Fisheries and Oceans Canada
Pêches et Océans Canada
Ecosystems and Oceans Science
Sciences des écosystèmes et des océans

NOAA FISHERIES
NATIONAL MARINE FISHERIES SERVICE

CERT

Comité d'évaluation des ressources transfrontalières

Document de référence 2018/??

Ne pas citer sans autorisation des auteurs

TRAC

Transboundary Resources Assessment Committee

Reference Document 2018/??

Not to be cited without permission of the authors

Stock Assessment of Georges Bank Yellowtail Flounder for 2018

Christopher M. Legault[1] and Quinn M. McCurdy[2]

[1] National Marine Fisheries Service
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA, 02543 USA

[2] Fisheries and Oceans Canada
St Andrews Biological Station
531 Brandy Cove Road
St. Andrews, NB E5B 2L9 Canada

Ce document est disponible sur l'Internet à :
This document is available on the Internet at :
http://www.bio.gc.ca/info/intercol/index-en.php

TABLE OF CONTENTS

ABSTRACT

The combined Canada/US Yellowtail Flounder catch in 2017 was 95 mt, with neither country filling its portion of the quota. For only the second time, discards were greater than landings. Despite the low catch, all three bottom trawl surveys declined, two of the surveys to the lowest value in the time series.

The empirical approach recommended at the 2014 Diagnostic Benchmark and modified during last year's TRAC was applied in this year's assessment update. The three recent bottom trawl surveys were scaled to absolute biomass estimates, averaged, and an exploitation rate applied to generate catch advice for the following year. Last year, the TRAC external reviewers and science members recommended an exploitation rate of 2% to 6% for catch advice. Applying this range of exploitation rate to this year's updated surveys results in catch advice of 23 mt to 68 mt for 2019. Last year, the broader TRAC considered the full range of exploitation rates from the 2014 Diagnostic and Empirical Benchmark, 2% to 16%, to still be informative. This range of exploitation rate applied to this year's surveys results in 23 mt to 180 mt. There are no indications in the data that support increasing the catch advice for 2019 from the 300 mt quota for 2018. Catch advice of 300 mt in 2019 has an associated exploitation rate of 27%. This year the TRAC recommended 6% as an upper bound for the exploitation rate, which results in catch advice of 68 mt for 2019.

RÉSUMÉ

Will be translated later.

INTRODUCTION

The Georges Bank Yellowtail Flounder (*Limanda ferruginea*) stock is a transboundary resource in Canadian and US jurisdictions. The management unit currently recognized by Canada and the US for the Georges Bank stock includes the entire bank east of the Great South Channel to the Northeast Peak, encompassing Canadian fisheries statistical areas 5Zj, 5Zm, 5Zn and 5Zh (Figure 1a) and US statistical reporting areas 522, 525, 551, 552, 561 and 562 (Figure 1b). This paper updates the last stock assessment of Yellowtail Flounder on Georges Bank, completed by Canada and the US (Legault and McCurdy 2017), taking into account advice from the 2014 Diagnostic and Empirical Approach Benchmark (hereafter 2014 Diagnostic Benchmark; O'Brien and Clark 2014). During the June 2014 Transboundary Resources Assessment Committee (TRAC) assessment, it was decided to no longer use the virtual population analysis model which had previously provided stock condition and catch advice. This assessment follows that decision and does not provide any stock assessment model results. The 2014 Diagnostic Benchmark recommended an empirical approach to providing catch advice based on the three bottom trawl surveys and an assumed exploitation rate.

Last year, the empirical approach was modified to use wing width instead of door width when expanding the surveys catch per tow to population estimates and to change the catchability of all three surveys from the value of 0.37 derived from the literature to an experimentally derived value of 0.31. The TRAC external reviewers and science members recommended an exploitation rate between 2% and 6% for catch advice, which resulted in 62 mt to 187 mt for 2018. The Transboundary Management Guidance Committee (TMGC) selected the combined US-Canada catch quota for 2018 to be 300 mt.

THE FISHERIES

UNITED STATES

The principle fishing gear used in the US fishery to catch Yellowtail Flounder is the otter trawl, accounting for more than 95% of the total US landings in recent years, although scallop dredges have accounted for some historical landings. Recreational fishing for Yellowtail Flounder is negligible.

Landings of Yellowtail Flounder from Georges Bank by the US fishery during 1994-2017 were derived from the trip-based allocation algorithm (GARM 2007; Legault et al. 2008; Palmer 2008; Wigley et al. 2007a). US landings have been limited by quotas in recent years. Total US Yellowtail Flounder landings (excluding discards) for the 2017 fishery were 35 mt (Table 1 and Figure 2a-b).

US discarded catch for years 1994-2017 was estimated using the Standardized Bycatch Reporting Methodology (SBRM) as recommended in the GARM III Data meeting (GARM 2007, Wigley et al. 2007b). Observed ratios of discards of Yellowtail Flounder to kept of all species for large mesh otter trawl, small mesh otter trawl, and scallop dredge were applied to the total landings by these gears and by half-year (Table 2). Large and small mesh otter trawl gears were separated at 5.5 inch (14 cm) cod-end mesh size. Total discards of Yellowtail Flounder in the US were 57 mt in 2017.

The total US catch of Georges Bank Yellowtail Flounder in 2017, including discards, was 92 mt.

The US Georges Bank Yellowtail Flounder quota for fishing year 2017 (1 May 2017 to 30 April 2018 for groundfish and 1 March 2016 to 31 March 2018 for scallops due to a change in the fishing year) was set at 207 mt. Monitoring of the US catches relative to the quota was based on

Vessel Monitoring Systems (VMS) and a call-in system for both landings and discards. Reporting on the Regional Office webpage (NOAA Fisheries Northeast Multispecies (Groundfish) Monitoring Reports and NOAA Fisheries Sea Scallop Fishery Monitoring) indicates the US groundfish fishery caught 19.3% of its 162.6 mt sub-quota and the scallop fleet caught 164.3% of its 32 mt sub-quota for their 2017 fishing years. Including the other minor fisheries, the US caught 84.4 mt (41%) of the 207 mt quota (D. Caless, GARFO, pers. comm.)

No adjustments have been made to US catch of Georges Bank Yellowtail Flounder to account for catch misreporting due to lack of information. Amounts of misreported fish caught in the Carlos Rafael case are not available and Palmer (2017) did not indicate strong stock misreporting based on VMS locations during fishing activity in most years.

CANADA

Canadian fishermen initiated a directed fishery for Yellowtail Flounder on Georges Bank in 1993, but landings have been less than 100 mt every year since 2004, and less than 3 mt in the last five years. Since 2004, with the exception of 2011 and 2012, there has been no directed Canadian Yellowtail Flounder fishery (the fishery is not permitted to target Yellowtail Flounder, nor use gear appropriate for targeting this species); the Canadian quota has been reserved to cover bycatch in the commercial groundfish and scallop fisheries. From 2004-2011, and during 2013-2017, most of the reported Yellowtail Flounder landings were from trips directed for Haddock.

The Canadian offshore scallop fishery is the only source of Canadian Yellowtail Flounder discards on Georges Bank. Discards are estimated from at-sea observer deployments using the methodology documented in Van Eeckhaute et al. (2005). Since August 2004, there has been routine observer coverage on vessels in the Canadian scallop fishery on Georges Bank. Discards for the years 2004-2017 were obtained by estimating a monthly prorated discard rate (kg/(hr*meters)), using a 3-month moving-average calculation to account for the seasonal pattern in bycatch rate, applied to a monthly standardized effort (Table 3) (Sameoto et al. 2013; Van Eeckhaute et al. 2011). The result of these calculations for 2017 is a discard estimate of 2 mt, the lowest in the time series (Table 1).

For 2017, the total Canadian catch, including discards, was 3 mt, which is 3% of the 2017 quota of 93 mt.

LENGTH AND AGE COMPOSITION

Despite low landings, the level of US port sampling continued to be proportionally strong in 2017, with 1,046 length measurements available, resulting in 3,000 lengths per 100 mt of landings (Table 4). The port samples also provided 229 age measurements for use in age-length keys. This level of sampling has generally resulted in high precision (i.e. low coefficients of variation) for the US landings at age from 1994-2017 (Table 5).

In 2017, no samples were collected from the <1 mt of Canadian landings. The Canadian landings at age were assumed to follow the same proportions at age as the US landings and to have the same weights at age as the US landings.

The US discard length frequencies were generated from 1,460 length measurements provided by the Northeast Fisheries Observer Program, expanded to the total weight of discards by gear type and half year.

The size composition of Yellowtail Flounder discards in the Canadian offshore scallop fishery was estimated by half year using length measurements obtained from 18 observed trips in 2017. These were prorated to the total estimated bycatch at size using the corresponding half year length-weight relationship and the estimated half year bycatch (mt) calculated using the methods of Stone and Gavaris (2005).

The low amount of landings and discards by both countries makes comparisons of length distributions uninformative.

Percent agreement on scale ages by the US readers continues to be high (>85% for most studies) with no indication of bias (Results of all QA/QC Exercises for Yellowtail Flounder, *Limanda ferruginea*).

For the US fishery, sample length frequencies were expanded to total landings at size using the ratio of landings to sample weight (predicted from length-weight relationships by season; Lux 1969), and apportioned to age using pooled-sex age-length keys in half year groups. Landings were converted by market category and half year, while discards were converted by gear and half-year. The age-length keys for the US landings used only age samples from US port samples, while age-length keys for the US discards used age samples from US surveys and port samples.

No scale samples were available for the Canadian fishery in 2017. Therefore, the Canadian discards at length were converted to catch at age using the US age-length keys by half-year.

Since the mid 1990s, ages 2-4 have constituted most of the exploited population, with very low catches of age 1 fish due to the implementation of larger mesh (increased from 5.5 to 6 inches in May 1994) in the cod-end of US commercial trawl gear (Table 6 and Figure 3).

The fishery mean weights at age for Canadian and US landings and discards were derived using the applicable age-length keys, length frequencies, and length-weight relationships. The combined fishery weights at age were calculated from Canadian and US landings and discards, weighted by the respective catch at age (Table 7 and Figure 4). Low catches make the recent estimates of weights at age more uncertain than earlier years when catches were much larger.

ABUNDANCE INDICES

Research bottom trawl surveys are conducted annually on Georges Bank by Fisheries and Oceans Canada (DFO) in February and by the US National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) in April (denoted spring) and October (denoted fall). Both agencies use a stratified random design, though different strata boundaries are used (Figure 5).

The NMFS spring and fall bottom trawl (strata 13-21) and DFO bottom trawl (strata 5Z1-5Z4) survey catches were used to estimate relative stock biomass and relative abundance at age for Georges Bank Yellowtail Flounder. Conversion coefficients, which adjust for survey door, vessel, and net changes in NMFS groundfish surveys (1.22 for BMV oval doors, 0.85 for the former NOAA ship *Delaware II* relative to the former NOAA ship *Albatross IV*, and 1.76 for the Yankee 41 net; Rago et al. 1994; Byrne and Forrester 1991) were applied to the catch of each tow for years 1973-2008.

Beginning in 2009, the NMFS bottom trawl surveys were conducted with a new vessel, the NOAA ship *Henry B. Bigelow*, which uses a different net and protocols from the previous survey vessel. Conversion coefficients by length have been estimated for Yellowtail Flounder (Brooks et al. 2010) and were applied in this assessment when examining the entire survey time series, but not in the empirical approach.

The 2017 NMFS fall survey was completed by NOAA ship *Pisces*, due to the unavailability of the regular vessel, NOAA ship *Henry B. Bigelow*. The *Pisces* and the *Henry B. Bigelow* are sister ships, so no conversion factors were necessary. In 2018, the DFO survey was conducted by the *Mersey Venture* also due to unavailability of the usual survey vessels, the CCGS *Alfred Needler* and the *Teleost*. The *Mersey Venture* is a sister ship to the *Teleost* and no conversion factor was applied to account for this boat change. On May 29, 2018 a TRAC inter-sessional conference call was held to discuss the NMFS fall 2017 and DFO 2018 survey delays related to the use of different vessels. The consensus decisions were to accept both surveys as valid indicators of population trends because timing was within previous survey times (Figure 6) and to assume the replacement ships had the same catchability as the standard ships. Due to delays caused by the change of vessel in fall 2017 and a combination of weather and mechanical issues in spring 2018, fewer valid tows were made in the most recent NMFS surveys compared to recent years (Table 8, Figure 7a-b).

Trends in Yellowtail Flounder biomass indices from the three surveys track each other well over the past three decades, with the exception of the DFO survey in 2008 and 2009, which were influenced by single large tows (Table 9a-c; Figures 8-9). The 2018 DFO biomass is the lowest in the 32 year time series. The 2018 NMFS spring biomass is the lowest in the 51 year time series. The 2017 NMFS fall biomass is the second lowest in the 55 year time series. These survey biomass levels are below those observed in the mid-1990s when the stock was declared collapsed (Stone et al. 2004). Coefficients of variation for the survey biomass estimates have increased over time, with large spikes associated with the 2008 and 2009 DFO surveys due to the large catch in single tows (Figure 10).

The spatial distribution of catches (weight/tow) for the most recent year compared with the previous ten year average for the three groundfish surveys show that Yellowtail Flounder distribution on Georges Bank in the most recent year has been consistent relative to the previous ten years (Figure 11a-b). Most of the DFO survey biomass of Yellowtail Flounder has occurred in strata 5Z2 and 5Z4, with the notable exception of 2008 and 2009 when almost the entire Canadian survey catch occurred in just one or two tows in stratum 5Z1 (Figure 12a). NMFS bottom trawl surveys have been dominated by stratum 16 since the mid 1990s (Figure 12b-c). Note the NMFS spring 2018 survey caught only two fish, one in stratum 13 and the other in stratum 16.

Age-structured indices of abundance for NMFS spring and fall surveys were derived using survey specific age-length keys (Table 9a-c; Figure 13a-c). There is some indication of cohort tracking in all three of the bottom trawl surveys (Figure 14a-c). Even though each index is noisy, the age specific trends track relatively well among the three surveys (Figure 15).

The condition factor (Fulton's K) of Yellowtail Flounder has declined during the available time series in all three surveys (Figure 16a-b). Note the low catch of Yellowtail Flounder in the 2018 NMFS spring survey makes interpretation of Fulton's K difficult for that year.

Relative fishing mortality (fishery catch biomass/survey biomass, scaled to the mean for 1987-2007) was quite variable but followed a similar trend for all three surveys, with a sharp decline to low levels since 1995 (Figure 17). In contrast, time series of total mortality (Z) estimated from the three bottom trawl surveys using the method of Sinclair (2001) do not show a similar decline since 1995 (Figure 18).

EMPIRICAL APPROACH

The 2014 Diagnostic Benchmark recommended an empirical approach be considered for catch advice. The three bottom trawl surveys are used to create a model-free estimate of population abundance. For the two NMFS surveys, the *Henry B. Bigelow* data are used directly (i.e. un-calibrated values) in these calculations to avoid the complexities that arise due to calibration with the *Albatross IV* (Table 10). The original empirical approach used door width when computing the area of a tow, catchability of the net from the literature, and a range of 2% to 16% for the exploitation rate to apply for catch advice from a group decision based on a number of per-recruit calculations and discussion about resulting catch estimates. The literature value for catchability was derived in working paper 13 of the 2014 Diagnostic Benchmark as the mean of the value 0.22 in Harden Jones et al. (1977) and four values of 0.33, 0.42, 0.43, and 0.45 in Somerton et al. (2007). The Harden Jones et al. (1977) study was conducted with English plaice in the North Sea using a Granton otter trawl. The Somerton et al. (2007) study was conducted with four flatfish species (arrowtooth flounder, flathead sole, rex sole, and Dover sole) in the Gulf of Alaska using a Poly nor'eastern survey trawl. The survey biomass estimates from DFO and the NMFS spring survey in year t and the NMFS fall survey in year t-1 are averaged to form the estimate of population biomass in year t. Multiplying the average biomass by an exploitation rate results in the catch advice for year t+1.

A TRAC intersessional conference call on June 26, 2017 reviewed three working papers that addressed survey catchability and tow area. Two of the working papers estimated survey catchability based on a twin trawl experiment conducted in 2015 and 2016 (Miller et al. 2017, Richardson et al. 2017). One of the twin trawl nets used the NMFS standard rockhopper sweep while the other net used chain gear to prevent flounders from escaping under the sweep. After discussing the merits of both approaches, a practical consensus was achieved that set survey catchability to 0.31 based on the statistically best fitting models that incorporated length effects and diel effects. The other working paper described a bridle study experiment that examined the effect of different lengths of ground gear connecting the net to the doors to determine if herding of flatfish was occurring (Politis and Miller 2017). The results of this study were not definitive, but indicated that herding was probably not a strong feature of the NMFS bottom trawl. This led to the consensus decision to use wing width instead of door width when calculating the area of a survey tow. Both decisions were applied to all three surveys. The wing width of the DFO survey generated a fair amount of discussion during the 2017 TRAC meeting. The final decision was to use the value of 12.5 m for wing width of the DFO survey based on the Clark (1993) report. The average biomass under these new conditions is approximately three times the average biomass computed from the 2014 Diagnostic Benchmark settings, but the average biomass trend is the same. The exploitation rate to apply to the average biomass to generate catch advice also generated a lot of discussion during the 2017 TRAC meeting. The TRAC external reviewers and science members recommended using a range of 2% - 6% for the exploitation rate based on historical performance of the approach. The broader TRAC considered the full range of exploitation rates from the 2014 Diagnostic and Empirical Benchmark, 2% to 16%, to still be informative.

Applying the wing spread and survey catchability decisions from last year's TRAC (Table 11) to the updated surveys results in an average biomass of 1,126 mt in 2018 (Table 12). An exploitation rate of 2% to 6% results in catch advice for 2019 of 23 to 68 mt. Historical exploitation rates for the quota and catch averaged 8% and 2%, respectively (Table 13). The 2019 catch advice for the full range of exploitation rates from the 2014 TRAC ranged from 23 mt to 180 mt (Table 14). Maintaining the current quota of 300 mt in 2019 has an associated exploitation rate of 27%.

The empirical approach as described above consists of point estimates for all parameters. There are a number of uncertain elements that can be incorporated in a Monte Carlo evaluation to examine the uncertainty in the catch advice. The surveys have coefficients of variation that are reported each year, the experiment that estimated the new survey catchability of 0.31 had an estimate of uncertainty reported, there may be untrawlable regions on Georges Bank where Yellowtail Flounder are not found (meaning the survey area is less than the nominal value used in the calculations), there may be some herding of Yellowtail Flounder, and the chainsweep may not be 100% efficient at capturing Yellowtail Flounder. Each of these uncertainties can be examined one at a time (Figure 19) and all of them together (Figure 20) for a given exploitation rate (6% was selected for these figures). Examining the factors one at a time shows the low uncertainty of survey area (uniform 0.95 – 1.00), tow area (uniform 1.0 – 1.2, 1.2 means 20% increase in tow area due to herding), and chainsweep efficiency (90%-100% catchability) relative to the higher uncertainty of the chain to rockhopper survey catchability estimate (lognormal with CV = 0.65), and the highest uncertainty associated with the survey catch per tow. Combining the results indicates that despite these uncertainties, there is a strong indication that catch advice should have decreased during this time period because there is little overlap between the distributions early in the time series and those late in the time series.

MANAGEMENT CONSIDERATIONS

During the 2014 Diagnostic Benchmark, considerations were provided as reasons to decrease or to maintain or increase the quota. The assessment findings this year support reasons to both decrease the quota and to maintain the quota for 2019. Last year's catch was 32% of the quota and the relative F continues to be low, which support maintaining the quota. All three of the surveys declined last year (two of the surveys to the lowest value in the time series, the other to the second lowest in its time series), recent recruitment continues to be below average, and fish condition (i.e., Fulton's K) continues to be low relative to the available time series, which support decreasing the quota.

During the 2016 TRAC meeting, a reviewer asked whether times series of recruits per spawning stock biomass had been examined using only data from the surveys. The request was premised on the concern that changes in recruits per spawning stock biomass could be masking important trends in recruitment. For example, if recruits per spawning stock biomass increased over time, it could result in recruitment staying relatively high while spawning stock biomass declined, which would be of biological concern because this pattern could not continue indefinitely. Alternatively, if recruits per spawning stock biomass declined at low spawning stock biomass, this could be an indication of depensation in the stock-recruitment relationship, which would be concerning for the ability of the stock to rebuild even under no fishing. For each of the three surveys, both age 1 and age 2 were used for recruitment and appropriately lagged relative to total biomass from that survey to create a proxy for the recruits per spawning stock biomass. Age 2 was examined because the age 1 survey values contained many zeros. The time series of recruits per survey biomass were variable without strong trend but have been low in recent years in all cases (Figure 21). There is an indication of depensation in recent years because the recent recruits per biomass are low relative to earlier recruits per biomass at similar biomasses (Figure 22). This could have strong implications for the (in)ability of the stock to rebuild even under no fishing.

LITERATURE CITED

Brooks, E.N., T.J. Miller, C.M. Legault, L. O'Brien, K.J Clark, S. Gavaris, and L. Van Eeckhaute. 2010. Determining Length-based Calibration Factors for Cod, Haddock, and Yellowtail Flounder. TRAC Ref. Doc. 2010/08.

Byrne, C.J., and J.R.S. Forrester. 1991. Relative Fishing Power of Two Types of Trawl Doors. NEFSC Stock Assessment Workshop (SAW 12). 8 p.

Clark, D.S. 1993. The influence of depth and bottom type on area swept by groundtrawl, and consequences for survey indices and population estimates. DFO Atlantic Fisheries Research Document 93/40. 15 p.

GARM (Groundfish Assessment Review Meeting). 2007. Report of the Groundfish Assessment Review Meeting (GARM) Part 1. Data Methods. R. O'Boyle [chair]. Available at http://www.nefsc.noaa.gov/nefsc/saw/.

Harden Jones, F.R., A.R. Margetts, M.G. Walker, and G.P. Arnold. 1977. The Efficiency of the Granton Otter Trawl Determined by Sector-scanning Sonar and Acoustic Transponding tags. Rapp. P-v. Reun. Cons. Explor. Mer 170:45−51.

Legault, C.M. and Q.M. McCurdy. 2017. Stock Assessment of Georges Bank Yellowtail Flounder for 2017. TRAC Ref. Doc. 2017/??. 59 p. (not yet available)

Legault C.M., M. Palmer, and S. Wigley. 2008. Uncertainty in Landings Allocation Algorithm at Stock Level is Insignificant. GARM III Biological Reference Points Meeting. WP 4.6.

Lux, F.E. 1969. Length-weight Relationships of Six New England Flatfishes. Trans. Am. Fish. Soc. 98(4): 617-621.

Miller, T.J., M. Martin, P. Politis, C.M. Legault, and J. Blaylock. 2017. Some statistical approaches to combine paired observations of chain sweep and rockhopper gear and catches from NEFSC and DFO trawl surveys in estimating Georges Bank yellowtail flounder biomass. TRAC Ref. Doc. 2017/??. 36 p. (not yet available)

O'Brien, L., and K. Clark. 2014. Proceedings of the Transboundary Resources Assessment Committee for Georges Bank Yellowtail Flounder Diagnostic and Empirical Approach Benchmark. TRAC Proc. Ser. 2014/01. 55 p.

Palmer, M. 2008. A Method to Apportion Landings with Unknown Area, Month and Unspecified Market Categories Among Landings with Similar Region and Fleet Characteristics. GARM III Biological Reference Points Meeting. WP 4.4. 9 p.

Palmer, M.C. 2017. Vessel Trip Reports Catch-area Reporting Errors: Potential Impacts on the Monitoring and Management of the Northeast United States Groundfish Resource. NFSC Ref. Doc. 17-02: 53p

Politis, P.J. and T.J. Miller. 2017. Bridle herding efficiency of a survey bottom trawl with different bridle configurations. TRAC Ref. Doc. 2017/??. 33 p. (not yet available)

Rago, P., W. Gabriel, and M. Lambert. 1994. Georges Bank Yellowtail Flounder. NEFSC Ref. Doc. 94-20.

Richardson, D., J. Hoey, J. Manderson, M. Martin, and C. Roebuck. 2017. Empirical estimates of maximum catchability and minimum biomass of Georges Bank yellowtail flounder on the NEFSC bottom trawl survey. TRAC Ref. Doc. 2017/??. 28 p. (not yet available)

Sameoto, J., B. Hubley, L. Van Eeckhaute, and A. Reeves. 2013. A Review of the Standarization of Effort for the Calculation of Discards of Atlantic Cod, Haddock and Yellowtail Flounder from the 2005 to 2011 Canadian Scallop Fishery on Georges Bank. TRAC. Ref. Doc. 2013/04. 22 p.

Sinclair, A.F. 2001. Natural mortality of cod (*Gadus morhua*) in the Southern Gulf of St Lawrence. ICES J. Mar. Sci. 58: 1-10.

Somerton, D.A., P.T. Munro, and K.L. Weinberg. 2007. Whole-gear Efficiency of a Benthic Survey Trawl for Flatfish. Fish. Bull. 105: 278-291.

Stone, H.H., and S. Gavaris. 2005. An Approach to Estimating the Size and Age Composition of Discarded Yellowtail Flounder from the Canadian Scallop Fishery on Georges Bank, 1973-2003. TRAC Ref. Doc. 2005/05. 10p.

Stone, H.H., S. Gavaris, C.M. Legault, J.D. Neilson, and S.X. Cadrin. 2004. Collapse and Recovery of the Yellowtail Flounder (*Limanda ferruginea*) Fishery on Georges Bank. J. Sea Res. 51: 261-270.

TMGC (Transboundary Management Guidance Committee). 2002. Development of a Sharing Allocation Proposal for Transboundary Resources of Cod, Haddock and Yellowtail Flounder on Georges Bank. DFO Fisheries Management Regional Report 2002/01. 59 p.

Van Eeckhaute, L., S. Gavaris, and H.H. Stone. 2005. Estimation of Cod, Haddock and Yellowtail Flounder Discards for the Canadian Georges Bank Scallop Fishery from 1960 to 2004. TRAC Ref. Doc. 2005/02. 18p.

Van Eeckhaute, L., Y. Wang, J. Sameoto, and A. Glass. 2011. Discards of Atlantic Cod, Haddock and Yellowtail Flounder from the 2010 Canadian Scallop Fishery on Georges Bank. TRAC Ref. Doc. 2011/05. 14p.

Wigley S.E., P. Hersey, and J.E. Palmer. 2007a. A Description of the Allocation Procedure Applied to the 1994 to Present Commercial Landings Data. GARM III Data Meeting. WP A.1.

Wigley S.E., P.J. Rago, K.A. Sosebee, and D.L. Palka. 2007b. The Analytic Component to the Standardized Bycatch Reporting Methodology Omnibus Amendment: Sampling Design, and Estimation of Precision and Accuracy (2nd Edition). NEFSC Ref. Doc. 07-09. 156 p.

TABLES

Table 1. Annual catch (mt) of Georges Bank Yellowtail Flounder.

Year	US Landings	US Discards	Canada Landings	Canada Discards	Other Landings	Total Catch	% discards
1935	300	100	0	0	0	400	25%
1936	300	100	0	0	0	400	25%
1937	300	100	0	0	0	400	25%
1938	300	100	0	0	0	400	25%
1939	375	125	0	0	0	500	25%
1940	600	200	0	0	0	800	25%
1941	900	300	0	0	0	1200	25%
1942	1575	525	0	0	0	2100	25%
1943	1275	425	0	0	0	1700	25%
1944	1725	575	0	0	0	2300	25%
1945	1425	475	0	0	0	1900	25%
1946	900	300	0	0	0	1200	25%
1947	2325	775	0	0	0	3100	25%
1948	5775	1925	0	0	0	7700	25%
1949	7350	2450	0	0	0	9800	25%
1950	3975	1325	0	0	0	5300	25%
1951	4350	1450	0	0	0	5800	25%
1952	3750	1250	0	0	0	5000	25%
1953	2925	975	0	0	0	3900	25%
1954	2925	975	0	0	0	3900	25%
1955	2925	975	0	0	0	3900	25%
1956	1650	550	0	0	0	2200	25%
1957	2325	775	0	0	0	3100	25%
1958	4575	1525	0	0	0	6100	25%
1959	4125	1375	0	0	0	5500	25%
1960	4425	1475	0	0	0	5900	25%
1961	4275	1425	0	0	0	5700	25%
1962	5775	1925	0	0	0	7700	25%
1963	10990	5600	0	0	100	16690	34%
1964	14914	4900	0	0	0	19814	25%
1965	14248	4400	0	0	800	19448	23%
1966	11341	2100	0	0	300	13741	15%
1967	8407	5500	0	0	1400	15307	36%
1968	12799	3600	122	0	1800	18321	20%
1969	15944	2600	327	0	2400	21271	12%
1970	15506	5533	71	0	300	21410	26%
1971	11878	3127	105	0	500	15610	20%
1972	14157	1159	8	515	2200	18039	9%
1973	15899	364	12	378	300	16953	4%
1974	14607	980	5	619	1000	17211	9%
1975	13205	2715	8	722	100	16750	21%
1976	11336	3021	12	619	0	14988	24%
1977	9444	567	44	584	0	10639	11%
1978	4519	1669	69	687	0	6944	34%

Table 1. Continued.

Year	US Landings	US Discards	Canada Landings	Canada Discards	Other Landings	Total Catch	% discards
1979	5475	720	19	722	0	6935	21%
1980	6481	382	92	584	0	7539	13%
1981	6182	95	15	687	0	6979	11%
1982	10621	1376	22	502	0	12520	15%
1983	11350	72	106	460	0	11989	4%
1984	5763	28	8	481	0	6280	8%
1985	2477	43	25	722	0	3267	23%
1986	3041	19	57	357	0	3474	11%
1987	2742	233	69	536	0	3580	21%
1988	1866	252	56	584	0	2759	30%
1989	1134	73	40	536	0	1783	34%
1990	2751	818	25	495	0	4089	32%
1991	1784	246	81	454	0	2564	27%
1992	2859	1873	65	502	0	5299	45%
1993	2089	1089	682	440	0	4300	36%
1994	1431	148	2139	440	0	4158	14%
1995	360	43	464	268	0	1135	27%
1996	743	96	472	388	0	1700	28%
1997	888	327	810	438	0	2464	31%
1998	1619	482	1175	708	0	3985	30%
1999	1818	577	1971	597	0	4963	24%
2000	3373	694	2859	415	0	7341	15%
2001	3613	78	2913	815	0	7419	12%
2002	2476	53	2642	493	0	5663	10%
2003	3236	410	2107	809	0	6562	19%
2004	5837	460	96	422	0	6815	13%
2005	3161	414	30	247	0	3852	17%
2006	1196	384	25	452	0	2057	41%
2007	1058	493	17	97	0	1664	35%
2008	937	409	41	112	0	1499	35%
2009	959	759	5	84	0	1806	47%
2010	654	289	17	210	0	1170	43%
2011	904	192	22	53	0	1171	21%
2012	443	188	46	48	0	725	33%
2013	130	49	1	39	0	218	40%
2014	70	74	1	14	0	159	56%
2015	63	41	3	11	0	118	44%
2016	26	7	1	10	0	44	39%
2017	35	57	<1	2	0	95	63%

Table 2. Derivation of Georges Bank Yellowtail Flounder US discards (D mt) for 2017 calculated as the product of the ratio estimator (d:k – discard to kept all species on observed trips in a stratum) and total kept (K_all) in each stratum. Coefficient of variation (CV) provided by gear. A dash (-) indicates the value is not reported at that level of half year.

	Small Mesh Trawl				
Half	ntrips	d:k	K_all (mt)	D (mt)	CV
1	14	0.00011	1213	0	-
2	20	0.00027	1364	0	-
Total	34	-	-	1	52%

	Large Mesh Trawl				
Half	ntrips	d:k	K_all (mt)	D (mt)	CV
1	56	0.00002	3604	0	-
2	52	0.00001	2666	0	-
Total	108	-	-	0	39%

	Scallop Dredge				
Half	ntrips	d:k	K_all (mt)	D (mt)	CV
1	28	0.00260	10236	27	-
2	34	0.00178	16783	30	-
Total	62	-	-	56	20%

Table 3. Three month moving-average (ma) discard rate (kg/hm), standardized fishing effort (hm), and discards (mt) of Georges Bank Yellowtail Flounder from the Canadian scallop fishery in 2017 based on n number of observed trips. Note April observed discards and effort were assumed equal to March discards and effort.

Month	n	Monthly Prorated Discards (kg)	Monthly Effort (hm)	3-month ma Discard Rate (kg/hm)	3-month ma Effort (hm)	ma Discards (mt)	Cum. Annual Discards (mt)
Jan	2	48	4134	0.012	14254	0	0
Feb	2	45	2367	0.013	14947	0	0
Mar	2	32	3191	0.012	13067	0	1
Apr	0	32	3191	0.015	2584	0	1
May	2	47	1214	0.022	17373	0	1
Jun	1	64	2110	0.030	23540	1	2
Jul	3	110	4115	0.019	19843	0	2
Aug	1	14	3685	0.015	14126	0	2
Sep	1	2	723	0.003	9275	0	2
Oct	2	1	1837	0.002	7222	0	2
Nov	1	2	538	0.001	3315	0	2
Dec	1	6	4494	0.001	2387	0	2

Table 4. Port samples used in the estimation of US landings at age for Georges Bank Yellowtail Flounder in 2017.

	Landings (metric tons)			Number of Lengths			Number	Lengths /
Half	large	small	Total	large	small	Total	of Ages	100 mt
1	17	3	20	402	245	647	199	3214
2	12	2	15	299	100	399	30	2708
Total	29	5	35	701	345	1046	229	3000

Table 5. Coefficient of variation for US landings at age of Georges Bank Yellowtail Flounder by year. A dash (-) indicates fish of that age were not caught in that year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
1994	-	57%	6%	14%	27%	41%
1995	-	27%	11%	13%	22%	40%
1996	-	23%	7%	15%	26%	60%
1997	-	17%	11%	8%	30%	35%
1998	-	64%	31%	16%	36%	30%
1999	97%	21%	9%	25%	33%	34%
2000	-	11%	9%	11%	20%	32%
2001	-	17%	11%	10%	22%	48%
2002	76%	15%	11%	11%	15%	22%
2003	-	16%	8%	9%	11%	16%
2004	-	53%	8%	6%	9%	11%
2005	-	11%	4%	6%	12%	16%
2006	-	10%	5%	6%	6%	13%
2007	103%	10%	5%	6%	14%	19%
2008	-	17%	4%	6%	17%	33%
2009	-	14%	4%	4%	6%	23%
2010	-	20%	5%	4%	6%	14%
2011	98%	19%	6%	4%	7%	15%
2012	-	23%	10%	6%	12%	45%
2013	167%	24%	10%	9%	9%	27%
2014	-	39%	12%	10%	12%	22%
2015	-	24%	18%	13%	12%	13%
2016	-	-	23%	28%	28%	38%
2017	-	124%	19%	20%	13%	8%

Table 6. Total catch at age including discards (number in 000s of fish) for Georges Bank Yellowtail Flounder.

	Age												
Year	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
1973	359	5175	13565	9473	3815	1285	283	55	23	4	0	0	34037
1974	2368	9500	8294	7658	3643	878	464	106	71	0	0	0	32982
1975	4636	26394	7375	3540	2175	708	327	132	26	14	0	0	45328
1976	635	31938	5502	1426	574	453	304	95	54	11	2	0	40993
1977	378	9094	10567	1846	419	231	134	82	37	10	0	0	22799
1978	9962	3542	4580	1914	540	120	45	16	17	7	6	0	20748
1979	321	10517	3789	1432	623	167	95	31	27	1	3	0	17006
1980	318	3994	9685	1538	352	96	5	11	1	0	0	0	16000
1981	107	1097	5963	4920	854	135	5	2	3	0	0	0	13088
1982	2164	18091	7480	3401	1095	68	20	7	0	0	0	0	32327
1983	703	7998	16661	2476	680	122	13	16	4	0	0	0	28672
1984	514	2018	4535	5043	1796	294	47	39	0	0	0	0	14285
1985	970	4374	1058	818	517	73	8	0	0	0	0	0	7817
1986	179	6402	1127	389	204	80	17	15	0	1	0	0	8414
1987	156	3284	3137	983	192	48	38	26	25	0	0	0	7890
1988	499	3003	1544	846	227	24	26	3	0	0	0	0	6172
1989	190	2175	1121	428	110	18	12	0	0	0	0	0	4054
1990	231	2114	6996	978	140	21	6	0	0	0	0	0	10485
1991	663	147	1491	3011	383	67	4	0	0	0	0	0	5767
1992	2414	9167	2971	1473	603	33	7	1	1	0	0	0	16671
1993	5233	1386	3327	2326	411	84	5	1	0	0	0	0	12773
1994	71	1336	6302	1819	477	120	20	3	0	0	0	0	10150
1995	47	313	1435	879	170	25	10	1	0	0	0	0	2880
1996	101	681	2064	885	201	13	10	5	0	0	0	0	3960
1997	82	1132	1832	1857	378	39	43	7	1	0	0	0	5371
1998	169	1991	3388	1885	1121	122	18	3	0	3	0	0	8700
1999	60	2753	4195	1548	794	264	32	4	1	0	0	0	9651
2000	132	3864	5714	3173	826	420	66	38	4	0	0	0	14237
2001	176	2884	6956	2893	1004	291	216	13	4	0	0	0	14438
2002	212	4169	3446	1916	683	269	144	57	10	6	0	0	10911
2003	160	3919	4710	2320	782	282	243	96	47	23	2	0	12585
2004	61	1152	3184	3824	1970	889	409	78	74	18	2	0	11661
2005	60	1580	4032	1707	392	132	37	16	0	0	0	0	7956
2006	150	1251	1577	923	358	123	65	14	7	3	0	0	4470
2007	51	1493	1708	664	137	44	9	2	0	0	0	0	4108
2008	28	490	1897	853	125	17	8	0	0	0	0	0	3417
2009	17	283	1266	1360	516	59	10	4	0	0	0	0	3516
2010	2	141	651	899	449	88	10	2	0	0	0	0	2241
2011	11	166	775	904	310	67	8	1	0	0	0	0	2242
2012	12	108	370	579	240	38	4	4	0	0	0	0	1355
2013	15	61	99	148	91	19	2	0	0	0	0	0	435
2014	6	43	90	98	50	19	3	0	0	0	0	0	311
2015	1	30	61	58	51	21	6	2	0	0	0	0	230
2016	1	14	19	27	17	8	4	1	0	0	0	0	91
2017	6	7	19	34	48	28	20	8	2	0	0	0	172

Table 7. Mean weight at age (kg) for the total catch of US and Canadian landings and discards, for Georges Bank Yellowtail Flounder. A dash (-) indicates no data available.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1973	0.101	0.348	0.462	0.527	0.603	0.690	1.063	1.131	1.275	1.389	1.170	-
1974	0.115	0.344	0.496	0.607	0.678	0.723	0.904	1.245	1.090	-	1.496	1.496
1975	0.113	0.316	0.489	0.554	0.619	0.690	0.691	0.654	1.052	0.812	-	-
1976	0.108	0.312	0.544	0.635	0.744	0.813	0.854	0.881	1.132	1.363	1.923	-
1977	0.116	0.342	0.524	0.633	0.780	0.860	1.026	1.008	0.866	0.913	-	-
1978	0.102	0.314	0.510	0.690	0.803	0.903	0.947	1.008	1.227	1.581	0.916	-
1979	0.114	0.329	0.462	0.656	0.736	0.844	0.995	0.906	1.357	1.734	1.911	-
1980	0.101	0.322	0.493	0.656	0.816	1.048	1.208	1.206	1.239	-	-	-
1981	0.122	0.335	0.489	0.604	0.707	0.821	0.844	1.599	1.104	-	-	-
1982	0.115	0.301	0.485	0.650	0.754	1.065	1.037	1.361	-	-	-	-
1983	0.140	0.296	0.441	0.607	0.740	0.964	1.005	1.304	1.239	-	-	-
1984	0.162	0.239	0.379	0.500	0.647	0.743	0.944	1.032	-	-	-	-
1985	0.181	0.361	0.505	0.642	0.729	0.808	0.728	-	-		-	-
1986	0.181	0.341	0.540	0.674	0.854	0.976	0.950	1.250	-	1.686	-	-
1987	0.121	0.324	0.524	0.680	0.784	0.993	0.838	0.771	0.809	-	-	-
1988	0.103	0.328	0.557	0.696	0.844	1.042	0.865	1.385	-	-	-	-
1989	0.100	0.327	0.520	0.720	0.866	0.970	1.172	1.128	-	-	-	-
1990	0.105	0.290	0.395	0.585	0.693	0.787	1.057	-	-	-	-	-
1991	0.121	0.237	0.369	0.486	0.723	0.850	1.306	-	-	-	-	-
1992	0.101	0.293	0.365	0.526	0.651	1.098	1.125	1.303	1.303	-	-	-
1993	0.100	0.285	0.379	0.501	0.564	0.843	1.130	1.044	-	-	-	-
1994	0.193	0.260	0.353	0.472	0.621	0.780	0.678	1.148	-	-	-	-
1995	0.174	0.275	0.347	0.465	0.607	0.720	0.916	0.532	-	-	-	-
1996	0.119	0.276	0.407	0.552	0.707	0.918	1.031	1.216	-	-	-	-
1997	0.214	0.302	0.408	0.538	0.718	1.039	0.827	1.136	1.113		-	-
1998	0.178	0.305	0.428	0.546	0.649	0.936	1.063	1.195	-	1.442	-	-
1999	0.202	0.368	0.495	0.640	0.755	0.870	1.078	1.292	1.822	-	-	-
2000	0.229	0.383	0.480	0.615	0.766	0.934	1.023	1.023	1.296	-	-	-
2001	0.251	0.362	0.460	0.612	0.812	1.011	1.024	1.278	1.552	-	-	-
2002	0.282	0.381	0.480	0.665	0.833	0.985	1.100	1.286	1.389	1.483	-	-
2003	0.228	0.359	0.474	0.653	0.824	0.957	1.033	1.144	1.267	1.418	1.505	-
2004	0.211	0.292	0.438	0.585	0.726	0.883	1.002	1.192	1.222	1.305	1.421	-
2005	0.119	0.341	0.447	0.597	0.763	0.965	0.993	1.198	1.578	1.578	-	-
2006	0.100	0.311	0.415	0.557	0.761	0.917	1.066	1.186	1.263	1.225	1.599	-
2007	0.154	0.290	0.409	0.541	0.784	0.968	1.108	1.766	-	-	-	-
2008	0.047	0.302	0.415	0.533	0.675	0.882	1.130	-	-	-	-	-
2009	0.155	0.328	0.434	0.538	0.699	0.879	1.050	1.328	-	-	-	-
2010	0.175	0.323	0.432	0.519	0.661	0.777	0.997	1.176	-	-	-	-
2011	0.128	0.337	0.461	0.553	0.646	0.739	0.811	0.851	-	-	-	-
2012	0.185	0.338	0.452	0.555	0.671	0.792	0.935	0.798	-	-	-	-
2013	0.193	0.263	0.393	0.533	0.689	0.825	1.002	1.183	-	-	-	-
2014	0.171	0.292	0.417	0.541	0.679	0.799	0.883	0.814	0.864	-	-	-
2015	0.091	0.233	0.408	0.496	0.656	0.800	0.890	0.893	-	-	-	-
2016	0.025	0.186	0.418	0.507	0.611	0.650	0.862	0.952	-	-	-	-
2017	0.094	0.306	0.395	0.490	0.564	0.644	0.732	0.778	0.799	0.830	-	-

Table 8. Number of valid survey tows in the Georges Bank Yellowtail Flounder strata (5Z1-5Z4 for DFO, 13-21 for the NMFS spring and fall surveys) in recent years. A dash (-) indicates data are not available.

Year	DFO	NMFS Spring	NMFS Fall
2009	50	48	49
2010	57	53	53
2011	74	53	49
2012	75	54	54
2013	63	60	56
2014	52	47	57
2015	47	56	58
2016	61	56	58
2017	50	57	47
2018	58	39	-

Table 9a. DFO survey indices of abundance for Georges Bank Yellowtail Flounder in both numbers and kg per tow, along with the coefficient of variation (CV) for the biomass estimates.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	B(kg/tow)	CV(B)
1987	0.120	1.194	1.970	0.492	0.087	0.049	1.987	0.274
1988	0.000	1.776	1.275	0.610	0.278	0.024	1.964	0.217
1989	0.114	1.027	0.609	0.294	0.066	0.022	0.748	0.257
1990	0.000	2.387	3.628	0.914	0.209	0.014	2.405	0.222
1991	0.024	0.858	1.186	3.759	0.525	0.014	2.796	0.330
1992	0.055	11.039	3.677	0.990	0.350	0.030	3.937	0.163
1993	0.079	2.431	4.085	4.076	0.887	0.130	4.201	0.151
1994	0.000	6.056	3.464	3.006	0.781	0.207	4.378	0.228
1995	0.210	1.251	4.353	2.546	0.647	0.101	3.223	0.201
1996	0.446	7.142	9.174	5.406	1.155	0.123	8.433	0.223
1997	0.022	12.482	13.902	16.369	4.044	0.670	21.138	0.233
1998	0.893	3.330	4.907	4.334	1.988	0.558	6.826	0.244
1999	0.159	20.861	20.834	7.669	5.350	2.200	28.093	0.325
2000	0.011	13.765	27.442	19.243	5.069	3.689	31.723	0.253
2001	0.291	19.896	42.124	13.307	4.581	2.397	35.236	0.416
2002	0.088	11.962	31.015	12.234	5.553	2.833	32.916	0.305
2003	0.089	11.889	24.618	11.086	3.421	1.988	25.839	0.317
2004	0.033	3.599	16.260	9.205	2.273	1.416	14.397	0.313
2005	0.600	1.602	27.959	20.564	5.696	1.565	21.240	0.530
2006	0.623	4.893	18.600	6.572	0.820	0.238	10.462	0.444
2007	0.173	12.159	27.708	12.799	2.288	0.248	21.219	0.435
2008	0.000	48.315	170.363	57.119	8.059	0.055	107.052	0.939
2009	0.021	8.540	137.957	116.966	19.900	4.764	114.566	0.791
2010	0.000	0.489	9.392	20.943	3.533	1.279	14.532	0.294
2011	0.022	0.651	6.093	8.205	1.701	0.327	6.091	0.294
2012	0.044	0.644	8.243	11.423	3.096	0.453	8.937	0.356
2013	0.081	0.129	0.831	1.254	0.604	0.140	1.109	0.328
2014	0.030	0.395	0.741	0.960	0.471	0.018	0.816	0.337
2015	0.000	0.467	1.112	1.659	0.747	0.093	1.308	0.367
2016	0.000	0.218	3.151	2.104	1.257	0.657	2.748	0.608
2017	0.000	0.014	0.185	0.435	0.437	0.388	0.545	0.469
2018	0.000	0.006	0.263	0.194	0.315	0.223	0.401	0.378

Table 9b. NMFS spring survey indices of abundance for Georges Bank Yellowtail Flounder in both numbers and kg per tow in Albatross units, along with the CV for the biomass estimates.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	B(kg/tow)	CV(B)
1968	0.335	3.176	3.580	0.304	0.073	0.310	2.791	0.214
1969	1.108	9.313	11.121	3.175	1.345	0.699	11.170	0.291
1970	0.093	4.485	6.030	2.422	0.570	0.311	5.146	0.146
1971	0.835	3.516	4.813	3.300	0.780	0.320	4.619	0.198
1972	0.141	6.923	7.050	3.705	1.127	0.239	6.455	0.214
1973	1.940	3.281	2.379	1.068	0.412	0.217	2.939	0.174
1974	0.317	2.234	1.850	1.262	0.347	0.282	2.720	0.186
1975	0.422	3.006	0.834	0.271	0.208	0.089	1.676	0.224
1976	1.112	4.315	1.253	0.312	0.197	0.112	2.273	0.162
1977	0.000	0.674	1.131	0.396	0.063	0.013	0.999	0.312
1978	0.940	0.802	0.510	0.220	0.027	0.008	0.742	0.197
1979	0.406	2.016	0.407	0.338	0.061	0.092	1.271	0.209
1980	0.057	4.666	5.787	0.475	0.057	0.036	4.456	0.350
1981	0.017	1.020	1.777	0.720	0.213	0.059	1.960	0.322
1982	0.045	3.767	1.130	1.022	0.458	0.091	2.500	0.190
1983	0.000	1.865	2.728	0.530	0.123	0.245	2.642	0.294
1984	0.000	0.093	0.831	0.863	0.896	0.183	1.646	0.428
1985	0.110	2.199	0.262	0.282	0.148	0.000	0.988	0.501
1986	0.027	1.806	0.291	0.056	0.137	0.055	0.847	0.298
1987	0.027	0.076	0.137	0.133	0.053	0.055	0.329	0.365
1988	0.078	0.275	0.366	0.242	0.199	0.027	0.566	0.257
1989	0.047	0.424	0.739	0.290	0.061	0.045	0.729	0.270
1990	0.000	0.110	1.063	0.369	0.163	0.057	0.699	0.312
1991	0.435	0.000	0.254	0.685	0.263	0.021	0.631	0.247
1992	0.000	2.048	1.897	0.641	0.165	0.017	1.566	0.470
1993	0.046	0.290	0.501	0.317	0.027	0.000	0.482	0.263
1994	0.000	0.621	0.633	0.354	0.145	0.040	0.660	0.223
1995	0.040	1.179	4.812	1.485	0.640	0.010	2.579	0.631
1996	0.025	0.987	2.626	2.701	0.610	0.058	2.853	0.320
1997	0.019	1.169	3.733	4.080	0.703	0.134	4.359	0.257
1998	0.000	2.081	1.053	1.157	0.760	0.350	2.324	0.234
1999	0.050	4.746	10.819	2.721	1.623	0.779	9.307	0.433

Table 9b. Continued.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	B(kg/tow)	CV(B)
2000	0.183	4.819	7.666	2.914	0.813	0.524	6.696	0.221
2001	0.000	2.315	6.563	2.411	0.484	0.453	5.006	0.329
2002	0.188	2.412	12.334	4.078	1.741	0.871	9.563	0.250
2003	0.202	4.370	6.764	2.876	0.442	0.862	6.722	0.405
2004	0.049	0.986	2.179	0.735	0.255	0.217	1.891	0.261
2005	0.000	2.013	5.080	2.404	0.270	0.115	3.407	0.325
2006	0.509	0.935	3.523	2.177	0.317	0.082	2.420	0.182
2007	0.090	5.048	6.263	2.846	0.556	0.129	4.701	0.217
2008	0.000	2.274	5.071	1.732	0.310	0.027	3.247	0.218
2009	0.211	0.600	7.446	4.653	1.002	0.191	4.856	0.223
2010	0.017	0.694	5.412	8.451	2.721	0.654	5.944	0.267
2011	0.031	0.243	3.331	3.735	0.964	0.108	2.561	0.226
2012	0.095	0.718	4.178	5.745	1.411	0.200	3.995	0.455
2013	0.048	0.376	1.006	1.401	0.657	0.124	1.104	0.218
2014	0.027	0.234	0.679	0.682	0.367	0.196	0.740	0.175
2015	0.000	0.183	0.513	0.420	0.368	0.049	0.507	0.189
2016	0.006	0.022	0.233	0.283	0.072	0.133	0.312	0.252
2017	0.012	0.095	0.070	0.109	0.180	0.177	0.244	0.212
2018	0.000	0.022	0.000	0.000	0.000	0.013	0.012	0.632

Table 9c. NMFS fall survey indices of abundance for Georges Bank Yellowtail Flounder in both numbers and kg per tow in Albatross units, along with the CV for the biomass estimates.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	B(kg/tow)	CV(B)
1963	14.722	7.896	11.227	1.859	0.495	0.549	12.788	0.187
1964	1.722	9.806	7.312	5.967	2.714	0.488	13.567	0.378
1965	1.197	5.705	5.988	3.532	1.573	0.334	9.120	0.326
1966	11.663	2.251	1.685	0.898	0.101	0.000	3.928	0.335
1967	8.985	9.407	2.727	1.037	0.342	0.103	7.670	0.270
1968	11.671	12.057	5.758	0.745	0.965	0.058	10.536	0.229
1969	9.949	10.923	5.217	1.811	0.337	0.461	9.807	0.250
1970	4.610	5.132	3.144	1.952	0.452	0.080	4.979	0.287
1971	3.627	6.976	4.914	2.250	0.498	0.298	6.365	0.209
1972	2.462	6.525	4.824	2.094	0.610	0.342	6.328	0.273
1973	2.494	5.498	5.104	2.944	1.217	0.618	6.490	0.311
1974	4.623	2.864	1.516	1.060	0.458	0.379	3.669	0.179
1975	4.625	2.511	0.877	0.572	0.334	0.063	2.326	0.164
1976	0.344	1.920	0.474	0.117	0.122	0.100	1.508	0.233
1977	0.934	2.212	1.621	0.617	0.105	0.126	2.781	0.192
1978	4.760	1.281	0.780	0.411	0.136	0.036	2.343	0.204
1979	1.321	2.069	0.261	0.120	0.138	0.112	1.494	0.294
1980	0.766	5.120	6.091	0.682	0.219	0.258	6.607	0.210
1981	1.595	2.349	1.641	0.588	0.079	0.054	2.576	0.322
1982	2.425	2.184	1.590	0.423	0.089	0.000	2.270	0.290
1983	0.109	2.284	1.915	0.511	0.031	0.049	2.131	0.222
1984	0.661	0.400	0.306	0.243	0.075	0.063	0.593	0.305
1985	1.377	0.516	0.171	0.051	0.081	0.000	0.709	0.266
1986	0.282	1.108	0.349	0.074	0.000	0.000	0.820	0.371
1987	0.129	0.373	0.396	0.053	0.080	0.000	0.509	0.280
1988	0.019	0.213	0.107	0.027	0.000	0.000	0.171	0.325
1989	0.248	1.993	0.773	0.079	0.056	0.000	0.977	0.582
1990	0.000	0.370	1.473	0.294	0.000	0.000	0.725	0.323
1991	2.101	0.275	0.439	0.358	0.000	0.000	0.730	0.293
1992	0.151	0.396	0.712	0.162	0.144	0.027	0.576	0.287
1993	0.839	0.139	0.586	0.536	0.000	0.022	0.546	0.426
1994	1.195	0.221	0.983	0.713	0.263	0.057	0.897	0.311
1995	0.276	0.119	0.346	0.275	0.046	0.013	0.354	0.359
1996	0.149	0.352	1.869	0.447	0.075	0.000	1.303	0.570
1997	1.393	0.533	3.442	2.090	1.071	0.082	3.781	0.344
1998	1.900	4.817	4.202	1.190	0.298	0.074	4.347	0.347
1999	3.090	8.423	5.727	1.433	1.437	0.261	7.973	0.215

Table 9c. Continued.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	B(kg/tow)	CV(B)
2000	0.629	1.697	4.814	2.421	0.948	0.827	5.838	0.482
2001	3.518	6.268	8.092	2.601	1.718	2.048	11.553	0.381
2002	2.093	5.751	2.127	0.594	0.277	0.055	3.754	0.517
2003	1.077	5.031	2.809	0.565	0.100	0.191	4.038	0.316
2004	0.876	5.508	5.010	2.107	0.924	0.176	5.117	0.436
2005	0.313	2.095	3.763	0.614	0.185	0.000	2.463	0.492
2006	6.194	6.251	3.664	1.167	0.255	0.046	4.521	0.247
2007	1.058	11.447	7.866	1.998	0.383	0.094	8.151	0.309
2008	0.168	7.174	9.883	1.033	0.000	0.000	7.109	0.291
2009	0.477	4.382	12.202	2.219	0.631	0.064	6.744	0.269
2010	0.125	2.811	4.507	0.781	0.298	0.000	2.247	0.283
2011	0.237	2.865	3.897	1.106	0.145	0.010	2.452	0.264
2012	0.195	1.475	3.658	1.586	0.441	0.014	2.520	0.459
2013	0.332	1.028	0.940	0.537	0.116	0.044	0.875	0.369
2014	0.163	1.177	1.123	0.647	0.146	0.084	1.024	0.334
2015	0.031	0.394	0.589	0.303	0.069	0.020	0.469	0.619
2016	0.077	0.460	0.553	0.258	0.085	0.044	0.439	0.361
2017	0.047	0.105	0.142	0.172	0.042	0.097	0.196	0.355

Table 10. Survey indices of abundance (kg/tow) used in the Empirical Approach. The NMFS spring and fall survey values are in Henry B. Bigelow units.

Year	DFO	Spring	Fall (year-1)
2010	14.532	13.339	16.198
2011	6.091	5.747	5.398
2012	8.937	8.965	5.889
2013	1.109	2.477	6.053
2014	0.816	1.662	2.101
2015	1.308	1.137	2.460
2016	2.748	0.700	1.127
2017	0.545	0.547	1.054
2018	0.401	0.028	0.470

Table 11. Derivation of conversion factors relating catch per tow in kg to minimum swept area biomass in metric tons. See text for details.

	DFO	Spring	Fall	Units
Total Area in Survey =	25453	37286	37286	square kilometers
Wing Width =	12.5	12.6	12.6	Meters
Length of Tow =	3.241	1.852	1.852	Kilometers
Area Swept by Tow (Wing) =	0.0405	0.0233	0.0233	square kilometers
Expansion Factor to Min Swept Area Biomass in mt (Wing) =	628.275	1597.844	1597.844	None

Table 12. Empirical approach used to derive catch advice based on 2017 TRAC intersessional consensus formulation (wing width with survey catchability = 0.31). The mean of the three bottom trawl survey population biomass values is denoted Avg. The catch advice is computed as the exploitation rate multiplied by Avg. The catch advice year is applied in the year following (e.g., the 2018 row of catch advice will be applied in 2019).

								Exploitation rate	
		Biomass (mt) Wings						0.02	0.06
Year		DFO	Spring	Fall (year-1)		Average		Catch Advice (mt)	
2010		29452	68752	83490		60565		1211	3634
2011		12344	29621	27821		23262		465	1396
2012		18113	46209	30354		31559		631	1894
2013		2249	12766	31199		15404		308	924
2014		1654	8564	10828		7015		140	421
2015		2650	5861	12682		7064		141	424
2016		5569	3610	5811		4997		100	300
2017		1104	2819	5432		3118		62	187
2018		812	143	2424		1126		23	68

Table 13. Recent quotas and catches by year and corresponding exploitation rates (computed by dividing annual quota or catch by the average survey biomass in Table 13) based on 2017 TRAC intersessional consensus formulation (wing width with survey catchability = 0.31). Model type refers to the approach used to set the quota for that year.

Assmt Year	Quota Year	Quota (mt)	Catch (mt)	Quota/Avg	Catch/Avg	Model Type
2009	2010	1956	1170	3%	2%	VPA
2010	2011	2650	1171	11%	5%	VPA
2011	2012	1150	725	4%	2%	VPA
2012	2013	500	218	3%	1%	VPA
2013	2014	400	159	6%	2%	VPA
2014	2015	354	118	5%	2%	Empirical
2015	2016	354	44	7%	1%	Empirical
2016	2017	300	95	10%	3%	Empirical
2017	2018	300		27%		Empirical
	mean	885	462	8%	2%	

Table 14. Catch advice for 2019 associated with the full range of exploitation rates from the 2014 benchmark.

Exploitation Rate	Catch Advice (mt)
2%	23
4%	45
6%	68
8%	90
10%	113
12%	135
14%	158
16%	180

FIGURES

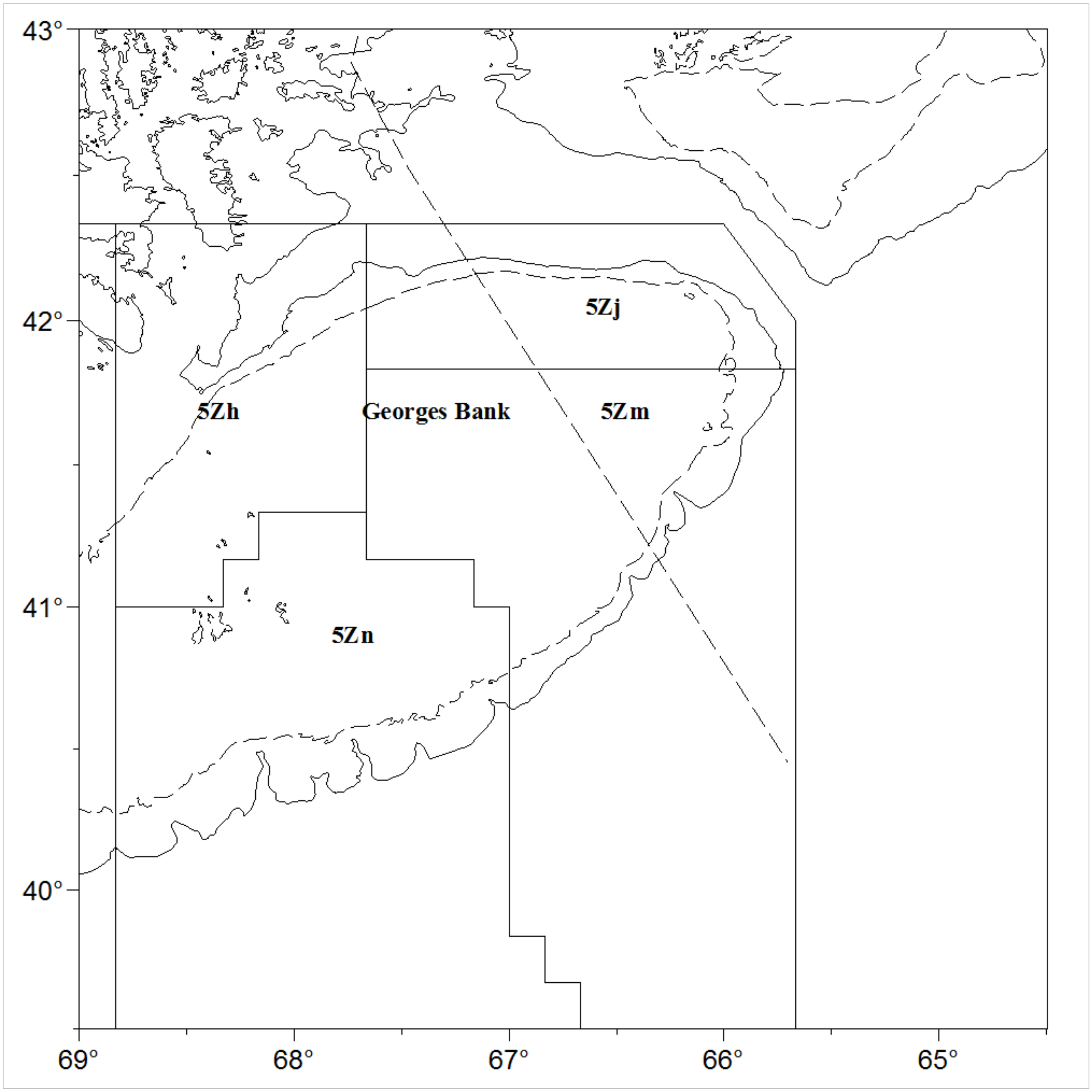


Figure 1a. Location of statistical unit areas for Canadian fisheries in NAFO Subdivision 5Ze.Catches of Yellowtail Flounder in areas 5Zhjmn are used in this assessment.

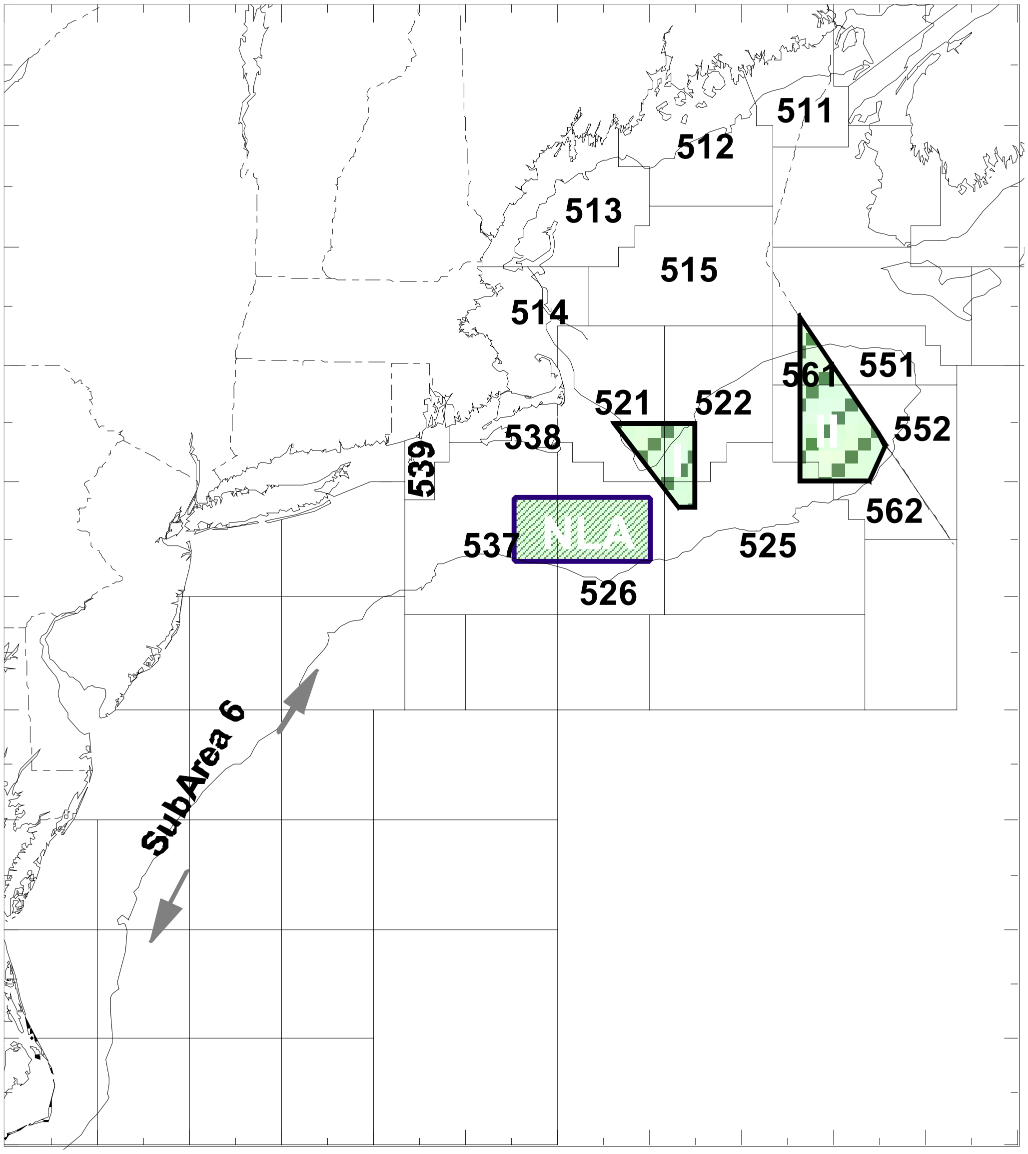


Figure 1b. Statistical areas used for monitoring northeast US fisheries. Catches from areas 522, 525, 551, 552, 561 and 562 are included in the Georges Bank Yellowtail Flounder assessment. Shaded areas have been closed to fishing year-round since 1994, with exceptions.

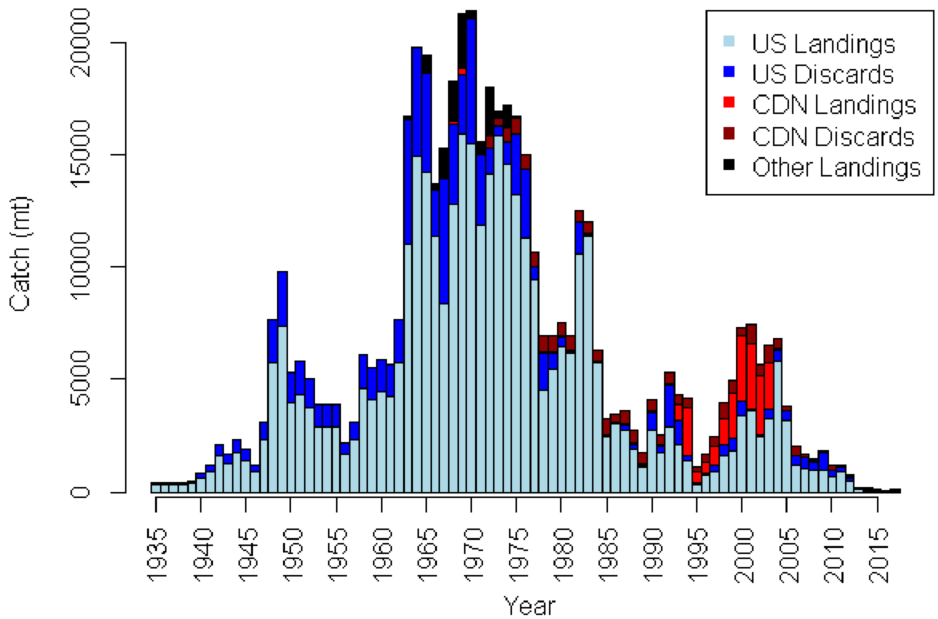


Figure 2a. Catch (landings plus discards) of Georges Bank Yellowtail Flounder by nation and year.

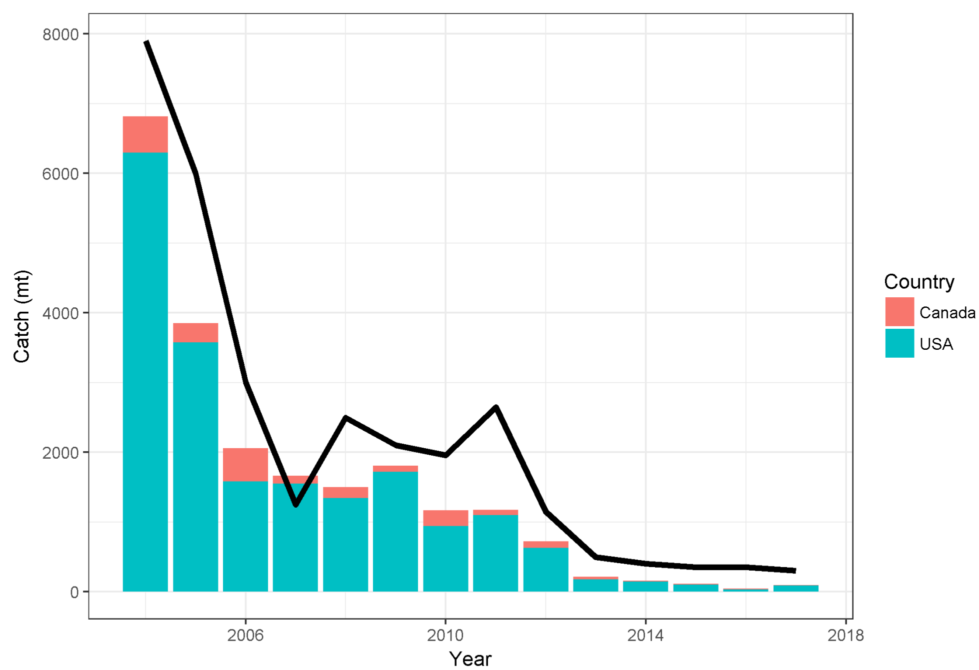


Figure 2b. Recent catches by country (bars) and quotas (solid line). Note the US quota is not applied for the calendar year and that in 2010 the TMGC could not agree on a quota, so the 2010 value is the sum of the implemented quotas by each country.

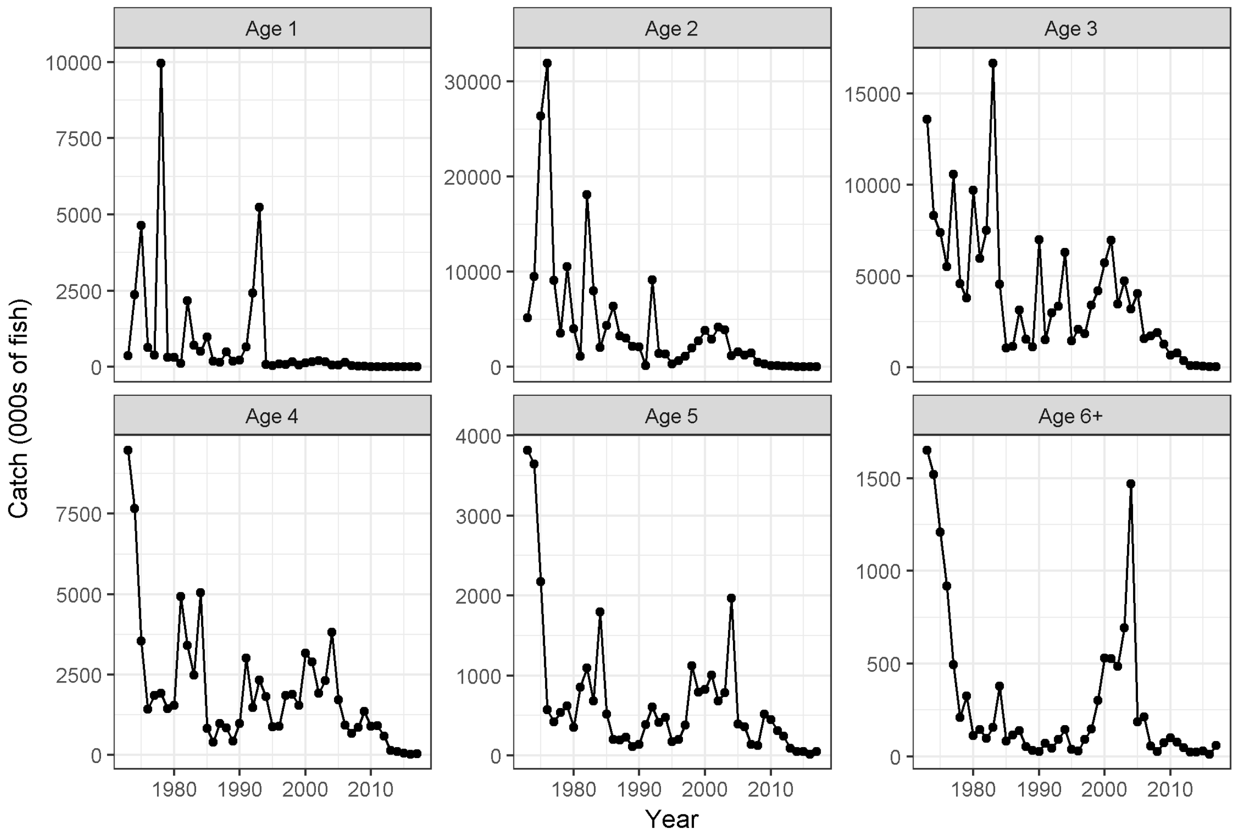


Figure 3. Catch at age (thousands of fish) over time for Georges Bank Yellowtail Flounder (Canadian and US fisheries combined). Note the y-axes vary by age.

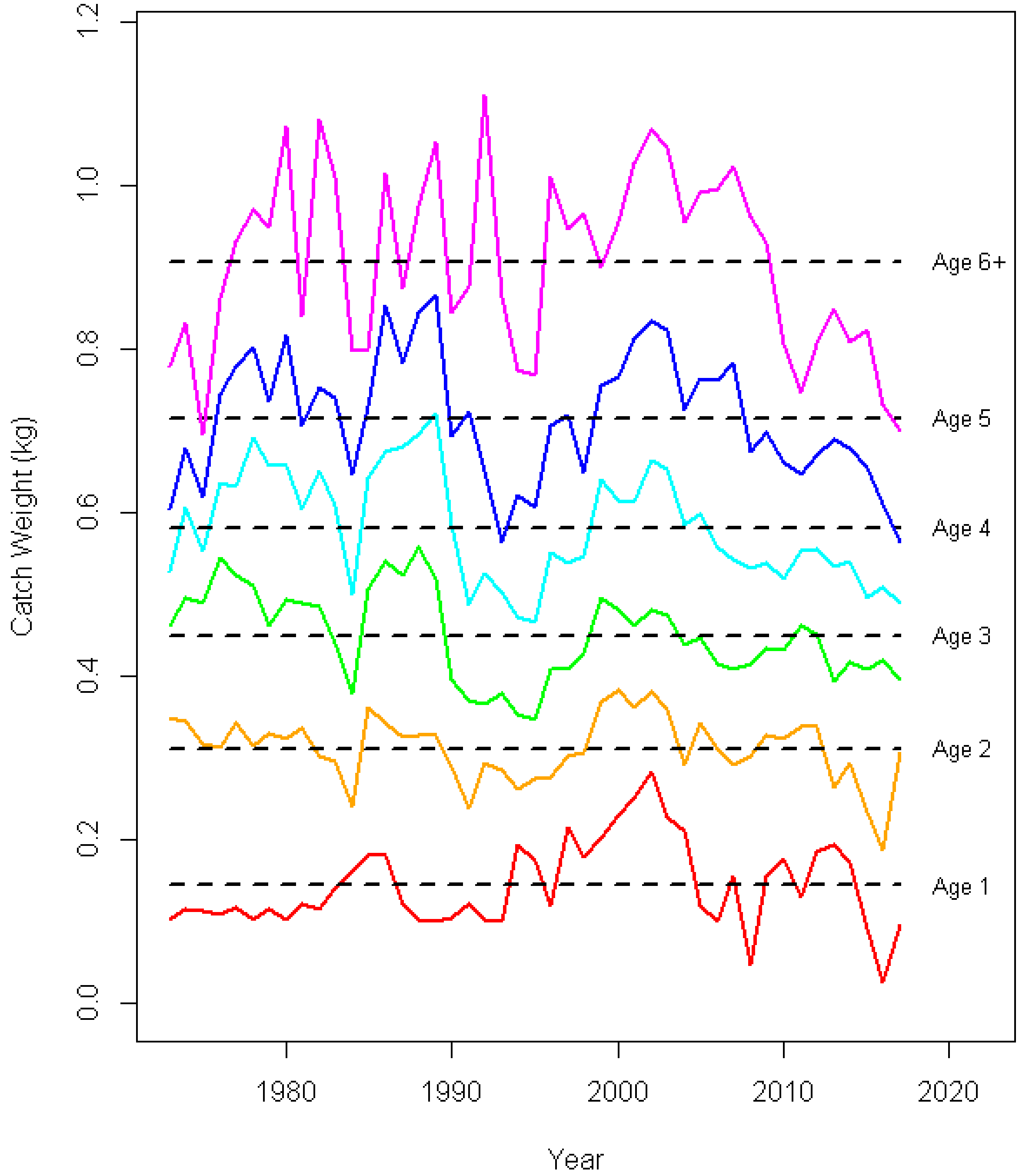


Figure 4. Trends in mean weight at age from the Georges Bank Yellowtail Flounder fishery (Canada and US combined, including discards). Dashed lines denote average of time series.

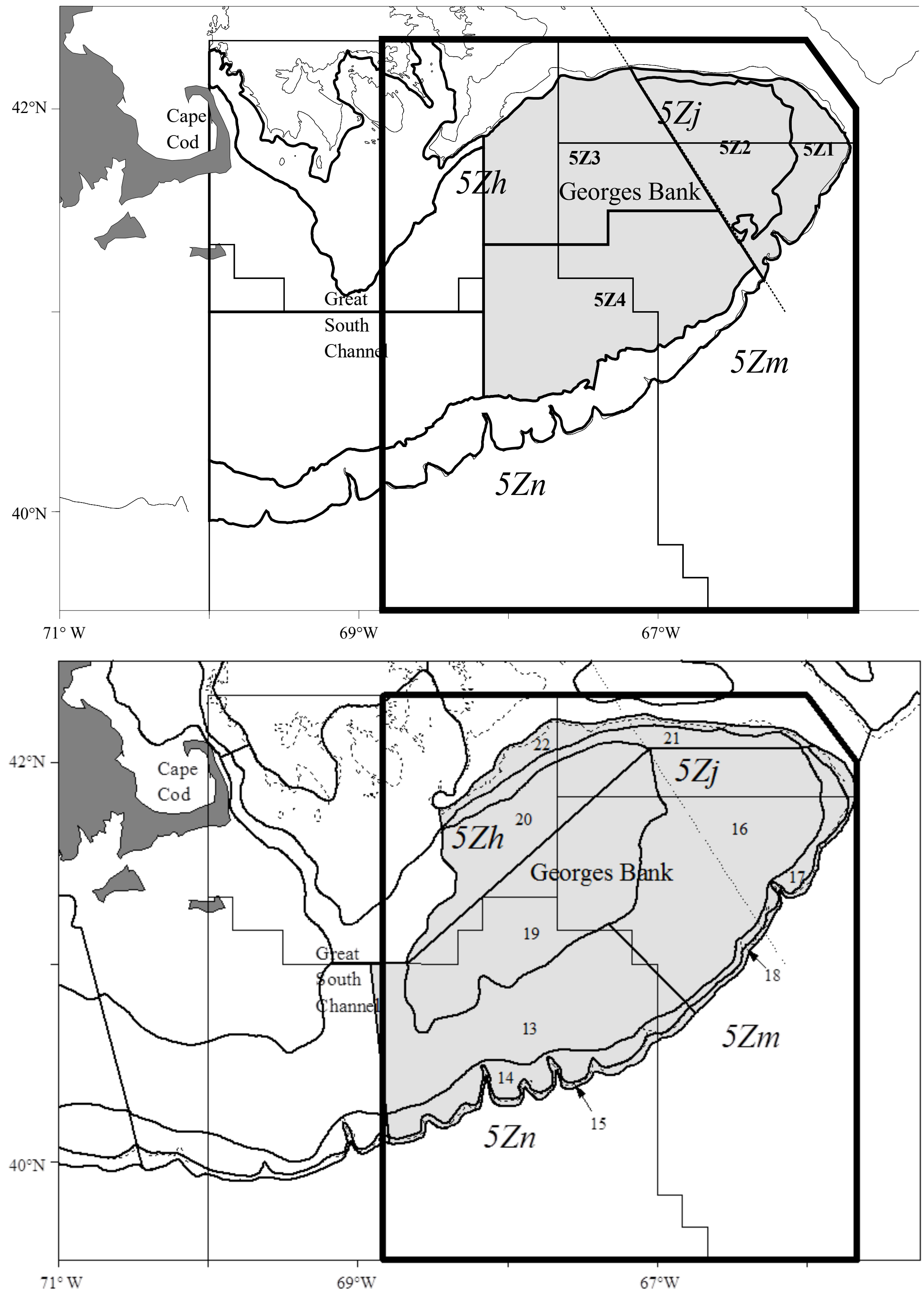


Figure 5. DFO (top) and NMFS (bottom) strata used to derive research survey abundance indices for Georges Bank groundfish surveys. Note NMFS stratum 22 is not used in assessment.

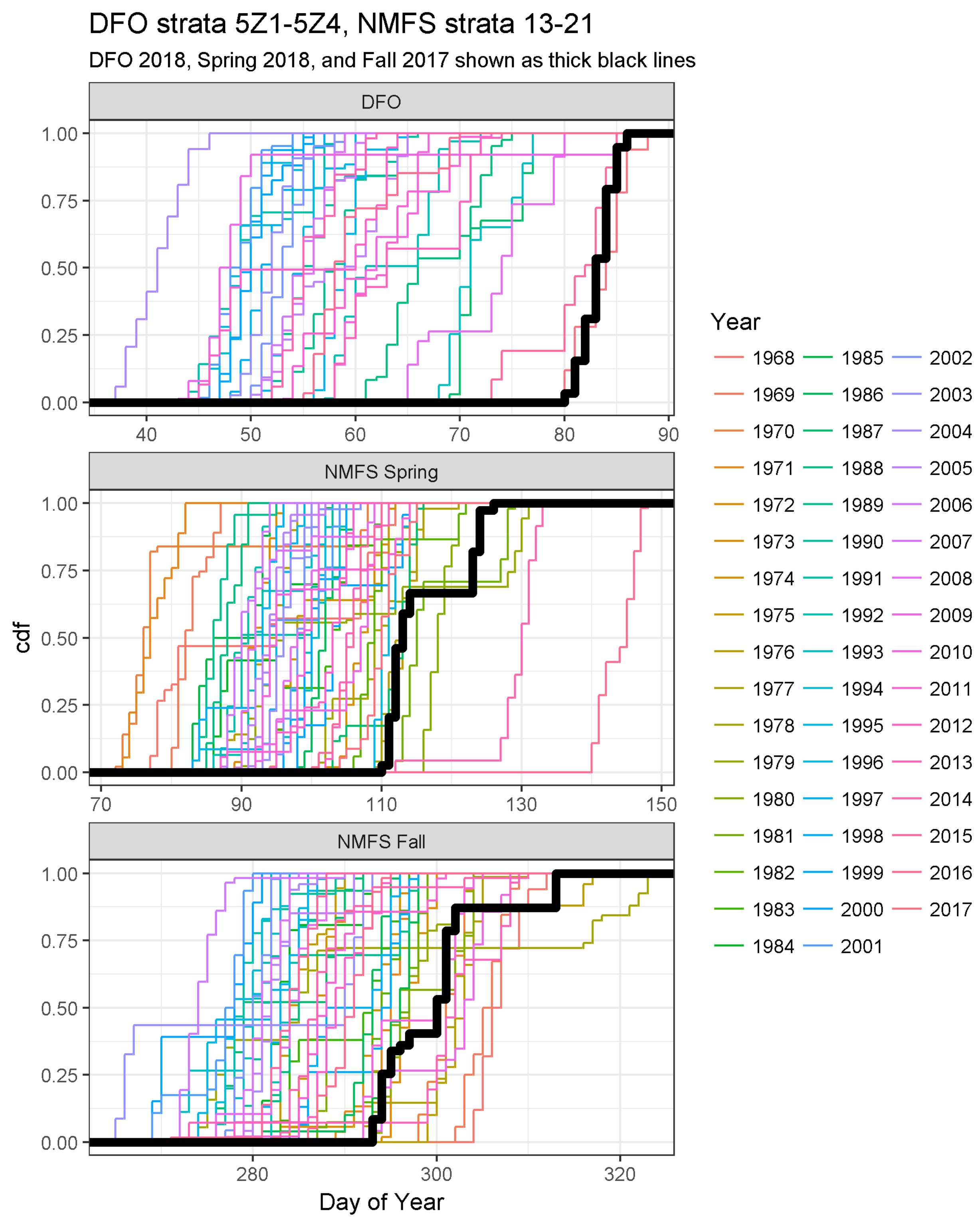


Figure 6. Cumulative distribution function (cdf) of the timing for the three surveys with most recent year highlighted in black.

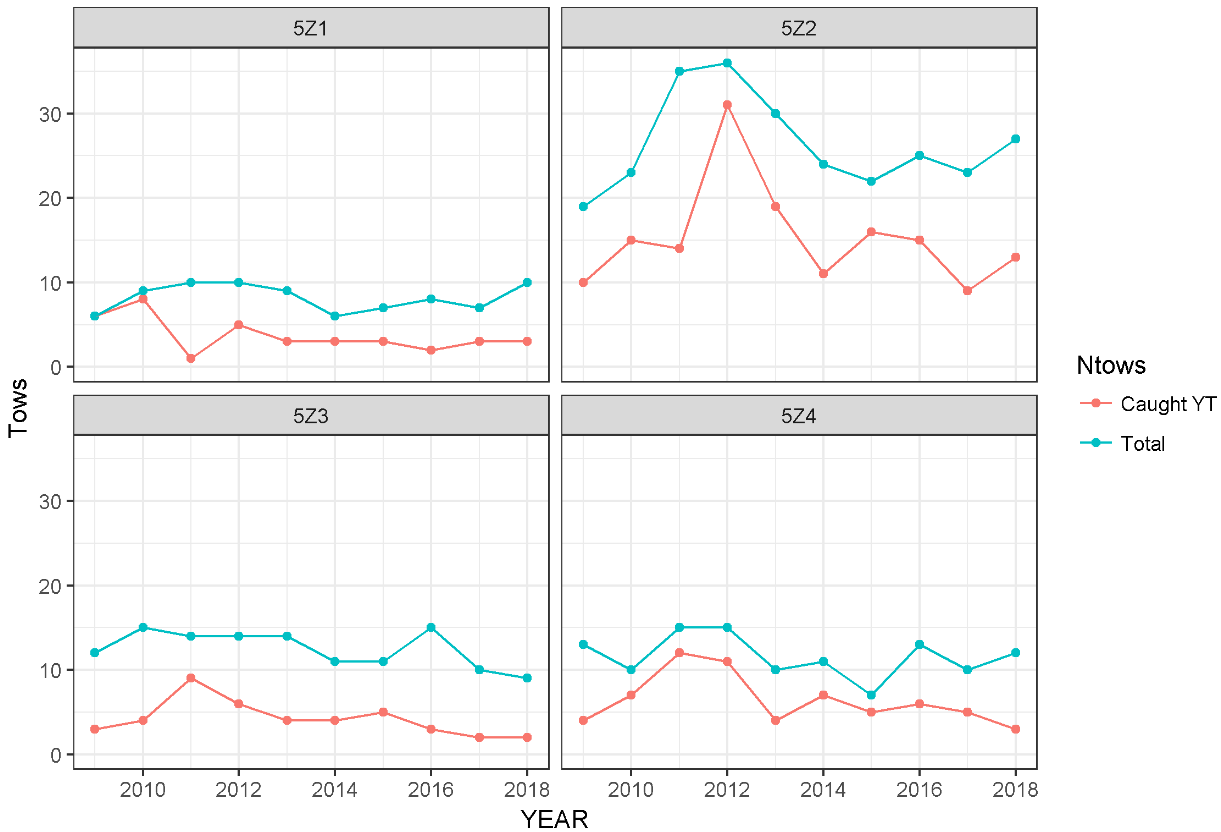


Figure 7a. Total number of tows conducted in each stratum by season and year for the DFO survey compared to the number of tows that caught Yellowtail Flounder.

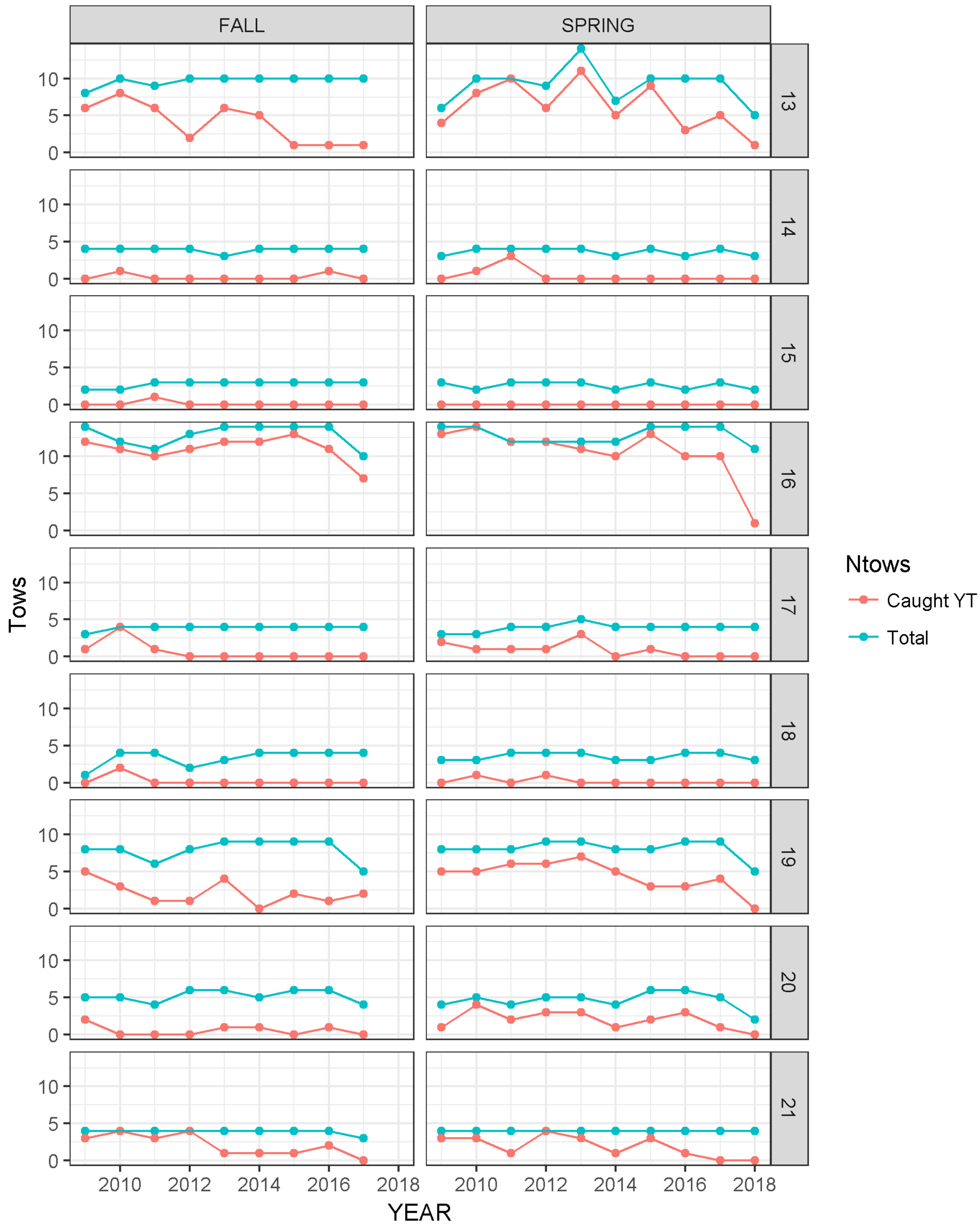


Figure 7b. Total number of tows conducted in each stratum by season and year for the two NMFS surveys compared to the number of tows that caught Yellowtail Flounder.

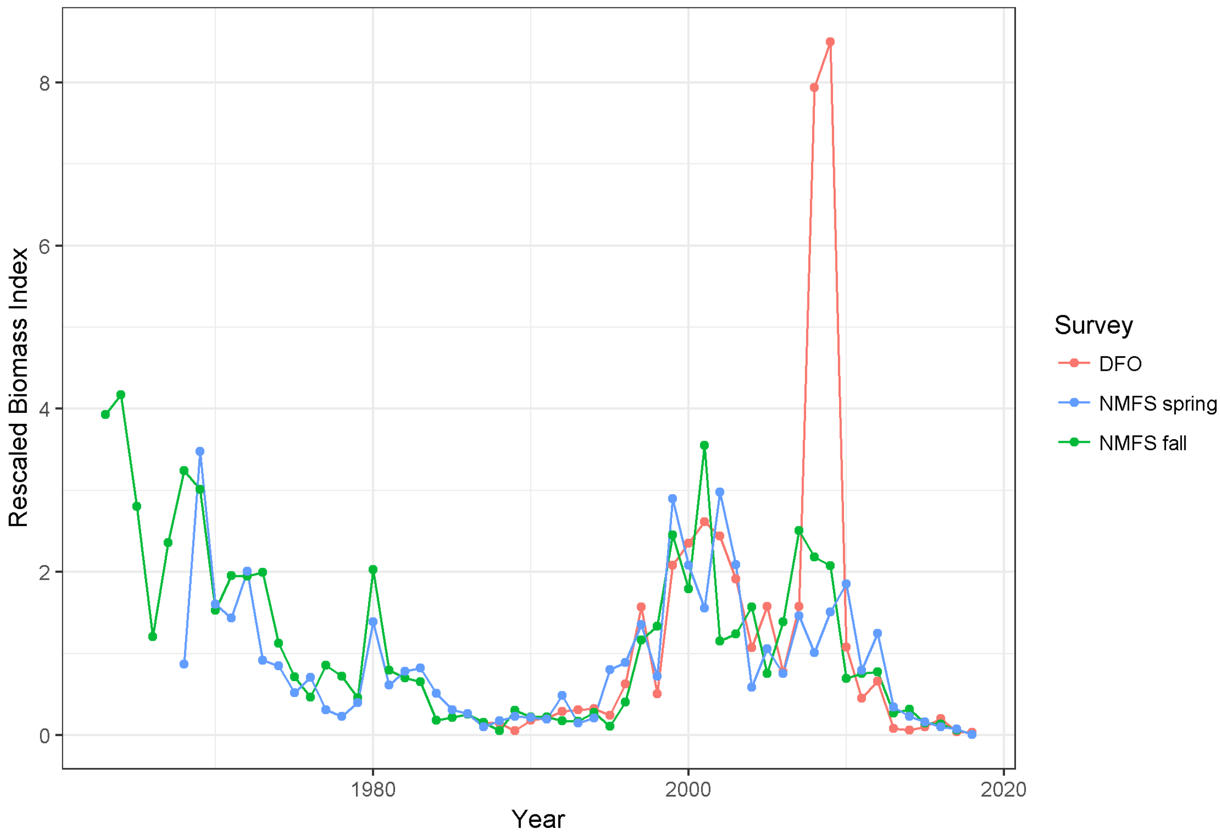


Figure 8. Three survey biomass indices (DFO, NMFS spring, and NMFS fall) for Yellowtail Flounder on Georges Bank rescaled to their respective means for years 1987-2007.

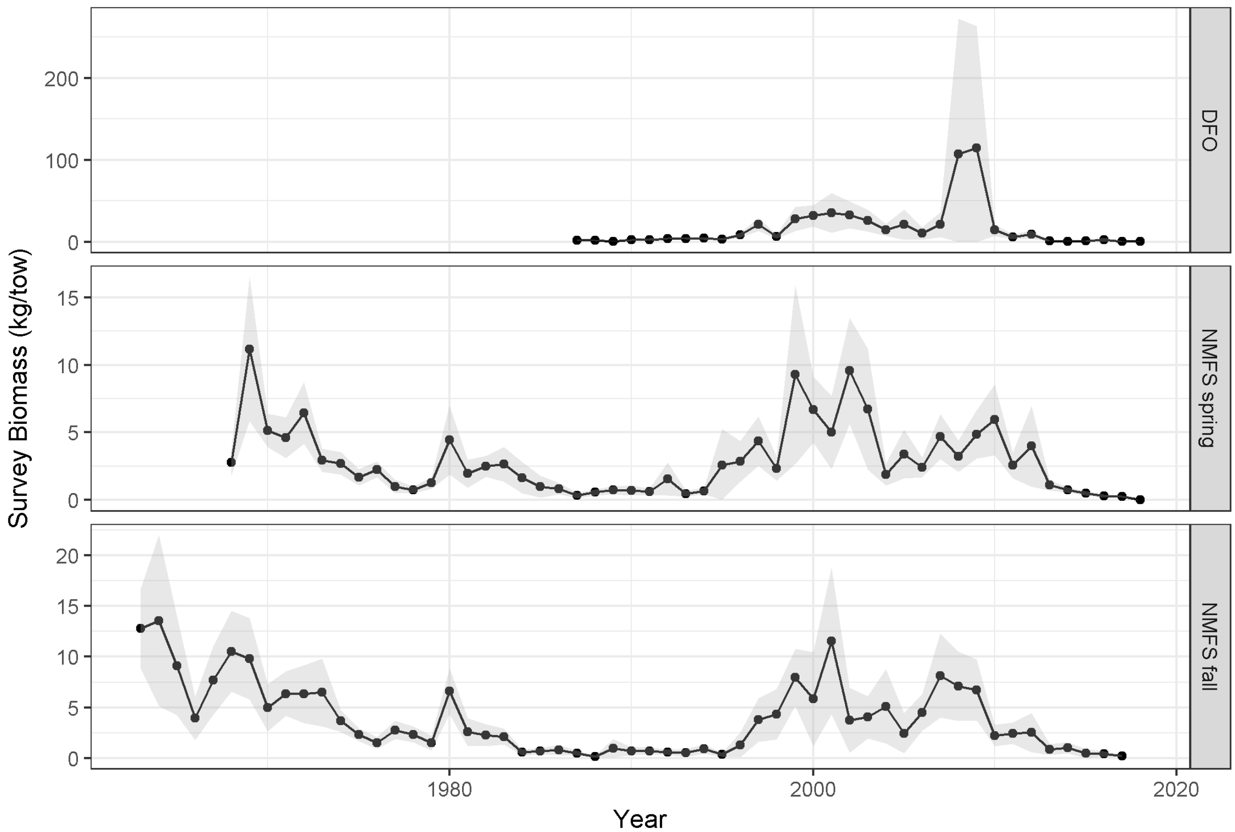


*Figure 9. Survey biomass for Yellowtail Flounder on Georges Bank in units of kg/tow with 90% confidence intervals from +/- 1.645*stdev (DFO) or bootstrapping (NMFS spring and NMFS fall). Note the y-axes vary by survey.*

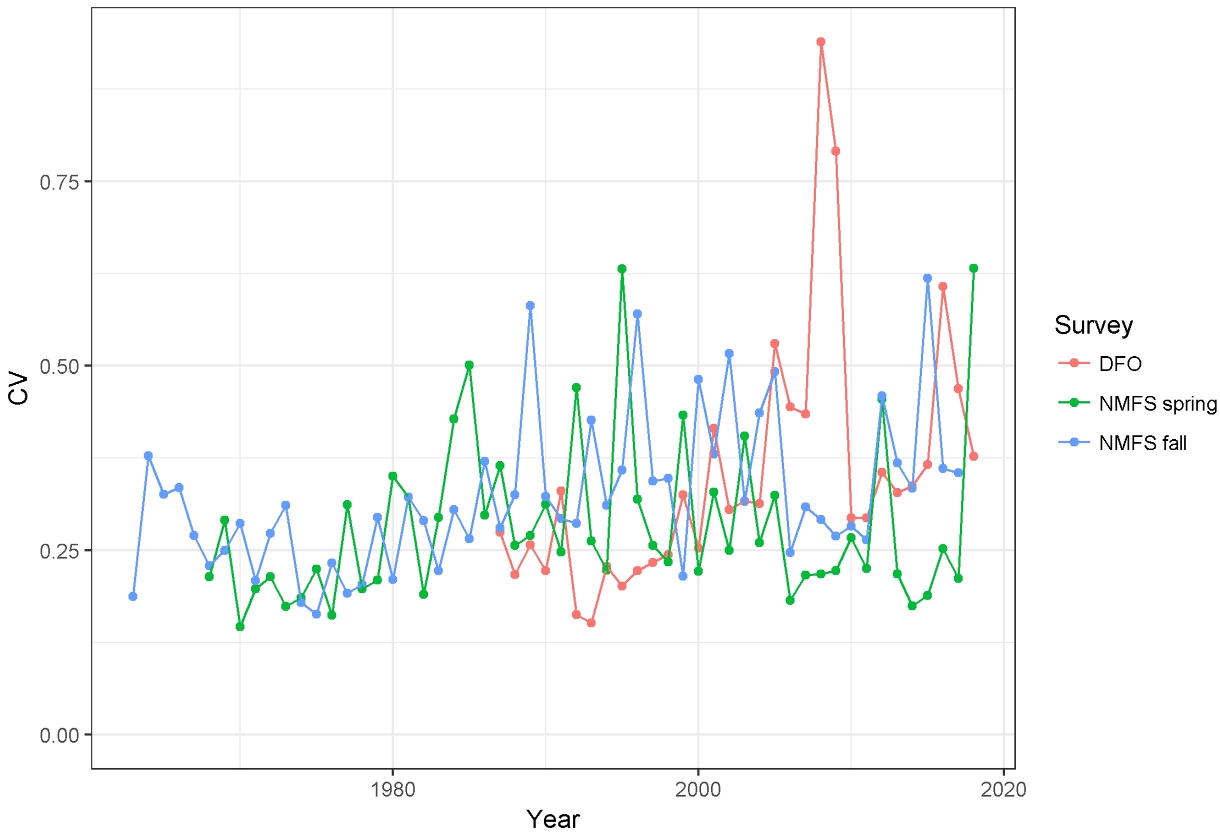
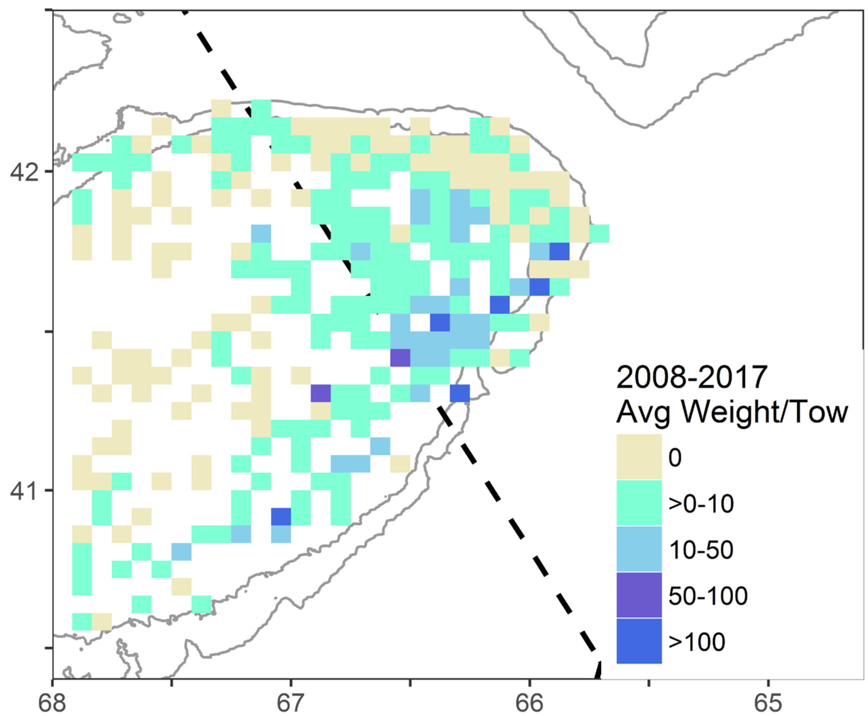


Figure 10. Three survey coefficients of variation (CV) for Yellowtail Flounder biomass on Georges Bank.



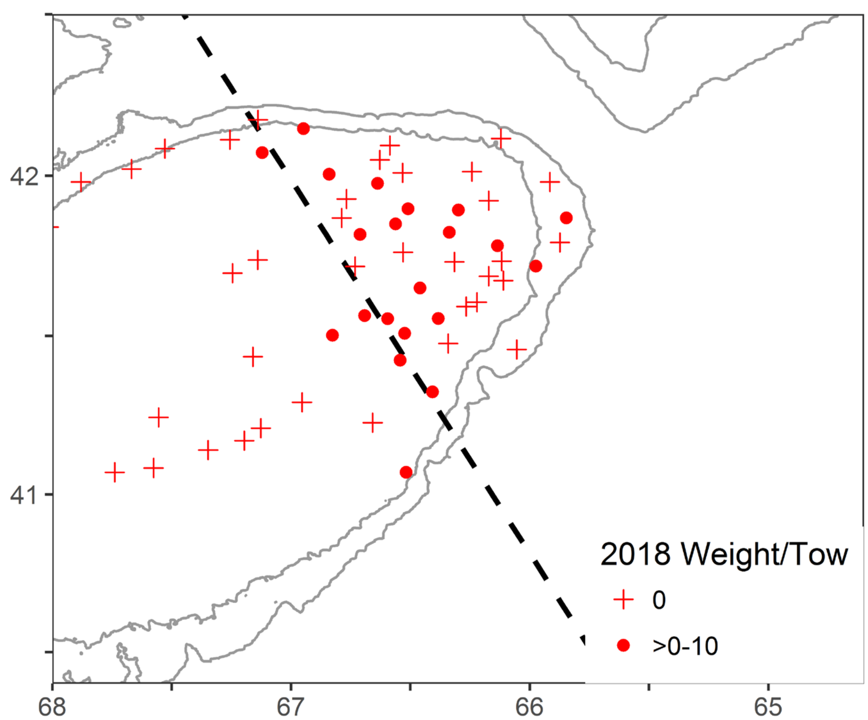


Figure 11a. Catch of Yellowtail Flounder in weight (kg) per tow for DFO survey: recent ten year average (top panel) and most recent year (bottom panel).

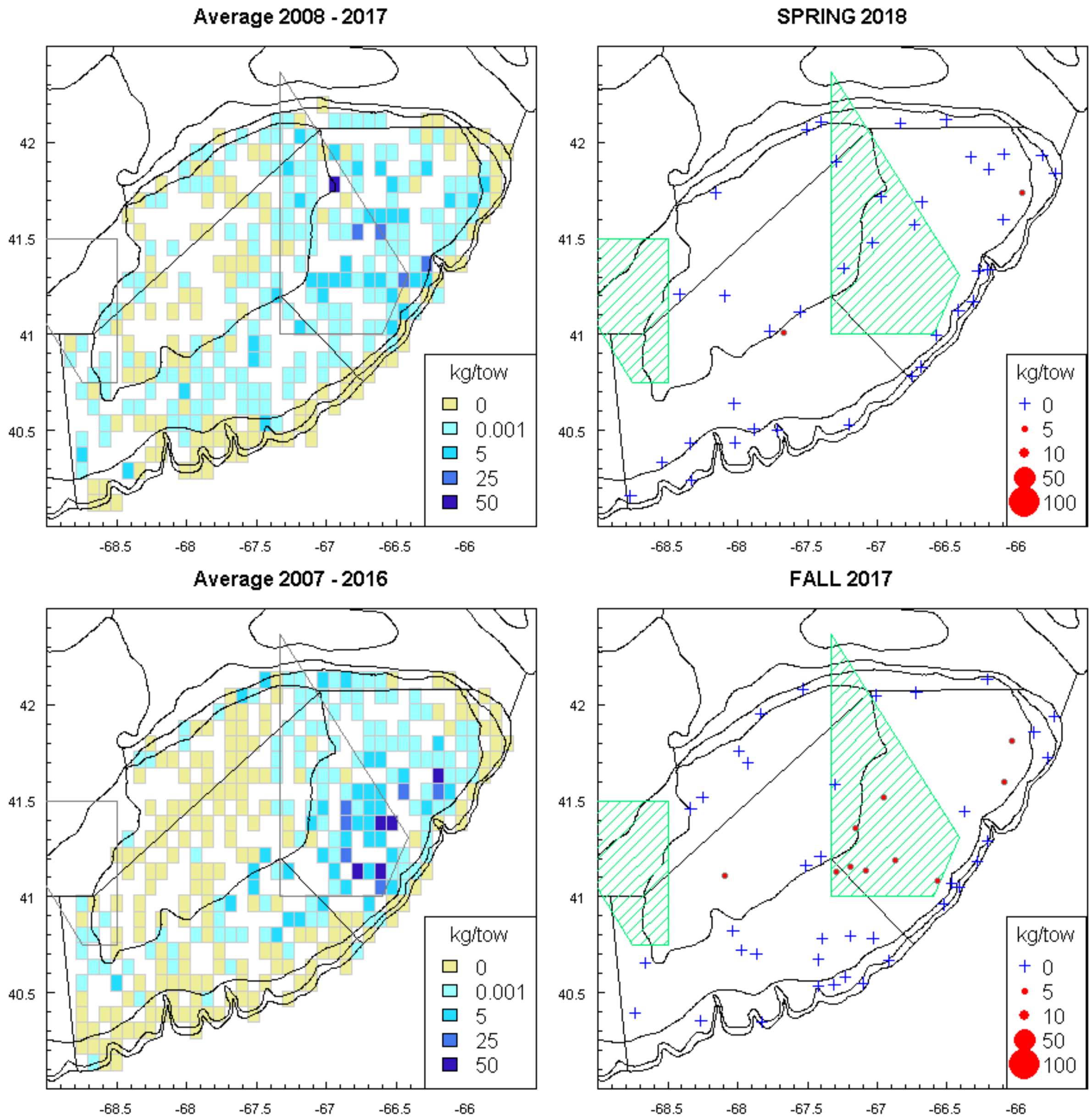


Figure 11b. Catch of Yellowtail Flounder in weight (kg) per tow for NMFS spring (top) and NMFS fall (bottom) surveys. Left panels show previous 10 year averages, right panels most recent data. Note the 2009-2018 survey values were adjusted from Henry B. Bigelow to Albatross IV equivalents by dividing Henry B. Bigelow catch in weight by 2.244 (spring) or 2.402 (fall).

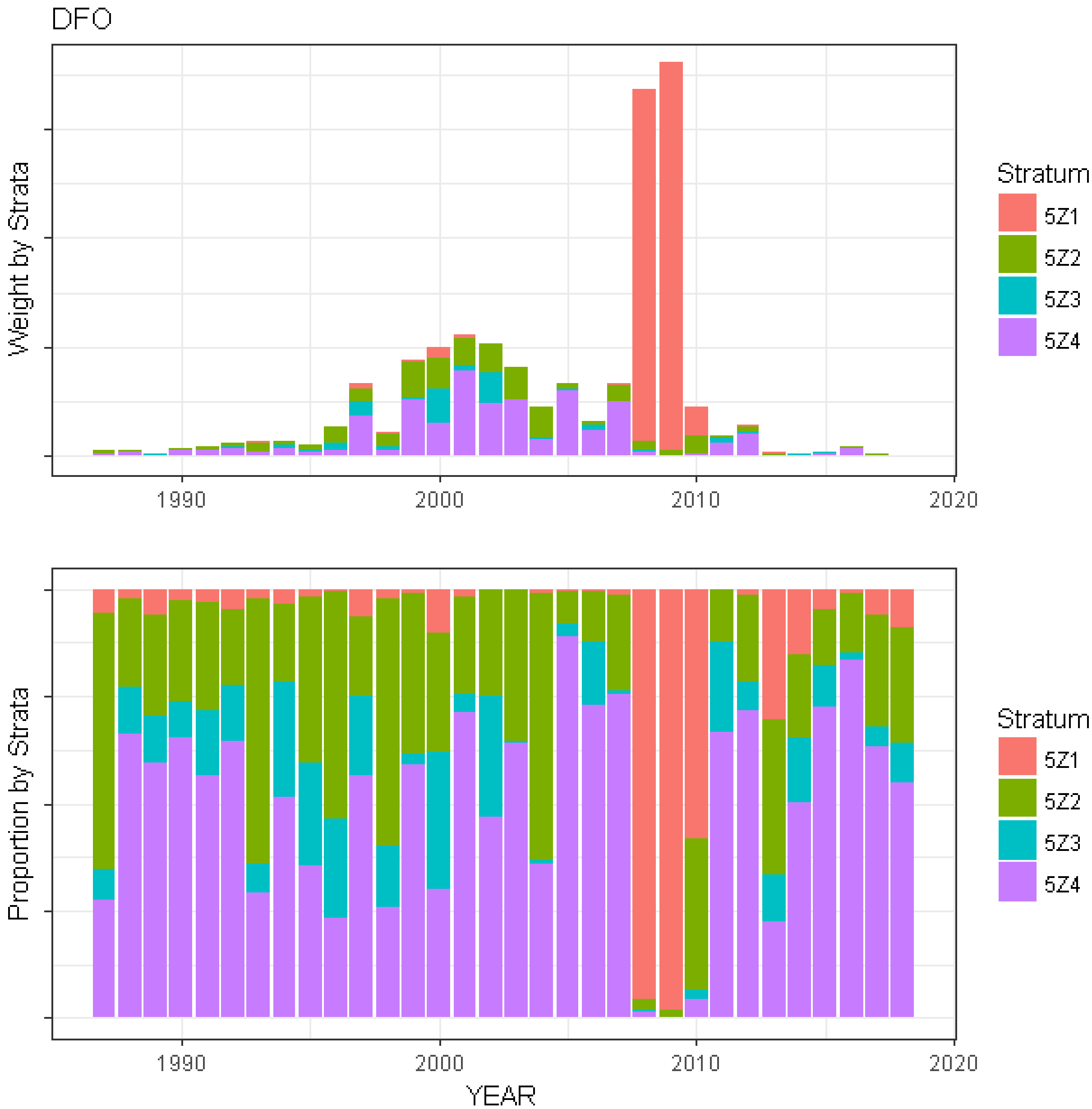


Figure 12a. DFO survey estimates of total biomass (top panel) and proportion (bottom panel) by stratum for Yellowtail Flounder on Georges Bank.

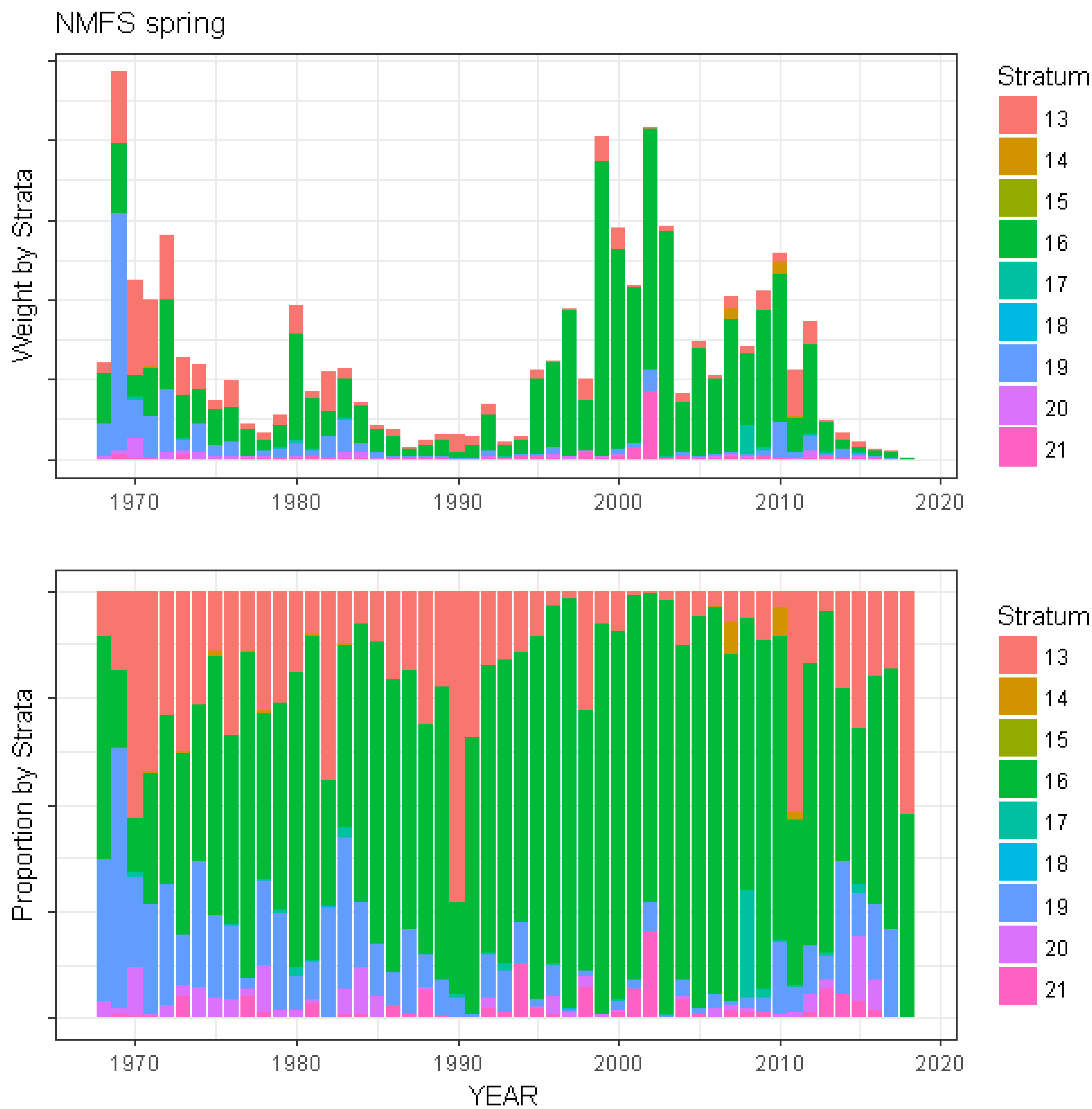


Figure 12b. NMFS spring survey estimates of total biomass (top panel) and proportion (bottom panel) by stratum for Yellowtail Flounder on Georges Bank.

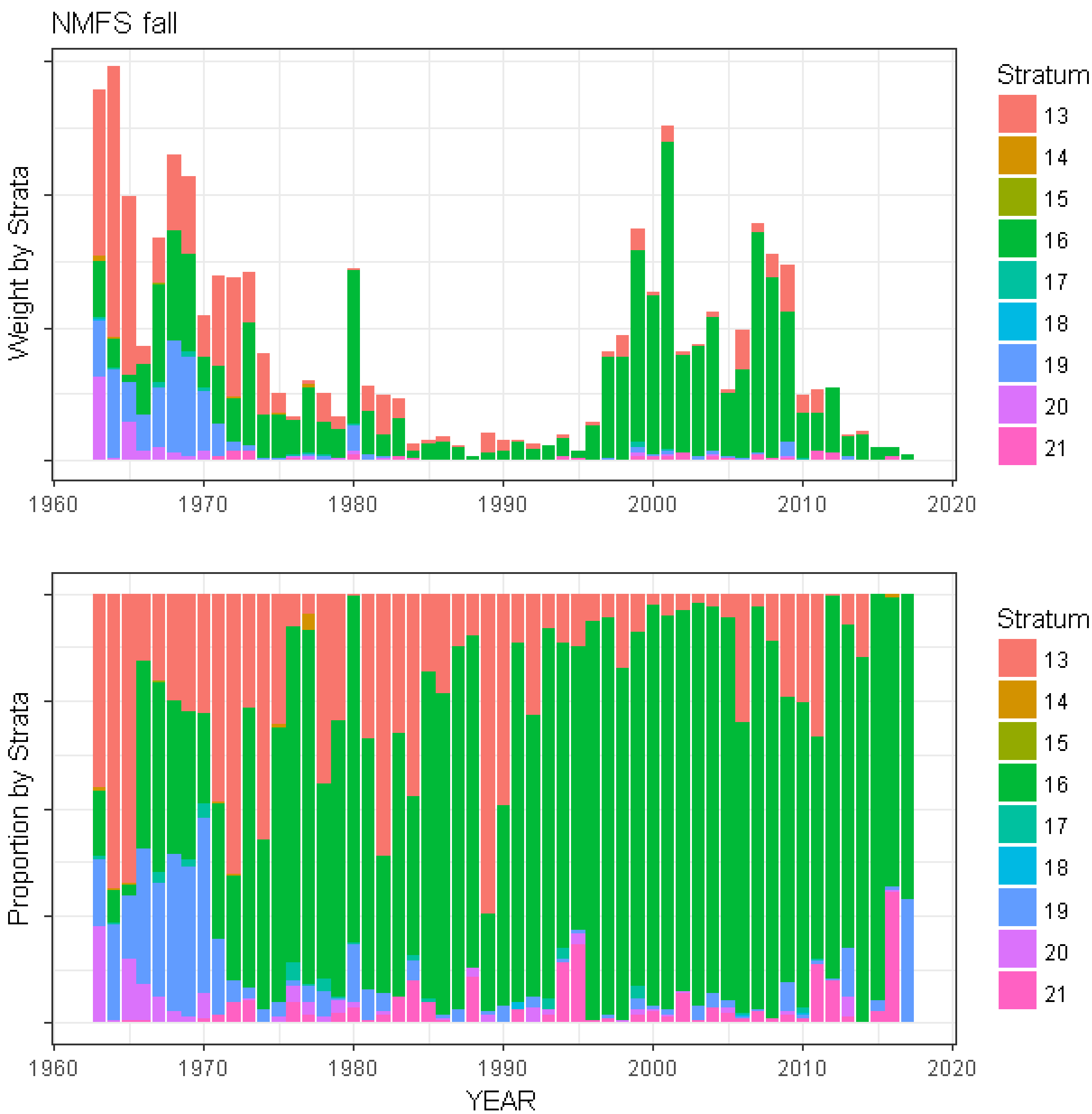


Figure 12c. NMFS fall survey estimates of total biomass (top panel) and proportion (bottom panel) by stratum for Yellowtail Flounder on Georges Bank.

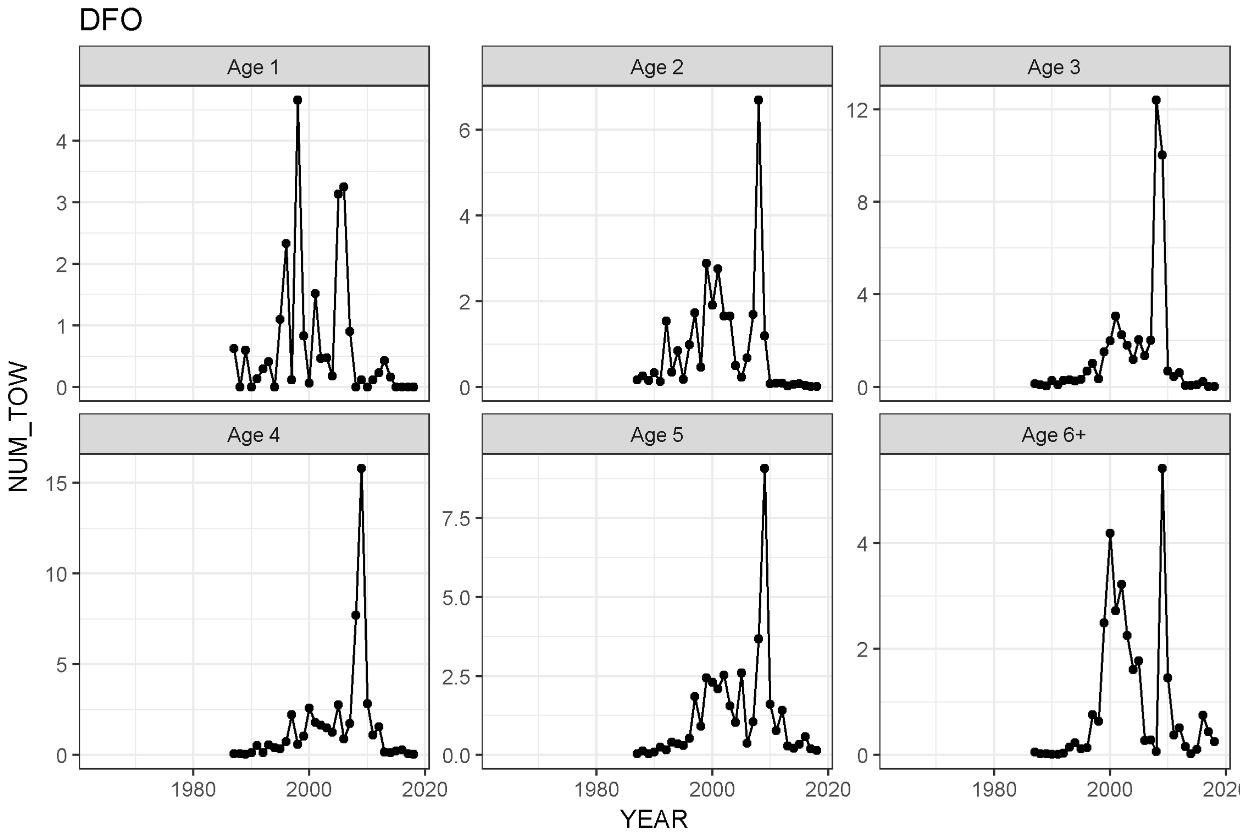


Fig 13a. Stratified mean number of fish per tow (NUM_TOW) at age over time in the DFO survey of Georges Bank Yellowtail Flounder. Note the y-axes vary by age.

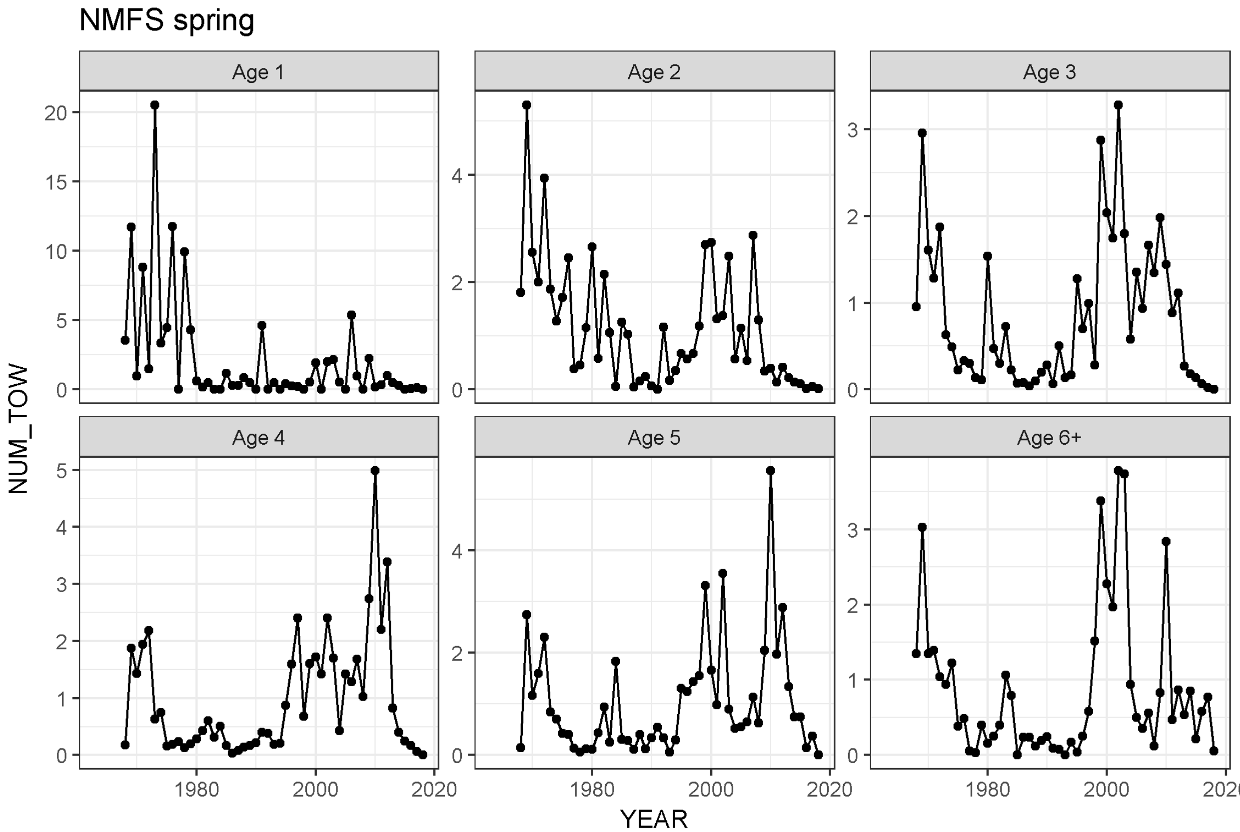


Fig 13b. Stratified mean number of fish per tow (NUM_TOW) at age over time in the NMFS spring survey of Georges Bank Yellowtail Flounder. Note the y-axes vary by age.

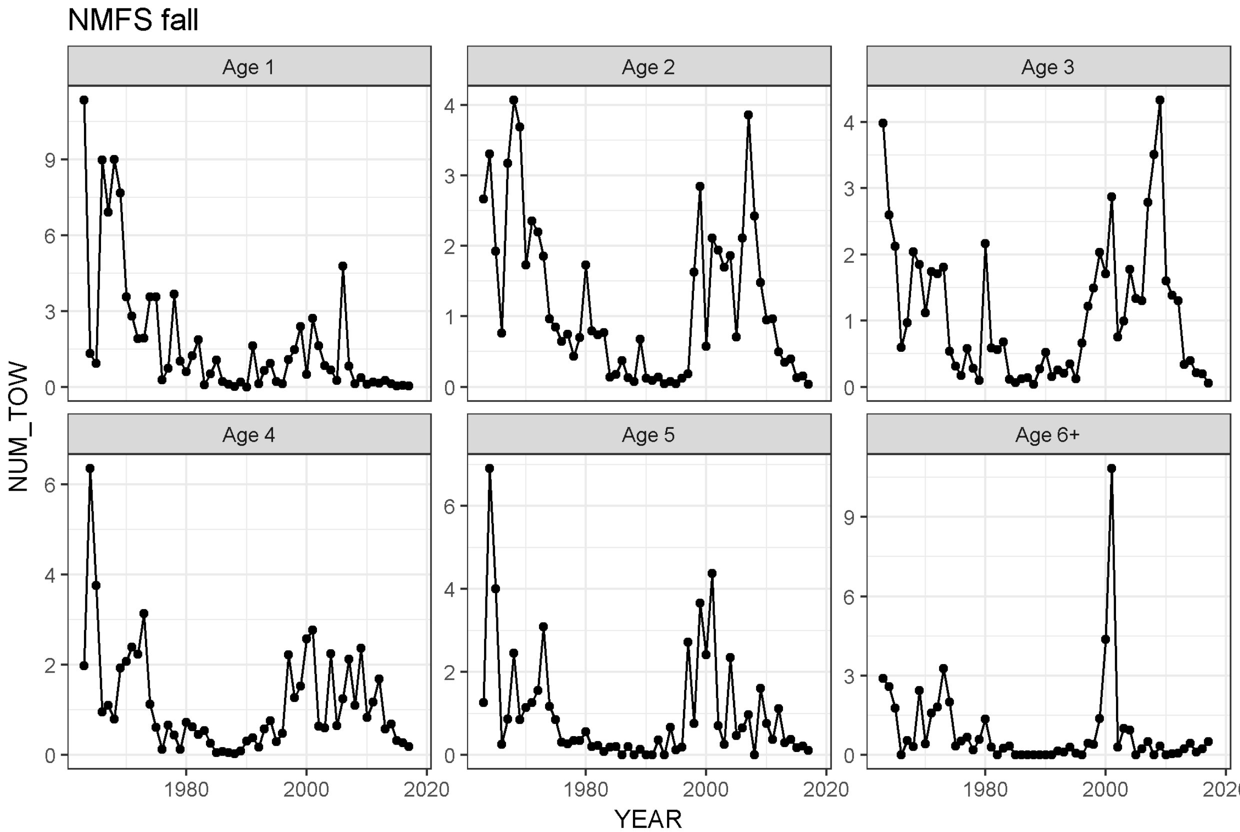


Fig 13c. Stratified mean number of fish per tow (NUM_TOW) at age over time in the NMFS fall survey of Georges Bank Yellowtail Flounder. Note the y-axes vary by age.

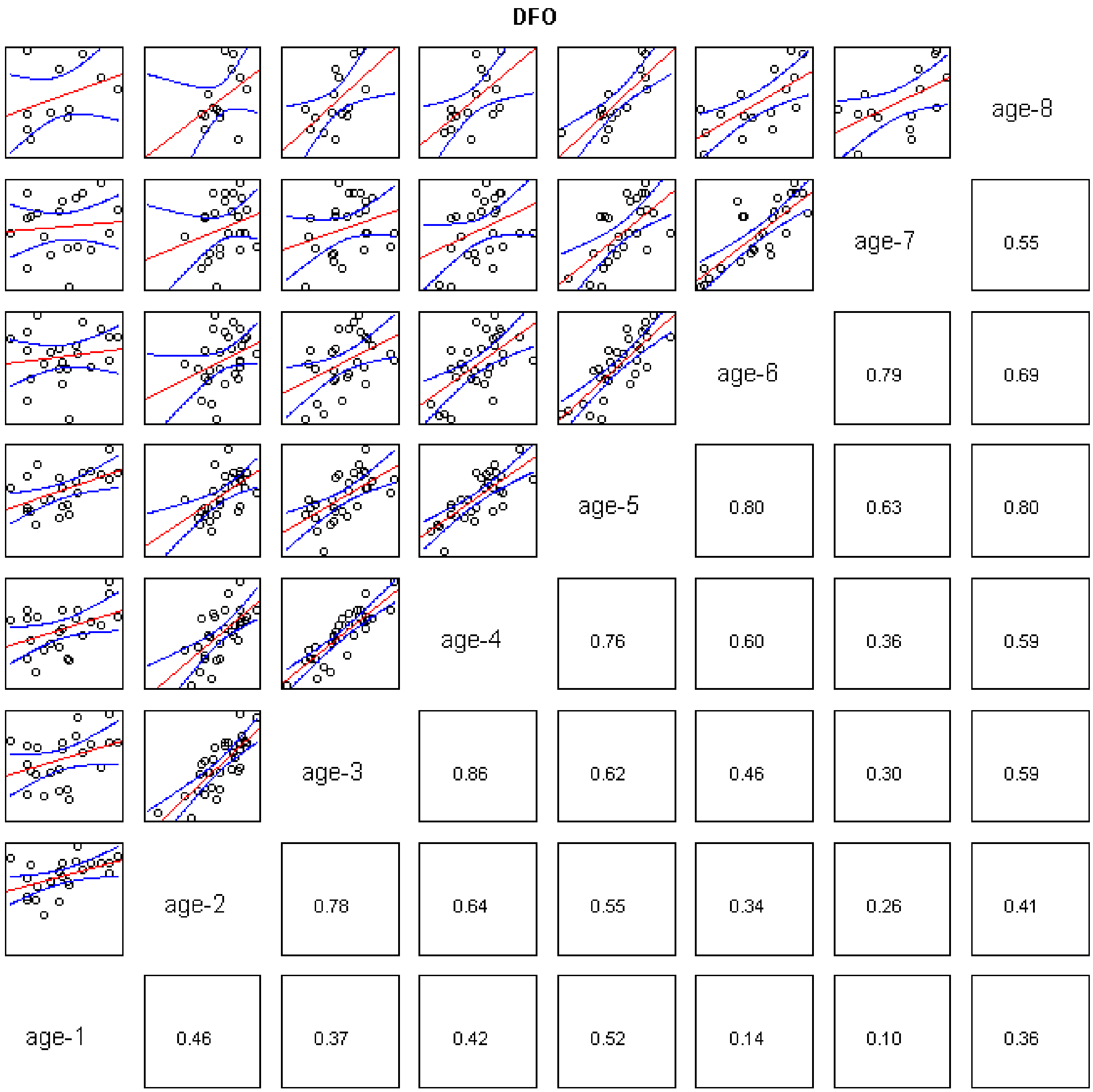


Figure 14a. DFO survey catch at age by cohort on log scale. Red lines denote linear regression and blue lines denote 95% prediction interval for the linear regression. Correlation values are shown in lower right triangle.

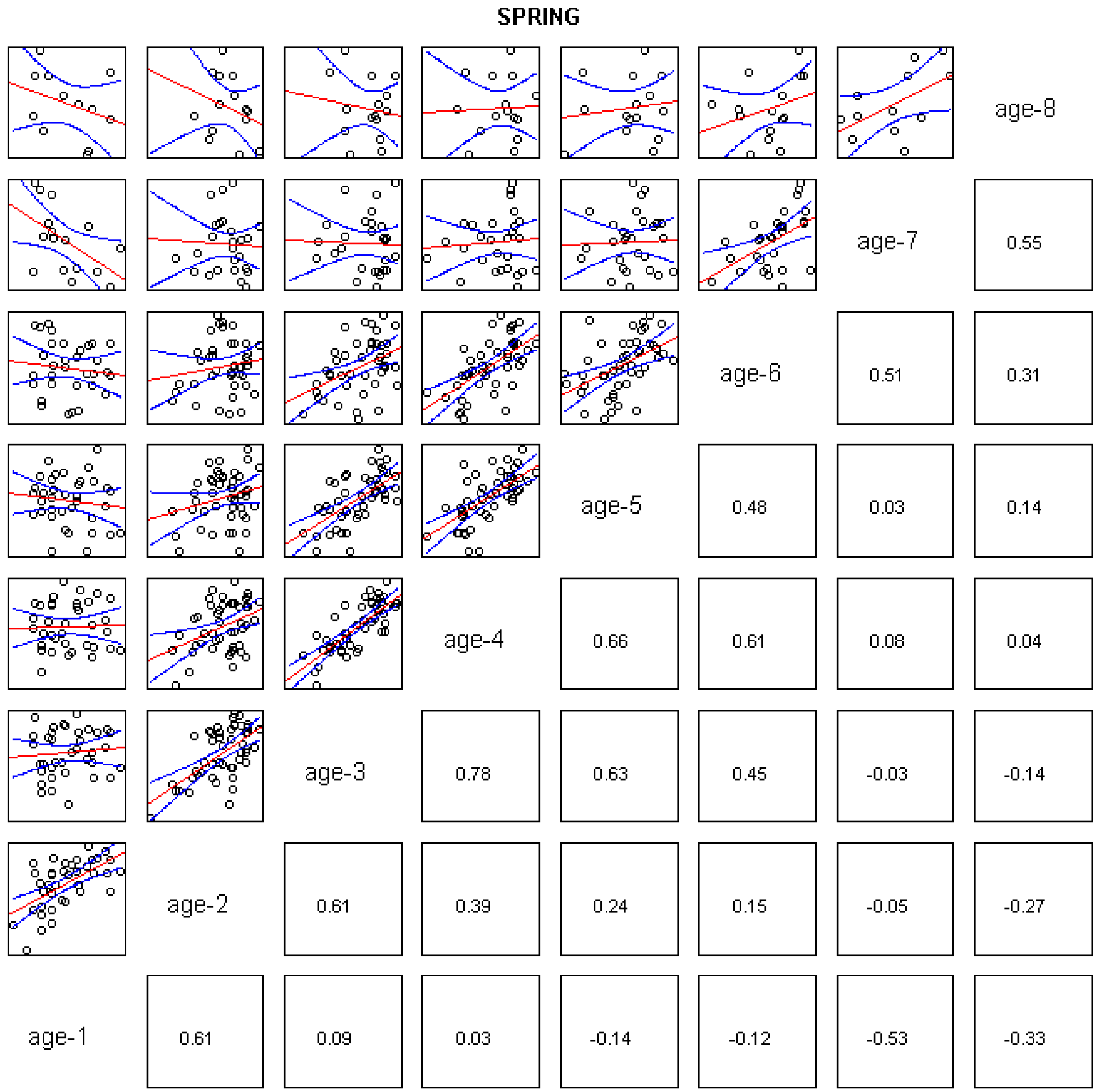


Figure 14b. NMFS spring survey catch at age by cohort on log scale. Red lines denote linear regression and blue lines denote 95% prediction interval for the linear regression. Correlation values are shown in lower right triangle.

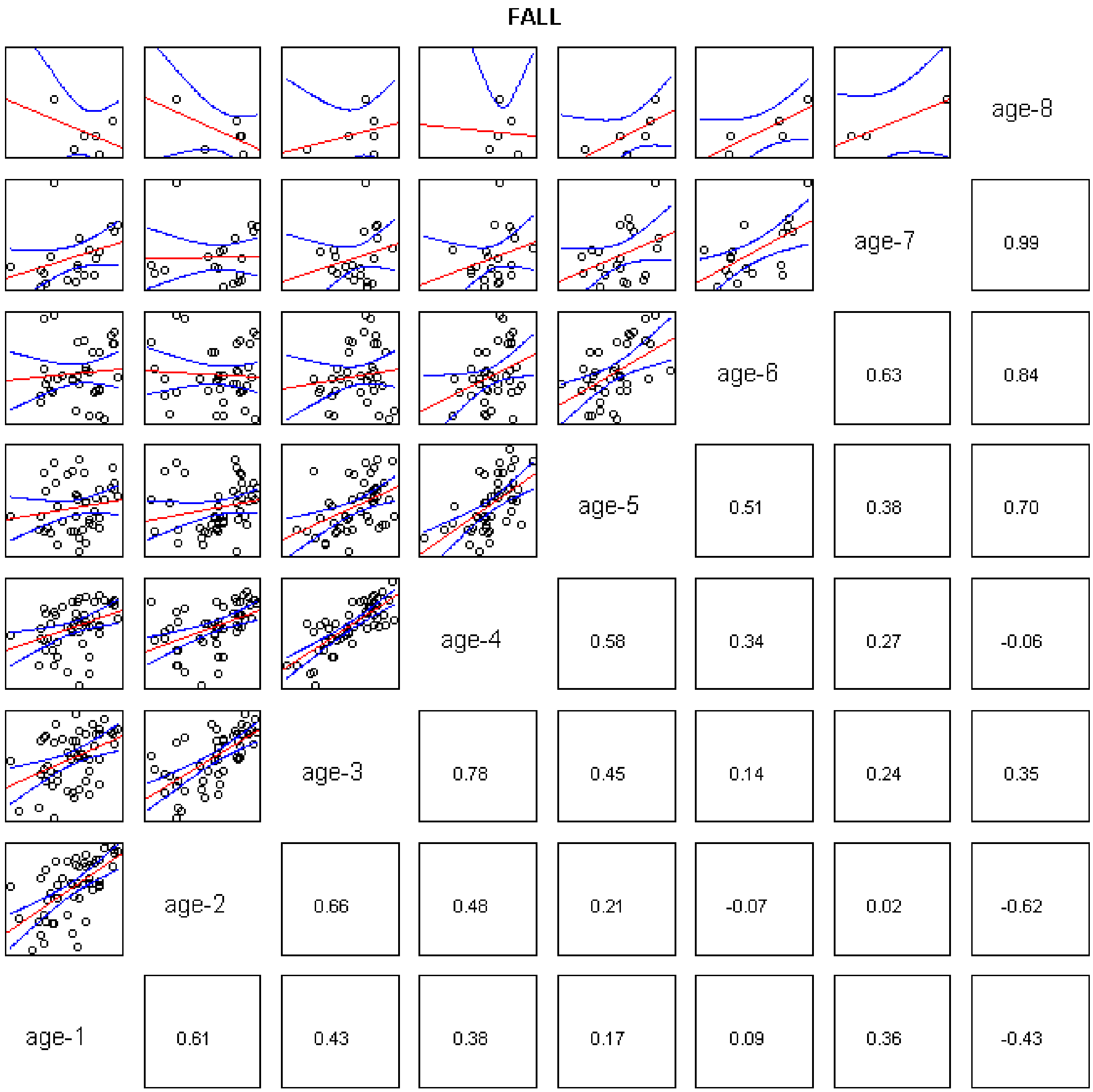


Figure 14c. NMFS fall survey catch at age by cohort on log scale. Red lines denote linear regression and blue lines denote 95% prediction interval for the linear regression. Correlation values are shown in lower right triangle.

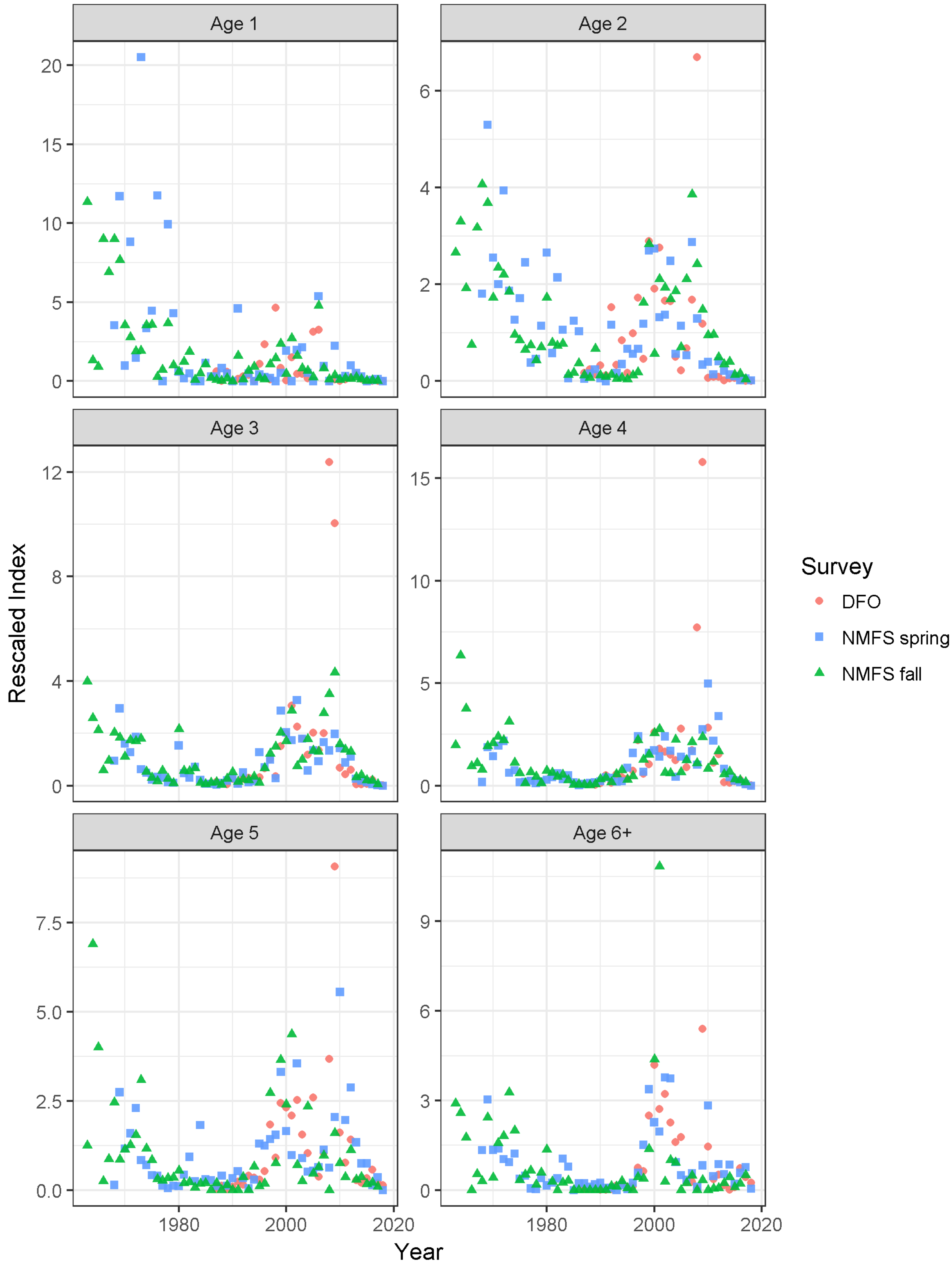


Figure 15. Standardized catch/tow in numbers at age for the three surveys. The standardization was the division of each index value by the mean of the index during 1987 through 2007.

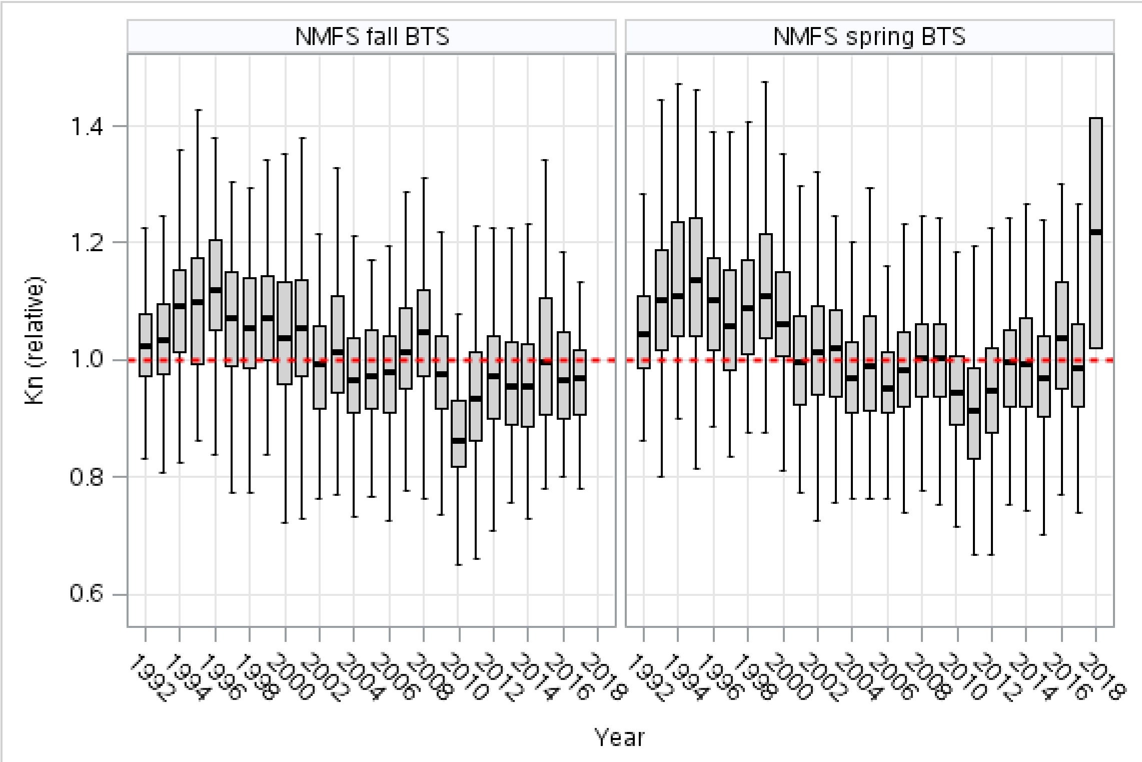


Figure 16a. Condition factor (Fulton's K) of Georges Bank Yellowtail Flounder from the NMFS fall and spring surveys.

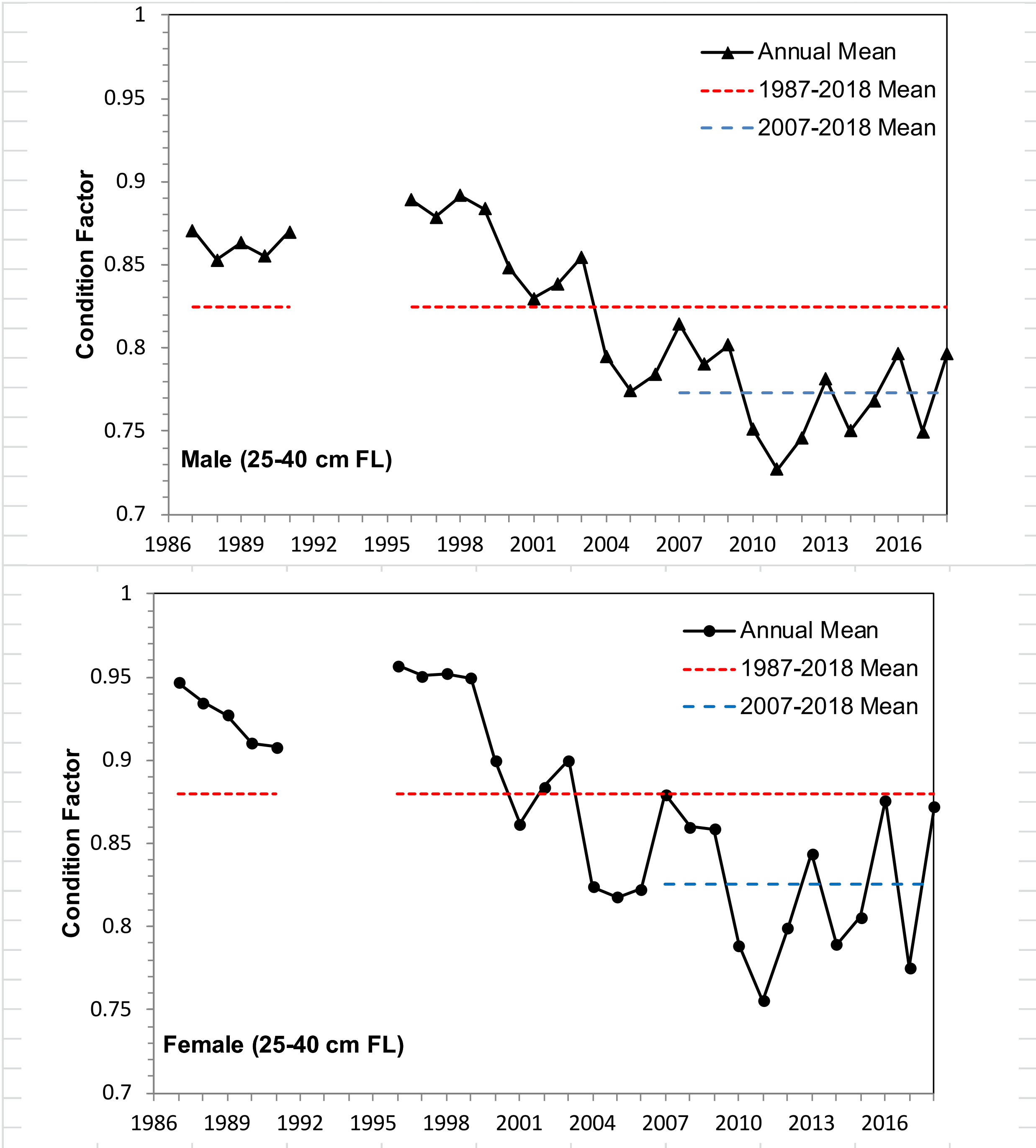


Figure 16b. Condition factor (Fulton's K) for male and female Yellowtail Flounder in the DFO survey.

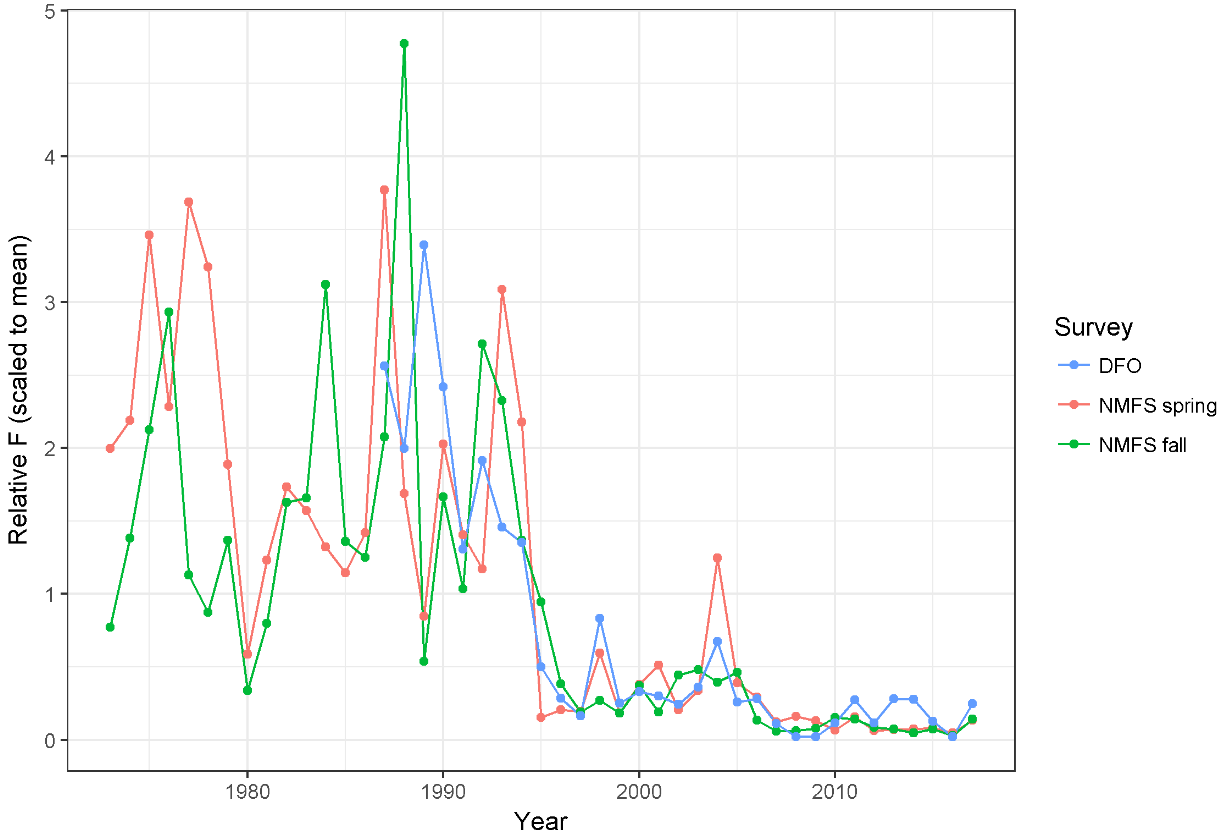


Figure 17. Trends in relative fishing mortality (catch biomass/survey biomass), or relative F, standardized to the mean for 1987-2007.

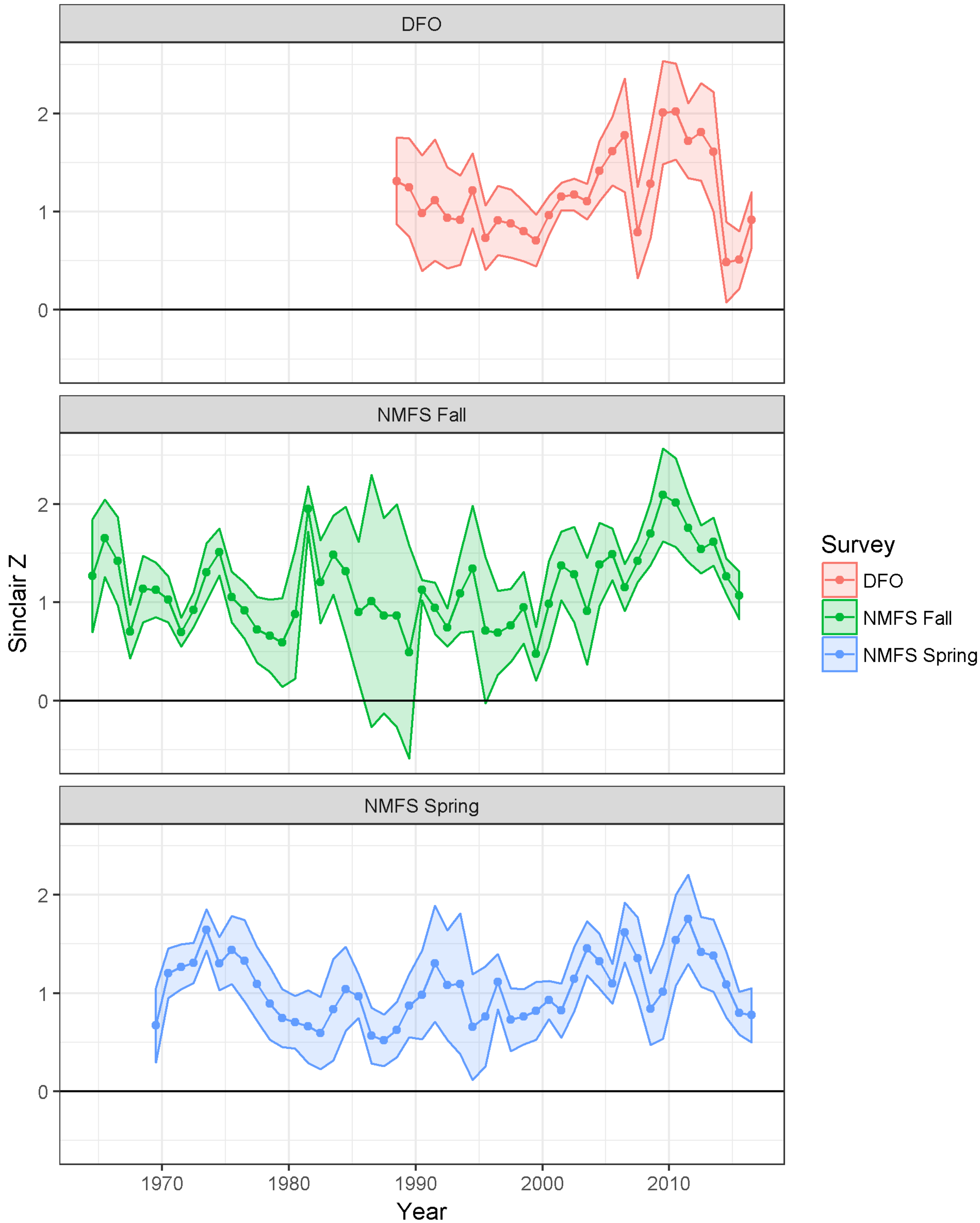


Figure 18. Total mortality (Z) estimated using method of Sinclair (2001) with four year moving window catch curve analysis using cohorts of ages 3-8. The midpoint of the four year moving window is plotted as Year (e.g., years 2015-2018 are plotted as 2016.5). The filled circles denote the estimated values and the shaded region the 95% confidence intervals.

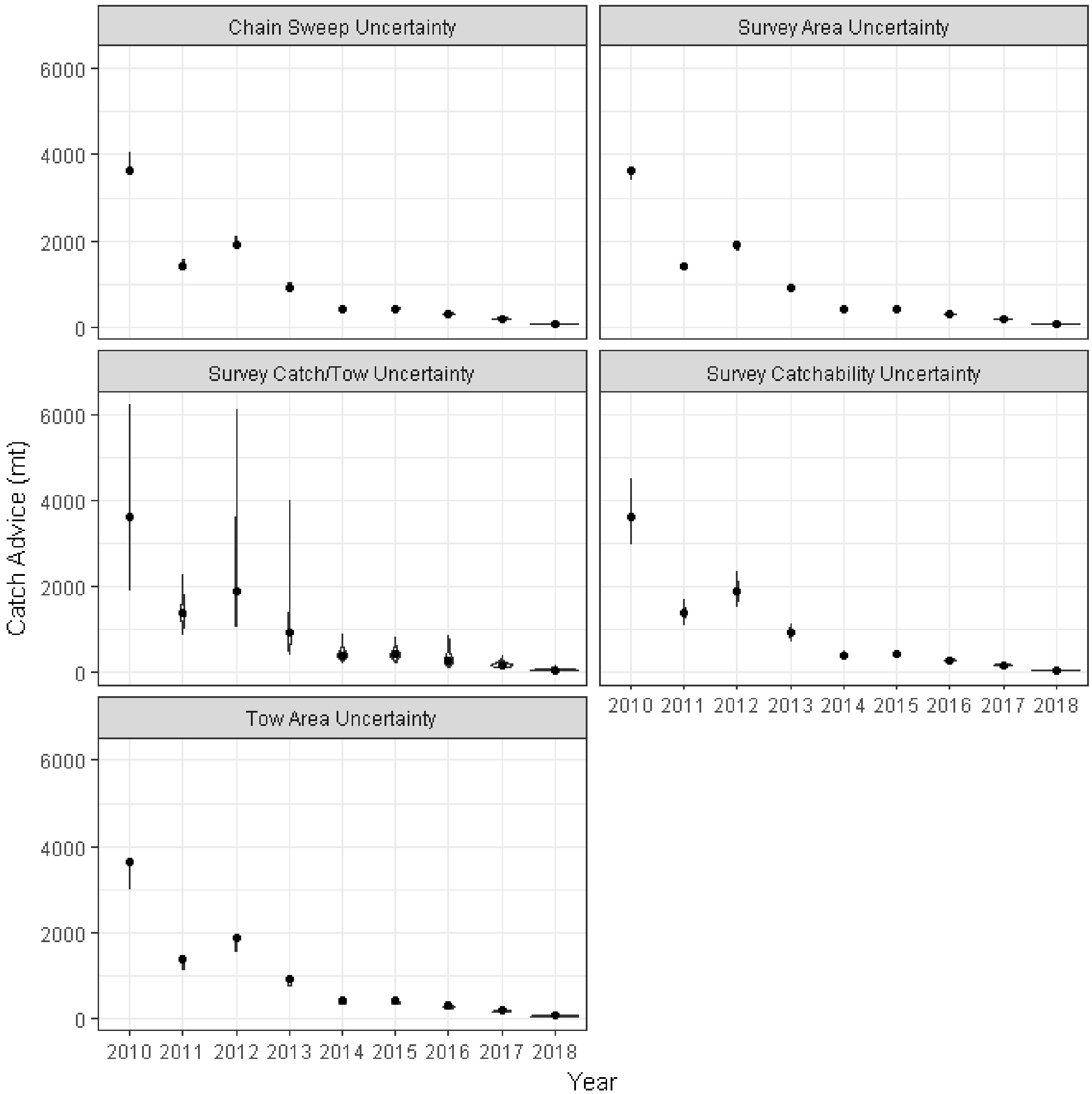


Figure 19. Distribution of catch advice over time from 1000 Monte Carlo evaluations of five types of uncertainty. The dots show the point estimates.

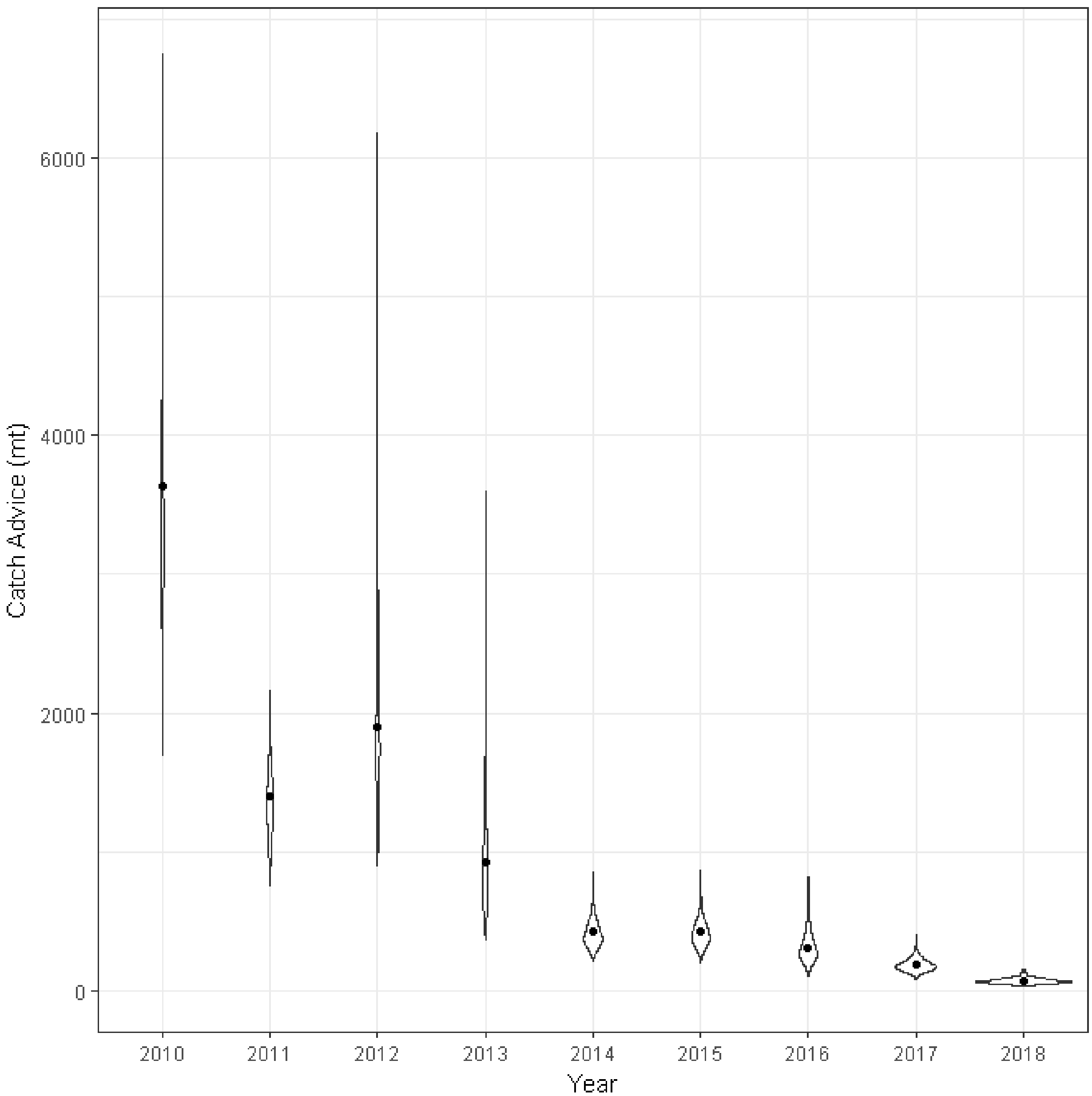
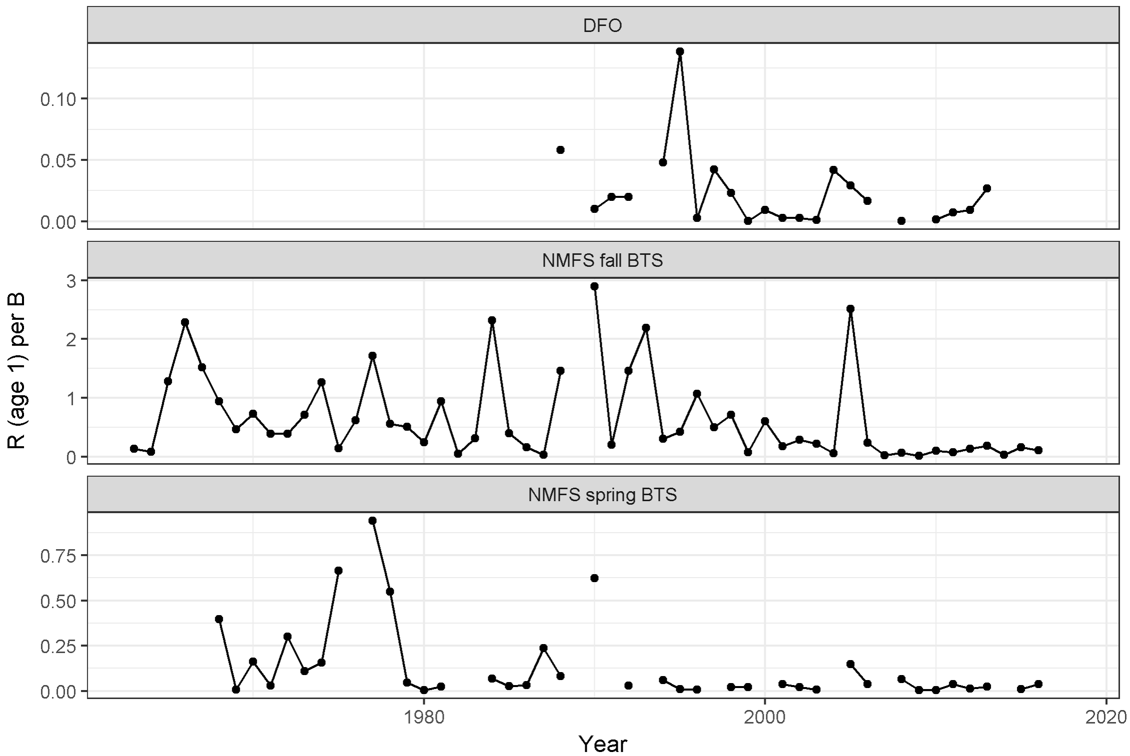


Figure 20. Distribution of catch advice from 1000 Monte Carlo evaluations with all five sources of uncertainty. The dots show the point estimates.



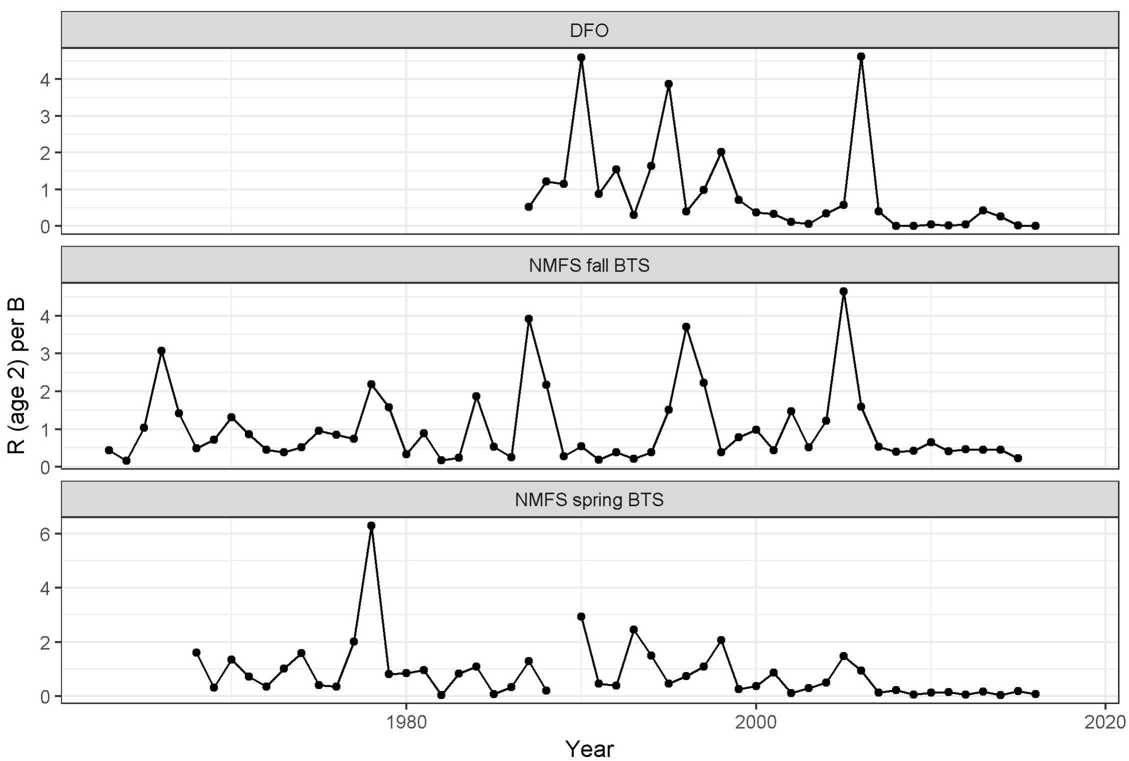
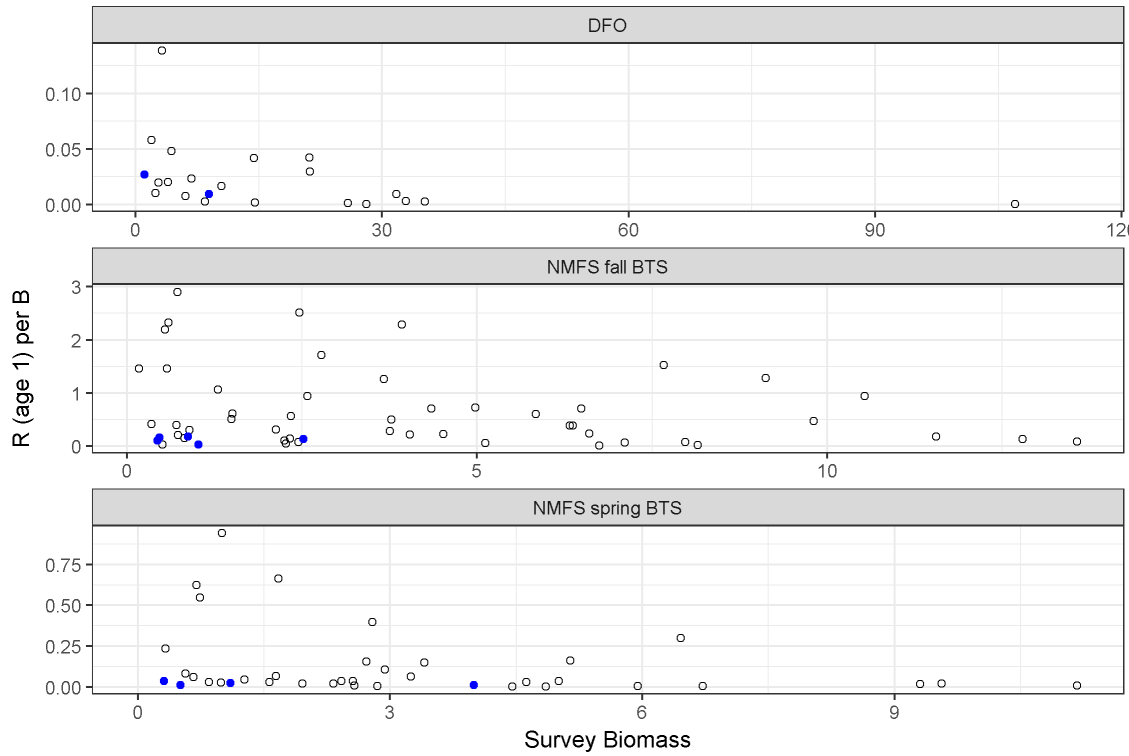
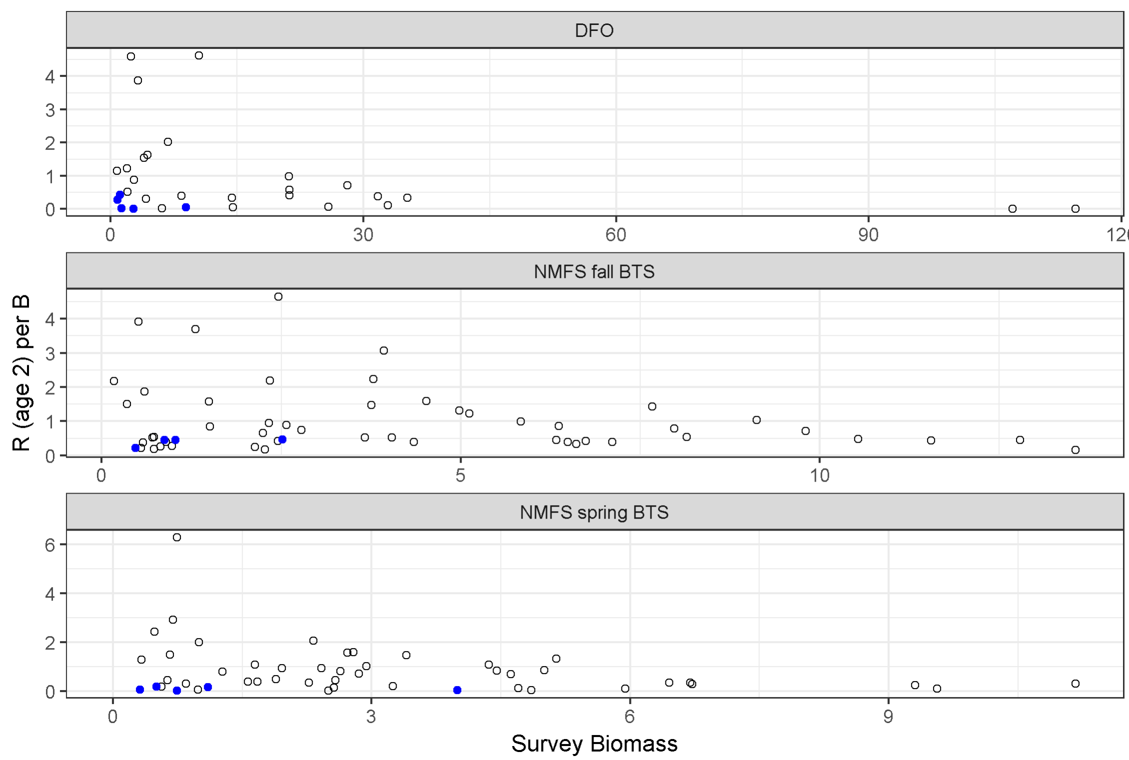


Figure 21. Recruits (at age 1 in top three panels, at age 2 in bottom three panels) per total biomass (a proxy for recruits per spawning stock biomass) over time from the three bottom trawl surveys. Recruits per biomass values of zero are not shown. Note the y-axes vary by survey.


DFO
NMFS fall BTS
NMFS spring BTS
R (age 1) per B
Survey Biomass


DFO
NMFS fall BTS
NMFS spring BTS
R (age 2) per B
Survey Biomass

t

Figure 22. Recruits (at age 1 in top three panels, at age 2 in bottom three panels) per total biomass (a proxy for recruits per spawning stock biomass) in relation to the survey biomass. Blue filled circles denote years since 2012 (not all plots show each year due to zeros treated as missing values). Note both the x-axes and y-axes vary by survey.

APPENDIX

The table below was kindly initiated by Tom Nies (NEFMC). It summarizes the performance of the management system. It reports the TRAC advice, TMGC quota decision, actual catch, and realized stock conditions for Georges Bank Yellowtail Flounder.

(1) All catches are calendar year catches

(2) Values in italics are assessment results in year immediately following the catch year; values in normal font are results from this assessment

TRAC	**Catch Year**	**TRAC Analysis/Recommendation**		**TMGC Decision**		**Actual Catch$^{(1)}$/Compared to Risk Analysis**	**Actual Result$^{(2)}$**
		Amount	**Rationale**	**Amount**	**Rationale**		
1999[1]	1999	(1) 4,383 mt (2) 6,836 mt	Neutral risk of exceeding Fref (1)VPA (2)SPM	NA	NA	4,963 mt/ 50% risk of exceeding Fref (VPA)	
2000	2000	7,800 mt	Neutral risk of exceeding Fref	NA	NA	7,341 mt/About 30% risk of exceeding Fref	
2001	2001	9,200 mt	Neutral risk of exceeding Fref	NA	NA	7,419 mt/Less than 10% risk of exceeding Fref	
2002	2002	10,300 mt	Neutral risk of exceeding Fref	NA	NA	5,663 mt/Less than 1% risk of exceeding Fref	
Transition to TMGC process in following year; note catch year differs from TRAC year in following lines							

[1] Prior to implementation of US/CAN Understanding

TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch[1]/Compared to Risk Analysis	Actual Result[2]
		Amount	**Rationale**	**Amount**	**Rationale**		
2003	2004		No confidence in projections; status quo catch may be appropriate	7,900 mt	Neutral risk of exceeding Fref, biomass stable; recent catches between 6,100-7,800 mt	6,815 mt	*F above 1.0* Now NA
2004	2005	4,000 mt	Deterministic; other models give higher catch but less than 2004 quota	6,000 mt	Moving towards Fref	3,852 mt	*F = 1.37* *Age 3+ biomass decreased 5% 05-06* Now NA
2005	2006	(1) 4,200 (2) 2,100 (3) 3,000 -3,500	Neutral risk of exceeding F ref (1-base case; 2 – major change) (3) Low risk of not achieving 20% biomass increase	3,000 mt	Base case TAC adjusted for retrospective pattern, result is similar to major change TAC (projections redone at TMGC)	2,057 mt/ (1) Less than 10% risk of exceeding Fref (2) Neutral risk of exceeding Fref	*F = 0.89* *Age 3+ biomass increased 41% 06-07* Now NA
2006	2007	1,250 mt	Neutral risk of exceeding Fref; 66% increase in SSB from 2007 to 2008	1,250 mt (revised after US objections to a 1,500 mt TAC)	Neutral risk of exceeding Fref	1,664 mt About 75 percent probability of exceeding Fref	*F = 0.29* *Age 3+ biomass increased 211% 07-08* Now NA

TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch[1]/Compared to Risk Analysis	Actual Result[2]
		Amount	**Rationale**	**Amount**	**Rationale**		
2007	2008	3,500 mt	Neutral risk of exceeding Fref; 16% increase in age 3+ biomass from 2008 to 2009	2,500 mt	Expect F=0.17, less than neutral risk of exceeding Fref	1,499 mt No risk plot; expected less than median risk of exceeding Fref	*F~0.09* *Age 3+ biomass increased between 35%-52%* Now NA
2008	2009	(1) 4,600 mt 2) 2,100 mt	(1) Neutral risk of exceeding Fref; 9% increase from 2009-2010 (2) U.S. rebuilding plan	2,100 mt	U.S. rebuilding requirements; expect F=0.11; no risk of exceeding Fref	1,806 mt No risk of exceeding Fref	*F=0.15* *Age 3+ biomass increased 11%* Now NA
2009	2010	(1) 5,000 – 7,000 mt (2) 450 – 2,600 mt	(1) Neutral risk of exceeding Fref under two model formulations (2) U.S. rebuilding requirements	No agreement. Individual TACs total 1,975 mt	No agreement	1,170 mt No risk of exceeding Fref About 15% increase in median biomass expected	*F=0.13* *3+ Biomass increased 6% 10-11* Now Avg survey B decreased 62% 10-11
2010	2011	(1) 3,400 mt	(1) Neutral risk of exceeding Fref; no change in age 3+ biomass	2,650 mt	Low probability of exceeding Fref; expected 5% increase in biomass from 11 to 12	1,171 mt No risk of exceeding Fref About 15% increase in biomass expected	*F=0.31* *Age 3+ biomass decreased 5% 11-12* Now Avg survey B increased 35% 11-12

TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch[1]/Compared to Risk Analysis	Actual Result[2]
		Amount	Rationale	Amount	Rationale		
2011	2012	(1) 900-1,400 mt	(1) trade-off between risk of overfishing and change in biomass from three projections	1,150 mt	Low probability of exceeding Fref; expected increase in biomass from 12 to 13	725 mt	*F=0.32* *Age 3+ biomass decreased 6% 12-13* Now Avg survey B decreased 50% 12-13
2012	2013	(1) 200-500 mt	(1) trade-off between risk of overfishing and change in biomass from five projections	500 mt	Trade-off risk of F>Fref and biomass increase among 5 sensitivity analyses	218 mt	*F=0.32 (0.78 rho adjusted)* Now Avg survey B decreased 55% 13-14
2013	2014	(1) 200 mt (2) 500 mt	(1) F<Fref (2) B increase	400 mt	Reduction from 2013 quota, allow rebuilding	159 mt	Now Avg survey B increased 0% 14-15
2014	2015	(1) 45-354 mt (2) 400 mt	(1) constant exploitation rate 2%-16% (2) constant quota	354 mt	One year quota at 16% exploitation rate, reduction from 2014 quota	118 mt	Now Avg survey B decreased 31% 15-16
2015	2016	(1) 45-359 mt (2) 354 mt	(1) constant exploitation rate 2%-16% (2) constant quota	354 mt	Constant quota (and essentially no change in surveys)	44 mt	Now Avg survey B decreased 36% 16-17

TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch[1]/Compared to Risk Analysis	Actual Result[2]
		Amount	Rationale	Amount	Rationale		
2016	2017	(1) 31-245 mt (2)	(1) constant exploitation rate 2%-16% (2)	300 mt	Decline in surveys and low inter-annual changes in quota	95 mt	Now Avg survey B decreased 64% 17-18
2017	2018	62-187 mt	Constant exploitation rate 2%-6%	300 mt	Balance yellowtail flounder stock conditions and the utilization of other species		