Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat
Newfoundland and Labrador Region | Science Advisory Report 2021/008

ASSESSMENT OF AMERICAN LOBSTER IN NEWFOUNDLAND

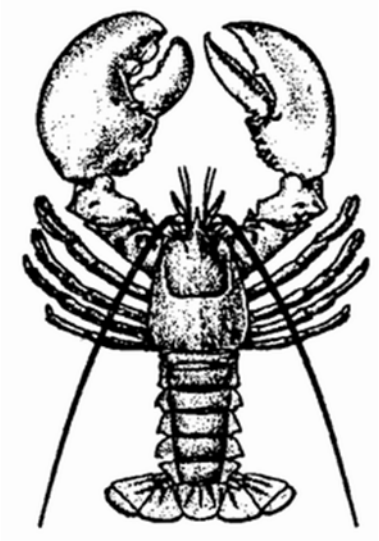

Image: American Lobster (Homarus americanus).

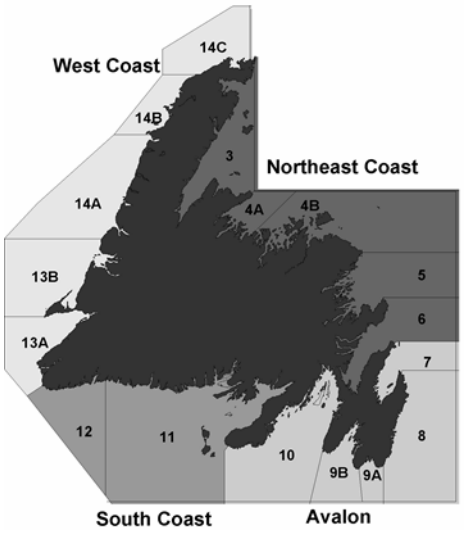

Figure 1. Newfoundland Lobster Fishing Areas (LFAs) 3-14 combined into assessment regions.

Context:

The American Lobster (Homarus americanus) is distributed near shore around the island of Newfoundland and along the Strait of Belle Isle portion of the Labrador coast. Major life history events (i.e., molting, mating, egg extrusion, and hatching) generally take place during mid-July to mid-September, following the fishing season.

The fishery is localized and prosecuted from small open boats during an 8-10 week spring fishing season. Traps are set close to shore, at depths generally less than 20 m. Fishing effort is controlled through restrictive licensing and daily trap limits. Regulations prohibit the harvest of undersized (i.e., <82.5 mm carapace length) and ovigerous animals. In addition, there is a voluntary practice called v-notching, which involves cutting a shallow mark in the tail fan of an ovigerous female. The mark is retained for at least 2-3 molts and notched females cannot be retained in the fishery. The practice serves to protect mature females, even when they are not brooding eggs externally. The number of licenses is currently around 2,300 and trap limits range from 100 to 300 depending on the Lobster Fishing Area (LFA) (Fig. 1).

This stock was last assessed in 2016 and is currently assessed every three years. The present assessment of this stock was requested by Fisheries and Oceans Canada (DFO) Resource Management to provide current information on the status of the resource and provide the data that will be used in the updated Integrated Fisheries Management Plan. The LFAs were assessed based on four regions: Northeast (LFAs 3-6); Avalon (LFAs 7-10); South Coast (LFAs 11-12;) and West Coast (LFAs 13-14) (Fig. 1). The key indicators for the assessment are reported landings, catch per unit effort (CPUE), and relative survival index.

This Science Advisory Report (SAR) is from the Newfoundland and Labrador Regional Peer Review Process on the Assessment of American Lobster in Newfoundland held on October 16, 2019. Additional

publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

Overall (LFAs 3-14)

- As in previous assessments, LFAs 3-14C were grouped into geographical regions: Northeast Coast (LFAs 3-6), Avalon (LFAs 7-10), South Coast (LFAs 11-12), and West Coast (LFAs 13-14).
- Summer sea surface temperature has increased since 1981 over the four geographical regions, characterized by a low in the early-1990s and a high in the early-2010s. This has led to more favourable oceanographic habitat conditions for American Lobster.
- A diver survey in 18 sites over various substrates during September/October of 2017-18 showed that juvenile lobster densities were low in Placentia Bay sites, compared to those in Port Saunders and Fortune Bay. Juvenile distributions indicated a selection for shallow depths compared to adult lobsters, but little evidence of selection for specific substrate and vegetation types.
- The current assessment is limited to fishery-dependent data and would benefit from the addition of fishery-independent data, as well as more comprehensive fishery-dependent data (i.e., at-sea sampling data and modified trap surveys).
- Total reported landings in 2019 were at their highest level in a century (4,400 t); this reflects increasing trends in the South and West regions, while reported landings in the Northeast and Avalon regions remain near historic lows.
- Since 2004, the CPUE index (unstandardized) has steadily increased to recent highs in the South and West Coast regions, while it has remained unchanged at low levels in the Northeast and Avalon regions.
- Size frequency distributions suggest higher fishing pressure on the South and West Coast regions, relative to the Northeast and Avalon regions.
- V-notching was shown to have a high level of efficacy at protecting egg-bearing females from fishing mortality. In all four regions, the majority of large surviving lobster in the population were v-notched females.

BACKGROUND

Species Biology

The American Lobster (*Homarus americanus*) is a decapod crustacean characterized by a life cycle which is predominately benthic. Lobsters may live for more than 30 years (Lawton and Lavalli 1995). In Newfoundland waters, at the northern range of the species distribution, it takes about 8-10 years for a newly hatched lobster to reach the minimum legal size (MLS) of 82.5 mm in carapace length (CL). Growth is achieved through molting, and frequency of molting decreases with increasing age. Growth is also affected by temperature, as molting probability tends to increase with water temperature.

Molting and mating occur in the months of July to September, and females typically extrude (spawn) eggs roughly one year subsequent to mating. Ovigerous (egg bearing) female lobsters

carry the eggs in clutches on the underside of their tail, protecting and maintaining the eggs for 9-12 months. Thus, female lobsters are typically characterized by a biennial molt-reproductive cycle, though smaller mature females sometimes molt and spawn within the same year. Fecundity and egg quality increase with size. Hatching occurs during a four-month period extending from late May through most of September. Once released, the larvae swim upward and undergo a series of three molts during their 4-6 week planktonic phase, during which most mortality is thought to occur. With the third molt, a metamorphosis occurs and the newly developed postlarvae (which resemble miniature adults) are prepared to settle to the benthic environment. Newly-settled lobster progress through several stages before reaching sexual maturity (Lawton and Lavalli 1995).

The adult lobster is thought to have few natural predators and commercial harvesting accounts for most adult mortality. Diet typically consists of rock crab, polychaetes, molluscs, echinoderms, and various finfish.

The Fishery

The American Lobster fishery in Newfoundland dates back to the early-1870s. The fishery is prosecuted from small open boats, and traps are set close to shore, at depths generally less than 20 m. Effort was uncontrolled until 1976, at which point a limited-entry licensing policy was implemented, and trap numbers were regulated. The minimum legal size was increased from 81 mm CL to 82.5 mm CL in 1998.

With the implementation of the 1998-2002 DFO Integrated Fisheries Management Plan (IFMP), there was a 25% reduction in licenses in the Newfoundland lobster fishery. Reductions in trap limits, season lengths, and licenses were put in place as deemed necessary by fishery managers. In recent years, a Lobster Enterprise Retirement Program and the Atlantic Lobster Sustainability Measures program were implemented. These programs have led to license and trap limit reductions in the Newfoundland lobster fishery, particularly in the South and West Coast regions.

There are currently about 2,300 licenses with trap limits varying from 100 to 300 per licensed fisher, depending on LFA. Traps must possess vents which allow undersized lobster to escape. Regulations prohibit the retention of undersize animals, as well as ovigerous and v-notched females.

Reported landings peaked at almost 8,000 t in 1889 (Fig. 2). Early documentation indicates that all lobsters captured were landed and processed by small canning operations that existed around the coast. A stock collapse occurred in the mid-1920s, after which the fishery was closed for three years (1925 to 1927). The fishery reopened in 1928, and reported landings reached over 2,000 t, but declined sharply the following year. In the early-1930s, regulations were introduced to protect undersized and ovigerous animals.

Total reported landings for Newfoundland have increased from approximately 1,900 t in 2010 to the highest level in a century with landings of 4,400 t in 2019 (Fig. 2). This reflects increasing trends in the South and West regions while the landings in the Northeast and Avalon regions have continued to decline and have remained near historic lows (Fig. 3).

Specifically, the landings in the Northeast region averaged approximately 170 t in the last 10 years with 200 t in 2019; in the Avalon region the landings averaged 40 t since 2009 and increased to 50 t in 2019. In the South Coast and West Coast regions the landings in the last 10 years averaged approximately 1,200 t and increased to 1,700 t and 2400 t, respectively, in 2019 (Fig. 3).

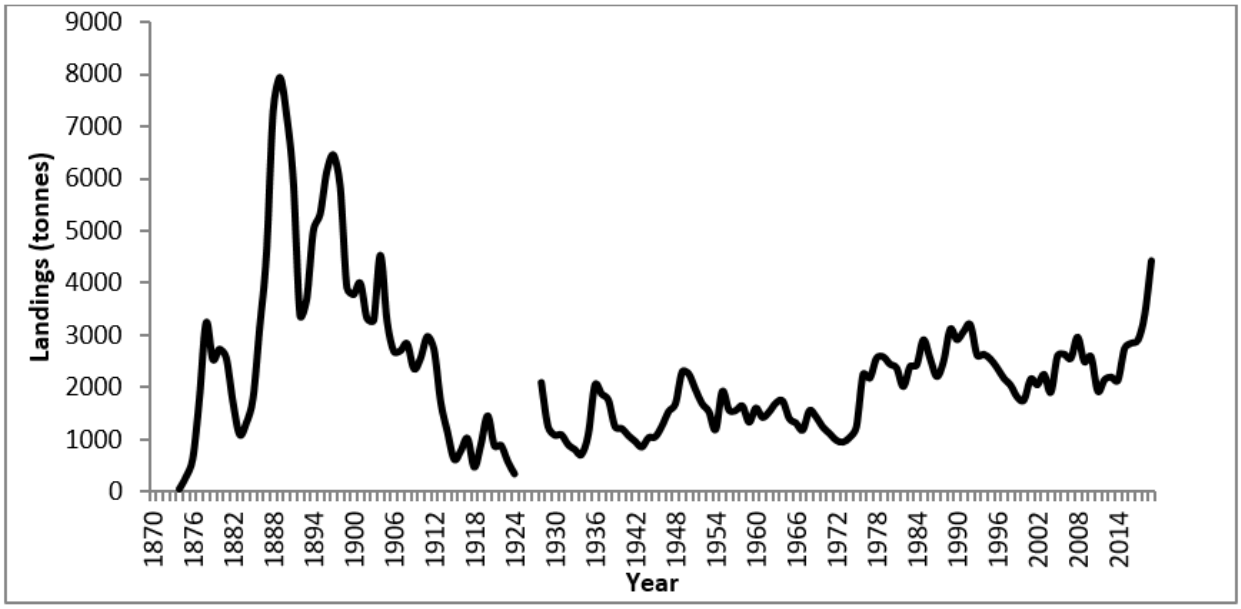

Figure 2. Reported landings for the Newfoundland lobster fishery since the 1870s.

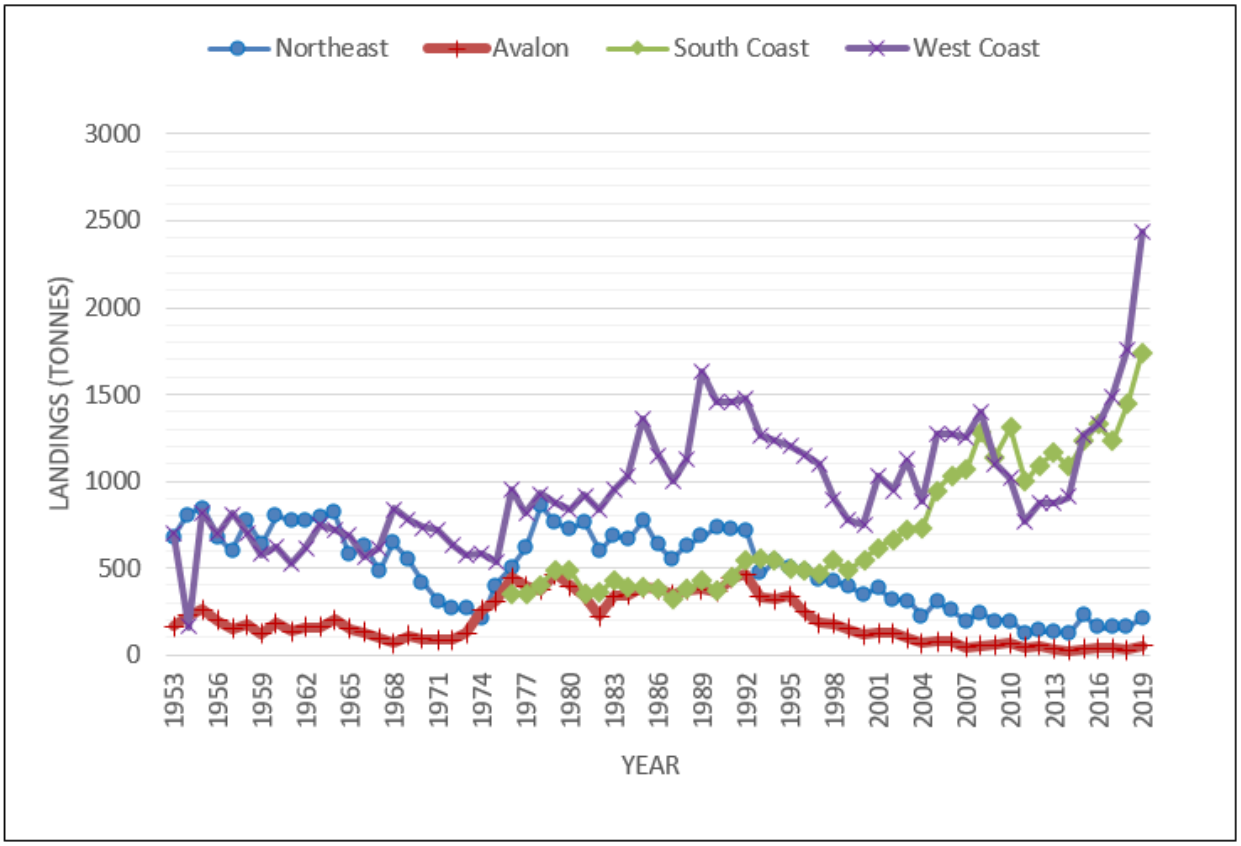

Figure 3. Reported landings, 1953-2019, in the Northeast, Avalon, South Coast, and West Coast assessment regions.

ASSESSMENT

The Newfoundland American Lobster assessment was completed for four regions, which are a geographical grouping of LFAs: Northeast (LFAs 3-6), Avalon (LFAs 7-10), South Coast (LFAs 11-12), and West Coast (LFAs 13-14) (Fig. 1). All available data are fishery-dependent and each LFA/region has varying data sources including reported landings, DFO logbooks, Fish, Food and Allied Workers Union (FFAW) index logbooks, and at-sea sampling data.

FFAW index logbook data, available since 2004, were used to compute mean CPUE (i.e., number of lobster caught per trap) annually within regions. CPUE was also calculated from the DFO mandatory logbooks (2010-18), and comparisons with FFAW index logbook data showed similar trends within the four regions (Fig. 4).

Throughout the time series, the highest mean CPUE values were from the South Coast and West Coast regions, with increasing trends in both regions and mean CPUEs of 0.75 to 1.25 in 2019. The mean CPUE remained stable at approximately 0.25 in both the Northeast and Avalon regions (Fig. 4).

FFAW index logbooks were also used to calculate the percentage of v-notching (number of ovigerous females v-notched/total ovigerous females) annually for all regions. On average, the extent of v-notching ranged from 4% to 20% (Fig. 5).

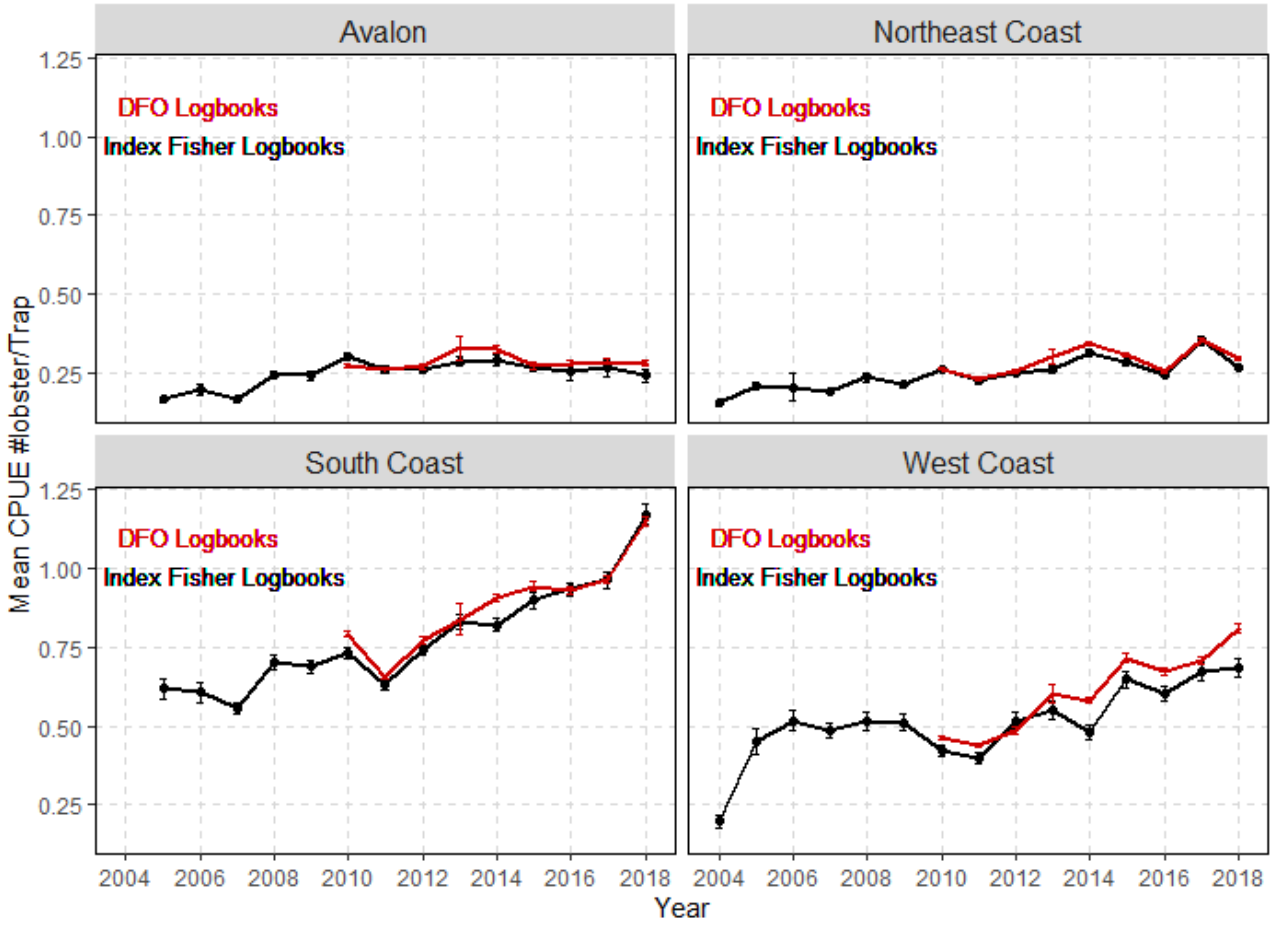

Figure 4. Mean CPUE (# of lobster / trap) from the FFAW (index fisher) logbooks, 2004-18, and DFO logbooks, 2010-18, in the four regions.

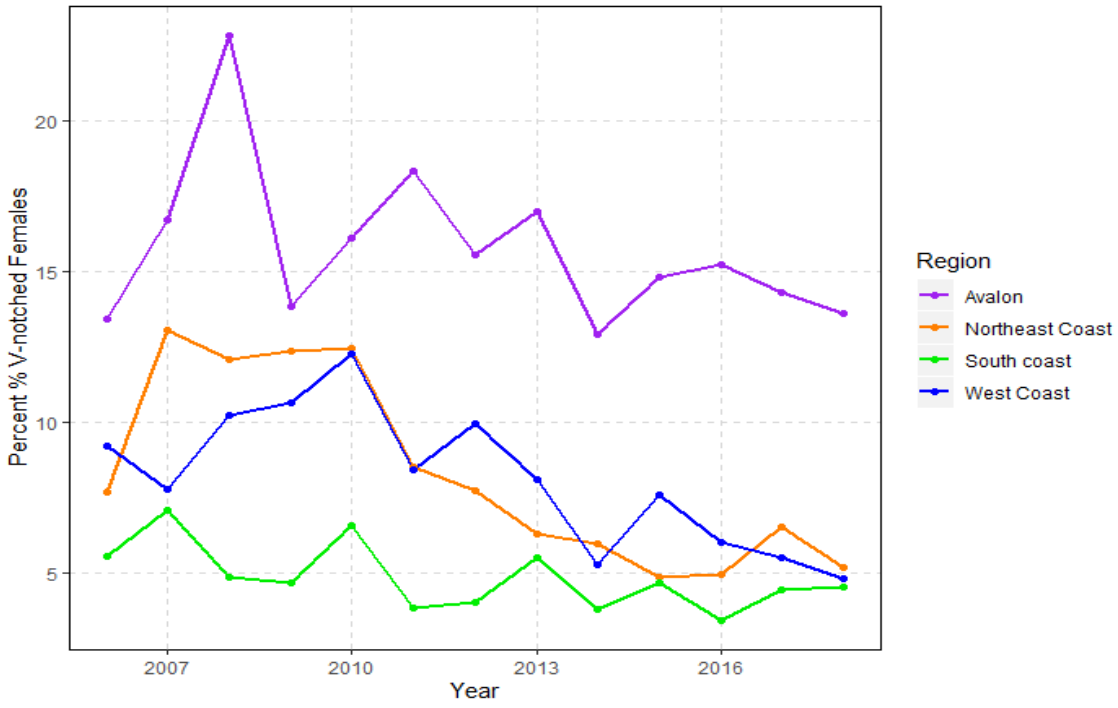

Figure 5. Percentage of ovigerous females v-notched in each region, 2004-2018, based on the FFAW (index fisher) logbooks.

At-sea sampling data were used to generate size-frequency distributions for males and females within each region from 2010 to 2018 (Fig. 6). Most size-frequency distributions clearly show a sharp decline at legal size (consistent with knife-edge recruitment to the fishery), with few lobsters surviving to the larger sizes beyond the first molt class (defined as 82.5 mm-92 mm for females and 82.5-95 mm for males) eligible for harvest, indicating that most of the exploitable biomass is caught in the year of recruitment to the fishery (Fig. 6).

With respect to the size structure within each of the four regions, there was a larger range of sizes caught in the Northeast and Avalon regions, with more lobster surviving to attain larger sizes (i.e., more than 92 mm carapace length); in the South Coast and West Coast regions, there was little sign of lobster surviving to larger sizes (refer to Fig. 6 and 7). This suggests higher fishing pressure on the South and West Coast regions, relative to the Northeast and Avalon regions.

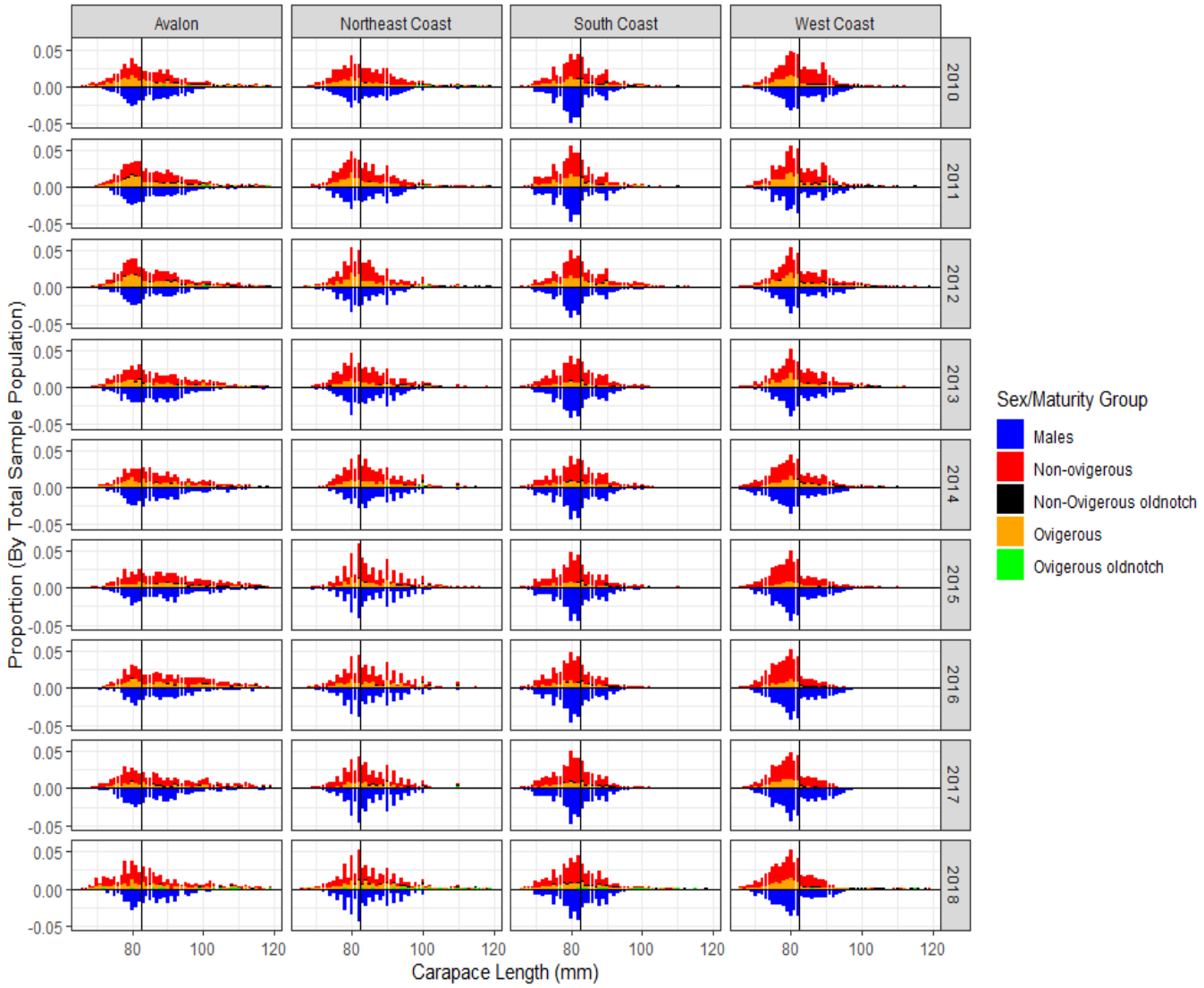

Figure 6. Size-frequency distributions for males (bottom half of each panel) and females (top half of each panel) in each of the four regions, 2010-2018. The black vertical line represents the minimum legal size of 82.5 mm carapace length.

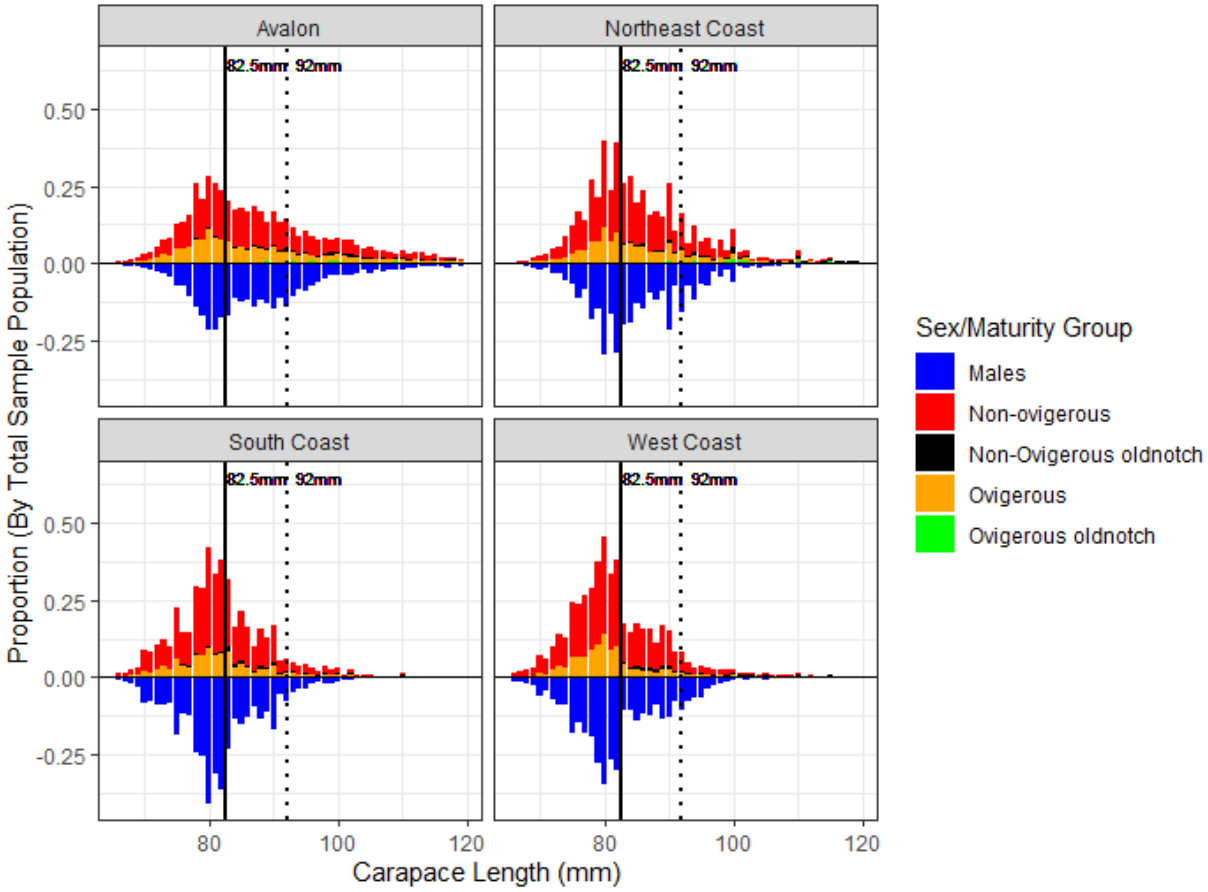

Figure 7. Size-frequency distributions for males (bottom half of each panel) and females (top half of each panel) in each of the four regions, with all years combined within each regional plot, 2010-2018. The black vertical line represents the minimum legal size of 82.5 mm carapace length, and the black dotted line represents 92mm carapace length.

Based on the at-sea sampling data, a mean-length mortality equation (Beverton and Holt 1956) was used to determine relative levels of instantaneous mortality during the fishery each year from catch sampled throughout the season (Fig. 8). Input parameters for the equation are length-at-first capture (L_c) and maximum size (L_{inf}), with the mean length of legal-sized individuals in the catch constituting a continuous measured input variable that ultimately scales the magnitude of the index, with a low mean size suggesting high mortality in the population. The analysis is sensitive to the L_{inf} parameter, which was based at 110 mm CL, as few lobster larger than this size have been captured over the available time series. It is recognized that this parameter estimate is lower than the maximum size biologically possible for Newfoundland lobster, and the analysis outcome is only viewed as a relative index of mortality. The instantaneous mortality estimate was subsequently converted to an annual survival estimate (Fig. 9, Equation 1.1).

Equation 1.1

$$Z/K = (L_{inf} - L_{bar}) / (L_{bar} - L_c)$$

$$Z/K = Z \text{ (with implicit growth parameter } K)$$

$$L_{inf} = 110 \text{ mm CL}$$

$$L_{bar} = \text{mean of all sizes between MLS and } L_{inf} \text{ (110 mm)}$$

$$L_c = MLS$$

$$S = \exp(-(Z/K))$$

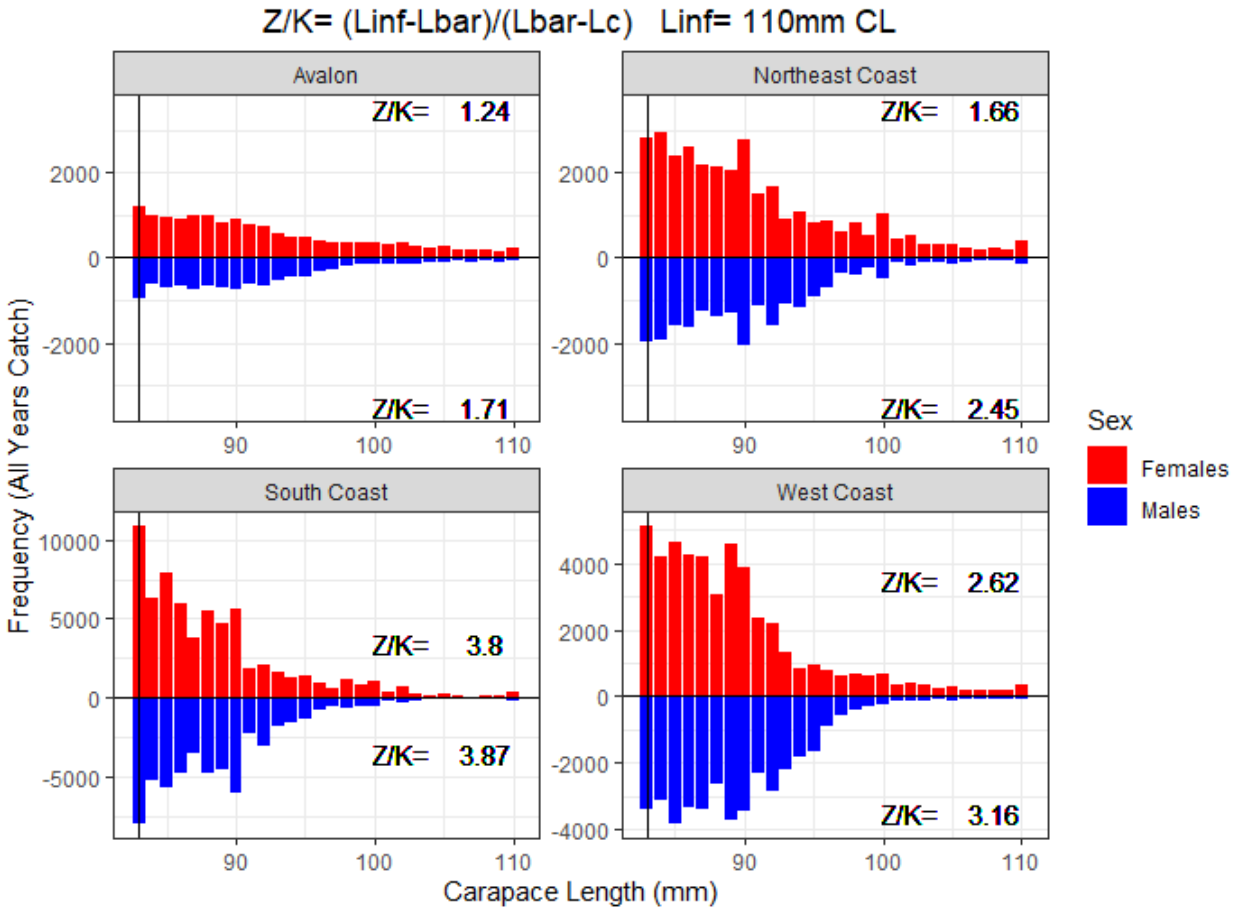

Figure 8. Size frequencies of both sexes in each region describing the Beverton-Holt (1956) Mean Length Mortality Equation with Z/K defined and identified for each sex within each regional plot. The black vertical line represents the minimum legal size of 82.5 mm carapace length.

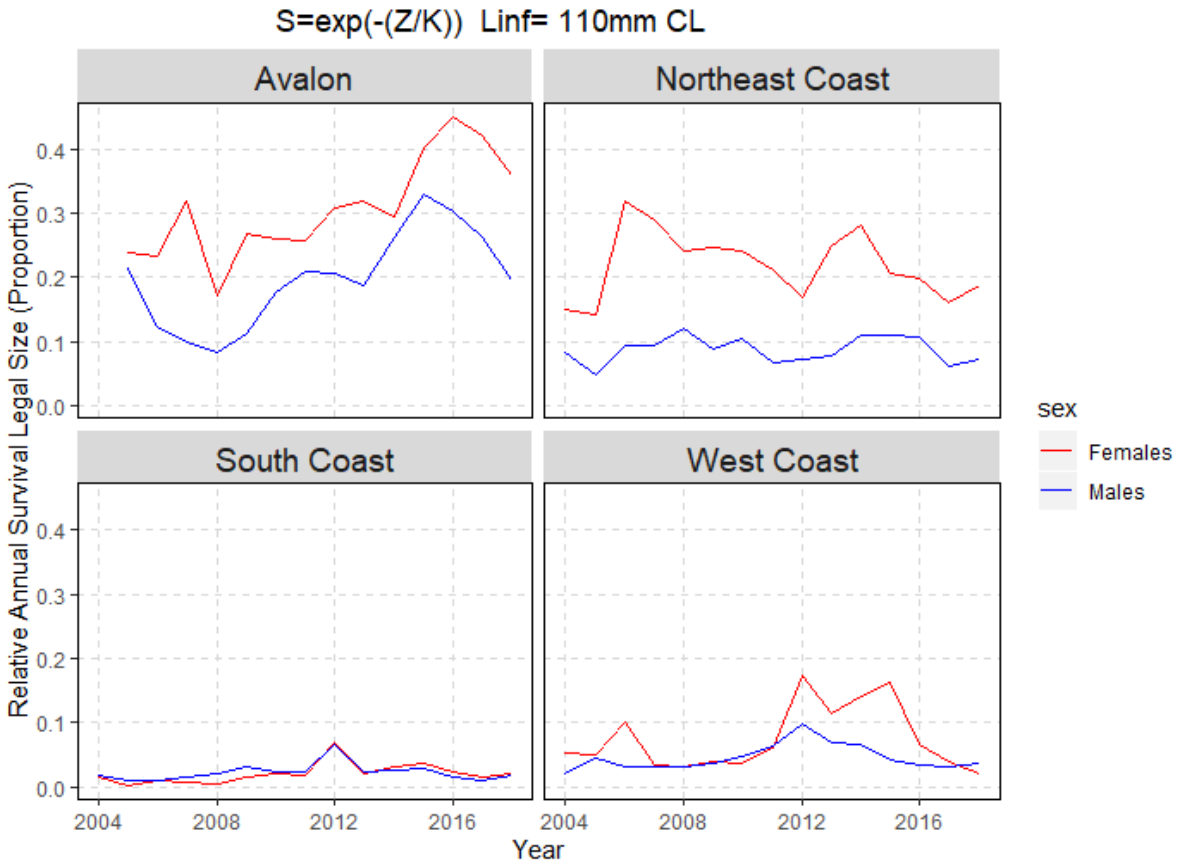

Figure 9. Annual survival index (S = exp -(Z/K)) of male (blue line) and female (red line) lobster in each region, 2004-2018.

The annual survival index was calculated as S = exp (-(Z/K)) from 2004 to 2018 within each of the four regions.

The annual survival index of females is higher in all regions except for the South Coast, where both females and males follow the same trend. In the South and West Coast regions, where fishing pressure is stronger, the survival of both sexes is lower overall (Fig. 9).

The at-sea sampling data were also used to examine the proportion of females in each maturity category for all years sampled (2004-2018) over the size ranges within each region (Fig.10). The results consistently showed that the highest proportion of larger females in the sample population were non-ovigerous/v-notched females and that the majority of large surviving lobster in the population were v-notched females.

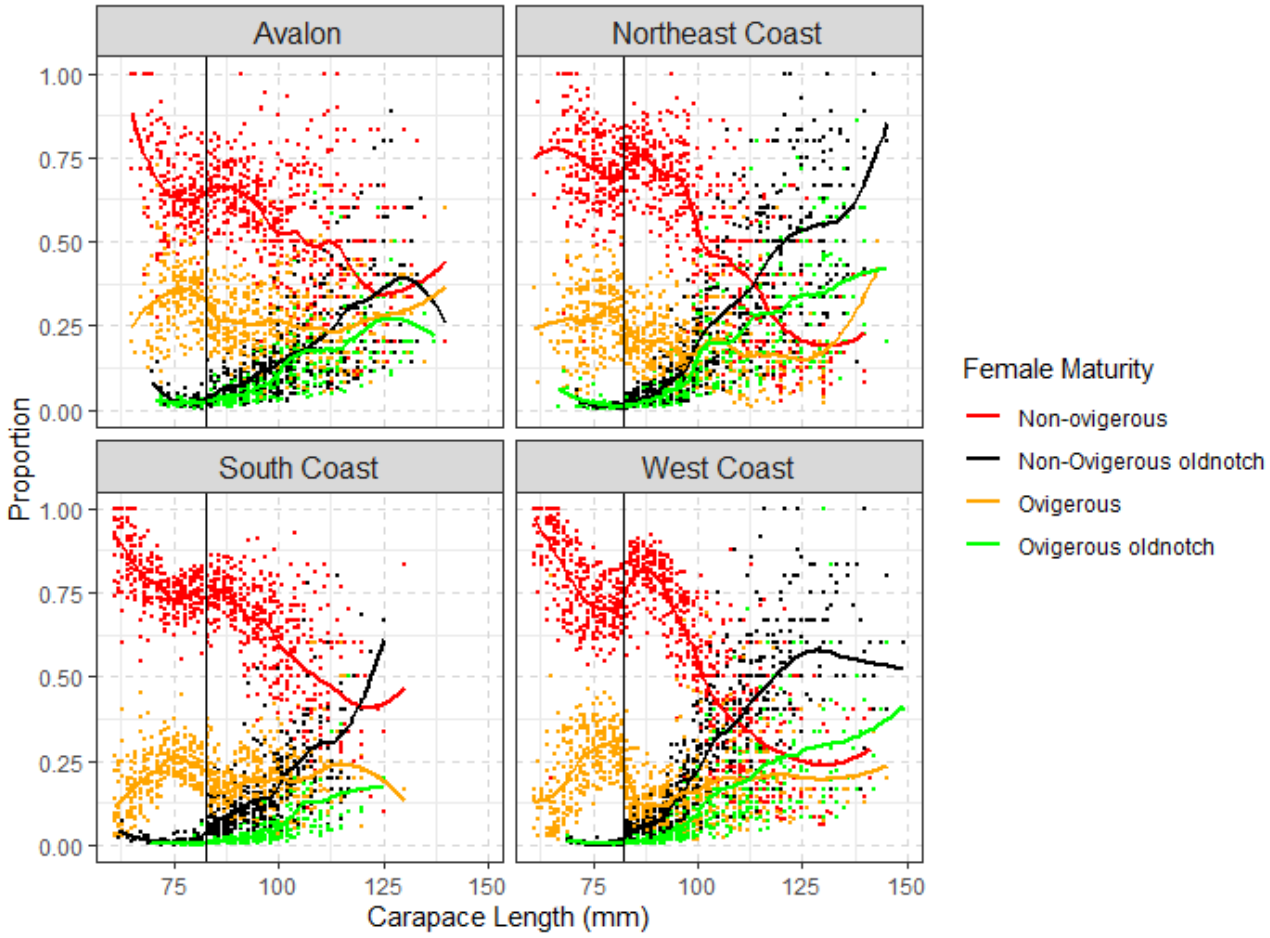

Figure 10. Proportion of females within each maturity category for all years combined over the size range within each region. The black vertical line represents the minimum legal size of 82.5 mm carapace length.

Sources of Uncertainty

The assessment is based solely on fishery-dependent data. Reported landings are based on purchase slips that are supplied to Fisheries and Oceans Canada by buyers and do not account for local sales, poaching, and handling mortalities that can occur prior to the sale of the catch. The extent of local sales, in particular, can be considerable and varies by location and year. Therefore, is it difficult to obtain an estimate of total annual removals for any given year.

With respect to at-sea sampling data, potential effects of year to year differences in spatial and temporal coverage are unknown. Differences in catchability among sizes and categories (i.e, immature versus sexually mature; v-notched versus not notched), as well as density-dependent effects, can complicate the interpretation of both at-sea sampling and logbook data. Environmental conditions, soak time, and changes in fishing gear can also affect catchability. There are vast changes in relative amounts of size categories over the fishing season; therefore, size data aggregated over the entire fishing season are difficult to interpret.

CONCLUSIONS

Most size frequency distributions clearly show a sharp drop at minimum legal size and few lobsters surviving to larger sizes (i.e., past the first molt into fishery eligibility), suggesting higher

fishing pressure on the South and West Coast regions, relative to the Northeast and Avalon regions. Over the time series, CPUEs have increased in the South and West Coast regions to 0.75 and 1.25, respectively, in 2019 and have remained low in the Northeast and Avalon regions, at approximately 0.25. Overall, the annual survival index of females is higher relative to males in all regions, except in the South Coast where females and males follow the same trend and have a lower survival index compared to the other three regions.

OTHER CONSIDERATIONS

Ecosystem Considerations

A diver survey of 18 sites in Placentia Bay, Fortune Bay, and Port Saunders during September/October in 2017-18 found that over various substrates juvenile lobster densities were low in Placentia Bay sites, compared to those in Port Saunders and Fortune Bay. Juvenile distributions indicated a selection for shallow depths compared to adult lobsters, but little evidence of selection for specific substrate and vegetation types (Lancaster et al. in prep[1]).

Summer sea surface temperature has increased since 1981 over the four geographical regions, characterized by a low in the early-1990s and a high in the early-2010s. This has led to more favorable oceanographic habitat conditions for American Lobster (Fig. 11).

[1] Lancaster, D., Gregory, R.S., Sargent, P.S., and K. Matheson. Habitat associations of juvenile American lobster in three nearshore areas of Newfoundland. DFO Can. Sci. Advis. Sec. Res. Doc. In prep.

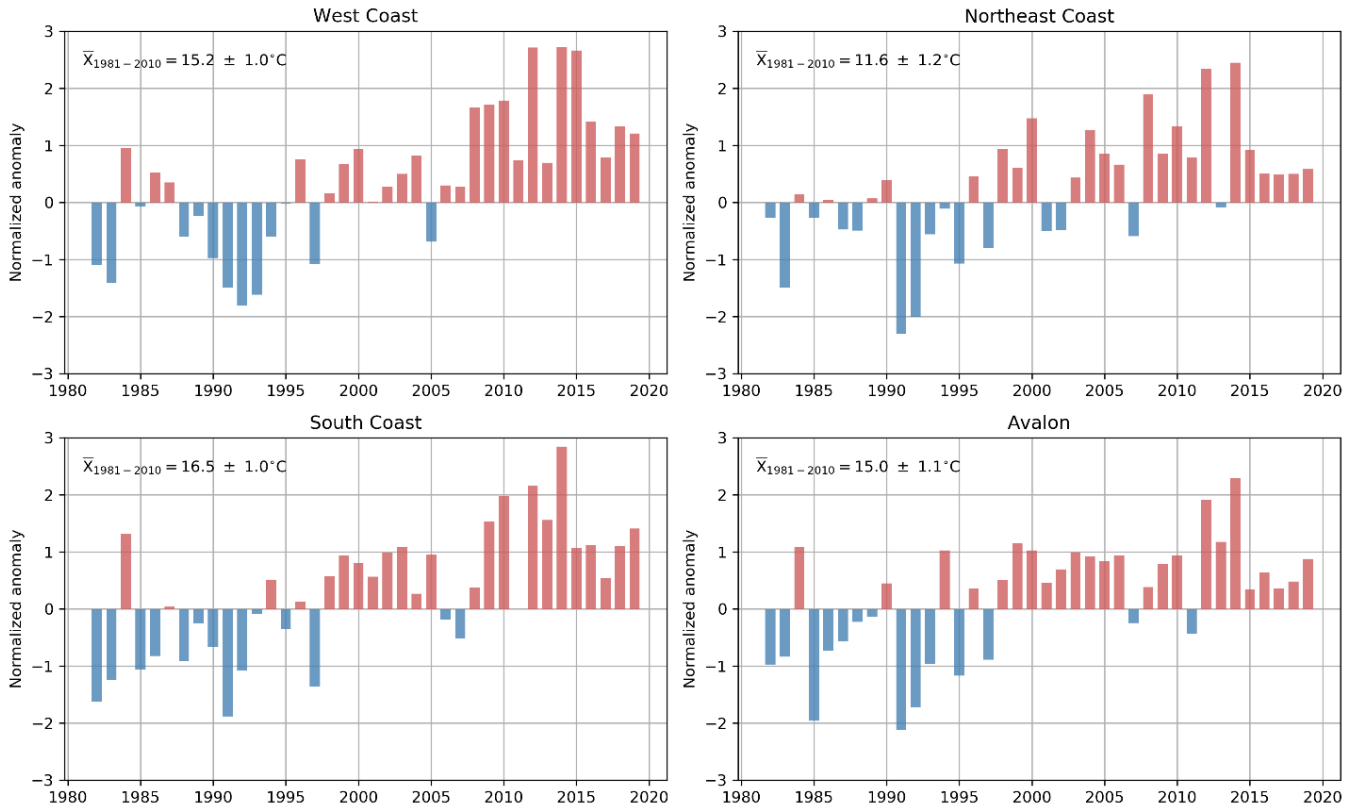

Figure 11. Normalized anomalies of the mean sea surface temperature (SST) for the warmest week of the year in the four assessment regions, 1981-2019. The normalized anomalies are expressed as the departure (by standard deviation increment) from the 1981-2010 climatological average. The climatological average and standard deviation for each region is shown in the upper left of each panel. Data are from the NOAA High-resolution Blended Analysis of Daily SST on 1/4 deg. global grid (Reynolds et al. 2007). Only grid points in the regions truncated at 46°N and 51°W are considered.

Management Considerations

Since mandatory DFO logbooks were implemented in 2010, there have been some years characterized by low return rates. However, in the last few years, the rates have improved in some areas as a result of more follow-up and reminders to industry to ensure logbooks are provided to DFO. It is recommended to continue follow-up efforts to ensure consistent and accurate logbook returns.

In order to account for changes in fishing gear and address concerns of catchability, DFO logbooks should collect detailed data pertaining to gear specifications (e.g., trap types, trap size, and size of entrance rings).

LIST OF MEETING PARTICIPANTS

Name	Affiliation
Derek Butler	Association of Seafood Producers
Brittany Keough	DFO – Centre for Science Advice
Erika Parrill	DFO – Centre for Science Advice
Eugene Lee	DFO – Centre for Science Advice
Laura Park	DFO – Ecosystems Management

Name	Affiliation
Lynn Lush	DFO – Ecosystems Management
Olivia Clark	DFO – Ecosystems Management
David Small	DFO – Resource Management
Laurie Hawkins	DFO – Resource Management
Martin Henri	DFO – Resource Management
Darienne Lancaster	DFO – Science
Darrell Mullowney	DFO – Science
Derek Osborne	DFO – Science
Elizabeth Coughlan	DFO – Science
Frédéric Cyr	DFO – Science
Julia Pantin	DFO – Science
Krista Baker	DFO – Science
Kyle Matheson	DFO – Science
Phil Sargent	DFO – Science
Robert Gregory	DFO – Science
Sana Zabihi-Seissan	DFO – Science
Roanne Collins	DFO Science; Meeting Chair
Erin Carruthers	Fish, Food and Allied Workers Union (UNIFOR)
Mildred Skinner	Fish, Food and Allied Workers Union (UNIFOR)
Brian Pitcher	Harvester
Roger LaCosta	Harvester
Wade Savoury	Harvester
Wayne Hicks	Harvester
Arnault LeBris	Marine Institute
Nancy Pond	NL Department of Fisheries and Land Resources

SOURCES OF INFORMATION

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Beverton, R.J.H. and S.J. Holt. 1956. A review of the methods for estimating mortality rates in fish populations, with special reference to sources of bias in catch sampling. Rapp.P.-V.Réun. Cons. Int. Explor.Mer. (140): 67–83.

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Newfoundland and Labrador Region
Fisheries and Oceans Canada
P.O. Box 5667
St. John's, NL A1C 5X1

Telephone: (709) 772-8892
E-Mail: DFONLCentreforScienceAdvice@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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