A. GEORGES BANK WINTER FLOUNDER – REVIEW PANEL SUMMARY

The panel and workshop participants reviewed a draft report that updated the stock assessment using the methods from SAW52 (NEFSC 2011) with fishery data through 2013 and survey data through spring 2014. The panel identified some new research publications that were not available at SAW52. Although those publications were not reviewed by all participants, the Panel evaluated SAW52 data and model decisions in the context of new research. The panel requested additional sensitivity projections, minor additions to the report and revisions of the draft text, and recommended some topics for the research track.

Terms of Reference

1. Update all fishery-dependent data (landings, discards, catch-at-age, etc.) and all fishery-independent data (research survey information) used as inputs in the baseline model or in the last operational assessment.

The panel confirmed that there were no changes to the data protocols or modeling methods developed for SAW52. The data patterns recognized at SAW52 continued. Data quality improved since the last assessment. For example, precision of the U.S. discards and precision of the US landings improved during 2011-2013. US catches continued to be well-sampled, but similar to SAW52, no length or age samples were available for the Canadian fisheries and no age data were available from the Canadian spring surveys. Since 2006, most catch has continued to come from statistical area 522, Cultivator Shoals. Although recent survey trends were somewhat inconsistent among surveys (e.g., increasing NEFSC spring survey indices during 2012-2014, but fluctuating NEFSC fall and Canadian survey indices), age compositions of all three surveys showed expansion of age structure since 2009. The Panel also noted that the decreasing trend in weight-at-age continued during 2010-2013, and that this trend is common among several species in the region, possibly a result of warming temperatures.

The Panel requested information on statistical distribution (e.g., proportion of positive tows) and geographic distribution of recent NEFSC survey data. The GARM III assessment (NEFSC 2008) reported survey distributions through 2007. The statistical distribution of the Bigelow survey should be different from the Albatross survey, because of increased catchability. Therefore, the Panel requested distributional information for the entire Bigelow series (2009-2013).

The assessment update assumed 100% discard mortality as in previous assessments. At GARM III (NEFSC 2008), a review of the existing discard mortality rate studies for Northeast groundfish stocks was conducted and it was decided that discard mortality rates would be set at 100% unless an adequate discard mortality study was available to do otherwise. The Panel recommends that the results of a recent discard mortality study by Barkley and Cadrin (2012) and any other relevant discard mortality studies be considered during the next benchmark assessment.

Recently published information on stock structure confirms SAW52 conclusions about stock definition. An interdisciplinary review of winter flounder stock structure (DeCelles and Cadrin 2011) found that the Georges Bank stock definition was supported by an examination of life history traits, seasonal movement patterns as indicated by tagging, parasite characteristics and meristics. However, they also concluded that there is some uncertainty regarding the stock structure of winter flounder in the Great South Channel and on Nantucket Shoals, which is close to the western boundary of the

Georges Bank management unit, and further research is needed to examine the stock identity of these individuals. Wirgin et al. (2014) used microsatellite DNA analysis of young-of-the year and adult winter flounder collected throughout the range of the species to conclude that winter flounder from Georges Bank was marginally distinct from the inshore collections from the Gulf of Maine and Southern New England/Mid-Atlantic stocks, but the genetic differences were less pronounced than would have been expected based on the differences in life history characteristics that have been reported. On a related topic, the Panel discussed the use of survey data from stratum 23 (in the Great South Channel), which was well justified by SAW52.

Recent publications also confirm the SAW52 method for deriving maturity at age from moving averages of macroscopic data. McBride et al. (2013) compared maturity assignment by macroscopic and microscopic methods and demonstrated that results from both methods were compatible for Georges Bank winter flounder, justifying the continued use of macroscopic data. McElroy et al. (2013) found skipped spawning of winter flounder, but did not observe skipped spawning in Georges Bank samples, so that macroscopic maturity is not a biased approach to determining maturity. Winton et al. (2014) found greater variation in size- and age-at-maturity within than between existing stock areas, justifying the use of a moving average.

2. Estimate fishing mortality and stock size for the current year, and update estimates of these parameters in previous years, if these have been revised.

The panel confirmed that there were no changes to the VPA methodology developed for SAW52 for the updated assessment. The updated model fit was similar to the SAW52 application, with patterns in survey residuals. The Panel questioned the equal weighting of survey indices, but was satisfied that VPA results were relatively insensitive to the alternative weightings considered by SAW52.
The retrospective pattern of the updated assessment was worse than the SAW52 assessment, with a tendency for SSB to decrease as data are added, and for F to increase as data are added. The retrospective-adjusted estimates of SSB and F are just within the 90% confidence limits of the unadjusted point estimates of SSB and F. Based on the criteria developed by GARM III (NEFSC 2008), , retrospective adjustments should not be applied. However, the panel noted that the retrospective pattern is worth considering as a source of uncertainty (approximately 20% for SSB and F). The panel noted that a retrospective pattern is a nonrandom error, whereas bootstrapped confidence limits of point estimates quantify random errors. The panel discussed the possibility of estimating bootstrap confidence limits for retrospective-adjusted F and SSB.

3. Identify and quantify data and model uncertainty that can be considered for setting Acceptable Biological Catch limits.

The Panel confirmed that the updated assessment includes the information needed to recommend ABC (e.g., stock status, stochastic projections at F_{MSY}, projections and 75%F_{MSY} and stochastic rebuilding projections). Although the bootstrap analysis quantifies much of the uncertainty in the assessment, the Panel also suggested that the emergence of a retrospective pattern in the updated assessment should be considered in the evaluation of uncertainty.
Although Canadian catch has been a small portion of the total catch, Canadian catch is not explicitly accounted for in the determination of the US catch limit. The Panel suggests that the PDT consider recommending that Canadian catch be considered somehow in the US Annual Catch Limit to account for all removals.

4. If appropriate, update the values of biological reference points (BRPs).

The SAW52 method of deriving F_{MSY} based on a stock-recruitment relationship assuming fixed steepness (h=0.78) was updated. The updated estimate of F_{MSY} is 0.44, slightly greater than the SAW52 estimate of 0.42. The long-term projection method developed at SAW52 was also updated and produced an estimate of SSB_{MSY}=8,100 mt, which is considerably less than the SAW52 estimate (11,800 mt). The Panel concluded that the revised estimates of MSY reference points were appropriate because of continued reductions in weight-at-age and the updated 3-year moving window of maturity-at-age and fishery selectivity.

5. Evaluate stock status with respect to updated status determination criteria.

The Panel accepts the stock status determined by updated VPA results (2013 F=0.30, 2013 SSB=6,950 mt) and updated MSY reference points (F_{MSY}=0.44, SSB_{MSY}=8,100 mt). Therefore, the stock was not overfished or experiencing overfishing in 2013.

6. Perform short-term projections; compare results to rebuilding schedules.

Short-term projections assuming 75%F_{MSY} did not achieve the rebuilding target of SSB_{MSY} by 2017 with 75% probability. Therefore, $F_{rebuild}$ was iteratively derived as 0.27.
The Panel recognized that SAW52 projections indicated that the stock should have been rebuilt, with 78% probability by 2012 and 93% probability by 2017, based on an SSB_{MSY} of 11,800 mt and fishing at 75% of F_{MSY} (=0.315), during 2012-2017, with an assumed catch of 2,118 mt in 2011. The 2011-2013 U.S. catches were similar to SAW52 projections, so the apparently slower rebuilding is primarily a result of the retrospective pattern (i.e., decreased estimates of 2011 abundance from the updated assessment) and reduced weight-at-age in recent years. Therefore, if the retrospective pattern continues, the updated projections will also be optimistic. The Panel recommends that a sensitivity projection with retrospective adjustment be provided by the PDT. The Panel recommended that performance of all groundfish projections should be evaluated in the 2015 assessment updates, similar to the evaluations provided by the 2012 update assessments (NEFSC 2012).

7. Comment on whether assessment diagnostics—or the availability of new types of assessment input data—indicate that a new assessment approach is warranted (i.e., referral to the research track).

The Panel recommends that a statistical catch at age model should be considered at the next benchmark assessment of Georges Bank winter flounder. A statistical catch at age model could estimate stock-recruitment relationships and MSY reference points within the model and include information on stock productivity before 1982.

The Panel recommends that the criterion for retrospective adjustment should be re-considered in a research track assessment. Specifically, incorporating retrospective inconsistency and adjustment in the bootstrap analysis might be a more statistically appropriate approach.
The Panel also noted that the approach of fixing steepness in the estimation of F_{MSY}, and the relationship between steepness and natural mortality should be considered for a research track topic.

8. Should the baseline model fail when applied in the operational assessment, provide guidance on how stock status might be evaluated. Should an alternative assessment approach not be readily available, provide guidance on the type of scientific and management advice that can be. The panel concluded that the updated assessment is a reliable basis for fishery management and alternative approaches are not necessary at this time.

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UPDATE OF THE GEORGES BANK WINTER FLOUNDER STOCK ASSESSMENT THROUGH 2013

Terms of Reference

1. Update all fishery-dependent data (landings, discards, catch-at-age, etc.) and all fishery-independent data (research survey information) used as inputs in the baseline model or in the last operational assessment.

2. Estimate fishing mortality and stock size for the current year, and update estimates of these parameters in previous years, if these have been revised.

3. Identify and quantify data and model uncertainty that can be considered for setting Acceptable Biological Catch limits.

4. If appropriate, update the values of biological reference points (BRPs).

5. Evaluate stock status with respect to updated status determination criteria.

6. Perform short-term projections; compare results to rebuilding schedules.

7. Comment on whether assessment diagnostics—or the availability of new types of assessment input data—indicate that a new assessment approach is warranted (i.e., referral to the research track).

8. Should the baseline model fail when applied in the operational assessment, provide guidance on how stock status might be evaluated. Should an alternative assessment approach not be readily available, provide guidance on the type of scientific and management advice that can be provided.

1.0 Background

Winter flounder on Georges Bank reach a maximum age of 19 years, and these fish reach larger sizes and have much faster growth rates than winter flounder from the Gulf of Maine and Southern New England/Mid-Atlantic stocks (NEFSC 2011a).

A portion of the Georges Bank stock (2-17% of the total catch during 2004-2013) is not regulated by the United States (US), yet is susceptible to fishing mortality, as incidental catch by the Canadian scallop dredge and groundfish bottom trawl fleets. The quantities of winter flounder discarded by the latter fleet are unknown because of a lack of observer data. Precision of the discard estimates for the scallop dredge fleet is also unknown because observer sampling coverage is very low: one trip per month during 2004-2007 and two trips per month during 2008-2013.

The Georges Bank winter flounder stock was most recently assessed during June, 2011 at SAW/SARC 52 (NEFSC 2011a, 2011b) by using an ADAPT Virtual Population Analysis (VPA) model (Gavaris 1988) that included US and Canadian catch-at-age data (ages 1-7+) for 1982-2010, an instantaneous natural mortality rate of 0.3, and a maturity schedule based on a three-year moving window that incorporated data from 1981 to 2010. The VPA model was tuned by using minimum population size estimates derived from NEFSC spring (ages 1-7+, 1982-2010) and fall bottom trawl surveys (1981-2009, ages 0-6 lagged forward one year and age) and Canadian spring bottom trawl

surveys (ages 1-7+, 1987-2010). Model diagnostics indicated trends in residuals patterns for multiple ages for each of the three tuning indices. Retrospective patterns for terminal year estimates of fishing mortality (F) and spawning stock biomass (SSB), during 2001-2009, were considered very mild and did not require adjustment. There was no retrospective pattern for terminal year estimates of age-1 recruitment (R), but terminal year estimates were highly variable.

The existing biological reference points (BRPs) were estimated during SARC 52. FMSY (= 0.42) was estimated from a Beverton-Holt stock-recruitment model (Beverton and Holt 1957) with an unfished steepness parameter that was fixed at 0.78. SSBMSY (= 11,800 mt) and MSY (= 4,400 mt) were estimated as the median values from a 100-year stochastic projection with an assumed constant harvest rate of 0.42 and 2006-2010 averages of the proportions mature-at-age, mean weights, and fishery selectivity patterns-at-age. Based on the SARC 52 BRPs, the stock was not overfished and overfishing was not occurring in 2010. However, the stock was subject to a rebuilding plan with a regulatory requirement for rebuilding to SSBMSY, with at least 75% probability, by 2017. Under the assumptions of a stochastic projection conducted for 2011-2017, the stock was predicted to be rebuilt by 2012 with 78% probability and by 2017 with 93% probability.

2.0 Fisheries

Commercial Landings

Statistical Areas (SAs) used for reporting commercial fishery data for the Georges Bank winter flounder stock include: 522-525, 542-543, 551-552, and 561-562 (Figure A1). There is no recreational fishery for winter flounder on Georges Bank. Commercial landings data were available for 1964-2013 and the data collection methodology changes are discussed in SARC 52 assessment (NEFSC 2011a). Since 1964, total landings have been predominately from the US groundfish trawl fleet, but landings have also been reported for the Canadian groundfish trawl fisheries, as bycatch in the haddock and cod fisheries (Heath Stone pers. comm.). During 1965-1977, landings were also reported by the former USSR and reached a peak of 1,699 mt in 1972 (Table A1, Figure A2). Canadian landings generally comprised a low percentage (1-2%) of the total landings until 1994, at which time Canadian landings increased rapidly from 6% of the total to a peak of 24% in 2001 (529 mt). The increasing trend in Canadian landings occurred primarily during the second half of the year because, since 1994, Canadian groundfish fisheries on Georges Bank have, for the most part, been closed during January-May (Van Eeckhaute and Brodziak 2005). After 2001, Canadian landings declined rapidly to 1% in 2007 (12 mt) and ranged between 1% and 4% of the total landings during 1982-2013.

Total landings increased from 1,516 mt in 1964 to a peak of 4,509 mt in 1972, then declined to 1,892 mt in 1976 (Figure A2, Table A1). A sustained period of high landings occurred during 1977-1984, ranging from 3,061-4,009 mt. After 1984, landings gradually declined to the lowest level in the time series, 783 mt in 1995, but then increased again to 3,139 mt in 2003. Thereafter, landings declined rapidly and reached the second lowest level on record in 2007 (807 mt). During 1982-2013, total landings averaged 1,948 mt and were slightly below average in 2013 (1,687 mt).

Most of the US landings (92-100%) are harvested with bottom trawls, and most of the remainder is harvested by the scallop dredge fleet (Table A2). During most years since 1982, landings harvested by the scallop dredge fleet comprised less than 1% of the total US landings. However, a high period of landings by the scallop dredge fleet (4-8% of the total landings) occurred during 1988-1993 and in 2005-2006 (6% and 3%, respectively, of the total landings).

The spatial distribution of winter flounder landings on Georges Bank has largely been affected by complex management regulations. During 1982-1993, prior to the implementation of groundfish Closed Areas I and II (Figure A3), most of the Georges Bank landings of winter flounder were taken

in the two northern Statistical Areas (SAs), 522 and 562. Since 1994, portions of the four SAs where most of the landings occur (522, 525, 561, and 562) have been closed, for the most part, to groundfish bottom trawl fishing (Figure A4). During 1994-2001, most of the landings occurred in SA 522 (37-69%), but then shifted to SA 562 during 2002-2005, where 38-54% of the landings occurred (Figure A4). With implementation of the Eastern (SAs 561 and 562) and Western US/CA Areas (SAs 522 and 525) in May of 2004, which was linked to the establishment of total allowable catches (TACs) for cod, haddock and yellowtail for the US versus CA within their respective Exclusive Economic Zones (EEZs), landings began increasing again in SAs 522 and 525. The shift in where the predominant landings occurred (from the Eastern to the Western US/CA Area), after 2004, may have been attributable, in part, to the 2005 requirement to use a haddock separator trawl when fishing in the Eastern US/CA Area as well as closures of this Area when cod, haddock, or yellowtail quotas were reached. The haddock separator trawl was designed to catch haddock but to reduce incidental catches of other demersal finfish species. During 2006-2013, most of the landings occurred in SA 522 (Figure A4).

Precision (Proportional Standard Error, reported as a %) of the US landings, because of allocation of the landings to Statistical Area using Vessel Trip Reports, averaged 0.9% during 1995-2013 and was much lower during 2012 (0.3 %) and 2013 (0.5%, Table A3).

Discards

US Fisheries

US discard estimates were updated for 2011-2013 by using data from the Northeast Fisheries Observer Program (NEFOP) Database and the Commercial Fisheries Database. Discards were estimated for the large-mesh bottom trawl (codend mesh size >= 5.5 inches), small-mesh bottom trawl (codend mesh size < 5.5 inches), and sea scallop dredge fleets (Table A4 and Figure A5), according to the combined ratio method (Wigley et al 2008) for 1989 onward, and the hindcast methods used for the earlier years, similar to the most recent Georges Bank winter flounder stock assessment (NEFSC 2011a).

US discards of Georges Bank winter flounder were much higher during 1964-1991 (average = 195 mt) than during 1992-2013 (average = 70 mt). During 1964-1975, US discards were predominately (49-87%) attributable to the large-mesh groundfish trawl fleet (listed in Table A4 as the small-mesh fleet because the minimum codend mesh size prior to 1982 was less than 5.5 in.), but were primarily attributable to the scallop dredge fleet thereafter. Total US discards were highest during 1976-1991 (ranging between 142 mt and a peak of 348 mt in 1990), but then declined to 29 mt in 1992 and remained low through 2004, averaging 35 mt (Table A4, Figure A5). During 2005-2009, US discards averaged 130 mt. During 1982-2009, the trend in US discards of Georges Bank winter flounder has followed the trend in fishing effort (days fished) of the US scallop dredge fleet (NEFSC 2010). During 2010-2013, US discards of winter flounder declined from 138 mt to 47 mt, respectively (Table A4). During most years since 2005, when trip sampling rates increased substantially in the scallop dredge and large-mesh bottom trawl fleets, precision of the US discard estimates greatly improved (average CV = 0.15 during 2005-2013) and was lowest during 2011-2013, with coefficients of variation (CV) ranging between 0.07 and 0.11 (Table A4).

Canadian Fisheries

The Canadian sea scallop fishery operates with dredges on the Canadian portion of Georges Bank and closes when the annual TACs are caught for the two respective management areas. Landings of groundfish bycatch in the Canadian sea scallop fishery have been prohibited since 1996, so presumably all winter flounder bycatch in the fishery is discarded. Observer coverage of the Canadian scallop dredge fleet was very low and consisted of one trip per month from January 2004

to July 2007 and two trips per month thereafter. Observer discard data for winter flounder caught in the Canadian sea scallop fishery were available for September 2004-December 2013, and discard estimates for the fleet were provided by staff from the CA Division of Fisheries and Oceans (DFO) using the method of Garvaris and VanEeckhaute (2007). The 2004-2010 average of the proportions of Georges Bank winter flounder discards to sea scallop landings by the Canadian scallop fleet (= 0.029) was multiplied by the sea scallop landings in the Canadian scallop fleet (CSAS 2010; J. Sameoto, pers. comm. 2011) in order to obtain hindcast estimates of winter flounder discards for the entire fleet during 1982-2003.

Winter flounder discards in the Canadian sea scallop fishery averaged 128 mt during 2004-2013 and declined between 2009 and 2013, from 252 mt to 29 mt, respectively (Table A1). Hindcast discard estimates for the fleet during 1982-2003 ranged between 58 and 199 mt. The associated precision of the discard estimates is unknown because of the lack of adequate observer sampling.

Estimates of winter flounder discards in the Canadian bottom trawl fisheries were not available from the CA DFO. Since most of the Canadian landings of Georges Bank winter flounder occur as bycatch in bottom trawl fisheries targeting haddock and cod in (H. Stone pers. comm.), presumably some winter flounder discards also occur in these and possibly other Canadian bottom trawl fisheries that operate on Georges Bank. Since the mid-1980s, discarding of groundfish in the Canadian groundfish fisheries operating on Georges Bank (NAFO Division 5Zj) has been prohibited. However, although there is no discarding of groundfish during observed trips, observer coverage of the groundfish bottom trawl fleet is very low, and there is no doubt that discarding of winter flounder occurs because discards for species that are more highly sought after in the Georges Bank Canadian groundfish fisheries (e.g., cod, haddock, and yellowtail flounder) have been estimated (Gavaris et al. 2010).

Total Discards

During 1982-2013, discards of winter flounder on Georges Bank were higher in the US fisheries prior to 1991 and higher in the Canadian scallop dredge fishery thereafter (Figure A6). Total discards were much higher during 1982-1991, than thereafter, but total discards slowly increased again from 59 mt in 1995 to 343 mt in 2009 then declined rapidly to 76 mt in 2013 (Table A1, Figure A6). During 1982-2013, total discards averaged 12% of the total catch (Table A1).

Catches

Total catches were dominated (69-95%) by the US landings, primarily from the groundfish bottom trawl fleet, during 1964-2013 (Table A1). Catches from Canadian fleets, landings in the haddock and cod fisheries, and discards from the scallop dredge fleet, represented 2-17% of the total catch during 1982-2013, but discards in the bottom trawl fleets and the precision of the Canadian discard estimates are unknown. In recent years, the Canadian percentage of the total catches declined from 13% in 2009 to 2% in 2013. During 1964-2010, total catch averaged 2,526 mt. During 2011-2013, catches totaled 2,070 mt, 2,185 mt, and 1,763 mt, respectively (Table A1, Figure A7).

Historical catches were likely higher than those observed since 1964 because the US landings alone reached a peak of 4,089 mt in 1945, close to the magnitude of the peak catch during 1964-2013 (4,608 mt), and without the inclusion of discards which presumably would have been substantial prior to 1964 because codend mesh sizes were much smaller (Figure A7).

Landings-at-age

Length and age composition data are not collected from either the landings or discards of Canadian fleets that fish on Georges Bank. Length and age composition samples from the US landings were available, by market category and quarter, for 1982-2013. Since 1982, landings of Georges Bank winter flounder have been reported, depending on the port of landing, for eight market

categories (Lemon Sole = 1201, Extra Large = 1204, Large = 1202, Large /Mixed = 1205, Medium = 1206, Small = 1203, Peewee = 1207, and Unclassified = 1200). However, 85% of the landings during 1982-2013 were composed of only three market categories (Lemon Sole, Large, and Small). After comparing the length frequencies by market category, across years, the data were binned into the following market category groups: Lemon Sole (1201 and 1204), Large (1202 and 1205) and Small (1203, 1206, and 1207).

During 1982-2013, the annual sampling intensity of lengths of landed fish, consisting of approximately 100 fish per sample, ranged between 15 mt and 271 mt per sample (Table A5). Sampling intensity was lowest during 1996-2000, but particularly during 1998 and 1999 when sampling intensity was 271 mt per sample and 192 mt per sample, respectively. After 2000, sampling intensity improved substantially and has been highest since 2005 (Table A5, Figure A8). During 1982-2002, landings were dominated by the Large and Medium/Small market category groups, but during 2002-2008, landings were dominated by larger fish (Lemon Sole and Large, Tables A6 and A7), which was reflected in the increased sampling intensity of these larger fish. Landings of Medium/Small fish increased after 2007, as the 2006 year class moved through the fishery, and constituted the predominant market category during 2009-2013 (Figure A9). Landings of Lemon Sole and Extra Large fish declined after 2003 and were very low during 2010-2013.

During most years, biological sampling of the US landings was adequate to construct the landings-at-age (LAA) matrix. The matrix was constructed by applying the commercial age-length keys to the corresponding landings length frequency data, on either a quarterly or half-year basis, by market category group (Table A8). The LAA matrix from the most recent assessment (NEFSC 2011a) was updated to include data for 2011-2013 (Table A9). The US Unclassified market category samples were prorated, and the Canadian landings were assumed to have the same age compositions as the sampled US landings, and therefore, the US LAA were adjusted by a raising factor to incorporate the Canadian landings. The minimum size limit for winter flounder landings in the US bottom trawl fishery was 28 cm from January 1986 to April 1994 and has been 30 cm since then.

Landings-at-age (numbers, in thousands) during 1982-2013 were computed for ages 1-7+. Large year classes were traceable in the landings-at-age matrix. For example, landings of large numbers of fish from the 1994 cohort can be tracked through age 3 in 1997. Age 0 fish do not appear in the landings and landings of age 1 fish were insignificant during most years (Table A9). The landings were dominated by age 3-5 fish during 1982-1984 and were dominated by age 2-4 fish during 1985-2000. Since 2001, the landings have returned to a predominance of age 3-5 fish. In part, this change was due to a codend mesh size increase (to 6.5 in. square or diamond mesh) that was required in the Georges Bank bottom trawl fishery for groundfish beginning in August 2002.

Discards-at-age

The annual numbers of lengths sampled from winter flounder discards in the US bottom trawl and scallop dredge fisheries were inadequate to characterize discard length compositions during 1989-2001 and 1989-2003 (with the exception of 1997), respectively (Table A10). Length and age composition data for winter flounder discards in the Canadian fisheries are not collected. For years lacking adequate length composition data, US bottom trawl discards-at-age were characterized based on the assumption that fish smaller than the US minimum regulatory size limits were discarded. The minimum size limit for winter flounder landings by the US bottom trawl fishery was 28 cm from January 1986 to April 1994 and has been 30 cm since then. Examination of survey length-at-age data indicates that fish of this size are one year old in the NEFSC fall surveys and two years old in the spring surveys. Therefore, discards-at-age for the US bottom trawl fleet, during 1982-2001, were estimated by dividing the estimated discard weight of winter flounder by the bottom trawl fleet, during January-June, by the annual mean weights of age 2 fish from the NEFSC spring surveys.

Likewise, winter flounder discard weights for July-December were divided by the annual mean weights of age 1 fish from the NEFSC fall surveys. Discards-at-age for the US bottom trawl fleet, during 2002-2013, were estimated by using the discard numbers at length from the NEFOP Database, binned as January-June and July-December, to characterize the proportion discarded at length and ages were determined by applying the NEFSC spring and fall survey age-length keys and length-weight relationships, respectively. Length compositions of discarded fish in the US bottom trawl fishery indicate that for most years during 2002-2013, discarding of all sizes of winter flounder occurred (NEFSC 2011a), particularly when Georges Bank winter flounder trip limits were in place during May, 2006 - July 6 of 2009 (5,000 lbs per trip). As of October of 2010, all NE multispecies permit holders that fished on a sector trip were prohibited from discarding legal-sized fish (must land all winter flounder > 30 cm TL).

Length samples of winter flounder discarded in the US scallop dredge fishery were inadequate to characterize discard length compositions during 1989-2003, with the exception of 1997 (Table A10). The post-2003 discard length composition data suggested that, in general, all sizes of winter flounder were discarded in the US scallop dredge fishery, but that catches of winter flounder smaller than 30 cm were very low. Similar types of scallop dredges are used by the Canadian scallop dredge fleet (H. Stone, pers. comm.). The Canadian scallop dredge fleet has been prohibited from landing groundfish since 1996 and winter flounder is a low-value species in CA in relation to cod, haddock, and yellowtail flounder (there is no existing directed fishery for winter flounder). Given these considerations, discards-at-age for the both the US and Canadian scallop dredge fisheries, during 1982-2003, were estimated by scaling up the LAA by the ratio of total scallop dredge discards to total landings. During years when sufficient numbers of length samples of winter flounder discards were available, 1997 and 2004-2013, the annual discard length frequency distributions were used to characterize the proportion of discards-at-length for both the US and Canadian scallop dredge fleets. The NEFSC fall survey age-length keys and length-weight relationships were applied to the combined annual discard weights (US and CA) because most of the US discards occurred during the second half of the year.

Discards-at-age (numbers, in thousands) were computed for ages 1-7+. Discards occurred across all age categories because most discards occur in the US and Canadian scallop dredge fleets. Numbers of discarded fish shifted primarily from age 2-4 fish during 1982-1997 to age 3-5 fish during 1998-2003 (Table A11). The total numbers of fish discarded were consistently much lower during 2004-2010, when the fishing in Closed Areas I and II was mostly prohibited for groundfish trawlers and limited for scallop fishing. However, the range of ages that were discarded broadened to include mostly ages 2-5. Discards of age 1 fish, which occur primarily in bottom trawl rather than scallop dredge fisheries, were highest during 1982-1985; a time when there was no minimum landings size limit in effect and the minimum codend mesh size was smallest (5.5 in) for groundfish trawlers. During 1982-2010, the numbers of age 1 discards decreased, presumably because the minimum codend mesh size required in groundfish bottom trawls was increased to 6.5 in.

Catch-at-age

Catch-at-age (CAA, numbers in thousands) during 1982-2013 was computed for ages 1-7+. Components of the CAA consisted of the combined US and Canadian landings-at-age, discards-at-age for the US large-mesh and small-mesh bottom trawl fleets, and the US and Canadian scallop dredge fleets (Table A12). During 1982-1984, the CAA contained a broad range of ages, but was dominated by ages 2-5 and had the highest numbers of fish aged 6 and older (Table A13, Figure A10). The CAA changed from this more stable age composition to one dominated by ages 2-4, during 1985-1996. During 2000-2005, the catch composition changed back to a predominance of age 3-5 fish and contained more older fish (ages 6 and older), but not at the higher levels observed during

1980-1984. Catches were dominated by age 3-4 fish during 2008-2013 as the 2006 year-class moved through the fishery (Table A13, Figure A10).

Mean weights-at-age in the catch remained relatively stable during 1985-1996 across most ages, but then declined to a lower level during 1997-2001, for ages 3-5 possibly due, in part, to poor sampling of large fish during part of this time period (Figure A11, Table A14). Mean weights-at-age, for ages 3-7+, reached their highest levels during 2003-2007, but then declined through 2013 to some of the lowest levels since 1982 (Figure A11).

3.0 Research Bottom Trawl Surveys

Biomass and Abundance Indices

Relative abundance and biomass indices were derived for Georges Bank winter flounder with data from NEFSC spring (April, 1982-2014) and fall (1981-2013) bottom trawl surveys (offshore strata 13-23, Figure A12). Indices were also derived from Canadian stratified random bottom trawl surveys, conducted in strata 5Z1-4 (Figure A13) during February by Maritimes Region staffs from the CA Division of Fisheries and Oceans (DFO), were also included in the assessment. Survey design and sampling protocols for the Canadian surveys are provided in Chadwick et al. (2007).

Relative biomass (stratified mean kg per tow) and abundance (stratified mean number per tow) indices are presented for the NEFSC spring (April, 1968-2014) and fall (October, 1963-2013) bottom trawl surveys, as well the Canadian spring bottom trawl surveys conducted during February, 1987-2013 (Table A15, Figure A14). NEFSC survey indices prior to 1985 were standardized for gear changes (weight = 1.86 and numbers = 2.02, Sissenwine and Bowman 1978) and trawl door changes (weight = 1.39 and numbers = 1.4, Byrne and Forrester 1991). A stock-specific, calibration factor for numbers-at-length (combined seasons) was to convert post-2008 RSV *H.B. Bigelow* survey abundance indices of Georges Bank winter flounder to R/V *Albatross IV* units (NEFSC 2011a).

Despite considerable interannual variability, the NEFSC fall survey relative abundance indices showed an increasing trend during the 1970s, followed by a declining trend during the 1980s to a time series low in 1991 (Figure A14). Thereafter, fall relative abundance increased through 2001 then declined to a level below the 1963-2009 median during 2005-2007. In 2009, fall relative abundance reached the second highest point in the time series but declined and was slightly below the median in 2013. Trends in the NEFSC spring survey relative abundance indices exhibited more interannual variability and were most similar to the fall survey indices during 1982-2008, but the two time series varied from one another thereafter (Figure A14). NEFSC spring survey abundance indices were at record low levels during 2004-2007. Spring relative abundance increased steadily after 2011 and was well above the median in 2014. Relative abundance trends in the Canadian spring surveys were similar to those in the NEFSC spring survey during most years but were of greater magnitude during 1988-1990 and 1993-1997. Unlike the NEFSC spring indices, the Canadian spring indices remained stable at some of the lowest levels in the time series during 2008-2014.

The spatial distribution of winter flounder on Georges Bank (kg per tow), during the 2011-2014 NEFSC spring surveys and the 2011-2013 NEFSC fall bottom trawl surveys, was similar to the average distribution patterns for each of the two surveys during 2001-2010 (Appendix A1).

In order to estimate catchability coefficients (q) for each survey within the VPA model, minimum population size estimates were computed based on swept-area estimates of wingspread (= 0.011 nmi^2 for NEFSC surveys conducted by the R/Vs *Albatross IV* and *Delaware II* and 0.012 nmi^2 for the CA surveys). During NEFSC and CA surveys, tows are conducted for 30 minutes, between winch lock and reengage, at a target speed of 3.5 knots (Azarovitz 1981; Chadwick et al 2007). Minimum population sizes-at-age (in thousands) included in the VPA included: the US fall (1981-

2013, ages 0-6 lagged forward one year and age, Table A16) and spring bottom trawl surveys (1982-2014, Table A17) and the Canadian spring bottom trawl surveys (1987-2014, Table A18).

Age samples of winter flounder are not collected during Canadian bottom trawl surveys, so the NEFSC spring survey age-length keys were used to partition stratified mean numbers-at-length from the Canadian surveys into numbers-at-age. Although the numbers-at-age were highly variable, large cohorts appeared to track through the numbers-at-age matrices, for the NEFSC surveys, for the 1980, 1987, 1994, 1998-2001, and 2006 cohorts (Figure A15). Age truncation occurred between 1983 and 1997, during which time the population was dominated by two to four age groups rather than seven or more. During 1998-2004, the age structure improved but then became truncated again. Both the US and Canadian spring surveys showed reduced numbers of age 1-3 fish (and age 4 fish in the CA surveys) during 2000-2007. During 2008-2010, increases in the numbers of age 1-6 fish occurred in the NEFSC spring surveys, but the Canadian spring surveys did not show the similar increases. Population age structure has expanded since 2009 in the NEFSC spring and fall surveys but not in the Canadian surveys (Figure A15).

Maturity Schedule

Georges Bank winter flounder spawn during March-May, with a peak in April (Smith 1985). As in the previous assessment (NEFSC 2011a), the maturity schedule was estimated as a 3-year moving window based on an adjustment of the female maturity-at-age data from the NEFSC spring surveys. The 1982-2010 maturity schedules were updated with data for 2011-2014. The average of the median age-at-maturity (A50), during 1982-2013, was 2.4 years (Figure A16).

4.0 Assessment

The current assessment update utilizes the VPA model formulation from SARC 52 (NEFSC 2011a) with the addition of catch-at-age (CAA) data for 2011-2013 and survey tuning indices for 2011-2014. Version 3.4.5 of the ADAPT/VPA software available from the NOAA Fisheries Toolbox (NOAA 2014) was utilized. A retrospective analysis for terminal years 2006-2012 was conducted and averages of the relative differences in the estimates of F, SSB and R for each retrospective run, Mohn's rho values (Mohn 1999), were computed to determine the need for adjustments to terminal year estimates of average F, SSB and R values. Input data to the VPA model are presented in Table A19.

Similar to SARC 52, trends in the residuals patterns, both positive and negative, were evident for a number of ages within each of the three sets of VPA calibration indices, with variability by age and year. For example, residuals trends from NEFSC spring surveys were the worst for age 2 and age 3 fish (Figure A17). The Canadian spring survey indices for ages 2-4 showed major residuals trends (Figure A18), also both positive and negative, but the patterns differed from those evident in the NEFSC spring surveys. Residuals trends for the NEFSC fall survey abundance indices were the worst for older fish, ages 5-7+ (actually ages 4-6 lagged forward one year and age, Figure A19).

VPA estimates of survey catchability coefficients (q), by age, were similar to those from SARC 52 and indicated that catchabilities for all three surveys generally increased with age (Figure A20). Catchabilities-at-age were higher for the NEFSC fall surveys than for the NEFSC spring surveys but were not significantly different between surveys for ages 4-7+. Catchabilities for the Canadian spring surveys can be compared across ages but not between surveys because the vessels and gear were different. For all three surveys, catchabilities of age 1-3 fish were significantly lower than for age 5-7+ fish (Figure A20).

Fishing mortality, spawning stock biomass and recruitment

VPA estimates-at-age of Jan. 1 stock sizes (numbers, in thousands), average fishing mortality rates (fully recruited F at ages 4-6), and spawning stock biomass are presented in Tables A20-A22. Fishing mortality rates averaged 0.56 during 1982-2012. Fishing mortality rates were highest during 1984-1993, ranging between 0.57 and 1.17, then declined to between 0.31 and 0.51 during 1994-1998 (Figure A21, Table A23). The second highest period of fishing mortality rates occurred during 2001-2005, ranging between 0.52 and 0.89 and was followed by a decline to the second lowest level (0.25) in 2006. During 2007-2010, fishing mortality rates ranged between 0.29 and 0.41, then declined from 0.40 in 2011 to 0.30 in 2013 (Table A23). Based on 1,000 bootstrap iterations, the 90% confidence limits for the 2013 fishing mortality rate estimate are 0.22 and 0.43 (Table A24).

During 1982-2012, SSB averaged 7,388 mt. SSB declined rapidly from a time series peak of 17,380 mt in 1982 to 6,256 mt in 1985 and then gradually declined further to a time series low of 3,420 mt in 1995 (Figure A21, Table A23). SSB subsequently increased to 13,685 mt in 2000 but then declined to 4,533 mt in 2005 and remained stable at this low level through 2008. SSB has been increasing since 2008 and totaled 6,947 mt in 2013. Based on 1,000 bootstrap iterations, the 90% confidence limits for the 2013 SSB estimate are 5,525 mt and 9,274 mt (Table A25).

Recruitment (age 1) was highly variable and averaged 12.4 million fish during 1982-2012. Recruitment trends showed two periods of rise-and-fall, during 1983-1993 and during 1993-2005, with a peak of 26.3 million fish in 1988 (Figure A21, Table A23). After reaching a time series low of 4.1 million fish in 2005, recruitment increased to 15.2 million fish in 2009 and ranged between 7.7 and 16.8 million fish during 2010-2013. The 2014 recruitment value (9.9 million fish) is very uncertain because it represents the geometric mean of the 2006-2012 numbers of age-1 fish from the surveys.

January 1 stock sizes were estimable for ages 4-6. Based on 1,000 bootstrap iterations, stock sizes at the beginning of 2014 were fairly well estimated for ages 3-6, with CVs varying between 0.34-0.45 (Table A26). The fully recruited F for ages 4-6, in 2013, was well estimated with CVs ranging between 0.20 and 0.32 (Table A27).

Retrospective analysis

The 2006-2012 terminal year estimates of fishing mortality were underestimated and spawning stock biomass estimates were overestimated (Figures A22 and A23). There was no retrospective pattern for terminal year age-1 recruitment, but the estimates were highly variable (Figures A22 and A23). Overall, the retrospective patterns in F, SSB and age-1 R were stronger than those observed in the SARC52 assessment (NEFSC 2011a). Mohn's rho values for terminal years 2006-2012 were F = -0.1639 and SSB = 0.2565. Retrospective adjustment factors (1/(1+rho)) of 1.196 and 0.796 were applied to the 2013 F and SSB estimates, respectively. The retrospective-adjusted point estimates of F and SSB in 2013 were F = 0.36 and SSB = 5,529 mt.

5.0 Biological Reference Points

The existing BRPs were estimated at SARC52 (NEFSC 2011a). FMSY (= 0.42) was estimated from a Beverton-Holt stock-recruitment model using the Stock-Recruitment Fitting Model (SRFIT) software (version 7.0.1) available in the NOAA Fisheries Toolbox (NOAA 2010). The model incorporated R (age 1, 1982-2012 year-classes) and SSB estimates from the final VPA model with a fixed prior on unfished steepness (h = 0.78). At SARC 52, the review panel noted that the stock-recruitment data for the Georges Bank stock were less informative than the SNE/MA data for predicting recruitment at low spawner levels, making direct estimation of the spawner-recruit relationship difficult without external information. The SARC 52 review panel also concluded that steepness values should be similar between winter flounder stocks and used the steepness log-

likelihood profiles of the two stocks to select fixed values for steepness with which to estimate FMSY for each stock. Steepness values that were within two units of the minimum AIC were considered to be realistic values for each stock and fixed steepness values of 0.61 and 0.78 were recommended for the SNE/MA and Georges Bank winter flounder stocks, respectively.

The SARC 52 formulation of the Beverton-Holt model (steepness fixed at 0.78) was updated with R and SSB estimates from the updated VPA model for year-classes 1982-2012. Additional input data included the most recent five-year averages (2009-2013) of fishery selectivity-at-age, proportion mature-at age, and weights-at-age from the updated VPA model (Table A28). A sensitivity analysis was conducted to reevaluate the log-likelihood profile of the fixed steepness parameter. Parameter estimates from the updated run of the model are shown in Table A29. Similar to the SARC 52 results, the steepness parameter for the model could not be estimated (h=1) without assuming a prior. The steepness and FMSY values, when estimated with a steepness prior of 0.80, were also similar to the estimates from SARC 52. Again, the steepness log-likelihood profile indicated that the steepness prior was highly influential in determining the FMSY estimate (Table A30). The updated FMSY estimate resulting from fixing steepness at 0.78 was 0.44. Precision estimates for FMSY were not possible because of fixing the steepness parameter. Results from the model fit and standardized residuals are shown in Figure A24. Similar to the SARC 52 model results, trends in the residuals alternated between positive and negative for most of the time series.

SSBMSY and MSY, and their associated precision, were estimated with the same method used for SARC 52: medians of 100-year stochastic projections that incorporated the parameter estimates and variance from the Beverton-Holt model and the most recent five-year averages (2009-2013) of fishery selectivity-at-age, weights-at-age, and proportions mature-at-age (Table A28). Existing and updated BRPs are presented in Table A31. The updated BRPs were used to determine the status of the Georges Bank winter flounder stock during 2013 and were estimated as: FMSY (Fthreshold) = 0.44; SSBMSY (Btarget) = 8,100 mt; ½ SSBMSY (Bthreshold) = 4,050 mt and MSY = 3,200 mt.

The retrospective-adjusted 2013 F and SSB point estimate was compared with the 90% confidence intervals of the unadjusted 2013 F and SSB point estimate to determine whether retrospective error adjustments were necessary for stock status determination and for the stochastic projection runs described in Section 6.0. The 2013 retrospective-adjusted point estimate of F and SSB (F = 0.36, SSB = 5,529 mt) fell within the 90% confidence intervals of the 2013 unadjusted point estimate but was very close to the lower confidence limit of the F estimate (Table A31, Figure A25). Consequently, based on the guidance provided at GARM III (NEFSC 2008), retrospective error adjustments of the 2013 F and SSB values were not necessary. Based on the updated BRPs, overfishing was not occurring in 2013 because the 2013 fishing mortality rate (= 0.30) was below the updated value of FMSY (= 0.44, Figure A25). The stock was also not overfished in 2013 because spawning stock biomass in 2013 (= 6,947 mt) was above the SSBMSY threshold (= 4,050 mt, Figure A25).

The results of a bootstrap analysis (1,000 iterations) indicated that there was a 90% probability that the 2013 F estimate (0.30) was between 0.22 and 0.43 and that the 2013 SSB estimate (6,947 mt) was between 5,525 mt and 9,274 mt (Figure A26, Table A30).

6.0 Projections

Stochastic projections of SSB and catch during 2014-2017 were conducted based on results from the updated VPA model run and the updated BRPs with AGEPRO software (v. 4.2.2) from the NOAA Fisheries Toolbox (NOAA 2014). In order to reflect current conditions in the stock and fishery, the projections incorporated uncertainty in the current population estimate from bootstrap

replicates (N=1,000) and input data included the parameter and variance estimates from the updated Beverton-Holt stock-recruitment model as well as the 2009-2013 proportions mature-at-age, mean weights-at-age, and fishery selectivity patterns-at-age (Table A27). The regulations require rebuilding of the Georges Bank winter flounder stock, with at least 75% probability, by 2017.

Two sets of projections were run. Both sets assumed an Annual Catch Limit (ACL) of 1,522 mt in calendar year 2014 (source: GARFO Monitoring and Analysis staff). The first projection included fishing at 75% of FMSY (= 0.33) during 2015-2017. The projection results indicated that rebuilding to SSBMSY (= 8,100 mt) should occur by 2017, but with only 60% rather than the required 75% minimum probability (Figure A27). Therefore, an iterative series of projection runs were conducted to determine Frebuild with the same input data. The results indicated that rebuilding to SSBMSY is expected to be achieved in 2017, with 76% probability, when fishing at Frebuild = 0.27 (Figure A28). The projected median estimate of SSB in 2017 was 9,221 mt (90% CLs = 6,909, 12,803), and projections of median catches during 2015-2017 were 2,124 mt, 2,222 mt, and 2,294 mt, respectively (Figure A29).

7.0 Summary

Updated biological reference points (BRPs) for the stock are:

FMSY = 0.44
SSBMSY = 8,100 mt
MSY = 3,200 mt

Stock Status in 2013

Retrospective bias adjustments were not required for the determination of stock status in 2013 because the bias-adjusted 2013 point estimate of SSB and F was within the 90% confidence intervals of the unadjusted 2013 point estimate of these values (Table A31, Figure A25). SSB in 2013 (6,947 mt) was above the new reference point biomass threshold (½ SSBMSY = 4,050 mt), and therefore, the stock was not overfished in 2013. F in 2013 (0.30) was below the new FMSY threshold (= 0.44), and therefore, overfishing was not occurring during 2013. The stock is predicted to rebuild to SSBMSY (= 8,100 mt), with 76% probability, in 2017 based on stochastic projections that assumed an Annual Catch Limit of 1,522 mt in 2014 and fishing at Frebuild = 0.27 during 2015-2017.

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Table A1. Landings, discards, and catches (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by US Statistical Areas and Northwest Atlantic Fishery Organization (NAFO) fishery reporting areas, during 1964-2013.

YEAR	522-525 561-562 USA[1]	5Ze[2] (521-526 and 551-562) CA	5Ze[2] (521-526 and 551-562) USSR	5Z[3] (521-562) CA USSR	TOTAL LANDINGS		DISCARDS USA	DISCARDS CA	TOTAL CATCH
1964	1,370			146		1,516	231		1,747
1965	1,175			199	312	1,686	165		1,851
1966	1,876			164	156	2,196	137		2,333
1967	1,916			83	349	2,348	106		2,454
1968	1,569	57	372			1,998	140		2,138
1969	2,165	116	235			2,516	117		2,633
1970	2,613	61	40			2,714	109		2,824
1971	3,089	62	1,029			4,180	105		4,286
1972	2,802	8	1,699			4,509	98		4,608
1973	2,267	14	693			2,974	94		3,068
1974	2,123	12	82			2,217	98		2,315
1975	2,407	13	515			2,935	118		3,053
1976	1,876	15	1			1,892	142		2,034
1977	3,569	15	7			3,591	207		3,798
1978	3,183	65				3,248	262		3,510
1979	3,042	19				3,061	257		3,319
1980	3,928	44				3,972	255		4,227
1981	3,990	19				4,009	281		4,290
1982	2,959	19				2,978	246	114	3,338
1983	3,894	14				3,908	225	70	4,203
1984	3,927	4				3,931	195	56	4,182
1985	2,151	12				2,163	158	111	2,432
1986	1,761	25				1,786	182	142	2,110
1987	2,637	32				2,669	272	197	3,138
1988	2,804	55				2,859	293	126	3,278
1989	1,880	11				1,891	316	136	2,343
1990	1,898	55				1,953	338	151	2,442
1991	1,814	14				1,828	314	168	2,310
1992	1,822	27				1,849	29	178	2,056
1993	1,662	21				1,683	11	179	1,873
1994	931	65				996	10	145	1,150
1995	729	54				783	1	58	842
1996	1,370	71				1,441	26	87	1,554

Table A1, continued. Landings, discards, and catches (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by US Statistical Areas and Northwest Atlantic Fishery Organization (NAFO) fishery reporting areas, during 1964-2013.

YEAR	522-525 561-562 USA[1]	5Ze[2] (521-526 and 551-562) CA	5Ze[2] (521-526 and 551-562) USSR	5Z[3] (521-562) CA	5Z[3] (521-562) USSR	TOTAL LANDINGS	DISCARDS USA	DISCARDS CA[4]	TOTAL CATCH
1997	1,226	143				1,369	69	124	1,562
1998	1,308	93				1,401	52	116	1,569
1999	939	104				1,043	85	107	1,235
2000	1,603	161				1,764	65	198	2,027
2001	1,674	529				2,203	11	199	2,413
2002	2,100	244				2,344	20	193	2,558
2003	2,829	310				3,139	9	179	3,328
2004	2,660	191				2,851	69	105	3,026
2005	2,012	73				2,085	118	145	2,347
2006	825	55				880	110	135	1,125
2007	795	12				807	188	44	1,039
2008	947	20				967	143	69	1,179
2009	1,658	12				1,670	91	252	2,013
2010	1,252	45				1,297	138	109	1,544
2011	1,801	52				1,853	129	88	2,070
2012	1,911	83				1,994	113	79	2,185
2013	1,675	12				1,687	47	29	1,763

[1] USA landings during 1964-1985 include those from Statistical Areas 551 and 552, and since May of 1994, landings have been self-reported by dealers and were allocated to statistical areas based on Vessel Trip Report data.
[2] During 1968-1985, landings were reported to NAFO for Division 5Ze and may include landings from Statistical Areas 521 and 526 which are located outside of the Georges Bank winter flounder stock area.
[3] During 1964-1967, landings were reported to NAFO for Division 5Z and may include landings from Statistical Areas 533-539 which are located outside of the Georges Bank winter flounder stock area.
[4] Only includes discards from the CA scallop dredge fleet during 1982-2013 because discards from the CA bottom trawl fleets were not provided by the CA Department of Fisheries and Oceans. The 2004 CA discard estimate is only based on fishery observer data for August-December because no data were collected during January-July.

Table A2. USA landings (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by major gear type, during 1964-2013.

	USA Landings (mt)				
Year	Bottom Trawl	Scallop Dredge	Other	Total	% Bottom Trawl
1964	1,359	11.2	0.0	1,370	99.2
1965	1,174	0.9	0.0	1,175	99.9
1966	1,872	4.2	0.0	1,876	99.8
1967	1,914	1.8	0.0	1,916	99.9
1968	1,564	4.6	0.0	1,569	99.7
1969	2,163	1.8	0.0	2,165	99.9
1970	2,609	4.4	0.0	2,613	99.8
1971	3,085	4.8	0.0	3,089	99.8
1972	2,795	7.9	0.0	2,802	99.7
1973	2,264	3.4	0.1	2,267	99.8
1974	2,115	7.7	0.0	2,123	99.6
1975	2,407	0.0	0.0	2,407	100.0
1976	1,875	1.0	0.0	1,876	99.9
1977	3,568	1.1	0.0	3,569	100.0
1978	3,165	17.9	0.0	3,183	99.4
1979	3,018	24.9	0.0	3,042	99.2
1980	3,885	42.5	0.3	3,928	98.9
1981	3,934	53.5	2.5	3,990	98.6
1982	2,917	41.2	0.0	2,959	98.6
1983	3,868	25.4	0.8	3,894	99.3
1984	3,908	18.4	0.4	3,927	99.5
1985	2,148	3.1	0.0	2,151	99.9
1986	1,725	36.0	0.0	1,761	98.0
1987	2,559	77.9	0.0	2,637	97.0
1988	2,697	106.4	0.0	2,804	96.2
1989	1,760	119.7	0.0	1,880	93.6
1990	1,780	118.1	0.1	1,898	93.8
1991	1,673	141.1	0.0	1,814	92.2
1992	1,685	136.3	0.0	1,822	92.5
1993	1,546	115.4	0.0	1,662	93.1
1994	894	21.6	15.3	931	96.0
1995	716	8.5	4.5	729	98.2
1996	1,365	4.6	0.7	1,370	99.6
1997	1,212	12.0	2.0	1,226	98.9
1998	1,293	13.3	1.8	1,308	98.8
1999	925	11.2	2.5	939	98.5
2000	1,577	23.1	3.4	1,603	98.3
2001	1,667	6.3	0.3	1,674	99.6
2002	2,092	1.0	7.1	2,100	99.6
2003	2,826	0.4	3.2	2,829	99.9
2004	2,627	4.5	28.7	2,660	98.8
2005	1,892	111.8	7.8	2,012	94.1
2006	778	21.9	25.8	825	94.2
2007	785	8.8	1.3	795	98.7
2008	944	0.7	2.1	947	99.7
2009	1,656	0.7	2.0	1,658	99.8
2010	1,251	0.1	0.6	1,252	99.9
2011	1,794	3.7	3.9	1,801	99.6
2012	1,902	6.8	2.0	1,911	99.5
2013	1,673	1.4	0.7	1,675	99.9

Table A3. Proportional standard errors (PSE) for the 1995-2013 total landings of Georges Bank winter flounder (*Pseudopleuronectes americanus*). Canadian landings average 7% during this period and were assumed to have precision estimates similar to the US landings. The PSE (in percent) which are due to allocation to statistical area using Vessel Trip Reports for 1995 and later years.

Year	Landings (mt)	PSE%
1995	783	1.1
1996	1,441	0.9
1997	1,369	1.0
1998	1,401	1.3
1999	1,043	1.2
2000	1,764	1.0
2001	2,203	1.0
2002	2,345	0.7
2003	3,139	0.7
2004	2,851	0.8
2005	2,085	0.7
2006	880	0.8
2007	807	1.0
2008	967	0.8
2009	1,670	0.9
2010	1,297	1.3
2011	1,853	0.8
2012	1,994	0.3
2013	1,687	0.5

Table A4. US discards (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*) in the large mesh (codend mesh ≥ 5.5 in.) and small mesh (codend mesh < 5.5 in.) bottom trawl (BT) fleets and the scallop dredge fleet during 1964-2013. Discards during 1982-1988, 1964-1988, and 1964-1991 were hindcast for the large and small mesh bottom trawl (BT) fleets and the scallop dredge fleet, respectively.

	US Discards (mt)				
Year	Large mesh BT	Small mesh BT	Scallop dredge	Total	CV
1964		112.1	118.4	230.5	
1965		135.4	29.7	165.1	
1966		118.9	18.2	137.1	
1967		82.0	24.0	106.0	
1968		74.1	65.9	140.0	
1969		74.8	42.2	117.0	
1970		72.6	36.8	109.4	
1971		69.5	35.9	105.4	
1972		61.4	36.7	98.1	
1973		61.1	32.8	94.0	
1974		59.7	38.3	97.9	
1975		60.4	57.6	118.0	
1976		48.8	93.0	141.9	
1977		68.3	138.8	207.0	
1978		77.0	184.9	261.9	
1979		75.8	181.7	257.4	
1980		83.1	171.6	254.7	
1981		97.3	184.0	281.3	
1982	11.4	72.3	162.6	246.3	
1983	39.8	21.8	163.6	225.3	
1984	47.3	3.3	144.5	195.1	
1985	28.9	1.6	127.7	158.2	
1986	23.3	1.6	156.6	181.5	
1987	24.8	1.9	245.5	272.1	
1988	28.3	6.4	258.3	293.0	
1989	13.8	0.1	302.4	316.2	
1990	15.7	0.0	322.3	338.0	
1991	1.9	0.0	311.9	313.8	
1992	8.5	0.0	20.3	28.8	0.22
1993	2.5	0.0	8.1	10.6	0.49
1994	2.3	0.9	6.4	9.5	0.16
1995	1.1	0.0	0.0	1.1	0.56
1996	8.3	0.0	17.4	25.7	0.31
1997	0.0	0.0	69.2	69.2	---
1998	0.1	0.0	51.5	51.7	0.01
1999	44.0	0.0	41.2	85.2	0.46
2000	16.7	0.1	48.2	64.9	0.31
2001	2.4	0.0	8.3	10.7	0.15
2002	3.1	0.0	16.5	19.7	0.13
2003	6.5	0.9	2.1	9.5	0.34
2004	46.6	15.4	7.3	69.3	0.48
2005	15.0	15.3	87.5	117.9	0.09
2006	26.3	14.9	68.8	110.0	0.12
2007	50.1	16.0	122.2	188.3	0.23
2008	70.2	0.15	72.6	143.0	0.14
2009	37.5	6.36	46.9	90.8	0.14
2010	29.0	94.2	14.3	137.6	0.44
2011	11.5	7.0	110.3	128.7	0.09
2012	4.6	0.4	107.5	112.5	0.11
2013	7.4	14.1	25.3	46.9	0.07

Table A5. Numbers (N) of Georges Bank winter flounder (*Pseudopleuronectes americanus*) sampled for length, by year and market category group, and sampling intensity (mt landed per 100 lengths) during 1982-2013.

Year	N lengths by market category					Sampling intensity (mt landed per 100 lengths)
	Unclassified (1200)	Lemon/XL (1201, 1204)	Large/Lg mix (1202, 1205)	Med/small (1203, 1206, 1207)	Total	
1982	350	724	1,019	807	2,900	102
1983		625	1,768	2,100	4,493	87
1984		518	1,435	902	2,855	138
1985	68	728	1,675	1,456	3,927	55
1986	124	389	1,125	1,184	2,822	62
1987		603	1,068	1,437	3,108	85
1988		478	1,034	1,447	2,959	95
1989		167	566	737	1,470	128
1990	399	27	1,285	1,758	3,469	55
1991	103	136	1,603	1,295	3,137	58
1992		131	1,420	1,483	3,034	60
1993		336	509	590	1,435	116
1994		183	632	556	1,371	68
1995		103	279	469	851	86
1996		370	484	138	992	138
1997		43	518	443	1,004	122
1998			79	403	482	271
1999	94		121	274	489	192
2000		486	160	697	1,343	119
2001	102	670	990	804	2,566	65
2002	274	699	1,458	424	2,855	74
2003	268	1,589	2,863	625	5,345	53
2004		1,579	4,643	188	6,410	42
2005	161	1,987	3,790	576	6,514	31
2006	100	1,978	3,196	293	5,567	15
2007		1,659	1,381	161	3,201	25
2008		1,688	2,815	819	5,322	18
2009		2,060	2,383	2,065	6,509	25
2010	456	1,346	3,906	2,686	8,394	15
2011	352	1,296	3,818	3,207	8,673	21
2012	69	637	2,421	2,210	5,337	36
2013		288	2,182	1,838	4,308	39

Table A6. Summary of US winter flounder (*Pseudopleuronectes americanus*) landings, from Georges Bank (Statistical Areas 522-525, 551-562), sampled for length and age compositions, during 1982-2013. Unless footnoted, total sample numbers do not include unclassified market category samples collected in: 1980 (1), 1981 (2), 1982 (4), 1985 (1), 1986 (1), 1990 (4), 1991 (1), 1999 (1), 2001 (1), 2002 (3), 2003 (4), 2005 (3), 2006 (1), and 2012 (1).

				Number of Samples by Market Category and Quarter														Annual Sampling Intensity (mt landed/100 lengths)		
				Lemon Sole Lemon Sole (1201) Extra-Large (1204)					Large Large (1202) Large/Mixed (1205)					Small Small (1203) Medium (1206) Pee-Wee (1207)					1201 1204	1202 1205	1203 1206 1207
Year	N Samples	N Lengths	N Ages	Q1	Q2	Q3	Q4	Tot	Q1	Q2	Q3	Q4	Tot	Q1	Q2	Q3	Q4	Tot	Lemon	Large	Small
1982	26	2,900	739	0	1	6	2	**9**	0	1	6	3	**10**	0	1	5	1	**7**	76	168	69
1983	36	4,493	874	0	3	2	1	**6**	2	5	6	2	**15**	2	3	9	1	**15**	58	100	81
1984	24	2,855	593	0	1	3	1	**5**	3	3	4	3	**13**	1	2	0	3	**6**	73	142	151
1985	38	3,927	827	1	2	5	1	**9**	2	4	9	1	**16**	2	3	7	1	**13**	37	64	50
1986	29	2,822	563	1	1	0	3	**5**	2	3	3	2	**10**	1	6	3	4	**14**	46	66	56
1987	33	3,108	618	2	1	1	2	**6**	4	3	3	1	**11**	5	3	4	4	**16**	40	96	87
1988	34	2,959	693	2	2	1	2	**7**	4	3	3	1	**11**	4	4	4	4	**16**	34	96	103
1989	16	1,470	280	1	1	0	0	**2**	3	2	0	1	**6**	1	3	3	1	**8**	66	127	126
1990	34	3,469	737	0	0	0	1	**1**	3	3	4	3	**13**	6	7	3	4	**20**	265	49	62
1991	35	3,137	698	1	1	1	1	**4**	6	6	2	2	**16**	6	3	3	3	**15**	40	42	72
1992	35	3,034	688	1	2	1	1	**5**	5	4	3	3	**15**	6	5	3	1	**15**	50	47	63
1993	16	1,435	338	1	2	0	1	**4**	3	2	0	0	**5**	1	5	0	1	**7**		125	139
1994	14	1,371	276	0	2	1	0	**4**	1	2	2	1	**6**	1	2	1	1	**5**	33	59	83
1995	9	851	215	1	0	0	1	**2**	1	0	0	2	**3**	2	1	0	1	**4**	43	93	78
1996	10	992	218	0	2	1	1	**4**	0	2	1	1	**4**	0	0	1	1	**2**	18	92	457
1997	13	1,004	232	0	0	0	1	**1**	1	2	1	1	**5**	2	2	0	3	**7**	101	84	81

Year	N Samples[1]	N Lengths	N Ages	Number of Samples by Market Category and Quarter														Annual Sampling Intensity (mt landed/100 lengths)		
				Lemon Sole: Lemon Sole (1201), Extra-Large (1204)					Large: Large (1202), Large/Mixed (1205)					Small[2]: Small (1203), Medium (1206), Pee-Wee (1207)					1201 1204	1202 1205	1203[2] 1206 1207
				Q1	Q2	Q3	Q4	Tot	Q1	Q2	Q3	Q4	Tot	Q1	Q2	Q3	Q4	Tot	Lemon	Large	Small
1998	6	482	70	0	0	0	0	**0**	0	1	0	0	**1**	0	1	1	3	**5**	-----	624	193
1999	6	395	78	0	0	0	0	**0**	0	0	0	1	**1**	2	0	0	3	**5**	-----	313	178
2000	17	1,343	283	0	0	1	4	**5**	0	0	0	2	**2**	2	4	1	3	**10**	24	412	111
2001	27	2,464	606	2	2	1	3	**8**	1	5	3	1	**10**	1	0	2	6	**9**	29	82	73
2002	33	2,485	753	2	4	3	2	**11**	0	9	5	3	**17**	1	1	0	3	**5**	53	81	98
2003	60	4,864	1,396	2	7	4	5	**18**	5	17	8	5	**35**	1	1	0	5	**7**	64	49	52
2004	78	6,343	1,862	1	5	6	5	**17**	6	15	22	13	**56**	1	2	1	1	**5**	37	39	123
2005	75	6,353	1,561	3	9	8	4	**24**	4	17	13	6	**40**	1	4	4	2	**11**	20	35	47
2006	68	5,467	1,458	5	13	4	6	**28**	4	17	9	5	**35**	0	3	1	1	**5**	11	15	35
2007	45	3,201	931	4	7	5	6	**22**	7	7	3	1	**18**	3	0	2	0	**5**	8	35	87
2008	77	5,322	1,463	3	12	7	9	**31**	4	9	9	8	**30**	0	3	9	4	**16**	7	20	30
2009	100	6,509	1,734	4	15	7	15	**41**	2	8	10	4	**24**	2/1	6/3	8/4	10/1	**35**	4	32	38
2010[1]	140	8,394	2,521	2	14	12	23	**51**	4	20	7	11	**42**	0/0	13/	1/8	10/3	**42**	2	11	28
2011	141	8,673	2,543	8	15	7	10	**40**	11	19	6	6	**42**	6/4	23/	8/3	4/2	**55**	2	19	31
2012	83	5,268	1,144	2	11	6	7	**26**	3	11	6	5	**25**	0/1	5/5	9/5	5/2	**32**	3	34	45
2013	64	4,308	1,094	0	6	3	4	**13**	3	10	4	6	**23**	0/0	10/	4/2	5/2	**28**	6	34	50

[1] Includes Unclassified samples; 5 length and 4 age samples during 2010 and 4 length and age samples during 2011.
[2] Samples and sampling intensities during 2009-2013 are indicated as N Small/Peewee combined / N Medium.

Table A7. Percentage of US landings of Georges Bank winter flounder (*Pseudopleuronectes americanus*), during 1982-2013, by market category group.

	US Landings by Market Category Group (%)			
	Lemon/XL	Large/LG Mix	Med/Small	Unclassified
Year	1201	1202	1203	1200
1982	18.6	57.9	18.9	4.7
1983	9.3	45.5	43.4	1.8
1984	9.6	51.7	34.8	3.9
1985	12.4	50.1	33.9	3.5
1986	10.1	42.0	37.5	10.4
1987	9.2	38.9	47.4	4.5
1988	5.9	35.5	53.3	5.3
1989	5.9	38.1	49.2	6.7
1990	3.8	33.1	57.3	5.9
1991	3.0	37.5	51.2	8.3
1992	3.6	36.9	51.2	8.3
1993	5.3	38.2	49.3	7.1
1994	6.5	40.3	49.4	3.8
1995	6.1	35.4	50.3	8.2
1996	4.8	32.6	46.1	16.6
1997	3.6	35.5	29.2	31.7
1998	4.0	37.7	56.4	1.9
1999	4.8	40.4	51.8	2.9
2000	7.3	41.1	48.4	3.3
2001	11.4	48.7	34.9	4.9
2002	17.6	56.5	19.8	6.0
2003	35.9	49.3	11.6	3.2
2004	22.3	67.9	8.7	1.2
2005	20.0	65.6	13.4	1.0
2006	25.3	59.4	12.3	3.0
2007	16.9	60.4	17.7	5.1
2008	12.1	59.5	26.0	2.4
2009	5.3	45.8	47.2	1.7
2010	1.9	34.9	60.0	3.3
2011	1.4	39.9	55.4	3.2
2012	1.2	42.5	52.2	4.2
2013	1.0	44.4	54.5	0.1

Table A8. Data pooling procedures used to apply length frequency samples to landings, by market category, to estimate landings-at-age of Georges Bank winter flounder (*Pseudopleuronectes americanus*), during 1982-2013. An "X" indicates that the time bin applies to all market categories unless otherwise noted.

<table>
<tr><th>Year</th><th>Quarter 1</th><th>Quarter 2</th><th>Quarter 3</th><th>Quarter 4</th><th>Market Category Groups</th></tr>
<tr><td>1982</td><td colspan="2">Pooled each mkt cat group</td><td>X</td><td>X</td><td rowspan="12">Pooled 1204 (Extra Large) and 1201 Lemon Sole

Pooled 1205 (Large/Mixed) and 1202 (Large)

Pooled 1206 (Medium), 1207 (Peewee) and 1203 (Small)</td></tr>
<tr><td>1983</td><td colspan="2">Pooled each mkt cat group</td><td>X</td><td>X</td></tr>
<tr><td>1984</td><td colspan="2">Pooled each mkt cat group</td><td colspan="2">Pooled each mkt cat group</td></tr>
<tr><td>1985</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>1986</td><td>X</td><td>X</td><td colspan="2">Pooled each mkt cat</td></tr>
<tr><td>1987</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>1988</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>1989</td><td>X</td><td>X</td><td colspan="2">Pooled each mkt cat</td></tr>
<tr><td>1990</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>1991</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>1992</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>1993</td><td>X</td><td colspan="3">Pooled each mkt category group</td></tr>
<tr><td rowspan="2">1994</td><td colspan="2">Pooled Lemon/Lg</td><td colspan="2">Pooled Lemon/Lg</td><td rowspan="6">Pooled 1201 (Lemon Sole), 1204 (Extra Large), 1202 (Large), and 1205 (Large/Mixed)

Pooled 1206 (Medium), 1207 (Peewee) and 1203 (Small)</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">1995</td><td colspan="2">Pooled Lemon/Lg</td><td colspan="2">Pooled Lemon/Lg</td></tr>
<tr><td>X</td><td>X</td><td colspan="2">Pooled Med/Sm/Peewee</td></tr>
<tr><td rowspan="2">1996</td><td colspan="2">Pooled Lemon/Lg</td><td>X</td><td>X</td></tr>
<tr><td colspan="3">Pooled Med/Sm</td></tr>
<tr><td>1997</td><td>X</td><td>X</td><td colspan="2">Pooled Lemon/Lg
Pooled Med/Sm/Peewee</td></tr>
<tr><td>1998</td><td colspan="4">Pooled across all mkt categories</td><td rowspan="2">Pooled all market categories and included all kept lengths from otter trawl observer trips</td></tr>
<tr><td>1999</td><td colspan="4">Pooled across all mkt categories</td></tr>
</table>

Table A8, continued. Data pooling procedures used to apply length frequency samples to landings, by market category, to estimate landings-at-age of Georges Bank winter flounder (*Pseudopleuronectes americanus*), during 1982-2013. An "X" indicates that the time bin applies to all market categories unless otherwise noted.

<table>
<tr><th>Year</th><th>Quarter 1</th><th>Quarter 2</th><th>Quarter 3</th><th>Quarter 4</th><th>Market Category Groups</th></tr>
<tr><td>2000</td><td colspan="2">Pooled across all mkt categories</td><td colspan="2">Pooled Lemon/Lg
Pooled Med/Sm/Peewee</td><td>Pooled market categories as in 1994-1997 and included kept lengths from otter trawl observer trips (months 1-6)</td></tr>
<tr><td>2001</td><td colspan="2">Pooled Med/Sm/Peewee</td><td>X</td><td>X</td><td rowspan="10">Pooled 1204 (Extra Large) and 1201 Lemon Sole

Pooled 1205 (Large/Mixed) and 1202 (Large)

Pooled 1206 (Medium), 1207 (Peewee) and 1203 (Small)</td></tr>
<tr><td>2002</td><td>X</td><td>X</td><td colspan="2">Pooled Med/Sm/Peewee</td></tr>
<tr><td>2003</td><td>X</td><td>X</td><td colspan="2">Pooled Med/Sm/Peewee</td></tr>
<tr><td>2004</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2005</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2006</td><td colspan="2">Pooled Med/Sm/Peewee</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">2007</td><td colspan="2">Pooled Med/Sm/Peewee</td><td colspan="2">Pooled Med/Sm/Peewee</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2008</td><td colspan="2">Pooled Med/Sm/Peewee</td><td>X</td><td>X</td></tr>
<tr><td>2009</td><td colspan="2">Pooled Med, pooled Sm/Peewee</td><td colspan="2">Pooled Med</td><td rowspan="6">Pooled 1204 (Extra Large) and 1201 Lemon Sole
Pooled 1205 (Large/Mixed) and 1202 (Large)
1206 (Medium)
Pooled 1207 (Peewee) and 1203 (Small)</td></tr>
<tr><td>2010*</td><td colspan="2">Pooled Lemon/XL, pooled Sm/Peewee, pooled Med.</td><td colspan="2">Pooled Sm/Peewee</td></tr>
<tr><td>2011*</td><td colspan="2">Pooled Lemon/XL</td><td colspan="2">Pooled Sm/Peewee, pooled Med.</td></tr>
<tr><td>2012</td><td colspan="2">Pooled Lemon/XL, pooled Sm/Peewee, pooled Med.</td><td>X</td><td>X</td></tr>
<tr><td rowspan="2">2013</td><td colspan="4">Pooled Lemon/XL</td></tr>
<tr><td colspan="2">Pooled Sm/Peewee, pooled Med.</td><td>X</td><td>X</td></tr>
</table>

* Pooled 1200 (Unclassified) across year

Table A9. Total landings-at-age (numbers, in thousands) of Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2013.

	Age							
Year	1	2	3	4	5	6	7+	Total
1982	0	353	1707	1,048	511	258	281	4,157
1983	10	787	2,902	1,454	551	206	528	6,438
1984	0	282	570	1,371	1,408	635	920	5,186
1985	20	805	693	812	491	112	100	3,031
1986	0	665	1,328	235	229	131	88	2,675
1987	0	1,294	1,681	899	133	89	121	4,217
1988	0	835	2,774	843	197	90	93	4,832
1989	0	1,381	1,222	509	147	107	61	3,427
1990	0	295	2,032	668	185	46	17	3,241
1991	0	593	1,270	951	136	38	60	3,047
1992	0	796	756	727	468	92	61	2,902
1993	37	301	1,143	451	320	163	47	2,461
1994	0	367	635	360	97	50	45	1,554
1995	371	701	172	142	105	32	41	1,563
1996	0	1,319	423	185	95	98	88	2,208
1997	0	355	993	444	176	79	87	2,135
1998	0	10	1,426	826	131	43	12	2,447
1999	0	296	786	521	147	20	20	1,790
2000	0	646	1,108	369	254	186	160	2,723
2001	11	372	1,280	801	586	158	99	3,307
2002	0	121	927	757	445	236	189	2,675
2003	0	259	694	925	455	252	400	2,987
2004	0	62	579	844	520	234	367	2,606
2005	0	224	529	752	362	142	217	2,227
2006	0	25	283	278	122	55	113	876
2007	0	108	135	217	167	73	84	784
2008	0	191	372	303	203	102	95	1,265
2009	0	671	1,097	556	198	91	90	2,702
2010	0	628	803	546	198	68	50	2,294
2011	3	147	786	1,064	521	142	82	2,745
2012	0	126	943	1,114	710	156	124	3,174
2013	0	166	777	585	497	276	101	2,402

Table A10. Number of Georges Bank winter flounder (*Pseudopleuronectes americanus*) lengths sampled by fishery observers (and at-sea monitors during May 1, 2010-2013) from the discards of the bottom trawl and scallop dredge fleets during 1989-2013.

	N lengths sampled from discards	
Year	Bottom trawl	Scallop dredge
1989	70	0
1990	22	0
1991	5	0
1992	15	1
1993	5	3
1994	6	35
1995	11	0
1996	39	2
1997	1	417
1998	1	84
1999	2	111
2000	4	15
2001	1	0
2002	88*	1
2003	89	1
2004	293	137
2005	420	804
2006	437	413
2007	827	887
2008	1,966	640
2009	909	743
2010	1,336	133*
2011	430	1,041
2012	105*	1,199
2013	239	254*

*Because of low sample sizes, bottom trawl discard length composition samples were combined for 2002 and 2003 and for 2012 and 2013. Length composition samples from scallop dredges were combined with 2009 for 2010 and with 2012 for 2013.

Table A11. US discards-at-age (numbers, in thousands) for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2013.

	Age								
Year	0	1	2	3	4	5	6	7+	Total
1982	0	116	706	1,843	1,131	551	278	303	4,928
1983	0	137	1,051	3,053	1,530	580	217	556	7,123
1984	0	138	431	595	1,432	1,471	663	961	5,690
1985	0	67	987	768	899	544	124	111	3,499
1986	0	38	816	1,522	270	262	150	101	3,159
1987	0	99	1,556	1,912	1,022	151	101	138	4,980
1988	0	72	1,049	3,044	925	216	98	102	5,507
1989	0	34	1,655	1,428	595	172	125	71	4,079
1990	0	36	392	2,400	789	218	54	20	3,909
1991	0	2	710	1,505	1,127	161	45	72	3,621
1992	0	23	842	778	749	482	95	63	3,031
1993	0	43	317	1,184	467	331	169	49	2,558
1994	0	8	416	706	400	108	55	51	1,744
1995	0	394	742	182	149	111	34	43	1,655
1996	0	35	1,417	450	197	101	104	94	2,397
1997	0	6	145	74	33	7	2	2	268
1998	0	0	11	1,561	904	143	47	13	2,680
1999	0	70	425	887	588	165	22	23	2,180
2000	0	52	749	1,225	408	281	206	177	3,099
2001	0	16	410	1,393	872	638	172	108	3,608
2002	0	0	127	970	793	466	247	198	2,802
2003	0	0	273	729	972	479	266	421	3,141
2004	0	4	33	29	39	18	15	18	156
2005	0	5	42	26	44	26	44	29	217
2006	0	5	24	52	57	58	11	14	220
2007	0.2	23	44	30	41	62	17	13	230
2008	0.4	15	135	87	27	24	16	9	313
2009	0.4	7	124	145	102	34	22	18	453
2010	0.1	3	36	94	79	31	22	22	288
2011	0	12	23	91	81	41	11	18	277
2012	0	2	17	66	55	20	20	22	203
2013	0	4	27	32	21	8	9	14	116

Table A12. Georges Bank winter flounder (*Pseudopleuronectes americanus*) catch-at-age components. LAA = landings-at-age, BT= bottom trawl

Catch-at-age component	Years	Time Period	Length data	Age data
US landings	1982-2013		Commercial	Commercial
CA landings	1982-2013		None available, scaled-up the US LAA	None available
US BT discards (lg & sm mesh) ≤ MLS as discard /mean wt-at-age in NEFSC surveys	1982-2001	Half yr est.	No discard L-F	discard ages unavailable; MLS 1st half yr = age 2 spring and 2nd half yr = age 1 fall
	2002-2013	Half yr est.	US BT discards	NEFSC spring and fall L-W and A/L keys
CA BT discards No discard est. provided, assumed zero				
US scallop dredge discards	1982-1996 & 1998-2003		No discard L-F; scaled-up LAA	
	1997 & 2004-2013		Annual US scallop dredge discards	NEFSC fall survey L-W and A/L keys
CA scallop dredge discards				
Avg. 2004-2010 rate x annual CA scallop landings	1982-1996 & 1998-2003		None collected by CA ; scaled up LAA	None collected by CA
Estimated by CA Dept of Fisheries and Oceans	2004-2013		Annual US scallop dredge discards	None collected by CA; 1st half yr = NEFSC spr survey A/L keys & L-W 2nd half yr = NEFSC spring survey

Table A13. Catch-at-age (numbers, in thousands) for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2013. Age 0 fish were not included in the Virtual Population Analysis (VPA) runs.

	Age								
Year	0	1	2	3	4	5	6	7+	Total
1982	0	116	1,058	3,550	2,179	1,061	536	584	9,086
1983	0	147	1,838	5,954	2,983	1,131	423	1,084	13,561
1984	0	138	713	1,165	2,803	2,879	1,298	1,880	10,876
1985	0	87	1,791	1,461	1,711	1,034	235	211	6,530
1986	0	38	1,481	2,850	505	491	281	189	5,834
1987	0	99	2,850	3,593	1,921	285	189	259	9,196
1988	0	72	1,884	5,818	1,767	413	188	196	10,339
1989	0	34	3,035	2,650	1,104	319	231	131	7,506
1990	0	36	687	4,431	1,457	402	99	36	7,150
1991	0	2	1,302	2,775	2,077	297	83	132	6,668
1992	0	23	1,638	1,534	1,476	950	187	124	5,932
1993	0	80	617	2,327	918	650	332	95	5,019
1994	0	8	783	1,341	760	206	105	96	3,298
1995	0	765	1,443	354	291	217	66	83	3,218
1996	0	35	2,737	872	381	196	203	182	4,605
1997	0	2	407	1020	456	179	80	87	2,231
1998	0	0	21	2,987	1,730	274	91	26	5,127
1999	0	70	720	1,673	1,109	312	42	43	3,970
2000	0	52	1,395	2,333	777	536	392	337	5,823
2001	0	27	782	2,673	1,673	1,223	330	207	6,915
2002	0	0	249	1,896	1,551	910	483	387	5,477
2003	0	0	533	1,423	1,897	934	518	821	6,127
2004	0	3	87	594	861	525	238	374	2,682
2005	0	4	265	548	771	373	160	229	2,350
2006	0	4	37	306	301	146	61	122	978
2007	0.2	23	152	165	258	230	90	96	1,014
2008	0.4	15	325	459	330	226	118	104	1,577
2009	0.4	7	786	1235	662	231	113	107	3,141
2010	0.1	3	233	961	704	242	97	73	2,313
2011	0	14	170	877	1,145	562	153	100	3,021
2012	0	2	143	1,009	1,169	730	176	147	3,376
2013	0	4	194	809	606	505	285	115	2,518

Table A14. Mean weights-at-age (kg) for catches of Georges Bank winter flounder (*Pseudopleuronectes americanus*) Virtual Population Analysis (VPA) during 1982-2013.

	Age							
Year	1	2	3	4	5	6	7+	All ages
1982	0.216	0.234	0.444	0.779	1.041	1.228	1.615	0.647
1983	0.149	0.260	0.451	0.668	0.899	0.991	1.340	0.576
1984	0.110	0.281	0.467	0.585	0.744	0.891	1.266	0.719
1985	0.191	0.386	0.522	0.782	1.050	1.366	1.720	0.683
1986	0.197	0.392	0.617	0.778	1.029	1.194	1.589	0.650
1987	0.081	0.375	0.549	0.868	1.107	1.217	1.724	0.606
1988	0.145	0.327	0.510	0.760	1.149	1.323	1.761	0.567
1989	0.123	0.355	0.459	0.826	1.076	1.332	1.742	0.538
1990	0.110	0.432	0.510	0.757	0.992	1.339	2.021	0.588
1991	0.190	0.415	0.479	0.702	0.985	1.438	1.751	0.594
1992	0.137	0.386	0.494	0.744	0.906	1.185	1.465	0.627
1993	0.246	0.382	0.537	0.758	0.941	1.294	1.900	0.680
1994	0.200	0.413	0.543	0.803	0.954	1.380	1.618	0.651
1995	0.285	0.387	0.590	0.666	0.999	1.267	1.652	0.501
1996	0.120	0.444	0.649	0.892	1.223	1.467	1.763	0.639
1997	0.000	0.342	0.527	0.691	0.981	1.243	1.440	0.652
1998	0.178	0.244	0.486	0.631	0.809	1.322	1.829	0.572
1999	0.215	0.337	0.452	0.703	1.040	1.569	1.778	0.534
2000	0.119	0.416	0.478	0.568	1.003	1.277	1.627	0.628
2001	0.238	0.306	0.488	0.750	0.827	1.241	1.821	0.664
2002	0.137	0.481	0.554	0.845	1.071	1.340	1.812	0.878
2003	0.124	0.404	0.608	0.968	1.254	1.540	1.893	1.052
2004	0.132	0.475	0.705	0.967	1.223	1.455	1.763	1.096
2005	0.157	0.379	0.595	0.937	1.170	1.495	1.760	0.959
2006	0.170	0.465	0.647	0.937	1.262	1.568	1.887	1.024
2007	0.154	0.375	0.699	0.963	1.277	1.566	1.991	1.035
2008	0.157	0.361	0.583	0.768	0.998	1.193	1.640	0.747
2009	0.117	0.359	0.551	0.760	0.975	1.231	1.624	0.637
2010	0.287	0.320	0.497	0.726	0.899	1.133	1.512	0.604
2011	0.177	0.328	0.497	0.690	0.877	1.091	1.448	0.691
2012	0.385	0.436	0.428	0.650	0.793	1.014	1.224	0.649
2013	0.181	0.372	0.581	0.675	0.807	0.979	1.281	0.710

Table A15. Georges Bank winter flounder (*Pseudopleuronectes americanus*) relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) indices from the US spring (1968-2013) and autumn (1963-2013) bottom trawl surveys (derived using offshore survey strata 13-23), conducted by the Northeast Fisheries Science Center, and from the Canadian spring (1987-2013) bottom trawl surveys conducted on Georges Bank (derived using strata 5Z1-5Z4). US survey indices for 1963-1984 were multiplied by standardization coefficients (numbers = 1.46 and weight = 1.39) to account for a trawl door change in 1985 and US spring survey indices for 1973-1981 were divided by standardization coefficients (numbers = 2.02 and weight = 1.86) to account for a net change during 1973-1981. CV = coefficients of variation.

	US Spring Survey				US Autumn Survey				Canadian Spring Survey	
Year	**Number**	**CV**	**Kg**	**CV**	**Number**	**CV**	**Kg**	**CV**	**Number**	**Kg**
1963					1.94	44.9	3.02	41.0		
1964					1.75	56.4	2.77	51.8		
1965					2.70	36.8	3.03	28.2		
1966					4.79	40.2	5.26	33.7		
1967					1.78	42.3	2.11	35.9		
1968	2.66	51.1	2.99	53.1	1.92	23.1	1.83	28.1		
1969	2.95	20.8	4.02	20.9	2.59	33.2	2.53	32.5		
1970	1.81	21.8	2.20	24.5	7.02	47.3	7.73	47.7		
1971	1.71	20.6	2.04	26.1	1.53	37.5	1.32	36.2		
1972	4.71	34.8	4.90	34.0	1.64	31.4	1.56	27.8		
1973	1.34	36.7	1.73	39.4	2.56	35.9	2.30	33.5		
1974	3.19	33.8	3.16	31.9	1.36	37.7	1.55	42.6		
1975	0.92	37.6	0.72	60.0	3.74	52.3	2.09	34.8		
1976	2.23	27.5	1.57	27.4	5.52	36.7	3.63	40.7		
1977	1.95	43.6	0.90	40.7	4.81	25.0	3.97	22.5		
1978	3.25	35.9	2.52	36.8	4.22	17.9	3.47	17.6		
1979	0.79	26.8	1.09	28.1	5.06	24.8	4.08	23.9		
1980	1.63	43.9	1.45	38.4	2.03	24.8	2.32	25.8		
1981	1.92	35.8	2.00	36.5	5.50	25.3	4.41	20.5		
1982	2.42	29.0	1.57	34.7	5.61	18.6	3.32	20.2		
1983	8.29	35.8	6.93	36.4	3.03	31.9	2.89	35.9		
1984	5.12	27.2	5.22	26.0	4.90	41.5	3.28	40.8		
1985	3.54	43.4	2.44	39.2	1.98	32.8	1.18	32.9		
1986	2.10	34.2	1.26	31.3	3.31	45.0	2.00	43.0		
1987	2.61	30.8	1.16	29.6	0.96	33.6	1.03	42.6	1.24	1.74
1988	2.68	37.5	1.51	33.7	3.90	58.5	1.29	32.1	4.31	2.75
1989	1.25	33.3	0.73	35.9	1.43	45.2	0.96	40.1	4.05	1.95
1990	2.65	47.0	1.48	49.3	0.51	32.7	0.34	37.4	4.93	2.64
1991	2.21	35.0	1.21	28.6	0.31	38.7	0.24	44.0	1.98	1.38
1992	1.34	26.0	0.83	30.5	0.69	35.9	0.38	37.2	0.51	0.59

Table A15, continued. Georges Bank winter flounder (*Pseudopleuronectes americanus*) relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) indices from the US spring (1968-2013) and autumn (1963-2013) bottom trawl surveys (derived using offshore survey strata 13-23), conducted by the Northeast Fisheries Science Center, and from the Canadian spring (1987-2013) bottom trawl surveys conducted on Georges Bank (derived using strata 5Z1-5Z4). US survey indices for 1963-1984 were multiplied by standardization coefficients (numbers = 1.46 and weight = 1.39) to account for a trawl door change in 1985 and U,S spring survey indices for 1973-1981 were divided by standardization coefficients (numbers = 2.02 and weight = 1.86) to account for a net change during 1973-1981. CV = coefficients of variation.

	US Spring Survey				**US Autumn Survey**				**Canadian Spring Survey**	
Year	**Number**	**CV**	**Kg**	**CV**	**Number**	**CV**	**Kg**	**CV**	**Number**	**Kg**
1993	1.00	30.1	0.58	25.6	1.22	36.2	0.78	30.9	3.53	1.76
1994	1.25	48.9	0.56	46.9	0.85	34.3	0.56	31.1	5.10	2.01
1995	2.42	37.8	1.38	44.5	2.74	30.3	1.62	28.6	5.63	1.96
1996	2.12	32.7	1.38	28.0	1.48	24.5	1.68	25.1	4.12	2.30
1997	1.48	78.8	1.09	72.5	1.78	20.7	1.55	21.5	4.58	3.09
1998	0.78	34.9	0.71	36.0	3.50	28.1	3.40	30.5	1.14	1.21
1999	3.56	46.2	3.21	50.4	2.45	36.4	2.47	42.0	1.25	1.89
2000	4.25	36.8	3.55	39.2	4.60	57.8	4.82	52.7	1.48	2.22
2001	1.25	38.7	1.16	37.8	6.08	36.6	4.85	31.4	2.28	2.54
2002	4.73	35.6	4.82	32.6	4.67	36.5	5.60	44.2	3.17	3.85
2003	1.22	47.4	1.30	46.2	2.36	38.3	2.96	45.7	1.09	1.31
2004	0.42	33.5	0.51	33.6	5.01	46.3	4.06	44.8	2.10	1.79
2005	1.00	56.8	0.80	64.3	1.94	31.4	2.11	30.9	1.19	1.23
2006	0.58	35.4	0.49	36.9	1.36	28.8	1.42	26.4	0.36	0.39
2007	0.75	29.8	0.68	29.5	2.13	40.1	2.00	50.6	0.18[1]	0.27
2008	7.35	57.8	5.42	66.8	4.58	31.0	2.70	25.5	1.07	0.65
2009	2.68	51.9	1.36	42.1	6.58	26.8	5.20	29.0	0.70	0.56
2010	2.08	28.0	1.36	26.1	2.38[2,4]	36.3	1.83	36.7	0.79	0.66
2011	1.86	26.5	1.15	23.5	5.48	32.1	4.64	36.7	0.69	0.42
2012	2.60	28.6	2.01	30.7	5.24	27.2	4.44	28.0	1.01	0.73
2013	3.37	34.2	2.55	37.8	2.11	52.0	1.90	49.8	1.19	0.57
2014	4.34[5]	38.8	3.45	39.6					0.56	0.37
Median	2.11		1.42		2.57		2.40		1.25	1.74

[1] No tows conducted in the northwest portion of stratum 5Z3 because of adverse weather conditions.
[2] One station in each of strata 16 and 19 were not sampled because of vessel mechanical problems.
[3] For US survey indices from 2009 onward, length-based conversion factors were applied to the FSV *H. B. Bigelow* numbers-at-length to obtain RV *Albatross IV* equivalents and kg per tow indices were computed by applying the respective seasonal survey length-weight equations for 1982-2007.
[4] Stations located on the Canadian side of Georges Bank were not sampled during the fall of 2010 because of severe weather delays during previous survey legs.
[5] The 2014 US spring survey occurred on Georges Bank during May, instead of April, because of vessel mechanical problems.

Table A16. NEFSC fall survey minimum population size-at-age (thousands of fish) for Georges Bank winter flounder (*Pseudopleuronectes americanus*) (offshore strata 13-23), during 1981-2013, lagged forward one year and age.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1982	0	2,396	674	814	1,082	504	135	244	147	63	6,059
1983	284	2,094	2,178	583	542	283	184	0	33	0	6,181
1984	27	70	568	1,347	619	236	264	95	57	57	3,339
1985	239	654	1,189	1,391	1,408	368	113	26	12	0	5,401
1986	110	341	885	550	80	190	27	0	0	0	2,182
1987	145	1,160	1,627	370	205	48	24	23	0	48	3,652
1988	36	53	239	256	208	99	80	62	27	0	1,061
1989	49	2,958	620	468	139	9	25	25	0	0	4,293
1990	24	97	1,072	73	143	74	58	9	27	0	1,577
1991	24	61	44	376	0	52	0	0	0	0	557
1992	109	46	0	81	53	18	36	0	0	0	344
1993	0	53	509	158	9	27	0	0	0	0	757
1994	0	592	192	283	213	27	0	18	0	18	1,343
1995	0	167	424	224	86	33	0	0	0	0	934
1996	18	937	1,115	685	187	57	0	0	18	0	3,018
1997	0	124	344	614	259	131	94	63	0	0	1,628
1998	18	79	648	758	344	79	30	3	0	0	1,960
1999	91	273	386	1,713	1,109	190	66	27	0	0	3,854
2000	18	388	796	381	367	608	88	27	24	0	2,697
2001	18	53	1,286	1,666	753	902	270	56	69	0	5,073
2002	18	599	1,536	2,442	1,276	322	332	100	53	25	6,703
2003	0	206	496	1,053	1,309	1,148	410	477	23	23	5,146
2004	309	176	27	352	770	652	209	80	21	0	2,597
2005	231	326	1,353	1,377	1,328	282	349	230	44	0	5,520
2006	97	55	167	493	464	297	358	132	18	58	2,139
2007	0	101	179	307	380	422	72	42	0	0	1,502
2008	231	313	317	307	428	613	91	34	18	0	2,351
2009	90	1,152	1,612	1,202	286	346	224	48	0	88	5,047
2010	0	190	1,509	2,401	1,882	665	363	72	46	121	7,249
2011	38	31	487	941	696	211	134	28	15	42	2,623
2012	25	585	464	1,528	1,887	1,024	25	86	58	128	6,037
2013	117	252	936	1,098	1,799	949	348	140	31	103	5,774
2014	0	58	348	489	459	389	267	183	31	100	2,324

Table A17. NEFSC spring survey minimum population size-at-age (thousands of fish) for Georges Bank winter flounder (*Pseudopleuronectes americanus*) (offshore strata 13-23) during 1982-2014.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1982	74	903	555	660	191	151	41	18	36	36	2,665
1983	27	1,037	3,704	1,555	692	796	608	424	125	169	9,135
1984	36	168	2,107	1,635	390	379	477	280	27	146	5,644
1985	0	1,701	821	636	402	223	47	24	49	0	3,902
1986	255	752	857	192	170	85	0	0	0	0	2,310
1987	163	1,647	670	275	91	0	24	0	0	0	2,871
1988	73	556	1,433	692	117	42	18	0	27	0	2,958
1989	49	560	293	251	157	18	0	53	0	0	1,381
1990	129	653	1,611	357	99	74	0	0	0	0	2,923
1991	273	349	834	587	278	36	24	0	49	0	2,430
1992	73	652	302	141	148	111	0	24	27	0	1,477
1993	172	291	362	175	0	47	33	24	0	0	1,105
1994	127	604	436	96	66	45	0	0	0	0	1,374
1995	150	790	1,295	297	103	30	0	0	0	0	2,664
1996	38	1,233	436	494	70	27	43	0	0	0	2,339
1997	24	194	542	677	115	24	27	0	24	0	1,627
1998	0	24	218	468	125	0	27	0	0	0	861
1999	225	548	675	1,313	896	200	53	18	0	0	3,927
2000	18	620	1,069	697	1,155	734	200	120	71	0	4,685
2001	0	73	335	314	197	193	268	0	0	0	1,380
2002	113	167	245	1,935	772	784	701	312	159	26	5,215
2003	52	27	163	231	367	320	154	27	0	0	1,341
2004	0	36	27	63	215	73	24	28	0	0	465
2005	98	188	130	315	212	132	0	27	0	0	1,101
2006	43	0	188	210	88	81	0	24	0	0	634
2007	91	128	67	159	180	100	56	23	19	0	822
2008	945	1,280	1,513	1,945	1,427	386	94	504	0	0	8,094
2009	43	1,258	831	456	161	145	22	28	0	13	2,957
2010	7	153	901	693	242	230	25	18	3	25	2,297
2011	39	104	507	837	426	92	11	0	7	31	2,054
2012	37	200	184	890	1,012	295	107	17	22	97	2,862
2013	93	326	602	497	627	926	305	131	54	155	3,716
2014	16	317	907	1,278	343	691	579	397	143	107	4,777

Table A18. Canadian spring survey (February) minimum population size-at-age (thousands of fish) for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1987-2014.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1987	0	68	153	202	255	102	0	0	0	0	780
1988	102	386	1,396	653	101	46	0	23	0	0	2,708
1989	54	1,244	623	448	141	27	4	6	0	0	2,547
1990	0	88	683	1,991	262	42	25	3	0	0	3,094
1991	44	57	412	577	129	29	0	0	0	0	1,247
1992	0	17	38	131	48	86	0	3	0	0	323
1993	746	419	595	282	85	48	41	3	0	0	2,219
1994	10	2,083	705	155	234	1	11	10	0	0	3,207
1995	992	1,544	799	134	57	8	2	0	0	0	3,534
1996	562	792	589	408	136	50	48	2	3	4	2,594
1997	11	609	990	1,102	120	23	9	17	0	0	2,880
1998	11	19	100	382	180	21	0	0	0	0	714
1999	32	154	146	252	145	36	12	4	4	0	784
2000	6	0	7	87	82	227	227	120	121	54	932
2001	150	49	121	147	276	92	232	348	10	11	1,437
2002	0	58	136	51	729	256	270	284	126	83	1,993
2003	29	135	37	53	80	131	86	126	7	2	686
2004	331	113	59	138	136	327	101	96	17	0	1,319
2005	55	100	55	104	107	107	102	63	37	17	748
2006	0	3	3	50	62	33	68	2	3	1	226
2007	0	0	3	0	8	39	24	21	8	9	112
2008	260	123	48	54	75	26	32	54	0	0	671
2009	11	75	184	68	25	35	5	21	0	16	439
2010	0	8	133	210	81	45	1	18	0	0	495
2011	48	40	54	170	90	20	3	0	0	7	432
2012	26	19	27	175	164	60	15	0	11	39	637
2013	244	94	121	65	55	80	42	17	13	17	747
2014	70	46	32	67	14	49	37	24	9	2	350

Table A19. Input data and descriptions of the final Virtual Population Analysis (VPA)model run conducted for the 2014 assessment update of Georges Bank winter flounder (*Pseudopleuronectes americanus*). Catch-at-age data were included for 1982-2013 for ages 1-7+.

Description of Abbreviations	Catch-at-age	Tuning Indices (swept-area nos.)	M	Maturity	2011 stock estimates	R in 2014	Avg. F	Recruits	Selectivity
US bottom trawl (BT) and scallop dredge (SD) discards	Ages 1-7+, US BT and SD discards-at-age; CA SD discards-at-age; US landings-at-age; US landings bumped up by CA landings	US spr & CA spr surveys, ages 1-7+; US fall svy, ages 0-6 (lagged forward 1 yr and age)	Constant across all ages at 0.3	1981-2014 3-yr moving window for 1982-2013	Ages 3-6	Geom. Mean, 2006-2012	Ages 4-6	Age 1	Flat-topped, full at age 4

Table A20. Virtual Population Analysis (VPA) estimates of January 1 stock sizes (numbers in thousands), by year and age, for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2014.

AGE	1982	1983	1984	1985	1986
1	13763.	8338.	17881.	16791.	21914.
2	21622.	10097.	6051.	13129.	12365.
3	15683.	15111.	5913.	3873.	8197.
4	8440.	8597.	6164.	3387.	1634.
5	3016.	4400.	3842.	2206.	1073.
6	1897.	1336.	2298.	479.	764.
7	2066.	3426.	3329.	430.	515.
Total	66488.	51305.	45478.	40296.	46461.

AGE	1987	1988	1989	1990	1991
1	15542.	26316.	14912.	9880.	13235.
2	16202.	11429.	19434.	11018.	7288.
3	7895.	9572.	6860.	11807.	7574.
4	3659.	2822.	2240.	2842.	4999.
5	782.	1099.	619.	731.	882.
6	382.	339.	465.	191.	205.
7	521.	353.	263.	70.	327.
Total	44983.	51930.	44793.	36538.	34511.

AGE	1992	1993	1994	1995	1996
1	6422.	5200.	7308.	22770.	16283.
2	9803.	4738.	3784.	5407.	16213.
3	4289.	5865.	2983.	2136.	2780.
4	3263.	1879.	2379.	1080.	1281.
5	1950.	1174.	620.	1118.	553.
6	402.	646.	325.	285.	644.
7	267.	186.	298.	361.	577.
Total	26397.	19688.	17698.	33157.	38330.

AGE	1997	1998	1999	2000	2001
1	16181.	18634.	18185.	14200.	8626.
2	12033.	11985.	13803.	13412.	10474.
3	9677.	8565.	8861.	9609.	8743.
4	1320.	6297.	3816.	5138.	5134.
5	625.	592.	3195.	1886.	3144.
6	244.	311.	208.	2100.	942.
7	268.	88.	212.	1806.	591.
Total	40347.	46472.	48280.	48150.	37654.

AGE	2002	2003	2004	2005	2006
1	6654.	5155.	4354.	4074.	6559.
2	6367.	4929.	3819.	3223.	3014.
3	7091.	4504.	3196.	2754.	2161.
4	4210.	3642.	2129.	1861.	1574.
5	2385.	1807.	1106.	850.	728.
6	1295.	997.	555.	378.	315.
7	1037.	1581.	874.	542.	625.
Total	29039.	22614.	16033.	13682.	14976.

AGE	2007	2008	2009	2010	2011
1	10481.	14949.	15182.	7851.	8828.
2	4856.	7745.	11062.	11241.	5814.
3	2201.	3467.	5459.	7523.	8128.
4	1339.	1490.	2176.	2993.	4752.
5	909.	772.	823.	1051.	1619.
6	415.	478.	380.	413.	572.
7	444.	425.	361.	312.	375.
Total	20645.	29325.	35443.	31385.	30088.

AGE	2012	2013	2014
1	8671.	16789.	9909.
2	6528.	6422.	12434.
3	4161.	4713.	4591.
4	5272.	2224.	2801.
5	2547.	2910.	1133.
6	723.	1267.	1725.
7	604.	511.	977.
Total	28506.	34836.	33570.

Table A21. Virtual Population Analysis (VPA) estimates of average fishing mortality rates (ages 4-6), by year and age, for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2013.

AGE	1982	1983	1984	1985	1986
1	0.0098	0.0206	0.0089	0.0060	0.0020
2	0.0582	0.2351	0.1461	0.1711	0.1486
3	0.3012	0.5968	0.2570	0.5630	0.5066
4	0.3513	0.5053	0.7276	0.8498	0.4365
5	0.5145	0.3495	1.7823	0.7608	0.7339
6	0.3918	0.4498	1.0157	0.8138	0.5440
7	0.3918	0.4498	1.0157	0.8138	0.5440

AGE	1987	1988	1989	1990	1991
1	0.0074	0.0032	0.0027	0.0042	0.0002
2	0.2262	0.2105	0.1983	0.0748	0.2303
3	0.7287	1.1525	0.5811	0.5594	0.5421
4	0.9026	1.2171	0.8195	0.8699	0.6412
5	0.5372	0.5610	0.8774	0.9732	0.4856
6	0.8278	0.9861	0.8318	0.8902	0.6163
7	0.8278	0.9861	0.8318	0.8902	0.6163

AGE	1992	1993	1994	1995	1996
1	0.0041	0.0179	0.0012	0.0396	0.0025
2	0.2137	0.1627	0.2716	0.3653	0.2161
3	0.5254	0.6023	0.7160	0.2114	0.4451
4	0.7222	0.8079	0.4552	0.3695	0.4171
5	0.8044	0.9838	0.4769	0.2523	0.5189
6	0.7522	0.8719	0.4597	0.3082	0.4467
7	0.7522	0.8719	0.4597	0.3082	0.4467

AGE	1997	1998	1999	2000	2001
1	0.0001	0.0001	0.0045	0.0043	0.0037
2	0.0399	0.0020	0.0622	0.1279	0.0901
3	0.1297	0.5085	0.2449	0.3268	0.4309
4	0.5023	0.3784	0.4050	0.1913	0.4667
5	0.3970	0.7456	0.1196	0.3940	0.5869
6	0.4672	0.4051	0.2648	0.2418	0.5107
7	0.4672	0.4051	0.2648	0.2418	0.5107

AGE	2002	2003	2004	2005	2006
1	0.0001	0.0001	0.0007	0.0013	0.0007
2	0.0462	0.1332	0.0267	0.0999	0.0144
3	0.3664	0.4491	0.2407	0.2597	0.1784
4	0.5458	0.8915	0.6182	0.6388	0.2489
5	0.5720	0.8810	0.7738	0.6926	0.2628
6	0.5552	0.8880	0.6687	0.6553	0.2533
7	0.5552	0.8880	0.6687	0.6553	0.2533

AGE	2007	2008	2009	2010	2011
1	0.0025	0.0011	0.0005	0.0004	0.0019
2	0.0370	0.0498	0.0856	0.0243	0.0344
3	0.0904	0.1657	0.3009	0.1593	0.1329
4	0.2508	0.2937	0.4280	0.3149	0.3237
5	0.3423	0.4094	0.3891	0.3073	0.5056
6	0.2868	0.3317	0.4172	0.3129	0.3669
7	0.2868	0.3317	0.4172	0.3129	0.3669

AGE	2012	2013
1	0.0003	0.0003
2	0.0257	0.0355
3	0.3264	0.2203
4	0.2941	0.3746
5	0.3983	0.2229
6	0.3269	0.2988
7	0.3269	0.2988

Table A22. Virtual Population Analysis (VPA) estimates of spawning stock biomass (mt), by year and age, for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2013.

AGE	1982	1983	1984	1985	1986
1	53.	20.	0.	0.	34.
2	707.	438.	143.	593.	1086.
3	4057.	3698.	1639.	1396.	3566.
4	5282.	4155.	2587.	1747.	957.
5	2593.	3245.	1653.	1535.	796.
6	1880.	1111.	1477.	425.	715.
7	2807.	3806.	3033.	560.	663.
Total	17380.	16474.	10533.	6256.	7817.

AGE	1987	1988	1989	1990	1991
1	8.	28.	0.	0.	0.
2	1270.	603.	487.	253.	228.
3	2989.	2987.	2321.	4436.	2664.
4	2159.	1353.	1240.	1417.	2561.
5	643.	949.	455.	504.	669.
6	336.	311.	449.	180.	213.
7	678.	450.	346.	105.	455.
Total	8082.	6682.	5298.	6895.	6790.

AGE	1992	1993	1994	1995	1996
1	0.	0.	0.	0.	0.
2	474.	175.	0.	105.	510.
3	1518.	2106.	1151.	1015.	1316.
4	1684.	970.	1430.	578.	861.
5	1258.	756.	460.	921.	473.
6	350.	571.	337.	289.	712.
7	301.	263.	399.	512.	844.
Total	5585.	4841.	3778.	3420.	4716.

AGE	1997	1998	1999	2000	2001
1	0.	0.	0.	0.	0.
2	489.	24.	1449.	1403.	666.
3	4550.	3310.	2996.	3598.	3415.
4	759.	3245.	2051.	2438.	2840.
5	511.	358.	2641.	1455.	1896.
6	249.	322.	240.	2225.	905.
7	321.	135.	327.	2566.	879.
Total	6878.	7393.	9703.	13685.	10601.

AGE	2002	2003	2004	2005	2006
1	0.	0.	0.	0.	0.
2	24.	14.	0.	0.	242.
3	2838.	2056.	823.	1333.	1086.
4	2510.	2276.	1457.	1285.	1148.
5	1879.	1528.	976.	740.	742.
6	1242.	1042.	611.	423.	401.
7	1518.	2223.	1210.	751.	1038.
Total	10011.	9139.	5077.	4533.	4656.

AGE	2007	2008	2009	2010	2011
1	0.	0.	0.	0.	0.
2	116.	124.	89.	81.	34.
3	1246.	1416.	1872.	2456.	1851.
4	1015.	962.	1291.	1734.	2559.
5	908.	639.	637.	778.	1107.
6	527.	494.	371.	390.	504.
7	738.	593.	490.	423.	459.
Total	4550.	4229.	4749.	5862.	6514.

AGE	2012	2013
1	0.	20.
2	209.	399.
3	1069.	1880.
4	2734.	1120.
5	1638.	1952.
6	605.	1013.
7	632.	563.
Total	6887.	6947.

Table A23. Virtual Population Analysis (VPA) model estimates of average fishing mortality rates (ages 4-6) and spawning stock biomass (mt), during 1982-2013, and age- 1 recruitment (numbers, in thousands), during 1982-2014, for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

Year	Average F (ages 4-6)	Spawning Stock Biomass (mt)	Recruitment (nos., in thousands)
1982	0.42	17,380	13,763
1983	0.43	16,474	8,338
1984	1.17	10,533	17,881
1985	0.81	6,256	16,791
1986	0.57	7,817	21,914
1987	0.76	8,082	15,543
1988	0.92	6,682	26,316
1989	0.84	5,298	14,912
1990	0.91	6,895	9,880
1991	0.58	6,790	13,235
1992	0.76	5,585	6,422
1993	0.89	4,841	5,200
1994	0.46	3,778	7,308
1995	0.31	3,420	22,770
1996	0.46	4,716	16,283
1997	0.46	6,878	16,181
1998	0.51	7,393	18,634
1999	0.26	9,703	18,185
2000	0.28	13,685	14,200
2001	0.52	10,601	8,626
2002	0.56	10,011	6,654
2003	0.89	9,139	5,155
2004	0.69	5,077	4,354
2005	0.66	4,533	4,074
2006	0.25	4,656	6,559
2007	0.29	4,550	10,481
2008	0.34	4,229	14,949
2009	0.41	4,749	15,182
2010	0.31	5,862	7,851
2011	0.40	6,514	8,828
2012	0.34	6,887	8,671
2013	0.30	6,947	16,789
2014			9,909

Table A24. Bootstrapped estimates (based on 1,000 iterations) of the 2013 average fishing mortality rate (fully recruited F at ages 4-6) for Georges Bank winter flounder (*Pseudopleuronectes americanus*), from the final Virtual Population Analysis (VPA) run, and the associated precision and bias estimates. CV = coefficients of variation.

NLLS	Bootstrap Estimate	Bootstrap Mean	C.V. For Std Error	NLLS Soln.
AVG F	0.2988	0.3100	0.061479	0.1983
N WTD	0.2906	0.2913	0.057402	0.1970
B WTD	0.2831	0.2847	0.056876	0.1998
C WTD	0.3042	0.3156	0.063701	0.2018

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
AVG F	0.011242	0.001976	3.7627	0.2875	0.2138
N WTD	0.000695	0.001815	0.2390	0.2899	0.1980
B WTD	0.001553	0.001799	0.5486	0.2816	0.2020
C WTD	0.011355	0.002046	3.7322	0.2929	0.2175

	LOWER 90. % CI	UPPER 90. % CI
AVG F	0.222185	0.427749
N WTD	0.209589	0.395203
B WTD	0.207446	0.387621
C WTD	0.225519	0.434803

Table A25. Bootstrapped estimates (based on 1,000 iterations) of the 2013 spawning stock biomass (mt) and the 2014 January 1 biomass and mean biomass estimates for Georges Bank winter flounder (*Pseudopleuronectes americanus*), from the final Virtual Population Analysis (VPA) run, and the associated precision and bias estimates. CV = coefficients of variation.

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
JAN-1	13237.	13732.	2224.	0.1620
MEAN	11136.	11637.	1924.	0.1653
SSB	6947.	7255.	1147.	0.1580

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
JAN-1	495.	72.	3.7429	12741.	0.1746
MEAN	501.	63.	4.4985	10635.	0.1809
SSB	308.	38.	4.4288	6639.	0.1727

	LOWER 90. % CI	UPPER 90. % CI
JAN-1	10444.	17608.
MEAN	8775.	14973.
SSB	5525.	9274.

Table A26. Uncertainty measures for Georges Bank winter flounder (*Pseudopleuronectes americanus*) predicted stock sizes-at-age during 2014, for ages 3-6, based on 1,000 bootstrap iterations. CV = coefficients of variation.

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
N 3	4591.	5069.	2293.	0.4523
N 4	2801.	3012.	1253.	0.4158
N 5	1133.	1203.	437.	0.3630
N 6	1725.	1825.	618.	0.3389

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
N 3	478.	74.	10.4024	4114.	0.5573
N 4	211.	40.	7.5386	2590.	0.4836
N 5	70.	14.	6.2179	1062.	0.4111
N 6	99.	20.	5.7642	1626.	0.3804

	LOWER 90. % CI	UPPER 90. % CI
N 3	2241.	9451.
N 4	1413.	5328.
N 5	644.	2015.
N 6	971.	2946.

Table A27. Uncertainty measures for Georges Bank winter flounder (*Pseudopleuronectes americanus*) fishing mortality-at-age during 2013, for ages 1-7+, based on 1,000 bootstrap iterations. CV = coefficients of variation.

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
AGE 1	0.0003	0.0003	0.000061	0.1983
AGE 2	0.0355	0.0387	0.017486	0.4515
AGE 3	0.2203	0.2344	0.085178	0.3633
AGE 4	0.3746	0.3874	0.111226	0.2871
AGE 5	0.2229	0.2326	0.073549	0.3162
AGE 6	0.2988	0.3100	0.061479	0.1983
AGE 7	0.2988	0.3100	0.061479	0.1983

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
AGE 1	0.000011	0.000002	3.7627	0.0003	0.2138
AGE 2	0.003204	0.000562	9.0200	0.0323	0.5411
AGE 3	0.014144	0.002730	6.4208	0.2061	0.4132
AGE 4	0.012809	0.003541	3.4190	0.3618	0.3074
AGE 5	0.009675	0.002346	4.3405	0.2132	0.3449
AGE 6	0.011242	0.001976	3.7627	0.2875	0.2138
AGE 7	0.011242	0.001976	3.7627	0.2875	0.2138

	LOWER 90. % CI	UPPER 90. % CI
AGE 1	0.000222	0.000428
AGE 2	0.017109	0.071199
AGE 3	0.121711	0.395780
AGE 4	0.227934	0.584326
AGE 5	0.136736	0.365278
AGE 6	0.222185	0.427749
AGE 7	0.222185	0.427749

Table A28. Input data to stochastic projection software used to compute median estimates of catch (mt) and spawning stock biomass (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 2015-2017. The data are 2009-2013 averages from the final Virtual Population Analysis (VPA) model. Selectivity, stock weights, catch weights, and proportions mature-at-age data were also used in the Beverton-Holt stock-recruitment model to estimate FMSY.

Age	Selectivity on F	Selectivity on M	Stock weights	Catch weights	Spawning stock weights	Proportion mature
1	0.002	1	0.275	0.241	0.238	0.003
2	0.116	1	0.264	0.368	0.319	0.073
3	0.641	1	0.443	0.518	0.473	0.745
4	1.000	1	0.616	0.699	0.647	1.000
5	1.000	1	0.809	0.870	0.830	1.000
6	1.000	1	1.024	1.092	1.043	1.000
7+	1.000	1	1.464	1.431	1.431	1.000

Table A29. Summary of Beverton-Holt stock-recruitment model fits for Georges Bank winter flounder (*Pseudopleuronectes americanus*) based on updated input data from the final Virtual Population Analysis (VPA)model (1982-2012 year-classes). The updated FMSY reference point (= 0.44) was estimated from the model run with steepness (*h*) fixed at 0.78. Note that only the FMSY estimate from this model was used as a biological reference point.

			Final Model
	No prior	Prior on h^1	Fixed h^2
FMSY	2.0	0.53	0.44
SSBMSY (mt)	1,832	5,745	6,828
MSY (mt)	3,157	2,825	2,807
Fmax	N/A	N/A	N/A
h	1.00	0.84	0.78
R_0	12,632	14,257	15,234
NegLL	311.785	310.897	306.660
AIC	630.460	631.457	632.187

[1] Steepness prior (*h*) set to 0.80 and SE set to 0.09 based on values for Pleuronectids reported in Myers et al. (1999)

[2] See text regarding rationale for fixing *h* at 0.78

Table A30. Log-likelihood profile for fixed unfished steepness (*h*) values from Beverton-Holt stock-recruitment models (1982-2012 year-classes) for Georges Bank winter flounder (*Pseudopleuronectes americanus*). The steepness parameter was fixed at 0.78 in the final model run.

Fixed unfished steepness (*h*)	F_{MSY}	SSBMSY (mt)	MSY (mt)	Bias-corrected AIC	NLL
0.60	0.27	12,196	3,119	636.717	308.926
0.70	0.35	8,660	2,852	633.648	307.391
0.78	0.44	6,828	2,807	632.187	306.660
0.80	0.47	6,411	2,809	631.917	306.525

Table A31. Existing biological reference points (and 80% confidence limits) and updated biological reference points (and 90% confidence limits) in relation to the 2013 F and SSB estimates (and 90% confidence limits) used to determine the stock status of Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 2013.

	Existing	Updated
FMSY[1]	0.42	0.44
SSBMSY (mt)	11,800 (8,500, 16,800)	8,100 (5,890, 11,300)
MSY (mt)	4,400 (3,200, 6,100)	3,200 (2,340, 4,460)
F2013		0.30 (0.22, 0.43)
SSB2013 (mt)		6,947 (5,525, 9,274)

[1] Precision estimates were not possible because the steepness parameter (*h*) from the Beverton-Holt stock-recruitment model was fixed at 0.78

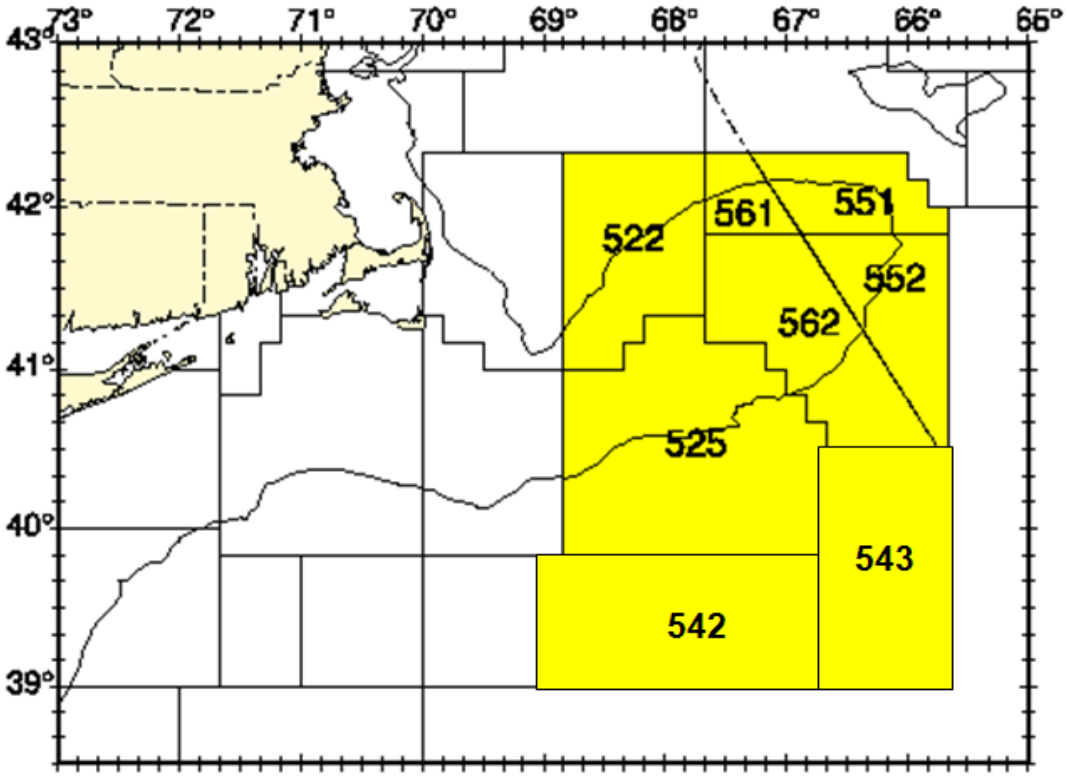


Figure A1. Statistical Areas used for reporting fishery data for the Georges Bank winter flounder (*Pseudopleuronectes americanus*) stock.

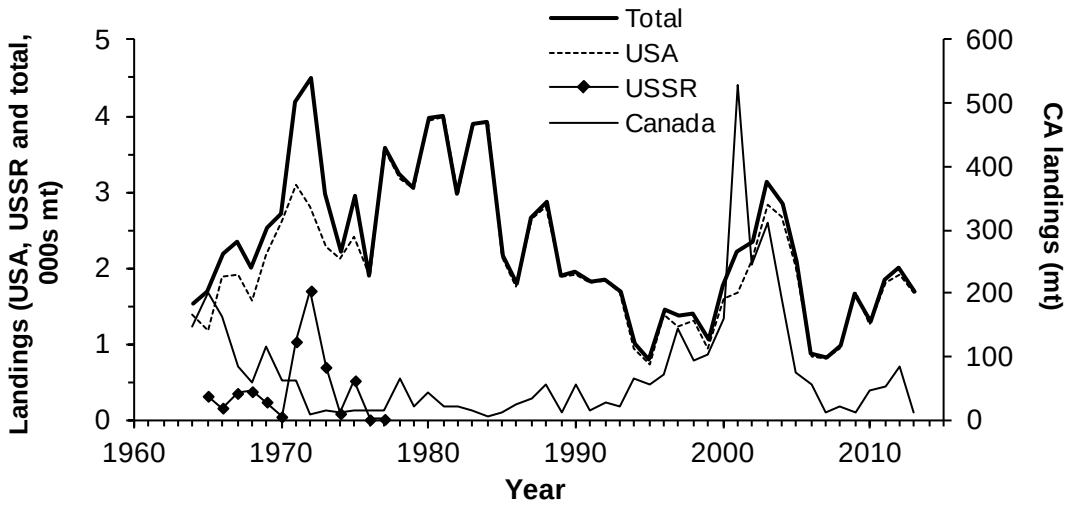


Figure A2. Landings (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by country, during 1964-2013.

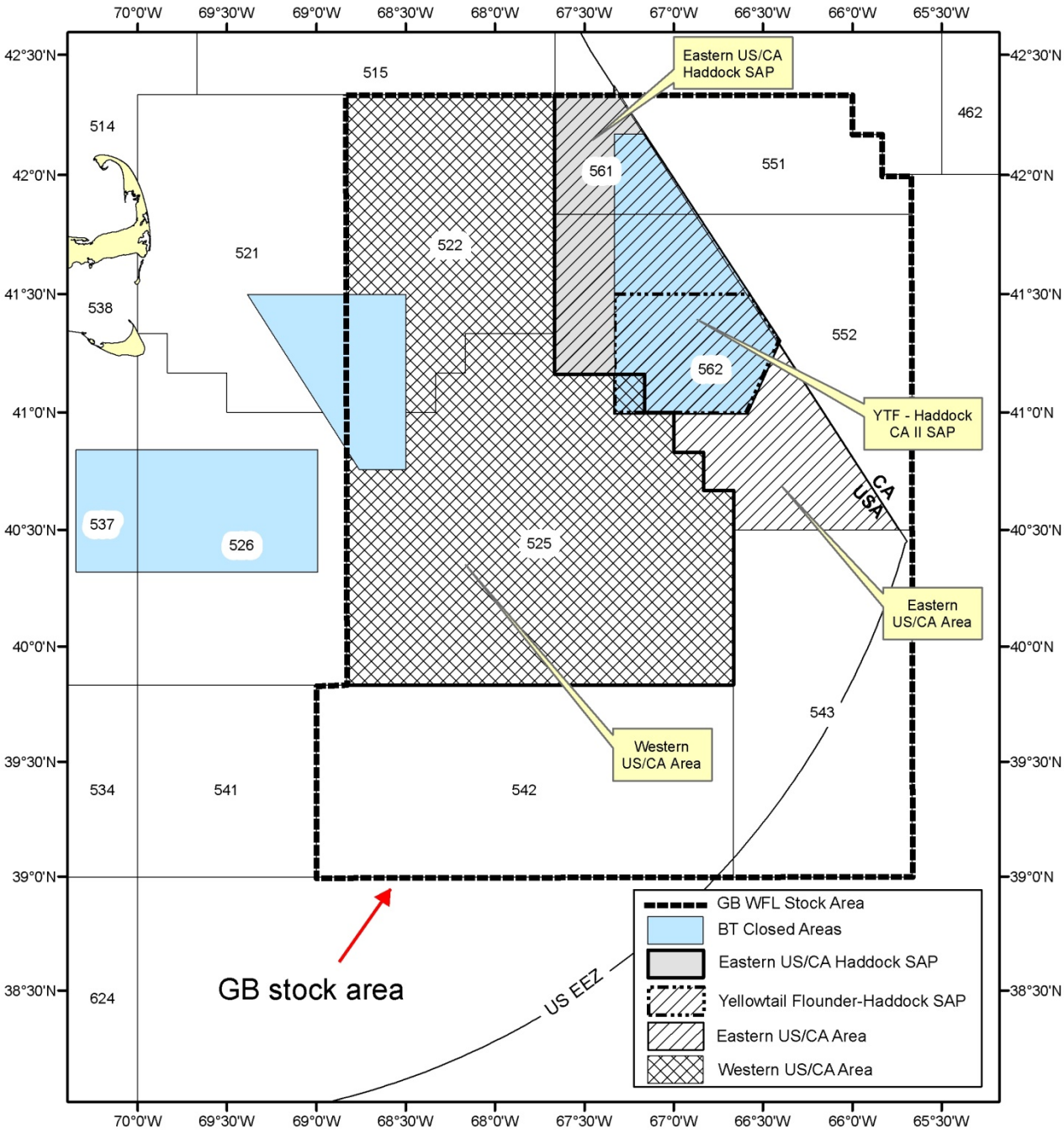


Figure A3. Fishery management areas that may affect the Georges Bank winter flounder stock (*Pseudopleuronectes americanus*). Blue polygons have been closed (CA) to bottom trawl vessels since 1994 but have been open to scallop dredge vessels with fishery closures dependent on scallop and yellowtail flounder bycatch limits. The US/CA areas were implemented beginning in May of 2004 and involve jointly managed Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and yellowtail flounder (*Limanda ferruginea*) stocks.

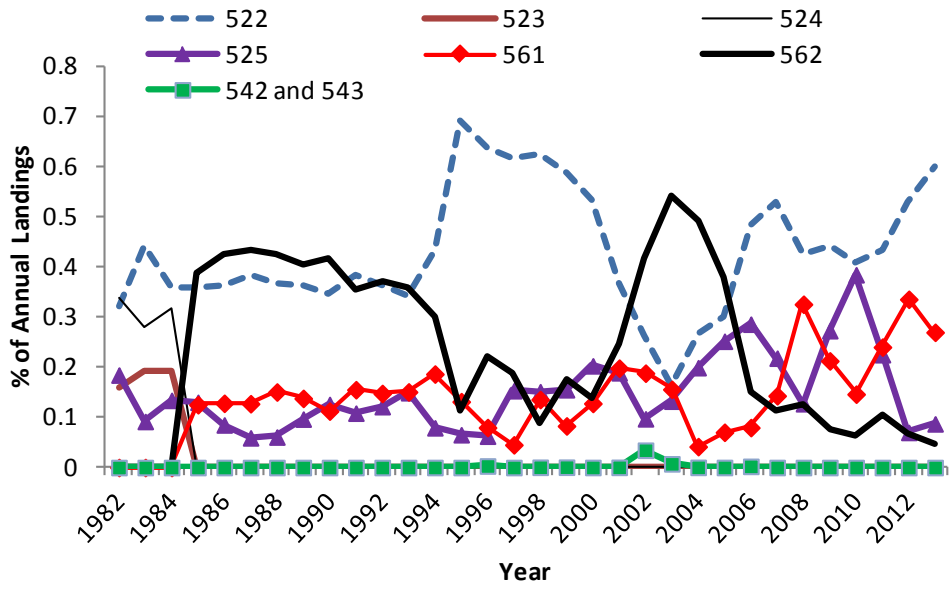


Figure A4. US landings of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by Statistical Area, during 1982-2013.

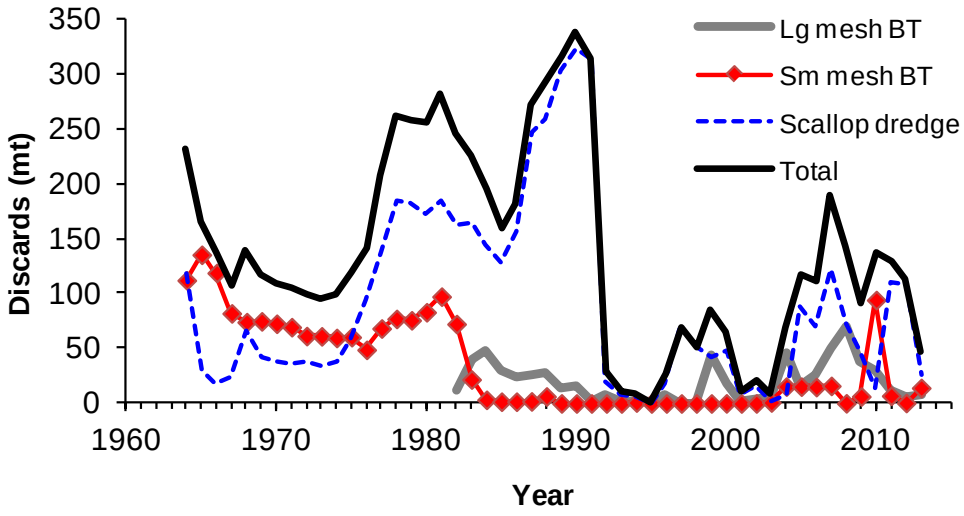


Figure A5. US discards (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by major gear type, during
1964-2013.

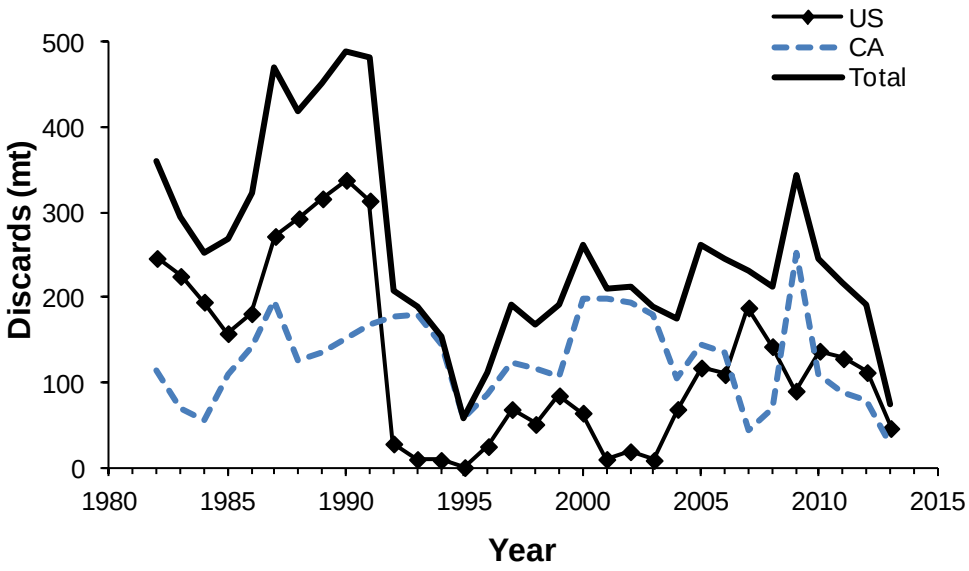


Figure A6. Estimates of total discards (mt) of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by country, during 1982-2013.

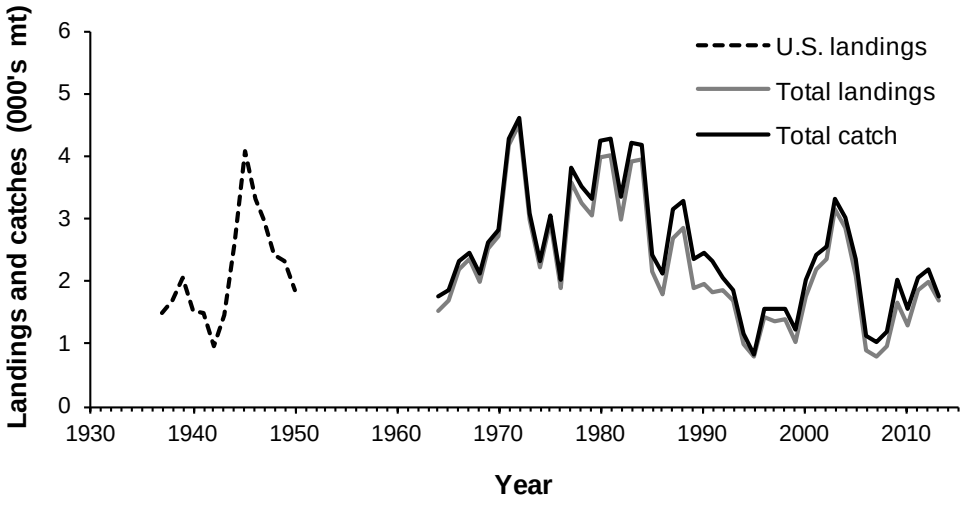


Figure A7. Historical US landings of winter flounder (*Pseudopleuronectes americanus*) from Georges Bank, during 1937-1950, in relation to total landings and catches during 1964-2013.

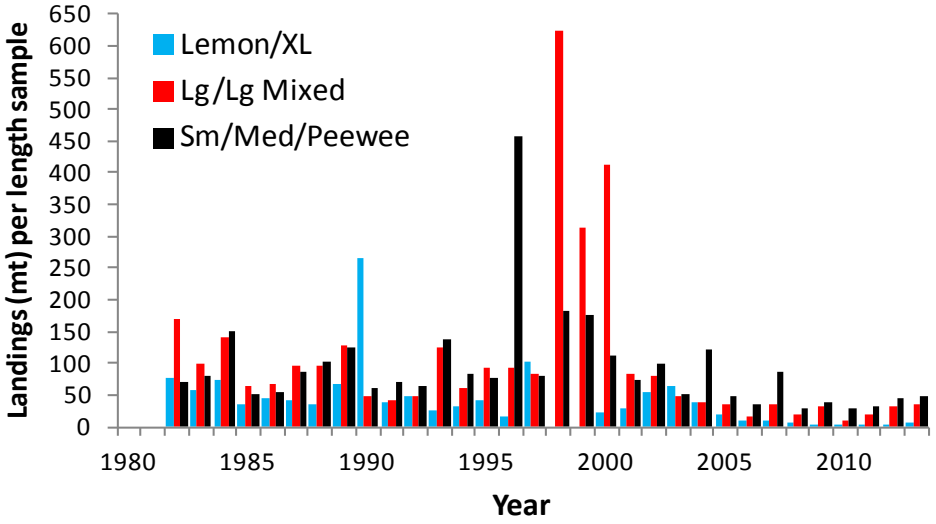


Figure A8. Landings of Georges Bank winter flounder (*Pseudopleuronectes americanus*) per length sample (approximately 100 lengths per sample), by market category group, during 1982-2013.

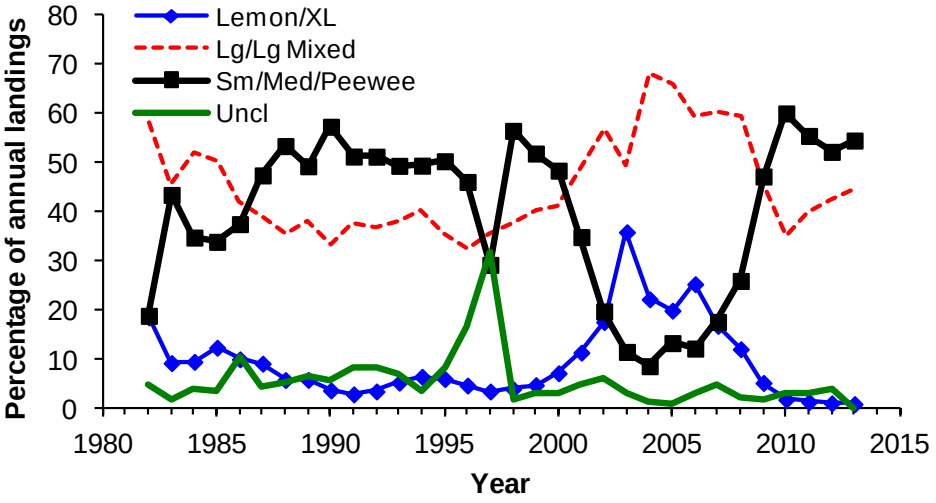


Figure A9. US landings of Georges Bank winter flounder (*Pseudopleuronectes americanus*), by market category group, during 1982-2013.

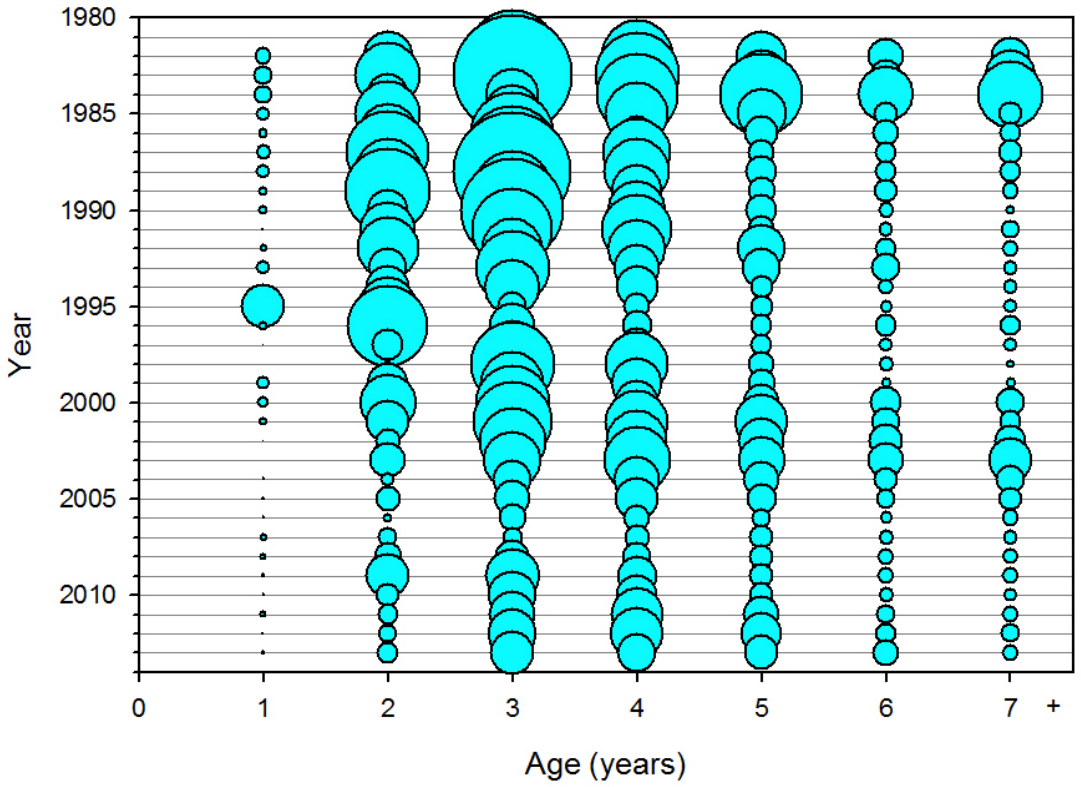


Figure A10. Georges Bank winter flounder (*Pseudopleuronectes americanus*) catch-at-age during 1982-2013. Catches increase with circle size.

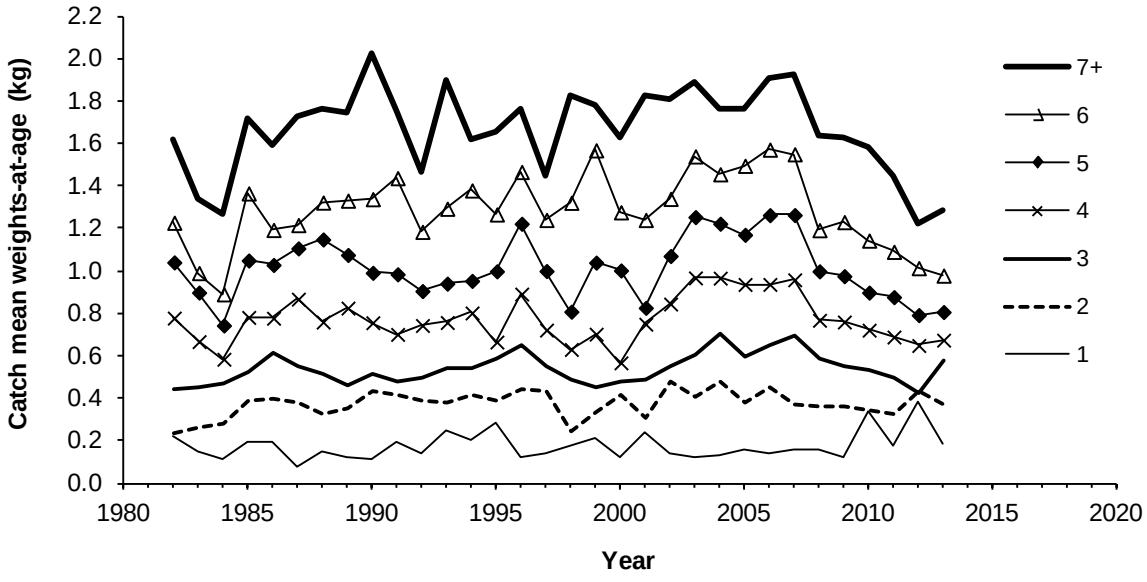


Figure A11. Trends in mean weights-at-age (kg) of GB winter flounder (*Pseudopleuronectes americanus*) catches, 1982-2013.

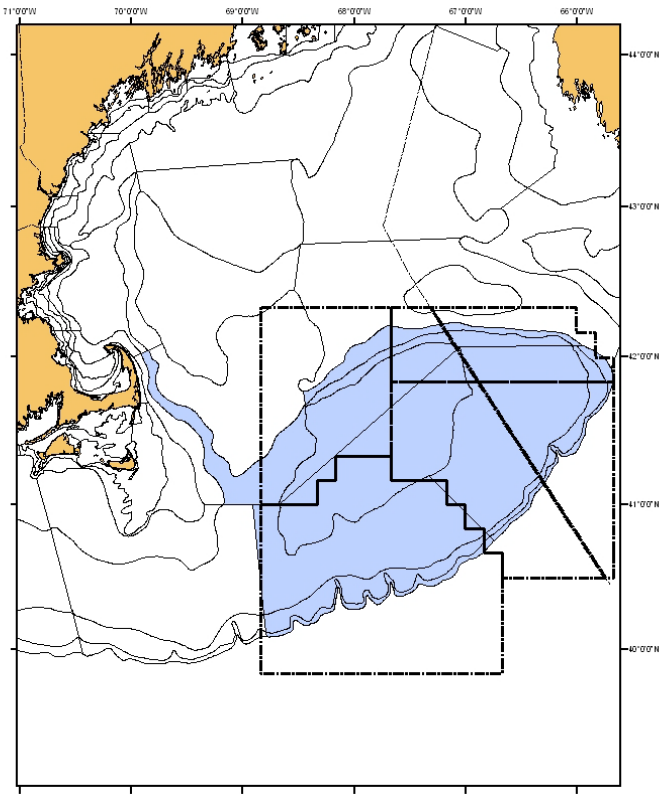


Figure A12. NEFSC survey strata (13-23) included in the assessment of Georges Bank winter flounder (*Pseudopleuronectes americanus*) in relation to fishery Statistical Areas for the stock.

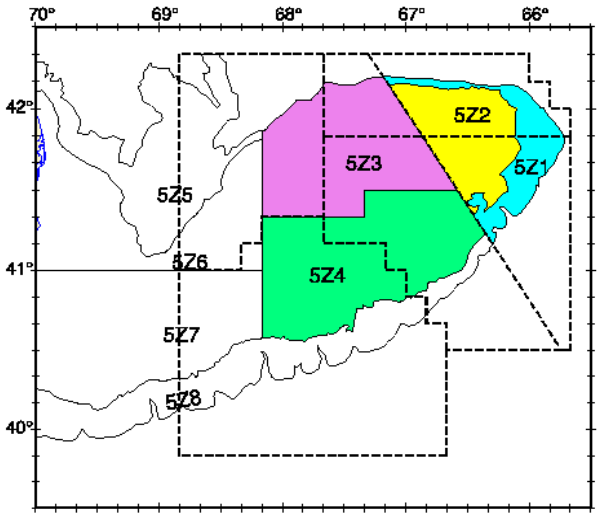


Figure A13. Strata (5Z1-5Z4) from the Canadian spring survey included in the assessment of Georges Bank winter flounder (*Pseudopleuronectes americanus*) in relation to fishery Statistical Areas for the stock.

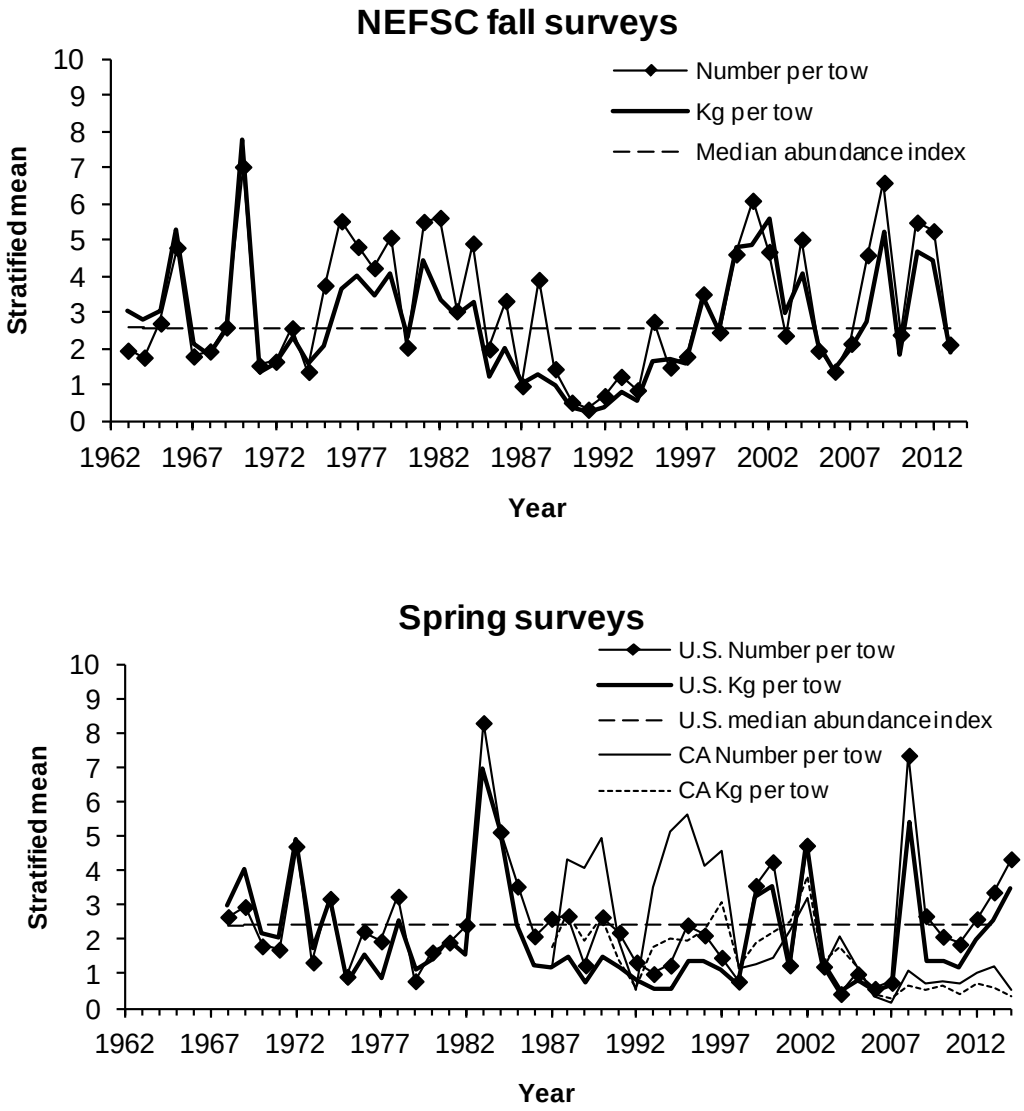


Figure A14. Relative biomass (stratified mean kg per tow) and abundance (stratified mean numbers per tow) indices for Georges Bank winter flounder (*Pseudopleuronectes americanus*) caught during (top) NEFSC fall (1963-2013) bottom trawl surveys and (bottom) NEFSC spring (1968-2014) and Canadian spring (1987-2014 strata 5Z1-5Z4) bottom trawl surveys. NEFSC survey indices include strata 13-23 and were standardized for gear changes (weight = 1.86 and numbers = 2.02) and trawl door changes (weight = 1.39 and numbers = 1.46) prior to 1985. NEFSC indices for the SRV *H.B. Bigelow*, from 2009 onward, were converted to SRV *Albatross* equivalents by using length-based conversion factors.

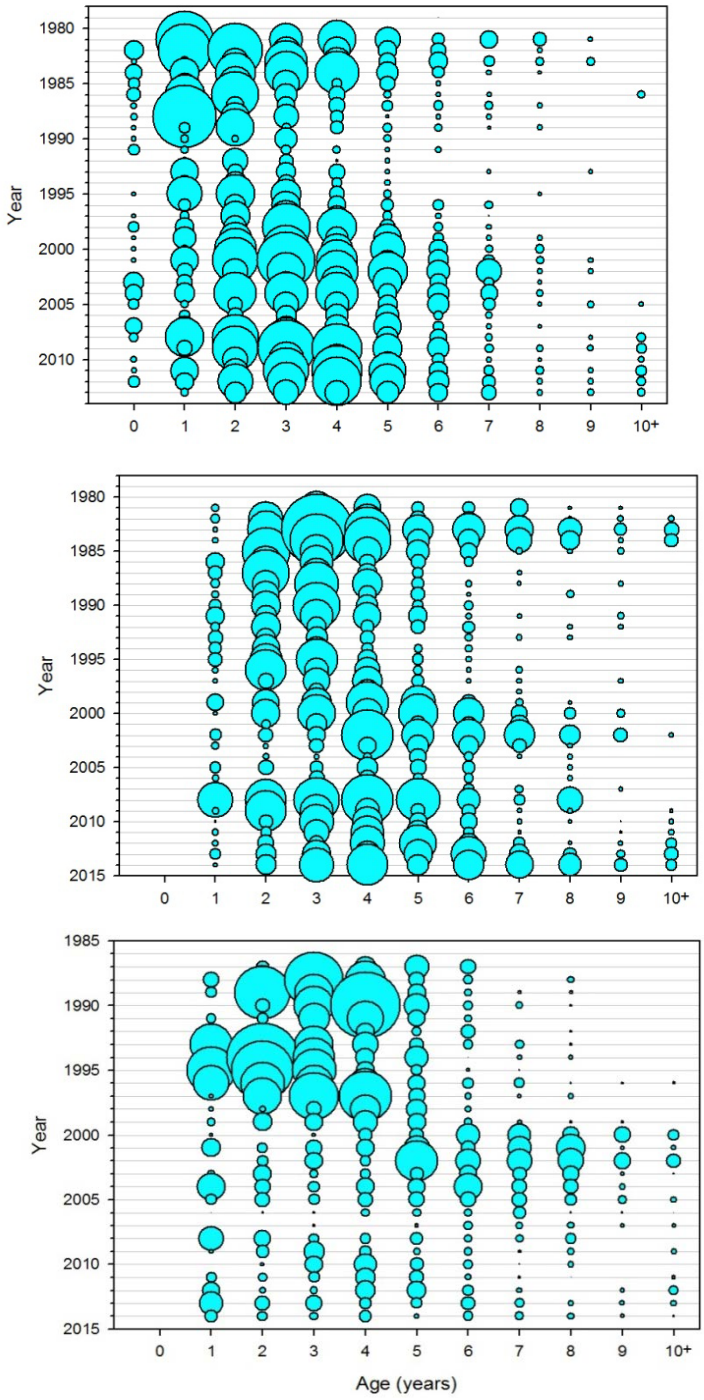


Figure A15. Stratified mean number of winter flounder (*Pseudopleuronectes americanus*) per tow-at-age indices for (top) NEFSC fall bottom trawl surveys (1981-2013), (middle) NEFSC spring surveys (1982-2014), and (bottom) CA spring surveys (1987-2014). Relative abundance increases with circle size.

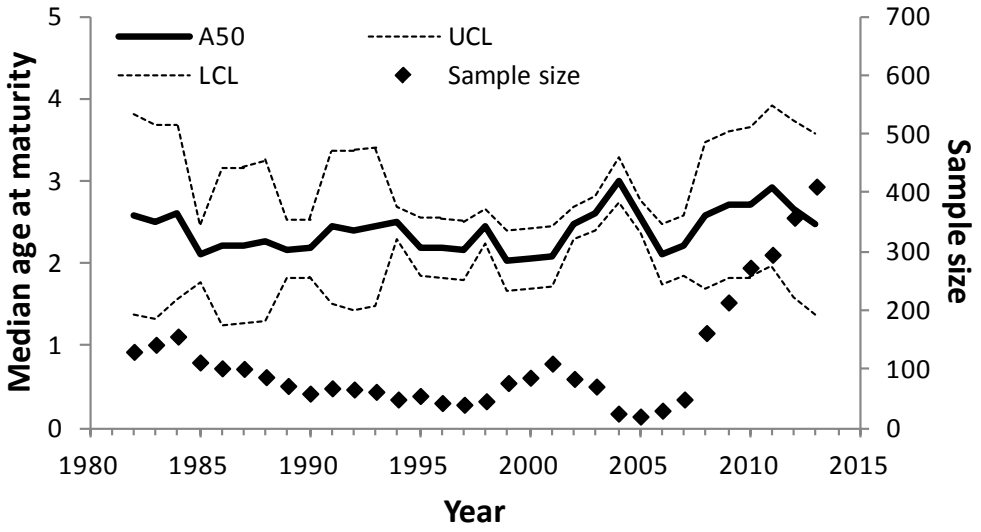


Figure A16. Three-year moving window (NEFSC spring survey data for 1981-2014) of female A50 values (median age-at-maturity) for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 1982-2013.

Figure A17. Weighted residuals, plotted as Z scores, from the Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey indices (ages 1-7+, 1982-2014) used to calibrate the Virtual Population Analysis (VPA) model for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

Figure A18. Weighted residuals, plotted as Z scores, from the Canadian spring bottom trawl survey indices (ages 1-7+, 1987-2014) used to calibrate the Virtual Population Analysis (VPA) model for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

Figure A19. Weighted residuals, plotted as Z scores, from the US fall bottom trawl survey indices (ages 1-7+, 1982-2014; data for ages 0-6 during 1981-2013 were lagged forward by one year and age) used to calibrate the Virtual Population Analysis (VPA) model for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

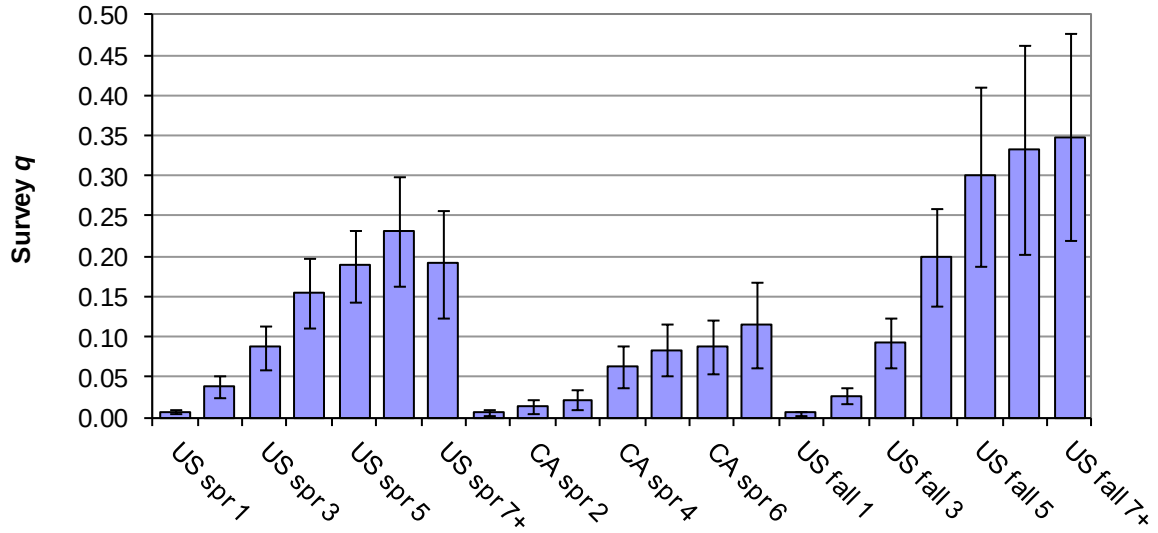


Figure A20. Estimates of swept-area survey catchability coefficients (+/- 2 SE) for the final Virtual Population Analysis (VPA) model run, by age, for Georges Bank winter flounder (*Pseudopleuronectes americanus*) caught during the US spring (1982-2014, ages 1-7+), Canadian spring (1987-2014, ages 1-7+), and US fall (1981-2013, ages 0-6 lagged forward one year and age) bottom trawl surveys.

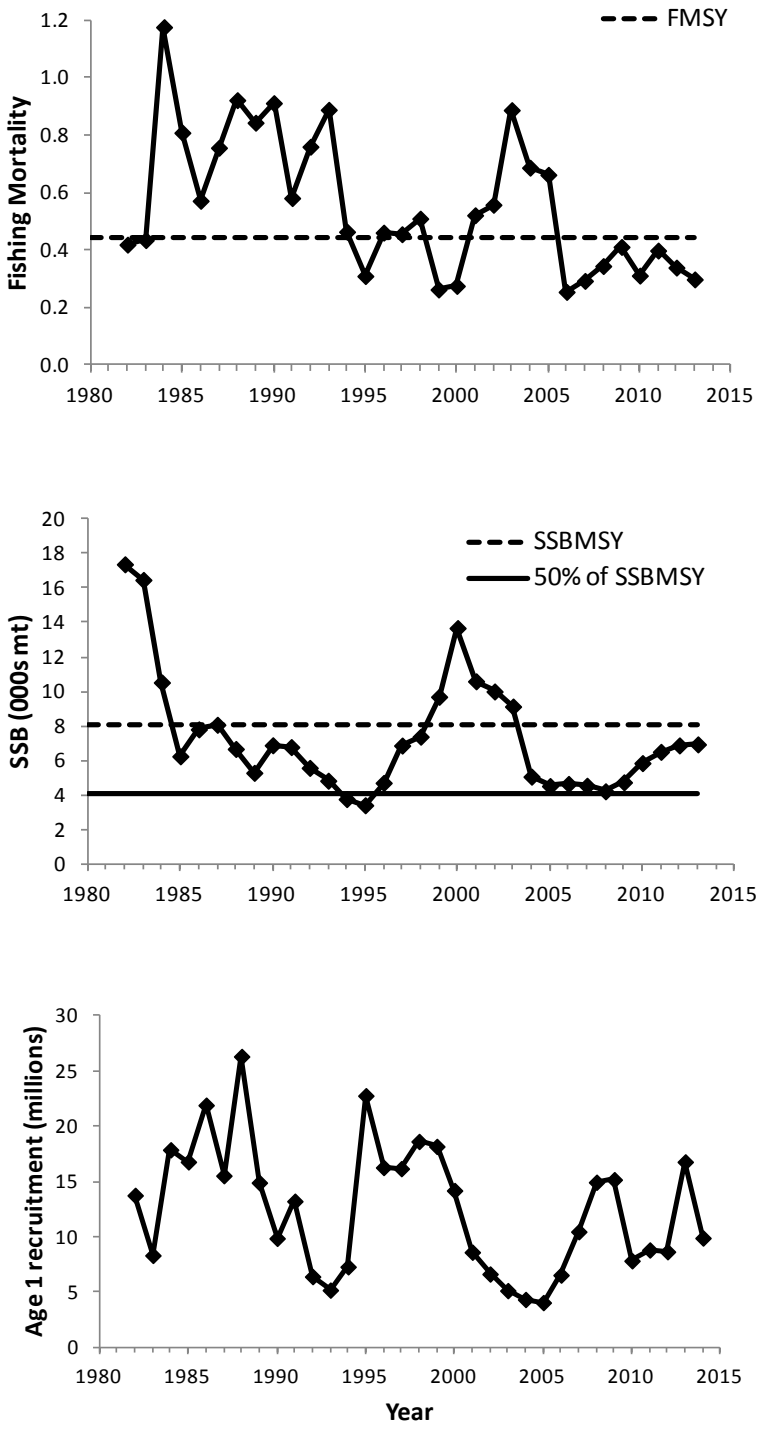


Figure A21. Final Virtual Population Analysis (VPA) model estimates of average fishing mortality rate (ages 4-6, top panel), spawning stock biomass (mt in thousands, middle panel), during 1982-2013, and age-1 recruitment (thousands of fish) during 1982-2014 (bottom panel), for the Georges Bank winter flounder (*Pseudopleuronectes americanus*) stock. The updated reference point thresholds, FMSY and 50% of SSBMSY, and SSBMSY are also shown. The 2014 recruitment estimate is based solely on survey data (2006-2013 geometric mean of age 1 fish).

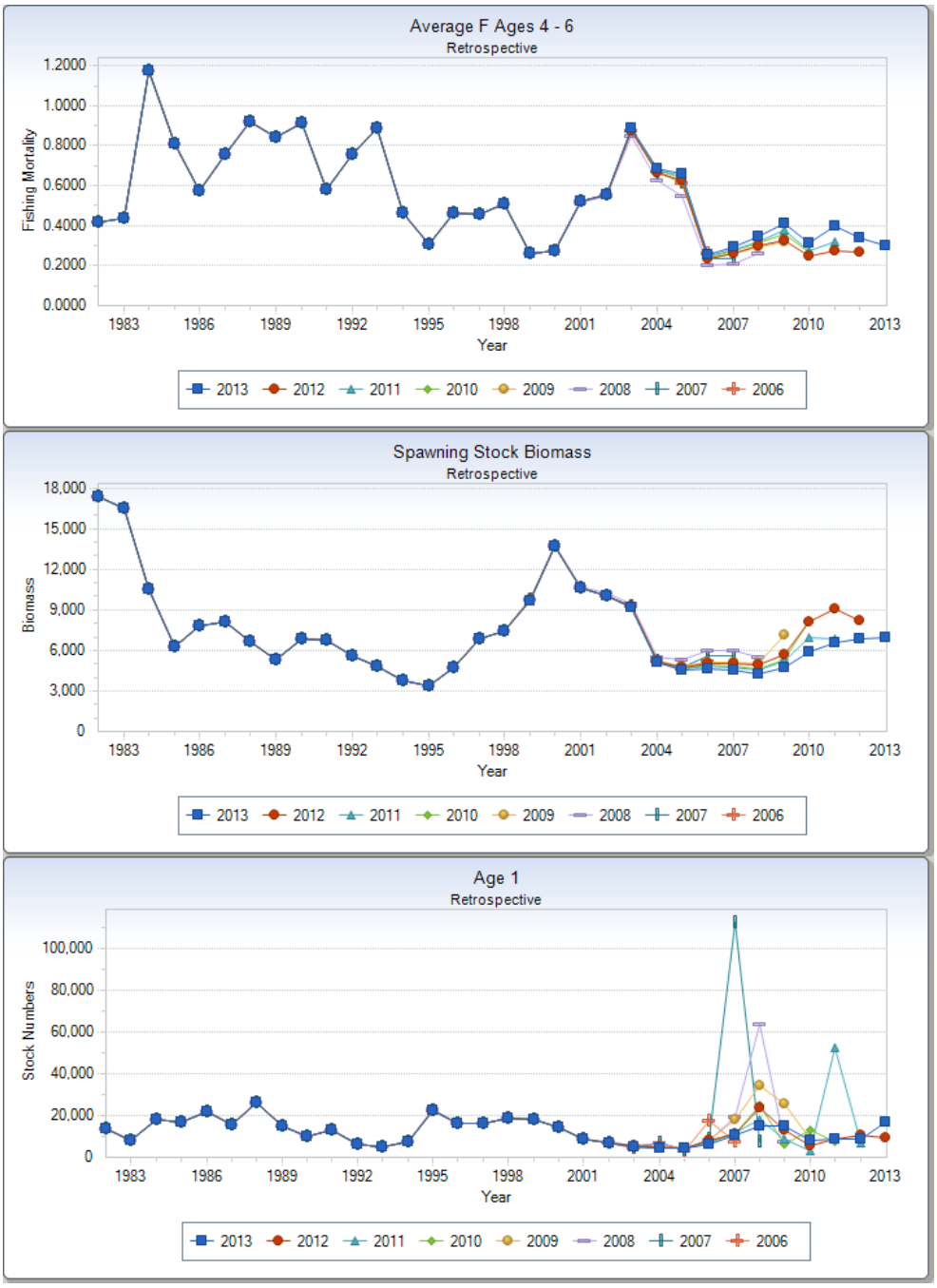


Figure A22. Virtual Population Analysis (VPA) retrospective analysis results for terminal years 2006-2012: average fishing mortality rates (F at ages 4-6, top panel), spawning stock biomass (mt, middle panel), and age 1 recruitment (numbers in thousands, bottom panel) for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

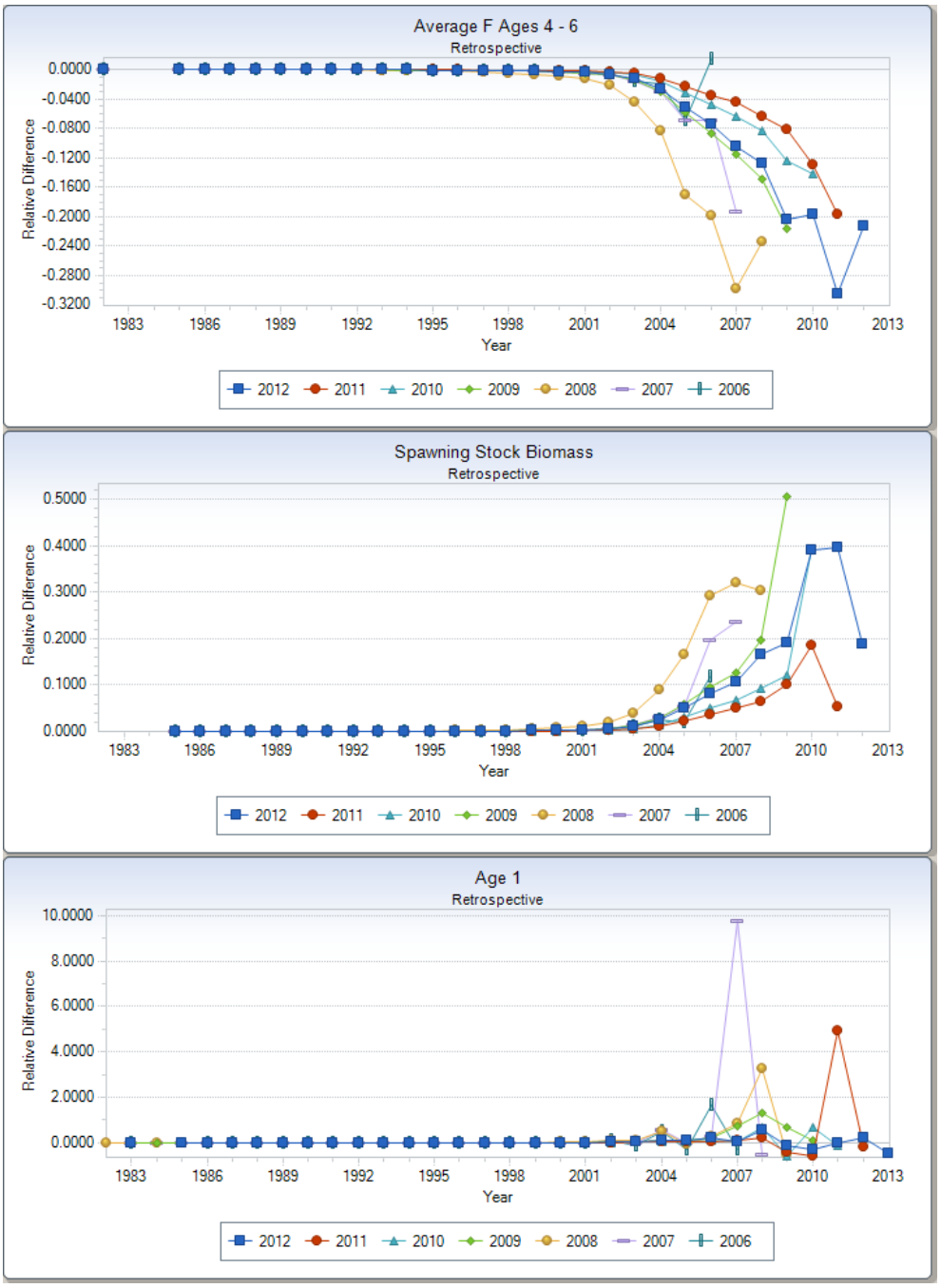


Figure A23. Virtual Population Analysis (VPA) retrospective analysis results for relative differences between terminal years 2006-2012 and 2013, of average F (ages 4-6, top panel), spawning stock biomass (mt, middle panel), and age 1 recruitment (bottom panel) for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

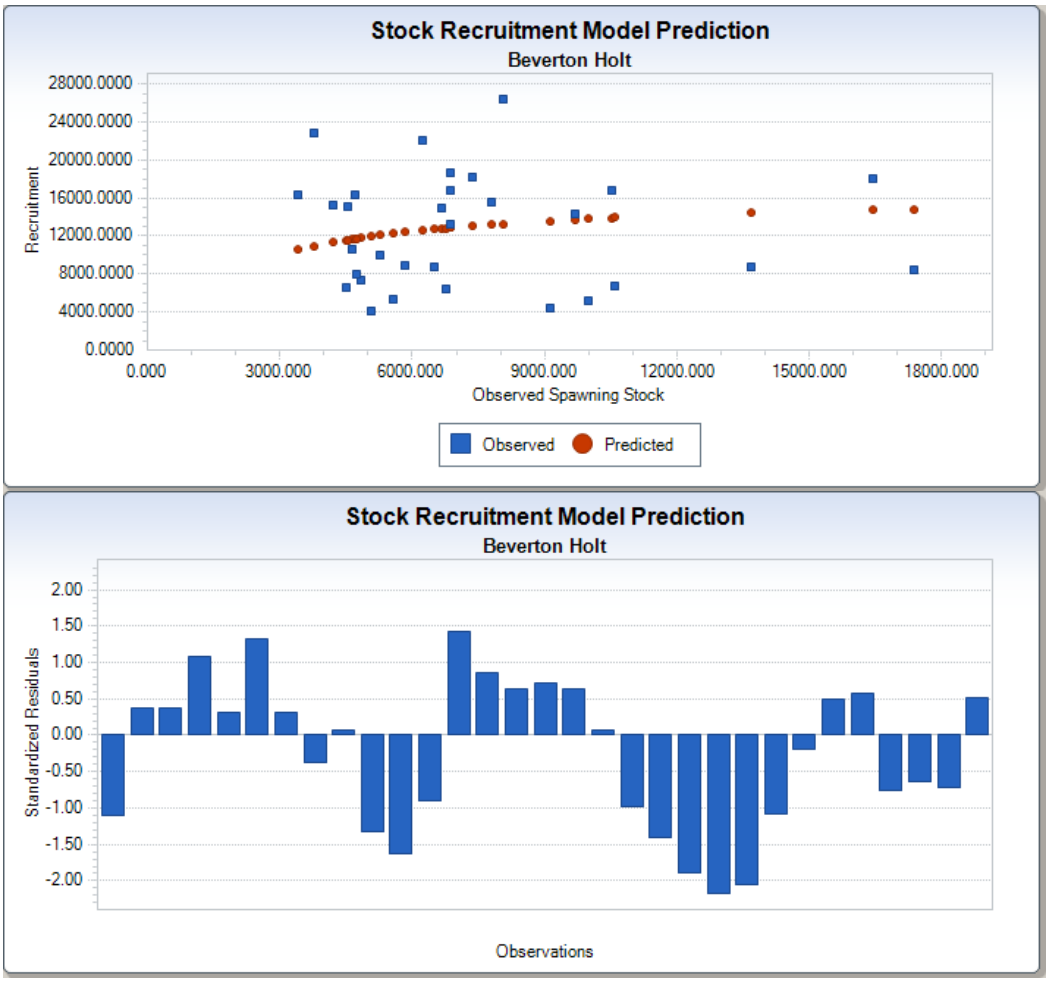


Figure A24. Results from a Beverton-Holt stock-recruitment model fit to Georges Bank winter flounder (*Pseudopleuronectes americanus*) estimates of recruitment (age 1 numbers in thousands, 1982-2012 year classes) and spawning stock biomass (mt) from the final Virtual Population Analysis (VPA) model (top panel). The model was fit assuming a fixed value of 0.78 for unfished steepness (*h*). The bottom panel shows the standardized residuals from the model.

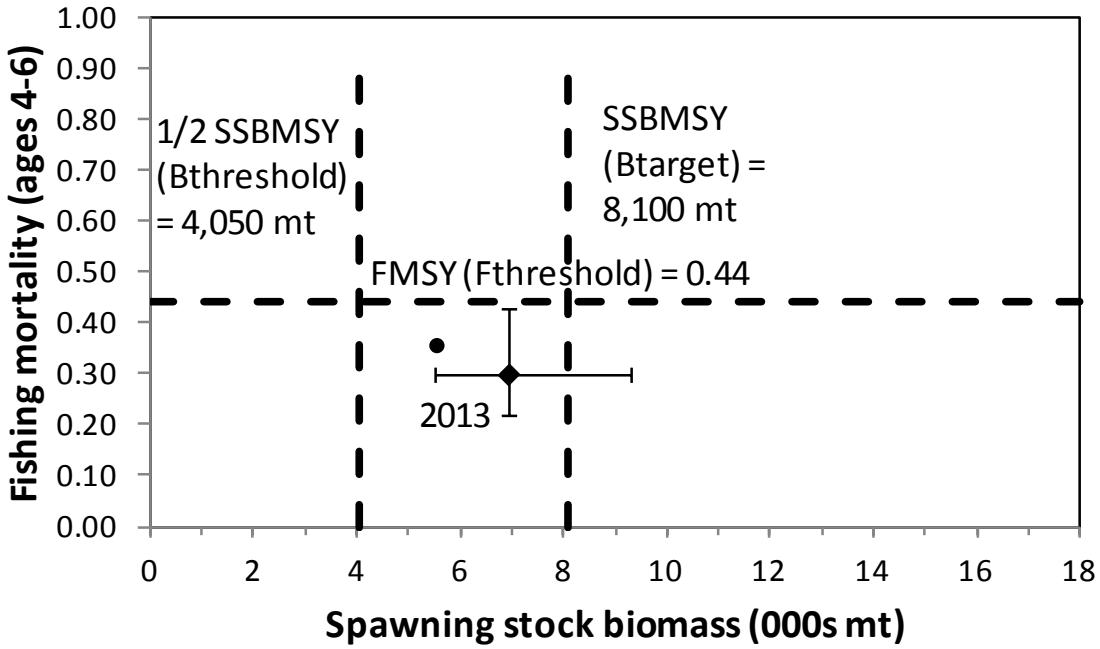


Figure A25. Stock status for Georges Bank winter flounder (*Pseudopleuronectes americanus*), during 2013, based on updated FMSY and SSBMSY reference points. The diamond is the 2013 F and SSB point estimate, with 90% confidence intervals, and the triangle is the 2013 F and SSB point estimate adjusted for retrospective error.

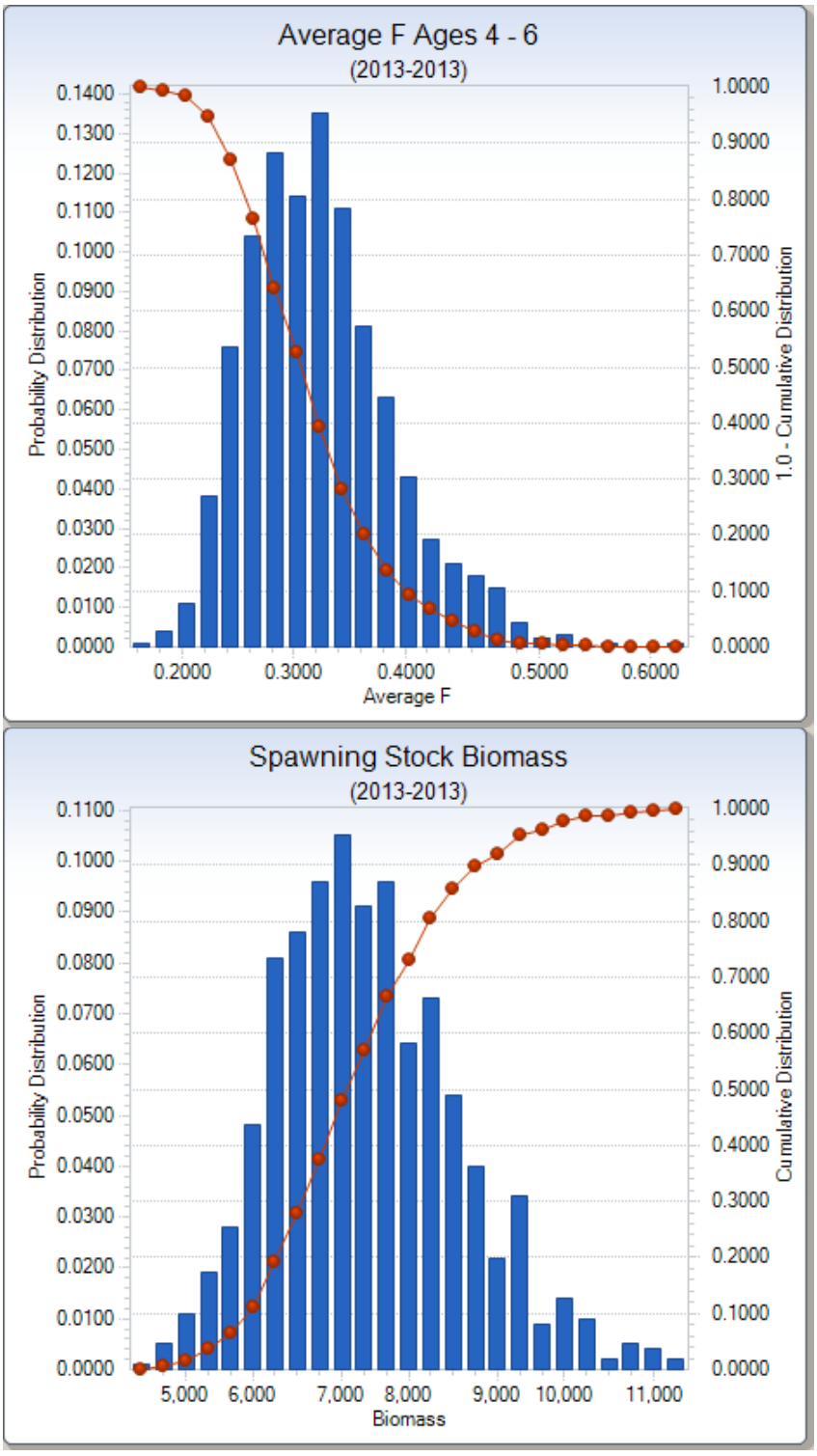


Figure A26. Precision (based on 1,000 bootstrap iterations) of the 2013 estimates of average fishing mortality rate (ages 4-6) and spawning stock biomass (mt) from the final Virtual Population Analysis (VPA) model for Georges Bank winter flounder (*Pseudopleuronectes americanus*).

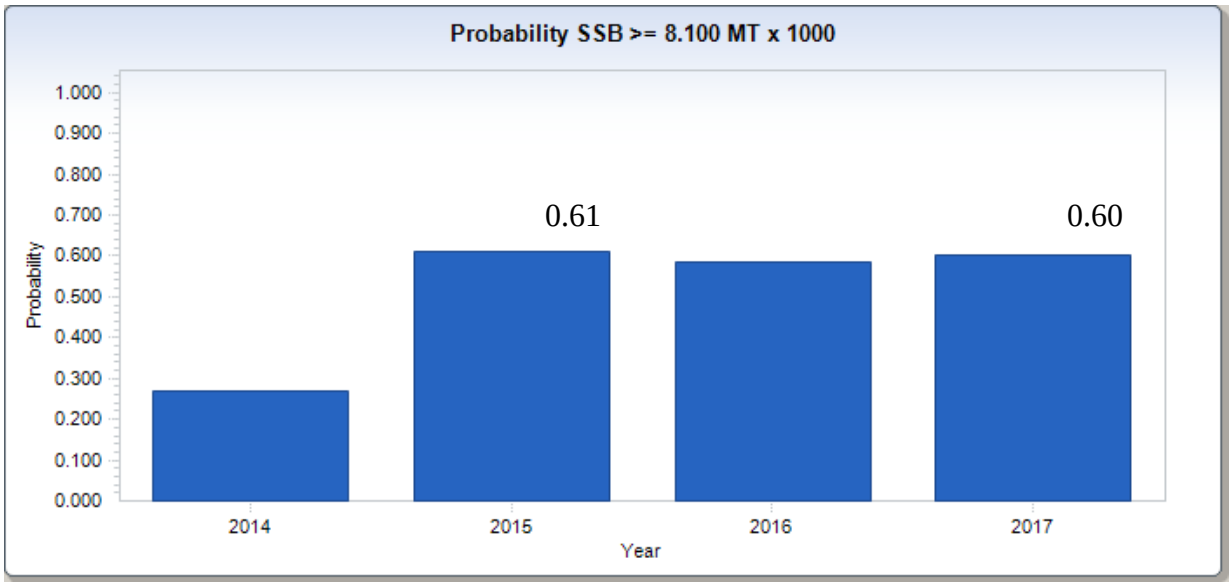


Figure A27. Probability of the Georges Bank winter flounder (*Pseudopleuronectes americanus*) stock being rebuilt to SSBMSY (= 8,100 mt) by 2017 based on an Annual Catch Limit of 1,522 mt in 2014 and fishing at 75% of the updated FMSY value (= 0.33). The regulations require a probability of being rebuilt of at least 75% by 2017.

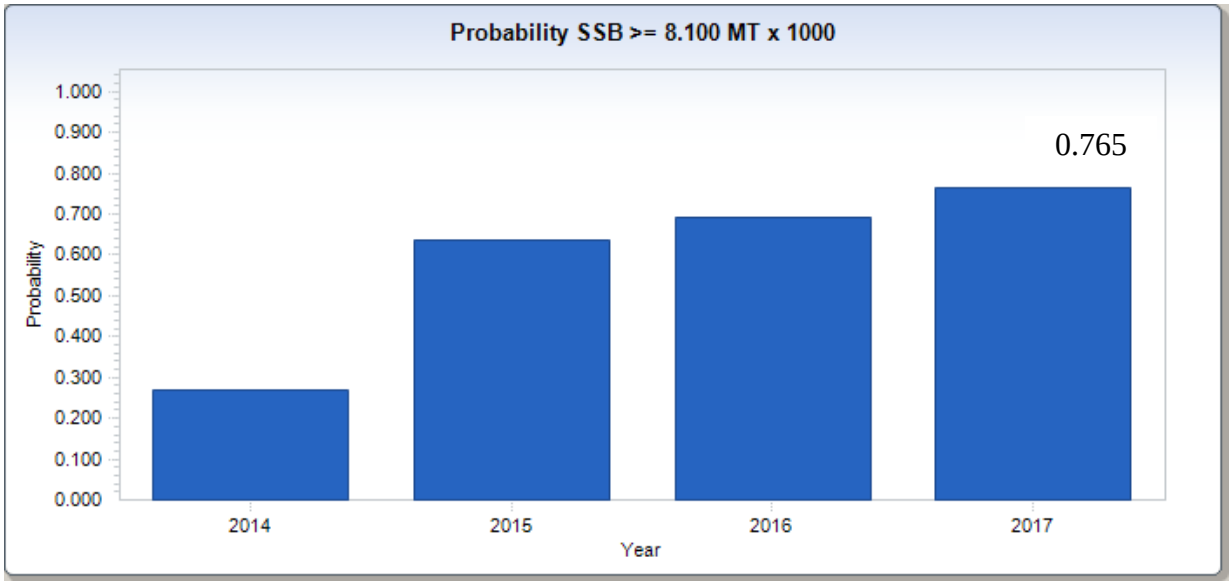
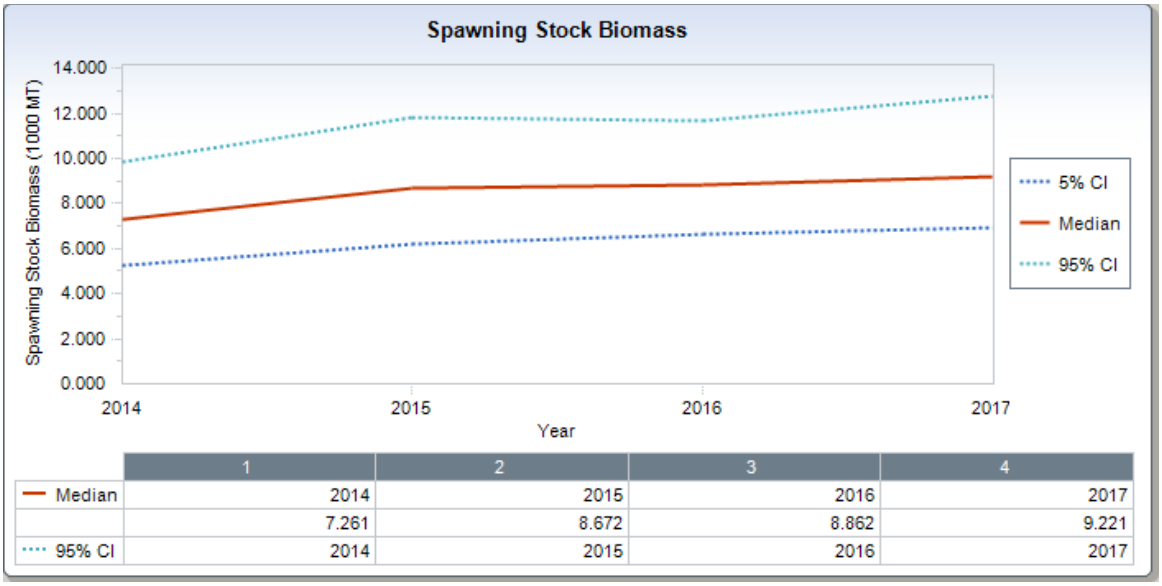
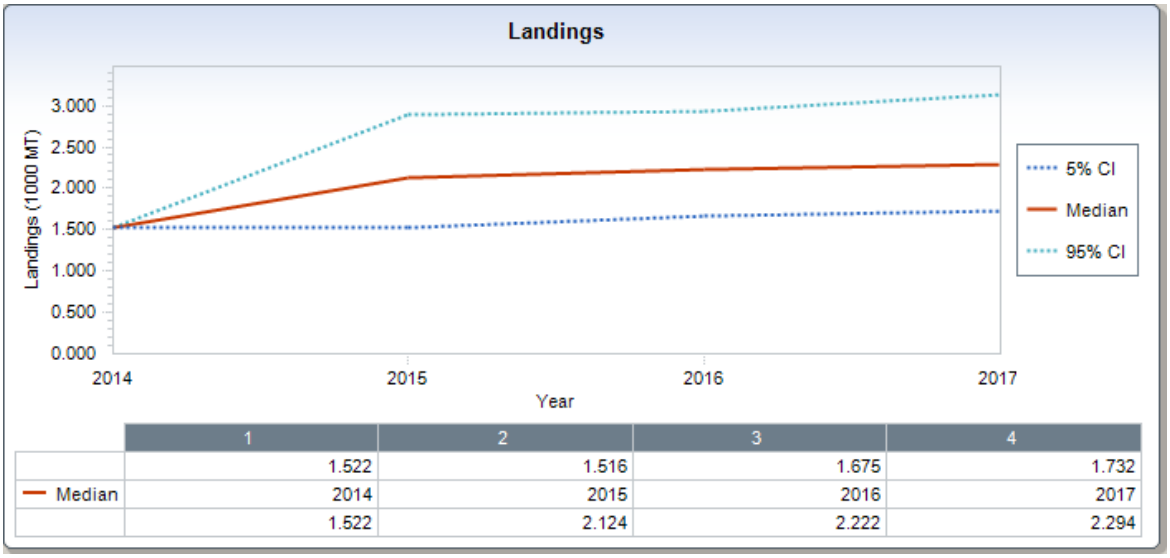


Figure A28. The probability of the Georges Bank winter flounder (*Pseudopleuronectes americanus*) stock being rebuilt to the updated SSBMSY value (= 8,100 mt) by 2017 is 76% when assuming an Annual Catch Limit of 1,522 mt in 2014 and fishing mortality rate of 0.270 during 2015-2017.



	1	2	3	4
Median	2014	2015	2016	2017
	7.261	8.672	8.862	9.221
95% CI	2014	2015	2016	2017

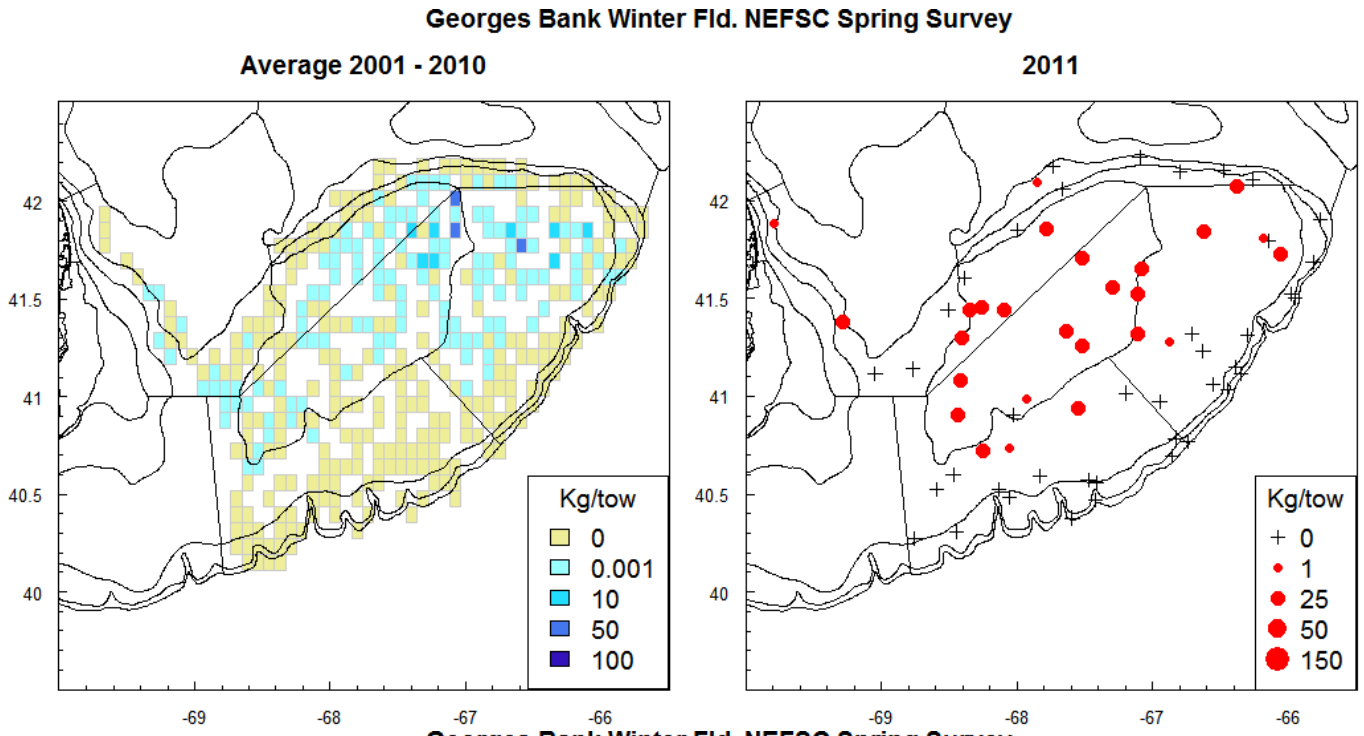


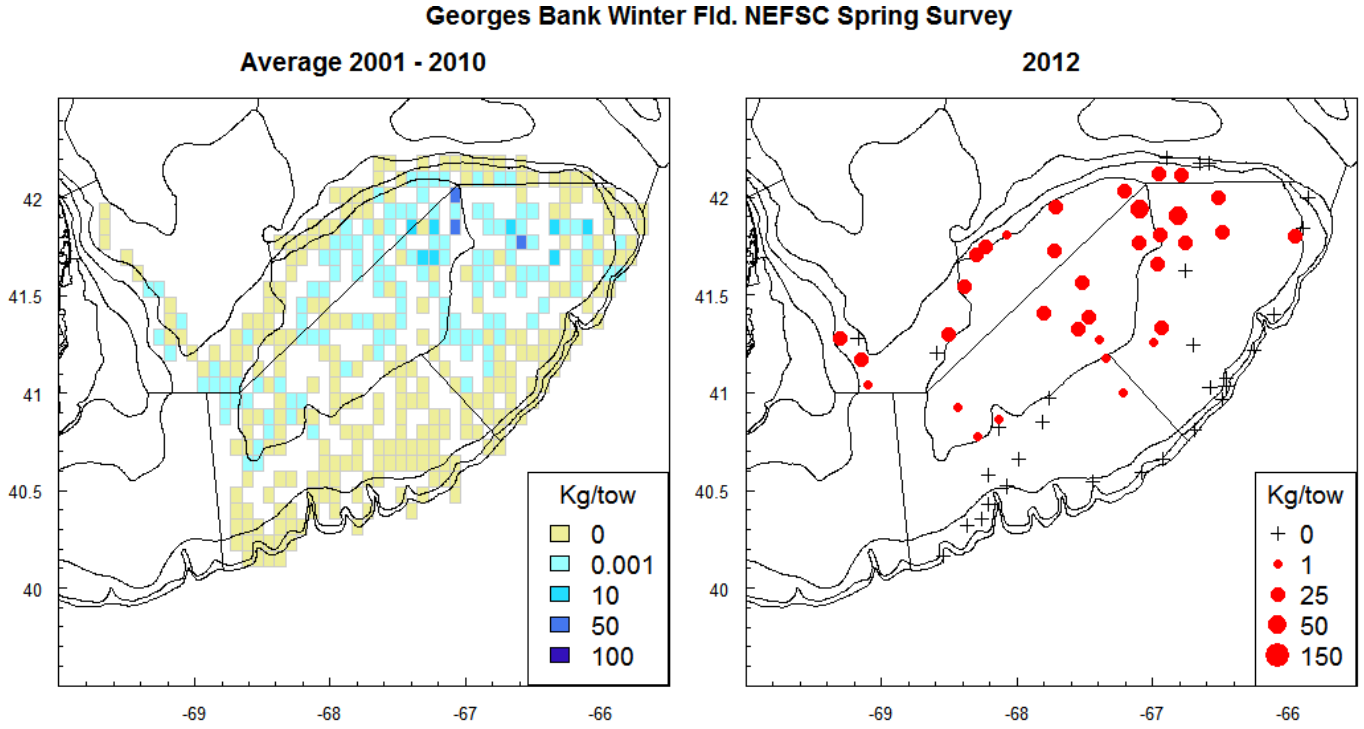
	1	2	3	4
	1.522	1.516	1.675	1.732
Median	2014	2015	2016	2017
	1.522	2.124	2.222	2.294

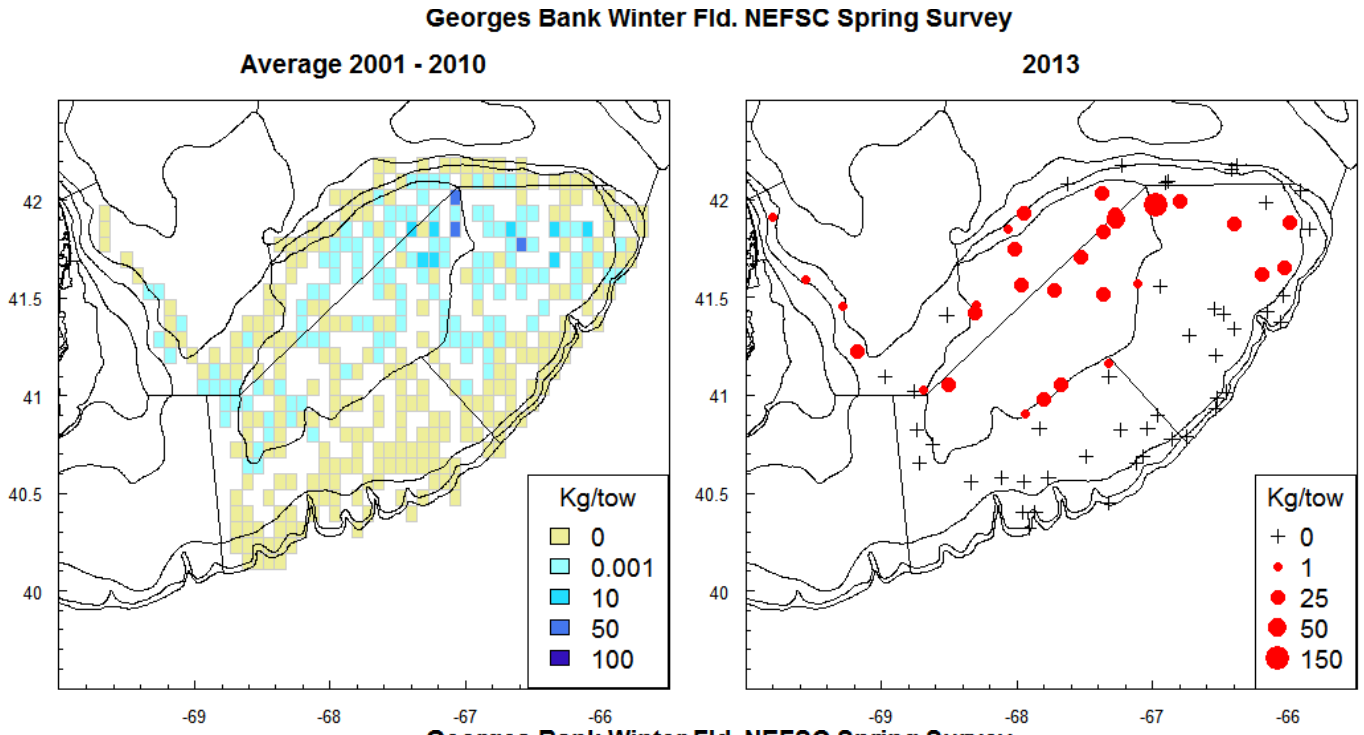
Figure A29. Projected median spawning stock biomass (mt in thousands, top panel) and catches (mt in thousands, bottom panel), for Georges Bank winter flounder (*Pseudopleuronectes americanus*) during 2015-2017 (deadline for rebuilding is 2017), based on an assumed Annual Catch Limit of 1,522 mt in 2014 and fishing at Frebuild = 0.27. Projected Spawning Stock Biomass (SSB) in 2017 is 9,221 mt. Dashed lines represent the 5% and 95% confidence limits of SSB (6,909, 12,803).

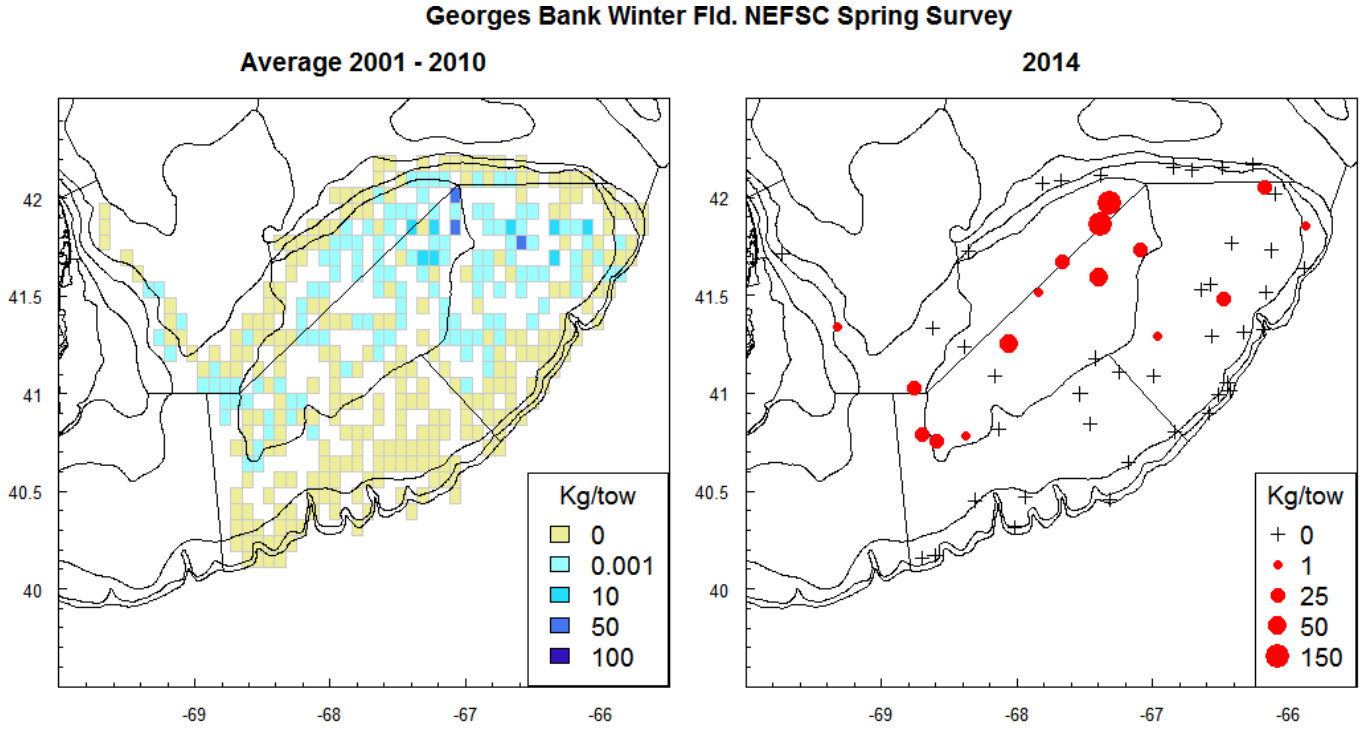
Appendix A1. Distribution maps of Georges Bank winter flounder (*Pseudopleuronectes americanus*)

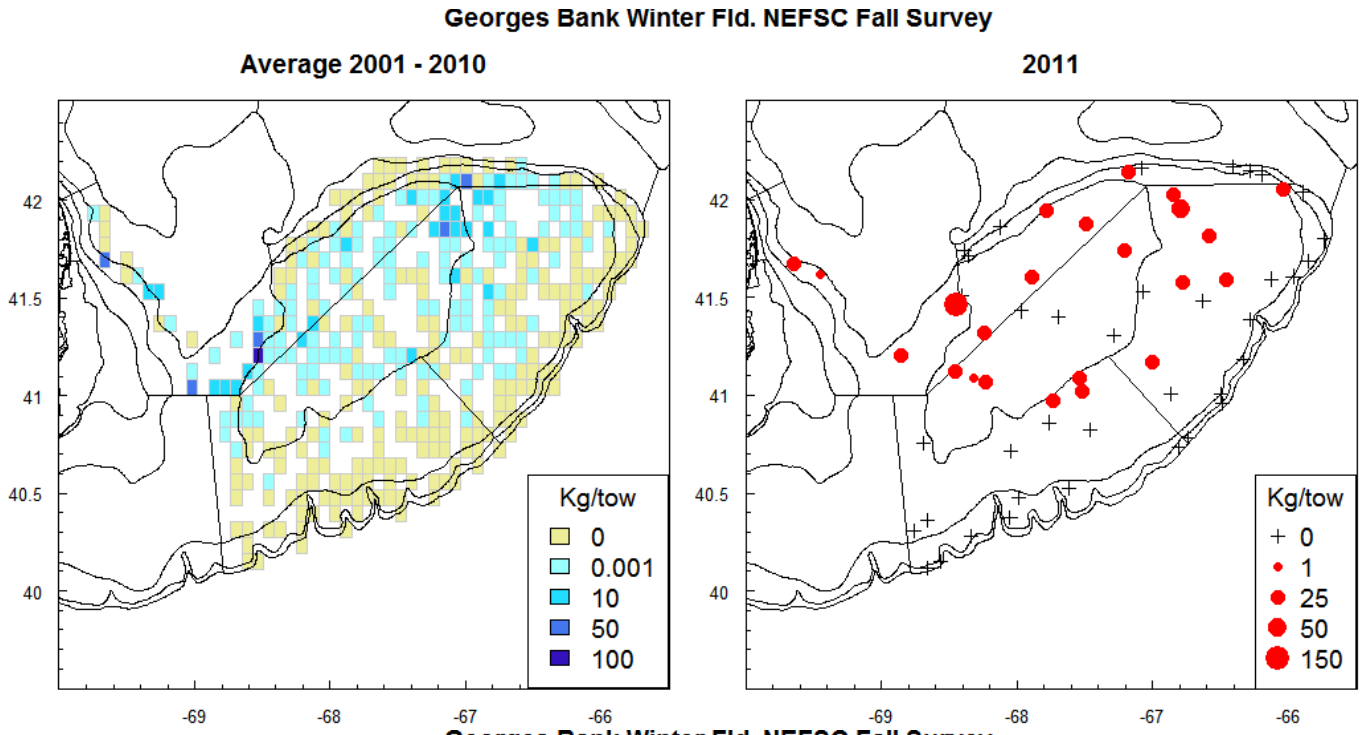
During NEFSC spring and fall bottom trawl surveys during 2001-2010 (average kg per tow by ten-minute square) and annual maps (kg per tow) during 2011-2013 (2014 for the spring survey)

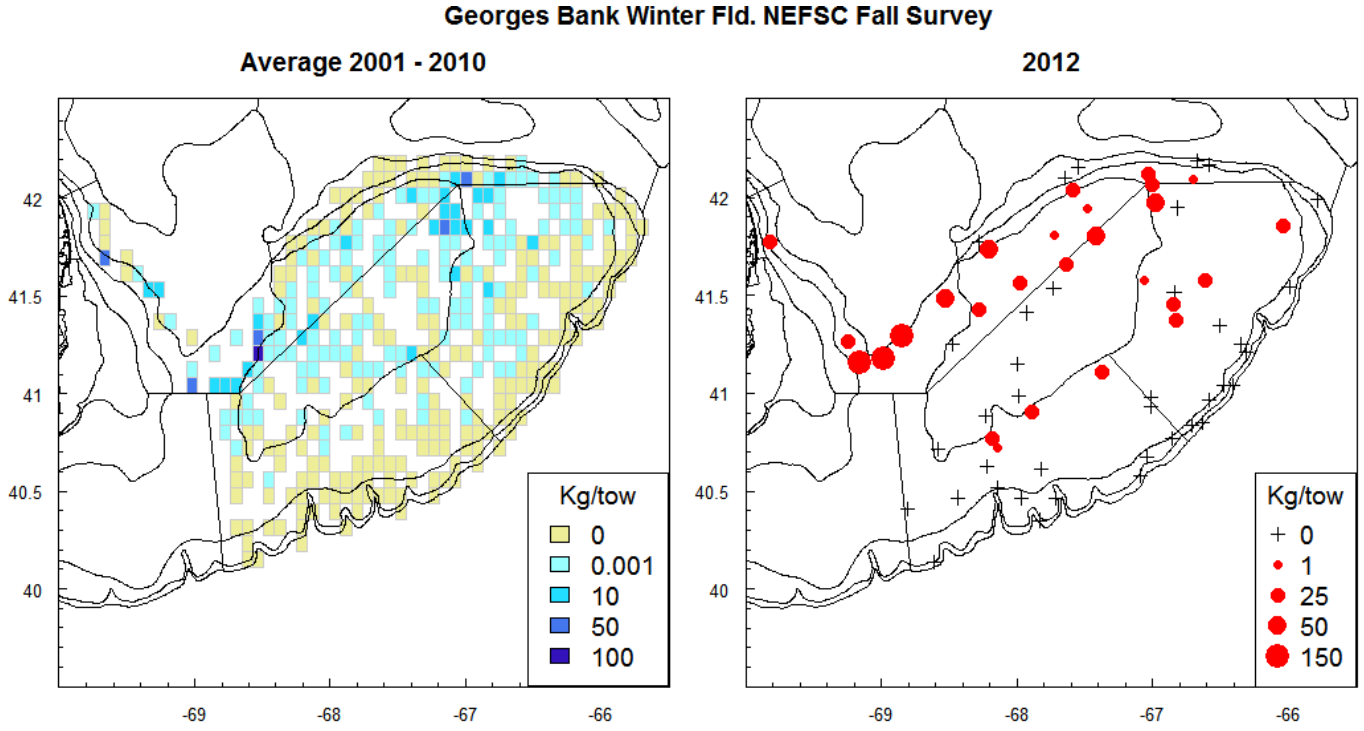


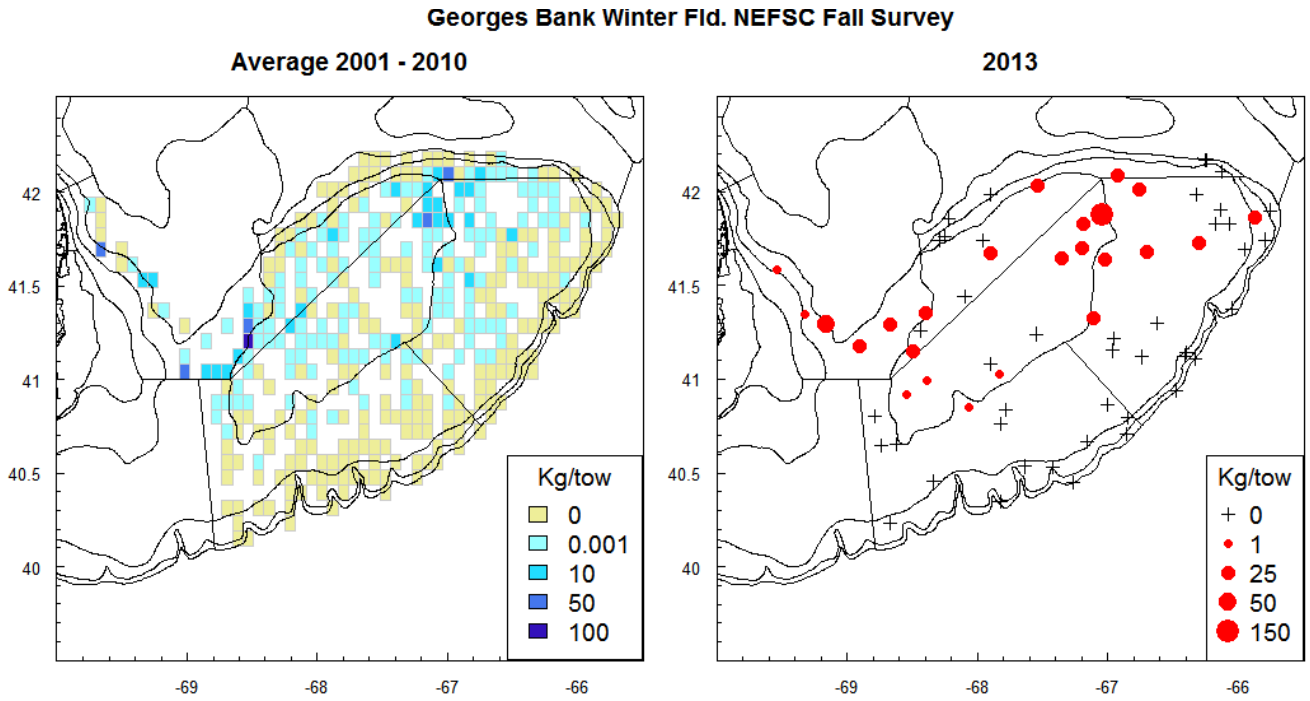



Georges Bank Winter Fld. NEFSC Spring Survey
Average 2001 - 2010
2013
Kg/tow
0
0.001
10
50
100
Kg/tow
0
1
25
50
150
42
41.5
41
40.5
40
-69
-68
-67
-66


Georges Bank Winter Fld. NEFSC Spring Survey
Average 2001 - 2010
2014
Kg/tow
0
0.001
10
50
100
Kg/tow
0
1
25
50
150
42
41.5
41
40.5
40
-69
-68
-67
-66


Georges Bank Winter Fld. NEFSC Fall Survey
Average 2001 - 2010
2011
42
41.5
41
40.5
40
-69
-68
-67
-66
Kg/tow
0
0.001
10
50
100
Kg/tow
0
1
25
50
150


Georges Bank Winter Fld. NEFSC Fall Survey
Average 2001 - 2010
2012
42
41.5
41
40.5
40
-69
-68
-67
-66
Kg/tow
0
0.001
10
50
100
Kg/tow
0
1
25
50
150


Georges Bank Winter Fld. NEFSC Fall Survey
Average 2001 - 2010
2013
42
41.5
41
40.5
40
-69
-68
-67
-66
Kg/tow
0
0.001
10
50
100
Kg/tow
0
1
25
50
150