Monitoring of vegetation and fish in six eelgrass beds in Quebec (2005–2010)

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Monitoring of vegetation and fish in six eelgrass beds in Quebec (2005–2010)

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ABSTRACT

Nellis, P., Dorion D., Pereira, S., Ellefsen, H.-F. and Lemay, M. 2012. Monitoring of vegetation and fish in six eelgrass beds in Quebec (2005–2010). Can. Tech. Rep. Fish. Aquat. Sci. 2985E: ix + 96 pp.

From 2005 to 2010, samples were taken from six eelgrass beds throughout the St. Lawrence marine area in June and September. The purpose of the study was to determine whether there were differences over the years and between months for the different variables measured. These variables were leaf length and type as well as the abundance and size of various fish species. Two physical variables, water temperature and light, were also measured to explain variations in leaf length and type.

In general, leaf lengths measured from 2005 to 2010 were longer in September than in June. There were differences over the years for leaf lengths in three of the eelgrass beds and differences in the proportion of fruiting stems versus vegetative stems in only one bed. The physical variables measured explain little of variation in plant lengths.

Analyses of the number of fish species and their abundance revealed that most differences were between seasons (June and September) rather than among years. The results of multivariate analyses on the fish abundance matrices showed the same trends. Only a few dominant species, like *Gasterosteus* spp. and *Apeltes quardacus*, strongly contributed to the differences between the months. The analyses of these species seem to show that they use the eelgrass beds in June for reproduction and in September for juvenile growth.

RÉSUMÉ

Nellis, P., Dorion D., Pereira, S., Ellefsen, H.-F. et Lemay, M. 2012. Suivi de la végétation et des poissons dans six zosteraies au Québec (2005-2010). Rapp. tech. can. sci. halieut. aquat. 2985F: ix + 96 p.

Entre 2005 et 2010, six zosteraies distribuées dans le Saint-Laurent maritime ont été échantillonnées en juin et septembre. L'objectif de l'étude était de vérifier, pour les différentes variables mesurées, s'il y avait des différences entre les années et les mois. Ces variables étaient la longueur et le type de feuille, ainsi que l'abondance et la taille des différentes espèces de poissons. Deux variables physiques, la temperature de l'eau et la luminosité, ont aussi été mesurées pour expliquer les variations de la longueur et du type de feuille.

En général, les longueurs de feuilles mesurées entre 2005 et 2010 sont plus élevées en septembre qu'en juin. Il y a des différences entre les années dans les longueurs des feuilles pour trois des zosteraies et des différences dans la proportion de tiges fructifères versus tiges végétatives pour une seule des zosteraies. Les variables physiques mesurées expliquent une faible proportion des variations des longueurs des plants de zostères.

Des analyses du nombre d'espèces de poisson et de leur abondance montrent que la majorité des différences sont entre les mois de juin et septembre et non entre les années. Les résultats d'analyses multivariées sur les matrices d'abondance des poissons montrent les mêmes

tendances. Seules quelques espèces dominantes, comme *Gasterosteus* spp. et *Apeltes quardacus* contribuent fortement aux différences entre les mois. Les analyses sur ces espèces semblent démontrer qu'elles utilisent les zosteraies en juin pour la reproduction et en septembre pour la croissance des juvéniles.

1 INTRODUCTION

Eelgrass, *Zostera marina* (L.), is a true halophytic herbaceous plant[1] that grows in relatively calm waters (Marie-Victorin 1964). This plant forms large beds, or meadows, in estuaries, bays and lagoons in the northern hemisphere. *Zostera marina* is the only submerged phanerogamous marine plant[2] found in Quebec (Grant and Provencher 2007). It is widespread in the middle and lower estuaries and Gulf of St. Lawrence, Chaleur Bay and the Magdalen Islands (Lemieux and Lalumière 1995; Martel et al. 2009). It also grows in James Bay (Lalumière et al. 1994; Short 2008).

This species is capable of reproducing asexually through elongation of its rhizomes or sexually through seed formation (Bintz and Nixon 2001). It appears to rely more frequently on the latter method in disruptive environments (e.g., eutrophication, changing salinity) (Ewanchuk 1995). Eelgrass is also capable of dispersion via broken shoots or dissemination through rhizome fragments (Hemminga and Duarte 2000).

Eelgrass beds are recognized as highly productive environments that provide vital habitats to many animal species in coastal areas (Hemminga and Duarte 2000; Polte and Asmus 2006a). The complex structure of the beds provides refuge and food to a large number of species during critical stages of their life cycles (Orth *et al.* 1984; Lazzari *et al.* 2003). Heck et al. (1989) demonstrated in this regard that fish are more abundant in eelgrass beds than in vegetation-free habitats. Birds also use these beds as a major food source.

According to one group of DFO experts (2009), eelgrass provides an important three-dimensional structure for biodiversity and productivity in the Gulf of St. Lawrence. The plant is recognized as an ecologically significant species (ESS) as described in DFO (2006) as part of the Gulf of St. Lawrence integrated management (GSLIM) (DFO 2007). The presence of eelgrass may also help to offset the erosion processes observed in maritime Quebec. This is because the plant's leaves slow the force of the waves and promote sedimentation, while its roots help to stabilize shoreface sediment (Widdows *et al.* 2008; Comité ZIP du Sud-de-l'Estuaire 2010).

In spite of this, little knowledge is available in Quebec concerning eelgrass and the fish species found in its environs. The focus of the leading studies on eelgrass in Quebec to date has been on reporting the locations of eelgrass beds (Lalumière 1991; Lalumière et al. 1994; Lemieux and Lalumière 1995; CREGÎM 2006; Martel et al. 2009). One recent study by Grant and Provencher (2007) served in characterizing eelgrass as a habitat in the Manicouagan Peninsula area.

To compensate for this lack of knowledge about eelgrass in Quebec, the Oceans Management Divisionand and Area Offices of DFO, Quebec Region, established the Eelgrass Monitoring Network (EMN) in conjunction with outside partners in 2005. This entity has multiple objectives including (i) acquiring knowledge about the eelgrass beds located in the various St. Lawrence coastal regions and (ii) monitoring any potential change affecting these eelgrass beds and the fish

[1] A halophyte is a plant adapted to saline environments (Henderson et al. 1979).
[2] A phanerogamous plant has flowers with visible reproductive organs (Henderson *et al.* 1979).

communities that use them as habitats. The Monitoring Network also strives to raise awareness within the local population about the importance of preserving eelgrass beds.

A community network seeking to acquire knowledge about coastal environments is also active in the southern Gulf of St. Lawrence area. Supported by biologists from DFO, Gulf Region, the Community Aquatic Monitoring Program (CAMP) was established in 2003 as a pilot project and then officially launched by local watershed groups as a stewardship program in 2004 (Weldon *et al.* 2005). However, although the objectives of CAMP overlap those of the Eelgrass Monitoring Network, CAMP's activities are focused on the estuaries of the Maritimes and extend to habitats other than eelgrass. There are also two international eelgrass monitoring networks. The members of Seagrass Net are distributed globally, while those of Seagrass-Watch are located around the Indian Ocean (McKenzie et al. 2003; Short et al. 2006).

The objectives of this report are to provide a summary of the knowledge collected by the Monitoring Network and to determine whether any changes in selected variables over time (year to year or month to month) can be detected in the eelgrass beds and the fish communities that use them. This report presents data from six survey years (2005 through 2010) for the six eelgrass beds studied.

The length of eelgrass leaves and the type of reproduction were monitored with to identifying any changes in the eelgrass beds over time. Fish were sampled twice a year to detect any differences in the fish habitats and populations associated with the eelgrass beds. The body lengths of fish species occurring in great abundance were also measured to gauge the use of the eelgrass beds during the species' various life stages. Two physical variables (temperature and light) were also tracked as potential explanatory variables.

2 MATERIALS AND METHODS

2.1 OVERVIEW OF EELGRASS BEDS

Beds were monitored annually in four locations between 2005 and 2010 (Figure 1): Rimouski Bay[3] (referred to as Rimouski in the text) in the Lower St. Lawrence; the Saint-Jean River estuary[3] (St-Jean) on the Gaspé Peninsula; Sept-Îles Bay[4] (Sept-Îles) on the North Shore; and Bassin aux Huîtres[5] (Bassin aux Huîtres) in the Îles-de-la-Madelaine. The last site was sampled in cooperation with the Comité ZIP des Îles-de-la-Madeleine between 2005 and 2010 with an interruption in data collection in 2008. The eelgrass bed at Penouille[6] (Penouille), on the Gaspé Peninsula, was added to the initiative in 2007 in cooperation with Forillon National Park. In

[3] Data source: EMN.
[4] Data source: Amik in conjunction with EMN (DFO).
[5] Data source: Comité ZIP des Îles-de-la-Madeleinein conjunction with EMN (DFO).
[6] Data source: Forillon National Park in conjunction with EMN (DFO).

2008, the Cacouna-Sud[7] eelgrass bed (Cacouna) was also added to the study in cooperation with the CÉGEP de La Pocatière.

With the exception of the Cacouna bed, sampling was carried out at all beds during at least two different time periods: in June, to sample the fish using the beds and in September, to measure maximum growth of the eelgrass leaves and survey the presence of juvenile and adult fish. Due to the schedule of the students at the CÉGEP de La Pocatière, the Cacouna bed was sampled only in September for the fish-related variables. Eelgrass shoots at the Cacouna bed were sampled by DFO in June and September 2009 and 2010.

In 2007, the Rimouski study area was relocated to a site where the bed was more accessible. Samples for that year were consequently taken in two areas approximately 750 m apart within the same bed. Since variance analyses (univariate and multivariate, not presented herein) of the eelgrass growth and the fish community revealed no significant difference between the two areas, the new zone was retained for subsequent sampling and analysis (2008–2010).

2.2 CHOICE OF MONITORING METHODOLOGY AND TECHNIQUES

Decisions concerning the monitoring methodology and techniques were dictated by the requirement for simplicity and low cost. One important piece of information in monitoring changes in eelgrass beds is variation in the bed area (DFO 2009). Despite the importance of this variable, however, the techniques (whether satellite or field) allowing for its accurate measurement either require excessive time or are prohibitively expensive or not applicable to all eelgrass beds. These methods were consequently rejected. Taking density (or biomass) measurements at all beds was also rejected for similar reasons. Measurement of leaf length and determination of plant types growing in a single area at each bed were chosen for the simplicity of the associated techniques. With respect to fish sampling, several techniques were tested during the first two years before settling on the minnow seine and the hoop net, both of which could be used at all types of eelgrass beds. Any invertebrates (e.g., *Gammaridae*, *Cancer irroratus*, *Crangon crangon*) captured during sampling were disregarded for the purposes of this report in light of the difficulties associated with counting and identifying them.

2.3 MEASUREMENTS TAKEN

2.3.1 TEMPERATURE AND LIGHT

Temperature and light were measured using the Pendant Temp/Light Data Logger model UA-002-64 Hobo® manufactured by Onset®. Sensors were programmed to take measurements every 10 minutes from June through September (between the first and last samples) and were installed in areas free of eelgrass cover so that light conditions could be measured without concern about plants covering the sensor at low tide. Sensors were alwas submergeds. Light measurements

[7] Data source: CÉGEP de La Pocatière in conjunction with EMN (DFO).

served to quantify the energy available for eelgrass photosynthesis. No physical data are available for 2006 or 2007 for the eelgrass bed at St-Jean or for 2008 at Sept-Îles because the Hobo® sensors could not be located in the fall.

2.3.2 EELGRASS PLANTS

Between 2005 and 2008, three random samples were taken near of the Hobo® sensor in June and September. In 2009 and 2010, the number of samples was increased to six. This sampling was performed using a metal collar 10 cm in diameter (surface area 78.5 cm^2). The measurements taken on all eelgrass plants present in the samples were the maximum length (mm) of the longest leaf and identification of the shoot type (vegetative or fruit-bearing; beginning in 2006).

2.3.3 FISH COMMUNITIES

2.3.3.1 Fishing Gear

Two types of gear were used to sample the fish communities present at the eelgrass beds: mobile in the form of the minnow seine, and fixed, in the form of the hoop net (see Appendix 1).

The minnow seine used was 15 m long by 1.2 m high with a 6.25 mm square mesh. The seine was equipped with a square or rectangular centre bag for ease of fish handling. Three tows were made in nJune and September over an average distance of 20 m.

The hoop net used had a funnel shaped pocket held in place by a series of hoops; cones on the inside allowed fish to enter but not exit. The hoops were 75 cm high with a 6.25 mm mesh. The trap also include wings (15 m) attached to either side of the frame ans a 30 m main leader; these increased the trap's efficieng by channeling the fish toward the net's mouth. The hoop net was positioned perpendicular to the shoreline at low tide. Each sampling period was made up of three fishing sessions of 24 hours (i.e., two full tide cycles) each.

2.3.3.2 Measurements Taken on Catches

The following measurements were taken on all fish regardless of the fishing gear used: count (or estimated count based on sub-samples and known volumes) per species and measurement of total length (mm) of a maximum of 30 randomly selected individuals per species. Since several species present in the eelgrass beds resemble one another closely and are consequently difficult to identify in the field, particularly in situations involving large volumes, these were grouped by genus. The grouped species were as follows:

- *Ammodytes americanus* + *Ammodytes dubius* = *Ammodytes* spp.
- *Fundulus heteroclitus* + *Fundulus diaphanus* = *Fundulus* spp.
- *Gasterosteus aculeatus* + *Gasterosteus wheatlandi* = *Gasterosteus* spp.
- *Myoxocephalus scorpius* + *Myoxocephalus aeneus* = *Myoxocephalus* spp.

A table indicating the English and taxomonique names is provided in Appendix 2.

2.4 DATA PROCESSING

2.4.1 TEMPERATURE AND LIGHT ANALYSIS

Temperature and light readings measured with the Hobo® Data Logger were averages over the period beginning with the first sampling of eelgrass (June) and ending at the last (September); minimum and maximum values were also noted (Table 1) to show seasonal variation. When multiple sensors were deployed in a single bed, averages were calculated. These data were used for multiple regression on transformed (log+1) data (see Section 2.4.1).

2.4.2 EELGRASS PLANTS

The average maximum length of eelgrass leaves was calculated for each replicate. Two-way (year and month nested within year) analysis of variance (ANOVA) (Sokal and Rohlf 1995) was performed to determine whether differences in maximum leaf length values were statistically significant. The data were transformed (log+1) to meet the requirements of normality and homoscedasticity.

A multiple regression using the September leaf length (log+1) as a dependent variable and the physical variables as explanatory variables (Hair et al. 2010) was used to confirm the existence of correlations among these variables.

The number of fruit-bearing shoots as a proportion (see Equation 1) of the number of vegetative shoots was calculated for each bed and year for each replicate. The average and standard error were then calculated by year and bed. This proportion ranged from 0%, where all shoots were vegetative, to 100%, where all shoots were fruit-bearing. The proportion was calculated only for the month of June due to the greater difficulty of distinguishing shoot types in September (due to the absence of flowers and seeds in the fall.)

Equation 1: $\boldsymbol{Proportion}\ (\%) = \{[\sum \boldsymbol{Fruit-bearing} \div (\sum \boldsymbol{Fruit-bearing} + \sum \boldsymbol{Vegetative})] \boldsymbol{X\ 100}\}$

One-way (year) ANOVA was then performed on arcsine- transformed to linearize the sigmoid distributions and equalize variances in proportions (Sokal and Rohlf 1995).

2.4.3 CATCHES

Two-way (year and month nested within year) ANOVA (Sokal and Rohlf 1995) was performed on the number of species (S) and total abundance (N) using seine and hoop net fishing data. This analysis was carried out on (log+1) transformed data.

Two-way (year and month) permutational multivariate analysis of variance (PERMANOVA) (Anderson et al. 2008) was performed on the Bray-Curtis similarity index ($\sqrt[4]{\chi}$ transformed data) to identify any significant differences between the total seine and hoop net catches. This $\sqrt[4]{\chi}$ transformation helped to decrease the importance of highly abundant species while also increasing the influence of rare species (Clarke and Warwick 2001). Only one-way (year) analysis was performed on the data from Cacouna because sampling was carried out only in September at that site. The dissimilarity relationships between the various years and months were represented graphically using multidimensional scaling (MDS) applied to each type of fishing gear and eelgrass bed. Where a factor (year or month) demonstrated significant differences, the dissimilarity for that factor and the contribution of the dominant species to these differences were calculated following the SIMPER procedure (Clarke and Warwick 2001).

Two-way (year and month) PERMANOVA for the Bray-Curtis similarity index was also performed on the frequency data (%) for the size of the dominant species sampled at the various beds via seine and hoop net. The species identified as having sufficient data to support analysis were *Apeltes quadracus, Gasterosteus* spp. and *Osmerus mordax*.

Data normality and homoscedasticity were verified for all ANOVAs on the residue using the Shapiro-Wilk and Levene tests respectively (SAS Institute 1999). Wherever a significant ($P < 0.05$) difference in a factor was identified, an *a posteriori* multiple comparison test was carried out using least squares means (SAS Institute 1999) with a Bonferroni correction (Day and Quinn 1989). Significant differences are identified by different letters on the histograms.

Statistical calculations were performed using SAS 9.2 (SAS Institute) and PRIMER 6 & PERMANOVA + (PRIMER-E Ltd.) applications.

3 RESULTS AND DISCUSSION

3.1.1 TEMPERATURE AND LIGHT

This section describes the temperature and light data collected for each eelgrass bed. The average, minimum, and maximum temperature and luminosity values are discussed. The temperature and luminosity data are then compared to vegetation data collected concerning (Sections 3.2 and 3.3).

Table 1 shows the seasonal (June to September) descriptive statistics for temperature and light recorded at the various beds.

The highest seasonal average temperatures were recorded in the eelgrass bed at Bassin aux Huîtres in the Magdalen Islands, with values ranging between 18.26°C (± 0.03) and 20.43°C (± 0.01). The eelgrass beds at St-Jean and Penouille had intermediate average temperatures, with values of between 16.07°C (± 0.03) and 18.45°C (± 0.03). Seasonal average temperatures at the Sept-Îles eelgrass bed were more variable, ranging between 15.64°C (± 0.04) and 22.54°C (± 0.01). The lowest average temperatures were found at the Rimouski and Cacouna beds, where values of 13.68°C (± 0.04) to 16.49°C (± 0.06) were recorded. The lowest minimum temperature was recorded at Sept-Îles in 2009, with a value of 0.56°C, while the highest minimum temperature, 14.52°C, was recorded at Bassin aux Huîtres in 2005. The highest maximum temperature was also found at Sept-Îles, where a value of 46.9°C was recorded in 2009. This extreme temperature was probably recorded during a period when the sensor was above water and fully exposed to sunlight. The lowest maximum temperature was recorded at the Bassin aux Huîtres bed, with a value of 26.2°C in 2005.

Average luminosity values ranged between 1,260 (± 49) lux at Penouille in 2009 and 12,688 (± 156) lux at Rimouski in 2005. The bed at Bassin aux Huîtres appeared to have the lowest average luminosity values of all the beds. The maximum luminosity value of 126,756 lux was recorded at all eelgrass beds a total of 19 times. This probably represents the maximum lux value when the sun is at its zenith in summer at our latitude. The lowest luminosity value, 35,822 lux, was recorded at the Sept-Îles eelgrass bed in 2006.

The least variation in average temperatures was found at the St-Jean and Penouille beds. Both of these eelgrass beds lie in the intertidal zone but are influenced by a river and a salt marsh, which may limit emersion time (D. Sigouin[8], pers. comm., February 2009) and moderate temperature differences. Exception for Bassin aux Huîtres, eelgrass beds are in the intertidal zone and consequently subjected to periods of complete immersion and emersion, resulting in significant temperature and light differences.

The temperature differences recorded among the various eelgrass beds may also be attributed to the dynamics of the currents in the Estuary and Gulf of St. Lawrence. Upwellings of the current at the head of the Laurentian Channel carry cold water to the surface and partway toward the south shore of the lower St. Lawrence estuary (Biorex Inc. 1999; Dufour and Ouellet 2007), which could explain the lower average temperatures in the eelgrass beds at Rimouski and Cacouna in relation to the other beds. Temperatures at the various eelgrass beds vary by the same proportions as those recorded at the nearest DFO's oceanographic monitoring reference stations (Galbraith et al. 2007). The values recorded at the eelgrass beds are nevertheless a few degrees higher. Insofar as the beds are located in gently sloping coastal areas, the water around the beds is more likely to warm during low tide. Since sensors spend several hours a day either in only a few centimetres of water or fully exposed, heating of the sensors by the sun could also explain the higher values recorded in the eelgrass beds.

3.1.2 LEAF LENGTH

Leaf length at each of the eelgrass beds was measured in June and September; leaf growth over the season was based on the difference of thes two measures. Maximum lengths were examined to see if there were differences among years. Leaf lengths were then compared with environmental factors. A number of elements are discussed in this regard to assess whether other types of disruptions in the eelgrass beds might explain the interannual differences in leaf length observed.

Table 2 gives the ANOVA results concerning year and month effects on leaf length. Based on this analysis, significant differences in leaf length between June and September were noted at

[8] Daniel Sigouin, Park Ecologist, Forillon National Park, Parks Canada, Gaspé.

Bassin aux Huîtres, Penouille, Rimouski, St-Jean and Sept-Îles. These differences likely correspond in part to annual plant growth. Significant interannual differences were also noted at four eelgrass beds: Penouille, Rimouski, St-Jean and Cacouna (Figure 2). In Rimouski, for example, the difference in length between June and September was much greater in 2006 than in other years. At Cacouna, ANOVA revealed no significant difference between lengths in June and in September. Plant growth at that eelgrass bed is likely higher early in the season (April to May), and June sampling did not reval these differences. Nevertheless, a difference was noted between lengths, with the 2010 length of 246 mm (± 8 mm) being significantly greater than the 2009 length of 173 mm (± 5 mm). A higher average luminosity value in 2010 (8,415 lux ± 138) than in 2009 (4,755 lux ± 125; see Table 1) or other favourable conditions in 2010 may explain this difference.

The greatest leaf length, 457 mm (± 29 mm), was observed at Penouille in September 2010. The shortest length, 88 mm (± 4 mm), was recorded at the St-Jean eelgrass bed in September 2008.

According to the results of stepwise multiple regression (Table 3), only two variables enter into the model. These two variables, which are negatively correlated with maximum leaf length in September, are maximum temperature and average temperature. However, both of these variables combined explain only 28% of the variation in maximum leaf length in September. Other variables, which we did not track throughout the season for lack of means, such as salinity (Nejrup and Pedersen 2008), turbidity, nutrients salt, and flow regimes (Fonseca et al. 2007) as well as biotic variables such as the presence of filter-feeding shellfish (Carroll *et al.* 2008; Wall et al. 2008) surely also play an important role in bed growth (Van Lent and Verschuure 1994; Larkum et al. 2006).

It was therefore impossible to clearly demonstrate links between leaf length data and temperature and luminosity data; other factors must have contributed to the differences observed. Some analysis results showed differences in length from one year to the next. These differences are likely be attributed to variable environmental conditions. It is also impossible to establish a relationship between interannual variations in length and environmental perturbations. Sampling on a much larger scale of both leaf growth and environmental variables would be required in order to use leaf length to track changes in the eelgrass beds and detect environmental changes.

3.1.3 FRUIT-BEARING SHOOTS AS A PROPORTION OF VEGETATIVE SHOOTS

The number of fruit-bearing (representing sexual reproduction) shoots as a proportion of the number of vegetative (asexual reproduction) shoots provides an indication of main reproductive strategy. An eelgrass bed with a low proportion of fruit-bearing shoots would appear to depend more on asexual reproduction to maintain and increase the bed size. While, a bed with a high proportion of the fruit-bearing shoots would depend more on sexual reproduction. Sexual reproduction may be more prominent in situations involving environmental disruptions, such as changes in current and nutrient availability (Ewanchuk 1995). Therefore, this proportion was measured and interannual variations in each eelgrass bed analyzed.

One-way ANOVA (Table 4) did not reveal any significant year-to-year differences in eelgrass beds in terms of the proportion of fruit-bearing to vegetative shoots with the exception of the

Sept-Îles bed. The eelgrass bed with the highest proportion was at Bassin aux Huîtres in 2009, with a value of 42.3 (±10.4). Four eelgrass beds exhibited a had no fruit-bearing: Penouille in 2008, St-Jean in 2008, Sept-Îles in 2010, and Cacouna in 2009 (Figure 3). Significant interanual differences in proportions were observed only at Sept-Îles, where the proportion decreased over time (Figure 3) from 28% (± 4%) in 200, 23% (± 5%) in 2007, 2.5% (± 2.5%) in 2008, to 0% in 2010. This decrease could indicate that the bed was reaching or returning to a state of stability following a period of instability or stress. Bintz and Nixon (2001) have demonstrated that seed production in eelgrass increases as light levels decrease. However, luminosity data for the Sept-Îles eelgrass bed (Table 1) do not reveal a relationship in this regard.

Other factors may also influence this proportion. Disruptions caused by winter ice, for example, could have an impact on the reproductive strategy adopted (Robertson and Mann 1984). Biotic factors such as grazing by migratory birds could also have an effect (Rivers and Short 2007). The physical location of shoots within a particular eelgrass bed appears to play a role in determining the number of reproductive shoots (Olesen and Sand-Jensen 1994; Billingham et al. 2003; Grant and Provencher 2007; Harwell and Rhode 2007). According to Meling-López and Ibarra-Obando (2003), eelgrass allocates more energy to sexual (i.e., via seeds) reproduction in intertidal zones than in subtidal zones within the same bed. This phenomenon could have an influence on the results for most of the monitord eelgrass beds with the exception of the Magdalen Islands, where the bed is entirely subtidal.

3.1.4 FISHING AT EELGRASS BEDS

Twenty-two fish species in seven genera were identified from minnow seine and hoop net captures in the six eelgrass beds (Appendices 3 and 4). The greatest number of species (21) was captured at Sept-Îles, and the least (13) at Cacouna. Concerning the other beds, 15 species were captured at Bassin aux Huîtres, 17 at Penouille, 14 at Rimouski, and 20 at St-Jean.

Of all the species collected, only *Gasterosteus* spp. was found at all beds and in every catch (Appendices 3 and 4). Other species were captured at all of the beds but not in every sample or every year. Three other species were found at most of the eelgrass beds, including two species of stickleback, *Apeltes quadracus* and *Pungitius pungitius*, and one flounder species, *Pseudopleuronectes americanus.* A number of other species were collected at only one eelgrass bed. For example, *Salvelinus fontinalis* was captured only at the St-Jean site and *Pholis gunnellus* only at Bassin aux Huîtres.

Of the species captured, four are in a precarious situation according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or under the Quebec Act respecting threatened or vulnerable species: *Anguilla rostrata*, *Gadus morhua*, *Morone saxatilis* and *Osmerus mordax* (southern St. Lawrence Estuary population). Identification of juveniles of *Gadus morhua* (Éric Parent[9], pers. comm., October 2010) was carried out using genetics. In addition, genetic tests confirmed that more than 97% of *Osmerus mordax* at the Rimouski site were from the southern St. Lawrence Estuary population (Marie-Andrée Godboult[10], pers.

[9] Éric Parent, Genetics Technician, DFO, Mont-Joli.
[10] Marie-Andrée Godboult, Master's Student, Université Laval, Quebec City.

comm., February 2008). Other species may be present in the eelgrass beds but were not captured because of the selectivity of our sampling gear.

The principal species collected (Appendices 3 and 4) as part of the Monitoring Network's activities were those reported for the Manicouagan eelgrass bed (Grant and Provencher 2007) and the Kouchibouguac River Estuary in New Brunswick (Joseph et al. 2006) and under CAMP (Weldon et al. 2008, 2009). These species are also found at other eelgrass beds along the Atlantic coast, although in differing proportions and in association with other species (Heck et al. 1989; Mattila et al. 1999; Lazzari et al. 2003).

3.1.4.1 Seine Fishing

A total of 19 species in five different genera were collected by seine at the various eelgrass beds (Appendix 3). Table 5 displays the ANOVA results concerning the number of species and total fish abundance using the minnow seine with the years and months as the source of variations.

Based on the ANOVA, year and month have no impact on the number of species captured using the seine (Table 5) at the Bassin aux Huîtres bed. Significant differences were noted among June and September for the eelgrass beds at Penouille, Rimouski, St-Jean, and Sept-Îles. A significant interannual difference was also observed at Rimouski and Sept-Îles. At Penouille and St-Jean, the number of species in September was generally higher than in June. The seasonnal differences were less apparent at Rimouski. In fact, the only significant differences here in the number of species occurred between September 2007 and June and September 2009. Differences were observed at Sept-Îles in June 2008, September 2009, and June and September 2010, when results revealed a higher number of species than for the other samplings. No significant differences were observed at Cacouna among the three sampling years, i.e., the number of species remained constant among years. The eelgrass bed where the highest number of species was captured was Sept-Îles in June 2008 (8.3 species ± 0.9). The Rimouski bed exhibited the fewest species, in September 2009 (1.0 species ± 0.0) (Figure 4).

The eelgrass bed with the highest total abundance (Figure 5) was the St-Jean site, in June 2010 (3,146 individuals ± 1,408), while the bed with the lowest total abundance was at Sept-Îles, in September 2007 (3.5 individuals ± 0.3). Based on ANOVA (Table 5), only 2005 was significantly different from the others at the Bassin aux Huîtres eelgrass bed: when abundance was greater than in all other years, although significantly different only in relation to 2007 (Figure 5). Significant seasonal differences were noted at Penouille, Rimouski, St-Jean, and Sept-Îles. At Penouille and St-Jean, the catches were generally higher in June than in September. At Rimouski the catches were higher in September. At Sept-Îles, threre was no clear pattern (Figure 5): during the first two years, there was no significant difference between June and September, while inn 2007, 2009, and 2010, the total number of fish captured at Sept-Îles was higher in June than in September. A significant interannual difference was also observed at Rimouski, St-Jean, and Sept-Îles. At Rimouski, the total abundance in 2006, 2007, and 2009 was significantly higher than in other years. At the St-Jean eelgrass bed, the catches were higher in 2006, 2007, and 2010. The catches at Sept-Îles were highest in the first two years, 2005 and 2006.

Based on PERMANOVA (

Table 6) carried out on the entire seine catch at all six eelgrass beds monitored, only the Cacouna bed exhibited significant interannual differences. MDS (Figure 6) revealed that 2008 was more different than the two other years. This was based mainly on the lower abundance of *Gasterosteus* spp. in 2008 (average 30.8 individuals) in comparison to values for 2009 (383.1 individuals) and 2010 (95.7 individuals) (Table 8). At Bassin aux Huîtres, Penouille, Rimouski, St-Jean, and Sept-Îles, MDS reveals clear distinctions between June and September (Figure 6). Dissimilarity analysis (Table 7) showed a percentage of dissimilarity between the indices for June and September ranging between 69.2% and 82.9%. At Bassin aux Huîtres, the dissimilarity between months is attributable to four species: *Apeltes quadracus*, *Fundulus* spp., and *Menidia menidia*, which are more abundant in September than in June, and *Gasterosteus* spp., which is more abundant in June than in September. At the Penouille, Rimouski, and St-Jean eelgrass beds, the differences are due primarily to two species, *Gasterosteus* spp. and *Apeltes quadracus.* At Penouille and St-Jean, *Gasterosteus* spp. is much more abundant in June (average 1,321.0 at Penouille and 1,448.5 at St-Jean) than in September (68.3 and 176.3 individuals respectively). At Rimouski, *Gasterosteus* spp. is much more abundant in September (average 862.1 individuals) than in June (142.0 individuals). The other species, *Apeltes quadracus,* is more abundant in September than in June at Penouille and Rimouski. The inverse is true at St-Jean. Seven different species contribute to the dissimilarity at Sept-Îles (Table 7). Four of these, *Gasterosteus* spp., *Pseudopleuronectes americanus*, *Myoxocephalus* spp., and *Gadus morhua*, are more abundant in June than in September. The other three, *Apeltes quadracus, Microgadus tomcod*, and *Liopsetta putnami*, are more abundant in September. It is to be noted that the first two species, *Gasterosteus* spp. and *Apeltes quadracus*, contribute to 83.2% of the dissimilarity (accounting for 58.1% and 25.1%, respectively). The nesting of months is much more significant at Rimouski (Figure 6) insofar as the percentage of dissimilarity is lower at that site.

3.1.4.2 Hoop Net Fishing

A total of 18 species from seven genera and one family were captured using the hoop net between 2006 and 2010 (Appendix 4). Table 9 displays the ANOVA results concerning the number of species and total fish abundance using the hoop net with the years and months as the source of variations.

The eelgrass bed where the greatest number of species was collected was the Bassin aux Huîtres site, in September 2009 (10.3 species ± 0.3), while the Rimouski bed had the fewest species, in September 2006 (3.1 species ± 0.4) (Figure 7). No significant differences in the number of species were observed for the beds at St-Jean, Sept-Îles and Cacouna (Table 9). Highly significant seasonal differences were noted at the Bassin aux Huîtres eelgrass bed (Figure 7). This was most evident between the months of September 2009 (10.3 species ± 0.3) and September 2010 (6.7 species ± 0.3). There was also a slight interannual difference, with more species observed in 2009 than in 2010. Significant seasonal differences were also seen at Penouille due mainly to the values for June 2007 (6.0 species ± 1.0) and September 2010 (9.3 species ± 0.3). A significant interannual difference was also noted at Penouille, particularly between 2007 and 2008. Only one significant difference in this regard was observed at Rimouski, between 2006 (3.1 species ± 0.4) and 2010 (5.6 species ± 0.2).

The St-Jean eelgrass bed exhibited the highest total abundance, with an average of 19,467.3 individuals (± 3470.8) in June 2008, and the lowest total abundance, with an average of 72.7 individuals per hoop net (± 19.9) (Figure 8) in September 2006. Table 9 shows the ANOVA results for total abundance in relation to hoop net fishing. No significant seasonal or interannual differences were noted at the Bassin aux Huîtres eelgrass bed. Significant seasonal differences were noted at the Penouille bed, where more fish were generally found in June than in September (Figure 8). That site also exhibited a slight interannual difference, with higher abundance noted in 2007 and 2009. Highly significant interannual and seasonal differences were observed at Rimouski. The primary source of interannual variations was the difference observed between 2006 (high abundance) and 2010 (low abundance). In terms of seasonal comparisons, the greatest differences were noted between June 2006 and September 2009, and September 2008, 2009, and 2010 (Figure 8). The significant difference at the St-Jean eelgrass bed was clearly between the months of June and September for each year, with much greater abundance generally observed in June. As for interannual differences, the most notable year was 2006 with its particularly low abundance (fewer than 5,000 individuals on average). Only seasonal differences were significant at Sept-Îles, although no clear pattern could be identified. Abundance was generally higher in June, with the exception of 2009, and the only significant differences were noted between September 2006, September 2007, and June 2006. No significant interannual differences were observed at the Cacouna eelgrass bed.

Based on PERMANOVA (

Table 10) applied to the catch matrices for the hoop net catches, none of the eelgrass beds exhibited significant interannual differences, which is in keeping with the results obtained with the minnow seine, where no significant interannual differences were identified except at the Cacouna bed. Significant differences between the months of June and September were noted for the eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, St-Jean, and Sept-Îles. MDS (Figure 9) revealed that the fish assemblage at these sites was relatively distinct when comparing the months of June and September. The dissimilarity between months ranges between 67.6% at Rimouski and 90.4% at Penouille (Table 11). The dissimilarity between months of 74.2% at Bassin des Huîtres is due mainly to four species: *Fundulus* spp., *Gasterosteus* spp., *Menidia menidia*, and *Apeltes quadracus*. *Fundulus* spp., which contributes 38.6% of the dissimilarity, is more abundant in September (3,616.8 individuals) than in June (630.8 individuals). The same trend was observed for *Menidia menidia* (contributing 26.7%), with average abundance of 2,760.8 individuals in September compared with 240.5 individuals in June. *Gasterosteus* spp. and *Apeltes quadracus* exhibited greater abundance in June than in September. At the Penouille eelgrass bed, five species contributed to the dissimilarity of 90.4% between months (Table 11). The species making the greatest contribution in this regard (72.6%) was *Gasterosteus* spp., which was more abundant in June, with an average of 7,704.0 individuals, than in September, with 225.9 individuals. Two species, *Menidia menidia* and *Ammodytes* spp., were sampled in large quantities (averages of 345.8 and 268.5, respectively) at the Penouille eelgrass bed in

September but were practically absent in June. The dissimilarity between the months of June and September at the Rimouski eelgrass bed was 67.6%, with two species contributing to this difference. One, *Gasterosteus* spp., was more abundant in September, with an average of 3,342.8 individuals, than in June, with 2,696.7 individuals. The other, *Osmerus mordax*, was much more abundant in June, with an average of 1,908.7 individuals, in comparison with 125.3 individuals in September. Dissimilarity was 89.8% at the St-Jean eelgrass bed, where the same two species contributed to this phenomenon as for the minnow seine catches: *Gasterosteus* spp. and *Apeltes quadracus*. As with the minnow seine catches, *Gasterosteus* spp. was more abundant in June and *Apeltes quadracus* in September. At Sept-Îles, dissimilarity of 81.7% between the two months was due to five species. The species contributing the most to this dissimilarity was *Gasterosteus spp.*, with average abundance of 1,101.6 individuals in June and just 69.2 individuals in September. As at the Penouille eelgrass bed, *Ammodytes spp.* was present in high numbers in September (444.1 individuals) but practically absent in June (0.2 individuals).

Several analogies may be made when comparing the species contributing the most to dissimilarity between the months of June and September between the minnow seine and hoop net catches (Tables 7 and 11). The same species contributed to the dissimilarity at the Bassin aux Huîtres and St-Jean eelgrass beds, although not in the same order. At the Penouille eelgrass bed, in addition to the two species present in the seine catches (*Gasterosteus* spp. and *Apeltes quadracus*), three other species were also dominant in the hoop net catches: *Menidia menidia, Ammodytes* spp., and *Fundulus* spp. At the Rimouski bed, the dominant species was: *Gasterosteus* spp. However, *Osmerus mordax* took the place of *Apeltes quadracus* as second most dominant in the hoop net catches. At Sept-Îles, three of the species contributing the most to the dissimilarity were the same: *Gasterosteus* spp., *Apeltes quadracus*, and *Microgadus tomcod*. *Ammodytes* spp. and *Osmerus mordax* were the additional species contributing to the dissimilarity in the hoop net catches, while *Pseudopleuronectes americanus*, *Myoxocephalus* spp., *Liopsetta putnami*, and *Gadus morhua* were the additional species in this respect in the minnow seine catches. The slight differences between the seine and hoop net catches at the Penouille, Rimouski, and Sept-Îles eelgrass beds in terms of the dominant species may likely be attributed to the greater effectiveness of hoop net fishing. With its longer time in the water, the hoop net is more suited for capturing highly mobile species such as *Osmerus mordax* and *Ammodytes spp.* at eelgrass beds that are fully exposed at low tide.

3.1.4.3 Size Classes of Dominant Species

Size class is a good indicator of the types of uses that fish make of eelgrass beds. For example, a high proportion of large individuals may indicate use for reproduction; a significant proportion of small individuals could indicate use as a nursery; and similar proportions of fish of various sizes could indicate use for food during the various life stages of a species. Interannual differences could reflect a change in the environment or in reproductive success among the species under study.

Tables 12 to 14 show the PERMANOVA results for the size class matrices for the dominant species. These specieswith sufficient numbers for statistical analysis for the most sites, are *Apeltes quadracus*, *Gasterosteus* spp., and *Osmerus mordax*. The average lengths measured for all species and the number of individuals counted (N) are provided in Appendices 5 and 6.

As Table 12 illustrates, there was no significant interannual difference for *Apeltes quadracus*, which was present in the seine catches at all eelgrass beds. However, this species did exhibit significant seasonal differences: generally speaking, the specimens from this species were larger in June than in September at all eelgrass beds (Figures 10 to 14).

With regard to hoop net catches of *Apeltes quadracus*, Table 12 reveals no significant seasonal or interannual differences in size class at the Bassin aux Huîtres bed (Figure 15). Only seasonal differences were noted for the other three eelgrass beds at Penouille, St-Jean, and Sept-Îles. At all three sites, specimens of *Apeltes quadracus* were larger in June than in September (Figures 16 to 18). The fact that size classes were larger in June than in September for most of the eelgrass beds and interannual comparisons regardless of the type of fishing gear (seine or hoop net) could indicate that the individuals present in June were mainly adults possibly using the eelgrass beds for reproduction while the majority of the individuals found in September were juveniles.

Table 13 shows the PERMANOVA results for the size class matrices of *Gasterosteus spp.* present in the seine and hoop net catches at the various eelgrass beds. Significant differences were again noted for seasonal, but never for interannual, for the eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, St-Jean, and Sept-Îles. These differences were associated with both the seine and the hoop net catches. The size classes at all eelgrass beds were always larger in June than in September (Figure 19 to Figure 23, 25 to 29). At Cacouna, no interannual differences were observed concerning the size classes of this species regardless of the fishing gear used, seine or hoop net (Figures 24 and 30). Like the species *Apeltes quadracus*, adult and juvenile *Gasterosteus* spp. appear to use the eelgrass beds for reproduction in June and for growth in September. Visual evidence (males in breeding colours, gravid females) confirmed that adults were using the beds as breeding sites in June. The adults of this species are frequently found in eelgrass beds, where they make their nests out of plant debris, especially leaves of the genus *Zostera* (Scott and Scott 1988; Polte and Asmus 2006b).

Table 14 shows the PERMANOVA results for size classes for *Osmerus mordax* present in hoop net catches. No significant interannual differences were observed at the Penouille, Rimouski, and Sept-Îles eelgrass beds (Figures 31 to 34). However, significant seasonal differences were recorded at all three of these sites. For example, *Osmerus mordax* individuals were found in larger size classes in September than in June in most years at all three beds. This likely reflects growth in that species during the summer period. Moreover, adults enter their breeding period in June, which typically takes place in rivers and streams, and so are not found in estuaries. Juveniles (0+ and 1 year) are much more common in estuaries at this time (Scott and Scott 1988), possibly explaining why the size classes were smaller in June than in September. Significant interannual differences were noted at the Cacouna bed. As shown in Figure 33, individuals collected in 2009 were in larger size classes than those collected in 2008 or 2010.

At the Rimouski eelgrass bed (Figure 32), the majority of specimens of *Osmerus mordax* were less than 120 mm long, except in 2010, when nearly 30% of individuals exceeded that size. The 120 mm length corresponds to sexual maturity in males of that species (Guy Verrault[11], pers. comm., January 2009). Given that males reach sexual maturity before females (Guy Verrault, pers. comm., January 2009), it might be supposed that, with the exception of 2010, more than 90% of individuals measured in June and 77% to 97% of specimens measured in September were immature. Comparisons using data from control samples of various known ages (Ministère des Ressources naturelles et de la Faune du Québec) from the southern estuary population and data collected for September at Rimouski suggest that 55% of the individuals captured at Rimouski may have been 0+ juveniles, 30% 1+ juveniles, and 15% adults (Pierre Pettigrew[12], pers. comm., February 2009). The presence of immature individuals in June and September may indicate the presence of a spawning site in the vicinity of the eelgrass bed, since spawning takes place in the spring in rivers and immature individuals use the beds as a growing site. This information is especially important in that eelgrass beds are used as a habitat by a vulnerable population of smelt, according to the Ministère des Ressources naturelles et de la Faune du Québec (see section 2.4.2) and no spawning sites are known to be located nearby (Équipe de rétablissement de l’éperlan arc-en-ciel 2008).

At the Sept-Îles eelgrass bed (Figure 33), a large proportion of the *Osmerus mordax* individuals measured were in a size class smaller than 125 mm, meaning that they were likely immature. In September 2007 and June 2008, however, the majority of individuals at this site were larger than 125 mm, which tends to demonstrate that the eelgrass bed is also frequented by adults. At the Penouille bed (Figure 31), most of individuals in 2007 were smaller than 125 mm, indicating a significant proportion of immature fish in June and September. In June 2008 and 2010, on the other hand, 100% of the individuals measured were smaller than 120 mm, while in September 2008, 2009, and 2010, more than 97% of the individuals were in larger than 120 mm. Thus it appears that juveniles frequent the Penouille eelgrass bed in June and adults in September. At Cacouna (Figure 34), 50% of *Osmerus mordax* individuals collected in autumn 2008 and 2010 were smaller than or equal to 120 mm. This corresponds to the size of the adult males in the southern estuary population. In September 2009, more than 75% of the individuals captured at Cacouna exceeded 125 mm in size.

Based on these results, it can be argued that a high proportion of *Osmerus mordax* juveniles, coming from nearby spawning sites use the Rimouski and Sept-Îles eelgrass beds as growing and feeding sites. Meanwhile, juveniles and adults appear to use the habitats at the Penouille and Cacouna sites in equal proportions.

4 CONCLUSION

Eelgrass leaves show greater seasonal variation than interannual, due probably to annual growth. The number of fruit-bearing shoots as a proportion of the number of vegetative shoots

[11] Guy Verrault, Biologist, Ministère des Ressources naturelles et de la Faune du Québec, Rivière-du-Loup.
[12] Pierre Pettigrew, Biologist, Ministère des Ressources naturelles et de la Faune du Québec, Rivière-du-Loup.

demonstrates a significant decrease in this ratio only at the Sept-Îles eelgrass bed. Variations in this regard could suggest a reduction of stress factors at Sept-Îles. The same proportion at the other eelgrass beds does not reveal any interannual trends, indicating that these beds have not been subjected to significant stress factors. It can therefore be presumed that all six of the eelgrass beds monitored between 2005 and 2010 are relatively stable. However, sampling activities, including measurement of bed surface area and plant density, are likely required on a larger scale to enable monitoring of changes in the eelgrass beds.

The two parameters measured on the eelgrass shoots, length and reproduction mode, are related to physico-chemical factors such as the amount of light energy available for photosynthesis and temperature. However, since two physico-chemical factors were monitored during this study, it is difficult to identify essential factors for maintaining the health of eelgrass beds. Additional factors, listed in sections 2.2 and 2.3, likely play a significant role, along with temperature and light, in the health of these beds.

More than 25 different fish species were found at the six eelgrass beds under study taking into account both the seine and the hoop net catches. Differences in the variables measured in this regard were much more significant month over month than year over year. This provides further support for the notion that the eelgrass beds sampled were relatively stable and providing comparable habitats from one year to the next. Interannual differences became more numerous and highly significant only in terms of the total abundance of individuals present in the seine and hoop net catches. These differences were probably due to annual cyclic variations in the abundance of certain species or to the limitations of our sampling activities.

The species *Gasterosteus* spp., *Fundulus* spp., *Apeltes quadracus, Menidia menidia and Osmerus mordax* were consistently present and dominant during the two sampled periods at one or more of the eelgrass beds monitored. Each of these species uses this habitat to suit its particular needs. For example, *Gasterosteus* spp. and *Apeltes quadracus* appear to use the eelgrass beds in June for reproduction and in September for juvenile growth. *Osmerus mordax*, meanwhile, appears to use the eelgrass beds as a growing site.

Other species, are also associated with the various eelgrass beds and help to enhance the biodiversity of this habitat. These species, including *Clupea harengus*, *Pseudopleuronectes americanus*, and *Salvelinus fontinalis*, are considered permanent residents (Hemminga and Duarte 2000) during the summer season. At the eelgrass beds under study, the presence was also noted of sentinel fish, or fish that serve as indicators of environmental or ecological changes (Couillard 2009), such as *Gasterosteus* spp. and *Fundulus* spp. (Couillard and Nellis 1999; Pottinger et al. 2002). The presence of more vulnerable and fragile species such as *Anguilla rostrata*, *Osmerus mordax*, *Gadus morhua*, and *Menidia menidia* lends still more credence to the hypothesis that the eelgrass beds are in stable condition (Castonguay et al. 1994; Robinet and Feuteun 2002; Caron et al. 2007; Équipe de rétablissement de l'éperlan arc-en-ciel du Québec 2009; Warren *et al.* 2010). A change in the conditions observed at the eelgrass beds would likely have significant impact on the communities found there (e.g., disappearance of certain more fragile species to the benefit of opportunistic species).

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Table 1: Descriptive statistics for temperature and luminosity recorded with Hobo sensors in different eelgrass beds. Note: The average temperature and luminosity calculated using data collected from June to September.

Eelgrass bed	**Year**	**Average Temperature (±SE) (°C)**	**Minimum Temperature (°C)**	**Maximum Temperature (°C)**	**Average Luminosity (±SE) (Lux[13])**	**Maximum Luminosity (Lux)**
Bassin aux Huîtres	2005	20.43 (0.01)	14.52	26.20	3407(69)	126756
	2006	19.82 (0.02)	11.53	30.86	4960 (99)	126756
	2007	18.26 (0.03)	6.88	38.38	2171(40)	104711
	2009	19.27 (0.03)	10.75	29.25	3287 (52)	126756
	2010	20.18 (0.02)	7.38	28.06	5274 (82)	126756
Penouille	2007	17.52 (0.03)	10.16	28.56	4182 (68)	121245
	2008	19.20 (0.03)	11.92	31.88	7517 (147)	115734
	2009	18.45 (0.03)	7.58	32.29	1260 (49)	121245
	2010	17.97 (0.03)	8.18	28.26	5084 (85)	126756
Rimouski	2005	15.73 (0.03)	6.27	34.80	12688 (156)	126756
	2006	15.42 (0.02)	5.55	35.01	9698(115)	126756
	2007	14.01 (0.02)	5.76	27.86	9316(165)	126756
	2008	14.73 (0.03)	5.14	32.29	3049 (68)	126756
	2009	14.16 (0.04)	4.62	31.27	10012 (199)	126756
	2010	13.68 (0.04)	5.14	29.35	7420 (172)	126756
St-Jean	2005	17.74 (0.02)	9.08	33.54	8208 (123)	126756
	2008	16.07 (0.04)	7.28	30.15	4533 (98)	121245
	2009	16.19 (0.02)	12.98	30.05	4754 (92)	9300
	2010	16.00 (0.03)	7.20	30.10	3859(75)	101060
Sept-Îles	2005	16.35 (0.02)	4.10	35.33	9479(123)	126756
	2006	22.54 (0.01)	11.63	39.96	8369(132)	35822
	2007	16.30 (0.02)	4.10	35.30	10434 (148)	103430
	2009	15.64 (0.04)	0.56	46.98	6180 (110)	126756
	2010	17.23 (0.04)	1.66	39.28	9447(164)	126756
Cacouna	2008	14.11 (0.04)	2.73	35.33	10575 (229)	126756
	2009	16.49 (0.06)	7.18	46.85	4755 (125)	126756
	2010	15.14 (0.03)	6.67	30.26	8415 (139)	126756

[13] Lux = Luminous flux of 1 lumen (lm) covering an area of 1 square meter; 1 Lux = 1 lm/m^2.

Table 2: ANOVAs showing the annual and monthly effects on the length of eelgrass leaves (Log+1). **P<0.01, ***P<0.001, ns = not-significant.

Eelgrass bed	Source of Variation	df	Mean square	F
Bassin aux Huîtres	Year	4	0.105	2.20^{ns}
(2005 to 2007, 2009, 2010)	Month(Year)	5	0.210	4.39**
	Error	32	0.048	
Penouille	Year	3	0.434	8.73 ***
(2007 to 2010)	Month(Year)	4	0.466	9.36 ***
	Error	27	0.049	
Rimouski	Year	5	0.704	13.26***
(2005 to 2010)	Month(Year)	6	0.883	16.63***
	Error	36	0.053	
rivière St-Jean	Year	3	0.440	22.99**
(2005, 2008 to 2010)	Month(Year)	4	0.517	26.41***
	Error	28	0.066	
Sept-Îles	Year	4	0.063	1.41 ^{ns}
(2005 to 2008, 2010)	Month(Year)	5	0.213	4.77**
	Error	26	0.044	
Cacouna	Year	1	0.931	7.10 **
(2009, 2010)	Month(Year)	2	0.300	2.29 ^{ns}
	Error	23	0.131	

Table 3: Results from stepwise multiple regression analyses between the maximum lengths of leaves in September (log+1) and the different physical variables (log+1) (see section 1.4.1). Variables are presented according to the order in which they were entered in the model. R^2= 0.28; N=25; * P<0.05.

Variable	**Regression coefficent**	**Standard error**	**t-Statistic**	**Standardized regression coefficients**	**Partial R^2**
Maximal Temperature	-0.84	0.44	-1.90*	-0.34	0.17
Average Temperature	-0.87	0.39	-2.20*	-0.39	0.11
Intercept	11.07	1.84	6.01		

Table 4: ANOVAs showing annual effects on the proportion of seed stems/vegetative stems (ARCSIN). *** P<0.001, ns = not-significant.

Eelgrass beds	**Source of variation**	**df**	**Mean square**	**F**
Bassin aux Huître	Year	2	264.8	1.36^{ns}
(2007,2009, 2010)	Error	12	195.2	
Cacouna	Year	1	568.4	3.88^{ns}
(2009, 2010)	Error	10	146.4	
Penouille	Year	3	395.6	1.28^{ns}
(2007 to 2010)	Error	14	309.1	
Rimouski	Year	4	252.8	1.89^{ns}
(2006 to 2010)	Error	16	134.02	
rivière St-Jean	Year	2	200.6	1.21^{ns}
(2008 to 2010)	Error	12	165.7	
Sept-Îles	Year	3	696.4	37.1***
(2006 to 2008, 2010)	Error	11	18.7	

Table 5: ANOVAs showing the annual and monthly effects on the number of species (S: log+1) and total abundance (N: log+1) of catches made using seines. * P<0.05, **P<0.01, ***P<0.001, ns = not-significant. BaH: Bassin aux Huîtres.

Variable	Eelgrass bed	Source of variation	df	Mean square	F
S	BaH	Year (2005 to 2007, 2009, 2010)	4	0.057	0.99 ns
		Month(Year)	5	0.110	1.89ns
		Error	21	0.058	
	Penouille	Year (2007 to 2010)	3	0.015	0.31 ns
		Month(Year)	4	0.229	4.39*
		Error	16	0.052	
	Rimouski	Year (2005 to 2010)	5	0.225	3.73*
		Month(Year)	6	0.189	3.13*
		Error	25	0.060	
	r. St-Jean	Year (2005 to 2010)	5	0.081	1.73 ns
		Month(Year)	6	1.045	22.14***
		Error	25	0.047	
	Sept-Îles	Year (2005 to 2010)	5	0.870	39.83***
		Month(Year)	5	0.226	10.35***
		Error	22	0.021	
	Cacouna	Year (2008 to 2010)	2	0.106	1.73 ns
		Error	19	0.082	
N	BaH	Year (2005 to 2007, 2009, 2010)	4	4.77	8.84**
		Month(Year)	5	1.26	1.35 ns
		Error	21	0.93	
	Penouille	Year (2007 to 2010)	3	1.20	2.09 ns
		Month(Year)	4	9.14	15.91***
		Error	16	0.57	
	Rimouski	Year (2005 to 2010)	5	9.03	18.30***
		Month(Year)	6	6.66	13.49***
		Error	25	0.49	
	r. St-Jean	Year (2005 to 2010)	5	1.90	3.51*
		Month(Year)	6	5.93	10.89***
		Error	24	0.54	
	Sept-Îles	Year (2005 to 2010)	5	7.37	33.77***
		Month(Year)	5	2.11	9.68***
		Error	22	0.21	
	Cacouna	Year (2008 to 2010)	2	3.29	1.47 ns
		Error	19	2.24	

Table 6: Permutation multivariate analyses (PERMANOVA) showing the annual and monthly effects on the distance matrix (transformation = $\sqrt[4]{\chi}$) of catch abundance using seines. * P<0.05, **P<0.01, ***P<0.001, ns = not-significant.

Eelgrass bed	Source of variation	df	Mean square	Pseudo-F
BaH	Year (2005 to 2007, 2009, 2010)	4	1392,1	1,19 ns
	Month(Year)	5	1164,0	3,29***
	Error	21	353,5	
Penouille	Year (2007 to 2010)	3	857,7	0,47 ns
	Month(Year)	4	1827,0	7,67***
	Error	16	238,0	
Rimouski	Year (2005 to 2010)	5	1731,3	1,01 ns
	Month(Year)	6	1709,2	10,40***
	Error	25	164,3	
r. St-Jean	Year (2005 to 2010)	5	442,2	0,13 ns
	Month(Year)	6	3270,8	18,22 ***
	Error	25	179,4	
Sept-Îles	Year (2005 to 2010)	5	5029,3	1,67 ns
	Month(Year)	5	3011,3	18,81***
	Error	22	160,0	
Cacouna	Year (2008 to 2010)	2	1775,5	6,58***
	Error	8	269,4	

Table 7: Dissimilarity analyses (SIMPER) between June and September showing the species contributing the most and their contribution to the dissimilarity for catches made with minnow seines in different eelgrass beds. The cumulative percentage of dissimilarity after which the species are ignored in the analysis is 95%.

Eelgrass bed	**% of dissimilarity between months**	**Species**	**Average Abundance in June**	**Average Abundance in September**	**Average Dissimilarity**	**Dissimilarity Contribution (%)**
BaH	70.5	*Apeltes quadracus*	72.2	157.7	21.30	30.23
		Fundulus spp.	12.4	352.7	19.45	27.61
		Menidia menidia	42.3	70.6	15.34	21.76
		Gasterosteus spp.	33.9	13.3	9.59	13.61
		Pungitius pungitius	1.5	13.0	3.45	4.89
Penouille	82.9	*Gasterosteus* spp.	1321.0	68.3	76.42	92.1
		Apeltes quadracus	70.9	43.5	4.24	5.11
Rimouski	69.2	*Gasterosteus* spp.	142.0	862.1	63.9	92.4
		Apeltes quadracus	2.5	17.0	2.63	3.8
r. St-Jean	76.0	*Gasterosteus* spp.	1448.5	176.3	69.7	91.7
		Apeltes quadracus	4.6	48.4	3.82	5.0
Sept-Îles	78.4	*Gasterosteus* spp.	76.5	54.3	45.6	58.1
		Apeltes quadracus	15.5	34.0	19.7	25.1
		Microgadus tomcod	0.0	2.5	3.2	4.0
		P. americanus	1.9	0.3	2.7	3.4
		Myoxocephalus sp.	0.9	0.4	1.4	1.8
		Liopsetta putnami	0.5	0.7	1.3	1.7
		Gadus morhua	0.5	0.1	0.9	1.2

Table 8: Dissimilarity analyses (SIMPER) between 2008, 2009, and 2010 showing the species contributing the most and their contribution to the dissimilarity for the catches made with minnow seines for eelgrass beds at Cacouna. The cumulative percentage of dissimilarity after which the species are ignored in the analysis is 95%.

% of Dissimilarity between years	**Species**	**Average Abundance**	**Average Abundance**	**Average Dissimilarity**	**Dissimilarity Contribution (%)**
		2008	**2009**		
75,4	*Gasterosteus* spp.	30.8	383.1	63.7	84.4
	Pungitius pungitius	1.4	5.4	7.1	9.5
	Apeltes quadracus	0.3	1.3	2.9	3.8
		2008	**2010**	49.6	89.8
55,2	*Gasterosteus* spp.	30.8	95.7	3.0	5.4
	Pungitius pungitius	1.4	2.0		
		2009	**2010**		
75,4	*Gasterosteus* spp.	383.1	95.7	68.0	90.2
	Pungitius pungitius	5.4	2.0	3.3	4.5
	Apeltes quadracus	1.3	0.0	1.6	2.1

Table 9: Variance analyses (ANOVA) showing the annual and monthly effects on the number of species (S: log+1) and total abundance (N: log+1) of catches made using hoop nets. * P<0.05, **P<0.01, ***P<0.001, ns = not-significant. BaH: Bassin aux Huîtres.

Variable	Eelgrass bed	Source of variation	df	Mean square	F
S	BaH	Year (2009, 2010)	1	0.033	5.79*
		Month(Year)	2	0.123	21.35***
		Error	8	0.005	
	Penouille	Year (2007 to 2010)	3	0.068	3.62*
		Month(Year)	4	0.067	3.56*
		Error	16	0.018	
	Rimouski	Year (2006 to 2010)	4	0.196	3.04*
		Month(Year)	5	0.058	0.91 ns
		Error	20	0.064	
	r. St-Jean	Year (2006 to 2010)	4	0.069	1.36 ns
		Month(Year)	5	0.107	2.12ns
		Error	20	0.050	
	Sept-Îles	Year (2006 to 2010)	4	0.072	1.02 ns
		Month(Year)	5	0.008	0.12 ns
		Error	20	0.071	
	Cacouna	Year (2008 to 2010)	2	0.021	0.39ns
		Error	15	0.056	
N	BaH	Year (2009, 2010)	1	1.67	3.88 ns
		Month(Year)	2	0.67	1.57 ns
		Error	8	0.43	
	Penouille	Year (2007 to 2010)	3	3.88	5.01*
		Month(Year)	4	5.71	7.37**
		Error	16	0.77	
	Rimouski	Year (2006 to 2010)	4	3.82	8.56***
		Month(Year)	5	4.77	10.67***
		Error	20	0.44	
	r. St-Jean	Year (2006 to 2010)	4	9.64	7.80***
		Month(Year)	5	13.17	10.66***
		Error	20	0.54	
	Sept-Îles	Year (2006 to 2010)	4	1.12	1.81 ns
		Month(Year)	5	4.30	9.68***
		Error	20	0.62	
	Cacouna	Year (2008 to 2010)	2	1.63	0.91ns
		Error	15	1.78	

Table 10: Permutation multivariate analyses (PERMANOVA) showing the annual and monthly effects on the distance matrix (transformation $=\sqrt[4]{\chi}$) of catch abundance using hoop nets. **P<0.01, ***P<0.001, ns = not-significant. BaH= Bassin aux Huîtres.

Eelgrass bed	Source of variation	df	Mean square	Pseudo-F
BaH	Year (2009 to 2010)	1	576.9	0.42 ns
	Month(Year)	2	1357.9	11.2***
	Error	8	120.4	
Penouille	Year (2007 to 2010)	3	1189.5	0.30 ns
	Month(Year)	4	3902.6	13.88***
	Error	16	281.0	
Rimouski	Year (2006 to 2010)	4	993.2	0.80 ns
	Month(Year)	5	1228.5	7.13***
	Error	20	179.2	
r. St-Jean	Year (2006 to 2010)	4	1298.4	0.43 ns
	Month(Year)	5	2953.3	7.47***
	Error	20	395.0	
Sept-Îles	Year (2006 to 2010)	4	1164.6	0.83 ns
	Month(Year)	5	1398.8	4.63 ***
	Error	20	301.6	
Cacouna	Year (2008 to 2010)	2	274.6	0.80 ns
	Error	6	343.1	

Table 11: Dissimilarity analyses (SIMPER) between June and September showing the species contributing the most and their contribution to the dissimilarity for catches made with hoop nets in different eelgrass beds. The cumulative percentage of dissimilarity after which the species are ignored in the analysis is 95%.

Eelgrass bed	**% of dissimilarity between months**	**Species**	**Average abundance in June**	**Average abundance in September**	**Average dissimilarity**	**Dissimilarity contribution (%)**
BaH	74,2	*Fundulus* spp.	630,8	3616,8	28,6	38,6
		Gasterosteus spp.	2362,0	189,0	22,0	29,7
		Menidia menidia	240,5	2760,8	19,8	26,7
		A. quadracus	154,2	58,0	1,2	1,6
Penouille	90,4	*Gasterosteus* spp.	7704,0	225,9	65,6	72,6
		Menidia menidia	0,1	345,8	6,9	7,6
		A. quadracus	607,9	34,4	5,7	6,3
		Ammodytes spp.	0,1	268,5	5,6	6,2
		Fundulus spp.	6,1	166,8	0,5	3,8
Rimouski	67,6	*Gasterosteus* spp.	2696,7	3342,8	40,9	60,6
		Osmerus mordax	1908,7	125,3	25,9	38,4
r. St-Jean	89,8	*Gasterosteus* spp.	13135,2	538,7	82,3	91,6
		A. quadracus	221,7	240,7	4.7	5,2
Sept-Îles	81,7	*Gasterosteus* spp.	1101,6	69,2	51,8	63,4
		Ammodytes spp.	0,2	444,1	15,0	18,3
		A. quadracus	41,4	70,2	5,3	6,5
		Osmerus mordax	51,0	43,6	4,4	5,4
		M. tomcod	60,5	31,2	3,8	4,7

Table 12: Permutation multivariate analyses (PERMANOVA) showing the annual and monthly effects on the distance matrix of size classes of *Apeltes quadracus* caught using seines or hoop nets. **P<0.01, ***P<0.001, ns = not-significant.

Gear	Eelgrass bed	Source of variation	df	Mean square	Pseudo-F
Seine	BaH	Year (2005 to 2007; 2009, 2010)	4	718.2	0.22 ns
		Month(Year)	5	3130.0	7.71***
		Error	21	1405.8	
	Penouille	Year (2007 to 2010)	3	945.8	0.32 ns
		Month(Year)	4	2907.6	6.00 **
		Error	16	484.0	
	Rimouski	Year (2005, 2007, 2008)	2	3085.2	0.53 ns
		Month(Year)	3	5988.2	5.33 ***
		Error	9	1121.8	
	r. St-Jean	Year (2007 to 2010)	3	1886.9	0.67 ns
		Month(Year)	4	2817.1	3.30 ***
		Error	12	851.9	
	Sept-Îles	Year (2005 to 2007)	2	1057.7	0.32 ns
		Month(Year)	3	3313.0	5.43 **
		Error	9	609.0	
Hoop net	BaH	Year (2009-2010)	1	461.6	0.12 ns
		Month(Year)	2	3682.2	1.75 ns
		Error	8	2099.7	
	Penouille	Year (2007-2010)	2	1911.1	0.54 ns
		Month(Year)	3	3824.8	8.96 ***
		Error	17	426.6	
	r. St-Jean	Year (2006 to 2010)	4	1956.0	0.62 ns
		Month(Year)	5	3109.5	2.73 ***
		Error	20	1135.0	
	Sept-Îles	Year (2006 to 2009)	3	2850.3	0.68 ns
		Month(Year)	4	4174.9	4.26 ***
		Error	15	978.0	

Table 13**:** Permutation multivariate analyses (PERMANOVA) showing the annual and monthly effects on the distance matrix of size classes of *Gasterosteus spp.* caught using seines or hoop nets. **P<0.01, ***P<0.001, ns = not-significant.

Gear	Eelgrass bed	Source of variation	df	Mean square	Pseudo-F
Seine	BaH	Year (2005 to 2007; 2009 to 2010)	4	3506.3	0.55 ns
		Month(Year)	5	6317.3	5.81***
		Error	18	1085.7	
	Penouille	Year (2007 to 2010)	3	1098.3	0.09 ns
		Month(Year)	4	11736.0	20.31 **
		Error	16	577.5	
	Rimouski	Year (2005 to 2010)	5	1410.4	0.14 ns
		Month(Year)	6	9480.7	11.41 ***
		Error	24	830.6	
	r. St-Jean	Year (2005 to 2010)	5	2875.5	0.22 ns
		Month(Year)	5	12582.0	24.43 ***
		Error	22	514.8	
	Sept-Îles	Year (2005 to 2007, 2009 to 2010)	4	4378.8	0.47 ns
		Month(Year)	3	9440.9	17.86 ***
		Error	13	528.3	
	Cacouna	Year (2008 to 2010)	2	724.7	0.12 ns
		Error	16	1031.1	
Hoop net	BaH	Year (2009 to 2010)	1	2866.8	0.67 ns
		Month(Year)	2	4254.9	5.26 ***
		Error	8	807.9	
	Penouille	Year (2007 to 2010)	3	1842.4	0.19 ns
		Month(Year)	4	9596.8	23.22 ***
		Error	16	413.2	
	Rimouski	Year (2006 to 2010)	4	1896.7	0.21 ns
		Month(Year)	5	8791.7	23.07 ***
		Error	19	380.9	
	r. St-Jean	Year (2005 to 2010)	4	1986.8	0.25 ns
		Month(Year)	5	7794.2	8.38 ***
		Error	20	929.9	
	Sept-Îles	Year (2006 to 2010)	4	1608.9	0.16 ns
		Month(Year)	5	9641.8	29.52 ***
		Error	18	326.5	
	Cacouna	Year (2008 to 2010)	2	393.4	0.48 ns
		Error	12	818.3	

Table 14: Permutation multivariate analyses (PERMANOVA) showing the annual and monthly effects on the distance matrix of size classes of *Osmerus mordax* caught using hoop nets. ***P<0.001, ns = not-significant.

Eelgrass bed	**Source of variation**	**df**	**Mean square**	**Pseudo-F**
Penouille	Year (2007 to 2010)	3	6303.9	0.91 ns
	Month(Year)	3	6418.9	4.22 ***
	Error	10	1520.9	
Rimouski	Year (2006 to 2010)	4	1951.8	0.66 ns
	Month(Year)	5	2933.2	4.01 ***
	Error	19	730.5	
Sept-Îles	Year (2006 to 2010)	4	4020.3	0.61 ns
	Month(Year)	5	6579.5	4.62 ***
	Error	18	1422.4	
Cacouna	Year (2008 to 2010)	2	2734.3	5.58 ***
	Error	12	490.02	

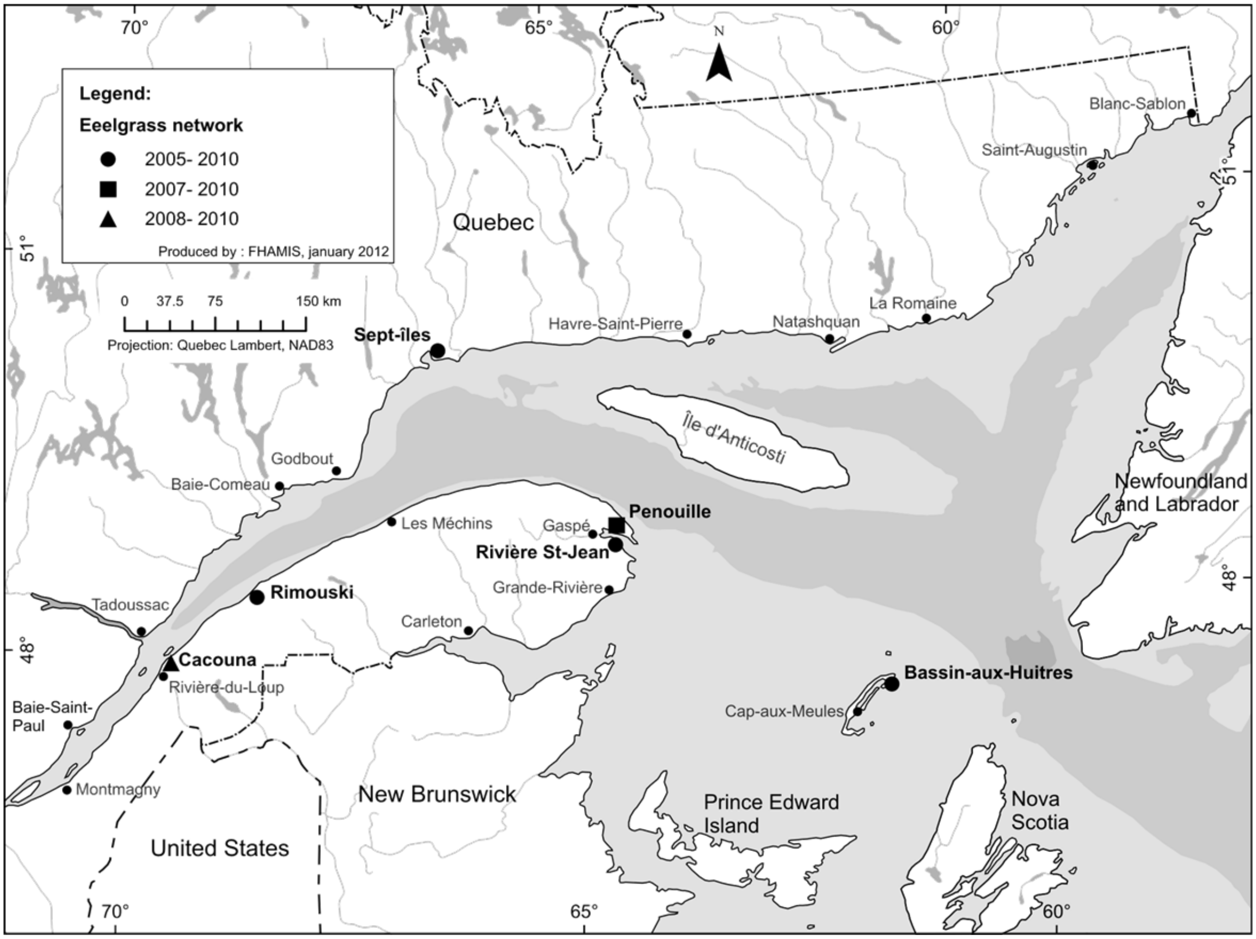


Figure 1: Location of the different eelgrass beds monitored between 2005 and 2010.

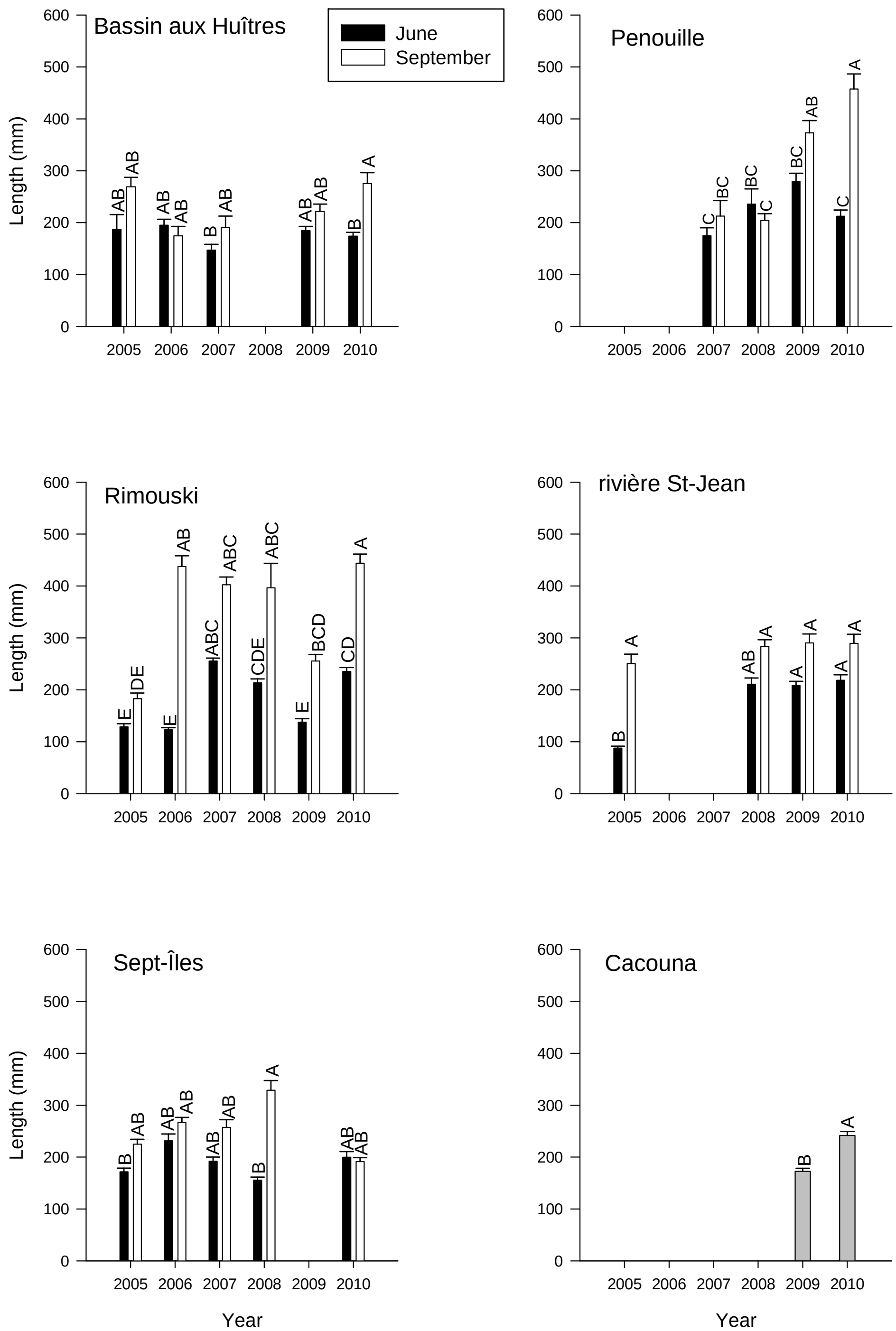


Figure 2: Maximum length (mean ± standard error) of eelgrass leaves measured in June and September for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, and Sept-Îles. For Cacouna, the year factor is significantly different, as shown.

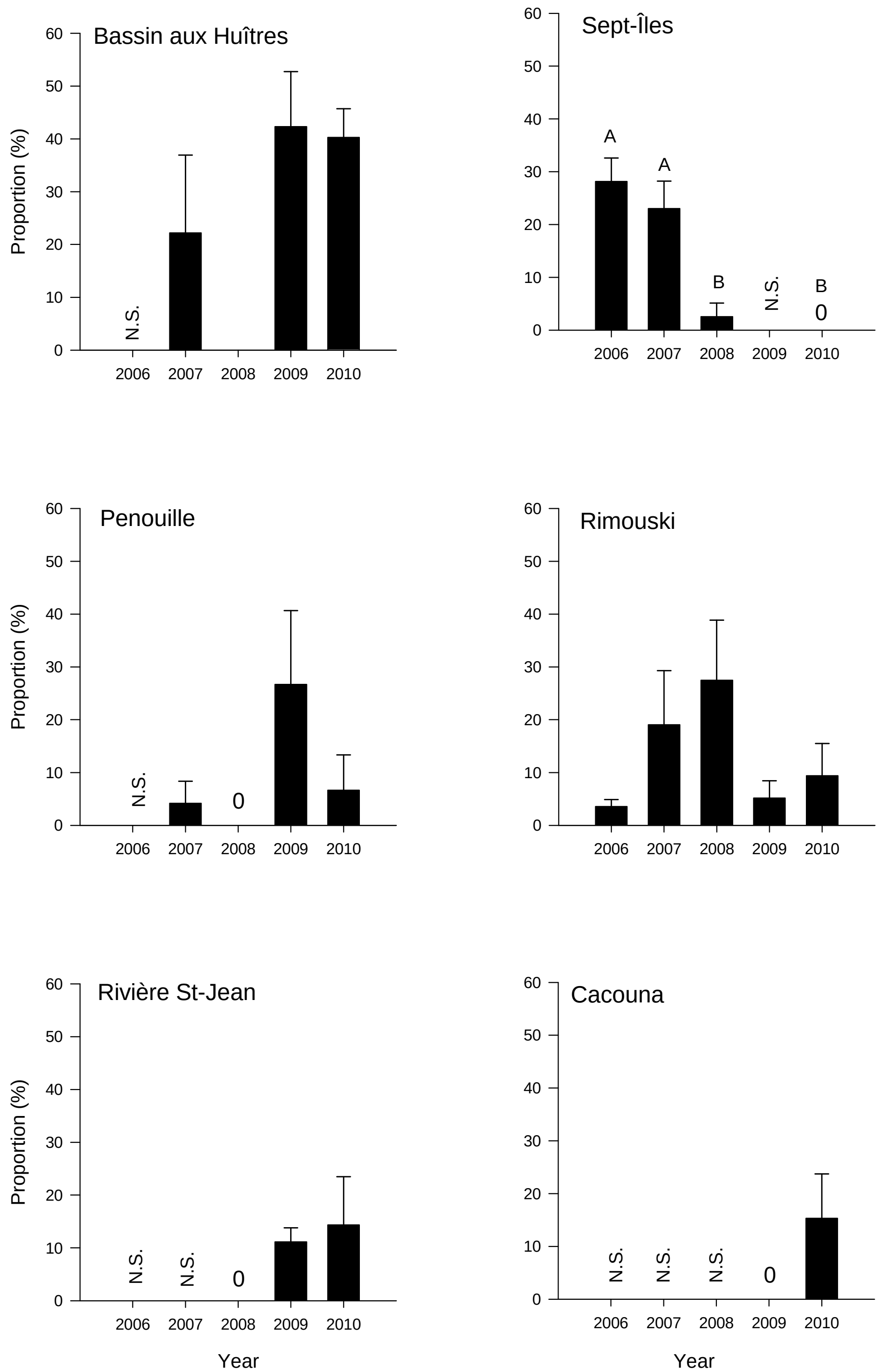


Figure 3: Proportion (%) (mean ± standard error) of the number of seed stems on the number of vegetative stems collected in June for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, Sept-Îles, and Cacouna. N.S. =not sampled.

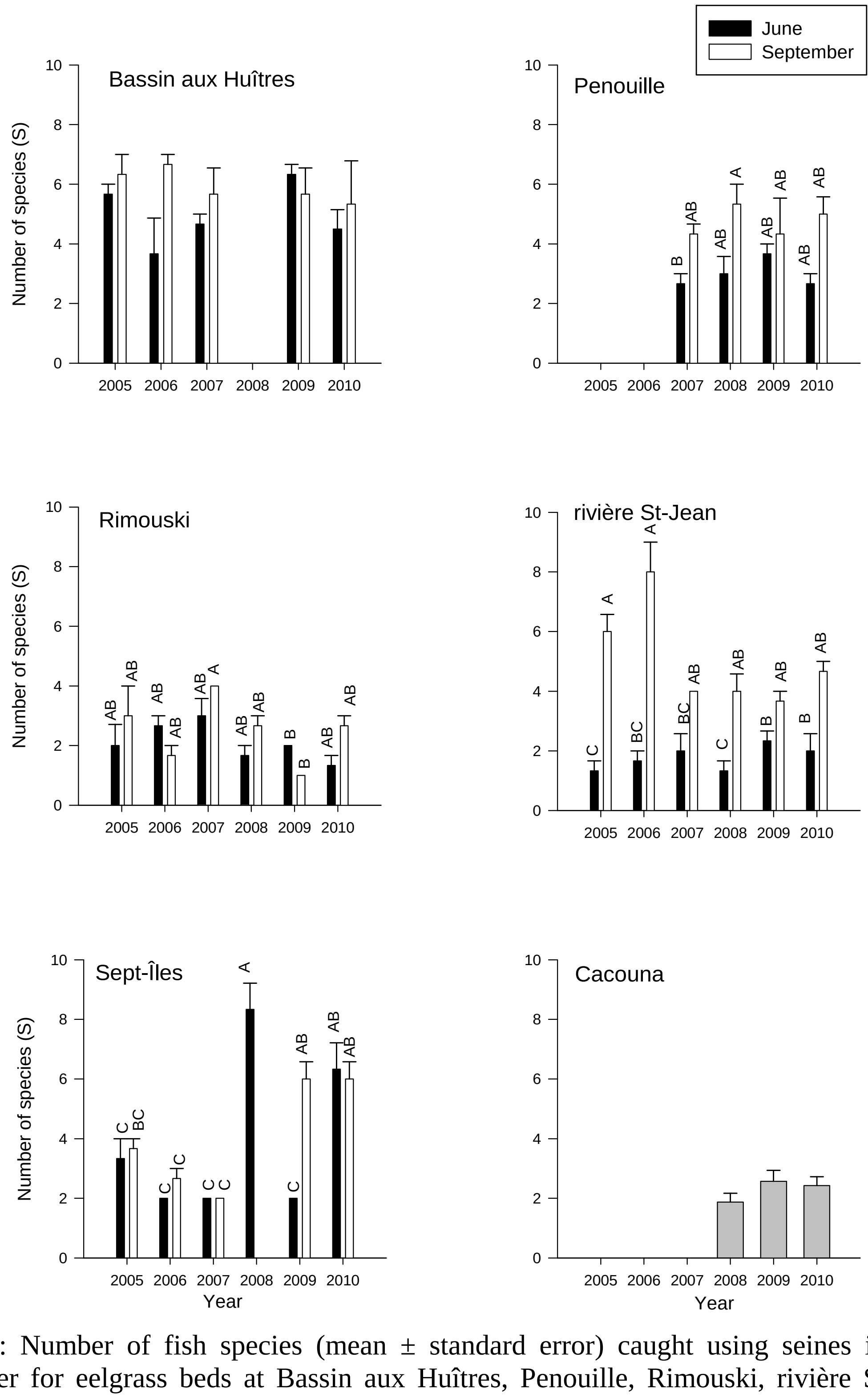


Figure 4: Number of fish species (mean ± standard error) caught using seines in June and September for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, and Sept-Îles. For Cacouna, fauna sampling was conducted in September only.

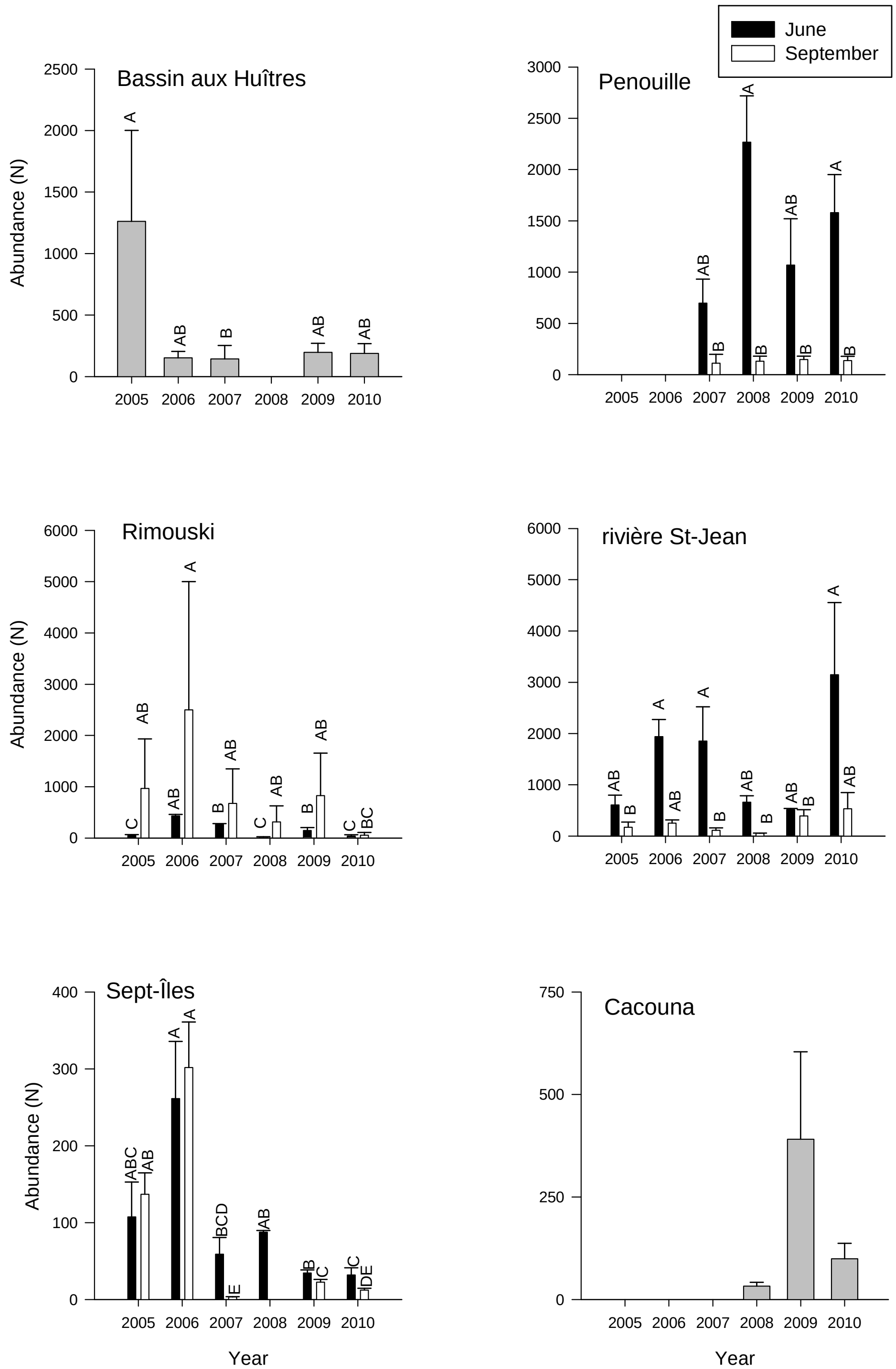


Figure 5: Total abundance (mean ± standard error) of individuals caught using seines in June and September for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, and Sept-Îles. For Cacouna, fauna sampling was conducted in September only (see section 2.2) and for Bassin aux Huîtres, only the year factor is significant.

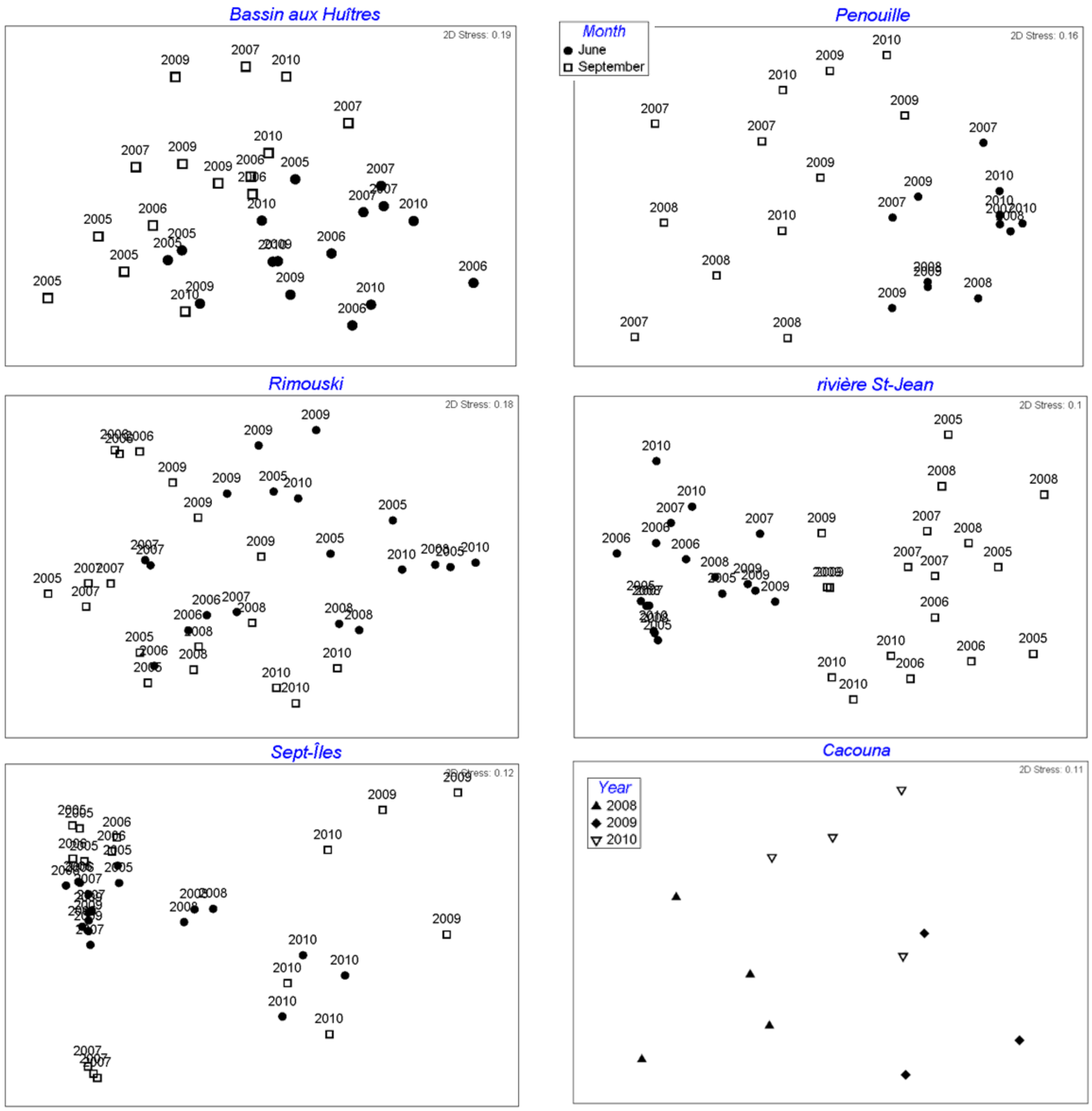


Figure 6: Multidimensional scaling (MDS) (mean ± standard error) of Bray-Curtis similarity indices for abundance matrices (transformation $=\sqrt[4]{\chi}$) of fish caught using seines for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, Sept-Îles, and Cacouna.

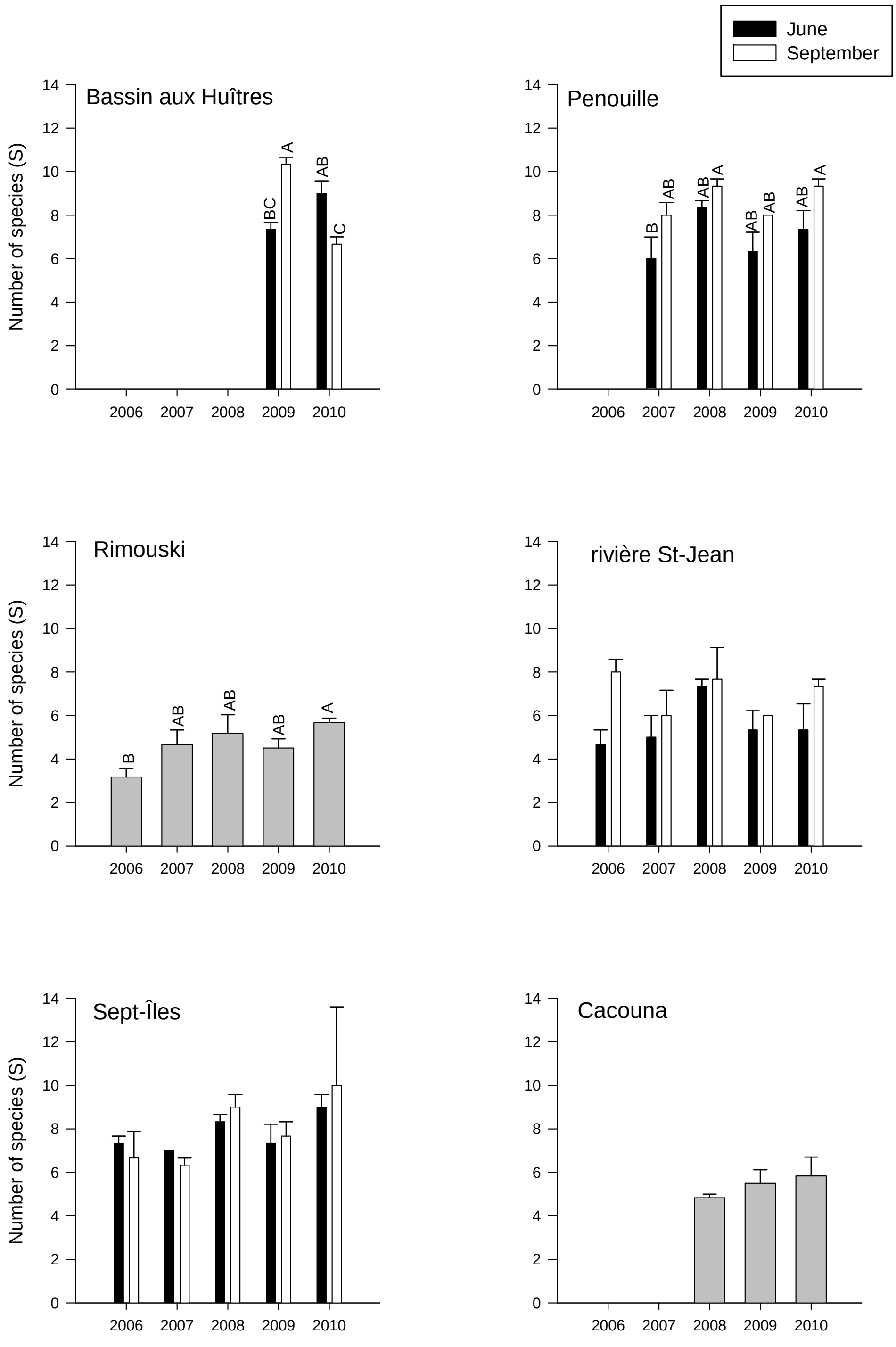


Figure 7: Number of species (mean ± standard error) caught using hoop nets in June and September for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, and Sept-Îles. For Cacouna, fauna sampling was conducted in September only (see section 1.1) and for Rimouski, only the year factor is significant.

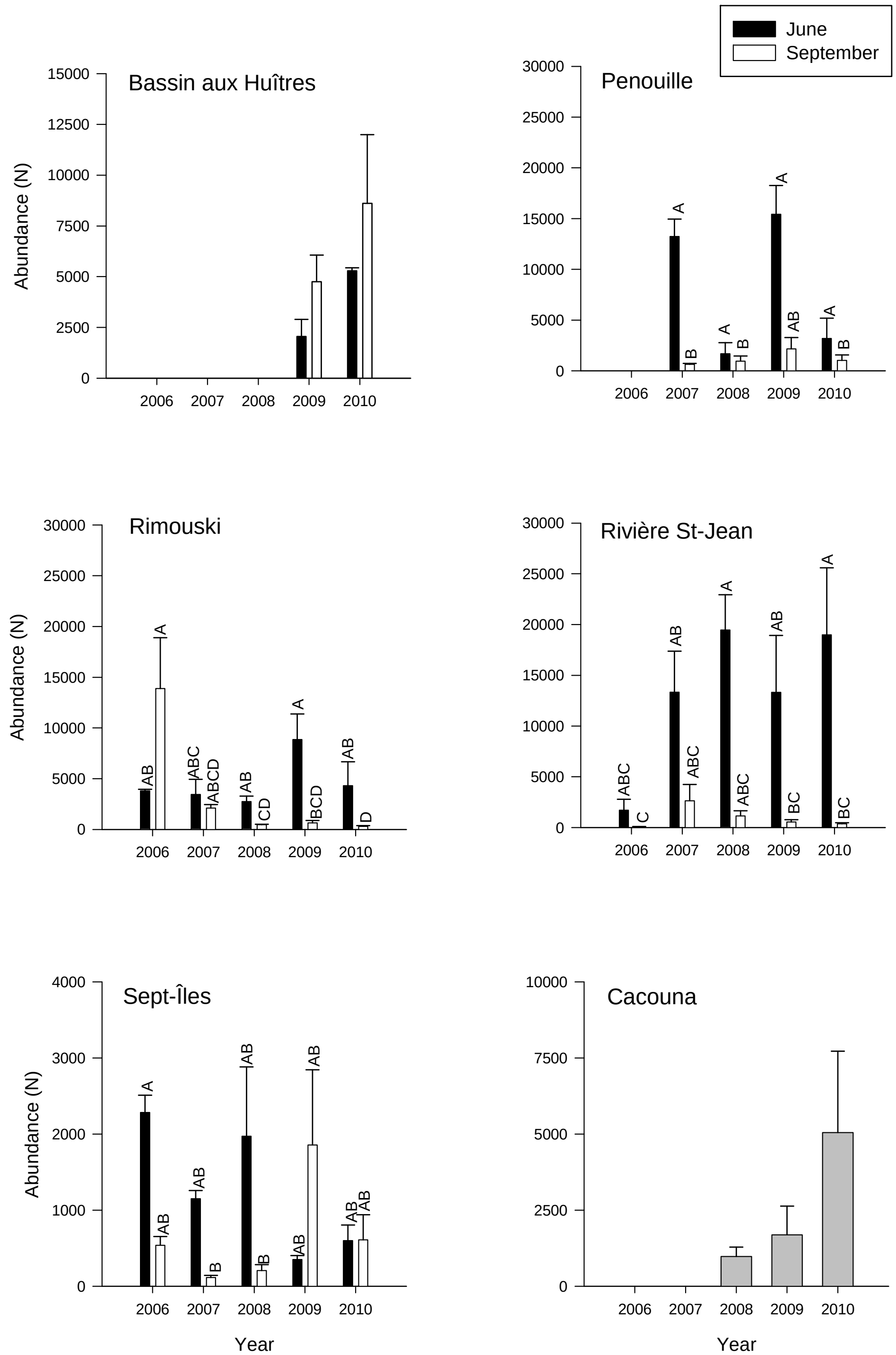


Figure 8: Total abundance (mean ± standard error) of individuals caught using hoop nets in June and September for the eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean and Sept-Îles. For Cacouna, fauna sampling was conducted in September only (see section 2.1).

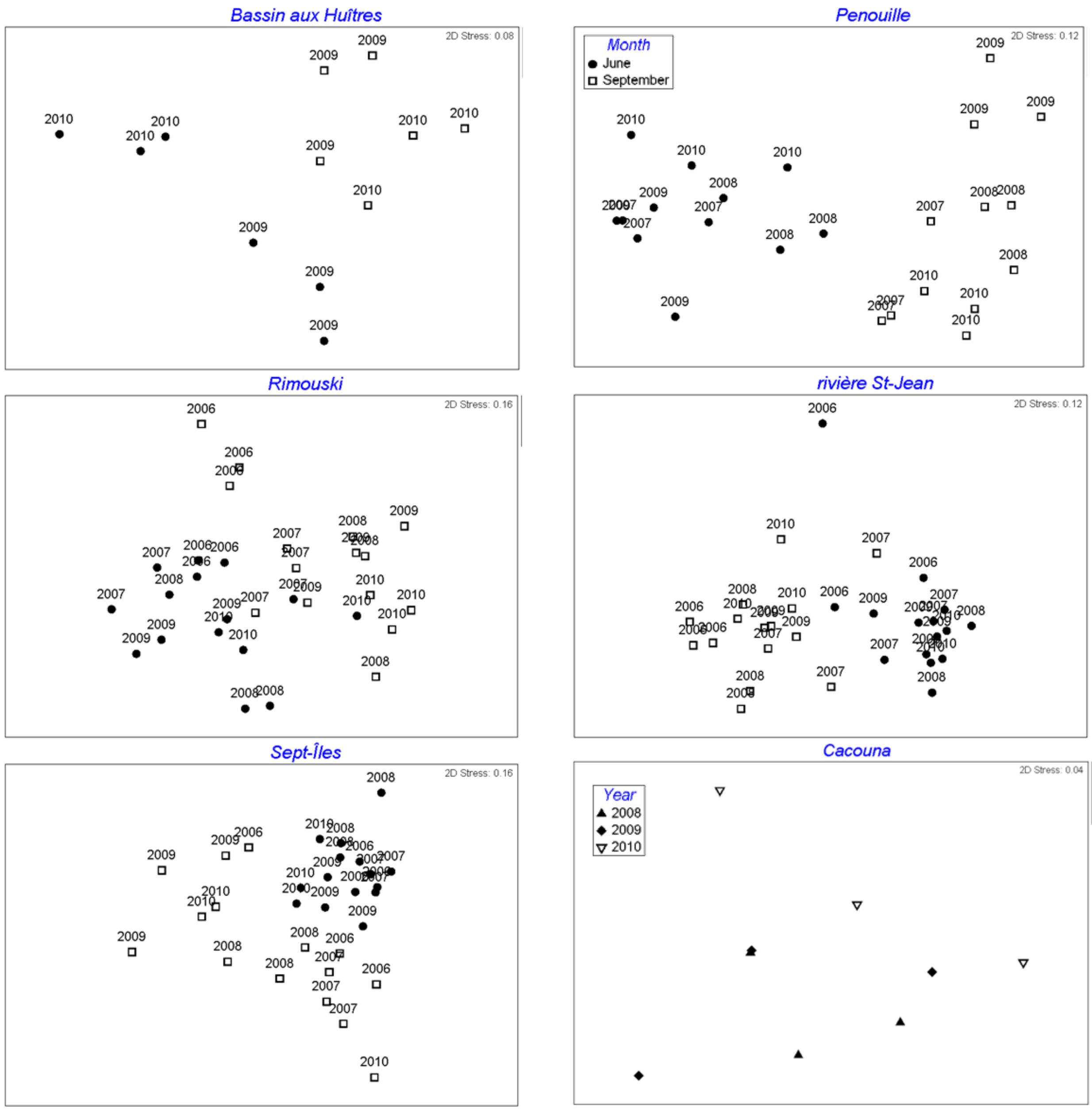


Figure 9: Multidimensional scaling (MDS) of Bray-Curtis similarity indices for abundance matrices (transformation $=\sqrt[4]{\chi}$) of fish caught using hoop nets for eelgrass beds at Bassin aux Huîtres, Penouille, Rimouski, rivière St-Jean, Sept-Îles, and Cacouna.

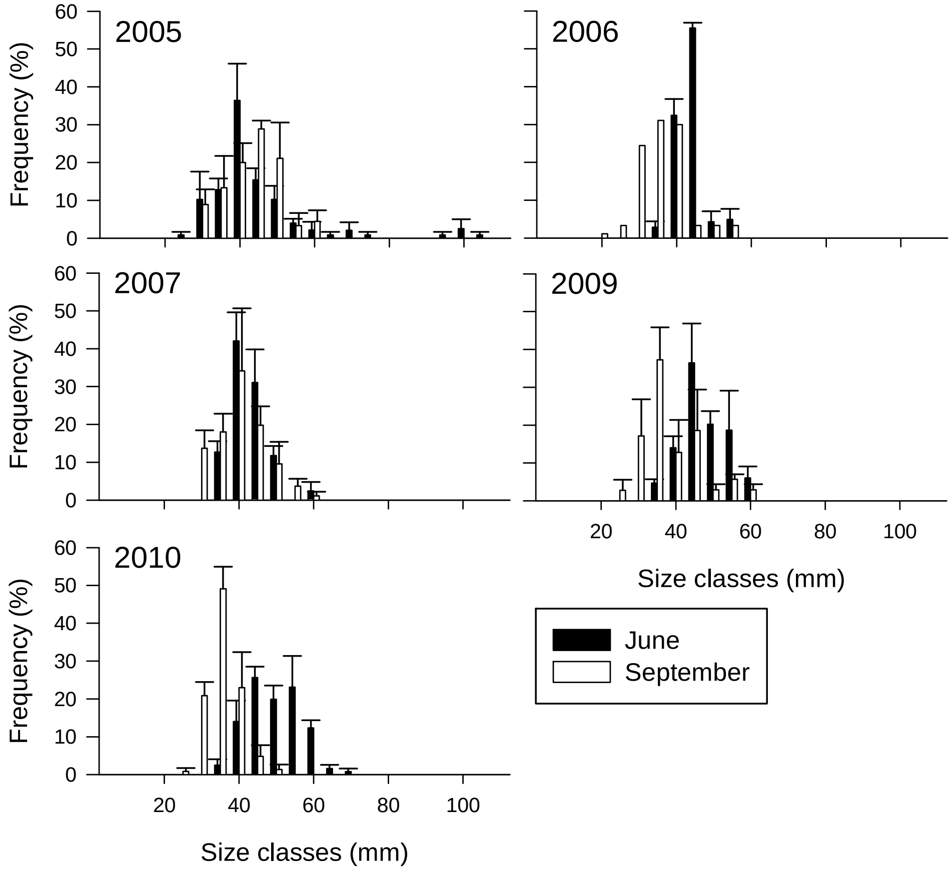


Figure 10: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using seines for the eelgrass bed at Bassin aux Huîtres in June and September 2005, 2006, 2007, 2009, and 2010.

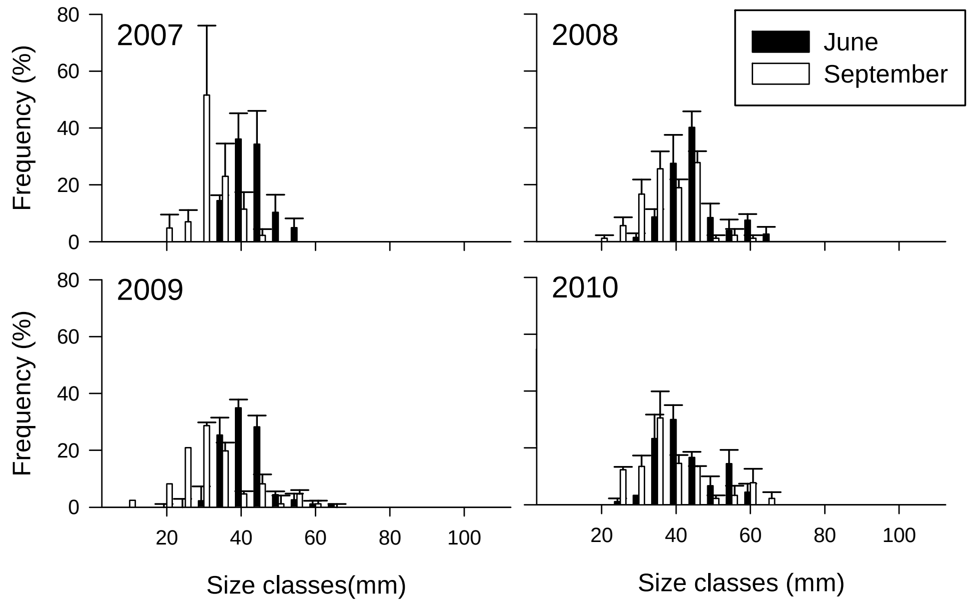


Figure 11: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using seines for the eelgrass bed at Penouille in June and September between 2007 and 2010.

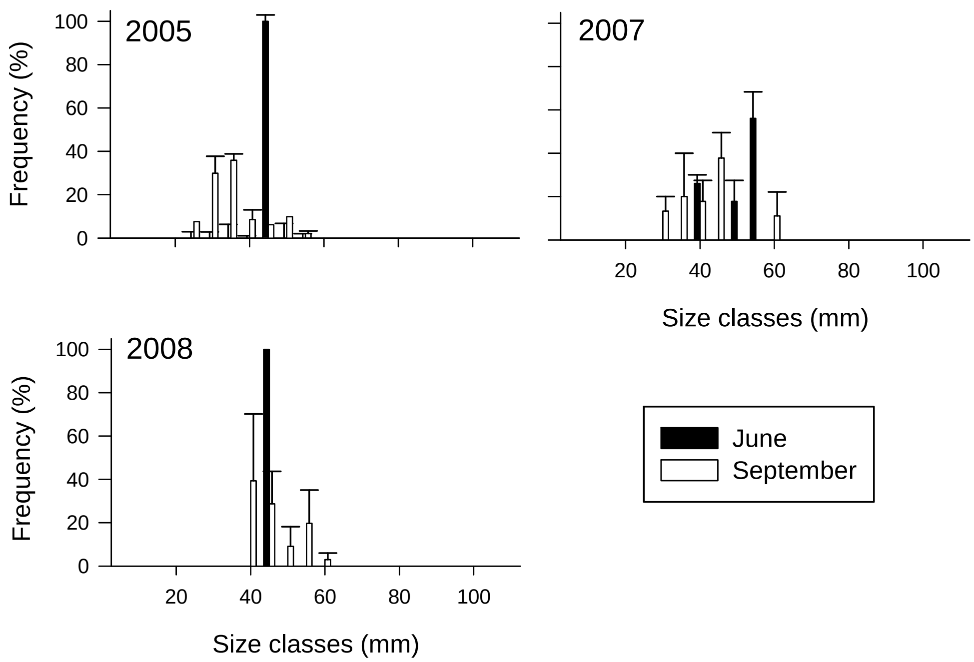


Figure 12: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using seines for the eelgrass bed at Rimouski in June and September 2005, 2007, and 2008.

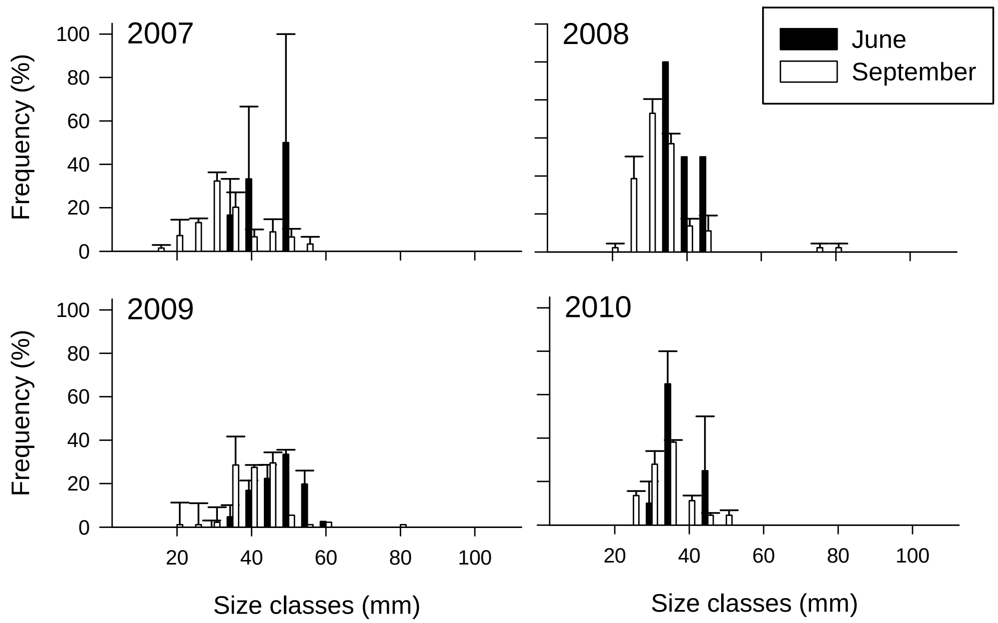


Figure 13: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using seines for the eelgrass bed at Rivière-St-Jean in June and September between 2007 and 2010.

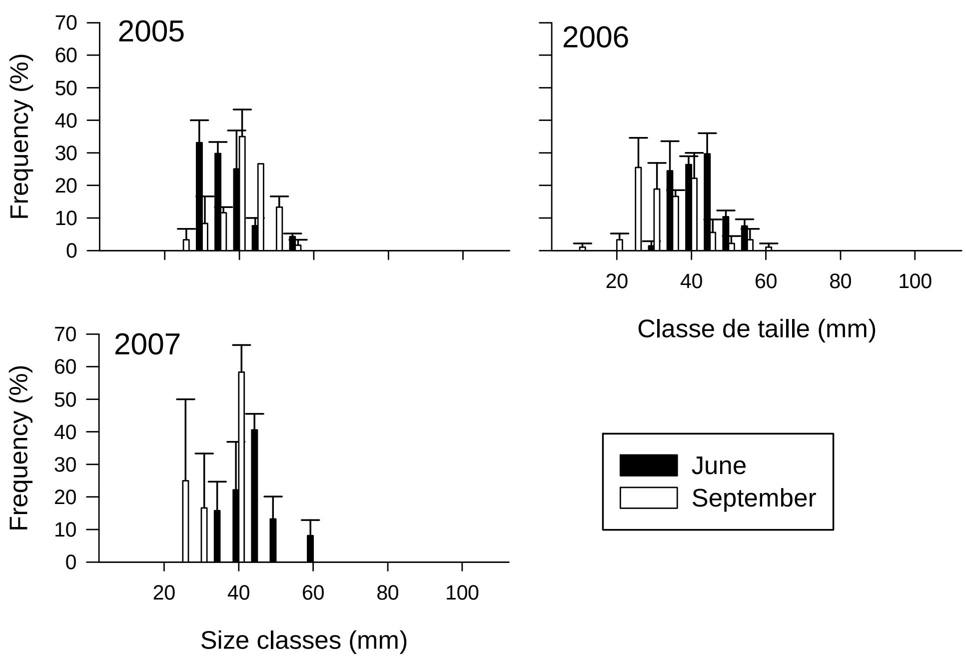


Figure 14: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using seines for the eelgrass bed at Sept-Îles in June and September between 2005 and 2007.

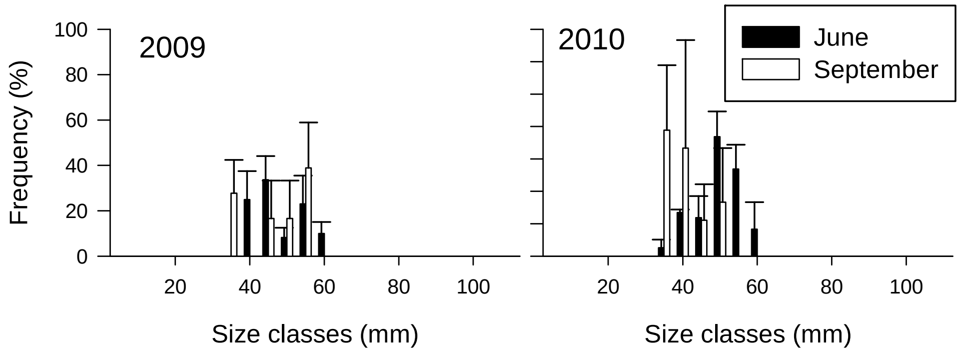


Figure 15: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using hoop nets for the eelgrass bed at Bassin aux Huîtres in June and September 2009 and 2010.

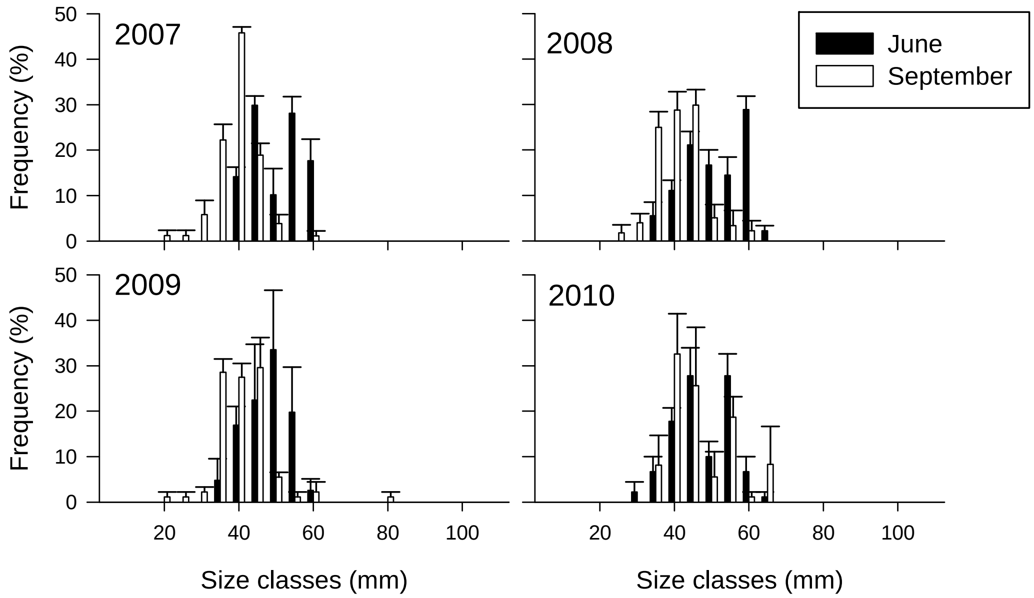


Figure 16: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using hoop nets for the eelgrass bed at Penouille in June and September between 2007 and 2010.

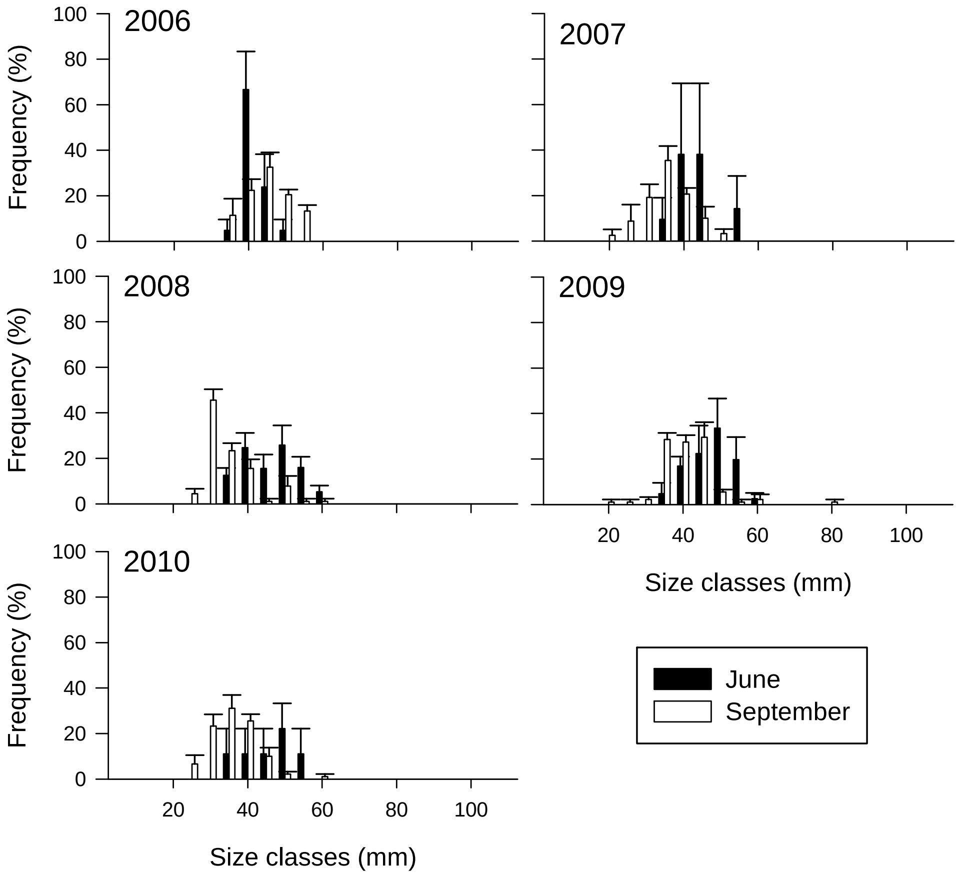


Figure 17: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using hoop nets for the eelgrass bed at Rivière-St-Jean in June and September between 2006 and 2010.

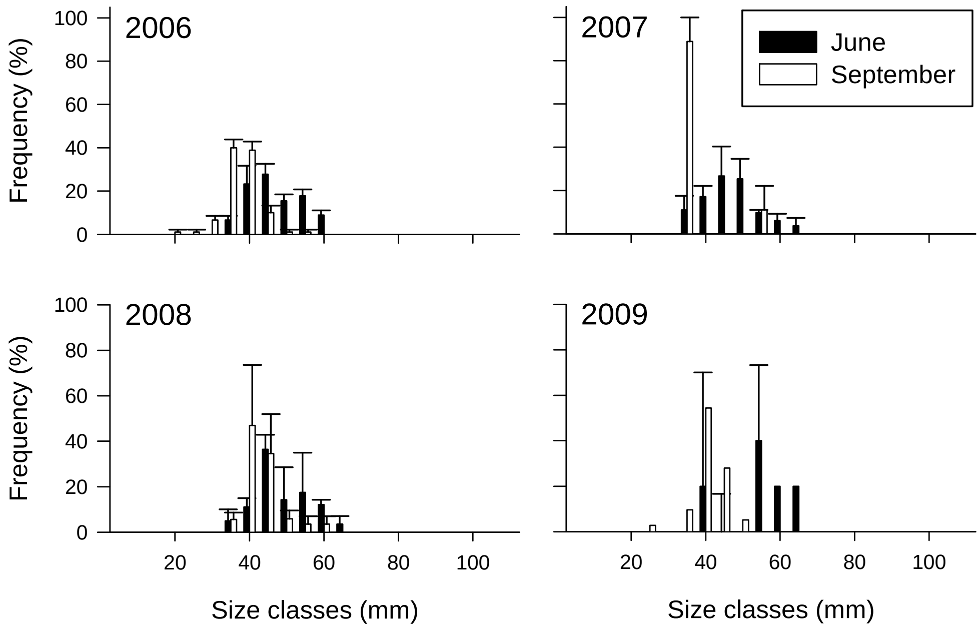


Figure 18: Frequency (%) (mean ± standard error) of size classes of *Apeltes quadracus* caught using hoop nets for the eelgrass bed at Sept-Îles in June and September between 2006 and 2009.

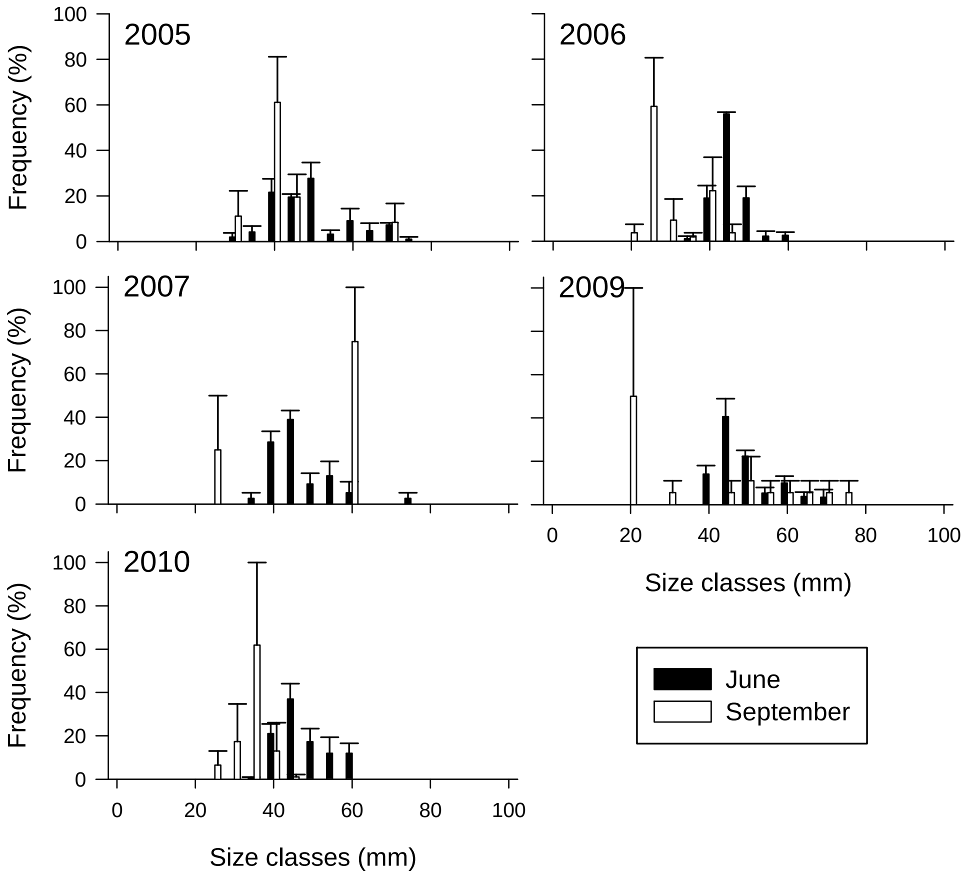


Figure 19: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using seines for the eelgrass bed at Bassin aux Huîtres in June and September 2005, 2006, 2007, 2009, and 2010.

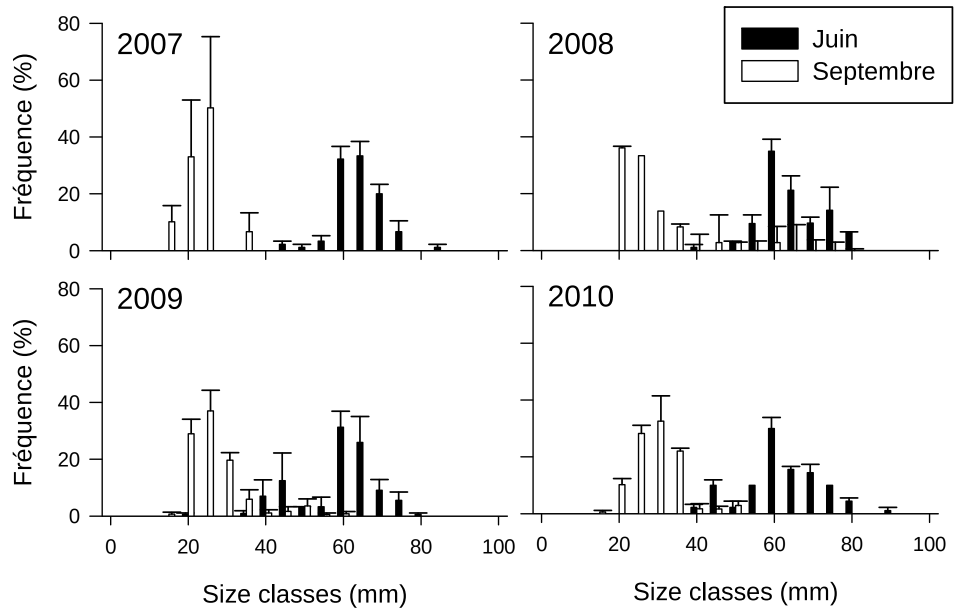


Figure 20: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using seines for the eelgrass bed at Penouille in June and September between 2007 and 2010.

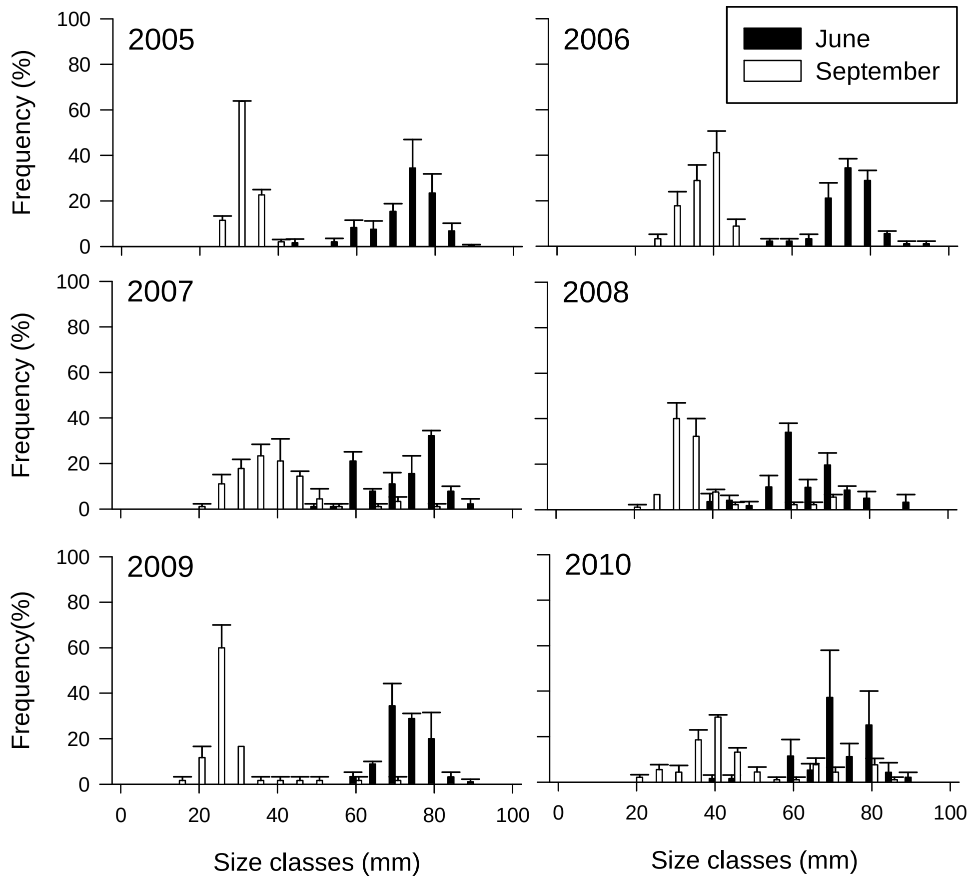


Figure 21: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using seines for the eelgrass bed at Rimouski in June and September between 2005 and 2010.

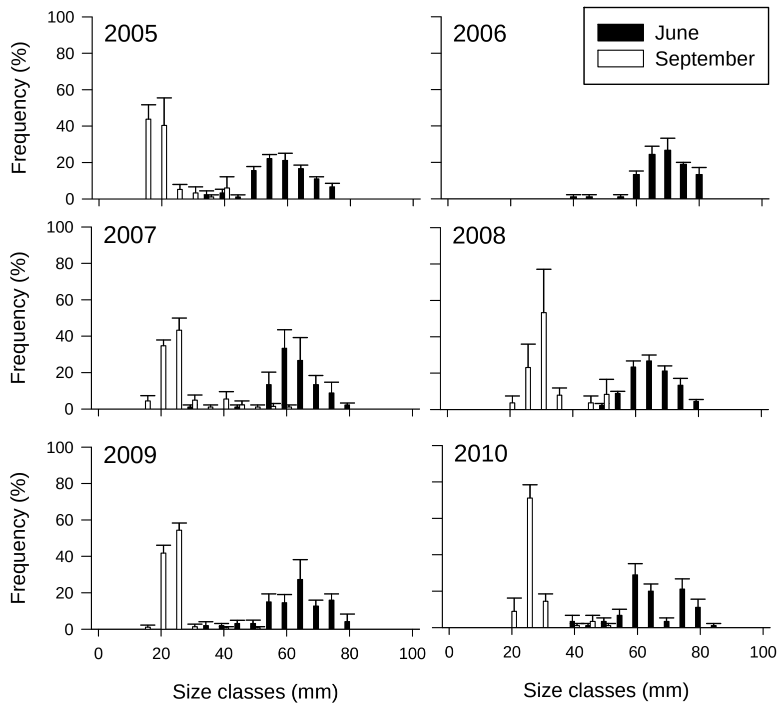


Figure 22: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using seines for the eelgrass bed at Rivière-St-Jean in June and September between 2005 and 2010.

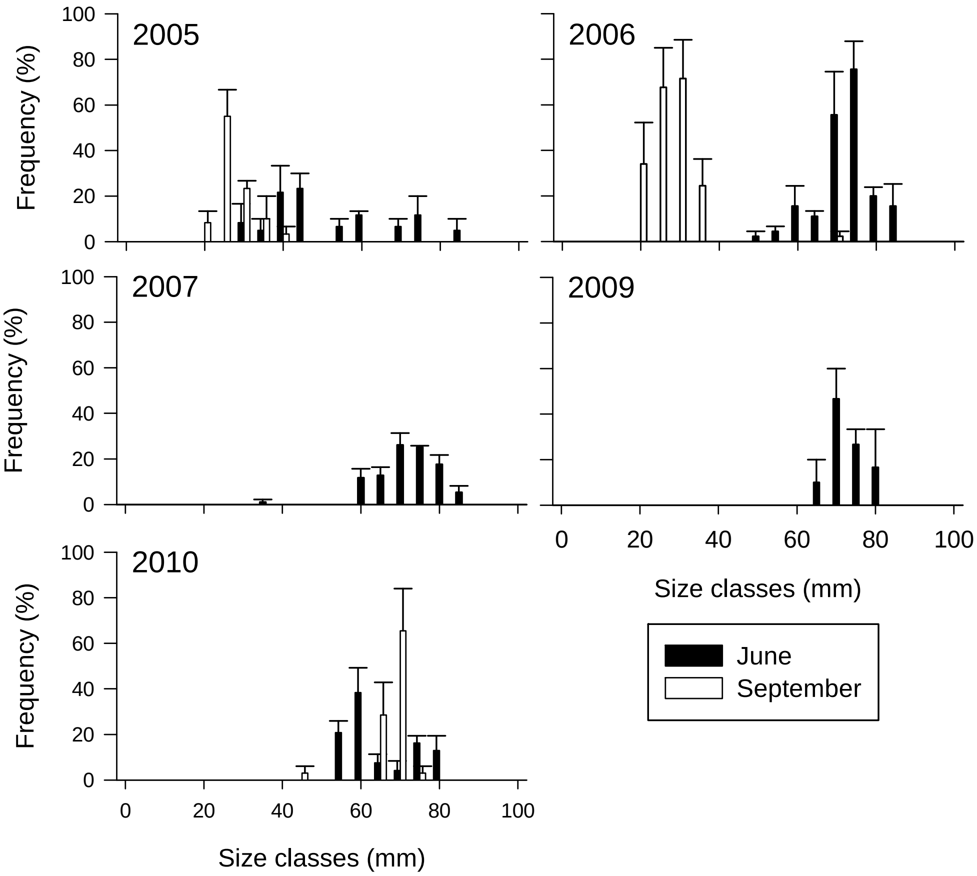


Figure 23: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using seines for the eelgrass bed at Sept-Îles in June and September of 2005, 2006, 2007, 2009, and 2010.

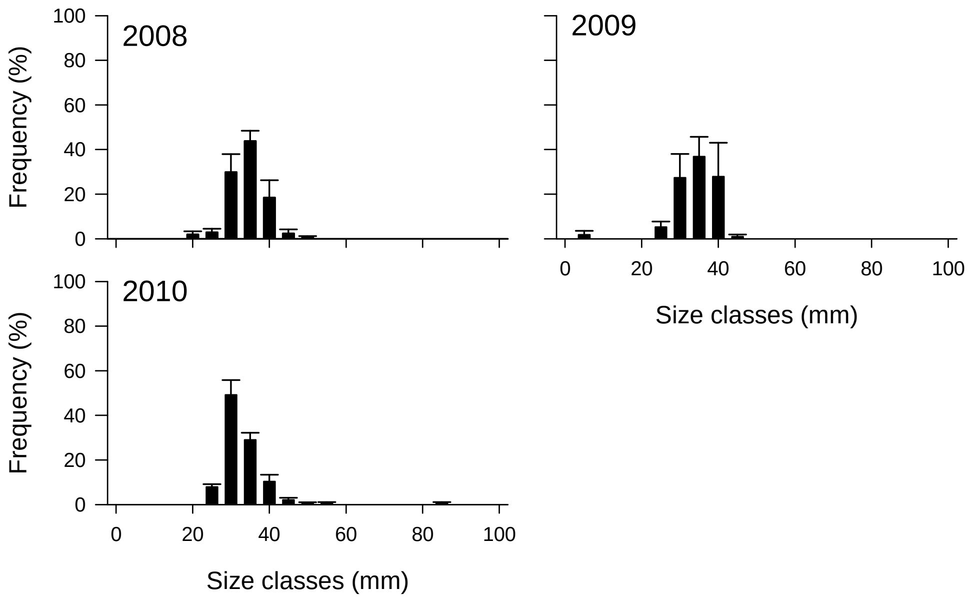


Figure 24: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using seines for the eelgrass bed at Cacouna September between 2008 and 2010.

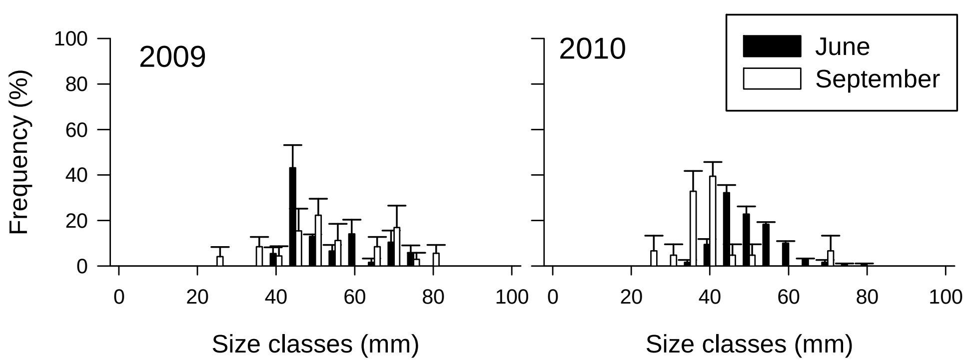


Figure 25: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using hoop nets for the eelgrass bed at Bassin aux Huîtres in June and September 2009 and 2010.

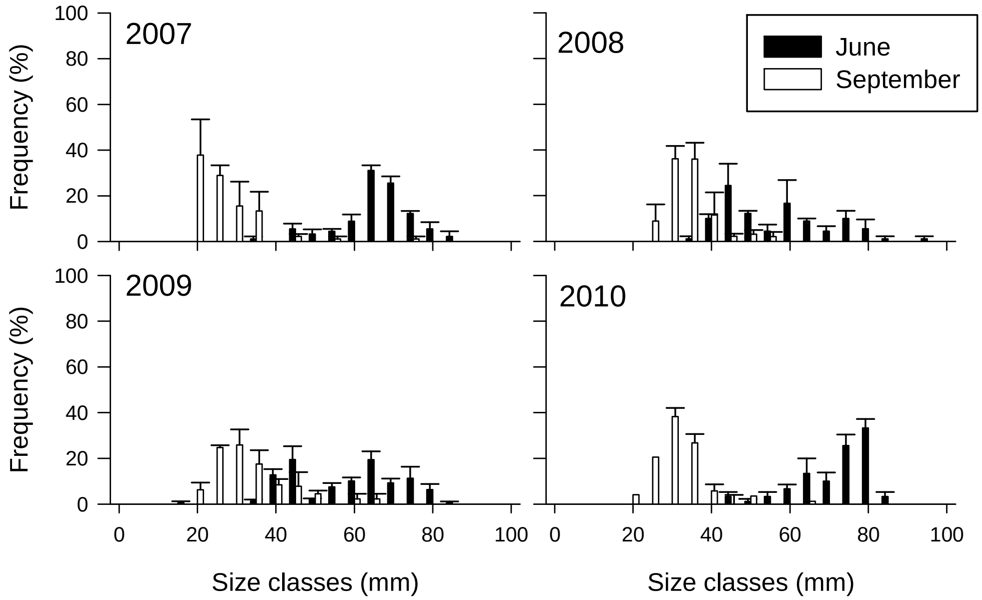


Figure 26: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using hoop nets for the eelgrass bed at Penouille in June and September between 2007 and 2010.

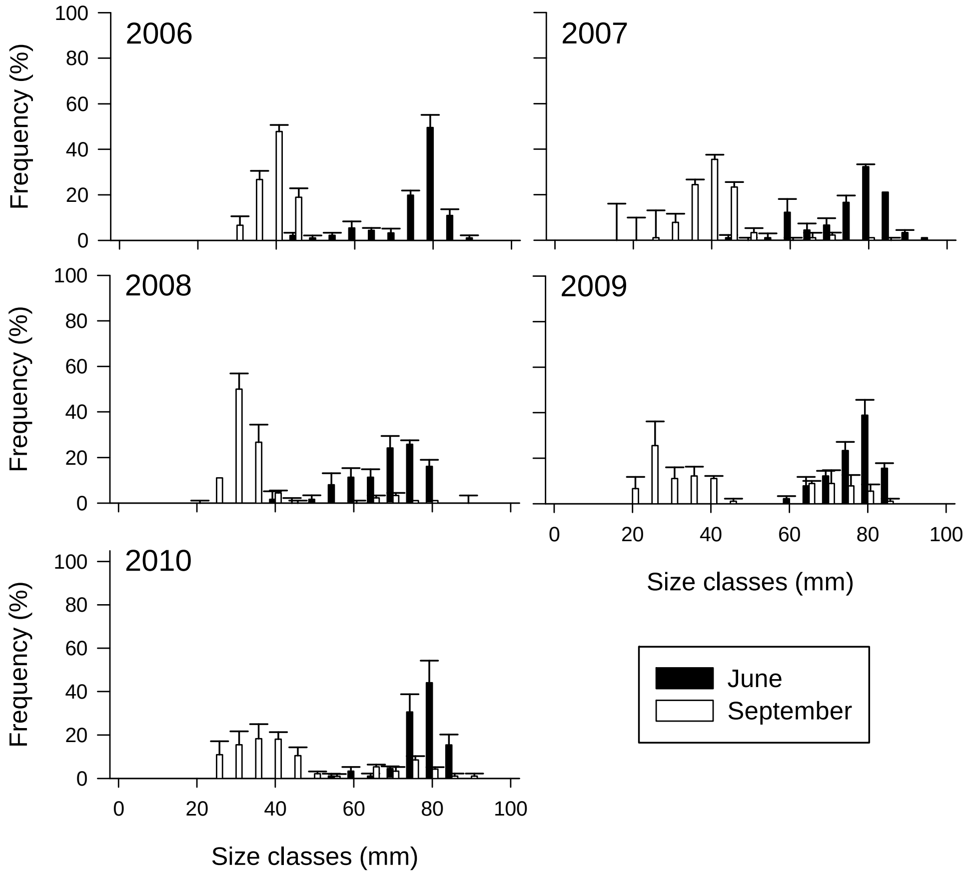


Figure 27: Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using hoop nets for the eelgrass bed at Rimouski in June and September between 2006 and 2010.

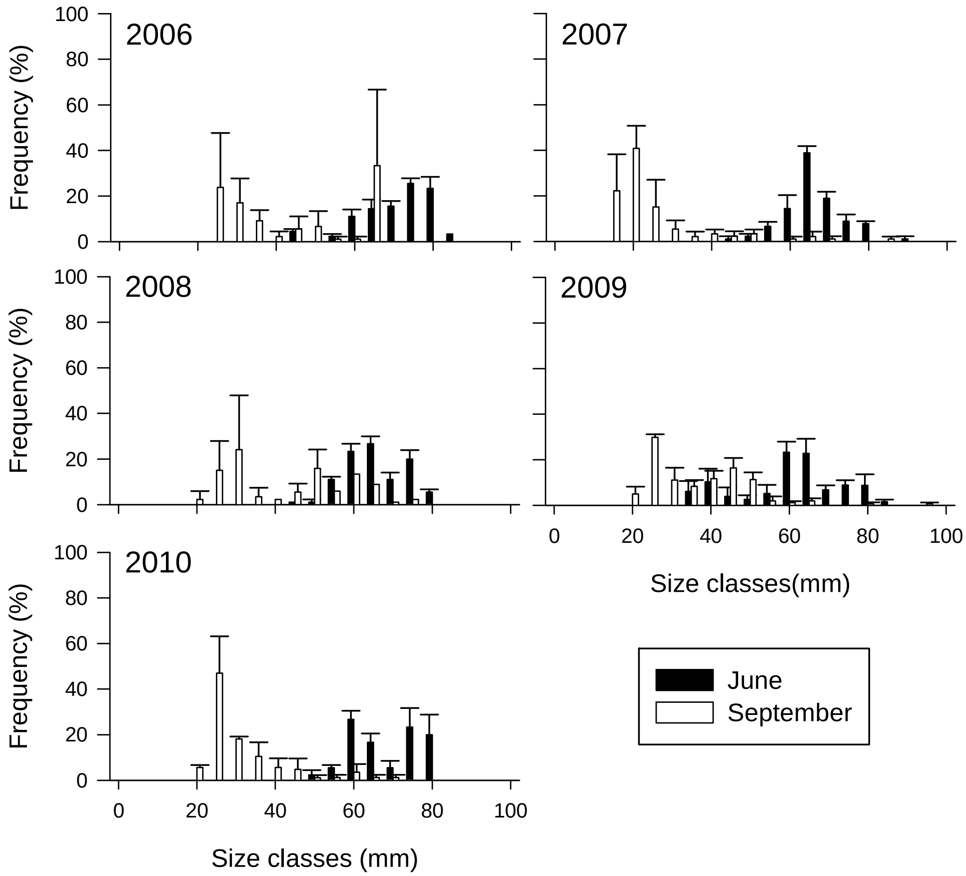


Figure 28 : Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using hoop nets for the eelgrass bed at rivière St-Jean in June and September between 2006 and 2010.

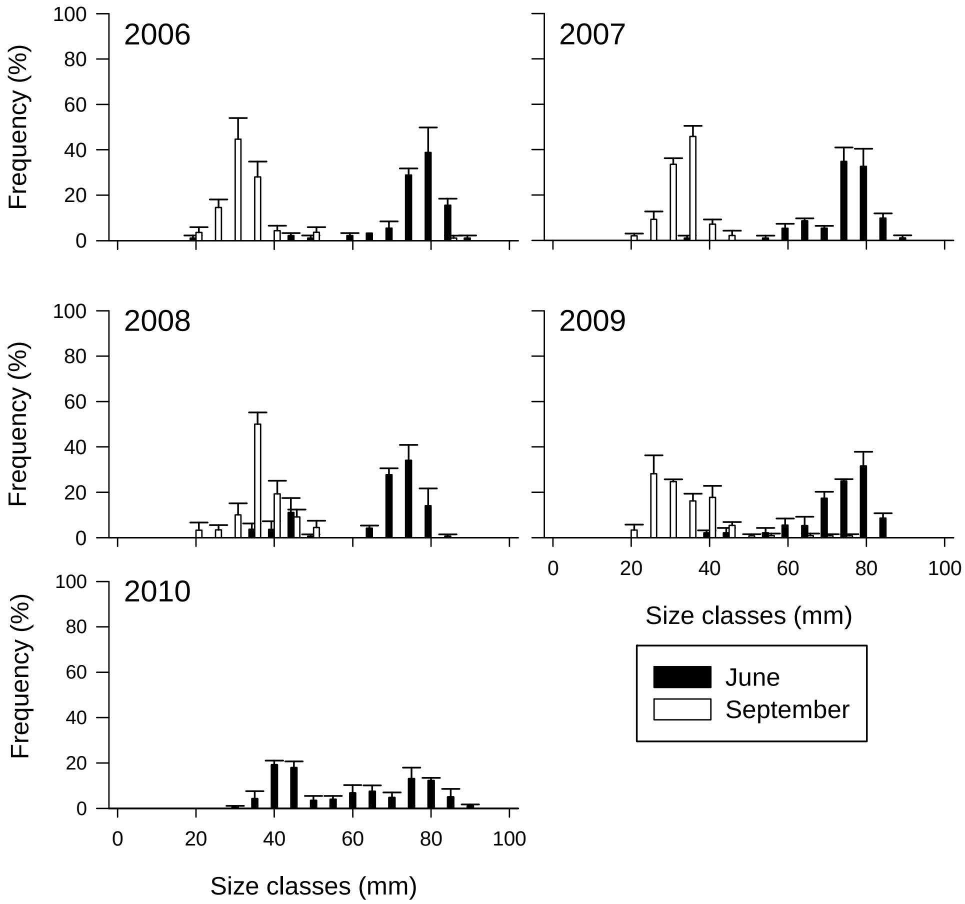


Figure 29 : Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught using hoop nets for the eelgrass bed at Sept-Îles in June and September between 2006 and 2010.

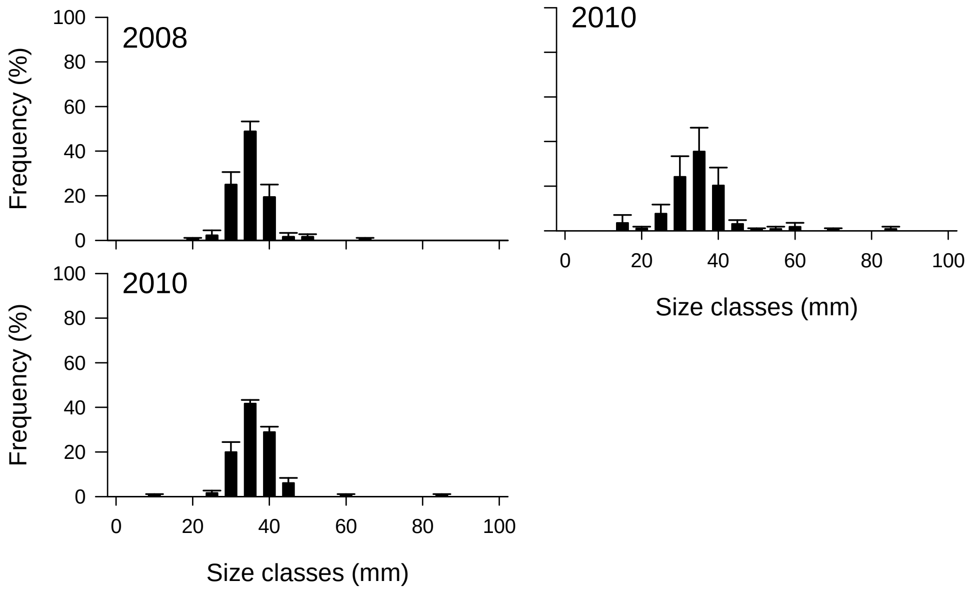


Figure 30 : Frequency (%) (mean ± standard error) of size classes of *Gasterosteus* spp. caught in September using hoop nets for the eelgrass bed at Cacouna between 2008 and 2010.

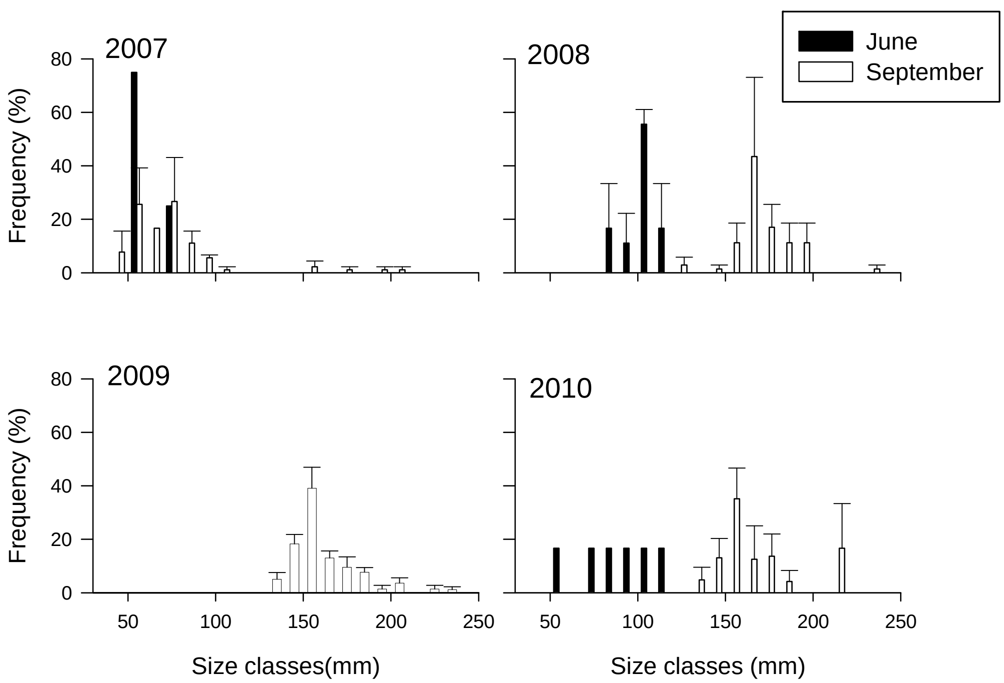


Figure 31 : Frequency (%) (mean ± standard error) of size classes of *Osmerus mordax* caught using hoop nets for the eelgrass bed at Penouille in June and September between 2007 and 2010.

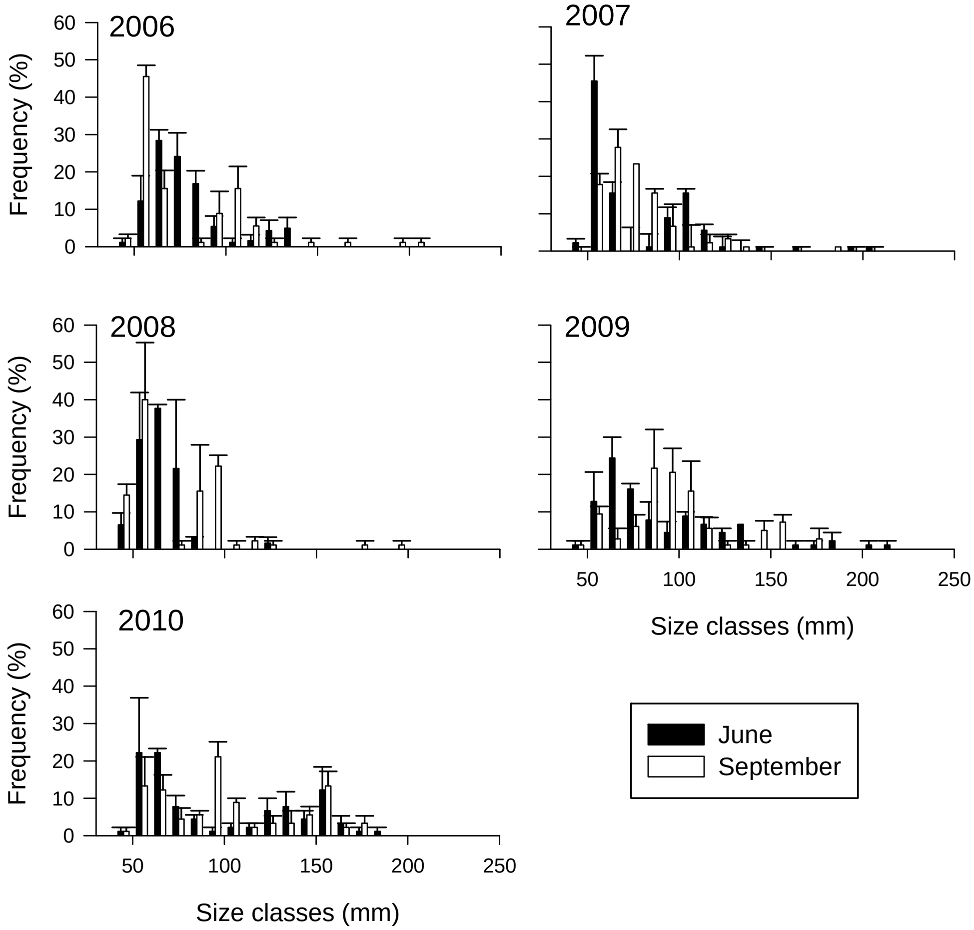


Figure 32 : Frequency (%) (mean ± standard error) of size classes of *Osmerus mordax* caught using hoop nets for the eelgrass bed at Rimouski in June and September between 2006 and 2010.

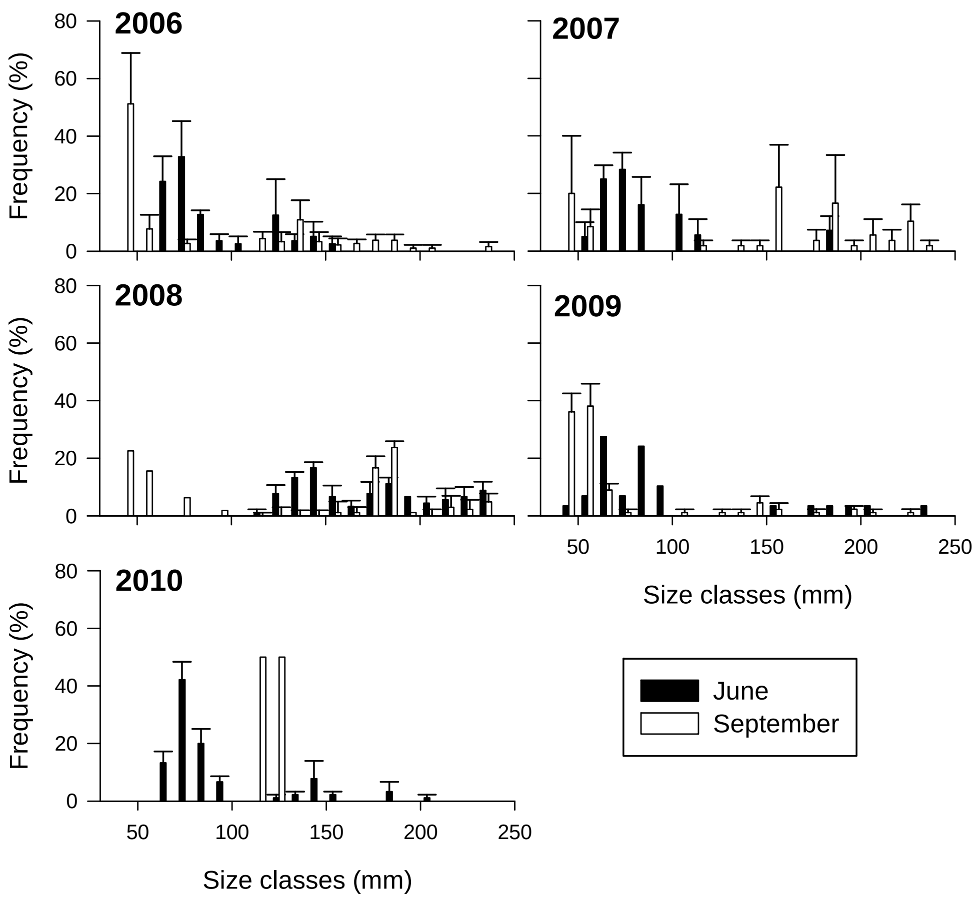


Figure 33 : Frequency (%) (mean ± standard error) of size classes of *Osmerus mordax* caught using hoop nets for the eelgrass bed at Sept-Îles in June and September between 2006 and 2010.

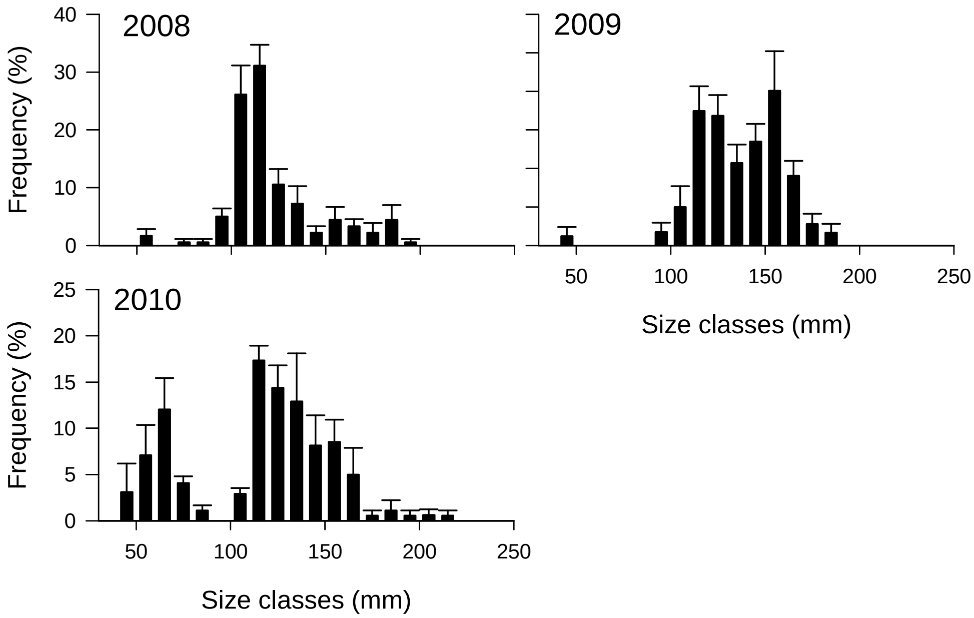
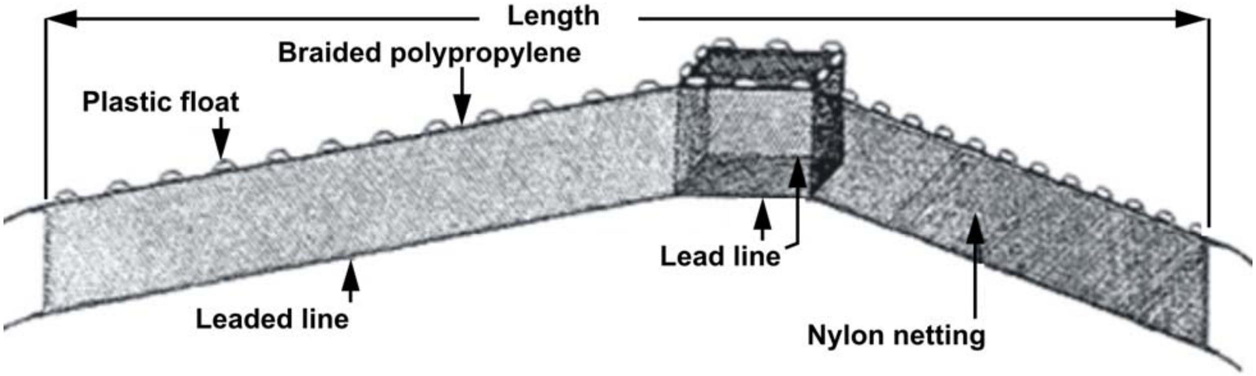


Figure 34 : Frequency (%) (mean ± standard error) of size classes of *Osmerus mordax* caught in September using hoop nets for the eelgrass bed at Cacouna between 2008 and 2010.

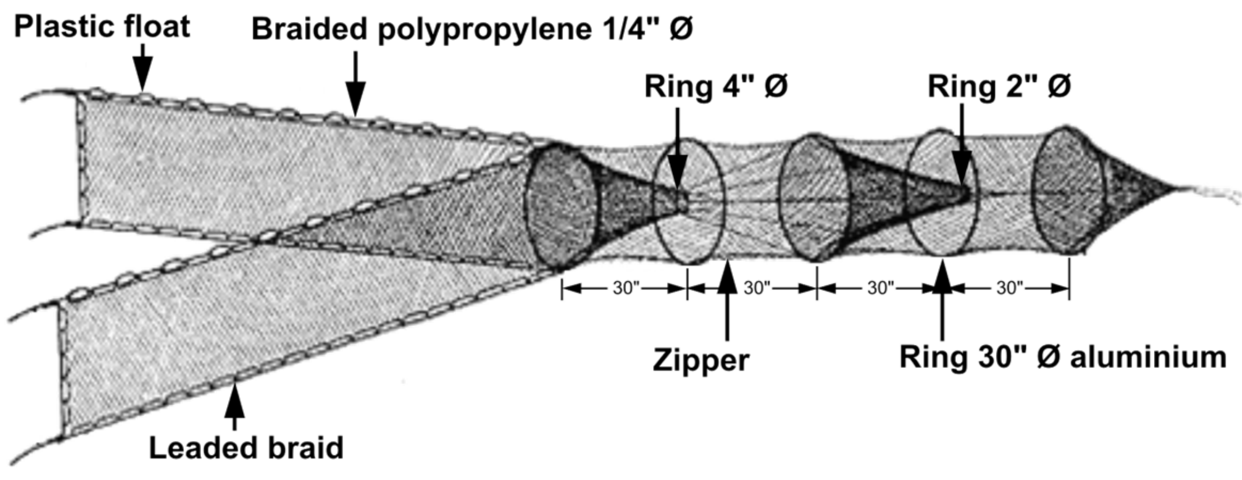
Appendix

Appendix 1: Drawing showing the minnow seine (A) and hoop net (B) used for sampling fish communities in eelgrass beds

A) Minnow seine



B) Hoop net without main leader



Appendix 2: Taxonomique and English names of fish species caught in the different eelgrass beds.

Taxonomique name	**English name**
Ammodytes spp.	American sand lance and northern sand lance
Anguilla rostrata	American eel
Apeltes quadracus	Fourspine stickleback
Clupea harengus	Atlantic herring
Cyclopterus lumpus	Lumpfish
Eumicrotremus spinosus	Atlantic spiny lumpsucker
Fundulus spp.	Mumminchog and banded killifish
Gadus morhua	Atlantic cod
Gasterosteus spp.	Three-spined and blackspotted stickleback
Limanda ferruginea	Yellowtail flounder
Liopsetta putnami	American smooth flounder
Liparis atlanticus	Atlantic seasnail
Liparis sp.	Seasnail sp.
Mallotus villosus	Capelin
Menidia menidia	Atlantic silverside
Microgadus tomcod	Atlantic tomcod
Morone saxatilis	Striped bass
Myoxocephalus spp.	Grubby and shorthorn sculpin
Osmerus mordax	Rainbow smelt
Pholis gunnellus	Rock gunnel
Pleuronectidae spp.	Flounder spp.
Pseudopleuronectes americanus	Winter flounder
Pungitius pungitius	Ninespine stickleback
Salvelinus fontinalis	Brook trout
Stichaeus punctatus	Arctic shanny
Tautogolabrus adspersus	Cunner
Urophycis sp.	Hake sp.
Urophycis tenuis	White hake
Zoarces americanus	Ocean pout

Appendix 3: Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Bassin aux Huîtres**									
	2005		**2006**		**2007**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.										
Anguilla rostrata				0.67 (0.67)						0.33 (0.33)
Apeltes quadracus	184.33 (79.18)	538.33 (164.56)	32.00 (12.01)	130.33 (45.95)	19.33 (9.06)	28.67 (12.73)	50.67 (12.86)	19.33 (3.71)	74.00 (15.76)	72.00 (24.52)
Clupea harengus						1.33 (1.33)				
Cyclopterus lumpus										
Eumicrotremus spinosus										
Fundulus spp.	45.33 (6.69)	1467.33 (1299.40)	0.33 (0.33)	51.33 (24.94)	2.00 (0.58)	200.00 (193.52)	10.67 (5.17)	10.67 (4.48)	6.00 (2.86)	34.00 (9.02)
Gadus morhua										
Gasterosteus spp.	27.67 (9.50)	19.00 (17.35)	46.00 (34.07)	7.00 (9.54)	11.33 (2.08)	1.00 (1.00)	45.33 (16.95)	3.33 (2.85)	37.00 (23.86)	36.33 (35.83)
Limanda ferruginea	1.00 (0.00)	7.00 (2.82)								
Liopsetta putnami										
Liparis sp.										
Menidia menidia	92.33 (63.33)	104.00 (25.79)	1.67 (0.88)	5.67 (3.28)		14.00 (11.64)	127.00 (123.50)	102.67 (66.540	4.75 (2.81)	126.67 (125.67)
Microgadus tomcod										
Myoxocephalus spp.										
Osmerus mordax										
Pholis gunnellus						0.33				
Pseudopleuronectes Americanus			1.33 (1.33)	1.33 (0.67)	2.33 (1.45)	0.33 (0.33)	0.67 (0.33)			
Pungitius pungitius	3.67 (1.33)	16.33 (11.70)	0.33 (0.33)	24.67 (14.25)	3.33 (0.67)	2.33 (1.86)	0.33 (0.33)	17.00 (7.23)	0.25 (0.25)	4.67 (3.71)
Salvelinus fontinalis										
Stichaeus punctatus										
Tautogolabrus adspersus		17.33 (11.46)		1.67 (1.22)		0.33 (0.33)	5.00 (1.73)	0.67 (0.33)	0.25 (0.25)	0.67 (0.67)
Urophycis tenuis							0.33 (0.33)	0.33 (0.33)		
Zoarces americanus										

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Penouille**							
	2007		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		11.33 (9.40)		1.00 (0.58)	9.66 (9.17)		1.33 (1.33)	1.00 (0.57)
Anguilla rostrata								
Apeltes quadracus	50.33 (27.49)	10.00 (4.51)	79.33 (45.04)	99.00 (40.04)	70.00 (27.14)	34.67 (6.67)	84.00 (6.66)	30.33 (0.88)
Clupea harengus								
Cyclopterus lumpus								
Eumicrotremus spinosus								
Fundulus spp.	0.67 (0.67)	6.67 (2.60)	9.67 (9.17)	2.67 (0.88)	21.33 (20.34)	0.33 (0.33)		2.00 (1.53)
Gadus morhua								
Gasterosteus spp.	646.00 (207.22)	82.00 (76.04)	2174.67 (474.92)	8.67 (3.33)	970.00 (436.62)	99.67 (25.78)	1493.33 (364.87)	85.00 (36.83)
Limanda ferruginea								
Liopsetta putnami								
Liparis sp.								
Menidia menidia						0.67 (0.33)	17.00 (8.19)	
Microgadus tomcod								
Myoxocephalus spp.								
Osmerus mordax		1.00 (0.58)		7.33 (5.46)				
Pholis gunnellus								
Pseudopleuronectes	0.67 (0.67)							
Pungitius pungitius			3.00 (3.00)	13.33 (7.88)	7.00 (1.53)	2.00 (1.15)		1.00 (1.00)
Salvelinus fontinalis								
Stichaeus punctatus								
Tautogolabrus adspersus								
Urophycis tenuis								
Zoarces americanus								

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Rimouski**							
	2005		**2006**		**2007**		**2008**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.								
Anguilla rostrata								
Apeltes quadracus		82.00 (38.30)	11.33 (6.84)		4.00 (0.58)	11.33 (5.24)	0.67 (0.33)	5.67 (2.73)
Clupea harengus		0.67 (0.67)						
Cyclopterus lumpus								
Eumicrotremus spinosus								
Fundulus spp.								
Gadus morhua								
Gasterosteus spp.	41.33 (23.38)	883.00 (338.37)	418.00 (22.37)	2494.67 (120.83)	236.00 (18.73)	613.00 (121.6)	19.00 (5.20)	306.33 (89.07)
Limanda ferruginea								
Liopsetta putnami								
Liparis sp.								
Menidia menidia								
Microgadus tomcod								
Myoxocephalus spp.								
Osmerus mordax		0.33 (0.33)		5.33 (2.73)	21.67 (14.05)	48.00 (12.77)		
Pholis gunnellus								
Pseudopleuronectes americanus	0.33 (0.33)		1.33 (0.88)		0.33 (0.33)			
Pungitius pungitius		0.33 (0.33)				3.00 (2.00)		1.00 (0.58)
Salvelinus fontinalis								
Stichaeus punctatus								
Tautogolabrus adspersus								
Urophycis tenuis								
Zoarces americanus								

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Rimouski**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata				
Apeltes quadracus				
Clupea harengus				
Cyclopterus lumpus				
Eumicrotremus spinosus				
Fundulus spp.				
Gadus morhua.				
Gasterosteus spp.	126,00 (63,50)	827,00 (316,97)	37,66 (25,64)	48,66 (9,02)
Limanda ferruginea				
Liopsetta putnami				
Liparis sp.				
Menidia menidia				
Microgadus tomcod				
Myoxocephalus spp.				
Osmerus mordax	20,66 (8,81)		0,33 (0,33)	
Pholis gunnellus				
Pseudopleuronectes americanus				
Pungitius pungitius				2,33 (0,88)
Salvelinus fontinalis				
Stichaeus punctatus				
Tautogolabrus adspersus				
Urophycis tenuis				
Zoarces americanus				

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**rivière St-Jean**							
	2005		**2006**		**2007**		**2008**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		0.33 (0.33)		0.11 (0.11)				
Anguilla rostrata								
Apeltes quadracus	1.00 (1.00)	76.67 (38.66)	0.33 (0.33)	45.93 (12.98)	7.00 (6.51)	26.33 (10.53)	1.33 (1.33)	39.33 (6.64)
Clupea harengus		4.67 (2.19)		1.89 (0.59)				
Cyclopterus lumpus								
Eumicrotremus spinosus								
Fundulus spp.		62.33 (55.92)	0.33 (0.33)	38.00 (20.17)	0.33 (0.33)	35.67 (23.69)		6.00 (2.08)
Gadus morhua								
Gasterosteus spp.	605.67 (191.13)	22.00 (8.19)	1939.67 (333.08)	28.44 (8.86)	1847.00 (667.56)	50.67 (14.34)	659.33 (125.69)	6.00 (2.52)
Limanda ferruginea								
Liopsetta putnami								
Liparis sp.								
Menidia menidia				0.44 (0.44)				1.33 (1.33)
Microgadus tomcod								
Myoxocephalus spp.		0.33 (0.33)		0.11 (0.11)				
Osmerus mordax								
Pholis gunnellus								
Pseudopleuronectes americanus								
Pungitius pungitius		3.00 (2.08)		2.30 (1.04)		1.33 (0.33)		1.67 (1.67)
Salvelinus fontinalis								
Stichaeus punctatus								
Tautogolabrus adspersus		0.67 (0.67)		0.22 (0.22)				
Urophycis tenuis		0.33 (0.33)		0.22 (0.11)				0.33 (0.33)
Zoarces americanus								

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**rivière St-Jean**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata				
Apeltes quadracus	15.67 (2.19)	25.67 (7.88)	2.33 (1.45)	74.00 (26.27)
Clupea harengus				
Cyclopterus lumpus				
Eumicrotremus spinosus				
Fundulus sp.	1.33 (0.33)			0.33 (0.33)
Gadus morhua				
Gasterosteus spp.	497.67 (25.12)	363.33 (112.44)	3141.67 (1405.94)	439.67 (283.06)
Limanda ferruginea				
Liopsetta putnami				
Liparis sp.				
Menidia menidia				12.00 (7.55)
Microgadus tomcod				
Myoxocephalus sp				0.67 (0.67)
Osmerus mordax				
Pholis gunnellus				
Pseudopleuronectes americanus				
Pungitius pungitius	0.33 (0.33)	2.00 (1.15)		5.00 (1.53)
Salvelinus fontinalis				2.00 (2.00)
Stichaus punctatus				
Tautogolabrus adspersus				
Urophycis tenuis				
Zoarces americauns				

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	Sept-Îles						
	2005		2006		2007		2008
	June	Sept.	June	Sept.	June	Sept.	June
Ammodytes spp.							
Anguilla rostrata							
Apeltes quadracus	38.00 (10.97)	83.50 (6.06)	21.33 (3.28)	84.00 (13.01)	7.00 (3.21)	2.50 (0.29)	14.17 (2.92)
Clupea harengus		1.5 (0.87)					
Cyclopterus lumpus							0.6 (0.6
Eumicrotremus spinosus							
Fundulus spp.							
Gadus morhua							0.49 (0.18)
Gasterosteus spp.	66.00 (32.33)	49.00 (19.63)	240.00 (77.50)	216.33 (46.93)	52.00 (18.50)		69.00 (3.40)
Limanda ferruginea							
Liopsetta putnami							0.46 (0.27)
Liparis sp.							
Menidia menidia							
Microgadius tomcod							
Myoxocephalus spp.	0.50 (0.29)					1.00 (0.00)	0.84 (0.25)
Osmerus mordax				1.33 (0.88)			0.18 (0.01)
Pholis gunnellus							
Pseudopleuronectes americanus							1.79 (0.75)
Pungitius pungitius	3.00 (1.73)	3.00 (1.15)					0.53 (0.29)
Salvelinus fontinalis							
Stichaeus punctatus							
Tautogolabrus adspersus							
Urophycis tenuis							
Zoarces americanus							0.17 (0.17)

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Sept-Îles**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.		0.33 (0.33)		
Anguilla rostrata				
Apeltes quadracus	13.00 (3.21)			
Clupea harengus				
Cyclopterus lumpus			0.33 (0.33)	2.00 (0.00)
Eumicrotremus spinosus		0.67 (0.67)		
Fundulus spp.				
Gadus morhua			2.67 (0.88)	1.00 (0.00)
Gasterosteus spp.	21.67 (1.45)	0.33 (0.33)	10.33 (3.18)	6.50 (4.50)
Limanda ferruginea				
Liopsetta putnami		3.33 (0.67)	2.67 (1.67)	0.50 (0.50)
Liparis sp.				
Menidia menidia				
Microgadus tomcod		11.67 (3.18)		1.00 (0.00)
Myoxocephalus spp.		0.33 (0.33)	4.33 (1.33)	1.00 (0.00)
Osmerus mordax		2.67 (0.88)	0.67 (0.33)	
Pholis gunnellus				
Pseudopleuronectes americanus		1.00 (1.00)	10.0 (4.36)	0.50 (0.50)
Pungitius pungitius				
Salvelinus fontinalis				
Stichaeus punctatus				1.00 (1.00)
Tautogolabrus adspersus				
Urophycis tenuis		2.00 (0.00)		
Zoarces americanus			1.00 (1.00)	

Appendix 3 (continued): Mean abundance (± standard error) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Cacouna**		
	2008	**2009**	**2010**
Ammodytes spp.			
Anguilla rostrata			
Apeltes quadracus	0.25 (0.16)	1.29 (1.29)	
Clupea harengus			
Cyclopterus lumpus			
Eumicrotremus spinosus			
Fundulus spp.			
Gadus morhua			
Gasterosteus spp.	30.75 (8.98)	383.14 (212.68)	95.71 (37.73)
Limanda ferruginea			
Liopsetta putnami	0.25 (0.16)	1.14 (0.55)	
Liparis sp.			1.57 (1.25)
Menidia menidia			
Microgadus tomcod			
Myoxocephalus spp.			
Osmerus mordax	0.13 (0.13)		0.14 (0.14)
Pholis gunnellus			
Pseudopleuronectes americanus			
Pungitius pungitius	1.38 (0.91)	5.43 (2.09)	2.00 (0.62)
Salvelinus fontinalis			
Stichaeus punctatus			
Tautogolabrus adspersus			
Urophycis tenuis			
Zoarces americanus			

Appendix 4: Mean abundance (± standard error) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Bassin aux Huîtres**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata	0.33 (0.33)	4.33 (1.20)	25.33 (3.18)	3.67 (1.20)
Apeltes quadracus	82.33 (54.88)	35.67 (6.01)	226.0 (13.0)	80.33 (16.76)
Clupea harengus		2.33 (0.88)		
Fundulus spp.	5625.67 (153.65)	3552.0 (1331.9)	699.0 (120.0)	3681.7 (1703.6)
Gadus morhua				
Gasterosteus spp.	1130.7 (520.9)	195.7 (130.8)	3593.33 (266.7)	182.3 (40.8)
Liopsetta putnami				
Liparis atlanticus				
Liparis sp.				
Mallotus villosus				
Menidia menidia	200.0 (129.7)	906.0 (333.2)	281.0 (188.8)	4616.7 (2698.2)
Microgadus tomcod				
Morone saxatilis				
Myoxocephalus spp.		0.33 (0.33)		
Osmerus mordax			2.33 (1.20)	116.33 (34.98)
Pholis gunnellus				5.67 (5.67)
Pleuronectidae spp.				
Pseudopleuronectes americanus	0.33 (0.58)	3.33 (0.67)	85.33 (47.64)	4.00 (1.15)
Pungitius pungitius	69.00 (36.35)	45.67 (24.44)	221.33 (35.38)	41.67 (27.65)
Salvelinus fontinalis				
Tautogolabrus adspersus	6.33 (2.73)	0.67 (0.67)		
Urophycis sp.				
Urophycis tenuis				
Zoarces americanus				

Appendix 4 (continued): Mean abundance (± standard error) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Penouille**							
	2007		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		21.67 (21.67)		108.33 (47.02)		944.0 (254.50)	0.33 (0.33)	
Anguilla rostrata	0.33 (0.33)	2.67 (0.88)	1.00 (1.00)	0.67 (0.67)	0.67 (0.67)	0.33 (0.33)		3.00 (1.00)
Apeltes quadracus	622.0 (98.0)	31.6 (7.4)	105.33 (51.5)	65.3 (35.3)	1404.0 (339.3)	1.33 (0.6)	300.33 (114.6)	39.3 (13.7)
Clupea harengus	0.67 (0.67)		1.67 (1.20)	1.33 (0.88)				
Fundulus spp.	3.0 (3.0)	246.3 (110.0)	1.6 (0.6)	7.0 (5.0)	19.0 (19.0)	330.6 (320.1)	0.6 (0.6)	83.3 (23.7)
Gadus morhua			0.33 (0.33)				4.33 (3.38)	
Gasterosteus spp.	12593.6 (1822.9)	194.6 (33.3)	1549.6 (1045.5)	34.0 (9.6)	13813.6 (2387.8)	549.6 (482.6)	2859.0 (1891.5)	125.3 (102.3)
Liopsetta putnami	0.3 (0.3)		0.7 (0.7)		1.0 (1.0)	2.0 (0.6)	0.7 (0.3)	
Liparis atlanticus							0.67 (0.33)	
Liparis sp.								
Mallotus villosus								
Menidia menidia				600.6 (513.1)		34.0 (23.1)	0.3 (0.3)	748.6 (462.1)
Microgadus tomcod	10.0 (1.0)	31.3 (9.8)	11.3 (1.8)	108.6 (44.4)	22.0 (7.2)	108.3 (97.8)	8.3 (4.2)	11.3 (2.6)
Morone saxatilis								
Myoxocephalus spp.	0.6 (0.6)	1.3 (0.8)			0.3 (0.3)			
Osmerus mordax	1.3 (1.3)	98.0 (12.1)	2.3 (0.3)	9.3 (6.8)		190.6 (167.1)	2.0 (2.0)	5.6 (1.8)
Pholis gunnellus			0.3 (0.3)		0.3 (0.3)		0.3 (0.3)	0.3 (0.3)
Pleuronectidae spp.								
Pseudopleuronectes americanus	3.0 (0.6)		1.7 (0.3)		4.3 (1.2)		2.0 (1.2)	0.3 (0.3)
Pungitius pungitius		16.3 (13.9)	1.0 (1.0)	26.7 (16.9)	164.0 (118.0)		1.0 (1.0)	3.0 (1.5)
Salvelinus fontinalis								
Tautogolabrus adspersus								
Urophycis sp.								
Urophycis tenuis				0.3 (0.3)				3.3 (1.5)
Zoarces americanus								

Appendix 4 (continued): Mean abundance (± standard error) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Rimouski**									
	2006		**2007**		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.								4.3 (4.3)		
Anguilla rostrata							2.0 (2.0)			
Apeltes quadracus	35.0 (5.9)		12.3 (7.5)	5.3 (3.9)		0.3 (0.3)				0.7 (0.3)
Clupea harengus			0.7 (0.3)					0.3 (0.3)		
Fundulus spp.										
Gadus morhua					2.7 (1.3)				2.0 (1.0)	
Gasterosteus spp.	2804.3 (338.1)	13811.3 (5017.6)	1375.0(469.6)	1825.3 (358.2)	1156.0 (235.6)	395.3 (61.5)	4659.3 (1021.6)	502.7 (157.1)	3489.0 (2055.8)	179.3 (79.3)
Liopsetta putnami			3.0 (1.7)	1.3 (0.7)		3.0 (2.5)	16.7 (7.3)	2.0 (1.2)	2.3 (0.3)	1.3 (0.3)
Liparis atlanticus						0.3 (0.3)				
Liparis sp.										
Mallotus villosus			0.3 (0.3)							
Menidia menidia										
Microgadus tomcod	2.7 (1.7)	0.3 (0.3)		18.0 (1.7)	17.3 (8.7)	5.7 (2.6)	3.7 (2.0)	15.0 (6.4)	36.7 (11.3)	11.0 (4.0)
Morone saxatilis										
Myoxocephalus spp.				0.3 (0.3)	1.3 (0.7)	1.0 (1.0)	1.3 (0.9)		0.7 (0.3)	0.7 (0.7)
Osmerus mordax	967.0 (257.7)	72.7 (7.5)	2058.3 (1053.3)	246.7 (125.9)	1567.5 (302.2)	57.7 (14.1)	4171.0 (1899.0)	134.0 (69.8)	779.7 (316.0)	115.7 (31.4)
Pholis gunnellus										
Pleuronectidae spp.										
Pseudopleuronectes americanus			0.7 (0.7)		0.7 (0.3)					1.7 (0.7)
Pungitius pungitius					6.7 (3.3)	0.7 (0.7)				
Salvelinus fontinalis										
Tautogolabrus adspersus										
Urophycis sp.										
Urophycis tenuis										
Zoarces americanus										

Appendix 4 (continued): Mean abundance (± standard error) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**rivière St-Jean**									
	2006		**2007**		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.				0.3 (0.3)	0.3 (0.3)		0.3 (0.3)		1.0 (0.0)	
Anguilla rostrata	0.7 (0.3)	2.3 (1.3)	2.0 (1.0)	3.3 (1.8)	2.0 (1.0)	1.7 (0.7)	5.0 (3.5)	4.3 (0.7)	0.3 (0.3)	2.7 (0.9)
Apeltes quadracus	5.7 (4.2)	10.0 (1.0)	4.0 (1.5)	130.7 (63.7)	640.0 (421.4)	921.7 (416.1)	277.7 (28.3)	76.0 (6.0)	181.0 (43.3)	65.3 (14.4)
Clupea harengus		0.3 (0.3)	0.7 (0.7)			0.7 (0.3)				
Fundulus spp.	0.3 (0.3)	22.7 (12.7)	3.3 (2.8)	553.0 (380.8)	0.7 (0.3)	67.7 (41.7)		20.3 (9.2)	0.7 (0.3)	6.3 (3.8)
Gadus morhua					1.3 (1.3)					
Gasterosteus spp.	1701.3 (1079.3)	15.7 (11.8)	13335.7 (4024.7)	1929.7 (1255.6)	18814.3 (3671.7)	83.0 (34.5)	13031.0 (5624.3)	402.7 (200.1)	18793.7 (262.3)	262.3 (120.5)
Liopsetta putnami										0.3 (0.3)
Liparis atlanticus										
Liparis sp.										
Mallotus villosus	0.3 (0.3)		0.3 (0.3)		5.7 (0.3)		0.3 (0.3)			
Menidia menidia						15.7 (8.5)				7.0 (4.7)
Microgadus tomcod		1.0 (0.0)	0.3 (0.3)	1.3 (0.7)		0.7 (0.7)		1.3 (0.3)		1.0 (1.0)
Morone saxatilis										
Myoxocephalus spp.	0.3 (0.3)	3.7 (2.7)		0.3 (0.3)		0.3 (0.3)	1.0 (0.6)			0.3 (0.3)
Osmerus mordax		7.7 (5.0)		2.7 (2.7)		0.3 (0.3)			0.7 (0.7)	
Pholis gunnellus					1.0 (0.6)		0.3 (0.3)		1.3 (0.9)	
Pleuronectidae spp.										
Pseudopleuronectes americanus					0.7 (0.3)				0.3 (0.3)	0.7 (0.7)
Pungitius pungitius	0.3 (0.3)	9.3 (3.5)		15.7 (8.1)	0.3 (0.3)	48.3 (28.3)	0.7 (0.7)	45.3 (8.0)		13.0 (5.0)
Salvelinus fontinalis	0.3 (0.3)			0.3 (0.3)	1.0 (0.6)	0.3 (0.3)	0.3 (0.3)			
Tautogolabrus adspersus										
Urophycis sp.										
Urophycis tenuis	0.3 (0.3)									1.0 (0.6)
Zoarces americanus			0.3 (0.3)							

Appendix 4 (continued): Mean abundance (± standard error) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Sept-Îles**									
	2006		**2007**		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		65.0 (65.0)				17.7 (17.7)		1702.0 (1006.2)	1.0 (0.6)	653.9 (301.1)
Anguilla rostrata	0.3 (0.3)	1.3 (0.9)				0.3 (0.3)	0.3 (0.3)		0.3 (0.3)	0.6 (0.1)
Apeltes quadracus	167.7 (13.2)	261.7 (26.3)	10.7 (1.7)	2.0 (0.6)	11.3 (5.9)	12.3 (5.2)	3.0 (1.2)	27.7 (14.2)	14.3 (9.1)	70.8 (1.8)
Clupea harengus	1.0 (0.6)	0.3 (0.3)	7.7 (5.2)		2.0 (1.0)	0.3 (0.3)	2.0 (2.0)	0.7 (0.7)		0.1 (0.1)
Fundulus spp.										
Gadus morhua					0.3 (0.3)				2.0 (1.5)	
Gasterosteus spp.	2064.3 (232.2)	109.7 (52.2)	1110.0 (103.6)	71.0 (25.2)	1637.0 (934.0)	42.7 (24.2)	304.7 (57.2)	61.7 (21.7)	392.0 (111.2)	75.9 (2.9)
Liopsetta putnami	1.7 (0.7)	0.7 (0.7)	2.3 (1.5)		10.3 (0.3)	0.3 (0.3)	3.7 (1.2)	1.7 (1.2)	5.7 (1.5)	0.8 (0.3)
Liparis atlanticus										
Liparis sp.										
Mallotus villosus					0.3 (0.3)					
Menidia menidia						0.7 (0.7)				0.3 (0.3)
Microgadus tomcod	29.3 (1.7)	62.3 (11.8)	4.0 (1.2)	26.3 (2.8)	204.7 (31.5)	41.7 (9.5)	12.3 (1.5)	3.3 (0.9)	52.0 (24.3)	30.1 (7.4)
Morone saxatilis										
Myoxocephalus spp.	1.7 (0.3)	3.3 (1.7)	3.7 (1.2)	6.0 (0.6)	17.0 (3.0)	2.3 (0.3)	2.0 (0.0)		4.7 (2.7)	2.8 (0.8)
Osmerus mordax	16.7 (6.3)	32.7 (16.4)	10.7 (4.7)	8.3 (4.9)	81.0 (26.5)	81.7 (71.8)	21.7 (5.9)	57.3 (14.4)	125.0 (84.2)	54.0 (16.0)
Pholis gunnellus										
Pleuronectidae spp.				0.3 (0.3)						0.1 (0.1)
Pseudopleuronectes americanus	0.3 (0.3)	1.3 (1.3)	1.3 (1.3)		8.3 (1.3)	1.0 (0.0)	1.0 (0.6)	0.3 (0.3)	3.0 (0.6)	0.9 (0.4)
Pungitius pungitius				1.7 (1.2)		6.7 (3.8)		0.7 (0.7)	0.7 (0.7)	3.1 (1.9)
Salvelinus fontinalis										
Tautogolabrus adspersus								0.3 (0.3)		0.1 (0.1)
Urophycis sp.								0.3 (0.3)		0.1 (0.1)
Urophycis tenuis				0.3 (0.3)		0.3 (0.3)		0.7 (0.7)		0.5 (0.3)
Zoarces americanus										

Appendix 4 (continued): Mean abundance (± standard error) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	Cacouna		
	2008	**2009**	**2010**
Ammodytes spp.			
Anguilla rostrata			0.2 (0.2)
Apeltes quadracus	0.2 (0.2)	0.83 (0.5)	0.2 (0.2))
Clupea harengus		0.3 (0.2)	0.2 (0.2)
Fundulus spp.			
Gadus morhua			
Gasterosteus spp.	724.0 (324.2)	1533.0 (948.0)	4812.3 (2674.1)
Liopsetta putnami	3.5 (1.1)	9.5 (4.8)	3.5 (1.6)
Liparis atlanticus	7.0 (6.6)	0.3 (0.3)	4.2 (3.6)
Liparis sp.			
Mallotus villosus			
Menidia menidia			
Microgadus tomcod	37.8 (7.4)	44.8 (8.3)	109.5 (30.5)
Morone saxatilis		0.2 (0.2)	
Myoxocephalus spp.			0.3 (0.3)
Osmerus mordax	203.3 (50.6)	96.5 (31.3)	112.2
Pholis gunnellus			
Pleuronectidae spp.			
Pseudopleuronectes americanus	0.2 (0.2)		
Pungitius pungitius	2.8 (2.0)	2.8 (1.2)	5.0 (2.1)
Salvelinus fontinalis			
Tautogolabrus adspersus			
Urophycis sp.			
Urophycis tenuis			0.5 (0.3)
Zoarces americanus			

Appendix 5: Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Bassin aux Huîtres**									
	2005		**2006**		**2007**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.				336.0 (243.0;2)						840 (0.0;1)
Anguilla rostrata										
Apeltes quadracus	42.7 (1.6;103)	40.4 (0.8;90)	40.8 (0.4;70)	33.4 (0.7; 90)	39.3 (0.7;51)	38.2 (0.9;63)	44.6 (0.7;85)	36.6 (1.0;58)	46.4 (0.6;121)	32.8 (0.5;88)
Clupea harengus						61.8 (7.2;4)				
Cyclopterus lumpus										
Eumicrotremus spinosus										
Fundulus spp.	66.7 (2.2;93)	56.7 (2.4;91)	66.0 (0.0;1)	38.1 (0.7;67)	61.7 (6.5;6)	57.2 (2.4;43)	72.4 (2.7;30)	39.3 (1.7;32)	65.7 (4.0;24)	46.3 (1.8;51)
Gadus morhua										
Gasterosteus spp.	46.4 (1.1;79)	39.7 (3.3;10)	42.3 (0.5;82)	28.1 (1.6;21)	43.7 (1.3;34)	45.0 (11.0;3)	45.5 (0.8;91)	49.5 (5.4;10)	44.0 (0.7;89)	30.6 (0.8;47)
Limanda ferruginea	161.3 (43.6;3)	82.7 (5.2;10)								
Liopsetta putnami										
Liparis sp.										
Menidia menidia	88.2 (2.0;62)	66.9 (2.6;67)	79.2 (7.4;5)	65.4 (4.0;17)		49.0 (2.5;42)	93.3 (1.1;37)	38.3 (2.2;68)	83.9 (2.4;19)	46.3 (1.4;32)
Microgadus tomcod										
Myoxocephalus spp.										
Osmerus mordax										
Pholis gunnellus						85.0 (0.0;1)				
Pseudopleuronectes Americanus			132.3 (1.1;4)	62.5 (23.4;4)	117.3 (13.6;7)	244.0 (0.0;1)	136.0 (83.0;2)		228.7 (32.6;6)	120.0 (6.1;3)
Pungitius pungitius	52.8 (1.5;11)	44.1 (0.9;13)	49.0 (0.0;1)	40.4 (0.8;52)	47.2 (2.8;10)	47.4 (4.1;7)	40.0 (0.0;1)	46.1 (1.0;51)	47.0 (0.0;1)	40.4 (0.9;8)
Salvelinus fontinalis										
Stichaeus punctatus										
Tautogolabrus adspersus		65.9 (16.5;8)		30.6 (1.5;5)		32.0 (0.0;1)	49.4 (1.8;15)	29.0 (3.0;2)	56.0 (0.0;1)	49.5 (1.5;2)
Urophycis tenuis								51.0 (0.0;1)		
Zoarces americanus										

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Penouille**							
	2007		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		77.8 (1.4;34)		81.0 (3.1;3)		86.9 (2.2;29)	80.3 (1.9;4)	68.0 (9.5;3)
Anguilla rostrata								
Apeltes quadracus	39.6 (0.6;67)	29.5 (1.1;30)	42.2 (0.9;64)	35.1 (0.8;90)	37.9 (0.7;83)	28.9 (1.0;86)	39.6 (0.8;90)	35.5 (1.1;89)
Clupea harengus								
Cyclopterus lumpus								
Eumicrotremus spinosus								
Fundulus spp.	56.0 (22.0;2)	35.0 (2.0;20)	39.9 (1.5;7)	45.0 (6.0;8)	40.3 (0.8;52)	65.0 (0.0;1)		37.2 (4.0;6)
Gadus morhua								
Gasterosteus spp.	61.3 (0.7;90)	18.7 (0.6;41)	61.2; 0.8;94)	25.5 (2.0;26)	54.4 (1.0;125)	23.8 (0.6;151)	59.5 (1.1;90)	26.3 (0.6;117)
Limanda ferruginea								
Liopsetta putnami							45.0 (0.0;1)	
Liparis sp.								
Menidia menidia						67.0 (3.0;2)		50.8 (1.5;51)
Microgadus tomcod								
Myoxocephalus spp.								
Osmerus mordax		44.0 (6.0;3)		66.8 (3.0;22)				
Pholis gunnellus								
Pseudopleuronectes Americanus	76.0 (6.0;2)							52.0 (0.0;1)
Pungitius pungitius			55.5 (0.6;4)	54.6 (0.8;40)	54.0 (1.8;21)	52.3 (2.4;6)		39.3 (8.2;3)
Salvelinus fontinalis								
Stichaeus punctatus								
Tautogolabrus adspersus								
Urophycis tenuis								
Zoarces americanus								

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Rimouski**							
	2005		**2006**		**2007**		**2008**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.								
Anguilla rostrata								
Apeltes quadracus	40.0 (0.0;1)	32.3 (0.7;94)	34.2 (0.7;34)		47.0 (1.9;12)	37.7 (1.8;18)	40.5 (0.5;2)	43.6 (1.7;16)
Clupea harengus		42.0 (2.0;2)						
Cyclopterus lumpus								
Eumicrotremus spinosus								
Fundulus spp.								
Gadus morhua								
Gasterosteus spp.	69.4 (0.7;134)	27.5 (0.3;105)	72.0 (0.7;90)	33.7 (0.5;90)	69.8 (1.0;90)	35.1 (1.1;90)	59.6 (1.3;57)	33. 0 (1.2;90)
Limanda ferruginea								
Liopsetta putnami								
Liparis sp.								
Menidia menidia								
Microgadus tomcod								
Myoxocephalus spp.								
Osmerus mordax	50.7 (1.1;6)	96.0 (0.0;1)		49.6 (0.7;16)	58.1 (1.5;47)	50.5 (0.5;86)		
Pholis gunnellus								
Pseudopleuronectes americanus	48.0 (1.0;2)		39.8 (2.3;4)		52.0 (0.0;1)			
Pungitius pungitius		44.0 (0.0;1)				54.2 (1.5;9)		58.3 (2.7;3)
Salvelinus fontinalis								
Stichaeus punctatus								
Tautogolabrus adspersus								
Urophycis tenuis								
Zoarces americanus								

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Rimouski**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata				
Apeltes quadracus				45.0 (2.2;9)
Clupea harengus				
Cyclopterus lumpus				
Eumicrotremus spinosus				
Fundulus spp.				
Gadus morhua				
Gasterosteus spp.	70.5 (0.5;150)	24.2 (1.1;60)	71.6 (1.2;52)	42.7 (1.7;91)
Limanda ferruginea				
Liopsetta putnami				
Liparis sp.				
Menidia menidia				
Microgadus tomcod				
Myoxocephalus spp.				
Osmerus mordax	54.9 (1.2;62)		52.0 (0.0;1)	
Pholis gunnellus				
Pseudopleuronectes americanus				
Pungitius pungitius				53.4 (1.6;7)
Salvelinus fontinalis				
Stichaeus punctatus				
Tautogolabrus adspersus				
Urophycis tenuis				
Zoarces americanus				

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010. In September 2006, there were no measures on catches.

Species	**rivière St-Jean**							
	2005		**2006**		**2007**		**2008**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		63.0 (0.0;1)						
Anguilla rostrata								
Apeltes quadracus		24.3 (0.8;98)	37.0 (0.0;1)		37.0 (3.6;4)	29.8 (1.1;63)	36.0 (1.8;4)	29.9 (0.9;88)
Clupea harengus		47.8 (1.3;14)						
Cyclopterus lumpus								
Eumicrotremus spinosus								33.6 (4.0;18)
Fundulus spp.		29.4 (1.6;43)	96.0 (0.0;1)		82.0 (0.0;1)	33.9 (2.1;54)		
Gadus morhua								
Gasterosteus sp	55.9 (0.9;90)	16.6 (0.8;58)	65.8 (0.8;90)		60.5 (0.8;90)	22.5 (0.9;82)	62.4 (0.7;90)	28.6 (2.0;18)
Limanda ferruginea								
Liopsetta putnami								
Liparis sp.								
Menidia menidia								56.5 (9.4;4)
Microgadus tomcod								
Myoxocephalus spp.		62.0 (0.0;1)						
Osmerus mordax								
Pholis gunnellus								
Pseudopleuronectes americanus								
Pungitius pungitius		39.0 (1.8;9)				48.3 (6.7;4)		50.0 (2.4;5)
Salvelinus fontinalis								
Stichaeus punctatus								
Tautogolabrus adspersus		29.0 (3.0;2)						
Urophycis tenuis		61.0 (0.0;1)						70.0 (0.0;1)
Zoarces americanus								

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**rivière St-Jean**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata				
Apeltes quadracus	37.5 (0.9;47)	26.6 (0.9;70)	32.6 (1.8;7)	30.7 (0.6;89)
Clupea harengus				
Cyclopterus lumpus				
Eumicrotremus spinosus				
Fundulus spp.		54.0 (6.3;4)		51.0 (0.0;1)
Gadus morhua				
Gasterosteus spp.	60.1 (1.0;95)	20.2 (0.4;108)	62.2 (1.0;90)	23.4 (0.6;90)
Limanda ferruginea				
Liopsetta putnami				
Liparis sp.				
Menidia menidia				73.3 (2.2;36)
Microgadus tomcod				
Myoxocephalus spp.				68.0 (2.0;2)
Osmerus mordax				
Pholis gunnellus				
Pseudopleuronectes americanus				
Pungitius pungitius	54.0 (0.0;1)	47.2 (2.1;6)		42.9 (1.3;15)
Salvelinus fontinalis			136.2 (1.9;5)	
Stichaus punctatus				
Tautogolabrus adspersus				
Urophycis tenuis				
Zoarces americauns				

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010. In June 2008, there were no measures on catches.

Species	**Sept-Îles**						
	2005		**2006**		**2007**		**2008**
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**
Ammodytes spp.							
Anguilla rostrata							
Apeltes quadracus	32.8 (0.8;49)	37.7 (0.8;60)	39.2 (0.8;64)	30.6 (0.9;90)	41.3 (1.6;21)	45.0 (4.0;2)	
Clupea harengus		38.0 (0.0; 3)					
Cyclopterus lumpus							
Eumicrotremus spinosus							
Fundulus spp.							
Gadus morhua							
Gasterosteus sp	44.9 (2.3;40)	24.4 (0.7; 45)	69.3 (0.7;90)	24.5 (0.7;89)	68.2 (0.9;83)		
Limanda ferruginea							
Liopsetta putnami							
Liparis sp.							
Menidia menidia							
Microgadius tomcod							
Myoxocephalus spp.	60.0 (0.0;1)					45.0 (4.0;2)	
Osmerus mordax				36.8 (1.6;4)			
Pholis gunnellus							
Pseudopleuronectes americanus							
Pungitius pungitius	35.3 (0.4;6)	48.7 (2.0;6)					
Salvelinus fontinalis							
Stichaeus punctatus							
Tautogolabrus adspersus							
Urophycis tenuis							
Zoarces americanus							

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010. In September 2009, there were no measures on catches.

Species	**Sept-Îles**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata				
Apeltes quadracus				
Clupea harengus				
Cyclopterus lumpus			61.0 (0.0;1)	20.5 (1.6;4)
Eumicrotremus spinosus				
Fundulus spp.				
Gadus morhua			87.5 (1.4;8)	101.5 (23.5;2)
Gasterosteus spp.	67.6 (1.6;8)		62.9 (1.6;31)	63.1 (1.9;13)
Limanda ferruginea				
Liopsetta putnami			111.3 (16.2;8)	187.0 (0.0;1)
Liparis sp.				
Menidia menidia				
Microgadus tomcod				262.0 (10.0;2)
Myoxocephalus sp.			85.8 (6.7;13)	84.5 (24.5;2)
Osmerus mordax	74.0 (0.0;1)		145.5 (2.5;2)	
Pholis gunnellus				
Pseudopleuronectes americanus			10.0 (4.36)	98.0 (0.0;1)
Pungitius pungitius				
Salvelinus fontinalis				
Stichaeus punctatus				68.0 (1.0;2)
Tautogolabrus adspersus				
Urophycis tenuis				
Zoarces americanus			68.7 (2.0;3)	

Appendix 5 (continued): Mean length (mm) (± standard error; N) of fish caught using seines in eelgrass beds between 2005 and 2010.

Species	**Cacouna**		
	2008	**2009**	**2010**
Ammodytes spp.			
Anguilla rostrata			
Apeltes quadracus	40.0 (0.0;1)	38.2 (1.7;9)	
Clupea harengus			
Cyclopterus lumpus			
Eumicrotremus spinosus			
Fundulus spp.			
Gadus morhua			
Gasterosteus spp.	30.4 (0.3;158)	29.1 (0.4;119)	29.8 (0.4;182)
Limanda ferruginea			
Liopsetta putnami	63.0 (1.0;2)	63.3 (3.6;8)	
Liparis sp.			
Menidia menidia			24.2 (1.0;11)
Microgadus tomcod			
Myoxocephalus spp.			
Osmerus mordax	107.0 (0.0;1)		
Pholis gunnellus			
Pseudopleuronectes americanus			
Pungitius pungitius	41.7 (2.8;11)	48.3 (1.3;38)	53.8 (2.3;14)
Salvelinus fontinalis			
Stichaeus punctatus			
Tautogolabrus adspersus			
Urophycis tenuis			
Zoarces americanus			

Appendix 6: Mean length (mm) (± standard error; N) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Bassin aux Huîtres**			
	2009		**2010**	
	June	**Sept.**	**June**	**Sept.**
Ammodytes spp.				
Anguilla rostrata	142.0 (0.0;1)	298.7 (56.9;13)	175.5 (15.5;76)	152.1 (9.7;11)
Apeltes quadracus	46.4 (1.2;28)	44.0 (3.8;7)	46.2 (1.2;77)	36.7 (2.1;7)
Clupea harengus		95.9 (14.0;7)		
Fundulus spp.	80.6 (1.7;90)	49.6 (1.4;120)	46.2 (1.2; 9)	59.4 (1.6;107)
Gadus morhua				
Gasterosteus spp.	49.6 (1.0;108)	51.8 (2.5;34)	47.0 (0.5;180)	36.4; 2.4;16)
Liopsetta putnami				
Liparis atlanticus				
Liparis sp.				
Mallotus villosus				
Menidia menidia	88.3 (1.0;60)	58.5 (1.6;110)	88.1 (2.4;38)	71.3 (2.0;96)
Microgadus tomcod		139.3 (30.6;13)	195.3 (30.0;4)	
Morone saxatilis				
Myoxocephalus spp.		163.0 (0.0;1)		
Osmerus mordax		191.9 (14.2;7)	187.8 (6.7;14)	248.5 (27.1;12)
Pholis gunnellus			155.0 (0.0;1)	
Pleuronectidae spp.				
Pseudopleuronectes americanus	152.6 (29.5;9)	235.9 (31.5;10)	154.2 (23.3;10)	
Pungitius pungitius	52.3 (1.6;23)	46.9 (1.3;20)	51.9 (1.4;27)	46.3 (4.0;4)
Salvelinus fontinalis				
Tautogolabrus adspersus	53.3 (1.0;8)	71.0 (5.0;2)		
Urophycis sp.				
Urophycis tenuis				
Zoarces americanus				

Appendix 6 (continued): Mean length (mm) (± standard error; N) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Penouille**							
	2007		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		86.0 (0.9;30)		93.2 (1.1;75)		82.1 (0.9;100)	114.0 (0.0;1)	
Anguilla rostrata	269.0 (0.0;1)	258.5 (37.0;8)	469.0 (104.1;3)	175.0 (40.0;2)	375.0 (115.0;2)	185.0 (0.0;1)		299.6 (40.8 9)
Apeltes quadracus	47.6 (1.1;35)	36.5 (0.6;79)	47.9 (0.8;90)	38.2 (0.7;79)	41.7 (0.7;89)	36.8 (4.0;4)	44.3 (0.8;90)	41.7 (0.9;53)
Clupea harengus	139.5 (7.5;2)		137.8 (16.2;5)	66.5 (3.3;4)				
Fundulus spp.	65.4 (2.0;9)	41.8 (1.3;90)	45.8 (6.7;5)	53.2 (4.0;21)	76.0 (0.0;1)	71.7 (1.3;76)	70.5 (4.5;2)	49.1 (2.5;79)
Gadus morhua			83.0 (0.0;1)				80.9 (1.9;13)	
Gasterosteus spp.	63.0 (1.0;90)	23.3 (0.9 90)	54.5 (1.6;90)	30.2 (0.7;76)	54.4 (1.1;143)	28.1 (0.7;133)	68.8 (1.0;90)	28.5 (0.9;66)
Liopsetta putnami	188.0 (0.0;1)		112.0 (10.0;2)		159.3 (13.4;1)	141.7 (3.8;6)	69.5 (6.5;2)	
Liparis atlanticus							97.0 (2.0;2)	
Liparis sp.								
Mallotus villosus								
Menidia menidia				70.9 (1.0;90)		72.6 (2.4;27)	82.0 (0.0;1)	67.5 (0.9;90)
Microgadus tomcod	150.4 (3.0;30)	140.2 (4.8;74)	165.8 (3.0;34)	148.9 (4.9;80)	163.6 (2.6;61)	135.1 (8.1;40)	165.7 (9.7;11)	208.3 (9.2;34)
Morone saxatilis								
Myoxocephalus spp.	92.0 (1.0;2)	64.5 (2.1;4)			140.0 (0.0;1)			
Osmerus mordax	54.8 (3.8;4)	68.4 (3.1;90)	96.1 (3.6;7)	169.2 (4.3;28)		158.6 (2.4;77)	81.5 (8.4;6)	158.4 (4.7;17)
Pholis gunnellus			153.0 (0.0;1)		126.0 (0.0;1)		150.0 (0.0;1)	160.0 (0.0;1)
Pleuronectidae spp.								
Pseudopleuronectes americanus	162.2 (22.4;9)		207.8 (26.4;5)		146.5 (18.2;13)		156.5 (21.7;6)	130.0 (0.0;1)
Pungitius pungitius		53.4 (1.0;35)	63.0 (2.0;3)	56.0 (0.8;50)	53.8 (1.8;9)		54.7 (1.5;3)	54.3 (2.0;9)
Salvelinus fontinalis								
Tautogolabrus adspersus								
Urophycis sp.								
Urophycis tenuis				79.0 (0.0;1)				82.7 (3.3;1)
Zoarces americanus								

Appendix 6 (continued): Mean length (mm) (± standard error; N) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Rimouski**									
	2006		**2007**		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.								86.4 (0.9;11)		
Anguilla rostrata							270.7 (20.8;6)			
Apeltes quadracus	40.2 (1.6;13)		52.0 (1.0;2)	49.0 (5.2;4)						35.5 (5.5;2)
Clupea harengus			124.0 (22.0;2)					119.0 (0.0;1)		
Fundulus sp.										
Gadus morhua					89.3 (7.6;4)				80.5 (14.0;6)	
Gasterosteus spp.	72.8 (0.9;91)	36.0 (0.4;90)	73.3 (1.0;90)	37.7 (0.9;90)	66.4 (1.1;62)	31.3 (1.2;90)	72.8 (0.6;120)	40.3 (2.2;90)	74.5 (0.6;91)	41.6 (1.8;93)
Liopsetta putnami			99.7 (10.9;9)	126.3 (2.9;4)		99.6 (9.4;9)	91.2 (2.7;50)	127.4 (20.9;8)	126.1 (19.7;7)	135.0 (13.7;4)
Liparis atlanticus						66.0 (0.0;1)				
Liparis sp.										
Mallotus villosus			140.0 (0.0;1)							
Menidia menidia										
Microgadus tomcod	120.8 (4.6;8)	175.0 (0.0;1)		149.9 (3.9;54)	118.0 (2.9;26)	169.0 (11.7;17)	165.2 (10.0;10)	151.9 (4.6;45)	133.9 (1.4;60)	191.7 (5.6;33)
Morone saxatilis										
Myoxocephalus spp.				119.0 (0.0;1)	107.5 (8.5;2)	94.3 (5.9;3)	134.3 (5.0;4)		95.0 (42.0;2)	98.0 (1.0;2)
Osmerus mordax	72.3 (2.2;81)	72.2 (3.4;90)	70.8 (2.2;90)	95.7 (4.1;92)		67.2 (2.9;90)		93.7 (3.3;72)	90.9 (4.4;90)	97.2 (4.0;90)
Pholis gunnellus										
Pleuronectidae spp.										
Pseudopleuronectes americanus			59.5 (0.5;2)		131.0 (0.0;1)					114.2 (14.6;5)
Pungitius pungitius					52.0 (0.0;1)	56.0 (0.0;2)				
Salvelinus fontinalis										
Tautogolabrus adspersus										
Urophycis sp.										
Urophycis tenuis										
Zoarces americanus										

Appendix 6 (continued): Mean length (mm) (± standard error; N) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	rivière St-Jean									
	2006		2007		2008		2009		2010	
	June	Sept.	June	Sept.	June	Sept.	June	Sept.	June	Sept.
Ammodytes spp.				60.0 (0.0;1)	110.0 (0.0;1)				101.7 (12.0;3)	
Anguilla rostrata	373.0 (75.0;2)	164.4 (40.8;7)	378.0 (38.9;6)	210.2 (25.4;10)	416.8 (28.0;6)	246.2 (93.3;5)	361.9 (41.9;15)	346.7 (30.0;13)	602.0 (0.0;1)	443.6 (54.3;8)
Apeltes quadracus	39.4 (1.0;17)	41.9 (1.1;30)	41.6 (2.0;12)	32.8 (0.6;116)	43.6 (1.0;48)	31.8 (0.7;90)	44.8 (1.0;37)	38.0 (0.8;91)	38.1 (2.0;12)	32.6 (0.6;90)
Clupea harengus		183.0 (0.0;1)	265.5 (0.5;2)			91.0 (1.0; 2)				
Fundulus spp.	41.0 (0.0;1)	45.2 (2.3;50)	65.2 (1.8;10)	39.3 (2.2;90)	46.5 (6.5;2)	36.4 (1.9;82)		58.5 (2.5;61)	65.5 (5.5;2)	38.7 (2.4;19)
Gadus morhua					82.0 (1.5; 4)					
Gasterosteus spp.	67.7 (0.9;90)	34.5 (1.7;38)	63.1 (0.8;90)	21.3 (1.0;151)	62.9 (0.8;90)	42.0 (1.8;74)	55.6 (1.2;125)	33.1 (1.0;164)	65.2 (0.9;90)	27.9 (1.1;88)
Liopsetta putnami										278.0 (0.0;1)
Liparis atlanticus										
Liparis sp.										
Mallotus villosus	157.0 (0.0;1)		158.0 (0.0;1)		155.2 (1.6;17)		150.0 (0.0;1)			
Menidia menidia						67.8 (1.6;47)				69.2 (2.4;21)
Microgadus tomcod		185.7 (41.5;3)	117.0 (0.0;1)	266.5 (9.7;4)		219.0 (59.0;2)		216.5 (27.5;4)		233.7 (5.7;3)
Morone saxatilis										
Myoxocephalus spp.	141.0 (0.0;1)	64.1 (2.8;11)		108.0 (0.0;1)		112.0 (0.0;1)	139.0 (2.3;3)			75.0 (0.0;1)
Osmerus mordax		75.3 (3.4; 23)		47.4 (2.7; 8)		151.0 (0.0; 1)			73.0 (0.0; 2)	
Pholis gunnellus					162.3 (16.3;3)		130.0 (0.0;1)		177.5 (9.5;4)	
Pleuronectidae spp.										
Pseudopleuronectes americanus					233.0 (25.0;2)				210.0 (0.0;1)	184.5 (24.5;2)
Pungitius pungitius	34.0 (0.0;1)	47.3 (1.0;28)		47.5 (1.0;47)	48.0 (0.0;1)	50.4 (0.9;64)	44.5 (12.5;2)	44.6 (0.7; 90)		45.2 (1.3;39)
Salvelinus fontinalis	198.0 (0.0;1)			245.0 (0.0;1)	143.0 (4.0;3)	245.0 (0.0;1)	170.0 (0.0;1)			
Tautogolabrus adspersus										
Urophycis sp.			198.0 (0.0;1)							
Urophycis tenuis	261.02 (0.0;1)									80.0 (5.1;3)
Zoarces americanus										

Appendix 6 (continued): Mean length (mm) (± standard error; N) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	**Sept-Îles**									
	2006		**2007**		**2008**		**2009**		**2010**	
	June	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**	**June**	**Sept.**
Ammodytes spp.		82.2 (0.9;31)				77.0 (1.3;30)		76.3 (0.5;91)	72.5 (11.5;2)	
Anguilla rostrata	158.0 (0.0;1)	183.5 (32.1;4)				521.0 (0.0;1)	403.0 (0.0;1)		526.0 (0.0;1)	
Apeltes quadracus	43.7 (0.7;90)	34.6 (0.5;90)	44.1 (1.3;32)	36.3 (3.4;6)	45.5 (1.3;34)	41.8 (0.9;37)	50.0 (2.8;9)	38.0 (0.5;56)	43.8 (1.2;41)	
Clupea harengus	94.0 (15.6;3)	166.0 (0.0;1)	78.8 (3.3;23)		167.2 (4.6;6)	64.0 (0.0;1)	39.7 (1.3;6)	64.5 (4.5;2)		
Fundulus spp.										
Gadus morhua					60.0 (0.0;1)				93.2 (2.7;6)	
Gasterosteus spp.	72.8 (1.0;90)	29.1 (0.9;74)	72.0 (0.8;92)	39.8 (0.4;98)	63.3 (1.3;111)	33.2 (0.6;68)		29.9 (0.7;140)	55.1 (1.3;172)	34.5 (0.8;32)
Liopsetta putnami	144.0 (6.1;4)	140.0 (10.0;2)	108.0 (19.7;7)		130.9 (4.2;31)	157.0 (0.0;1)	146.8 (10.0;11)	152.6 (25.2;5)	125.6 (10.8;16)	
Liparis atlanticus										
Liparis sp.										
Mallotus villosus					127.0 (0.0;1)					
Menidia menidia						34.5 (1.5;2)				
Microgadus tomcod	156.5 (1.3;86)	179.5 (5.4;90)	184.3 (9.7;12)	200.7 (6.3;77)	158.5 (2.7;90)	211.7 (6.0;85)	167.0 (6.3;37)	142.7 (13.2;10)	169.9 (1.8;77)	225.7 (7.1;6)
Morone saxatilis										
Myoxocephalus spp.	99.0 (6.0;5)	104.1 (4.0;10)	104.5 (5.1;11)	125.7 (5.5;18)	74.7 (2.7;51)	108.9 (8.6;7)	98.3 (4.6;6)		89.0 (4.7;14)	
Osmerus mordax	79.4 (3.5;50)	93.3 (7.5;63)	77.8 (5.6;32)	154.8 (12.9;25)	170.3 (4.1;90)	99.7 (10.5;50)	120.0 (7.2;65)	63.9 (4.5;89)	82.3 (3.5;70)	113.2 (1.9;6)
Pholis gunnellus										
Pleuronectidae spp.				132.0 (0.0;1)						
Pseudopleuronectes americanus	119.0 (0.0;1)	122.5 (16.2;4)	79.0 (1.4;4)		110.1 (3.5;25)	145.7 (17.0;3)	223.3 (38.0;3)	56.0 (0.0;1)	174.7 (30.6;9)	
Pungitius pungitius				43.4 (1.2;5)		45.8 (1.3;20)		50.5 (4.5;2)	50.0 (1.0;2)	
Salvelinus fontinalis										
Tautogolabrus adspersus								31.0 (0.0;1)		
Urophycis sp.								145.0 (0.0;1)		
Urophycis tenuis				151.0 (0.0;1)		150.0 (0.0;1)		130.0 (7.0;2)		
Zoarces americanus										

Appendix 6 (continued): Mean length (mm) (± standard error; N) of fish caught using hoop nets in eelgrass beds between 2006 and 2010.

Species	Cacouna		
	2008	2009	2010
Ammodytes spp.			
Anguilla rostrata			347.0 (0.0;1)
Apeltes quadracus	47.0 (0.0;1)	31.0 (0.6;5)	38.0 (0.0;1)
Clupea harengus		193.5 (73.5;2)	312. 0 (0.0;1)
Fundulus spp.			
Gadus morhua			
Gasterosteus spp.	31.9 (0.4;180)	31.5 (0.6;169)	33.1 (0.5;180)
Liopsetta putnami	67.1(1.4;21)	66.7 (2.8;41)	117.1 (9.3;21)
Liparis atlanticus	81.4 (3.5;32)		
Liparis sp.		50.5 (8.5;2)	35.5 (4.2;25)
Mallotus villosus			
Menidia menidia			
Microgadus tomcod	140.8 (3.2;170)	180.5 (1.8;166)	203.4 (1.7;178)
Morone saxatilis		57.0 (0.0;1)	
Myoxocephalus spp.			89.0 (2.0;2)
Osmerus mordax	116 (2.0;180)	132.9 (1.8;164)	110.9 (2.9;174)
Pholis gunnellus			
Pleuronectidae spp.			
Pseudopleuronectes americanus	77.0 (0.0;1)		
Pungitius pungitius	55.0 (1.0;17)	53.3 (1.3;12)	54.2 (1.4;30)
Salvelinus fontinalis			
Tautogolabrus adspersus			
Urophycis sp.			
Urophycis tenuis			241.3 (16.7;3)
Zoarces americanus			