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ALLOWABLE HARM ASSESSMENT OF STRIPED BASS (*MORONE SAXATILIS*) IN THE SOUTHERN GULF OF ST. LAWRENCE

Illustration by Jeffrey C. Domm

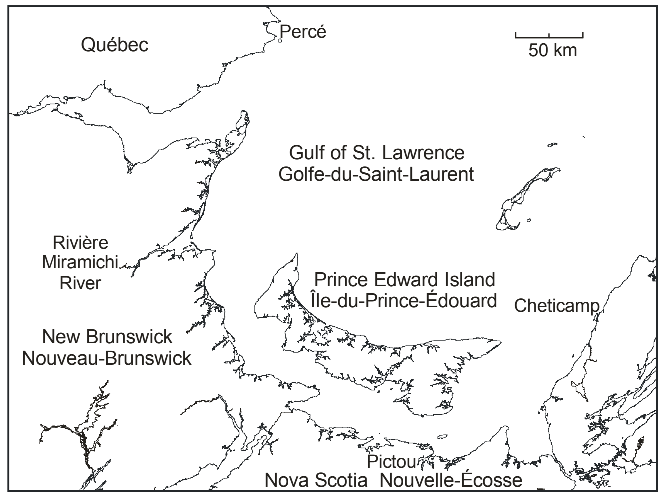

Figure 1: The southern Gulf of St. Lawrence.

Context :

*The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) identified three designatable units (DUs) of Striped Bass (*Morone saxatilis*) in eastern Canada with the southern Gulf of St. Lawrence DU assessed as 'Threatened' (COSEWIC 2004). The rationale for COSEWIC's listing recommendation of 'Threatened' for the southern Gulf of St. Lawrence DU was largely based on the population's single spawning location in the Northwest Miramichi estuary. The Recovery Potential Assessment (RPA) for Striped Bass evaluated whether the survival or recovery of the species was compromised by impacts of existing activities on the species (DFO 2006, Douglas et al. 2006). Due to a lack of quantitative information, the RPA for the southern Gulf of St. Lawrence DU did not provide any assessment of the mortality resulting from any specific fishery or other potential threat, but rather provided a qualitative description of the expected effects from many possible sources of mortality. The RPA concluded that illegal fishing and incidental mortalities in some fisheries constituted the most important constraints to the recovery of Striped Bass in the southern Gulf of St. Lawrence.*

Supplementary advice to the 2006 RPA was requested by the Species at Risk Secretariat (Gulf Region) and by the Ecosystems and Fisheries Management Branch of Fisheries and Oceans Canada (DFO EFM) to identify those activities which could be authorized by permit as defined by Section 73 or those activities to which the prohibitions of the Species at Risk Act (SARA) could be excluded as defined by Section 83(4). This advice will be considered as complementary advice to that provided in the 2006 RPA (DFO 2006).

A DFO Regional Advisory Process meeting was held February 4, 2011 in Moncton (NB) to respond to the request for advice on allowable harm. Participants at the science peer review meeting included DFO scientists and fishery managers, DFO Aboriginal Fishery coordinators, DFO SARA staff, non-government external experts, Aboriginal peoples, a representative from the commercial fishing industry, and academia.

SUMMARY

- Abundance of Striped Bass returning to the Northwest Miramichi River to spawn increased during 2007 to 2010, the result of three good recruiting year classes which followed more than 10 years of weak year classes.
- The constricted length and age distributions of Striped Bass in the southern Gulf of St. Lawrence (sGSL) is consistent with the high levels of annual mortality (28% to 47%) estimated for this population.
- Results from a questionnaire circulated to all DFO Conservation and Protection detachments and sub-detachments in Gulf Region indicated that nearly 70% of all adult Striped Bass fishery-related losses are the result of illegal (55%) and recreational (14%) fisheries. Losses from striped bass bycatch in commercial fisheries for gaspereau, rainbow smelt, Atlantic herring, American shad, American eel and Atlantic silverside were less important.
- Responses from First Nations in Gulf Region with Food, Social, and Ceremonial (FSC) gillnet and trapnet fisheries for Atlantic salmon indicated that the losses of striped bass were less than 5% of the total fisheries related losses.
- The uncertainty around the estimates of striped bass mortality for each fishery is not quantifiable with the available information but is considered to be large.
- In the absence of any fishery related losses, there is a high probability (>75%) that striped bass in the southern Gulf of St. Lawrence will meet the recovery limit of 21,600 spawners by 2015 and remain above it into 2020.
- Striped bass losses associated with illegal fishing by themselves result in a low probability (<25%) of meeting the recovery limit.
- An allocation of 2,000 adult Striped Bass to First Nations in the sGSL was not considered additional mortality on the population as this level of bycatch mortality is currently being experienced in FSC fisheries for Atlantic salmon. By itself, this fishery allocation would result in a medium chance (25% to 75%) of meeting the recovery limit for the population.
- Under any commercial fisheries bycatch scenario, and assuming no illegal or recreational fishery losses, there is a medium probability (25% to 75%) of meeting the recovery limit by 2015 and being compliant into 2020.
- With the cumulative mortality from all sources remaining at current levels, there is no measurable chance that Striped Bass from the sGSL will meet and remain above the recovery objectives into 2020.

INTRODUCTION

The Recovery Potential Assessment (RPA) for sGSL Striped Bass evaluated whether the survival or recovery of the species was compromised by impacts of existing activities on the population (DFO 2006). The RPA also assessed whether the recovery potential could be improved by reducing mortality on Striped Bass, primarily for those mortalities associated with fishing. Due to a lack of quantitative information, the RPA did not provide any assessment of the mortality resulting from any specific fishery or other potential threat but rather provided a qualitative description of the expected effects from several possible sources of mortality. The RPA concluded that illegal fishing and incidental mortalities in some fisheries constituted the most important constraints to the recovery of Striped Bass in the sGSL.

The RPA indicated that, under existing conditions, the cumulative mortality on Striped Bass from all activities resulted in a small chance (<25%) of achieving the recovery objective within ten years. The chance of recovery within ten years would be much higher if the mortality on incidentally captured adults and young-of-the-year (YOY) Striped Bass was reduced. The RPA provided some examples of measures to be considered to reduce these mortalities (DFO 2006).

The RPA did not provide any assessment of the activities which could be authorized if it was determined that they did not jeopardize the survival or recovery of the species. Complementary advice to that provided in 2006 is required for the following:

- To the extent possible, assess the impacts of activities described in Table 4 of the RPA (DFO 2006) on the survival and recovery of Striped Bass from the sGSL.
- To the extent possible and relative to objectives defined by management, assess the impacts of the activities on the survival and recovery objective trajectories.
- For the assessed activities above, determine if the probability of survival and the trajectory of the population can be improved by the application of mitigation measures and assess any residual effects.
- Based on the analyses above and relative to criteria defined by management (recovery objective, timeline), define those activities which would not jeopardize the survival or recovery of Striped Bass from the sGSL and therefore whose incidental effects could be authorized or exempted under the SARA. Also identify those activities whose effects are considered negligible.

The increased abundance of Striped Bass in the sGSL in recent years has renewed the interest of First Nation communities and the public for access to the resource. The interest is related to aboriginal FSC fisheries, to increased angling opportunities, and to the perceived fear that the increased abundance of Striped Bass will have (or is having) a negative impact on other species, in particular out-migrating Atlantic salmon smolts in the Miramichi River. Consequently, additional advice was requested for the following:

- Assess specifically the consequences to the population trajectory of annual FSC allocations to aboriginal fisheries of 2,000 Striped Bass.
- What additional mortality would be permitted on Striped Bass other than current bycatch mortality in FSC aboriginal and other fisheries?
- What size or sizes of Striped Bass could be retained with minimal impact on recovery?
- What is the mortality of Striped Bass, by size, from hook and release angling with a fly or with a fly with a barbless hook?

ASSESSMENT

Biology and Status of Southern Gulf of St. Lawrence Striped Bass

Striped Bass is widely distributed throughout the estuaries and coastal waters of the sGSL and exists at the northern limit of the species distribution. Based on tagging studies and catches from various fisheries, the coastal areas from Percé Quebec in the northwest, to Chéticamp, Cape Breton, in the east, and to Prince Edward Island in the north, represent the extent of occurrence of Striped Bass in the sGSL (Fig. 1). This population is geographically isolated within the sGSL and distinct from any other Striped Bass population, including those in the U.S.A. and the Bay of Fundy. Anadromous Striped Bass leave wintering areas in spring and return to estuaries where spawning occurs at the upper extent of the salt wedge. The Northwest Miramichi estuary remains the only known spawning location for Striped Bass in the sGSL and the spring spawning migration to this river is annually predictable in time and space. Female Striped Bass are highly fecund averaging 50,000 eggs per kg of body weight (over half a million eggs for larger females) and can reach lengths exceeding 1 m and ages older than 15 years in the sGSL.

Striped Bass spawning occurs in late May and early June in the upper portions of the Northwest Miramichi estuary when water temperatures exceed 10°C. Fertilized eggs remain in suspension until hatching occurs in 2 to 3 days depending on the temperature of the water. Larvae move to the near-shore habitats of the estuary where they grow rapidly and metamorphose into the adult body form by early July. YOY Striped Bass progress downstream and into salt water over the course of the summer months and spread along the coast both northwest and southeast of the Miramichi system, reaching as far south and east as Pictou, NS, by early fall. Striped Bass of all ages return to estuaries to overwinter and cease feeding when water temperatures fall below 10°C.

Management and Recovery Objectives

Striped Bass in the sGSL is managed as a single unit. Efforts to rebuild the low spawner abundance during the mid 1990s included the introduction of restrictive management measures, most notably the closure of directed commercial fishing in 1996, and the closure of recreational and aboriginal FSC fisheries in 2000. There has been no change in the management regime for the species since these closures took effect.

The RPA for Striped Bass in the sGSL proposed a recovery limit and compliance rule of 21,600 spawners in 5 of 6 years (DFO 2006). Douglas et al. (2006) further proposed that once the recovery limit was met, achieving an increased level of 31,200 spawners in 3 of 6 years could be a recovery target to consider for managing access to the resource.

Current Status

Levels of spawner abundance in the last 6 years (2005-2010) have not been sufficient to meet the recovery limit and respect the compliance rule (Fig. 2). A complete estimate of spawners was not possible in 2010 but spawner abundance was considered to have been sufficient to satisfy the recovery limit level of 21,600 spawners. If the lower confidence limit of the number of spawners returning to the Northwest Miramichi in 2011 exceeds 31,200 fish, the recovery limit and recovery target will have both been met.

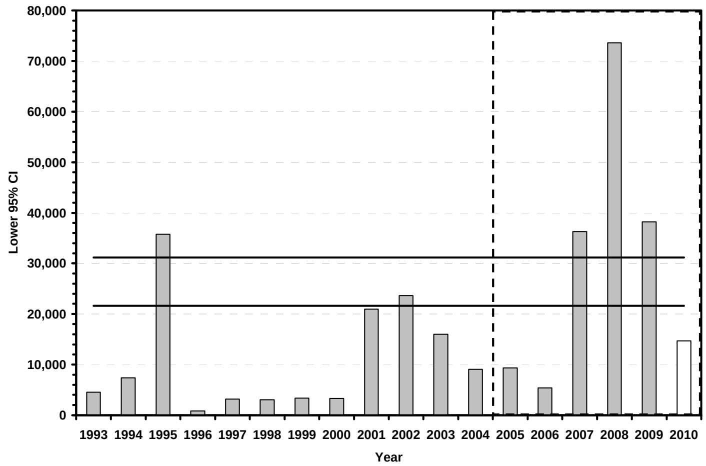

***Figure 2**. The lower confidence limit (95% CL) of the spawner abundance estimates for Striped Bass from the Northwest Miramichi relative to the recovery limit of 21,600 spawners (bottom horizontal line) and recovery target of 31,200 spawners (top horizontal line). The hatched box represents the 6 year sliding window for evaluation of compliance.*

There has been some relatively strong recruitment of Striped Bass in the last decade, specifically the year classes of 2003, 2004, 2005, and 2007 have been well represented. The 2004 year class was the first strong year class since the 1991 year class; all the year classes between 1991 and 2003 were weak (Fig. 3). Contributions to the spawning stock of Striped Bass aged 5 to 7 have improved since 2003 but remain low relative to younger year classes.

The increased abundance of Striped Bass spawners in 2007 to 2010 is the result of three good recruiting year classes, which follow more than ten years of weak year classes. Such variation in yearclass strength has also been reported in Striped Bass populations in the eastern US (Goodyear 1985).

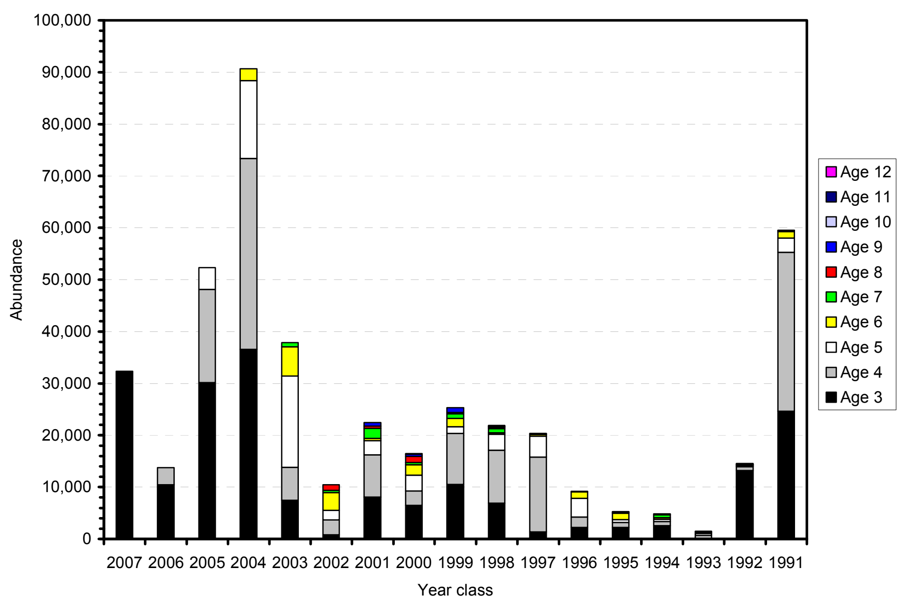

***Figure 3:** Striped Bass abundance at age by year class and total contribution to the spawning stock for year classes 1991 to 2007.*

Sources of Mortality on Southern Gulf of St. Lawrence Striped Bass

Based on the average abundance at ages 3 to 9 years over the period 1997 to 2010, the annual mortality rate of adult Striped Bass is about 47% (Z = 0.63), values marginally lower than the estimates of 50% to 60% (Z = 0.8 - 0.9) previously calculated for this population (Douglas et al. 2006). Estimates of annual mortality of Striped Bass based on acoustic tagging programs are lower than estimates derived from the catch curve analysis. In five replicates, estimates of Z consistently ranged between 0.34 and 0.48, corresponding to annual total mortality rates of 28% to 38%. It is not clear why the estimates of Striped Bass mortality differ between the two methods.

Potential threats and their associated mortality to Striped Bass in the sGSL were described previously and qualitatively ranked as low, medium, or high (DFO 2006, Douglas et al. 2006). The threats discussed below include only activities known to have a direct negative impact on Striped Bass in the sGSL. No further information has emerged on the ‘Other potential sources of Striped Bass mortality/harm’ that were reported in the RPA and these will not be discussed further (specifically Fisheries impacts on habitat, Direct mortality under permit, Habitat alterations under permit, Ecotourism and recreation, Shipping, transport and noise, Fisheries on food supplies, Aquaculture, Military activities, and Non-domestic) (Douglas et al. 2006).

Levels of Striped Bass bycatch in many of the region’s estuarial fisheries have previously been ranked qualitatively by DFO Conservation and Protection officers (Chiasson et al. 2002). In 2010-2011, DFO’s Conservation and Protection Branch (22 responses from all 19 detachments and sub-detachments in coastal areas) were asked to respond to a questionnaire in order to estimate the level of Striped Bass bycatch in various fisheries, including illegal fisheries, throughout the sGSL. In addition, First Nation communities with access to Atlantic salmon in the Aboriginal Fisheries agreements (12 respondents from 5 communities) were asked to respond to the same questionnaire but only specifically to striped bass bycatch in their FSC Atlantic salmon gillnet and trapnet fisheries.

The responses were collected with a questionnaire which was modified after initial testing internally. The questionnaire asked respondents to semi-quantitatively rank (in broad catch categories of 0, <100, 101-1000, 1001-5000, 5001-10,000, >10,000), the level of bycatch (number of fish) released dead and released alive in various fisheries throughout the sGSL. Midpoints of the bycatch categories (except 0 was used for 0, and 10,000 was used for >10,000) were used to derive total estimates of Striped Bass handled, released, and killed in the various fisheries. Individuals were also asked to differentiate between the sizes of captured Striped Bass as small (< 12 inches), medium (12-24 inches) or large (>24 inches).

Striped Bass mortality as a proportion of the total number of bass handled was used to estimate the impact of the bycatch activity in a fishery. The estimated mortality of Striped Bass in a fishery divided by the total mortality from all fisheries was used to describe the proportion of the total fishery induced mortality attributed to a specific fishery.

Estimated Losses Among Fisheries

Due to the type of data collected and the calculation method, the point estimates for Striped Bass mortality in the various fisheries reported below provide an estimated scale of impact but should not be considered absolute values. The uncertainty around the estimates is not quantifiable with the available information but is considered to be large.

Striped Bass of various life stages continue to be intercepted in a variety of illegal fisheries, commercial fisheries, and aboriginal FSC fisheries. The total estimated loss of medium and large sized Striped Bass in all southern Gulf of St. Lawrence fisheries was estimated to be in the range of 60,000 fish per year. It was estimated that 90,000 fish were handled and released alive. The total number of bass handled was estimated to be 152,000 fish, of which 41% were estimated to have died or been killed (retained) (Table 1). Loss estimates are not considered to include post-release mortality of fish that were angled and released. These values are high considering the estimates of spawner abundance between 2007 and 2010. The numbers reported in the questionnaires most likely apply to recent years when Striped Bass abundance has increased. Removal levels estimated from the questionnaire would not have been realistic in the mid 1990s and early 2000s when spawner abundance was less than 20,000 fish annually (Fig. 2).

The fisheries that occur with gillnets have the highest mortality rates on Striped Bass. All (100%) of the Striped Bass captured in the illegal fisheries are considered to be dead. Over 80% and 65% of Striped Bass handled in the gillnet fisheries for American shad and Atlantic herring, respectively, were estimated to have died (Table 1). About 60% of the Striped Bass captured in FSC fisheries for Atlantic salmon are considered to be dead.

The activity with the greatest contribution to the total loss of Striped Bass is considered to be the illegal fishery, accounting for over 50% of the estimated adult losses, followed by the recreational fishery (illegal retention and bycatch) at about 15% (Table 1). The Atlantic silverside and American eel fisheries were estimated to contribute the least to the total losses of adult Striped Bass in the sGSL.

Table 1*. Summary of estimated losses of medium and large sized striped bass in fisheries of the southern Gulf of St. Lawrence. All values have been rounded to the nearest 100.*

	Total			Percentage	Percentage of
Fishery	**Released**	**Dead**	**Handled**	**killed**	**total killed**
Atlantic silverside	400	0	400	0.0%	0.0%
American eel	15,500	1,300	16,800	7.7%	2.1%
FSC salmon	1,200	1,900	3,100	61.3%	3.1%
American shad	500	2,500	3,000	83.3%	4.1%
Rainbow smelt	12,900	3,900	16,800	23.2%	6.3%
Atlantic herring	2,300	4,500	6,800	66.2%	7.3%
Gaspereau	37,900	4,800	42,700	11.2%	7.8%
Recreational	19,600	8,900	28,500	31.2%	14.4%
Illegal	0	33,900	33,900	100.0%	54.9%
Total	90,300	61,700	152,000	40.6%	

Projections and Probabilities of Stock Recovery

The life history model used in the RPA for Striped Bass in the sGSL was used to assess the probability of achieving the recovery limit (21,600 spawners) by 2015 and being compliant into 2020 for various fishing scenarios. The inputs were the same as those used previously and included assumed values for fishing and natural mortality: F=0.1 for YOY bycatch in the autumn rainbow smelt fishery, F=0.2 on adult bass (ages 2 and older) and M = 0.6 (ages 2 and older) (Douglas et al. 2006). Given the level of uncertainty in many of the life history model parameters, the outcomes of the projections are evaluated against the recovery objectives and the results are presented as low probability (<25%), medium probability (25% to 75%) and high probability (> 75%) of meeting the recovery objective.

In the absence of any fishing related mortality (M = 0.6 on adults), the probability of meeting the recovery limit of 21,600 fish by 2015 and respecting the compliance rule into 2020 is high.

Table 2. *Assessment of the probability (low <25%; medium 25% to 75%; high >75%) of meeting the recovery limit of 21,600 Striped Bass spawners by 2015 and being compliant into 2020, for various fishery scenarios in the southern Gulf of St. Lawrence.*

Activity		**Prob. of recovery**
No fishing related losses		High
Only illegal fishing losses		Low
FSC only (2,000 adult bass)		Medium
FSC (as above) and	Atlantic silverside fishery	Medium
	American eel fishery	Medium
	American shad fishery	Medium
	Rainbow smelt fishery	Medium
	Atlantic herring fishery	Medium
	Gaspereau fishery	Medium
	All coastal and estuarine commercial fisheries.	Medium
	Recreational fishery	Medium
All fisheries - FSC, commercial, recreational, excluding illegal		Low
All fisheries - FSC, commercial, recreational, and illegal (status quo)		Low (~0%)

Fishery specific effects

Over 50% of adult Striped Bass losses were estimated to occur in **illegal fisheries** throughout the sGSL. In the absence of any other fishery related losses, this activity results in a low probability of meeting the recovery limit by 2015.

Food, social, and ceremonial fisheries presently contribute to Striped Bass mortality on adult sized fish. The losses occur as a result of bycatch in fisheries targeting Atlantic salmon. These fisheries are limited geographically but can intercept several thousand Striped Bass with corresponding high mortality on individual fish. First Nation estimates of current annual Striped Bass losses in FSC fisheries for Atlantic salmon were greater than 2,000 fish (Table 1). An FSC fishery of 2,000 adults, in the absence of any other fishing related mortality on any life stage (and assuming M = 0.6 for age 2 and older), would result in a medium chance of meeting the recovery limit by 2015. FSC allocations greater than 2,000 fish will further reduce the chance of meeting and respecting the compliance rule into 2020. The removal of 2,000 Striped Bass for an FSC allocation in the sGSL is not considered to be an additional mortality on Striped Bass as this level of mortality already occurs as bycatch in gillnets set for Atlantic salmon. Alternative gear to gillnets, such as trapnets or angling, are options for conducting these fisheries which would allow for selective harvesting of salmon or Striped Bass.

There are two fisheries which are expected to have a low impact on Striped Bass abundance. The **Atlantic silverside** fishery, as it is presently carried out, mostly in the eastern counties of Prince Edward Island, likely has a low to negligible impact in terms of absolute number of Striped Bass lost. The consequences of this fishery are that there is a medium probability of recovery.

Commercial fisheries for **American eel** exist throughout the region and are carried out with fyke nets and spears. Little quantitative information is known about the bycatch in eel fisheries but all sizes of Striped Bass have the potential of being intercepted albeit in low numbers (Bradford et al. 1995). The eel fishery, practiced with fyke nets and with appropriate culling practices can return bycatch to the water alive, and should have a low impact on Striped Bass. The eel fishery was estimated to contribute about 2% of the total losses of adult Striped Bass and there is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2). The spear fishery for American eel is not expected to have any impact on Striped Bass.

The **gaspereau** fishery has a high potential of intercepting Striped Bass (Douglas et al. 2006). This fishery occurs in many estuaries of the Gulf Region and can intercept large numbers of Striped Bass, mostly aged 2 and older. Results from the questionnaire indicated that losses of Striped Bass in the gaspereau fishery represented 8% of the losses from all fisheries (Table 1) and there is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2). The type of gear used (trapnet), the time of year of the fishery (late spring, early summer), and the possibility of adopting effective culling practices to return bycatch with minimal harm to the water should result in a low impact on Striped Bass. Fishers in the NW Miramichi have already adopted efficient culling practices (single dipnet scoops, immediate culling) for Striped Bass which produces minimal handling mortality. Similar practices could be implemented in other areas of the sGSL.

The Atlantic herring and American shad gillnet fisheries are carried out along the coast and have the potential of intercepting Striped Bass. Gillnet mesh sizes ($2^{1/4}$ to $2^{7/8}$ inches; 57 to 73 mm) used in the **Atlantic herring** fishery should not be very effective at capturing adult-sized Striped Bass. Losses of Striped Bass in the herring fishery were estimated to be 7% of the total losses (Table 1) and there is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2). The **American shad** fishery deploys set gillnets with a minimum mesh size of 127 mm in an area where there is a high probability of intercepting Striped Bass. According to reports from shad fishers and C&P, the Striped Bass bycatch in this fishery can be in the hundreds of fish. The estimated loss of Striped Bass from this fishery was 2,500 fish annually and represented 4% of the total annual losses and there is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).

The open-water **rainbow smelt** fishery with boxnets, bagnets, and gillnets is the fishery with the largest impact on YOY Striped Bass. This fishery is geographically widespread in the sGSL and YOY are captured in most estuaries where the fishery occurs. The number of YOY killed in this fishery would be proportional to the abundance, and in some cases, can result in losses equivalent to thousands of adults. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2). The only quantitative assessment of Striped Bass bycatch in any commercial smelt fishery is from the Miramichi River during the open-water season. During a two year study, 100,000 to 400,000 YOY, and depending on the year, >1000 each of Age 1 and Age ≥2 fish were captured in Miramichi box nets (Bradford et al. 1997). Even though the catch in this fishery is loaded alive, the mortality on YOY Striped Bass can be high (almost 100%) and is largely attributed to the difficulty of culling large numbers of small bass from smelt catches. The magnitude of the Striped Bass bycatch in smelt boxnets and other fisheries elsewhere in the sGSL is not well documented but known to occur and qualified as substantial at times (Chiasson et al. 2002). The loss of 1,000 YOY equates to the loss of about 100 adult bass over the lifespan of the animal (life history model assumptions). Some of the YOY captured in the smelt fishery in the fall may not survive the winter due to their small body size but the smelt fishery is not selective for size; small and large YOY are captured in the nets. A two-week delay to Nov. 1 in the opening date of the open-water smelt fishery in Miramichi Bay was introduced in 1999 to reduce the high bycatch of YOY Striped Bass. The number of Striped Bass captured in the winter component of the smelt fishery is low and less than the open-water component because YOY avoid the relatively cold and saline waters of the lower estuary where the smelt fishery is concentrated (Hanson and Courtenay 1995). YOY Striped Bass that are captured in the winter fishery generally die when they are removed from the water and placed on the ice.

Tidal and marine recreational fisheries occur along the entire coast of the southern Gulf of St. Lawrence. Striped Bass are targeted, released or retained, but under the guise of angling for a different species with a legal season and bag limit (trout in estuaries, mackerel from wharves and coasts, etc.). There are large numbers of people angling and Striped Bass are extremely vulnerable to these fisheries. DFO C&P estimated that 9,000 Striped Bass were killed and 20,000 were released alive throughout the sGSL, representing over 14% of the total mortality from all fisheries bycatch combined with the result that there is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).

Striped Bass fishing with barbed or barbless artificial flies under the guise of fishing for other species is not a common practice in the sGSL. Striped Bass are intercepted in angling fisheries that occur in estuaries and coastal waters, with spin casting and surf casting equipment. Terminal tackle for spin and surf casting equipment tends to be jigs and lures in estuarine environments while natural bait is the norm for coastal fisheries. There is no information on mortality rates for Striped Bass hooked and then released in the sGSL. On the eastern seaboard of the U.S.A., hooking mortality estimates range from a low of 3% to a high of 74% and vary considerably depending on the type of tackle used and the water conditions (Millard et al. 2005).

Cumulative effects of bycatch losses in FSC fisheries and in commercial estuarine and coastal fisheries results in a medium probability of meeting the recovery limit by 2015 (Table 2). When recreational fishery losses are added, the probability of meeting the recovery limit is reduced to low (Table 2). Under what are considered status quo conditions (F = 0.1 on YOY and age 1, F = 0.2 for Striped Bass age 2 and older in all other fisheries including illegal fisheries, and M = 0.6 on age 2+), there is no measurable chance (0%) of meeting the recovery limit and complying with the rule into 2020.

Uncertainties and Knowledge Gaps

Losses of Striped Bass in recent years from incidental bycatch and handling mortality, and from illegal retention fisheries, have not been directly measured in the sGSL. Questionnaires to C&P personnel indicated that the losses from fishing are in the tens of thousands of Striped Bass per year. The values reported in the 2010 questionnaire may be more representative of the losses in the recent years (past three years) when the overall spawning stock of Striped Bass was estimated to be between 50,000 and 100,000 animals annually. Even so, the losses and fish handled would represent a very high proportion of the estimated spawner abundance, which may in part explain the high mortality rate estimated from catch curve analyses (Z = 0.63 in the recent assessment).

The design, delivery, and results of the questionnaire are presently under review by an external expert. A number of issues were raised regarding the design and how the data were analysed, including:

- Generally, the total number of respondents was low and the representativeness of the results are unknown. For the DFO C&P respondents however, the questionnaires were completed by detachments throughout Gulf Region, were based on the experience and opinions of several officers, and the information was considered to be reliable and representative of the situation.

- Only the DFO C&P information for fisheries other than FSC and the aboriginal community information specific to the FSC fishery were used to estimate the bycatch of Striped Bass. The few responses from commercial fishermen (n = 11) were not used in this analysis, but it may be informative to compare their responses with those from DFO C&P to help evaluate the reliability of the results.
- There are responses in the questionnaire which contrast to findings from other studies. For example, there are low numbers of small bass reported captured in the smelt fisheries in contrast to previous studies indicating that YOY bass are frequent bycatch in the open-water smelt fisheries. It is possible that respondents did not consider YOY bass within the small fish category, due to the lack of a clear definition of what was considered small Striped Bass.
- Definitions of recreational fisheries or illegal fisheries were not clear.
- The use of midpoints in the categories and the use of a single number for the high and low categories is not standard practice in the analysis of ordinal data.

The population model used to determine reference levels for sGSL striped bass assumed or borrowed features from other populations (Douglas et al. 2006). The same model was used to assess the probability of meeting the recovery objectives under various scenarios of Striped Bass bycatch mortality in FSC, commercial, recreational tidal and illegal fisheries.

In order to adequately assess consequences of fishing activities on recovery potential, a partitioning of total mortality (Z) into natural (M) and fishing related (F) mortality is required. The constricted age distribution of adult Striped Bass observed in the Northwest Miramichi is indicative of some or all of the following: high natural mortality on adult size animals (in the range of M = 0.6), lower natural mortality but high fishing mortality, or lower natural mortality but higher size-dependent fishing mortality on older ages. The most recent catch curve estimate of Z = 0.63 is lower than the value previously reported by Douglas et al. (2006). If Z is 0.63, then M should be less than the value of 0.6 assumed in the life history model for the RPA (Douglas et al. 2006). At the level of reported losses of Striped Bass estimated over all fisheries, M should be much lower than the assumed value of 0.6. It is not simply a matter of changing the value of M in the life history model and running it to evaluate the probability of meeting the defined objectives in the RPA (DFO 2006). If M is in fact lower, then the recovery limits and targets would be higher than those identified in the RPA and which were based on M = 0.6.

Recent acoustic tracking data indicates that the total loss (Z) for Striped Bass implanted with a sonic transmitter in one year that returned to the Miramichi to spawn in the following year is in the range of 0.3 to 0.4. Knowing that some of these losses of tagged fish occurred in fisheries, M is therefore less than 0.4 and a value of 0.2 as assumed in other parts of the species range (eastern USA) may not be unreasonable. If M is in fact this low, then mortality from other factors, primarily fishing, must be high to account for the absence of old fish and the constricted age structure of the spawning population.

CONCLUSIONS AND ADVICE

To the extent possible, assess the impacts of activities described in Table 4 of the 2006 RPA on the survival and recovery of Striped Bass from the southern Gulf.

- No further information was presented on the 'Other potential sources of Striped Bass mortality/harm' that were reported in the RPA (specifically Fisheries impacts on habitat, Direct mortality under permit, Habitat alterations under permit, Ecotourism and recreation, Shipping, transport and noise, Fisheries on food supplies, Aquaculture, Military activities, and Non-domestic) (Douglas et al. 2006). The threats examined in this review included only activities known to have a direct negative impact on Striped Bass in the sGSL. Results from the questionnaire circulated to all DFO Conservation and Protection detachments and sub-detachments in Gulf Region and to First Nations in Gulf Region indicated that nearly 70% of adult Striped Bass losses from fishing activities occur in illegal (55%) and recreational (14%) fisheries. In order of importance, the remainder of the losses are in the commercial fisheries for gaspereau, rainbow smelt, Atlantic herring, American shad, American eel and Atlantic silverside fisheries of the sGSL. Responses from First Nations in Gulf Region with Food, Social, and Ceremonial (FSC) gillnet and trapnet fisheries for Atlantic salmon indicated that the losses of striped bass were less than 5% of the total fisheries related losses. Mortality from all other potential sources is considered minimal relative to those caused by fisheries.

To the extent possible and relative to objectives defined by management, assess the impacts of the activities on the survival and recovery objective trajectories.

- Based on the assumptions of the life history model used to define recovery objectives for Striped Bass in the sGSL (DFO 2006), there is no measurable chance of achieving the recovery objectives at the current levels of total mortality experienced by the population. Strong year classes have occurred periodically (1991 followed by the 2004 year class) and these may produce sufficient abundance of spawners to occasionally achieve the defined recovery objectives. This scenario is not expected to occur frequently given the biology of sGSL Striped Bass and the high number of adult removals which continue to occur on an annual basis.

For the assessed activities above, determine if the probability of survival and the trajectory of the population can be improved by the application of mitigation measures and assess any residual effects.

- In the absence of any fishing related mortality and assuming natural mortality of adults at $M = 0.6$, the probability of meeting the recovery limit of 21,600 fish by 2015 and respecting the compliance rule into 2020 is considered to be high. The probability of meeting the recovery limit and the recovery target by 2015 and respecting the compliance rule into 2020 is medium.

Based on the analyses above and relative to criteria defined by management (recovery objective, timeline), define those activities which would not jeopardize the survival or recovery of Striped Bass from the southern Gulf and therefore whose incidental effects could be authorized or exempted under the SARA. Also identify those activities whose effects are considered negligible.

- The Atlantic silverside fishery and the American eel fisheries, as presently carried out, likely have a low to negligible impact on Striped Bass. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).
- The gaspereau trapnet fishery has a high potential of intercepting Striped Bass (the fishery occurs in many estuaries of the southern Gulf) and can intercept large numbers of Striped Bass, but the type of gear used (trapnet), the time of year of the fishery (late spring, early summer), and the possibility of adopting effective culling practices to return bycatch with minimal harm to the water should result in a low impact on Striped Bass. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).
- Aboriginal FSC fisheries presently contribute to Striped Bass mortality on adult sized fish as a result of bycatch in gillnet fisheries targeting Atlantic salmon. These fisheries are limited geographically but can intercept several thousand Striped Bass with corresponding high mortality on individual fish. Alternative gear to gillnets, such as trapnets or angling, are options for conducting these fisheries which would allow for selective harvesting of salmon or Striped Bass. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).
- Atlantic herring gillnet fisheries were reported to capture important numbers of Striped Bass and to have a high mortality rate. Gillnet mesh sizes ($2^{1/4}$ to $2^{7/8}$ inches; 57 to 73 mm) used in the Atlantic herring fishery should not be effective at capturing the larger adult-sized Striped Bass. The extent of the losses associated with this bait fishery in both the spring and fall is unknown. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).
- The limited American shad fishery deploys set gillnets with a minimum mesh size of 127 mm in an area where there is a high probability of intercepting Striped Bass. There are presently 10 licences fishing in the Pointe Sapin area in the spring. Considering the limited amount of gear, the single location and short season, this fishery has a relatively large impact on Striped Bass. According to reports from shad fishers, the Striped Bass bycatch in this fishery can be in the hundreds of fish with estimated losses of 2,500 fish annually. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).
- The open-water rainbow smelt fishery with boxnets, bagnets, and gillnets has the largest impact on YOY Striped Bass. This fishery is geographically widespread in the sGSL and YOY are captured in most estuaries where the fishery occurs. The mortality on YOY Striped Bass can be high (almost 100%) and is largely attributed to the difficulty of rapidly culling large numbers of small bass from smelt catches. The number of YOY killed in this fishery would be proportional to the abundance, and in some cases, can result in losses equivalent to thousands of adults annually. There are no proposed mitigation measures that could reduce the bycatch of YOY Striped Bass without negatively affecting the catch of the targeted species. The abundance of Striped Bass captured in the winter component of the smelt fishery is low because YOY avoid the relatively cold and saline waters of the lower estuary where the smelt fishery is concentrated in the winter. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).
- Tidal and marine recreational fisheries occur along the entire coast of the sGSL and are practiced by large numbers of people fishing for Striped Bass under the guise of fishing for other fish species. Striped Bass are intercepted in these angling fisheries with spin casting and surf casting equipment. There is no information on mortality rates for Striped Bass hooked and then released in the sGSL with any angling gears. On the eastern seaboard of the U.S.A., hooking mortality estimates range from a low of 3% to a high of 74% and vary considerably depending on the type of tackle used and the water conditions. It was estimated that 14% of the total mortality of Striped Bass from all fisheries was the result of recreational fisheries. There is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).

Assess specifically the consequences to the population trajectory of a potential FSC allocation of 2,000 Striped Bass to First Nations in the sGSL.

- More than 2,000 adult Striped Bass are currently being intercepted and killed in aboriginal gillnet fisheries that target Atlantic salmon for FSC purposes. An allocation of Striped Bass at this level (2,000) is not considered to represent additional mortality on the population and there is a medium probability of meeting the recovery objective at this level of fishery related loss (Table 2).

What additional mortality would be permitted on Striped Bass other than current bycatch mortality in food, social, and ceremonial aboriginal and other fisheries?

- Nearly 70% of adult Striped Bass losses were estimated to occur in illegal (55%) and recreational (14%) fisheries throughout the sGSL. Illegal fisheries are those where Striped Bass are targeted and retained. In recreational fisheries, Striped Bass are targeted, released or retained, but under the guise of angling for a different species with a legal season and bag limit (trout in estuaries, mackerel from wharves and coasts, etc.). Any additional authorized mortality would further reduce the chance of achieving and remaining above the recovery objectives. A legalized hook and release angling fishery on Striped Bass for example would represent an additional source of mortality on the population as there would be increased participation by anglers currently abstaining from the illegal recreational fishery on Striped Bass.

What size or sizes of striped bass could be retained with minimal impact on recovery?

- The number of eggs per fish increases with size so larger females contribute substantially more eggs than younger and smaller females. Striped Bass recruitment is annually variable due mostly to the variations in survival of the early life stages (egg to summer YOY). As a result, there is benefit in maintaining a broad age distribution in the spawning population so that the spawning potential is maintained and distributed over a number of spawning years to take advantage of favourable environmental conditions that can produce good year classes of recruitment. Allowing a potentially high harvest rate on fish larger than a minimum length could result in further constricting the age structure in the spawning population with low numbers of older animals. Managing on a slot size or a maximum size limit, would result in high exploitation rates on a specific age component, reducing the abundance of older animals once they grow through the slot or above the limit. Neither of these measures is considered good practice for a species whose life history (high fecundity, multiple years of spawning, old age) suggests that persistence depends upon the presence of a sufficient spawning stock to take advantage of infrequent favourable environmental conditions that produce strong year classes. The use of a minimum size limit, a maximum size limit, or a slot limit may not be effective measures to manage the exploitation and sustain the spawning population of adult Striped Bass in the sGSL.

What is the mortality of Striped Bass, by size, from hooked and released by angling with a fly or with a fly with a barbless hook?

- Angling for Striped Bass with a barbed or barbless artificial fly is not a common practice in the sGSL, and hooking mortality by this means should be very low. Artificial baits such as jigs, lures, and single hooks with natural bait are the most common terminal tackle used to angle Striped Bass in the sGSL. There is no evidence that hooking mortality is related to the size of Striped Bass, however water temperature, salinity, and types of terminal tackle have all been identified as important factors influencing hooking mortality, which can vary from a low of 3% to a high of 74%.

OTHER CONSIDERATIONS

Nearly 70% of adult Striped Bass losses were estimated to occur in illegal (55%) and recreational (14%) fisheries throughout the sGSL. Illegal fisheries are those where Striped Bass are targeted and retained while in recreational fisheries, Striped Bass are targeted, released or retained, but under the guise of angling for a different species with a legal season and bag limit (trout in estuaries, mackerel from wharves and coasts, etc.). There is no easy solution to this problem.

Striped Bass in the sGSL spawn at a single location in the upper portion of the Northwest Miramichi estuary. Staging occurs first at the confluence of the Northwest and Southwest Miramichi rivers (locally known as Strawberry Marsh) during the month of May. The spawning period is brief and the majority of spent Striped Bass have returned to the coastal environment by mid June.

Striped bass in the sGSL are at the northern limit of the species distribution where environmental conditions may play an important role in the success or failure of a year class. Striped Bass eggs are highly sensitive to environmental conditions in the spring and young-of-the-year must attain a critical size by the end of the first growing season to survive the winter. Striped bass abundance in the sGSL is expected to be variable even in the absence of fishing related mortality.

Habitat quality on the spawning area should be improving as the two large pulp and paper mill operations in the Miramichi have recently closed down and are being dismantled, eliminating the treated effluent discharge in the area immediately below the spawning grounds in the Northwest Miramichi.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Gulf Regional Advisory Process of February 4, 2011 on Allowable Harm assessment for the striped bass population from the southern Gulf of St. Lawrence. Additional publications resulting from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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