RECREATIONAL FISHERY CATCHES, SPAWNER ABUNDANCE, AND BIOLOGICAL CHARACTERISTICS OF STRIPED BASS (MORONE SAXATILIS) IN THE SOUTHERN GULF OF ST. LAWRENCE IN 2013

Context

After having been closed for 13 years, a recreational fishery for Striped Bass with provisions for two retention periods was opened in 2013 in the southern Gulf of St. Lawrence. DFO Gulf Ecosystems and Fisheries Management branch requested a compilation of the recreational fishery information and an update on the size of the spawning stock and information on biological characteristics for southern Gulf Striped Bass for 2013.

This report is the result of the Science Response Process of February 3, 2014. This report provides an examination of the recreational fishery information collected by Conservation and Protection staff during the two Striped Bass retention periods (May 1 to 15 and August 2 to 11) in 2013. It also provides an update of the current biological characteristics and spawner abundance estimates in the Northwest Miramichi estuary in 2013. The estimated number of harvested Striped Bass in the Miramichi River during the May retention season was in the order of 900 to 2,400 fish (depending upon the method of raising the effort information from interviewed anglers), while 20,000 to 29,000 bass were estimated to have been caught and released. During the August retention period, approximately 250 Striped Bass were estimated to have been harvested throughout the southern Gulf of St. Lawrence (excluding waters adjacent to Québec), while 1,600 to 2,900 Striped Bass were estimated to have been caught and released. The catches of Striped Bass during both retention periods were considered to be underestimated. The limitations of the angler information are discussed. The estimated spawner abundance in the Northwest Miramichi in 2013 was 255,000 fish (median value, 5th to 95th percentile range of 66,680 to 864,000) and sufficient to meet the population's recovery objective for the third consecutive time since 1993. As the abundance of Striped Bass has increased, those with fork lengths greater than 60 cm and older than five years of age have also increased in abundance but these fish remain a small proportion of the spawning population.

This Science Response report results from the Science Response Process of February 3, 2014 on the Update on status of Striped Bass from the Southern Gulf of St. Lawrence to 2013.

Background

As a result of the low abundance of Striped Bass during the early 1990s, restrictive fisheries management measures were introduced and included the closure of the commercial fishery in 1996, the closure of the recreational fishery in 2000, and the suspension of allocations to aboriginal groups in 2000. Access to Striped Bass incidentally captured in food, social, and ceremonial fisheries was reinstituted in 2012 and 2013 for some aboriginal groups that previously had allocations prior to the closure.

A recreational fishery for Striped Bass in the southern Gulf of St. Lawrence was re-opened in 2013 after having been closed for 13 years. In 2013, anglers were permitted to fish for Striped Bass between May 1 and September 30 in waters adjacent to the Maritime Provinces in the

southern Gulf of St. Lawrence (Variation orders GVO-2013-026, GVO-2013-29, GVO-2013-055, GVO-2013-057). There were two Striped Bass retention periods; the first between May 1 and May 15 and the second between August 2 and August 11. During the retention periods, anglers could retain one Striped Bass per day but could not have more than one Striped Bass in their possession. Only Striped Bass with a total length between 55 and 65 centimeters could be retained.

Anglers fishing the tidal waters of the Miramichi River, specifically from the Centennial bridge to Doyle's brook on the Southwest Miramichi River and from the confluence of the Southwest Miramichi and Northwest Miramichi rivers to Red Bank / Sunny Corner highway bridge on the Northwest Miramichi River could use the following terminal tackle in 2013: bait with a single barbless hook dressed with materials similar to that of an artificial fly to which no weight, spinning device or natural bait is attached, an unbaited spinner with a single barbless hook, an unbaited lure with a single barbless hook, a baited or unbaited non-offset circular barbless hook, a baited or unbaited lure with non-offset circular barbless hook, and a baited or unbaited spinner with non-offset circular barbless hook (Variation order GVO-2013-027). These regulations regarding terminal tackle were in effect only for the Miramichi system and for the entire angling season (January 1 to December 29).

The monitoring of the Striped Bass bycatch in the commercial gaspereau trapnets of the Miramichi River has provided the platform for assessing the Striped Bass spawning population of the southern Gulf since 1993. The spawner abundance has generally been estimated from a mark and recapture experiment where adult Striped Bass were tagged early in May and monitored throughout June as they were captured and released as bycatch in the gaspereau fishery of the Northwest Miramichi estuary (Bradford and Chaput 1996; Douglas and Chaput 2011a). An analysis of catch per unit of effort (CPUE) from this fishery has also been used as an index of abundance for Striped Bass since 1993 (Douglas and Chaput 2011a).

Analysis and Response

Striped Bass recreational fishery survey methods

Conservation and Protection officers conducted a survey of the Striped Bass recreational fishery throughout the southern Gulf in 2013 with a particular focus on the May and August retention periods. To assess total effort in the fishery, Conservation and Protection officers were asked to count the number of individuals angling within stretches of river or coastline at the beginning and end of each shift. During their shift, officers were asked to interview individual anglers and collect information on their Striped Bass catches (retained and released) and effort (hours fished).

Analysis of the recreational fishery information has been limited to the fishery retention periods (May 1-15 and August 2-11) and the same procedure was followed in both cases. The total angling effort (angler days) was determined by calculating the average daily maximum number of anglers for each location and raising it by the number of days in the appropriate season (15 days for May, 10 days for August). The number of Striped Bass released or retained was then estimated using the average catch per angler day for each location and raising it by the estimated effort for the complete retention period. This method ignored the fact that the catch and effort information was often incomplete because most anglers were interviewed before the end of their fishing trip.

A second method for estimating effort was considered. An adjustment to the number of hours fished by interviewed anglers was made to account for incomplete fishing events. Based on a summary of the effort from the May interviews, 35% of anglers had been fishing for one hour or

less, 28% had been fishing between one and two hours, 14% between two and three hours, and 23% for more than three hours (range 3-12 hours). Based on these data, it was assumed that a complete trip would be three hours of effort. For individuals that reported having fished for less than three hours, the total hours fished was adjusted upwards to three hours. For anglers that reported having fished for three or more hours, the fishing event was considered complete and no adjustments were made. The mean CPUE (released or retained bass per hour) was calculated based on interviews and raised by the estimate of total effort in hours for the retention period.

Results for the May retention period (May 1 to May 15)

The angler counts and interviews were grouped into five areas. The Inner Miramichi Bay was considered to be the waters located inside the barrier islands and included all bays and estuaries upstream to the mouth of the Miramichi River (Appendix Figure 1). The Main Miramichi River was considered to be the tidal waters between Loggieville and the Miramichi Bridge at Newcastle. The waters from the Miramichi bridge upstream to the train bridge on the Southwest Miramichi River and upstream to the Anderson bridge on the Northwest Miramichi River was considered as the third area and encompassed the known staging area for Striped Bass around Beaubear's Island and Strawberry Marsh (Douglas et al. 2009). The fourth location was the Southwest Miramichi River which included the tidal waters from the train bridge to the community of Quarryville. The final location was considered to be the Northwest Miramichi which included all tidal waters between the Anderson bridge and the communities of Red Bank and Sunny Corner.

Conservation and Protection officers counted over 5,500 anglers and interviewed over 2,000 anglers during the May retention period in 2013. The majority of anglers counted (97%) and those interviewed (92%) were within the Miramichi system. Due to the sparseness of information outside of the Miramichi system, no attempt was made to estimate catches of Striped Bass in those areas. Individual anglers reported catches of striped bass in single trips ranging from 0 to as high as 120 fish per trip, and there was large variation among angler catches and success rates.

The total number of Striped Bass reported released from the angler interviews was over 7,000 fish, while 300 were reported harvested (Appendix Table 1). These levels of catch and effort resulted in an average number of bass released per angler day that ranged from 0.7 to 4.5 for all Miramichi areas with the highest CPUE estimate in the Northwest Miramichi River. The average number of bass retained per angler day ranged between 0.1 and 0.2 with the highest values estimated in the staging area and the Northwest Miramichi River. When these average catch rates were applied to the estimated number of anglers for the retention period, about 20,000 Striped Bass were estimated to have been caught and released and about 900 Striped Bass harvested (Appendix Table 1).

Interviewed anglers in the Miramichi reported having fished for over 4,300 hours, the equivalent of over 6,400 hours once adjustments were made for incomplete fishing trips (Appendix Table 1). Similar to the number of anglers, the majority of the effort (hours) was concentrated in the staging area (35%) and the Northwest Miramichi River (33%). Average catch rates for Striped Bass caught and released ranged from 0.3 to 1.9 bass per hour of effort, with the high value estimated for the staging area. The average catch rate for retained Striped Bass ranged between 0.0 bass per hour (main and Southwest Miramichi) and 0.2 bass per hour in the staging area. When these average catch rates were applied to the estimated hours of effort for the 15-day season, 29,000 Striped Bass were estimated to have been caught and released and 2,400 retained (Appendix Table 1).

The estimated mortality of Striped Bass caught and released can vary widely from a low of 3% to a high of 74%, depending on water temperature, salinity, and type of tackle used (DFO 2011). A recent study in the USA estimated that the average catch-and-release mortality for Striped Bass was 16% for traditional J hooks and 5% for circle hooks (Millard et al. 2005). The Atlantic States Marine Fisheries Commission currently assumes a hooking mortality factor of 9% for Striped Bass caught and released (ASMFC 2013). Assuming a catch-and-release mortality rate of 10% (DFO 2013), the minimum caught and release mortality during the May retention period would be 2,900 fish which is higher than the estimate of retained fish (Table 1).

The angler survey information in 2013 indicated that there is high participation and that this is a high catch fishery in the Miramichi area in May. Catches of Striped Bass were likely underestimated given that interviews were from incomplete fishing trips and that the survey only covered a portion of the 15-day season, not all Miramichi locations, and not all times of the day.

The concentration of angling effort in the Miramichi River during May is consistent with the population's only known spawning location in the southern Gulf of St. Lawrence (Robichaud-LeBlanc et al. 1996). The higher angling effort at the confluence of the Southwest and Northwest Miramichi rivers and the Northwest Miramichi River compared to the rest of the Miramichi system is consistent with the population's known staging and spawning grounds (Robichaud-LeBlanc et al. 1996, Bradford and Chaput 1996, Douglas et al. 2009).

Results for the August retention period (August 2 to August 11)

The survey design for the August retention period was the same as the one used during May but the survey area was much larger. The areas surveyed in the southern Gulf of St. Lawrence were grouped into eight locations: Chaleur Bay (Caraquet to Bathurst), the Acadian Peninsula (Shippagan to Miscou), Tracadie (Rivère du Portage to Pokemouche), Tabusintac (Neguac to Tabusintac), Miramichi (complete system including the inner bay), Eastern New Brunswick (Cape Tormentine to Escuminac), Prince Edward Island (all), and Gulf Nova Scotia (St. Georges Bay to Pleasant Bay, Cape Breton) (Appendix Figure 1).

Conservation and Protection officers counted over 2,400 anglers and interviewed over 1,700 anglers during the August Striped Bass retention period in 2013. Interviewed anglers reported releasing and retaining 766 and 86 Striped Bass, respectively (Appendix Table 2). The mean catch of released Striped Bass per angler day ranged between 0.1 (Miramichi) and 3.2 (Gulf Nova Scotia) while the mean catch of retained Striped Bass per angler day ranged between 0.0 (Tabusintac, Miramichi, and Eastern New Brunswick) and 0.1 (all other areas). The estimated number of Striped Bass released and harvested during the August retention period was 1,571 and 155, respectively (Appendix Table 2).

Interviewed anglers reported having fished for about 3,400 hours, the equivalent of 5,500 hours once adjustments were made for incomplete fishing trips. The average catch of Striped Bass released per hour ranged between 0.0 (Miramichi) and 1.7 (Gulf Nova Scotia). The average catch of Striped Bass retained per hour was <0.0 and identical for each of the locations. The estimated number of Striped Bass released and harvested during the August retention period by this method was 2,911 and 244, respectively (Table 1). Assuming a catch-and-release mortality rate of 10%, the catch and release mortality of Striped Bass during the August retention period would be 291.

The total catch of Striped Bass (released and retained) from either calculation is considered to be underestimated. This can be partially explained by the large size of the southern Gulf and the very large number of access points which makes it difficult to obtain representative catch and effort information. For example, the majority of angler counts and interviews were conducted at obvious access points (bridges, wharves, public beaches etc.) and during the daily open period

(two hours before sunrise, two hours after sunset) and little to none of the effort from shoreline or boats was measured in the survey.

The summer recreational fishery survey demonstrated that there was a large interest in the fishery and Striped Bass were distributed and caught in all areas of the southern Gulf. Few Striped bass were caught in the Miramichi system in August. This is consistent with the species post-spawning behaviour and coastal summer feeding migrations (Bradford and Chaput 1996). Striped Bass were distributed beyond the DFO jurisdiction of the southern Gulf as anglers from Chaleur Bay (Quebec side) to Gaspé reported excellent angling in July and August. No data were collected on this fishery (M. Legault pers. comm.) or considered in these analyses.

Summary of results for the two retention periods in 2013

A minimum of 32,000 Striped Bass were caught and released during the two short retention periods in 2013 and over 2,600 or more were retained. With an assumed catch and release mortality rate of 10%, losses of Striped Bass directly attributed to fishing during the two retention periods in 2013 were at least 6,000 fish, of all size groups with almost half within the total length slot of 55 to 65 cm.

Table 1. Summary of recreational fishery survey estimates of effort, catch and release, retained, and total losses during the May and August retention seasons for Striped Bass in 2013. Details are in Appendix tables 1 and 2.

Descriptor	May retention period	August retention period	Total for retention periods
Effort (angler days)	6,263	2,970	9,213
Estimated catch and release	20,162	1,571	21,733
Estimated retained	931	155	1,086
Estimated loss (retained plus catch and release mortality)	2,947	312	3,259
Adjusted effort (hours)	23,281	9,465	32,746
Estimated catch and release	29,224	2,911	32,135
Estimated retained	2,400	244	2,644
Estimated loss (retained plus catch and release mortality)	5,322	535	5,857

Estimated spawner abundance

The assessment program for southern Gulf Striped Bass in the Northwest Miramichi River consisted of sampling catches from a dedicated commercial gaspereau trapnet set before the opening of the gaspereau season. The trapnet was first set on May 11 and fished continuously until May 31; the official start day for the 2013 gaspereau season in the Northwest Miramichi River. The trapnet was generally checked every other day for a total of nine times between May 13 and May 31, 2013. As in previous years, a portion of the Striped Bass catches were marked with individually numbered dorsal tags, measured for fork and total length (nearest 1 mm), checked for sex, and had scales removed to determine age. During this phase of the program, approximately 1,100 tags were applied to Striped Bass while another 4,600 were sampled for biological characteristics.

Monitoring of the Striped Bass bycatch in the gaspereau fishery followed the tagging phase with a total of 50 catches sampled of a possible 137 (36%) between June 3 and June 27 (end of the commercial season) (see Bradford and Chaput 1996; Douglas and Chaput 2011a). During this

phase of the program, 17 Striped Bass carrying current year tags were recaptured in a total observed catch of about 33,000 bass.

Similar to previous years, catches of Striped Bass in 2013 were highest early in the gaspereau season and had diminished significantly by mid-June (Appendix Figure 2; Douglas and Chaput 2011a). The Bayesian hierarchical mark and recapture model used in the most recent peer reviewed assessment was applied to the 2013 data in two ways (Chaput and Douglas 2011a). Similar to most previous assessments, the first application of the model incorporated both the mark-recapture and catch-per-unit-of effort (CPUE) information collected from the gaspereau fishery. In the second application, the mark and recapture data was omitted and the model relied exclusively on the CPUE information to estimate abundance. Relying on the CPUE information alone to estimate the population size has been necessary in years when the mark recapture information has been poor or absent (1994, 1996, 2006, 2010, 2012) (Chaput and Douglas 2011).

The median estimate of Striped Bass spawner abundance in 2013 using the mark and recapture data was 1,128,000 (5th to 95th percentile range of 839,700 and 1,589,000), while the median estimate using only the CPUE data was 255,000 (5th to 95th percentile range of 66,680 and 864,000). The latter estimate of 255,000 spawners is considered more credible for several reasons (Figure 1). The catches of Striped Bass in the gaspereau fishery and at the DFO's index trapnets were at levels similar to those observed in recent years (2011) when total spawners were estimated to be approximately 200,000 fish and did not correspond to expected catches with an abundance of over a million fish (Figure 2). The number of recaptured Striped Bass were few relative to the number of tags applied (1.5%) and lower than expected based on estimates of trapnet efficiencies from previous years. The spawner abundance estimate of 255,000 in 2013 is the highest of the assessment time series (Figure 1).

The Recovery Potential Assessment proposed a recovery limit and target for the southern Gulf Striped Bass population based on the abundance of spawners estimated for the Northwest Miramichi estuary (DFO 2006; Douglas et al. 2006). The proposed recovery limit was an abundance of at least 21,600 spawners in five of six consecutive years. Once that was achieved, then the proposed recovery target for considering fisheries access was when total spawners were ≥ 31,200 in three of six consecutive years. It was also suggested that the lower confidence interval (5th percentile) of the spawner abundance estimate be used to assess status relative to these recovery objectives (Douglas et al. 2006).

The abundance of Striped Bass spawners in the Northwest Miramichi in 2013 was sufficient to meet the recovery limit and target for the third consecutive year (2011-2013) (Figure 1). In 2011, both the recovery limit and target were met for the first time (5 of 6 years) (Douglas and Chaput 2011a). Although no estimate was available for 2012, the indications were that the abundance was high and that the recovery objective was likely met for the second time (6 of 6 years) (DFO 2013). Although the population estimate was considered to be incomplete in 2010 due to an early spawning period that preceded the assessment activity, the conclusion was that the spawning stock abundance exceeded the recovery objectives for that year (Douglas and Chaput 2011a).

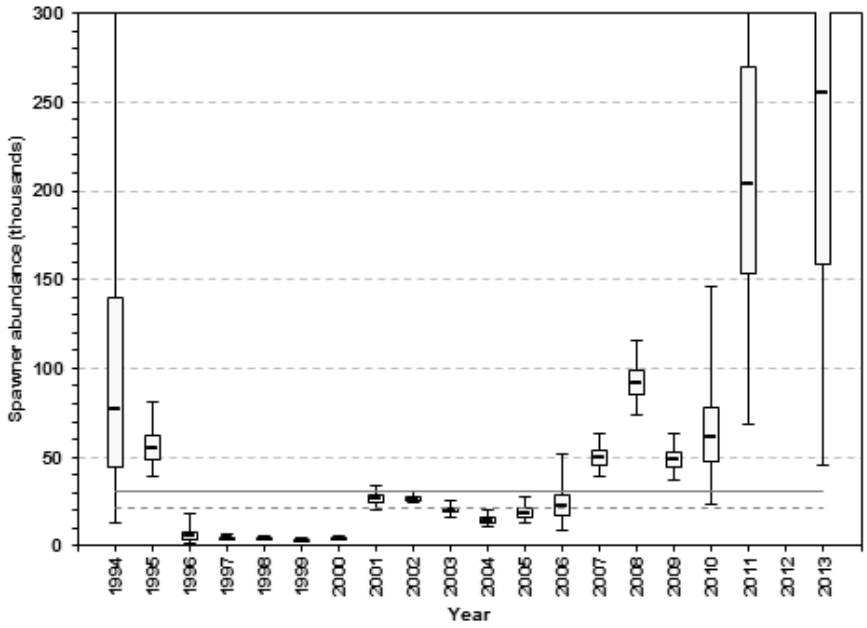

Figure 1. Estimated abundances of adult Striped Bass in the Northwest Miramichi estuary between 1994 and 2013. The estimate for 2010 is considered to be an underestimate due to the earlier timing of the spawning events (Douglas and Chaput 2011a). Box plots are interpreted as: dash is the median, boxes are the interquartile range, and the vertical dashes are the 5th to 95th percentile ranges. The solid and dashed horizontal lines show the recovery objectives defined in the Recovery Potential Assessment (DFO 2006).

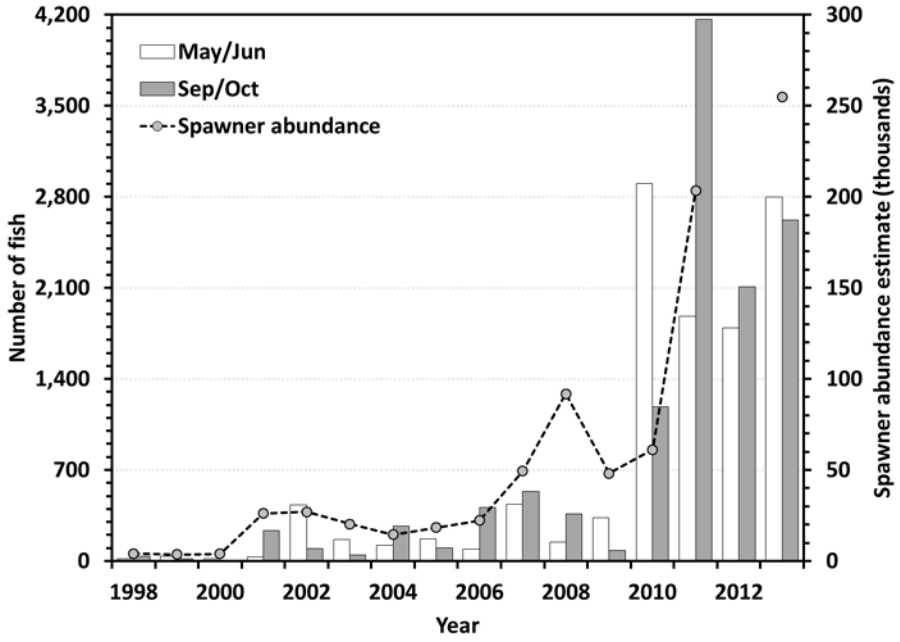

Figure 2. The combined number of striped bass captured in DFO's index trapnets at Cassilis on the Northwest Miramichi River and at Millerton on the Southwest Miramichi River during the spring (May/June) and autumn (Sep/Oct) from 1998 to 2013. The median estimates of spawner abundance are also shown for comparison.

Biological characteristics

Similar to previous years, Striped Bass sampled in 2013 ranged in age between 2 and 14 years with the majority between the ages of 3 and 6 years old (Appendix Table 3) (Douglas and Chaput 2011a).

Adult Striped Bass sampled (n > 5,700) in the Northwest Miramichi River between May 11 and 31, 2013 had an average fork length of 42.3 cm (range 30.1 – 89.0) (Figure 3). Similar to previous years, 96% of samples measured 60 cm fork length or less. Seventeen percent of samples had a total length between 55 and 65 cm, the legal retention size for Striped Bass in the 2013 angling fishery. This result differed from that of a concurrent study where 56 of 228 (25%) angled Striped Bass satisfied the slot regulation (S. Douglas pers. comm.).

The 2010 year class appears strong with a large influx of three-year old Striped Bass in 2013 that measured between 31 and 44 cm fork length (Appendix Table 3, Figure 3). This cohort was not well represented in the catches at DFO index trapnets during the autumn of 2012 (Figure 3). It is unknown if these fish overwintered in the Miramichi system or migrated from elsewhere after ice-out. The length of the individuals in this cohort increased over the summer months as evidenced from the spike in catches of bass between 40 and 45 cm at the DFO index trapnets in the autumn of 2013 (Figure 3). Thirty percent of Striped Bass sampled at the DFO index trapnets in the autumn of 2013 had a fork length of 51 to 61 cm (corresponding to a total length of 55 to 65 cm). This is less than the 49% of Striped Bass caught at the same facilities of similar size prior to overwintering in 2012.

In the Maritimes Fisheries General Regulations, the length regulation for Striped Bass is presented as a total length. Prior to 2013, the length data collected during the assessment program had been exclusively in fork length. In 2013, Striped Bass were measured for both fork length and total length. The relationship between total length and fork length (Total length (cm) = 1.068 * Fork length (cm) + 0.2374; n = 5,700) for Striped Bass in the southern Gulf was highly significant (r^2 = 1.00) (Appendix Figure 3). A slot of 55 to 65 cm total length equates to fish between 51 and 61 cm fork length.

Striped Bass were sacrificed in 2013 as part of a three-year study designed to evaluate their diet in the Miramichi River during the spring. Striped Bass were sampled between May and June and all fish were measured (fork and total length) and weighed (whole weight) fresh. The relationship between fork length (cm) and weight (kg) was highly significant for both female ($Wt = 8.0E\text{-}06 * FL^{3.1075}$; $r^2 = 0.98$) and male ($Wt = 2.0E\text{-}05 * FL^{2.9113}$; $r^2 = 0.98$) Striped Bass (Appendix Figure 4). Similarly, the relationship between total length (cm) and weight (kg) was highly correlated for both sexes (Female: $Wt = 7.0E\text{-}06*TL^{3.114}$; $r^2=0.98$, Male : $Wt = 1.0E\text{-}05 * TL^{2.9225}$; $r^2=0.98$). On average, female Striped Bass were heavier than males. A Striped Bass measuring 55 to 65 cm total length weighs between 1.6 and 2.9 kg.

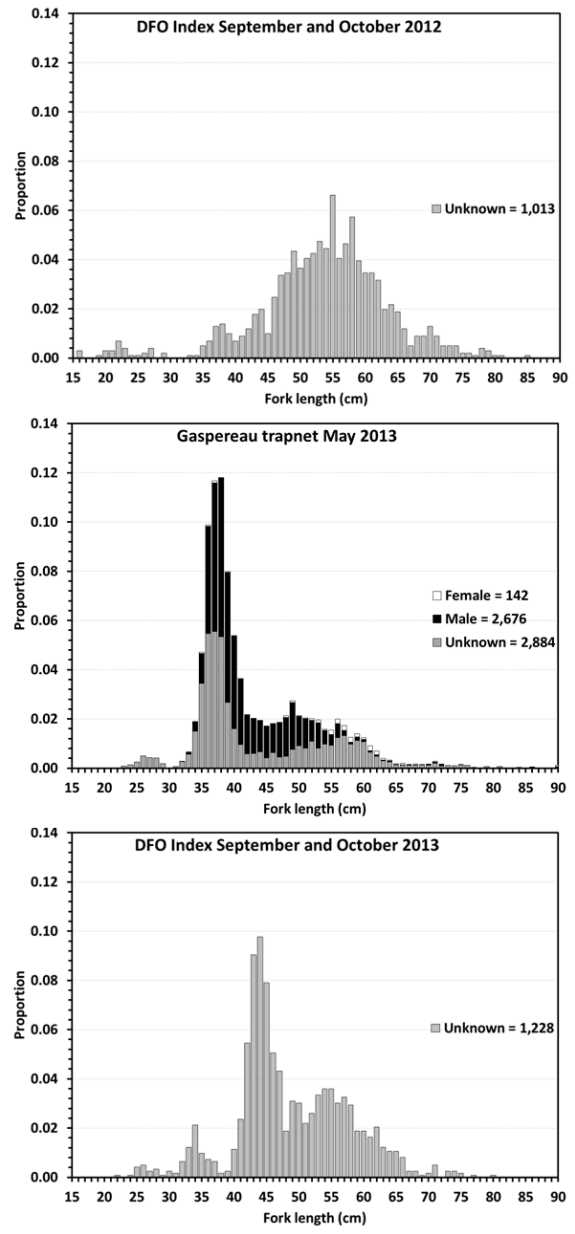

Figure 3. Fork length distributions of Striped Bass by sex and season. The upper (2012) and lower (2013) panels represent Striped Bass measured at DFO index trapnets in September and October and the middle panel represents Striped Bass measured in the gaspereau trapnet in the Northwest Miramichi in May 2013.

Migration and distribution

The increased effort to apply dorsal tags to striped bass and the re-opening of the recreational fishery in 2013 resulted in reports of recaptured striped bass in 2013. From over 1,100 tags applied to Striped Bass in the Northwest Miramichi River in spring 2013, only six were returned from bass angled weeks later (range June 17 to September 27) in the Rivière du Portage, Lamèque, Grande Anse (all New Brunswick) and Gaspé, Quebec. Similarly, two striped bass carrying dorsal tags that were originally applied in the Southwest Miramichi River in autumn 2012 were recaptured in Chaleur Bay in August 2013. Two striped bass originally tagged in the

Kouchibouguac River in autumn 2009 were recaptured in the gaspereau fishery of the Northwest Miramichi River in May and June 2013. Finally, one striped bass tagged in the Northwest Miramichi River in 2006 (fork length = 67.6 cm; 7 year old fish) was recaptured at the same location in spring 2013 (fork length = 83.7 cm; aged 14 years old). These data on recaptured Striped Bass are spatially and temporally consistent with previous tag returns and the known migration and distribution patterns of southern Gulf Striped Bass (Bradford and Chaput 1996; Douglas and Chaput 2011b).

Striped Bass spawning and environmental conditions

Striped bass spawning behaviour was first observed in the Northwest Miramichi River between the mouth of the Northwest Millstream and Cassilis on May 21, 2013. Observations of spawning continued on May 22 and increased significantly in the Cassilis area during the afternoon and evening of May 23. Water temperatures collected at Cassilis between May 21 and May 23 averaged 11.5 ºC (range 10.5 to 13.3 ºC). The mean daily water temperature dropped 4.6 ºC between May 24 (13.2 ºC) and May 26 (8.6 ºC) and after considerable spawning had taken place and spawned eggs were presumably developing (Appendix Figure 2). Sudden drops in temperature over a short duration have been shown to have significant effects on the survival of spawned eggs and larvae (Rutherford et al. 1997). The effect that the decrease in water temperature to 8.6 ºC on May 26 had on developing Striped Bass eggs and larvae in the Northwest Miramichi estuary is unknown. Less intense Striped Bass spawning activity resumed by May 30 and coincided with increasing water temperatures (Appendix Figure 2).

Knowledge gaps and uncertainties

The estimates of Striped Bass released and retained from the recreational fishery surveys should be considered as minimum values. The estimates were derived from catch and effort data of incomplete fishing trips. Not all days, locations, or daily times during the retention periods were sampled, and even less during the non-retention portion of the angling season in 2013. No independent validation of angler reports was done. Field sampling did not follow a statistical sampling design. The field coverage in August was too sparse to provide a reliable estimate of effort and catch.

The total mortality of Striped Bass in the southern Gulf in 2013 is unknown but considered to be substantial and not reflected in the results of the recreational fishery surveys. Losses of Striped Bass in recent years from illegal fisheries, catch and release fisheries, and incidental bycatch have been estimated to be in the tens of thousands per year (DFO 2011). With the continued number of anecdotes about the bycatch and illegal retention of striped bass, there is no reason to think that the level of illegal fisheries has changed.

The large discrepancy in the spawner abundance estimates generated with and without the mark and recapture data in the Bayesian hierarchical model is difficult to resolve. Only one gaspereau trapnet operated in May so the mark and recapture experiment did not benefit from multiple daily catches when all of the tags were available to capture. It is possible that a component of the Striped Bass spawned and left the system before the gaspereau fishery opened which limited the number of tags available to recapture during the fishery. However, the complementary information on catches of Striped Bass at DFO index trapnets suggest that the abundance was high, and similar to recent years when spawners were estimated at approximately 200,000.

Conclusions

The estimated minimum number of Striped Bass harvested during the 15-day retention season between May 1 and 15 in the Miramichi River was approximately 2,400, while 29,000 were estimated to have been caught and released. These values are considered to be underestimated because the survey did not cover all locations in the Miramichi, all times of day, or on each day of the season. The recreational fishery survey indicated that angling effort for Striped Bass in May was low in all areas of the southern Gulf except the Miramichi system, however the survey effort in May in other portions of the southern Gulf was less intense than in the Miramichi. Catches of Striped Bass in May were the highest in the staging and spawning areas of the Miramichi estuary.

The estimated minimum number of Striped Bass harvested during the 10-day retention season in August was approximately 240, while 2,900 were estimated to have been caught and released. These values are considered to be underestimated and due mainly to the difficulty of obtaining complete effort information throughout the southern Gulf. The recreational fishery survey indicated that Striped Bass were caught throughout the southern Gulf during the August retention fishery. From angler interviews, the proportion of the striped bass captured which was retained was higher in the August period (10%) than in the May period in the Miramichi (4%).

Assuming a 10% hook and release mortality, there were more losses attributed to catch and release mortality then retentions although the catch and release losses occur over the entire size range of bass angled whereas the retention losses are for a slot size. Striped bass are available for capture from late April to September and if effort during the catch and release season is as important as during the retention season, the potential cumulative loss from catch and release fishing can be more important than the losses associated with the short season retention fisheries.

The relatively small area of the Miramichi estuary coupled with the high concentration of anglers in the spring facilitated the collection of recreational fishery data in May. The large area of the southern Gulf and large number of access points made it difficult to collect reliable information during the August survey.

The spawner abundance of Striped Bass in the Northwest Miramichi in 2013 was at the highest level estimated since monitoring began in 1993. The recovery objective for southern Gulf Striped Bass was met for the third consecutive time in 2013. The recovery objectives for the southern Gulf Striped Bass are not synonymous to Precautionary Approach reference points for managing fisheries. An assessment of harvestable surplus would require consideration of the assessment program to gain more reliable estimates of abundance (due to annual variations in the spawning period and the reliance on gaspereau trapnets as the sampling platform), reliable fisheries catch statistics, and appropriate reference points.

Male striped bass first mature at age 3 and females at age 4. Striped bass aged 3 to 5 continue to be the most abundant age classes sampled in the spawning area of the Northwest Miramichi estuary.

As the spawner abundance of Striped Bass has increased, those with fork lengths greater than 60 cm and older than five years of age have too but are a small proportion of the overall spawning population.

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Sources of information

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Appendices

Appendix Table 1. Summary of the recreational fishery survey information collected during the first retention period (May 1 - 15) of the 2013 Striped Bass recreational fishery in the southern Gulf of St. Lawrence. SW/NW confluence refers to the confluence of the Southwest and Northwest Miramichi rivers. Areas are shown in Appendix Figure 1. The cell entry "nd" means not determined. The dashed horizontal line in the table separates the analyses using angler effort in days (upper section) from angler effort in hours (lower section).

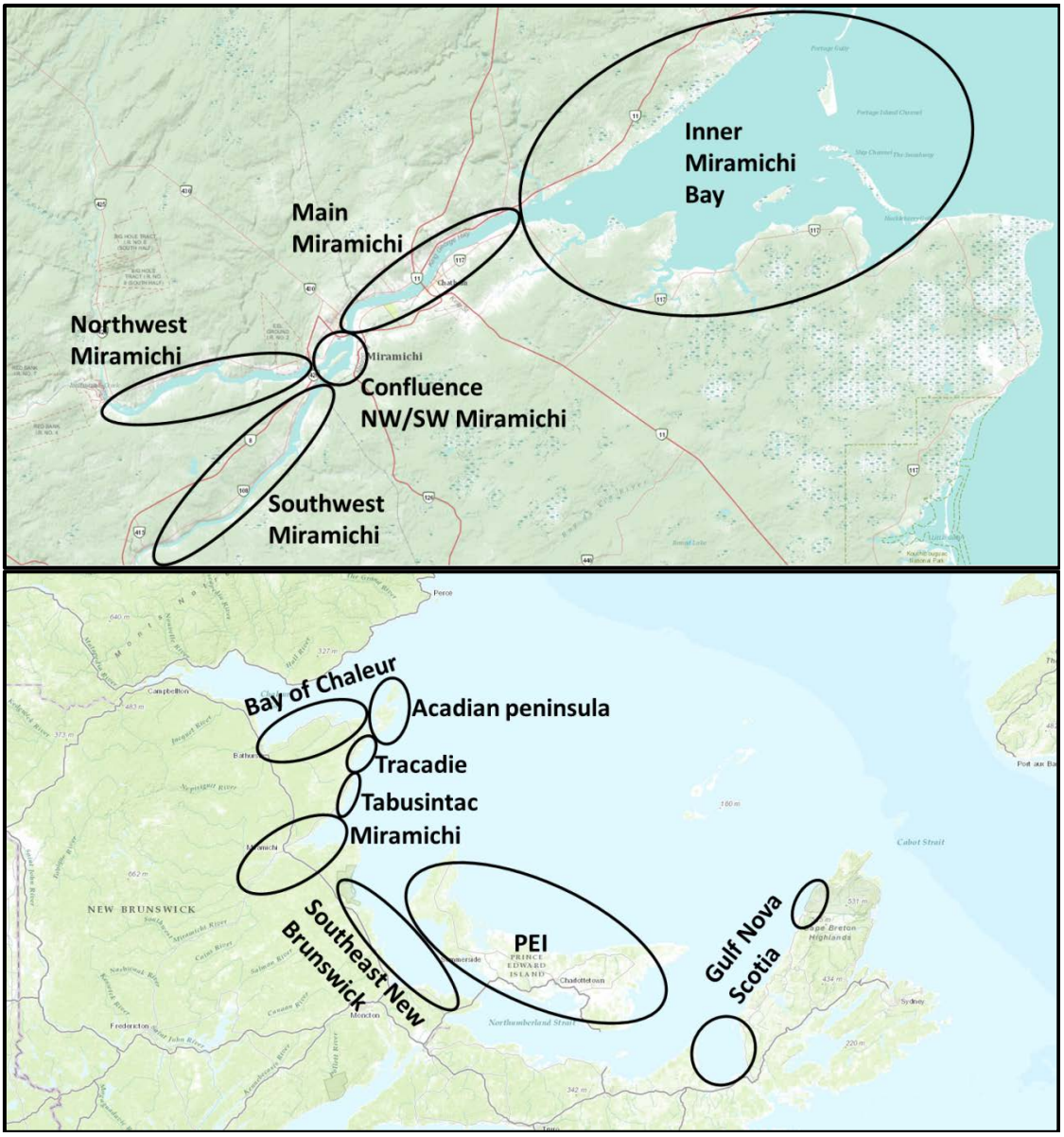
Characteristics	Inner bay	Main Miramichi	SW/NW confluence	Northwest	Southwest	Total
Days surveyed	8	11	13	13	14	nd
Number of angler interviews	227	88	724	585	252	1,876
Bass released from interviews	993	387	2,819	2,695	175	7,069
Bass retained from interviews	28	9	128	112	23	300
Average maximum anglers counted per day	35.6	13.1	111.7	134.8	122.4	nd
Estimated total effort (anglers)	534	196	1,675	2,023	1,835	6,263
Proportion over all areas	0.09	0.03	0.27	0.32	0.29	1.00
Mean CPUE (released bass/angler)	4.37	4.40	3.89	4.53	0.69	nd
Mean CPUE (retained bass/angler)	0.12	0.10	0.18	0.19	0.09	nd
Estimate of bass released May 1-15	2,338	864	6,523	9,162	1,275	20,162
Proportion over all areas	0.12	0.04	0.32	0.45	0.06	1.00
Estimate of bass retained May 1-15	66	20	296	381	168	931
Proportion over all areas	0.07	0.02	0.32	0.41	0.18	1.00
Total hours fished from interviews	551	175	1,344	1,426	865	4,359
Hours adjusted for incomplete trips	769	280	2,220	2,107	1,046	6,421
Mean CPUE (released bass per hour)	1.78	1.53	1.93	1.60	0.34	nd
Mean CPUE (retained bass per hour)	0.11	0.04	0.17	0.12	0.04	nd
Average adjusted hours fished per day	3.39	3.41	3.35	3.54	4.37	nd
Estimated total effort (hours)	1,810	671	5,610	7,161	8,029	23,281
Proportion over all areas	0.08	0.03	0.24	0.31	0.34	1.00
Estimate of bass released May 1-15	3,224	1,023	10,820	11,463	2,694	29,224
Proportion over all areas	0.11	0.04	0.37	0.39	0.09	1.00
Estimate of bass retained May 1-15	204	26	973	874	323	2,400
Proportion over all areas	0.09	0.01	0.41	0.36	0.13	1.00

Appendix Table 2. Summary of the recreational fishery survey information collected during the second retention period (August 2 - 11) of the 2013 Striped Bass recreational fishery in the southern Gulf of St. Lawrence. Areas are shown in Appendix Figure 1. The cell entry "nd" means not determined. The dashed horizontal line in the table separates the analyses using angler effort in days (upper section) from angler effort in hours (lower section).

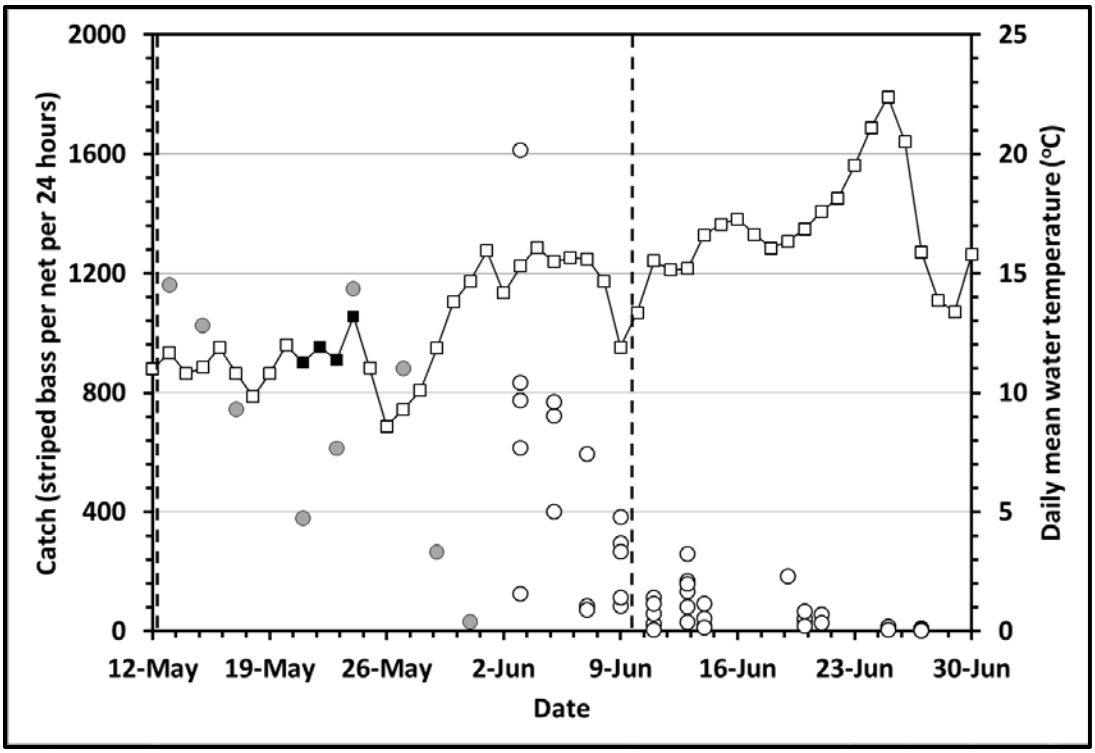
Characteristics	Chaleur Bay	Acadian Peninsula	Tracadie	Tabusintac	Miramichi	Eastern New Brunswick	Prince Edward Island	Gulf Nova Scotia	Total
Days surveyed of 10-day season	9	8	8	9	9	7	9	3	nd
Number of angler interviews	352	159	460	353	123	187	57	51	1,742
Bass released (interviews)	129	60	82	118	10	137	67	163	766
Bass retained (interviews)	26	15	31	4	0	0	5	5	86
Average maximum anglers counted per day	86.9	20.9	65.8	39.2	21.8	38.1	7.3	17.0	nd
Estimated total effort (days)	869	209	658	392	218	381	73	170	2,970
Proportion of all areas	0.29	0.07	0.22	0.13	0.07	0.13	0.02	0.06	1.00
Mean CPUE (released bass/angler)	0.37	0.38	0.18	0.33	0.08	0.73	1.18	3.20	nd
Mean CPUE (retained bass/angler)	0.07	0.09	0.07	0.01	0.00	0.00	0.09	0.10	nd
Estimate of bass released Aug 2-11	318	79	117	131	18	279	86	543	1,571
Proportion of all areas	0.20	0.05	0.07	0.08	0.01	0.18	0.05	0.35	1.00
Estimate of bass retained Aug 2-11	64	20	44	4	0	0	6	17	155
Proportion of all areas	0.41	0.13	0.28	0.03	0.00	0.00	0.04	0.11	1.00
Total hours fished (interviews)	544	218	1,199	734	182	269	137	101	3,383
Hours adjusted for incomplete trips	1,089	506	1,550	1,091	376	573	174	158	5,516
Mean CPUE (released bass/hr)	0.22	0.16	0.05	0.27	0.03	0.61	0.43	1.70	nd
Mean CPUE (retained bass/hr)	0.04	0.03	0.03	0.00	0.00	0.00	0.03	0.02	nd
Average adjusted hours fished per day	3.1	3.2	3.4	3.1	3.1	3.1	3.5	3.1	nd
Estimated total effort (hours)	2,719	668	2,220	1,212	665	1,194	260	527	9,465
Proportion of all areas	0.29	0.07	0.23	0.13	0.07	0.13	0.03	0.06	1.00
Estimate of bass released Aug 2-11	604	107	117	330	18	730	111	894	2,911
Proportion of all areas	0.21	0.04	0.04	0.11	0.01	0.25	0.04	0.31	1.00
Estimate of bass retained Aug 2-11	122	22	75	6	0	0	7	12	244
Proportion of all areas	0.50	0.09	0.31	0.02	0.00	0.00	0.03	0.05	1.00

Appendix Table 3. Summary statistics of fork length (cm) at age (years) of Striped Bass sampled on the spawning grounds of the Northwest Miramichi estuary during May 2013. Na means no relevant statistic.

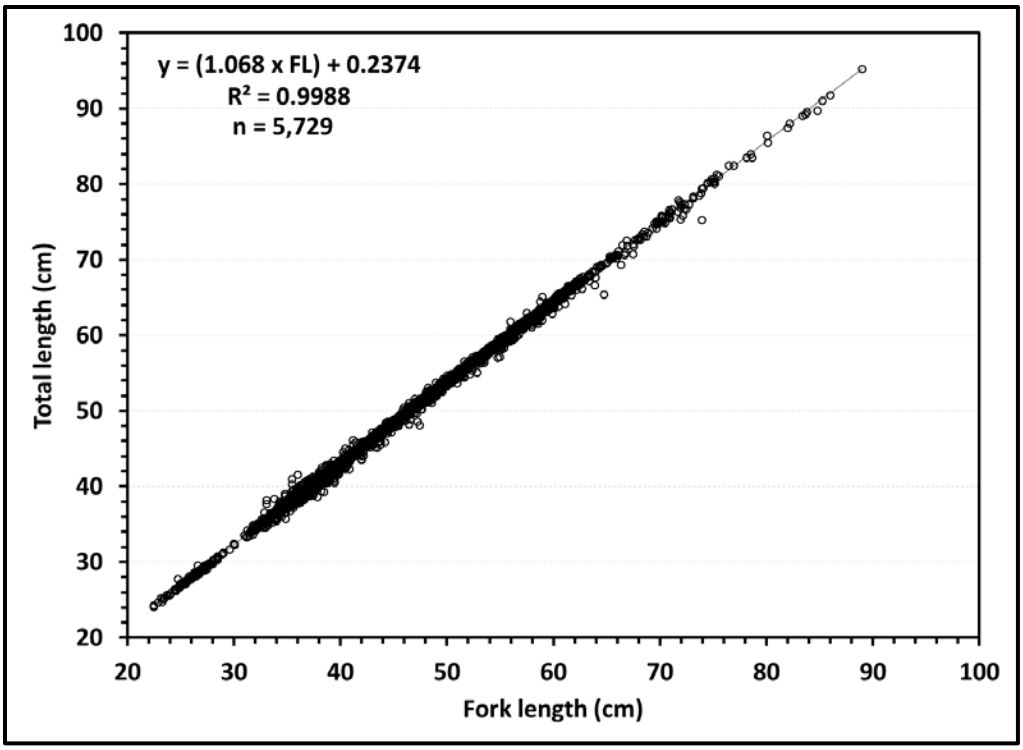
Age	Number sampled	Minimum to maximum range	Mean	Std. dev.	Median	Mode	5th to 95th percentile range
2	26	22.5 to 30.0	25.6	2.0	25.1	27.2	23.0 to 28.4
3	319	31.2 to 44.5	37.9	2.4	37.6	36.1	34.5 to 42.1
4	170	38.4 to 54.1	45.0	3.0	44.8	45.5	40.8 to 50.0
5	461	43.0 to 63.5	51.0	3.7	50.4	48.1	45.8 to 58.0
6	405	46.2 to 70.9	57.2	3.6	57.2	55.5	51.0 to 63.0
7	28	54.6 to 74.0	64.9	5.0	65.6	na	58.0 to 72.5
8	32	59.4 to 75.6	70.4	3.9	71.0	71.0	62.9 to 75.3
9	21	62.0 to 84.8	71.6	5.2	71.0	na	62.8 to 78.7
10	4	74.9 to 78.6	76.4	1.7	76.1	na	74.9 to 78.4
11	9	70.2 to 86.0	80.7	4.6	82.0	na	73.4 to 85.1
12	1	85.3 to 85.3	85.3	na	85.3	na	na
13	0	na	na	na	na	na	na
14	1	83.7 to 83.7	83.7	na	83.7	na	na



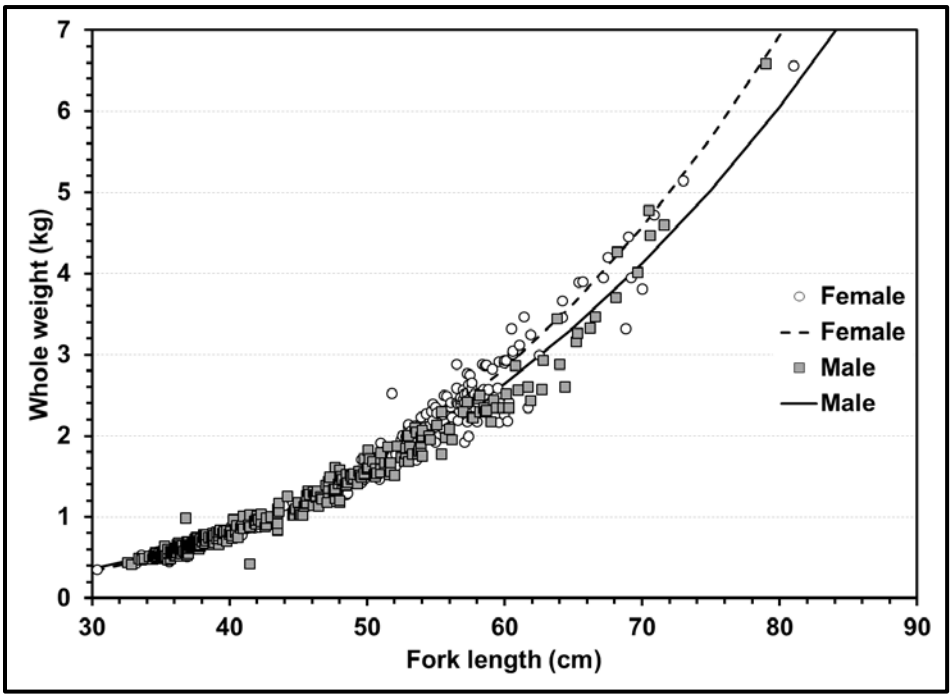
Appendix Figure 1. Maps showing the locations surveyed during the May (upper panel) and August (lower panel) Striped Bass retention fisheries in the southern Gulf of St. Lawrence in 2013.



Appendix Figure 2. The number of striped bass captured per net per day in the commercial gaspereau fishery of the Northwest Miramichi estuary in 2013 (circles). Shaded circles represent catches before the opening of the gaspereau season. Hatch lines encompass the data and the period which were used in the CPUE analyses. Squares show the mean daily water temperature and the black squares represent the dates of the initial observations of striped bass spawning in the upper Northwest Miramichi estuary in 2013.



Appendix Figure 3. The relationship between fork length and total length for southern Gulf of St. Lawrence Striped Bass sampled in the Northwest Miramichi estuary during May 2013.



Appendix Figure 4. The relationship between fork length (cm) and whole weight (kg) by sex of Striped Bass sampled in the Northwest Miramichi estuary during May 2013.

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