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 2024/010

MARITIMES RESEARCH VESSEL SURVEY TRENDS ON THE SCOTIAN SHELF AND BAY OF FUNDY FOR 2023

Context

Fisheries and Oceans Canada (DFO) has conducted Summer Ecosystem Research Vessel (RV) surveys in the Maritimes Region, Northwest Atlantic Fisheries Organization (NAFO) Divisions 4VWX5Yb, using a standardized protocol since 1970 (Figure 1). Results of these surveys provide information on trends in abundance for most groundfish species in the Maritimes Region. While these data reflect trends in biomass and abundance and are a critical part of science-based stock assessments, a full assessment, including other sources of data, would be required to evaluate the impacts of management measures on population status. DFO Resource Management requested a review of the DFO Summer Ecosystem RV Survey information on the following list of fish stocks: 4Vn, 4VsW, and 4X5Y Atlantic Cod; 4VW and 4X5Y Haddock; 4X and 4VW White Hake; 4VWX Silver Hake; 4VWX+5 Pollock; Unit II and Unit III redfish; 3NOPs4VWX5Zc Atlantic Halibut; 4VW and 4X American Plaice; 4VW and 4X Witch Flounder; 4VW and 4X Winter Flounder; 4VW and 4X Yellowtail Founder; 4VW and 4X Smooth Skate; 4VW and 4X Thorny Skate; 4VW and 4X Barndoor Skate; 4VW and 4X Winter Skate; 4VW and 4X Little Skate; 4VW and 4X Atlantic Wolffish; 4VW and 4X Monkfish; 4VW and 4X Longhorn Sculpin; 4VWX Spiny Dogfish; 4X and 4VW Red Hake; 4X and 4VW Sea Raven; 4X and 4VW Ocean Pout; 4VWX Blackbelly Rosefish; 4VWX John Dory; and 4VWX Shortfin Squid. 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 above 41 cm in 4X). 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 2024.

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

This Science Response Report results from the regional peer review of December 6, 2023, on the Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy.

Background

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

There were changes to the net used and the vessel conducting the survey in 1982 and 1983, along with some changes in data collection protocols. While the vessel change in 1983 would

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

The bottom trawl surveys were designed to provide abundance trends for fish 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. The areas of Georges Bank (strata 5Z1, 5Z2, 5Z3 and 5Z4), Browns Bank (strata 480), the Fundian Channel (strata 5Z9), the Laurentian Channel (strata 558 and 559) and areas surrounding the Gully Marine Protected Area (strata 450 and 452) can all be important for species biomass and diversity (Figure 2). From 1970–1995, sampling was generally restricted to strata 440–495. Spatial coverage was extended to the Scotian Shelf slope (strata 496–498) in 1996 and the Fundian Channel in 2011. The sampled area expanded to include strata 558 and 559 in 2014 and strata 5Z2 in 2016 and now regularly includes all offshore waters of the Maritimes Region down to a depth of 750 m.

Catch distribution plots for the entire DFO Summer Ecosystem 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 2022 and 2023 length frequencies from the survey catch to the long-term median (from beginning of survey series, or the period deemed appropriate for that particular species, to 2020) are also included, using data from the geographic areas that are used in assessments for those stocks. For stocks that did not receive full survey coverage of their respective stock areas in 2022, comparisons of 2020 and 2023 length frequencies to the long-term mean (1970–2019) are reported.

All strata from 440–495 have had some sampling annually since 1970 with the exception of 2018, 2021 and 2022. In all three years, sampling was conducted in all standard strata in 4X5Yb, as well as 5Zc in 2021 and 2022, but the majority of the survey area, including all of 4V and most of 4W were not sampled due mostly to mechanical problems with vessels. Of the 280 stations selected for sampling in 2018, 2021 and 2022, only 85, 107 and 153 successful tows were completed, respectively. Therefore, for most stocks that include 4V or 4W strata, data for years 2018, 2021 and 2022 are excluded.

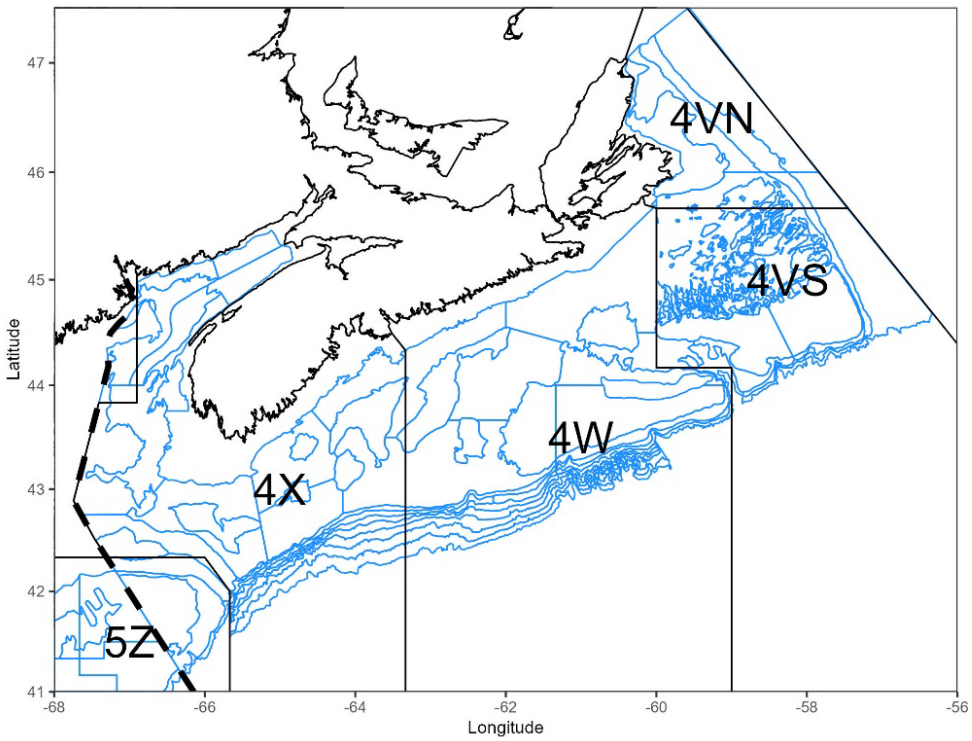

Figure 1. Northwest Atlantic Fisheries Organization (NAFO) Divisions. Dashed line represents the border between Canada and United States of America.

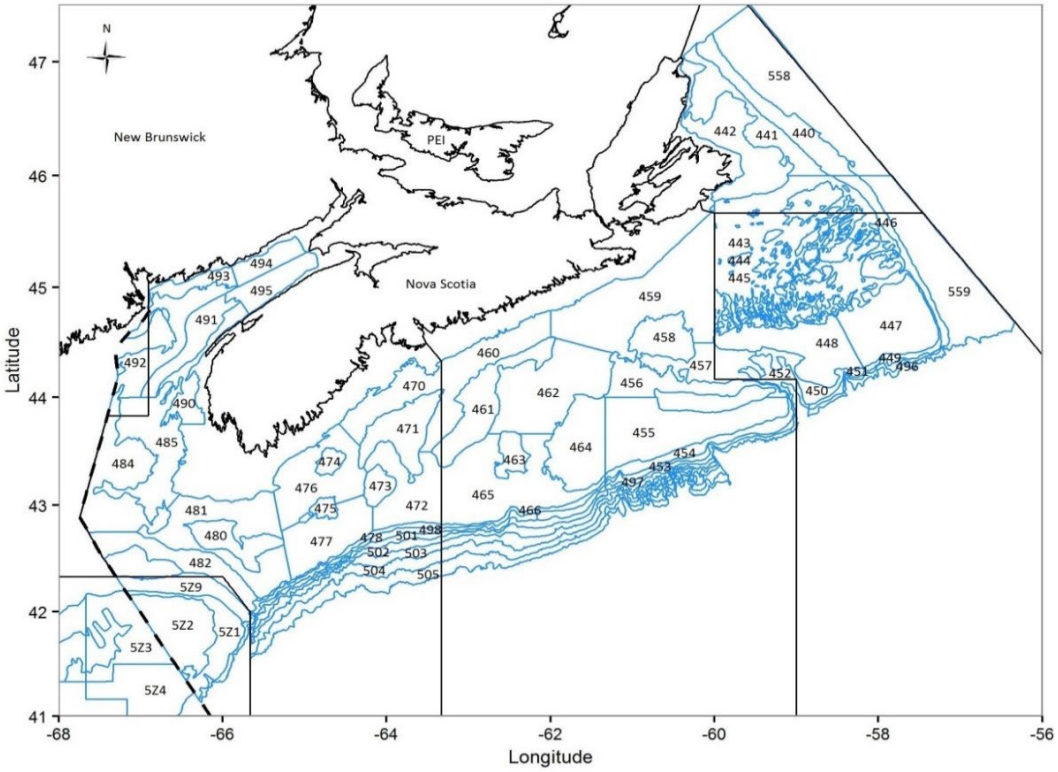

Figure 2. Fisheries and Oceans Canada DFO Summer Ecosystem Research Vessel Survey strata.

Analysis

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

In 2023, 237 successful fishing tows were completed by the *CCGS Teleost* out of 285 planned tows between June 27 and August 12. This was the second highest number of valid tows since 2018 as issues relating to vessel availability resulted in areas not being covered in 2018, 2021 and 2022. In 2023, at least two sets were completed in all strata from 440–495 with the exception of stratum 478 which only received one valid set by the Teleost, and thus was excluded from analyses. A second valid set was completed by the *CCGS Capt. Jacques Cartier* in stratum 478 using a Northeast Fisheries Science Center Ecosystem Survey Trawl (NEST), but cannot be included in the analyses until conversion factors are available. Strata 5Z1, 5Z2, 5Z9, 558, 559 also received coverage; however, stratum 559 only received one valid tow. No sets were completed in strata 496–498 in 2023.

Biomass indices for each stock are calculated using the set of strata which are included in calculating indices for the stock assessment. As no assessments have integrated data from strata added since 1996 (496–498, 558–559, 5Z1, 5Z2, 5Z9), these data are not included in time-series trends. For some stocks, where these deeper water strata, or strata from Georges Bank, appear to be important parts of the stock distribution, the potential contribution to biomass indices of these strata has been discussed.

The time series of survey biomass indices and the three-year (3-yr) running geometric mean (GM) are compared to 40% and 80% of the long-term GM 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.

Table 1. DFO Summer Ecosystem Research Vessel Survey biomass indices (tonnes) for species by stock/region for 2020, 2022, 2023, current 3-yr geometric mean (GM) biomass index (2020, 2022, 2023), and 40% and 80% of the long-term GM biomass index (1970–2022). The 2021 biomass indices are not included as conversion factors were not yet available. NA = not available.

Stock	2020	2022	2023	Current 3-yr GM	40% Long-term GM	80% Long-term GM
Atlantic Cod 4X	1,669	1,335	2,808	1,843	4,853	9,706
Atlantic Cod 4VN	1,351	NA	1,979	960	2,954	5,907
Atlantic Cod 4VSW	36,809	NA	8,232	14,882	10,210	20,420
Haddock 4X	32,943	35,907	108,630	50,462	19,304	38,608
Haddock 4VW	12,743	NA	14,314	15,766	18,244	36,488
White Hake 4X	6,771	6348	6,765	6,625	5,401	10,803
White Hake 4VW	2,535	NA	1,412	1,672	2,861	5,723
Silver Hake 4VWX*	17,471	NA	44,957	27,003	12,683	25,366
Silver Hake 4X West*	14,380	39,408	43,721	29,153	1,483	2,966
Pollock Eastern component	7,027	NA	3,433	3,943	6,751	13,502
Pollock Western component	9,312	5,034	27,268	10,853	7,461	14,922
Redfish Unit 2	31,013	NA	57,238	51,072	14,779	29,559
Redfish Unit 3	70,586	33,959	60,765	52,615	31,123	62,246
American Plaice 4X	341	294	370	333	539	1,078
American Plaice 4VW	4,620	NA	11,288	6,465	7,143	14,285
Witch Flounder 4X	1,270	525	1,112	905	582	1,163
Witch Flounder 4VW	5,750	NA	9,327	6,674	1,413	2,827
Yellowtail Flounder 4X	155	63	251	135	164	327
Yellowtail Flounder 4VW	3,793	NA	7,631	5,134	4,661	9,322
Winter Flounder 4X	4,608	3,499	5,980	4,585	1,062	2,124
Winter Flounder 4VW	301	NA	288	300	238	477
Atlantic Halibut 3NOPs4VWX5Zc	10,202	NA	12,611	11,617	1,384	2,768
Atlantic Wolffish 4X	320	226	169	230	388	777
Atlantic Wolffish 4VW	241	NA	288	314	467	934
Monkfish 4X	1,495	1,033	3,488	1,753	613	1,227
Monkfish 4VW	1,209	NA	1,037	1,116	782	1,565
Smooth Skate 4X	326	292	511	365	143	285
Smooth Skate 4VW	108	NA	271	163	112	224
Thorny Skate 4X	162	69	313	152	618	1,236
Thorny Skate 4VW	910	NA	1,698	1,566	2,482	4,964
Barndoor Skate 4X ŧ	1,515	3,536	2,895	2,895	NA	NA
Barndoor Skate 4VW ŧ	893	NA	1,418	893	NA	NA
Winter Skate 4X	1,341	636	420	710	239	479
Winter Skate 4VW	34	NA	43	32	460	919
Little Skate 4X	1,499	2,171	570	1,229	201	401
Little Skate 4VW	87	NA	362	108	14	28
Longhorn Sculpin 4X	1,012	1,035	1,291	1,106	499	998
Longhorn Sculpin 4VW	1,703	NA	1,387	1,428	845	1,690
Red Hake 4X *	1,784	7,333	3,212	3,476	531	1,061
Red Hake 4VW *	875	NA	1,082	1,097	384	767
Ocean Pout 4X	21	49	127	51	152	304
Ocean Pout 4VW	12	NA	24	24	47	94
Sea Raven 4X	1,471	1,365	855	1,197	657	1,313
Sea Raven 4VW	1,143	NA	230	632	338	677

NA–Indices not available due to reduced spatial coverage of the 2022 survey. For these stocks, the current 3-yr GM is calculated using the biomass indices from 2019, 2020, and 2023.

* For Silver Hake and Red Hake, the long-term average time series begins in 1982.

ŧ For Barndoor Skate the current 3-yr geometric mean is replaced by the current 3-yr median and the 40% and 80% long-term geometric mean is NA due to numerous years of catches of zero early in the time series.

The time series of abundance-at-length indices are compared with long-term (full time series) and short-term (ten years) median values to provide context on population length composition for each stock. For stock areas that did not receive full coverage in some years (e.g., 2018, 2021, 2022), the short term median was extended to include the most recent 10 years where data exist.

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

For all stocks in 4X5Yb, short and long-term GM values include data up to 2022 and 3-yr GM values are calculated using data from 2020, 2022 and 2023. Data for 2021 were collected on the new offshore fishing science vessel, *CCGS Capt. Jacques Cartier*, and using NEST trawl. Conversion factors for this change in vessel and gear are not yet available, thus, data cannot be compared to the historical time series. Length-based conversion factors for many fish and invertebrate species will be calculated during the winter of 2023/2024.

Biomass and abundance indices for stocks that extend into 4VW are updated to 2023; however, the current 3-yr GM was calculated using 2019, 2020 and 2023 data and the long-term GM includes data up to 2020.

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

The total biomass index for 4X shows high inter-annual variability but no clear trend over time (Figure 3a). The large drop in biomass from 2018–2019 reflects lower catches for most demersal species. The increase in biomass in 2022 and 2023 is largely reflective of higher catches of Haddock, Silver Hake, and Pollock. Haddock accounted for 31% of total biomass in 2023.

In 4W, demersal fish biomass increased in the 1980s, but in the early 1990s, dropped back to the level seen in the 1970s (Figure 3b). The biomass for 2023 is higher than in 2020, largely due to higher Silver Hake and Spiny Dogfish catches in the area. Silver Hake and Spiny Dogfish accounted for 32% and 34% of total biomass, respectively.

In 4V, the demersal fish biomass dropped in the 1990s and has remained low since then (Figure 3c). In 2023, the overall biomass remained similar to what was observed in 2020; however, there were fewer Atlantic Cod and more redfish caught within the area in 2023. Atlantic Cod decreased from accounting for 35% of total biomass in 2020 to 8% in 2023, while redfish accounted for 48% of the total biomass in 2023.

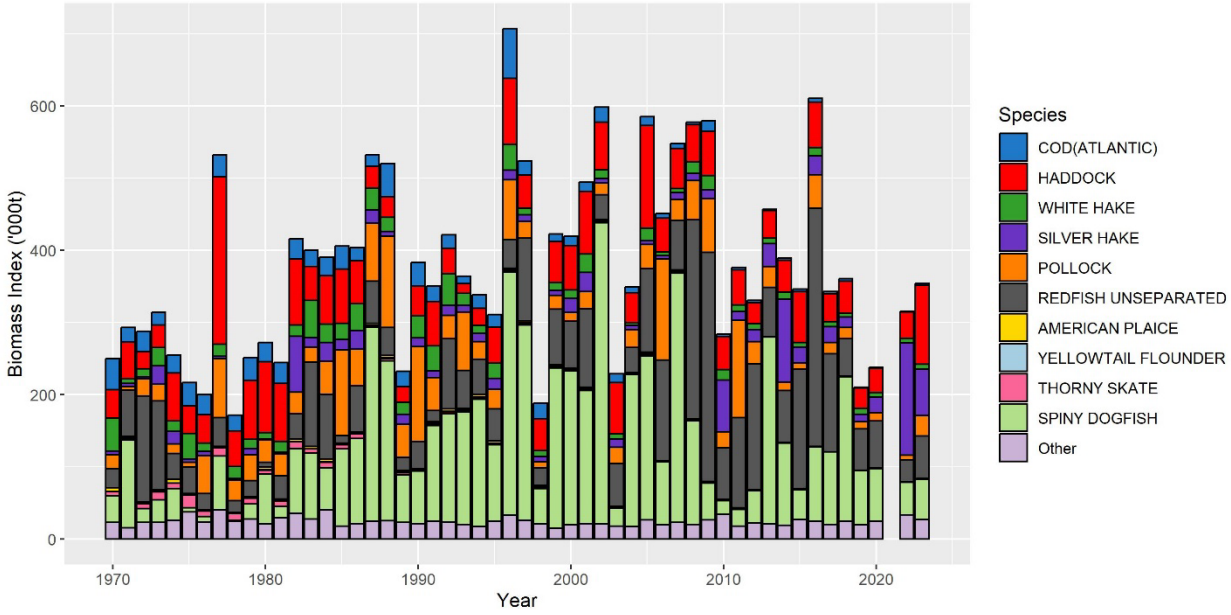

Figure 3a. Biomass indices for ten demersal fish species (bars) in 4X and for all other demersal fish species combined. Refer to Figure 1 for NAFO Divisions within the Maritimes Region. Data for 2021 are currently missing until conversion factors become available.

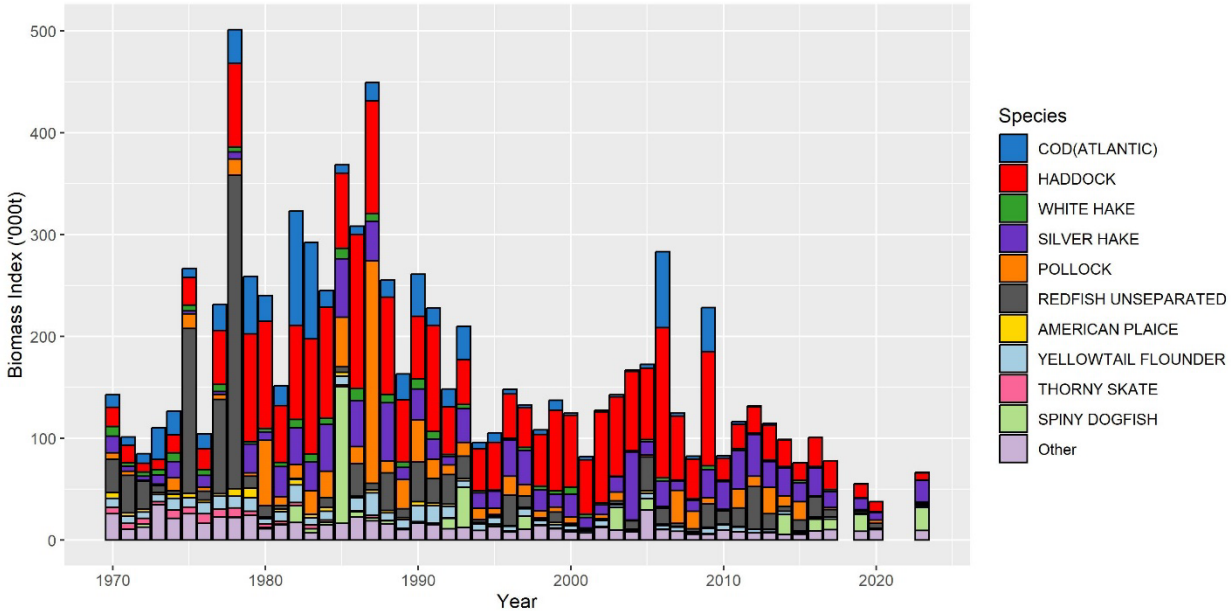

Figure 3b. Biomass indices for ten demersal fish species (bars) in 4W and for all other demersal fish species combined. Refer to Figure 1 for NAFO Divisions within the Maritimes Region. Data for 2018, 2021 and 2022 are missing due to incomplete survey coverage.

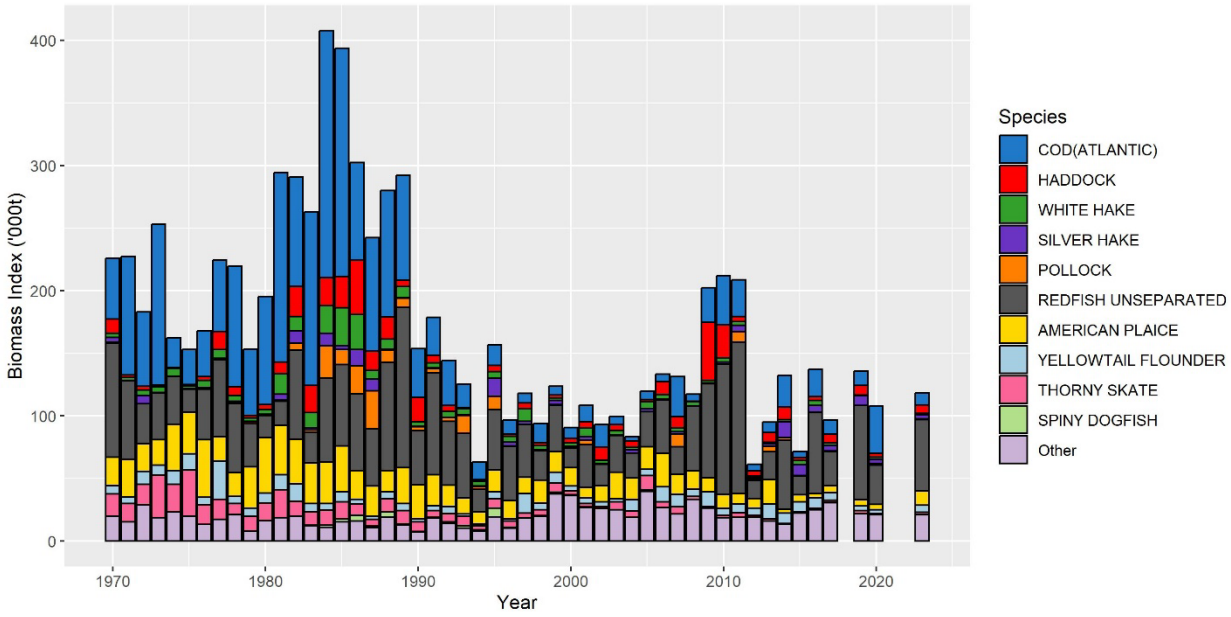

Figure 3c. Biomass indices for ten demersal fish species (bars) in 4V and for all other demersal fish species combined. Refer to Figure 1 for NAFO Divisions within the Maritimes Region. Data for 2018, 2021 and 2022 are missing due to incomplete survey coverage.

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

In 4W, increases in Atlantic Cod, Haddock, and Silver Hake led to the increase in biomass in the 1980s (Figure 3b). However, redfish biomass, which made up the majority of biomass during the 1970s saw a large decline during the 1980s. Biomass indices for Atlantic Cod and redfish dropped to very low levels in 4W by the 1990s and were responsible for most of the overall decline in biomass. Haddock biomass has declined in 4W since about 2010, and total demersal fish biomass in recent years has been the lowest in the time series.

In 4V, Atlantic Cod and American Plaice comprised a large part of the biomass index in the 1970s and 1980s; both have experienced large declines (Figure 3c). Redfish did not experience the same drop in biomass and are the largest contributors to the 4V biomass indices in the last decade. Thorny Skate, White Hake, and Yellowtail Flounder biomasses has declined since the 1980s in 4V. The overall index has remained low since the early 1990s.

Atlantic Cod

The largest Atlantic Cod (*Gadus morhua*) catch (405 kg) came from Georges Bank in 2023, although the highest densities of catches occurred in 4Vn (Figure 4a). The 3-yr GM in 4X remains under 40% of the long-term GM and is among the lowest in the time series (Figure 4b). Abundance indices in 4X are generally below the short-term median for most lengths; however, in 2023, indices for fish above 60 cm are above the short-term median (Figure 4c). In 4VsW, the 3-yr GM remains between 40–80% of the long-term GM, but is largely influenced by a single, large tow observed in 2020 (5,800 kg). The 2023 biomass index is more similar to previous years in comparison to 2020 (Figure 4d). Abundance indices in 4VsW show the abundance of fish below 45 cm being similar or below the short-term medians, while the abundance of fish above 45 cm are above the short-term medians (Figure 4e). Similar to the latter two areas, the 4Vn biomass index is below the 40% long-term GM (Figure 4f). Abundance indices for most lengths in 2023 are similar to or below the short-term medians with the exception of lengths between 37–48 cm and below 18 cm which are above the short-term median values (Figure 4g).

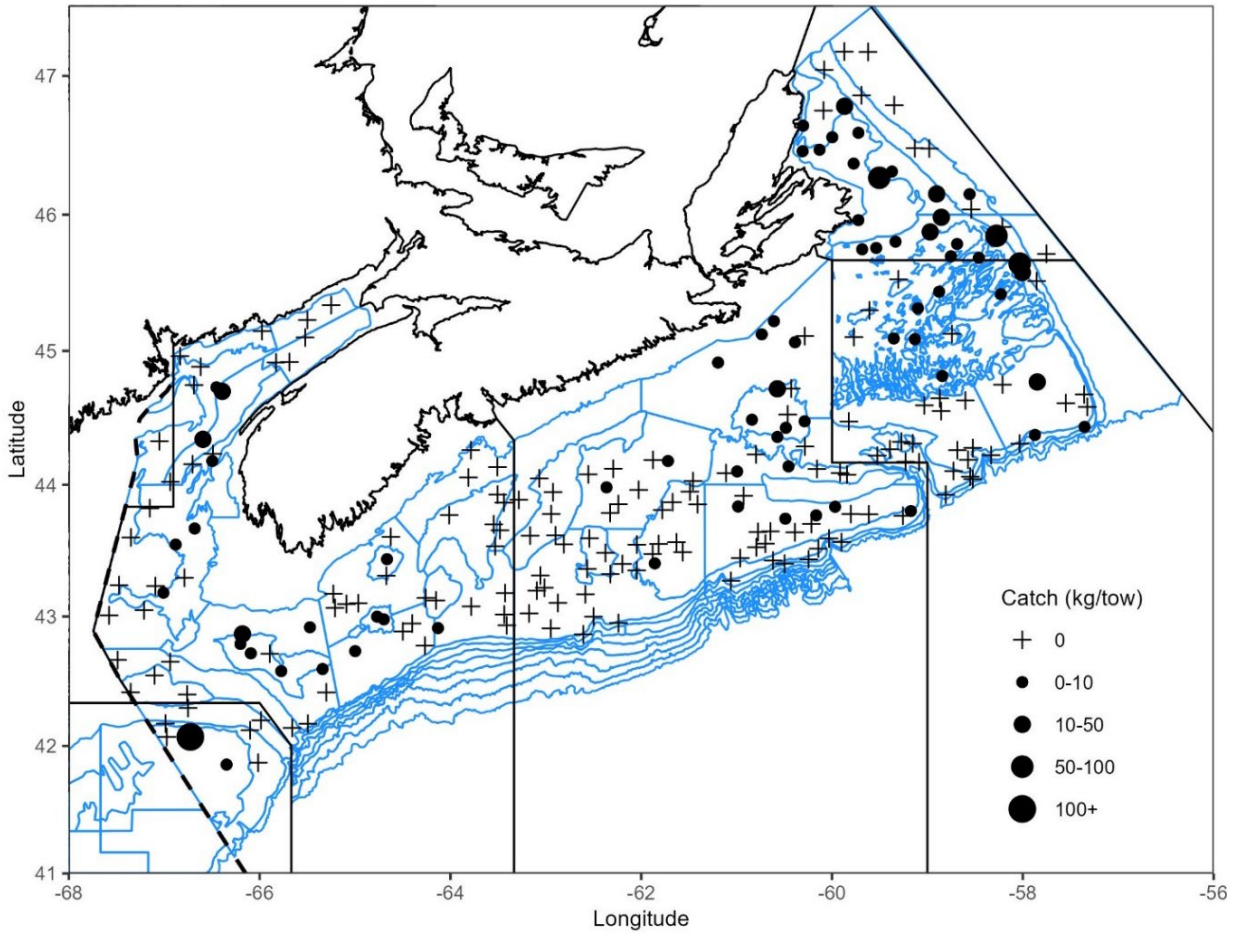

Figure 4a. Distribution of Atlantic Cod catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

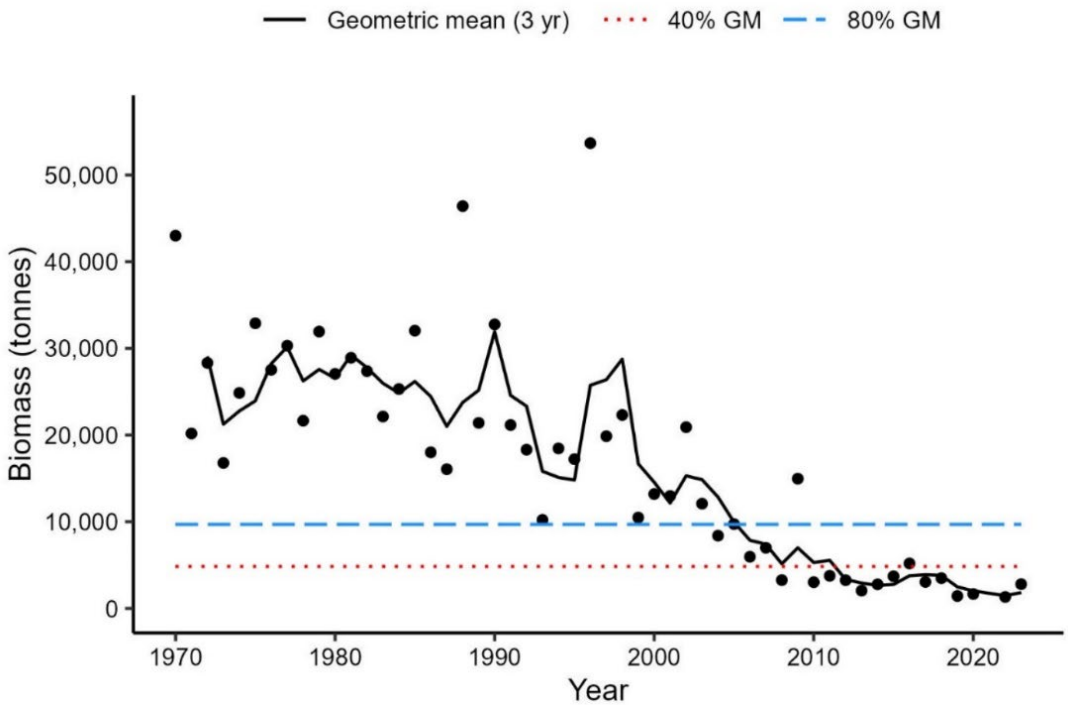

Figure 4b. Biomass index for Atlantic Cod in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

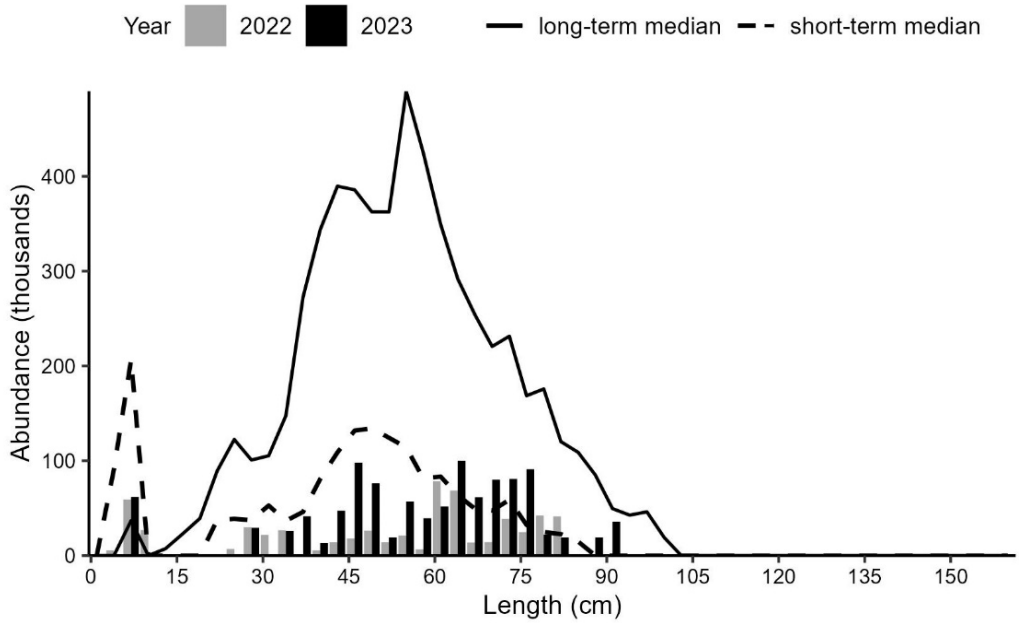

Figure 4c. Length frequency indices for Atlantic Cod in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

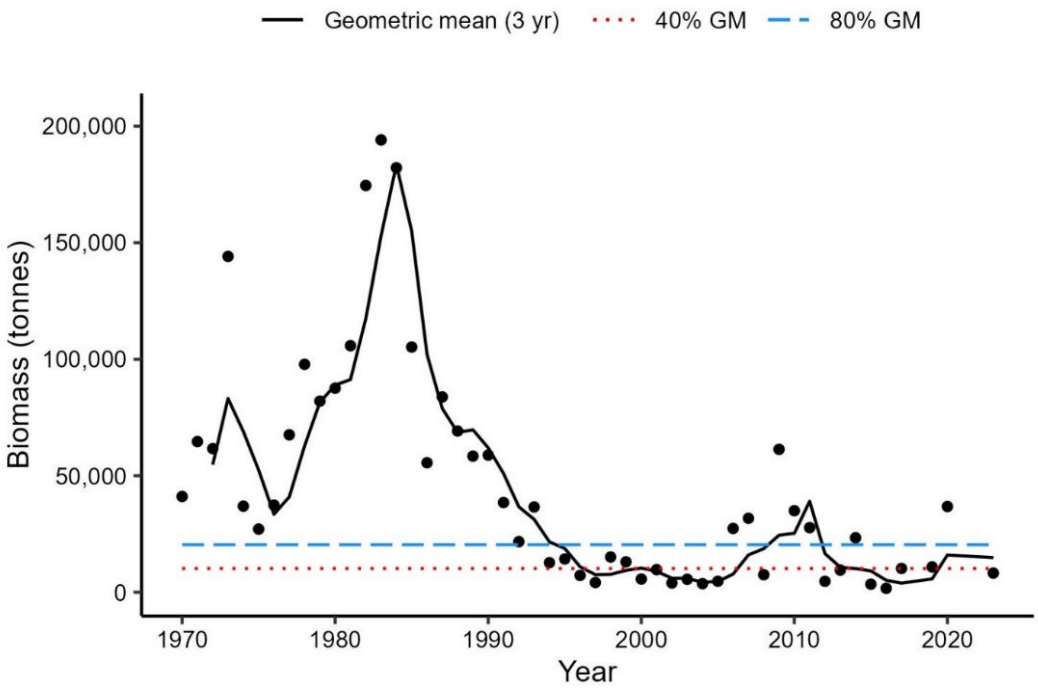

Figure 4d. Biomass index for Atlantic Cod in 4VsW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

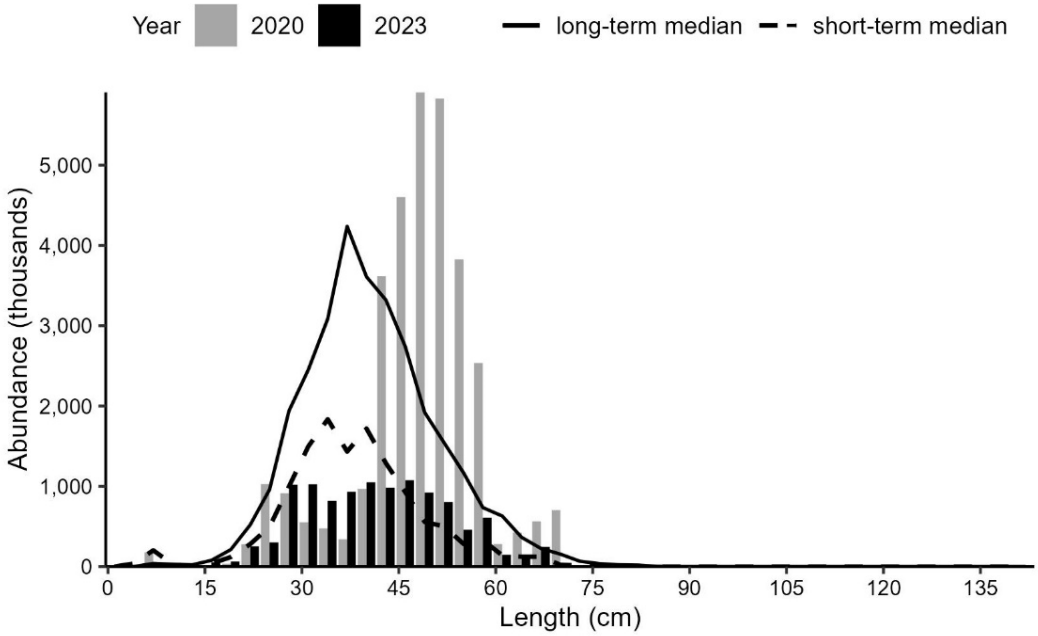

Figure 4e. Length-frequency indices for Atlantic Cod in 4VsW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

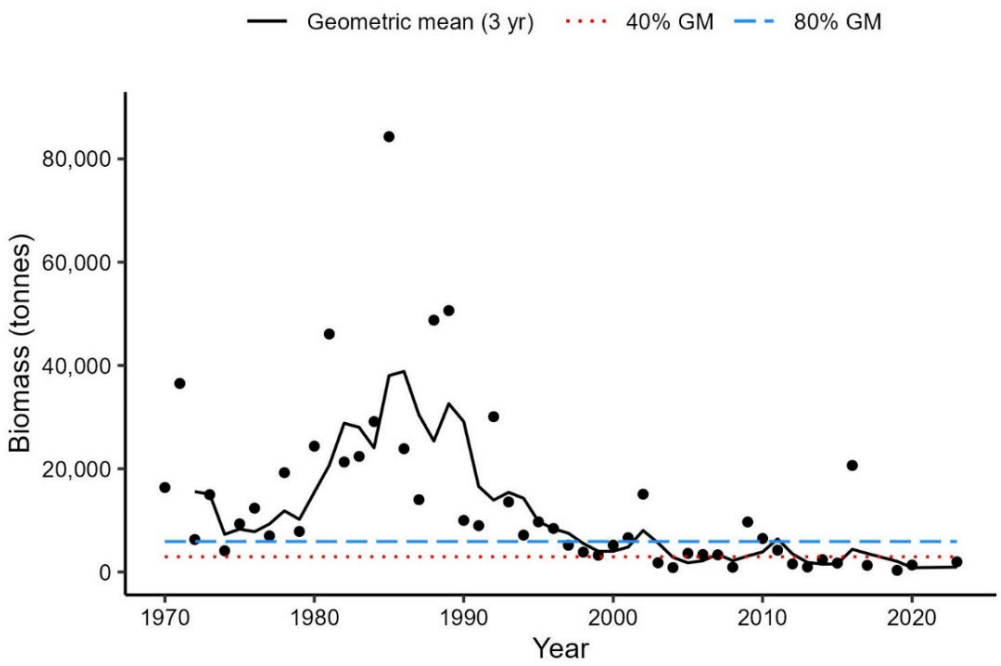

Figure 4f. Biomass index for Atlantic Cod in 4Vn from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

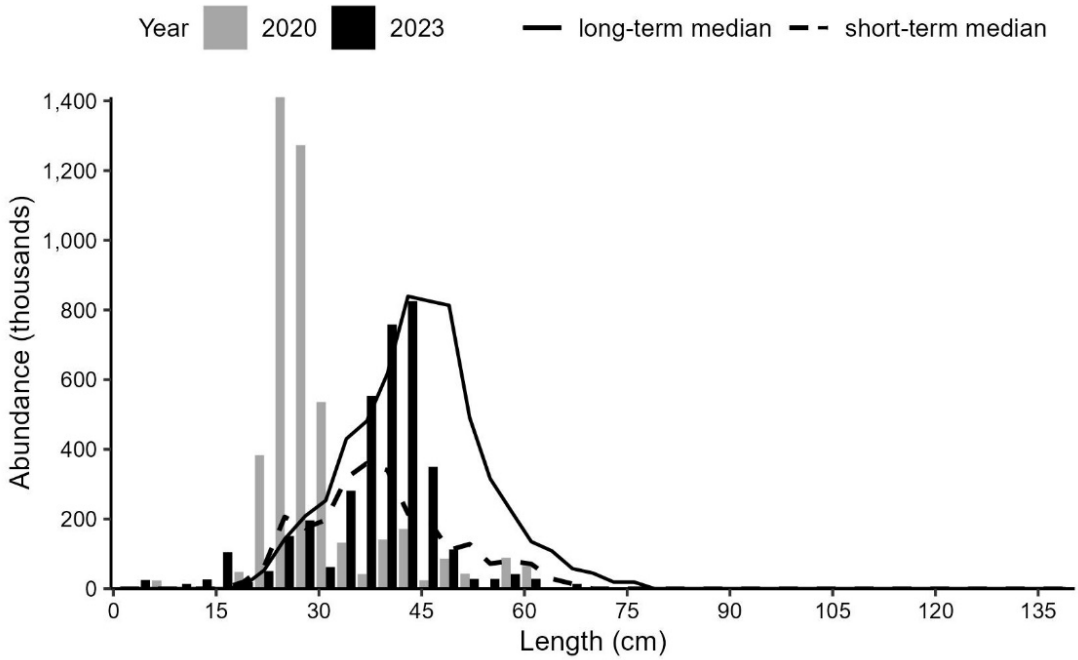

Figure 4g. Length-frequency indices for Atlantic Cod in 4Vn from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Haddock

Haddock (*Melanogrammus aeglefinus*) were predominantly caught in 4X and 4W in 2023 (Figure 5a). The largest catches occurred on Browns and Georges banks. The 2023 biomass estimate in 4X is the third highest in the time series and the highest since 1982. Both the biomass index and 3-yr GM are above the 80% long-term GM (Figure 5b). Indices at length show a large increase in fish above 28 cm in comparison to 2022 and fish above 22 cm are generally above the short and long-term medians (Figure 5c). Very few fish below 15 cm were observed in 2023 compared to 2022 and the short-term median, indicating a below average recruitment of age 0 and age 1 Haddock. In 4VW, the 2023 biomass index is below the 40% long-term GM and is the fourth lowest estimate in the time series (Figure 5d). The 3-yr GM is also below the 40% long-term GM for the first time since 1976. Length frequencies are also predominantly below both the short and long-term medians while fish below 15 cm (age 0 and 1 Haddock) were almost entirely absent from the catch (Figure 5e).

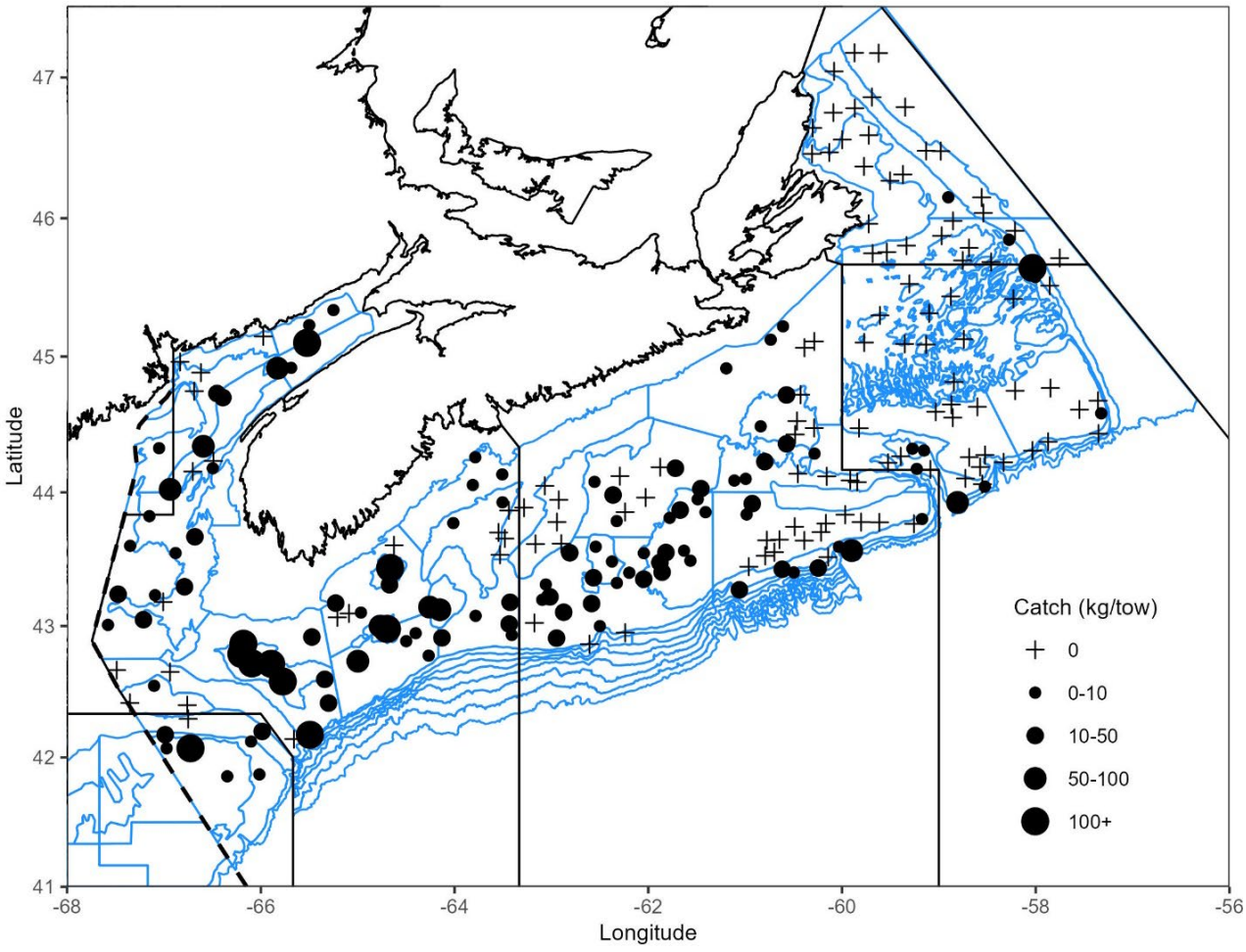

Figure 5a. Distribution of Haddock catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

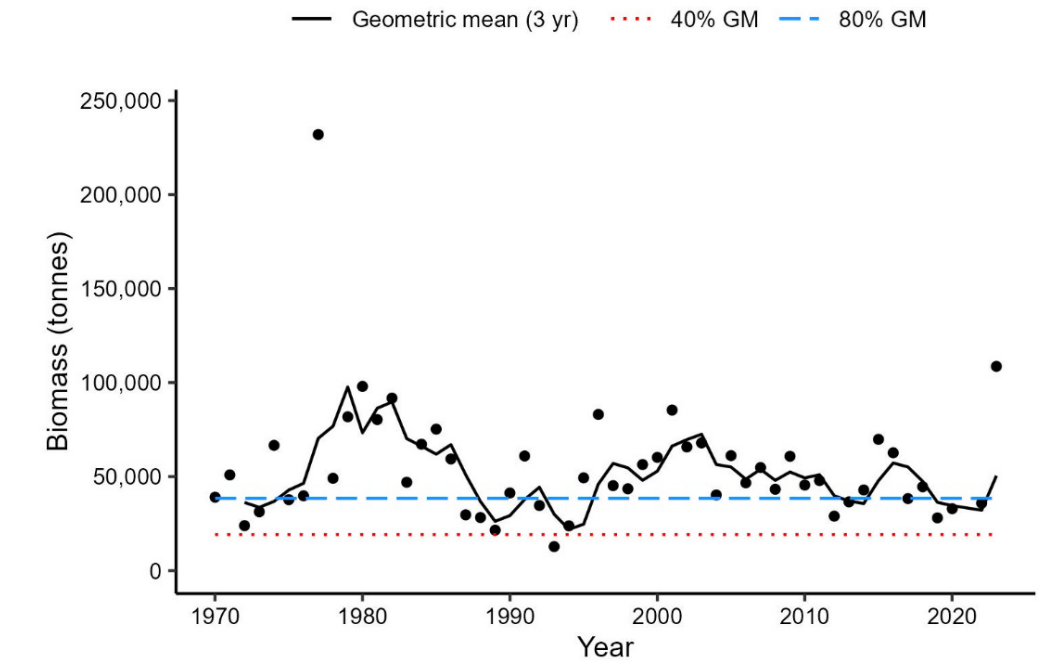

Figure 5b. Biomass index for Haddock in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

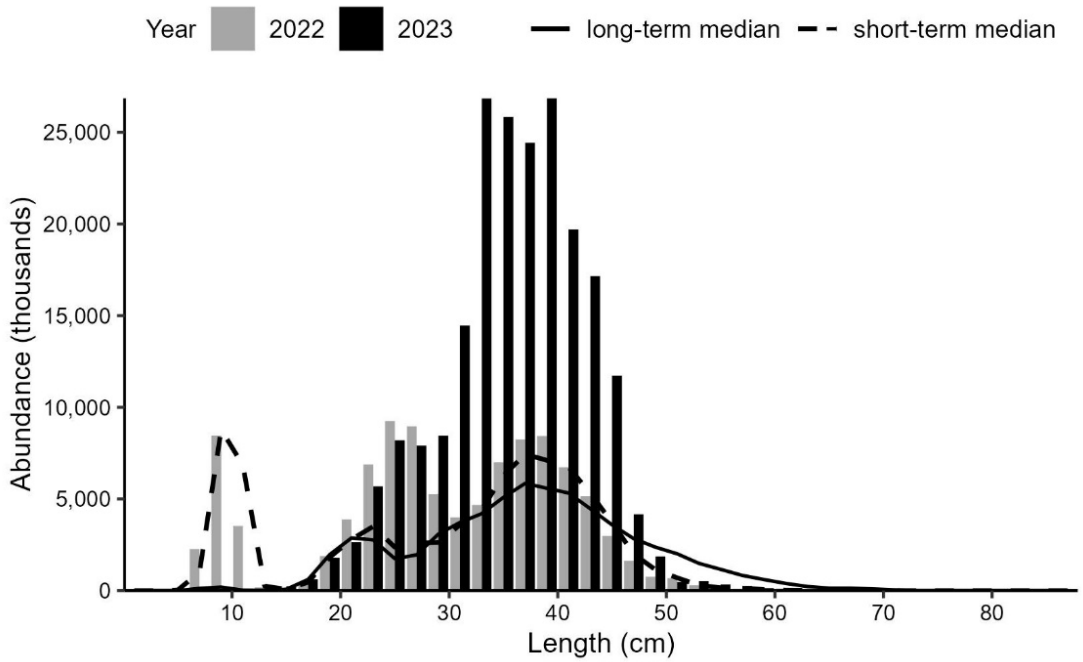

Figure 5c. Length frequency indices for Haddock in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

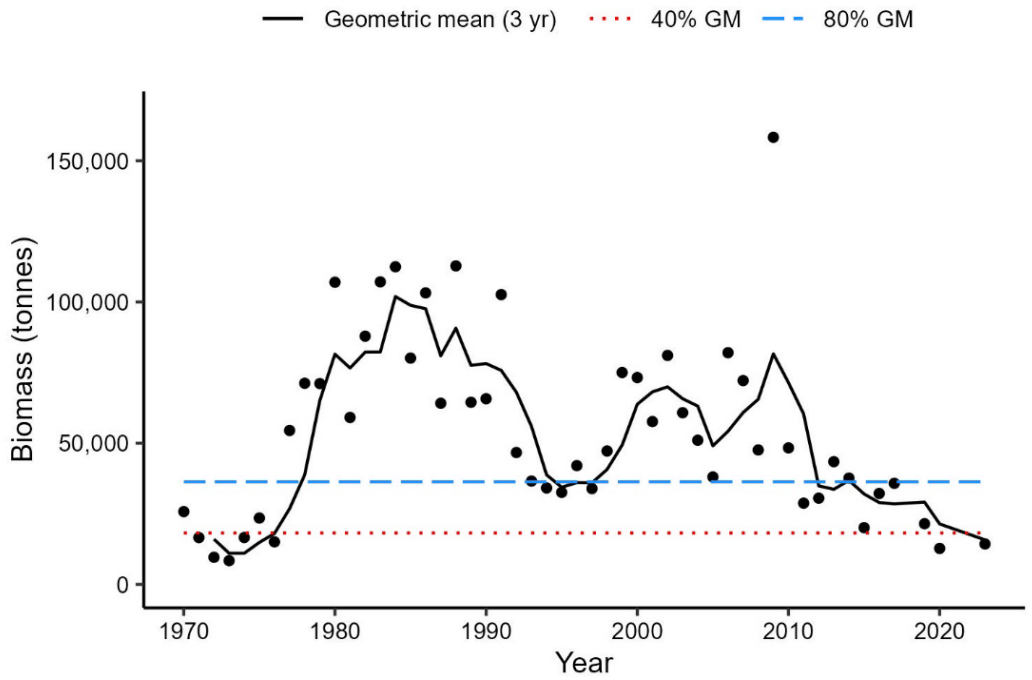

Figure 5d. Biomass index for Haddock in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

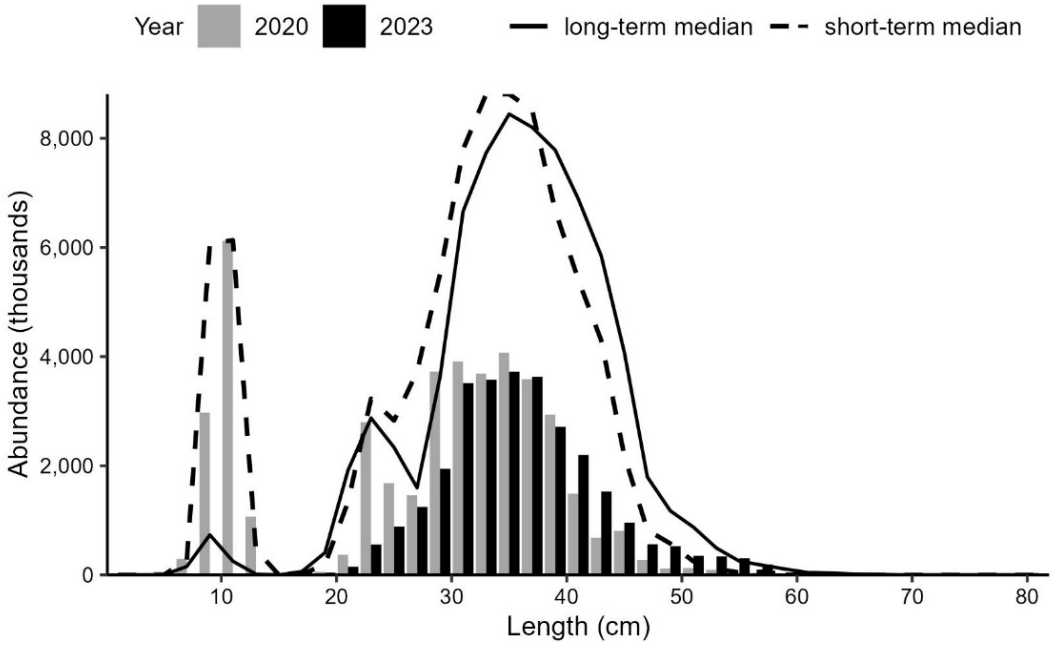

Figure 5e. Length frequency indices for Haddock in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

White Hake

Prior to 1982, small White Hake and Red Hake were not easily distinguished (Clark and Emberley 2011). Therefore, abundance at length estimates for White Hake do not include data prior to 1982. Biomass estimates however, do include data prior to 1982 as any misidentified Red Hake would have made up a very small proportion of the total biomass (Bundy and Simon 2005).

White Hake (*Urophycis tenuis*) were caught primarily in the deeper waters of the Fundian Channel, Gulf of Maine, and Laurentian Channel (Figure 6a). In 4X, the 3-yr GM remains between 40–80% of the long-term GM and is similar to estimates from the past decade (Figure 6b). Abundance indices in 4X are generally below the short-term and long-term medians in 2023; however, more larger fish above 90 cm were observed compared to 2022 (Figure 6c). The 2023 biomass index in 4VW remains below the 40% long-term GM and is the second lowest in the time series, while the 3-yr GM is the lowest in the time series (Figure 6d). Abundance estimates also predominantly remain below the short-term and long-term medians (Figure 6e).

The 2015 Recovery Potential Assessment (RPA) (Guenette and Clark 2016) proposed a biomass recovery target of 6,867 t mature (above 41 cm) biomass in 4X5Z and 3,885 t in 4VW. The 3-yr GM biomass index for 4X White Hake above 41 cm remains below the RPA-proposed biomass recovery target for the 8th year in a row (Figure 6f). 4VW mature White Hake (above 41 cm) has been below the RPA-proposed biomass recovery target since 1994 (Figure 6g).

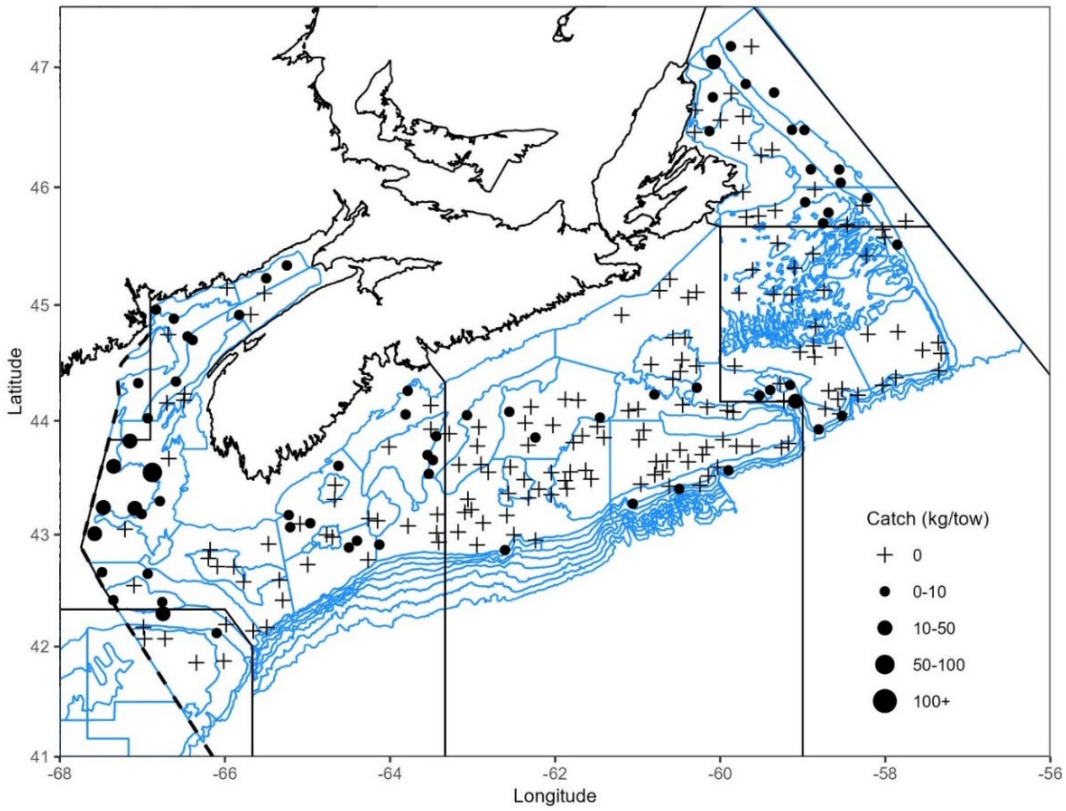

Figure 6a. Distribution of White Hake catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

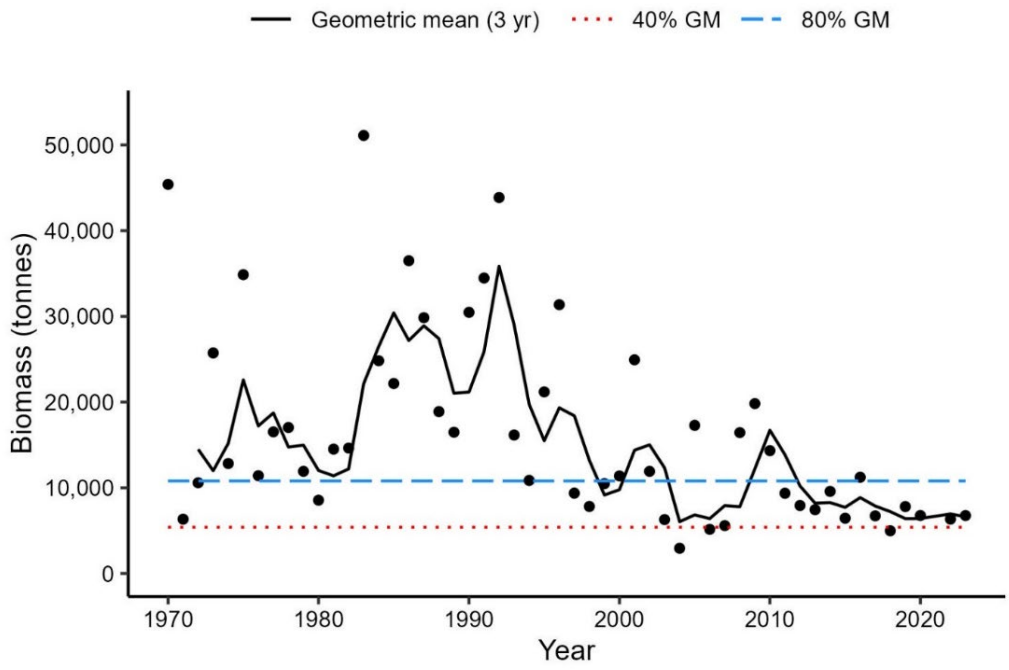

Figure 6b. Biomass index for White Hake in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

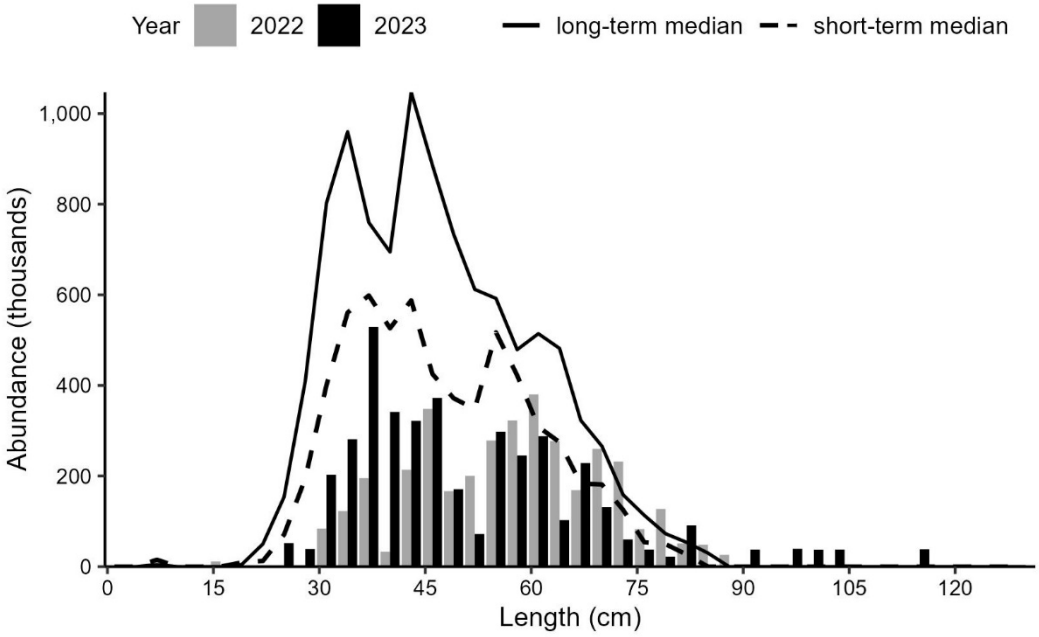

Figure 6c. Length frequency indices for White Hake in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1982–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

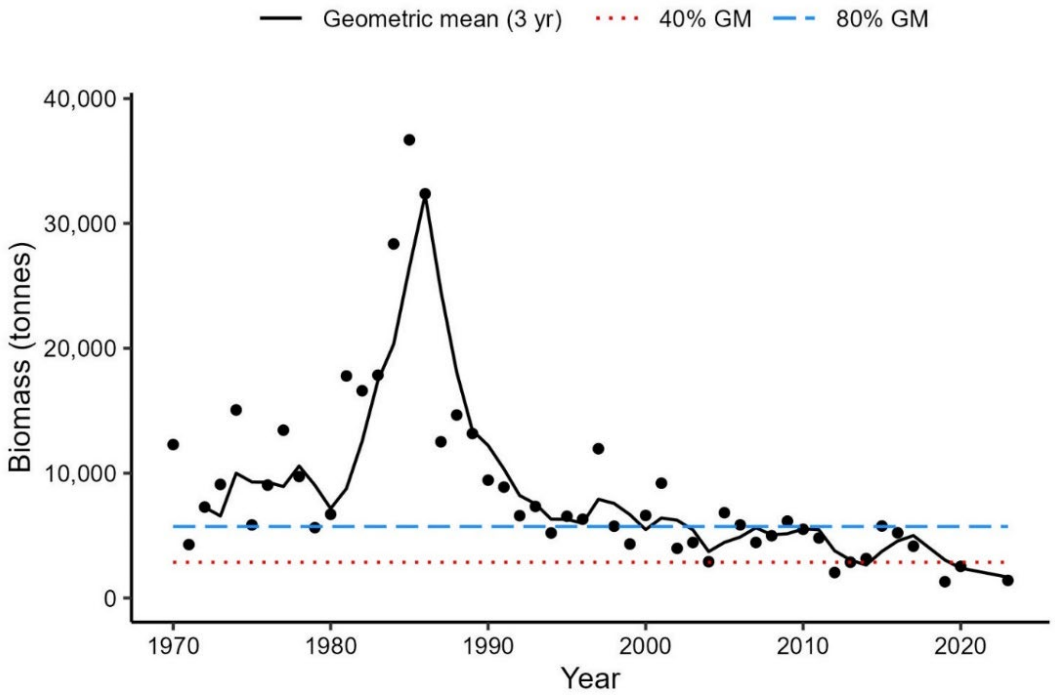

Figure 6d. Biomass index for White Hake in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

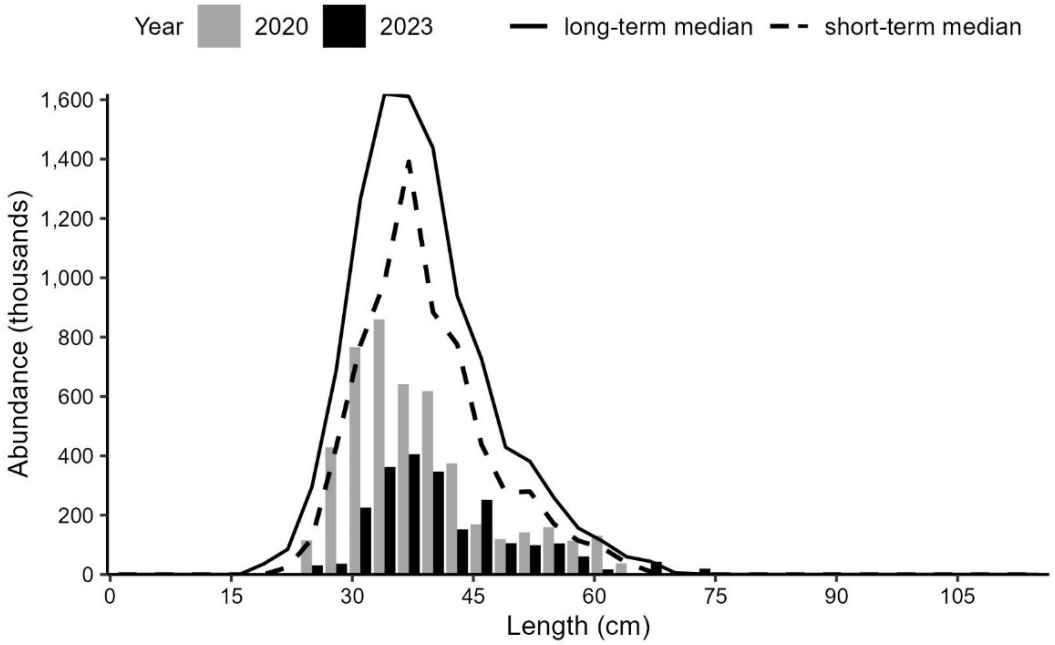

Figure 6e. Length frequency indices for White Hake in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1982–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

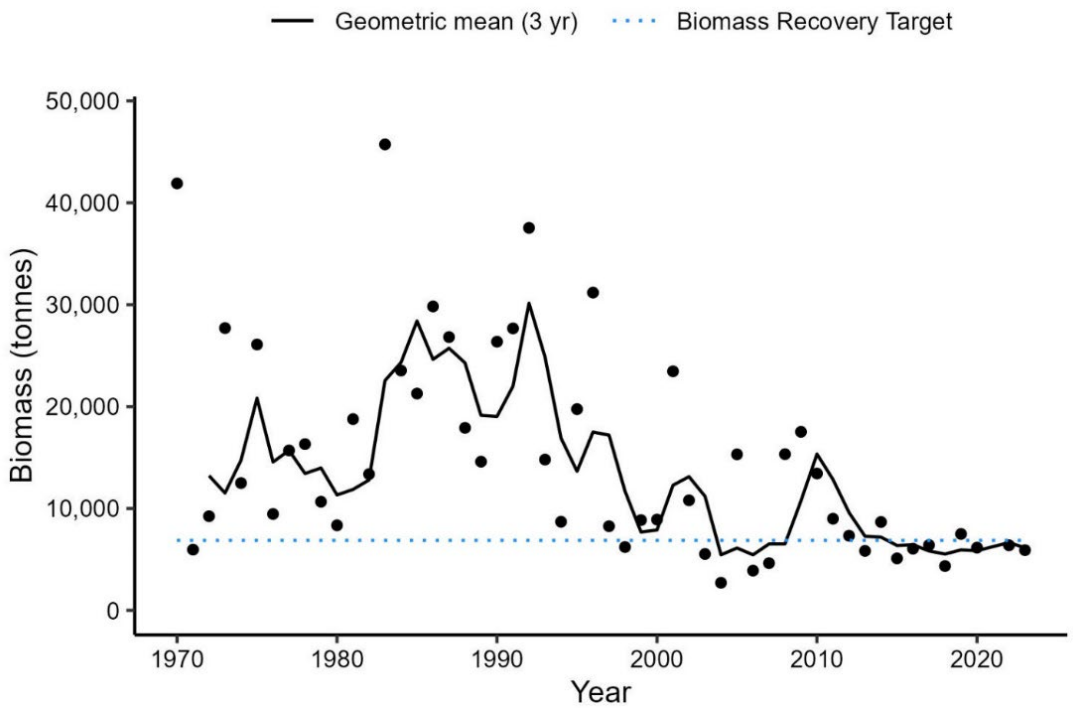

Figure 6f. Biomass index for 4X White Hake above 41 cm from the DFO Summer Ecosystem RV Survey represented by the black circles. The solid black line represents the three-year geometric mean. The dashed blue line represents the proposed biomass recovery target (6,867 t).

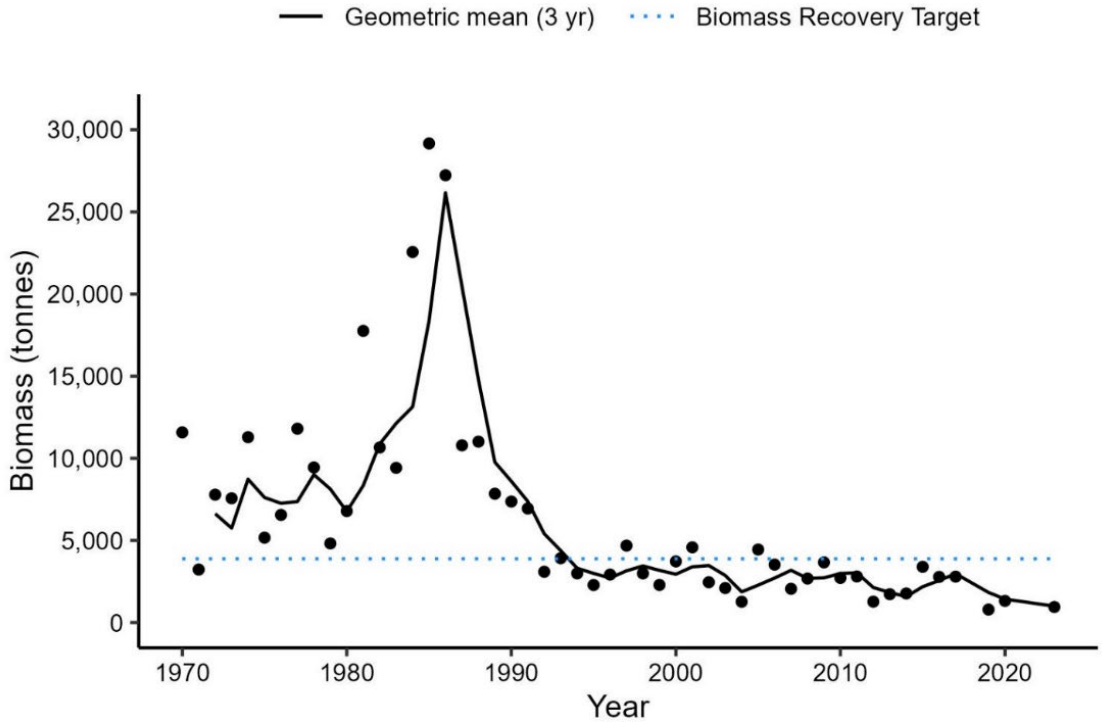

Figure 6g. Biomass index for 4VW White Hake above 41 cm from the DFO Summer Ecosystem RV Survey represented by the black circles. The solid black line represents the three-year geometric mean. The dashed blue line represents the proposed biomass recovery target (3,885 t).

Silver Hake

Silver Hake (*Merluccius bilinearis*) were caught throughout most of the survey area in 2023 with the largest catches occurring in 4W and 4X (Figure 7a). The biomass index for the 4VWX east stock (strata 440 to 483) increased from 2020 and the 3-yr GM is now above the 80% long-term GM (Figure 7b). Abundance indices are generally above both the short and long-term medians for most lengths (Figure 7c). The 3-yr GM in the Bay of Fundy (4X west; strata 484 to 495) is well above 80% of the long-term GM in 2023 and the biomass index is the third highest in the time series (Figure 7d). Indices at lengths in 4X west for fish below 15 cm and above 21 cm are above the short and long-term medians (Figure 7e).

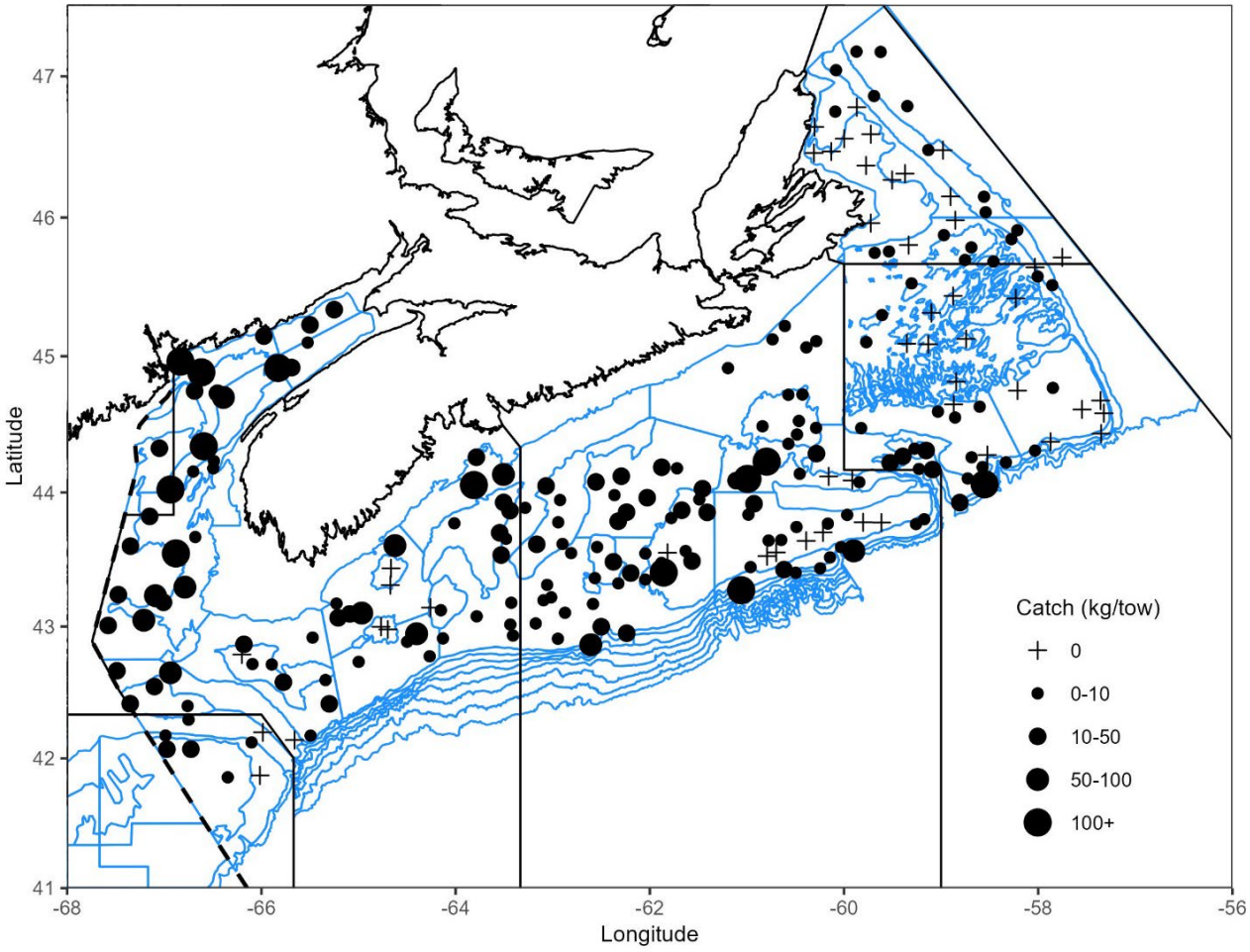

Figure 7a. Distribution of Silver Hake catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

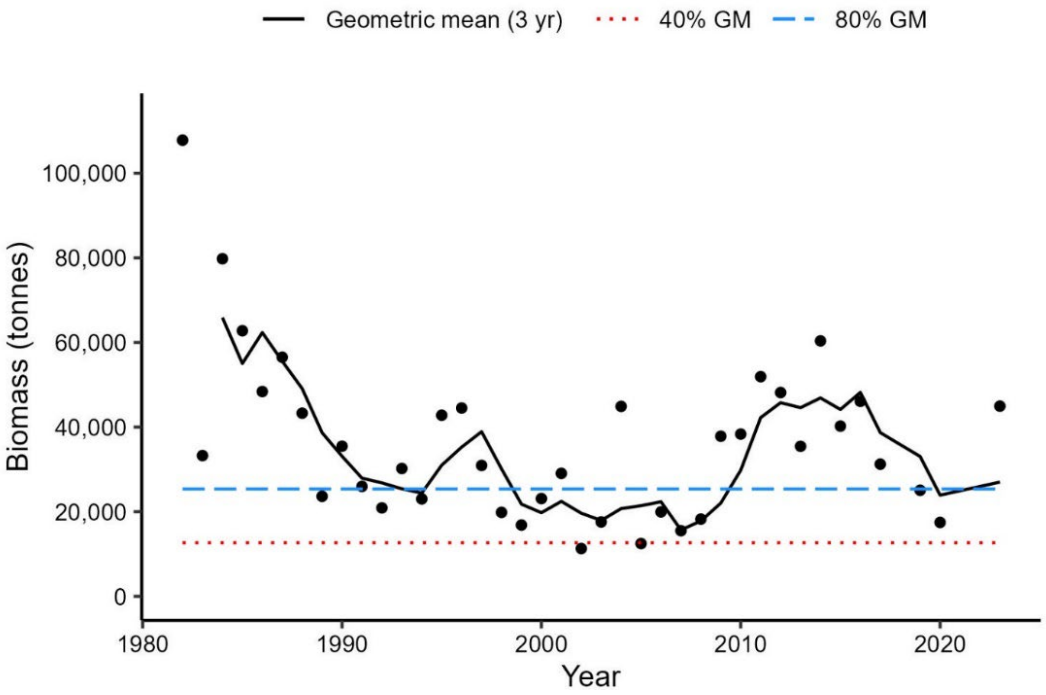

Figure 7b. Biomass index for Silver Hake in 4VWX east (strata 440–483) from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2020), respectively. The black dots represent the biomass index for that year.

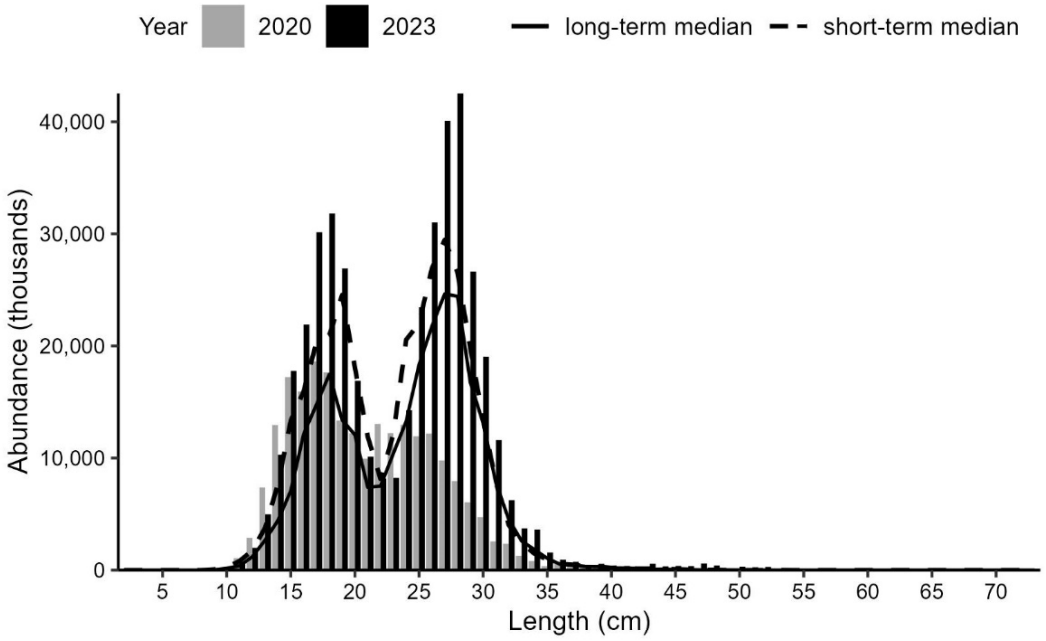

Figure 7c. Length frequency indices for Silver Hake in 4VWX east (strata 440–483) from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1982–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

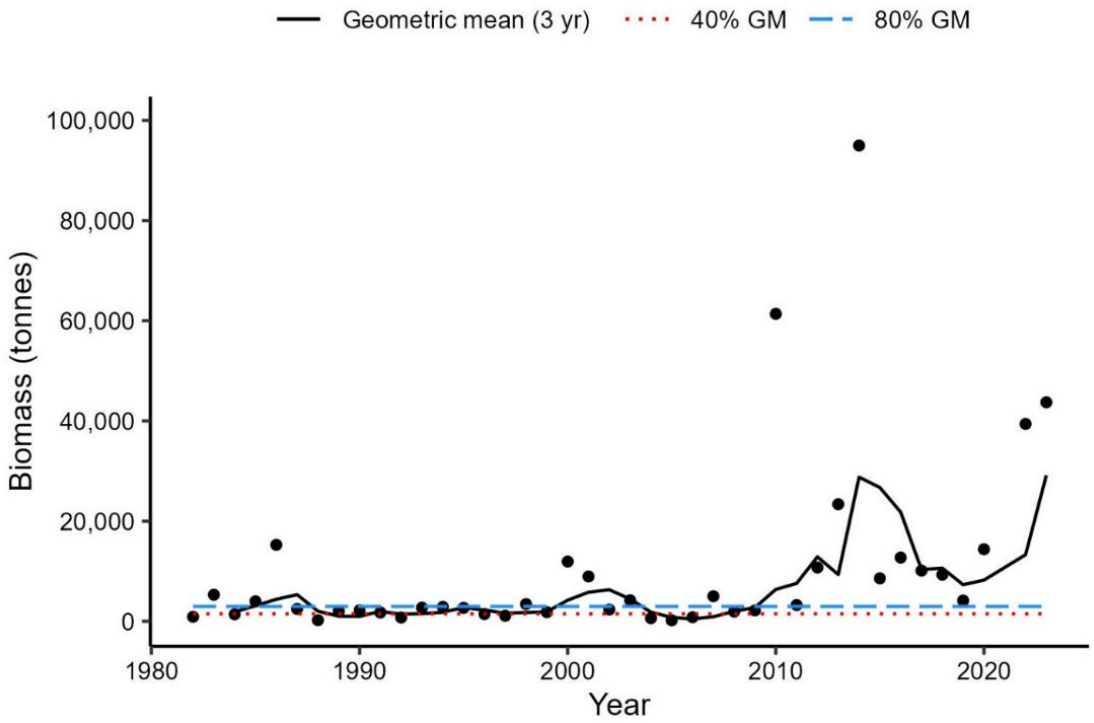

Figure 7d. Biomass index for Silver Hake in 4X west (strata 484–495) from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2022), respectively. The black dots represent the biomass index for that year.

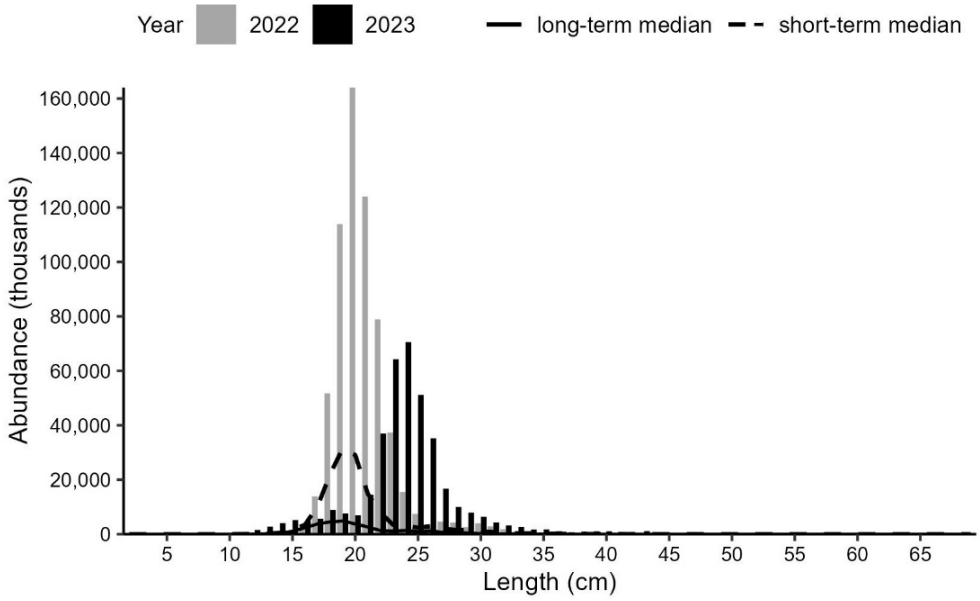

Figure 7e. Length frequency indices for Silver Hake in 4X west (strata 484–495) from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1982–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

Pollock

Pollock (*Pollachius virens*) were caught primarily in deeper water in the Gulf of Maine, and were encountered less frequently throughout 4V and 4W (Figure 8a). The 2023 biomass index for the Western component (strata 474, 476, 480–495) increased from 2022 to above the 80% long-term GM which also increased the 3-yr GM to above the 40% long-term GM (Figure 8b). Western component abundance indices for fish below 60 cm are above both the short and long-term medians while those for fish larger than 60 cm are similar to the short-term medians (Figure 8c). For the Eastern component (strata 440–473, 475, 477, 478), both the biomass index and 3-yr GM remain at low levels below the 40% long-term GM (Figure 8d). Abundances indices are generally below the short and long-term medians for all lengths (Figure 8e).

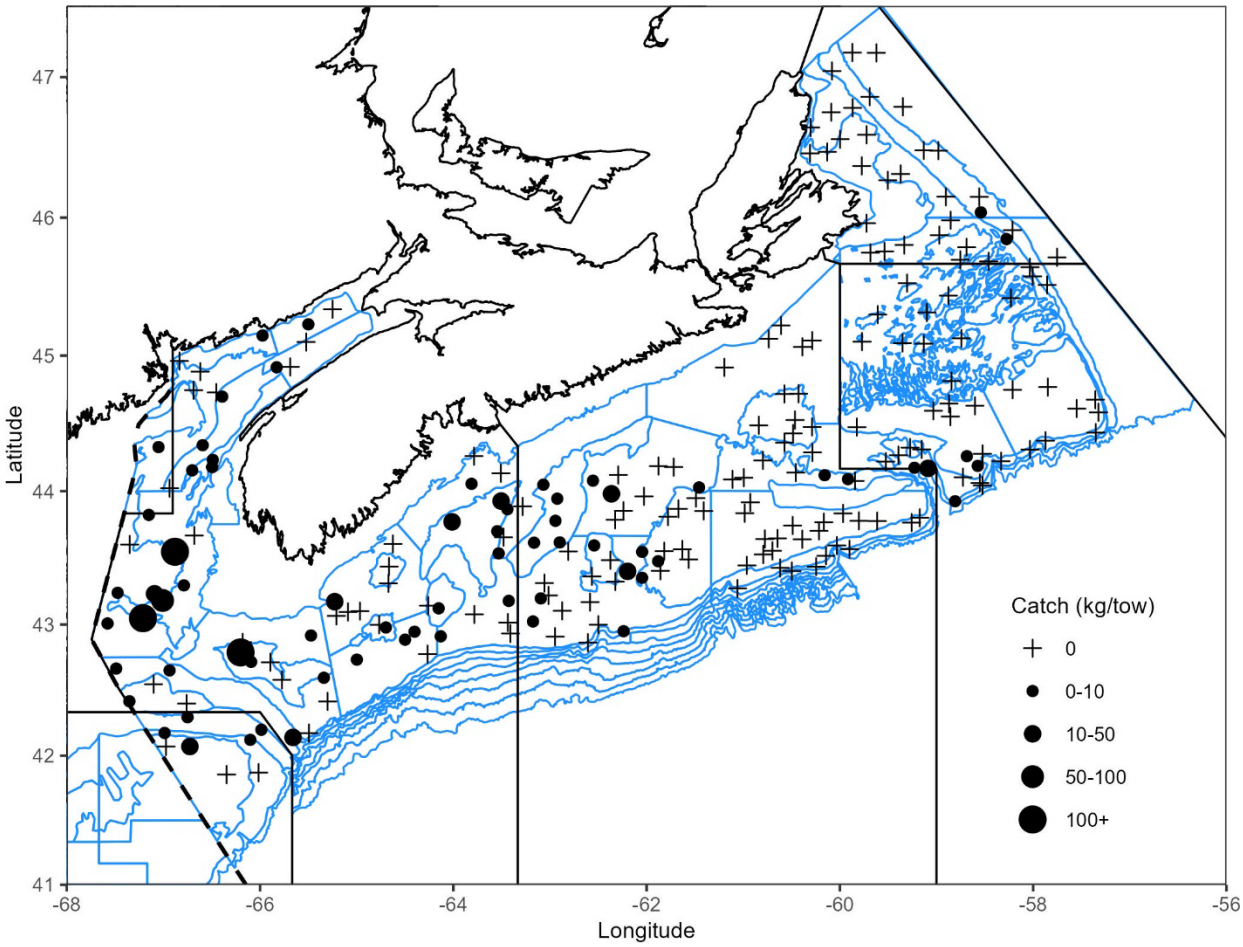

Figure 8a. Distribution of Pollock catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

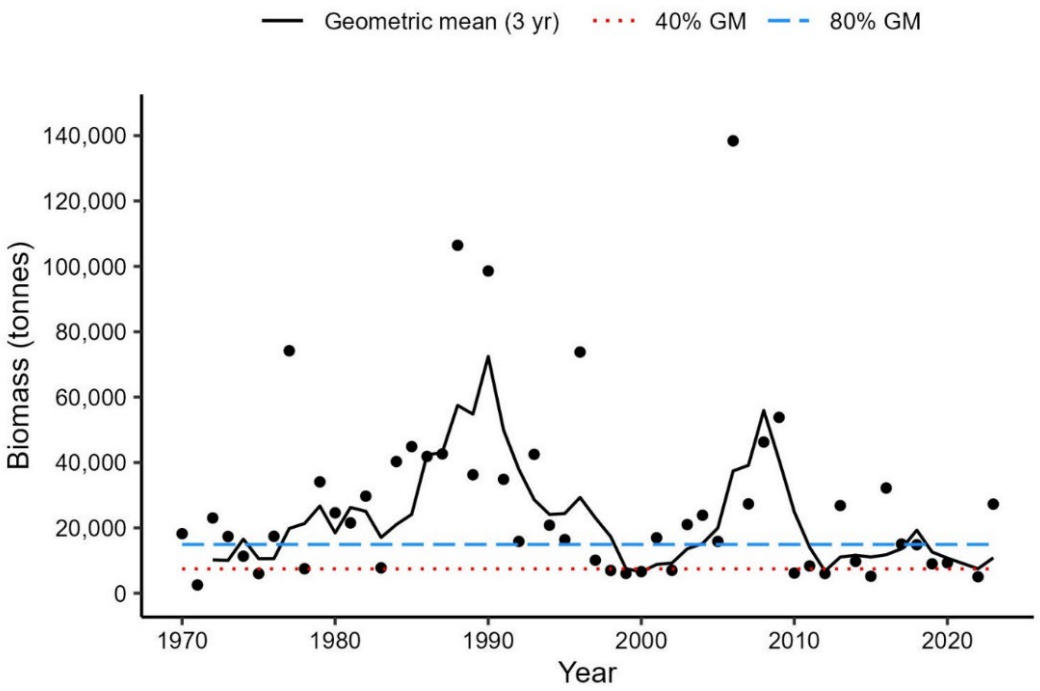

Figure 8b. Biomass index for Western component Pollock (strata 474, 476, 480–495) from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

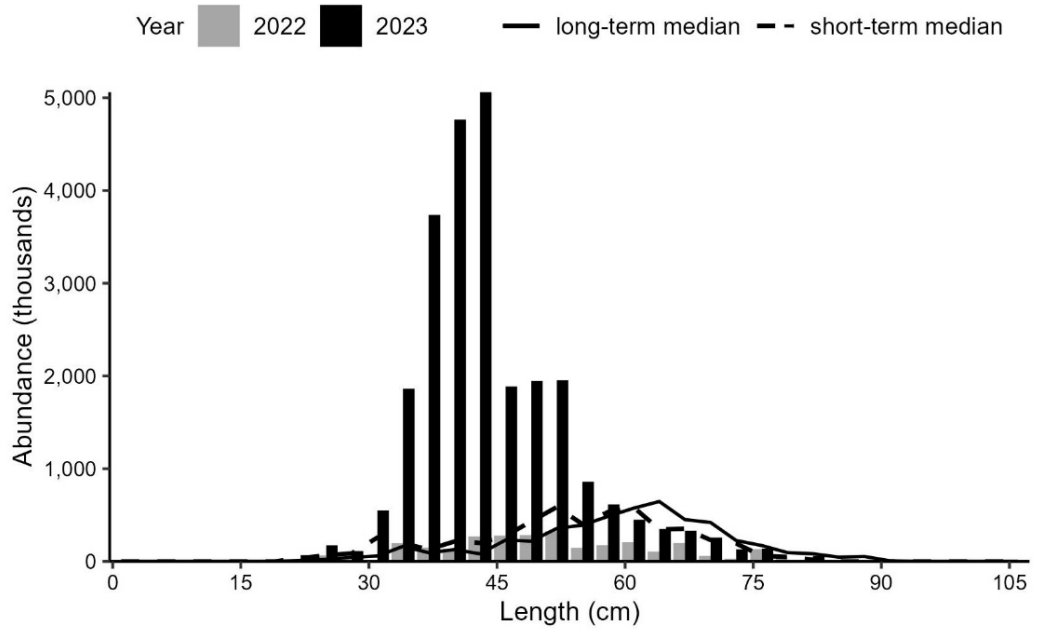

Figure 8c. Length frequency indices for Western component Pollock (strata 474, 476, 480–495) from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

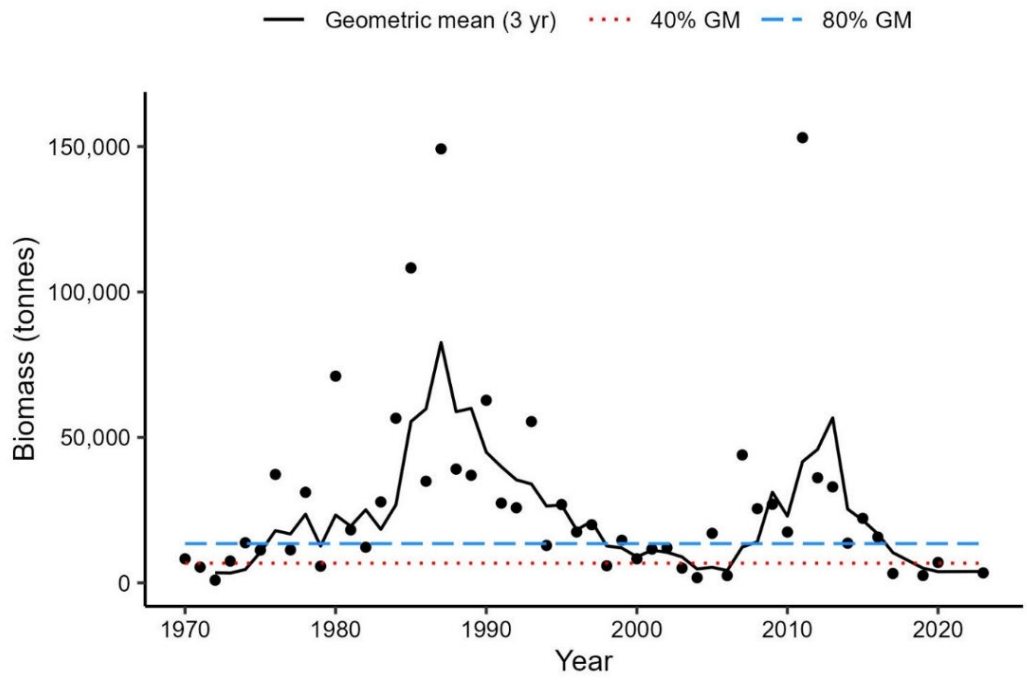

Figure 8d. Biomass index for Eastern component Pollock (strata 440–473, 475, 477, 478) from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

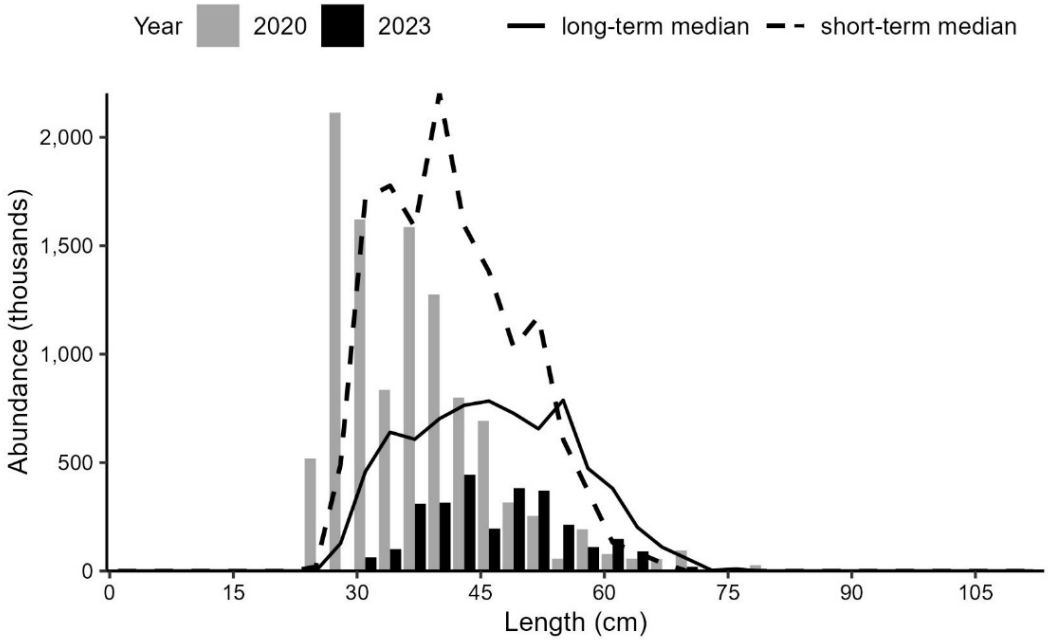

Figure 8e. Length frequency indices for the eastern component Pollock from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Redfish

A change in gear and vessel occurred in 1982, and a conversion factor was estimated for redfish (*Sebastes fasciatus* and *Sebastes mentella*) based on comparative fishing studies done at the time. However, due to small sample sizes and badly distributed data, the conversion factor estimated for redfish was considered unreliable by the authors (Fanning 1985). It is expected that the gear used from 1970–1981 was less efficient at catching redfish compared to the gear used since 1982, and thus indices of abundance and biomass are likely to be higher for the period of 1970–1981 if conversion factors were applied and compared to the remaining time series (1982–present). Rather than restrict the survey time series for redfish to 1982–2023, a vertical line is included in Figure 9b and Figure 9d to indicate the change in gear and vessel, and pre-1982 indices should be interpreted with caution relative to the rest of the time series.

The largest redfish catches in 2023 were in and along the edges of the Laurentian Channel, and east of Browns Bank (Figure 9a). Three of the five largest redfish catches in 2023 came from stratum 558 in the Laurentian Channel, a stratum not currently included in the Unit II (strata 440–456, 464) biomass estimates. The biomass index for Unit II redfish increased from 2020 and both the index and the 3-yr GM are above the 80% long-term GM (Figure 9b). Abundance indices of Unit II redfish between 23 and 29 cm are above both the short and long-term medians (Figure 9c) while indices for fish under 22 cm are well below both the short and long-term medians. It appears the average length of Unit II redfish has increased in recent years and there are no clear signs of recruitment. The 2023 biomass index and 3-yr GM for Unit III (strata 456, 458–495) redfish increased from 2022 but remain below 80% of the long-term GM (Figure 9d). Abundance indices for Unit III redfish above 20 cm are predominantly below the short and long-term medians, while those for fish below 20 cm are above both the short and long-term medians including an increase in age 0 and age 1 fish (below 10 cm) (Figure 9e).

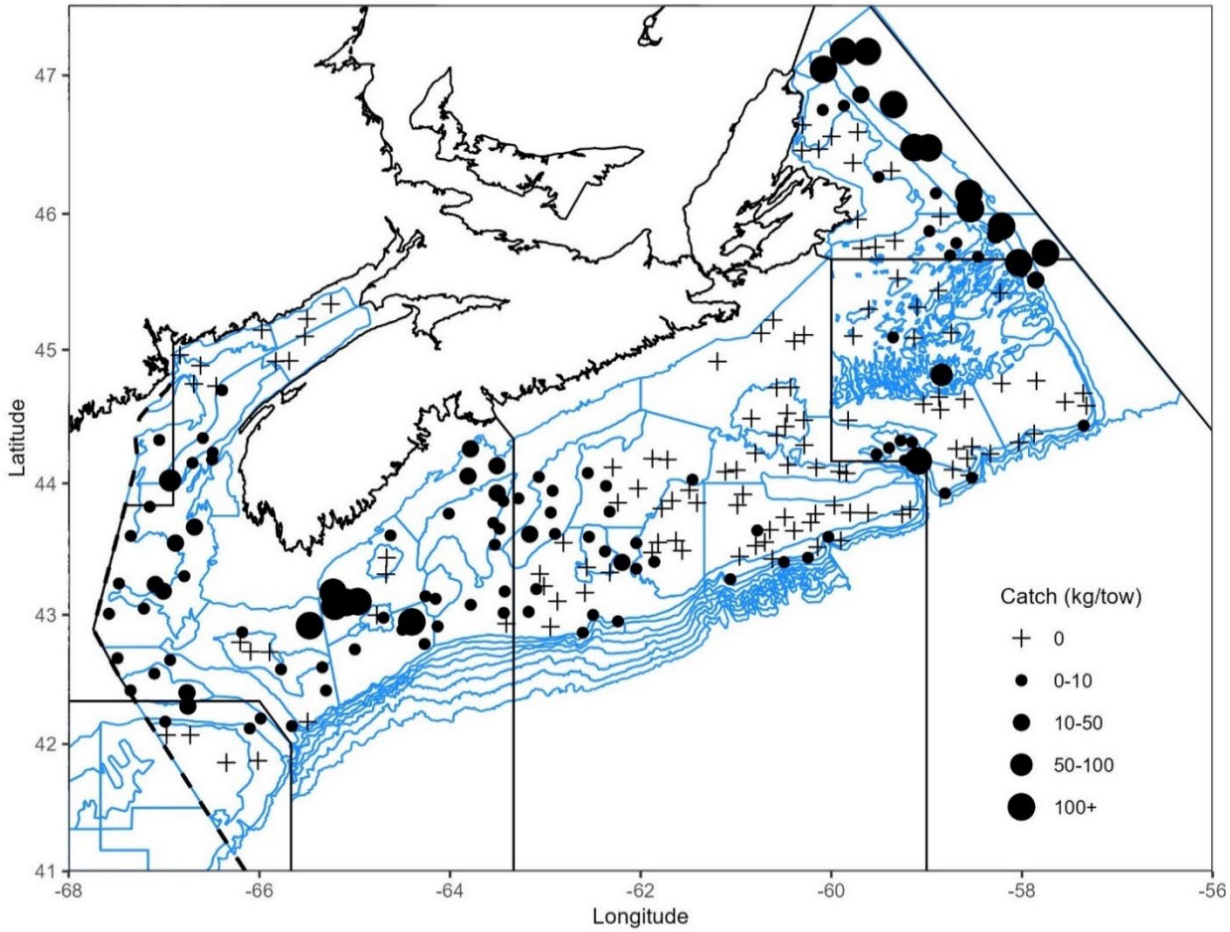

Figure 9a. Distribution of redfish catches during the 2023 DFO Summer Ecosystem RV Survey including the Laurentian channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

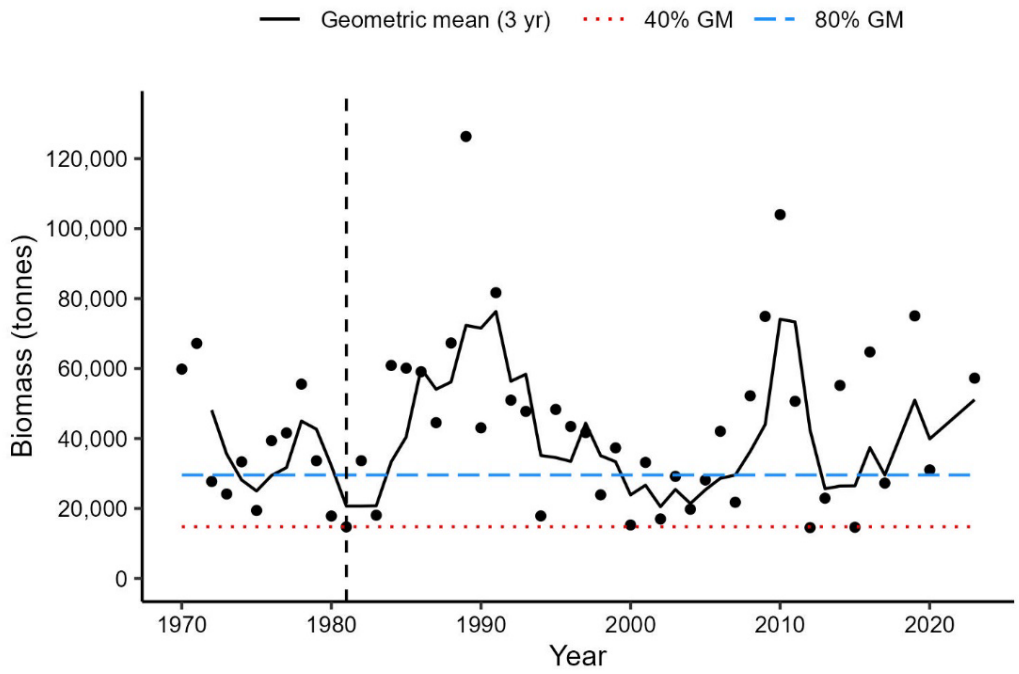

Figure 9b. Biomass index for Unit II redfish (strata 440–456, 464) from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year. The vertical dashed line represents the final year before a change in vessel and gear occurred.

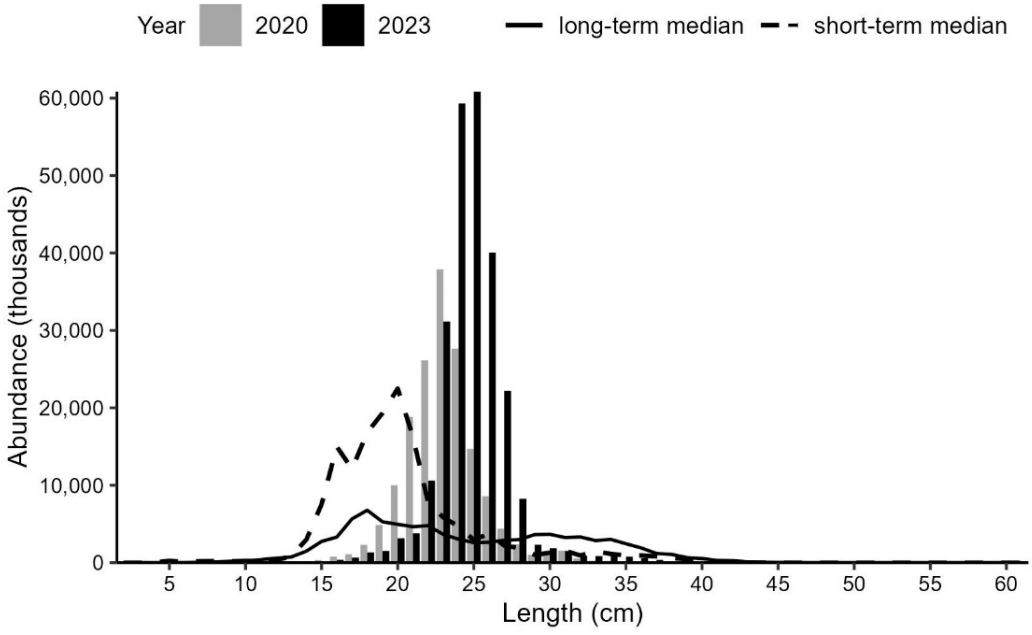

Figure 9c. Length frequency indices for Unit II redfish (strata 440–456, 464) from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

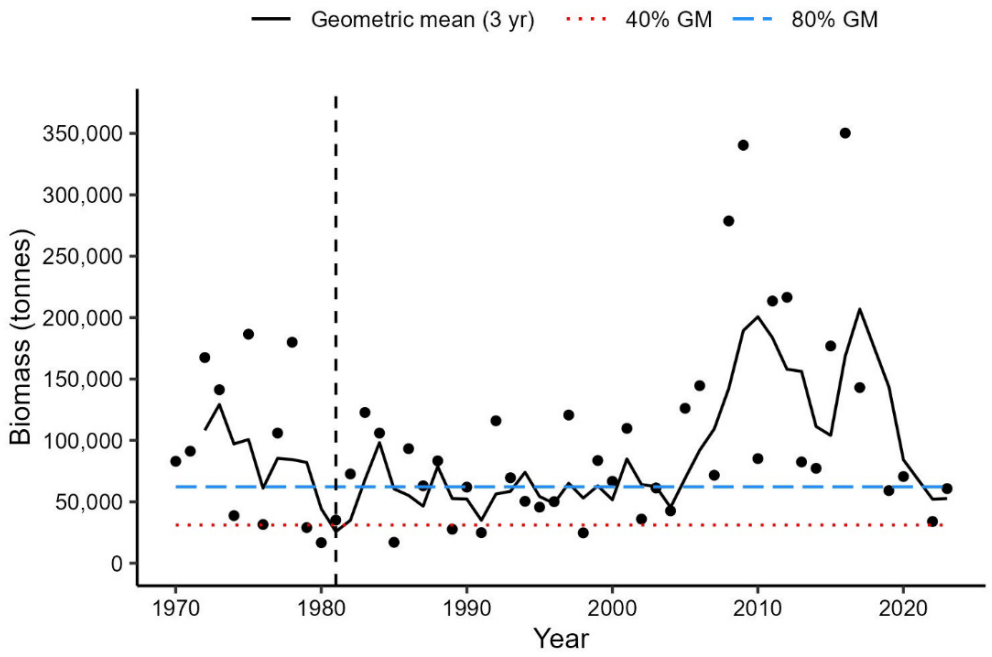

Figure 9d. Biomass index for Unit III redfish (strata 456, 458–495) from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year. The vertical dashed line represents the final year before a change in vessel and gear occurred.

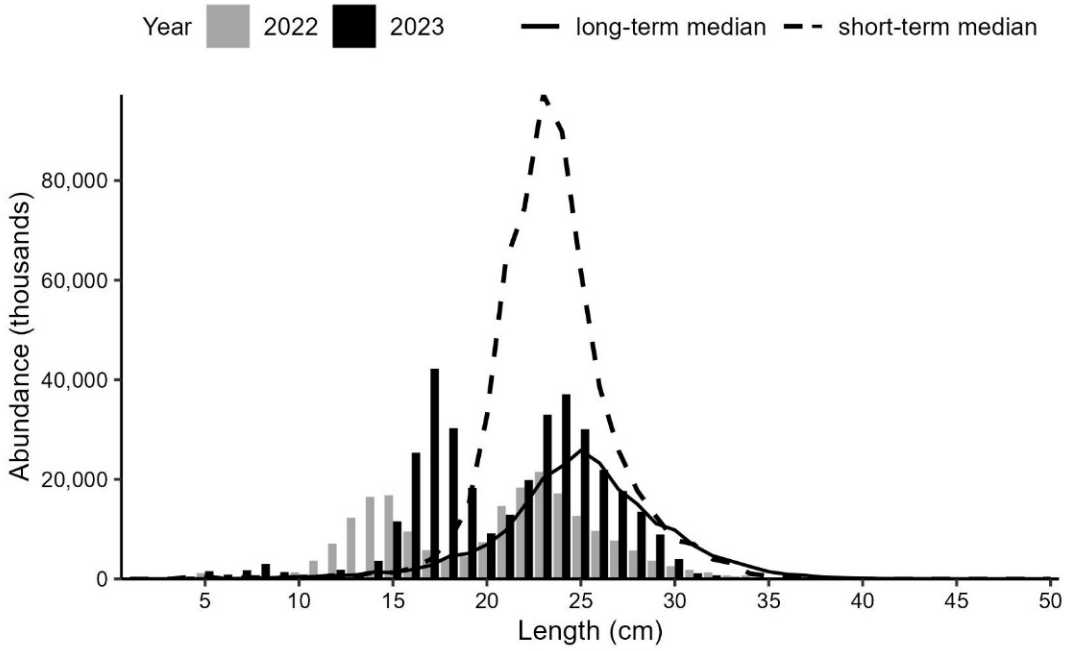

Figure 9e. Length frequency indices for Unit III redfish (strata 456, 458–495) from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

Atlantic Halibut

Atlantic Halibut (*Hippoglossus hippoglossus*) were caught sporadically throughout the 4VWX area (Figure 10a). The 2023 biomass index in 4VWX is the second highest observed in the time series and the 3-yr GM remains well above 80% of the long-term GM (Figure 10b). Since 2000, there has been a consistent increase in biomass throughout the area. In general, length frequencies for most lengths are at or above both the short and long-term medians, most notably for immature fish between 37 and 78 cm (Figure 10c).

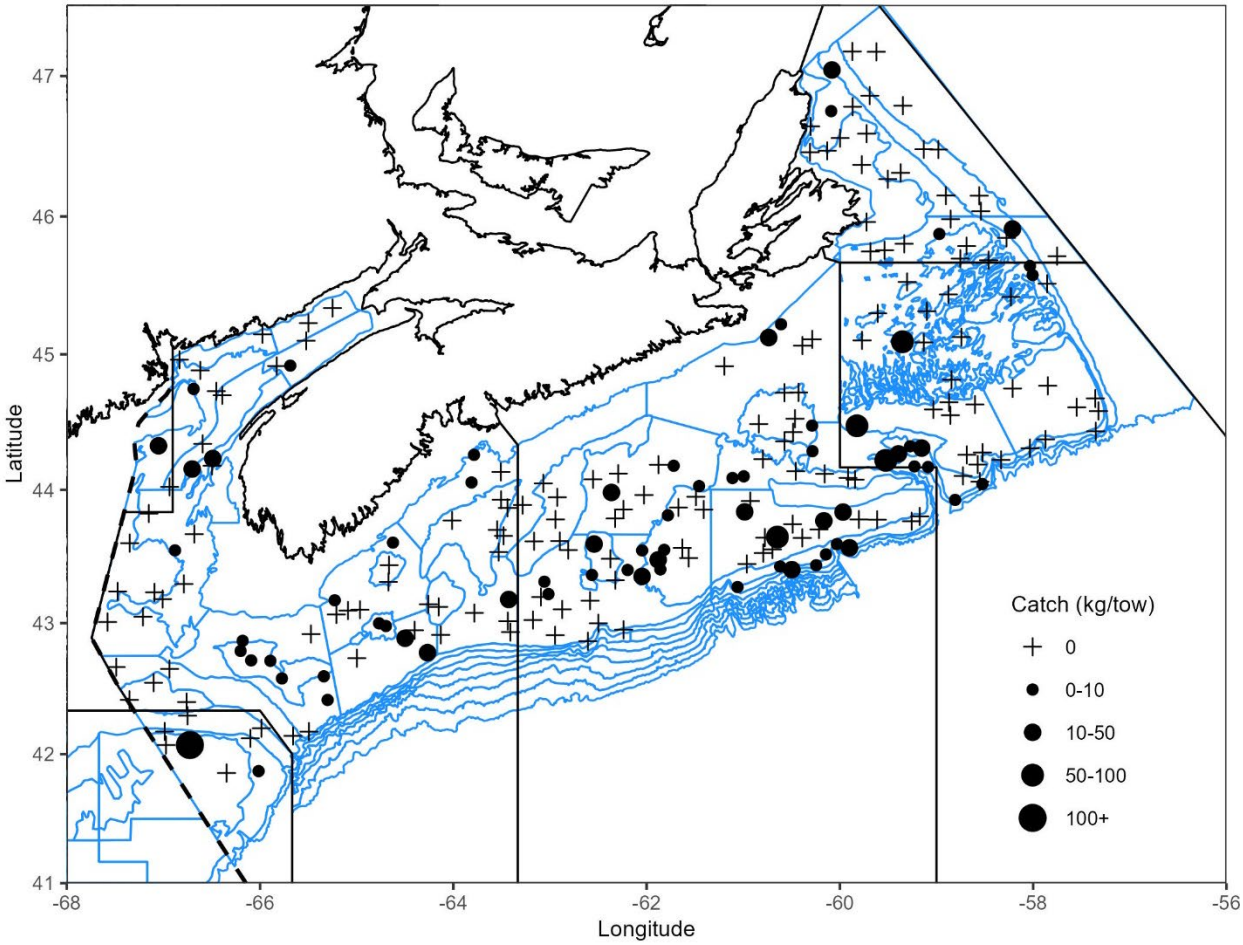

Figure 10a. Distribution of Atlantic Halibut catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

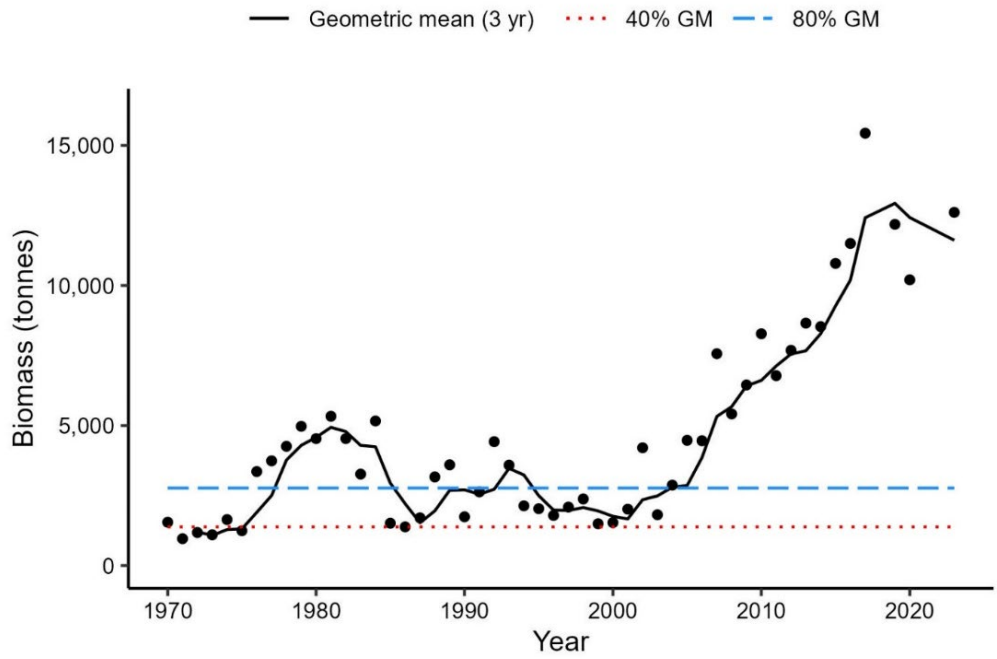

Figure 10b. Biomass index for Halibut in 4VWX from the DFO Summer Ecosystem RV Survey. The 3-year geometric mean biomass is represented by the solid black line. The dashed blue and dotted red lines represent 80% and 40% of the long-term GM (1970–2020), respectively. The black dots represent the biomass estimate for that year.

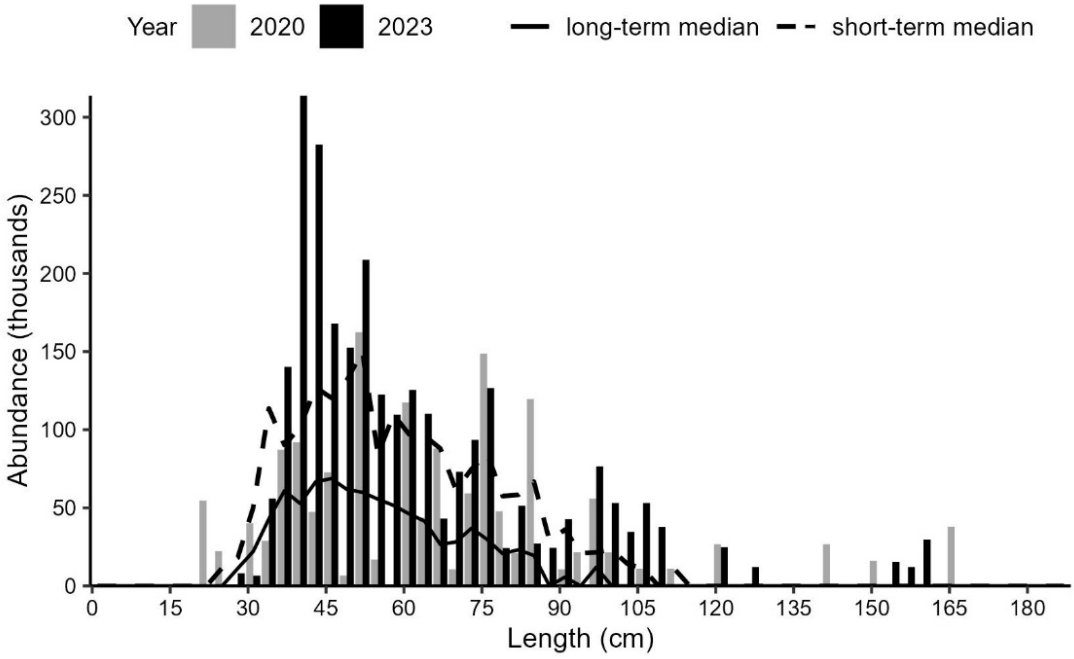

Figure 10c. Length frequency indices for Halibut in 4VWX from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Yellowtail Flounder

Yellowtail Flounder (*Limanda ferruginea*) were primarily caught on the banks in 4VW (Figure 11a). Within 4X, the majority of catches occurred on Browns Bank. In 4X, the biomass index increased above the 40% long-term GM and is the highest it has been since 2016; however, the 3-yr GM still remains below the 40% long-term GM (Figure 11b). The abundance indices in 2023 for 4X are generally at or below the short-term median for fish less than 33 cm while fish between 33 and 37 cm are generally above both the short and long-term medians (Figure 11c). The 2023 biomass index within 4VW increased from the time series low in 2020 and is now above the 40% long-term GM. In contrast, the 3-yr GM decreased slightly to the lowest in the time series while remaining just above the 40% long-term GM (Figure 11d). Abundance indices in 2023 are similar to, or below, both the short and long-term medians (Figure 11e). In recent years, there has been a general increase in smaller fish abundances below 25 cm as the short-term median has exceeded the long-term median.

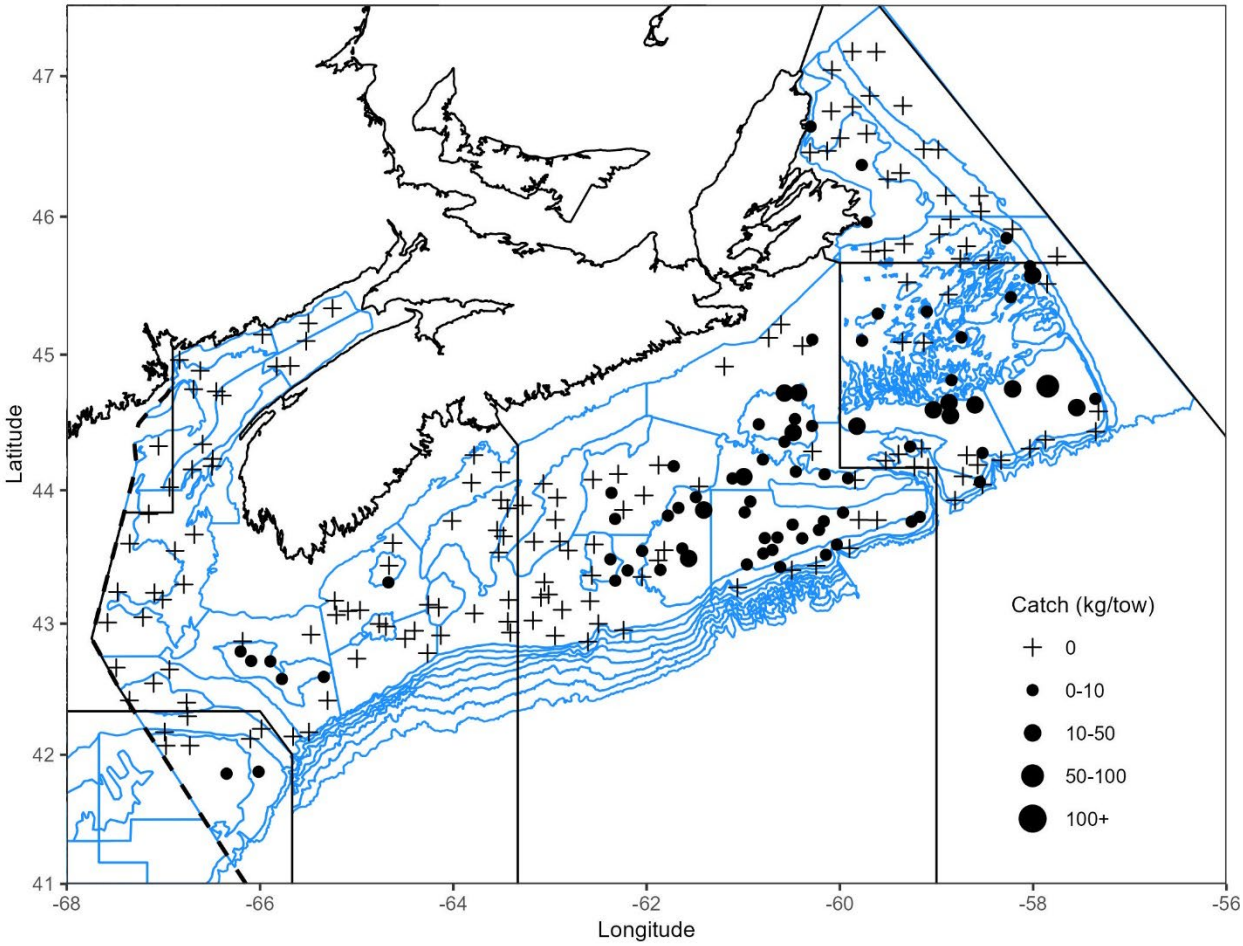

Figure 11a. Distribution of Yellowtail Flounder catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

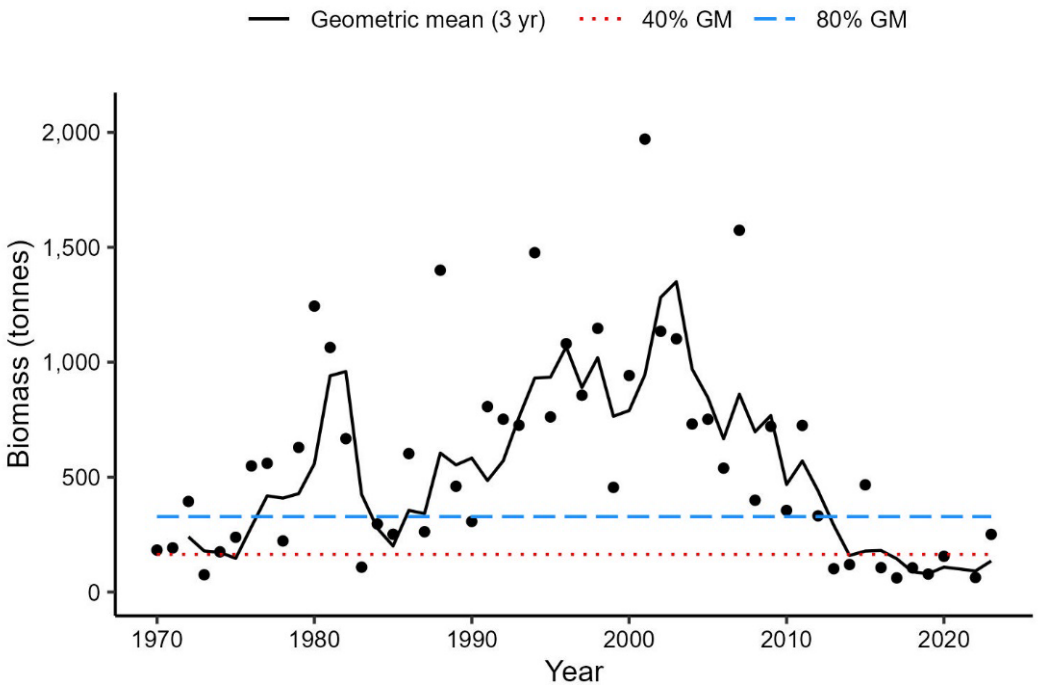

Figure 11b. Biomass index for Yellowtail Flounder in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

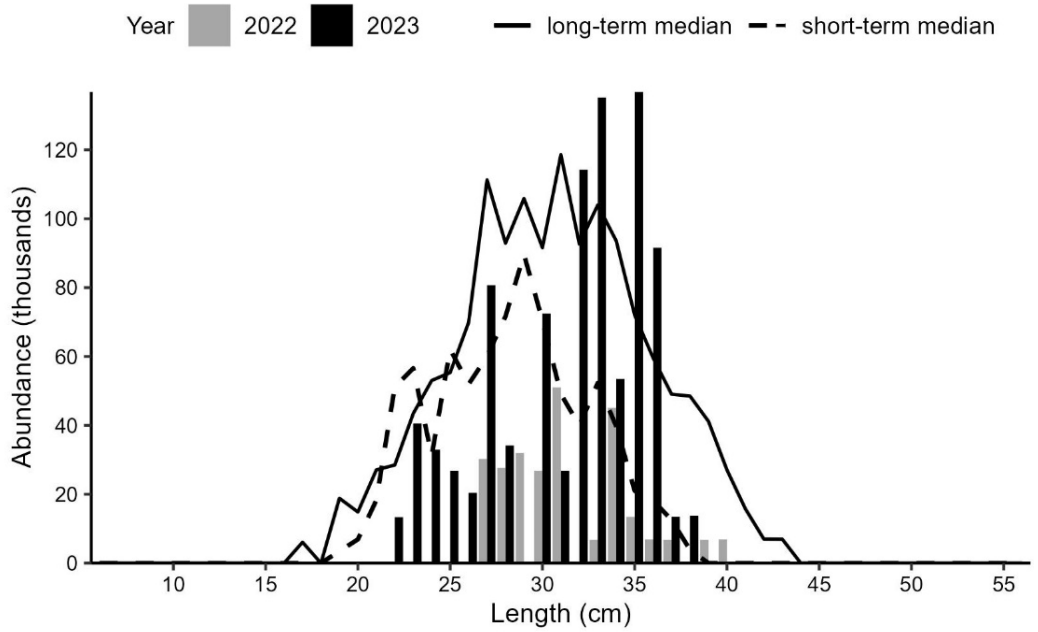

Figure 11c. Length frequency indices for Yellowtail Flounder in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

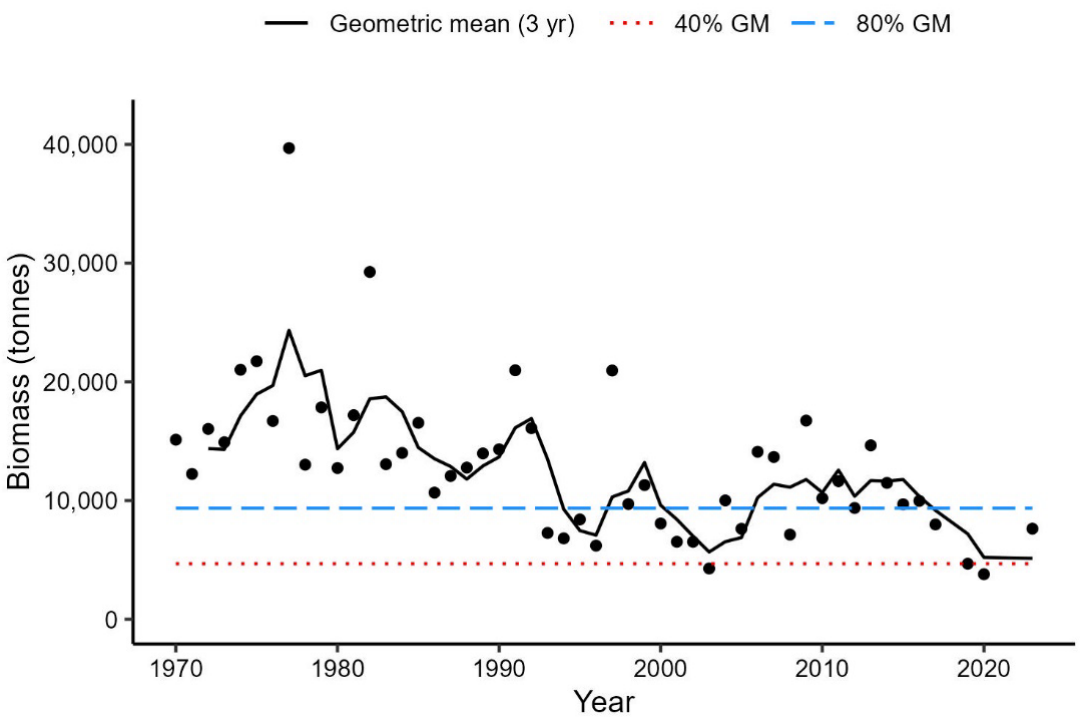

Figure 11d. Biomass index for Yellowtail Flounder in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

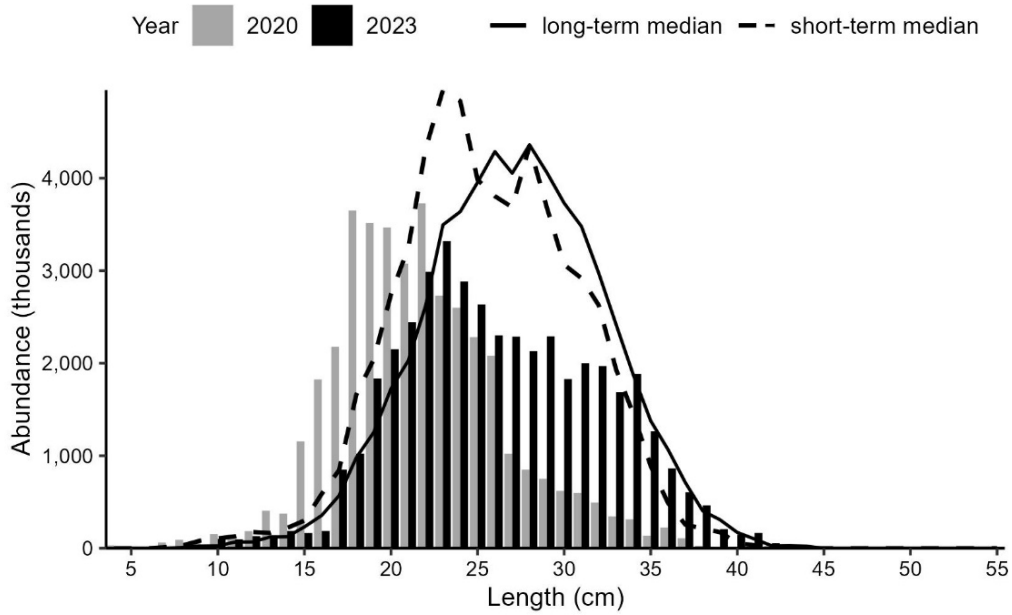

Figure 11e. Length frequency indices for Yellowtail Flounder in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

American Plaice

American Plaice (*Hippoglossoides platessoides*) catches were generally distributed across much of the survey range with the majority of catches occurring in 4V and the eastern portions of 4W (Figure 12a). In 4X, the biomass index and 3-yr GM remain low and neither has exceeded the 40% long-term GM since 2013 (Figure 12b). Abundance indices in 2023 for 4X are generally similar to or below the short-term medians for most lengths (Figure 12c). In 4VW, the biomass index is the highest since 2010; however, the 3-yr GM remains below the 40% long-term GM (Figure 12d). Abundance indices in 4VW for fish below 20 cm are mostly higher than both the long and short-term medians, while indices for fish above 25 cm are generally above the short-term but below the long-term medians (Figure 12e).

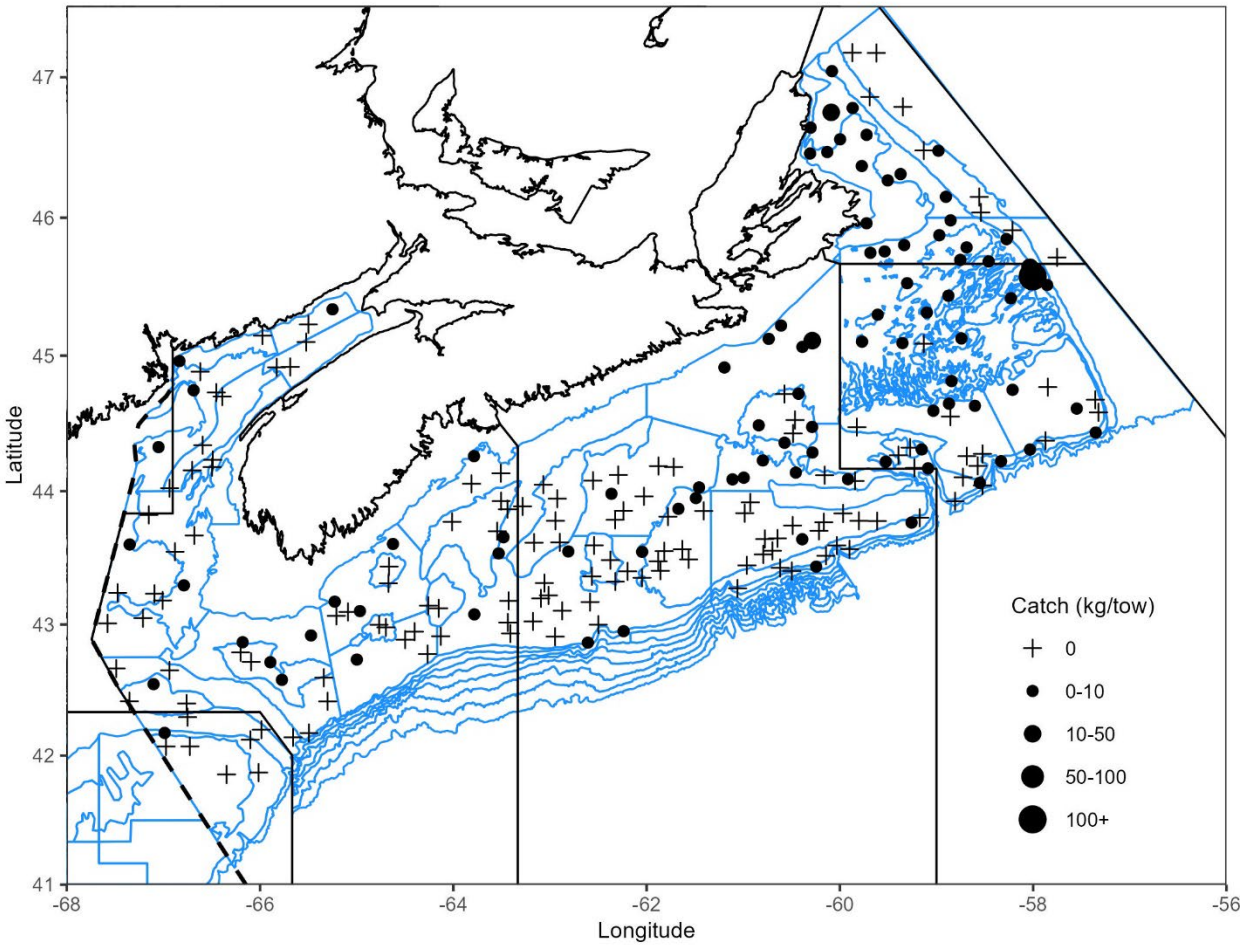

Figure 12a. Distribution of American Plaice catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

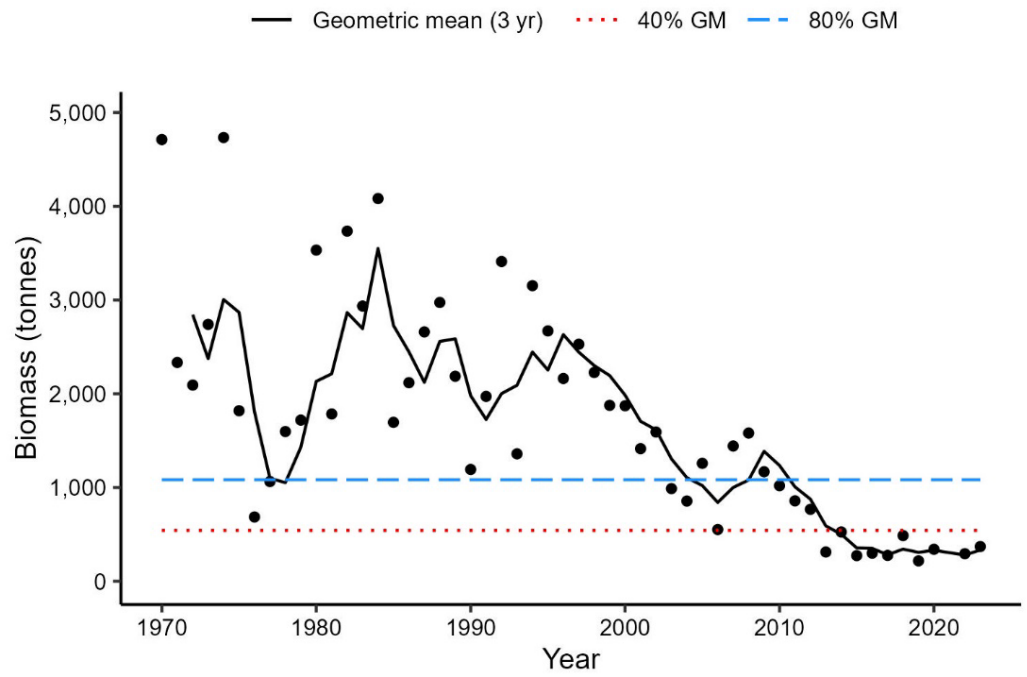

Figure 12b. Biomass index for American Plaice in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

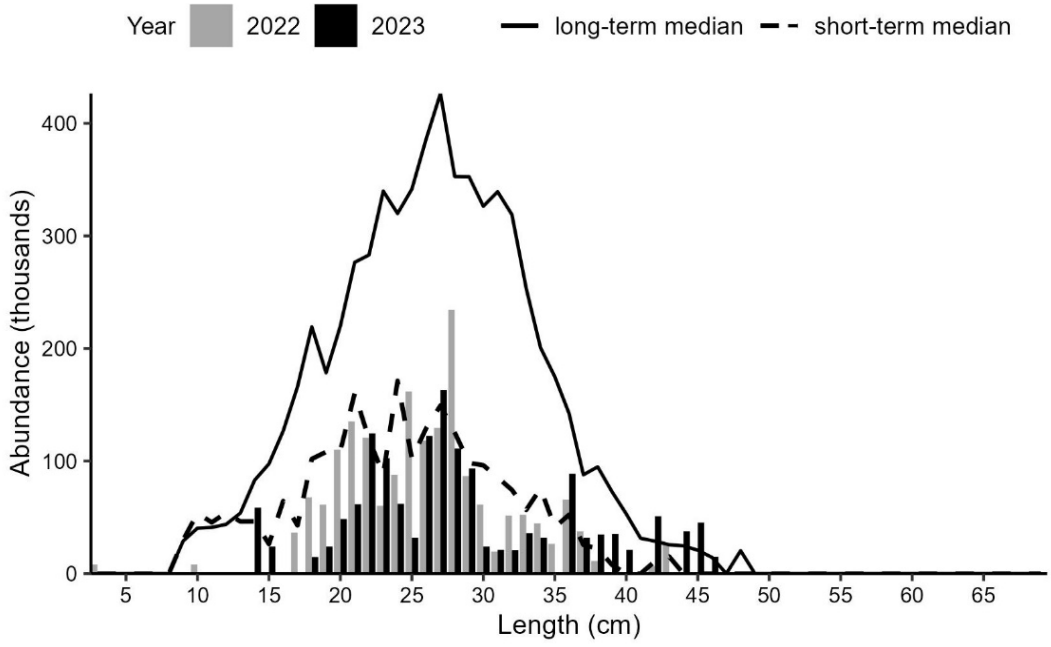

Figure 12c. Length frequency indices for American Plaice in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

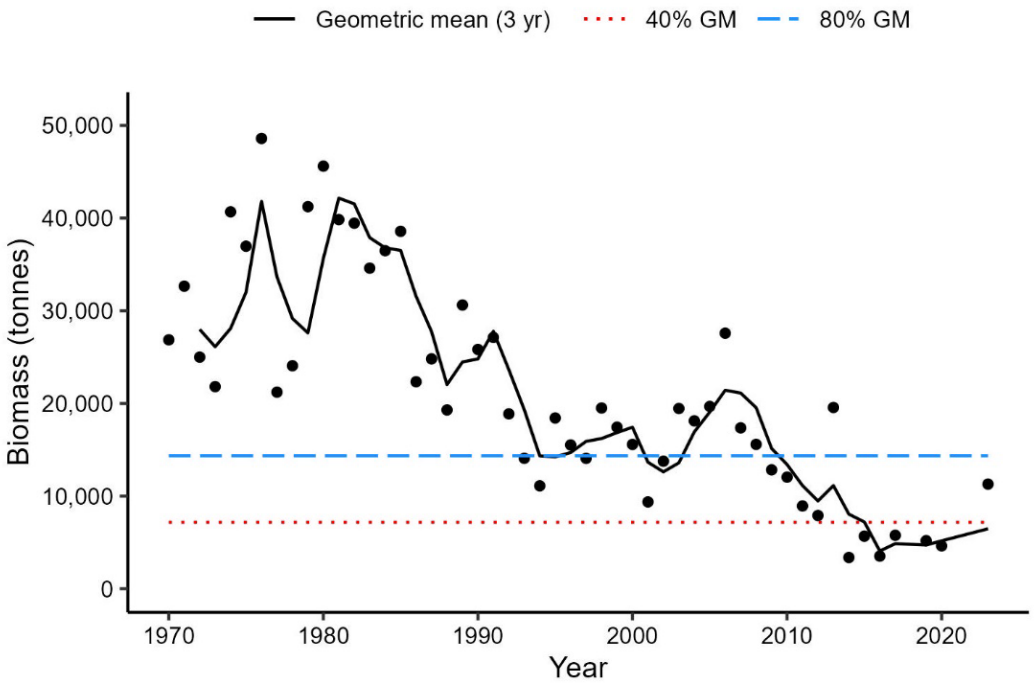

Figure 12d. Biomass index for American Plaice in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

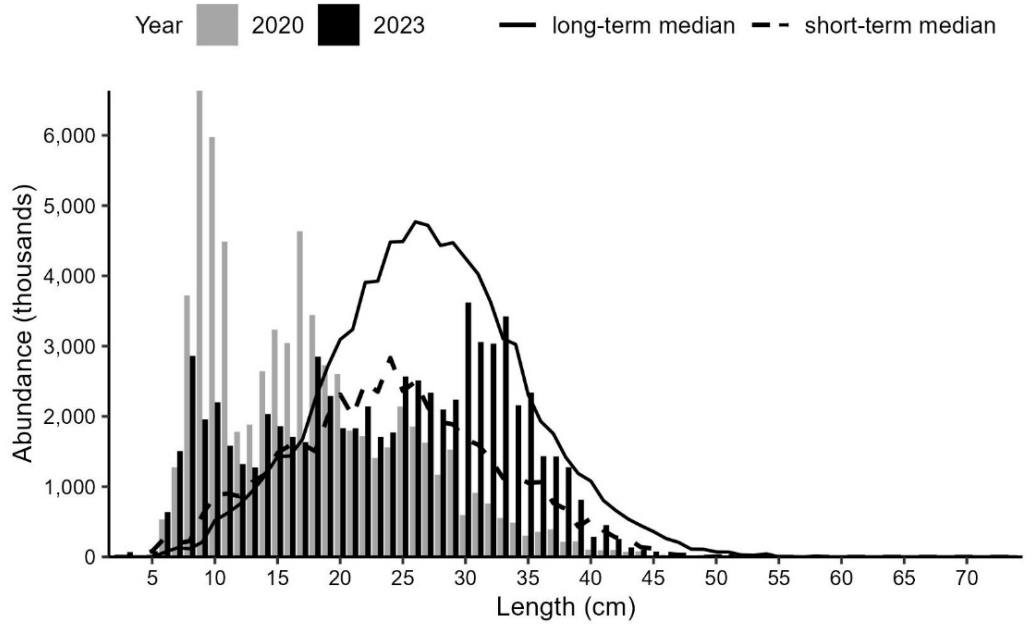

Figure 12e. Length frequency indices for American Plaice in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Witch Flounder

Witch Flounder (*Glyptocephalus cynoglossus*) were widespread throughout 4V and 4W, with the highest densities observed in 4Vn (Figure 13a). The 2023 biomass index for 4X increased to just below the 80% long-term GM; however, the 3-yr GM decreased again and remains below the 80% long-term GM (Figure 13b). Abundance indices in 4X are similar to the short-term medians for most lengths with the exception of fish between 34 and 39 cm which are below, but are similar to the long-term medians (Figure 13c). In 4VW, the 2023 biomass index increased to the third highest of the time series (Figure 13d). The 3-yr GM index also increased to the fourth highest in the time series and is now over double the 80% long-term GM. Abundance indices are above the short and long-term medians for the majority of lengths (Figure 13e). The short-term median numbers-at-length are generally higher than the long-term medians in both 4X and 4VW indicating a general increase in abundance of Witch Flounder across the Scotian Shelf.

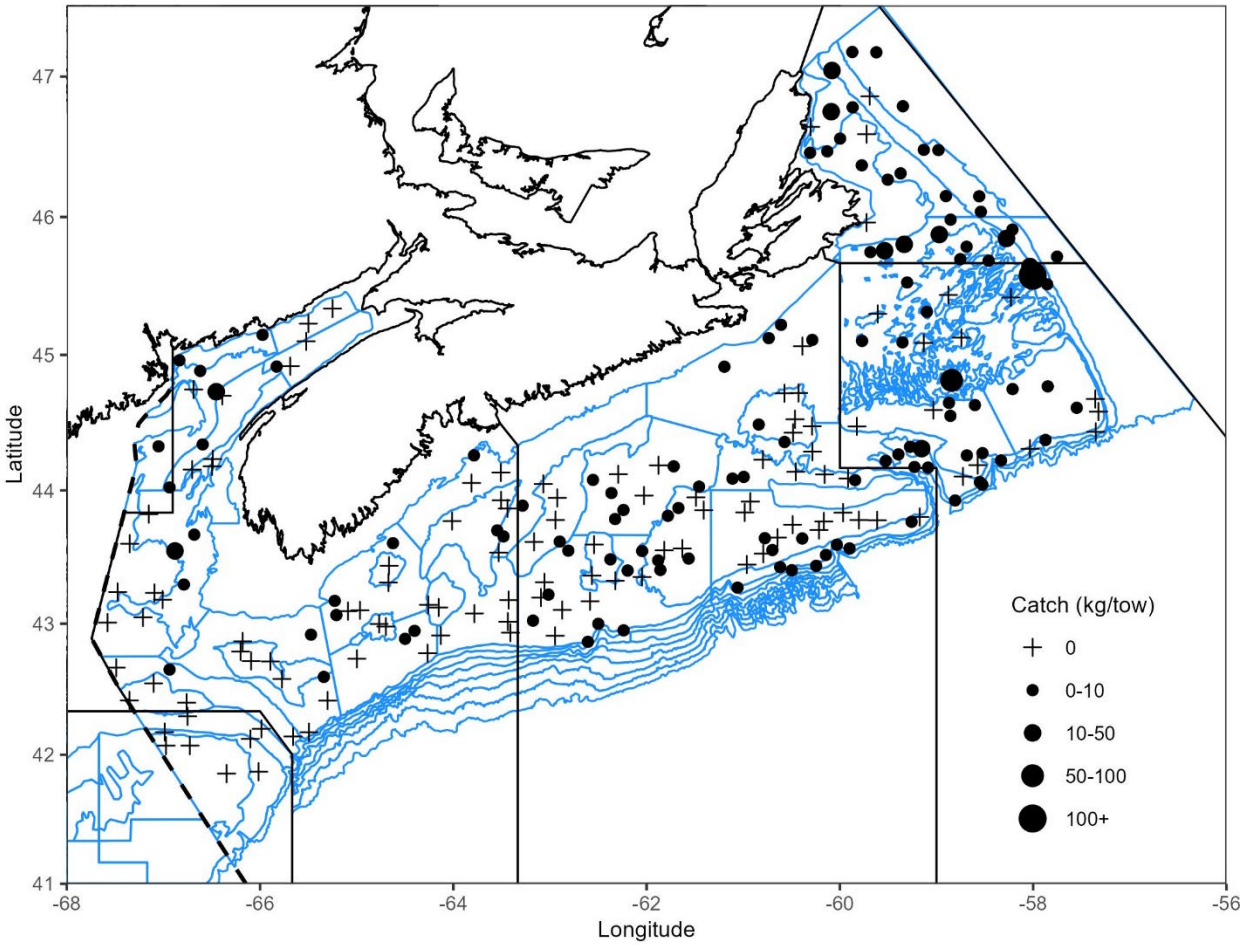

Figure 13a. Distribution of Witch Flounder catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

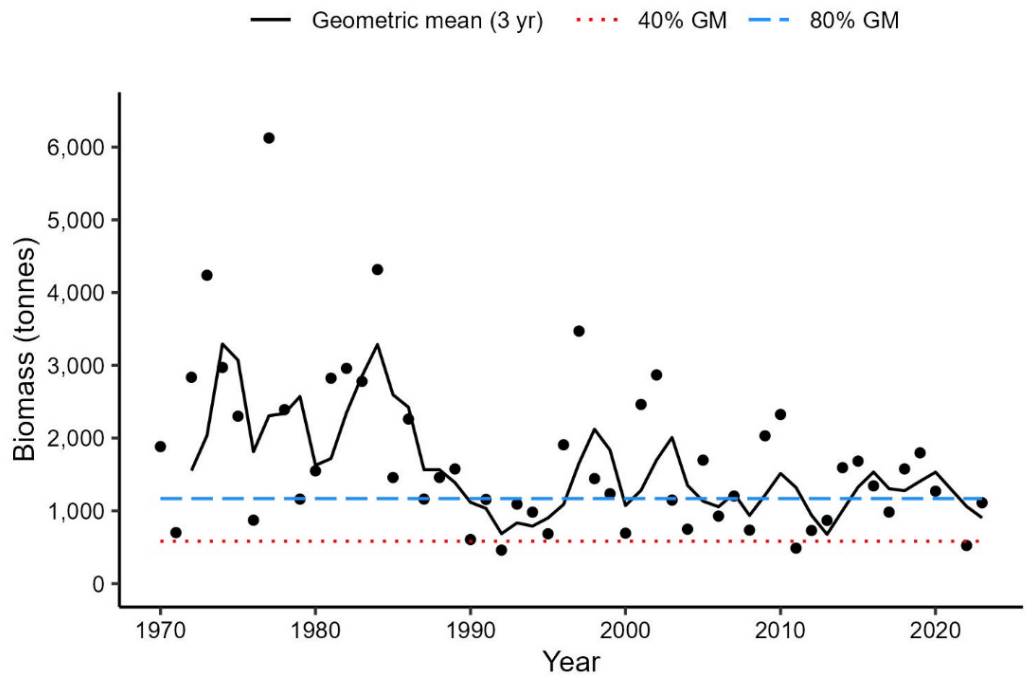

Figure 13b. Biomass index for Witch Flounder in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

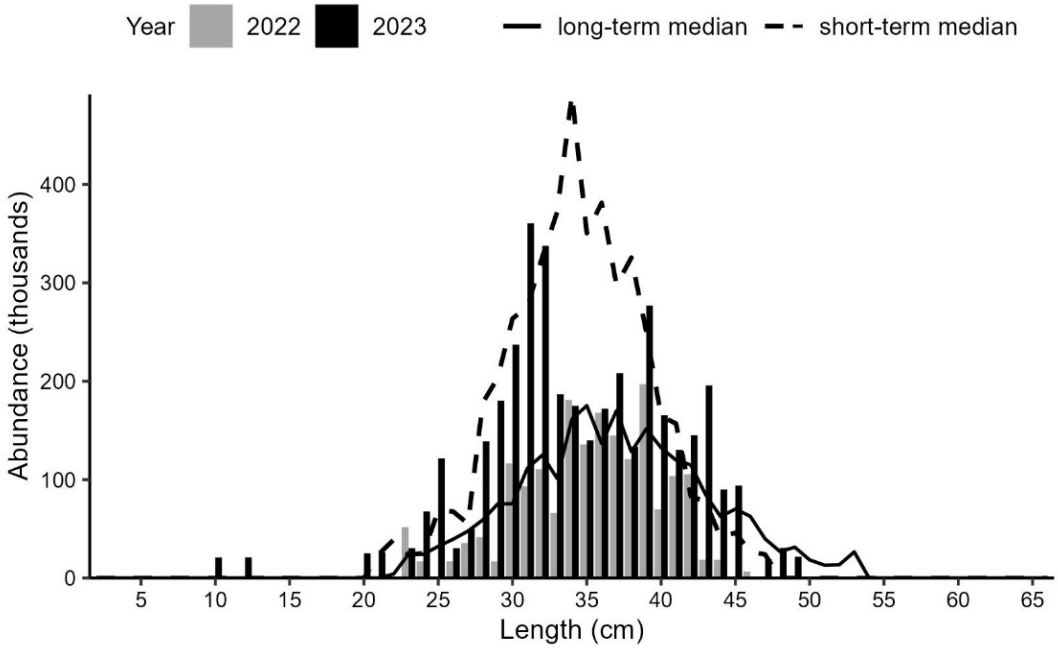

Figure 13c. Length frequency indices for Witch Flounder in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

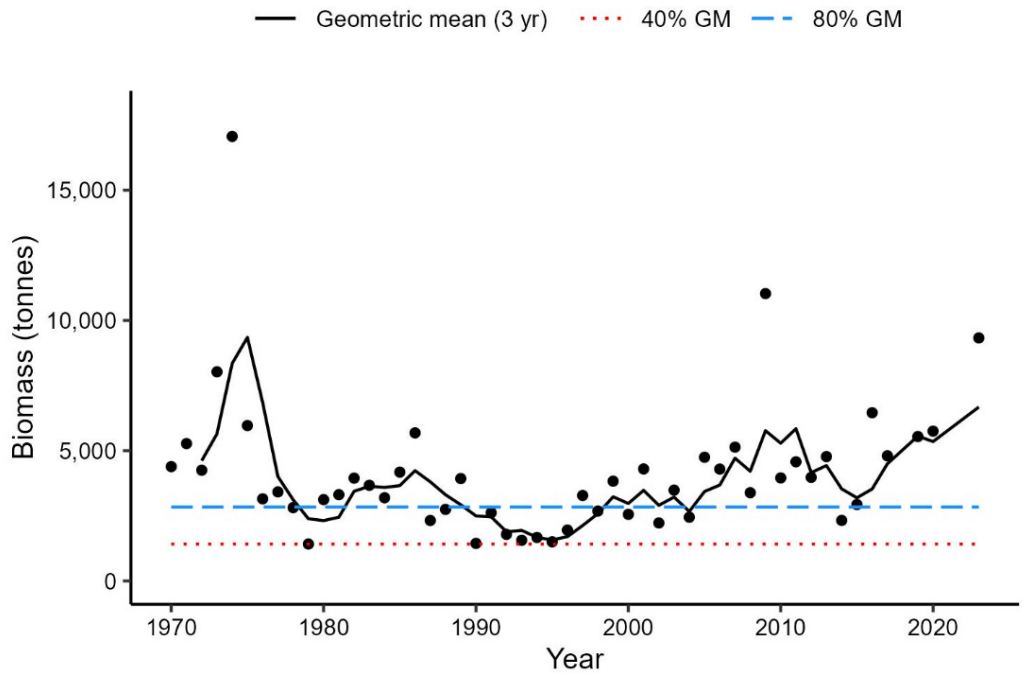

Figure 13d. Biomass index for Witch Flounder in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

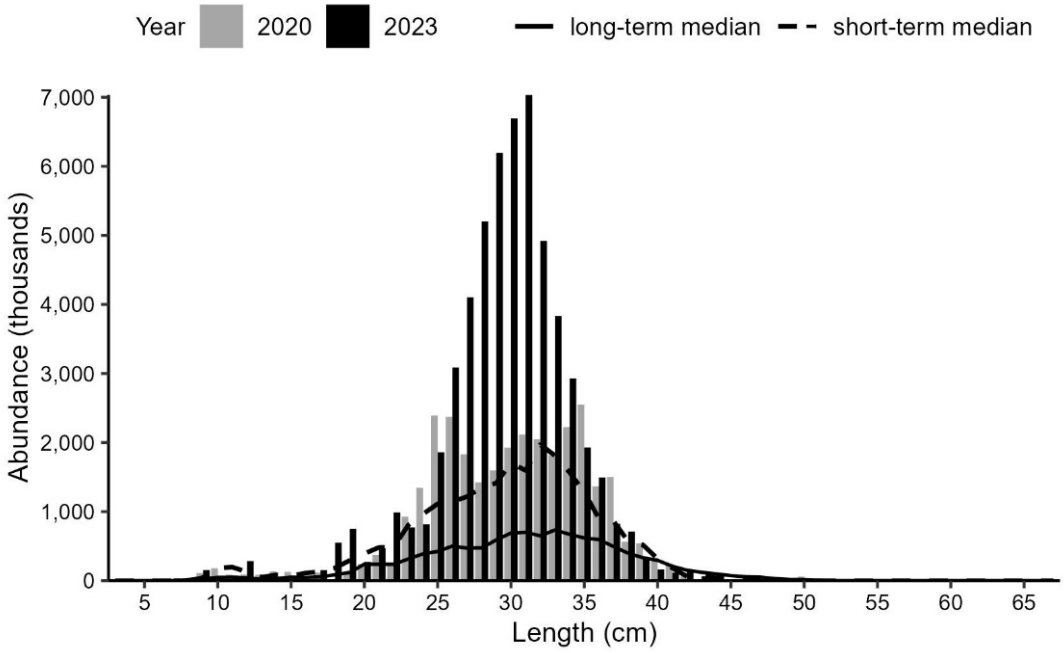

Figure 13e. Length frequency indices for Witch Flounder in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Winter Flounder

Winter Flounder (*Pseudopleuronectes americanus*) were caught primarily on Browns Bank, and in the Bay of Fundy, with smaller catches concentrated on the Western and Sable Island Banks (Figure 14a). In 4X, the 2023 biomass index increased to the 8th highest of the time series and the 3-yr GM remains above 80% of the long-term GM since 1988 (Figure 14b). The short-term median abundance indices-at-length in 4X are higher than the long-term medians at length under 36 cm (Figure 14c). In 2023, abundance indices are above the long-term medians for all lengths but are below the short-term medians for fish under 31 cm (Figure 14c). Both the 4VW biomass index and 3-yr GM remain below the 80% long-term GM and marginally above the 40% long-term GM (Figure 14d). Abundance indices for fish below 23 cm generally exceed both the short and long-term medians, while indices for fish above 23 cm are below the short and long-term medians (Figure 14e).

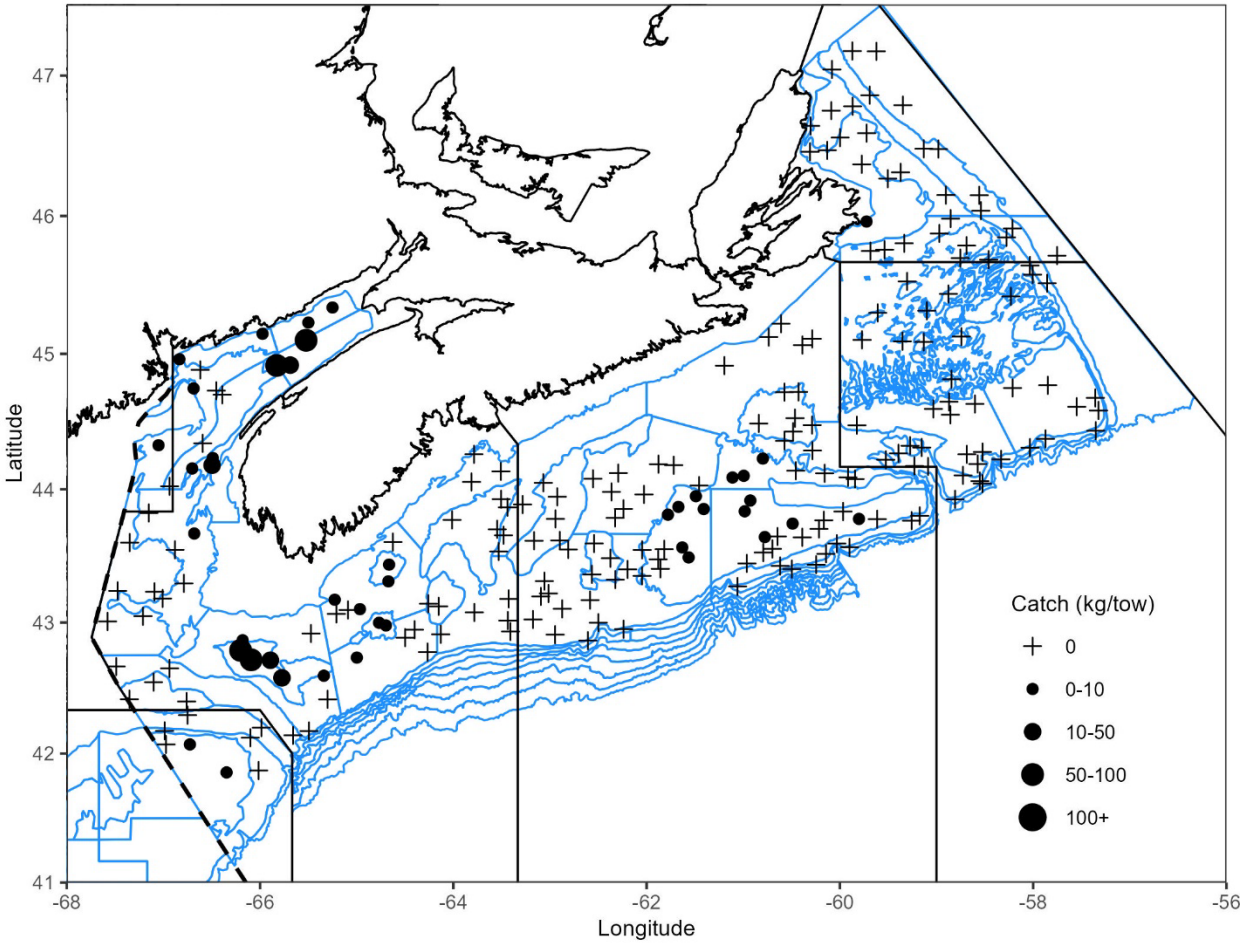

Figure 14a. Distribution of Winter Flounder catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

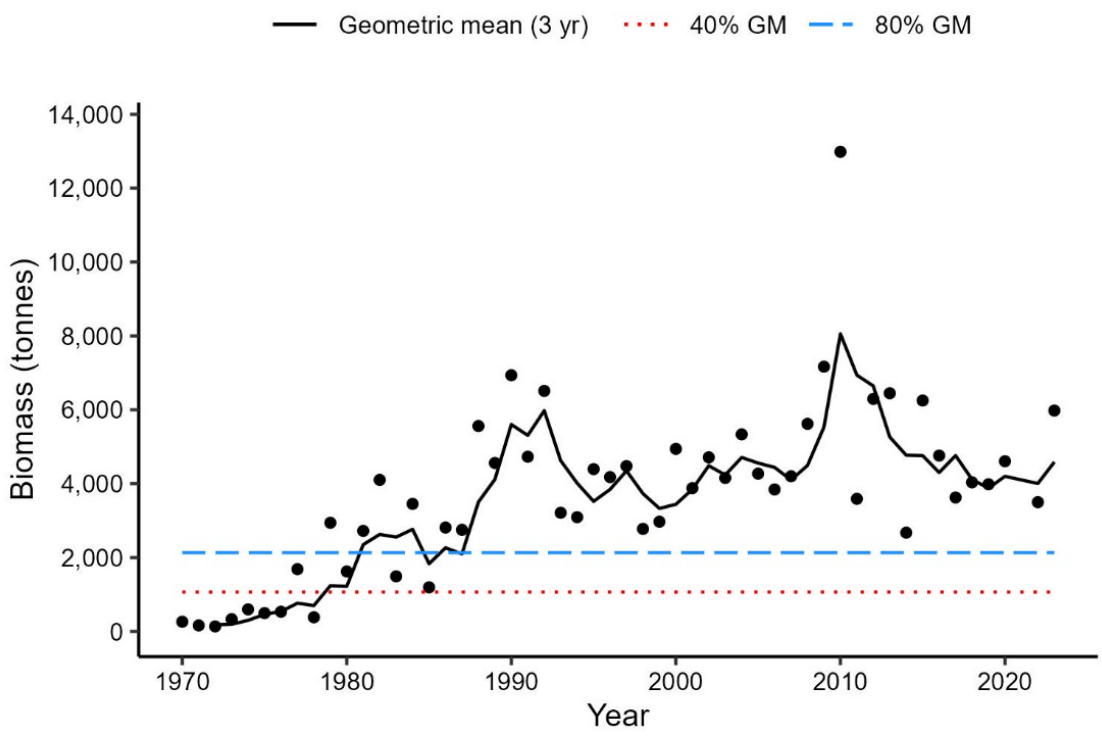

Figure 14b. Biomass index for Winter Flounder in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

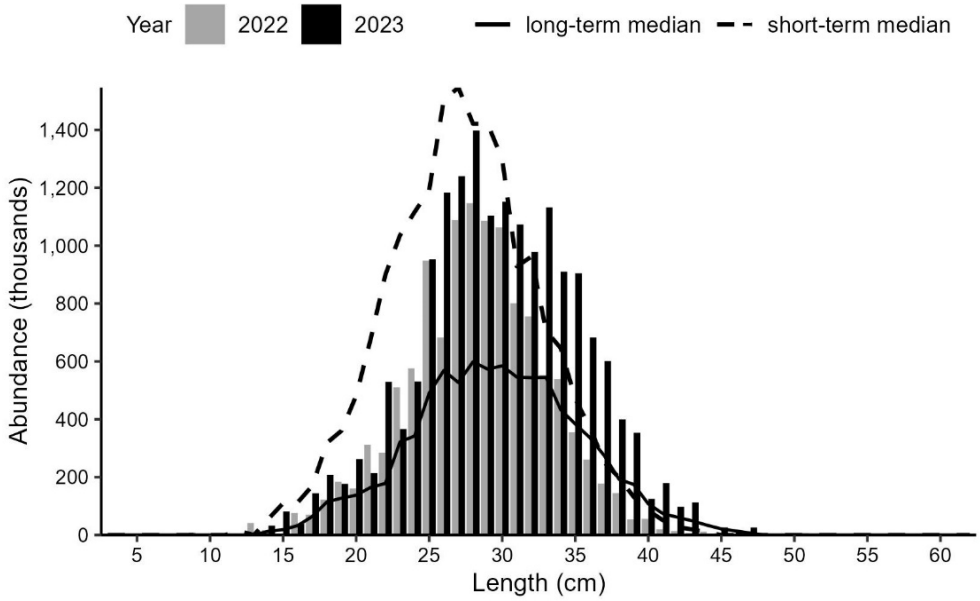

Figure 14c. Length frequency indices for Winter Flounder in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

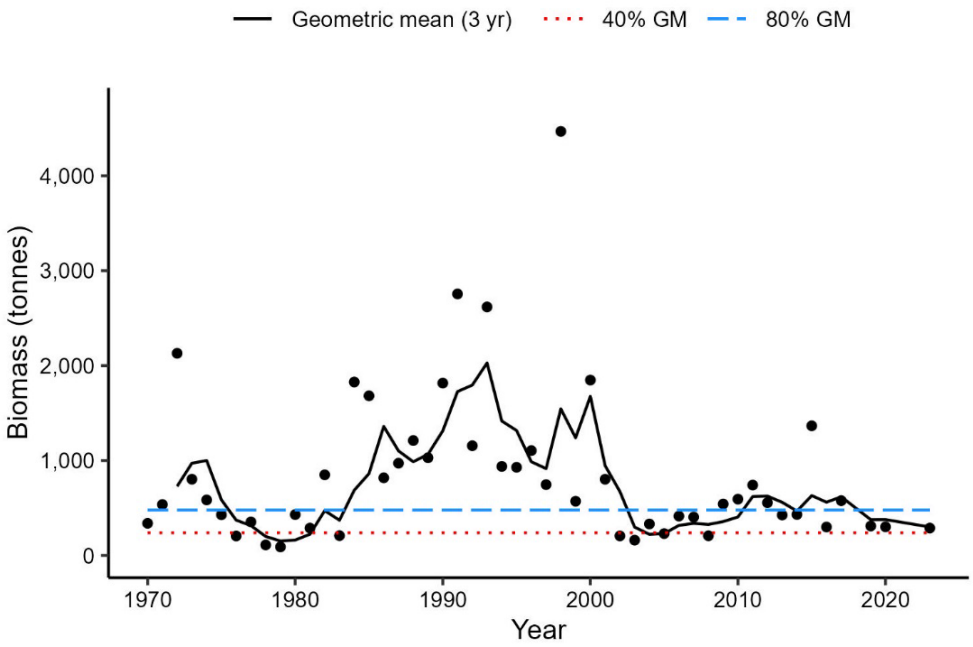

Figure 14d. Biomass index for Winter Flounder in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

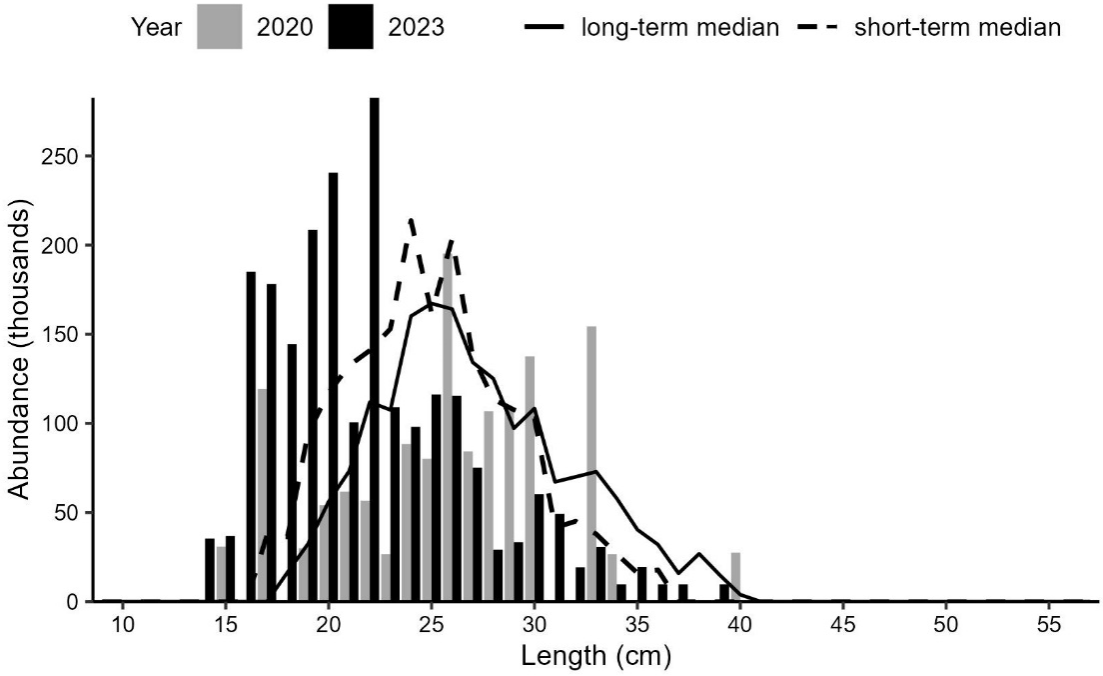

Figure 14e. Length frequency indices for Winter Flounder in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Atlantic Wolffish

Atlantic Wolffish (*Anarhichas lupus*) catches in 2023 predominantly occurred in 4VN; however the largest catch occurred on Georges Bank which consisted of a single fish weighing 14 kg (Figure 15a). The 2023 3-yr GM biomass index for 4X remains below 40% of the long-term GM since 2012 (Figure 15b). Only three individuals were caught in 4X (Figure 15c). In 4VW, the 3-yr GM in 2023 remains below the 40% long-term GM and has not exceeded this threshold since 2011 (Figure 15d). Twenty five individuals were caught in 4VW in 2023 ranging between 6 and 61 cm (Figure 15e).

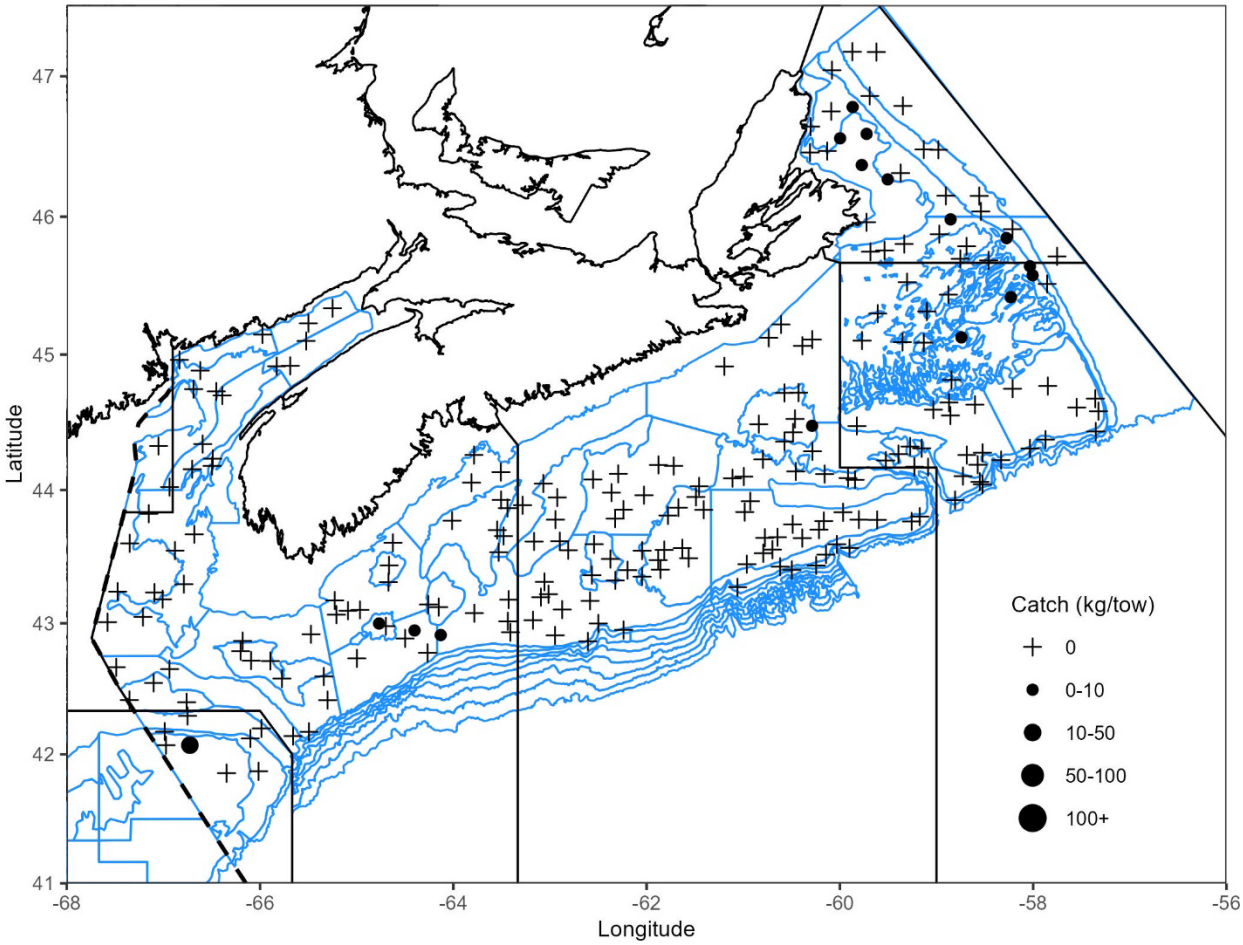

Figure 15a. Distribution of Atlantic Wolffish catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

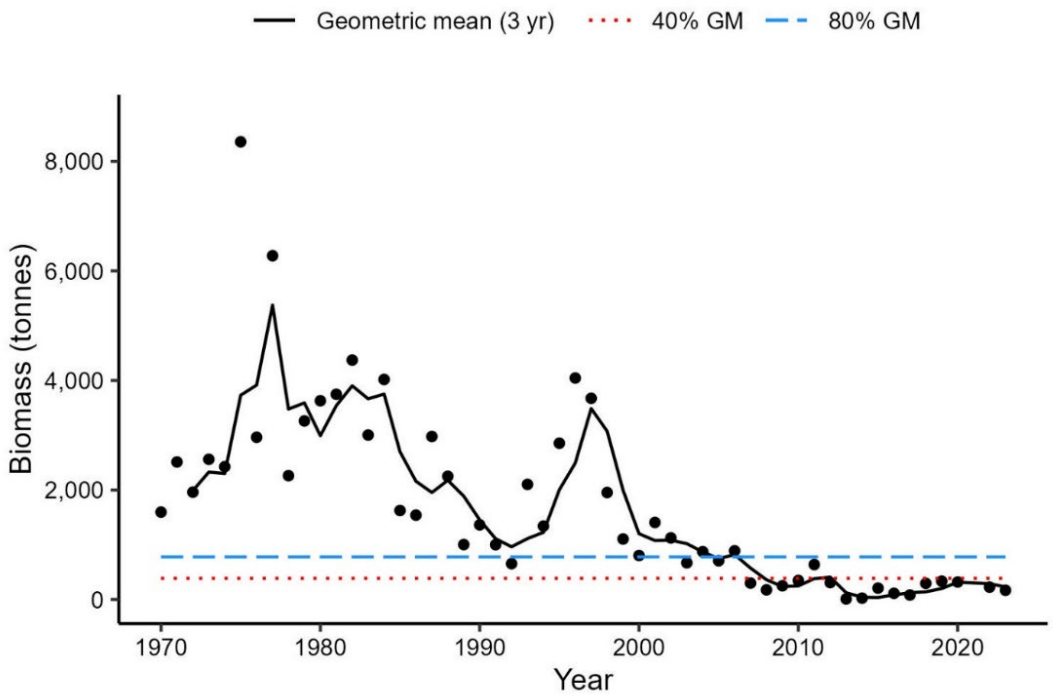

Figure 15b. Biomass index for Atlantic Wolffish in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

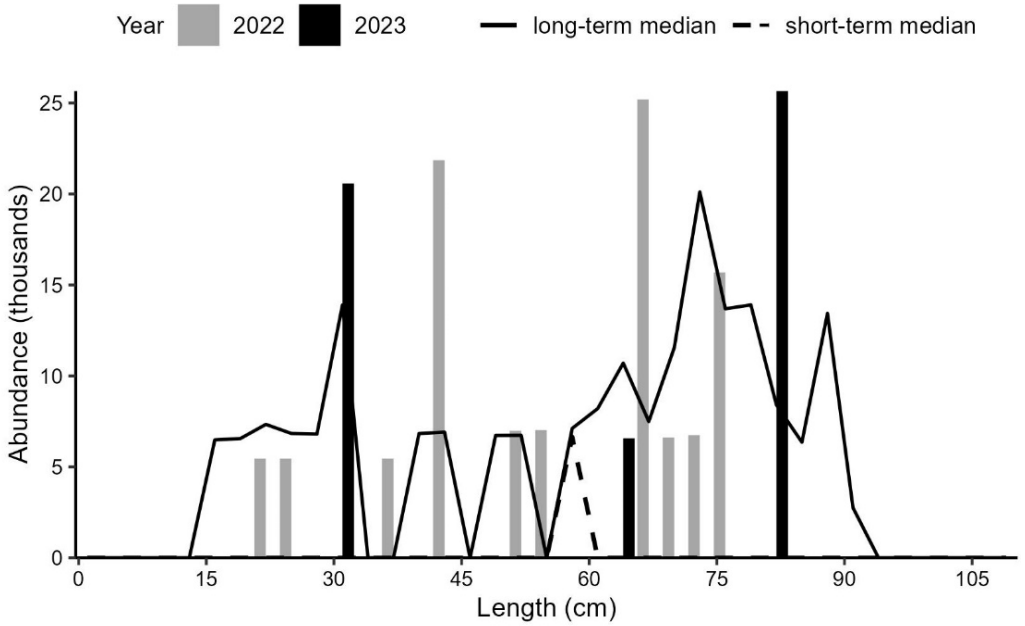

Figure 15c. Length frequency indices for Atlantic Wolffish in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

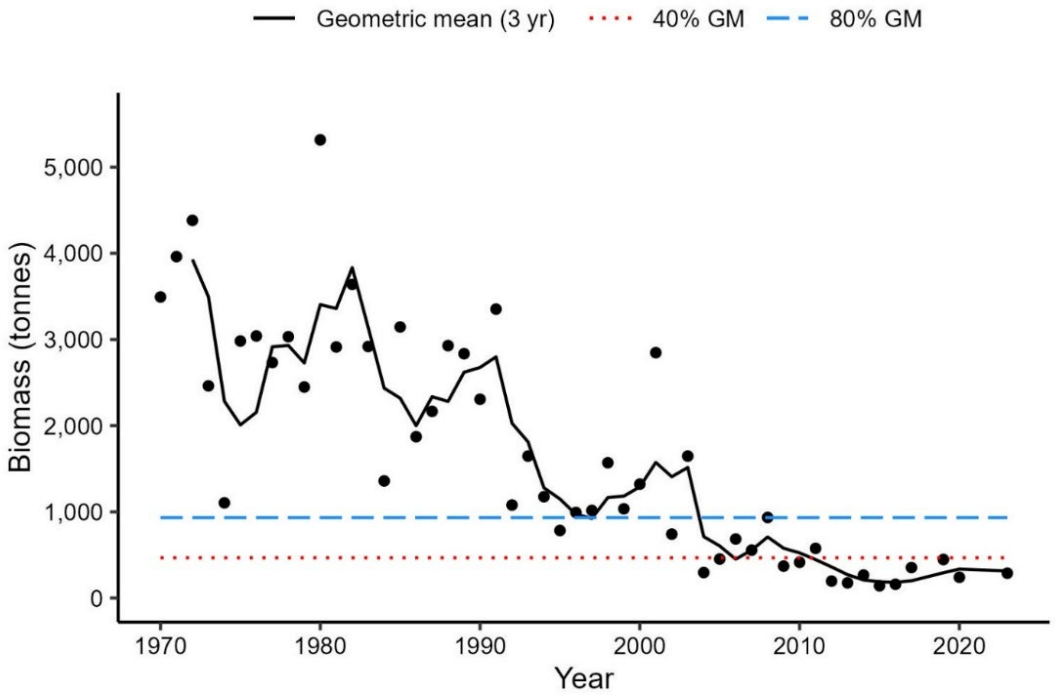

Figure 15d. Biomass index for Atlantic Wolffish in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

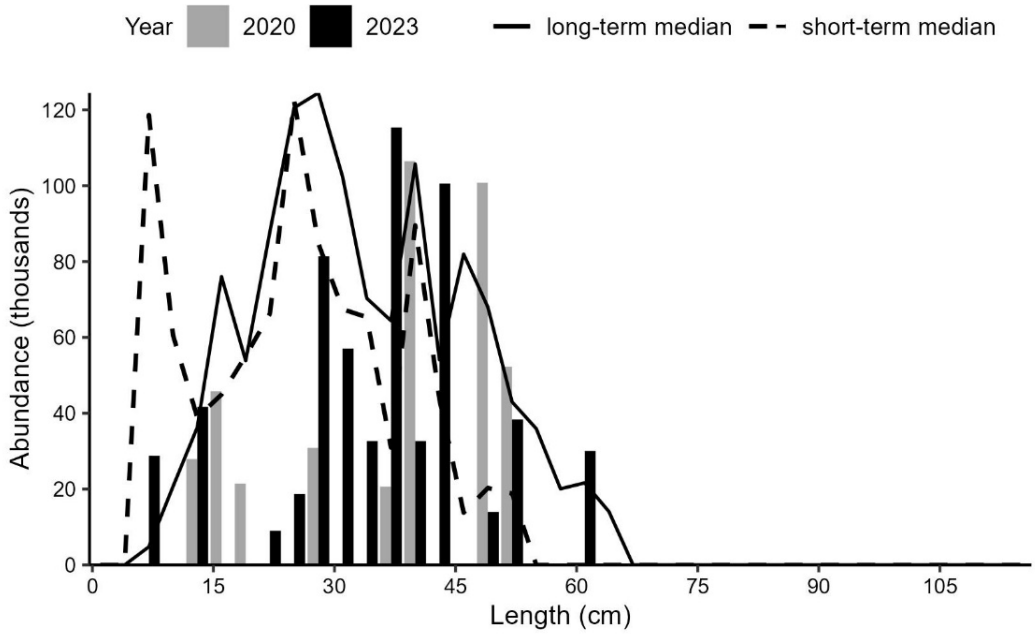

Figure 15e. Length frequency indices for Atlantic Wolffish in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Monkfish

Monkfish (*Lophius americanus*) catches predominantly occurred throughout 4X, 4W and near the Gully Marine Protected Area in 4V (Figure 16a). In 4X, both the biomass index and 3-yr GM increased to above 80% of the long-term GM in 2023 (Figure 16b). The indices at length are generally above both the long and short-term medians for most lengths (Figure 16c). In 4VW, the biomass index and the 3-yr GM remain similar to recent years and are above the 40% long-term GM (Figure 16d). Abundance indices for fish below 45 cm are generally below the short and long-term medians (Figure 16e).

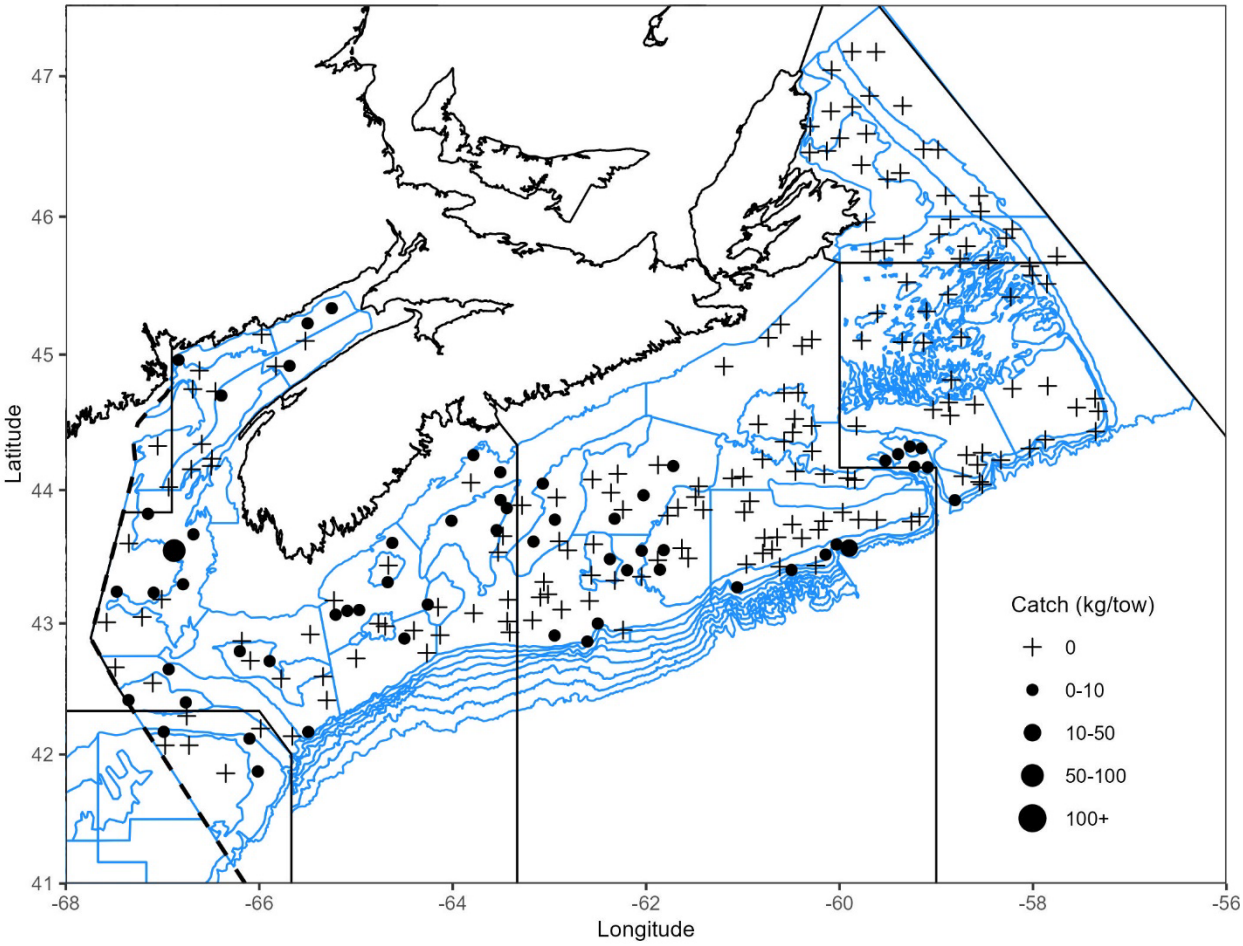

Figure 16a. Distribution of Monkfish catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

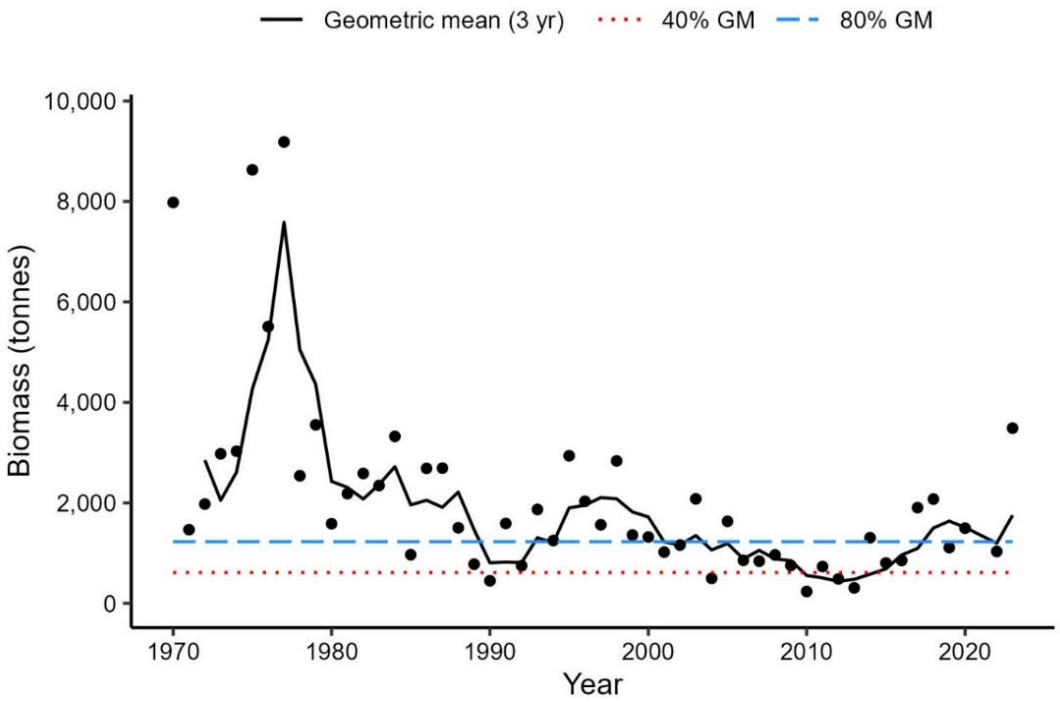

Figure 16b. Biomass index for Monkfish in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

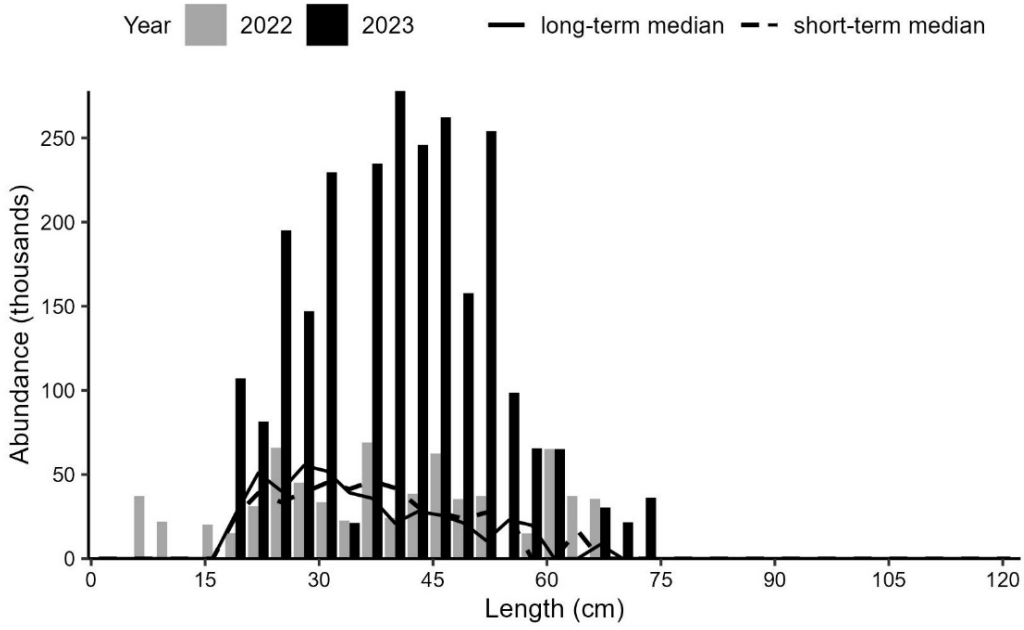

Figure 16c. Length frequency indices for Monkfish in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

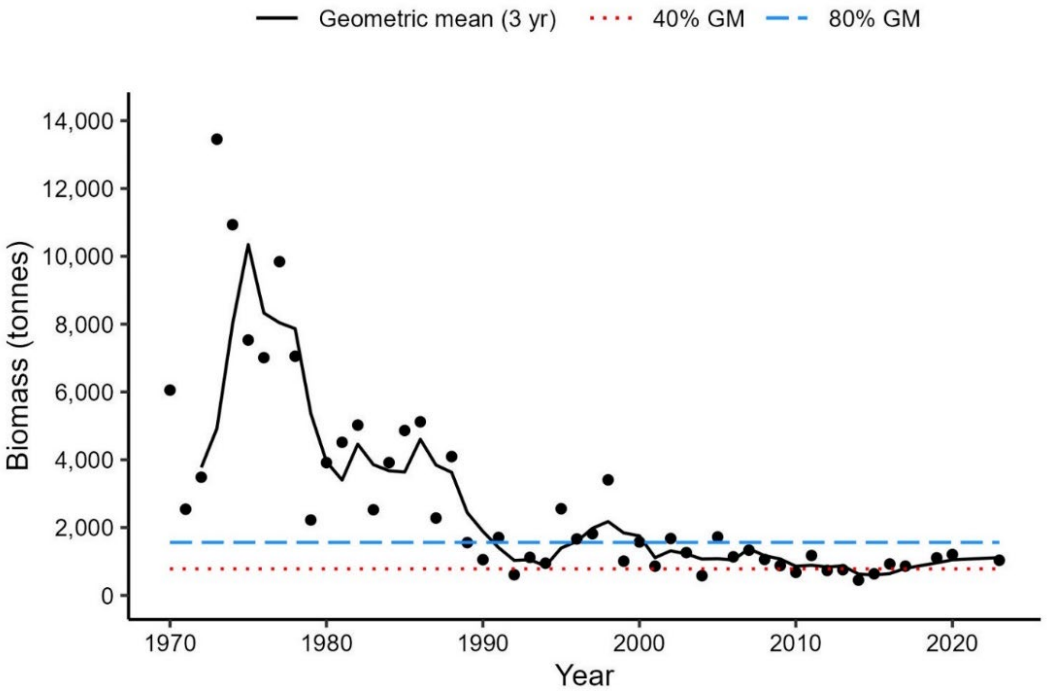

Figure 16d. Biomass index for Monkfish in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

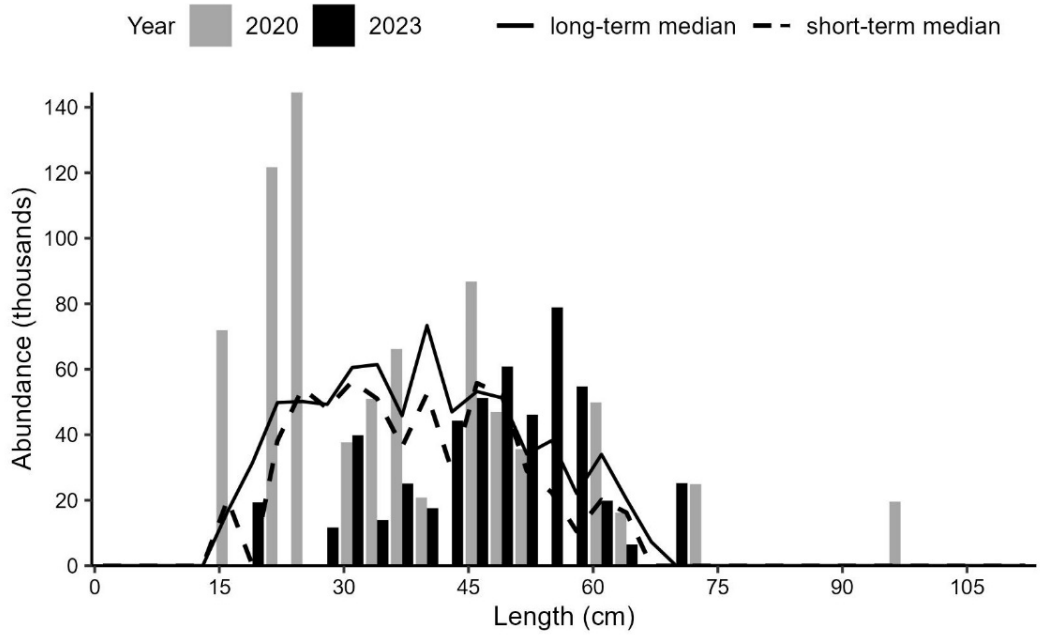

Figure 16e. Length frequency indices for Monkfish in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Longhorn Sculpin

The majority of Longhorn Sculpin (*Myoxocephalus octodecemspinosus*) are caught on banks throughout the Scotian Shelf and in the Bay of Fundy (Figure 17a). In 4X, both the 2023 biomass index and 3-yr GM increased from 2022 and are above 80% of the long-term mean (Figure 17b). In 4X, abundance indices surrounding the mode of 24 cm are above the short and long-term medians while most other lengths are generally similar or below the short and long-term medians. (Figure 17c). The 2023 biomass index and 3-yr GM in 4VW are similar to indices in the previous decade and remain between 40–80% of the long-term GM (Figure 17d). Similar to 4X, abundance indices in 4VW exceed the short and long-term medians surrounding the mode of 23 cm, while other length abundances are more similar to the short-term medians (Figure 17e).

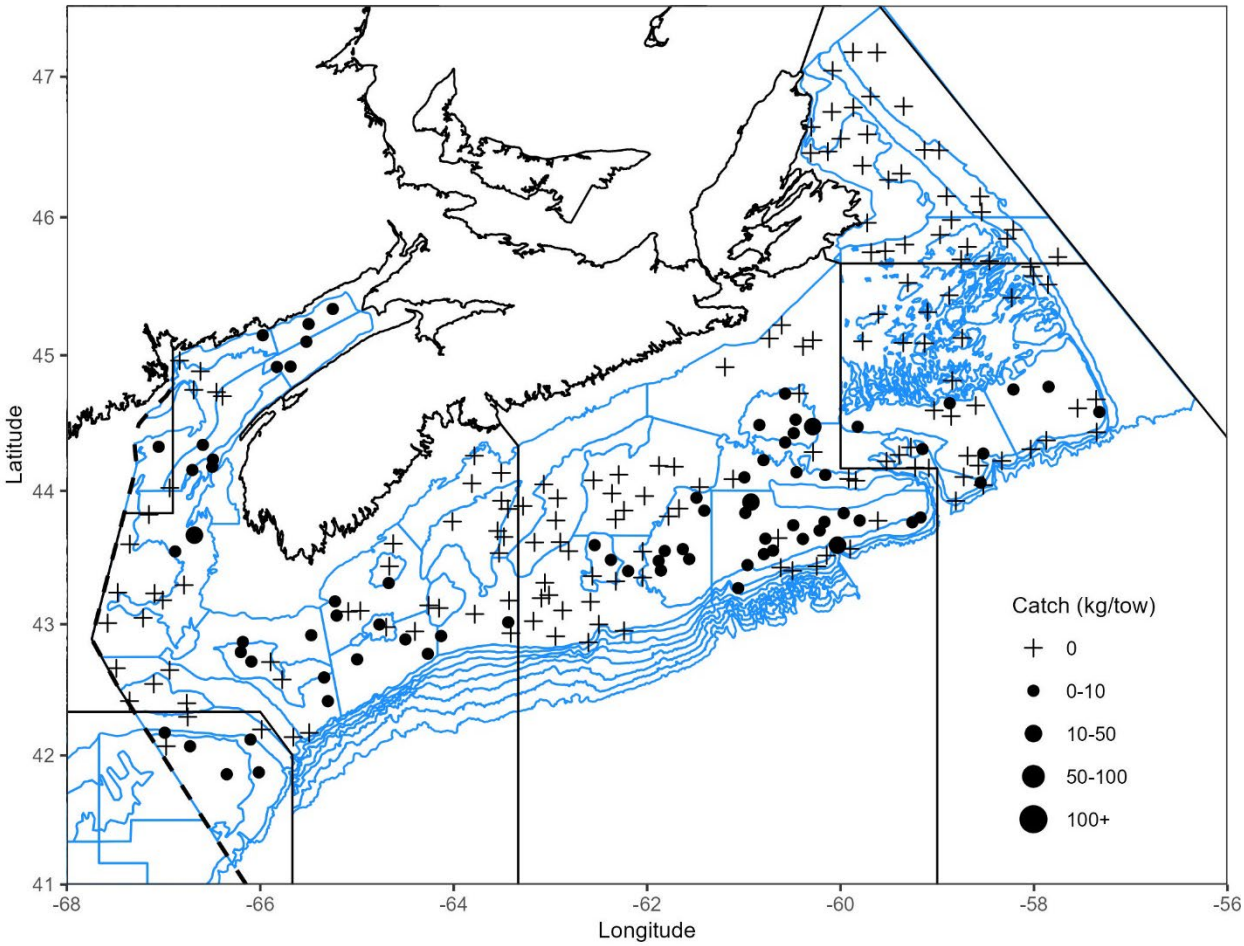

Figure 17a. Distribution of Longhorn Sculpin catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

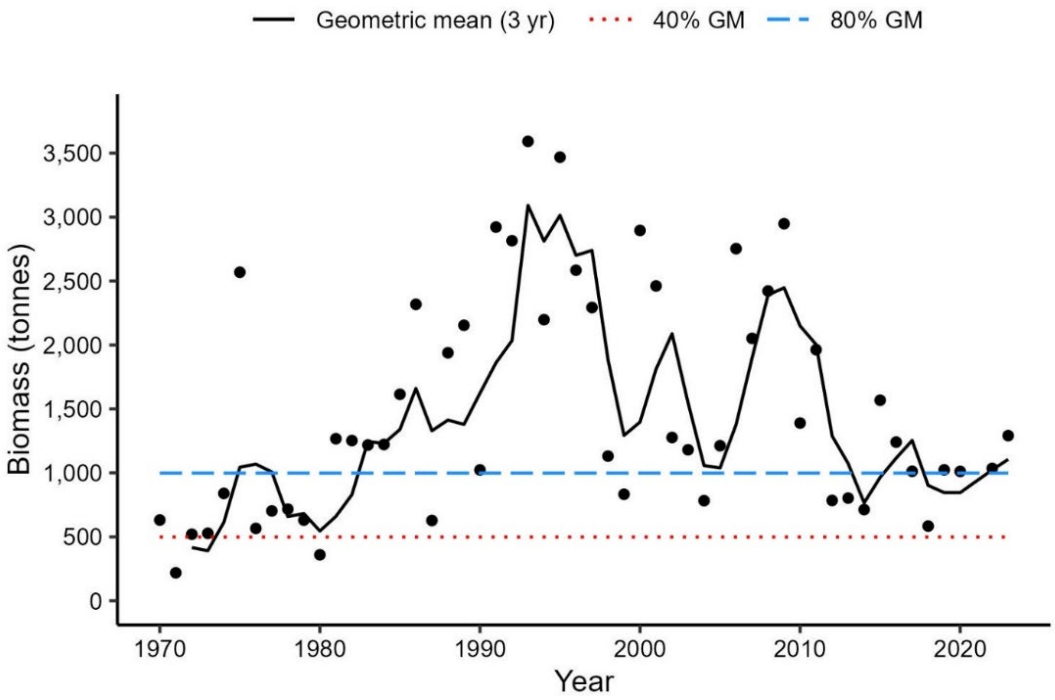

Figure 17b. Biomass index for Longhorn Sculpin in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

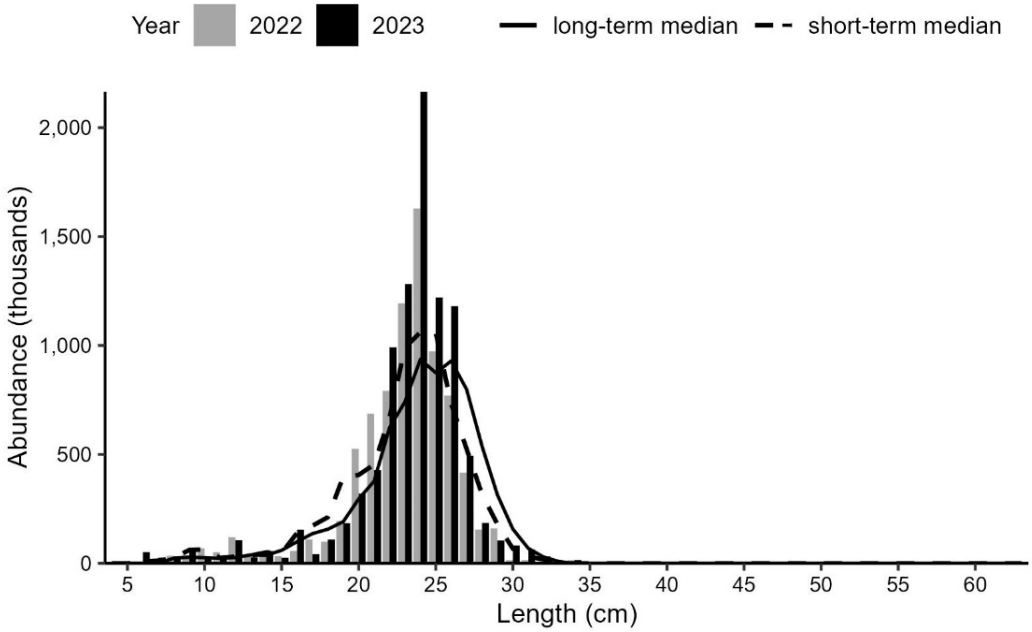

Figure 17c. Length frequency indices for Longhorn Sculpin in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

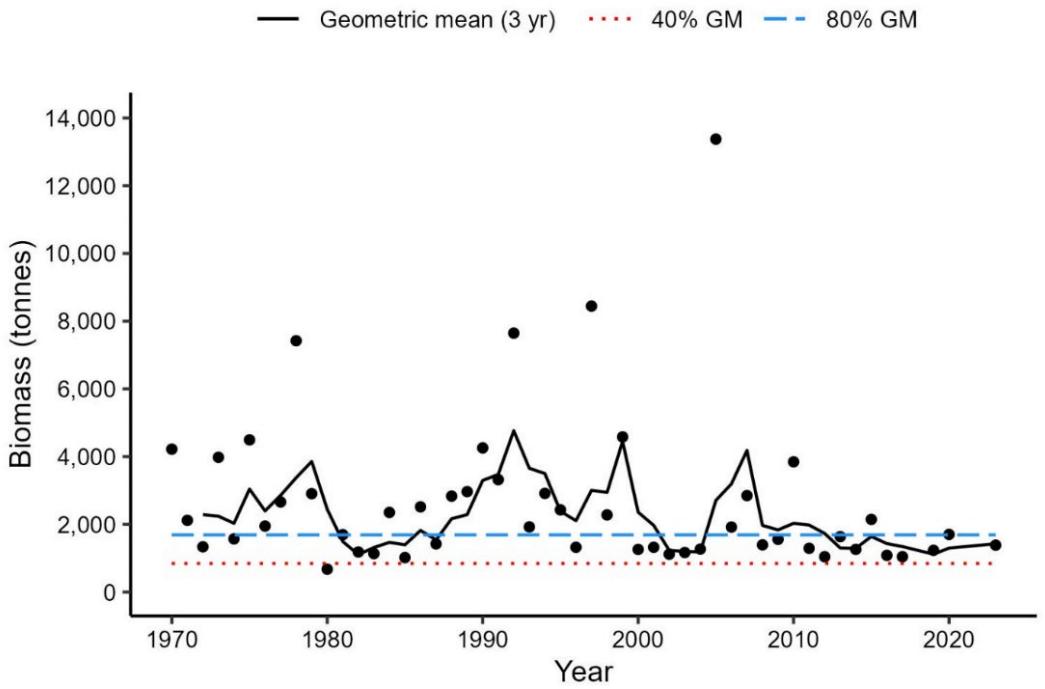

Figure 17d. Biomass index for Longhorn Sculpin in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

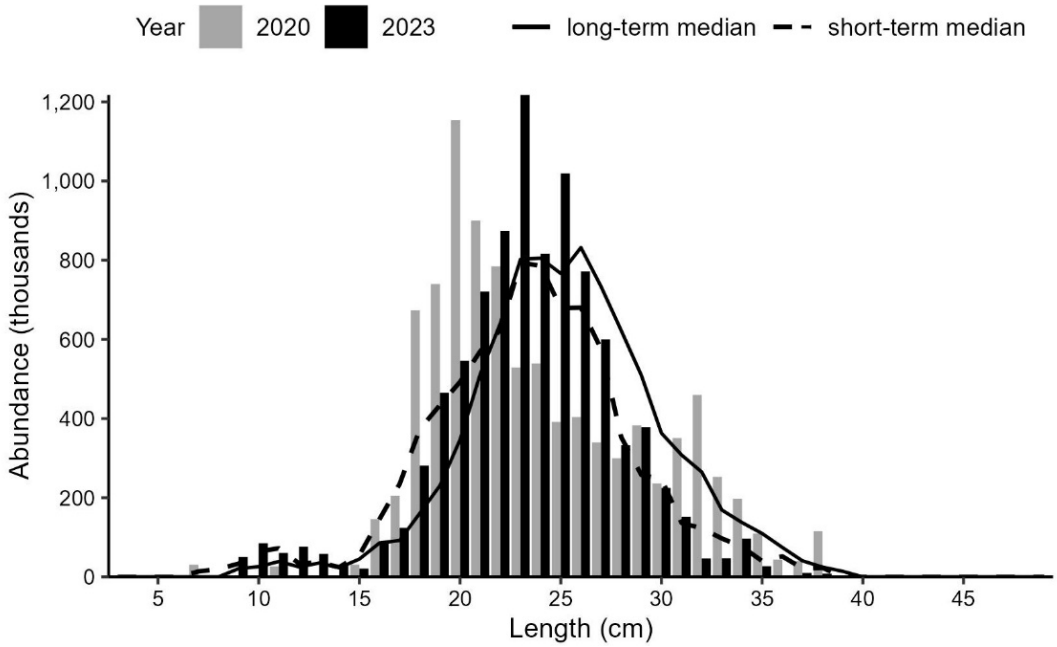

Figure 17e. Length frequency indices for Longhorn Sculpin in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Barndoor Skate

In 2023, Barndoor Skate (*Dipturus laevis*) were caught west of −61° longitude on the Scotian Shelf and on Georges Bank (Figure 18a). The 2023 biomass index for Barndoor Skate in 4X decreased from the 2022 time series high but is still the third highest index in the time series (Figure 18b). Since the late 1990s, the 3-yr median biomass has shown an increasing trend and in 2023 reached the highest point of the time series. Prior to 1998, catches were close to zero for all sizes of Barndoor Skates in 4X and 4VW, so the long-term median indices are zero for all lengths. In 2023, Barndoor Skates were caught at lengths ranging from 62 to 127 cm in 4X (Figure 18c). In 4VW, the 2023 biomass index is the second highest of the time series (Figure 18d); however, only eight individuals were captured in six sets in 4W (Figure 18e).

Barndoor Skate are a large, wide ranging fish which prefer the warmer waters in the Maritimes Region. When reviewed by the Committee on the Status of Endangered Wildlife in Canada, the Designatable Unit (DU) included 4VWX5Zc; all of the area typically covered by the DFO Summer Ecosystem RV Survey since 2011. On Georges Bank (5Zc) the biomass index in 2023 was 1,899 t, which is 66% of the index in 4X (2,895 t). Of the 114 Barndoor Skates observed in 2023, 82 (72%) were caught in 5Z and consisted of mostly smaller individuals (73% below 62 cm). In the winter, few Barndoor Skate are caught on top of Georges Bank (5Z1+2), as they move off the bank into deeper waters of the Fundian Channel and Gulf of Maine. Given their seasonal movements and preference for warmer water, it may be more informative to look at biomass trends for Barndoor Skates for the survey area as a whole rather than separately for NAFO Divisions.

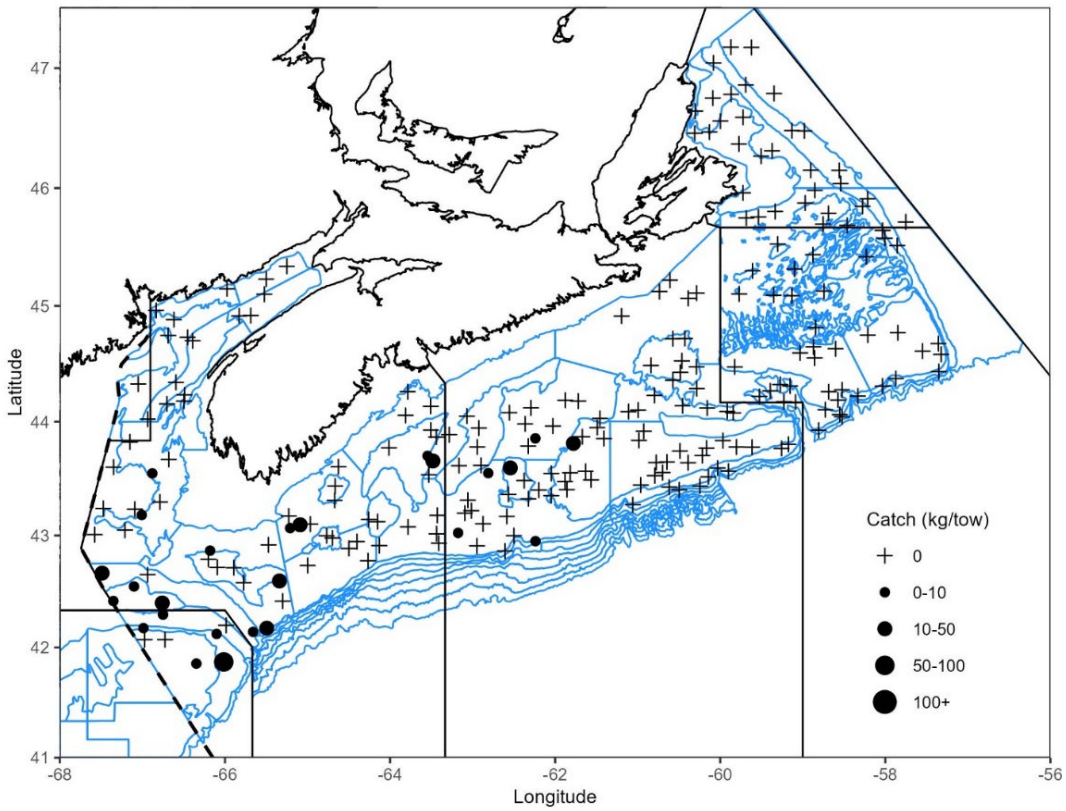

Figure 18a. Distribution of Barndoor Skate catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

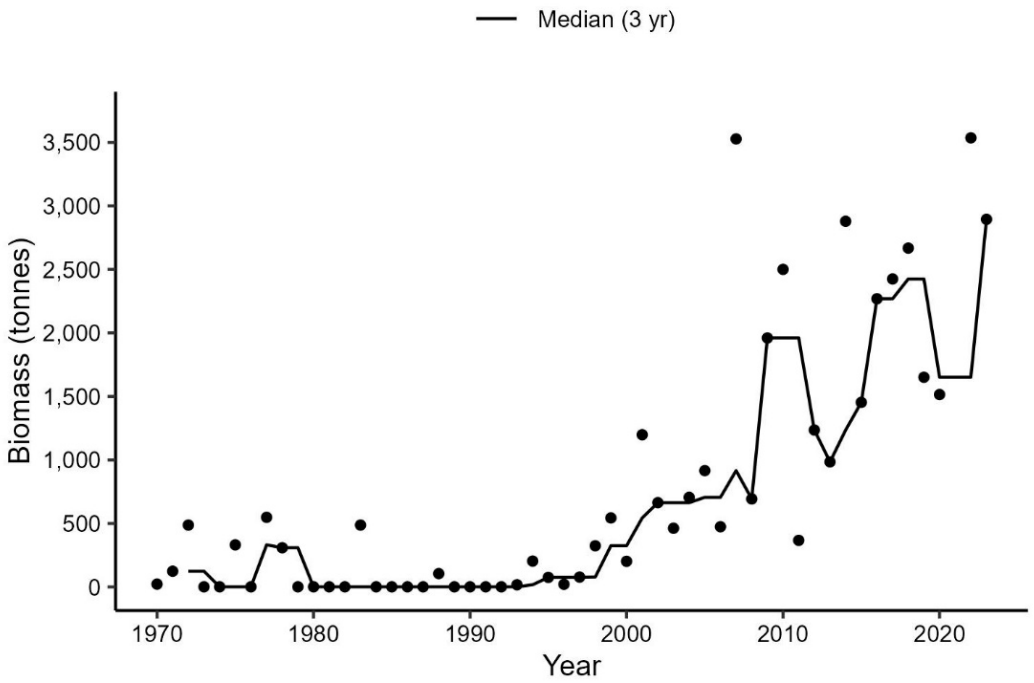

Figure 18b. Biomass index for Barndoor Skate in 4X from the DFO Summer Ecosystem RV Survey. The three-year median biomass index is represented by the solid black line. The black dots represent the biomass index for that year.

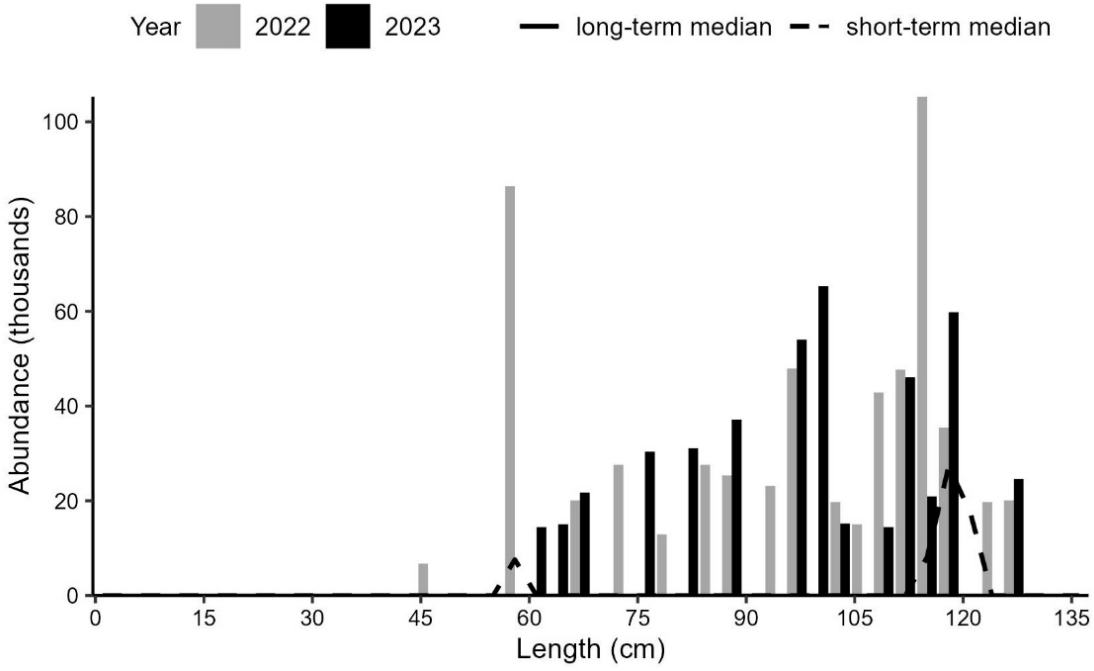

Figure 18c. Length frequency indices for Barndoor Skate in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

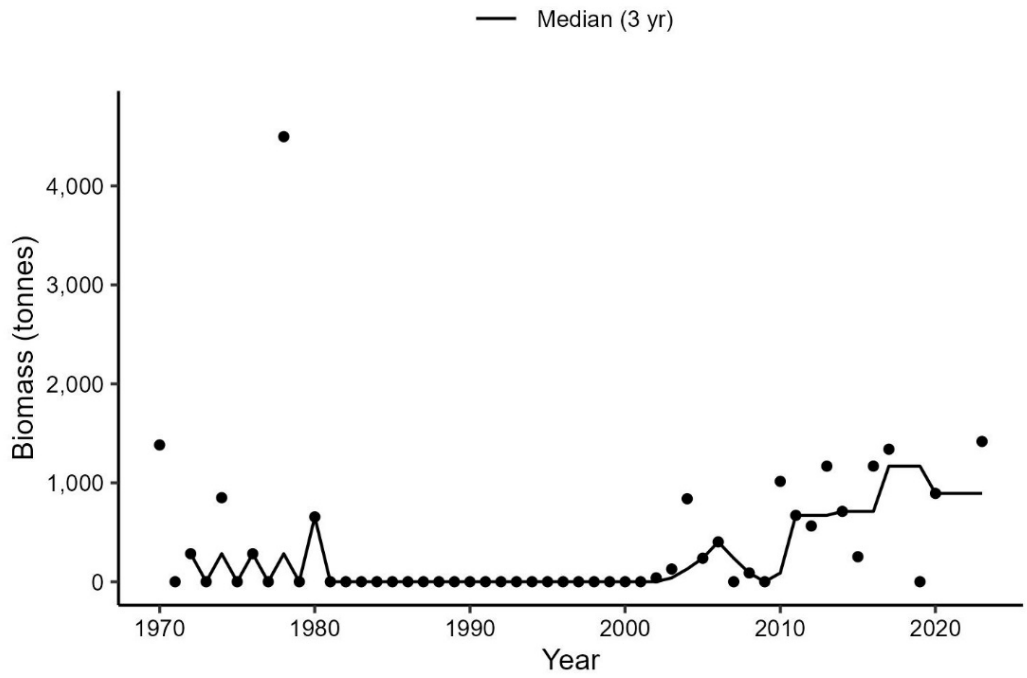

Figure 18d. Biomass index for Barndoor Skate in 4VW from the DFO Summer Ecosystem RV Survey. The three-year median biomass index is represented by the solid black line. The black dots represent the biomass index for that year.

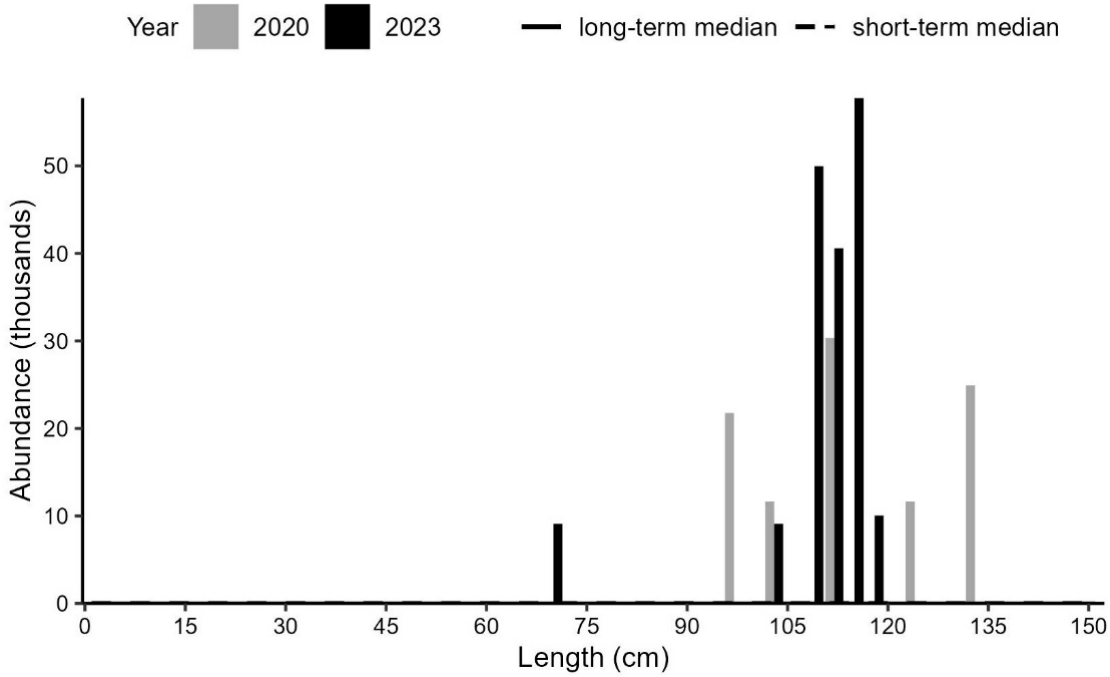

Figure 18e. Length frequency indices for Barndoor Skate in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Thorny Skate

In 2023, Thorny Skate (*Amblyraja radiata*) were predominantly captured in 4V with very few catches occurring in 4W or 4X (Figure 19a). In 4X, the biomass index and 3-yr GM has remained stable at low levels below the 40% long-term GM since 2010 (Figure 19b). Only eight individuals were caught in 4X in 2023 (Figure 19c). In 4VW, the 3-yr GM has also remained below the 40% long-term GM since 2010 (Figure 19d). Abundance indices are similar to or above the short-term median for lengths greater than 29 cm, but below for smaller lengths (Figure 19e).

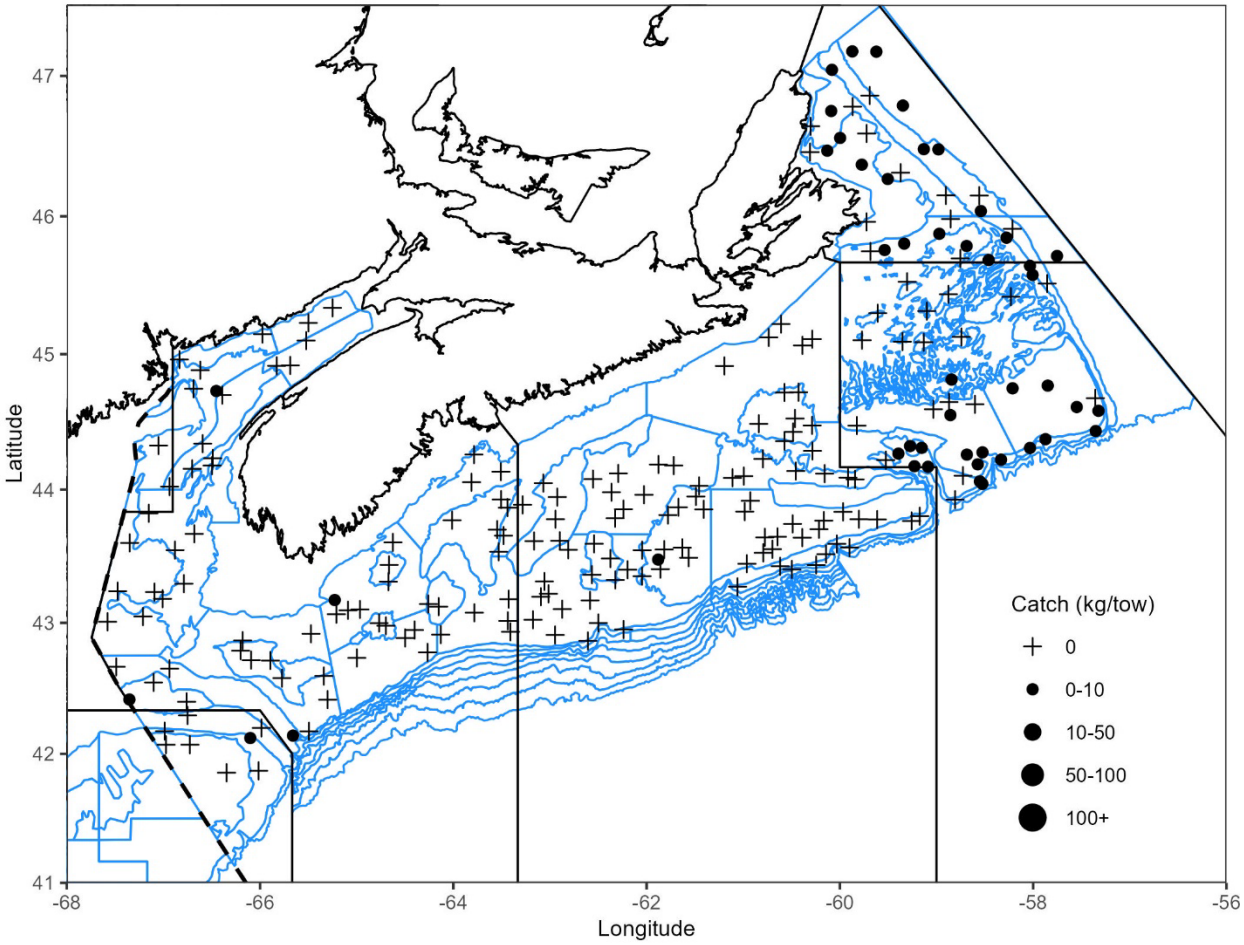

Figure 19a. Distribution of Thorny Skate catches during the 2023 DFO Summer Ecosystem RV Survey including the Laurentian channel and Georges Bank. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

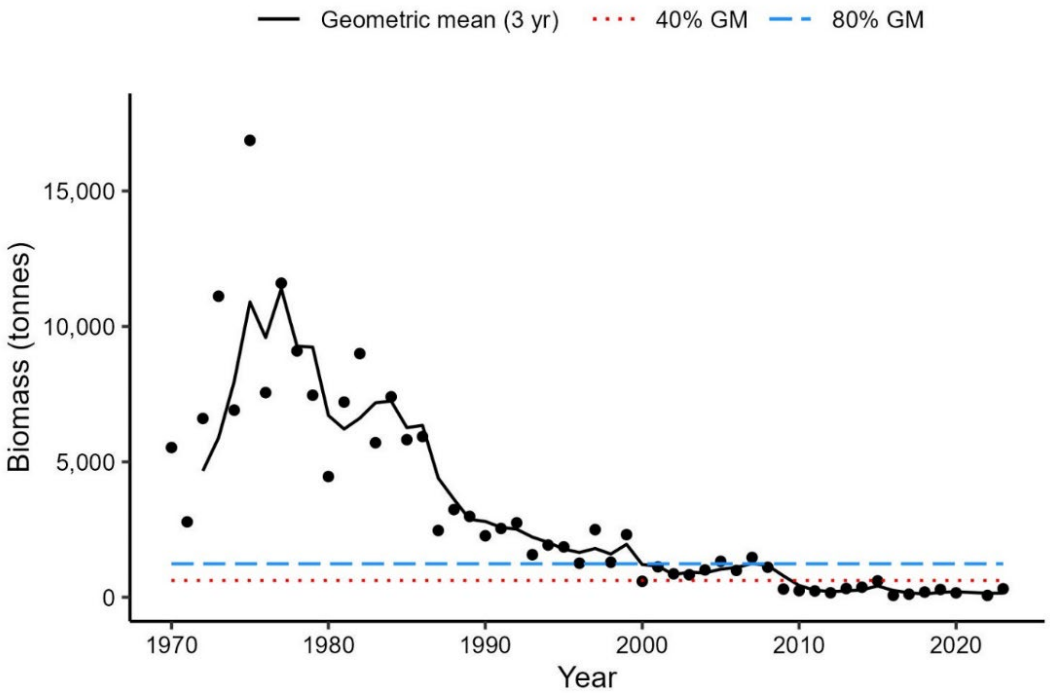

Figure 19b. Biomass index for Thorny Skate in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

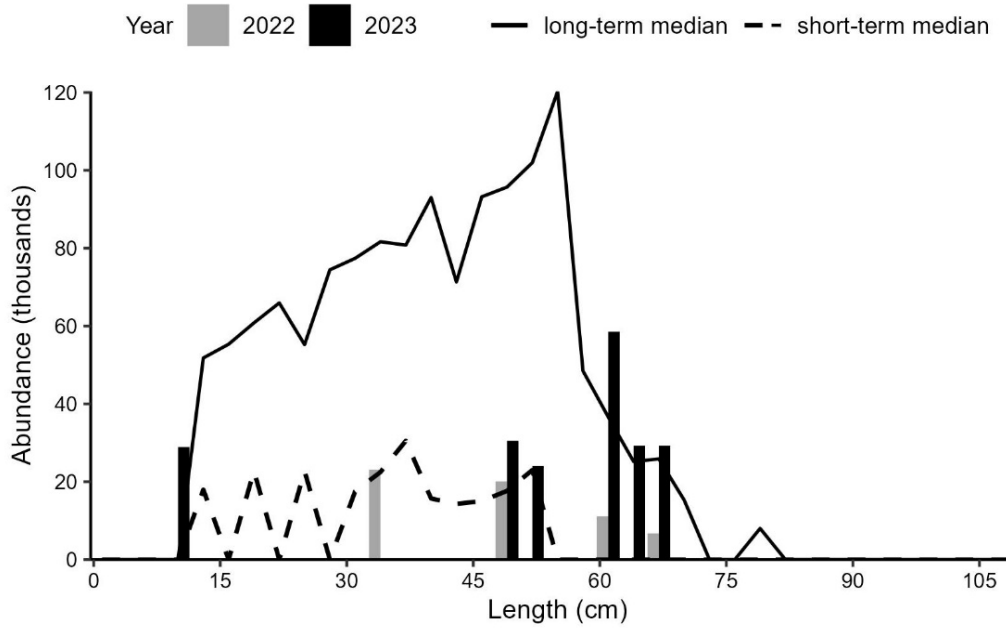

Figure 19c. Length frequency indices for Thorny Skate in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

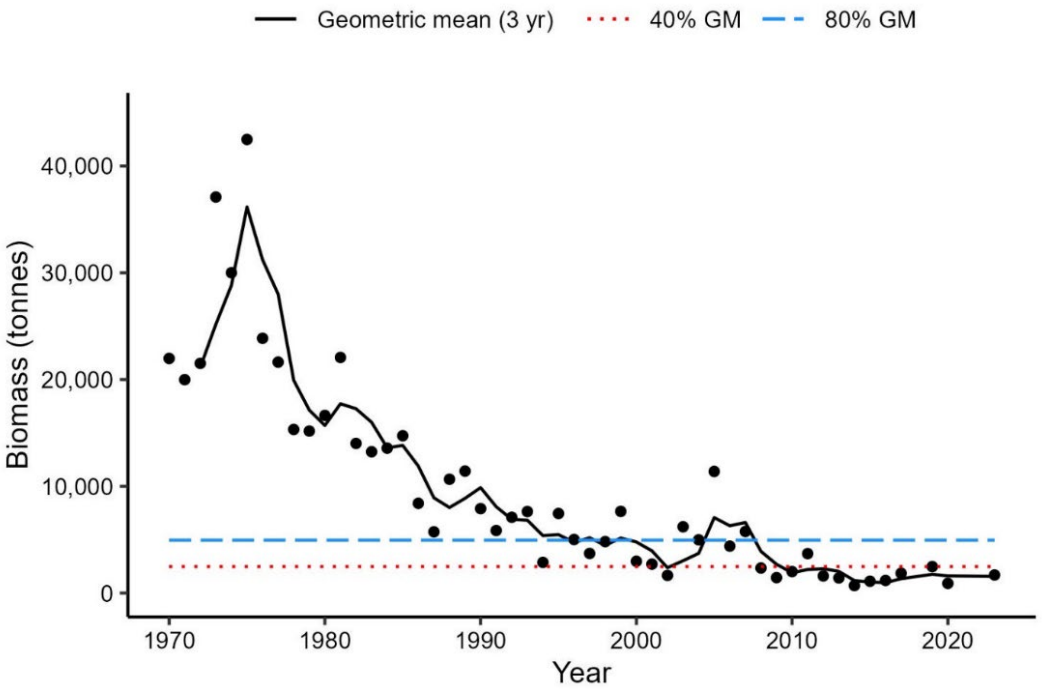

Figure 19d. Biomass index for Thorny Skate in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

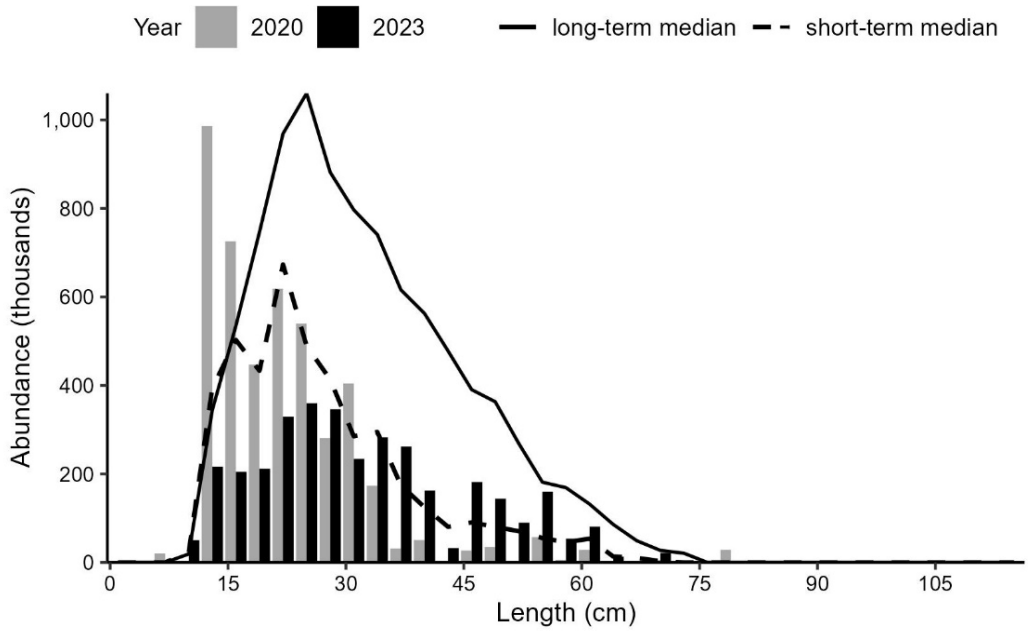

Figure 19e. Length frequency indices for Thorny Skate in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Winter Skate

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

Winter Skate were caught primarily on Georges Bank with smaller catches on Browns Bank and in the Bay of Fundy (Figure 20a). In 4X, the 3-yr GM remains above 80% of the long-term GM (Figure 20b). Abundance at length indices are generally above both the long and short-term medians for lengths above 58 cm (Figure 20c). In 4VW, the 3-yr GM has been below the 40% long-term GM since 2006 (Figure 20d) and only four individuals were caught in 2023 (Figure 20e).

The biomass index for Georges Bank from the 2023 DFO Summer Ecosystem RV Survey was 37,991 t; this is 84 times the index for 4X. The DU for Winter Skate includes both 4X and 5Z; however, they are seldom caught in the deeper water of the Fundian Channel between Browns Bank and Georges Bank. While it may be appropriate to review the biomass trends for 4X and 5Zc separately, summer survey data may be useful in reviewing the status of Winter Skate on Georges Bank.

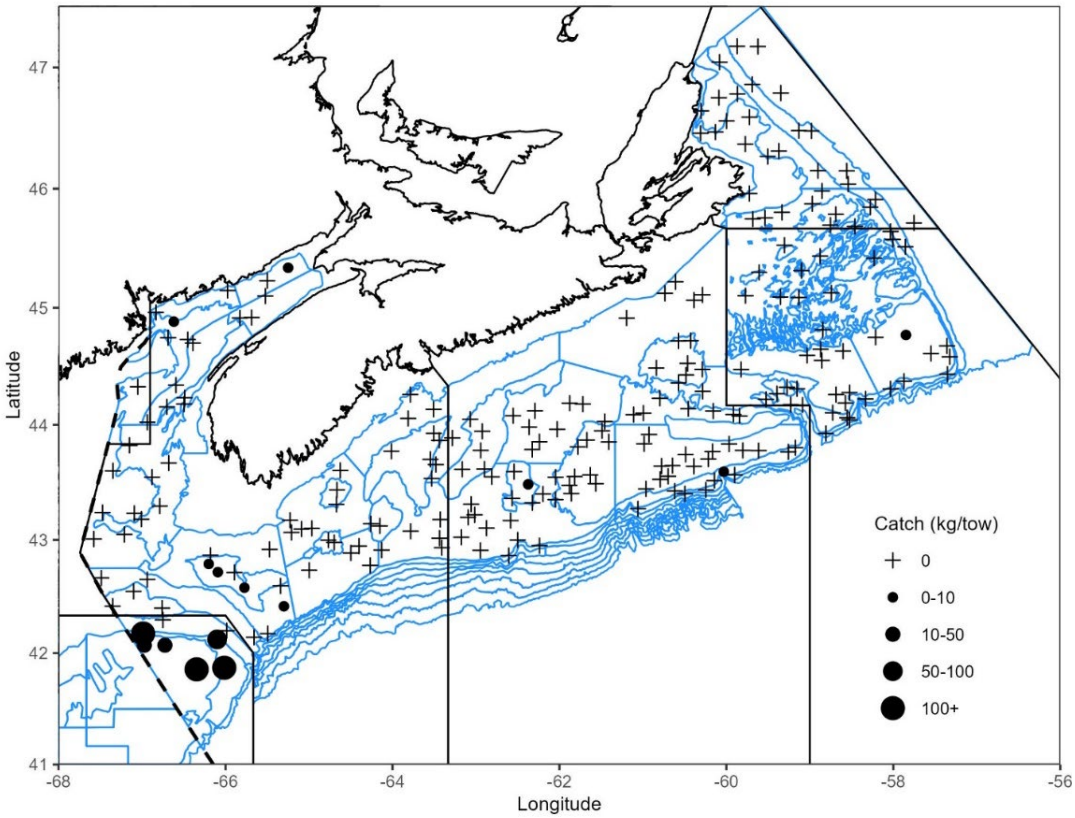

Figure 20a. Distribution of Winter Skate catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

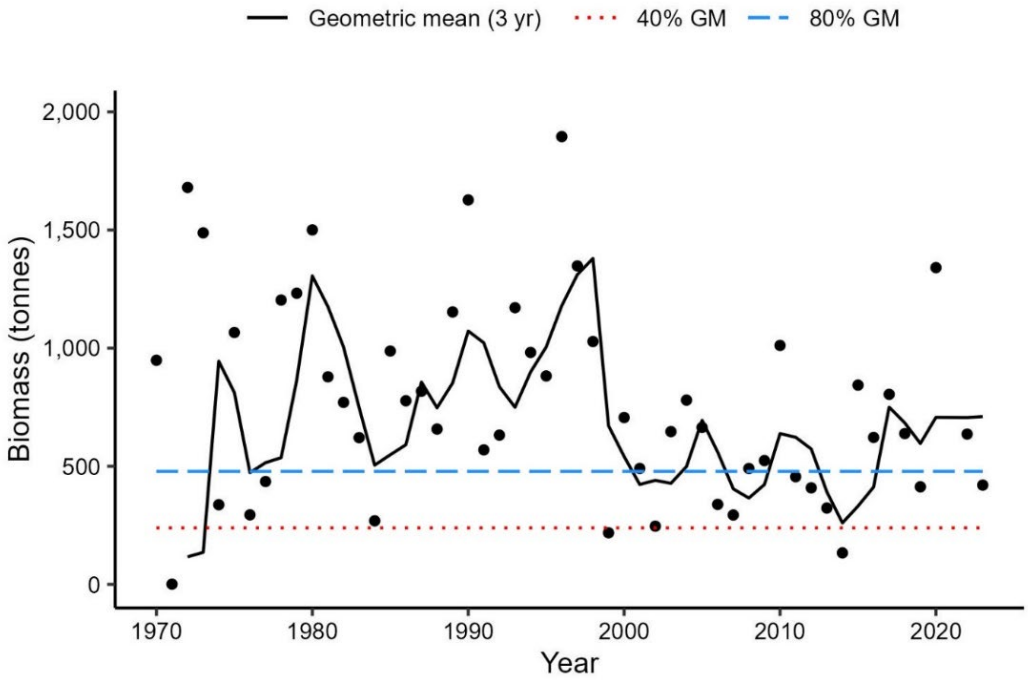

Figure 20b. Biomass index for Winter Skate above 40 cm in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

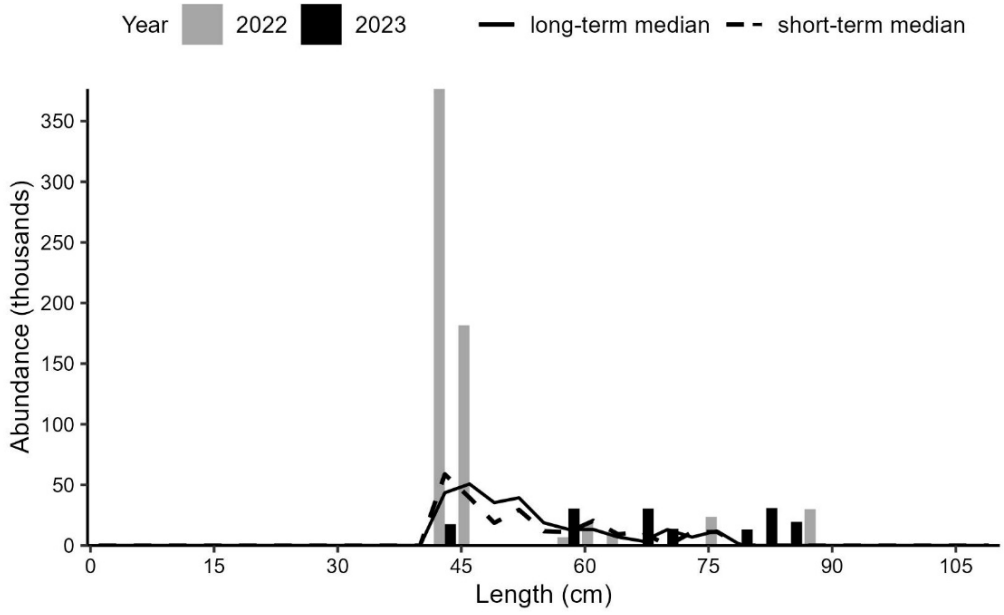

Figure 20c. Length frequency indices for Winter Skate above 40 cm in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

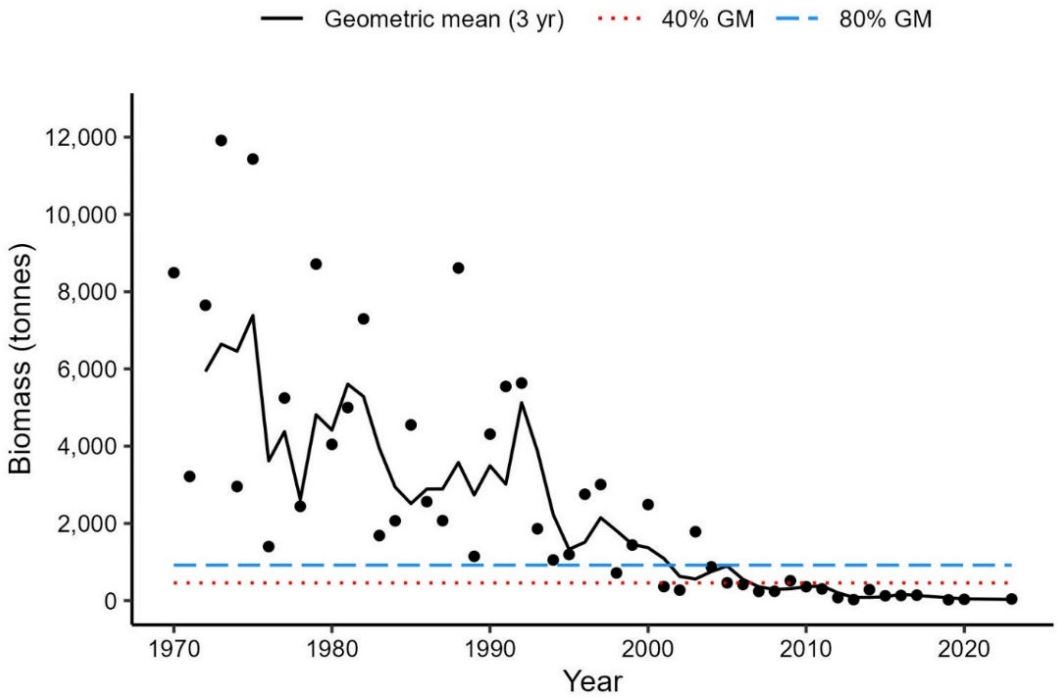

Figure 20d. Biomass index for Winter Skate in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

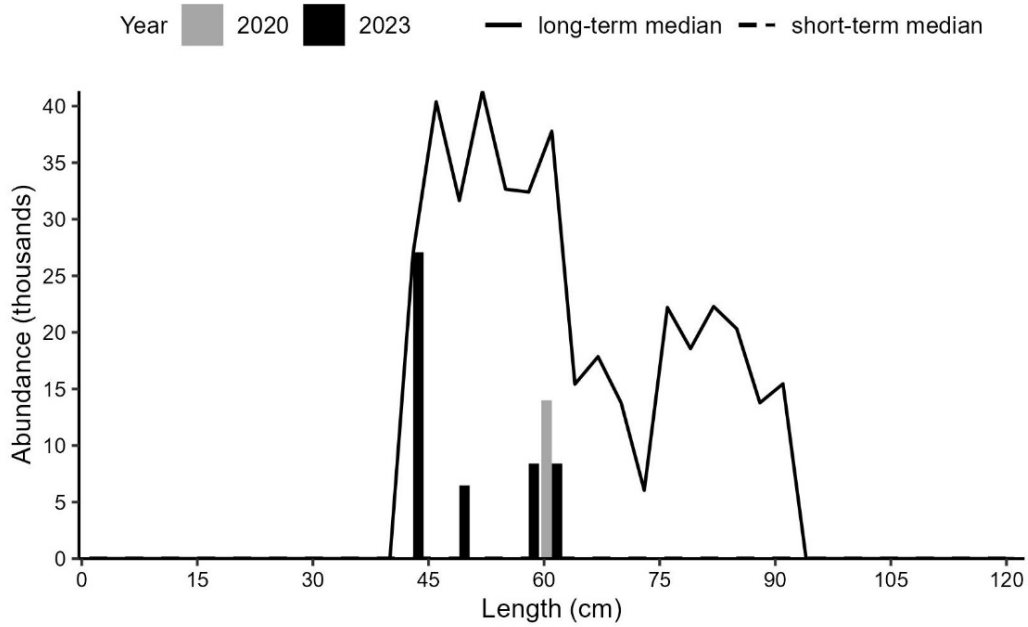

Figure 20e. Length frequency indices for Winter Skate in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Little Skate

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

Little Skate were caught primarily on Georges Bank, Browns Bank, in the Bay of Fundy and on the shallow banks in 4W (Figure 21a). The biomass index and 3-yr GM for 4X declined in 2023 from the time series high in 2022, but both remain above the 80% long-term GM. (Figure 20b). Abundance indices for 4X are generally below the short-term median for most lengths but above the long-term median for fish below 45 cm (Figure 21c). The geographic range of Little Skate does not extend far into 4VW and catches are historically very small; however, the 3-yr GM in 2023 remains above the 80% long-term GM and the biomass index is the fifth highest in the time series (Figure 21d). Compared to 2020, where only three individuals were caught, a much wider length distribution was observed in 2023 with Little Skate ranging between 40 and 59 cm.

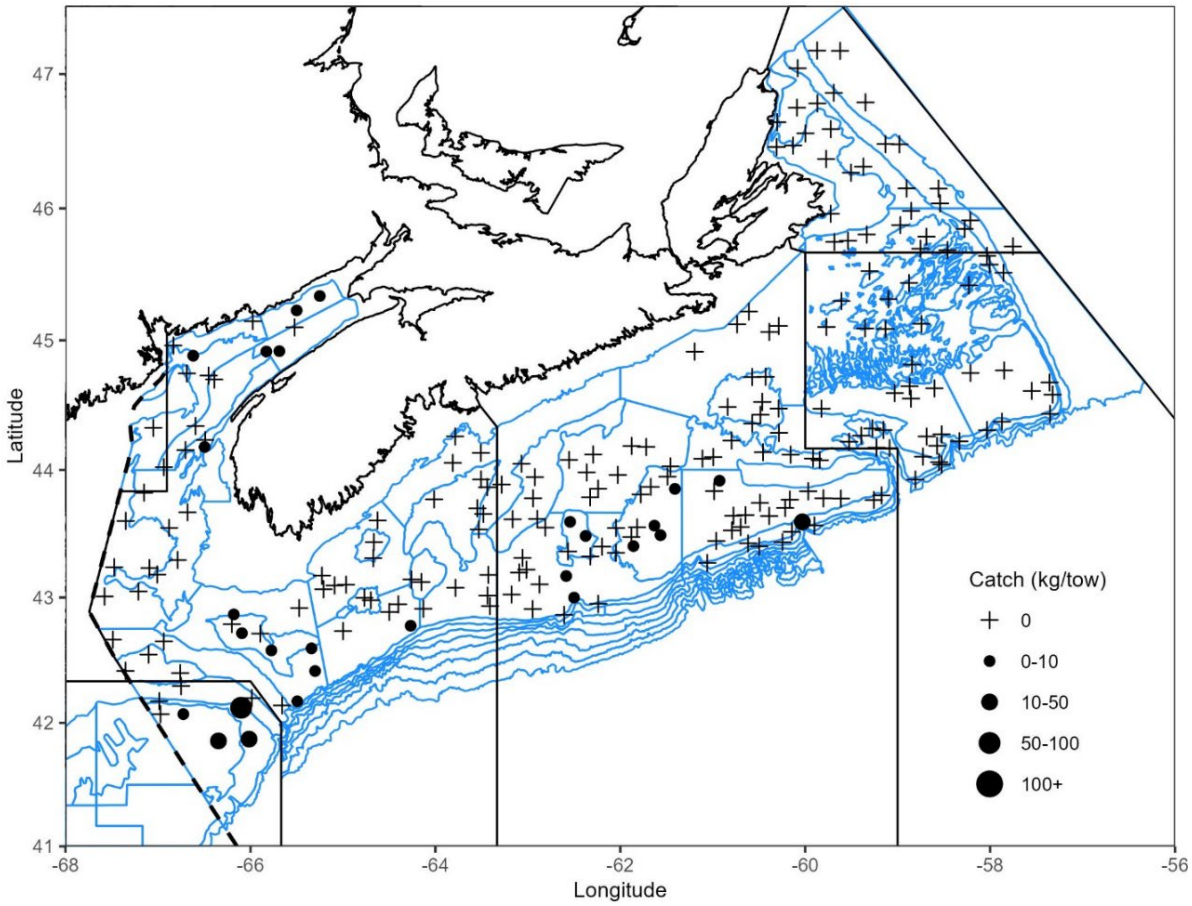

Figure 21a. Distribution of Little Skate catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

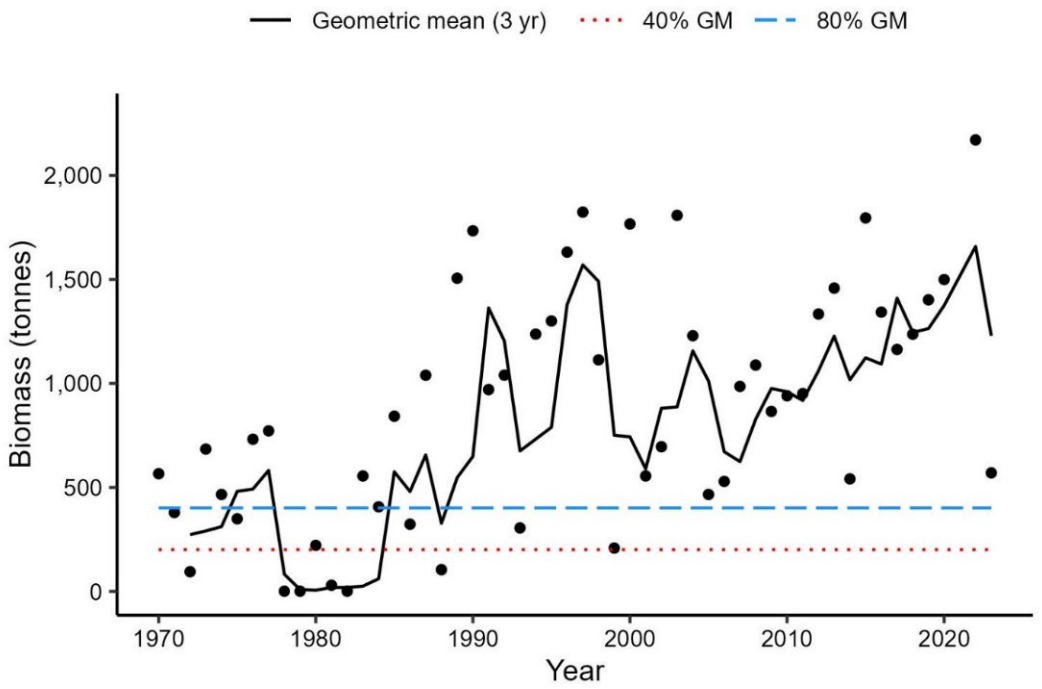

Figure 21b. Biomass index for Little Skate in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

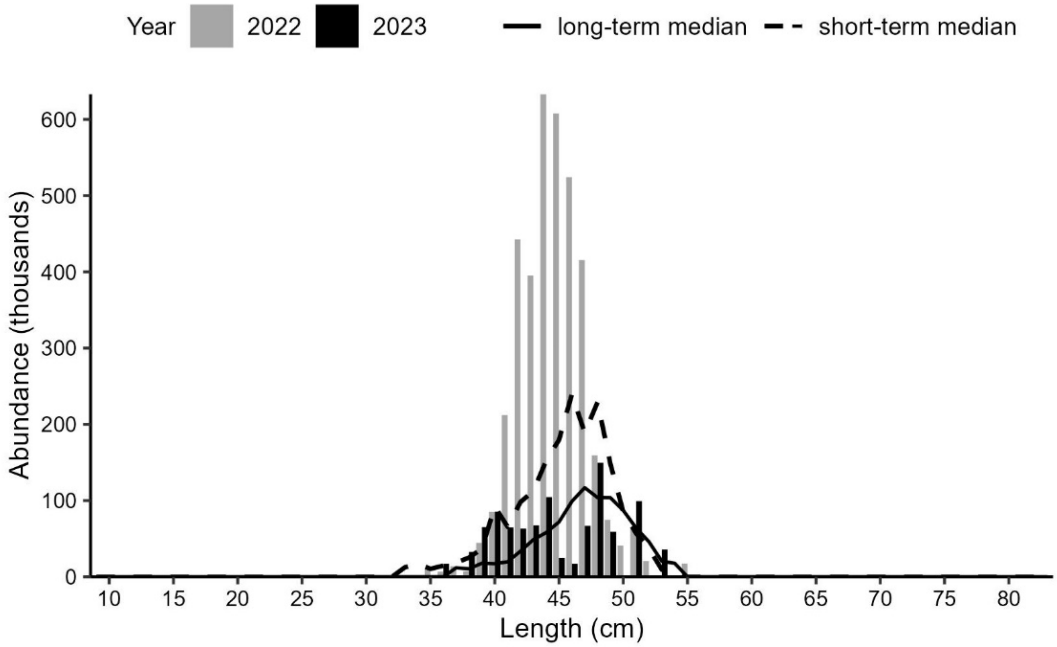

Figure 21c. Length frequency indices for Little Skate in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

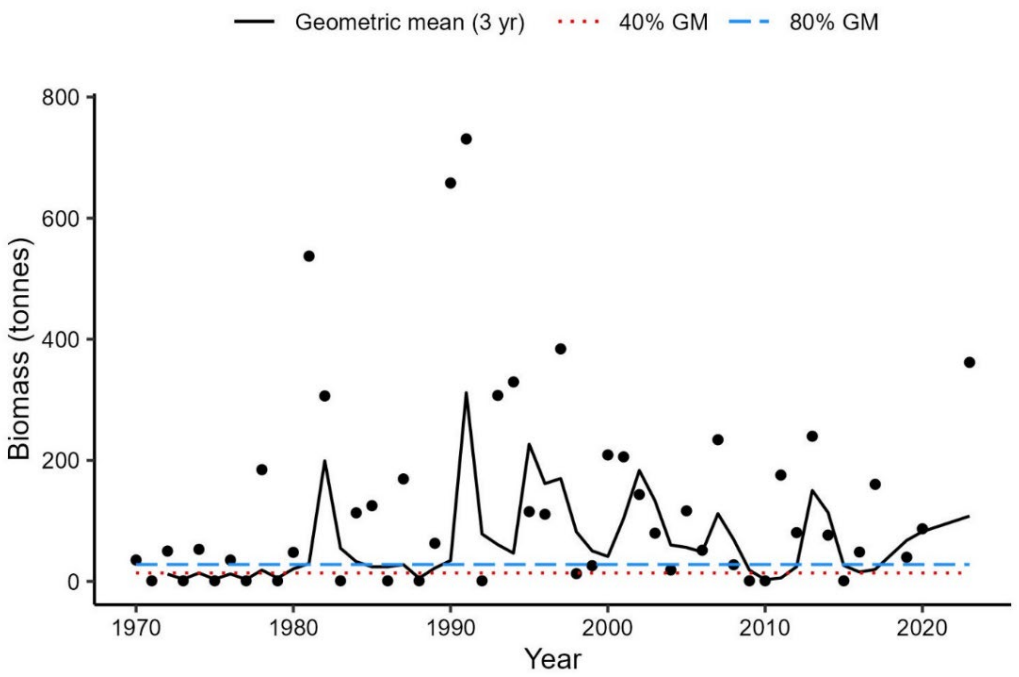

Figure 21d. Biomass index for Little Skate in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

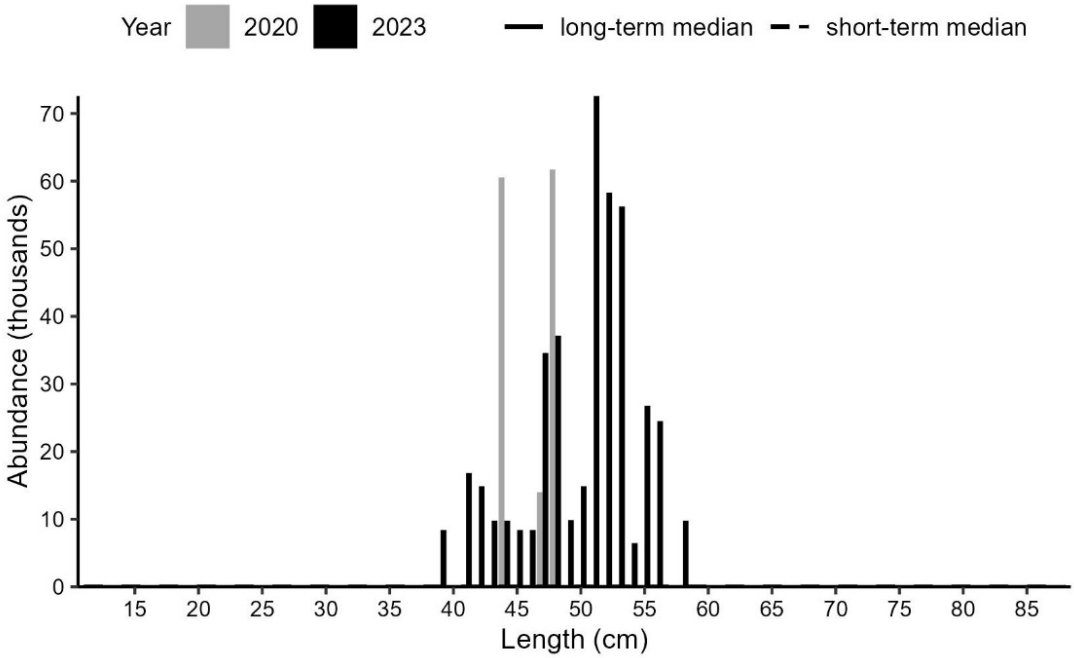

Figure 21e. Length frequency indices for Little Skate in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Smooth Skate

Smooth Skate (*Malacoraja senta*) are generally caught at the eastern and western ends of the survey area (Figure 22a). In 4X, the 3-yr GM increased from its lowest point in the early 1990s and fluctuated around 80% of the long-term mean in recent years. In 2023, the biomass index and 3-yr GM both increased from 2022 and remains above the 80% long-term GM (Figure 22b). For the majority of lengths observed in 4X in 2023, abundance indices are generally higher than both the short-term and long-term medians (Figure 22c). The 2023 biomass index for 4VW is above the 80% long-term GM for the first time since 2012, but the 3-yr GM remains between the 40-80% long-term GM (Figure 22d). Similar to 4X, 4VW experienced a drastic decline in biomass during the 1980s but has not shown a similar increase since then and has instead remained at low levels. Abundance indices in 4VW are above both the short and long-term medians for most lengths in 2023, and more larger (above 40 cm) and smaller (below 20 cm) Smooth Skate were observed than in recent years (Figure 22e).

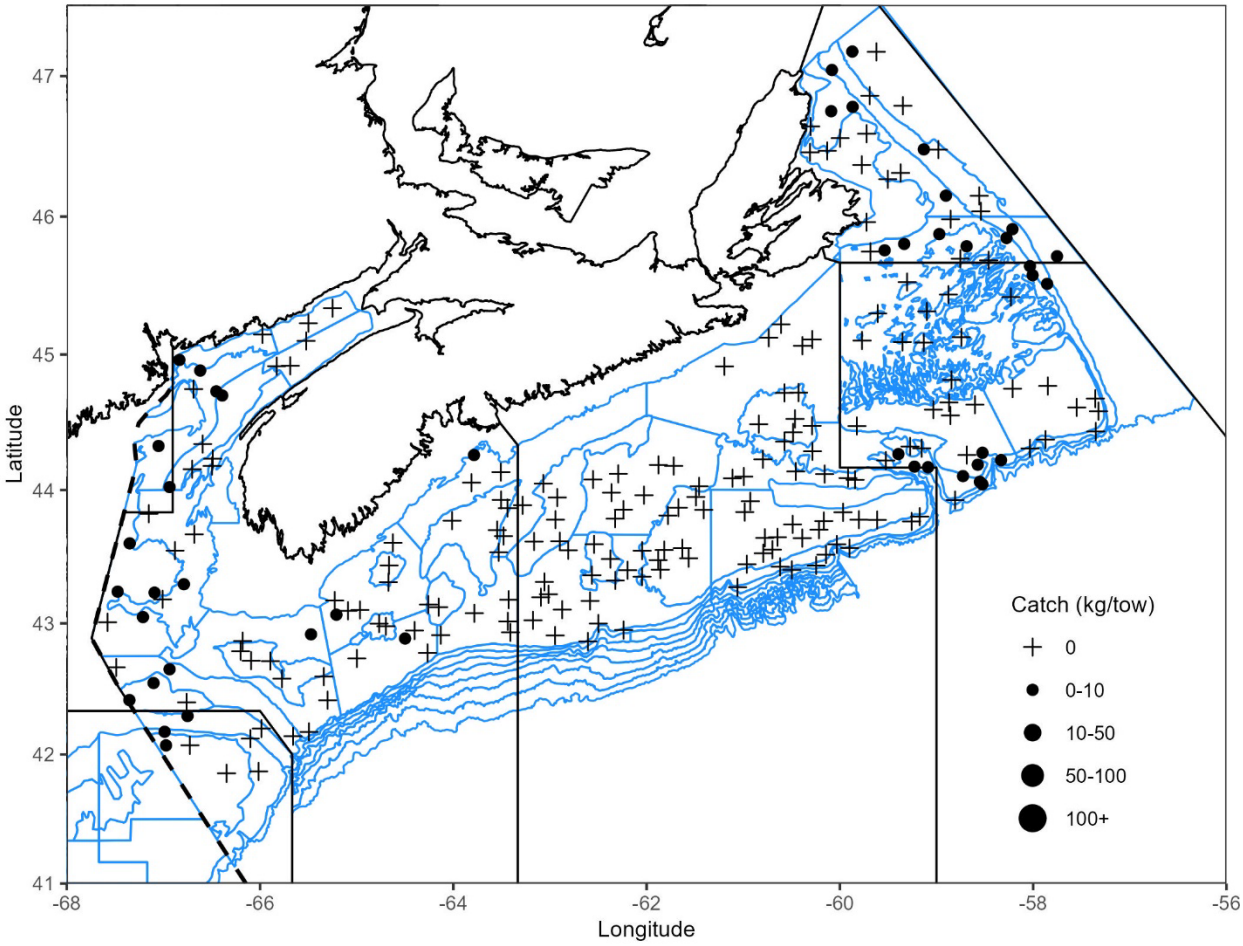

Figure 22a. Distribution of Smooth Skate catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

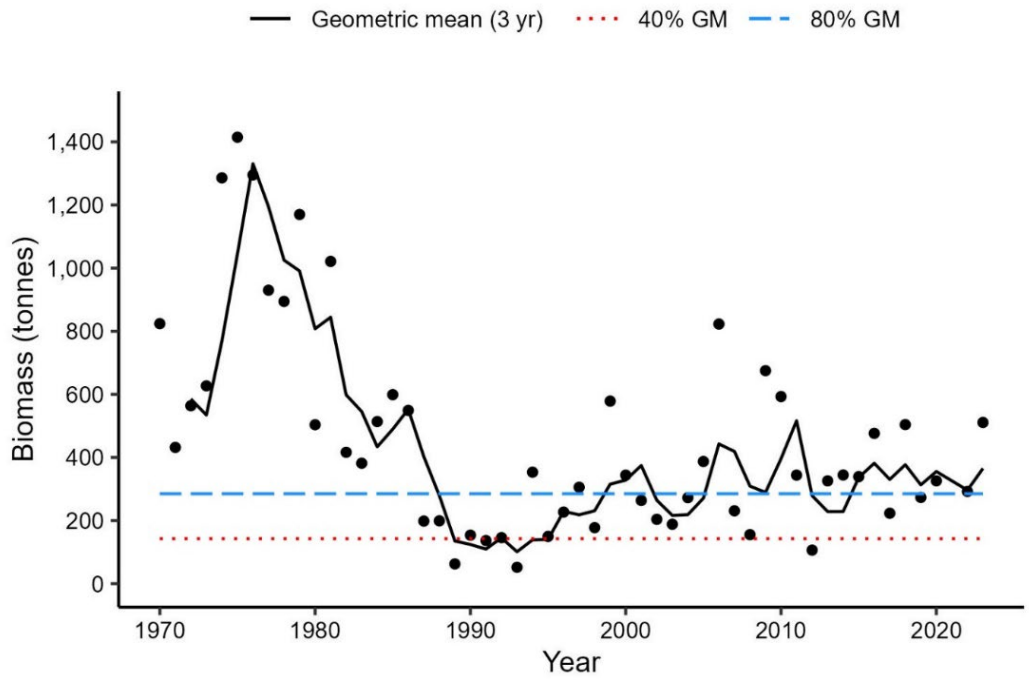

Figure 22b. Biomass index for Smooth Skate in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

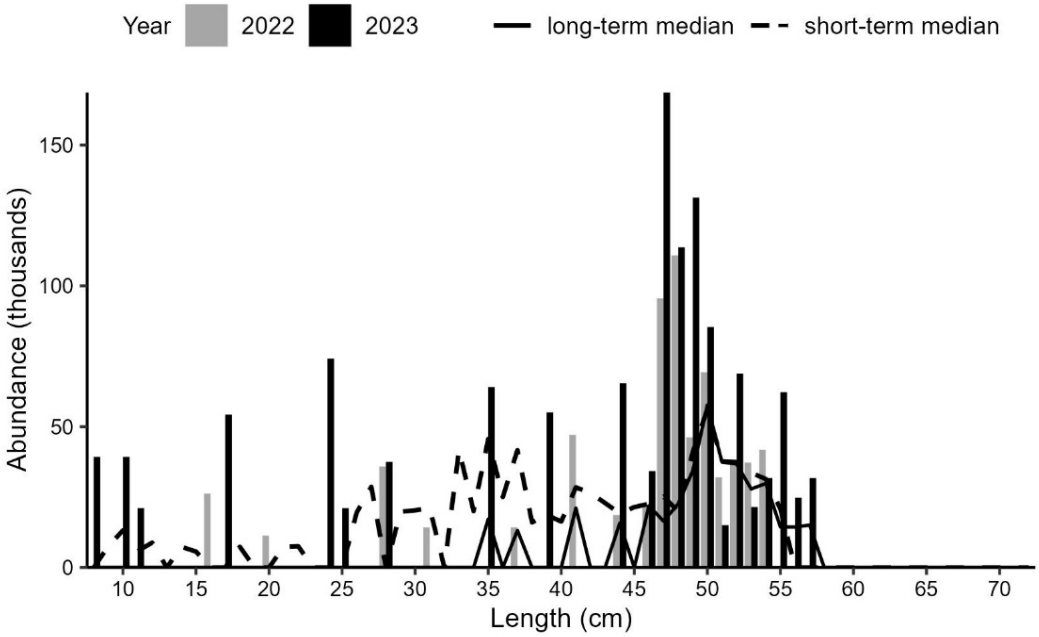

Figure 22c. Length frequency indices for Smooth Skate in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

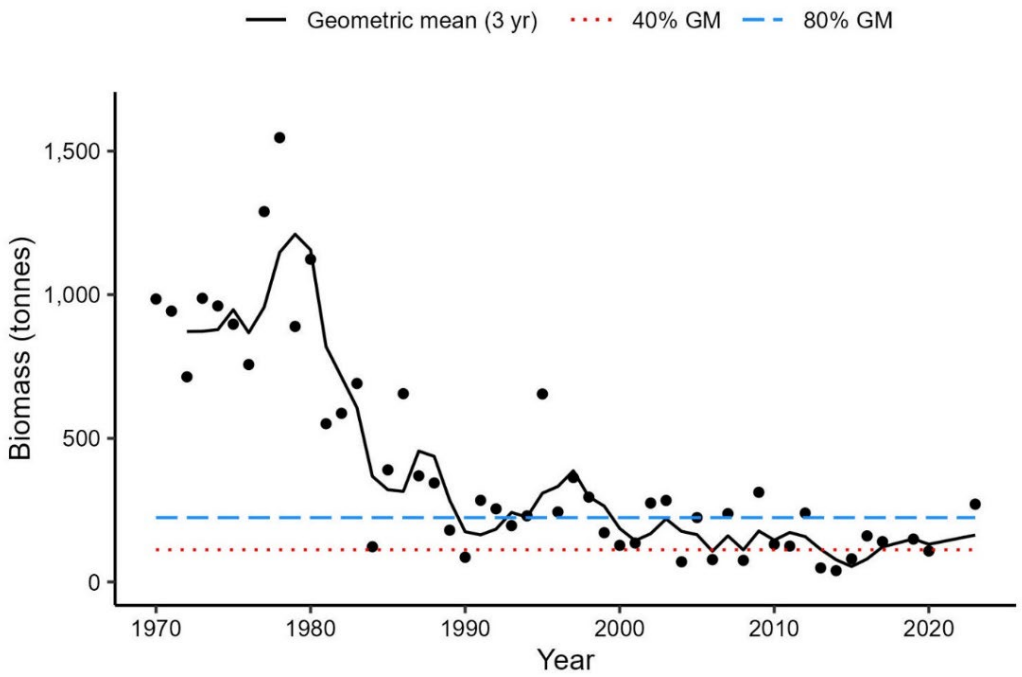

Figure 22d. Biomass index for Smooth Skate in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

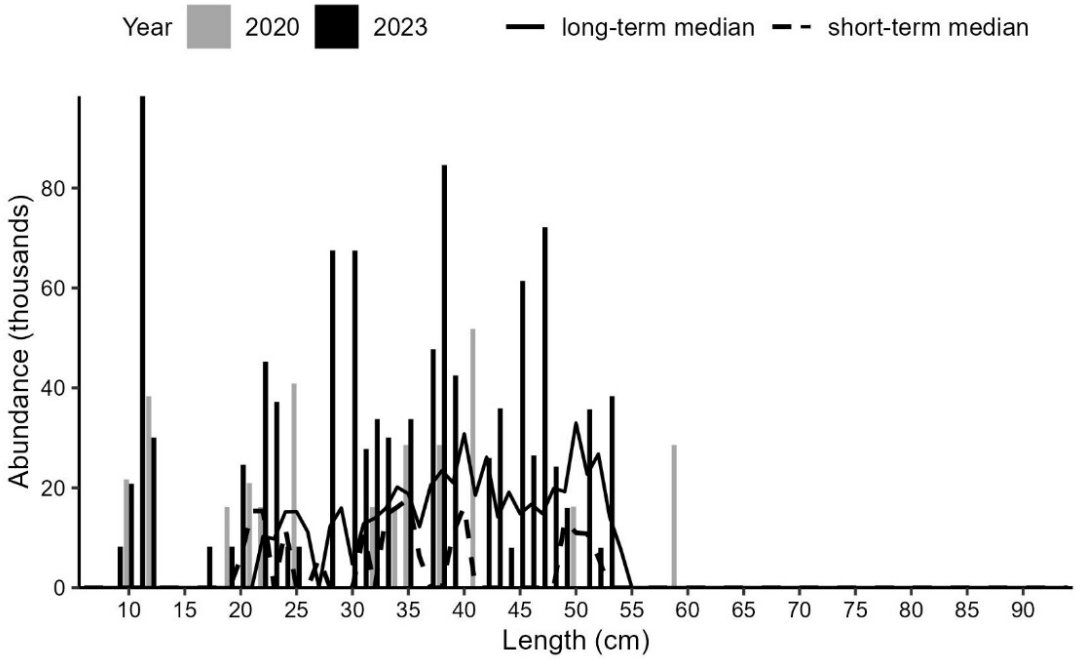

Figure 22e. Length frequency indices for Smooth Skate in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Spiny Dogfish

Spiny Dogfish (*Squalus acanthias*) are well distributed in 4X and on Georges Bank but catches within 4V and 4W are much less frequent and smaller (Figure 23a). Catches in 4X contribute on average approximately 95% of the total biomass for the index area.

Inter-annual variability in survey catch is high for Spiny Dogfish. In 4VWX, the 3-yr GM biomass index remains above 80% of the long-term GM in 2023 and has not declined below this threshold since 2014 (Figure 23b). The indices-at-length are generally at or below the median values for most lengths in 2023 (Figure 23c). The Spiny Dogfish population extends across the Canada-United States (US) boundary, with the majority of the population in US waters in most years (DFO 2020). The biomass index on Georges Bank in 2023 was 20,856 t compared to 55,875 t for 4X.

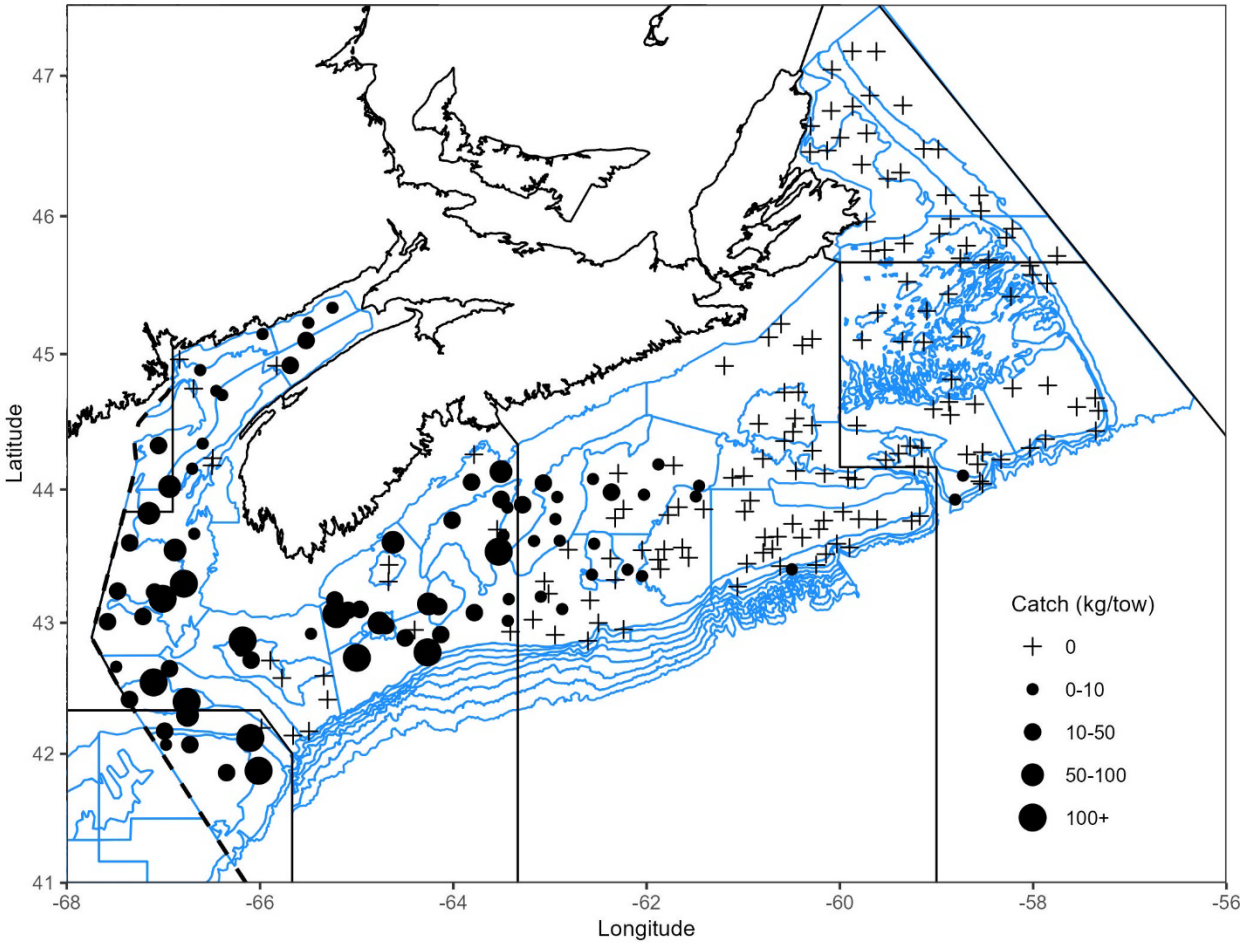

Figure 23a. Distribution of Spiny Dogfish catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

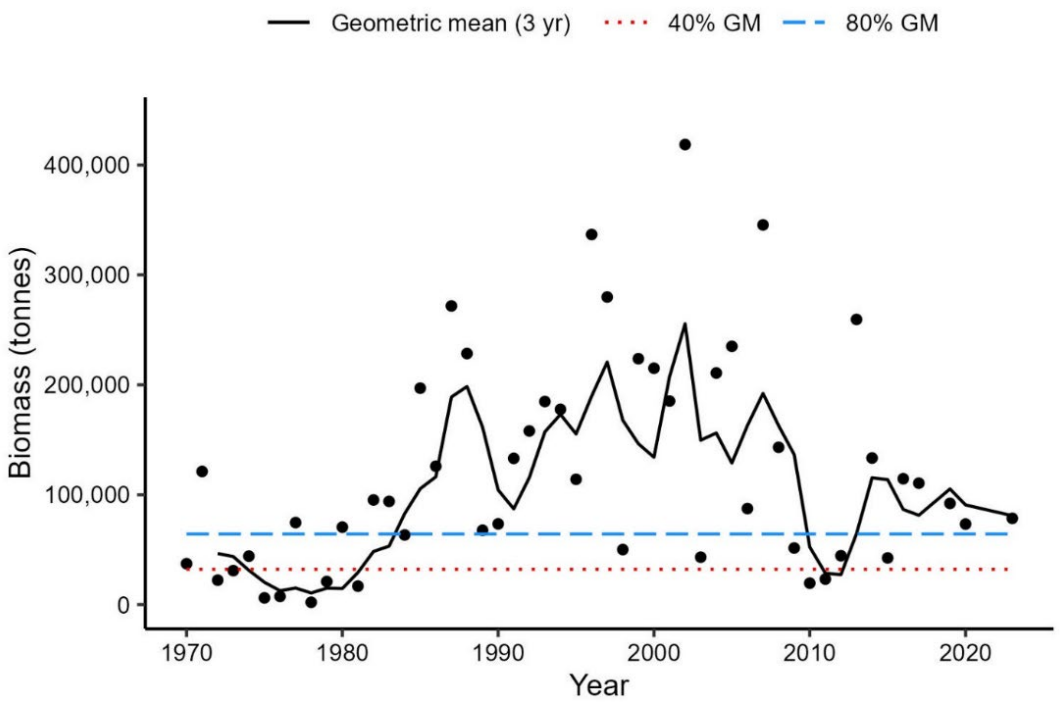

Figure 23b. Biomass index for Spiny Dogfish in 4VWX from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

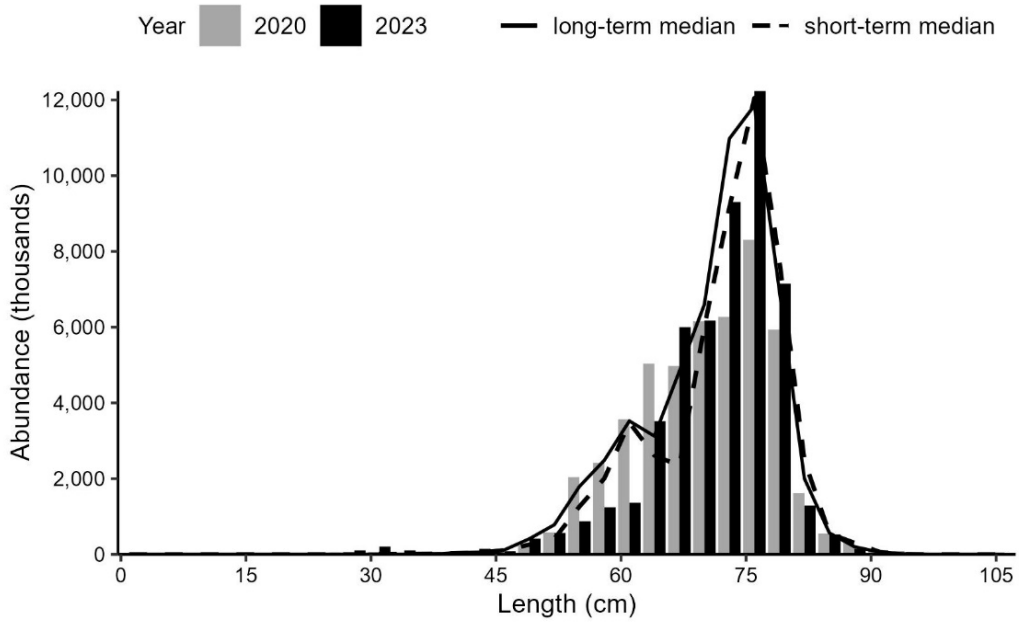

Figure 23c. Length frequency indices for Spiny Dogfish in 4VWX from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Red Hake

Red Hake (*Urophycis chuss*) can be difficult to distinguish from White Hake. Prior to about 1982, these two species were not consistently separated (Clark and Emberley 2011). The standard guide to Canadian Atlantic Fishes (Leim and Scott 1966) did not differentiate between them.

In 2023, Red Hake were caught throughout 4X and 4W, but were only encountered in the south-western portions of 4V near the Gully Marine Protected Area (Figure 24a). In 4X, the 3-yr GM increased to the second highest in the time series and remains well above the 80% long-term GM (Figure 24b). The short-term median numbers-at-length are generally higher than the long-term median in 4X, indicating a general increase in abundance (Figure 24c). The indices at length in 2023 are above both the short and long-term median values for all lengths. Two separate year classes are evident in the length distributions peaking at around 21 and 31 cm, with the former indicating a potential strong recruitment event. The 2023 biomass index and the 3-yr GM in 4VW are both above the 80% long-term GM (Figure 24d). Similar to 4X, median abundances are higher in the short-term compared to the long-term (Figure 24e). In 2023, abundance indices at length are generally higher than both the long and short-term medians. Similar to 4X, two dominant years classes exist, while signs of an emerging third is apparent at lengths below 15 cm.

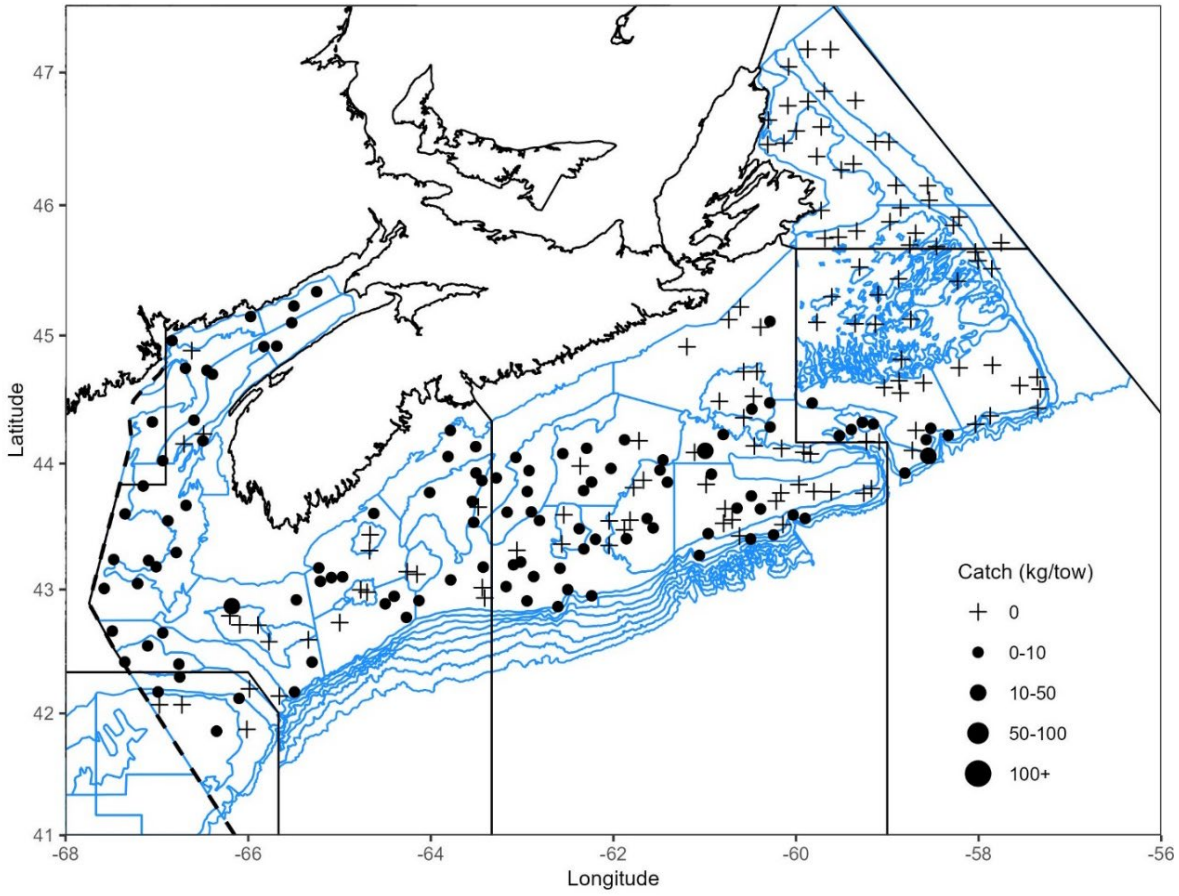

Figure 24a. Distribution of Red Hake catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

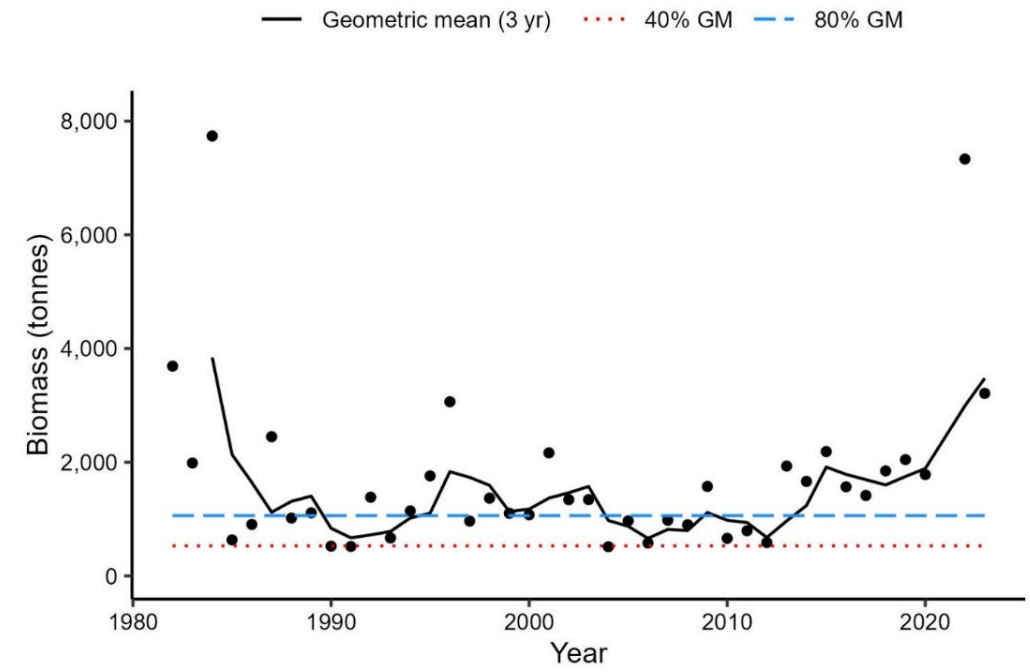

Figure 24b. Biomass index for Red Hake in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2022), respectively. The black dots represent the biomass index for that year.

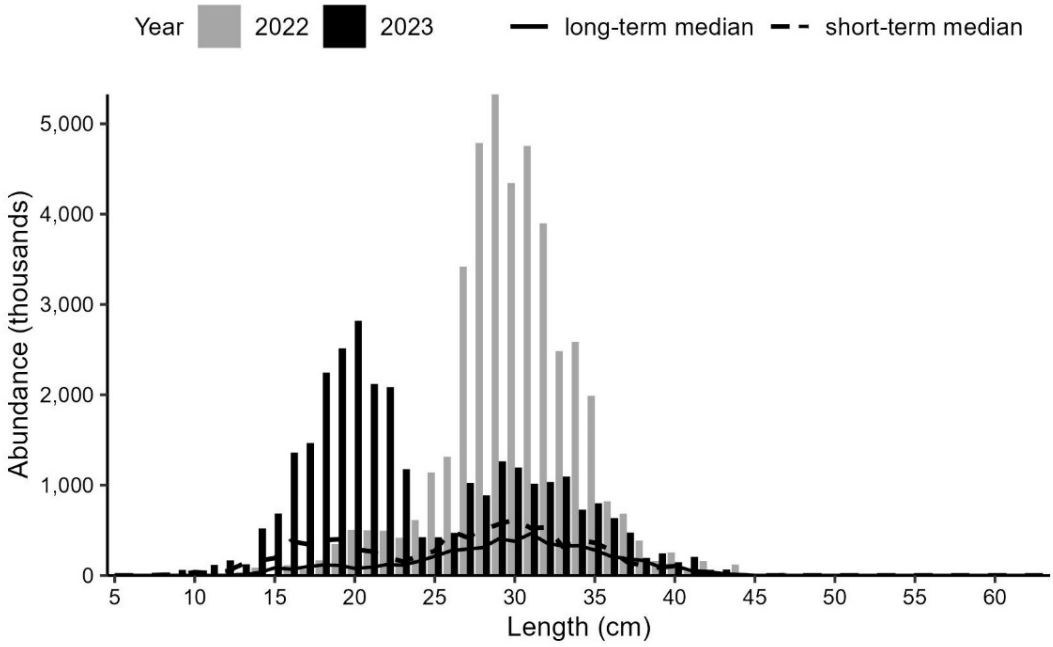

Figure 24c. Length frequency indices for Red Hake in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1982–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

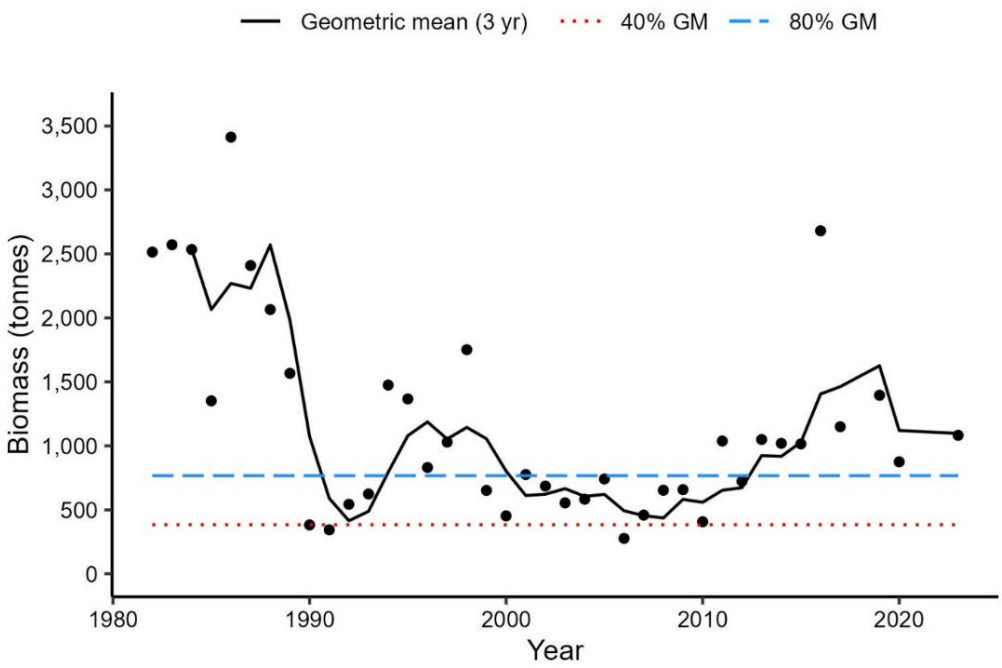

Figure 24d. Biomass index for Red Hake in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1982–2020), respectively. The black dots represent the biomass index for that year.

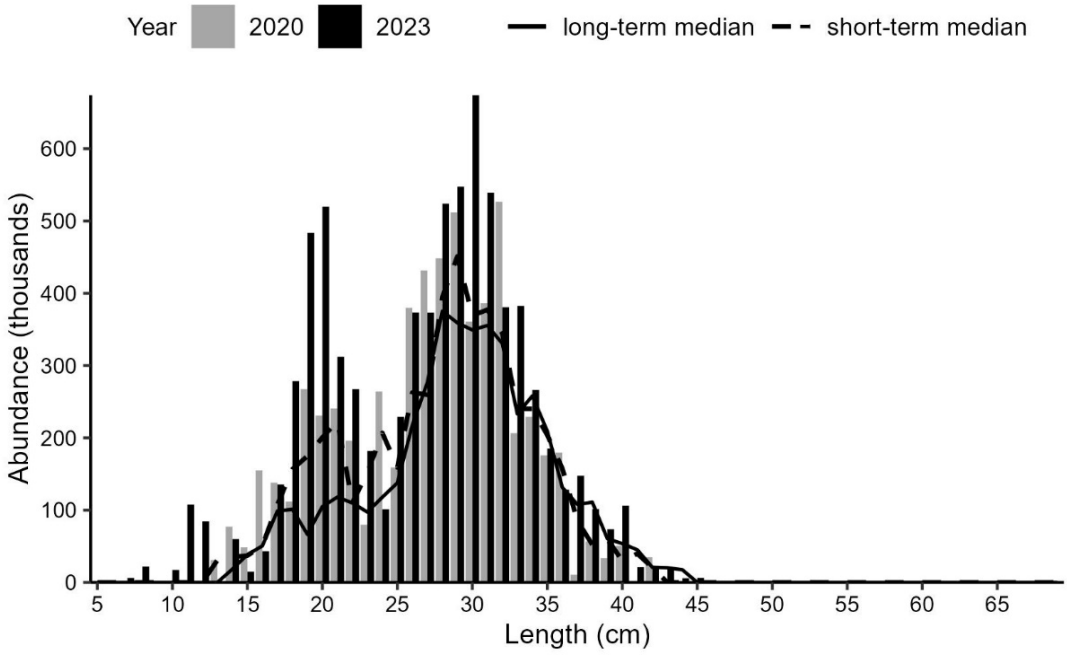

Figure 24e. Length frequency indices for Red Hake in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1982–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Sea Raven

Sea Raven (*Hemitripterus americanus*) were predominantly caught in the Bay of Fundy, on Georges Bank and on the banks of 4W in 2023 (Figure 25a).

In 4X, the 2023 biomass index decreased from 2022 to below the 80% long-term GM, and while the 3-yr GM actually increased, it remains one of the lowest in the time series and is below the 80% long-term GM (Figure 25b). The indices at length in 4X in 2023 are generally below the long and short-term medians except for lengths between 25 to 30 cm (Figure 25c). The 2023 4VW biomass index is the lowest of the time series and the 3-yr GM is now below the 80% long-term GM (Figure 25d). Abundance at length indices are below both the short and long-term medians for most lengths (Figure 25e).

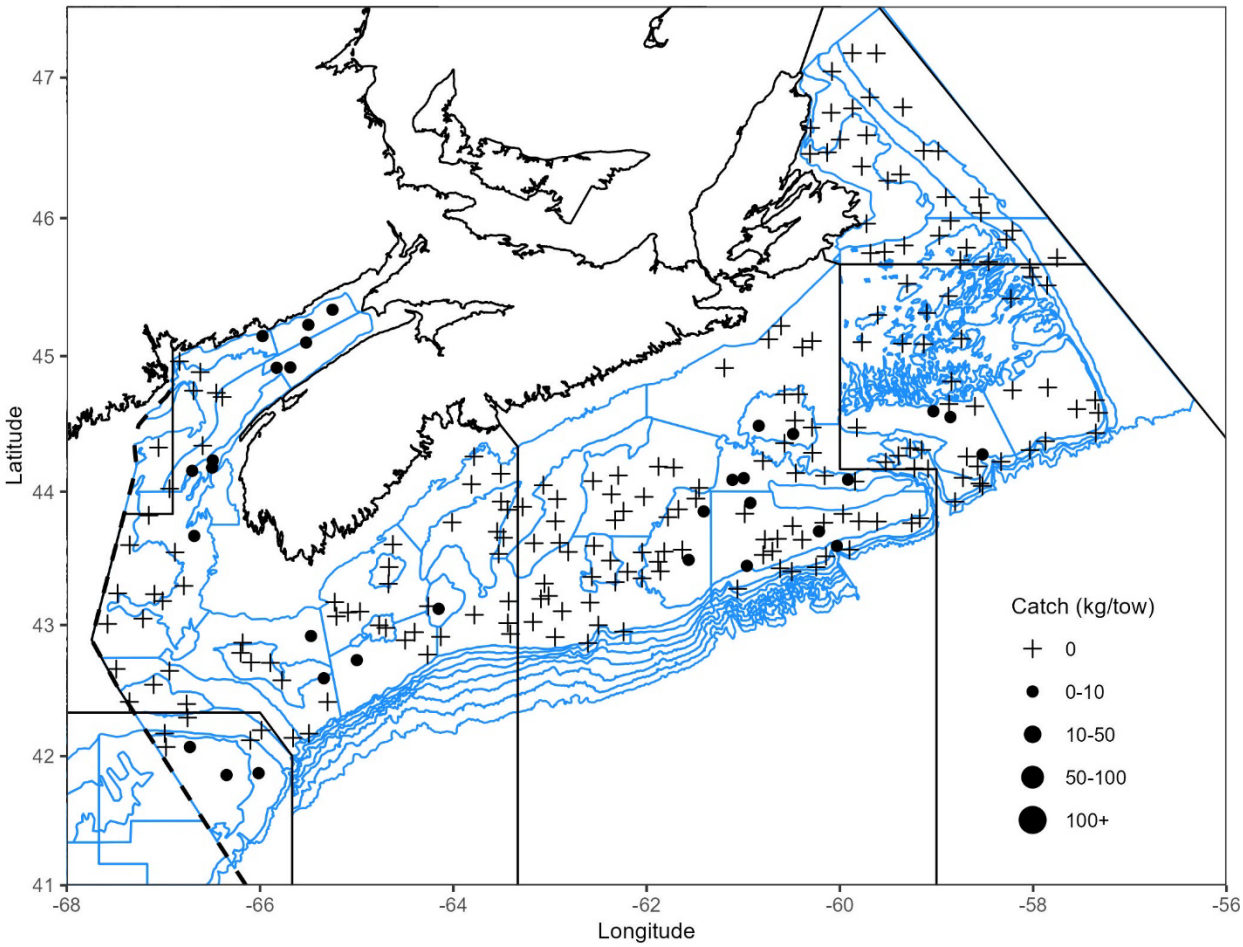

Figure 25a. Distribution of Sea Raven catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

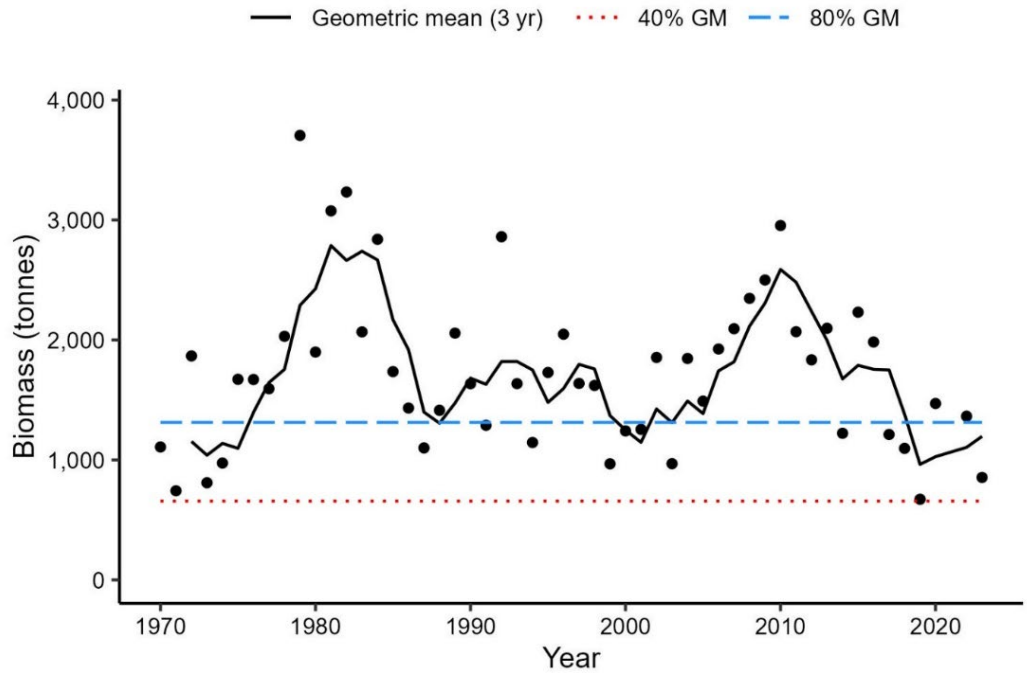

Figure 25b. Biomass index for Sea Raven in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

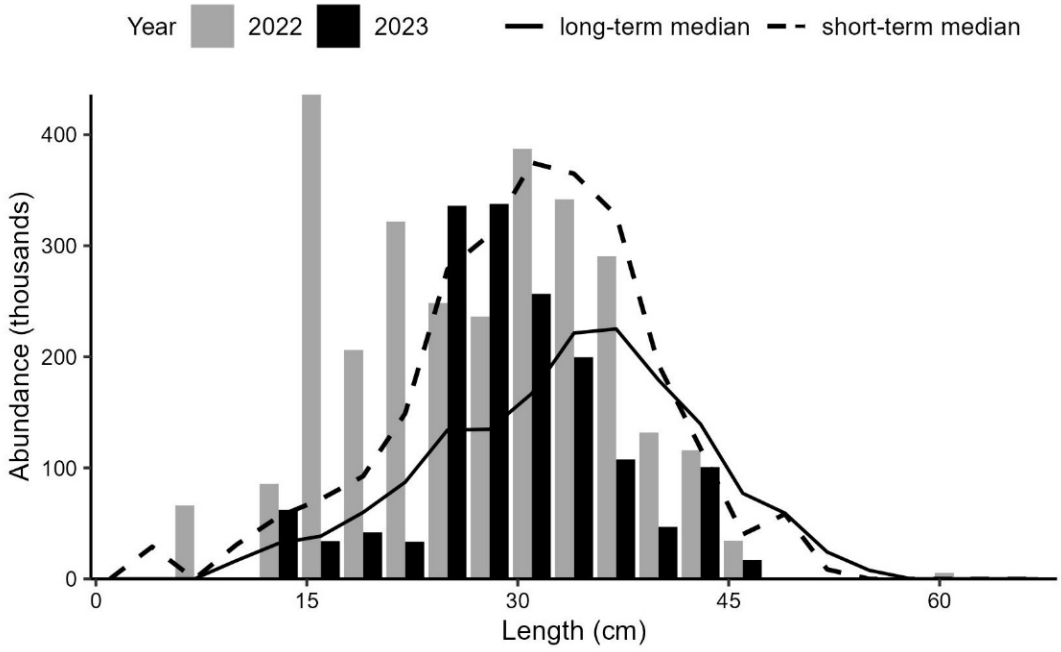

Figure 25c. Length frequency indices for Sea Raven in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

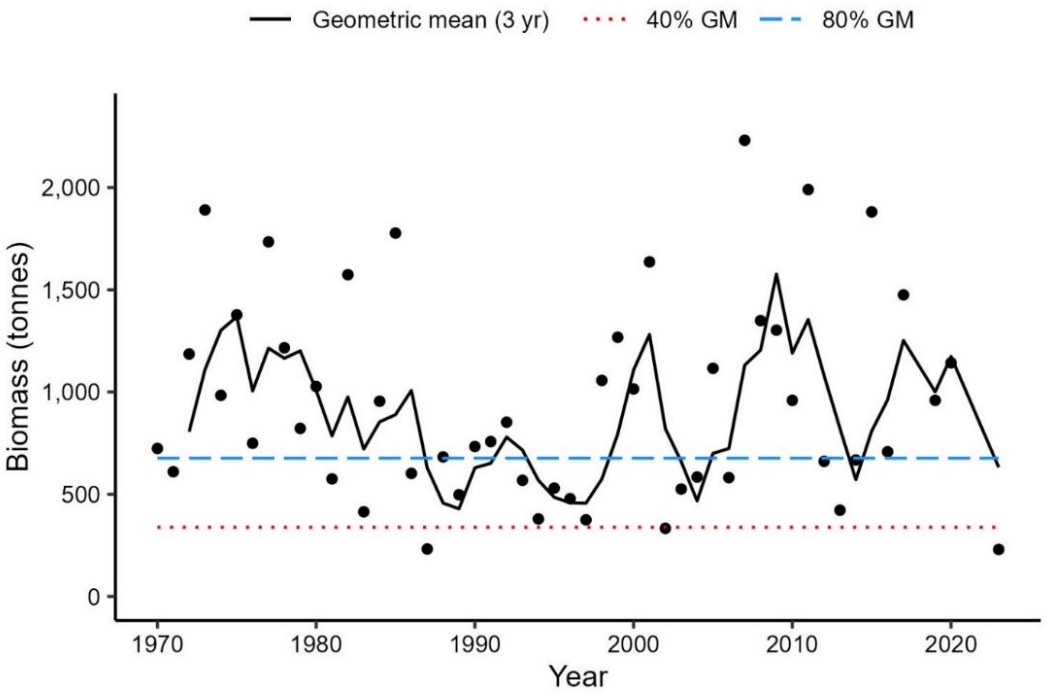

Figure 25d. Biomass index for Sea Raven in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

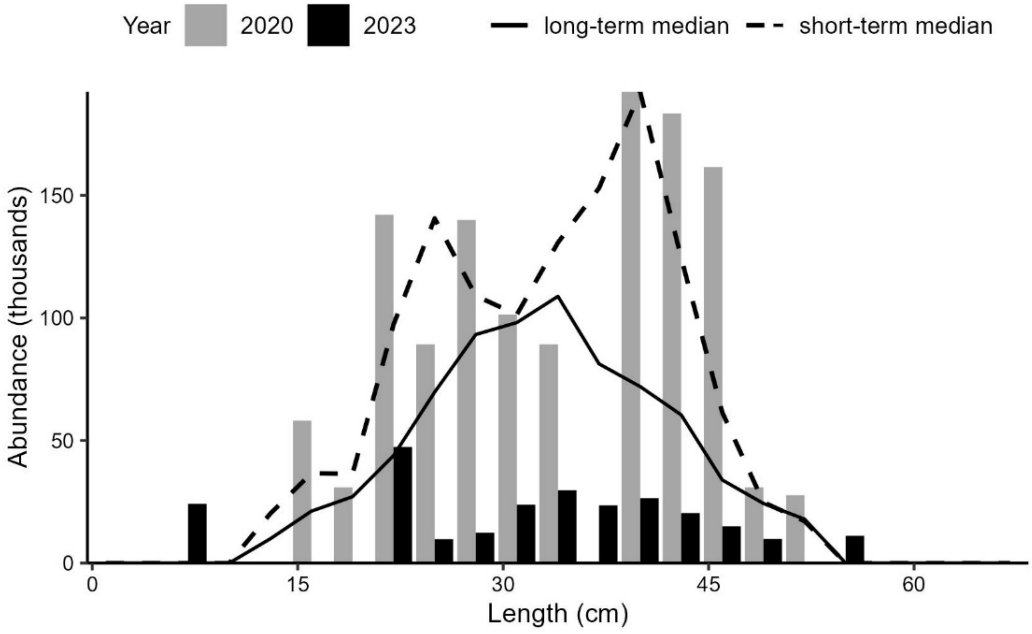

Figure 25e. Length frequency indices for Sea Raven in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Ocean Pout

Ocean Pout (*Zoarces americanus*) catches were mostly spread out through 4X and 4W in 2023 (Figure 26a). The 2023 biomass index and 3-yr GM in 4X remain below the 40% long-term GM and have been stable at low levels since 2014 (Figure 26b). Catches of larger Ocean Pout continue to be very low relative to the median values in 4X (Figure 26c). In 4VW, the 3-yr GM remains below the 40% long-term GM and has not exceeded this threshold since 2011 (Figure 26d). Abundance indices at length are generally similar to or above the short-term median values, but below the long-term median for most lengths (Figure 26e).

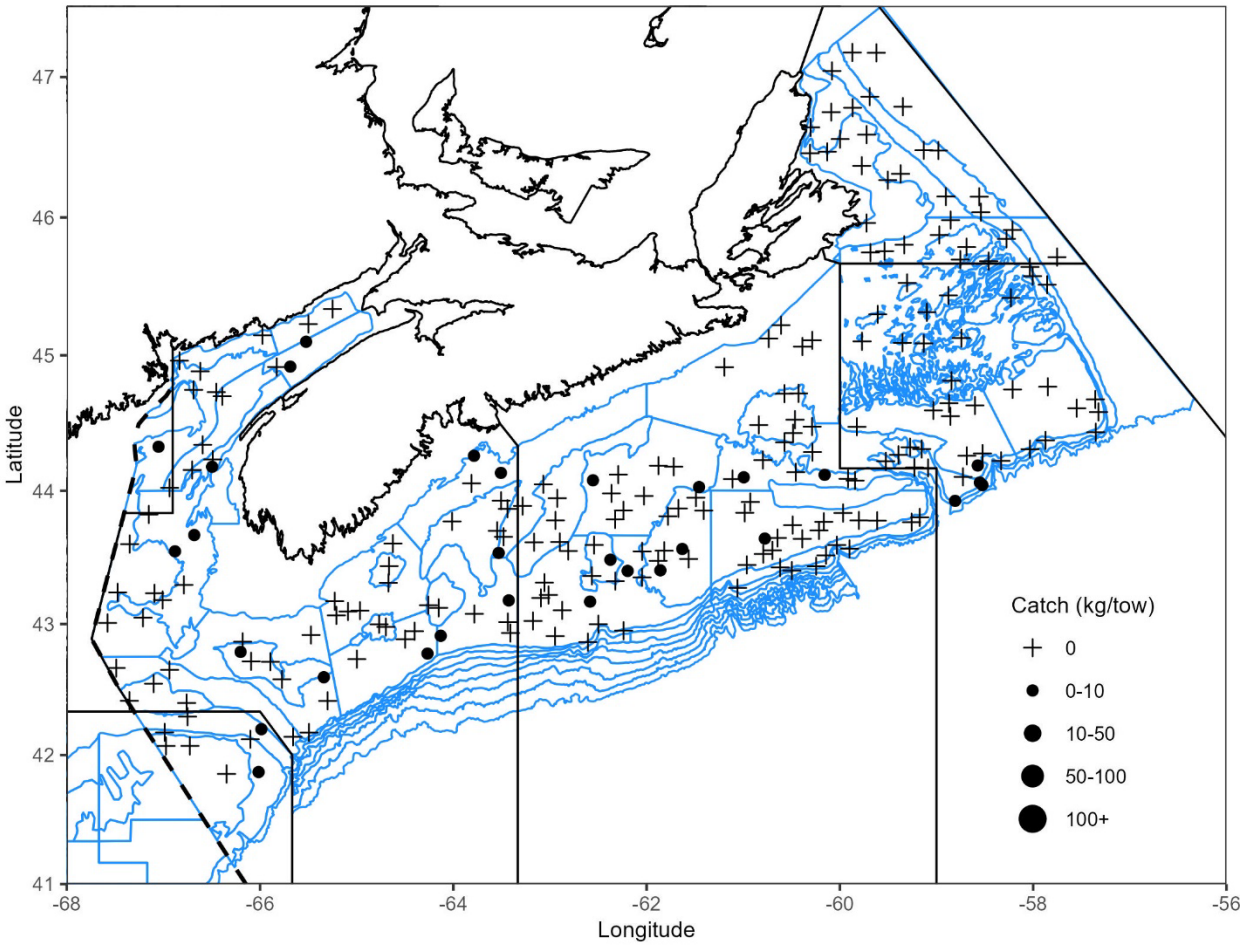

Figure 26a. Distribution of Ocean Pout catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

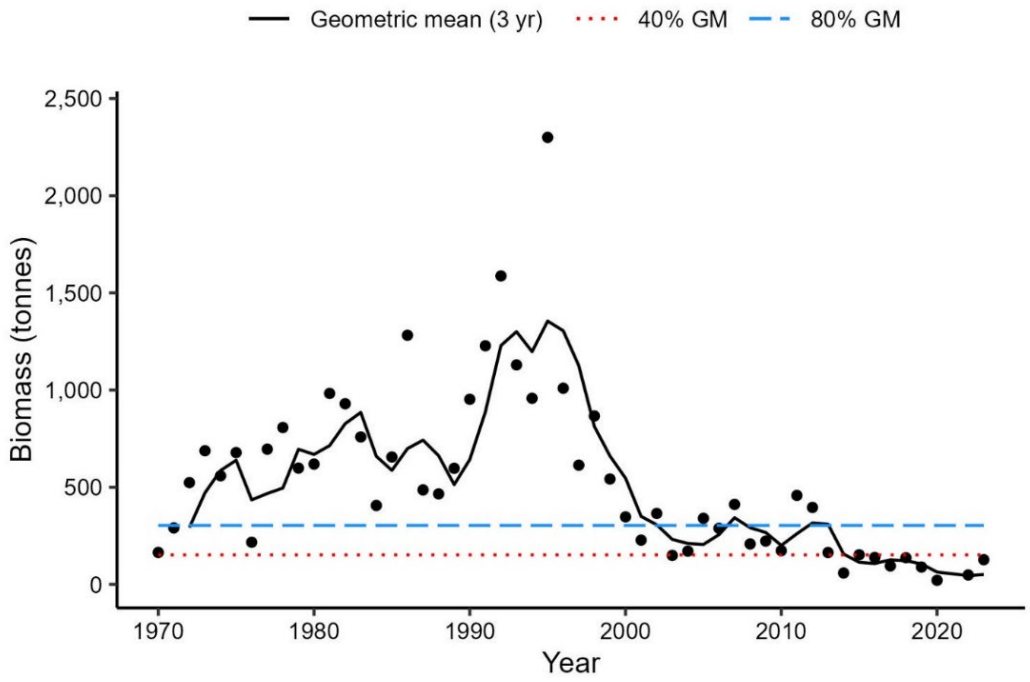

Figure 26b. Biomass index for Ocean Pout in 4X from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2022), respectively. The black dots represent the biomass index for that year.

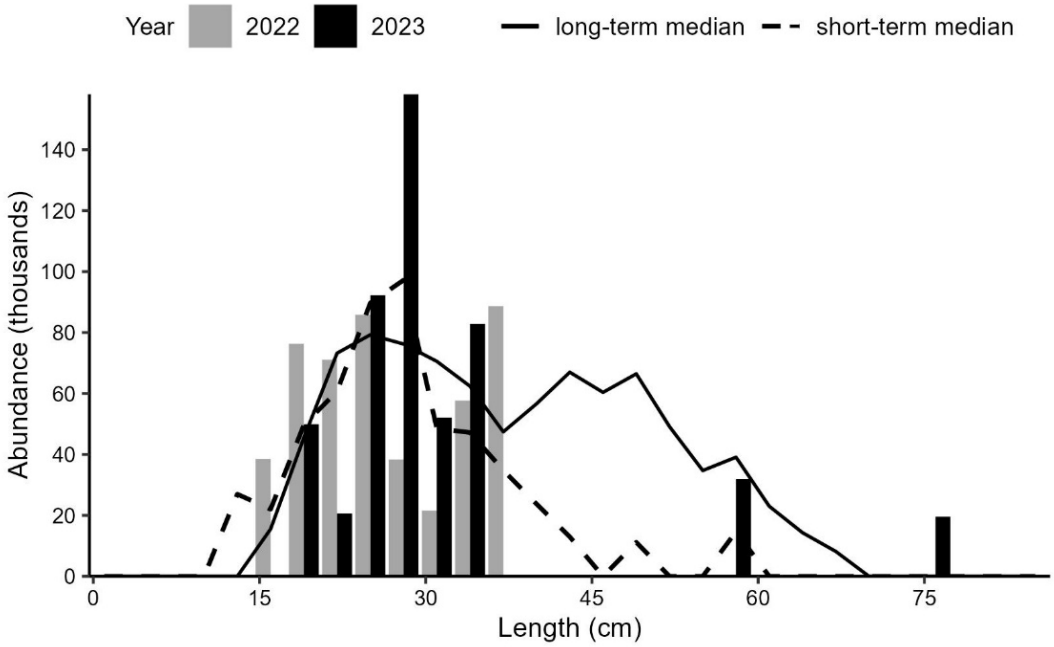

Figure 26c. Length frequency indices for Ocean Pout in 4X from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2022 survey. The solid black line represents the median in thousands at length for the time period 1970–2020. The dashed black line represents the median in thousands at length for the time period 2011–2020.

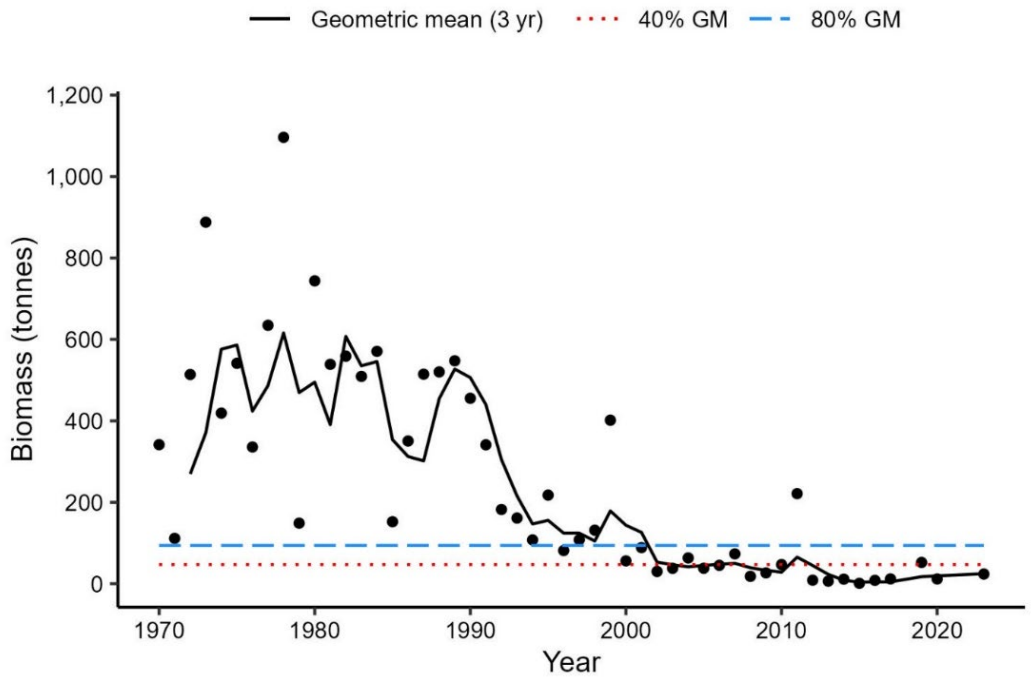

Figure 26d. Biomass index for Ocean Pout in 4VW from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

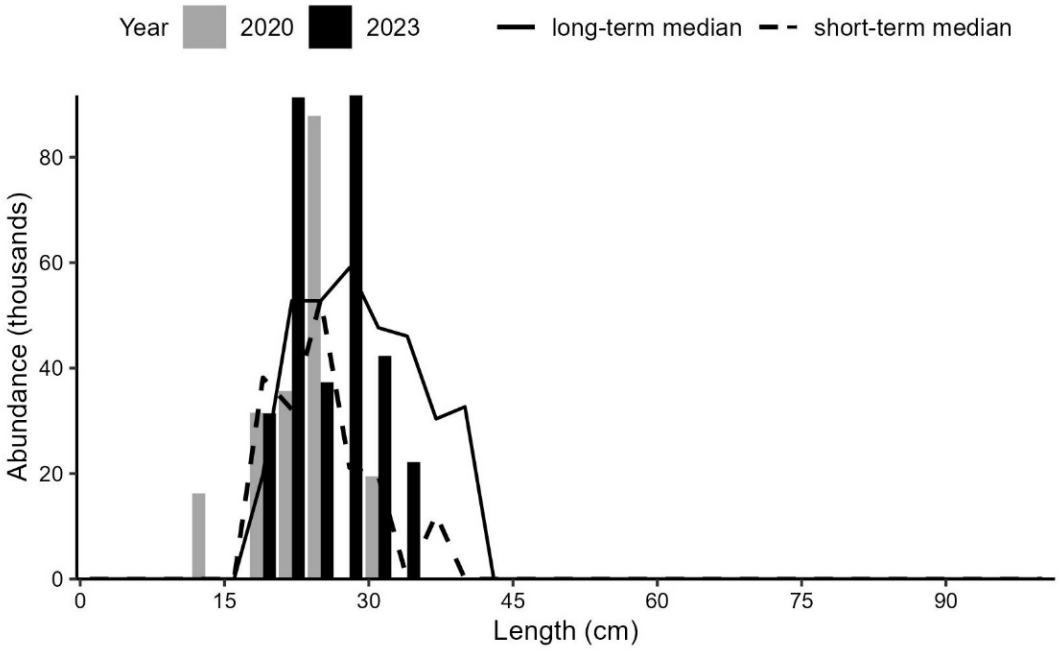

Figure 26e. Length frequency indices for Ocean Pout in 4VW from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands-at-length from the 2023 survey. Grey bars represent the number in thousands-at-length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

Blackbelly Rosefish

Blackbelly Rosefish (*Helicolenus dactylopterus*) were caught primarily in the deeper warmer waters along the edge of the Scotian Shelf during the 2023 DFO Summer Ecosystem RV Survey (Figure 27a). They would also generally be found in the deeper strata along the shelf edge (370 m–750 m); however, these strata were not sampled in 2023. Blackbelly Rosefish in 4VWX have been caught in the survey in all years since 1980, but their biomass index has increased since 1990 and has varied at a higher level since about 2004 (Figure 27b). In 2023; however, biomass decreased substantially and is the lowest index since the late 1990s. The 3-yr GM index also decreased, but remains well above the 80% long-term GM. The short-term median indices-at-length are higher than the long-term indices-at-length; this reflects the overall increase in abundance in recent years, particularly for larger fish, which were rarely caught earlier in the series (Figure 27c). In 2023, however, indices-at-length decreased substantially for fish above 10 cm compared to 2020 and the median indices, while a large increase in abundance of fish below 10 cm was observed (Figure 27c). The biomass index in 2020 was over 15 times higher than the 2023 index, but total abundance was only 1.2 times greater. This reflects the lack of larger fish caught in 2023 that ultimately contribute more to the population biomass, but also the high number of smaller individuals observed in 2023, which suggests strong recruitment.

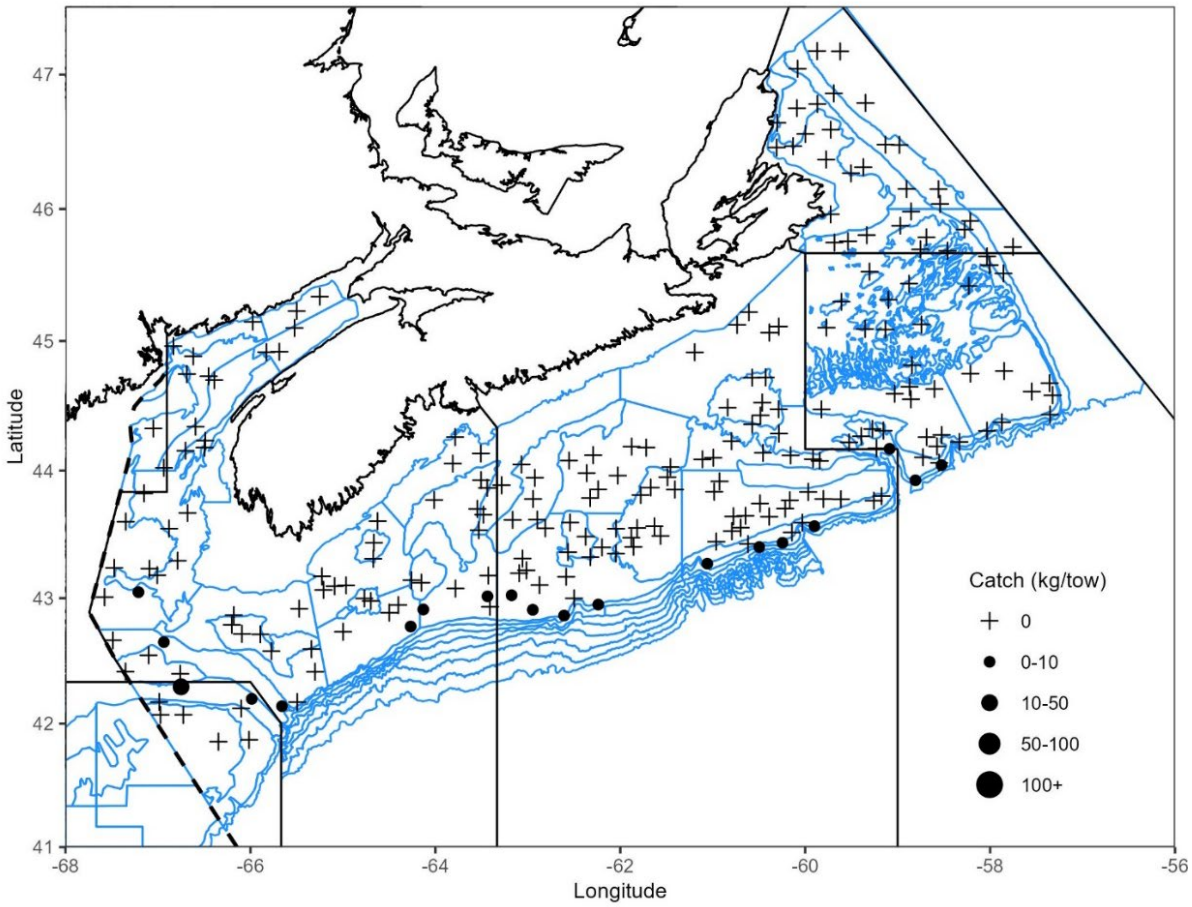

Figure 27a. Distribution of Blackbelly Rosefish catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

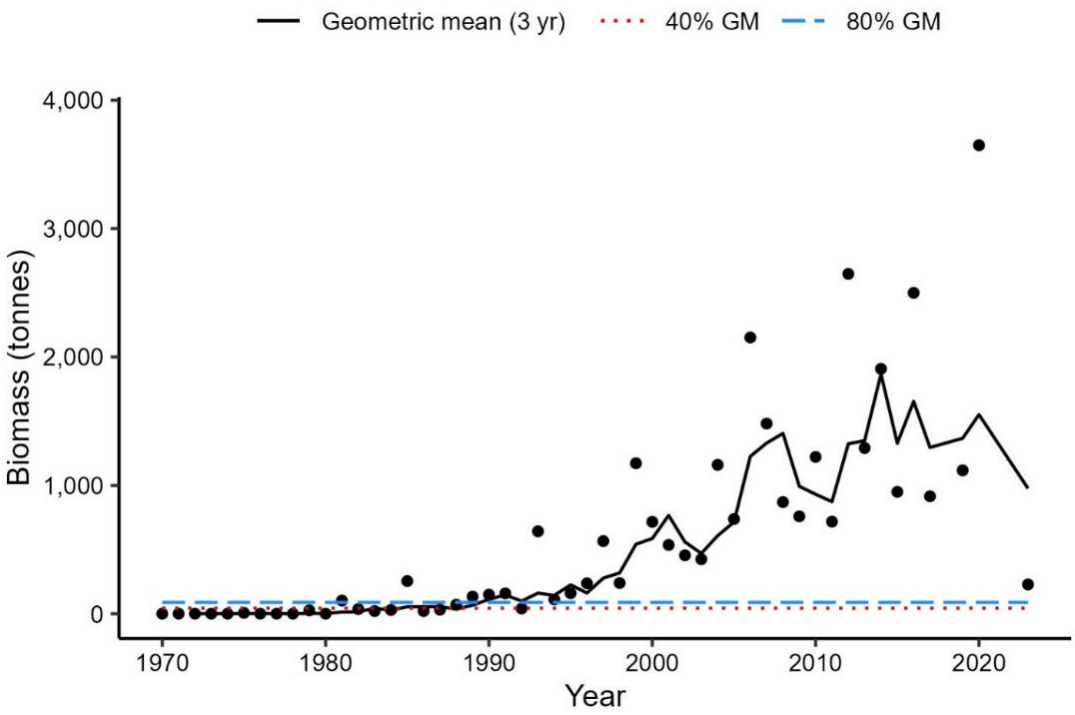

Figure 27b. Biomass index for Blackbelly Rosefish in 4VWX from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

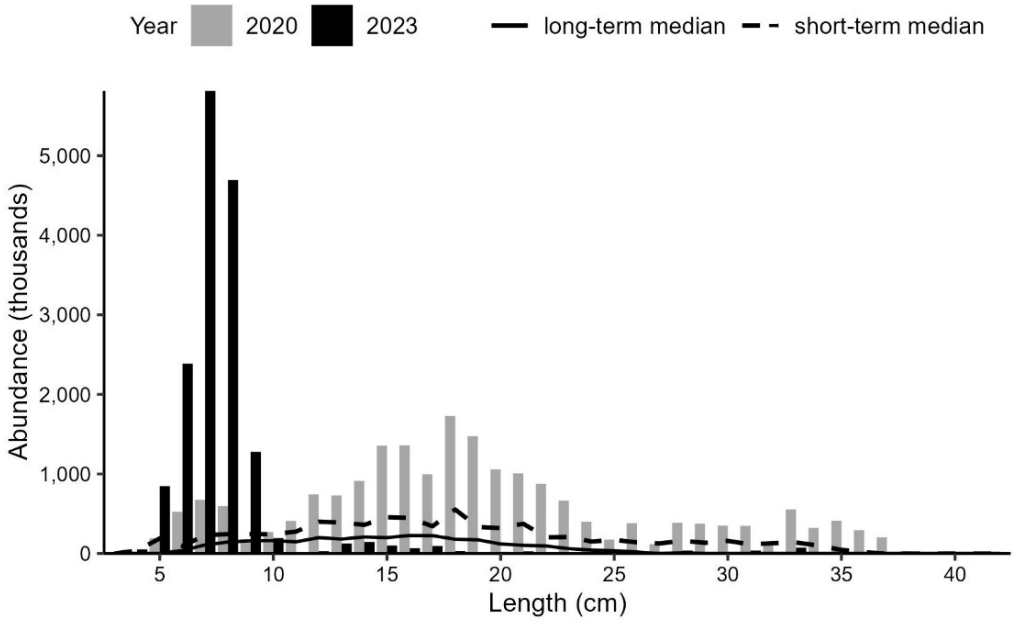

Figure 27c. Length frequency indices for Blackbelly Rosefish in 4VWX from the DFO Summer Ecosystem RV Survey. Black bars represent the number in thousands at length from the 2023 survey. Grey bars represent the number in thousands at length from the 2020 survey. The solid black line represents the median in thousands at length for the time period 1970–2019. The dashed black line represents the median in thousands at length for the time period 2009–2019.

John Dory

John Dory (*Zenopsis conchifer*) are caught during the DFO Summer Ecosystem RV Survey primarily in the deeper warmer waters along the edge of the Scotian Shelf and in the Scotian Gulf (South of Halifax), as well as in the Fundian Channel (Figure 28a). John Dory catches were rare for most of the time series, but, since 2014, they have been caught every year, with the largest catch exceeding 150 kg in 2018. While their distribution remains restricted within the survey area, they can be locally abundant. John Dory caught in the survey have included adults in spawning condition and juveniles as small as 5 cm. In 2023, John Dory were caught in five sets including the second largest catch in the time series (50 kg) and the biomass index is the highest of the time series (Figure 28b). The 2018 biomass index is not shown in Figure 28a due to incomplete survey coverage that year, although it is expected to have been even higher given the largest catch in the time series of 150 kg. The largest individual throughout the entire time series was also caught in 2023 and measured 75 cm.

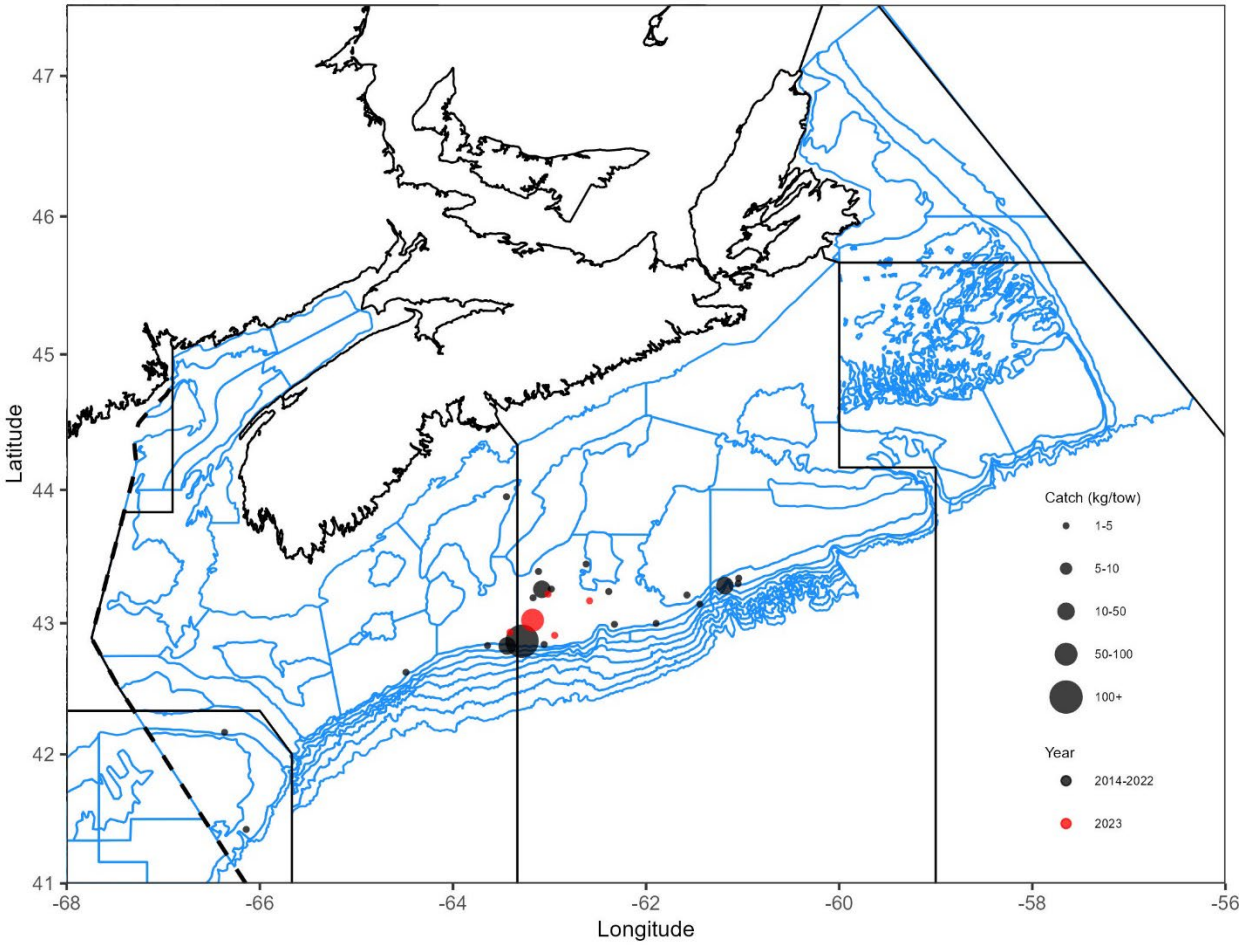

Figure 28a. Distribution of John Dory catches during the DFO Summer Ecosystem RV Survey from 2014–2023. Black circles represent catches from 2014–2022 and red circles are 2023 catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

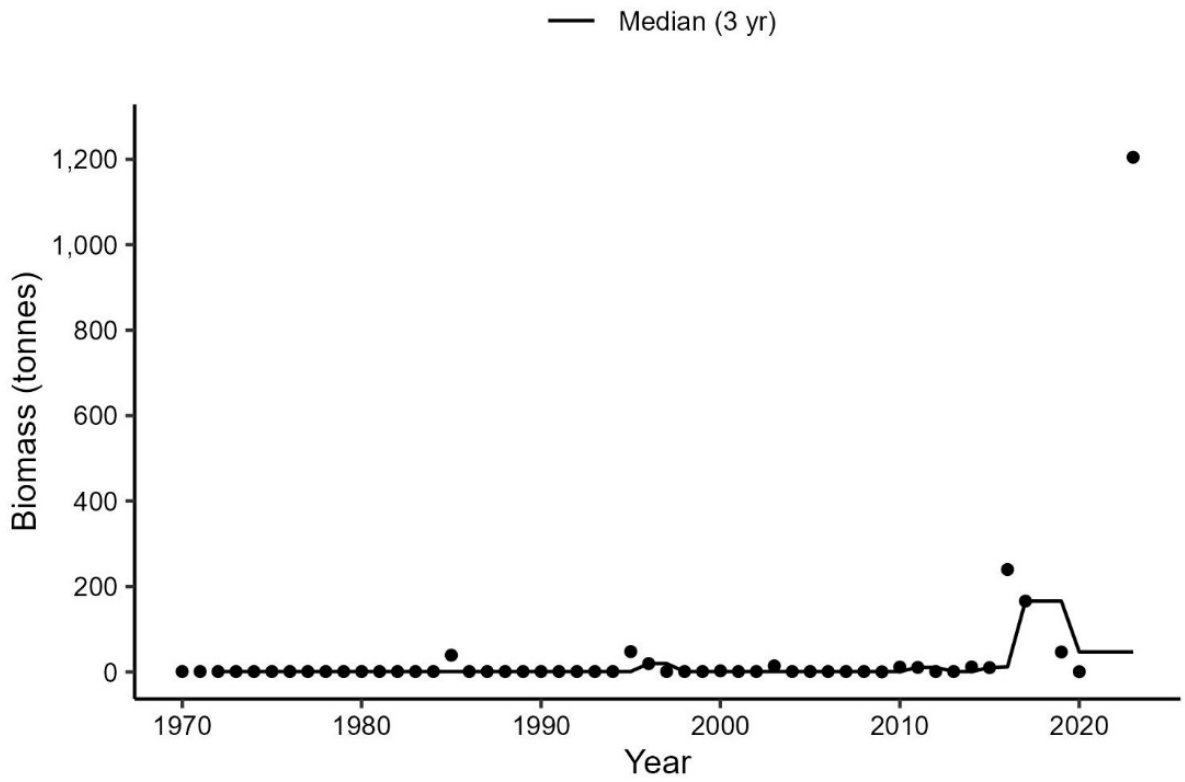

Figure 28b. Biomass index for John Dory in 4VWX from the DFO Summer Ecosystem RV Survey. The three-year median biomass index is represented by the solid black line. The black dots represent the biomass index for that year.

Shortfin Squid

Shortfin Squid (*Illex illecebrosus*) are a short-lived, highly migratory species, with a broad distribution in the North Atlantic. In 2023, Shortfin Squid were caught throughout the 4VWX area (Figure 29a), but catches were relatively small compared to recent years. The 2023 biomass index for 4VWX Shortfin Squid decreased to below the 40% long-term GM for the first time since 2016; however, the 3-yr GM remains above the 80% long-term GM (Figure 29b).

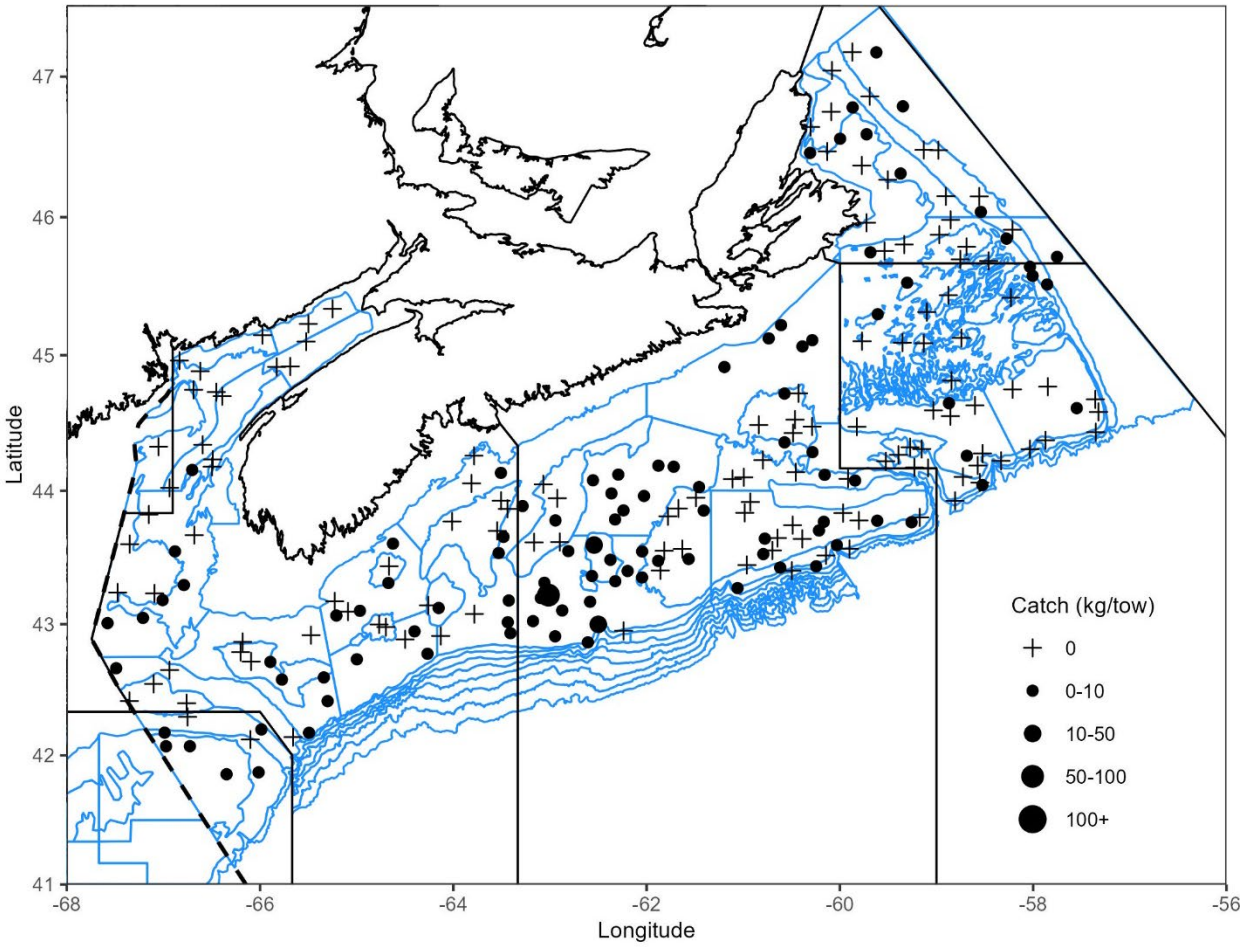

Figure 29a. Distribution of Shortfin Squid catches during the 2023 DFO Summer Ecosystem RV Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue polygons represent survey strata boundaries.

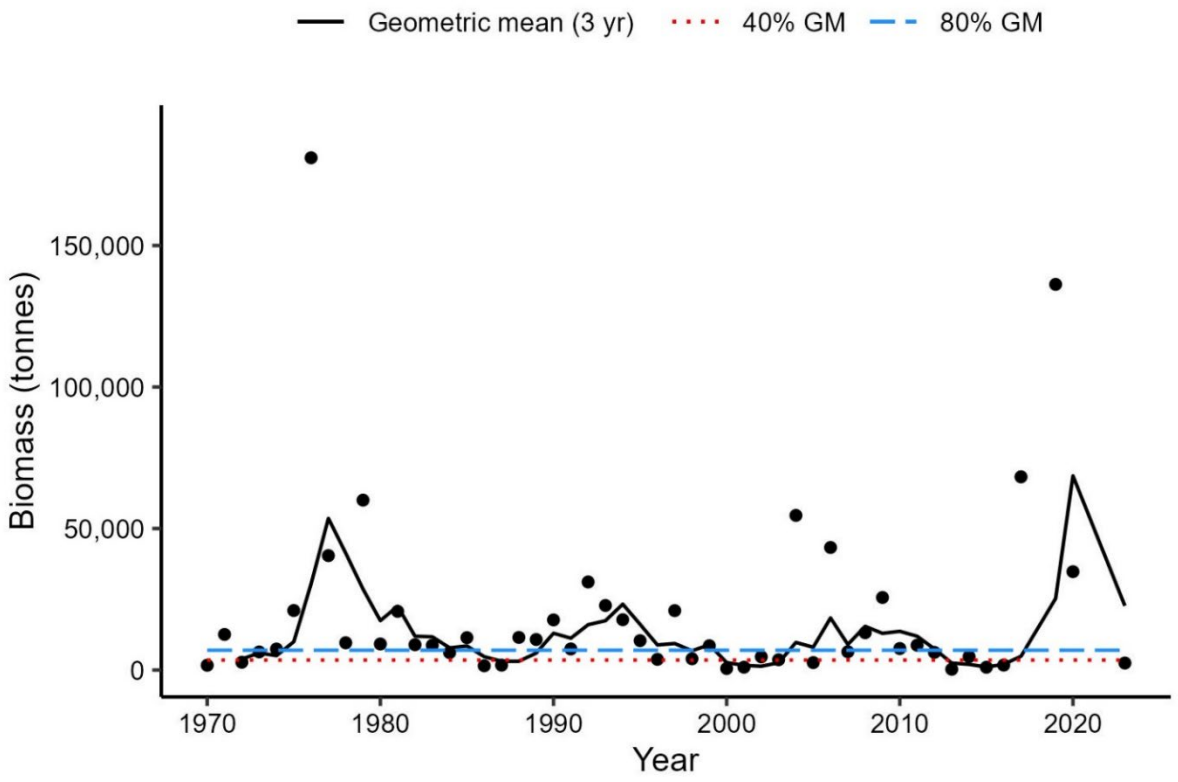

Figure 29b. Biomass index for Shortfin Squid in 4VWX from the DFO Summer Ecosystem RV Survey. The three-year geometric mean biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the long-term geometric mean (1970–2020), respectively. The black dots represent the biomass index for that year.

Other Species

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

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

Tilefish *(Lopholatilus chamaeleonticeps*) are large, slow-growing fish found in deep, warm waters off the US coast from the Gulf of Mexico to Georges Bank. It is considered accidental in Canadian waters. Five specimens have been caught during the time series, ranging in size from 1.0 to 10.3 kg. This species is caught in both recreational and commercial fisheries off the US coast, generally with hook and line. The DFO Summer Ecosystem RV Surveys may not be suitable for providing useful information on distribution or abundance for this species.

Black Sea Bass (*Centropristis striata*) are a demersal species found from the Gulf of Mexico to Maine. This species has been caught during Winter RV Surveys on Georges Bank but has not been recorded during the DFO Summer Ecosystem RV Survey. It is considered accidental in Canadian waters.

Conclusions

In 2023, sampling was conducted in the majority of standard strata within 4VWX and the Canadian portion of 5Z. Of the 285 stations selected for sampling in 2023, 237 successful bottom trawl tows were completed in 37 fishing days. The 2023 DFO Summer Ecosystem RV Survey marks the first time since 2020 when sufficient coverage of 4VWX was achieved and all standard strata received at least the minimum acceptable sampling with the exception of stratum 478. Both the *CCGS Teleost* and *Capt. Jacques Cartier* completed one station each in stratum 478 which is sufficient for minimum coverage once conversion factors are available for the Cartier data. Only three times since the survey began in 1970 have there not been some sampling in all strata from 440–495, all of which were in the last 5 years (2018, 2021, 2022). In addition to the bottom trawl sampling, a total of 203 conductivity temperature depth (CTD) casts and 53 vertical zooplankton tows were completed. A variety of special sampling was also completed including the collection of tissue samples from various species for genetic and stable isotope analyses, multi-species stomach collections for predator/prey and diet analyses, and monkfish tail weights for commercial landings conversion factors, among many others.

Several species more commonly associated with warmer waters south of the Scotian Shelf have been caught in the DFO Summer Ecosystem RV Survey in recent years. Some, like Blackbelly Rosefish, are now well established on the Scotian Shelf. As water temperatures warm on the Scotian Shelf, it is expected that more southern species will appear in the survey and will become established in the region.

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

The total biomass index for 4X shows high inter-annual variability but no clear trend over time. The large drop in biomass index in 2019 and 2020 reflects lower catches for most demersal species. The biomass index in 2023 increased from 2022, largely due to higher catches of Haddock. The biomass index for 4X Haddock is the third highest in the time series in 2023 and has been increasing since 2019.

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

The Western component Pollock stock experienced a large increase in biomass and exceeded the 80% long-term GM for the first time since 2016. The Eastern component Pollock stock biomass remains low and below the 40% long-term GM. Halibut biomass in 4VWX was the second highest of the time series and has been steadily increasing since 2000. Witch Flounder in 4VW had the third highest biomass index in the time series.

Barndoor Skate biomass in 4X has been steadily increasing since the 1990s and the 2023 index is the third highest of the time series. Biomass in 4VW has also been increasing, to a lesser extent, and began a decade later in comparison to 4X. In 2023, the biomass index in 4VW is the second highest of the time series.

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

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

Biomass indices for large White Hake above 41 cm in 4X and 4VW in 2023 remained below the biomass recovery targets (DFO 2016).

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

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