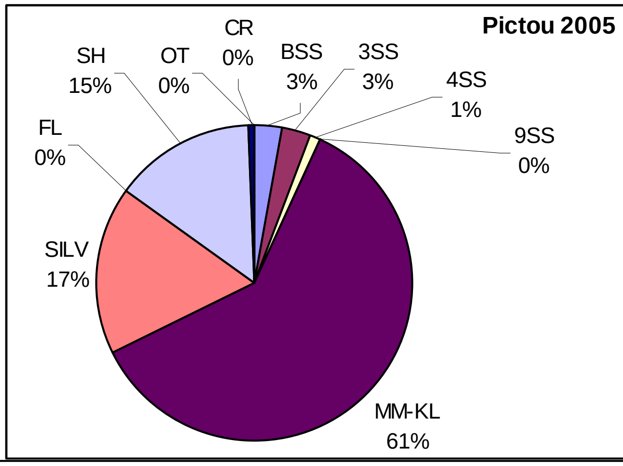


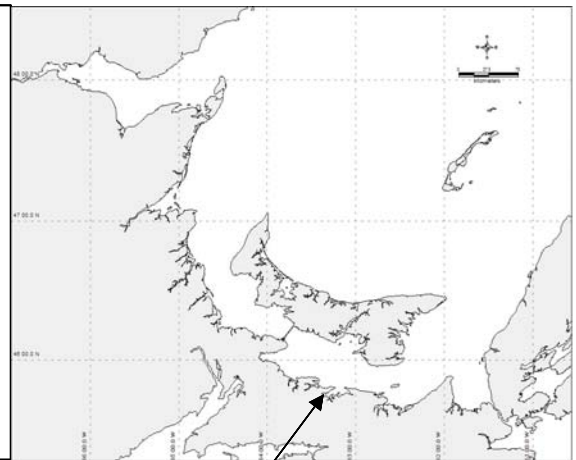


Black Spot Stickleback (BSS)	3%	Atlantic Silverside (SILV)	5%
3 Spine Stickleback (3SS)	9%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	15%	Shrimp Species (SH)	40%
9 Spine Stickleback (9SS)	2%	Crab Species (CR)	0.02%
Mummichog/Killifish (MM-KL)	25%	Other Species (OT)	0.1%

Nova Scotia / River Phillip - Pugwash

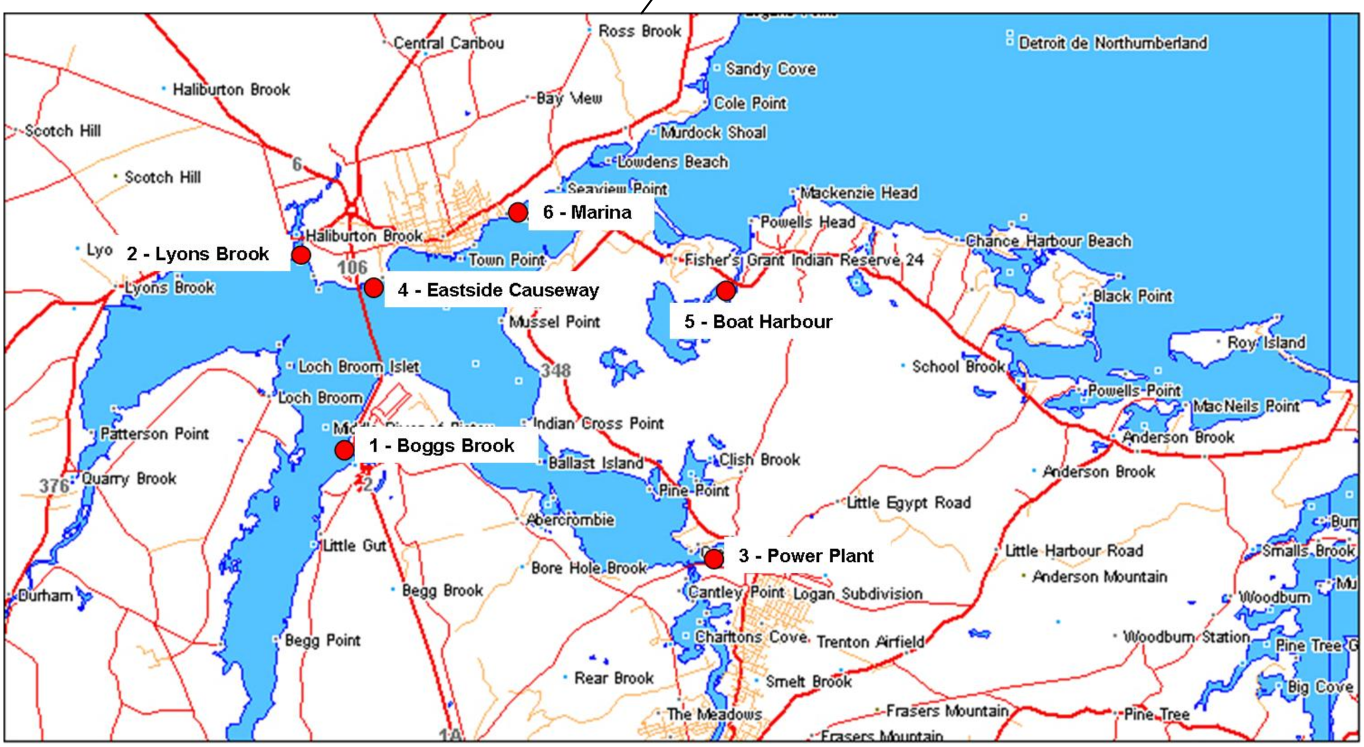


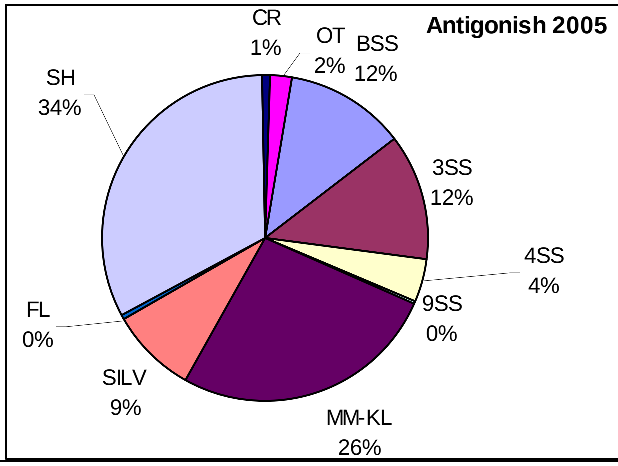


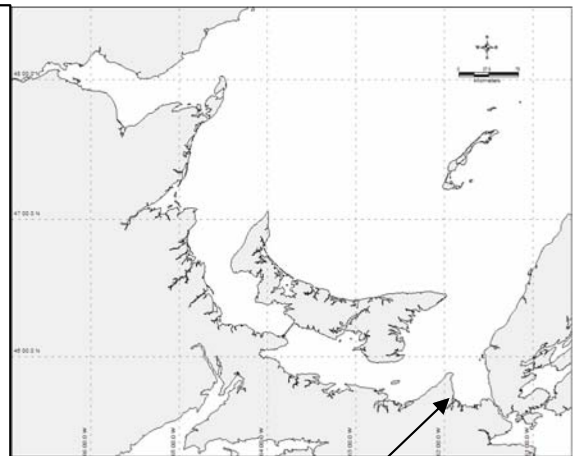


Black Spot Stickleback (BSS)	3%	Atlantic Silverside (SILV)	17%
3 Spine Stickleback (3SS)	3%	Flounder Species (FL)	0.1%
4 Spine Stickleback (4SS)	1%	Shrimp Species (SH)	15%
9 Spine Stickleback (9SS)	0.2%	Crab Species (CR)	0.4%
Mummichog/Killifish (MM-KL)	61%	Other Species (OT)	0.1%

Nova Scotia / Pictou

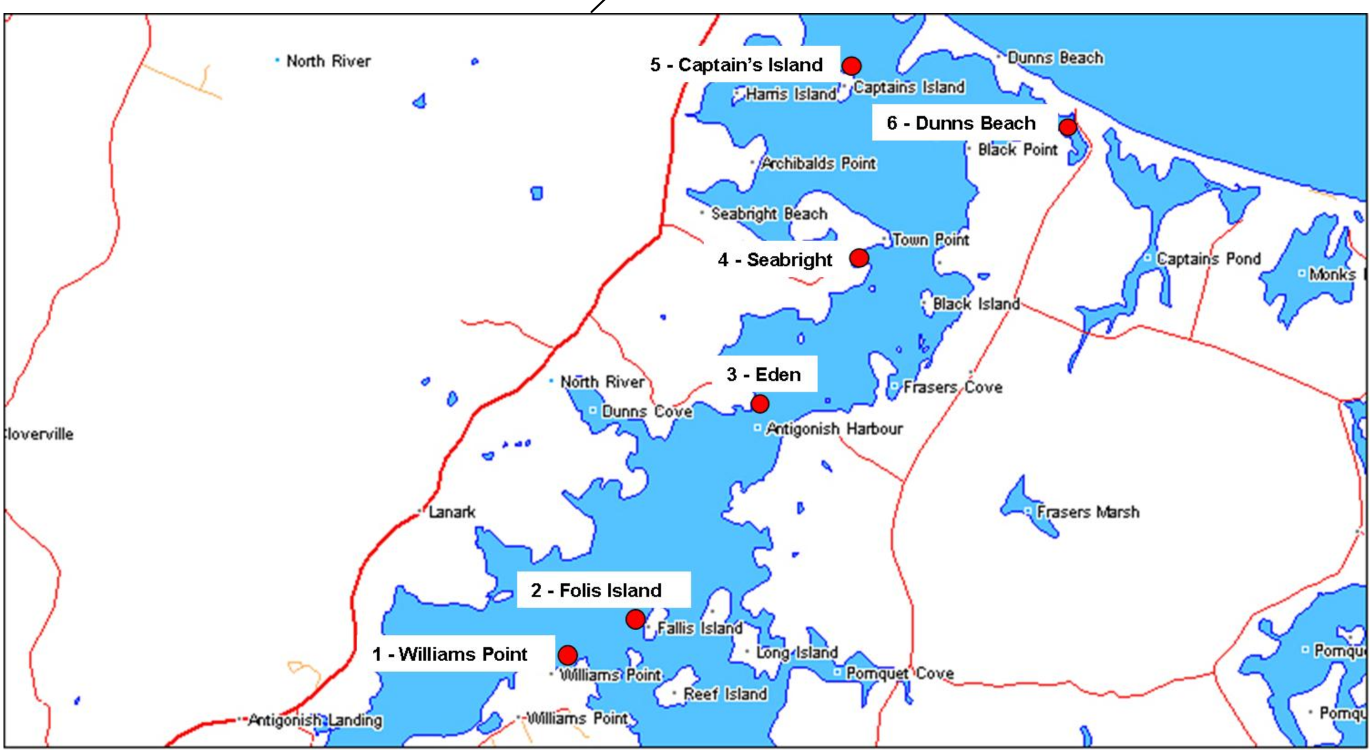


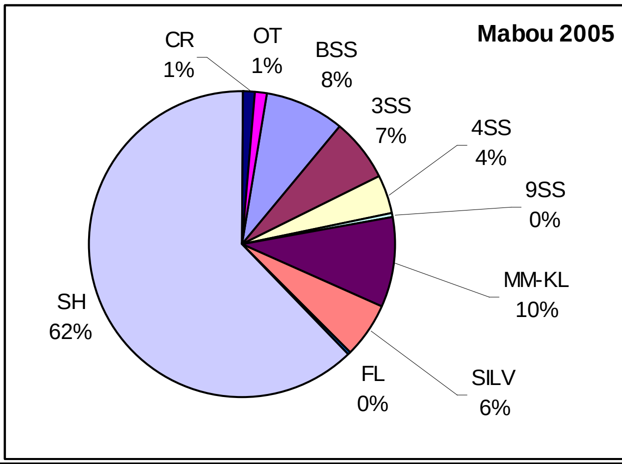


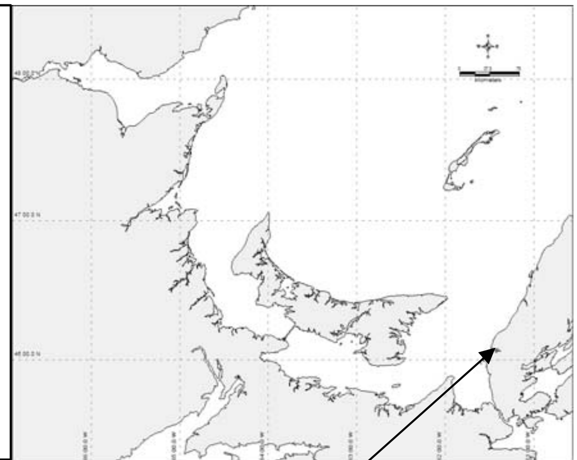


Black Spot Stickleback (BSS)	12%	Atlantic Silverside (SILV)	9%
3 Spine Stickleback (3SS)	12%	Flounder Species (FL)	0.2%
4 Spine Stickleback (4SS)	4%	Shrimp Species (SH)	33%
9 Spine Stickleback (9SS)	0.3%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	26%	Other Species (OT)	2%

Nova Scotia / Antigonish

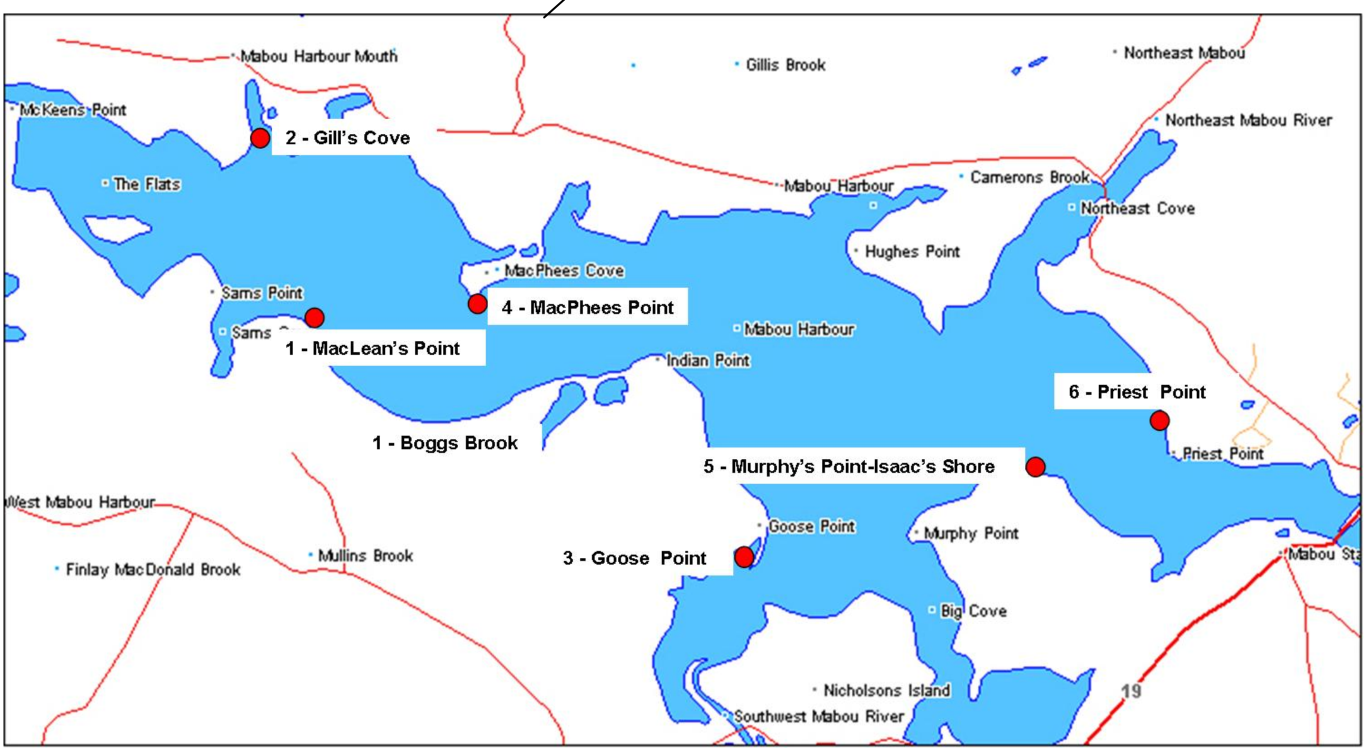


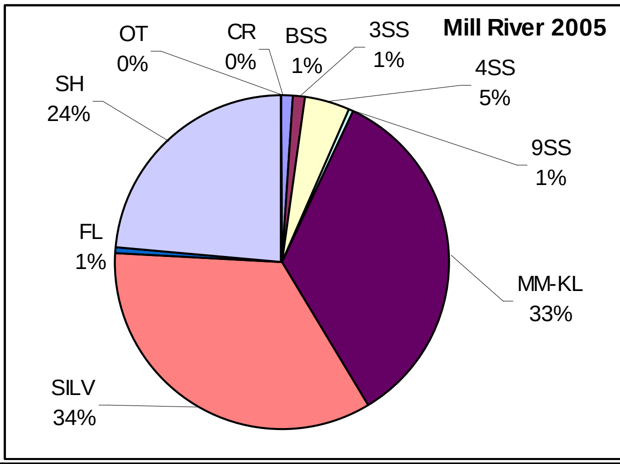


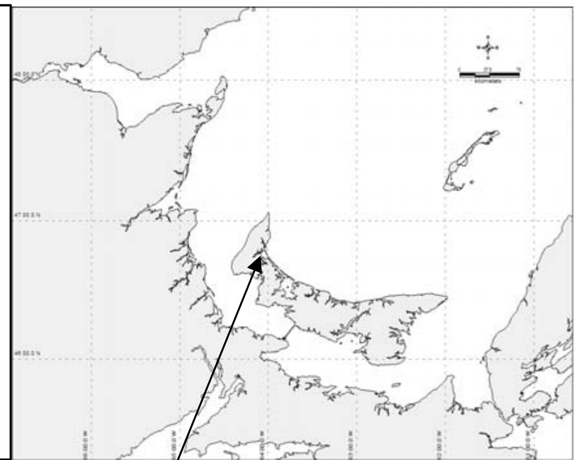


Black Spot Stickleback (BSS)	9%	Atlantic Silverside (SILV)	6%
3 Spine Stickleback (3SS)	7%	Flounder Species (FL)	0.3%
4 Spine Stickleback (4SS)	4%	Shrimp Species (SH)	62%
9 Spine Stickleback (9SS)	0.5%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	9%	Other Species (OT)	1%

Nova Scotia / Mabou

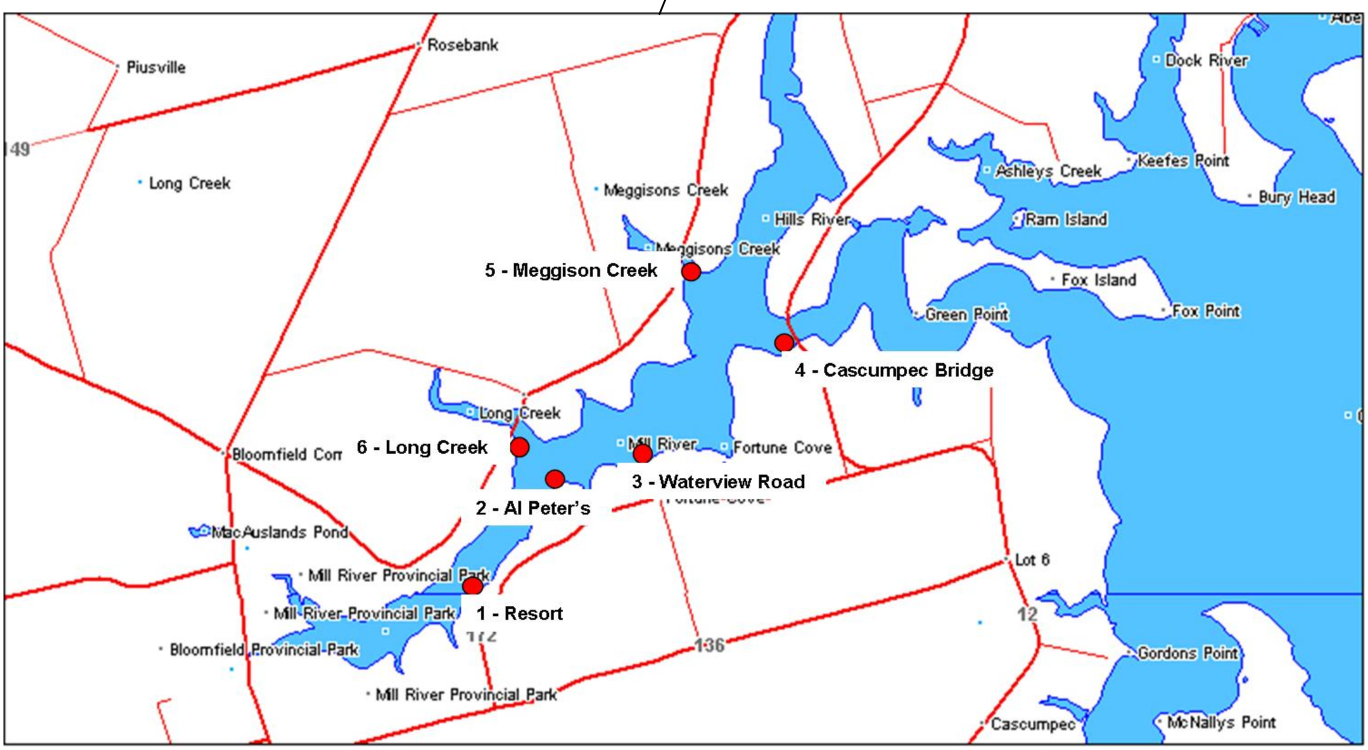


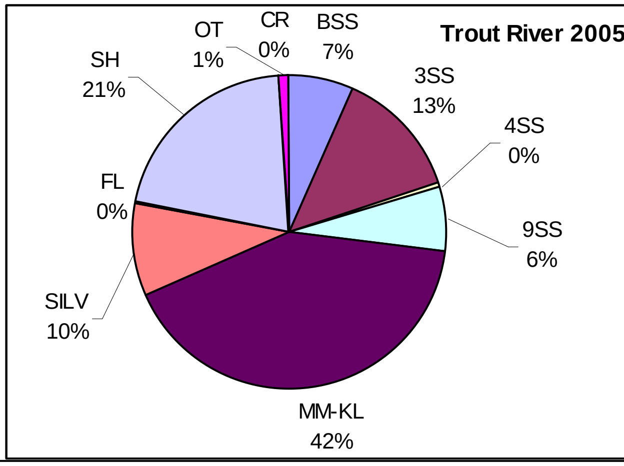


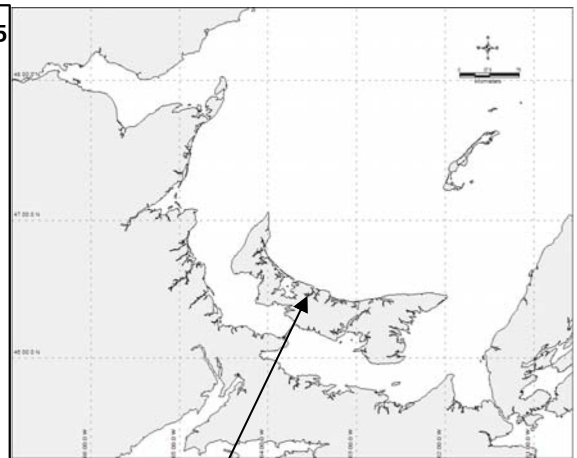


Black Spot Stickleback (BSS)	1%	Atlantic Silverside (SILV)	34%
3 Spine Stickleback (3SS)	1%	Flounder Species (FL)	0.5%
4 Spine Stickleback (4SS)	5%	Shrimp Species (SH)	24%
9 Spine Stickleback (9SS)	0.5%	Crab Species (CR)	0%
Mummichog/Killifish (MM-KL)	34%	Other Species (OT)	0.1%

Prince Edward Island / Mill River

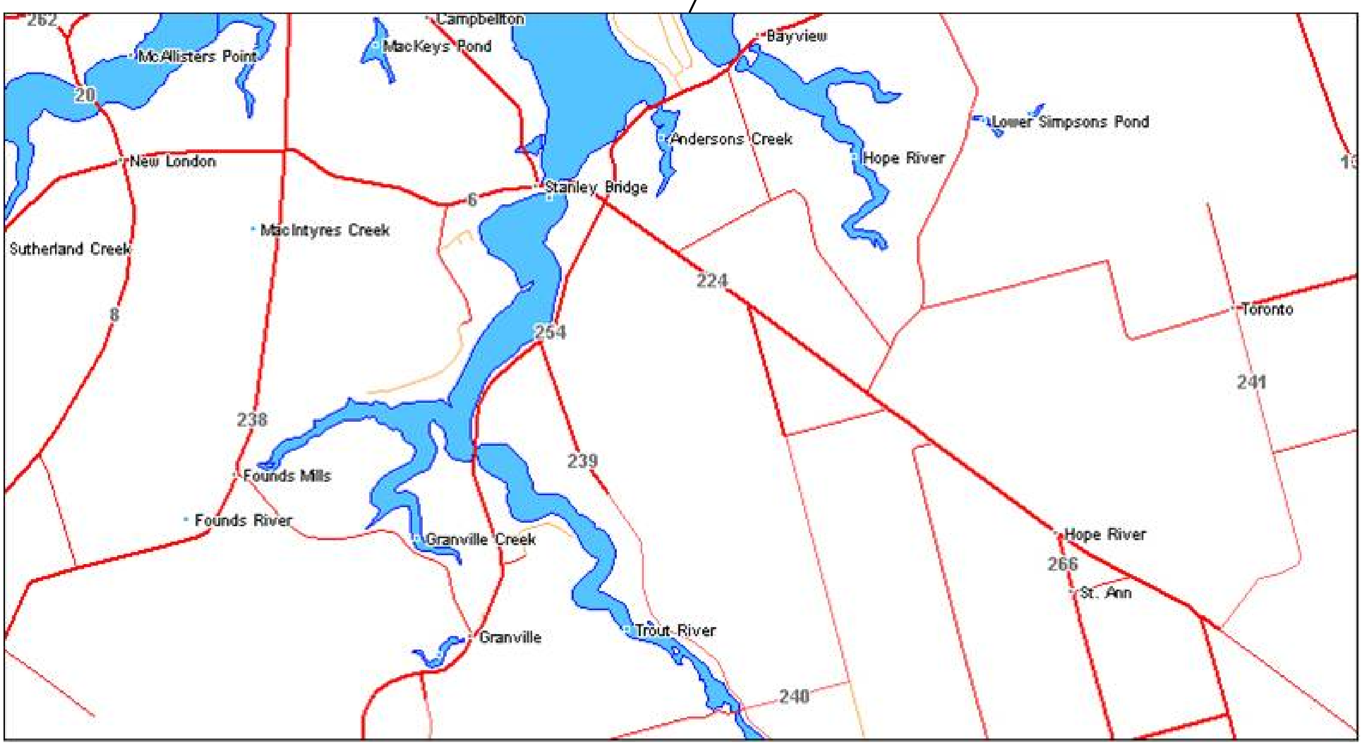


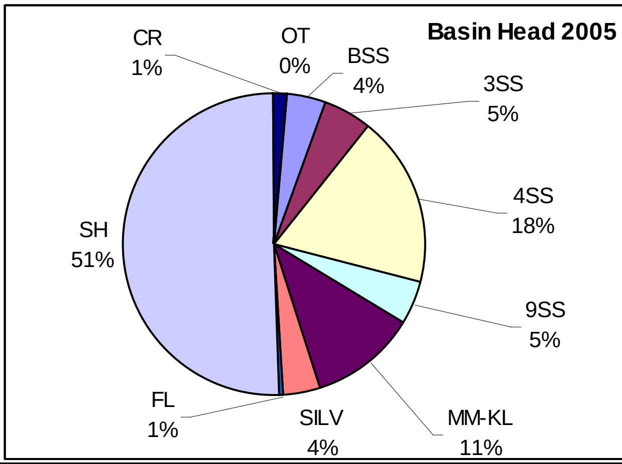


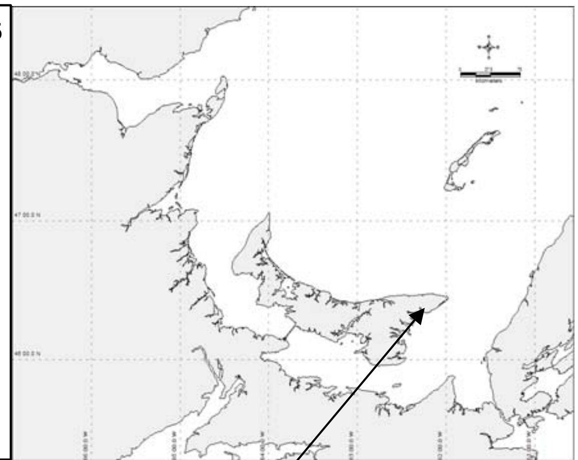


Black Spot Stickleback (BSS)	1%	Atlantic Silverside (SILV)	34%
3 Spine Stickleback (3SS)	1%	Flounder Species (FL)	0.5%
4 Spine Stickleback (4SS)	5%	Shrimp Species (SH)	24%
9 Spine Stickleback (9SS)	0.5%	Crab Species (CR)	0%
Mummichog/Killifish (MM-KL)	34%	Other Species (OT)	0.1%

Prince Edward Island / Trout River

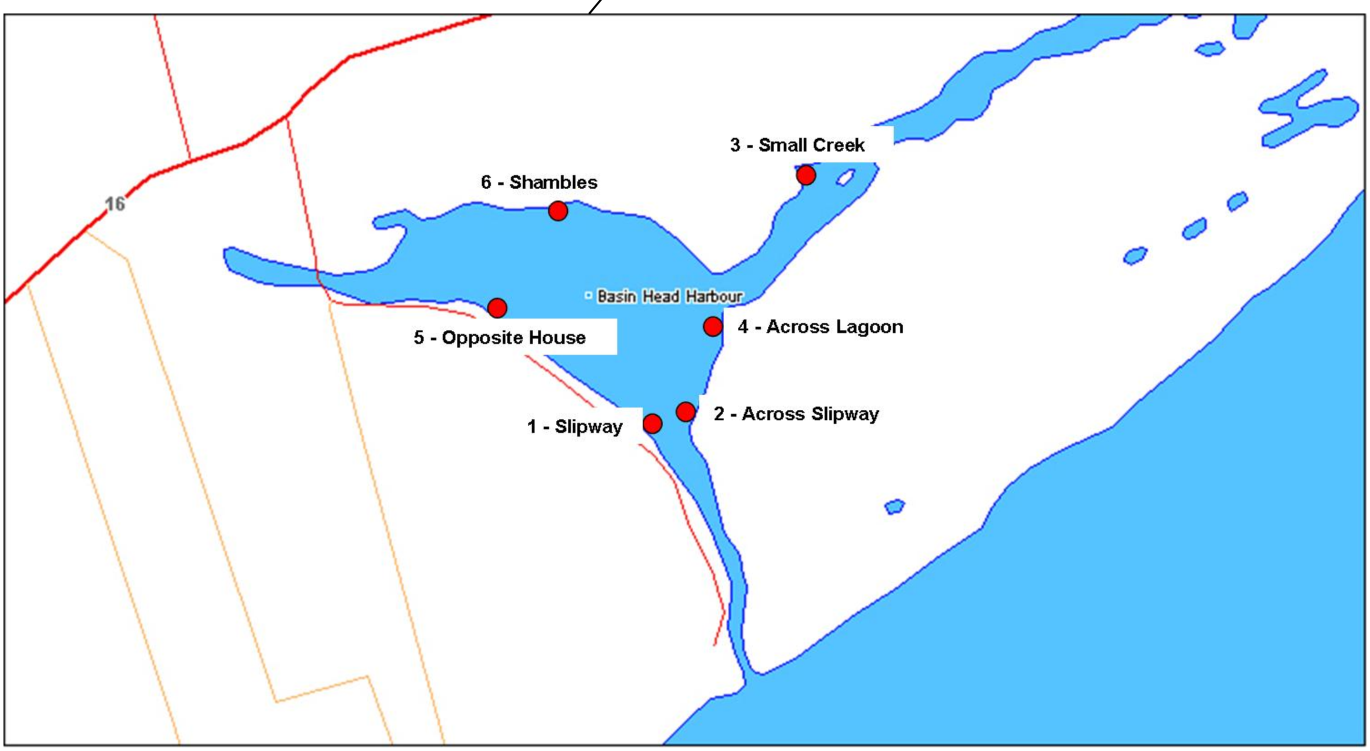


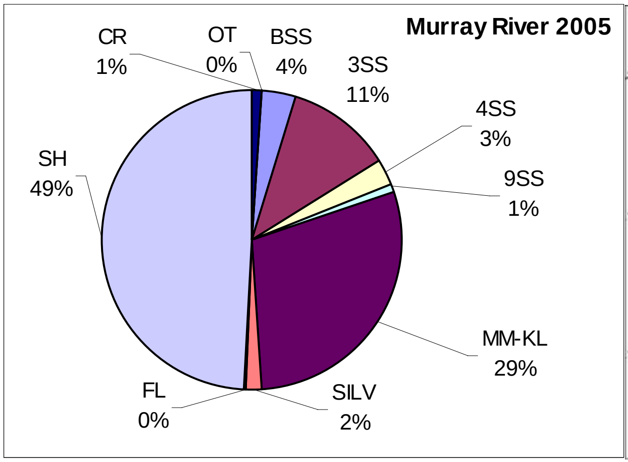


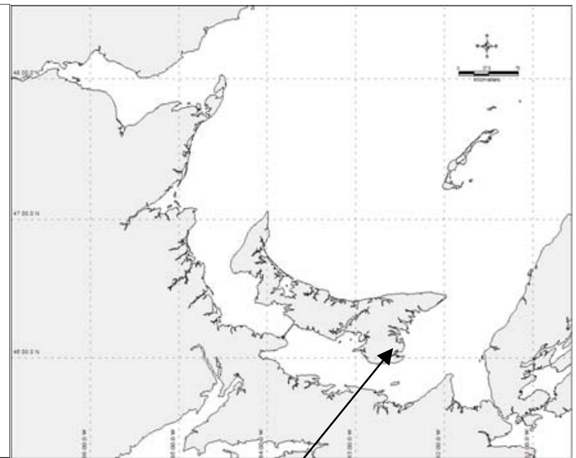


Black Spot Stickleback (BSS)	4%	Atlantic Silverside (SILV)	4%
3 Spine Stickleback (3SS)	5%	Flounder Species (FL)	1%
4 Spine Stickleback (4SS)	18%	Shrimp Species (SH)	51%
9 Spine Stickleback (9SS)	5%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	11%	Other Species (OT)	0.05%

Prince Edward Island / Basin Head

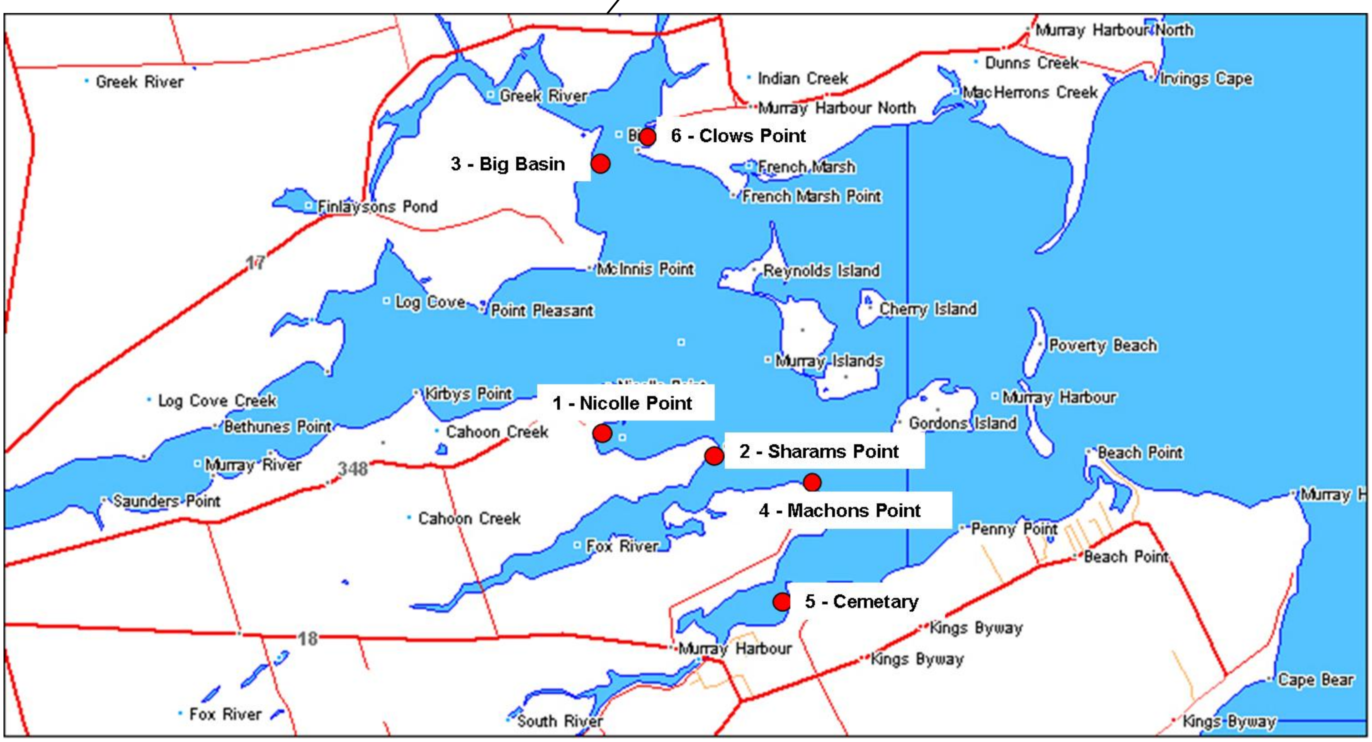


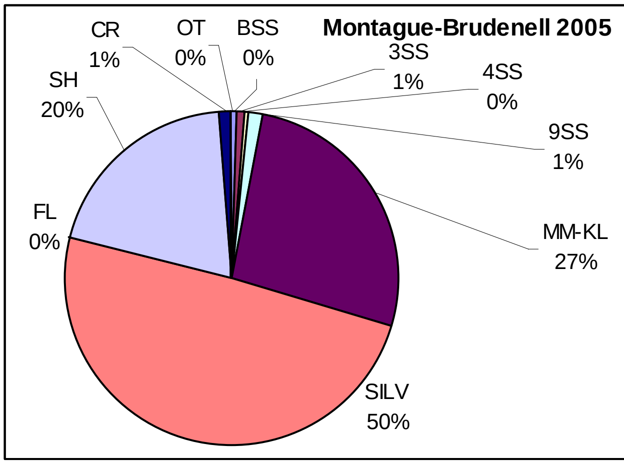


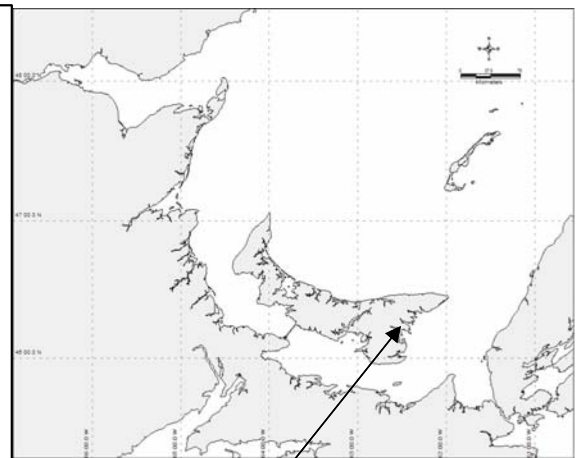


Black Spot Stickleback (BSS)	4%	Atlantic Silverside (SILV)	2%
3 Spine Stickleback (3SS)	11%	Flounder Species (FL)	0%
4 Spine Stickleback (4SS)	3%	Shrimp Species (SH)	49%
9 Spine Stickleback (9SS)	1%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	29%	Other Species (OT)	0%

Prince Edward Island / Murray River

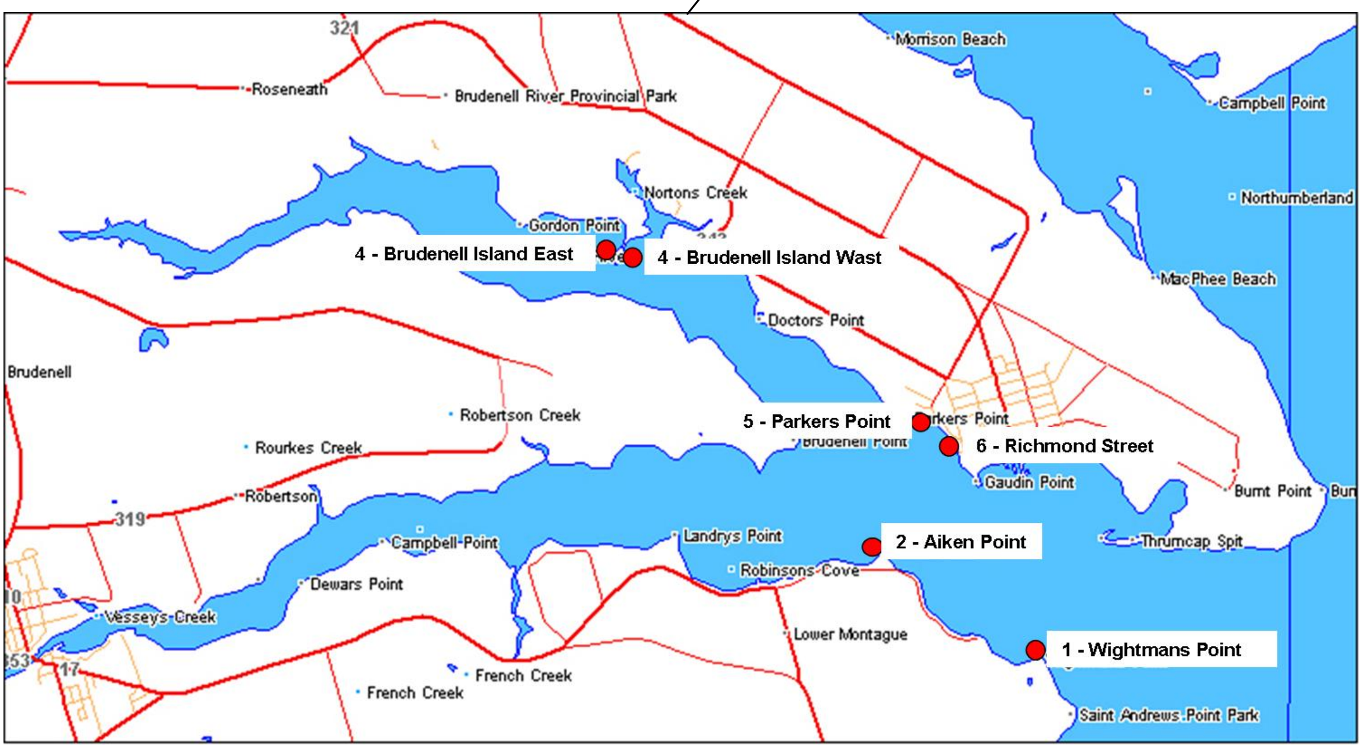


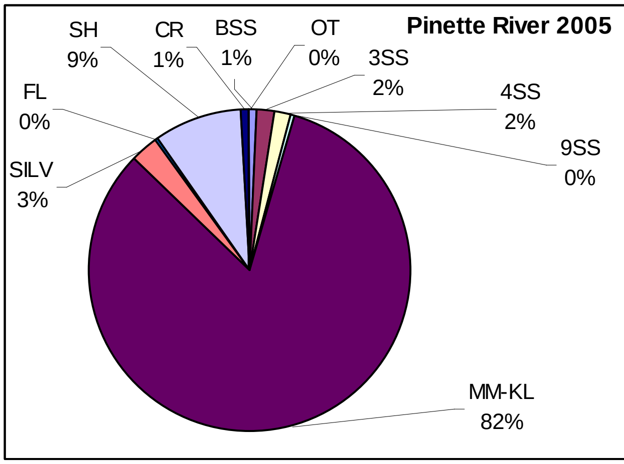


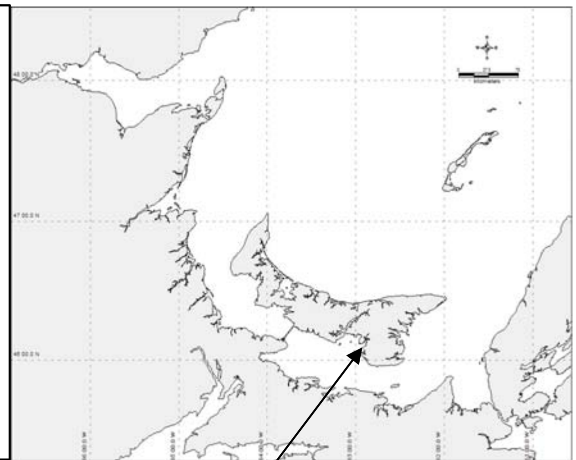


Black Spot Stickleback (BSS)	0%	Atlantic Silverside (SILV)	50%
3 Spine Stickleback (3SS)	1%	Flounder Species (FL)	0%
4 Spine Stickleback (4SS)	0%	Shrimp Species (SH)	20%
9 Spine Stickleback (9SS)	1%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	27%	Other Species (OT)	0%

Prince Edward Island / Montague-Brudenell







Black Spot Stickleback (BSS)	1%	Atlantic Silverside (SILV)	3%
3 Spine Stickleback (3SS)	2%	Flounder Species (FL)	0%
4 Spine Stickleback (4SS)	2%	Shrimp Species (SH)	9%
9 Spine Stickleback (9SS)	0%	Crab Species (CR)	1%
Mummichog/Killifish (MM-KL)	82%	Other Species (OT)	0%

Prince Edward Island / Pinette River