**C. 2012 Update of the Gulf of Maine haddock (*Melanogrammus aeglefinus*) stock assessment: an update of the resource through calendar year 2010.**

**Gulf of Maine haddock (*Melanogrammus aeglefinus*)**

*Michael C. Palmer, Sandra Sutherland, Elizabeth N. Brooks*

## 1. Background

The Gulf of Maine haddock stock was last assessed at the 3rd Groundfish Assessment Review Meeting (GARM III) in 2008 (NEFSC 2008). That assessment was conducted using the ADAPT-VPA model covering the years 1977 to 2007. In prior assessments the stock was assessed using index-based methods (e.g., NEFSC 2005). At GARM III, 2007 spawning stock biomass was estimated at 5,850 mt and average fishing mortality on ages 6-8 was estimated at 0.35. GARM III reference points were based on a yield per recruit analysis proxy of $F_{MSY}$=F40%=0.43and use of long-term stochastic projections to estimate $SSB_{MSY}$ and MSY. The corresponding values were 5,900 mt (1/2 $B_{MSY}$=$B_{threshold}$=2,950 mt) and 1,360 mt, respectively. As of GARM III, the stock was not overfished and overfishing was not occurring. Based on the GARM III assessment, the stock was considered fully rebuilt due to the fact that the GARM III assessment indicated that spawning stock biomass had exceeded the biomass threshold in 2000.

This current assessment represents an operational update of the 2008 GARM III benchmark assessment through calendar year 2010. Three additional years of data have been prepared using methods identical to those used in the previous assessment and incorporated into the existing model configuration. The 2007 catch has been re-estimated to account for revisions made to the 2007 commercial seafood dealer landings which has impacts both commercial landings and discards.

## 2. Biology

The Gulf of Maine haddock stock assessment region is defined as statistical areas 511 – 515 (NAFO area 5Y; fig. C.1). the stock complex extends from the north side of Cape Cod, Massachusetts northeast to the Canadian border. The other haddock stock in United States (US) waters is the Georges Bank haddock stock which occupies the region directly to the south of the Gulf of Maine haddock stock complex. The delineation of the two stocks is supported by differences in growth rates, and general distribution patterns (Begg et al., 1999), though tagging studies do indicate some degree of mixing between the stocks as well as with those stocks in Canadian waters (reviewed in Begg 1998).

Growth curves estimated using Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey data for Gulf of Maine haddock are shown in figure C.2. The majority of growth occurs between ages 0 and 5, with limited growth beyond age 6; $L_\infty$ is estimated at 62.6 cm and 66.0 cm for the spring and fall respectively. The oldest age observed in the NEFSC bottom trawl survey is 18. Assuming natural mortality (M) is proportional to the oldest observed

age using the relationship of Hewitt and Hoenig (2005; $M=4.22/t_{max}$), M is estimated at 0.23. This suggests that the assumed M used in the previous assessment is a reasonable approximation of true natural mortality.

In the GARM III assessment, a time invariant maturity ogive based on the maturity stage of female haddock observed in the NEFSC spring bottom trawl survey was used to estimate maturity-at-age. The decision was based on the temporal stability of age-at-50% maturity ($A_{50}$). The maturity schedule was re-evaluated as part of this update. Using a three-year moving average, the temporal stability of the age-at-50% maturity was examined. It should be noted that there were insufficient maturity observations to support examination of single year calculations of $A_{50}$; pooling of maturity observations using 3-year averages was still not sufficient to estimate $A_{50}$ during the late 1980's to mid 1990's when samples were limited. For the periods where $A_{50}$ could be estimated, there was little evidence of any temporal trends suggesting that the approach applied in GARM III is still reasonable (fig. C.3). The resulting maturity ogive is presented in figure C.4; this maturity ogive has been updated from the one used in GARM III to incorporate three years of additional maturity data.

The same length-weight relationships used in GARM III have been used in this assessment update (fig. C.5; **note the fall LW equation was erroneously reported in the GARM III assessment document*). The length-weight relationships are based on data collected by the NEFSC surveys between 1992 and 2007. Length-weight relationships were not recalculated for this update because it would mean that the conversion of catch weights to fish numbers would be performed on a different basis for the more recent catch series relative to the older catch series from GARM III. In general Gulf of Maine haddock are slightly heavier at length in the fall relative to their condition in the spring (fig. C.6). Length-weight relationships are provided below:

(1) Spring: $W_{live\ (kg)} = 0.000007690 \cdot L_{(fork\ cm)}^{3.0622}$ ($p < 0.0001$, n=2502)

(2) Fall: $W_{live\ (kg)} = 0.000009870 \cdot L_{(fork\ cm)}^{3.0090}$ ($p < 0.0001$, n=4890)

(3) Annual: $W_{live\ (kg)} = 0.000009298 \cdot L_{(fork\ cm)}^{3.0205}$ ($p < 0.0001$, n=4890)

## 3. Ageing precision

Precision age testing for haddock is conducted six times a year, once for each season of the bottom trawl survey (spring and fall) and for each quarter of the commercial samples. The precision tests are for both Georges Bank and Gulf of Maine stocks combined. Each precision test includes a subsample of about 100 fish, and measures the repeatability of age assignment by the age reader. Two accuracy tests for Georges Bank haddock are conducted each year, using the reference collection of Georges Bank samples ($n \approx 60$; one prior to and one after the production ageing). In addition to these tests, an annual exchange of Georges Bank age samples is conducted with Fisheries and Oceans Canada (DFO) staff to compare age assignments between the age readers (2-4 separate precision tests each year representing a range of sample sources/seasons; $n \approx 50$ within each test).

For the period 2008 to 2010, the precision levels for all haddock (Georges Bank and Gulf of Maine) had an average agreement of 97% and an average CV of 0.5%. The best results showed complete agreement (100%, 0.0% CV) between the ages for each fish; the worst results were 92% agreement and a CV of 1.3%, both on tests of the autumn survey. No bias occurred in any of the tests. All of these results exceed our standards for adequate ages (>80% agreement, <5% CV, and no bias).

Accuracy tests on Georges Bank haddock resulted in an average 94% agreement (1.6% CV). The best result was 96.7% (0.3% CV) for the January 2009 test; the worst result was 88% agreement (4.1% CV) in October 2010.

Exchange results on Georges Bank samples were more variable, in part due to a change in the Canadian age reader between 2009 and 2010. Average precision levels in the exchange were 95% (1.0% CV) for 2009, followed by 78% (3.3% CV) in 2010 and 89% (2.4% CV) in 2011. The best result among the three years was 98.1% (0.5% CV) for survey samples in the 2009 exchange. The worst results were 63% agreement and 4.1% CV, both in 2010 tests of commercial samples. The tests did not reveal the presence of any bias.

The 2003 year class still dominates age samples, but it is unlikely to present issues in the quality of age data. All QA/QC testing has demonstrated that the ages are accurate (as compared with the reference collection) and consistent (both by the NEFSC age reader and in comparison with the DFO age reader). It is unlikely that confusion between the 2003 year-class and neighboring year-classes has occurred.

Full testing results and an explanation of the statistics listed above can be found at http://www.nefsc.noaa.gov/fbp/QA-QC/hd-results.html.

## 4. Fishery

*Commercial landings*

Commercial landings of haddock in the region have ranged from a low of 120.1 mt in 1993 to a high of 6317.6 mt in 1980. Between 2006 and 2010, commercial landings have averaged approximately 570 mt annually (table C.1). The commercial fishery has been largely dominated by the US domestic fleet; there have been no foreign landings since 1986. Commercial landings of haddock are dominated by the trawl fleet, though the longline and gillnet fleets land small amounts (table C.2). Gillnet landings contributed a larger proportion of the total landings during the 1980s when minimum mesh sizes ranged from 5 1/8" to 5 1/2". Handline, beam trawl, pot and scallop dredge gear account for the remaining landings.

Length and age samples of US commercial landings were collected through the Northeast Region Port Sampling Program. Sampling of landings are stratified by market category (scrod and large) and quarter. To the extent possible catches-at-age were estimated using the same stratification used to collect the port samples (i.e., by quarter and market category), however in years where available length/age data were insufficient to characterize the catch, quarters were

grouped to achieve full length frequency distributions. Prior to 1977 port sampling intensity was low with limited, or no sampling of many markets and quarters. From 1977 on, sampling remained relatively high until the late-1980s when landings began to decline (table C.3). Sampling remained low until 1997 when haddock trip limit restrictions were relaxed and landings increased. Sampling of commercial ages has followed similar trends (table C.4). Commercial age-length keys were supplemented with survey age data as necessary when the number of ages per year was less than 100. This practice was limited to the extent possible.

Commercial landings-at-age were estimated from 1977 to 2010 using the Commercial Data Biostatistical Analysis Program (BioStat) software (NOAA Fisheries Toolbox, http://nft.nefsc.noaa.gov/). The length-weight equations presented in equations 1-3 were used. In situations where biological sampling was limited and samples had to be aggregated across semesters, the annual length-weight equation was applied. Resulting commercial landings-at-age and weights at age are presented in tables C.5 and C.6, respectively. A bubble plot of landing-at-age is shown in figure C.8. Uncertainty in the landings-at-age was evaluated through a bootstrap analysis of 1000 realizations (e.g., Legault and Seaver 2007). The catch-at-age coefficients of variation (CV) were generally less than the informal standard of 0.3 for age 4-8. Fish age 4-8 make up the majority of the landings (table C.7). Prior to 1984 individual sampling events can not be identified which precludes estimation of CVs using a bootstrap approach.

*Commercial discards*

Gulf of Maine haddock are primarily discarded in the commercial fishery because they are below the minimum retention size (table C.8). For the commercial fishery, the minimum size has ranged from 16" to 19" between 1977 and 2010 (table C.9). During the period from 1994 to 1997 when possession limits ranged from 500 to 1,000 lb/day regulatory discards were responsible for >10% of the total discards.

Commercial discards were estimated for four commercial fleets: the large mesh bottom otter trawl (≥ 5.5"), small mesh bottom otter trawl (< 5.5"), benthic longline, sink gillnet, midwater trawl (includes both paired midwater and midwater trawls). For years where direct observations of commercial discards were made by at-sea observers (1989 – present) estimates of commercial discards were calculated using the combined-ratio method (Wigley et al. 2007). For years 1977 to 1989, discards were estimated using the survey-scaling method (Palmer et al. 2008). Prior to 1983, the large mesh otter trawl fishery did not exist due to minimum mesh sizes below the existing large-mesh definition. It was assumed that the primary reason for discards in the period before 1994 was similar to the most recent period, i.e., below minimum size. It is unknown whether groundfish quotas in place in the late 1970's to early 1980's resulted in significant discarding of legal sized fish.

Commercial discards average less than 100 mt per year (table C.10). There are two predominant peaks in discards, the first between 1977 and 1978 when there was an abundance of undersized fish and a second from 1994 to 1997 when restrictive trip limits were in place. Discards constitute a minor fraction of total fishery removals with the exception of the 1994 to 1997 period (fig. C.7).

Length and age samples of commercial discards are collected by the Northeast Fisheries Observer Program. The number of individual lengths sampled annually has varied from zero in 1990 to over 900 in 2005 (table C.11). Because of the relative sparseness of discard sampling, a non-fleet specific annual discard length frequency was used to characterize the length distribution of the discarded catch. An examination of the length frequencies by gear type indicates that the gears have similar selectivities, with the exception of the small mesh otter trawl which catches a large proportion of haddock below 25 cm (fig. C.9). Length distributions by gear type over time have been highly variable, reflective of the sparse sampling in many years (fig. C.10). In years where the total number of sampled fish was less than 100, discard length frequencies were supplemented by the length frequency distribution of fish from the NEFSC surveys that were below the minimum size. Age-length keys were supplemented with survey age data in all years. Discards-at-age were estimated from 1977 to the present using the BioStat software (table C.12, fig. C.11). Because of the combined nature of the discard biosampling sources (i.e., discards and survey) analyses of the uncertainty in the discards at age could not be assessed. Commercial weights-at-age are presented in table C.13.

*Recreational landings*

Gulf of Maine haddock recreational landings (types A and B1 catch) were obtained from the Marine Recreational Fisheries Statistics Survey (MRFSS). MRFSS data are available from 1981 onward. Estimation of the numbers-at-age of recreational live releases (B2) was not possible due to very limited sampling of the recreational releases. For this reason type B2 catch could not be fully accounted for and are not included in the assessment. Landings were partitioned among stock complexes using a standard algorithm (S. Steinback pers. comm.). Historically, recreational landings have been a minor component of overall fishery removals, though between 2006 and 2010 they were of a similar magnitude to commercial landings, averaging approximately 603 mt (table C.14). Type B2 recreational catch is has ranged from 19% to 59% of recreational landings in terms of numbers over the last five years.

Recreational length samples were extremely limited prior to 2002 (table C.14). The size distribution of haddock landed by the recreational fishery is similar to those of the commercial longline fishery and from those fish captured in the bottom trawl survey above the recreational minimum size (fig. C.12). Length samples before 2002 were supplemented with length frequency data from these sources. Because no ages were sampled from the recreational fishery, age-length keys were obtained from survey age data for all years. Recreational landings-at-age were estimated from 1981 to the present using the BioStat software (table C.15, fig. C.13). Because of the combined nature of the recreational landings biosampling sources (i.e., MRFSS survey, commercial longline and survey) analyses of the uncertainty in the recreational catch at age could not be assessed nor were weights-at-age calculated.

Total fishery catch at age are presented in table C.16 and figure C.14. Per the convention used in GARM III, the age composition utilizes an age 9 plus group. This decision was based on the increasing imprecision of landings-at-age beyond the age 9 group. The mean catch weights-at-age were calculated using a numbers-weighted average of the commercial landings and discards (table C.17). Minor imputation of the weights-at-age was required for the youngest and oldest age classes. This was performed using a 5-year centered moving average. January 1 stock and

spawning stock weights-at-age were estimated from the catch weights-at-age using the Rivard method (table C.18). The method adjusts the catch weights-at-age, which are generally presumed to represent mid-year weights, back to January 1. Mean weights at the beginning of the year for a given age class are calculated as the geometric mean of the weight in the same year and of the same cohort in the previous year. No adjustments are made for the plus group calculation. Calculations for the initial and final years and ages are described in Rivard (1980, 1982). Overall mean weights have declined over the last decade and are currently below their long-term averages (fig. C.15).

## 5. Research surveys

Survey indices of abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) were estimated from both the NEFSC spring and autumn bottom trawl surveys between 1963 and 2010/11 (spring survey commenced in 1968). The indices include catch data from stations within the NEFSC offshore survey strata 01260 – 01280 and 01360 – 01400 (fig. C.16). Survey indices were adjusted for catchability differences over time due to the effects of changing vessels, trawl doors and survey protocols. The NEFSC bottom trawl survey has utilized three different vessels and three different door configurations throughout the time series of the survey (table C.19). In an effort to maintain a consistent survey time series, survey indices are converted to 'Albatross IV/Polyvalent door' equivalents using several different conversion factors (table C.20). The largest change in the survey time series occurred in 2009 when the FSV Albatross IV was decommissioned and replaced by the FSV Henry B. Bigelow. This resulted in changes not only to the vessel and doors, but also to the overall trawl gear and survey protocols (summarized in table C.21). Calibration experiments to estimate survey differences were conducted in the spring and fall of 2008 (Brown 2009). The results of those experiments were peer reviewed by a panel of external (non-NMFS) experts and are summarized in Miller et al. (2010). These results provided annual calibration coefficients both in terms of abundance (numbers) and biomass (weight). Further work by Brooks et al. (2010) developed length-specific abundance calibration coefficients for haddock. This method uses a segmented regression model where a constant conversion factor is applied to fish $\leq$ 18 cm and $\geq$ 51 cm, and a constantly decreasing linear regression is fit to fish between 19 and 50 cm (table C.20).

Indices declined from highs in the mid-1960's to lows in the early 1970's before again increasing during the late 1970's and early 1980's. The period from 1987 to 1992 experienced historically low indices. Increases have been observed between the mid 1990s through the early 2000s due to the contribution of the large 1998 year class. Survey indices have slowly declined since the recent highs in the early 2000s and are currently in the range of survey values observed during the early 1980s (table C.21, figures C.17 and C.18). Survey CVs average between 0.33 and 0.43, with the fall survey generally having higher survey indices and a higher degree of precision (table C.22). The spring 2011 age 1 index provides some indication of a moderately strong year class in 2010, though there is insufficient information available to determine its absolute strength (tables C.23 and C.24, figures C.19 and C.20).

## 6. Assessment

*Model Selection*

The ADAPT-VPA model configuration applied at GARM III included catch, survey and biological data for years 1977 through 2007 with a maximum age of $9^+$ calibrated using the ADAPT-VPA software, version 2.8.0 (NOAA Fisheries Toolbox, http://nft.nefsc.noaa.gov/). Backward computation of fishing mortality on the plus group was employed. The decision to start the VPA at 1977 and plus the ages at $9^+$ was made based on the availability of biological sampling and high CVs in the catch at age estimates for the older age classes, respectively. During GARM III several calibration runs were undertaken to assess the sensitivity of the VPA results to inclusion/exclusion of the survey indices at age. The final model configuration included catch at age estimates of ages 1 to $9^+$ and survey abundance at age (age 1 and above), however, the spring survey and autumn surveys plus groups began at age-6 and age-8 respectively because of the predominance of zero values in the survey indices of the older age classes (tables C.23 and C.24). The VPA configuration of ages 1-9+ is a departure from the GARM III configuration. There was an inconsistency in the GARM III VPA formulation (ages 0-$9^+$) and biological reference point/projections (ages 1-$9^+$). This inconsistency was resolved in this update. The change in configuration had no impact on the overall assessment results. The comparison of an age 0-$9^+$ configuration to the base model is presented in Appendix C1.

The NEFSC spring and autumn survey series were converted to area swept equivalents prior to inclusion in the model. The area swept conversion assumes a trawl area of 0.0112 $nm^2$/tow and a total strata area of 14,028 $nm^2$. Comparatively, the total stock area shown in figure C.1 is 15,708 $nm^2$. These calculations assume 100% trawl efficiency.

For the 2012 update of the Gulf of Maine haddock assessment all model configuration details were kept identical to the configuration used in GARM III with the exception of the age 1-$9^+$ formulation noted above.

*Model diagnostics and results*

Age-specific survey residual plots for the BASE run do not exhibit any evidence of systematic patterning (fig. C.21a-c). BASE run survey catchability coefficients (*q)* were < 1.0 for all but the NEFSC fall ages 6-$8^+$ indices (fig. C.22; *note the fall ages were lagged forward an age an a year in the model). While the *q* estimates exceed 1 for these older ages, suggestive of > 100% efficiency of the survey, the CVs on these estimates are moderately large (table C.25).

A variant of the retrospective statistic, Mohn's rho (Mohn 1999; equation 4) was used to quantify the relative retrospective bias in terminal year estimates of fishing mortality (F), spawning stock biomass (SSB) and age-1 recruitment. There is a moderate retrospective pattern observable in the terminal year F, SSB and recruitment estimates (fig. C.23-25), however there is no separation of the bootstrap distributions (1000 iterations; fig. C.26) suggesting absence of a strong retrospective pattern (Legault 2009). There is a tendency for the model to underestimate SSB, overestimate F, with recruitment patterns being variable. Annual values of relative differences and Mohn's rho values are reported in table C.26. There is some evidence of a dampening of the retrospective patterns in the most recent years with respect to SSB and F.

(4) $$\rho = \frac{\left( \sum_{y} \frac{x_{y,tip} - x_{y,ref}}{x_{y,ref}} \right)}{y}$$

The precision of the 2011 (terminal year + 1) stock size at age, SSB in 2010, and F at age in 2010 was evaluated by resampling the errors from 1000 bootstrap realizations. Bootstrapped CVs of the stock size at age are moderately large (>30%) for all ages, notably for age 2 and the $9^{+}$ group (table C.27). The 2010 SSB was estimated at 2,868 mt with a 90% probability of the SSB being between 2,140 mt and 4,233 mt (fig. C.27).

Bootstrapped CVs of F-at-age ranged from 0.34 at age 8 and 9 to 0.69 at age 1 (table C.27). The 2003 year class which is estimated to have been moderately strong (4.2 million fish at age 1) is experiencing high fishing mortality. In the GARM III assessment there was the presence of a weak year class (2000) with a high, but highly uncertain estimate of fishing mortality. The high fishing mortality on this year class inflated the estimates of average F on the full recruited age classes ($F_{6-8}$) leading to highly unstable estimates of the average $F_{6-8}$ relative to the numbers-weighted $F_{6-8}$ (fig. C.28). For this reason, the use of a numbers-weighted average $F_{6-8}$ was applied in the GARM III assessment. The situation in this current assessment update is exactly the opposite, with a moderately strong year class experiencing high fishing mortality (table C.28). This argues for a return to the use of a straight average $F_{6-8}$ consistent with other groundfish stocks in the Northeast Region. The 2012 Groundfish Update Integrated Peer Review Panel supported the move to the average $F_{6-8}$ for the basis of stock status determination. The 2010 average $F_{6-8}$ was estimated at 0.82 with a 90% probability of being between 0.42 and 1.63 (table C.32, fig. C.29); comparatively, the 2010 numbers-weighted average $F_{6-8}$ was estimated at 1.04.

Partial recruitment patterns over the past five years have been highly variable (fig. C.31). The patterns are suggestive of a slight doming in fishery selectivity with decreasing selectivity beyond age 7. Fish age 5 and older are at least 50% selected by the fishery. Selectivity patterns have changed over time, with a general decrease in overall selectivity for fish age 3 and younger over time in response to changes in mesh size and minimum retention size (table C.29).

The VPA model results indicate the stock numbers were around 25.5 million fish during the late 1970s and declined to 1.3 million fish by 1991 (table C.30). The high abundances in the late 1970s were driven by the strong year class of 1975 and moderate year classes of 1978 and 1979. Two back-to-back moderate strength year classes in 1993 and 1994 contributed to an increase in population numbers following the lows observed in the late 1980s and early 1990s. A very strong year class developed in 1998. This 1998 year class increased stock numbers above 20 million for the first time since 1980. Stock size declined after the high in 1999, though the contribution of the 2003 year class led to a slight increase in 2004. Since 2004 stock size has declined. With the exception of the 2003 year class, recruitment over the past decade has been poor. Based on the NEFSC spring bottom trawl survey there is some indication of a moderate 2010 year class,

though existing information does not suggest it will be a strong year class. Current stock size in 2010 is estimated around 3.5 million fish.

SSB was estimated at approximately 15,000 mt during the early 1980s, declining to a low of approximately 550 mt by 1989 (table C.31). Moderate recruitment during the mid-1990s combined with the strong 1998 year class led to a recent peak in the SSB in 2002 at around 16,700 mt. SSB has since declined as the 1998 year class has been removed from the population. The 2003 year class should have reached near 100% maturity in 2007. 2010 spawning stock biomass is estimated at 2,868 mt, just under the GARM III overfished threshold of 2,950 mt (1/2 $B_{MSY}$). Fishing mortality rates have been generally increasing over the last decade in response near constant harvest and declining stock numbers (table C.32, fig. C.32). Fishing mortality in 2010 is estimated to have exceed the GARM III overfishing definition of 0.43 ($F_{MSY}$=$F_{40\%}$)

## 7. Biological Reference Points

GARM III biological reference points (BRPs) were determined from yield per recruit (YPR) and SSB per recruit (SSBPR) analyses based on mean weight and partial recruitment vectors calculated from an un-weighted average of the most recent five years in the assessment (2003 – 2007; NEFSC 2008). Similar to the treatment in GARM III, fishery selectivity was forced to be 'flat-topped' beyond the fully selected age (age 7). All other inputs were time invariant. Given the continued decline in haddock weights-at-age and updates to the maturity ogive and recruitment estimates, BRPs should be updated. It should be noted that applying averages of the recent weights-at-age for the purposes of yield projections could be cause for concern when used for long-term projection. However, without better understanding the underlying cause(s), the current biological parameters are the best indicator of future parameters. Yield per recruit input vectors are presented in table C.33. Results of the YPR/SSBPR analysis are presented in table C.34. Using the same $F_{MSY}$ basis as used in GARM III of $F_{40\%}$, the revised estimate of $F_{MSY}$ is 0.46. This compares to the GARM III estimate of 0.43. Current levels of fishing mortality exceed the revised F-threshold of $F_{40\%}$ regardless of whether the average or numbers-weight $F_{6-8}$ are used (fig. C.35).
Maximum sustainable yield and $SSB_{MSY}$ were derived from the median values of long-term projections (100 years) of the Age Structured Model Projections (AGEPRO, NOAA Fisheries Toolbox, http://nft.nefsc.noaa.gov/) model run at a constant harvest of $F_{40\%}$ = 0.46. Input vectors for the AGEPRO runs are the same as those used for the YPR/SSBR analyses (table C.33). Following on the methods employed in the GARM III assessment, projected recruitment was determined using the cumulative density function (CDF) of a recruitment series that included both VPA-estimated age-1 recruitment and hindcasted recruitment estimates based on NEFSC fall bottom trawl survey age-1 indices. A linear regression was fit to VPA estimates of age 1 recruitment and NEFSC autumn bottom trawl survey indices of abundance of age 1 fish (fig. C.33). Using the regression relationship, recruitment was estimated back to the 1962 year class (fig. C.34). The 2008 GARM BRP Panel recommended a recruitment series that includes VPA estimated recruitment excluding recruitment estimates for years when SSB was less than 3,000 mt in addition to hindcasted recruitment from 1962 to 1976 with the large 1962 year class removed (considered a "bonanza" outlier). The resulting BRP estimates were: $SSB_{MSY}$ = 4,904 mt (90% confidence interval of 2,272 – 10,604 mt), and MSY = 1,117 mt (90% confidence

interval of 553 – 2,563 mt). For comparison, GARM III $SSB_{MSY}$ was estimated at 5,900 mt and MSY was estimated at 1,360 mt. Current SSB is above the revised $B_{threshold}$ value of 2,452 mt (1/2 $B_{MSY}$; fig. C.36).

Based on the updated 2012 assessment and revised reference points, the stock is not currently overfished, but overfishing is occurring (table C.35, fig. C.37). The 2012 Groundfish Update Integrated Peer Review Panel supported the move to the average $F_{6-8}$ for the basis of stock status determination for the reasons noted earlier. Accounting for the observed retrospective bias does change stock status with respect to the overfishing definition. However, the revised stock status point does not fall outside the confidence intervals of the un-adjusted point (fig. C.37). The GARM III precedence was to not adjust stock status or projection inputs when the F and SSB estimates revised for retrospective bias do not fall outside the confidence intervals of the model.

## 8. Projections

Short term projections of future stock status were conducted based on the current assessment results without accounting for retrospective bias. This rationale was identical to that of stock status determination. Numbers-at-age in 2011 were derived from 1000 different bootstrap iterations of the VPA model. Short term projections have assumed catch in 2011 to be equal to the catch in 2010 (i.e., 1,309 mt). This is a reasonable assumption given that the 2011 ABC is nearly identical to the 2010 ABC ($\Delta$=51 mt). Recruitment was sampled from a cumulative density function (CDF) of the same recruitment inputs used in BRP determination. This recruitment series omits recruitment estimates when SSB < 3,000 mt. While 2010 SSB is estimated at 2,928 mt, below the <3,000 mt threshold, the 2012 Groundfish Update Integrated Peer Review Panel felt that it was important to retain consistency between the recruitment stream used in reference points and that used for short term projections. Projections were run under two different F assumptions: $F_{MSYproxy} = F_{40\%} = 0.47$, and $F_{75\%FMSY} = 0.35$. Projection results are summarized in terms of median SSB and fishery catch (yield) under both scenarios outlined above in table C.36. Under all scenarios SSB is projected to drop below $B_{threshold}$ from 2011-2014.

## 9. Conclusions

*Gulf of Maine haddock stock status*
SSB in 2010 is estimated to be 2,868 mt.
F in 2010 is estimated to be 0.82.

Revised estimates of the biological reference points are:
SSBmsy proxy= 4,904 mt,
Fmsy proxy = 0.46, and
MSY proxy= 1,177 mt.

Based on these results, the Gulf of Maine haddock stock is not overfished and overfishing is occurring. The stock is below the biomass target. This represents a change from GARM III status when the stock was not experiencing overfishing.

The results are based on the same model used in GARM-III (NEFSC 2008, CRD#08-15) with the exception that the model was configured with ages 1-9$^{+}$ rather than the age 0-9$^{+}$ configuration used in GARM III. A sensitivity run was examined showing that the change in configuration had no impact on assessment results.

The BRPs are based on the following updates: average of the most recent 5 years of weights, maturity, and selectivity at age, the same approach used in GARM 2008

*Sources of Uncertainty*

Sources of uncertainty in the current assessment include: 1) assumption of 100% survival in the recreational released live catch (type B2); 2) use of the weights-at-age from the recent five years for long term projections, 3) expectation of median recruitment in the near future, and 4) differences between MRFSS-based recreational landings and recreational landings re-estimated using the new Marine Recreational Information Program (MRIP) statistical design. With respect to the last area of uncertainty, the 2012 Groundfish Update Integrated Peer Review Panel recommended that a sensitivity of the assessment results to the MRIP-based recreational landings estimates be conducted. These sensitivity analyses are presented in Appendix C2. In general, use of MRIP recreational landings does not alter stock status determination and has negligible influence on estimates of spawning stock biomass and recruitment. There is a slight decrease in the 2010 fishing mortality estimate compared to the BASE assessment results, but the 2010 $F_{6-8}$ based on the MRIP sensitivity run is still above the overfishing threshold.

GOM Haddock. Summary of Assessment Information

| GOM Haddock | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Avg | Min | Max | YrRange |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rec Landings (mt)** | 190 | 166 | 192 | 430 | 717 | 504 | 628 | 611 | 531 | 743 | 181 | 0 | 743 | 1981-'10 |
| **Comm Landings (mt)** | 929 | 977 | 1023 | 946 | 962 | 618 | 674 | 508 | 486 | 561 | 1871 | 120 | 6318 | 1964-'10 |
| **Discards (mt)** | 27 | 24 | 23 | 27 | 37 | 49 | 50 | 12 | 14 | 5 | 40 | 1 | 368 | 1977-'10 |
| **Catch (mt)** | 1147 | 1166 | 1237 | 1403 | 1716 | 1172 | 1352 | 1132 | 1031 | 1309 | 2015 | 217 | 6339 | 1964-'10 |
| **F avg 6-8** | 0.19 | 0.18 | 0.15 | 0.14 | 0.19 | 0.19 | 0.23 | 0.26 | 0.53 | 0.82 | 0.53 | 0.14 | 3 | 1977-'10 |
| **SSB (mt)** | 12525 | 16757 | 14741 | 12545 | 10125 | 7958 | 6796 | 4481 | 3864 | 2868 | 6940 | 543 | 16757 | 1977-'10 |
| **Recruits (000's)** | 1197 | 1070 | 82 | 4193 | 482 | 1236 | 2130 | 287 | 289 | 433 | 2237 | 82 | 15112 | 1977-'10 |

**10. Panel discussion/comments**

The work that is presented is accepted by the Review Panel for determining stock status and providing catch advice.

At GARM III a numbers-weighted F was recommended. The basis for this recommendation was there was a single age group in the fully recruited ages which had an unusually high mortality rate. This situation is not present in the current assessment and the Panel supported adoption of an average F, rather than the numbers-weighted F used in the previous assessment. This is consistent with the calculation of fully recruited fishing mortality in other NE groundfish stocks.

Recreational landings are a large portion of the landings. Differences exist between the MRFSS and preliminary MRIP estimates, although the differences are not systematic. A sensitivity run using preliminary MRIP estimates of recreational landings (although same proportion at age) indicated no change to stock status.

Based on the projections, the stock SSB has declined below the threshold and is overfished in 2011. Estimates of the 2006 and 2005 yearclasses were revised downward from the GARM III assessment and the 2007-2009 yearclasses are well below the median. The panel discussed the episodic nature of recruitment in this stock and the implications for rebuilding.

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## Tables

Table C.1. Total catch of Gulf of Maine haddock between 1977 and 2010.

| Year | Foreign landings (mt) | US recreational landings (mt) | US commercial discards (mt) | US commercial landings (mt) | Total (mt) |
|---|---|---|---|---|---|
| 1964 | 70.0 | | | 5378.8 | 5378.8 |
| 1965 | 159.0 | | | 4154.7 | 4154.7 |
| 1966 | 1125.0 | | | 4524.0 | 4524.0 |
| 1967 | 589.0 | | | 4852.2 | 4852.2 |
| 1968 | 120.0 | | | 3417.3 | 3417.3 |
| 1969 | 290.0 | | | 2404.6 | 2404.6 |
| 1970 | 105.0 | | | 1435.8 | 1435.8 |
| 1971 | 112.0 | | | 1190.2 | 1190.2 |
| 1972 | 27.0 | | | 912.3 | 912.3 |
| 1973 | 49.0 | | | 526.0 | 526.0 |
| 1974 | 207.0 | | | 628.8 | 628.8 |
| 1975 | 83.0 | | | 1180.2 | 1180.2 |
| 1976 | 91.0 | | | 1834.5 | 1834.5 |
| 1977 | 26.0 | | 78.7 | 3230.1 | 3308.8 |
| 1978 | 641.0 | | 47.6 | 4382.5 | 4430.1 |
| 1979 | 257.0 | | 18.0 | 4130.6 | 4148.6 |
| 1980 | 203.0 | | 21.7 | 6317.6 | 6339.3 |
| 1981 | 513.0 | 36.3 | 19.4 | 5720.4 | 5776.1 |
| 1982 | 1278.0 | 30.9 | 15.3 | 5637.0 | 5683.2 |
| 1983 | 2003.0 | 57.6 | 17.9 | 5593.4 | 5668.9 |
| 1984 | 1245.0 | 49.4 | 21.4 | 2792.8 | 2863.6 |
| 1985 | 791.0 | 30.7 | 17.3 | 2234.3 | 2282.3 |
| 1986 | 225.0 | 55.0 | 8.0 | 1590.4 | 1653.3 |
| 1987 | | 29.7 | 1.2 | 829.2 | 860.0 |
| 1988 | | 12.1 | 1.5 | 416.2 | 429.8 |
| 1989 | | 9.5 | 8.7 | 263.8 | 282.0 |
| 1990 | | 2.9 | 2.4 | 433.3 | 438.6 |
| 1991 | | 0.4 | 4.1 | 430.9 | 435.4 |
| 1992 | | 0.0 | 19.1 | 311.8 | 330.9 |
| 1993 | | 0.5 | 29.7 | 193.0 | 223.2 |
| 1994 | | 3.8 | 93.5 | 120.1 | 217.4 |
| 1995 | | 175.1 | 127.6 | 173.0 | 475.7 |
| 1996 | | 6.6 | 106.5 | 246.6 | 359.7 |
| 1997 | | 31.6 | 368.2 | 588.6 | 988.4 |
| 1998 | | 44.5 | 24.1 | 885.2 | 953.8 |
| 1999 | | 19.2 | 2.9 | 542.5 | 564.6 |
| 2000 | | 127.6 | 37.9 | 737.9 | 903.4 |
| 2001 | | 190.3 | 27.1 | 929.1 | 1146.5 |
| 2002 | | 165.9 | 23.6 | 976.9 | 1166.4 |
| 2003 | | 191.8 | 22.6 | 1023.0 | 1237.4 |
| 2004 | | 429.6 | 26.6 | 946.5 | 1402.7 |
| 2005 | | 717.1 | 37.4 | 961.5 | 1716.0 |
| 2006 | | 503.9 | 49.4 | 618.2 | 1171.5 |
| 2007 | | 627.9 | 50.2 | 673.7 | 1351.8 |
| 2008 | | 611.4 | 12.4 | 508.5 | 1132.3 |
| 2009 | | 531.0 | 13.8 | 486.0 | 1030.8 |
| 2010 | | 743.2 | 4.6 | 561.1 | 1308.9 |

Table C.2. United States commercial landings of Gulf of Maine haddock by primary gear type between 1964 and 2010.

| Year | Otter trawl (mt) | Benthic longline (mt) | Sink gillnet (mt) | Other (mt) | Total landings (mt) |
|---|---|---|---|---|---|
| 1964 | 4690 | 528 | 156 | 6 | 5379 |
| 1965 | 3309 | 687 | 147 | 12 | 4155 |
| 1966 | 4107 | 335 | 79 | 3 | 4524 |
| 1967 | 4621 | 161 | 64 | 6 | 4852 |
| 1968 | 3285 | 94 | 33 | 5 | 3417 |
| 1969 | 2227 | 104 | 74 | 1 | 2405 |
| 1970 | 1155 | 211 | 68 | 2 | 1436 |
| 1971 | 850 | 260 | 77 | 4 | 1190 |
| 1972 | 440 | 375 | 95 | 2 | 912 |
| 1973 | 235 | 205 | 85 | 1 | 526 |
| 1974 | 456 | 127 | 45 | 1 | 629 |
| 1975 | 1016 | 90 | 74 | 0 | 1180 |
| 1976 | 1552 | 38 | 244 | 1 | 1835 |
| 1977 | 2576 | 102 | 552 | 1 | 3230 |
| 1978 | 3564 | 84 | 734 | 1 | 4382 |
| 1979 | 3362 | 52 | 715 | 1 | 4131 |
| 1980 | 4836 | 72 | 1387 | 23 | 6318 |
| 1981 | 4560 | 75 | 1085 | 0 | 5720 |
| 1982 | 5293 | 7 | 332 | 5 | 5637 |
| 1983 | 4906 | 16 | 654 | 17 | 5593 |
| 1984 | 2360 | 12 | 410 | 11 | 2793 |
| 1985 | 1885 | 9 | 247 | 93 | 2234 |
| 1986 | 1361 | 9 | 184 | 37 | 1590 |
| 1987 | 653 | 11 | 159 | 6 | 829 |
| 1988 | 252 | 14 | 145 | 5 | 416 |
| 1989 | 150 | 2 | 101 | 10 | 264 |
| 1990 | 333 | 10 | 85 | 5 | 433 |
| 1991 | 357 | 7 | 62 | 4 | 431 |
| 1992 | 257 | 13 | 40 | 1 | 312 |
| 1993 | 160 | 6 | 26 | 0 | 193 |
| 1994 | 84 | 9 | 27 | 0 | 120 |
| 1995 | 93 | 37 | 38 | 5 | 173 |
| 1996 | 162 | 43 | 39 | 3 | 247 |
| 1997 | 464 | 69 | 55 | 1 | 589 |
| 1998 | 705 | 81 | 68 | 31 | 885 |
| 1999 | 438 | 22 | 79 | 4 | 543 |
| 2000 | 588 | 21 | 123 | 6 | 738 |
| 2001 | 813 | 8 | 104 | 3 | 929 |
| 2002 | 690 | 30 | 242 | 15 | 977 |
| 2003 | 810 | 87 | 82 | 45 | 1023 |
| 2004 | 707 | 81 | 128 | 30 | 946 |
| 2005 | 592 | 144 | 93 | 132 | 962 |
| 2006 | 384 | 138 | 79 | 18 | 618 |
| 2007 | 410 | 180 | 67 | 17 | 674 |
| 2008 | 394 | 49 | 51 | 14 | 508 |
| 2009 | 346 | 38 | 73 | 28 | 486 |
| 2010 | 446 | 37 | 41 | 38 | 561 |

Table C.3. Number of lengths sampled from commercially landed Gulf of Maine haddock by market category and quarter between 1977 and 2010. The blue and grey shaded cells indicate where quarterly samples have been aggregated when length sampling was insufficient to support quarterly stratification.

| | Large | | | | Scrod | | | | Total | Commercial | Metric tons/100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | QTR 1 | QTR 2 | QTR 3 | QTR 4 | QTR 1 | QTR 2 | QTR 3 | QTR 4 | lengths | landings (mt) | lengths |
| 1977 | | 197 | 358 | | 382 | 511 | 481 | 569 | 2498 | 3230.1 | 129.3 |
| 1978 | 149 | 35 | 200 | | 223 | 322 | 179 | 203 | 1311 | 4382.5 | 334.3 |
| 1979 | 195 | | 124 | 100 | 114 | | | 66 | 599 | 4130.6 | 689.6 |
| 1980 | | 319 | 102 | | 51 | 175 | 257 | 201 | 1105 | 6317.6 | 571.7 |
| 1981 | | 52 | 257 | 638 | 53 | 358 | 514 | 381 | 2253 | 5720.4 | 253.9 |
| 1982 | 103 | | 1361 | 104 | 473 | 53 | 273 | 154 | 2521 | 5637.0 | 223.6 |
| 1983 | 249 | 868 | 1317 | 496 | 312 | 308 | 340 | 203 | 4093 | 5593.4 | 136.7 |
| 1984 | | 79 | 828 | 391 | 187 | 94 | 139 | 113 | 1831 | 2792.8 | 152.5 |
| 1985 | 347 | 597 | 573 | 536 | 353 | 202 | 298 | 84 | 2990 | 2234.3 | 74.7 |
| 1986 | 283 | 234 | 789 | 271 | 181 | 242 | 207 | 204 | 2411 | 1590.4 | 66.0 |
| 1987 | 214 | 102 | 515 | 405 | 162 | 79 | 75 | 136 | 1688 | 829.2 | 49.1 |
| 1988 | 91 | | 100 | 202 | 261 | 50 | 42 | | 746 | 416.2 | 55.8 |
| 1989 | | | 65 | 118 | 99 | | | 129 | 411 | 263.8 | 64.2 |
| 1990 | 34 | | | 100 | 41 | 50 | | 50 | 275 | 433.3 | 157.6 |
| 1991 | | 146 | 216 | 213 | 57 | | 179 | 212 | 1023 | 430.9 | 42.1 |
| 1992 | 121 | | | 19 | 107 | | 53 | 111 | 411 | 311.8 | 75.9 |
| 1993 | combined 1992 & 1994 and ran annual | | | | 103 | 56 | 125 | | 284 | 193.0 | 68.0 |
| 1994 | | 100 | 52 | 297 | | | | 219 | 668 | 120.1 | 18.0 |
| 1995 | 62 | | | | 194 | | | | 256 | 173.0 | 67.6 |
| 1996 | 77 | | | 427 | | 92 | | 100 | 696 | 246.6 | 35.4 |
| 1997 | 120 | 255 | 497 | 355 | | 124 | 358 | 147 | 1856 | 588.6 | 31.7 |
| 1998 | 309 | 111 | 78 | 313 | 689 | 49 | 156 | 35 | 1740 | 885.2 | 50.9 |
| 1999 | 117 | | 300 | 211 | | | 214 | 102 | 944 | 542.5 | 57.5 |
| 2000 | 488 | 313 | 339 | 107 | 414 | 259 | 105 | 287 | 2312 | 737.9 | 31.9 |
| 2001 | 528 | 93 | 207 | 579 | 353 | 108 | 66 | 847 | 2781 | 929.1 | 33.4 |
| 2002 | 729 | 210 | | 262 | 348 | 143 | 247 | 161 | 2100 | 976.9 | 46.5 |
| 2003 | 792 | 348 | 1282 | 1043 | 485 | 216 | 716 | 513 | 5395 | 1023.0 | 19.0 |
| 2004 | 1898 | 942 | 101 | 601 | 1021 | 1085 | 262 | 451 | 6361 | 946.5 | 14.9 |
| 2005 | 1313 | 325 | 573 | 752 | 661 | 449 | 733 | 769 | 5575 | 961.5 | 17.2 |
| 2006 | 1193 | 687 | 453 | 617 | 928 | 535 | 569 | 514 | 5496 | 618.2 | 11.2 |
| 2007 | 817 | 348 | 1016 | 616 | 781 | 360 | 768 | 400 | 5106 | 673.7 | 13.2 |
| 2008 | 789 | 472 | 351 | 141 | 566 | 466 | 348 | 295 | 3428 | 508.5 | 14.8 |
| 2009 | 1248 | 409 | 142 | 181 | 568 | 306 | 135 | 119 | 3108 | 486.0 | 15.6 |
| 2010 | 1018 | 214 | 187 | 614 | 600 | 239 | 135 | 156 | 3163 | 561.1 | 17.7 |

Table C.4. Number of ages sampled from commercially landed Gulf of Maine haddock by market category and quarter between 1977 and 2010. Italicized 'combined' cells indicate where age-length-keys were augmented with age information from NEFSC bottom trawl surveys.

| | Large | | | | Scrod | | | | Combined | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | QTR 1 | QTR 2 | QTR 3 | QTR 4 | QTR 1 | QTR 2 | QTR 3 | QTR 4 | QTR 1 | QTR 2 | QTR 3 | QTR 4 | Total ages | Commercial landings (mt) | Metric tons/100 ages |
| 1977 | | 40 | 57 | | 112 | 155 | 175 | 220 | 112 | 195 | 232 | 220 | 1421 | 3230.1 | 227.3 |
| 1978 | 40 | 20 | 39 | | 80 | 115 | 50 | 49 | 120 | 135 | 89 | 49 | 687 | 4382.5 | 637.9 |
| 1979 | 48 | | 25 | 45 | 30 | | | 16 | *78* | | *25* | *61* | 210 | 4130.6 | 1966.9 |
| 1980 | | 58 | 20 | | 17 | 39 | 68 | 46 | 17 | 97 | 88 | 46 | 418 | 6317.6 | 1511.4 |
| 1981 | | 15 | 61 | 147 | 14 | 105 | 124 | 80 | 14 | 120 | 185 | 227 | 869 | 5720.4 | 658.3 |
| 1982 | 20 | | 284 | 21 | 103 | 14 | 75 | 45 | 123 | 14 | 359 | 66 | 799 | 5637.0 | 705.5 |
| 1983 | 65 | 214 | 225 | 110 | 90 | 90 | 77 | 43 | 155 | 304 | 302 | 153 | 1214 | 5593.4 | 460.7 |
| 1984 | | 21 | 229 | 94 | 47 | 31 | 47 | 31 | *47* | *52* | 276 | 125 | 656 | 2792.8 | 425.7 |
| 1985 | 95 | 140 | 135 | 148 | 95 | 64 | 95 | 10 | 190 | 204 | 230 | 158 | 1046 | 2234.3 | 213.6 |
| 1986 | 49 | 61 | 149 | 55 | 54 | 75 | 58 | 61 | 103 | 136 | 207 | 116 | 810 | 1590.4 | 196.3 |
| 1987 | 36 | 24 | 125 | 105 | 40 | 14 | 28 | 45 | 76 | 38 | 153 | 150 | 544 | 829.2 | 152.4 |
| 1988 | 18 | | 17 | 39 | 86 | | 15 | | 104 | | *32* | *39* | 276 | 416.2 | 150.8 |
| 1989 | | | 16 | 15 | 58 | | | 27 | *58* | | *16* | *42* | 201 | 263.8 | 131.3 |
| 1990 | 28 | | | 22 | 15 | 16 | | 15 | *43* | *16* | | *37* | 142 | 433.3 | 305.2 |
| 1991 | | 32 | 37 | 40 | 16 | | 80 | 47 | *16* | *32* | 117 | 87 | 395 | 430.9 | 109.1 |
| 1992 | 20 | | | 18 | 20 | | 15 | 65 | *40* | | *15* | *83* | 238 | 311.8 | 131.0 |
| 1993 | | | | | 20 | 23 | 49 | | *20* | *23* | *49* | | 184 | 193.0 | 104.9 |
| 1994 | | 26 | 21 | 124 | | | | 72 | | *26* | 21 | 196 | 315 | 120.1 | 38.1 |
| 1995 | 28 | | | | 58 | | | | *86* | | | | 144 | 173.0 | 120.2 |
| 1996 | 25 | | | 91 | | 13 | | 18 | *25* | *13* | | 109 | 178 | 246.6 | 138.6 |
| 1997 | 23 | 79 | 130 | 81 | | 22 | 69 | 56 | 23 | 101 | 199 | 137 | 607 | 588.6 | 97.0 |
| 1998 | 45 | 24 | 23 | 145 | 82 | 21 | 41 | 21 | 127 | 45 | 64 | 166 | 567 | 885.2 | 156.1 |
| 1999 | 13 | | 76 | 70 | 20 | | 67 | 35 | *33* | | 143 | 105 | 403 | 542.5 | 134.6 |
| 2000 | 136 | 88 | 98 | 38 | 148 | 93 | 57 | 91 | 284 | 181 | 155 | 129 | 1138 | 737.9 | 64.8 |
| 2001 | 143 | 33 | 71 | 177 | 99 | 39 | 18 | 197 | 242 | 72 | 89 | 374 | 1130 | 929.1 | 82.2 |
| 2002 | 264 | 71 | | 92 | 159 | 47 | 24 | 66 | 423 | 118 | 24 | 158 | 1019 | 976.9 | 95.9 |
| 2003 | 250 | 88 | 431 | 274 | 161 | 90 | 308 | 199 | 411 | 178 | 739 | 473 | 2559 | 1023.0 | 40.0 |
| 2004 | 500 | 142 | | 41 | 283 | 206 | 33 | 41 | 783 | 348 | 33 | 82 | 1809 | 946.5 | 52.3 |
| 2005 | 251 | 48 | 211 | 314 | 157 | 122 | 274 | 246 | 408 | 170 | 485 | 560 | 2422 | 961.5 | 39.7 |
| 2006 | 634 | 165 | 287 | 255 | 444 | 268 | 294 | 225 | 1078 | 433 | 581 | 480 | 3803 | 618.2 | 16.3 |
| 2007 | 392 | 166 | 501 | 322 | 391 | 172 | 387 | 193 | 783 | 338 | 888 | 515 | 3667 | 673.7 | 18.4 |
| 2008 | 424 | 309 | 205 | 69 | 261 | 226 | 168 | 149 | 685 | 535 | 373 | 218 | 2615 | 508.5 | 19.4 |
| 2009 | 720 | 293 | 141 | 106 | 273 | 150 | 77 | 70 | 993 | 443 | 218 | 176 | 2400 | 486.0 | 20.3 |
| 2010 | 619 | 117 | 133 | 292 | 322 | 75 | 51 | 47 | 941 | 192 | 184 | 339 | 2151 | 561.1 | 26.1 |

Table C.5. Gulf of Maine haddock commercial landings-at-age between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.0 | 43.8 | 1747.2 | 51.1 | 365.0 | 215.0 | 143.6 | 4.8 | 1.6 | 6.3 | 2578.4 |
| 1978 | 0.0 | 0.0 | 337.7 | 1958.4 | 181.2 | 320.3 | 154.6 | 32.0 | 0.0 | 4.6 | 2988.8 |
| 1979 | 0.0 | 7.5 | 81.4 | 613.5 | 1348.8 | 200.5 | 105.5 | 32.4 | 23.8 | 0.0 | 2413.4 |
| 1980 | 0.0 | 0.0 | 861.6 | 109.8 | 754.9 | 1235.8 | 165.4 | 134.1 | 11.5 | 25.3 | 3298.4 |
| 1981 | 0.0 | 0.0 | 1458.3 | 641.3 | 266.8 | 356.8 | 498.2 | 69.1 | 96.8 | 12.1 | 3399.4 |
| 1982 | 0.0 | 67.0 | 440.7 | 1245.1 | 510.4 | 80.5 | 225.1 | 400.0 | 89.6 | 59.6 | 3118.0 |
| 1983 | 0.0 | 0.0 | 6.4 | 595.4 | 712.7 | 588.9 | 109.1 | 184.0 | 251.0 | 86.8 | 2534.3 |
| 1984 | 0.0 | 0.0 | 44.7 | 32.0 | 409.8 | 173.1 | 247.3 | 43.1 | 48.9 | 99.7 | 1098.8 |
| 1985 | 0.0 | 0.0 | 16.6 | 236.1 | 62.2 | 267.1 | 107.9 | 173.4 | 34.7 | 37.6 | 935.4 |
| 1986 | 0.0 | 0.0 | 0.0 | 153.7 | 287.7 | 63.4 | 97.5 | 73.8 | 88.0 | 11.4 | 775.4 |
| 1987 | 0.0 | 0.0 | 2.3 | 16.2 | 90.4 | 48.9 | 33.1 | 51.9 | 37.5 | 17.1 | 297.4 |
| 1988 | 0.0 | 0.0 | 0.0 | 12.7 | 9.8 | 52.9 | 38.2 | 9.0 | 20.5 | 4.3 | 147.5 |
| 1989 | 0.0 | 0.0 | 15.7 | 3.4 | 48.5 | 16.5 | 21.2 | 16.1 | 1.7 | 0.8 | 124.0 |
| 1990 | 0.0 | 0.0 | 1.9 | 133.3 | 1.8 | 24.1 | 17.7 | 28.2 | 3.4 | 0.0 | 210.4 |
| 1991 | 0.0 | 0.0 | 26.6 | 47.7 | 61.6 | 17.7 | 19.2 | 13.0 | 2.7 | 2.2 | 190.7 |
| 1992 | 0.0 | 0.0 | 7.4 | 88.9 | 36.3 | 23.3 | 2.4 | 2.3 | 0.0 | 1.1 | 161.8 |
| 1993 | 0.0 | 0.0 | 11.7 | 25.4 | 29.8 | 17.6 | 5.9 | 6.4 | 0.0 | 0.0 | 96.7 |
| 1994 | 0.0 | 0.0 | 5.3 | 29.5 | 9.4 | 1.7 | 6.9 | 4.5 | 1.0 | 0.6 | 58.9 |
| 1995 | 0.0 | 0.0 | 1.8 | 5.7 | 30.8 | 9.4 | 5.0 | 5.0 | 3.0 | 2.8 | 63.5 |
| 1996 | 0.0 | 0.0 | 2.4 | 53.3 | 53.0 | 14.0 | 4.3 | 6.1 | 5.3 | 0.8 | 139.2 |
| 1997 | 0.0 | 0.0 | 2.4 | 82.7 | 104.6 | 53.4 | 12.7 | 4.2 | 1.0 | 1.2 | 262.3 |
| 1998 | 0.0 | 0.0 | 11.8 | 20.0 | 111.3 | 171.5 | 50.3 | 16.4 | 7.3 | 7.2 | 395.7 |
| 1999 | 0.0 | 0.0 | 0.3 | 41.4 | 60.5 | 89.8 | 60.5 | 30.6 | 6.7 | 6.0 | 295.8 |
| 2000 | 0.0 | 0.0 | 3.6 | 27.9 | 84.2 | 53.3 | 114.7 | 49.8 | 26.3 | 13.9 | 373.7 |
| 2001 | 0.0 | 0.0 | 7.8 | 148.0 | 101.3 | 72.4 | 67.6 | 64.4 | 31.8 | 20.7 | 513.9 |
| 2002 | 0.0 | 0.0 | 0.0 | 11.0 | 176.5 | 89.9 | 90.8 | 28.5 | 53.3 | 56.7 | 506.8 |
| 2003 | 0.0 | 0.0 | 0.0 | 2.3 | 29.8 | 344.9 | 70.2 | 51.5 | 18.0 | 60.4 | 577.1 |
| 2004 | 0.0 | 0.0 | 0.0 | 2.1 | 19.8 | 42.9 | 344.7 | 52.6 | 24.6 | 40.9 | 527.6 |
| 2005 | 0.0 | 0.0 | 0.0 | 1.4 | 18.3 | 41.9 | 68.7 | 310.7 | 35.8 | 53.8 | 530.6 |
| 2006 | 0.0 | 0.0 | 0.0 | 8.0 | 0.3 | 20.5 | 35.4 | 39.7 | 200.7 | 40.9 | 345.5 |
| 2007 | 0.0 | 0.0 | 0.1 | 1.5 | 97.1 | 5.4 | 26.4 | 21.6 | 47.6 | 216.6 | 416.3 |
| 2008 | 0.0 | 0.0 | 0.6 | 18.9 | 8.3 | 173.3 | 1.7 | 18.4 | 13.0 | 99.5 | 333.8 |
| 2009 | 0.0 | 0.0 | 0.0 | 2.2 | 14.6 | 5.6 | 142.0 | 2.6 | 16.6 | 85.6 | 269.3 |
| 2010 | 0.0 | 0.0 | 0.5 | 0.5 | 16.9 | 26.5 | 9.2 | 168.7 | 2.2 | 84.6 | 309.0 |

Table C.6. Gulf of Maine haddock average weights-at-age of commercial landings between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 | Age10 | Age11 | Age12 | Age13 | Age14 | Age15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | | 0.124 | 0.760 | 1.142 | 2.014 | 2.624 | 3.302 | 4.664 | 5.980 | | | 7.291 | | 4.778 | 1.253 | |
| 1978 | | | 0.783 | 1.220 | 1.776 | 2.423 | 2.950 | 4.135 | | | | 5.980 | | | | |
| 1979 | | 0.596 | 0.806 | 1.223 | 1.797 | 2.247 | 2.535 | 2.829 | 3.293 | | | | | | | |
| 1980 | | | 0.760 | 1.253 | 1.873 | 2.389 | 3.288 | 3.376 | 3.989 | | | 4.359 | | | | |
| 1981 | | | 0.681 | 1.489 | 1.970 | 2.520 | 3.280 | 3.840 | 4.188 | 3.482 | | | | 4.074 | 4.017 | |
| 1982 | | 0.351 | 0.644 | 0.998 | 2.142 | 2.560 | 3.102 | 3.648 | 4.260 | 4.296 | 3.838 | 4.153 | 4.311 | | 3.269 | |
| 1983 | | | 0.878 | 1.200 | 1.732 | 2.375 | 2.963 | 3.379 | 3.719 | 4.185 | 4.266 | 4.456 | 3.653 | | | |
| 1984 | | | 0.959 | 1.243 | 1.804 | 2.303 | 3.158 | 3.948 | 4.414 | 4.118 | 4.074 | 5.221 | 2.549 | 4.695 | | |
| 1985 | | | 1.142 | 1.103 | 1.909 | 2.356 | 2.655 | 3.573 | 4.116 | 4.495 | 3.949 | 6.339 | 5.073 | | | |
| 1986 | | | | 1.221 | 1.456 | 2.281 | 2.495 | 3.051 | 3.632 | 4.636 | 4.158 | | | | | |
| 1987 | | | 1.059 | 1.299 | 1.995 | 2.431 | 2.618 | 3.364 | 4.186 | 4.991 | 5.572 | 5.559 | | | | |
| 1988 | | | | 1.231 | 1.494 | 2.654 | 2.337 | 3.649 | 4.894 | 4.811 | 6.089 | | | | | |
| 1989 | | | 1.269 | 1.850 | 1.667 | 2.507 | 2.304 | 3.378 | 4.474 | 4.331 | | | | | | |
| 1990 | | | 0.800 | 1.523 | 3.361 | 2.361 | 2.962 | 3.628 | 3.506 | | | | | | | |
| 1991 | | | 1.347 | 1.485 | 2.490 | 2.960 | 2.964 | 3.307 | 4.245 | 3.372 | | | | | | |
| 1992 | | | 1.401 | 1.711 | 1.916 | 2.679 | 2.936 | 2.918 | | 2.803 | | | | | | |
| 1993 | | | 1.092 | 1.399 | 1.919 | 2.521 | 3.165 | 3.907 | | | | | | | | |
| 1994 | | | 1.155 | 1.659 | 2.175 | 2.624 | 2.814 | 3.350 | 3.545 | 2.795 | 4.897 | 3.989 | | | | |
| 1995 | | | 1.565 | 1.777 | 2.056 | 2.610 | 3.725 | 4.575 | 5.150 | 4.692 | 4.331 | 6.312 | | | | |
| 1996 | | | 1.605 | 1.399 | 1.802 | 2.224 | 3.128 | 2.396 | 2.120 | 3.190 | | | | | | |
| 1997 | | | 1.240 | 2.135 | 2.019 | 2.526 | 3.203 | 3.417 | 3.937 | 4.020 | 4.311 | 2.549 | | | | |
| 1998 | | | 1.236 | 1.530 | 1.890 | 2.254 | 2.857 | 3.378 | 3.124 | 2.861 | 2.880 | 4.778 | | | | |
| 1999 | | | 0.919 | 1.324 | 1.704 | 1.717 | 1.935 | 2.349 | 3.103 | 3.295 | | 3.442 | 3.229 | 4.416 | | |
| 2000 | | | 1.301 | 1.223 | 1.543 | 1.843 | 2.068 | 2.374 | 2.611 | 2.959 | 3.493 | | 3.309 | 4.426 | 3.390 | |
| 2001 | | | 1.151 | 1.388 | 1.518 | 1.814 | 2.251 | 2.276 | 2.457 | 2.454 | 2.771 | 2.369 | | | | 3.442 |
| 2002 | | | | 1.231 | 1.411 | 1.682 | 2.206 | 2.668 | 2.457 | 2.617 | 2.943 | 3.471 | 5.895 | | | |
| 2003 | | | | 1.022 | 1.361 | 1.554 | 1.868 | 2.194 | 2.537 | 2.582 | 2.577 | 2.345 | 2.826 | 2.149 | 3.989 | |
| 2004 | | | | 1.038 | 1.391 | 1.441 | 1.736 | 2.111 | 2.167 | 2.298 | 2.156 | 2.284 | 2.326 | 3.500 | | |
| 2005 | | | | 1.060 | 1.232 | 1.586 | 1.552 | 1.813 | 2.024 | 2.194 | 2.592 | 2.334 | 2.860 | 2.456 | 2.549 | |
| 2006 | | | | 1.143 | 1.365 | 1.494 | 1.778 | 1.636 | 1.809 | 2.001 | 2.174 | 2.673 | 2.275 | 2.396 | 2.350 | 2.549 |
| 2007 | | | 0.812 | 1.163 | 1.236 | 1.238 | 1.626 | 1.682 | 1.672 | 1.755 | 1.864 | 2.124 | 3.029 | 2.401 | 2.109 | 3.004 |
| 2008 | | | 1.061 | 1.162 | 1.232 | 1.384 | 1.496 | 1.793 | 1.778 | 1.662 | 1.795 | 1.950 | 1.913 | 2.990 | | |
| 2009 | | | | 1.131 | 1.235 | 1.381 | 1.730 | 1.677 | 2.021 | 2.151 | 1.985 | 2.020 | 2.339 | 1.775 | 2.133 | |
| 2010 | | | 1.130 | 0.994 | 1.155 | 1.433 | 1.663 | 1.785 | 2.172 | 2.183 | 2.273 | 2.103 | 2.113 | 2.265 | 3.511 | 2.488 |

Table C.7. Coefficients of variation (CV) associated with the estimates of Gulf of Maine haddock commercial landings-at-age of between 1984 and 2010. CVs could not be estimated prior to 1984 due to the inability to uniquely identify biological samples of commercial landings.

| Year | Age0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 | Age 10 | Age 11 | Age 12 | Age 13 | Age 14 | Age 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984 | | | 0.23 | 0.09 | 0.09 | 0.11 | 0.03 | 0.09 | 0.12 | 0.09 | 0.27 | 0.53 | 0.17 | 0.25 | | |
| 1985 | | | 0.18 | 0.10 | 0.16 | 0.08 | 0.11 | 0.05 | 0.11 | 0.16 | 0.18 | 1.28 | 0.79 | | | |
| 1986 | | | | 0.07 | 0.06 | 0.05 | 0.04 | 0.04 | 0.08 | 0.17 | 0.24 | | | | | |
| 1987 | | | 0.41 | 0.19 | 0.07 | 0.05 | 0.07 | 0.05 | 0.08 | 0.10 | 0.19 | 0.46 | | | | |
| 1988 | | | | 0.34 | 0.23 | 0.31 | 0.46 | 0.31 | 0.45 | 0.55 | 0.65 | | | | | |
| 1989 | | | 0.79 | 1.02 | 0.43 | 0.41 | 0.38 | 0.32 | 0.93 | 1.13 | | | | | | |
| 1990 | | | 0.85 | 0.24 | 1.07 | 0.50 | 0.48 | 0.52 | 1.04 | | | | | | | |
| 1991 | | | 0.54 | 0.26 | 0.13 | 0.25 | 0.23 | 0.24 | 0.52 | 0.85 | | | | | | |
| 1992 | | | 0.89 | 0.19 | 0.40 | 0.57 | 0.73 | 1.01 | | 1.43 | | | | | | |
| 1993 | | | 0.18 | 0.18 | 0.19 | 0.25 | 0.28 | 0.49 | | | | | | | | |
| 1994 | | | 0.17 | 0.10 | 0.27 | 0.38 | 0.31 | 0.23 | 0.47 | 1.09 | 1.13 | 0.88 | | | | |
| 1995 | | | | 0.74 | 0.14 | 0.44 | 0.42 | 0.35 | 0.44 | 8.11 | 0.99 | 0.61 | | | | |
| 1996 | | | 0.85 | 0.26 | 0.24 | 0.34 | 0.31 | 0.45 | 0.76 | 1.06 | | | | | | |
| 1997 | | | 0.99 | 0.12 | 0.14 | 0.13 | 0.26 | 0.24 | 0.37 | 0.35 | 0.77 | 1.15 | | | | |
| 1998 | | | 0.83 | 0.30 | 0.14 | 0.11 | 0.19 | 0.36 | 0.37 | 0.61 | 1.24 | 1.38 | | | | |
| 1999 | | | | 0.28 | 0.21 | 0.20 | 0.23 | 0.22 | 0.37 | 0.55 | | 1.12 | 0.97 | 1.43 | | |
| 2000 | | | 0.54 | 0.24 | 0.16 | 0.12 | 0.11 | 0.17 | 0.26 | 0.52 | 0.65 | | 0.87 | 0.70 | 0.77 | |
| 2001 | | | 0.45 | 0.10 | 0.10 | 0.16 | 0.11 | 0.15 | 0.22 | 0.37 | 0.53 | 0.92 | | | | 1.10 |
| 2002 | | | | 0.44 | 0.08 | 0.15 | 0.13 | 0.24 | 0.17 | 0.21 | 0.28 | 0.48 | 1.36 | | | |
| 2003 | | | | 0.81 | 0.19 | 0.05 | 0.11 | 0.14 | 0.19 | 0.15 | 0.18 | 0.46 | 0.40 | 0.75 | 1.28 | |
| 2004 | | | | 0.68 | 0.47 | 0.17 | 0.04 | 0.12 | 0.19 | 0.26 | 0.28 | 0.31 | 0.46 | 0.99 | | |
| 2005 | | | | 0.73 | 0.27 | 0.15 | 0.10 | 0.03 | 0.15 | 0.17 | 0.27 | 0.29 | 0.27 | 0.73 | 1.21 | |
| 2006 | | | | 0.25 | 0.76 | 0.16 | 0.13 | 0.09 | 0.04 | 0.12 | 0.18 | 0.30 | 0.22 | 0.33 | 0.55 | 1.34 |
| 2007 | | | 1.33 | 0.52 | 0.08 | 0.35 | 0.14 | 0.14 | 0.10 | 0.04 | 0.18 | 0.25 | 0.50 | 0.59 | 0.59 | 1.36 |
| 2008 | | | 1.22 | 0.33 | 0.30 | 0.07 | 0.44 | 0.15 | 0.18 | 0.17 | 0.09 | 0.26 | 0.46 | 0.97 | | |
| 2009 | | | | 0.59 | 0.24 | 0.31 | 0.05 | 0.38 | 0.12 | 0.19 | 0.15 | 0.09 | 0.32 | 0.47 | 1.06 | |
| 2010 | | | 1.21 | 1.08 | 0.20 | 0.16 | 0.26 | 0.06 | 0.37 | 0.18 | 0.18 | 0.21 | 0.13 | 0.40 | 0.64 | 1.43 |
| Average | | | 0.69 | 0.38 | 0.25 | 0.22 | 0.23 | 0.25 | 0.32 | 0.74 | 0.43 | 0.61 | 0.53 | 0.69 | 0.87 | 1.31 |

Table C.8. Discard reason by year described as the fractional occurrence of the total observed hauls with discard reasons recorded by observers and at-sea monitors between 1989 and 2010. The predominant discard reason for each year is highlighted in bold.

| Year | Other/unknown | No Market | Poor quality | Regulatory, other | Regulatory, below minimum size | High grading | Count of observed hauls with discard reason available |
|---|---|---|---|---|---|---|---|
| 1989 | **0.625** | 0.000 | 0.375 | 0.000 | 0.000 | 0.000 | 16 |
| 1990 | **0.800** | 0.000 | 0.200 | 0.000 | 0.000 | 0.000 | 10 |
| 1991 | **0.841** | 0.000 | 0.159 | 0.000 | 0.000 | 0.000 | 44 |
| 1992 | **0.837** | 0.000 | 0.163 | 0.000 | 0.000 | 0.000 | 49 |
| 1993 | **0.848** | 0.030 | 0.121 | 0.000 | 0.000 | 0.000 | 66 |
| 1994 | **0.425** | 0.050 | 0.000 | 0.200 | 0.325 | 0.000 | 40 |
| 1995 | 0.015 | 0.067 | 0.030 | 0.336 | **0.552** | 0.000 | 134 |
| 1996 | 0.000 | 0.025 | 0.058 | 0.133 | **0.725** | 0.058 | 120 |
| 1997 | 0.000 | 0.132 | 0.019 | 0.170 | **0.679** | 0.000 | 53 |
| 1998 | 0.118 | 0.000 | 0.118 | 0.000 | **0.765** | 0.000 | 17 |
| 1999 | 0.000 | 0.059 | **0.471** | 0.294 | 0.176 | 0.000 | 17 |
| 2000 | 0.022 | 0.156 | 0.244 | 0.000 | **0.578** | 0.000 | 45 |
| 2001 | 0.000 | 0.014 | 0.056 | 0.000 | **0.931** | 0.000 | 72 |
| 2002 | 0.000 | 0.088 | 0.165 | 0.077 | **0.670** | 0.000 | 91 |
| 2003 | 0.004 | 0.063 | 0.091 | 0.012 | **0.831** | 0.000 | 254 |
| 2004 | 0.000 | 0.037 | 0.137 | 0.097 | **0.730** | 0.000 | 300 |
| 2005 | 0.005 | 0.016 | 0.143 | 0.040 | **0.795** | 0.000 | 552 |
| 2006 | 0.006 | 0.000 | 0.078 | 0.028 | **0.888** | 0.000 | 179 |
| 2007 | 0.000 | 0.034 | 0.087 | 0.034 | **0.846** | 0.000 | 208 |
| 2008 | 0.000 | 0.014 | 0.096 | 0.089 | **0.801** | 0.000 | 146 |
| 2009 | 0.000 | 0.006 | 0.256 | 0.028 | **0.711** | 0.000 | 180 |
| 2010 | 0.000 | 0.023 | 0.128 | 0.174 | **0.674** | 0.000 | 86 |

Table C.9. Gulf of Maine haddock minimum size limits for the commercial and recreational fishery from 1977 to 2010. Prior to 1977 there were no federal minimum size limits for either fishery. Values in italics are assumed pending clarification of regulations under the initial Groundfish Fishery Management Plan.

| Year | Commercial minimum size limit (total length, inches) | Recreational minimum size limit (total length, inches) | Management action |
|---|---|---|---|
| 1977 | 16 | *15* | Groundfish Fishery Management Plan |
| 1978 | 16 | *15* | |
| 1979 | 16 | *15* | |
| 1980 | 16 | *15* | |
| 1981 | 16 | *15* | |
| 1982 | 16 | *15* | |
| 1983 | 17 | 15 | Interim' Groundfish Fishery Management Plan |
| 1984 | 17 | 15 | |
| 1985 | 17 | 15 | |
| 1986 | 17 | 15 | |
| 1987 | 19 | 17 | Amendment 1 |
| 1988 | 19 | 17 | |
| 1989 | 19 | 19 | |
| 1990 | 19 | 19 | |
| 1991 | 19 | 19 | |
| 1992 | 19 | 19 | |
| 1993 | 19 | 19 | |
| 1994 | 19 | 19 | Amendment 5 |
| 1995 | 19 | 19 | |
| 1996 | 19 | 19 | |
| 1997 | 19 | 19 | |
| 1998 | 19 | 19 | |
| 1999 | 19 | 19 | |
| 2000 | 19 | 19 | |
| 2001 | 19 | 19 | |
| 2002 | 19 | 23 | Framework 33 |
| 2003 | 19 | 21 | Framework 22 |
| 2004 | 19 | 19 | Amendment 13 |
| 2005 | 19 | 19 | |
| 2006 | 19 | 19 | |
| 2007 | 18 | 19 | Emergency action (August 10, 2007 through August 10, 2008) |
| 2008 | 18 | 19 | |
| 2009 | 18 | 18 | Amendment 16 |

Table C.10. Commercial discards of Gulf of Maine haddock by primary gear type between 1977 and 2010. Values prior to 1989 were estimated using a hindcasting procedure. Coefficients of variation (CVs) are provided in italics.

| Year | Large mesh otter trawl (≥ 5.5" mesh) | | | Small mesh otter trawl (< 5.5" mesh) | | | Sink gillnet | | | Benthic longline | | | Midwater trawl | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | discards (mt) | number of observed trips | CV | discards (mt) | number of observed trips | CV | discards (mt) | number of observed trips | CV | discards (mt) | number of observed trips | CV | discards (mt) | number of observed trips | CV | discards (mt) | CV |
| 1977 | 0.0 | | | 39.0 | | | 14.3 | | | 25.3 | | | 0.1 | | | 78.7 | |
| 1978 | 0.0 | | | 25.8 | | | 11.8 | | | 9.9 | | | 0.0 | | | 47.6 | |
| 1979 | 0.0 | | | 11.2 | | | 3.3 | | | 3.4 | | | 0.0 | | | 18.0 | |
| 1980 | 0.0 | | | 14.5 | | | 4.4 | | | 2.8 | | | 0.0 | | | 21.7 | |
| 1981 | 0.0 | | | 11.9 | | | 4.7 | | | 2.9 | | | 0.0 | | | 19.4 | |
| 1982 | 8.5 | | | 3.1 | | | 2.7 | | | 1.0 | | | 0.0 | | | 15.3 | |
| 1983 | 10.4 | | | 3.5 | | | 3.1 | | | 0.9 | | | 0.0 | | | 17.9 | |
| 1984 | 12.4 | | | 3.7 | | | 4.7 | | | 0.6 | | | 0.0 | | | 21.4 | |
| 1985 | 10.9 | | | 2.5 | | | 3.3 | | | 0.7 | | | 0.0 | | | 17.3 | |
| 1986 | 4.7 | | | 1.0 | | | 1.8 | | | 0.5 | | | 0.0 | | | 8.0 | |
| 1987 | 0.7 | | | 0.1 | | | 0.3 | | | 0.1 | | | 0.0 | | | 1.2 | |
| 1988 | 0.8 | | | 0.1 | | | 0.5 | | | 0.1 | | | 0.0 | | | 1.5 | |
| 1989 | 5.8 | 37 | *0.91* | 0.0 | 23 | *0.97* | 2.9 | 84 | *0.50* | | | | | | | 8.7 | *0.62* |
| 1990 | 0.5 | 26 | *1.10* | 0.0 | 8 | | 1.9 | 120 | *0.43* | | | | | | | 2.4 | *0.41* |
| 1991 | 2.3 | 48 | *0.62* | 0.0 | 29 | | 1.4 | 801 | *0.31* | 0.4 | 2 | *1.20* | | | | 4.1 | *0.38* |
| 1992 | 18.0 | 44 | *0.66* | 0.0 | 15 | | 1.0 | 896 | *0.25* | 0.0 | 9 | | | | | 19.1 | *0.62* |
| 1993 | 26.3 | 17 | *0.53* | 0.0 | 6 | | 3.4 | 560 | *0.34* | 0.0 | 2 | | | | | 29.7 | *0.47* |
| 1994 | 85.8 | 6 | *0.56* | | | | 7.6 | 85 | *0.44* | | | | | | | 93.5 | *0.52* |
| 1995 | 121.4 | 25 | *0.37* | 0.5 | 30 | *0.34* | 5.7 | 69 | *0.39* | | | | 0.0 | 4 | | 127.6 | *0.36* |
| 1996 | 85.9 | 11 | *0.69* | 2.4 | 40 | *0.19* | 18.3 | 46 | *0.50* | | | | | | | 106.5 | *0.57* |
| 1997 | 368.0 | 5 | *1.65* | 0.0 | 3 | | 0.3 | 33 | *1.08* | | | | | | | 368.2 | *1.65* |
| 1998 | 20.9 | 6 | *0.42* | | | | 3.2 | 78 | *0.64* | | | | | | | 24.1 | *0.37* |
| 1999 | 1.3 | 21 | *1.47* | 0.2 | 11 | *0.47* | 1.3 | 73 | *0.53* | | | | 0.0 | 2 | | 2.9 | *0.70* |
| 2000 | 30.0 | 79 | *0.59* | | | | 7.9 | 81 | *0.44* | | | | 0.0 | 3 | | 37.9 | *0.47* |
| 2001 | 13.1 | 113 | *0.51* | 8.3 | 4 | *0.71* | 5.7 | 47 | *0.31* | | | | | | | 27.1 | *0.34* |
| 2002 | 11.1 | 149 | *0.32* | 0.8 | 35 | *0.53* | 11.8 | 80 | *0.36* | 0.0 | 1 | | 0.0 | 1 | | 23.6 | *0.24* |
| 2003 | 11.2 | 253 | *0.20* | 0.3 | 19 | *0.56* | 5.8 | 295 | *0.19* | 5.3 | 14 | *0.46* | 0.0 | 28 | | 22.6 | *0.16* |
| 2004 | 20.1 | 258 | *0.30* | 0.7 | 67 | *0.89* | 3.9 | 775 | *0.20* | 0.5 | 8 | *0.37* | 1.5 | 68 | *0.55* | 26.6 | *0.23* |
| 2005 | 14.5 | 498 | *0.21* | 0.1 | 69 | *0.54* | 4.5 | 651 | *0.14* | 17.0 | 58 | *0.26* | 1.2 | 70 | *0.34* | 37.4 | *0.15* |
| 2006 | 38.8 | 206 | *0.50* | 0.2 | 24 | *0.43* | 3.2 | 128 | *0.23* | 7.1 | 36 | *0.35* | 0.0 | 10 | *1.07* | 49.4 | *0.40* |
| 2007 | 4.8 | 234 | *0.28* | 0.5 | 19 | *0.37* | 25.1 | 118 | *0.78* | 18.5 | 36 | *0.39* | 1.3 | 7 | *1.02* | 50.2 | *0.42* |
| 2008 | 5.3 | 260 | *0.40* | 0.7 | 15 | *0.16* | 2.7 | 150 | *0.28* | 3.7 | 20 | *0.47* | 0.0 | 14 | | 12.4 | *0.23* |
| 2009 | 3.0 | 428 | *0.34* | 0.4 | 27.5 | *0.74* | 6.4 | 276 | *0.27* | 4.0 | 35 | *0.81* | 0.0 | 32 | | 13.8 | *0.28* |
| 2010 | 2.6 | 685 | *0.27* | 0.4 | 36.5 | *0.62* | 1.2 | 1239 | *0.17* | 0.3 | 52 | *0.40* | 0.0 | 35 | *0.82* | 4.6 | *0.17* |

Table C.11. Summary of Gulf of Maine length sampling (number of lengths) of commercial discards by observers and at-sea monitors between 1989 and 2010 by gear type and semester.

| Year | Longline | | Large mesh otter trawl | | Small mesh otter trawl | | Sink gillnet | | Midwater trawl | | Total | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | |
| 1989 | | | 1 | 8 | | | | | | | 1 | 8 | 9 |
| 1990 | | | | | | | | | | | | | 0 |
| 1991 | | | | | | | | 1 | | | 0 | 1 | 1 |
| 1992 | | | 10 | 12 | | | | 1 | | | 10 | 13 | 23 |
| 1993 | | | 8 | 44 | | | 2 | 1 | | | 10 | 45 | 55 |
| 1994 | | | 7 | 12 | | | 1 | 18 | | | 8 | 30 | 38 |
| 1995 | | | 210 | 201 | | 16 | 7 | 6 | | | 217 | 223 | 440 |
| 1996 | | | 46 | 13 | 21 | 3 | 25 | 12 | | | 92 | 28 | 120 |
| 1997 | | | 737 | 3 | | | 1 | 2 | | | 738 | 5 | 743 |
| 1998 | | | 10 | | | | 2 | 1 | | | 12 | 1 | 13 |
| 1999 | | | | 5 | | 6 | | 18 | | | 0 | 29 | 29 |
| 2000 | | | | 10 | | | 6 | 2 | | | 6 | 12 | 18 |
| 2001 | | | 24 | 16 | 1 | | 5 | | | | 30 | 16 | 46 |
| 2002 | | | 4 | 49 | | 40 | 35 | 3 | | | 39 | 92 | 131 |
| 2003 | 105 | | 96 | 116 | | 22 | 45 | 56 | | | 246 | 194 | 440 |
| 2004 | 23 | | 39 | 194 | | 121 | 58 | 64 | | 35 | 120 | 414 | 534 |
| 2005 | 207 | 7 | 202 | 228 | | 18 | 14 | 87 | 19 | 128 | 442 | 468 | 910 |
| 2006 | 140 | | 219 | 81 | 4 | 3 | | 5 | | | 363 | 89 | 452 |
| 2007 | 299 | | 118 | 91 | | 8 | 14 | 10 | 32 | | 463 | 109 | 572 |
| 2008 | 63 | | 32 | 185 | | | 3 | 3 | | | 98 | 188 | 286 |
| 2009 | 127 | | 79 | 17 | | 10 | 91 | 1 | | | 297 | 28 | 325 |
| 2010 | 11 | | 25 | 55 | | 3 | 3 | 35 | | | 39 | 93 | 132 |

Table C.12. Gulf of Maine haddock commercial discards-at-age between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 8.2 | 504.6 | 44.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 557.0 |
| 1978 | 9.9 | 3.1 | 95.8 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 110.9 |
| 1979 | 46.5 | 62.0 | 6.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 115.7 |
| 1980 | 76.6 | 121.9 | 3.7 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 202.4 |
| 1981 | 3.8 | 164.0 | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 170.7 |
| 1982 | 178.9 | 10.8 | 15.5 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 206.0 |
| 1983 | 2.5 | 76.1 | 10.0 | 7.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 96.0 |
| 1984 | 0.0 | 11.4 | 43.2 | 1.0 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 57.4 |
| 1985 | 0.2 | 3.1 | 8.3 | 21.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 33.0 |
| 1986 | 10.0 | 19.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.9 |
| 1987 | 14.6 | 8.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 22.8 |
| 1988 | 0.0 | 18.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.5 |
| 1989 | 0.0 | 3.4 | 7.1 | 0.8 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 13.0 |
| 1990 | 4.5 | 4.5 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.8 |
| 1991 | 9.2 | 7.9 | 2.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.8 |
| 1992 | 4.8 | 20.4 | 11.0 | 4.8 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 41.0 |
| 1993 | 15.7 | 12.4 | 17.8 | 3.1 | 1.8 | 0.2 | 0.6 | 0.1 | 0.4 | 0.6 | 52.7 |
| 1994 | 60.4 | 89.9 | 17.8 | 21.4 | 3.9 | 1.5 | 3.2 | 2.0 | 0.3 | 0.4 | 200.8 |
| 1995 | 0.9 | 50.1 | 58.5 | 42.0 | 14.5 | 1.6 | 0.9 | 0.6 | 0.0 | 0.0 | 169.1 |
| 1996 | 47.7 | 9.9 | 32.4 | 85.8 | 10.3 | 1.7 | 0.4 | 0.4 | 0.2 | 0.0 | 189.0 |
| 1997 | 0.2 | 2.9 | 5.7 | 87.4 | 123.1 | 23.9 | 4.4 | 1.5 | 0.5 | 0.2 | 249.8 |
| 1998 | 107.6 | 13.3 | 13.8 | 1.5 | 4.7 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 145.9 |
| 1999 | 1.1 | 8.4 | 0.7 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 10.8 |
| 2000 | 1.1 | 5.4 | 47.0 | 14.2 | 1.7 | 0.2 | 0.4 | 0.1 | 0.0 | 0.0 | 70.1 |
| 2001 | 1.2 | 1.6 | 11.2 | 21.1 | 2.3 | 0.4 | 0.4 | 0.3 | 0.0 | 0.0 | 38.6 |
| 2002 | 0.0 | 2.1 | 1.3 | 6.6 | 17.3 | 1.8 | 0.3 | 0.0 | 0.1 | 0.1 | 29.5 |
| 2003 | 0.0 | 0.1 | 3.9 | 1.0 | 3.6 | 14.3 | 1.5 | 0.3 | 0.2 | 0.1 | 25.0 |
| 2004 | 0.3 | 7.8 | 0.4 | 4.9 | 1.1 | 2.9 | 12.1 | 1.0 | 0.4 | 0.5 | 31.4 |
| 2005 | 0.0 | 0.3 | 15.6 | 1.0 | 5.1 | 4.3 | 4.1 | 10.1 | 0.6 | 0.5 | 41.5 |
| 2006 | 5.2 | 9.4 | 1.6 | 35.9 | 3.8 | 3.7 | 1.6 | 2.8 | 9.2 | 0.4 | 73.6 |
| 2007 | 0.0 | 1.8 | 13.4 | 4.6 | 30.7 | 0.3 | 2.1 | 0.5 | 1.5 | 5.4 | 60.3 |
| 2008 | 0.0 | 0.0 | 4.4 | 3.1 | 0.6 | 6.5 | 0.2 | 0.4 | 0.0 | 0.9 | 16.0 |
| 2009 | 0.4 | 0.1 | 0.7 | 6.8 | 3.4 | 0.5 | 3.3 | 0.1 | 0.2 | 0.5 | 15.9 |
| 2010 | 0.1 | 1.6 | 0.8 | 0.9 | 1.7 | 0.4 | 0.1 | 0.7 | 0.0 | 0.1 | 6.3 |

Table C.13. Gulf of Maine haddock average weights-at-age of commercial discards between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 | Age10 | Age11 | Age12 | Age13 | Age14 | Age15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.023 | 0.145 | 0.115 | | | | | | | | | | | | | |
| 1978 | 0.022 | 0.116 | 0.483 | 0.459 | | | | | | | | | | | 0.262 | |
| 1979 | 0.016 | 0.207 | 0.598 | 0.726 | | | | | | | | | | | | |
| 1980 | 0.019 | 0.153 | 0.390 | 0.453 | | | | | | | | | | | | |
| 1981 | 0.032 | 0.114 | 0.207 | | | | | | | | | | | | | |
| 1982 | 0.036 | 0.196 | 0.410 | 0.455 | | | | | | | | | | | | |
| 1983 | 0.034 | 0.123 | 0.368 | 0.644 | 0.723 | | | | | | | | | | | |
| 1984 | | 0.237 | 0.397 | 0.452 | 0.581 | | | | | | | | | | | |
| 1985 | 0.053 | 0.327 | 0.461 | 0.583 | | | | | | | | | | | | |
| 1986 | 0.072 | 0.365 | | | | | | | | | | | | | | |
| 1987 | 0.027 | 0.100 | | | | | | | | | | | | | | |
| 1988 | | 0.081 | | | | | | | | | | | | | | |
| 1989 | | 0.254 | 0.788 | 0.830 | 0.942 | | | | | | | | | | | |
| 1990 | 0.025 | 0.231 | | 0.698 | | | | | | | | | | | | |
| 1991 | 0.014 | 0.235 | 0.766 | 0.969 | | | | | | | | | | | | |
| 1992 | 0.036 | 0.206 | 0.872 | 1.061 | 1.239 | | | | | | | | | | | |
| 1993 | 0.029 | 0.185 | 0.702 | 1.066 | 1.848 | 2.227 | 4.426 | 1.949 | 4.172 | 4.446 | | | | 4.812 | 4.446 | |
| 1994 | 0.034 | 0.065 | 0.756 | 1.641 | 2.347 | 3.275 | 3.333 | 4.786 | 3.466 | | 4.105 | 4.105 | | | | |
| 1995 | 0.015 | 0.068 | 0.760 | 1.109 | 1.649 | 2.837 | 3.096 | 3.378 | | | | | | | | |
| 1996 | 0.070 | 0.238 | 0.479 | 0.748 | 1.483 | 2.067 | 2.373 | 1.943 | 2.171 | | | | | | | |
| 1997 | 0.069 | 0.148 | 0.801 | 1.484 | 1.395 | 1.879 | 2.350 | 2.619 | 3.587 | 3.617 | 3.779 | 2.639 | | | | |
| 1998 | 0.023 | 0.220 | 0.707 | 0.757 | 0.821 | 0.784 | 1.759 | | | 1.759 | | | | | | |
| 1999 | 0.047 | 0.168 | 0.511 | 0.730 | 1.271 | 1.744 | 2.809 | 2.922 | 4.441 | 3.850 | 3.828 | | 3.452 | 4.448 | | |
| 2000 | 0.039 | 0.190 | 0.531 | 0.629 | 0.943 | 1.242 | 1.554 | 2.940 | 3.365 | | | | | | 2.891 | |
| 2001 | 0.020 | 0.200 | 0.626 | 0.786 | 0.895 | 1.010 | 0.837 | 0.874 | 1.702 | | | | | | | |
| 2002 | 0.074 | 0.178 | 0.374 | 0.721 | 0.902 | 1.080 | 1.202 | 1.395 | 1.312 | 1.360 | | | | | | |
| 2003 | | 0.130 | 0.516 | 0.767 | 0.829 | 1.004 | 1.041 | 1.469 | 1.172 | 1.847 | 2.218 | 2.088 | 2.452 | | | |
| 2004 | 0.024 | 0.164 | 0.581 | 0.742 | 1.164 | 1.074 | 1.165 | 1.378 | 1.676 | 1.852 | 1.575 | 2.602 | 2.505 | 3.764 | | |
| 2005 | 0.099 | 0.154 | 0.503 | 0.723 | 0.900 | 0.991 | 1.174 | 1.314 | 1.624 | 1.819 | 2.057 | 1.948 | 2.192 | 2.165 | 2.637 | |
| 2006 | 0.035 | 0.085 | 0.452 | 0.740 | 0.635 | 0.956 | 1.152 | 1.103 | 1.063 | 1.216 | 1.367 | | 1.455 | 1.565 | | |
| 2007 | | 0.223 | 0.601 | 0.754 | 0.892 | 1.099 | 0.957 | 1.321 | 1.150 | 1.131 | 1.543 | 1.636 | 2.814 | 1.912 | 2.214 | |
| 2008 | | | 0.536 | 0.735 | 0.957 | 0.900 | 0.873 | 0.906 | 1.132 | 1.017 | 0.987 | | | | | |
| 2009 | 0.058 | 0.123 | 0.599 | 0.785 | 0.954 | 1.014 | 1.041 | 1.116 | 1.144 | 1.548 | 1.141 | 1.229 | 2.013 | 1.552 | | |
| 2010 | 0.090 | 0.282 | 0.541 | 0.824 | 0.874 | 1.032 | 1.120 | 1.154 | 2.685 | 2.175 | 2.281 | 1.681 | 1.750 | 2.848 | 2.685 | |

Table C.14. Recreational harvest of Gulf of Maine haddock by type (A, B1 and B2) in numbers and weight.

| Year | Annual length samples (numbers) | Estimated recreational landings, A + B1 (numbers) | Estimated recreational releases, B2 (numbers) | Recreational landings (mt) | Metric tons/100 lengths |
|---|---|---|---|---|---|
| 1981 | 13 | 22,990 | 0 | *36.3* | 279.4 |
| 1982 | 2 | 19,531 | 122 | *30.9* | 1543.1 |
| 1983 | 10 | 36,455 | 0 | *57.6* | 576.0 |
| 1984 | 16 | 31,277 | 1,687 | *49.4* | 308.9 |
| 1985 | 7 | 19,417 | 92 | *30.7* | 438.3 |
| 1986 | 0 | 34,777 | 432 | *55.0* | |
| 1987 | 6 | 18,765 | 0 | *29.7* | 494.2 |
| 1988 | 2 | 7,630 | 2,970 | *12.1* | 602.8 |
| 1989 | 3 | 5,995 | 5,134 | *9.5* | 315.7 |
| 1990 | 0 | 1,836 | 278 | *2.9* | |
| 1991 | 0 | 242 | 0 | *0.4* | |
| 1992 | 0 | 0 | 0 | 0.0 | |
| 1993 | 0 | 336 | 0 | *0.5* | |
| 1994 | 4 | 2,385 | 1,720 | *3.8* | 94.2 |
| 1995 | 153 | 110,818 | 43,469 | 175.1 | 114.4 |
| 1996 | 25 | 4,190 | 8,597 | 6.6 | 26.5 |
| 1997 | 21 | 20,022 | 15,733 | 31.6 | 150.7 |
| 1998 | 62 | 28,161 | 9,550 | 44.5 | 71.8 |
| 1999 | 32 | 12,128 | 16,673 | 19.2 | 59.9 |
| 2000 | 34 | 80,735 | 101,016 | 127.6 | 375.2 |
| 2001 | 25 | 120,422 | 112,326 | 190.3 | 761.1 |
| 2002 | 119 | 83,283 | 171,955 | 165.9 | 139.4 |
| 2003 | 210 | 119,788 | 260,881 | 191.8 | 91.3 |
| 2004 | 928 | 278,497 | 142,426 | 429.6 | 46.3 |
| 2005 | 1,711 | 444,739 | 116,168 | 717.1 | 41.9 |
| 2006 | 1,171 | 277,858 | 164,196 | 503.9 | 43.0 |
| 2007 | 1,068 | 398,229 | 105,432 | 627.9 | 58.8 |
| 2008 | 1,151 | 358,480 | 124,259 | 611.4 | 53.1 |
| 2009 | 1,188 | 311,584 | 71,984 | 531.0 | 44.7 |
| 2010 | 723 | 391,482 | 72,595 | 743.2 | 102.8 |

Table C.15. Gulf of Maine haddock recreational landings-at-age between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1978 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1979 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1980 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1981 | 0.0 | 0.0 | 5.3 | 4.2 | 2.1 | 3.2 | 5.0 | 1.0 | 1.6 | 0.6 | 23.0 |
| 1982 | 0.0 | 0.0 | 2.4 | 10.6 | 3.5 | 0.6 | 0.6 | 1.3 | 0.2 | 0.3 | 19.5 |
| 1983 | 0.0 | 0.0 | 0.6 | 9.8 | 11.4 | 7.5 | 1.2 | 1.7 | 3.1 | 1.2 | 36.5 |
| 1984 | 0.0 | 0.0 | 8.4 | 1.2 | 8.3 | 3.1 | 6.4 | 0.9 | 0.8 | 2.3 | 31.3 |
| 1985 | 0.0 | 0.0 | 0.7 | 8.8 | 1.1 | 3.4 | 1.4 | 2.6 | 0.7 | 0.8 | 19.4 |
| 1986 | 0.0 | 1.2 | 0.0 | 5.9 | 16.3 | 2.8 | 4.2 | 1.9 | 2.0 | 0.4 | 34.8 |
| 1987 | 0.0 | 0.0 | 1.3 | 1.9 | 6.3 | 2.6 | 1.9 | 2.2 | 1.2 | 1.3 | 18.8 |
| 1988 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 2.1 | 1.8 | 0.4 | 2.1 | 0.5 | 7.6 |
| 1989 | 0.0 | 0.0 | 1.1 | 0.3 | 1.0 | 1.2 | 1.2 | 1.1 | 0.1 | 0.1 | 6.0 |
| 1990 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.2 | 0.1 | 0.4 | 0.3 | 0.0 | 1.8 |
| 1991 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| 1992 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1993 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| 1994 | 0.0 | 0.0 | 0.3 | 1.3 | 0.2 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | 2.4 |
| 1995 | 0.0 | 0.0 | 18.3 | 51.7 | 37.9 | 1.1 | 0.7 | 0.5 | 0.3 | 0.3 | 110.8 |
| 1996 | 0.0 | 0.0 | 0.1 | 1.8 | 1.5 | 0.3 | 0.1 | 0.2 | 0.1 | 0.0 | 4.2 |
| 1997 | 0.0 | 0.0 | 0.1 | 6.9 | 8.3 | 2.8 | 1.0 | 0.4 | 0.2 | 0.3 | 20.0 |
| 1998 | 0.0 | 0.0 | 1.1 | 2.2 | 10.0 | 11.5 | 2.1 | 0.5 | 0.3 | 0.4 | 28.2 |
| 1999 | 0.0 | 0.0 | 0.0 | 1.7 | 1.9 | 3.6 | 3.0 | 1.5 | 0.3 | 0.2 | 12.1 |
| 2000 | 0.0 | 0.0 | 0.6 | 5.8 | 20.7 | 12.8 | 23.5 | 11.3 | 4.6 | 1.4 | 80.7 |
| 2001 | 0.0 | 0.0 | 4.4 | 44.4 | 26.4 | 15.8 | 10.9 | 10.0 | 5.5 | 3.0 | 120.4 |
| 2002 | 0.0 | 0.0 | 0.0 | 0.4 | 23.6 | 16.4 | 16.4 | 4.5 | 10.2 | 11.8 | 83.3 |
| 2003 | 0.0 | 0.0 | 0.0 | 0.2 | 5.2 | 71.6 | 16.2 | 10.3 | 3.9 | 12.2 | 119.8 |
| 2004 | 0.0 | 0.3 | 0.1 | 1.4 | 14.1 | 33.5 | 189.1 | 15.5 | 11.4 | 13.1 | 278.5 |
| 2005 | 0.0 | 0.3 | 1.2 | 1.7 | 25.6 | 40.8 | 74.5 | 248.2 | 23.7 | 28.7 | 444.7 |
| 2006 | 0.0 | 0.0 | 0.0 | 25.9 | 0.8 | 21.0 | 33.5 | 34.8 | 141.6 | 20.2 | 277.9 |
| 2007 | 0.0 | 0.0 | 0.3 | 2.7 | 159.4 | 4.8 | 25.1 | 21.1 | 37.4 | 147.6 | 398.2 |
| 2008 | 0.0 | 0.0 | 0.7 | 15.7 | 4.7 | 180.1 | 0.0 | 33.8 | 19.9 | 103.6 | 358.5 |
| 2009 | 0.0 | 0.0 | 0.3 | 15.8 | 37.2 | 15.8 | 162.0 | 2.2 | 22.2 | 56.1 | 311.6 |
| 2010 | 0.0 | 0.0 | 0.0 | 3.0 | 44.2 | 69.2 | 21.0 | 176.3 | 0.0 | 77.8 | 391.5 |

Table C.16. Gulf of Maine haddock total catch numbers-at-age between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9$^{+}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 8.2 | 548.4 | 1791.5 | 51.1 | 365.0 | 215.0 | 143.6 | 4.8 | 1.6 | 6.3 |
| 1978 | 9.9 | 3.1 | 433.5 | 1959.5 | 181.2 | 320.3 | 154.6 | 32.0 | 0.0 | 5.6 |
| 1979 | 46.5 | 69.5 | 87.4 | 614.6 | 1348.8 | 200.5 | 105.5 | 32.4 | 23.8 | 0.0 |
| 1980 | 76.6 | 121.9 | 865.2 | 110.0 | 754.9 | 1235.8 | 165.4 | 134.1 | 11.5 | 25.3 |
| 1981 | 3.8 | 164.0 | 1466.5 | 645.6 | 268.9 | 360.0 | 503.2 | 70.1 | 98.3 | 12.7 |
| 1982 | 178.9 | 77.9 | 458.6 | 1256.6 | 513.9 | 81.2 | 225.7 | 401.3 | 89.8 | 59.8 |
| 1983 | 2.5 | 76.1 | 17.0 | 612.5 | 724.2 | 596.3 | 110.3 | 185.7 | 254.1 | 88.0 |
| 1984 | 0.0 | 11.4 | 96.4 | 34.1 | 420.0 | 176.2 | 253.7 | 44.0 | 49.8 | 102.1 |
| 1985 | 0.2 | 3.1 | 25.5 | 266.2 | 63.3 | 270.5 | 109.3 | 176.0 | 35.3 | 38.3 |
| 1986 | 10.0 | 21.1 | 0.0 | 159.6 | 304.0 | 66.2 | 101.7 | 75.8 | 90.0 | 11.8 |
| 1987 | 14.6 | 8.1 | 3.6 | 18.1 | 96.7 | 51.5 | 35.0 | 54.2 | 38.7 | 18.4 |
| 1988 | 0.0 | 18.5 | 0.0 | 13.0 | 10.1 | 55.0 | 40.1 | 9.4 | 22.7 | 4.8 |
| 1989 | 0.0 | 3.4 | 23.9 | 4.4 | 51.2 | 17.7 | 22.4 | 17.2 | 1.8 | 0.9 |
| 1990 | 4.5 | 4.5 | 1.9 | 136.0 | 1.8 | 24.2 | 17.8 | 28.6 | 3.7 | 0.0 |
| 1991 | 9.2 | 7.9 | 28.9 | 48.3 | 61.7 | 17.7 | 19.2 | 13.0 | 2.7 | 2.2 |
| 1992 | 4.8 | 20.4 | 18.3 | 93.7 | 36.4 | 23.3 | 2.4 | 2.3 | 0.0 | 1.1 |
| 1993 | 15.7 | 12.4 | 29.6 | 28.7 | 31.7 | 17.8 | 6.5 | 6.4 | 0.4 | 0.6 |
| 1994 | 60.4 | 89.9 | 23.4 | 52.2 | 13.5 | 3.4 | 10.3 | 6.7 | 1.3 | 1.0 |
| 1995 | 0.9 | 50.1 | 78.5 | 99.4 | 83.2 | 12.1 | 6.5 | 6.1 | 3.4 | 3.1 |
| 1996 | 47.7 | 9.9 | 35.0 | 141.0 | 64.8 | 16.1 | 4.8 | 6.6 | 5.6 | 0.8 |
| 1997 | 0.2 | 2.9 | 8.3 | 177.0 | 235.9 | 80.1 | 18.1 | 6.1 | 1.8 | 1.8 |
| 1998 | 107.6 | 13.3 | 26.6 | 23.7 | 126.1 | 188.0 | 52.4 | 16.9 | 7.6 | 7.6 |
| 1999 | 1.1 | 8.4 | 0.9 | 43.4 | 62.4 | 93.5 | 63.6 | 32.1 | 7.1 | 6.2 |
| 2000 | 1.1 | 5.4 | 51.2 | 47.8 | 106.6 | 66.3 | 138.6 | 61.2 | 31.0 | 15.3 |
| 2001 | 1.2 | 1.6 | 23.4 | 213.5 | 130.0 | 88.5 | 79.0 | 74.7 | 37.3 | 23.7 |
| 2002 | 0.0 | 2.1 | 1.3 | 18.0 | 217.4 | 108.0 | 107.5 | 33.1 | 63.5 | 68.6 |
| 2003 | 0.0 | 0.1 | 3.9 | 3.6 | 38.6 | 430.8 | 87.9 | 62.1 | 22.2 | 72.7 |
| 2004 | 0.3 | 8.1 | 0.5 | 8.4 | 34.9 | 79.3 | 546.0 | 69.1 | 36.4 | 54.5 |
| 2005 | 0.0 | 0.6 | 16.7 | 4.1 | 49.0 | 87.0 | 147.4 | 569.0 | 60.1 | 83.1 |
| 2006 | 5.2 | 9.4 | 1.6 | 69.9 | 4.9 | 45.2 | 70.5 | 77.3 | 351.5 | 61.5 |
| 2007 | 0.0 | 1.8 | 13.9 | 8.8 | 287.1 | 10.5 | 53.6 | 43.2 | 86.4 | 369.6 |
| 2008 | 0.0 | 0.0 | 5.7 | 37.7 | 13.5 | 359.9 | 1.9 | 52.6 | 32.9 | 204.0 |
| 2009 | 0.4 | 0.1 | 1.0 | 24.8 | 55.2 | 21.9 | 307.3 | 4.9 | 39.0 | 142.2 |
| 2010 | 0.1 | 1.6 | 1.3 | 4.3 | 62.8 | 96.1 | 30.2 | 345.7 | 2.2 | 162.5 |

Table C.17. Gulf of Maine haddock average catch weights-at-age between 1977 and 2010. Grey shaded cells were imputed using a 5-year centered moving average.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.023 | 0.143 | 0.744 | 1.142 | 2.014 | 2.624 | 3.302 | 4.664 | 5.980 | 5.702 |
| 1978 | 0.022 | 0.116 | 0.717 | 1.220 | 1.776 | 2.423 | 2.950 | 4.135 | 4.421 | 4.999 |
| 1979 | 0.016 | 0.249 | 0.792 | 1.222 | 1.797 | 2.247 | 2.535 | 2.829 | 3.293 | 4.712 |
| 1980 | 0.019 | 0.153 | 0.758 | 1.251 | 1.873 | 2.389 | 3.288 | 3.376 | 3.989 | 4.359 |
| 1981 | 0.032 | 0.114 | 0.680 | 1.489 | 1.970 | 2.520 | 3.280 | 3.840 | 4.188 | 3.786 |
| 1982 | 0.036 | 0.329 | 0.636 | 0.998 | 2.142 | 2.560 | 3.102 | 3.648 | 4.260 | 4.086 |
| 1983 | 0.034 | 0.123 | 0.566 | 1.193 | 1.732 | 2.375 | 2.963 | 3.379 | 3.719 | 4.226 |
| 1984 | 0.049 | 0.237 | 0.683 | 1.220 | 1.798 | 2.303 | 3.158 | 3.948 | 4.414 | 4.091 |
| 1985 | 0.053 | 0.327 | 0.914 | 1.060 | 1.909 | 2.356 | 2.655 | 3.573 | 4.116 | 4.205 |
| 1986 | 0.072 | 0.365 | 0.885 | 1.221 | 1.456 | 2.281 | 2.495 | 3.051 | 3.632 | 4.505 |
| 1987 | 0.027 | 0.100 | 1.059 | 1.299 | 1.995 | 2.431 | 2.618 | 3.364 | 4.186 | 5.181 |
| 1988 | 0.041 | 0.081 | 0.993 | 1.231 | 1.494 | 2.654 | 2.337 | 3.649 | 4.894 | 5.353 |
| 1989 | 0.022 | 0.254 | 1.119 | 1.666 | 1.642 | 2.507 | 2.304 | 3.378 | 4.474 | 4.331 |
| 1990 | 0.025 | 0.231 | 0.800 | 1.512 | 3.361 | 2.361 | 2.962 | 3.628 | 3.506 | 3.965 |
| 1991 | 0.014 | 0.235 | 1.303 | 1.480 | 2.490 | 2.960 | 2.964 | 3.307 | 4.245 | 3.372 |
| 1992 | 0.036 | 0.206 | 1.085 | 1.678 | 1.914 | 2.679 | 2.936 | 2.918 | 3.863 | 2.803 |
| 1993 | 0.029 | 0.185 | 0.857 | 1.363 | 1.915 | 2.517 | 3.289 | 3.888 | 4.172 | 4.603 |
| 1994 | 0.034 | 0.065 | 0.848 | 1.651 | 2.226 | 2.931 | 2.976 | 3.795 | 3.529 | 3.990 |
| 1995 | 0.015 | 0.068 | 0.784 | 1.189 | 1.926 | 2.643 | 3.630 | 4.451 | 5.150 | 5.563 |
| 1996 | 0.070 | 0.238 | 0.557 | 0.997 | 1.750 | 2.207 | 3.066 | 2.369 | 2.122 | 3.190 |
| 1997 | 0.069 | 0.148 | 0.931 | 1.801 | 1.682 | 2.326 | 2.983 | 3.209 | 3.816 | 3.735 |
| 1998 | 0.023 | 0.220 | 0.951 | 1.475 | 1.847 | 2.213 | 2.856 | 3.378 | 3.124 | 3.003 |
| 1999 | 0.047 | 0.168 | 0.624 | 1.320 | 1.704 | 1.717 | 1.937 | 2.350 | 3.110 | 3.343 |
| 2000 | 0.039 | 0.190 | 0.586 | 1.022 | 1.531 | 1.840 | 2.066 | 2.375 | 2.612 | 3.387 |
| 2001 | 0.020 | 0.200 | 0.841 | 1.313 | 1.504 | 1.809 | 2.242 | 2.270 | 2.457 | 2.575 |
| 2002 | 0.074 | 0.178 | 0.374 | 1.040 | 1.366 | 1.670 | 2.203 | 2.667 | 2.456 | 2.753 |
| 2003 | 0.054 | 0.130 | 0.516 | 0.945 | 1.304 | 1.532 | 1.851 | 2.190 | 2.520 | 2.566 |
| 2004 | 0.024 | 0.164 | 0.581 | 0.829 | 1.379 | 1.418 | 1.717 | 2.097 | 2.159 | 2.244 |
| 2005 | 0.099 | 0.154 | 0.503 | 0.919 | 1.159 | 1.531 | 1.531 | 1.797 | 2.018 | 2.381 |
| 2006 | 0.035 | 0.085 | 0.452 | 0.814 | 0.693 | 1.411 | 1.752 | 1.601 | 1.776 | 2.121 |
| 2007 | 0.064 | 0.223 | 0.603 | 0.855 | 1.153 | 1.231 | 1.577 | 1.675 | 1.656 | 1.769 |
| 2008 | 0.061 | 0.178 | 0.601 | 1.102 | 1.215 | 1.367 | 1.441 | 1.775 | 1.777 | 1.771 |
| 2009 | 0.058 | 0.123 | 0.599 | 0.871 | 1.183 | 1.351 | 1.714 | 1.663 | 2.013 | 2.029 |
| 2010 | 0.090 | 0.282 | 0.762 | 0.883 | 1.129 | 1.427 | 1.659 | 1.782 | 2.172 | 2.144 |
| **2006-2010 average** | 0.062 | 0.178 | 0.603 | 0.905 | 1.075 | 1.357 | 1.629 | 1.699 | 1.879 | 1.967 |

Table C.18. Gulf of Maine haddock average stock/spawning stock weights-at-age between 1977 and 2010.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.010 | 0.064 | 0.581 | 0.916 | 1.836 | 2.475 | 2.951 | 4.791 | 5.281 | 5.702 |
| 1978 | 0.007 | 0.052 | 0.320 | 0.953 | 1.424 | 2.209 | 2.782 | 3.695 | 4.541 | 4.999 |
| 1979 | 0.005 | 0.074 | 0.303 | 0.936 | 1.481 | 1.998 | 2.478 | 2.889 | 3.690 | 4.712 |
| 1980 | 0.008 | 0.050 | 0.434 | 0.995 | 1.513 | 2.072 | 2.718 | 2.925 | 3.359 | 4.359 |
| 1981 | 0.010 | 0.047 | 0.323 | 1.062 | 1.570 | 2.173 | 2.799 | 3.553 | 3.760 | 3.786 |
| 1982 | 0.020 | 0.103 | 0.269 | 0.824 | 1.786 | 2.246 | 2.796 | 3.459 | 4.045 | 4.086 |
| 1983 | 0.013 | 0.067 | 0.432 | 0.871 | 1.315 | 2.256 | 2.754 | 3.238 | 3.683 | 4.226 |
| 1984 | 0.019 | 0.090 | 0.290 | 0.831 | 1.465 | 1.997 | 2.739 | 3.420 | 3.862 | 4.091 |
| 1985 | 0.020 | 0.127 | 0.465 | 0.851 | 1.526 | 2.058 | 2.473 | 3.359 | 4.031 | 4.205 |
| 1986 | 0.061 | 0.139 | 0.538 | 1.056 | 1.242 | 2.087 | 2.425 | 2.846 | 3.602 | 4.505 |
| 1987 | 0.016 | 0.085 | 0.622 | 1.072 | 1.561 | 1.881 | 2.444 | 2.897 | 3.574 | 5.181 |
| 1988 | 0.017 | 0.047 | 0.315 | 1.142 | 1.393 | 2.301 | 2.384 | 3.091 | 4.058 | 5.353 |
| 1989 | 0.007 | 0.102 | 0.301 | 1.286 | 1.422 | 1.935 | 2.473 | 2.810 | 4.041 | 4.331 |
| 1990 | 0.008 | 0.071 | 0.451 | 1.301 | 2.366 | 1.969 | 2.725 | 2.891 | 3.441 | 3.965 |
| 1991 | 0.004 | 0.077 | 0.549 | 1.088 | 1.940 | 3.154 | 2.645 | 3.130 | 3.924 | 3.372 |
| 1992 | 0.016 | 0.054 | 0.505 | 1.479 | 1.683 | 2.583 | 2.948 | 2.941 | 3.574 | 2.803 |
| 1993 | 0.019 | 0.082 | 0.420 | 1.216 | 1.793 | 2.195 | 2.968 | 3.379 | 3.489 | 4.603 |
| 1994 | 0.024 | 0.043 | 0.396 | 1.190 | 1.742 | 2.369 | 2.737 | 3.533 | 3.704 | 3.990 |
| 1995 | 0.004 | 0.048 | 0.226 | 1.004 | 1.783 | 2.426 | 3.262 | 3.640 | 4.421 | 5.563 |
| 1996 | 0.048 | 0.060 | 0.195 | 0.884 | 1.443 | 2.062 | 2.847 | 2.933 | 3.073 | 3.190 |
| 1997 | 0.039 | 0.102 | 0.471 | 1.002 | 1.295 | 2.018 | 2.566 | 3.137 | 3.007 | 3.735 |
| 1998 | 0.009 | 0.123 | 0.375 | 1.172 | 1.824 | 1.929 | 2.577 | 3.174 | 3.166 | 3.003 |
| 1999 | 0.023 | 0.062 | 0.371 | 1.120 | 1.585 | 1.781 | 2.070 | 2.591 | 3.241 | 3.343 |
| 2000 | 0.017 | 0.095 | 0.314 | 0.799 | 1.422 | 1.771 | 1.883 | 2.145 | 2.478 | 3.387 |
| 2001 | 0.007 | 0.088 | 0.400 | 0.877 | 1.240 | 1.664 | 2.031 | 2.166 | 2.416 | 2.575 |
| 2002 | 0.056 | 0.060 | 0.274 | 0.935 | 1.339 | 1.585 | 1.996 | 2.445 | 2.361 | 2.753 |
| 2003 | 0.031 | 0.098 | 0.303 | 0.595 | 1.165 | 1.447 | 1.758 | 2.197 | 2.593 | 2.566 |
| 2004 | 0.010 | 0.094 | 0.275 | 0.654 | 1.142 | 1.360 | 1.622 | 1.970 | 2.174 | 2.244 |
| 2005 | 0.107 | 0.061 | 0.287 | 0.731 | 0.980 | 1.453 | 1.473 | 1.757 | 2.057 | 2.381 |
| 2006 | 0.014 | 0.092 | 0.264 | 0.640 | 0.798 | 1.279 | 1.638 | 1.566 | 1.787 | 2.121 |
| 2007 | 0.038 | 0.088 | 0.226 | 0.622 | 0.969 | 0.924 | 1.492 | 1.713 | 1.628 | 1.769 |
| 2008 | 0.043 | 0.107 | 0.366 | 0.815 | 1.019 | 1.255 | 1.332 | 1.673 | 1.725 | 1.771 |
| 2009 | 0.026 | 0.087 | 0.327 | 0.724 | 1.142 | 1.281 | 1.531 | 1.548 | 1.890 | 2.029 |
| 2010 | 0.063 | 0.128 | 0.306 | 0.727 | 0.992 | 1.299 | 1.497 | 1.748 | 1.901 | 2.144 |
| **2006-2010 average** | 0.037 | 0.100 | 0.298 | 0.706 | 0.984 | 1.208 | 1.498 | 1.650 | 1.786 | 1.967 |

Table C.19. Vessel and door types used in the Northeast Fisheries Science Center's bottom trawl survey.

| Year | Spring | Autumn | Door |
|---|---|---|---|
| 1963 | | Albatross IV | BMV |
| 1964 | | Albatross IV | BMV |
| 1965 | | Albatross IV | BMV |
| 1966 | | Albatross IV | BMV |
| 1967 | | Albatross IV | BMV |
| 1968 | Albatross IV | Albatross IV | BMV |
| 1969 | Albatross IV | Albatross IV | BMV |
| 1970 | Albatross IV | Albatross IV | BMV |
| 1971 | Albatross IV | Albatross IV | BMV |
| 1972 | Albatross IV | Albatross IV | BMV |
| 1973 | Albatross IV | Albatross IV | BMV |
| 1974 | Albatross IV | Albatross IV | BMV |
| 1975 | Albatross IV | Albatross IV | BMV |
| 1976 | Albatross IV | Albatross IV | BMV |
| 1977 | Albatross IV | Delaware II | BMV |
| 1978 | Albatross IV | Delaware II | BMV |
| 1979 | Albatross IV/Delaware II | Albatross IV/Delaware II | BMV |
| 1980 | Albatross IV/Delaware II | Delaware II | BMV |
| 1981 | Delaware II | Albatross IV/Delaware II | BMV |
| 1982 | Delaware II | Albatross IV | BMV |
| 1983 | Albatross IV | Albatross IV | BMV |
| 1984 | Albatross IV | Albatross IV | BMV |
| 1985 | Albatross IV | Albatross IV | Polyvalent |
| 1986 | Albatross IV | Albatross IV | Polyvalent |
| 1987 | Albatross IV/Delaware II | Albatross IV | Polyvalent |
| 1988 | Albatross IV | Albatross IV/Delaware II | Polyvalent |
| 1989 | Delaware II | Delaware II | Polyvalent |
| 1990 | Delaware II | Delaware II | Polyvalent |
| 1991 | Delaware II | Delaware II | Polyvalent |
| 1992 | Albatross IV | Albatross IV | Polyvalent |
| 1993 | Albatross IV | Delaware II | Polyvalent |
| 1994 | Delaware II | Albatross IV | Polyvalent |
| 1995 | Albatross IV | Albatross IV | Polyvalent |
| 1996 | Albatross IV | Albatross IV | Polyvalent |
| 1997 | Albatross IV | Albatross IV | Polyvalent |
| 1998 | Albatross IV | Albatross IV | Polyvalent |
| 1999 | Albatross IV | Albatross IV | Polyvalent |
| 2000 | Albatross IV | Albatross IV | Polyvalent |
| 2001 | Albatross IV | Albatross IV | Polyvalent |
| 2002 | Albatross IV | Albatross IV | Polyvalent |
| 2003 | Delaware II | Albatross IV | Polyvalent |
| 2004 | Albatross IV | Albatross IV | Polyvalent |
| 2005 | Albatross IV | Albatross IV | Polyvalent |
| 2006 | Albatross IV | Albatross IV | Polyvalent |
| 2007 | Albatross IV | Albatross IV | Polyvalent |
| 2008 | Albatross IV | Albatross IV | Polyvalent |
| 2009 | Henry B. Bigelow | Henry B. Bigelow | PolyIce oval |
| 2010 | Henry B. Bigelow | Henry B. Bigelow | PolyIce oval |
| 2011 | Henry B. Bigelow | | PolyIce oval |

Table C.20. Summary of the calibration factors applied to the Northeast Fisheries Science Center bottom trawl survey and corresponding coefficients of variation (CV) where available.

| Calibration type | Index | Length (cm) | Calibration coefficient | CV | Source |
|---|---|---|---|---|---|
| Deleware II to Albatross IV | Biomass (weight) | *NA* | 0.790 | *NA* | Forrester et al., 1997 |
| | Abundance (numbers) | *NA* | 0.820 | *NA* | |
| BMV door to Polyvalent door | Biomass (weight) | *NA* | 1.510 | *NA* | |
| | Abundance (numbers) | *NA* | 1.490 | *NA* | |
| Bigelow to Albatross IV | Biomass (weight), spring | *NA* | 0.878 | *NA* | Miller et al. 2010 |
| | Biomass (weight), fall | *NA* | 1.489 | *NA* | |
| | Abundance (numbers) | ≤ 18 | 2.626 | 0.07 | Brooks et al. 2010 |
| | | 19 | 2.581 | 0.07 | |
| | | 20 | 2.535 | 0.07 | |
| | | 21 | 2.489 | 0.07 | |
| | | 22 | 2.444 | 0.06 | |
| | | 23 | 2.398 | 0.06 | |
| | | 24 | 2.352 | 0.06 | |
| | | 25 | 2.307 | 0.06 | |
| | | 26 | 2.261 | 0.06 | |
| | | 27 | 2.216 | 0.06 | |
| | | 28 | 2.170 | 0.05 | |
| | | 29 | 2.124 | 0.05 | |
| | | 30 | 2.079 | 0.05 | |
| | | 31 | 2.033 | 0.05 | |
| | | 32 | 1.988 | 0.05 | |
| | | 33 | 1.942 | 0.04 | |
| | | 34 | 1.896 | 0.04 | |
| | | 35 | 1.851 | 0.04 | |
| | | 36 | 1.805 | 0.04 | |
| | | 37 | 1.759 | 0.04 | |
| | | 38 | 1.714 | 0.03 | |
| | | 39 | 1.668 | 0.03 | |
| | | 40 | 1.623 | 0.03 | |
| | | 41 | 1.577 | 0.03 | |
| | | 42 | 1.531 | 0.03 | |
| | | 43 | 1.486 | 0.03 | |
| | | 44 | 1.440 | 0.03 | |
| | | 45 | 1.394 | 0.04 | |
| | | 46 | 1.349 | 0.04 | |
| | | 47 | 1.303 | 0.04 | |
| | | 48 | 1.258 | 0.05 | |
| | | 49 | 1.212 | 0.05 | |
| | | 50 | 1.166 | 0.06 | |
| | | ≥ 51 | 1.164 | 0.06 | |

Table C.21. Summary of differences in survey protocol from the FSV Albatross IV survey (2008 and earlier) and FSV Henry B. Bigelow (2009 - present). Adapted from Brooks et al. (2010).

| **Measure** | **FSV Henry B Bigelow** | **FSV Albatross IV** |
|---|---|---|
| Tow speed | 3.0 knots SOG | 3.8 knots SOG |
| Tow duration | 20min | 30 mins |
| Headrope height | 3.5-4m | 1-2m |
| Ground gear | Rockhopper Sweep | Roller Sweep |
| (cookies, rock hoppers, etc.) | Total Length-25.5m | Total Length-24.5m |
| | Center- 8.9m length, 16” rockhoppers. | Center-5m length, 16” rollers. |
| | Wings- 8.2m each | Wings- 9.75m each, 4” cookies. |
| | 14” rockhoppers | |
| Mesh | Poly webbing | Nylon webbing |
| | Forward Portion of trawl (jibs, upper and lower wing ends, 1st&2nd side panels, 1st bottom belly)12cm,4mm | Body of trawl= 12.7cm |
| | Square aft to codend:6cm, 2.5mm | Codend- 11.5cm |
| | Codend: 12cm, 4mm dbl. | Liner (codend and aft portion of top belly)-1.27cm knotless |
| | Codend Liner: 2.54cm, knotless | |
| Net design | 4 Seam, 3 Bridle | Yankee 36 (recent years) |
| Door type | 550 kg PolyIce oval | 450 kg polyvalent |
| Other comments | Wing End to Door distance= 36.5m | Wing End to Door Distance= 9m |

Table C.21. Gulf of Maine haddock Northeast Fisheries Science Center bottom trawl survey stratified mean indices in terms of both abundance (numbers/tow) and biomass (weight (kg)/tow).

| Year | Spring | | Fall | |
|---|---|---|---|---|
| | Mean number/tow | Mean weight (kg)/tow | Mean number/tow | Mean weight (kg)/tow |
| 1963 | | | 69.549 | 50.697 |
| 1964 | | | 14.176 | 18.386 |
| 1965 | | | 17.434 | 17.731 |
| 1966 | | | 10.742 | 13.103 |
| 1967 | | | 12.186 | 16.871 |
| 1968 | 6.066 | 8.107 | 8.564 | 17.307 |
| 1969 | 3.719 | 6.607 | 5.451 | 12.721 |
| 1970 | 0.906 | 1.784 | 2.918 | 7.354 |
| 1971 | 0.878 | 2.523 | 2.880 | 8.159 |
| 1972 | 0.862 | 0.867 | 1.984 | 3.036 |
| 1973 | 1.312 | 1.598 | 4.165 | 8.583 |
| 1974 | 1.437 | 1.059 | 2.687 | 3.347 |
| 1975 | 2.770 | 3.482 | 5.533 | 8.616 |
| 1976 | 8.326 | 6.350 | 6.035 | 8.040 |
| 1977 | 6.799 | 6.725 | 8.296 | 8.752 |
| 1978 | 1.356 | 1.434 | 9.775 | 21.658 |
| 1979 | 2.890 | 3.948 | 6.174 | 15.567 |
| 1980 | 2.212 | 2.673 | 7.152 | 9.835 |
| 1981 | 3.613 | 3.545 | 4.456 | 10.874 |
| 1982 | 2.047 | 2.555 | 2.627 | 4.164 |
| 1983 | 3.678 | 3.567 | 2.598 | 5.219 |
| 1984 | 1.095 | 1.144 | 1.697 | 3.893 |
| 1985 | 1.773 | 1.882 | 4.079 | 6.149 |
| 1986 | 0.707 | 1.284 | 0.623 | 1.392 |
| 1987 | 0.092 | 0.063 | 1.035 | 2.645 |
| 1988 | 0.187 | 0.301 | 0.335 | 1.476 |
| 1989 | 0.083 | 0.125 | 0.283 | 0.631 |
| 1990 | 0.024 | 0.000 | 0.145 | 0.432 |
| 1991 | 0.074 | 0.066 | 0.142 | 0.120 |
| 1992 | 0.193 | 0.271 | 0.211 | 0.091 |
| 1993 | 0.450 | 0.200 | 0.866 | 0.472 |
| 1994 | 0.402 | 0.253 | 0.325 | 0.217 |
| 1995 | 0.806 | 0.350 | 0.977 | 1.099 |
| 1996 | 0.305 | 0.338 | 2.407 | 3.543 |
| 1997 | 1.935 | 1.222 | 2.688 | 2.424 |
| 1998 | 0.197 | 0.112 | 3.130 | 2.917 |
| 1999 | 4.267 | 1.108 | 6.730 | 4.910 |
| 2000 | 3.610 | 1.815 | 16.589 | 14.032 |
| 2001 | 2.364 | 3.205 | 9.960 | 11.981 |
| 2002 | 5.704 | 2.793 | 3.920 | 4.835 |
| 2003 | 3.191 | 3.908 | 4.733 | 5.359 |
| 2004 | 1.061 | 1.199 | 5.704 | 7.171 |
| 2005 | 0.862 | 0.971 | 4.132 | 3.932 |
| 2006 | 3.151 | 2.661 | 3.910 | 3.945 |
| 2007 | 0.771 | 0.675 | 5.153 | 4.393 |
| 2008 | 1.848 | 1.510 | 2.266 | 3.147 |
| 2009 | 1.531 | 2.573 | 2.017 | 1.203 |
| 2010 | 1.630 | 3.713 | 2.662 | 1.339 |
| 2011 | 1.233 | 1.259 | | |

Table C.22. Coefficients of variation (CV) associated with the Gulf of Maine haddock Northeast Fisheries Science Center bottom trawl survey indices.

| Year | Abundance (num/tow) | | Biomass (kg/tow) | |
|---|---|---|---|---|
| | Spring | Fall | Spring | Fall |
| 1963 | | 0.26 | | 0.15 |
| 1964 | | 0.34 | | 0.17 |
| 1965 | | 0.32 | | 0.19 |
| 1966 | | 0.33 | | 0.27 |
| 1967 | | 0.22 | | 0.24 |
| 1968 | 0.29 | 0.15 | 0.23 | 0.15 |
| 1969 | 0.19 | 0.23 | 0.21 | 0.21 |
| 1970 | 0.24 | 0.22 | 0.24 | 0.20 |
| 1971 | 0.44 | 0.31 | 0.42 | 0.32 |
| 1972 | 0.35 | 0.23 | 0.54 | 0.34 |
| 1973 | 0.22 | 0.20 | 0.35 | 0.30 |
| 1974 | 0.37 | 0.55 | 0.42 | 0.31 |
| 1975 | 0.27 | 0.26 | 0.44 | 0.30 |
| 1976 | 0.35 | 0.23 | 0.34 | 0.27 |
| 1977 | 0.31 | 0.32 | 0.38 | 0.27 |
| 1978 | 0.41 | 0.18 | 0.28 | 0.19 |
| 1979 | 0.21 | 0.20 | 0.21 | 0.22 |
| 1980 | 0.38 | 0.33 | 0.43 | 0.24 |
| 1981 | 0.23 | 0.19 | 0.22 | 0.24 |
| 1982 | 0.32 | 0.34 | 0.32 | 0.28 |
| 1983 | 0.41 | 0.28 | 0.42 | 0.27 |
| 1984 | 0.39 | 0.27 | 0.42 | 0.27 |
| 1985 | 0.37 | 0.40 | 0.30 | 0.28 |
| 1986 | 0.45 | 0.43 | 0.49 | 0.38 |
| 1987 | 0.37 | 0.32 | 0.49 | 0.28 |
| 1988 | 0.53 | 0.64 | 0.59 | 0.73 |
| 1989 | 0.77 | 0.38 | 0.88 | 0.49 |
| 1990 | 0.56 | 0.37 | 0.89 | 0.35 |
| 1991 | 0.53 | 0.59 | 0.61 | 0.72 |
| 1992 | 0.58 | 0.52 | 0.94 | 0.60 |
| 1993 | 0.45 | 0.71 | 0.68 | 0.81 |
| 1994 | 0.34 | 0.41 | 0.37 | 0.89 |
| 1995 | 0.47 | 0.57 | 0.44 | 0.40 |
| 1996 | 0.31 | 0.39 | 0.35 | 0.44 |
| 1997 | 0.38 | 0.36 | 0.48 | 0.27 |
| 1998 | 0.40 | 0.48 | 0.44 | 0.43 |
| 1999 | 0.40 | 0.30 | 0.35 | 0.25 |
| 2000 | 0.39 | 0.45 | 0.40 | 0.39 |
| 2001 | 0.58 | 0.27 | 0.66 | 0.26 |
| 2002 | 0.51 | 0.34 | 0.31 | 0.32 |
| 2003 | 0.23 | 0.22 | 0.27 | 0.24 |
| 2004 | 0.33 | 0.25 | 0.38 | 0.29 |
| 2005 | 0.39 | 0.19 | 0.46 | 0.16 |
| 2006 | 0.45 | 0.24 | 0.42 | 0.20 |
| 2007 | 0.35 | 0.29 | 0.34 | 0.24 |
| 2008 | 0.51 | 0.32 | 0.33 | 0.30 |
| 2009 | 0.37 | 0.35 | 0.36 | 0.27 |
| 2010 | 0.35 | 0.46 | 0.38 | 0.61 |
| 2011 | 0.35 | | 0.38 | |
| **Average** | **0.39** | **0.34** | **0.43** | **0.33** |

Table C.23. Northeast Fisheries Science Center spring bottom trawl survey indices-at-age for Gulf of Maine haddock.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 0.0 | 0.0 | 0.0 | 63.9 | 377.0 | 5552.3 | 1118.5 | 167.8 | 140.3 | 177.9 |
| 1969 | 0.0 | 0.0 | 0.0 | 67.6 | 23.8 | 329.4 | 3163.8 | 983.2 | 36.3 | 53.9 |
| 1970 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 179.1 | 766.5 | 115.2 | 73.9 |
| 1971 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 32.6 | 32.6 | 797.8 | 236.7 |
| 1972 | 0.0 | 731.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 348.2 |
| 1973 | 0.0 | 161.6 | 982.0 | 0.0 | 67.6 | 0.0 | 0.0 | 0.0 | 0.0 | 432.1 |
| 1974 | 0.0 | 1127.3 | 110.2 | 417.1 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | 126.5 |
| 1975 | 0.0 | 37.6 | 2452.4 | 190.4 | 476.0 | 0.0 | 254.3 | 0.0 | 0.0 | 60.1 |
| 1976 | 0.0 | 6405.3 | 155.3 | 2171.8 | 220.4 | 1179.9 | 83.9 | 41.3 | 0.0 | 170.3 |
| 1977 | 0.0 | 1450.4 | 4093.2 | 61.4 | 1677.1 | 509.8 | 723.9 | 0.0 | 0.0 | 0.0 |
| 1978 | 0.0 | 106.5 | 896.8 | 417.1 | 37.6 | 240.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1979 | 0.0 | 464.7 | 393.3 | 501.0 | 1727.2 | 291.8 | 243.0 | 0.0 | 0.0 | 0.0 |
| 1980 | 0.0 | 1318.9 | 190.4 | 214.2 | 569.9 | 398.3 | 31.3 | 0.0 | 0.0 | 46.3 |
| 1981 | 0.0 | 1479.2 | 1243.7 | 760.3 | 266.8 | 445.9 | 200.4 | 31.3 | 47.6 | 47.6 |
| 1982 | 0.0 | 56.4 | 542.3 | 1117.2 | 582.4 | 184.1 | 82.7 | 0.0 | 0.0 | 0.0 |
| 1983 | 179.1 | 1693.4 | 171.6 | 1548.1 | 399.5 | 383.3 | 0.0 | 204.2 | 0.0 | 27.6 |
| 1984 | 0.0 | 23.8 | 713.9 | 67.6 | 374.5 | 135.3 | 0.0 | 0.0 | 56.4 | 0.0 |
| 1985 | 0.0 | 52.6 | 350.7 | 1371.5 | 72.6 | 212.9 | 73.9 | 62.6 | 25.1 | 0.0 |
| 1986 | 0.0 | 63.9 | 0.0 | 151.6 | 504.8 | 0.0 | 45.1 | 91.4 | 28.8 | 0.0 |
| 1987 | 0.0 | 45.1 | 31.3 | 38.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1988 | 0.0 | 53.9 | 0.0 | 0.0 | 18.8 | 149.0 | 12.5 | 0.0 | 0.0 | 0.0 |
| 1989 | 0.0 | 0.0 | 45.1 | 15.0 | 0.0 | 15.0 | 15.0 | 15.0 | 0.0 | 0.0 |
| 1990 | 15.0 | 15.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1991 | 0.0 | 17.5 | 8.8 | 65.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1992 | 0.0 | 106.5 | 0.0 | 0.0 | 136.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1993 | 0.0 | 326.9 | 182.9 | 0.0 | 0.0 | 36.3 | 18.8 | 0.0 | 0.0 | 0.0 |
| 1994 | 0.0 | 92.7 | 228.0 | 152.8 | 30.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1995 | 0.0 | 552.4 | 300.6 | 91.4 | 37.6 | 0.0 | 0.0 | 0.0 | 28.8 | 0.0 |
| 1996 | 0.0 | 0.0 | 46.3 | 182.9 | 154.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1997 | 0.0 | 970.7 | 289.3 | 299.3 | 741.5 | 95.2 | 27.6 | 0.0 | 0.0 | 0.0 |
| 1998 | 0.0 | 100.2 | 57.6 | 0.0 | 77.7 | 11.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1999 | 0.0 | 4664.3 | 109.0 | 202.9 | 36.3 | 284.3 | 48.8 | 0.0 | 0.0 | 0.0 |
| 2000 | 0.0 | 1298.8 | 1488.0 | 1212.4 | 181.6 | 105.2 | 66.4 | 170.3 | 0.0 | 0.0 |
| 2001 | 0.0 | 91.4 | 164.1 | 1302.6 | 657.6 | 209.2 | 284.3 | 81.4 | 60.1 | 112.7 |
| 2002 | 0.0 | 4132.0 | 259.3 | 757.8 | 1776.0 | 101.5 | 45.1 | 27.6 | 45.1 | 0.0 |
| 2003 | 0.0 | 449.6 | 254.3 | 116.5 | 136.5 | 2492.5 | 255.5 | 180.4 | 45.1 | 67.6 |
| 2004 | 0.0 | 144.0 | 0.0 | 192.9 | 41.3 | 119.0 | 777.8 | 36.3 | 0.0 | 18.8 |
| 2005 | 0.0 | 12.5 | 215.4 | 0.0 | 87.7 | 104.0 | 281.8 | 343.2 | 0.0 | 36.3 |
| 2006 | 0.0 | 224.2 | 115.2 | 2101.7 | 340.7 | 130.3 | 27.6 | 264.3 | 686.4 | 58.9 |
| 2007 | 0.0 | 195.4 | 106.5 | 35.1 | 315.6 | 0.0 | 35.1 | 36.3 | 42.6 | 199.1 |
| 2008 | 0.0 | 45.1 | 825.4 | 514.8 | 0.0 | 418.3 | 0.0 | 35.1 | 71.4 | 405.8 |
| 2009 | 0.0 | 40.2 | 111.5 | 527.1 | 274.5 | 49.8 | 685.7 | 0.0 | 16.9 | 211.5 |
| 2010 | 0.0 | 129.0 | 15.8 | 9.9 | 163.8 | 161.7 | 63.3 | 985.2 | 0.0 | 512.8 |
| 2011 | 0.0 | 694.6 | 248.6 | 12.1 | 0.0 | 31.1 | 218.3 | 0.0 | 203.0 | 136.4 |

Table C.24. Northeast Fisheries Science Center fall bottom trawl survey indices-at-age for Gulf of Maine haddock.

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | 44591.5 | 15259.2 | 2134.3 | 3772.5 | 8694.9 | 6184.8 | 2090.4 | 1650.8 | 1303.9 | 1430.4 |
| 1964 | 101.5 | 7394.8 | 2314.6 | 884.3 | 1221.2 | 2279.6 | 2196.9 | 1232.5 | 0.0 | 129.0 |
| 1965 | 67.6 | 459.7 | 10008.7 | 6342.7 | 316.9 | 1816.1 | 1509.3 | 830.4 | 417.1 | 67.6 |
| 1966 | 23.8 | 0.0 | 657.6 | 8262.7 | 2731.7 | 355.7 | 771.5 | 504.8 | 104.0 | 42.6 |
| 1967 | 0.0 | 0.0 | 0.0 | 1931.4 | 10013.7 | 2255.8 | 661.3 | 156.6 | 186.6 | 57.6 |
| 1968 | 0.0 | 0.0 | 0.0 | 0.0 | 241.7 | 7846.9 | 1818.6 | 271.8 | 399.5 | 146.5 |
| 1969 | 0.0 | 0.0 | 0.0 | 46.3 | 35.1 | 46.3 | 5159.0 | 1166.1 | 172.8 | 201.7 |
| 1970 | 0.0 | 60.1 | 0.0 | 0.0 | 0.0 | 157.8 | 170.3 | 2437.4 | 759.0 | 71.4 |
| 1971 | 335.7 | 0.0 | 0.0 | 0.0 | 20.0 | 0.0 | 152.8 | 211.7 | 2541.3 | 345.7 |
| 1972 | 0.0 | 1490.5 | 0.0 | 30.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 964.4 |
| 1973 | 1414.1 | 27.6 | 1202.4 | 0.0 | 445.9 | 32.6 | 27.6 | 47.6 | 27.6 | 1994.0 |
| 1974 | 27.6 | 2079.2 | 261.8 | 537.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 460.9 |
| 1975 | 1112.2 | 284.3 | 2399.8 | 698.9 | 1738.5 | 0.0 | 56.4 | 56.4 | 0.0 | 583.7 |
| 1976 | 2045.3 | 2247.0 | 96.4 | 1596.9 | 186.6 | 1129.8 | 0.0 | 236.7 | 0.0 | 20.0 |
| 1977 | 130.3 | 3864.0 | 4259.8 | 171.6 | 1287.6 | 240.5 | 319.4 | 0.0 | 0.0 | 117.7 |
| 1978 | 217.9 | 109.0 | 2149.3 | 6917.6 | 251.8 | 801.6 | 1508.0 | 157.8 | 0.0 | 130.3 |
| 1979 | 978.2 | 527.3 | 105.2 | 1406.6 | 3574.6 | 637.5 | 408.3 | 78.9 | 0.0 | 16.3 |
| 1980 | 4951.1 | 637.5 | 400.8 | 0.0 | 373.2 | 1337.7 | 814.1 | 196.6 | 131.5 | 116.5 |
| 1981 | 0.0 | 769.0 | 703.9 | 1268.8 | 393.3 | 1070.9 | 853.0 | 212.9 | 229.2 | 80.2 |
| 1982 | 483.5 | 70.1 | 854.2 | 1070.9 | 383.3 | 68.9 | 0.0 | 140.3 | 60.1 | 160.3 |
| 1983 | 0.0 | 697.6 | 66.4 | 799.1 | 755.3 | 390.8 | 215.4 | 85.2 | 201.7 | 42.6 |
| 1984 | 0.0 | 253.0 | 677.6 | 0.0 | 353.2 | 0.0 | 511.0 | 0.0 | 42.6 | 285.6 |
| 1985 | 0.0 | 111.5 | 589.9 | 3413.1 | 21.3 | 228.0 | 187.9 | 494.7 | 0.0 | 63.9 |
| 1986 | 0.0 | 18.8 | 0.0 | 86.4 | 439.6 | 106.5 | 22.5 | 31.3 | 73.9 | 0.0 |
| 1987 | 36.3 | 0.0 | 159.1 | 142.8 | 238.0 | 76.4 | 298.1 | 182.9 | 0.0 | 162.8 |
| 1988 | 0.0 | 0.0 | 0.0 | 40.1 | 28.8 | 126.5 | 0.0 | 51.4 | 171.6 | 0.0 |
| 1989 | 0.0 | 73.9 | 73.9 | 23.8 | 15.0 | 38.8 | 65.1 | 65.1 | 0.0 | 0.0 |
| 1990 | 11.3 | 30.1 | 0.0 | 70.1 | 0.0 | 0.0 | 0.0 | 47.6 | 23.8 | 0.0 |
| 1991 | 66.4 | 58.9 | 0.0 | 0.0 | 52.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1992 | 53.9 | 181.6 | 0.0 | 28.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1993 | 124.0 | 584.9 | 274.3 | 46.3 | 37.6 | 18.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1994 | 258.0 | 58.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 45.1 | 0.0 | 45.1 |
| 1995 | 0.0 | 117.7 | 756.5 | 231.7 | 45.1 | 45.1 | 0.0 | 0.0 | 0.0 | 28.8 |
| 1996 | 53.9 | 144.0 | 284.3 | 1306.4 | 774.0 | 85.2 | 142.8 | 87.7 | 45.1 | 91.4 |
| 1997 | 268.0 | 1663.3 | 31.3 | 473.4 | 731.5 | 104.0 | 93.9 | 0.0 | 0.0 | 0.0 |
| 1998 | 1836.2 | 301.9 | 539.8 | 164.1 | 529.8 | 372.0 | 87.7 | 60.1 | 31.3 | 0.0 |
| 1999 | 678.9 | 4046.8 | 776.6 | 1023.3 | 348.2 | 597.4 | 657.6 | 164.1 | 63.9 | 72.6 |
| 2000 | 417.1 | 1009.5 | 14039.3 | 2009.0 | 1584.4 | 558.6 | 774.0 | 278.1 | 110.2 | 0.0 |
| 2001 | 245.5 | 300.6 | 2865.7 | 6038.3 | 946.9 | 1084.7 | 359.5 | 240.5 | 339.4 | 56.4 |
| 2002 | 17.5 | 151.6 | 17.5 | 603.7 | 3157.6 | 457.2 | 169.1 | 0.0 | 256.8 | 81.4 |
| 2003 | 1068.4 | 0.0 | 350.7 | 91.4 | 608.7 | 3123.7 | 438.4 | 60.1 | 0.0 | 187.9 |
| 2004 | 91.4 | 435.9 | 36.3 | 700.1 | 328.2 | 1017.0 | 4026.8 | 155.3 | 210.4 | 145.3 |
| 2005 | 235.5 | 137.8 | 1977.7 | 110.2 | 179.1 | 393.3 | 534.8 | 1399.0 | 95.2 | 114.0 |
| 2006 | 288.1 | 353.2 | 110.2 | 2206.9 | 35.1 | 274.3 | 134.0 | 357.0 | 1053.4 | 85.2 |
| 2007 | 18.8 | 1305.1 | 1064.6 | 276.8 | 2701.6 | 82.7 | 17.5 | 202.9 | 152.8 | 631.3 |
| 2008 | 0.0 | 0.0 | 505.4 | 138.7 | 0.0 | 1308.7 | 0.0 | 201.9 | 142.7 | 541.1 |
| 2009 | 1112.7 | 323.5 | 115.0 | 235.2 | 14.4 | 50.6 | 435.4 | 0.0 | 64.6 | 174.6 |
| 2010 | 2035.2 | 43.1 | 26.6 | 62.2 | 210.5 | 363.9 | 139.7 | 301.1 | 0.0 | 151.4 |

Table C.25. VPA estimates of NEFSC bottom trawl survey catchability (q).

| Survey ID | Survey | q | CV |
|---|---|---|---|
| 1 | NEFSC spring age1 | 0.16 | 0.23 |
| 2 | NEFSC spring age2 | 0.15 | 0.18 |
| 3 | NEFSC spring age3 | 0.21 | 0.17 |
| 4 | NEFSC spring age4 | 0.23 | 0.21 |
| 5 | NEFSC spring age5 | 0.21 | 0.16 |
| 6 | NEFSC spring age6+ | 0.18 | 0.19 |
| 7 | NEFSC fall age1 (modeled age2) | 0.22 | 0.17 |
| 8 | NEFSC fall age2 (modeled age3) | 0.33 | 0.20 |
| 9 | NEFSC fall age3 (modeled age4) | 0.55 | 0.16 |
| 10 | NEFSC fall age4 (modeled age5) | 0.56 | 0.16 |
| 11 | NEFSC fall age5 (modeled age6) | 0.88 | 0.13 |
| 12 | NEFSC fall age6 (modeled age7) | 1.09 | 0.22 |
| 13 | NEFSC fall age7 (modeled age8) | 1.48 | 0.27 |
| 14 | NEFSC fall age8+ (modeled age9+) | 2.28 | 0.39 |

Table C.26. ADAPT-VPA retrospective Mohn's rho statistics for Gulf of Maine haddock using the average of a 7-year peel from 2003 to 2010.

| Year | SSB | $F_{6-8}$ | Age-1 recruitment |
|---|---|---|---|
| 2003 | -0.03 | 1.89 | 31.39 |
| 2004 | -0.42 | 1.07 | -0.67 |
| 2005 | -0.34 | 0.95 | -0.52 |
| 2006 | -0.33 | 1.27 | 0.34 |
| 2007 | -0.26 | 1.04 | 0.39 |
| 2008 | 0.04 | 0.52 | 0.02 |
| 2009 | -0.17 | -0.06 | 1.39 |
| **Mohn's Rho (7 year)** | **-0.21** | **0.95** | **4.62** |

Table C.27. VPA model uncertainty measures in terminal year + 1 (2011) Gulf of Maine haddock stock numbers-at-age.

| Age | NLLS estimate | Bootstrap mean | Bootstrap standard error | CV for NLLS solution | Bias estimate | Bias standard error | Percent bias | NLLS estimated corrected for bias | CV for corrected estimate | Lower 80% CI | Upper 80% CI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Age2 | 590 | 735 | 613 | 0.83 | 145 | 20 | 24.6 | 445 | 1.38 | 220 | 1683 |
| Age3 | 150 | 166 | 83 | 0.50 | 16 | 3 | 10.6 | 134 | 0.62 | 68 | 313 |
| Age4 | 153 | 171 | 86 | 0.50 | 18 | 3 | 12.1 | 134 | 0.64 | 71 | 336 |
| Age5 | 695 | 734 | 269 | 0.37 | 39 | 9 | 5.7 | 656 | 0.41 | 373 | 1235 |
| Age6 | 346 | 355 | 144 | 0.41 | 9 | 5 | 2.6 | 337 | 0.43 | 169 | 610 |
| Age7 | 94 | 102 | 47 | 0.46 | 8 | 2 | 8.3 | 86 | 0.55 | 42 | 187 |
| Age8 | 122 | 154 | 131 | 0.85 | 32 | 4 | 26.3 | 90 | 1.46 | 13 | 400 |
| Age9 | 81 | 483 | 2149 | 4.45 | 402 | 69 | 497.6 | -321 | -6.69 | 2 | 1538 |

| Age | NLLS estimate | Bootstrap mean | Bootstrap standard error | CV for NLLS solution | Bias estimate | Bias standard error | Percent bias | NLLS estimated corrected for bias | CV for corrected estimate | Lower 80% CI | Upper 80% CI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Age1 | 0.00 | 0.00 | 0.00 | 0.69 | 0.00 | 0.00 | 19.8 | 0.00 | 1.03 | 0.00 | 0.01 |
| Age2 | 0.01 | 0.01 | 0.00 | 0.47 | 0.00 | 0.00 | 11.7 | 0.01 | 0.60 | 0.00 | 0.02 |
| Age3 | 0.03 | 0.03 | 0.01 | 0.48 | 0.00 | 0.00 | 10.5 | 0.02 | 0.60 | 0.01 | 0.05 |
| Age4 | 0.08 | 0.08 | 0.03 | 0.36 | 0.01 | 0.00 | 6.8 | 0.07 | 0.41 | 0.04 | 0.14 |
| Age5 | 0.22 | 0.25 | 0.09 | 0.35 | 0.02 | 0.00 | 10.3 | 0.20 | 0.44 | 0.13 | 0.41 |
| Age6 | 0.25 | 0.28 | 0.14 | 0.50 | 0.03 | 0.00 | 10.3 | 0.23 | 0.61 | 0.14 | 0.50 |
| Age7 | 1.26 | 1.48 | 0.84 | 0.57 | 0.22 | 0.03 | 17.7 | 1.04 | 0.81 | 0.57 | 3.14 |
| Age8 | 0.93 | 0.95 | 0.32 | 0.34 | 0.01 | 0.01 | 1.5 | 0.92 | 0.35 | 0.48 | 1.51 |
| Age9 | 0.93 | 0.95 | 0.32 | 0.34 | 0.01 | 0.01 | 1.5 | 0.92 | 0.35 | 0.48 | 1.51 |

Table C.28. VPA model estimates of average fishing mortality-at-age on Gulf of Maine haddock between 1977 and 2010. *The model estimates of fishing mortality hit a bound of 5.0 in several instances which are highlighted by italicized text.*

| Year | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9$^+$ |
|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.10 | 0.15 | 0.03 | 0.20 | 0.51 | 0.42 | *5.00* | 0.42 | 0.42 |
| 1978 | 0.00 | 0.10 | 0.25 | 0.14 | 0.27 | 0.87 | 0.15 | 0.47 | 0.47 |
| 1979 | 0.01 | 0.06 | 0.21 | 0.28 | 0.23 | 0.13 | 0.45 | 0.16 | 0.16 |
| 1980 | 0.02 | 0.18 | 0.11 | 0.42 | 0.44 | 0.30 | 0.25 | 0.28 | 0.28 |
| 1981 | 0.05 | 0.34 | 0.20 | 0.40 | 0.36 | 0.32 | 0.20 | 0.30 | 0.30 |
| 1982 | 0.15 | 0.18 | 0.56 | 0.25 | 0.20 | 0.41 | 0.45 | 0.44 | 0.44 |
| 1983 | 0.05 | 0.05 | 0.38 | 0.74 | 0.50 | 0.47 | 0.69 | 0.59 | 0.59 |
| 1984 | 0.02 | 0.09 | 0.12 | 0.49 | 0.39 | 0.41 | 0.34 | 0.40 | 0.40 |
| 1985 | 0.02 | 0.04 | 0.39 | 0.34 | 0.69 | 0.45 | 0.56 | 0.51 | 0.51 |
| 1986 | 0.08 | 0.00 | 0.41 | 1.05 | 0.71 | 0.61 | 0.67 | 0.63 | 0.63 |
| 1987 | 0.07 | 0.02 | 0.22 | 0.47 | 0.49 | 1.11 | 0.79 | 0.89 | 0.89 |
| 1988 | 0.03 | 0.00 | 0.09 | 0.19 | 0.55 | 0.91 | 1.10 | 0.94 | 0.94 |
| 1989 | 0.01 | 0.05 | 0.06 | 0.57 | 0.57 | 0.45 | 1.48 | 0.64 | 0.64 |
| 1990 | 0.01 | 0.01 | 0.49 | 0.03 | 0.58 | 2.54 | 2.02 | 2.18 | 2.18 |
| 1991 | 0.02 | 0.11 | 0.18 | 0.43 | 0.44 | 1.38 | *5.00* | 1.43 | 1.43 |
| 1992 | 0.03 | 0.07 | 0.63 | 0.20 | 0.29 | 0.10 | 0.58 | 0.16 | 0.16 |
| 1993 | 0.01 | 0.06 | 0.14 | 0.45 | 0.14 | 0.12 | 0.40 | 0.19 | 0.19 |
| 1994 | 0.04 | 0.02 | 0.14 | 0.09 | 0.08 | 0.11 | 0.18 | 0.13 | 0.13 |
| 1995 | 0.02 | 0.04 | 0.11 | 0.35 | 0.11 | 0.21 | 0.09 | 0.13 | 0.13 |
| 1996 | 0.01 | 0.01 | 0.09 | 0.10 | 0.11 | 0.06 | 0.34 | 0.11 | 0.11 |
| 1997 | 0.00 | 0.01 | 0.10 | 0.23 | 0.17 | 0.17 | 0.10 | 0.14 | 0.14 |
| 1998 | 0.01 | 0.02 | 0.03 | 0.09 | 0.28 | 0.16 | 0.23 | 0.17 | 0.17 |
| 1999 | 0.00 | 0.00 | 0.03 | 0.10 | 0.09 | 0.15 | 0.14 | 0.14 | 0.14 |
| 2000 | 0.00 | 0.00 | 0.03 | 0.10 | 0.14 | 0.19 | 0.21 | 0.19 | 0.19 |
| 2001 | 0.00 | 0.01 | 0.02 | 0.11 | 0.11 | 0.25 | 0.15 | 0.19 | 0.19 |
| 2002 | 0.00 | 0.00 | 0.01 | 0.03 | 0.12 | 0.19 | 0.15 | 0.18 | 0.18 |
| 2003 | 0.00 | 0.00 | 0.00 | 0.03 | 0.08 | 0.14 | 0.16 | 0.15 | 0.15 |
| 2004 | 0.00 | 0.01 | 0.01 | 0.06 | 0.07 | 0.13 | 0.15 | 0.13 | 0.13 |
| 2005 | 0.00 | 0.01 | 0.09 | 0.10 | 0.21 | 0.18 | 0.20 | 0.19 | 0.19 |
| 2006 | 0.01 | 0.00 | 0.03 | 0.14 | 0.12 | 0.26 | 0.14 | 0.18 | 0.18 |
| 2007 | 0.00 | 0.01 | 0.03 | 0.15 | 0.50 | 0.21 | 0.25 | 0.23 | 0.23 |
| 2008 | 0.00 | 0.00 | 0.05 | 0.06 | 0.29 | 0.16 | 0.33 | 0.31 | 0.31 |
| 2009 | 0.00 | 0.00 | 0.02 | 0.09 | 0.13 | 0.42 | 0.75 | 0.43 | 0.43 |
| 2010 | 0.00 | 0.01 | 0.03 | 0.08 | 0.22 | 0.25 | 1.26 | 0.93 | 0.93 |

Table C.29. VPA model estimates of partial recruitment of Gulf of Maine haddock between 1977 and 2010.

| Year | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ |
|---|---|---|---|---|---|---|---|---|---|
| 1977 | 0.02 | 0.03 | 0.01 | 0.04 | 0.10 | 0.08 | 1.00 | 0.08 | 0.08 |
| 1978 | 0.00 | 0.12 | 0.29 | 0.16 | 0.31 | 1.00 | 0.17 | 0.54 | 0.54 |
| 1979 | 0.02 | 0.14 | 0.46 | 0.62 | 0.52 | 0.30 | 1.00 | 0.36 | 0.36 |
| 1980 | 0.05 | 0.42 | 0.24 | 0.96 | 1.00 | 0.70 | 0.58 | 0.64 | 0.64 |
| 1981 | 0.12 | 0.85 | 0.50 | 1.00 | 0.89 | 0.79 | 0.50 | 0.74 | 0.74 |
| 1982 | 0.27 | 0.32 | 1.00 | 0.44 | 0.37 | 0.73 | 0.82 | 0.78 | 0.78 |
| 1983 | 0.07 | 0.06 | 0.52 | 1.00 | 0.68 | 0.64 | 0.94 | 0.80 | 0.80 |
| 1984 | 0.03 | 0.19 | 0.24 | 1.00 | 0.80 | 0.83 | 0.70 | 0.81 | 0.81 |
| 1985 | 0.03 | 0.06 | 0.56 | 0.49 | 1.00 | 0.66 | 0.81 | 0.75 | 0.75 |
| 1986 | 0.08 | 0.00 | 0.39 | 1.00 | 0.68 | 0.58 | 0.63 | 0.60 | 0.60 |
| 1987 | 0.06 | 0.02 | 0.20 | 0.43 | 0.44 | 1.00 | 0.71 | 0.80 | 0.80 |
| 1988 | 0.03 | 0.00 | 0.08 | 0.17 | 0.50 | 0.83 | 1.00 | 0.86 | 0.86 |
| 1989 | 0.01 | 0.04 | 0.04 | 0.38 | 0.39 | 0.30 | 1.00 | 0.43 | 0.43 |
| 1990 | 0.01 | 0.00 | 0.19 | 0.01 | 0.23 | 1.00 | 0.79 | 0.86 | 0.86 |
| 1991 | 0.00 | 0.02 | 0.04 | 0.09 | 0.09 | 0.28 | 1.00 | 0.29 | 0.29 |
| 1992 | 0.05 | 0.11 | 1.00 | 0.32 | 0.46 | 0.16 | 0.93 | 0.26 | 0.26 |
| 1993 | 0.02 | 0.13 | 0.32 | 1.00 | 0.32 | 0.27 | 0.90 | 0.41 | 0.41 |
| 1994 | 0.21 | 0.11 | 0.81 | 0.52 | 0.44 | 0.64 | 1.00 | 0.75 | 0.75 |
| 1995 | 0.05 | 0.11 | 0.31 | 1.00 | 0.32 | 0.58 | 0.26 | 0.36 | 0.36 |
| 1996 | 0.02 | 0.04 | 0.28 | 0.29 | 0.32 | 0.18 | 1.00 | 0.34 | 0.34 |
| 1997 | 0.01 | 0.03 | 0.42 | 1.00 | 0.75 | 0.74 | 0.44 | 0.63 | 0.63 |
| 1998 | 0.02 | 0.05 | 0.10 | 0.32 | 1.00 | 0.56 | 0.82 | 0.61 | 0.61 |
| 1999 | 0.00 | 0.00 | 0.21 | 0.65 | 0.62 | 1.00 | 0.95 | 0.98 | 0.98 |
| 2000 | 0.01 | 0.02 | 0.15 | 0.48 | 0.68 | 0.92 | 1.00 | 0.95 | 0.95 |
| 2001 | 0.01 | 0.04 | 0.10 | 0.44 | 0.45 | 1.00 | 0.60 | 0.76 | 0.76 |
| 2002 | 0.01 | 0.01 | 0.05 | 0.16 | 0.64 | 1.00 | 0.81 | 0.95 | 0.95 |
| 2003 | 0.01 | 0.03 | 0.03 | 0.17 | 0.48 | 0.86 | 1.00 | 0.91 | 0.91 |
| 2004 | 0.01 | 0.05 | 0.08 | 0.39 | 0.47 | 0.86 | 1.00 | 0.87 | 0.87 |
| 2005 | 0.01 | 0.03 | 0.41 | 0.46 | 1.00 | 0.88 | 0.94 | 0.92 | 0.92 |
| 2006 | 0.03 | 0.02 | 0.11 | 0.54 | 0.47 | 1.00 | 0.53 | 0.68 | 0.68 |
| 2007 | 0.00 | 0.03 | 0.06 | 0.30 | 1.00 | 0.42 | 0.51 | 0.45 | 0.45 |
| 2008 | 0.00 | 0.01 | 0.14 | 0.18 | 0.88 | 0.48 | 1.00 | 0.96 | 0.96 |
| 2009 | 0.00 | 0.01 | 0.03 | 0.12 | 0.17 | 0.57 | 1.00 | 0.57 | 0.57 |
| 2010 | 0.00 | 0.01 | 0.02 | 0.06 | 0.18 | 0.20 | 1.00 | 0.74 | 0.74 |
| 2006-2010 Average | 0.01 | 0.01 | 0.07 | 0.24 | 0.54 | 0.53 | 0.81 | 0.68 | 0.68 |
| 5yr-standardized | 0.01 | 0.02 | 0.09 | 0.30 | 0.67 | 0.66 | 1.00 | 0.85 | 0.85 |
| 5yr-standardized flat topped | 0.01 | 0.02 | 0.09 | 0.30 | 0.67 | 0.66 | 1.00 | 1.00 | 1.00 |

Table C.30. VPA model estimates of Gulf of Maine haddock numbers-at-age between 1977 and 2010.

| Year | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 6,599 | 13,777 | 1,888 | 2,204 | 588 | 463 | 1 | 5 | 20 | 25,545 |
| 1978 | 1,916 | 4,908 | 9,666 | 1,500 | 1,476 | 289 | 250 | 0 | 16 | 20,021 |
| 1979 | 7,024 | 1,565 | 3,627 | 6,151 | 1,065 | 920 | 99 | 176 | 0 | 20,627 |
| 1980 | 6,908 | 5,688 | 1,203 | 2,417 | 3,823 | 691 | 658 | 52 | 114 | 21,554 |
| 1981 | 3,955 | 5,545 | 3,878 | 886 | 1,301 | 2,022 | 417 | 418 | 54 | 18,476 |
| 1982 | 606 | 3,090 | 3,223 | 2,594 | 484 | 742 | 1,203 | 279 | 186 | 12,407 |
| 1983 | 1,573 | 426 | 2,117 | 1,514 | 1,661 | 323 | 405 | 625 | 217 | 8,861 |
| 1984 | 818 | 1,219 | 333 | 1,183 | 593 | 826 | 166 | 166 | 340 | 5,644 |
| 1985 | 152 | 660 | 911 | 242 | 592 | 328 | 449 | 96 | 104 | 3,534 |
| 1986 | 286 | 122 | 517 | 507 | 141 | 244 | 170 | 210 | 28 | 2,225 |
| 1987 | 140 | 215 | 100 | 280 | 145 | 57 | 108 | 72 | 34 | 1,151 |
| 1988 | 625 | 108 | 173 | 65 | 143 | 73 | 15 | 40 | 9 | 1,251 |
| 1989 | 489 | 495 | 88 | 130 | 44 | 68 | 24 | 4 | 2 | 1,344 |
| 1990 | 372 | 398 | 384 | 68 | 60 | 21 | 35 | 4 | 0 | 1,342 |
| 1991 | 387 | 300 | 324 | 192 | 54 | 28 | 1 | 4 | 3 | 1,293 |
| 1992 | 706 | 310 | 220 | 222 | 102 | 28 | 6 | 0 | 8 | 1,602 |
| 1993 | 1,593 | 559 | 237 | 96 | 149 | 63 | 21 | 3 | 4 | 2,725 |
| 1994 | 2,763 | 1,293 | 431 | 168 | 50 | 106 | 45 | 12 | 9 | 4,877 |
| 1995 | 3,277 | 2,181 | 1,037 | 306 | 126 | 38 | 77 | 31 | 28 | 7,101 |
| 1996 | 1,432 | 2,637 | 1,715 | 760 | 176 | 92 | 25 | 58 | 8 | 6,903 |
| 1997 | 2,391 | 1,163 | 2,128 | 1,277 | 564 | 129 | 71 | 15 | 15 | 7,753 |
| 1998 | 2,658 | 1,955 | 945 | 1,582 | 833 | 389 | 90 | 53 | 53 | 8,558 |
| 1999 | 15,211 | 2,164 | 1,577 | 752 | 1,182 | 513 | 271 | 58 | 51 | 21,779 |
| 2000 | 2,961 | 12,446 | 1,771 | 1,252 | 560 | 883 | 363 | 193 | 95 | 20,524 |
| 2001 | 1,205 | 2,419 | 10,144 | 1,407 | 929 | 398 | 598 | 242 | 154 | 17,496 |
| 2002 | 1,081 | 985 | 1,960 | 8,112 | 1,035 | 680 | 255 | 423 | 456 | 14,987 |
| 2003 | 82 | 883 | 805 | 1,588 | 6,445 | 750 | 460 | 179 | 586 | 11,778 |
| 2004 | 4,251 | 67 | 720 | 656 | 1,265 | 4,888 | 535 | 321 | 480 | 13,183 |
| 2005 | 501 | 3,473 | 55 | 582 | 506 | 964 | 3,510 | 375 | 519 | 10,485 |
| 2006 | 1,378 | 410 | 2,828 | 41 | 432 | 336 | 657 | 2,361 | 413 | 8,856 |
| 2007 | 1,723 | 1,120 | 334 | 2,253 | 29 | 313 | 212 | 468 | 2,003 | 8,455 |
| 2008 | 287 | 1,409 | 904 | 265 | 1,586 | 14 | 208 | 134 | 833 | 5,640 |
| 2009 | 226 | 235 | 1,149 | 706 | 205 | 975 | 10 | 123 | 449 | 4,078 |
| 2010 | 722 | 185 | 191 | 918 | 528 | 148 | 522 | 4 | 291 | 3,509 |
| 2011 | 1,124 | 590 | 150 | 153 | 695 | 346 | 94 | 122 | 81 | 3,355 |
| **1977-2010 mean** | 2,244 | | | | | | | | | |
| **1977-2010 median** | 1,292 | | | | | | | | | |
| **1977-2010 geometric mean** | 1,124 | | | | | | | | | |

Table C.31. VPA model estimates of Gulf of Maine haddock January 1 and spawning stock biomass between 1977 and 2010.

| Year | January 1 total stock biomass (mt) | Spawning stock biomass (mt) |
|---|---|---|
| 1977 | 17,169 | 9,077 |
| 1978 | 18,086 | 13,036 |
| 1979 | 18,841 | 15,207 |
| 1980 | 20,064 | 15,158 |
| 1981 | 19,233 | 14,750 |
| 1982 | 17,391 | 13,822 |
| 1983 | 13,292 | 10,396 |
| 1984 | 8,483 | 6,902 |
| 1985 | 5,833 | 4,500 |
| 1986 | 3,531 | 2,648 |
| 1987 | 1,848 | 1,369 |
| 1988 | 1,111 | 826 |
| 1989 | 843 | 543 |
| 1990 | 1,158 | 706 |
| 1991 | 1,194 | 807 |
| 1992 | 1,280 | 914 |
| 1993 | 1,437 | 959 |
| 1994 | 2,084 | 1,343 |
| 1995 | 3,243 | 2,249 |
| 1996 | 4,115 | 3,031 |
| 1997 | 6,370 | 4,743 |
| 1998 | 8,273 | 6,483 |
| 1999 | 8,933 | 6,474 |
| 2000 | 11,619 | 7,373 |
| 2001 | 16,345 | 12,525 |
| 2002 | 18,905 | 16,757 |
| 2003 | 16,230 | 14,741 |
| 2004 | 14,117 | 12,545 |
| 2005 | 11,967 | 10,125 |
| 2006 | 9,305 | 7,958 |
| 2007 | 7,956 | 6,796 |
| 2008 | 5,618 | 4,481 |
| 2009 | 4,648 | 3,864 |
| 2010 | 3,651 | 2,868 |
| 2011 | 2,575 | |

Table C.32. VPA model estimates of average Gulf of Maine haddock fishing mortality on ages 6 through 8 between 1977 and 2010.

| Year | Average $F_{6-8}$ | N-weighted $F_{6-8}$ | Biomass weighted $F_{6-8}$ | Catch weighted $F_{6-8}$ |
|---|---|---|---|---|
| 1977 | 1.94 | 0.42 | 0.42 | 0.56 |
| 1978 | 0.50 | 0.54 | 0.49 | 0.75 |
| 1979 | 0.25 | 0.16 | 0.17 | 0.20 |
| 1980 | 0.28 | 0.28 | 0.28 | 0.28 |
| 1981 | 0.27 | 0.30 | 0.30 | 0.30 |
| 1982 | 0.43 | 0.44 | 0.44 | 0.44 |
| 1983 | 0.58 | 0.59 | 0.59 | 0.60 |
| 1984 | 0.38 | 0.40 | 0.40 | 0.40 |
| 1985 | 0.51 | 0.52 | 0.52 | 0.52 |
| 1986 | 0.64 | 0.63 | 0.63 | 0.63 |
| 1987 | 0.93 | 0.89 | 0.89 | 0.90 |
| 1988 | 0.98 | 0.94 | 0.95 | 0.95 |
| 1989 | 0.86 | 0.72 | 0.74 | 0.89 |
| 1990 | 2.25 | 2.21 | 2.20 | 2.22 |
| 1991 | 2.60 | 1.53 | 1.55 | 2.73 |
| 1992 | 0.28 | 0.18 | 0.18 | 0.34 |
| 1993 | 0.24 | 0.19 | 0.20 | 0.26 |
| 1994 | 0.14 | 0.13 | 0.14 | 0.14 |
| 1995 | 0.14 | 0.13 | 0.13 | 0.15 |
| 1996 | 0.17 | 0.12 | 0.12 | 0.18 |
| 1997 | 0.14 | 0.14 | 0.14 | 0.15 |
| 1998 | 0.19 | 0.17 | 0.18 | 0.18 |
| 1999 | 0.14 | 0.14 | 0.14 | 0.14 |
| 2000 | 0.20 | 0.19 | 0.19 | 0.19 |
| 2001 | 0.19 | 0.19 | 0.19 | 0.20 |
| 2002 | 0.18 | 0.18 | 0.18 | 0.18 |
| 2003 | 0.15 | 0.15 | 0.15 | 0.15 |
| 2004 | 0.14 | 0.13 | 0.13 | 0.13 |
| 2005 | 0.19 | 0.19 | 0.19 | 0.19 |
| 2006 | 0.19 | 0.18 | 0.18 | 0.18 |
| 2007 | 0.23 | 0.23 | 0.23 | 0.23 |
| 2008 | 0.26 | 0.31 | 0.32 | 0.32 |
| 2009 | 0.53 | 0.43 | 0.43 | 0.43 |
| 2010 | 0.82 | 1.04 | 1.06 | 1.18 |

Table C.33. Summary of the inputs to the Gulf of Maine haddock yield per recruit analysis.

| Age | Fishery selectivity | Natural mortality | Catch weights (kg) | Stock weights (kg) | Spawning stock weights (kg) | Proportion mature |
|---|---|---|---|---|---|---|
| Age1 | 0.009 | 0.200 | 0.178 | 0.100 | 0.100 | 0.027 |
| Age2 | 0.017 | 0.200 | 0.603 | 0.298 | 0.298 | 0.236 |
| Age3 | 0.091 | 0.200 | 0.905 | 0.706 | 0.706 | 0.773 |
| Age4 | 0.297 | 0.200 | 1.075 | 0.984 | 0.984 | 0.974 |
| Age5 | 0.672 | 0.200 | 1.357 | 1.208 | 1.208 | 0.998 |
| Age6 | 0.660 | 0.200 | 1.629 | 1.498 | 1.498 | 1.000 |
| Age7 | 1.000 | 0.200 | 1.699 | 1.650 | 1.650 | 1.000 |
| Age8 | 1.000 | 0.200 | 1.879 | 1.786 | 1.786 | 1.000 |
| Age$9^{+}$ | 1.000 | 0.200 | 1.967 | 1.967 | 1.967 | 1.000 |

Table C.34. Yield per recruit results for Gulf of Maine haddock.

| Reference point | F | YPR | SSB/R | Mean age |
|---|---|---|---|---|
| $F_0$ | 0.00 | 0.000 | 4.921 | 5.5 |
| $F_{0.1}$ | 0.34 | 0.435 | 2.258 | 3.3 |
| $F_{max}$ | 2.11 | 0.539 | 0.900 | 2.4 |
| $F_{40\%}$ | 0.46 | 0.470 | 1.968 | 3.1 |

Table C.35. Biological reference points for Gulf of Maine haddock and the ratio of 2010 model estimates of fishing mortality and spawning stock biomass used for stock status determination.

| Reference point | | 90% confidence interval |
|---|---|---|
| $F_{MSY}$ ($F_{40\%}$) | 0.46 | |
| $SSB_{MSY}$ (mt) | 4,904 | (2,272 - 10,604) |
| MSY (mt) | 1,177 | (553 - 2,563) |

| VPA base model | | | Ratio 2010/reference point | | Retrospective adjusted | |
|---|---|---|---|---|---|---|
| 2010 point estimate | | 90% confidence interval | Ratio | 90% confidence interval | Point estimate | Ratio |
| $F_{6-8}$ (average) | 0.82 | (0.42 - 1.63) | 1.78 | (0.91 - 3.54) | 0.42 | 0.91 |
| SSB | 2,868 | (2,140 - 4,233) | 0.58 | (0.44 - 0.86) | 3,630 | 0.74 |

Table C.36. Short-term projections of Gulf of Maine haddock fishery yield (catch) and spawning stock biomass conducted at both $F_{MSY}$ (0.46) and 75% $F_{MSY}$ (0.35) harvest scenarios in the years 2011 – 2020. Projections have not been adjusted to account for retrospective bias.

| Year | 1964-2010 recruitment series (SSB ≥ 3 kmt) | |
|---|---|---|
| | 75% $F_{MSY}$ (0.35) | $F_{MSY}$ ($F_{40\%}$ = 0.46) |
| **Total fishery yield (mt)** | | |
| 2011 | 1,309 | 1,309 |
| 2012 | 258 | 327 |
| 2013 | 270 | 322 |
| 2014 | 331 | 387 |
| 2015 | 428 | 498 |
| 2016 | 584 | 679 |
| 2017 | 739 | 853 |
| 2018 | 885 | 996 |
| 2019 | 976 | 1,085 |
| 2020 | 1,034 | 1,129 |
| | | |
| **Spawning stock biomass (mt)** | | |
| 2011 | 1,904 | 1,904 |
| 2012 | 1,317 | 1,296 |
| 2013 | 1,607 | 1,532 |
| 2014 | 2,154 | 2,021 |
| 2015 | 2,956 | 2,771 |
| 2016 | 3,800 | 3,558 |
| 2017 | 4,426 | 4,093 |
| 2018 | 4,902 | 4,464 |
| 2019 | 5,174 | 4,635 |
| 2020 | 5,379 | 4,783 |

**Figures**

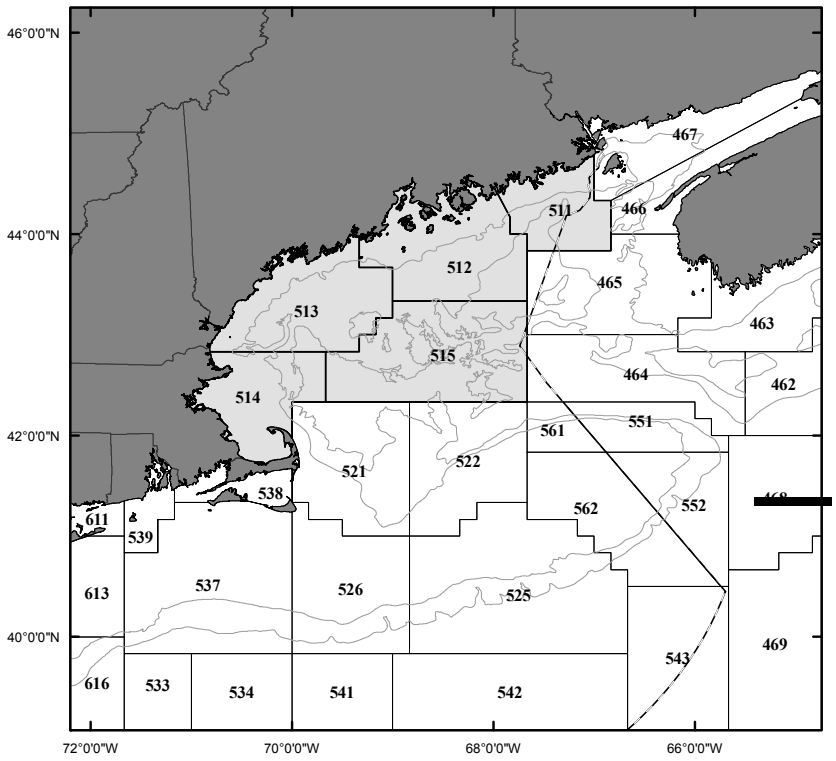



Figure C.1. Map of the Gulf of Maine haddock assessment area (shaded grey). The United States exclusive econic zone (EEZ) is defined by the dashed line. Within the Gulf of Maine region, this line is informally referred to as the "Hague Line".

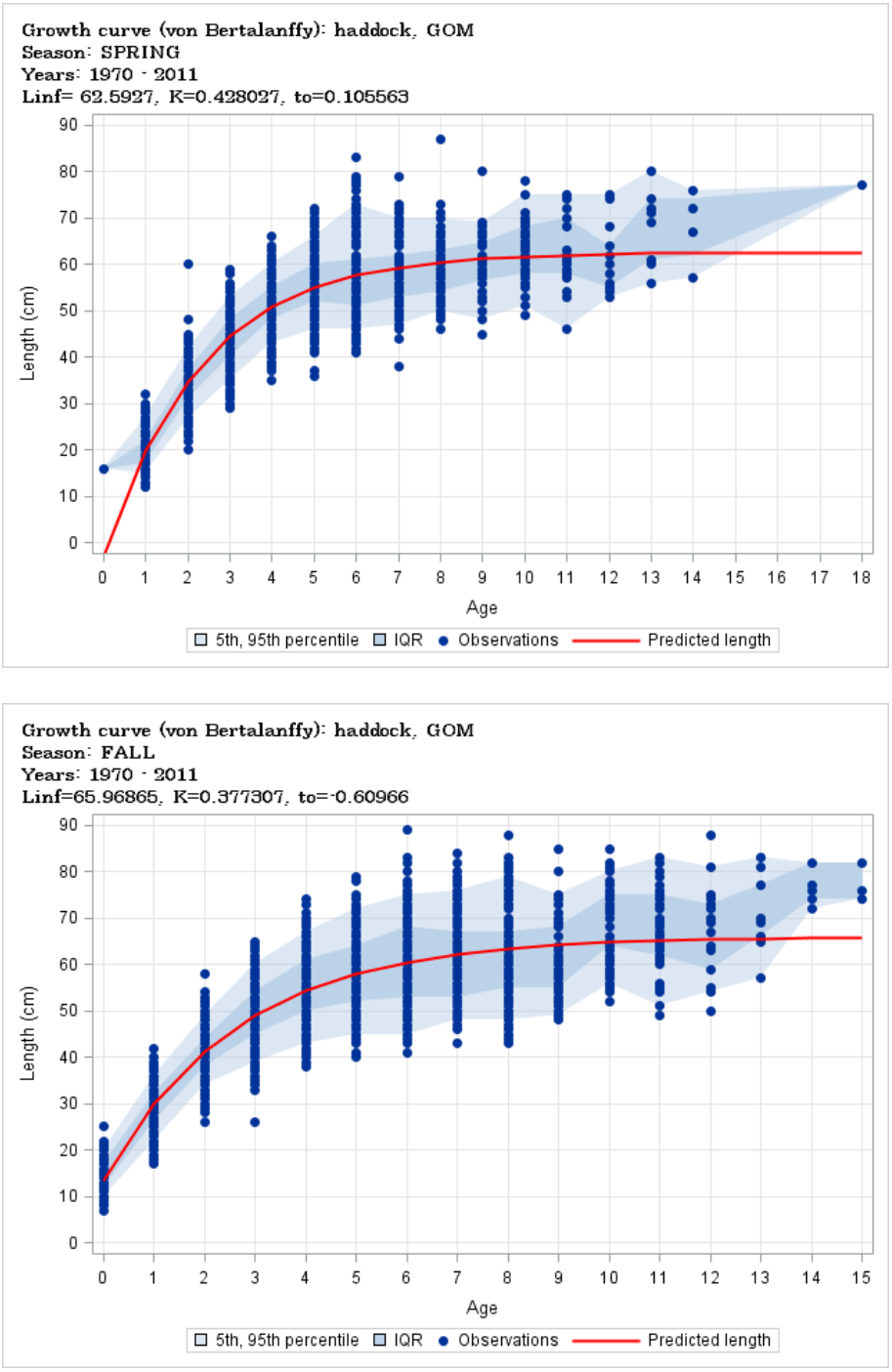



Figure C.2. Comparison of von Bertalanffy growth curves for the Gulf of Maine haddock stocks as estimated from data collected from the Northeast Fisheries Science Center spring (top) and fall (bottom) bottom trawl surveys between 1970 and 2011.

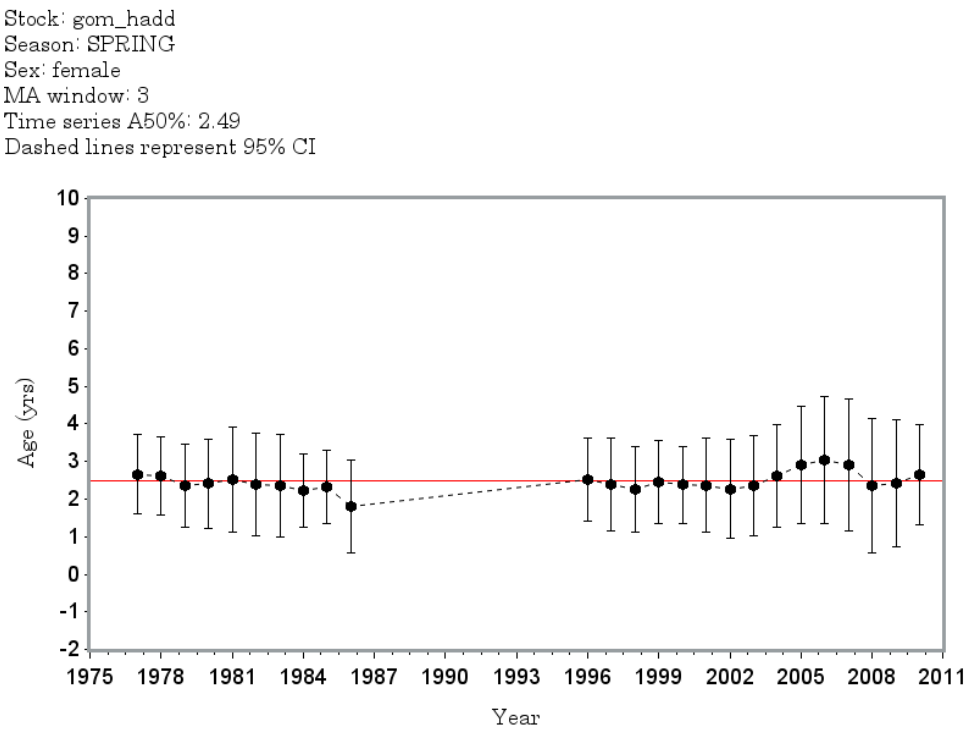



Figure C.3. Three-year moving averages of the average age-at-50% maturity (A50) and corresponding 95% confidence intervals for female Gulf of Maine haddock from 1977 to 2011. Average maturity has been estimated from data collected from the Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey. Years in which maturity ogives could not be estimated are omitted from the top panel.

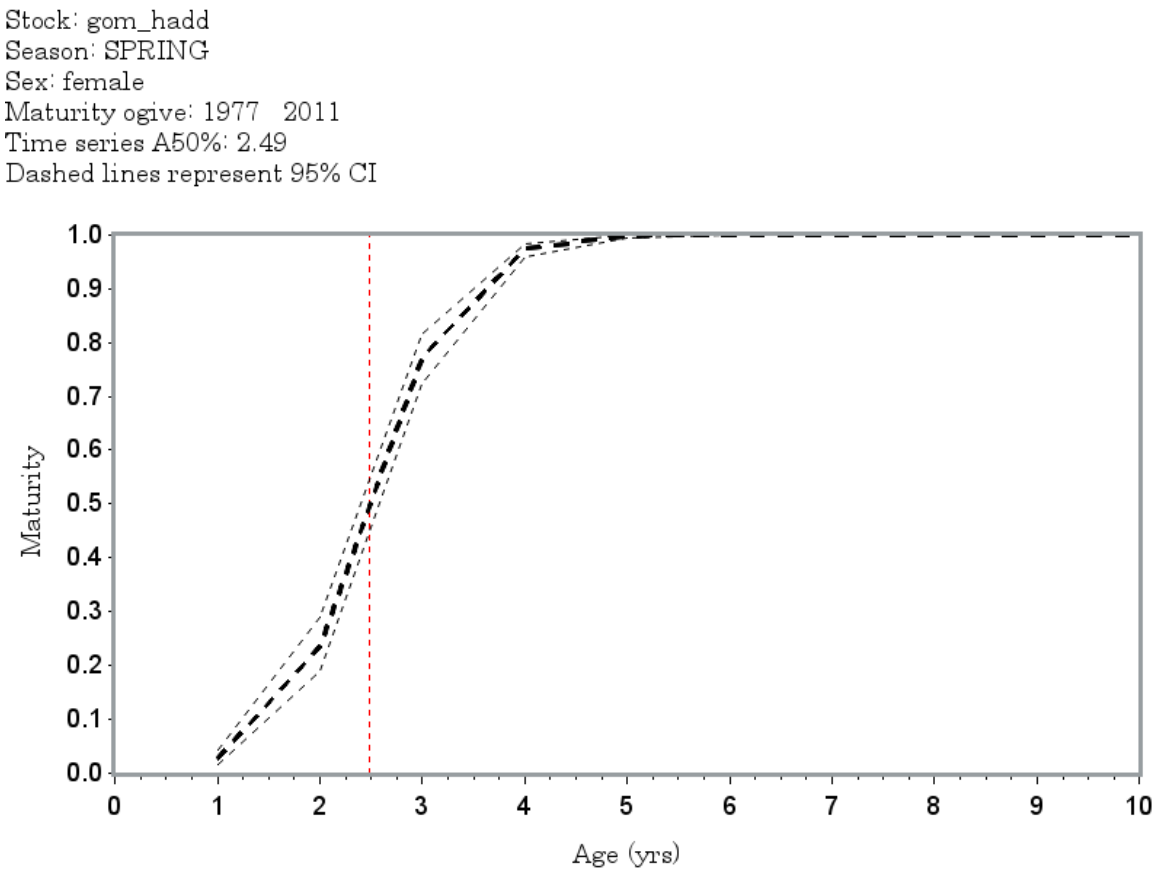



Figure C.4. Maturity ogive for female Gulf of Maine haddock based on time series averages of maturity and age information collected from the Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey from 1977 to 2011.

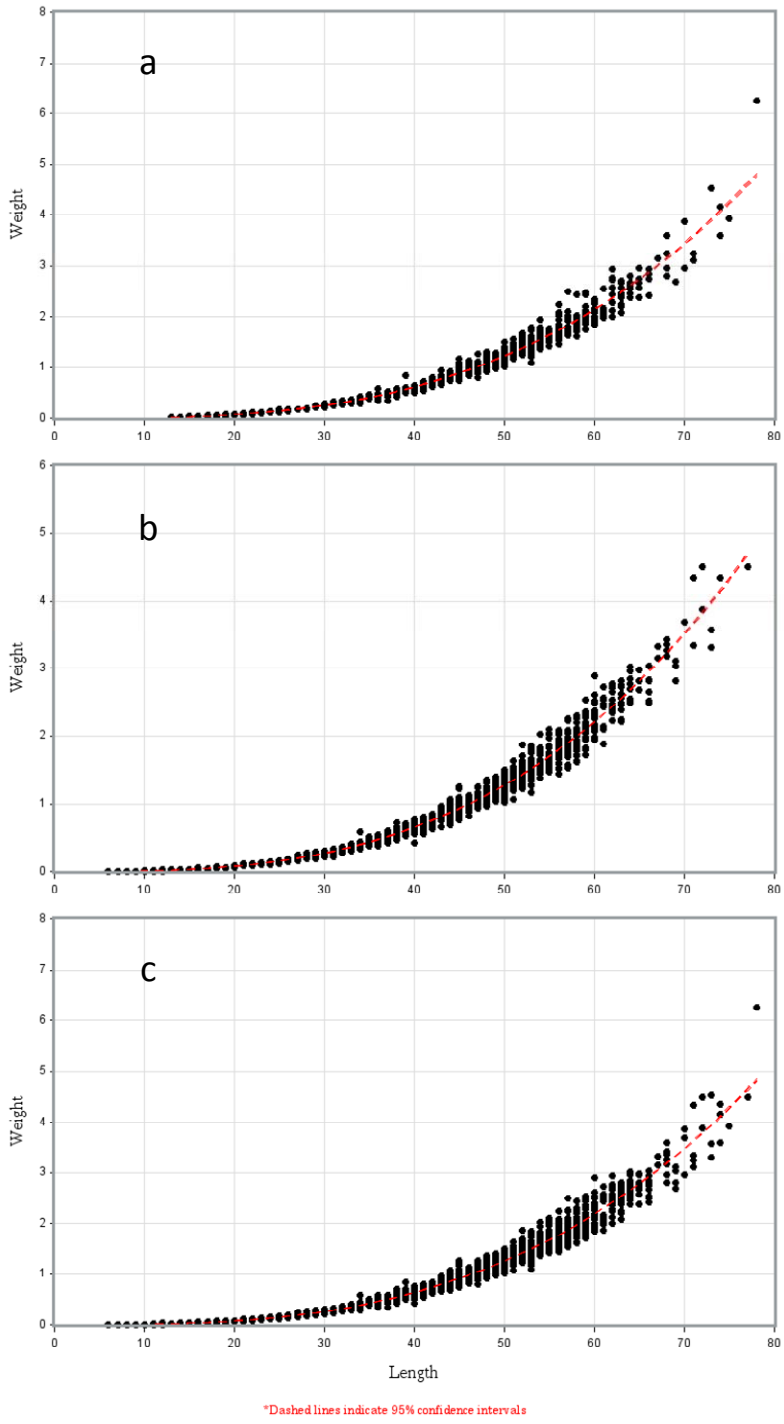



Figure C.5. Gulf of Maine haddock length-weight relationships for spring (a), fall (b) and annual (c; combined spring and fall). Length-weight relationships were estimated from Northeast Fisheries Science center bottom trawl survey data.

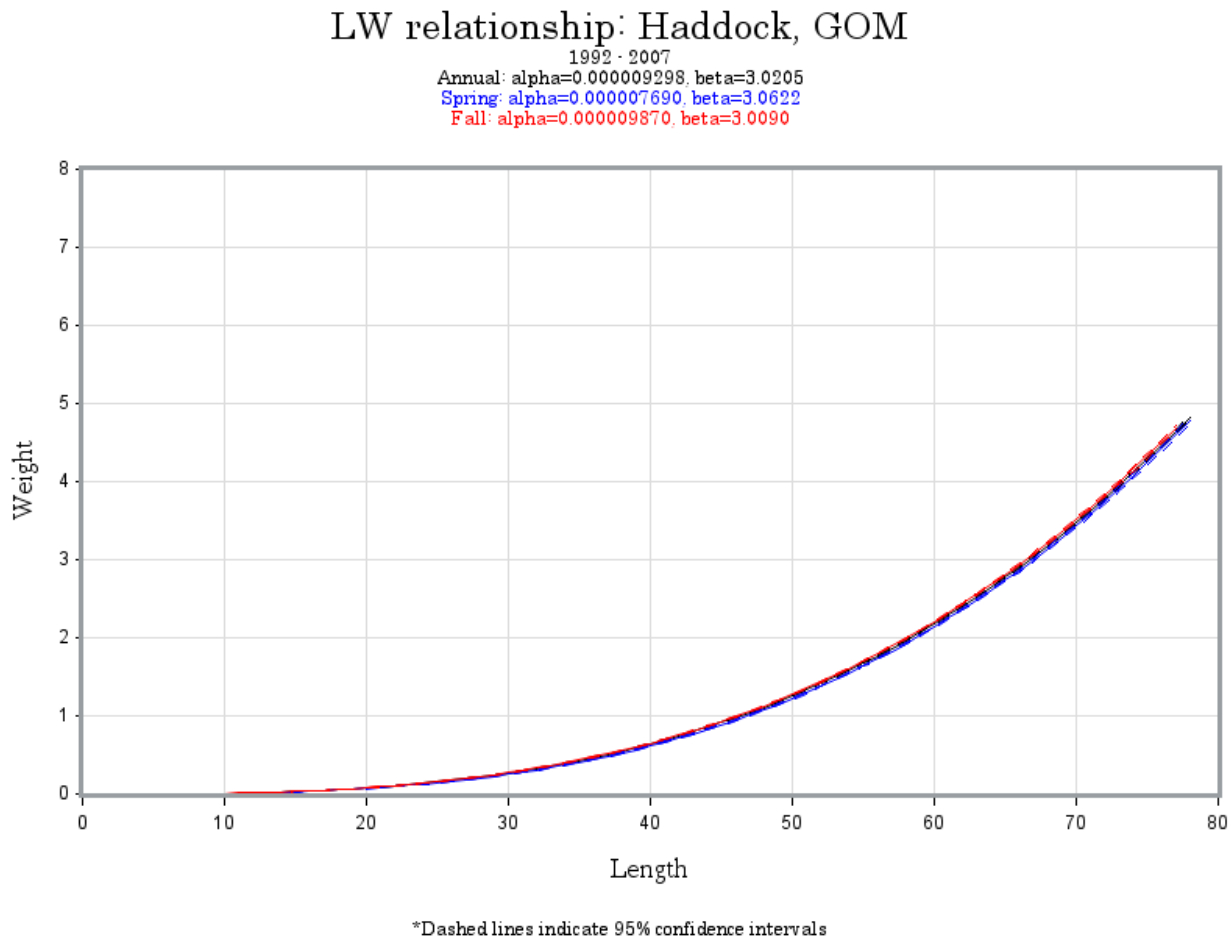



Figure C.6. Comparison of the Gulf of Maine haddock seasonal and annual length-weight equations estimated from Northeast Fisheries Science center bottom trawl survey data.

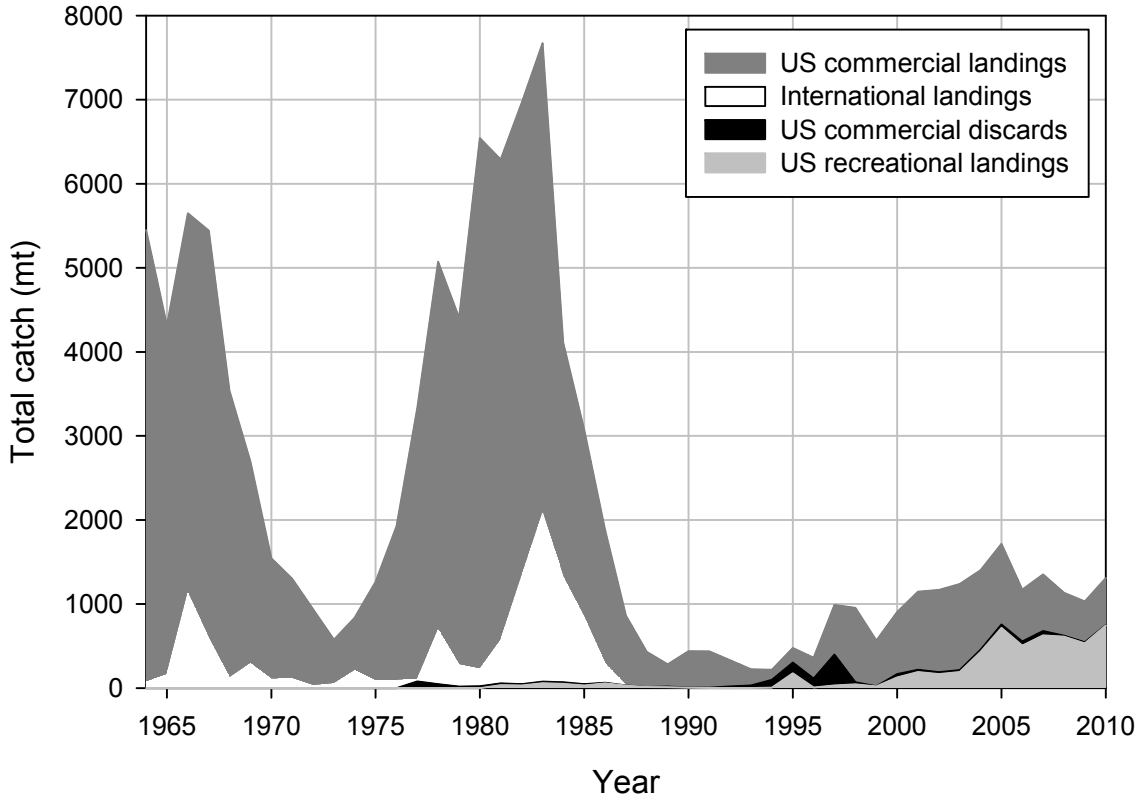



Figure C.7. Total catch (mt) of Gulf of Maine haddock by fishery and disposition from 1964 to 2010.

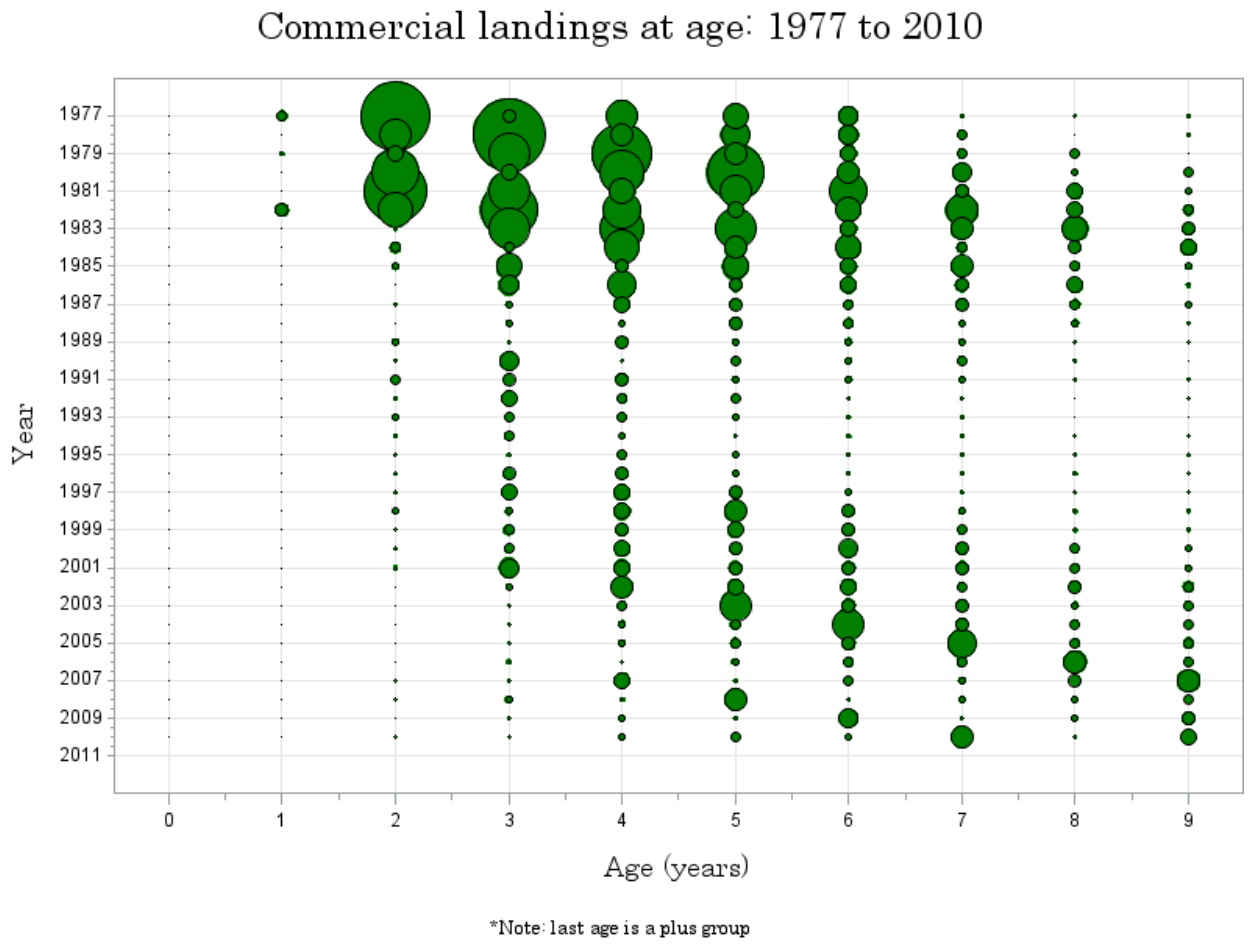



Figure C.8. Commercial landings-at-age of Gulf of Maine haddock from 1977 to 2010. **Note that age 9 is a plus group.*

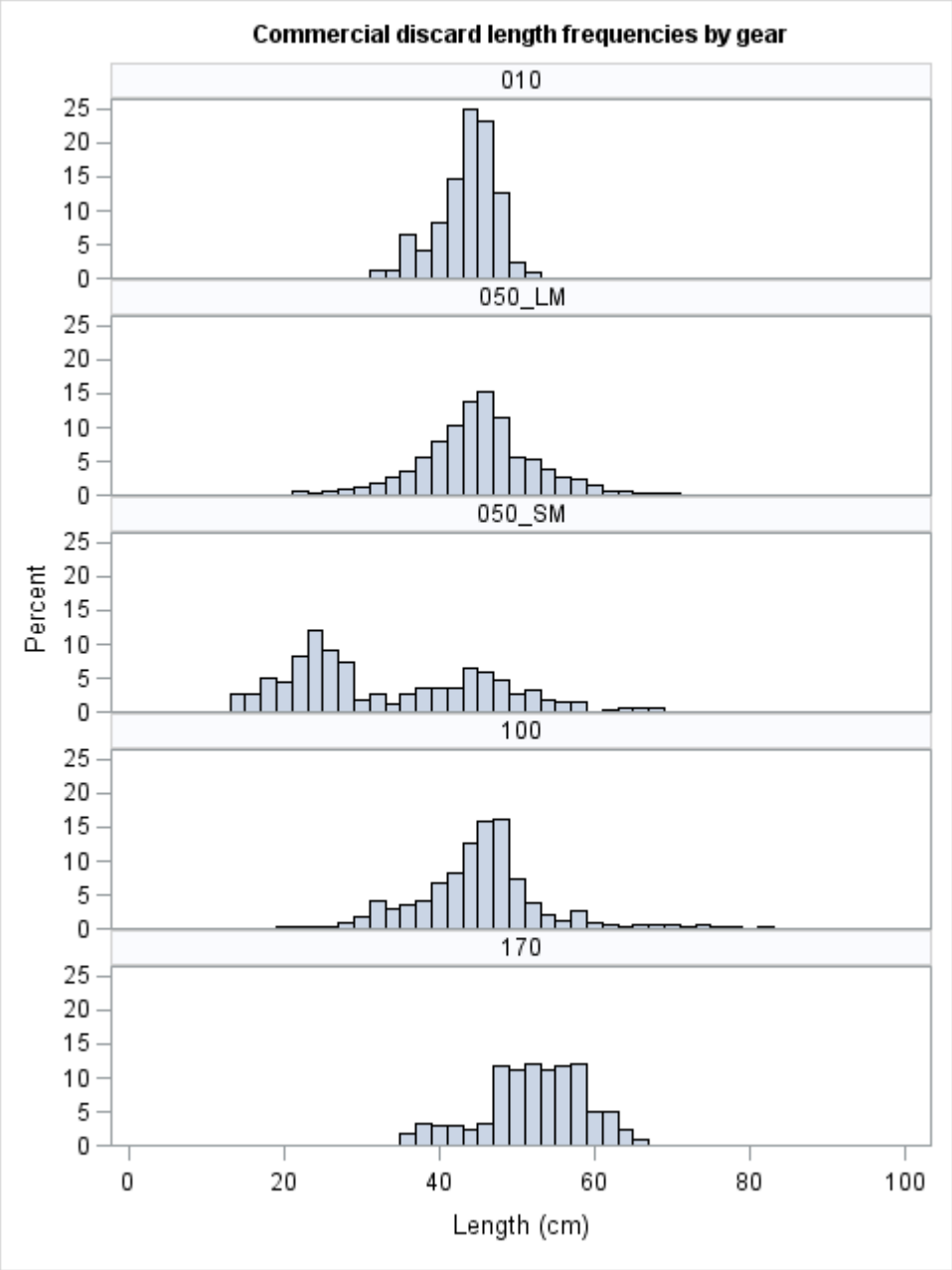



Figure C.9. Aggregate length frequency distributions, by gear type, of Gulf of Maine haddock discarded in the commercial fishery between 1989 and 2010. Gear types shown include: longline (010), large mesh otter trawl (050_LM), small mesh otter trawl (050_SM), sink gillnet (100) and midwater trawl (170).

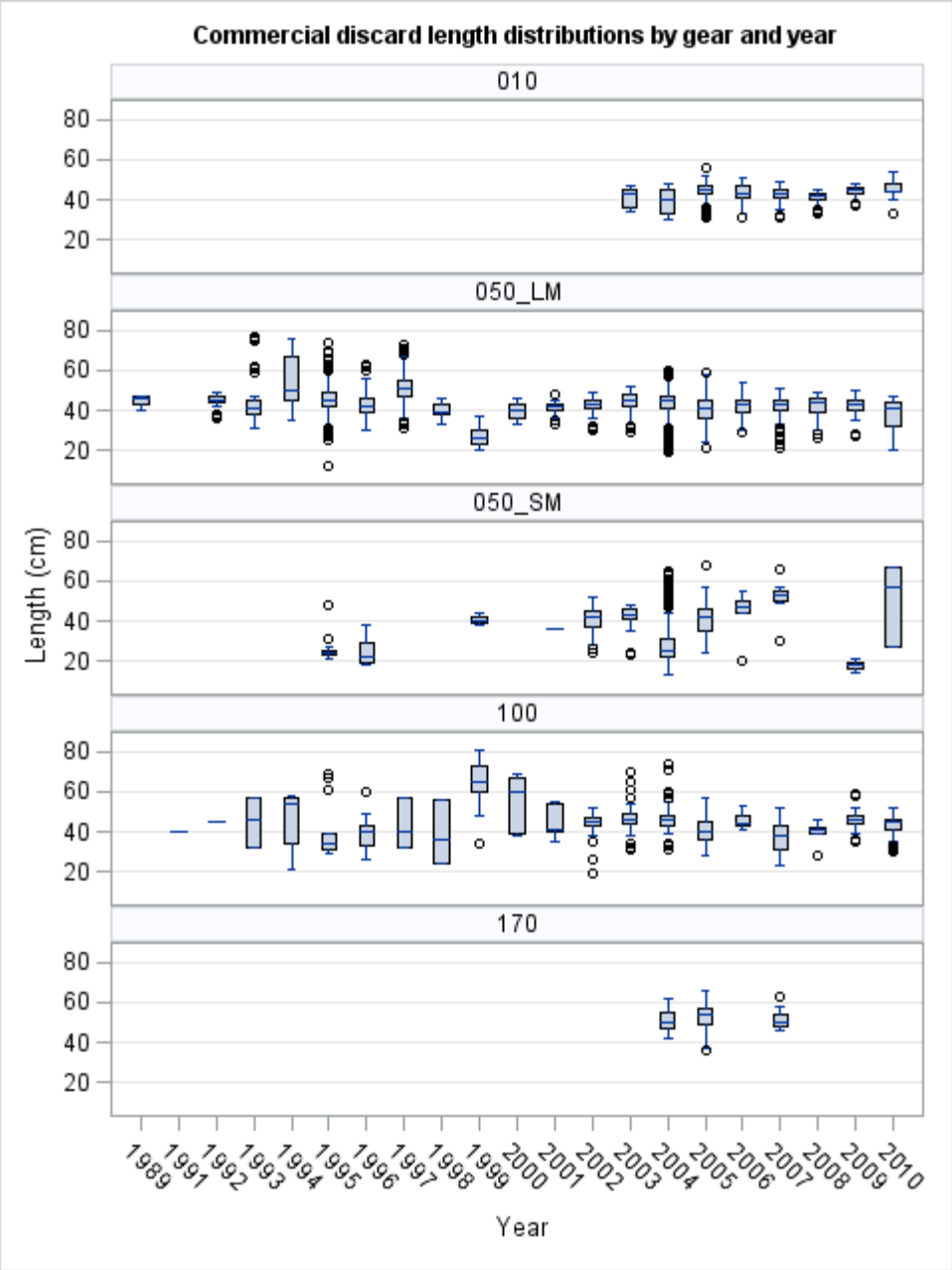



Figure C.10. Box plots showing the length distributions of Gulf of Maine haddock discarded by the commercial fishery between 1989 and 2010. Gear types shown include: longline (010), large mesh otter trawl (050_LM), small mesh otter trawl (050_SM), sink gillnet (100) and midwater trawl (170). Missing years indicate that there were either no observed trips in the Gulf of Maine or no haddock were observed to have been discarded.


Figure C.11. Commercial discards-at-age of Gulf of Maine haddock from 1977 to 2010. **Note that age 9 is a plus group.*

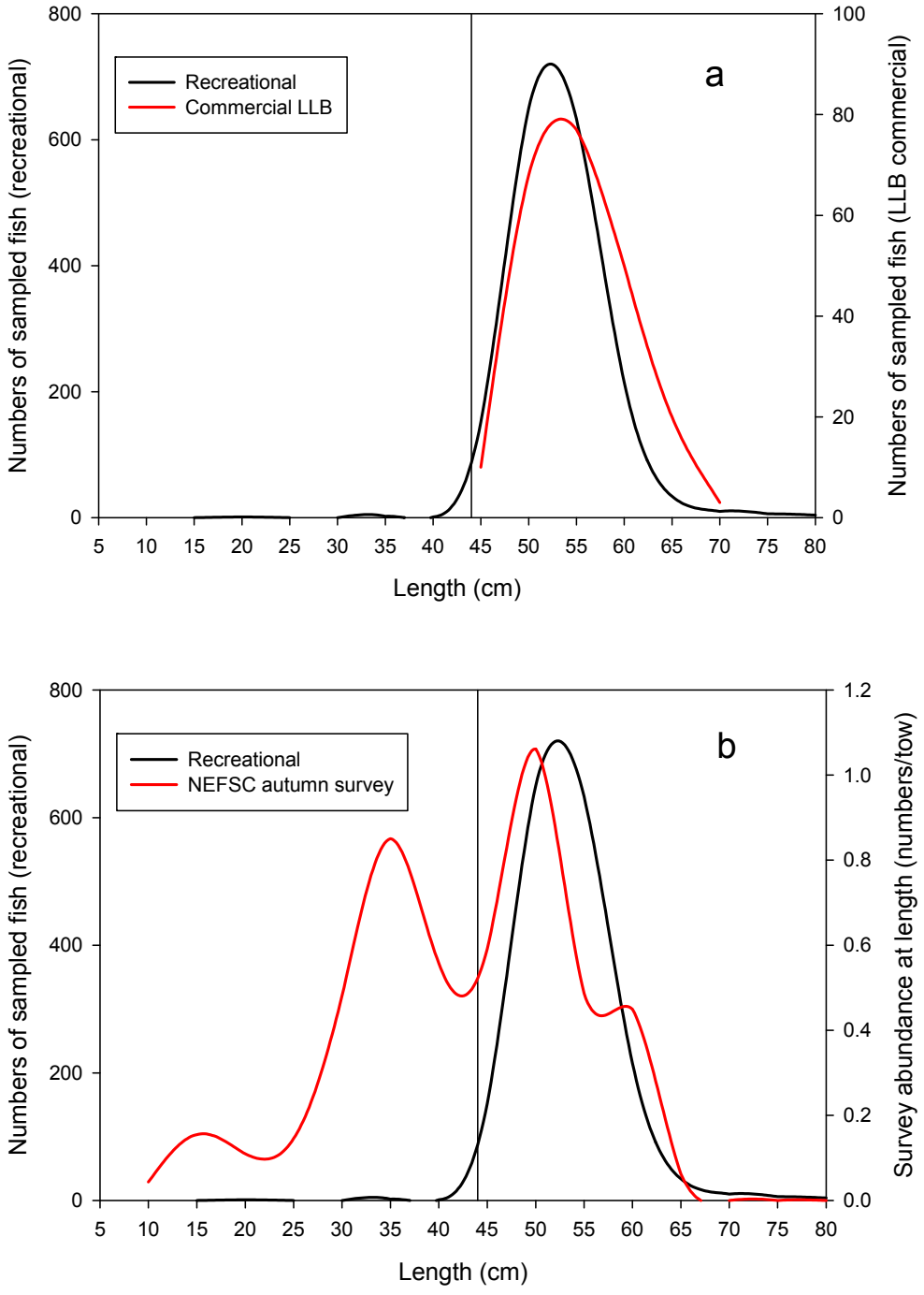



Figure C.12. Selectivity of the recreational fishery relative to the commercial longline fishery (a) and Northeast Fisheries Science Center bottom trawl survey (b). Solid vertical lines indicate minimum legal size for recreational fishery. Data shown are from 2005.

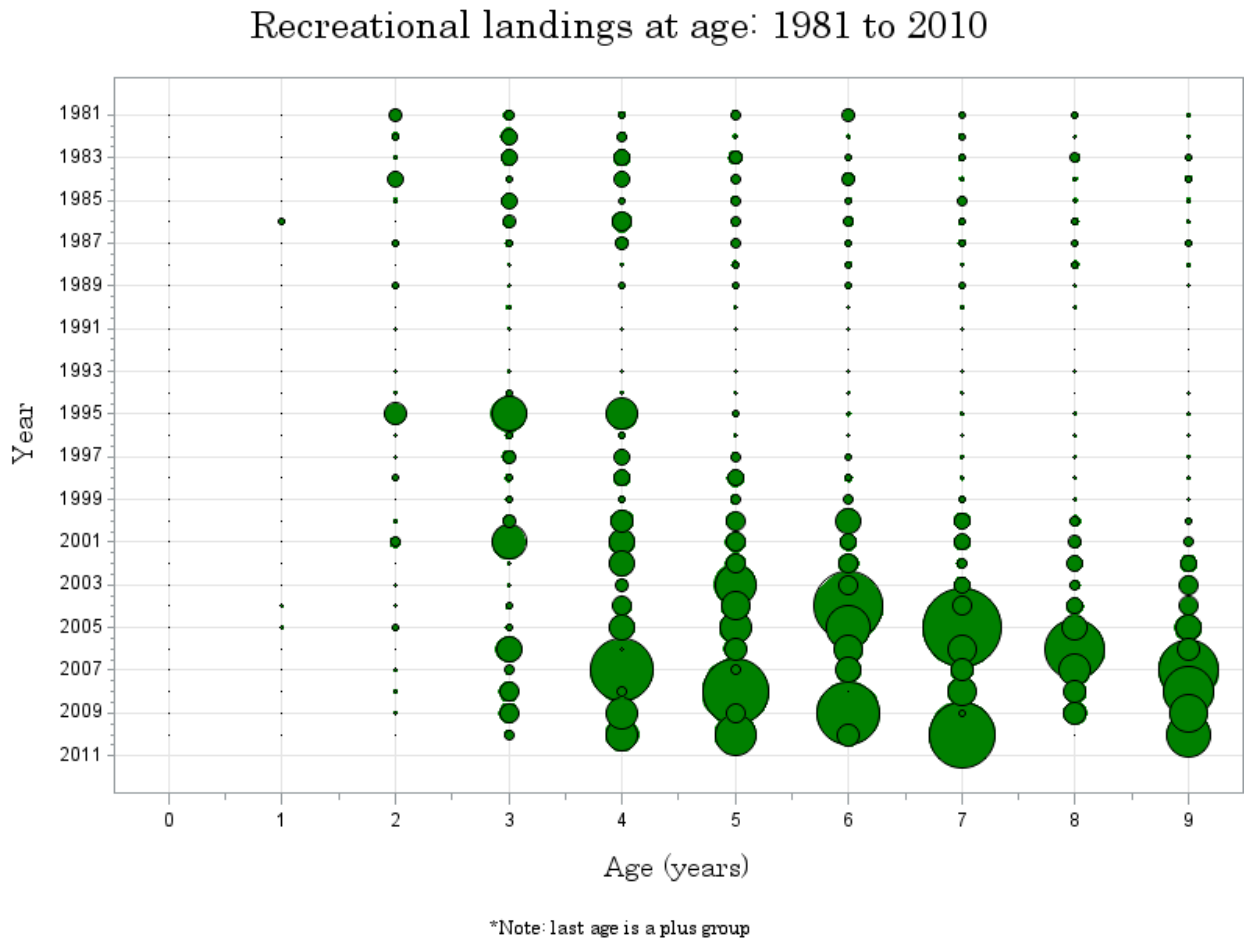



Figure C.13. Recreational landings-at-age of Gulf of Maine haddock from 1981 to 2010. **Note that age 9 is a plus group.*

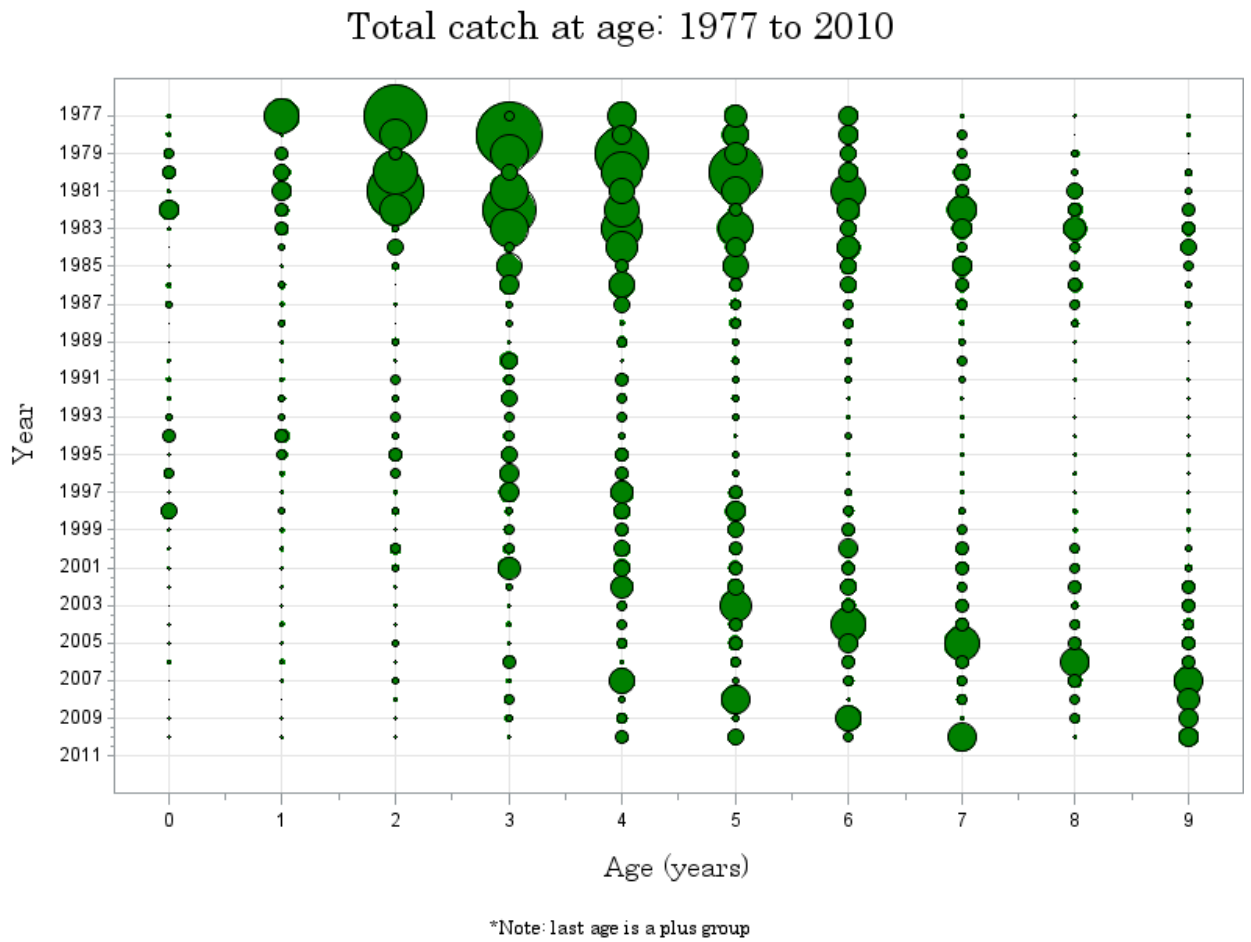



Figure C.14. Total fishery catch-at-age of Gulf of Maine haddock from 1977 to 2010. **Note that age 9 is a plus group.*

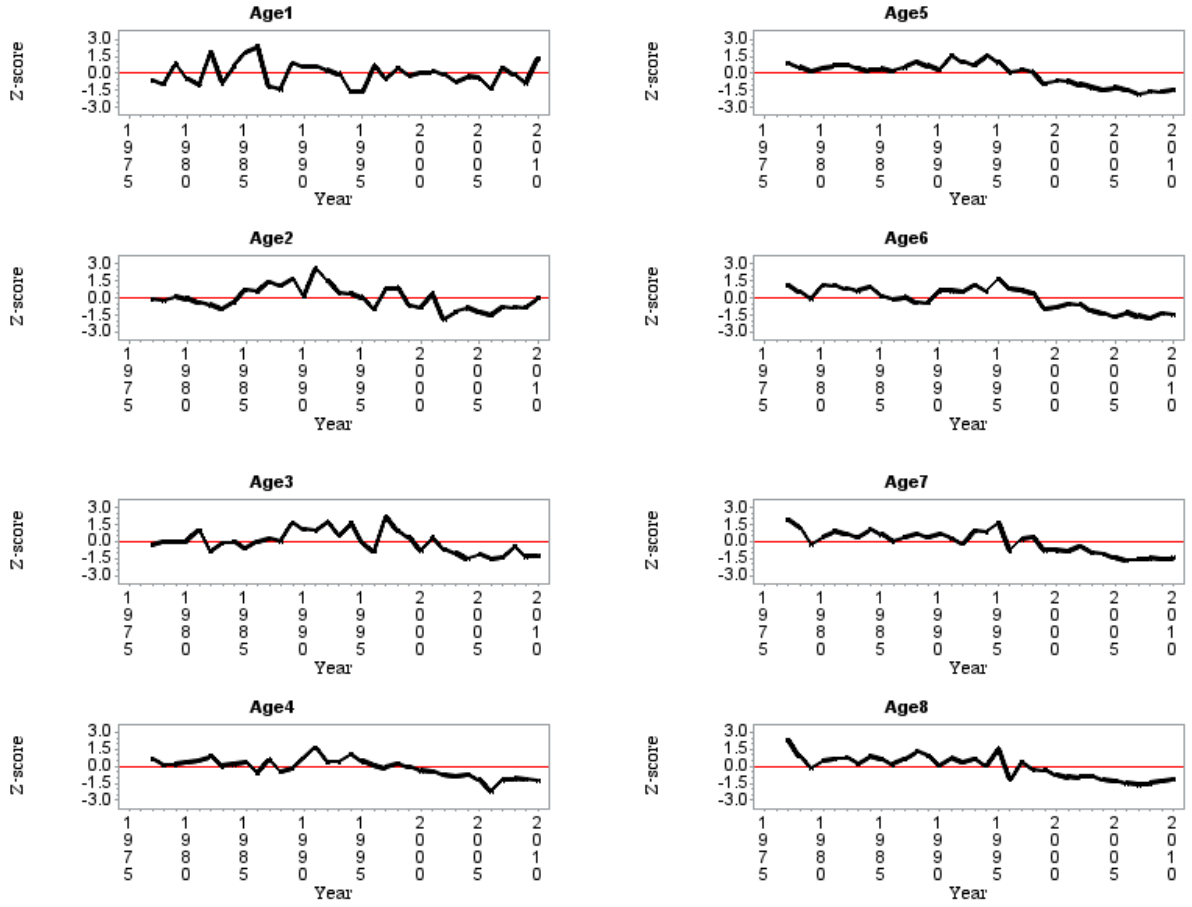



Figure C.15. Average catch weights-at-age of age 1 through age 8 Gulf of Maine haddock from 1977 to 2010. Weights-at-age were estimated using a number weighted average of commercial landing and commercial discard weights-at-age. Average weights are presented as z-scores ([*x*-μ]/σ).

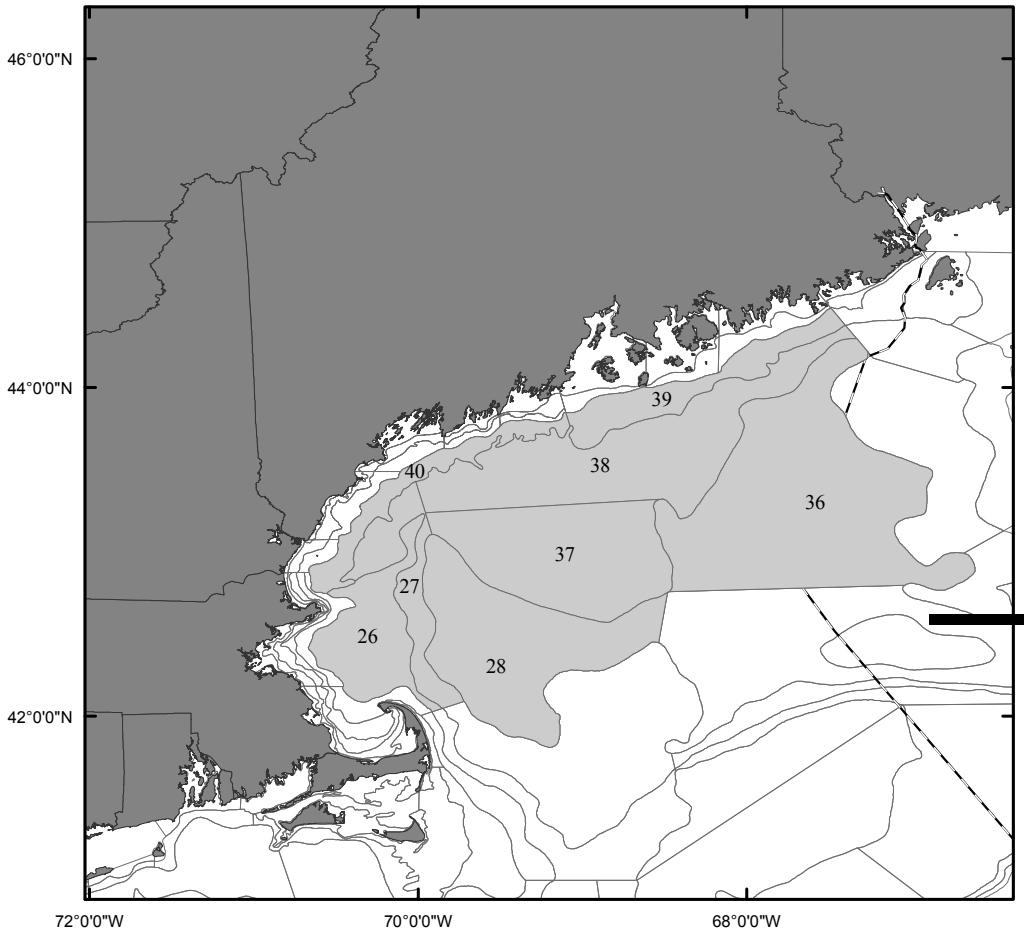
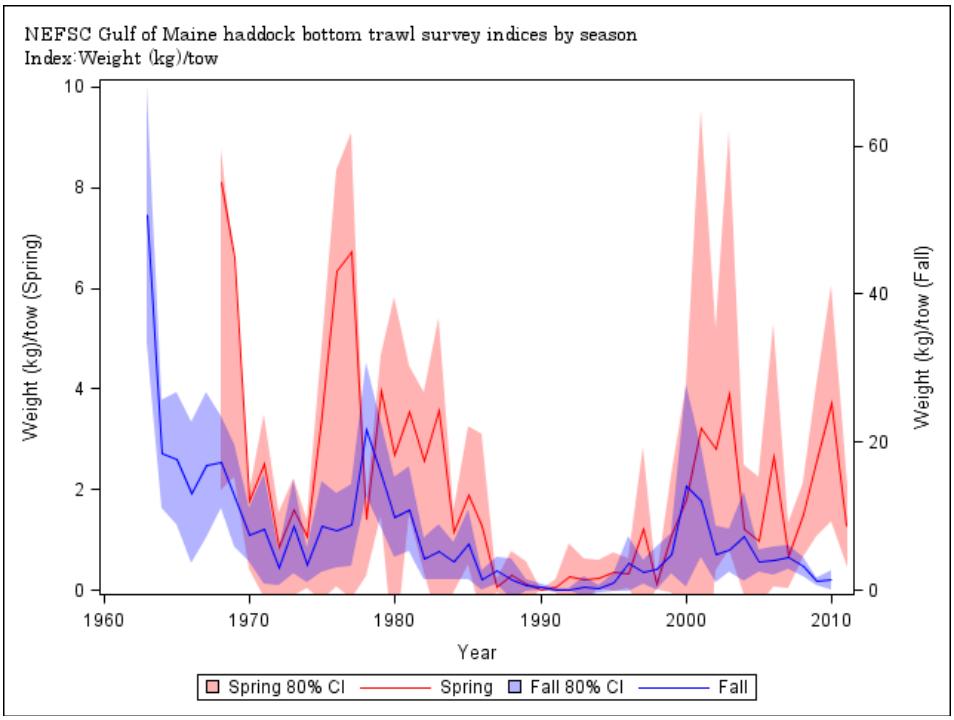



Figure C.16. Map of the Northeast Fisheries Science Center (NEFSC) bottom trawl offshore survey strata included in the Gulf of Maine haddock stock assessment (shaded grey).



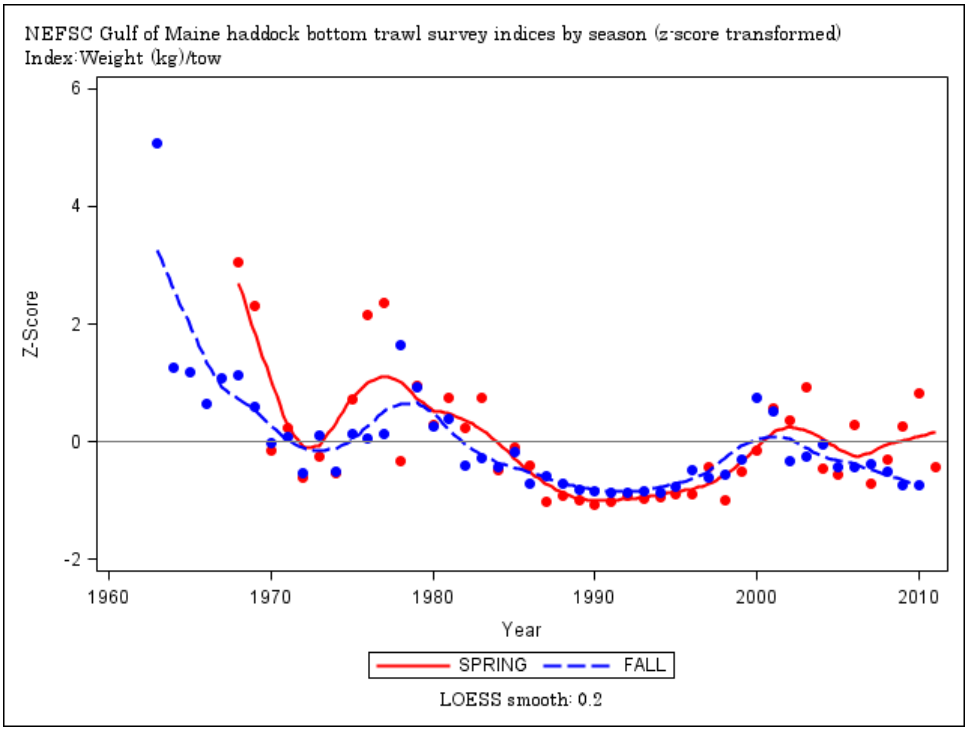




Figure C.17. Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey biomass (weight/tow) indices from 1963 to 2011 for Gulf of Maine haddock. The bottom plot shows the survey indices plotted as z-scores with a Loess smooth fit to the data. **Spring survey did not begin until 1968, 2011 fall survey data are not available at the time of this report.*

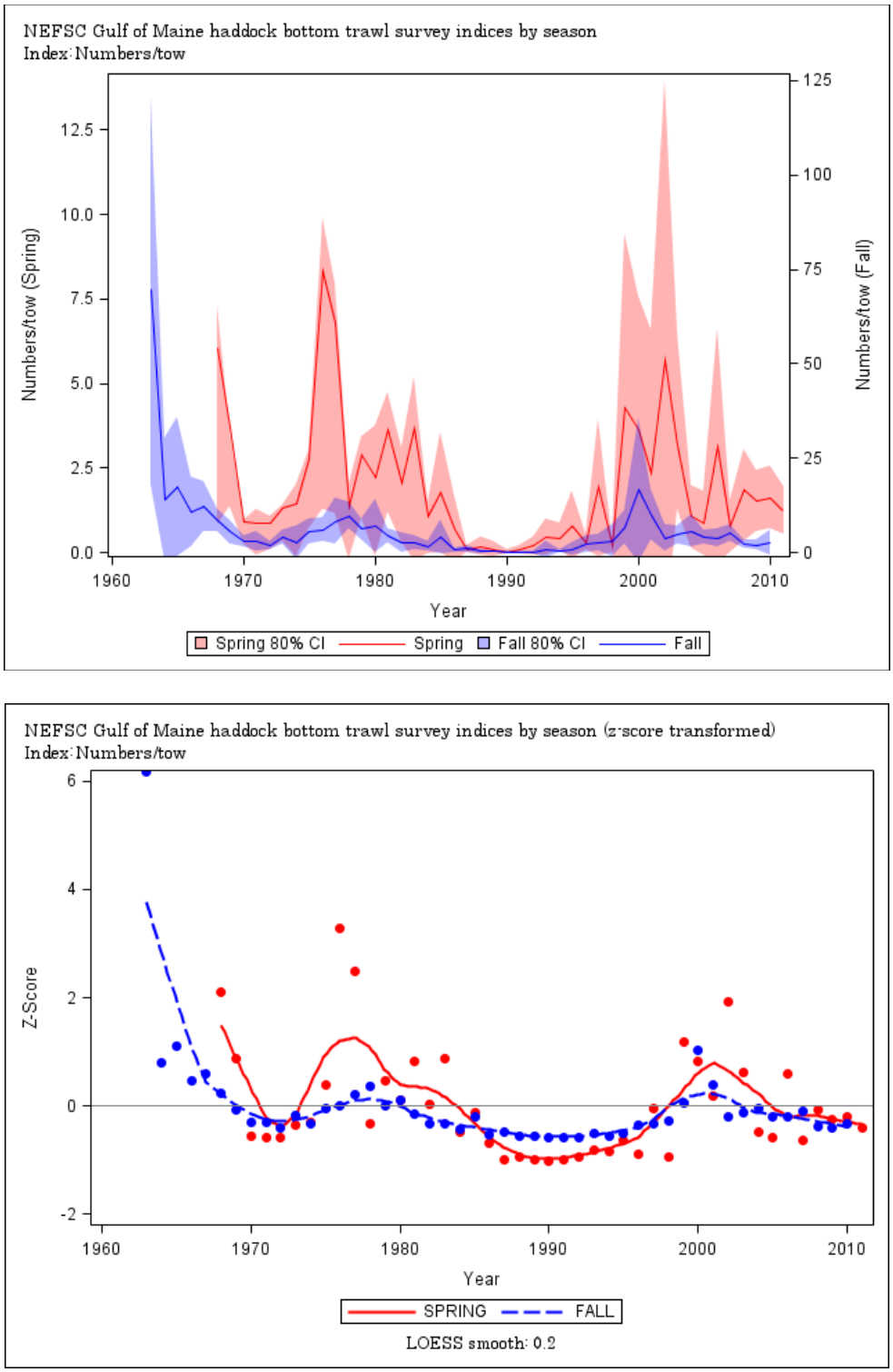



Figure C.18. Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl survey abundance (numbers/tow) indices from 1963 to 2011 for Gulf of Maine haddock. The bottom plot shows the survey indices plotted as z-scores with a Loess smooth fit to the data. **Spring survey did not begin until 1968, 2011 fall survey data are not available at the time of this report.*

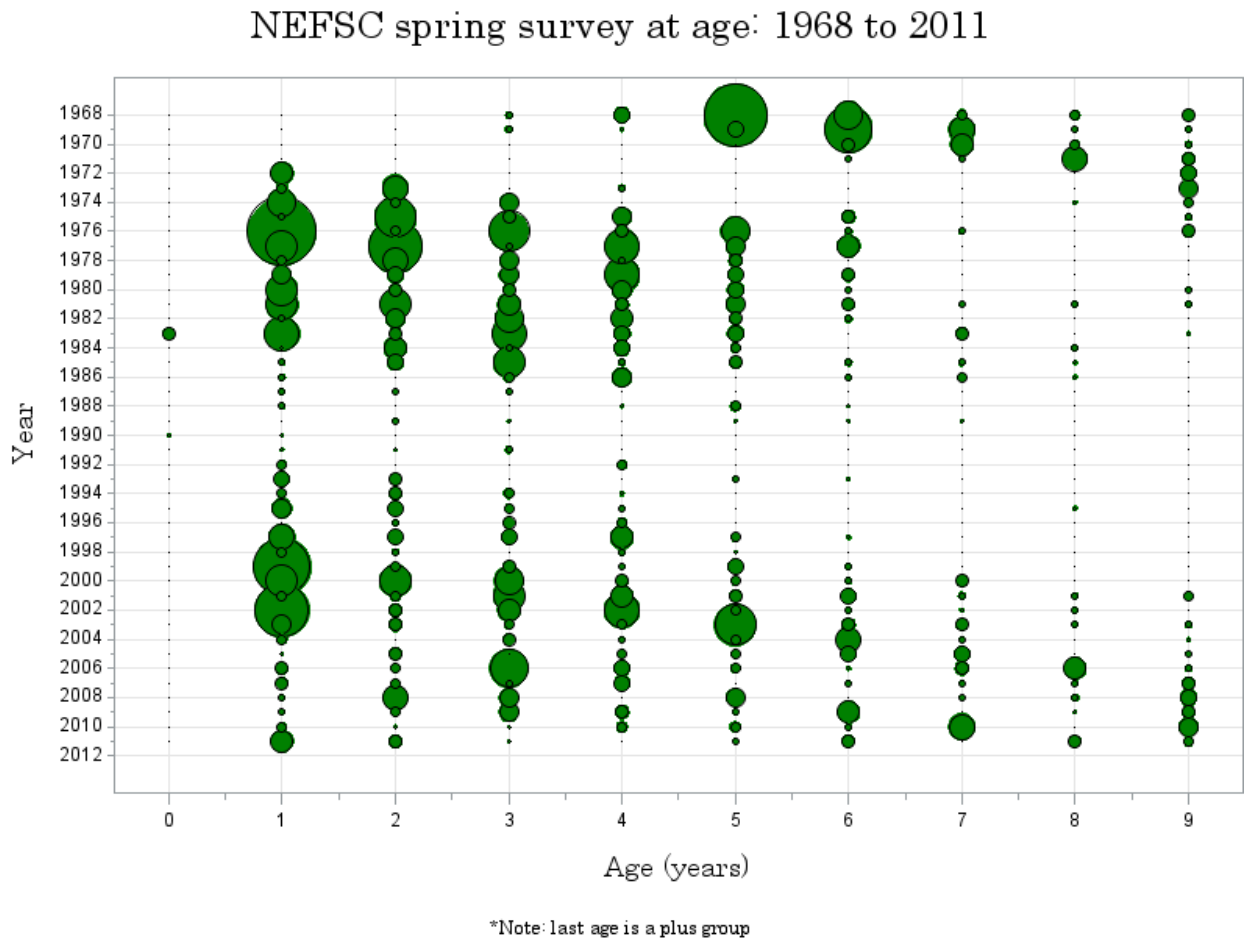



Figure C.19. Gulf of Maine haddock numbers-at-age from the NEFSC spring bottom trawl survey, 1968-2011. **Note that age 9 is a plus group.*

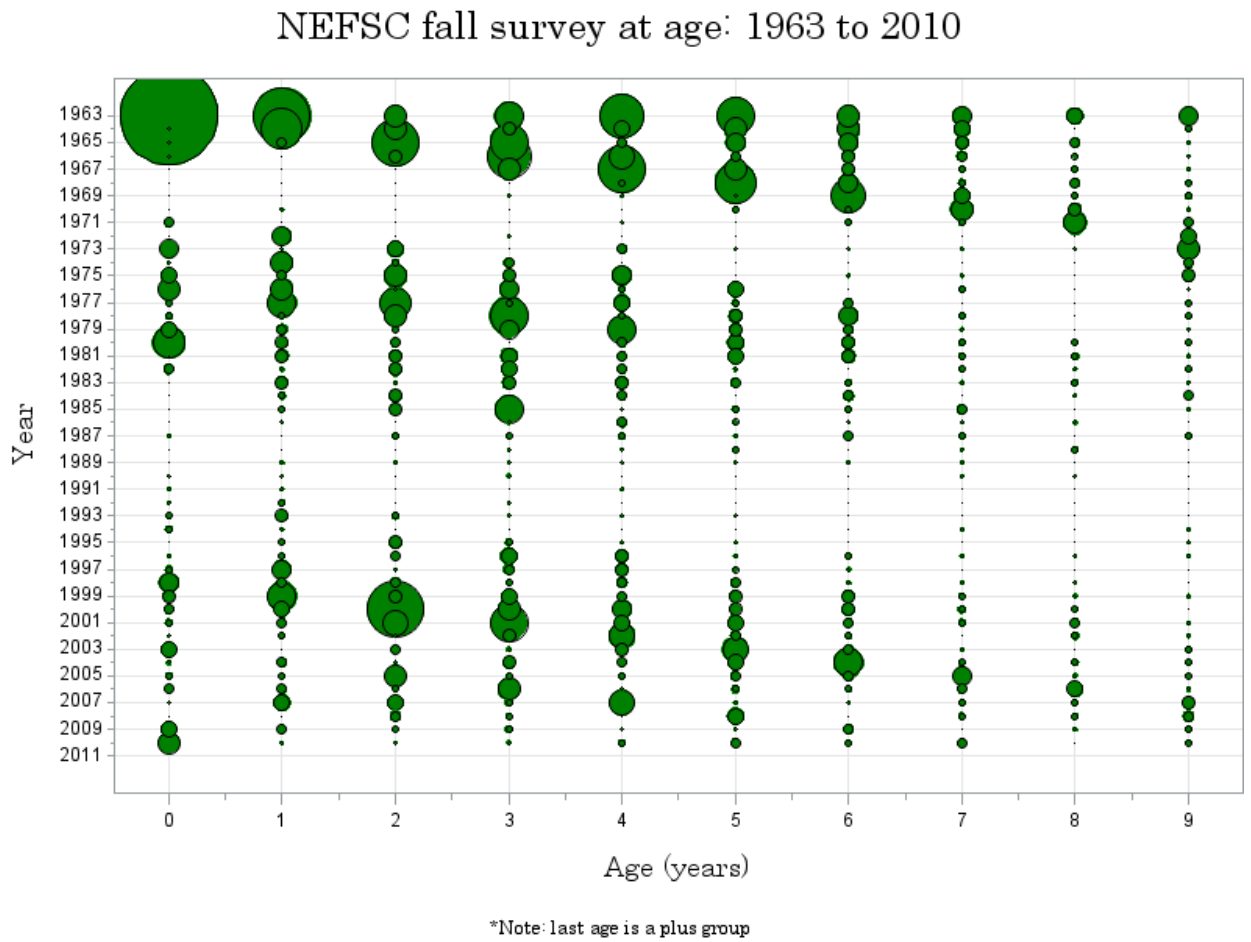



Figure C.20. Gulf of Maine haddock numbers-at-age from the NEFSC fall bottom trawl survey, 1963-2010. **Note that age 9 is a plus group.*

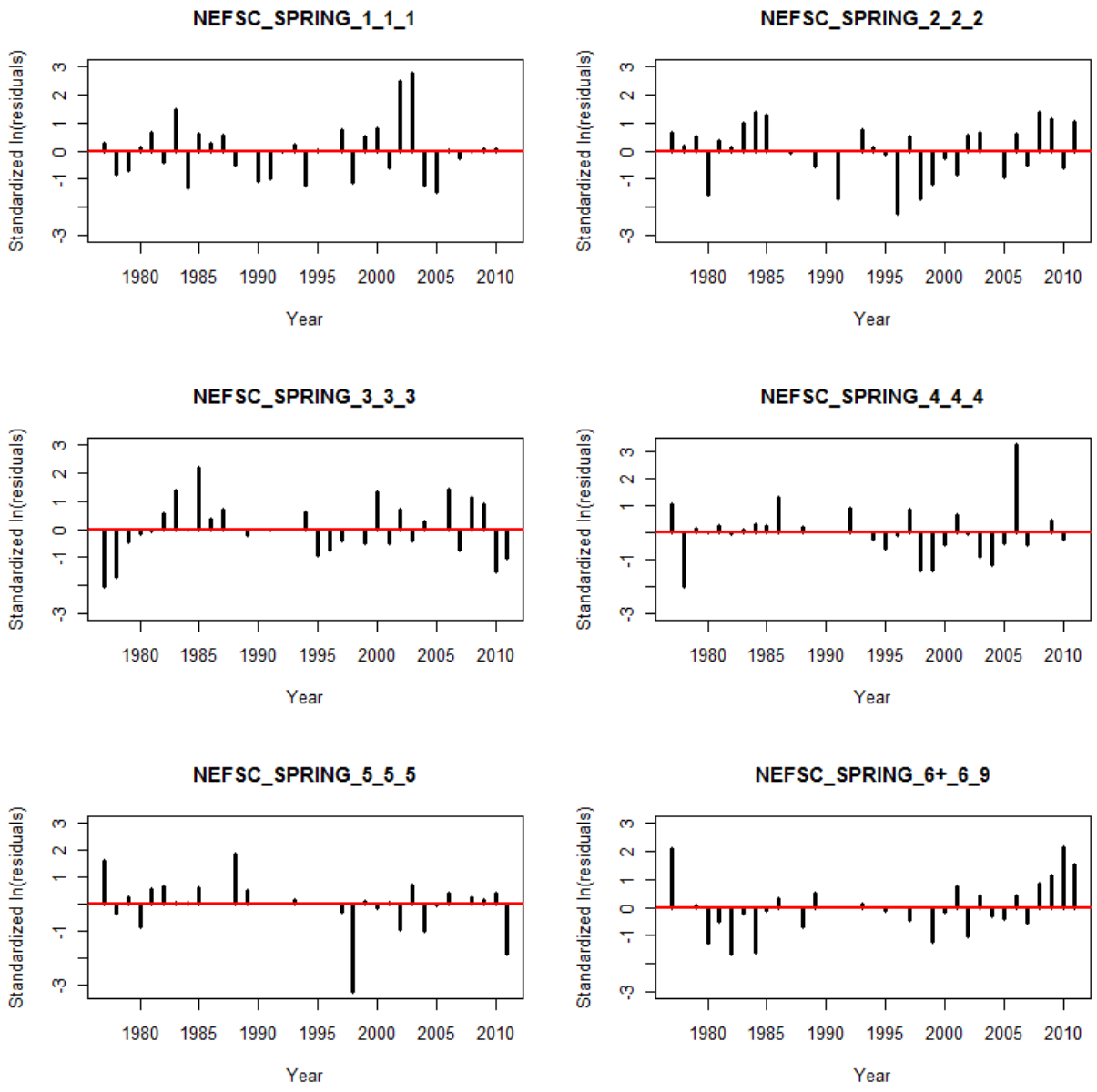



Figure C.21a. ADAPT-VPA model residuals to the survey fits of the Northeast Fisheries Science Center spring Gulf of Maine haddock survey ages 1 (NEFSC_SPRING_1_1_1) through $6^{+}$ (NEFSC_SPRING_6+_6_9).

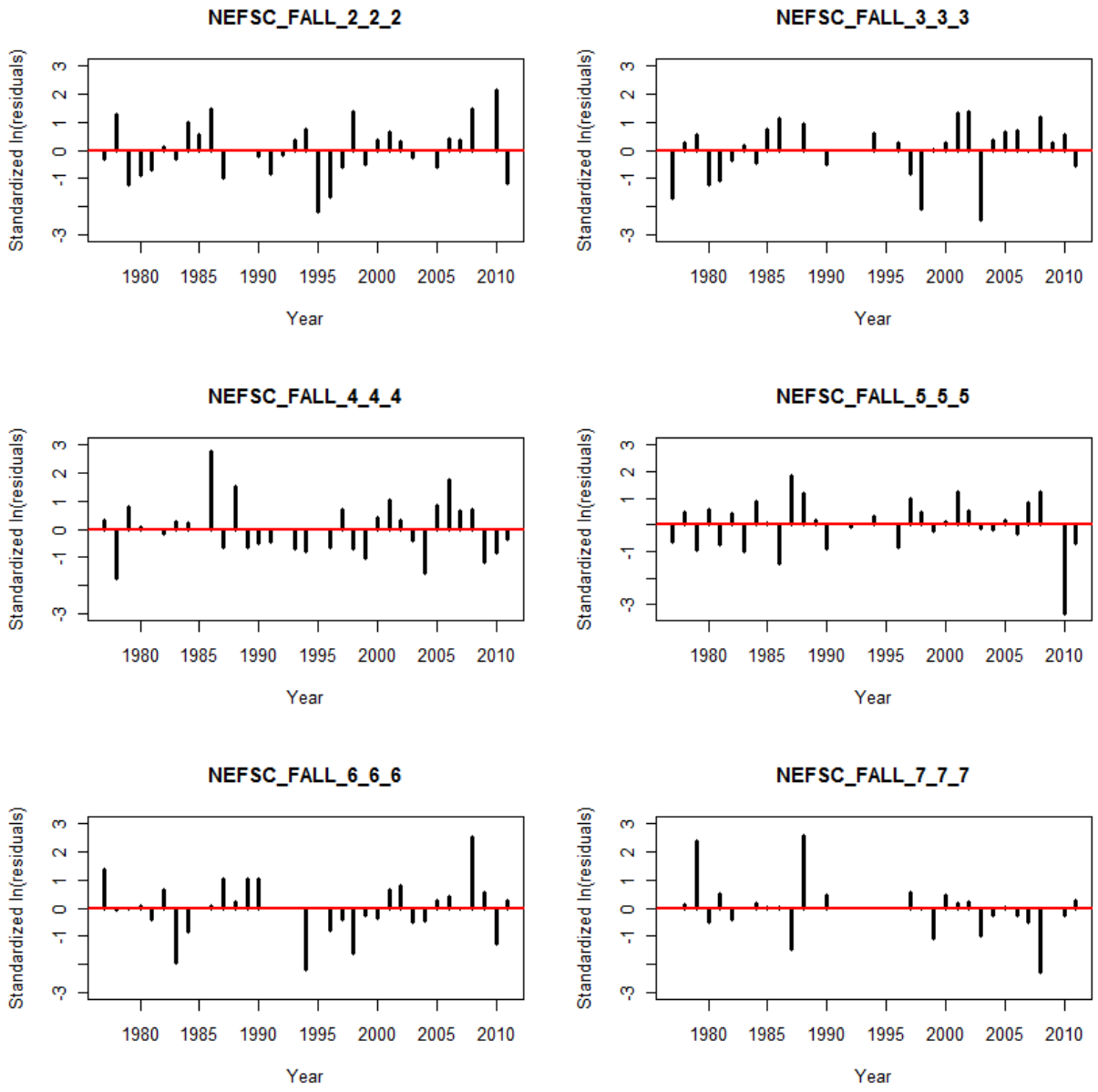



Figure C.21b. ADAPT-VPA model residuals to the survey fits of the Northeast Fisheries Science Center spring Gulf of Maine haddock survey ages 1 (NEFSC_FALL_2_2_2) through 6 (NEFSC_FALL_7_7_7). **Note: fall surveys have been lagged forward a year and an age (e.g., 2008 age 1 index was modeled as 2009 age 2).*

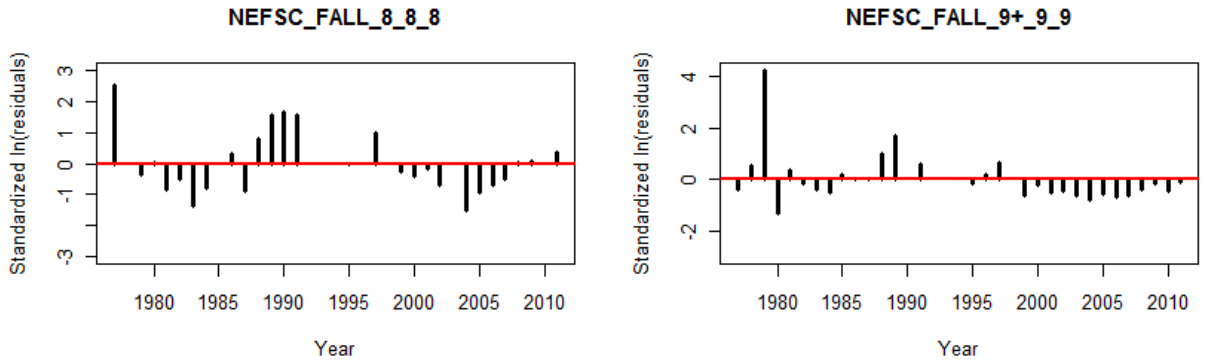



Figure C.21c. ADAPT-VPA model residuals to the survey fits of the Northeast Fisheries Science Center spring Gulf of Maine haddock survey ages 7 (NEFSC_FALL_8_8_8) through $8^{+}$ (NEFSC_FALL_9_9_9). **Note: fall surveys have been lagged forward a year and an age (e.g., 2008 age 1 index was modeled as 2009 age 2).*

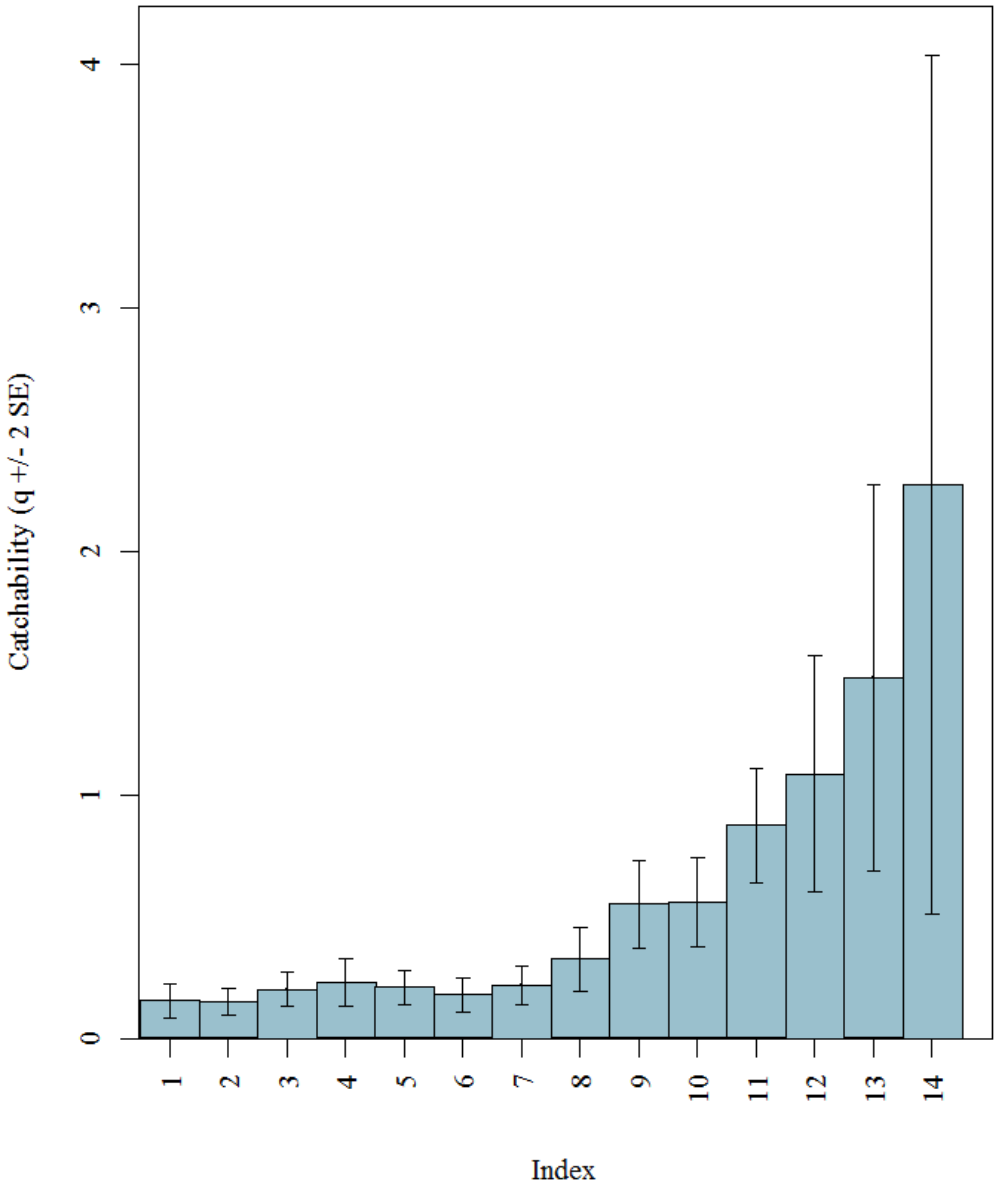



Figure C.22. ADAPT-VPA estimated survey catchability (*q*) for the Northeast Fisheries Science Center spring (index 1-7) and fall (index 8-14) bottom trawl surveys.

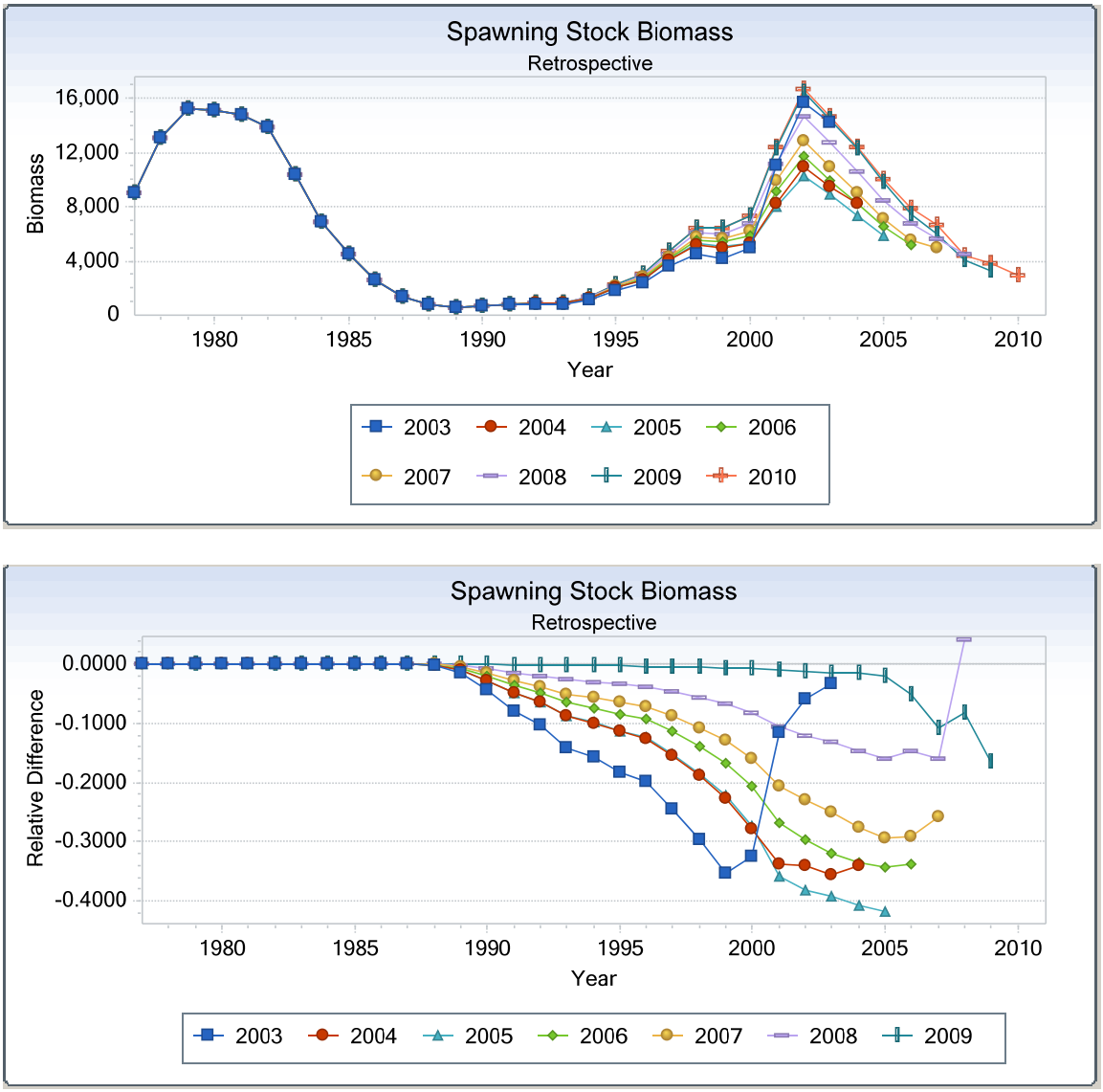



Figure C.23. ADAPT-VPA model retrospective patterns for Gulf of Maine haddock spawning stock biomass (mt) in absolute (top) and relative (bottom) terms.

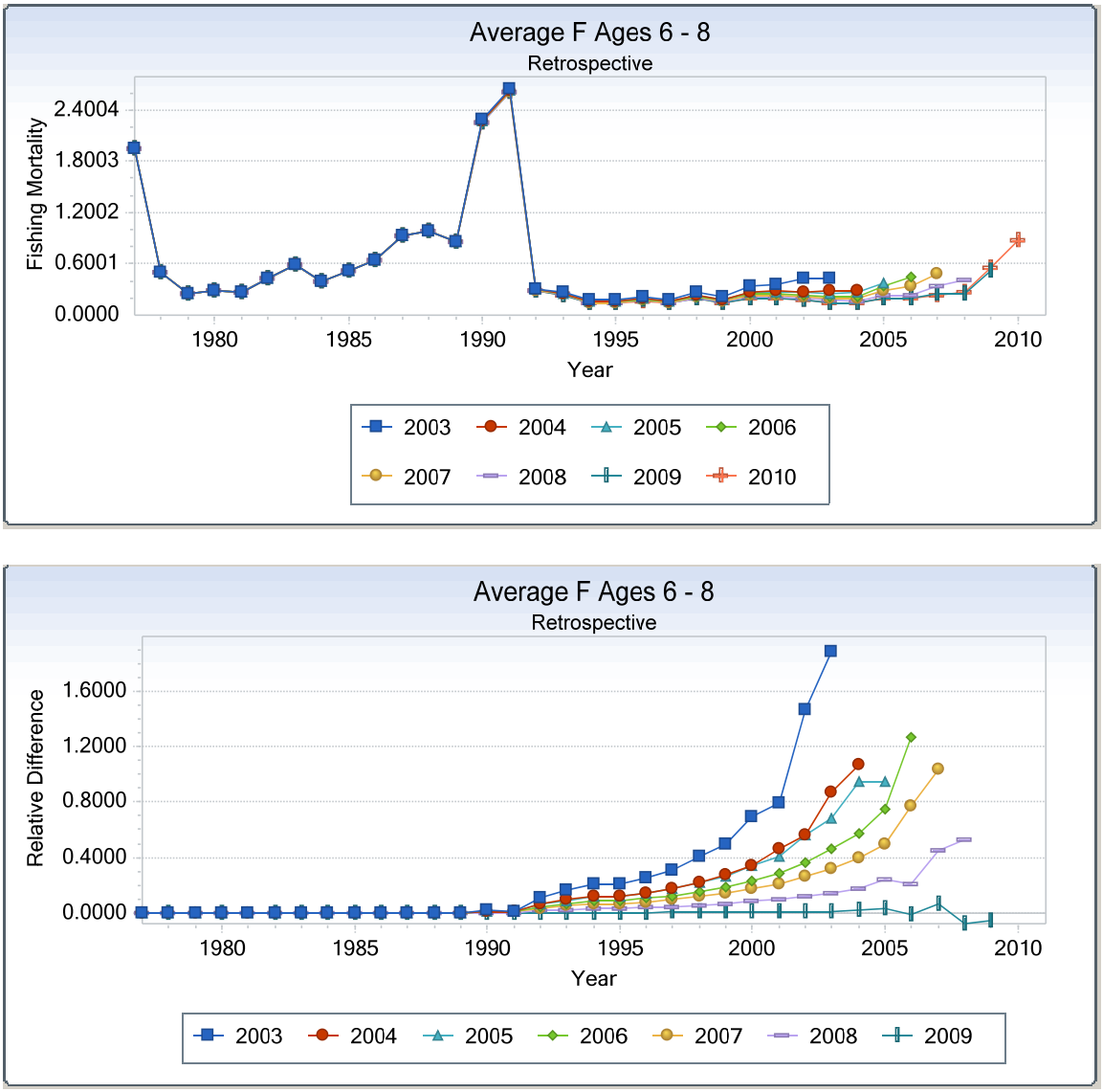



Figure C.24. ADAPT-VPA model retrospective patterns for Gulf of Maine haddock average fishing mortality in absolute (top) and relative (bottom) terms.

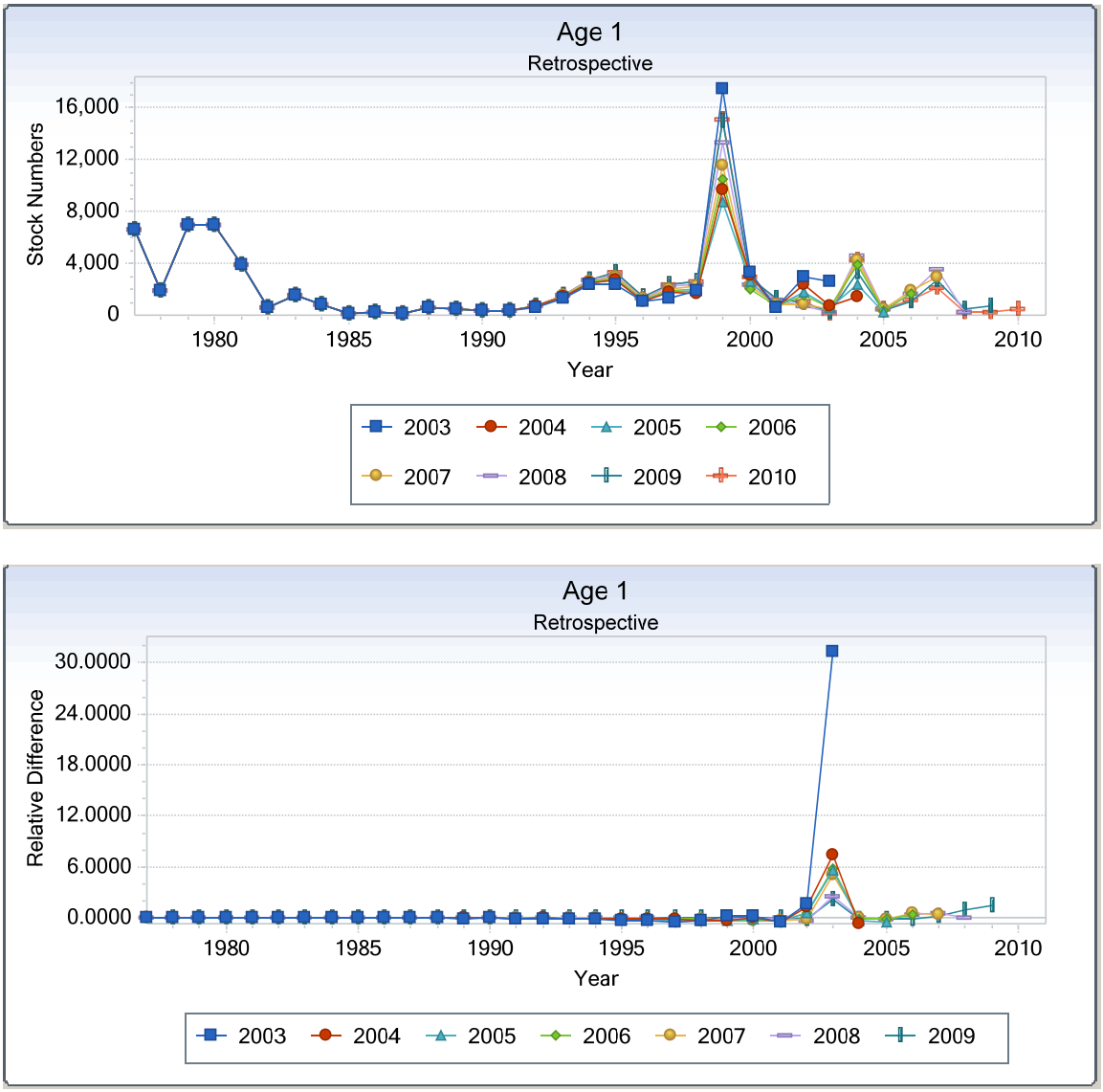



Figure C.25. ADAPT-VPA model retrospective patterns for Gulf of Maine haddock age-1 recruitment in absolute (top) and relative (bottom) terms.

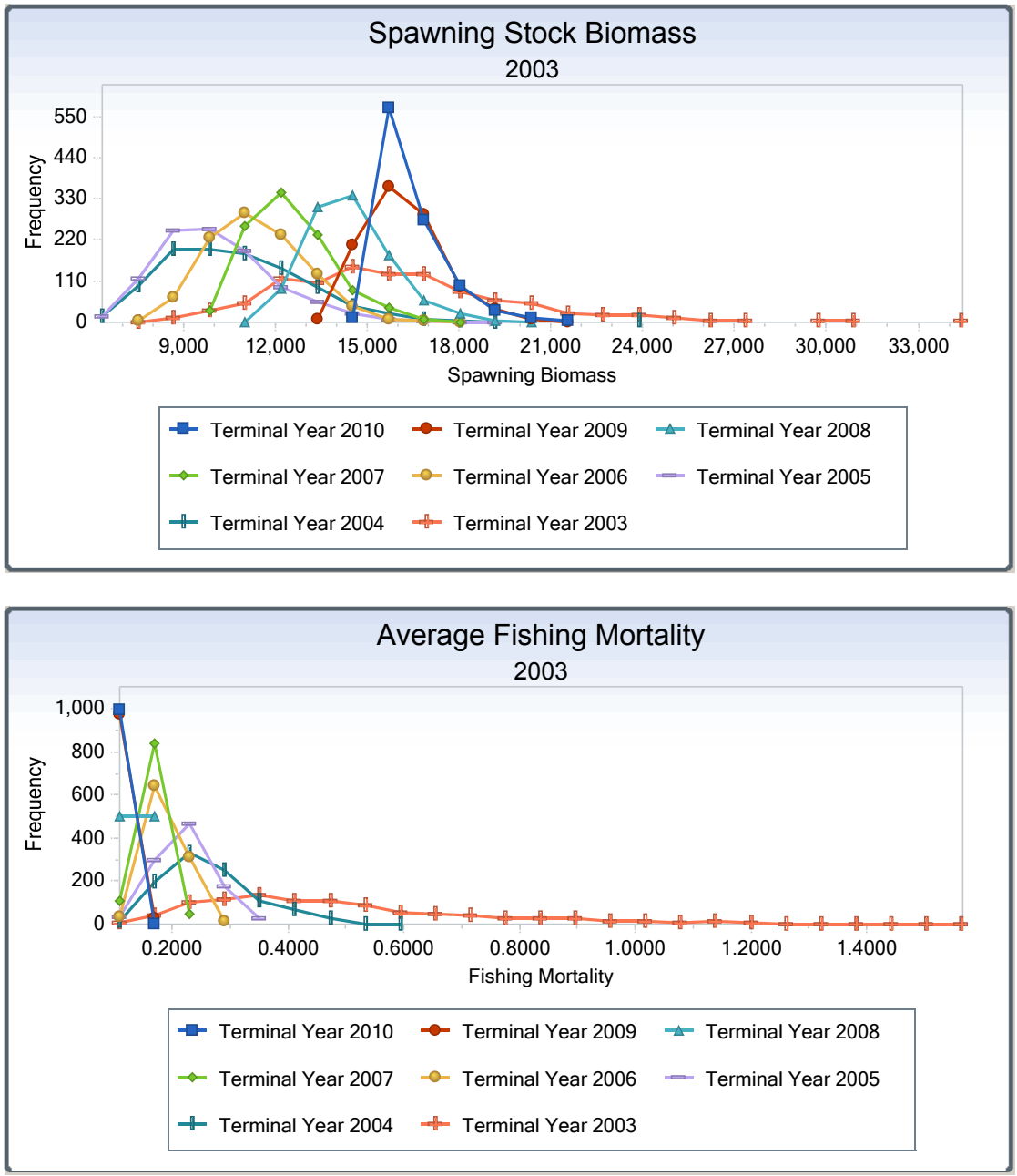



Figure C.26. Distribution of 2003 spawning stock biomass (top) and average fishing mortality (bottom) estimates from 1000 bootstrap iterations of a 7-year peel (2003-2010) of the ADAPT-VPA model.

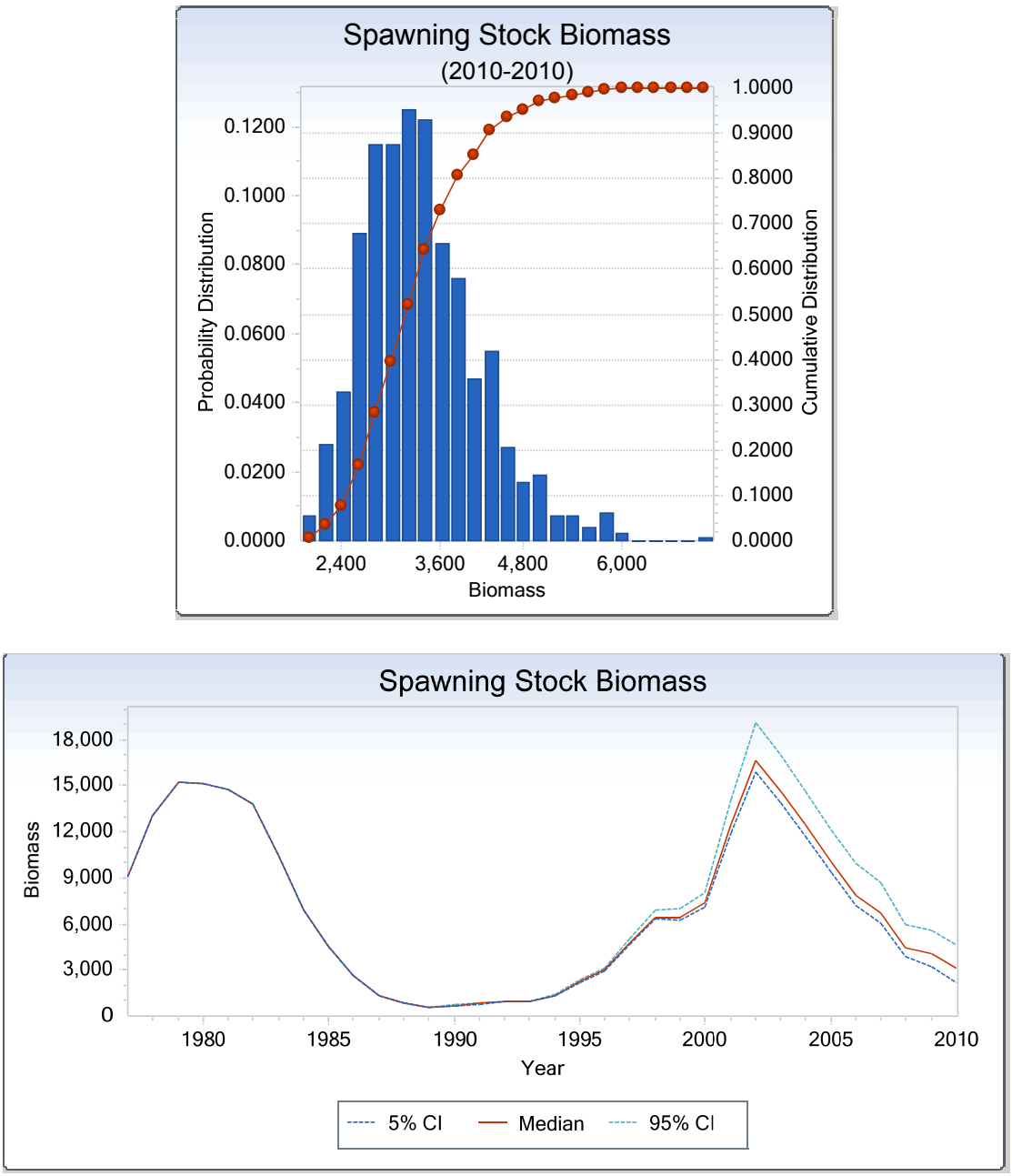



Figure C.27. Top: bootstrap distribution of 2010 Gulf of Maine haddock spawning stock biomass. Bottom: time series of Gulf of Maine haddock spawning stock biomass and the associated 90% confidence interval for Gulf of Maine from the ADAPT-VPA model from 1977 to 2010.

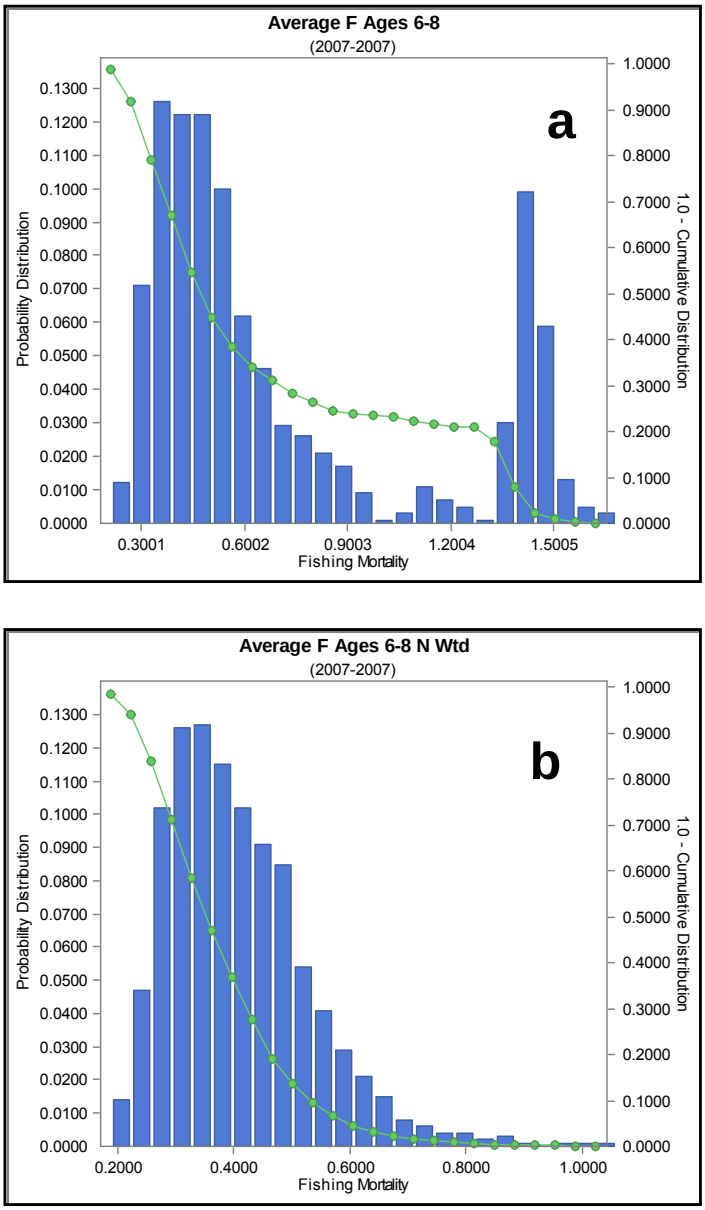



Figure C.28. Bootstrap distribution of 2007 fishing mortality (F) on Gulf of Maine haddock from the GARM III assessment. Bootstrap distributions are shown for both un-weighted average $F_{6-8}$ (a), and numbers weighted average $F_{6-8}$ (b). The vertical bars provide the probability distribution of values of $F_{6-8}$ from 1000 bootstrap realizations of the virtual population analysis (VPA). The solid line tracks the cumulative distribution.

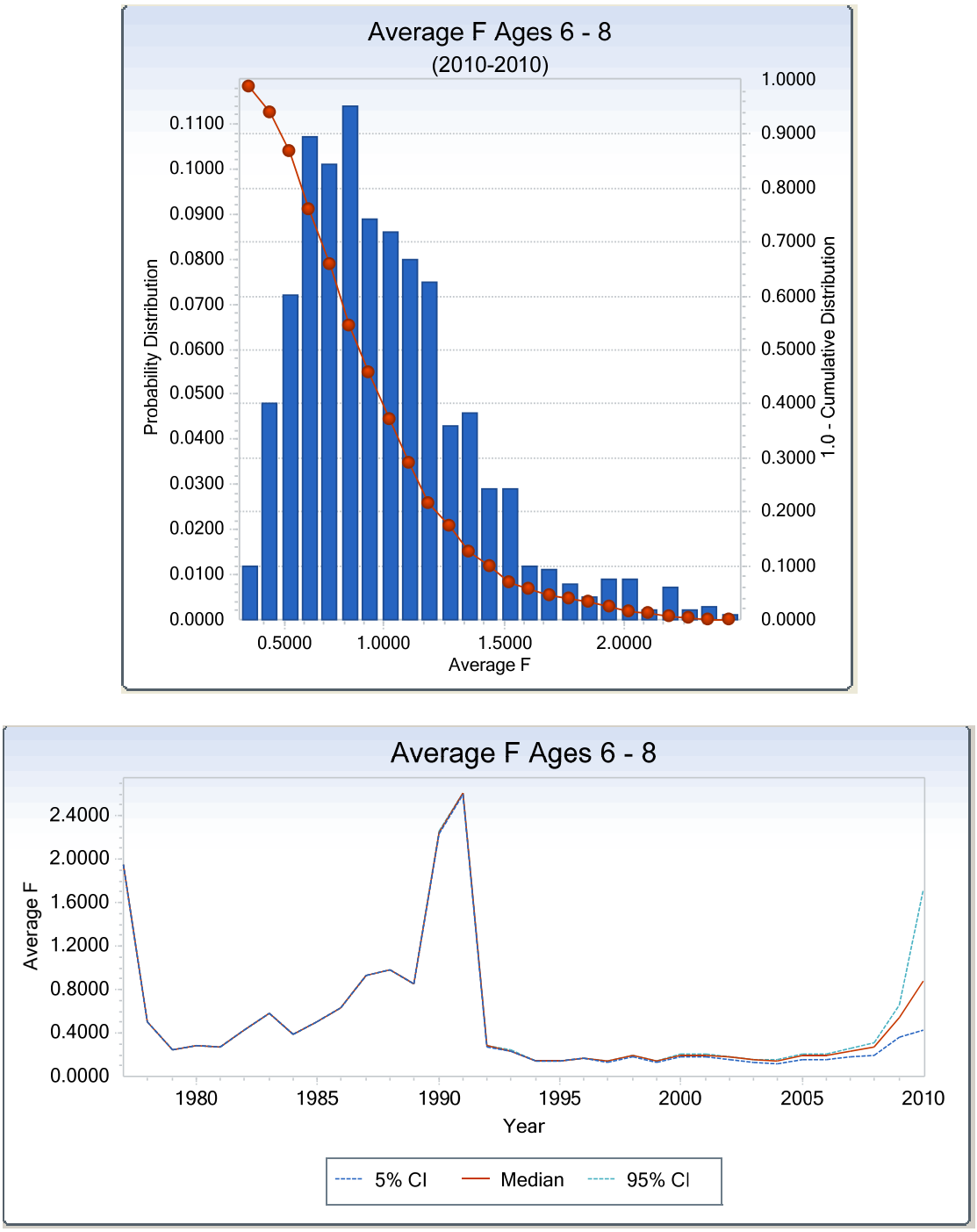



Figure C.29. Top: bootstrap distribution of 2010 Gulf of Maine haddock of average fishing mortality on ages 6-8. Bottom: time series of Gulf of Maine haddock average fishing mortality on ages 6-8 and the associated 90% confidence interval for Gulf of Maine from the ADAPT-VPA model from 1977 to 2010. The vertical bars provide the probability distribution of values of $F_{6\text{-}8}$ from 1000 bootstrap realizations of the virtual population analysis (VPA). The solid line tracks the cumulative distribution.

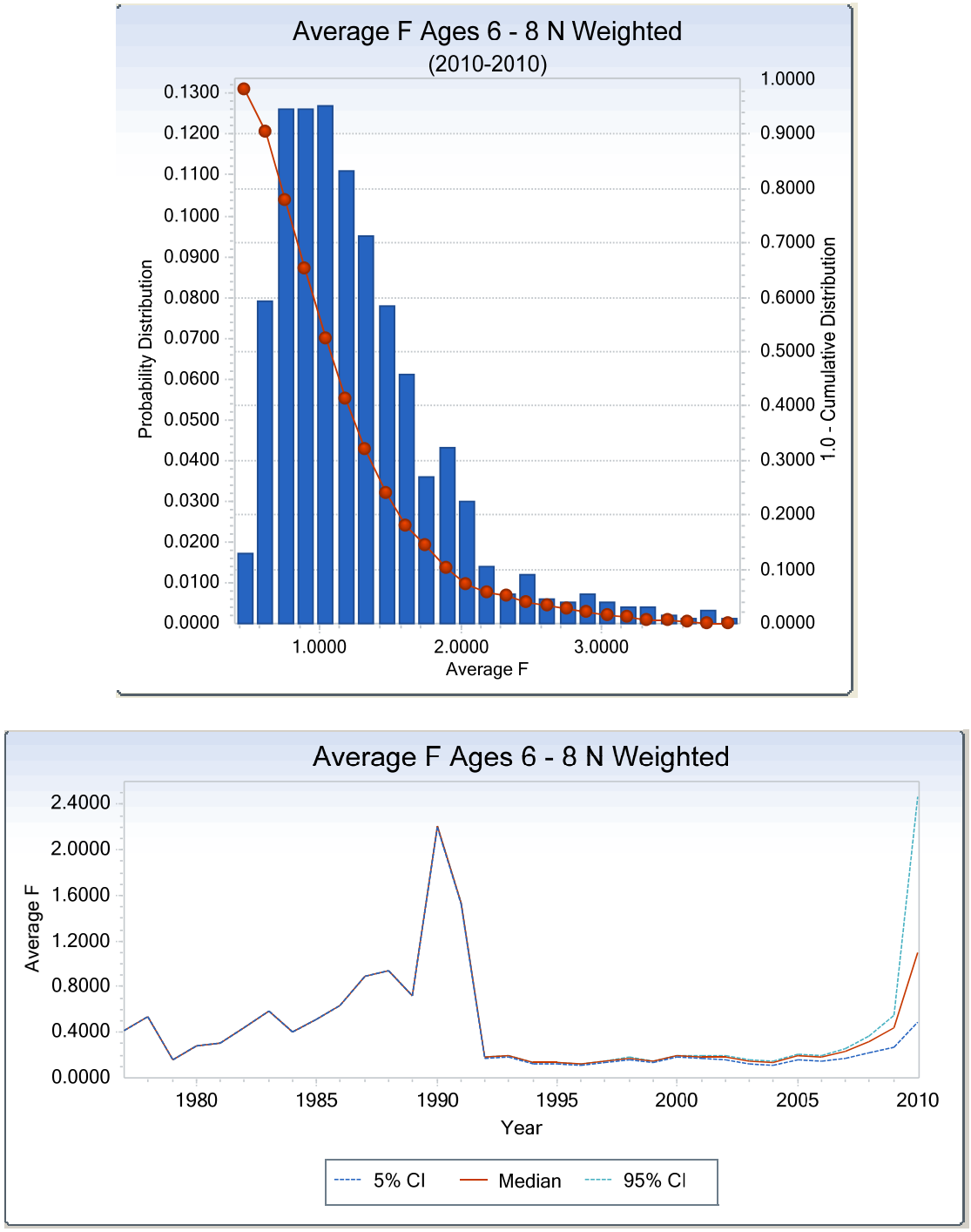



Figure C.30. Top: bootstrap distribution of 2010 Gulf of Maine haddock numbers-weighted average fishing mortality on ages 6-8. Bottom: time series of Gulf of Maine haddock numbers-weighted average fishing mortality on ages 6-8 and the associated 90% confidence interval for Gulf of Maine from the ADAPT-VPA model from 1977 to 2010. The vertical bars provide the probability distribution of values of $F_{6\text{-}8}$ from 1000 bootstrap realizations of the virtual population analysis (VPA). The solid line tracks the cumulative distribution.

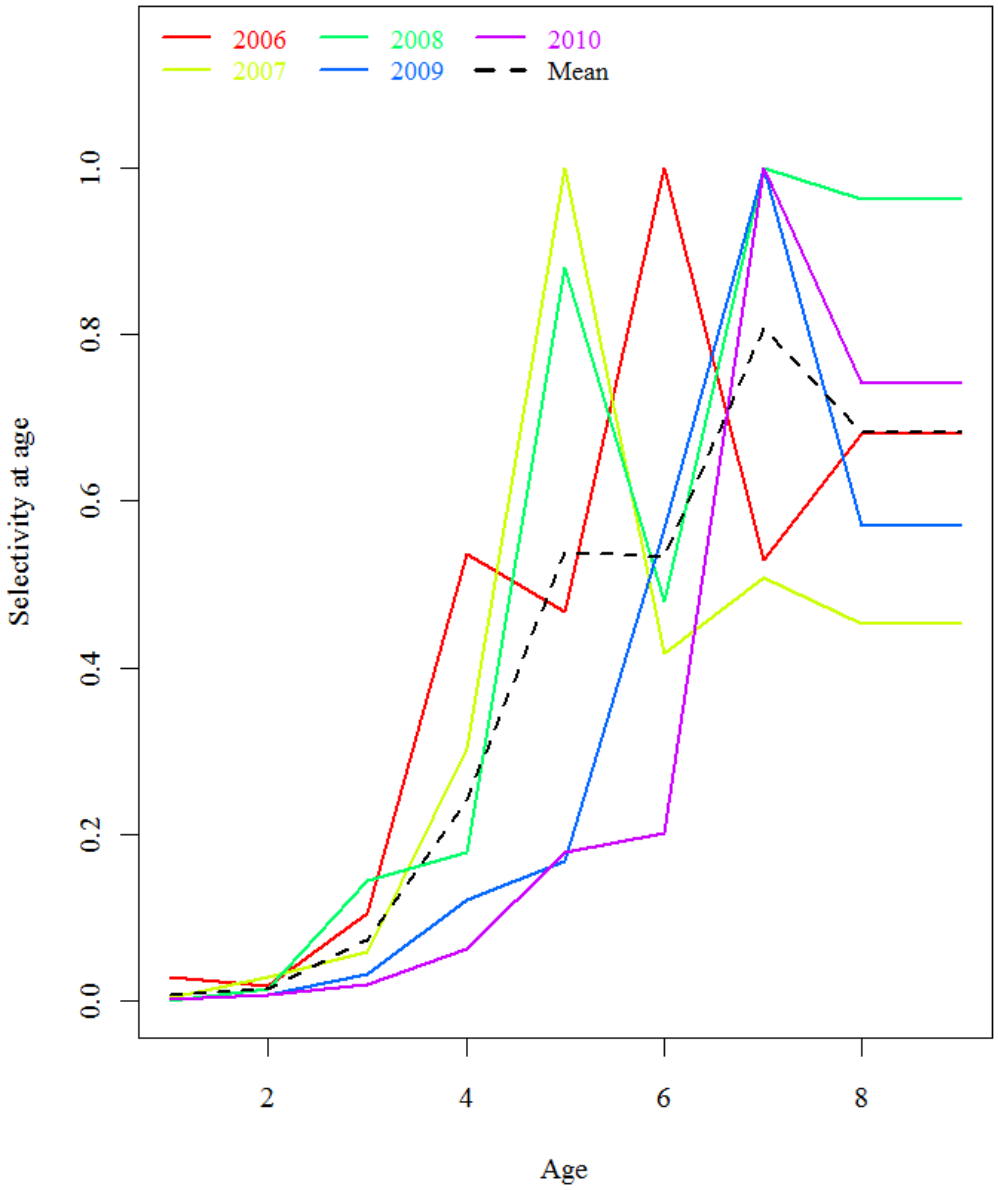



Figure C.31. ADAPT-VPA model catch selectivity patterns for Gulf of Maine haddock over the last five years of the model (2006- 2010).

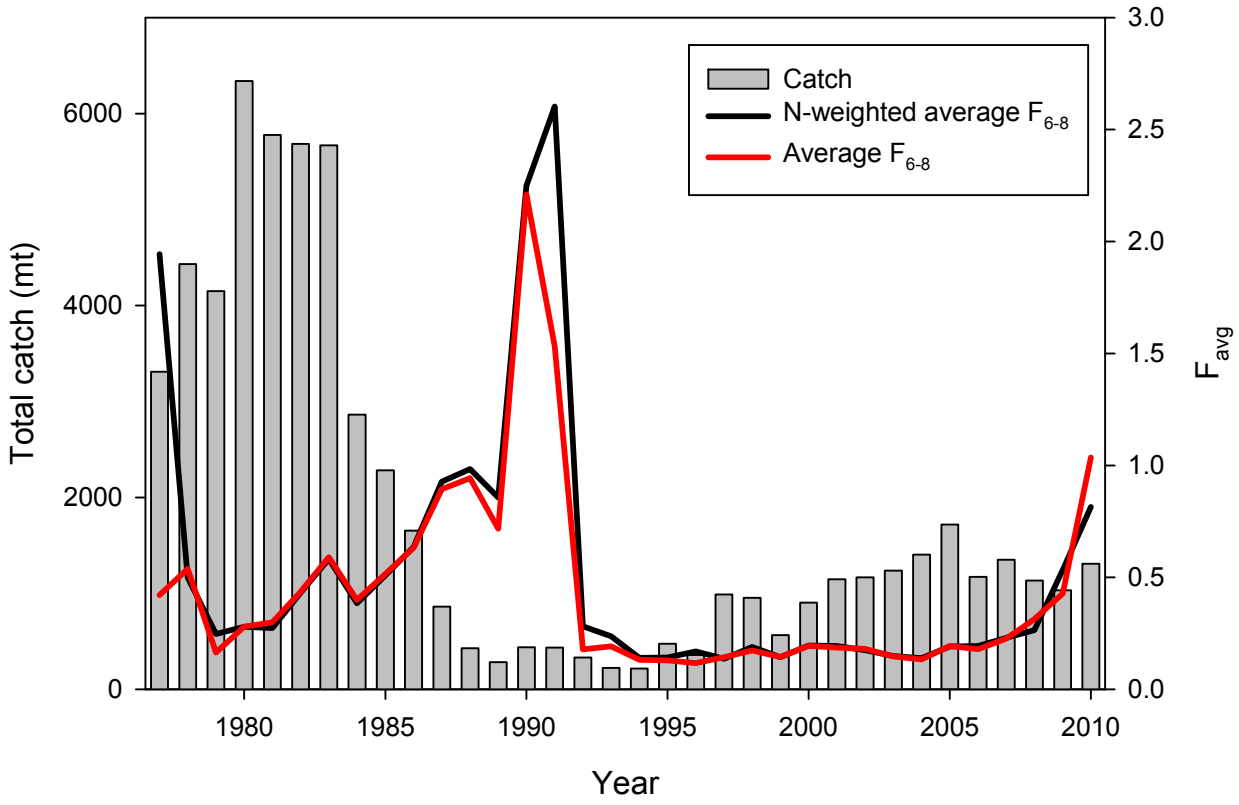



Figure C.32. Trends in total catch (commercial landings, commercial discards and recreational landings), average F on ages 6-8 and numbers-weighted average fishing mortality between 1982 and 2010.

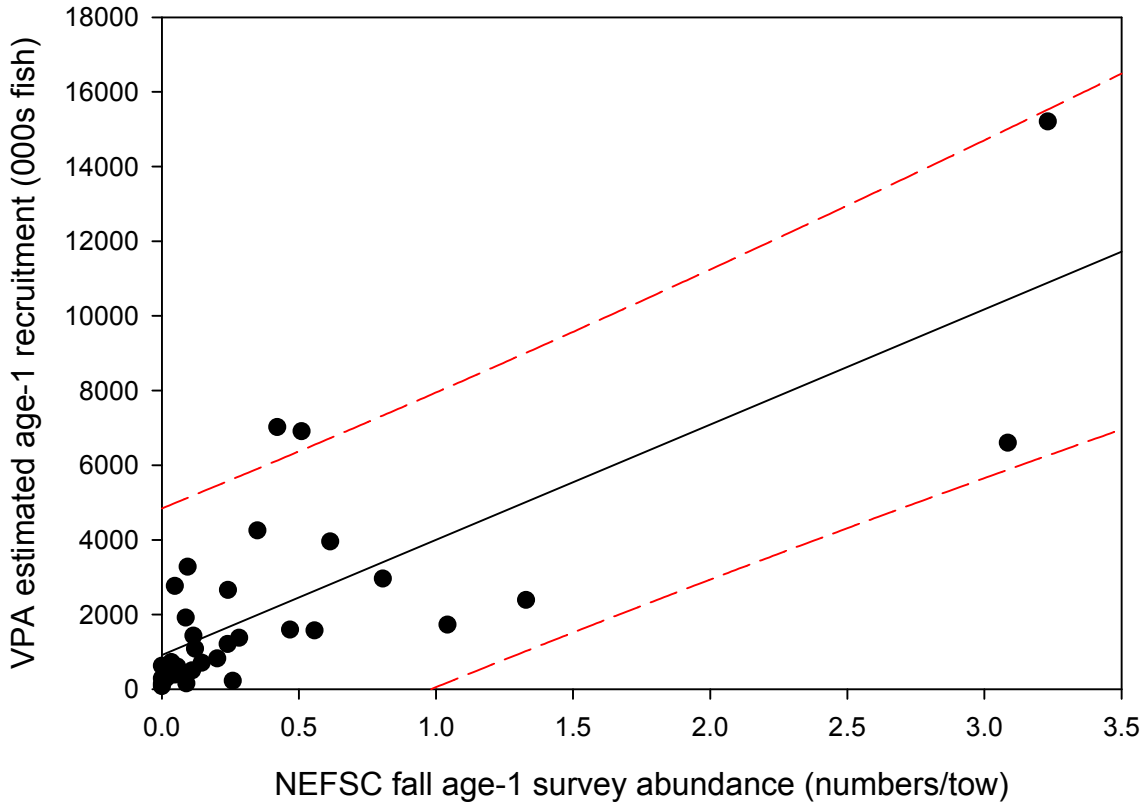



Figure C.33. Regression of ADAPT-VPA model estimates of age-1 numbers on age-1NEFSC fall survey abundance index.

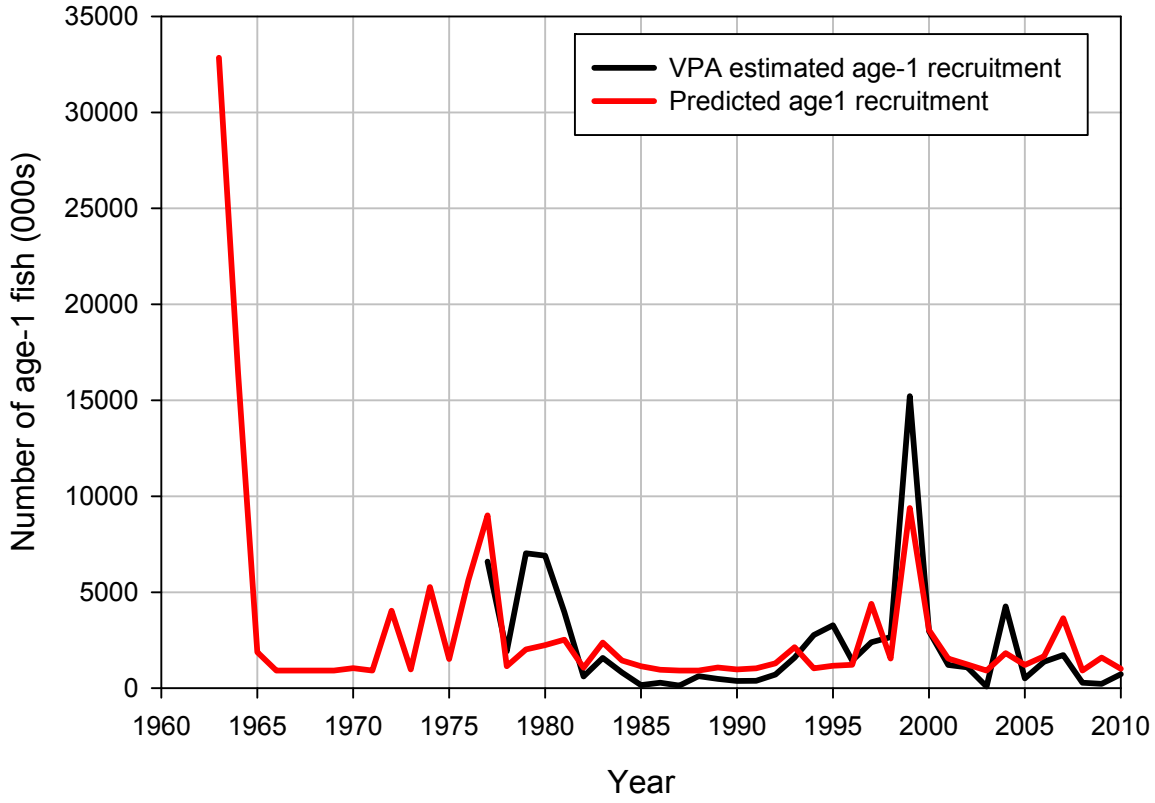



Figure C.34. Comparison of estimated age-1 numbers from survey regression model to age-1 numbers estimated by the ADAPT-VPA model.

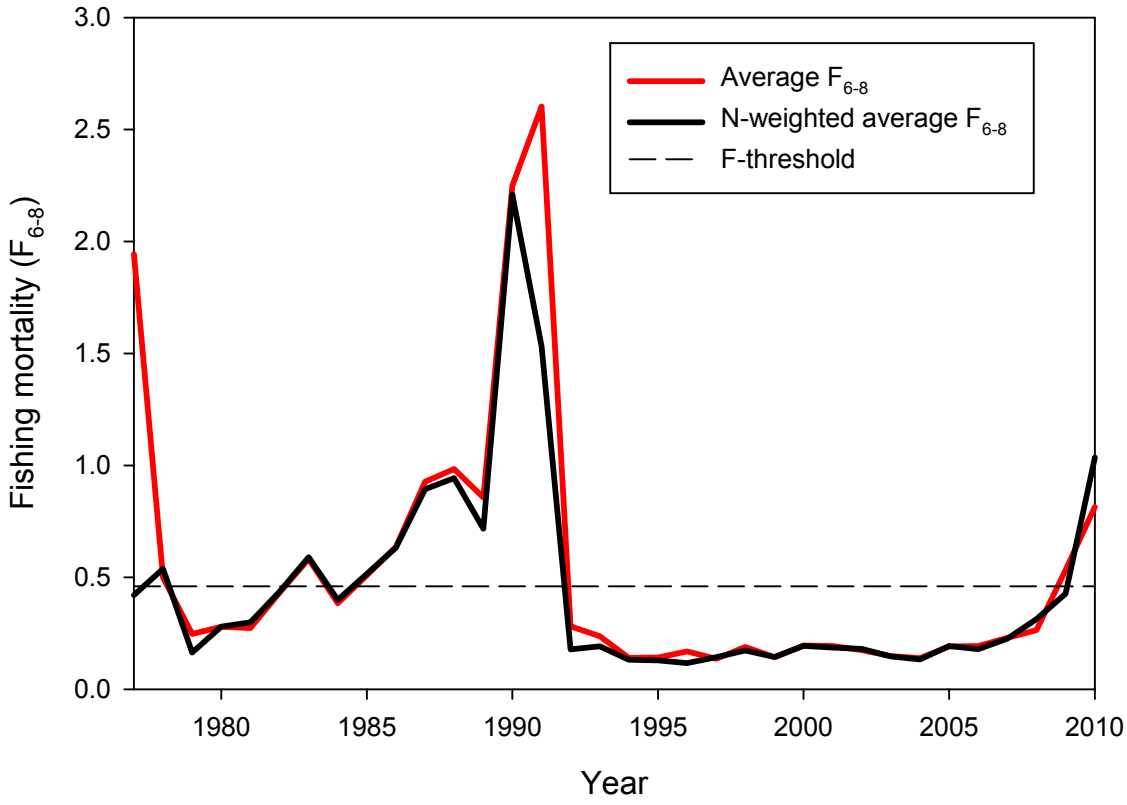



Figure C.35. Trends in total fully recruited average fishing mortality (F) on ages 6-8 and numbers-weighted average between 1982 and 2010. The fishing threshold corresponding to $F_{MSY}=F_{40\%}=0.46$ is shown by a dashed line.

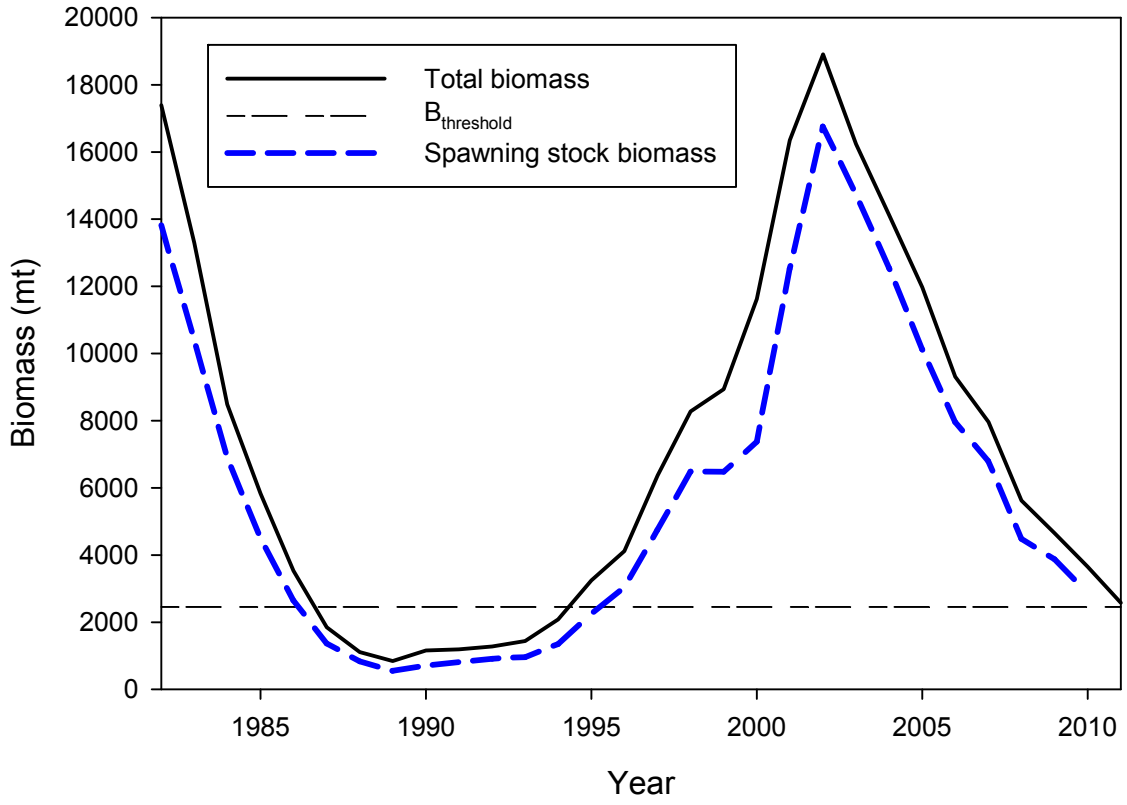



Figure C.36. Trends in total biomass and spawning stock biomass between 1982 and 2010. The biomass threshold corresponding to ½ $B_{MSY}$=2,452 mt is shown by a dashed line.

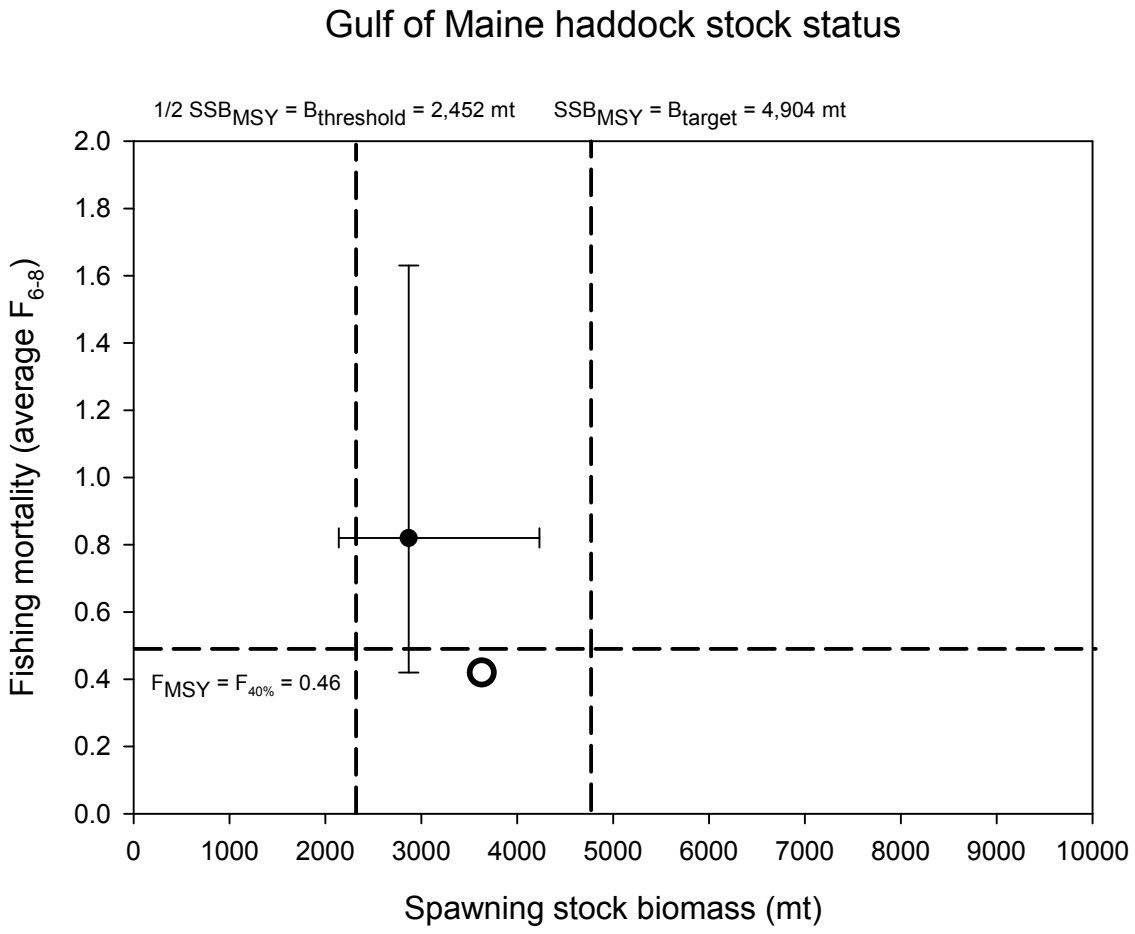



Figure C.37. Gulf of Maine haddock stock status in 2010 with respect to updated biological reference points using average $F_{6-8}$. Error bars represent the 90% confidence intervals.

**Appendix C1. Comparison of Gulf of Maine haddock BASE VPA results to results achieved using an age 0-9$^{+}$ VPA configuration as was done in GARM III.**

The GARM III VPA configuration used an age 0-9$^{+}$ configuration, but only considered ages 1-9$^{+}$ in the biological reference point determinations. To resolve this consistency, an age 1-9+ configuration was applied in the 2012 update of the Gulf of Maine haddock assessment. A sensitivity run was conducted on the 2012 VPA assessment to quantify the impacts of the change in formulation between the GARM III and the 2012 VPA model in terms of spawning stock biomass, average fishing mortality and age-1 recruitment. Results are shown in figures C1.1 – C1.3. There are no discernable differences between the two model configurations. The use of an age 1-9$^{+}$ configuration in the 2012 assessment will have no impacts on assessment results and will resolved the inconsistency between the assessment and biological reference point/projections.

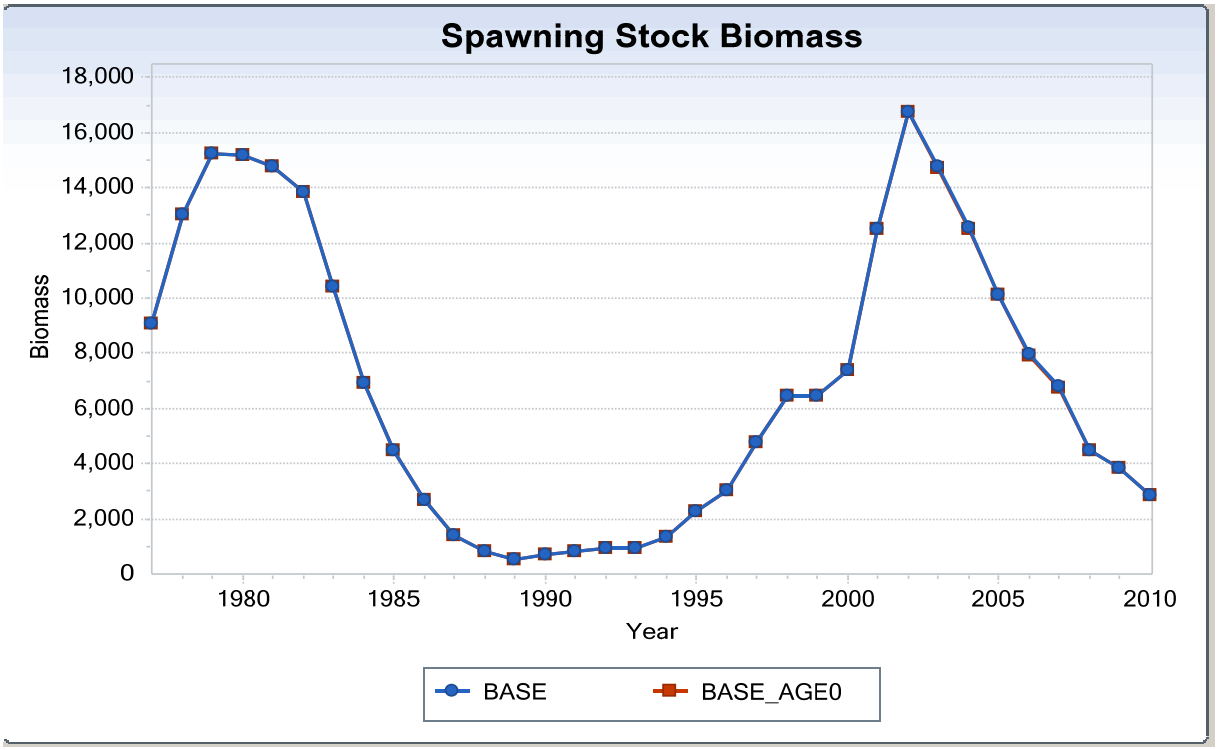



Figure C1.1. Comparison of Gulf of Maine haddock spawning stock biomass from the 2012 updated BASE VPA age 1-9$^{+}$ configuration to a sensitivity configuration applying an age 0-9$^{+}$ configuration (BASE_AGE0) as was used in GARM III.

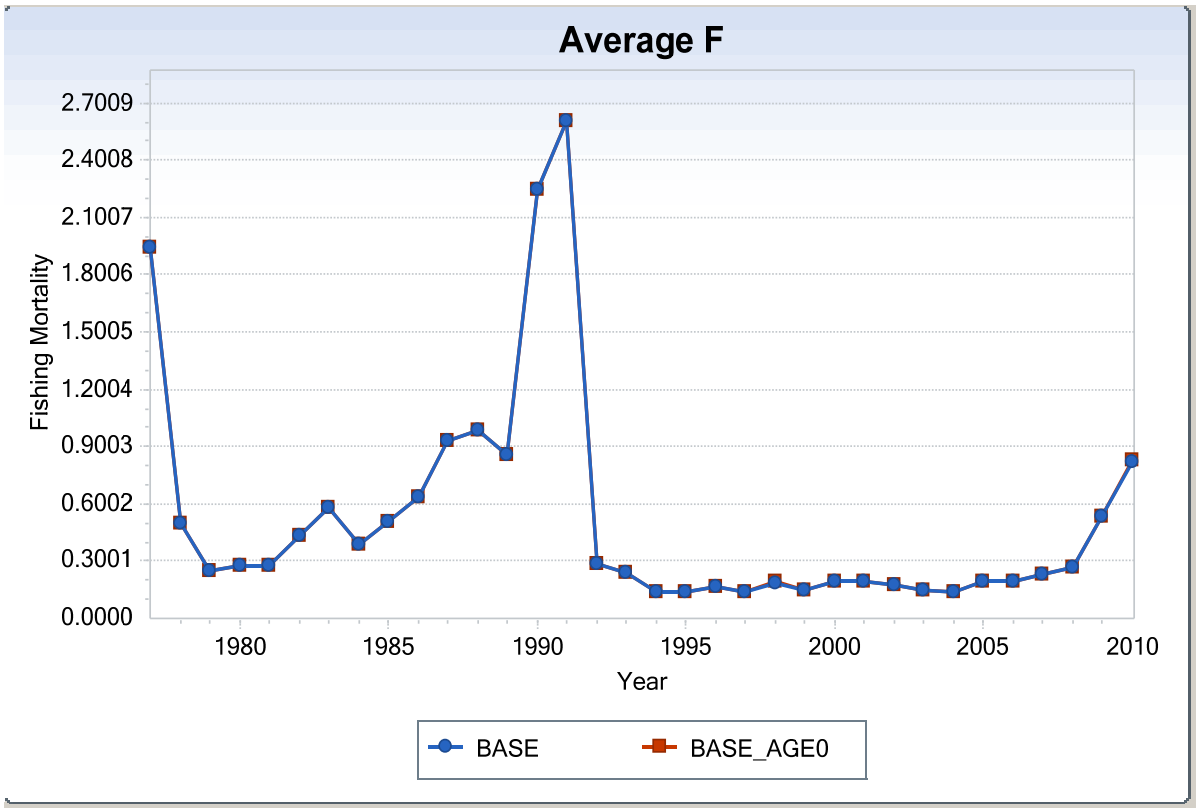



Figure C1.2. Comparison of Gulf of Maine haddock average fishing mortality on ages 6-8 ($F_{6-8}$) from the 2012 updated BASE VPA age 1-9$^{+}$ configuration to a sensitivity configuration applying an age 0-9$^{+}$ configuration (BASE_AGE0) as was used in GARM III.

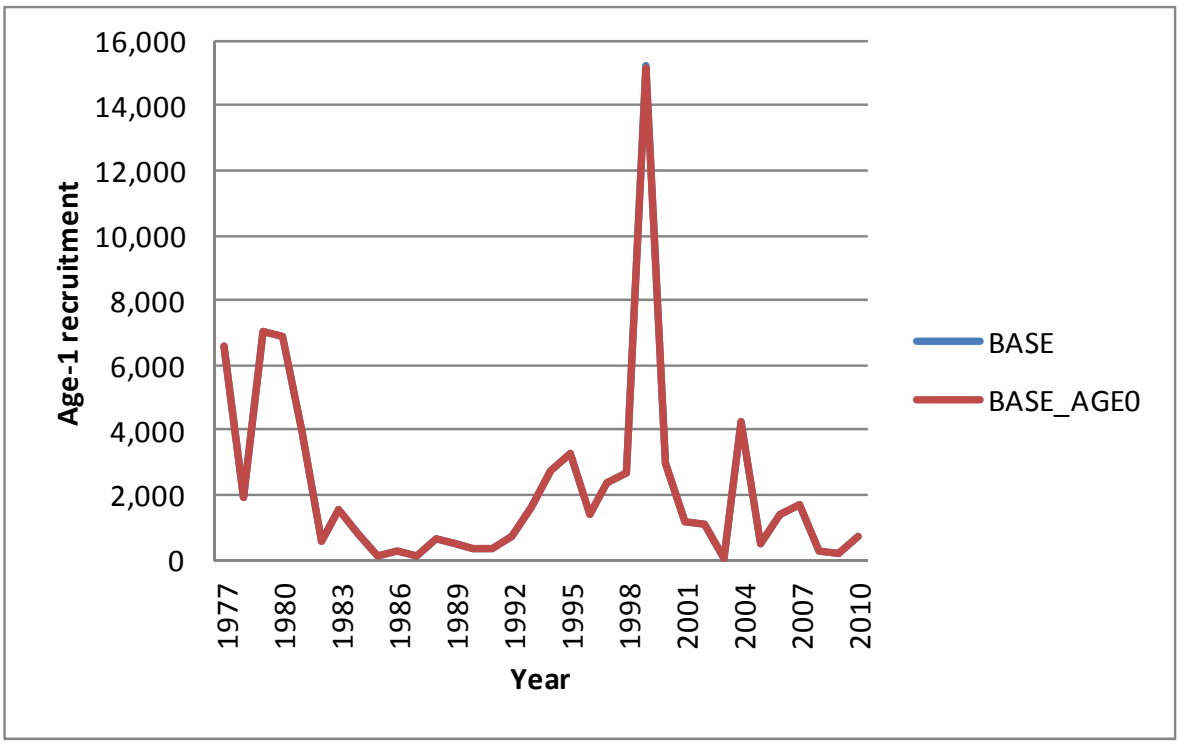



Figure C1.3. Comparison of Gulf of Maine haddock age-1 recruitment from the 2012 updated BASE VPA age 1-9$^{+}$ configuration to a sensitivity configuration applying an age 0-9$^{+}$ configuration (BASE_AGE0) as was used in GARM III.

**Appendix C2. Sensitivity of the Gulf of Maine haddock assessment to Marine Recreational Information Program (MRIP) estimates of recreational landings.**

In January, 2012 revised estimates of recreational catch were released which reflected a new treatment of the recreational catch statistics collected under the MRFSS system. These new catch estimates were released under the new name of the Marine Recreational Information Program (MRIP). There were several issues that precluded the incorporation of MRIP data into the 2012 Groundfish Assessment Updates, most notably was the late release of the data. Other issues include the partial time series of revised recreational catch that is currently available (only 2004-present recreational catch have been revised) and the fact that adjustments had not been made to the length sampling data to account for the revised MRIP statistical design. Despite these issues, the 2012 Groundfish Update Integrated Peer Review Panel recommended that a sensitivity analysis of the Gulf of Maine haddock assessment to revised MRIP-based recreational landings estimates be conducted.

Estimates of Gulf of Maine haddock MRIP recreational landings were approximated from the total haddock MRIP landings. Since there are virtually no recreational landings of Georges Bank haddock during this period, the total haddock landings provide a reasonable proxy of Gulf of Maine haddock landings. Estimates of stock-specific Gulf of Maine haddock MRIP landings were available, but measures of precision were not readily available for the stock-specific estimates. The ratios of the stock-specific landings to the total haddock landings ranged from 0.97 to 1.01, with an average of 1.0; ratios higher than 1.0 are indicative of some estimation error in the stock-specific landings. The comparison supports the use of the total haddock landings as a proxy for stock-specific Gulf of Maine haddock landings. MRFSS landings are greater than MRIP landing estimates in two out of the seven years, but within the 95% confidence intervals of the MRIP landing estimates in all years except 2010 (fig. C2.1). The ratio of MRIP landings to the MRFSS landings used in the assessment ranged from 0.50 (2010) to 1.07 (2006).

To evaluate the sensitivity of the Gulf of Maine haddock assessment to the revised MRIP landings, the total recreational catch was adjusted using the MRIP:MRFSS ratio for the years 2004 to 2010. Given that there was no consistent bias to the MRFSS data and because there is no information on MRIP prior to 2004, no adjustments were made to recreational landings between 1981 and 2003. Since no information was available on modifications to the length-frequency distributions, it was assumed that there was no change to the landings-at-age proportions. Correspondingly, the recreational landings-at-age were adjusted by the MRIP:MRFSS ratio in the corresponding year. Total catch-at-age was recalculated following the adjustment to the recreational landings-at-age.

The ADAPT-VPA was rerun using the revised catch-at-age matrix. No other changes were made to the VPA formulation. Overall, the revised MRIP VPA run was consistent with the results of the BASE VPA run. There were minor changes to the spawning stock biomass (SSB) from 1999 to 2010, with the MRIP run tending to estimate slightly lower SSB in all but the terminal year (fig. C2.2). The 2010 SSB was estimated at 2,868 mt in the BASE run and 2,886 mt in the MRIP run. Estimates of average fishing mortality were nearly identical between the two runs, with the exception of 2009 and 2010 when the MRIP run estimated lower fishing mortality (fig. C2.3). The 2010 average $F_{6-8}$ was estimated at 0.82 in the BASE run and 0.56 in the MRIP run. The

MRIP run resulted in minor downward rescaling of the 1998 year class (-3%) and a slight positive rescaling of the 2003 year class (4%; fig. C2.4). Overall, the impacts of the revised MRIP landings on the assessment were minor.

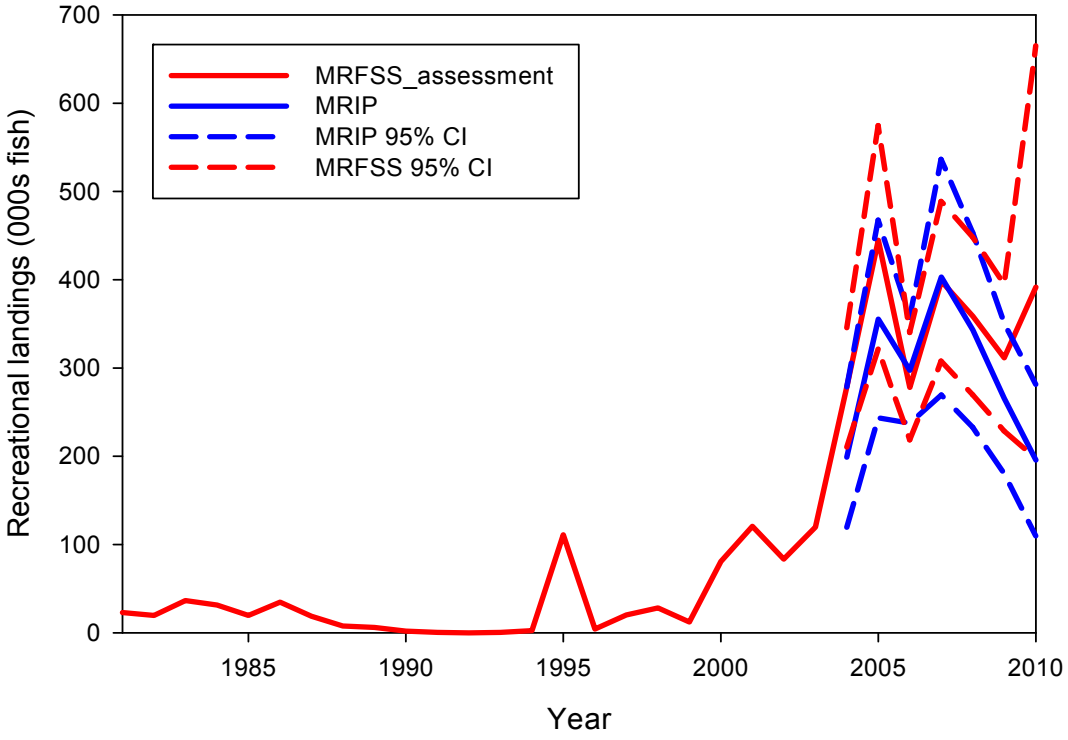



Figure C2.1. Comparison of Gulf of Maine haddock recreational landings used in the BASE assessment (MRFSS) and Marine Recreational Information Program (MRIP) estimates of recreational landings. The associated 95% confidence intervals for both time series are shown between 2004 and 2010.

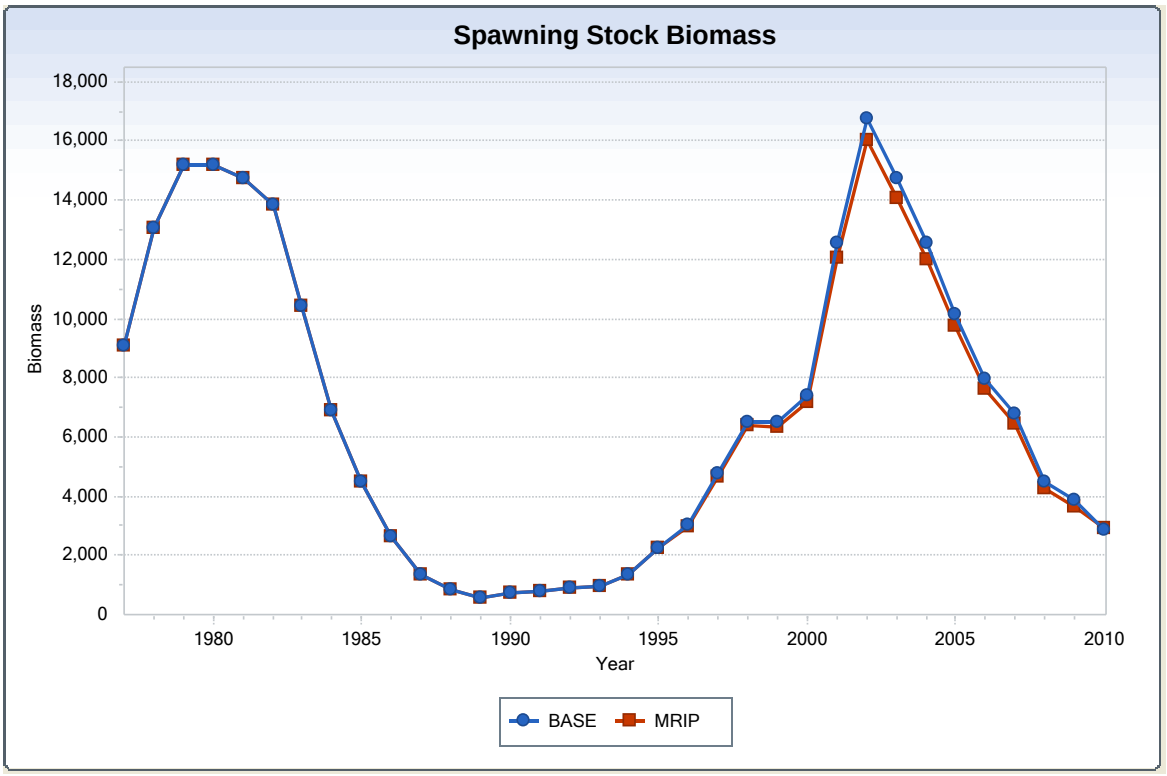



Figure C2.2. Comparison of Gulf of Maine haddock spawning stock biomass from the 2012 updated BASE assessment to an assessment using MRIP estimates of recreation landings between 2004 and 2010 (MRIP).

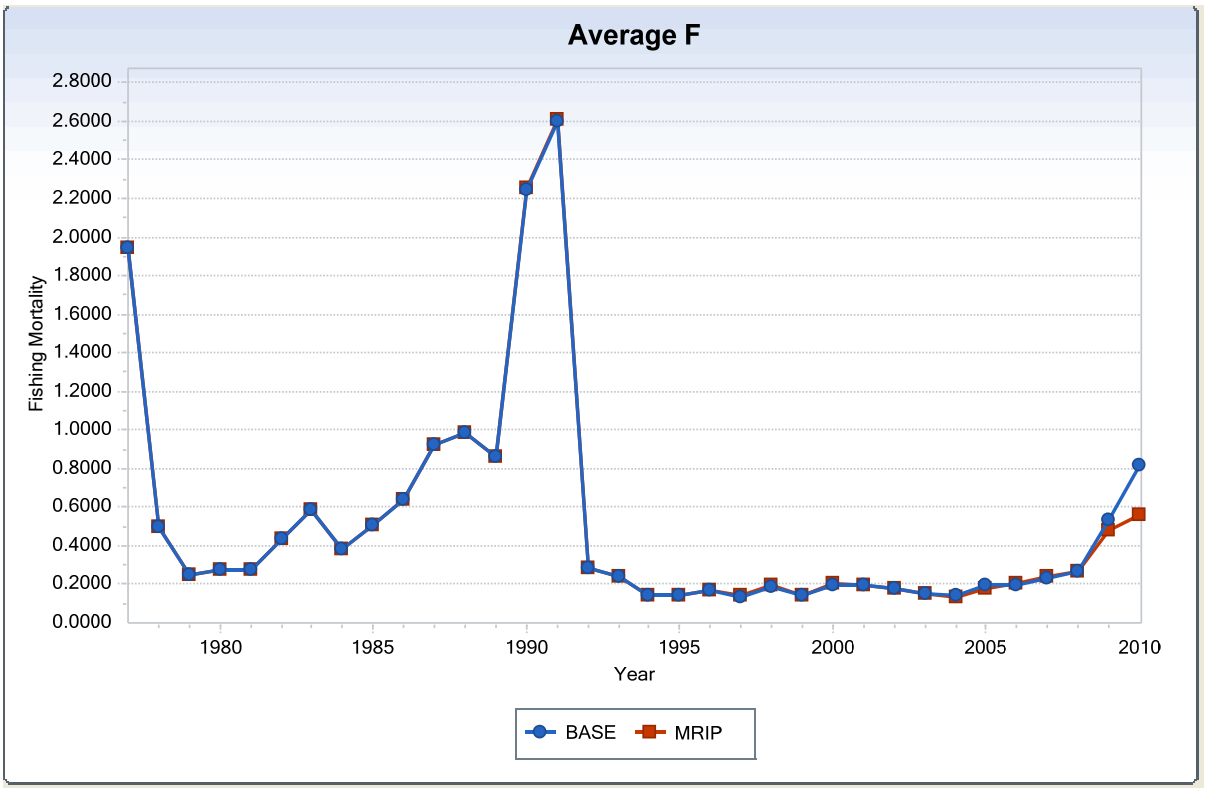



Figure C2.3. Comparison of Gulf of Maine haddock average fishing mortality on ages 6-8 ($F_{6-8}$) from the 2012 updated BASE assessment to an assessment using MRIP estimates of recreation landings between 2004 and 2010 (MRIP).

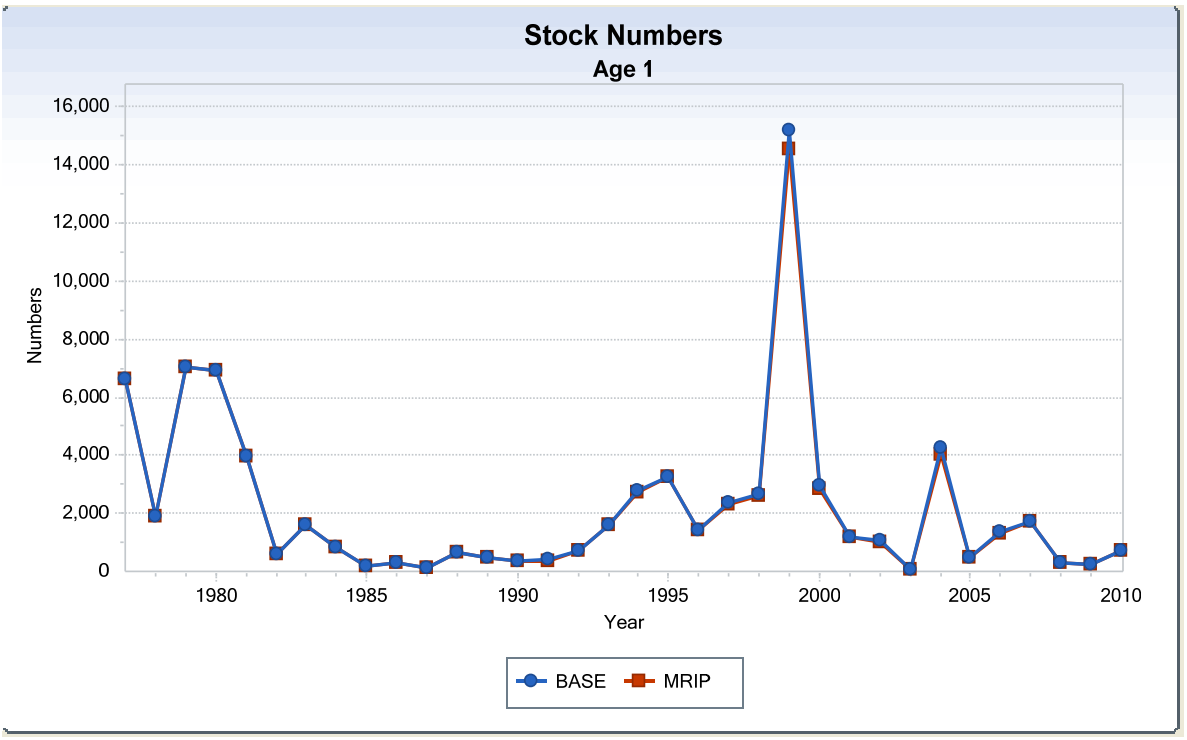



Figure C2.4. Comparison of Gulf of Maine haddock age-1 recruitment from the 2012 updated BASE assessment to an assessment using MRIP estimates of recreation landings between 2004 and 2010 (MRIP).