Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

**Canadian Science Advisory Secretariat**
**Maritimes Region** **Science Response 2017/004**

# 2016 MARITIMES RESEARCH VESSEL SURVEY TRENDS ON THE SCOTIAN SHELF AND BAY OF FUNDY

## 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. 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. Fisheries and Aquaculture Management (FAM) requested a review of the DFO Summer RV survey information on the following list of fish stocks: 4Vn Atlantic Cod, 4VsW Atlantic Cod, 4X5Y Atlantic Cod, 4VW Haddock, 4X5Y Haddock, 4X White Hake, 4VW White Hake, 4VWX Silver Hake, 4VWX+5 Pollock, Unit II Redfish, 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, and 4VWX Spiny Dogfish. 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 2017.

This Science Response Report results from the Science Response Process of December 1, 2016, on the Stock Abundance Trends from the Maritimes Research Vessel Survey of the Scotian Shelf and Bay of Fundy.

## Background

The DFO Summer RV survey of the Scotian Shelf and Bay of Fundy has been conducted annually since 1970, using a standardized protocol since 1970 (Figure 1). The surveys follow a stratified random sampling design, and include sampling of fish and invertebrates using a bottom otter trawl. 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. These changes may affect the biomass trends for some species. For long-term averages, the most appropriate starting point has been selected for each species (for details see Clark and Emberley 2011).

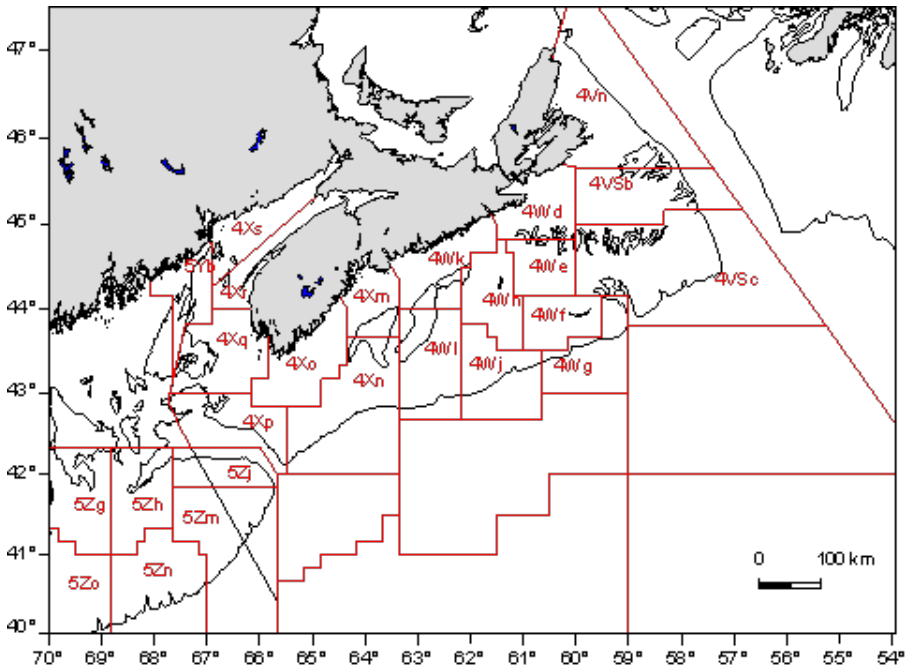


*Figure 1. Northwest Atlantic Fisheries Organization (NAFO) Unit Areas.*

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. Sampling was conducted in all 4VWX5Yb strata and in the deeper strata of area 5Zc (Canadian portion of 5Z). Sampled area has expanded to include strata 558 and 559 in 2015 and 5Z2 in 2016. 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 2015 and 2016 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 2015) are also included, using data from the geographic areas that are used in the assessments for those stocks. The expanded survey strata are not used in biomass or length frequency calculations because they have only been sampled for a short time frame.

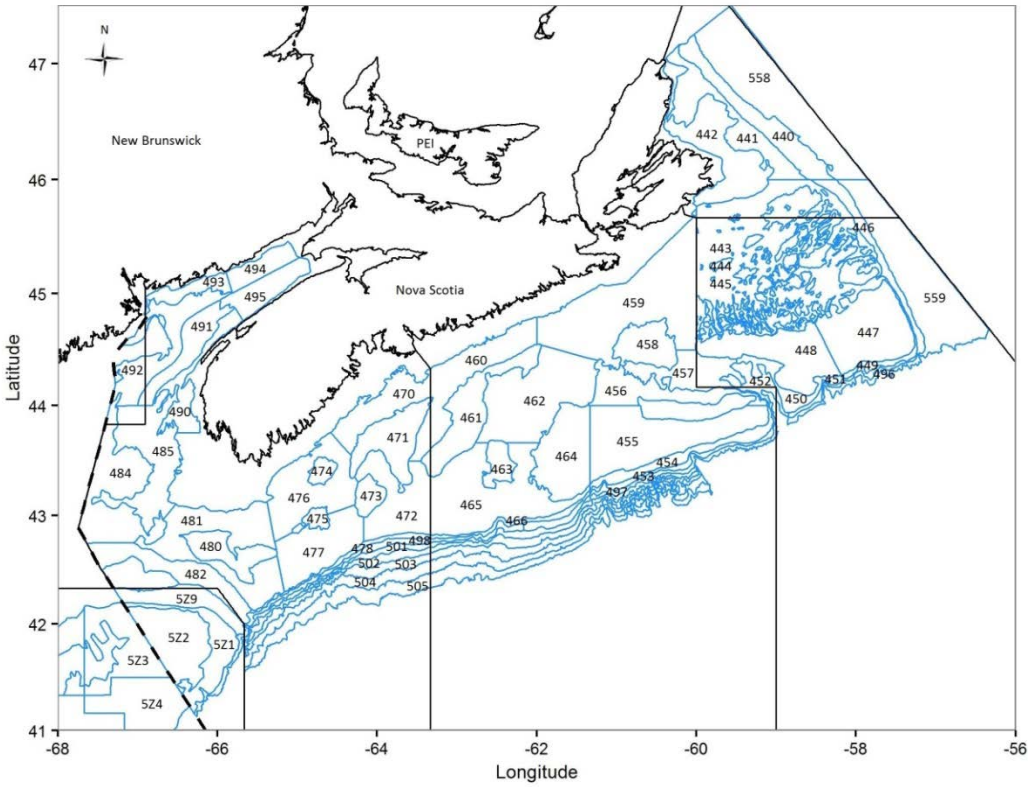


*Figure 2. 2016 DFO Summer Research Vessel survey strata.*

## Analysis

The stratified random survey design ensures that sampling occurs 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 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 there are other data to aid interpretation.

The time-series of survey biomass indices are compared to averages for a series of time periods to provide historical context for biomass levels. The time periods used are a short-term 5-year average (2011-2015), a medium-term 15-year average (2001-2015), and the long-term survey average (1970-2015) (Table 1). These data are used to compare recent biomass indices to the long-term average. For each stock, it was determined whether the short-term biomass was <20%, <50%, or <70% of the long-term average. Length frequency data are included to allow comparisons of recent length range and numbers-at-length with the long-term average.

This can also be used as an indication of recruitment strength for species such as Haddock where recruitment pulses are apparent in the length frequency.

*Table 1. DFO Summer Research Vessel survey biomass indices (tonnes) for species by stock/region for 2014, 2015, 2016 and averages for long-term (1970-2015), medium-term 15-year (2001-2015), and short-term 5-year (2011-2015) time periods. Only strata 440-495 were included in calculations.*

| Stock/Region (page number) | 2014 | 2015 | 2016 | 1970-2015 Avg | 2001-2015 Avg | 2011-2015 Avg |
|---|---|---|---|---|---|---|
| 4X Atlantic Cod (p6) | 2,786 | 3,722 | 5,195 | 19,397 | 7,599 | 3,122 |
| 4VsW Atlantic Cod (p7) | 23,393 | 3,464 | 1,691 | 49,207 | 17,299 | 13,762 |
| 4Vn Atlantic Cod (p8 | 2,388 | 1,729 | 20,643 | 14,500 | 4,178 | 2,175 |
| 4VW Haddock (p11) | 37,638 | 20,093 | 32,209 | 58,191 | 57,175 | 32,099 |
| 4X Haddock (p10) | 42,911 | 69,820 | 62,550 | 56,031 | 53,192 | 45,233 |
| 4VW White Hake (p15) | 3,159 | 5,767 | 5,221 | 9,605 | 4,865 | 3,729 |
| 4X White Hake (p13) | 9,582 | 6,452 | 11,216 | 17,889 | 11,033 | 8,155 |
| 4VWX Silver Hake (p18)* | 60,364 | 40,230 | 46,074 | 36,778 | 32,091 | 47,227 |
| Western Component Pollock (p20) | 9,752 | 5,199 | 32,192 | 29,409 | 27,522 | 11,234 |
| Eastern Component Pollock (p21) | 13,654 | 22,190 | 15,754 | 30,152 | 28,146 | 51,610 |
| Unit II Redfish (p23) | 55,170 | 14,675 | 64,701 | 48,788 | 39,200 | 31,638 |
| Unit III Redfish (p24) | 76,917 | 176,411 | 345,764 | 117,221 | 134,099 | 149,536 |
| 4X American Plaice (p32) | 525 | 273 | 299 | 1,945 | 974 | 547 |
| 4VW American Plaice (p33) | 3,369 | 5,669 | 3,515 | 22,872 | 14,078 | 9,085 |
| 4X Witch Flounder (p35) | 1,594 | 1,684 | 1,344 | 1,793 | 1,434 | 1,073 |
| 4VW Witch Flounder (p36) | 2,323 | 2,932 | 6,457 | 3,904 | 4,239 | 3,716 |
| 4X Yellowtail Flounder (p29) | 119 | 466 | 106 | 647 | 733 | 349 |
| 4VW Yellowtail Flounder (p30) | 11,485 | 9,690 | 9,973 | 13,443 | 10,241 | 11,364 |
| 4X Winter Flounder (p38) | 2,673 | 6,250 | 4,760 | 3,622 | 5,428 | 5,051 |
| 4VW Winter Flounder (p39) | 431 | 1,366 | 299 | 893 | 494 | 704 |
| 3NOPs4VWX5Zc Atlantic Halibut (p27) | 8,530 | 10,789 | 11,501 | 3,780 | 5,999 | 8,488 |
| 4X Atlantic Wolffish (p41) | 25 | 208 | 113 | 1,978 | 529 | 238 |
| 4VW Atlantic Wolffish (p42) | 267 | 142 | 159 | 1,855 | 687 | 272 |
| 4X Monkfish (p44) | 1,306 | 803 | 853 | 2,152 | 911 | 727 |
| 4VW Monkfish (p45) | 454 | 638 | 928 | 3,054 | 998 | 754 |
| 4X Smooth Skate (p62) | 344 | 339 | 476 | 471 | 350 | 292 |
| 4VW Smooth Skate (p63) | 40 | 81 | 160 | 441 | 157 | 107 |
| 4X Thorny Skate (p53) | 372 | 606 | 69 | 3,724 | 731 | 340 |
| 4VW Thorny Skate (p54) | 705 | 1,111 | 1,184 | 10,766 | 3,432 | 1,707 |
| 4X Barndoor Skate (p50) | 2,879 | 1,453 | 2,225 | 519 | 1,335 | 1,384 |
| 4VW Barndoor Skate (p51) | 712 | 253 | 1,169 | 306 | 408 | 674 |
| 4X Winter Skate (p56) | 206 | 1,134 | 818 | 985 | 837 | 970 |
| 4VW Winter Skate (p57) | 419 | 139 | 161 | 3,354 | 517 | 266 |
| 4X Little Skate (p59) | 536 | 1,726 | 1,325 | 821 | 995 | 1,171 |
| 4VW Little Skate (p60) | 76 | 0 | 44 | 134 | 92 | 109 |
| 4VWX Spiny Dogfish (p65) | 133,384 | 42,472 | 114,542 | 125,805 | 149,521 | 100,608 |
| 4X Longhorn Sculpin (p47) | 713 | 1,568 | 1,241 | 1,563 | 1,621 | 1,166 |
| 4VW Longhorn Sculpin (p48) | 1,261 | 2,147 | 1,085 | 2,777 | 2,481 | 1,477 |

*For silver hake, long-term average is 1982 – 2015

## Atlantic Cod

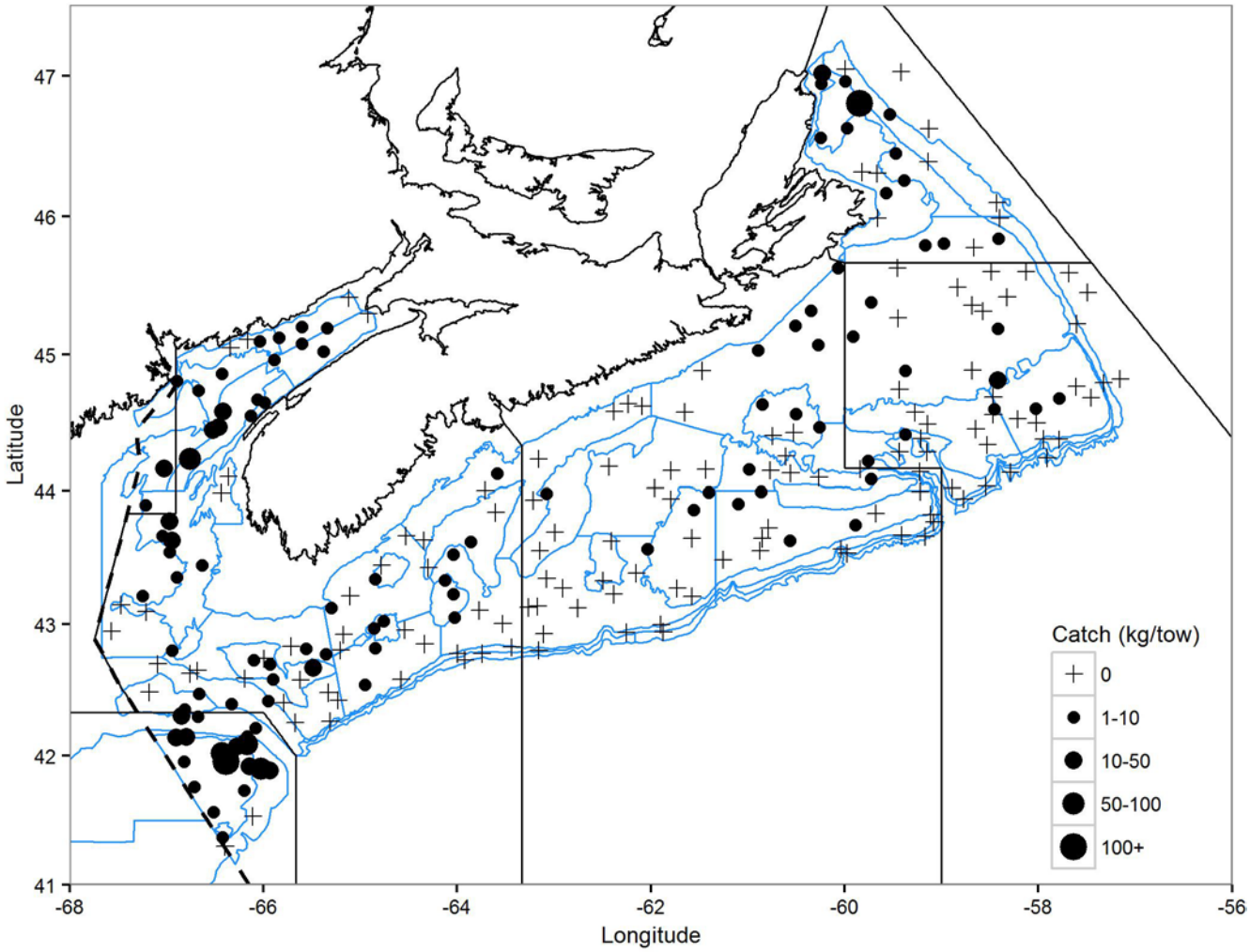


*Figure 3a. Distribution of Atlantic Cod catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

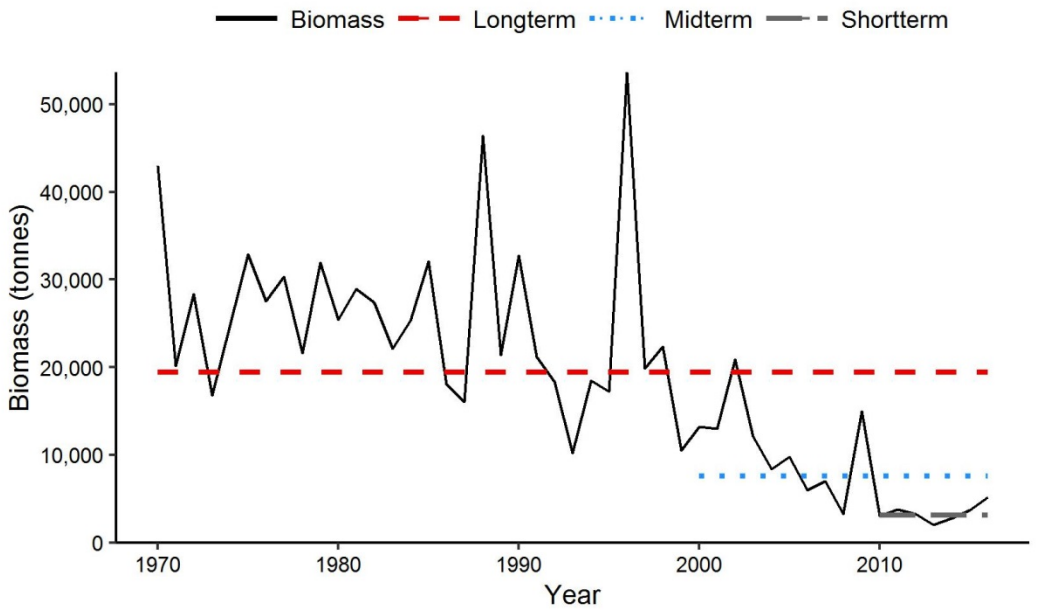


*Figure 3b. Biomass index for Atlantic Cod in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

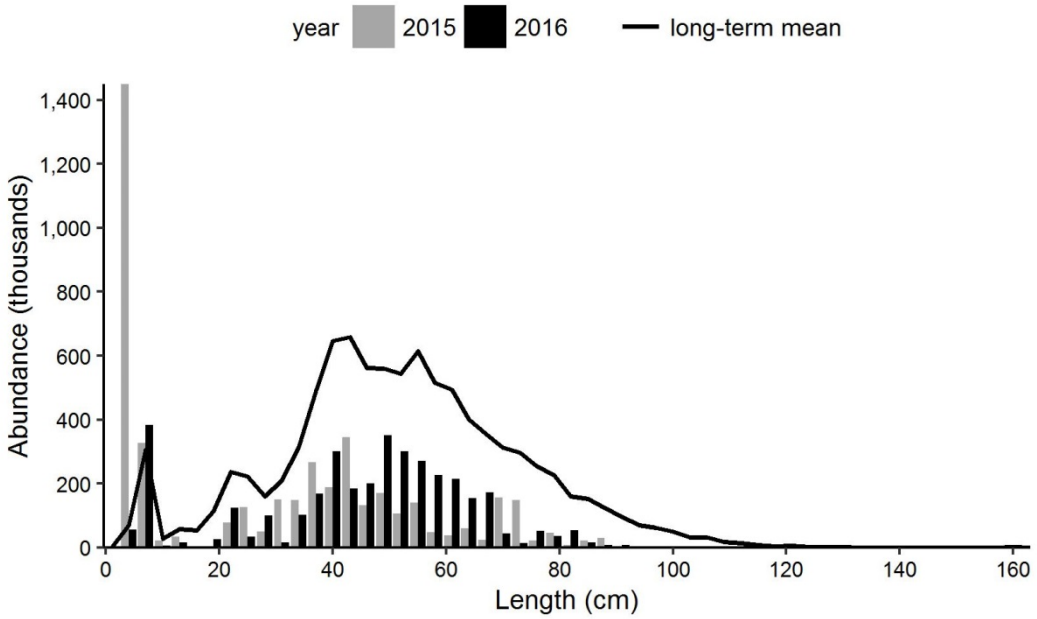


*Figure 3c. Length frequency indices for Atlantic Cod in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

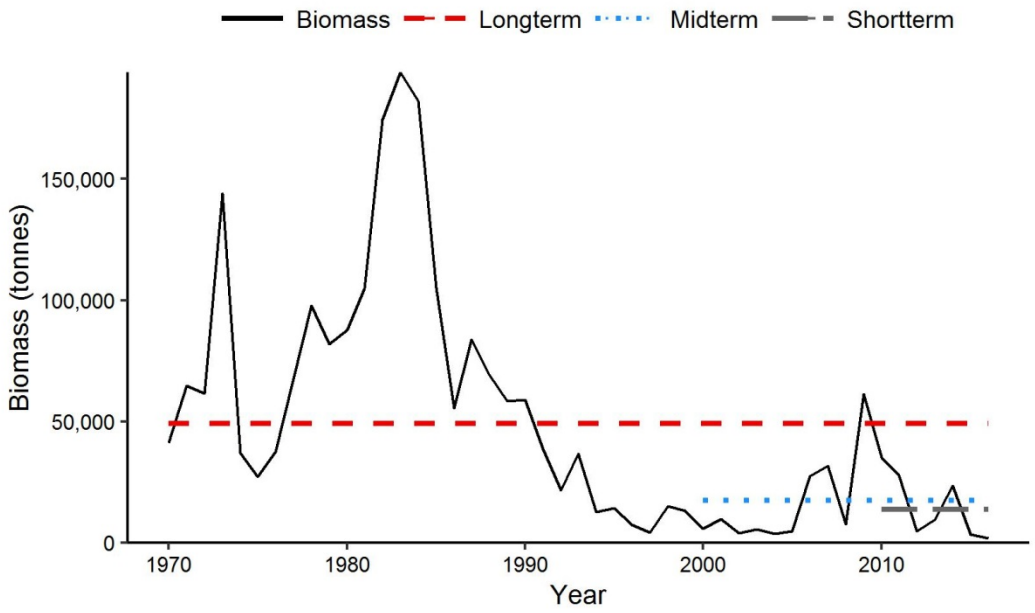


*Figure 3d. Biomass index for Atlantic Cod in 4VsW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

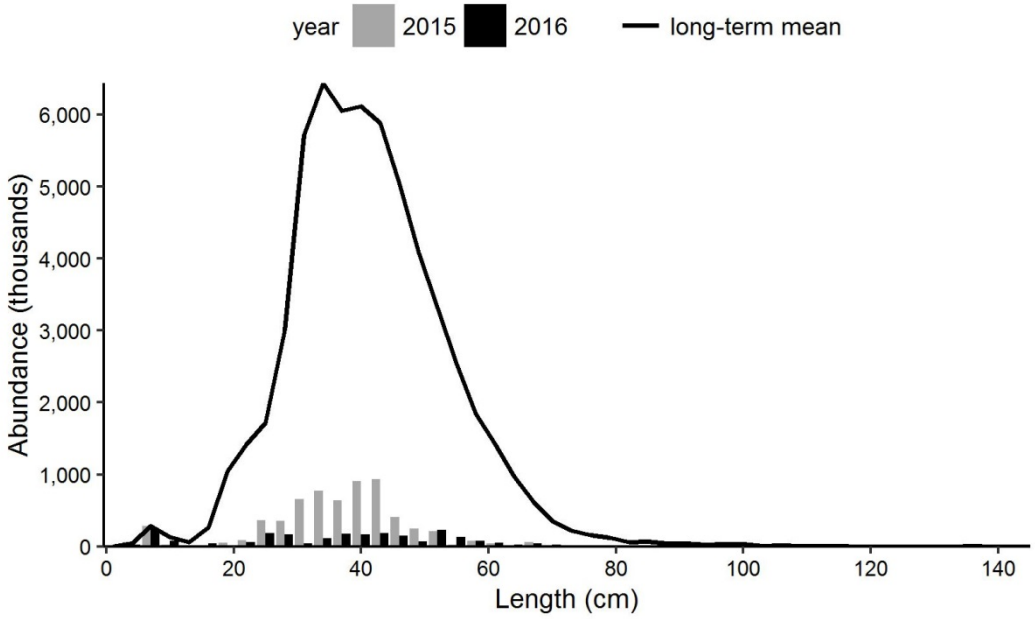


*Figure 3e. Length frequency indices for Atlantic Cod in 4VsW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

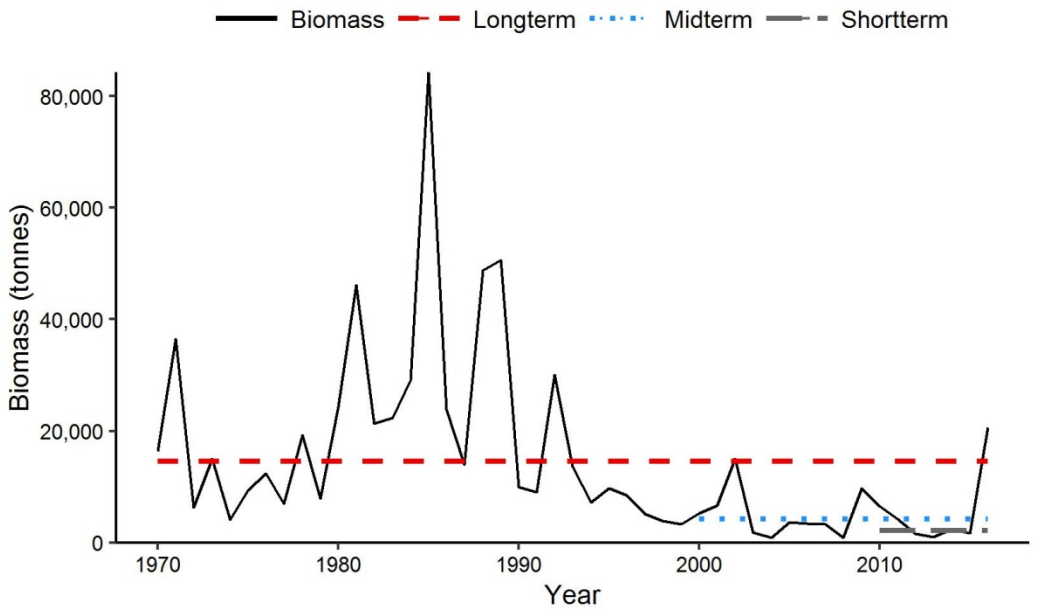


*Figure 3f. Biomass index for Atlantic Cod in 4Vn from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

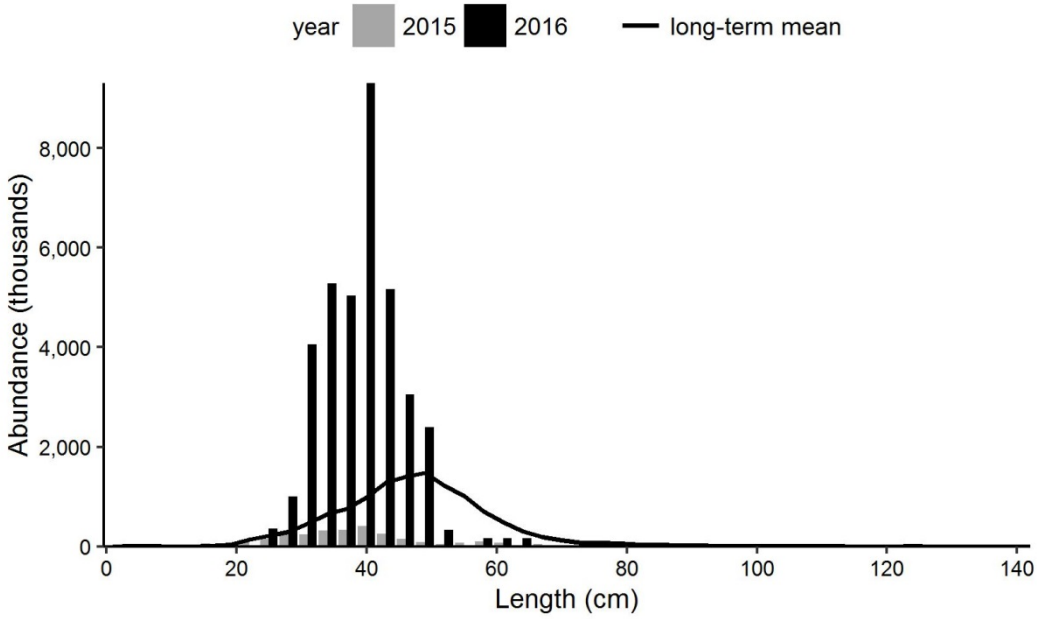


*Figure 3g. Length frequency indices for Atlantic Cod in 4Vn from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Haddock

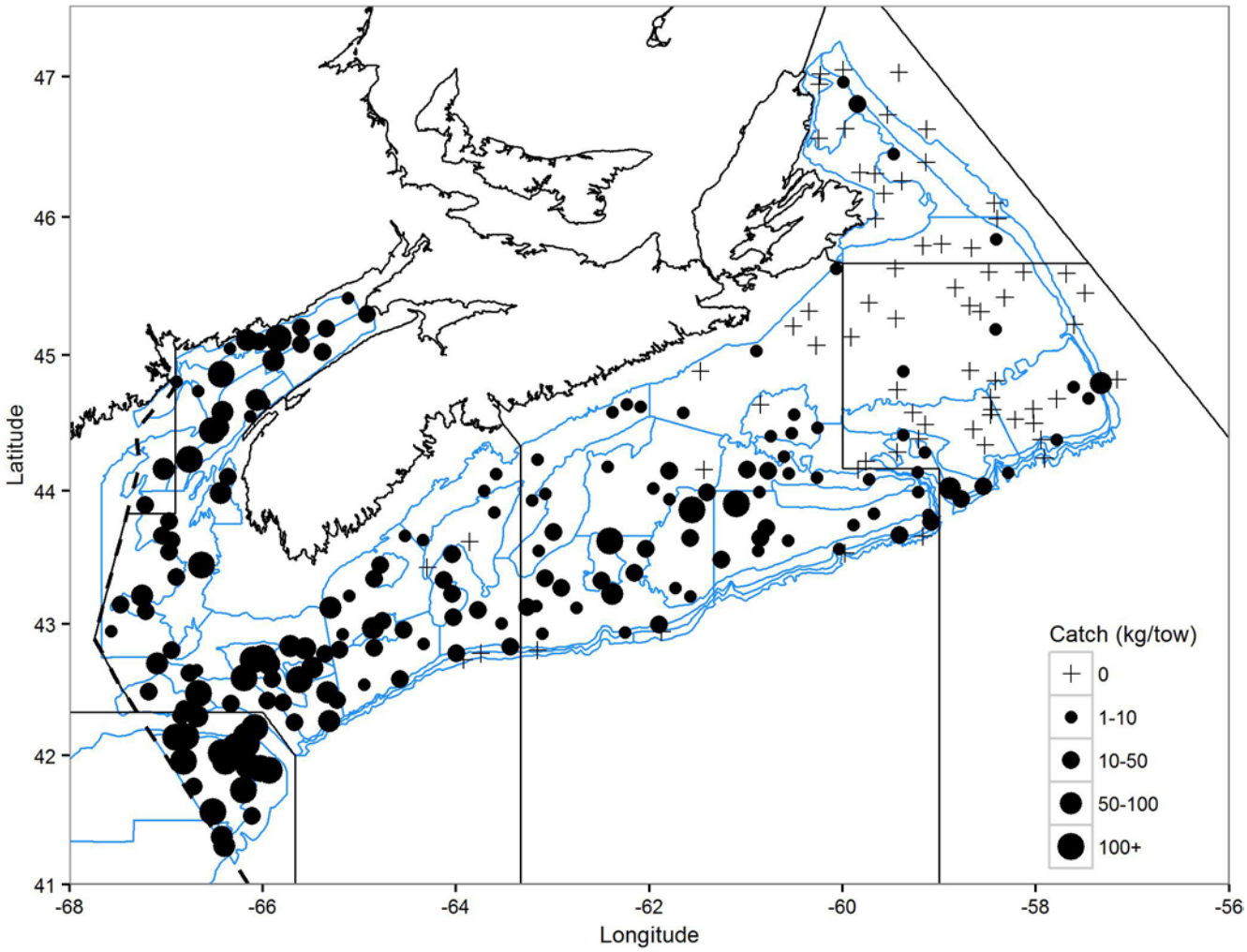


*Figure 4a. Distribution of Haddock catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

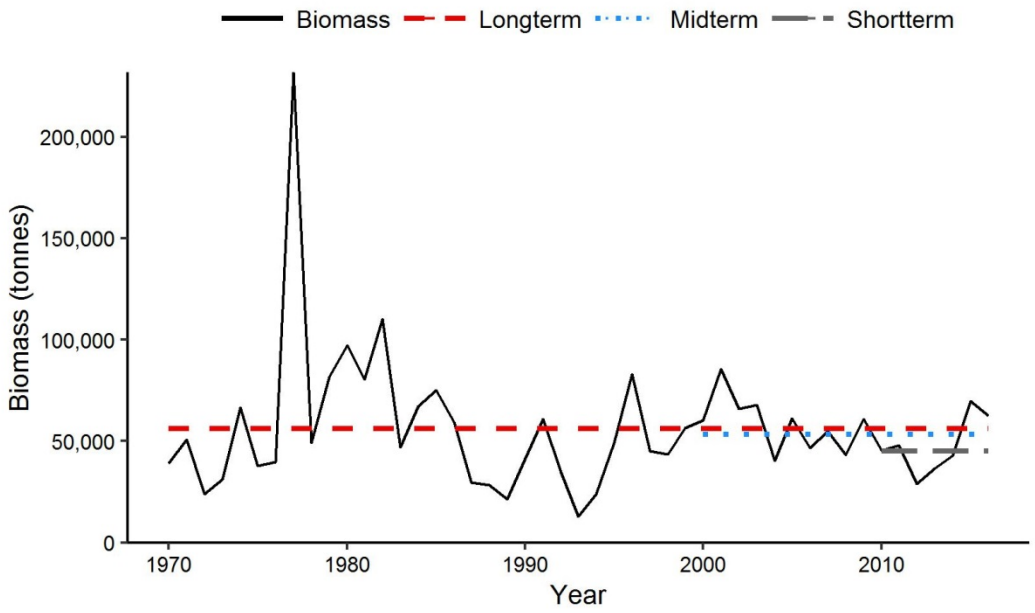


*Figure 4b. Biomass index for Haddock in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

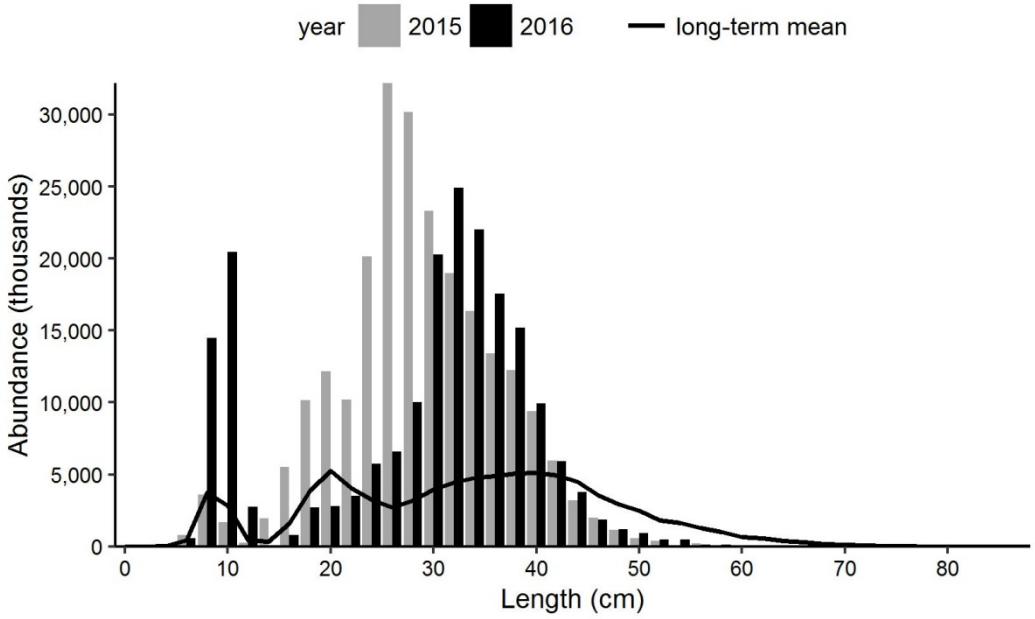


*Figure 4c. Length frequency indices for Haddock in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

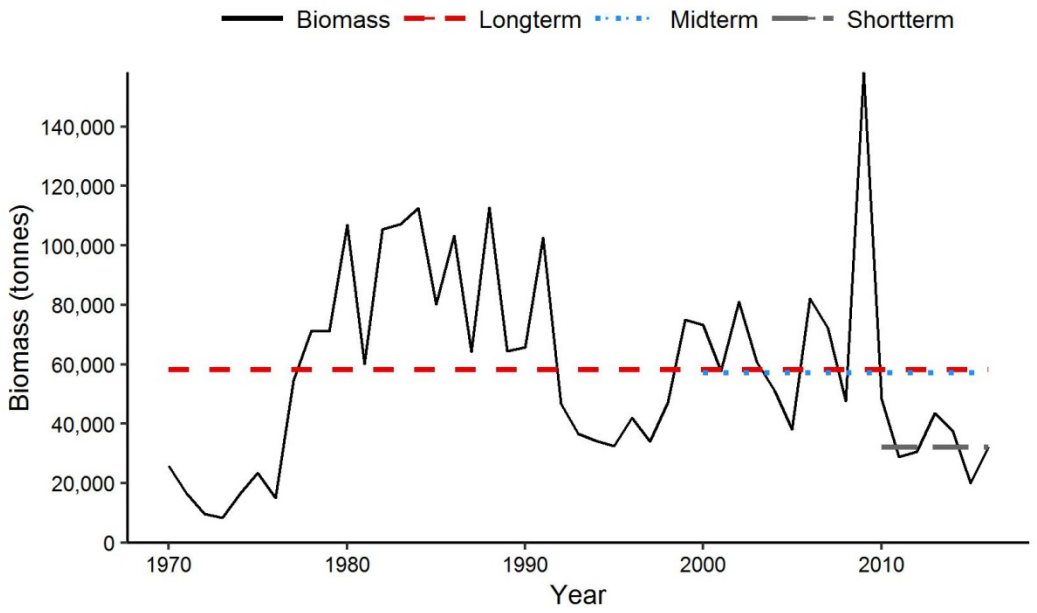


*Figure 4d. Biomass index for Haddock in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

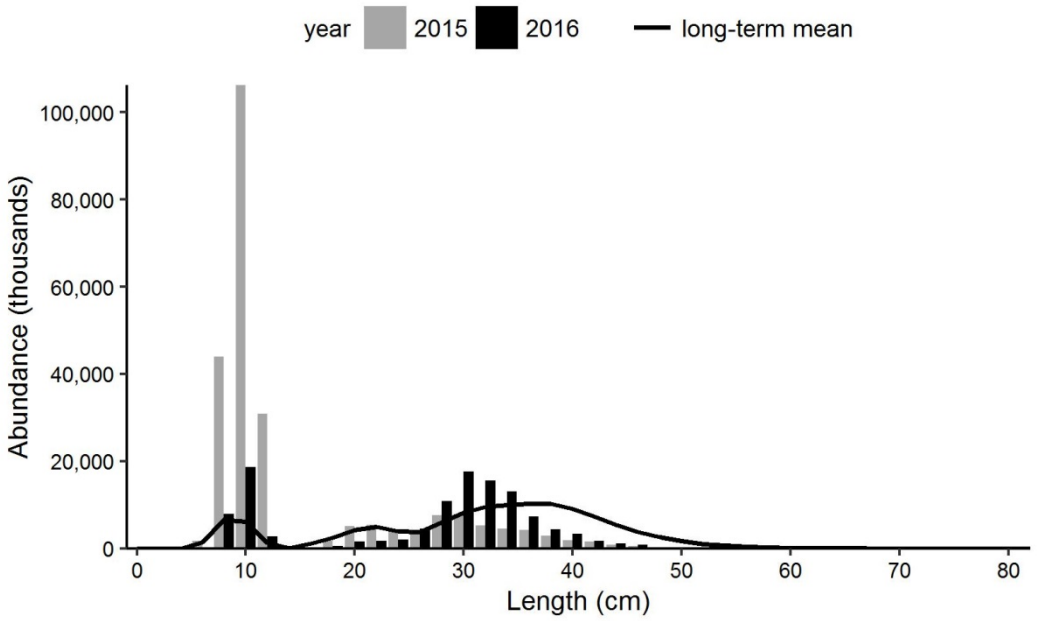


*Figure 4e. Length frequency indices for Haddock in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## White Hake

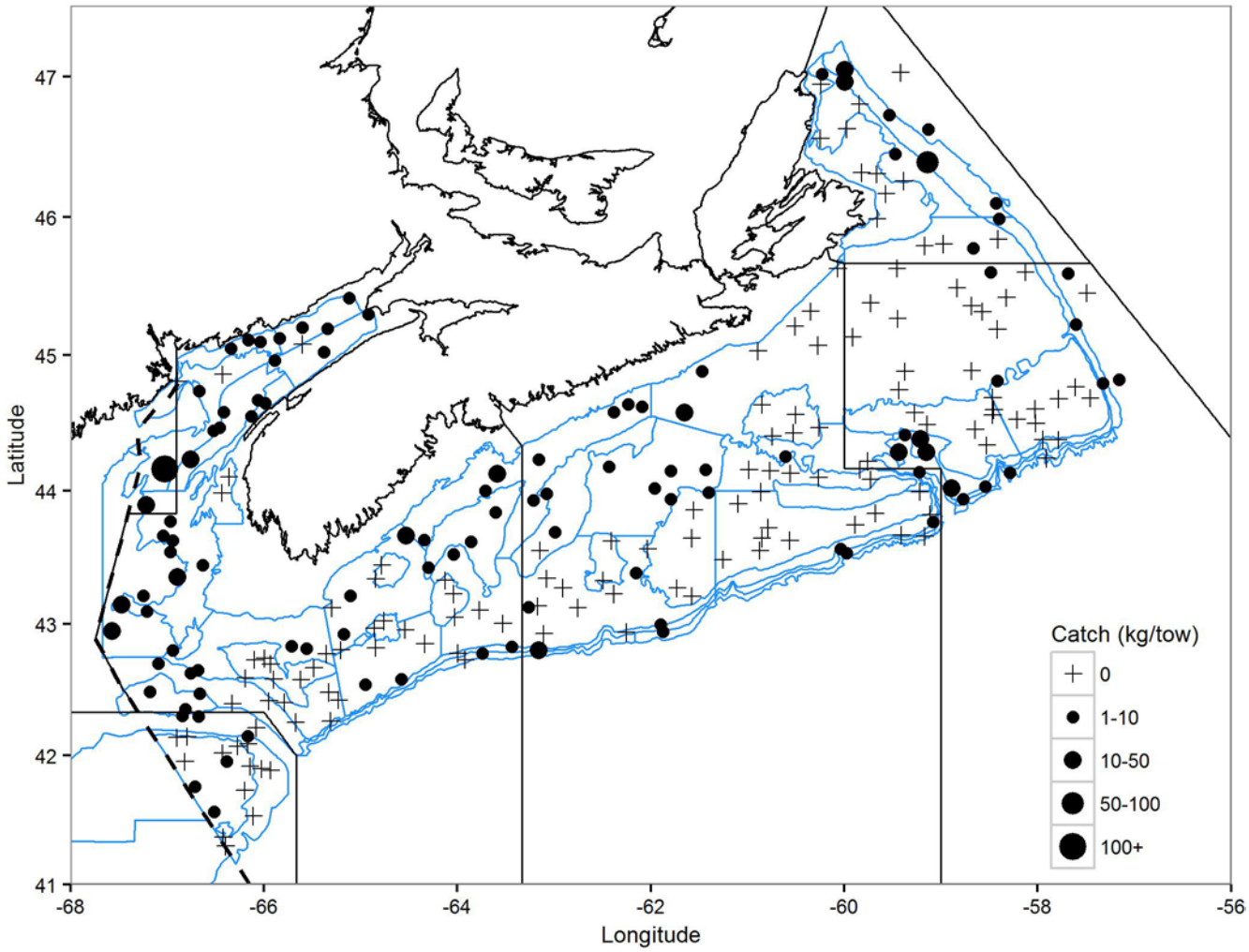


*Figure 5a. Distribution of White Hake catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

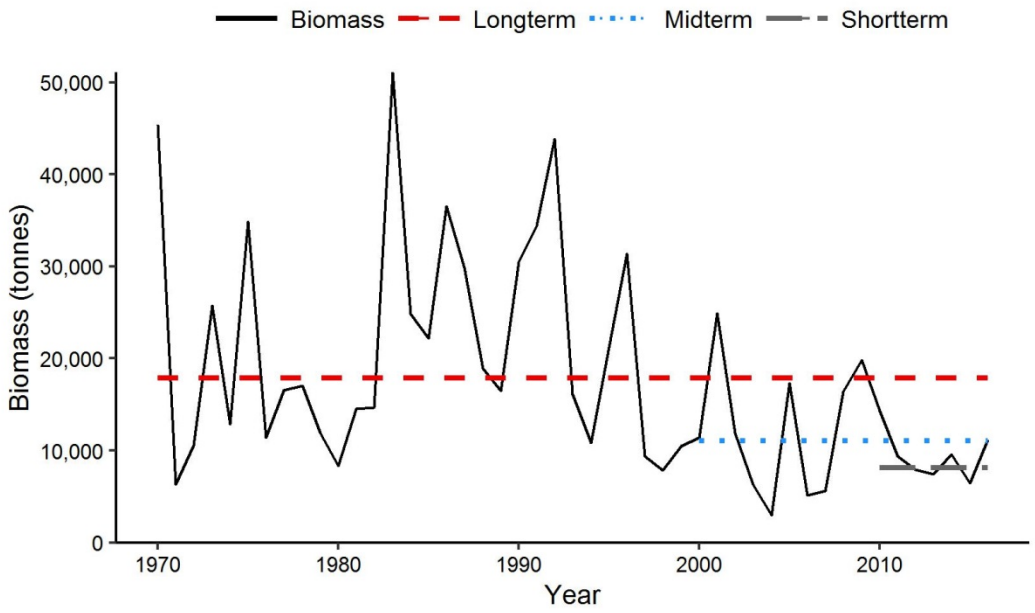


*Figure 5b. Biomass index for White Hake in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

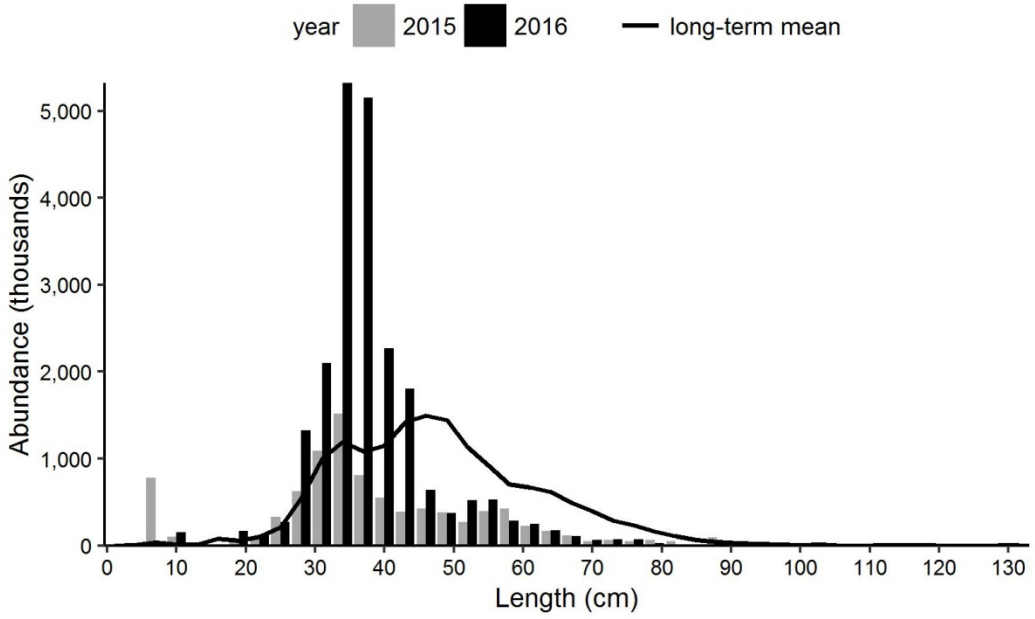


*Figure 5c. Length frequency indices for White Hake in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1982-2014.*

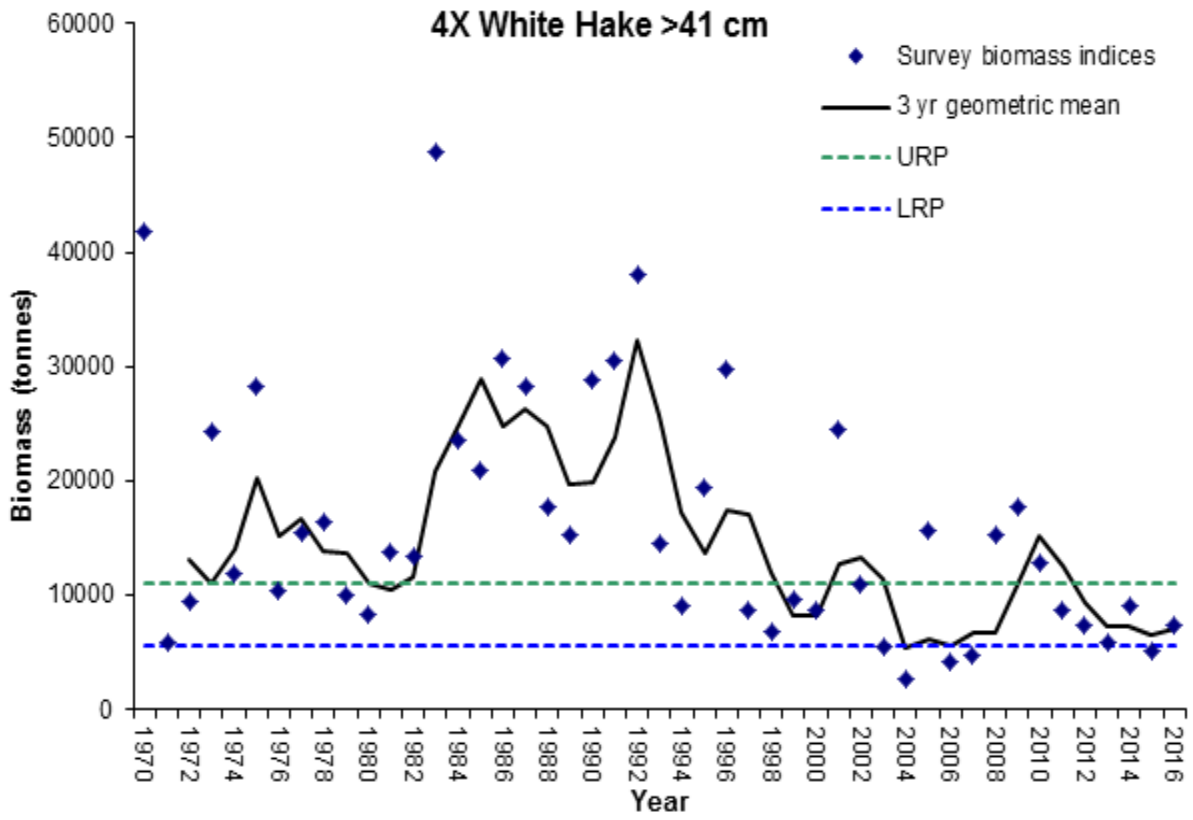


*Figure 5d. Biomass index for 4X White Hake >41 cm from the DFO Summer Research Vessel survey represented by the dark blue diamonds. The solid black line represents the 3 year geometric mean. The dashed blue line represents the lower limit reference point and the dashed green line represents the upper limit reference point.*

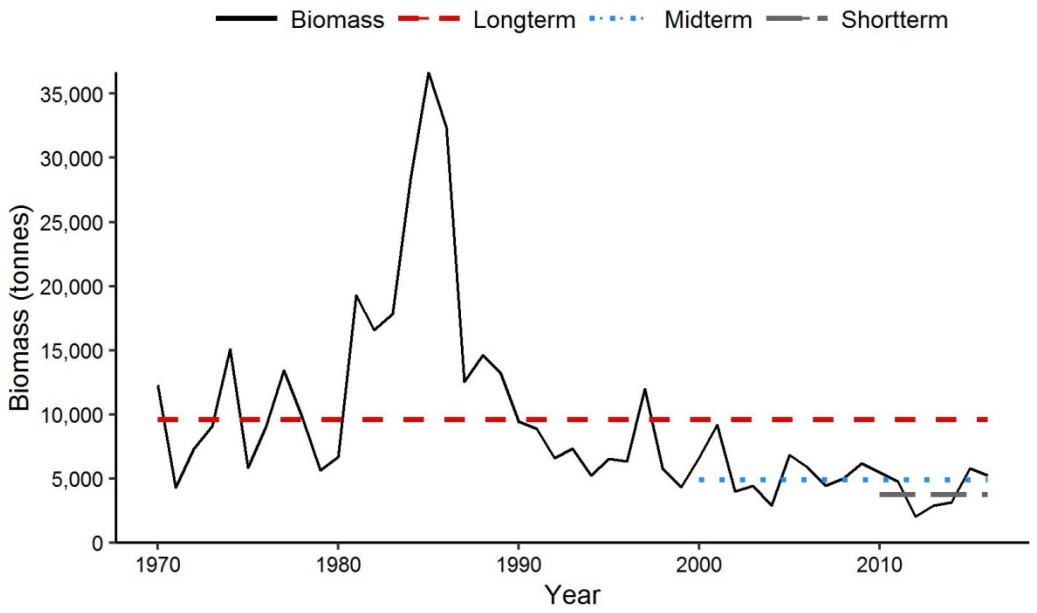


*Figure 5e. Biomass index for White Hake in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

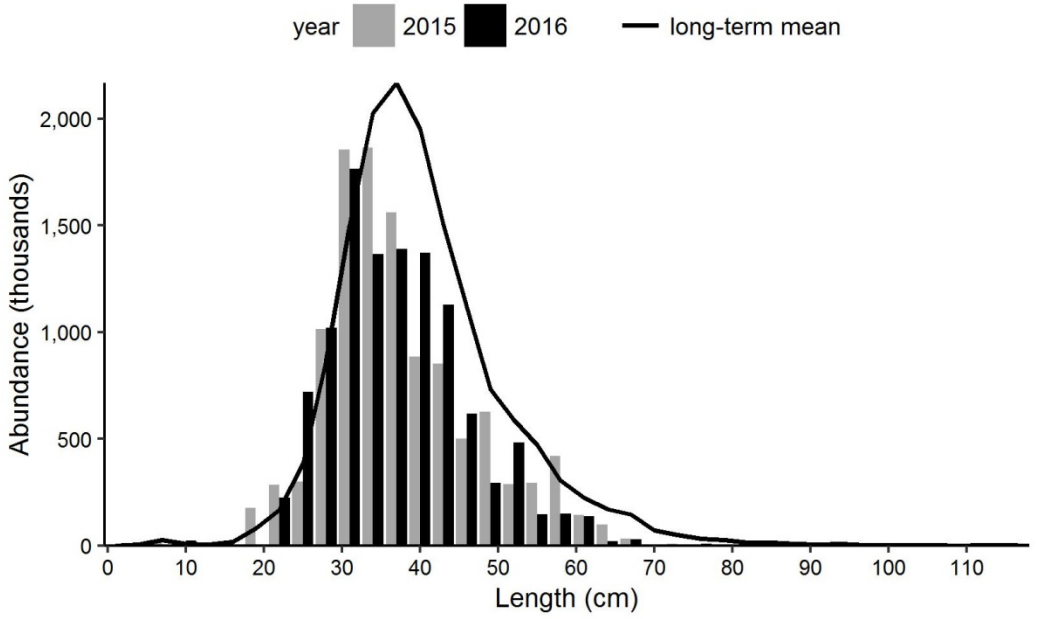


*Figure 5f. Length frequency indices for White Hake in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1982-2014.*

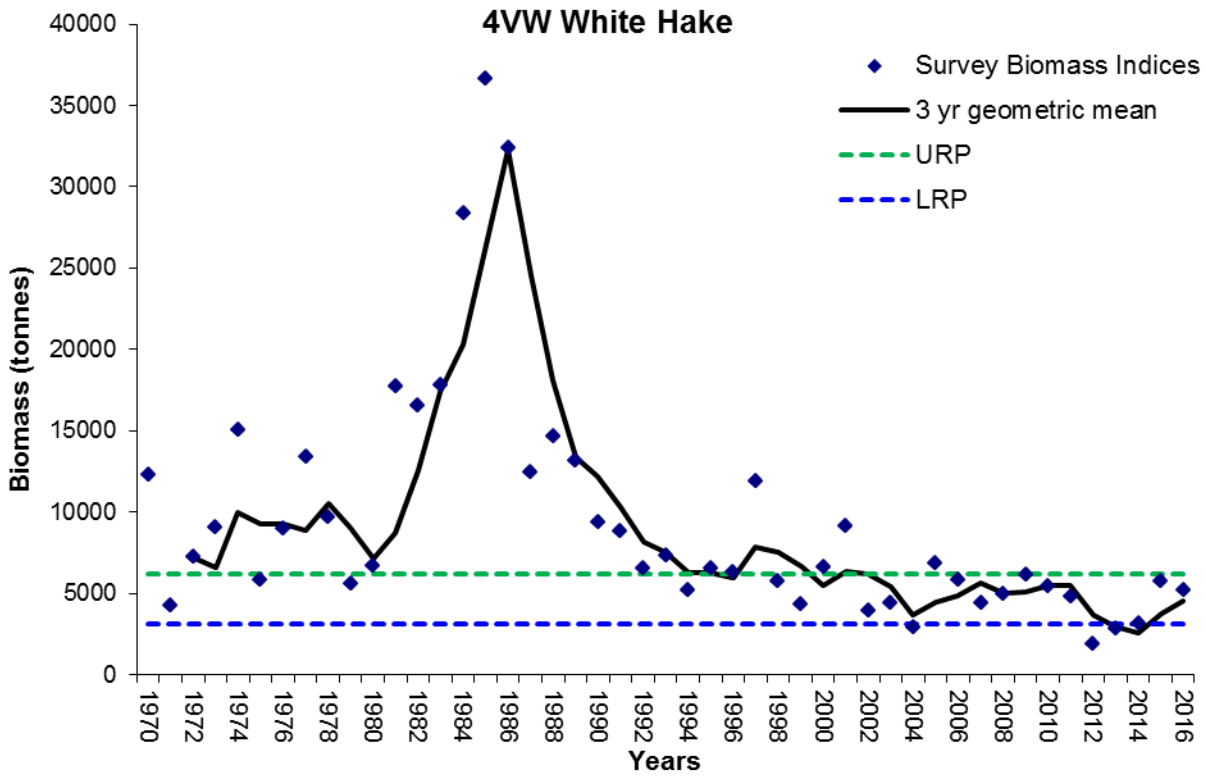


*Figure 5g. Biomass index for 4VW White Hake from the DFO Summer Research Vessel survey represented by the dark blue diamonds. The solid black line represents the 3 year geometric mean. The dashed blue line represents the lower limit reference point and the dashed green line represents the upper limit reference point.*

## Silver Hake

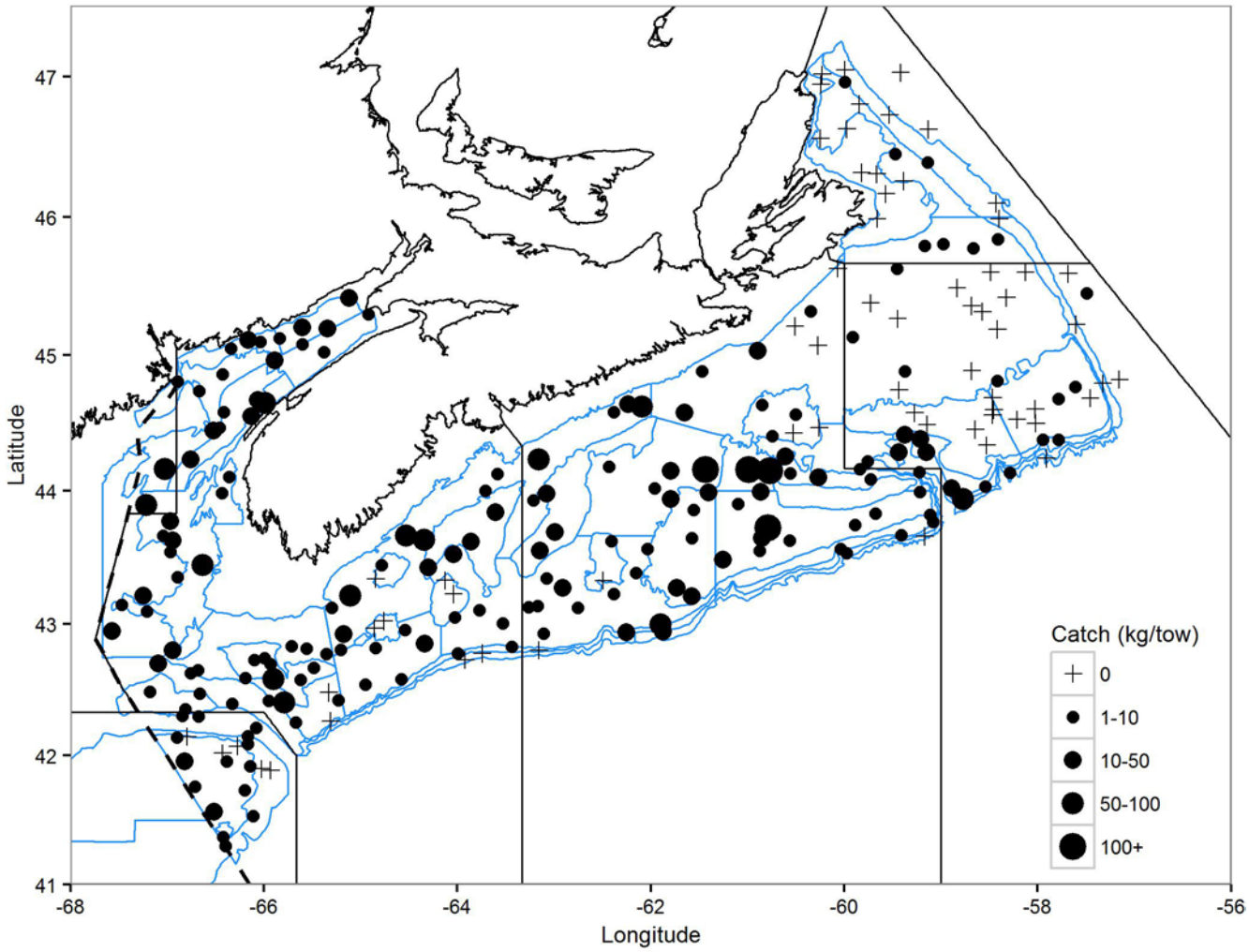


*Figure 6a. Distribution of Silver Hake catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

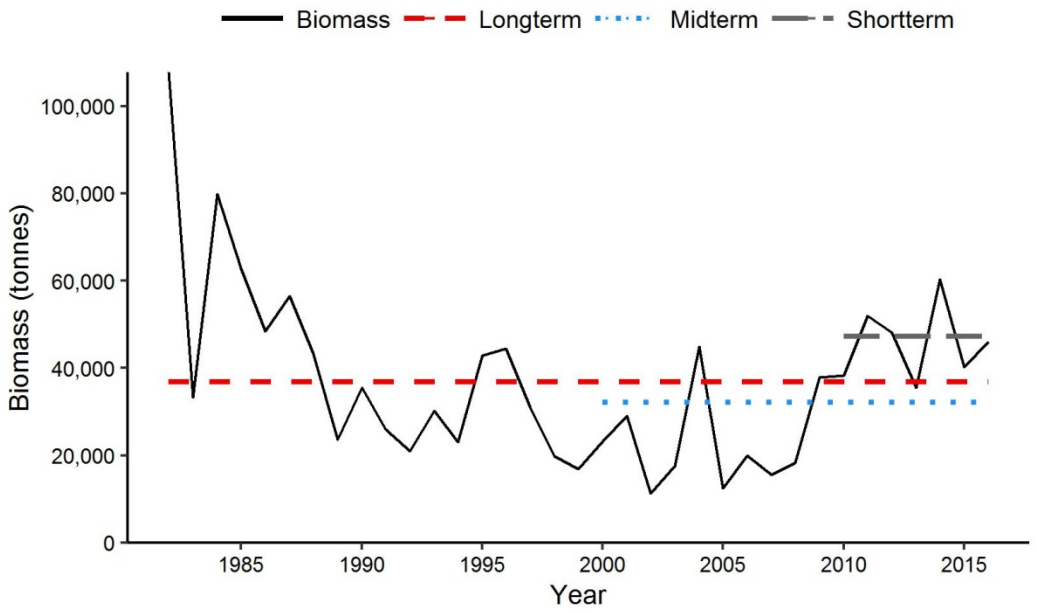


*Figure 6b. Biomass index for Silver Hake in 4VWX (strata 440-483) from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1982-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

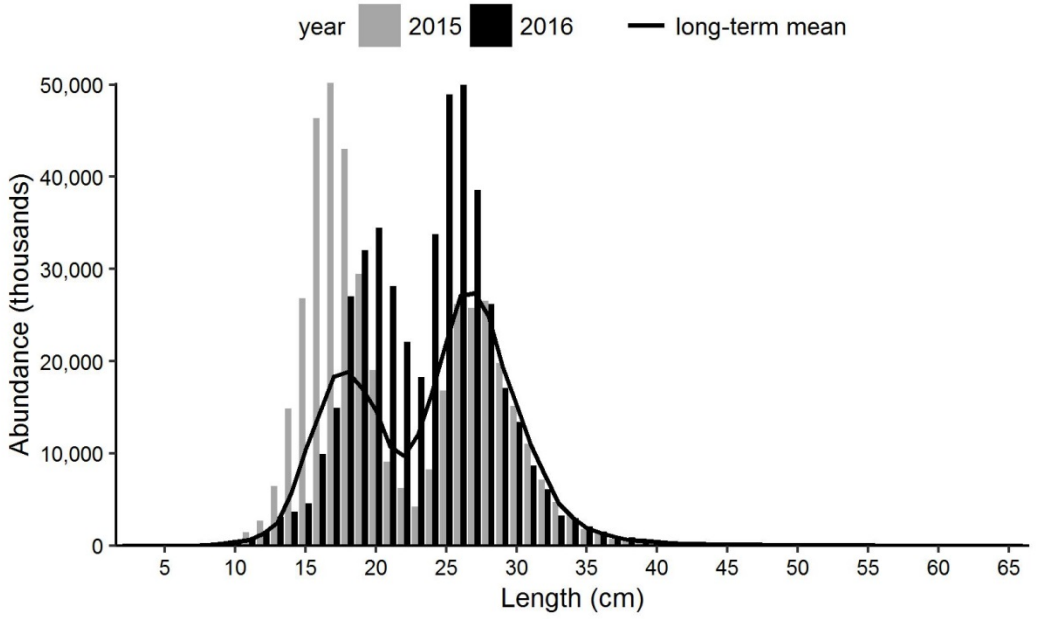


*Figure 6c. Length frequency indices for Silver Hake in 4VWX from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1982-2014.*

## Pollock

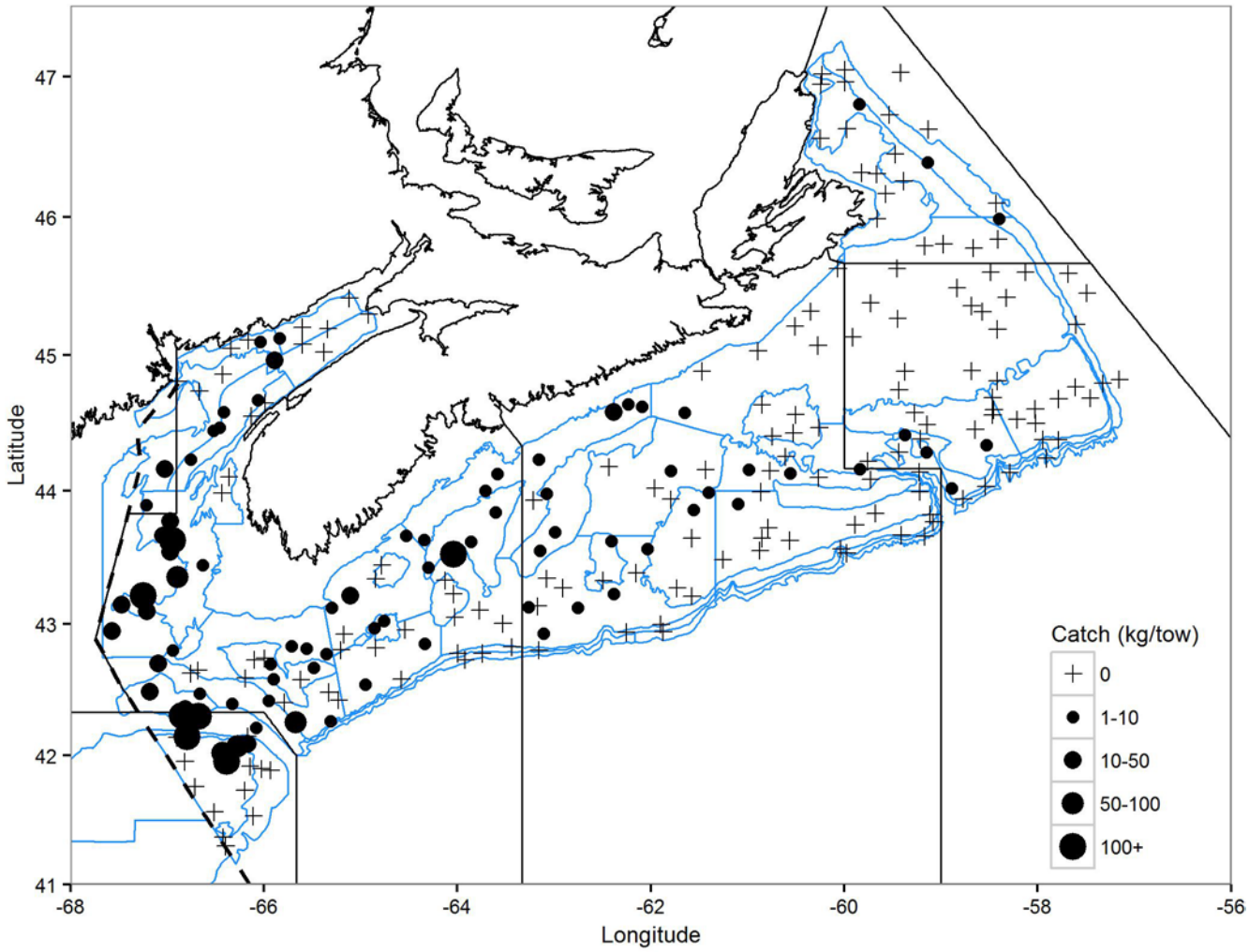


*Figure 7a. Distribution of Pollock catches during the 2016 DFO Summer Research Vessel survey including the Laurentian channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

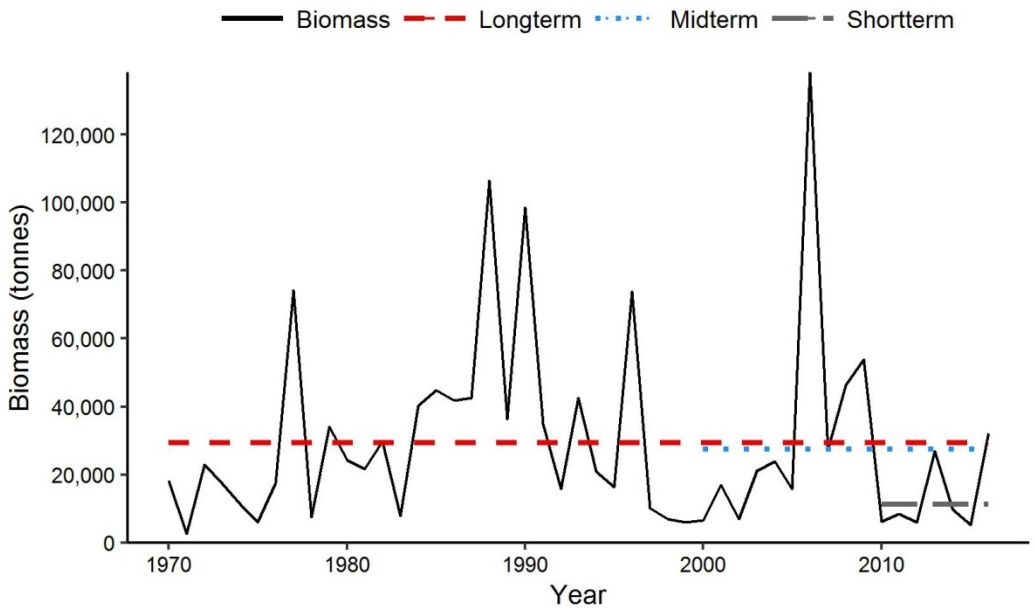


*Figure 7b. Biomass index for Western Component Pollock (strata 474, 476, 480-495) from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

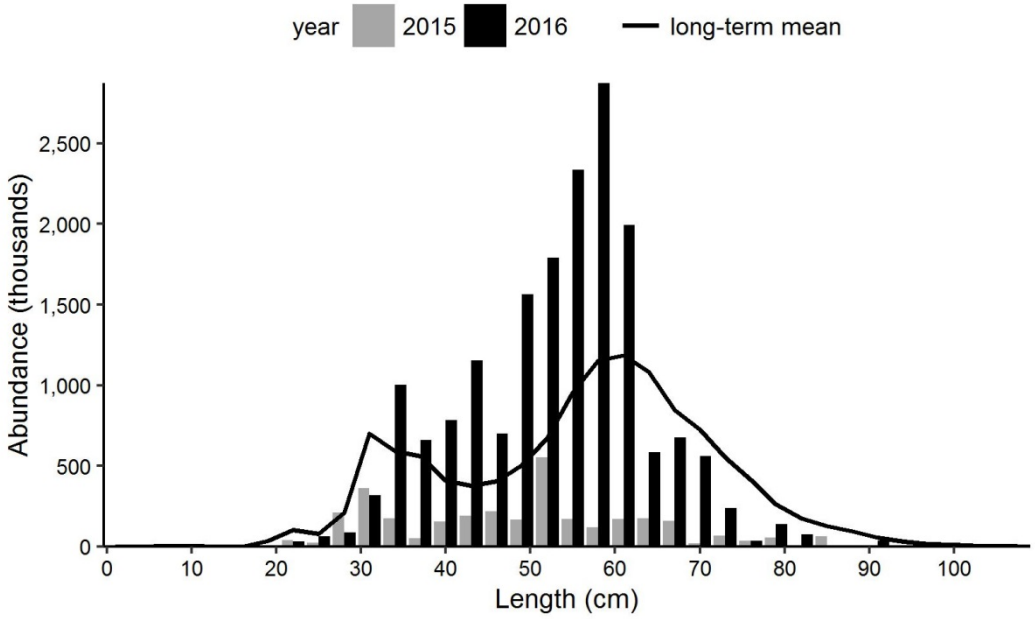


*Figure 7c. Length frequency indices for Western Component Pollock from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

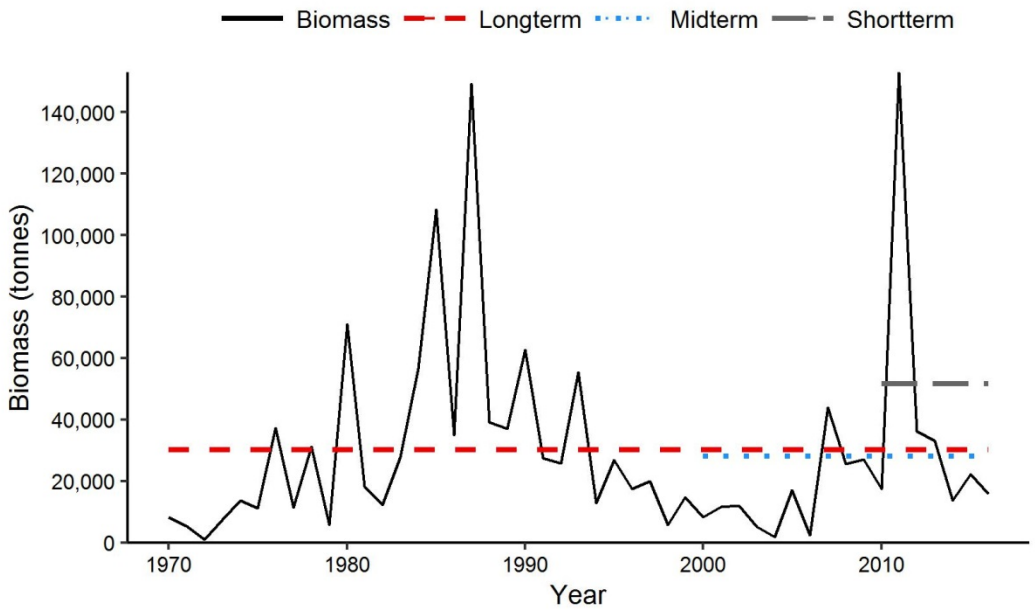


*Figure 7d. Biomass index for Eastern Component Pollock (strata 440-473, 475, 477, 478) from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

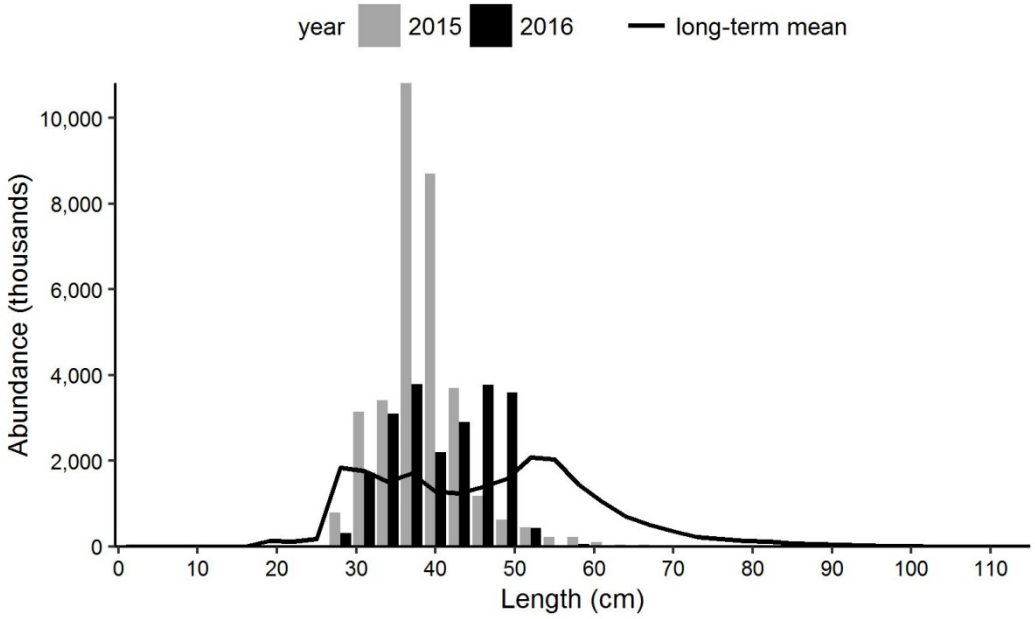


*Figure 7e. Length frequency indices for Eastern Component Pollock from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Redfish

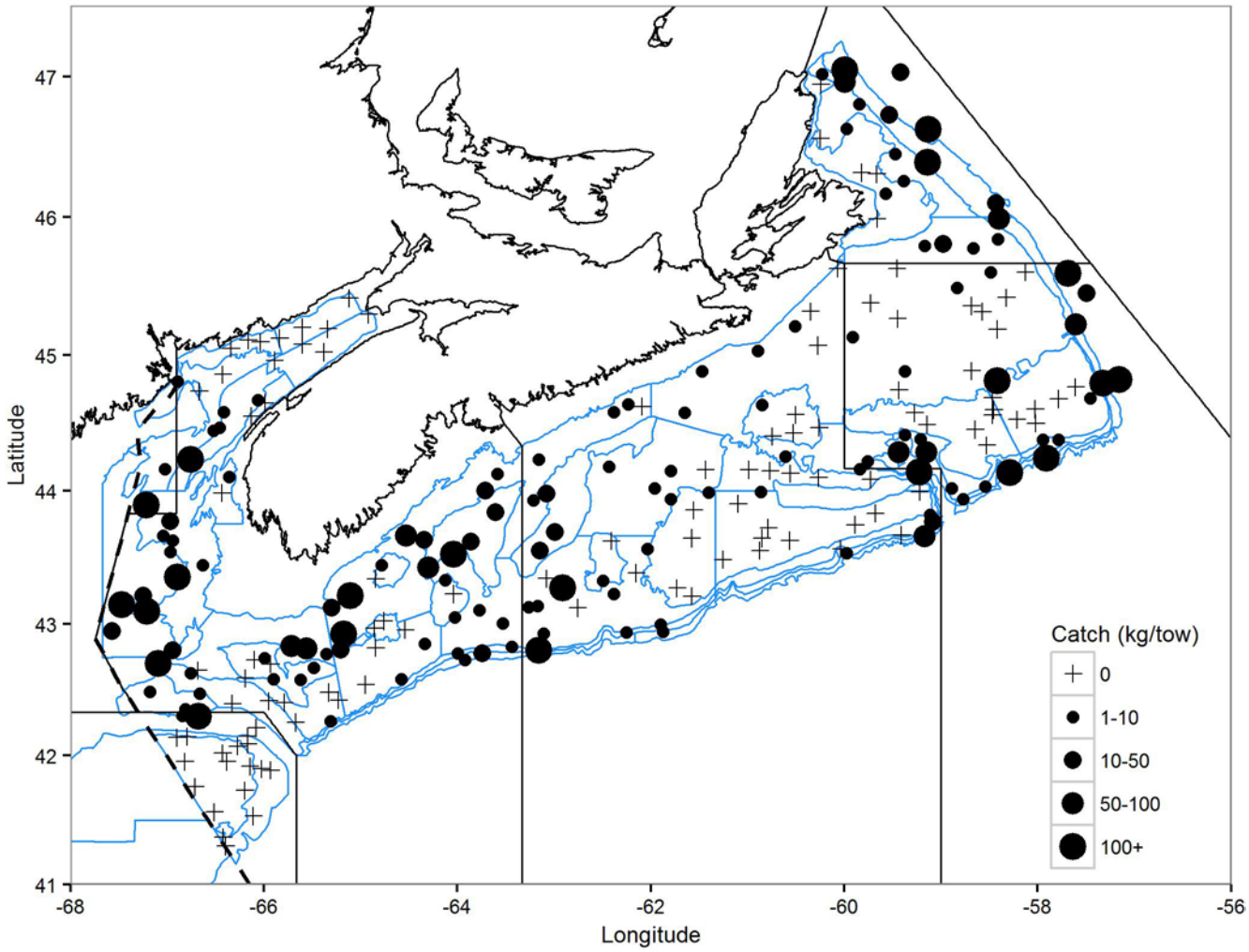


*Figure 8a. Distribution of Redfish catches during the 2016 DFO Summer Research Vessel survey including the Laurentian channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

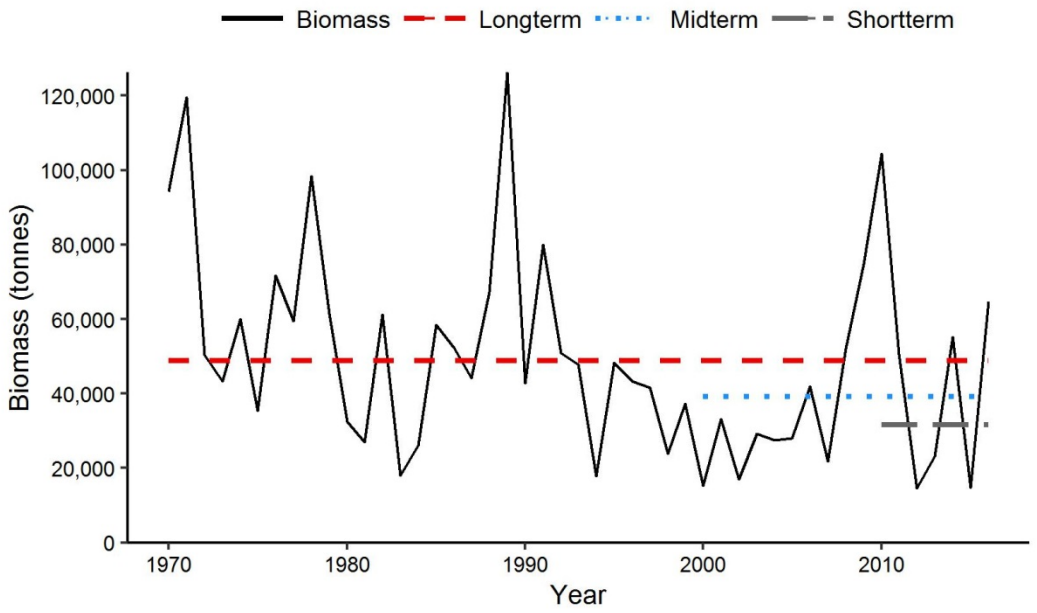


*Figure 8b. Biomass index for Unit II Redfish (strata 440-456, 464) from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

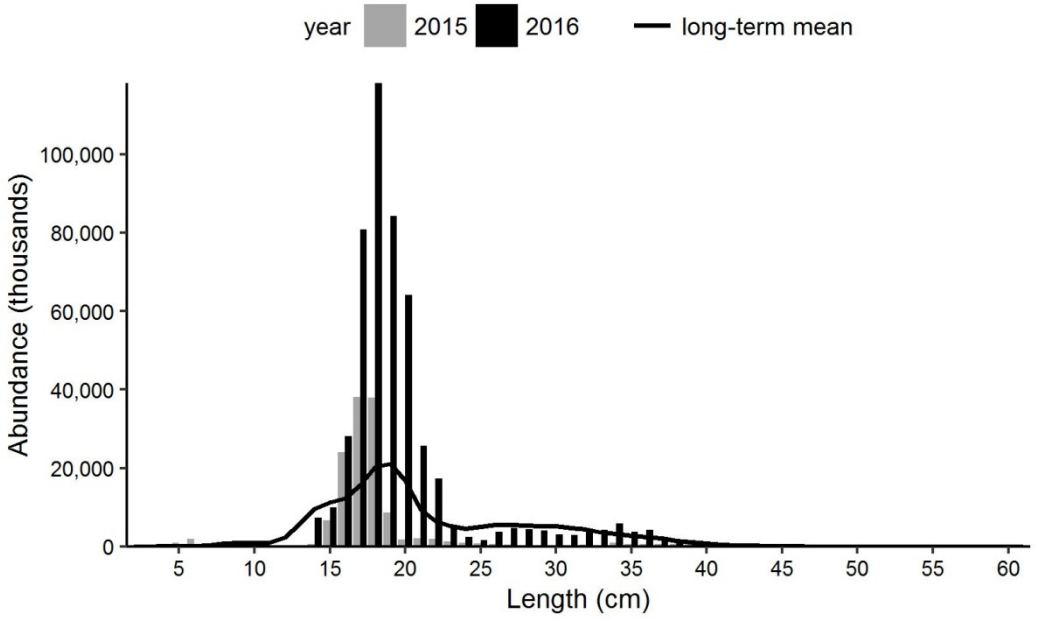


*Figure 8c. Length frequency indices for Unit II Redfish from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

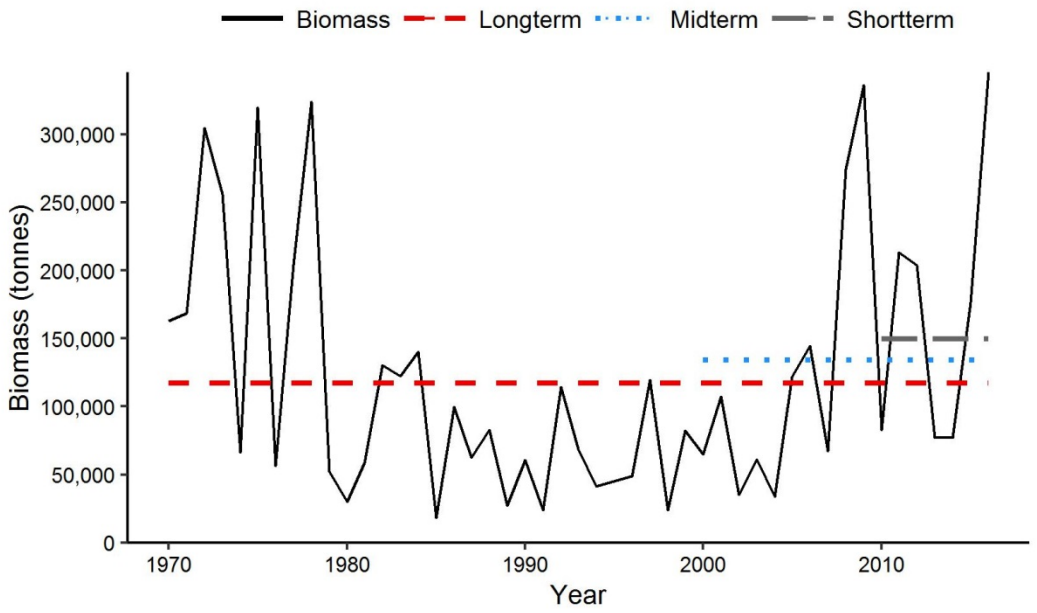


*Figure 8d. Biomass index for Unit III Redfish (strata 457-463, 465-485) from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

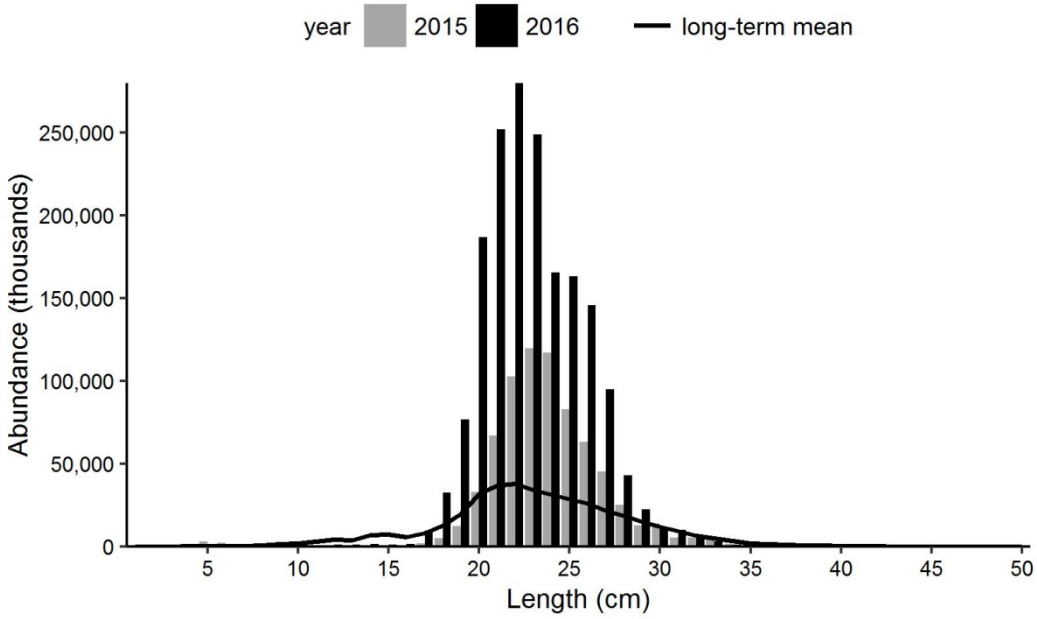


*Figure 8e. Length frequency indices for Unit III Redfish from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

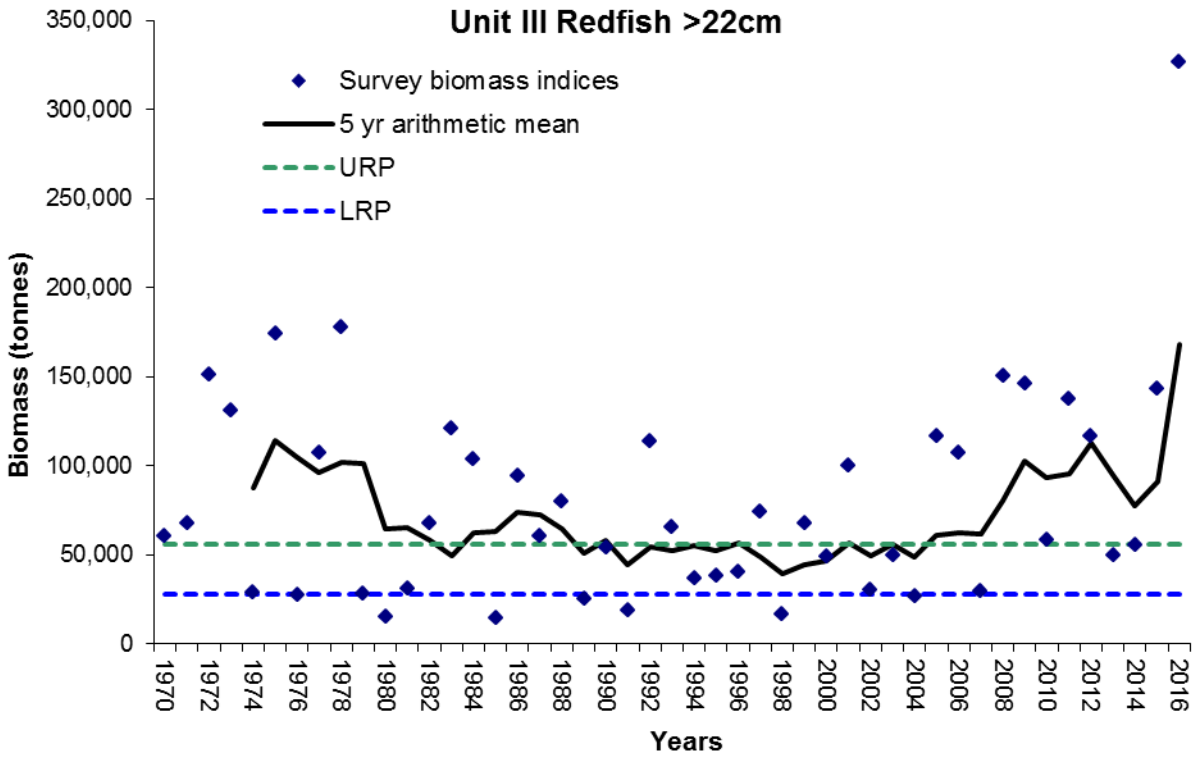


*Figure 8f. Biomass index for Unit III redfish > 22cm from the DFO Summer Research Vessel survey represented by the dark blue diamonds. The solid black line represents the 5-year arithmetic mean. The dashed blue line represents the lower limit reference point and the dashed green line represents the upper limit reference point.*

## Atlantic Halibut

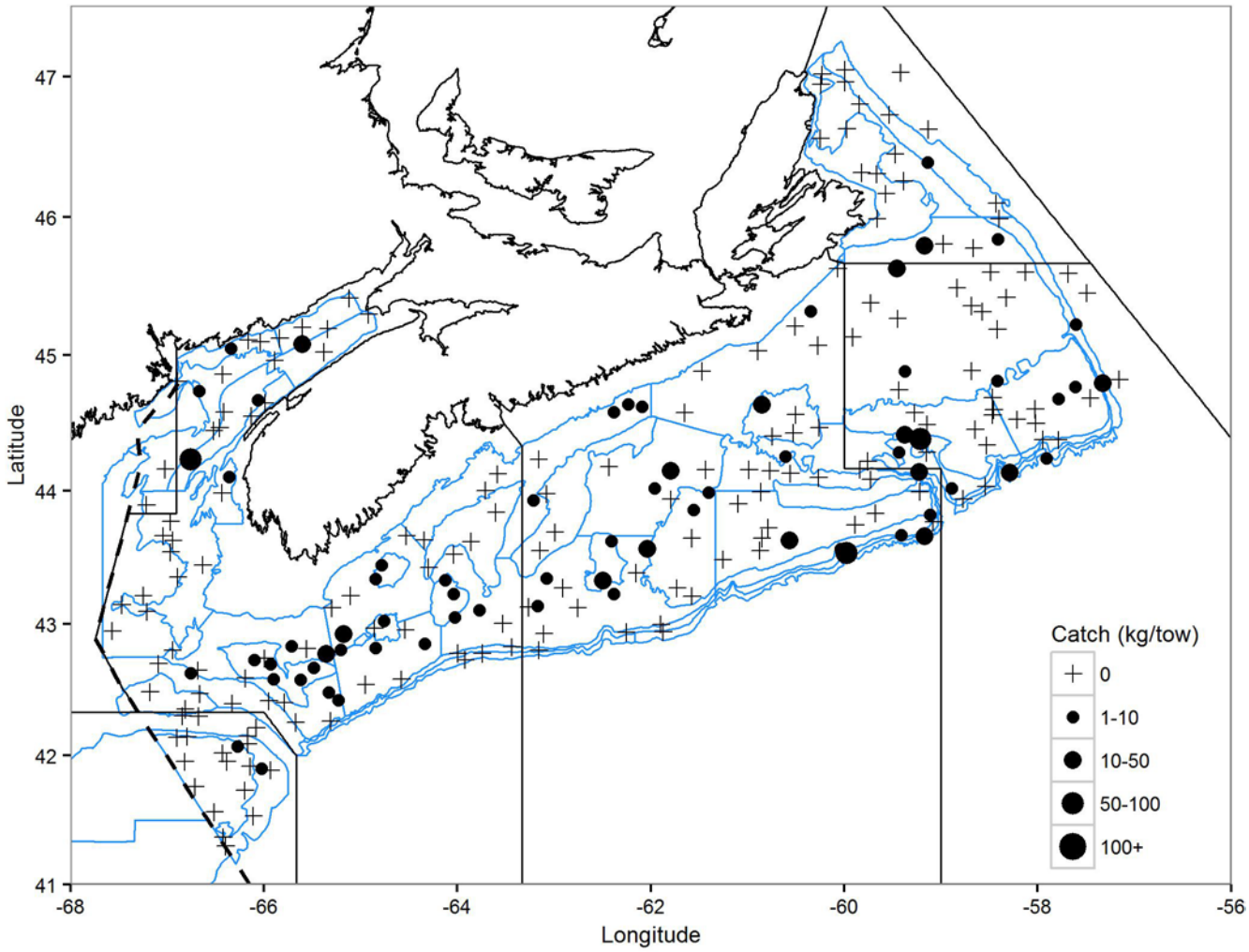


*Figure 9a. Distribution of Atlantic Halibut catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

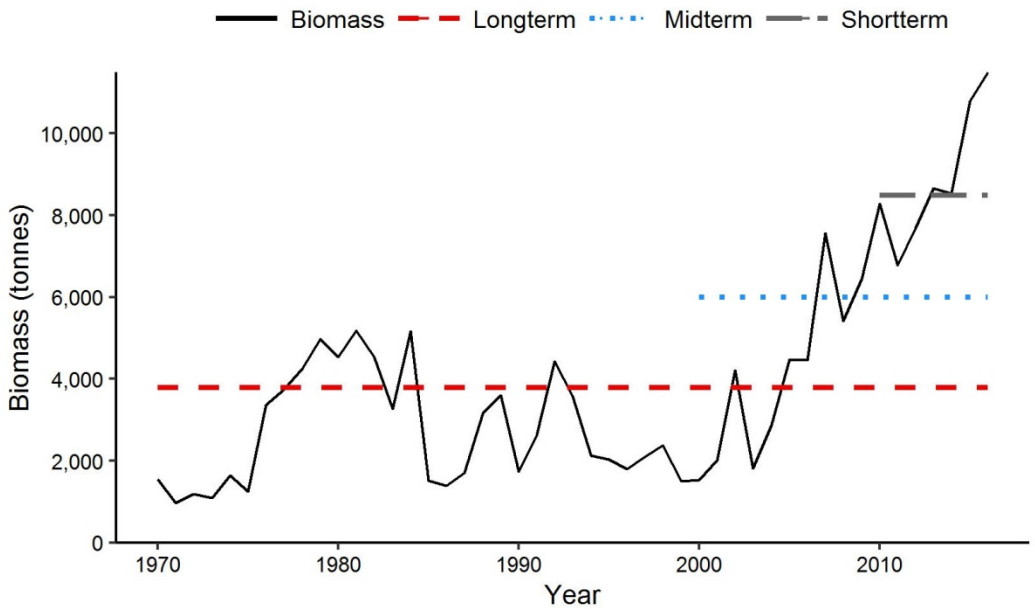


*Figure 9b. Biomass index for 3NOPs4VWX5Zc Atlantic Halibut in 4VWX from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

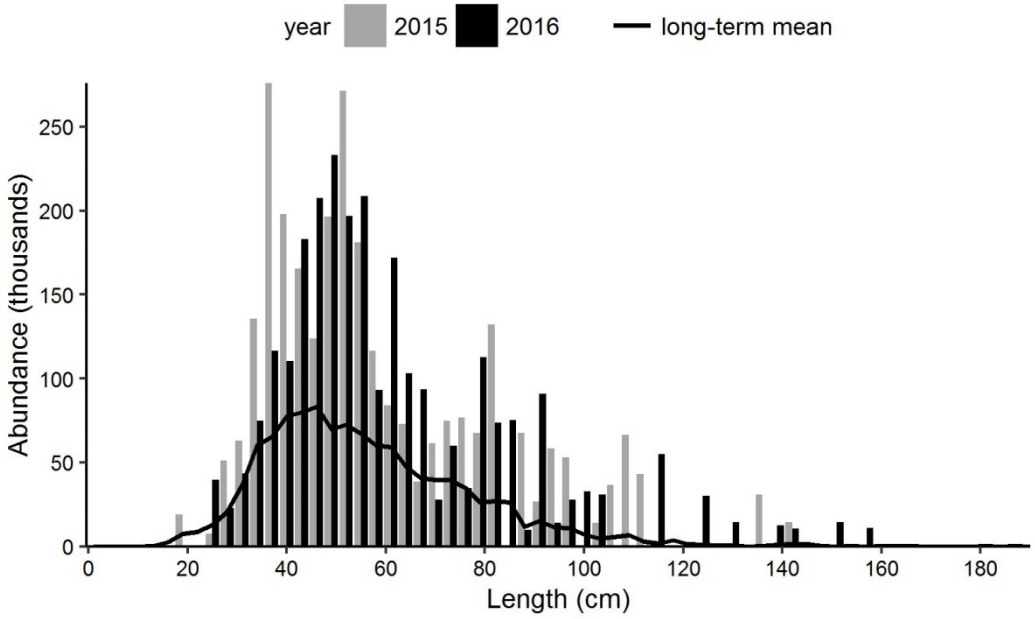


*Figure 9c. Length frequency indices for 3NOPs4VWX5Zc Atlantic Halibut in 4VWX from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Yellowtail Flounder

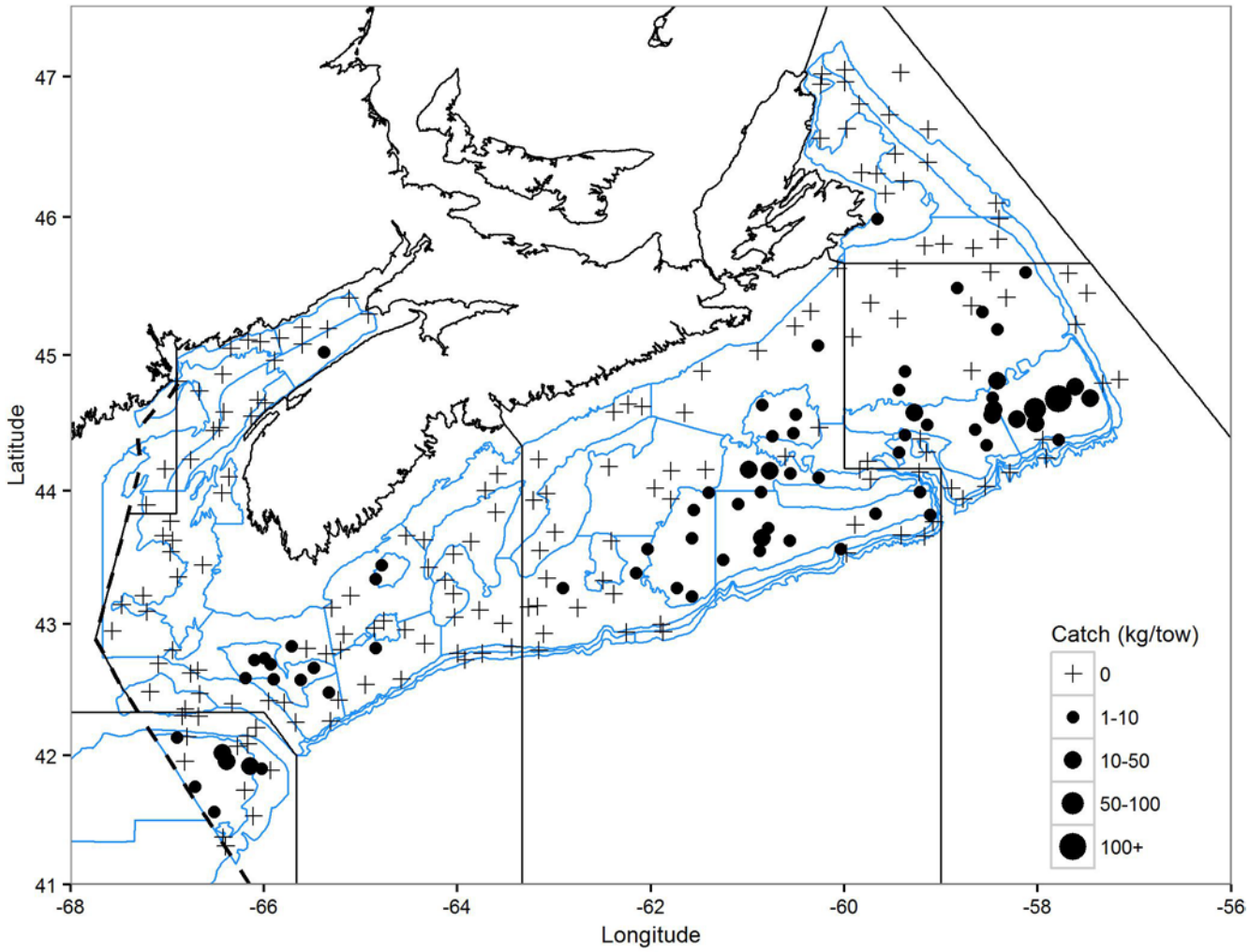


*Figure 10a. Distribution of Yellowtail Flounder catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

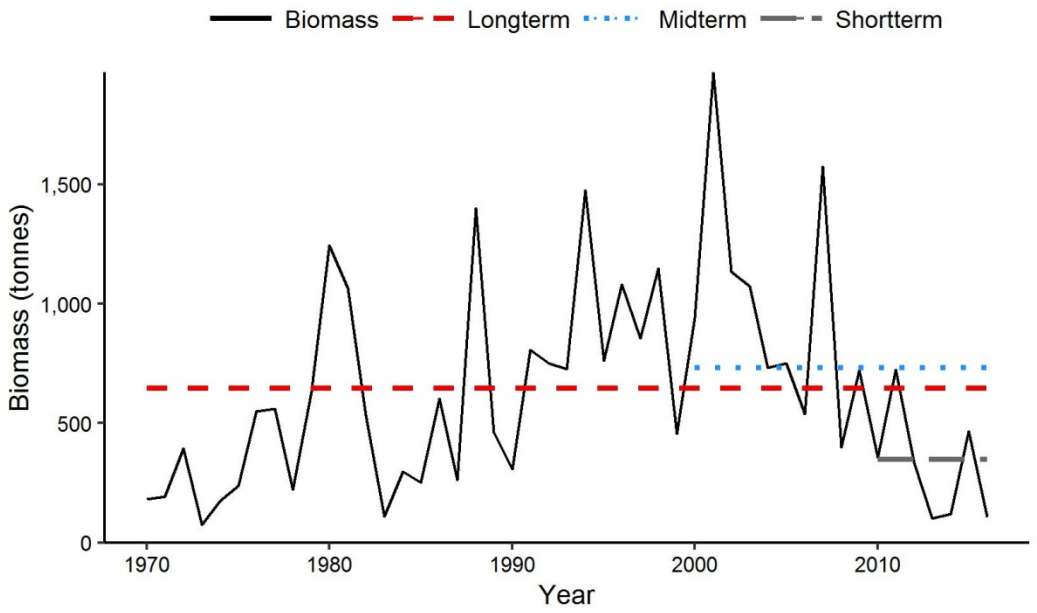


*Figure 10b. Biomass index for Yellowtail Flounder in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

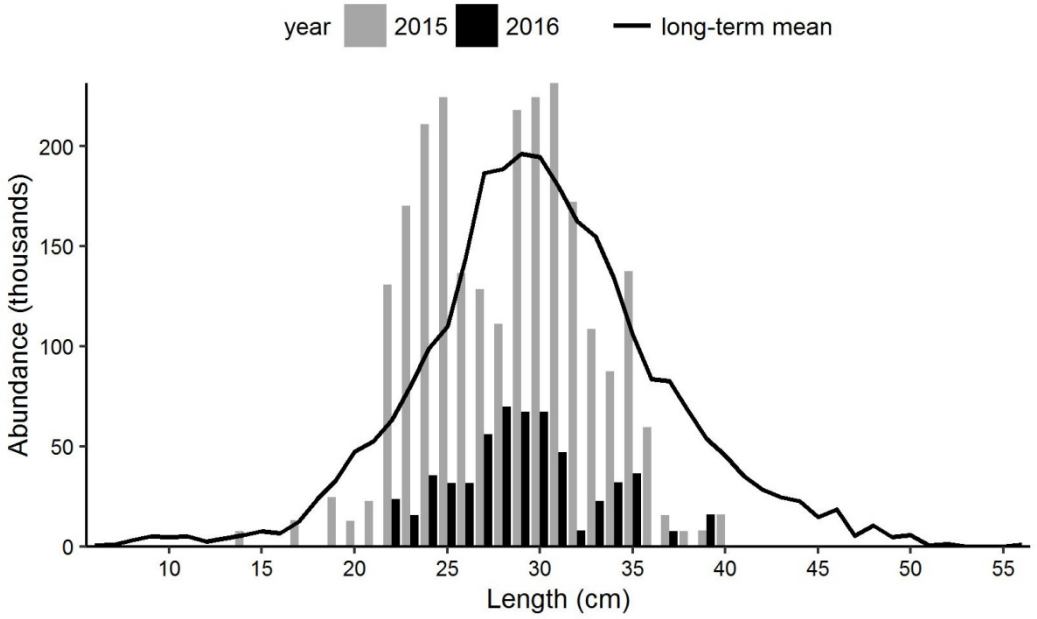


*Figure 10c. Length frequency indices for Yellowtail Flounder in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

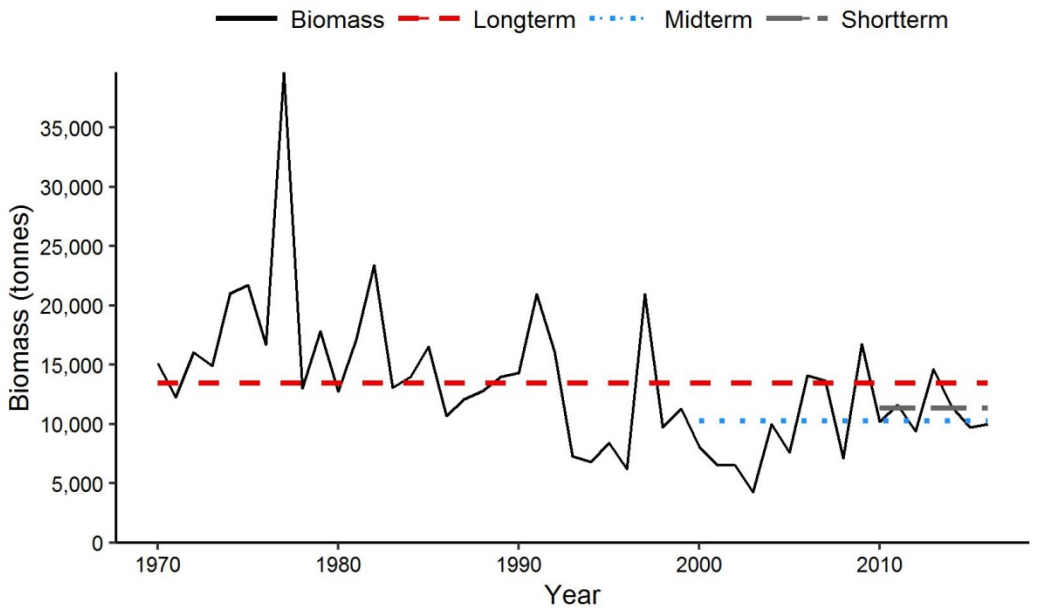


*Figure 10d. Biomass index for Yellowtail Flounder in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

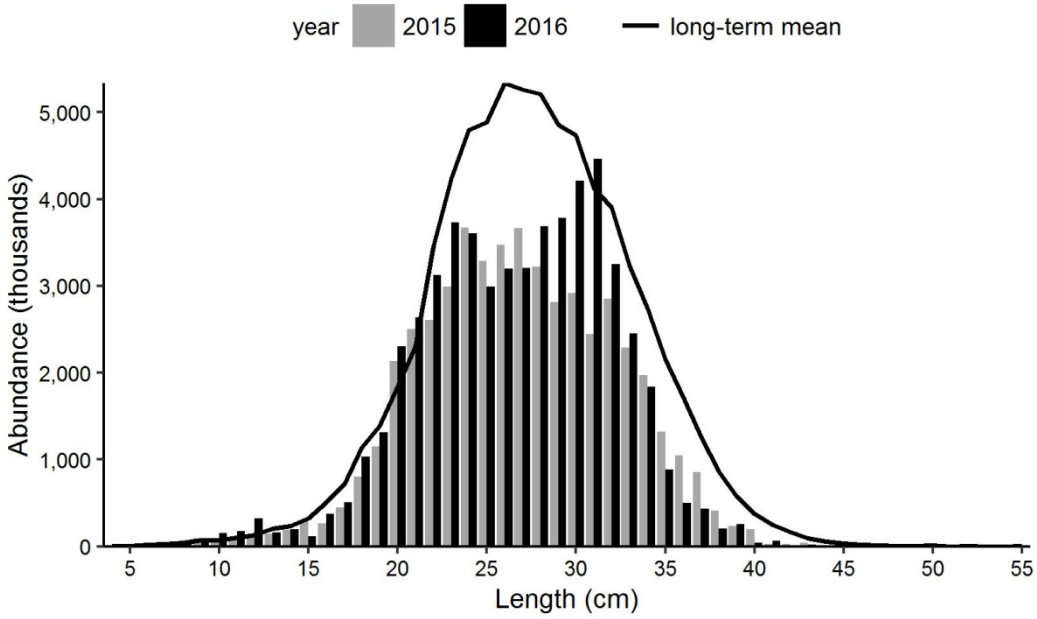


*Figure 10e. Length frequency indices for Yellowtail Flounder in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## American Plaice

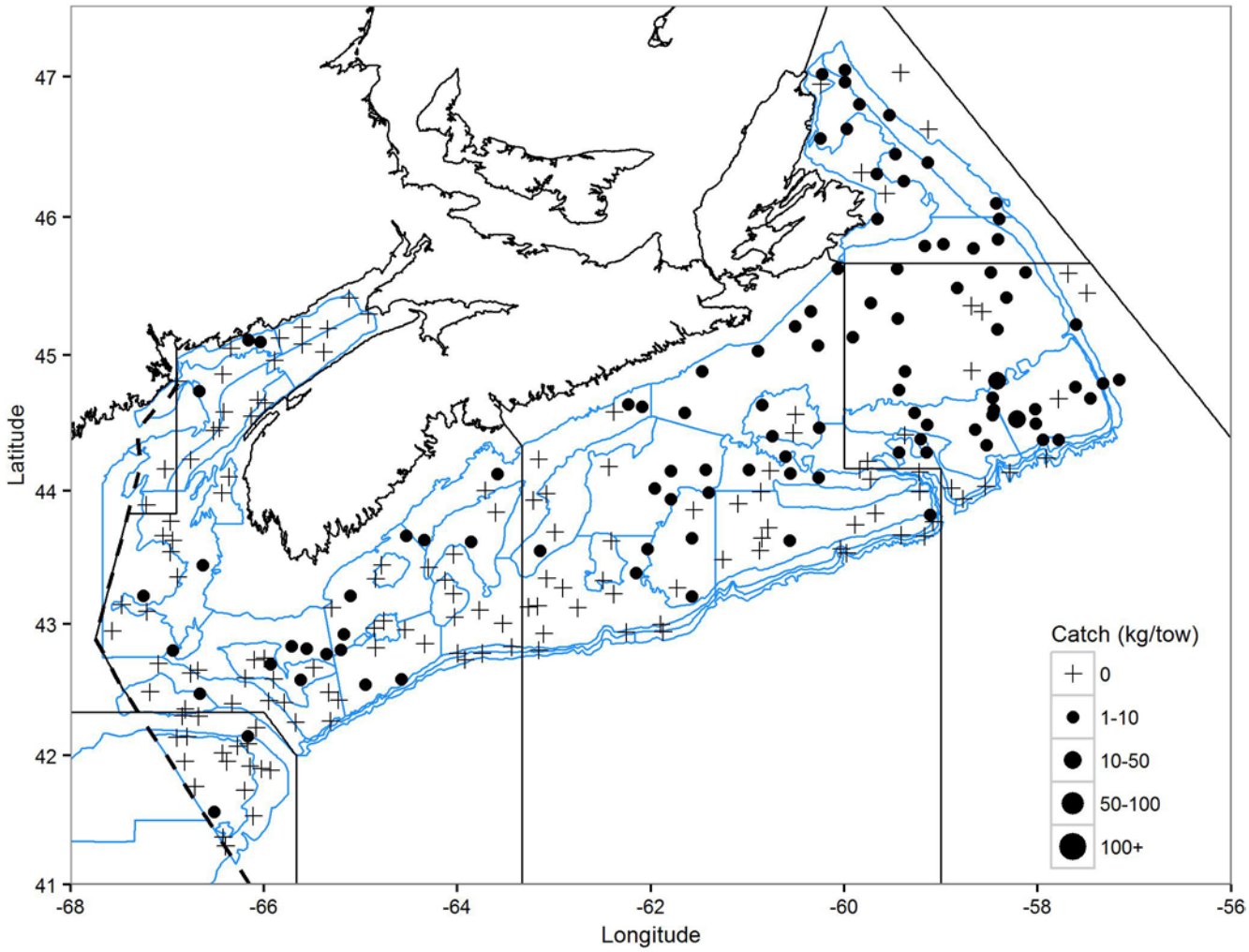


*Figure 11a. Distribution of American Plaice catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

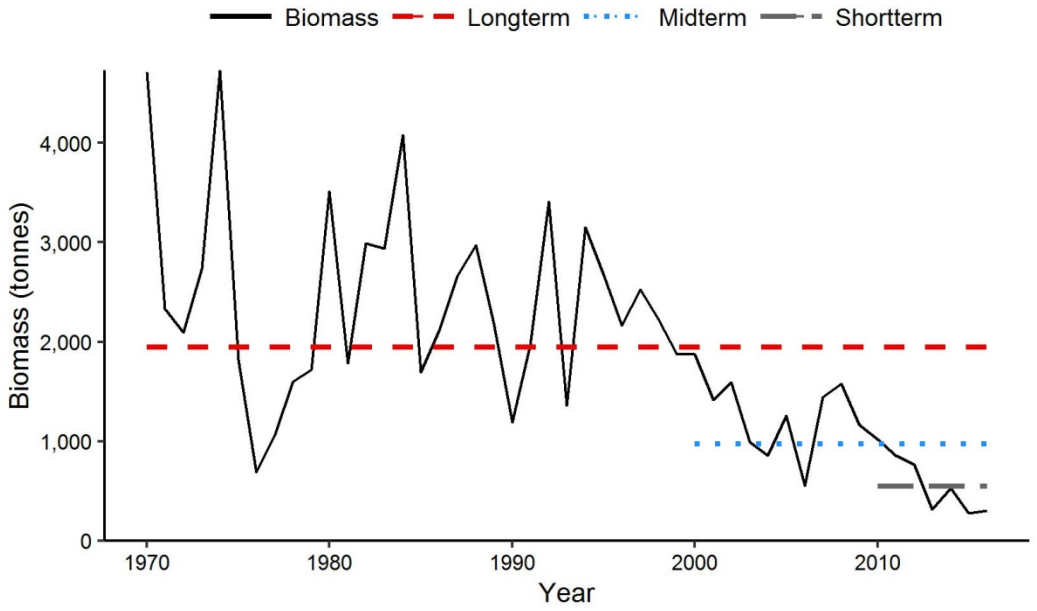


*Figure 11b. Biomass index for American Plaice in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

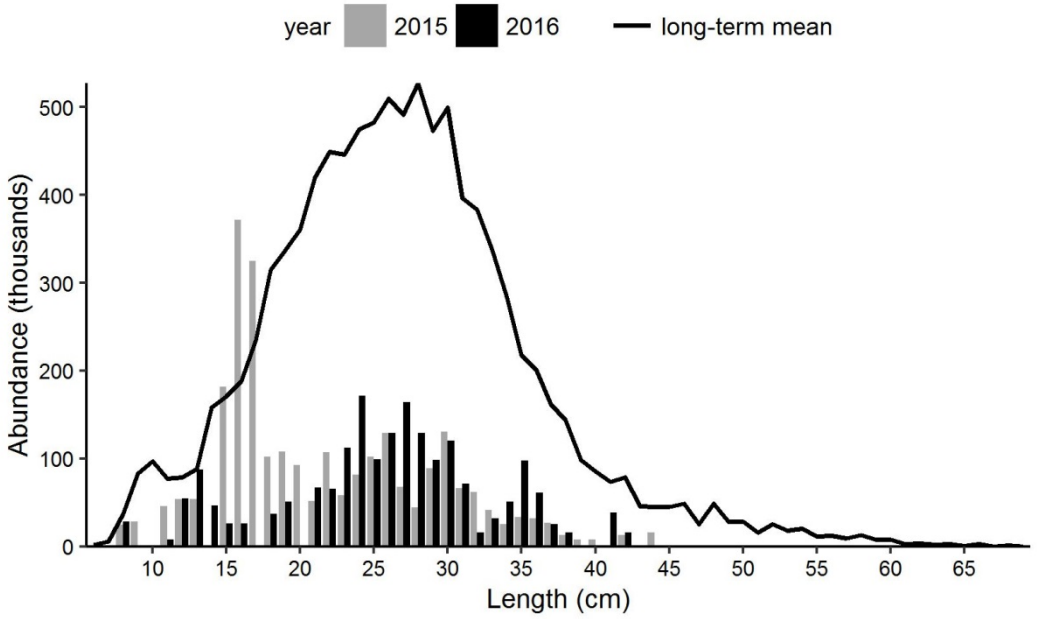


*Figure 11c. Length frequency indices for American Plaice in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

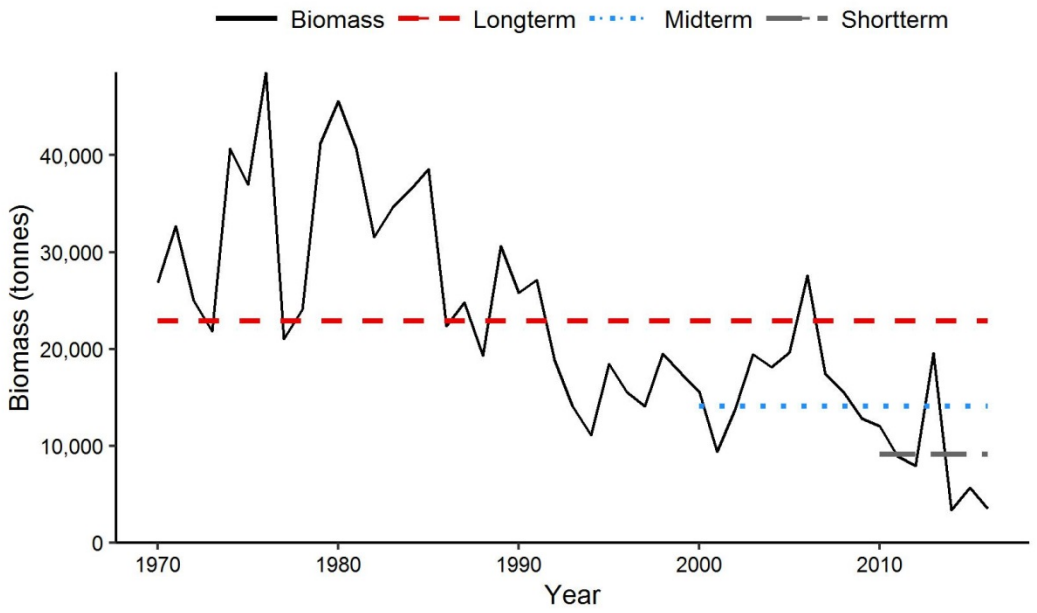


*Figure 11d. Biomass index for American Plaice in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

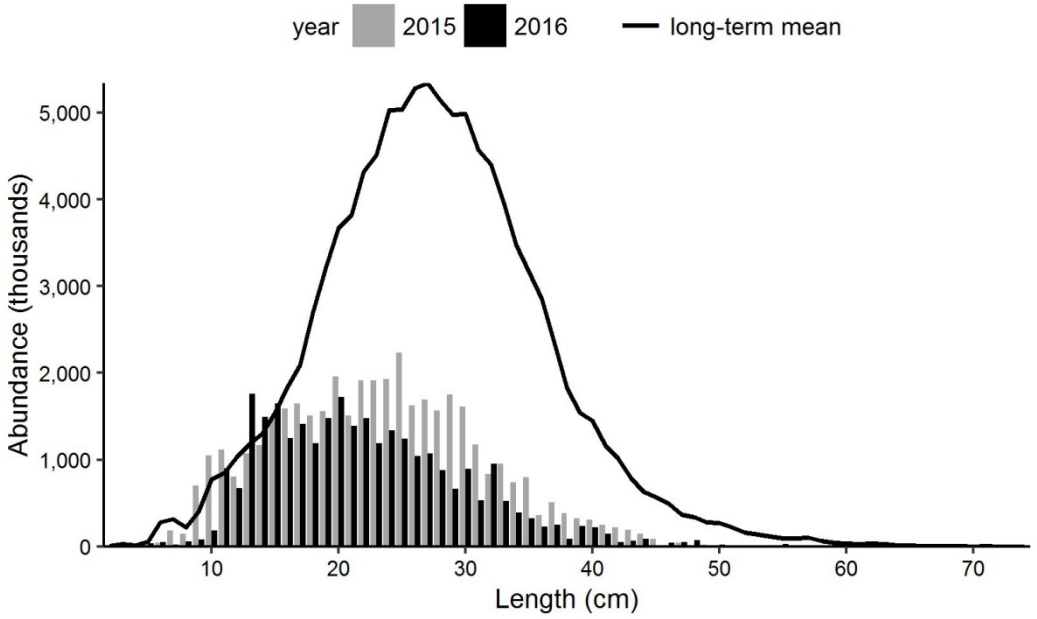


*Figure 11e. Length frequency indices for American Plaice in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Witch Flounder

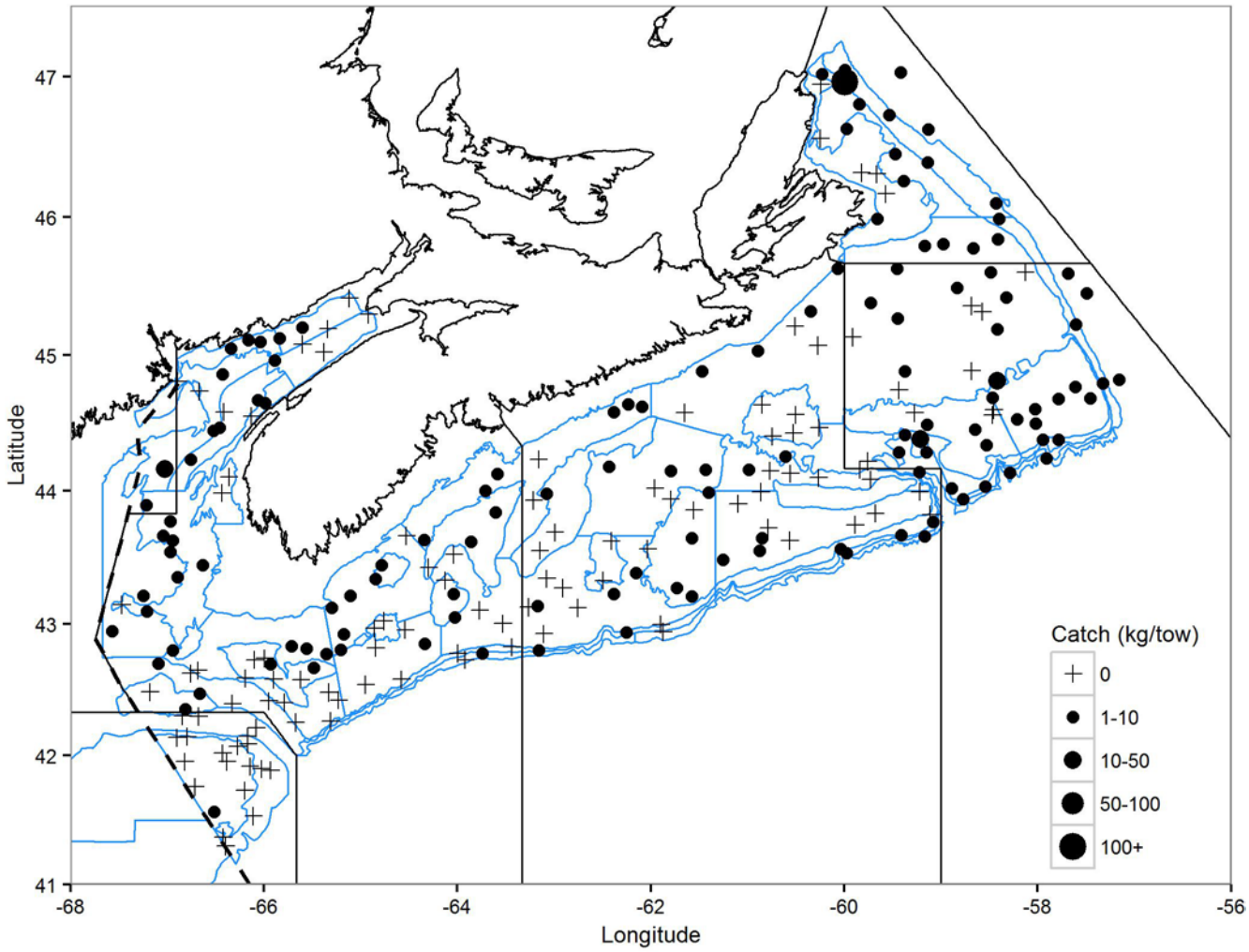


*Figure 12a. Distribution of Witch Flounder catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

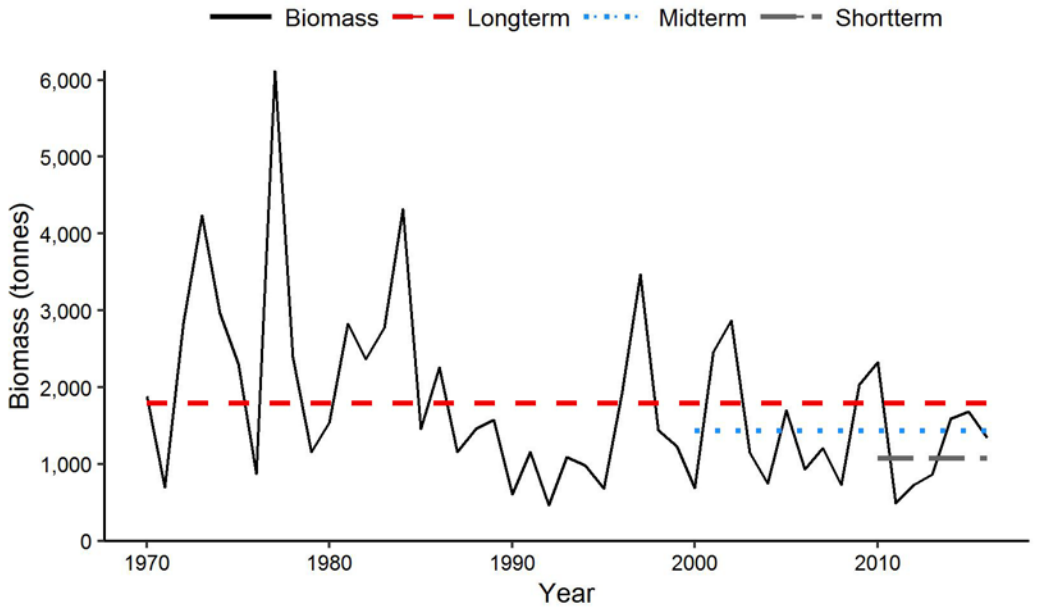


*Figure 12b. Biomass index for Witch Flounder in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

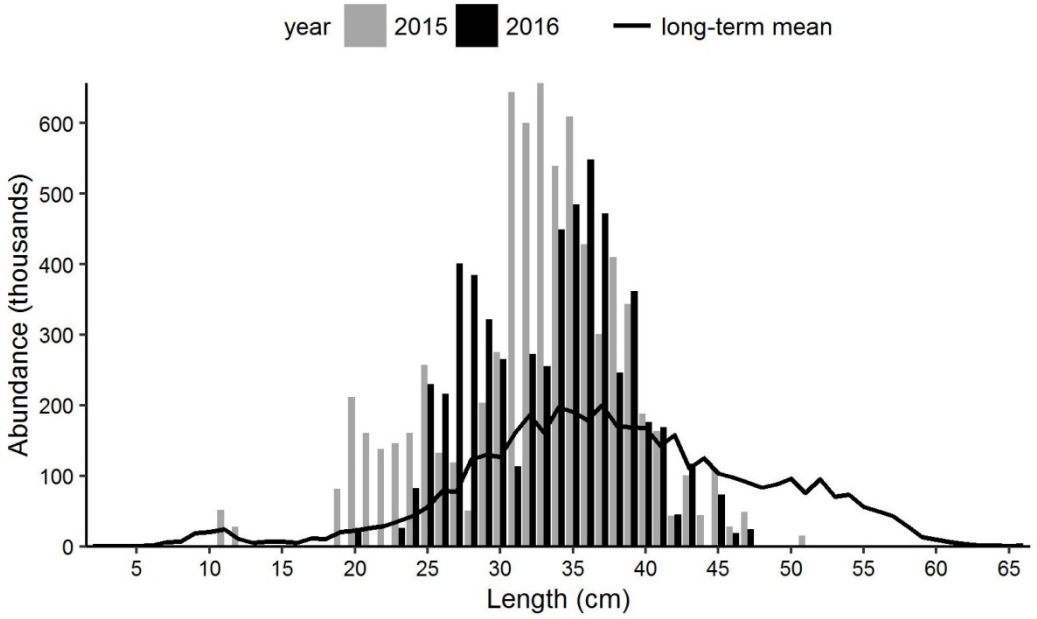


*Figure 12c. Length frequency indices for Witch Flounder in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

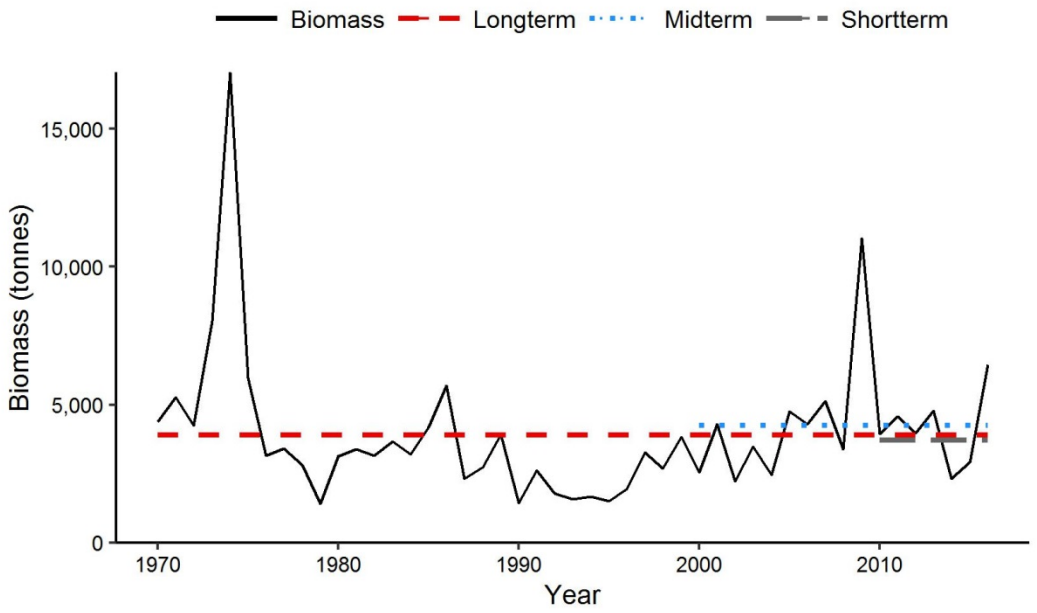


*Figure 12d. Biomass index for Witch Flounder in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

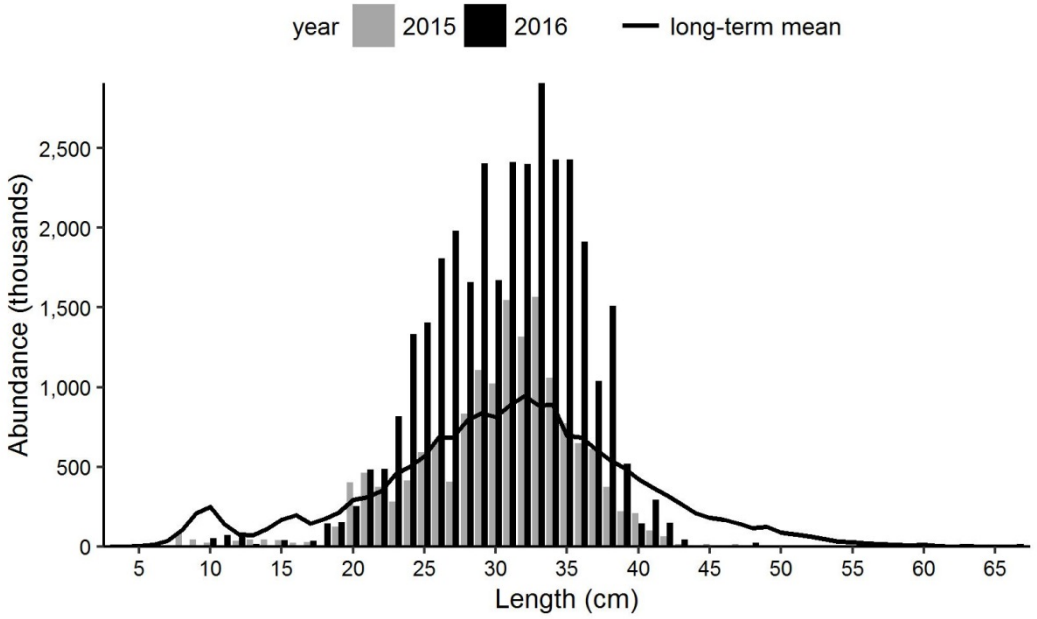


*Figure 12e. Length frequency indices for Witch Flounder in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Winter Flounder

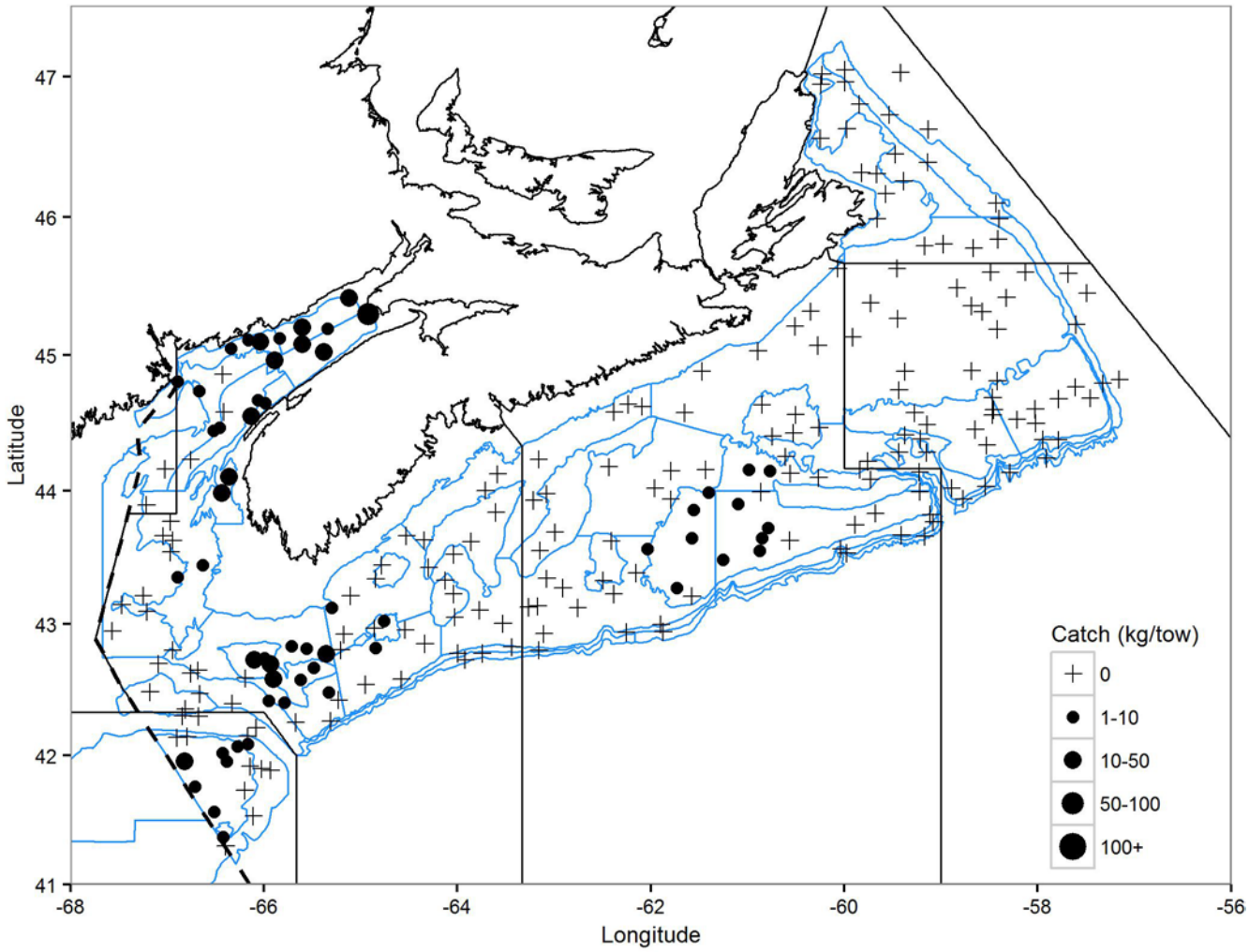


*Figure 13a. Distribution of Winter Flounder catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

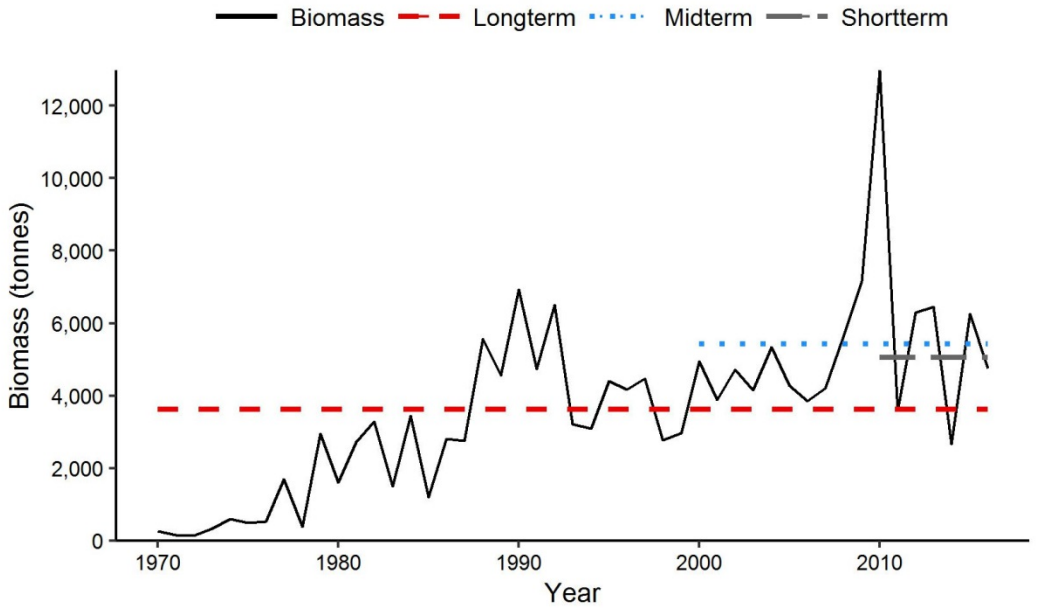


*Figure 13b. Biomass index for Winter Flounder in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

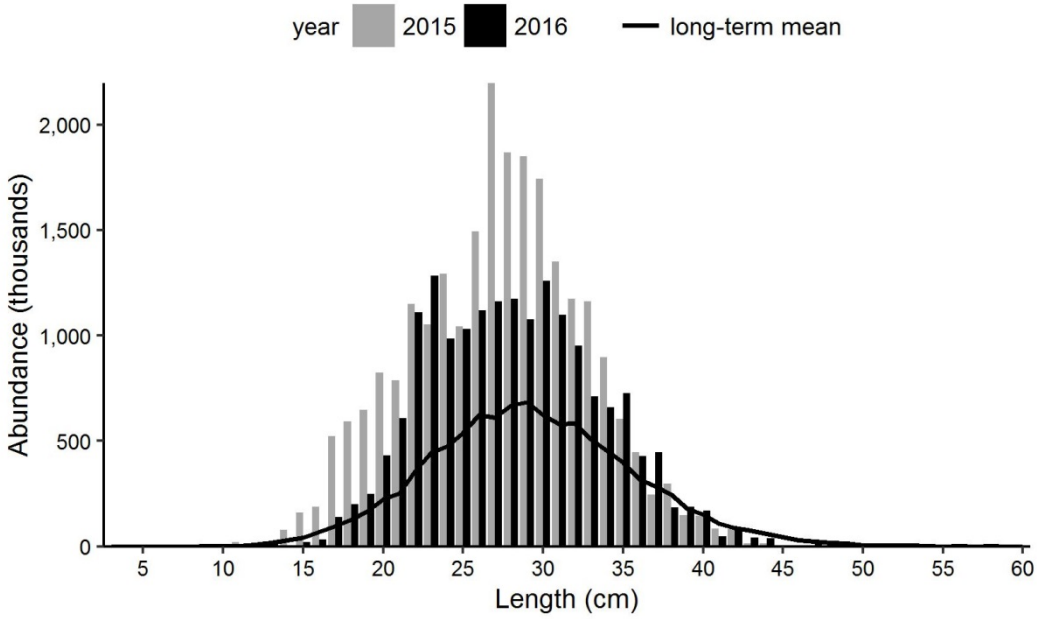


*Figure 13c. Length frequency indices for Winter Flounder in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

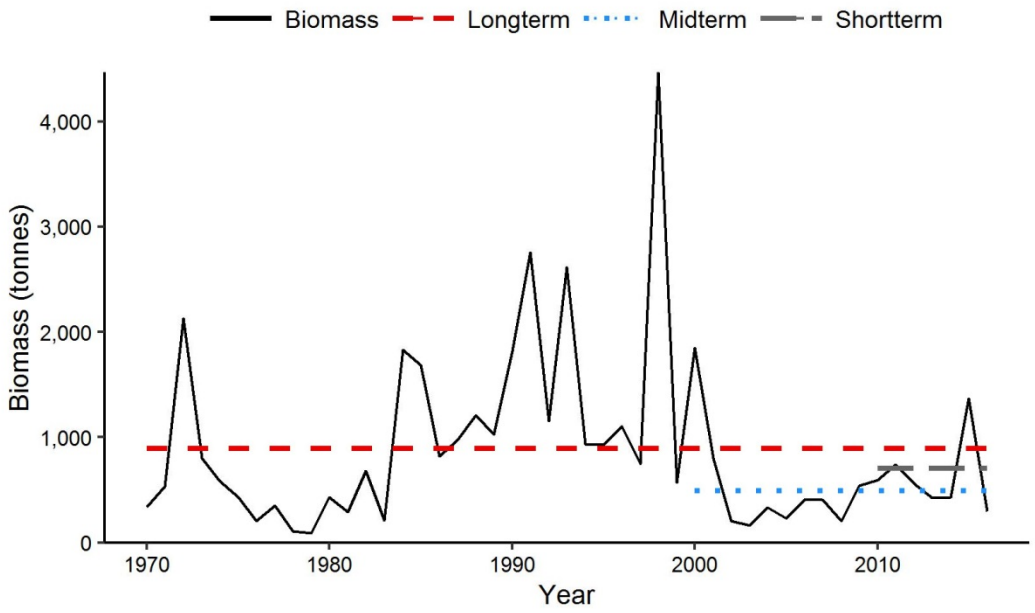


*Figure 13d. Biomass index for Winter Flounder in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

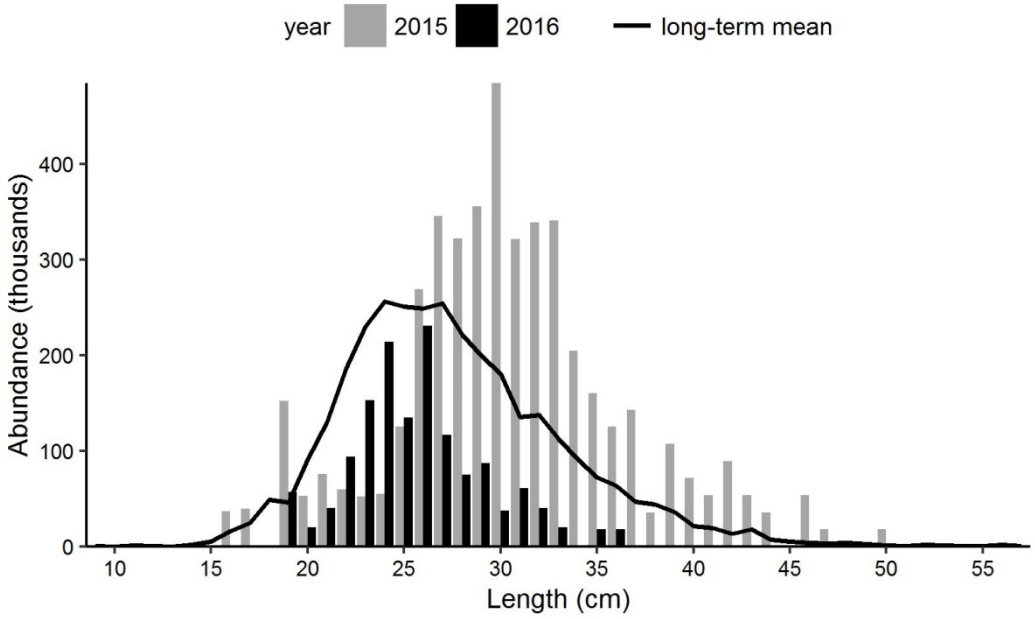


*Figure 13e. Length frequency indices for Winter Flounder in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Atlantic Wolffish

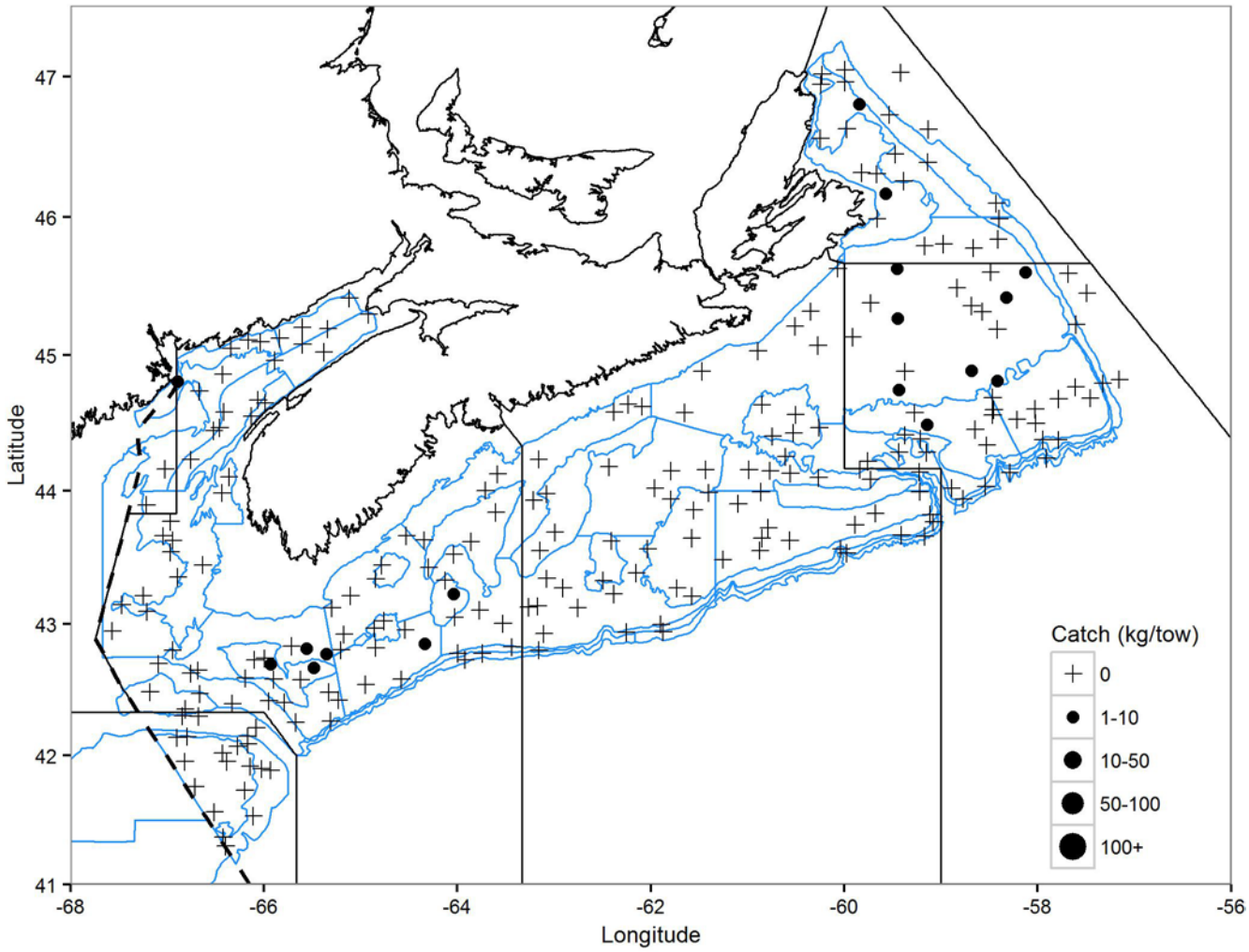


*Figure 14a. Distribution of Atlantic Wolffish catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

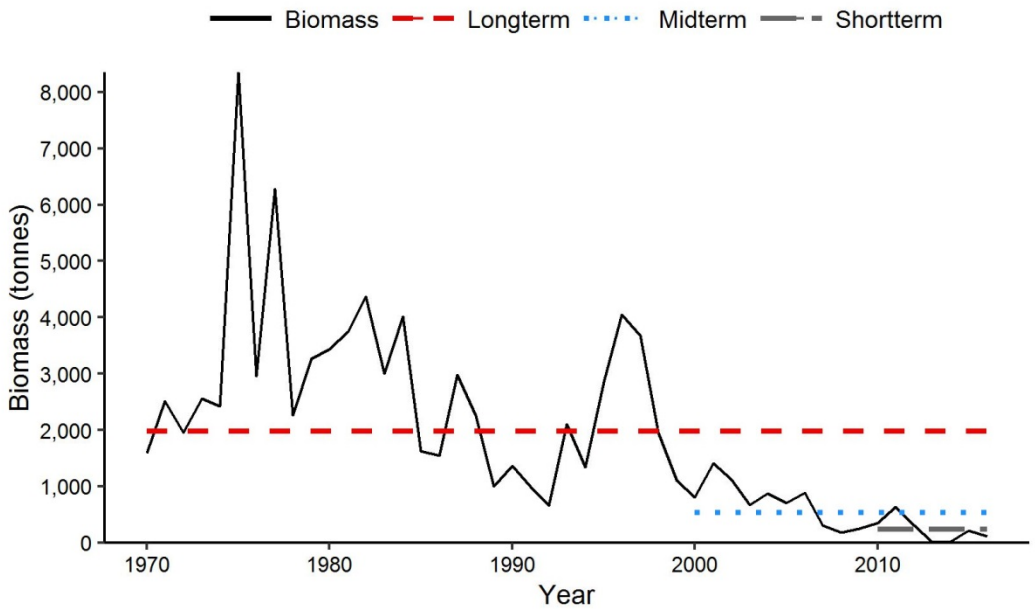


*Figure 14b. Biomass index for Atlantic Wolffish in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

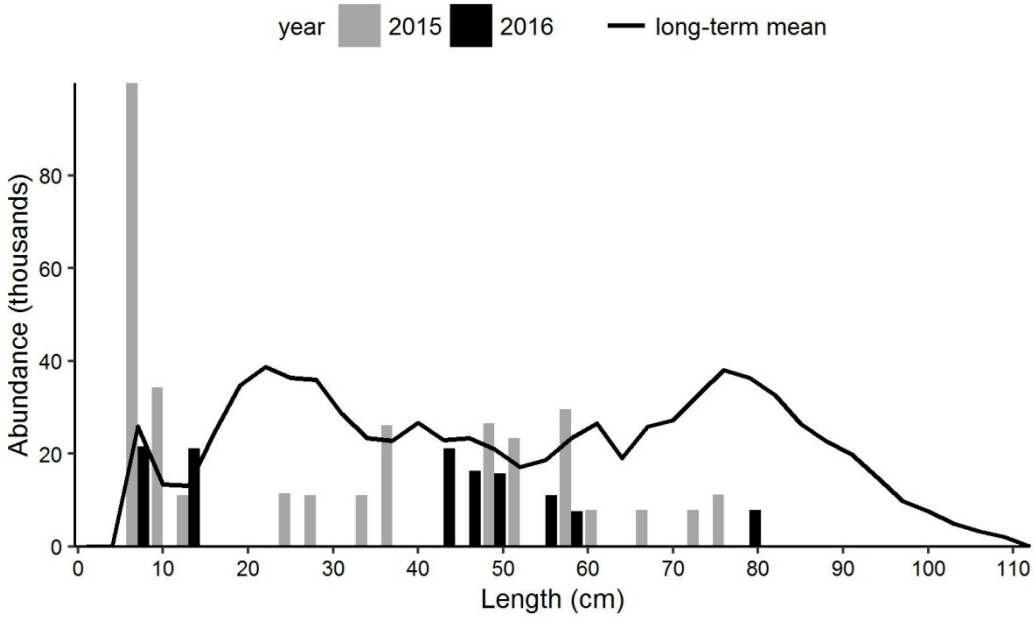


*Figure 14c. Length frequency indices for Atlantic Wolffish in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

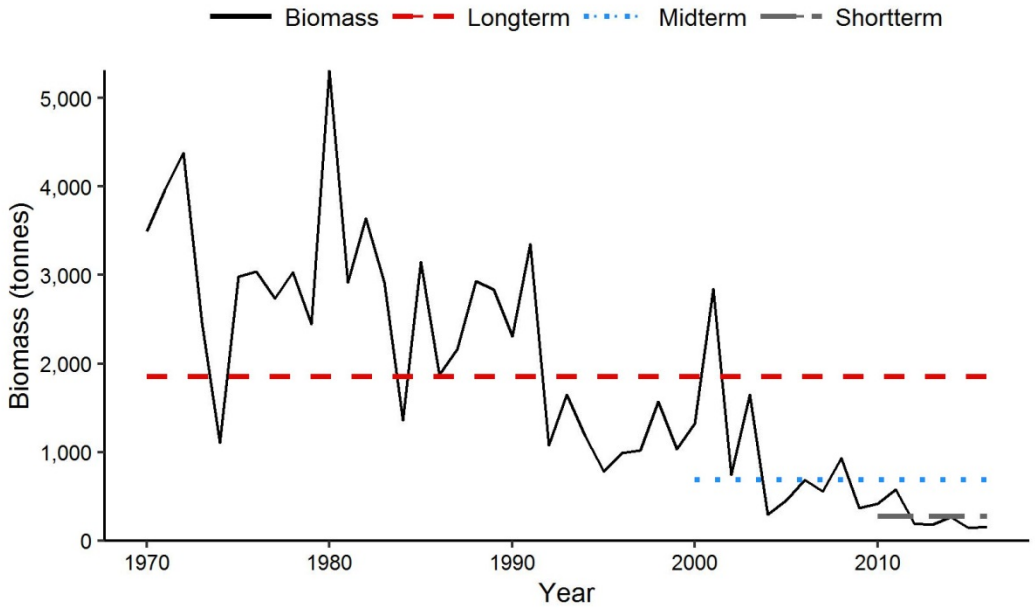


*Figure 14d. Biomass index for Atlantic Wolffish in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

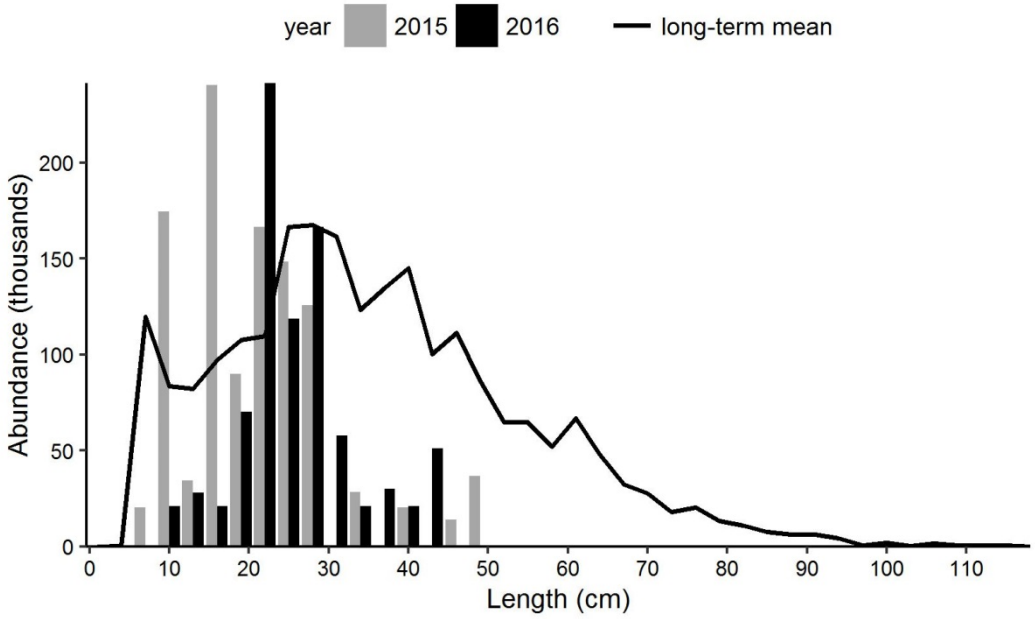


*Figure 14e. Length frequency indices for Atlantic Wolffish in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Monkfish

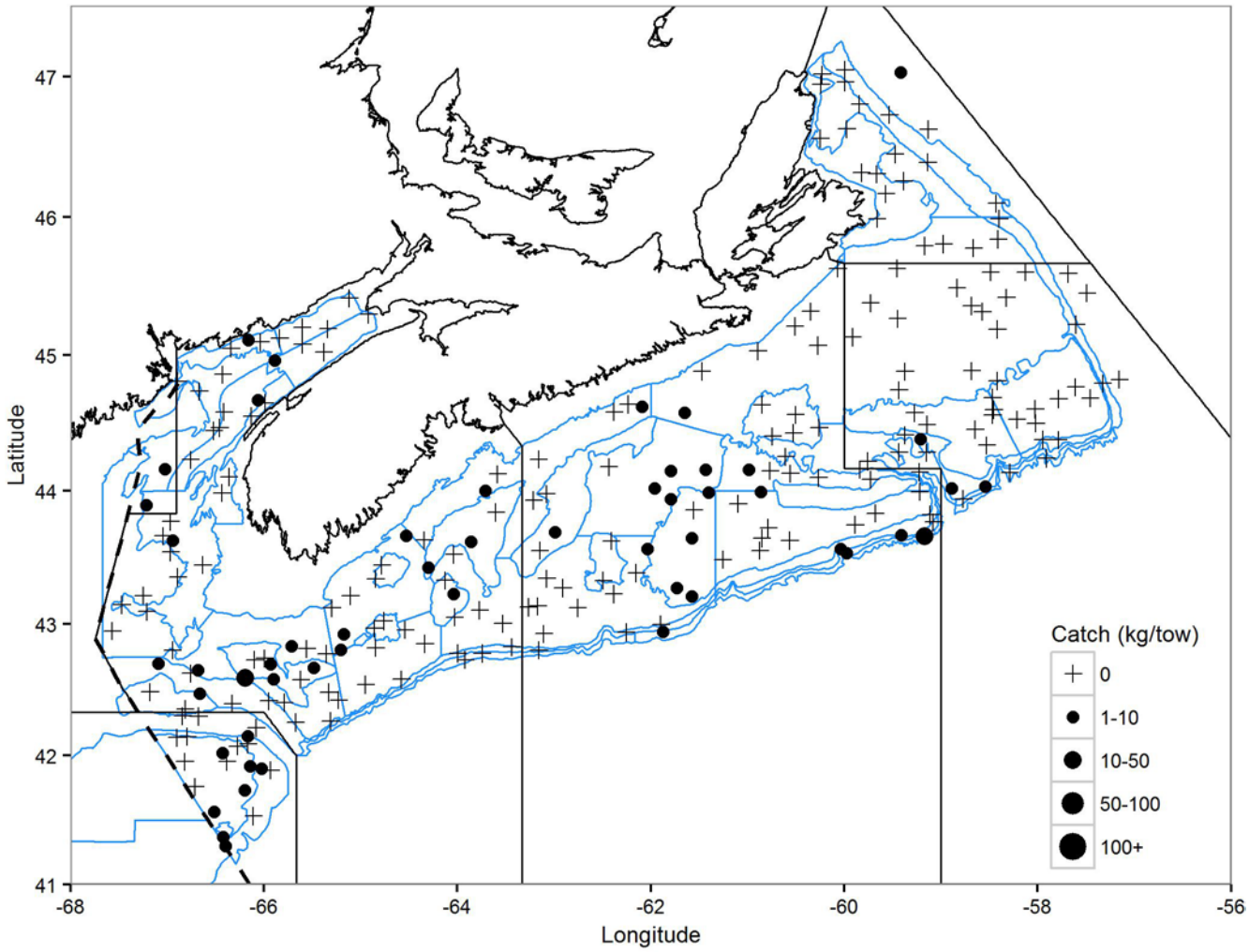


*Figure 15a. Distribution of Monkfish catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

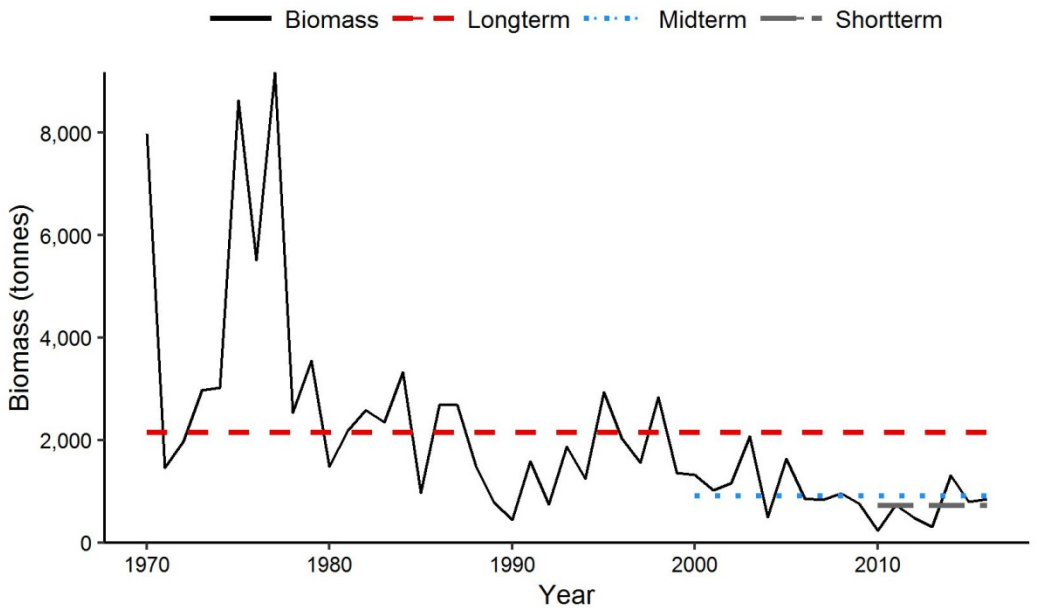


*Figure 15b. Biomass index for Monkfish in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

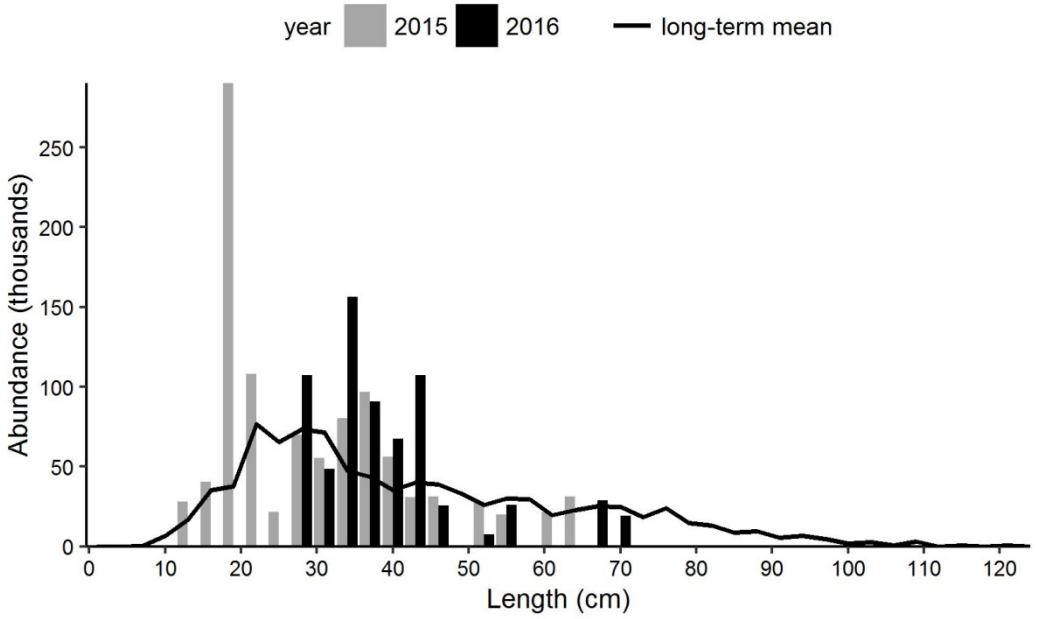


*Figure 15c. Length frequency indices for Monkfish in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

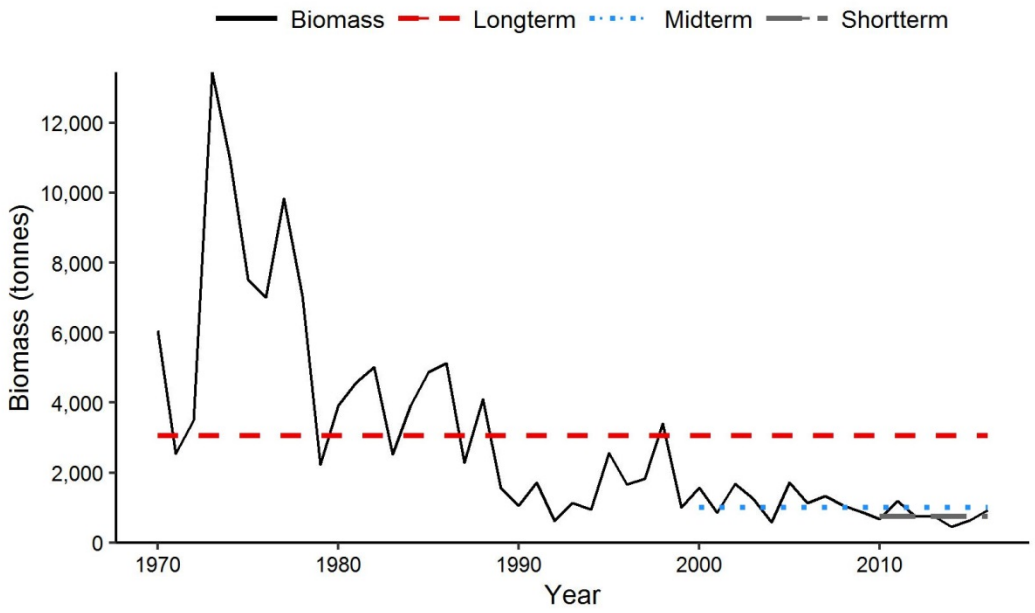


*Figure 15d. Biomass index for Monkfish in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

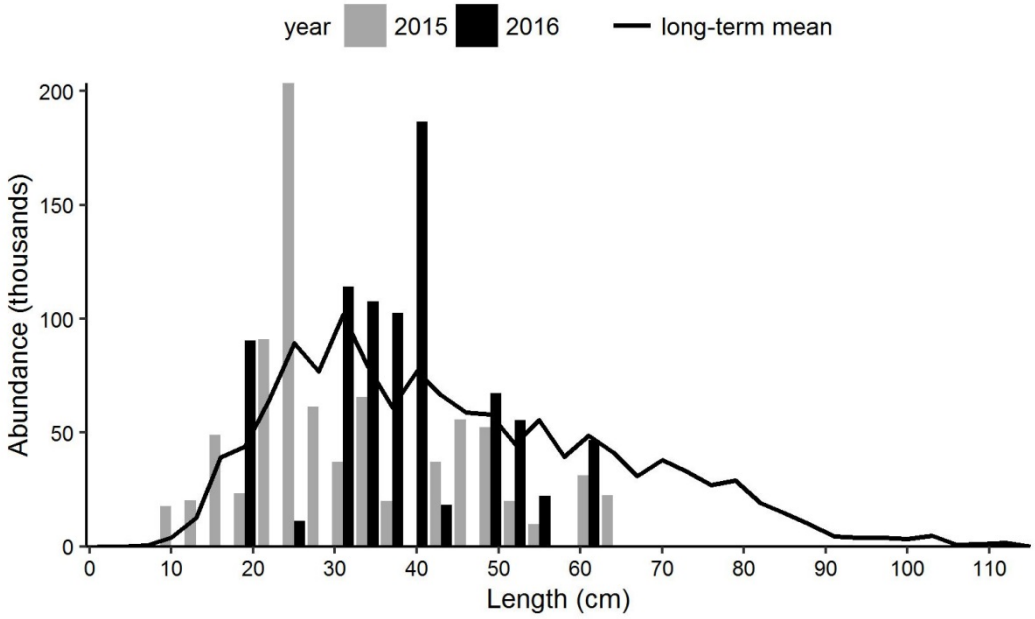


*Figure 15e. Length frequency indices for Monkfish in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Longhorn Sculpin

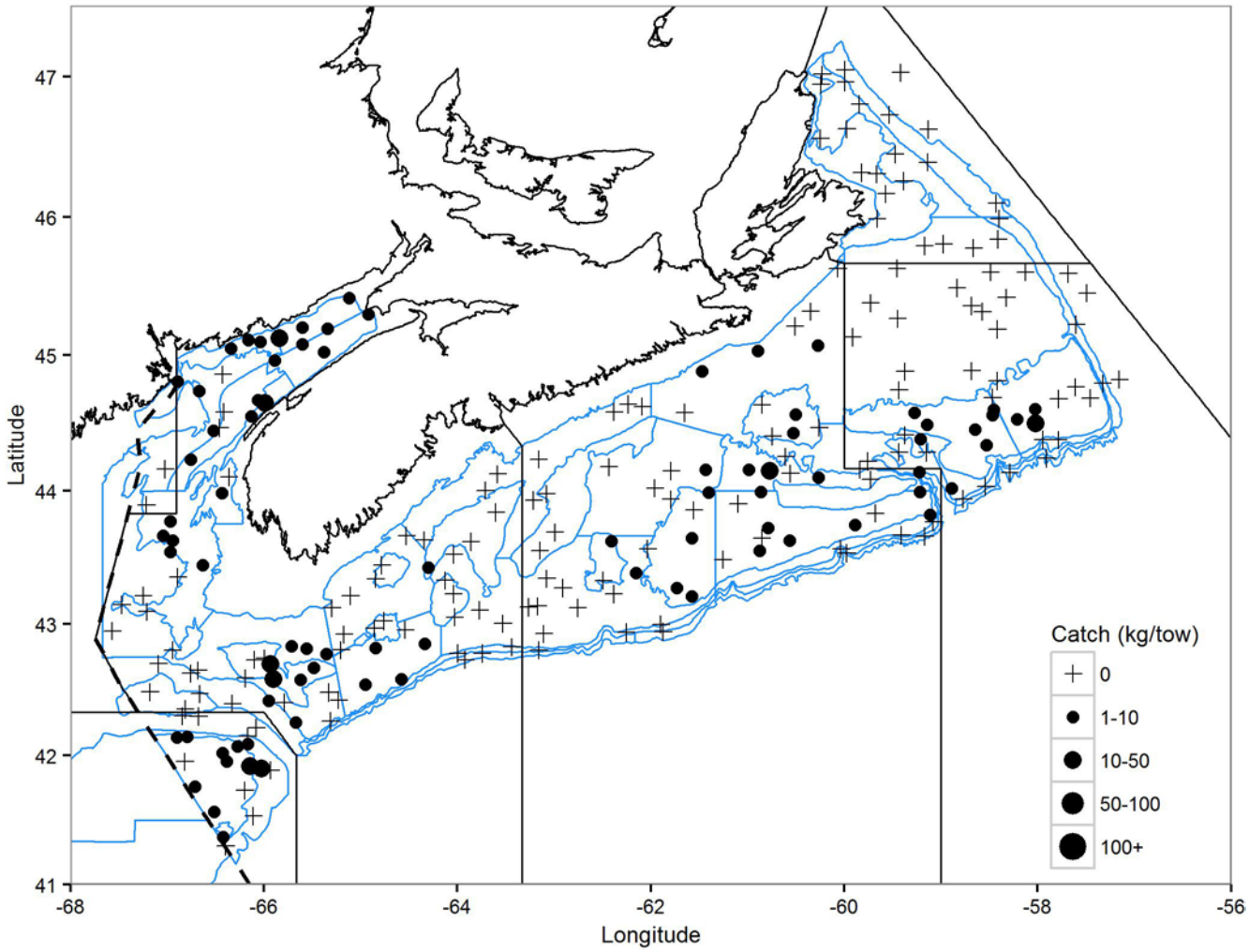


*Figure 16a. Distribution of Longhorn Sculpin catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

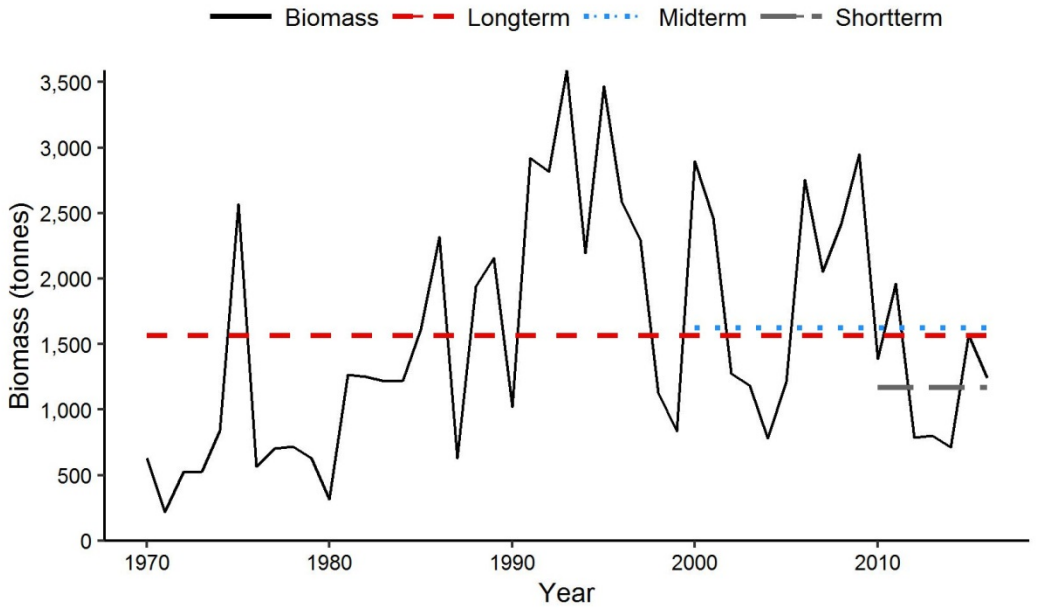


*Figure 16b. Biomass index for Longhorn Sculpin in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

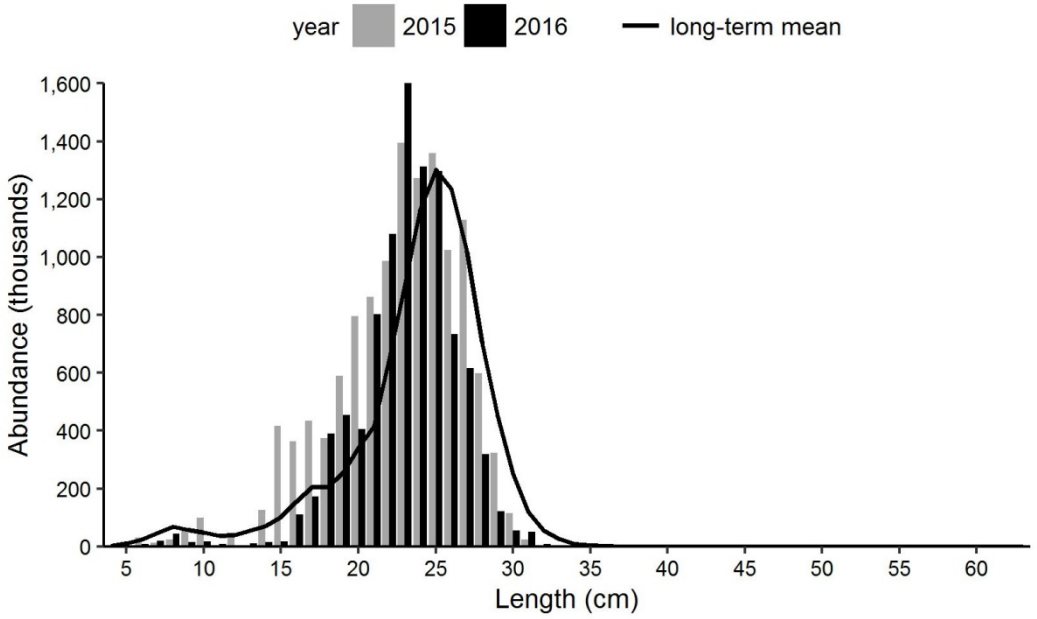


*Figure 16c. Length frequency indices for Longhorn Sculpin in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

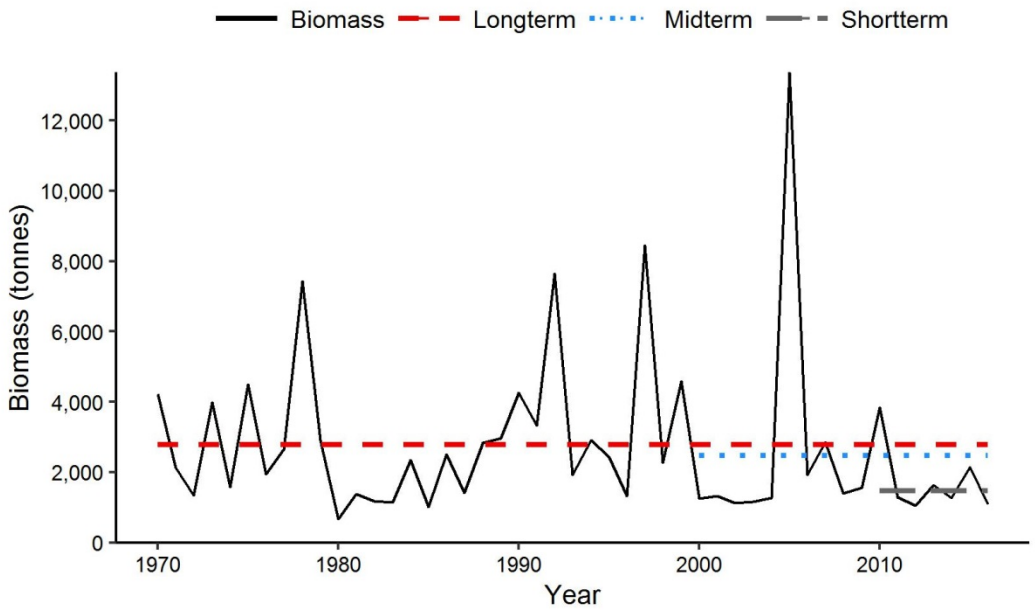


*Figure 16d. Biomass index for Longhorn Sculpin in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

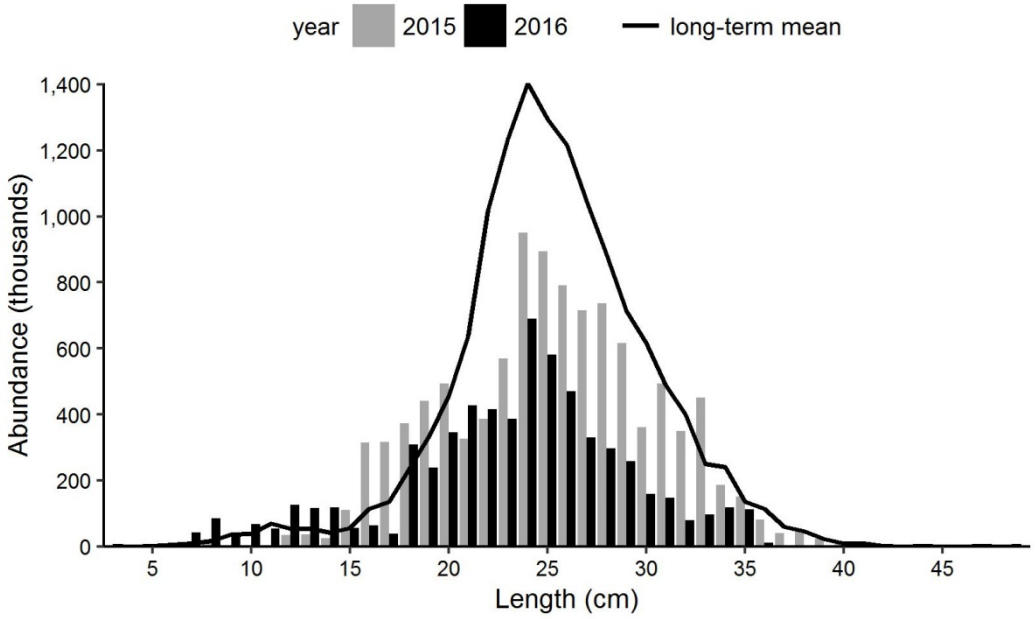


*Figure 16e. Length frequency indices for Longhorn Sculpin in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Barndoor Skate

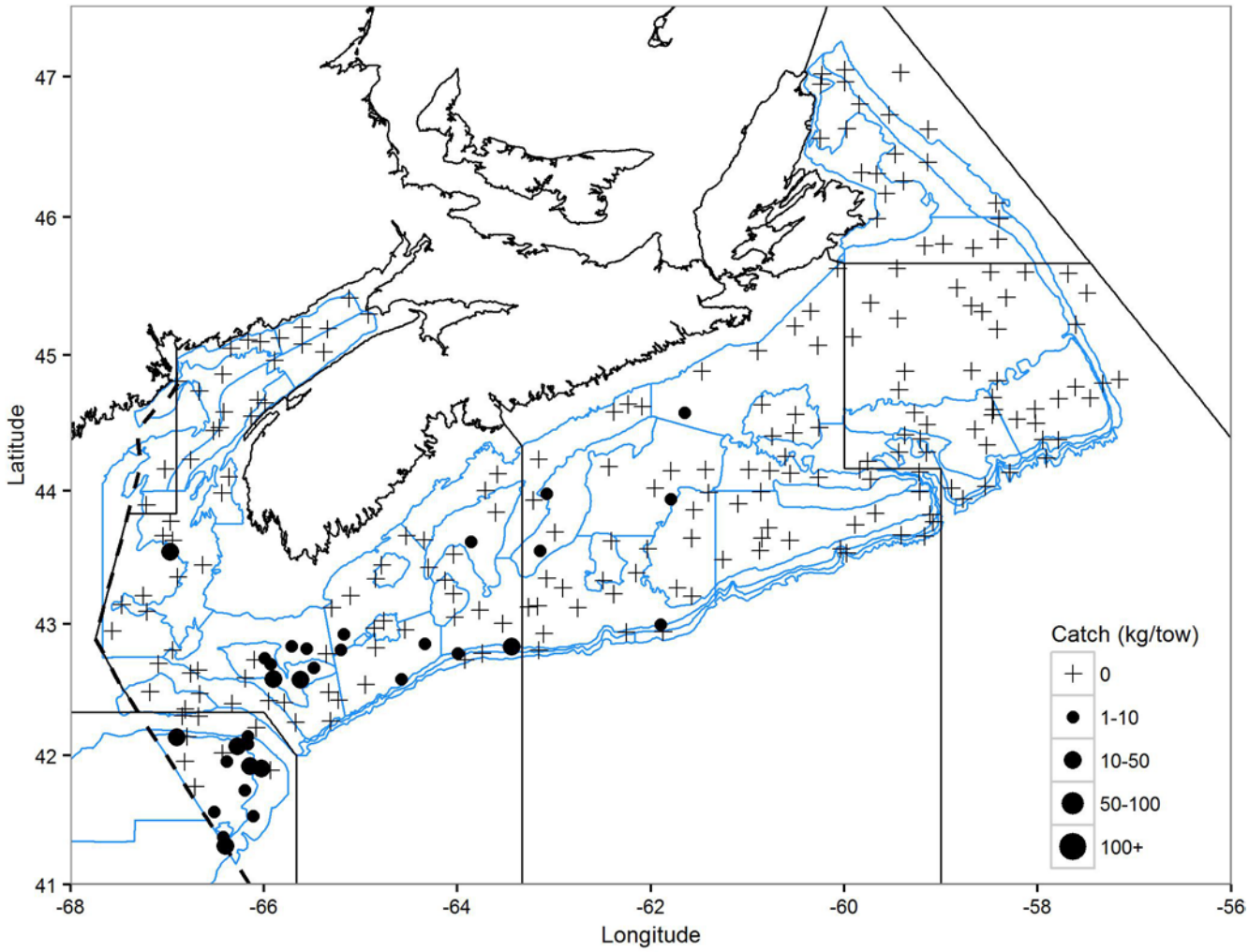


*Figure 17a. Distribution of Barndoor Skate catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

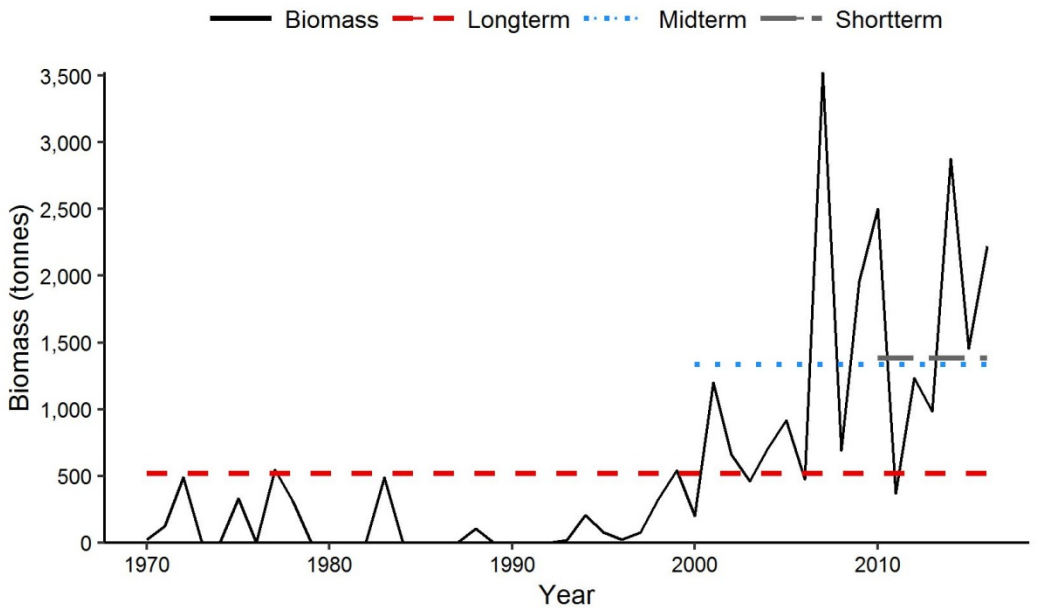


*Figure 17b. Biomass index for Barndoor Skate in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

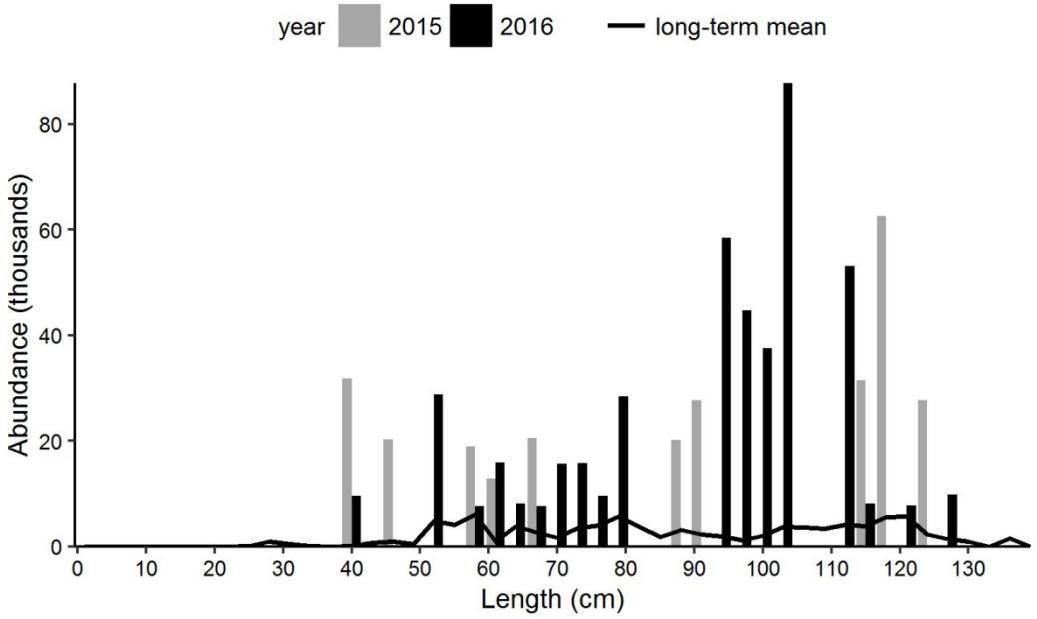


*Figure 17c. Length frequency indices for Barndoor Skate in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

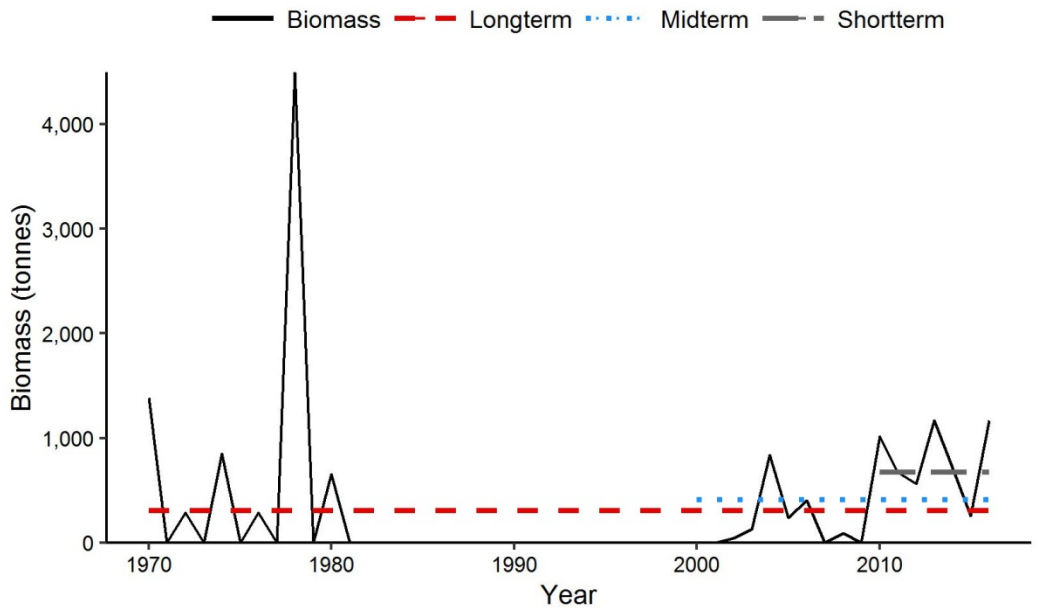


*Figure 17d. Biomass index for Barndoor Skate in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

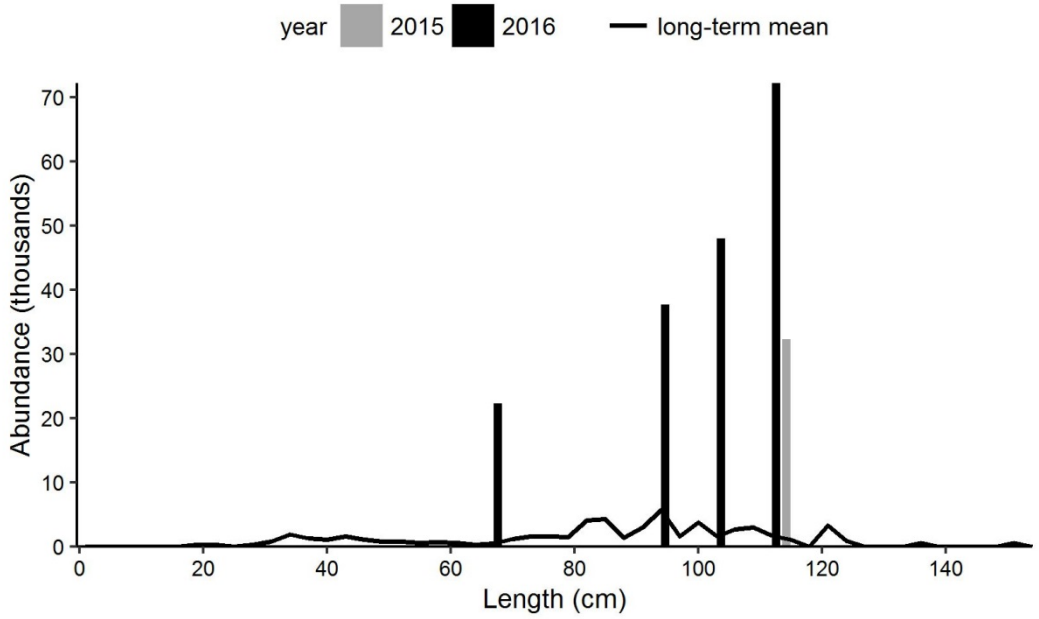


*Figure 17e. Length frequency indices for Barndoor Skate in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Thorny Skate

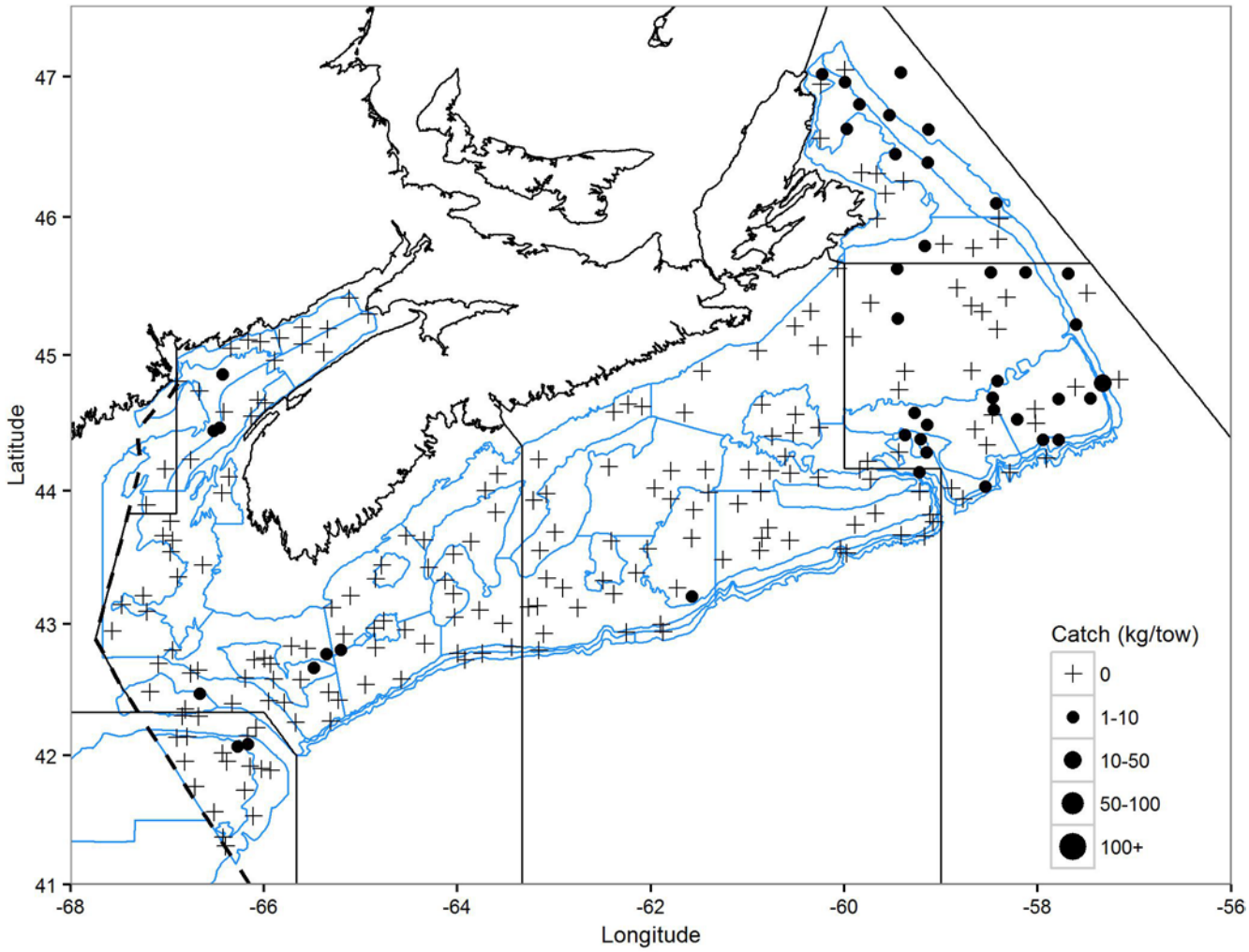


*Figure 18a. Distribution of Thorny Skate catches during the 2016 DFO Summer Research Vessel survey including the Laurentian channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

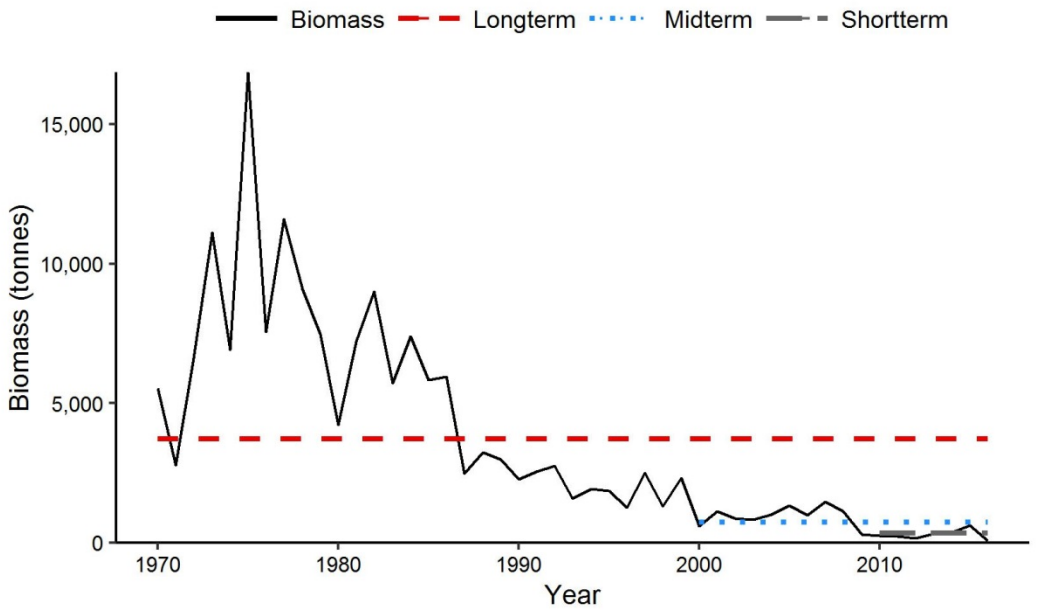


*Figure 18b. Biomass index for Thorny Skate in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

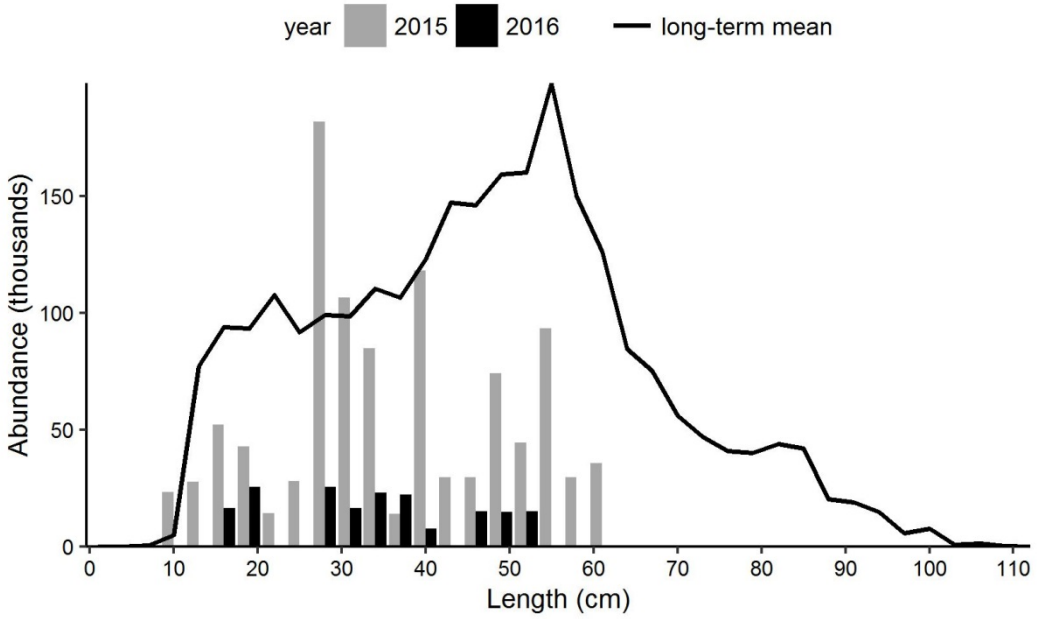


*Figure 18c. Length frequency indices for Thorny Skate in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

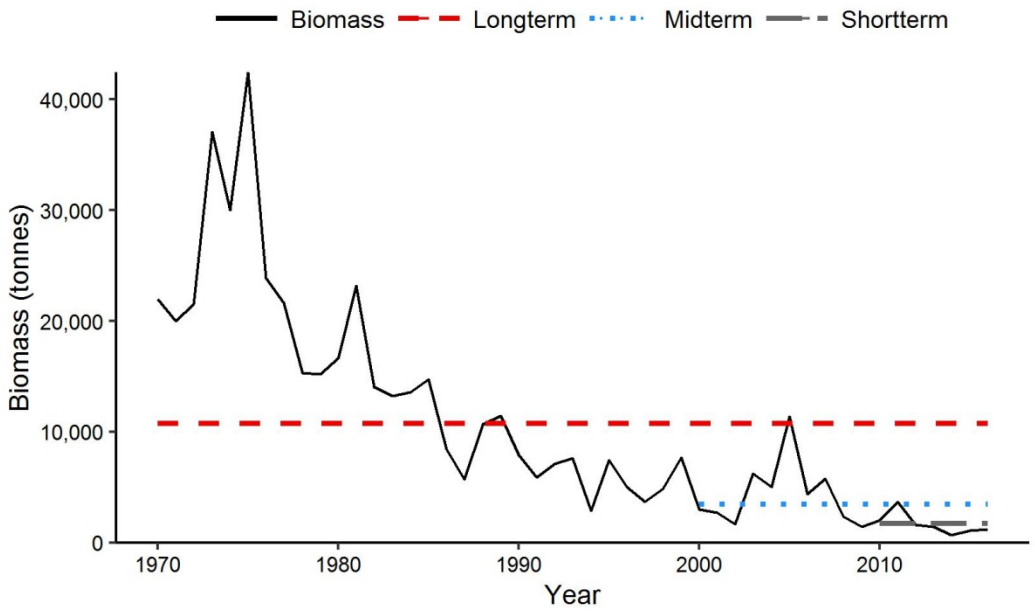


*Figure 18d. Biomass index for Thorny Skate in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

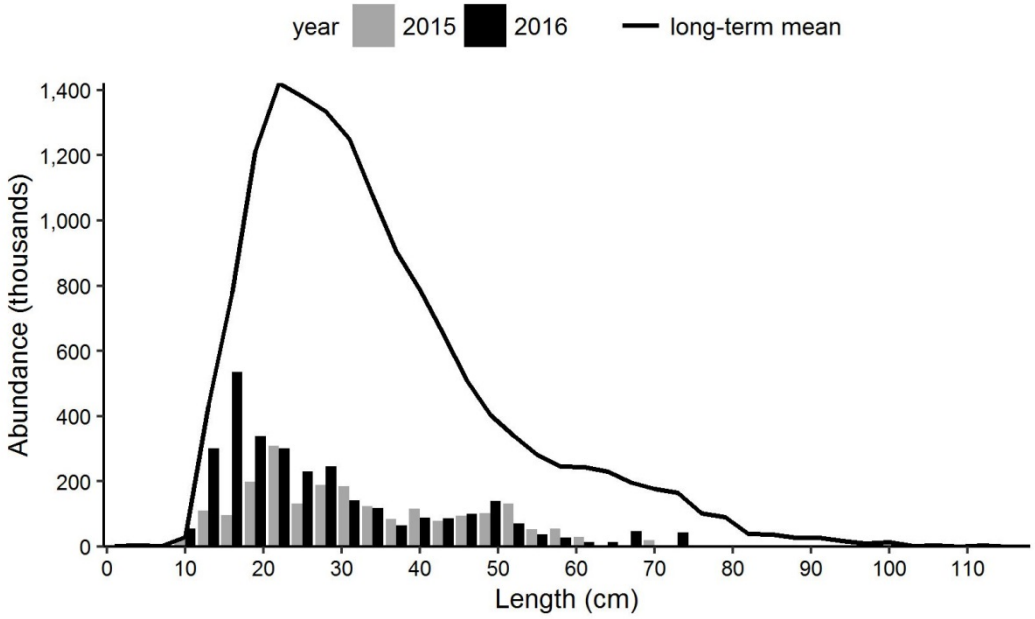


*Figure 18e. Length frequency indices for Thorny Skate in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

**Winter Skate** and **Little Skate** cannot be reliably distinguished at lengths less than about 40cm. Given that the majority of the Winter and Little skates captured in the surveys are in this length range, the biomass trends are influenced by the contribution of fish for which identification is uncertain (for more information see McEachran and Musick 1973).

## Winter Skate

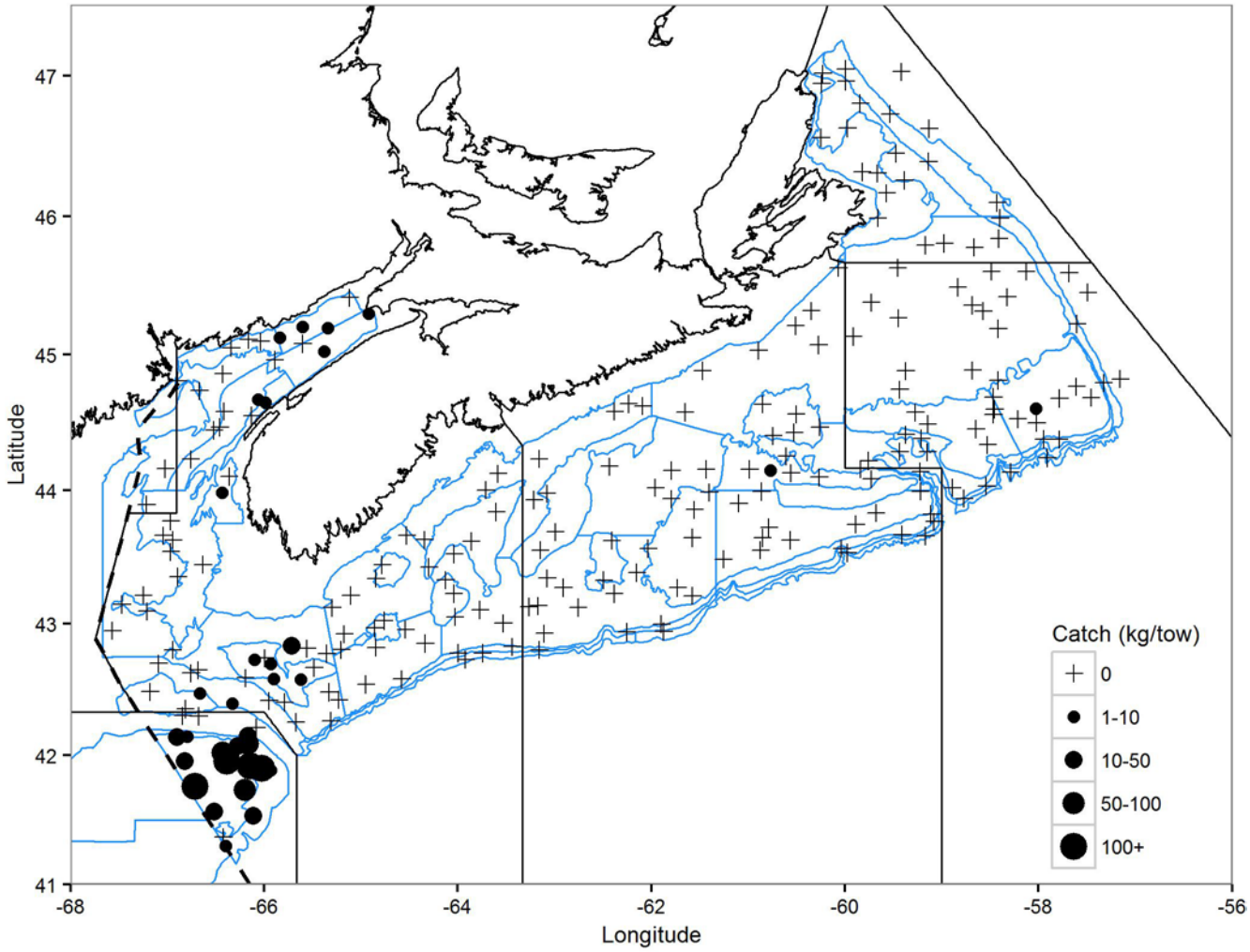


*Figure 19a. Distribution of Winter Skate catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

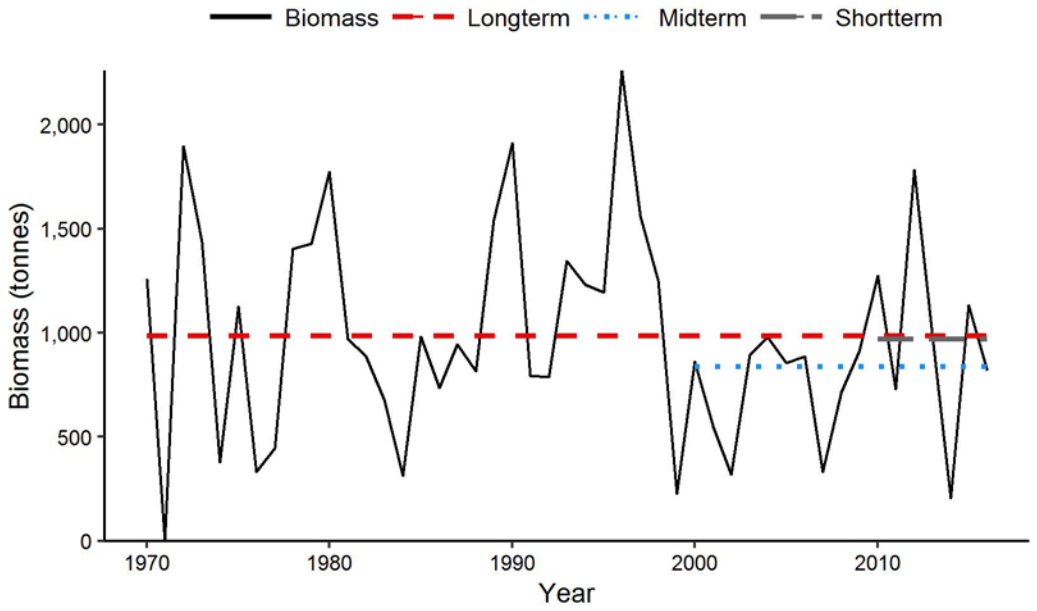


*Figure 19b. Biomass index for Winter Skate in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

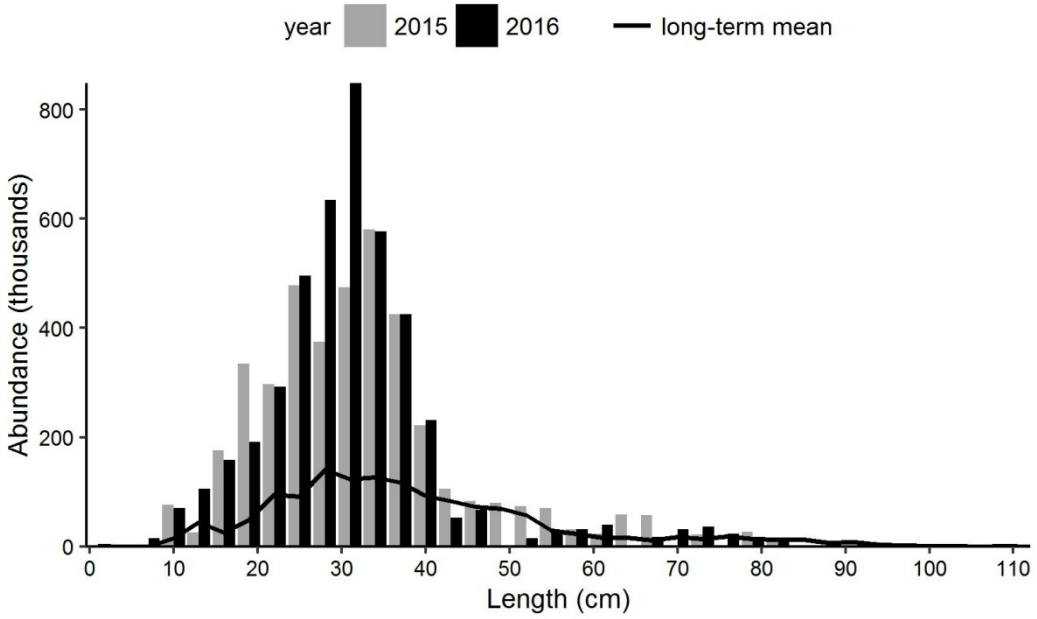


*Figure 19c. Length frequency indices for Winter Skate in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

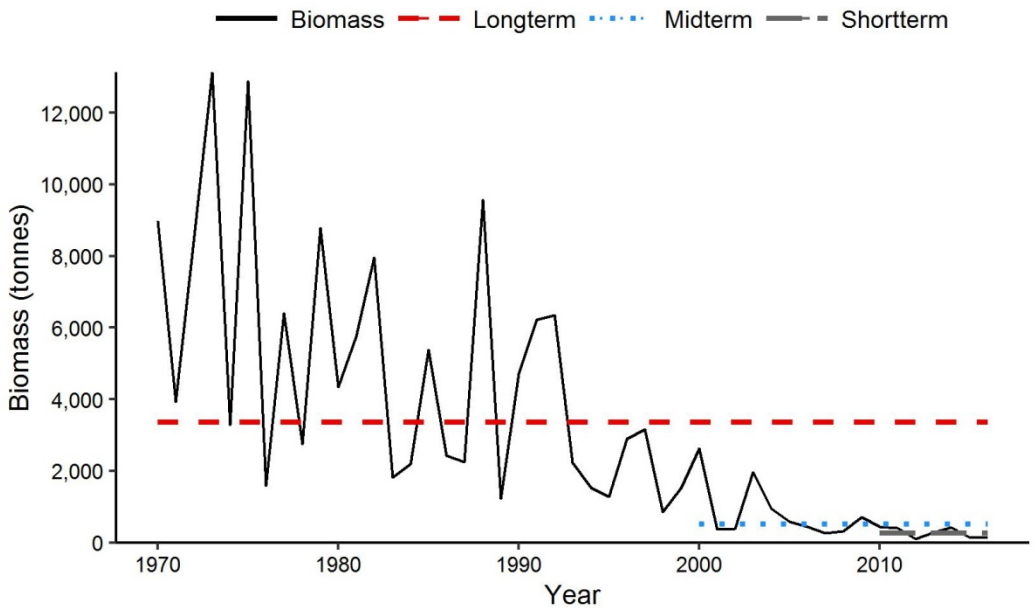


*Figure 19d. Biomass index for Winter Skate in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

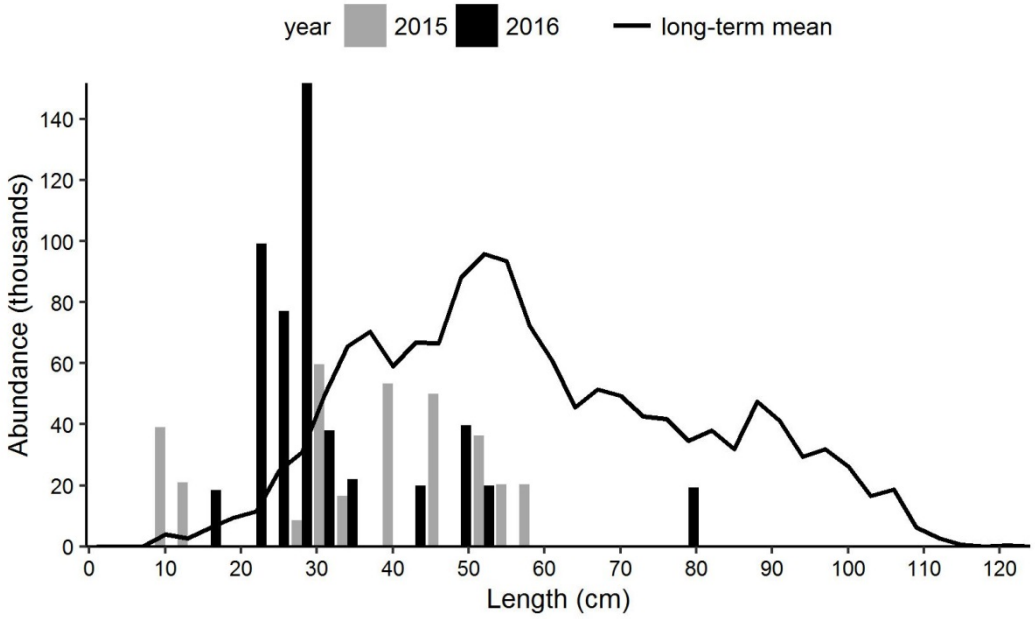


*Figure 19e. Length frequency indices for Winter Skate in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Little Skate

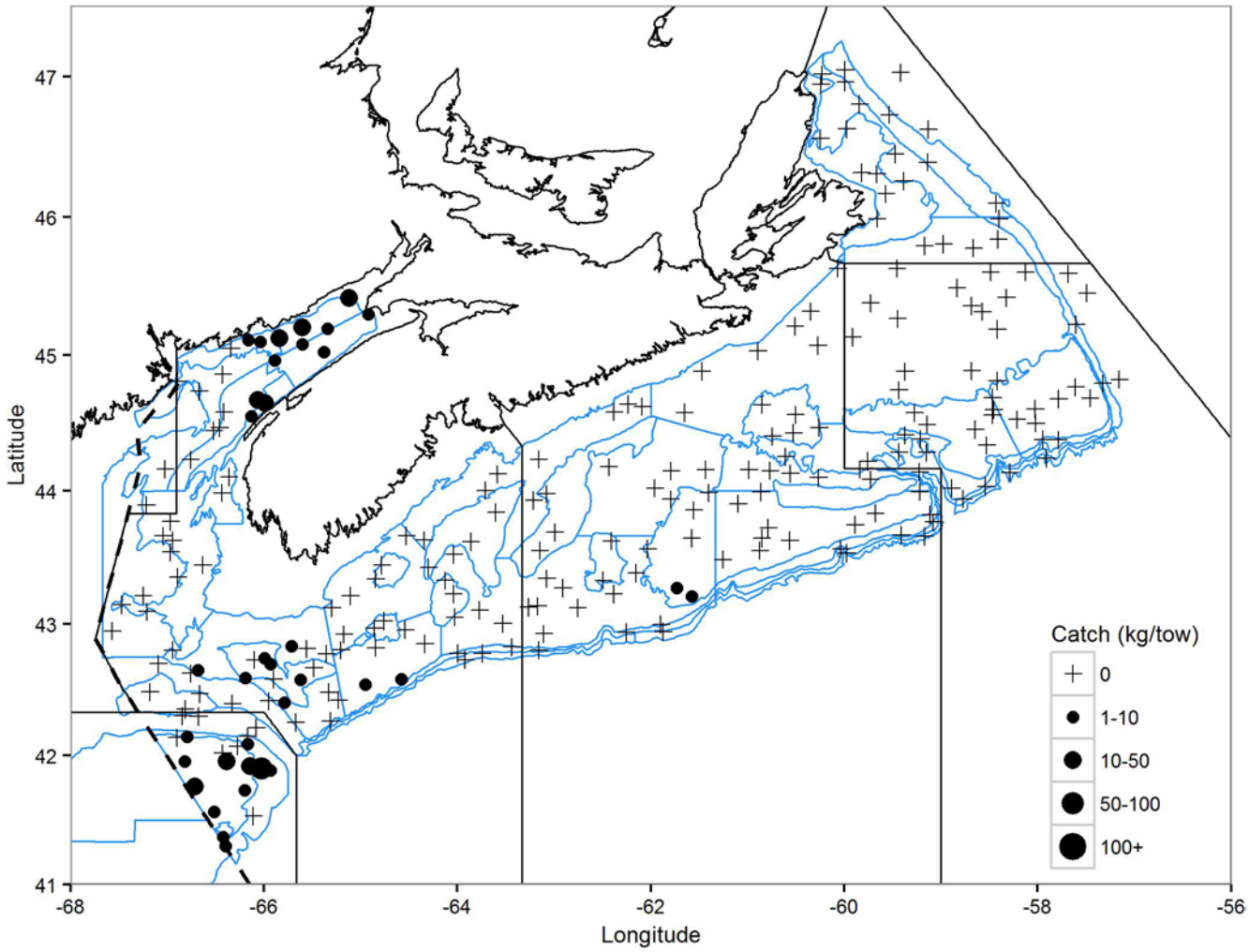


*Figure 20a. Distribution of Little Skate catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

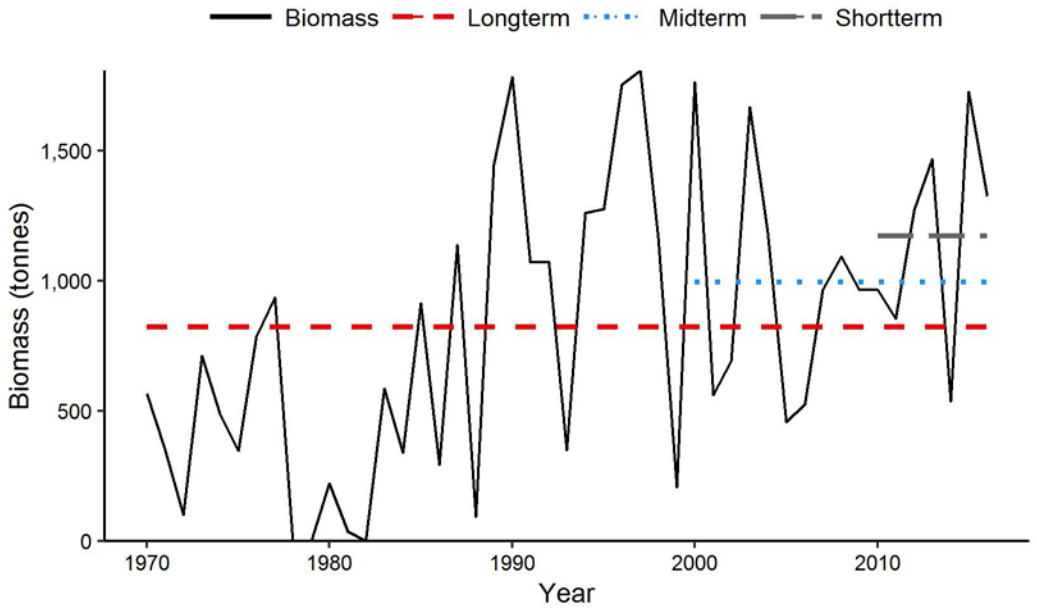


*Figure 20b. Biomass index for Little Skate in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

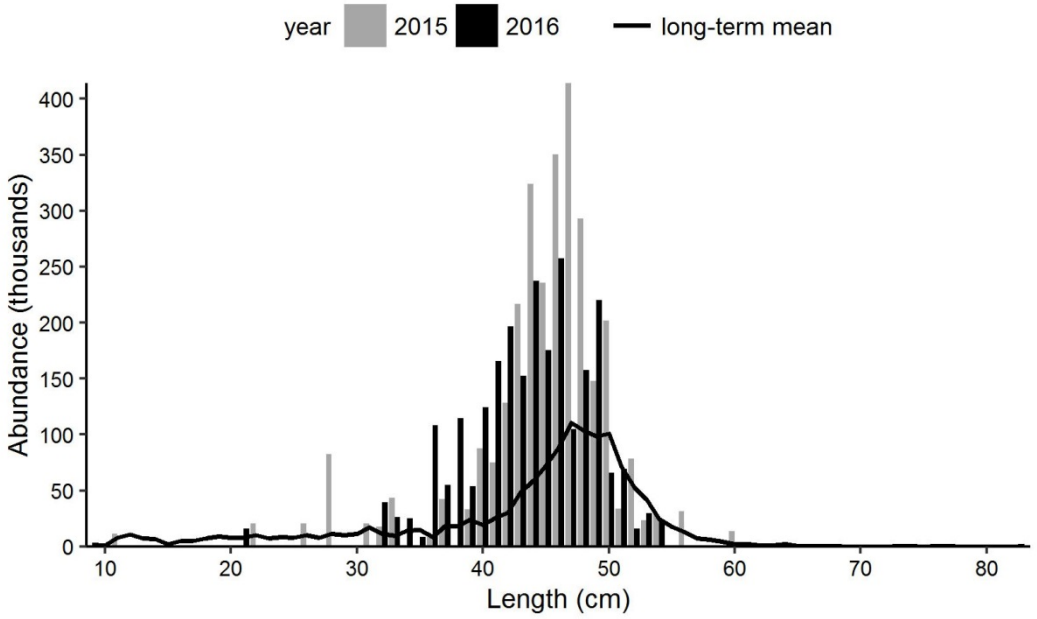


*Figure 20c. Length frequency indices for Little Skate in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

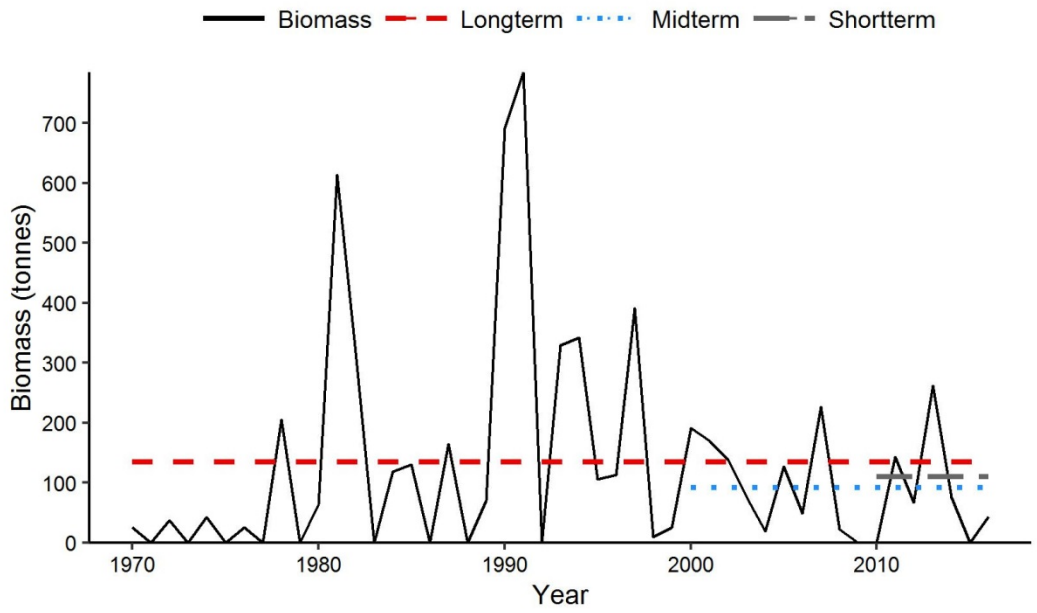


*Figure 20d. Biomass index for Little Skate in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

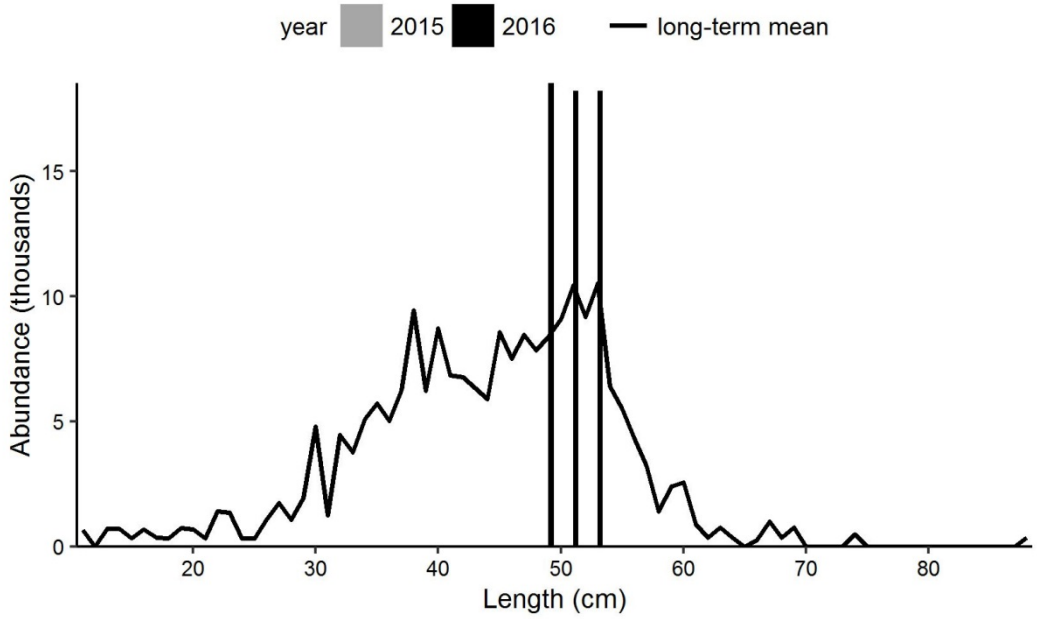


*Figure 20e. Length frequency indices for Little Skate in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. There were none caught in 2015. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Smooth Skate

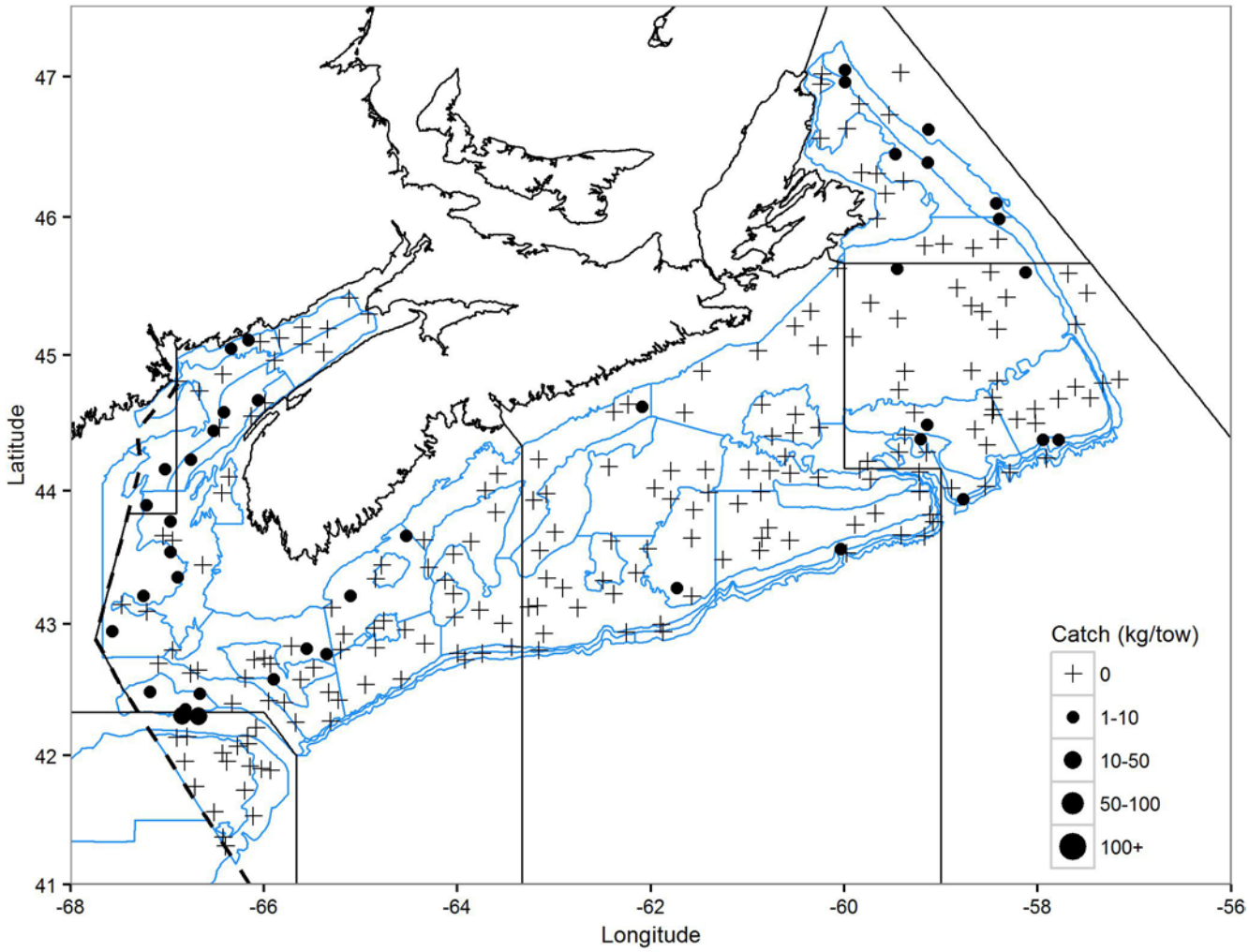


*Figure 21a. Distribution of Smooth Skate catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

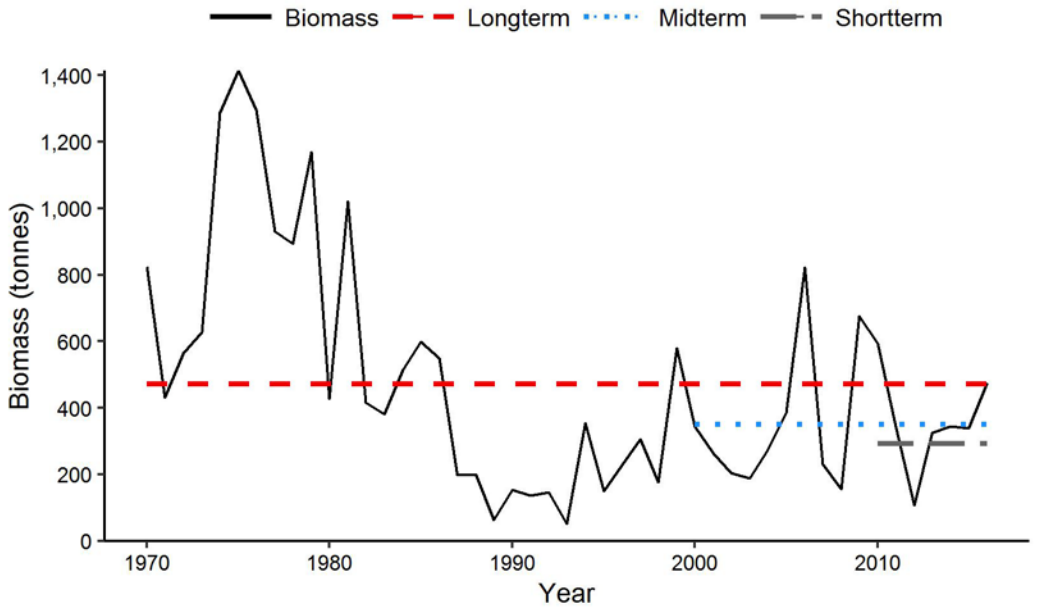


*Figure 21b. Biomass index for Smooth Skate in 4X from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

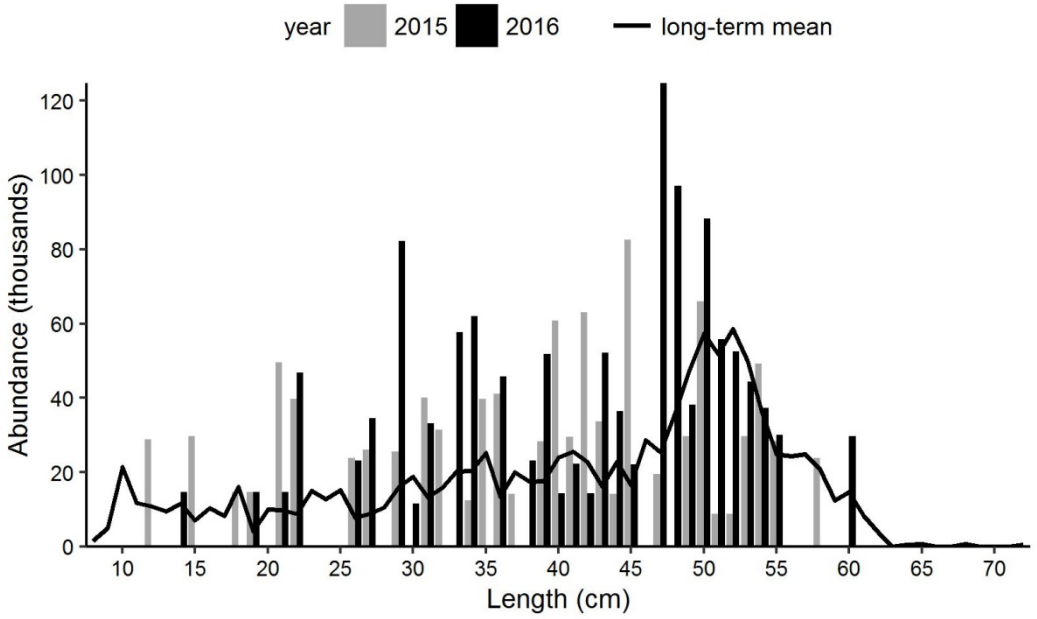


*Figure 21c. Length frequency indices for Smooth Skate in 4X from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

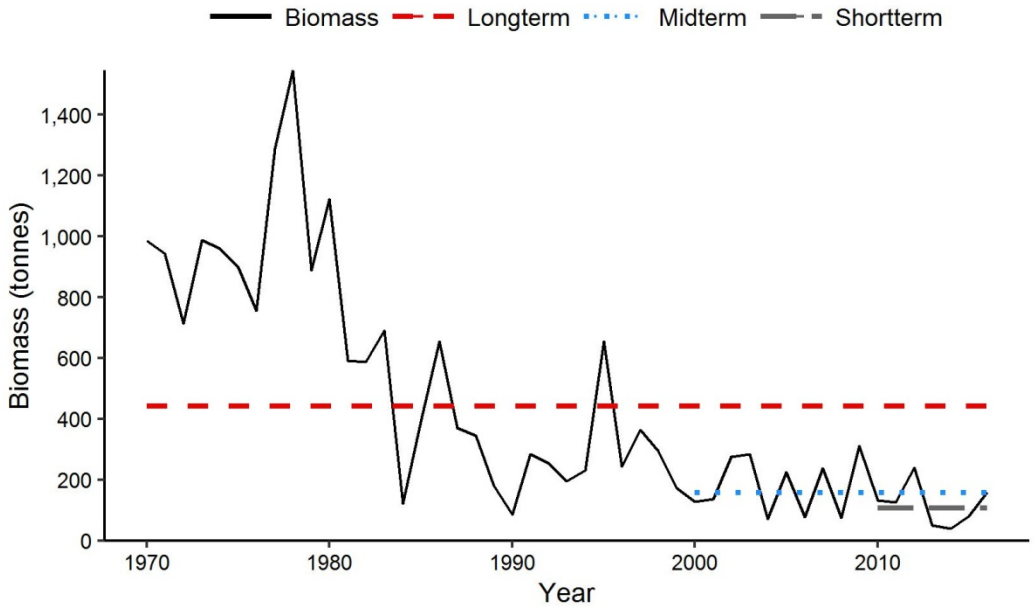


*Figure 21d. Biomass index for Smooth Skate in 4VW from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

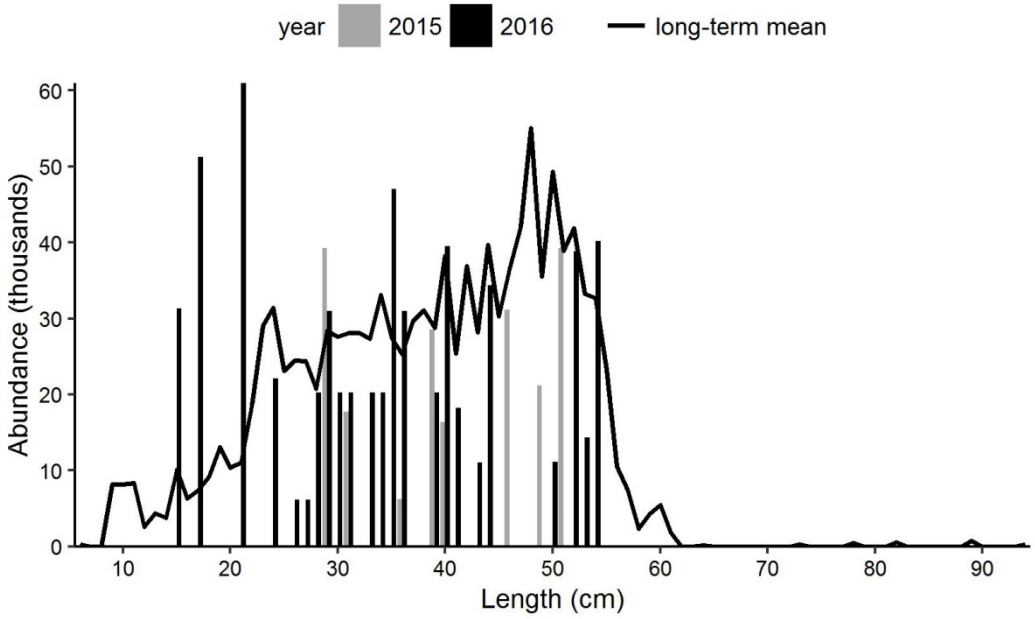


*Figure 21e. Length frequency indices for Smooth Skate in 4VW from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

## Spiny Dogfish

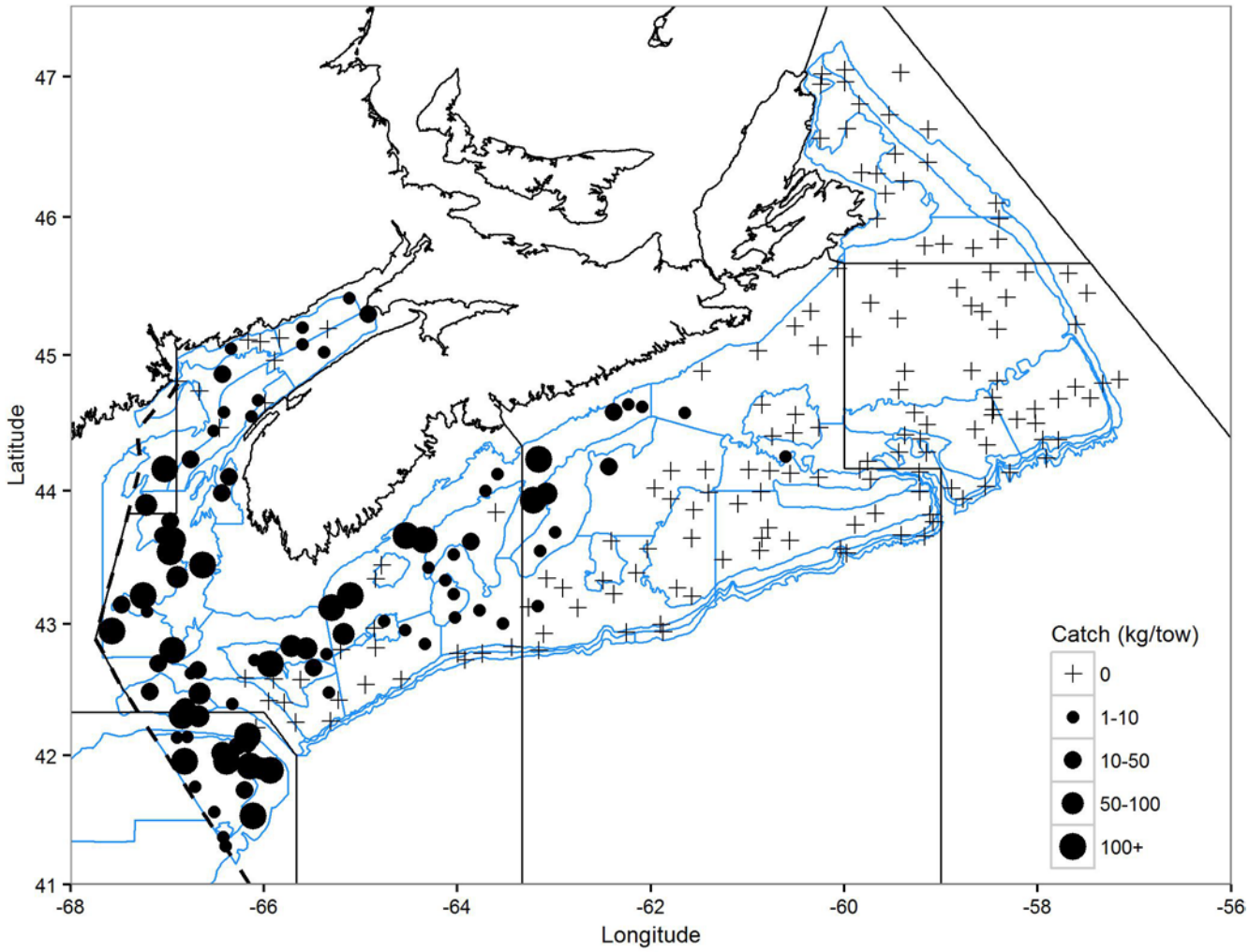


*Figure 22a. Distribution of Spiny Dogfish catches during the 2016 DFO Summer Research Vessel survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size.*

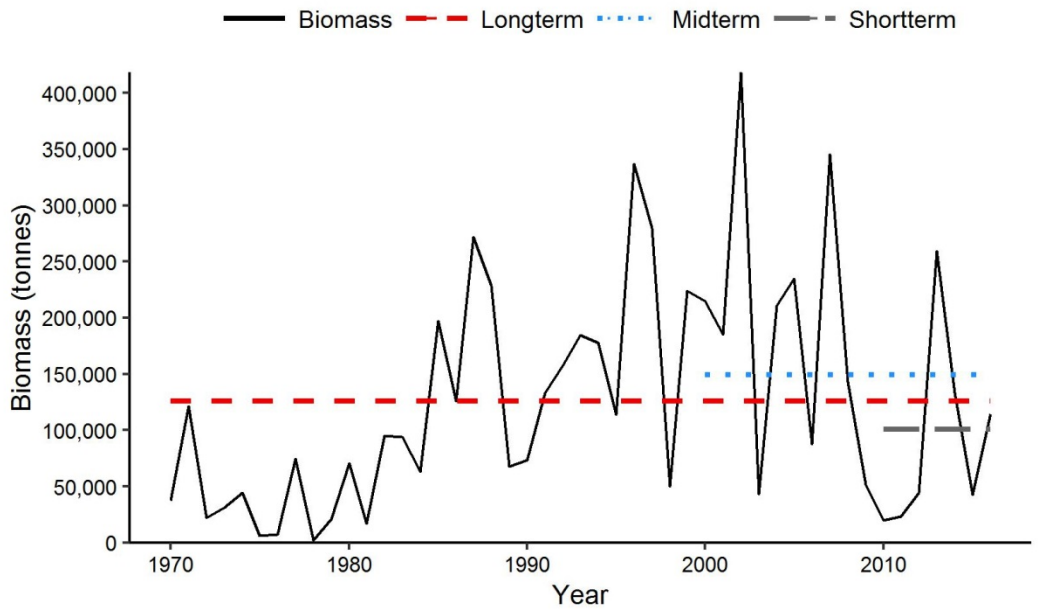


*Figure 22b. Biomass index for Spiny Dogfish in 4VWX from the DFO Summer Research Vessel survey represented by the black line. The dashed red line indicates the long-term survey average (1970-2015). The dotted blue line represents the medium-term 15-year average (2001-2015). The long-dash grey line represents the short-term 5-year average (2011-2015).*

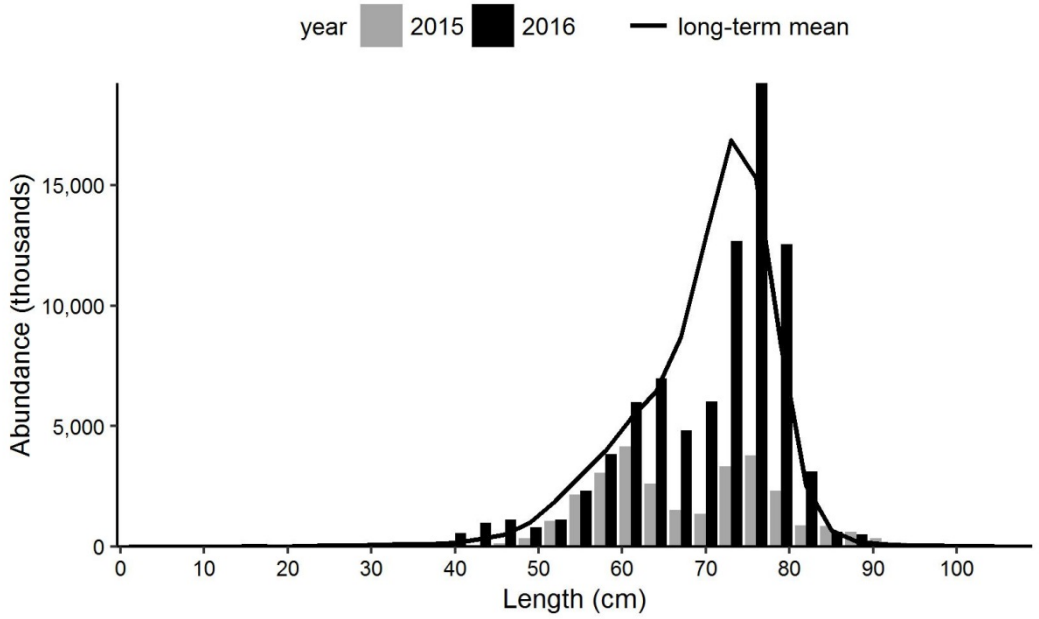


*Figure 22c. Length frequency indices for Spiny Dogfish in 4VWX from the DFO Summer Research Vessel survey. Black bars represent the number in thousands at length from the 2016 survey. Grey bars represent the number in thousands at length from the 2015 survey. The black line represents the average number in thousands at length for the time period 1970-2014.*

# Conclusions

Biomass indices for recent years may be compared with the averages over 3 time periods; short-term being the most recent 5-year average, mid-term being the most recent 15-year average, and long-term being since the beginning of the survey time series, or the period deemed appropriate for that particular species. Biomass indices for 3NOPs4VWX5Zc Halibut and Unit III Redfish in 2016 were the highest in the time-series, while the 2016 values for 4VsW cod and 4X Thorny Skate are the lowest in the time-series.

Following the 2016 DFO Summer RV survey the short-term average for 4VWX Silver Hake, eastern Pollock, Unit III Redfish, 3NOPs4VWX5Zc Atlantic Halibut, 4X Winter Flounder, 4X and 4VW Barndoor Skate, and 4X Little Skate are all greater than the long-term average of the time series. The short-term mean of 4X5Y Haddock, 4VW Yellowtail Flounder, 4VW Winter Flounder, 4VW Witch Flounder, 4X Winter Skate, 4VW Little Skate, 4X Longhorn Sculpin, and 4VWX Spiny Dogfish all remain at similar biomass estimates to the long-term average (short-term mean biomass greater than 70% of the long-term mean). The short term mean biomass estimate for all other fish stocks (4Vn, 4VsW, and 4X5Y Atlantic Cod, 4VW Haddock, 4X and 4VW White Hake, Western Pollock, Unit II Redfish, 4VW and 4X American Plaice, 4X Witch Flounder, 4X Yellowtail Founder, 4VW and 4X Smooth Skate, 4VW and 4X Thorny Skate, 4VW Winter Skate, 4VW and 4X Atlantic Wolffish, 4VW and 4X Monkfish, 4VW Longhorn Sculpin) are below the long-term mean. The short-term average biomass is discussed in relation to the long-term based on cut-off points of less than 20%, 50%, and 70%.

The short-term mean for all Atlantic Cod stocks are reduced to less than 50% of the long-term average, and both 4Vn and 4X Cod are less than 20% of the long-term. A biomass index greater than the long term mean was observed in 4Vn Atlantic Cod in 2016; this was largely due to the catch from a single tow and may not represent an increase that will continue in the stock. The short-term mean for both 4X and 4VW White Hake are less than 50% of the long-term mean, but the biomass indices for these stocks remain above the SFGAC defined lower reference points. The short-term mean for western Pollock remains below 50% of the long-term mean; however, the 2016 biomass index was above the mean and large catches were widespread in the Gulf of Maine and on Georges Bank, suggesting the 2016 result may be representative of the stock biomass. The short-term mean of eastern Pollock is well above the long-term mean, but is largely influenced by a time-series high catch in 2011. The short-term mean is less than 50% of the long-term for American Plaice and Monkfish in all areas, and biomass continues to be at or near the time-series low. Similarly, the short-term mean for Atlantic Wolffish and Thorny Skate are below 20% of the long-term average and biomass estimates remained very low in recent years. The short-term average of biomass estimates of Smooth Skate in 4VW are less than 50% of the long-term, but the stock biomass in 4X has been at or near the long-term average in recent years. Similarly, the short-term average of 4X Winter Skate is similar to the long-term average, but 4VW short-term biomass estimates are less than 20% of the long-term. 4X Yellowtail and Witch Flounder, and 4VW Haddock and Longhorn Sculpin have short-term biomass estimates between 50-70% of the long-term average.

A comparison of length frequency indices for 2015 and 2016 with the long-term average demonstrates that for those stocks where biomass is very low, the abundance and length range are similarly diminished. For many stocks, there were relatively few large fish in the length distribution in 2015 and 2016. This was not the case for Redfish, Silver Hake, Halibut and Winter Flounder, where the full length-range was observed in 2016, or for Spiny Dogfish, where the length frequency was skewed towards larger than average fish in 2016.

## Contributors

| Name | Affiliation |
|---|---|
| Donald Clark (Lead) | DFO Science, Maritimes Region |
| Kirsten Clark | DFO Science, Maritimes Region |
| Andrew Taylor | DFO Science, Maritimes Region |
| Ryan Martin | DFO Science, Maritimes Region |
| Dheeraj Busawon | DFO Science, Maritimes Region |
| Yanjun Wang | DFO Science, Maritimes Region |
| Danielle MacDonald | DFO Science, Maritimes Region |
| Mark Showell | DFO Science, Maritimes Region |
| Quinn McCurdy | DFO Science, Maritimes Region |
| Jamie Emberley | DFO Science, Maritimes Region |
| Catriona Régnier-McKellar | DFO Science ,Maritimes Region |
| Rabindra Singh | DFO Science, Maritimes Region |
| Tana Worcester | DFO Science, Maritimes Region |
| Cornelia den Heyer | DFO Science, Maritimes Region |
| Heath Stone | DFO Science, Maritimes Region |
| Mark Fowler | DFO Science, Maritimes Region |
| Heather Bowlby | DFO Science, Maritimes Region |
| Catalina Gomez | DFO Science, Maritimes Region |
| Lottie Bennett | DFO Science, Maritimes Region |
| Alida Bundy | DFO Science, Maritimes Region |
| Corina Busby | DFO Fish Population Science, National Capital Region |
| Jennifer Ford | DFO Resource Management, Maritimes Region |

## Approved by

Alain Vézina
Regional Director of Science
DFO Maritimes Region
Dartmouth, Nova Scotia
Ph. 902-426-3490
Date: January 18, 2017

## Sources of Information

Clark, D.S., and J. Emberley. 2011. Update of the 2010 Summer Scotian Shelf and Bay of Fundy Research Vessel Survey. Can. Data Rep. Fish. Aquat. Sci. 1238

McEachran, J.D., and J.A. Musick. 1973. Characters for Distinguishing Between Immature Specimens of the Sibling Species, *Raja erinacea* and *Raja ocellata* (Pisces: Rajidae). Copeia 1973: 238-250.

## This Report is Available from the:

Centre for Science Advice (CSA)
Maritimes Region
Fisheries and Oceans Canada
Bedford Institute of Oceanography
1 Challenger Drive, PO Box 1006
Dartmouth, Nova Scotia B2Y 4A2

Telephone: 902-426-7070
E-Mail: XMARMRAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769


Correct Citation for this Publication:

DFO. 2017. 2016 Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/004.

*Aussi disponible en français :*

*MPO. 2017. Tendances dans les relevés par navire scientifique sur le plateau néo-écossais et dans la baie de Fundy dans la région des Maritimes en 2016. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2017/004.*