# MARITIMES RESEARCH VESSEL SURVEY TRENDS ON THE SCOTIAN SHELF AND BAY OF FUNDY FOR 2020

## Context

Fisheries and Oceans Canada (DFO) has conducted Summer Research Vessel (RV) surveys in the Maritimes Region, Northwest Atlantic Fisheries Organization (NAFO) Divisions 4VWX5Yb, using a standardized protocol since 1970 (Figure 1). Results of these surveys provide information on trends in abundance for most groundfish species in the Maritimes Region. While these data reflect trends in biomass and abundance and are a critical part of science-based stock assessments, a full assessment, including other sources of data, would be required to evaluate the impacts of management measures on population status. DFO Resource Management requested a review of the DFO Summer RV Survey information on the following list of fish stocks: 4Vn, 4VsW, and 4X5Y Atlantic Cod; 4VW and 4X5Y Haddock; 4X and 4VW White Hake; 4VWX Silver Hake; 4VWX+5 Pollock; Unit II and Unit III redfish; 3NOPs4VWX5Zc Atlantic Halibut; 4VW and 4X American Plaice; 4VW and 4X Witch Flounder; 4VW and 4X Winter Flounder; 4VW and 4X Yellowtail Founder; 4VW and 4X Smooth Skate; 4VW and 4X Thorny Skate; 4VW and 4X Barndoor Skate; 4VW and 4X Winter Skate; 4VW and 4X Little Skate; 4VW and 4X Atlantic Wolffish; 4VW and 4X Monkfish; 4VW and 4X Longhorn Sculpin; 4VWX Spiny Dogfish; 4X and 4VW Red Hake; 4X and 4VW Sea Raven; 4X and 4VW Ocean Pout; and 4VWX Blackbelly Rosefish. In addition, biomass trends relative to the Scotia Fundy Groundfish Advisory Committee (SFGAC) accepted biomass reference points were requested for White Hake (biomass for lengths > 41 cm in 4X) and Unit III redfish (biomass for lengths > 22 cm). The survey information will be used by DFO Resource Management as background for discussions with various stakeholders on recommendations for management measures and to determine which stocks should be reviewed in more detail in 2021.

In addition, a review of available survey information was undertaken for a suite of species, including Black Sea Bass, Dusky Shark, Triggerfish, John Dory, and Tilefish. These species are being captured as bycatch in commercial fishing operations but are not covered under any license conditions and cannot be landed.

This Science Response Report results from the Science Response Process of December 1–2, 2020, on the Stock Status Updates of Groundfish Stocks in the Maritimes Region.

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

## Background

The DFO Summer RV Survey of the Scotian Shelf and Bay of Fundy has been conducted annually since 1970. The survey follows a stratified random sampling design and includes sampling of fish and invertebrates using a bottom otter trawl, along with physical oceanographic and plankton sampling. These surveys are the primary data source for monitoring trends in species distribution, abundance, and biological condition within the region.

There were changes to the net used and the vessel conducting the survey in 1982 and 1983, along with some changes in data collection protocols. While the vessel change in 1983 would not be expected to strongly influence catches, the change in trawl in 1982 should impact catch. The Yankee 36 trawl used from 1970–1982 had a slightly narrower wingspread and a lower headline and smaller footgear than the Western IIa (W IIa). These differences in trawl configuration would be expected to lead to higher catches of fish that disperse up into the water column with the W IIa, but also lower catches for the W IIa of fish that are strongly associated with the substrate or whose escape response when frightened is to hide on the sea floor. Conversion factors were calculated for only a limited number of commercial species. Conversion factors calculated by Fanning (1985) range from about 0.8 for American Plaice,Yellowtail Flounder, Witch Flounder, and Winter Flounder, to 1.2 for Haddock, and over 2 for Silver Hake. For most other species, no conversion factor has been calculated for the change in trawl. For species that have no conversion factor, abundance indices for the period 1970–1981 may not be directly comparable to those from subsequent years. For long-term averages, the most appropriate starting point has been selected for each species (for details see Clark and Emberley 2011).

The bottom trawl surveys were designed to provide abundance trends for fish and invertebrates between depths of about 30 m to 400 m. Survey indices are expected to be proportional to abundance for most species.

Strata boundaries are shown in Figure 2 for the 4VWX5 area. From 1970–1995, sampling was generally restricted to strata 440–495. Spatial coverage was extended to the Scotian Shelf slope (strata 496–498) in 1996 and the Fundian Channel (5Z9) in 2011. The sampled area expanded to include strata 558 and 559 in 2015 and 5Z2 in 2016 and now regularly includes all offshore waters of the Maritimes Region down to a depth of 750 m.

Catch distribution plots for the entire DFO Summer RV Survey area are provided for a suite of species that are commonly caught in the 4VWX groundfish fishery. Biomass-index trends are shown for the area appropriate for each stock. Comparisons of 2019 and 2020 length frequencies from the survey catch to the long-term mean (from beginning of survey series, or the period deemed appropriate for that particular species, to 2018) are also included, using data from the geographic areas that are used in assessments for those stocks.

All strata from 440–495 have had some sampling annually since 1970 with the exception of 2018. In 2018, sampling was conducted in all standard strata in 4X5Yb, but the majority of the survey area, including all of 4V, most of 4W and depths < 183 m in 5Zj, were not sampled in 2018 due to mechanical problems with the vessel. Of the 270 stations selected for sampling in 2018, only 85 successful tows were completed.

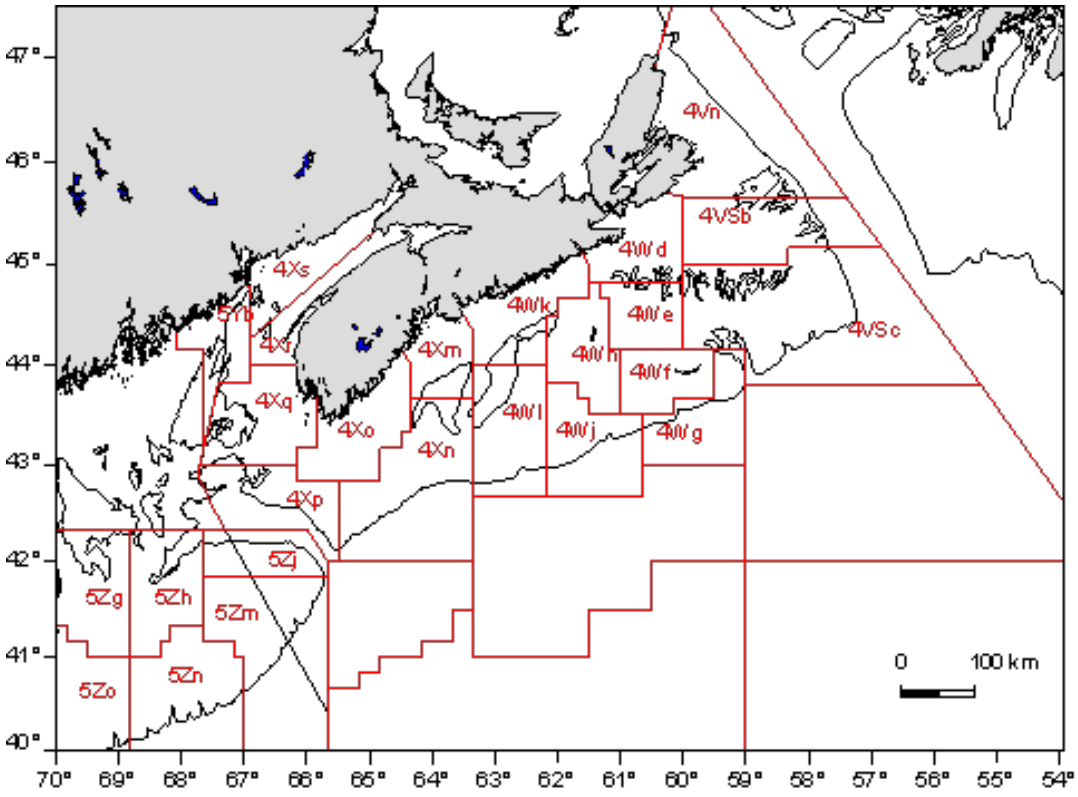


*Figure 1. Northwest Atlantic Fisheries Organization (NAFO) Divisions.*

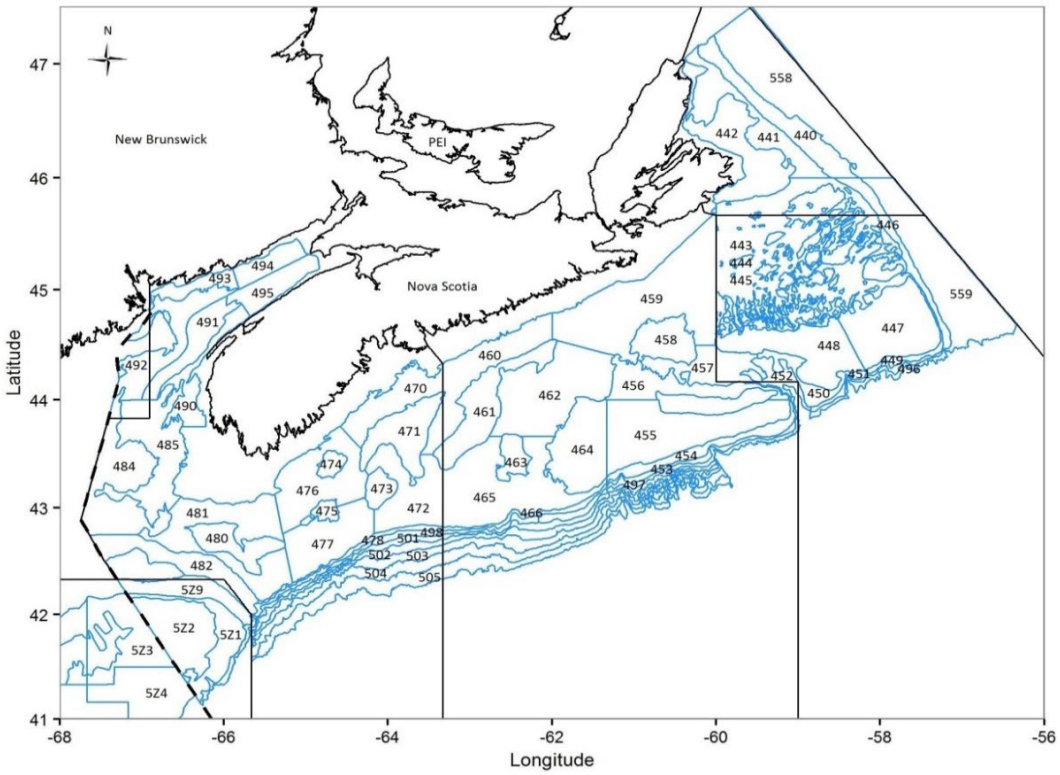


*Figure 2. Fisheries and Oceans Canada DFO Summer Research Vessel Survey strata.*

# Analysis

The stratified random survey design ensures that sampling takes places throughout the range covered by the survey. The strata were originally selected to represent different depths and habitats. Sampling occurs at randomly selected stations within all strata. The data are averaged within each stratum, weighted by stratum area, and then summed over all appropriate strata for each stock. While this ensures that sampling is representative of the entire area, low sampling intensity means that there is high variability, particularly for stocks that are highly aggregated or that inhabit only a small part of the entire survey area; single data points in the biomass series should be interpreted with caution as large inter-annual changes could simply reflect variability in the data rather than changes in population abundance. Comparisons between the long-term and short-term averages may be more useful for representing the relative status of the population. Large inter-annual changes could also reflect the appearance of a strong year-class or, conversely, the impact of a single large tow; thus, biomass indices should be interpreted with reference to the length-frequency data and the distribution of catches to see if these data aid interpretation.

In 2020,195 successful fishing tows were completed out of 280 planned tows. This is the second lowest in the last decade, better only than 2018, when lost vessel time meant that less than half the area was covered. The majority of the reduction came in 4V and 4W, as these were the last areas covered during the survey. At least two sets were completed in each stratum from 440–495. No sets were completed in strata 496–498, along the edge of the Scotian Shelf. These strata are not used in the standard indices for any stocks reviewed in this document. Low sampling intensity will increase variability in the indices and also reduce the chances that rare species will be encountered.

Biomass indices for each stock are calculated using the set of strata that are included in calculating indices for the stock assessment. As no assessments have integrated data from strata added since 1996, these data are not included in time-series trends. For some stocks, where these deeper water strata appear to be important parts of the stock distribution, the potential contribution to biomass indices of these strata has been discussed.

The time series of survey biomass indices and the three-year (3-yr) running geometric mean are compared to 40% and 80% of the long-term geometric mean (GM) to provide context for biomass levels. The geometric mean was selected for these comparisons to reduce the impact of very high values observed in some years. The values are presented in Table 1.

*Table 1. DFO Summer Research Vessel Survey biomass indices (tonnes) for species by stock/region for 2018, 2019, 2020, current 3-yr geometric mean (GM) biomass index, and 40% and 80% of the long-term GM biomass index (1970–2019).*

| Stock/Region (page number) | 2018 | 2019 | 2020 | Current 3-yr GM | 40% Long-term GM | 80% Long-term GM |
|---|---|---|---|---|---|---|
| 4X Atlantic Cod (9) | 3,500 | 1,443 | 1,669 | 2,035 | 5,280 | 10,560 |
| 4VsW Atlantic Cod (11) | NA[1] | 10,877 | 36,808 | 15,998 | 10,133 | 20,267 |
| 4Vn Atlantic Cod (12) | NA | 331 | 1351 | 834 | 3,058 | 6115 |
| 4VW Haddock (15) | NA | 21,485 | 12,742 | 21,400 | 18,725 | 37,449 |
| 4X Haddock (14) | 44,628 | 28,081 | 32,942 | 34,561 | 19,588 | 39,176 |
| 4VW White Hake (17) | NA | 1,306 | 2,535 | 2,395 | 2,923 | 5,845 |
| 4X White Hake (16) | 4,988 | 7,811 | 6,771 | 6,414 | 5,560 | 11,120 |
| 4VWX Silver Hake * (20) | NA | 25,068 | 17,470 | 23,939 | 12,889 | 25,778 |
| 4X West Silver Hake * (22) | 9,301 | 4,138 | 14,379 | 8,210 | 791 | 1,583 |
| Western Component Pollock (23) | 14,836 | 8,990 | 9,311 | 10,749 | 7,766 | 15,532 |
| Eastern Component Pollock (25) | NA | 2,541 | 7,027 | 3,860 | 6,873 | 13,745 |
| Unit II redfish (26) | NA | 75,041 | 31,012 | 39,876 | 17,386 | 34,771 |
| Unit III redfish (27) | NA | 59,153 | 70,584 | 84,219 | 37,177 | 74,355 |
| 4X American Plaice (35) | 487 | 217 | 341 | 330 | 571 | 1143 |
| 4VW American Plaice (36) | NA | 5,182 | 4,620 | 5,167 | 7,341 | 14,682 |
| 4X Witch Flounder (38) | 1,577 | 1,797 | 1,270 | 1,533 | 595 | 1,191 |
| 4VW Witch Flounder (39) | NA | 5,542 | 5,750 | 5,349 | 1,399 | 2,799 |
| 4X Yellowtail Flounder (32) | 105 | 78 | 155 | 109 | 174 | 347 |
| 4VW Yellowtail Flounder (33) | NA | 4,675 | 3,792 | 5,212 | 4,769 | 9,538 |
| 4X Winter Flounder (41) | 4,035 | 3,983 | 4,608 | 4,200 | 1,045 | 2,089 |
| 4VW Winter Flounder (42) | NA | 310 | 301 | 378 | 242 | 483 |
| 3NOPs4VWX5Zc Atlantic Halibut (29) | NA | 12,183 | 10,202 | 12,429 | 1,354 | 2,707 |
| 4X Atlantic Wolffish (44) | 295 | 335 | 320 | 316 | 409 | 819 |
| 4VW Atlantic Wolffish (45) | NA | 447 | 241 | 336 | 482 | 965 |
| 4X Monkfish (47) | 2,075 | 1,110 | 1,495 | 1,510 | 619 | 1,237 |
| 4VW Monkfish (48) | NA | 1,109 | 1,209 | 1,050 | 790 | 1,580 |
| 4X Smooth Skate (65) | 504 | 273 | 326 | 355 | 143 | 287 |
| 4VW Smooth Skate (66) | NA | 149 | 108 | 131 | 114 | 228 |
| 4X Thorny Skate (56) | 193 | 287 | 162 | 208 | 688 | 1,377 |
| 4VW Thorny Skate (57) | NA | 2,485 | 910 | 1,614 | 2,581 | 5,162 |
| 4X Barndoor Skate (53) | 2,668 | 1,651 | 1,515 | 1,883 | 30 | 59 |
| 4VW Barndoor Skate (54) | NA | 0 | 893 | 106 | 5 | 10 |
| 4X Winter Skate (59) | 571 | 401 | 1,456 | 693 | 298 | 597 |
| 4VW Winter Skate (60) | NA | 22 | 45 | 55 | 590 | 1,180 |
| 4X Little Skate (62) | 1,156 | 1,362 | 1,455 | 1,318 | 192 | 383 |
| 4VW Little Skate (63) | NA | 35 | 93 | 76 | 13 | 25 |
| 4VWX Spiny Dogfish (68) | NA | 92,106 | 73,311 | 90,698 | 32,222 | 64,444 |
| 4X Longhorn Sculpin (50) | 584 | 1,024 | 1,012 | 846 | 503 | 1,006 |
| 4VW Longhorn Sculpin (51) | NA | 1,234 | 1,703 | 1,299 | 849 | 1,698 |
| 4X Red Hake (70) | 1,848 | 2,046 | 1,784 | 1,889 | 154 | 308 |
| 4VW Red Hake (71) | NA | 1,395 | 875 | 1,120 | 188 | 376 |
| 4X Ocean Pout (76) | 137 | 89 | 21 | 64 | 168 | 335 |
| 4VW Ocean Pout (77) | NA | 52 | 12 | 19 | 49 | 98 |
| 4X Sea Raven (73) | 1,097 | 673 | 1,471 | 1,028 | 661 | 1,321 |
| 4VW Sea Raven (74) | NA | 959 | 1,143 | 1,174 | 336 | 673 |

NA – Indices not available due to reduced spatial coverage of the 2018 survey. For these stocks, the current 3-yr GM is calculated using the biomass indices from 2017, 2019, and 2020

*For Silver Hake and Red Hake, the long-term average is 1982–2019

The time series of abundance-at-length indices are compared with long-term (full time series) and short-term (ten years) median values to provide context on population length composition for each stock.

For some species, including Silver Hake and Haddock, modes are apparent in the length-frequency data at smaller sizes that are comprised primarily of individual year-classes, providing information on relative abundance of pre-recruit ages.

For those stocks that extend into 4VW, 3-yr GM values for 2020 were calculated using data from 2017, 2019, and 2020, and, for 2019, they were calculated using data from 2016, 2017, and 2019.

Of note in the data, particularly for Cod and Haddock, is the increased abundance of young-of-the-year fish (Age 0) in recent years. The short-term median length frequency shows a strong mode at < 10 cm for both Cod and Haddock. This likely reflects earlier spawning and, thus, these fish, that in the past would have still been in the pelagic phase in July, are available to the July survey in recent years.

The total biomass index for 4X shows high inter-annual variability but no clear trend over time (Figure 3a). The large drop in biomass from 2018–2019 reflects lower catches for most demersal species.

In 4W, demersal fish biomass increased in the 1980s, but, in the early 1990s, dropped back to the level seen in the 1970s (Figure 3b). The biomass for 2020 is lower than in 2019, largely due to lower Haddock and Spiny Dogfish catches in the area.

In 4V, the demersal fish biomass dropped in the 1990s and has remained low since then (Figure 3c). Although the area has seen larger catches of Cod this year, the biomass for 4V is lower than in 2019, largely due to lower catches of Haddock, Silver Hake, and redfish.

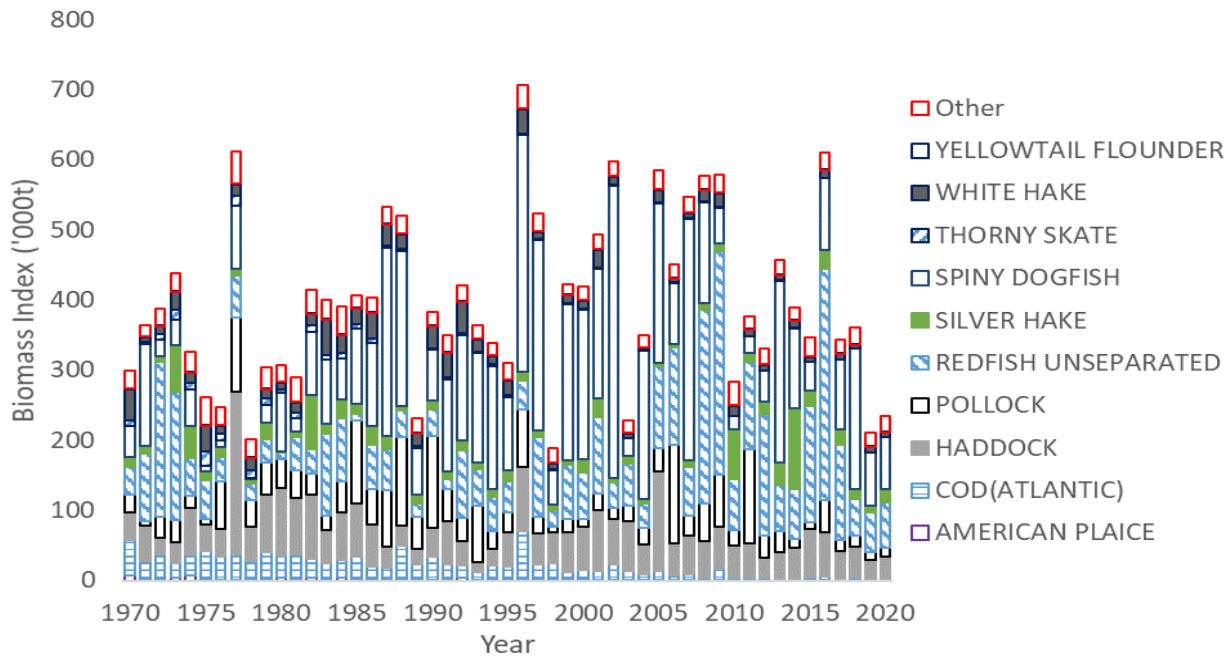


*Figure 3a. Biomass indices for the top ten demersal fish species (bars) in 4X and for all other demersal fish species combined. Refer to Figure 1 for NAFO Divisions within the Maritimes Region.*

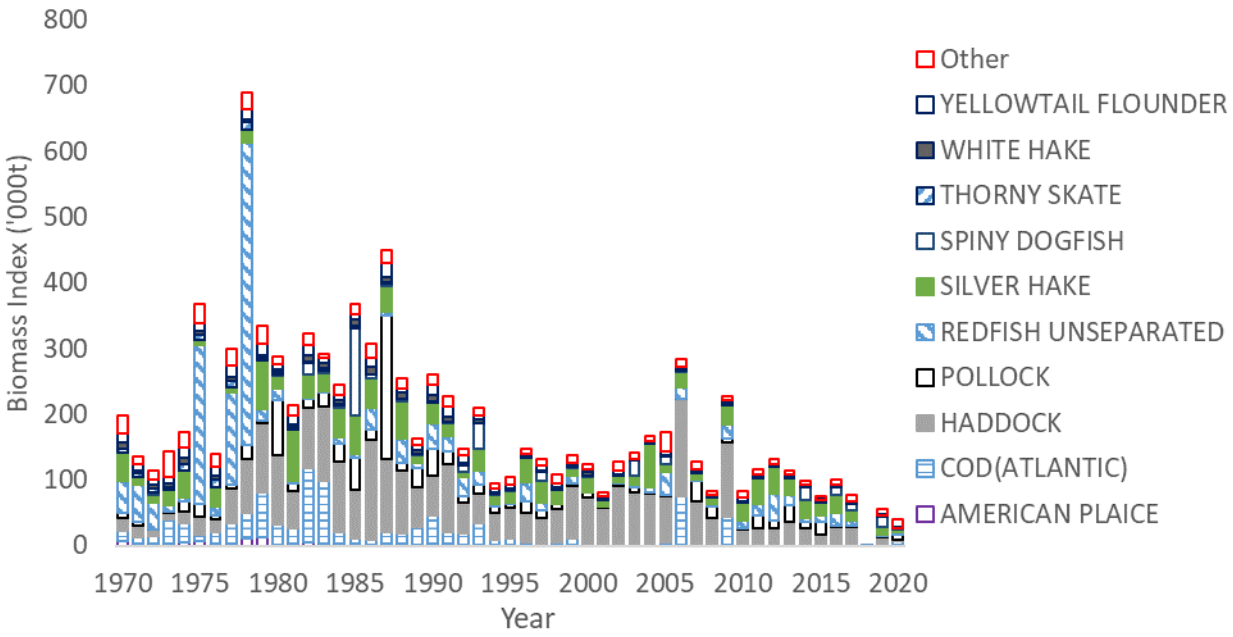


*Figure 3b. Biomass indices for the top ten demersal fish species (bars) in 4W and for all other demersal fish species combined. Refer to Figure 1 for NAFO Divisions within the Maritimes Region.*

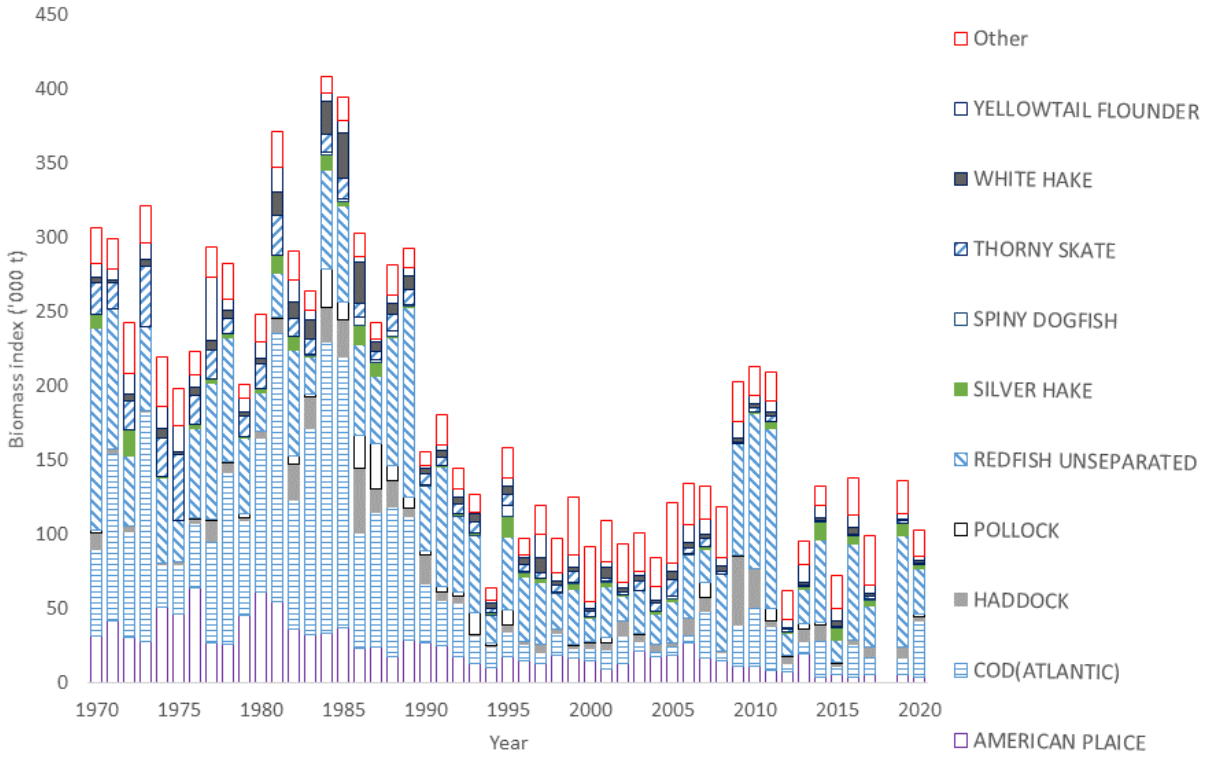


*Figure 3c. Biomass indices for the top ten demersal fish species (bars) in 4V and for all other demersal fish species combined. Refer to Figure 1 for NAFO divisions within the Maritimes Region.*

In 4V, Atlantic Cod and American Plaice comprised a large part of the biomass index in the 1970s and 1980s; both have experienced large declines (Figure 3c). Redfish did not experience the same drop in biomass and are the largest contributors to the 4V biomass indices in the last decade. While additional species, including Thorny Skate, White Hake, and Yellowtail Flounder, have also declined since the 1980s in 4V, there are no demersal fish species that have experienced a large increase in biomass over time, so the overall index has remained low since the early 1990s.

In 4W, increases in Atlantic Cod, Haddock, and redfish led to the increase in biomass in the 1980s (Figure 3b). Biomass indices for Atlantic Cod and redfish dropped to very low levels in 4W by the 1990s and were responsible for most of the overall decline in biomass. Haddock biomass has declined in 4W since about 2010, and total demersal fish biomass in recent years has been the lowest in the time series.

In 4X, Spiny Dogfish, redfish, and Haddock have made up the bulk of the demersal fish biomass index throughout the time series (Figure 3a). While Cod and Thorny Skate have clearly declined over time, their combined biomass did not represent a large part of the total (12% in the 1970s). These declines are balanced by increases for other species, so, unlike 4V or 4W, there has been no general decline in demersal fish biomass over time.

Changes in biomass indices from one year to the next for individual species should be interpreted cautiously. For those species where a population model is used, the inter-annual variability in population biomass estimates is lower than the variability in survey indices. Additional information from commercial landings and age composition can help in interpreting survey data. The running 3-yr GM may be a better indicator of biomass trends.

## Atlantic Cod

The largest Atlantic Cod (*Gadus morhua*) catches came from Banquereau and Georges Bank (Figure 4a). The 3-yr GM in 4X remains under 40% of the long-term GM for the 11th year in a row and is the lowest in the entire time series (Figure 4b). Abundance indices are generally below the short-term median, with the exception of fish 9–15 cm where the median is zero (Figure 4c). The biomass index in 4VsW for 2020 is the highest since 2009, and the 3-yr GM is above 40% of the long-term GM (Figure 4d). This increase is a reflection of one 5,800 kg tow, the second largest Cod catch in the survey time series. The abundance indices for larger Cod (> 42 cm) are generally above the short- and long-term medians (Figure 4e). The 3-yr GM in 4Vn remains under 40% of the long-term GM for the third year in a row and is the lowest in the time series (Figure 4f). Abundance indices of fish below 32 cm are above both the short- and long-term median, but are below for larger fish (Figure 4g).

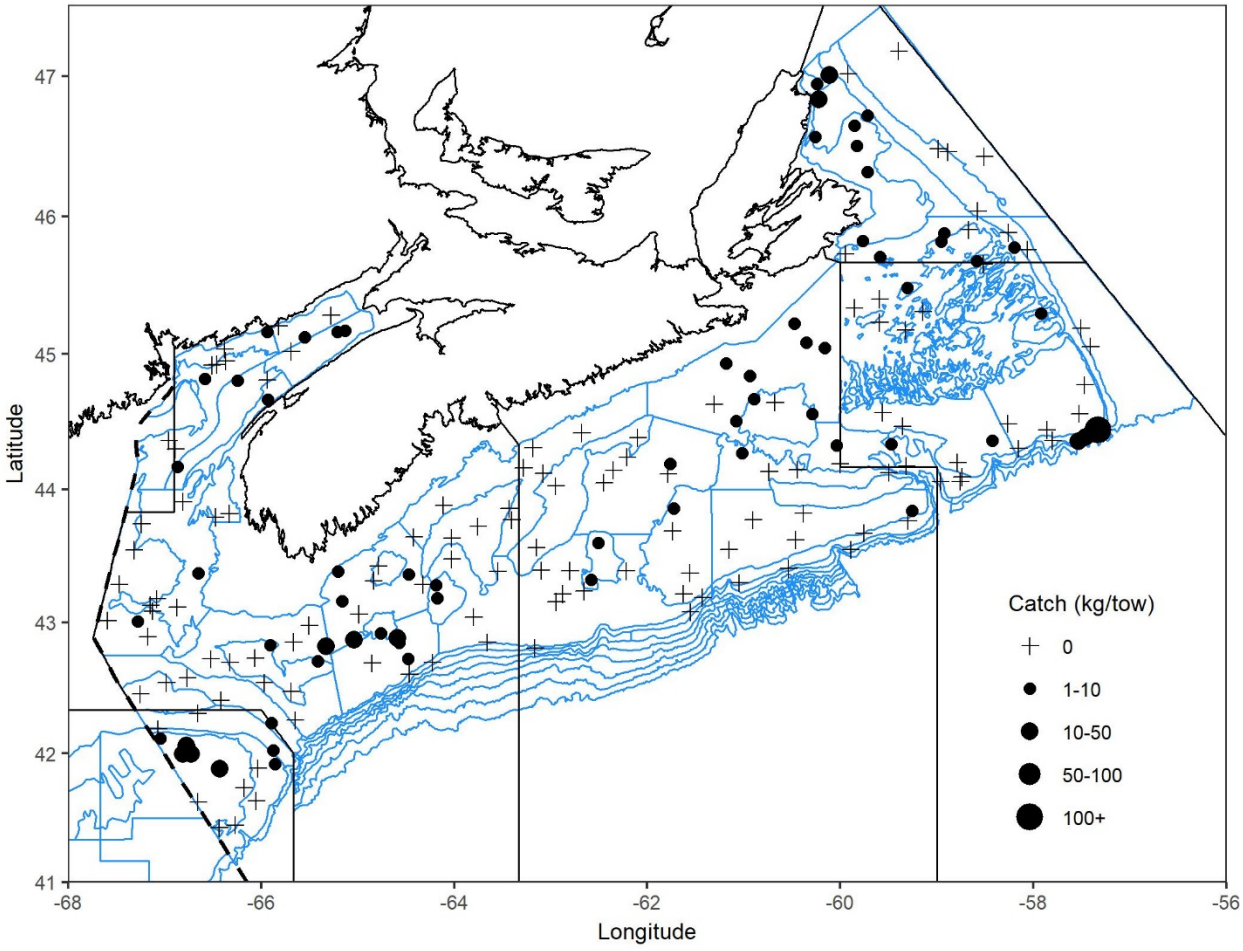


*Figure 4a. Distribution of Atlantic Cod catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

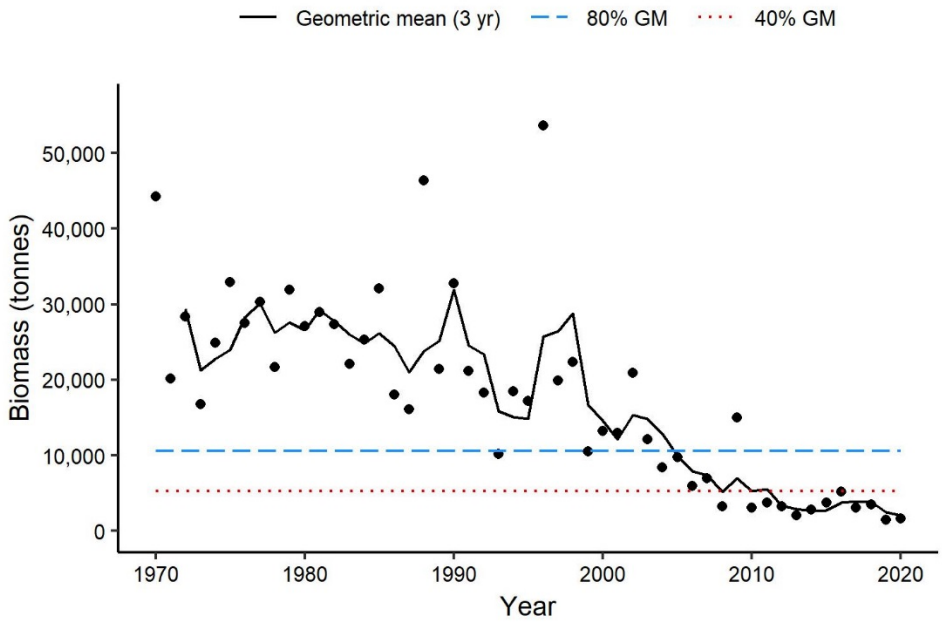


*Figure 4b. Biomass index for Atlantic Cod in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

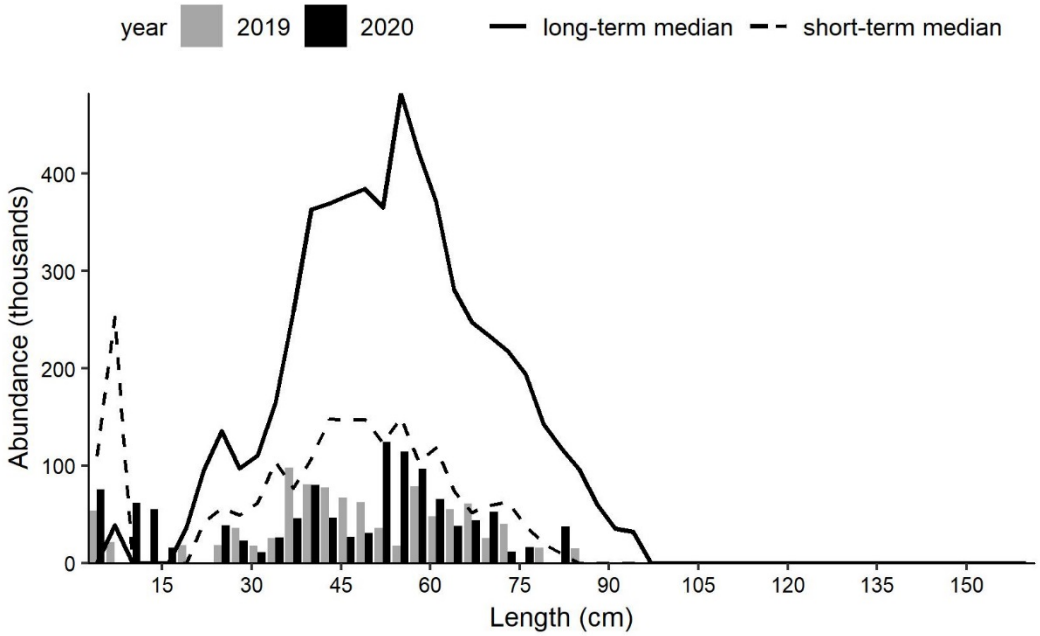


*Figure 4c. Length-frequency indices for Atlantic Cod in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

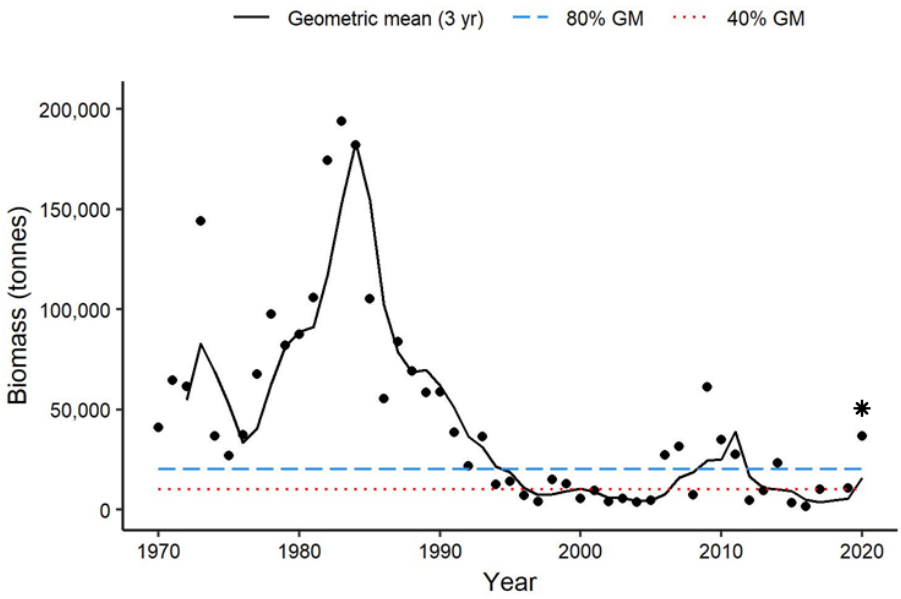


*Figure 4d. Biomass index for Atlantic Cod in 4VsW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*
**The increase in 2020 is a reflection of one 5,800 kg tow, the second largest Cod catch in the survey time series.*

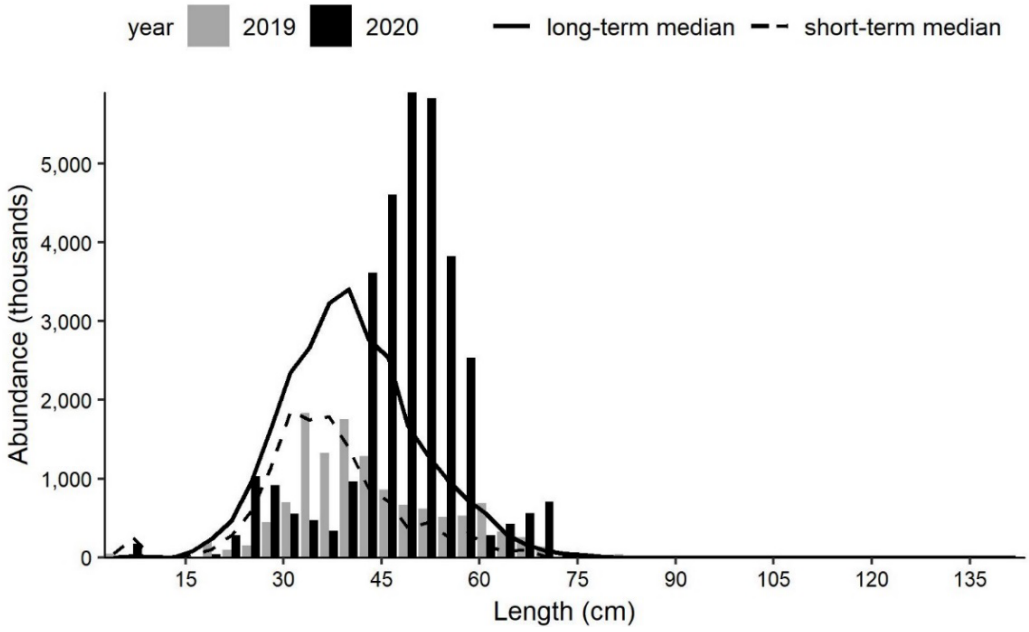


*Figure 4e. Length-frequency indices for Atlantic Cod in 4VsW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017. The 2nd largest tow of Cod in the time series was taken in 4VsW in 2020 and was influential in the biomass index for that year.*

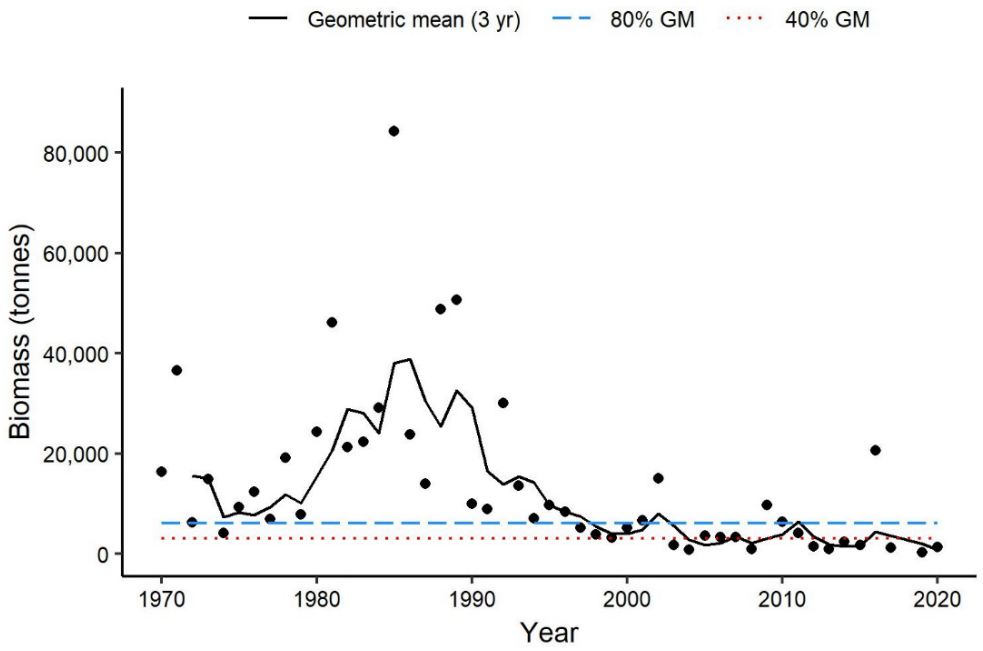


*Figure 4f. Biomass index for Atlantic Cod in 4Vn from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

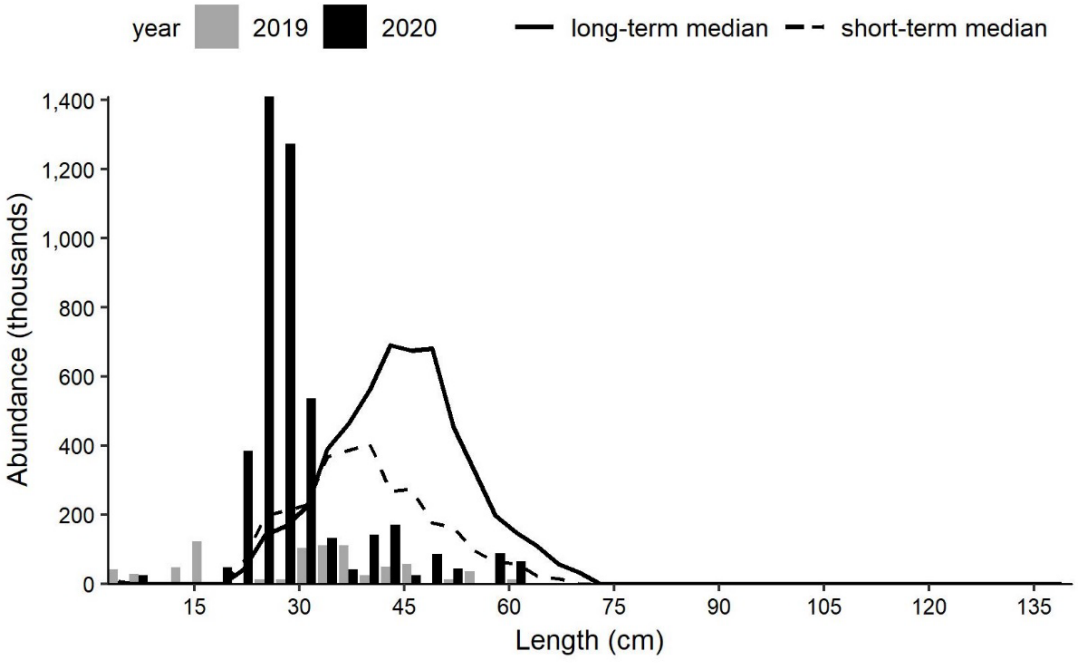


*Figure 4g. Length-frequency indices for Atlantic Cod in 4Vn from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Haddock

Haddock (*Melanogrammus aeglefinus*) were caught in all but two sets in 4X in 2020, but there were only three sets where the catch exceeded 100 kg (Figure 5a). The 3-yr GM remains between 40–80% of the long-term GM (Figure 5b). The numbers at length were generally at or below the short-term median with the exception of lengths < 15 cm, which may indicate above-average recruitment for the 2020 year-class (Figure 5c). In 4VW, the biomass index was the lowest since 1973, but the 3-yr GM remains just above 40% of the long-term GM (Figure 5d). As in 4X, the numbers at length were generally below the short-term median at all lengths (Figure 5e).

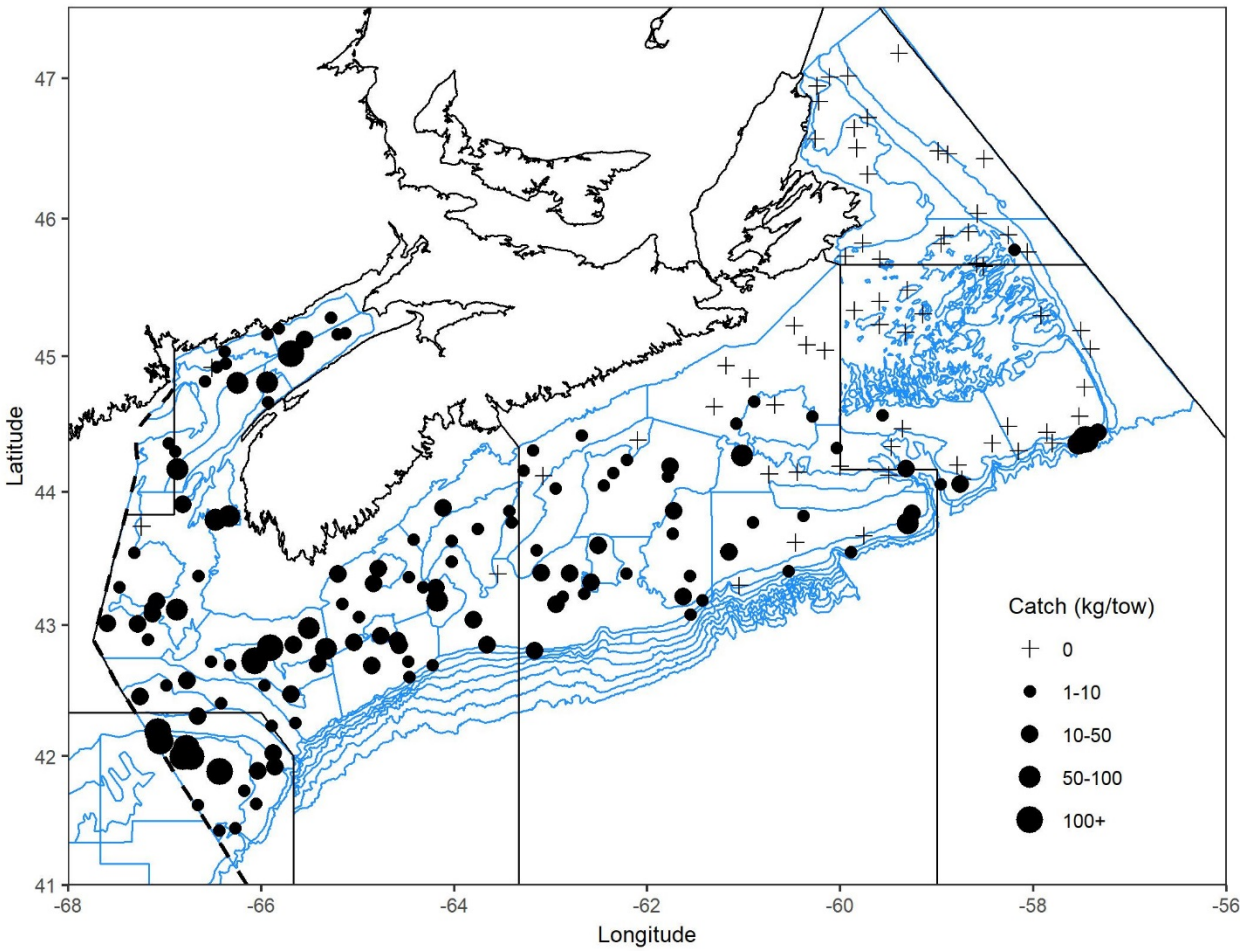


*Figure 5a. Distribution of Haddock catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

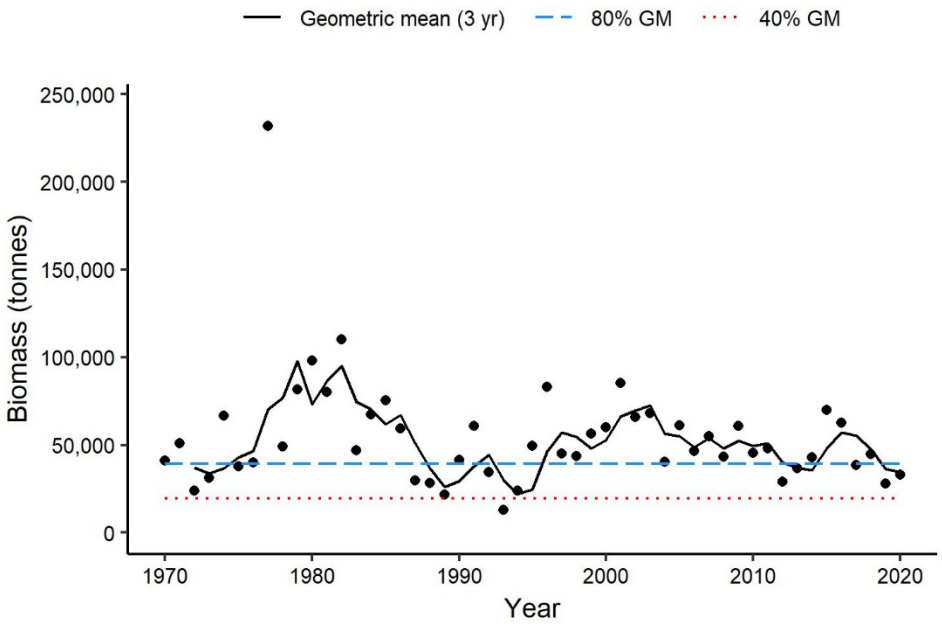


*Figure 5b. Biomass index for Haddock in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

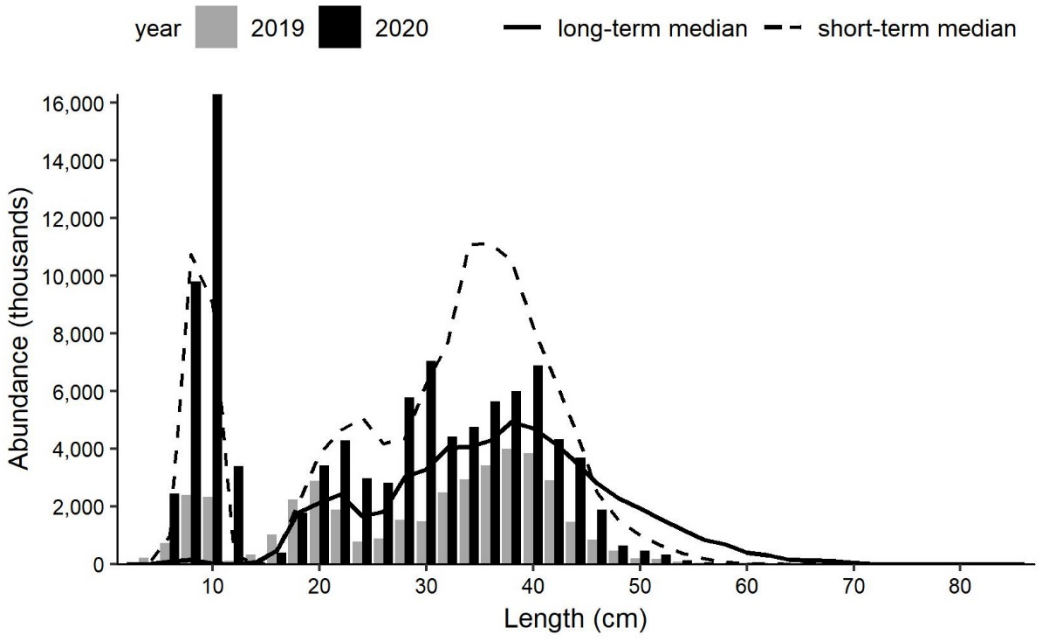


*Figure 5c. Length-frequency indices for Haddock in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

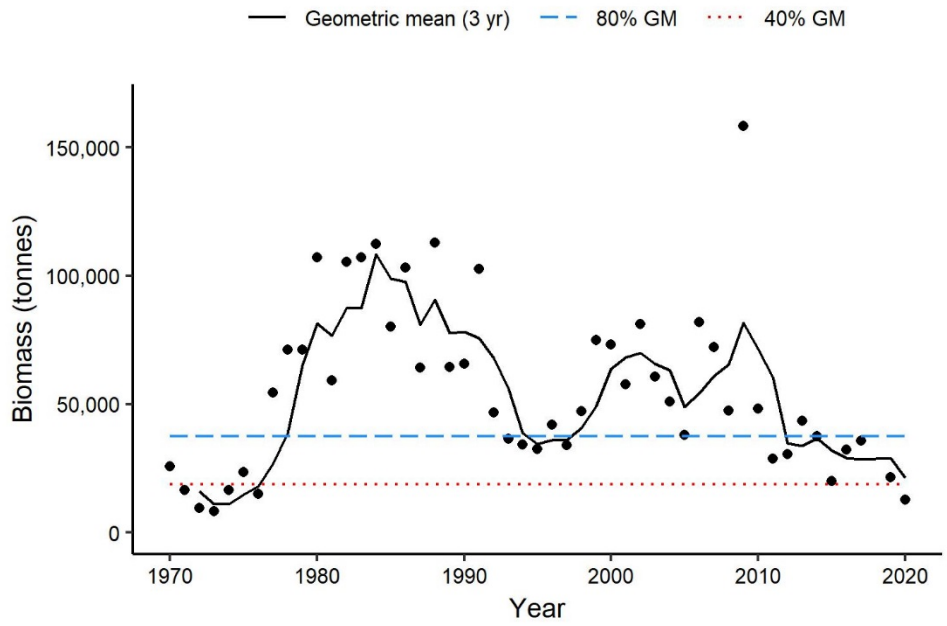


*Figure 5d. Biomass index for Haddock in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

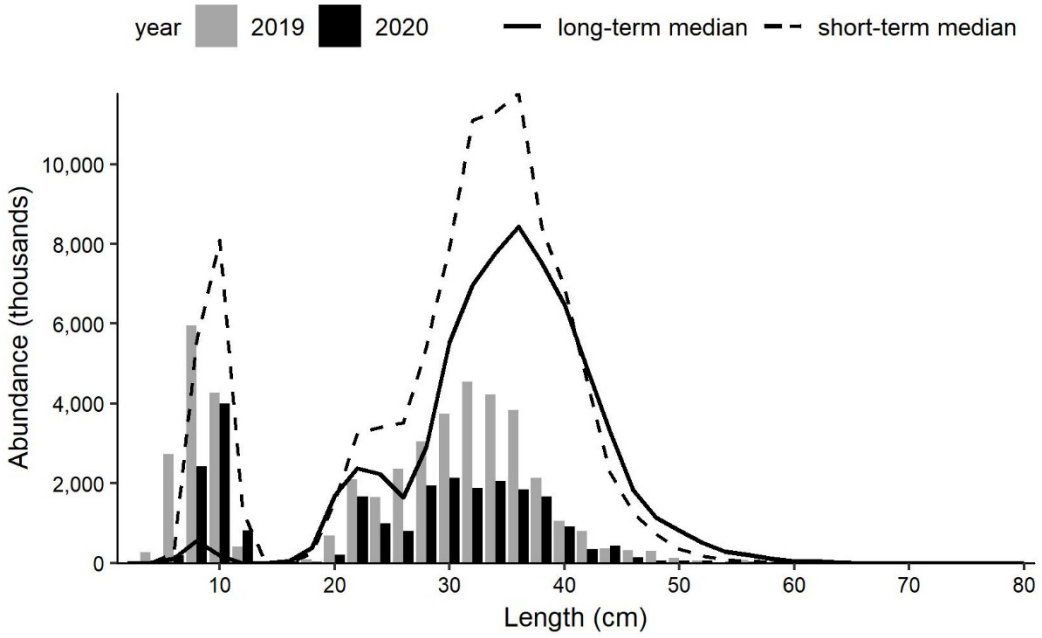


*Figure 5e. Length-frequency indices for Haddock in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## White Hake

White Hake (*Urophycis tenuis*) are broadly distributed in deeper waters along the shelf edge and in basins of the Scotian Shelf and Gulf of Maine (Figure 6a). No sets with a catch of over 50 kg were recorded. In 4X, the 3-yr GM remained between 40–80% of the long-term GM (Figure 6b). Abundance indices were similar to 2019 and were generally below the short- and long-term medians but above for several lengths > 84 cm, indicating that although the biomass indices remained low, the population includes some large, older fish. (Figure 6c). In 4VW, the 3-yr GM fell below 40% of the long-term GM for the first time in the times series (Figure 6d). Abundance indices were similar to 2019 and were generally below the short- and long-term medians at most lengths (Figure 6e).

The 2015 Recovery Potential Assessment (RPA) (Guenette and Clark 2016) proposed biomass recovery targets of 6,867 t mature biomass (> 41 cm) in 4X5Z and 3,885 t in 4VW. The 3-yr GM biomass index for 4X White Hake > 41 cm remained below the RPA-defined biomass recovery target for the sixth year in a row (Figure 6f). In 4VW, White Hake > 41cm has been below the RPA-defined biomass recovery target since 1994 (Figure 6g).

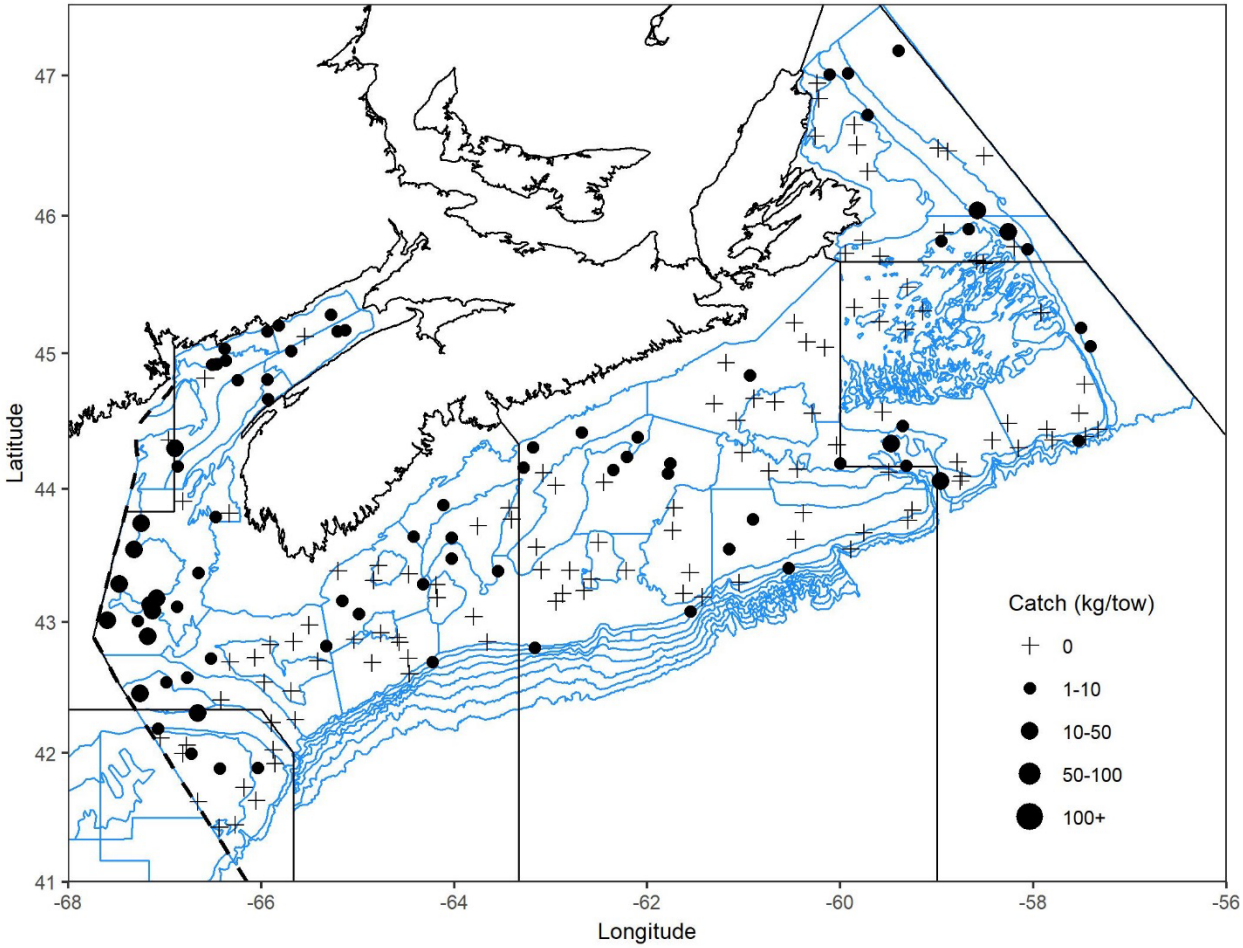


*Figure 6a. Distribution of White Hake catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

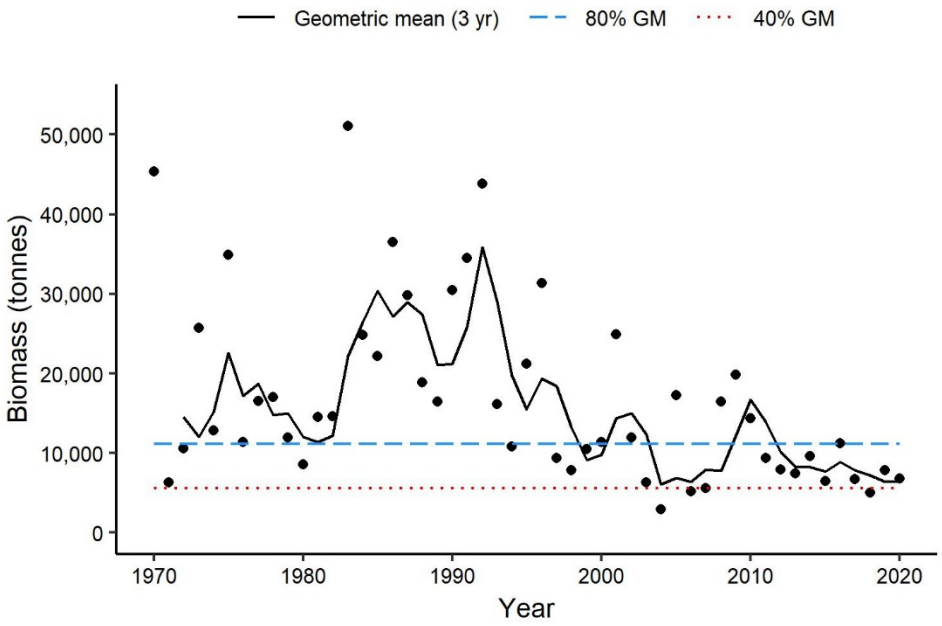


*Figure 6b. Biomass index for White Hake in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

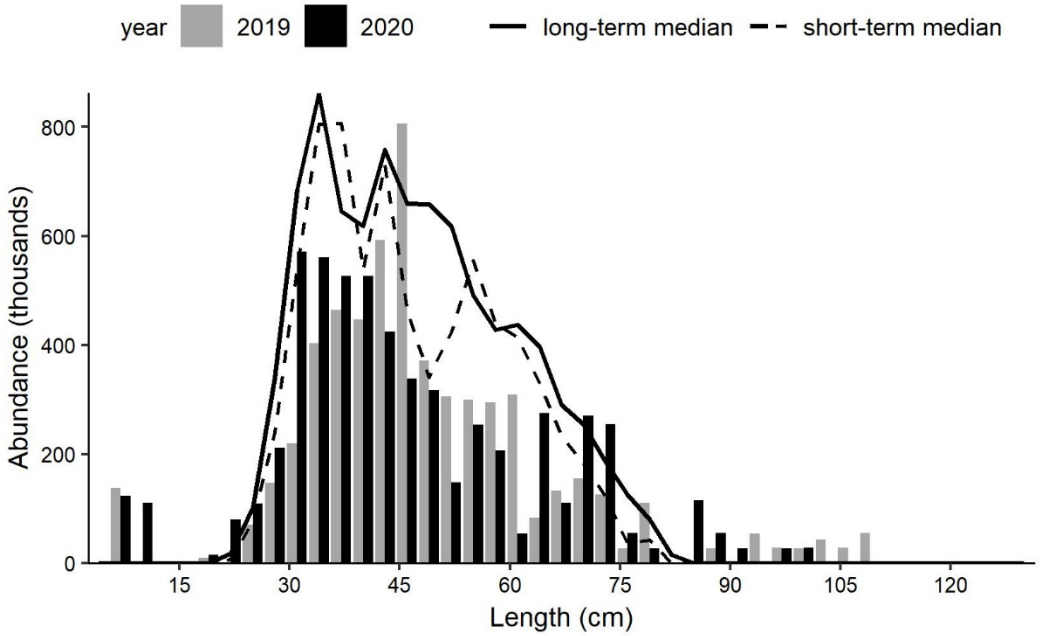


*Figure 6c. Length-frequency indices for White Hake in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

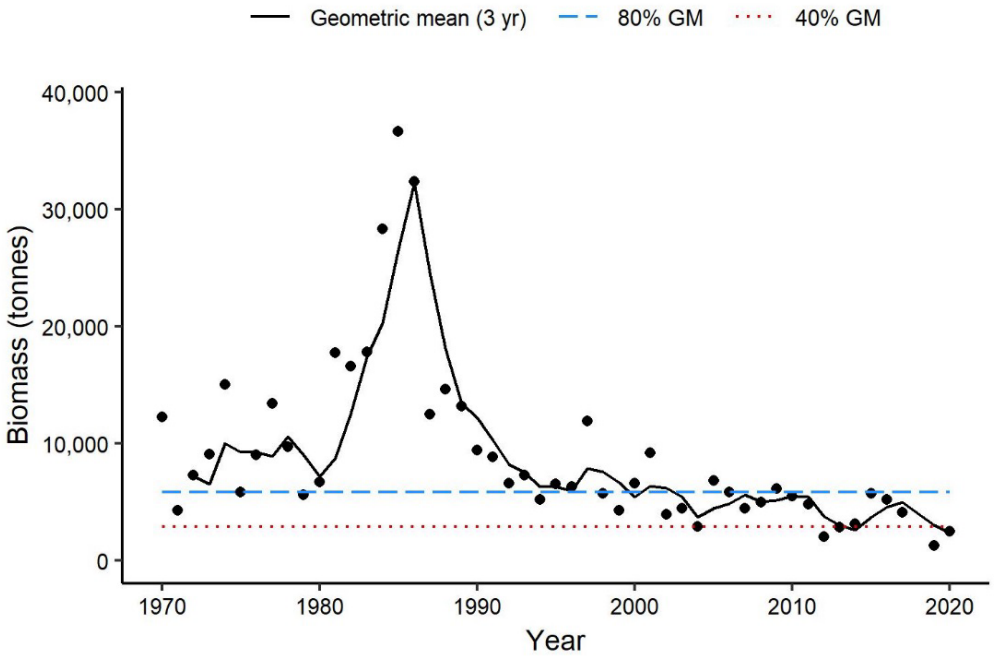


*Figure 6d. Biomass index for White Hake in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

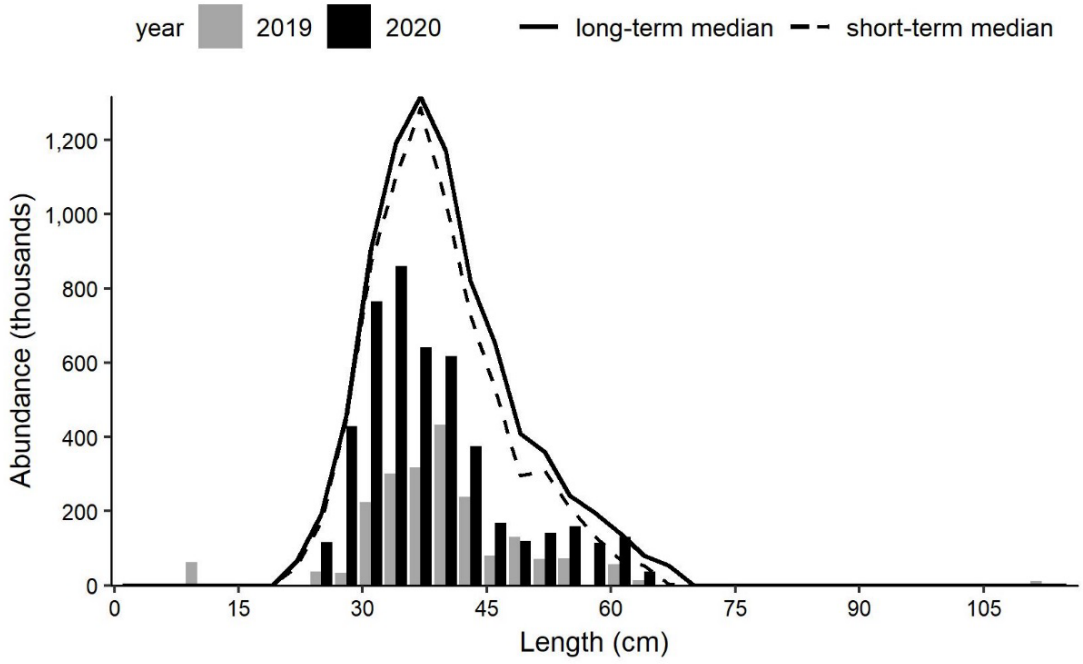


*Figure 6e. Length-frequency indices for White Hake in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

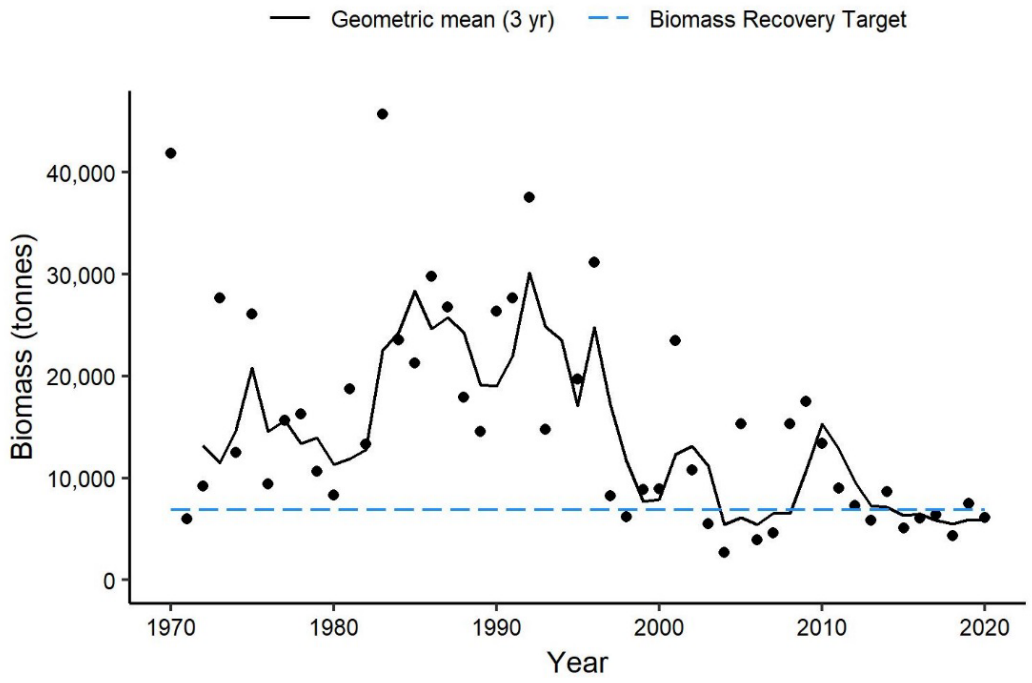


*Figure 6f. Biomass index for 4X White Hake > 41 cm from the DFO Summer RV Survey represented by the black circles. The solid black line represents the three-year geometric mean. The dashed blue line represents the biomass recovery target.*

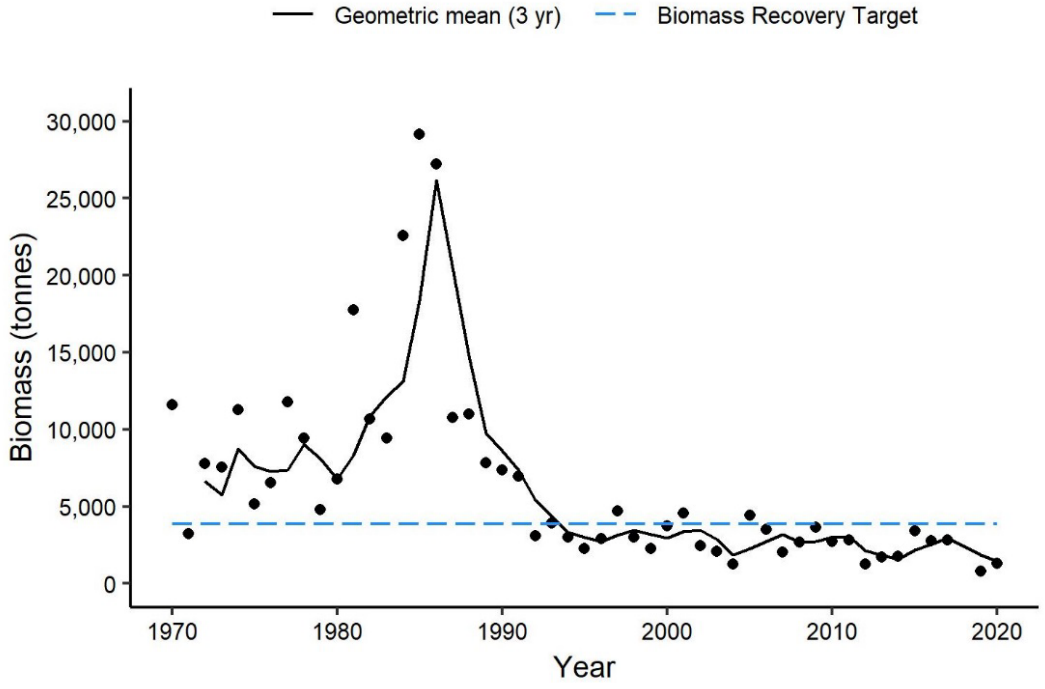


*Figure 6g. Biomass index for 4VW White Hake > 41 cm from the DFO Summer RV Survey represented by the black circles. The solid black line represents the three-year geometric mean. The dashed blue line represents the biomass recovery target.*

## Silver Hake

Silver Hake (*Merluccius bilinearis*) were caught throughout most of the survey area, with the largest catches in the Gulf of Maine (Figure 7a). The 3-yr GM biomass index for the Scotian Shelf stock area (4VWX east) has been declining since 2016 and fell below 80% of the long-term mean for the first time since 2009 (Figure 7b). Abundance indices were above the short-term GM for all lengths below 16 cm in both 2019 and 2020, indicative of above-average recruitment for the 2018 and 2019 year-classes (Figure 7c). Abundance indices were below the short-term GM for all lengths above 24 cm in both 2019 and 2020, suggesting that spawning stock biomass was low relative to the recent past. The 3-yr GM in the Bay of Fundy (4X west) was well above 80% of the long-term GM in 2020 (Figure 7d), with indices-at-lengths < 22 cm above the short- and long-term medians.

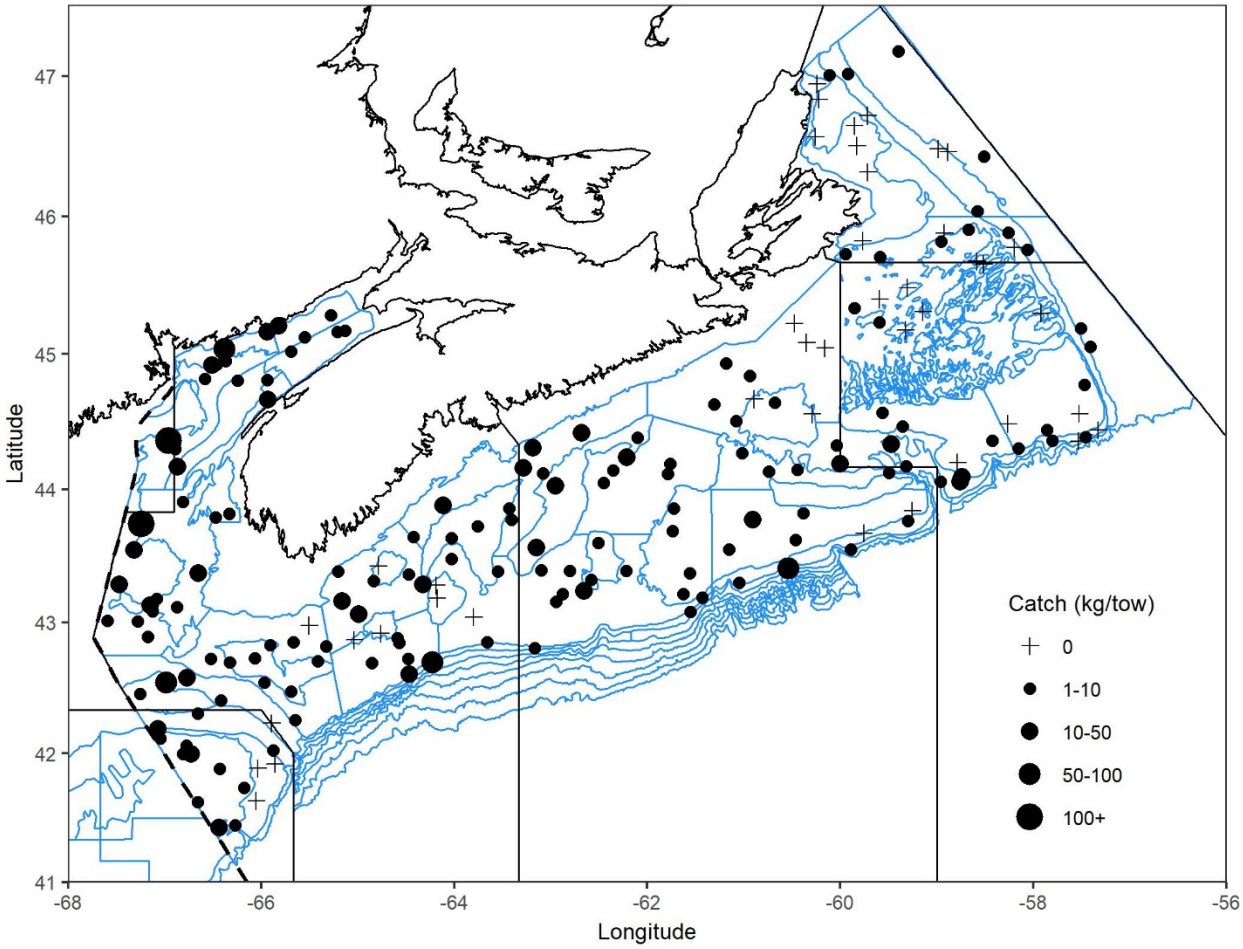


*Figure 7a. Distribution of Silver Hake catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

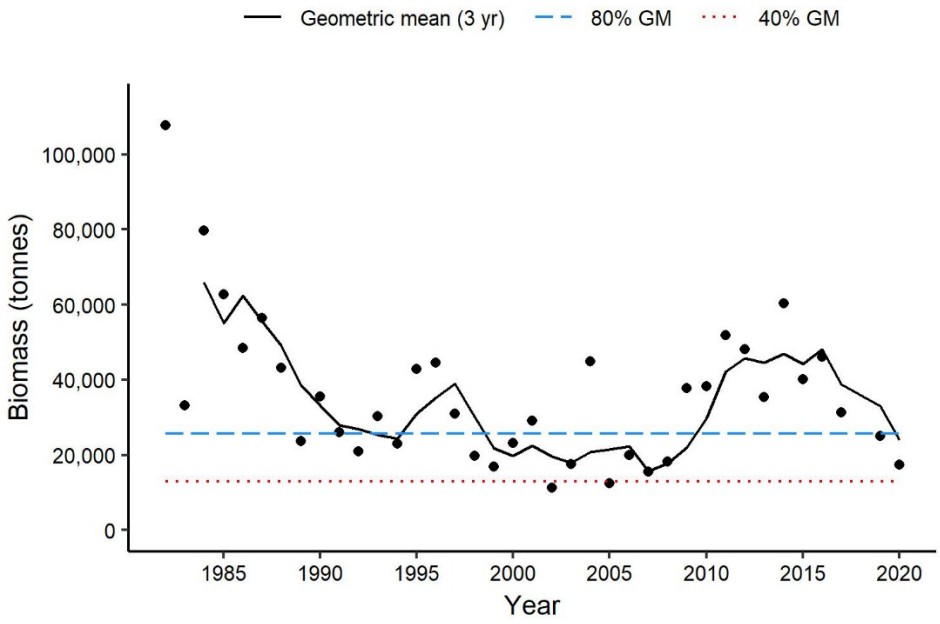


*Figure 7b. Biomass index for Silver Hake in 4VWX east (strata 440–483) from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2019), respectively. The black dots represent the biomass index for that year.*

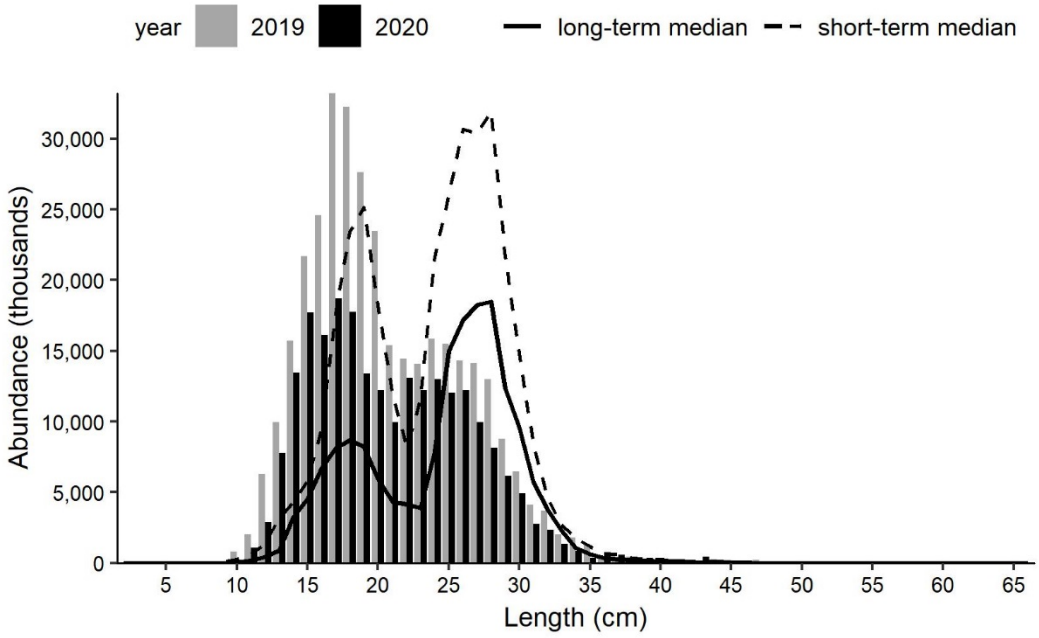


*Figure 7c. Length-frequency indices for Silver Hake in 4VWX east (strata 440–483) from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1982–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

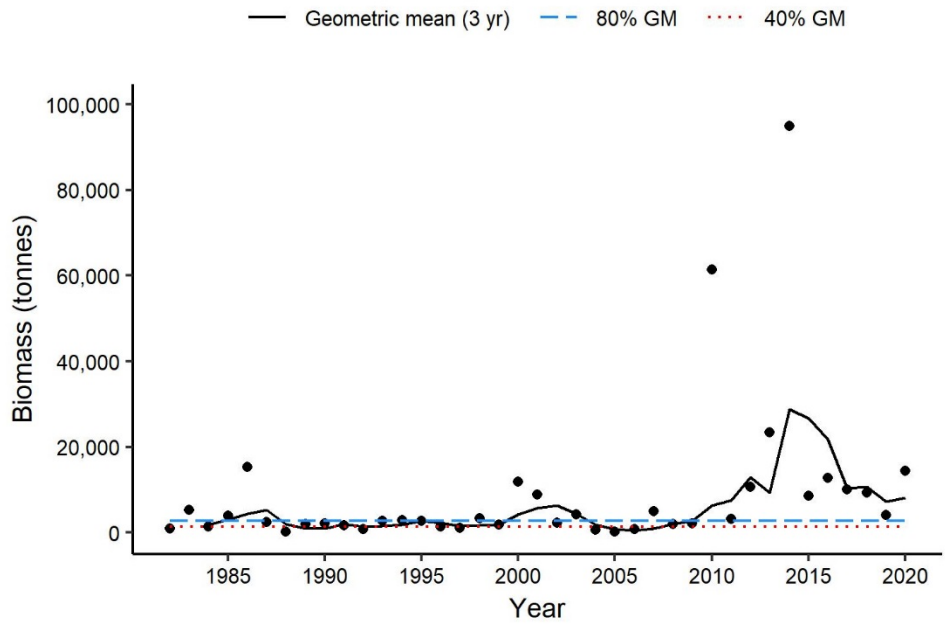


*Figure 7d. Biomass index for Silver Hake in 4X west (strata 484–495) from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2019), respectively. The black dots represent the biomass index for that year.*

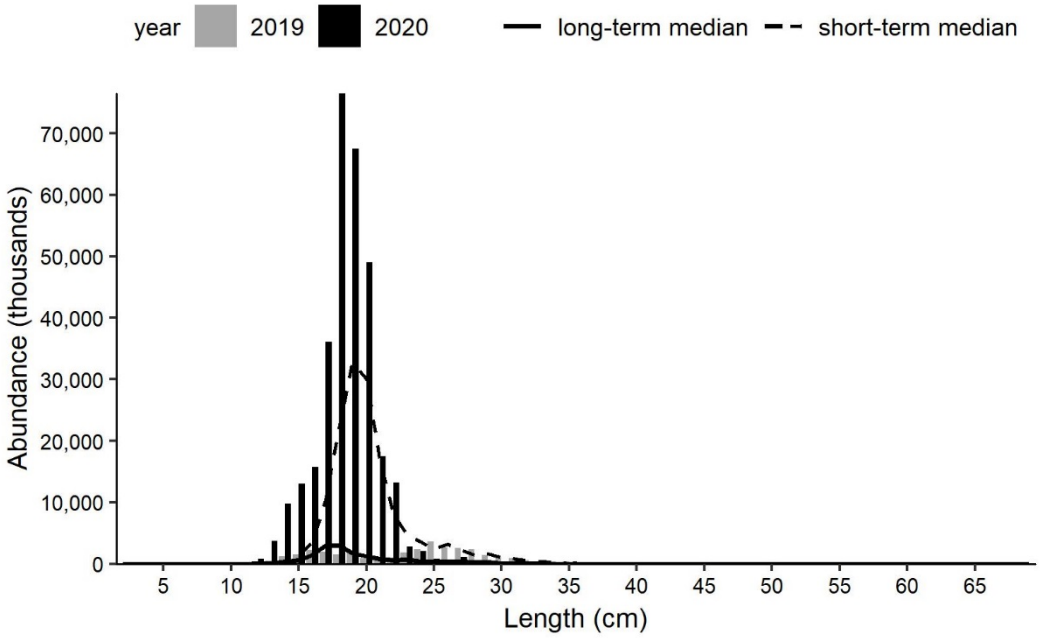


*Figure 7e. Length-frequency indices for Silver Hake in 4X west (strata 484–495) from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1982–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

## Pollock

Pollock (*Pollachius virens*) were caught primarily in deeper water in the Fundian Channel, the Gulf of Maine, and the edge of Banquereau (Figure 8a). The 3-yr GM biomass index for Western Component Pollock remains just above 40% of the long-term GM for the second year in a row (Figure 8b). Indices-at-length were above both the long-term and short-term median for lengths between 32 and 53 cm and below, or at, for most other lengths (Figure 8c).

Few Pollock were caught on the eastern Scotian Shelf. The 3-yr GM was below 40% of the long-term GM for the first time since 2007 (Figure 8d). Indices-at-length were above both the long- and short-term medians at lengths below 30 cm, but below short-term median for all lengths > 30 cm (Figure 8e).

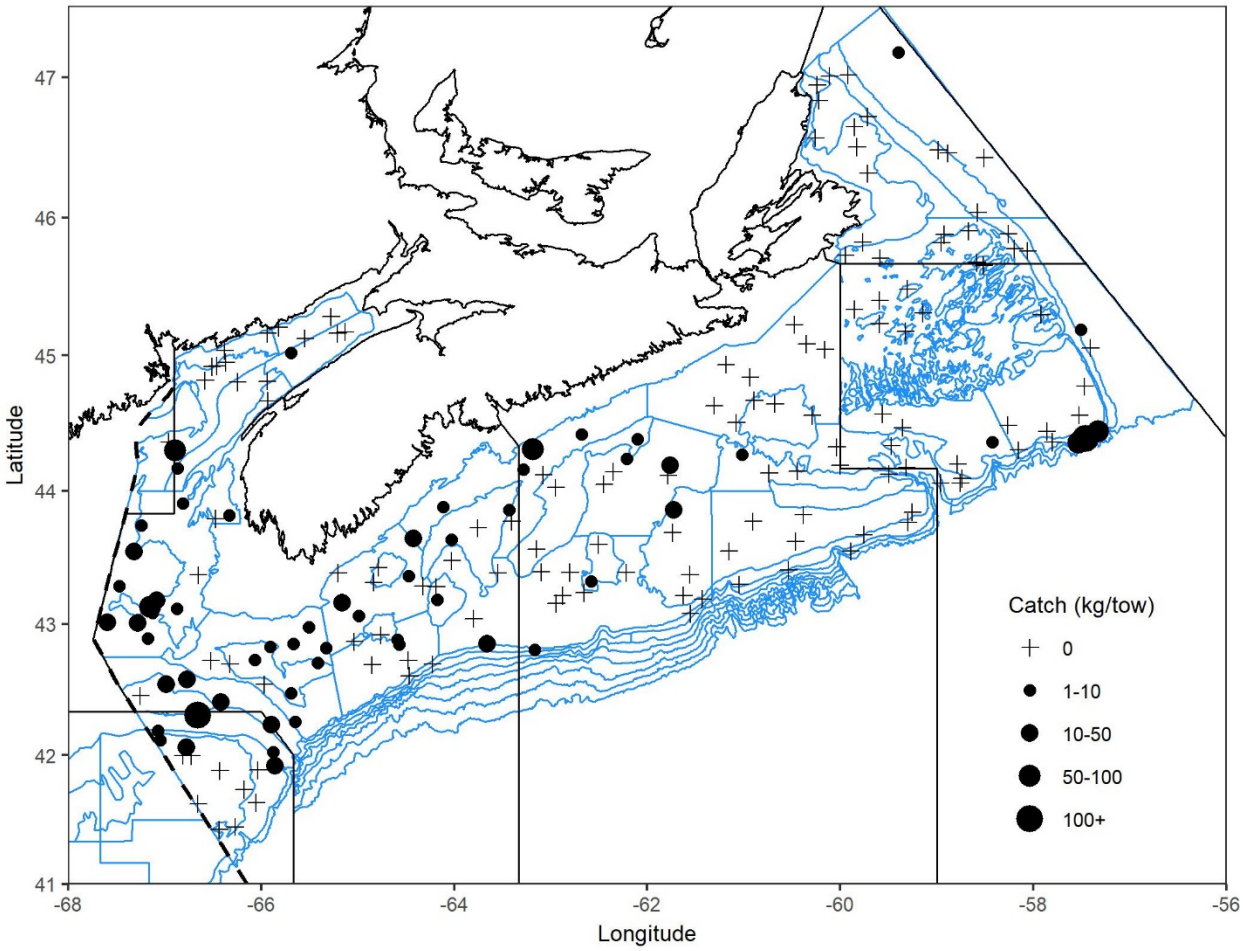


*Figure 8a. Distribution of Pollock catches during the 2020 DFO Summer RV Survey including the Laurentian Channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

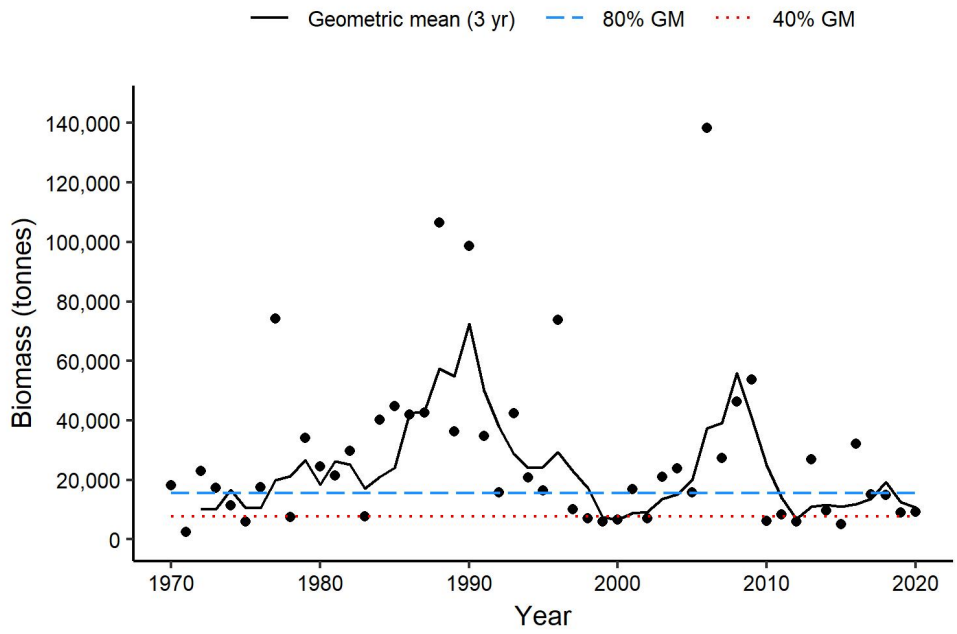


*Figure 8b. Biomass index for Western Component Pollock (strata 474, 476, 480–495) from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

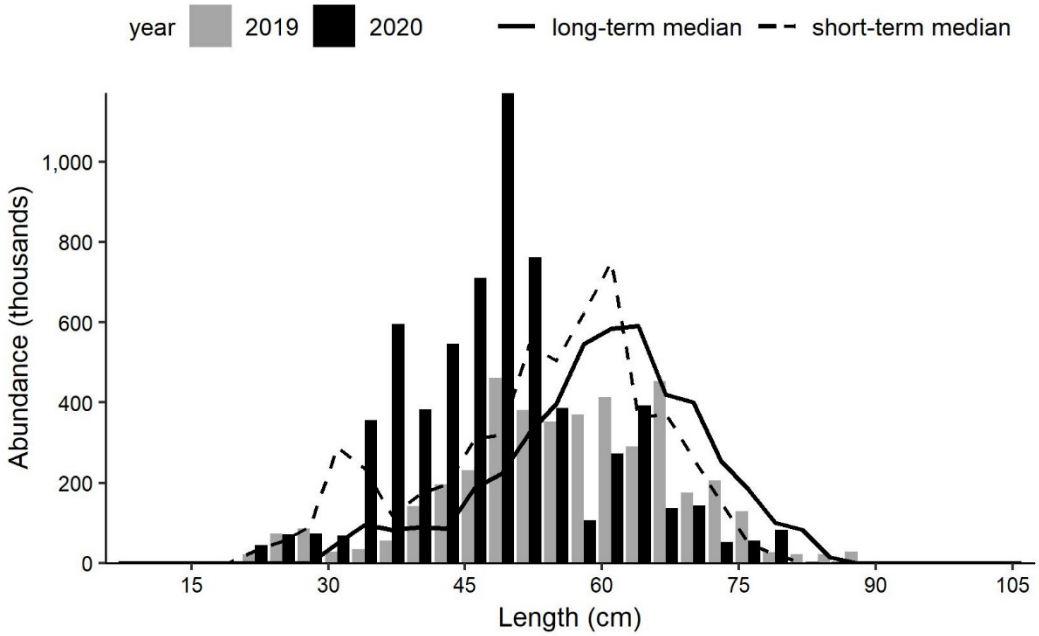


*Figure 8c. Length-frequency indices for Western Component Pollock (strata 474, 476, 480–495) from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

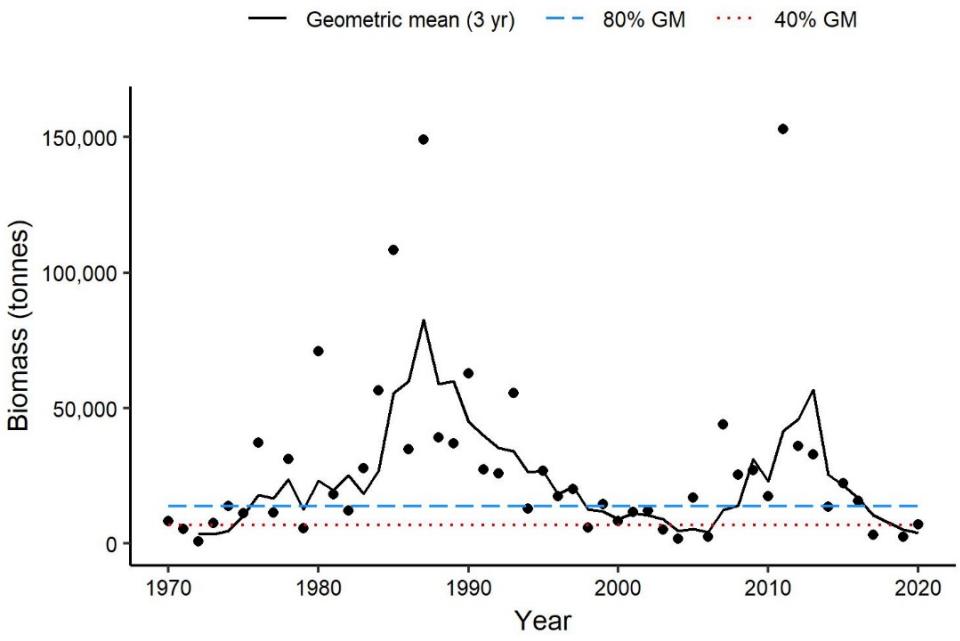


*Figure 8d. Biomass index for Eastern Component Pollock (strata 440–473, 475, 477, 478) from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

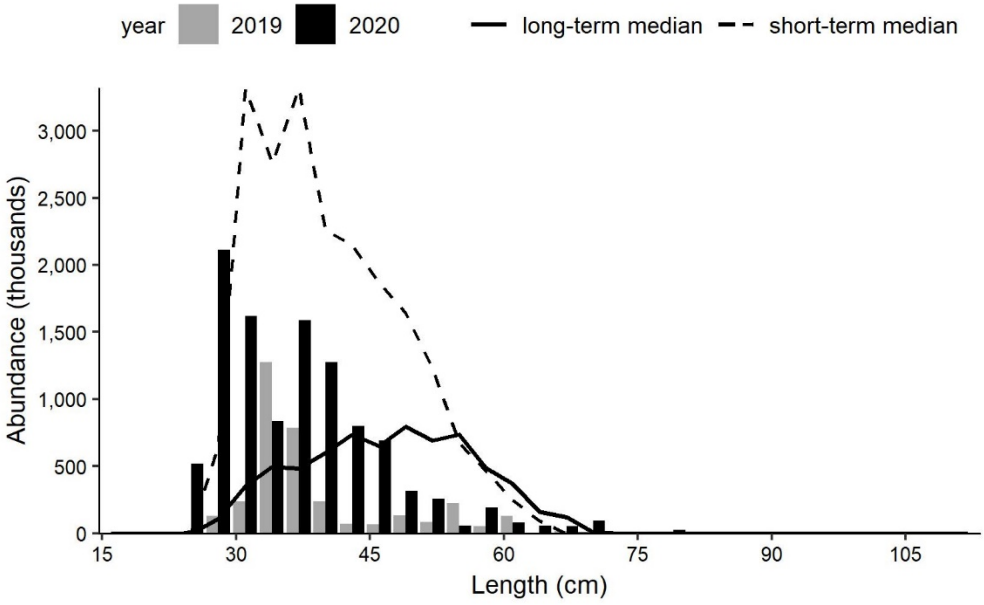


*Figure 8e. Length-frequency indices for Eastern Component Pollock (strata 440–473, 475, 477, 478) from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Redfish

Catches of redfish were largest along the Laurentian Channel and in deeper strata in 4X. The deep water of the Laurentian Channel has only been included in the Summer RV Survey coverage for 5 years and, thus, it is not used in the abundance index. The data are available for use in redfish assessments and should be included in indices once detailed analyses have been undertaken.

Biomass indices for Unit II redfish have high inter-annual variability. The 3-yr GM biomass index remains above 80% of the long-term GM (Figure 9b). In 2020, the abundance indices were above the short- and long-term medians between 21 and 27 cm, but below for all other lengths (Figure 9c).

In Unit III, the 2020 biomass index increased slightly from 2019 and the 3-yr GM biomass index remained above 80% of the long-term GM for 2020 (Figure 9d). The short-term median abundance indices are generally higher than the long-term, reflecting the recent high abundance. The abundance indices were below the short-term medians for all lengths except for lengths < 10 cm, which may be indicative of an above-average recruitment (Figure 9e). The mature biomass index (five-year average biomass for fish > 22 cm) in 2020 was among the highest in the series and remained in the healthy zone (Figure 9f).

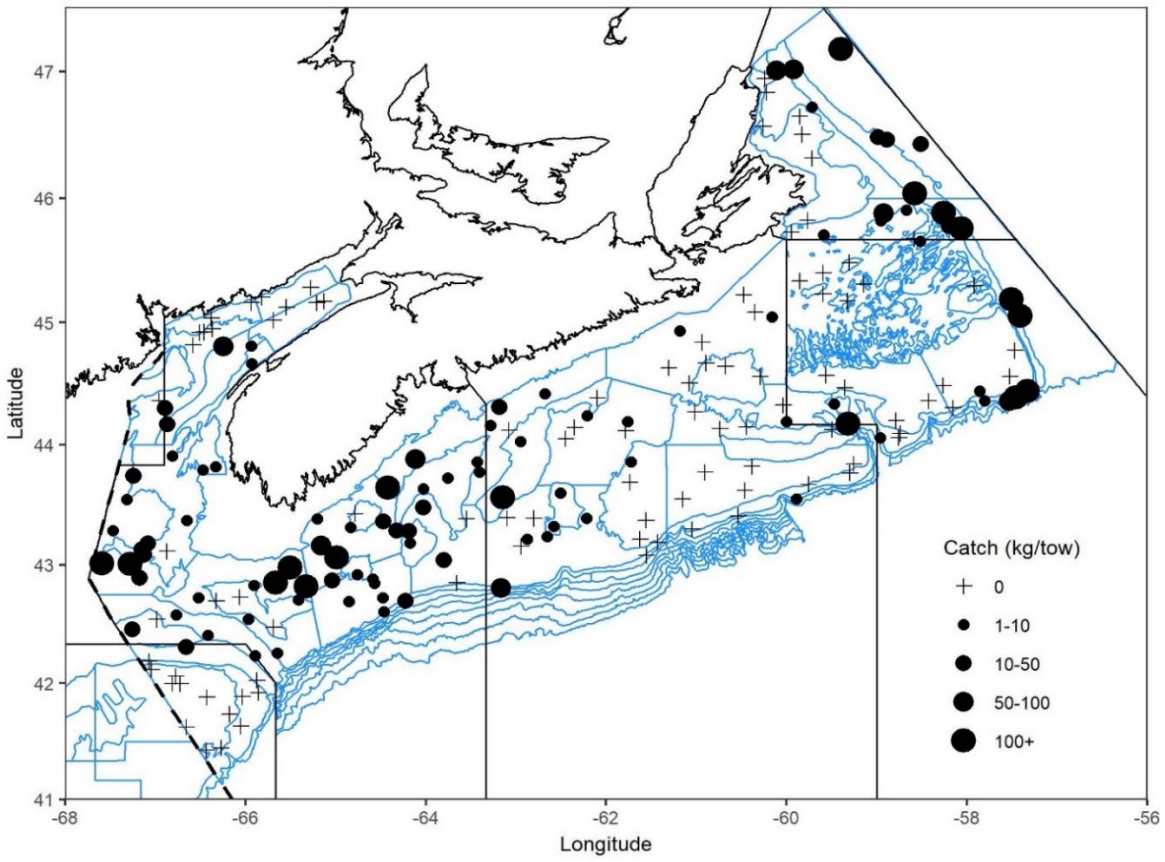


*Figure 9a. Distribution of redfish catches during the 2020 DFO Summer RV Survey including the Laurentian Channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

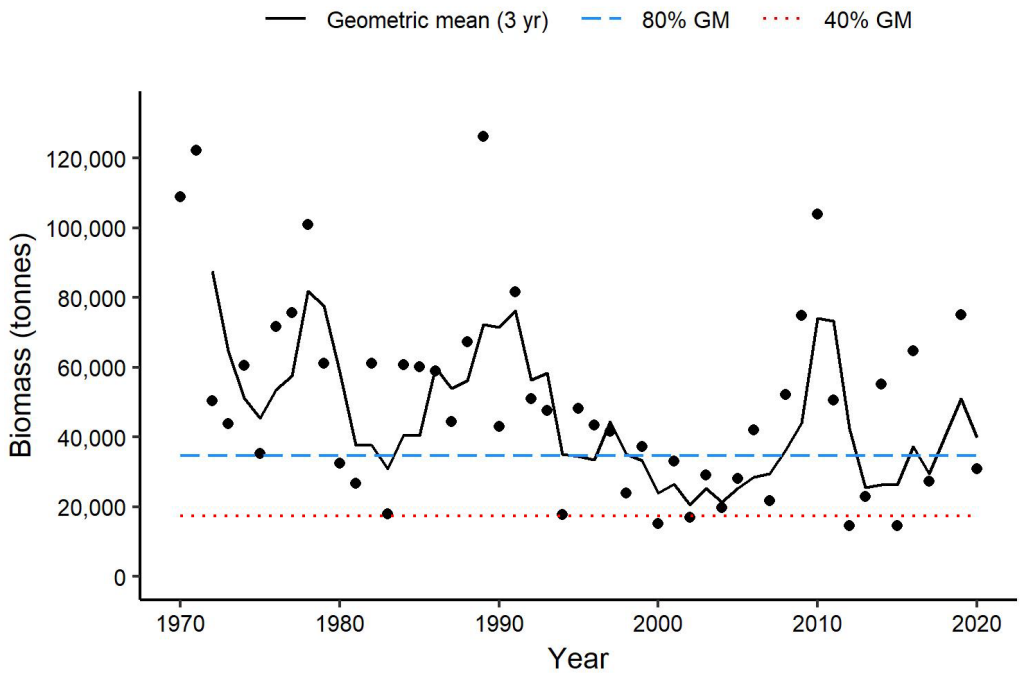


*Figure 9b. Biomass index for Unit II redfish (strata 440–456, 464) from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

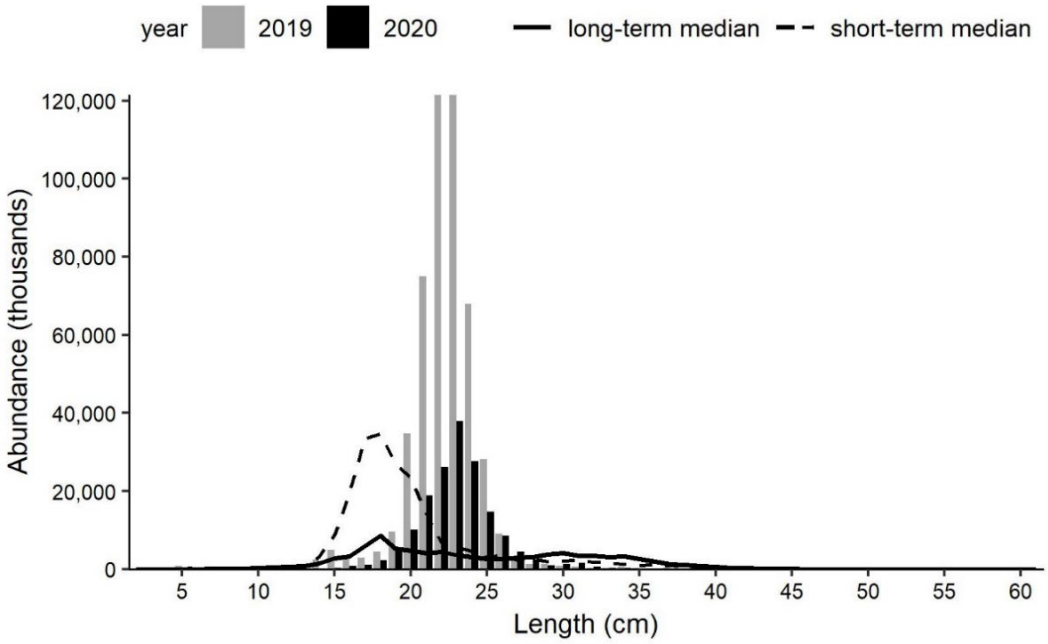


*Figure 9c. Length-frequency indices for Unit II redfish (strata 440–456, 464) from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

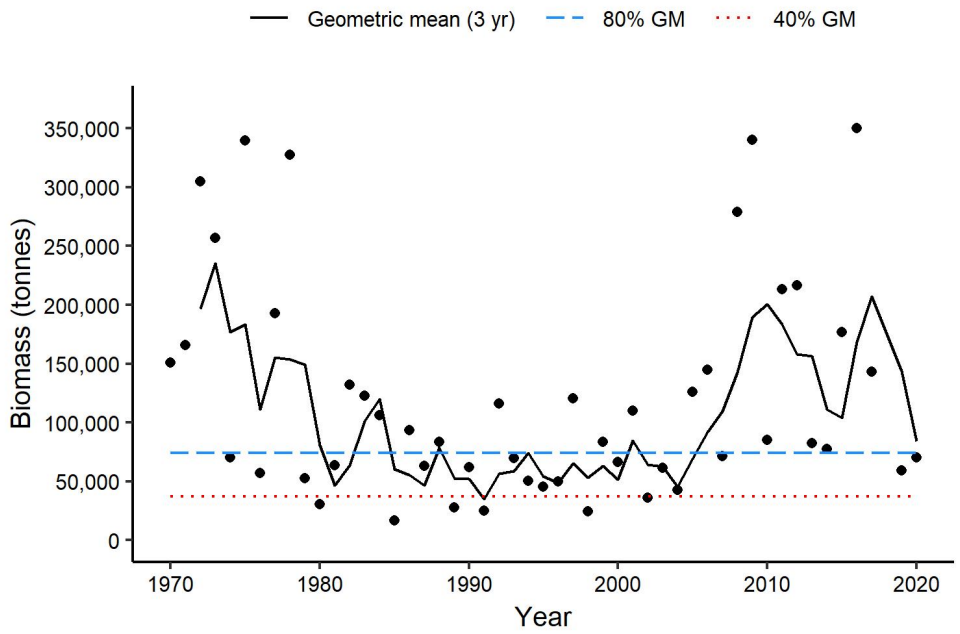


*Figure 9d. Biomass index for Unit III redfish (strata 457–463, 465–485) from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

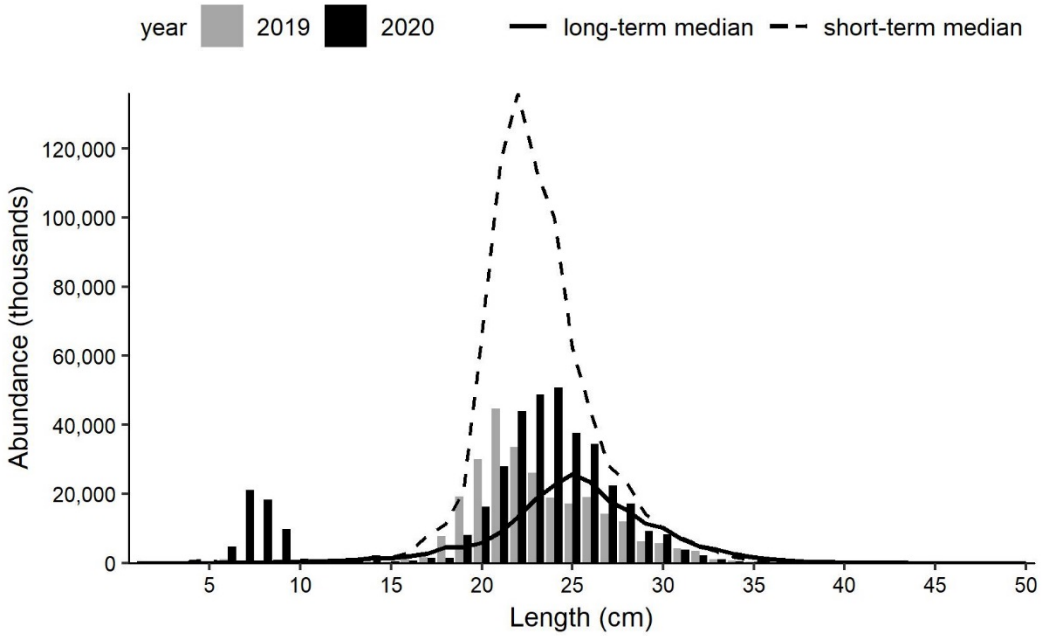


*Figure 9e. Length-frequency indices for Unit III redfish (strata 457–463, 465–485) from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

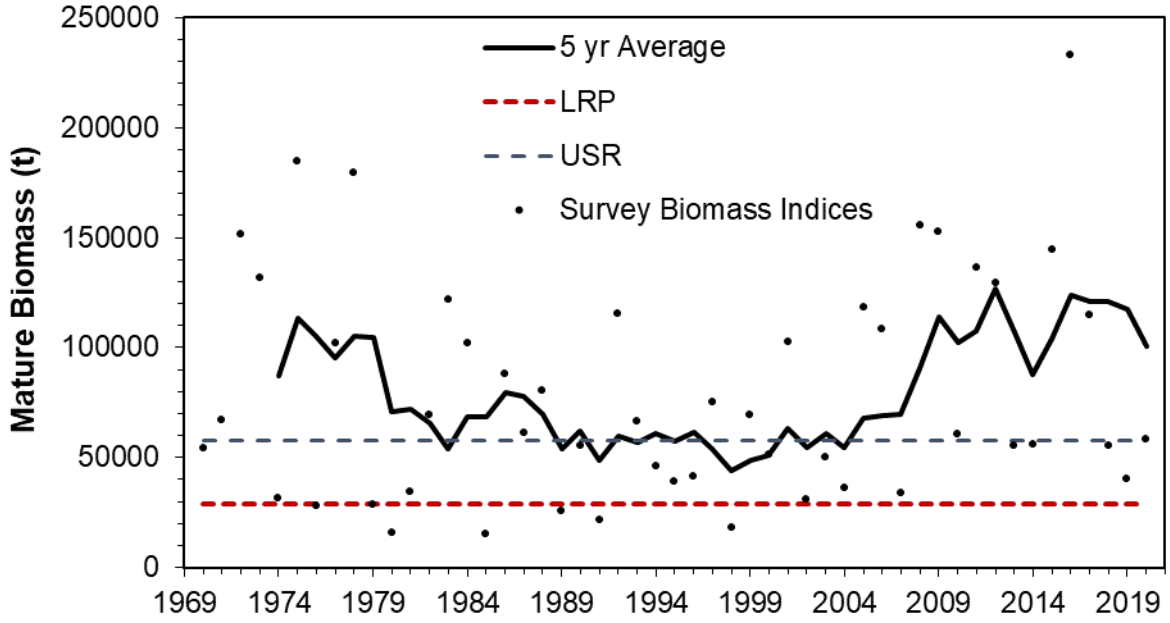


*Figure 9f. Biomass index for Unit III redfish > 22 cm from the DFO Summer RV Survey represented by the black circles. The solid black line represents the 5-year arithmetic mean. The dashed red line represents the limit reference point and the dashed blue line represents the upper stock reference point.*

## Atlantic Halibut

Atlantic Halibut (*Hippoglossus hippoglossus*) catches were wide spread in the survey area (Figure 10a). The 3-yr GM is well above the long-term GM and remains one of the highest in the time series (Figure 10b). Indices of abundance for fish between 30 and 50 cm were generally below the short-term median in 2020, suggesting recruitment may be lower than in most recent years for these year classes (Figure 10c). Indices were above average at 22 and 25 cm, suggesting the 2019 year-class may be above average.

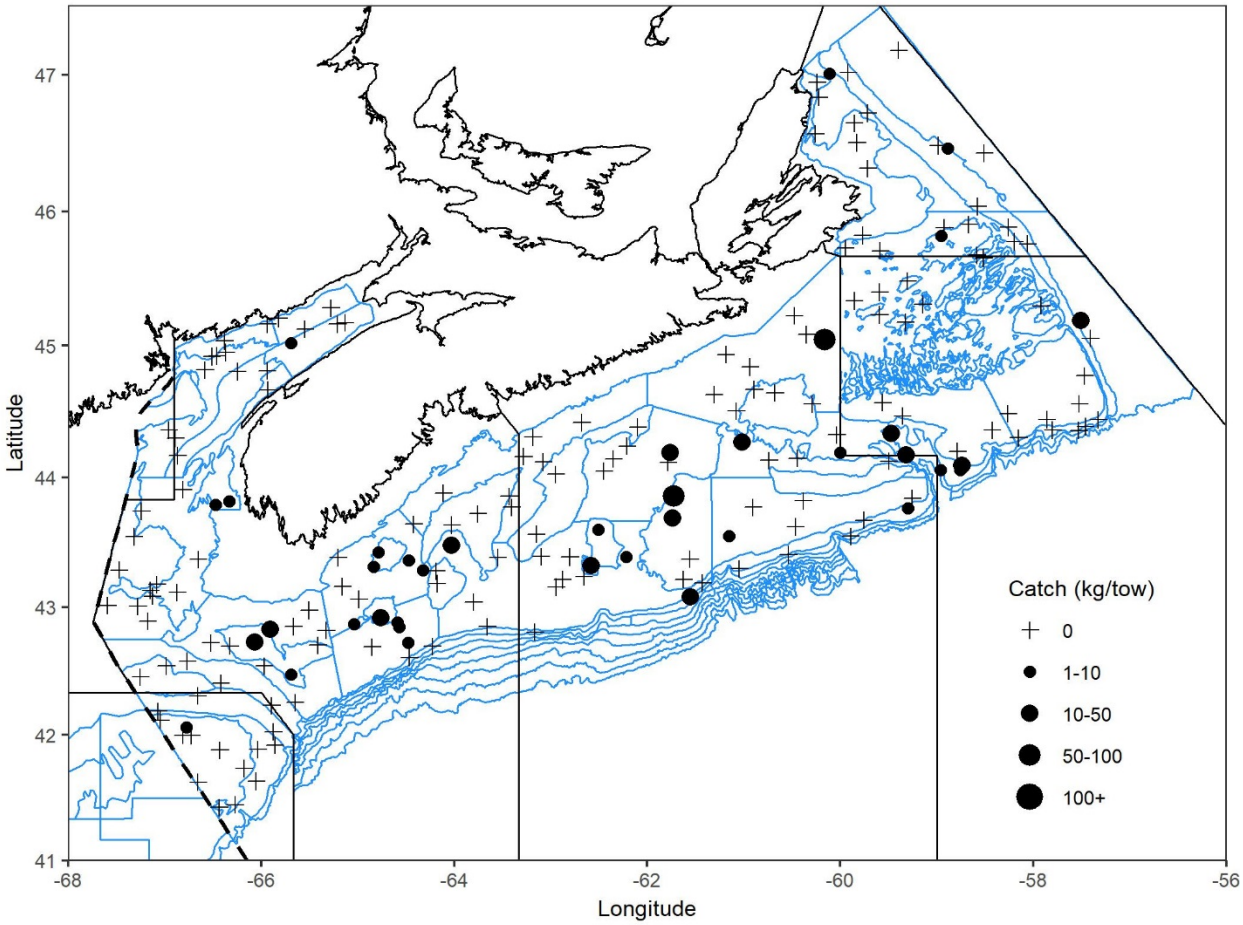


*Figure 10a. Distribution of Atlantic Halibut catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

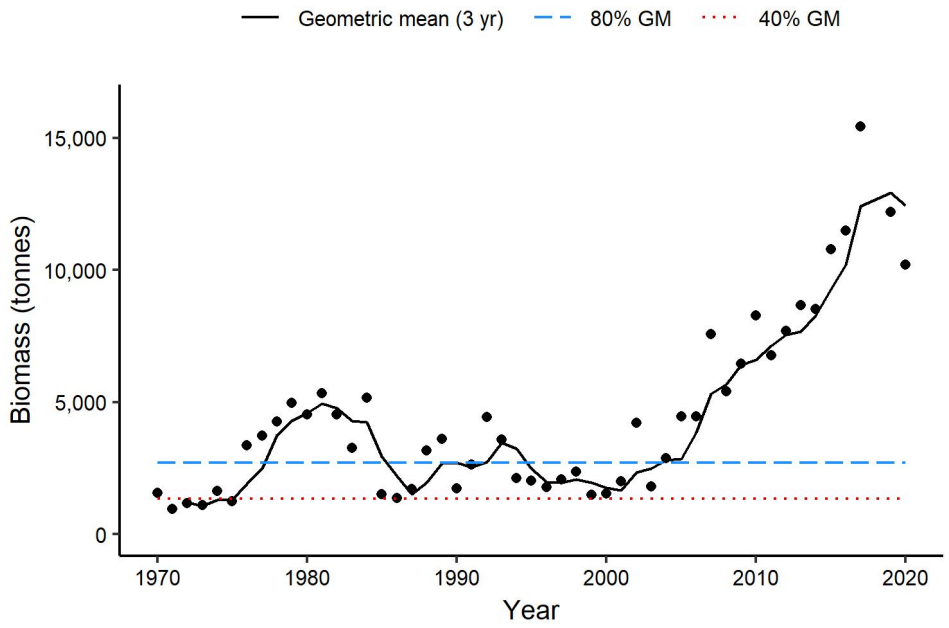


*Figure 10b. Biomass index for 3NOPs4VWX5Zc Atlantic Halibut in 4VWX from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year*

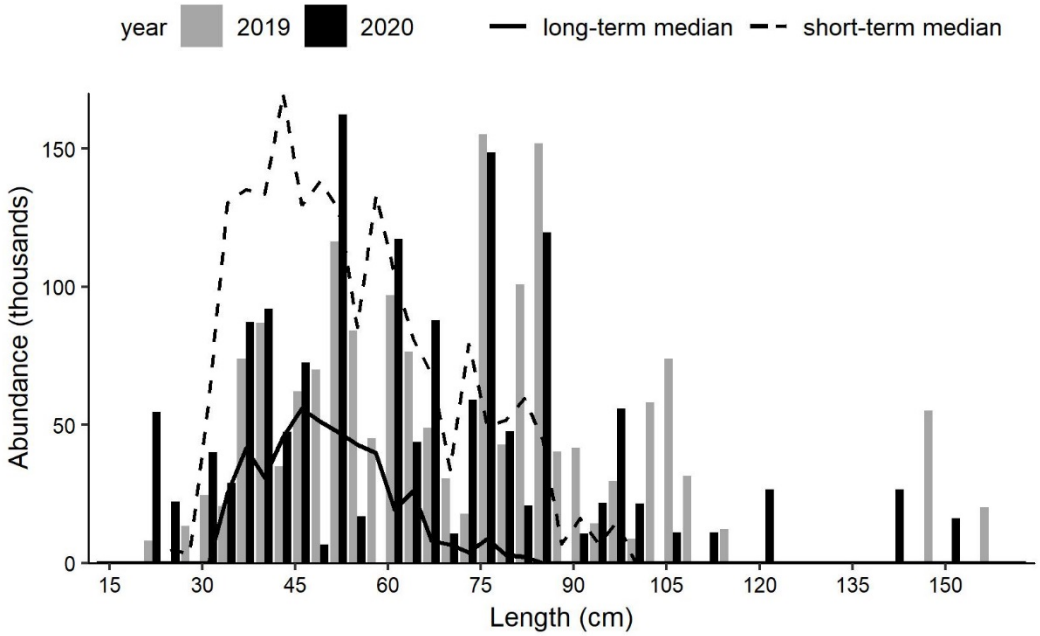


*Figure 10c. Length-frequency indices for 3NOPs4VWX5Zc Atlantic Halibut in 4VWX from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Yellowtail Flounder

Yellowtail Flounder (*Limanda ferruginea*) were caught primarily in 4Vs and south-eastern 4W. Catches in 4X were primarily from Browns Bank (Figure 11a). The 3-yr GM for 4X is under 40% of the long-term GM for the seventh year in a row (Figure 11b). The abundance indices were above both the long- and short-term medians for most lengths < 27 cm, but there was an absence of fish over 36 cm (Figure 11c). In 4VW, the 3-yr GM is the lowest in the time series (Figure 11d). The abundance indices in 4VW are above the long- and short-term median for lengths under 23 cm, but below, or at, for all longer lengths (Figure 11e).

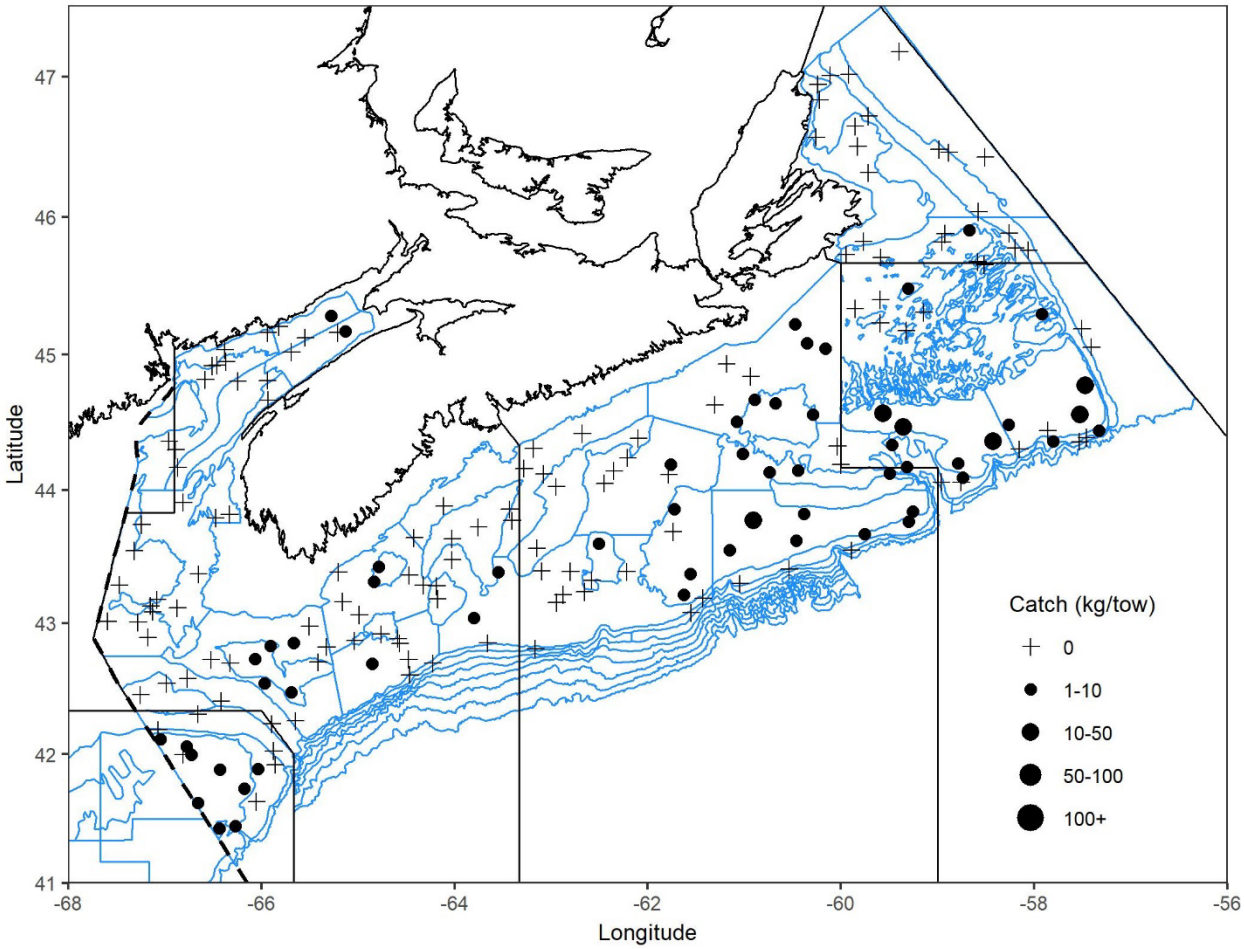


*Figure 11a. Distribution of Yellowtail Flounder catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

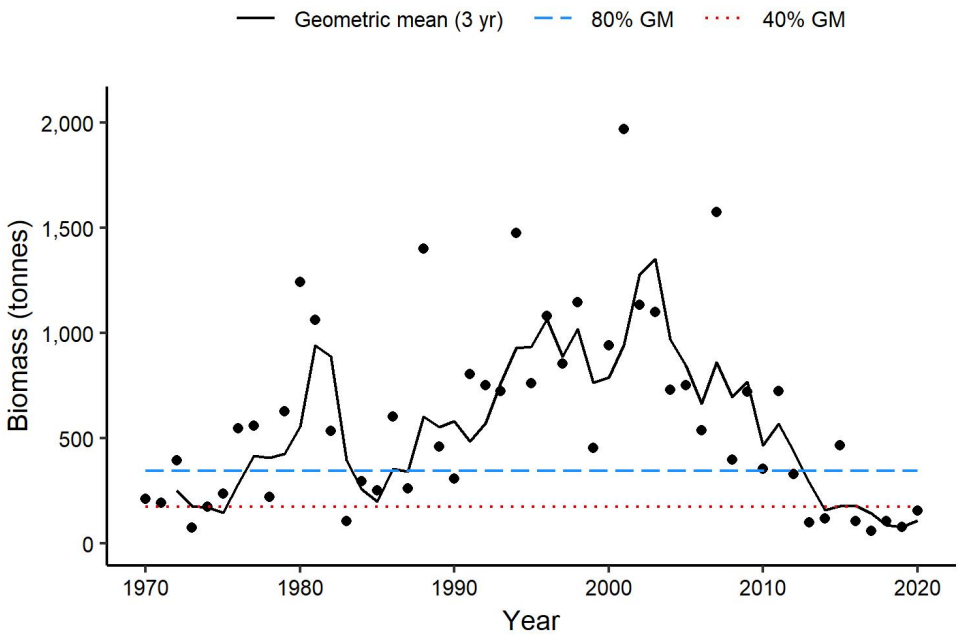


*Figure 11b. Biomass index for Yellowtail Flounder in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

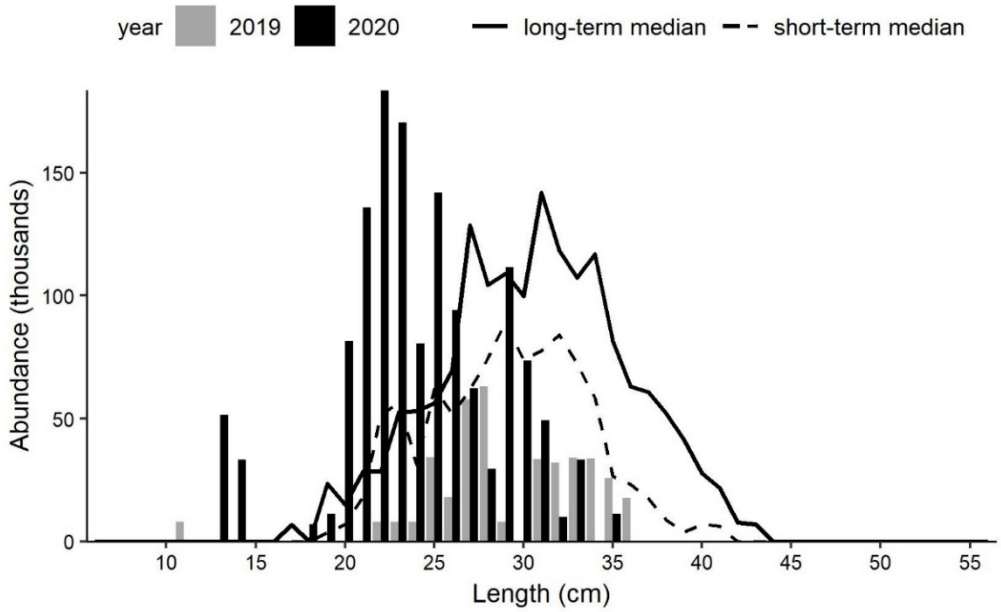


*Figure 11c. Length-frequency indices for Yellowtail Flounder in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

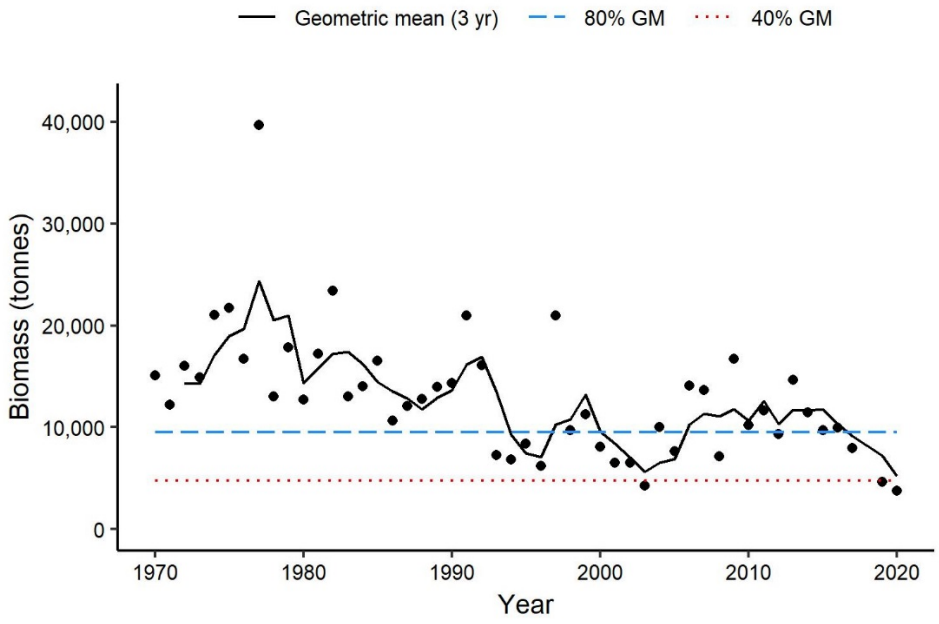


*Figure 11d. Biomass index for Yellowtail Flounder in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

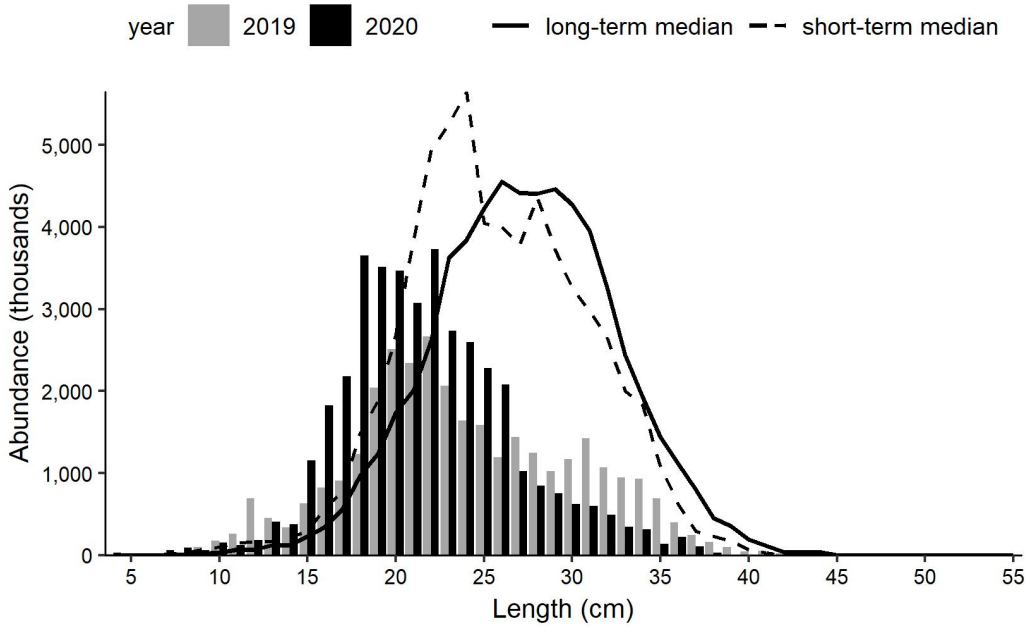


*Figure 11e. Length-frequency indices for Yellowtail Flounder in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## American Plaice

American Plaice (*Hippoglossoides platessoides*) catches were generally small in the 2020 Summer RV Survey (Figure 12a). In 4X, the 3-yr GM remains below 40% of the long-term GM for the seventh year in a row (Figure 12b). Abundance indices are above both the long- and short-term medians for lengths below 15 cm, but below for bigger fish (Figure 12c). In 4VW, the 3-yr GM remains under 40% of the long-term GM for the fifth year in a row (Figure 12d). Abundance indices are above the short- and long-term medians for lengths < 20 cm, but well below the long-term median for lengths > 20 cm (Figure 12e).

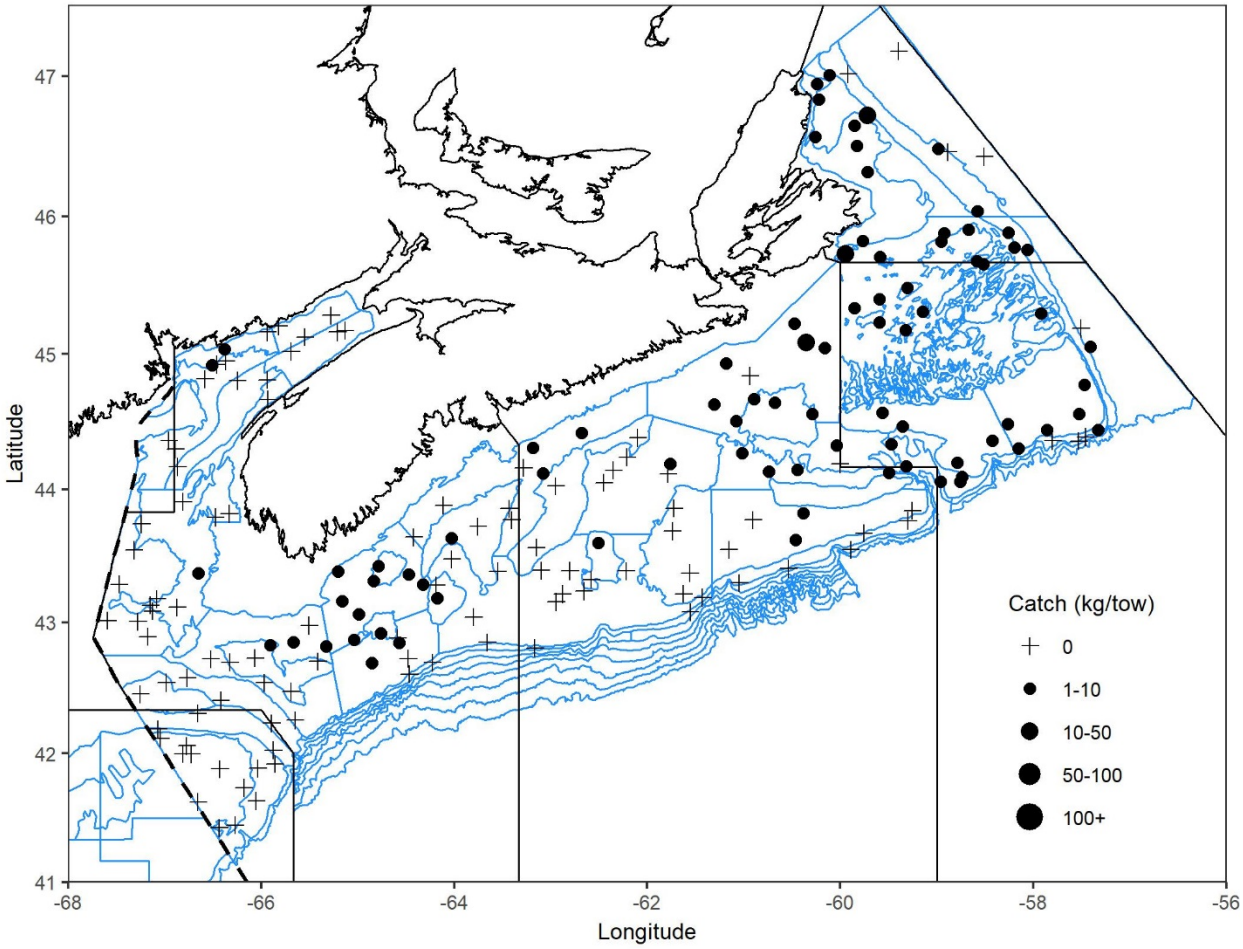


*Figure 12a. Distribution of American Plaice catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

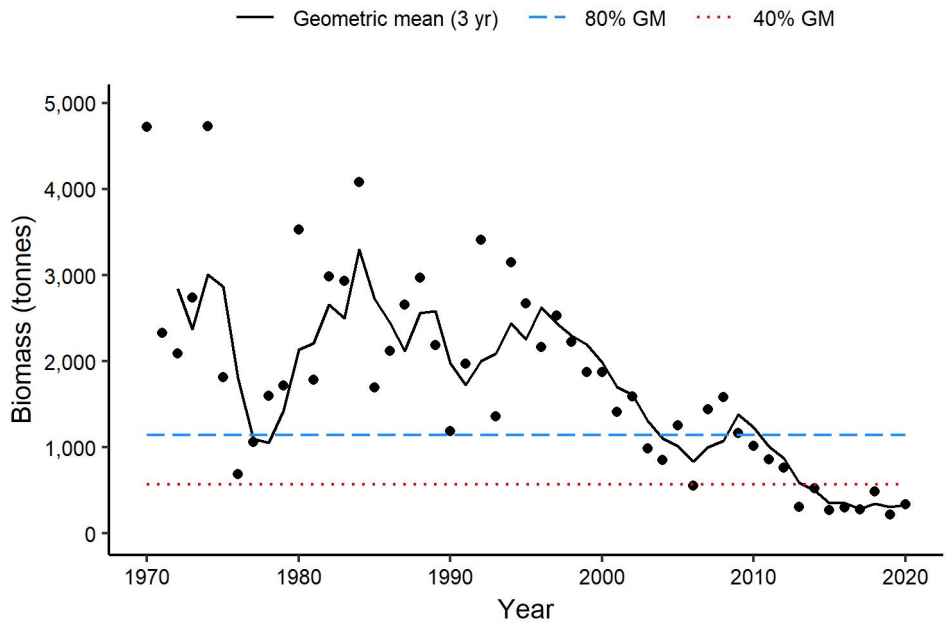


*Figure 12b. Biomass index for American Plaice in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

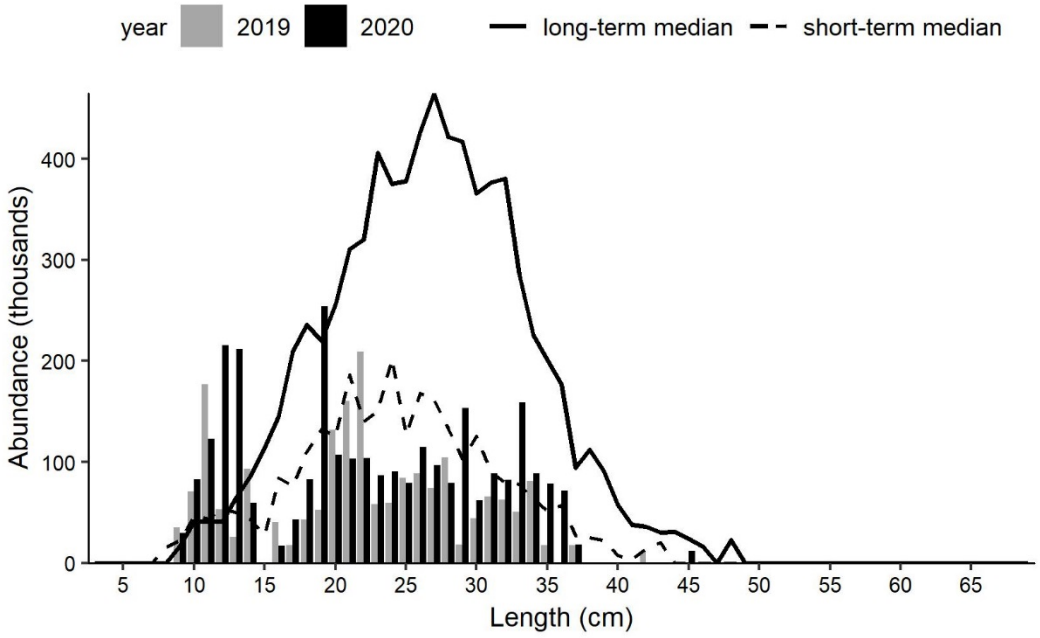


*Figure 12c. Length-frequency indices for American Plaice in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

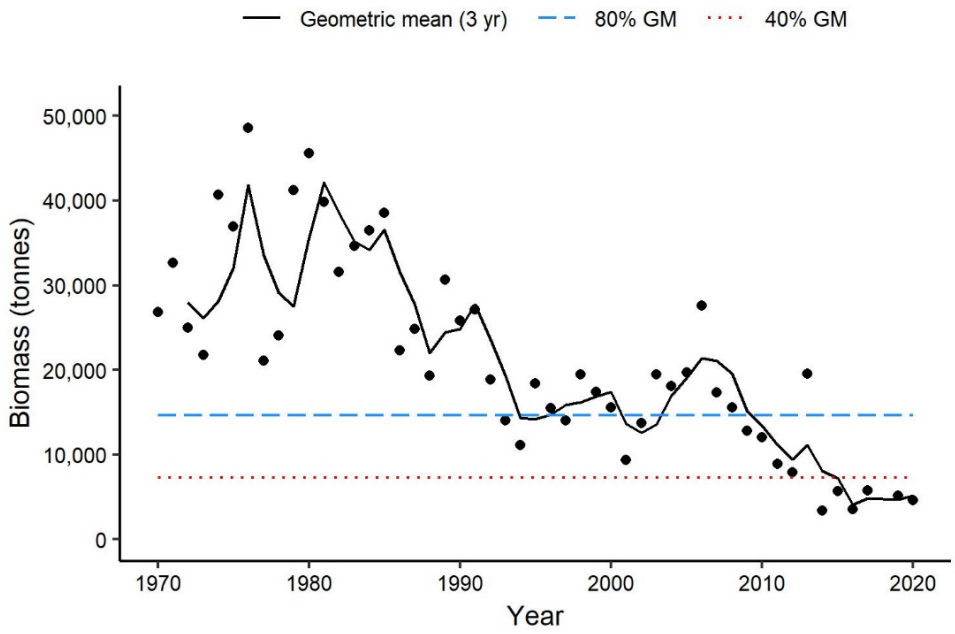


*Figure 12d. Biomass index for American Plaice in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

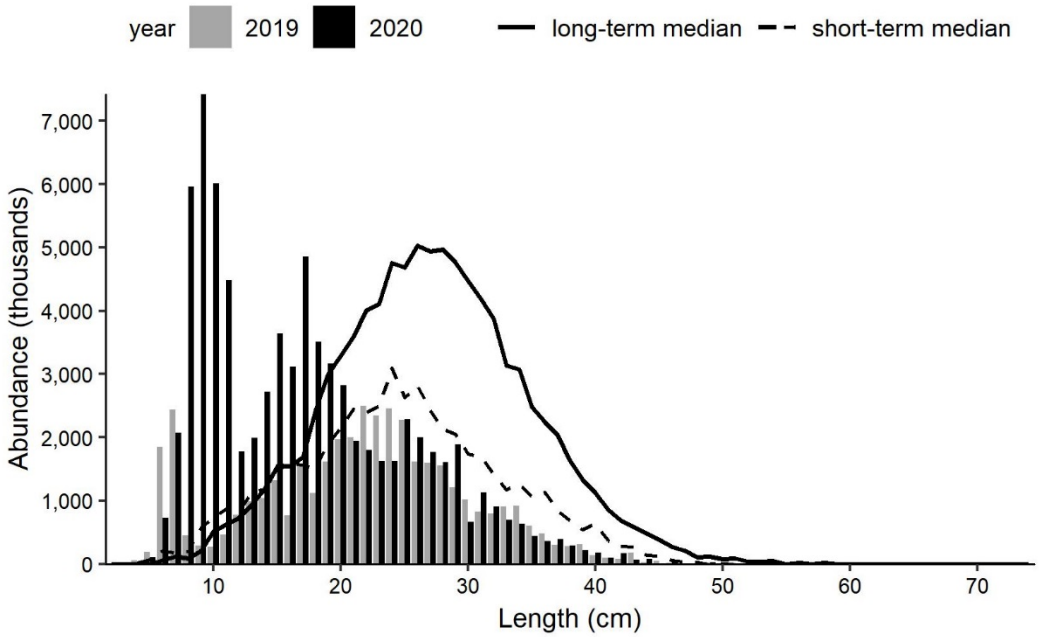


*Figure 12e. Length-frequency indices for American Plaice in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Witch Flounder

Witch Flounder (*Glyptocephalus cynoglossus*) were widespread across the survey area in 2020 (Figure 13a). The 3-yr GM has been above 80% of the long-term GM in 4X for the last 6 years (Figure 13b). The abundance indices in both 2019 and 2020 were above the short-term median for most lengths between 30 and 40 cm, but there were very few fish < 22 cm in 2020 (Figure 13c). Witch Flounder above 45 cm have been largely absent from catches in the last 20 years.

In 4VW, the 3-yr GM in 2020 is well above 80% of the long-term mean (Figure 13d). The abundance indices are high for lengths under 41 cm relative to both the long-term and short-term averages, but larger fish appear to be mostly absent (Figure 13e).

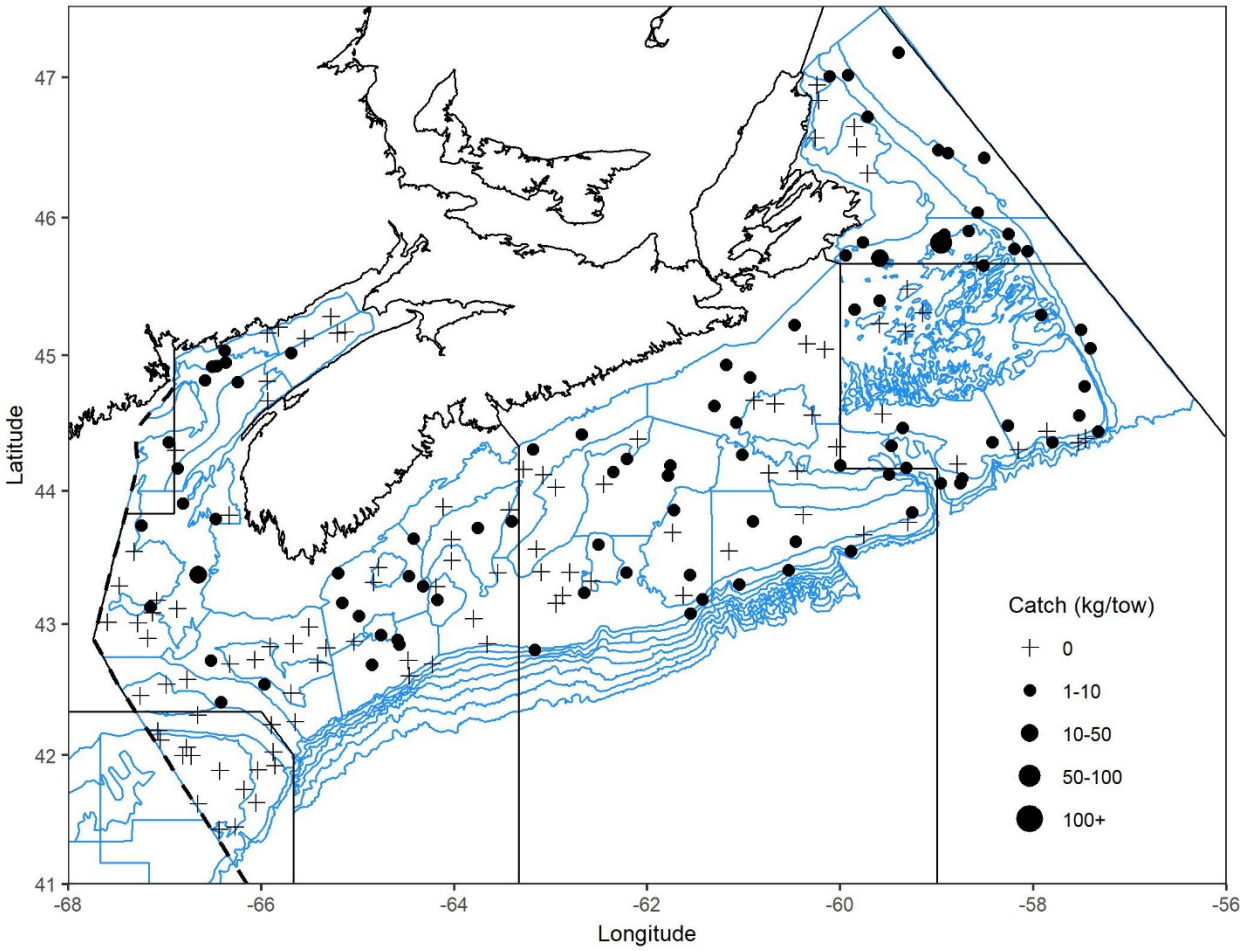


*Figure 13a. Distribution of Witch Flounder catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

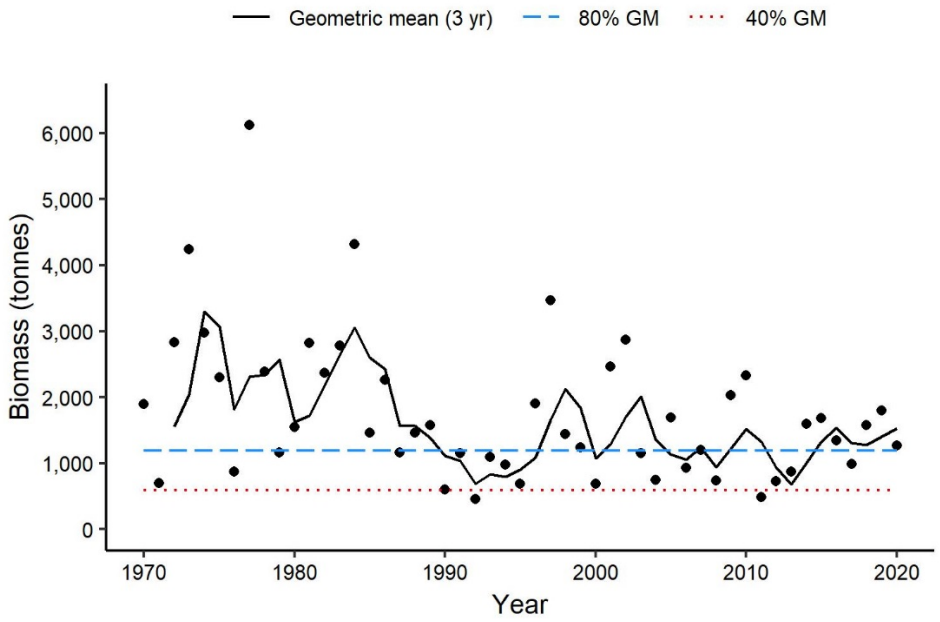


*Figure 13b. Biomass index for Witch Flounder in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

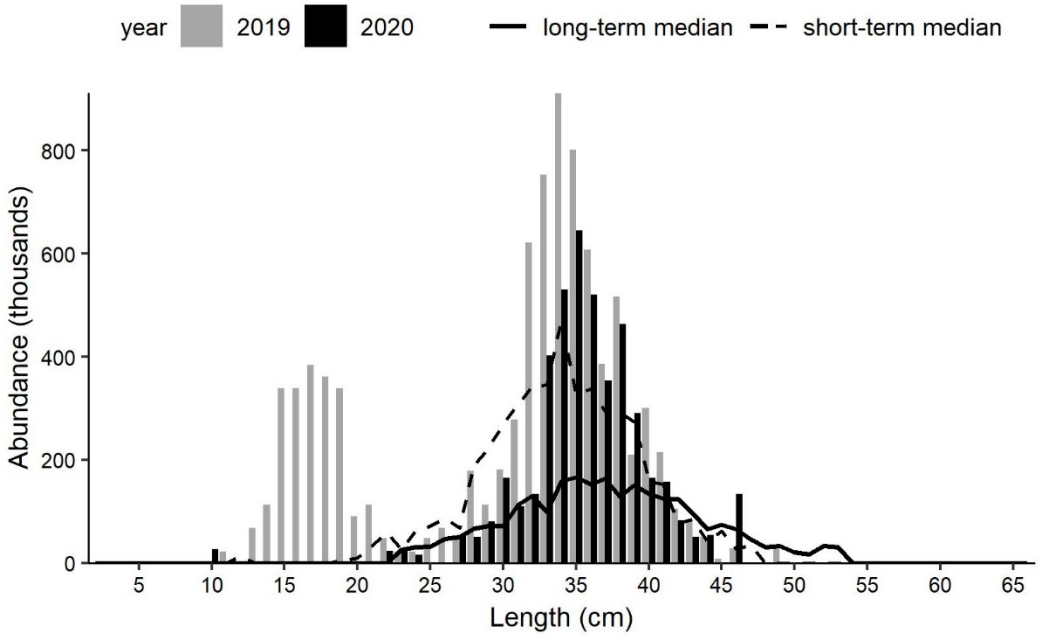


*Figure 13c. Length-frequency indices for Witch Flounder in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

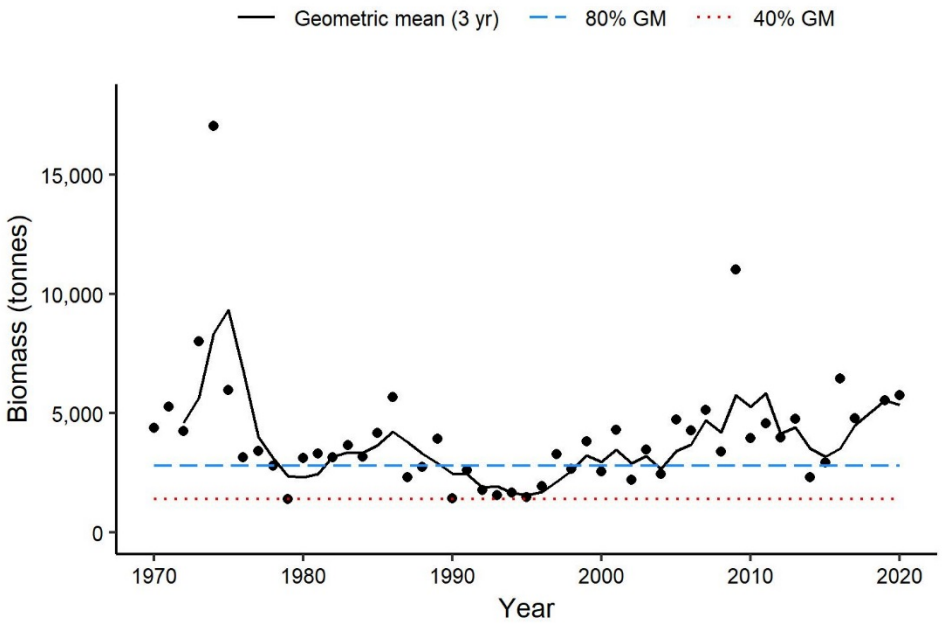


*Figure 13d. Biomass index for Witch Flounder in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

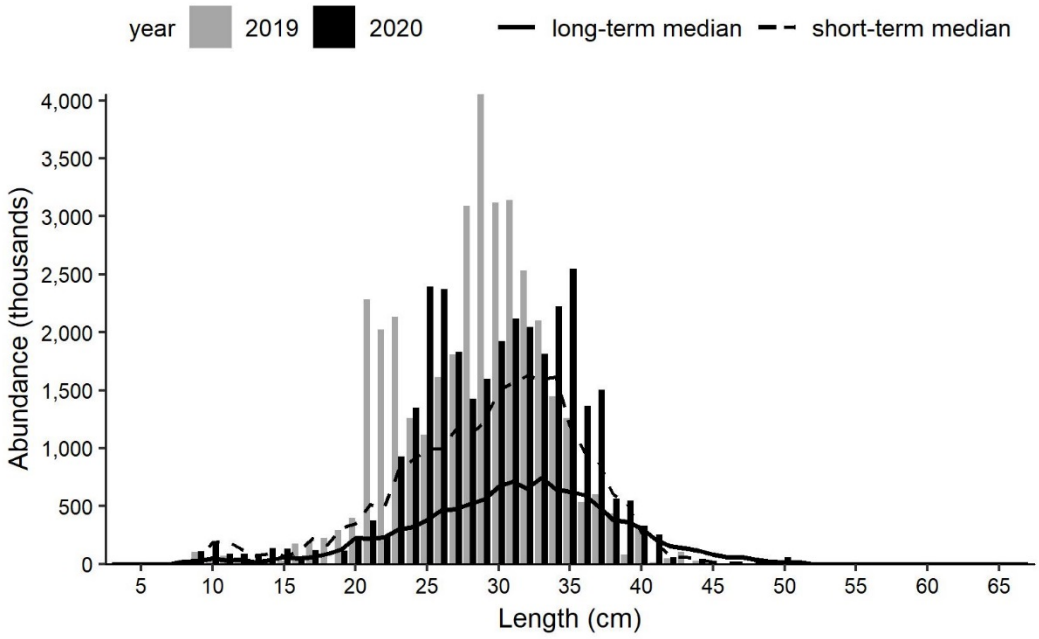


*Figure 13e. Length-frequency indices for Witch Flounder in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Winter Flounder

Winter Flounder (*Pseudopleuronectes americanus*) were caught primarily on shallow banks and in the Bay of Fundy (Figure 14a). In 4X, the 3-yr GM has remained above 80% of the long-term GM since 1988 (Figure 14b). The short-term median abundance indices-at-length are higher than the long-term medians at length under 36 cm (Figure 14c). In 2020, the indices-at-length are below short-term medians under 26 cm. In 4VW, the 3-yr GM is almost identical to 2019, just above 40% of the long-term GM (Figure 14d). Abundance indices are below the short-term GM for most lengths above 17 cm (Figure 14e).

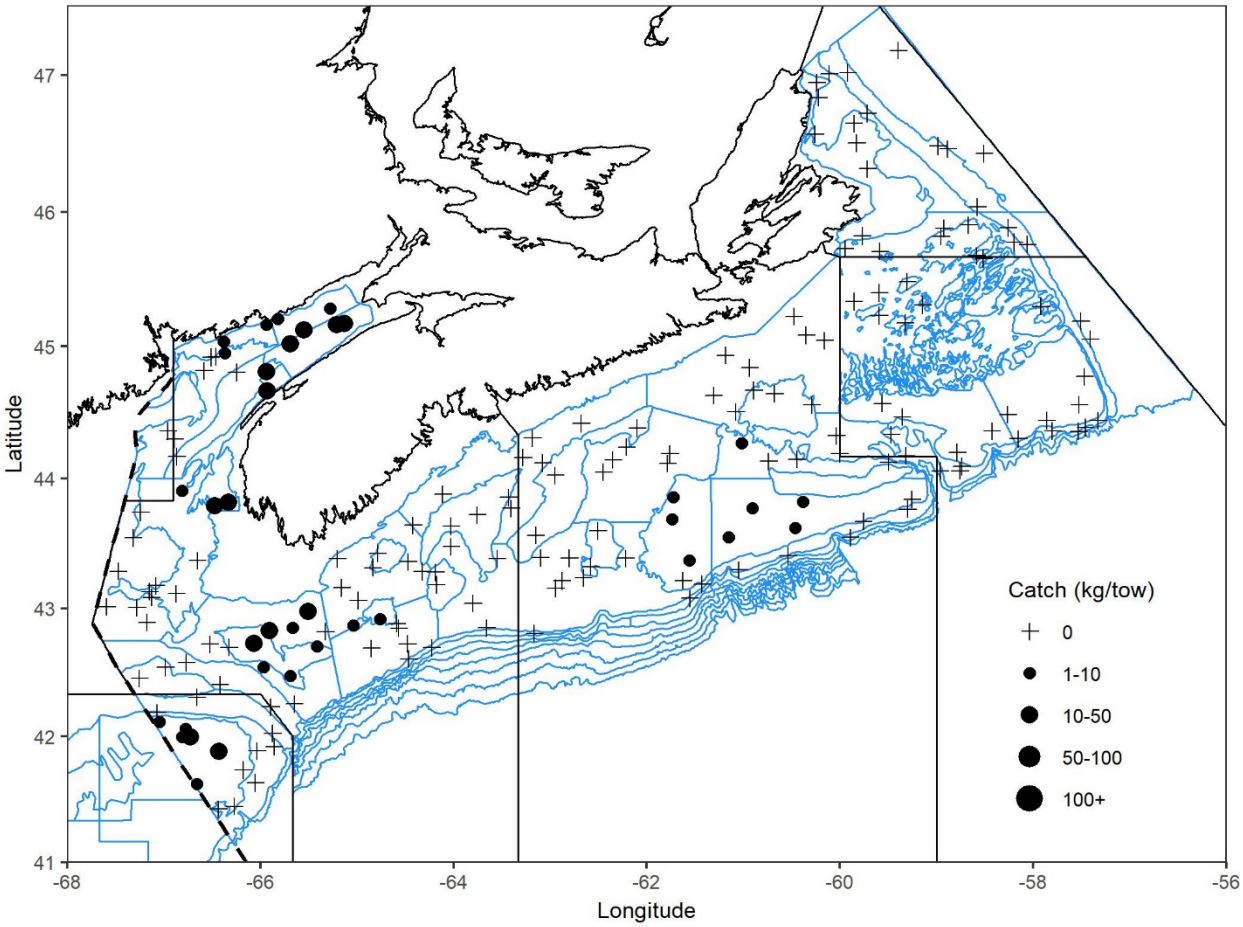


*Figure 14a. Distribution of Winter Flounder catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

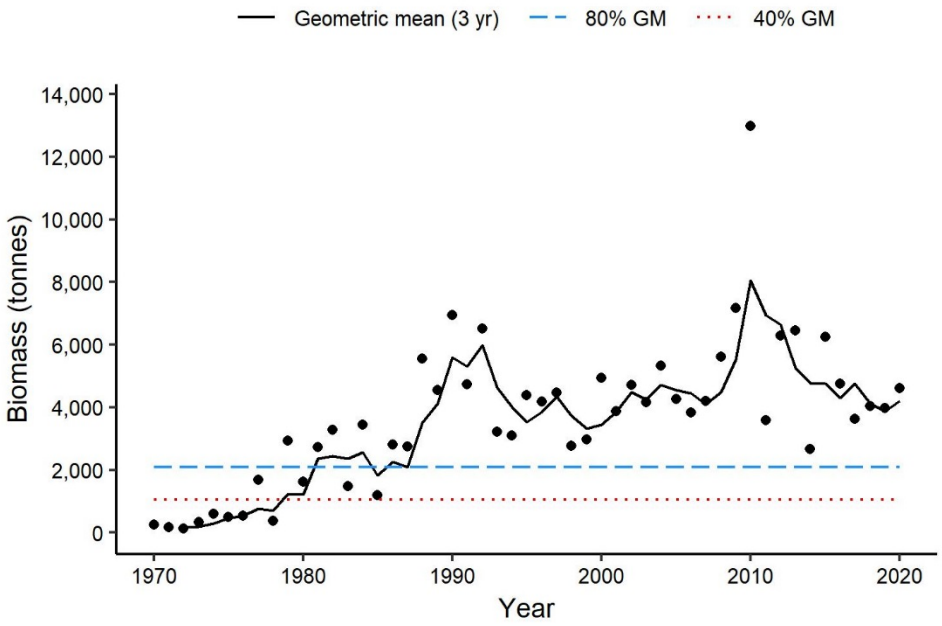


*Figure 14b. Biomass index for Winter Flounder in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

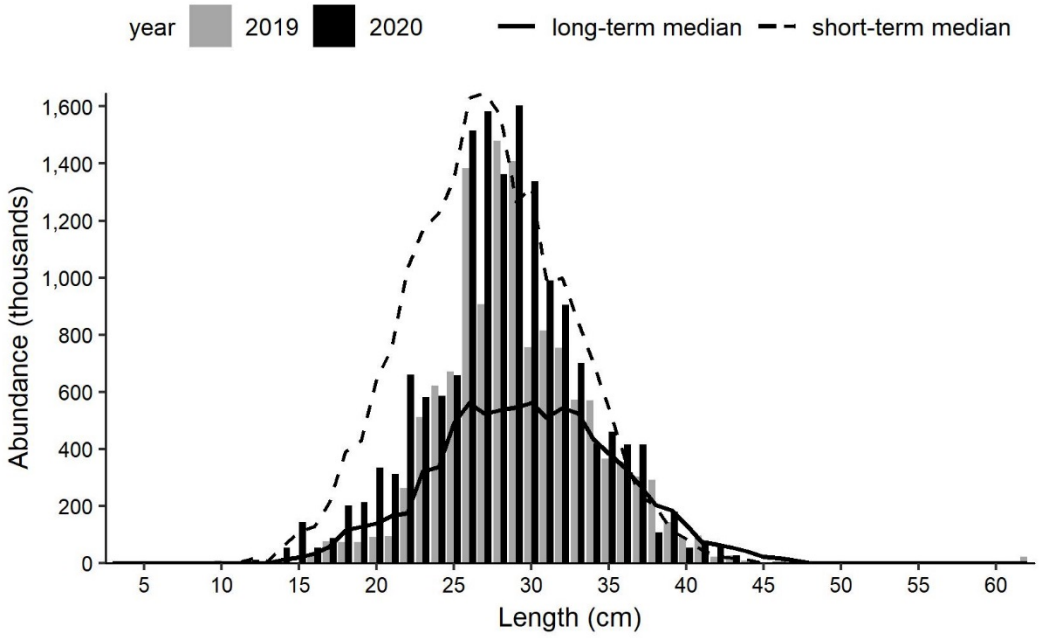


*Figure 14c. Length-frequency indices for Winter Flounder in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

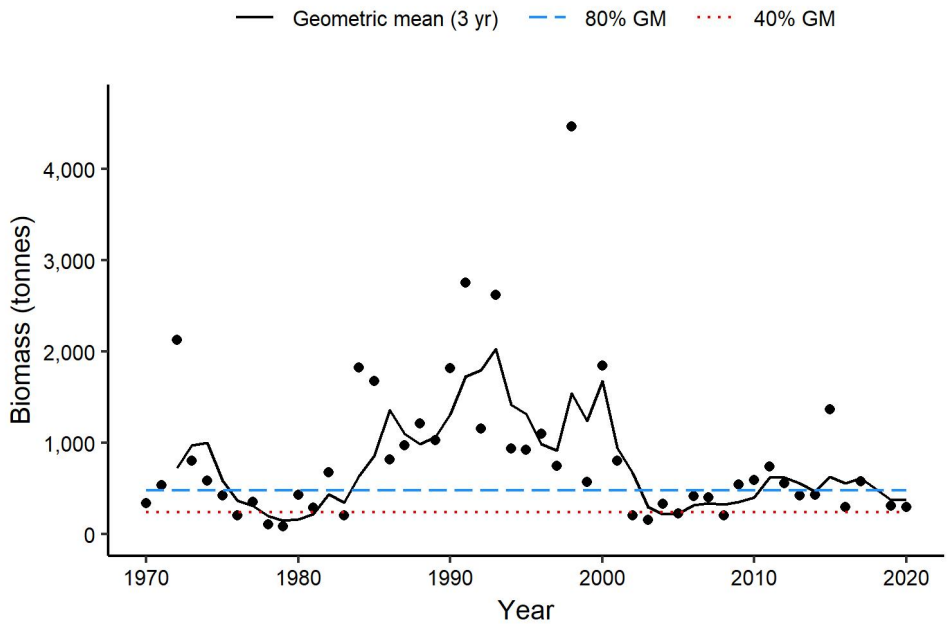


*Figure 14d. Biomass index for Winter Flounder in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

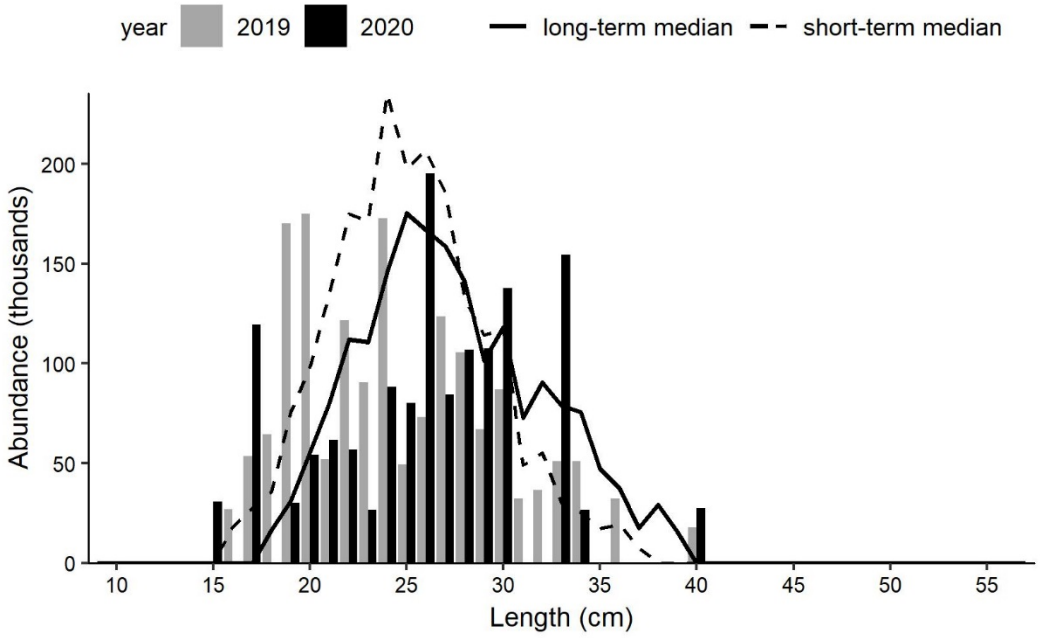


*Figure 14e. Length-frequency indices for Winter Flounder in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Atlantic Wolffish

Atlantic Wolffish (*Anarhichas lupus*) catches in 2020 came primarily from 4V and the western Scotian Shelf in 4X (Figure 15a). In 4X, the 3-yr GM biomass index for 2020 remains below 40% of the long-term GM for the ninth year in a row (Figure 15b). Only 9 individuals were caught (Figure 15c). The 3-yr GM in 4VW remains below 40% of the long-term GM for the ninth year in a row (Figure 15d). Abundance indices-at-length were much lower in 2020 than in 2019 for lengths < 40 cm (Figure 15e). Only 8 individuals were caught.

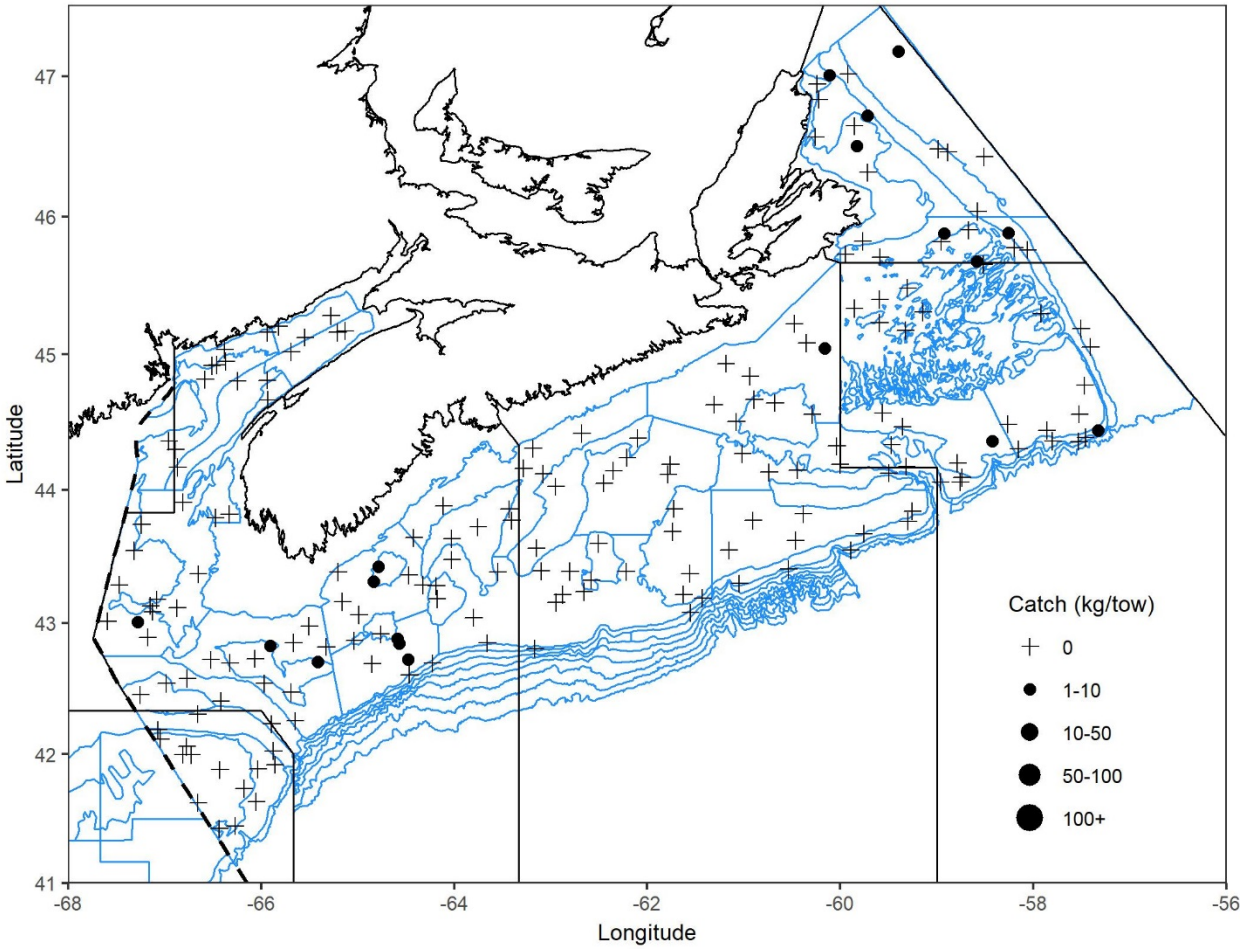


*Figure 15a. Distribution of Atlantic Wolffish catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

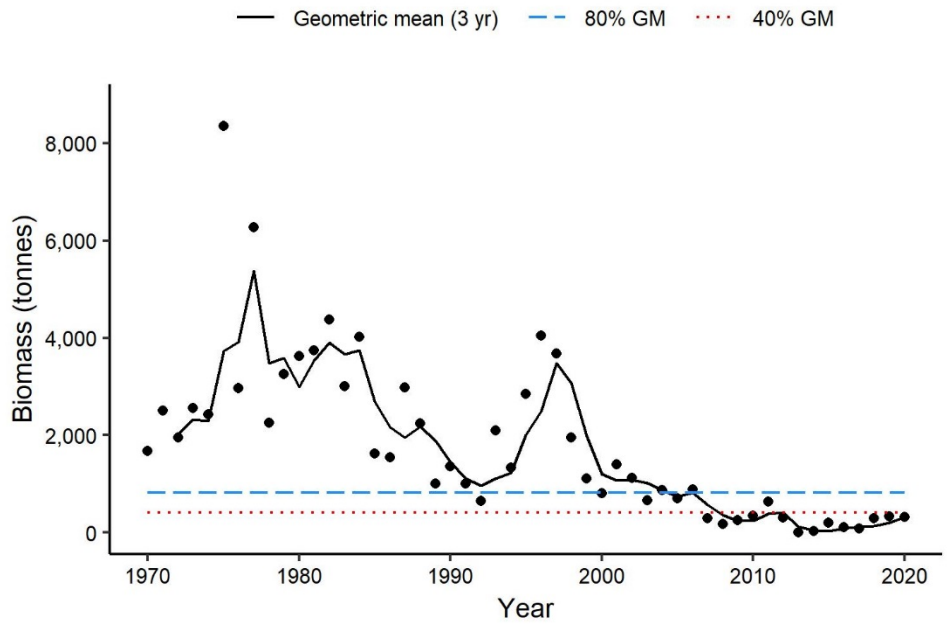


*Figure 15b. Biomass index for Atlantic Wolffish in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

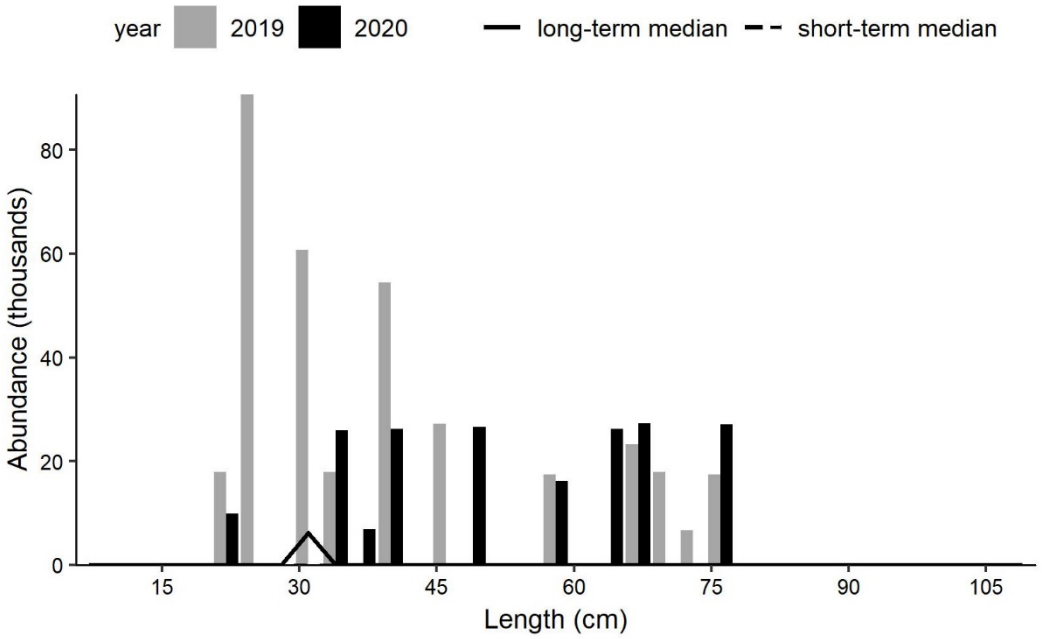


*Figure 15c. Length-frequency indices for Atlantic Wolffish in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

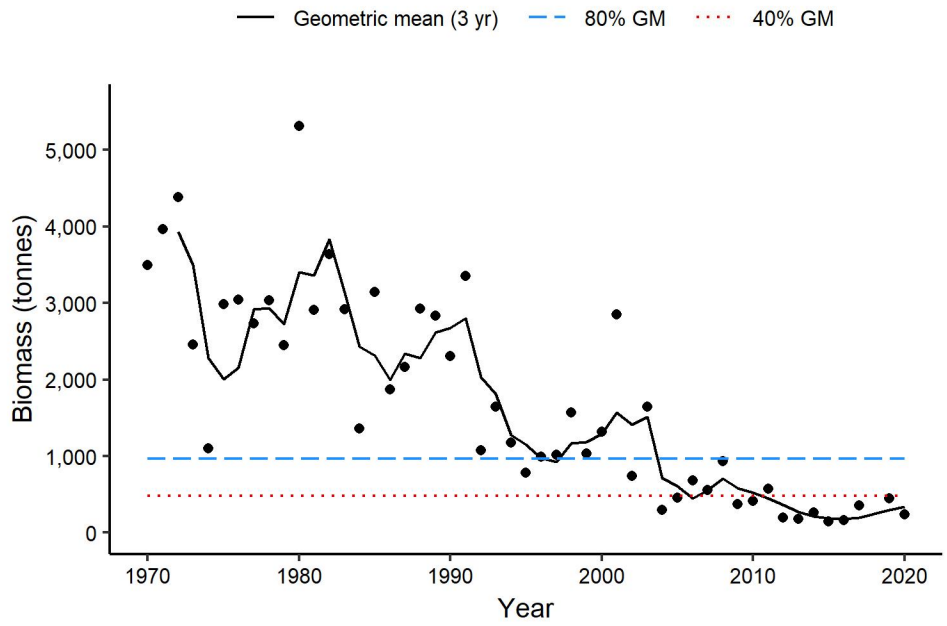


*Figure 15d. Biomass index for Atlantic Wolffish in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

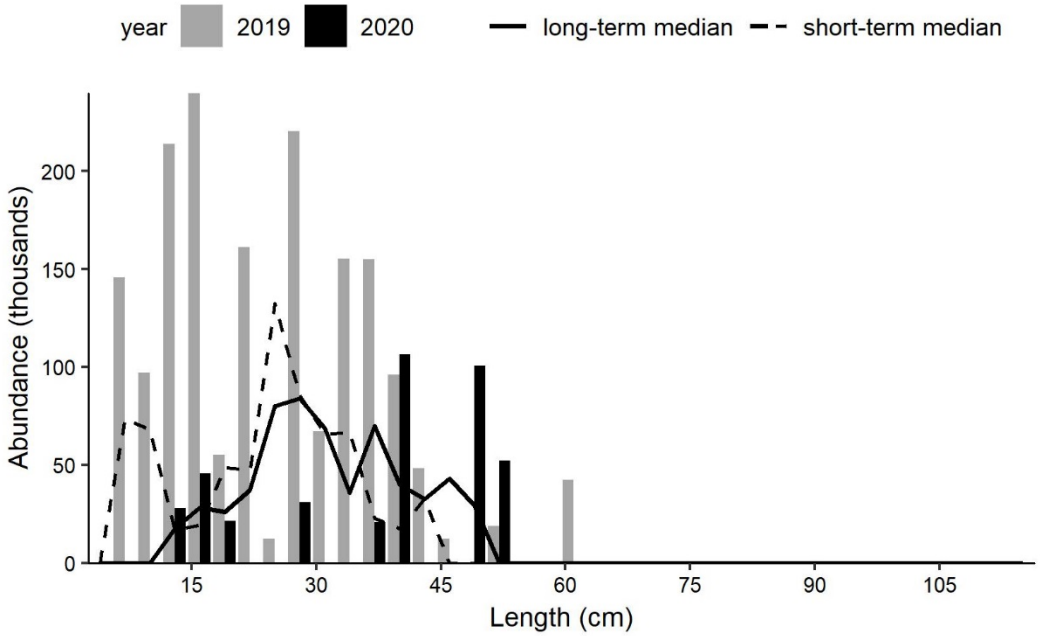


*Figure 15e. Length-frequency indices for Atlantic Wolffish in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Monkfish

Monkfish (*Lophius americanus*) catches were scattered through much of the survey area (Figure 16a). In 4X, the 3-yr GM remains above 80% of the long-term GM for the third year in a row (Figure 16b). The abundance indices are above both the long- and short-term medians at all lengths (Figure 16c). The 3-yr GM in 4VW is up slightly from 2019 and remains between 40% and 80% of the long-term GM (Figure 16d). Abundance indices are above both the short- and long-term medians at all lengths (Figure 16e).

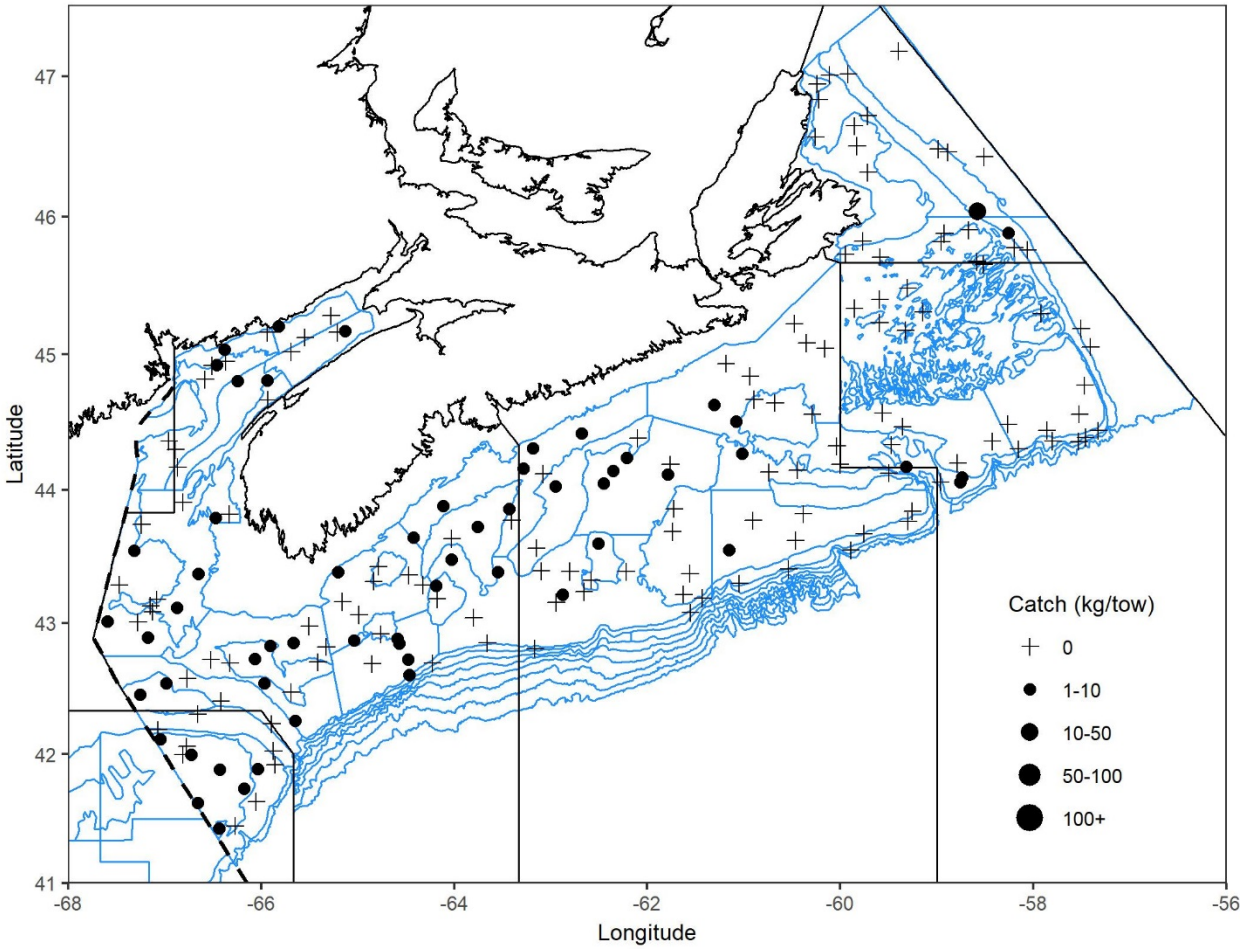


*Figure 16a. Distribution of Monkfish catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

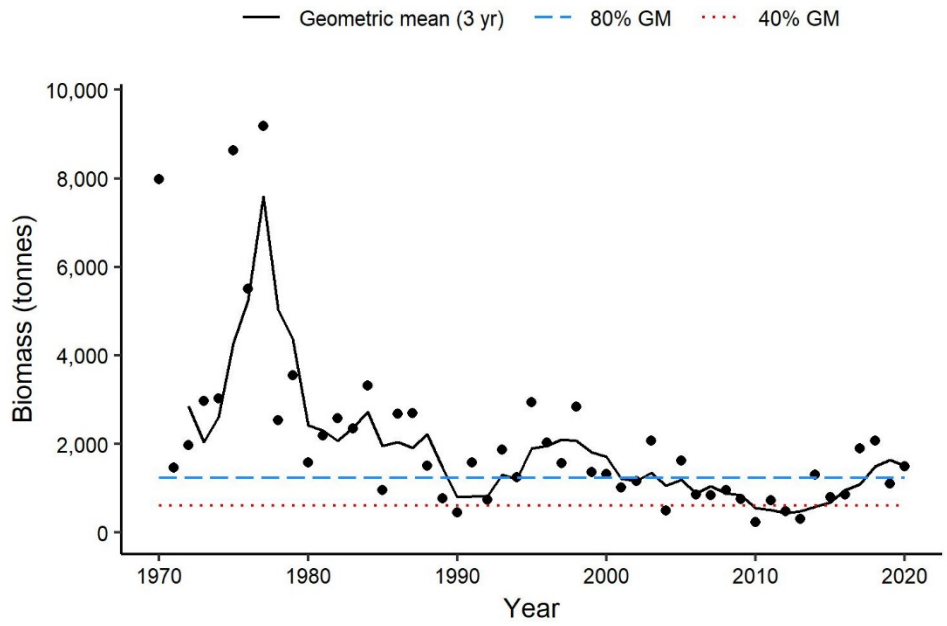


*Figure 16b. Biomass index for Monkfish in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

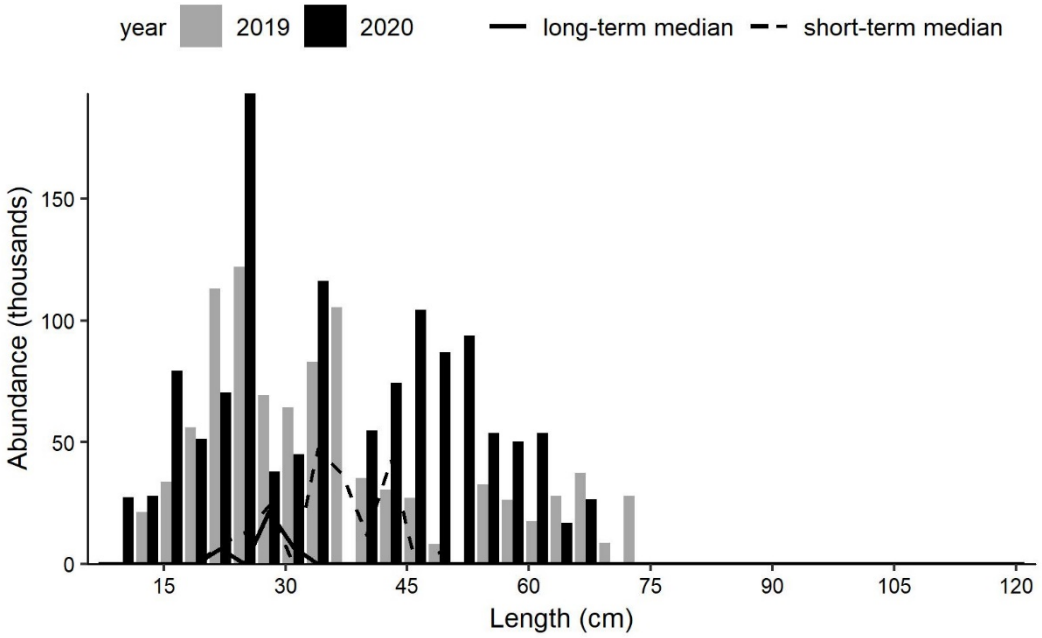


*Figure 16c. Length-frequency indices for Monkfish in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

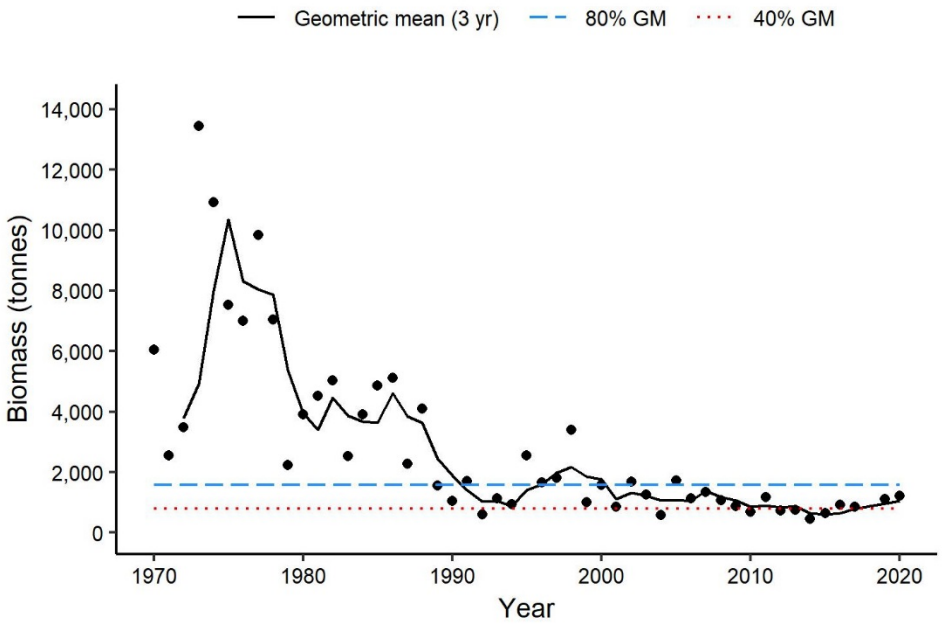


*Figure 16d. Biomass index for Monkfish in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

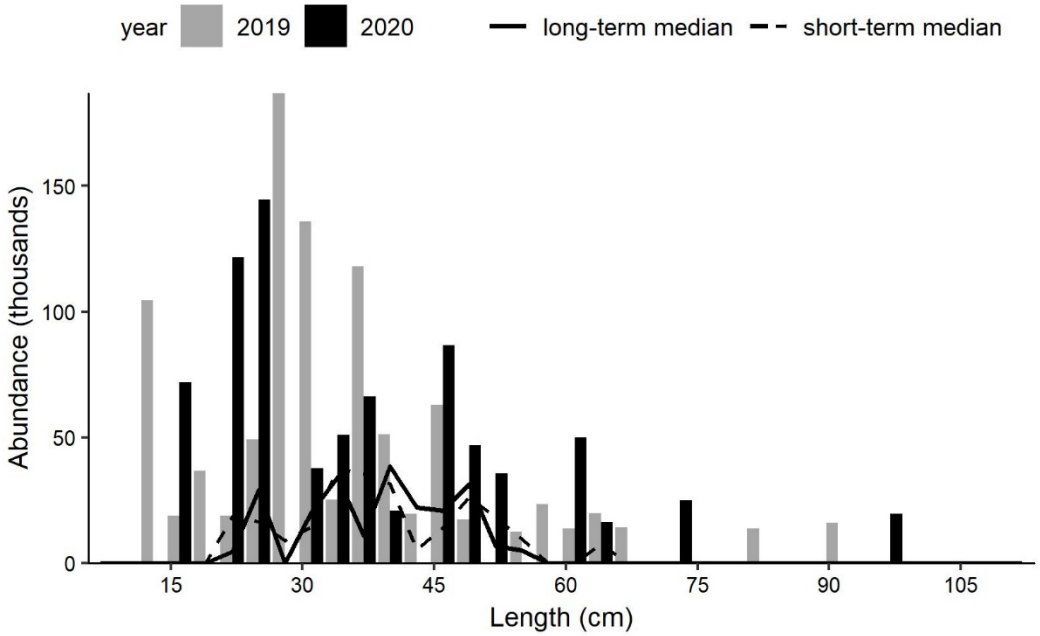


*Figure 16e. Length-frequency indices for Monkfish in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Longhorn Sculpin

Longhorn Sculpin (*Myoxocephalus octodecemspinosus*) are caught primarily on banks throughout the Scotian Shelf and in the Bay of Fundy (Figure 17a). In 4X, the 3-yr GM is almost identical to 2019, at almost exactly 80% of the long-term GM (Figure 17b). Abundance indices-at-length are above the short-term median at length < 12 cm, but below for lengths > 25 cm (Figure 17c). In 4VW, the 3-yr GM remains between 40–80% of the long term GM (Figure 17d). Abundance indices are below the median between 22 and 31 cm, the range in which the length frequency generally peaks, but at or above the long-term median for most other lengths (Figure 17e).

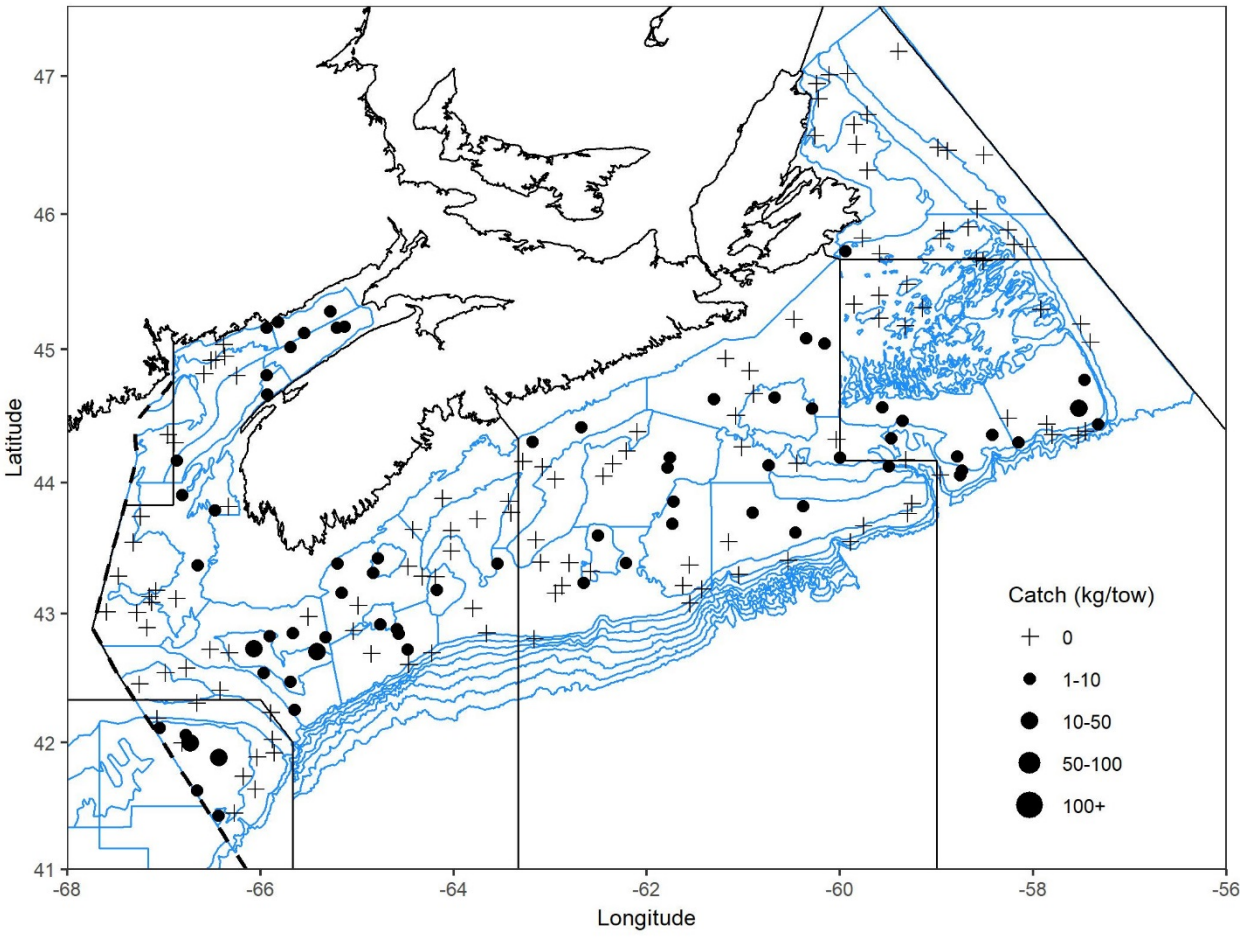


*Figure 17a. Distribution of Longhorn Sculpin catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

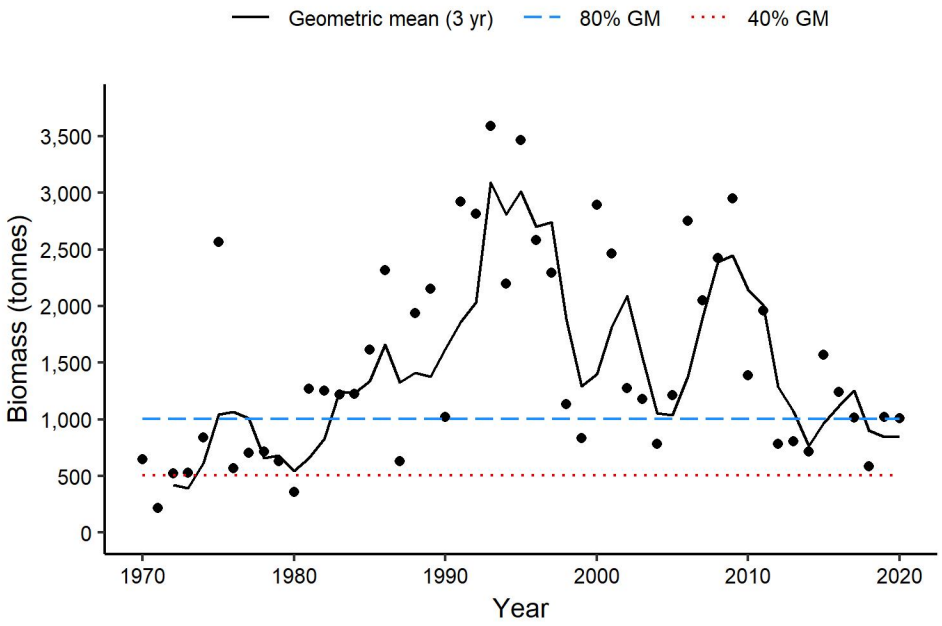


*Figure 17b. Biomass index for Longhorn Sculpin in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year*

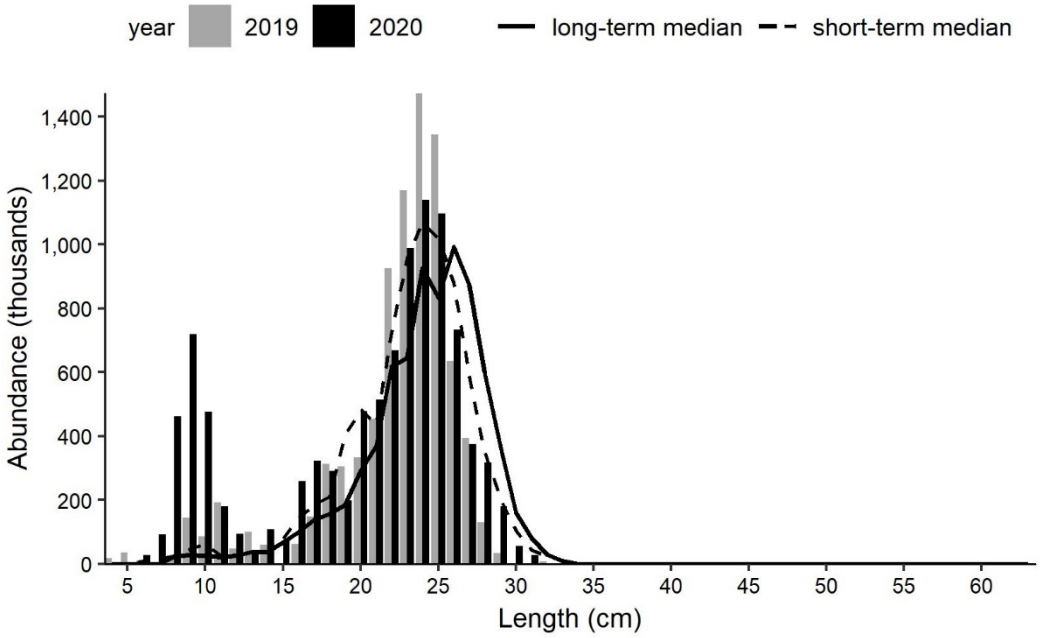


*Figure 17c. Length-frequency indices for Longhorn Sculpin in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

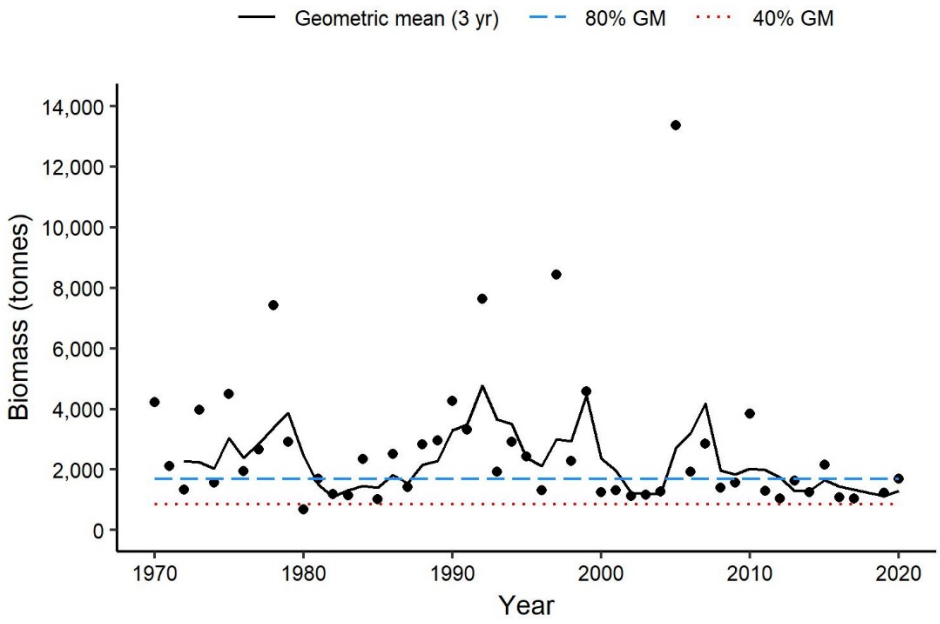


*Figure 17d. Biomass index for Longhorn Sculpin in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

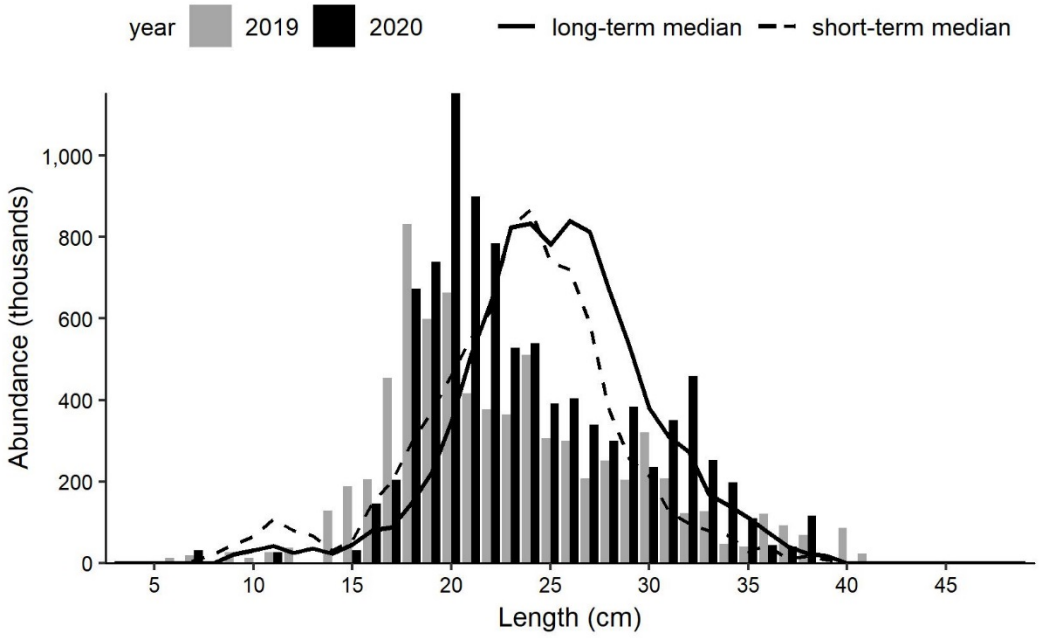


*Figure 17e. Length-frequency indices for Longhorn Sculpin in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Barndoor Skate

Barndoor Skate (*Dipturus laevis*) were caught primarily on Georges Bank and in 4X (Figure 18a). Due to the catch of Barndoor Skate being zero in many years, a 3-yr median is used instead of a 3-yr GM. The 3-yr median remains among the highest in the series both in 4X and in 4VW in 2020. Prior to 1998, catches were close to zero for all sizes of Barndoor Skates, so the median indices are zero for all lengths. In 2020, Barndoor Skates were caught at lengths ranging from 39 to 133 cm in 4VWX.

Barndoor Skate are a large wide-ranging fish that prefer the warmer waters in the Maritimes Region. When reviewed by the Committee on the Status of Endangered Wildlife in Canada, the Designatable Unit (DU) included 4VWX5Zc; all of the area covered by the survey in 2020. On Georges Bank (5Zc), the biomass index in 2020 was 1,353 t, roughly equivalent to the index for 4VWX. The lengths caught were also very similar to the survey catch in 4VWX. In the winter, few Barnoor Skate are caught on top of Georges Bank (5Z1+2), as they move off the bank into deeper waters of the Fundian Channel and Gulf of Maine. In 2019, there were no Barndoor Skate caught in 4VW. Given their seasonal movements and preference for warmer water, it may be more informative to look at biomass trends for Barndoor Skates for the survey area as a whole rather than separately for NAFO Unit Areas.

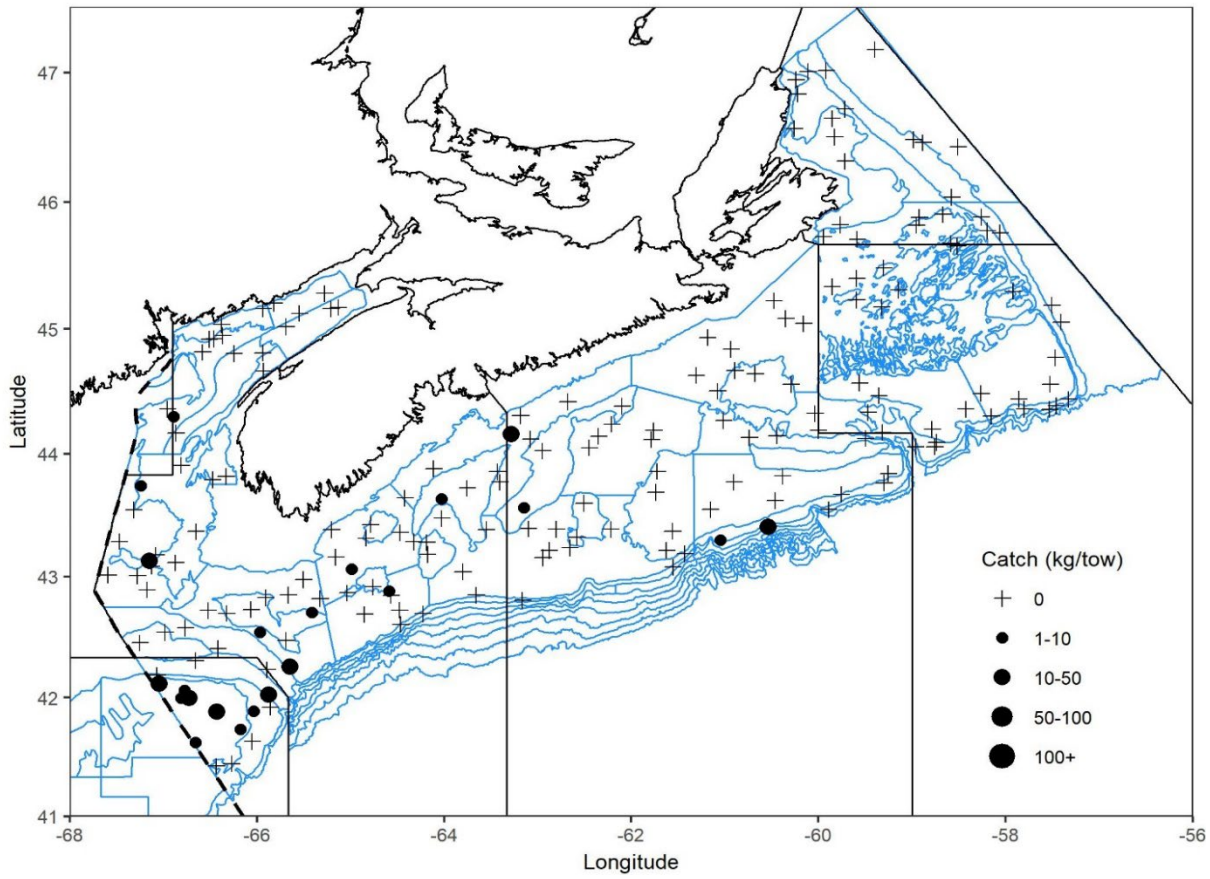


*Figure 18a. Distribution of Barndoor Skate catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

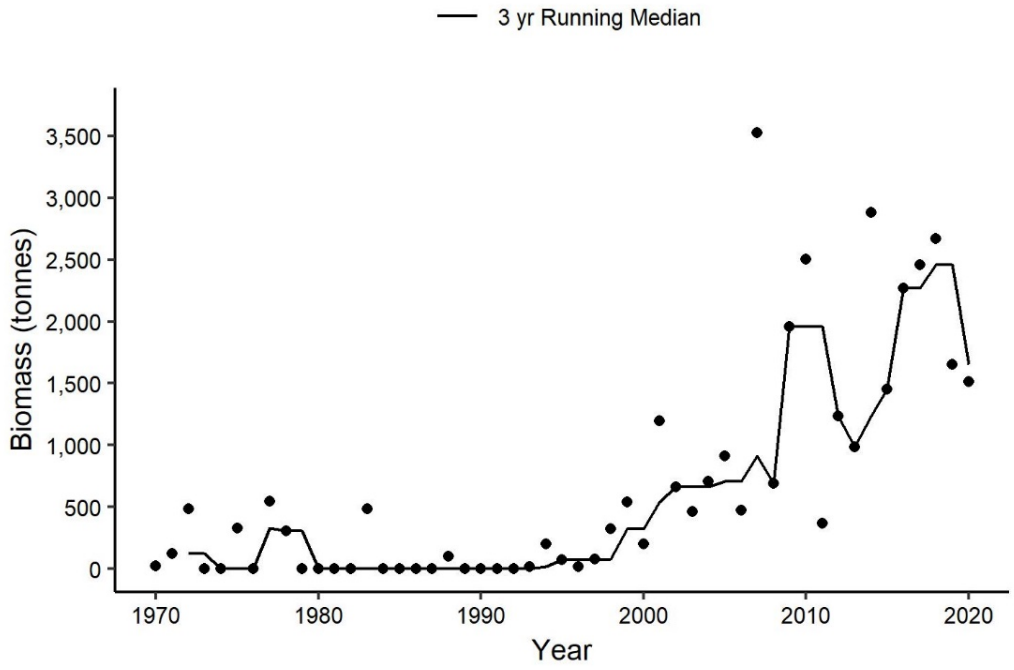


*Figure 18b. Biomass index for Barndoor Skate in 4X from the DFO Summer RV Survey. The three-year running median biomass index is represented by the solid black line. The black dots represent the biomass index for that year.*

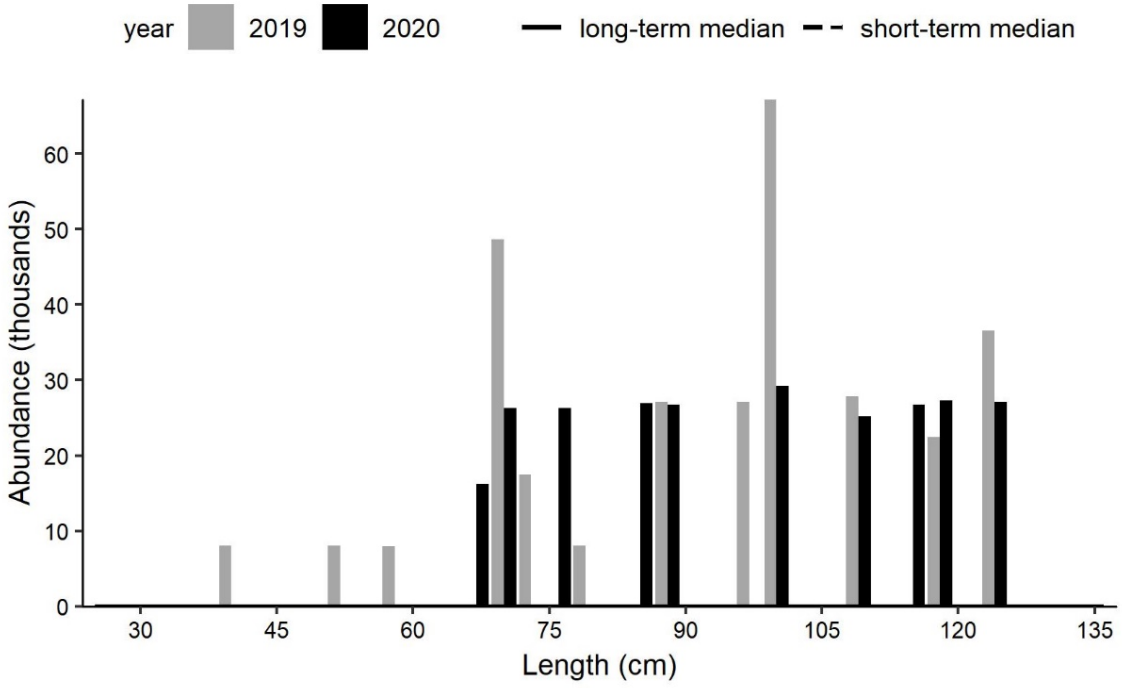


*Figure 18c. Length-frequency indices for Barndoor Skate in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey.*

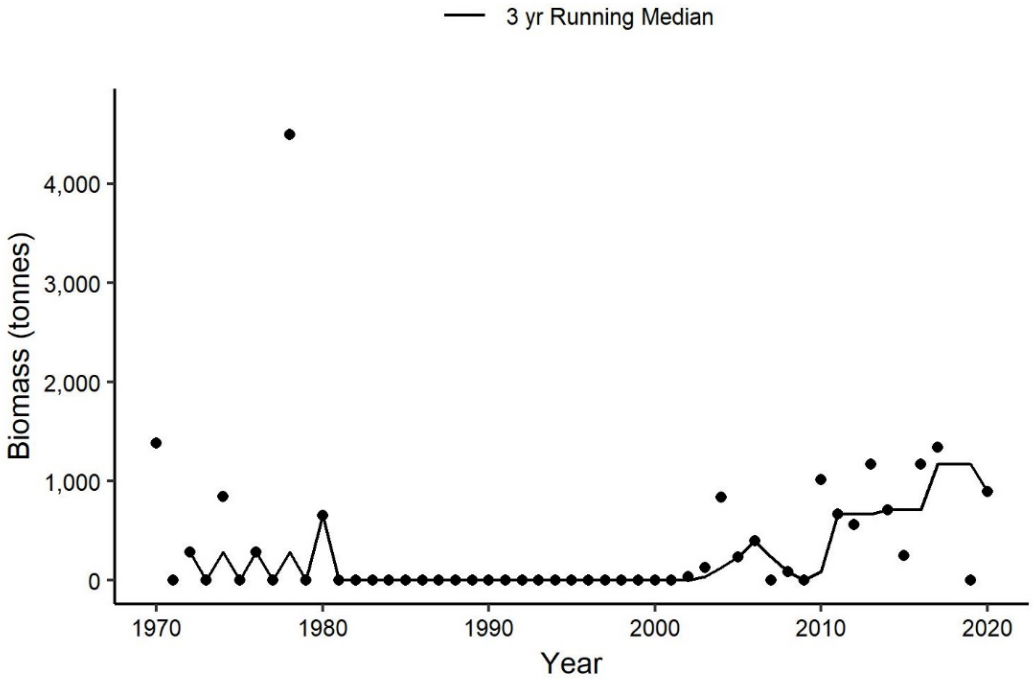


*Figure 18d. Biomass index for Barndoor Skate in 4VW from the DFO Summer RV Survey. The three-year running median biomass index is represented by the solid black line. The black dots represent the biomass index for that year.*

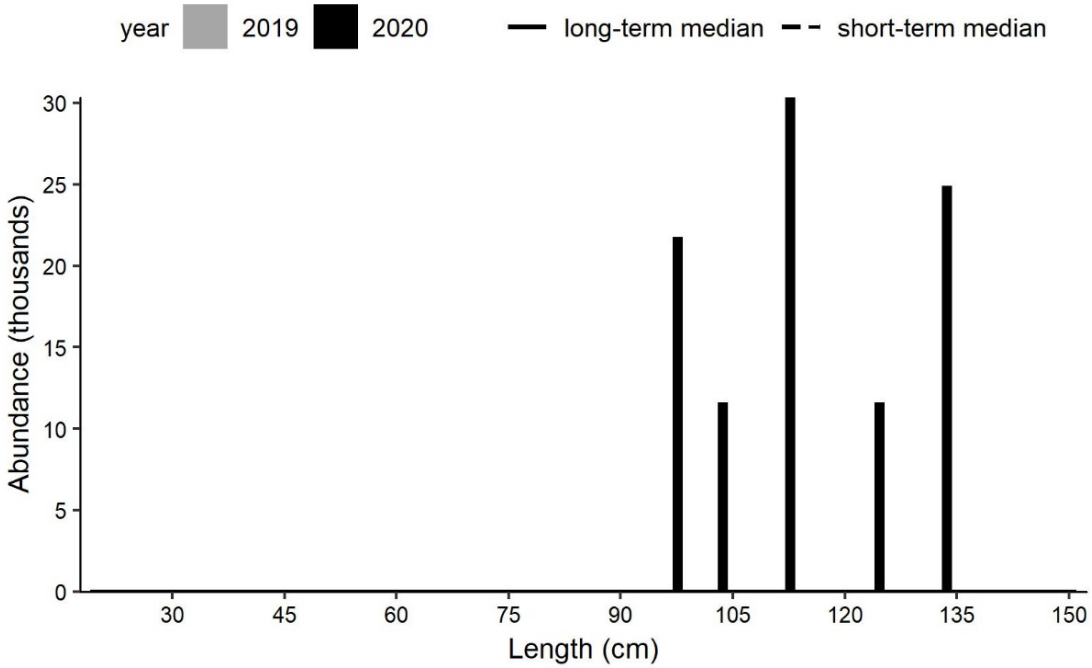


*Figure 18e. Length-frequency indices for Barndoor Skate in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey.*

## Thorny Skate

Thorny Skate (*Amblyraja radiata*) catches in 2020 were restricted primarily to 4V (Figure 19a). The 3-yr GM for 4X has been below 40% of the long-term GM since 2010 and is among the lowest in the series (Figure 19b). Only four individuals were caught (Figure 19c). In 4VW, the 3-yr GM has also been below 40% of the long-term GM since 2010 (Figure 19d). The abundance index was above both the long- and short-term index for lengths below 18 cm, but below for all larger lengths (Figure 19e).

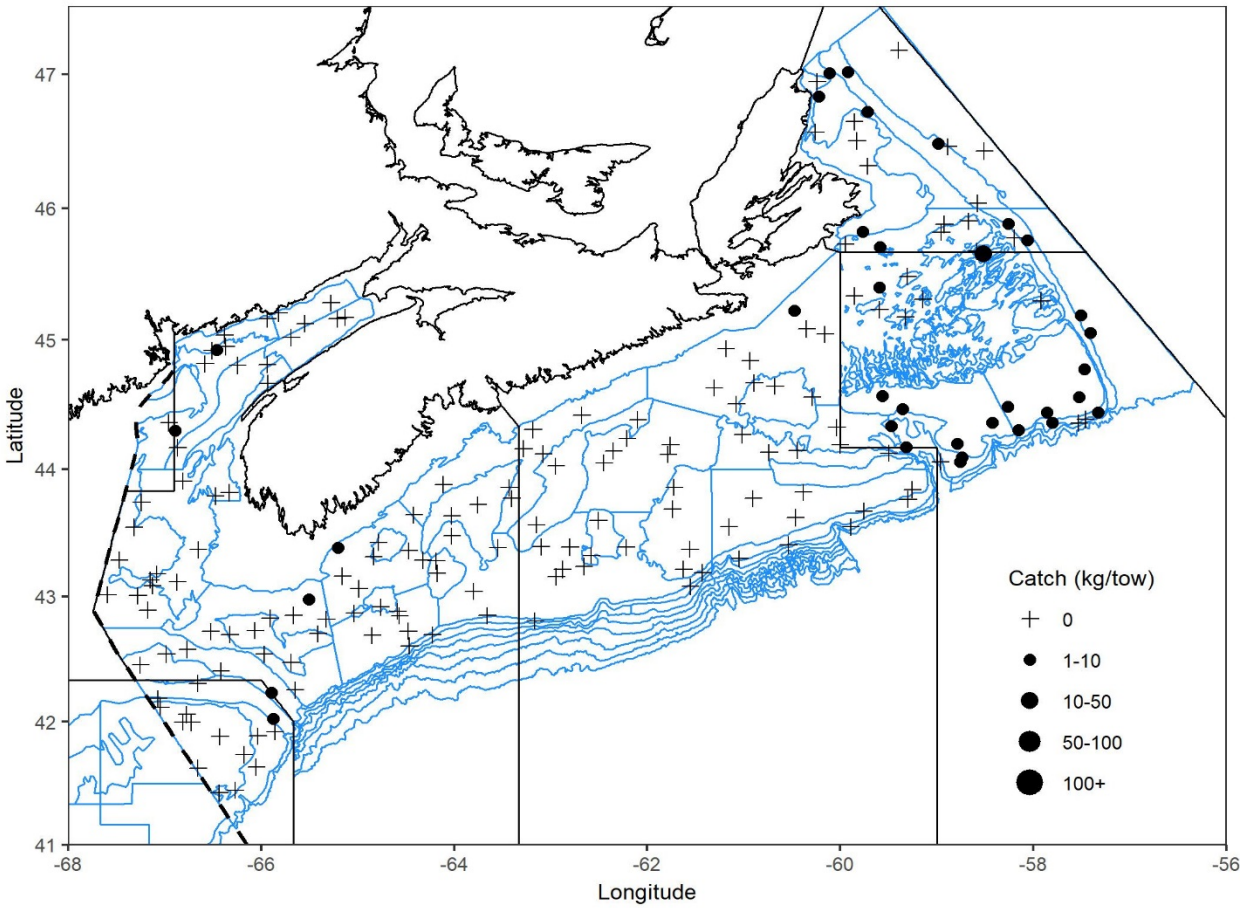


*Figure 19a. Distribution of Thorny Skate catches during the 2020 DFO Summer RV Survey including the Laurentian Channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

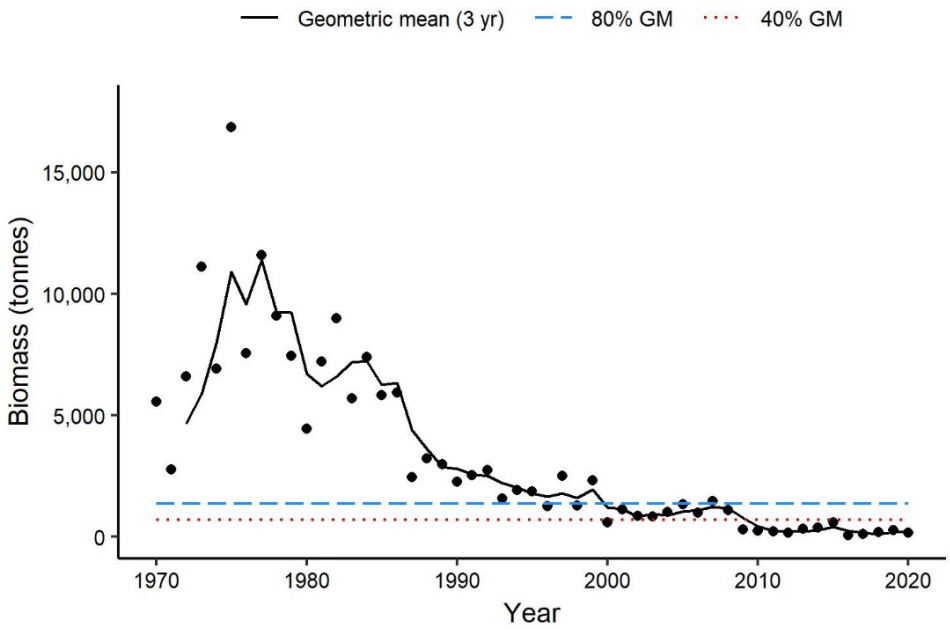


*Figure 19b. Biomass index for Thorny Skate in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

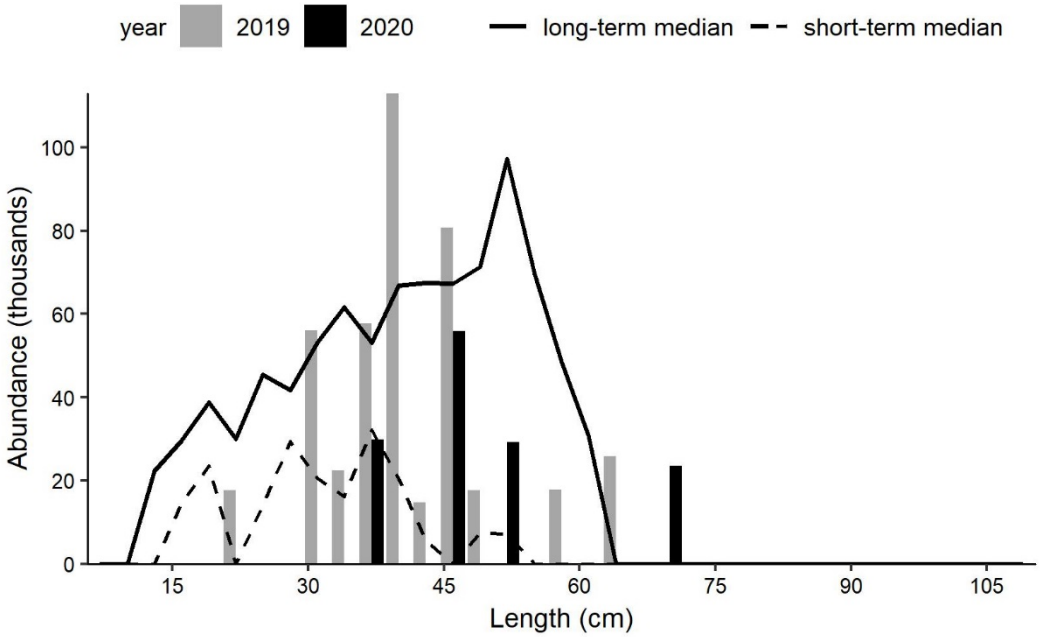


*Figure 19c. Length-frequency indices for Thorny Skate in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

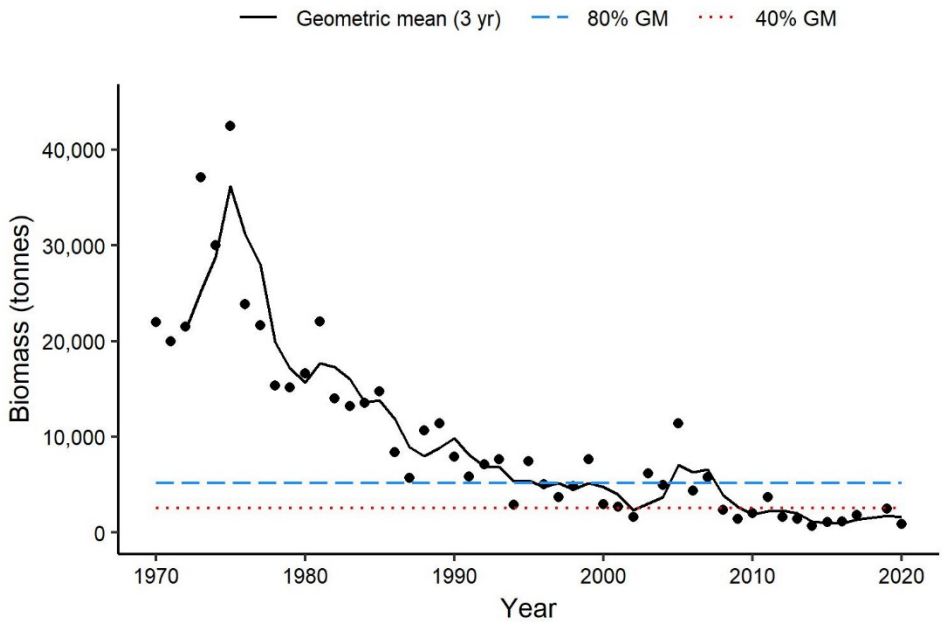


*Figure 19d. Biomass index for Thorny Skate in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

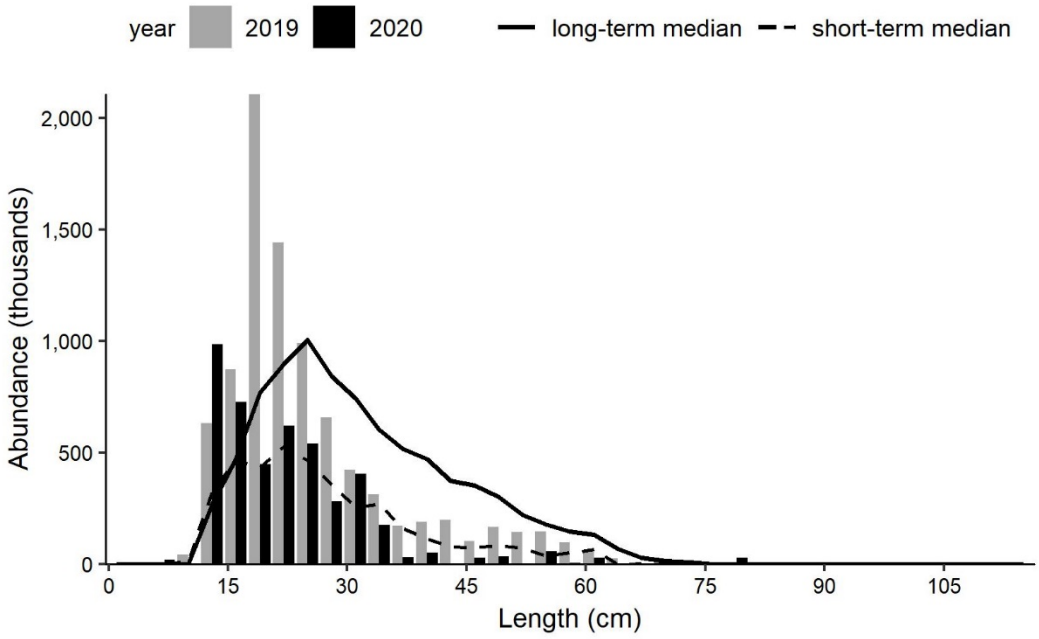


*Figure 19e. Length-frequency indices for Thorny Skate in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Winter Skate

**Winter Skate** (*Leucoraja ocellata*) and **Little Skate** (*Leucoraja erinacea*) cannot be reliably distinguished at lengths less than about 40 cm (for more information, see McEachran and Musick 1973). The practice at sea in most years was to record immature Winter and Little skates for which the identification was uncertain as Winter Skate. Given that the majority of the skates recorded as Winter Skate in the surveys are in this length range, the biomass trends were influenced by the contribution of fish for which identification was uncertain. For this document, only Winter Skates > 40 cm are included in calculating the biomass indices.

Winter Skate were caught primarily on Georges Bank, with some catches on Browns Bank and in the Bay of Fundy (Figure 20a). In 4X, the 3-yr GM remains above 80% of the long-term GM (Figure 20b). Abundance indices are above both the short- and long-term medians for most lengths (Figure 20c). In 4VW, the 3-yr GM remains below 40% of the long-term GM since 2006 (Figure 20d). Only two individuals were caught (Figure 20e).

The biomass index for Georges Bank from the 2020 Summer RV Survey was 6,117 t; this is quadruple the index for 4X and double the index for Georges Bank in the winter survey. The DU for Winter Skate includes both 4X and 5Z; however, they are seldom caught in the deeper water of the Fundian Channel between Browns Bank and Georges Bank. While it may be appropriate to review the biomass trends for 4X and 5Zc separately, summer survey data may be useful in reviewing the status of Winter Skate on Georges Bank.

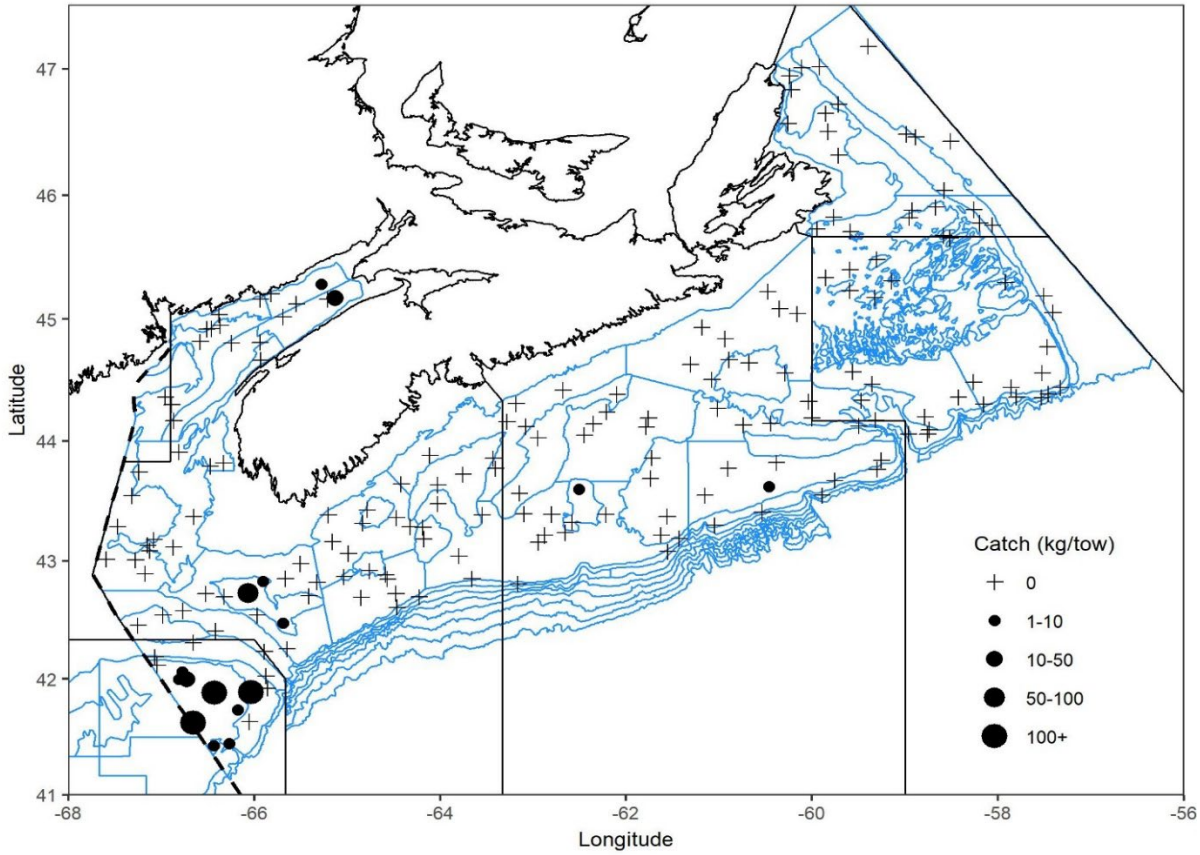


*Figure 20a. Distribution of Winter Skate catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

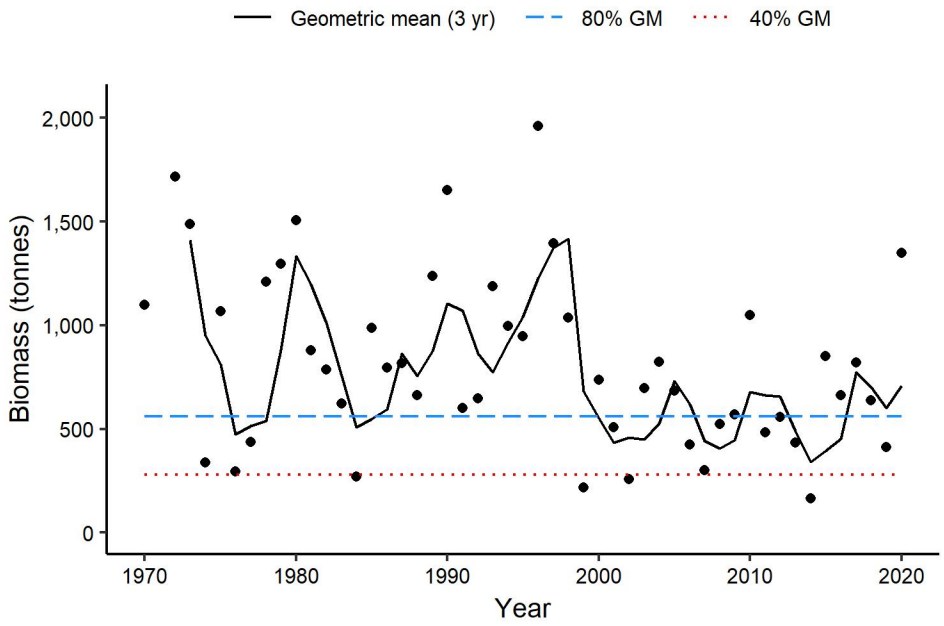


*Figure 20b. Biomass index for Winter Skate in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

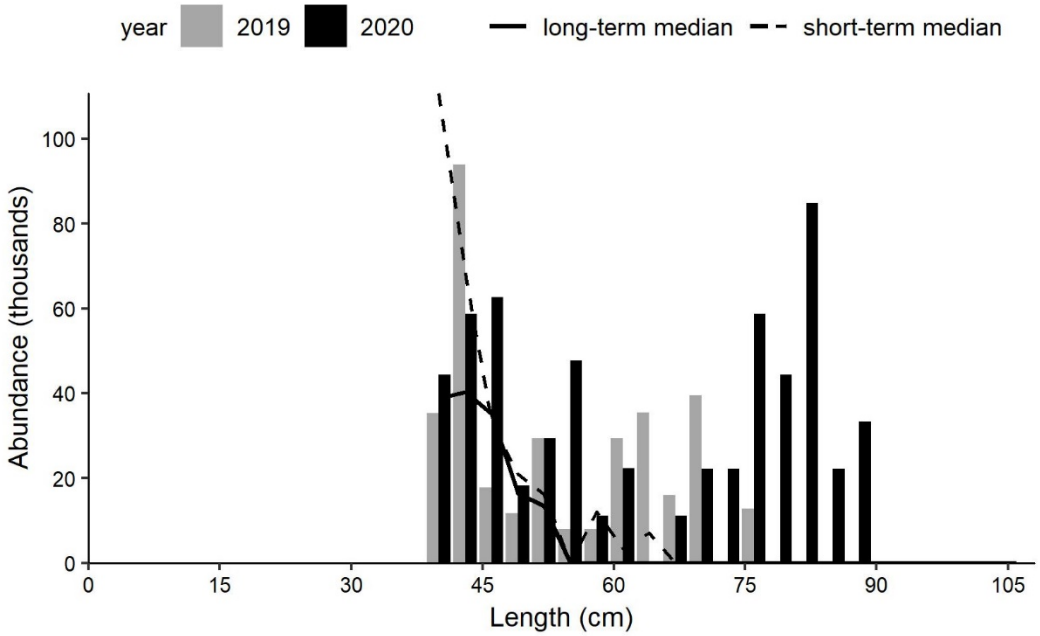


*Figure 20c. Length-frequency indices for Winter Skate in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

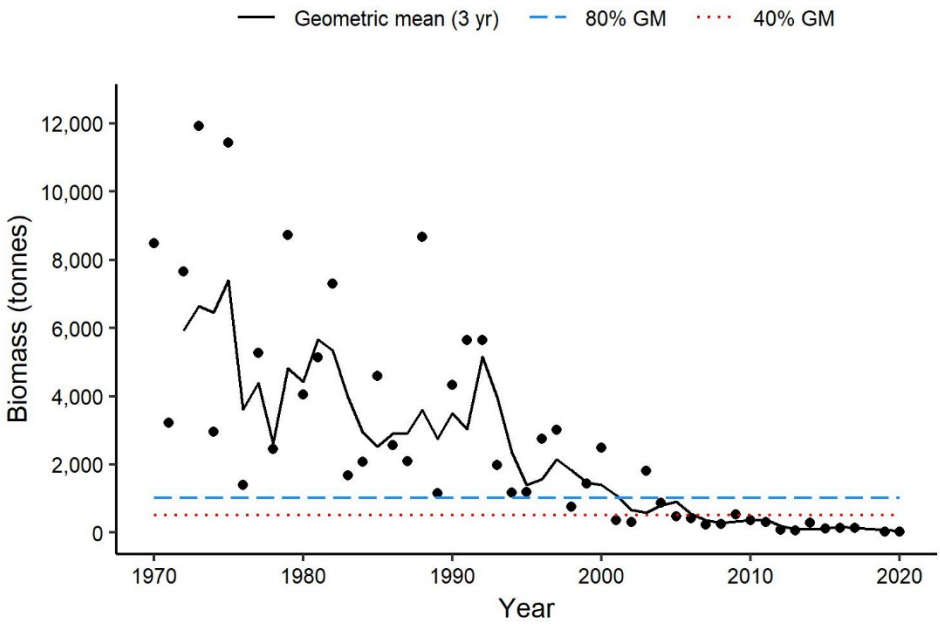


*Figure 20d. Biomass index for Winter Skate in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

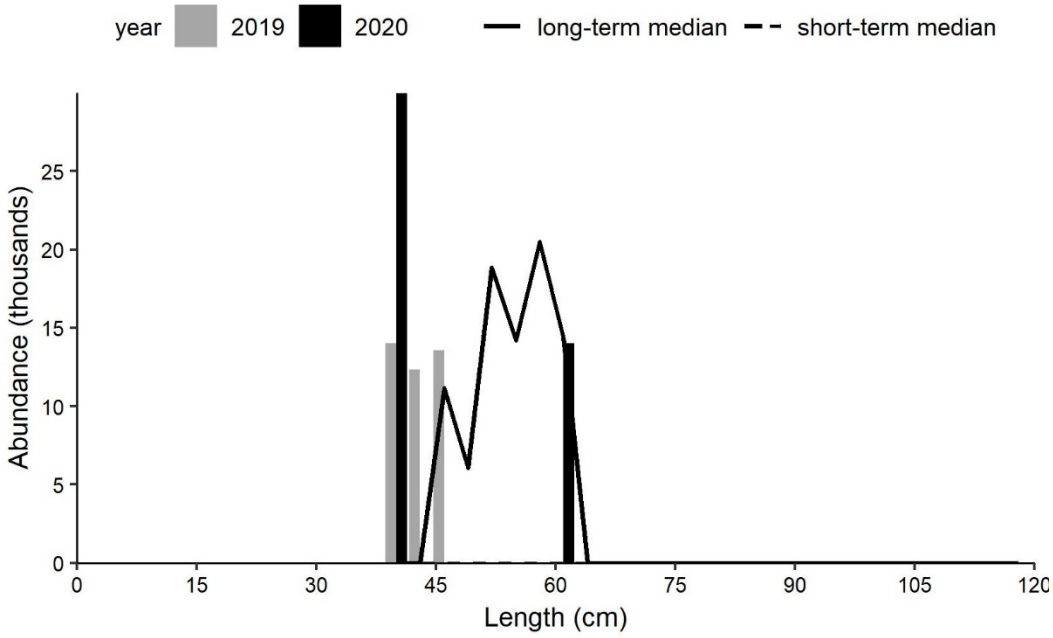


*Figure 20e. Length-frequency indices for Winter Skate in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Little Skate

**Winter Skate** (*Leucoraja ocellata*) and **Little Skate** (*Leucoraja erinacea*) cannot be reliably distinguished when immature (for more information, see McEachran and Musick 1973). The practice at sea in most years was to record these immature skates as Winter Skate. Little Skate begin to mature at about 32 cm and can then be easily distinguished from Winter Skate. For this document, only Little Skate > 32 cm are included in the long-term average length frequency.

Little Skate were caught primarily on Browns Bank, Georges Bank, and in the Bay of Fundy (Figure 21a). The 3-yr GM for 4X has remained above 80% of the long-term GM since 1988 (Figure 21b). Abundance indices remain above both the long- and short-term medians at lengths below 52 cm, with larger individuals absent from the catch (Figure 21c). The geographic range of Little Skate does not extend far into 4VW. Catches are very small, but the 3-yr GM remains above 80% of the long-term GM (Figure 21d). The median catch at most lengths for the survey is zero, with only three individuals caught in 2020 (Figure 21e).

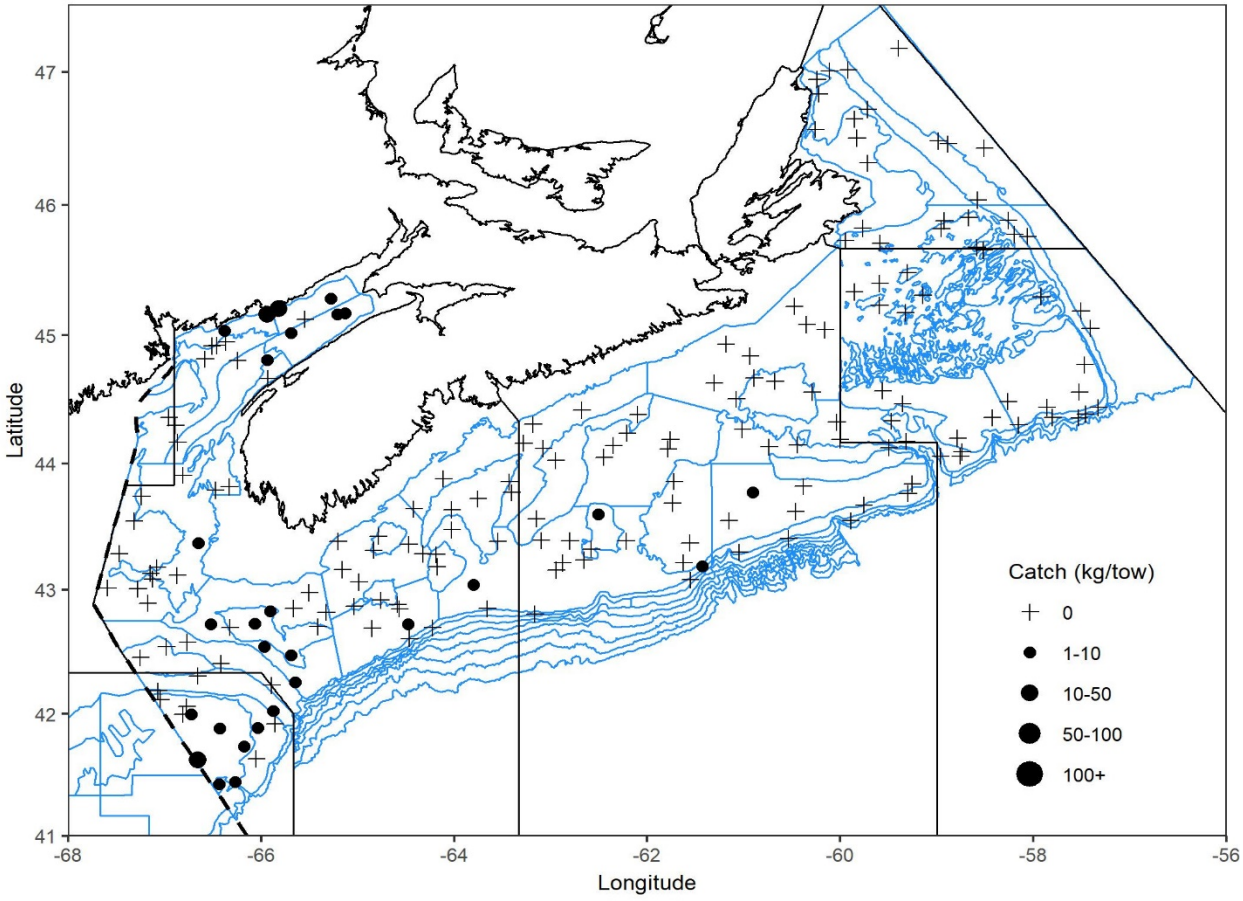


*Figure 21a. Distribution of Little Skate catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

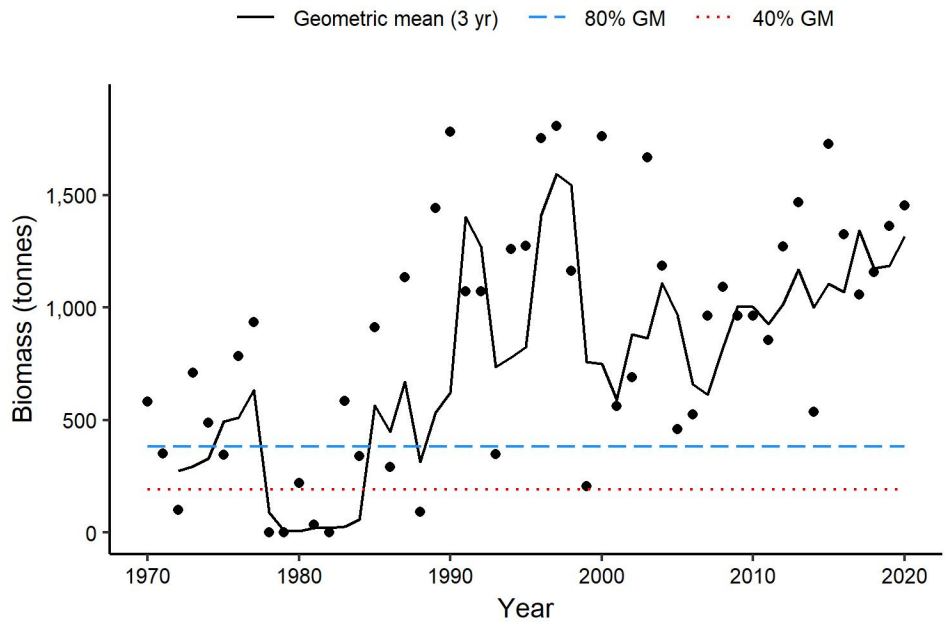


*Figure 21b. Biomass index for Little Skate in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

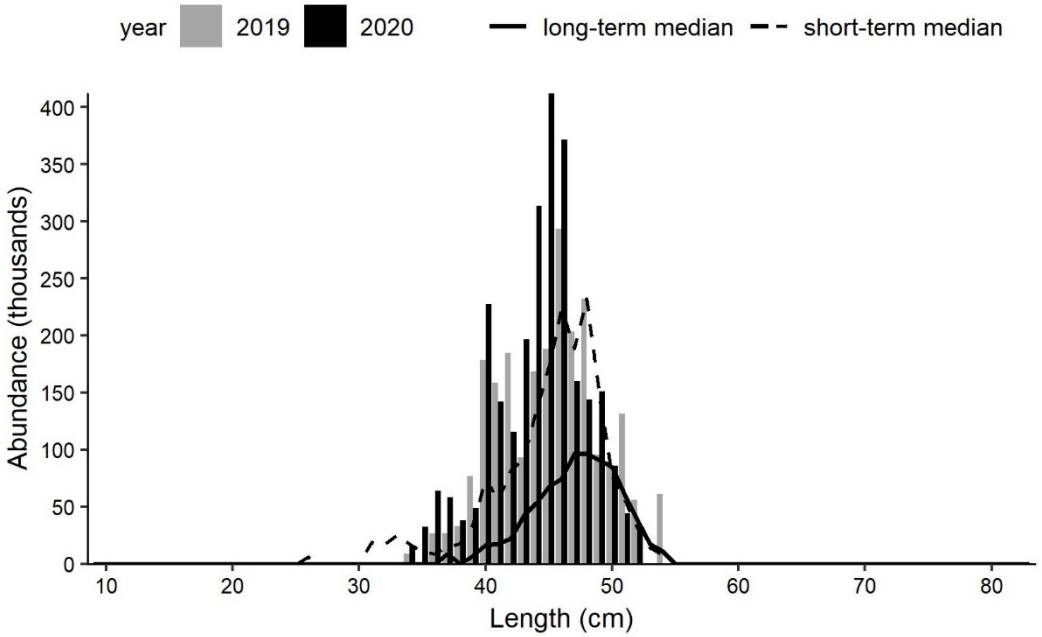


*Figure 21c. Length-frequency indices for Little Skate in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

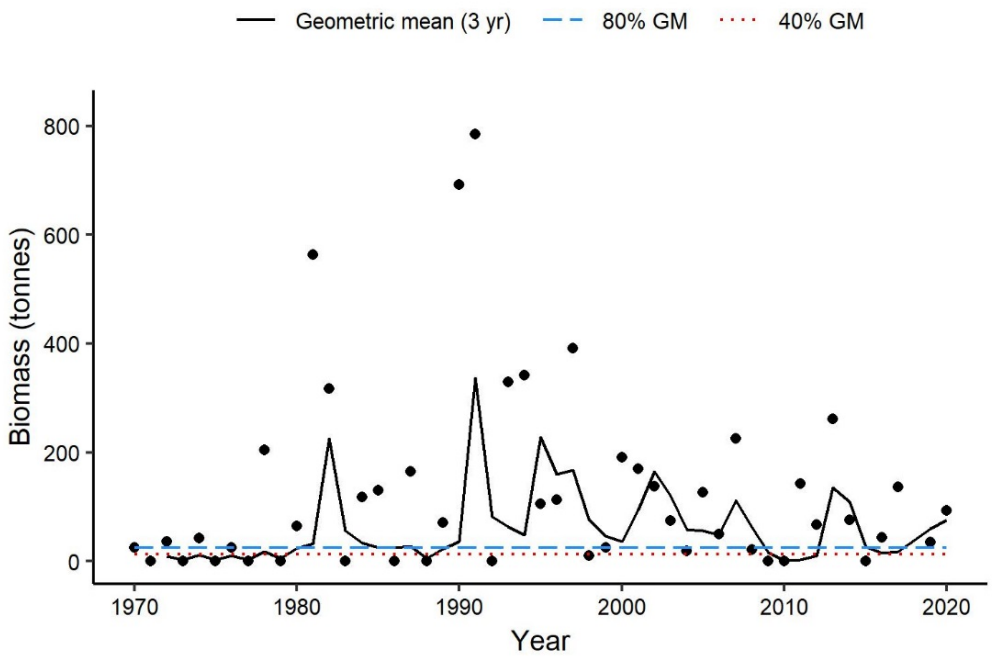


*Figure 21d. Biomass index for Little Skate in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

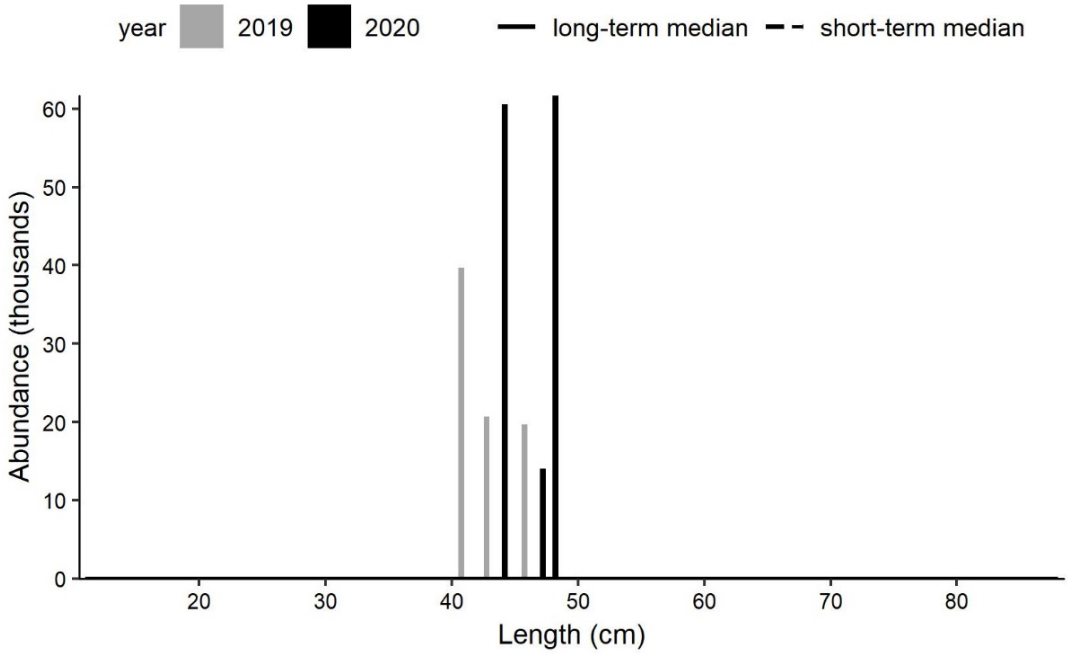


*Figure 21e. Length-frequency indices for Little Skate in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey.*

## Smooth Skate

Smooth Skate (*Malacoraja senta*) are caught at the eastern and western ends of the survey area (Figure 22a). In 4X, the 3-yr GM has increased from its lowest point in the early 1990s and fluctuated around 80% of the long-term mean in recent years (Figure 22b). In 2020, it remains above 80% of the long-term GM. Abundance indices were above the long-term median for most lengths in 2020 (Figure 22c).

Biomass indices for Smooth Skate in the Winter RV Survey are higher than those from the Summer RV Survey and, in recent years, winter survey biomass indices have been higher in 4X than in the late 1970s and early 1980s. Winter RV surveys have used the Western IIa trawl in all years, whereas the trawl used for the Summer RV Survey changed in 1982 from a Yankee 36 to the Western IIa. No conversion factor has been calculated for Smooth Skate in relation to this change in net.

In 4VW, the 3-yr GM continues to fluctuate at low levels near 40% of the long-term GM (Figure 22d). Few Smooth Skate > 40 cm were caught in either 2019 or 2020 (Figure 22e). In the deeper water strata of the Laurentian Channel, which have recently been added to the survey coverage, the biomass index was roughly two-thirds of the index in the rest of 4VW and the individuals caught were larger, mature fish.

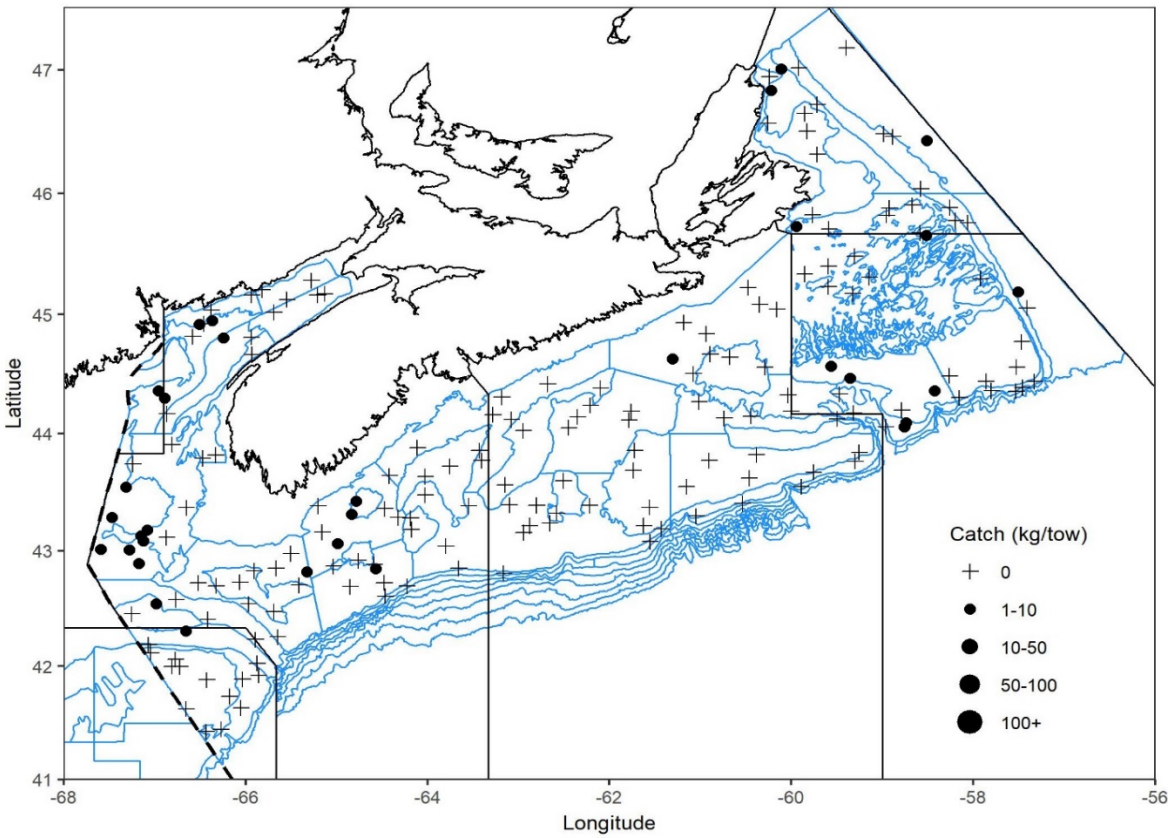


*Figure 22a. Distribution of Smooth Skate catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

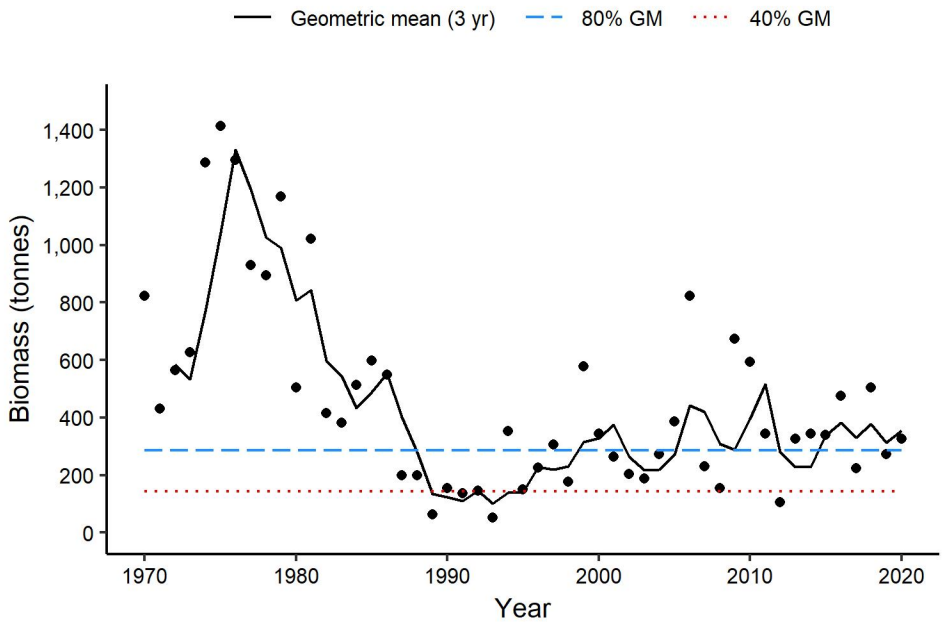


*Figure 22b. Biomass index for Smooth Skate in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

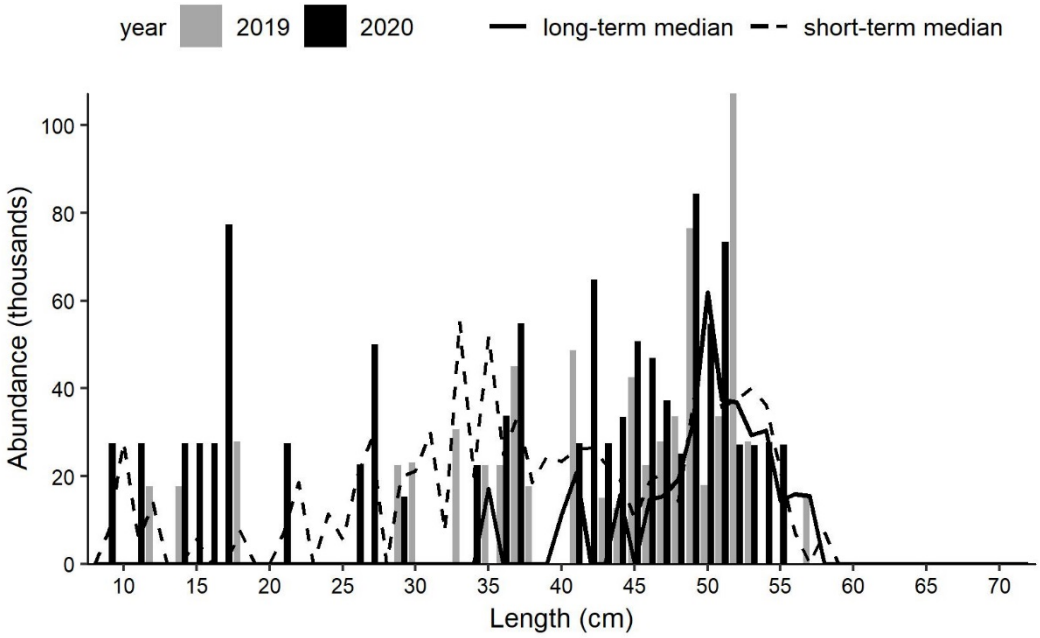


*Figure 22c. Length-frequency indices for Smooth Skate in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

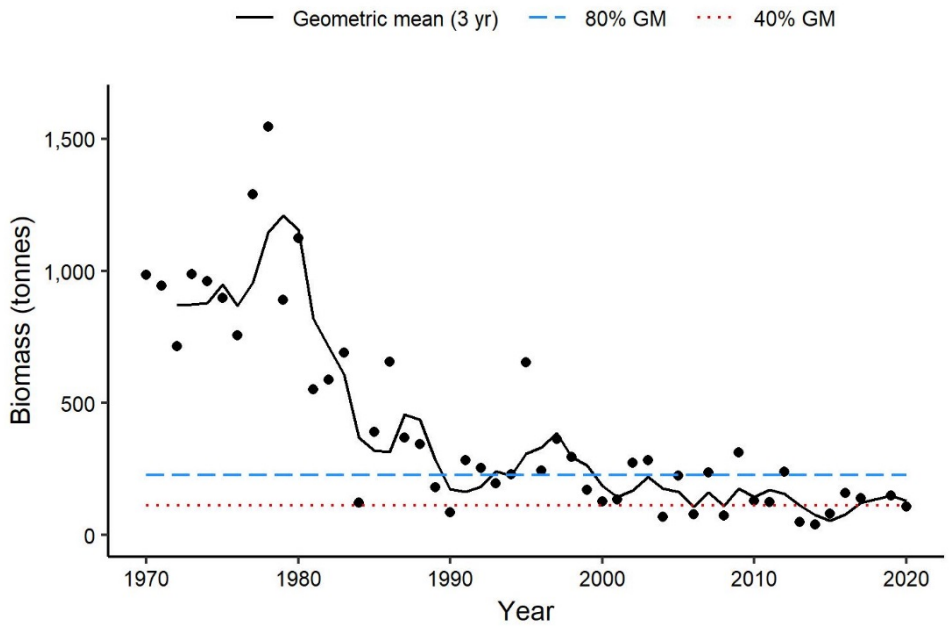


*Figure 22d. Biomass index for Smooth Skate in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

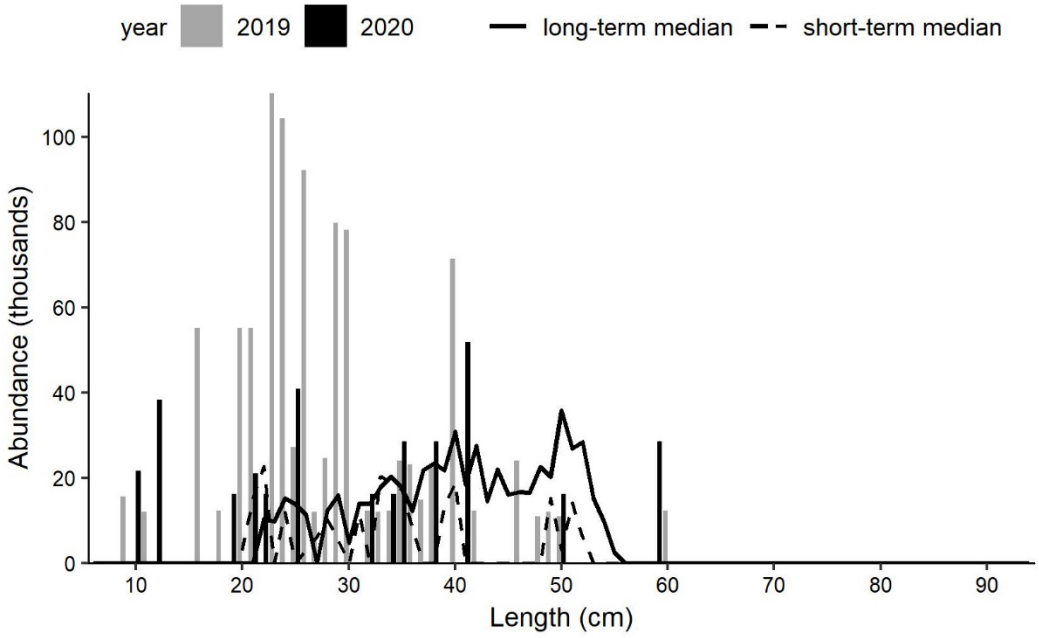


*Figure 22e. Length-frequency indices for Smooth Skate in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Spiny Dogfish

Spiny Dogfish (*Squalus acanthias*) are well distributed in 4X and on Georges Bank, but they were caught in only 3 sets in 4VW (Figure 23a). Catches of Spiny Dogfish in 4V are not common, and the catch of 19 kg at a station in 2020 is the largest since 1979.

Inter-annual variability in survey catch is high for Spiny Dogfish. The 3-yr GM biomass index is above 80% of the long-term GM in 2020 (Figure 23b). The indices-at-length are at or above the median values for most lengths (Figure 23c). The Spiny Dogfish population extends across the Canada-US boundary, with the majority of the population in US waters in most years. The biomass index for 5Zc was 10,000 t compared to 73,000 t for 4X. Dogfish caught on Georges Bank were smaller than in 4X, with the indices-at-length peaking at 55–58 cm.

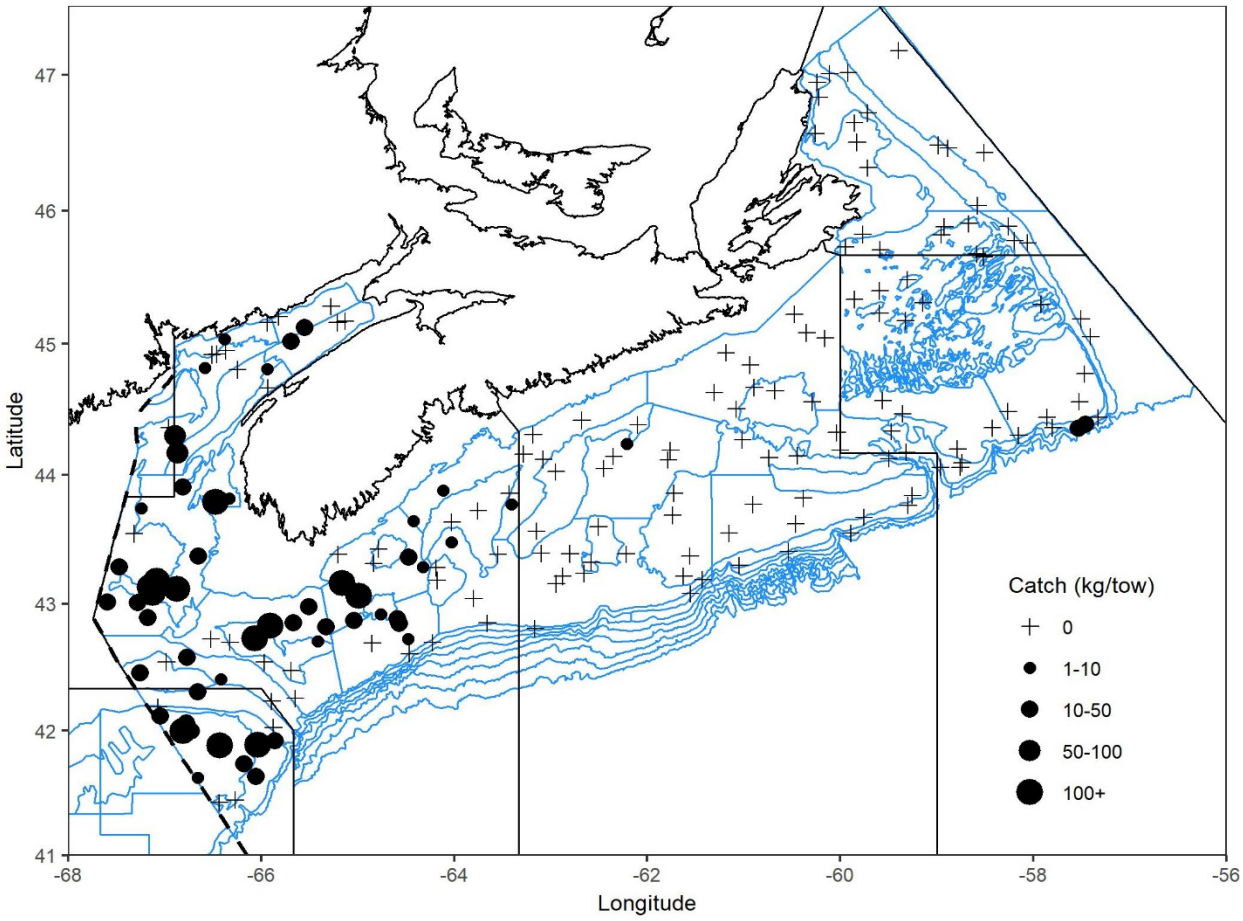


*Figure 23a. Distribution of Spiny Dogfish catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

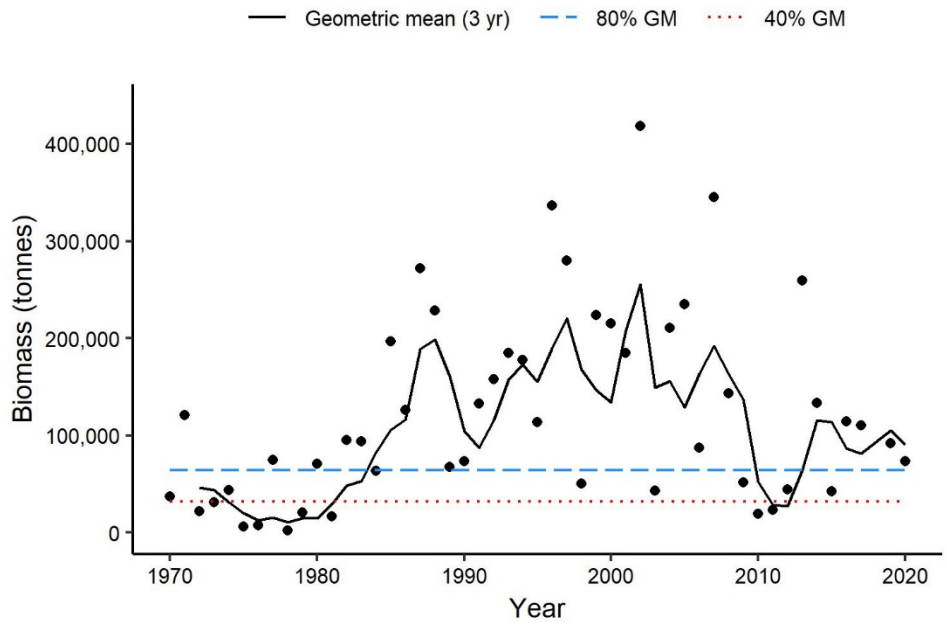


*Figure 23b. Biomass index for Spiny Dogfish in 4VWX from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

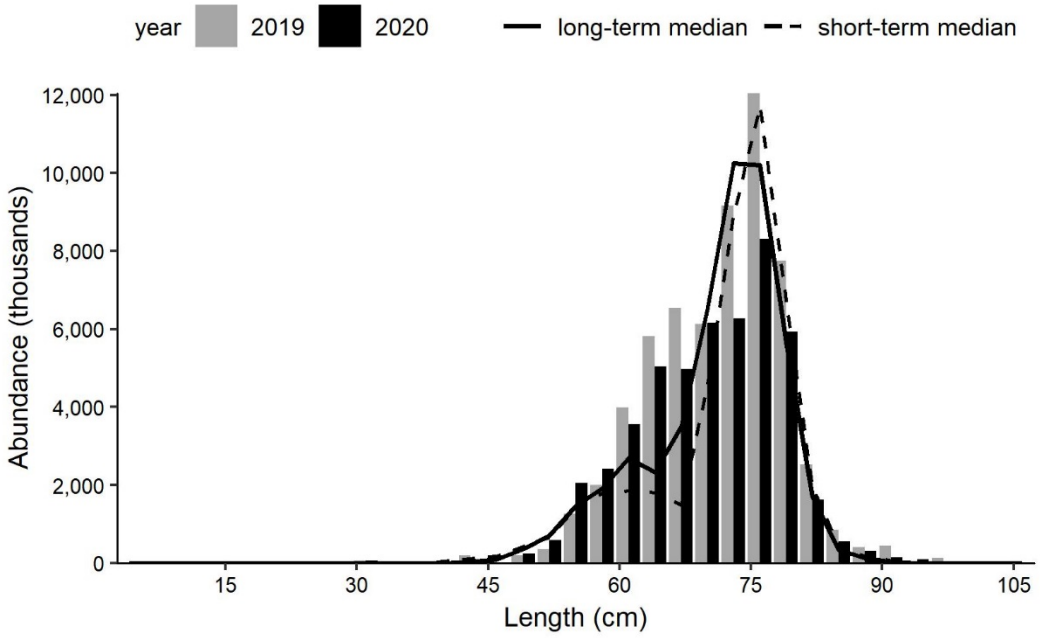


*Figure 23c. Length-frequency indices for Spiny Dogfish in 4VWX from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Red Hake

Red Hake (*Urophycis chuss*) can be difficult to distinguish from White Hake. Prior to about 1985, these two species were not consistently separated. The standard guide to Canadian Atlantic fishes (Leim and Scott 1966) did not differentiate them.

Red Hake were caught throughout 4X and 4W in 2020 but are seldom found in 4V (Figure 24a). In 4X, the 3-yr GM has remained over 80% of the long-term GM since 2014 (Figure 24b). The abundance indices are above the long- and short-term medians at most lengths and include large individuals where the medians are zero (Figure 24c). In 4VW, the 3-yr GM has remained over 80% of the long-term GM since 2013 (Figure 24d). The abundance indices are at or above the long- and short-term medians at most lengths (Figure 24e).

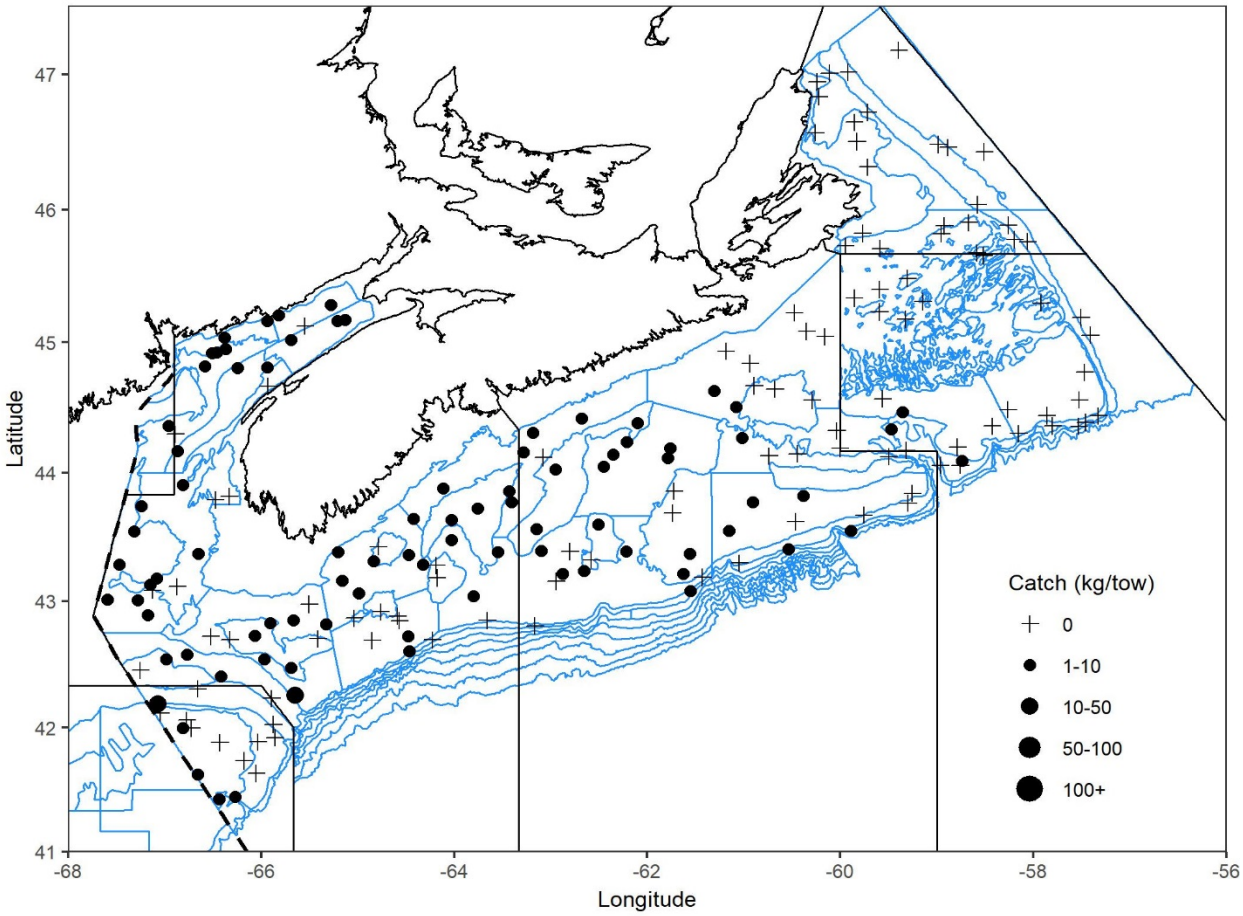


*Figure 24a. Distribution of Red Hake catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

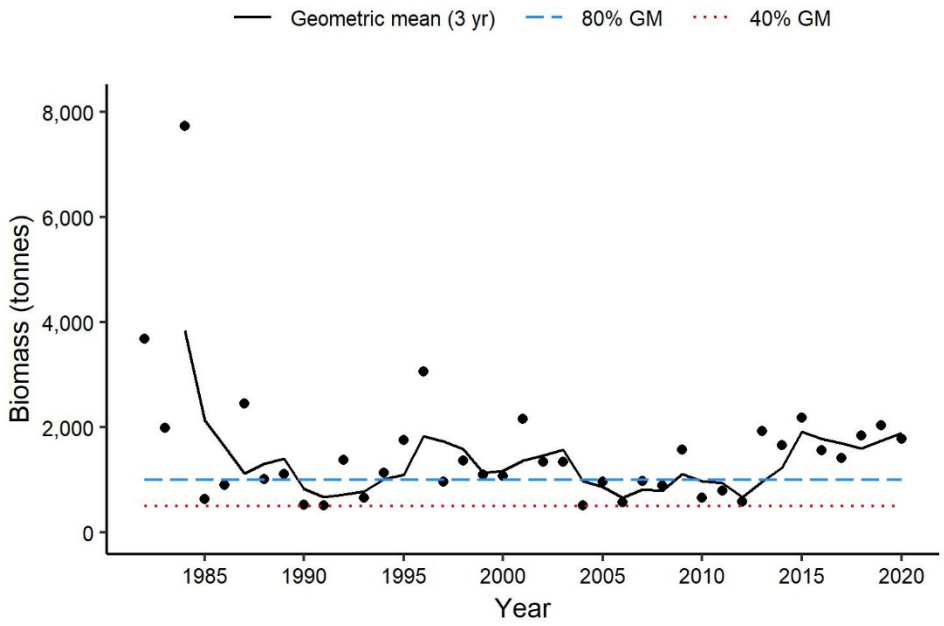


*Figure 24b. Biomass index for Red Hake in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2019), respectively. The black dots represent the biomass index for that year.*

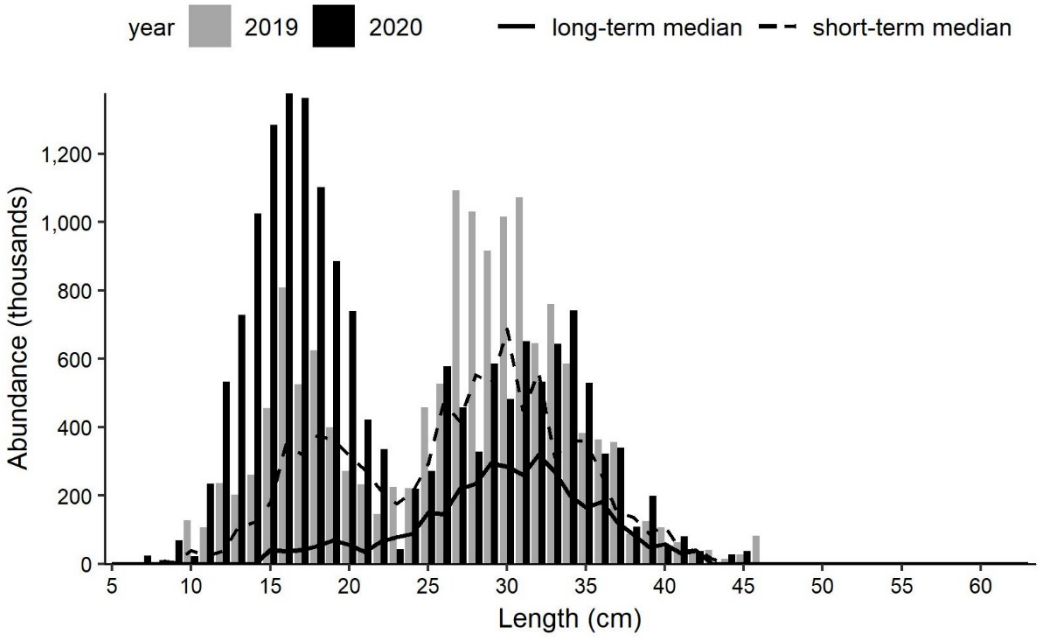


*Figure 24c. Length-frequency indices for Red Hake in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1982–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

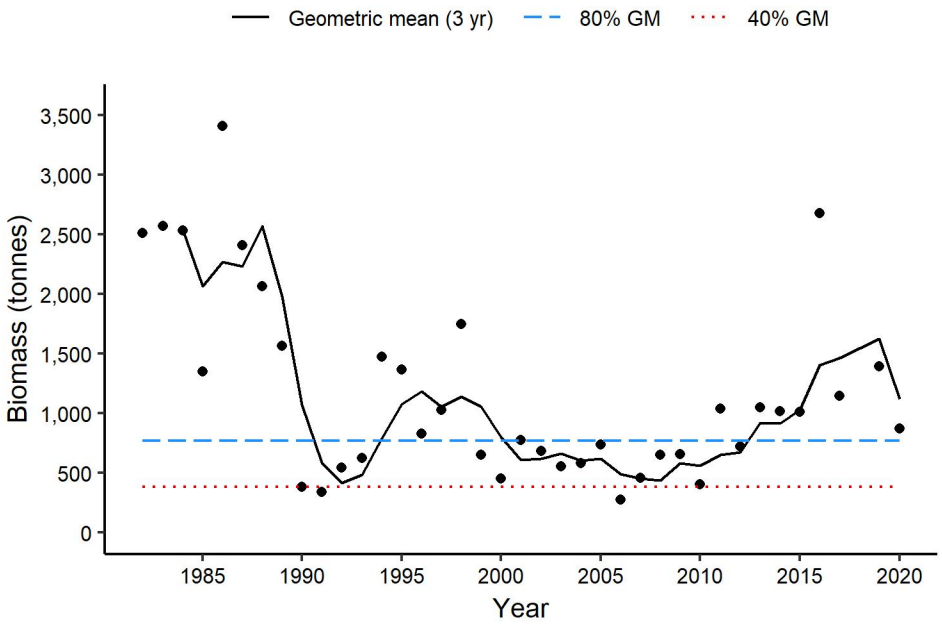


*Figure 24d. Biomass index for Red Hake in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2019), respectively. The black dots represent the biomass index for that year.*

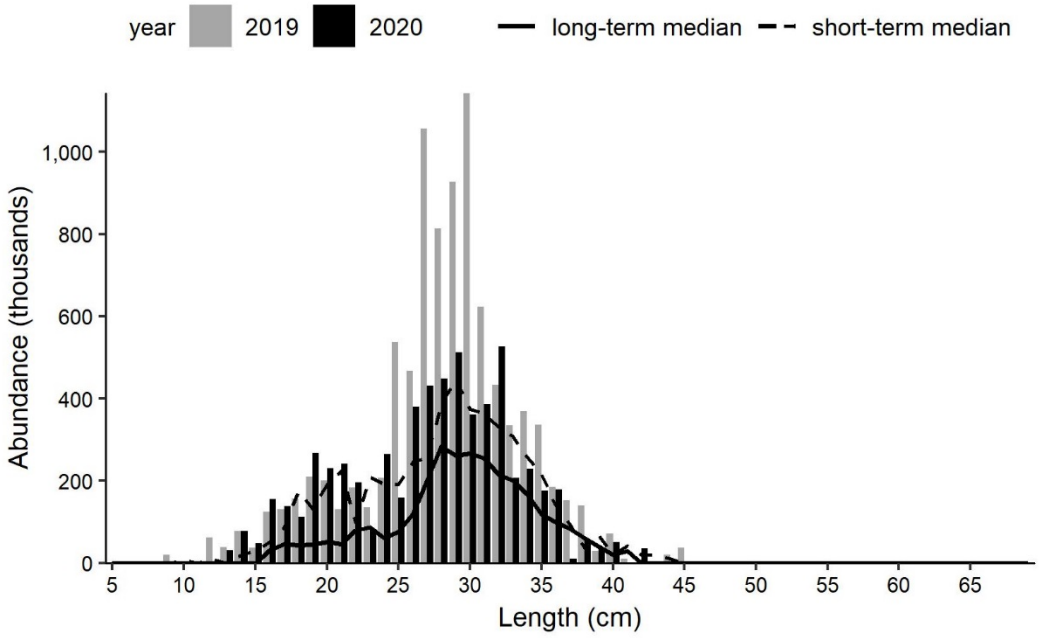


*Figure 24e. Length-frequency indices for Red Hake in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1982–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Sea Raven

Sea Raven (*Hemitripterus americanus*) are caught primarily on the banks and in the Bay of Fundy. In 4X, the 2020 biomass index increased from the lowest in the time series in 2019 to above 80% of the long-term GM, while the 3-yr GM biomass index remained among the lowest in the series. The indices-at-length in 2020 are generally above the long-term median for most lengths. In 4VW, the survey biomass index remains above 80% of the long-term GM. The indices-at-length are above the short- and long-term medians for most lengths for both 2019 and 2020.

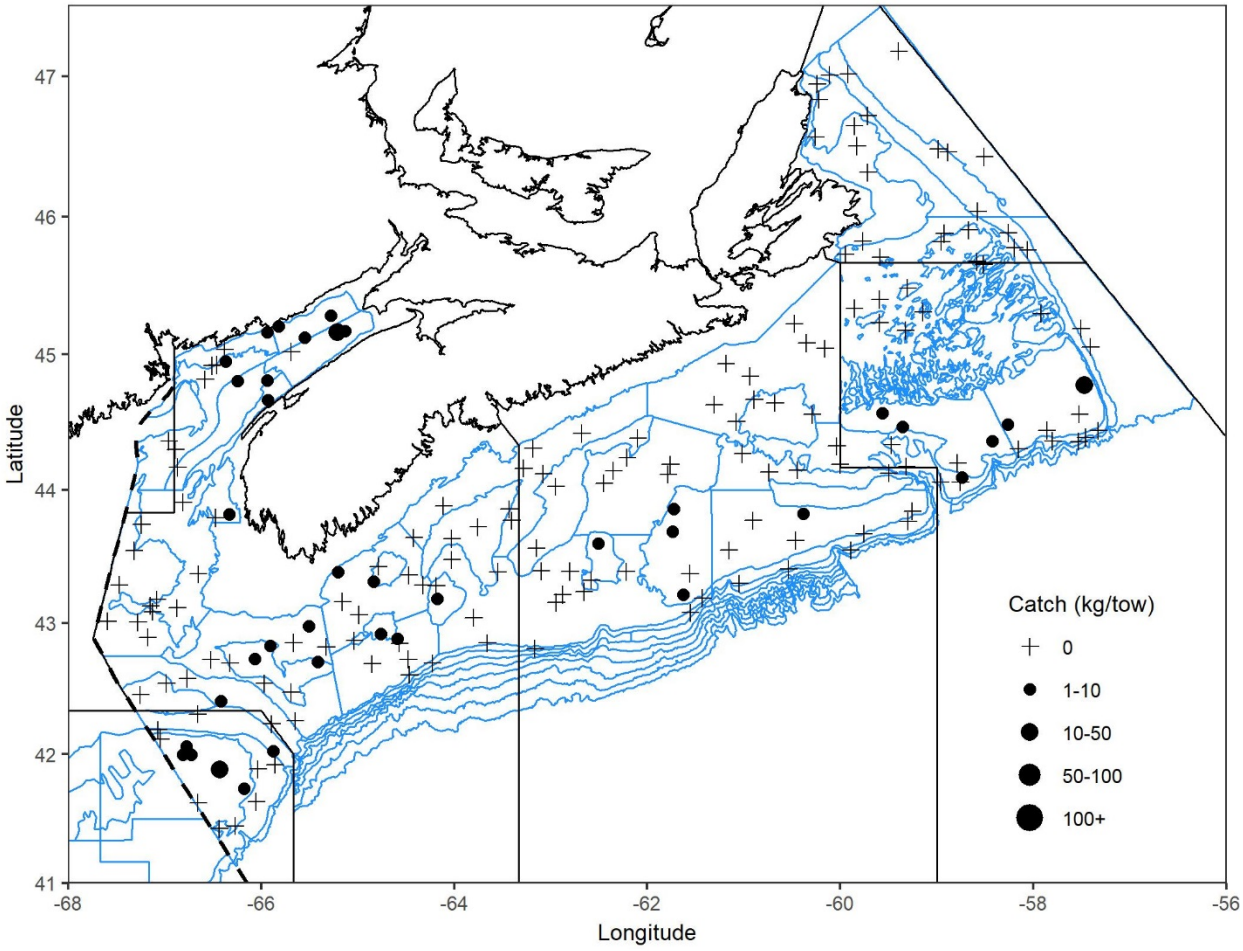


*Figure 25a. Distribution of Sea Raven catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

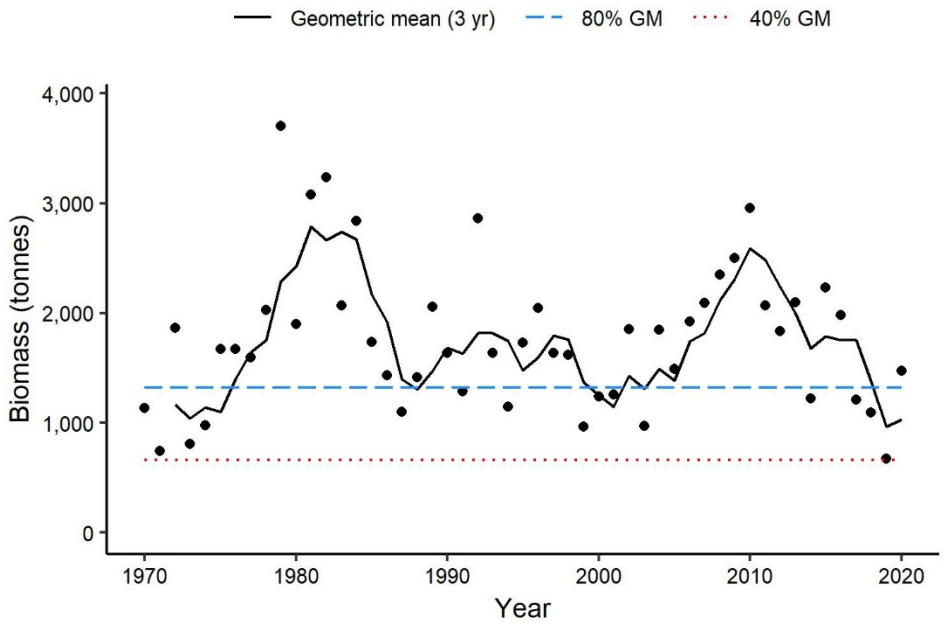


*Figure 25b. Biomass index for Sea Raven in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

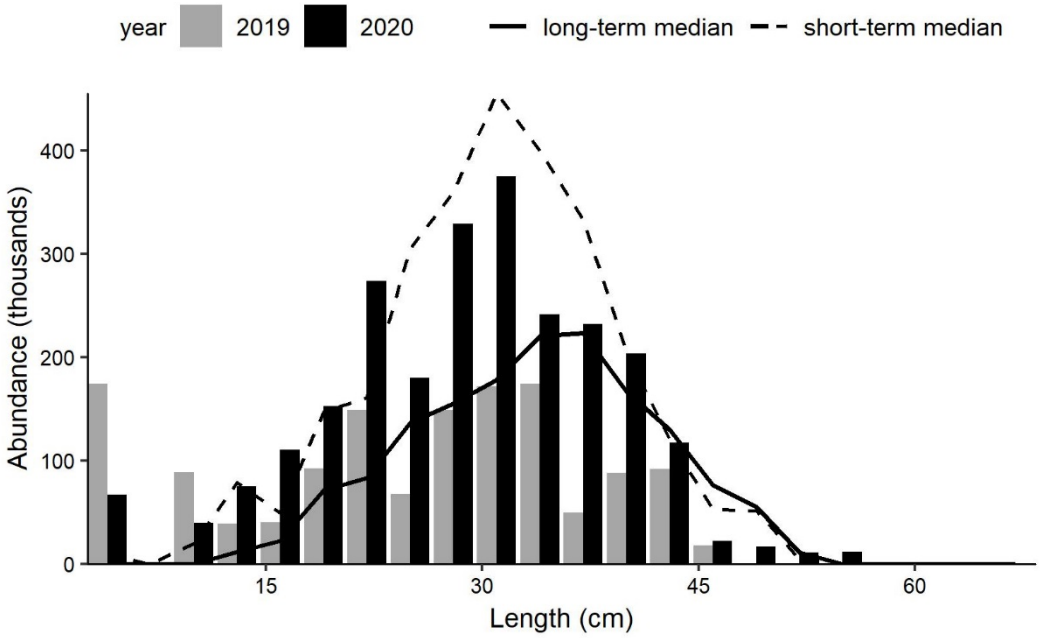


*Figure 25c. Length-frequency indices for Sea Raven in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

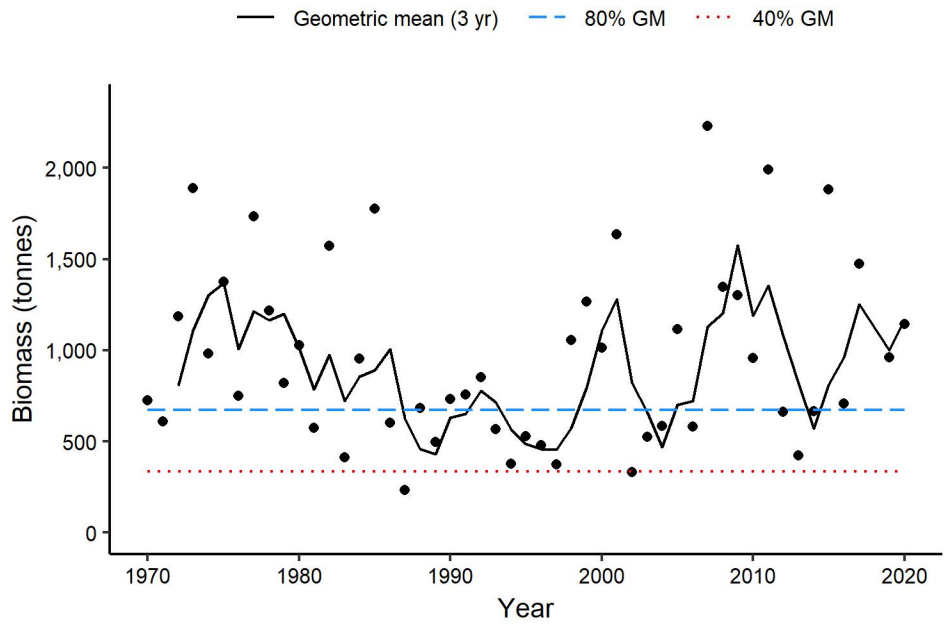


*Figure 25d. Biomass index for Sea Raven in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

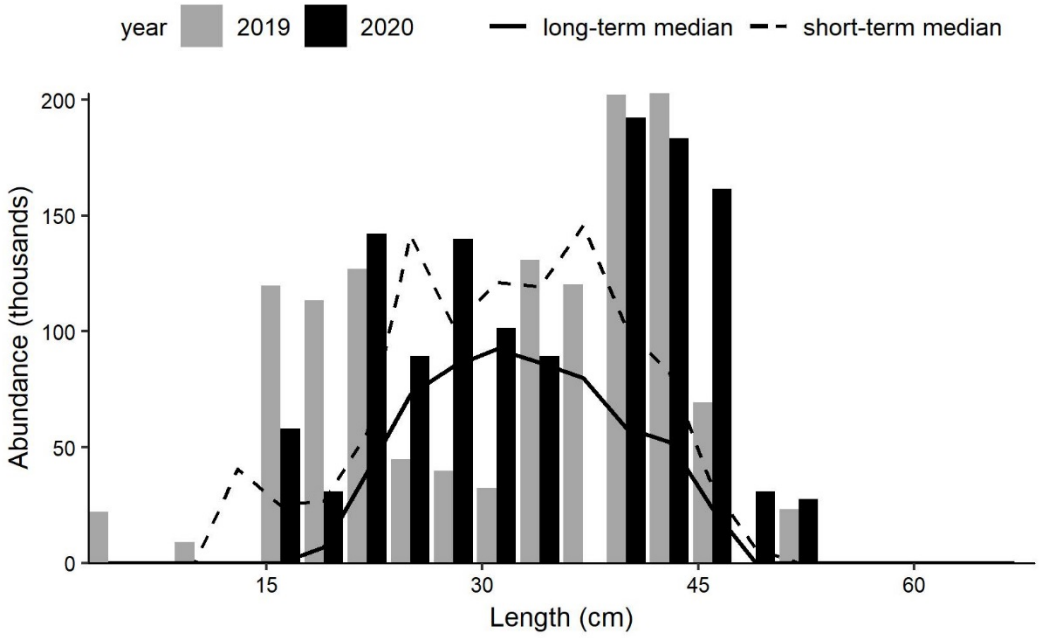


*Figure 25e. Length-frequency indices for Sea Raven in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Ocean Pout

Ocean Pout (*Zoarces americanus*) were caught in only a few sets in 2020. The 2020 biomass index and 3-yr GM in 4X are the lowest in the time series and have been below 40% of the long-term GM for the last 7 years. In 4VW, biomass indices remain at very low levels and have been at or below 40% of the long-term GM since 2002. Catches of larger Ocean Pout are very low relative to the median values in 4X.

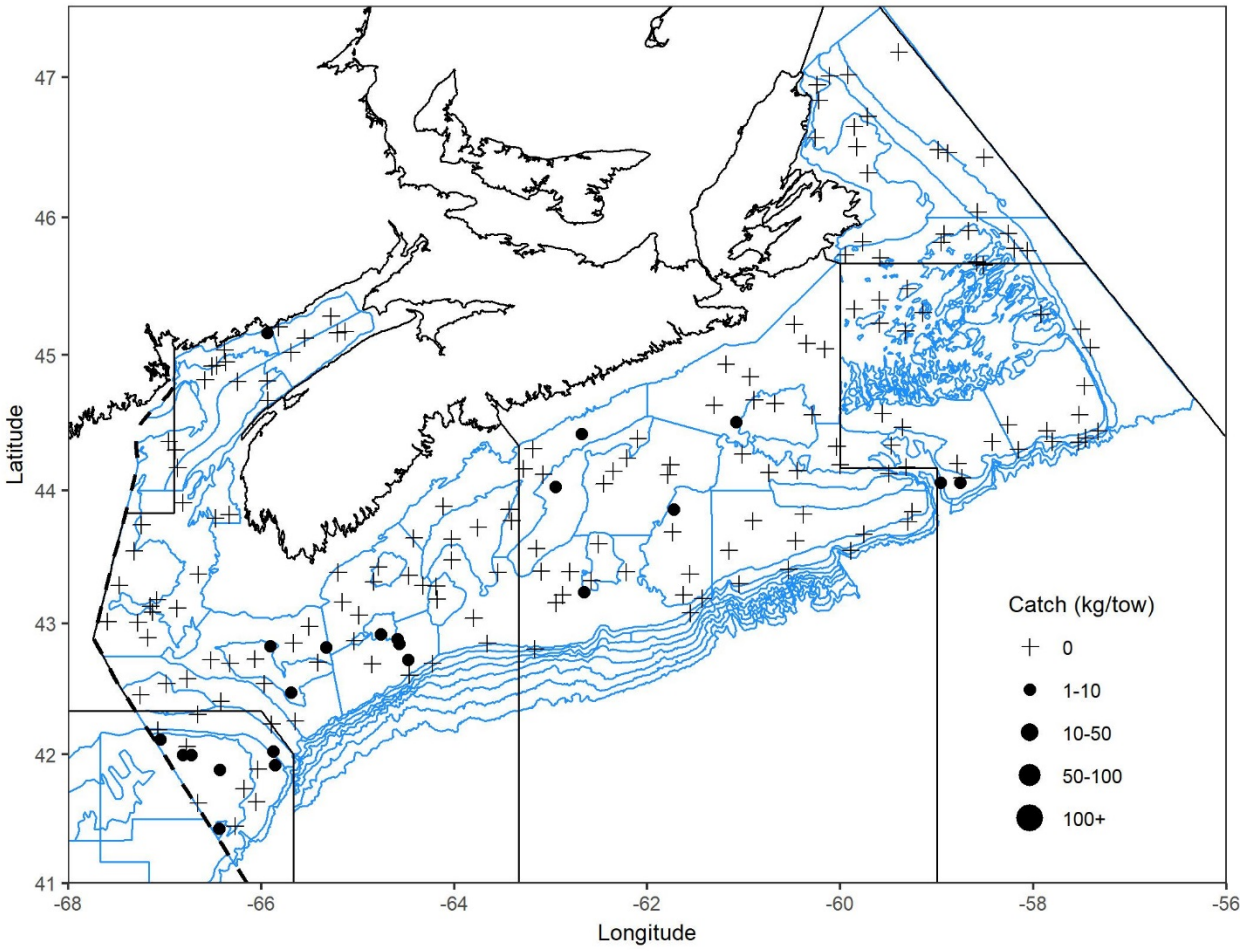


*Figure 26a. Distribution of Ocean Pout catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

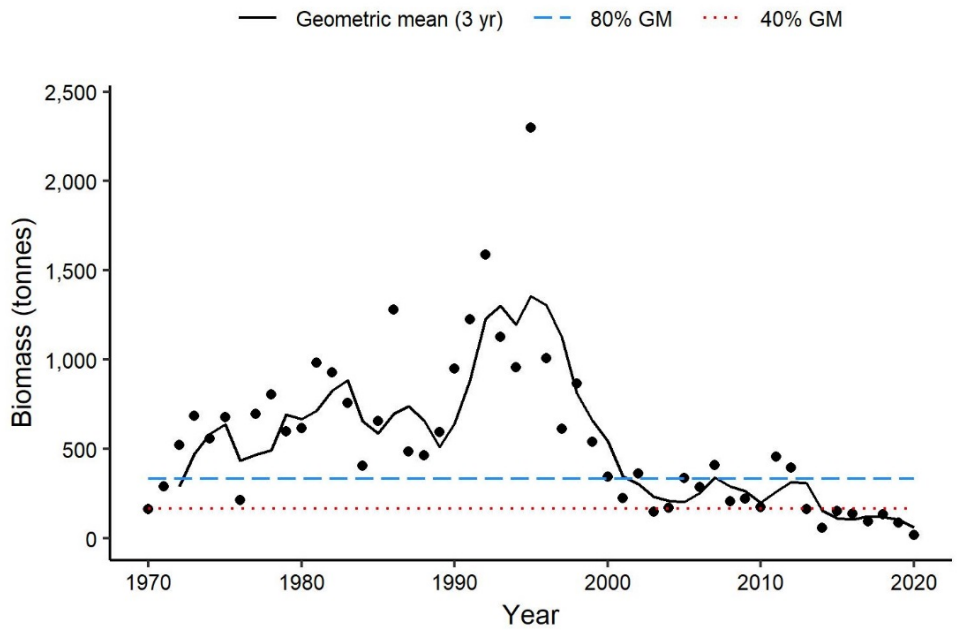


*Figure 26b. Biomass index for Ocean Pout in 4X from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

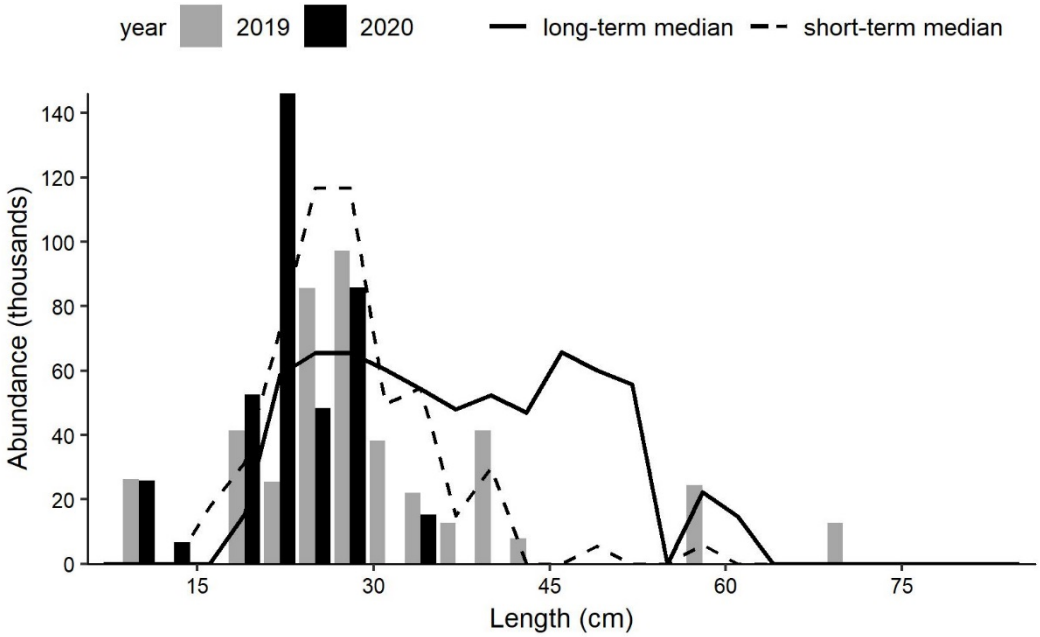


*Figure 26c. Length-frequency indices for Ocean Pout in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2018. The dashed black line represents the median in thousands at length for the time period 2009–2018.*

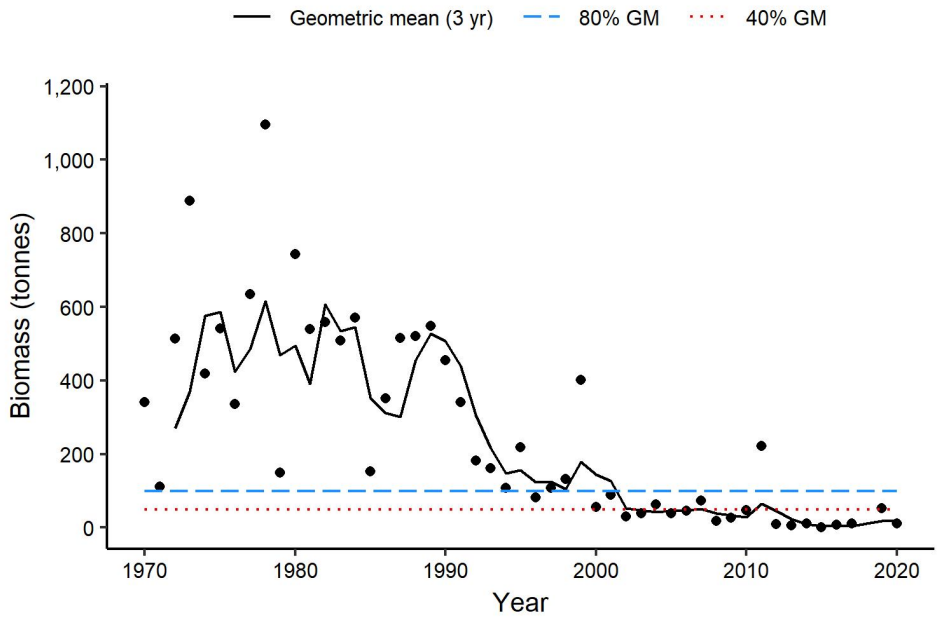


*Figure 26d. Biomass index for Ocean Pout in 4VW from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

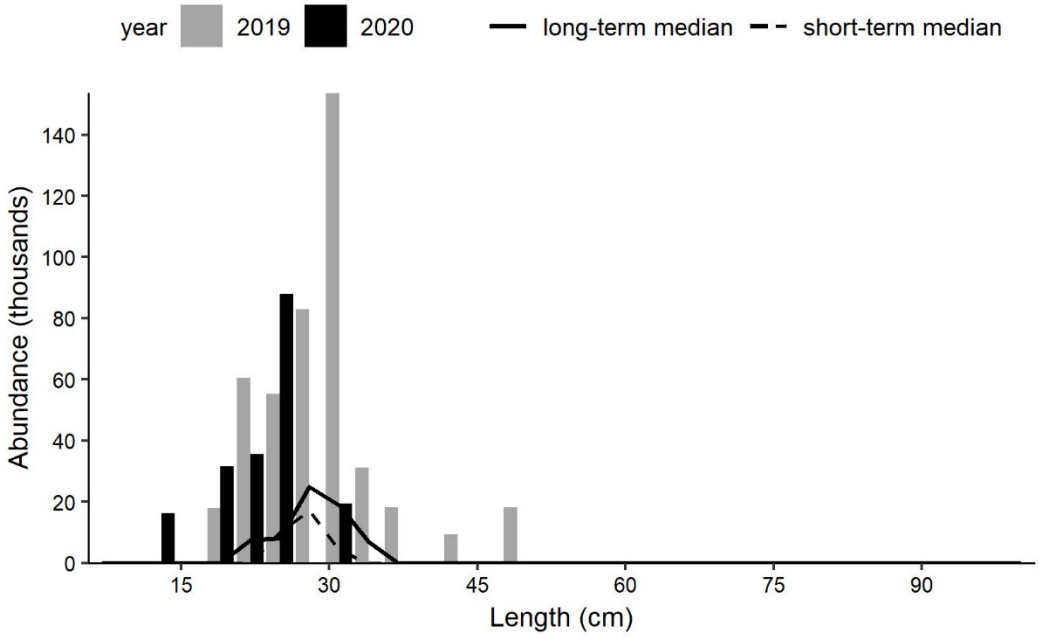


*Figure 26e. Length-frequency indices for Ocean Pout in 4VW from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## Blackbelly Rosefish

Blackbelly Rosefish (*Helicolenus dactylopterus*) are caught primarily in the deeper warmer waters of the Fundian Channel and along the edge of the Scotian Shelf during the Summer RV Survey (Figure 27a). They would also generally be found in the deeper strata along the shelf edge (370 m–750 m); however, these strata were not sampled in 2020 due to lost vessel time. Blackbelly Rosefish have been caught in the survey in all years since 1980, but their biomass index has increased since 1990 and has varied at a higher level since about 2004 (Figure 27b). The 3-yr GM is well above the long-term GM and the 2020 biomass index is the highest in the time series.

The short-term median indices-at-length are generally higher than the long-term indices-at-length, particularly above 25 cm; this reflects the overall increase in abundance, particularly for larger fish, which were rarely caught earlier in the series (Figure 27c). In 2019, indices-at-length were generally similar to the short-term median values, while in 2020 indices are higher for smaller fish.

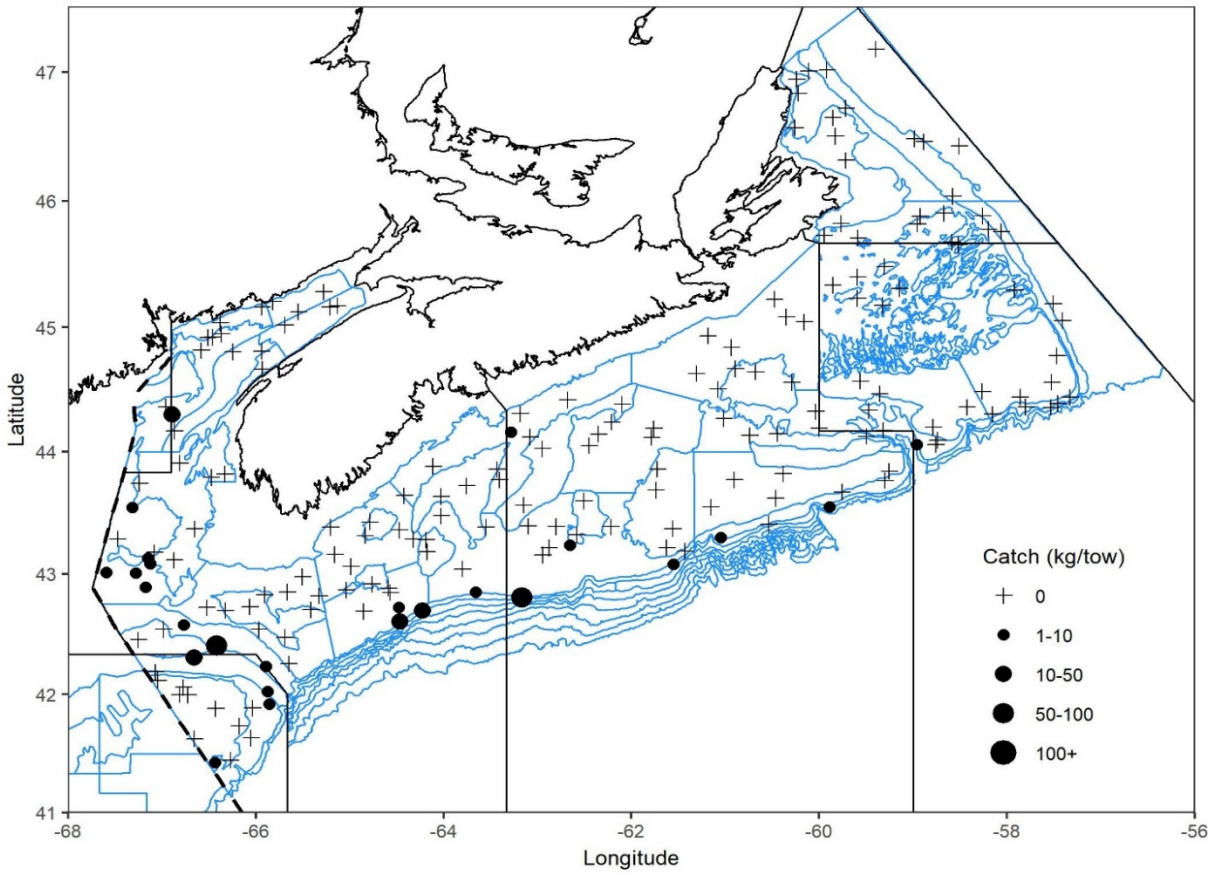


*Figure 27a. Distribution of Blackbelly Rosefish catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

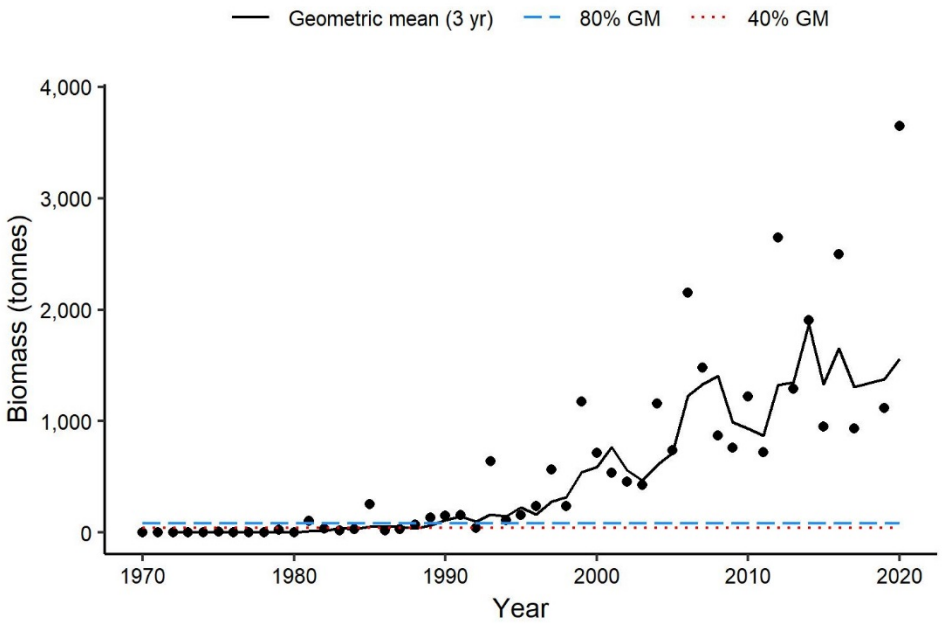


*Figure 27b. Biomass index for Blackbelly Rosefish in 4VWX from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

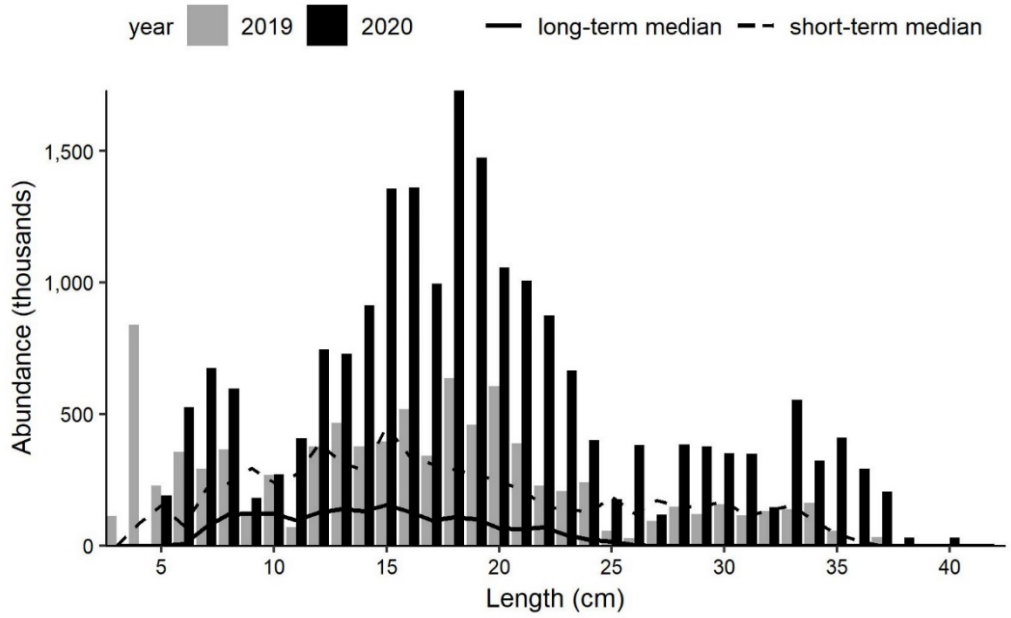


*Figure 27c. Length-frequency indices for Blackbelly Rosefish in 4VWX from the DFO Summer RV Survey. Black bars represent the number in thousands at length from the 2020 survey. Grey bars represent the number in thousands at length from the 2019 survey. The solid black line represents the median in thousands at length for the time period 1970–2017. The dashed black line represents the median in thousands at length for the time period 2008–2017.*

## John Dory

John Dory (*Zenopsis conchifer*) are caught during the Summer RV Survey primarily in the deeper warmer waters along the edge of the Scotian Shelf and in the Scotian Gulf (South of Halifax), as well as in the Fundian Channel (Figure 28a). John Dory catches were rare for most of the time series, but, since 2014, they have been caught every year, with the largest catch exceeding 150 kg (Figure 28b). While their distribution remains restricted within the survey area, they can be locally abundant. John Dory caught in the survey have included adults in spawning condition.

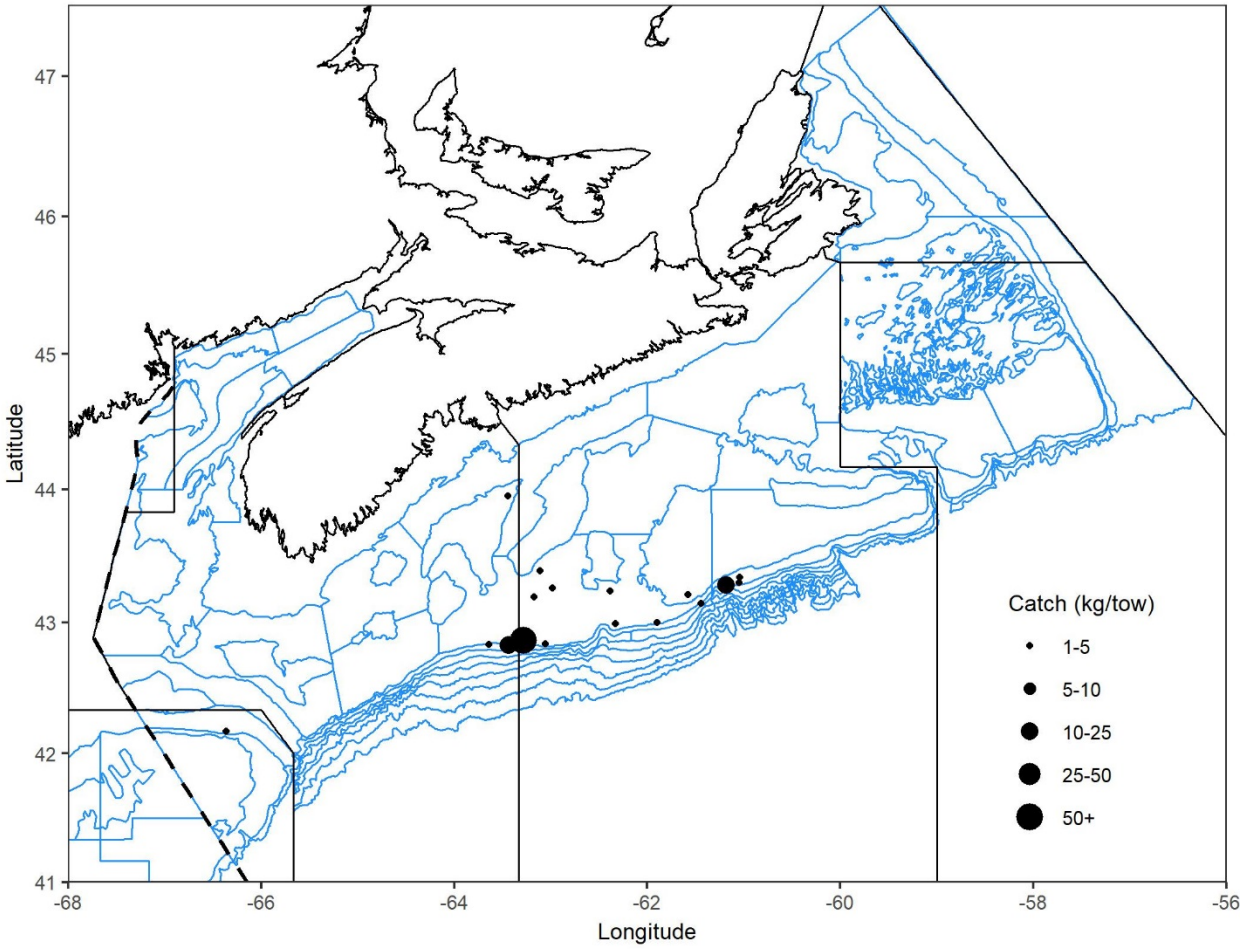


*Figure 28a. Distribution of John Dory catches during the DFO Summer RV Surveys from 2014–2020. Black circles represent catches. The circle area is proportional to the catch size.*

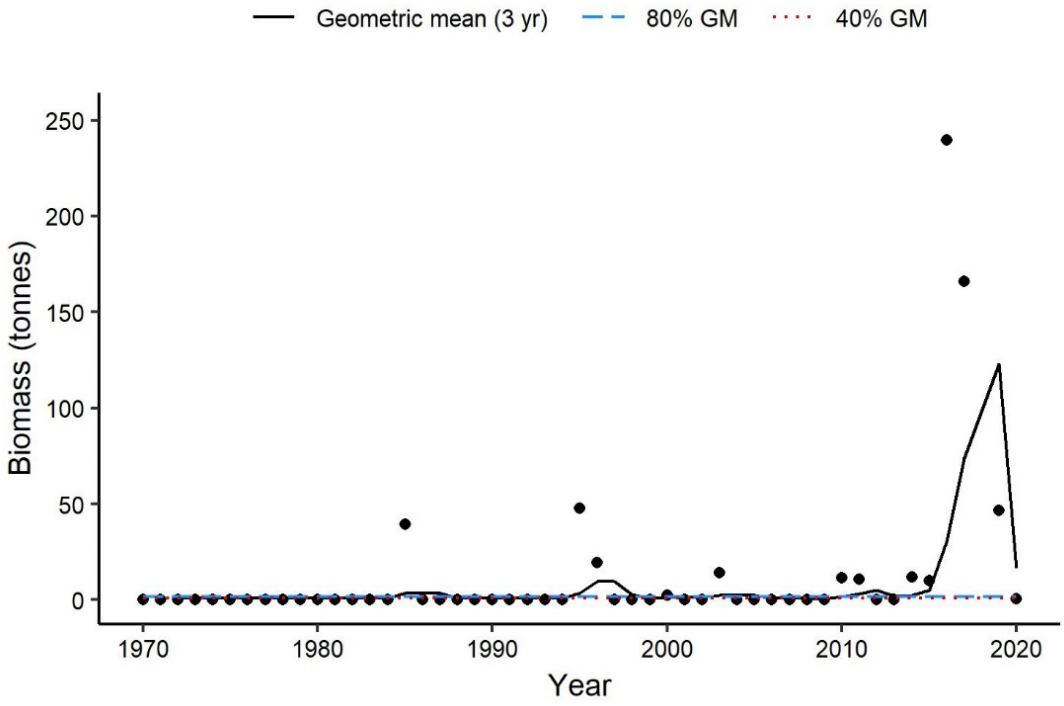


*Figure 28b. Biomass index for John Dory in 4VWX from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

## Shortfin Squid

Shortfin Squid (*Illex illecebrosus*) are a short-lived, highly migratory species, with a broad distribution in the North Atlantic. They are caught throughout the survey area (Figure 29a). The biomass indices for Shortfin Squid since 2017 have been among the highest observed in the time series, and, in 2020, the 3-yr GM is the highest in the time series (Figure 29b).

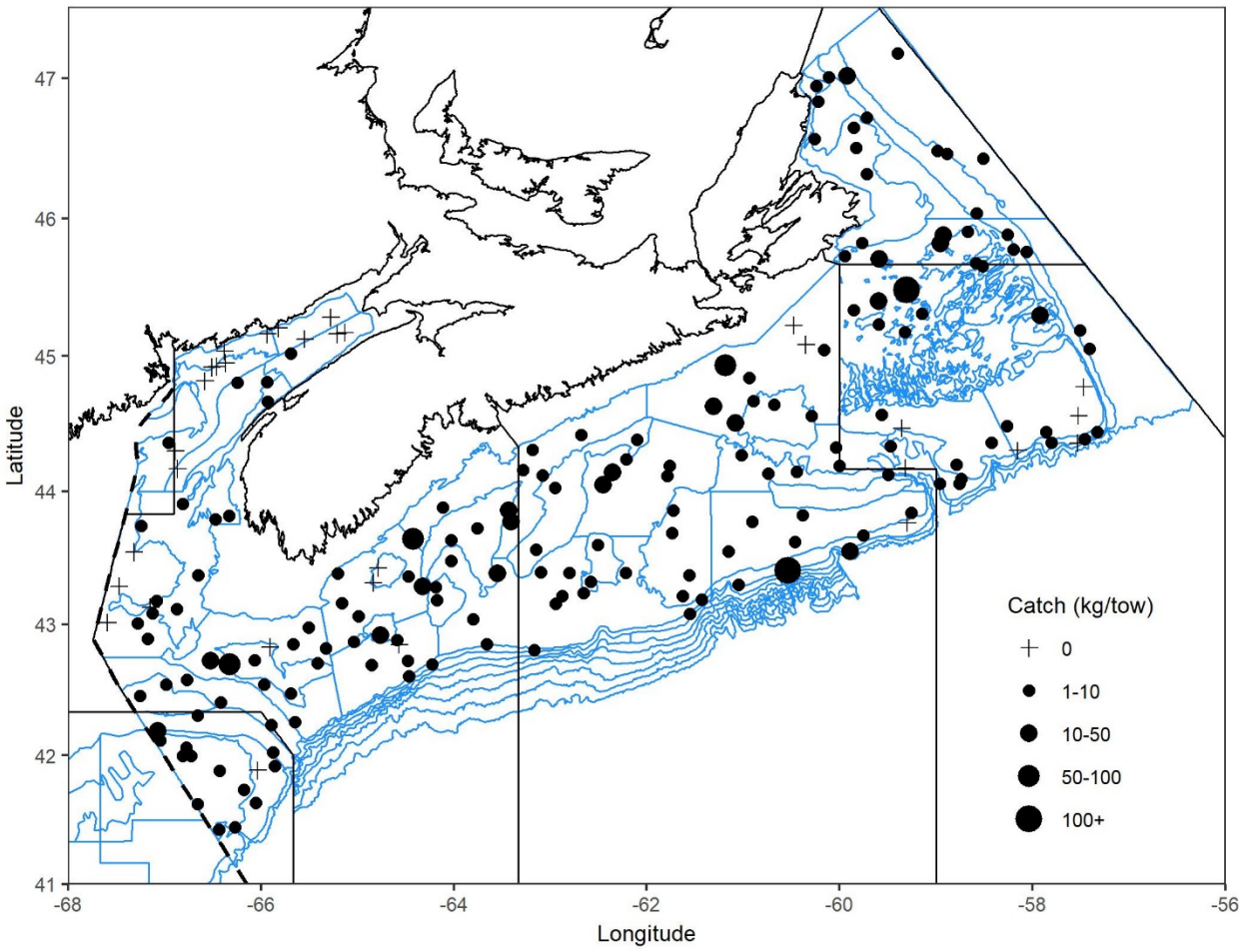


*Figure 29a. Distribution of Shortfin Squid catches during the 2020 DFO Summer RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

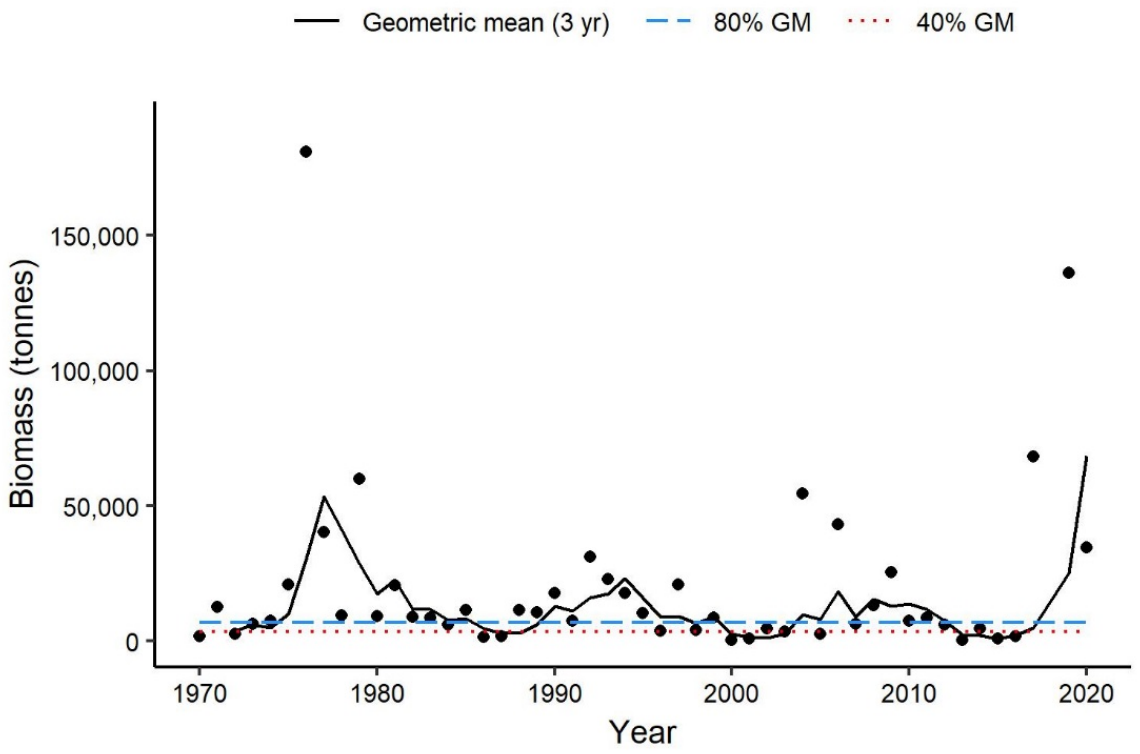


*Figure 29b. Biomass index for Shortfin Squid in 4VWX from the DFO Summer RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2019), respectively. The black dots represent the biomass index for that year.*

## Other Species

Dusky Shark (*Carcharhinus obscurus*) is a large pelagic shark. None have been captured in any Maritime Region survey, and these surveys are unlikely to provide useful information on distribution or abundance for this species.

Triggerfish (*Balistes capriscus*) are a demersal fish common off Florida and in other sub-tropical waters on both sides of the Atlantic. They are a demersal fish, which should be susceptible to capture by a bottom trawl; however, only one specimen has ever been caught in the Summer RV survey time-series. If these are being captured in commercial fisheries, it may be a seasonal migrant or may be found in depths not regularly sampled by the survey.

Tilefish *(Lopholatilus chamaeleonticeps*) are large, slow-growing fish found in deep, warm waters off the US coast from the Gulf of Mexico to Georges Bank. Four specimens have been caught during the time series, ranging in size from 1.0 to 10.3 kg. All four specimens were captured in locations where the bottom temperature exceeded 10 oC. This species is caught in both recreational and commercial fisheries off the US coast, generally with hook and line. The Summer RV surveys may not be suitable for providing useful information on distribution or abundance for this species.

Black Sea Bass (*Centropristis striata*) are a demersal species found from the Gulf of Mexico to Maine. This species has been caught during winter surveys on Georges Bank but has not been recorded during the Summer RV Survey.

## Temperature

The average bottom temperature recorded during the Summer RV Survey time series is 5.7 °C. This varies annually, but, since 2012, bottom temperatures have, in general, been the warmest in the series (Figure 30). Bottom temperature varies greatly across the area covered, ranging from below 2 °C to above 11 °C, with the warmest waters on Georges Bank, in the Bay of Fundy, and on the central Scotian Shelf (Figure 31). Temperatures are above the long-term average over much of the survey area, with the greatest positive anomalies in 2020 seen in 4W and eastern 4X (Figure 32). This variation in temperature influences species assemblage dynamics over the area.

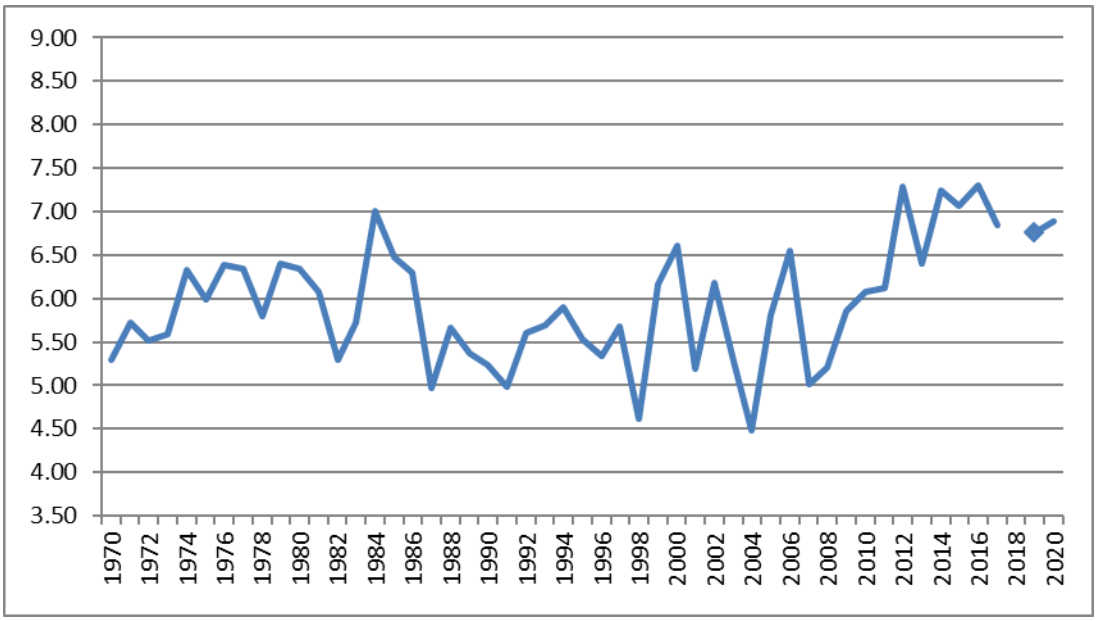


*Figure 30. Average annual bottom temperature (°C) from the DFO Summer RV Survey.*

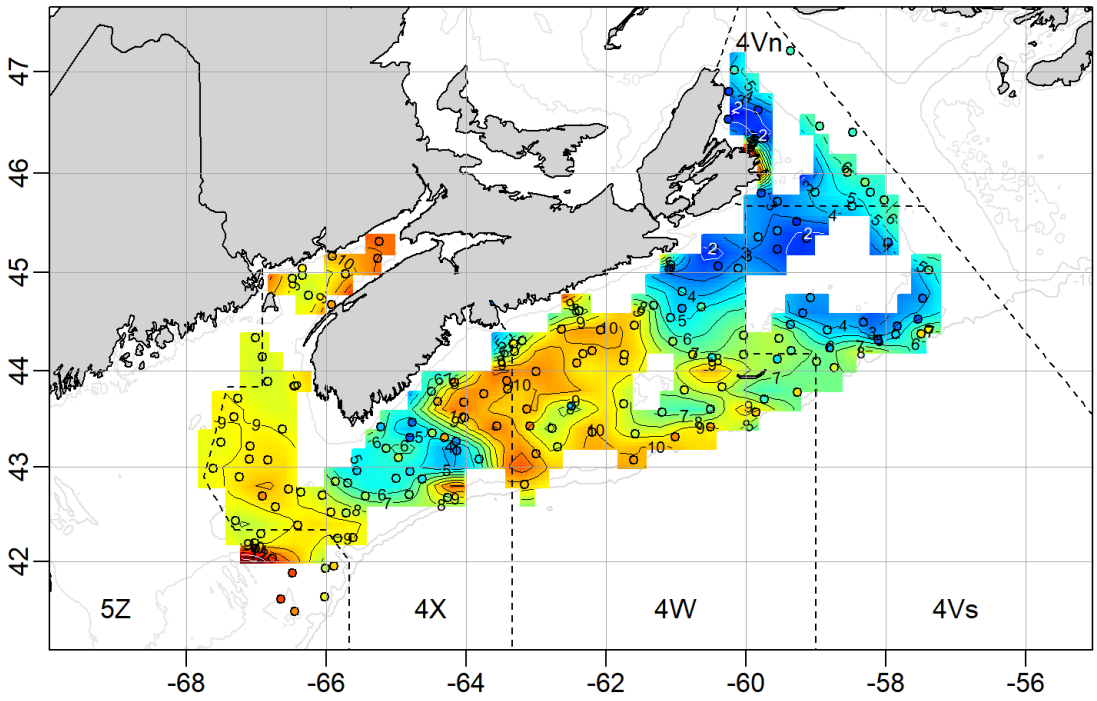


*Figure 31. Bottom temperatures (°C) from the 2020 DFO Summer RV Survey.*

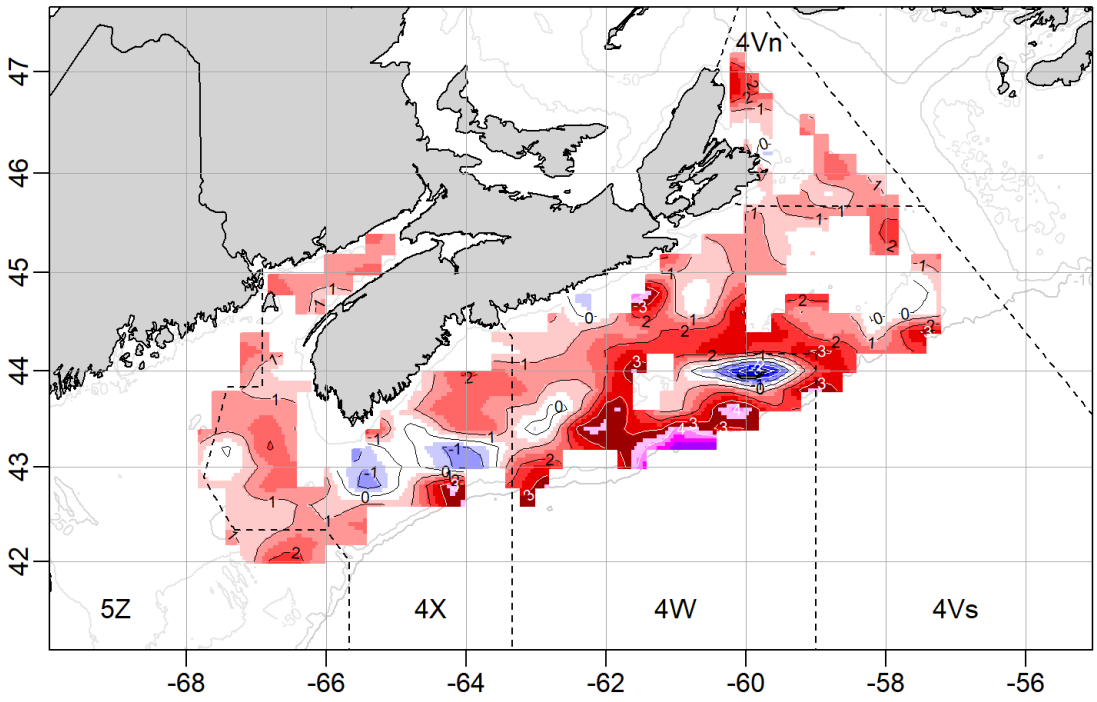


*Figure 32. Bottom temperature anomalies (°C) from the 2020 DFO Summer RV Survey.*

# Conclusions

In 2020, 195 successful bottom trawl tows were conducted out of the 280 stations initially selected, and all standard strata in the survey area were sampled at least at the minimum acceptable level. In addition, sampling was completed at the Halifax hydrographic station three times.

As water temperatures warm on the Scotian Shelf, it is expected that more southern species will appear in the survey and will become established in the region. In 2020, the biomass index for Blackbelly Rosefish is the highest in the time series.

The total biomass index for demersal fish from the survey has been low in 4V since the 1990s. In 4W, total demersal fish biomass index increased in the 1980s, then declined in the 1990s. Recently, in 4W, the biomass index has declined to the lowest levels in the time series as Haddock biomass has declined.

The total biomass index for 4X shows high inter-annual variability but no clear trend over time. The large drop in biomass index from 2018–2019 reflects lower catches for most demersal species. The biomass index in 2020 did not change significantly from 2019, but it is slightly higher, largely due to increases in Silver Hake.

The numbers of large fish have been low for several species in recent years, and, for some species, the length range has been constricted. This constriction is apparent in the length-frequency figures, with the long-term median length frequency extending to larger sizes or with much lower numbers at larger sizes in the most recent 10 years for species including Cod, Haddock, Witch Flounder, American Plaice, Thorny Skate, and Ocean Pout.

The abundance index for Age 0 4X Haddock was the highest in the time series in 2018, but this has not carried through to 2019, where there is no indication of strong year-classes for either Age 0 or 1. In 2020, there has been a rebound, and abundance indices are at or above the short-term median for lengths below 15 cm.

The 3-yr GM for 4X Cod, 4Vn Cod, 4VW White Hake, 4VW Yellowtail Flounder, 4VW Winter Skate, and 4X Ocean Pout are the lowest in the time series. The 2020 biomass indices for 4VW Yellowtail Flounder, 4VW Thorny Skate, 4VW Winter Skate, and 4X Ocean Pout are also the lowest in the time series. The 2020 biomass index for 4VW Haddock is the lowest it has been since 1973.

The 3-yr GM for 4X Cod, 4X Yellowtail Flounder,4X American Plaice, 4VW American Plaice, 4X Thorny Skate, 4VW Thorny Skate, 4VW, Winter Skate,4X Wolffish, 4VW, Wolffish, 4X Ocean Pout, and 4VW Ocean Pout have been consistently below 40% of the long-term GM for several years.

The 3-yr GM for 4X West (Bay of Fundy) Silver Hake, 3NOPs4VWX5Zc Atlantic Halibut, 4VW Witch Flounder, 4X Winter Flounder, 4X Little Skate, 4X Red Hake, 4VW Red Hake, 4X Smooth Skate, and 4VWX Spiny Dogfish have been consistently above 80% of the long-term GM for several years.

Biomass indices for White Hake > 41 cm in 4X and 4VW remain in the Critical Zone in 2020, relative to the biomass recovery targets.

Changes in biomass indices from one year to the next for individual species should be interpreted cautiously. A 3-yr GM of the survey biomass indices reduces the apparent variability in biomass estimates and may better reflect actual biomass trends. For those species where a population model is used, the inter-annual variability in population biomass estimates is lower

than the variability in survey estimates. Additional information from commercial landings and age composition, where available, can help in interpreting survey data.

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