Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat
Maritimes Region **Science Response 2023/018**

STOCK STATUS UPDATE OF HADDOCK (*MELANOGRAMMUS AEGLEFINUS*) IN NAFO DIVISIONS 4X5Y FOR 2022

Context

Advice on the status of Haddock (*Melanogrammus aeglefinus*) in Northwest Atlantic Fisheries Organization (NAFO) Divisions 4X5Y (herein referred to as 4X5Y Haddock) is requested annually by Fisheries and Oceans Canada (DFO) Resource Management to help determine a Total Allowable Catch (TAC) that is consistent with the Integrated Fisheries Management Plan (IFMP). The most recent framework and assessment occurred in 2016 (Stone and Hansen 2015, Wang et al. 2017, Finley et al. 2018). A Virtual Population Analysis (VPA) model with natural mortality (M) at ages 10 and older for three 5-year time blocks (2000–2004, 2005–2009, and 2010–2014) fixed at 0.3, 0.6, and 0.9, respectively, was recommended as the model for the 4X5Y Haddock stock assessment. Despite the uncertainties in estimating fishing mortality at Maximum Sustainable Yield (F_{MSY}), it was agreed at this Framework meeting that a fishing mortality limit reference (F_{lim}) of 0.25 would be the removal fishing mortality reference when the stock is in the Healthy Zone, and a fishing mortality target reference (F_{ref}) of 0.15 would be an appropriate target when the stock is in the Cautious Zone. Given that the poor stock recruitment relationship precludes the calculation of an appropriate biomass at Maximum Sustainable Yield (B_{MSY}), a more conservative biomass level from which the stock has been shown to recover ($B_{recover}$; Age 4+ biomass; 19,700 metric tonnes (mt)) was recommended as the Limit Reference Point (LRP) for 4X5Y Haddock. In the spring of 2017, Resource Management agreed upon approximately twice the LRP, or 40,000 mt, as the Upper Stock Reference (USR; Age 4+ biomass).

Since 2021, the standard projection from the 2018 model has not been used due to the retrospective pattern that was observed in 2018 and the mismatch between the model results and the survey biomass (DFO 2020). The objectives of this update are to report new information from the DFO Summer Research Vessel (RV) Survey and commercial fishery landings data, provide the most recent data on the length of Haddock captured by the fleet, evaluate the survey biomass index compared to the time-series' 40% and 80% median (1985–2020), as well as provide indicators to increase, maintain, or reduce catch.

This Science Response Report results from the regional peer review of December 6–7, 2022 on the Stock Status Update of Haddock in 4X5Y.

Background

Biology

Haddock are found on both sides of the North Atlantic and occur in the northwestern Atlantic from southwest Greenland to Cape Hatteras, USA. A major stock of Haddock exists on the western Scotian Shelf and in the Bay of Fundy (NAFO Divisions 4X5Y; Figure 1). Growth rates of Haddock in the Bay of Fundy (Unit Areas 4Xqrs5Y) are higher than those of Haddock on the western Scotian Shelf (Unit Areas 4Xmnop; Hurley et al. 1998); therefore, separate age-length keys are used in the calculation of the fishery Catch-At-Age (CAA) and the survey indices of abundance. Major spawning grounds are found on Browns Bank, and peak spawning occurs annually from April to May, although it can occur as early as February if conditions are favourable (Head et al. 2005).

There has been a declining trend in Weight-At-Age (WAA) and Length-At-Age (LAA) since the early 1990s, and the time-series minimum for most ages occurred in the past five years. While it is not clear what caused the declining trend, the effect on stock productivity is significant and has been discussed in previous assessments (Hurley et al. 2009, Mohn et al. 2010).

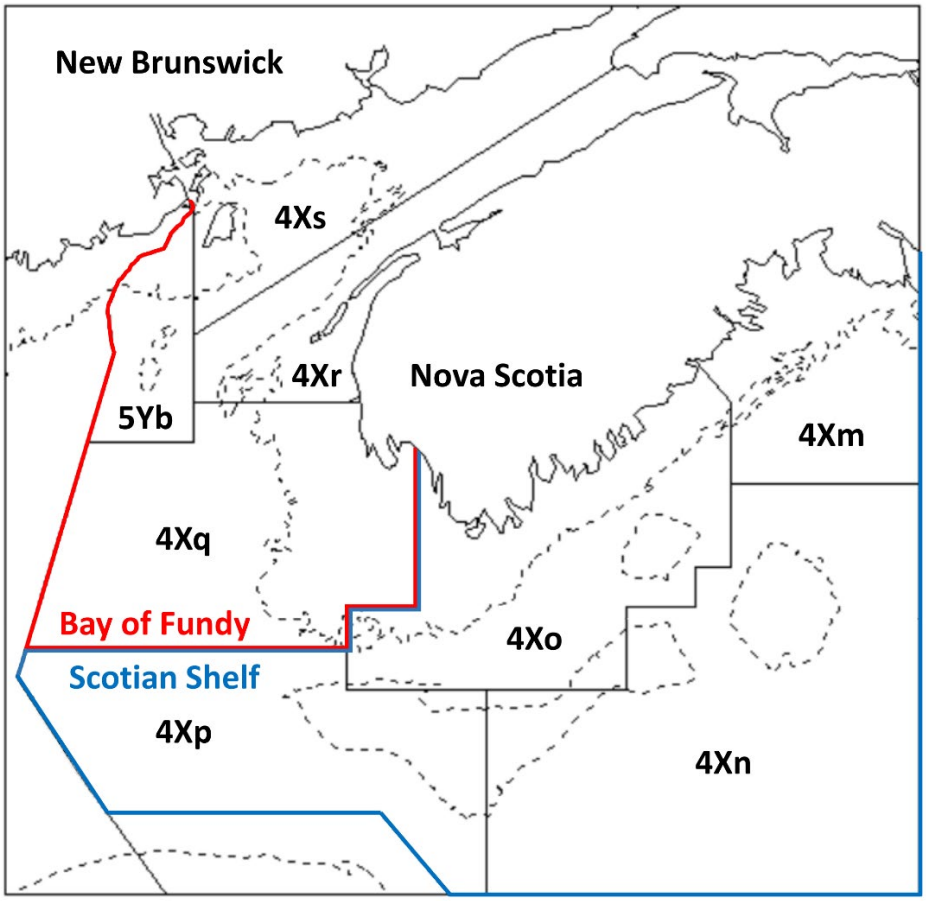

Figure 1. Northwest Atlantic Fisheries Organization Divisions, 4X5Y. Canadian Statistical unit areas for the Bay of Fundy (4Xqrs) and western Scotian Shelf (4Xmnop) are highlighted in red and blue, respectively.

Description of the Fishery

Haddock is harvested as part of a mixed groundfish fishery. Reported annual landings of 4X5Y Haddock averaged 18,500 mt during the 1970s and 19,800 mt during the 1980s, with peaks occurring in the late 1970s and early 1980s (Table 1; Figure 2). Noteworthy is that from 1982–1984, the TAC peaked at 32,000 mt, but it was quickly reduced to 4,600 mt by 1989. In 1991 and 1992, there was no TAC for Haddock under a Management Plan that called for a bycatch fishery only, although landings exceeded 9,000 mt during these years (Hurley et al. 2009). The TAC for Haddock was 5,100 t for the 2012–13 to 2016–17 fishing years, it increased to 7,650 t for the 2017–18 to 2018–19 fishing years, followed by an increase to 9,000 t for the 2019–20 fishing year, and a reduction to 6,877 t in 2020–21. Due to challenges related to the COVID-19 pandemic, a carry-forward request of 960 t from 2019–20 to 2020–21 was granted by Resource Management to the mobile fleet. While the TAC was set to 6,877 t for the 2021–22 fishing year, only 4,718 t of Haddock was landed (Table 1). A TAC of 6,198 t was kept for the 2022–23 fishing year, which is ongoing and hence the landing statistics are incomplete. Catches have been lower than the TAC since 1993 (Figure 2).

Table 1. Reported annual and fishing-year catch (mt) of 4X5Y Haddock. Annual catch is used for 1970–1999 (January 1st–December 31st); subsequent years use fishing-year catch (April 1st–March 31st).

Year	1970–1979 Average	1980–1989 Average	1990–1999 Average	2000/01–2009/10 Average	2010/11–2016/17 Average	2019/20	2020/21	2021/22*
TAC	14,650	21,385	5,050	8,030	5,357	9,000	6,877	6,877
Landings	18,522	19,851	7,219	6,579	3,697	5,206	4,866	4,718

* Extracted from Maritimes Fisheries Information System (MARFIS) September 2022

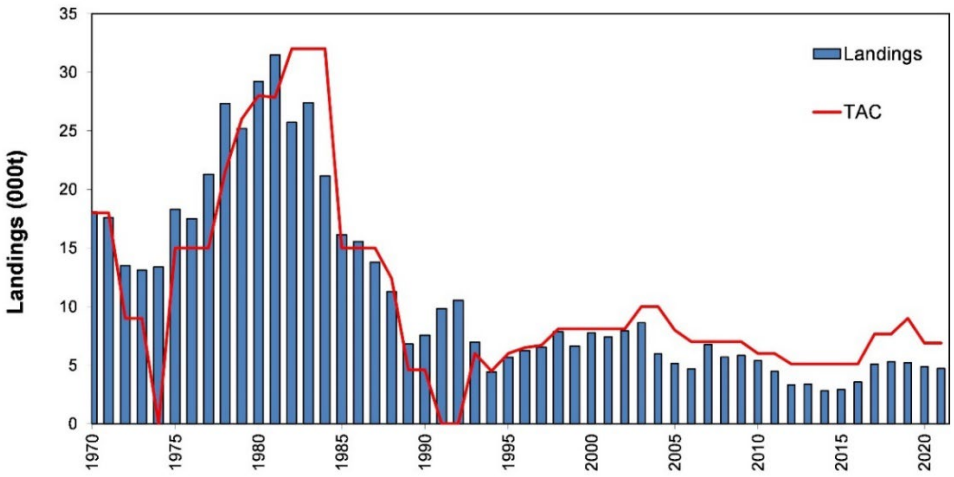

Figure 2. Reported annual and fishing-year landings and Total Allowable Catch (TAC) for the 4X5Y Haddock fishery, 1970–2021. The fishing year changed from Jan 1st–Dec 31st to Apr 1st–Mar 31st in 2000.

Analysis and Response

Indicators of Stock Status

Fishery

The 4X5Y Haddock fishery CAA analysis shows a decreasing contribution of the 2013 year-class (yc) in 2021, relative to the previous few years (Figure 3). In the 2021 fishery, the 2013 yc (Age 8) was still the dominant year-class, representing 22.6% of the Number-At-Age (NAA) in the catch, followed by the 2017 yc (Age 4) at 18.1%, the 2018 yc (Age 3) at 17.4% and the 2016 yc (Age 5) at 16.9%. By weight, the 2013 yc also made up the largest proportion of the catch at 28.8%, followed by the 2016, 2017, and 2018 year-classes at 16.5%, 15.1%, and 12.6%, respectively.

Preliminary data for the first half of 2022 fishery suggest the reduced availability of the 2013 yc at Age 9 comprising 17.4% of the CAA in numbers. The dominant year-class is the 2017 yc (Age 5), making up 23.8% of the catch, followed by the 2018 yc (Age 4) at 19.1% of the NAA. An analysis of WAA reveals similar results for the first half of 2022. The 2013 yc (Age 9) comprised 24.3% of the total weight of the catch, the remainder being made up by the 2017 (Age 5), 2018 (Age 4), 2016 (Age 6), and 2020 (Age 2) year-classes making up 23.0%, 15.5%, 11.3%, and 9.7%, in weight, respectively.

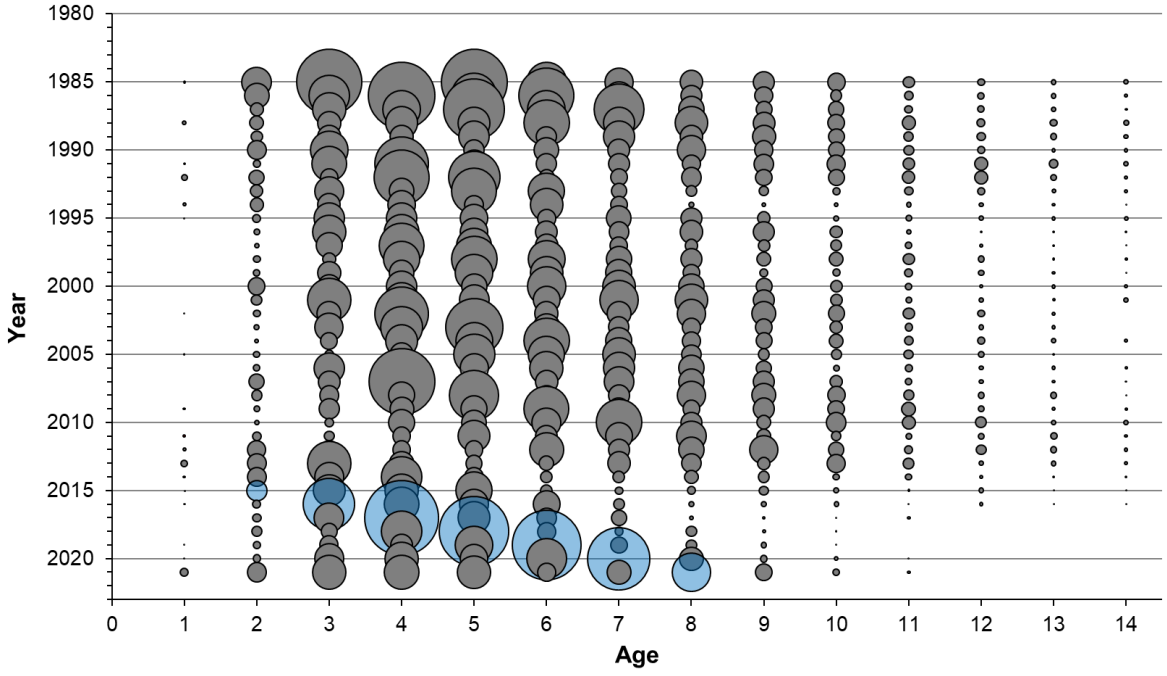

Figure 3. Fishery catch-at-age for 4X5Y Haddock for ages 1–14, 1985–2021. The area of the circle is proportional to the catch in numbers at that age and year. The 2013 year-class is highlighted in blue.

Separate age-length keys are used for the western Scotian Shelf and Bay of Fundy samples to generate NAA, which are then used for weighting the calculations of the overall fishery WAA. In

2021, the fishery weighted mean WAA for ages 2–7 are higher than those recorded in 2020 (which were the lowest in the time series; Table 2).

Table 2. Fishery and DFO Summer Research Vessel Survey weighted mean weight-at-age (kg) of 4X5Y Haddock for ages 1–11+ calculated separately for Scotian Shelf strata (470–481) and Bay of Fundy strata (482–495), then combined after weighting. Cells with dashes (-) have no data available. There are no data for 2021 due to a lack of survey data (see text for explanation).

		Age Group										
Year	**Source**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
2021	Fishery	0.41	0.57	0.53	0.61	0.71	0.74	086	0.93	0.99	1.18	1.23
1985–2020 Minimum value	Fishery	0.11	0.29	0.27	0.41	0.48	0.61	0.69	0.90	0.86	0.86	1.10
2019	Survey	0.07	0.21	0.35	0.39	0.58	0.66	0.96	1.03	0.96	1.40	1.68
2020	Survey	0.09	0.23	0.34	0.46	0.63	0.69	0.78	0.88	1.00	1.13	-
2021	Survey	-	-	-	-	-	-	-	-	-	-	-
2022	Survey	0.13	0.27	0.46	0.49	0.63	0.70	0.79	0.77	0.89	1.18	1.09

There have been significant changes in the catch-at-size by gear type (mobile versus fixed) and area (Bay of Fundy versus Scotian Shelf; Wang et al. 2017). The realized observer coverage for the 4X5Y Haddock mobile gear fishery in 2021 was 4.0% of all trips (13 observed trips). The analyzed observer data from 2021 consisted of 18 trips (including 5 trips from the small mesh fishery) with a total of 95 sets. There were a total of 38 port samples completed from the 4X5Y Haddock mobile gear fishery. Catch size composition is characterized using biological measurements collected from both observer and port sampling programs. The peak length of fish in the catch (mode of length frequencies) has decreased from 46.5 cm in 2008 (Wang et al. 2017) to 40.5 cm in 2021.

The Conservation Harvesting Plan for 4X5Y defines small Haddock as having a length less than 38 cm (DFO 2022a). According to this plan, areas will be closed when the number of undersized Haddock reaches or exceeds 40% of the catch. In the mobile fleet, 12 of 38 port samples had greater than 40% of small fish (< 38 cm) in the catch. Of the trips that exceeded 40% small fish in 2021, most occurred in 4Xn during the months of March and April. None of the observer samples from the mobile fleet contained more than 40% small fish (< 38 cm) in the catch. This discrepancy between port and observer sample length frequencies was also observed on Georges Bank (5Zjm) in 2021 (Y. Wang, DFO, unpublished data).

A small mesh gear (< 130 mm) fishery which targets redfish also catches Haddock as bycatch. In 2021, 2 of 5 observer (40%) and 5 of 11 port bycatch samples (45.5%) from the small mesh gear fishery (< 130 mm) exceeded 40% small fish in the catch. The bycatch of Haddock from the small mesh gear fishery made up 17.4% of the total Haddock landings in 2021 (by calendar year). This is a substantial increase from percentages in 2019 and 2020 (10% and 6.4%, respectively. In comparison, the Haddock bycatch by the small mesh gear fleet increased from 363.6 mt in 2020 to 716.0 mt in 2021.

The preliminary coverage of the 4X5Y Haddock mobile gear fishery in 2022 consists of 9 observer trips with a total of 32 sets and 54 port samples. Of the available data for 2022, 1 observer sample and 12 port samples (2 in small mesh gear, 10 in mobile groundfish gear) exceeded 40% small fish in the catch. Most of the port sample trips that exceeded 40% small fish in 2022 occurred between February and June in 4Xn. The one observer trip that exceeded 40% small fish was groundfish directed in the Bay of Fundy (4Xs). To date, 0 of 2 observer and 2 of 5 port bycatch samples in 2022 from the small mesh gear fleet have exceeded 40% small fish in the catch.

In comparison to 2021, the length frequencies of observer samples are more tightly distributed around a reduced length in 2022 (44.5 cm vs. 42.5 cm; Figure 4A and 4C). Port samples collected in 2021 were quite variable with a significant difference in frequency distribution in the first and second half of the year (Figure 4B). Conversely, all port samples collected in 2022 are more narrowly concentrated around a mode of 38.5 cm (Figure 4D). The length distribution of port samples collected from the Bay of Fundy in the first half of the year has 2 peaks below 38 cm (small fish; 32.5 cm and 36.5 cm) and a third peak at 40.5 cm (Figure 4D).

The fixed gear fleet accounts for a small proportion of the total Haddock landings in 4X5Y (1.1% in 2021). None of the 2021 (n = 2) or 2022 (n = 3) fixed gear port samples have exceeded 30% or 40% small fish (< 38 cm) in the catch.

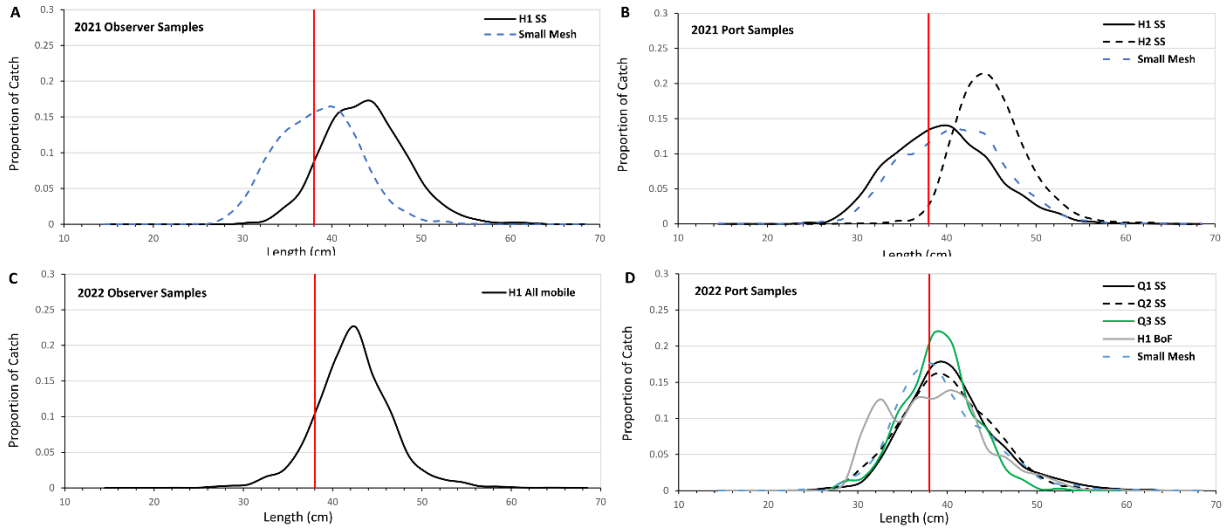

Figure 4. The proportion of catch-at-length from the 4X5Y Haddock observer (A and C) and port (B and D) samples for mobile gear trips by half year or quarter (H1 = Jan–Jun; H2 = Jul–Dec; Q1 = Jan–Mar, Q2 = Apr–Jun, Q3 = Jul–Sept) from the western Scotian Shelf (SS) in 2021 and 2022. Haddock are caught as bycatch in the redfish fishery; the 'Small mesh' length-frequency data (blue line) are samples from redfish directed trips. The red reference line indicates small fish as identified in the Conservation Harvesting Plan, which are Haddock < 38 cm. The observer samples for 2022 were grouped to include all 2022 samples in order to meet data sharing guidelines. Observer data presented here consists of 18 trips with 95 sets in 2021 and 9 trips with 32 sets in 2022. This figure includes data available as of November 7, 2022. Sample collection and data entry for 2022 are considered incomplete.

Survey

The 2022 DFO Summer Research Vessel (RV) Survey was conducted on the CCGS *Teleost* using the Western IIA trawl. Comparative sets were completed on the CCGS *John Cabot* using the Northwest Atlantic Ecosystem Survey Trawl (NEST) trawl, but these sets are not included in this report, as the calibration factors are still in development. Once the calibration factors have been approved, these data will be added to the time series. The 2021 data will also be included in the time series, once comparative fishing data are available and the calibration factors have been approved. Haddock were caught in 89% (85 of 96) of tows in 4X5Y; eight tows had > 100 kg of Haddock, including four tows that had > 150 kg of Haddock (Figure 5).

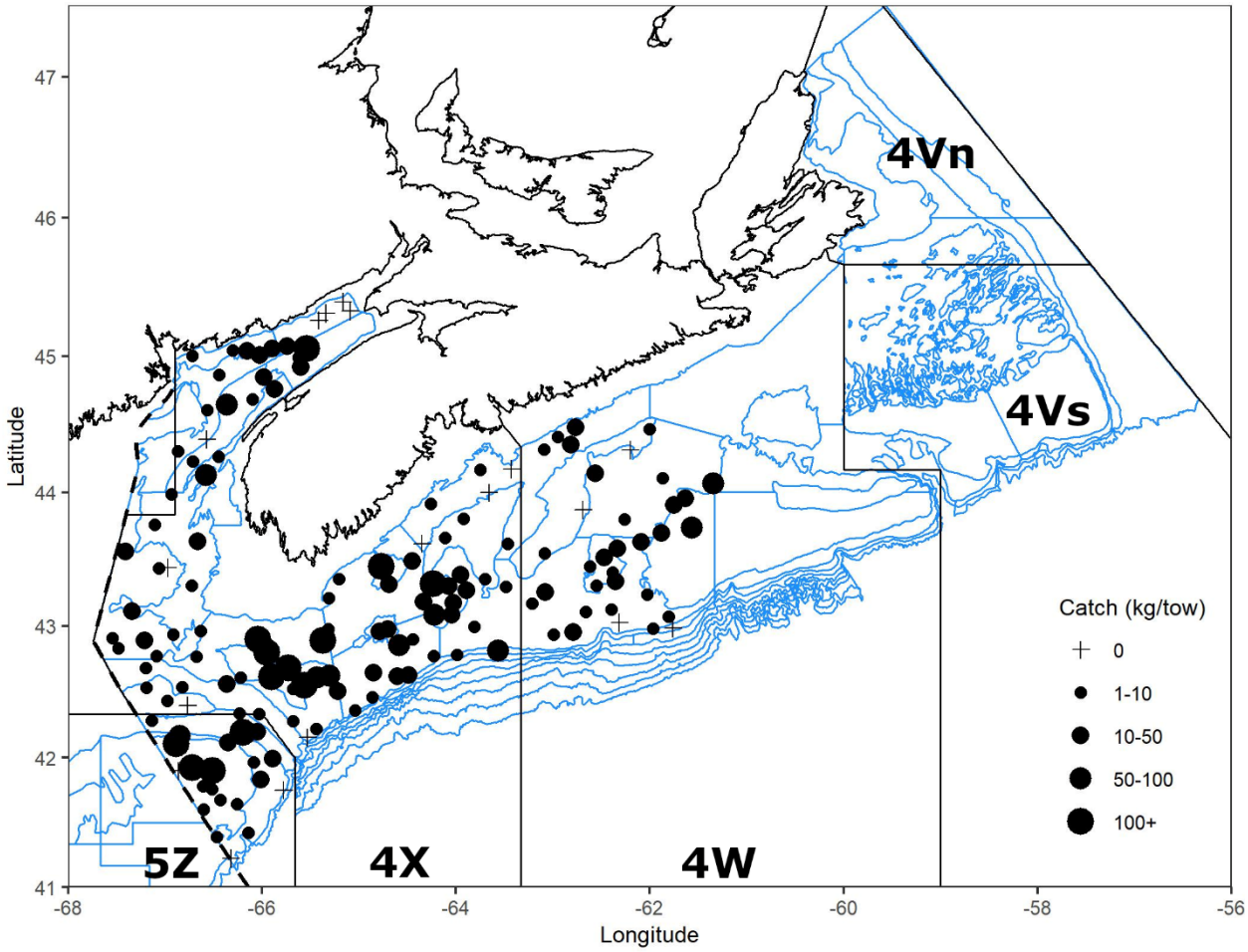

Figure 5. Distribution of Haddock catches during the 2022 DFO Summer Research Vessel (RV) Survey. Zero catch is represented by the + symbol. Black circles represent catches. The circle area is proportional to the catch size. Blue lines represent survey strata. No vessel or net calibration factor was applied to the DFO Summer RV Survey in 2022.

The DFO Summer RV Survey biomass indices for 4X5Y in 2020 and 2022 were 32,943 mt and 35,907 mt, respectively (Figure 6). The 2020 and 2022 indices are below the long-term median (1985–2020: 44,920 mt).

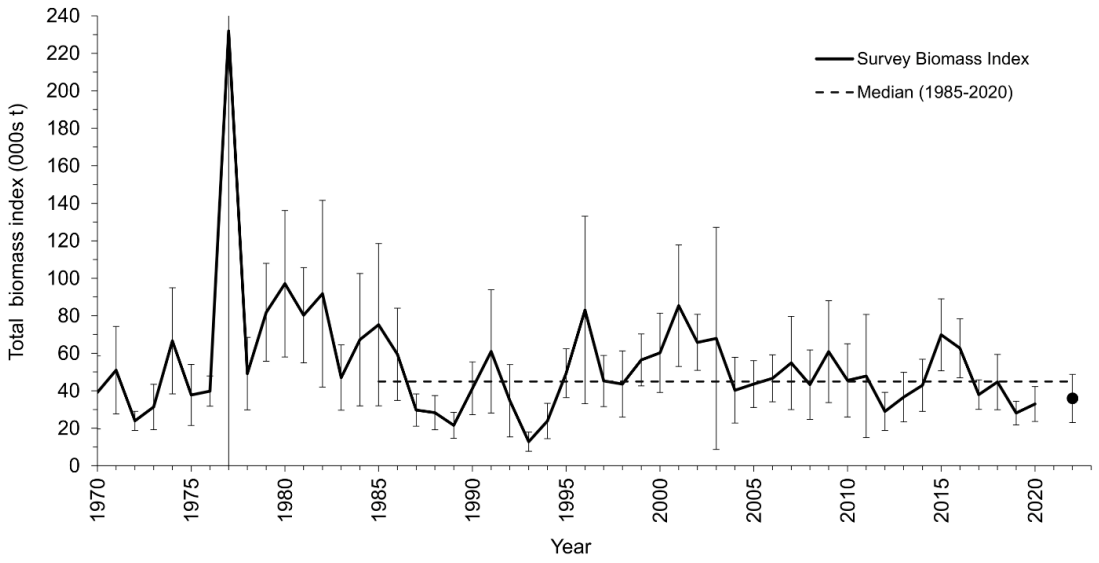

Figure 6. The total biomass index (all ages) ± 2 standard error (000s mt) from the DFO Summer Research Vessel (RV) Survey for 4X5Y Haddock, 1970–2022. The black dashed line represents the long-term median from 1985–2020. A conversion factor of 1.2 has been applied to indices from 1970–1981 to account for vessel and gear changes. In 1982, the RV Lady Hammond was used, towing a Western IIA trawl, no conversion factor is available to apply here. Note: The large error bar in 1977 is the result of a single exceptionally large set in strata 176. There are no data for 2021 due to a lack of survey data.

Similar to the trends observed from the commercial fishery, the mean LAA and WAA values for the DFO Summer RV Survey showed a decline from the early 1990s to the mid-2000s, then a levelling off or a modest increase, and then further decline in both indices since 2011 (Figure 7). This decrease has also resulted in a significant narrowing of the variation of average LAA and WAA between age groups, such that the range of values overlap among some ages. The lowest WAA for most ages occur in the past five years. The lack of older fish increases the uncertainty in the WAA for older fish; only 3 fish aged 10 or greater were found in the 2022 survey catch.

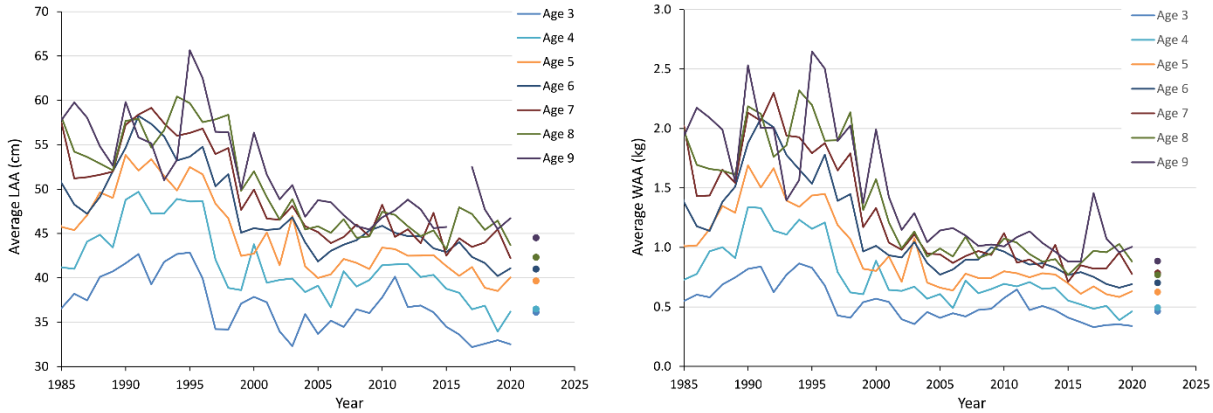

Figure 7. The DFO Summer Research Vessel survey mean length-at-age (cm; left) and weight-at-age (kg; right) for 4X5Y Haddock ages 3–9 for 1985–2022 (2021 excluded because of new vessel used and no calibration factor yet).

Recruitment is variable throughout the survey time series, with the 2013 yc index at Age 1 being the highest on record with a survey estimate of 168 million fish (Figure 8). The 2018 yc was anticipated to be another large cohort; however, this has failed to materialize and is currently considered as only moderately strong (DFO 2019a, DFO 2019b). The young-of-the-year index for 2022 of 14.5 million is above long-term median as well as the short-term median in the Bay of Fundy (Figure 8). In 2022, the 2013 yc (Age 9) contributed just 6% of the survey Age 1+ CAA, while the 2020 yc (Age 2) had the highest contribution (30%), followed by the 2021 yc (Age 1) at 27% (Figure 8). There are a higher number of juveniles in both the Scotian Shelf and Bay of Fundy stock areas in comparison to the long- and short-term medians (Figure 9). While the abundance of Haddock measuring 30–45 cm has increased since 2020 on the Scotian Shelf, it has decreased in the Bay of Fundy. The number of larger Haddock (> 45 cm) in both locations is lower than the long- and short-term medians.

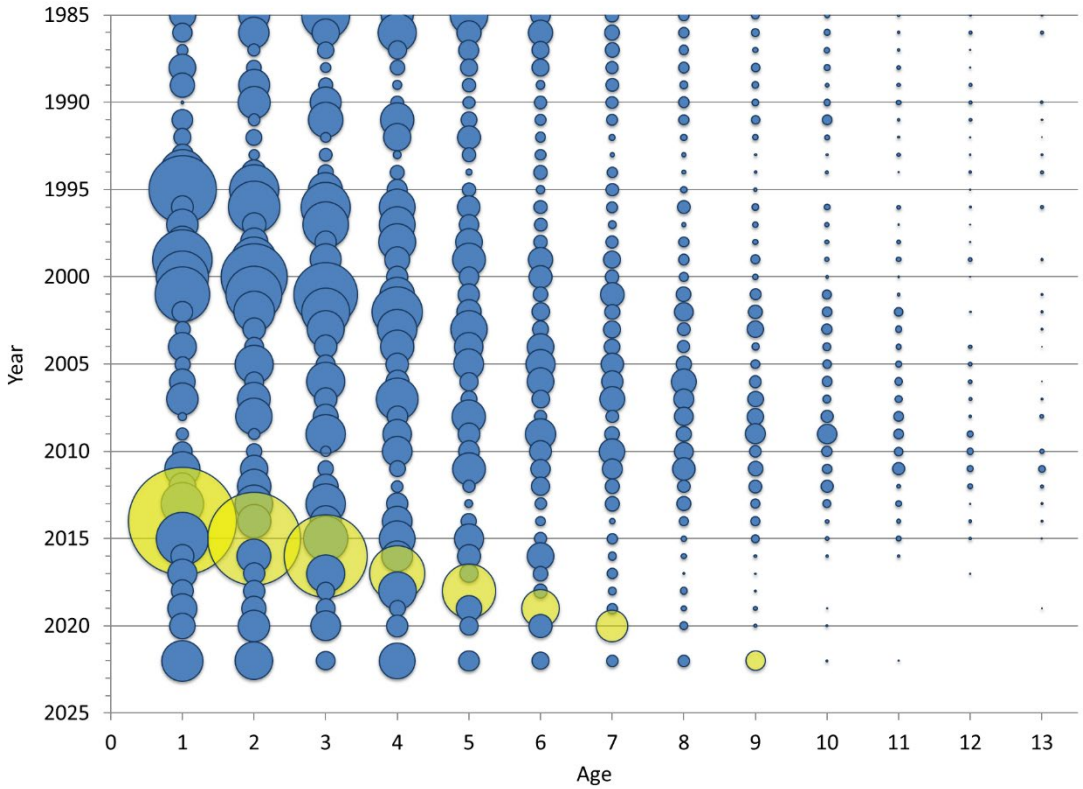

Figure 8. Stratified swept area total number per tow at age (1–13) for 4X5Y Haddock from the DFO Summer Research Vessel (RV) survey, 1985–2022. The yellow circles represent the 2013 year-class at Age 1 in 2014 to Age 9 in 2022. The area of the circle is proportional to the number-at-age for each age and year. Note: There are no data for 2021 and that is why the 2013 yc skips age 8.

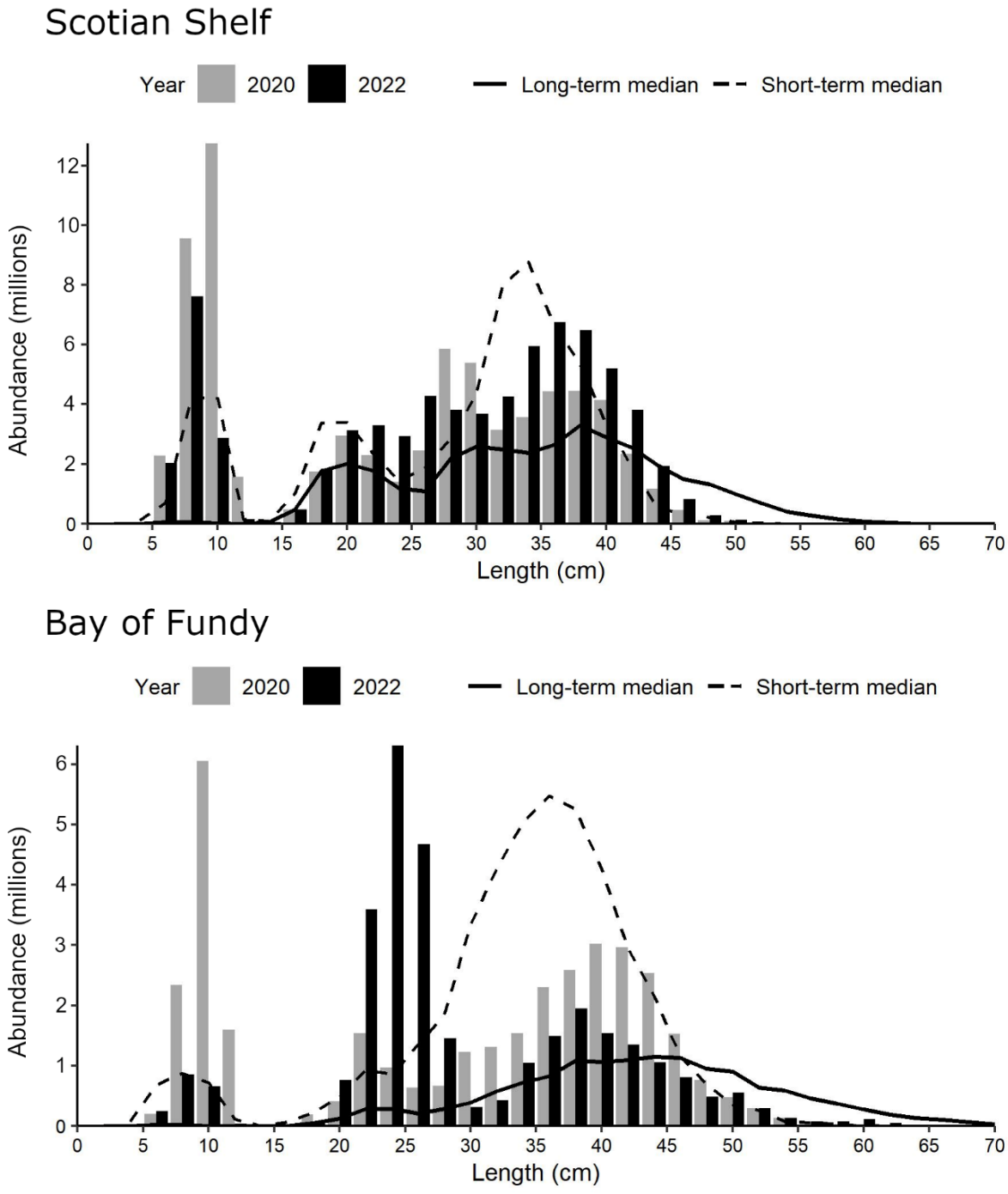

Figure 9. Length frequency of Haddock from the 2020 (grey) and 2022 (black) DFO Summer Research Vessel (RV) Survey for the Scotian Shelf (top) and the Bay of Fundy (bottom). The dashed line represents the short-term median (2015–2019) and the solid line represents the long-term median (1985–2019). The vertical axis represents total estimated number of individuals in millions.

Sources of Uncertainty

The 2018 model retrospective analysis indicated a pattern of overestimating biomass and recruitment (numbers at Age 1), and underestimating F. This pattern has occurred in the past for this stock, particularly when strong year-classes occur (Hurley et al. 2002). The 1998 yc was the largest in the time series during the 2002 assessment of 4X5Y Haddock. The model retrospective analysis indicated that the early estimates of large year-classes may be overestimated by a factor of at least 2 and that the pattern can persist at older ages. It is likely that estimates of natural mortality (M) is higher than assumed in the model due to density dependent effects on large year-classes. The 2013 yc number at Age 1 was first estimated at 317 million in 2016 (Wang et al. 2017); however, this was adjusted to 264 million (Finley et al. 2018) and then later to 168 million (DFO 2018). Similarly, the young-of-the-year index for the 2018 year-class was estimated to be the largest in the time series at 137 million (DFO 2019); however, this cohort failed to materialize as a very strong year-class (Figure 8).

Three years of survey data have been collected since the 2018 model run, and an assessment was scheduled for this stock in 2020. A model run was completed including the 2018-2020 data; however, model diagnostics were poor. Year effects were apparent in the analysis of model residuals, and the resulting historical biomass estimates were not supported by the data. The 2020 VPA model run was not used to provide 4X5Y Haddock biomass estimates, or catch advice, for the 2021/22 fishing year. The following two primary causes for the model misspecification were identified: 1) lack of older ages in the survey and fishery resulted in zeros at Age 10 in 2017 and 2018, as well as zeros in the 11 plus group category, and 2) the assumed natural mortality of 0.2 for some ages less than Age 10 no longer appears to be true.

Survey data were not provided for 2021 because the lack of an approved calibration factor, due to several logistical issues, including the long-reaching impacts of the COVID-19 pandemic and the unavailability of comparative survey vessel. This lack of data will impact our ability to provide statistics that combine data across 3- and 5-year time spans (e.g., 5-year median abundance, relative F, total mortality). Without a model, the absence of these indicators will have a significant impact on our ability to provide management advice.

Discordance between data from port and observer samples may be a source of concern, particularly in terms of the reported number of small fish caught. Additional port sampling (more than one sampler at multiple locations) may shed light on this data discrepancy. Increased observer coverage (only 4.0% in 2021) is also required for comprehensive data analysis.

State of the Resource Relative to Adopted Reference Points

The assessment model developed in 2016 was determined to not provide reliable biomass estimates (DFO 2020). Current survey biomass indices, therefore, cannot be compared directly with the model derived Limit Reference Point (LRP = 19,700 mt) and Upper Stock Reference (USR = 40,000 mt) for stock status determination. During the 2016 framework, the LRP was based on a model estimated spawning stock biomass (SSB, ages 4+) from 1994, from which the stock has shown a steady recovery. Comparing the survey biomass index from 2022 to that of 1994 indicates that the 2022 index of 20,164 mt (SSB; total biomass 35,907 mt) is well above the 1994 index of 13,612 mt (total biomass 23,853). As such, it may be assumed that the stock is currently above the Critical Zone. In 2016, when the VPA model worked well based on model

diagnostics, the SSB was estimated at 33,770 mt and assessed as within the Cautious Zone. That same year, the survey biomass was estimated at 24,060 mt (SSB) from which it has declined to 20,164 mt (SSB) in 2022. The 2022 survey biomass index suggests that the stock remains in the Cautious Zone.

Reference points (LRP and USR) were defined for 4X5Y Haddock in the spring of 2017 (DFO 2018) using biomass estimates from the 2016 assessment model (DFO 2017). Since 2019, the model and the associated reference points have not been used. Recent stock status updates from 2020 and 2021 (DFO 2021 and DFO 2022, respectively) have assessed the stock status by comparing the survey biomass index to 40% and 80% of the 1985–2020 time series median. However, caution must be taken when drawing reference points from a truncated time series, as this can lead to misperceptions of stock status by failing to capture historical biomass maxima, past recoveries, low abundance levels and biomass fluctuations (Schijns and Pauly 2021). Here, we present the biomass index for 2022 (35,907 mt) relative to the 40% (17,968 mt) and 80% (35,936 mt) of the same time series (1985–2020), but they should not be considered as formalized reference points. While these comparisons may have served a purpose in the 2020 and 2021 stock updates, it should no longer be used for stock status determination in the future. An upcoming framework will provide more suitable reference points.

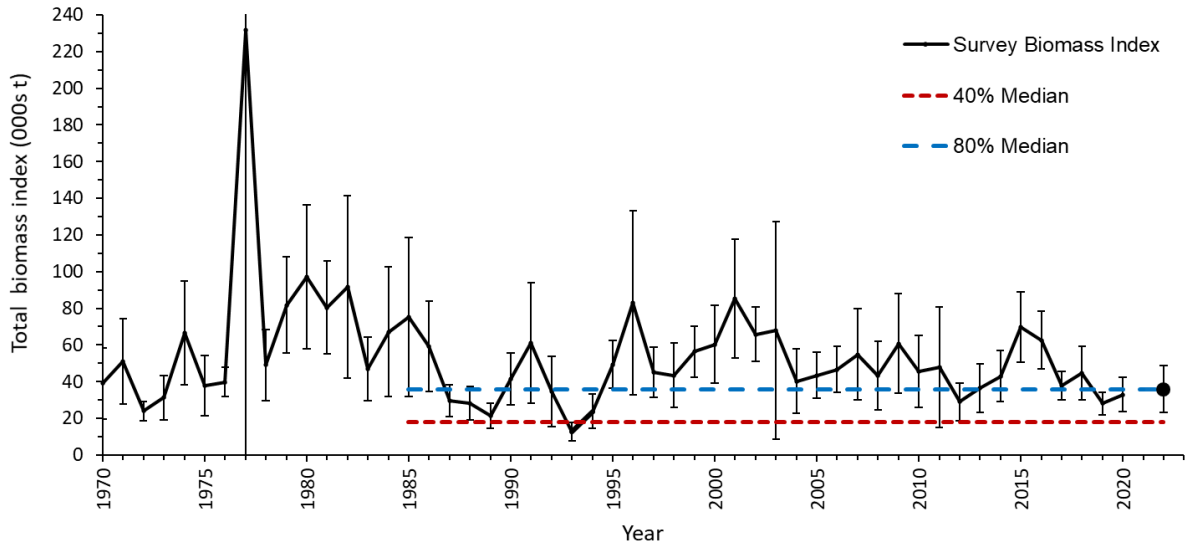

Figure 10. Biomass index for Haddock in 4X5Y from the DFO Summer Research Vessel (RV) survey, 1970–2022. The biomass index is represented by the solid black line. The dashed blue and red lines represent 80% and 40% of the 1985–2020 median, respectively. A conversion factor of 1.2 has been applied to indices from 1970–1981 to account for vessel and gear changes.

Relative Fishing Mortality

Due to the lack of an assessment model, an estimate of fishing mortality (F) rate can no longer be calculated. Relative fishing mortality (fishery catch/survey biomass) was examined; however, model estimated F and relative F are not directly comparable. Relative F tended to be above the mean during the earlier years of the time series until 1994 and has remained low since (Figure 11). Due to the absence of 2021 survey data relative F for 2021 is unavailable

(Figure 11). The figure has not been updated for 2022 as the annual catch has not been totalled yet.

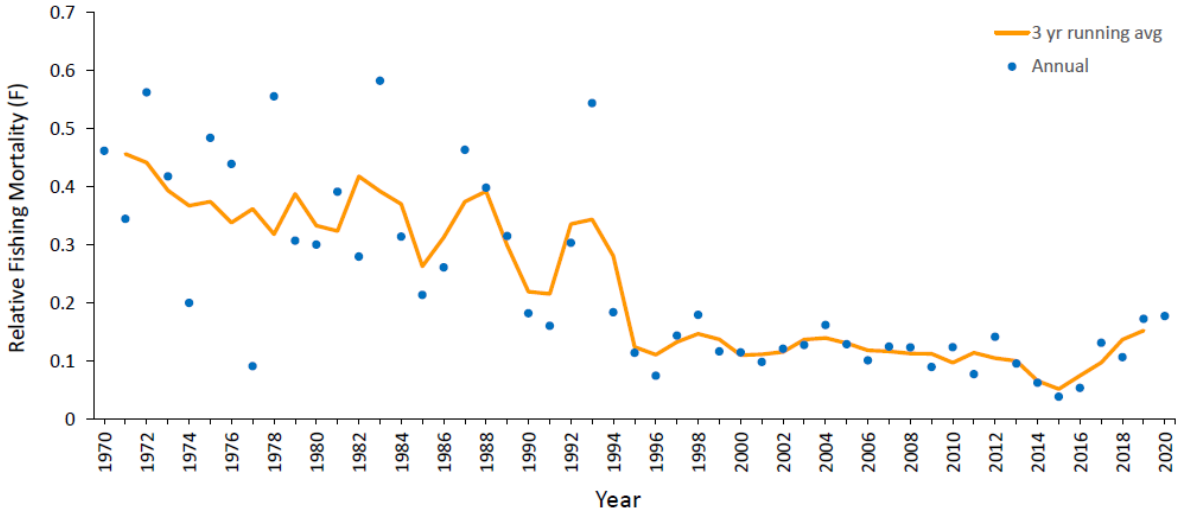

Figure 11. Annual relative fishing mortality (blue dots; catch by calendar year/survey biomass) with 3-year running average (orange line) for 4X5Y Haddock for 1970–2020. Data for 2021 and 2022 are not shown, due to a lack of data from the 2021 survey and incomplete fishery data for 2022 (ongoing).

Total Mortality

Total mortality (Z; Sinclair 2001) was calculated for ages 4+ from 1985 to 2020. This was then smoothed using a 3-year running average (mean of $Z_{yearj-1}$, Z_{yearj}, $Z_{yearj+1}$) and compared to relative fishing mortality (Figure 12). As before, this time series ends at 2020, due to the impacts of the COVID-19 pandemic on the survey schedule.

Total mortality and fishing mortality appear correlated during the first decade of the analyzed time series (1985–1995; Figure 12). In the early 1990s, the survey biomass estimate reduced to an all time low and concurrently the TAC was drastically reduced. Since the mid-1990s, relative fishing mortality has remained low and appears to be decoupled from total mortality (Figure 12). Moreover, the trends of these two indices over the past two decades may be indicative of increasing M. A growing body of evidence suggests an increasing M on Eastern Georges Bank in the past decade (TRAC 2022).

Between 2012 and 2019, Z has been extremely variable among ages 6+ with a peak occurring in 2015 (Figure 13).

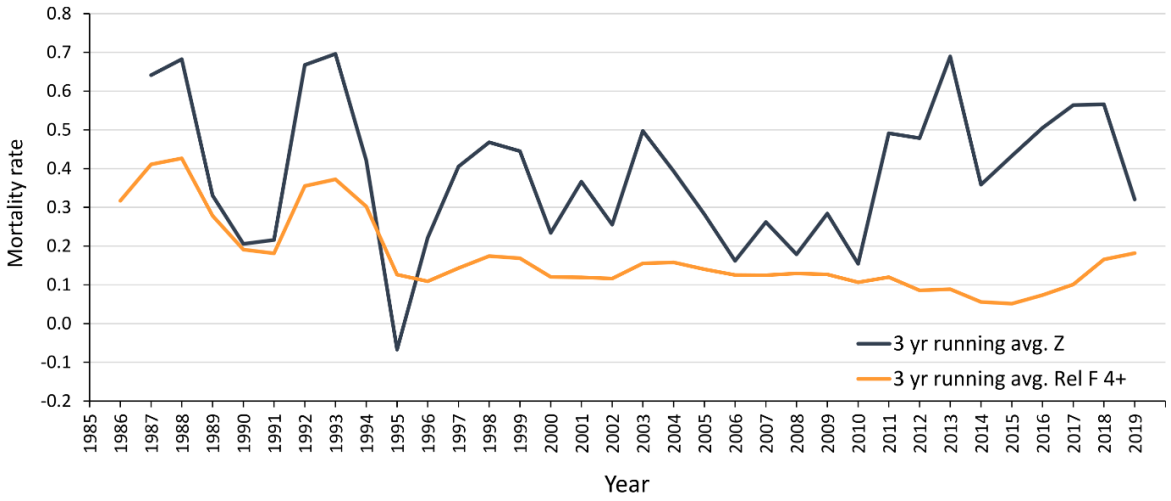

Figure 12. The 3-year running average of total mortality on ages 4+ (solid blue line) and the 3-year running average of relative fishing mortality on ages 4+ (solid orange line) for 4X5Y Haddock, 1985–2020. Estimates end at 2019 for 3-year running averages due to the lack of data from the 2021 survey and incomplete fishery data for 2022 (ongoing).

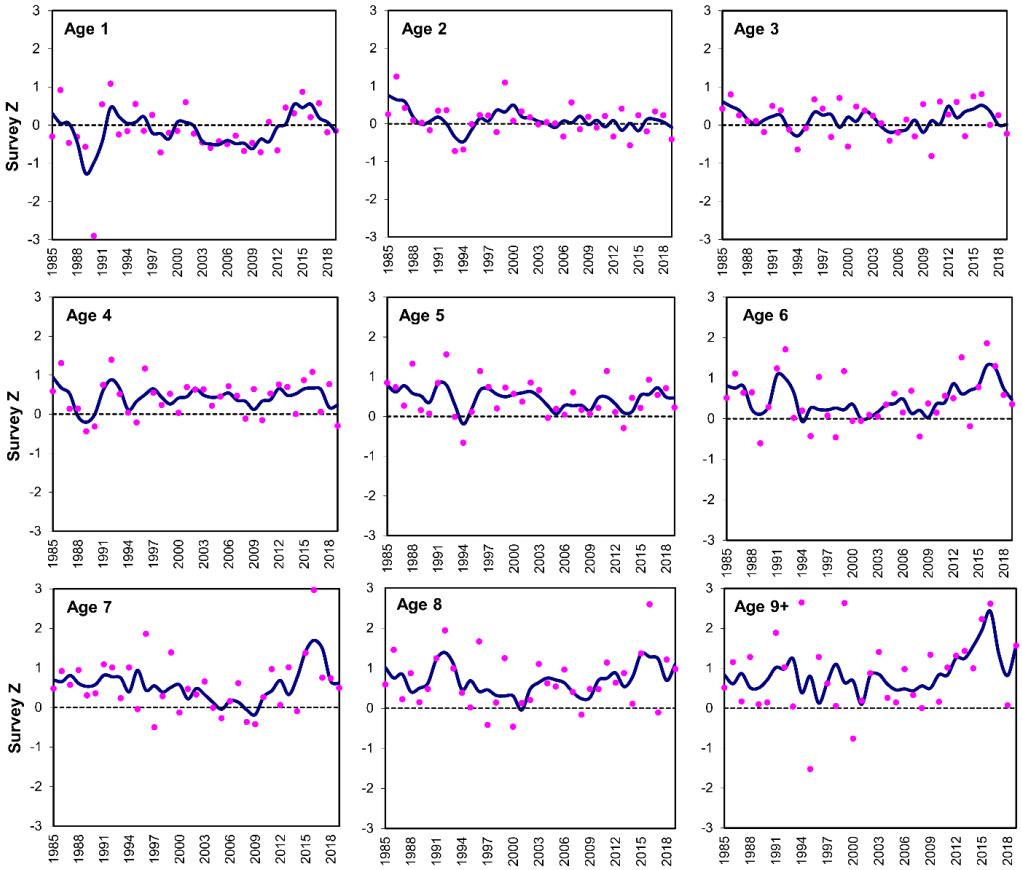

Figure 13. A 3-year smooth (solid blue line) and point estimates (pink dots) of total mortality (Z) at age, 1985–2019. The dashed reference line is at zero.

Conclusions

In 2020, the assessment model was not deemed appropriate to provide stock advice, so there are no analytical projections to characterize risk for catches in 2023–2024. Without the vessel and net calibration factor, there is limited information available from the DFO Summer RV Survey in 2021 to provide catch advice for 4X5Y Haddock. Therefore, this stock does not have an updated relative fishing mortality or total mortality for 2022. The 2022 biomass index for Haddock in 4X5Y from the DFO Summer RV Survey is 35,907 mt. This estimate places the stock in the Cautious Zone, relative to reference points used in the past (DFO 2018, 2019, 2020, 2022).

Fishery data indicate a waning influence of the 2013 year-class and an increasing scarcity of older fish (9+ years). WAA and LAA remain low and show no signs of recovery to pre-2000s levels, while variation continues to narrow. A growing proportion of small fish in the fishery is resulting in an increased proportion of catches exceeding the small fish threshold. The bycatch of Haddock from small mesh gear appears to be increasing and this may warrant additional investigation. Table 3 provides information to support increasing, maintaining, or reducing catch in 2023/24.

Table 3. Information either supporting increasing, maintaining, or reducing existing catch for the 2023/24 fishing year. A dash (-) indicates a blank cell, as the lists are not equal in length.

Increase Existing Catch	Maintain Existing Catch	Reduce Catch
-	The survey biomass in 2022 was 9% higher than 2020.	Based on survey data, the 2019 year-class, which will be targeted by the fishery in 2023, is less than half (42.0%) of the 1985–2020 time-series median for Age 4 Haddock.
-	A smaller proportion of survey tows contained Haddock in 2022 (89%), relative to 2019 (> 95%) and 2020 (> 96%).	The 2022 survey biomass estimate places the stock in the cautious zone, relative to reference points used in the past.
-	The number at Age 2 (2020 year-class) in the survey index is nearly twice (188%) the 1970–2020 time-series median.	Total mortality has increased on ages 6+ in the past decade.
-	Relative F has been low since 1994.	Older ages (Age 11+) are all but absent from both the survey catches and fishery.

Increase Existing Catch	Maintain Existing Catch	Reduce Catch
-	-	The lowest survey and fishery weights-at-age for most ages occurred in the past 5 years.

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