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Assessment of striped bass (*Morone saxatilis*) in the Maritime Provinces in the context of species at risk

Evaluation du bar rayé (*Morone saxatilis*) des provinces maritimes dans un contexte des espèces en péril

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Abstract

There are two extant populations of striped bass in the Maritime Provinces: the southern Gulf of St. Lawrence population that spawns in the Northwest Miramichi River in northern New Brunswick, and a population in the Bay of Fundy that spawns in the Shubenacadie-Stewiacke River, Nova Scotia. Evidence of extirpated striped bass populations exist for the Annapolis and Saint John rivers that flow into the Bay of Fundy. Genetic discreteness between the two extant Canadian populations and their discreteness from adjacent spawning populations of the eastern U.S.A. has been demonstrated from analyses of mitochondrial and nuclear DNA. There are no reported occurrences of fish tagged in either the NW Miramichi or the Shubenacadie-Stewiacke having been recaptured as spawners in any river other than their presumed river of origin. Both populations of striped bass in the Maritime Provinces are managed as discrete biological units. Their genetic structuring relative to the larger striped bass assemblage in eastern North America, in combination with evidence for unique life-history attributes of probable adaptive significance at the population level, and their contribution to biodiversity within two recognizable biogeographic regions within Canada lend support to their designation as “evolutionarily significant units”. As such, the present DFO management framework for this species is already applied at the level that reflects their conservation significance. Assessment of the striped bass spawning run to the NW Miramichi since 1993 reveals that this population has undergone large fluctuations in size. Spawner estimates for the NW Miramichi peaked in 1995 at 50,000 fish, dropped to approximately 4,000 fish between 1998 and 2000, but have recovered to between 24,000 and 29,000 in 2001 and 2002. Spawner abundance data available for the Shubenacadie-Stewiacke population does not yet lend itself to analysis of interannual trends. Provisional estimates of spawner abundance for 2002 are in the range of 20 to 30 thousand fish of minimum reproductive age (age 3+ years). Available data indicate that several age classes have contributed eggs to the population every year since 1999. Based on landings, and tag returns, the area of occupancy for striped bass in the southern Gulf of St. Lawrence appears unchanged with striped bass occurring seasonally throughout the inshore, coastal portions of the whole region. Beach seine surveys indicate that young-of-the-year striped bass leave the Miramichi system during summer and are distributed throughout much of the southern Gulf by the end of their first growing season. Tag returns from fish marked while descending the Shubenacadie River in May (1999-2002) suggest a summer range within Minas Basin, although this interpretation is likely confounded by low recreational fishing effort outside of Minas Basin. The summer seaward distribution of young-of-the-year Shubenacadie-Stewiacke striped bass appears to be limited to the inner, turbid, and relatively warm water portions of Minas Basin. All indications are that there are in excess of 10,000 mature individuals in both extant Maritime populations.

Résumé

Il existe deux populations de bar rayé dans les provinces maritimes: la population du Sud du golfe du Saint-Laurent qui fraie dans la rivière Miramichi Nord-Ouest, située dans le Nord du Nouveau-Brunswick, et la population de la baie de Fundy qui fraie dans la rivière Shubenacadie-Stewiacke en Nouvelle-Écosse. Des données montrent que des populations de bar rayé ont déjà existé dans le fleuve Saint-Laurent (Québec) ainsi que dans les rivières Annapolis et Saint-Jean, qui se jettent dans la baie de Fundy. Des analyses d'ADN mitochondrial et nucléaire ont montré que les deux populations canadiennes existantes et les populations voisines de l'Est des États-Unis sont toutes distinctes au plan génétique. Aucun poisson marqué dans les rivières Miramichi Nord-Ouest, ou Shubenacadie-Stewiacke n'a été recapturé à l'état de géniteur dans une rivière autre que sa rivière d'origine présumée. Les deux populations de bar rayé des provinces Maritimes sont gérées comme deux unités biologiques distinctes. Les particularités de leur génome par rapport à celui des autres populations de bar rayé de l'Est de l'Amérique du Nord, les indications que leur cycle de vie présente des différences revêtant sans doute une importance adaptative pour la population ainsi que leur contribution à la biodiversité de deux régions biogéographiques du Canada justifient leur désignation d'« unités évolutionnaires significatives ». Ainsi, le cadre de gestion actuel du MPO du bar rayé reflète l'importance de sa conservation. Les évaluations de la remonte de géniteurs dans la rivière Miramichi Nord-Ouest depuis 1993 révèlent que la taille de cette population a grandement fluctué. En 1995, le nombre de géniteurs a atteint un maximum de 50,000 poissons, puis a chuté à environ 4,000 poissons entre 1998 et 2000 et a remonté à un niveau se situant entre 24,000 et 29,000 poissons en 2001 et 2002. Les données disponibles sur l'abondance des géniteurs de la population du rivière Shubenacadie-Stewiacke ne se prêtent pas à une analyse des tendances pluriannuelles. Selon les estimations provisoires du nombre de géniteurs en 2002, le nombre de poissons en âge de se reproduire (3 ans et plus) varie entre 20,000 et 30,000. Les données disponibles montrent que plusieurs classes d'âge fraient chaque année depuis 1999. Selon les débarquements et les recaptures de poissons marqués, l'aire de répartition du bar rayé dans le Sud du golfe du Saint-Laurent ne semble pas avoir changé; la population est présente de façon saisonnière dans toutes les zones côtières de la région. Des relevés à la senne de plage indiquent que les jeunes de l'année du bar rayé quittent le système Miramichi durant l'été et sont distribués presque partout dans le sud du golfe par la fin de leur première année de croissance. Selon les recaptures de bars marqués lorsqu'ils descendaient la rivière Shubenacadie (en mai de 1999 à 2002), cette population passerait l'été dans le bassin Minas, mais cette interprétation pourrait bien être biaisée par le faible effort de pêche sportive à l'extérieur du bassin Minas. L'aire de répartition estivale en mer des jeunes bars rayés de l'année provenant du rivière Shubenacadie-Stewiacke semble se limiter aux zones d'eau intérieures, turbides et relativement chaudes du bassin Minas. Tout porte à croire que les deux populations des Maritimes comptent chacune plus de 10,000 individus matures.

Rationale

This assessment of striped bass (*Morone saxatilis*) in the Maritime Provinces was conducted in response to striped bass having been recommended for review by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Our role in this process was to assemble all relevant striped bass information held by the Department of Fisheries and Oceans (DFO) in an effort to aid COSEWIC with the appropriate determination of risk for the species. Specifically, we were asked to address four terms of reference: to evaluate striped bass populations in the context of "evolutionarily significant units" (ESU), to evaluate trends in abundance, trends in distribution, and the number of mature individuals. Accordingly, this review considers data relevant only to populations that spawn, or were known to spawn in Canadian waters. Data concerning the seasonal distribution and abundance of U.S.A.-origin migrant fish to Canadian waters is included only where required to interpret abundance trends and stock composition. The majority of the data presented in this document for southern Gulf of St. Lawrence (southern Gulf) striped bass (Gulf Region) has been peer reviewed and can be found in previous DFO Research Documents. Owing to their preliminary nature, data collected by Maritimes Region in the years 1999 and 2000 were tabled at Regional Advisory Process meetings as information items only. The data for 2001 and 2002 have not previously been peer reviewed.

Introduction

Life History of Striped Bass in the Maritimes

The striped bass is an anadromous percoid that spawns in many estuaries along the eastern seaboard of North America, and returns to the marine environment to feed and mature. The natural range of the striped bass extends along the western Atlantic Ocean from the St. Lawrence River in Québec, Canada, to the St. John's River in Florida, U.S.A. but is only considered anadromous north of Cape Hatteras, North Carolina (Scott and Scott 1988). Highest concentrations of striped bass occur in the middle of the species range; specifically in the Chesapeake Bay area of Maryland, the Hudson River of New York, and the Delaware River of Maryland. Striped bass are an important high order predator in the coastal and estuarial zones when occurring there in abundance.

Striped bass spawning occurs in the spring with a progression that generally begins at the south of the species distribution and ends in the north. Striped bass spawn as early as the end of March in the Savannah River, Georgia and as late as the second week of June in the NW Miramichi River in New Brunswick (NB) (Van den Avyle and Maynard 1994; Robichaud-LeBlanc et al. 1996; Bradford and Chaput 1996). Eggs and milt are broadcast simultaneously into the water column, float freely, and hatch in a few days (2-3) depending on water temperature (Scott and Scott 1988). Hogans and Melvin (1984) reported fecundity of southern Gulf striped bass from Kouchibouguac River, NB, between 78,000 and 121,000 eggs for fish with forklengths between 47.5 – 52.5 cm and weights between 2.0 to 2.5 kg. The Shubenacadie-Stewiacke population in the Bay of Fundy exhibited the same trend of higher egg counts with increased age and length (Paramore 1998). Paramore's (1998) predicted number of eggs for fish between the ages of 4 and 11 and between forklengths of 44.9 – 91.0 cm was 53,000 to 1,464,000 eggs. The yolk of young larvae is exhausted within 5 to 10 days post-hatch. A move to

the near shore shallows of the rivers occurs shortly after the onset of exogenous feeding. The young-of-the-year (YOY) striped bass from northern (Canadian) populations exhibit a high rate of intrinsic somatic growth, perhaps in compensation for the relative brevity of the summers in comparison to those realized by the more southerly U.S.A. populations (Conover et al. 1997; Robichaud-LeBlanc et al. 1998). Observed end-of-season average weights of YOY Miramichi striped bass can vary from ~10 g to ~50 g among years (Bradford et. al. 1997b), a factor that may contribute to year class size variability as a consequence of differences among years in starvation endurance during the ensuing winter (Bernier 1996; Bradford and Chaput 1998).

Most post-spawned adults return to the ocean and begin a coastal feeding migration that lasts into late autumn. At the onset of winter, adult striped bass in the Maritimes re-enter estuaries, river mouths, and even headwater lakes, presumably to avoid low, potentially lethal, seawater temperatures. The selection of an overwintering location in the southern Gulf appears to be opportunistic. Miramichi-origin striped bass are known to occur during the winter months in many river estuaries along the New Brunswick shore of the southern Gulf of St. Lawrence. Through a winter biotelemetric study, Bradford et al. (1997a) demonstrated that striped bass under the ice in the Kouchibouguac and Kouchibouguacis rivers showed very little movement (<1km), and preferred an average water temperature of not less than minus 0.4^0C and a salinity of 0-15 ppt. Large numbers of Shubenacadie-Stewiacke striped bass are known to ascend to Shubenacadie-Grand Lake where they remain for the winter. The winter range of this population, (i.e. their occurrence in other river systems) is not known.

ToR1. Population structure of striped bass in the Maritime provinces in the context of "evolutionarily significant units"

Historically, five populations of striped bass are known to have spawned in eastern Canada: the St. Lawrence River Québec (Beaulieu 1985), the Saint John and Northwest Miramichi rivers of NB (M.J. Dadswell DFO memorandum, 2 February 1982; Bradford et al. 1995; Robichaud-LeBlanc et al. 1996), and the Annapolis and Shubenacadie-Stewiacke rivers in Nova Scotia (NS) (Williams et al. 1984; Tull 1997; Rulifson and Tull 1999) (Figure 1). Striped bass populations in the St. Lawrence, Saint John and Annapolis rivers are all believed to have been extirpated during the last 40 to 50 years (Beaulieu 1985, Jessop 1995; Bradford et al. 2001a).

The remaining self-sustaining populations of striped bass spawn in the Northwest (NW) Miramichi River, NB (southern Gulf) and the Shubenacadie-Stewiacke River (Shubenacadie), NS (inner Bay of Fundy). The NW Miramichi River is the most northerly of the known historical spawning populations, and the only confirmed spawning grounds for the species in the southern Gulf (Bradford et al. 1995; Robichaud-LeBlanc et al. 1996) (Figure 1). Efforts to restore a striped bass population to the St. Lawrence River with seed stock from the Miramichi are underway.

There is no documented evidence that striped bass spawn or once spawned in any other rivers than the five mentioned above. Yet, there continues to be community based convictions of localized spawning populations in many southern Gulf rivers (e.g. Kouchibouguac, Tabusintac) (Rulifson and Dadswell 1995). This conviction is largely based upon the presence of striped bass of various age classes and at various times of the year throughout the southern Gulf. Presence of striped bass however, does not

necessarily indicate spawning. The spawning behaviour reported by Rulifson and Dadswell (1995) in southern Gulf rivers other than the Miramichi is based entirely on anecdotal information and is inconsistent with the seasonal migrations of this population as revealed by mark-recapture experiments (Bradford and Chaput 1996) and the lack of genetic discreteness of fish sampled from several locations within the southern Gulf (Robinson 2000).

Ichthyoplankton surveys to collect striped bass eggs and larvae in the Richibucto and Kouchibouguac rivers in 1997-98 (Robinson et al. 1998; Robinson 2000), and the Tabusintac River in 2001 (DFO data unpublished) were not successful. In each case however, YOY striped bass were captured in mid-summer during beach seine surveys of those same estuaries in those same years. It has been confirmed that YOY striped bass leave the Miramichi system and extend their distribution into estuaries throughout the southern Gulf (Robinson 2000, this report).

Genetics of Maritime Striped Bass

Genetic investigations of striped bass in the Maritime Provinces to 1999 were summarized in Robinson and Courtenay (1999). The genetic makeup of neither the St. Lawrence River nor the Annapolis River, nor the Saint John River populations of striped bass was resolved prior to their extirpation.

Briefly, restriction fragment length polymorphism analysis (RFLP) of mitochondrial DNA (mtDNA) has shown that juvenile striped bass from Canadian waters are highly distinct from striped bass in American waters (Wirgin et al. 1993). Wirgin et al. (1993) compared mtDNA from juvenile striped bass collected in the Miramichi and Tabusintac rivers (southern Gulf of St. Lawrence) the Shubenacadie River (Bay of Fundy), and the Hudson River and Chesapeake Bay of the U.S.A.. No significant differences were detected between Miramichi and Tabusintac striped bass but both were highly distinct from Shubenacadie and U.S.A. striped bass. Shubenacadie striped bass were also significantly different than U.S.A. fish. During a follow up study to estimate the number of U.S.A. fish migrating to Canadian waters, Wirgin et al. (1995) compared RFLP mtDNA of adult fish from the Saint John and Shubenacadie rivers (Bay of Fundy) and adult bass from the coast of the U.S.A. (Long Island, New York). Their results showed that the probable composition of striped bass in the Saint John River was >90% fish of U.S.A. origin. Only 50% of adult-sized fish sampled in the tidal Shubenacadie River could be stated with certainty to belong to the local population with the proportion of non-local fish in the spawning area varying between years. Wirgin et al. (1995) suggested that the entire Saint John population was largely composed of seasonal migrants from the U.S.A. and the remainder was made up of striped bass from the Shubenacadie system.

Results from nuclear DNA studies (Diaz et al. 1997; Robinson 2000) support those of the mtDNA studies (Wirgin et al. 1993; Wirgin et al. 1995). Diaz et al. (1997) tested striped bass from the Tabusintac River (southern Gulf), Shubenacadie River (Bay of Fundy) and several other populations along the U.S.A. coast. Allele frequencies were significantly different between Canadian and American fish and between the two Canadian populations (Diaz et al. 1997). Finally, nuclear DNA microsatellite analysis of YOY from the Miramichi, Richibucto, and Stewiacke rivers showed no difference between fish from the southern Gulf rivers, but did show significant differences between

fish from the southern Gulf and Bay of Fundy (F_{ST} = 0.04, α = 0.05, $p < 0.0001$; Robinson 2000).

Regardless of the method or the investigation, all genetic analyses of striped bass in Canadian waters have revealed that there are two distinct, reproductively isolated populations that exist in the Canadian Maritimes: the southern Gulf of St. Lawrence population and the Shubenacadie-Stewiacke population (Bay of Fundy). Furthermore, no differences have ever been detected between any striped bass collected in waters of the southern Gulf of St. Lawrence. There is no evidence that these two populations mix or migrate between areas. Numerous tagging (see tagging section below), meristic (Williamson 1974), and morphometric (Melvin 1978) studies offer further evidence that only two populations of striped currently exist in the Canadian Maritimes.

Striped Bass Management in the Maritimes

Striped bass are managed as two biological units (southern Gulf of St. Lawrence and Shubenacadie-Stewiacke), with one occurring in each of the two DFO fisheries management regions within the Maritime Provinces. Striped bass are managed under the Canada *Fisheries Act* and the Maritime Provinces Fishery Regulations (SOR/93-55) (Appendix 1). The Maritime Provinces Fishery Regulations provides the regulatory framework within which fishery managers can regulate harvests in the fisheries.

Southern Gulf of St. Lawrence

New regulations that came into effect in 1993 included the closure of directed commercial fisheries, season, size, and bag limits in the recreational fishery, and size restrictions in the Aboriginal fishery (Table 1).

A provisional conservation requirement of 5,000 female spawners was introduced in 1996 (Bradford and Chaput 1997) for NW Miramichi striped bass. The concept for the spawning requirement was based on abundance data which showed that when spawning females numbered in excess of 5,000, a several fold increase in YOY was apparent (years 1995-96 Bradford and Chaput 1996, 1997). Since the interim conservation requirement of 5,000 female spawners for the southern Gulf bass was not met in 1998-2000, measures to arrest further decline were imposed. They included a zero tolerance for bycatch in all commercial fisheries (1998), the closure of inland and coastal waters to angling (2000), and Native allocations were suspended (2000) (Table 1). The measures introduced in 1998 and 2000 (still in effect) provide striped bass in the southern Gulf with the maximum protection possible under the *Fisheries Act*.

Bay of Fundy

There are no conservation reference points to guide harvest allocations (recreational, aboriginal) and bycatch tolerances for striped bass occurring in the Maritimes Region. Recreational angling is permitted in tidal waters year round, with the exception of the inner portion of the Annapolis River estuary which is closed to striped bass angling between April 1 and June 30. Anglers are permitted to retain one striped bass $\geq$ 68 cm total length, per day. This corresponds approximately with the length at

which most striped bass would have had the chance to spawn at least once before their removal from the population.

By specific licence condition, only three commercial fisheries are permitted to retain striped bass for personal use (i.e. not for sale) in waters of the Bay of Fundy. There are 12 brush weir fishers in the inner Bay of Fundy that are permitted to retain one striped bass per day that is 68 cm or more in length. Licensed shad gill-netters in the Shubenacadie River are permitted to retain up to three striped bass per day that are less than 3.6 kg in weight (a restriction limiting drift gill-netters to nets with a mesh size of 89 mm after May 30 is in effect to reduce the bycatch of striped bass). On the Saint John River, licensed commercial shad and gaspereau fishers are permitted to retain striped bass that are 68 cm in length or longer with no restriction on quantity since the bass are believed to be mostly of U.S.A. origin.

Evolutionarily Significant Units

Striped bass are currently managed as two single biological units: one in the southern Gulf of St. Lawrence, and the other in the Bay of Fundy. Each region is generally regarded to represent distinct biogeographic regions, an implicit factor in the management framework for many harvested fish species in eastern Canada that exhibit a geographically broad spawning range that is organized into spatially separable spawning sites. As such, each of the remaining striped bass populations represents an important component of biodiversity within individual biogeographic regions. The RFLP mtDNA information of Wirgin et al. (1993) reveals 1) that the most common haplotypes exhibited by U.S.A. origin fishes are rare or absent in both Canadian populations, and 2) that the Canadian fish, in particular those spawning in the Shubenacadie, possess haplotypes that are extremely rare in U.S.A. stocks. In combination, these data would argue that loss of either population would represent a loss of genetic diversity within the species as a whole. Furthermore, each population exhibits an extremely narrow breeding range, to single rivers within each region, and to single tributaries within each river wherein a spawning niche of no more than a few square kilometers is occupied. Tagging studies (see below) indicate that spawning site fidelity in the Miramichi population is extremely high, no fish tagged as a spawner on the Miramichi has been reported as a recapture in later years in another southern Gulf estuary. In the Shubenacadie, the local population maintains high genetic discreteness even though striped bass with probable U.S.A. origins occur in biologically significant abundance in the spawning area and at the time of spawning.

The Miramichi population is the only population where avoidance of lethal marine conditions during winter is an obligate element of their life history. Low lethal marine temperatures can occur in some years or for brief periods within the year in the inner Bay of Fundy but only rarely within the next most northerly spawning group in the Hudson River. The Shubenacadie population is the sole representative of successful life cycle closure within a turbid, hydrodynamically energetic, tidal bore river. Furthermore, Shubenacadie striped bass are the only known population to ascend a river in significant numbers to a specific freshwater lake to overwinter. Members of each population exhibit high rates of intrinsic somatic growth when compared to U.S.A. stocks, a possible adaptive trait to compensate for a comparatively brief growing season and a correspondingly lengthier winter period under starvation (“countergradient variation” Conover 1990; Conover et al. 1997).

Thus the composite view is one of two genetically discrete, and ecologically unique populations, with each exhibiting highly structured life histories. The weight of evidence indicates that neither would be easily or even likely replaced by an event of natural recolonization.

ToR2 Striped bass population abundance and trends by population

Southern Gulf of St. Lawrence Striped Bass

Indices of Abundance - Adults

Landings

Striped bass landings from 1917 to 1988 for the Gulf of St. Lawrence were summarized by LeBlanc and Chaput (1991). Updated versions of striped bass landings since 1988 appeared in Bradford and Chaput (1996) and have been updated to present here for Gulf NB (Table 2) and Gulf NS (Table 3). There were no registered landings from PEI between 1988 and 2002. Landings data presented in this document were provided by DFO Gulf Region Statistics Branch. Estimates of landings originate from a combination of two sources: 1) purchase slips (which are known to be incomplete) and 2) subjective estimates from fishery officers on patrol. Reliability of both methods of estimating landings are questionable.

Historic landings of striped bass from the southern Gulf of St. Lawrence dates back to 1917 and coincides with the peak harvest for the time series (61.4 tonnes) (LeBlanc and Chaput 1991). Presumably, striped bass went through a period of extremely low abundance between 1935 and 1968 in which no landings were registered (Figure 2). Since 1969, average landings have been registered at just over 10 tonnes (t) with a minimum of 0.79 t and maximum of 47.8 t in 1990 and 1981 respectively. Although commercial fisheries for striped bass were closed permanently in 1996, 15 t were harvested in that year. No landings have been registered since those in 1996.

Throughout the time series, the majority of striped bass harvests have been reported from Kent Co., NB, (Fisheries Statistical Districts (FSDs) 75-77, Kouchibouguac, Richibucto, and Buctouche areas) (Table 2; Figure 3). Harvests of striped bass were also reported from Northumberland Co., NB (FSDs 70-71, Miramichi area), and Gloucester Co., NB (FSD 68, Pokemouche area) but in lesser quantities. Observations by DFO-Science indicate that landings in the Miramichi were often under reported. Landings of striped bass in Gulf Nova Scotia or PEI were negligible for the time series (Table 3). Historically, striped bass in the southern Gulf have been captured predominantly as a bycatch species in the gaspereau fisheries and as a target species in the winter hoop net fishery under the ice (LeBlanc and Chaput 1991).

Mark-recapture and CPUE

Mark-recapture experiments have been conducted annually since 1993 to estimate the size of the striped bass spawning run to the NW Miramichi. Adult striped bass are tagged in the Miramichi system during their ascent to the spawning grounds. The commercial alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis* (collectively gaspereau) fishery of the NW Miramichi River functions as the recapture locations for tagged striped bass. Bycaught striped bass from the gaspereau trapnets are counted for catch per unit effort (CPUE) analysis and searched for tags for mark-recapture analysis. Sampling of biological characteristics is also conducted on much of the striped bass bycatch. For a more detailed description of the mark-recapture experiments and biological sampling of striped bass in the NW Miramichi see previous assessments (Bradford et al. 2001b; Douglas et al. 2001).

Spawner estimates since 1993 reveal that the population of striped bass in the southern Gulf has undergone large annual fluctuations (Figure 4). Peak spawner abundance in 1995 was estimated at 50,000 fish but quickly dropped to about 8,000 fish in 1996 and 1997. Spawners were estimated at just under 4,000 fish between 1998 and 2000 but increased substantially to between 24,000 and 29,000 fish in 2001 and 2002 (Figure 4).

Catches of striped bass in the gaspereau fishery of the NW Miramichi were standardized to units of adult bass per trap per day and analyzed with analysis of variance models (Douglas et al. 2001). In most years, striped bass catches declined progressively throughout the gaspereau season (Figure 5). The generalized linear model indicated that CPUE among traps within a year and among years is highly variable (Figure 6). CPUE has been highest in years of high abundance and particularly high at the beginning of the 2001 and 2002 sampling season. Although the linear relationship between mean catch/trap/day and population size is weak (r^2 = 0.41), mean catches have always been below 10 when spawners have been estimated to be less than 10,000 (Figure 7).

The decline in spawner abundance after the peak in 1995 can be largely attributed to commercial harvests of striped bass. Registered striped bass landings of between 15 and 17 t were removed from the adult population between the spawner estimate in 1995 and 1996.

Better than expected recruitment of the 1998 year class is responsible for the increase in the number of bass participating in the 2001 spawning run to the NW Miramichi River. The strong showing of age 3 males (1999 year class) in 2002 (DFO data unpublished) was expected given the large body size of the 1999 year-class (Douglas et al. 2001). The female counterpart of the 1999 year class should spawn for the first time in the spring of 2003. Fortunately, striped bass are highly fecund fish that can demonstrate high resilience when environmental conditions are favorable for good survival of spawned eggs. Strong year classes are able to carry the population through times of low abundance. Peaks in population abundance coincide with strong year classes recruiting to the adult population.

Limiting Factors

Closure of the commercial striped bass fisheries in 1996 did not result in any increase in spawner abundance in 1997-2000 but may explain part of the increase in 2001-02. There continues to be substantial bycatches of striped bass YOY during the fall and winter in the commercial rainbow smelt (*Osmerus mordax*) fisheries of the southern Gulf. Young-of-the-year are first vulnerable to capture in the smelt fishery while moving upstream to wintering sites and then again after freshets when the fish can be flushed back downstream into the smelt fishing areas (Bradford et al. 1997b). Young-of-the-year exhibit a range extension in early July that results in an area of occupancy well beyond the physical boundaries of the Miramichi estuary (DFO data unpublished). As a result they are susceptible to capture in virtually any of the southern Gulf (coastal, estuarial etc.) fixed-gear fisheries that they may encounter. Although the only estimates of YOY mortality in the smelt fishery come from the Miramichi (Bradford et al. 1997b), it is likely that there is YOY mortality in the commercial smelt fisheries of every estuary in the southern Gulf from Bathurst, NB to Margaree, Cape Breton (PEI being the possible exception). Adult and more commonly, YOY striped bass are captured in fyke nets set for American eels throughout the southern Gulf (Bradford et al. 1995). Neither the cumulative number of bass intercepted in this fishery nor the subsequent mortality on these fish is known.

Poaching is likely a major factor limiting the rebuilding of the adult striped bass population to the southern Gulf. At this time, estimates of striped bass mortality from poaching are not available but is believed to be substantial in some years. During beach seining surveys throughout 2001 and 2002, frequent discussions with local residents revealed a wealth of anecdotal information of striped bass poaching in their area. Reports of adult striped bass poaching were most common in the areas of the Acadian peninsula (FSDs 65-68), Tabusintac River (statistical district 70), and the Richibucto River (FSD 76) (Figure 3). If the reports of half-ton truck loads of striped bass captured from overwintering grounds in the Richibucto River in the recent past are true, it is understandable that this mortality has revealed itself during years of low spawner abundance on the Miramichi. Furthermore, residents in the Richibucto area have been approached to purchase illegally caught striped bass in October of 2002 (S. Douglas, DFO Gulf Region, pers. comm.).

Numerous studies on U.S.A. populations report that recruitment is controlled by exogenous density-independent factors (Ulanowicz and Polgar 1980; Rutherford and Houde 1995; Rutherford et al. 1997; Bulak et al. 1997). The effect of environmental variables such as water temperature on the viability of striped bass eggs in the southern Gulf has not been studied. In addition, the effect of effluent from pulp and paper mills, power generating stations, and other industries on striped bass habitat in the Maritimes is unknown. Specifically, the effect of the effluent from the UPM-Kymmene pulp and paper mill and the sewage treatment facilities in Miramichi which is discharged directly into the known spawning and rearing grounds of striped bass is unknown (Robichaud-LeBlanc et al. 2000). Size-dependent winter mortality has also been suggested as a factor that could limit recruitment within more northerly striped bass populations (Bernier 1996; Bradford and Chaput 1997; Hurst and Conover 1998).

Biological Characteristics

Male striped bass have comprised the majority of the spawning run to the NW Miramichi for the past six years (Table 4, Figure 4). The higher ratio of males to females is largely attributable to the fact that the majority of males generally first mature at age three, one year earlier than females (Bradford and Chaput 1996). Mature males and females aged two and three years old respectively are sampled infrequently (Table 5). While sampling catches for biological characteristics, many striped bass are not ripe enough to expel sexual fluids and are therefore identified as sex unknown. A portion of these fish identified as 'unknowns' are subsequently assigned to a sex upon their recapture in a visibly obvious reproductively mature state. Many do not exhibit sexual maturation over the course of the spawning season (Douglas et al. 2001).

Female striped bass sampled in the southern Gulf are generally older and larger than males. Large striped bass (> 80 cm) similar to those frequently sampled in the Bay of Fundy and U.S.A. waters are rare in catches in the NW Miramichi River (Figure 8). The two largest striped bass sampled as part of the annual assessment of the NW Miramichi striped bass were females measuring 115 cm in 1993 and another measuring 91 cm in 2002 (Table 6). In each year of the striped bass program on the NW Miramichi (since 1993), the majority of striped bass have had lengths between 40 and 50 cm (Figure 8). These results are identical to those of Chaput and Randall (1990) and Chaput and Robichaud (1995) who reported on lengths of striped bass sampled at the DFO index trapnet which operated at Millbank (lower Miramichi estuary) between 1975 and 1982. The reason for the repeated and truncated length and age distributions in the Miramichi system is unknown. Striped bass in the southern Gulf rarely exceed lengths of 50-60 cm and ages over 7 years.

Indices of Abundance - Young-of-the-year

Catch per Unit Effort

In an effort to estimate the abundance of YOY striped bass in the Miramichi system and to get a first look at spawner success for the year, sampling of the commercial smelt fishery of the Miramichi estuary was initiated in 1991 (Hanson and Courtenay 1995). The bycatch of YOY striped bass was counted and measured from smelt box nets operating during the open-water (generally from October 15 to December 1) and in some years after ice formation (January 1 on). Estimates of CPUE (standardized to bass per net per 24 hr) were calculated for this fishery each year between 1991 and 1998 (Bradford et al. 2001b). Because of data collected from the bycatch in the smelt fishery of the Miramichi system, the opening of the season was delayed by two weeks in 1999 (still in effect). At that time, DFO science was no longer welcomed to sample commercial catches of smelt and this index was discontinued.

Abundance of YOY striped bass in the commercial smelt fishery was the basis upon which an interim conservation requirement was implemented in 1996 (Bradford and Chaput 1997). When the estimate of female spawners numbered in excess of 5,000, a several fold increase in YOY was apparent (years 1995-96) (Bradford and Chaput 1996; Bradford and Chaput 1997). Catch per unit of effort estimates (YOY/net/day)

ranged from a low of 7 in 1994 to a high of 452 in 1996 and averaged 107 over the course of the program. Albeit a limited data set, the CPUE index was generally a poor indicator of recruitment three and four years later for males and females respectively. For example, low median CPUE values of 18 and 50 in 1991-1992 translated into the highest spawner estimate ever (50,000 predominantly aged 3 and 4) (Bradford and Chaput 1997) while the highest median CPUE of 452 in 1996 corresponded to the lowest spawner estimates on record (1999-2000) (Douglas et al. 2001). Whether the proportion of YOY leaving the Miramichi system is the same on an annual basis is unknown.

The other, equally important component of the CPUE index was an indication of YOY body size at the end of the first growing season. Bernier (1996) reported that Miramichi YOY < 10 cm were less likely to survive their first winter than larger conspecifics. Other evidence for first year, size-dependent winter mortality exists for striped bass in the U.S.A. (Hurst and Conover 1998). Median values of forklengths at the end of the first growing season ranged from 10 cm to 13 cm during the 1991-1998 period (Bradford et al. 2001b). The mean pre-winter length of YOY striped bass spawned in 1999 was 15.3 cm, substantially larger than lengths previously recorded for other year classes (Douglas et al. 2001). Lengths at the end of the first growing season between 2000 and 2002 (Figure 9) were similar to those of the 1991-1998 time period. The specific role of YOY size and/or abundance in recruitment has not been resolved for southern Gulf striped bass.

Beach Seine Surveys

A beach seine survey for YOY striped bass in the Miramichi system and surrounding southern Gulf of St. Lawrence was initiated in 2000 to obtain estimates of spawner success for that year. Similar to many U.S.A. agencies (NFSC 1998; ASMFC 1989; Versar 1988), annual beach seine surveys may be useful as an index of spawner success once several years of data have been collected. The limited beach seine data set (2000-2002) makes recruitment forecasting impossible at this time.

Saint John River Striped Bass

Striped bass spawning was reported by Cox (1893) to occur in the section of the Saint John River lying above tidal influence and upstream of Fredericton and downstream of Mactaquac Dam which was completed in 1967. There has been no positive evidence of successful spawning by striped bass in the Saint John River system since 1979 when eggs were collected from the inner portions of Belleisle Bay (Figure 10) (M.J. Dadswell, DFO memorandum, 2 February 1982). Surveys were unsuccessful in collecting eggs, larvae or juveniles during either 1992 or 1994 (Jessop 1995). Beach seine surveys failed to detect the presence of YOY striped bass in either 2000 or 2001 (this report).

Adult striped bass still occur within the Saint John River system where they are captured in the fish collection facility at the base of the Mactaquac Dam. Total catches for the years since 1970 varied between 0 (1974, 1976, 1977) and 715 (1998) (Figure 11). Run strength exhibits general correspondence with the aggregate recruitment index (Figure 11) for the U.S.A. populations (NFSC 1998). There is no substantive run of fish

to the base of the dam until the end of June (standard week 24; Figure 12). Unlike rivers with striped bass production, catches of bass at the base of the dam have been only of age 3 or greater in recent years (Figure 13). The aggregate data lend support to the conclusion of Wirgin et al. (1995), based on an analysis of mtDNA, that these fish are most likely seasonal migrants from spawning rivers located elsewhere along the east coast. A somewhat contrary view is supported by observations that at least some of the striped bass sampled at Mactaquac are recaptured in subsequent years (Table 7) and by the presence of very large and presumably very old striped bass in the vicinity of Belleisle Bay in early May.

Habitat degradation and loss is believed largely responsible for the collapse or probable extirpation of native Saint John River striped bass. Construction of the large Mactaquac hydroelectric impoundment on and upstream of the spawning grounds is believed to be the single greatest factor contributing to the cessation of spawning (Jessop 1995) The unnatural fluctuations in water velocity and volume spilled from the Dam are not conducive to striped bass spawning. Jessop (1995) concluded that reclamation of the spawning habitat lost when the Mactaquac Dam was built may be impossible. Dadswell (1976) attributed the high incidence of membrane rupture and embryo mortality to high levels of organochlorines (DDT, PCB) but high PCB levels may have little effect on striped bass reproduction (ASMFC 1990).

There is uncertainty as to whether the lack of detectable evidence for viable spawning activity (absence of juvenile striped bass in beach seine surveys) indicates a complete loss of the indigenous population or if it means a remnant Saint John River population is not able to close their life-cycle owing to a recruitment failure (as inferred from the absence of juveniles). A satisfactory determination is not possible at this time. The population affinity of the large (presumably old) striped bass that occur in the lower Saint John River is not known, nor are there adequate data on their spawning readiness at the time of their appearance in Belleisle Bay. Striped bass from U.S.A. rivers do not necessarily spawn every year upon attaining sexual maturity for the first time (Waldman et al. 1990). A study of the thermal suitability of the spawning habitat below Mactaquac Dam is presently underway as part of an assessment of the prospects for successfully restoring (or resuscitating) striped bass to the lower Saint John River.

Annapolis River Striped Bass

Viable spawning by striped bass in this system has evidently not occurred since 1976 (Williams et al. 1984; Jessop 1990; Jessop 1995) although spawning activity, as revealed from collections of eggs from the river was known (Jessop 1995). Hence, survival beyond the egg stage is thought to be very low to negligible (Jessop 1990). A remnant population of old (>20 years of age) adult fish may still exist, owing to the general longevity (>25 years) of striped bass (Scott and Scott 1988) and reports from credible sources that adult sized striped bass were captured in the river during May at least up to the mid 1990's (J. Gibson, DFO Maritimes Region, pers. comm.). The population origin of these fish is not known. Beach seine surveys of the Annapolis River estuary (including the head pond behind the tidal power plant and of Annapolis Basin to the seaward) (Figure 14) during the summers of 2001 and 2002 did not detect juveniles.

Jessop (1990) noted that "eggs spawned in the Annapolis River are viable and have a high hatching rate when held in water of suitable quality from sources other than the Annapolis River." The failure of naturally spawned eggs to yield viable offspring and the absence of age 0+ striped bass in the river system suggests either inadequate water

chemistry or quality (Jessop 1995) or perhaps deleterious alterations to the physical circulation of the estuary. The Annapolis River and estuary are impacted by tidal power development, natural pH depression, and agricultural runoff.

Striped bass are sensitive to river acidity with water pH of 5.9 or less considered to be lethal (Buckler et al. 1987). Hydroelectric impoundments on streams flowing to the Annapolis River near and upstream of the historical spawning site store water from snow melt and therefore of low pH. The stored waters are subsequently released from the reservoirs through May and June thereby raising the possibility that the natural cycle leading to early spring (March-April) depression in water pH has become extended into the spawning season.

As was the case with the Saint John River, there is uncertainty as to whether the lack of detectable evidence for viable spawning activity (2001-2002 beach seine surveys) indicates a complete loss of the indigenous population or if it means a remnant population is not able to close their life-cycle owing to a recruitment failure.

Shubenacadie-Stewiacke River Striped Bass

Indices of Abundance - Adults

In late autumn large numbers of striped bass ascend the Shubenacadie River to Shubenacadie-Grand Lake where they remain for the winter months (Figure 15). The run of striped bass is characteristically of a broad size distribution and includes both juvenile fish and those that would be at least of the minimum reproductive age (3+ years) the following spring (Figure 16). Owing to the regular appearance of these fish, their tendency to descend from the lake to the estuary en masse in early May (Figure 17), their ease of capture (in comparison with attempting to sample within a tidal bore estuary), and the confounding influence of the presence of non-native fish with probable U.S.A. river origins in the estuary during spring (Wirgin et al. 1995), stock assessment efforts have targeted the downstream run.

Mark-recapture experiments to estimate the annual abundance of both juvenile striped bass (< 3+ years) and striped bass of reproductive age (≥ 3+ years) descending from Shubenacadie-Grand Lake have been in development since 1999. Indices of run-timing and catch per unit effort could be calculated and compared for the 1999-2002 time series but comparisons among years are confounded because the operation and configuration of trapnets changed in 2000 from the previous year, and they have been subject to minor modifications in the succeeding years. In addition, a sustained period of freshet coincided with the peak of the run in 2001 with a resultant loss of more than half of the fishing days corresponding with downstream run-timing of the fish. Credible information is available for 2002 only. The mark-recapture data lends itself to a provisional estimate of run strength of between 18 and 27 thousand individuals. The number of fish of minimum breeding age (males cannot be distinguished from females using external characters) is estimated at no less than 15 thousand, and those with a minimum age of 4+ years at no less than 7 thousand (Table 8).

Biological Characteristics

Inspection of the time series of length frequencies for the years 1999-2002 confirms the breadth in body size of the migrant fish (Figure 16). Provisional age assignments reveal the presence of both juvenile fish (age 2+ years) and those of minimum reproductive age (Figure 16). The downstream migration of the immature fish is concurrent with that of mature fish (Figure 17). Validation of ages determined from the interpretation of annuli recorded on external body scales is in progress. Age validations will be based on the reading of scales extracted from fish with a known history of multiple recaptures (from tagging) and by comparison/contrast to those obtained from otoliths excised from sacrificed fish.

Indices of Abundance – Young-of-the-year

Shubenacadie-Stewiacke YOY striped bass are sampled via summer beach seine surveys of both the tidal Shubenacadie River and along both shores of Minas Basin seaward to Minas Channel (Figure 18). This report only considers the information for the tidal Shubenacadie and the sites located along the north shore of Minas Basin (Figure 18) that are common to all years of sampling (1999-2002), and only for collections obtained from the beginning of August to mid-September. Briefly, following spawning in late May-early June (Figure 19), the young juveniles become fully recruited to the sample gear (beach seine) by early August (Figure 19). Young-of-the-year striped bass were captured with regularity within the tidal Shubenacadie (Table 9). In at least one year (1999) the YOY exhibited a pronounced range extension into Minas Basin where they were a frequent component of the catches at all sites seaward to Five Islands (Figure 18), No YOY striped bass have ever been captured at Partridge Island (Figure 18) the site most influenced by 'ocean' conditions (low temperature, high salinity, low turbidity). In 2000 YOY striped bass were virtually absent from any of the sweeps along the Minas Basin. Few YOY were captured seaward of Economy Point in the years 2000 and 2001 (Table 9).

ToR3. Striped bass distribution by population

Southern Gulf of St. Lawrence Striped Bass - Adults

Adult striped bass are distributed throughout the southern Gulf of St. Lawrence. Historic accounts of striped bass in the southern Gulf include, Perley (1852), Cox (1893), and McKenzie (1959). However population structure and dynamics were not components of the early studies. Without documented proof of distributions, it is impossible to know whether the area of occupancy has changed and if so to what degree. We have only recently learned that YOY leave the NW Miramichi during their first few weeks of life and are distributed throughout the southern Gulf by the end of the first growing season (Robinson 2000; this report).

Marine Distribution

September, seasonal, or juvenile cod, bottom trawl surveys of the southern Gulf of St. Lawrence did not collect any striped bass (H. Benoit, DFO Gulf Region, pers. comm.). A single striped bass occurrence was recorded in the observer database (1995-2001) from the winter flounder gillnet fishery off Escuminac, NB (FSD 73; Figure 3) (H. Benoit, DFO Gulf Region, pers. comm.). Bradford and Chaput (1998) reported two striped bass tag returns from coastal nets off Escuminac in the spring of 1997.

Landings

Although striped bass landings have occurred in every county of New Brunswick that borders the Gulf of St. Lawrence, the vast majority has been from waters adjacent to Kent Co. (Richibucto, Kouchibouguac, Buctouche) followed by Northumberland Co. (Miramichi) and Gloucester Co. (Pokemouche). Landings of striped bass in Gulf NB beyond those areas have been sporadic (Table 2). Landings in Gulf Nova Scotia have also been registered in every county that borders the Gulf of St. Lawrence but to a lesser extent than NB. Historic landings in NS range from Cumberland Co. (FSDs 45 - 46) to Inverness Co. in Cape Breton (statistical district 3; Figure 3). Oddly, few landings have been reported from Pictou Co., NS (FSDs 11-12) where striped bass of various age classes have recently been sampled from waters of the Pugwash River, Wallace Bay, and Pictou Harbour (DFO data unpublished). Landings on PEI have occurred but are negligible. It is likely that landings of striped bass in areas where they are not common may be a reflection of high population abundance in those years.

Tag Returns

The first striped bass tagging program in the southern Gulf was conducted on a presumed localized spawning run in the Kouchibouguac River during 1983-84 (Hogans and Melvin 1984). Striped bass tagging was minimal until 1993 when annual assessments of the spawning run to the NW Miramichi were initiated and over 250 tags were applied as part of a study to develop assessment protocols to obtain estimates of spawner abundance. Tagging of NW Miramichi striped bass during their spring spawning migration has continued every year since. Tagging in other locations such as the Bathurst Harbour (Meagher 1987), and the Kouchibouguac, and Tabusintac rivers has been sporadic and opportunistic (Table 10). Tagging of striped bass was initiated in the Wallace Bay and East Rivers of NS in 2001. There are no data yet to report from this recent study.

Through the annual assessment of NW Miramichi striped bass and the myriad of other striped bass tagging programs (Table 10), over 8,000 tags have been placed on striped bass in the southern Gulf since 1983. Regardless of the tagging program or the number of striped bass tagged, striped bass have invariably been recaptured from waters of the Gulf of St. Lawrence. Striped bass tagged during the fall in the Kouchibouguac and the Tabusintac rivers were recaptured the following spring in the NW Miramichi in a ripened state (Bradford et al. 2001b). Furthermore, of 10 striped bass

tagged in Margaree Harbour (FSD 2; Figure 3), one was recaptured on the spawning grounds of the NW Miramichi (Bradford and Chaput 1996). Although recaptured tags are most commonly from striped bass within the same estuary as the tagging location or a nearby estuary within close proximity of the tagging location (Richibucto, Kouchibouguac, Tabusintac), striped bass have been recaptured as far away as Percé, Québec, and the Margaree, Cape Breton (Bradford and Chaput 1996). The only exception to the "all southern Gulf" recapture profile is one reported recapture from the Wye River, Maryland U.S.A., that was tagged (597 tags applied during study) in the Kouchibouguac River in 1983-84 (Hogans and Melvin 1984) (Table 10).

Commercial gaspereau fishermen of the Miramichi system account for the vast majority of recaptured tags in any given year. High recapture rates from this fishery are expected since run timing of gaspereau and striped bass are simultaneous and the location of the trapnets are adjacent to the known spawning grounds. Anglers throughout the southern Gulf account for a small portion of tags returned. With the current closure of the striped bass recreational fishery, fewer tag returns are expected.

The current area of occupancy of southern Gulf striped bass appears to be the entire Gulf of St. Lawrence from the most northern location of Percé, Québec, to Margaree, in Cape Breton (and maybe beyond), with rare reports of striped bass on PEI. Based on historical landings and current tagging and recapture profiles, the area of occupancy for southern Gulf striped bass has not changed. Commercial fishing districts with highest reported catches continue to be areas where striped bass are most common. Occasional landings of striped bass in the past are consistent with occasional present day occurrences of striped bass in those same areas. Tag returns indicate that striped bass are confined to the southern Gulf.

Southern Gulf Striped Bass - Young-of-the-year

Beach Seine Surveys

While the beach seine survey of the Miramichi and surrounding southern Gulf was implemented in 2000 to quantify spawner success, indications of YOY distributions were also noted. Since the inception of the program, beach seine sites have increased on a yearly basis and in 2002 sites were distributed from as far north as the Bathurst Harbour in northern NB and as far south as the East River in Pictou Co. NS (Figure 20).

Data collected during each of the three years reveals the same trend of YOY first appearing along the shores of the known spawning grounds of the NW Miramichi River (Robichaud-LeBlanc et al. 1998). Similar to what Robichaud-LeBlanc et al. (1998) showed, YOY extend their distribution down river and can be collected in Miramichi Bay only a few days after they have first been detected in the vicinity of the spawning grounds. By the end of July in 2002, YOY striped bass had extended their distribution both north and south of the Miramichi estuary (Figure 20). By the first of August, YOY were captured at the mouth of the Kouchibouguac River in the south, and in coastal waters off Neguac in the north. By mid August, YOY were collected as far south as the Buctouche River, and as far north as the coastal waters off Shippagan (Figure 20). These two catches represent the most northern and southern records of YOY range

extension out of the Miramichi system during their first year of life. These results concur with Robinson (2000) who also reported of Miramichi YOY in the Kouchibouguac and Richibucto estuaries in August of 1996-1998. Catches of striped bass in beach seine surveys after mid August decline rapidly. The usefulness of beach seine gear after the middle of August is questionable as there are indications that the fish are no longer available to capture in the shallows at this time of year. It is possible that YOY have moved into deeper waters off shore as evidenced with large catches of YOY in commercial smelt box and bag nets in the fall of the year (Bradford et al. 1997b). It is also possible that YOY are large enough to avoid the beach seine after the middle of August. It is likely that YOY spawned in the Miramichi system extend their range well beyond the waters of Gulf NB. Young-of-the-year sampled in Wallace Bay and the Pugwash River of NS in 2001 are believed to have originated from the Miramichi (DFO data unpublished). Young-of-the-year have been captured during late fall in 1998 by First Nation fishers operating salmon trapnets in River Phillip NS (Robinson 2000). Young-of-the-year were captured in smelt gear in Wallace Bay as early as October 15 in 2002.

Young-of-the-year, likely with Miramichi River origins, utilized every southern Gulf estuary from Shippagan in the north to the Buctouche River in the south as rearing habitat in 2002. Estuaries beyond those into Bathurst and Gulf NS were likely utilized as rearing habitat as well. Whether this range extension out of the Miramichi is a function of abundance or size, or a combination of the two is unknown. A lack of documented historical YOY distributions negates an attempt to infer a change in distribution.

Saint John River Striped Bass - Adults

There have been no reports of recaptures outside of the lower Saint John River from any of the nearly 600 fish marked and released from Mactaquac Dam.

Saint John River Striped Bass – Young-of-the-year

Beach Seine Surveys

Summer beach seine surveys during the summers of 2000 and 2001 were not successful in demonstrating the presence of YOY striped bass (Figure 10). No striped bass of any age was captured.

Annapolis River Striped Bass - Adults

There have been no reported recaptures from the Annapolis River of striped bass marked on the Shubenacadie River. This likely reflects in part the large decline in recreational angling effort for striped bass that has occurred on the Annapolis River over the past decade (Rulifson and Dadswell 1995).

Annapolis River Striped Bass – Young-of-the-year

Summer beach seine surveys during 2001 and 2002 were not successful in demonstrating the presence of YOY striped bass (Figure 14). No striped bass of any age was captured.

Shubenacadie-Stewiacke River Striped Bass - Adults

There have been no reports of recaptures outside of Minas Basin of any of the ~ 2,500 striped bass marked on the Shubenacadie River. In contrast, Rulifson et al. (1987) reported recaptures from along the east coast of the U.S.A., as well as from the spawning grounds on the Shubenacadie-Stewiacke River, that were marked during the summer months from Cobequid Bay (Figure 18). These differences are consistent with the known presence of migrant U.S.A. fish in the Bay of Fundy during the summer months, and a restricted distribution range for native fish wintering in Shubenacadie-Grand Lake.

ToR4. Number of mature individuals

Southern Gulf of St. Lawrence Striped Bass

Although the spawner estimate of southern Gulf striped bass has fluctuated widely since the inception of the monitoring program in 1993, all indications are that southern Gulf striped bass currently exceed 10,000 mature individuals. Whether this estimate of spawners encompasses the entire mature population is currently unknown. However, tagging studies on the NW Miramichi indicate that there are yearly repeat and consecutive spawners. For example, 5.4% of striped bass tagged on the spawning grounds in 1998 (n = 909) were recaptured again on the spawning grounds in 1999. Furthermore, the number of juvenile fish (age 1+ and 2+) in other estuaries throughout the southern Gulf is also unknown but is considered to be substantial.

Saint John River Striped Bass

Strong evidence suggests that this population has been extirpated. The majority of the striped bass in the river are believed to be of U.S.A. or Shubenacadie-Stewiacke origin.

Annapolis River Striped Bass

It is believed that the Annapolis population of striped bass has been extirpated. There have been no efforts to check the status of a possible remnant adult population since those of Jessop (1990).

Shubenacadie-Stewiacke River Striped Bass

At this time, every indication suggests that there are in excess of 10,000 mature striped bass in this population (this report).

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Table 1. Generalized striped bass management milestones in the southern Gulf of St. Lawrence since 1992.

	Management milestones		
Year	Commercial	Recreational	Aboriginal
prior to 1992	gillnet licenses (mesh restriction 127 mm) bow net fishery open to all (mesh and season) incidental catches retained and marketed	no harvesting of bass < 38 cm unless in Kent Co. waters	Sparrow decision 1990 food, social, and ceremony bass > 68 cm TL
1992	DFO conservation strategy written - closure of all directed fisheries - incidental catches > 38 cm to be released - bycatch tolerance for bass < 38 cm (gasp, smelt) bow net fishery designated as recreational - recreational bag limit and size restrictions	1st recreational regulations ever - season, size, and bag limit - one bass / day, > 68 cm TL - July 1 to October 31	bass > 68 cm TL
1993	DFO conservation strategy implemented	one bass / day, > 68 cm TL July 1 to October 31	bass > 68 cm TL July 1 to October 31
1994	DFO conservation strategy implemented	one bass / day, > 68 cm TL July 1 to October 31	bass > 68 cm TL July 1 to October 31
1995	release of bass > 38 cm not imposed -17 t harvested - some voluntary release of spawning fish in Miramichi (May-June)	one bass / day, > 68 cm TL July 1 to October 31	bass > 68 cm TL July 1 to October 31
1996	all commercial fisheries permanently closed sale of wild striped bass no longer permitted tolerance limit for bass < 35 cm TL (gasp, smelt) - retained but not sold -15 t harvested	hook and release only May 1 to October 31	size restrictions lifted - impractical because of gillnets July 1 to October 31
1997	tolerance for bass < 35 cm TL (gasp, smelt) - retained but not sold	hook and release only May 1 to October 31	July 1 to October 31
1998	zero tolerance for any bass bycatch of any size	hook and release only April 15 to October 31	July 1 to October 31
1999	zero tolerance for any bass bycatch of any size smelt season delayed by two weeks in Miramichi	hook and release only April 15 to October 31	July 1 to October 31
2000	zero tolerance for any bass bycatch of any size smelt season delayed by two weeks in Miramichi precautionary approach	inland and coastal waters closed	allocations suspended
2001	zero tolerance for any bass bycatch of any size smelt season delayed by two weeks in Miramichi precautionary approach	inland and coastal waters closed	allocations suspended
2002	zero tolerance for any bass bycatch of any size smelt season delayed by two weeks in Miramichi precautionary approach	inland and coastal waters closed	allocations suspended

Table 2. New Brunswick, Gulf of St. Lawrence striped bass landings (tonnes) by Fisheries Statistical Districts from 1989 to 2002.

	NB Fisheries Statistical Districts															
	Restigouche	Gloucester					Northumberland				Kent			Westmorland			NB of Gulf
Year	63	64	65	66	67	68	70	71	72	73	75	76	77	78	80	NB Total	total (%)
1989								0.09				3.78				3.87	100.0
1990											0.02	0.76				0.79	100.0
1991											0.24	1.15				1.38	100.0
1992								0.23			0.27	8.39				8.89	100.0
1993											0.02	0.58	0.08			0.67	42.5
1994											0.12	1.14				1.26	100.0
1995		0.45		0.23		0.45					0.36	15.51	0.23	0.05		17.29	99.4
1996				0.23								14.52	0.23			14.97	100.0
1997																	
1998																	
1999																	
2000																	
2001																	
2002																	
Total		0.45		0.45		0.45		0.32			1.03	45.83	0.54	0.05		49.12	98.0

Table 3. Nova Scotia, Gulf of St. Lawrence striped bass landings (tonnes) by Fisheries Statistical Districts from 1989 to 2002.

	NS Fisheries Statistical Districts									
	Inverness		Colchester	Pictou		Antigonish	Cumberland			NS of Gulf
Year	2	3	10	11	12	13	45	46	NS Total	total (%)
1989										
1990										
1991										
1992										
1993				0.91					0.91	57.5
1994										
1995						0.09		0.02	0.11	0.6
1996										
1997										
1998										
1999										
2000										
2001										
2002										
Total				0.91		0.09		0.02	1.02	2.0

Table 4. Sex ratios of adult striped bass sampled during their spawning migration to the NW Miramichi River 1993 - 2002.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total spawners (mode)	5500	29000	50000	8090	8000	3400	3940	3900	24000	29000
95% confidence limit (lower)	4550	23000	35000	6275	5800	2900	3450	2850	18000	25500
95% confidence limit (upper)	7300	47000	175000	13370	17500	4800	4430	5250	33000	32500
Proportion mature males	0.94	0.92	0.63	0.37	0.69	0.83	0.69	0.64	0.77	0.58
Proportion mature females (minimum)	na	na	na	na	na	na	0.03	0.04	0.02	0.01
Proportion mature females (maximum)	0.06	0.08	0.37	0.63	0.31	0.17	0.31	0.36	0.23	0.42
Mature males (minimum)	5170	26680	31500	2993	5500	2822	2719	2496	18480	16820
Mature females (minimum)	na	na	na	na	na	na	118	156	480	290
Mature females (maximum)	330	2320	18500	5097	2500	578	1221	1404	5520	12180

Table 5. Biological characteristics of striped bass caught during their spawning migration to the NW Miramichi. Mean lengths calculated from initial tagging events only, min and max lengths from opportunistic sampling throughout the gaspereau season. Ages include 1+ - one year old fish, J – juvenile (age 2+); sexes F – female, M – male, U – unknown, and "–" indicates no data available.

	Age /	Forklength (cm)				Age (years)			
Year	Sex	N	Min	Max	Mean	N	Min	Max	Mean
1998	1+	-	-	-	-	-	-	-	-
	J	29	23.1	28.0	25.6	-	-	-	-
	F	50	51.5	73.5	60.3	-	-	-	-
	M	418	28.7	72.4	41.6	-	-	-	-
	U	103	34.4	68.4	43.0	-	-	-	-
	All adults	571	28.7	73.5	44.3	-	-	-	-
1999	1+	16	11.5	20.9	-	13	1	1	1.0
	J	45	22.4	29.8	26.5	41	2	2	2.0
	F	29	47.6	82.0	57.1	22	3	10	5.6
	M	633	28.3	62.2	42.5	496	2	8	3.3
	U	344	32.9	88.5	48.2	281	3	9	4.1
	All adults	1006	28.3	88.5	45.0	799	2	10	3.6
2000	1+	50	15.5	20.3	18.6	51	1	1	1.0
	J	62	26.7	33.3	30.6	35	2	2	2.0
	F	45	48.7	80.5	67.6	17	4	9	6.2
	M	680	29.0	68.0	46.5	238	2	7	3.7
	U	327	32.8	75.7	51.7	182	3	7	4.2
	All adults	1052	29.0	80.5	48.7	437	2	9	4.0
2001	1+	-	-	-	-	-	-	-	-
	J	68	25.6	34.0	29.3	40	2	2	2.0
	F	34	42.7	77.0	51.5	10	3	9	6.2
	M	1091	29.6	63.5	42.5	303	3	8	4.3
	U	250	32.0	72.5	47.1	106	3	9	5.2
	All adults	1375	29.6	77.0	43.6	419	3	9	4.6
2002	1+	5	16.8	19.1	18.5	-	-	-	-
	J	79	26.3	32.2	29.6	-	-	-	-
	F	41	46.8	91.1	58.8	-	-	-	-
	M	2481	33.2	61.3	45.1	-	-	-	-
	U	1705	34.1	84.7	50.4	-	-	-	-
	All adults	4227	33.2	91.1	47.7	-	-	-	-

Table 6. Forklengths at age from striped bass sampled in the NW Miramichi River.

Year	Age	N	Forklength (cm)		
			Min	Max	Mean
1999	1	16	11.5	20.9	17.1
	2	43	22.4	46.4	27.3
	3	525	30.3	61.3	41.6
	4	166	35.4	61.0	48.1
	5	47	44.5	61.8	53.1
	6	31	46.5	66.5	55.1
	7	11	51.8	60.4	55.4
	8	14	57.0	69.8	63.3
	9	2	64.8	65.6	65.2
	10	1	82.0	82.0	82.0
	Adults	797	30.3	82.0	44.8
2000	1	51	15.5	20.3	18.2
	2	36	26.7	38.8	31.3
	3	138	31.5	48.0	41.8
	4	200	29.0	57.0	49.5
	5	62	47.9	63.5	56.2
	6	27	51.5	68.0	61.5
	7	6	66.7	74.9	70.4
	8	2	70.8	71.7	71.3
	9	1	80.5	80.5	80.5
	10	-	-	-	-
	Adults	436	29.0	80.5	49.2
2001	1	-	-	-	-
	2	28	25.6	34.0	29.7
	3	50	26.8	42.9	35.7
	4	203	36.7	47.5	41.7
	5	100	39.4	55.0	46.2
	6	57	48.5	60.9	55.7
	7	16	55.0	67.2	59.7
	8	3	63.5	73.5	67.6
	9	2	72.5	77.0	74.8
	10	-	-	-	-
	Adults	431	26.8	77.0	44.9

Table 7. Summary of tagging activities at the Mactaquac Dam (Saint John River) and returns to the Dam for the years 1999 - 2002. All recaptured fish were released to the river.

Tagging		Recapture year				
Year	**Number**	**1999**	**2000**	**2001**	**2002**	**Totals**
1999	189	2	7	1	1	11
2000	137			1	1	2
2001	44			1	0	1
2002	225				0	0
Totals	595	2	7	3	2	14

Table 8. Estimated numbers of striped bass leaving Shubenacadie-Grand Lake, May 2002. The simple Petersen population estimate is calculated for the period from 10-23 May and only for nights when tags were available. Adjusted catch is calculated as the sum of all fish captured on nights when no tags were applied plus the geometric mean catch (260 fish per night) for nights when the recapture trapnet was not set.

	Recapture trapnet		Marks
Date	Catch	Recaptures	applied
2-May	45		
3-May	158		
4-May	181		
5-May	68		
6-May	446		
7-May	62		
8-May	391		
9-May	395		
10-May	533	4	8
11-May	808	1	51
12-May			
13-May	177	0	
14-May	278	3	4
15-May	146	0	0
16-May	149	2	5
17-May	226	5	21
18-May	380	6	74
19-May	1,274	7	30
20-May			
21-May	768	27	34
22-May	853	16	25
23-May	339	13	39
24-May	125	3	0
T(10-23 May minus May13,	5,608	87	291

Simple Petersen (10-23 May)	18,612
Standard	3,090
Geometric Mean Catch/Night	260
Exploitation rate (*e*)	0.30
Adjusted Catch (AC) for	2,714
Petersen plus (adjusted catch x *e*)	27,690

	Petersen	Petersen+AC
Adults: ~0.91 of population age 3^+ and older	16,937	25,198
Adults: ~0.27 of population age 4^+ and older	5,025	7,476

Table 9. Summary of catch of YOY striped bass by beach seining for the years 1999-2002. The catch from two sweeps per site were combined and standardized to number caught per 50m of shoreline. Summary statistics have been calculated for sites situated within the tidal portions of the Shubenacadie River and Minas Basin excluding Partridge Island.

Year- class		Tidal Shubenacadie	Minas Basin	Areas Combined
1999	Observations	8	12	20
	Geometric Mean Catch per 50m sweep	3.78	7.51	5.70
	Standard Deviation	2.68	36.75	16.92
2000	Observations	8	16	24
	Geometric Mean Catch per 50m sweep	22.90	0.06	0.71
	Standard Deviation	4.11	11.91	39.34
2001	Observations	11	23	33
	Geometric Mean Catch per 50m sweep	3.33	0.25	0.58
	Standard Deviation	31.43	32.50	37.74
2002	Observations	10	23	33
	Geometric Mean Catch per 50m sweep	2.01	0.18	0.37
	Standard Deviation	43.73	31.46	39.21

Table 10. Tags applied to striped bass in the southern Gulf of St. Lawrence, 1983 – 2002, and location of recapture.

Date	Tagging location	Number tagged	Recapture locations		Investigation
			Gulf	Other	
1983 - 1984	Kouchibouguac River	597	Bathurst Harbour Tabusintac River Miramichi River Black River Richibucto River	Wye River MD USA	Hogans and Melvin 1984
1986 - 1987	Bathurst Harbour	39	Bathurst Harbour Tabusintac River Miscou Isand	none	Meagher 1987
1993	Kouchibouguac River	36	Miramichi River	none	Bradford et al. 2001b
1994	Margaree River	10	Miramichi River	none	Bradford and Chaput 1996
1996	Tabusintac River	373	Miramichi River	none	Bradford et al. 2001
1993	Miramichi River	272	Miramichi River	none	Bradford et al. 1995
1994	Miramichi River	1748	Napan River		Bradford et al. 1995
1995	Miramichi River	350	Richibucto River		Bradford and Chaput 1996
1996	Miramichi River	893	Tabusintac River		Bradford and Chaput 1997
1997	Miramichi River	447	Tracadie River		Bradford and Chaput 1998
1998	Miramichi River	341	Bathurst Harbour		Bradford et al. 2001
1999	Miramichi River	909	Chaleur Bay		Douglas et al. 2001
2000	Miramichi River	188	Escuminac, NB		Douglas et al. 2001
2001	Miramichi River	322	Percé, Québec		DFO data unpublished
2002	Miramichi River	1424			DFO data unpublished
2001	Wallace Bay	58	Wallace bay	none	DFO data unpublished
2002	East River	15	none	none	DFO data unpublished

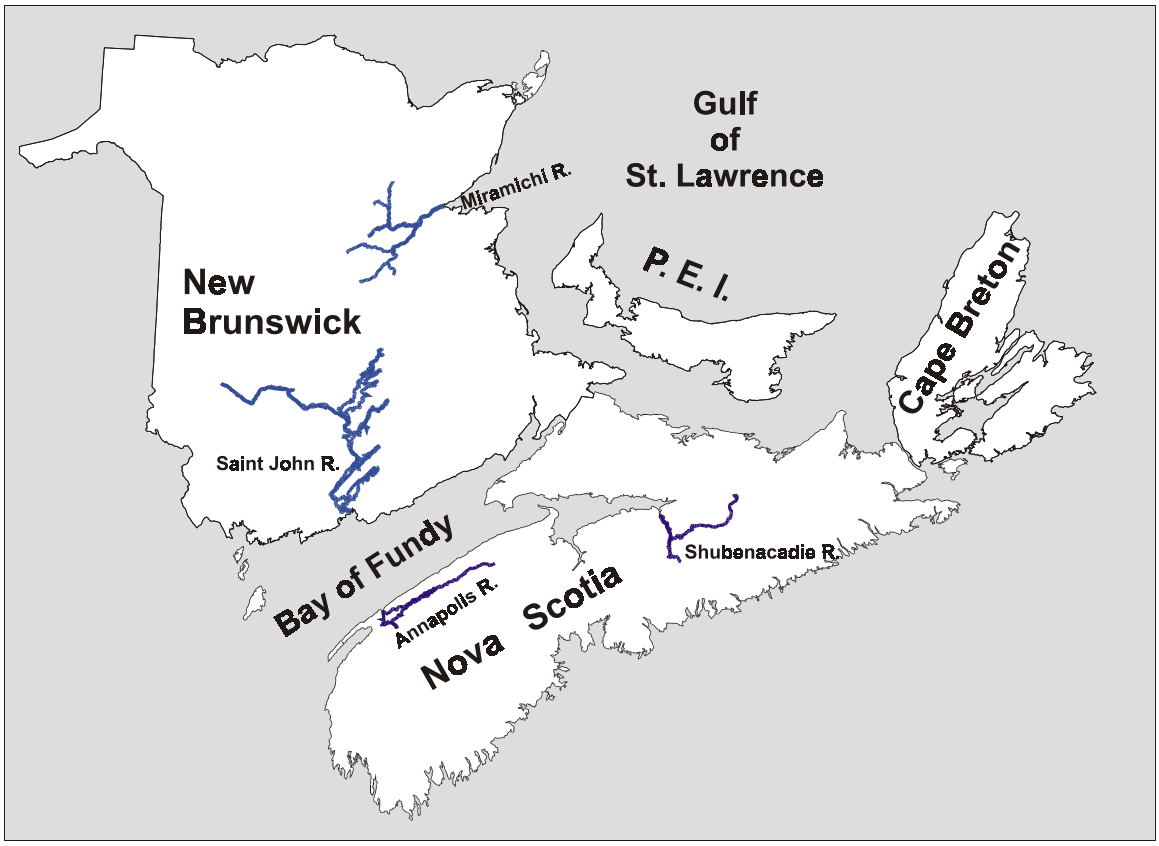

Figure 1. The four confirmed spawning locations for striped bass in the Canadian Maritimes.

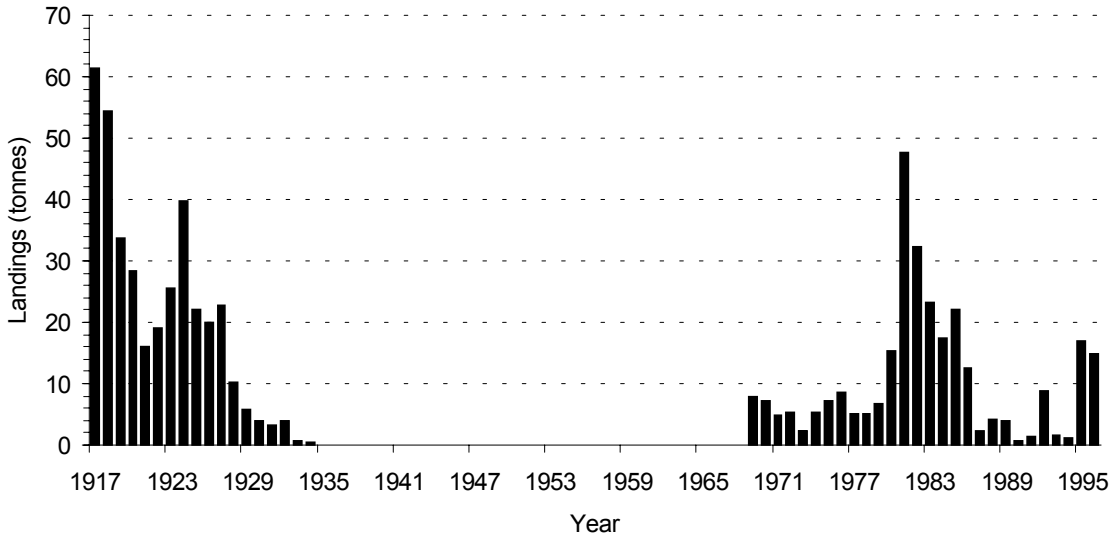

Figure 2. Striped bass landings in the southern Gulf of St. Lawrence from 1917 to 1996. No landings were reported between 1935 and 1968. Commercial fisheries for striped bass were closed in 1996.

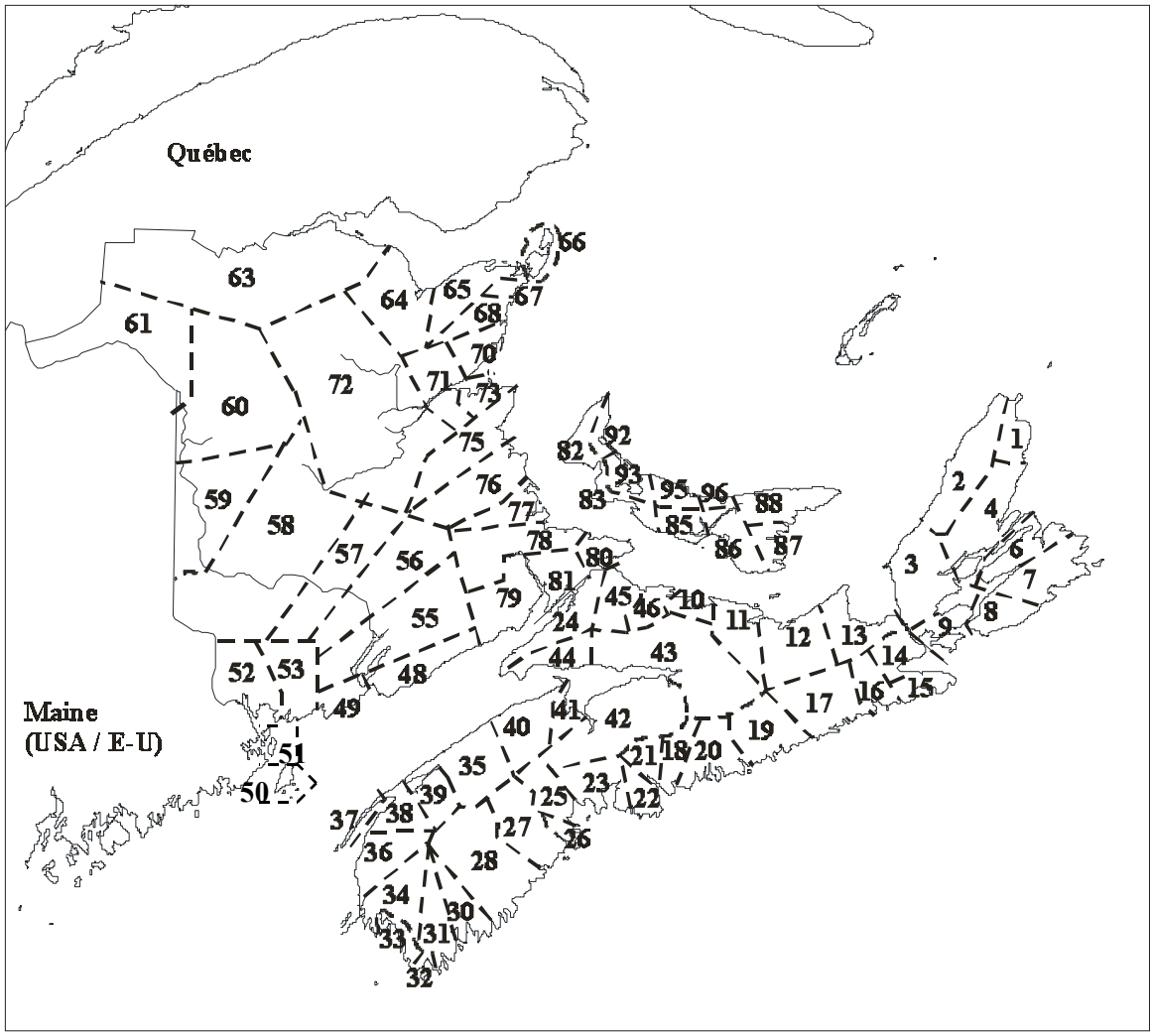

Figure 3. Fisheries Statistical Districts of the Maritime Provinces. Descriptions of FSDs are summarized in O'Neil and Swetnam (1991).

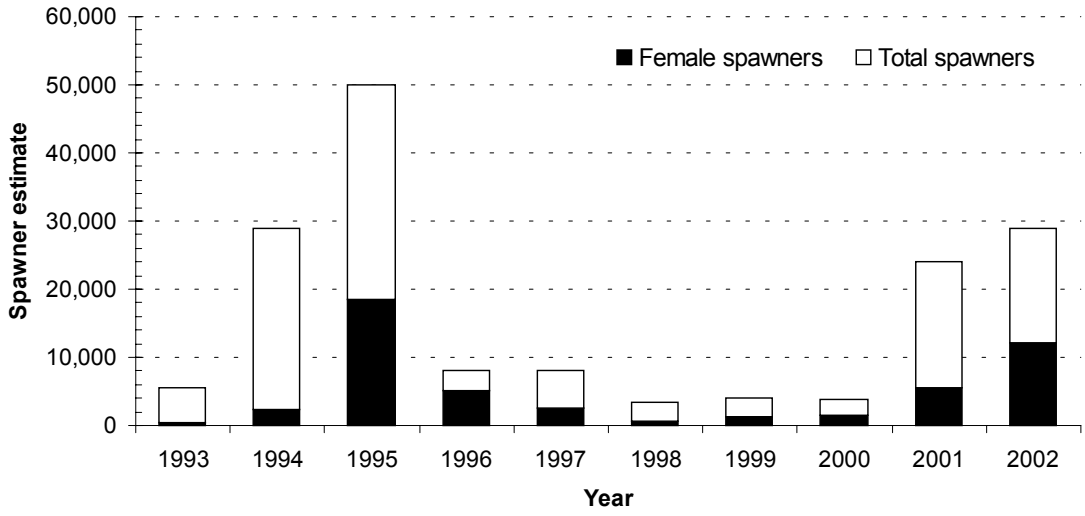

Figure 4. Spawner estimates for NW Miramichi striped bass since 1993.

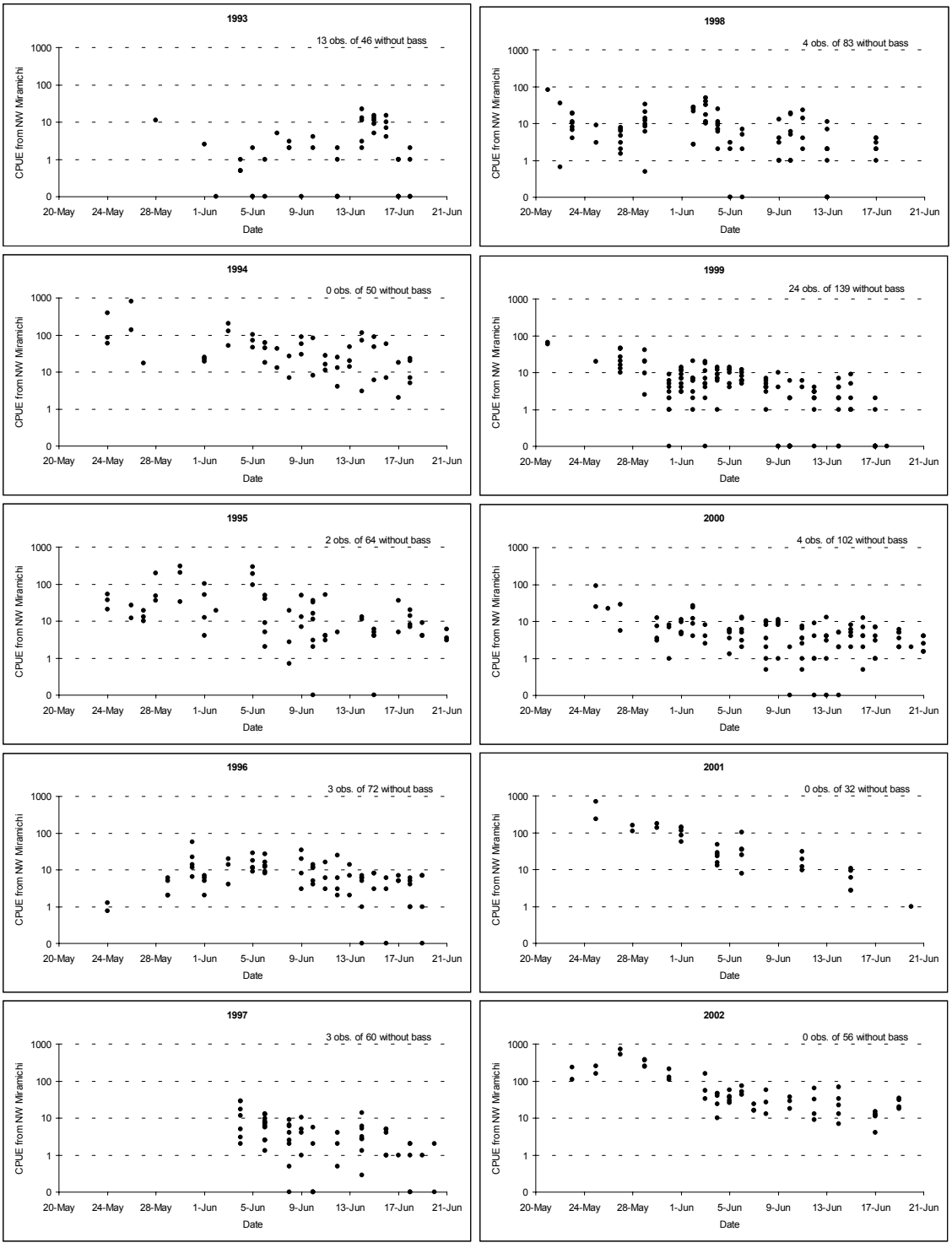

Figure 5. Catch per unit of effort of adult striped bass (bass per trapnet per 24 hr period) in the commercial gaspereau fishery of the NW Miramichi River for years 1993 to 2002. Individual points may represent more than one observation.

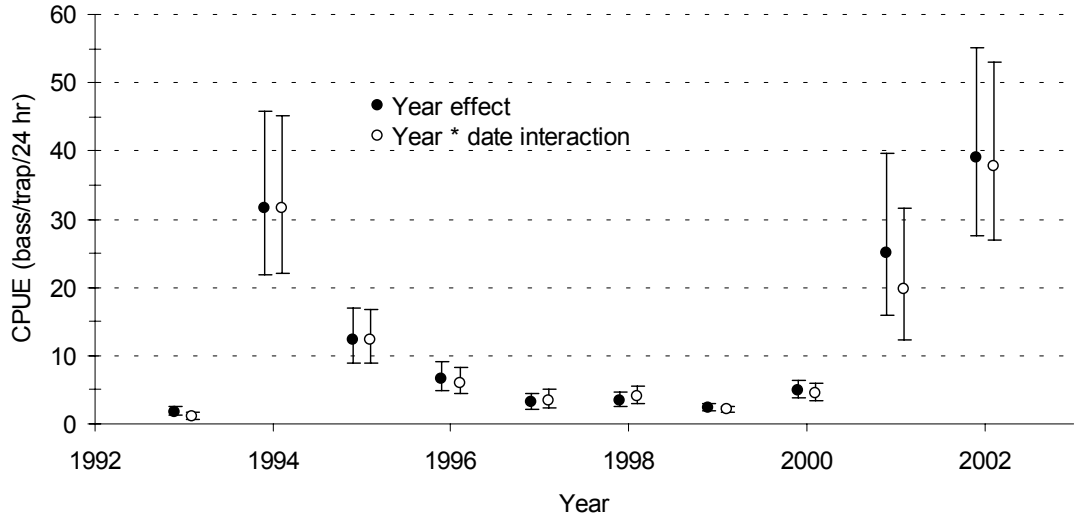

Figure 6. Mean CPUE (catch per net per 24 hours) and standard deviation (error bars) of adult striped bass on the spawning grounds of the NW Miramichi River for the entire gaspereau season, 1993 to 2002.

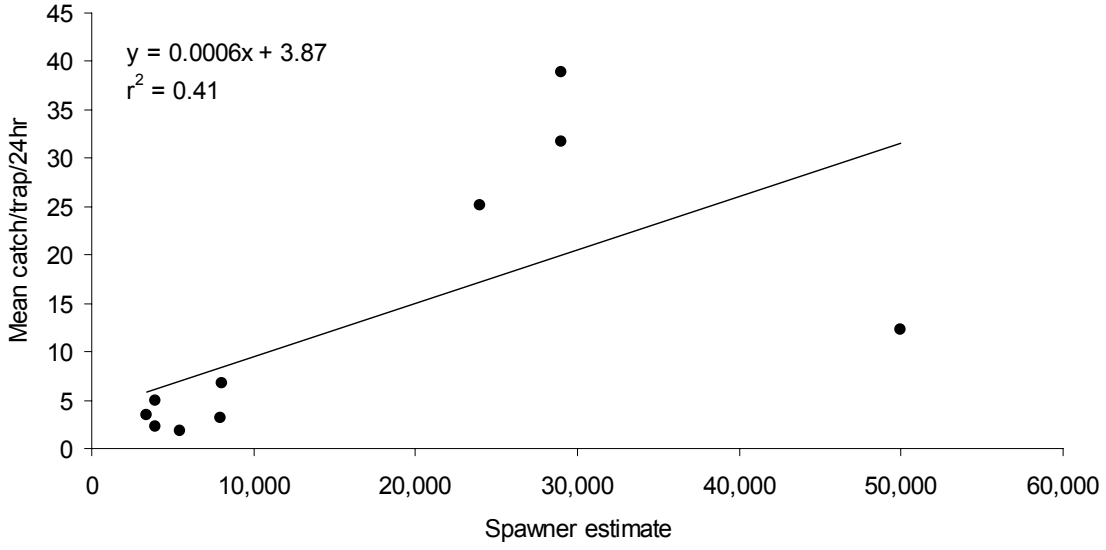

Figure 7. Relationship between mean catch of striped bass per trap per 24 hr (GLM model) and estimated abundance of spawners for years 1993 to 2002.

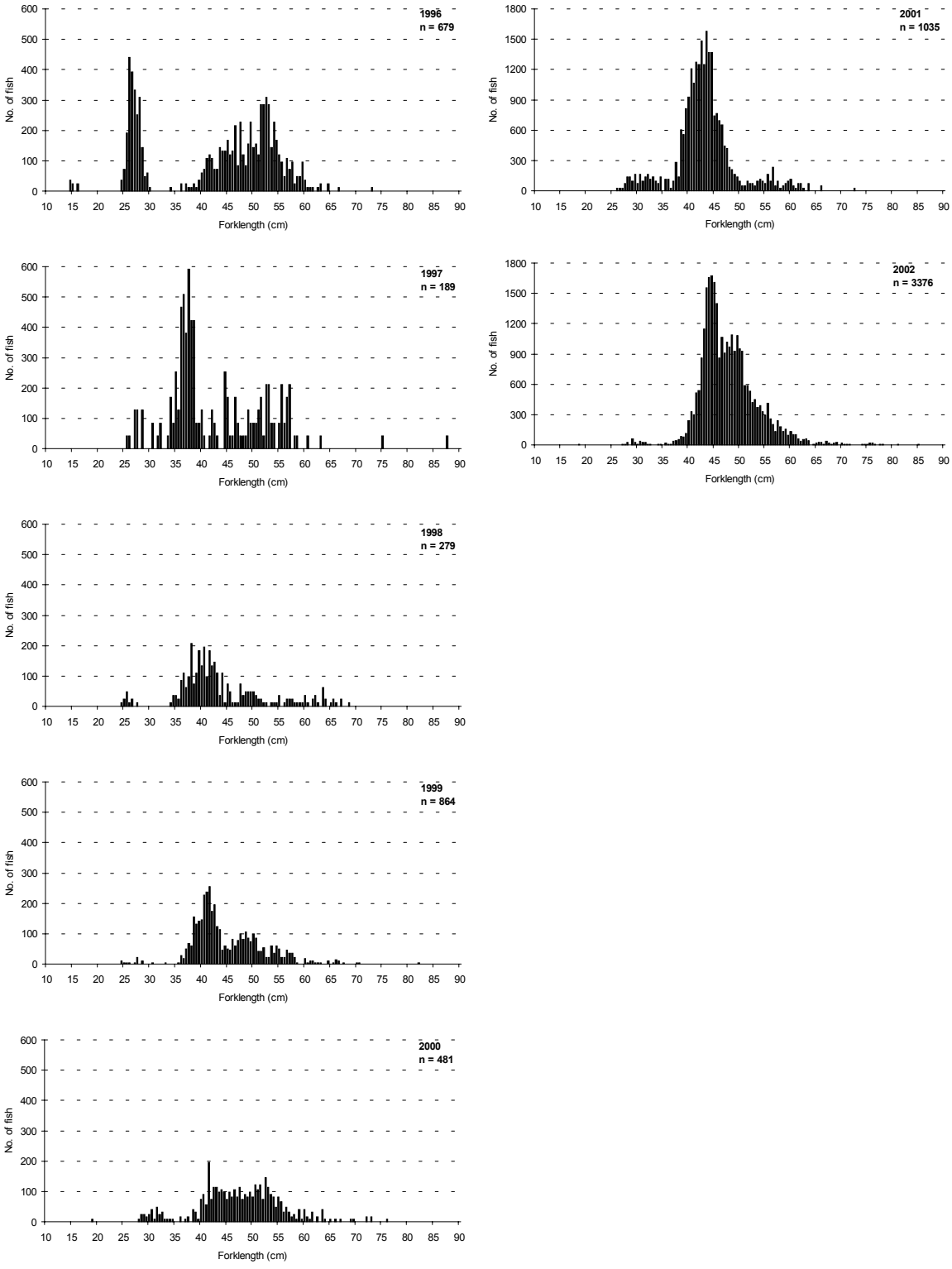

Figure 8. Forklength distributions of striped bass sampled during their spring spawning migration to the NW Miramichi River (1996-2002). Distributions standardized to population size (scale difference between right and left panels).

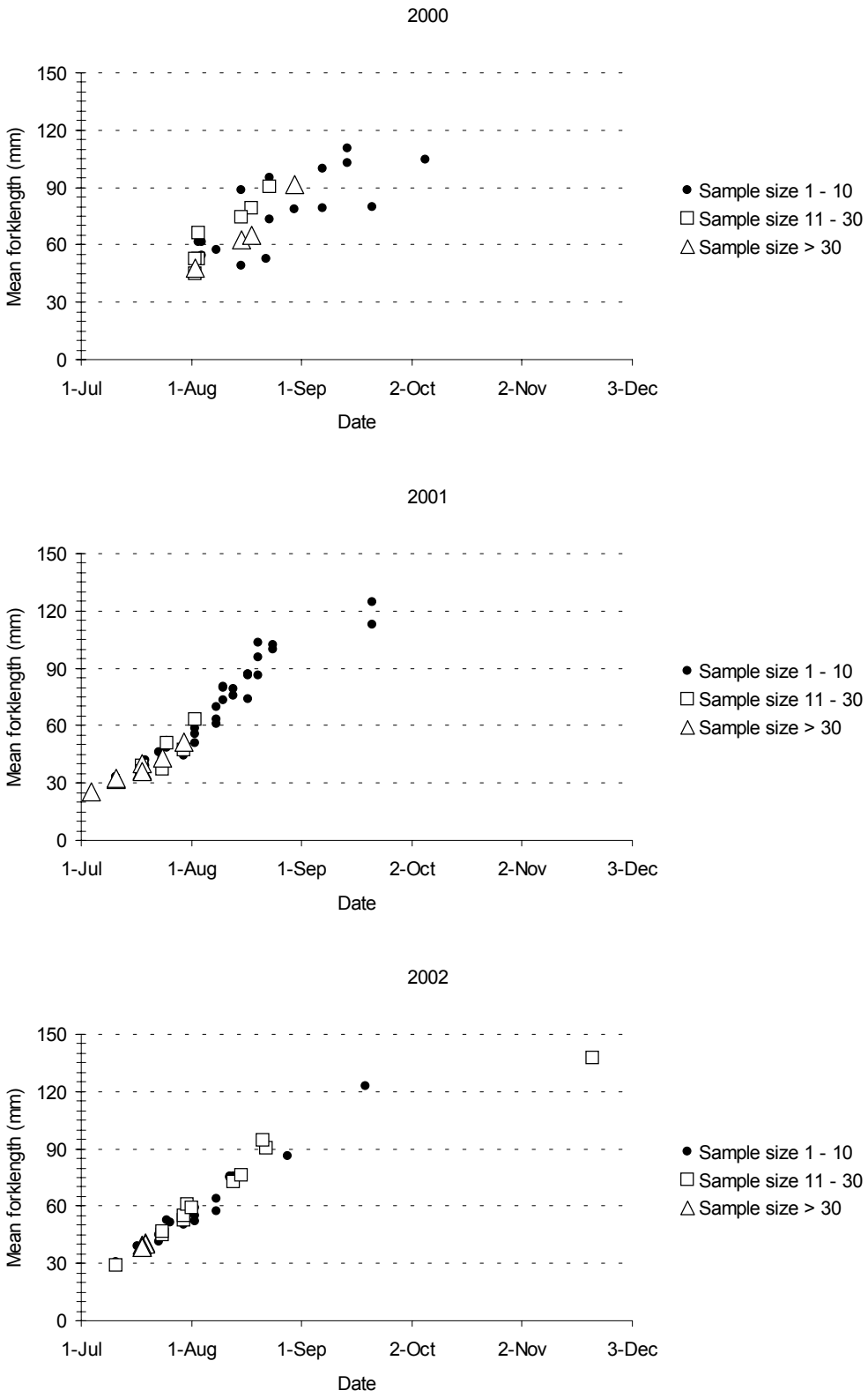

Figure 9. Mean forklengths of YOY striped bass collected over the course of their their first growing season 2000-2002.

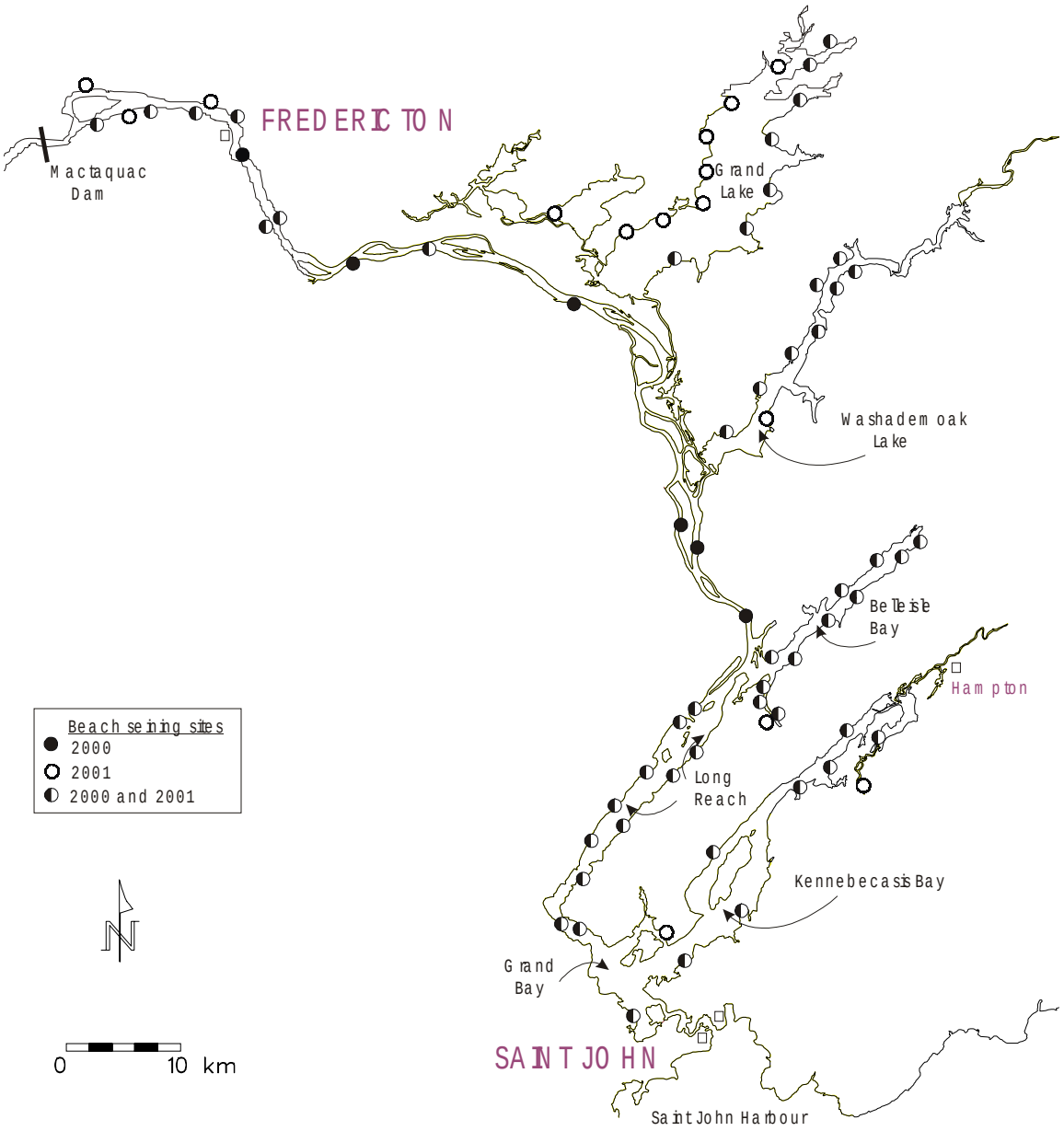

Figure 10. Beach seining sites sampled in 2000 and 2001 in the Saint John River system.

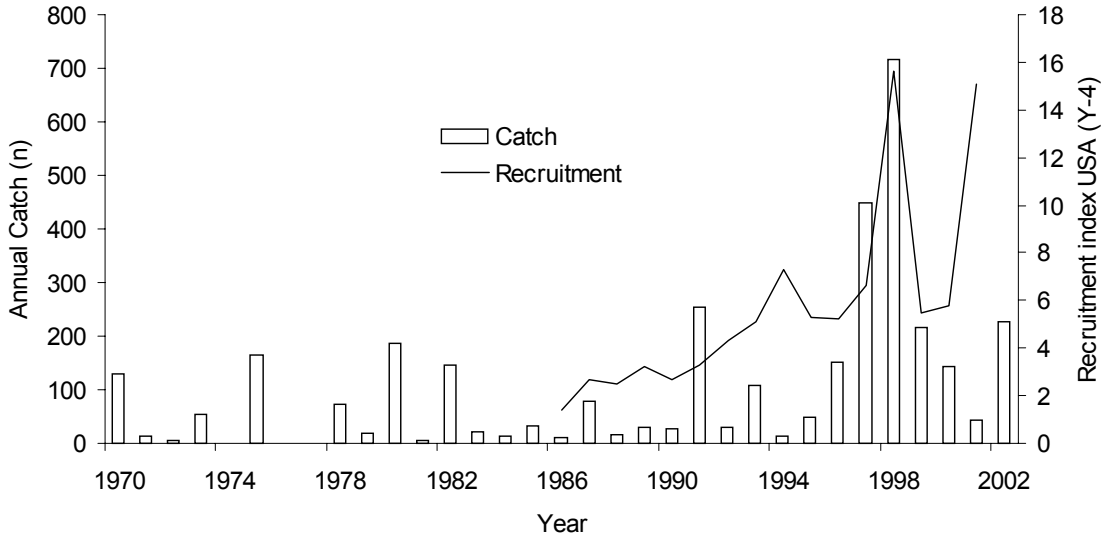

Figure 11. Striped bass catch at Mactaquac Dam and the aggregate recruitment index of U.S.A. striped bass 4 years previous.

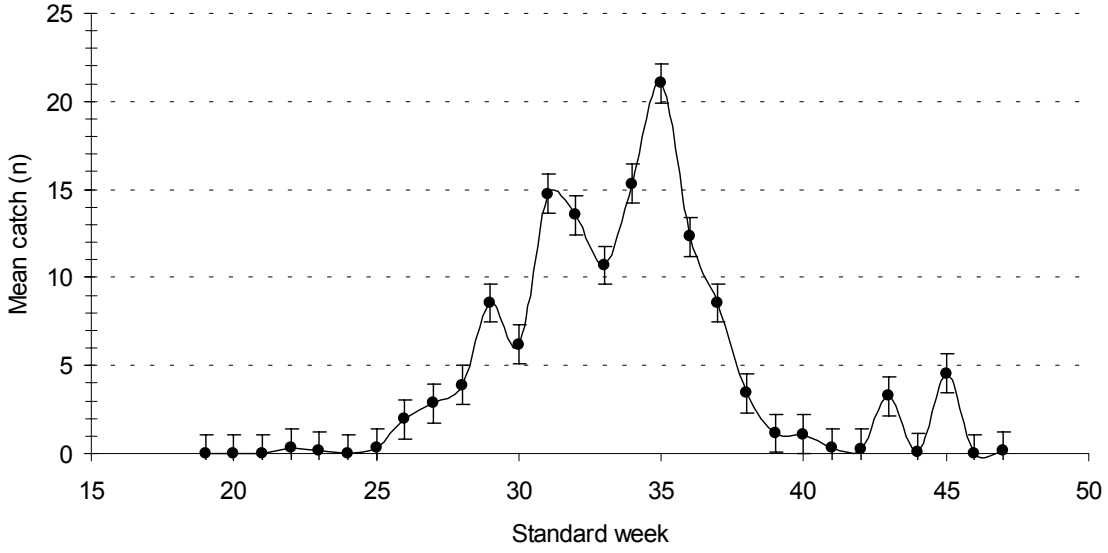

Figure 12. Mean number (n) and standard error (SE) of striped bass caught per standard week at Mactaquac Dam for the years 1968-2000.

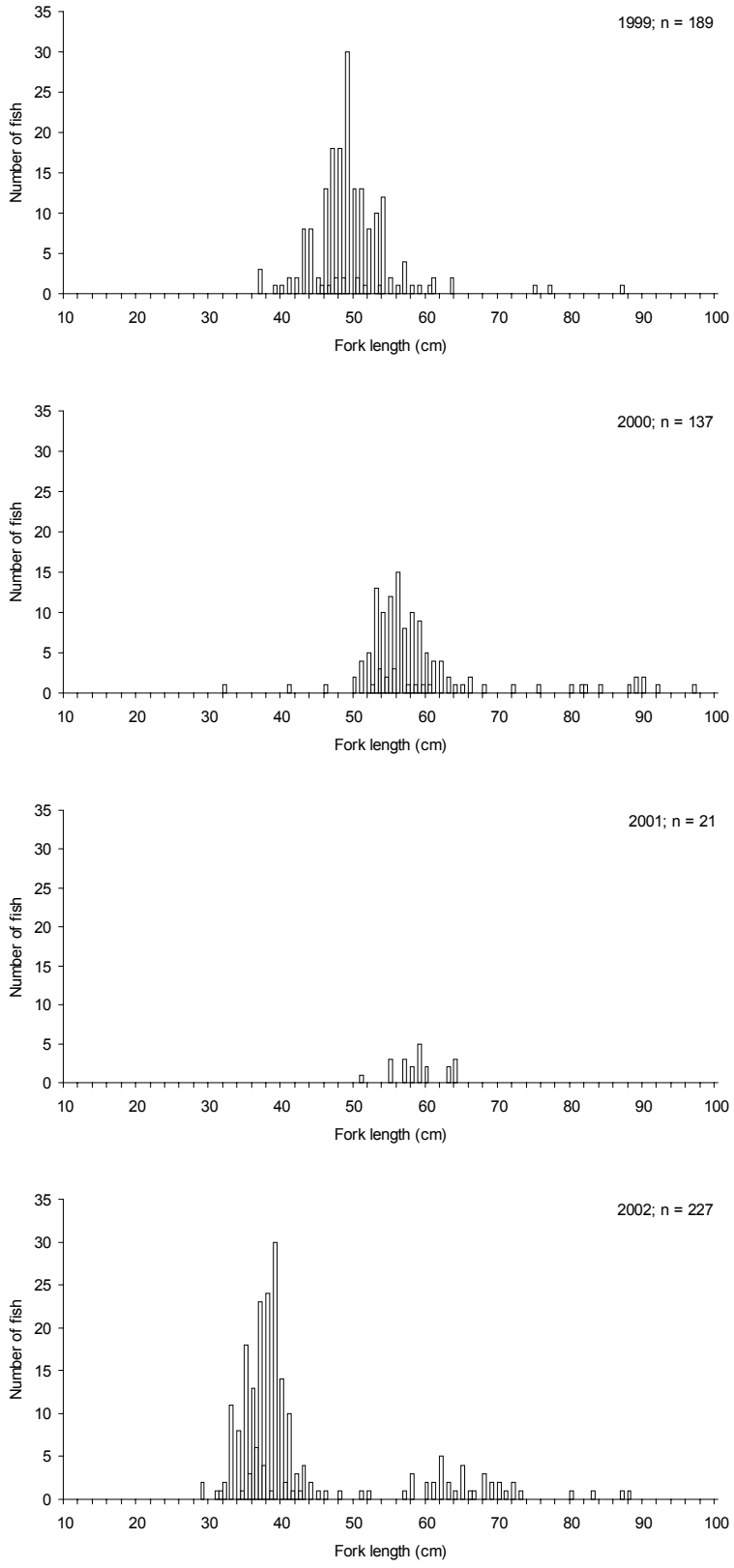

Figure 13. Length frequency of striped bass captured at the Mactaquac Dam (Saint John River) from 1999 to 2002.

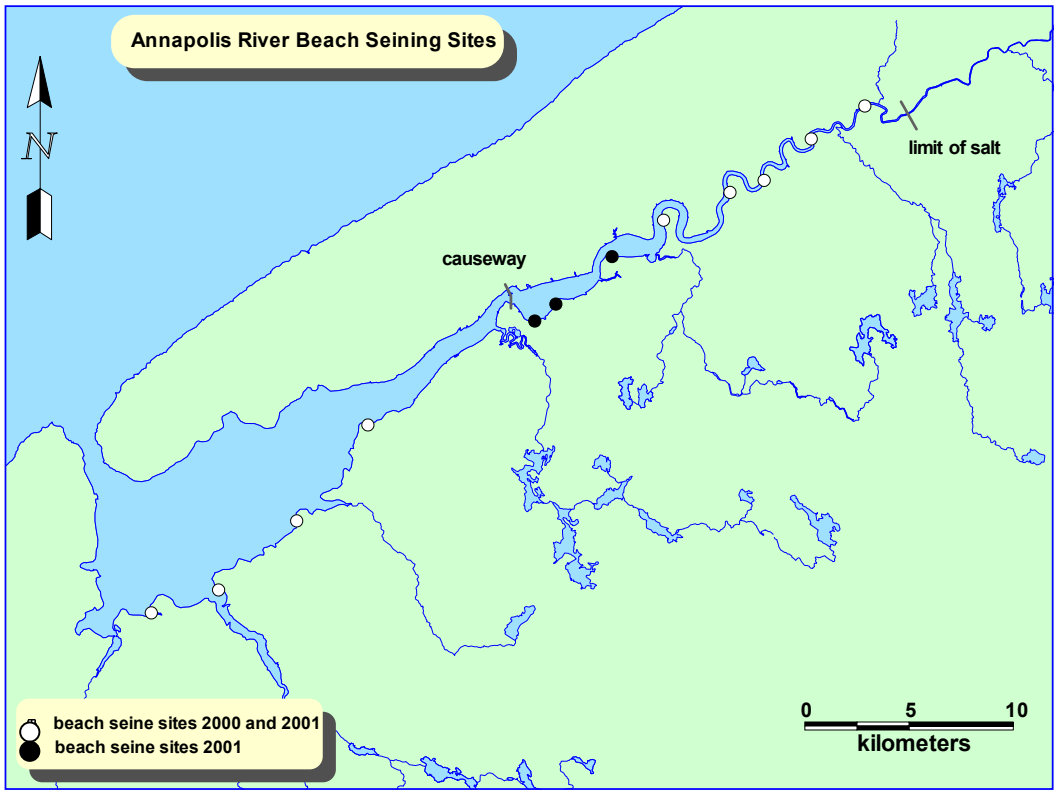

Figure 14. Beach seine sites sampled in the Annapolis River 2000 and 2001.

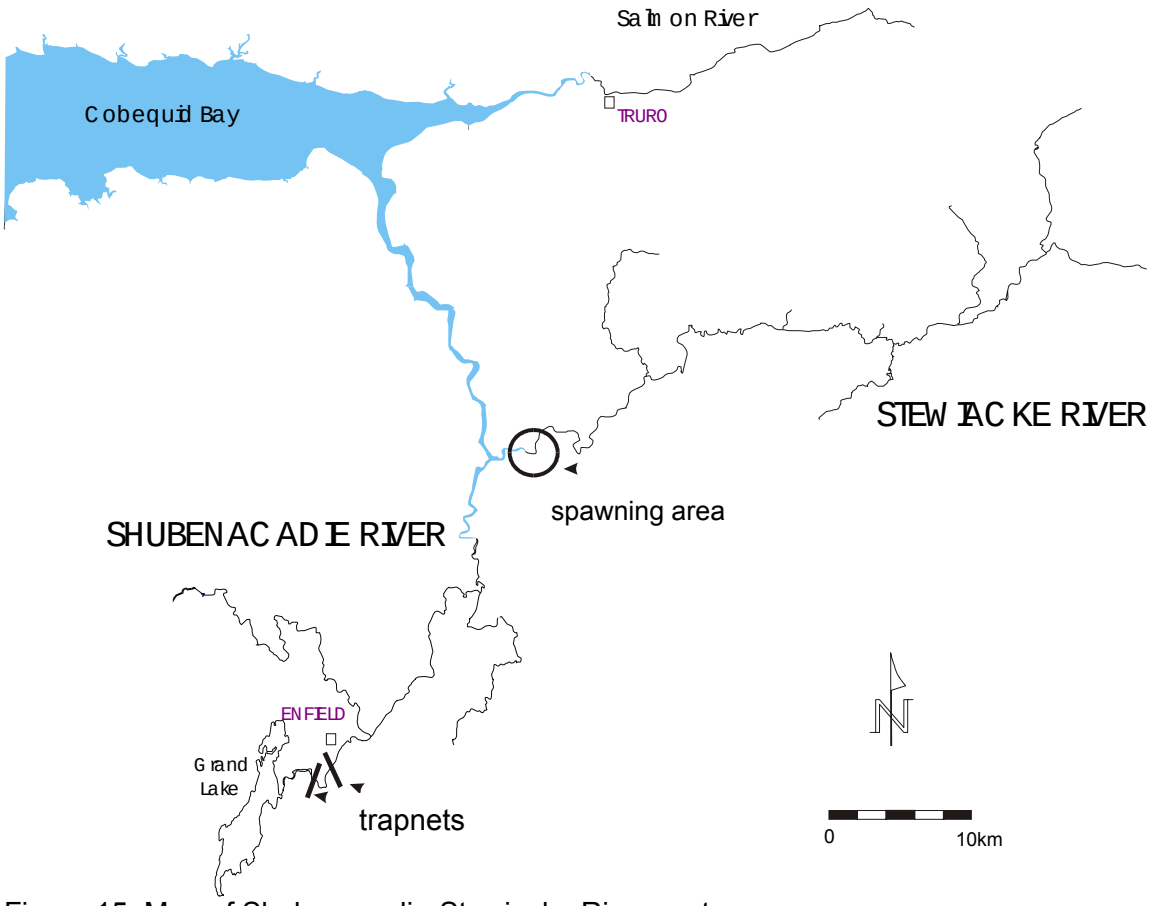

Figure 15. Map of Shubenacadie-Stewiacke River system.

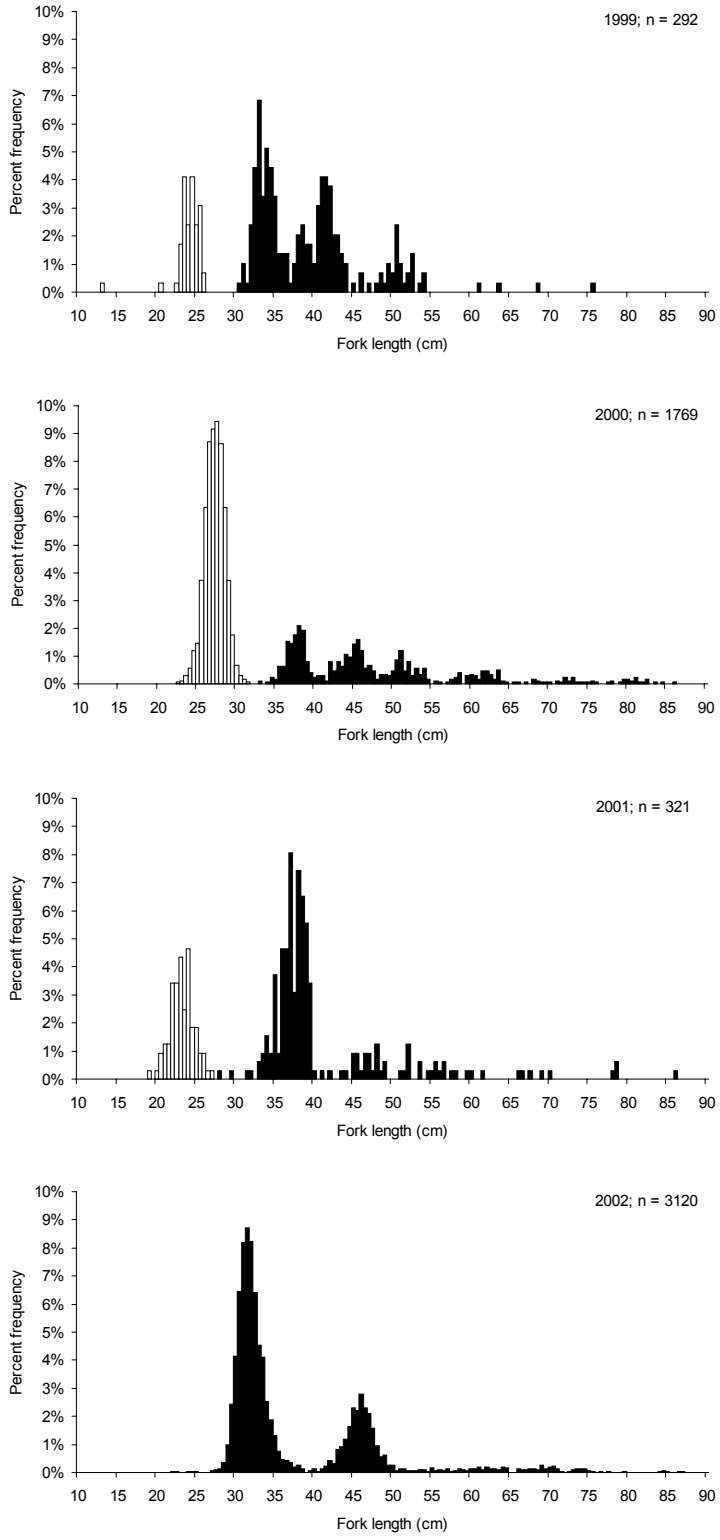

Figure 16. Length frequency distributions of downstream migrating striped bass intercepted in a research trapnet located at Enfield N.S. for the years 1999 to 2002. Both juveniles (age 2+, open bars) and striped bass of minimum spawning age (3+ or older, shaded bars) are shown.

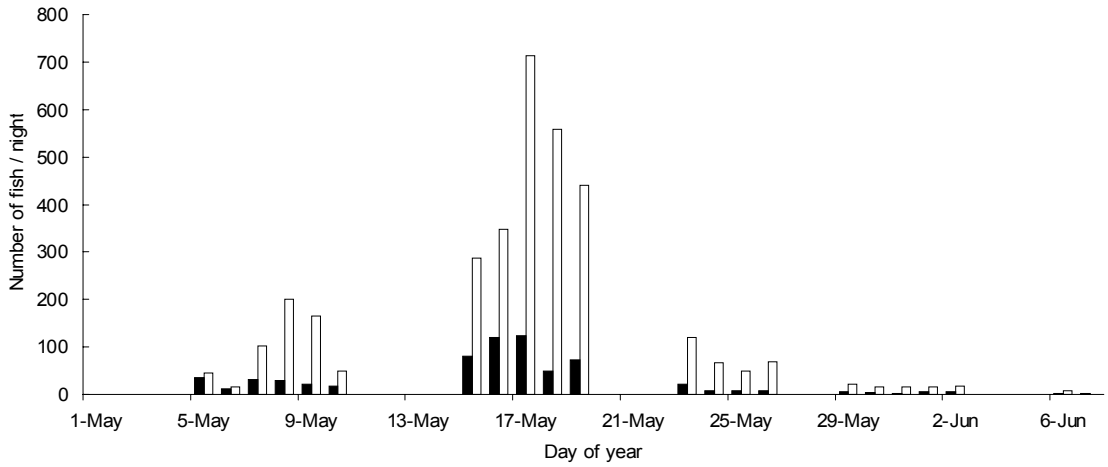

Figure 17. Run timing of downstream migrating adult (shaded bars) and juvenile (open bars) striped bass from Shubenacadie-Grand Lake for the year 2000.

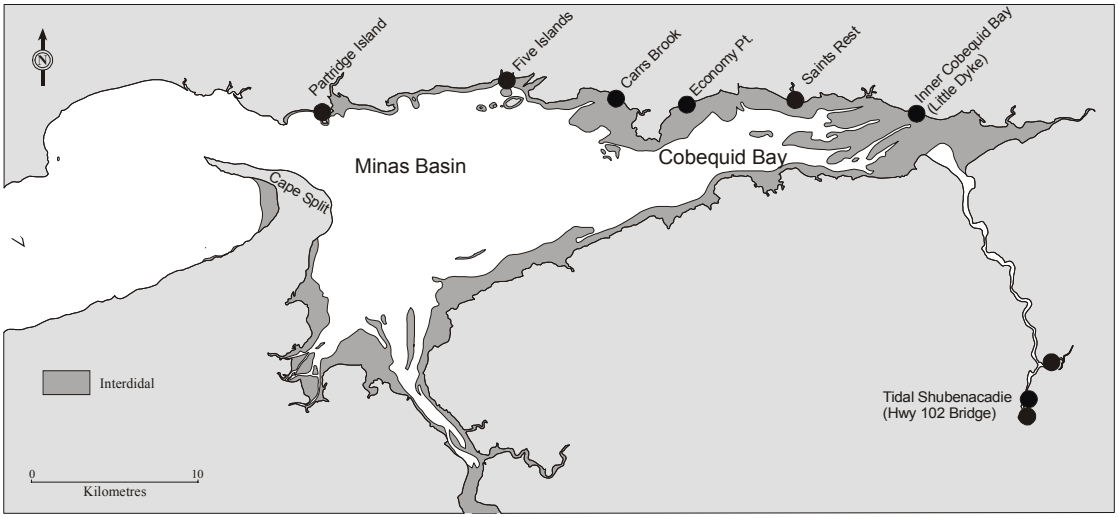

Figure 18. Beach seine sites sampled in Minas Basin, Bay of Fundy, 1999-2002.

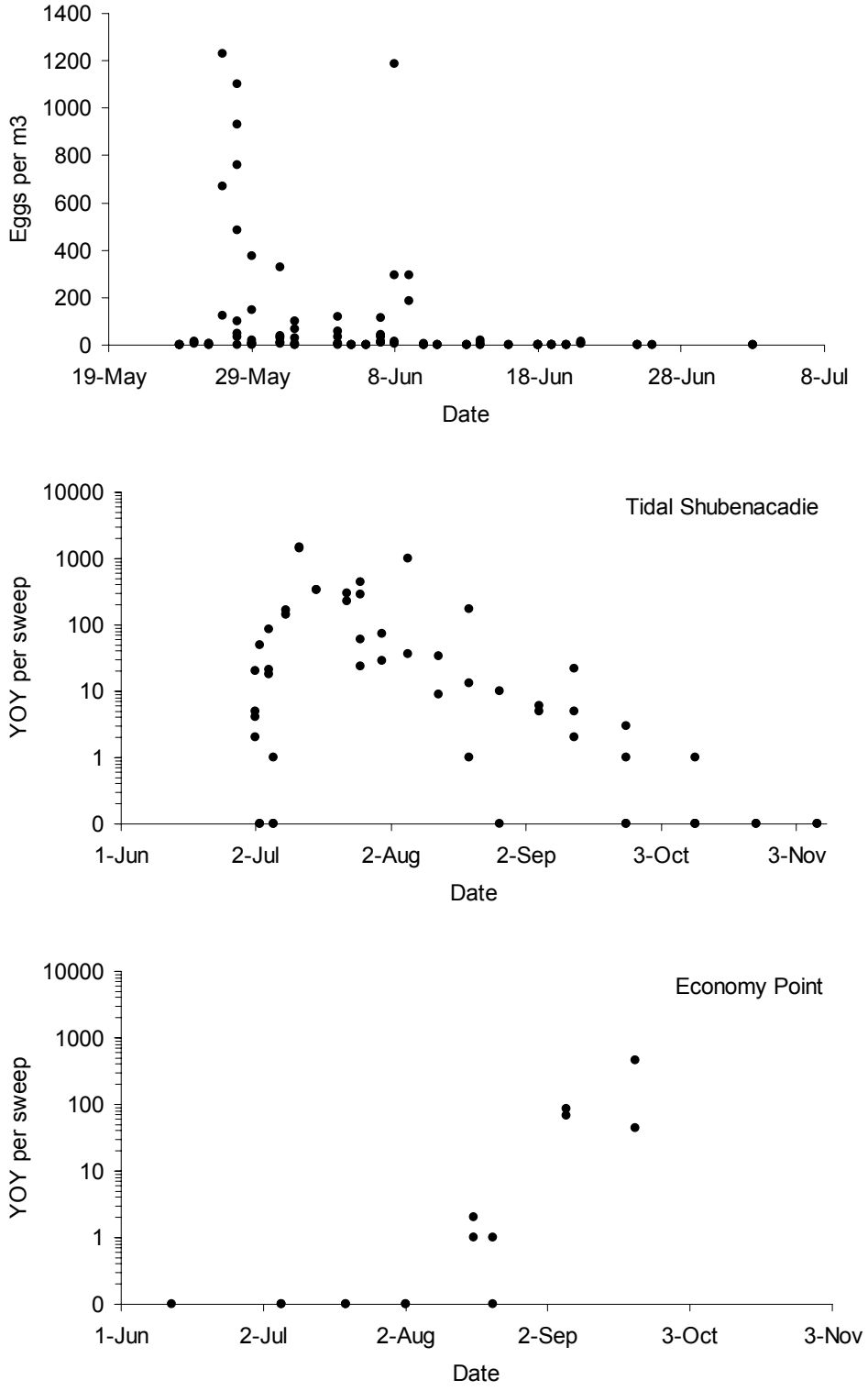

Figure 19. Egg (500 um plankton net, upper panel) and juvenile collections (beach seine) from the tidal Shubenacadie (middle panel) and Economy Point, Cobequid Bay (lower panel) for the year 2001. The data are typical of all years of sampling (1999-2002).

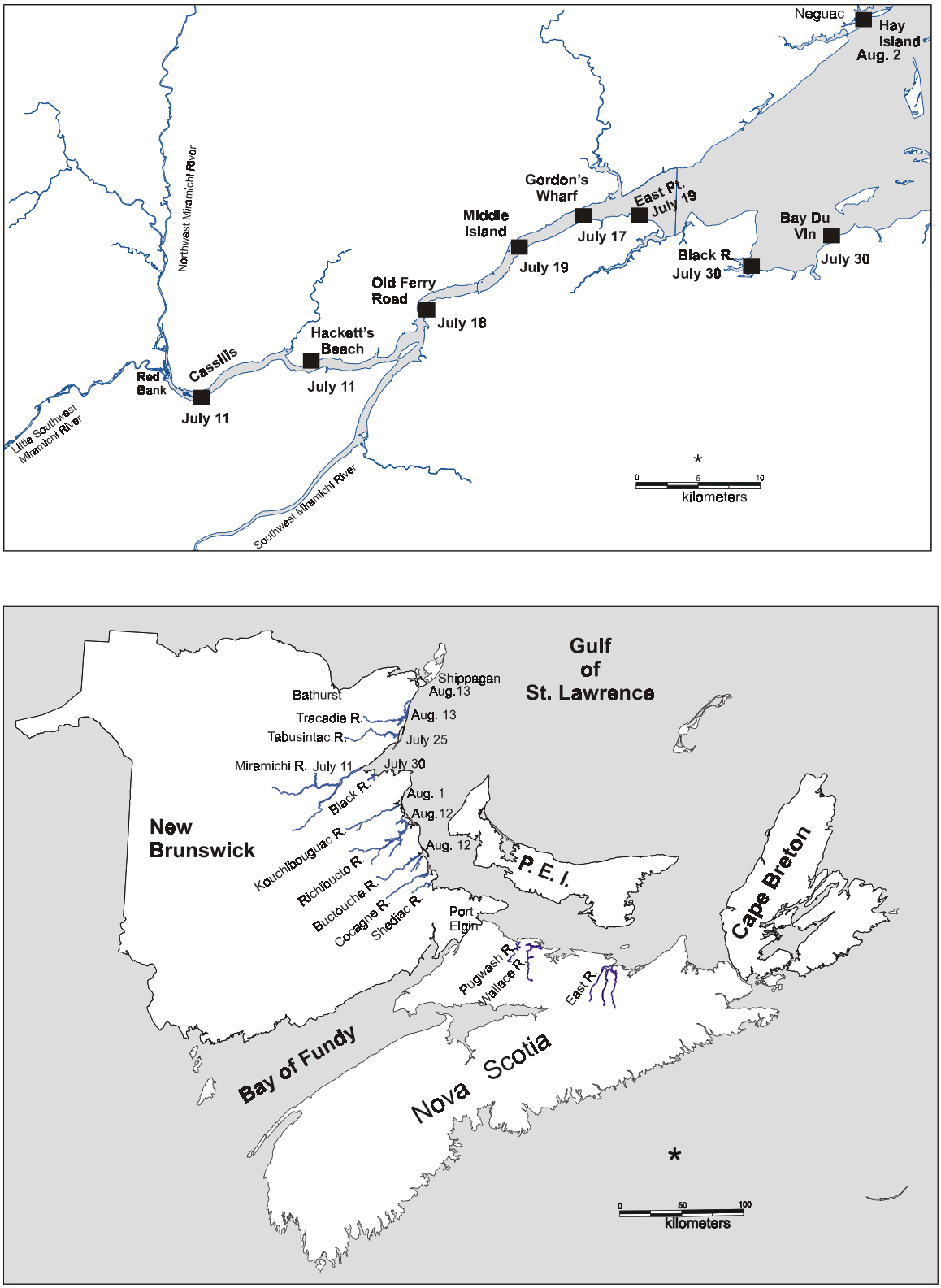

Figure 20. Beach seine sites and dates at the time of first YOY striped bass capture in the Miramichi River system (upper panel) and in other estuaries of the southern Gulf (lower panel) in 2002. Estuaries and places identified on the map without dates indicate areas covered during the beach seine survey without any capture of YOY striped bass.

Appendix

Appendix 1. Part XIV and XVIII (striped bass sections) of the Maritime Provinces Fishery Regulations (SOR/93-55), Canadian Fisheries Act.

PART XIV

STRIPED BASS

Application

89. This Part does not apply in respect of recreational fishing for striped bass by angling or with set lines in the waters set out in Schedule IX during the period beginning on January 1 and ending on March 31.

Gear Restrictions

90. No person shall fish for striped bass except by angling or with a bow net.

Close Times

91. No person shall fish for striped bass in the waters set out in column I of an item of the table to this section

(*a*) by a method set out in column II of that item during the yearly close time set out in column III of that item; or

(*b*) with a bow net during the weekly close time set out in column IV of that item.

TABLE

Item	Column I Waters	Column II Method	Column III Yearly Close Time	Column IV Weekly Close Time
	Nova Scotia			
1.	The Annapolis River from grid reference 16716671 at Hebbs Landing upstream to the highway bridge at Lawrencetown (Refer to map Bridgetown 21 A/14)	(1) Angling (2) Bow nets	(1) Apr. 1 to June 30 (2) Jan. 1 to Dec. 31	n/a
2.	Tidal waters of Nova Scotia not set out in item 1.	(1) Angling (2) Bow nets	(1) Dec. 30 to Dec. 31 (2) Jan. 1 to Dec. 31	n/a
3.	Inland waters of Nova Scotia not set out in item 1	(1) Angling (2) Bow nets	(1) Oct. 1 to Apr. 14 (2) Jan. 1 to Dec. 31	n/a
	New Brunswick			

Item	Column I Waters	Column II Method	Column III Yearly Close Time	Column IV Weekly Close Time
4.	Tidal waters of Kent County.	(1) Angling (2) Bow nets	(1) Dec. 30 to Dec. 31 (2) Apr. 1 to Nov. 30	From 08:00 h each Saturday to 08:00 h on the following Monday
5.	Tidal waters of New Brunswick not set out in item 4.	(1) Angling (2) Bow nets	(1) Dec. 30 to Dec. 31 (2) Jan. 1 to Dec. 31	n/a
6.	Inland waters of New Brunswick.	(1) Angling (2) Bow nets	(1) Sept. 16 to Apr. 30 (2) Jan. 1 to Dec. 31	n/a
	Prince Edward Island			
7.	Tidal waters of Prince Edward Island.	(1) Angling (2) Bow nets	(1) Dec. 30 to Dec. 31 (2) Jan. 1 to Dec. 31	n/a
8.	Inland waters of Prince Edward Island.	(1) Angling (2) Bow nets	(1) Oct. 1 to Apr. 14 (2) Jan. 1 to Dec. 31	n/a

Mesh Size

92. No person shall fish for striped bass with a bow net that has a mesh size of less than 127 mm.

Quotas and Length Restrictions

93. No person shall catch and retain from the waters set out in column I of an item of the table to this section by a method set out in column II of that item

(*a*) more striped bass in any day than the fishing quota set out in column III of that item; or

(*b*) any striped bass the length of which is less than the minimum length set out in column IV, or more than the maximum length set out in column V.

(SOR/2001-452)

TABLE

Item	Column I Waters	Column II Method	Column III Fishing Quota	Column IV Minimum Length	Column V Maximum Length
	Nova Scotia				
1.	The Annapolis River upstream from Goat Island.	Angling	1	68 cm	150 cm
2.	Inland and tidal waters of Nova Scotia not set out in item 1.	Angling	1	68 cm	150 cm
	New Brunswick				
3.	Tidal waters of Kent County	(1) Angling (2) Bow nets	(1) 1 (2) 1	(1) 68 cm (2) 38 cm	(1) 150 cm (2) 150 cm
4.	Inland and tidal waters of New Brunswick not set out in item 3.	Angling	1	68 cm	150 cm
	Prince Edward Island				

5.	Inland and tidal waters of Prince Edward Island	Angling	1	30 cm	150 cm

(SOR/2001-452)

PART XVIII

WINTER FISHING IN NEW BRUNSWICK

Application

108. This Part applies in respect of recreational fishing by angling and with set lines in the waters set out in Schedule IX during the period beginning on January 1 and ending on March 31.

Gear Restrictions

109. No person shall fish except

*(*a*)* through a man-made hole in the ice; or

(b) from shore through a natural opening in the ice.

110. (1) No person shall fish with more than five set lines.

(2) Every person who fishes with set lines shall attend those lines and maintain an unobstructed view of those lines.

Close Times

111. No person shall fish during the period beginning on March 30 and ending on March 31.

112. No person shall fish in Lac Baker, Madawaska County, during the period beginning on Monday and ending on Friday in any week.

113. No person shall, except in the waters set out in items 4, 7, 13, 14, 16, 20, 21, 28 and 60 of Schedule IX, fish during the period beginning one-half hour after sunset and ending one-half hour before sunrise.

Quotas and Length Restrictions

114. (1) No person shall catch and retain

(*a*) in any day more fish of a species set out in column I of an item of the table to this subsection than the fishing quota set out in column II of that item; or

(*b*) any fish of a species set out in column I of an item of the table to this subsection the length of which is less than the minimum length set out in column III of that item.

TABLE

Item	Column I Species	Column II Fishing Quota	Column III Minimum Length
1.	Arctic char	The lesser of 5 fish and 3.5 kg plus 1 fish	15 cm
2.	Brook trout	The lesser of 5 fish and 3.5 kg plus 1 fish	15 cm
3.	Brown trout	The lesser of 5 fish and 3.5 kg plus 1 fish	15 cm
4.	Lake trout	The lesser of 5 fish and 3.5 kg plus 1 fish	45 cm
5.	Rainbow trout	The lesser of 5 fish and 3.5 kg plus 1 fish	15 cm
6.	Landlocked salmon	The lesser of 5 fish and 3.5 kg plus 1 fish	35 cm
7.	Smallmouth bass	The lesser of 5 fish and 3.5 kg plus 1 fish	30 cm
8.	Striped bass	The lesser of 5 fish and 3.5 kg plus 1 fish	n/a
9.	Smelt	60, except from the waters set out in items 4, 7, 13, 14, 16, 20, 21, 28 and 60 of Schedule IX	n/a
10.	Whitefish	The lesser of 5 fish and 3.5 kg plus 1 fish	n/a

(2) No person shall catch and retain in any day more sport fish and striped bass in the aggregate than the lesser of five fish and 3.5 kg plus one fish.

Provisions Specific to Nictau Lake

115. No person who fishes in Nictau Lake, Restigouche County, shall

(*a*) fish with more than one set line;

(*b*) use any fish as bait;

(*c*) catch and retain any landlocked salmon that is less than 50 cm in length or more than 63 cm in length;

(*d*) catch and retain any brook trout that is less than 25 cm in length;

(*e*) in any day, catch and retain more than one landlocked salmon; or

(*f*) continue to fish in that lake on any day after catching and retaining two sport fish in that day.