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American shad (*Alosa sapidissima*) in Atlantic Canada

L'Alose savoureuse (*Alosa sapidissima*) dans l'atlantique Canada

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ABSTRACT

The document summarizes information held by Fisheries and Oceans Canada (DFO) which could be used by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) to assess the status of American shad (*Alosa sapidissima*) in Canadian waters. Shad are exploited in commercial, recreational and First Nations fisheries. The commercial fisheries are local in nature, generally small in individual landings, and of small capitalization which makes landings difficult to track. The marine distribution of shad in eastern Canada extends from the Bay of Fundy to Labrador. Shad were captured exlcusively in the nearshore shallow waters of the southern Gulf of St. Lawrence and the locations of capture are consistent with a migration of shad into the Gulf of St. Lawrence in the spring and migration out of the Gulf in the fall. Shad are frequently represented in the catches from research surveys along the Atlantic coast of Nova Scotia and in the Bay of Fundy. Summer catches are consistent with the well-described occurrence of migrant feeding shad in the Bay of Fundy and Gulf of Maine originating from virtually all rivers along the eastern seaboard. Late fall surveys suggest a 'winter' distribution at depths of between 100 and 200 m along the edges of Georges Bank and the Scotian Shelf and within the basins along the top of the shelf. Shad have been reported from essentially all coastal areas of the Maritimes. Shad have been observed in rivers from the Bay of Fundy to Labrador but occur infrequently in Labrador and insular Newfoundland. In the Gulf of St. Lawrence, shad are most abundant in the Miramichi River in May to mid-July, consistent with a spawning run. Spawning shad occur in the lesser tributaries flowing into the lower Saint John River below Mactaquac Dam. Within Minas Basin shad runs occur on the Shubenacadie/Stewiacke River and the Kennetcook River. There is a large spawning run of shad on the Annapolis River. The fisheries management regime within the Maritime provinces is organized regionally and is therefore consistent with the principle of managing discrete units which are at least if not at a finer scale than the evolutionary significant unit designations which may develop for shad. Run sizes to the major rivers of the Maritimes are expected to be in the order of 100s of thousands of fish. In the Bay of Fundy, there is an appearance of a range contraction owing to the loss of the spawning run to the St. Croix River, upper Saint John River (upstream of Mactaquac) and the Petitcodiac River. Information is available to confirm that there are nine extant spawning runs and the status of 19 other rivers is unknown.

RÉSUMÉ

Le document résume les données du ministère des Pêches et des Océans du Canada (MPO) que le Comité sur la situation des espèces en péril au Canada (COSEPAC) pourrait utiliser afin d'évaluer l'état de l'alose savoureuse (*Alosa sapidissima*) dans les eaux canadiennes. L'alose savoureuse est exploitée dans le cadre de pêches commerciales, récréatives et autochtones. Les pêches commerciales sont de nature locale, leurs débarquements individuels sont généralement petits, et leur capitalisation est faible, ce qui rend difficile le suivi des débarquements. Dans les eaux marines de l'Est du Canada, l'alose savoureuse est présente de la baie de Fundy jusqu'au Labrador. Elle est capturée exclusivement dans les eaux côtières peu profondes du sud du golfe du Saint-Laurent. Les sites de capture concordent avec la migration de cette espèce vers l'intérieur du golfe au printemps et vers l'extérieur à l'automne. L'alose savoureuse est fréquemment prise dans le cadre de relevés de recherche effectués dans les eaux côtières atlantiques de la Nouvelle-Écosse et dans la baie de Fundy. Les prises estivales concordent avec la présence bien documentée d'aloses savoureuses migratrices qui se nourrissent dans la baie de Fundy et dans le golfe du Maine; ces aloses proviennent de pratiquement toutes les rivières de la côte Est. Les relevés effectués à la fin de l'automne portent à croire qu'au cours de l'hiver, l'alose savoureuse se tient à une profondeur de 100 à 200 m le long des limites du banc Georges et de la plate-forme Scotian et dans les bassins situés sur cette plate-forme. L'alose savoureuse a été observée dans pratiquement toutes les zones côtières des Maritimes et dans des rivières de la baie de Fundy jusqu'au Labrador, mais elle est rare à ce dernier endroit et le long des côtes de Terre-Neuve. Dans le golfe du Saint-Laurent, cette espèce est abondante dans la rivière Miramichi de mai jusqu'à la mi-juillet, ce qui concorde avec une remonte de reproducteurs. Les reproducteurs de cette espèce sont également présents dans les petits affluents du cours inférieur de la rivière Saint-Jean, en aval du barrage de Mactaquac. Dans le bassin Minas, des remontes de reproducteurs se produisent dans les rivières Shubenacadie, Stewiacke et Kennetcook. Une forte remonte se produit dans la rivière Annapolis. Le régime de gestion des pêches dans les provinces Maritimes est organisé en composantes régionales et respecte ainsi le principe de gestion d'unités distinctes qui sont au moins à la même échelle, si ce n'est à une échelle plus détaillée, que les unités évolutionnaires significatives, qui pourraient être établies pour l'alose savoureuse. On s'attend à ce que les remontes dans les principales rivières des Maritimes soient de l'ordre de centaines de milliers de poissons. Dans la baie de Fundy, il semble que l'aire de répartition diminue en raison de la disparition des remontes dans la rivière Sainte-Croix, dans le cours supérieur de la rivière Saint Jean (en amont de Mactaquac) et dans la rivière Petitcodiac. Des données confirment qu'il existe neuf remontes de reproducteurs et que l'état de 19 autres est inconnu.

I - INTRODUCTION

Leim (1924) compiled the first review of American shad in the Maritime provinces and attempted to identify the factors which limited shad abundance. A large part of the document focused on factors which affected the survival and growth of eggs and larvae. Included was a summary of the rivers in the Maritimes which were reported to have contained spawning runs of shad. However, he also indicated that the large rivers were invariably the most important.

Following on Leim (1924), we present an updated compilation of American shad (*Alosa sapidissima*) data for the Atlantic provinces (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador) of Canada. This document collates and summarizes the information held by Fisheries and Oceans Canada (DFO) which could be used by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) to assess the status of American shad (*Alosa sapidissima*) in Canadian waters. The information presented is not intended as a complete review of all the biological knowledge of shad in eastern Canada. The mandate for management of American shad in the St. Lawrence River was delegated to the province of Quebec in 1922. American shad have been the subject of much research in the last four decades, and information on American shad from the Annapolis River is more extensive and associated with studies on the impacts of tidal water generating project. Much of this information resides in the "Estuarine Centre" at Acadia University (Wolfville, NS).

The first section of this document deals with information on American shad for Atlantic Canada as it relates to the fisheries, distribution within fresh, coastal, and marine waters and occurrence of spawning runs or evidence of spawning.

The second section deals with addressing the specific terms of reference of the National Assessment Process (NAP) review. The terms of reference were:
Review the population structure in the context of "evolutionarily significant units" (ESU)
By stock and for ESUs identified, summarize overall trends in population size and the degree to which the causes of declines (if any) are understood
By stock and for ESUs identified, summarize current and changes in area of occupancy, or degree of fragmentation
By stock and for ESUs identified, tabulate the best estimates of the number of mature individuals

II - BACKGROUND BIOLOGY

Class	Osteichthyes
Order	Clupeiformes
Family	Clupeidae
Scientific name:	*Alosa sapidissima* (Wilson, 1811)
Common name:	English: American shad
	Français: alose savoureuse (gatte en Acadie)

The general biology of American shad has been reviewed by Scott and Crossman (1973), Scott and Scott (1988) and Weiss-Glanz et al. (1986) and is summarized below.

- Anadromous fish spawning in freshwater, lower portions of rivers in spring, May to July in Maritimes
- Northern extent of spawning distribution is Gulf of St. Lawrence and St. Lawrence River
- Juveniles spend a brief time in freshwater before migrating downstream to brackish waters (especially so in northern populations)
- Age at maturity varying from 3 to 6 years of age, earlier for males than females
- Latitudinal gradient in fecundity (negative association) and proportion of runs which are repeat spawners (positive association) (Leggett and Carscadden 1978)

- Shad are iteroparous in northern rivers, with previous spawners representing greater than 50% of the spawning runs (depending on exploitation rates in the fisheries)
- Fecundities of maiden shad in the order of 100 to 175 thousand eggs in northern populations (Leggett and Carscadden 1978; Melvin et al. 1985)
- Maximum size of shad in Maritime populations at over 60 cm fork length
- Shad leave the Gulf of St. Lawrence and overwinter on the Scotian Shelf and south
- Migration ranges for shad at sea extend from Labrador to Florida (Dadswell et al. 1987)
- Shad from different river populations are mixed to varying degrees while at sea (Dadswell et al. 1987)
- High spawning site fidelity (Melvin et al. 1986)

III - MATERIALS AND METHODS

Fisheries related data

Commercial landings are compiled by individual landings report for communities and generally summarized by DFO Fisheries Statistical District (Fig. III-1).

In Maritimes Region (DFO operational region encompassing the watersheds draining into the Bay of Fundy and the Atlantic coast of Nova Scotia to the north east tip of Cape Breton Island), logbook reports are mandatory for both commercial gaspereau fishers (which can retain shad under condition of licence) and commercial shad fishers (which operate under a specific commercial shad licence). There is about 50% or more return rate with years of higher compliance attributable to increased visits by enforcement officers to remind fishers that completion of logbooks is mandatory.

There are some voluntary logbook reports from the gaspereau fisheries in Miramichi River and a few other smaller rivers in Gulf Region (DFO operational region encompassing the portion of the southern Gulf of St. Lawrence for which the rivers of the Maritime provinces empty into the Gulf). Fishermen were asked to record the number of shad landed daily during the gaspereau fishery. There was generally less than 50% return rate of logbooks from the Miramichi and not all fishermen who returned logbooks indicated the amount of shad bycatch.

The logbook reports from both regions provide an indication of the quantity of shad which could potentially have been landed in a given year and a measure of the reliability of the commercial landings compiled by DFO.

Research and monitoring data

Counting facilities are operated in a large number of rivers in Atlantic Canada and shad observed at these facilities are enumerated and in some cases sampled for biological characteristics. Most of these facilities have been described in a number of reports (for example: Moores and Ash 1984, Claytor 1996, Hayward 2001).

Opportunistic but regular sampling of shad at research facilities has occurred on the Miramichi River. Sampling included measurements of fork length, external determination of sex, and scale samples. Shad catches in DFO research trapnets on the Shubenacadie River, Nova Scotia are recorded for each day of operation. However, the traps are located in an area of significant shad spawning activity with the result that trap re-entry of released fish is believed to be high. The numbers are therefore not considered to be a reliable indicator of run timing and strength in their raw form, and are not reported here. Ripe and running males and females were sampled from those trapnet catches.

Other rivers in the Maritimes where sampling for biological characteristics has occurred include the Saint John River (Bay of Fundy NB) and the Annapolis River (Bay of Fundy NS). DFO does not sample these rivers with regularity but data for these rivers are available in publications and specifically for the Annapolis River can be found at Acadia University Estuarine Research Centre (Wolfville, NS).

IV - MANAGEMENT OF THE SHAD FISHERIES

Fisheries for shad in Maritime provinces are managed under the *Fisheries Act* under regulations described in the Fishery (General) Regulations and the Maritime Provinces Fishery Regulations. These regulations define the conditions under which shad can be fished including closed times, closed areas, and gear restrictions. The Fishery (General) Regulations also define the process for variation orders and conditions of license which can be used to further manage the fisheries.

Shad are exploited in commercial, recreational and First Nations fisheries.

Commercial Fisheries

In the Maritime provinces, shad are fished in directed fisheries prosecuted by fishermen who hold commercial shad licenses and as bycatch in gaspereau fisheries (Table IV-1). Commercial shad fisheries are local in nature, generally small in individual landings, and of small capitalization which makes landings difficult to track.

There are only 10 commercial shad licenses in the southern Gulf of St. Lawrence, all issued for gillnets (Table IV-1). In the Bay of Fundy, there were 156 commercial licenses issued in 2002, 152 for gillnets and four gear not-specified (Table IV-1). In the Atlantic coast of Nova Scotia districts, a total of 9 gillnet and 6 dipnet licenses were issued in 2002 (Table IV-1). The number of licenses has essentially remained unchanged over the last six years (Table IV-1).

The gear, seasons and weekly close time restrictions for the directed commercial fishery by location in the Maritime provinces are described in the Maritime Provinces Fishery Regulations (Scehdule VIII) and are summarized in Table IV-2.

In the southern Gulf of St. Lawrence, fisheries for shad can be prosecuted using gillnets, trapnets and dipnets during a relatively short season in May and June for New Brunswick and Prince Edward Island but extending into July for Nova Scotia. The commercial fishery in the southern Gulf is however limited to ten commercial license holders, all in the Gulf New Brunswick portion. This directed commercial fishery is restricted to fixed gill nets of maximum length 100.6 m (55 fa) in the waters of Northumberland Strait adjacent to Kent County (statistical districts 75, 76, and 77; Fig. III-1) (Table IV-1) and since they are situated in New Brunswick would only be allowed to fish between May 15 and June 20 (Table IV-2).

Seasons and gears are more varied in the Bay of Fundy portion of the Maritimes (Table IV-2). Fisheries for shad can be prosecuted using set and drift gillnets, dipnets, square nets, and trapnets. The earliest season opening of April 1 occurs in the tidal waters of the Shubenacadie/Stewiacke system and the remaining locations open May 1. Seasons close either in mid- to late-June, end of July, mid-August or end of September with the latest closure in Cumberland Basin (inner Bay of Fundy bordering New Brunswick and Nova Scotia) (Table IV-2). All these fisheries have a designated weekly close time equivalent to about a two-day tie-up per week.

For the Atlantic coast of Nova Scotia, the season extends from May 1 to July 30 with a two-day per week mandatory tie-up (Table IV-2).

Shad may also be caught and retained as bycatch in licensed commercial gaspereau fisheries (aritime Provinces Fishery Regulations). Gaspereau fisheries are prosecuted using gillnets, estuarine trapnets and tiptraps within river (in combination with dipnets). Gaspereau fisheries have season and weekly close time restrictions which vary by location (Maritime Provinces Fishery Regulations Schedule V).

In Prince Edward Island, the gaspereau season extends from May 1 to June 30. For Gulf New Brunswick, the inland waters season extends from January 1 to June 30 but the tidal water season extends from May 15 to June 30. These seasons can vary within individual tributaries and local preference (DFO 2001).

In Nova Scotia (both Gulf and Maritimes Region) the gaspereau seasons open March 15 and generally closes the end of June to July 10. In the Bay of Fundy, gaspereau fishery seasons extend from January 1 to June 30.

In the gaspereau fishery, there is a large amount of gear which could catch shad. For example, in the New Brunswick portion of the Gulf Region, there were 132 gaspereau fishery licenses with licensed gear equivalents of 328 trapnets and 600 fa of gillnet in 2000 (DFO 2001). The total number of licenses declined from 179 in 1987 to 132 licenses in 2000 (DFO 2001). There are similarly large numbers of gaspereau licenses and licensed gears in the Bay of Fundy and Atlantic coast of Nova Scotia.

Recreational Fisheries

Regulations for the recreational fisheries in tidal and inland waters are described in the Maritime Provinces Fishery Regulations. A bag limit of five shad per day is in effect for the inland and tidal waters of the Maritime provinces (Maritime Provinces Fishery Regulations, Section 73.1). Recreational fishing for shad is not widespread in the Maritimes but of generally moderate to high participation where these fisheries occur. Effort is generally concentrated within specific areas of only a few rivers, most notably the Southwest Miramichi River (Gulf of St. Lawrence), Annapolis River, and Shubenacadie/Stewiacke rivers (Bay of Fundy). In 2002, a total of 52 recreational gillnet licences were issued, the majority within the tidal water districts of the Saint John River (Table IV-1). The number of recreational gillnet licenses has decreased slightly over the last six years. There are no statistics on the number of people angling for shad or the number of shad captured in either the angling or recreational gillnet fisheries.

First Nations Fisheries

Licenses issued to several First Nations in the Maritime provinces for Food, Social and Ceremonial Purposes include an allowance for the capture and harvest of shad. The allowances are generally based on community needs or requests for shad. Harvest statistics for shad in these fisheries are not available.

Fisheries Landings

Landings in commercial fisheries are recorded by the Dept. of Fisheries and Oceans. Data are recorded in three forms (Chaput and LeBlanc 1991). Purchase slips are recorded by the buyer of the product and include the fisherman's name (and license number), the place of landing and the date of purchase. The second form is called a "Supplementary B" (coded 9000) which is submitted by protection staff and are monthly estimates of catch which was consumed locally, i.e. not sold to buyers. The quantity of "Supplementary B" slips has varied among statistical districts and species fished and has declined in the recent decade as protection staff spend less time collating these statistics (Chaput and LeBlanc 1991). The final form has been called "Supplementary A" (coded 9999) forms which are slips completed by buyers outside the statistical district of the fishery which gives the total catch purchased by species and the date and

location of the purchase. In the last few years, self-declaration slips (coded 9997) have been received directly from the fishers which gives the total catch sold by the individual to an unspecified buyer.

Logbook reports have been mandatory in the commercial fisheries of the Bay of Fundy and Atlantic coast of Nova Scotia since 1993. The data from logbooks are more reliable than other sources but are still considered incomplete.

For American shad, the reliability of the commercial fisheries data varies with the region. In the southern Gulf of St. Lawrence, historical data are considered to be more reliable than that of recent years. In the first half of the 20th century, there was a larger number of participants in the fisheries and there was a larger enforcement contingent to record the fisheries landings. In the last decade, the data quality has diminished and the reported landings are minimal and in some cases represent but a minor portion of the actual harvests. For example, with less than half the gaspereau fishermen from the Miramichi returning logbooks in the best years, the estimated weight of the shad captured as bycatch has been two to three times the value recorded in the purchase slips (Table IV-3). In some years, there were no recorded landings of shad but shad catches were recorded in the harvests. All bycatch of shad in the gaspereau fishery of the Miramichi are landed with a large number of these sold directly at the wharf or consumed locally (G. Chaput, DFO pers. comm.).

The landings of shad for Canada and the southern of Gulf of St. Lawrence for 1917 to 2001 are summarized in Figure IV-1. Detailed landings by statistical district and year for 1984 to 2001 are summarized in Table IV-4 for Gulf New Brunswick, in Table IV-5 for Gulf Nova Scotia, and in Table IV-6 for Gulf PEI. Landings for the Bay of Fundy are summarized in Table IV-7 and for the Atlantic coast of Nova Scotia in Table IV-8.

Fisheries landings for shad for the years 1871 to 1921 are shown in Leim (1924) for eight regions of eastern Canada.

Gulf of St. Lawrence

For Gulf Region, landings for 1917 to 1983 are summarized by LeBlanc and Chaput (1991). Landings of American shad peaked in the mid 1950s and have declined to low (less than 50 t annually) but constant levels since 1970 (Fig. IV-1). The area around Miramichi River in the southern Gulf of St. Lawrence accounted for more than 75% of the landings from the southern Gulf prior to the 1960s and continues to account for more than 50% (Fig. IV-2; Chaput 1995). Catches of gaspereau in the southern Gulf and particularly Miramichi also increased dramatically and peaked in the mid-1950s to be followed by a rapid decline and steady to slightly increased catches since the 1970s (Chaput 1995). Landings of American shad from PEI and Gulf Nova Scotia are low and sporadic (Table IV-5, IV-6).

Bay of Fundy / Atlantic Coast of Nova Scotia

Dadswell (1986) summarized the landings of American shad from Cumberland and Minas basins of the Bay of Fundy and for the Saint John River fisheries of the Bay of Fundy for 1870 to 1978. Peak landings of 100 to 200 t per year were reported at the turn of the century in Cumberland and Minas Basins whereas the Saint John River fisheries had a peak landing of 450 t in the 1950s (Dadswell 1986). Landings of shad in the commerical fisheries of the Bay of Fundy remain more important than those of the southern Gulf of St. Lawrence and the Atlantic coast of Nova Scotia (Fig. IV-3). In the Bay of Fundy, landings of shad include migrant fish from U.S.A. rivers.

Recent landings have been below historic levels, fluctuating between 32 t and 110 t in the last decade but in 1988, 358 t were reported landed from the Bay of Fundy (Fig. IV-3). The greatest proportion of the landings are recorded from districts 48 and 49 bordering the Saint John River and upper Cumberland Basin (district 81) on the New Brunswick shore and from districts 42 and

43, the Minas Basin portion of the Bay of Fundy (Table IV-7). The landings from the Atlantic coast of Nova Scotia are low and sporadic with the majority reported from the offshore (non-tidal water) fisheries (Fig. IV-3; Table IV-8).

Fishing Effort

There is no information on the effort expended in the commercial shad fishery of the southern Gulf of St. Lawrence. There are only 10 commercial licenses issued in the southern Gulf with a total of 525 fathoms of potential gear effort (Table IV-1).

Fishing effort for gaspereau in the Miramichi River districts (71 and 72) declined from over 200 licenses in 1950 to 36 licenses in 1965 (Figure IV-4) (Alexander and Vromans 1988). For the Miramichi River districts, the decline in landings during 1950 to 2000 parallels the reductions in trapnet licenses for gaspereau (Fig. IV-4).

There is some effort information from logbook reports within the Maritimes Region but not all licensed fishermen submit logbooks and there has not been any verification of the reported effort.

V - AREA OF OCCUPANCY

Shad spend the majority of their life at sea and utilize the freshwater habitat for the purpose of spawning. In the rivers of the Maritime Provinces, it is common for post-larvae and young juvenile shad to occupy both freshwater and brackish water environments. Juveniles eventually descend to the estuary and sea before the end of their first season of growth. There are instances when shad can be found in tidal waters of rivers outside the spawning season.

Marine Distribution

The marine distribution of shad has been described by Neves and Depres (1979), Leggett (1973). Dadswell et al. (1987) provide a summary of seasonal marine migration patterns of American shad.

The marine distribution of shad in eastern Canada extends from the Bay of Fundy to Labrador. There are few observations of shad catches in marine fisheries off Newfoundland (Appendix I - NFLD observer reports). No information was obtained on catches of shad in the DFO research surveys in the Newfoundland Region.

Gulf of St. Lawrence

Shad have been infrequently captured in the September groundfish survey of the southern Gulf (Appendix II; Appendix Fig. II-1, 2). Over the last 30 years of survey, shad were observed at 23 of the more than 3000 trawl/stations sampled, totalling 89 fish (Appendix Table II-1). In 14 of the 23 sets, only one individual was captured. The largest single catch was 30 fish. Shad were captured exlcusively in the nearshore shallow waters of the southern Gulf (Appendix Fig. II-2). Shad sampled ranged in size between 7 and 71 cm fork length (Appendix Table II-2).

Shad have been captured in May, July, September, October and December in the southern Gulf (Appendix Table II-1, 3, 4). The locations of capture are consistent with a migration of shad into the Gulf of St. Lawrence in the spring and migration out of the Gulf in the fall.

In an October 2002 survey of the western portion of the Northumberland Strait region of the Gulf of St. Lawrence, juvenile shad were captured in 54 of 99 bottom trawl sets (Appendix Table II-4). A total of 850 shad were captured with the highest single trawl catch of 125 individuals.

Fishery observer reports of American shad captured in the Gulf of St. Lawrence indicate that shad occur occasionally as a bycatch in the southern Gulf of St. Lawrence from May to December (Appendix Table II-5). The majority of the bycatch occurred in gill nets. The geographic distribution of the catches is also consistent with a migration into the Gulf in the spring followed by an eastward and outward migration from the Gulf of St. Lawrence in the fall.

Bay of Fundy / Atlantic Coast of Nova Scotia

Shad are frequently represented in the catches from research surveys along the Atlantic coast of Nova Scotia and in the Bay of Fundy. Summer catches are consistent with the well-described occurrence of migrant feeding shad originating from virtually all rivers along the eastern seaboard into the Bay of Fundy and Gulf of Maine (Fig. V-1). Winter surveys indicate that shad are distributed at depths of between 100 and 200 m along the edges of Georges Bank and the Scotian Shelf and within the basins along the top of the shelf (Fig. V-2, V-3). The 1999 observer data is typical for the years 1997-2001 and suggests a January to March distribution along the shelf slope, rather than the Shelf as has been the interpretation of the winter range based solely on research vessel survey data (Fig. V-4).

Coastal Distributions

The best indication of nearshore and estuarine occurrence of shad is the commercial fisheries data.

Gulf of St. Lawrence

Based on the commercial fisheries landings, shad have been reported from essentially all coastal areas of the Maritimes with the exception of the eastern shore of Cape Breton Island and some districts in PEI (Fig. V-5). In the southern Gulf of St. Lawrence, shad are captured in coastal or estuarine waters primairly in spring and summer with limited catches in late fall (Table V-1). There are few to no fisheries which could capture shad in late summer and fall because of closed seasons, gear restrictions (Table IV-2).

Bay of Fundy / Atlantic coast of Nova Scotia

Catches from this area are concentrated in the Bay of Fundy with the largest catches from the inner portions (Chignecto Bay which includes both Shepody Bay and Cumberland Basin; and Minas Basin and approaches which includes Scots Bay, Minas Basin, Southern Bight, and Cobequid Bay). The inner portions of the Bay of Fundy are the traditional locations for fishing shad in shallow coastal water principally with gillnets and low head weirs as has been the case for more than a century and a half (Perley 1852). The large fishery for migrant feeding shad exists because of the combination of high water turbidity and therefore high light attenuation down the water column and the preference exhibited by shad for low light. Hence, shad are available to capture with shallow water fishing gear because of the fish's close proximity to the sea surface (Dadswell et al. 1983). Tagging information and analysis of the morphometric and meristic characters of the fish captured there indicate that the summer-autumn fishery is a mixed-stock fishery, with virtually every shad population on the eastern seaboard of North America contributing to the catch in rough proportion to their individual population abundances.

River fisheries for spawning shad from April-June occur on the Shubenacadie/Stewiacke and lesser rivers flowing into the Southern Bight of Minas Basin, and at one time on the Petitcodiac River which flows to Shepody Bay. The commercial fishery for spawning shad on the Petitcodiac does not appear to have been large apparently owing to the fact that the commercial fishers of the area regarded these fish to be of inferior quality to those that would arrive in early summer and remain available to capture through to mid-autumn (Perley 1852). This also appears to be

the reason why river fisheries for spawning shad did not become established to any great extent on the Tantramar, River Hebert, and Maccan and Nappan rivers, all flowing to Cumberland Basin.

Important fisheries for shad also occur in the Saint John River (NB) and along the coast on either side of the Saint John River estuary (Fig. V-5; Table IV-7, V-2).

Shad are generally exploited in May to July in most areas of the Bay of Fundy and Atlantic coast of Nova Scotia although some landings of shad were reported from February to November consistent with fishing activities in the coastal waters and the presence of shad on the Scotian Shelf during the fall and winter (see Marine Distribution Section) (Table V-2).

Freshwater Distribution

Shad have been observed in rivers from the Bay of Fundy to Labrador (Fig. V-6; Table V-3). Shad occur infrequently in Labrador and insular Newfoundland (Fig. V-6; Table V-3, V-4) (Dempson et al. 1983). American shad at fresh water facilities in Newfoundland and Labrador have been observed from May to August (Table V-5). Most of the facilities in Newfoundland do not operate after August but it is unlikely that shad would have been present yet missed based on the timing of occurrence of shad in the Newfoundland and Maritime rivers.

Gulf of St. Lawrence

In the Gulf of St. Lawrence, shad are abundant in the Miramichi River and have been observed at the counting facilities of the major rivers of the southern Gulf, the Restigouche River (NB) and the Margaree River (Cape Breton, NS) (Table V-3, V-6).

Shad are most abundant in the Miramichi River in May to mid-July, consistent with a spawning run into that river (Fig. V-7). A few shad have been observed in September (Claytor 1996). Similarly, shad in the Margaree River were observed in June and July with no observations after July (trapnets were operating in those years to late October) (Table V-7). In Chaleur Bay (NB), shad were observed at a coastal trapnet near the mouth of the Restigouche River from May into September with peak periods of occurrence in June, July and August (Fig. V-8). This occurrence of shad is consistent with spawning runs to the Restigouche although no sampling for biological characteristics was conducted to confirm the presence of mature adults. Infrequent observations of shad in the other rivers of the Gulf occurred in July.

Bay of Fundy

A large in-river fishery was once reported to have existed on the St. Croix River (Perley 1852) but the stock has been extirpated for several decades as a result of inadequate fish passage.

Leim (1924) indicated that shad historically ascended the Saint John River up to Grand Falls (320 km from the mouth of the river) but that the bulk of the catch was taken in the lower 200 km of river. In the Saint John River system, shad were observed at the Tobique Narrows fishway, over 180 km above the head of tide prior to the construction of the downstream dams (Smith 1979). Annual counts of shad at the Beechwood Dam facility, located 153 km above the head of tide ranged from 0 to 1,490 fish between 1957 and 1971 and shad were infrequently observed at Beechwood Dam after the construction of the Mactaquac Dam (2 km above the head of tide) (Table V-8). Counts of shad at Mactaquac obtained between 1969 (when the fish trapping facilities became operational) to 2002 were highest in the first three years (between 36,400 and 39,000 fish) and declined to less than 500 fish by 1976 (Table V-8). The continued transport of shad above Mactaquac dam became an issue when it was found that the handling procedures resulted in high mortalities of fish when released (Smith 1979). Shad transport above Mactaquac is presently incidental to the transport and release of gaspereau above the dam and counts at the

fish trapping facilities at Mactaquac are not a reliable indicator of abundance of shad in that portion of the Saint John River.

Spawning shad still run to the lesser tributaries flowing into the lower Saint John River below Mactaquac, including the Grand Lake, Washademoak Lake, and the Kennebecasis (including the Hammond) River systems (Fig. V-9). Analysis of meristic characters (Carscadden and Leggett, 1975a,b) has indicated that these are discrete spawning runs.

Leim (1924) indicated spawning shad were observed in May and June in the Petitcodiac and that this river probably represented the principal spawning ground for Shepody Bay and perhaps Cumberland Basin. Shad were sampled moving upstream and downstream through a counting fence on the Petitcodiac River in 1942 (Wilder 1942a). The first upstream movements were observed in early May and sampling of downstream migrating shad indicated both male and female shad in post-spawning condition (Wilder 1942c). Because of difficulties in keeping shad alive in the holding trap and the effects of warm water, parts of the fence were removed to allow shad to pass unobstructed (Wilder 1942a,c). Shad abundance in the Petitcodiac that year was in the thousands based on 1,100 fish counted going downstream and reports of more than 2,500 shad which were collected and disposed of following mortality in the river associated with warm water temperatures (Wilder 1942b). After construction of the causeway in 1968, shad appear to have been unable to pass through the fishway. Between 1983 and 1997, only 4 shad (all in 1983) were counted at the fishway (DFO Unpubl. data).

The River Hebert was also mentioned by Leim (1924) as an important spawning river for shad with the possibility that shad may also spawn in the LaPlanche, Nappan and Maccan rivers of Cumberland Basin. Beyond the report by Leim (1924), there are no historic or current data to confirm the historic existence and the continued presence of spawning runs in these rivers. A flood control structure in the tidal channel of the Tantramar River impedes fish passage.

Within Minas Basin shad runs occur on the Shubenacadie/Stewiacke (Leim 1924) and the Kennetcook rivers (Table V-3; Fig. V-6). The Shubenacadie/Stewiacke River (FSD 42, 43; Fig. III-1) supports a large April-June shad fishery (Table IV-8). Shad were a regular component of the daily catch in a research trapnet operated during May for striped bass assessments at Enfield on the Shubenacadie River during 1999-2002 (DFO, unpublished data). Shad were also intercepted during most of the days that a counting fence operated on the Stewiacke River and a partial count of shad totalling about 15,000 fish was tallied between May 20 and June 30, 1993 (DFO Unpubl. data).

Commercial fishing above the head of tide on the Kennetcook River was prohibited by regulations in the early 1900's as a way of protecting spawning shad and Atlantic salmon (Prince 1912). Therefore the continued occurrence of this population is known to DFO only through local knowledge and reports of fish in the river from credible sources. Spawning fish (that are presumably) running to the Kennetcook are exploited in an April to June gillnet (set and drift) fishery in the tide way that is shared with the Avon River and lesser streams. Leim (1924) suggested that shad spawned, but in low numbers, in the Kennetcook, Avon and St. Croix rivers. Prince (1912) provides details of the collapse and eventual elimination from catch-failure of a shad gillnet fishery within the tidal portions of the Cornwallis River. The present status of these presumed runs is unknown.

There is a large spawning run of shad on the Annapolis River (Fig. V-6) (Dadswell et al. 1983; Melvin and Dadswell 1984; Melvin et al. 1986). As was the case with the Kennetcook, the Annapolis River was closed to commercial fishing in the early 1900's in order to protect spawners (Prince 1912).

Atlantic Coast Nova Scotia

Shad have also been observed in rivers along the Atlantic coast of Nova Scotia, primarily the LaHave River (Fig. V-6) where they are intercepted as a bycatch in the dipnet fishery for gaspereau (FSD 27; Table V-2). Shad have been infrequently (approximately 30 fish over past ten years) observed at the Morgan Falls fish counting facility on the LaHave River, about 25 km above the head of tide.

Rivers for which local knowledge of shad runs exist but for which the DFO does not possess corroborative information include Mira (FSD 7 - Cape Breton), St. Mary's (FSD 17), and Musquodoboit (FSD 20) rivers. Inspection of April-June landings (Table V-2) and as reported in logbooks indicates that shad runs may occur on the Annis River (FSD 34; Fig. III-1) and Porter's Lake (FSD 20; Fig. III-1). These will require further investigation. Note that Leim (1924) indicated that shad ascended the Tusket River (FSD 33) for the purposes of spawning but in small numbers. No shad were observed ascending the fishways on the Tusket during May to June in recent years (15 minute counts every half hour during daylight hours with 60, 53, 20, and 46 days of observation for the years 1996, 1997, 1999, 2001 respectively) Further along the Atlantic coast, Leim (op. cit.) indicated that the absence of large accessible rivers precluded the presence of large runs of shad but based on small but more or less persisent catches, shad may spawn in a few of those rivers including the Liverpool (Mersey) and Medway rivers (FSD 25) and the Mira Lakes in Cape Breton.

VI - EVIDENCE OF EXTANT SPAWNING RUNS

Spawning runs of shad are identified on the basis of the presence of ripe and running fish, both males and females, from the presence of eggs/larvae or juveniles, and from anectodal reports of mature fish (Table V-3). The presence of shad in an estuary is not assumed to indicate a spawning run nor is the absence of eggs or larvae in ichthyoplankton surveys intended to infer the absence of spawning in that river. Where shad spawning does occur, eggs and larvae were recovered in the fresh water portions of the river with few in the lower and estuarine sections of the river (Williams and Daborn 1984) therefore ichtyoplankton surveys conducted in estuarine portions of the rivers may not be indicators of spawning activity. Anecdotal reports from fishermen of mature adults in their catches at the appropriate season for shad spawning may be indicative of spawning runs into those rivers but this information is less reliable than the other indicators. The data presented below include observations from DFO monitoring programs or evidence from literature.

Newfoundland and Labrador

There is no evidence of spawning runs of shad in Newfoundland and Labrador (Table V-3). Dempson et al. (1983) suggest that the shad observed in Newfoundland and Labrador are likely strays and not fish from self-sustaining runs.

Southern Gulf of St. Lawrence

In the southern Gulf of St. Lawrence, spawning runs of shad have only been confirmed in the Northwest and Southwest Miramichi rivers.

In the southern Gulf of St. Lawrence, ripe and running male and female American shad have been sampled at tidal trapnets in both the Northwest Miramichi and Southwest Miramichi rivers (Table V-3). These mature spawners had modal lengths of 40 cm for males and 45 cm for females (Fig. VI-1). The size range of mature males in the Miramichi was 27.0 to 55.5 cm fork length whereas the size range of mature females was 36.0 to 58.5 cm fork length (Fig. VI-1). The youngest spawning male was three years old and the oldest male was 11 years old having first

spawned at age 5 years. The youngest female spawner was 4 years of age and the oldest spawner was 10 years old having first spawned at 5 years. Age at first maturity observed in the Miramichi shad runs ranged between 3 and 5 years for males, 4 and 6 years for females (DFO Unpubl. data). Proportionally, more males have been observed than females and the males are present in the river for a longer period of time than females (Fig. VI-2).

Shad are abundant and readily captured in First Nations fisheries near the head of tide in the Northwest Miramichi but do not appear to migrate far upstream. No shad were reported at the Curventon counting fence in the Northwest Miramichi located 13 km above the head of tide (Table V-3). Few post-spawning shad were captured in the Little Southwest Miramichi at the rotary screw trap facility located 29 km above the head of tide and operated early May to mid June although shad are observed in the pools in that location (P. Hardie, DFO pers. comm.). The spawning location in the Northwest Miramichi is not known. In the Southwest Miramichi, shad congregate and behaviour consistent with spawning has been observed at upper Blackville (S. Douglas, DFO pers. comm.), about 50 km above the head of tide (altitude 30 m above sea level). No shad eggs or larvae were recovered in the Miramichi during an ichthyoplankton survey in 1992 but a personal communication referenced in the document indicates shad larvae were present in the Northwest Miramichi in June 1992 (Locke and Courtenay 1995). This survey was concentrated in the upper and middle estuary and large numbers of gaspereau (*Alosa* sp.) larvae were collected (Locke and Courtenay 1995).

No American shad eggs or larvae were identified in the ichthyoplankton samples collected in 1996 to 1998 from the Kouchibouguac River and Richibucto River (New Brunswick) but larvae of *Alosa* sp. were captured and identified as being larvae of gaspereau rather than shad (Bernier et al. 1998; Robinson et al. 1998, 2001).

No shad eggs or larvae were identified from icthyoplankton samples collected between May and August 1983 from two estuaries of Prince Edward Island (Johnston and Morse 1988). Larvae of blueback herring (*Alosa aestivalis*) were identified in large numbers from these estuaries indicating that the season and sampling locations would have been appropriate for capturing shad eggs or larvae if they had been present.

American shad opportunistically sampled from the estuarine trapnet in the Margaree River were of the appropriate size range to be spawners (Fig. VI-3). One ripe male but no ripe females were observed at the trapnet.

Bay of Fundy

It is assumed that shad spawned in the St. Croix River (Perley 1852) but the run declined precipitously over the years and is not believed to presently exist because of manmade barriers to upstream fish passage (Fig. VI-4).

Prior to the construction of the hydroelectric dams at Beechwood and Mactaquac on the Saint John River, shad ascended beyond the dams and were present in June and could have represented spawning runs in that upper portion of the river (Fig. VI-5). Shad transport above Mactaquac is presently incidental to the transport and release of gaspereau above the dam. Shad runs to Mactaquac are consistent in timing to what would be expected for spawning runs (Table V-8).

There are spawning runs of shad to the lesser tributaries flowing into the lower Saint John River below Mactaquac, including the Grand Lake, Washamadoak Lake, and the Kennebecasis (including the Hammond) River systems (Table V-3; Fig. V-9, VI-4). Analysis of meristic characters (Carscadden and Legget, 1975) has indicated that these are discrete spawning runs.

Wilder (1942a, c) reported several thousand shad in the Petitcodiac River, and considered these to be a spawning run based on the presence of post-spawned males and females. Few or no

shad have been reported ascending through the fishway at the causeway in the last years when monitoring occurred and the shad run in this river is considered to have been eliminated, caused by the lack of suitable fish passage facilities (Fig. VI-4). Recent evidence for shad spawners in on the Tantramar, River Hebert, and Maccan and Nappan rivers, all flowing to Cumberland Basin are based on scientific collections which occurred in river during the anticipated spawning period (Bradford and Dadswell 1983) (Fig. VI-4).

Within Minas Basin shad runs occur on the Shubenacadie/Stewiacke and the Kennetcook rivers (Fig. VI-4). Egg surveys (DFO, unpublished data) on the Shubenacadie/Stewiacke rivers indicated that spawning occurred on the main Shubenacadie below Enfield, the Nine Mile River that joins the Shubenacadie at Elmsdale, and on the main Stewiacke River several kilometres upstream from the head of tide (Fig. VI-6). These are all areas of low stream gradient. In recent years shad have run into Shubenacadie River to Grand Lake (Fig. VI-6; DFO unpublished data). It is not known where spawning occurs above Enfield or if this activity contributes to recruitment. The continued occurrence of spawning shad in the Kennetcook River is known to DFO only through local knowledge and reports of fish in the river from credible sources (Fig. VI-4).. Spawning fish (that are presumably) running to the Kennetcook are exploited in the April to June set and drift gillnet fisheries in the tideway that is shared with the Avon River and lesser streams. Prince (1912) provides details of the collapse and eventual elimination from catch-failure of a shad gillnet fishery within the tidal portions of the Cornwallis River (Fig. VI-4). The present status of this run has not been determined.

There is a large spawning run of shad on the Annapolis River as evidenced by the large number of adult shad in the river and the presence of eggs and larvae (Fig. VI-4; Dadswell et al. 1983; Melvin et al. 1985). As was the case with the Kennetcook this river was closed to commercial fishing in the early 1900's in order to protect spawners (Prince 1912).

Atlantic Coast Nova Scotia

Shad have also been observed in rivers along the Atlantic coast of Nova Scotia, primarily the LaHave River (Fig. VI-4) where they are intercepted as a bycatch in the dipnet fishery for gaspereau. It is suspected that shad spawn in the LaHave River but there is no supporting evidence based on egg or larval sampling nor from directed assessment programs on this river.

Rivers for which local information of shad spawning occurs but for which the DFO does not possess corroborative information include Mira (Cape Breton), St. Mary's, Musquodoboit, Annis rivers and Porter's Lake (Fig. VI-4). There is no confirmation however that any of these rivers have ever or continue to have self-sustaining (complete life cycle over several generations) runs of American shad.

VII - ADDRESSING THE SPECIFIC TERMS OF REFERENCE

VII-1 Review the population structure in the context of "evolutionarily significant units"

Smedbol et al. (2002) provide a detailed review of the considerations for defining ESUs for marine fishes. The arguments will not be repeated here. However, the conclusions of these authors that the management units used were at finer spatial scales than what might be anticipated as ESUs for cod is relevant for the discussion of shad population structure.

Life history differences among shad populations have been suggested as indicative of population structuring within eastern North America and perhaps within spawning rivers that share a common estuary (Carscadden and Leggett 1975a,b). Repeat spawners are generally absent in shad runs south of 36˚N and a high proportion of repeat spawning occurs in rivers north of 40˚ latitude (Leggett and Carscadden 1978). A number of studies of American shad have found

significant differences in meristic and morphometric characteristics among shad sampled from rivers on the eastern seaboard of North America (Carscadden and Leggett 1975a and references within Dadswell et al. 1987). Based on tag returns and migrations, Dadswell et al. (1987) suggested that there were three regional groups of shad: a northern group consisting of the Bay of Fundy and the Gulf of St. Lawrence, a mid-Atlantic group from Cape Hatteras to Cape Cod and a southern group (south of Cape Hatteras). Shad tagged in the Minas Basin of the Bay of Fundy in summer were subsequently recaptured in all areas of the eastern seaboard of North America (Melvin 1984; Dadswell et al. 1987). Some of these fish were recaptured in Newfoundland and Labrador, in the Gulf of St. Lawrence and into the St. Lawrence River, from June to December (Dadswell et al. 1987). The extent of the recaptures suggests that shad from the entire Atlantic coast may spend part of their life in the Bay of Fundy area.

Bentzen et al. (1989) conducted a study of mitochondrial DNA polymorphism in American shad sampled from spawning runs in 14 rivers from Florida to the Miramichi in the Gulf of St. Lawrence and the St. Lawrence River. They concluded that the shad in their sampled rivers represented genetically distinct assemblages but there was no evidence of a phylogenetic split between northern and southern shad (i.e. genotypes were commonly distributed over the entire geographic range). The results of Bentzen et al. (1989) suggest that there was sufficient isolation among the shad runs of these rivers for genetic differences to have become established.

The latitudinal gradient in proportion repeat spawners and fecundity suggests a grouping of southern and northern shad runs. Within the Canadian shad runs, the observed genetic differences in mitochondrial DNA would suggest a grouping into the St. Lawrence River, Miramichi River, and Bay of Fundy. The fisheries management regime within the Maritime provinces is organized regionally such that shad from the Gulf of St. Lawrence are managed as a unit while shad from the Bay of Fundy and Atlantic coast of Nova Scotia are managed as a separate unit. Even within the Bay of Fundy area, fisheries are managed in accordance to local characteristics of the shad runs. The present treatment of shad in the Maritimes is therefore consistent with the principle of managing discrete units and it is likely that the management units are at least if not at a finer scale than the ESU definitions which may develop for shad. The present structure for the management of fisheries for spawning shad could accommodate further divisions should genetic and life-history data indicate more than one ESU occurs within a particular region, as for example Bay of Fundy versus Atlantic Nova Scotia.

VII-2 By stock and for ESUs identified above summarize overall trends in population size

Shad spend the majority of their life at sea and utilize the freshwater habitat for the purpose of spawning. In the shad rivers of the Maritime Provinces it is common for post-larvae and young juveniles to occupy both freshwater and brackish water environments. Juveniles eventually descend to the estuary and sea before the end of their first season of growth. There are instances when shad can be found in tidal waters of rivers outside the spawning season, especially in the Saint John River of the Bay of Fundy (Gabriel et al. 1976) and via tidal advection into the Shubenacadie estuary. Male shad in the Maritime provinces mature at ages 3 to 6 years while female shad mature at ages 4 to 6 years. Estimates of total numbers of shad in the population are therefore not available since fish observed in the rivers are only the mature component of the populations.

Estimates of the size of spawning runs of American shad are limited to a few rivers in Atlantic Canada. With the exception of counts at monitoring facilities, there are no estimates of total run size of spawners into the rivers. Where counts at facilities are considered complete, they may represent only part of the run because of their location in the river.

Estimates of run size based on counting facilities

There are no rivers in the southern Gulf of St. Lawrence with complete counts of runs of shad.

Runs of shad enumerated at the Mactaquac Dam in the first three years of operation averaged just over 37,000 fish (Table V-8) although the size of the shad run in the Saint John River was considered to be much larger (Jessop 1975). Prior to the construction of the Mactaquac Dam, shad ascended beyond the Beechwood dam but numbered less than 1,500 animals annually. Very few shad are presently observed at the fish trapping facility at Mactaquac, generally less than 1,000 animals per year since 1974 (Table V-8).

A counting fence operating on the Stewiacke River in 1993 provides another measure of the minimum size of the shad run at no less than 10,000 animals (DFO Unpubl. data). Estimates of the shad run on the Annapolis River prior to operation of the tidal power facility were on the order of 100 thousand animals (Melvin et al. 1985).

Estimates of run size based on catches

Fisheries catches provide an indication of the relative size of runs. Jessop (1975) indicated that the fisheries catches in the Saint John River in 1953 amounted to about 238 thousand fish (at an assumed average weight of 1.92 kg per fish). At a similar assumed weight through the history of the fisheries, then the number of shad captured in Canada at the peak of the fishery (1955) would have amounted to over one half million fish (Fig. IV-1). Landings in the last three decades have been much lower but would put the catches of shad in the fisheries as high as 200 thousand fish in the Bay of Fundy (in 1988) and as high as 30,000 fish in the southern Gulf of St. Lawrence. The number of shad in the runs is much higher because the landings are incomplete and considered to be minimum, and the fisheries do not remove 100% of the runs. A component of the shad catches in the Bay of Fundy and Atlantic coast of Nova Scotia would be shad of U.S.A. origin.

Chaput (1995) assumed catch rates for shad at the Millbank trapnet in the Miramichi River (Gulf of St. Lawrence) to be about 1.3% (between those for gaspereau at 0.2% and salmon at 1.5% to 3%). This results in annual run size estimates to the Miramichi of close to 100 thousand fish (Table V-6). Partial reported landings of shad from the gaspereau fishery have been as high as 21,000 fish annually with less than one-third of potential gear reporting catches (Table IV-3). These indicate that the spawning run of shad to the Miramichi is in the order of 100 thousand or more animals.

Trends in population size

No analysis of trends of abundance were conducted on the fisheries landings data. The data are considered incomplete and changes in effort over time preclude the use of these data to infer trends in abundance. For example, the number of licenses in the Miramichi River gaspereau fishery has declined from over 200 in the early 1950s to just over 35 licenses since the mid 1960s (Fig. IV-4). There is a strong positive association between the reported landings of shad from the Miramichi and the number of gaspereau licenses for that area (Fig. IV-4).

A catch rate analysis was conducted on the catches of shad at the index estuary trapnets in the Miramichi: Millbank (main stem of the Miramichi), SW Enclosure (lower portion of the Southwest Miramichi) and SW Millerton (upper portion of Southwest Miramichi estuary) (Table V-6; Fig. VII-1). Counts of shad at the index trapnets show important annual variations among individual trapnets and rivers (Fig. VII-1; Table V-6). An analysis of trends in the annual counts indicated that the Millbank trapnet captured more shad than either of the Southwest Miramichi trapnets but only a minimal amount of the annual variation (7%) in counts could be explained by a trend over time or a trapnet location. The trend over time (1970 to 2001) was positive and significant ($P < 0.01$).

Conclusion

Run sizes to the major rivers of the Maritimes (Miramichi, Saint John, Shubenacadie/Stewiacke, Annapolis) are expected to be in the order of 100s of thousands of fish.

There is insufficient information to draw conclusions on the trends in abundance of American shad in Atlantic Canada. Fisheries landings have declined over the past 5 decades but some of the decline can be attributed to reduced effort. Where indices of abundance are available, there is no significant temporal trend in the indices.

VII-2a Where declines have occurred over the past three generations, summarize the degree to which the causes of the declines are understood, and the evidence that the declines are a result of natural variability, habitat loss, fishing, or other human activity

There are three rivers in the Maritimes, all in the Bay of Fundy, where declines in abundance of shad have been observed. In the Petitcodiac River, the construction of the causeway at Moncton/Riverivew (NB) has prevented the migration of shad into the river. In 1942, Wilder (1942a,c) reported several thousand shad in the Petitcodiac River, considered to be a spawning run. Few or no shad have been reported ascending through the fishway at the causeway in the last years when monitoring occurred and the shad run in this river is considered to have been eliminated, caused by the lack of suitable fish passage facilities.

On the Saint John River, shad ascended above the Mactaquac Dam prior to its construction. After construction, attempts were made to transport and release shad above the dam but with limited success and the practice has been discontinued although some shad are undoubtedly released into the headpond within the gaspereau transportation activities (R. Jones, pers. comm.). Jessop (1975) attributed the decline in shad at Mactaquac to the construction of the dam, the stress associated with upstream transportation of spawning adults, downstream fish passage constraints, and modified spawning habitat due to headpond construction.

A substantive fishery for shad on the St. Croix River, an international waterway lying between the State of Maine and the Province of New Brunswick, was described by Perley (1852). This run declined precipitously over the years following his report because of manmade barriers to upstream fish passage.

A large portion of the southern Uplands of Nova Scotia has been impacted by acid precipitation (DFO 2000). This has resulted in significant declines in Atlantic salmon populations. Although American shad are known to be more tolerant of river acidification than salmonids (Klauda, 1994) the impact of acid depositions on American shad production in Nova Scotia rivers has not been studied but it is likely to have degraded the spawning habitat of shad in this area.

There is no evidence of fisheries induced declines in American shad in Atlantic Canada. Fisheries for shad are regulated by season and gear restrictions and there are no new entrants into the fishery. Some of the fisheries for shad, such as in the Saint John River at the harbour, are constrained by bycatch considerations for Atlantic salmon.

VII-2b Where declines have occurred over the past three generations, summarize the evidence that the declines have ceased, are reversible, and likely time scales for reversibility.

Specifically for Petitcodiac, and the Saint John River (upstream of Mactaquac), there have few to no shad for years and this status is not expected to change under present conditions. The major impediment to shad in these rivers is fish passage, both upstream and downstream.

The prospects for re-colonization of the St. Croix are presently poor owing to the practice by State of Maine authorities of blocking fishways to gaspereau (and presumably shad) at Woodland and Grand Falls.

VII-3 By stock and for ESUs identified above summarize current area of occupancy

Leim (1924) indicated that there were five important regions for shad in eastern Canada: Saint John, Chignecto Bay, Minas Basin, Miramichi and St. Lawrence River, all located within proximity to large rivers.

The present knowledge of shad ecology is greatly enhanced relative to the information available in 1924. The extensive migrations of shad along the eastern seaboard and the mixed stock origin of shad in the Bay of Fundy were unknown to Leim (1924) who indicated that it was probable that shad did not leave the Bay of Fundy or the Gulf of St. Lawrence but remained within those bodies of water year round.

Shad undertake migrations similar to gaspereau to overwinter outside the Gulf of St. Lawrence, because marine surface waters in the Gulf are generally below freezing for several months. Shad overwinter on the Scotian Shelf, the edge of Georges Bank lying within the Bay of Fundy-Gulf of Maine, and apparently along the Shelf Slope (this manuscript). Marine distributions are also sparse in the northern areas and limited to the open water periods (late spring to fall) (Dempson et al. 1983; this document).

In freshwater, American shad have been observed from the most southern rivers of the Maritimes to a few rivers in Labrador (Table V-3; Fig. V-6). At most facilities in Newfoundland and Labrador, shad are rare occurences and are not observed annually in rivers, suggesting that these do not represent sustained spawning runs or even spawners in those rivers.

The Miramichi River is the only confirmed river within the southern Gulf of St. Lawrence that supports shad spawning. The presence of numbers of shad in the Chaleur Bay region and in the Margaree River do not preclude that spawning may also occur in those locations but run sizes would be small relative to the Miramichi. There is no reason to believe this has changed from historical conditions.

Shad are found throughout the Bay of Fundy in numerous rivers and within the Bay itself. Spawning shad runs are known from three rivers and suspected in another six rivers. Spawning runs have been eliminated from the St. Croix and the Petitcodiac rivers.

Along the Atlantic coast of Nova Scotia, shad runs are suspected in at least four rivers. There is no data to indicate American shad have been extirpated from any of the Canadian rivers flowing directly into the Atlantic Ocean.

VII-3a Summarize changes in area of occupancy over as long a time as possible, and in particular, over the past three generations

In the Bay of Fundy, there is an appearance of a range contraction owing to the loss of the spawning run to the St. Croix River, New Brunswick. However, and when taken in the context of the known occurrence of extant spawning runs to rivers draining into the U.S.A. portions of the Gulf of Maine, and along the eastern seaboard to the south, the loss is of greater importance in terms of loss of local production than in a biogeographic context. In combination with the loss of the upper Saint John River run (upstream of Mactaquac) and that to the Petitcodiac the net loss due to land-based human activities is three spawning runs which existed historically. Information

is available to confirm that nine spawning runs are still sustained (Table VII-1) and the status of of 18 other rivers is unknown (Table VII-1).

Shad have been and continue to be observed throughout Atlantic Canada and the lack of dedicated assessment programs for shad preclude any description of short to medium term changes in occupancy.

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Table IV-1. Commercial and recreational fishery licenses, gears, restrictions by DFO Fishery Statistical District (FSD) within the Gulf and Maritimes Region of Atlantic Canada. FSDs are shown in Figure III-1.

Commercial licenses – southern Gulf of St. Lawrence					
Gear	**County**	**Statistical district**	**Number of licenses**	**Number of gear**	**Gear restrictions**
Fixed gill net	Kent	75, 76, 77	9	9	Max. 55 fathom
Fixed gill net	Kent	75, 76, 77	1	1	Max 30 fathom

Commercial licenses							
District	**Gear**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Atlantic coast of Nova Scotia							
17	Gillnet	1	1	1			
20	Gillnet	1	1	1	1	1	1
21	Gillnet				5	6	6
26	Dipnet	2	2	2	2	2	2
27	Dipnet	5	4	3	3	3	3
31	Dipnet			1	1	1	1
32	Gillnet	1	1	1	1	1	1
33	Gillnet				1	1	1
Bay of Fundy – Nova Scotia							
40	Gillnet	1	1	1	1	1	1
41	Gillnet	1	1	1	1	1	1
42	Gillnet	21	21	20	21	21	22
	Not-specified	1	1	1	1	1	1
43	Gillnet	26	26	27	26	26	25
44	Gillnet	5	5	5	5	5	5
24	Gillnet	8	8	8	8	8	8
Bay of Fundy – New Brunswick							
81	Gillnet	20	19	19	19	18	18
	Not-specified	1	1	1	1	1	1
79	Gillnet	1	1	1	1	1	1
57	Gillnet	6	5	5	5	5	5
56	Gillnet	13	13	13	13	13	13
55	Gillnet	11	11	10	10	9	9
48	Gillnet	39	39	40	39	40	39
	Not specified	2	2	2	2	2	2
49	Gillnet	9	9	8	4	4	5
53	Gillnet			1	1	1	1
50	Gillnet	1	1	1	1	1	1

Recreational licenses							
District	**Gear**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Bay of Fundy – New Brunswick							
48	Gillnet	2	2	2	1	1	1
55	Gillnet	1	1	1	1	1	1
56	Gillnet	13	13	13	13	13	13
57	Gillnet	37	34	34	34	34	34
58	Gillnet	3	3	3	3	3	3

Table IV-2. Summary of American shad commerical fishery gear, season and weekly close time restrictions in the Maritime Provinces, as summarized from the Maritime Provinces Fishery Regulations, Schedule VIII.

Location	Gear	Season open	Weekly close time
Nova Scotia			
Tidal waters of Shubenecadie/Stewiacke system	Drift gillnet	April 1 to June 15	08:00 Friday to 08:00 following Sunday
Cumberland Basin	Dipnet, gillnet (set and drift), trapnet	May 1 to Sept. 30	08:00 Saturday to 08:00 following Monday
Tidal waters of Kings County	Dipnet, gillnet (set and drift), trapnet	May 1 to July 30	08:00 Saturday to 08:00 following Monday
Remaining tidal waters of Nova Scotia (including Gulf of St. Lawrence)	Dipnet, gillnet (set and drift), trapnet	May 1 to July 30	08:00 Friday to 08:00 following Sunday
Inland waters of Annapolis River	Dipnet	May 1 to May 31	24:00 Tuesday to 06:00 following Monday
Inland waters of Kings County (except Annapolis River)	Square net	March 15 to May 31	21:30 Friday to 05:30 following Monday
New Brunswick			
Inland waters of the Saint John River	Dipnet	May 2 to June 25	09:00 Saturday to 09:00 following Monday
Tidal waters of the Saint John River above Reversing Falls	Dipnet, gillnet (excluding drift), trapnet	May 1 to June 20	12:00 Friday to 08:00 following Sunday
Tidal waters of the Saint John River, below Reversing Falls	Dipnet, gillnet (set and drift), trapnet	May 1 to June 20	12:00 Friday to 08:00 following Sunday
Waters of Shepody Bay	Dipnet, gillnet (set and drift), trapnet	May 1 to Aug. 15	12:00 Friday to 08:00 following Sunday
Waters of Cumberland Basin	Dipnet, gillnet (set and drift), trapnet	May 1 to Sept. 30	08:00 Saturday to 08:00 following Monday
Remaining tidal waters of New Brunswick that borders on the Bay of Fundy	Dipnet, gillnet (set and drift), trapnet	May 1 to Aug. 15	12:00 Friday to 08:00 following Sunday
Tidal waters of New Brunswick that borders on the Gulf of St. Lawrence and Northumberland Strait	Gillnet (set and drift)	May 15 to June 20	12:00 Friday to 08:00 following Sunday
Inland waters of the Southwest Miramichi River	Dipnet	May 2 to June 25	09:00 Saturday to 09:00 following Monday
Remaining Inland waters of New Brunswick	None	Closed	
Prince Edward Island			
Tidal waters of Prince Edward Island	Gillnet (set), trapnet	May 15 to June 30	08:00 Saturday to 08:00 following Monday
Inland waters of Prince Edward Island	None	Closed	

Table IV-3. Comparison of logbook reported catches of American shad from the gaspereau fishery of the Miramichi River and the reported landings as recorded in the DFO database for the corresponding area, 1981 to 1994.

American shad landed by individual license holders in the Miramichi gaspereau fishery										
		Number of shad reported in logbooks				Total catch reported for the season		Effort (trapnets)		Purchase slip estimates (t)
	Logbook	Location						Logbooks	Potential	
Year	report	Napan River	Loggieville	Chatham	Newcastle	Number	Weight (t)[1]	reporting shad	effort	FSD 70-73
1981	1	3	33	331	70					
	2		649	1,166	180					
	3		2,494	5,915	202					
	4				247					
	5				275					
	6				275					
	7				357					
	8				393					
	9				429					
						13,019	13	23 of 23	36	15.3
1982	1	.	360	.	72					
	2	3	435	.	87					
	3	8	682	55	108					
	4			128	137					
	5			205	212					
	6			381	288					
	7			683	298					
	8			1219	433					
						5,794	6	25 of 28	36	12.5
1983	1		65	45	26					
	2		67	79	176					
	3		376	134	222					
	4		754	172	257					
	5		1132	833	364					
	6				488					
	7				573					
						5,763	6	25 of 25	36	12.8
1984	1	.	69	57						
	2	.	132	108						
	3		249	148						
	4		329	239						
	5		412	698						
	6		911							
						3,352	3	13 of 15	36	2.1
1985	1	.	137	88	238					
	2		766	151	301					
	3		1347	228	353					
	4			256	614					
	5				759					
	6				980					
	7				1473					
	8				1771					
						9,462	9	20 of 21	36	8.0
1986	1	.	1895	483	105					
	2		2673	498	1497					
	3		4640	588	1931					
	4			975						
						15,285	15	11 of 12	36	7.2
1987	1		.	86	770					
	2		1458	737	969					
	3			3270	1520					
	4				5193					
						14,003	14	12 of 13	36	14.1
1988	1	.	1031	1035	1878					
	2		2235	1726	2143					
	3		4793		6339					
						21,180	21	8 of 10	36	7.0
1989	1	.	.	.	.					
	2	.	4,747	.	.					
	3			586	136					
	4			1,597	7,839					
						14,905	15	7 of 19	36	3.7
1991	1	.	.	.	.					
	2	2	196	.	312					
	3	28	1,500	.	830					
						2,868	3	8 of 20	36	0.0
1992	1	.	.	.	10					
	2		407	179	592					
	3		3007							
						4,195	4	7 of 12	36	22.1
1994	1	16	.	406	.					
	2		211	548	538					
	3		1667	802	1654					
	4			1168	3535					
						10,545	11	14 of 19	36	0.0

[1] - Conversion of number of shad to weight based on an average weight of 1 kg per fish

Table IV-4. Landings (t) of American shad by FSD for the Gulf New Brunswick portion of the Maritime Provinces, 1984 to 2001. Data for 1917 to 1983 are available in LeBlanc and Chaput (1991). Data for 1984 to 2001 are from the database of Statistics and Economics Branch, Gulf Region, Fisheries and Oceans Canada.

	Fishery Statistical District (FSD)														
Year	63	65	66	67	68	70	71	72	73	75	76	77	78	80	Total
1984	0.0	0.9			0.0		0.9		1.2	2.0	0.7				5.7
1985		0.4					7.9		0.0			0.1			8.5
1986		1.7					7.0		0.1	0.2					9.1
1987		1.0					13.9		0.2	1.8		0.4	15.1	3.7	36.1
1988		6.4					6.9		0.1	0.5	1.1	0.9			15.9
1989		0.3					3.1		0.6	1.8	9.6				15.4
1990		0.6	0.9		0.0		13.6		0.3	1.4					16.7
1991		0.1								1.3	0.2				1.6
1992		0.3					22.0			1.4					23.8
1993		0.0								0.6	0.1				0.8
1994		0.1	0.2							0.3	0.0				0.5
1995		0.1					19.1			2.5					21.7
1996		0.0													0.0
1997		0.0					0.4		0.0						0.4
1998									0.0						0.0
1999		0.0					3.8		0.3						4.1
2000		0.0					1.4								1.4
2001							18.9				0.0		0.0		18.9

Table IV-5. Landings (t) of American shad by FSD for the Gulf Nova Scotia portion of the Maritime Provinces, 1984 to 2001. Data for 1917 to 1983 are available in LeBlanc and Chaput (1991). Data for 1984 to 2001 are from the database of Statistics and Economics Branch, Gulf Region, Fisheries and Oceans Canada.

	Fishery Statistical District (FSD)								
Year	2	3	10	11	12	13	45	46	Total
1984	1.2								1.2
1985									
1986									
1987									
1988	0.4								0.4
1989	0.2								0.2
1990									
1991									
1992									
1993									
1994									
1995									
1996									
1997									
1998	0.0								0.0
1999									
2000									
2001									

Table IV-6. Landings (t) of American shad by FSD for Prince Edward Island (Gulf Region of the Maritime Provinces), 1984 to 2001. Data for 1917 to 1983 are available in LeBlanc and Chaput (1991). Data for 1984 to 2001 are from the database of Statistics and Economics Branch, Gulf Region, Fisheries and Oceans Canada.

	Fishery Statistical District (FSD)					
Year	82	92	93	95	88	Total
1984						
1985		0.1				0.1
1986						
1987	1.7					1.7
1988						
1989	0.5					0.5
1990						
1991	34.4	6.1				40.5
1992	16.3	0.8				17.1
1993	0.0	0.0				0.0
1994	0.2	0.1				0.3
1995	0.0					0.0
1996						
1997						
1998						
1999						
2000					0.0	0.0
2001						

Table IV-7. Landings (t) of American shad by FSD for the Bay of Fundy portion of New Brunswick, 1984 to 2000. Data for 1984 to 2000 are from the database of Statistics and Economics Branch, Maritimes Region, Fisheries and Oceans Canada. Inshore refers to landings from rivers and estuaries. Offshore refers to landings from coastal or marine fisheries.

	New Brunswick - Bay of Fundy										
				District							
	Total	Total		57	56	55	49	48	79	81	
Year	Inshore	Offshore	Total	Inshore	Inshore	Inshore	Inshore	Inshore	Inshore	Inshore	
1984	24		24		2	6	7	1		8	
1985	78		78		5	1	4			68	
1986	99		99		7	40	11	16		25	
1987	52		52	1		3	14	2		32	
1988	298		298			1	116	2		179	
1989	147		147				69	31		47	
1990	74		74			6	32	34		2	
1991	51		51	1	3	6	7	32	1	1	
1992	35		35		4	6	4	20		1	
1993	17		17		8	4			1	4	
1994	33		33		5	3	1	13		11	
1995	19		19		4	2		11	1	1	
1996	19		19		4	3		9		3	
1997	37		37		3	2		19		13	
1998	17		17		3	4		3		7	
1999	10		10		1	2		2		5	
2000	19		19		5	8		4		2	

	Nova Scotia - Bay of Fundy										
				District							
	Total	Total		24	44	43	42	41	40	35	37
Year	Inshore	Offshore	Total	Inshore	Inshore	Inshore	Inshore	Inshore	Inshore	Inshore	Offshore
1984	.		.								
1985	17		17	9		8					
1986	15		15	2		11				2	
1987	16		16			16					
1988	60		60			37	23				
1989	49		49			27	22				
1990	86		86			50	34		2		
1991	19		19			10	7		2		
1992	31		31			22	8	1			
1993	42		42	6		13	19	4			
1994	25	1	26	1		14	10				1
1995	71		71			62	9				
1996	91		91	1	30	41	19				
1997	67		67	2	15	44	6				
1998	22		22	1		12	9				
1999	22		22	2		11	9				
2000	30		30		1	20	9				

Table IV-8. Landings (t) of American shad by FSD from the Atlantic coast of Nova Scotia (FSDs 1 to 36 in Maritimes Region of DFO), 1984 to 2000. are from the database of Statistics and Economics Branch, Maritimes Region, Fisheries and Oceans Canada. Inshore refers to landings from rivers and estuaries. Offshore refers to landings from coastal or marine fisheries.

	Nova Scotia - Atlantic Coast										
				District							
	Total	Total		34	32	27	26	20	18	17	
Year	Inshore	Offshore	Total	Inshore	Inshore	Inshore	Inshore	Inshore	Inshore	Inshore	
1984	.	.	.								
1985	.	.	.								
1986	1	0	1			1					
1987	1	0	1						1		
1988	1	1	2						1		
1989	.	.	.								
1990	0	16	16								
1991	0	18	18								
1992	4	6	10			3	1				
1993	0	1	1								
1994	5	0	5							5	
1995	0	3	3								
1996	2	1	3		2						
1997	1	7	8		1						
1998	0	1	1								
1999	3	1	4	1				2			
2000	0	0	0								

	Nova Scotia - Atlantic Coast															
				Districts												
	Total	Total		34	33	32	31	28	27	26	25	22	21	19	17	
Year	Inshore	Offshore	Total	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	Offshore	
1984	.	.	.													
1985	.	.	.													
1986	1	0	1													
1987	1	0	1													
1988	1	1	2													1
1989	.	.	.													
1990	0	16	16				2	8	1	2	3					
1991	0	18	18		1					2	2		13			
1992	4	6	10	1				2			2			1		
1993	0	1	1				1									
1994	5	0	5													
1995	0	3	3			2					1					
1996	2	1	3			1										
1997	1	7	8	1		5	1									
1998	0	1	1		1											
1999	3	1	4									1				
2000	0	3	3	3												

Table V-1. Landings (t) of American shad as recorded in the Economics and Statistics Branch database by geographic area and season for the Gulf Region, 1984 to 2001. A value of 0.0 indicates less than 50 kg of landings were reported.

Zone	Year	April to June	July to September	October to December	Total
Northeast NB	1984	0.0	0.9	0.0	0.9
FSDs 63-68	1985	0.0	0.4		0.4
	1986	0.0	1.7	0.0	1.7
	1987	0.0	0.9	0.1	1.0
	1988	0.0	5.9	0.4	6.4
	1989	0.0	0.3		0.3
	1990	0.0	1.0	0.5	1.5
	1991	0.0	0.1		0.1
	1992		0.1	0.2	0.3
	1993		0.0		0.0
	1994	0.2	0.1		0.2
	1995		0.1		0.1
	1996		0.0		0.0
	1997		0.0		0.0
	1999		0.0		0.0
	2000		0.0		0.0
Miramichi	1984	1.4	0.7		2.1
FSDs 70-73	1985	8.0	0.0		8.0
	1986	7.0	0.1		7.2
	1987	14.1	0.0		14.2
	1988	6.9	0.1		7.0
	1989	3.1	0.6		3.7
	1990	13.8			13.8
	1992	22.0			22.0
	1995	19.1			19.1
	1997	0.4	0.0		0.4
	1998		0.0		0.0
	1999	4.1			4.1
	2000	0.7	0.7		1.4
	2001	18.7	0.2		18.9
Southeast NB	1984	2.4	0.3		2.7
FSDs 75-80	1985	0.1			0.1
	1986	0.2	0.0		0.2
	1987	0.9	20.0		20.9
	1988	0.5	2.0		2.5
	1989	11.4			11.4
	1990	1.4			1.4
	1991	1.5			1.5
	1992	1.4			1.4
	1993	0.8			0.8
	1994	0.3	0.0		0.3
	1995	2.5			2.5
	2001	0.0			0.0
PEI	1985	0.0	0.0		0.1
All FSDs	1987		1.7		1.7
	1989		0.5		0.5
	1991		39.7	0.8	40.5
	1992	0.0	17.1	0.1	17.1
	1993		0.0		0.0
	1994		0.3	0.0	0.3
	1995		0.0		0.0
	2000	0.0			0.0
Gulf NS	1984		0.2	1.0	1.2
All FSDs	1988	0.0		0.3	0.4
	1989			0.2	0.2
	1998			0.0	0.0

Table V-2. Timing of the coastal and river fisheries on American shad from the Bay of Fundy and Atlantic coast of Nova Scotia as inferred from logbook reports. Landings (t) in the table are the values for the returned logbooks, are totals for the years 1995 to 2001, and do not represent the entire landings for the districts.

	Month									
District	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov
	Bay of Fundy									
	Saint John River - Bay of Fundy									
56				2.1	1.0					
55		0.1	0.0	75.6	20.8	0.9				
	Chignecto Bay - Bay of Fundy									
79				6.4	9.6	6.1	2.8	2.4		
24					1.0	0.2	0.3	0.9		
	Minas Basin									
42		0.5	42.1	119.3	14.6	14.3	3.0	1.4		1.5
40					0.1	0.2	0.0			
	Atlantic Coast of Nova Scotia									
36			0.0	0.0						
34				1.0						
31	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
27		0.0	0.1	1.2	1.5	0.6	0.3	0.3		
20				0.7	0.8					
7				0.4						

Table V-3. Rivers and estuaries (Fig. V-6) with facilities for monitoring American shad and those facilities where American shad have been observed and reference for observations. N means not recorded from this facility, Rare means generally less than 20 individuals seen on average, annually, Y means common or very abundant at this facility. ? means unconfirmed. For environment: FW means freshwater, TidalFW means freshwater within tidal influence, TidalEst means brackish water within tidal influence, Est means estuary, Coastal means outside an estuary.
[1] facility not operating during spring and summer

River Name	Gear	Present [A]	Spawning [B]	Gaspereau Present [C]	Environment	Dates shad present	Reference
Gulf New Brunswick							
Chaleur Bay (Dalhousie)	Trapnet	Y	?	Y	Coastal	May to September	A, C – DFO Unpubl. data
Restigouche	Trapnet	Rare	?	Y	TidalFW	June 26 – July 3	A, C - Claytor 1996
Nepisiguit	Counting fence	N			FW		
Tabusintac	Trapnet	? [1]	?	Y	TidalFW		A, C - Claytor 1996
Napan	**Trapnet**	**Y**	?	Y	TidalEst	May-June	Commercial logbook
Southwest Miramichi	Trapnet	Y	Y	Y	TidalEst		A, C - Claytor 1996; Hayward 2001
Bartholomew	Fence	N		Y	FW		A, C - Claytor 1996
Northwest Miramichi	Trapnet Ichthyoplankton	Y	Y	Y	TidalEst	May-July	A, C - Claytor 1996; Hayward 2001 B – Locke and Courtenay 1995
Northwest Miramichi	Fence	N		Y	FW		A, C – Curventon DFO Unpubl. Data
Little SW Miramichi	Rotary screw trap	Rare	?	Y	FW	June	A, C - DFO Unpubl. Data
Catamaran Brook	Fence	N		Rare	FW		A, C - Hardie et al. 1998
Black	Fence	N		Y	TidalFW		A, C - Delaney et al. 1993
Kouchibouguac	Ichthyoplankton	?	N				B – Bernier et al. 1998; Robinson et al. 1998, 2001
Richibucto	Trapnet, Ichthyoplankton	? [1]	N	Y	TidalEst		A, C - Claytor 1996; B – Robinson et al. 2001
Buctouche	Trapnet	? [1]	?	Y	TidalEst		A, C - Claytor 1996

Table V-3 (continued).

River Name	Gear	Present [A]	Spawning [B]	Gaspereau Present [C]	Environment)	Dates shad present	Reference
Gulf Nova Scotia							
South	Fence	N		Y	FW		A, C - Claytor 1996
Margaree	Trapnet	Rare	?	Y	TidalFW	June – Aug., Oct.	A, C – Claytor 1996
Southwest Margaree	Traps	Rare?	?	Y	FW		Commercial gaspereau fishery reports
Lake O'Law Bk	Fence	N		Y	FW		A, C – Davidson et al. 1995
PEI							
Morell	Fishway	N		Y	FW		A, C - Claytor 1996
Hillsborough	Ichthyoplankton	?	N	Y	FW, TidalFW, Est		B – Johnston and Morse 1988
Winter (Tracadie Bay)	Ichthyoplankton	?	N	Y	Est		B – Johnston and Morse 1988
Bay of Fundy							
Magaguadavic	Fishway	N		Y	FW		A, C - Martin 1984
Saint John							
Mactaquac	Fishway	Y	?	Y	FW	May - July	A, C - Smith 1979;
Beechwood	Fishway	Y	?	Y	FW	June – Aug.	A, C - Smith 1979
Nashwaak	Fence	Rare	?		FW		R. Jones, DFO Unpubl. data
Big Salmon	Fence	N			FW		DFO Unpubl. data
Petitcodiac	Fence	Y	Y	Y	FW	May - June	A, B, C - Wilder 1942(a, b, c)
Tantramar	Adult sampling	Y	?		FW		Melvin 1984
Maccan/Nappan	Adult sampling Anecdotal	Y	?				Melvin 1984
River Hebert	Adult sampling Anecdotal	Y	?				Melvin 1984
Shubenacadie	Fisheries, Trapnet Ichthyoplankton	Y	Y	Y	TidalEst		DFO Unpubl. data
Stewiacke	Fence, Trapnet Ichthyoplankton	Y	Y	Y	FW		DFO Unpubl. data

Table V-3 (Continued).

River Name	Gear	Present [A]	Spawning [B]	Gaspereau Present [C]	Environment)	Dates shad present	Reference
Bay of Fundy							
Kennetcook	Fisheries	Y	?				Local knowledge
Gaspereau	Fishway	Rare	N	Y	FW		DFO Unpubl. data
Annapolis	Nets, Ichthyoplankton	Y	Y	Y	FW, TidalFW	May - June	A, B, C – Williams and Daborn 1984; Melvin et al. 1985
Atlantic Coast Nova Scotia							
LaHave (Morgans Falls)	Fishway	Rare			FW		A – DFO Unpubl data
Musquodoboit	Fisheries	Y	?		FW, TidalFW		Local knowledge
East River (Sheet Harbour)	Fishway	N			FW		A – DFO Unpubl data
St. Mary's	Fisheries	Y	?				Local knowledge
Grand	Fishway	N		N			A – DFO Unpubl data
Mira	Fisheries, anecdotal	Y	?				Local knowledge
Insular Newfoundland							
Little Codroy	Fence	N		N	FW		A, C – Murray 1968; Moores and Ash 1984
Highlands	Fence	N			FW		A – Dempson et al. 1983
Fischells	Fence	N			FW		A – DFO Unpubl. data
Harrys (Pinchgut)	Fence	N		N	FW		A – DFO Unpubl. data
Hughes	Fence	N		Rare	FW		A, C – C. Mullins, DFO Unpubl. data
Humber	Trapnet	Rare	?	Rare	TidalEst	August	A, C – C. Mullins, DFO Unpubl. data

Table V-3 Contiued.

River Name	Gear	Present [A]	Spawning [B]	Gaspereau Present [C]	Environment)	Dates shad present	Reference
Insular Newfoundland							
Lomond	Fishway	N		N	FW		A, C – C. Mullins, DFO Unpubl. data; Moores and Ash 1984
Torrent	Fishway	N		N	FW		A, C – C. Mullins, DFO Unpubl. data; Moores and Ash 1984
Western Arm Brook	Fence	Rare	?	N	FW	June	A, C – Moores and Ash 1984; Chadwick et al. 1985; C. Mullins, DFO Unpubl. data
LaPoile	Fence	Rare			FW		A, - M. O'Connell DFO Unpubl. data
White Bear	Fence	N		N	FW		A, C – Moores and Ash 1984
Salmon	Fishway	N		N	FW		A, C – Moores and Ash 1984
Conne	Fence	Rare			FW		A, C – B. Dempson, DFO Unpubl. data
Long Harbour	Fyke net	N		N	FW		A, C – Moores and Ash 1984
Come by Chance	Fence	N		N	FW		A, C – Moores and Ash 1984
Northeast (Placentia)	Fishway	N		N	FW		A, C – Moores and Ash 1984
Colinet	Fence	Rare			FW		A - M. O'Connell DFO Unpubl. data
Biscay Bay	Fence	Rare			FW		A - M. O'Connell DFO Unpubl. data
Terra Nova	Fishway (lower)	N		N	FW		A, C – Moores and Ash 1984
Middle Brook	Fishway	N		N	FW		A, C – Moores and Ash 1984
Salmon Brook	Fishway	N		N	FW		A, C – Moores and Ash 1984
Gander	Fence	Rare			FW		A - M. O'Connell DFO Unpubl. data
Exploits (Bishop's Falls)	Fishway	N		N	FW		A, C – Moores and Ash 1984
Indian Brook	Fishway	N		N	FW		A, C – Moores and Ash 1984
Salmon	Fence	N		N	FW		A, C - Moores and Ash 1984

Table V-3 Contiued.

River Name	Gear	Present [A]	Spawning [B]	Gaspereau Present [C]	Environment)	Dates shad present	Reference
Labrador							
Forteau	Fishway	N			FW		A - C. Mullins, DFO Unpubl. data
Pinware	Trapnet	N			TidalEst		A - C. Mullins, DFO Unpubl. data
St. Charles	Fence	N		Rare	FW		A, C - Moores and Ash 1984
Sand Hillo	Fence	Rare	?	Rare	FW	?	A, C - Moores and Ash 1984
Paradise	Trapnet	Rare	?		TidalEst		A - D. Reddin, DFO Unpubl. data
Big Brook	Fence	N			FW		A - D. Reddin, DFO Unpubl. data
English	Fence	N			FW		A - D. Reddin, DFO Unpubl. data
Double Brook	Fence	N			FW		A - Dempson et al. 1983
Fraser	Fence	N			FW		A - Dempson et al. 1983
Ikarut	Fence	N			FW		A - Dempson et al. 1983

Table V-4. Observations of American shad at counting facilities in Newfoundland and Labrador, 1971 to 2000. Data from M. O'Connell and B. Dempson, DFO, White Hills, St. John's, Newfoundland.

Numbers of American shad recorded at Newfoundland fishways, counting fences or trapnets

	River								
Year	Biscay Bay	Colinet	Conne	La Poile	Humber	Western Arm	Gander	Sand Hill	Paradise
1971								1	
1972									
1973								1	
1974						1			
1975									
1976									
1977						1			
1978									
1979						2			
1980						4			
1981						5			
1982									
1983									
1984	1	1							
1985		4				4			
1986		1							
1987			1			1			
1988	9	4							
1989	10								
1990	3								
1991	3				10				
1992		1	3		3		2		
1993				2	1		2		
1994					1	2	1		
1995					1	1	3		
1996					1		1		
1997					2				
1998			1		3	5			
1999						8			1
2000						2			
Total	26	11	5	2	22	36	9	2	1

Table V-5. Timing of observations of American shad at counting facilities in Newfoundland and Labrador, 1971 to 2000. Data from M. O'Connell and B. Dempson, DFO, White Hills, St. John's, Newfoundland.

Month	Day	River Biscay Bay	Colinet	Conne	Gander	Sand Hill	Western Arm	All Rivers
May	12			1				1
June	10			1				1
	13				1			1
	14	3						3
	17	1	1					2
	21	4			1			5
	22	3	1					4
	25	1						1
	26	4			1			5
	27		2				3	5
	28		1					1
	29	1	1			1	1	4
	30	2					2	4
July	1						2	2
	2						1	1
	3				1		2	3
	5		1			1	1	3
	10		2	1				3
	12					1	2	3
	13	2					1	3
	14						1	1
	15				1			1
	17	4						4
	19			2	1			3
	20			1				1
	21				1			1
	28		2					2
August	7					1		1
	8				1			1
	9				1			1
Grand Total		25	11	6	9	4	16	71

Table V-6. Number of American shad reported from counting facilities in Gulf Region estuaries. Trapnet abbreviations for the Miramichi are from Hayward (2001).

Annual counts of shad at the estuary trapnets operated by DFO or in collaboration with Eel Ground First Nation and Red Bank First Nation													
	Miramichi	Soutwest Miramichi: upstream --->>			Northwest Miramichi: upstream --->>						Chaleur Bay	Margaree River
Year	Millbank	SWEE	SWEFF	SWM	NWEGFF	NWEGI	HB	CU	RBLSW	RBNW	Dalhousie trapnet	Trapnet
1970	116											
1971	358											
1972	467										153	
1973	1,115										122	
1974	1,385										99	
1975	558										70	
1976	247										55	
1977	310										127	
1978	325										87	
1979	593										112	
1980	763										32	
1981	619											
1982	370											
1983	602											
1984	332											
1985	483	231				469						
1986	1,134	314				762						
1987	1,816	158				608						
1988	1,701											
1989	1,469											
1990	1,335											
1991	560											15
1992	463	253				162						20
1993		430				48						28
1995		202		307								25
1996		491	431	791	157				12	8		30
1997		1,111	139	320								13
1998		250	313	382				202				
1999		145	127	170	9		35	117	158	156		
2000		487	621	354	128			39	1,622	847		
2001				267				79	31	7		
2002				186				1,323	10	12		

Table V-7. Number and timing of catches of American shad from tidal water trapnets in the Margaree River, Gulf Nova Scotia.

Margaree River, Nova Scotia							
Month	Day	1991	1992	1993	1994	1995	1996
June	11						1
	12	1					
	13						1
	15			1			
	16		2				
	18		1	1	1	1	1
	20	1	1	1			
	21			2	1		
	22	1					
	23		1	5	1	2	
	24		2		1	2	1
	25				1	1	1
	26		1		1	1	
	27	1	1	2		2	1
	28		6	1		4	
	29				4	5	
	30			4	1		
July	1				1		
	2				1	3	1
	3			3	4	2	
	4	1	1	1	1		
	5				1		
	6	1					
	7	1		1	2	2	1
	8				1	2	1
	9					2	
	10	1			1		1
	11	1		1			
	12			2	1		
	14	3					
	15	1		1			1
	16		1	1	1		
	18		1				1
	19		1				1
	20	2					
	22					1	
	29			1			
	31		1				
Total		15	20	28	25	30	13

Table V-8. Annual counts of American shad and median date of the count at the hydro-electric fish trapping facilities in the Saint John River, 1957 to 2002. Data for 1957 to 1976 are from Smith (1979) and Ingram (1980). Data for Mactaquac for 1977 to 2002 are DFO (Unpubl. data. R. Jones). The Beechwood facility is located about 153 km above the head of tide and was completed in 1957-58. The Mactaquac dam, constructed approx. 2 km above the head of tide, was completed in 1967.

Annual counts of shad at Saint John River facilities

	Beechwood	Mactaquac	
Year	Count	Count	Median date
1957	0		
1958	55		
1959	1,155		
1960	1,490		
1961	251		
1962	209		
1963	43		
1964	103		
1965	139		
1966	199		
1967	0		
1968	0	38,838	
1969	17	37,449	
1970	9	36,437	
1971	16	15,294	
1972		1,497	
1973		7,363	
1974		432	
1975		549	
1976		458	
1977		154	Jul-02
1978		142	Jun-30
1979		185	Jun-25
1980		562	Jun-14
1981		534	Jun-10
1982		20	Jul-24
1983		242	Jun-08
1984		246	Jun-20
1985		155	Jun-02
1986		466	Aug-04
1987		43	Jul-21
1988		69	Jul-28
1989		476	Jun-28
1990		367	Jun-02
1991		836	Jun-13
1992		691	Jul-09
1993		61	Jun-21
1994		110	Jun-30
1995		175	Jun-26
1996		1,465	Jun-24
1997		0	
1998		102	Jun-19
1999		263	Jun-22
2000		573	Jun-22
2001		19	May-23
2002		39	Jul-02

Table VII-1. Status summary of known and suspected American shad spawning runs in the Maritime Provinces.

			Historical Occurrence		Evidence for Recent/Current Occurrence				Current	Constraining
FSD	Drainage	River/Tributary	Report	Cited Evidence	Eggs/larvae	Juveniles	River fishery	Other	Status	Factor
	Gulf of St. Lawrence									
72	Miramichi	Northwest			present		commercial, Native	research tidal trapnet	**Extant**	
72	Miramichi	Southwest					commercial, Native	research tidal trapnet	**Extant**	
76	Richibucto	Richibucto	Leim 1924		absent				Unconfirmed	
45	River Philip	River Philip	Leim 1924						Unconfirmed	
	Eastern Cape Breton-Bras D'Or									
7	Mira	Mira	Leim 1924				gillnet, nontidal	anecdotal reports	Unconfirmed	
	Atlantic									
17	St.Mary's	St.Mary's					recreational, non-tidal		Unconfirmed	
20	Musquoboit	Musquoboit						local knowledge	Unconfirmed	
27	LaHave	LaHave					dipnet, nontidal	recreational angling	Unconfirmed	
28	Mersey	Mersey	Leim 1924 (Liverpool)						Unconfirmed	
28	Medway	Medway	Leim 1924						Unconfirmed	
33	Tusket	Tusket	Leim 1924						Unconfirmed	
	Bay of Fundy - Nova Scotia									
35	Annapolis	Annapolis	Leim 1924	May-June fishery	present	present	recreational, non-tidal		**Extant**	
35	Nictaux	Nictaux	Leim 1924						Unconfirmed	
41	Cornwallis	Cornwallis	Prince 1852	tidal fishery					Unconfirmed	
42	Avon	Avon	Leim 1924						Unconfirmed	
42	St. Croix	St. Croix	Leim 1924						Unconfirmed	
42	Kennetcook	Kennetcook	Prince 1912; Leim 1924	May-June fishery			closed to fishing		Unconfirmed	
42	Shubenacadie/Stewiacke	Shubenacadie	Perley 1852; Leim 1924	May-June fishery	present	present	dipnet, nontidal	research non-tidal trapnet	**Extant**	
43	Shubenacadie/Stewiacke	Stewiacke	Perley 1852; Leim 1924	May-June fishery	present	present	recreational angling	counting fence	**Extant**	
44	River Hebert	River Hebert	Leim 1924						Unconfirmed	
24	Maccan	Maccan	Leim 1924					science collections	Unconfirmed	
24	Nappan	Nappan	Leim 1924						Unconfirmed	
24	La Planche	La Planche	Leim 1924						Unconfirmed	
	Bay of Fundy - New Brunswick									
81	Tantramar	Tantramar	Prince 1912					science collection	Unconfirmed	Tidal Barrier
79	Petitcodiac	Petitcodiac	Perley 1852, Prince 1912, Leim 1924; Wilde 1942	counting fence counts				fishway observations	**Extirpated**	Tidal Barrier
58	Saint John	above Mactaquac	Perley 1852, Prince 1912, Leim 1924; Smith 1979					fish trap facility counts	**Extirpated**	Fish passage
56	Saint John	Washademoak	Leim 1924				gillnet, trapnet		**Extant**	
55	Saint John	Kennebecasis	Perley 1852, Prince 1912				gillnet		**Extant**	
55	Saint John	Hammond	Perley 1852, Prince 1912				gillnet		**Extant**	
57	Saint John	Grand Lake	Perley 1852, Prince 1912				gillnet, trapnet		**Extant**	
52	St. Croix	St. Croix	Perley 1852					collapsed fishery, fishway facility	**Extirpated**	Fish passage

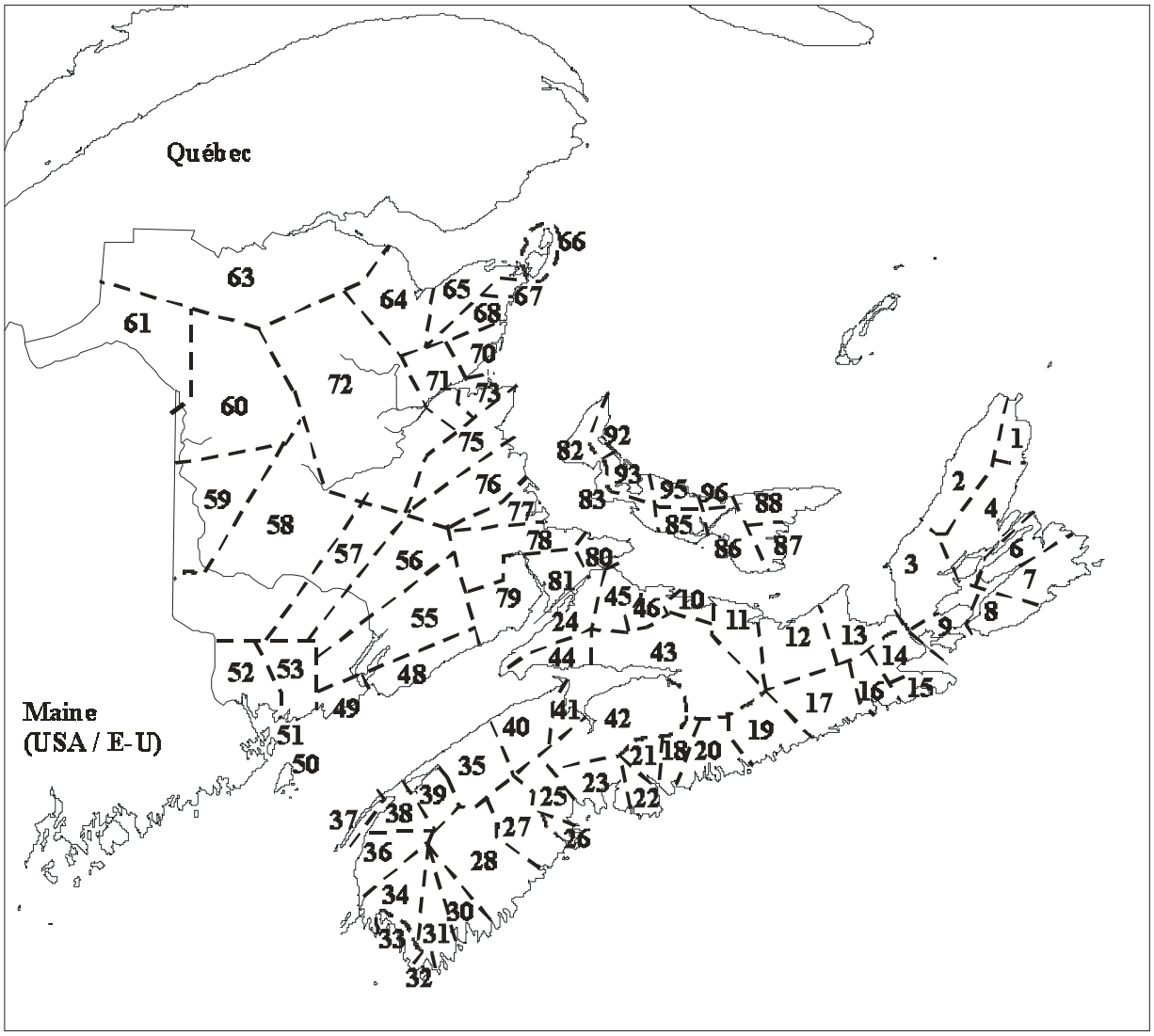

Figure III-1. Fishery Statistical Districts (FSD) used to collate the landings of American shad in the Maritimes provinces. Descriptions of the statistical districts are summarized in O'Neil and Swetnam (1991).

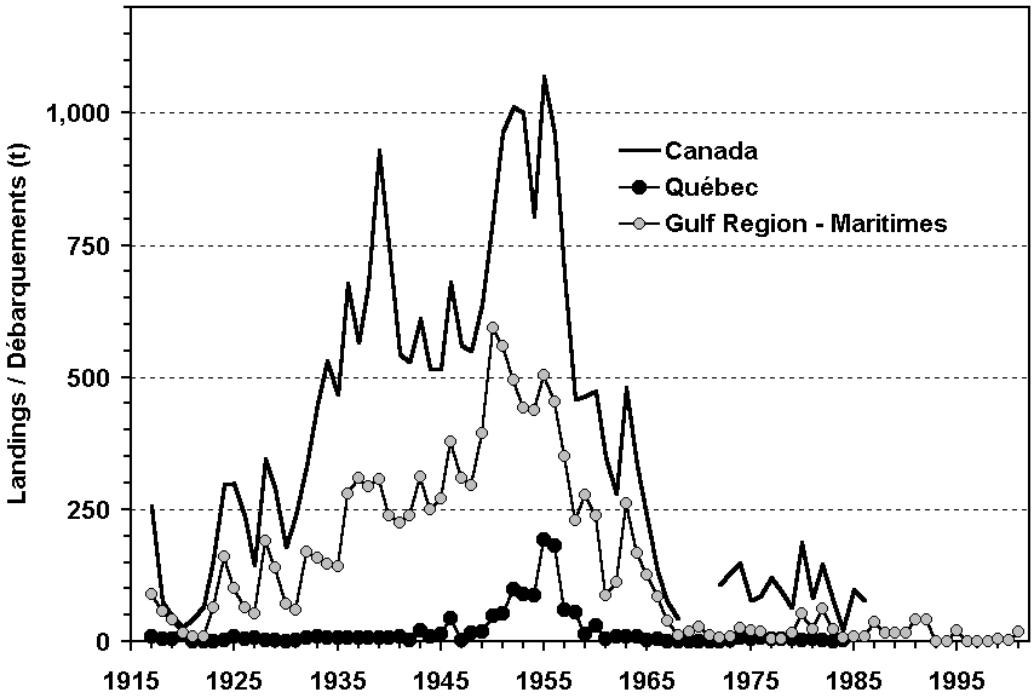

Figure IV-1. American shad landings (t) from Canada, Québec and Gulf Region of the Maritime Provinces, 1917 to 2001. Data for 1917 to 1983 are from LeBlanc and Chaput (1991). Data for 1984 to 2001 are from the database of Statistics and Economics Branch, Gulf Region, Fisheries and Oceans Canada.

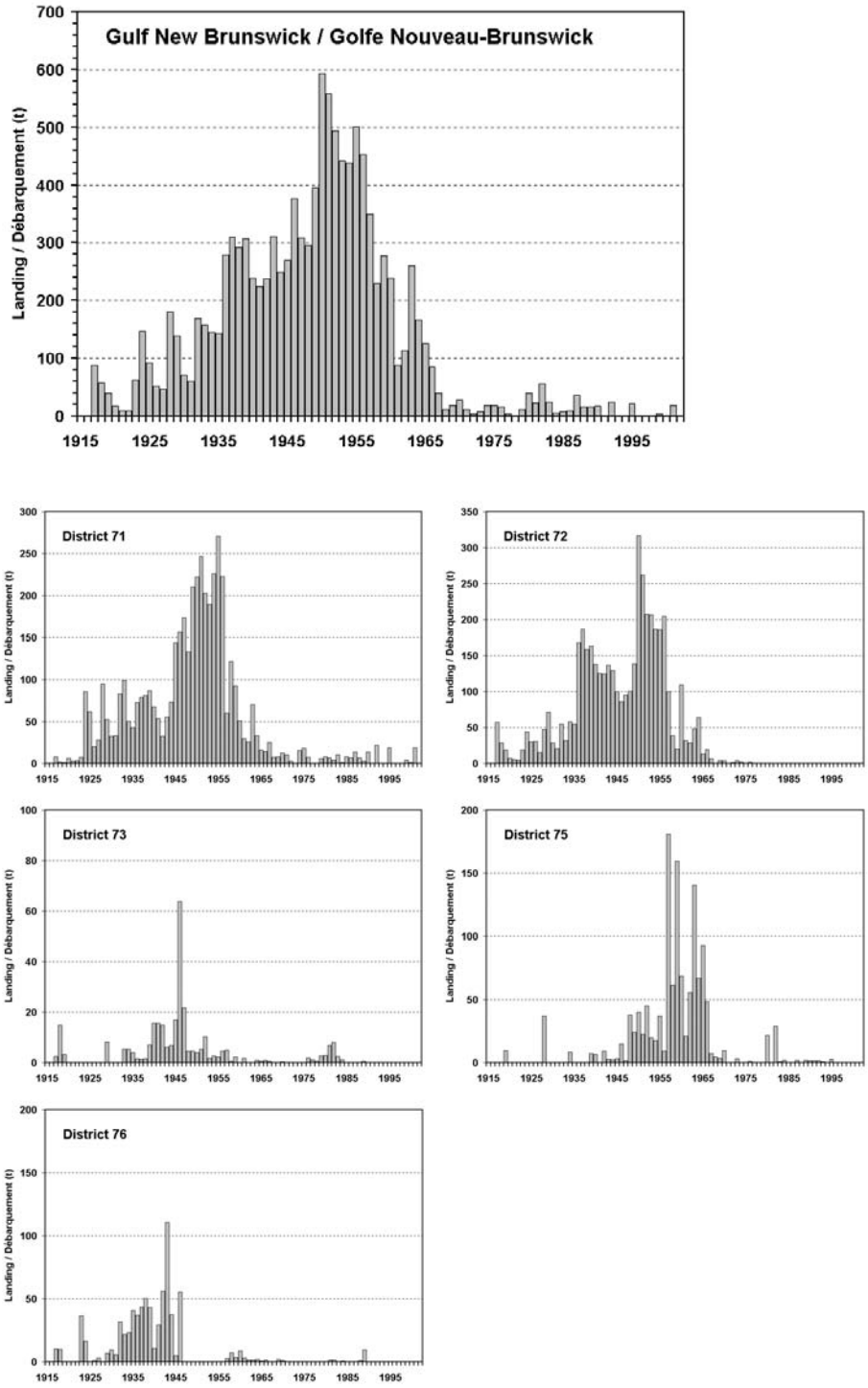

Figure IV-2. American shad landings (t) from the Gulf New Brunswick fishery statistical districts. Data for 1917 to 1983 are from LeBlanc and Chaput (1991). Data for 1984 to 2001 are from the database of Statistics and Economics Branch, Gulf Region, Fisheries and Oceans Canada.

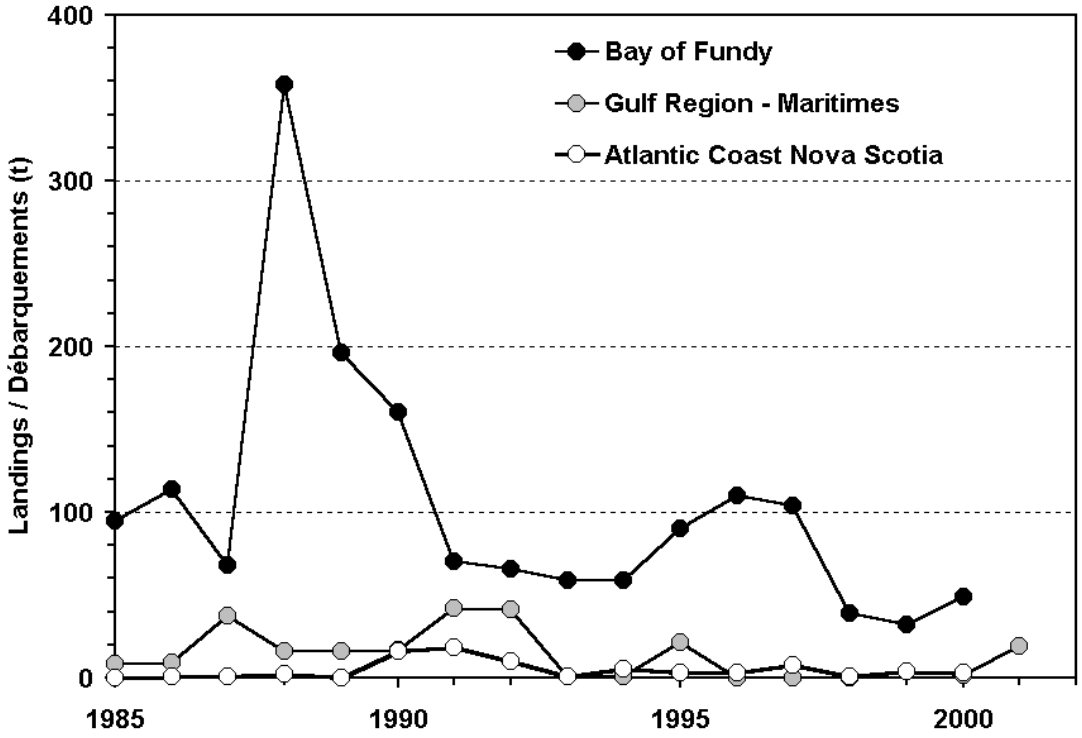

Figure IV-3. Reported landings (t) of American shad from the Bay of Fundy, Atlantic coast of Nova Scotia, and the Gulf of St. Lawrence fisheries, 1985 to 2001.

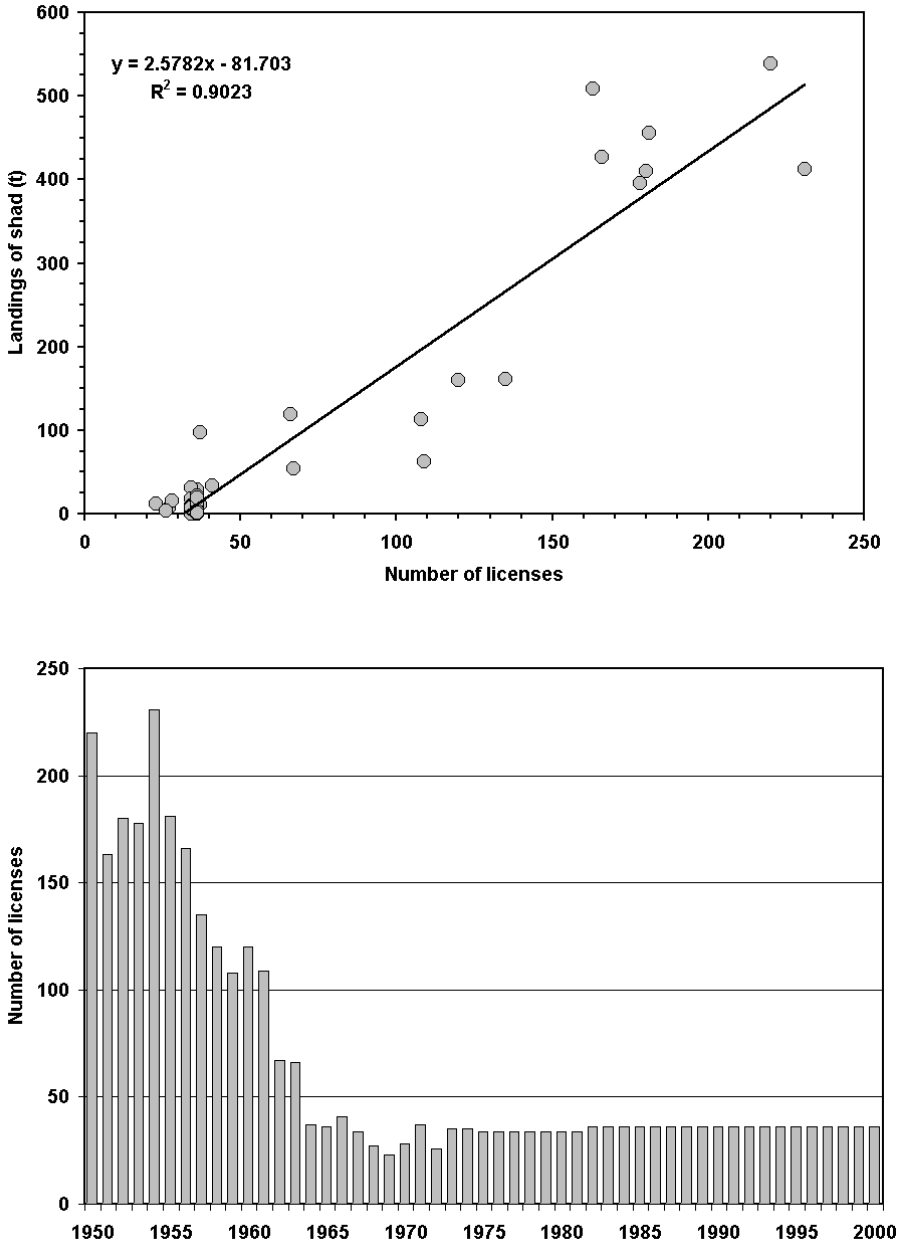

Figure IV-4. Number of gaspereau trapnet licenses in the Miramichi River fishery (FSDs 71, 72) (lower panel) and relationship between landings of shad reported from FSDs 71 and 72 relative to the number of trapnet licenses in those FSDs. Annual license information from Alexander and Vromans (1988).

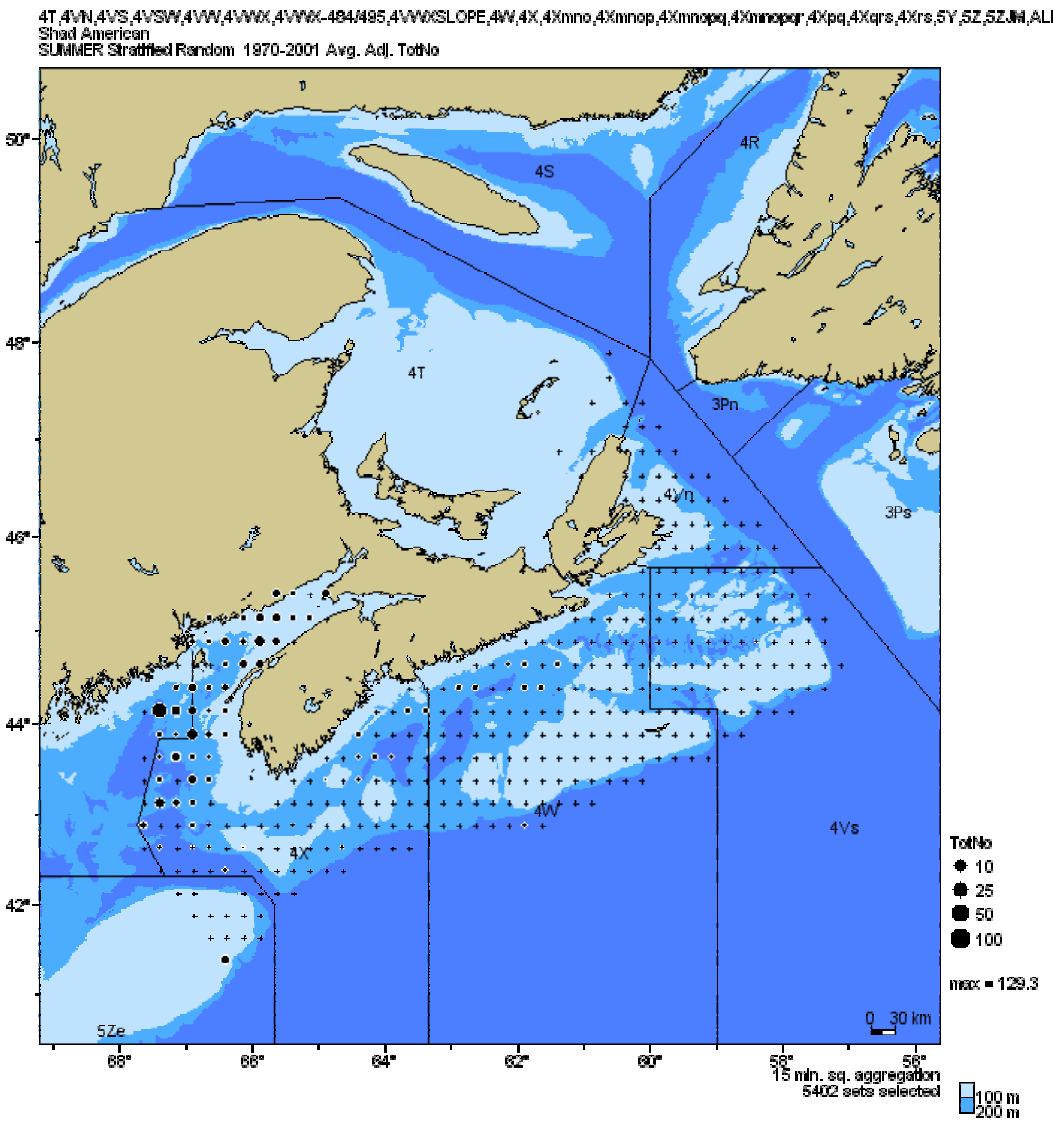

Figure V-1. Catches of American shad from the summer DFO research vessel surveys. Data are for all years combined.

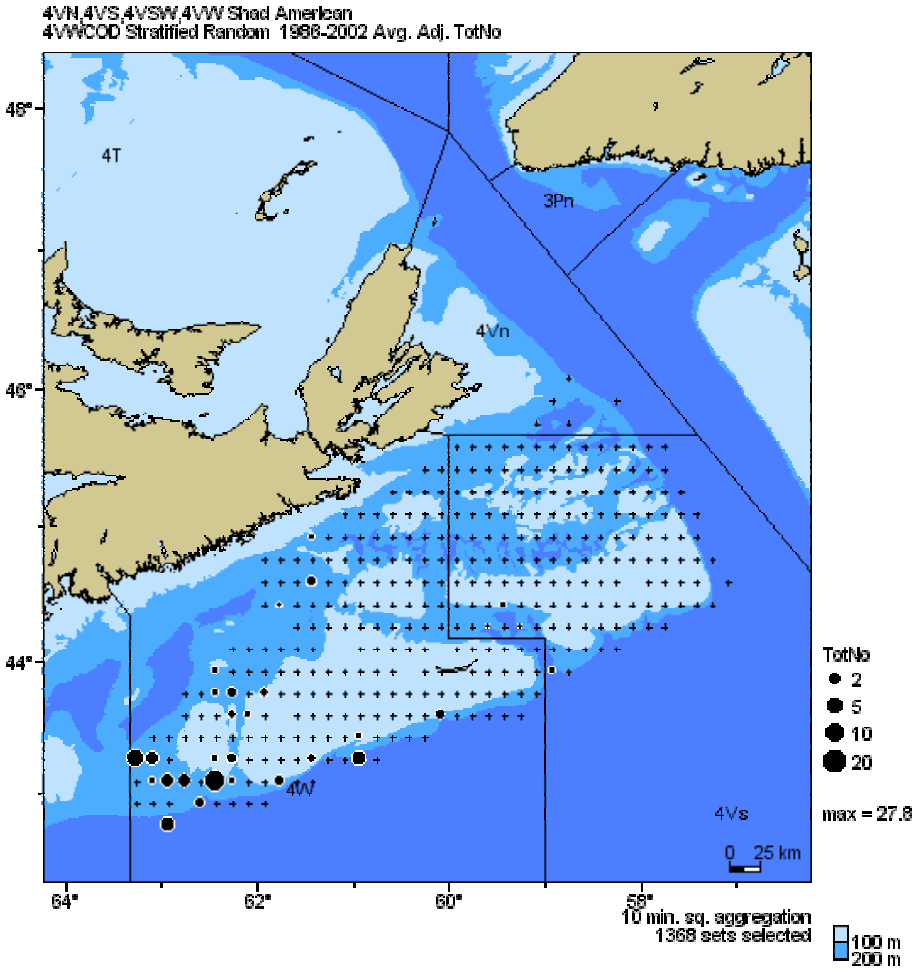

Figure V-2. Catches of American shad in winter Scotian Shelf DFO surveys. Data are for all years combined.

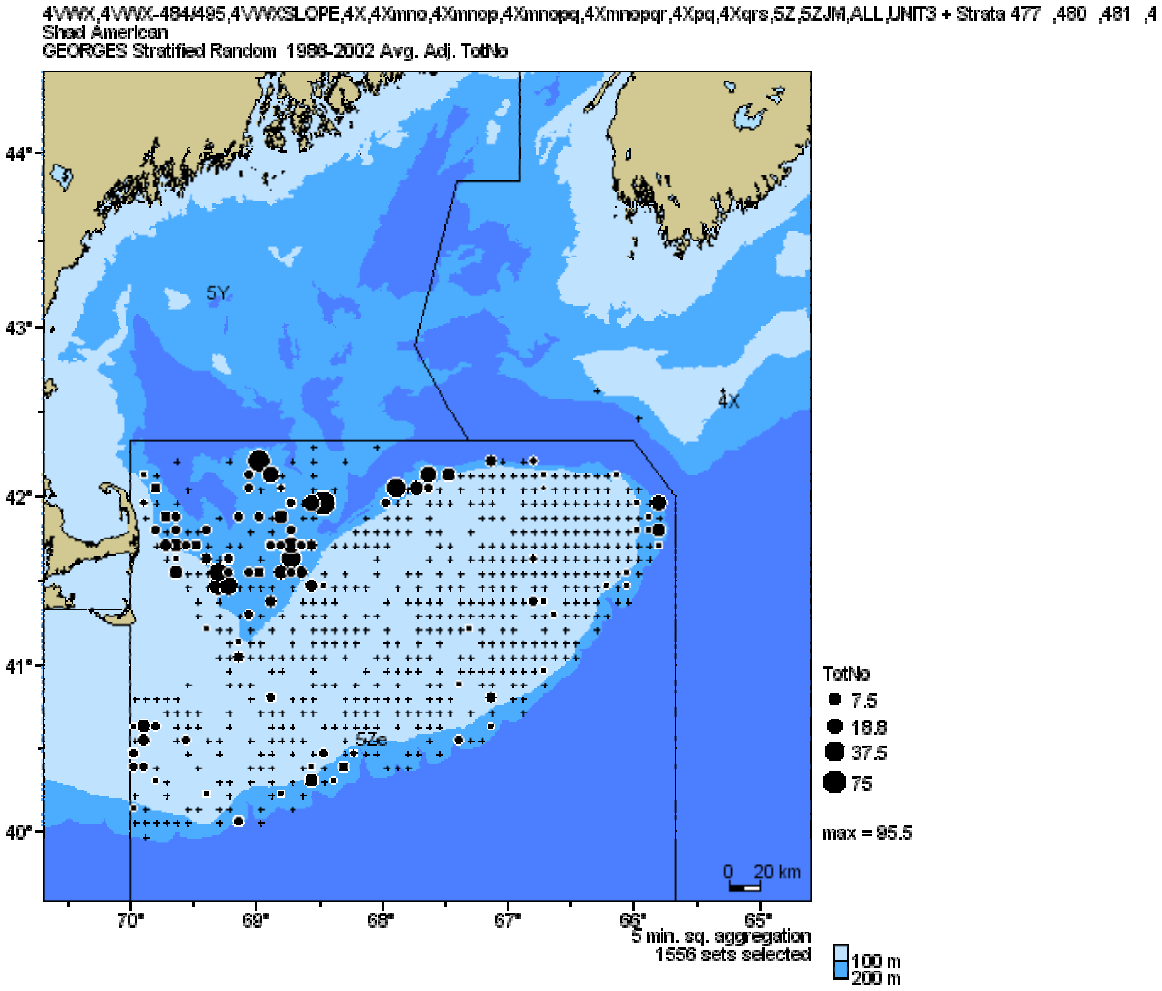

Figure V-3. Catches of American shad in the winter Georges Bank DFO surveys. Data are for all years combined.

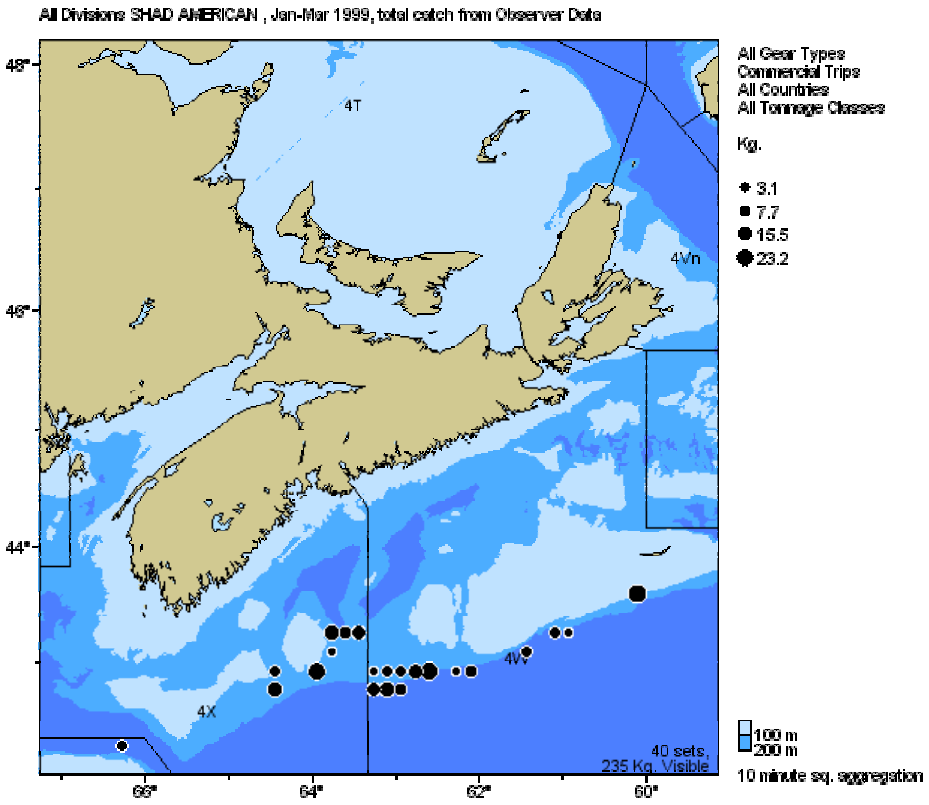

Figure V-4. American shad catches as recorded in the observer data base for January to March, 1999.

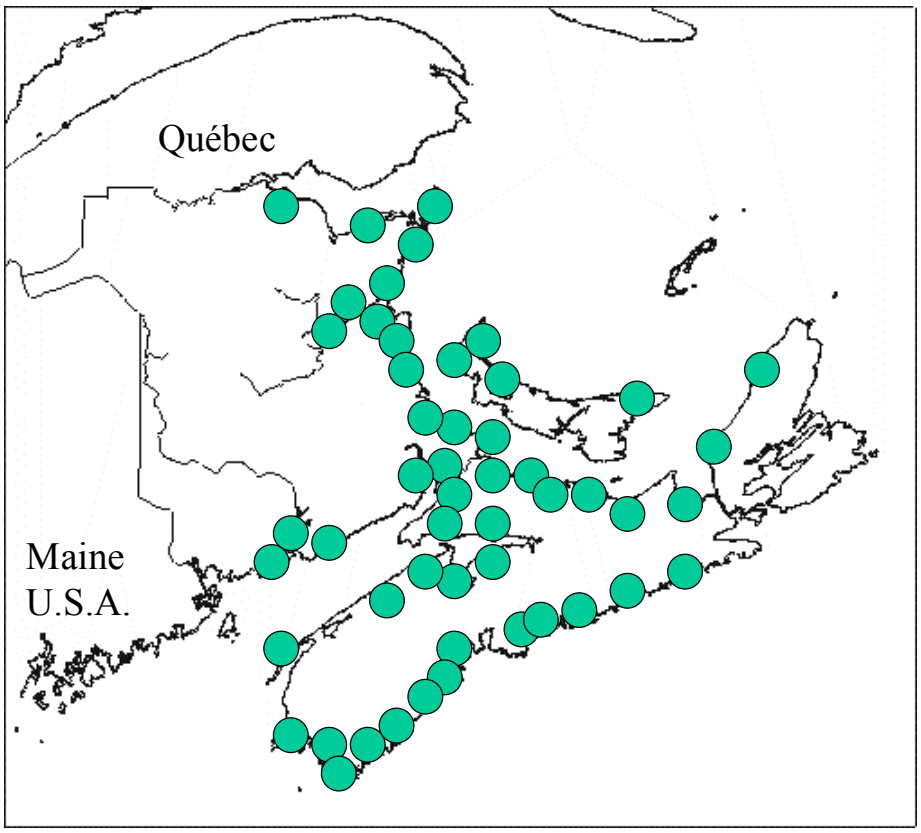

Figure V-5. Nearshore and estuarine occurrence of American shad in the Maritime Provinces based on reported landings of shad in the commercial fisheries, 1984 to 2000.

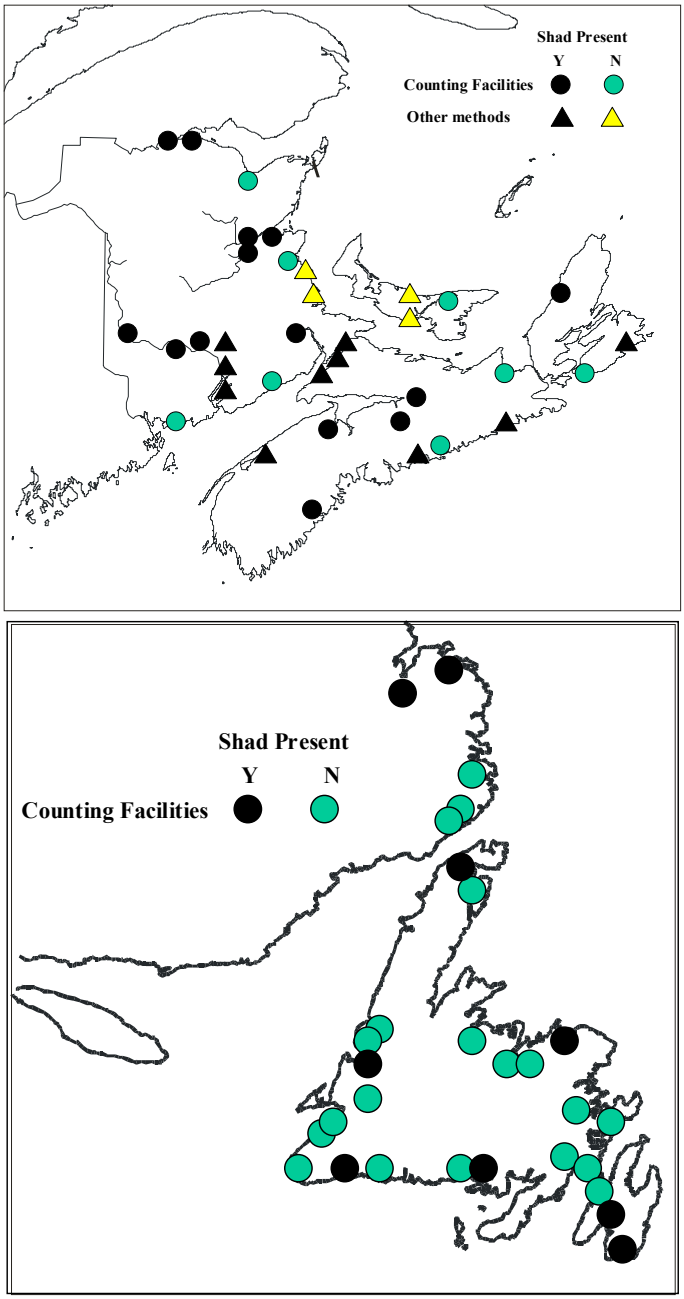

Figure V-6. Fresh water and tidal water occurrence of American shad at counting facilities operated by or associated with DFO monitoring projects and based on information from other sources. Facilities which were not operating during the season when shad would be expected in freshwater (May to August) are not shown (Table V-3). The other methods include ichthyoplankton surveys, fisheries and special collections.

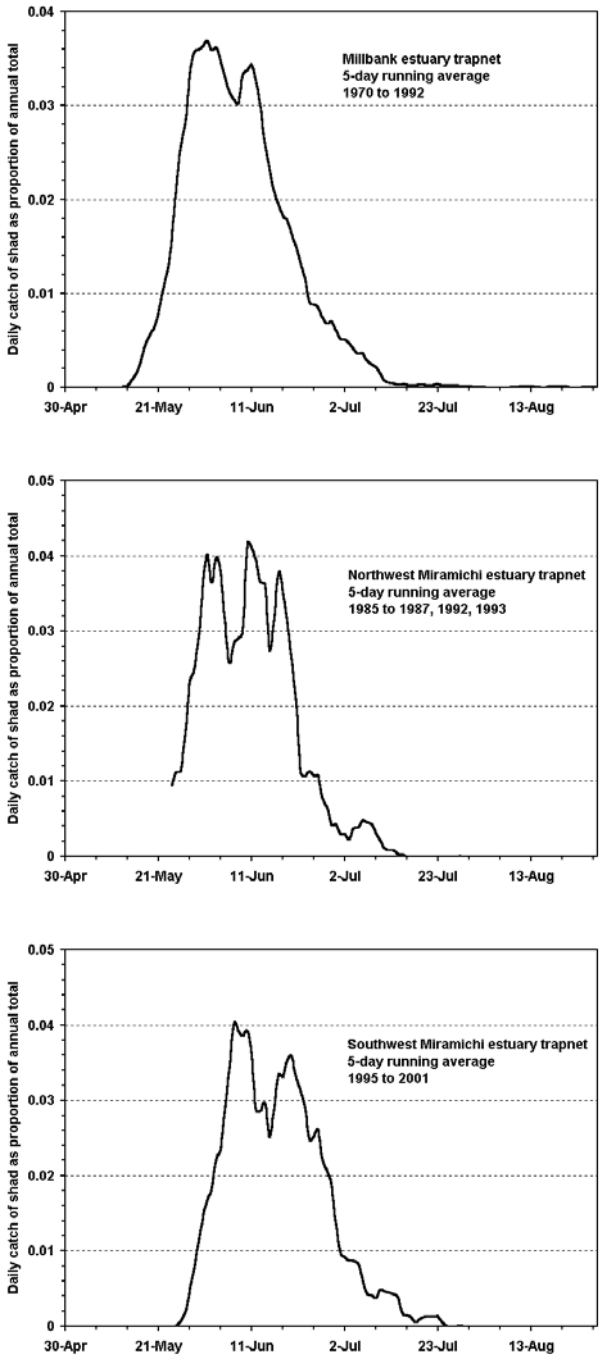

Figure V-7. Run-timing of American shad to the Miramichi River based on catches at the Millbank trapnet (upper panel), and in the Northwest Miramichi (middle panel) and the Southwest Miramichi rivers (lower panel). Shad migrate into the Miramichi at the same time as gaspereau (alewife and blueback herring).

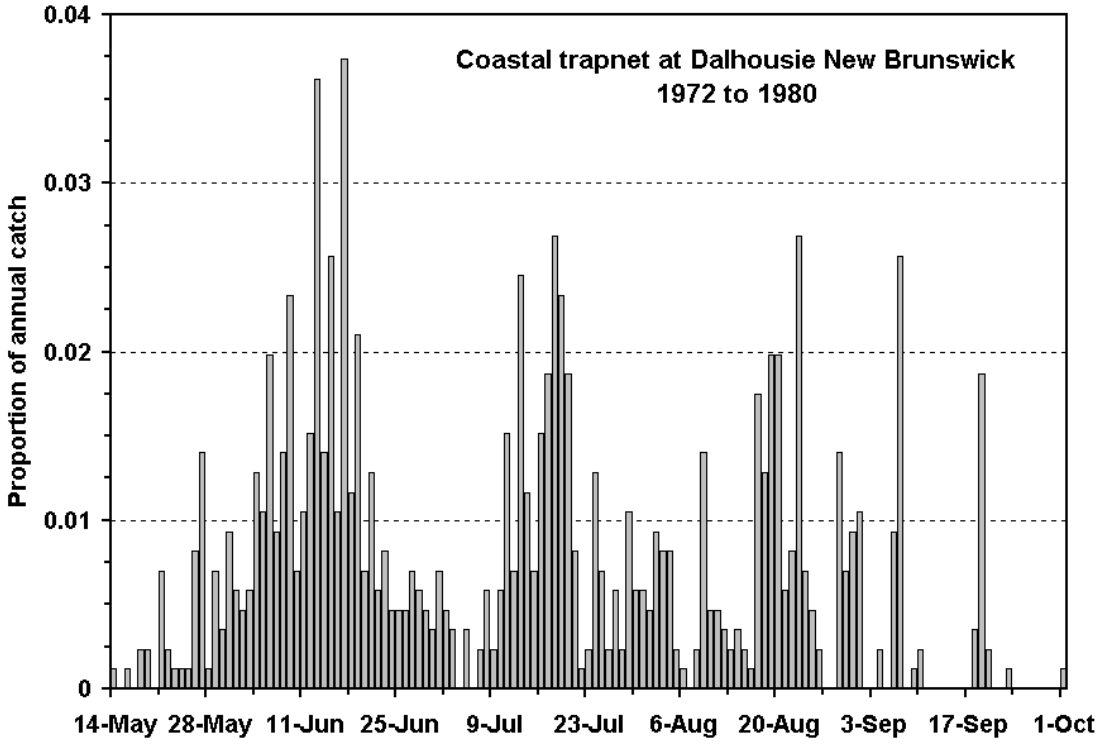

Figure V-8. Run-timing of American shad based on catches at the Dalhouise (New Brunswick) coastal trapnet in Chaleur Bay, 1972 to 1980.

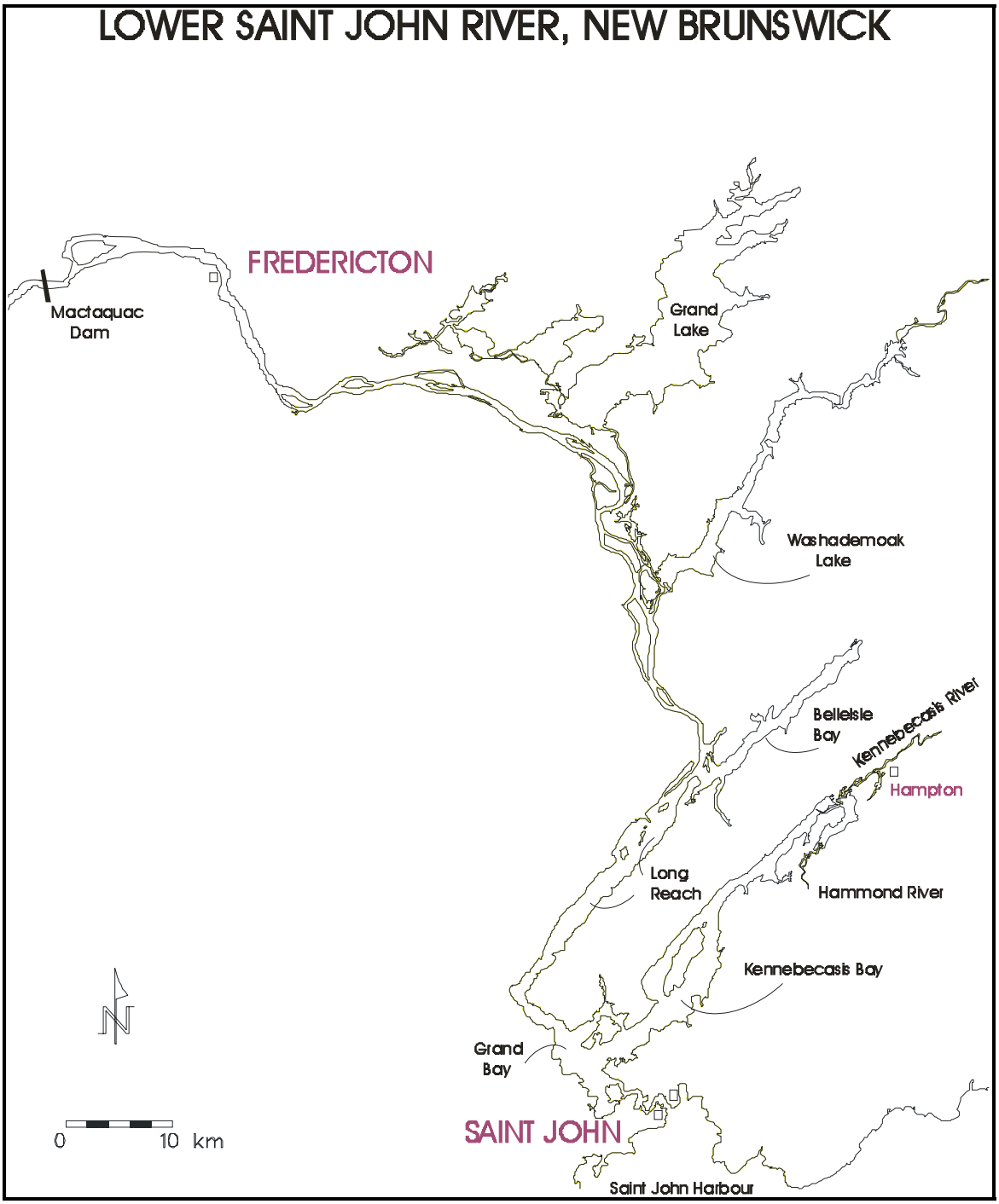

Figure V-9. Locations within the Saint John River where American shad spawning runs are inferred to occur based on catches in commercial fisheries.

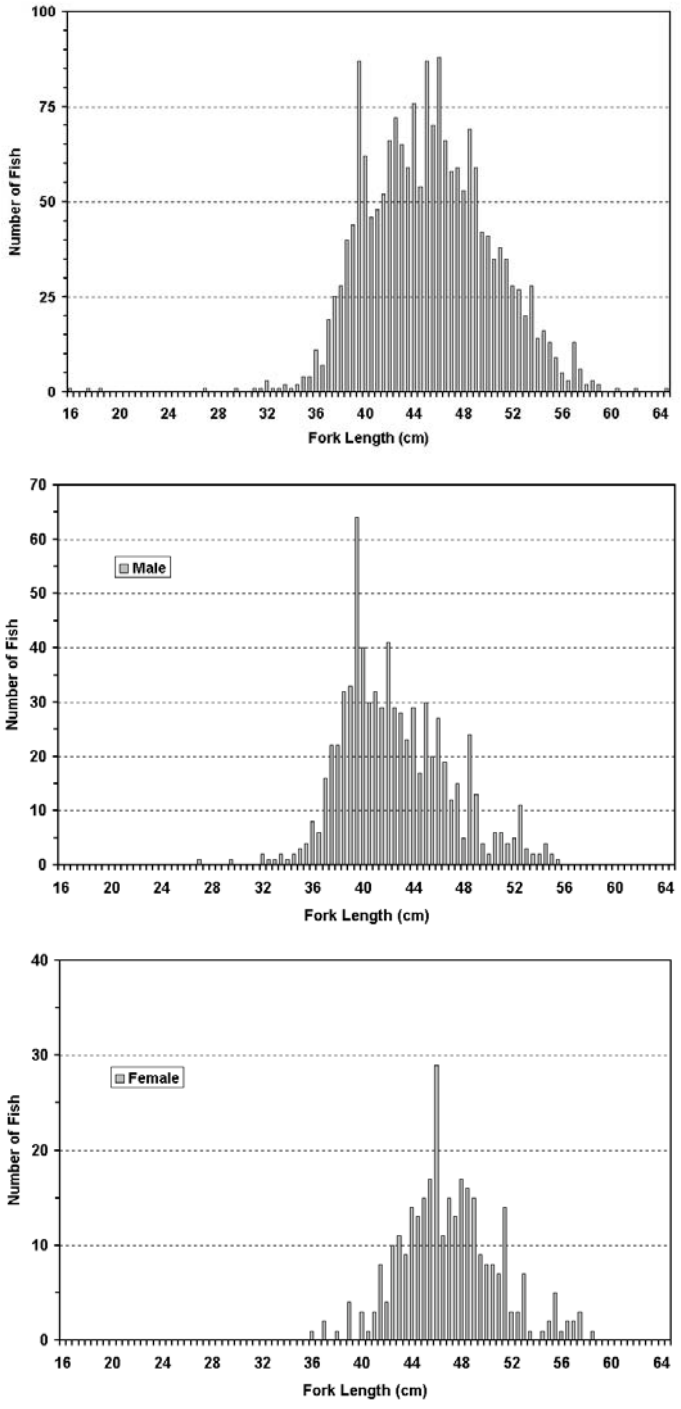

Figure VI-1. Fork length distributions of opportunistically sampled American shad from estuarine index trapnets from the Miramichi River, 1994 to 2001. All shad measured (upper panel), male shad (middle panel) and female shad (lower panel). Sex was determined based on extrusion of gonadal products on live fish and therefore represent fish in a spawning state.

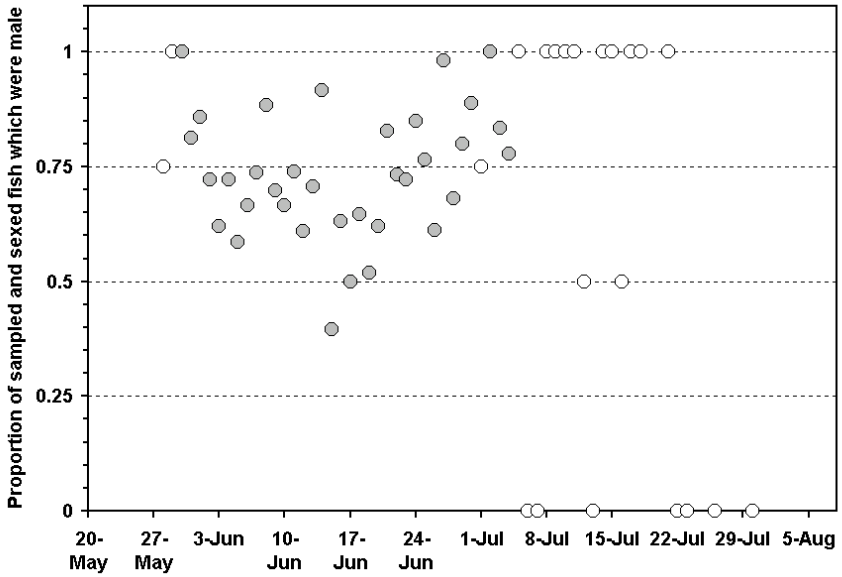

Figure VI-2. Presence of male and female American shad in the Southwest Miramichi trapnet samples, 1996 to 2001. Symbols in white are dates when sex was determined from fewer than five fish.

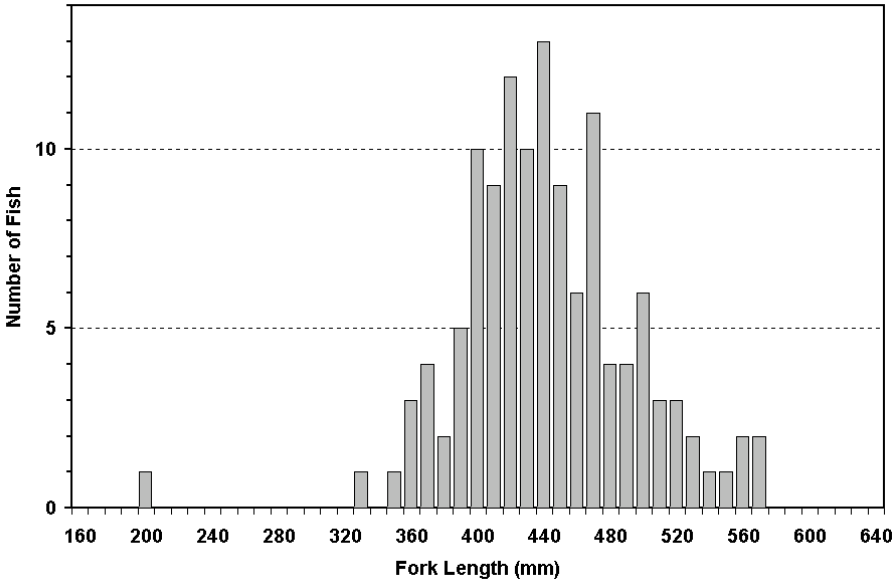

Figure VI-3. Fork length distribution of opportunistically sampled American shad from estuarine index trapnets of the Margaree River, 1991 to 1996. Only one male (ripe and running) was observed in all the fish sampled: 485 mm fork length, July 11, 1991.

Extant spawning runs:

Northwest Miramichi (1)
Southwest Miramichi (2)
Saint John: Grand Lake (30)
Washademoak (27)
Kennebecasis (28)
Hammond (29)
Shubenacadie (18)
Stewiacke (19)
Annapolis (12)

Extirpated spawning runs:

St. Croix (31)
Saint John (above Mactaquac) (26)
Petitcodiac (25)

Status unconfirmed:

Richibucto (3), River Philip (4)
Mira (5), St. Mary's (6), Musquodoboit (7),
LaHave (8), Mersey (9), Medway (10),
Tusket (11), Nictaux (13), Cornwallis (14),
Avon (15), St. Croix (16), Kennetcook (17),
Hebert (20), Maccan (21), Nappan (22),
La Planche (23), Tantramar (24)

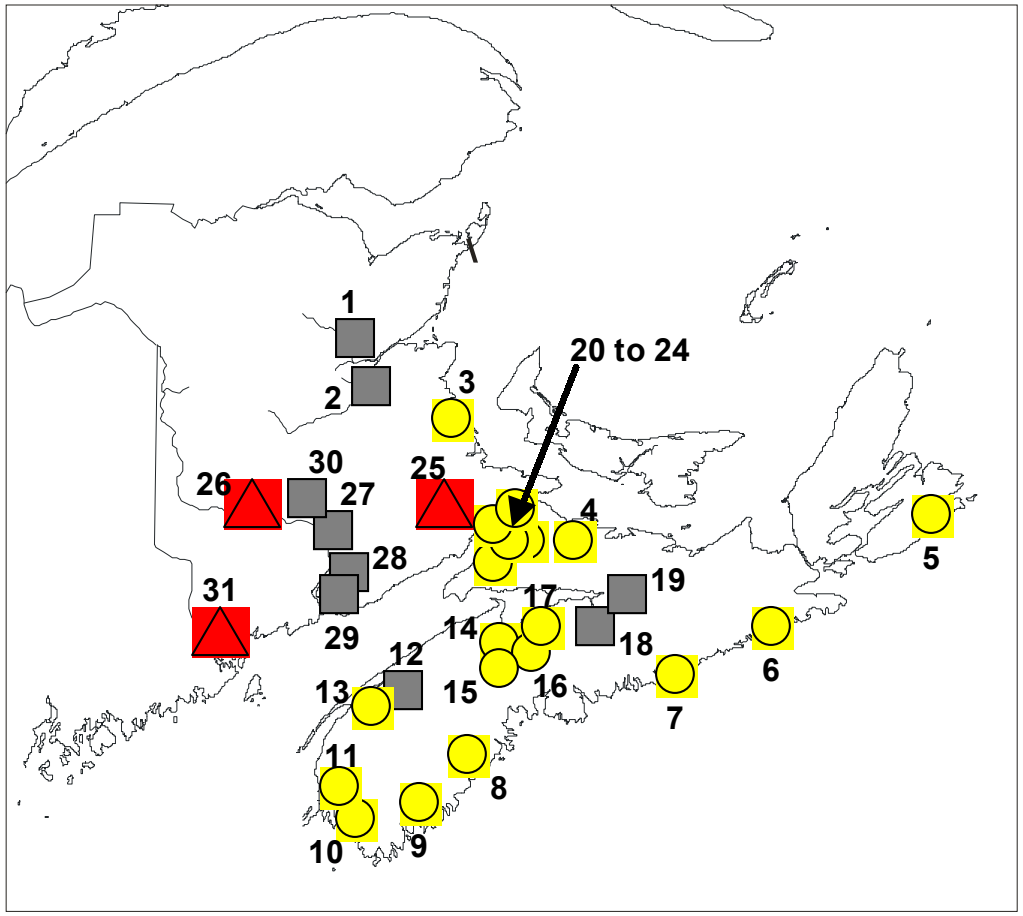

Figure VI-4. Summary of status of American shad spawning runs in rivers of the Maritime provinces.

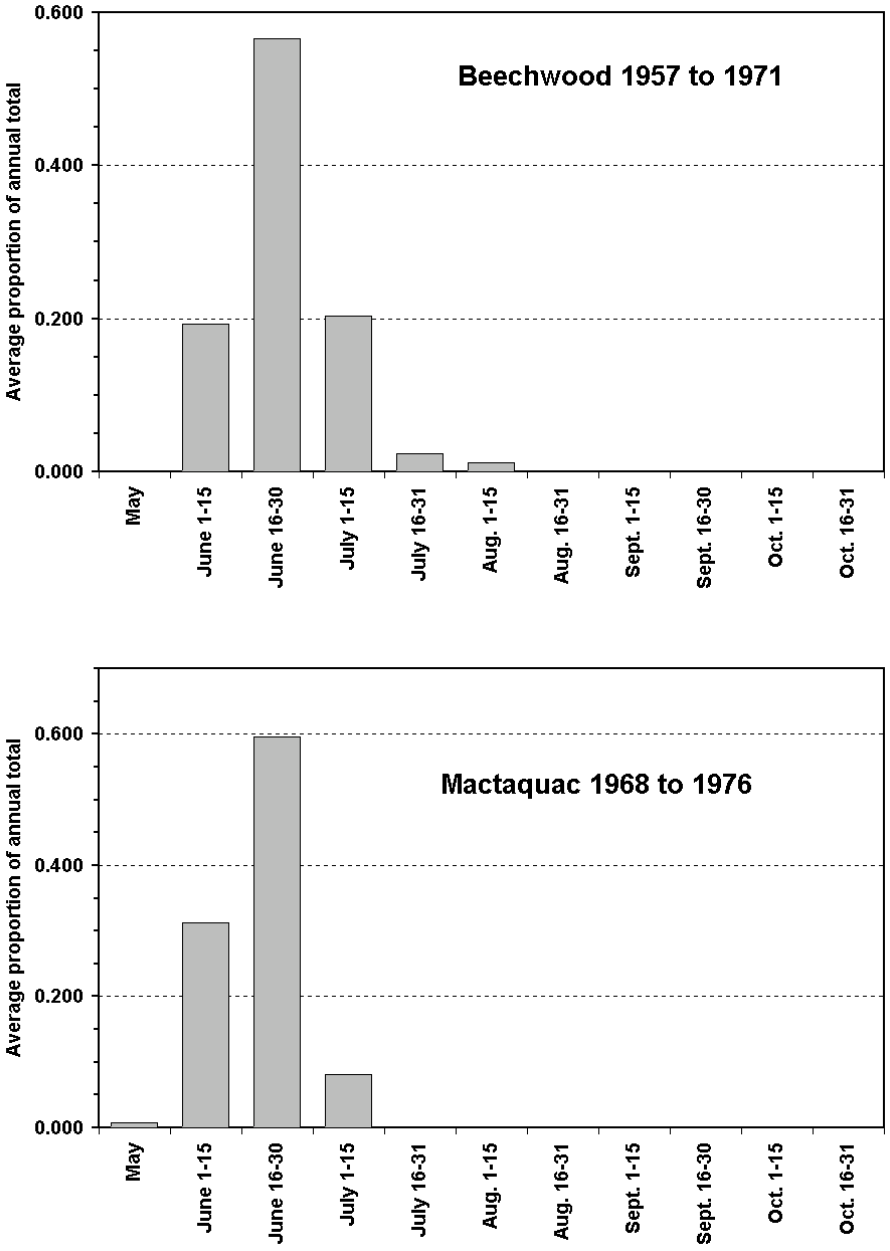

Figure VI-5. Run-timing of American shad at the hydro-electric trapping facilities in the Saint John River. Counts of American shad at Beechwood ceased in 1971 after construction of the downstream Mactaquac Dam.

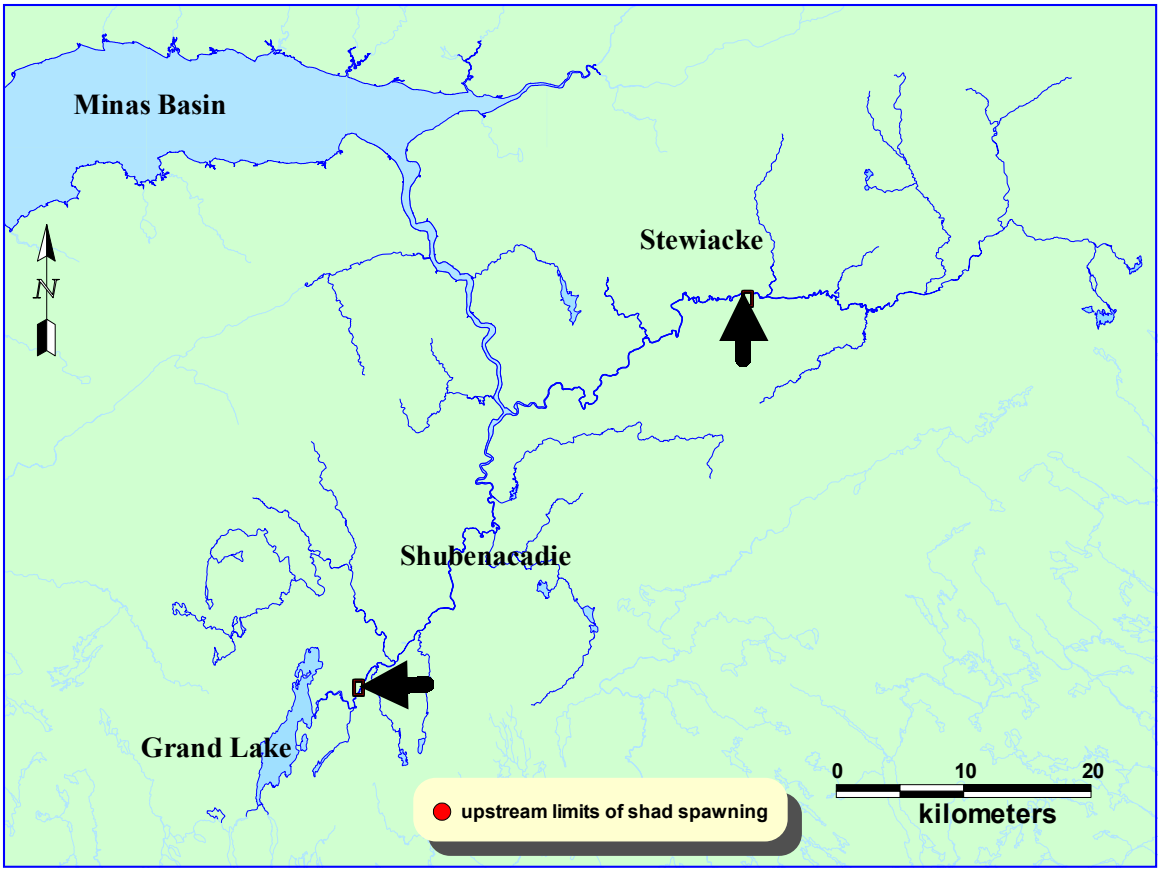

Figure VI-6. Limits of observed spawning of American shad within the Shubenacadie/Stewiacke River system.

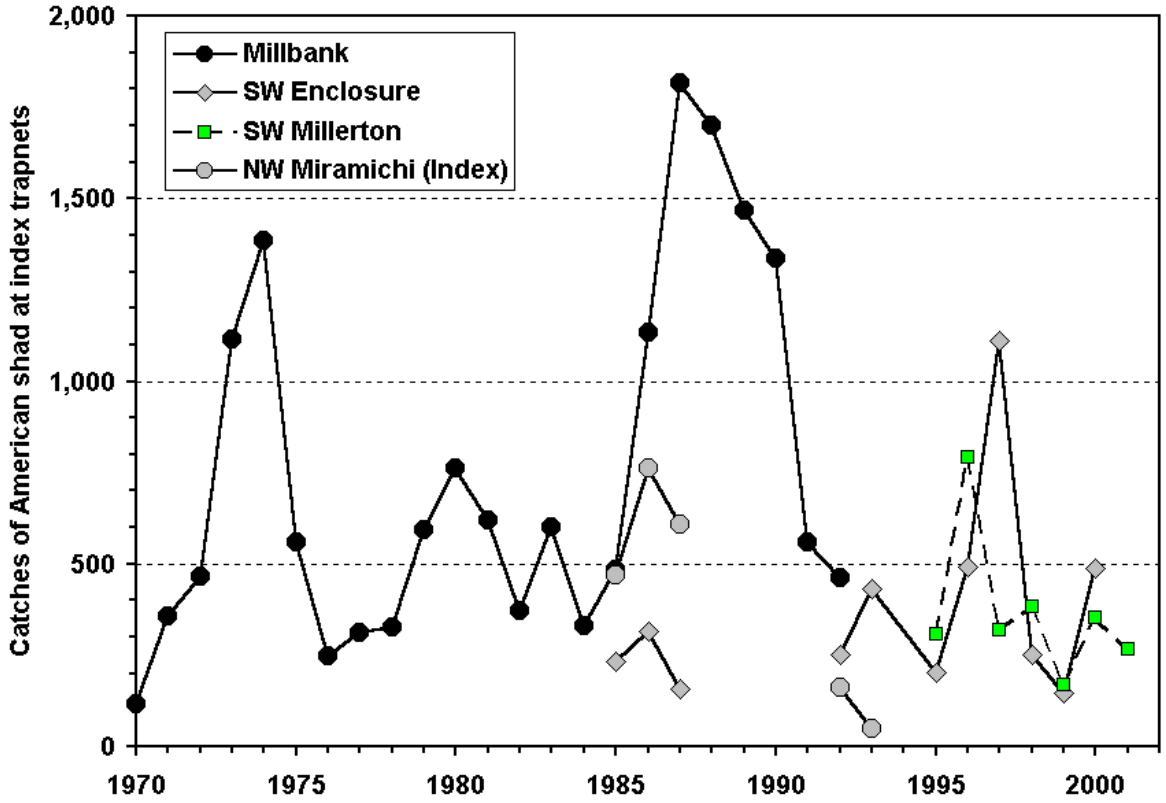

Figure VII-1. Counts of American shad at the index trapnets in the Miramichi River, 1970 to 2001.

Appendix I. American shad observations in marine waters as recorded in the observer database for Newfoundland. Information were provided by Joe Firth, DFO Newfoundland Region.

From the Observer database from 1978 to 2002 (all data for 2002 not reviewed).

The search showed catches of American Shad for 1980, 1994 and 2002.

YEAR	MONTH	DAY	TRIP	SET	NAFO	LAT	LONG	DEPTH	GEAR	KEPT	DISCARD
2002	6	4	199	8	3PS	4734	5719	176	5	2	.

The species name recorded on the Set and catch sheet agrees with the data in the database. The Observer recorded American Shad on the set and catch.

The records for 1994 were confirmed as errors.

The review of the database showed twenty three records of American Shad for 1980. These records occurred on two trips, Trip 31 and 207. I have reservations concerning these records and would like to see if we still have the original data sheets to confirm that it is not a coding error. All records except for one show discarded weights with amounts ranging from 5 kgs to 906 kgs. That is a lot of American Shad. I would like to have the opportunity to confirm these records if possible.

Appendix II. Research survey and fishery observer catches of American shad from the Gulf of St. Lawrence.

Research surveys conducted in the southern Gulf and
fishery observer reports of American shad catches from the Gulf of St. Lawrence.

by

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September bottom-trawl survey methods

Bottom-trawl surveys of the southern Gulf of St. Lawrence have been conducted each September since 1971. Surveys have followed a stratified random design, with stratification based on depth and geographic area. The target fishing procedure in all years was a 30-min tow at 3.5 knots. The number of tows conducted each year varied between 64-70 tows in the 1971-1980 period and over 200 tows in recent years. The distribution of tows is shown for each 4-yr block between 1971 and 2002 in Appendix Figure II-1. Further details are given by Hurlbut and Clay (1990).

Fishing in the September survey was by the *E.E.Prince* using a Yankee-36 trawl from 1971-1985, by the *Lady Hammond* using a Western IIA trawl from 1985-1991, and by the *Alfred Needler* using a Western IIA trawl since 1992. Fishing was restricted to daylight hours (07:00-19:00) in 1971-1984 but conducted 24-hr per day since 1985. Adjustments for differences in catchability between vessels or gears or for differences in catchability between day and night cannot be reliably estimated for American shad in the Southern Gulf due to lack of data. Consequently the catches of American shad are summarized in 4-yr blocks, standardized to a 1.75 nautical mile standard tow (Appendix Figure II-2). Bubble sizes in Appendix Figure II-2 are the 10, 25, 50, 75 and 90th percentiles based on non-zero catches.

Other research surveys were conducted at different times of the year (Appendix Table II-1, II-3). The protocols for these sruveys were similar to those of the annual September survey. Additional details on the Southeastern Gulf seasonal surveys are provided by Clay (1991). During the seasonal surveys, shad were captured in 2 of 582 sets.

Juvenile cod surveys were run annually in July and August during 1990 to 1995. The survey area was concentrated in the Shediac Valley (NB), a principal cod nursery area (Hanson 1996). An average of 44 stations were sampled each year (range 34-54 stations). Although four different vessels were used over the years, the same trawling gear was used. Details of the surveys are provided in Sinclair et al. (1995) and Hanson (1996). In the more than 260 sets made from 1990 to 1995, American shad was observed once: July 4, 1993, (Lat. 46 45 Long 64 32).

More recently, juvenile shad have been captured in Northumberland Strait during a fall lobster trawl survey in 2002 (Appendix Table II-4). A total of 850 shad were captured in 56 of 99 sets, in

depths ranging between 3 m and 30. The largest single catch was 125 individuals and 70% of the sets with shad had ten or fewer individuals. All the shad were juveniles. Surveys in the same areas in the summer of 2001 and 2002 captured one adult shad in each survey (Mark Hanson, DFO Gulf Region, pers. Comm.).

References

Clay, D. 1991. Seasonal distribution of demersal fish (Osteichthyes) and skates (Chrondrichthyes) in the southeastern Gulf of St. Lawrence, p. 241 – 259. In J.-C. Therriault [ed.] The Gulf of St. Lawrence: small ocean or big estuary? Can. Spec. Publ. Fish. Aquat. Sci. 113.

Hanson, J.M. 1996. Seasonal distribution of juvenile Atlantic cod in the southern Gulf of St. Laurence. J. Fish Biol. 49:1138-1152.

Hurlbut, T. and D. Clay. 1990. Protocols for Research Vessel Cruises within the Gulf Region (Demersal Fish) (1970 - 1987). Can. MS Rep. Fish. Aquat. Sci. No. 2082:143 p.

Sinclair, A. F., G. Chouinard, D. Swain, G. Nielsen, M. Hanson, L. Currie, T. Hurlbut, and R. Hébert. 1995. Assessment of the southern Gulf of St. Lawrence cod stock, March 1995. DFO Atl. Fish. Res. Doc. 95/39: 84 p.

Appendix Table II-1. Catches of American shad in the research groundfish surveys of the southern Gulf of St. Lawrence.

Trip	Year	Month	Day	Time	Stratum	Set	Station Latitude	Station Longitude	Fork Length (cm)	Number Caught	Depth (m)	Water temperature (C) Surface	Water temperature (C) Bottom
Seasonal surveys													
172	1987	5	20	1253	437	69	470900	602400	63	1	178	2.9	.
209	1989	12	1	1359	403	1	454500	613400	25	1	25	4.1	0.1
					* stratum 403 = St. George's Bay, NS								
					* stratum 437 = Cape Breton Trough (North west coast of Cape Breton)								
Juvenile survey													
446	1993	7	4	943	421	13	464500	643200	60	1	22	15.9	5.8
					* stratum 421- between NB and western PEI								
Annual September groundfish survey													
106	1972	9	19	855	421	38	464800	643800		3	22	13.6	13.2
122	1973	9	18	725	421	44	464900	643000		2	24	14.6	13.3
143	1974	9	26	1215	420	75	470600	642900		1	33	13.1	6.4
157	1975	9	3	915	432	1	455500	624200		1	60	17.3	.
188	1977	9	10	805	419	19	475900	655300		1	31	12.9	3.7
204	1978	9	9	825	432	1	454700	622000		1	27	16.9	16.8
244	1980	9	4	805	432	1	455400	624200		1	44	16.7	.
244	1980	9	24	1225	422	69	471000	641200		30	42	11.9	9.4
244	1980	9	25	755	423	73	474900	630100		1	75	12.2	0.4
296	1983	9	17	945	432	36	455000	625000		1	38	15.2	7.2
296	1983	9	23	1545	419	49	475200	650700		2	44	12.7	0.9
141	1985	9	19	727	417	16	480900	642100		2	38	13	8.3
141	1985	9	18	725	421	24	470000	641500		8	35	16	5
141	1985	9	17	1825	402	114	455200	631000		21	18	17.3	16.4
141	1985	9	17	2053	402	115	460100	633100		5	18	17	17.1
327	1985	9	18	715	421	24	465900	641500		1	35	15.1	5.3
159	1986	9	20	1017	418	14	480300	643500		1	37	11.6	3.9
159	1986	9	3	1031	403	50	454500	613900		1	31	16.4	16.7
192	1988	9	9	1729	401	27	463000	630400		1	32	16	3.4
232	1991	9	3	826	433	6	460800	615600		1	40	15.8	4.7
249	1996	9	8	625	421	51	465837	642743		2	36	16.5	4.5
846	1998	9	24	1737	403	215	454868	614153		1	32	.	16.1
45	2000	9	5	1832	433	1	455013	622360		1	20	18.6	16.1

Appendix Table II-2. Length frequency distributions of catches of shad by research trip and set in the annual September groundfish survey in the southern Gulf of St. Lawrence.

Fork	Research trip / set number																						
Length	45	106	122	141				143	157	159		188	192	204	232	244			249	296		327	846
(cm)	1	38	44	16	24	114	115	75	1	14	50	19	27	1	6	1	69	73	51	36	49	24	215
7							1																
8						1	1																
9						4	2																
10						6	1																
11						4																	
12						3																	
13						2																	1
19					1																		
23					1																		
24					4												1						
25																	1						
26																	2						
27													1				6						
28																	1						
29																	1						
41														1									
43																			1				
44		1																					
45		1																					
46			1								1												
47		1															3		1	1			
48	1			1													1						
49			1		1										1		2	1					
50																	3						
51																	3						
52										1							4						
53					1												1						
54								1				1				1	1					1	
55						1																	
58																					1		
60									1														
62																					1		
71				1																			
Total	1	3	2	2	8	21	5	1	1	1	1	1	1	1	1	1	30	1	2	1	2	1	1

Appendix Table II-3. Timing and location of seasonal surveys conducted in the Southern Gulf of St. Lawrence at times other than the standard September surveys, including number of sets fished and number of sets in which American shad were captured. Survey protocols and gear were identical to the standard bottom-trawl surveys.

Survey abbreviation	Dates	Area surveyed[1]	Number of bottom-trawl sets	Sets with American shad
H166	Dec. 04-09, 1986	S.E. Gulf	34	0
N073	Jan. 07-10, 1987	S.E. Gulf	23	0
H172	May 19-24,1987	S.E. Gulf	43	1
H174	June 17-22, 1987	S.E. Gulf	48	0
H209	Dec. 01-07, 1989	S.W. Gulf	24	1
H215	Jun. 29-Jul. 6, 1990	S.W. and S.C. Gulf	70	0
H223	Nov. 20-28, 1990	S.W. and S.C. Gulf	79	0
N151	Apr. 18-28, 1991	S.W. and S.C. Gulf	85	0
H245 / N176	Aug. 01-08, 1992	S.W. and S.C. Gulf	68 / 66	0

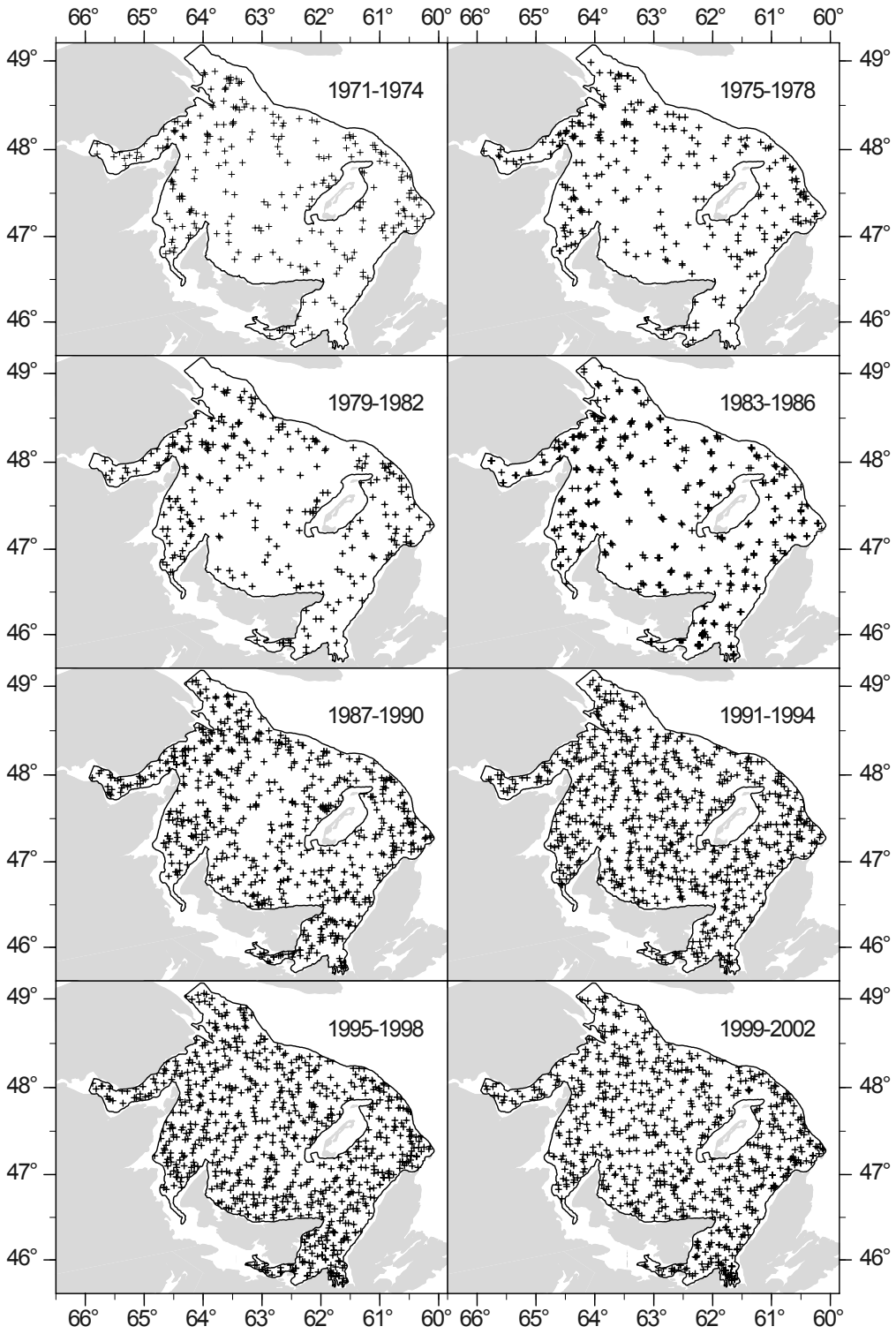
[1] S.E. (Southeastern Gulf), S.W. (Southwestern Gulf), S.C. (South-central Gulf)

Appendix Table II-4. Catches of American shad during the 2002 fall lobster survey in the western portion of Northumberland Strait, Gulf of St. Lawrence. Data collected and provided by Mark Hanson (DFO Gulf Region).

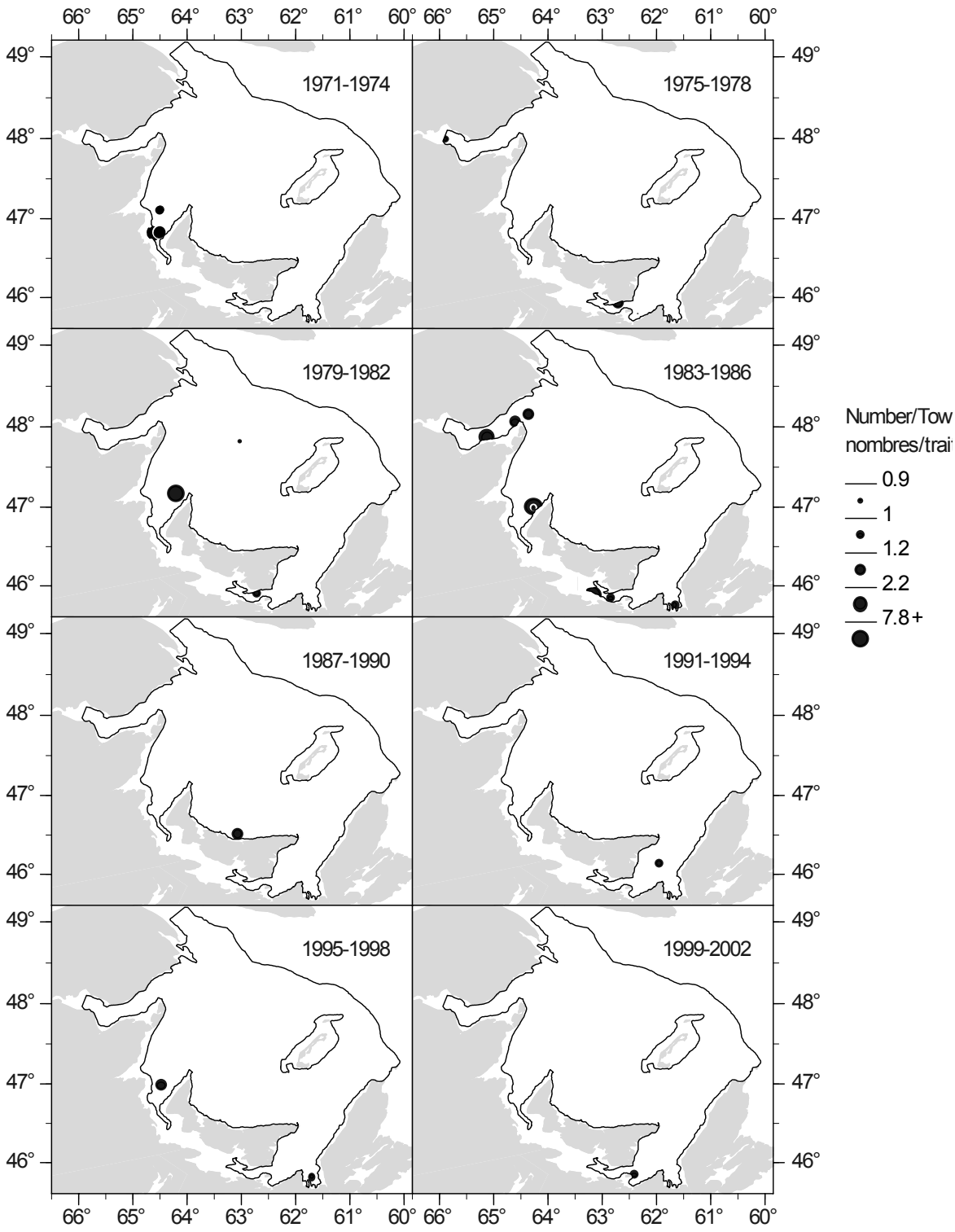
							Tow	Shad catch		
				Depth	Midpoint position		Distance		Weight (kg)	
Stratum	Station	Set	Date	(m)	Latitude	Longitude	(km)	Number	Total	Averag
4	310	3	10-Oct-02	11	46.136	64.084	1.24	30	0.3	0.01
4	312	5	10-Oct-02	15	46.144	64.024	1.27	5	0.05	0.01
4	321	6	10-Oct-02	13	46.117	63.532	1.25	5	0.1	0.02
4	314	7	10-Oct-02	20	46.143	63.577	1.28	5	0.05	0.01
4	304	8	10-Oct-02	21	46.164	63.576	1.29	6	0.3	0.05
4	306	10	10-Oct-02	23	46.156	63.516	1.23	10	0.4	0.04
4	277	12	10-Oct-02	8	46.201	63.523	1.27	5	0.05	0.01
4	262	13	11-Oct-02	3	46.214	63.541	1.16	30	0.2	0.01
4	261	14	11-Oct-02	6	46.218	63.578	1.08	30	0.15	0.01
4	275	15	11-Oct-02	8	46.198	63.584	1.28	40	4.6	0.12
4	274	16	11-Oct-02	8	46.200	64.007	1.25	4	0.06	0.02
4	288	17	11-Oct-02	14	46.175	63.800	1.39	10	0.2	0.02
4	258	21	11-Oct-02	9	46.223	64.066	1.46	10	0.5	0.05
3	270	22	11-Oct-02	16	46.201	64.119	1.14	20	2.3	0.12
3	246	24	11-Oct-02	14	46.246	64.145	1.46	2	0.2	0.10
3	238	25	11-Oct-02	13	46.268	64.114	1.40	1	0.08	0.08
3	230	26	11-Oct-02	8	46.284	64.084	0.81	10	0.05	0.01
3	220	27	12-Oct-02	11	46.301	64.098	1.21	5	0.1	0.02
3	219	28	12-Oct-02	11	46.301	64.123	1.35	2	0.02	0.01
3	228	29	12-Oct-02	13	46.273	64.149	1.26	1	0.01	0.01
3	218	30	12-Oct-02	13	46.305	64.142	1.36	5	0.2	0.04
3	209	31	12-Oct-02	11	46.318	64.113	1.18	15	0.15	0.01
3	184	35	12-Oct-02	5	46.358	64.178	1.31	100	3.4	0.03
3	207	36	12-Oct-02	16.7	46.314	64.170	1.33	50	1.2	0.02
3	206	37	12-Oct-02	22.2	46.312	64.198	1.19	5	0.7	0.14
3	280	38	13-Oct-02	11	46.182	64.224	1.05	5	0.05	0.01
3	296	40	13-Oct-02	9.3	46.159	64.192	1.20	15	0.3	0.02
3	297	41	13-Oct-02	7.4	46.161	64.165	1.16	10	0.05	0.01
3	298	42	13-Oct-02	11.1	46.159	64.139	1.49	1	0.01	0.01
3	283	43	13-Oct-02	14.8	46.178	64.143	1.25	12	0.075	0.01
3	279	46	16-Oct-02	9	46.185	64.267	1.26	20	0.2	0.01
3	266	47	16-Oct-02	14	46.202	64.233	1.24	5	0.05	0.01
3	253	48	16-Oct-02	13	46.224	64.205	0.81	65	1.3	0.02
3	244	49	16-Oct-02	16	46.242	64.203	1.32	20	0.2	0.01
3	235	50	16-Oct-02	18	46.262	64.203	1.38	12	0.12	0.01
3	225	51	16-Oct-02	25	46.283	64.232	1.48	2	0.05	0.03
3	215	52	16-Oct-02	15	46.305	64.230	1.18	10	0.95	0.10
3	195	53	16-Oct-02	8	46.340	64.178	1.37	70	1.8	0.03
3	194	54	16-Oct-02	10	46.340	64.199	1.14	125	2.45	0.02
3	182	55	16-Oct-02	9	46.362	64.236	1.28	26	0.26	0.01
3	278	56	18-Oct-02	6	46.182	64.288	1.30	2	0.02	0.01
3	265	57	18-Oct-02	11	46.203	64.259	1.24	2	0.02	0.01
3	233	60	18-Oct-02	11	46.263	64.259	1.25	1	0.01	0.01
2	181	66	18-Oct-02	26	46.359	64.260	1.30	2	0.02	0.01
3	241	72	19-Oct-02	11	46.241	64.285	1.31	8	0.5	0.06
3	240	73	19-Oct-02	9	46.239	64.316	1.22	8	0.5	0.06
3	231	74	19-Oct-02	8	46.261	64.314	1.28	2	0.02	0.01
3	200	77	19-Oct-02	9	46.321	64.374	1.29	5	0.05	0.01
3	199	78	19-Oct-02	10	46.344	64.401	1.25	4	0.01	0.00
3	201	81	19-Oct-02	10	46.322	64.343	1.26	3	0.02	0.01
3	202	82	19-Oct-02	12	46.321	64.315	1.13	2	0.02	0.01
1	170	84	21-Oct-02	13	46.380	64.372	1.39	2	0.02	0.01
3	243	92	25-Oct-02	15	46.240	64.231	1.26	2	0.02	0.01
3	227	94	25-Oct-02	17	46.280	64.172	1.29	1	0.01	0.01
3	269	99	25-Oct-02	18	46.199	64.143	1.27	1	0.02	0.02

Appendix Table II-5. Fishery observer reports of American shad in the fisheries of the Gulf of St. Lawrence, 1995 to 2001.

Gear	Year	Month	Day	LAT	LONG	Unit Area	Catch Number
other	1995	4	8	49.50	63.93	4Ss	1
scottish seine	1999	5	5	46.95	59.95	4VN	3
scottish seine	1999	5	5	46.93	59.93	4VN	2
gillnet	2000	7	11	47.64	64.41	4Tn	2
gillnet	2000	7	20	47.58	64.46	4Tl	2
gillnet	2000	7	23	48.45	64.27	4Tn	2
gillnet	1997	8	6	47.17	64.47	4Tl	1
gillnet	1997	8	6	47.20	64.53	4Tl	1
gillnet	1997	8	26	48.07	64.32	4Tn	2
gillnet	1998	8	17	46.17	61.47	4Tg	2
gillnet	1998	8	25	47.20	64.42	4Tl	4
gillnet	1999	8	12	47.57	64.42	4Tl	2
gillnet	2000	8	9	47.21	64.54	4Tl	2
gillnet	2000	8	9	47.15	64.40	4Tl	2
gillnet	2000	8	20	47.14	64.41	4Tl	6
other	2000	8	3	48.52	62.80	4Tk	1
gillnet	1995	9	13	46.47	63.12	4Tg	2
scottish seine	1996	9	5	47.15	64.28	4Tl	5
scottish seine	1996	9	5	47.20	64.32	4Tl	4
gillnet	1996	9	16	47.53	64.47	4Tn	1
otter trawl	1996	9	25	47.73	64.25	4Tn	1
gillnet	1997	9	8	48.12	64.37	4Tn	4
otter trawl	1997	9	9	48.40	63.78	4Tn	2
otter trawl	1998	9	26	47.83	64.13	4Tn	5
gillnet	1998	9	9	47.17	64.43	4Tl	10
gillnet	1998	9	18	48.40	64.27	4Tn	3
gillnet	1999	9	8	47.58	64.42	4Tl	2
gillnet	2000	9	26	48.33	64.56	4Tn	4
gillnet	1995	10	3	48.13	64.22	4Tn	7
gillnet	1995	10	3	48.10	64.22	4Tn	3
gillnet	1995	10	3	48.12	64.23	4Tn	7
otter trawl	1996	10	8	47.38	64.18	4Tl	3
scottish seine	1997	10	13	47.12	64.40	4Tl	1
gillnet	1997	10	14	47.18	64.40	4Tl	2
gillnet	1997	10	6	47.48	64.53	4Tl	4
scottish seine	1997	10	13	47.58	64.15	4Tl	2



Appendix Figure II-1. Location of stations sampled during the annual September bottom-trawl survey of the southern Gulf of St. Laurence for eight four-year periods from 1971-2002.



Appendix Figure II-2. Distribution of catches (number/standard tow) of American shad in the Southern Gulf of St. Lawrence September surveys.