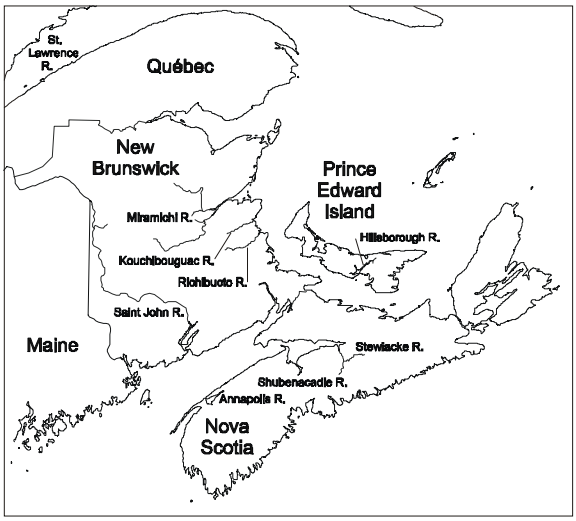
Fisheries and Oceans / Pêches et Océans
Maritimes Region

DFO Science
Stock Status Report D3-22(1999)



Status of Wild Striped Bass (*Morone saxatilis*) and Interaction Between Wild and Cultured Striped Bass in the Maritime Provinces

Background

*The anadromous striped bass (*Morone saxatilis*) ranges from the Gulf of Mexico to the St. Lawrence system. Historically, spawning in Canada occurred in rivers flowing to the Bay of Fundy, the southern Gulf of St. Lawrence, and the St. Lawrence River. The southern Gulf of St. Lawrence is the northern limit of spawning for the species and striped bass which spawn there are genetically distinct from Bay of Fundy spawners. Both are genetically distinct from U.S.A. striped bass.*

Canadian populations of striped bass share many life-history attributes. Adults enter fresh to slightly brackish water to spawn during May and June. Fertilized eggs are planktonic and larvae are pelagic. Adult and juvenile striped bass may range several hundred kilometers beyond their natal rivers during summer but return to fresh water to overwinter. The overwintering sites appear unrelated to the spawning sites. Males reach maturity at about age three whereas females mature first at age four. Generally, spawning occurs every year thereafter for the remainder of their natural life span which can exceed 20 years in some populations.

Sales of wild striped bass caught in Atlantic Canada are prohibited. In the DFO Gulf Fisheries Management Region, retention of wild striped bass is permitted only in the Aboriginal fishery. Limited retention of striped bass from commercial bycatch and from recreational angling is allowed in the Bay of Fundy where U.S.A. origin migrants are frequently encountered.

Enhancement efforts and aquaculture operations using striped bass are still in the development stage in eastern Canada. Hatchery programs in the U.S.A. are well developed and aquaculture production there represents 3,000 to 5,000 t annually.

The following terms were used in this report;

- *Cultured bass: a fish cultured for any period of its life cycle.*
- *Wild bass: a fish that has not been cultured.*
- *Enhancement: the enlargement or increase in number of individuals in a population by providing access to more or improved habitats or by using fish culture facility production capability.*
- *Restoration: the re-establishment of a finfish species in waters occupied in historical times.*
- *Aquaculture: the culture or husbandry of aquatic fauna other than in research, in hobby aquaria, or in governmental enhancement activities.*

March 1999

Canada

Summary

- Stocking striped bass for enhancement and the culture of the species for commercial use is relatively new in Canada. It is therefore appropriate to consider the implications of such activities for wild striped bass stocks before such activities proceed further.

- Although four populations are known to have existed in the Maritime provinces in the past, there are only two populations left where the species reproduces annually--the Miramichi River in New Brunswick and the Shubenacadie River in Nova Scotia. The status of the Miramichi population is assessed to be below provisional conservation requirements while the status of the Shubenacadie population is unknown. It is recommended that fishing mortality be reduced on the former and a cautious approach to fishing mortality be considered for the latter.

- For the southern Gulf of St. Lawrence population, management measures should include deterence of poaching, closure of directed fisheries and minimizing mortality from fisheries directed on other species.

- Interactions between cultured and wild stocks in the Maritime provinces are not currently a major issue as enhancement possibilities are only now being considered and to date there have been few requests for collection of broodstock for aquaculture purposes.

- While there is potential for interaction between cultured and wild striped bass, the magnitude of the potential effect is unclear and heavily dependent upon the source of the broodstock used and the technology and husbandry practices employed in their culture.

- Interactions, as evidenced from the U.S.A. experience, can be related to genetic, ecological, disease and parasite concerns.

- In the face of the uncertainty regarding interactions and the current reduced status of wild striped bass stocks in the Maritimes provinces, a cautious approach is warranted when managing the wild stocks and when considering any proposal to culture striped bass for enhancement, restoration or commercial aquaculture.

- Mitigative measures include reductions in fishing mortality on wild stocks, the use of local stocks for enhancement and for aquaculture operations where there is a significant risk of escapes, and the application of containment and siting criteria to reduce escapes from culture situations.

- A data-gathering system should be put in place that records all introductions and transfers of striped bass genetic material, including milt, eggs, larvae, juveniles, and adults, within eastern Canada and between eastern Canada and other areas. Releases, both accidental and deliberate, should also be registered in the system.

- Research recommendations recognize the need for all potential users of the resource to collaborate in the acquisition of scientific data needed to address knowledge gaps, including further assessment on wild stocks, development of criteria and risk analysis procedures for consideration of enhancement and

aquaculture proposals, and the development and testing of containment facilities and broodstocks for aquaculture.

The Issue

A scientific review meeting was held on December 9-11, 1998 to:

- review the current status of the wild striped bass stocks;
- document the protocols and regulatory controls which exist to protect the wild striped bass stocks of the Maritime provinces;
- describe the potential for interactions between wild and cultured striped bass;
- propose measures which could minimize the risk of negative effects of cultured bass on wild striped bass.

Wild Stock Structure

Four self-sustaining populations of striped bass are known to have existed within the Maritime provinces: populations in the Miramichi and Saint John rivers in New Brunswick, and populations in the Shubenacadie-Stewiacke and Annapolis rivers in Nova Scotia. The Miramichi and Shubenacadie-Stewiacke rivers are the only confirmed sites where striped bass now reproduce annually, and as such they are the sole representatives of the species within the southern Gulf of St. Lawrence and Bay of Fundy biogeographic areas, respectively. The native stock may be extirpated from the Saint John River while in the Annapolis River, spawning activity has declined since the 1980s and may have ceased recently.

Within the southern Gulf of St. Lawrence, the presence of spawning fish, ichthyoplankton (fish eggs and larvae), and young-of-the-year in the littoral zone has confirmed that striped bass spawn annually in the Northwest Miramichi River. Similar sampling efforts have not found any evidence of spawning in the Kouchibouguac River in 1996-1998 or Richibucto River in 1997 or 1998. However, young-of-the-year striped bass appear to migrate from the Miramichi Estuary to the Kouchibouguac and Richibucto estuaries in late summer. Tagging and recapture studies of fish two years old and older in the southern Gulf of St. Lawrence also suggests that bass exhibit spawning site fidelity in the Northwest Miramichi River and this may be the only spawning population in the southern Gulf of St. Lawrence.

Genetic studies to date have demonstrated that striped bass caught in the southern Gulf of St. Lawrence (Miramichi and Tabusintac rivers) differ from striped bass from the Bay of Fundy (Shubenacadie-Stewiacke River system), and both groups differ from striped bass of American origin. Within the southern Gulf of St. Lawrence, no genetic differences have been observed between juvenile striped bass sampled from the Miramichi and Tabusintac rivers. Analysis of striped bass caught in two Bay of Fundy rivers indicated that up to 97% of adults sampled during the summer from the Saint John River were likely of U.S.A. origin compared to less than 10% of adult striped bass collected during the spring spawning season in the Shubenacadie-Stewiacke River.

Status of Wild Stocks

Annual stock assessments have been conducted since 1993 on the Miramichi population. In the Bay of Fundy, sampling of the Saint John River system with ichthyoplankton nets and beach seines in 1992 and 1994 failed to find any evidence of successful striped bass spawning. Similar sampling in the Shubenacadie-Stewiacke River system suggests that striped bass spawn annually there. However, the status of the Shubenacadie-Stewiacke population has not been formally assessed.

In the southern Gulf of St. Lawrence, **spawner abundance** on the Northwest Miramichi River declined from an estimated 8000 fish in 1997 to 3400 fish in 1998. Male and female spawner abundance in 1998 were estimated to be 2825 and 575 fish, respectively.

	1993	1994	1995	1996	1997	1998
Population estimates (number of fish)						
Spawners	5500	29 000	50 000	8100	8000	3400
Females	300	2300	18 500	5100	3000	600
% Provisional Conservation Requirement						
	7	46	370	102	50	12
Catch rate index (fish per net per 24 h)						
	3.6	68.7	36.8	8.9	3.5	5.7

Uncertainty exists as to whether the 1998 spawning run was fully censused. Spent fish comprised about 22% of the sampled catch prior to estimation of population size, suggesting that spawner abundance may have been as high as 4150 fish (700 females). This is the second consecutive year that the provisional conservation requirement of 5000 female spawners has not been met.

The 1998 **juvenile abundance** index generated from bycatch sampling of young-of-the-year striped bass in the autumn Miramichi smelt fishery was correspondingly low (<20) relative to years when female spawner abundance exceeded provisional conservation requirements (>250: 1995 and 1996). However, the median pre-winter body size of the 1998 year-class was 13 cm fork length, a value associated with high first winter survivorship in 1991.

Catch rate index (fish per net per 24 h) of young-of-the-year striped bass.

		Confidence interval	
Year	**Median**	**5th**	**95th**
1991	18	15	227
1992	50	0	191
1993	17	2	62
1994	7	2	21
1995	255	132	671
1996	452	159	2964
1997	10	1	59
1998	16	2	109

Catch and mark-recapture data supported the 1997 expectation of a weak 1995 year-class. This was apparently due to high mortality during the second winter, a phenomenon that had not been previously observed. Therefore, previous expectations that rebuilding of the southern Gulf population could commence in 1999 with recruitment of the female component are not likely to be realized. Female spawners are expected to number less than 2500 fish in 1999.

Extirpations of striped bass from Canadian rivers appear to have been a consequence of disruptions and permanent alterations to essential habitat, with overexploitation in directed and non-directed fisheries as a potentially exacerbating factor. Spawning, rearing, and overwintering habitat for the extant Canadian populations remain susceptible to alteration by land- and sea-based human activities.

Striped Bass Aquaculture

Three of the five recognized populations of striped bass in eastern Canada are either extirpated or at non-detectable levels. One of the remaining two populations is well below its designated conservation requirement. These low or depleted stock levels have given rise to considerations of culturing striped bass for stock restoration of extirpated stocks and enhancement of existing populations. Questions are being raised about earlier existence and present status of populations in other rivers (e.g., Hillsborough, Kouchibouguac, Richibucto), and the feasibility of restoring or introducing striped bass to these systems. Also, private interest exists in the culture of striped bass for commercial aquaculture, particularly with the closure of the commercial fisheries for striped bass.

In U.S.A.

The U.S.A. striped bass aquaculture industry for food-fish production is based primarily on hybrids of striped bass and other species of *Morone*, especially the white bass, *M. chrysops*. Annual production in the private sector is approximately 4500 t with an average market-size of 700 g. Greater than 90% of food-fish production is land-based. Open-water net-pen culture is regulated on a state-by-state basis, the general approach being to restrict such practices to fish native to the local river system.

For the last 30 years, private production has relied on obtaining broodstock from wild populations. However, to maximize production and reduce costs, the industry is moving toward broodstock development through domestication and selective breeding with the objectives of improving economic viability and continued growth of the industry. Selective breeding currently utilizes a traditional agricultural progeny-based approach, but efforts also include molecular genetic techniques to select for desirable traits.

U.S.A. programs for stock enhancement and restoration of natural populations also use wild broodstock. In the past, a few hatcheries used wild broodstock held on-site for annual production (i.e., captive broodstock), but the practice was stopped in order to avoid selection of a given “type”. Stock enhancement was started in North Carolina in the 1880s, and major stock enhancement programs were common in most U.S.A. east coast states by the 1970s. Both state and federal hatcheries were used for coastal population enhancement and restoration during the late 1980s and early 1990s. From 1985 to 1992, over 10.5 million juvenile striped bass were released in coastal waters from North Carolina to Maine.

All fish were tagged with micro-coded wire tags for assessing the hatchery contribution to wild production. Stocking criteria were developed in 1989 by the Atlantic States Marine Fisheries Commission (ASMFC) for a coast-wide coordinated stock enhancement and restoration program. Criteria pertained to minimizing disease transmission, maintaining genetic integrity of the wild stocks, and evaluating stock performance. Stocking was implemented as one of several management options and criteria were established for both implementing and terminating stocking.

Stocking “success” has varied greatly, depending on the objectives of the program, and the measurement criteria used by each state. The coast-wide stocking program coordinated by ASMFC from 1985 to 1995 was largely terminated in 1994. Based on

spawning stock biomass models, the Chesapeake Bay population was declared "recovered" by the ASMFC in 1995. Stocking outcomes ranged from restoration of certain extirpated populations to little evidence of positive stocking effect on other (usually larger) populations.

Presently, only state hatcheries continue to produce striped bass, primarily for stocking upper and inland watersheds to enhance the recreational fishery. The stocking of juvenile fish into non-native watersheds has been strongly discouraged by ASMFC criteria. However, some states continue to stock young fish into non-native watersheds, either for restoration programs or because of economic and logistic considerations.

In Canada

Striped bass aquaculture in eastern Canada began in 1988 with experimental programs at the St. Andrews Biological Station, which were continued until 1997. Research and development work began in 1989 at the Huntsman Marine Science Centre, which continues to supply other aquaculture operators with striped bass eggs. The Nova Scotia Agricultural College in Truro and the Miramichi and Cardigan fish hatcheries are also involved in development work, and the Shippagan Marine Centre holds striped bass for public display and for transfer to other facilities. Since the early 1990s, small commercial ventures in striped bass aquaculture have been initiated in southern New Brunswick, mainland and Cape Breton Nova Scotia, and Prince Edward Island. Of these, only three remain active. Products to date have included eggs, larvae, and juveniles, and in one case, market-size fish for human consumption. In addition to Maritime operations, four facilities in Quebec have held striped bass. Two of these keep striped bass for public display, one has recently acquired striped bass for commercial production, and one is a failed commercial venture.

Striped bass used in these facilities have originated from local spawning stocks in the Shubenacadie-Stewiacke River, the Miramichi River, other rivers in the southern Gulf of St. Lawrence (presumed to be of Miramichi origin), and rivers in southwest New Brunswick (including the Saint John River) where striped bass are potentially of Canadian and U.S.A. origins. There has been much interchange of eggs, larvae, juveniles, and adults among these facilities, and material has also left the region for display and commercial operations in Quebec and for research and commercial operations in the U.S.A.

Several aquaculture striped bass operations in the Maritime provinces have failed, and those currently in operation are producing at a small scale. This situation does not necessarily indicate that a major striped bass industry is not economically possible, but instead may reflect the fact that no venture has yet combined sufficient capital investment with appropriate siting, facility design and husbandry expertise.

Perceived prospects for commercial striped bass aquaculture differ geographically within the Maritime provinces. On the Fundy coast of New Brunswick, low summer temperatures preclude marine cage culture of striped bass, although this method might be feasible along the southern Gulf of St. Lawrence coast. The most promising scenarios appear to be recirculation facilities, utilizing waste industrial heat or pond facilities using fresh water or pumped seawater that is allowed to warm by ambient heat.

On Prince Edward Island, striped bass aquaculture is being considered, and a proposal for a working model has been developed for the culture of striped bass in land-based tanks and ponds and in estuarial cages. Prince Edward Island estuaries are unsuitable for traditional salmonid culture due to high summer water temperatures. The proposal links existing hatchery technology, available fish health support, and suitable environmental conditions for adult production. A marketing study has indicated a strong market potential.

In Nova Scotia, interest in expanding striped bass culture has been modest. Two culture operations are currently licensed with the Nova Scotia Department of Fisheries, but one of these is inactive.

Overall, aquaculture in ponds or tanks appears to have the most potential, but net cages with impermeable barriers (bags) may also hold promise in areas where summer conditions are warm. Current perceived constraints are access to broodstock and juveniles and uncertainty as to markets.

Stocking of striped bass for enhancement purposes has never been practiced in Canada except for a brief experiment in the 1980s in the Annapolis River in which eggs were taken from the river, hatched, and the juveniles returned to the river in the same year.

Regulatory Framework

DFO and other federal departments administer acts related to the exploitation, protection and conservation of fish, their habitat, and the transportation and trade of fish and fish products. The *Maritime Provinces Fishery Regulations*, promulgated under the *Fisheries Act*, regulate the exploitation of wild striped bass in the commercial and recreational angling fisheries. The *Aboriginal Communal Fishing License Regulations*, also promulgated under the *Act*, govern the communal allocation of striped bass for food, social, and ceremonial purposes.

The *Fisheries Act* also authorizes the issue of written permissions to obtain fish for the purposes of stocking or artificial breeding or for scientific purposes. The *Fish Health Protection Regulations*, promulgated under the *Fisheries Act*, control the importation of salmonids and salmonid eggs and are designed to limit the spread of disease. The *Fish Health Protection Regulations* do not apply to striped bass, but these regulations are currently under revision and will apply to the importation of all species in the future.

Commercial fishing for striped bass is prohibited in the Maritime provinces. Striped bass incidentally caught in other commercial fisheries cannot be retained, with the following exceptions. A specific license condition authorizes daily retention of a single striped bass of more than 68 cm total length (TL) for personal, non-sale use when taken as by-catch in the gaspereau/shad fishery of the Saint John River and in the weir fisheries of the Minas Basin. Similarly, three striped bass may be retained daily for non-sale use by each license in the gaspereau/shad drift-net fishery on the Shubenacadie-Stewiacke River.

Angling is permitted by provincial sport fishing license in inland waters during defined sport fishing seasons. No license is required to angle in tidal waters, which can be fished year-round, except for a two day closed season maintained for variation order purposes. On the Annapolis River, the angling season is closed from April 1 to June

30 in a defined geographic area to protect the spawning stock of striped bass. In the southern Gulf of St. Lawrence area, all angled striped bass must be released but, in the Scotia-Fundy area, one fish larger than 68 cm TL may be retained daily.

Applications for licenses to collect striped bass for scientific, educational, and aquacultural purposes are reviewed by scientific, fishery management and enforcement staff for compliance with existing regulations and policies. Where necessary, such applications are reviewed by the Introductions and Transfers Committee in each province. The release of any fish into fish habitat or the transfer of any fish to any fish rearing facility is prohibited, except under a licence issued by the federal Minister of Fisheries and Oceans Canada. pursuant to the *Fishery (General) Regulations* (Sections 22 and 54-57). The Ministerial authority to issue such licences has been delegated to regional DFO authorities. Risk of disease transmission and consequence and potential for escape are considered and conditions to minimize risks may be imposed on any license.

A five-year policy in the Scotia-Fundy Sector, implemented in 1995, prohibits removals of wild fish for culture and enhancement purposes, except that small numbers of fish may be approved for scientific research. Canada subscribes to the 1994 International Council for Exploration of the Seas (ICES) Code of Practice, which defines standards and procedures for the introduction and transfer of fish.
No formal consultative process has been developed for striped bass management but development of such a process is being considered.

Potential Interactions Between Cultured and Wild Striped Bass

Proposals for culturing striped bass for enhancement, restoration or commercial aquaculture, need to be assessed for interaction and potential impact on the wild striped bass stocks. Such assessments require consideration of the full range of potential biological and environmental effects.

Ecological Interactions
In the U.S.A., hatchery-reared striped bass stocked into coastal waters interact with, and contribute to, the wild populations of the coastal migratory stocks. The contribution of hatchery-released fish to wild populations is highest when large stocking programs overwhelm wild populations low in numbers, especially in smaller coastal watersheds, but the true ecological impact is unknown. Tagging data from Chesapeake Bay indicate that hatchery fish mirror wild fish in utilizing similar habitats, exhibiting similar growth patterns, and contributing to future generations through participation in spawning with wild fish. However, this is not the case for all stocked populations.

Escapees of cultured striped bass may have a negative ecological impact on wild populations due to size differentials and aggressiveness in feeding behavior of the cultured fish. Cultured striped bass of a given year class are often considerably larger than their wild counterparts due to the optimal husbandry and nutritional conditions under which the cultured fish were reared. The larger of the cultured fish typically are more aggressive in feeding behaviour than the smaller cohorts, and this behaviour may be continued once the fish escape to the natural environment and compete with wild fish. There is no evidence of hatchery fish

having a competitive advantage over wild fish for spawning success.

Disease and Parasite Interactions

In the U.S.A., while disease and parasite problems are fairly well documented under aquaculture conditions, interactions between wild and cultured fish have not been studied but are not considered a significant concern.

Currently, under aquaculture conditions in the U.S.A., striped bass are susceptible to a host of viral, fungal, bacterial, and parasitic diseases and infestations. Similar disease conditions could be expected in Canadian culture situations but these have not been documented. Most common diseases are bacterial and fungal with the bacteria *Aeromonas, Flexobacter, Vibrio,* and *Streptococcus* and the fungi *Saprolegnea* and *Branchiomyces* being the key concerns. The recent occurrence of the bacteria *Mycobacteria* within the Chesapeake Bay and Roanoke system in North Carolina, responsible for "fish-handlers disease" has human health implications. It is currently undergoing evaluation for both aquaculture and human impacts. Parasites of note are the protozoans *Costia* and *Trichodina*. Appearance of these parasites most often is associated with poor water quality and high organic loading. Other common bacterial, viral, and parasitic problems have been noted in striped bass, but are more or less opportunistic and present problems on an infrequent basis.

In almost every case, host loading and clinical expression of diseases are contingent on fish density, overall fish health, and stress. Stress or poor nutrition are almost always the predisposing factors causing clinical expression of infectious diseases. Non-infectious diseases usually are not of major concern to wild stocks in the U.S.A.

The present knowledge of parasites of striped bass in eastern Canada is poor. A total of 10 helminth and crustacean parasites have been reported and there is a potential gross underestimation of parasite abundance and diversity. Only one of these parasites, *Ergasilus labracis* (gill parasite), has been implicated as a problem in an aquaculture situation. Quantification of parasite species composition, geographical and seasonal variations, and age and sex structure in wild populations of striped bass would be beneficial in the evaluation of potential interactions between wild and cultured fish.

Genetics Interactions

Food-fish production of striped bass from captive or domesticated broodstock placed in open systems raises the concern that escaped fish may interbreed with wild stocks. Currently the only published information regarding the interaction or interbreeding between hatchery-produced and wild fish is **interspecific** introgression between hybrid *Morone* and pure striped bass. Given this, there is good reason to believe that **intraspecific** interbreeding would occur as well. The impact of introgression between cultured and wild striped bass and the effects on the population genetics and genetic diversity of wild stocks in the U.S.A. are unknown.

Genetic interactions between wild and escaped striped bass could be mitigated by the use in culture of functionally sterile striped bass.

Management Considerations

In the face of the uncertainty regarding interactions and the current reduced status of wild striped bass stocks in the Maritimes

provinces, a cautious approach is warranted when managing the wild stocks and when considering any proposal to culture striped bass for enhancement, restoration or commercial aquaculture.

Wild Striped Bass Stocks

There are now only two confirmed self-sustaining striped bass populations in eastern Canada, one spawning in the Miramichi River estuary, southern Gulf of St. Lawrence, and the other in the Shubenacadie-Stewiacke River, inner Bay of Fundy.

Southern Gulf of St. Lawrence striped bass are not likely to meet provisional conservation requirements (5000 female spawners) in either 1999 or 2000. Existing spawners require the maximum possible level of protection. Management measures should include deterrence of poaching, closure of directed fisheries (hook-and-release recreational angling and Aboriginal food fisheries), and minimizing mortality from fisheries directed on other species. As well, there needs to be communication among all parties on the need for collaboration in striped bass conservation management.

Neither the conservation requirements nor the current level of abundance of the Shubenacadie-Stewiacke River population is known. The consequences of allowing retention of striped bass captured by recreational angling, as commercial bycatch, or in the Aboriginal food fisheries is currently based on minimal and inadequate information. The exploitation rate on Shubenacadie-Stewiacke striped bass outside the river is not known. A cautious approach to current levels of fishing mortality is warranted.

Enhancement/Restoration

Decisions on enhancement and restoration should be guided by these principles:

- Effects of stocking on wild stocks must be subject to risks/benefit analysis. The criteria for such analyses include genetic effects, ecological effects, and probability of disease transmission. Formal risk/benefit models have yet to be developed (see Research Recommendations). Stocking should be considered only if its most likely effect on wild stocks will be neutral or positive.

- Stocking decisions must consider the status of striped bass in each river. The following categories exist:

  – Rivers with confirmed spawning populations (Miramichi, Shubenacadie-Stewiacke).

  – Rivers in the southern Gulf of St. Lawrence other than the Miramichi; striped bass are probably of Miramichi origin, but small or intermittent local spawning cannot be precluded (Kouchibouguac, Richibucto, Hillsborough, others).

  – Rivers where spawning appears to have ceased, but which might contain remnant numbers from the original spawning population (Saint John, Annapolis).

  – Rivers whose striped bass are migrants (rivers in the Bay of Fundy other than the Saint John, Shubenacadie-Stewiacke and the Annapolis and along the Atlantic coast of Nova Scotia).

- Rivers with extirpated populations (St. Lawrence).

In the event that stocking is to be undertaken, the following guidelines should apply:

- Broodstock, eggs, or young used for stocking or used to produce young for stocking should come from a population which spawns in the area which is to be stocked. If striped bass are not available from that river, broodstock should be taken from the population whose genetic composition is most likely to be suited to that river (normally this will be the stock whose spawning site is geographically closest to the river).

- Broodstock used to produce young for stocking should be taken directly from the wild. After spawning, they should be released at the point of capture.

- Aquaculture programs should be designed to maintain the genetic composition of stocked fish as similar as possible to that of the donor population.

Aquaculture

Development of striped bass aquaculture in the Maritimes provinces should reflect the principle that aquaculture should not put the viability of wild striped bass populations at risk, or reduce the likelihood that striped bass can be successfully restored in rivers from which local breeding populations have been extirpated.

Collections

Removals of eggs, larvae, juveniles or adults for aquaculture should not attain or exceed a level that would significantly decrease production of young in the river (removals for enhancement/restoration should be given similar consideration). Decisions on requests for aquaculture collections must also consider the priority of resource access legally specified by the Sparrow Decision (conservation first; Aboriginal food, social and ceremonial requirements second; other uses third).

Striped bass presently in captivity should receive first consideration for use in aquaculture development. If such fish are not available, or do not meet the criteria given below, or are not suitable for aquaculture development, then wild collections should be considered.

In the long term, it would be expected that the aquaculture industry would develop domesticated broodlines and would not require continued input of new genetic material from external sources. In the interim, wild collections should be organized in a way that maximizes the genetic diversity of developing broodlines while minimizing impact on wild populations.

Wild collections could be of eggs, larvae, juveniles, or broodstock adults. Broodstock

adults should be returned to their place of capture soon after spawning.

Containment

Potential containment systems for striped bass aquaculture, and their risk of escapement, can be categorized as follows:

a) Tank and pond systems with no outlet to open water and with treated effluent systems. Risk of escapement is very low.
b) Tank and pond systems, including net-cages inside ponds, whose outflows drain into open water. Risk of escapement is low.
c) Net-cages in estuaries or bays. Risk of escapement is high.

Containment categories a) and b) should be permitted for general use in striped bass aquaculture. Category c) should be considered only if designs offer a level of security against loss of fish that is equivalent to well-maintained facilities of category b). Detailed engineering analysis and field tests would be required to justify claims that category c) systems meet this requirement.

Siting

Applications for striped bass aquaculture facilities should be reviewed by a siting committee which would consider the scale and nature of the proposed culture program, husbandry procedures, disease control measures, and containment systems in the context of the local habitat. This review would examine risk of escape, risk of ecological, genetic, and disease effects on wild striped bass and on other flora and fauna in the area, and effects on other users in the area. Density of striped bass within the aquaculture facilities, the number of facilities per site, and proximity to other striped bass culture facilities should be considered in the context of disease control and transmission between facilities and other culture operations and between cultured fish and wild fish.

Genetic origin of stocks

If an aquaculture operation can demonstrate a level of containment security that leads to negligible risk of escape of striped bass genetic material and disease organisms, it should be permitted to use striped bass of any genetic origin. Until such time as adequate containment is demonstrated, aquaculture operations should be required to rear fish originating from local stock. For instance, aquaculture facilities in the southern Gulf of St. Lawrence watershed should be permitted to rear fish with a known southern Gulf of St. Lawrence spawning affinity. Similarly, aquaculture facilities in the Bay of Fundy and southwest Nova Scotia watersheds should be permitted to use only broodstock of Shubenacadie-Stewiacke spawning affinity. Elsewhere in the Maritime provinces, broodstock selection should reflect current information regarding the known home range of either of the two extant stocks.

Existing aquaculture facilities that have fish that are not of these affinities should dispose of these fish within two years, unless they can demonstrate a level of containment security that leads to negligible risk of escape.

Registry of Fish Movements

A data-gathering and registry system should be put in place that records all introductions and transfers of striped bass genetic material, including milt, eggs, larvae, juveniles, and adults, within eastern Canada and between eastern Canada and the U.S.A.. The system should record the dates, numbers, life stages, health status, providing facilities, genetic

origins, and destinations of transfers. Transfers between culture facilities and the wild, both intentional (stocking) and accidental (escapes), should be included in the registry.

The registry should record data in permanent archives, in a manner analogous to fishery landing statistics. A balance between confidentiality and public disclosure of information would need to be established.

If data gathering and archiving is conducted by different administrative units or by different levels of government, the system should be set up under common protocols so that inter-provincial transfers, and releases or escapes of fish that might later cross provincial boundaries, can be readily traced.

Research Recommendations

All potential users of the resource (fisheries and culture) have a role to play in the acquisition of the scientific data required to address the present knowledge gaps in wild striped bass ecology in the Maritimes. The current development stage of the culturing initiatives of striped bass in the Maritime provinces provides a special opportunity for collaboration.

Wild Striped Bass

- Resolve status of the populations considered extirpated, i.e. the Saint John and Annapolis rivers;
- Resolve stock structure and constraints on abundance of spawning populations in the southern Gulf of St. Lawrence through combined studies addressing adult abundance, spawning site fidelity and evidence of spawning, in all three Maritime provinces;
- Assess status of the extant Shubenacadie-Stewiacke River population in the Bay of Fundy; and
- Determine the habitat requirements of wild striped bass at all life stages and seasons.

Enhancement / Restoration

- Develop criteria and risk analysis procedures for determining the conditions under which enhancement initiatives would be neutral or beneficial to the conservation of wild striped bass populations;
- Determine life stage best suited for stock enhancement/restoration;
- Review and upgrade knowledge regarding occurrence and transmission of diseases and parasites of striped bass; and
- Research marking techniques which could be used to track interactions of cultured fish and wild fish.

Aquaculture

- Develop criteria and risk analysis procedures for determining the conditions under which aquaculture activities would be neutral or beneficial to the conservation of wild striped bass populations;
- Review and upgrade knowledge regarding occurrence and transmission of diseases and parasites of striped bass;
- Develop and test engineering and design information to improve containment facilities in freshwater and marine environments; and

- Develop broodstock from local populations for selection of optimum growth/survival characteristics.

For more Information:

Contact: Rod Bradford
Diadromous Fish Division
Science Branch
Dept. of Fisheries and Oceans
P.O. Box 550
Halifax, NS
B3J 2S7

Tel: (902) 426-4555
Fax: (902) 426-6814
E-Mail: BradfordR@mar.dfo-mpo.gc.ca

Dave Meerburg
Fisheries Research Branch
Dept. of Fisheries and Oceans
200 Kent Street
Ottawa, Ont.
K1A 0E6

Tel: (613) 990-0286
Fax: (613) 954-0807
E-Mail: Meerburd@dfo-mpo.gc.ca

John Ritter
Diadromous Fish Division
Science Branch
Dept. of Fisheries and Oceans
P.O. Box 550
Halifax, NS
B3J 2S7

Tel: (902) 426-3136
Fax: (902) 426-6814
E-Mail: Ritterja@mar.dfo-mpo.gc.ca

References

Bradford, R.G., D. Cairns, and B. Jessop. 1999. Update on the status of striped bass (*Morone saxatilis*) in eastern Canada in 1998. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/01.

Bradford, R.G., G. Chaput, S. Douglas, and J. Hayward. 1999. Status of striped bass (*Morone saxatilis*) in the Gulf of St. Lawrence in 1998. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/02.

Bradford, R.G. and J. Hutchings. 1999. Genetic interaction between artificially-reared and wild Canadian striped bass (*Morone saxatilis*): risk and uncertainties. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/03.

Cairns, D., K. Robichaud-LeBlanc, R. Bradford, R.H. Peterson, and R. Angus. 1999. Striped bass culture in eastern Canada. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/04.

Harrell, R. 1999. Overview of striped bass aquaculture breeding programs and review of studies conducted on the interaction between aquaculture escapees and wild striped bass in the United States. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/05.

Robinson, M. and S.C. Courtenay. 1999. Genetic investigations on striped bass (*Morone saxatilis*) in the Canadian Maritime provinces. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/06.

Rulifson, R.A. and R.W. Laney. 1999. Striped bass stocking programs in the United States: ecological and resource management issues. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/07.

Stevens, G., D. Dunn, J.B. Jenkins and R.H. Peterson. 1999. Striped bass in the Maritime provinces: the regulatory environment. Department of Fisheries and Oceans Canadian Stock Assessment Secretariat Res. Doc. 99/08.

This report is available from the:

Maritimes Regional Advisory Process
Department of Fisheries and Oceans
P.O. Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2
Phone number: 902-426-7070
e-mail address: myrav@mar.dfo-mpo.gc.ca

Internet address: www.dfo-mpo.gc.ca/csas
ISSN: 1480-4913

La version française est disponible à l'adresse ci-dessus.

Correct citation for this publication

DFO, 1999. Status of Wild Striped Bass and Interaction Between Wild and Cultured Striped Bass in the Maritime Provinces. DFO Science Stock Status Report D3-22(1999).