



**Maritimes Region**

## **2018 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. Resource Management 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, 4VW and 4X 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, 4X and 4VW Sea Raven, 4X and 4VW Red Hake, 4X and 4VW Ocean Pout, 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 2019.

This Science Response Report results from the Science Response Process of December 5, 2018, on the Maritimes Research Vessel Survey Trends on 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 (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. Conversion factors are used to adjust catches of pre-1983 surveys for Haddock, redfish, American Plaice, Yellowtail Flounder, Witch Flounder, and Winter Flounder (Fanning 1985). For long-term averages, the most appropriate starting point has been selected for each species (for details see Clark and Emberley 2011).

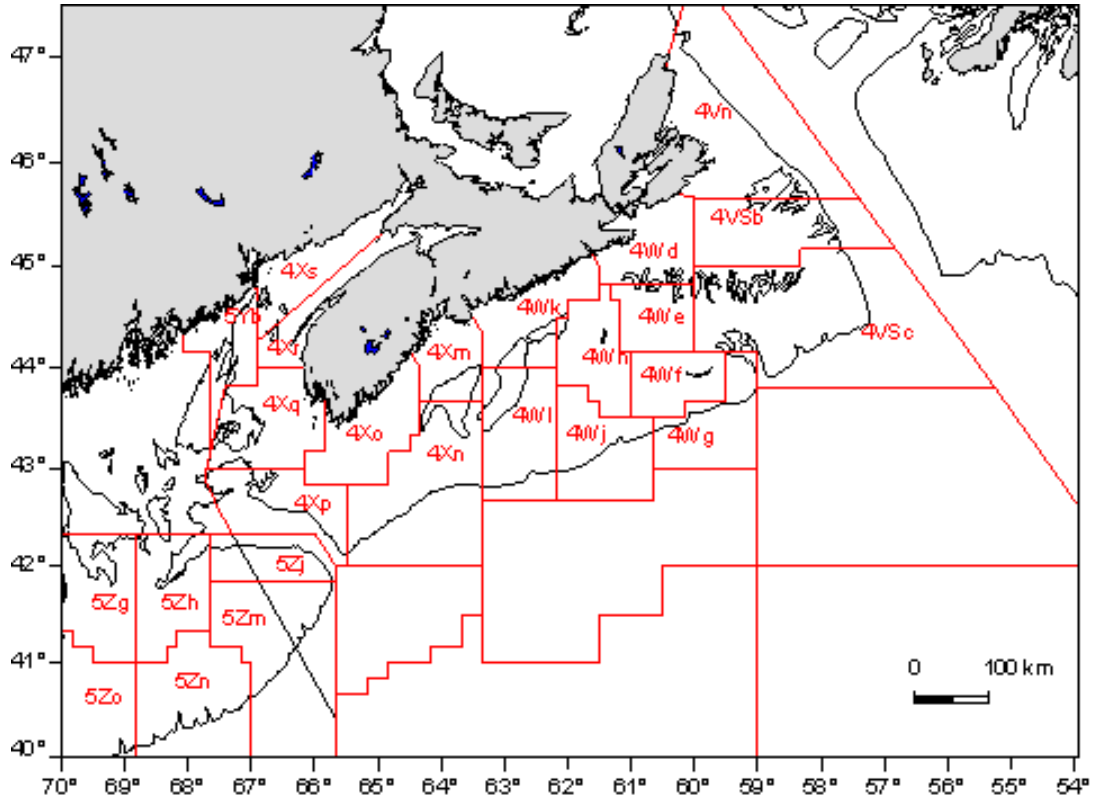


Figure 1. Northwest Atlantic Fisheries Organization (NAFO) Unit Areas.

The bottom trawl surveys were designed to provide abundance trends for fish and invertebrates between depths of about 30 m and 750 m. Survey indices are expected to be proportional to abundance for most species.

Strata boundaries for the 4VWX5 area are shown in Figure 2a. 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 due to mechanical issues with the research vessel (Figure 2b). Only 85 successful tows were completed. This is the first time since the survey began in 1970 that there has not been some sampling in all strata from 440 – 495.

Catch distribution plots, for the area sampled during the 2018 survey, 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, where possible. Comparisons of 2017 and 2018 length frequencies from the survey catch to the long-term mean are also included, using data from the geographic areas that are used in assessments for those stocks.

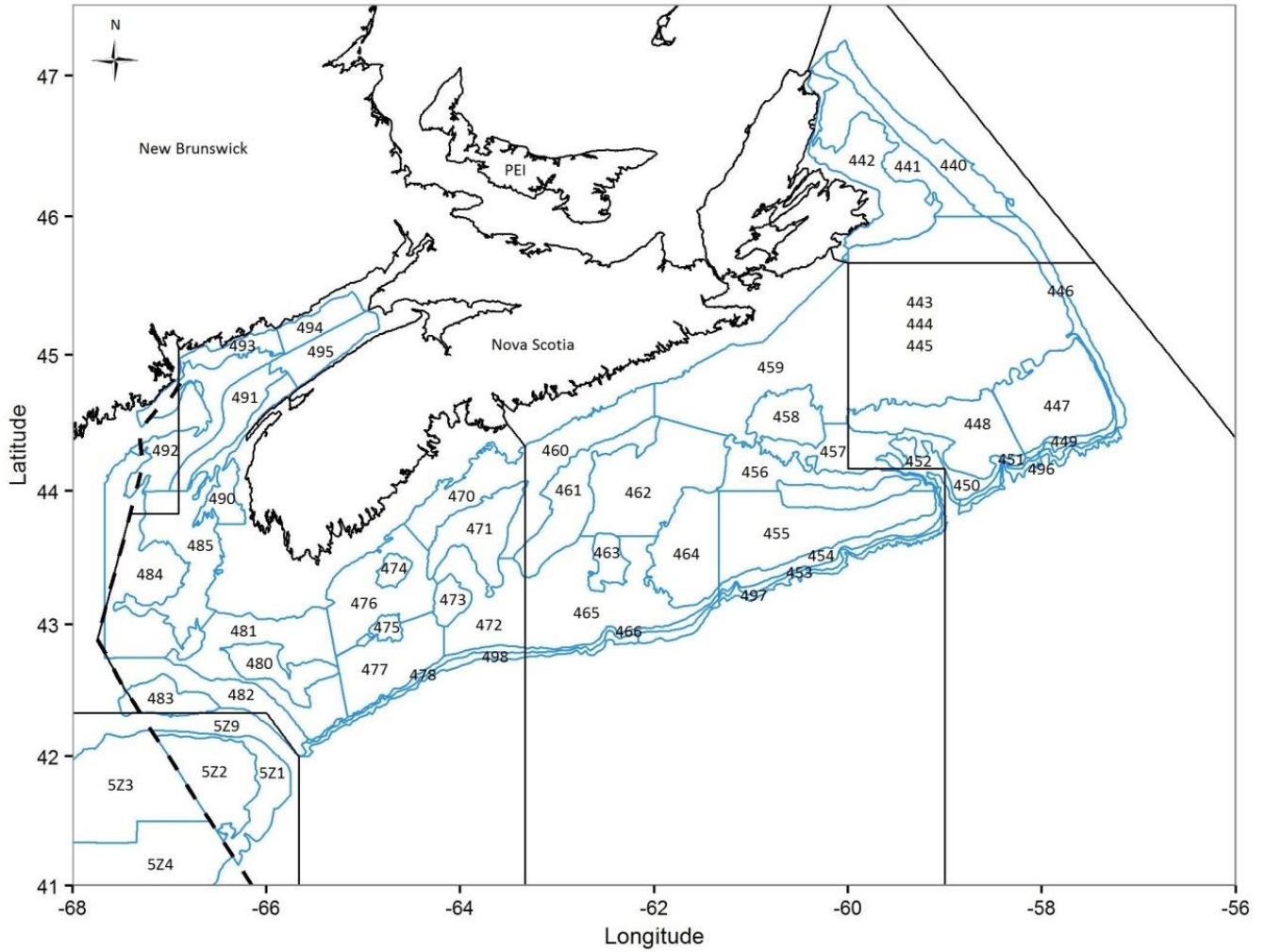


Figure 2a. Fisheries and Oceans Canada Maritimes Region Summer RV Survey Strata.

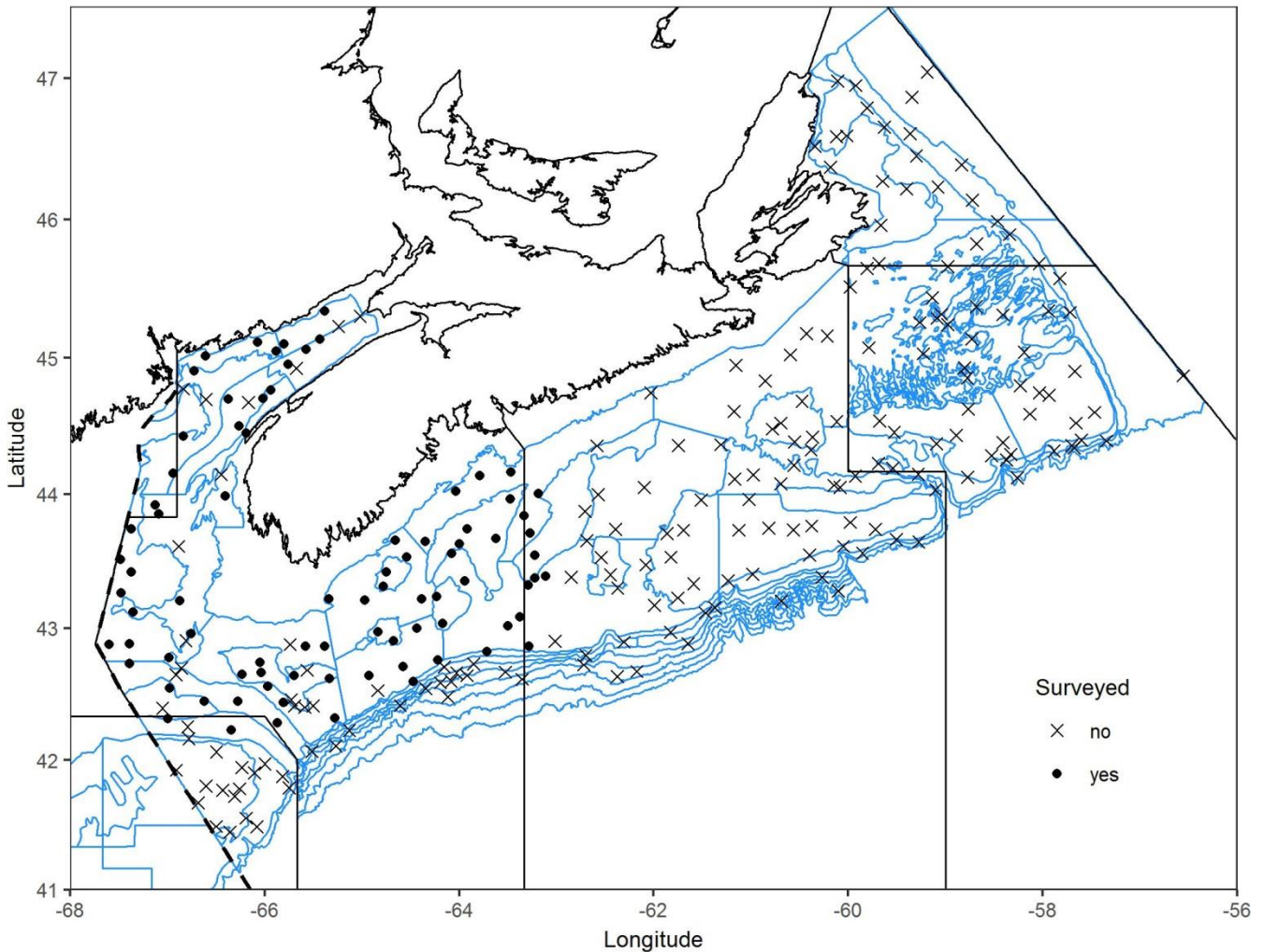


Figure 2b. Stations selected for the 2018 DFO Summer RV Survey. Locations not sampled are marked with an X; locations where fishing occurred are marked with a solid circle(●).

## Analysis and Response

The stratified random survey design ensures that sampling takes place throughout the range covered by the survey. The strata were originally selected to represent different depths and habitats. Sampling normally 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 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. 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.

Length frequency indices are calculated in a similar manner to biomass indices. These can be used to track year-class progression for some species. In addition, length frequency plots provide information on current size spectrum in relation to the long-term average and a recent (10-year) average.

Comparisons between the long-term and short-term averages are useful as indicators of long-term changes in the structure of the population.

The time series of survey biomass indices and the 3-year running Geometric Mean (GM) are compared to 40% and 80% of the GM of the long-term GM (full time series) to provide context for biomass levels. The GM was selected for these comparisons to reduce the impact of very high values observed in some years. The values are presented in Table 1. Information on the calculation of these indices is contained in Stone and Gross (2012).

Table 1. The DFO Summer RV Survey biomass indices (tonnes) for species by stock/region for 2016, 2017, 2018, current 3-year Geometric Mean (GM) biomass index, and 40% and 80% of the long-term GM biomass index (1970-2017).

Stock/Region	2016	2017	2018	Current 3-year GM	40% long-term GM	80% long-term GM
4X Cod	5,195	3,068	3,500	3,821	5,684	11,369
4VsW Cod	1,691	10,217	NA <sup>1</sup>	3,911	10,516	21,033
4Vn Cod	20,643	1,296	NA	3,590	3,394	6,789
4VW Haddock	32,209	35,796	NA	28,507	19,153	38,305
4X Haddock	62,550	38,456	44,628	47,556	19,855	39,710
4VW White Hake	5,221	4,150	NA	5,000	3,074	6,147
4X White Hake	11,216	6,735	4,988	7,226	5,748	11,497
4VWX Silver Hake	46,074	31,321	NA	5,054	13,788	6,894
4X West Silver Hake	12,719	10,112	9,301	10,614	1,300	2,599
Western Component Pollock	32,192	15,052	14,836	19,299	7,936	15,872
Eastern Component Pollock	15,754	3,222	NA	10,405	7,417	14,835
Unit II Redfish	64,701	28,808	NA	30,130	16,942	33,885
Unit III Redfish	345,767	141,450	NA	205,102	36,605	73,210
4X American Plaice	299	276	487	342	608	1,215
4VW American Plaice	3,515	5,763	NA	4,861	7,733	15,466
4X Witch Flounder	1,344	984	1,577	1,278	592	1,185
4VW Witch Flounder	6,457	4,803	NA	4,497	1,377	2,754
4X Yellowtail Flounder	106	61	105	88	185	370
4VW Yellowtail Flounder	9,973	7,984	NA	9,172	4,906	9,816
4X Winter Flounder	4,760	3,626	4,035	4,114	1,026	2,052
4VW Winter Flounder	299	577	NA	618	254	491
4VWX Atlantic Halibut	11,501	15,437	NA	12,419	1,275	2,549
4X Atlantic Halibut	4,287	2,404	5,040	3,731	466	932
4X Atlantic Wolffish	113	82	295	140	430	860
4VW Atlantic Wolffish	159	354	NA	200	506	1,011
4X Monkfish	853	1,906	2,075	1,500	619	1,238
4VW Monkfish	928	863	NA	800	814	1,629
4X Smooth Skate	476	224	504	377	143	286

Stock/Region	2016	2017	2018	Current 3-year GM	40% long-term GM	80% long-term GM
4VW Smooth Skate	160	140	NA	122	118	236
4X Thorny Skate	69	113	193	115	748	1,496
4VW Thorny Skate	1,184	1,858	NA	1,347	2,707	5,415
4X Barndoor Skate	2,269	2,457	2,668	2,459	26	52
4VW Barndoor Skate	1,169	1,340	NA	735	5	10
4X Winter Skate	818	840	571	732	304	608
4VW Winter Skate	876	562	NA	658	1,601	3,202
4X Little Skate	1,325	1,013	1,156	1,174	184	368
4VW Little Skate	44	136	NA	18	12	24
4VWX Spiny Dogfish	114,542	110,494	NA	136,425	31,915	63,830
4X Spiny Dogfish	102,571	100,211	200,476	127,253	30,227	60,453
4X Longhorn Sculpin	1,241	1,013	584	902	513	1,027
4VW Longhorn Sculpin	1,085	1,043	NA	1,345	868	1,736
4X Red Hake	1,568	1,419	1,848	1,602	491	983
4VW Red Hake	2,681	1,149	NA	1,463	378	757
4X Ocean Pout	139	95	137	122	177	354
4VW Ocean Pout	8	12	NA	5	53	105
4X Sea Raven	1,983	1,213	1,097	1,382	679	1,358
4VW Sea Raven	708	1,475	NA	1,252	331	661

<sup>1</sup>NA - indices not available due to reduced spatial coverage of the 2018 survey.

\* For Silver Hake and Red Hake, long-term average is from 1982-2017.

Total biomass index for demersal fish from the survey remains low in 4VW (Figure 3). Biomass declined on the Eastern Scotian Shelf in the early 1990s, and has generally remained low since.

In 4VW, Atlantic Cod and redfish comprised the bulk of the biomass index in the 1970s; both have experienced large declines (Figure 3). Other species, redfish, Haddock and Silver Hake are the largest contributors to the 4VW biomass index in the last decade. While additional species, including Thorny Skate, White Hake, American Plaice, and Yellowtail Flounder have also declined since the 1980s in 4VW, 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 4X, Spiny Dogfish, redfish, and Haddock have made up the bulk of the demersal fish biomass index throughout the time series (Figure 4). 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 4VW, there has been no general decline in demersal fish biomass over time.

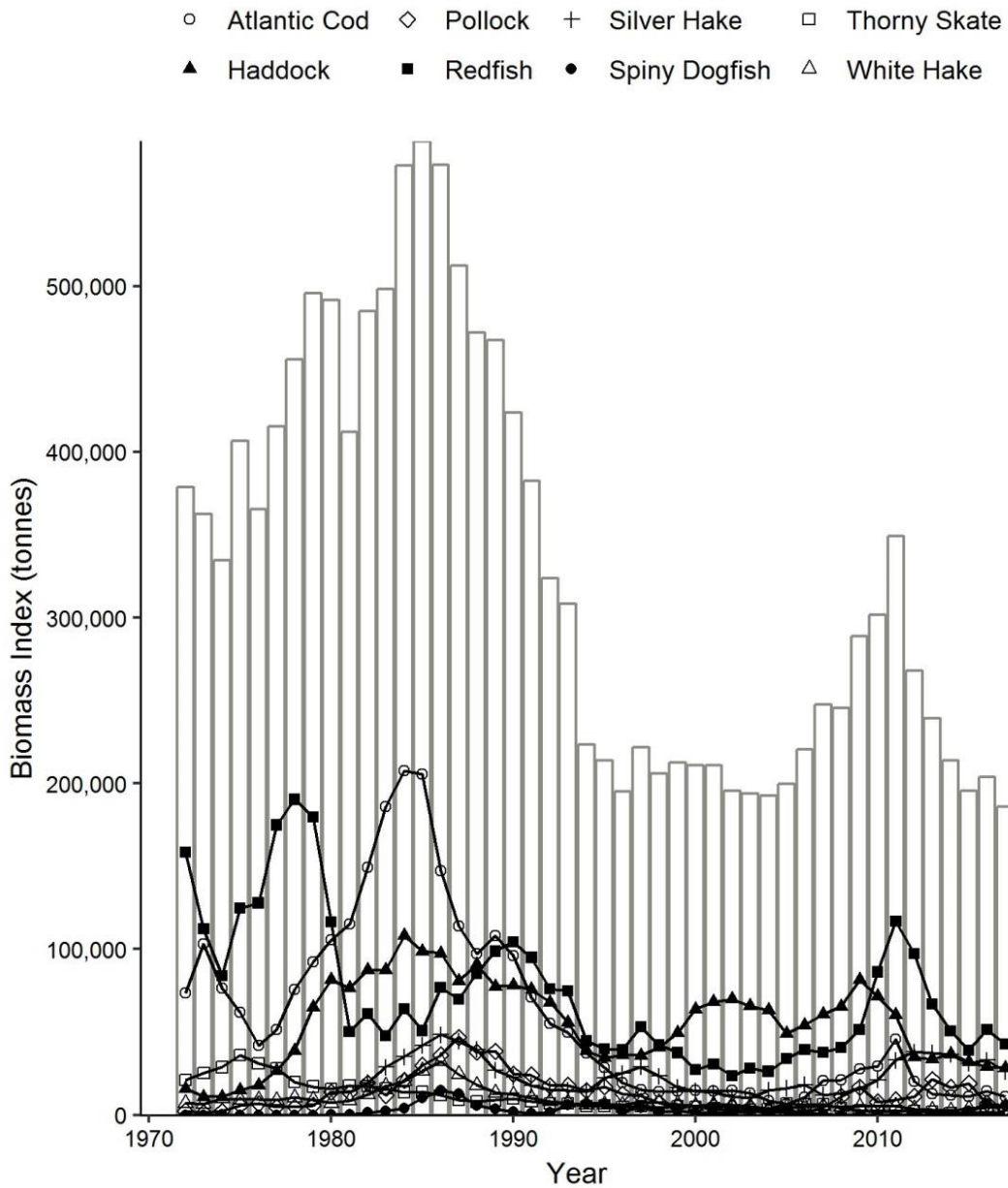


Figure 3. Three year geometric mean of the biomass index for all demersal fish (bars) and individual species (lines) in 4VW. Refer to Figure 1 for NAFO divisions within Atlantic Canada.

\*Data only shown until 2017 as 4VW was not covered in the 2018 DFO Summer RV Survey.

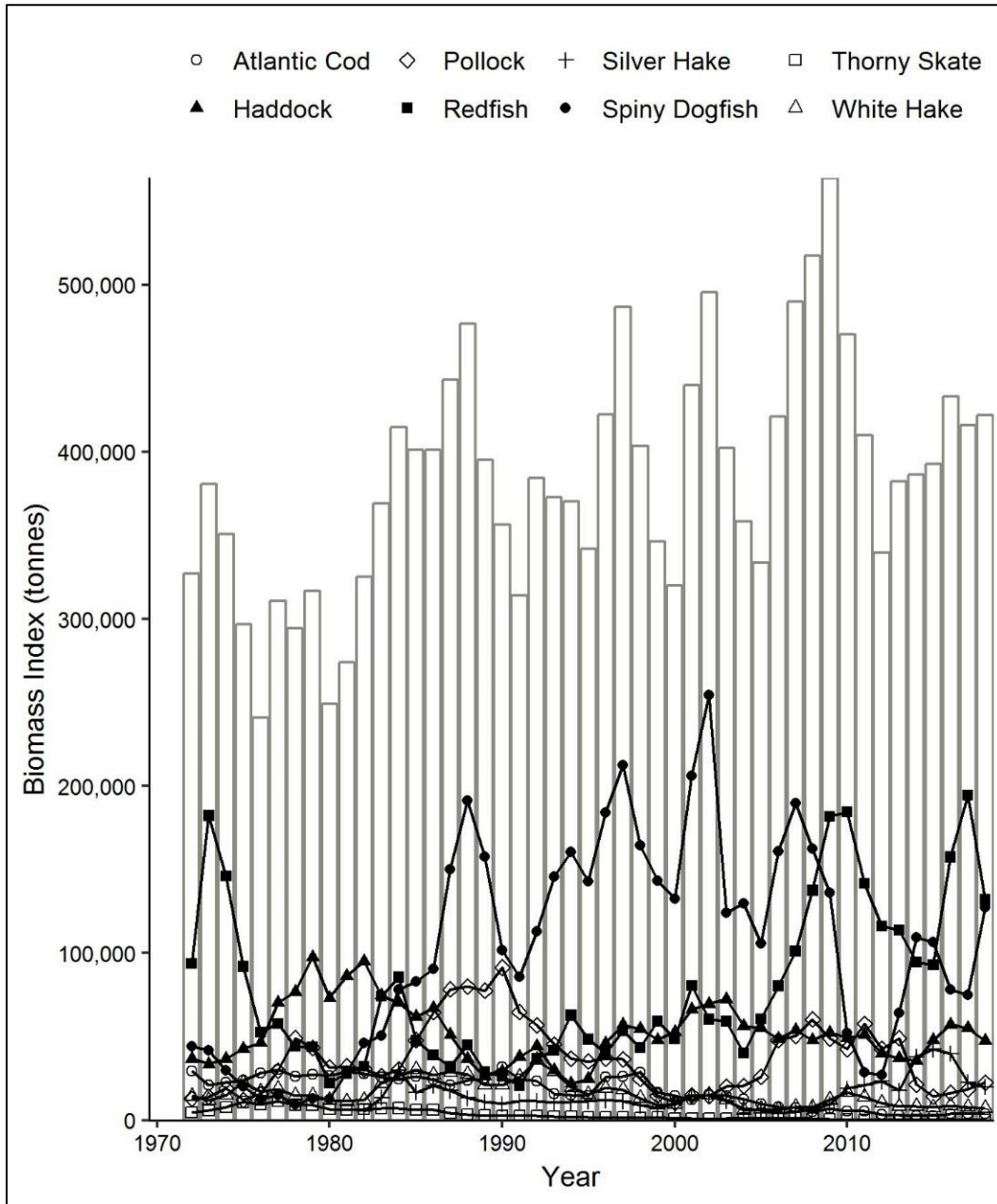


Figure 4. Three year geometric mean of the biomass index for all demersal fish (bars) and individual species (lines) in 4X. Refer to Figure 1 for NAFO divisions within Atlantic Canada.

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 estimates. Additional information from commercial landings and age composition can help in interpreting survey data.

Of note in the data, particularly for Atlantic Cod and Haddock, is the increased abundance of young-of-the-year fish (Age 0). The short-term median length frequency shows a strong mode at <10 cm for both species. This is not thought to be indicative of stronger than average recruitment in the last ten years; instead, it likely reflects a shift towards earlier spawning and settlement to the bottom in recent years, when in the past they would have still been in the pelagic phase in July.



**Atlantic Cod**

The largest Atlantic Cod (*Gadus morhua*) catches came from the Bay of Fundy, with a single catch >50kg. In 4X, the biomass index remains below 40% of the GM for the ninth year in a row. Abundance estimates are above the short-term median for large Cod (>60 cm) but are at or below the median at all other lengths.

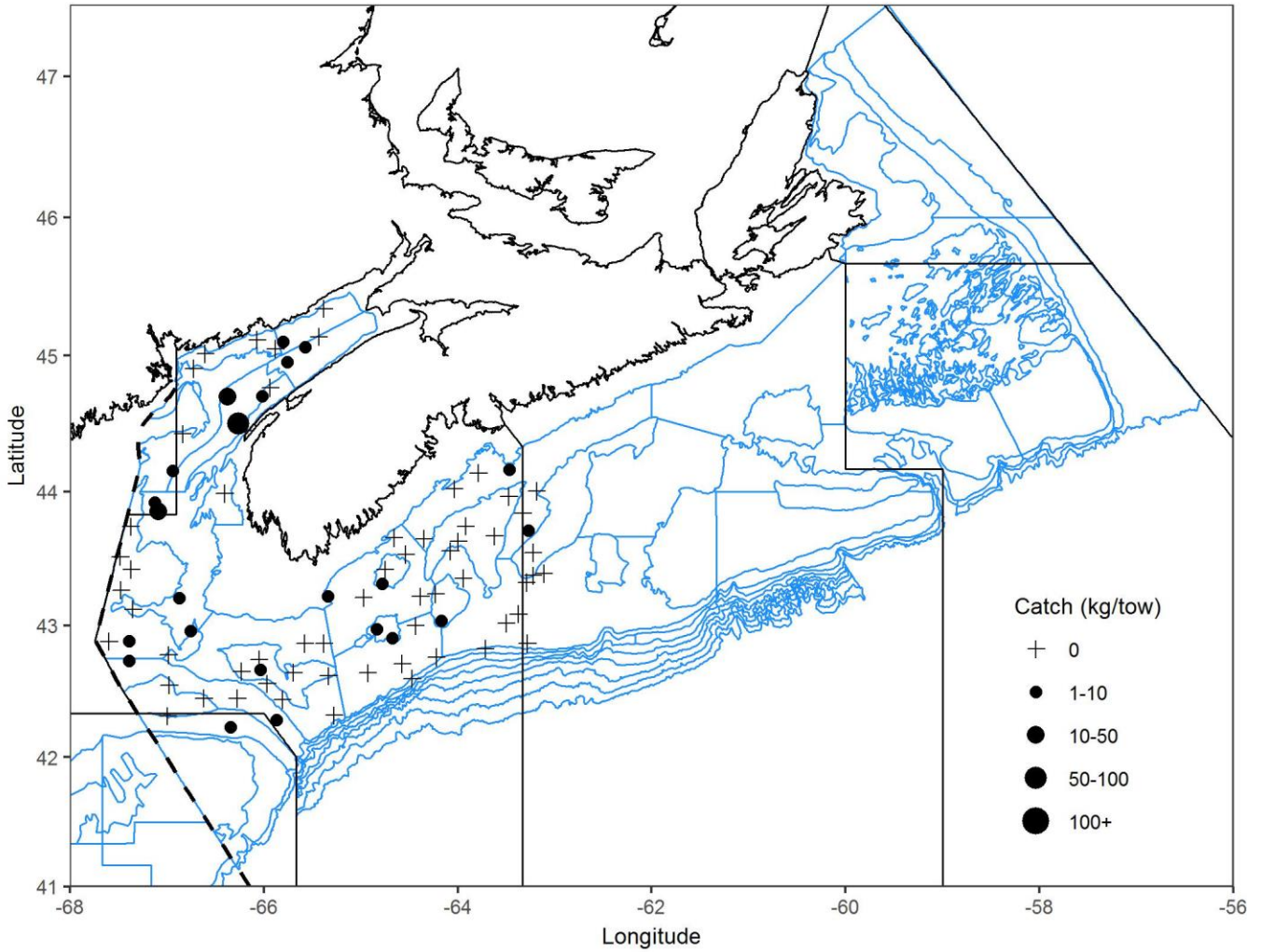


Figure 5a. Distribution of Atlantic Cod catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (●) represent catches. The circle area is proportional to the catch size.

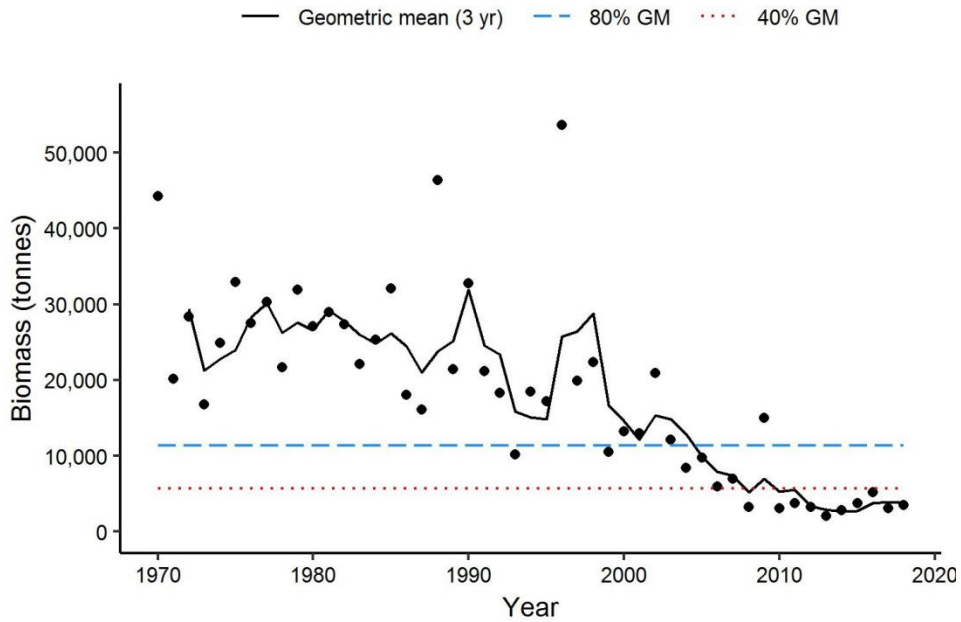


Figure 5b. Biomass index for Atlantic Cod in 4X from the DFO Summer RV Survey. The 3-year geometric mean (GM) biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

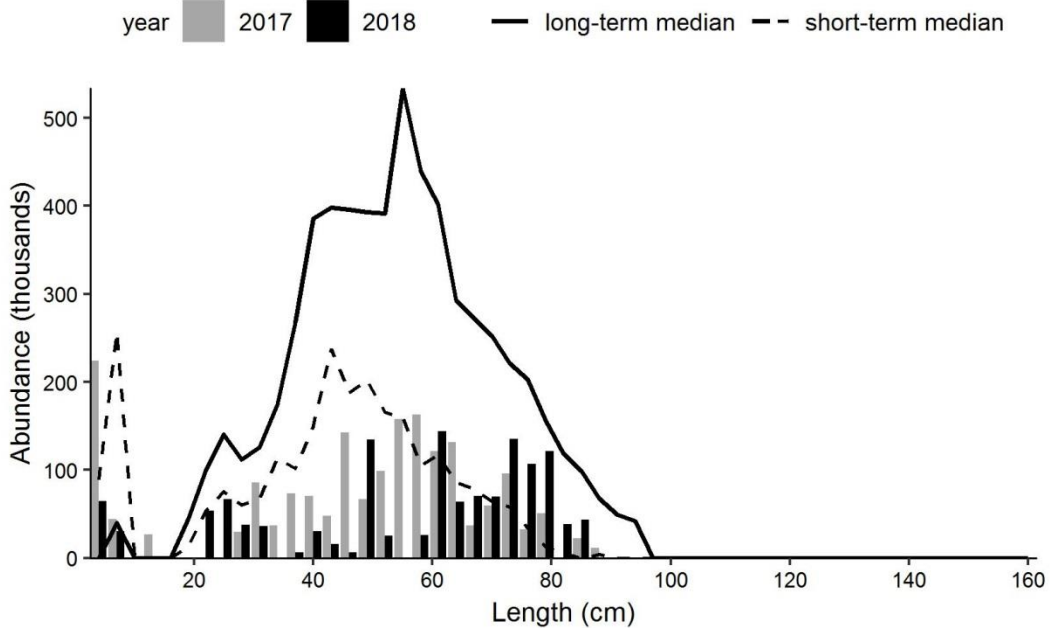


Figure 5c. Length frequency indices for Atlantic Cod in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

## Haddock

Haddock (*Melanogrammus aeglefinus*) were caught in every set in 2018. The biomass index increased from 2017 and remains above 80% of the long-term GM. For lengths below 50 cm, abundance is above the long- and short-term medians; however, abundance values are below both of these medians for Haddock larger than 50 cm. The abundance of Age 0 Haddock (6-12 cm) are the highest in the time series.

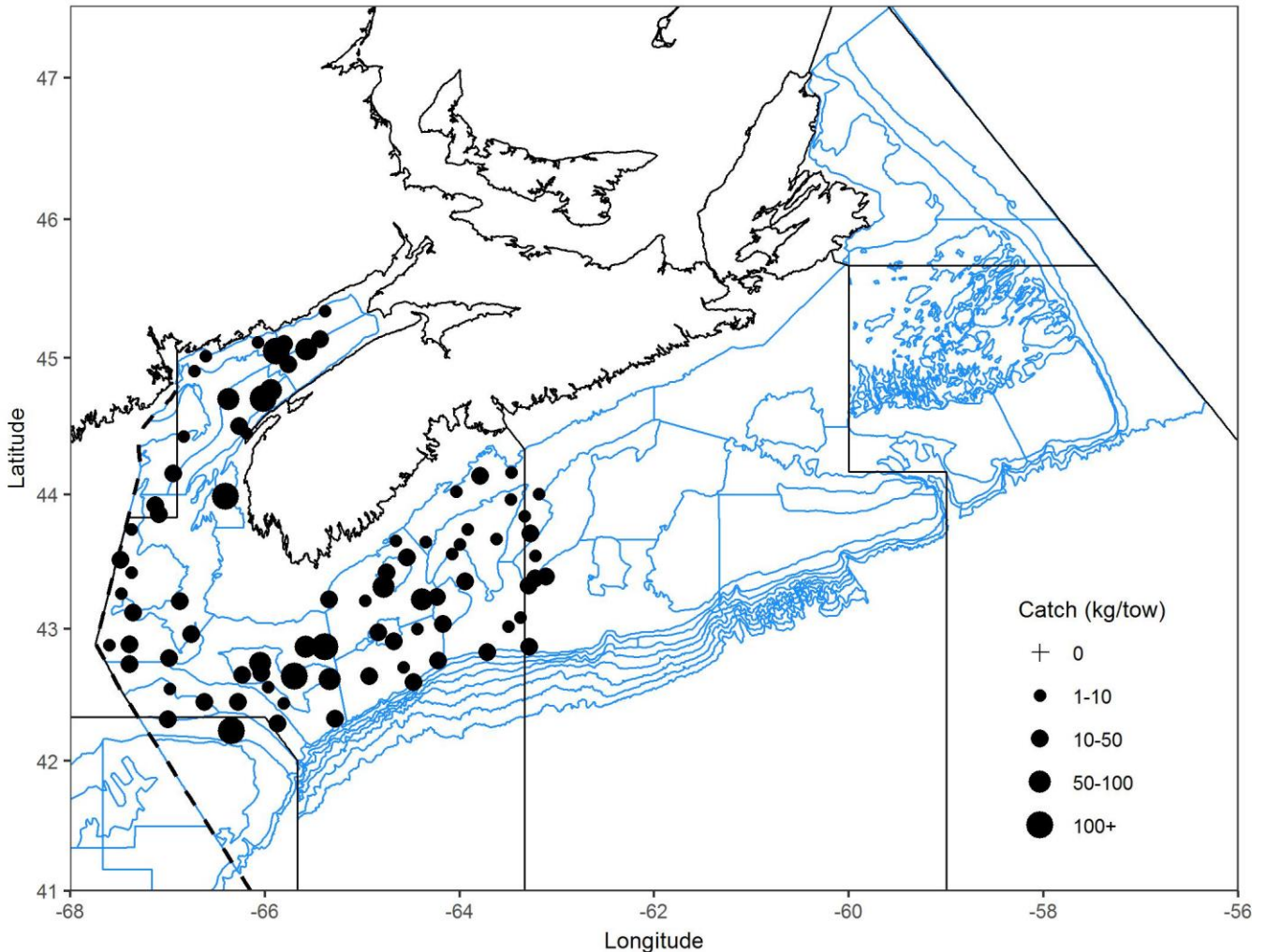


Figure 6a. Distribution of Haddock catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

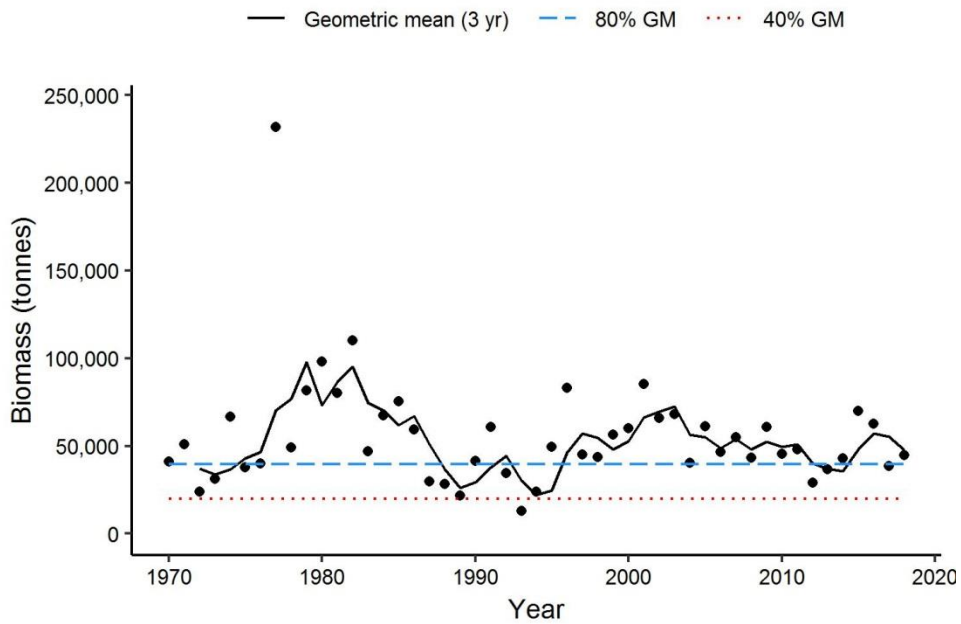


Figure 6b. Biomass index for Haddock in 4X from the DFO Summer RV Survey. The 3-year geometric mean (GM) biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

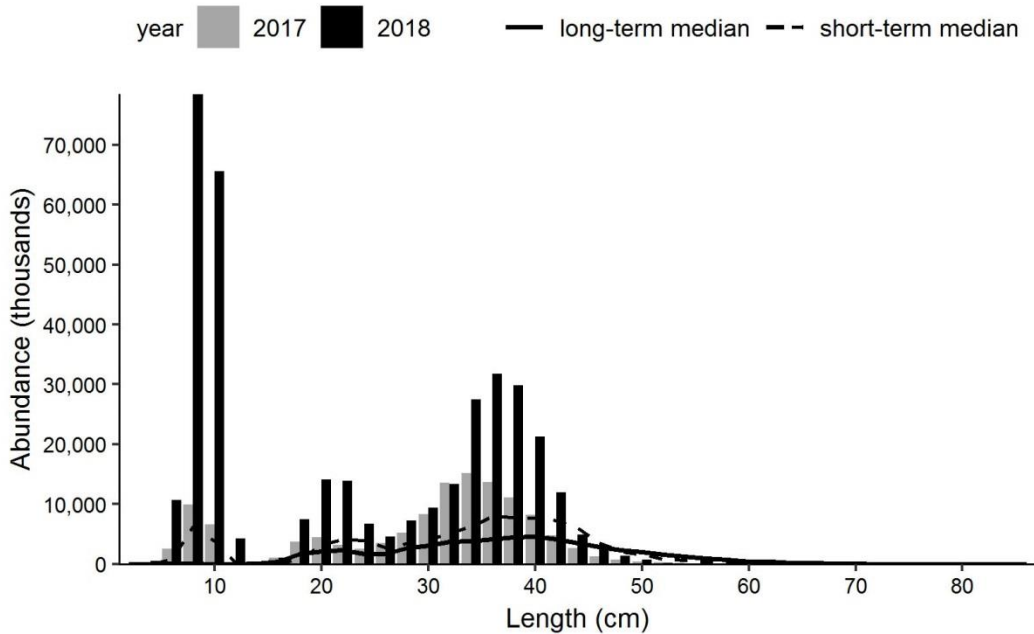


Figure 6c. Length frequency indices for Haddock in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**White Hake**

White Hake (*Urophycis tenuis*) are broadly distributed in areas where depth is greater than 50 m. Only one set in 2018, in the Gulf of Maine, had a recorded catch of over 50 kg. The biomass index for the 2018 survey was below 40% of the long-term GM and is among the lowest in the time series. Abundance is at or below the short-term median for most lengths with modes at 33 cm and 66 cm.

The biomass index for 4X White Hake >41 cm remained below the lower reference point, as defined in the 2016 Recovery Potential Assessment (Gu nette and Clark 2016).

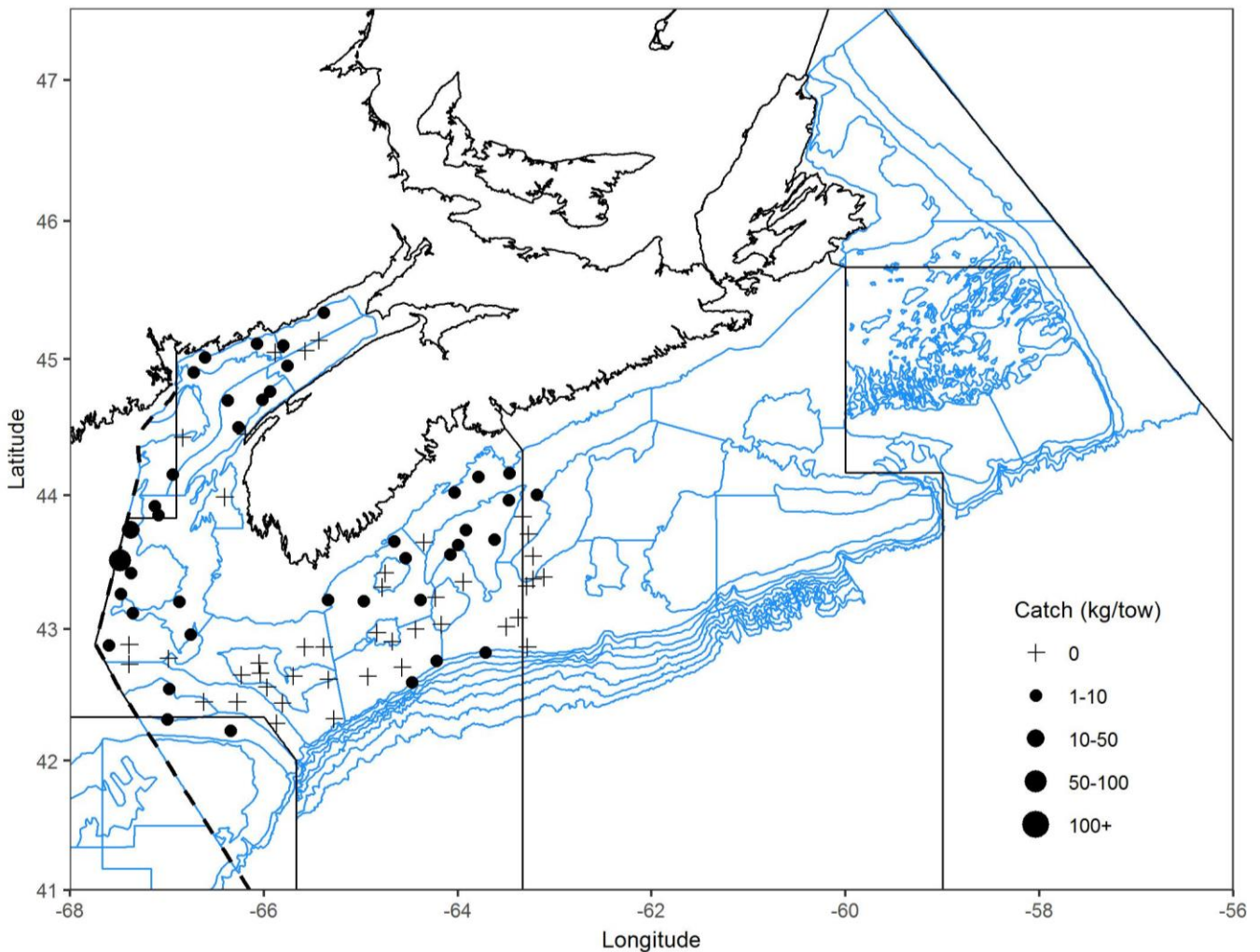


Figure 7a. Distribution of White Hake catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

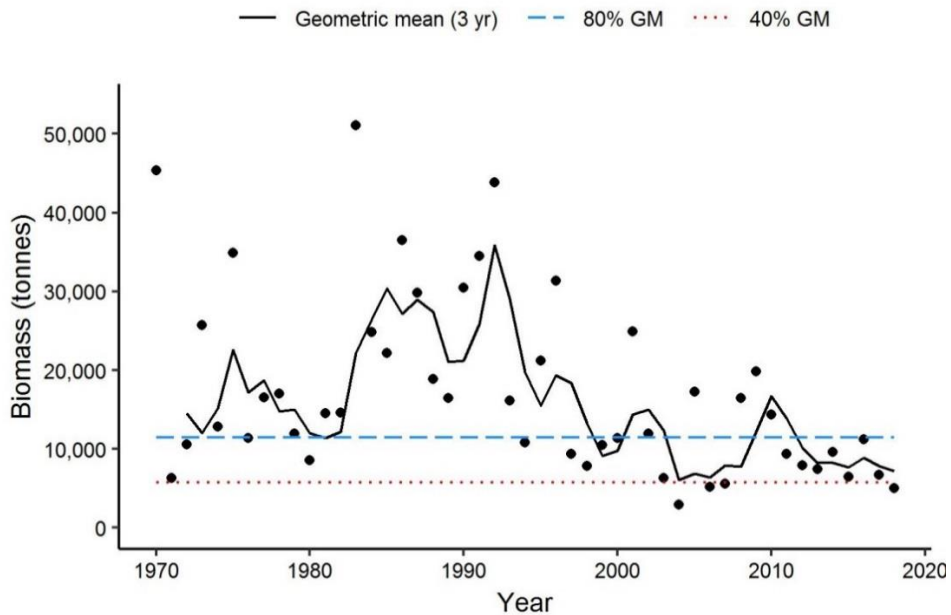


Figure 7b. Biomass index for White Hake in 4X from the DFO Summer RV Survey. The 3-year geometric mean (GM) biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (●) represent the biomass estimate for that year.

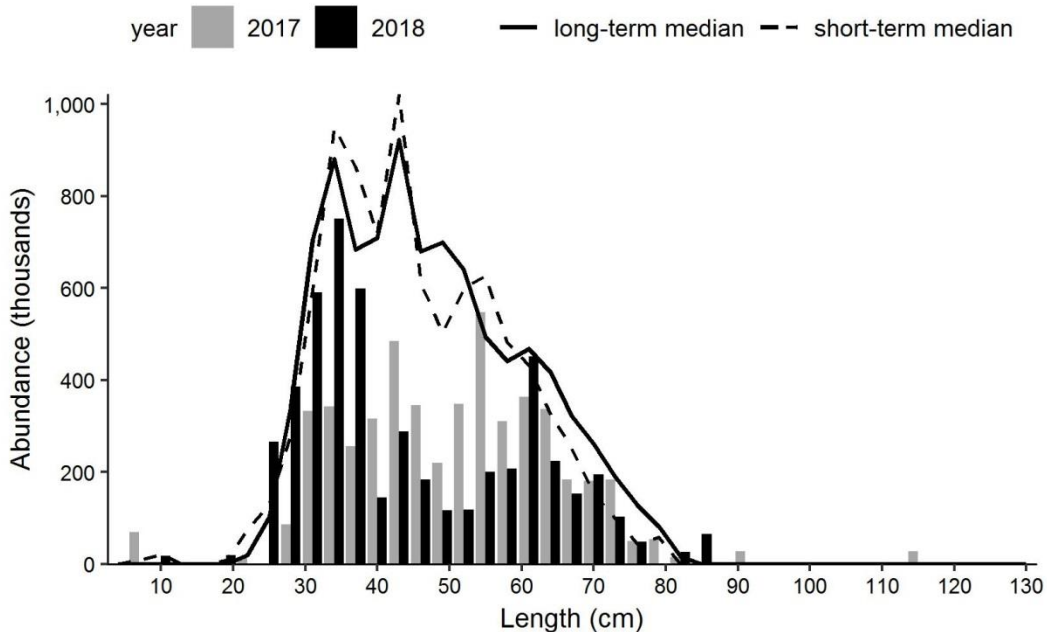


Figure 7c. Length frequency indices for White Hake in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

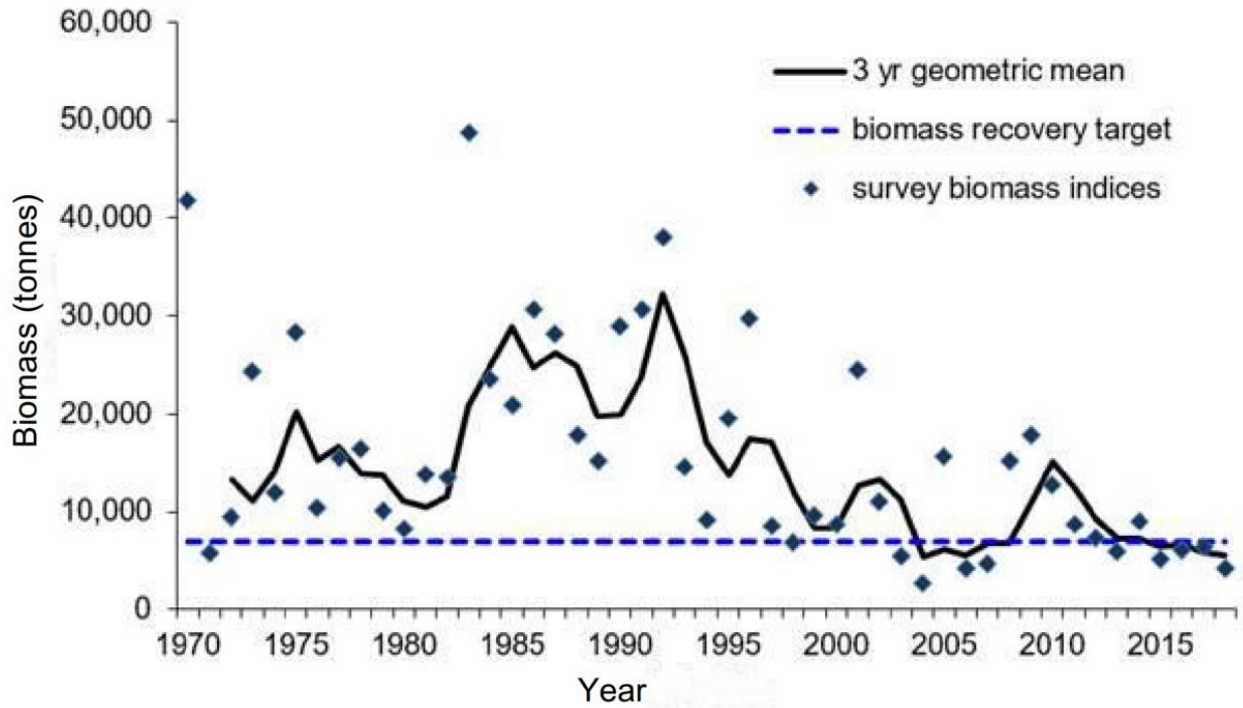


Figure 7d. Biomass index for 4X White Hake >41 cm from the DFO Summer RV Survey represented by the dark blue diamonds. The solid black line represents the 3-year geometric mean. The dashed blue line represents the lower reference point, as defined in the 2016 Recovery Potential Assessment (Gu enette and Clark 2016).

**Silver Hake**

Silver Hake (*Merluccius bilinearis*) were caught throughout most of the survey area, with the largest catches in the Bay of Fundy. The biomass index for Silver Hake in the Bay of Fundy is similar to 2017 and remains above 80% of the long-term mean. A strong mode at 18 cm is indicative of above average recruitment for the 2016 year class. In 2017, fish >25 cm were very abundant; however, fewer were present this year. The long-term median is zero for these lengths in the Bay of Fundy, indicating they were generally absent from the catch in the past.

Sampling within the geographic range of 4VWX Silver Hake was incomplete in 2018.

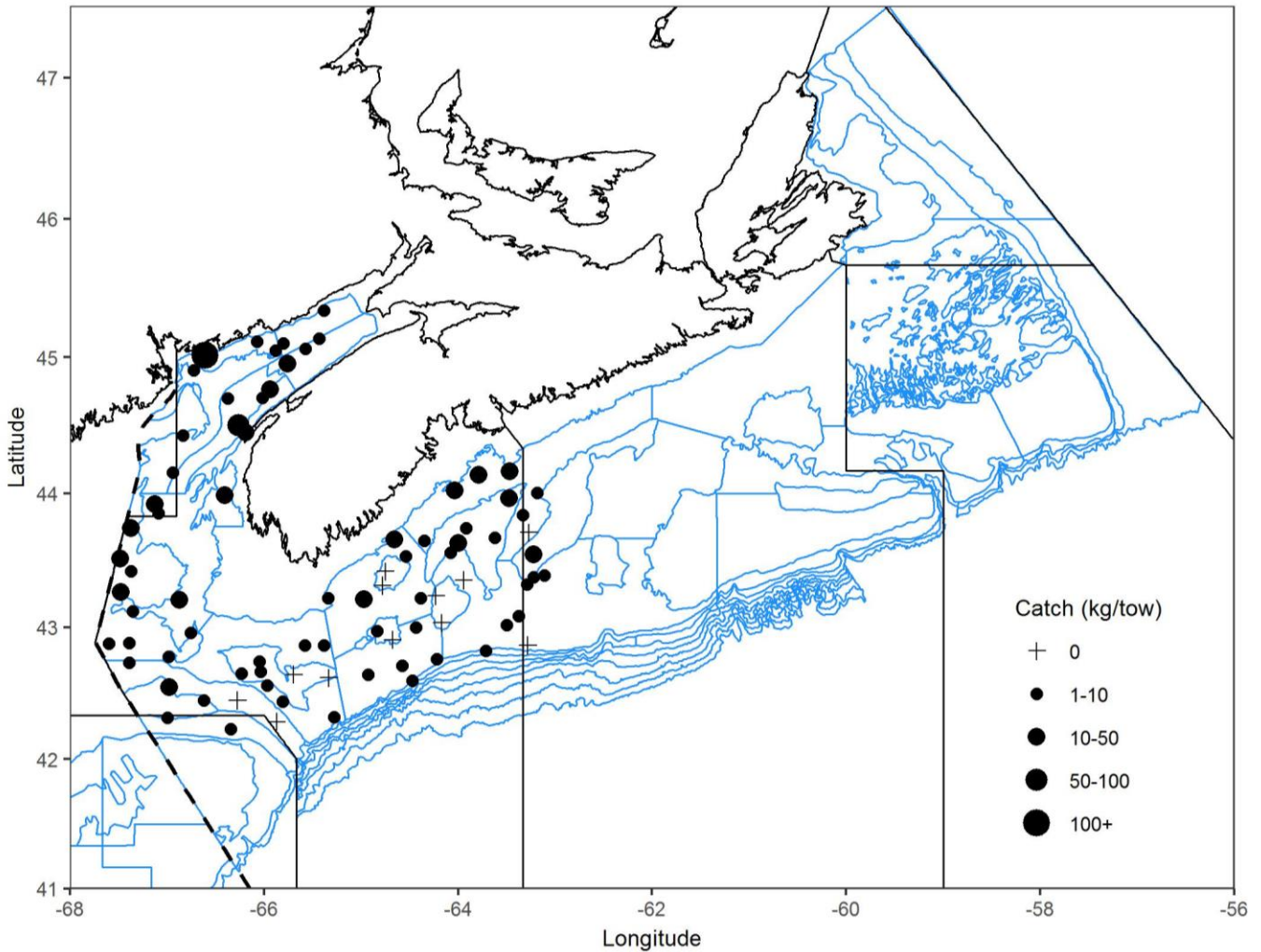


Figure 8a. Distribution of Silver Hake catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (●) represent catches. The circle area is proportional to the catch size.



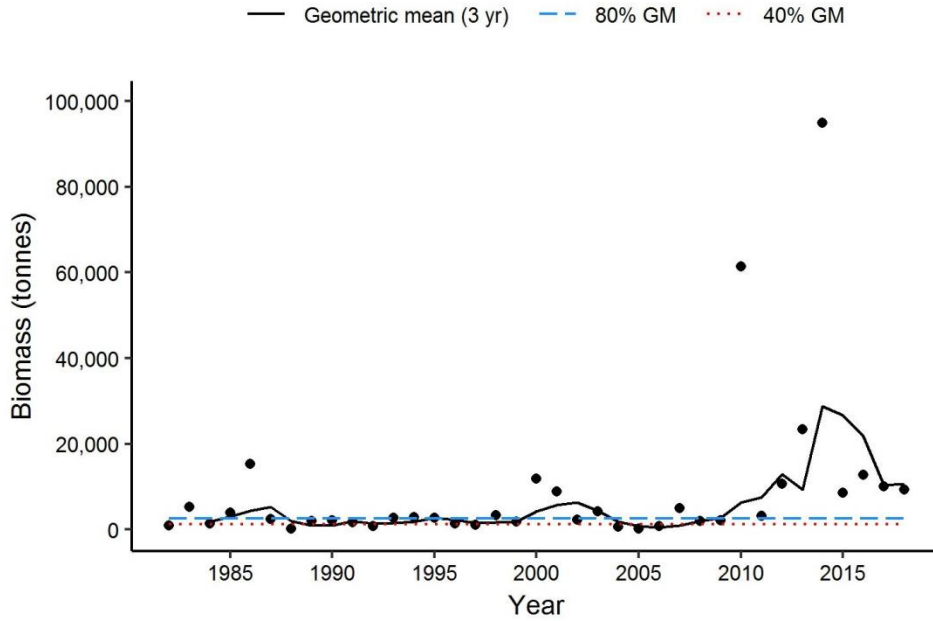


Figure 8b. Biomass index for Silver Hake in 4X west (strata 484-495) from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

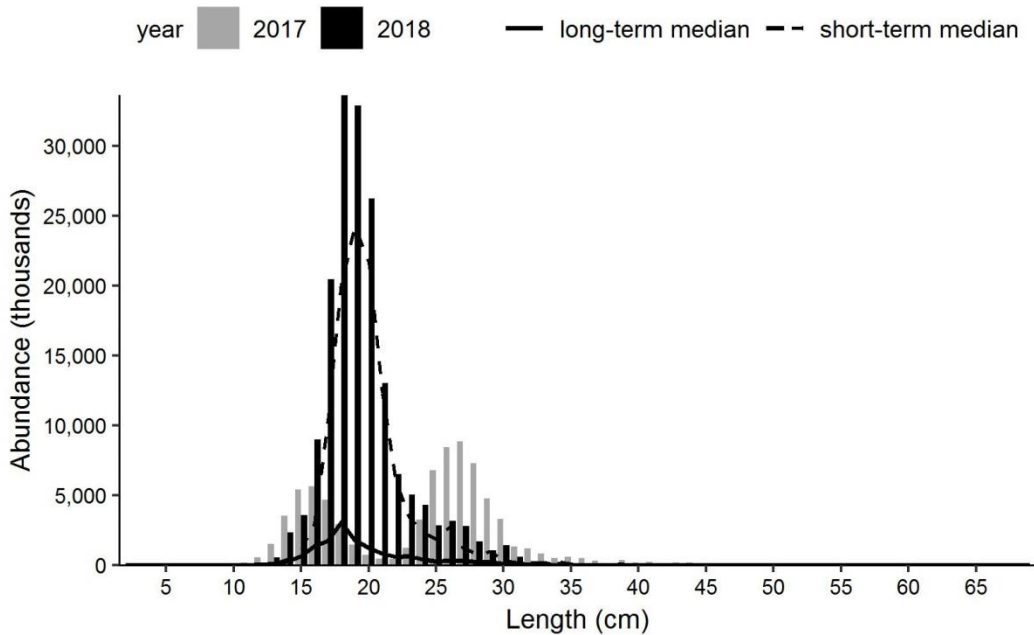


Figure 8c. Length frequency indices for Silver Hake in 4X west (strata 484-495) from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Pollock**

Pollock (*Pollachius virens*) were caught primarily in Crowell and Jordan basins. The Western Component Pollock biomass index is close to 80% of the long-term mean. Indices-at-length were close to or above the short-term median for Western Component Pollock between 30 and 60 cm, but are below the median for most lengths greater than 60 cm.

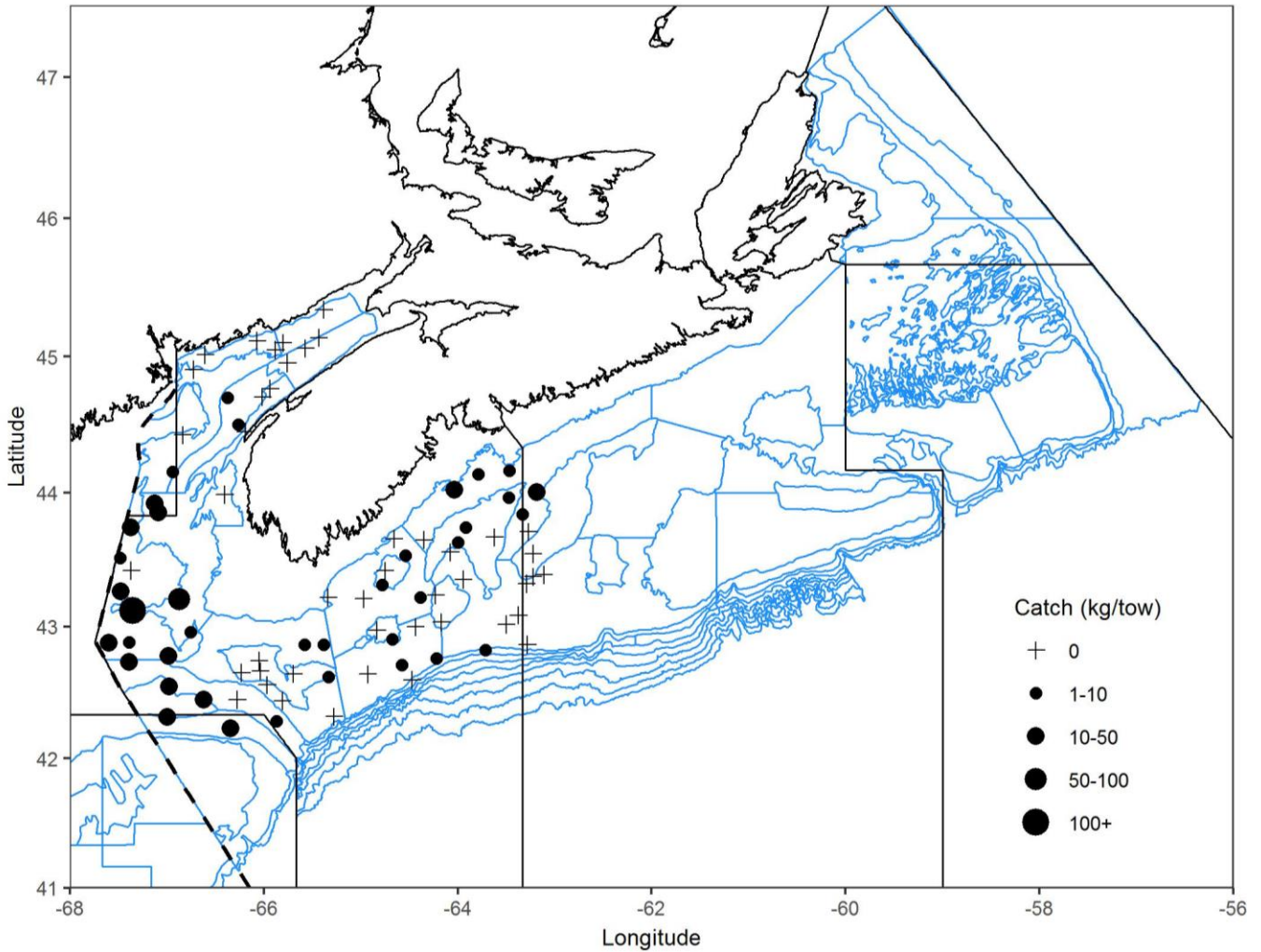


Figure 9a. Distribution of Pollock catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

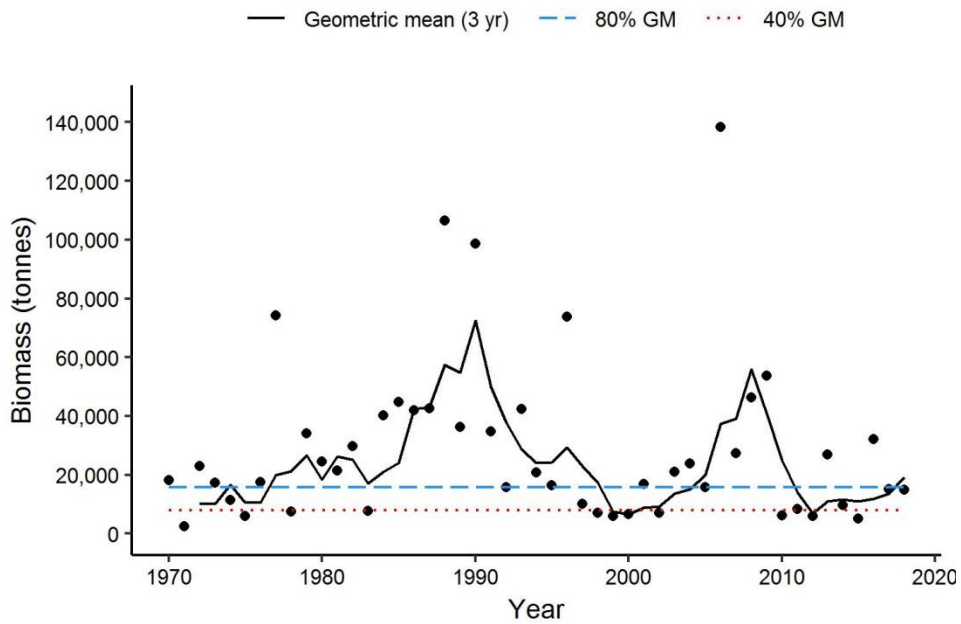


Figure 9b. Biomass index for Western Component Pollock (strata 474, 476, 480-495) from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

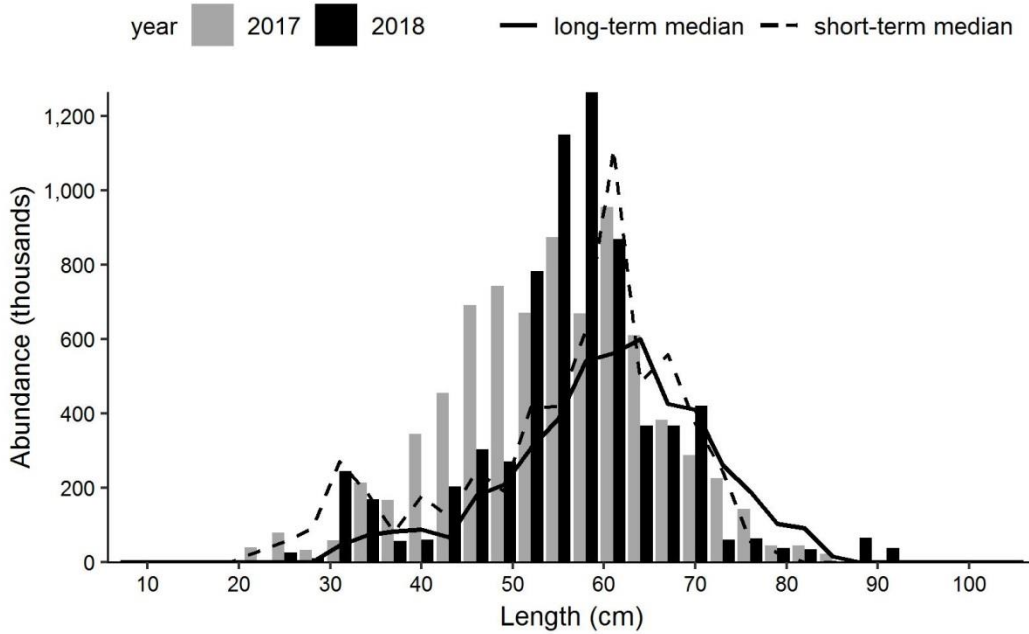


Figure 9c. Length frequency indices for Western Component Pollock (strata 474, 476, 480-495) from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Redfish**

Redfish (*Sebastes fasciatus* and *Sebastes mentella*) catches were largest in the eastern Gulf of Maine (Crowell, Tuskett and Jordan basins) and the deeper waters of the inshore Scotian Shelf. Sampling by the DFO Summer RV Survey within the index area for Unit II and Unit III redfish was incomplete in 2018; thus, biomass and length indices cannot be shown.

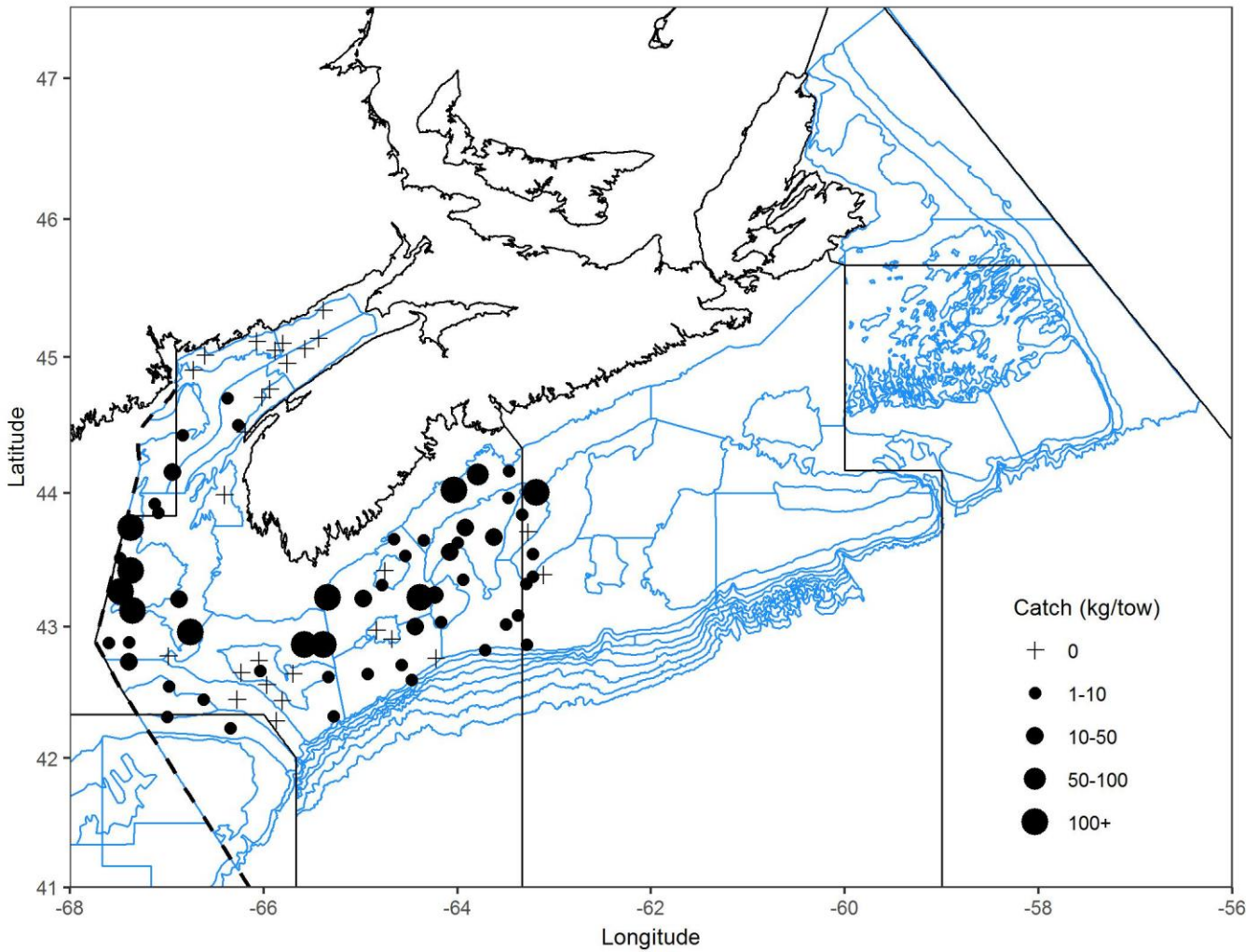


Figure 10. Distribution of redfish catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

### Atlantic Halibut

Sampling by the DFO Summer RV Survey was spatially incomplete in 2018; however, a sufficient portion of the survey area was covered to provide some useful information for Halibut (*Hippoglossus hippoglossus*). The biomass index in 4X remains near the highest observed in the time series. Catches of Halibut <50 cm, which are comprised primarily of 3 and 4-year old Halibut, were low in the 2017 survey, but in the 2018 survey, catches of small Halibut in 4X were close to the recent medians. Catches in 4X generally account for over half the survey catch of Halibut <50 cm, suggesting the catches in 2018 may be indicative of good recruitment for these sizes. The majority of Halibut above 60 cm are generally caught in 4VW; however, in 2018, catches of Halibut in this size range in 4X were close to the short-term median for the entire survey area, indicative of high abundance for these sizes.

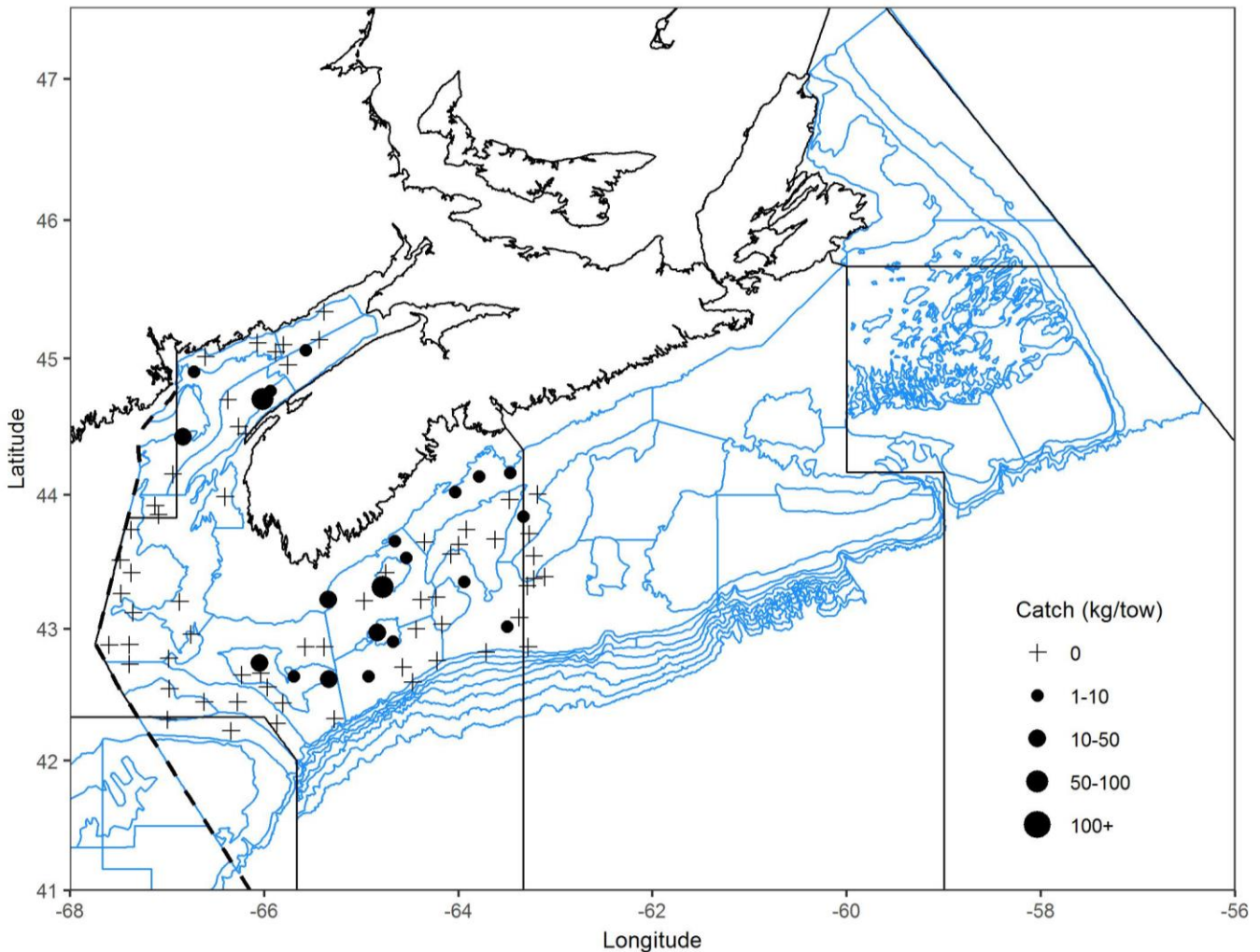


Figure 11a. Distribution of Atlantic Halibut catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

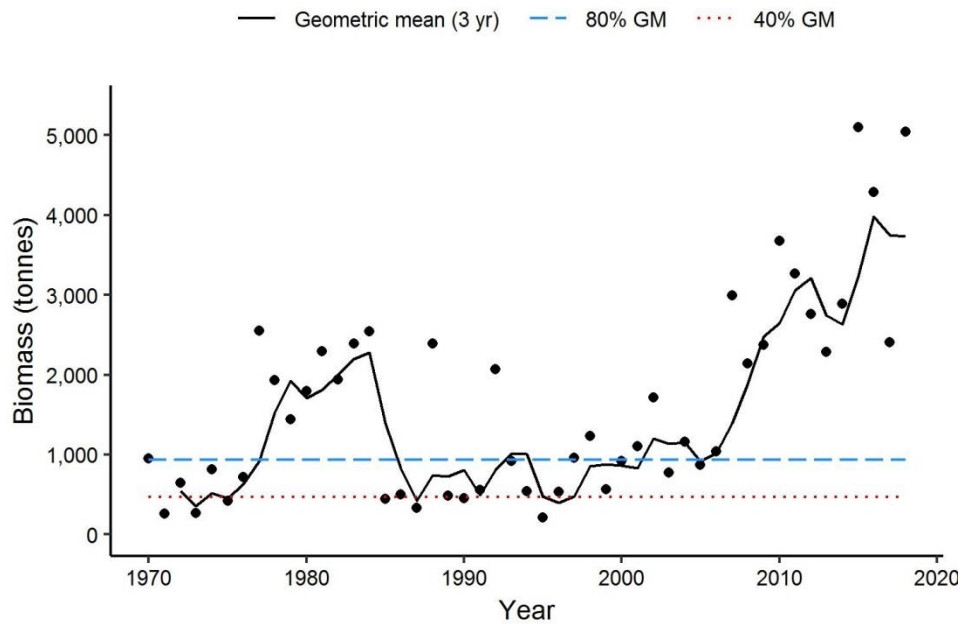


Figure 11b. Biomass index for Halibut in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

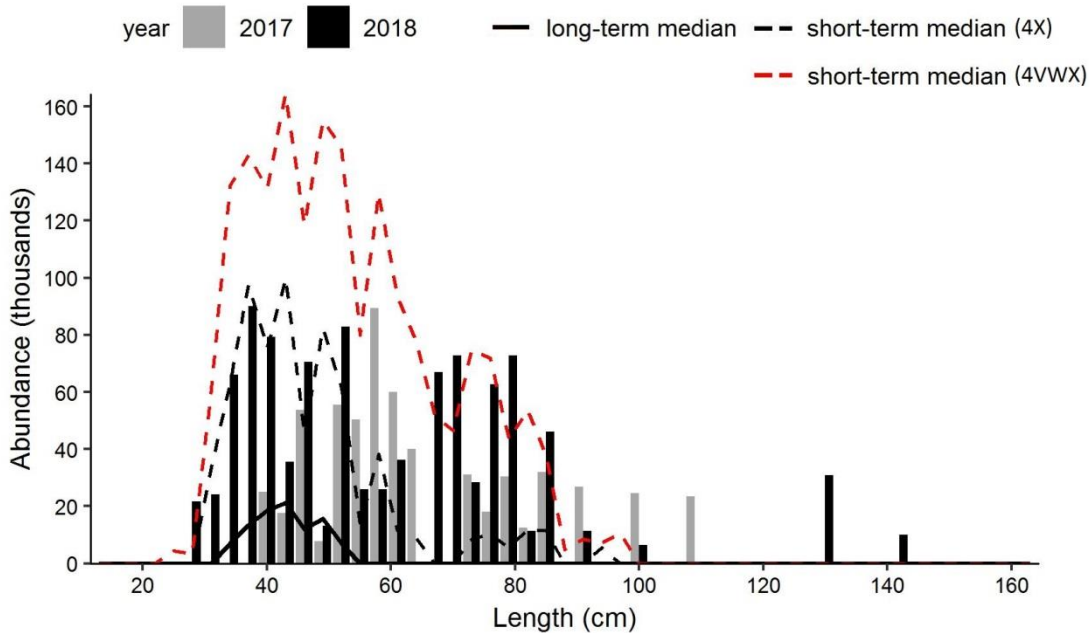


Figure 11c. Length frequency indices for Halibut in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016 in 4X. The dashed red line represents the median in thousands-at-length for the time period 2007-2016 in 4VWX.

**4X Yellowtail Flounder**

In NAFO area 4X, Yellowtail Flounder (*Limanda ferruginea*) catches were restricted to Browns Bank. In 2018, the biomass index for 4X increased from 2017, but it remains below 40% of the long-term GM. Abundance estimates from 19-23 cm are above both the short and long-term median, while abundances of all other lengths are at or below the median.

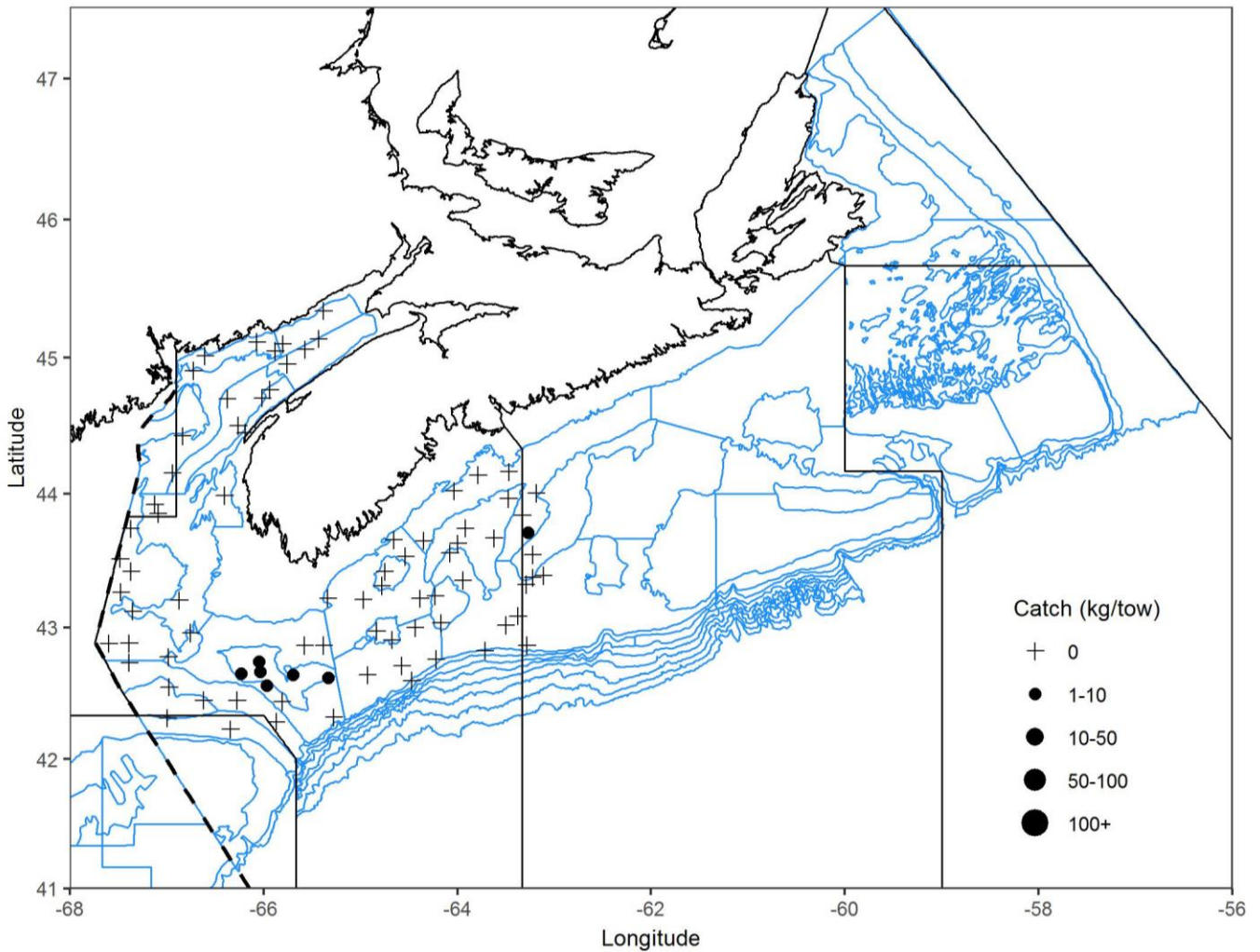


Figure 12a. Distribution of Yellowtail Flounder catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

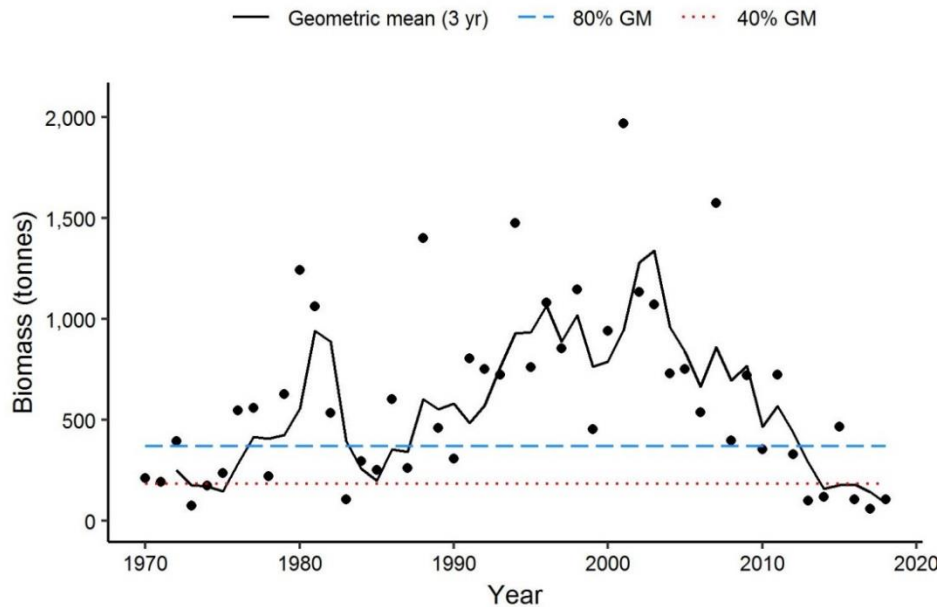


Figure 12b. Biomass index for Yellowtail Flounder in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

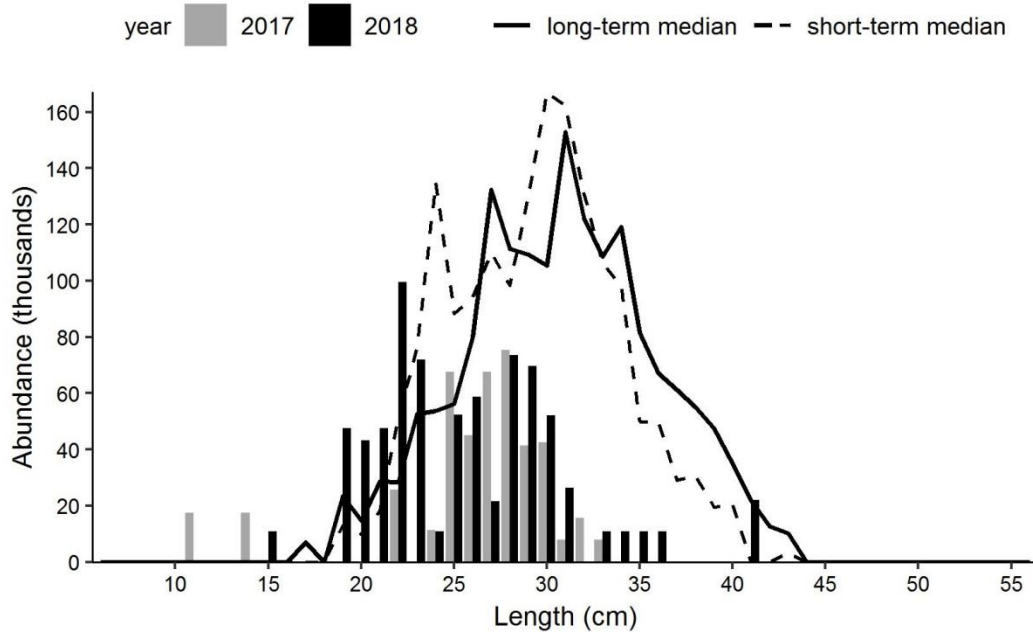


Figure 12c. Length frequency indices for Yellowtail Flounder in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.



**4X American Plaice**

American Plaice (*Hippoglossoides platessoides*) catches were generally small in the 2018 survey. The biomass index for 4X increased from 2017 to 2018, but it remains below 40% of the GM. Length frequencies indices were at or above the short-term median for most lengths for fish 19-27cm, but they remain below the long-term median for most lengths.

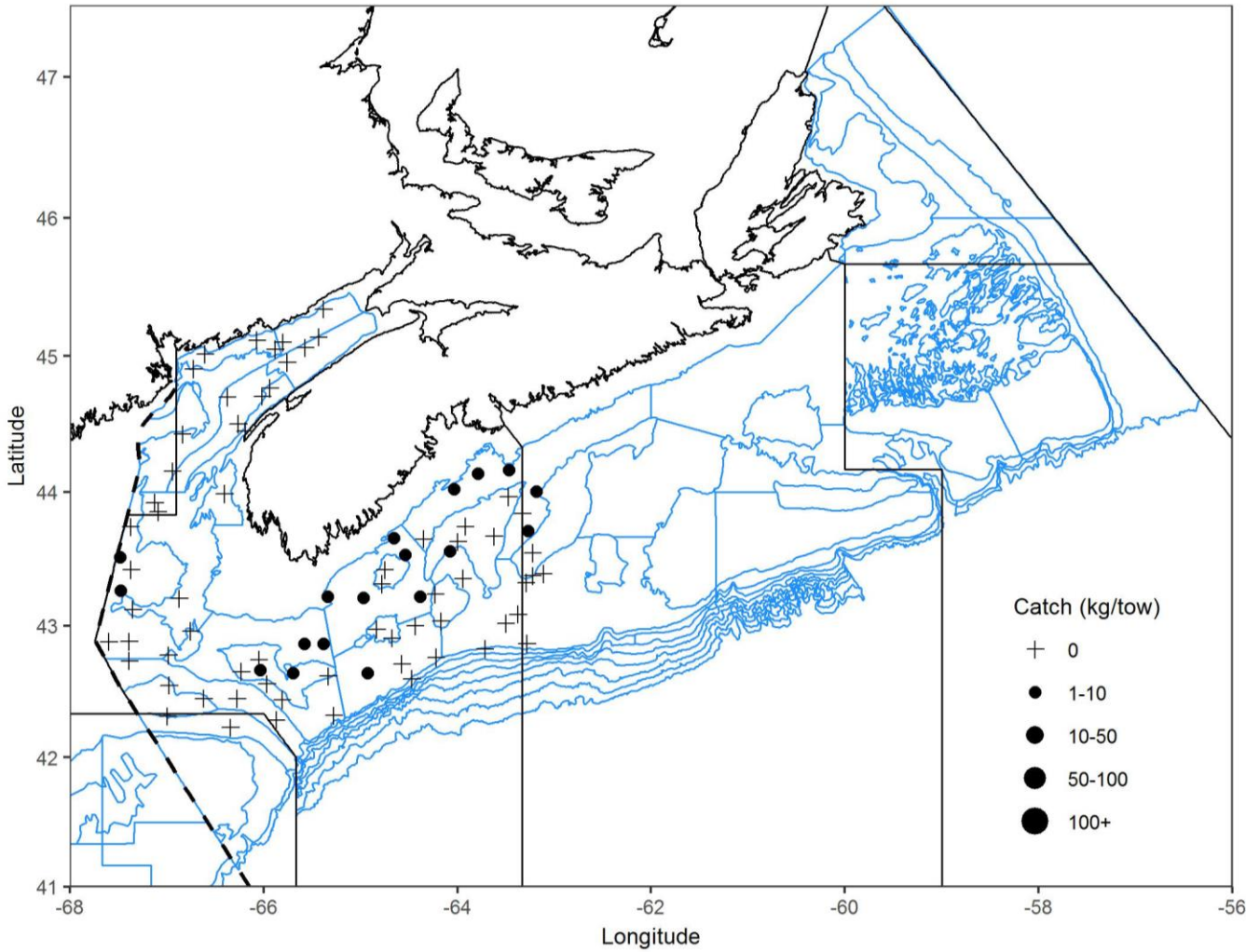


Figure 13a. Distribution of American Plaice catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

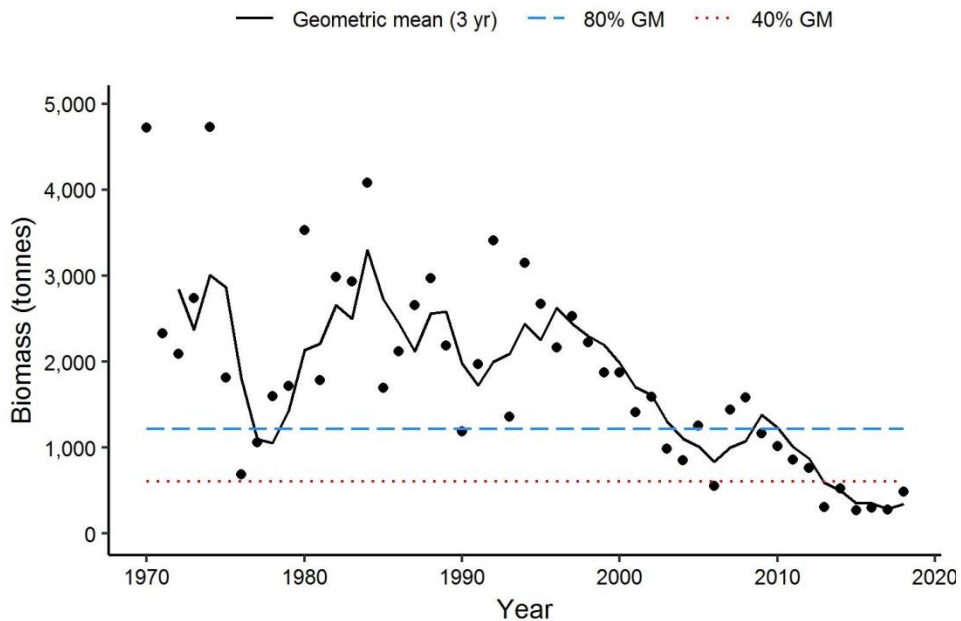


Figure 13b. Biomass index for American Plaice in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

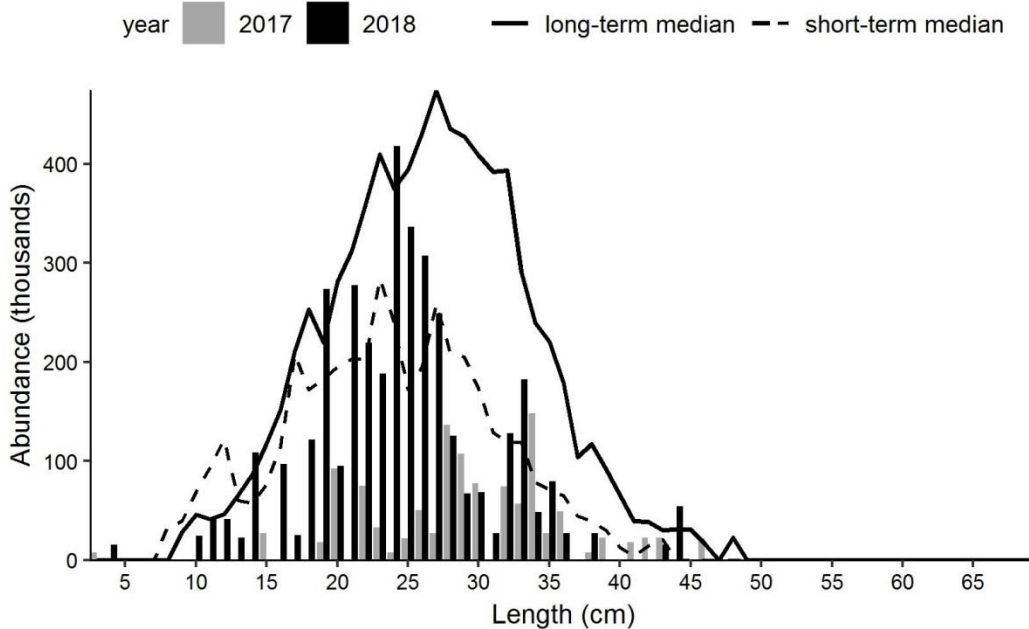


Figure 13c. Length frequency indices for American Plaice in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Witch Flounder**

Witch Flounder (*Glyptocephalus cynoglossus*) catches were widespread in the survey area in 2018. The 3-year mean biomass index has fluctuated around 80% of the long-term mean in 4X for the last 20 years. The length frequency indices are above both long and short-term median for fish 28-43 cm, with larger fish virtually absent.

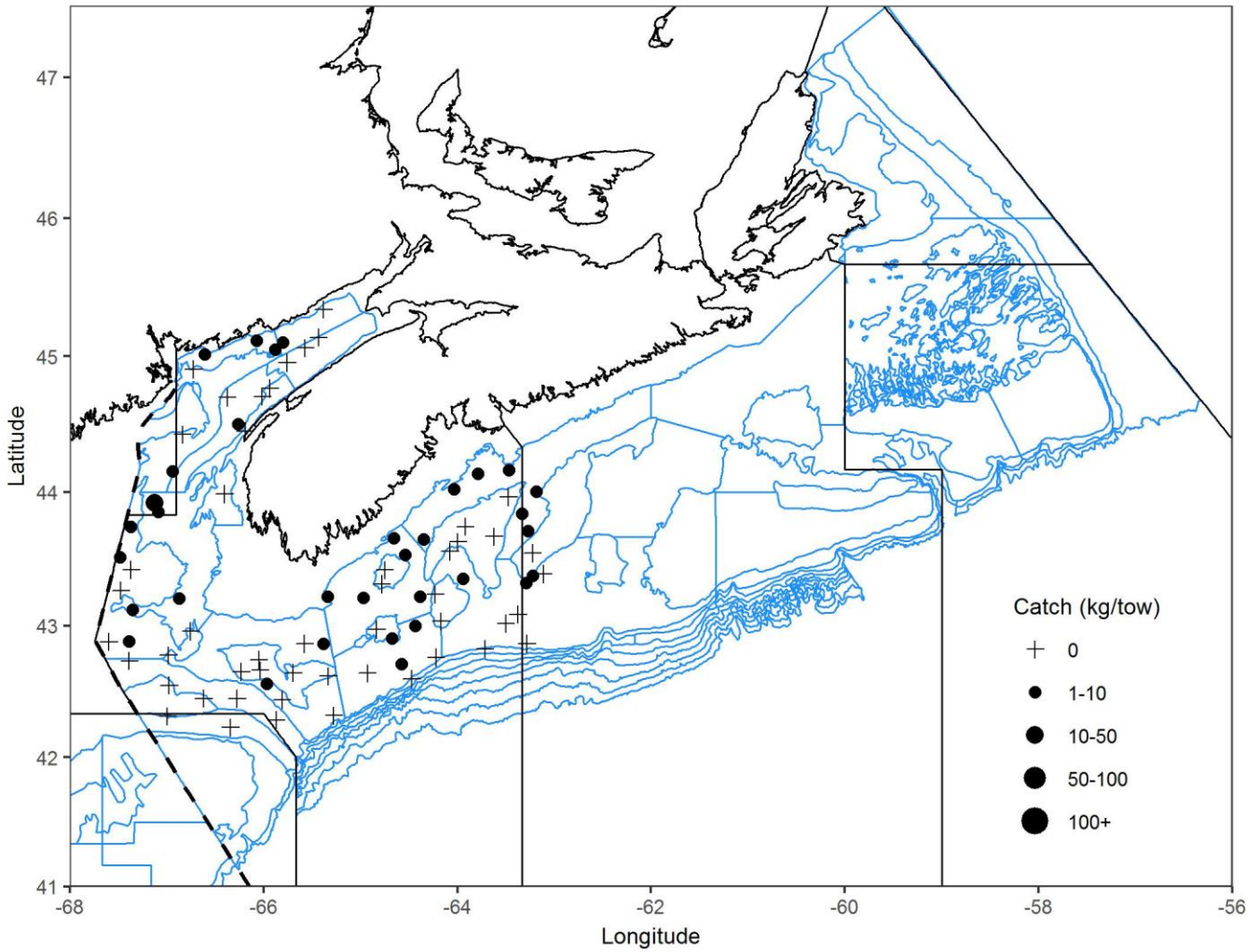


Figure 14a. Distribution of Witch Flounder catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

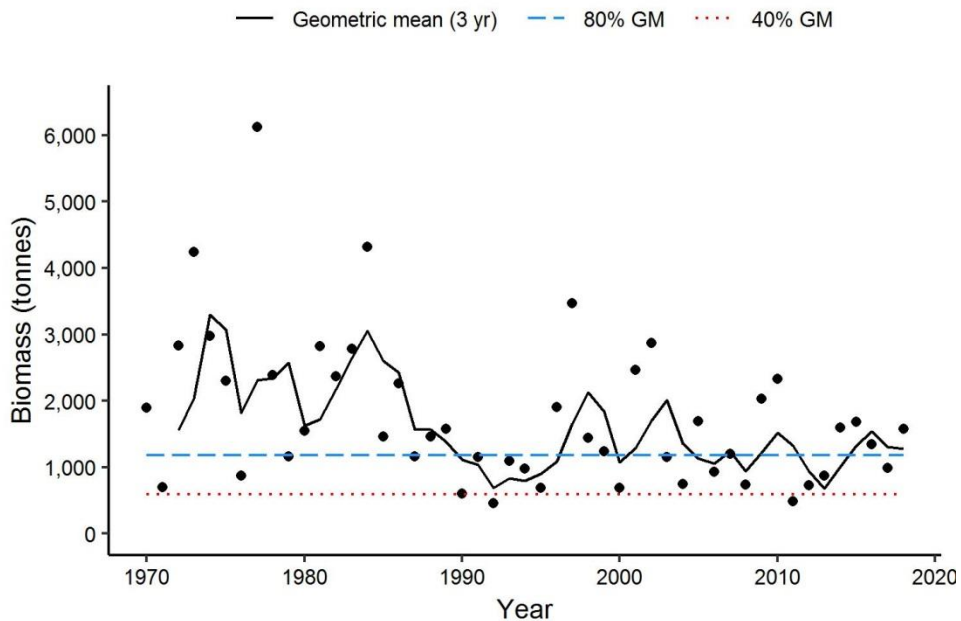


Figure 14b. Biomass index for Witch Flounder in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

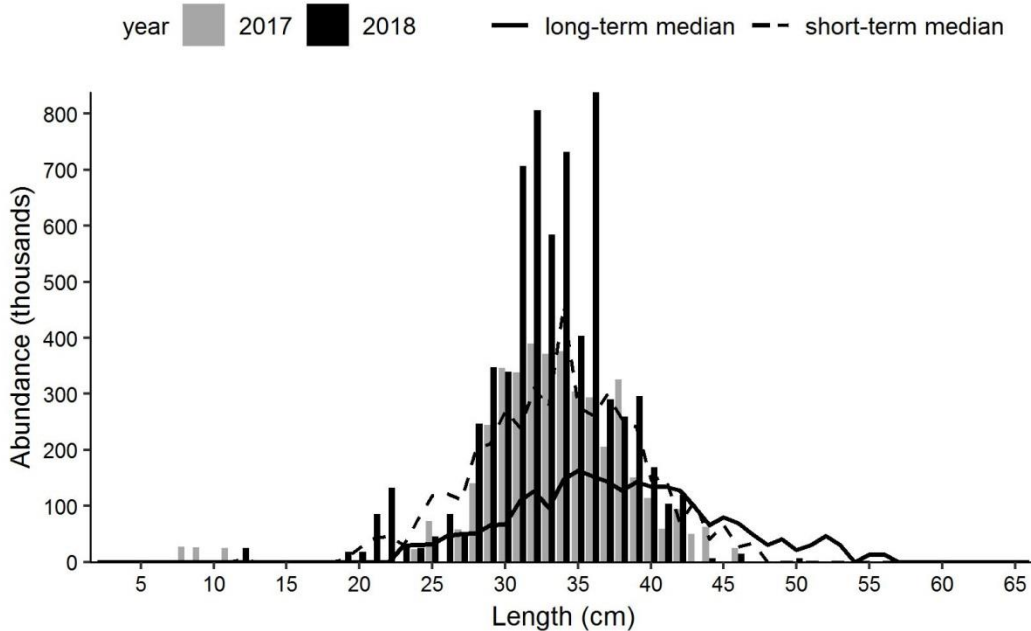


Figure 14c. Length frequency indices for Witch Flounder in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Winter Flounder**

Winter Flounder (*Pseudopleuronectes americanus*) were caught primarily in the Bay of Fundy and on Browns Bank. Biomass indices in 4X have been above 80% of the GM since the late 1980s. The length frequency indices for 2018 are lower than the short-term median for most lengths above 28 cm.

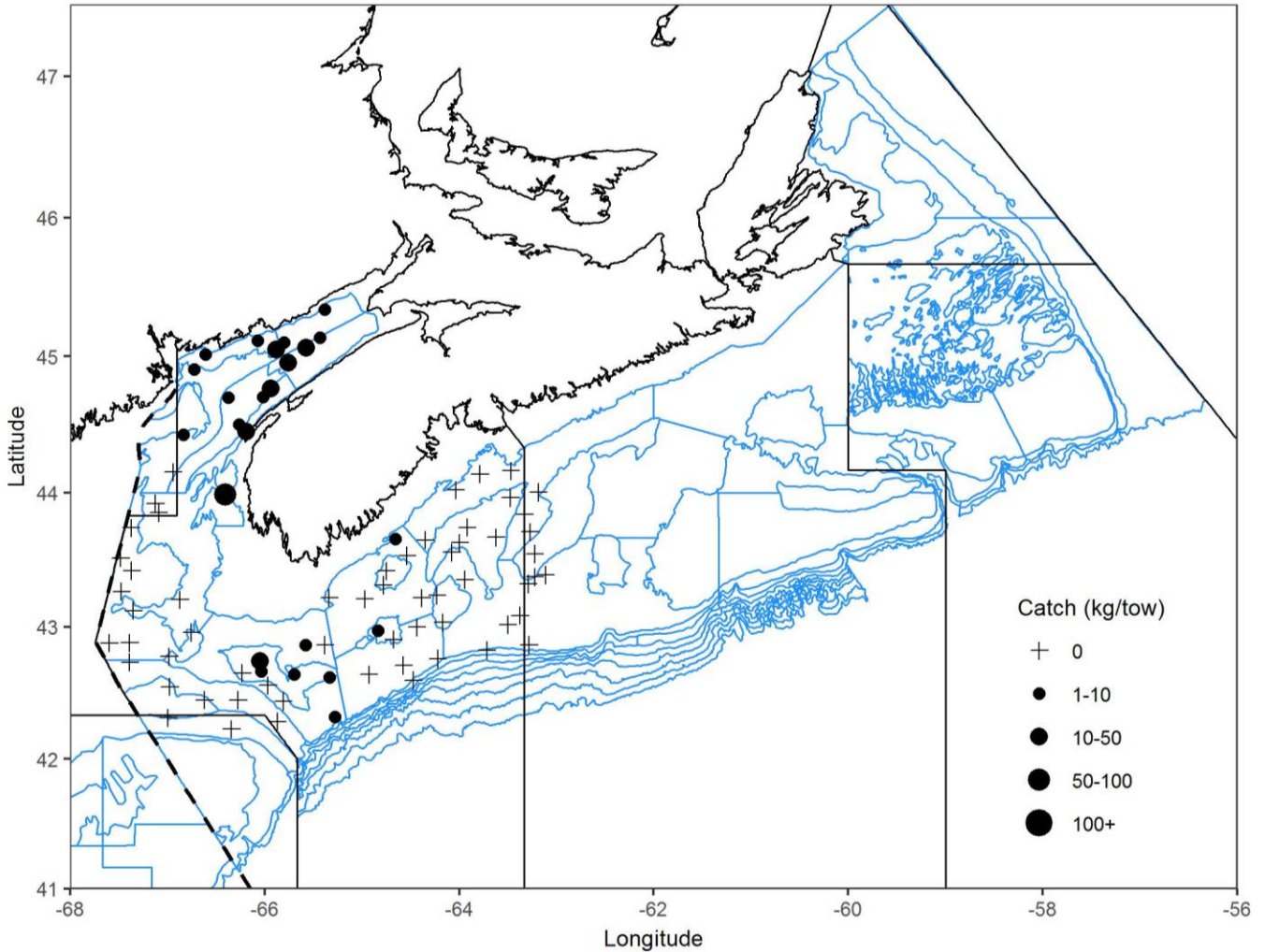


Figure 15a. Distribution of Winter Flounder catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

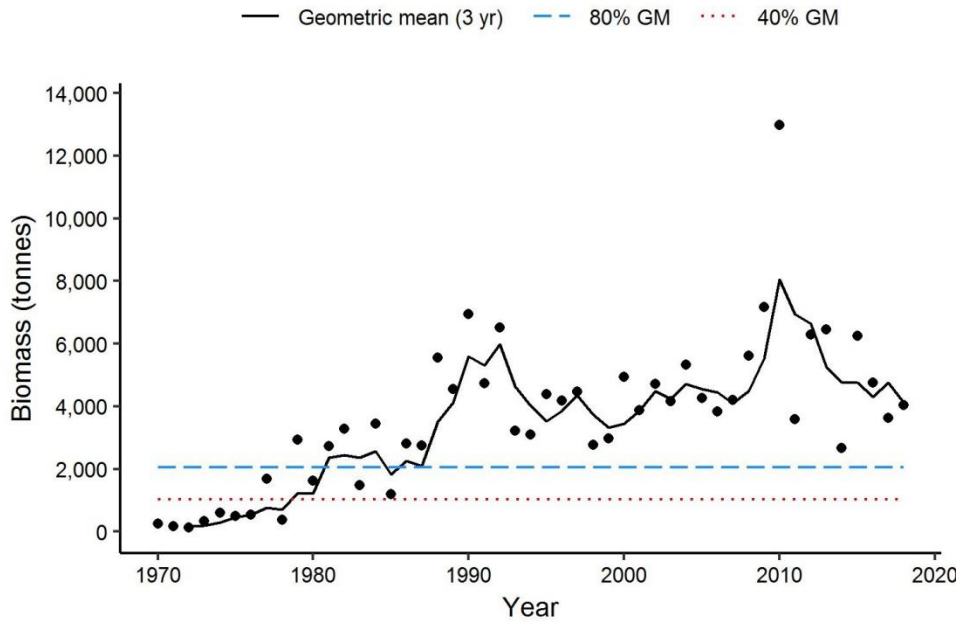


Figure 15b. Biomass index for Winter Flounder in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

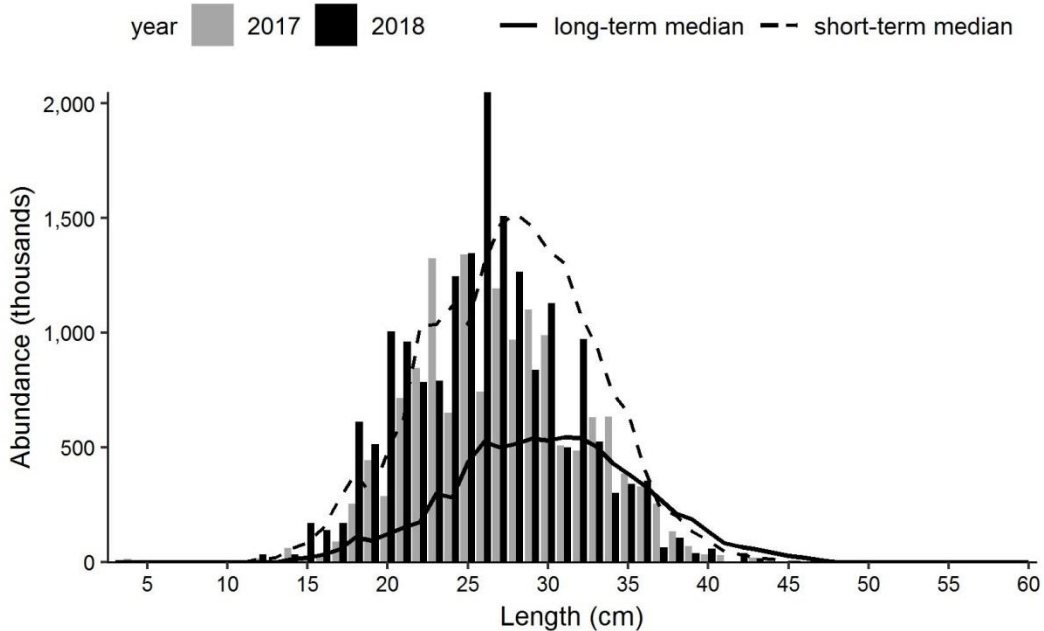


Figure 15c. Length frequency indices for Winter Flounder in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Atlantic Wolffish**

A total of nine Atlantic Wolffish (*Anarhichas lupus*) were caught in the 2018 DFO Summer RV Survey and were restricted to the Bay of Fundy and shallow banks. Biomass indices are very low in 4X and remain below 40% of the long-term GM for the seventh year in a row.

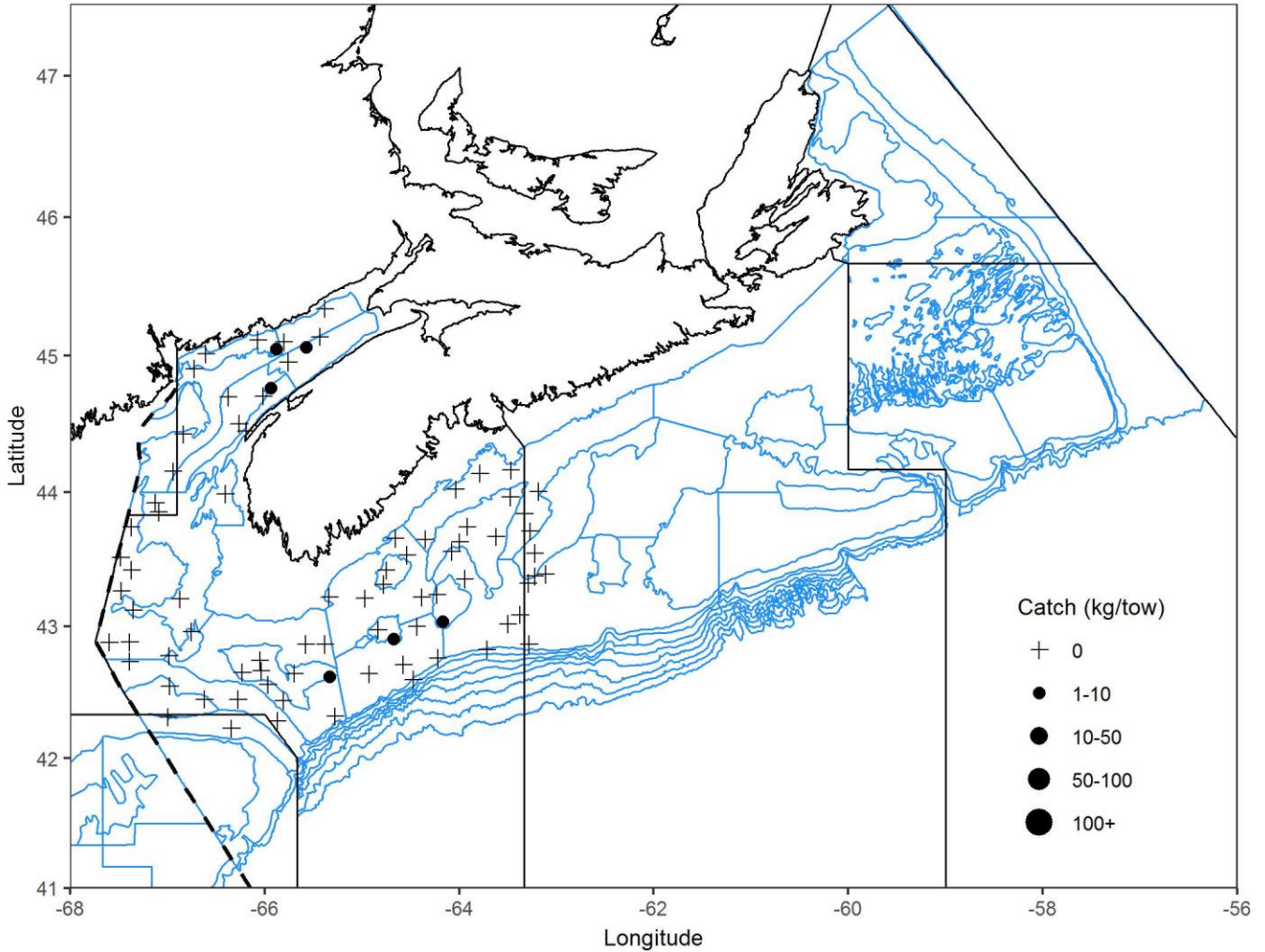


Figure 16a. Distribution of Atlantic Wolffish catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

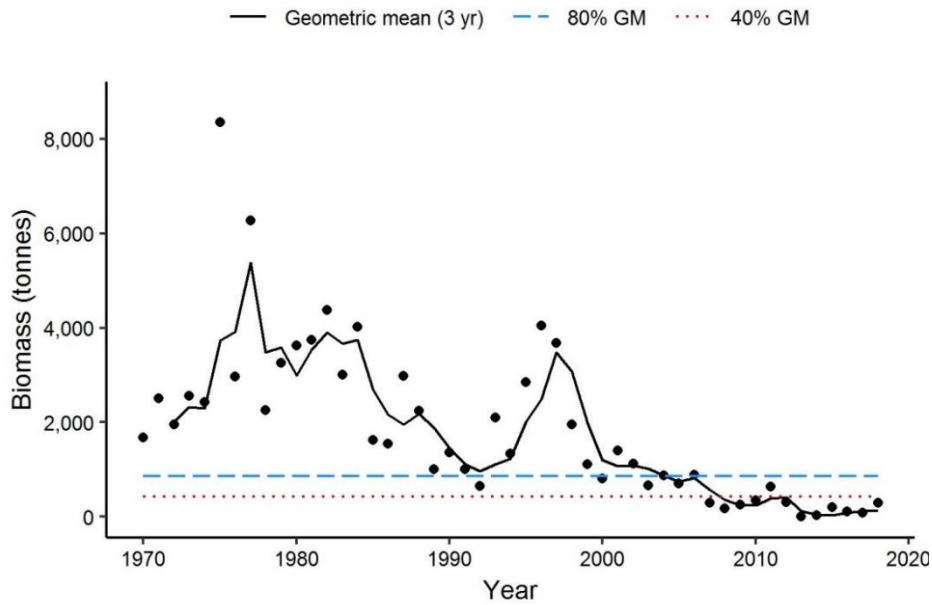


Figure 16b. Biomass index for Atlantic Wolffish in 4X from the DFO Summer RV Survey. The 3-year geometric mean (GM) biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

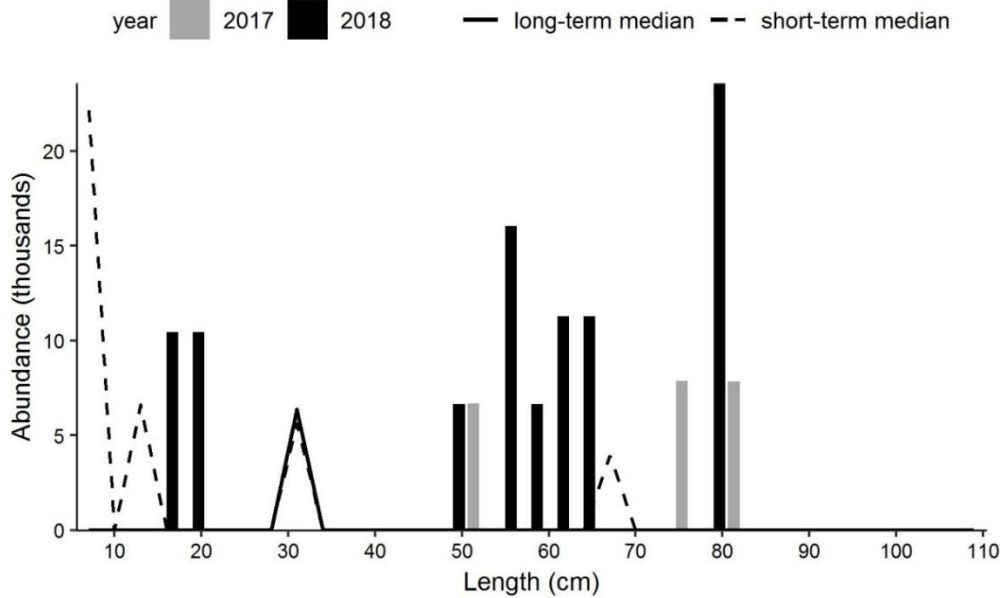


Figure 16c. Length frequency indices for Atlantic Wolffish in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.



**Monkfish**

Monkfish (*Lophius americanus*) catches were widespread in the survey area. The 3-year GM biomass index in 2018 for 4X was the highest since 2003, and the indices-at-length were generally above both the long and short-term medians.

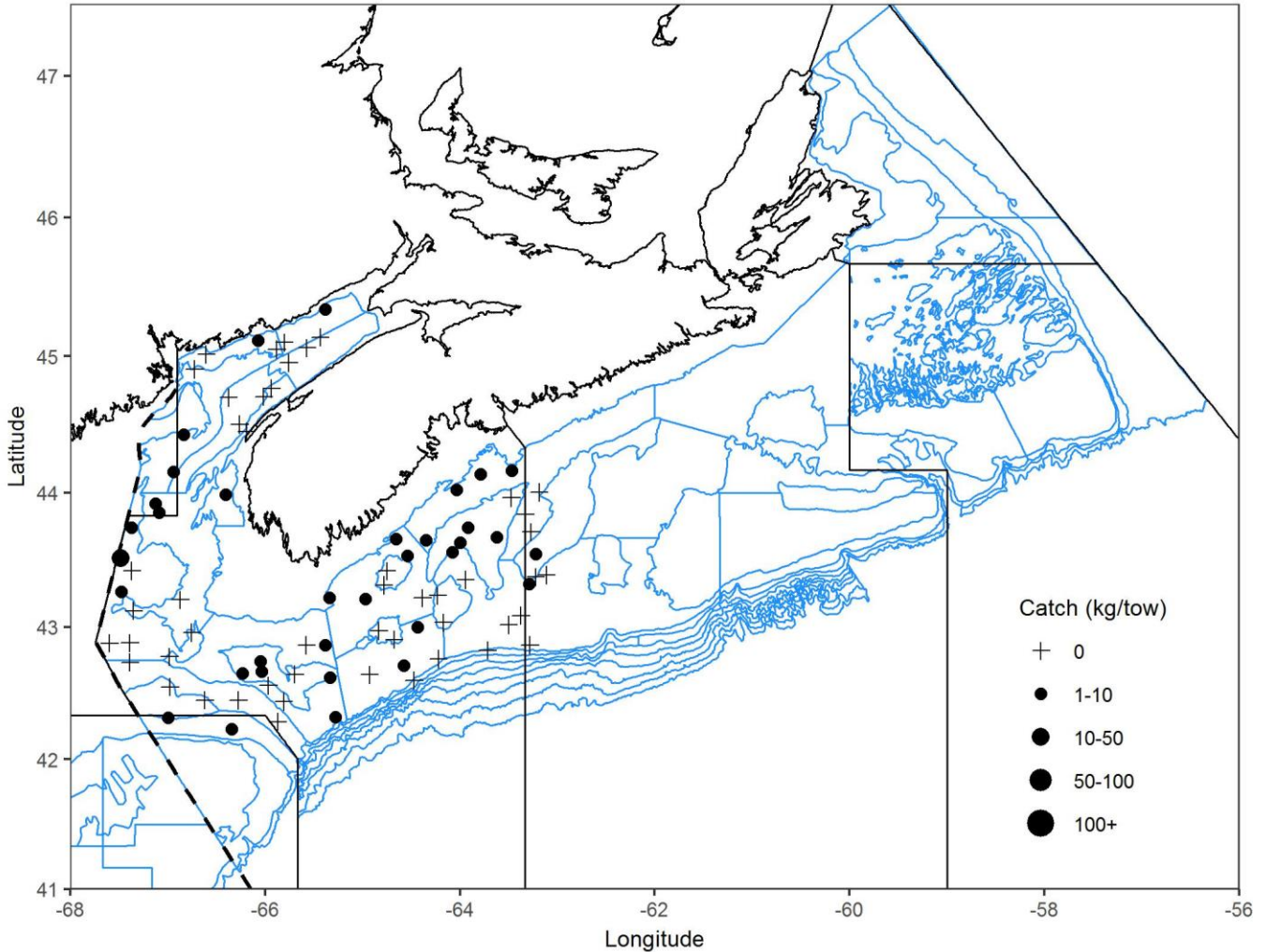


Figure 17a. Distribution of Monkfish catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

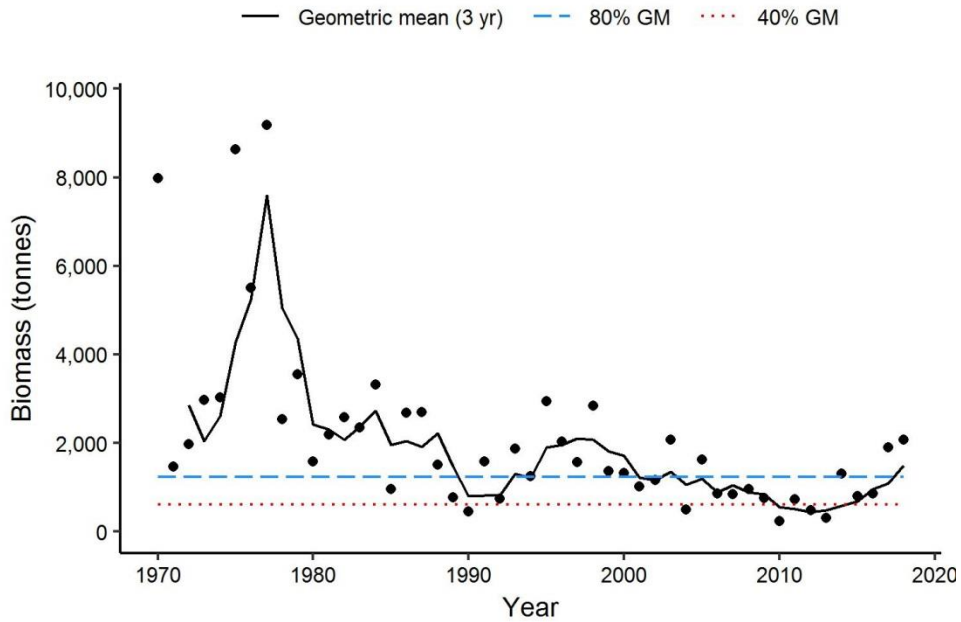


Figure 17b. Biomass index for Monkfish in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

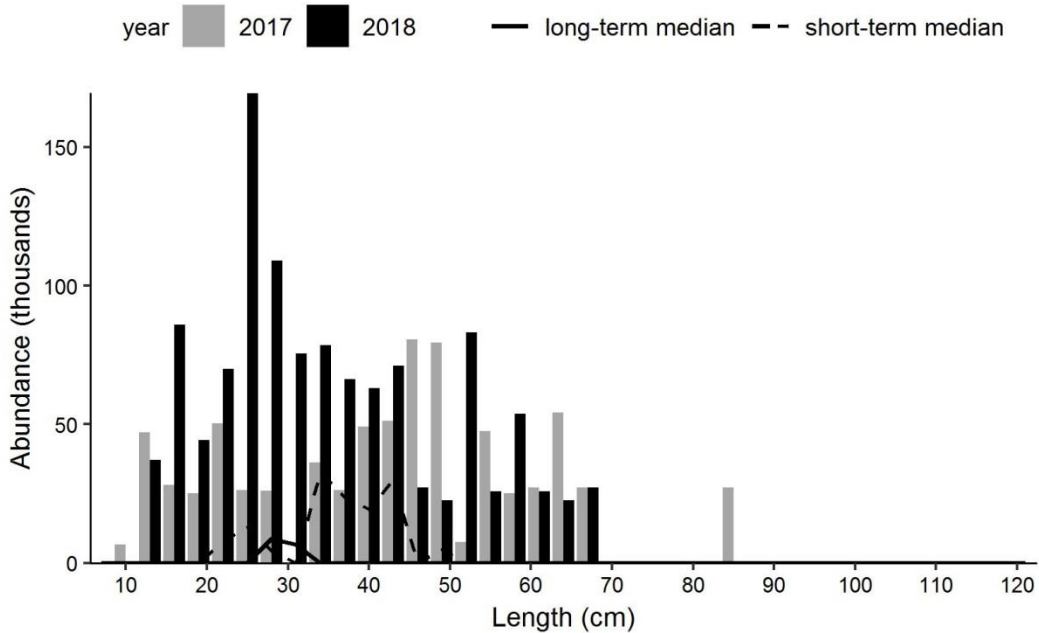


Figure 17c. Length frequency indices for Monkfish in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Longhorn Sculpin**

Longhorn Sculpin (*Myoxocephalus octodecemspinosus*) were caught primarily in the Bay of Fundy. The biomass index in 2018 is the lowest since 1980, and the 3-year GM is below 80% of the long-term GM. While the length-frequency indices were above medians for fish less than 13 cm, indices were below the medians for fish greater than 23 cm.

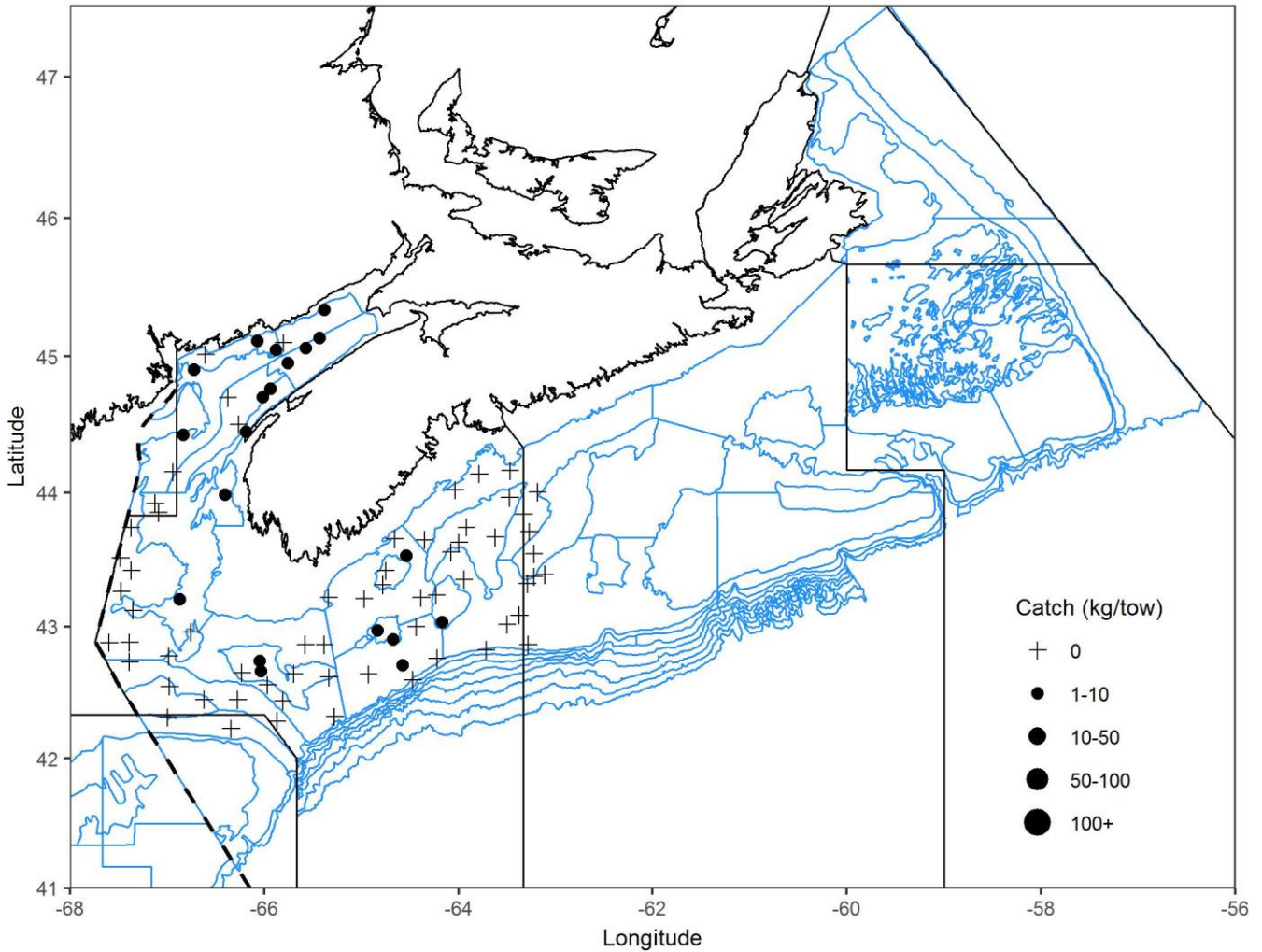


Figure 18a. Distribution of Longhorn Sculpin catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

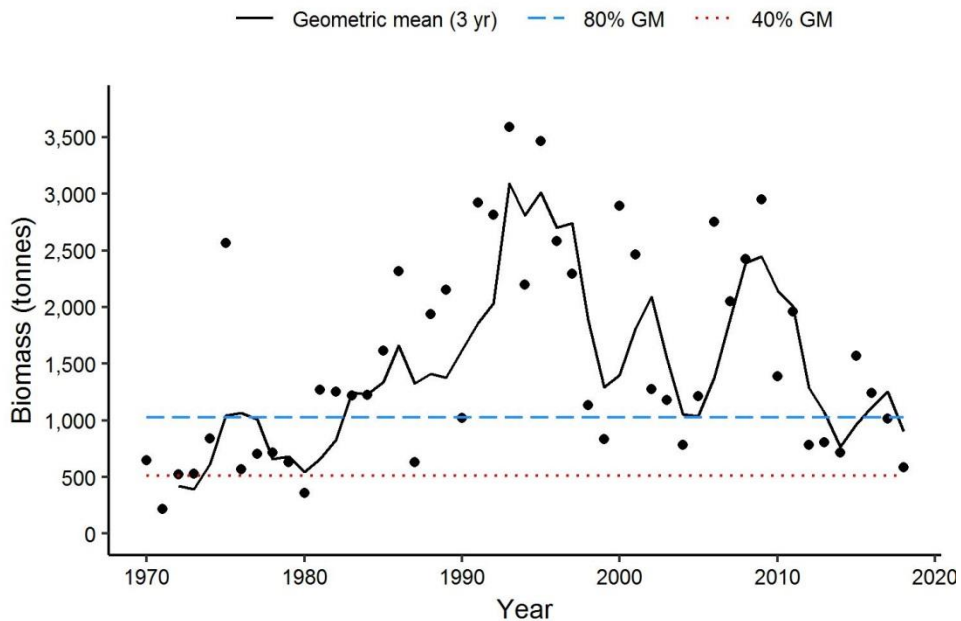


Figure 18b. Biomass index for Longhorn Sculpin in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

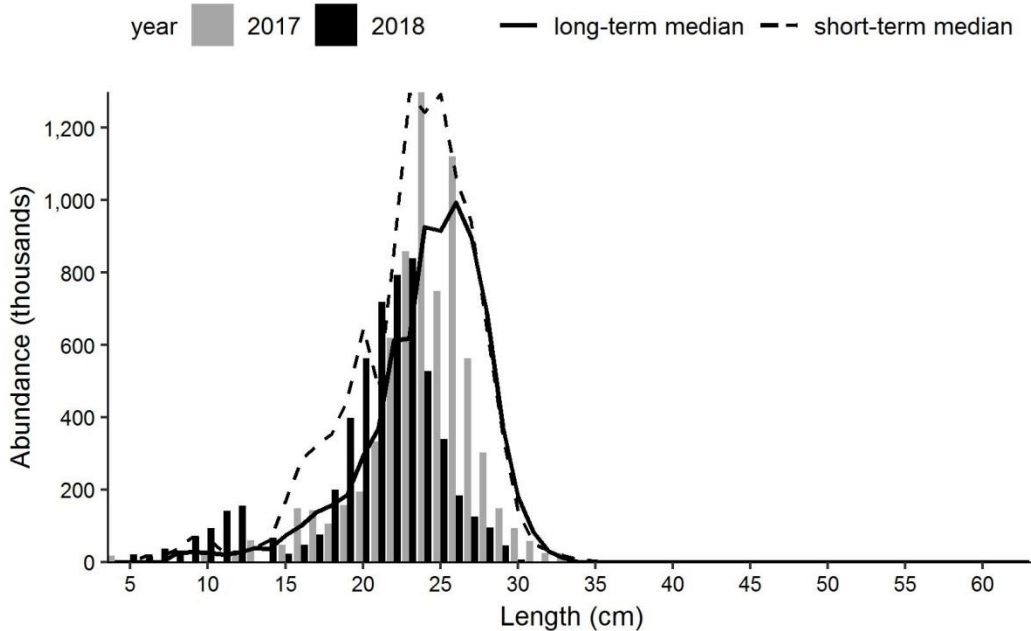


Figure 18c. Length frequency indices for Longhorn Sculpin in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey.. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Barndoor Skate**

Although only 18 individuals were caught in the 2018 DFO Summer RV Survey, the biomass index continues to rise for Barndoor Skate (*Dipturus laevis*), and it remains above 80% of the GM. Both the long and short-term medians are 0 for all lengths, which indicates that the survey infrequently captures Barndoor Skate at any length in 4X.

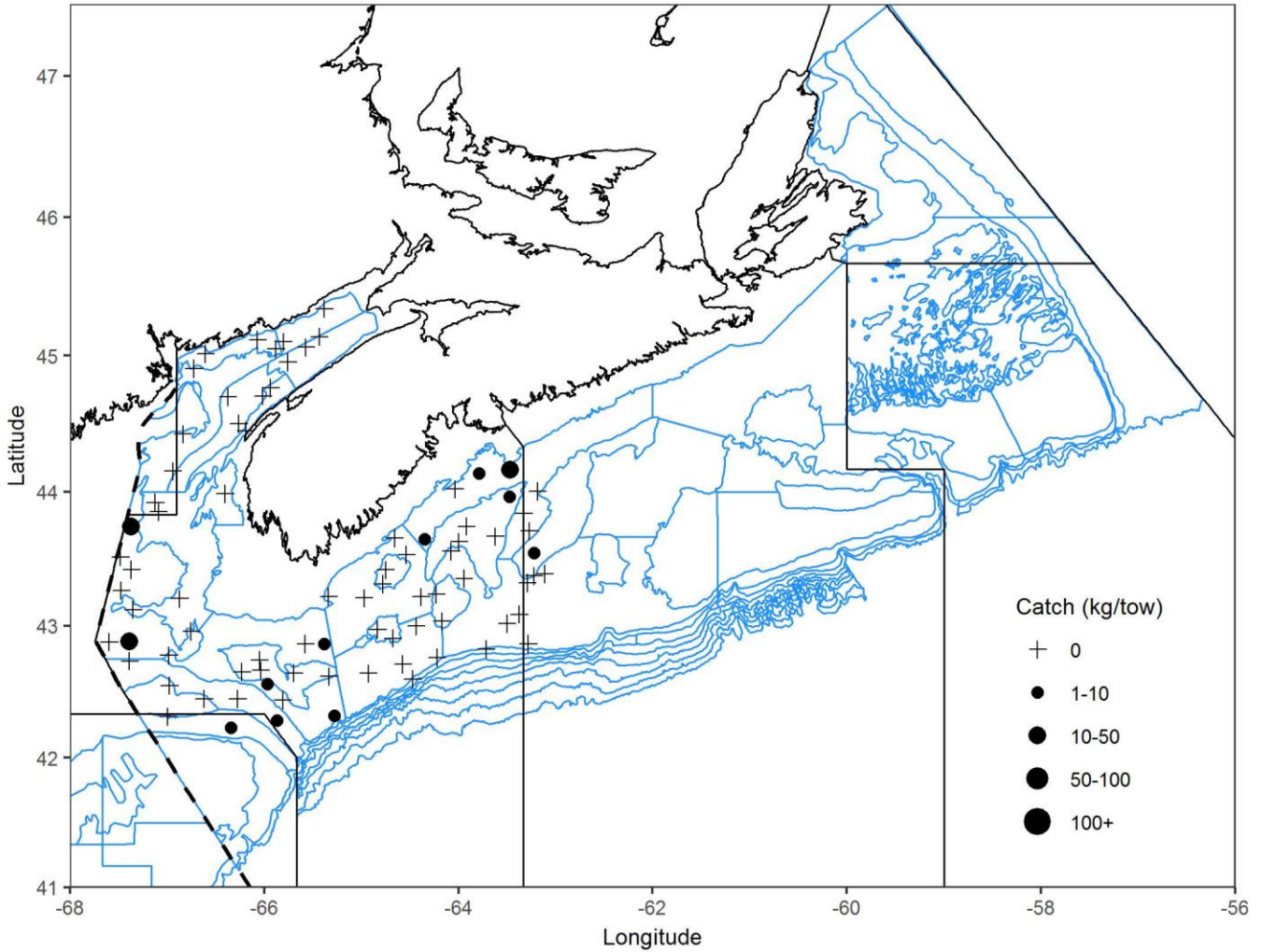


Figure 19a. Distribution of Barndoor Skate catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

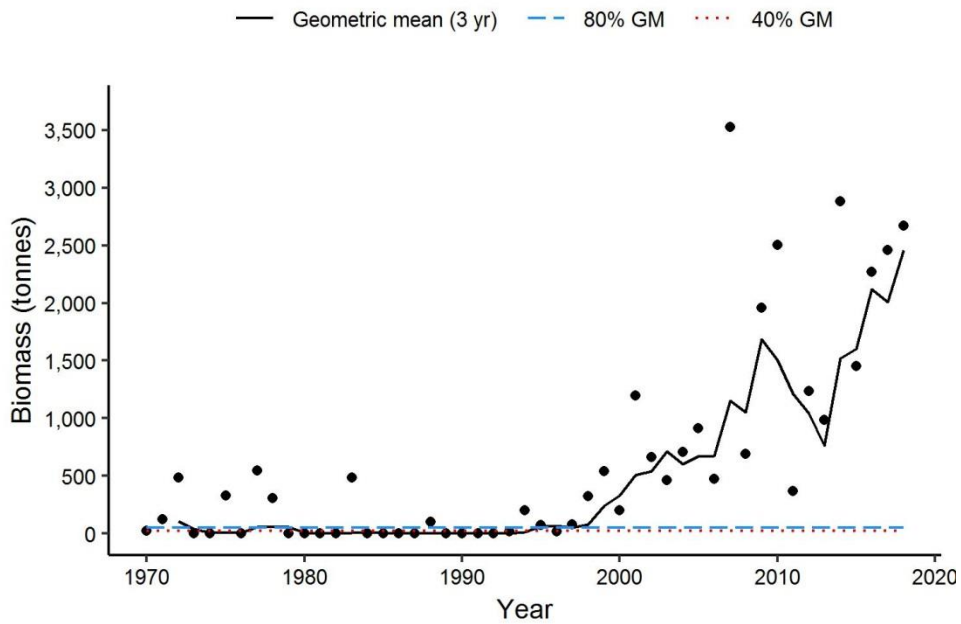


Figure 19b. Biomass index for Barndoor Skate in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

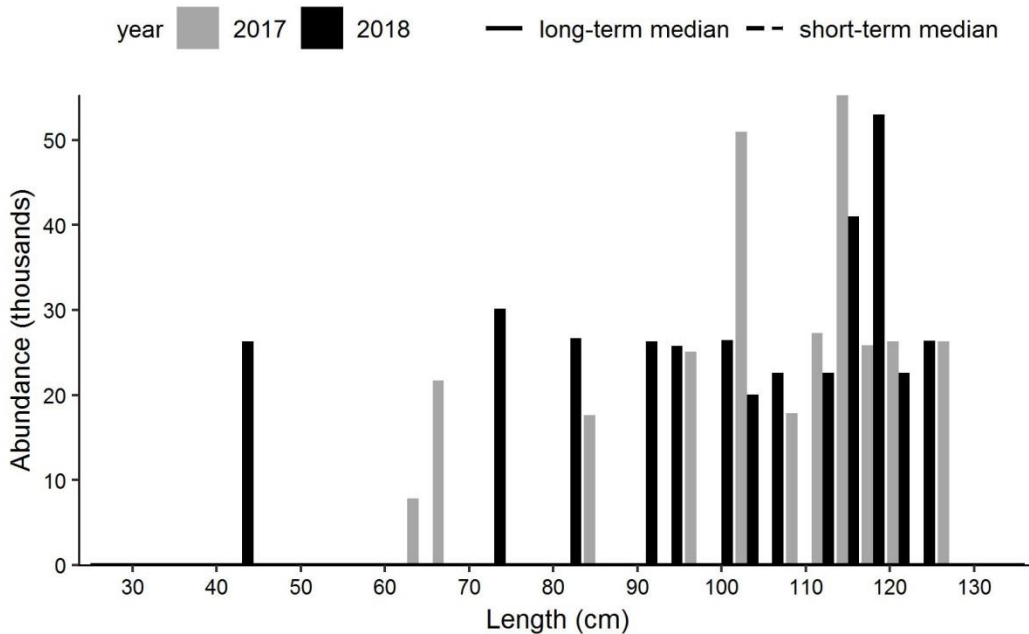


Figure 19c. Length-frequency indices for Barndoor Skate in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Thorny Skate**

A total of nine Thorny Skates (*Amblyraja radiata*) were captured in the 2018 DFO Summer RV Survey. The biomass index in 2018 was among the lowest in the series, and it has remained below 40% of the long-term GM since 2009.

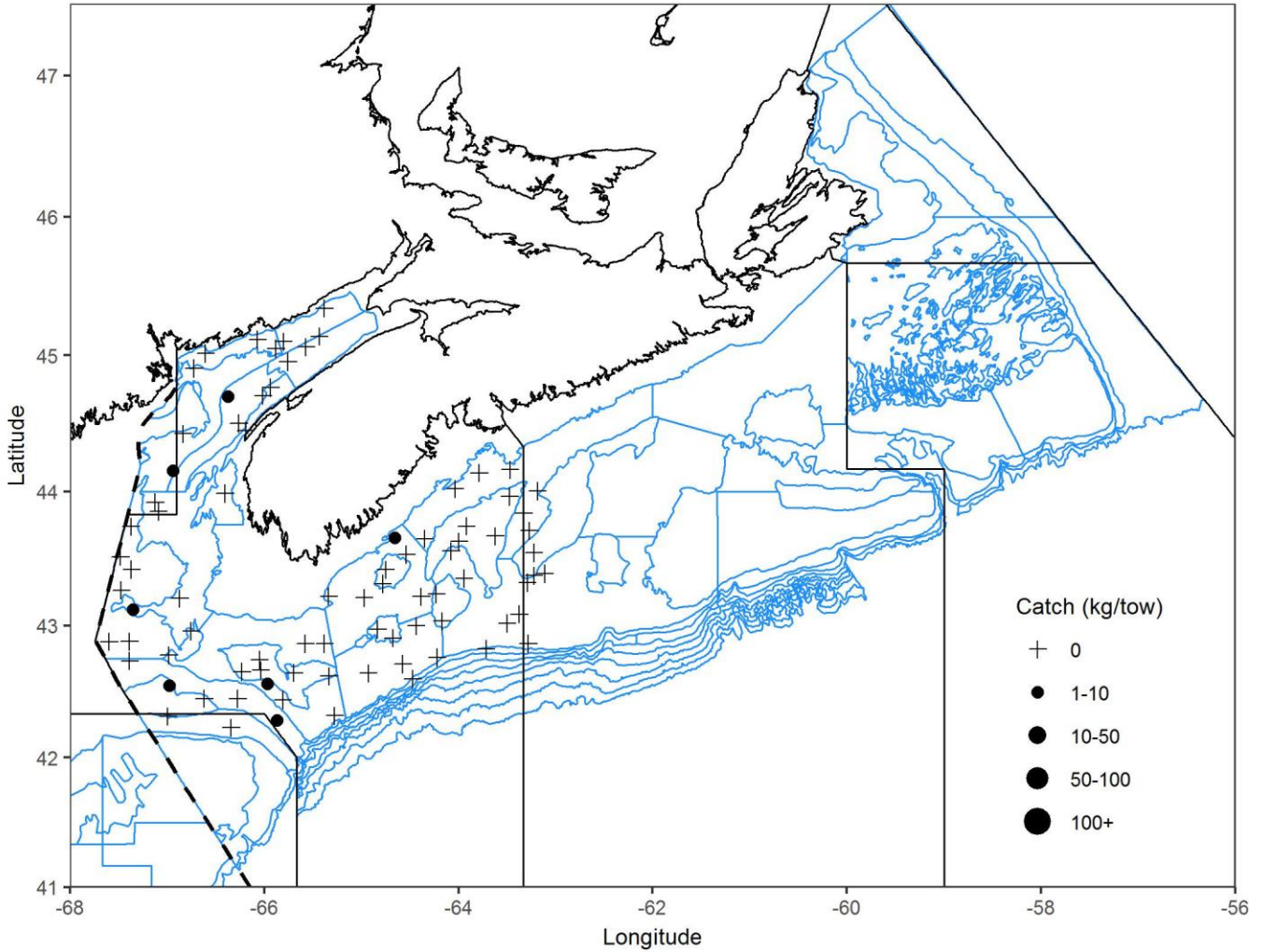


Figure 20a. Distribution of Thorny Skate catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

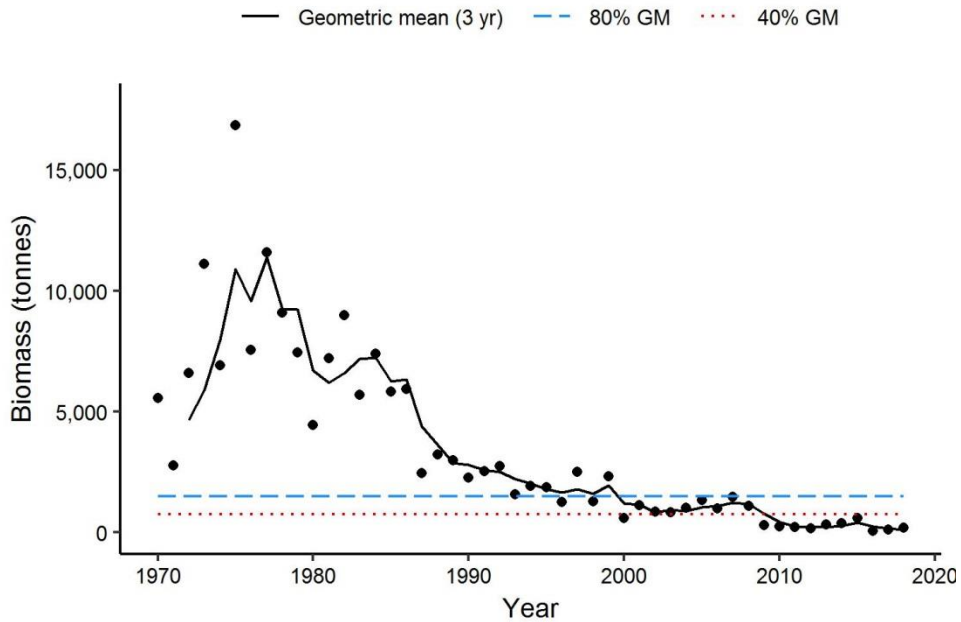


Figure 20b. Biomass index for Thorny Skate in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

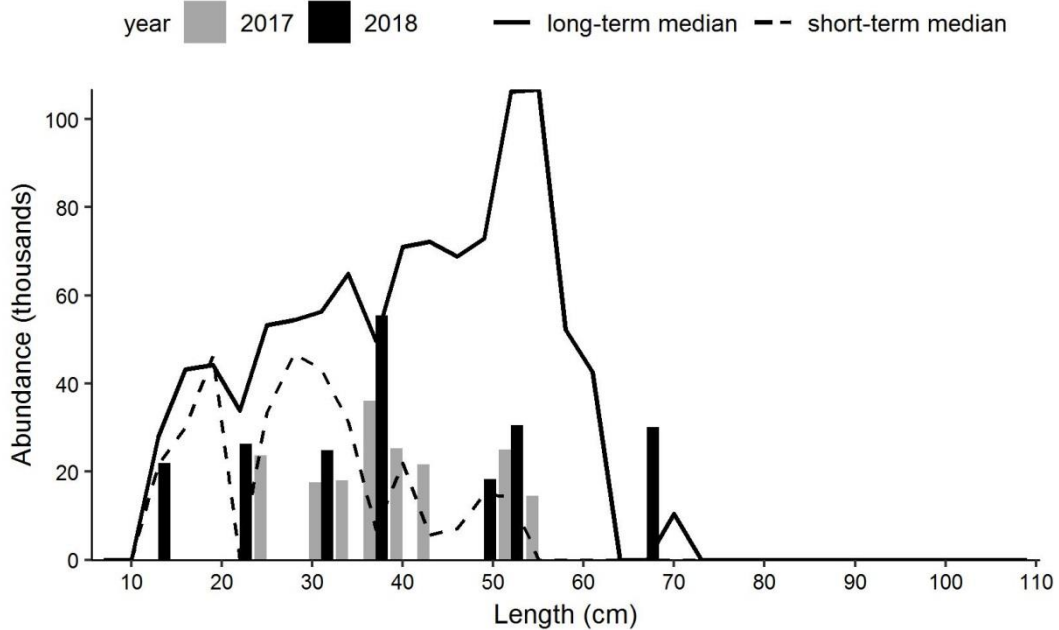


Figure 20c. Length-frequency indices for Thorny Skate in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.



**Winter Skate**

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

Winter Skate (*Leucoraja ocellata*) were caught primarily on Browns Bank in 2018. The Winter Skate 3-year GM biomass remains above 80% of the long-term GM.

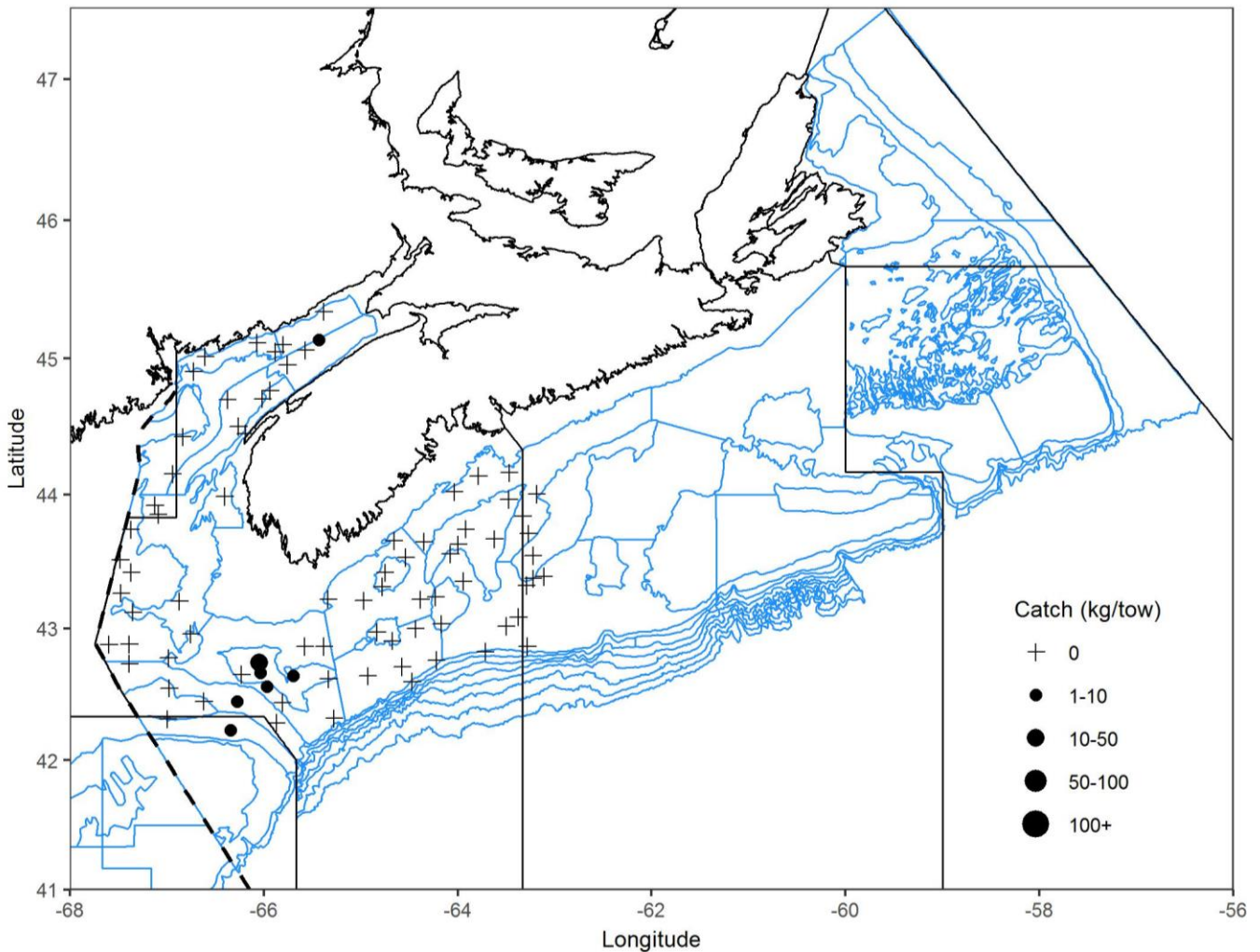


Figure 21a. Distribution of Winter Skate catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

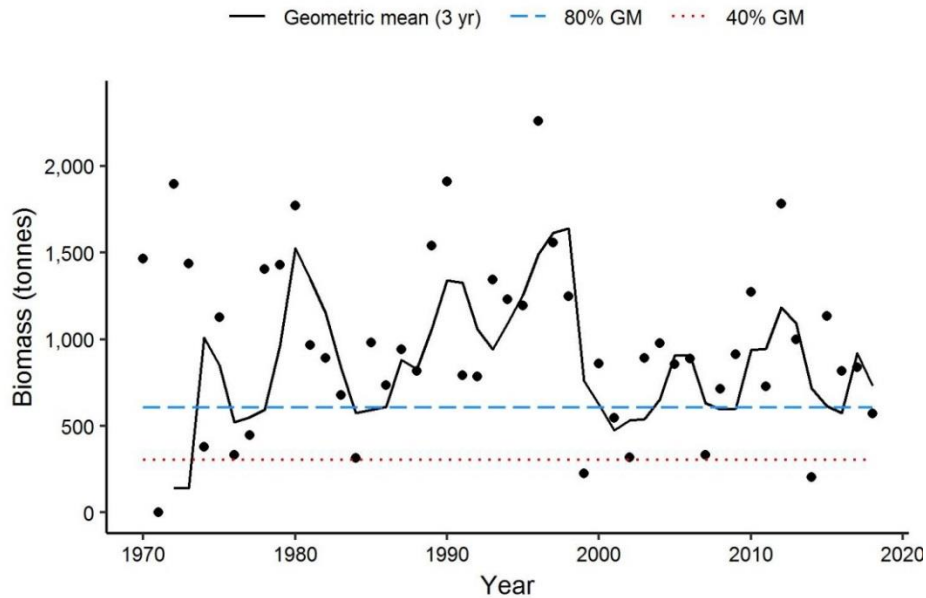


Figure 21b. Biomass index for Winter Skate in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

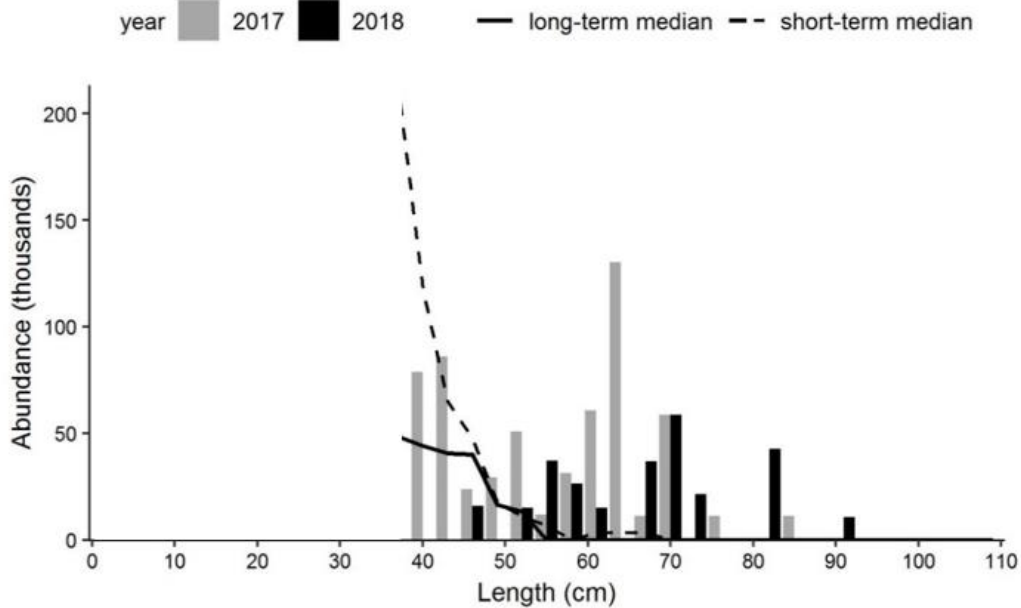


Figure 21c. Length frequency indices for Winter Skate in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016. Note: only Winter Skate >40 cm are included in this figure.

**Little Skate**

The largest catches of Little Skate (*Leucoraja erinacea*) in the 2018 survey were from the Bay of Fundy. The Little Skate biomass index remains above 80% of the geometric mean, and abundance-at-length indices are above the short and long-term medians for most lengths.

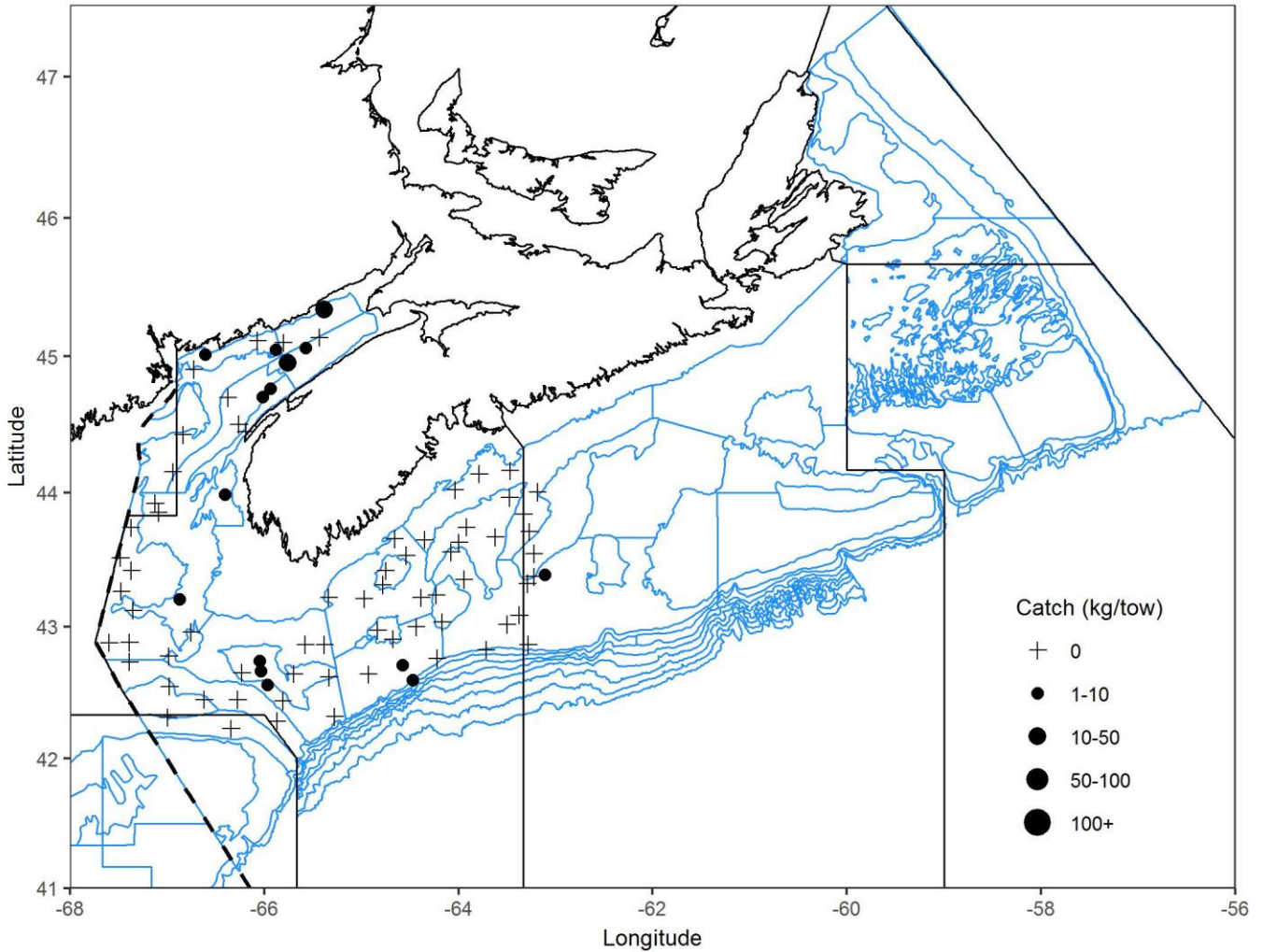


Figure 22a. Distribution of Little Skate catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

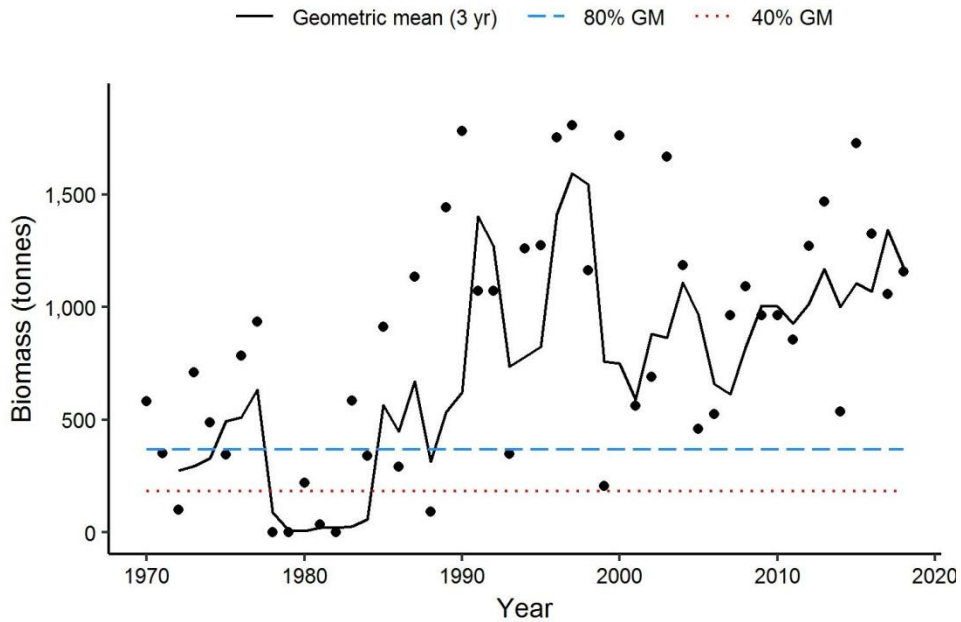


Figure 22b. Biomass index for Little Skate in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

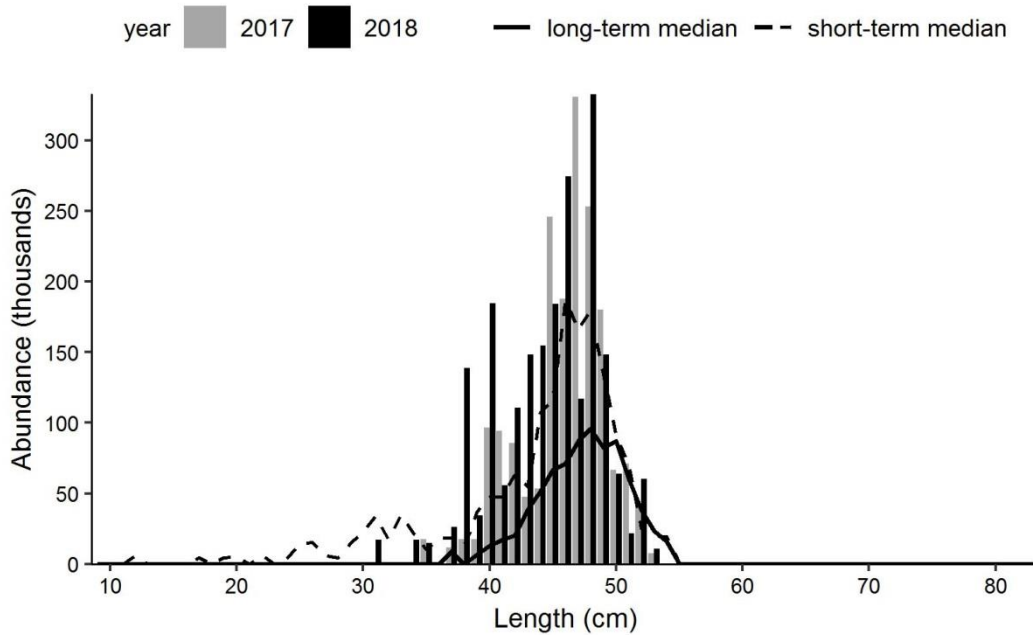


Figure 22c. Length frequency indices for Little Skate in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Smooth Skate**

Smooth Skate (*Malacoraja senta*) catches in the DFO Summer RV Survey are primarily in the Gulf of Maine and the mouth of the Bay of Fundy. In 4X, the Smooth Skate biomass index appears to be slowly increasing from a low in the early 1990s, and it has fluctuated around 80% of the long-term mean in recent years.

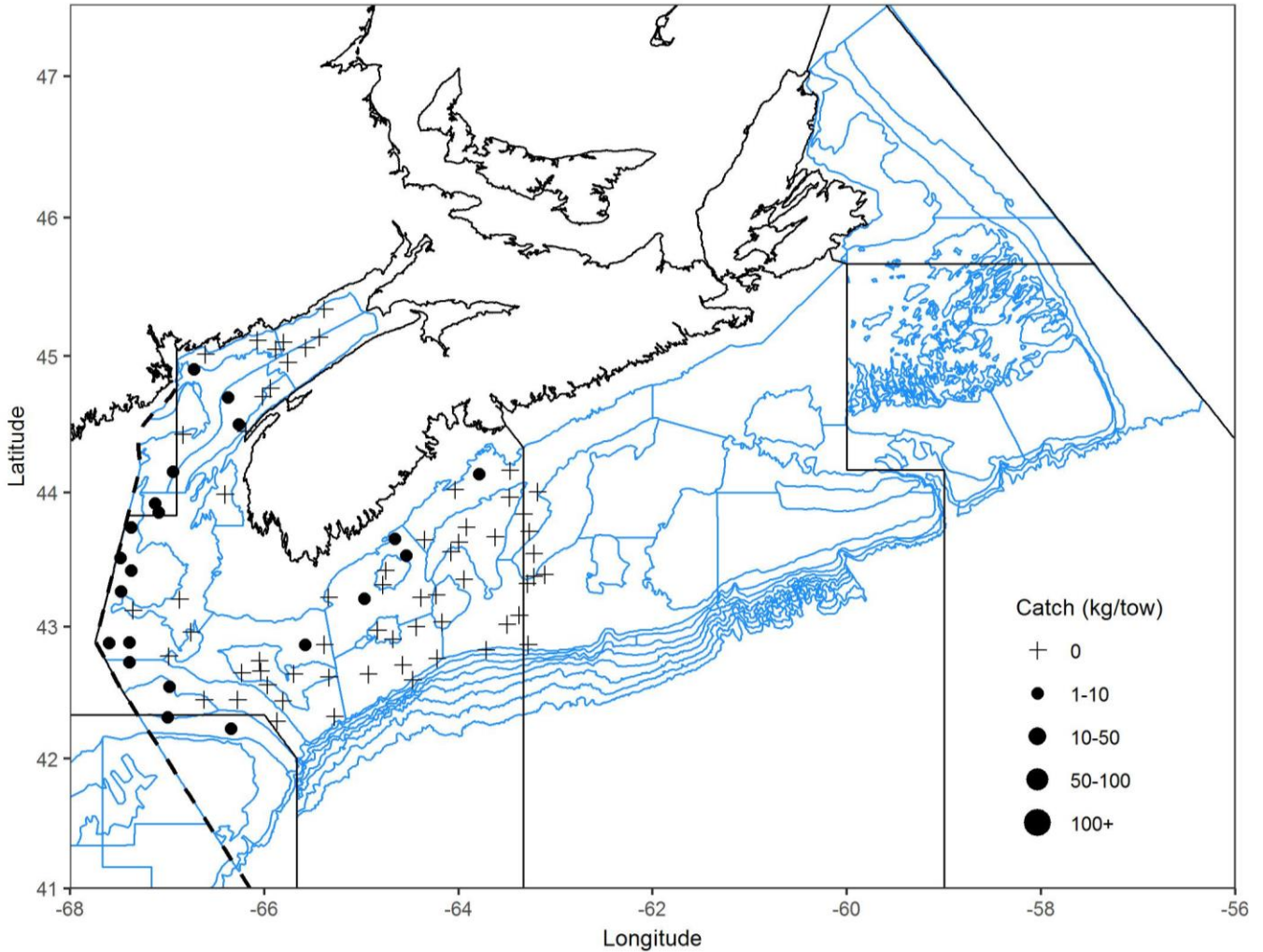


Figure 23a. Distribution of Smooth Skate catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

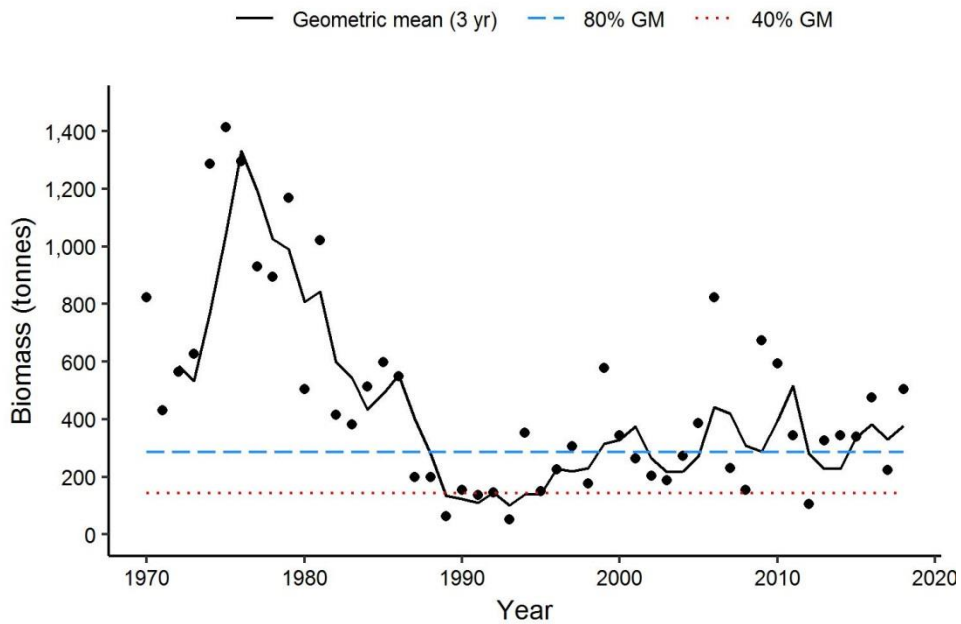


Figure 23b. Biomass index for Smooth Skate in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

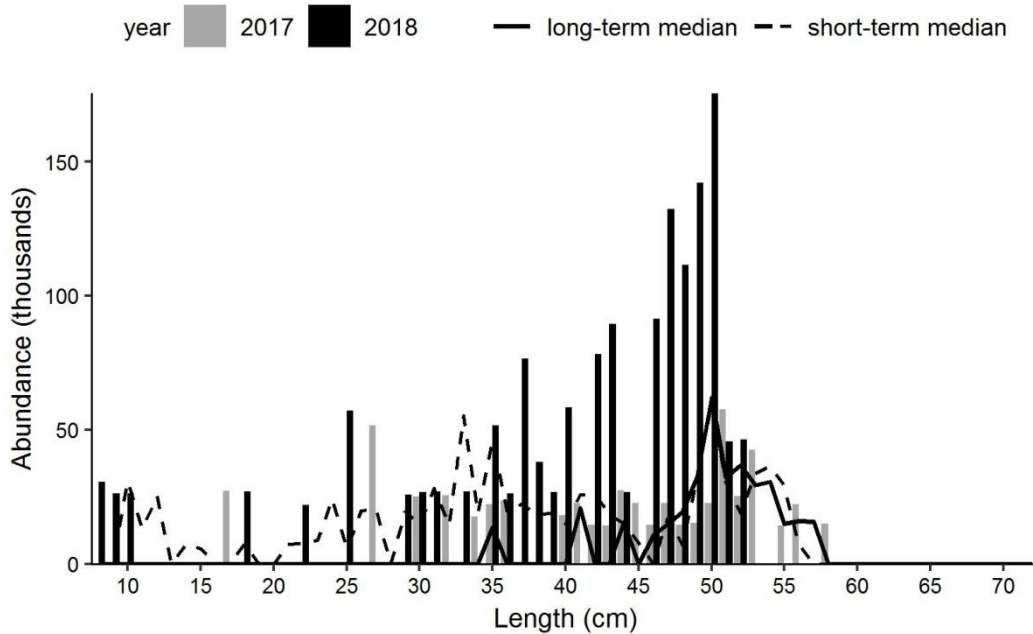


Figure 23c. Length frequency indices for Smooth Skate in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Spiny Dogfish**

Spiny Dogfish (*Squalus acanthias*) catches in the 2018 DFO Summer RV Survey are well distributed in 4X, with the largest set (>4,500 kg) taken in the Gulf of Maine. Inter-annual variability in the DFO Summer RV Survey catch is high for Spiny Dogfish. The 3-year GM biomass index is above 80% of the long-term GM in 2018.

The abundance-at-length indices in 4X are above the median values for most lengths in both 2017 and 2018.

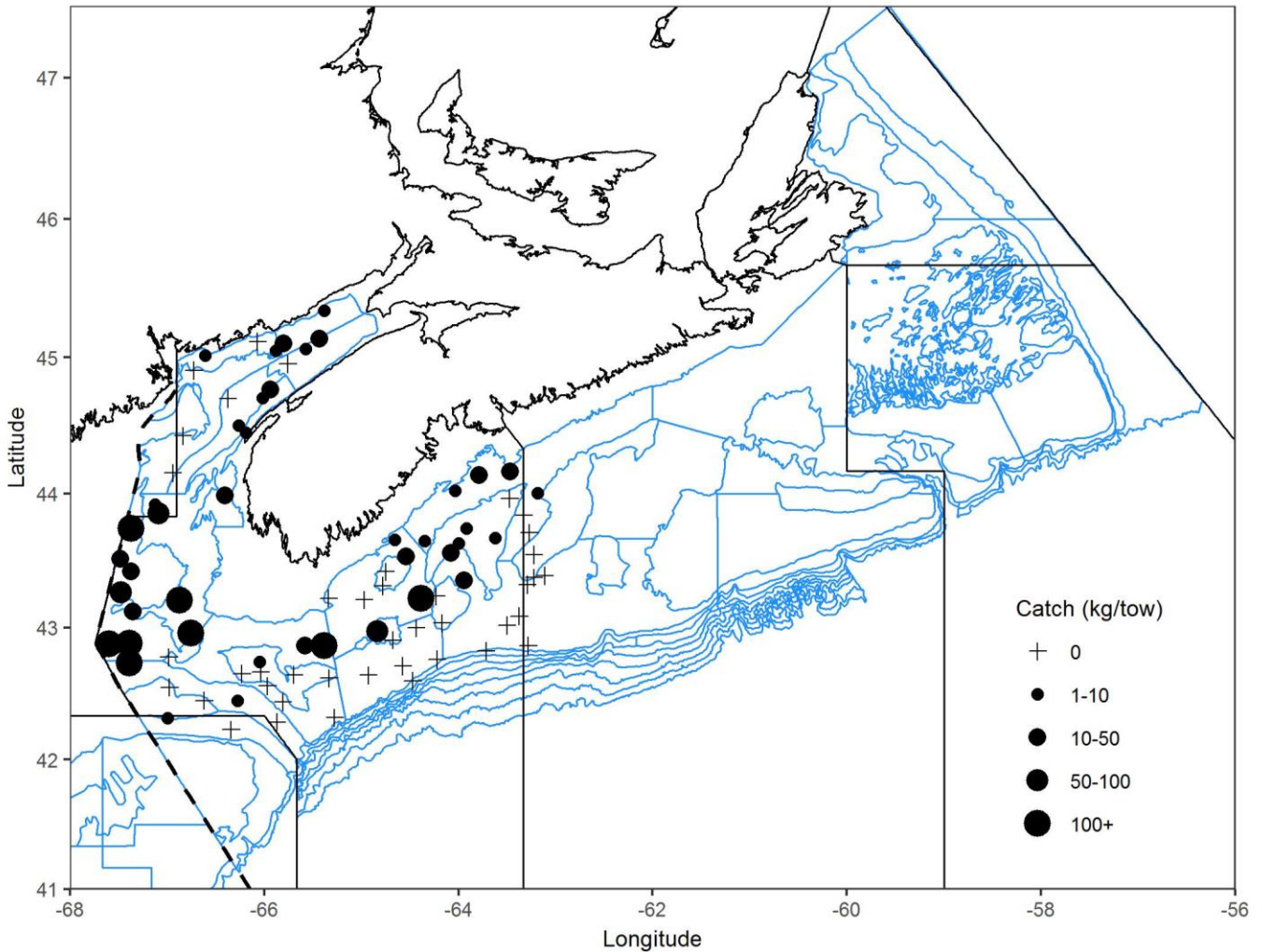


Figure 24a. Distribution of Spiny Dogfish catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

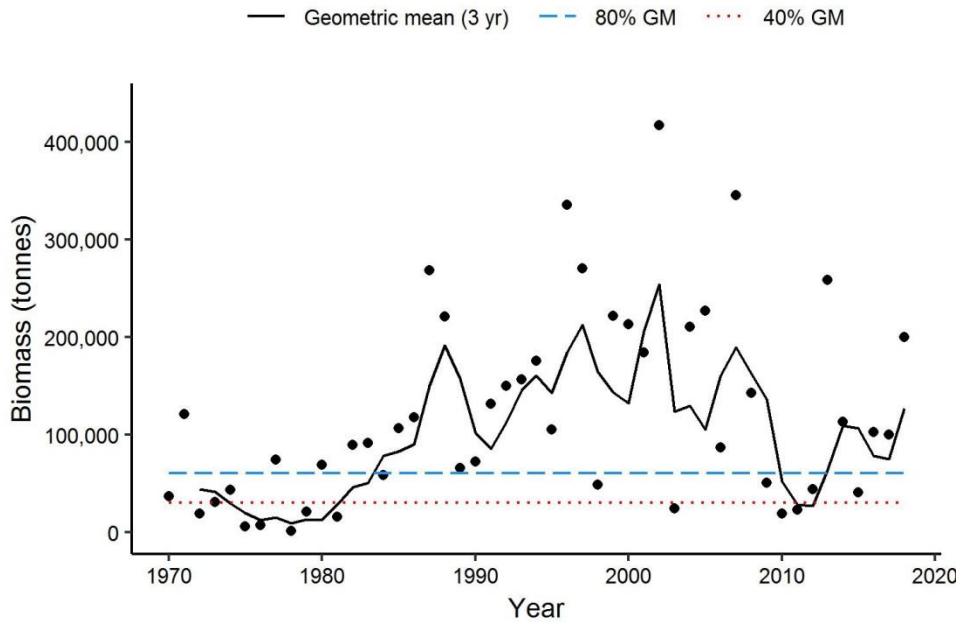


Figure 24b. Biomass index for Spiny Dogfish in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (\*) represent the biomass estimate for that year.

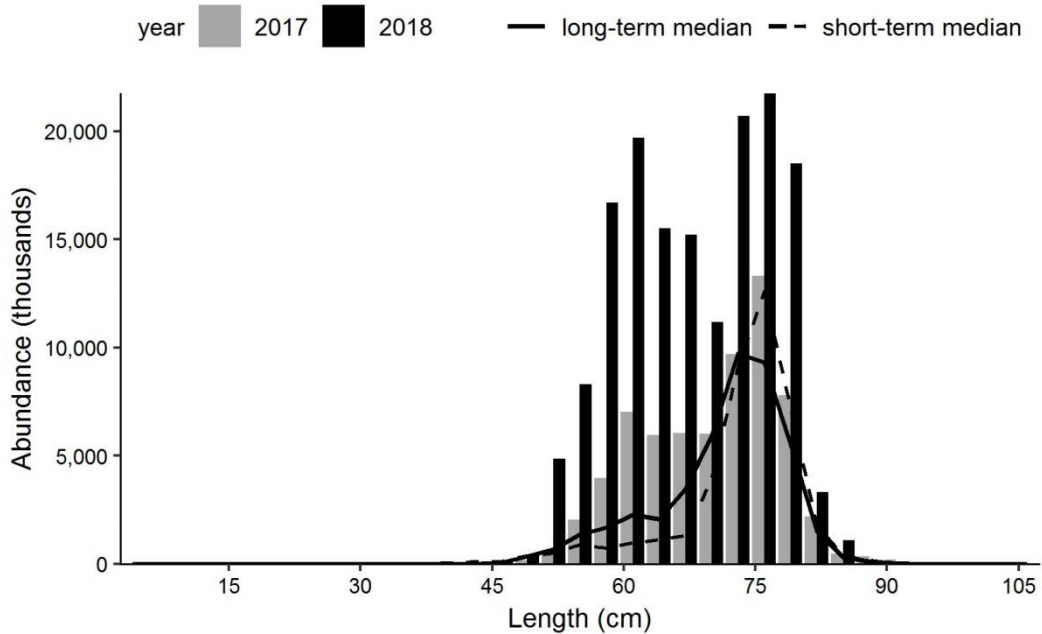


Figure 24c. Length frequency indices for Spiny Dogfish in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.



**Red Hake**

Red Hake (*Urophycis chuss*) can be difficult to distinguish from White Hake. Prior to about 1980, these two species were not consistently differentiated in the DFO Summer RV Survey. The standard guide to Canadian Atlantic fishes (Leim and Scott 1966) did not differentiate them.

Red Hake were caught throughout 4X in 2018. The biomass indices have been above 80% of the long-term GM for the last six years and the short-term median numbers-at-length are generally higher than the long-term medians, indicating a general increase in abundance. The indices-at-length in 2018 are generally above the short-term median value.

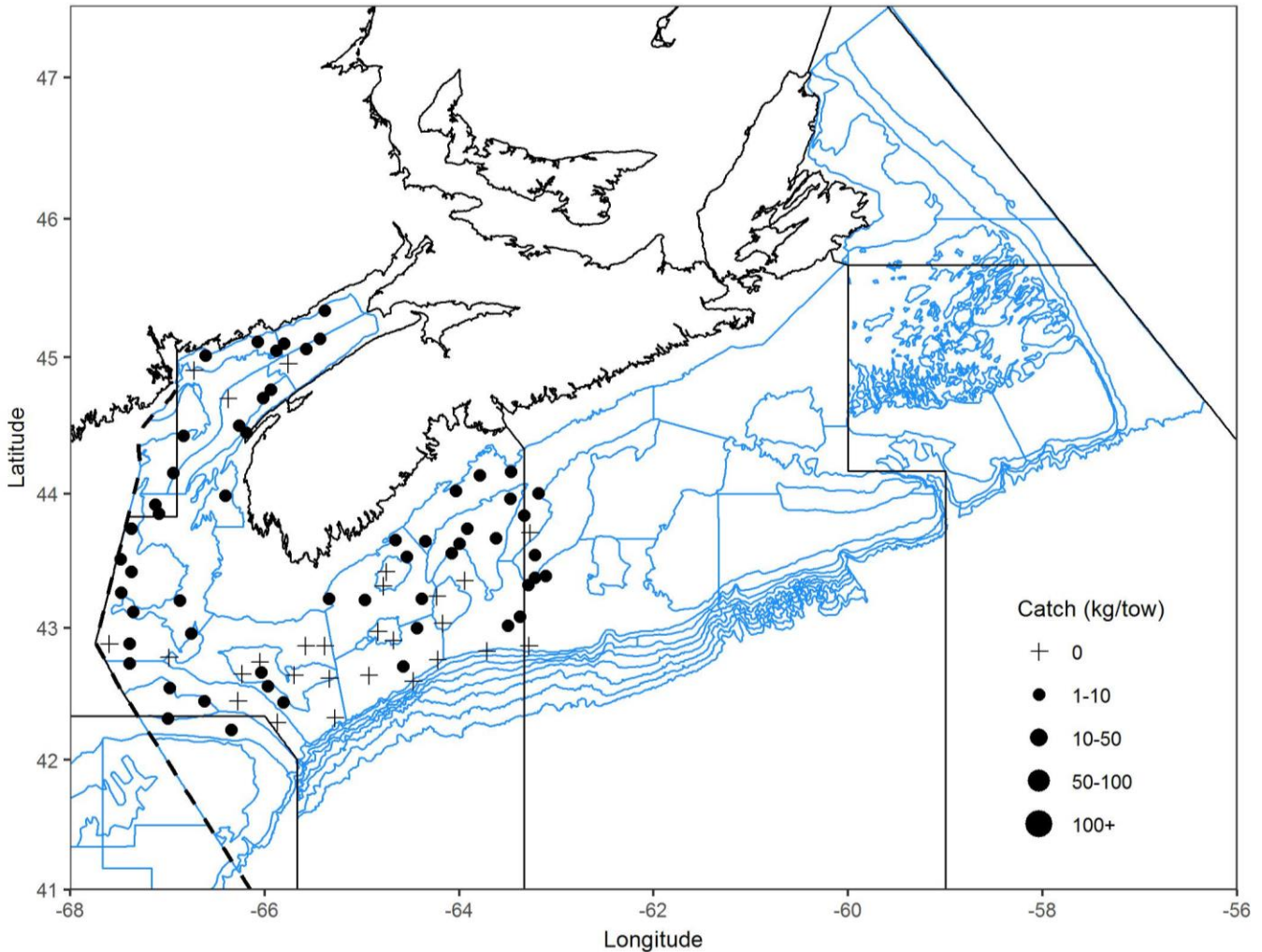


Figure 25a. Distribution of Red Hake catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

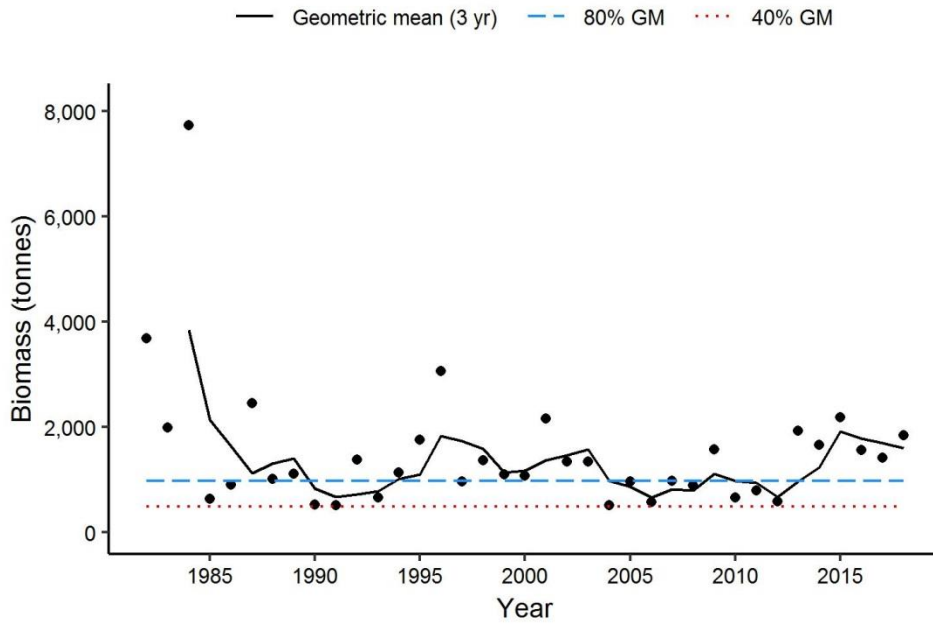


Figure 25b. Biomass index for Red Hake in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

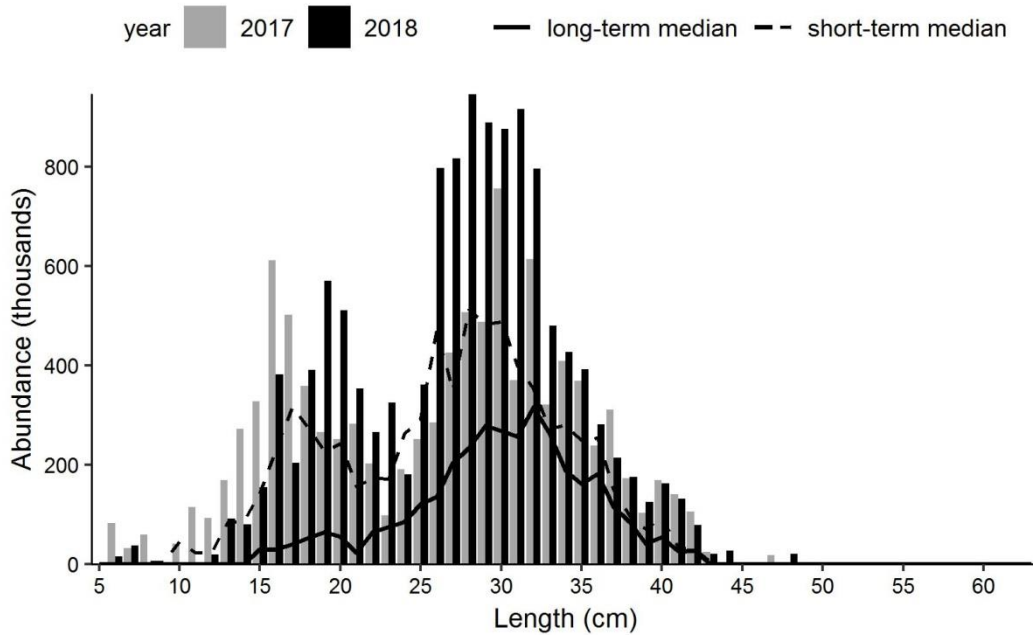


Figure 25c. Length frequency indices for Red Hake in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Sea Raven**

Sea Raven (*Hemipterus americanus*) were caught primarily on the banks and in the Bay of Fundy in 2018. The 3-year GM biomass index remains above 80% of the long-term GM, but it was the lowest since 2005. Large numbers of very small Sea Raven were caught in 2018.

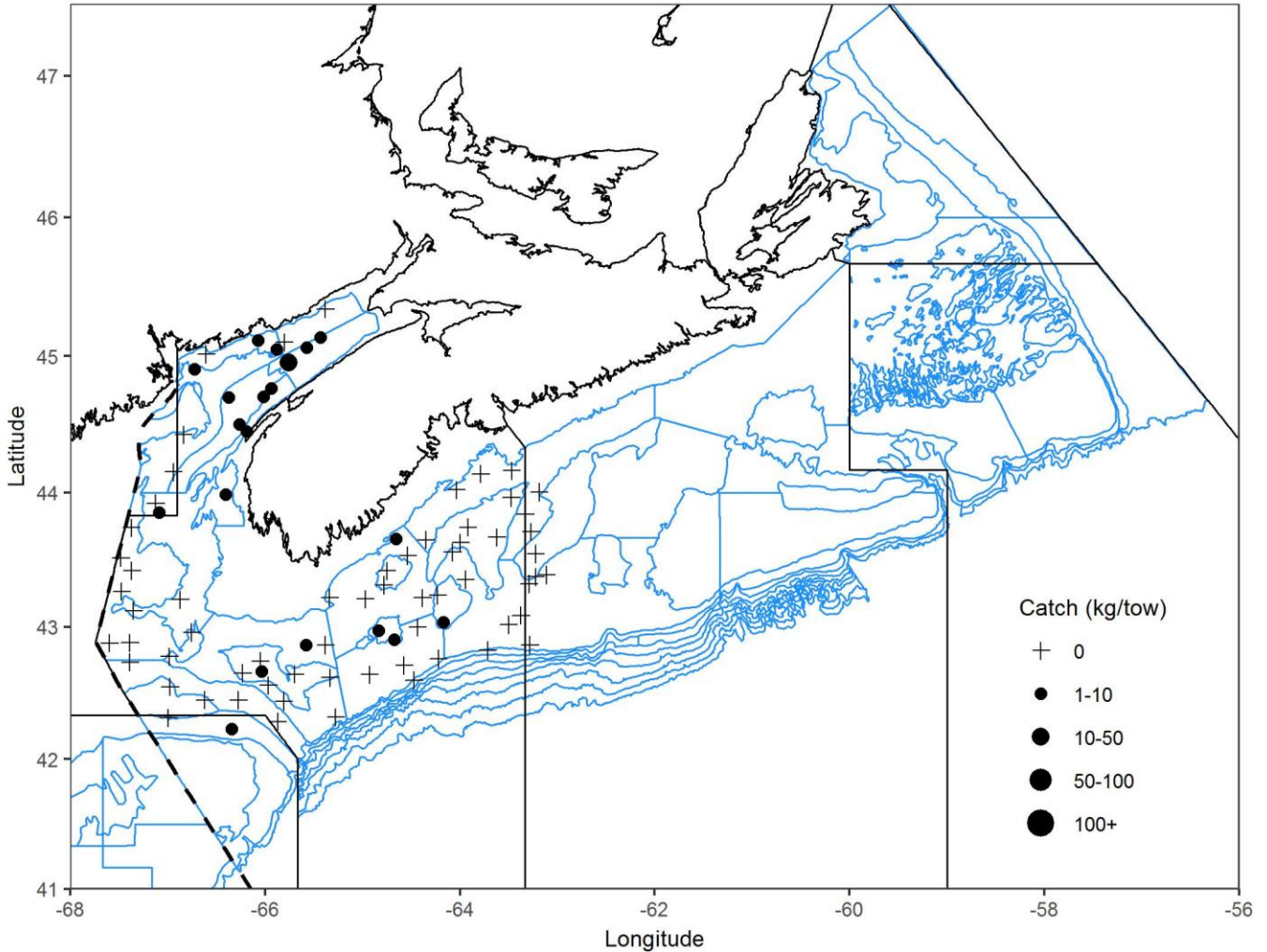


Figure 26a. Distribution of Sea Raven catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

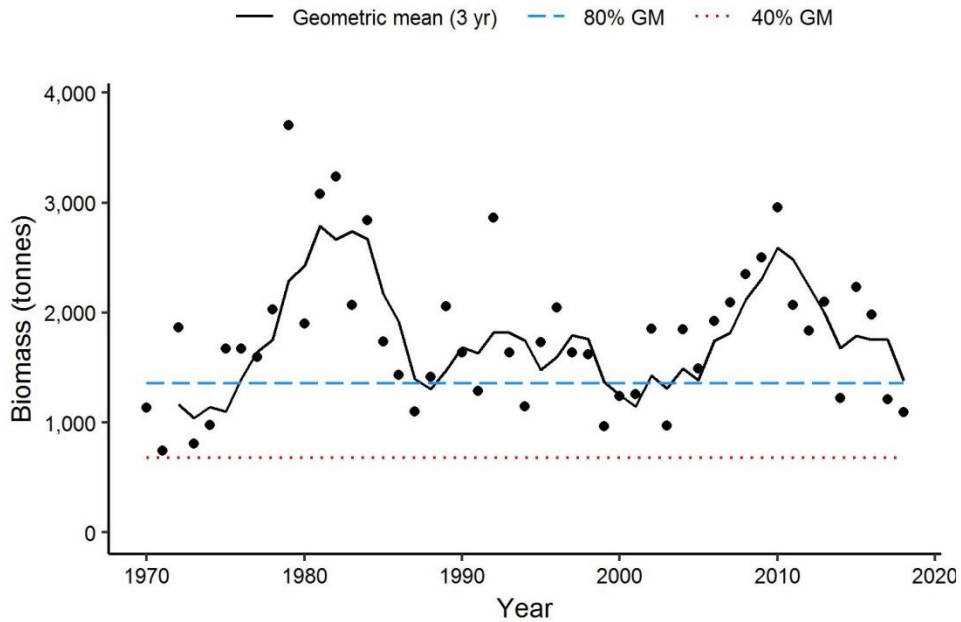


Figure 26b. Biomass index for Sea Raven in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

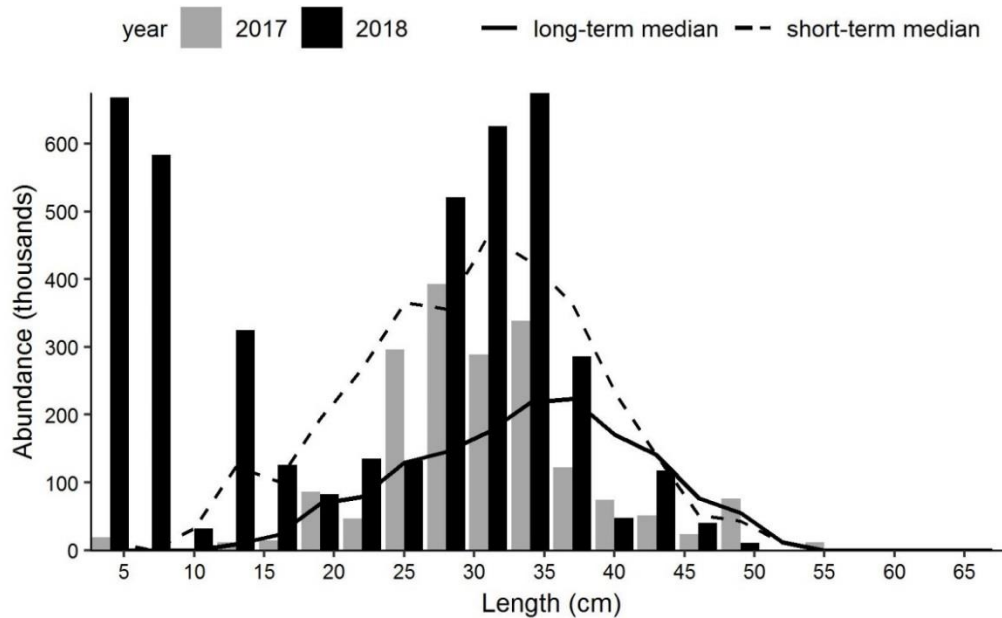


Figure 26c. Length frequency indices for Sea Raven in 4X from the DFO Summer RV Survey. Grey bars represent the number in thousands-at-length from the 2017 survey. Black bars represent the number in thousands-at-length from the 2018 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

**Ocean Pout**

Ocean Pout (*Zoarces americanus*) were caught in only a few sets in 2018. The biomass indices have been below 40% of the long-term mean for the last 6 years in 4X. Catches of Ocean Pout over 45 cm in 2018 were very low, relative to the long-term median values. The short-term median numbers are also much lower than the long-term median values for lengths above 40 cm, indicating this reduction in abundance of larger Ocean Pout is an enduring change.

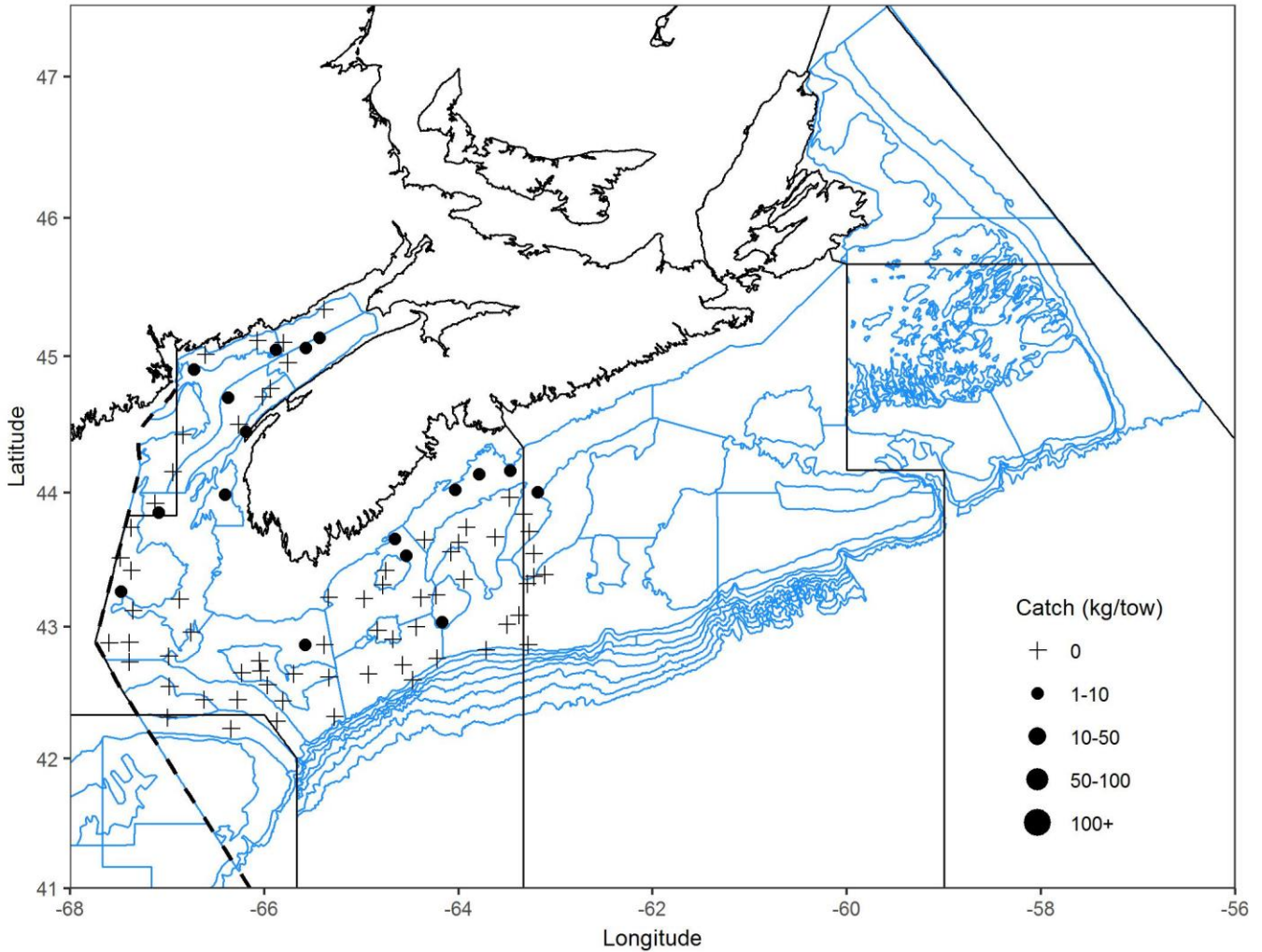


Figure 27a. Distribution of Ocean Pout catches during the 2018 DFO Summer RV Survey. Zero catch is represented by the plus (+) symbol. Black circles (•) represent catches. The circle area is proportional to the catch size.

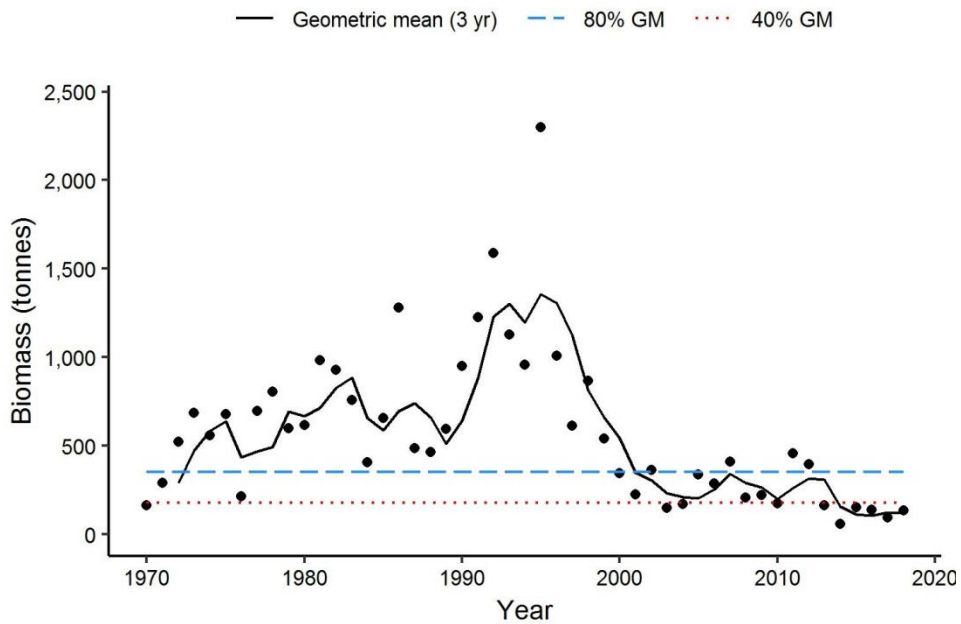


Figure 27b. Biomass index for Ocean Pout in 4X from the DFO Summer RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970-2017), respectively. The black dots (•) represent the biomass estimate for that year.

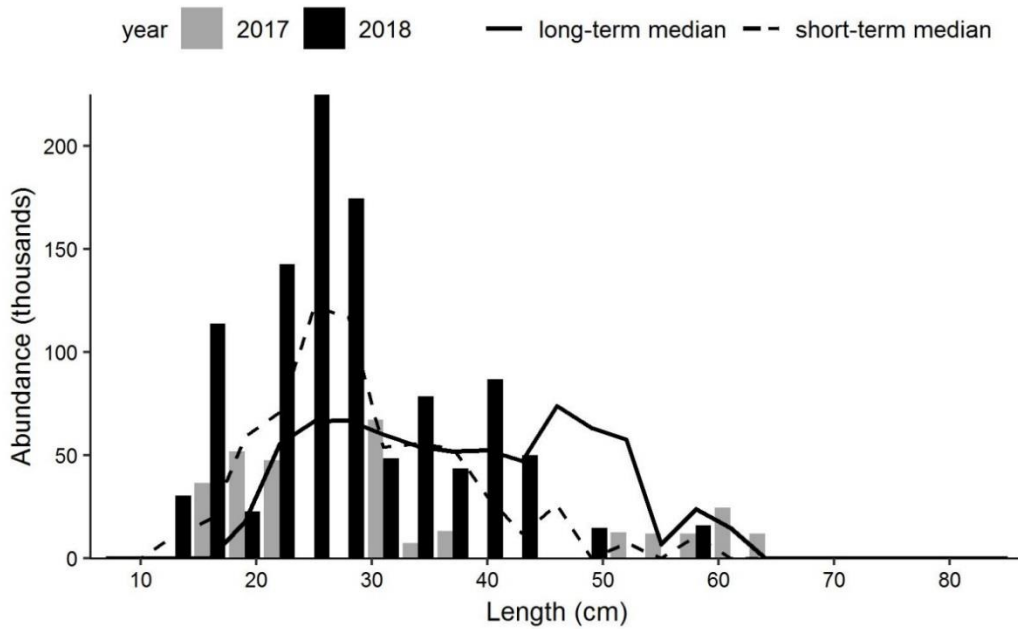


Figure 27c. Length frequency indices for Ocean Pout in 4X from the DFO Summer RV Survey. Black bars represent the number in thousands-at-length from the 2018 survey. Grey bars represent the number in thousands-at-length from the 2017 survey. The solid black line represents the median in thousands-at-length for the time period 1970-2016. The dashed black line represents the median in thousands-at-length for the time period 2007-2016.

## Conclusions

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 (Figure 2b). Of the 270 stations selected for sampling in 2018, only 85 successful tows were completed. This is the first time since the survey began in 1970 that there has not been some sampling in all strata from 440 – 495.

The total biomass index for demersal fish from the survey has been low in 4VW since the 1990s. In 4X, there is high inter-annual variability in the total biomass index. While biomass appears to have been low for approximately 15 years in the middle of the time series, the total biomass indices recorded in the last decade are similar in magnitude to those seen in the early part of the time series.

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 shifting to smaller sizes in recent years, including Cod, Haddock, Witch Flounder, American Plaice, Thorny Skate, and Ocean Pout.

Abundance indices for Age 0 Haddock were the highest in the time series in 2018, indicating that the 2018 year class should be well above average. The 3-year GM biomass index in 2018 for 4X Barndoor Skate is the highest in the time-series, and it was also the highest since 2000 for 4X Monkfish. Halibut biomass remains high in 4X, and the numbers of small Halibut were similar to the recent medians, indicative of continuing good recruitment. The biomass indices for 4X Smooth Skate and for Dogfish both increased in 2018, and they remain above 80% of the long-term mean. Conversely, the 3-year GM biomass indices for 4X Thorny Skate, 4X Yellowtail Flounder, 4X American Plaice, 4X Atlantic Wolffish, and 4X Ocean Pout were all below 40% of their respective long-term means, and are close to the lowest levels observed. Similarly, the biomass index for Longhorn Sculpin was the lowest they recorded since 1987.

Biomass indices for White Hake in 4X remain in the Critical Zone in 2018, relative to the precautionary approach reference points.

Changes in biomass indices from one year to the next for individual species should be interpreted cautiously. A 3-year 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.

## Contributors

<b>Name</b>	<b>Affiliation</b>
Donald Clark (Lead)	DFO Science, Maritimes Region
Kirsten Clark	DFO Science, Maritimes Region
Irene Andrushchenko	DFO Science, Maritimes Region
Ryan Martin	DFO Science, Maritimes Region
Allan Debertin	DFO Science, Maritimes Region
Yanjun Wang	DFO Science, Maritimes Region
Melanie Barrett	DFO Science, Maritimes Region
Quinn McCurdy	DFO Science, Maritimes Region
Virginia Noble	DFO Science, Maritimes Region
Jamie Emberley	DFO Science, Maritimes Region
Catrina Régner-McKellar	DFO Science, Maritimes Region

Cornelia den Heyer	DFO Science, Maritimes Region
Heath Stone	DFO Science, Maritimes Region
Lottie Bennett	DFO Science, Maritimes Region
Alida Bundy	DFO Science, Maritimes Region
Monica Finley	DFO Science, Maritimes Region
Fonya Irvine	DFO Science, Maritimes Region
Ellen MacEachern	DFO Science, Maritimes Region
Jennifer Ford	DFO Science, Maritimes Region
Caira Clark	DFO Science, Maritimes Region
Daphne Themelis	DFO Science, Maritimes Region
Brendan Wringe	DFO Science, Maritimes Region
Penny Doherty	DFO Resource Management, Maritimes Region

### **Approved by**

Alain Vézina  
Regional Director of Science, DFO Maritimes Region  
Dartmouth, Nova Scotia  
Ph. 902-426-3490  
Date: 2019-04-29

### **Sources of Information**

- Clark, D.S., and Emberley, J. 2011. Update of the 2010 Summer Scotian Shelf and Bay of Fundy Research Vessel Survey. Can. Data Rep. Fish. Aquat. Sci. 1238.
- Fanning, P. 1985. Intercalibration of Research Survey Results Obtained by Different Vessels. CAFSAC Res. Doc. 85/3.
- Guénette, S., and D. Clark. 2016. Information in Support of Recovery Potential Assessment for White Hake (*Urophycis tenuis*) from the Scotian Shelf (NAFO Divs. 4VWX5z). DFO Can. Sci. Advis. Sec. Res. Doc. 2016/100.
- Leim, A. H. and W. B. Scott. 1966. Fishes of the Atlantic Coast of Canada. Bulletin of the Fisheries Research Board of Canada no. 155.
- McEachran, J.D., and Musick, J.A. 1973. Characters for Distinguishing Between Immature Specimens of the Sibling Species, *Raja erinacea* and *Raja ocellata* (Pisces: Rajidae). Copeia 1973: 238-250.
- Stone, H.H. and Gross, W.E. 2012. Review of the Georges Bank Research Vessel Survey Program, 1987-2011. Can. Manuscr. Rep. Fish. Aquat. Sci. 2988.



**This Report is Available from the:**

Center for Science Advice (CSA)  
Maritimes Region  
Fisheries and Oceans Canada  
PO Box 1006, Station B203  
Dartmouth, Nova Scotia  
Canada B2Y 4A2

Telephone: 902-426-7070  
Fax: 902-426-5435

E-Mail: [MaritimesRAP.XMAR@dfo-mpo.gc.ca](mailto:MaritimesRAP.XMAR@dfo-mpo.gc.ca)  
Internet address: [www.dfo-mpo.gc.ca/csas-sccs/](http://www.dfo-mpo.gc.ca/csas-sccs/)  
ISSN 1919-3769

© Her Majesty the Queen in Right of Canada, 2019



Correct Citation for this Publication:

DFO. 2019. 2018 Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy.  
DFO Can. Sci. Advis. Sec. Sci. Resp. 2019/012.

*Aussi disponible en français :*

*MPO. 2019. Tendances dans les relevés par navire scientifique sur la plate-forme néo-écossaise et dans la baie de Fundy dans la région des maritimes en 2018. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2019/012.*