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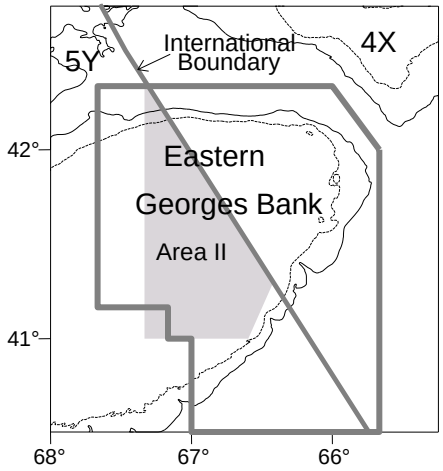
Transboundary Resources Assessment Committee

Status Update 2018/02

EASTERN GEORGES BANK HADDOCK

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



Summary

- Combined Canada/United States of America (USA) catches were 13,679 mt in 2017 (27% of the quota).

- In the most recent surveys, total biomass indices have decreased from record highs in the 2016 Fisheries and Oceans Canada (DFO) survey and 2015 National Marine Fisheries Service (NMFS) fall survey. In the most recent NMFS fall (2017), DFO (2018), and NMFS spring (2018) surveys, biomass indices decreased by 65%, 6%, and 49% respectively.

- The average survey adult biomass (as of January 2018) is 74% lower than the biomass predicted by the virtual population analysis (VPA) model with no rho adjustment and is 49% lower than the predicted biomass with rho adjustment.

- The measured weights-at-age (WAA) from the DFO survey continue to exhibit a declining trend since 2000, especially for ages 4 to 8.

- The beginning of year weights-at-age (WAA) used in projecting the 2018 biomass were overestimated for fish aged 5 (2013 year class) and 8 (2010 year class). Considering the 2013 and 2010 year classes are expected to contribute 75% and 10% of the total 2018 population biomass, the overestimation of WAA for these year classes would produce an overestimate of the projected population biomass.

- The 2018 Transboundary Resource Advisory Committee (TRAC) scientific advice was that the upper bound of 40,000 mt suggested at the Transboundary Management Guidance Committee for 2019 catch advice is too high, especially in light of the 68,017 mt estimate of

average survey 3+ biomass in 2018. The science advice from TRAC was that the rho-adjusted 2019 catch for low and neutral risk, which yields a range of 23,000 mt to 27,500 mt, is a more appropriate range for catch in 2019.

TRAC Review Process

In 2017 TRAC introduced a new process of review for eastern Georges Bank cod and haddock and Georges Bank yellowtail flounder. This process was reviewed by TRAC and TMGC following its first implementation in 2017, and some modifications were made to further improve clarity in the process. An overview of the entire process applied in 2018 is available at https://www.nefsc.noaa.gov/saw/trac/. Following the updated process, the TRAC review involved three steps for each stock: (1) presentation of the assessment by the assessment lead(s), followed by scientific and technical review by science assessment staff, designated reviewers and two identified resource managers (one from the USA and one from Canada); (2) contributions by all meeting participants, including stakeholders from the fishing industry, representatives from non-government organizations, and representatives from other levels of government (State, Federal, and Provincial) as well as the general public; (3) science assessment staff, reviewers, and resource managers then considered these additional contributions to inform the development of final conclusions and catch advice, adjusting their initial conclusions if appropriate and necessary.

Context

Since 1998, the TRAC has reviewed eastern Georges Bank haddock stock assessments and projections necessary to support management activities for shared resources across the USA - Canada boundary in the Gulf of Maine-Georges Bank region. These assessments have been conducted annually to advise the TMGC about the status of the resource and likely consequences of policy choices.

Eastern Georges Bank haddock is a stock that has increased from a very low state in the 1990s, and is showing improved recruitment with the production of six strong year classes in the last 15 years. In the 2014 stock assessment, adult biomass at the beginning of 2015 was estimated to be the second highest in the time series. Because the stock was perceived to be doing well, it was proposed in 2014 by TRAC and TMGC that the assessments would move to a two year cycle with an interim report produced in the intervening year.

In 2015, the Terms of Reference for the TRAC haddock assessment included the request for two years of catch advice (2016 and 2017) corresponding to low (25%), neutral (50%), and high (75%) probability that the fishing mortality (F) would exceed the reference level (F_{ref} = 0.26). In 2016, the TRAC was tasked with preparing an interim report for eastern Georges Bank haddock focusing on selected indicators of stock status to ensure that the 2016 advice from the 2015 assessment was still appropriate and if not, to revise the advice. In 2017, the Terms of Reference for the TRAC haddock assessment requested an evaluation of the interim report by including data from 2015 and provide improvements if necessary. The outcome was that members of TRAC were supportive of continuing the interim report in absence of the full assessment.

Fishery

Combined catches for USA and Canada increased from 12,409 mt in 2016 to 13,679 mt in 2017, against a quota of 50,000 mt (Table 1). **Canadian catches** increased to 13,384 mt in 2017, with 8 mt of discards from the scallop fishery and negligible discards from the groundfish fishery. The full Canadian quota of 20,500 mt was not caught in 2017.

USA catches decreased from 340 mt in 2016 to 295 mt in 2017 (USA calendar year), with 81 mt of discards estimated from the otter trawl and scallop dredge fisheries. As in other years, otter trawl gear accounted for nearly all of USA 2017 landings and discards. USA catch in fishing year 2017 was 1.4% of its 29,500 mt quota.

Table 1. Catches and Biomass (thousands mt) of haddock; recruits are in millions.

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Avg[1]	Min[1]	Max[1]
Canada[2]	**Quota**	15.0	18.9	17.6	12.5	9.1	6.4	16.5	19.2	21.8	20.5				
	Landed	14.8	17.6	16.6	11.2	5.0	4.6	13.0	14.6	11.9	13.4		6.2	0.5	17.6
	Discard	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	0.2
USA[2]	**Quota[3]**	8.1	11.1	12.0	9.5	6.9	4.0	10.5	17.8	15.2	29.5				
	Catch[3]	1.6	1.6	1.8	1.1	0.4	0.6	1.3	1.9	0.5	0.3				
	Landed	1.1	2.2	2.2	1.3	0.4	0.3	1.2	1.5	0.3	0.2		1.9	<0.1	9.1
	Discard	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.4	0.1	<0.1		0.5	0.0	7.6
Total[2]	**Quota[3]**	23.0	30.0	29.6	22.0	16.0	10.4	27.0	37.0	37.0	50.0	40.0			
	Catch[4,5]	16.5	19.2	18.4	12.3	5.5	5.2	14.3	16.5	12.4	13.8				
	Catch	16.0	19.9	18.8	12.7	5.6	5.1	14.2	16.1	12.4	13.7		8.7	2.1	23.3
Adult Biomass[6]		93.0	92.8	66.2	40.4	23.9	85.0	105.0	95.6	293.3	274.5	265.9	45.8	4.9	293.3
Age 1 Recruits		4.5	1.8	4.0	243.5	20.8	9.9	884.9	10.6	45.9	111.6		39.6	0.2	884.9
Fishing Mortality[7]		0.15	0.25	0.36	0.41	0.47	0.36	0.41	0.12	0.10			0.32	0.10	0.57
Exploitation Rate[7]		12%	20%	28%	30%	34%	28%	31%	10%	9%			24%	9%	40%

[1]1969 – 2017
[2] unless otherwise noted, all values reported are for calendar year
[3]for fishing year from May 1st – April 30th
[4]for Canadian calendar year and USA fishing year May 1st – April 30th
[5]sum of Canadian landed, Canadian discards, and USA catch (includes discards)
[6]ages 3+; from the 2017 assessment
[7]ages 5-8 for 2003 – 2016; from the 2017 assessment

Indicators and Recommendations

In the most recent surveys, total biomass indices have decreased from record highs in the 2016 DFO survey and 2015 NMFS fall survey (Figure 1). In the most recent NMFS fall (2017), DFO (2018), and NMFS spring (2018) surveys, biomass indices decreased by 65%, 6%, and 49%, respectively. Both the 2017 NMFS fall survey and 2018 DFO survey used vessels other than the standard survey vessels, although both were considered to be sister ships to the standard vessels.

No calibration tows were done in either case. A TRAC intersessional meeting concluded that both surveys would be accepted for use without conversion factors (Ford and Sosebee 2018).

The bias-adjusted **adult biomass** from the 2017 haddock assessment was projected to decrease from 274,482 mt in 2017 to 265,881 mt in 2018 (Table 1), assuming the 2017 quota of 50,000 mt was caught. The catchability (q) adjusted **survey biomass** showed a decrease in the recent spring (2018) and fall (2017) surveys. In order to smooth inter-survey variation whilst still providing information on incoming year-classes, the three surveys (2017 NMFS fall, 2018 DFO, and 2018 NMFS spring) were averaged to give an estimate that could be considered close to that of the start of the calendar year (Figure 2). The average survey biomass for January 2018 (68,017 mt) is about 74% lower than that predicted by the VPA model in the 2017 haddock assessment (265,881 mt, Figure 2). When compared to the rho-adjusted biomass of 133,841 mt, the average survey biomass was 49% lower than that predicted from the VPA (Figure 2).

Consistent with the trend reported in 2017, the measured WAA from the DFO survey exhibit a declining trend from 2000 to present, especially for ages 4 to 8. Growth of the 2013 year class is slower than other strong year classes (Figure 3). The beginning of year WAA used in projecting the 2018 biomass were overestimated for fish aged 5 (2013 year class) and 8 (2010 year class). Considering the 2013 and 2010 year classes are expected to contribute 75% and 10% of the total 2018 population biomass, the overestimation of WAA for these year classes would produce an overestimate of projected population biomass. The underestimation or overestimation of the WAA of all other year classes is expected to have little effect on the projected 2018 biomass (Table 2).

Quotas for catch years 2010-2012 were set using a neutral risk of exceeding F_{ref}=0.26, yet resulted in estimates of **fishing mortality** (F) that exceeded F_{ref} in those years despite the fact that 35%-65% of quotas were caught. In 2013 and 2014, neutral and low risk quotas were adopted by TMGC and only about half of the quotas were landed. The estimated F for these years was 0.36 and 0.41, respectively, which also exceeds F_{ref} despite not achieving quotas and selecting low risk quota advice in 2014. In 2017, a neutral risk quota of 50,000 mt was adopted by TMGC and only about 27% of the quota was landed (Table 1). This trend of positive bias in the projected quota, and underestimated risk of exceeding F_{ref} is a consequence of the retrospective pattern which has emerged and increased in the last four assessments, as well as the overestimation of projected WAA for large year classes.

Conclusions

In 2017, the TMGC agreed on a quota of 40,000 mt for 2018 and suggested an upper level of 40,000 mt for catch advice for 2019. There are several positive signals for the stock, such as the 2018 DFO survey index of abundance of haddock for age 5 (2013 year class) fish being the highest value for the time series and the second highest for NMFS spring survey, and all three surveys being above average values despite the decrease from 2017 to 2018. Only 27% of the 2017 quota was caught, and the 2018 projected quota (86,000 or 53,000 mt, standard or rho-adjusted) is unlikely to be caught (Table 3). The TRAC consensus was that the standard projections are overestimated (Table 3). The reasons include: the large discrepancy between the VPA-projected 2018 biomass and the q-adjusted average survey biomass, the incompatible patterns between survey Z and relative F, the expected impact of 2018 survey decline on population abundance estimates, uncertainty about the magnitude of the 2013 year class, and

overestimation of the 2013 and 2010 WAA. For these reasons, the 2018 TRAC advice was that the upper bound of 40,000 mt suggested at TMGC for 2019 catch advice is too high, especially in light of the 68,017 mt estimate of average survey 3+ biomass in 2018. The TRAC advised that the rho-adjusted 2019 catch for low and neutral risk, which yields a range of 23,000 mt to 27,500 mt, is a more appropriate range for catch in 2019 (Table 4).

Special Considerations

When the last two years (2017 and 2018) of survey data are compared for the dominant 2013 year class, the calculated total mortality (Z) from the average of the three surveys was 1.2, which would suggest only 30% of the 2013 year class survived from the beginning of 2017 to 2018. However, the relative fishing mortality (relative F, the ratio of fishery catch in biomass to the average survey biomass) for the 2017 fishing year was one of the lowest in the time series (Figure 4). While scales are not directly comparable between Z (calculated between successive numbers at age) and relative F (calculated for adult biomass), disparities in the trends between the two metrics is an underlying source of the retrospective pattern in the VPA assessment, and could also explain to some extent the discrepancy between the VPA projection and survey biomass.

In recent assessments, the VPA model has exhibited an increasing retrospective pattern, and research has shown that the assessment bias is propagated in the projections and magnified by carrying it out three years (Brooks and Legault 2016). The projected catches in Table 4 are inherently uncertain as a result of this retrospective bias, even when rho-adjusted. There is additional uncertainty in projections that results from misspecification of inputs to the projections, which could introduce positive or negative bias (i.e., overestimation or underestimation). For example, WAA were overestimated for the two large year classes (2010 and 2013), which would further exacerbate overestimated biomass and catch. Assumed catch exceeded realized catch for 2017 and most likely for 2018, which would underestimate projected biomass and catches corresponding to F_{ref}. A higher projected biomass, resulting from the assumed quota not being caught, would create a greater discrepancy between projected biomass and survey estimated 3+ biomass in Figure 2. Declines in growth rate, exacerbated in the 2013 year class, could impact the assumed partial recruitment, although the resulting bias could be positive or negative depending on the actual partial recruitment that was achieved. Reviewing the performance of previous projections, it was noted that $F>F_{ref}$ in years where only a fraction of the quota was taken, and that the dominant factor leading to the overestimation of the projections was the retrospective bias in estimated numbers at age. It is therefore expected that the current projections would be overestimates, despite the variety of projection input misspecifications and associated biases.

Table 2. Average weights-at-age (kg) of eastern Georges Bank haddock used in the 2017 TRAC haddock assessment projection (for 2018) and observed 2018 DFO survey average weights-at-age (kg). These weights are used to represent beginning of year population weights. Weights for 9+ are population weighted averages.

Year	Age Group								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
2017 Projection	0.06	0.18	0.39	0.61	0.59	1.00	1.14	0.95	1.59

2018 Observed	0.06	0.21	0.39	0.41	0.54	1.02	1.51	0.85	1.73

Table 3. Indicators derived from the 2017 NMFS fall, 2018 DFO, and 2018 NMFS spring surveys either supporting the catch advice from the 2017 assessment or supporting a reduction in the advice to a lower risk level.

Maintain Existing Catch Advice	Reduce Catch Advice
In 2018, DFO survey index of abundance for age 5 (2013 year class) fish are at the highest value for the time series and the second highest for NMFS spring survey.	Average biomass from the surveys was 74% lower than the biomass predicted in the VPA for 2018, despite only 27% of the quota being caught in 2017.
VPA estimate of adult biomass in 2017 declined slightly from 2016 value, which was the highest in the time series.	Weights at age from the DFO survey have been declining since 2000, and 2018 values were overestimated for the very large 2013 and 2010 year classes.
Only 27% of the 2017 quota was caught, and 2018 projected quota (86,000 mt standard or 53,000 mt rho-adjusted) is unlikely to be caught.	Recent quotas selected for neutral risk have not been fully caught, yet $F>F_{ref}$ (2010-2014). Risk is being underestimated and catch is being overestimated.
2017 NMFS fall and 2018 DFO and NMFS survey total biomass indices decreased, but all three are above historical values.	A retrospective pattern has been observed in the 2017 TRAC assessment. The pattern leads to overestimated biomass and underestimated F from the VPA, and overestimates of biomass and catch in the projections.

Table 4. The levels of catch projected in 2017 for which there is a 25%, 50% and 75% risk of the fishing mortality in 2018 and 2019 exceeding $F_{ref} = 0.26$ for both the standard and the rho adjusted projections. Catches in 2019 at each risk level are conditional on $F=F_{ref}=0.26$ in 2018.

Probability of exceeding F_{ref}	**25%**	**50%**	**75%**
2018 catch	71,000 mt	86,000 mt	102,000 mt
2018 catch (rho-adjusted)	35,000 mt	44,000 mt	53,000 mt
2019 catch	44,500 mt	53,000 mt	63,000 mt
2019 catch (rho-adjusted)	23,000 mt	27,500 mt	33,000 mt

Source Documents

Barrett M.A., E.N. Brooks, and Y. Wang. 2017. Assessment of Haddock on Eastern Georges Bank for 2017. TRAC Ref. Doc 2017/02: 89 p

Brooks, E.N., C.M. Legault. 2016. Retrospective forecasting — evaluating performance of stock projections for New England groundfish stocks. Can. J. Fish. Aquat. Sci. 73: 935–950 dx.doi.org/10.1139/cjfas-2015-0163

Ford, J., and K. Sosebee, editors. 2018. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Intersessional Meeting held 29 May 2018. TRAC Proceedings 2018/XX.

TRAC. 2017. Eastern Georges Bank Haddock. TRAC Status Report 2017/02: 10p.

Correct Citation

TRAC. 2018. Eastern Georges Bank Haddock Status Update. TRAC Status Update 2018/02.

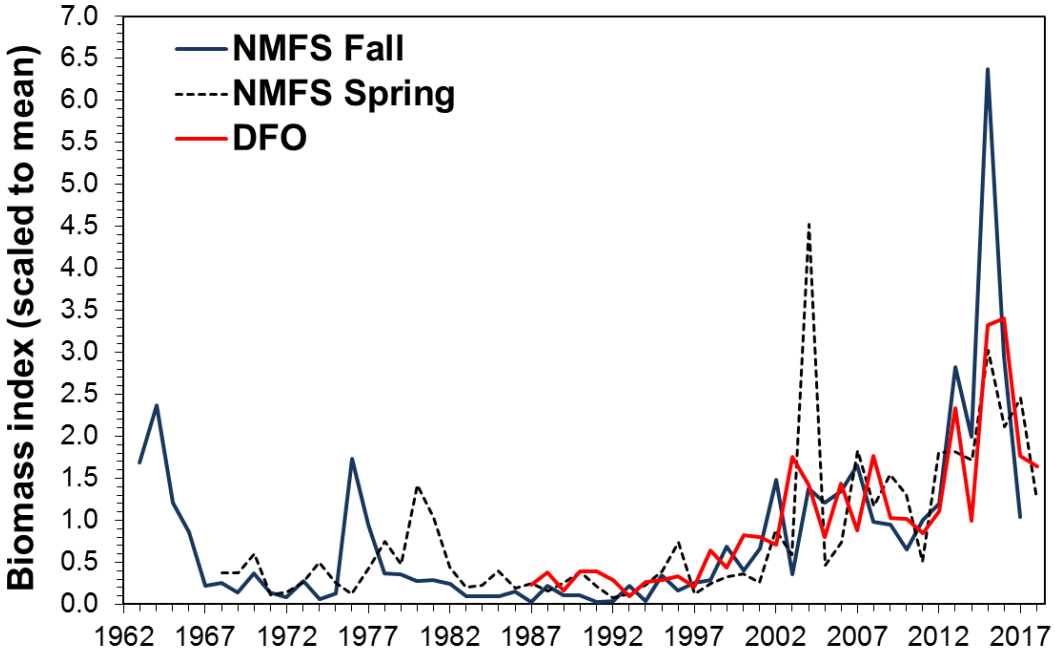


Figure 1. Scaled total biomass indices from NMFS fall (1963-2017), NMFS spring (1968-2018) and DFO (1987-2018) research surveys for eastern Georges Bank. Biomass conversion coefficients have been applied to the NMFS surveys to adjust for changes in door type (BMV vs Polyvalent; 1968-1984), vessel (Delaware II vs Albatross IV; 1968-2008) and vessel/net (Albatross IV vs Henry B. Bigelow; Yankee 36 vs 4 seam-3 bridle; 2009-2018). Biomass was scaled using the mean index value from 1987 to 2017.

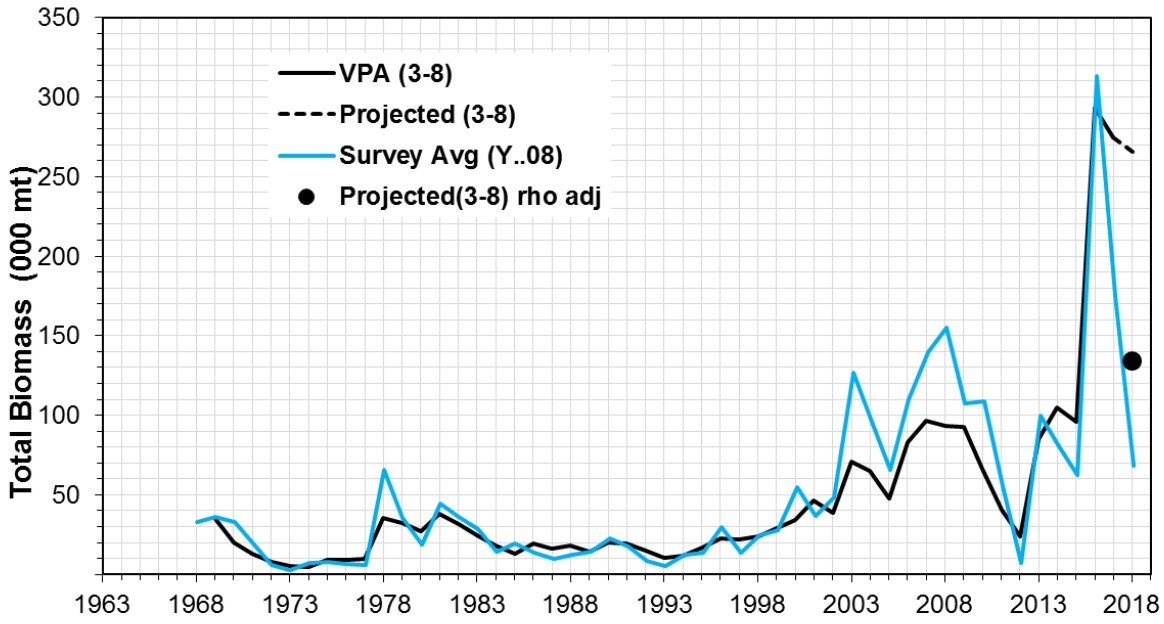


Figure 2. The 1969 to 2018 eastern Georges Bank adult haddock (ages 3-8) biomass from VPA (hatched line) and sensitivity analysis (rho adjusted; solid circle) compared with the average of the NMFS spring and DFO (ages 3-8) and NMFS fall (ages 2-7) survey biomass (scaled with catchability, q). The haddock VPA does not estimate q for fall ages 6 and 7, so the value was assumed equal to NMFS fall age 5 q (i.e. catchability asymptotes). If catchability declines at ages 6 and 7, rather than reaching an asymptote at these ages, then the calculated fall biomass would be an underestimate.

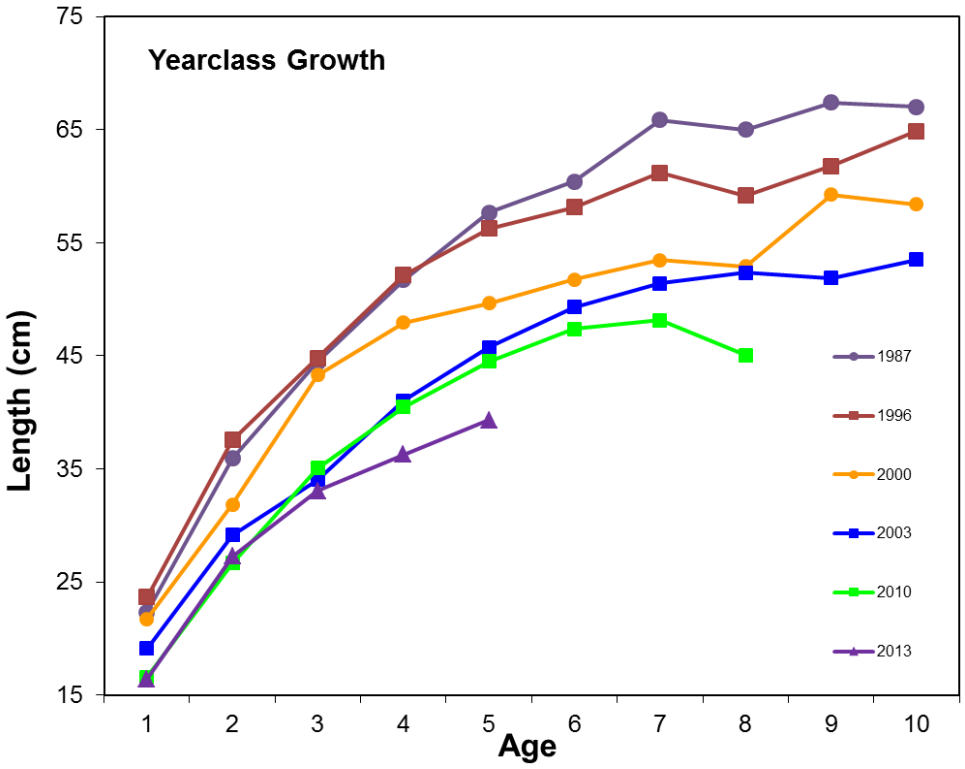


Figure 3. Mean length at age for selected year classes of eastern Georges Bank haddock sampled from the DFO survey.

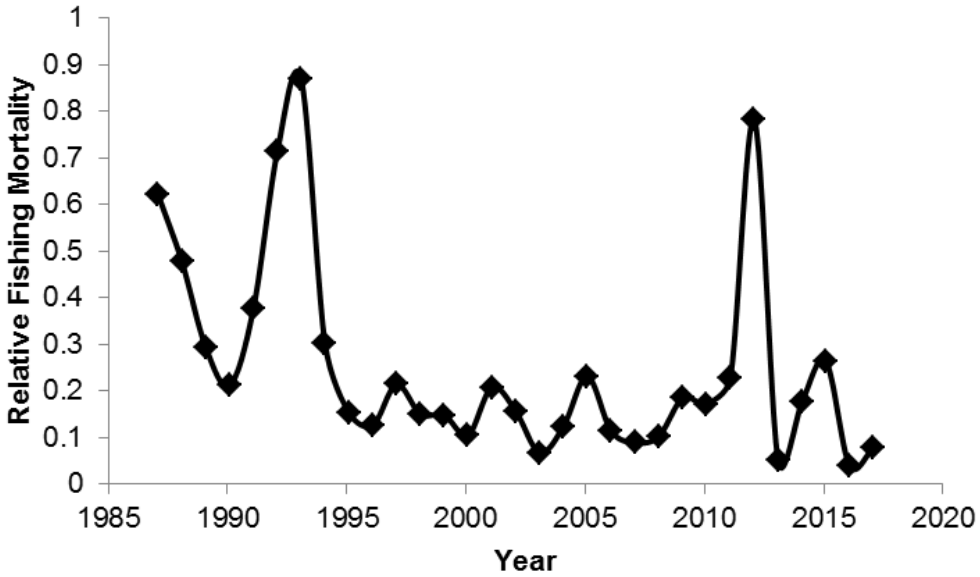


Figure 4. The relative fishing mortality (ratio of fishery catch in biomass to the average survey biomass) for eastern Georges Bank haddock from 1987 to 2017. The average survey biomass was calculated using the NMFS spring and DFO (ages 3-8) and NMFS fall (ages 2-7) survey biomass (scaled with catchability, q).