

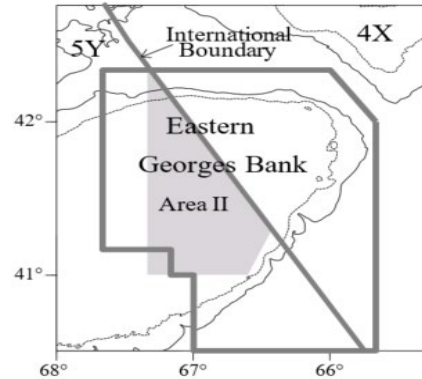


## Transboundary Resources Assessment Committee

Status Report 2022/02

# EASTERN GEORGES BANK COD DRAFT

[5Zjm; 551,552,561,562]



## Summary

- Combined Canada/United States of America (USA) catches of eastern Georges Bank (EGB) Cod in 2021 were 487 mt, including 11 mt of discards.
- The 2021 National Marine Fisheries Service (NMFS) fall survey swept area biomass value for EGB Cod has decreased from 2019, while the 2022 NMFS spring survey increased from 2021. The swept area abundance increased for both the 2022 spring and the 2021 fall surveys, but remains below the recent time series mean.
- Cod length frequency of the 2022 NMFS spring survey catch is comparable to last year, while that of the 2021 NMFS fall survey is characterized by an unusually large peak at 43 cm (17 in), representing one year old fish.
- Cod condition remains below the long-term mean for the Fisheries and Oceans Canada (DFO) spring survey and above the long-term mean for the NMFS fall and spring surveys.
- Preliminary analyses indicate an improvement in growth of young Cod on eastern Georges Bank, while older fish continue to grow slowly.
- Only aggregate landings and discards were available from the USA commercial fishery. The length and age composition information is not currently available for the 2020 or 2021 USA fishery. Full data from the 2022 DFO spring survey are not yet available pending the availability of a new vessel conversion factor.
- Available survey and fishery indicators generally remained consistent with the previous years, indicating that productivity of the stock remains low and there is no notable change in the state of the stock.



- Given that the biological assumptions going into Data Limited Methods tool (DLMtool) are maintained, the simulated operating models remain appropriate. Based on the approved Management Procedure selected by the Transboundary Management Guidance Committee (TMGC), the Transboundary Resource Assessment Committee (TRAC) catch advice for EGB Cod for 2023 is 520 mt and remains appropriate. There is a need to continue annual evaluation of whether the assumptions made in the projections of the DLMtool remain realistic, particularly if further evidence of higher than assumed growth emerges.
- The current application of the DLMtool is only intended as a short-term solution and should be replaced or supplemented with at least one functioning population model as soon as possible. The TRAC strongly recommends a benchmark for this stock.

## Fishery

**Combined Canada/USA catches** of eastern Georges Bank (EGB) Cod in 2021 were 487 mt, including 11 mt of discards, with a quota of 635 mt (Table A1). Historically, catches averaged 17,200 mt between 1978 and 1993, peaking at 26,463 mt in 1982. Catches declined to 1,683 mt in 1995, then fluctuated at about 3,000 mt until 2004, and have subsequently declined (Table A1).

**Canadian catches** increased from 377 mt in 2020, which was the lowest in the time series, to 431 mt in 2021 (Table A1). Discards of Cod were estimated at 6 mt from the groundfish fleet and 5 mt from the Canadian scallop fishery in 2021. The landings occurred primarily during the third and fourth quarter, using mobile (40%) and fixed (60%) gears (Figure A1).

**USA catches** decreased from 67 mt in 2020 to 56 mt in 2021 (Table A1). Estimated discards of Cod for 2021 were 0.6 mt. At the time of this status update, only the aggregate landing and discard data from the USA fishery were available for the 2020 and 2021 fishing years.

The **size composition** of the 2021 Canadian fishery EGB Cod catches (landings and discards) were derived from the pooled port samples and at-sea samples from all principal gears and seasons (Table A2). Catches in 2021 peaked at 64 cm (25 in) for the Canadian fishery representing a slight increase from the 2020 fishing season (Figure A2).

The age composition since 2020 is summarized for the Canadian fishery only, but will be updated for the combined fishery removals once the USA data become available. The 2017 age class at age 4 Cod was a major contributor to the Canadian 2021 fishery catch (34% of the fish by number), followed closely by the 2018 year class at age 3 (32% by number), and distantly by the 2019 year class at age 2 (16% by number) (Figure 3; Figure 4). In 2021, fish ages 8+ accounted for less than 1% of the individuals caught in the Canadian fishery.

## Harvest Strategy and Reference Points

The Transboundary Management Guidance Committee (TMGC) has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality limit reference,  $F_{ref}=0.18$  (TMGC 2003). When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. With the rejection of the 2013 Benchmark models and the implementation of the Data Limited Methods tool (DLMtool) simulation framework, an estimate of fishing mortality can no longer be calculated.

## Data Limited Methods Tool Application

Following the rejection of the EGB Cod stock assessment models in 2018, the Transboundary Resource Assessment Committee (TRAC) applied the Data Limited Methods Tool (DLMtool) to

identify a simple, simulation tested method of providing catch advice for EGB Cod until a Benchmark can be held for this stock. Prior to completion of this application, the TRAC was asked to examine survey and fishery indicators and determine if there is a need to revisit the 2018 TRAC advice of 650 mt, resulting in a carry-over of that advice in each year (TRAC 2018, TRAC 2020). On April 22<sup>nd</sup>, 2021, the outputs of the simulation were presented at a TMGC Intercessional (see Andrushchenko et al. 2021), with the TMGC selecting two Management Procedures (MP) to provide interim advice: status quo (650 mt) and status quo minus 20% (520 mt). In 2022, the TMGC revised their decision to only select the status quo minus 20% (520 mt) MP. Given the simulated low productivity state for this stock, none of the MPs considered are expected to substantially change the current state of the EGB Cod stock, as long as conditions of low productivity persist.

The application of DLMtool to EGB Cod required several assumptions about the current biological metrics of the stock, namely weight, growth and maturity (see Andrushchenko et al. 2021). The outputs of the simulation testing remain valid as long as these biological assumptions hold. The DLMtool uses empirical data up to 2018 as the basis for these assumptions, which leaves room to test whether these assumptions hold when additional years of information become available. This year, the weight-at-age, growth, and maturity assumptions were compared to empirical survey data from the available National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) surveys since 2019. Note that the 2020 NMFS spring and fall surveys were cancelled due to COVID-19 restrictions and are therefore absent from the analysis. In addition, the 2021 NMFS spring ages were not available in time for the 2021 TRAC assessment, so the current document includes updated information for the 2021 NMFS spring survey and newly presented 2022 data.

The updated data showed no major departure from the range used for the assumptions of weight-at-age, growth, and maturity, although the growth parameters are progressively moving towards the outer limits of the assumed range (Figures A5, A6, A7). A change in the growth rate of younger fish can cause a true increase in the K parameter, simultaneously causing the growth curve asymptote ( $S_{inf}$ ) to fluctuate and creating uncertainty around whether  $S_{inf}$  has actually changed in recent years. The cohorts experiencing high growth are currently incomplete, making it difficult to model growth beyond the young ages in recent years. If the young cohorts (2019+) continue to exhibit better growth as their contribution to the population increases, the growth parameters assumed in the projections of DLMtool may move outside of the bounds in the upcoming years.

## State of the Resource

Without an assessment model, the state of the resource is described by summarizing relevant survey trends. Biomass and abundance indices for the 2022 DFO spring survey will not be available until comparative fishing is complete. The survey **swept area biomass** was 1,114 mt for the 2021 NMFS fall survey, and 3,686 mt for the 2022 NMFS spring survey (Table A4; Figure A8). The 2021 NMFS fall survey swept area biomass value represents a decrease from 2019, while the NMFS spring value represents an increase from 2021 (Table A4; Figure A8). The **swept area abundance** from the NMFS fall survey increased slightly from 638,000 in 2019 to 653,000 in 2021, but remains below the recent series mean (1994–2019, 1.1 million fish) (Table A5c); for the NMFS spring survey, it increased from 1.5 million fish in 2020 to 1.8 million fish in 2021, but also remains below the recent series mean (2.8 million fish, 1994-2021). The DFO spring survey data are not ready for analysis, as a new vessel conversion factor has not yet been calculated.

**Total mortality (Z)** is calculated by two age groups (ages 4–5 and ages 6–8) using the NMFS spring survey abundance indices only, fitted with a LOESS smooth to help track trends (Figure A10). Total mortality trends from the NMFS spring survey based on catch curves began to break down over the past decade. The increasing occurrence of year and age combinations with no Cod observed in the surveys, particularly for the older ages, is problematic for these simple calculations of survey Z. For recent years where the calculation is functioning, total mortality on older fish is higher than on younger fish (Figure A10). Two additional years of data continue to show intermittent presence of older fish. In combination with missing surveys, this creates numerous gaps in the time series. Although the time series only provides intermittent glimpses into the level of total mortality, the absence of older fish from the survey catch confirms that high mortality on older fish continues. The total mortality calculation using the Sinclair (2001) approach also appears to have broken down for the NMFS spring survey, but the exact cause was not investigated due to time limitations (Figure A11).

## Productivity

The **spatial distributions** of Cod in the 2021 NMFS fall surveys and 2022 DFO and NMFS spring surveys remained comparable to the previous years. The DFO data are provided without conversion only to illustrate the location of catches and not catch size. For the NMFS spring and fall surveys, large survey sets recorded along the northeastern edge of Georges Bank in the previous ten years were absent in the most recent year (Figure A12). The catches from the DFO spring survey were distributed across the Canadian portion of the bank, while the NMFS spring catches were broadly distributed across the American portion of eastern Georges Bank, particularly near the Hague Line. The NMFS fall catches were confined to the northeast edge of the Canadian portion of the bank. Given the comparable magnitude of catches for the USA spring survey in the past two years, the accompanying coefficients of variation were relatively low (Figure A9).

The 2021 TRAC recommended exploration of **distribution indices** to help characterize the visual interpretation of changes in the spatial distribution of Cod on eastern Georges Bank. Consequently, the geographic range (D95) and the core area (D50) indices derived from the design-weighted area of occupancy (DWA0) were calculated for all three survey data sources (Figure A16). This method was initially developed for use in American Plaice assessments (Swain and Morin 1996, Busby et al. 2007) and applied most recently in Ricard (2022) to a wide range of species.

Long-term changes in the geographic range and the core area of Cod on eastern Georges Bank tend to be generally consistent by data source. The DFO survey shows a decrease in D95 post-1990s, while the D50 remains relatively constant over the time period (Figure A16). The trends in the NMFS spring survey are less pronounced, but also appear to show a slight constriction of both the D50 and the D95 in the 1990s (Figure A16). The NMFS fall survey shows a similar constriction of the D95 in the mid-1990s, while trends in the D50 are difficult to discern due to a large number of missing points (Figure A16). This is the consequence of a small number of sets that contain a large proportion of the catch.

It was noted that if the area surveyed is invariable over time the DWA0 can detect a shrinkage or expansion in the spatial distribution of a species, but is generally imperceptive to a spatial migration of the species within the surveyed area (i.e. NMFS Spring 2022). In addition, the variability in the area surveyed over time in the NMFS surveys can confound the DWA0's ability to detect trends, indicating that other indices may be more appropriate to use in the future (e.g., Gini).

The **length frequency** of the survey catch in the 2022 NMFS spring survey peaked at 58 cm (23in), while the 2021 NMFS fall survey catch is characterized by an unusually large peak at 43 cm (17 in), representing one-year old fish (Figure A13).

Fulton's **condition factor** (K) was updated for all three surveys (Figure A14). The surveys showed a downward trend throughout the series until 2009, when K either stabilized or began to increase for all three surveys (Figure A14). With the most recent data, Cod condition remains below the long-term mean for the DFO spring survey and above the long-term mean for both the NMFS fall and spring surveys.

The most recent data update indicated an improvement in **growth** of young Cod on eastern Georges Bank, while older fish continue to grow slowly. The effect is most pronounced on fish aged 1 through 5 (Figure A17), is evident across various data sources (Canadian fishery and surveys) and ageing labs (NMFS and DFO), and persists when time of year is taken into account. In general, it appears as though young fish sampled in 2021 and 2022 all grow as well as the faster growing fish sampled in previous years (Figure A17), comparable to the level of growth seen prior to 1994 (Figure A18). An initial examination of growth by cohort indicated that the growth rate of the 2019, 2020 and 2021 cohorts is among the highest in the recent time period (Figure A19). The current analysis is preliminary and was done under a tight timeline in preparation for the 2022 TRAC meeting; further examination of growth rates and investigation into likely causes should take place as resources permit, particularly in preparation for a benchmark.

## Outlook

Available survey and fishery indicators generally remained consistent with previous years (Table A6), indicating that productivity of the stock remains low and there is no notable change in the state of the stock.

Given that the biological assumptions going into DLMtool are maintained, the simulated operating models remain appropriate. Based on the approved Management Procedure selected by the TMGC, the TRAC catch advice for EGB Cod for 2023 is 520 mt and remains appropriate. There is a need to continue annual evaluation of whether the assumptions made in the projections of the DLMtool remain realistic, particularly if further evidence of higher than assumed growth emerges. The current application of the DLMtool is only intended as a short-term solution and should be replaced or supplemented with at least one functioning population model as soon as possible. The TRAC strongly recommends a benchmark for this stock.

## Special Considerations

Estimated removals in recent years in USA EGB Cod catches are a source of uncertainty. Further investigation is needed into the ecological role of Cod and the potential implications of these changes on the recent productivity trends of Cod. In addition, investigation into the recent levels of natural mortality on eastern Georges Bank is recommended.

The USA commercial fishery data processing system is undergoing a change. The new system is called the Catch Accounting and Monitoring System (CAMS). Due to delays in implementation, the 2020 and 2021 USA commercial fishery data could not be processed in time for this meeting. The USA fishery data presented in this report were provided courtesy of Jamie Cournane (New England Fishery Management Council), Spencer Talmage and Dan Caless (NOAA Fisheries Greater Atlantic Regional Fisheries Office).

The NMFS and DFO ageing labs assume a different birth date for EGB Cod, with NMFS labs assuming fish are all born on January 1<sup>st</sup> and DFO labs assuming fish are all born on February 1<sup>st</sup>. For analyses using integer ages (i.e., whole age), the impact of this difference is limited to only fish sampled in the month of January; calculations of partial age are impacted regardless of month sampled.

Apparent improvement in growth of young fish and their relatively high abundance compared to the recent years in 2021 NMFS fall survey must be monitored to see if the signal persists as the fish age and increase their contribution to the population.

The USA is conducting a research track assessment on Atlantic Cod and an update was provided at this meeting. The TRAC anticipates another update next year. The current application of the DLMtool was only intended as a short-term solution and should be replaced with at least one functioning population model as soon as possible, particularly in light of apparent changes in growth of incoming year classes and the need by both Canada and the USA for science advice on stock status, reference points, etc.

## Source Documents

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## **Correct Citation**

TRAC. 2022. Eastern Georges Bank Cod. TRAC Status Report 2022/XX.

## APPENDIX

**Table A1.** Catches (mt) of Cod from eastern Georges Bank, 1978 to 2021. USA landings, Discards and Total Catch are reported for Fishing Year (May 1 – April 30). All other values, including Total Allowable Catch (TAC) are reported for calendar year (Jan 1 – Dec 31). The Combined Catch is the sum of USA Fishing Year Total Catch and Canadian Calendar Year Total Catch.

Year	Canada					USA				Combined	
	Landings	Discards Scallop	Discards Groundfish	Total Catch	TAC	Landings	Discards	Total Catch	TAC	Catch	TAC
1978	8,777	98	-	8,875	-	5,502	-	5,502	-	14,377	-
1979	5,979	103	-	6,082	-	6,408	-	6,408	-	12,490	-
1980	8,066	83	-	8,149	-	6,418	-	6,418	-	14,567	-
1981	8,508	98	-	8,606	-	8,092	-	8,092	-	16,698	-
1982	17,827	71	-	17,898	-	8,565	-	8,565	-	26,463	-
1983	12,131	65	-	12,196	-	8,572	-	8,572	-	20,769	-
1984	5,761	68	-	5,829	-	10,558	-	10,558	-	16,387	-
1985	10,442	103	-	10,545	-	6,641	-	6,641	-	17,186	-
1986	8,504	51	-	8,555	-	5,696	-	5,696	-	14,251	-
1987	11,844	76	-	11,920	-	4,793	-	4,793	-	16,713	-
1988	12,741	83	-	12,824	-	7,645	-	7,645	-	20,470	-
1989	7,895	76	-	7,971	-	6,182	84	6,267	-	14,238	-
1990	14,364	70	-	14,434	-	6,414	69	6,483	-	20,917	-
1991	13,467	65	-	13,532	-	6,353	112	6,464	-	19,997	-
1992	11,667	71	-	11,738	-	5,080	177	5,257	-	16,995	-
1993	8,526	63	-	8,589	-	4,019	57	4,077	-	12,665	-
1994	5,277	63	-	5,340	-	998	5	1,003	-	6,343	-
1995	1,102	38	-	1,140	-	543	0.2	544	-	1,683	-
1996	1,924	56	0.0	1,980	-	676	1	677	-	2,657	-
1997	2,919	58	428	3,405	-	549	6	555	-	3,960	-
1998	1,907	92	273	2,272	-	679	7	686	-	2,959	-
1999	1,818	85	253	2,156	-	1,195	9	1,204	-	3,360	-
2000	1,572	69	0.0	1,641	-	772	16	788	-	2,429	-
2001	2,143	143	0.0	2,286	-	1,488	146	1,634	-	3,920	-
2002	1,278	94	0.0	1,372	-	1,688	9	1,697	-	3,069	-
2003	1,317	200	-	1,528	-	1,851	85	1,935	-	3,463	-
2004	1,112	145	-	1,257	NA	1,006	57	1,063	NA	2,321	1,300
2005	630	84	144	859	NA	171	199	370	NA	1,228	1,000
2006	1,096	112	237	1,445	NA	131	94	226	NA	1,671	1,700
2007	1,108	114	0.0 <sup>1</sup>	1,222	NA	234	279	513	NA	1,735	1,900

<sup>1</sup> Discards for the Mobile Fleet were calculated to be 0. Discards for the Fixed Gear fleet were not calculated due to low observer coverage.



Year	Canada					USA				Combined	
	Landings	Discards Scallop	Discards Groundfish	Total Catch	TAC	Landings	Discards	Total Catch	TAC	Catch	TAC
2008	1,390	36	103	1,529	1,633	224	20	244	667	1,774	2,300
2009	1,003	69	137	1,209	1,173	433	147	580	527	1,789	1,700
2010	748	44	48	840	1,012	357	97	454	338	1,294	1,350
2011	702	29	13	743	850	267	20	287	200	1,030	1,050
2012	395	42	31	468	612	96	52	148	63	616	675
2013	385	18	21	424	504	24	16	40	96	464	600
2014	430	15	13	458	546	114	2	116	154	574	700
2015	472	13	7	492	526	111	5	116	124	608	650
2016	428	9	3	440	488	92	5	97	136	537	624
2017	474	7	7	488	584	34	4	38	146	526	730
2018	510	5	2	517	694	47	2	48	257	565	951
2019	388	5	3	396	461	30	1	31	189	428	650
2020	362	11	4	377	461	64	3	67	189	444	650
2021	420	5	6	431	444.5	55	1	56	190.5	487	635
Min	362	5	0	377		377	24	0		428	
Max	17,827	200	428	17,898		17,898	10,558	279		26,463	
Ave	4,541	66	72	4,647		4,647	2,747	54		7,796	

**Table A2.** Length and age samples from the United States of America (USA) and Canadian fisheries on eastern Georges Bank. For Canadian fisheries, at-sea observer samples are included since 1990. The first quarter age samples are supplemented with USA fishery age samples from 5Zjm for 1978–1986 and Fisheries and Oceans Canada survey age samples for 1987–2021; the numbers are shown in brackets. The highlighted numbers include samples from western Georges Bank. “-” indicates commercial data from the USA fishery that is not available for 2020 or 2021.

Year	USA		Canada	
	Lengths	Ages	Lengths	Ages
1978	2,294	384	7,684	1,364
1979	2,384	402	3,103	796 (205)
1980	2,080	286	2,784	728 (192)
1981	1,498	455	4,147	897
1982	4,466	778	4,705	1,126 (268)
1983	3,906	903	3,822	754 (150)
1984	3,891	1,130	1,889	1,243 (858)
1985	2,076	597	7,031	1,309 (351)
1986	2,145	643	5,890	991 (103)
1987	1,865	524	9,133	1,429 (193)
1988	3,229	797	11,350	2,437 (510)
1989	1,572	347	8,726	1,561
1990	2,395	552	31,974	2,825 (1,153)
1991	1,969	442	27,869	1,782
1992	2,048	489	29,082	2,215 (359)
1993	2,215	569	31,588	2,146
1994	898	180	27,972	1,268
1995	2645	14	6,660	548
1996	4,895	1,163	26,069	828
1997	1,761	82	31,617	1,216
1998	1,301	338	26,180	1,643
1999	726	228	26,232	1,290 (410)
2000	500	121	20,582	1,374
2001	1,434	397	19,055	1,505
2002	1,424	429	16,119	1,252
2003	1,367	416	19,757	1,070
2004	1,547	517	18,392	1,357
2005	297	65	23,937	1,483 (697)
2006	446	151	44,708	1,460 (648)
2007	589	183	141,607	1,647 (456)
2008	972	295	64,387	1,709 (495)
2009	1,286	326	48,335	1,725 (246)

Year	USA		Canada	
	Lengths	Ages	Lengths	Ages
2010	1,446	333	30,594	1,455 (433)
2011	1,203	213	40,936	1,655 (536)
2012	598	746	49,447	1,115 (216)
2013	2,951	842	75,275	1,334 (319)
2014	547	85	50,501	1,141 (184)
2015	4,677	1,049	74,028	970 (202)
2016	715	149	76,869	990 (282)
2017	4,120	1,150	50,902	1,039 (334) <sup>1</sup>
2018	1,695	412	54,609	1,254 (309) <sup>1</sup>
2019	1,180	288	60,851	1,401 (190)
2020	-	-	45,567	1,199 (259)
2021	-	-	34,430	1,144 (151)

<sup>1</sup> Survey ALK used to supplement quarter 1 age and length data for scallop discards only

**Table A4.** Swept area biomass (mt) for eastern Georges Bank Cod from the Fisheries and Oceans (DFO), National Marine Fisheries Service (NMFS) spring and fall surveys. Conversion factors to account for vessel and trawl door changes have been applied. The biomass conversion factor used for the Henry B. Bigelow since 2009 is 1.58 ( $B_{survey} = B_{bigelow} / 1.58$ ). “-” indicates no data available.

Year	NMFS Fall	NMFS Spring	DFO
1970	5,054	7,801	-
1971	5,287	10,435	-
1972	3,947	13,779	-
1973	11,697	82,311	-
1974	2,741	27,269	-
1975	5,246	23,503	-
1976	5,082	10,354	-
1977	9,509	9,335	-
1978	12,213	22,731	-
1979	13,050	12,831	-
1980	4,494	20,520	-
1981	7,256	18,568	-
1982	2,216	172,300	-
1983	2,449	20,376	-
1984	7,018	4,808	-
1985	2,390	23,190	-
1986	2,174	12,532	18,633
1987	2,634	7,615	8,824
1988	6,764	9,294	19,452
1989	5,145	12,104	14,547
1990	5,121	10,828	56,665
1991	435	9,391	25,068
1992	1,734	6,113	14,581
1993	606	6,598	16,545
1994	1,734	1,294	13,140
1995	1,220	10,113	8,118
1996	1,790	6,613	32,173
1997	1,875	4,051	11,004
1998	2,970	12,267	5,006
1999	1,044	5,308	9,178
2000	895	7,374	32,298
2001	1,159	3,721	18,037
2002	11,525	4,432	20,333
2003	608	6,405	6,218

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<b>Year</b>	<b>NMFS Fall</b>	<b>NMFS Spring</b>	<b>DFO</b>
2004	8,347	21,080	5,661
2005	1,446	4,407	26,200
2006	2,165	7,331	12,546
2007	424	6,066	11,228
2008	792	5,327	13,657
2009	1,203	4,343	23,180
2010	732	3,587	26,352
2011	2,304	1,724	8,437
2012	609	4,864	2,449
2013	2,566	9,616	11,113
2014	1,376	3,254	2,409
2015	3,570	1,748	3,594
2016	5,438	3,579	3,656
2017	653	13,479	14,566
2018	2,549	3,097	7,198
2019	1,621	9,228	4,059
2020	-	-	4,214
2021	1,114	2,819	1,821
2022	-	3,686	-

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**Table A5a.** Indices of swept area abundance (thousands) for eastern Georges Bank Cod from the Fisheries and Oceans Canada (DFO) survey, 1986–2021. Data from the 2022 survey are not yet available.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1986	0	770	3,538	3,204	331	692	445	219	35	66	0	10	0	0	0	0	0	9,311
1987	0	48	1,791	642	753	162	89	181	89	13	13	0	13	16	0	0	0	3,812
1988	0	148	450	5,337	565	838	95	79	179	18	12	4	0	16	0	0	0	7,741
1989	0	350	2,169	764	1,706	258	332	42	85	112	5	32	8	5	0	0	0	5,868
1990	20	106	795	3,471	1,953	4,402	535	1,094	144	157	289	65	52	37	0	0	5	13,125
1991	0	1198	1,019	1,408	1,639	882	1195	148	249	38	45	30	12	5	8	0	0	7,876
1992	0	48	2,049	1,221	409	643	451	300	93	38	0	3	3	18	0	0	0	5,276
1993	0	31	355	1,723	622	370	754	274	268	51	31	0	20	6	0	0	0	4,504
1994	0	13	629	691	1,289	477	182	363	84	119	12	0	0	0	8	5	0	3,871
1995	0	32	187	1,240	757	520	186	44	67	28	18	8	6	0	0	0	0	3,093
1996	0	90	203	1,744	4,337	1,432	1034	445	107	149	39	4	0	0	5	0	0	9,590
1997	0	30	376	568	1,325	1,262	216	50	35	23	17	0	3	0	0	0	0	3,905
1998	0	6	582	831	322	317	238	56	29	7	8	3	4	0	0	0	0	2,402
1999	0	3	156	1,298	1,090	449	317	190	10	28	5	9	0	3	0	0	0	3,561
2000	0	0	423	1,294	4,967	2,157	1031	510	317	20	23	12	0	0	0	0	0	10,754
2001	0	3	37	802	519	1,391	645	334	224	225	36	24	7	0	0	0	0	4,248
2002	0	0	118	477	2,097	694	1283	458	188	63	76	7	0	0	0	0	0	5,462
2003	0	0	8	200	510	867	194	219	69	12	0	0	0	0	0	0	0	2,078
2004	0	427	40	246	381	422	353	59	108	25	5	0	3	0	0	0	0	2,069
2005	0	25	1,025	1,398	7,149	1,766	816	743	60	87	8	4	0	0	0	0	0	13,082
2006	0	0	41	1,500	673	1,779	757	217	216	83	34	10	15	0	0	0	0	5,325
2007	0	18	130	549	2,606	379	653	119	81	53	0	4	0	0	0	0	0	4,591
2008	0	12	147	1,027	755	2,978	194	392	41	4	20	0	0	0	0	0	0	5,569
2009	0	11	51	2,487	2,261	519	2,955	0	82	0	0	0	18	0	0	0	0	8,384

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
2010	0	5	92	956	4,105	1,781	703	1,828	65	84	5	0	0	0	0	0	0	9,623
2011	0	193	271	766	952	1,324	256	67	112	14	8	2	0	0	0	0	0	3,965
2012	0	9	149	327	315	195	158	7	18	4	0	0	0	0	0	0	0	1,182
2013	0	0	431	3,754	2,173	285	81	52	10	0	0	0	0	0	0	0	0	6,786
2014	0	76	9	360	538	169	35	0	27	0	0	0	0	0	0	0	0	1,213
2015	0	0	476	152	598	439	97	7	0	0	0	0	0	0	0	0	0	1,770
2016	0	8	197	1,004	199	273	147	16	4	0	0	0	0	0	0	0	0	1,848
2017	0	5	52	1,660	5,897	194	270	188	0	0	0	0	0	0	0	0	0	8,266
2018	0	39	149	520	1,060	1,610	77	50	7	0	0	0	0	0	0	0	0	3,512
2019	0	9	269	1,005	574	389	284	0	0	6	6	0	0	0	0	0	0	2,542
2020	0	32	466	1,753	620	330	49	20	5	0	0	0	0	0	0	0	0	3,274
2021	4	62	189	297	394	101	43	6	27	0	0	0	0	0	0	0	0	1,124

**Table A5b.** Indices of swept area abundance (thousands) for eastern Georges Bank Cod from the National Marine Fisheries Service (NMFS) spring survey, 1970–2022. Conversion factors to account for vessel and trawl door changes have been applied. During 1973–1981 a Yankee-41 net was used rather than the standard Yankee-36 net. There was no NMFS spring survey in 2020.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1970	0	354	1,115	302	610	73	263	48	0	71	24	0	48	0	0	0	0	2,907
1971	0	185	716	503	119	326	124	257	227	40	40	79	0	0	0	0	0	2,615
1972	56	1,578	1,856	2,480	393	114	136	60	88	73	18	14	0	0	14	0	0	6,879
1973	0	665	37,880	5,474	6,109	567	467	413	0	163	231	0	0	0	95	0	0	52,064
1974	0	461	5,877	4,030	759	2,001	360	91	267	45	48	54	0	0	0	0	0	13,991
1975	0	0	467	3,061	4,348	446	960	79	0	122	0	0	0	0	0	0	0	9,483
1976	84	1,733	1,111	620	444	759	0	167	35	0	0	0	0	48	0	0	0	5,001
1977	0	0	2,358	736	354	307	334	22	35	0	0	0	0	0	0	0	0	4,145
1978	373	187	0	2,825	615	916	153	787	62	43	40	0	0	0	0	0	0	6,001
1979	71	339	1,332	122	1,430	543	176	91	130	0	0	0	0	0	0	0	0	4,234
1980	0	11	2,251	2,168	169	1,984	410	78	48	31	0	47	0	0	0	0	0	7,197
1981	283	1,956	1,311	2,006	1,093	43	453	197	59	0	0	0	0	0	0	0	0	7,399
1982	44	455	6,642	13,614	12,667	9,406	0	3,088	992	120	0	0	0	0	0	0	0	47,027
1983	0	389	2,017	3,781	779	608	315	106	98	0	70	0	0	0	0	0	35	8,197
1984	0	103	117	344	483	92	182	74	18	105	0	0	0	0	0	0	0	1,518
1985	58	36	2,032	633	1,061	1,518	328	217	213	83	116	34	23	0	0	0	0	6,352
1986	97	619	339	1,132	298	427	536	20	109	142	0	0	0	0	0	0	0	3,719
1987	0	0	1,194	247	568	0	152	148	30	54	0	0	0	0	0	0	0	2,394
1988	138	320	243	2,795	274	461	51	5	67	0	0	10	0	0	0	0	0	4,364
1989	0	174	1,238	338	1,685	234	396	99	12	36	48	24	0	0	0	0	0	4,284
1990	24	45	360	1,687	586	634	152	164	19	0	0	24	0	0	0	0	0	3,696
1991	217	725	620	514	903	460	382	44	17	0	24	53	0	0	0	0	0	3,957
1992	0	81	666	349	103	261	152	159	27	52	0	0	0	0	0	0	0	1,850
1993	0	0	462	1,284	262	46	182	46	43	46	12	0	0	0	0	0	0	2,382



Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1994	38	54	194	152	185	44	11	33	0	8	0	0	0	0	0	0	0	720
1995	384	70	294	927	495	932	191	253	0	68	0	0	0	0	0	0	0	3,614
1996	0	139	300	990	1,343	121	94	28	0	0	0	0	0	0	0	0	0	3,016
1997	271	54	218	48	402	519	53	126	57	0	0	0	0	0	0	0	0	1,747
1998	54	0	1,040	1,985	995	983	609	30	31	0	0	0	0	0	0	0	0	5,729
1999	22	22	145	673	624	370	172	107	34	8	0	0	0	0	0	0	0	2,176
2000	36	0	304	643	1,348	492	138	52	20	0	0	0	0	0	0	0	0	3,032
2001	0	0	64	889	96	350	109	0	12	10	0	0	0	0	0	0	0	1,530
2002	36	0	121	470	1,081	175	214	61	0	0	0	0	0	0	0	0	0	2,158
2003	0	0	125	287	812	1,154	135	78	9	0	0	0	0	0	0	0	0	2,599
2004	0	549	10	838	2,091	2,105	1,351	239	382	29	0	0	0	0	0	0	0	7,595
2005	36	15	345	70	747	287	190	131	34	0	0	0	0	0	0	0	0	1,855
2006	0	37	73	952	411	1,007	340	151	79	0	0	0	0	0	0	0	0	3,050
2007	0	0	369	308	2,258	239	291	47	28	0	0	0	0	0	0	0	0	3,540
2008	43	37	112	675	372	1,385	51	66	0	0	0	0	0	0	0	0	0	2,741
2009	0	61	86	875	408	219	377	24	12	15	0	0	0	0	0	0	0	2,078
2010	0	25	126	367	667	168	44	147	0	12	0	0	0	0	0	0	0	1,556
2011	0	88	164	164	266	144	56	9	24	0	0	0	0	0	0	0	0	914
2012	3	3	450	749	834	209	127	13	0	0	0	0	0	0	0	0	0	2,389
2013	0	0	653	3,864	1,202	129	64	15	0	0	0	0	0	0	0	0	0	5,926
2014	0	55	64	568	922	109	27	0	0	0	0	0	0	0	0	0	0	1,746
2015	0	9	165	71	222	331	23	0	0	0	0	0	0	0	0	0	0	820
2016	4	4	179	1,454	173	168	82	10	0	0	0	0	0	0	0	0	0	2,074
2017	0	43	54	469	2,681	808	502	165	0	0	0	0	0	0	0	0	0	4,274
2018	0	99	149	607	550	346	0	0	0	18	0	0	0	0	0	0	0	1,770
2019	9	110	1,157	1,042	1,982	834	213	8	0	0	0	0	0	0	0	0	0	5,355

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Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	47	41	336	616	370	81	0	10	0	0	0	0	0	0	0	0	0	1,500
2022	4	85	398	886	315	95	26	0	0	0	0	0	0	0	0	0	0	1,810

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**Table A5c.** Indices of swept area abundance (thousands) for eastern Georges Bank Cod from the National Marine Fisheries Service (NMFS) fall survey, 1970-2021. Conversion factors to account for vessel and trawl door changes have been applied. There was no NMFS fall survey in 2020.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1970	348	1,416	836	208	412	11	0	0	5	25	0	0	0	0	0	0	0	3,261
1971	203	1,148	900	181	232	130	142	14	0	0	0	0	0	0	0	0	0	2,951
1972	1,110	3,299	614	667	24	40	0	0	0	0	0	0	0	0	0	0	0	5,753
1973	46	2,435	2,947	997	979	93	0	25	63	0	0	0	0	0	0	0	0	7,584
1974	77	196	399	622	54	31	15	0	0	0	0	0	0	0	0	0	0	1,394
1975	414	660	177	414	764	27	46	0	0	0	0	0	0	0	0	0	0	2,501
1976	0	8,260	362	144	0	91	0	48	0	0	0	0	0	0	0	0	0	8,904
1977	51	0	3,475	714	184	156	178	3	0	0	0	0	0	0	0	0	0	4,760
1978	113	1,519	58	3,027	417	58	63	77	0	0	0	0	0	0	0	0	0	5,330
1979	182	1,704	1,695	116	1,522	243	48	20	11	18	0	0	0	0	0	0	0	5,557
1980	315	782	409	649	22	184	14	17	20	0	0	0	0	0	0	0	0	2,412
1981	360	2,352	1,208	933	269	15	29	0	0	0	53	0	0	0	0	0	0	5,220
1982	0	549	718	54	59	0	0	27	0	0	0	0	0	0	0	0	0	1,406
1983	948	73	267	567	24	8	8	0	23	0	0	0	0	0	0	0	0	1,917
1984	29	1,805	120	690	1,025	23	32	0	0	9	0	0	0	0	0	0	0	3,734
1985	1,245	209	993	161	18	5	9	0	0	0	4	0	0	0	0	0	0	2,645
1986	119	3,018	56	198	0	0	6	0	0	0	0	0	0	0	0	0	0	3,396
1987	156	129	845	121	100	0	0	0	0	0	0	0	7	0	0	0	0	1,357
1988	95	561	177	1,182	163	206	0	30	41	10	0	0	0	0	0	0	0	2,464
1989	318	570	1,335	222	607	78	24	0	0	0	0	0	0	0	0	0	0	3,154
1990	198	403	442	831	120	204	20	0	15	0	0	0	0	0	0	0	0	2,232
1991	0	158	60	71	10	24	0	0	0	0	0	0	0	0	0	0	0	322
1992	0	205	726	154	0	37	12	0	0	0	0	0	0	0	0	0	0	1,134
1993	0	81	104	158	19	0	0	0	0	0	0	0	0	0	0	0	0	362

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1994	10	78	282	220	143	13	26	0	0	0	0	0	0	0	0	0	0	771
1995	223	28	122	304	66	29	7	0	0	0	0	0	0	0	0	0	0	779
1996	10	291	76	293	211	53	28	0	0	0	0	0	0	0	0	0	0	961
1997	0	161	394	181	58	84	29	0	0	0	0	0	0	0	0	0	0	907
1998	0	171	684	480	65	109	0	0	29	0	0	0	0	0	0	0	0	1,538
1999	0	15	14	249	124	32	0	0	0	0	0	0	0	0	0	0	0	434
2000	30	55	204	68	89	46	0	0	0	0	0	0	0	0	0	0	0	493
2001	25	74	106	257	38	75	12	12	0	0	0	0	0	0	0	0	0	598
2002	122	110	635	712	2,499	170	211	17	0	0	0	0	0	0	0	0	0	4,476
2003	76	0	24	100	70	17	0	6	0	0	0	0	0	0	0	0	0	293
2004	108	422	68	840	385	545	436	103	30	0	30	0	0	0	0	0	0	2,969
2005	21	29	508	114	251	43	0	10	0	0	0	0	0	0	0	0	0	976
2006	0	146	123	530	37	263	16	16	16	16	0	0	0	0	0	0	0	1,162
2007	60	22	136	7	69	0	7	0	0	0	0	0	0	0	0	0	0	302
2008	0	74	170	55	15	98	15	15	0	0	0	0	0	0	0	0	0	442
2009	54	37	194	280	39	18	11	0	0	0	0	0	0	0	0	0	0	633
2010	434	27	79	74	121	20	0	0	0	0	0	0	0	0	0	0	0	755
2011	58	323	362	248	177	110	32	0	0	0	0	0	0	0	0	0	0	1,309
2012	0	14	188	90	13	20	0	0	0	0	0	0	0	0	0	0	0	324
2013	162	51	565	554	226	0	0	0	0	0	0	0	0	0	0	0	0	1,559
2014	98	144	47	145	223	28	14	0	0	0	0	0	0	0	0	0	0	697
2015	42	223	1,208	94	162	131	0	0	0	0	0	0	0	0	0	0	0	1,859
2016	2	9	219	2,123	50	143	51	0	0	0	0	0	0	0	0	0	0	2,597
2017	43	73	76	66	91	0	0	0	0	0	0	0	0	0	0	0	0	348
2018	24	322	212	275	294	191	0	0	0	0	0	0	0	0	0	0	0	1,319
2019	17	80	171	163	82	63	62	0	0	0	0	0	0	0	0	0	0	638

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Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	13	457	71	63	36	13	0	0	0	0	0	0	0	0	0	0	0	653

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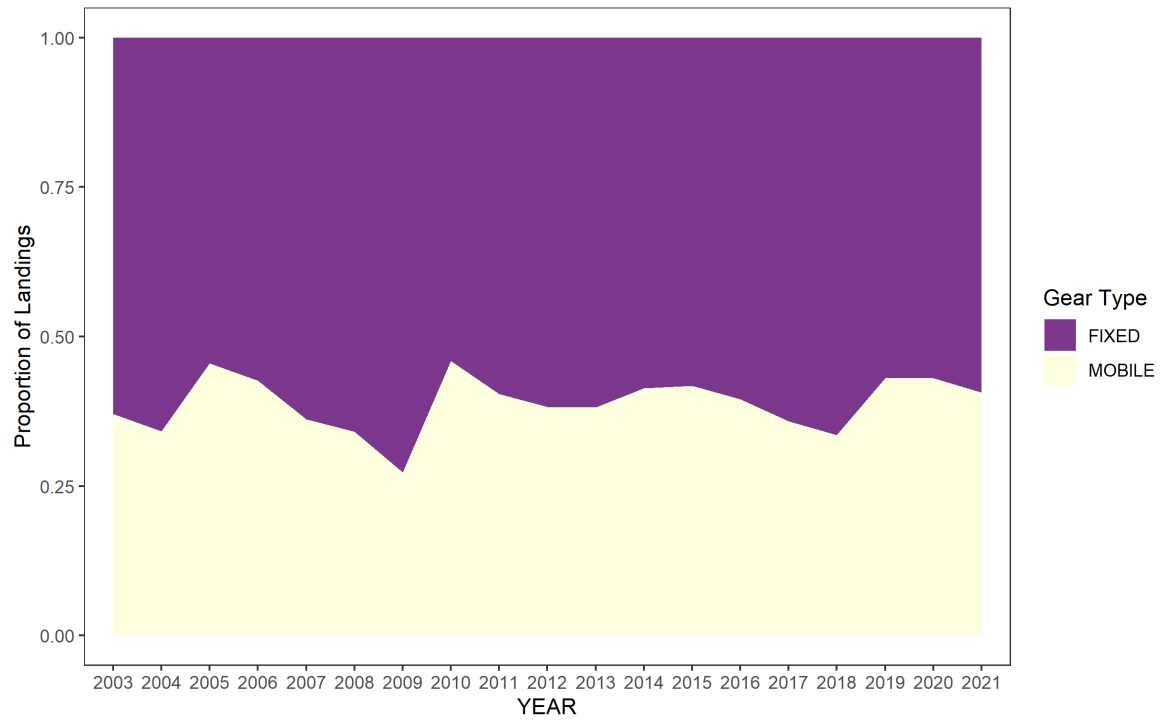
**Table A6.** Summary of change in fishery and survey indicators from 2021 to 2022 Transboundary Resource Assessment Committee (TRAC).  
 CDN=Canada. USA=United States of America. DFO=Fisheries and Oceans Canada. NMFS=National Marine Fisheries Service.

Indicators	2020 TRAC	2021 TRAC	2022 TRAC	Summary
Fishery Catch	Landings= 418 mt Discards= 9 mt	Landings = 426 mt Discards = 18 mt	Landings = 505 mt Discards = 11 mt	Increase in landings Decrease in discards
Fishery Catch at Length	CDN: 58 cm (23 in) USA: 60 cm (24 in)	CDN: 61 cm (24 in) USA: NA	CDN: 64 cm (25 in) USA: NA	CDN fishery: Slight Increase USA fishery: NA
Fishery Catch at Age	2016 (26% by number), 2017 (23%), and 2015 (22%) year classes	<b>Only Canadian data:</b> 2017 year class (43% by number)	<b>Only Canadian data:</b> 2017 (34% by number) and 2018 year classes (32% by number)	Pulled by two year classes, versus one in the previous year (**Based only on Canadian data)
Survey Catch at Length	DFO: 52 cm (20.5 in) NMFS spring: NA NMFS fall: multiple peaks (34 and 64 cm)	DFO: 61 cm (24 in) NMFS spring: 55 cm (22 in) NMFS fall: NA	DFO: NA NMFS spring: 58 cm (23 in) NMFS fall: 43cm (17 in) peak	DFO: NA NMFS spring: Slight Increase NMFS fall: One large peak, rather than two in 2019.

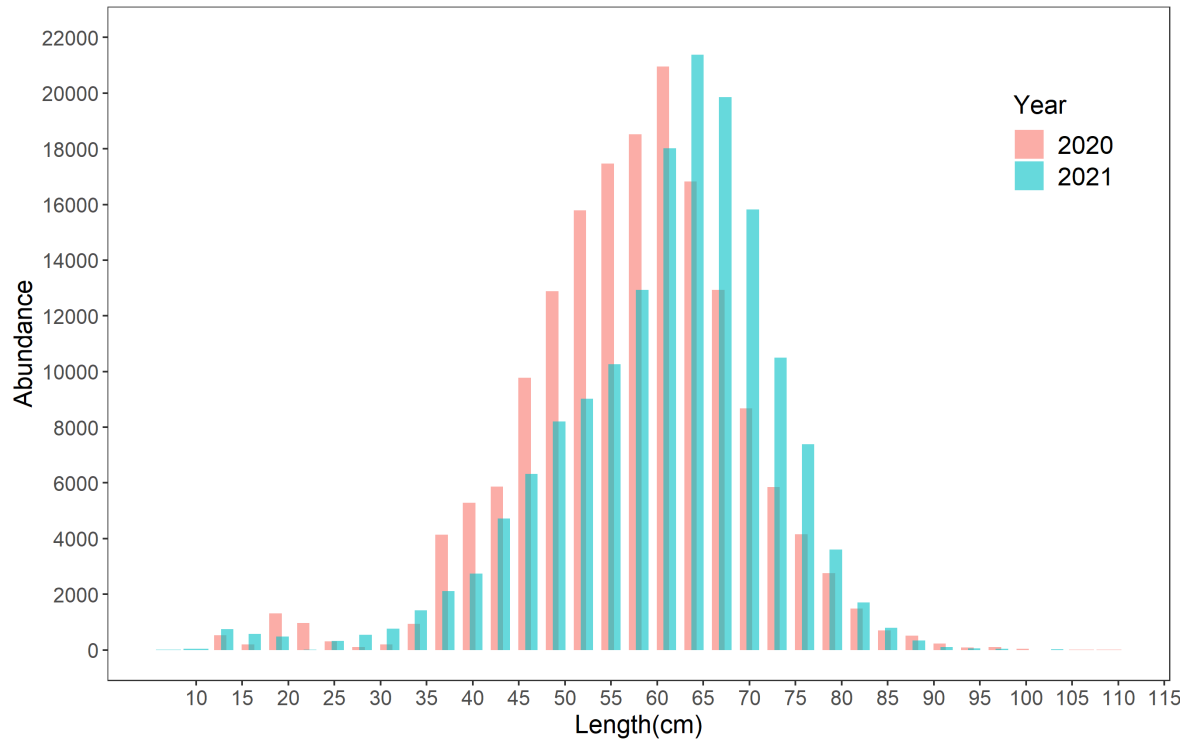
Indicators	2020 TRAC	2021 TRAC	2022 TRAC	Summary
Survey Catch at Age	DFO: Dominated by 2017 yc NMFS spring: NA NMFS fall: No dominant age class	DFO: Multiple contributing ycs NMFS spring: Multiple contributing ycs NMFS fall: NA	DFO: NA NMFS spring: Multiple contributing ycs NMFS fall: 2020 year class (70% by number)	DFO: NA NMFS spring: No Change NMFS fall: One dominant year class at Age 1
Swept Area Abundance	DFO: 3.3 million NMFS spring: NA NMFS fall: 638 000	DFO: 1.1 million NMFS spring: 1.5 million NMFS fall: NA	DFO: NA NMFS spring: 1.8 million NMFS fall: 653 000	DFO: NA NMFS spr : Increase NMFS fall: Slight increase from 2020
Biomass	DFO: 4,214 NMFS spring: NA NMFS fall: 1,621	DFO: 1,821 NMFS spring: 2,819 NMFS fall: NA	DFO: NA NMFS spring: 3,686 NMFS fall: 1,114	DFO: NA NMFS spr : Increase NMFS fall: Decrease from 2020 TRAC
Distribution (NEW)			D95 and D50 fluctuate since mid 1990s. DFO: Mostly east of Hague Line. NMFS spring: Mostly west of Hague Line NMFS fall: NE tip of EGB.	D95 or D50 continue fluctuating. Conflicting results from NMFS spring and DFO for centroid.

Indicators	2020 TRAC	2021 TRAC	2022 TRAC	Summary
Condition	DFO: < long term mean NMFS spring: NA NMFS fall: > long term mean	DFO: < long term mean NMFS spring: > long term mean NMFS fall: NA	DFO: < long term mean NMFS spring: > long term mean NMFS fall: >long term mean	DFO: No change NMFS spr : No change NMFS fall: No change since 2020
Total Mortality on older ages	DFO: high NMFS spring: NA	DFO: high NMFS spring: NA	DFO: NA NMFS spring: NA	DFO: NA NMFS spring: NA
Growth (NEW)			Improved growth on young fish. Slow growth continues on old fish.	Improved growth on young fish. Slow growth continues on old fish.

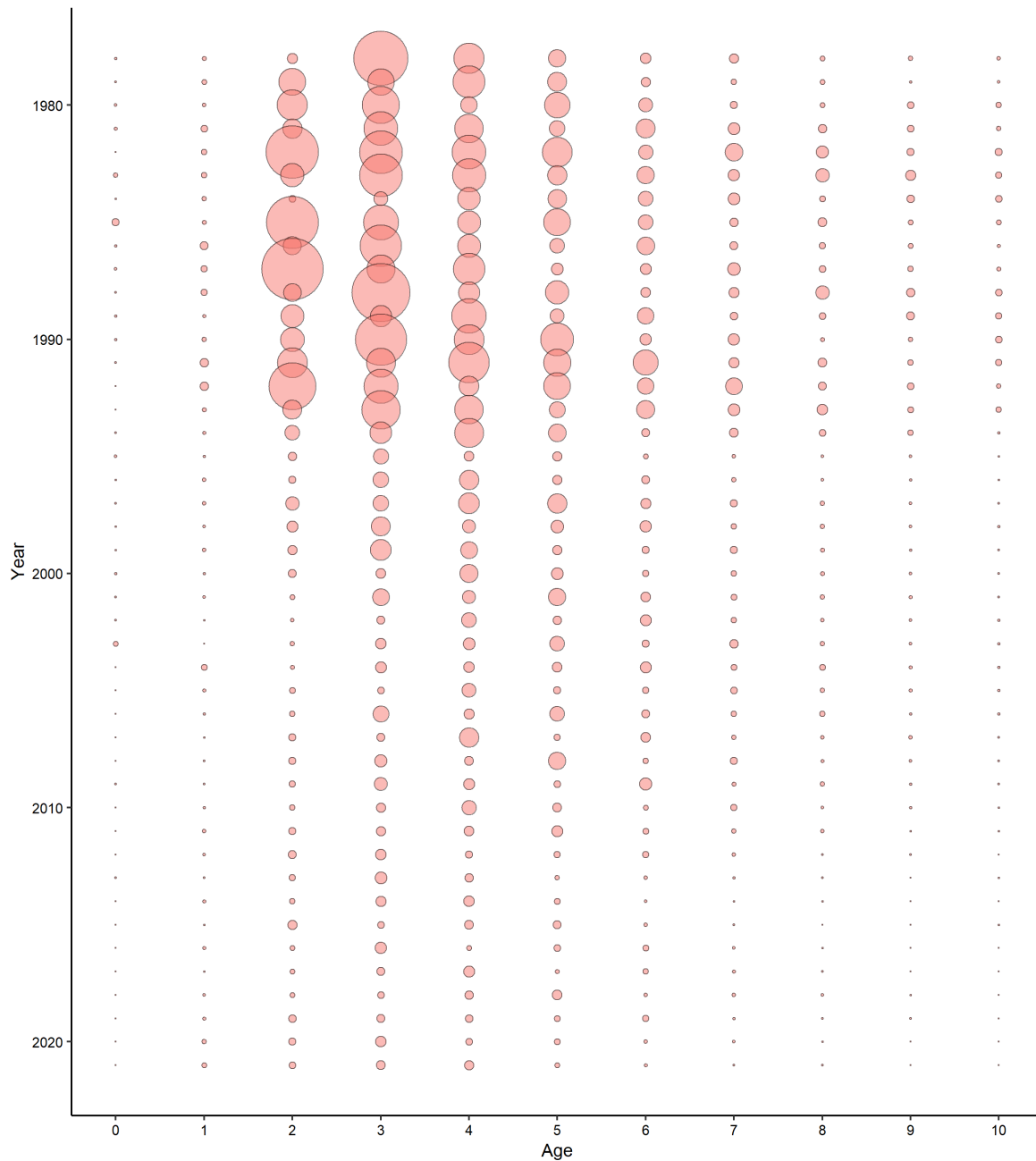




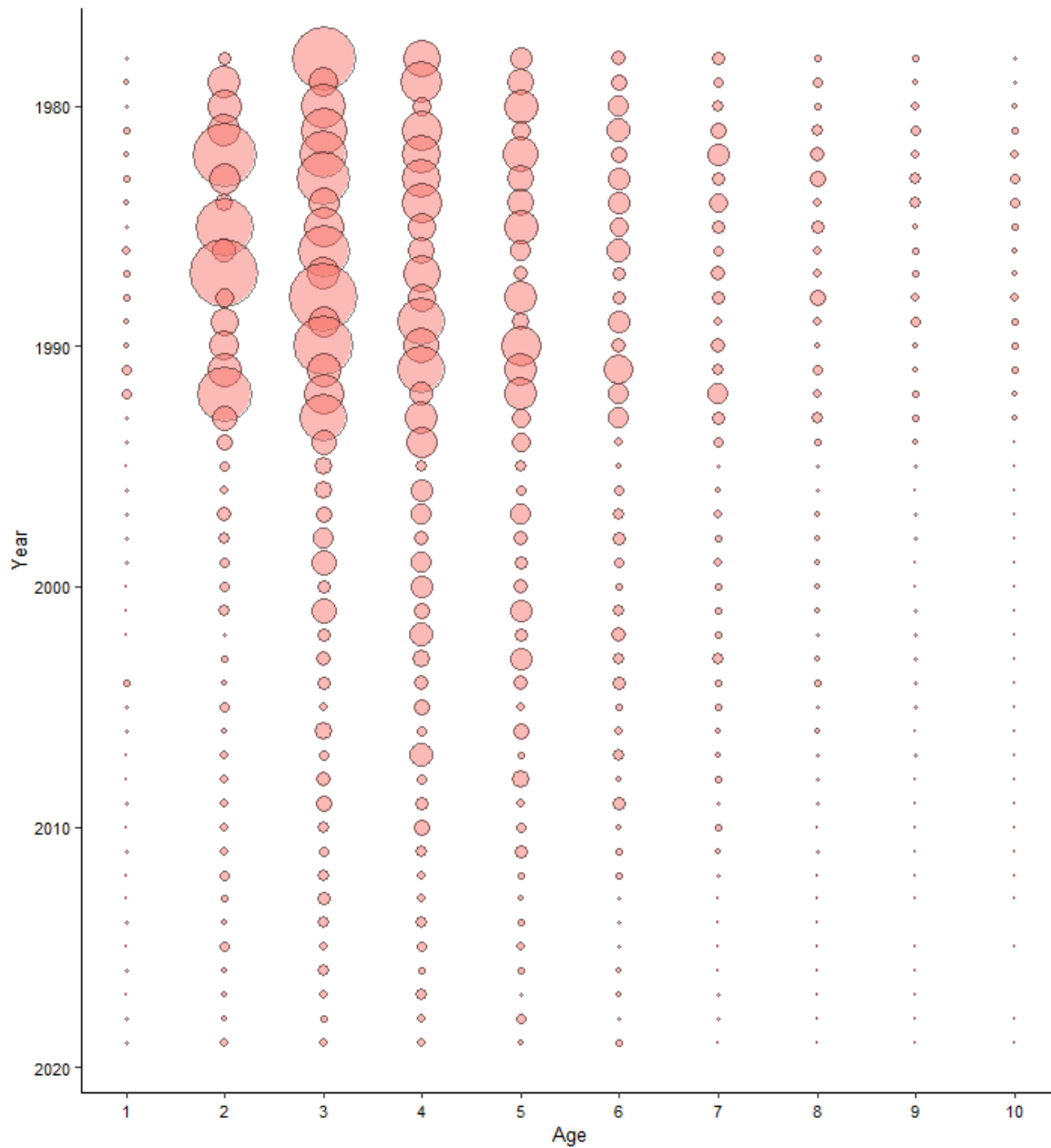
**Figure A1.** Proportional landings of Cod by major gear type from eastern Georges Bank for Canada (2002–2021). Commercial data from the United States of America fishery were not available for the 2020 or 2021 fishing years.



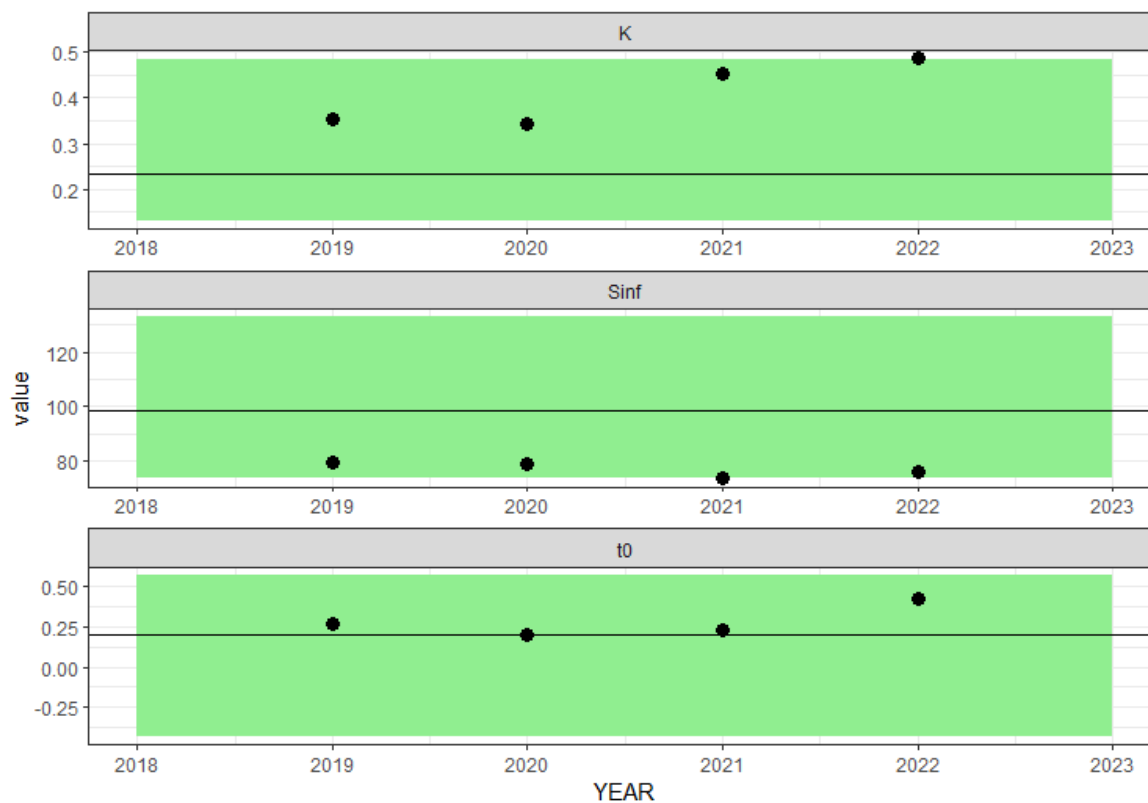
**Figure A2.** Length frequency of Cod catch (landings and discards) from the 2020 and 2021 Canadian fisheries on eastern Georges Bank. Commercial data from the USA fishery were not available for the 2020 or 2021 fishing years.



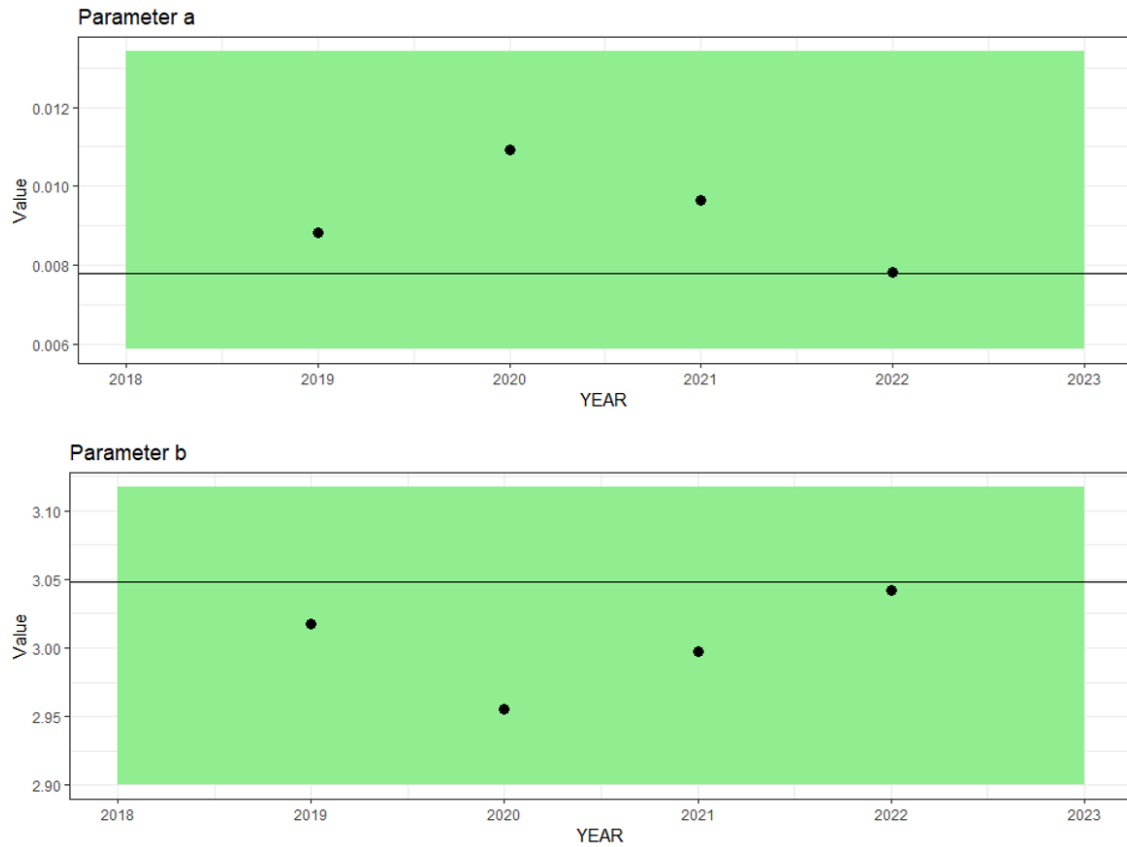
**Figure A3.** Fishery catch-at-age abundance for the Canadian fishery, updated through until 2021. Size of bubbles is representative of abundance.



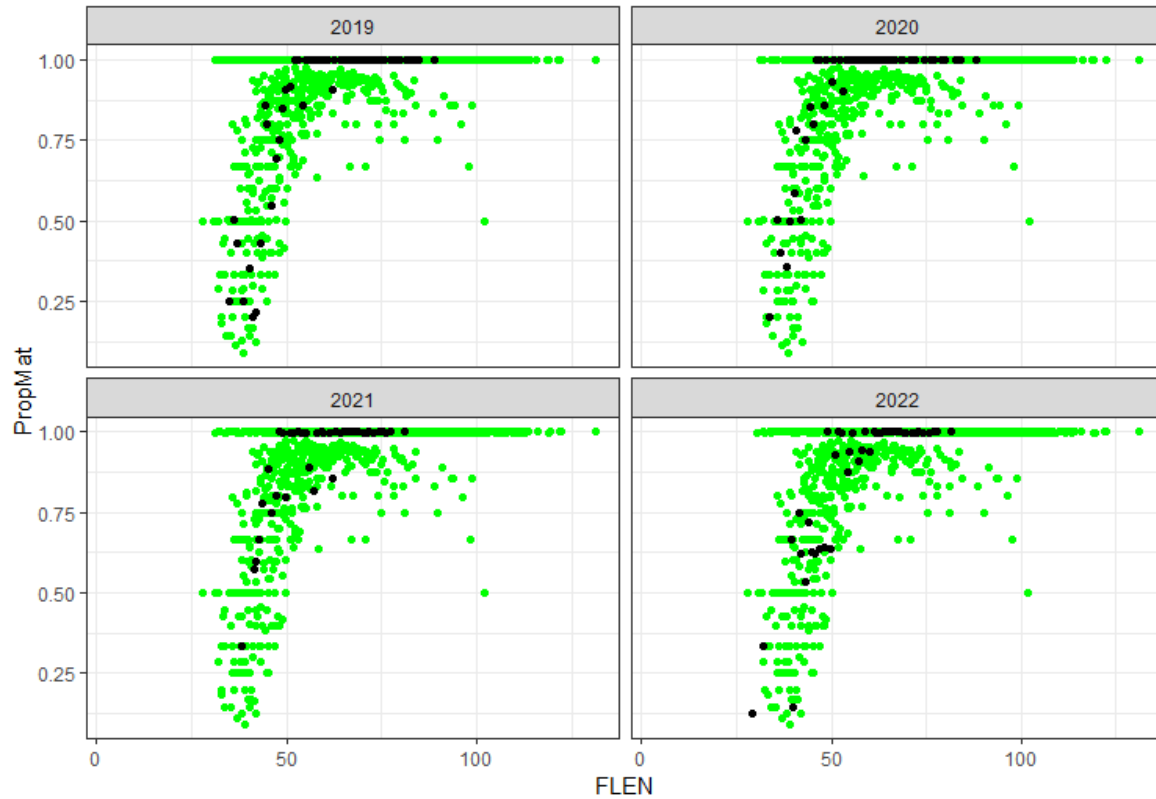
**Figure A4.** Combined Canada and United States of America fishery catch at age abundance for eastern Georges Bank Cod, updated to 2019. Size of bubbles is representative of abundance.



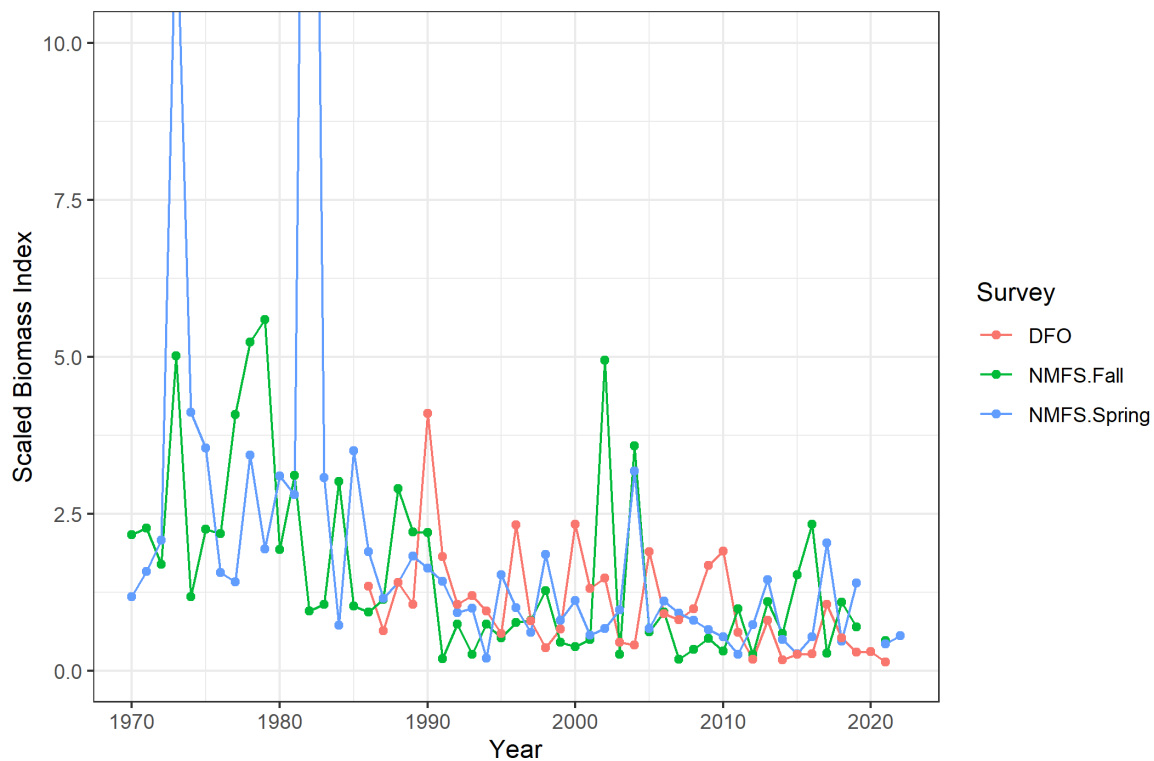
**Figure A5.** Temporal trends in von Bertalanffy growth parameters fit to survey data, for years 2019–2022. Points are annual growth curve fits, horizontal lines are growth curve fits spanning time period used in the Data Limited Methods tool (DLMtool) projection assumptions (2003-2019), and green rectangles indicate quantiles (0.01% and 99.9%) of that time period.



**Figure A6.** Trend in length-weight parameters for years 2019–2022. Horizontal lines indicate  $a$  (0.007812815) and  $b$  (3.048425056) values used in the projection assumptions in the Data Limited Methods tool (DLMtool), based on the complete time series (1980–2018). Green rectangles indicate quantiles (0.01% and 99.9%) for the complete time series (1980–2018).

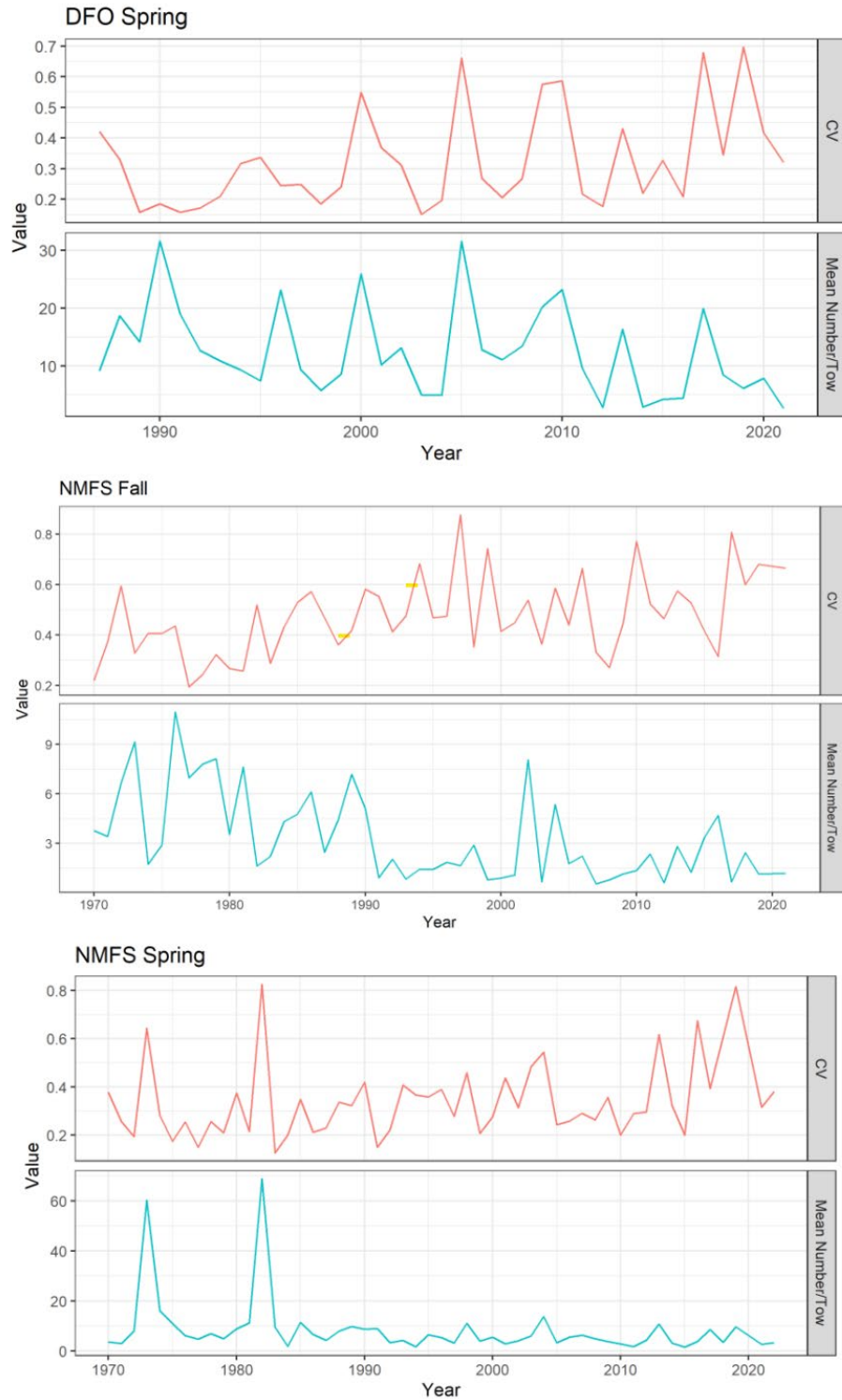


**Figure A7.** The pooled National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) spring survey length-at-maturity data from 2000–2018 used to inform the L50–L95 assumptions for Data Limited Method tool (DLMtool) projections (green). The black points indicate the data available since then from the NMFS spring (2019, 2021 and 2022) and DFO spring (2019–2022) surveys.

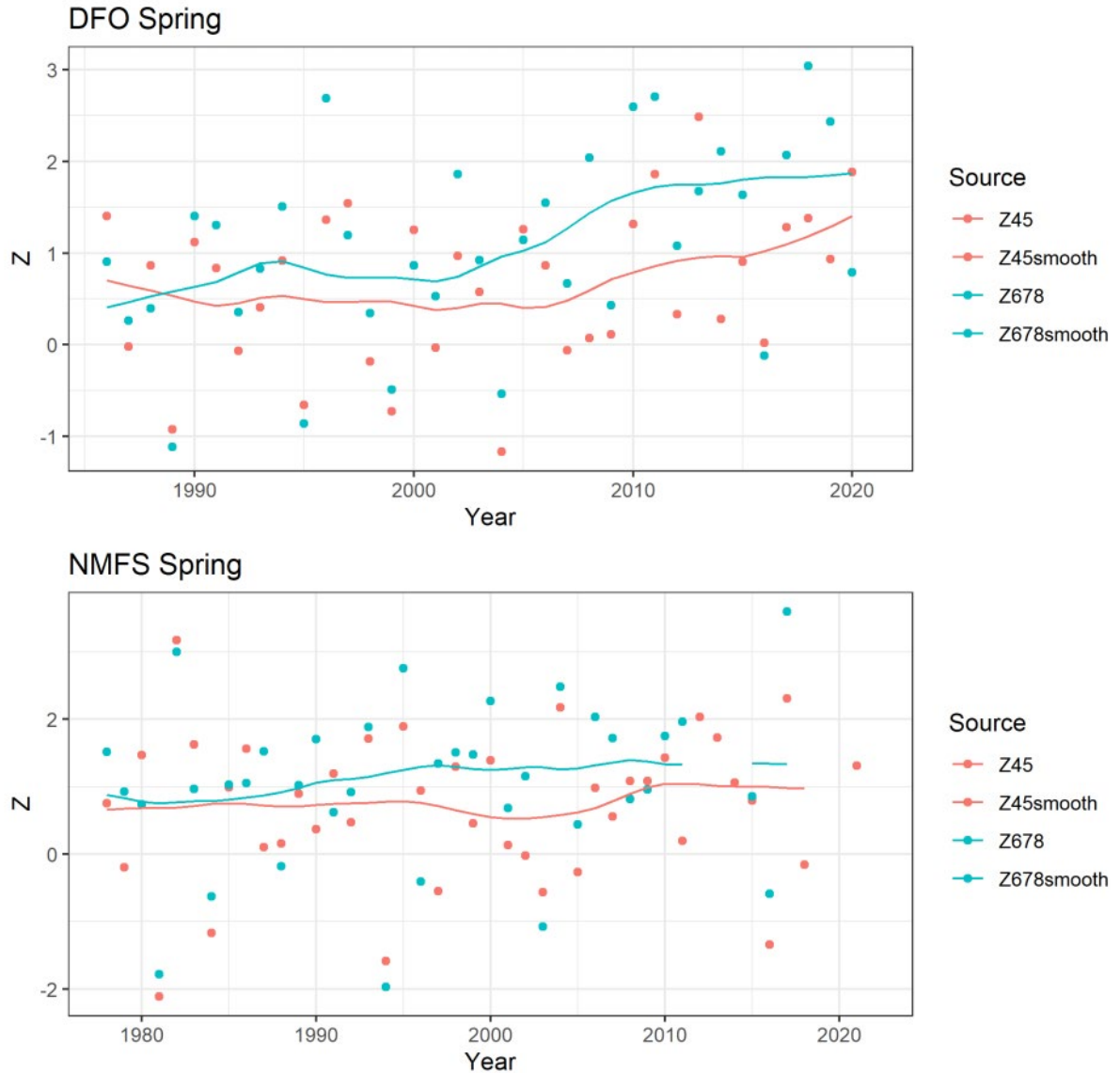


**Figure A8.** Survey biomass indices (ages 1+) for eastern Georges Bank Cod from the National Marine Fisheries Service (NMFS) spring (2021) and NMFS fall (2020) surveys scaled to their respective time series means. Data from the Fisheries and Oceans Canada (DFO) spring (2022) survey are missing pending calculation of a vessel conversion factor.

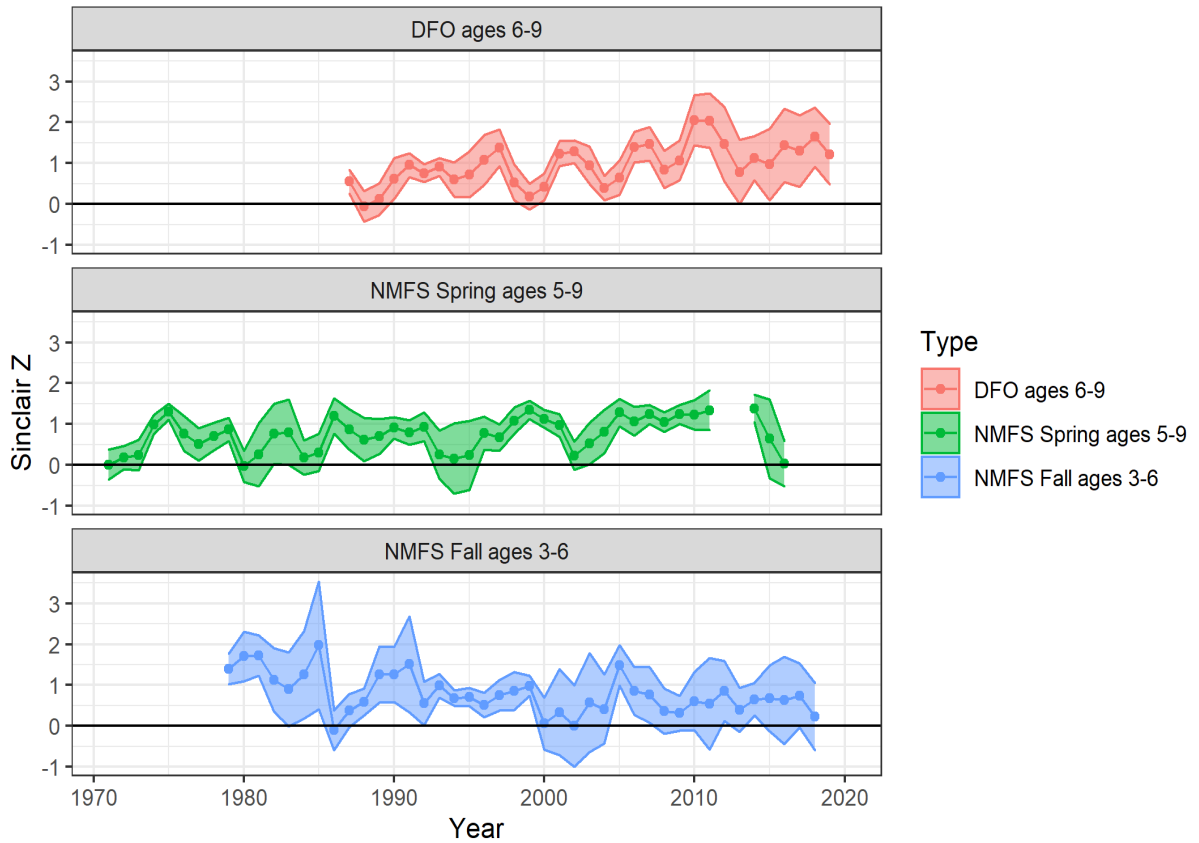




**Figure A9.** Stratified mean number-per-tow and coefficient of variation (CV) for Fisheries and Oceans Canada (DFO; top) and National Marine Fisheries Service (NMFS) fall (middle) and spring (bottom) survey catches of eastern Georges Bank Cod. DFO Spring 2022 data are missing pending calculation of a vessel conversion factor .

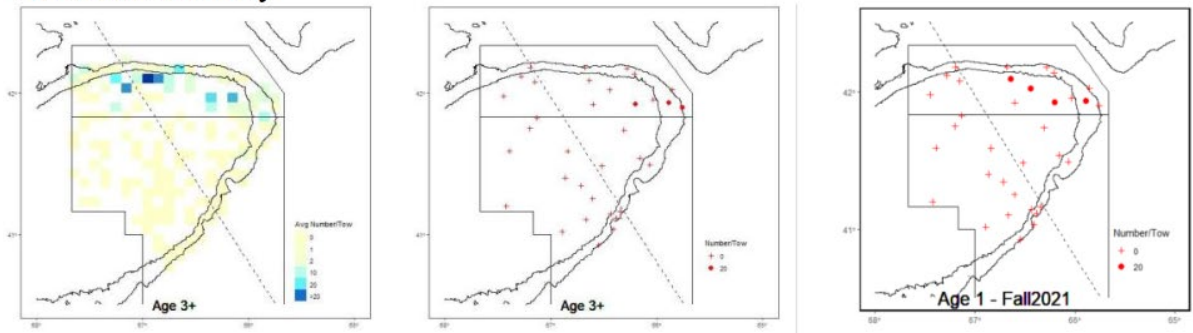


**Figure A10.** Total mortality ( $Z$ ) calculated using the Fisheries and Oceans Canada (DFO) spring survey data and National Marine Fisheries Service (NMFS) spring survey data for eastern Georges Bank Cod. Note that the DFO time series only has data up until 2021. Colour of the points refers to the age-group the mortality was calculated for (Z45 - ages 4 and 5; Z678 - ages 6, 7 and 8). Line is a smoother applied to the point data.

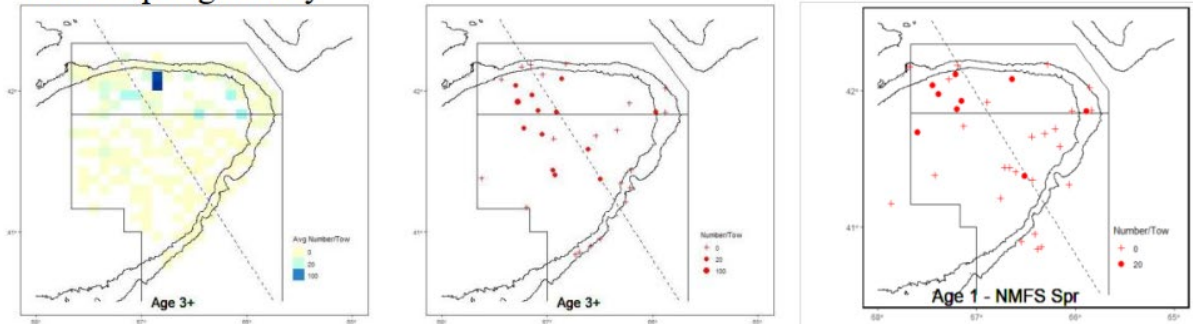


**Figure A11.** Empirical estimate of total mortality for the Fisheries and Oceans Canada (DFO; ages 6–9) spring survey and the National Marine Service (NMFS) fall (ages 3-6) and spring (ages 5-9) surveys. Calculation in recent years is breaking down.

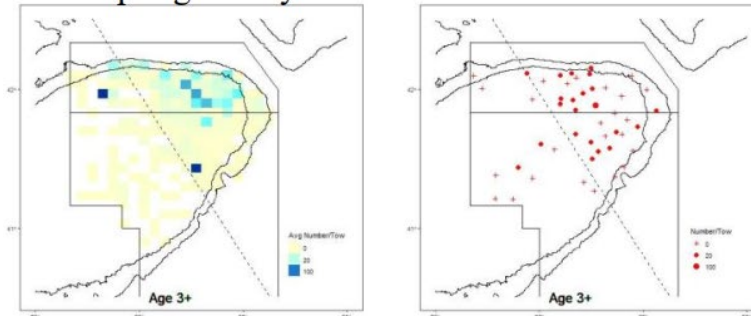
## NMFS Fall Survey



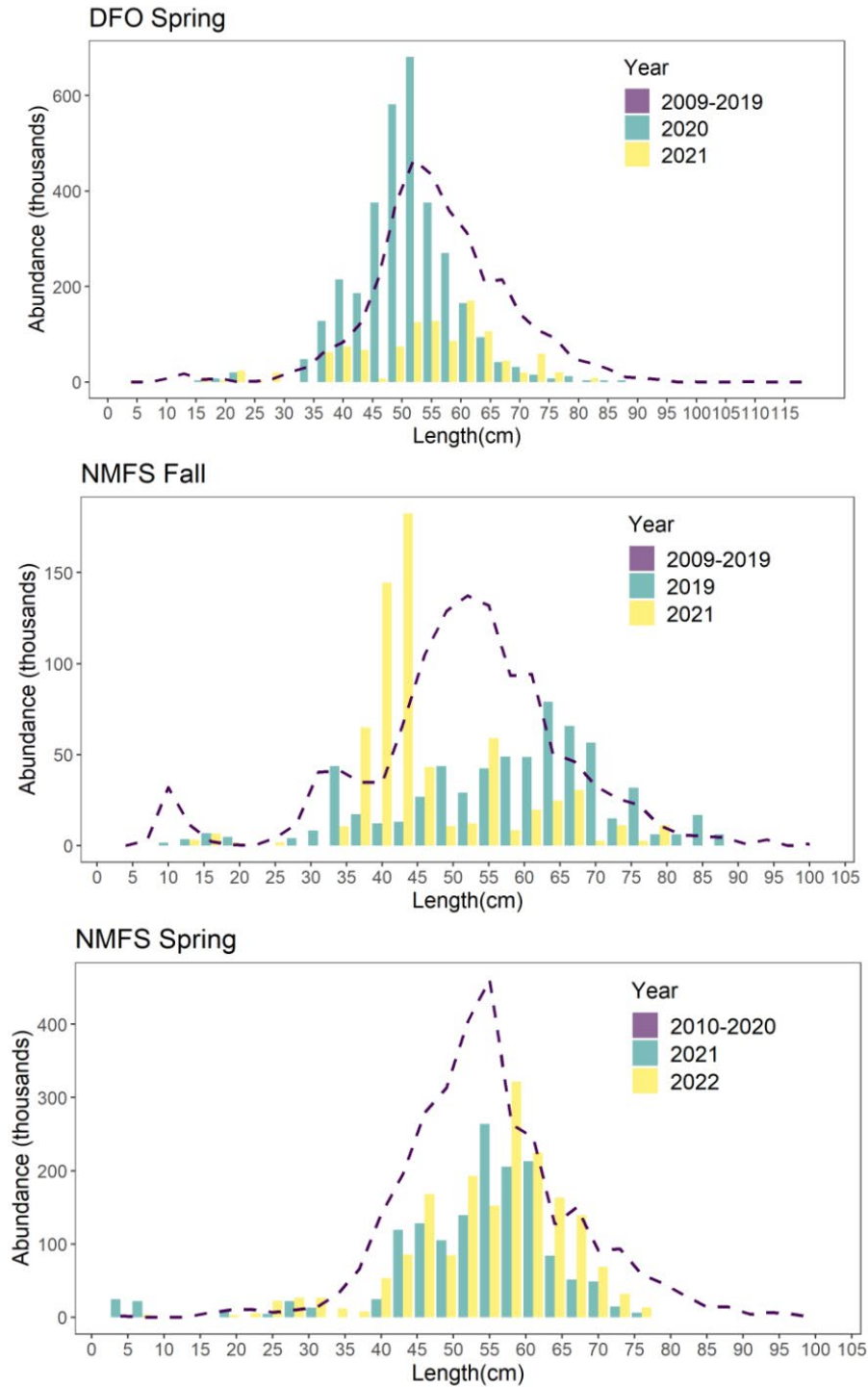
## NMFS Spring Survey



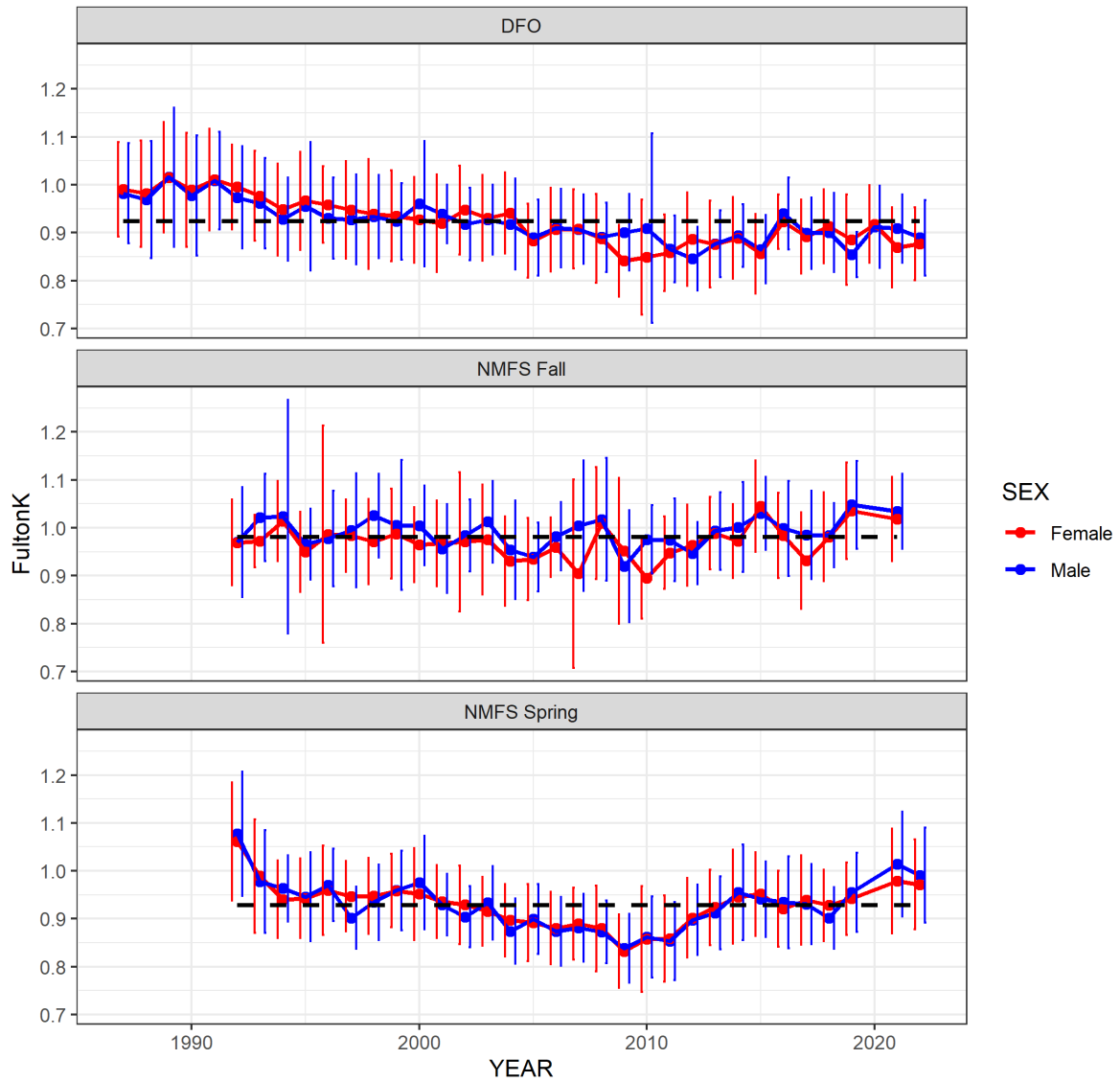
## DFO Spring Survey



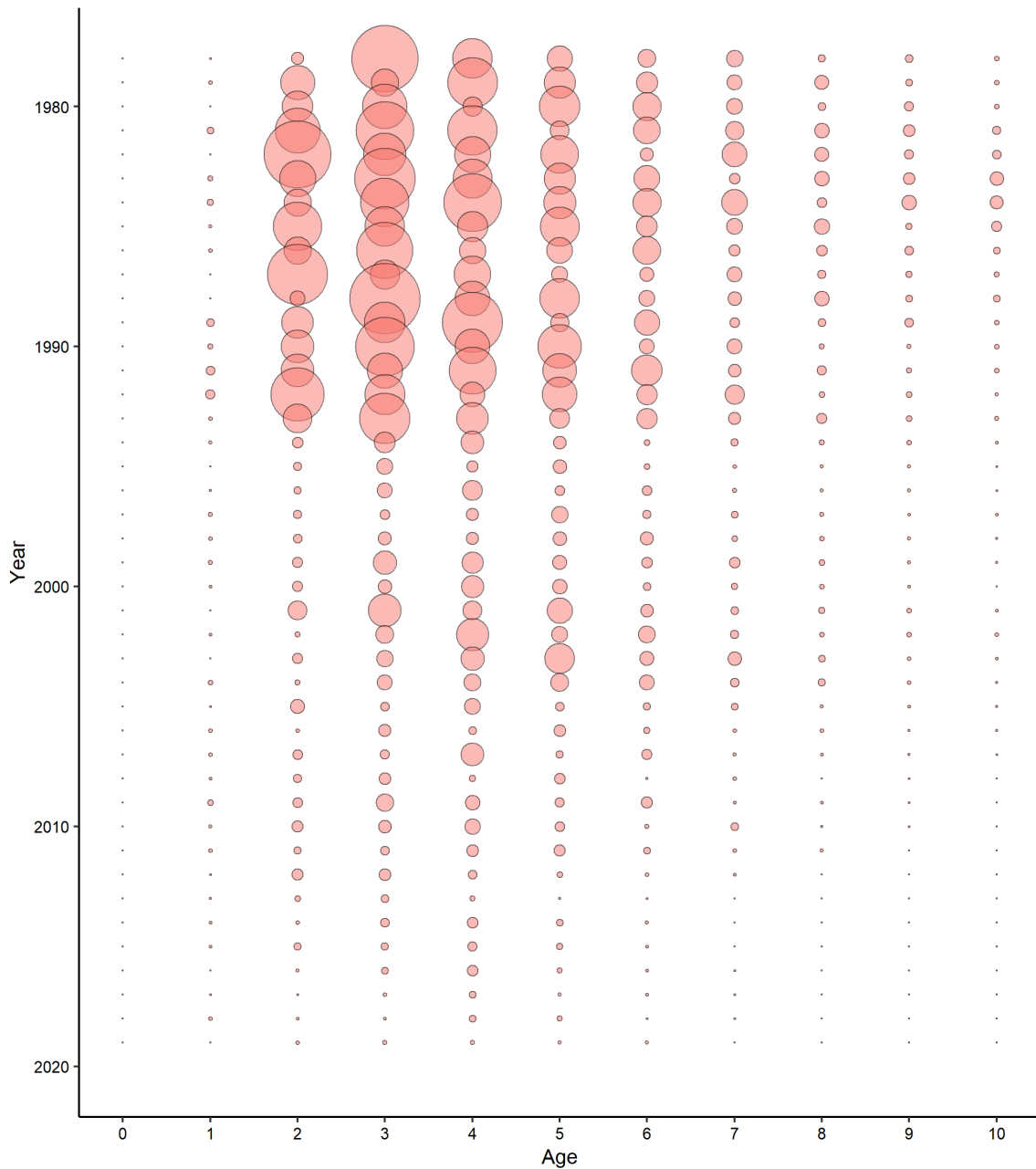
**Figure A12.** Spatial distribution of age 3+ Cod on eastern Georges Bank from the National Marine Fisheries Service (NMFS) fall survey for 2021 (top right) compared to the average for 2012–2021 (top left), and from the NMFS spring survey for 2022 (centre right) compared to the average for 2011–2020 (centre left). Although a new vessel conversion factor has not yet been calculated and applied, spatial distribution of 3+ Cod on eastern Georges Bank from the Fisheries and Oceans Canada (DFO) spring survey 2022 (bottom right) compared to the average for 2012-2021 (bottom left) is included to illustrate the distribution of catches.



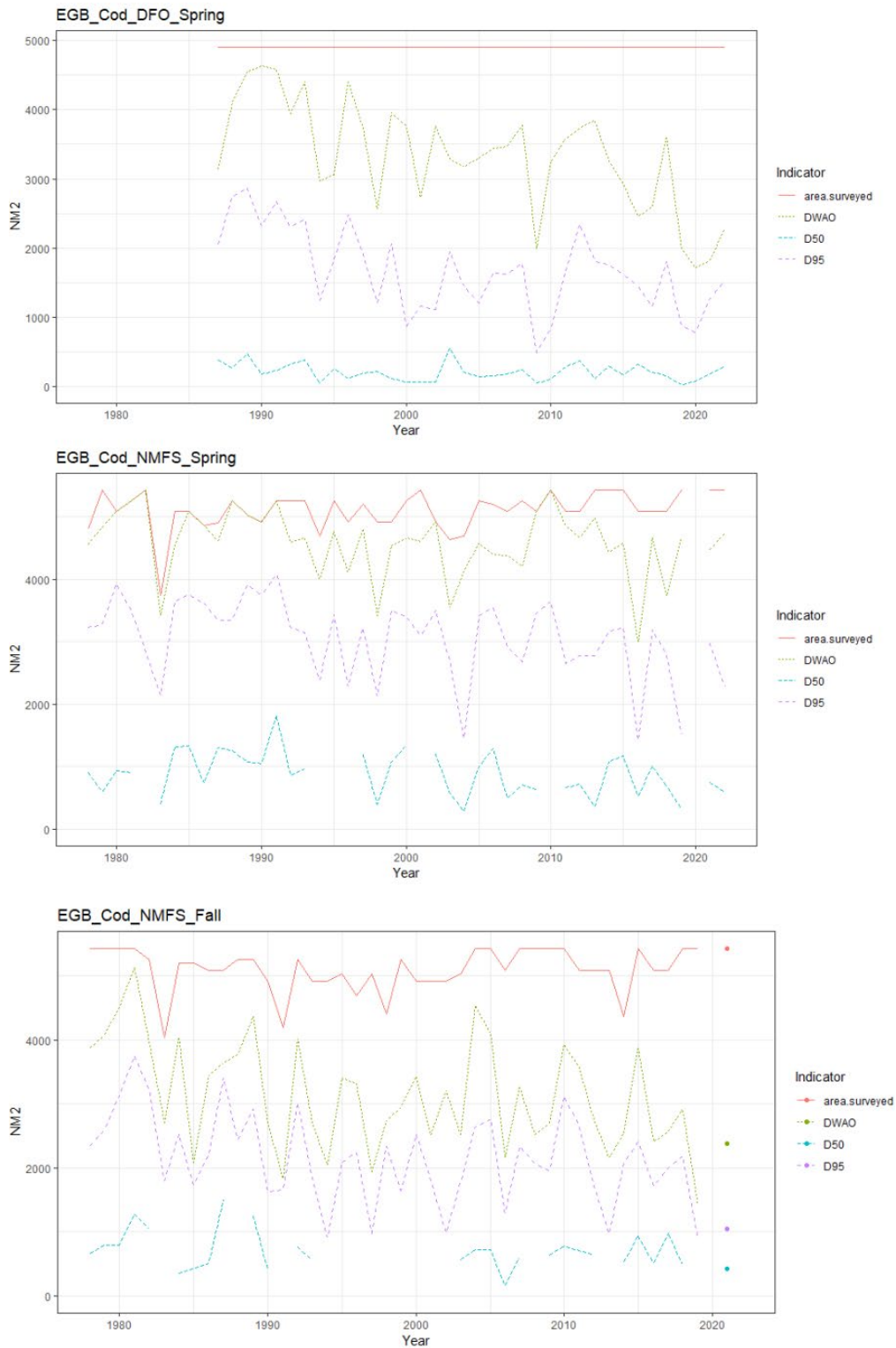
**Figure A13.** Length frequency distribution of the Fisheries and Oceans Canada (DFO) spring survey (2020 and 2021) and the National Marine Fisheries Service (NMFS) spring (2021 and 2022) and fall (2019 and 2021) surveys. Bars represent the most recent two years and the dashed line shows the average distribution from the previous ten years (2010-2020 for NMFS fall; 2011–2021 for NMFS spring). The NMFS fall survey plot compares 2019 and 2021 because there was no NMFS fall or spring survey in 2020.



**Figure A14.** Fish condition (Fulton's *K*) of post-spawning Cod for eastern Georges Bank from the 2021 National Marine Fisheries Service (NMFS) fall survey and the 2022 Fisheries and Oceans Canada (DFO) and NMFS spring surveys. The dashed lines shows the time series mean.

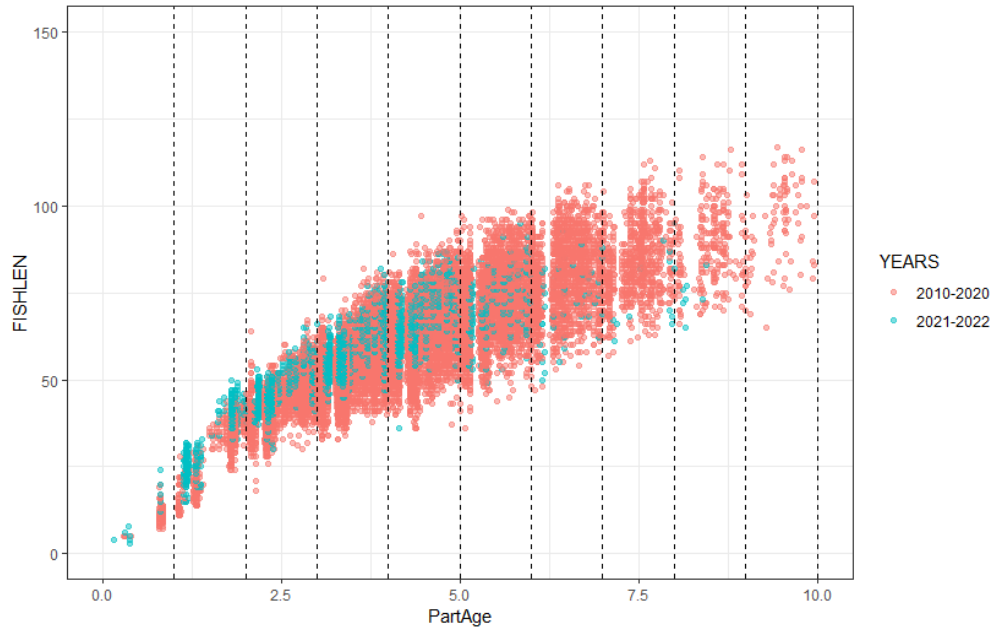


**Figure A15.** Fishery catch at age abundance for the United States of America fishery, updated until 2019. Size of bubbles is representative of abundance.

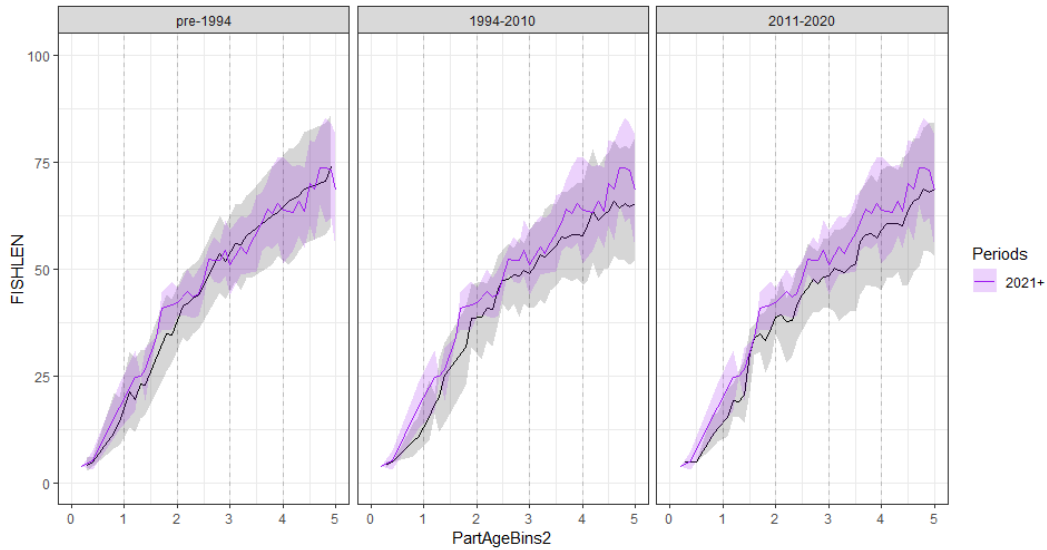


**Figure A16.** Distribution indices (square nautical miles) calculated for Cod on eastern Georges Bank (EGB) for each of the three surveys. The EGB NMFS fall plot (bottom) shows the 2021 survey data as points instead of lines so the values show up following the break in 2020 due to the missing survey. NMFS=National Marine Fisheries Service.

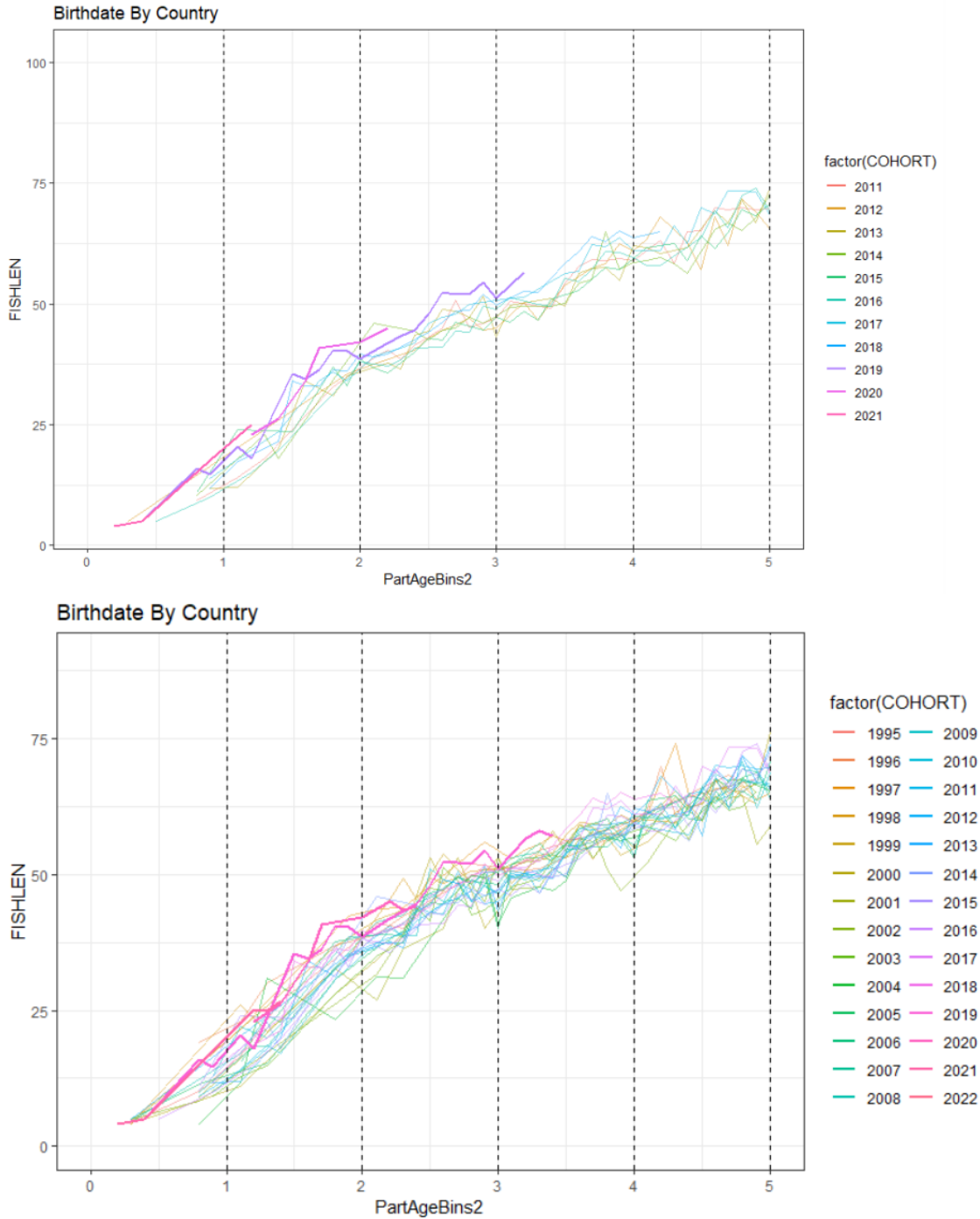




**Figure A17.** Growth of Cod sampled from the Canadian fishery, the National Marine Fisheries Service (NMFS) spring survey, the Fisheries and Oceans Canada (DFO) spring survey, and the NMFS fall survey data sets. Age has been adjusted to partial age based on the date of capture (surveys) or date sampled (fishery) for each fish. Partial age takes into accounts the birthdate assigned by the ageing lab where the fish was aged.



**Figure A18.** Mean growth (line) and 90% distribution (ribbons) of growth data from three time periods (facets) the Canadian fishery, the National Marine Fisheries Service (NMFS) spring survey, the Fisheries and Oceans Canada (DFO) spring survey, and the NMFS fall survey data sets. The purple line and ribbons show the data for 2021 and 2022, and repeat on every facet. Age has been adjusted to partial age based on the date of capture (surveys) or date sampled (fishery) for each fish. Partial age takes into account the birthdate assigned by the ageing lab where the fish was aged.



**Figure A19.** Growth by cohort of Cod sampled from the Canadian fishery, the National Marine Fisheries Service (NMFS) spring survey, the Fisheries and Oceans Canada (DFO) spring survey, and the NMFS fall survey since the 2010 cohort (upper panel) and since the 1995 cohort (bottom panel). Age has been adjusted to partial age based on the date of capture (surveys) or date sampled (fishery) for each fish. Partial age takes into accounts the birthdate assigned by the ageing lab where the fish was aged.