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Gulf Region

Gaspereau Assessment for the DFO Gulf Region to 2019: Fisheries, Data and Biological Characteristics and Indicators of Status

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

This document was prepared in support of the “Assessment of the status of gaspereau stocks of the southern Gulf of St. Lawrence” Regional Advisory Process, April 20-21, 2021. The previous assessment for Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*), collectively known as gaspereau, was done in 2001. Stock status in relation to reference points, fishing mortality rates and exploitation rates are available in Gibson and Breau (2024).

This document presents information for Fisheries and Oceans (DFO) Gulf Region up to 2019 on management measures for gaspereau fisheries, commercial gaspereau fisheries landings, gaspereau abundance indices in marine DFO research surveys and, indicators of stock status and biological characteristics for Alewife and Blueback Herring populations in the Margaree River (NS) and the Miramichi River (NB), two rivers in the DFO Gulf Region where these species are monitored.

Alewife and Blueback Herring in individual rivers are considered to be different stocks. The two species have different migration timing and spawning areas and therefore, stock assessments are conducted at river-specific scale and separately for each species.

Catch and effort in commercial fisheries is key for estimating removal rates from populations. No catch and effort information is available for commercial gaspereau fisheries in areas of New Brunswick and Prince Edward Island managed by DFO Gulf Region. In the Gulf Region, reported commercial landings of gaspereau from DFO Statistics Branch have declined over the time series from 1917 to 2019. These are known to be incomplete and may not reflect abundance.

Indicators of stock status for Alewife and Blueback Herring are available for the Margaree River. Catch per unit effort in the Margaree River commercial gaspereau fisheries peaked in the 1980s and has fluctuated around a mean of 61 kg/hour since the last management changes was implemented in 2001.

The commercial gaspereau fisheries in the Miramichi River have not been sampled since 2000. Indicators of stock status for Alewife and Blueback Herring in the Southwest and Northwest Miramichi River were collected from DFO research trapnets upstream of commercial gaspereau fisheries. Catches of both species have declined from 1994 to 2019 on the Southwest Miramichi River whereas catches on the Northwest Miramichi River have been variable.

Commercial gaspereau fisheries are conducted on a large number of rivers in the Gulf Region and systematic sampling of the fisheries catches has only been conducted on one river, the Margaree River. In order to assess the status of gaspereau stocks in the region, additional effort will be required to sample these fisheries, on an intermittent and rotational basis, and the development and validation of other indicators of status such as by examination of age composition and catch curve analyses will be required.

There are very few region-wide indicators of gaspereau abundance. At the regional scale, the bottom-trawl surveys showed a decline in catch rates of gaspereau over time although it is unclear how well the survey indices reflect abundance.

Over the sampling period of 1983 to 2019, the average size of Alewife and Blueback Herring in the Margaree River commercial fisheries declined 41% and 53% by length and 10% and 13% by weight, respectively. A significant declining trend in size-at-age of Alewife and Blueback Herring was observed from 1983 to 2019 on the Margaree River. This was not observed on the Miramichi River but, could be due to the much shorter time series.

1. INTRODUCTION

This working paper was prepared in support of the “Assessment of the status of gaspereau stocks of the southern Gulf of St. Lawrence (sGSL)” Regional Advisory Process, April 20-21, 2021. “Gaspereau” is a colloquial name for two anadromous species of fish, Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*). Where both species co-exist, they are harvested and marketed together as “gaspereau”. These species are typically harvested during their spring spawning runs. In the Fisheries and Oceans Canada (DFO) Gulf Region, which include rivers of New Brunswick (NB), Nova Scotia (NS), and Prince Edward Island (PEI) flowing into the sGSL, fisheries for these species occur in many rivers in this region and fishing practices and gear types differ among rivers. Management is typically through effort controls. The commercial gaspereau fisheries in the Margaree and Miramichi rivers have historically been the largest fisheries in the Gulf Region. The status of gaspereau stocks in this region has not been regularly assessed. The last published assessment of the status of gaspereau stocks in the Gulf Region was published in 2001 (DFO 2001).

This working paper addresses questions in the Terms of Reference pertaining to:

1. Description of present and recent management measures and catches to the end of 2019, including best estimates of total removals by all fisheries;
2. Overview of species biology and characteristics (for ex. size at age, age at maturity);
3. Indicators of stock status and trends (commercial catch rates, fishery independent indices) by size and age group (if available);
4. Description of the impacts of fishing activities for gaspereau on other species and fish habitat;
5. Description of the impacts of fishing activities for other species on gaspereau stocks; and,
6. Description of ecosystem components which are modifying the species abundance and population dynamics (for ex. temperature, predators, prey).

These questions are addressed via:

1. A description of management measures and catches up to year 2019;
2. An overview of the biology and biological characteristics for known populations;
3. Presentation of indicators of stock status and trends by fish size and age; and
4. A brief description of impacts of the gaspereau fisheries on other species and impacts of other fisheries on gaspereau.

The other working paper, Gibson and Breau (2024) addresses questions in the Terms of Reference pertaining to:

1. Estimates of total biomass as derived from population models for the Margaree River;
2. Estimates of absolute fishing mortality rates for the stocks;
3. Reference points by species against which to assess stock status; and
4. Indicators of stock status which can be used to inform fisheries management in the intervening years of the multi-year assessment and management cycle.

1.1. ABOUT GASPHEREAU

Gaspereau fisheries located in rivers and estuaries are thought to target separate populations of each species, and as such these individual populations are considered the appropriate level for assessing the status of these stocks (*sensu* DFO 2001; ASMFC 2012a,b; Gibson et al. 2016). Evidence supporting that anadromous *Alosa* home to natal rivers includes tagging studies that show homing to rivers of previous spawning in both American Shad (a closely related species) and gaspereau, and genetic studies that show substantial differentiation among samples collected from different rivers (McBride et al. 2014, Palkovacs et al. 2014).

Species distribution for Alewife extends from Newfoundland to North Carolina and for Blueback Herring from New Brunswick to northern Florida (Scott and Crossman 1973). In Canadian freshwater streams, Alewife are more common than Blueback Herring (Scott and Crossman 1973).

Similar to other anadromous fish, these two species have important functions in aquatic ecosystems: they transport and exchange nutrients and biomass between freshwater and marine ecosystems as part of their complex life cycle (Naiman et al. 2002; Walters et al. 2009); they are important forage fish in freshwater, the ocean and for terrestrial organisms and they are important predators that can modify the zooplankton community composition in lakes. At times, gaspereau are the most abundant species in diadromous fish runs, sometimes vastly outnumbering Atlantic salmon. Chaput (1995) reported that non-salmon species, including gaspereau, are 99% of diadromous runs in the Miramichi Estuary.

Alewife spawn in slow flowing water in lakes whereas Blueback Herring spawn in faster flowing streams (Scott and Crossman 1973).

1.2. LIFE CYCLE

The life cycles of Alewife and Blueback Herring are similar. Gibson et al. (2016) describe the life cycle as follows:

“Alewives and Blueback Herring are sympatric throughout much of their range (Loesch 1987), although Blueback Herring have a larger and more southerly range (Nova Scotia to Florida) than Alewife (Labrador to South Carolina). The species have similar life cycles (Figure 1). Adult river Herring migrate up coastal rivers in the spring (late-March to late-June) for spawning, with the majority of the combined runs returning in May to rivers in Nova Scotia and southwest New Brunswick. Adults spawn in fresh water during the spring, after which they return to the ocean. Young-of-the-year river Herring move downstream in the late summer and early fall to winter at sea. The fish mature at two to seven years of age at which time they return to the rivers to spawn. Alewife and Blueback Herring are iteroparous and in non-impacted populations may spawn as many as four to six times throughout their lives.

Although their spawning periods overlap, alewives may begin their spawning run 2 to 4 weeks earlier than Blueback Herring. Spawning runs are thought to be highly structured, with older and larger individuals returning first and smaller, first-time spawners coming later in the run. In rivers in the Maritimes Region, alewives typically begin spawning in May, and may continue to do so over two months (Scott and Scott 1988), utilizing ponds, lakes or slow-flowing portions of streams and rivers as spawning habitat. In areas where spawning seasons overlap, the two species are isolated by the use of different spawning sites (Loesch and Lund 1977), with Blueback Herring spawning in areas with faster moving water (Loesch 1987). Less is known about the habitat preferences or distribution patterns of adults in the marine environment, but it is thought that there is broad mixing among species as well as populations originating in Canada and those in the United States.”

1.3. ASSESSMENT HISTORY

The gaspereau stocks of the two largest fisheries in the southern Gulf, the Miramichi River (NB) and the Margaree River (NS), were last assessed in 2001 (DFO 2001). Annual assessments of the gaspereau fisheries on the Margaree and Miramichi rivers were published from 1983 to early 1990s (Margaree: Alexander 1984, Alexander and Vromans 1985, Alexander and Vromans 1986, Alexander and Vromans 1987, Alexander and Vromans 1988, Chaput and LeBlanc 1989, Chaput and LeBlanc 1990, Chaput et al. 1991; Miramichi: Alexander and Vromans 1983 to 1988, Chaput and LeBlanc 1989, LeBlanc et al. 1991). From 1992 to 1997, stock assessments were published every two years for these two rivers (Margaree: Chaput 1993, Claytor et al. 1995, Chaput et al. 1997; Miramichi: Mowbray et al. 1993, Anon 1995, Chaput and Atkinson 1997). The most recent assessment updated the previous assessments and also included the years 1997 to 2000 (Chaput et al. 2001, Chaput and Atkinson 2001).

Updates of the gaspereau fisheries in the rivers Richibucto, Pokemouche and Tracadie have been published in some years (Peppar and Pickard 1976; Chaput and Atkinson 1997, Chaput et al. 2001) and for the Kouchibouguac and Black rivers (Tremblay et al. 1994). An assessment of gaspereau stocks in rivers of Prince Edward Island has been prepared in 1997 (Cairns 1997). No formal gaspereau stock assessment has been conducted for other rivers in the Gulf Region although commercial gaspereau fisheries have been occurring every year. A report summarizing the landings of estuarine fishes, including gaspereau, in the Gulf of St. Lawrence was published in 1991 (LeBlanc and Chaput 1991).

2. FISHERIES MANAGEMENT

Management measures for commercial and recreational gaspereau fisheries have mostly remained unchanged since 2000 and are described in the [Integrated Gaspereau Fishery Management Plan 2007-2012](#). Cairns (1989) provides a description of the seasonal timing of fisheries and types of gears used in gaspereau commercial fisheries in the Gulf of St. Lawrence up to the late 1980s. No accidental bycatch can be kept in gaspereau commercial fisheries in the DFO Gulf Region except for *Alosa* species.

Gulf Nova Scotia (except Margaree River)

In tidal waters in the counties of Antigonish, Colchester, Cumberland and Pictou that border on Northumberland Strait, commercial gaspereau fishers can choose one of these gear types: trapnets, gill nets, dipnets, square nets, drift nets or weirs. The season for fishing is from March 15 to July 10, with weekly closed times from 14:00 each Friday to 14:00 on the following Sunday.

In tidal waters of Inverness County and that portion of Victoria County west of Cape North that borders on the Gulf of St. Lawrence, commercial gaspereau fishers can choose one of the following gear types: trapnets, gill nets, dipnets, square nets, drift nets or weirs. The season for fishing is from March 15 to July 10, with weekly closed times from 18:00 each Friday to 18:00 on the following Sunday.

In commercial inland gaspereau fisheries of Antigonish, Pictou, Colchester and Cumberland counties, fishers can choose one of these gear types: trapnets, gill nets, dipnets, square nets, drift nets or weirs. The fishing season is from March 15 to July 10, with weekly closed times from 14:00 each Friday to 14:00 on the following Sunday.

Bait fishing requires a license with gill nets and dipnets permitted during the same time period.

Recreational fishing, using dipnets, is permitted without the obligation of having a license or registering catches. There is a maximum daily limit of 20 gaspereau per person.

Margaree River

Prior to 1984, the fishing season for gaspereau in the Margaree River was from April 1 to June 30 with no closed periods during the fishing season. In 1984, weekend closures of the fisheries were introduced because exploitation rates on gaspereau were high. The closures were from 18:00 on Friday to 8:00 on Sunday morning for fishers located below the Highway 19 bridge and the closures for fishers above the bridge were from 18:00 Saturday to 8:00 on Monday morning. A different management plan was introduced in years 1992 to 1995 because fishers were concerned that the peak gaspereau migration could occur on weekends when traps were not fishing. Under this plan, traps could be fished in both zones during all days of the week with alternating morning and evening closures every second day (Chaput 1993; Claytor et al. 1995). Even with these changes in management measures, the stock had severely declined (Chaput et al. 1997) and additional fishing closures were put in place during the 1996 season. These closures consisted of complete closures for three days of the week and half day periods for two of the four remaining fishing days. This management plan remained in effect during 1996 to 2005. Beginning in 2006, closures consisted of complete closures on Sundays and Mondays with alternating half days and full days for each zone based on date.

Gulf New Brunswick

Commercial gaspereau fishers within a watercourse can chose by concensus among three options for fishing between mid-May and beginning of July: four consecutive weeks with no weekend fishing closures, five consecutive weeks with fishing closed the first two weekends of May, six consecutive weeks with all weekends closed to fishing. Only trapnets are allowed although two gaspereau permits are authorised to use gill nets under a terminal license. Limits on the number of fishing gears in the commercial gapereau fisheries is set for each permit depending on the river.

Recreational gaspereau fishing, using line or dipnets, is allowed without the obligation of having a license or registering catches. There is a maximum daily limit of 20 gaspereau per person. Fishing with lines varies among years whereas dipnet fishing are allowed on the same dates as the commercial fishery.

Prince Edward Island

A Conservation Harvesting Plan is in place for all commercial gaspereau fisheries and bait fisheries. The fish caught are predominantly for bait (usually for lobster fishery). Commercial license-holders can sell the gaspereau whereas bait license-holders are only permitted to fish for their own use in other fisheries. The permitted gear types are trapnets, gillnets and dip nets. The fishing season in 1997 to 2019 was from May 1 to June 30 with weekend closures from 20:00 on Fridays to 8:00 on Mondays.

For the recreational fishery, angling gear and dip net are authorized. The daily limit is 20 gaspereau. Dipnet is only for tidal waters and there is a weekend closure from 8:00 each Friday to 18:00 the following Sunday.

3. REPORTED COMMERCIAL GASPEREAU LANDINGS

3.1. TIME SERIES OF REPORTED CATCH

Reported commercial landings data are collected by Fisheries and Oceans' Department of Statistics and presented by statistical districts (Figure 2). These official reported landings are

minimum values as landings for bait are not recorded on purchase slips. Commercial landings may be indicative of abundance, but are also sensitive to changes in effort and changes in reporting.

Since 1997, gaspereau was landed in most statistical districts of the DFO Gulf Region highlighting the widespread presence of these two species in the sGSL (Figure 3; Tables 1 to 3). Reported commercial gaspereau landings in the DFO Gulf Region (Figure 4; Tables 1 to 3) have been variable from 1917 to 2019 with landings in excess of 4,000 tonnes (t) for most years from 1978 to 1995 (mean: 4,700 t) and a sharp decline in landings since 1999 (Figure 4). Reported commercial gaspereau landings in the DFO Gulf Region have been driven by the gaspereau fisheries in Gulf New Brunswick (69 to 91% of the annual reported landings), followed by coastal areas in Gulf Nova Scotia (4 to 17%) and Prince Edwards Island (2 to 7%). Gaspereau landings were highly variable among years with large landings often followed by a sharp decline in subsequent years.

3.2. MARGAREE RIVER

The Margaree River, located in Western Cape Breton (Figure 5), is an index river where DFO Science has monitored the gaspereau stock since 1983. DFO Science began a logbook program on the Margaree River in 1984 collecting detailed information on daily catch and effort in the commercial gaspereau fisheries. Since 1984, DFO Science has prepared and sent logbooks to all fishers on the Margaree prior to the commencement of the gaspereau fishing season.

3.2.1. Licenses

The total number of gaspereau licenses on the Margaree River has decreased by half from 1983 to 2019 with the number of active licenses varying from 17 to 21 since 2001 (Table 4). The number of active licenses has always been less than the total licenses on the river (Table 4). A freeze is in effect on new entrants into the fishery such that a license or a site can only be transferred to an immediate family member. Since 1997, logbooks have been mandatory and a condition of license. The return rate of logbooks was 58% prior to the mandatory returns of logbooks and has since varied between 70 and 100% (Table 4). For the period of 1983 to 2008, DFO Science also conducted phone surveys with all gaspereau fishers on the Margaree River at the end of the season to determine the total number of pails filled during the season. The logbooks and surveys both informed about the annual landings.

3.2.2. Commercial Landings

Reported commercial gaspereau landings in DFO Statistical District 2 (see Figure 2) are driven by reported landings in the Margaree River which have large annual variation from 1950 to 2019 with a mean reported landing of 609 t from 1950 to 2019 (Figure 6). Logbook data indicate landings were 424 t from 1984 to 2019 and declined to an average of 209 t in a more recent time period (2001 to 2019) (Figure 6). Landings were largest during 1970s and 1980s and smallest from 1996 onward with 1996, 2001, 2012 and 2013 having the lowest catches from 1996 to 2019.

3.3. PRINCE EDWARD ISLAND

Reported landings of gaspereau in rivers of Prince Edward Island (PEI) have varied from less than 10 t in the 1950s to peak landings of 405 and 464 t in 1979 and 1986, respectively (Figure 4; Table 3). The low landings from the 1950s to 1970s likely resulted from low reporting rather than fish abundance (Cairns 1997).

In 2010, logbooks were sent by DFO Science to gaspereau fishers on PEI to get information on catch and effort in the commercial gaspereau fishery. A total of eight fishers returned their logbooks encompassing 20 fishing sites over 12 rivers (reporting rate unknown). The number of gaspereau reported was 61,597 kg and total of 281 net-days for an estimated catch rate of 220 kg per net-day.

3.4. EASTERN CAPE BRETON (DFO'S MARITIMES REGION)

Although eastern Cape Breton is not part of DFO Gulf Region, gaspereau landings in this area are connected since Alewife tagged in the Margaree River and Pictou harbour have been recaptured at various location along the Atlantic seaboard (Chaput and Alexander 1989; Crawford and Tully 1989). Reported landings of gaspereau in eastern Cape Breton fluctuated annually with catches being higher in the 1980s and 1990s (Table 5). The smallest annual landing during 1984 to 2000 was 33 t and the highest annual landing was 323 t. Since 2001, landings have varied between 6 t in 2010 to 96 t in 2002. In 2019, the reported landing of gaspereau was 49 t (preliminary result). These official landings are minimum values as most landings are used for bait and not recorded on purchase slips.

3.5. SOURCES OF UNCERTAINTY

Daily catch and effort data from different user groups are lacking/incomplete for many rivers in the region preventing estimation of gaspereau removals and making stock status determination difficult. As of 2019, no logbook programs were in place for commercial gaspereau fisheries in rivers of Gulf New Brunswick and Prince Edward Island. Logbooks are important because they provide daily detailed information on catch and effort for individual stocks. Timing of the fish migration can also be inferred from logbooks.

Although DFO Statistics receives reported landings from purchase slips, no daily catch and effort data are available to estimate catch per unit effort for other rivers in the Gulf Region.

There are also no reporting of removals from recreational fishing.

First Nations and Aboriginal organizations throughout the Gulf Region harvest gaspereau under the Food, Social and Ceremonial (FSC) and the commercial communal licenses. No estimate of annual harvest was available for this assessment.

No estimate of poaching and illegal removals of gaspereau was incorporated in this assessment.

4. ABUNDANCE INDICES IN THE MARGAREE AND MIRAMICHI RIVERS

4.1. MARGAREE RIVER

4.1.1. Catch Per Unit Effort

The calculation of catch-per-unit effort (CPUE) requires information on both the landings and effort (hours fished). The Margaree River is the only river in the region where catch and effort data are available. CPUE were calculated in the Margaree River for years 1983 to 2019, however no data were available to estimate CPUE during years with the highest reported landings (1950s) for comparison. The average CPUE in the Margaree River declined from 113 kg/hour during the 1983 to 1990 period to 69 kg/hour from 1991 to 2019 (Figure 6) therefore, less fish were caught for the same amount of effort in the latter time period. Commercial CPUE may be indicative of abundance, but also can vary with environmental factors such as river water levels and fishermen behaviour.

4.1.2. Total Numbers of Fish Harvested

For each species, an age key consisting of the breakdown of catch-at-age by fish length categories was developed for each week with samples. The catch-at-age numbers were adjusted based on un-ageable detail samples and subsequently converted to percentages. The percentage of catch per age-length was multiplied by the fish frequency at the given length category in the daily random sample. The total fish per age class was multiplied by the daily logbook catch and divided by the daily detailed sample. The sum of all these fish corresponded to the total number of fish harvested in a given year.

From 2001 to 2019, annual catches of Alewife in the commercial gaspereau fisheries of the Margaree River varied between 620 thousands to 2.1 millions except for 2001, 2012 and 2013 when catches were lower at values of 402, 501 and 419 thousands Alewife, respectively (Table 6). The fisheries catches from 2001 to 2019 were lower than from 1983 to 2000 when catches were as high as 6.7 millions fish caught (Chaput et al. 2001). The fisheries catch of Blueback Herring were lower than Alewife from 2001 to 2019 with values ranging from 18 to 203 thousand fish (Table 7) however, the catches from 2001 to 2019 were much lower compared to the catches from 1983 to 2000 (Chaput et al. 2001).

4.2. MIRAMICHI RIVER

Gaspereau in the Miramichi River were last assessed in 2001 using data collected in the commercial gaspereau fisheries from 1983 to 2000 (Chaput and Atkinson 2001). No sampling of these fisheries occurred after 2000. The data from 2001 onward were collected from catches in DFO estuary trapnets (Figure 8). Gaspereau were sampled at two DFO research trapnets located on the Northwest and Southwest Miramichi River (Figure 8) since 1994 with species-specific data collected since 2001. The research trapnets are located upstream of the commercial gaspereau fisheries and therefore, gaspereau catches are considered as escapement.

4.2.1. Catches at DFO Research Trapnets in the Miramichi River

The majority of gaspereau caught at the trapnets were recorded as gaspereau with sub-samples collected for detailed measurements (described in 6.2.1). Daily proportion of Alewife and Blueback Herring in the detailed samples were applied to the overall daily gaspereau count to get a species-specific catch. In years when no species-specific samples were collected for details, fish visually identified by species were used as a ratio for the breakdown (years: 2001, 2005, 2011). Although highly variable, catches of both species have declined on the Southwest Branch whereas catches on the Northwest Branch have been variable (Figure 9).

5. ENVIRONMENTAL EFFECTS ON TIMING OF GASPHEREAU CATCHES

The timing of gaspereau catches in the commercial gaspereau fishery in the Margaree River, as inferred from logbook catches, has shifted from 1983 to 2019 with recent years having later peak catches (Figure 10; Table 8). Prior to 2013, 50% of the cumulative catch occurred in late May and occasionally the first few days in June. Since 2013, the 50% cumulative catch were a week later with fish captured from June 7 to June 12. Since 2014, the maximum catch has always been in June whereas it was in May in years prior. The dates when fish were captured have become more variable since 2013 with more fishing days invested to capture 90% of the catch (Table 8).

Continuous (1 hour intervals) water temperature recorders were installed in the upper Southwest Margaree River. In 2009 and 2010, no recorders were installed in the Southwest

branch therefore, water temperature data from a DFO weather station in the main stem of the Margaree River was used. Water temperature in the river did not predict catches of gaspereau with peak catches at temperature below 10 °C in some years (e.g. 2004) and at temperatures above 15 °C in other years (e.g. 2005 and 2006) (Figure 11a to 11c).

6. BIOLOGICAL CHARACTERISTICS

Data on biological characteristics was available for the Margaree and the Miramichi rivers.

6.1. MARGAREE RIVER

6.1.1. Sampling

Sampling of the commercial gaspereau fisheries in the Margaree River was conducted during the fishing season by visiting the lower and upper fishing zones (Appendix 1 for details). A two-stage stratified sampling design was used. Length-frequency data were obtained by measuring 200 to 250 gaspereau in each zone two to four times per week. A sub-sample was kept by retaining three fish for every half cm fork length group up to 28 cm and 5 fish for every half cm for fish longer than 28 cm. The sub-sample was either processed at the DFO field station in Margaree Forks or frozen for later measurements. The data collected from the sub-sample were: species (Alewife or Blueback Herring), fork length (mm), weight (g), scales for ageing, sex, maturity and female ovary weight (g). Age of individual fish was determined by scales collected from the left side of the fish, midway between the dorsal fin and the ventral scutes. For samples that were frozen prior to analysis, the fork lengths of fresh fish were estimated from frozen lengths with the following relationship:

$$\text{Adjusted fork length (mm)} = 1.0143 \times \text{frozen fork length (mm)} + 4.557$$

6.1.2. Species Identification

Alewife and Blueback Herring were identified based on their external appearance and the peritoneum colour (Scott and Crossman 1973). Alewife tend to have a peritoneal cavity that is pale to dusty whereas Blueback Herring have a peritoneal cavity that is sooty to black. Samples collected for detailed measurements during the 1983 to 2019 period ranged from 223 in 2004 to 2,248 in 1989. The gaspereau run in Margaree River during the fishing season was predominantly Alewife with annual proportions ranging from 0.81 to 1 (Figure 12).

6.1.3. First Time and repeat spawners

For Alewife in the Margaree River, the proportion of first time spawners was 0.72 (range: 0.43 to 0.96) with large annual variations (Figure 13) but, average proportions remained similar between time periods (1983-1989: 0.69, 1990-1999: 0.76 and 2000-2009: 0.72 and 2010-2019: 0.71). The proportion of repeat spawners in Blueback Herring also fluctuated widely and were more abundant than for Alewife (Figure 13) suggesting that more Blueback Herring reached spawning grounds than Alewife. Repeat spawners dominated the catches of Blueback Herring in most years. The proportion of repeat spawners is expected to decrease with increasing exploitation rate and is sensitive to the number of recruits in the spawning run.

6.1.4. Sex ratio

The mean proportion of female in Alewife was 0.52 over the time series varying very little from year to year (range: 0.45 and 0.56; Figure 14). The mean proportion of females in Blueback

Herring was more variable among years (sample size ≥ 50 fish) with a mean proportion of 0.47 (0.05 to 0.77; Figure 14).

6.1.5. Age distribution

Scale samples available for ageing ranged annually from 223 to 1,929 for Alewife and four to 346 for Blueback Herring (sample size ≥ 50 fish were used; Tables 9 and 10). Alewife of age 3 and 4 were the most abundant age groups in all years of the time series (Figure 15, Table 9). From 1983 to 1999, Alewife of age 4 were more abundant than age 3 in many years however, with the exception of 2018, Alewife of age 3 make up the highest proportion of the catch since 2000 (Figure 15). The proportion of Alewife of age 5 and older were captured in greater proportions earlier in the time series but have been caught in lower proportion since 2000. This pattern is similar to past conditions (see Alexander (1984) for 1978 to 1983). During 1978 to 1985, 8 year old to 10 year old Alewife were caught every year however; these older age groups have been missing from samples since 1986. Age 3 to 6 Alewife have been sampled from the fisheries almost every year from 1983 to 2012.

Blueback Herring in the Margaree River are primarily age 3 and age 4 fish since 1984 (Figure 15; Table 10) and Blueback Herring of age 8 and older have rarely caught during this time period.

Alexander (1984) compared the age composition of gaspereau in the exploited population of the Margaree River to the unexploited population in West River (Antigonish). Results showed that age 6 to 12 years old gaspereau (primarily Alewife) were more abundant in West River than the 3 and 4 year old fish. In the Margaree River, 3 and 4 year old fish were the most abundant age classes. A lower proportion of age 5 and older could be indicative of increased mortality or increased recruitment.

6.1.6. Fork length, weights and condition factor

Body condition of fish sampled was calculated using the Fulton condition factor (K; Anderson & Newmann 1996) taking into account the length and weight of fish as follows:

$$K = \left(\frac{W}{L^3} \right) * 100,000$$

6.1.6.1. Weight-length relationship

For both species, the weight and length were positively correlated (Alewife: $n = 30,487$, Pearson correlation: $r=0.93$, $p<0.0001$; Blueback Herring: $n = 4,358$, Pearson correlation: $r=0.96$, $p<0.0001$) with a non-linear relationship (Figure 16), at larger sizes, and positively correlated. Variability in weight increased at larger fish length.

6.1.6.2. Trends in length and weight

Alewife were, on average, slightly larger than Blueback Herring with an average fork length of $256 \text{ mm} \pm 19$ (range: 197 to 324 mm) and a mean weight of $224 \text{ g} \pm 59$ (range: 87 to 503 g) compared to $243 \text{ mm} \pm 22$ (range: 188 to 314 mm) and a weight of $179 \text{ g} \pm 57$ (range = 74 to 448 g) for Blueback Herring. In both species, females were larger and than males (Figures 17 and 18) throughout the time series. For both species, fork length and weight declined over the time series beginning in 1983.

6.1.6.3. Length and weight at age

The length and weight at age is incomplete over the time series for both species however, general trends can still be observed. Length at age for Alewife age 3 to 7 and Blueback Herring

age 3 to 6 has declined from 1983 to 2019 (Figures 19 to 22). The trends could be indicative of increased mortality, increased recruitment or a change in growth rate.

6.1.6.4. Seasonal trend in gaspereau run

Typically, the median fork length of gaspereau catches declined over the season with larger and older Alewife caught earlier in the season while first time Alewife spawners and Blueback Herring were caught later in the season (Figures 23 (a to c) and 24). Exceptions are 2004, 2006, 2009 and 2016 where the median fork length did not decrease and the range of length was wider. The length distribution of Alewife in 2001, 2007 and 2011 was wider because of a higher abundance of 5 year old Alewife in the catches.

6.2. MIRAMICHI RIVER

6.2.1. Sampling

Data presented for the Miramichi River in this document are based on fish samples collected at DFO estuary trapnets only (Figure 8). The commercial gaspereau fisheries were not sampled after 2000. Length-frequency data were obtained for each species by measuring approximately 75 fish per day while alternating between trapnets from day to day from 2001 to current. A sub-sample of Alewife and Blueback Herring was kept by retaining 3 fish for every 5 cm fork length group. The sub-samples were frozen and processed at the DFO research lab at a later time. The data collected from the sub-sample were: species (Alewife or Blueback Herring), fork length (mm), weight (g), scales for ageing at a later time, sex, maturity and female ovary weight (g).

6.2.2. Species Identification

Alewife and Blueback Herring were identified based on their external appearance and the peritoneum colour (Scott and Crossman 1973). Alewife tend to have a peritoneal cavity that is pale to dusty whereas Blueback Herring have a peritoneal cavity that is sooty to black. Unlike the Margaree River, Blueback Herring dominated the catches on both branches of the Miramichi River (Figure 25), a similar observation to the last assessment (Chaput and Atkinson 2001). Samples collected for detailed measurements from 2001 to 2019 ranged annually from 150 to 727 in the Northwest branch and from 166 to 729 in the Southwest branch. The mean annual proportion of Blueback Herring was 0.66 (range: 0.53 to 0.82) in the Northwest branch and 0.69 (range: 0.41 to 0.94) in the Southwest branch.

6.2.3. Age Distribution

Age of individual fish was determined by scales collected from the left side of the fish, midway between the dorsal fin and the ventral scutes.

Age data was available for years 2006 to 2013 (excluding 2011) with annual sample size ranging from 141 to 558 for Alewife and 419 to 1,136 for Blueback Herring. Blueback Herring and Alewife of age 3 and 4 were the most abundant age groups of the time series (Figure 26). No historical data exist for these species in the Miramichi River to allow for a comparison over a longer time period. Typically, older fish are observed and more abundant in an unfished population (Chaput and Alexander 1989).

6.2.4. Trends in length and Weight

Alewife were, on average, slightly larger than Blueback Herring with an average fork length of 241 mm \pm 16 (range: 119 to 307 mm) and a mean body weight of 165 g \pm 37 (range: 84 to 356 g) compared to 234 mm \pm 18 (range: 123 to 344 mm) and a body weight of 144 g \pm 36

(range = 46 to 348 g) for Blueback Herring. As in the Margaree River, females in both species were larger and heavier than males (Figures 27 and 28). No trend in fork length and weight was observed for Blueback Herring and Alewife over the time series but this may result from the short time series beginning in 2006. The fork length and weight of Alewife and Blueback populations in the Margaree River declined from 1983 to 2019.

6.3. NATURAL MORTALITY RATES

Natural mortality rates include all non-fishing mortality even the ones not typically considered as “natural” such as anthropogenic effects (e.g. fish passage, water quality). Natural mortality rate is a key parameter in the stock assessment models influencing total mortality rate. Estimates of mortality rates for Alewife and Blueback Herring are presented in Table 11. Chaput and Alexander (1989) conducted a 5-year study (1983-1987) on the South River (NS) where no in-river fishing occurred (although Alewife from this population was likely intercepted in coastal fisheries). They estimated instantaneous mortality rate for Alewife to be 0.44. The Atlantic State Marine Fisheries Commission (2017) assumed M to be 0.63 for all gaspereau stocks along the coast of New England, a value in line with Crecco and Gibson (1990) who set M at 0.66. The Atlantic State Marine Fisheries Commission (2012 a and b) also evaluated the effects of using different M values on results. Then et al. (2015) recommended the T_{max} based estimator to estimate natural mortality. It was calculated as:

$$M = 4.899 * T_{max}^{-0.916}$$

where M is the instantaneous natural mortality rate, T_{max} represents longevity of the fish which is 10 years for Alewife in the Margaree River. We estimated M to be 0.59 with the T_{max} estimator.

Estimates of M for Alewife age 2 to 10 were produced with the von Bertalanffy growth model as presented in Gislason et al. (2010). M was calculated as:

$$\ln(M) = 0.55 - 1.61 * \ln(L) + 1.44 * \ln(L_{\infty}) + \ln(K)$$

where M is the instantaneous natural mortality rate, L represents length of fish (mm) at given age, L_{∞} is the predicted asymptotic length from the von Bertalanffy growth function and K is the metabolic parameter from the von Bertalanffy growth model. L_{∞} was estimated at 323.7 mm and K at 0.2. Values of M obtained from the von Bertalanffy growth model varied from 0.24 for age 2 fish down to 0.13 for age 10 fish. The low variance in the predicted M are presumed to be related to the similar size of fish of different age.

In Gibson and Breau (2024), a value of 0.4 was used in the VPA (as in Chaput et al. 2001). In addition of using a fixed M of 0.4 in the catch-at-age models, M was also estimated in some model configurations (See Gibson and Breau 2024).

6.4. SOURCES OF UNCERTAINTY

The under-reporting of gaspereau fisheries catches going towards bait sale is widespread in DFO Gulf Region creating a data deficiency with the consequences that gaspereau fisheries removals are underestimated. Anecdotal evidence also suggests gaspereau sales for bait may be higher during years of low return (catch are low). Because the commercial landings are a primary scalar that determines biomass in an assessment results, the resulting biomass or abundance reference points are expected to be underestimated if the landings are consistently underestimated.

Age determination was based on scales. Published literature showed that scale ageing underestimate the age in older fish (ASMFC 2020) with otoliths becoming the preferred method to reliably age fish (see Research Recommendations and Gibson and Breau (2024)). However,

otoliths do not provide information about the previous spawning history used in assessment models for anadromous *Alosa*.

Although experienced individuals process the fish, another source of error is the misidentification of species. A comparison of field identification and lab details should be completed to determine error rate.

The commercial gaspereau fisheries have been ongoing for a long time and therefore, it is difficult to know how the biological characteristics of an exploited population compare to those prior to fisheries. The fisheries lead to change in age structure (fewer older fish) and fewer repeat spawners in the systems. Studying unexploited populations is a way to remediate this problem (Chaput and Alexander 1989).

7. MARINE INDICES OF ABUNDANCE

7.1. NORTHUMBERLAND STRAIT SURVEY

The survey began in 2001 and was designed to quantify the yearly variations in abundance and distribution of commercial size lobster in the Northumberland Strait because this region was not covered by other surveys (Comeau et al. 2004). Demersal fishes and large crustaceans were collected along a number of bottom trawls surveys (see Voutier and Hansen 2008 and Comeau et al. 2008 for methodology). Data used in the current analysis excluded 2001 to 2003, 2010 and 2011 because of gear-type did not capture gaspereau.

7.1.1. Spatial analysis and length-frequency distribution

The mean number of gaspereau per tow varied from 8 to 16 fish per tow during 2007 to 2009 and declined to less than 3 fish per tow from 2012 to 2019 (Figure 29, Table 12) indicating that the gaspereau abundance in the Northumberland Strait declined in recent years. The number of gaspereau caught each year is presented in Table 12. The abundance was standardized to a standard tow length of 0.625 nautical miles. These maps are shown in Figure 30. Although not presented here, a Generalized Linear Mixed-Model with random effects over year, location and water depth, was used to analyze fish counts over the NS survey area. The abundance indices were similar and therefore, was not presented here. Interpolated densities over the survey area were produced using a delta-lognormal model (Zuur et al. 2012). Catch data were first partitioned into a presence-absence component and a non-zero catch component.

The length frequency distribution of gaspereau caught in the survey show fish larger than 25 cm were present in catches. These larger fish have not been caught in surveys of 2012 to 2019 (Figure 31).

7.2. MULTI-SPECIES BOTTOM-TRAWL SEPTEMBER SURVEY

A bottom-trawl survey has been conducted by Fisheries and Oceans Canada in the Gulf of St. Lawrence during the month of September since 1971 (Savoie 2014). The trawl survey was designed to capture groundfish rather than pelagic species however, pelagic fish are caught giving species distribution over time. The results for coastal species, including gaspereau, began in 1984 when coastal strata were included. Figure 32 shows the strata covered by the survey.

The biomass index for gaspereau has fluctuated widely among 5-year periods since the beginning of the time series with low biomass from 1991 to 2010 and 2019 (Figure 33).

7.3. SENTINEL SURVEY

Following the collapse of groundfish fisheries, a bottom-trawl survey was initiated by Fisheries and Oceans Canada in NAFO division 4T in 1994 (Savoie 2014). The main objective of the survey was to collect data on species abundance and distribution and to involve fish harvesters in the assessments. The survey occurred in August of every year to complement the annual September multi-species survey discussed above. Pelagic species such as gaspereau were caught in the survey which provides an index of abundance.

Catches of gaspereau were made near shore in the shallow-water strata in the Northumberland Strait and Northwest of Prince Edward Island and in Shediac Valley and Chaleur Bay in certain years (Figure 34; figure from Savoie 2014). Fluctuations in the abundance index could have resulted from changes in abundance and/or gaspereau being distributed outside the sampling sites. No gaspereau length data was recorded in this survey.

8. FRESHWATER AND COASTAL INDICES OF ABUNDANCE

8.1. COMMUNITY AQUATIC MONITORING PROGRAM (CAMP)

The Community Aquatic Monitoring Program began in 2003 as an outreach program for DFO to work more closely with community groups (DFO 2011). The majority of the gaspereau caught in the survey was at sites in NB with large annual fluctuations in catch. Considering the large amount of effort involved in CAMP, the gaspereau catches were small likely because beach seines are not the best sampling method to capture gaspereau (Figures 35 and 36; Tables 13 and 14).

8.2. SILVER EEL MIGRATION IN LONG POND

During August 26 to September 19, 2003, silver eel migration was studied in Long Pond, Dalvay, Prince Edward Island National Park in which gaspereau was captured. Gaspereau were captured eels throughout the study period in gear set up to capture silver eels. Peak catches and biomass of gaspereau occurred from September 9 to 13, 2003 (Figure 37) coinciding with water temperatures falling to 15 and 16 °C.

8.3. CHETICAMP RIVER, CAPE BRETON HIGHLANDS NATIONAL PARK

A trapnet was installed in the estuary of the Cheticamp River during July 25 to November 1st 2004 to estimate the Atlantic salmon abundance. Other species, including gaspereau, were caught during the season (Landry et al. 2005). A total of 62 gaspereau were captured during the months of July to October. Species identification (Alewife and Blueback Herring) was not made.

9. INDICATORS OF STOCK STATUS

Although not quantitative, trends in reported commercial gaspereau fisheries landings, trapnet catches and biological characteristics can be informative about stock status. A summary of the trends in these indicators is provided in Table 15.

Reported commercial gaspereau landings in DFO Gulf Region declined from 1978 to 2019. Caution is advised when looking at Alewife and Blueback Herring combined (i.e. gaspereau) because the abundance of one species could be decreasing while the overall gaspereau abundance is not. Species-specific information can prevent this issue.

The indices available for Alewife and Blueback Herring in the Margaree River (landings, CPUE, biological characteristics) all declined except for the proportion of repeat spawners which were

variable for Alewife and increasing for Blueback Herring. The majority of Blueback Herring likely migrate in freshwater after the fishery resulting in older fish surviving. Blueback Herring are typically captured towards the end of the fishing season.

Indicators for Alewife and Blueback Herring in the Miramichi River were collected from DFO research trapnets located on the Southwest and Northwest branches. Estimates are indicative of spawner escapements as commercial gaspereau fisheries occur downstream. Although the time series is short, catches of Alewife and Blueback have declined on the Southwest branch from 2001 to 2019 and have been highly variable on the Northwest branch.

Marine indices of gaspereau abundance indicate overall declines. Both the September bottom-trawl (1975-2019) and Northumberland Strait (2007-2019) surveys show lower gaspereau abundance and reduced spatial coverage in the sGSL.

10. IMPACTS OF OTHER FISHERIES ON GASPHEREAU POPULATIONS

Gaspereau in the Gulf Region have been captured as bycatch in fisheries targeting Atlantic maquerel, Atlantic Herring and Rainbow smelt. A tagging study conducted in the 1980s showed that gaspereau tagged in the Margaree River and Pictou harbour were intercepted in fisheries at many locations in the Gulf of St. Lawrence as well as along the Atlantic seaboard (Chaput and Alexander 1989; Crawford and Tully 1989). Atlantic Herring fisheries were also identified as having bycatch of gaspereau (Davis and Schultz 2009, Hattala et al. 2011). Cairns (1989) reported bycatch of Alewife and Blueback Herring in the commercial smelt fishery in the sGSL. The occurrence of these two species as bycatch was more frequent in the fall than in winter. Bycatch occurred in all regions and all gear types used during the smelt fishery.

11. IMPACTS OF GASPHEREAU FISHERIES ON OTHER SPECIES

Impacts of gaspereau fisheries on other species can be both direct, via bycatch, and indirect, via the effects of altering the abundance of species that fill important ecological roles.

Bycatch of fish species other than gaspereau occurred in the gaspereau fishing gear. Atlantic salmon, Striped bass, White sucker, Brook trout have been captured in gaspereau fisheries. Although not fully analyzed, the amount of bycatch seemed low with live releases known to have less impacts on populations.

Gaspereau are important species ecologically. They are prey species both at sea and in fresh water, and are also important predators that can alter zooplankton community composition within lakes (Mills et al. 1992, Gibson and Daborn 1998). They can also serve as a vector for nutrient transport from the oceans to inland waters (Durbin et al. 1979, Garman 1992, Garman and Macko 1998), as well as from inland waters to the sea (Barber et al. 2018). As a result, human activities such as fishing and the construction of dams that impact upon gaspereau population size may indirectly alter the productivity and community structure within their natal watersheds (Freeman et al. 2003). Based on the dynamics of the Margaree River Alewife population, the effect of exploitation rates on spawner biomass and on the number of recruits is shown in Figure 12 of Gibson and Breau (2024). With increases in the exploitation rate, spawner biomass decreases more rapidly than the number of recruits due to density-dependent survival of young-of-the-year fish in freshwater. As shown by Barber et al (2018), this can change the direction of nutrient flow from a net transport inland when the impacts of fish passage at dams and fisheries are low, to a net transport seaward when the impacts of fish passage at dams and fisheries are high.

12. EFFECTS OF HABITATS AND ECOSYSTEM ON THE SPECIES

A full review of the effects of habitats and ecosystem change on the Alewife and Blueback Herring was not undertaken however, a few general topics of importance under human controls are presented: poor fish passage, introduced species and other factors in the ecosystem affecting productivity.

Habitat fragmentation by artificial structures can impede access of diadromous fish to upstream spawning areas leading to population declines (Gosset et al. 2006; Verhelst et al. 2021). In the DFO Gulf Region, poor fish passage at man-made structures (e.g. culverts) has been identified as limiting upstream migration of fishes (DFO GOSLIM report). Often, culverts are designed for fish that are strong swimmers such as salmonids and therefore, may act as barriers for species such as Alewife, Blueback Herring and Rainbow smelt.

Introduced species can significantly impact native fish communities by modifying primary productivity and food availability, predation, and competition (Jackson and Mandrak 2002; Brown et al. 2009). In the early 2000s, Smallmouth bass were illegally introduced in Lake Ainslie in the Margaree River (LeBlanc 2010) and have since been caught in the mainstem of the Southwest Margaree River. Smallmouth bass were also illegally introduced in Miramichi Lake in 2008 and were caught for the first time in the Southwest Miramichi River in 2019. Although the effects of Smallmouth bass on recruitment of Alewife and Blueback Herring are unknown, studies have documented reductions and loss of native small-bodied fish following Smallmouth bass introductions (e.g. Robinson and Tonn 1989, Findlay et al. 2000; MacRae and Jackson 2001).

The ocean and freshwater environments are rapidly warming and changing due to human activities such as climate change (Doney et al. 2012). In the USA, a declining trend in river Herring growth has been correlated to increasing sea surface temperature during the 1981 to 2017 time period (ASFMC 2017). Water temperature and acidification of the ocean may also be changing the phenology of prey availability and fish migration timing. In freshwater, survival of Alewife and Blueback Herring larvae is regulated by water temperature and flow (Tommasi et al. 2015) and therefore, could be affected by warming freshwater or flash flooding events. Information on species-specific early life history characteristics could advance our understanding of the populations.

13. RESEARCH AND DATA NEEDS

Information about the age and previous spawning history is key in stock assessments because it is informative about survival and, when a natural mortality rate is assumed, exploitation rates. It is also among the easier and cost effective data to collect. As discussed in Gibson and Breau (2024), management systems based solely on catch curves can effectively control exploitation rates and be used to rebuild over-exploited populations and increase landings from populations that are under-exploited (Billard 2020). In the case of the Miramichi River, age and previous spawning composition data, coupled with the trapnet CPUE, should provide a mechanism to assess the population in terms of both abundance and biomass, and the removal reference level. Collection of these data is the top research/data recommendation for improving these assessments.

Catch and effort data from commercial, recreational and First Nations' fisheries is needed to assess the extent of the removals and provide a more accurate assessment of the stock status.

Fisheries-independent data, in conjunction with fisheries-dependent data, is recommended to improve the assessment of populations assessments. Until 2000, a larvae survey was conducted in Lake Ainslie in the Margaree River which was used as an index in the assessment

model. Catch per unit effort from the commercial gaspereau fisheries, fisheries-dependent data, had to be used.

TABLES

*Table 1. Gaspereau landings (t) in Fisheries and Oceans statistical districts in Gulf Nova Scotia from 1997 to 2019. Data were obtained from purchase slips and supplementary “B” slips compiled by the Statistical Branch. Landings should be treated as minimum values. *Landings for 2017 to 2019 are preliminary. Landings for years 1917 to 2000 can be found in LeBlanc and Chaput (1991) and Chaput et al. (2001).*

Year	Nova Scotia Statistical Districts								NS	Gulf
	2	3	10	11	12	13	45	46		
1997	217	-	-	1	-	-	1	-	220	3,025
1998	308	-	-	24	20	8	154	28	544	4,283
1999	256	-	-	7	16	5	123	45	452	4,047
2000	132	-	-	0	29	-	113	-	275	2,453
2001	97	-	-	-	11	-	101	9	217	1,294
2002	222	-	-	-	1	10	164	9	406	2,108
2003	158	-	-	-	-	-	1	-	159	3,488
2004	250	5	-	-	-	1	78	13	347	3,155
2005	163	-	-	-	-	7	31	7	208	3,201
2006	214	-	-	2	1	-	183	10	410	3,606
2007	351	-	-	1	-	-	67	8	428	3,062
2008	306	-	-	10	-	-	76	14	406	3,418
2009	290	-	-	-	-	-	-	-	290	3,032
2010	360	-	-	25	-	5	56	17	462	2,485
2011	226	-	-	6	-	4	43	20	298	1,754
2012	94	-	-	8	-	4	52	5	164	1,481
2013	-	-	3	23	-	5	52	2	84	876
2014	-	-	24	22	-	9	58	14	127	844
2015	-	-	-	-	-	-	1	-	1	1,298
2016	17	-	-	11	-	-	62	-	89	560
2017*	33	-	-	25	-	5	138	-	202	660
2018*	29	-	-	3	-	6	94	46	178	960
2019*	6	-	-	7	-	5	1	29	48	1,041

Table 2. Reported landings (t) of gaspereau in Fisheries and Oceans statistical districts in the Gulf Region New Brunswick from 1997 to 2019. Data were obtained from purchase slips and supplementary "B" slips compiled by the DFO Statistical Branch. Landings should be treated as minimum values. * Landings for 2017 to 2019 are preliminary. Landings for years 1917 to 2000 can be found in LeBlanc and Chaput (1991) and Chaput and Akinson (1997).

Year	New Brunswick Statistical Districts												NB	Gulf
	63	65	67	68	70	71	73	75	76	77	78	80		
1997	-	0.0	159.2	56.0	84.8	739.6	215.9	24.6	1275.7	141.9	-	-	2,698	3,025
1998	-	-	430.4	89.3	1.4	2262.0	74.2	14.0	615.7	145.2	55.1	-	3,687	4,283
1999	-	-	277.8	42.1	16.3	2579.0	9.1	81.0	243.6	223.4	22.9	6.8	3,502	4,047
2000	-	1.4	232.4	5.0	34.4	787.6	35.8	57.6	534.4	255.7	138.6	6.8	2,090	2,453
2001	-	-	-	-	-	-	-	-	-	-	-	-	0	1,294
2002	-	-	-	-	-	-	-	-	-	-	-	-	0	2,108
2003	-	-	445.5	113.8	66.0	1843.2	49.8	33.2	522.7	81.9	89.9	-	3,246	3,488
2004	-	31.8	385.2	101.9	47.4	1125.5	249.0	27.9	541.7	155.7	33.4	-	2,699	3,155
2005	-	-	308.4	73.9	89.0	1367.2	450.3	40.2	321.8	139.2	36.3	0.1	2,826	3,201
2006	-	-	285.5	-	29.1	1161.0	156.1	33.3	892.1	284.0	75.6	-	2,917	3,606
2007	7.4	-	304.0	141.0	-	519.0	633.4	45.1	678.6	142.4	16.8	-	2,488	3,062
2008	11.7	-	345.6	162.5	-	1575.1	-	42.3	584.8	81.3	45.7	-	2,849	3,418
2009	7.0	-	333.5	155.3	31.0	1264.6	13.2	26.5	501.7	127.0	56.2	-	2,516	3,032
2010	-	-	103.0	139.1	82.8	721.0	66.0	9.1	477.6	178.5	62.0	-	1,839	2,485
2011	-	-	317.0	99.3	111.1	438.3	4.4	20.3	221.9	72.7	40.7	-	1,326	1,754
2012	-	23.5	97.4	0.1	155.9	16.2	145.1	53.4	479.3	181.6	63.4	-	1,216	1,481
2013	-	-	31.9	74.3	49.8	9.1	179.4	22.3	166.9	126.4	91.7	-	752	876
2014	-	-	-	18.6	-	-	161.6	11.3	156.0	134.2	181.4	-	663	844
2015	-	-	132.9	-	-	-	179.9	38.4	640.7	159.3	80.2	-	1,231	1,298
2016	-	-	6.4	-	0.3	-	224.7	42.0	194.1	28.4	-	-	496	560
2017*	0.6	-	-	-	-	28.8	234.8	-	131.9	-	-	-	396	660
2018*	-	-	-	-	-	-	456.4	-	271.6	-	-	-	728	960
2019*	-	-	-	-	-	175.7	493.8	-	215.8	67.0	-	-	952	1,041

Table 3. Reported landings (t) of gaspereau in Fisheries and Oceans statistical districts on Prince Edward Island from 1997 to 2019. Data were obtained from purchase slips and supplementary "B" slips compiled by the DFO Statistical Branch. Landings should be treated as minimum values. *Landings for 2017 to 2019 are preliminary. Landings for years 1917 to 2000 can be found in LeBlanc and Chaput (1991) and Cairns (1997).

Year	Prince Edward Island Statistical Districts										PEI	Gulf
	82	83	85	86	87	88	92	93	95	96		
1997	7.2	4.2	-	-	23.9	31.5	7.8	14.7	16.3	1.4	107	3,025
1998	-	2.4	-	-	14.2	24.9	1.9	-	3.3	5.6	52	4,283
1999	0.6	-	0.1	-	5.3	24.2	0	9.9	-	-	40	4,047
2000	-	0.5	-	9.3	3.4	31.1	5.8	10.2	2.6	24.9	88	2,453
2001	3.2	3.1	-	-	1.3	0.1	-	0.5	7.5	11.6	27	1,294
2002	-	20.3	-	18.7	27.7	0.1	0.9	-	-	9.6	77	2,108
2003	7.4	7.4	11.1	-	7.3	15.2	-	0.1	8.2	26.3	83	3,488
2004	1.8	14.5	2.2	-	-	10.0	1.2	-	-	79.0	109	3,155
2005	4.8	53.5	18.7	-	8.7	49.3	0.3	0.5	6.0	25.6	167	3,201
2006	2	20.7	0.3	10.8	2	59.7	0.7	86.3	37.8	59.0	279	3,606
2007	0.9	6.6	-	9.9	12.9	70.9	0.2	1.8	5.5	37.6	146	3,062
2008	0.5	11.8	5.4	-	16.7	65.4	0.1	1.5	6.4	55.3	163	3,418
2009	0.7	43.6	0.5	4.3	63	47.1	6.0	0.1	9.1	51.4	226	3,032
2010	0.5	17.5	0.5	8.7	88.2	33	11.7	0.2	11.7	11.8	184	2,485
2011	1.5	5.4	0.5	7.5	28.2	56	4.6	4.3	7.6	14.1	130	1,754
2012	-	2.6	0.5	4.6	1.8	28.6	1.1	8.4	39.7	13.3	101	1,481
2013	-	1.1	0.5	3.4	1.8	12.4	3.2	3.5	6.3	7.4	40	876
2014	-	0.1	-	-	38.6	3.5	-	1.4	6.8	3.8	54	844
2015	-	13.9	-	2	-	24.8	9.6	1.2	6.9	7.8	66	1,298
2016	-	-	-	0.7	5.6	26.6	2.3	-	3.8	7.2	46	560
2017*	-	-	-	-	14.4	36.3	4	3.3	-	4.0	62	660
2018*	-	3.0	-	1.1	10.7	25.5	-	4.8	0.2	8.7	54	960
2019*	-	-	-	0.7	1.9	20.1	-	5.9	2.3	10.0	41	1,041

Table 4. Gaspereau landings in the Margaree River, total and active licenses and the number of logbooks returned by fishermen from 1983 to 2019.

Year	Landings phone survey (t)	Logbook catch (t)	Total licenses	Active licenses	Logbooks returned
1983	579	113	69	44	9
1984	883	607	68	45	42
1985	1,223	507	68	25	18
1986	623	213	68	33	13
1987	1,259	884	68	33	23
1988	1,666	1434	69	38	35
1989	1,123	975	59	41	32
1990	1,016	782	62	41	30
1991	450	209	62	32	20
1992	553	302	62	27	14
1993	736	439	60	37	17
1994	498	265	59	36	18
1995	217	72	59	33	13
1996	94	20	59	24	7
1997	201	237	59	17	20
1998	284	272	59	24	24
1999	223	208	59	23	23
2000	121	103	59	18	23
2001	94	88	47	21	21
2002	431	446	45	18	21
2003	168	158	45	20	20
2004	206	234	43	18	20
2005	153	163	43	18	18
2006	190	213	43	16	22
2007	664	352	42	19	22
2008	628	307	41	17	19
2009	-	318	40	19	18
2010	-	360	40	21	21
2011	-	235	40	18	18
2012	-	94	40	18	18
2013	-	90	39	17	17
2014	-	138	38	18	18
2015	-	193	-	18	18
2016	-	173	-	18	18
2017	-	222	-	18	18
2018	-	114	-	18	18
2019	-	182	-	18	18

Table 5. Reported landings of gaspereau in eastern Cape Breton during 1984 to 2018. Landings cover the Fisheries and Oceans Canada statistical districts 1, 4, 6, 7, 8, 9 (see Figure 2 for map). Landings should be treated as minimum values. *Landings for 2017 to 2019 are preliminary.

Year	Landings (t)
1984	180
1985	323
1986	63
1987	54
1988	297
1989	33
1990	37
1991 and 1992	149
1993	157
1994	60
1995	129
1996	165
1997	229
1998	169
1999	158
2000	100
2001	72
2002	96
2003	34
2004	29
2005	85
2006	84
2007	34
2008	49
2009	17
2010	6
2011	52
2012	67
2013	34
2014	35
2015	61
2016	49
2017*	71
2018*	45
2019*	49

Table 6. Alewife catch-at-age for the Margaree River, N.S. gaspereau fishery. First number in age indicates total age, second number indicates age at first spawning. Catch is expressed in thousands (number) of fish. YC = year class.

Age	Year																		
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2.2	34	0	11	3	0	0	3	9	17	0	3	2	0	29	12	3	0	0	0
3.3	318	1865	389	667	454	560	724	1101	964	900	668	208	268	404	855	496	814	180	414
3.2	0	9	77	2	1	0	0	3	3	0	0	96	2	2	18	9	15	0	17
Total 3	318	1874	466	668	454	560	724	1104	967	900	669	304	271	406	873	504	829	180	431
4.4	11	121	59	27	108	44	94	130	172	191	167	65	32	98	73	173	231	140	200
4.3	25	85	176	108	303	115	349	187	284	460	290	99	95	137	68	142	152	282	251
4.2	0	0	1	0	0	0	0	0	3	0	0	0	0	5	20	0	0	1	2
Total 4	37	206	235	135	411	159	443	316	459	650	457	163	127	241	161	315	383	422	453
5.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	3	2	2	2
5.4	4	36	13	9	31	27	29	27	49	30	35	14	4	2	13	5	11	7	31
5.3	1	4	18	10	32	63	73	33	91	75	21	16	16	9	16	6	9	9	29
Total 5	5	40	31	19	62	96	101	60	143	105	56	30	20	11	29	14	22	18	62
6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.4	4	0	1	0	4	4	6	1	5	3	0	0	0	2	0	0	0	0	0
6.3	4	0	0	4	4	8	37	5	3	13	4	1	1	0	0	0	0	0	0
Total 6	7	0	1	4	8	12	43	6	8	16	4	1	1	3	0	0	0	1	1
7.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.4	0	0	0	0	0	0	0	0	0	1	0	0	0	6	0	0	0	0	0
7.3	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
Total 7	1	1	0	0	0	1	1	1	0	2	0	0	0	6	0	0	0	0	0
8.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total 8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
9.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Year																		
Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	402	2121	744	829	936	829	1314	1496	1594	1674	1189	501	419	696	1075	836	1234	620	947
% new recruit	90	94	62	84	60	74	62	83	72	65	71	55	72	76	87	81	85	52	65
Major YC	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2014	2015
Age	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4
% of total	79	88	63	81	49	68	55	74	61	54	56	61	65	58	81	60	67	68	48

Table 7. Blueback Herring catch-at-age for the Margaree River, N.S. gaspereau fishery. First number in age indicates total age, second number indicates age at first spawning. Catch is expressed in thousands (number) of fish. YC = year class. Year 2005, sampling conducted from week 1 to 5 which is typically before the Blueback Herring are caught.

	Year																		
Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.1	0	.	0	0	0	0	0	0	0	0	0	0	0
2.2	6	.	0	0	0	0	0	3	0	0	0	0	0
3.3	21	.	13	29	1	32	81	18	62	12	30	28	47
3.2	0	.	0	0	0	0	2	0	18	0	0	1	7
Total 3	21	.	13	29	1	32	83	18	80	12	30	29	54
4.4	27	.	18	53	2	7	7	4	1	2	20	13	42
4.3	5	.	10	37	2	2	22	24	7	22	16	16	49
4.2	0	.	1	0	1	0	0	1	1	1	1	0	4
Total 4	33	.	29	90	5	9	29	29	9	25	37	29	95
5.5	0	.	1	0	1	0	0	0	0	0	8	1	0
5.4	2	.	6	26	5	4	2	1	1	1	2	1	13
5.3	1	.	5	16	2	9	3	1	10	3	6	4	15
5.2	0	.	0	0	2	0	0	0	1	0	0	0	1
Total 5	3	.	12	42	10	13	5	2	12	4	17	6	29
6.6	0	.	0	0	0	0	0	0	0	0	0	0	0

Age	Year																		
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
6.5	.	.	.	.	.	.	0	.	2	1	1	0	0	0	0	0	0	0	1
6.4	.	.	.	.	.	.	1	.	4	8	1	4	1	0	0	0	0	0	5
6.3	.	.	.	.	.	.	0	.	1	5	0	4	1	0	0	1	0	0	5
6.2	.	.	.	.	.	.	0	.	0	0	0	1	0	0	0	0	0	0	0
Total 6	.	.	.	.	.	.	1	.	7	14	2	10	2	0	0	2	0	0	11
7.7	.	.	.	.	.	.	0	.	0	0	0	0	0	0	0	0	0	7	0
7.6	.	.	.	.	.	.	0	.	0	0	0	0	0	0	0	0	0	0	0
7.5	.	.	.	.	.	.	0	.	0	0	0	0	0	0	0	0	0	0	0
7.4	.	.	.	.	.	.	0	.	1	1	0	0	0	0	0	0	0	0	0
7.3	.	.	.	.	.	.	0	.	0	0	0	1	0	0	0	0	0	0	0
Total 7	.	.	.	.	.	.	0	.	1	2	0	1	1	0	0	0	0	7	0
New recruit	13	63	89	29	.	13	55	.	33	82	4	40	89	26	63	15	58	49	89
Maiden spawner	11	13	82	174	.	17	9	.	31	94	14	26	31	27	38	28	26	21	100
Grand Total	24	79	171	203	.	30	64	.	63	176	18	66	120	53	102	43	84	70	190

Table 8. Timing of the gaspereau catches in the commercial fisheries in the Margaree River as inferred from fishers' logbooks for 2001 to 2019 (see Chaput et al. 2001 for 1983 to 2000).

Year	Maximum catch	Cumulative 10%	Cumulative 50%	Cumulative 90%	Total days for 10% to 90%
2001	May 31	May 24	May 31	June 08	16
2002	June 01	May 16	May 29	June 01	17
2003	June 04	May 29	June 05	June 19	22
2004	May 28	May 28	May 29	June 12	16
2005	June 04	May 25	June 03	June 15	22
2006	May 24	May 13	May 24	June 03	22
2007	June 02	May 19	June 02	June 07	20
2008	May 31	May 28	May 31	June 07	11
2009	May 26	May 19	May 27	May 30	12
2010	May 28	May 21	May 28	June 11	22
2011	June 01	May 26	June 01	June 03	9
2012	May 19	May 12	May 19	June 19	39
2013	May 25	May 21	June 01	June 21	32
2014	June 06	May 24	June 07	June 25	33
2015	June 05	June 02	June 09	June 20	13
2016	June 01	May 19	June 07	June 24	37
2017	June 07	May 26	June 07	June 20	26
2018	June 01	May 25	June 07	June 23	23
2019	June 13	June 01	June 12	June 25	25

Table 9. The approximate percentage of biological samples per age group for Alewives collected in the Margaree River commercial gaspereau fisheries during 1983 to 2019. Readings of scales not completed for years 2013 to 2019.

Year	Age									Sample Size
	2	3	4	5	6	7	8	9	10	
1983	0	46	35	16	2	1	0	0	0	610
1984	0	53	25	16	4	1	1	0	0	999
1985	4	26	61	6	2	1	0	0	0	648
1986	1	57	17	24	1	0	0	0	0	882
1987	0	76	19	2	3	0	0	0	0	712
1988	0	42	51	7	1	0	0	0	0	692
1989	1	9	73	15	2	0	0	0	0	1922
1990	0	42	8	43	6	1	0	0	0	1929
1991	-	-	-	-	-	-	-	-	-	-
1992	0	54	23	21	2	0	0	0	0	554
1993	0	54	36	8	2	0	0	0	0	1330

Year	Age									Sample Size
	2	3	4	5	6	7	8	9	10	
1994	0	6	88	5	1	0	0	0	0	1149
1995	0	41	15	42	1	0	0	0	0	601
1996	1	28	59	5	6	0	0	0	0	403
1997	0	81	6	12	0	1	0	0	0	411
1998	0	49	49	2	0	0	0	0	0	530
1999	0	19	54	27	1	0	0	0	0	628
2000	1	34	13	36	15	0	0	0	0	1489
2001	12	52	12	7	15	3	0	0	0	1007
2002	0	77	18	3	0	1	0	0	0	675
2003	3	37	52	7	1	0	0	0	0	649
2004	1	66	20	10	2	0	0	0	0	223
2005	0	37	49	10	3	0	0	0	0	312
2006	0	51	20	23	5	1	0	0	0	255
2007	1	43	31	15	9	1	0	0	0	536
2008	3	51	30	14	2	1	0	0	0	471
2009	1	51	30	15	2	0	0	0	0	595
2010	0	41	38	17	4	1	0	0	0	1105
2011	2	42	36	15	5	1	0	0	0	845
2012	2	56	29	11	2	0	0	0	0	732
2013	0	47	37	13	2	0	0	0	0	893
2014	10	38	41	9	2	0	0	0	0	669
2015	1	57	27	14	1	0	0	0	0	278
2016	2	45	44	8	1	0	0	0	0	626
2017	0	52	37	10	0	0	0	0	0	699
2018	0	27	60	12	1	0	0	0	0	1072
2019	0	46	41	12	0	0	0	0	0	730

Table 10. The approximate percentage of biological samples per age group for Blueback Herring collected in the Margaree River commercial gaspereau fisheries during 1983 to 2019. Ageing not completed for years 2000 to 2006 and 2008.

Year	Age									Sample Size
	2	3	4	5	6	7	8	9	10	
1984	1	12	53	28	6	0	0	0	1	125
1985	0	8	60	18	13	0	1	0	0	93
1986	0	3	22	33	31	10	0	0	0	58
1987	0	11	30	11	24	16	8	0	0	37
1988	0	6	86	8	0	0	0	0	0	79
1989	0	0	13	82	5	1	0	0	0	326
1990	0	14	0	62	21	3	0	0	0	29
1991	-	-	-	-	-	-	-	-	-	-
1992	0	62	23	15	0	0	0	0	0	13
1993	0	68	26	6	0	0	0	0	0	31
1994	0	7	43	43	0	7	0	0	0	14
1995	0	4	25	55	14	2	0	0	0	51
1996	5	43	48	5	0	0	0	0	0	21
1997	0	25	0	0	25	50	0	0	0	4
1998	0	25	49	9	7	7	3	0	0	68
1999	0	7	42	48	2	1	0	0	0	89
2000	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-
2007	6	34	31	18	7	3	0	0	0	67
2008	-	-	-	-	-	-	-	-	-	-
2009	0	24	31	21	18	5	1	0	0	175
2010	0	21	33	24	16	4	1	0	0	98
2011	1	18	26	34	10	6	6	0	0	124
2012	3	43	10	20	20	3	0	0	0	327
2013	0	62	23	7	7	1	0	0	0	346
2014	11	26	50	8	5	2	0	0	0	66
2015	0	74	10	16	0	0	0	0	0	89
2016	0	41	42	9	8	0	0	0	0	64
2017	0	35	42	23	1	0	0	0	0	200
2018	0	52	34	13	1	0	0	0	0	172
2019	0	39	46	12	3	0	0	0	0	218

Table 11. Predicted natural mortality (*M*) and published values of *M* considered for Alewife and Blueback Herring.

Species	Population or Area	Life stage	Methods	Assumed maximum age	Natural mortality Rate	References
Alewife	South River (NS)	Maiden spawners	Paloheimo's method	5	0.44	Chaput and Alexander (1989)
Alewife	South River (NS)	Repeat spawners	Paloheimo's method	5	1.05	Chaput and Alexander (1989)
Alewife	Eleven populations along the coast of New England	-	-	11	0.63	Atlantic State Marine Fisheries Commission (2017)
Alewife and Blueback Herring	-	Maiden and repeat spawners	Pauly's method	9	1.0 (range 0.8 to 1.2)	Crecco and Gibson (1990)
Alewife	Margaree River	Maiden and repeat spawners	Statistical-catch-at-age model	10	0.44	Gibson and Myers (2004)
Alewife	Gaspereau River (includes fish passage at a turbine)	Maiden and repeat spawners	Statistical-catch-at-age model	10	0.53	Gibson and Myers (2004)
Alewife	Margaree River (this study)	Maiden and repeat spawners	Von Bertalanffy growth model	10	0.24 (age 2) to 0.13 (age 10)	(Gislason et al. 2010)
Alewife and Blueback Herring	-	-	Tmax-based estimator	10	0.59	Then et al. (2015)

Table 12. Number of gaspereau caught in the Northumberland Strait survey during 2007 to 2019 (except 2010-2011). Trawl locations are shown in Figure 30.

Year	Number gaspereau caught
2007	2501
2008	1681
2009	1589
2012	257
2013	68
2014	83
2015	90
2016	107
2017	87
2018	146
2019	196

Table 13. The number of adult gaspereau captured by beach seining from May to September in the CAMP program, 2004 to 2019, for the provinces of New Brunswick (NB), Nova Scotia (NS) and Prince Edward Island (PEI) (see DFO 2011 for details).

Province	Year	May	June	July	August	September	Total
NB	2004	0	0	0	39	0	39
NB	2005	0	0	2	0	0	2
NB	2006	0	0	0	0	0	0
NB	2007	0	835	0	0	0	835
NB	2008	0	0	0	35	0	35
NB	2009	0	14	4	248	1	267
NB	2010	0	127	2	19	0	148
NB	2011	-	1,196	0	4	0	1,200
NB	2012	-	0	184	7	-	191
NB	2013	-	1	5,483	2	0	5,486
NB	2014	-	339	142	58	0	539
NB	2015	-	3	37	3	-	43
NB	2016	-	1	19	299	-	319
NB	2017	-	313	7	46	-	366
NB	2018	-	151	0	0	-	151
NB	2019	-	1	155	-	-	156
NS	2004	0	0	0	0	0	0
NS	2005	0	0	0	0	0	0
NS	2006	0	0	0	0	0	0
NS	2007	2	1	0	0	0	3
NS	2008	4	0	10	20	0	34
NS	2009	0	0	11	2	3	16

Province	Year	May	June	July	August	September	Total
NS	2010	3	0	7	0	0	10
NS	2011	0	0	0	0	15	15
NS	2012	-	149	12	77	0	238
NS	2013	-	0	0	12	-	12
NS	2014	-	0	0	0	-	0
NS	2015	-	5	1	17	-	23
NS	2016	-	25	5	81	-	111
NS	2017	-	7	3	48	-	58
NS	2018	-	0	0	-	-	0
NS	2019	-	0	0	-	-	0
PEI	2004	0	0	0	0	0	0
PEI	2005	0	0	0	0	0	0
PEI	2006	0	0	0	0	0	0
PEI	2007	0	0	0	0	0	0
PEI	2008	0	0	0	0	0	0
PEI	2009	0	0	0	0	0	0
PEI	2010	0	0	0	2	0	2
PEI	2011	-	2	0	4	0	6
PEI	2012	0	30	0	1	20	51
PEI	2013	0	0	0	37	0	37
PEI	2014	0	8	0	4	0	12
PEI	2015	-	0	0	0	-	0
PEI	2016	-	0	0	0	-	0
PEI	2017	-	12	0	1	-	13
PEI	2018	-	25	0	-	-	25
PEI	2019	-	0	0	28	-	28

Table 14. The number of young-of-the-year (YOY) gaspereau captured by beach seining from May to September in the CAMP program, 2004 to 2019, for the provinces of New Brunswick (NB), Nova Scotia (NS) and Prince Edward Island (PEI) (see DFO 2011 for details).

Province	Year	May	June	July	August	September	Total
NB	2004	0	0	0	1	0	1
NB	2005	0	0	9	44	1	54
NB	2006	0	0	31	312	2	345
NB	2007	0	0	471	1	0	472
NB	2008	2	1	22	121	0	146
NB	2009	0	0	28	275	0	303
NB	2010	1	0	27	93	0	121
NB	2011	-	3	14	1,351	13	1,381
NB	2012	-	1	496	268	-	765
NB	2013	-	0	70	777	0	847
NB	2014	-	1	35	14	0	50

Province	Year	May	June	July	August	September	Total
NB	2015	-	529	194	485	-	1,208
NB	2016	-	0	41	76	-	117
NB	2017	-	0	739	2,432	-	3,171
NB	2018	-	0	0	1	-	1
NB	2019	-	0	0	-	-	0
NS	2004	0	0	0	4	0	4
NS	2005	0	0	0	0	0	0
NS	2006	0	0	0	10	4	14
NS	2007	0	0	2	0	0	2
NS	2008	0	0	208	2	2	212
NS	2009	0	0	0	0	1	1
NS	2010	3	0	19	16	5	43
NS	2011	0	4	145	39	1	189
NS	2012	-	1	2	0	0	3
NS	2013	-	0	252	14	-	266
NS	2014	-	0	0	3	-	3
NS	2015	-	0	3	15	-	18
NS	2016	-	0	0	1	-	1
NS	2017	-	13	0	0	-	13
NS	2018	-	0	0	-	-	0
NS	2019	-	0	0	-	-	0
PEI	2004	0	0	0	0	0	0
PEI	2005	0	0	0	0	0	0
PEI	2006	0	0	0	0	0	0
PEI	2007	0	0	0	5	0	5
PEI	2008	0	0	0	5	0	5
PEI	2009	0	0	82	3	0	85
PEI	2010	0	0	3	0	0	3
PEI	2011	-	0	3	1,082	0	1,085
PEI	2012	0	0	67	47	0	114
PEI	2013	0	0	30,359	557	7	30,923
PEI	2014	0	284	17	104	0	405
PEI	2015	-	0	0	0	-	0
PEI	2016	-	0	122	1,476	-	1,598
PEI	2017	-	0	11	438	-	449
PEI	2018	-	0	0	-	-	0
PEI	2019	-	0	12	3	-	15

Table 15. Summary for indicators of stock status. Gaspereau refers to Alewife and Blueback Herring combined as species identification was not done.

Geographic Region	Species	Indicator	Trend or value	Comments
DFO Gulf Region	Gaspereau	Commercial landings	Declined from 1978 to 2019	Commercial landings may be indicative of abundance, but are also sensitive to changes in effort and changes in reporting
Gulf New Brunswick	Gaspereau	Commercial landings	Declined from 1978 to 2019	Commercial landings may be indicative of abundance, but are also sensitive to changes in effort and changes in reporting
Gulf Nova Scotia	Gaspereau	Commercial landings	Declined from 1978 to 2019	Commercial landings may be indicative of abundance, but are also sensitive to changes in effort and changes in reporting
Prince Edward Island	Gaspereau	Commercial landings	Declined from 1978 to 2019	Commercial landings may be indicative of abundance, but are also sensitive to changes in effort and changes in reporting
Margaree River	Gaspereau	Commercial landings	Landings are lower from 2001-2019 compared to 1984-2000	Commercial landings may be indicative of abundance, but are also sensitive to changes in effort and changes in reporting

Geographic Region	Species	Indicator	Trend or value	Comments
Margaree River	Gaspereau	Catch per unit effort in the commercial fishery	CPUE are lower from 1983-1990 compared 1991-2019	1-Catches in a fishery may not be indicative of abundance. 2-Commercial CPUE may be indicative of abundance, but also can vary with environmental factors such as river water levels and fishermen behaviour
Margaree River	Alewife	Proportion of repeat spawners	Variable	1-The proportion of repeat spawners is expected to decrease with increasing exploitation rate 2- The proportion of repeat spawners is sensitive to the number of recruits in the spawning run
Margaree River	Blueback Herring	Proportion of repeat spawners	Increasing	1-The proportion of repeat spawners is expected to decrease with increasing exploitation rate 2- The proportion of repeat spawners is sensitive to the number of recruits in the spawning run
Margaree River	Alewife	Proportion at age	Lower proportion of age 5 and older fish from 2001-2019 compared to 1983-2000	Could be indicative of increased mortality or increased recruitment
Margaree River	Blueback Herring	Proportion at age	Lower proportion of age 5 and older fish from 2007-2019 compared to 1983-1994	Could be indicative of increased mortality or increased recruitment

Geographic Region	Species	Indicator	Trend or value	Comments
Margaree River	Alewife	Average fork length, body weight	Declining trends from 1983 to 2019	Could be indicative of increased mortality or increased recruitment or a change in growth rate
Margaree River	Blueback Herring	Average fork length, body weight	Decline in body weight from 1983 to 2019	Could be indicative of increased mortality or increased recruitment or a change in growth rate
Margaree River	Alewife	Length at age, weight at age	Decline for age 3 to 7 from 1983 to 2019	Could be indicative of a change in growth rate
Margaree River	Blueback Herring	Length at age, weight at age	Decline for all ages with data (3-6) from 1983 to 2019	Could be indicative of a change in growth rate
Southwest Miramichi River	Alewife	Catches at research trapnet	Catches declined from 2001-2019	1-Trapnets are located upstream of commercial gaspereau fisheries 2-Estimates are indicative of spawner escapements. 3-Short time series. Margaree and ASMFC (2017) show declining trends
Southwest Miramichi River	Blueback Herring	Catches at research trapnet	Catches are lower from 2008-2019 compared to 2001-2007	1-Trapnets are located upstream of commercial gaspereau fisheries 2-Estimates are indicative of spawner escapements. 3-Short time series. Margaree and ASMFC (2017) show declining trends

Geographic Region	Species	Indicator	Trend or value	Comments
Northwest Miramichi River	Alewife	Catches at research trapnet	Catches variable from 2001-2019	1-Trapnets are located upstream of commercial gaspereau fisheries 2-Estimates are indicative of spawner escapements. 3- Short time series. Margaree and ASMFC (2017) show declining trends
Northwest Miramichi River	Blueback Herring	Catches at research trapnet	Catches are lower from 2008-2019 compared to 2001-2007	1-Trapnets are located upstream of commercial gaspereau fisheries 2-Estimates are indicative of spawner escapements. 3- Short time series. Margaree and ASMFC (2017) show declining trends
Northwest Miramichi River	Blueback Herring	Proportion at age	No obvious trend from 2006-2013	Short time series
Southwest and Northwest Miramichi River	Alewife	Length at age, weight at age	No obvious trend from 2006-2013	Short time series
Southwest and Northwest Miramichi River	Blueback Herring	Length at age, weight at age	No obvious trend from 2006-2013	Short time series

Marine Indices

Northumberland Strait survey	Gaspereau	Abundance	Abundance from 2012 to 2019 lower compared to 2007-2009 period	-
Northumberland Strait survey	Gaspereau	length-frequency	After 2012, fish >25cm were not captured with overall length-frequency shifted to smaller fish	-

Geographic Region	Species	Indicator	Trend or value	Comments
Southern Gulf of St. Lawrence September bottom-trawl survey	Gaspereau	Abundance	Biomass and spatial coverage reduced 1980	-

FIGURES

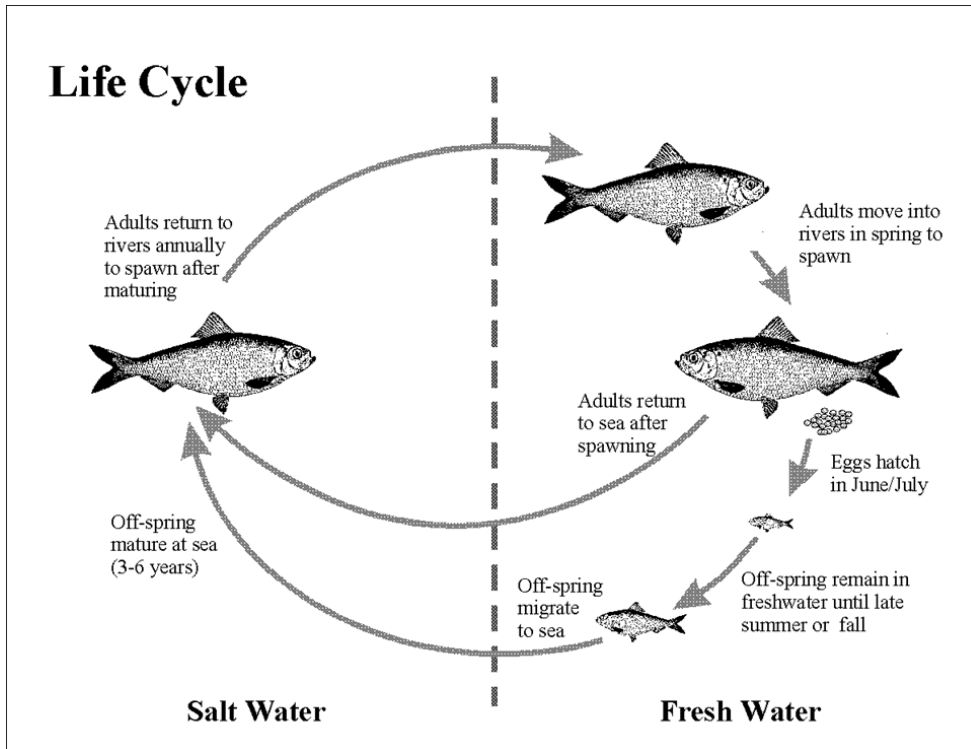


Figure 1. Life cycle of Alewife and Blueback Herring, two anadromous species with similar life cycles.



Figure 2. Fisheries and Oceans Canada statistical district in the Gulf and Maritimes Regions.

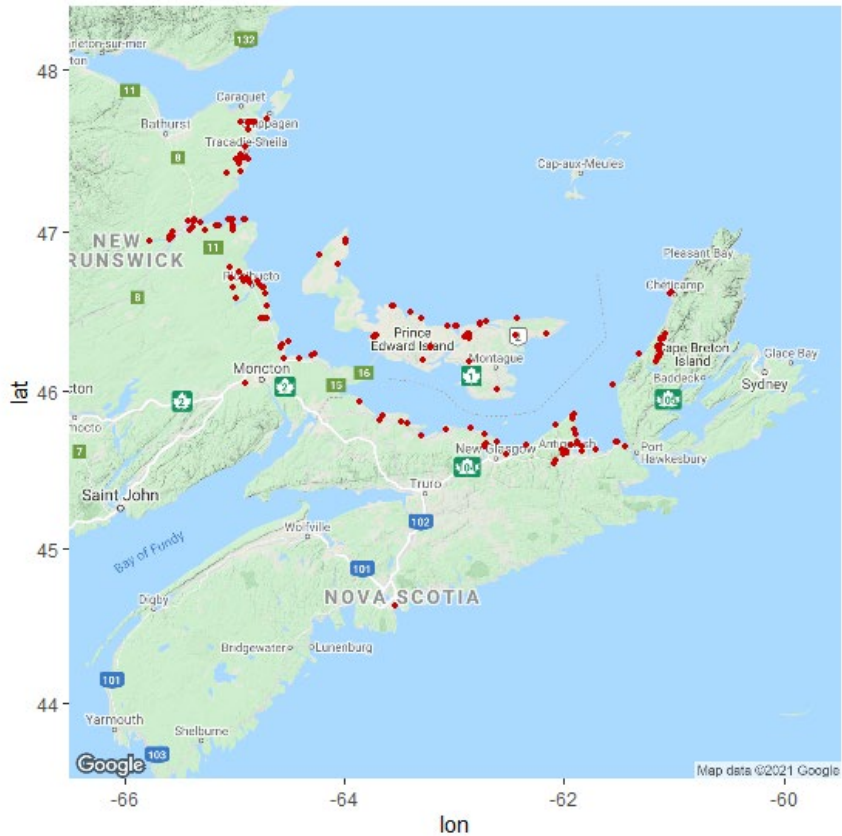


Figure 3. Map of general areas where commercial gaspereau fisheries occurred from 2015 to 2019.

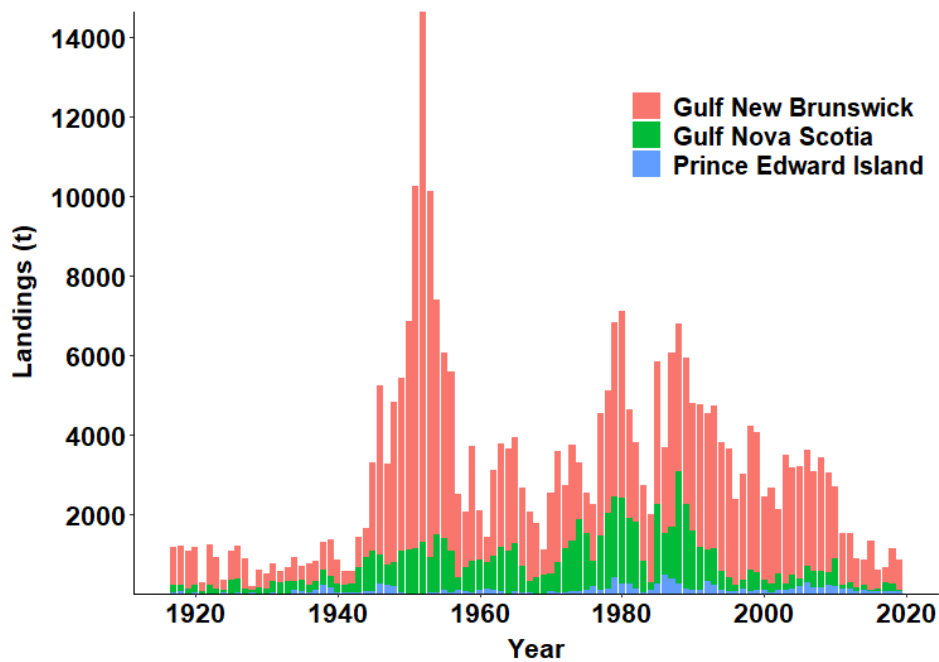


Figure 4. Commercial landings of gaspereau (Alewife and Blueback Herring) in the Gulf Region, as reported to the DFO Statistics Department, 1917 to 2019. Landings are also presented by province.

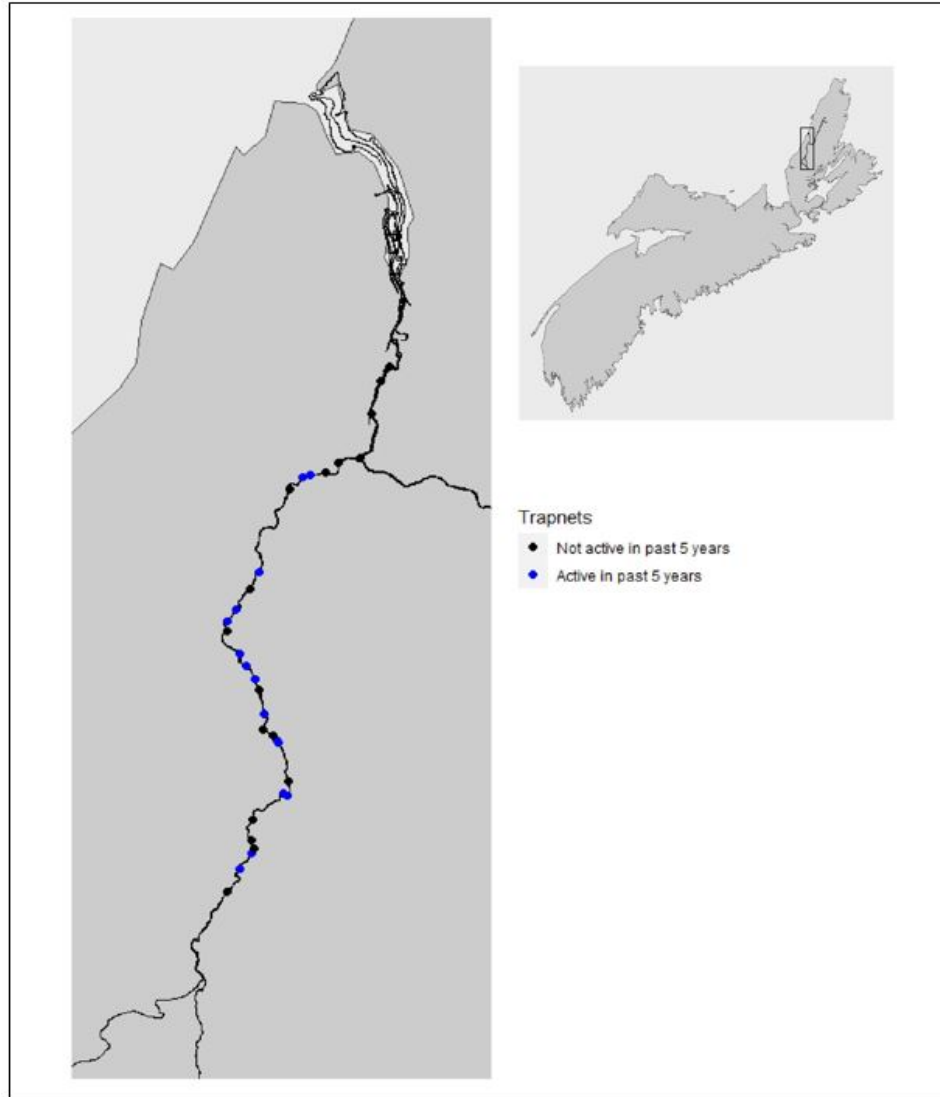


Figure 5. Map of the Margaree River (NS) showing the trapnet locations since 1983. Blue circles show the trapnets that fished at least once in the past 5 years.

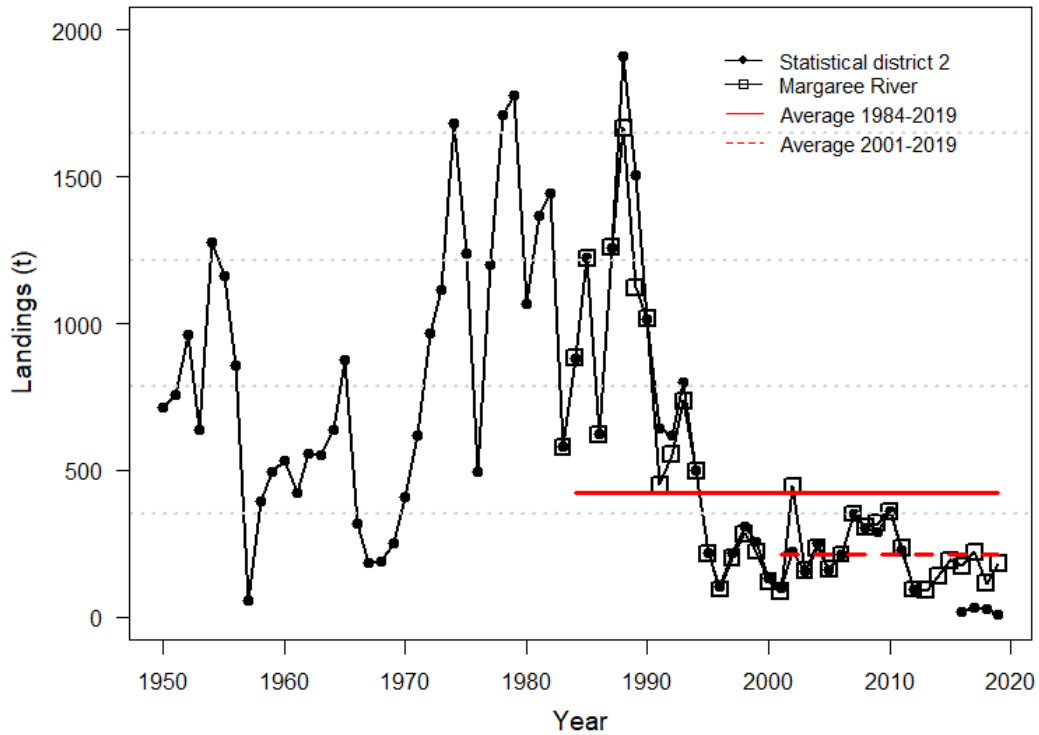


Figure 6. Reported commercial landings of gaspereau (Alewife and Blueback Herring) in the DFO Statistical District 2 and in the Margaree River, 1950 to 2019. Averages are presented for the period when detailed logbooks were available (1984 to 2019) and since last assessment (2001-2019).

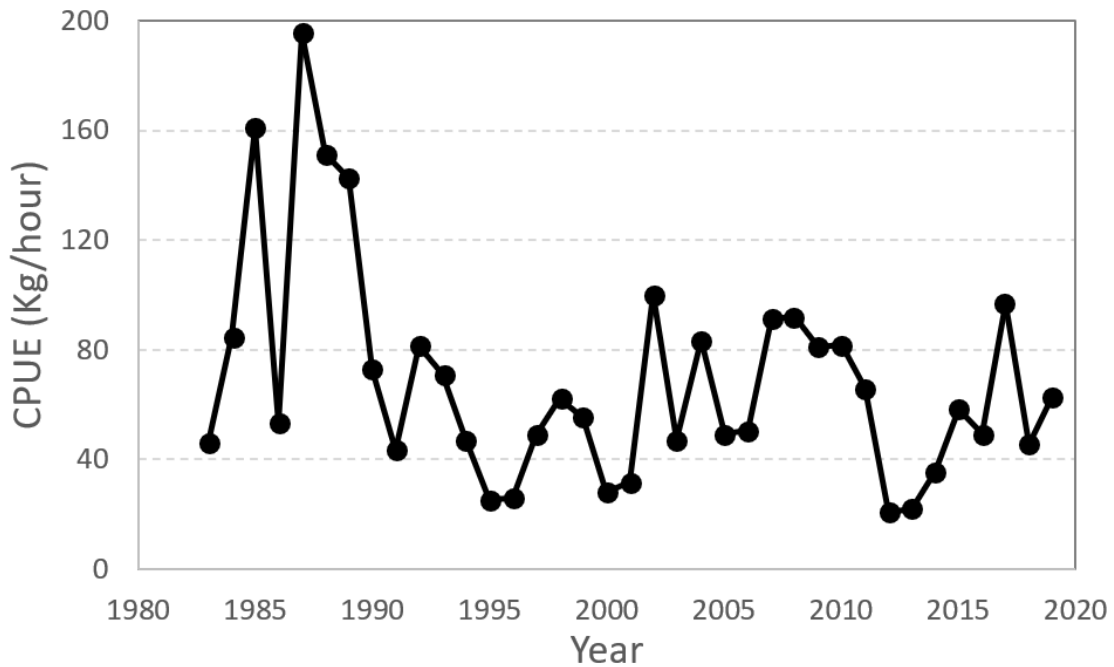


Figure 7. Annual catch per unit effort (CPUE), estimated from returned logbooks as total catch divided by the number of hours fished, in the Margaree River, 1983 to 2019.

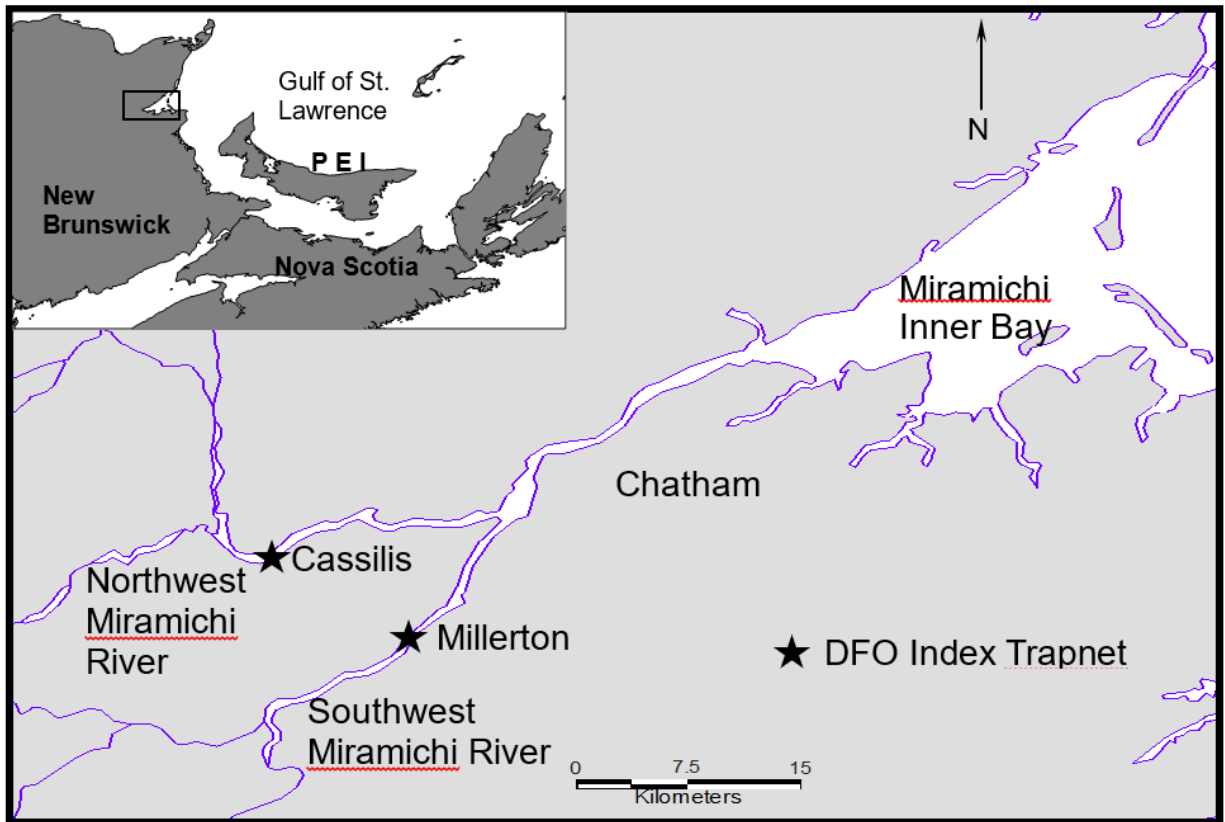


Figure 8. Map showing the DFO research trapnet locations (★) in the Miramichi River (NB) from 1992 to 2019.

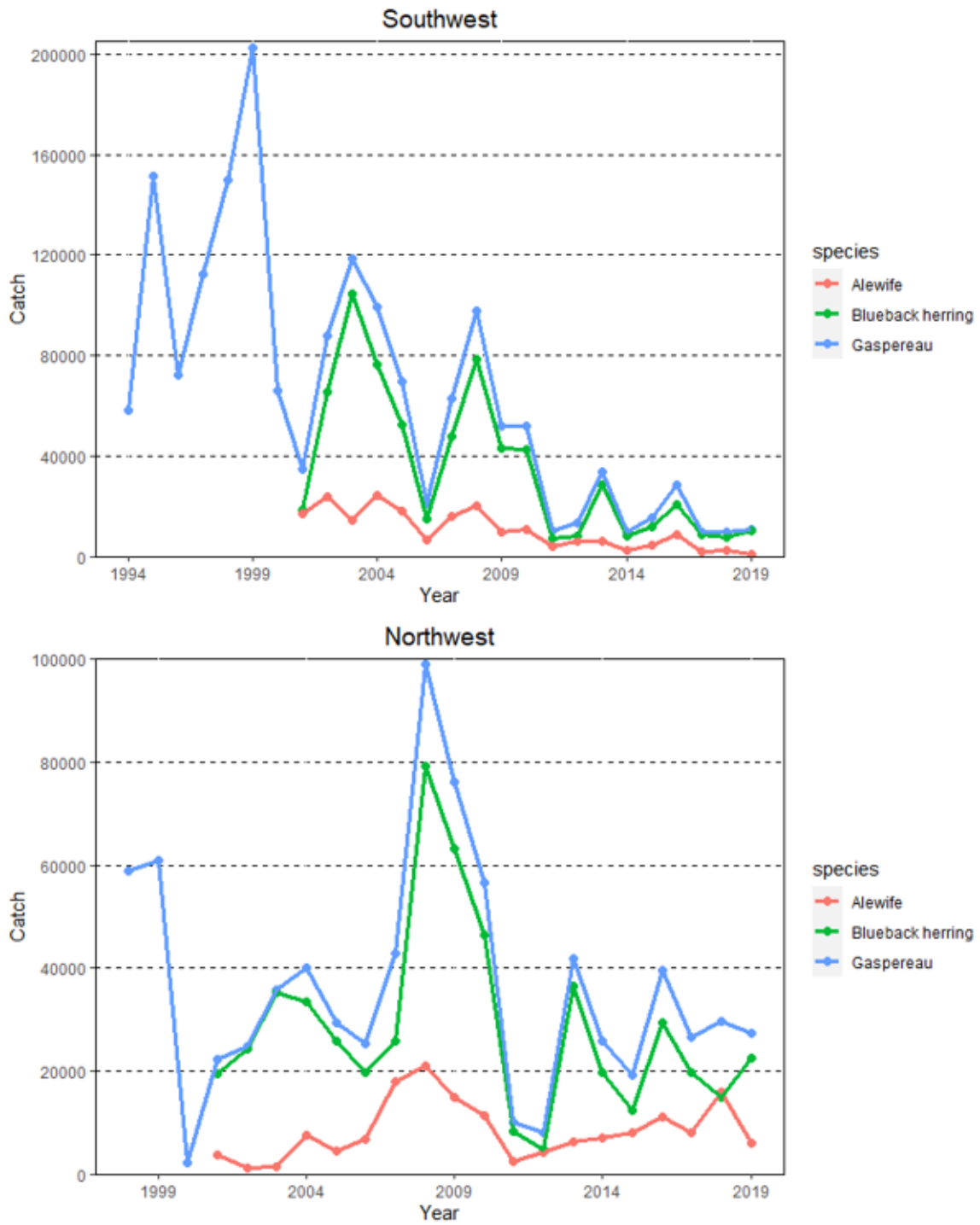


Figure 9. Annual catch of Alewife and Blueback Herring in the DFO research trapnets on the Northwest (upper) and Southwest (lower) branches of the Miramichi River from 2001 to 2019.

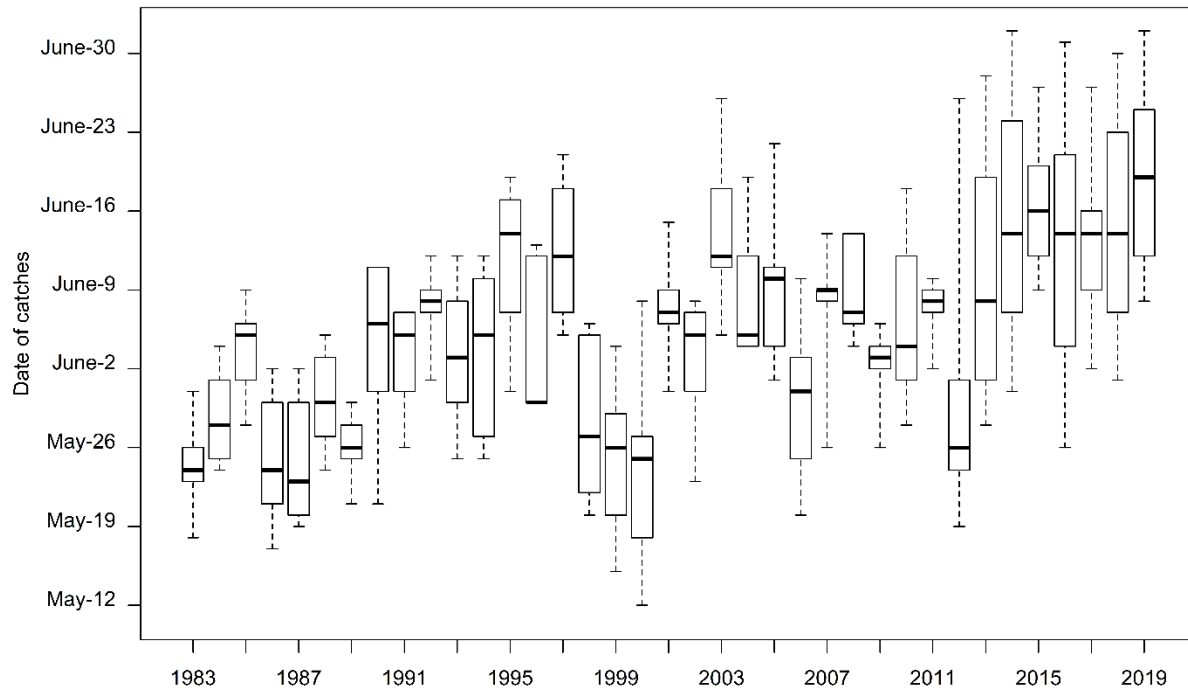


Figure 10. Timing of the commercial gaspereau fisheries in the Margaree River from 1983 to 2019 as reported in the fishers' logbooks from the fisheries. Box plots are interpreted as follows: vertical line is the 90% credibility interval, the rectangles are the interquartile spread (50% credibility interval) and the horizontal line in the rectangle is the median value.

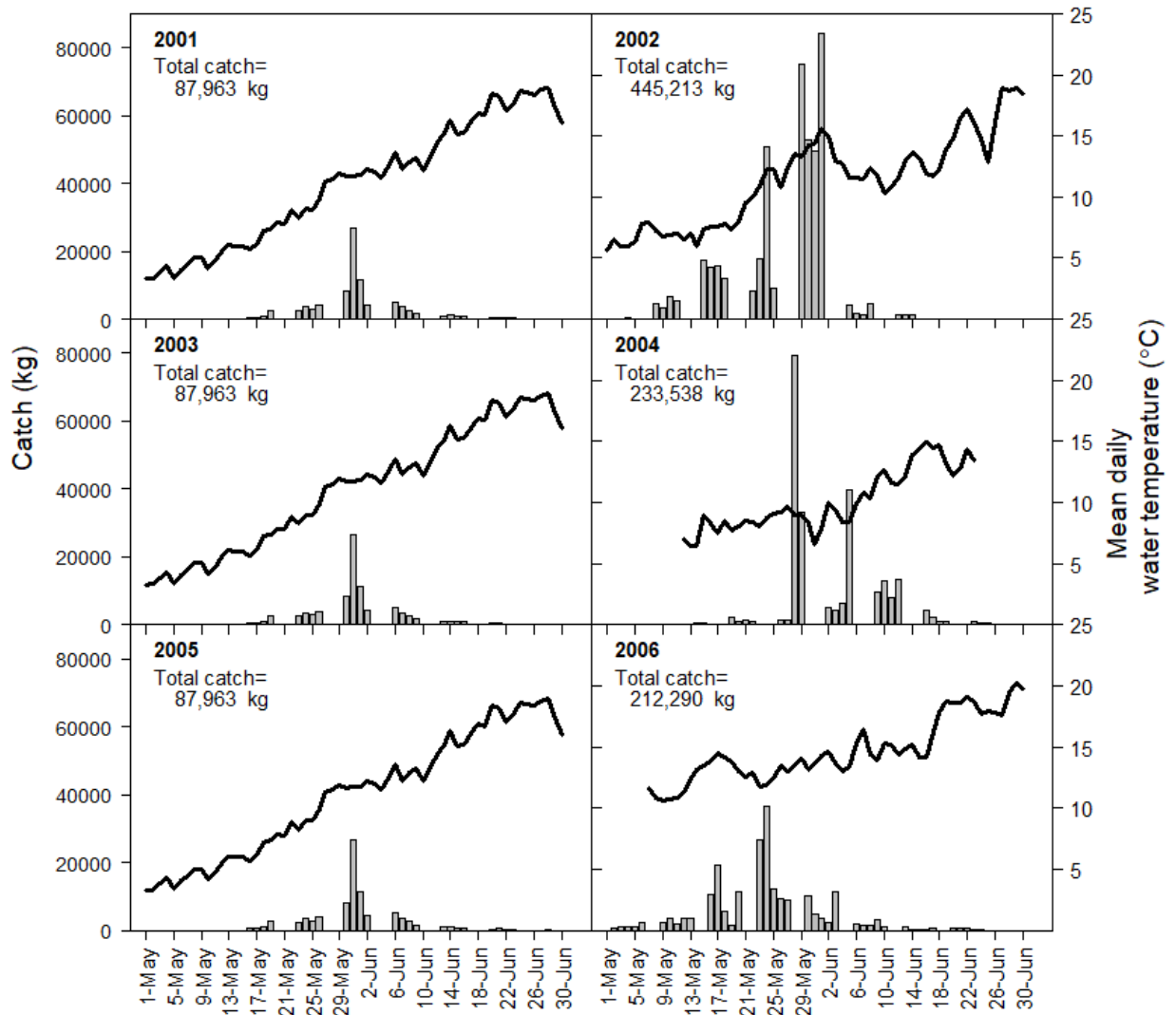


Figure 11a. Reported logbook catches of gaspereau (Alewife and Blueback Herring) in the commercial gaspereau fishery in the Margaree River relative to date and water temperature (—) for 2001 to 2019. See Chaput et al. (2001) for figures from 1996 to 2000.

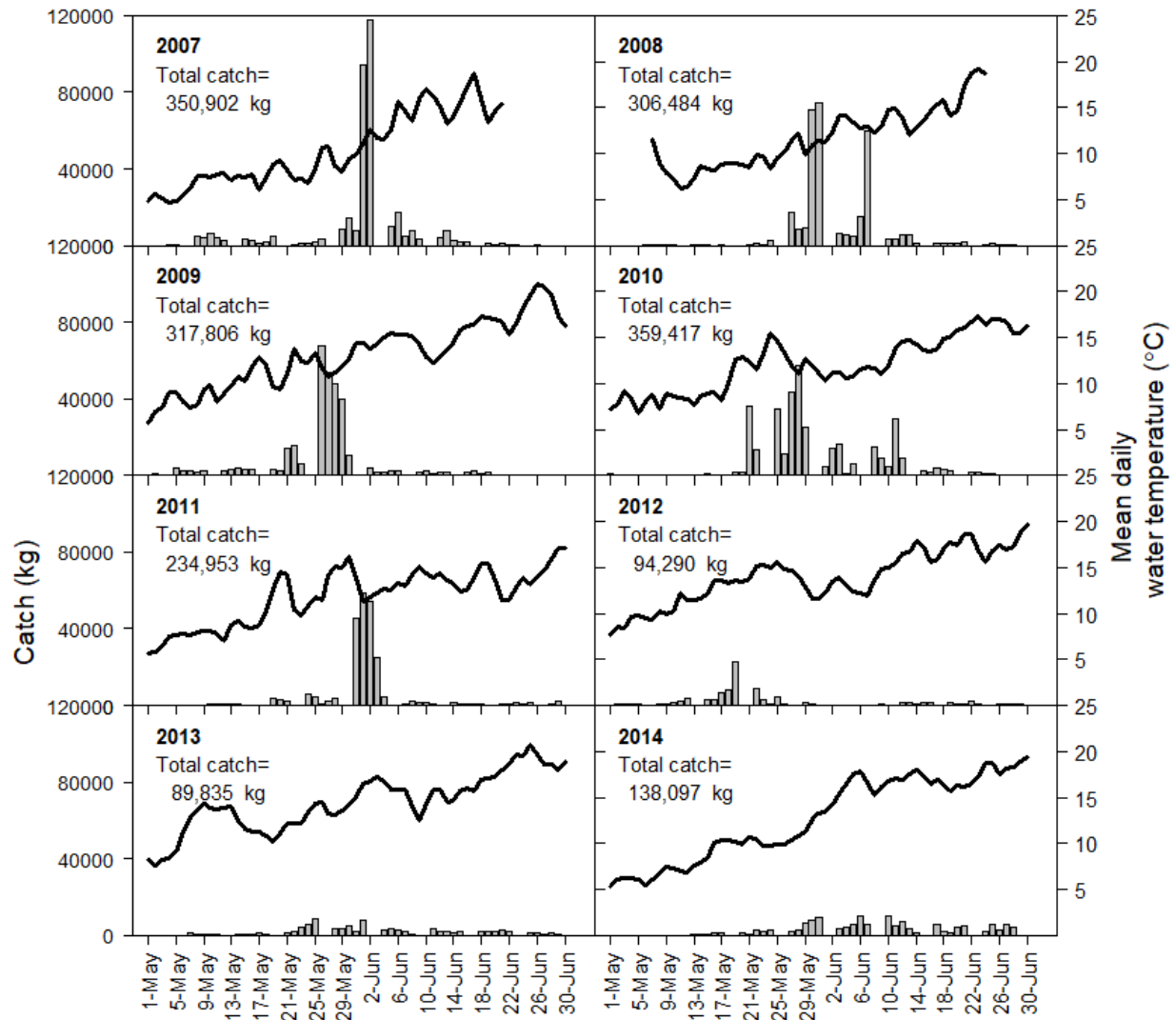


Figure 11b. Reported logbook catches of gaspereau (Alewife and Blueback Herring) in the commercial gaspereau fisheries in the Margaree River relative to date and water temperature (—) for 2001 to 2019. See Chaput et al. (2001) for figures from 1996 to 2000.

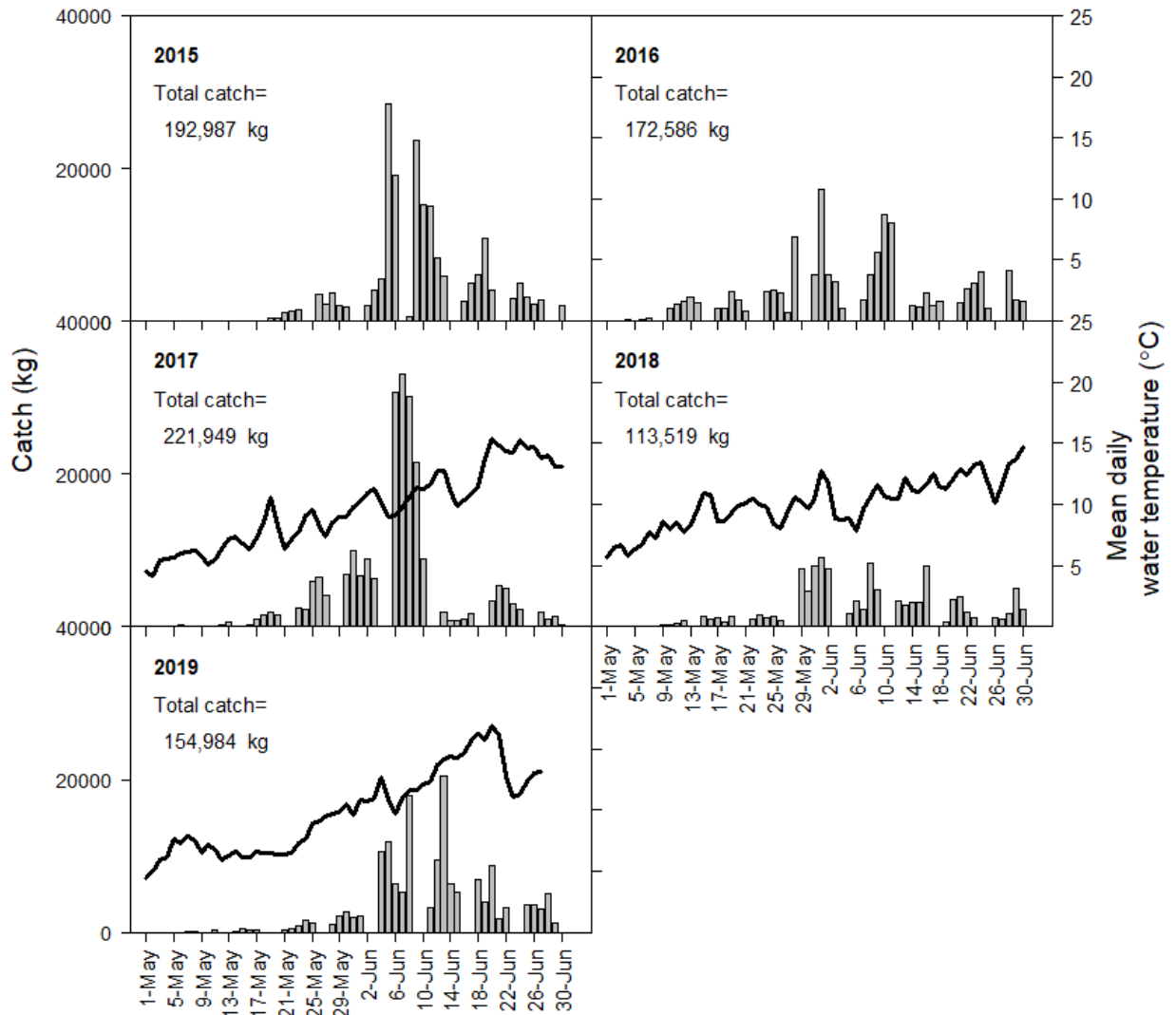


Figure 11c. Reported logbook catches of gaspereau (Alewife and Blueback Herring) in the commercial gaspereau fisheries in the Margaree River relative to date and water temperature (—) for 2001 to 2019. See Chaput et al. (2001) for figures from 1996 to 2000.

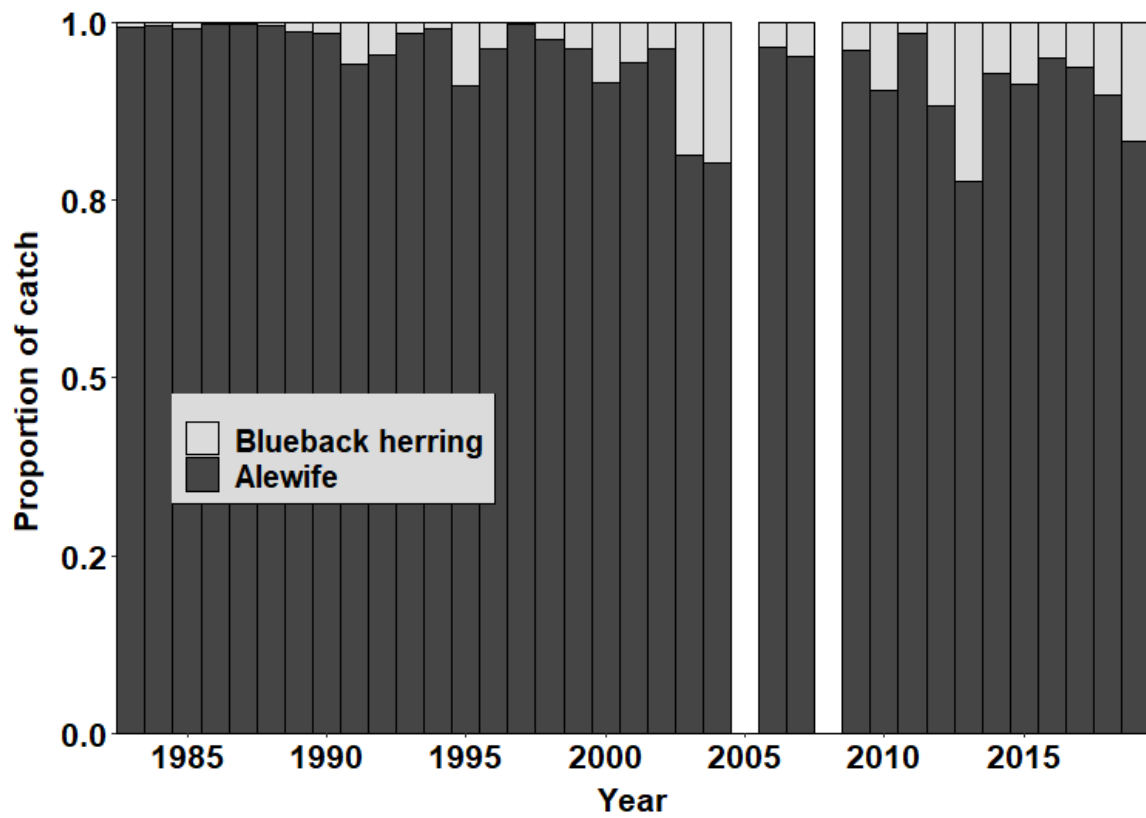


Figure 12. Proportion of Alewife and Blueback Herring in the annual catch of the commercial gaspereau fisheries in the Margaree River from 1983 to 2019. Sample size varied between 275 and 2,372 fish per year.

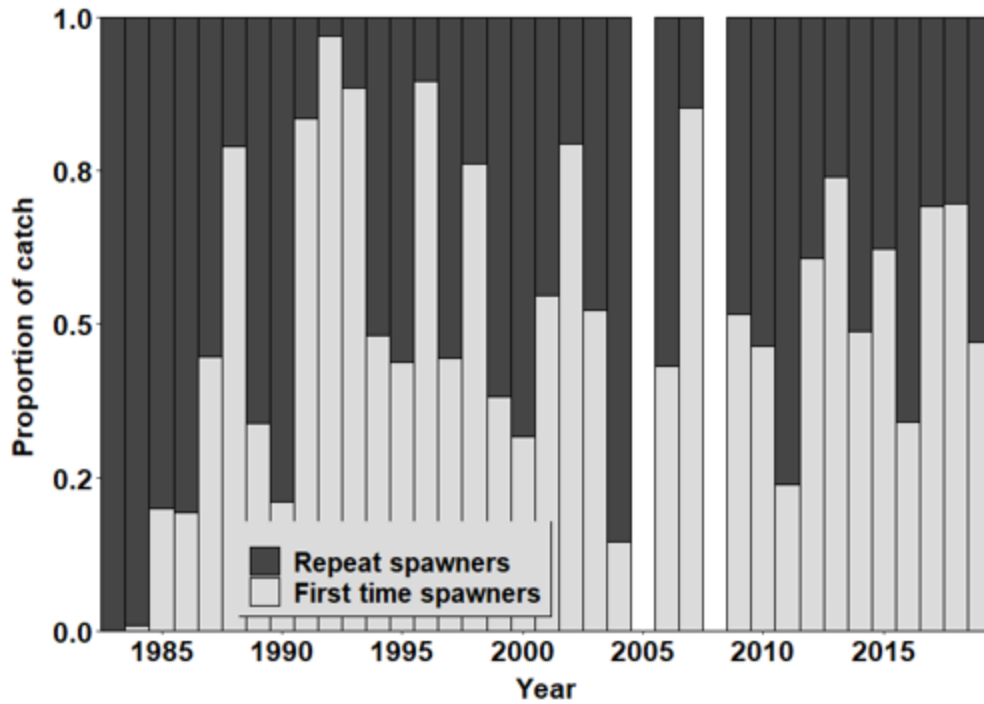
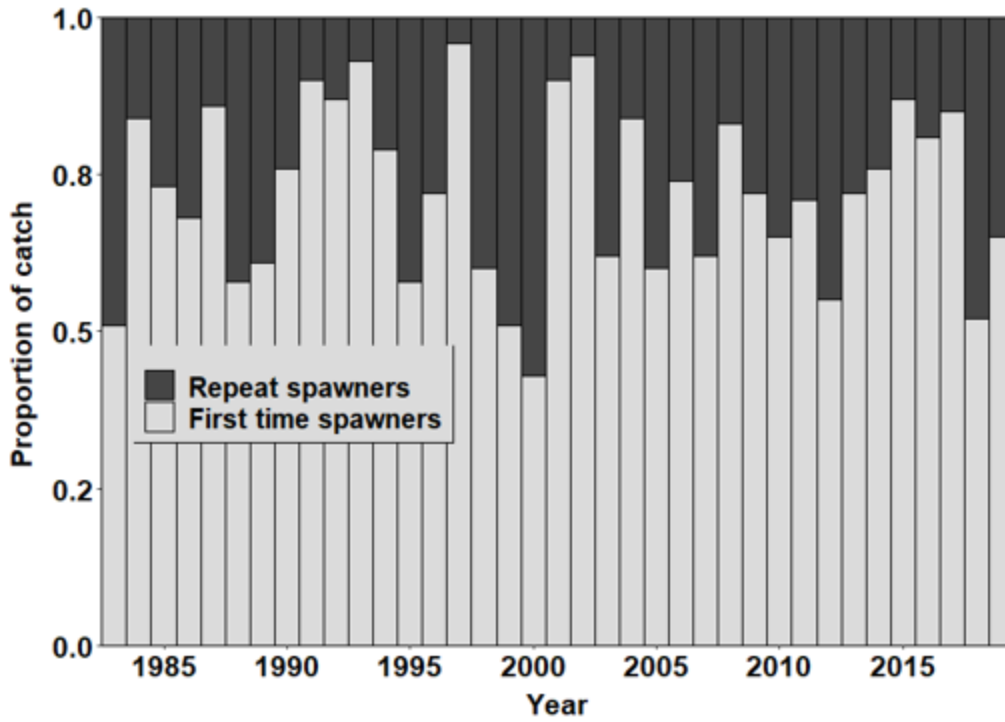


Figure 13. Proportion of first time and repeat spawners for Alewife (upper panel) and Blueback Herring (lower panel) sampled in the commercial gaspereau fisheries in the Margaree River from 1983 to 2019. Years with samples sizes < 10 were excluded.

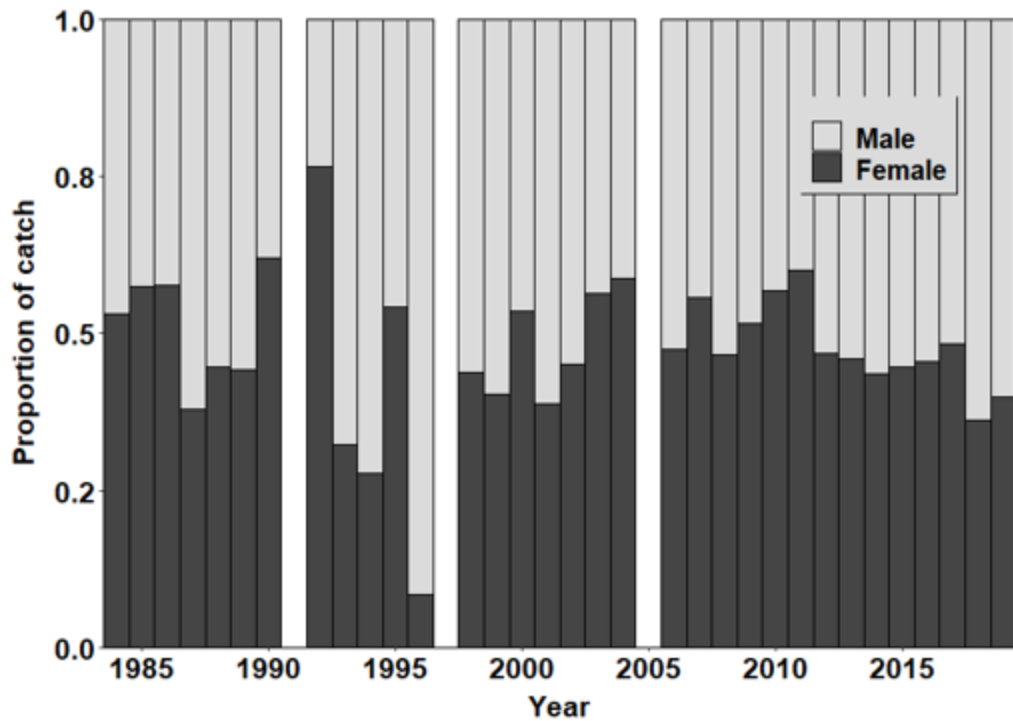
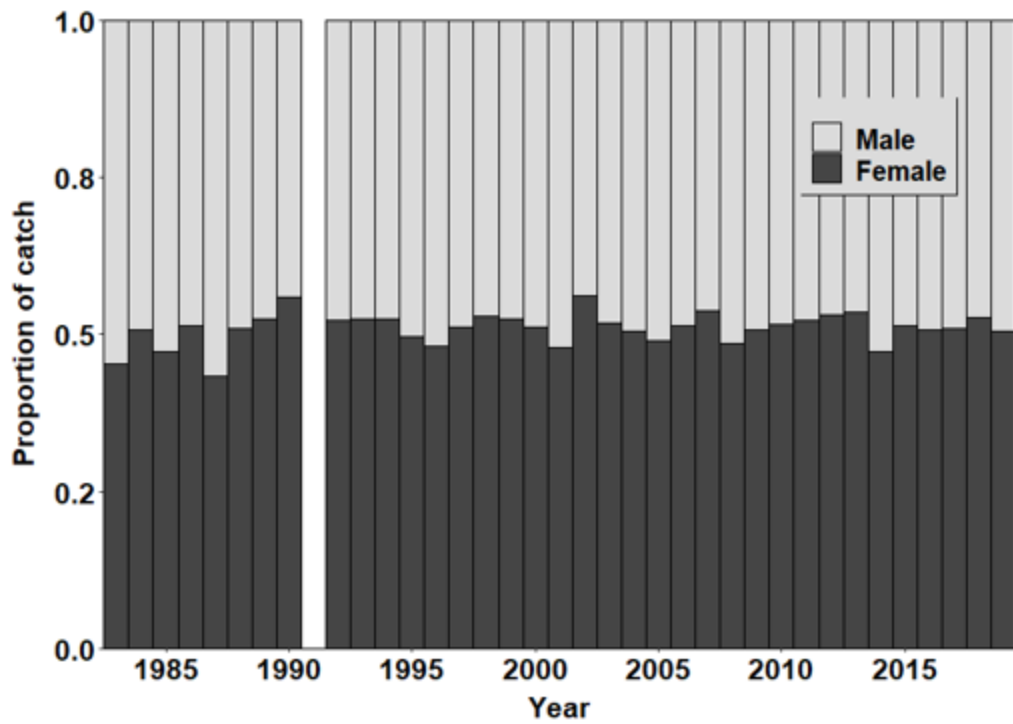


Figure 14. Proportion of females Alewife (upper) and Blueback Herring (lower) sampled in the commercial gaspereau fisheries in the Margaree River from 1983 to 2019. Years with samples sizes < 10 were excluded. No sampling in 1991.

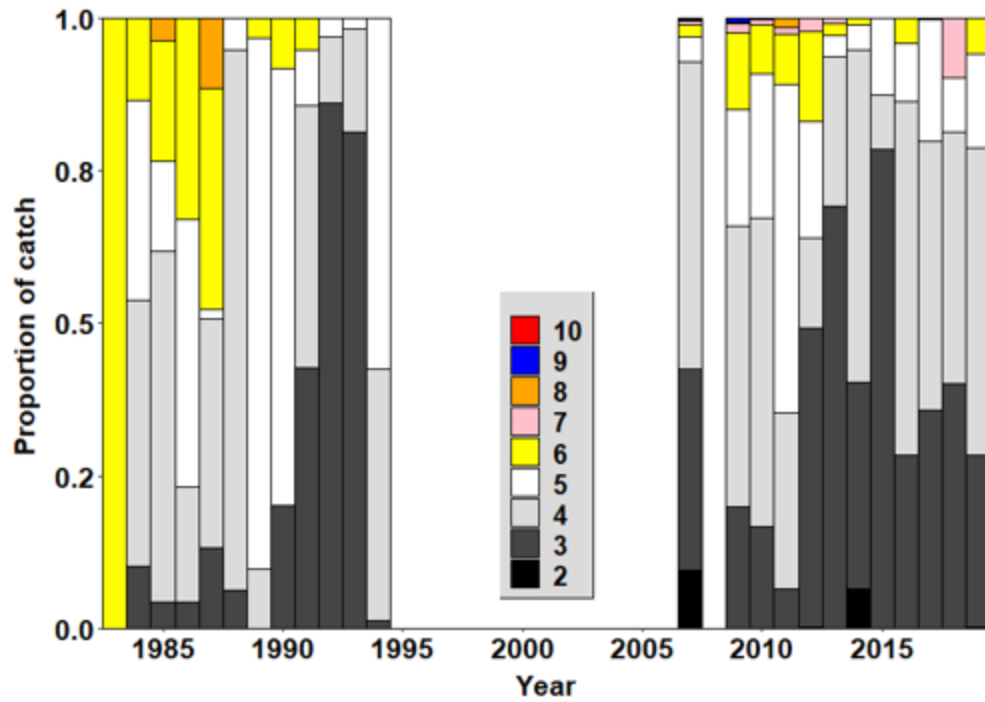
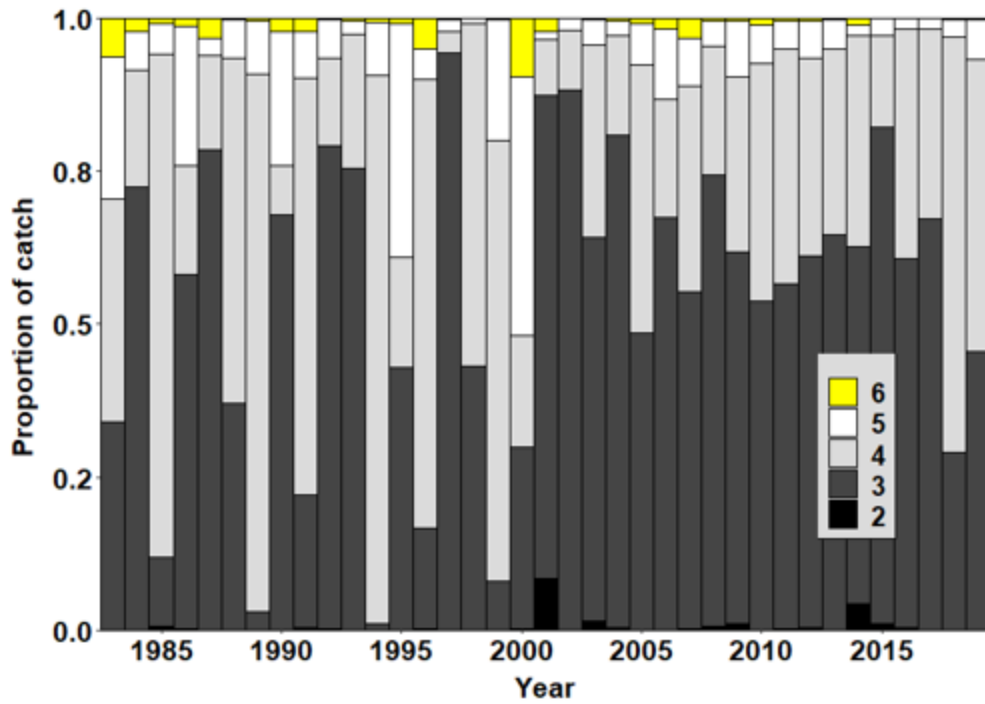


Figure 15. Proportion of catch at age for Alewife (upper) and Blueback Herring (lower) sampled in the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

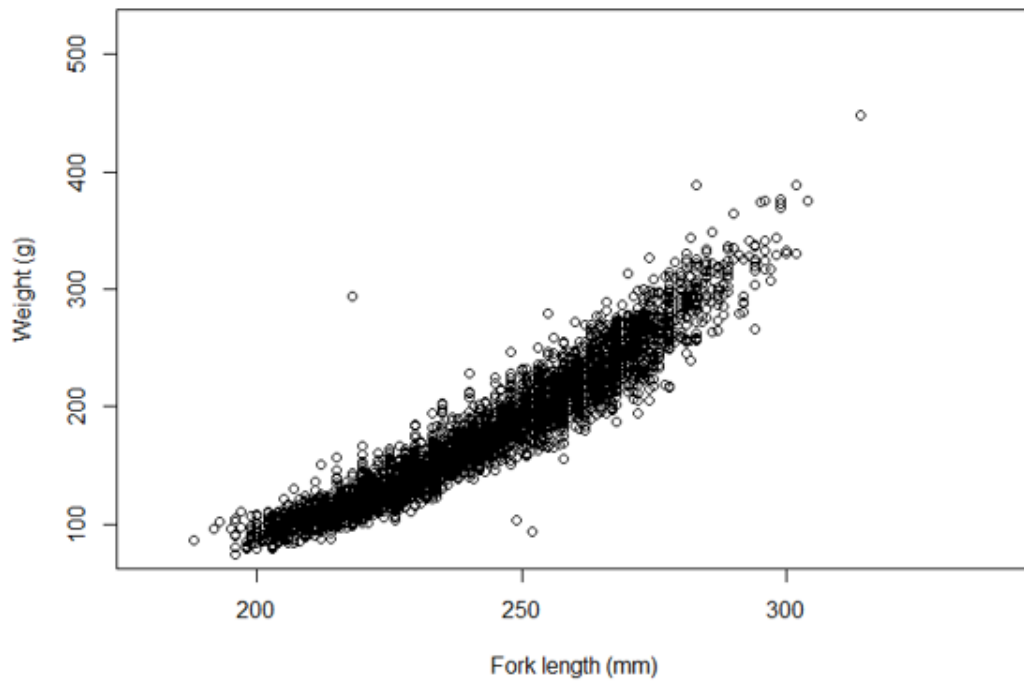
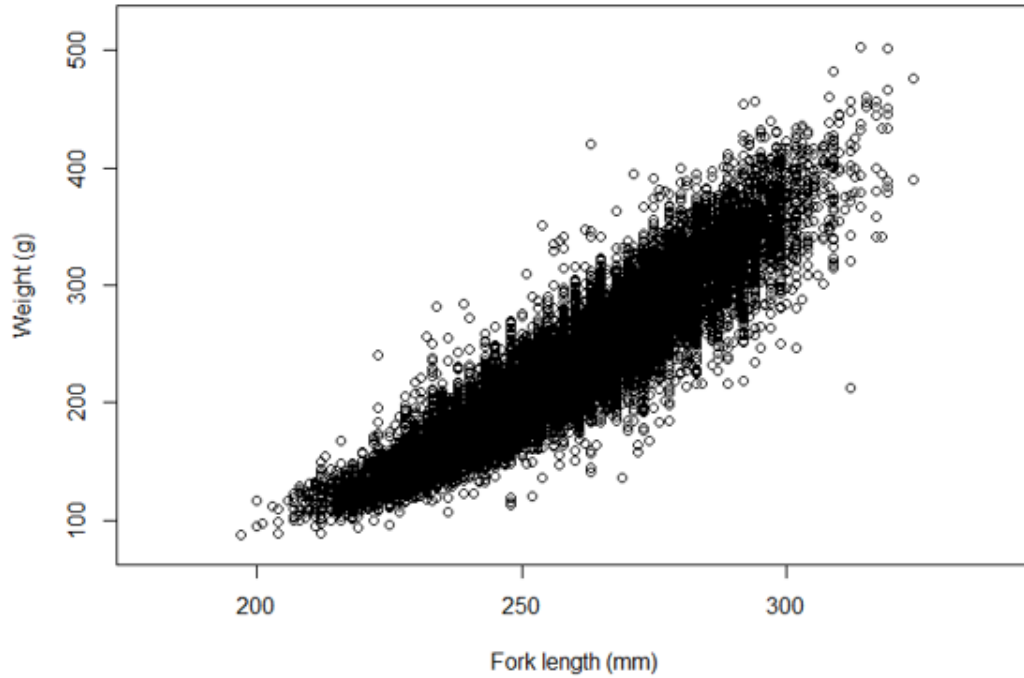


Figure 16. Weight to fork length relationship for Alewife (upper) and Blueback Herring (lower) sampled in the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

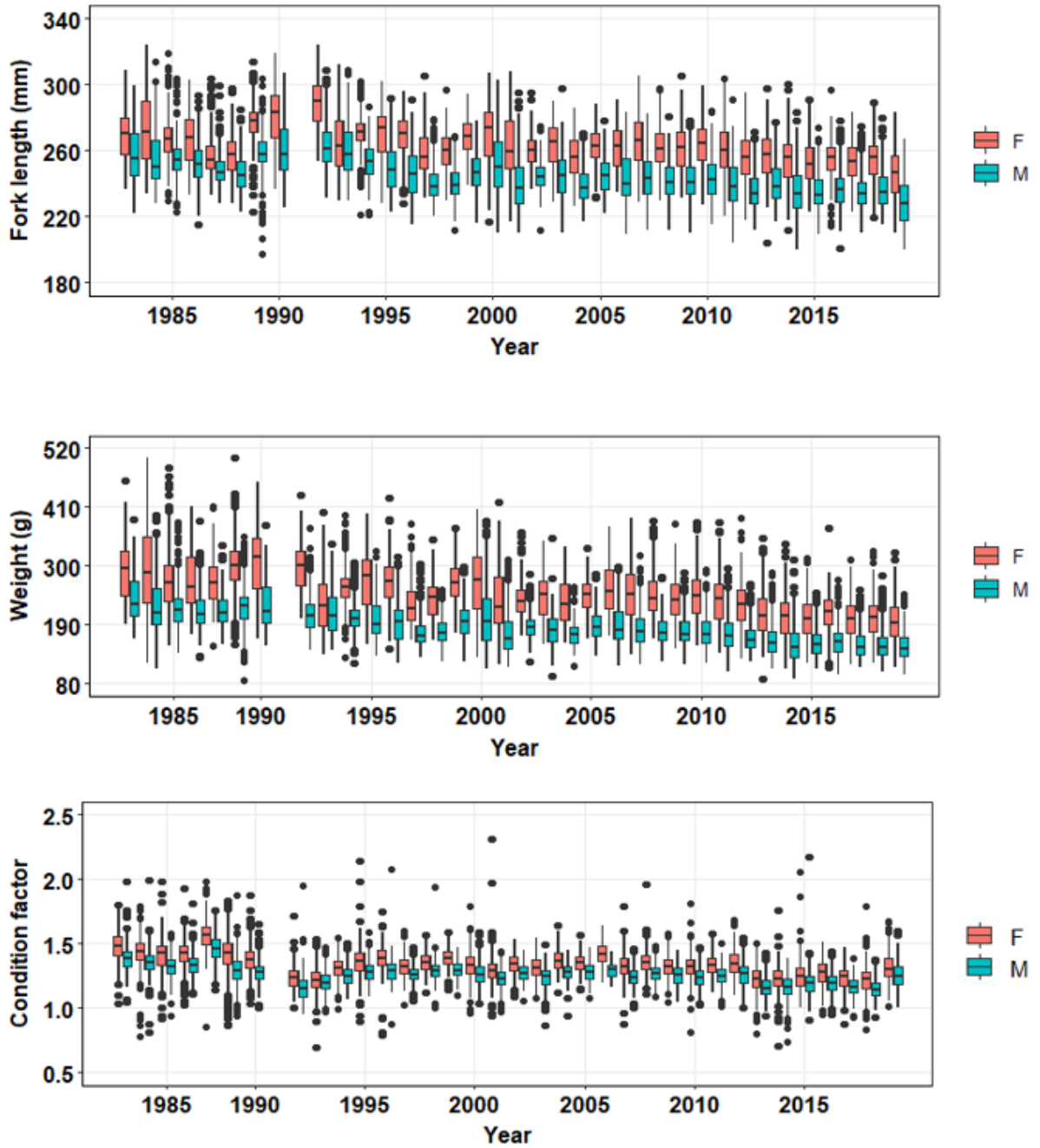


Figure 17. Trends of fork length (upper), weight (middle) and condition factor (lower) for male (M) and female (F) Alewife from biological samples collected from the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

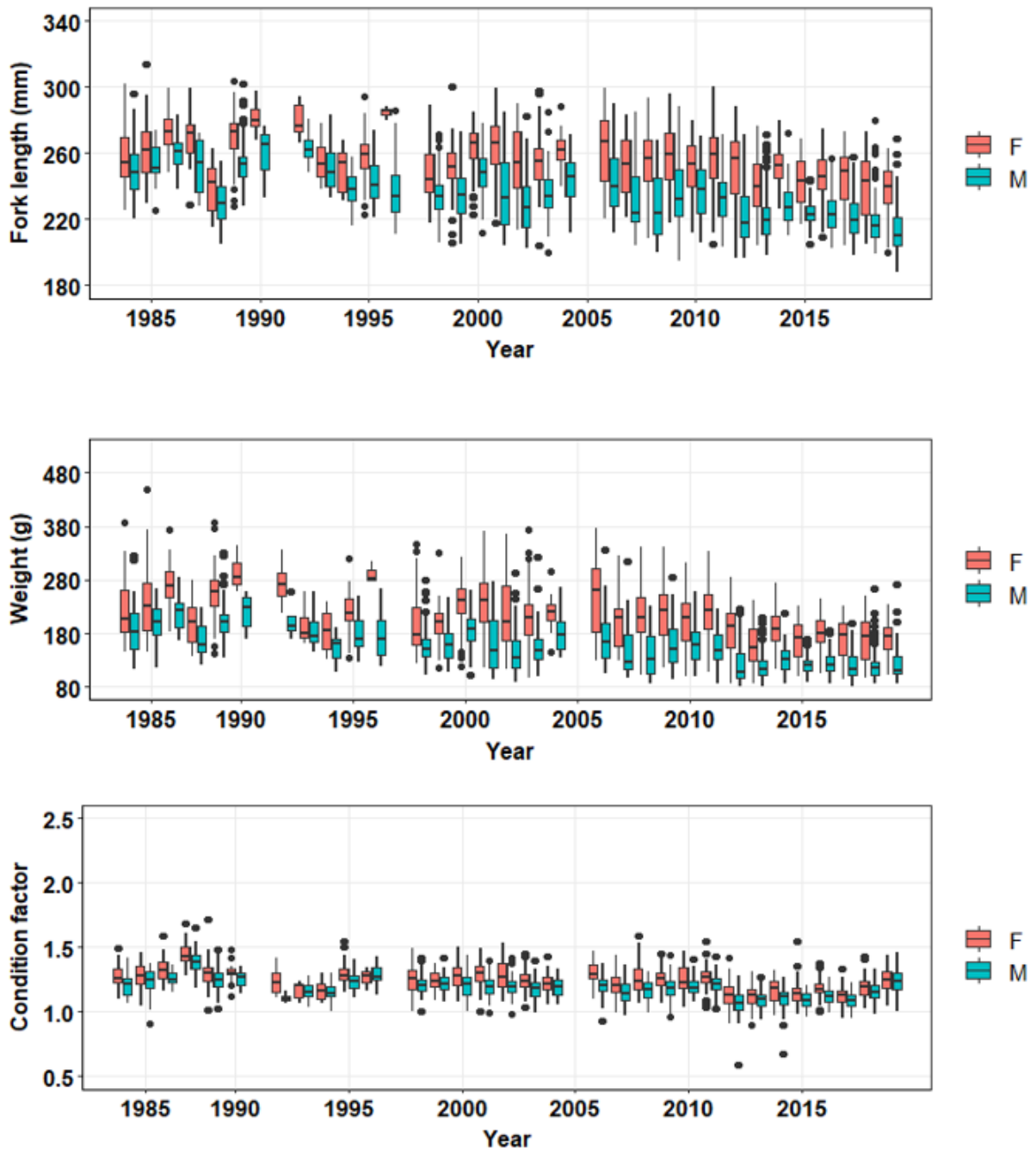


Figure 18. Trends of fork length (upper), weight (middle) and condition factor (lower) for male (M) and female (F) Blueback Herring from biological samples collected from the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

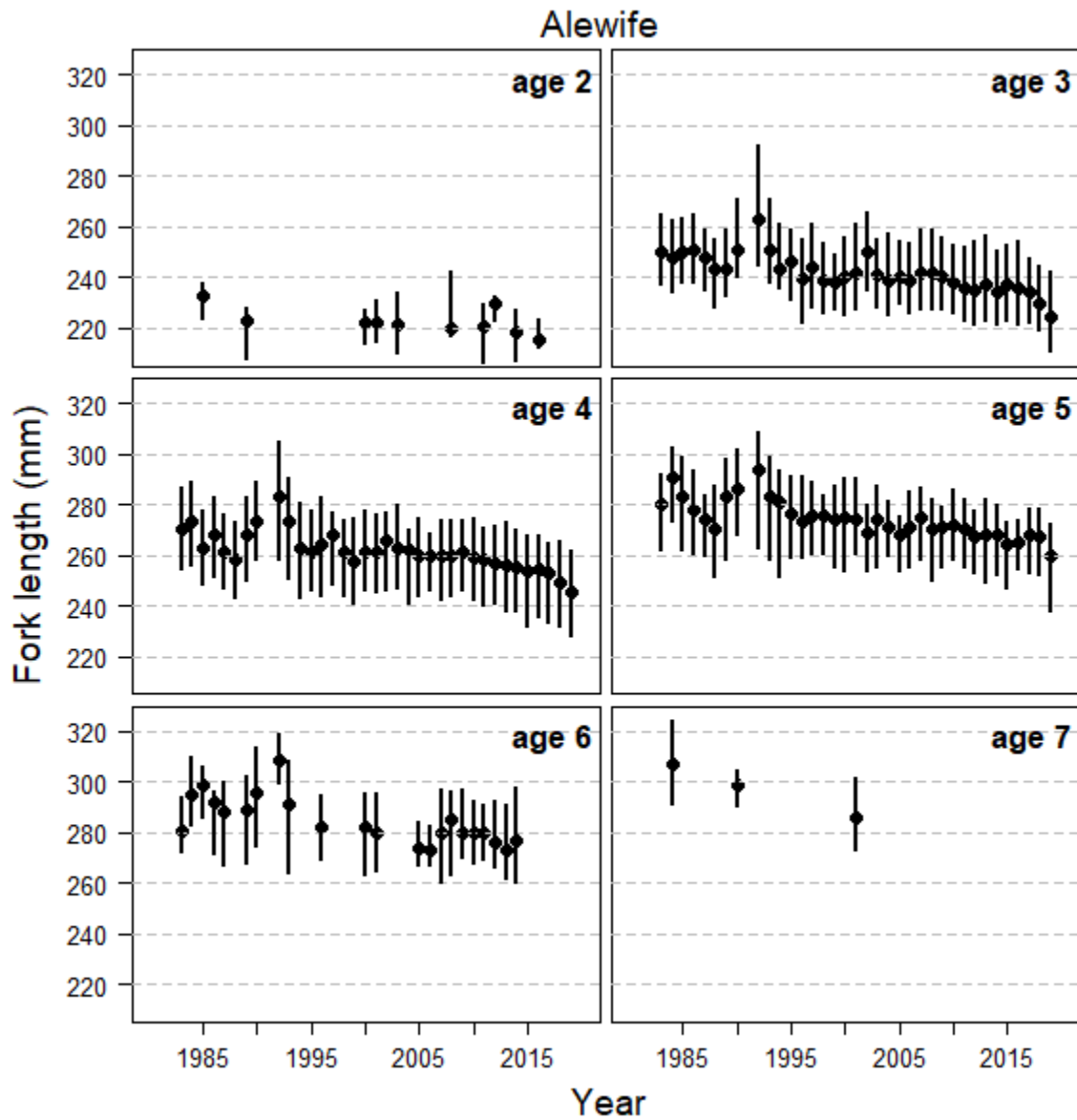


Figure 19. Lengths of Alewife by age group from biological samples collected from the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

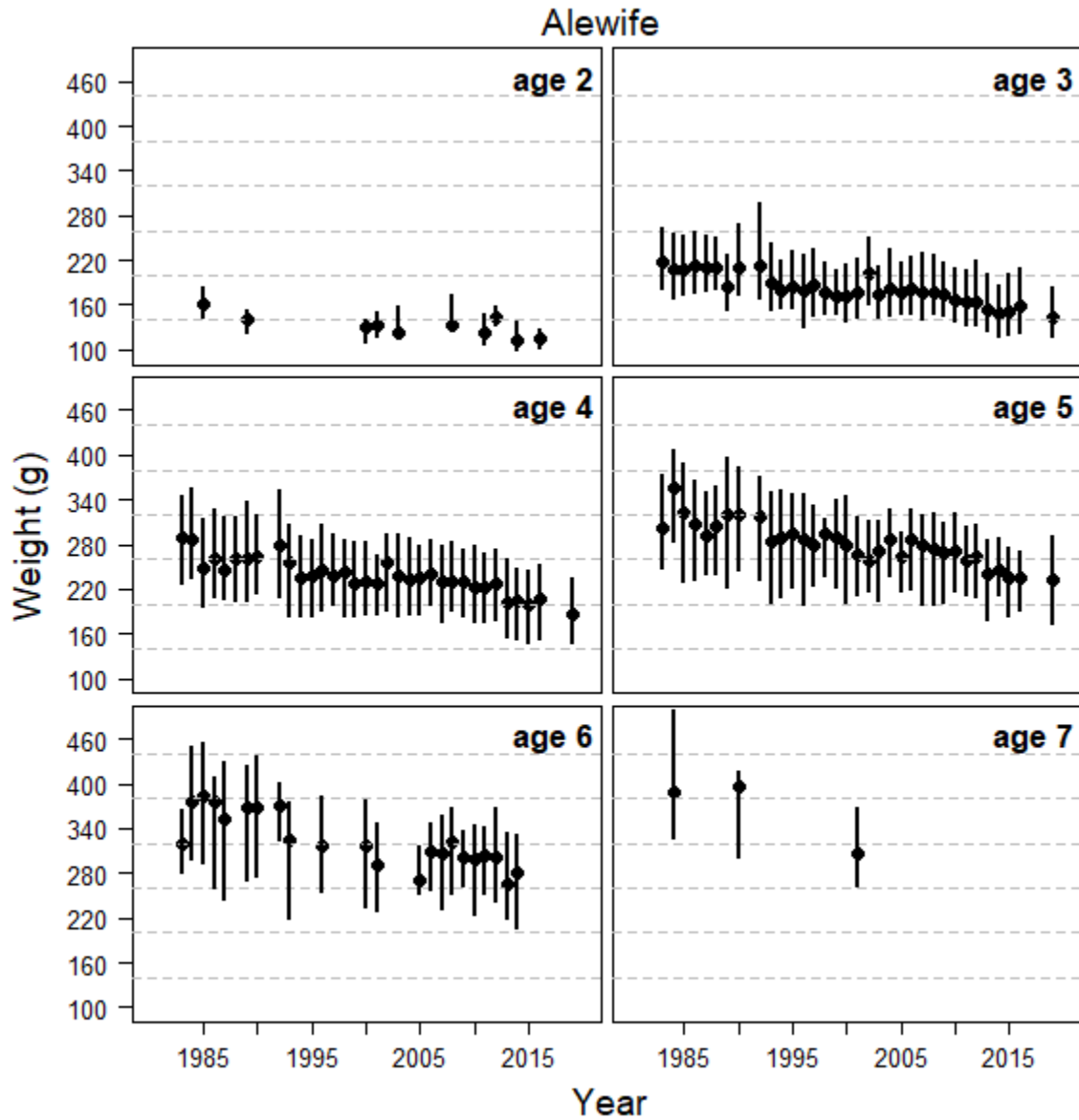


Figure 20. Weights of Alewife by age group from biological samples collected from the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

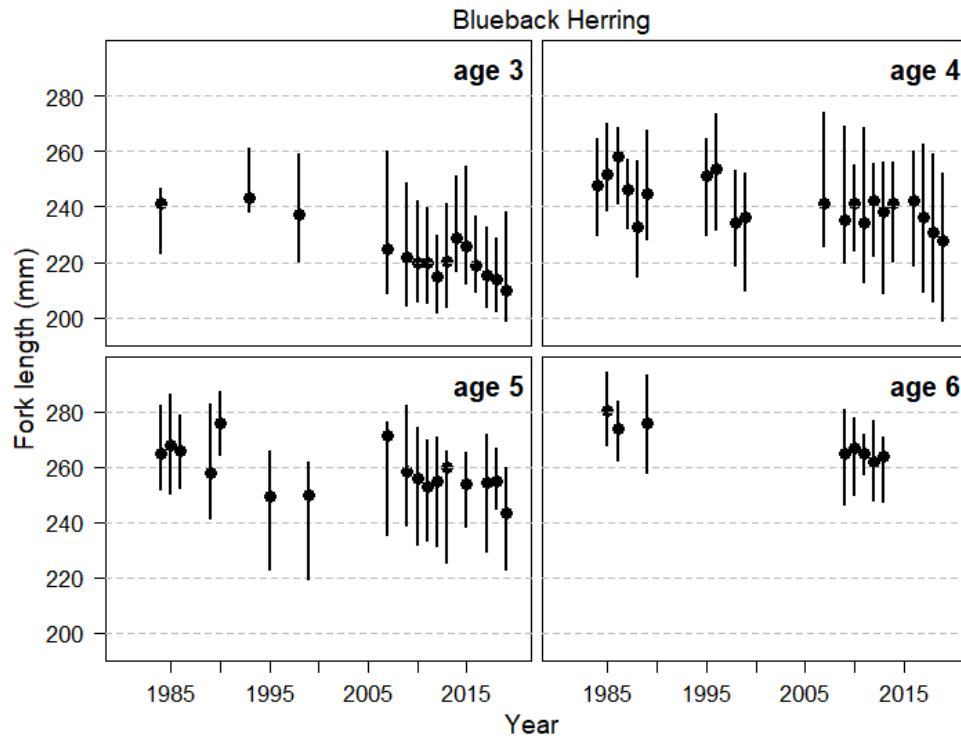


Figure 21. Lengths of Blueback Herring by age group from biological samples collected from the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

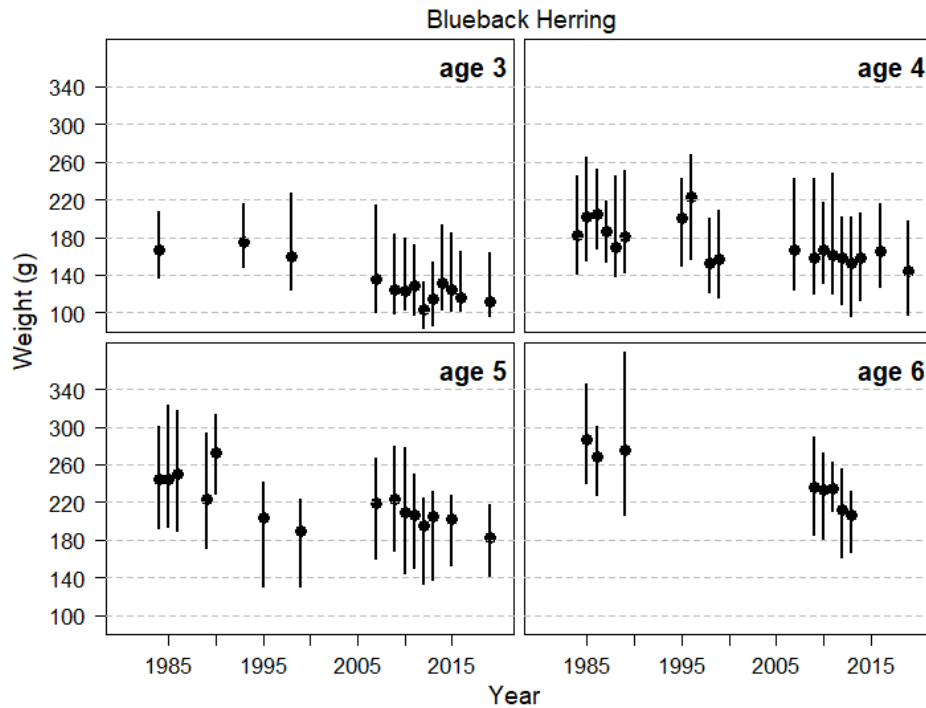


Figure 22. Weights of Blueback Herring by age group from biological samples collected from the commercial gaspereau fisheries in the Margaree River from 1983 to 2019.

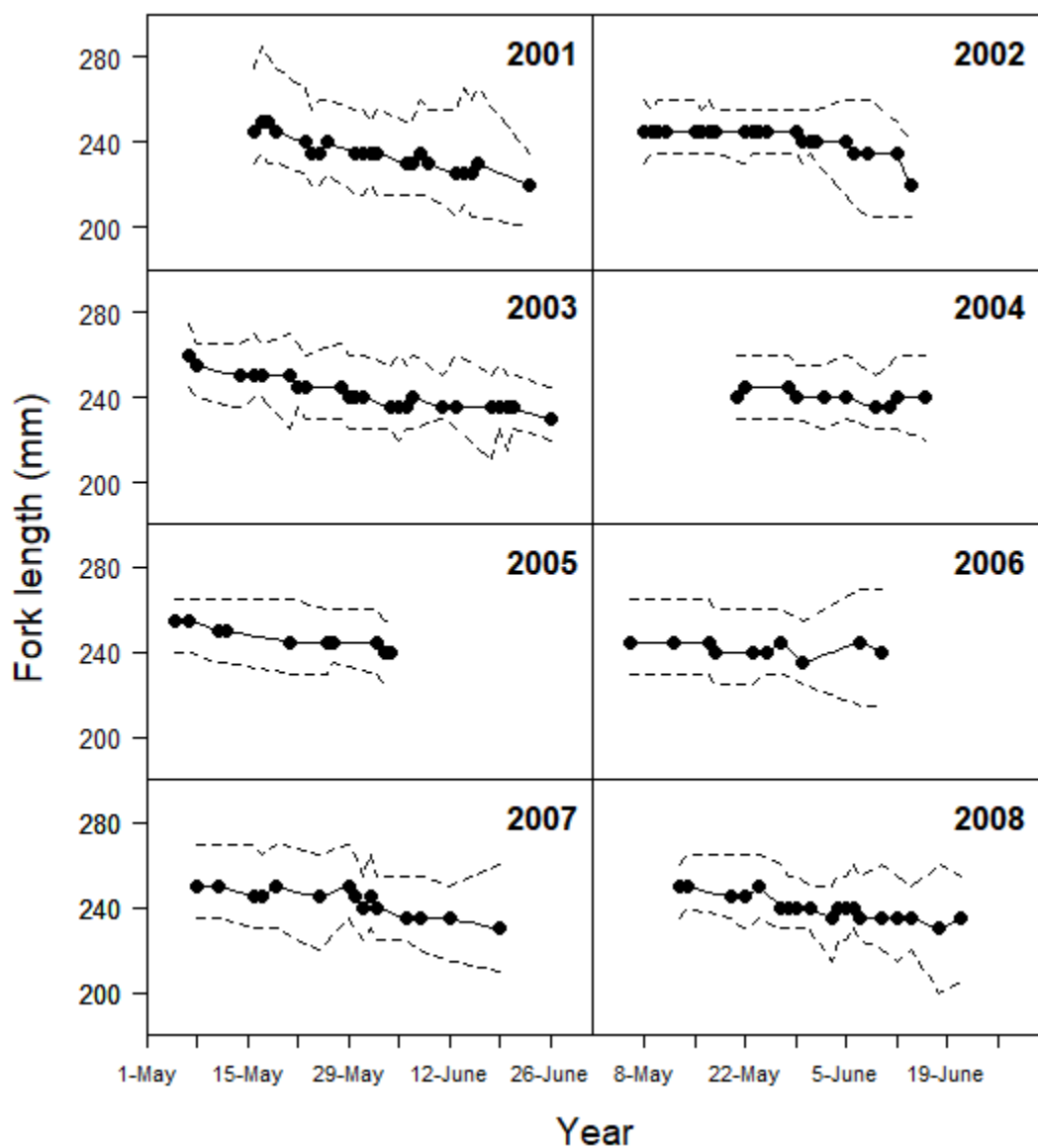


Figure 23a. Median lengths (points) of gaspereau (Alewife and Blueback Herring; mostly Alewife) in the fisheries catches relative to the date of the fishery from 2001 to 2019. The dotted lines represent the 5th and 95th percentiles from the samples.

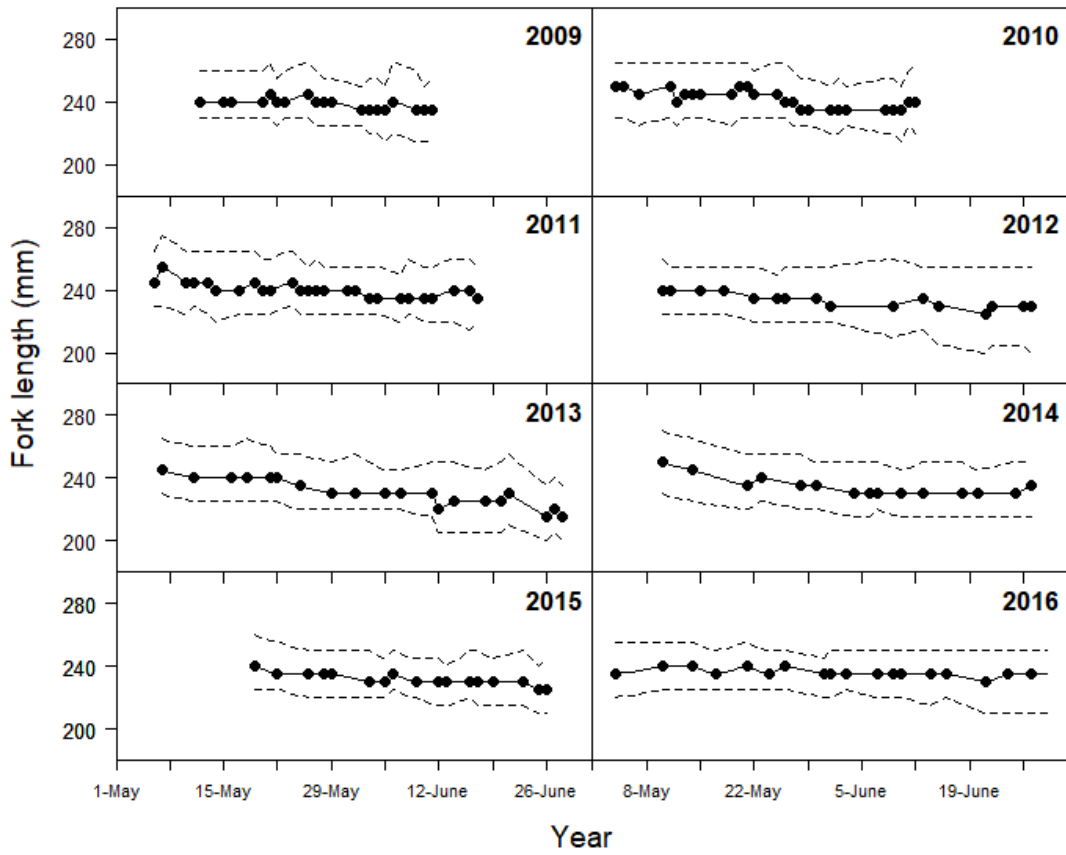


Figure 23b. Median lengths (points) of gaspereau (Alewife and Blueback Herring; mostly Alewife) in the fisheries catches relative to the date of the fishery from 2001 to 2019. The dotted lines represent the 5th and 95th percentiles from the samples.

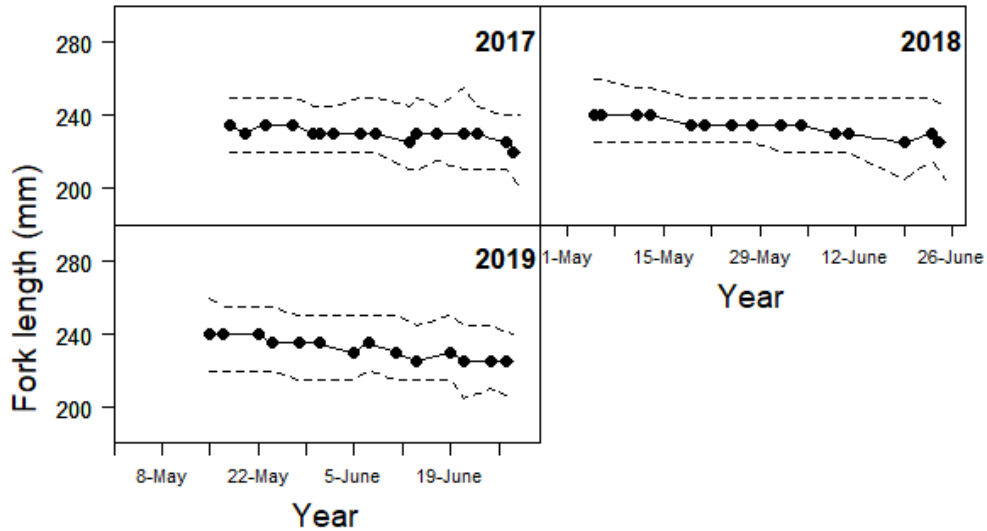


Figure 23c. Median lengths (points) of gaspereau (Alewife and Blueback Herring; mostly Alewife) in the fisheries catches relative to the date of the fishery from 2001 to 2019. The dotted lines represent the 5th and 95th percentiles from the samples.

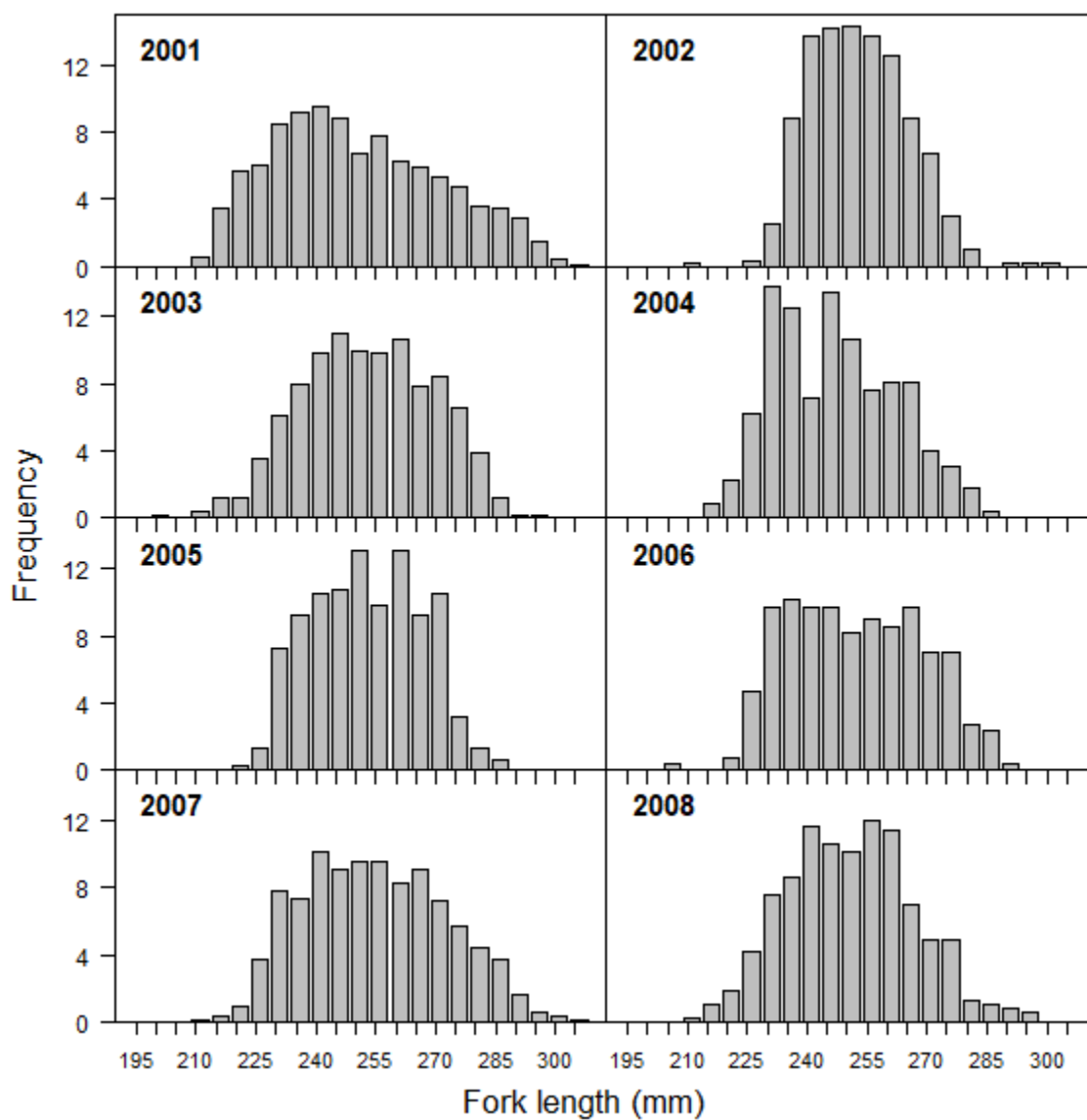


Figure 24a. Fork length distributions of Alewife in the commercial gaspereau landings in the Margaree River from 2001 to 2019.

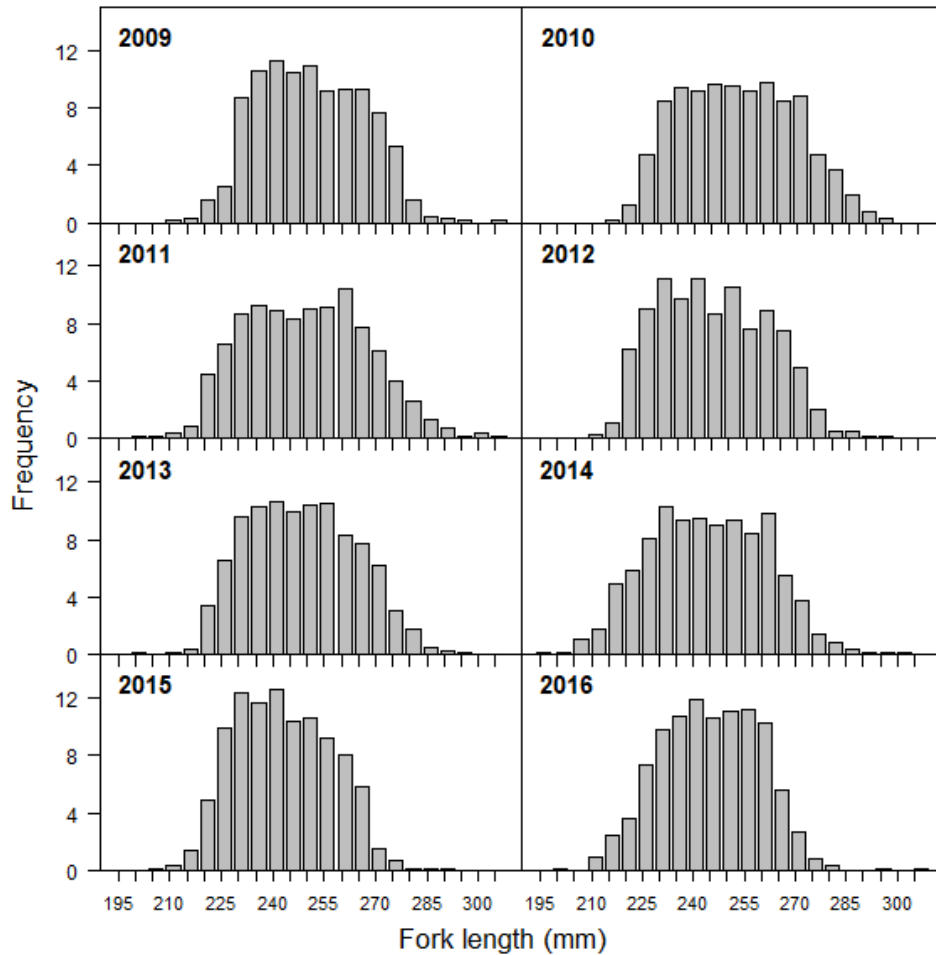


Figure 24b. Fork length distributions of Alewife in the commercial gaspereau landings in the Margaree River from 2001 to 2019.

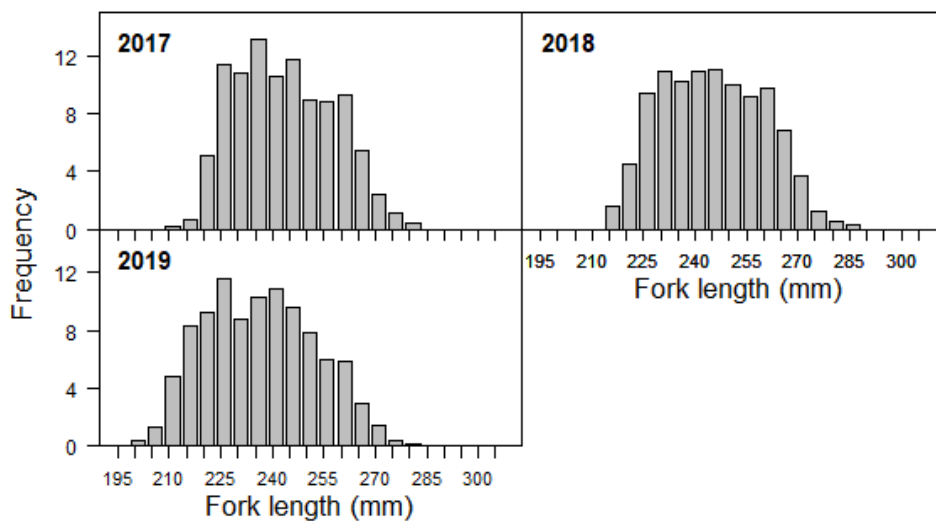


Figure 24c. Fork length distributions of Alewife in the commercial gaspereau landings in the Margaree River from 2001 to 2019.

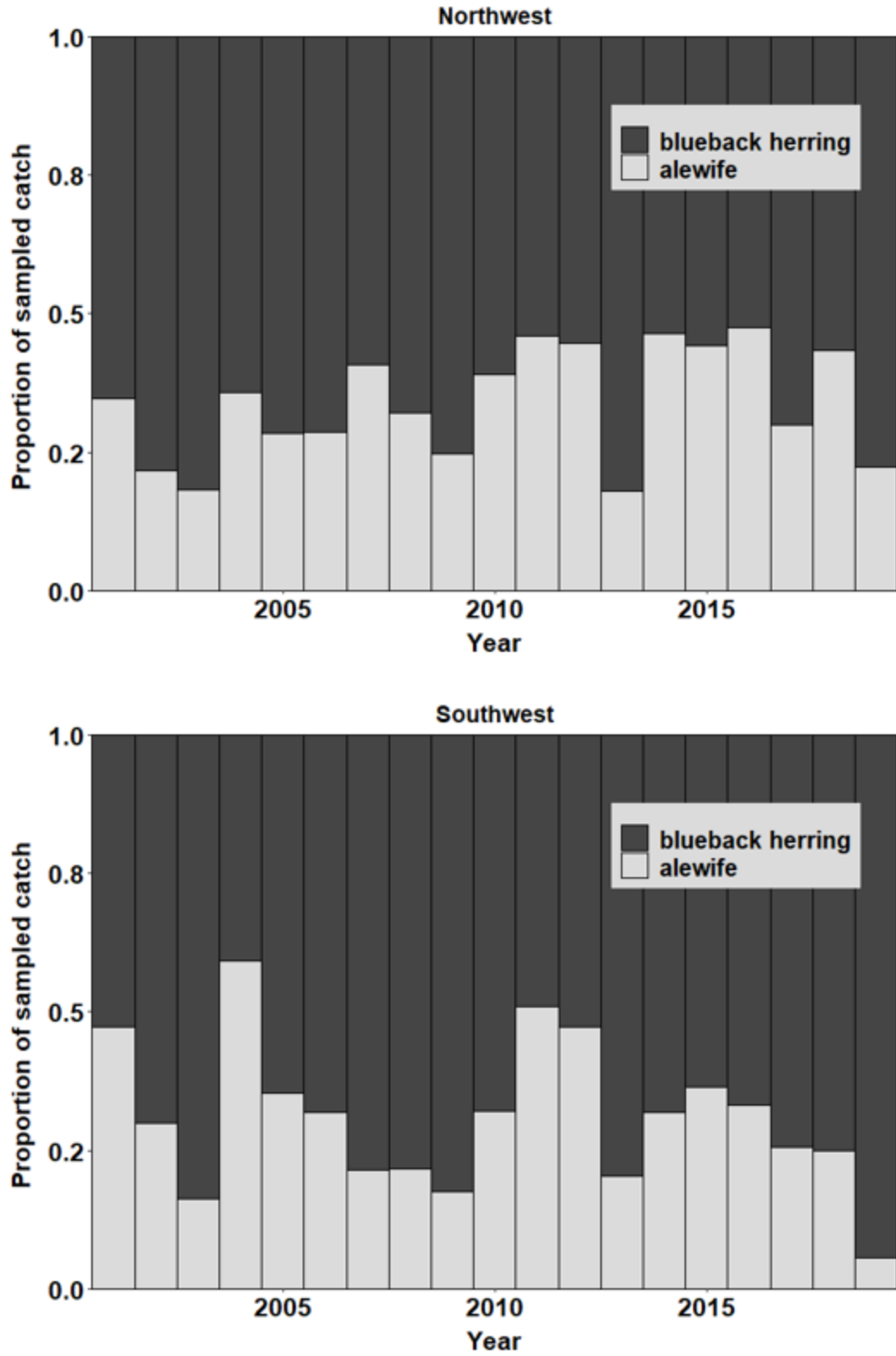


Figure 25. Proportion of Alewife and Blueback Herring in the sampled catch at DFO research trapnets on the Northwest (upper) and Southwest (lower) Miramichi River from 2001 to 2019.

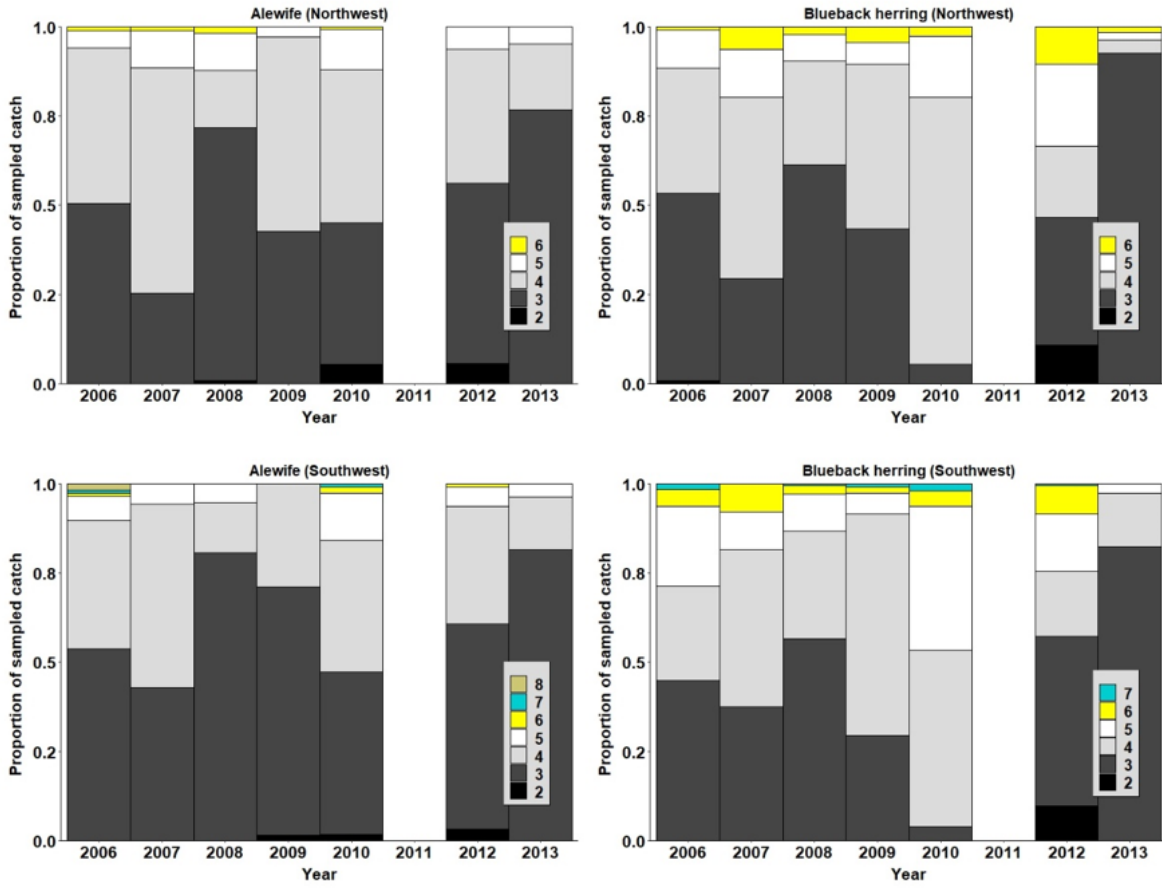


Figure 26. Proportions by age of Alewife (left) and Blueback Herring (right) in the sampled catch at DFO research trapnets on the Northwest (upper) and Southwest (lower) Miramichi River from 2006 to 2019.

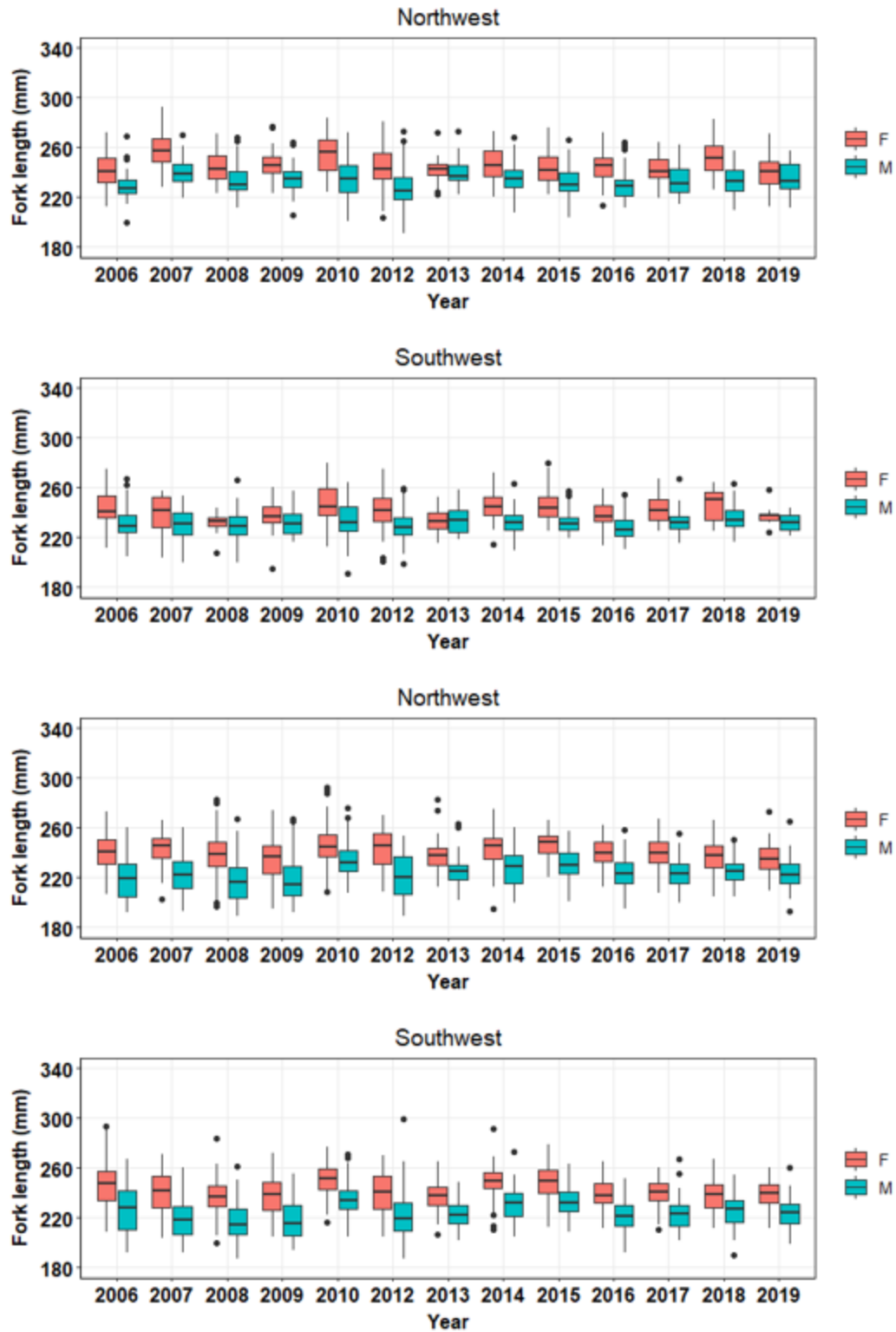


Figure 27. Fork length of male (M) and female (F) Alewife (two upper panels) and Blueback Herring (two lower panels) captured at DFO trapnets in the Northwest and Southwest Miramichi River from 2006 to 2019.

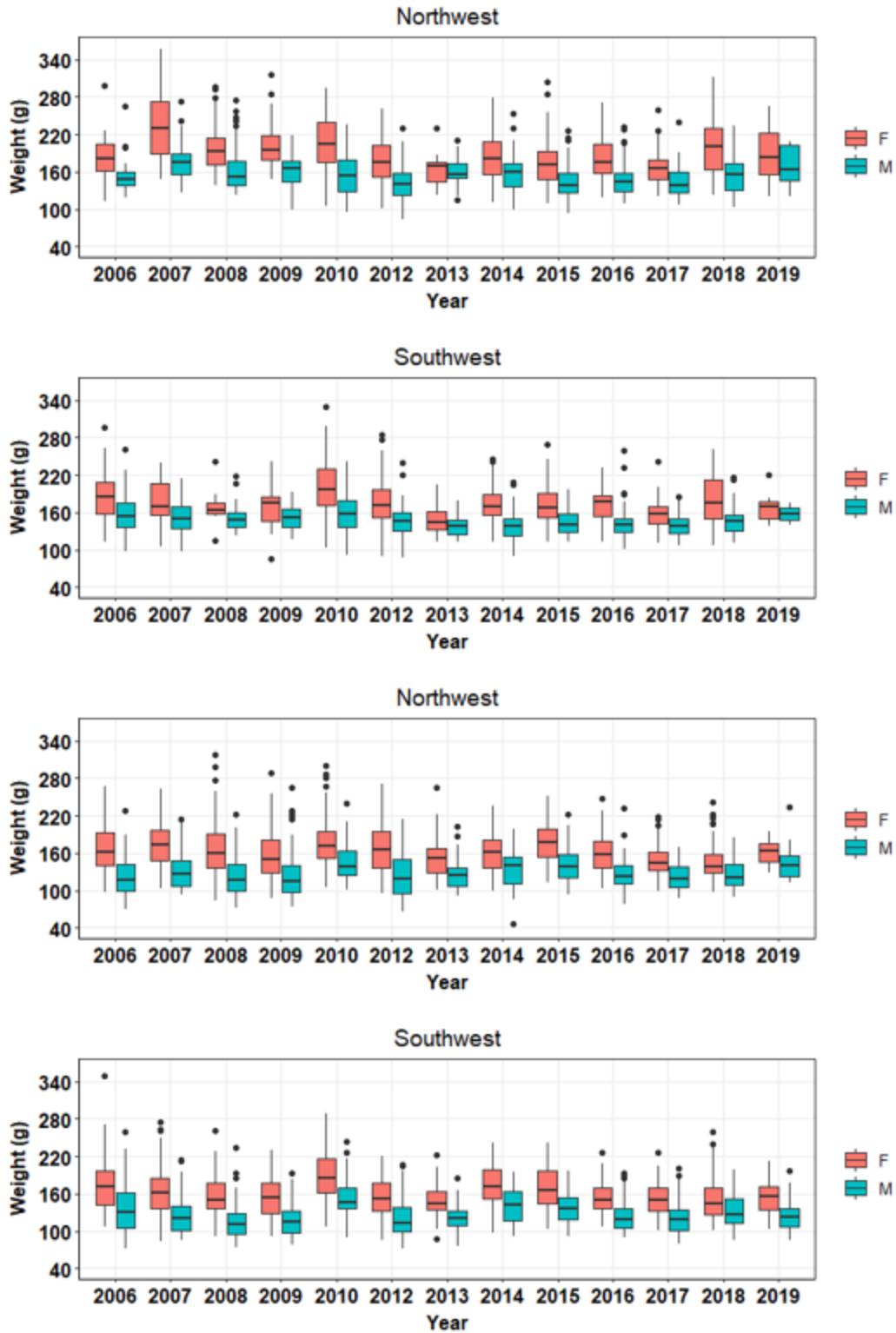


Figure 28. Weights of male (M) and female (F) Alewife (two upper panels) and Blueback Herring (two lower panels) captured at DFO trapnets in the Northwest and Southwest Miramichi River from 2006 to 2019.

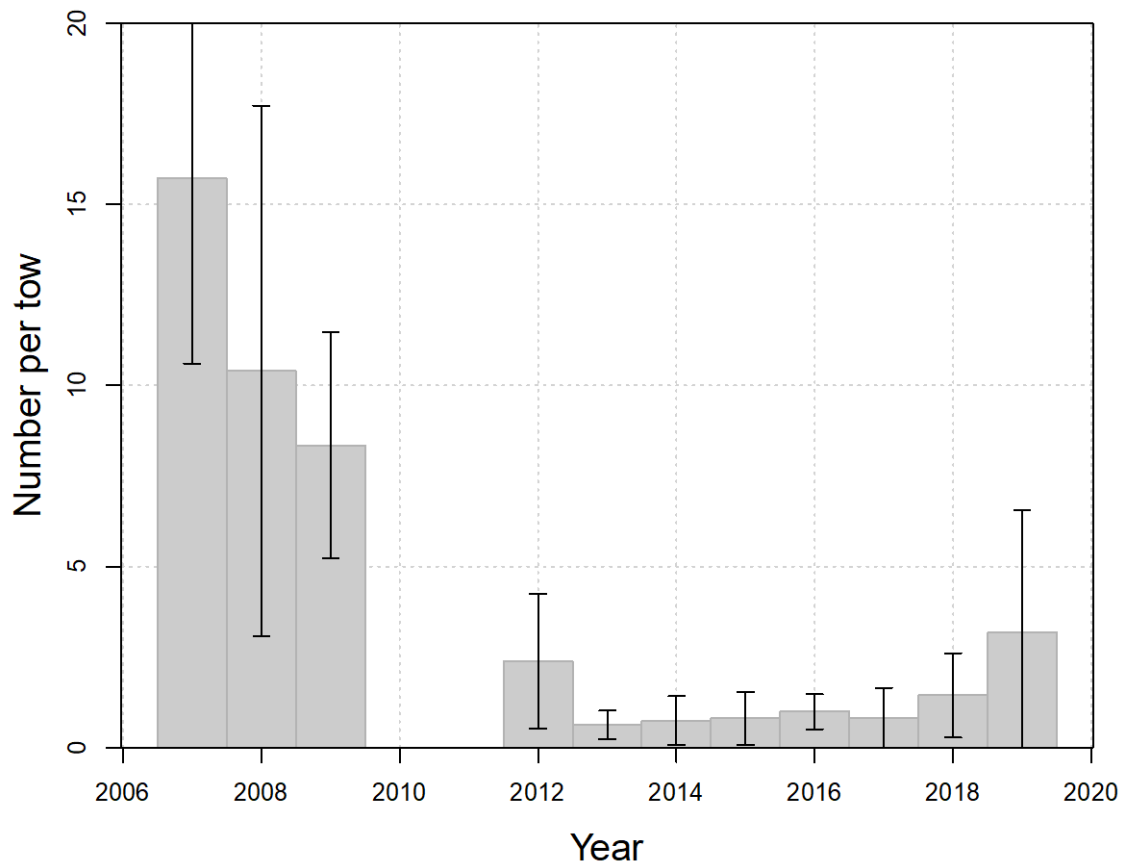


Figure 29. Abundance index values of gaspereau from the DFO Northumberland Strait trawl survey in average numbers of fish per standardized tow length of 0.625 nautical miles. Error bars show 95% confidence intervals.

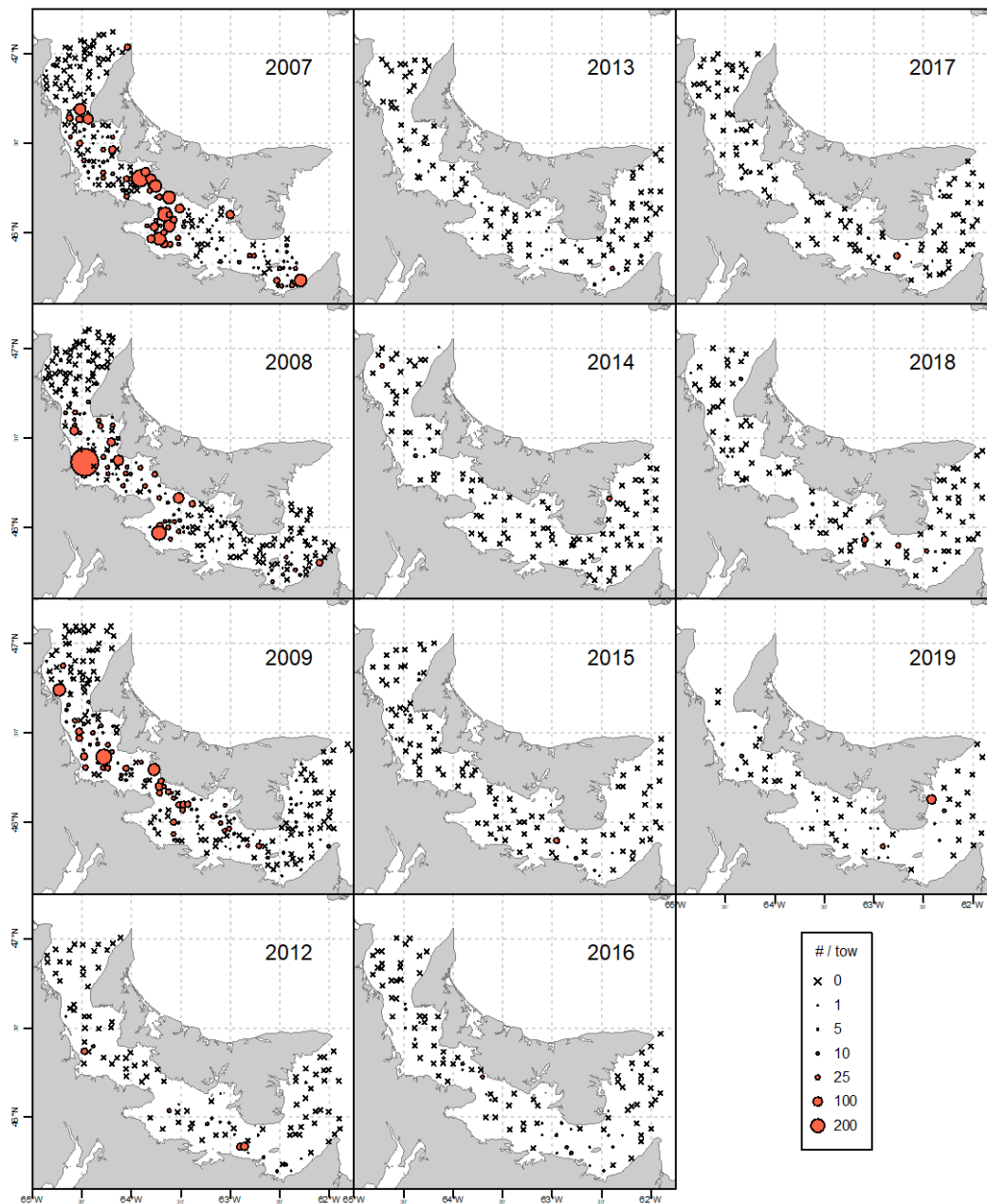


Figure 30. Spatial distribution of gaspereau catches from the DFO Northumberland Strait trawl survey during 2007 to 2019 (except 2010-2011). Catches were standardized to a standard tow length of 0.625 nautical miles. Catches with no gaspereau are shown as Xs.

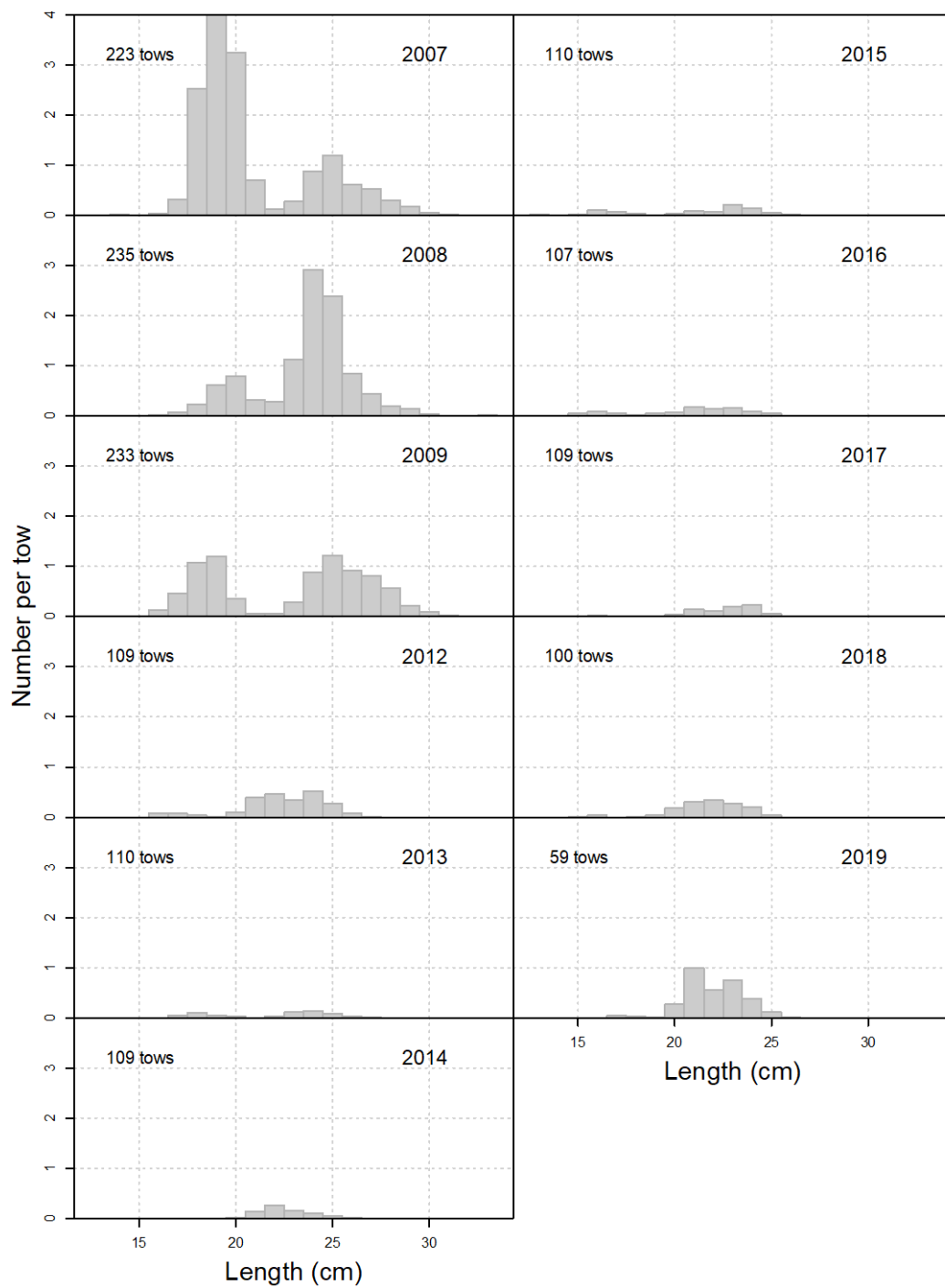


Figure 31. Length-frequency distributions of gaspereau from the DFO Northumberland Strait trawl survey from 2007 to 2019 (except 2010-2011).

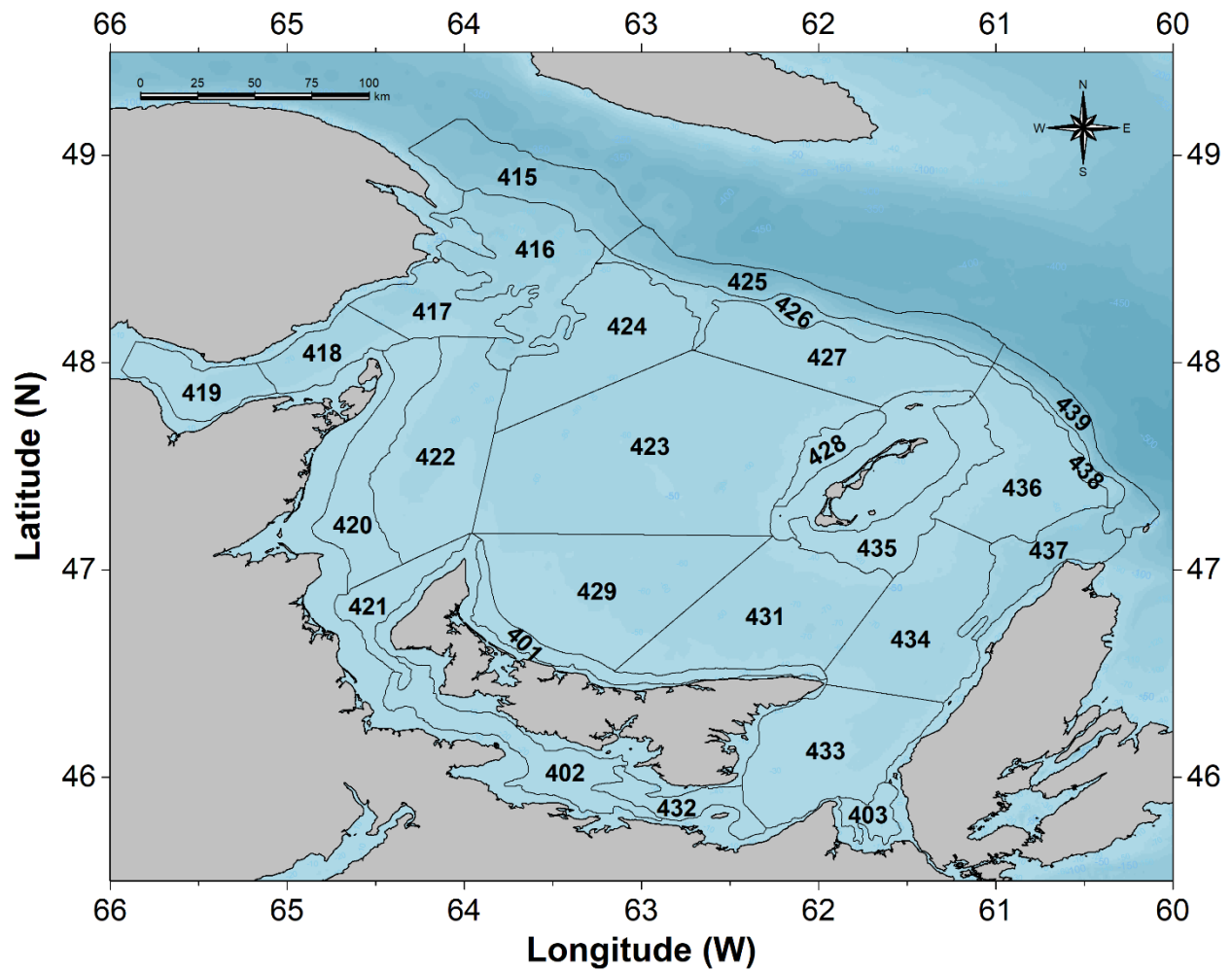


Figure 32. Map showing the survey strata covered by DFO in the southern Gulf of St. Lawrence September bottom-trawl survey (strata 401-439).

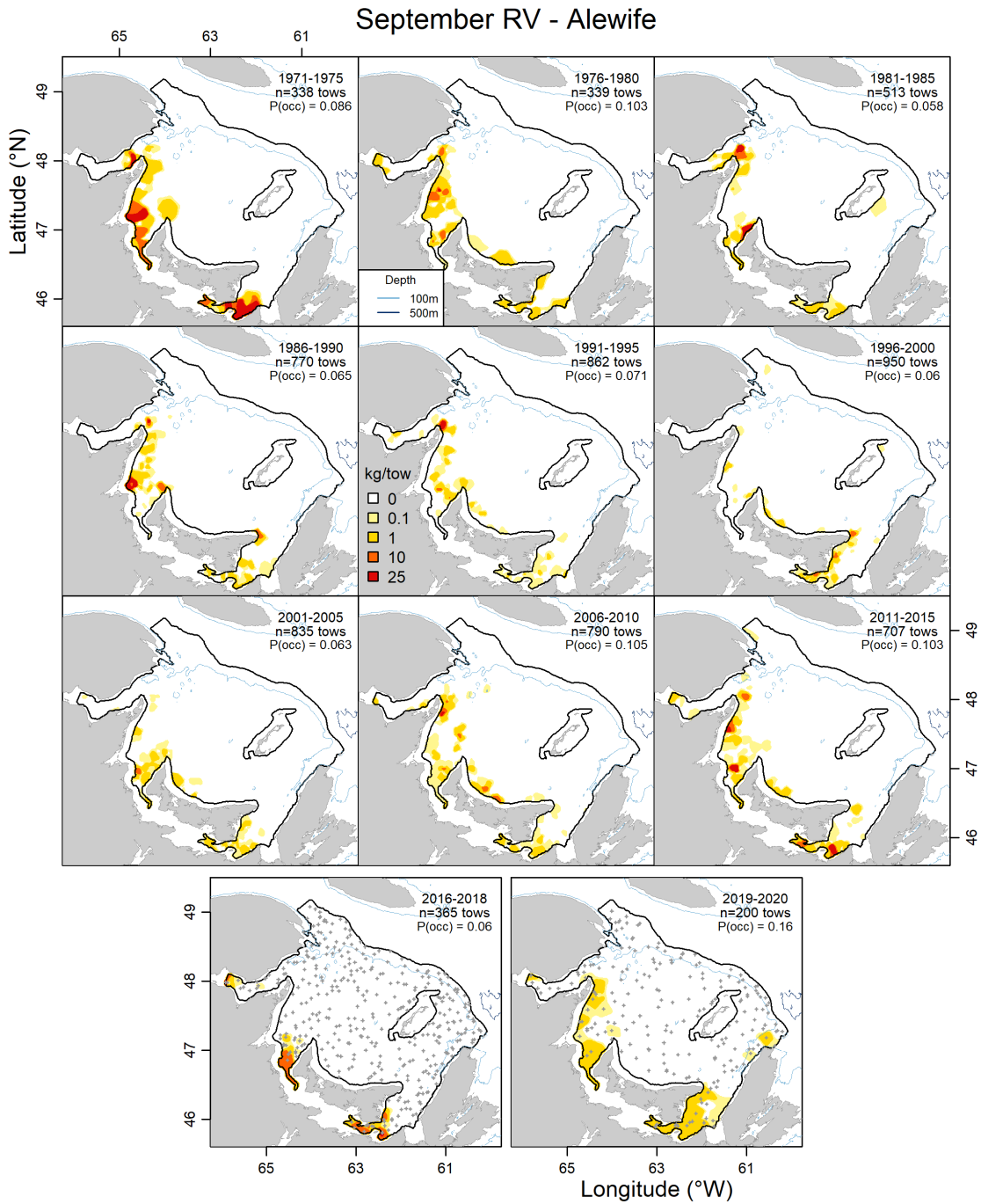


Figure 33. Map showing the relative abundance of gaspereau in the DFO southern Gulf of St. Lawrence September bottom-trawl survey (strata 401-439) from 1971 to 2020.

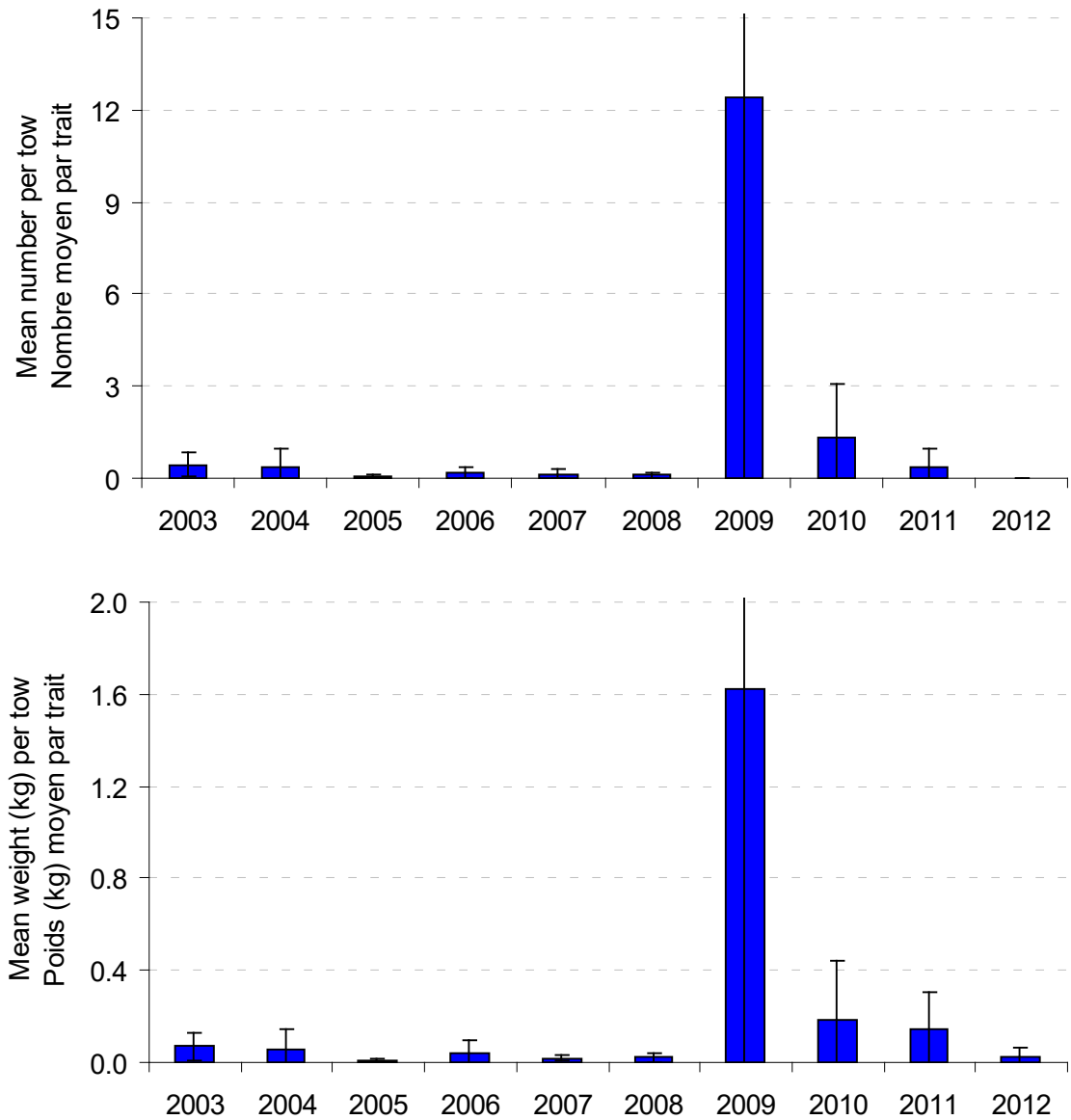


Figure 34. Mean annual numbers (top) and weights (bottom) per tow of gaspereau in the sentinel bottom trawl surveys of the southern Gulf of St. Lawrence. Error bars indicate approximate 95% confidence intervals. (Figure and Figure caption from Savoie 2014).

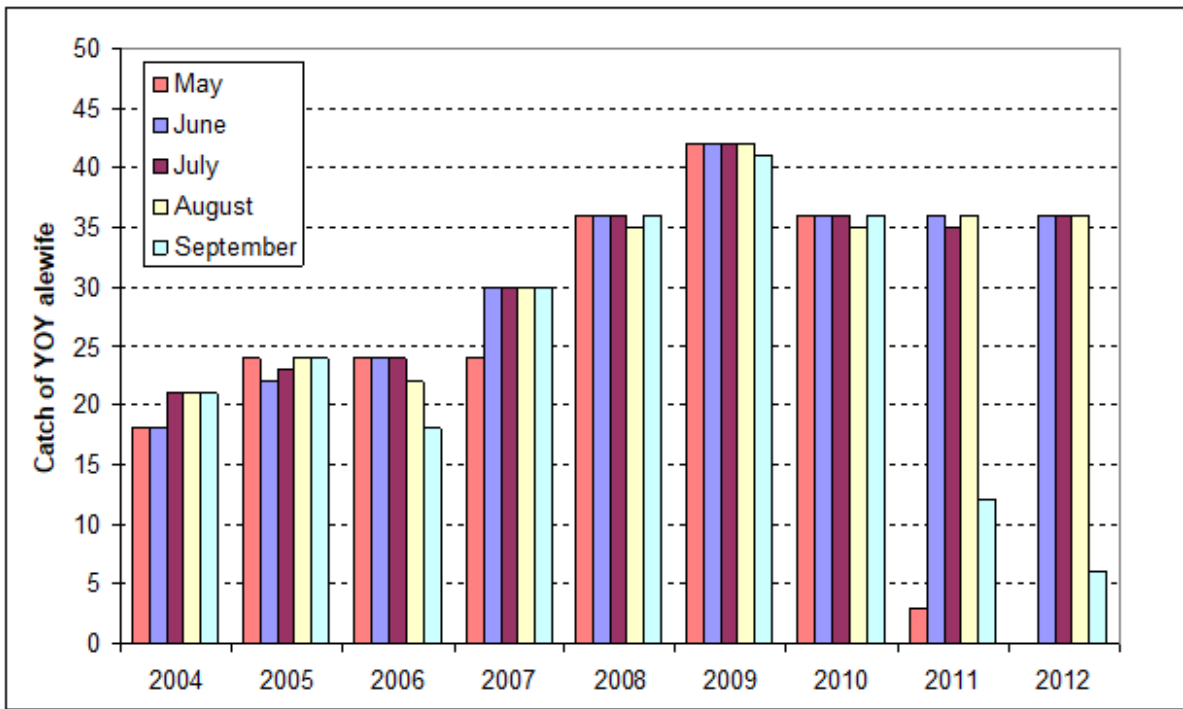
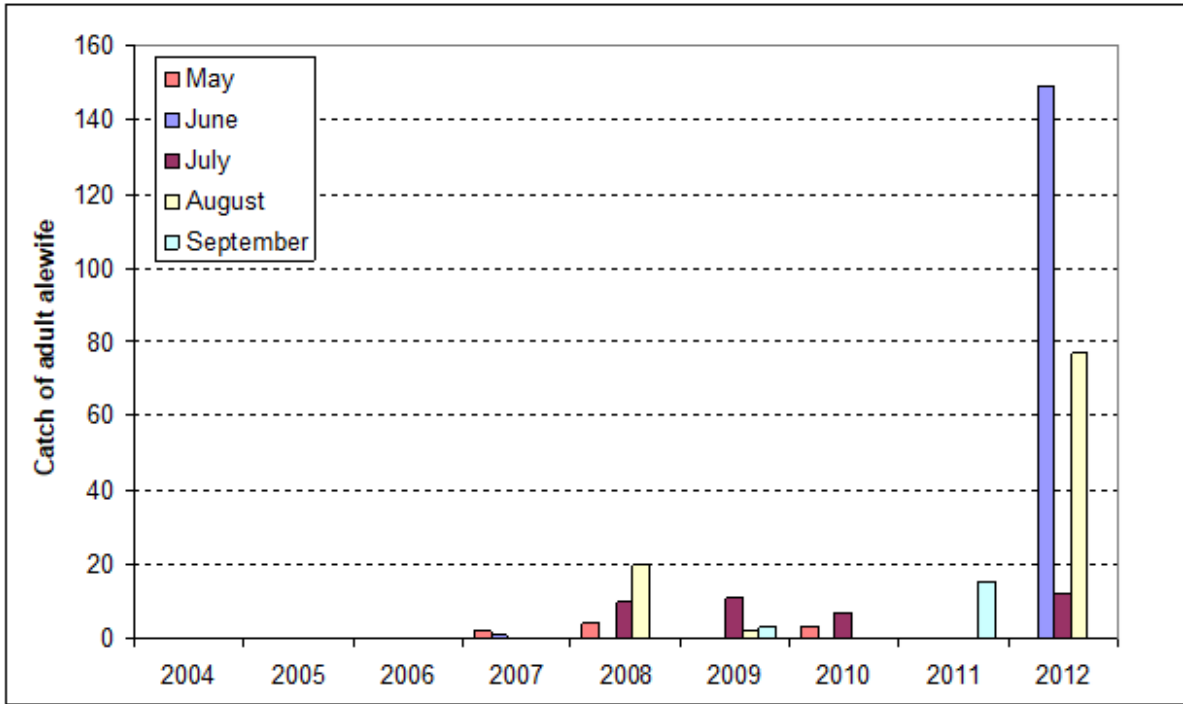


Figure 35. Catches of adult (upper panel) and young-of-the-year (lower panel) gaspereau in the CAMP seining program in estuaries of Gulf Nova Scotia from May to September of years 2004 to 2012. Alewife and Blueback Herring are not identified by species.

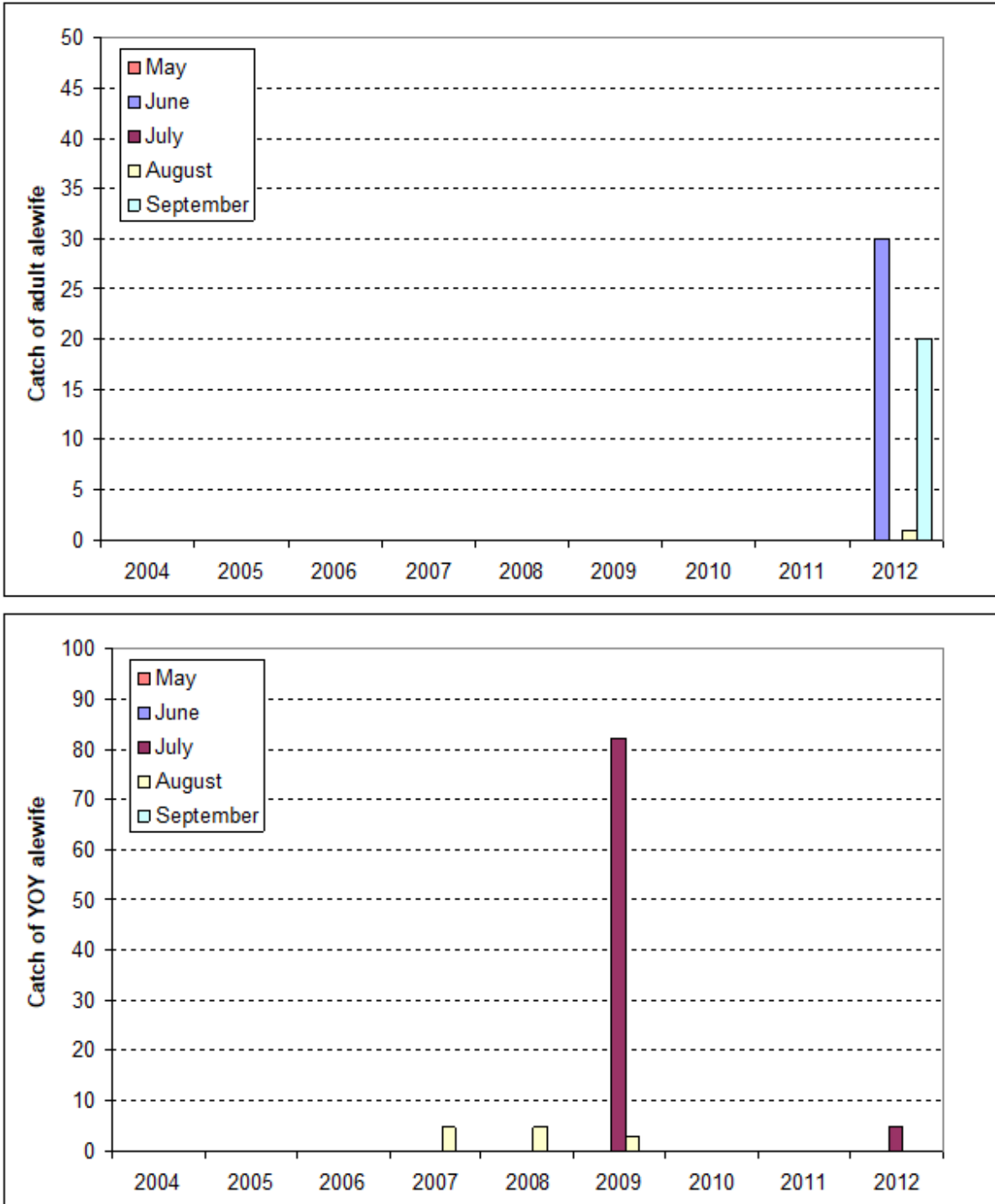


Figure 36. Catches of adult (upper panel) and young-of-the-year (lower panel) gaspereau in the CAMP seining program in estuaries of Prince Edward Island from May to September of years 2004 to 2012. Alewife and Blueback Herring are not identified by species.

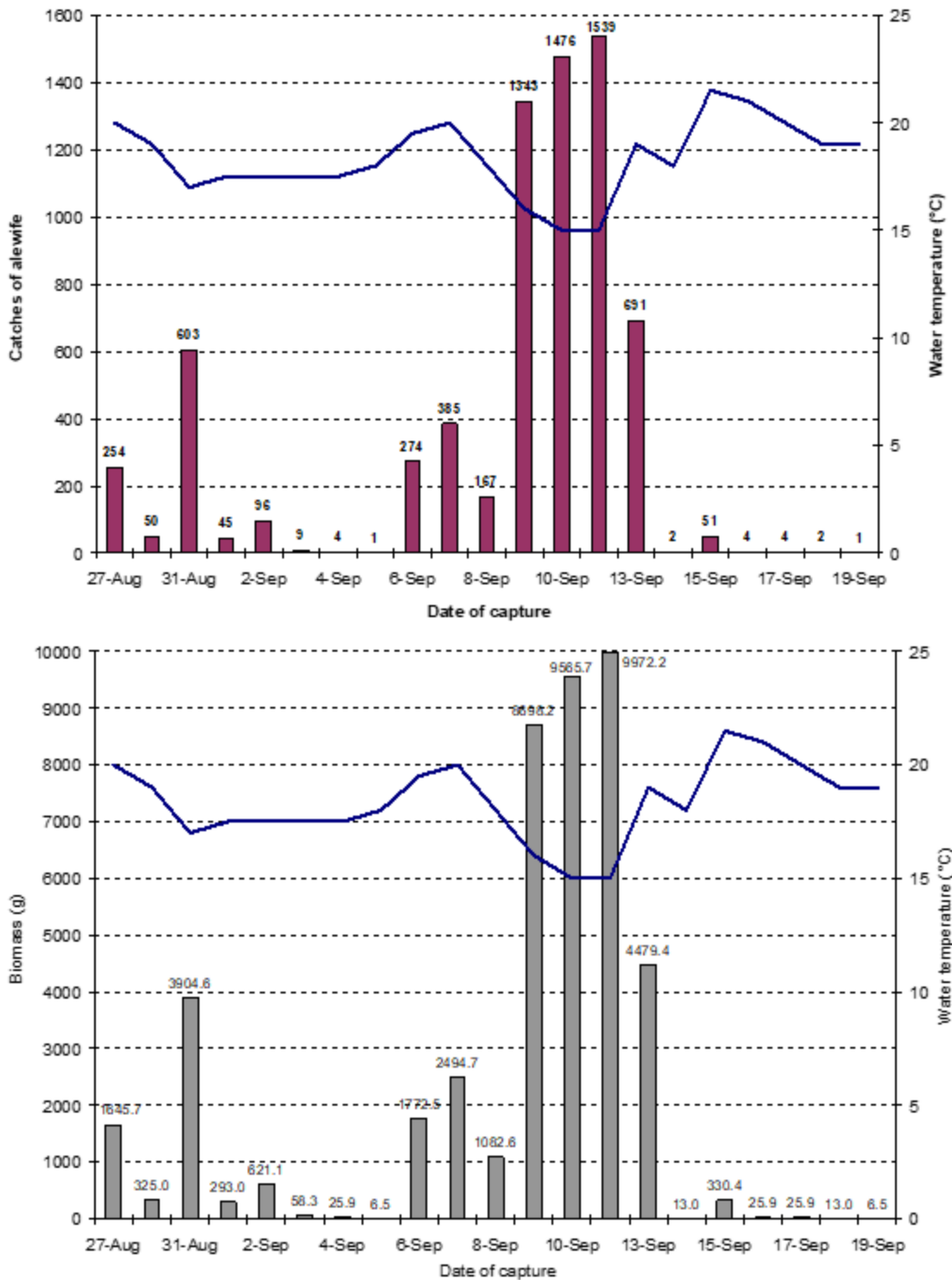


Figure 37. The number (upper) and biomass (lower) of Alewife caught in Long Pond Outlet (Prince Edward Island National Park) in relation to the water temperature during the downstream migration of silver eels in 2003.

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APPENDIX 1

		2001						2002					
		Lower			Upper			Lower			Upper		
		Sample			Sample			Sample			Sample		
Date	Site	Period	size	Site	Period	size	Site	Period	size	Site	Period	size	
May 1													
2													
3													
4													
5													
6													
7													
8										64	AM	270	
9								17	AM	79			
10								5	AM	109	64	PM	194
11								26	PM	310			
12													
13													
14													
15								26	AM	292	64	PM	214
16		5, 26	AM	530				26	PM	228	38	AM	267
17					41	PM	58						
18		26	PM	190	41	AM	90	5, 17	AM, PM	454			
19		5	AM	350	41	PM	233	26	AM	232	64	PM	247
20													
21													
22								26	AM	371	41	PM	323
23		26	AM	228	64	PM	226	26	AM	252	38	PM	236
24		5	AM	370	41	PM	301	5	PM	290	41	AM	637
25		26	PM	282	41	AM	171	17	PM	263	64	AM	289
26		5	PM	294	41	AM	155						
27													
28													
29								5, 17	PM	309	38	AM	321
30		26	PM	133	38	AM	274	26	AM	330	41	AM	336
31		17	PM	306	33	AM	317				38, 64	AM, PM	621
June 1					64	PM	298	17	AM	325	41	PM	287
2		5	AM	308	41	PM	273						
3													
4													
5								26	PM	330			
6		15, 17, 26	AM, PM	332							38	PM	200
7					41	PM	293						
8					64	PM	44	26	PM	269			
9					41	AM	134						
10													
11													
12								26	AM	111			
13		26	AM	83									
14					38	AM	154	26	AM	336			
15		26	PM	283	38	AM	177						
16		26	AM	282	38	PM	141						
17													
18													
19													
20													
21													
22													
23					38	AM	178						
		3971			3517			4890			4442		

Figure A1a. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

2003							2004										
Lower			Upper				Lower			Upper							
Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size			
May	1								May	1							
	2									2							
	3									3							
	4									4							
	5									5							
	6									6							
	7	5 PM	23							7							
	8	5 PM	66							8							
	9									9							
	10									10							
	11									11							
	12									12							
	13									13							
	14	5 AM, PV	318							14							
	15									15							
	16	25, 26 AM	203							16							
	17	5 PM	331	41	AM	33				17							
	18									18							
	19									19							
	20									20							
	21	25 AM	173							21	26 PM	112					
	22	5 PM	169	41	AM	124				22	12 AM	96					
	23	26 AM, PV	178							23							
	24									24							
	25									25							
	26									26							
	27									27							
	28	5 AM	327	35	PM	319				28	17 PM	253					
	29	26 AM	340							29	2 PM	273	41	AM	294		
	30			41	AM	335				30							
	31			38	AM	323				31							
June	1								June	1							
	2									2	5 PM	275					
	3									3							
	4			35, 38 AM, PV	675					4							
	5	5 PM	314	38	AM	307				5	5 PM	186					
	6	25 AM	237	41	PM	307				6							
	7	5, 26 AM, PV	636							7							
	8									8							
	9									9	25 PM	181					
	10									10							
	11	26 AM	319							11			35	PM	269		
	12									12	26 PM	296					
	13	5 PM	304							13							
	14									14							
	15									15							
	16									16	5 PM	99					
	17									17							
	18	25 AM	151							18							
	19			41	AM	131				19							
	20	26 AM	296							20							
	21	5 AM	325							21							
	22									22							
	23									23							
	24									24							
	25									25							
	26	5 AM	322							26							
						5032			2554					1771			563

Figure A1b. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

		2005						2006							
		Lower			Upper			Lower			Upper				
		Sample			Sample			Sample			Sample				
		Site	Period	size	Site	Period	size	Site	Period	size	Site	Period	size		
May	1							May	1						
	2								2						
	3								3						
	4								4						
	5		1 PM	18					5						
	6								6	5 PM		191			
	7		26 PM	24					7						
	8								8						
	9								9						
	10								10						
	11				41	AM	164		11						
	12		2 AM	67					12	26 PM		119			
	13								13						
	14								14						
	15								15						
	16								16						
	17								17	5 PM		259			
	18								18	26 PM		266			
	19								19						
	20								20						
	21		26 AM	212	49	PM	148		21						
	22								22						
	23								23	5 PM		268			
	24								24						
	25								25	2 PM		204			
	26		25 PM	229					26						
	27				35	PM	161		27	12 PM		245			
	28								28						
	29								29						
	30								30	26 PM		245			
	31								31						
June	1							June	1						
	2		5, 15 AM, PM	400					2						
	3				35	PM	274		3						
	4		2 PM	167					4						
	5								5						
	6								6						
	7								7	5 AM		82			
	8								8						
	9								9						
	10								10		47 AM		193		
				1117					747					1879	193

Figure A1c. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

		2007						2008							
		Lower			Upper			Lower			Upper				
		Sample			Sample			Sample			Sample				
		Site	Period	size	Site	Period	size	Site	Period	size	Site	Period	size		
May	1							May	1						
	2								2						
	3								3						
	4								4						
	5								5						
	6								6						
	7								7						
	8	26	PM	292					8						
	9								9						
	10								10						
	11				41	PM	238		11						
	12								12						
	13								13	26	PM	46			
	14								14	26	AM	41			
	15								15						
	16				47	PM	197		16						
	17	5	PM	202					17						
	18								18						
	19	26	AM	330					19						
	20								20	26	AM	83			
	21								21						
	22								22			41	AM	81	
	23								23						
	24								24			41	PM	256	
	25	25	AM	160					25						
	26								26						
	27								27	5	PM	287			
	28								28			35	AM	258	
	29				41	AM	289		29	26	PM	232			
	30	5	AM	313					30						
	31				41	PM	196		31	5	PM	263			
June	1	25	AM	298	47	PM	262	June	1						
	2	2, 26	PM	544	35	PM	4		2						
	3								3			41	AM	240	
	4								4	5	AM	282			
	5								5	26	AM	278			
	6	5	AM	247					6	5	PM	303			
	7								7	5	PM	298	41	AM	313
	8				35	PM	232		8						
	9								9						
	10								10			41	AM	245	
	11								11						
	12				47	PM	230		12	26	AM	303			
	13								13						
	14								14	26	PM	315			
	15								15						
	16								16						
	17								17						
	18								18	5	PM	204			
	19	26	AM	261					19						
	20								20						
	21								21			41	AM	253	
		2647			1648			2935			1646				

Figure A1d. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

		2009						2010							
		Lower			Upper			Lower			Upper				
		Sample			Sample			Sample			Sample				
		Site	Period	size	Site	Period	size	Site	Period	size	Site	Period	size		
May	1							May	1						
	2								2						
	3								3						
	4								4	26	AM	50	41	PM	259
	5								5				41	PM	224
	6								6						
	7								7	26	AM	246	41	AM	134
	8								8						
	9								9						
	10								10						
	11								11	26	AM, PV	167			
	12	26	AM	281					12				41	AM	70
	13								13	26	AM	213			
	14								14	26	AM	294			
	15				41	PM	279		15	26	AM	313			
	16	26	AM	321	41	PM	77		16						
	17								17						
	18								18						
	19								19	26	AM, PV	495			
	20	26	AM, PM	528					20	25	AM	271			
	21				41	PM	306		21	5	AM	264	41	PM	269
	22	26	AM, PM	584					22	26	PM	271	35	AM	280
	23				41	PM	298		23						
	24								24						
	25								25	25, 26	AM, PV	644			
	26	5	PM	233	41	AM	289		26	25	AM	259			
	27	26	AM	313	41	PM	307		27	26	AM, PV	543			
	28	26	PM	301					28	26	PM	241	41	AM	290
	29				41	PM	285		29	25	PM	281	41	AM	274
	30								30						
	31								31						
June	1							June	1	25	AM	295	41	PM	123
	2	5	AM	120					2	26	AM	258	41	PM	286
	3	26	AM	268					3	26	PM	326	41	AM	259
	4				41	AM	159		4						
	5				41	AM	278		5						
	6	26	AM	294	41	PM	301		6						
	7								7						
	8								8				41	PM	295
	9	26	AM	327					9				41	AM	305
	10				41	AM	296		10	26	PM	126	41	AM	269
	11	26	AM	314					11				41	AM	257
	12								12	26	AM	265			
		3884			2875			5822			3594				

Figure A1e. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

		2011						2012					
		Lower			Upper			Lower			Upper		
		Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size
May	1												
	2												
	3												
	4												
	5												
	6	26	AM	26									
	7	26	AM	39									
	8												
	9												
	10	26	AM	100									
	11				41	AM	63						
	12												
	13				41	PM	242						
	14				41	PM	336						
	15												
	16												
	17				41	AM	58						
	18												
	19	26	AM	332	41	PM	320						
	20	26	AM	318									
	21				41	AM	314						
	22												
	23												
	24				41	AM	305						
	25	26	AM	341									
	26	26	AM	84							35	PM	254
	27				41	AM	332				41	AM	271
	28	5	PM	269	41	AM	379						
	29												
	30												
	31	26	AM	426									
June	1	15	AM	261	41	PM	377	June	1	26	AM	169	
	2												
	3	25, 26	AM, PM	754									
	4				49	AM	367						
	5												
	6												
	7	26	AM	68									
	8				41	AM	365						
	9												
	10				41	AM	384						
	11	26	AM	196									
	12												
	13												
	14	26	PM	350							41	AM	113
	15												
	16	26	AM	355									
	17	26	AM	323									
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												
	26												
	27												
	28												
	29												
Total samples		4242			3842			4738			2770		

Figure A1f. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

	2013						2014					
	Lower			Upper			Lower			Upper		
	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size
May 1												
2												
3												
4												
5												
6												
7	25	AM	235	47	PM	231						
8												
9												
10									47	PM	195	
11				51	PM	229						
12												
13												
14							25	PM	205	47	AM	217
15												
16	26	AM	249	41, 47	PM, AM	398						
17												
18	25	PM	225	35	AM	130						
19												
20												
21	25	PM	232				21, 25	PM, AM	434			
22	12	AM	229	41	AM	237						
23							26	AM	229	62	PM	221
24												
25	12, 25	PM, AM	480	51	AM	236						
26												
27												
28							12	AM	250	41	AM	230
29	25, 26	PM, AM	461	47	PM	241						
30							5	PM	220	47, 62	AM, PM	465
31												
June 1	12	PM	249	51	AM	224						
2												
3												
4							5, 25	PM, AM	445	41	PM	226
5	2	PM	224	41, 51	PM, AM	484						
6							12, 26	PM, AM	501	62	AM	243
7	26	AM	235									
8												
9												
10							25, 26	AM, PM	487	47	PM	246
11	25	PM	221	47	PM	237						
12	26	AM	235									
13							12	AM	256	41	AM	268
14	25	AM	233	51	PM	254						
15												
16												
17												
18	2, 26	PM, AM	488	47	AM	238	26	AM	234	41	AM	241
19												
20	25	PM	225	41	PM	250	12, 26	PM, AM	473			
21				51	AM	236						
22												
23												
24												
25							26	AM	239	28, 41	PM, AM	460
26	26	AM	232									
27				41	PM	257	12	PM	216	41, 62	PM, AM	447
28	26	AM	236									
29												
Total samples			4689			3882			4189			3459

Figure A1g. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

		2015						2016					
		Lower			Upper			Lower			Upper		
		Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size
May	1												
	2												
	3												
	4										41	PM	166
	5												
	6												
	7												
	8												
	9												
	10							25	PM	212	47, 33	AM, PM	438
	11												
	12												
	13												
	14							15	PM	220	62, 41	AM, PM	449
	15												
	16												
	17							25, 12	AM, PM	473	33	AM	222
	18												
	19	26	AM	134	47	PM	238						
	20												
	21							26	AM, PM	223	41	AM	250
	22	12	AM	210	41, 62	AM, PM	437						
	23												
	24							12	AM, PM	229	33	AM	220
	25												
	26	25	PM	221	47, 33	AM, PM	463	62, 15	PM	433	41	PM	230
	27												
	28	26	AM	222	41	PM	205						
	29	12	AM	209									
	30												
	31							26	AM	230	unk	PM	217
June	1										41	AM	229
	2												
	3	25	AM	233	33, 64	AM, PM	457	25	AM	223	51, 33	AM, PM	466
	4												
	5	26	PM	210									
	6	12	AM	233	41	AM	231						
	7							12	PM	252	41	PM	246
	8												
	9	12	AM	242	47	PM	225	15	AM	231	47	PM	262
	10							26	AM	246			
	11												
	12	25	AM	231	33	AM	227						
	13	26	AM	214									
	14							25, 12	AM, PM	489	unk	AM	238
	15												
	16	12	PM	223				25	AM	225	41	PM	225
	17	25	PM	217	47	AM	230						
	18												
	19	26	AM	236	51, 41	AM, PM	441						
	20												
	21							25	AM	256	unk, 41	AM, PM	499
	22												
	23	12	PM	216	62, 41	AM, PM	434						
	24							26, 15	AM, PM	427	47	AM	234
	25				47	PM	227						
	26	25	AM	238	51	PM	242						
	27												
	28												
	29							25	PM	237	41	AM	226
Total samples		3489			4057			4606			4817		

Figure A1h. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).

		2017						2018					
		Lower			Upper			Lower			Upper		
		Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size	Site	Period	Sample size
May	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9							26	AM	221			
	10										64	AM	213
	11												
	12												
	13												
	14												
	15							15, 25	AM, PM	431	33	AM	215
	16												
	17							26, 25	AM, PM	411	47	PM	229
	18												
	19												
	20												
	21												
	22												
	23							26	AM	217	62	PM	211
	24												
	25							25	AM	212	41	AM	217
	26												
	27							12	AM	226	62, 47	AM, PM	473
	28												
	29												
	30							26	AM	236	unk	PM	228
	31										41	AM	240
June	1												
	2												
	3												
	4												
	5												
	6							25	PM	217	unk	AM	233
	7												
	8							12	AM	241	47	AM	226
	9												
	10												
	11												
	12												
	13										62	AM	225
	14							25	AM	224			
	15												
	16												
	17							26	AM	224			
	18												
	19												
	20												
	21							26, 12	AM, PM	464	62	PM	237
	22												
	23							26	AM	230	62	AM	223
	24												
	25												
	26												
	27							26	AM	217			
	28												
	29							26	AM	218			
Total samples		3339			3163			3999			4759		

Figure A1i. Dates, sites, time periods and numbers of fish sampled in the commercial gaspereau fishery on Margaree River from 2001 to 2019. Similar information for years 1983 to 2000 can be obtained in Chaput et al. (2001).