Northeast Fisheries Science Center Reference Document 19-08

# 66th Northeast Regional Stock Assessment Workshop (66th SAW) Assessment Report

by the Northeast Fisheries Science Center

April 2019

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**U.S. DEPARTMENT OF COMMERCE**
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Northeast Fisheries Science Center
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## B: STRIPED BASS STOCK ASSESSMENT FOR 2018

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## B2.0 TERMS OF REFERENCE (TOR)

1. Investigate all fisheries independent and dependent data sets, including life history, indices of abundance, and tagging data. Discuss strengths and weaknesses of the data sources.

2. Estimate commercial and recreational landings and discards. Characterize the uncertainty in the data and spatial distribution of the fisheries. Review new MRIP estimates of catch, effort and the calibration method, if available.

3. Use an age-based model to estimate annual fishing mortality, recruitment, total abundance and stock biomass (total and spawning stock) for the time series and estimate their uncertainty. Provide retrospective analysis of the model results and historical retrospective. Provide estimates of exploitation by stock component and sex, where possible, and for total stock complex.

4. Use tagging data to estimate mortality and abundance, and provide suggestions for further development.

5. Update or redefine biological reference points (BRPs; point estimates or proxies for $B_{MSY}$, $SSB_{MSY}$, $F_{MSY}$, MSY) for each stock component where possible and for the total stock complex. Make a stock status determination based on BRPs by stock component, where possible, and for the total stock complex.

6. Provide annual projections of catch and biomass under alternative harvest scenarios. Projections should estimate and report annual probabilities of exceeding threshold BRPs for F and probabilities of falling below threshold BRPs for biomass.

7. Review and evaluate the status of the Technical Committee research recommendations listed in the most recent SARC report. Identify new research recommendations. Recommend timing and frequency of future assessment updates and benchmark assessments.

## B3.0 EXECUTIVE SUMMARY

### B3.1 Major Findings for TOR 1 – Investigate all fisheries independent and dependent data sets, including life history, indices of abundance, and tagging data. Discuss strengths and weaknesses of the data sources.

Age-specific and aggregate indices of relative striped bass abundance are provided by states from fisheries-dependent and fisheries-independent sources. The Atlantic Striped Bass Stock Assessment Subcommittee (SAS) reviewed all indices used in the previous benchmark stock assessment (SAW 57) as well as several new indices. The SAS used a set of evaluation criteria to determine which indices should be considered for inclusion in the assessment. Based on their evaluation, the SAS dropped the Virginia Pound Net and the Northeast Fisheries Science Center Bottom Trawl Survey (NEFSC) as indices for this assessment. The ChesMMAP survey was introduced as a new index to replace the Virginia Pound Net as an adult index for the Chesapeake Bay. The Delaware Bay 30' Trawl survey was also introduced to provide information regarding the striped bass population in Delaware Bay. The following sources were included in the current assessment:

MRIP Total Catch Rate Index
Connecticut Long Island Sound Trawl Survey (CTLISTS)
New York Young-of-the-Year (NYYOY)
New York Western Long Island Beach Seine Survey (NY Age-1)
New York Ocean Haul Seine (NYOHS)
New Jersey Bottom Trawl Survey (NJTRL)
New Jersey Young-of-the-Year Survey (NJYOY)
Delaware Spawning Stock Electrofishing Survey (DESSN)
Delaware 30' Bottom Trawl Survey (DE30)
Maryland Spawning Stock Survey (MDSSN)
Maryland Young-of-the-Year and Yearlings Surveys (MDYOY and MD Age-1)
Virginia Young-of-the-Year Survey (VAYOY)
Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP)

Although not included as an index in the assessment, the Northeast Area Monitoring & Assessment Program (NEAMAP) provided valuable biological data (e.g., age and sex data) for this assessment.

### B3.2 Major Findings for TOR 2 - Estimate commercial and recreational landings and discards. Characterize the uncertainty in the data and spatial distribution of the fisheries. Review new MRIP estimates of catch, effort and the calibration method, if available.

Commercial and recreational data from the inland and ocean waters of Maine through Virginia, and the ocean waters of North Carolina were used in this assessment. Striped bass from the inland waters of North Carolina and states further south are believed to be non-migratory, based on tagging data, and are not considered part of the coastal migratory stock. Therefore, data from those regions are not included in this assessment.

Strict commercial quota monitoring is conducted by states through various state and federal dealer and fishermen reporting systems, and commercial landings are compiled annually from those sources by state biologists. Limited data on commercial discarding of striped bass was provided by Maryland and New Jersey and used, in combination with literature values and values from the previous assessment, to determine the discard mortality rates for commercial fishing gears. Recreational catch and harvest estimates for Atlantic striped bass were provided by the Marine Recreational Information Program (MRIP, formerly the Marine Recreational Fisheries Statistics Survey or MRFSS). These data include the newly calibrated MRIP estimates that were released on July 9, 2018. Calibrated annual estimates of recreational harvest (numbers of fish) and total catch (released + harvested fish) are on average 140% and 160% higher than prior MRIP estimates, respectively. Although the magnitude of these estimates has changed, the overall trend throughout time remains similar for both catch and harvest.

Following the striped bass stock reaching an all-time low, 151,000 pounds (68.5 mt or 3,730 fish) were landed in the commercial fishery in 1986. Commercial landings for striped bass increased in the 1990's as the stock recovered and management measures were liberalized. Between 2004 and 2014 landings were relatively stable due to the commercial quota system with average landings of 6.5 million pounds (2,948 mt) per year (943,000 fish per year). In response to the findings of the 2013 benchmark stock assessment, Addendum IV to the striped bass fishery management plan implemented harvest reductions 2015 for both the commercial and recreational sectors. On the commercial side, this was accomplished through a quota reduction. Since implementation of Addendum IV, coastwide commercial landings for Atlantic striped bass have decreased to an average of 4.7 million pounds (2,132 mt or 608,000 fish). Although the age structure of commercial harvest varies from state to state due to size regulations, season of the fisheries, and the size classes of striped bass available to the fisheries, from 2004-2014 ages 3-9 made up 86.5% of the commercial catch in numbers. The implementation of higher size limits in 2015 in several jurisdictions reduced the proportion of age-3 fish in the catch in subsequent years.

Commercial landings have generally exceeded discards since the early 1990's with discards comprising approximately 15% of the total commercial removals from 2015-2017. The Chesapeake Bay fisheries are estimated to have a lower proportion of commercial dead discards than the fisheries in the ocean and other areas; however, the Chesapeake Bay fisheries accounted for 74% of the total commercial removals by number from 2015-2017.

Recreational harvest of striped bass follows a similar trend to the commercial harvest. Since 1984 when landings were at their lowest (264,000 fish), harvest has increased reaching a high of 5.4 million fish in 2010. Between 2004 and 2014, harvest remained at a steady level averaging 4.7 million fish per year. Following the implementation of the size and bag limit changes in the recreational fisheries in Addendum IV, harvest decreased to an average of 3.2 million fish for 2015-2017. The number of recreational dead releases peaked in 2006 at 4.8 million fish and declined through 2011 to 1.5 million fish. Live releases increased after that with an average of 2.9 million dead releases estimated for 2015-2017.

### B3.3 Major Findings for TOR 3 – Use an age-based model to estimate annual fishing mortality, recruitment, total abundance and stock biomass (total and spawning stock) for the time series and estimate their uncertainty. Provide retrospective analysis of the model results and historical retrospective. Provide estimates of exploitation by stock component and sex, where possible, and for total stock complex.

For this assessment, the statistical catch-at-age model currently used for management was extensively modified to model two biologically distinct stocks. **However, the SARC-66 Panel concluded that the two stock model was not acceptable to serve as a basis for fishery management advice. The SARC-66 Panel recommended that the single stock statistical catch-at-age (SCA) model, which was accepted at SAW/SARC-57 and updated with new data for this assessment, be used for management. Therefore, final population estimates and stock status determinations were based on the single stock SCA and are presented below.**

The SCA model estimated annual recruitment, annual full F by fleet, and selectivity parameters for indices and fleets in order to calculate abundance and female spawning stock biomass (SSB). Recruitment was estimated as deviations from mean recruitment. Removals were separated into two fleets, a Chesapeake Bay fleet and an ocean fleet. The ocean fleet included removals from ocean waters and other areas such as Delaware Bay and Long Island Sound.

The combined full F was 0.307 in 2017. Fishing mortality for both the Chesapeake Bay fleet and the ocean fleet has been increasing since 1990.

The stock appears to have experienced a period of low recruitment at the beginning of the time series. Mean recruitment through the early 1990s to the present has been higher. The 2015 year class was strong, as was the 2011 year class, but the 2016 year class was below average. Recruitment in 2017 was estimated at 108.8 million age-1 fish, below the time series mean of 140.9 million fish.

Total striped bass abundance (age-1+) increased steadily from 1982 through 1997 when it peaked around 420 million fish. Total abundance fluctuated without trend through 2004 before declining to around 189 million fish in 2009, coinciding with several years of below average recruitment. There were upticks in abundance in 2012 and 2016, due to the strong 2011 and 2015 year classes. Total age-1+ abundance was 249 million fish in 2017. Abundance of age-8+ striped bass (considered the mature component of the population) increased steadily through 2004 to 16.5 million fish. After 2004 age-8+ abundance oscillated and has been in decline since 2011. Age-8+ abundance in 2017 is estimated at 6.7 million fish, a value near the 30th percentile of the time-series.

Female SSB started out at low levels and increased steadily through the late-1980s and 1990s, peaking at 113,602 mt (250 million pounds) in 2003 before beginning to gradually decline; the decline became sharper in 2012. Female SSB was at 68,476 mt (151 million pounds) in 2017, below the SSB threshold of 91,436 mt (202 million pounds).

Total biomass showed a similar pattern to SSB. Total biomass was very low at the beginning of the time series. Total biomass increased through the 1980s and 1990, peaking in 1999 at 334,661 mt (738 million pounds) before declining again. The total biomass of Atlantic coastal migratory stock striped bass was 173,663 mt (383 million pounds) in 2017.

### B3.4 Major Findings for TOR 4 – Use tagging data to estimate mortality and abundance, and provide suggestions for further development.

The 2017 estimates of F for fish ≥ 28 inches (711 mm) among coastal programs (excluding NYTRL) ranged from 0.07 (NJDB) to 0.12 (NCCOOP) where the unweighted average F was 0.09. The 2017 F estimates for the producer area programs ranged from 0.06 (VARAP) to 0.16 (HUDSON) with a weighted average of 0.09. For fish ≥ 18 inches (457 mm), the 2017 estimates of F among coastal programs (excluding NCCOOP) were similar, ranging from 0.06 (NYTRL) to 0.08 (MADFW) resulting in an unweighted average of 0.07. The average F value varied without trend ranging from 0.07 to 0.13 since 1995. The estimates of F for the producer area programs showed more variation, ranging from 0.06 (VARAP) to 0.12 (HUDSON) for a weighted average of 0.09.

For fish ≥ 28 inches (711 mm), the 2017 coastal program estimates of M (excluding NYTRL) ranged from 0.24 (MADFW) to 0.32 (NCCOOP) with an unweighted average of 0.27. The 2017 range of M values from the producer area programs was 0.27 (HUDSON) to 0.40 (VARAP) with a weighted mean of 0.35. For fish ≥ 18 inches (457 mm), the 2017 estimates of M from the coastal programs (excluding NCCOOP) ranged from 0.24 (MADFW) to 0.42 (NYTRL) with an unweighted average of 0.32. Producer area estimates for 2017 ranged from 0.32 (HUDSON) to 0.60 (VARAP) with a weighted average of 0.49. Overall natural mortality estimates were much higher for the producer area programs which could be driven by the prevalence of *Mycobacteriosis* in the Chesapeake Bay.

For fish ≥ 28 inches (711 mm) stock size estimates for 2017 were 20.9 million, a decrease from the peak value of 39 million that was reached in 2010. The stock size estimates for fish ≥ 18 inches (457 mm) have been decreasing since the peak of 95.4 million in 2006 and was estimated to be 61.4 million in 2016. In 2017 however, estimates showed an increase to 78.1 million.

The primary research need is to improve the estimate of the tag reporting rate. Factors that could be improved upon and may be contributing to the low reporting rate include a decline in tag quality, which has resulted in tags being illegible; angler fatigue as the tagging program has existed since 1987 with no change in reward; and the decrease in tag returns, particularly from the commercial sector.

### B3.5 Major Findings for TOR 5 – Update Biological Reference Points and determine stock status.

The reference points currently used for management are based on the 1995 estimate of female SSB. The 1995 female SSB is used as the SSB threshold because many stock characteristics (such as an expanded age structure) were reached by this year and the stock was declared recovered. Estimates of female $SSB_{1995}$ from the 2013 benchmark assessment were quite consistent across runs with different recruitment functions. The values currently used in management are $SSB_{Threshold}$ = female $SSB_{1995}$ = 57,626 mt and $SSB_{Target}$ = 125% female $SSB_{1995}$ = 72,032 mt. To estimate the F threshold, population projections were made using a constant F and changing the value until the SSB threshold value was achieved. The projected F to maintain $SSB_{Threshold}$ = $F_{Threshold}$ = 0.22, and the projected F to maintain $SSB_{Target}$ = $F_{Target}$ = 0.18.

For this assessment the reference point definitions remained the same, but values were updated. The SSB threshold was estimated at 91,436 mt (202 million pounds), with an SSB target of 114,295 mt (252 million pounds). The F threshold was estimated at 0.240, and the F target was estimated at 0.197.

Female SSB for Atlantic striped bass in 2017 was 68,476 mt, below the SSB threshold, indicating the stock is overfished. F in 2017 was 0.307, above the F threshold, indicating the stock is experiencing overfishing. Model-based estimates of MSY were not calculated for this assessment.

**B3.6 Major Findings for TOR 6 – Provide annual projections of catch and biomass under alternative harvest scenarios. Projections should estimate and report annual probabilities of exceeding threshold BRPs for F and probabilities of falling below threshold BRPs for biomass.**

Six-year projections of female spawning stock biomass (SSB) were made by using the same population dynamics equations used in the assessment model. Four scenarios of constant catch or F were explored.

The model projection began in year 2018. A composite selectivity pattern was calculated as the geometric mean of 2013-2017 of total F-at-age, scaled to the highest F. Residuals from the stock-recruitment fit were randomly re-sampled and added to the deterministic predictions of recruitment from the hockey-stick recruitment function to produce stochastic estimates of age-1 recruitment for each year of the projection. Projections were done using constant 2017 catch, constant 2017 F, F equal to $F_{threshold}$, and F equal the F required to achieve the 1993 estimate of female SSB in the long term.

Under status quo F ($F=F_{2017}$), the population trajectory remained relatively flat from 2018–2023; reducing F to the F threshold resulted in an increasing trend in SSB. However, under all four scenarios, the probability of female SSB being below the SSB threshold in 2023 was very high, equal or close to 100% in all scenarios. In addition, although the probability of F being above the F threshold declined over time in the constant catch scenario, there was still a 60% chance of F being above the F threshold in 2023.

**B3.7 Major Findings for TOR 7 - Review and evaluate the status of the Technical Committee research recommendations listed in the most recent SARC report. Identify new research recommendations. Recommend timing and frequency of future assessment updates and benchmark assessments.**

The Technical Committee was able to address or make progress on several of the recommendations from the most recent SARC report. These include:

- ✓ Evaluate to what extent rising natural mortality among Chesapeake Bay striped bass affects the existing F and female SSB thresholds, which are based on a fixed M assumption (M = 0.15) (Section B7.1).
- ✓ Develop simulation models to look at the implications of overfishing definitions relative to development of a striped bass population that will provide “quality” fishing. Quality fishing must first be defined (Section B9.2)
- ✓ Evaluate the stock status definitions relative to uncertainty in biological reference points (Section B9.2-B9.3).
- ✓ Develop a method to integrate catch-at-age and tagging models to produce a single estimate of F and stock status (Section B7.1).
- ✓ Develop a spatially and temporally explicit catch-at-age model incorporating tag based movement information (Section B7.1).
- ✓ Develop maturity ogives applicable to coastal migratory stocks (Section B5.1.7).

The Technical Committee identified several high priority research recommendations to improve the assessment. These included better characterization of commercial discards, expanded collection of sex ratio data and paired scale-otolith samples, development of an index of relative abundance for the Hudson River stock, better estimates of tag reporting rates, continued collection of mark-recapture data to better understand migration dynamics, and additional work on the impacts of *Mycobacteriosis* on striped bass population dynamics and productivity.

The Technical Committee recommends that the next benchmark stock assessment be conducted in five years in 2024, which will allow progress to be made on issues like state-specific scale-otolith conversion factors and directly incorporating tagging data into the 2SCA model.

## B4.0 MANAGEMENT AND ASSESSMENT HISTORY

### B4.1 Management History

For centuries, the Atlantic striped bass (*Morone saxatilis*) has supported valuable commercial and recreational fisheries from Maine through North Carolina. Striped bass regulations in the United States date to pre-Colonial times when striped bass were prohibited from being used as fertilizer (circa 1640). In 1981, the Atlantic States Marine Fisheries Commission (ASMFC or Commission) developed a fisheries management plan (FMP) for Atlantic striped bass in response to declining abundance as evidenced by drastic declines in commercial harvest during the 1970's and other indicators of low striped bass abundance and poor recruitment. The FMP recommended increased restrictions on commercial and recreational fisheries, such as minimum size limits and harvest closures on spawning grounds. Two amendments were passed in 1984 recommending additional management measures to reduce fishing mortality. To strengthen the management response and improve compliance and enforcement, the Atlantic Striped Bass Conservation Act (P.L. 98-613) was passed in late 1984. The Striped Bass Act mandated the implementation of striped bass regulations passed by the Commission and gave the Commission authority to recommend to the Secretaries of Commerce and Interior that states be found out of compliance when they failed to implement management measures consistent with the FMP.

The first enforceable plan under the Striped Bass Act, Amendment 3, was approved in 1985, and required size regulations to protect the 1982-year class – the first modest size cohort since the previous decade. The objective was to increase size limits to allow at least 95% of the females in the 1982 cohort to spawn at least once. Smaller size limits were permitted in producer areas than along the coast. Several states, beginning with Maryland in 1985, opted for a more conservative approach and imposed a total moratorium on striped bass commercial landings for several years. Amendment 3 contained a trigger mechanism to relax regulations when the 3-year moving average of the Maryland juvenile abundance index (JAI) exceeded an arithmetic mean of 8.0 – which was attained with the recruitment of the 1989 year class. Also, in 1985, the Commission concluded the Albemarle Sound-Roanoke River (A-R) stock in North Carolina contributed minimally to the coastal migratory population and was therefore allowed to operate under an alternative management program.

Amendment 4, implemented in 1989, aimed to rebuild the resource rather than maximize yield. State fisheries reopened under a target fishing morality (F) of 0.25, which was half the estimated F needed to achieve maximum sustainable yield (MSY). Amendment 4 allowed an increase in the target F once female spawning stock biomass (SSB) was restored to levels estimated during the late 1960s and early 1970s. The dual size limit concept was maintained, recreational trip limits were implemented, and commercial seasons were restricted to reduce harvest to 20% of that in the historic period of 1972-1979. A series of four addenda were implemented from 1990-1994 to maintain protection of the 1982 year class.

In 1990, to provide additional protection to striped bass and ensure the effectiveness of state regulations, NOAA Fisheries passed a final rule (55 Federal Register 40181-02) prohibiting possession, fishing, (i.e., catch and release fishing), harvest and retention of Atlantic striped bass in the Exclusive Economic Zone (EEZ), with the exception of a defined transit zone within Block Island Sound. Atlantic striped bass may be possessed and transported through this defined area, provided that the vessel is not used to fish while in the EEZ and the vessel remains in continuous transit. This federal moratorium remains in effect.

In 1995, Chesapeake Bay, Delaware Bay and Hudson River striped bass stocks were declared recovered by the Commission (the Albemarle Sound/Roanoke River stock was declared recovered in 1997), and Amendment 5 was adopted to increase the target F to 0.33, midway between the existing $F_{target}$ (0.25) and $F_{MSY}$. $F_{target}$ was allowed to increase again to 0.40 after two years of implementation. Regulations were developed to achieve the target F (which included measures aimed to restore commercial harvest to 70% of the average landings during the 1972-1979 historical period). From 1997-2000, a series of five addenda were implemented to respond to the latest stock status information and adjust the regulatory regime to achieve each change in target F.

Amendment 6 was approved in 2003. It addressed five limitations within the previous management program: potential inability to prevent the exploitation target from being exceeded; perceived decrease in availability or abundance of large striped bass in the coastal migratory population; a lack of management direction with respect to target and threshold biomass levels; inequitable impacts of regulations on the recreational, commercial, coastal, and producer area sectors of the striped bass fisheries; and excessively frequent changes to the management program. Amendment 6 established targets and thresholds for both the fishing mortality rate and female SSB. Additionally, Amendment 6 implemented a list of management triggers based on the female SSB and F targets and threshold, as well as juvenile abundance indices, which, if any or all are triggered in any given year, require the Atlantic Striped Bass Management Board (Board) to alter the management program to ensure achievement of the Amendment 6 objectives.

Under Amendment 6, and prior to Addendum IV (2014), the recreational striped bass fisheries were constrained by minimum size limits meant to achieve target fishing mortalities, rather than annual harvest quotas or caps. Most recreational fisheries were constrained by a two fish bag limit and a 28 inch minimum size limit. Through conservation equivalency, the Albemarle Sound/Roanoke River and Chesapeake Bay were able to employ different bag limits and smaller minimum size limits (18 inches) with the penalty of a target fishing mortality rate of 0.27. Amendment 6 restores the coastal commercial quotas to 100% of the average reported landings from 1972-1979, except for Delaware's coastal commercial quota, which remains at the level allocated in 2002. The Chesapeake Bay and Albemarle Sound commercial fisheries were managed to not exceed the 0.27 fishing mortality target. A series of addenda were approved to implement a bycatch data collection program (Addendum I, 2007), to modify the definition of recruitment failure under the FMP (Addendum II, 2010), and to implement a coastwide commercial harvest tagging program to address illegal harvest of striped bass (Addendum III, 2012).

In 2014, Addendum IV was approved. The addendum was initiated in response to the 2013 benchmark assessment which indicated a steady decline in female SSB since the mid-2000s. The addendum established new F reference points ($F_{target}$ = 0.18; $F_{threshold}$ = 0.22) for a coastwide population (which includes the Chesapeake Bay, Hudson River, and Delaware River/Delaware Bay as a metapopulation), and a suite of regulatory measures to reduce F to a level at or below the new target. The Addendum called for a 25% reduction in removals along the coast, and 20.5% reduction in removals in the Chesapeake Bay relative to the base period. To achieve this, coastal commercial quotas were cut by 25% and the Chesapeake Bay commercial quota was set at 3,120,247 pounds (1,415 mt) (a 20.5% reduction from the 2012 harvest level).

For the recreational sector, Atlantic coastal fisheries were required to implement a one fish bag limit and maintain the 28 inch minimum size limit. States could implement alternative regulations through the FMP's conservation equivalency process. The Addendum did not specify a standard measure for Chesapeake Bay fisheries, therefore Chesapeake Bay jurisdictions followed the conservation equivalency process to comply with the requirements of the Addendum. Addendum IV also formally defers management of the Albemarle Sound/Roanoke River stock to the state of North Carolina using Albemarle Sound/Roanoke River stock-specific biological reference points approved by the Board. Striped bass in the ocean waters of North Carolina continue to be managed under Amendment 6 and Addenda I-IV. Refer to Table B4.1 for a summary of commercial and recreational striped bass regulations in 2017, by state.

In February 2017, the Board initiated the development of Draft Addendum V to consider liberalizing coastwide commercial and recreational regulations. The Board's action responded to concerns raised by Chesapeake Bay jurisdictions regarding continued economic hardship endured by its stakeholders since the implementation of Addendum IV and information from the 2016 stock assessment update indicating that the Addendum IV measures successfully reduced F to a level below the target in 2015. The draft addendum proposed alternative measures aimed to increase total removals by 10% relative to 2015 in order to achieve the target F in 2017. However, the Board chose to not advance the draft addendum forward for public comment largely due to harvest estimates having increased in 2016 without changing regulations. Instead, the Board decided to wait until it reviews the results of this benchmark stock assessment before considering making changes to the management program.

## B4.2 Management Unit Definition

The management unit includes all coastal migratory striped bass stocks on the East Coast of the United States, excluding the Exclusive Economic Zone (3-200 nautical miles offshore), which is managed separately by NOAA Fisheries. The coastal migratory striped bass stocks occur in the coastal and estuarine areas of all states and jurisdictions from Maine through North Carolina. Inclusion of these states in the management unit is also congressionally mandated in the Atlantic Striped Bass Conservation Act (PL 98-613) (Figure B4.1). The Albemarle-Roanoke stock is currently managed as a non-coastal migratory stock by the state of North Carolina under the auspices of ASFMC.

The Chesapeake Bay area is defined as the area residing between the baseline from which the territorial sea is measured as it extends from Cape Henry, Virginia, to Cape Charles, Virginia, to the upstream boundary of the fall line (Figure B4.2). The striped bass in the Chesapeake Bay are part of the coastal migratory stock and are part of the coastal migratory striped bass management unit. Amendment 6 implements a separate management program for the Chesapeake Bay due to the size availability of striped bass in this area.

## B4.3 Assessment History

### B4.3.1 Past Assessments

The first analytical assessment of Atlantic striped bass stocks using virtual population analysis (VPA) was conducted in 1997 for years 1982-1996 and reviewed by the 26th Stock Assessment Review

Committee at the Northeast Fisheries Science Center. The results of the review were reported in the proceedings of the 26th Northeast Regional Stock Assessment Workshop (26th SAW): SARC Consensus Summary of Assessments (NEFSC Ref. Document 98-03). Subsequent to that peer review, annual updates were made to the VPA based assessment, and in 2001 estimates of F and exploitation rates using coast-wide tagging data were incorporated into the assessment. The tagging data analysis protocol was based on assumptions described in Brownie et al. (1985) and the tag recovery data was analyzed in program MARK (White and Burnham 1999). Adjusted R/M ratios (recovered tags/total number of tags released) were used to calculate exploitation rates.

The stock status and assessment procedures were reviewed once again at the 36th SAW in December 2002 and this time included review of the tag based portion of the assessment in addition to the ADAPT VPA portion of the assessment. Since then, annual updates to the assessment were conducted from 2003 through 2005.

In the 2005 assessment, Baranov's catch equation was used with the tagging data to develop estimates of F. By using the Z values from the Brownie models and μ from R/M (recovered tags/total number of tags released), F estimates could be developed for the first time without the assumption of constant natural mortality. This approach was used because of high and increasing estimates of F from the tag analysis when M was assumed constant. This conflicted with other estimates of exploitation and F in the bay from tag programs, and it coincided with the development of an epidemic of *Mycobacteriosis* in the Chesapeake Bay. Also, estimates of abundance could be made.

Two changes were made to the VPA input data. Modifications were made to the suite of tuning indices used in the VPA following a comprehensive review of the various indices. In addition, current and historical estimates of recreational harvest during January and February in North Carolina and Virginia were added to the catch at age matrix.

In the 2004 and 2005 ASMFC assessments of striped bass, the ADAPT VPA model produced high estimates of terminal-year fishing mortality. The consensus of the Technical Committee members was that the ADAPT estimates were likely overestimated given the uncertainty and retrospective bias in the terminal year estimate, especially the F on the older ages which are compared to the overfishing reference point. A run with data updated through 2006 showed even worse overestimation of terminal F (at age-10, F =2.2). As an alternative to ADAPT, an age-structured forward projecting statistical catch-at-age (SCA) model for the Atlantic coast migratory stocks of striped bass was constructed and used to estimate fishing mortality, abundance, and female SSB during 1982-2006 in the 2007 benchmark assessment. This was considered the preferred model over ADAPT.

Also in the 2007 benchmark assessment, the instantaneous tag return models of Jiang et al. (2007) were used for the first time. These type of tag models allow recaptured fish that are subsequently released alive without the tag to be incorporated in the estimation of fishing and natural mortality rather than using an ad hoc approach to adjust for release bias like the Smith et al. (1998) method used with the MARK models.

The SCA model was modified for the 57$^{th}$ SAW/SARC based on recommendations by the 2007 SARC and SA committee discussions. The SCA model was generalized to allow specification of multiple fleets, different stock-recruitment relationships, year- and age-specific natural mortality rates, different selectivity functions for fleets and surveys with age composition data, ageing errors, standardized residual plots, qqnorm plots of residuals, and various management reference points. The catch data were split into 3 regional "fleets" (Chesapeake Bay, Coast (includes Delaware Bay and Hudson River), and Commercial Discards) in attempt to better model changes in regional selectivity caused by changes in management regulations over time. In addition, age-specific natural mortality values were incorporated for the first time. Historical recreational data (2004-2010) were also updated due to changes in the MRIP estimation methodology.

For the tag data analyses, the age-independent, harvest/catch-release instantaneous tag return (IRCR) model was the preferred methodology. The catch equation and MARK modeling methodologies were eliminated. Only three MARK models were run as a double check on the IRCR model results. Instead of assuming constant reporting rates, year-specific report rates were estimated and used for 2001-2011.

### B4.3.2 Current Assessment and Changes from Past Assessments

For this assessment, the SCA model was extensively modified to allow the modeling of two biologically distinct stocks. This new striped bass two-stock statistical catch-at-age (2SCA) model allows the estimation of separate population characteristics for two stocks whose individuals are mixed in a common ("ocean") region where the stock composition of the catch in that region is unknown. The model is based on population dynamics observed for the Chesapeake Bay stock that is comprised of a resident population in the Chesapeake Bay and a migratory population that moves between the Chesapeake Bay and ocean region for spawning. For Stock-1 (the Chesapeake Bay stock), individuals move from the bay to the ocean based on age-specific emigration rates estimated from tag data. Spawning individuals from the ocean return to the bay during a specific period based on maturity schedules. For Stock-2 (the Delaware Bay and Hudson River stocks combined), it is assumed that the ocean region encompasses the spawning grounds and migration is not modeled. The model estimates stock-specific recruitment, stock-, year-, period- and age-specific abundance and fishing mortality, different selectivity functions for the Chesapeake Bay and Ocean catch data and surveys with age composition data, catchability coefficients for surveys and management reference points.

In addition, the inputs for the one-stock SCA model approved for management use at the 57$^{th}$ SAW/SARC were updated to reflect improvements in the 2SCA model data, including the separation of commercial discards into Chesapeake Bay and ocean components so that only two regional fleets were needed.

Both models used new MRIP estimates of recreational catch.

The tagging assessment used only the IRCR model and did not run the MARK model. The year-specific reporting rates were carried forward from the previous assessment and updated for 2012 – 2017. The addition of a new F period was explored given the implementation of Addendum IV and model diagnostics supported its inclusion for most programs.

### B4.4 Fishery Descriptions

Commercial fisheries operate in eight of the 14 jurisdictions regulated by the Commission's FMP (Massachusetts, Rhode Island, New York, Delaware, Maryland, Virginia, Potomac River Fisheries

Commission, and North Carolina; Table B4.1). Commercial fishing for striped bass is prohibited in Maine, New Hampshire, Connecticut, New Jersey, Pennsylvania, and the District of Columbia. The predominant gear types in the commercial fisheries are gillnets, pound nets, and hook and line. In a few states, the trap gear is an important part of this fishery. Massachusetts allows commercial fishing with hook-and-line gear only, while other areas allow net fisheries. Most commercial fisheries are seasonal in nature because of striped bass migration patterns and management regulations. Following the reopening of striped bass fisheries in 1990, a rebuilding management strategy remained in effect until 1995, when the stock was considered recovered. Since then, the commercial fishery has been managed via size limits and jurisdiction-specific quotas. In 2003, commercial quotas were restored to 100% of the average harvest (in weight) during the period of 1972-1979. In 2014, coastal commercial quotas were reduced by 25% and the Chesapeake Bay-wide quota was reduced by 20.5% relative to 2013 harvest (Addendum IV; Table B4.1)

Recreational fisheries operate in all 14 jurisdictions regulated by the Commission's FMP. The predominant gear type is hook and line (Table B4.1). Following the reopening of striped bass fisheries in 1990, state fisheries were limited to a 2-fish possession limit and a 28 inch minimum size limit (except "producer" areas, such as the Chesapeake jurisdictions, were allowed to implement 18 inch minimum size limits) and modest open fishing seasons. By 1995, coincident with the recovered status of striped bass, open fishing seasons were extended, with some states establishing year-round open seasons (Table B4.1). In Chesapeake Bay prior to Addendum IV, recreational fisheries were managed via harvest caps for specific seasonal fisheries. Beginning in 2015, Atlantic coastal fisheries were required to implement a one fish bag limit and maintain the 28 inch minimum size limit. States could implement alternative regulations through the FMPs conservation equivalency process. The Addendum did not specify a standard measure for Chesapeake Bay fisheries, therefore Chesapeake Bay jurisdictions followed the conservation equivalency process to comply with the requirements of the Addendum (i.e., implement measures to achieve a 20.5% reduction relative to 2013-levels; Table B4.1).

## TOR B1. INVESTIGATE ALL FISHERIES INDEPENDENT AND DEPENDENT DATA SETS, INCLUDING LIFE HISTORY, INDICES OF ABUNDANCE, AND TAGGING DATA. DISCUSS STRENGTHS AND WEAKNESSES OF THE DATA SOURCES.

### B4.5 Life History and Biology

#### B4.5.1 Geographic Range

The distribution of Atlantic striped bass along the eastern coast of North America extends from the St. Lawrence River in Canada to the St. Johns River in Florida, but the Atlantic coast migratory stocks range from the Gulf of Maine to the Roanoke River and other tributaries of Albemarle Sound in North Carolina (ASMFC 1990). Stocks which occupy coastal rivers from the Tar-Pamlico River in North Carolina south to the St. Johns River in Florida are believed primarily endemic and riverine and apparently do not presently undertake extensive Atlantic Ocean migrations as do stocks from the Roanoke River north (ASMFC 1990). Striped bass are also naturally found in the Gulf of Mexico from the western coast of Florida to Louisiana (Musick et al. 1997). Striped bass were introduced to the Pacific Coast using transplants from the Atlantic Coast in 1879. Striped bass also were introduced into rivers, lakes, and reservoirs throughout the US, and to foreign countries such as Russia, France and Portugal (Hill et al 1989). The following life history information applies to the Atlantic coast migratory population.

#### B4.5.2 Stock Definitions

The anadromous populations of the Atlantic coast are primarily the product of four distinct spawning stocks: an Albemarle Sound/Roanoke River stock, a Chesapeake Bay stock, a Delaware River stock, and a Hudson River stock (ASMFC 1998). The Atlantic coast fisheries, however, rely primarily on production from the spawning populations in the Chesapeake Bay and in the Hudson and Delaware rivers. Historically, tagging data indicated very little mixing between the Albemarle Sound/Roanoke River stock and the coastal population. Therefore, the inside fisheries of the Albemarle Sound and Roanoke River are managed separately from the Atlantic coastal management unit, which includes all other migratory stocks occurring in coastal and estuarine areas of all states and jurisdictions from Maine through North Carolina. However, recent tagging work indicates that most large A-R striped bass (>800 mm TL) are indeed migratory (Callihan et al. 2013). The Striped Bass Technical Committee examined this during the 2017 data workshop for this assessment and concluded that very few fish from the A-R stock, as a fraction of the total coastwide population, contribute to the Atlantic coastal migratory stock. The current Atlantic coast management unit, excluding the fisheries on the Albemarle Sound/Roanoke River stock, is the basis of this stock assessment.

The Chesapeake Bay stock of striped bass is widely regarded as the largest of the four major spawning stocks (Goodyear et al. 1985; Kohlenstein 1980; Fabrizio 1987). However, during most of the 1970s and 1980s, juvenile production in the Chesapeake Bay was extremely poor, causing a severe decline in commercial and recreational landings. The poor recruitment was probably due primarily to overfishing; but poor water quality in spawning and nursery habitats likely also contributed (Richards and Rago 1999).

Recent tag-recovery studies in the Rappahannock River and upper Chesapeake Bay show that larger and older (ages 7+) female striped bass, after spawning, move more extensively along the Atlantic coast than stripers from the Hudson River stock (ASMFC 2004). Tag recoveries of Chesapeake stripers from July through November have occurred as far south as Virginia to as far north as Nova Scotia, Canada. Like the Hudson River stock, nearly all recaptures of mature female striped bass from the Chesapeake Bay stock occur during winter (December and February) off Virginia and North Carolina (Crecco 2005).

Following extensive pollution abatement during the mid-1980s, striped bass abundance in the Delaware River, as measured by juvenile seine surveys, rose steadily thereafter to peak abundance in 2003 and 2004. Like the Chesapeake Bay and Hudson stocks, spawning migration in the Delaware River begins during early April and extends through mid-June (ASMFC 1990). Recent tagging studies in the Delaware River show that larger and older (ages 7+) female striped bass undergo extensive migration northward into New England from July to November that spatially overlap the migratory range of Chesapeake striped bass (ASMFC 2004). Like the Hudson River and Chesapeake Bay stocks, many tag recoveries from mature female striped bass from the Delaware River have taken place between December and February off Virginia, North Carolina, New England, and Long Island (Crecco 2005). The Delaware River stock was officially declared restored in 1998 (Kahn et al. 1998).

### B4.5.3 Movements and Migration

Atlantic striped bass move between a variety of habitats in their life cycle. Generally, spawning and early development occurs at the heads of estuaries and in their tributaries, fish mature in estuaries, and move into the ocean as adults. Movement at all developmental stages is affected by abiotic factors and trophic interactions.

*Eggs and Larvae*
The movement of planktonic eggs and larvae is largely determined by passive transport. Bilkovic et al. (2002) studied the distribution of striped bass and American shad eggs and larvae in two rivers of a tributary of the Chesapeake Bay, the largest of the four major spawning stocks (Goodyear et al. 1985; Kohlenstein 1980; Fabrizio 1987), and found that predation and competition with American shad were also important factors in the relative spawning and larval locations.

*Juveniles*
In summer and fall, juvenile striped bass move down river from their parent stream (Richards and Rago 1999; Smith and Wells 1977) to low salinity bays or sounds at about one year old (Shepherd 2007). A number of factors are correlated with the movements of these juveniles, including freshwater and tidal flow (Manderson et al. 2014; Dunning et al. 2009), salinity and pH (Able and Grothues 2007), temperature (Callihan et al. 2015; Hollema et al. 2017), photoperiod (Hollema et al. 2017), prey availability (Ferry and Mather 2012; Hollema et al. 2017), age of fish (Conroy et al. 2015), and abundance (Callihan et al. 2014).The timing of this juvenile migration varies by location. In Virginia, Setzler-Hamilton et al. (1980) observed the movement downstream during summer. In the Hudson River, striped bass begin migrating in July, as documented through an increase in the number of juvenile striped bass caught along the beaches and a subsequent decline in the numbers in the channel areas after mid-July. Downstream migration continues through late summer, and by the fall, juveniles start to move offshore into Long Island Sound (Raney 1952).

As young and as adults, striped bass move in schools, except for larger fish, which either travel alone or with a few others of similar size. Otolith microchemistry analysis of striped bass from the Hudson River and from the Roanoke River indicate that individuals in these populations exhibit multiple life history strategies (Morris et al. 2003; Zlokovitz et al. 2003; Secor and Piccoli 2007). Secor (1999), describes the Contingent Hypothesis based on his work with striped bass in the Hudson. Juveniles form distinct migratory groupings, called contingents, which have similar patterns in otolith microchemistry and reflects temporal changes in salinity. Contingents may be the result of divergent early growth rates and dispersal behaviors (Secor and Piccoli 2007), and may promote colonization of new habitats (Morissette et al. 2016). Three contingents, corresponding with freshwater residents, oligohaline migrants, and mesohaline migrants have been identified in the Hudson River (Secor 1999; Gahagan et al. 2015), the St. Lawrence River (Morissette et al. 2016), the Patuxent River (Conroy et al. 2015), and Albemarle Sound, where Patrick (2010) identified them as resident, stager, and sprinter contingents.

*Adults*

Most adult striped bass along the Atlantic coast are involved in two types of migrations: an upriver spawning migration from late winter to early spring (Shepherd 2007; Zurlo 2014), and coastal migrations that are apparently not associated with spawning activity. From Cape Hatteras, North Carolina, to New England, coastal migrations are generally northward in summer and southward in winter. Mather et al. (2009) found that in Massachusetts, some adult striped bass that had traveled long distances remained in small areas for the summer to feed. Results from tagging 6,679 fish from New Brunswick, Canada to the Chesapeake Bay, during 1959 – 1963, suggest that substantial numbers of striped bass leave their birthplaces when they are three or more years old and thereafter migrate in groups along the open coast (Nichols and Miller 1967). These fish are often referred to collectively as the “coastal migratory stock,” suggesting they form one homogeneous group, but this group is probably, in itself, heterogeneous, consisting of many migratory contingents of diverse origin (Clark 1968).

Coastal migrations may be quite extensive. Striped bass tagged in Chesapeake Bay have been recaptured in the Bay of Fundy. They are also quite variable, with the extent of the migration varying between sexes and populations (Hill et al. 1989; Secor and Piccoli 2007). Larger striped bass (>800 mm TL), most of which are females, tend to migrate farther distances (Callihan et al. 2011). Welsh et al. (2007) determined that striped bass tagged off North Carolina and Virginia in the winter migrated northward as far as Maine in the summer, although the largest numbers were recovered from New York to Massachusetts, as well as the waters of Maryland. During the spring months (April, May, and June), the largest numbers of tagged striped bass were caught within the waters of Maryland (Chesapeake Bay) and New York (Hudson River). Although usually beginning in early spring, the time period of migration can be prolonged by the migration of striped bass that are late-spawning.

Some areas along the coast are used as wintering grounds for adult striped bass. The inshore zones between Cape Henry, Virginia, and Cape Lookout, North Carolina, serve as the wintering grounds for the migratory segment of the Atlantic coast striped bass population (Setzler-Hamilton et al. 1980). There are three groups of fish that are found in nearshore ocean waters of Virginia and North Carolina between the months of November and March, the wintering period. These three groups are bass from Albemarle and Pamlico Sounds, North Carolina, fish from the Chesapeake Bay, and large bass that spend the summer in New Jersey and north (Holland and Yelverton 1973). Based on tagging studies conducted under the auspices of the ASMFC and Southeast Area Monitoring and Assessment Program

(SEAMAP; Welsh et al. 2007) each winter since 1988, striped bass wintering off Virginia and North Carolina range widely up and down the Atlantic Coast, at least as far north as Nova Scotia, and represent all major migratory stocks (Welsh et al. 2007).

Striped bass are not usually found more than 6 to 8 km offshore (Bain and Bain 1982), however, Kneebone et al. (2014), using acoustic telemetry, found that adult fish that aggregate on Stellwagen Bank, located in the U.S. Exclusive Economic Zone (EEZ) and beyond the 12-nautical mile territorial sea, move inshore as part of their normal migratory and feeding behavior. Additionally, Fishery-independent data collected by North Carolina DMF, ASMFC and USFWS (i.e., North Carolina Cooperative Winter Tagging Program) suggests striped bass distribution on their overwintering grounds during December through February has changed significantly since the mid-2000s. The migratory portion of the stocks has been well offshore in the EEZ (>3 miles), requiring travel as far as 25 nm offshore of Chesapeake Bay to locate fish to tag (ASMFC 2018).

Finally, strong homing behavior has been observed in some populations (Wingate and Secor 2007), and can make populations susceptible to local effects, such as over fishing and habitat damage. However, Grothues et al. (2009) investigated the dispersal patterns of adult striped bass using telemetry and found that migratory behavior is reactive rather than compulsive. These results are consistent with Patrick (2010), in which he reports finding no genetic basis for migratory behavior using otolith microchemistry, but rather that habitat condition was related to migration of young-of-year.

### B4.5.4 Age

Atlantic striped bass have been aged using scales for over 70 years (Merriman 1941). State ageing programs have shown high precision in scale-based ages of striped bass up to age-10. However, it is generally recognized that for older fish, scales may underestimate striped bass ages compared to otolith-based ages and known ages (Secor et al. 1995 and Liao et al. 2013), so ASMFC is working with states to facilitate collection of otoliths for 800 mm striped bass or larger.

Age data are fundamental to VPA- and SCA-based stock assessments of striped bass. Since 1996, catch-at-age models have used scale age, principally because the time series of catch data extends back to 1982 and scales have been the only consistently collected age structure. For the benchmark stock assessment, scales remained the primary source for ages although otolith ages from several states across multiple years were used when available to develop age-length-keys (ALKs).

Generally, longevity of striped bass has been estimated as 30 years, although a striped bass was aged to 31 years based on otoliths (Secor 2000). This longevity suggests that striped bass populations can persist during long periods of poor recruitment due to a long reproductive lifespan. It may also have conferred resiliency against an extended period of recruitment overfishing in the Chesapeake Bay (Secor 2000).

In general, the maximum ages observed have increased since 1995 when the striped bass fisheries reopened. From 1995 to 2016, the maximum observed female age increased from 16 to 31, with the oldest fish caught in Chesapeake Bay, Virginia, in 2014. During the same period, the maximum observed male age increased from 16 to 24 with the oldest fish caught in Chesapeake Bay, Virginia, in 2011. Figure 12 of Appendix B1 presents the maximum observed ages by state, showing that Virginia has the highest mean maximum age of 22.5 whereas New Jersey has the lowest mean maximum age of 12.

### B4.5.5 Growth

As a relatively long-lived species, striped bass are capable of attaining moderately large size, reaching as much as 125 pounds (57 kg) (Tresselt 1952). Fish weighing 50-60 pounds (23-27 kg) are not exceptional, and several fish harvested in North Carolina and Massachusetts with recorded weights in excess of 100 pounds (45 kg) were estimated to have been at least 6 feet (1.8 m) long (Smith and Wells 1977).

Growth rates of striped bass are variable, depending on season, age, sex, competition and location. For example, a 35 inch (889 mm) striped bass can be 7 to 15 years of age and a 10-pound (4.5 kg) striped bass can be 6 to 16 years old (ODU CQFE 2006).

Growth occurs during the seven-month period between April and October. Within this time frame, striped bass stop feeding for a brief period just before and during spawning, but feeding continues during the upriver spawning migration and begins again soon after spawning (Trent and Hassler 1966). Annuli form on scales of striped bass caught in Virginia between April and June, or during the spawning season (Grant 1974). From November through March, growth is negligible.

Growth (in length) is more rapid during the second and third years of life, before reaching sexual maturity, than during later years. Merriman (1941) observed that striped bass of the 1934 year class showed greatest growth during the 3$^{rd}$ year, when migratory movements began. The rate dropped sharply at age-4 and remained nearly constant at 6.5-8.0 cm per year until approximately age-8. The growth rate probably decreases even further after the 8$^{th}$ year.

Growth rates and maximum size are significantly different for males and females. Both sexes grow at the same rate until 3 years old; beginning at age-4, females grow faster than males. Females grow to a considerably larger size than males; striped bass over about 30 pounds (14 kg) are almost exclusively female (Bigelow and Schroeder 1953).

Compensatory growth, in which the smaller fish in a year-class grow at an accelerated pace that reduces or eliminates the size differences between themselves and other larger members of that age group, has been shown to occur in age-2 striped bass in Chesapeake Bay (Tiller 1942).

In preparation for this stock assessment, a review was conducted of age and length data. These data verified that females grow larger than males (Appendix B1, Figure 1). Growth rates were seen to be variable without trend for all states (Appendix B1, Figure 2 – 8). Finally, a comparison of older fish of the same age range showed that the largest fish are observed in Massachusetts and the smallest fish are in Virginia (Appendix B1, Figure 9).

### B4.5.6 Reproduction and Recruitment

Striped bass are anadromous, ascending coastal streams in early spring to spawn, afterward returning to ocean waters. Spawning takes place in the shallow stretches of larger rivers and streams, generally within about the first 40 km of freshwater in rivers flowing into estuaries (Tresselt 1952). The actual distance upstream of the center of spawning varies from river to river and even within the same river from year to year. Striped bass spawning areas characteristically are turbid and fresh, with significant current velocities due to normal fluvial transport or tidal action. Tributaries of Chesapeake Bay, most notably the Potomac River, and also the James, York, and most of the smaller rivers on the eastern shore of Maryland, are collectively considered the major spawning grounds of striped bass, but other rivers (Hudson and Delaware) make substantial contributions to the population along the middle Atlantic coast.

The spawning season along the Atlantic coast usually extends from April to June and is governed largely by water temperature (Smith and Wells 1977). Striped bass spawn at temperatures between 10 and 23° C, but seldom at temperatures below 13 to 14°C. Peak spawning activity occurs at about 18° C and declines rapidly thereafter (Smith and Wells 1977).

The number of mature ova in female striped bass varies by age, weight, and fork length. Jackson and Tiller (1952) found that fish from Chesapeake Bay produced from 62,000 to 112,000 eggs/pound of body weight, with older fish producing more eggs than younger fish. Raney (1952) observed egg production varying with size, with a 3 pound (1.4 kg) female producing 14,000 eggs and a 50-pound (23 kg) specimen producing nearly 5,000,000.

When ripe, the ovaries are greenish-yellow in color (Scofield 1931). After fertilization, the semi-buoyant eggs of striped bass are transported downstream or, if spawned in slightly brackish water, back and forth by tidal circulation. Hatching occurs in about 70-74h at 14-15°C, in 48h at 18-19°C, and in about 30h at 21-22°C (Bigelow and Schroeder 1953).

Newly hatched bass larvae remain in fresh or slightly brackish water until they are about 12 to 15 mm long. At that time, they move in small schools toward shallow protected shorelines, where they remain until fall. Over the winter, the young concentrate in deep water of rivers. These nursery grounds appear to include that part of the estuarine zone with salinities less than 3.2 $^{0}/_{00}$ (Smith 1970).

Maryland data suggest that full maturity of females is not achieved until age-8. Maryland data were accepted as valid and were used to guide changes in size limits needed to meet the management requirements of Amendment 3 to the FMP (i.e., to protect 95% of females of the 1982 and subsequent year classes until they had an opportunity to spawn at least once). Maryland maturity data were also incorporated into modeling work performed in order to develop management regimes specified in Amendment 4 to the FMP (ASMFC 1990).

There are indications that some older striped bass may not spawn every year (Raney 1952). Merriman (1941) reported that large, ripe females are regularly taken from Connecticut waters in late spring and early summer, during the regular spawning period. Jackson and Tiller (1952) reported curtailment of spawning in about 1/3 of the fish age-10 and older taken from Chesapeake Bay, though they also found striped bass up to age-14 in spawning condition.

Striped bass, like many fish populations, shows high interannual variability in recruitment (Figure B5.3). Martino and Houde (2012) found density-dependent effects on growth and mortality in the upper Chesapeake Bay for age-0 striped bass, where growth rates were higher and mortality rates lower in years with lower juvenile density. Kimmerer et al. (1998) found similar results for striped bass on the Pacific coast. Environmental effects have also been shown to be correlated with recruitment success in striped bass, including over-winter temperatures, hydrological conditions, and zooplankton prey availability (Hurst and Conover 1998; Martino and Houde 2010 and 2012).

The Maryland recruitment index reached its lowest values during the early 1980s, when the stock was heavily overfished. Recent years of lower recruitment (during a period of high female SSB) has led to speculation that a Ricker curve might be appropriate to describe the striped bass stock-recruitment relationship. However, the mechanism behind that kind of overcompensation is unclear for this species. The classically accepted mechanism is cannibalism, and while it has been documented in striped bass, it is a rare event occurrence, and even in studies conducted after the stock recovery, conspecifics make up only a tiny fraction of striped bass diet (NEFSC 2013).

### B4.5.7 Female Maturity

The 2013 striped bass benchmark stock assessment (NEFSC 2013) listed development of maturity ogives applicable to coastal migratory stocks as a moderate level research priority. The female striped bass maturity schedule used in the 2013 benchmark stock assessment is based on a 1987 white paper by Jones. In the white paper, data for ages 4-6 were based on relative CPUEs by sex from the 1985-1987 Maryland Spawning Stock Survey (gill net), while data for ages 7-8 appear to be from a Texas Instruments study (Texas Instruments Inc. 1980) done on the Hudson River from 1976-1979 that used a gonadosomatic index to determine maturity.

Both methods use an indirect, rather than histological approach, to estimate female maturity-at-age and the work has not been updated since the stock was rebuilt. The estimated female maturity-at-age was improved by using newer, standardized, and more detailed histological techniques that reflect the dynamics of a restored stock. While the work is summarized here, more information on the analysis can be found in Appendix B2.

The majority of the sampling effort (68%) was on fish between 520-879 mm TL which were estimated to be between 5-8 years old based on Maryland age-length keys. Sampling was focused on this size/age range to adequately characterize the steepest part of the current maturity ogive. However, samples were also collected at smaller and larger sizes where fish were expected to be mostly immature or all mature, respectively. By using only samples from the Chesapeake Bay, the results may be biased towards immature, pre-migratory fish and mature, migratory fish, while lacking immature migratory females that remain on the coast. To minimize this bias, complementary sampling was conducted by coastal states to fill in missing length groups. The New Jersey Bureau of Marine Fisheries, Rhode Island Division of Marine Fisheries, and the Northeast Area Monitoring and Assessment Program (NEAMAP) contributed samples from their routine surveys (Table B5.1). Ovaries were collected from the various surveys in the months of March through July and September through December during pre-spawn, spawning and post-spawn periods (Table B5.2). Total length (mm TL), weight (kg), visual (macroscopic) maturity stage, and external anomalies were recorded from all fish. Scales were collected to assign ages to fish sampled, as scale ages for striped bass are generally accurate through age ten (NEFSC 2013). Otoliths were also collected and could be used for future age validation.

Histological slides were prepared by the Maryland DNR Diagnostics & Histology Laboratory at the Cooperative Oxford Laboratory and followed methods from Boyd (2011). Slides were viewed under 40X or 100X magnification through a dissecting scope, and maturity stages were assigned according to the categories defined in Brown-Peterson et al. (2011). Slides were examined by three biologists to determine the final maturity stage. If there was disagreement between the readers, the slides were viewed and discussed until a final stage was agreed upon. The maturity-at-age data were analyzed using logistic regression by specifying the logit link in a binomial generalized linear model (GLM) in R (R Core Team 2016).

Brown-Peterson et al. (2011) defines immature fish as a gonadotropin independent phase and "fish enter the reproductive cycle when gonadal growth and gamete development first become gonadotropin dependent (i.e., the fish become sexually mature and enter the developing phase)." While a striped bass may enter the developing phase and be physiologically mature, it does not necessarily indicate that the fish will spawn in the upcoming spawning season (Olsen and Rulifson 1992; Berlinsky et al. 1995; Boyd 2011). For this reason, the data were analyzed in two ways: as the percent mature (with developing through regenerating phases designated as mature) and as percent spawning (spawning capable through regressing phases indicating spawning is imminent or completed). When developing fish were considered mature, the age of 50% maturity was 3.6 years old, much lower than the age that the Maryland Spawning Stock Survey observes females on the spawning grounds. Since 1994, no females younger than age four have been caught in the spawning stock survey and only 12 four-year-old fish have been caught in that time. Comparatively, the age of 50% maturity when developing fish were not included as imminently spawning was 5.8 years old and aligned better with observations from the spawning stock survey. For these reasons, the results presented here will only consider fish mature if they are imminently spawning or spawning is completed.

A total of 428 fish were sampled with the majority between the ages of 4 and 6 (Table B5.3). Data were analyzed using two time periods: March-July data (Figure B5.1) and the whole dataset (March-December, Figure B5.2). The GLM estimated maturity-at-age using the whole data set was generally slightly lower when compared to the spring-only dataset (Figure B5.3). Using the observed proportions mature, the maturity-at-age was more similar with the exception of ages 5 and 6 (Figure B5.3).

Studies are often recommended to be done either prior to spawning (Hunter and Macewicz 2003) or prior to and during the spawning season (Murua et al. 2003). This would align best with our March-July data subset or possibly even a smaller subset. However, consideration must also be given to the distribution of fish across the study area, particularly when immature and mature individuals occur in different areas (Berlinsky et al. 1995; Hunter and Macewicz 2003; Murua et al. 2003). It is for this reason that Berlinsky et al. (1995) sampled during the spring and fall feeding migrations even though this required an assumption that maturation rates were not significantly different among stocks. For these reasons and because it includes more coastal fish, this assessment used the maturity-at-age values derived from the full dataset. These values are similar to those reported by Berlinsky et al. (1995) for ages 3-5 and those reported by Jones (1987) for ages 6-9 (Table B5.4).

### B4.5.8 Predators and Prey

Bluefish, weakfish, and other piscivores prey on juvenile striped bass (Hartman and Brandt 1995b; Buckel et al. 1999; Gartland et al. 2006). Gartland et al. (2006) reported that striped bass in age-0 bluefish diets was the secondary important prey (10.7% in %W) in the lower Chesapeake Bay and coastal ocean of Virginia in June of 1999 and 2000. Adult striped bass consume a variety of fish (e.g., *Brevoortia tyrannus, Anchoa mitchilli*, *Mendia* spp.) and invertebrates (e.g., *Callinectes sapidus, Cancer irroratus, Homarus americanus*), but the species consumed depends upon predator size, time of year, and foraging habitat (Schaefer 1970; Hartman and Brandt 1995a; Nelson et al. 2003; Nemerson and Able 2003; Watler et al. 2003a; Rudershausen et al. 2005; Costantini et al. 2008; Overton et al. 2008; Ferry and Mather 2012). Several previous studies examined and discussed possible historical shifts in the diets of striped bass in Chesapeake Bay (Griffin and Margraf 2003; Pruell et al. 2003; Walter and Austin 2003; Overton et al. 2009 and 2015). Griffin and Margraf (2003) compared the diets of striped bass collected in the 1950s to those published since 1999. They found that small striped bass (a mean FL of 276 mm) consumed more invertebrates while large striped bass (a mean FL of 882 mm) relied more on small pelagic fish prey (such as bay anchovies and age-0 clupeids) in current years than in the 1950s. Pruell et al. (2003) examined δ 13C in striped bass scales collected from Chesapeake Bay between 1982 and 1997 and suggested that enrichment of δ 13C through the years could be due to a historical diet shift from fish prey to invertebrate prey. Although Walter and Austin (2003) and Overton et al. (2009) did not directly examine historical diets of striped bass, by comparing their findings to the results from previous studies, both studies concluded that striped bass consumed more benthic prey (such as blue crabs). However, all the studies interpreted their conclusions of the historical diet shifts with caution. They believed that other confounding factors, such as ontogenetic development, environmental change, and feeding locations could also contribute to their findings.

After recovery of Atlantic Coast striped bass was declared in 1995 (Richards and Rago 1999), concern emerged about the impact of high striped bass population size on its prey-base, and multiple analyses suggested that the recovered striped bass population had the potential to deplete prey populations along the Atlantic Coast (Griffin and Margraf 2003; Hartman 2003; Uphoff 2003; ASMFC 2004; Savoy and Crecco 2004; Heimbuch 2008; ASMFC Weakfish Technical Committee 2009; Davis et al. 2012; Davis 2016). In recent years, a particular interest was paid to the role of striped bass as the predator of Atlantic menhaden (ASMFC 2008; ASMFC 2014; Buccheister et al. 2017; Uphoff and Sharov 2018). To assess the role of striped bass, ASMFC developed a version of the multispecies VPA with striped bass, bluefish and weakfish as menhaden predators (Garrison et al. 2010). The MSVPA-X predicted that Atlantic Menhaden comprised a moderate proportion of striped bass diet biomass (15-30%) and those consumed consisted largely of age-0 and age-1 Atlantic Menhaden (ASMFC Multispecies Technical Committee 2008; ASMFC Atlantic Menhaden Technical Committee 2010). However, diet studies of large striped bass by Walter and Austin (2003) and Overton et al. (2008) suggested a greater role of Atlantic Menhaden of all ages in striped bass diets. Atlantic Menhaden were often dominant prey in studies of striped bass diets in the Chesapeake Bay and the mid-Atlantic region, and were important prey in New England waters (Walter et al. 2003; Walter and Austin 2003; Ruderhausen et al. 2005; Nelson et al. 2006; Overton et al. 2008; 2009; Overton et al. 2015).

### B4.5.9 Natural Mortality and Disease

Striped bass are a long-lived species, with a maximum age of approximately 30 years, suggesting natural mortality is relatively low. Early assessments assumed an age-constant M of 0.15, consistent with Hoenig's (1983) regression on maximum age. In the 2013 benchmark assessment, age-specific M estimates for ages 1-6 were derived from a curvilinear model fitted to tag-based Z estimates (assuming Z=M) for fish younger than age3 from New York and tag-based M estimates (Jiang et al. 2007) for age three to six striped bass from Maryland calculated for years prior to 1997 (Appendix B3). Natural mortality estimates from NESFC (2013) were used in this assessment.

The epizootic of *Mycobacteriosis* was first detected in the Chesapeake Bay in 1997 (Heckert et al 2001; Rhodes et al. 2001). However, a retrospective examination of archived tissue samples by Jacobs et al. (2009a) suggested that *Mycobacteriosis* was apparent in Chesapeake Bay striped bass as early as 1984. A rise in Mycobacterium disease in the Chesapeake Bay could be causing increases in natural mortality (Pieper 2006; Ottinger and Jacobs 2006). Two primary hypotheses have emerged regarding the mechanism for increased natural mortality (Vogelbein et al. 2006). One is that elevated nutrient inputs to the Chesapeake Bay, with associated eutrophication, results in loss of thermal refugia for striped bass, forcing them into suboptimal and stressful habitat during the summer. A second is that alternations in trophic structure and starvation have resulted due to over-harvest of key prey species such as Atlantic menhaden (*Brevoortia tyrannus*) and reductions in the forage base in the Chesapeake Bay.

Prevalence of the disease ranges from ~50%, as determined through standard histological methods (Overton et al. 2003), to 75% with molecular techniques (Kaattari et al. 2005). Prevalence is dependent on the age class sampled with prevalence increasing with age to approximately age 5 and then decreasing in older ages (Kaattari et al. 2005; Gauthier et al. 2008). The decline in prevalence with older ages is likely due to either increased mortality in fish which have contracted the disease and do not live to older ages due to limited ability of striped bass to resolve the disease once it is contracted (Matt Smith, *unpublished data*) or cessation of disease and/or healing as fish migrate to ocean waters (Kane et al. 2006). *Mycobacteriosis* appears to be much less prevalent in other producer areas such as the Delaware Bay (Ottinger et al. 2006) and the Albemarle Sound/Roanoke River (Overton et al. 2006; Matsche et al. 2010).

Although fish who are infected with the disease show overall decreased health (Overton et al. 2003), the slow progression of the disease may take years to become lethal in infected fish, thus allowing for multiple spawning opportunities, making determination of the population level impacts of the disease difficult (Jacobs et al. 2009b). However, recent estimates of annual survival of diseased fish relative to non-diseased fish have been made. Gauthier et al. (2008) estimated relative survival of diseased fish was 0.69 (0.55 – 0.84), while Hoenig et al. (2017) reported relative survival of diseased fish ranging from 0.54 to 0.96 depending on the severity of the disease. They also noted that if the mortality associated with the disease is additional to pre-disease estimates of natural mortality, this is equivalent to a change of natural mortality from 0.15 to 0.29 (95% CI 0.20–0.37), or almost a doubling of the natural mortality rate in the population.

In the most recent study, Groner et al. (2018) used a multi-event, multistate mark– recapture model (MMSMR) to quantify *Mycobacteriosis* processes and impacts on the population of striped bass in the Chesapeake Bay. The majority of fish tagged (95%) from the Rappahannock River, Virginia, were between 457 mm and 610 mm, corresponding to ages 3-5. They reported that this disease impacts nearly every adult striped bass. Mortality of diseased fish was high, particularly in severe cases, where it approached 80%. For both healthy and diseased fish, mortality increased with the modeled average summer sea surface temperature (SST); in warmer summers (average SST ≥ 29°C), a cohort is predicted to experience >90% mortality in 1 year. Groner et al. (2018) suggested that these fish are living at their maximum thermal tolerance and that this is driving increased disease and mortality. Accounting for additional mortality due to disease and temperature may result in more conservative population trajectories. Groner et al. (2018) further suggested that disease-associated mortality will likely increase with warming temperatures in the Chesapeake Bay, so these changes will be relevant into the future. Continued monitoring of disease in striped bass is advised to account for the effects of temperature and disease.

### B4.5.10 Potential Impacts due to Climate Change

Climate change has the potential to affect striped bass. Striped bass exhibit a number of characteristics identified by NOAA as increasing their vulnerability to climate change effects, including complexity of reproductive strategy, short duration aggregate spawning, sensitivity to temperature, prey-specificity, and specific larval requirements (Morrison et al. 2015). Recent literature, outlined below, provides some information about how climate change, including rising sea temperatures, changes in weather patterns, and more frequent extreme weather events may affect striped bass specifically.

Temperature is correlated with a number of aspects of striped bass biology. Time to hatch and egg and larval mortality (Massoudieh et al. 2011) are affected by temperature and temperatures above 18° C have been found to affect larval growth length and yolk utilization (Peterson et al. 2017). Activity levels (Hollema et al. 2017) and metabolic rate, consumption, and growth (Secor et al. 2000) are also correlated with temperature. Secor et al. (2017) found that seasonal changes in temperature affected growth and mortality in striped bass larvae. Manderson et al. (2014) concluded that changes in seasonal temperature and precipitation could impact the suitability of small estuarine tributaries as juvenile striped bass habitat. Temperature also affects daily, vertical movements (Keyser et al. 2016), and may, for example, affect availability to anglers if fish seek deeper waters as water temperatures rise.

The correlation between temperature and habitat selection/migratory behavior in striped bass is well established (e.g. Able and Grothues 2007; O'Connor et al. 2012). Estuarine residence time of young striped bass is affected by the temperature of freshwater discharge (Manderson et al. 2014). Williams and Waldman (2010) documented striped bass using power plant effluent as a warm-water refuge in the winter. Hollema et al. (2017) found that the presence of striped bass in Plymouth, Kingston, and Duxbury Bay, Massachusetts, was significantly correlated with temperature, and that individuals left the bay when water temperature reached 16.8° C. Brent et al. (1999) observed striped bass seeking cooler waters when temperatures were over 25° C. Temperature (along with photoperiod) has been shown to be a cue to fish to begin their fall migration (Wingate and Secor 2007; Hollema et al. 2017; Manderson et al. 2014).

In addition to rising sea temperatures, climate science predicts an increase in extreme weather events, such as hurricanes, coastal flooding, and marine heat waves (Herring et al. 2015). Bailey and Secor (2016) document novel migration in striped bass in the Hudson River Estuary related to high storm activity. Rates of freshwater flow can have significant impacts on transport and abundance of striped bass larvae within estuaries (Dunning et al. 2009; O'Connor et al 2012). Growth and mortality rates of striped bass larvae are affected by storm events (Secor et al. 2017)

## B4.6 Fishery Dependent and Independent Indices of Abundance

States provide age-specific and aggregate indices from fisheries-dependent and fisheries-independent sources that are assumed to reflect trends in striped bass relative abundance. A formal review of age-

2+ abundance indices was conducted by ASMFC at a workshop in July of 2004 (Appendix B4); young of-the-year and age-1 indices had been reviewed and validated previously (ASMFC 1996). The 2004 workshop developed a set of evaluation criteria and tasked states with a review of indices. Both the Technical Committee and the Board approved the criteria and the review. The resulting review led to revisions and elimination of some indices formerly used in the ADAPT VPA. For the 2018 benchmark assessment, based on the review of survey programs and Technical Committee recommendations, some changes were made to the suite of indices.

The Virginia Pound Net Index was dropped, due to concerns about the single, fixed-station design and the uncertainty about the future funding of the survey. The NEFSC Bottom Trawl Survey was also dropped, due to concerns about the low proportion of positive tows and the time-series ending in 2008 with a vessel change and the loss of the inshore strata that comprised the previous index.

The ChesMMAP survey (Section B5.2.2.15) was introduced to replace the information about adult fish in the Chesapeake Bay that the Virginia Pound Net Index provided. The Delaware Bay 30' Trawl survey (Section B5.2.2.9) was introduced to provide additional information about striped bass in the Delaware Bay.

Age-structure information was developed for indices that had previously been treated as age-aggregated indices (the MRFSS/MRIP CPUE and the Connecticut Long Island Sound Trawl Survey), so that the model could fit to both total index values and proportion at age information.

The Striped Bass SAS explored using GLMs to standardize the fishery independent indices for input into the model. However, the SAS ran into several issues with the standardization process, including problems with convergence and model diagnostics for some indices. In addition, not all surveys collected environmental covariates consistently across the entire time series, which would have resulted in the truncation or missing values in the time series. As a result, with a few exceptions noted below, the SAS chose to use the design-based geometric mean index values.

### B4.6.1 Fisheries-Dependent Catch Rates

#### *B4.6.1.1 MRIP Total Catch Rate Index*

An index of relative abundance for the coastal mixed population of striped bass was developed from MRFSS/MRIP intercept data. The complete MRFSS/MRIP intercept dataset was subset to private/rental boat trips that occurred in ocean waters during Waves 3-5 for states from Maine through Virginia. A guild approach was used to identify striped bass trips. For each state, a subset of commonly caught species was created (i.e., species that were intercepted at least 100 times over the entire time series). For each trip in that state, the presence or absence of each of the commonly caught species was recorded. A Jaccard coefficient was calculated for each species as:

$$S_j = \frac{a}{a+b+c}$$

Where:

- $a$ = number of trips where striped bass and species $j$ were caught together
- $b$ = number of trips where striped bass was caught but not species $j$
- $c$ = number of trips where species $j$ was caught but not striped bass

The Jaccard coefficient was used to identify species that were commonly caught with striped bass in order to better identify striped bass trips with zero striped bass catch. For each state, a subset of striped bass trips was created from all trips that caught either striped bass or the species with the highest Jaccard coefficient (meaning it was the species caught most often with striped bass). For most states, bluefish or Atlantic mackerel had the highest Jaccard coefficient (Figure B5.4).

The state subsets of striped bass trips were combined into a coastwide set of trips. An index of abundance was calculated using a zero-altered/hurdle model that predicted the number of striped bass per trip as a function of year, wave, state, area fished (state or federal waters), and avidity (number of days fished in the last 12 months). The natural log of hours fished was used as an offset. The model was fit using the *hurdle()* function in the *pscl* package in R. The hurdle model used a binomial model to predict the presence or absence of striped bass on a trip and a negative binomial model was used to predict the number of striped bass caught on positive trips. The statistically important factors for each component of the hurdle model were identified by comparing AIC values across different model formulations; the full model had the lowest AIC for both the binomial and count components. Bootstrapping was used to calculate confidence intervals and CVs for the index.

Age composition for the MRIP index was developed from the total catch-at-age for assessment period-3 for the ocean area. This combined the state-by-state catch-at-age for the harvest with the catch-at-age for the live releases (not scaled by release mortality as was done for the removals at age).

The MRIP index was low in the 1980s, increased through the 1990s to a peak in 1998 before slowly declining through 2010 (Table B5.5; Figure B5.5). The index has been steady since then with an uptick at the end.

### B4.6.2 Fisheries-Independent Survey Data

#### *B4.6.2.1 Connecticut Long Island Sound Trawl Survey (CTLISTS)*

Connecticut provides an aggregate index of relative abundance from a bottom trawl survey. The Connecticut DEEP Marine Fisheries Division has conducted a fisheries–independent Trawl Survey in Long Island Sound since 1984. The Long Island Sound Trawl Survey (LISTS) provides fishery independent monitoring of important recreational species, as well as annual total counts and biomass for all finfish taken in the Survey. Most species are measured on all tows including striped bass. Striped bass lengths were converted to ages using the same age-length keys used to age CT's recreational catch to develop proportions at age for the index. The Long Island Sound Trawl Survey encompasses an area from New London, Connecticut (longitude 72$^{o}$ 03') to Greenwich, Connecticut (longitude 73$^{o}$ 39'). The sampling area includes Connecticut and New York state waters from 5 to 46 meters in depth and is conducted over mud, sand and transitional (mud/sand) sediment types. Long Island Sound is surveyed in the spring (April-June) and fall (September-October) periods with 40 sites sampled monthly for a total of 200 sites annually.

The sampling gear employed is a 14 m otter trawl with a 51 mm codend. To reduce the bias associated with day-night changes in catchability of some species (Sissenwine and Bowman 1978), sampling is conducted during daylight hours only. LISTS employs a stratified-random sampling design. The sampling area is divided into 1.85 x 3.7 km (1 x 2 nautical miles) sites, with each site assigned to one of 12 strata defined by depth interval (0 - 9.0 m, 9.1 - 18.2 m, 18.3 - 27.3 m or, 27.4+ m) and bottom type (mud, sand, or transitional as defined by Reid et al. 1979). For each monthly sampling cruise, sites are selected randomly from within each stratum. The number of sites sampled in each stratum was determined by dividing the total stratum area by 68 $km^2$ (20 square nautical miles), with a minimum of two sites sampled per stratum. Discrete stratum areas smaller than a sample site are not sampled. The CT LISTS index is computed as the stratified geometric mean number per tow.

The CT LISTS index showed an increasing trend from low levels from the mid-1980s through the late 1990s (Table B5.5, Figure B5.6). It varied without trend through the early 2000s before declining somewhat from about 2007 onwards. The CT LISTS captures primarily age-2-4 fish, but has captured individuals across the full range of ages (Figure B5.6). The age composition of the index showed an expansion in the age structure along with the increasing trend through the late 1990s and then a slight contraction; although striped bass up to age-15+ have been caught in recent years, fewer age-6 – 10 fish were captured recently than in previous years (Figure B5.6)

***B4.6.2.2 Northeast Fisheries Science Center Bottom Trawl Survey (NEFSC)***

The Northeast Fisheries Science Center provided an aggregate (2-9) index of relative abundance from the spring stratified-random bottom trawl survey in previous assessments. The survey covers waters from the Gulf of Maine to Cape Hatteras, North Carolina. Only data from inshore strata from 1991-2008 were used. The survey was dropped for this assessment due to concerns about the low proportion of positive tows and the time-series ending in 2008 with a vessel change and the loss of the inshore strata that comprised the previous index.

***B4.6.2.3 New York Young-of-the-Year (NYYOY)***

The juvenile striped bass beach seine survey is New York's most standardized Hudson River striped bass survey and the data is used for the annual striped bass juvenile abundance index. This survey targets young-of-year striped bass in the lower, brackish, tidal portion of the Hudson River Estuary (river miles 22-39) rkm 35-63. The beach seine used in this study is an off-center 200 ft (61 m) seine with one wing measured at 150 ft x 10 ft (45.7 m x 3.05 m), a second smaller wing at 30 ft x 10 ft (9.1 m x 3.05 m) and a bunt measuring 20 ft x 12 ft (6.1 m x 3.7 m). The seine is constructed with 0.25 in (0.64 cm) bar mesh, with floats and a lead line. The floats at each end of the bunt are marked with a different color from the others.

The net is deployed from the rear starboard side of the boat. After nosing into a sample site, the end of the net with the shorter wing is landed and held on the beach, the boat is then rotated to face out from the beach, and the entire net is fed off the rear starboard side in a horseshoe fashion, ending back at the shoreline. With the horseshoe set completed, the river end of the net is dragged the remaining way to shore by hand. The net is then hauled to shore starting at the end with the large wing. Once the buoys marking the bunt are centered, both wings of the net are brought in so that the bunt comes in last. All fish collected are identified to species, counted and returned to the river. A subset of 30 individuals per seine haul of striped bass are measured for total length (mm). Water quality data, including temperature, salinity, pH, dissolved oxygen, conductivity and total dissolved solids is taken at each site, as are prevailing conditions, including wave height, wind velocity, cloud cover, and tide stage. Effort is defined as one haul.

At its Spring 2014 meeting, the Board approved a proposal to revise New York's Hudson River Juvenile Abundance Index. The "old" striped bass index was based on a 6-week, 25-station survey, which was initiated in 1979. Sampling was conducted from August through November. The “new” index is based on three additional weeks of sampling in mid-July, which have been sampled since 1985. The “new” survey runs from mid-July through November. The number of stations has been reduced from 25 to 13, due to staffing constraints, unsafe sites, and redundant habitat sampled, but retains the broad geographical range of the nursery area. Historical replacement sites were chosen when the current sites were not historically sampled. These were selected using proximity to the current site.

The NYYOY index began with two very low points in 1985 and 1986 before jumping to time series high values in 1987 and 1988; it has varied without trend since then (Table B5.6, Figure B5.7).

***B4.6.2.4 New York Western Long Island Beach Seine Survey (NY Age-1)***

The Western Long Island Survey began in 1984, sampling fixed stations in three bays: Little Neck Bay (LNB, 4 stations), Manhasset Bay (MB, 4 stations), and Jamaica Bay (JAM, 9 stations). Sampling of each bay is conducted using a 61 m by 3 m beach seine net (the same gear as the Hudson River YOY survey). Each bay is sampled twice per month. A single haul is conducted per station at each bay. Sampling occurs during daylight hours. Little Neck and Manhasset Bays are generally sampled on the same day; Jamaica Bay is generally sampled on a different day from LNB/MB, over a period of two days. The yearling (Age -1) index is calculated from samples collected during May through August. Striped bass are counted and measured, and scales are taken to determine ages. The Index is calculated as the geometric mean catch per haul. Other variables measured at each station included surface water salinity, surface water dissolved oxygen, bottom type, cloud cover, wind direction, wind velocity, air temperature, and sampling month. Consistent recording of surface water salinity, surface water dissolved oxygen, and bottom type were not made until 1988.

The NY Age-1 index showed a slight increasing trend through the late 1980s and 1990s followed by a slight declining trend through the 2000s (Table B5.6, Figure B5.7). The index identified strong year classes in 2010 and 2014, consistent with the YOY index (Figure B5.7)

***B4.6.2.5 New York Ocean Haul Seine (NYOHS)***

New York provides age-specific geometric mean indices of relative abundance for striped bass generated from an ocean haul seine survey that took place from 1987-2006. In 1987, New York DEC started sampling the mixed coastal stocks of striped bass by ocean haul seine. Sampling was conducted annually during the fall migration on the Atlantic Ocean facing beaches off the east end of Long Island. A crew of commercial haul seine fishermen was contracted to set and retrieve the gear, and assist department biologists in handling the catch. The survey seine measured approximately 1,800 feet (550 m) long and was composed of two wings attached to a centrally located bunt and cod end. The area swept was approximately ten acres. The seine was 15 feet (4.5 m) deep in the wings and twenty feet deep in the bunt.

Under the original design, sampling dates were selected at random to create a schedule of thirty dates. For each date selected, two of ten fixed stations were chosen at random, without replacement, as the sampling locations for that day. Since this design was difficult to implement due to weather-related delays, the sampling design was altered in 1990. Instead of randomly selecting thirty days, sixty consecutive working days were identified during the fall. One station was randomly selected, without replacement, for each working day until six "rounds" of ten hauls had been scheduled. Hauls that were missed due to bad weather or equipment failure were added to the next scheduled sampling day. No more than three hauls were attempted for any given day so that sampling was evenly distributed over time. Sixty hauls were scheduled for each year.

Since 1995, the survey team was prohibited from gaining access to several of the fixed stations. Instead of the original ten stations, two of the original stations plus three alternate sites were used to complete the annual survey. These alternate stations occur within the geographic range of the original standard stations. In 1995, funding delays resulted in a one-month delay in the commencement of field sampling activities. Between 1987 and 1994 field sampling began in early September. Since 1995, sampling began in late September to early October. In addition, decreased funding led to reductions in annual sampling effort from sixty seine hauls to forty-five seine hauls per season as of 1997. The time series of catch and catch-at-age was standardized by date for the entire time series. An Age-1+ index is calculated as a geometric mean.

The NYOHS index did not show a strong trend across its time series, although it was generally higher from 1996 – 2006 than from 1987 – 1995 (Table B5.5, Figure B5.8). The index age composition showed an expanding age structure from the late 1980s through the mid-1990s (Figure B5.8).

#### *B4.6.2.6 New Jersey Bottom Trawl Survey (NJTRL)*

New Jersey provides age-specific (2+) geometric mean indices of relative abundance for striped bass from a stratified-random bottom trawl initiated in 1989. The survey area consists of New Jersey coastal waters from Ambrose Channel, or the entrance to New York harbor, south to Cape Henlopen Channel, or the entrance to Delaware Bay, and from about the three fathom isobath inshore to approximately the 15 fathom (27 m) isobath offshore. This area is divided into 15 sampling strata. Latitudinal boundaries are identical to those which define the sampling strata of the National Marine Fisheries Service (NMFS) Northwest Atlantic groundfish survey. Exceptions are those strata at the extreme northern and southern ends of New Jersey. Where NMFS strata are extended into New York or Delaware waters, truncated boundaries were drawn which included only waters adjacent to New Jersey, except for the ocean waters off the mouth of Delaware Bay, which are also included.

Samples are collected with a three-in-one trawl, so named because all the tapers are three to one. The net is a two-seam trawl with forward netting of 12 cm (4.7 inches) stretch mesh and rear netting of 8 cm (3.1 inches) stretch mesh. The codend is 7.6 cm stretch mesh (3.0 inches) and is lined with a 6.4 mm (0.25 inch) bar mesh liner. The headrope is 25 m (82 feet) long and the footrope is 30.5 m (100 feet) long. Trawl samples are collected by towing the net for 20 minutes.

The total weight of each species is measured with hanging metric scales and the length of all individuals comprising each species caught, or a representative sample by weight for large catches, is measured to the nearest centimeter (cm) total length and only data from April are used for striped bass. Additionally, offshore strata are not included in the index due to low incidence of striped bass.

The NJTRL index was low at the beginning of its time series in 1990, before jumping up in the mid-1990s; it has been mostly high and variable since then (Table B5.5, Figure B5.9). The 2015 value was a time-series low, but the 2017 value was the second highest in the time-series. The age composition showed an expanding age structure through the 1990s and early 2000s followed by a contraction (Figure B5.9).

### *B4.6.2.7 New Jersey Young-of-the-Year Survey (NJYOY)*

A survey of juvenile abundance in the Delaware River has been conducted by the New Jersey Department of Environmental Protection since 1980 using a 30.5 m x 1.8 m beach seine with 5 mm mesh deployed with a vessel. The sample design involved 16 fixed stations sampled twice monthly from mid-July to mid-November, with two hauls per station. The survey design was re-evaluated in 1990 reducing the sampling frame of August through October, no replicate tows per station and incorporating both fixed and random stations. This design was followed until 1998 when the survey was again modified, returning 32 fixed stations sampled twice per month between mid-July and October (mid-June to mid-November 2002-2016) with no replicate tows per station. The NJYOY index is calculated as a geometric mean number per haul of all stations (first haul only where applicable) between August and October, inclusive.

The NJYOY index increased from the 1980s through the mid-1990s and remained at or above average into the early 2000s; the index become more variable after that, with more below-average year classes (Table B5.6, Figure B5.10)

### *B4.6.2.8 Delaware Spawning Stock Electrofishing Survey (DESSN)*

Delaware Division of Fish and Wildlife (DEDFW) provides an Age-1+ geometric mean index of relative abundance from its Spawning Stock Survey (DESSN) conducted from the lower Delaware River at the Delaware Memorial Bridge to the mouth of Big Timber Creek, New Jersey, which encompasses the main spawning grounds in the Delaware River. The spawning grounds are divided into lower and upper zones. The lower zone has twelve sampling stations extending from the Delaware Memorial Bridge to the boundary between the states of Delaware and Pennsylvania. The upper zone has thirteen sampling stations and extends from the Commodore Barry Bridge to Big Timber Creek. The average station length is approximately 1.6 km (ranges is roughly 1.1-2.2 km), however, the segment within each station sampled varies on any particular day depending on the direction of tidal current and fish abundance. Depth at each station ranges from 0.9 to 9.1 m. In addition to the shoreline stations, sampling is also conducted at Cherry Island Flats, a submerged island in the lower zone, as well as along Little Tinicum and Chester Islands in the upper zone.

Stations within the lower and upper zones of the spawning grounds are grouped into two categories based on average catch rates from the previous three years. The annual catch rates have been expressed in numerous ways since the project inception. The survey adopted the use of a geometric mean in 2001 to mitigate for years with substantially less effort (e.g. 2007) or high variation in catch per station. Stations with catch rates below average are categorized as “low” stations, while stations with average or above average catch rates are categorized as “high” stations. On each sampling day, five high stations and three low stations are randomly selected from a given zone. Each of the upper and lower zones are typically sampled weekly throughout the spawning season, which generally extends from mid-April to late May or early June depending on water temperature (14-22°C). In addition to randomized collections, ancillary collections are made at productive stations to increase the number of tagged fish released and the number of samples obtained for age and growth analyses.

Fish are collected using a Smith-Root, Inc. model 18-E boat electrofisher. The standardized sampling time at each station is 720 seconds of pedal time. The boat is operated moving with the tidal current in a serpentine-shaped pattern. Only fish ≥200 mm TL are collected. Fish <200 mm TL, which are typically immature and not yet recruited to the spawning population, generally pass through the mesh of dip nets used aboard the electrofishing boat. Captured fish are held in an onboard, flow-through, 280 liter live-well until the station is completed or until the live-well is full.

All sexually mature fish are measured to the nearest mm total length (TL). Sex is determined by the expression of milt by palpation of the gonadal region of the abdomen, obvious outward appearance, or presence of free flowing eggs. The condition of females is also noted as gravid or spent when apparent. Only sexually mature fish are included in total catch and catch rate calculations. All fish ≥ 400 mm TL and in good physical condition are tagged with a numbered internal anchor tag as part of the coast-wide tagging program coordinated by the U.S. Fish and Wildlife Service. Scale samples are collected from all fish for subsequent age and growth analyses.

Overall, the survey would suggest no trend in the relative abundance of spawning capable striped bass from 1996-2017 (Table B5.5, Figure B5.11). Due to equipment failure and staffing limitations, an index value is not available in 2014. Peaks were observed in 2003 and 2011. However, the two lowest points in the time series were observed in 2015 and 2016. The lower values in the index in recent years were also associated with a lower proportion of older fish in the age composition (Figure B5.11).

***B4.6.2.9 Delaware 30' Bottom Trawl Survey (DE30)***

The DEDFW has conducted a 30' (9 m) trawl survey within the Delaware Bay since 1966 (1966-1971, 1979-1984, and 1990-present). The Delaware Bay trawl survey occurs one of the producer regions of striped bass hosting a spawning population. The survey has been shown to capture a wide size and age range of striped bass throughout the year historically. The Striped Bass Stock Assessment Subcommittee determined that the Delaware 30-foot trawl survey provides an index of striped bass abundance that correlates to other surveys used in the stock assessment including the DESSN Survey, and the NJTRL survey.

The survey (DE30) collects monthly samples from March through December at nine fixed stations throughout the Delaware portion of the bay. The net used has a 30.5 foot (9.2 m) headrope and 2" (5 cm) stretch mesh codend. Species represented by less than 50 individuals are measured for fork length to the nearest half-centimeter. Species with more than fifty individuals were randomly sub-sampled (50 measurements) for length with the remainder being enumerated. Striped bass from a wide size and age distribution have been historically available to the survey, due to the temporal and spatial coverage of the survey design, including young of year to larger, mature individuals, with fish frequently spanning in size from 10-30" (25-76 cm) TL in any given year, with a range of 1-50" (2.5-127 cm) TL (Figure B5.12).

The data were limited to years 1990 through present to account for discrepancies in early sampling methodology including the number of stations and tow times. Similarly, the data were filtered to include the months of November and December only, as this is the period when the majority of striped bass are caught.

The DE30 survey was chosen for inclusion in the current benchmark stock assessment given the wide range of sizes observed in the survey, the ability to track cohorts through time, and the significant cross-correlations with surveys incorporated in the stock assessment. An Age-1+ index is calculated as the geometric mean. In order to examine the potential progression of cohorts through time in the survey, the total number of fish was expanded to catch at age using the survey specific length frequencies by year, and available age length keys from 2002-2016.

Overall, the index has declined since the 1990s with three large peaks observed in 1995, 1999 and 2002 (Figure B5.13). However, the lowest point in the time series was also observed earlier in the time series in 1991. The index appears to stabilize after 2007 remaining lower than the observed earlier portions of the time series. The survey index generally matches the decline in total catch (commercial harvest, recreational harvest, and dead releases) from Delaware Bay beginning in the early 2000s.

Cohorts can be seen moving through the survey at multiple points in time including, but not limited to Age-1 in 2002, Age-2 and Age-3 in 2005 (Figure B5.13).The survey index was significantly cross-correlated with the DESSN survey and the NJTRL survey at multiple lags in time (Table B5.7, Figure B5.14). The most significant cross-correlation with the DESSN survey occurred at a lag=-4 years, suggesting that recruitment of fish to the DE30 survey is linked to recruitment of fish to the DESSN survey four years later. The most significant cross-correlation of the DE30 survey with the NJTRL survey occurred at a lag=-1 year, suggesting that fish recruited to the DE30 survey are related to fish observed in the NJTRL survey the following year.

***B4.6.2.10 Maryland Spawning Stock Survey (MDSSN)***

Data consists of records of fish captured during the Maryland DNR striped bass Spawning Stock Survey, 1985-2017. This fishery independent survey’s objectives include: estimating relative abundance-at-age for striped bass in Maryland’s portion of Chesapeake Bay; characterize the striped bass spawning population and apply USFWS internal anchor tags.

Survey sites are associated by NOAA codes and GPS coordinates, and one randomly selected site is fished per day. The current sites are located in the upper Potomac River and the Upper Chesapeake Bay. The Choptank River was sampled in 1985-1994, and 1996. The Potomac River was not sampled in 1994. The survey is conducted from late March through May, collecting fish with experimental drift gill nets constructed of multifilament nylon webbing. Individual net panels were approximately 150 feet (46 m) long, and ranged from 8.0 to 11.5 feet (2.5-3.5 m) deep depending on mesh size. The Upper Chesapeake Bay and Potomac panels were in 3.0, 3.75, 4.5, 5.25, 6.0, 6.5, 7.0, 8.0, 9.0 and 10.0-inch (8, 10, 11, 13 15, 17, 18, 20, 23, and 25 cm) stretch-mesh, and the Choptank River mesh sizes were similar, but slightly different. 1985-1989 used fewer mesh sizes, but by 1990 the 10 panels were standard. Gill nets were fished 6 days per week, weather permitting. Numbers of days sampled per year varies, as commercial fishermen bid on the job, which has a cap on the total dollar amount.

Data are used to calculate area, age, and sex-specific catch per unit of effort. Sex-specific selectivity coefficients for each mesh and length group were estimated by fitting a skew-normal model to spring data from 1990 to 2000 (Helser et al. 1998). Sex-specific selectivity coefficients were used to correct the mesh-specific length group CPUE estimates. The selectivity-corrected CPUEs were then averaged across meshes and weighted by the capture efficiency of the mesh, resulting in a vector of selectivity-corrected length group CPUEs for each spawning area and sex. A subsample of fish are aged, and sex-specific ALKs are created from these subsample of aged fish and a similar subsample from the Maryland Spring Creel Survey. These sex-specific ALKs were applied to the appropriate vectors of selectivity-corrected length group CPUEs to attain estimates of selectivity-corrected year-class CPUEs. Sex- and area-specific, selectivity-corrected, year-class CPUEs were calculated using the skew-normal selectivity model. These area- and sex-specific estimates of relative abundance were summed to develop estimates of relative abundance for Maryland's Chesapeake Bay. Before pooling over spawning areas, weights corresponding to the fraction of total spawning habitat encompassed by each spawning area were assigned. For years when the Choptank River was sampled, the weights were Upper Chesapeake Bay (0.59), Potomac (0.37) and Choptank (0.04). The Choptank River has not been sampled since 1996, therefore, values for 1997 to the present were weighted using only the Upper Chesapeake Bay (0.615) and the Potomac River (0.385; Hollis 1967).

The MDSSN index was variable but relatively flat since the mid-1980s, while the age composition of the index showed an expanding age structure (Table B5.5, Figure B5.15.)

***B4.6.2.11 Maryland Young-of-the-Year and Yearlings Surveys (MDYOY and MD Age1)***

Maryland provides an index of relative abundance for young-of-the-year (YOY) and yearling (age-1) striped bass in the Maryland portion of Chesapeake Bay. Begun in 1954, the fixed station survey is conducted in the Upper Chesapeake Bay, Choptank, Nanticoke, and Potomac Rivers. Each station is sampled once during each monthly round performed during July, August, and September. A bagless beach seine (30.5 m long) is set by hand with one end fixed on the beach and the other fully extended perpendicular to the beach. The seine is swept with the current. Two hauls are made at each site. Abundance indices are computed as the geometric mean number of YOY or age-1 striped bass per haul.

The MD Age-1 index was consistent with the MDYOY index, with a very similar overall pattern and identifying many of the same high and low year classes at a one year lag (Figure B5.16). From the mid-1950s through the early 1970s, the indices were variable but showed frequent strong year classes entering the population; however, from the mid-1970s to the late 1980s, the indices showed time series low values with no strong year classes (Figure B5.16). Very strong year classes appeared in 1993 and 1996, and the indices returned to a pattern similar to the beginning of the time series of variable but high recruitment. Declines were observed from 2004-2010, and in some years, the indices were close to low values not observed since 1990 (Table B5.6, Figure B5.16). However, strong year classes appeared in 2011 and 2015.

***B4.6.2.12 Virginia Young-of-the-Year Survey (VAYOY)***

Virginia provides an index of relative abundance for young-of-the-year striped bass in the Virginia portion of Chesapeake Bay. Begun in 1980, the fixed station survey is conducted in the James, York, and Rappahannock river systems. Eighteen index stations are sampled five times a year on a biweekly basis from mid-July through September. Twenty auxiliary stations provide geographically expanded coverage during years of unusual precipitation or drought when the normal index stations do not yield samples. A bagged beach seine (30.5 m long) is set by hand with one end fixed on the beach and the other fully extended perpendicular to the beach. The seine is swept with the current. Two hauls are made at each site. Abundance indices are computed as the geometric mean number of young-of-the-year or yearling striped bass per haul.

The VAYOY was low at the beginning of the time series before showing an increasing trend from the late 1980s through the early 2000s (Table B5.6, Figure B5.17). There was a period of low variability from 2004 – 2010 with no strong or weak year classes, but 2011 was the highest index value in the time series (Figure B5.17).

### *B4.6.2.13 Composite Young-of-Year Index for the Chesapeake Bay (MDVAYOY)*

The MDYOY and VAYOY surveys occur in different areas of the Chesapeake Bay and do not cover the same range of years, but both indices are designed to track recruitment of the Chesapeake Bay stock. The Conn method (Conn 2010) was used to combine both datasets into a single coherent index of recruitment for the Chesapeake Bay stock (MDVAYOY).

The SAS explored using both the geometric mean of each survey and a GLMM-standardized index for each survey as the input to the Conn method. Both sets of input data showed similar trends and identified the same strong and weak year classes, although there were some differences in the relative strength of some year classes (Table B5.6, Figure B5.19). In addition, the MDVAYOY index developed using the GLMM-standardized inputs had a consistently higher CV than the geometric mean version (Figure B5.18). Since the assessment model uses an iterative re-weighting scheme to adjust the CVs of the input data internally (see Section B7.1), this difference was less of a concern to the SAS. The MDVAYOY index developed with the geometric mean indices was used in the base run.

### *B4.6.2.14 Northeast Area Monitoring & Assessment Program (NEAMAP)*

The Northeast Area Monitoring & Assessment Program (NEAMAP) Southern New England and Mid-Atlantic (SNE/MA) Nearshore Trawl Survey was initiated in the fall of 2007 and is designed to sample the late-juvenile and adult stages of fishes during each of two (spring and fall) annual survey cruises sampling in near shore Atlantic waters between Cape Cod, Massachusetts, and Cape Hatteras, North Carolina. The cruises are timed to roughly correspond to those conducted by the Northeast Fisheries Science Center, though they are timed somewhat later than the federal survey during each season.

Due to the particular migration habits of striped bass as they relate to survey timing (during the spring survey most fish are spawning in the estuaries and during the fall survey most fish have not yet begun their southward migration), the NEAMAP SNE/MA survey is not currently considered to be a reliable indicator of stock abundance. However, valuable biological data were extracted from the survey for this assessment (e.g., age and sex data). NEAMAP SNE/MA captured at least one striped bass on approximately 8% of tows (3,636 specimens; 12,243 kg), so it may be worth examining these data for future assessment when the time series is longer.

### *B4.6.2.15 Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP)*

The Chesapeake Bay Multispecies Monitoring & Assessment Program (ChesMMAP) was initiated in 2002 and is designed to sample the late-juvenile and adult stages of fishes over multiple seasonal and geographic gradients. Five bimonthly cruises (i.e., Mar, May, Jul, Sep, and Nov) are conducted annually by the Virginia Institute of Marine Science (VIMS) in the mainstem of Chesapeake Bay.

Fishes and invertebrates are collected using a 13.7 m (headline length), two-bridle, four-seam bottom trawl. During each cruise, 80 sites are sampled at sites selected using a stratified random design, where strata are defined by both latitude and depth. The number of stations sampled in each stratum (i.e., region/depth combination) is proportional to the surface area of that stratum. Sites are selected for a given cruise without replacement.

Each catch is sorted by species and modal size group (e.g., small, medium, and large size) within species. A subsample of five individuals from each species/size group is selected for full processing (see next paragraph). For all remaining specimens, aggregate biomass (kg), individual length measurements, and count are recorded for each species-size group combination.

Data collected from each of the subsampled specimens include individual length, individual whole and eviscerated weights (g), and macroscopic sex and maturity stage (immature, mature-resting, mature-ripe, mature-spent) determination. Stomachs are excised and those containing prey items are preserved for subsequent examination at VIMS. Otoliths or other appropriate ageing structures are removed from each subsampled specimen for age determination at VIMS. For species known to exhibit sexually dimorphic growth such as striped bass, individual length, whole weight, and sex are recorded from an additional 15 specimens per size-class per species per tow.

The ChesMMAP index captures primarily ages 1-3 of striped bass (Figure B5.18). The index declined from 2005 – 2011 during a period of weak recruitment in the Chesapeake Bay, then showed increases as the strong 2011 and 2015 year classes moved through the population (Table B5.5, Figure B5.18).

### B4.6.3 Comparison of Fisheries-Dependent and Fisheries-Independent Indices

The time series of each index used in the current assessment are shown in Table B5.5 and Table B5.6.

Indices of Age-1+ abundance were classified by what component of the striped bass population they represented: the coastal mixed population (the MRIP CPUE, and the CTLISTS, NJTRWL, and NYOHS surveys), the Chesapeake Bay stock (MDSSN and ChesMMAP surveys), or the Delaware Bay/Hudson River stock (DESSN and DE30 surveys). The MRIP index and the CT LIST index showed similar trends for the coastal mixed stock; both were low during the 1980s and began increasing during the 1990s, but have since declined (Figure B5.21). The NJTRWL was low at the beginning of its time series in 1990, before jumping up in the mid-1990s; it has been mostly high and variable since then (Figure B5.21). The NYOHS showed no trend from the mid-1980s to the end of its time series in 2007 (Figure B5.21).

The MDSSN survey showed a relatively stable female SSB population since the mid-1980s; the ChesMMAP survey started later, in 2002, and has been more variable as it tracks a smaller, younger component of the population and is more influenced by recruitment (Figure B5.21).

The DE30 survey showed an increase from 1990 to a peak in 1995, and has been variable but generally declining since then, with the current index close to where it was at the beginning of the time series (Figure B5.21). The DESSN index has been more stable, fluctuating around its long-term mean (Figure B5.21).

Recruitment indices (YOY and age-1) in Chesapeake Bay were variable but declines were observed from 2004-2010, and in some years, the indices were close to low values not observed since 1990 (Figure B5.22). However, strong year classes appeared in 2011 and 2015. The MDYOY, VAYOY and MD age-1 indices identified many of the same strong and weak year classes. In Delaware Bay, recruitment increased from the 1980s through the mid-1990s and remained at or above average into the early 2000s; the index became more variable after that, with more below-average year classes (Figure B5.22). Recruitment in the Hudson River showed several strong year classes in the late 1980s after very low values at the beginning of the time series, and has remained variable around the long-term mean since then (Figure B5.22). Strong year-classes were evident in 1993, 1996, 2001, 2003, 2011, and 2015 in Chesapeake Bay; in 1993, 1995, 1999, 2003, 2009, and 2014 in Delaware Bay; and in 1988, 1997, 1999, 2001 and 2007 in Hudson River (Figure B5.22).

### B4.7 Sex Proportions-At-Age

Sex and age data were available from the following sources: Massachusetts, Rhode Island, New York, Pennsylvania, Delaware, Maryland, Virginia, the Potomac River Fisheries Commission (PRFC), ChesMMAP, and NEAMAP. The data included both fishery dependent and independent sources, however, data from surveys conducted in known spawning reaches were excluded from the analysis as spawning aggregations are known to have high proportions of males relative to females and the sex ratios would likely be influenced by differences in maturity-at-age. Concerns were also raised regarding the accuracy of Massachusetts's sex determination methods in their commercial fishery monitoring so these data were also excluded from the analysis. Otolith ages were used preferentially in the analysis but scale ages were included if no otoliths were available. Sex ratios-at-age were initially analyzed annually but interannual variation was very large due to limited sample sizes. The analysis instead combined all years of data and the female proportions-at-age were calculated using only known sex fish with associated age data. Analyses were conducted by geographic area (Chesapeake Bay and Delaware Bay/ocean) and season (March-June (waves 2-3) and July-December (waves 4-6)). Following these subsets, the final data used are shown in Table B5.8. While expansion factors were provided for ChesMMAP and NEAMAP, most of the striped bass sampled on those surveys are aged and sexed and the sex ratios-at-age did not differ much between the raw and expanded data. For simplicity and to match the other data sources, the raw data were used. For the observed data, 95% confidence intervals were calculated. While the maximum age observed in the data is 31, sample sizes were low beyond age-15. Therefore, results are shown through age-15, aligning with the plus-group used in the stock assessment models used in this assessment.

The observed sex ratio in Chesapeake Bay in both the spring and fall is approximately 50-50 for ages 1 and 2 (Figure B5.23). As young females migrate to the coast, the observed proportion of females in Chesapeake Bay decreases for ages 3-5. A gradual increase in the proportions of females at age is observed for ages 6+ within Chesapeake Bay using all of the data. However, when samples from November and December were removed, the proportion of females observed remained low for ages 4-12. The increase in female proportions-at-age in the whole dataset is likely due to migratory, ocean run fish that have been observed to return to the lower Chesapeake Bay in the late fall/early winter following schools of bait. Most of the samples from this time frame are from Virginia's commercial fishery, these are likely larger migratory fish influencing the proportion of females-at-age in the fall (waves 4-6).

The ocean fishery consists of predominantly female fish at all ages, showing an increase in the proportion of females for ages 3-5 (Figure B5.24). This corresponds with the decrease in females in Chesapeake Bay at the same ages and is likely caused by females migrating to the coast. The decrease in the proportion of females around age 5 is likely due to some males also migrating to the coast. These observations on migrations by sex and age generally align with those of Kohlenstein (1981) who suggested that large numbers of females migrate to the coast around age-3. Secor and Piccoli (2007), using otolith microchemistry, also noted an increase in coastal migrations of fish with size/age and that both sexes undertook coastal migrations, though males to a lesser extent than females. Similar to Chesapeake Bay, from ages 7+ there is an observed gradual increase in the female proportions-at-age.

A LOESS smoothing function in the stats package in R (R Core Team 2016) was used to reduce the annual variability in observed sex rations of female proportions-at-age. In general, the LOESS smoothed estimates fell within the 95% confidence intervals of the observed data (Figures B5.23 and B5.24). The LOESS smoothed estimates in Table B5.9 were used in the assessment model for waves 2-3 and waves 4-6 for each geographic area (see Section B7.1.1). While the female proportions-at-age for age-15 was used for the plus group in the ocean, an average for ages 15-26 was used for the plus groups in Chesapeake Bay. Sample sizes of available data were much smaller for wave 1 (January-February) and for the model, it was assumed that the female proportions-at-age were the same in wave 1 as in waves 4-6. Exploratory analyses on the wave 1 female proportions-at-age data suggest that this is a reasonable assumption (A. Giuliano, pers. comm.).

While the new LOESS estimates of the female proportions-at-age were used in the new two-stock SCA model for each geographic area and wave period, previously calculated female sex proportions-at-age were used in the single-stock, non-migration SCA model and the ASAP model. These female sex proportions-at-age are used to apportion the numbers-at-age to female numbers-at-age for calculation of female SSB. The sex proportions were derived from available state catch datasets. The proportions used from previous assessments and for the non-migration SCA and ASAP models were:

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Proportion female** | 0.53 | 0.56 | 0.56 | 0.52 | 0.57 | 0.65 | 0.73 | 0.81 | 0.88 | 0.92 | 0.95 | 0.97 | 1.00 |

### B4.8 Atlantic Coast Striped Bass Tagging Data

Tagging data are compiled from eight tagging programs of the USFWS Atlantic coast-wide striped bass tagging program. Because the Atlantic Coast striped bass is a highly migratory anadromous species, tagging programs are separated as two categories: producer area programs and coastal programs. Most programs tag ≥ 18 inch (457 mm) TL striped bass during routine state monitoring programs.

Producer area tagging programs primarily target spawning grounds during the spring spawning season. Capture methods differ by tagging program, including pound nets, gill nets, seines, and electroshocking. Producer area tagging programs, including the timing of tagging, and the lengths of the current time series, are as follows:
Hudson River (HUDSON) - fish tagged in May, with a time series of 1988–2017;
Delaware and Pennsylvania (DE/PA) - fish tagged in the Delaware River primarily in April and May, with a time series of 1993–2017;
Maryland (MDCB) - fish tagged in the Potomac River and the upper Chesapeake Bay primarily in April and May, with a time series of 1987–2017; and
Virginia (VARAP) - fish tagged in the Rappahannock River during April and May, with a time series of 1990–2017.

Coastal programs tag striped bass from mixed stocks during fall, winter, or early spring. Gears include hook-and-line, seine, gill net, and otter trawl. The coastal tagging programs are as follows:
Massachusetts (MADFW) - fish tagged during fall months, with a time series of 1992–2017;

New York ocean haul seine survey (NYOHS) - fish tagged during fall months, with a time series of 1988–2007. This survey changed to a trawl survey (NYTRL) in 2008 (fish tagged in November), with a time series of 2008–2012. Due to differences in length frequency and gear types, data from the two surveys are analyzed separately.
New Jersey Delaware Bay - fish tagged in March and April, with a time series of 1989–2017; and
North Carolina winter trawl survey (NCCOOP) - fish tagged primarily in January, with a time series of 1988–2017. This survey used a trawl from 1988–2012, a combination of trawl and hook-and-line during 2013, 2014, and 2016, and hook-and-line only during 2015 and 2017. Rulifson et al. (2018) reported that survival and exploitation rates were similar for fish tagged from trawl and hook-and-line surveys, so further analyses of data from this tagging program have continued with a single data series.

The USFWS office in Annapolis, Maryland, maintains the tag release/recovery database and provides rewards to recreational anglers and commercial fishers who report the recaptures of tagged fish. The USFWS office exchanges tag release and recapture data with cooperating tagging agencies. From 1985 through August 2018, there were 542,149 striped bass tagged and released, with 92,344 recaptures reported and recorded in the USFWS database (Josh Newhard, pers. comm.).

Release data, recorded at time of tagging, include the following:
- tag number,
- total length,
- sex (if available),
- release date,
- release location,
- gear, and
- other physical data.

Recapture data obtained directly from anglers are as follows:
- tag number,
- total length,
- disposition,
- recapture date,
- recapture location,
- gear; and
- personal information.

### B4.9 Stock Composition Estimates

The SAS examined the USFWS tagging data base (1987-2016) to estimate stock composition of fished striped bass in coastal waters by assigning each tagged fish to a spawning stock based on recapture in putative spawning areas (Chesapeake Bay, Delaware Bay, and the Hudson River) (Kneebone et al. 2014).

The SAS considered fish tagged in coastal waters by three major tagging programs (Massachusetts Division of Fish & Wildlife, North Carolina Cooperative Tagging Program, and New York Department of Environmental Conservation Coastal Program) that were subsequently recaptured in and around spawning areas during the spawning season (Table B5.10 and B5.11). To accomplish this, criteria outlined in Kneebone et al. (2014) was used, with some modifications: (1) limited analyses to released fish where total length was either ≥ 457 mm (18'') or ≥ 711 mm (28'') (Figure B5.25) as these size cutoffs are used by the tagging subcommittee in their analyses (associated with ages 4+ and 7+, respectively, in the two-stock SCA model described in Section B7.1), (2) the fish must have been confirmed to have been alive during at least one spawning period after release, and (3) fish that were recaptured either on the spawning ground during the spawning season, or recaptured anywhere in the 'parent' producer area during the spawning season were assigned to that spawning stock. Preliminary analyses suggested that few fish met the more stringent criterion of recapture on the spawning grounds during the spawning season (e.g., due to regulatory closures), so spatial constraints were relaxed. Even accounting for relaxed spatial constraints, most fish did not meet these criteria, and so the fraction of fish assigned to 'unknown' stocks was large (Table B5.12 and B5.13). Consequently, stock composition accounting for fish from unknown stocks was estimated under the assumption that fish of unknown stock (e.g., fish released and recaptured in the ocean or in a producer area outside of the spawning season) would have distributed themselves identically to the known stock fish (i.e., allocated all 'unknown' stock fish proportional to known stock fish).

All spawning was assumed to occur between March 15th and June 15th in all areas. This window of time is longer than that assumed by Kneebone et al. (2014), but personal observations (A. Giuliano and M. Kauffman, pers. comm.) suggest that this window is reasonable. Fish were removed from the analysis that were at large for fewer than 10 days and only used the first recapture event. Raw tag returns were adjusted following the approach used by Hansen and Jacobson (2003) which used spawning area- and disposition-specific reporting rates and exploitation rates as reported in the 2013 assessment report (NEFSC 2013). Of note, reporting rates and exploitation rates were only available through 2011, so the terminal values were carried forward for the remaining years. Also of note, F in Chesapeake Bay was estimated to be 0 in 1989 by the Striped Bass TSC resulting in infinite adjusted tag returns. To avoid this, F was set at 0.01 in 1989 (a low, nominal value, equivalent to F in 1988), reasoning that the weighting of F in the Chesapeake Bay (NEFSC 2013) and timing of moratoria made this a more likely value than F in 1990 (0.08), or the average of the two. Fish were also assigned to an "unknown" stock wherever a fish was not recaptured in the parent spawning system during the spawning season – as a simplifying assumption, 'unknown' fish tag returns were adjusted using grand averages across dispositions, years, and areas (Figure B5.26).

Finally, the SAS conducted analyses grouping recaptured tags by regulatory period, aligning with the regulatory periods used by the Striped Bass TSC (regulatory periods described in Section B8.4; Figure B5.26). Relative stock composition was then calculated for each stock as the number of individuals assigned to a given spawning stock divided by the total number of individuals for which stock status could be assigned. More detail is available in Celestino and Giuliano (2018).

Stock composition by length group is provided in Table B5.12 and B5.13 and Figure B5.27. It is generally consistent with previous studies (Kneebone et al. 2014; Kohlenstein 1980). For both the 18" (457 mm) and 28" (711 mm) analyses, the contribution of Chesapeake Bay fish tagged in the ocean was low in the 1990s and increased by 2000. The 28" (711 mm) stock composition estimates have a lower Chesapeake Bay stock composition estimate in the 1980s and 1990s than those estimated using 18" (457 mm) fish. This trend reverses starting in 2000 with the Chesapeake Bay stock composition estimated to be higher for 28" (711 mm) fish than when using 18" (457 mm) fish. Fish of unknown stock were principally recaptured in the ocean (65%) or in Chesapeake Bay outside of the spawning season (28%).

As there is some uncertainty about the reporting rate and fishing mortality estimates from the stock assessment, a sensitivity analysis was done to determine the influence these estimates have on the overall stock composition estimates (Figure B5.28). The stock composition estimates were generally insensitive to estimates of reporting rate and fishing mortality between the producer areas, particularly in the 1990s. The differences between the raw recapture data and the reporting rate and fishing mortality adjusted estimates were larger in more recent years compared to the 1990s, particularly for the 28" (711 mm) fish. In all cases, the adjustments for reporting rate and fishing mortality increased the contribution of the Chesapeake Bay stock.

The SAS spent a considerable amount of time discussing the differences in the stock composition estimates across time and between size groups. Due to low numbers of recaptures for 1987-1989 in the producer areas as well as differences in the stock composition estimates in this time period from other studies, the SAS decided to not use the stock composition estimates for these years in the stock assessment model. Additionally, there were concerns based on the emigration rates that not many 18" (457 mm) fish had migrated to the coast from Chesapeake Bay whereas many more fish have migrated to the coast by the time they reach 28" (711 mm). Based on this, the SAS chose to use the 28" (711 mm) results in the base model run as it better aligned with the assumptions of the two-stock SCA model (see Section B7.1), however, the 18" (457 mm results were included as a sensitivity run.

**TOR B2. ESTIMATE COMMERCIAL AND RECREATIONAL LANDINGS AND DISCARDS. CHARACTERIZE THE UNCERTAINTY IN THE DATA AND SPATIAL DISTRIBUTION OF THE FISHERIES. REVIEW NEW MRIP ESTIMATES OF CATCH, EFFORT AND CALIBRATION METHOD IF AVAILABLE.**

## B4.10 Commercial Data Sources

Strict quota monitoring is conducted by states through various state and federal dealer and fishermen reporting systems, and landings are compiled annually from those sources by state biologists. Commercial harvest in some states is recorded in pounds and is converted to number of fish using conversion methods. Biological data (e.g., length, weight, etc.) and age structures (primarily scales with some supplemental sampling of otoliths) from commercial harvest are collected from a variety of gear types through state-specific port sampling programs. Sample sizes for lengths and age structures are summarized by state for 2000-2017 in Table B6.1. Harvest numbers are apportioned to age classes using length frequencies and age-length keys derived from biological sampling. Appendix B5 details the quota monitoring systems, commercial and recreational sampling programs, and methods used to develop commercial and recreational catch-at-age for each state.

## B4.11 Commercial Landings

### B4.11.1 Commercial Landings in Weight

Historically, annual commercial harvest of striped bass peaked at approximately 5,888 mt (13 million pounds) in 1973, but due to stock declines and subsequent management actions, landings decreased by 99 percent to 68 mt (151,000 pounds) in 1986 (Table B6.2, Figures B6.1 and B6.2). Commercial landings gradually increased through the early 1990s as the stock recovered and management measures were liberalized. The quota system has kept the commercial landings relatively stable from 2004 – 2014, with average landings of 2,935 mt (6.5 million pounds). The commercial quota was reduced in 2015 in response to the assessment update, and landings average-2,133 mt (4.7 million pounds) from 2015-2017.

### B4.11.2 Commercial Landings in Numbers

As with commercial landings in weight, commercial landings in numbers reached a low in 1987 with only 3,730 fish landed, before increasing through the early 1990s (Table B6.3, Figure B6.2). Commercial landings in numbers peaked in 1999 at 1.22 million fish. From 2004 – 2014, commercial landings averaged 943,000 fish per year, although numbers of fish landed was below average in 2012-2014. Total numbers landed continued to decline with the quota reduction implemented in 2015, with an average of 608,000 fish caught from 2015-2017.

From 2004 – 2017, landings from the Chesapeake Bay have made up 57% of total commercial striped bass landings by weight, and 78.5% by number. The difference is due to the higher availability of small fish and the lower size limits in the Chesapeake Bay.

The Chesapeake Bay has seasonal restrictions on commercial harvest to protect the spawning stock; from 2004 – 2014, 29% of commercial landings occurred during January and February (Wave 1, model period-1), 18% occurred from March – June (Waves 2-3, model period-2), and 53% occurred from July – December (Waves 4-6, model period-3). The proportions were not very different in 2015 – 2017, with 23% landed in January and February, 25% landed from March – June, and 51% landed from July – December. If landings were distributed evenly throughout the year, March – June should account for 33% of the total landings.

Commercial landings in the ocean and other areas occur mainly in the second half of the year, with 74% of total landings being taken from July – December for both 2004 – 2014 and 2015 – 2017. The proportion of landings occurring in January and February has declined in recent years; from 2004 – 2014, 7% of landings occurred in those months, while from 2015 – 2017 only 1% of landings occurred then. January and February harvest in the ocean occurs almost exclusively in the ocean waters of Maryland, Virginia, and North Carolina, and North Carolina has reported no commercial landings from their ocean winter fishery since 2013, and Virginia has reported none since 2015. Anecdotal evidence from fishers suggested that the striped bass were no longer available in state waters during January and February in Virginia and North Carolina, and instead were further offshore, where harvest is restricted, and further north than they were historically during that time period.

### B4.11.3 Commercial Landings Age Composition

The age structure of commercial harvest varies from state to state due to size regulations, season of the fisheries, and the size classes of striped bass available to the fisheries. From 2004 – 2014, ages 3 – 9 made up 86.5% of the commercial landings in numbers (Figure B6.3). The implementation of higher size limits in 2015 in several jurisdictions reduced the proportion of age-3 fish in the landings (Figure B6.3). Commercial landings from the Chesapeake Bay are dominated by younger fish (ages 4-6), while commercial landings from the ocean and other areas have a broader age structure with most landings coming from ages 6-12 (Figure B6.3).

## B4.12 Commercial Discards

### B4.12.1 Commercial Discard Mortality Rates

Discard mortality rates for commercial fishing gears were determined through a combination of literature review, review of values used in previous striped bass stock assessments, and new analyses of commercial fishing data from the New Jersey anchor and drift gill net fisheries and the Maryland pound net fishery.

The New Jersey gill net log book data spanned a time period from 2000 through 2015. Records were included in the analysis if they recorded striped bass being caught and the number of live and dead striped bass were specified. Estimated numbers or entries expressing striped bass in terms of weight were omitted. The resulting number of records included 899 anchor gill net sets and 1,880 drift gill net sets. A simple ratio estimator was used to estimate the mortality associated with anchor and drift gill nets, separately. The ratio estimator divided the sum of dead striped bass across all records by the sum of the total number of striped bass (live and dead) caught across all records and the associated variance and standard deviation was calculated.

$$r = \frac{\sum y_i}{\sum x_i}$$

$$\mathrm{var}(r) = \left(\frac{1}{\bar{x}^2}\right) \cdot \sum \frac{(y_i - r \cdot x_i)^2}{n \cdot (n-1)}$$

where $r$ is ratio estimate of mortality, $y_i$ is the number of dead striped bass in gill net $i$, $x_i$ is the total number of striped bass caught in gill net $i$, and $n$ is the number of gill nets.

Mortality was higher in New Jersey anchor gill nets than drift gill nets. Mortality in anchor gill nets was 0.46±0.03 (±st. dev.) while mortality in drift gill nets was 0.06±0.003. These estimates were similar to those from Seagraves and Miller (1989) which were used in the previous striped bass stock assessment (0.43 for anchor gill nets and 0.08 for drift gill nets).

The Maryland pound net fishery data spanned 1994 through 2016 and included a total of 754 pound net sets in which striped bass were caught. Of these, 584 (77%) had no mortality of striped bass. Again, a ratio estimator was used to estimate mortality associated with pound nets. Mortality was low with an estimate of 0.01±0.002, which was less than the value used in the previous stock assessment (0.05).

Gear specific values from the literature, previous stock assessments, and the new estimates from the New Jersey gill net and Maryland pound net fisheries are presented in Table B6.4. Gill nets and hook and line gears had several estimates of mortality, but there was little information for other gear types. Given the consistency of these estimates with previous estimates of mortality for these gear, and the lack of new information on other gear types, the estimates of release mortality from the previous assessment (NEFSC 2013) was carried forward for this assessment.

### B4.12.2 Commercial Discards Estimation

Prior to 1998, discard estimates for fisheries in Chesapeake Bay and coastal locations were based on the ratio of tags reported from discarded (or released) striped bass in the commercial fishery to tags reported from discarded striped bass in the recreational fishery, scaled by total recreational discards (releases):

1) CD = RD*(CT/RT)

where:
CD = unadjusted estimate of the number of fish discarded by commercial fishery,
RD = number of fish discarded by recreational fishery, estimates provided by the NOAA Marine Recreational Fisheries Survey/Marine Recreational Information Program (MRFSS/MRIP),
CT = number of tags returned from discarded fish by commercial fishermen,
RT = number of tags returned from discarded fish by recreational fishermen.

The total commercial discards were then apportioned to gear type by further partitioning of tag data (all dispositions) into gear types, calculating the proportions of tags by gear type and multiplying the proportions by the total discards. The number of dead discards were then calculated using discard mortality estimates for each gear type.

Starting in 1998, the Technical Committee attempted to improve the estimate of commercial discards by calculating tag return ratios and discards separately for Chesapeake Bay and the coast. A separate estimate for Delaware Bay was added in 2004.

Expanding recreational discards to commercial discards based on reported tag returns assumes equal tag reporting rates in commercial and recreational fisheries but in fact this is not true. To correct for this bias, the TC began calculating (ca. 2004) a correction factor by first calculating the ratios of commercial harvest and recreational harvest (LR) and commercially-harvested tag returns divided by recreationally-harvested tag returns (KT). The correction factor (CF) was then derived by

2) CF=LR/KT

The estimates of total discards are then derived by:

3) CD=RD*(CT/RT)*CF

However, there was considerable year-to-year variation in the estimates of total discards which was unlikely given the relatively consistent commercial and recreational catches among years. In previous years, a three year average of the CFs for the current year and previous two years are used to generate the annual estimates of total commercial discards for each region. Commercial discard estimates were not re-estimated with this new method prior to 2004.

Based on examination of other ways of smoothing variable data (Nelson 2017), commercial total discards are now estimated by applying a generalized additive model (GAM; Wood 2006; Appendix B6) with automatic selection of the degrees of freedom to the time series of number of tags of each fishery and disposition type from 1990 to present (e.g., commercial killed tags, recreational release tags). Predicted tag numbers are then used in Equation 1-3, above, and no smoothing of CF occurs. The GAM model is fitted to tag numbers versus year using the *gam* function in R package *mgcv,* assuming normal errors. Year was modeled as a spline and the maximum number of degrees of freedom was set to 20 (estimated degrees were less than 11 for all models explored).

For years prior to 1990, the smoothed tag data from the GAM and average correction factor for 1990-1991 was used in Equation 3 to calculate total discards in 1982-1989 for each region.
For Delaware Bay, scaling of the time series of total discards was accomplished using discard-to-harvest ratios calculated from landings and discards given in Clark and Kahn (2009) for gillnets in spring of 2002 and 2003. Resulting estimates were 0.40 for 2002 and 0.46 for 2003. Using these ratios and the total landings from the Delaware Bay (24,813 and 31,460 fish in 2002 and 2003), the total number of fish discarded was 9,925 fish in 2002 and 14,471 fish in 2003. The estimated time series of total discards is reduced by the ratio of the estimated total discards from Clark and Kahn in 2002 and 2003 and the estimated total discards from the GAM method for 2002 and 2003. The ratio is:

$$r = \frac{\sum_{2002}^{2003} D_i^{CK}}{\sum_{2002}^{2003} D_i^{tag}}$$

$D^{tag}$ and $D^{CK}$ are the total discard estimates from the smoothed tag data method and using the Clark and Kahn estimates, respectively. The total discard estimates are multiplied by *r* to scale values.

Total discards are then allocated to fishing gears based on the relative number of tags recovered by commercial gears regardless of disposition. The raw tag data are used for Chesapeake Bay and the Ocean (2016 data for anchor and drift gillnets in Ocean were used for 2017). For Delaware Bay, the raw tag data are used but missing values for 2012, 2014 and 2016 were imputed by using predicted values from a GAM smoothing method of the tag data by gear.

Discards by fishing gear were multiplied by gear-specific release mortalities (anchor gillnet=0.45, drift gillnet=0.06, hook-and-line=0.09, other=0.2, pound net=0.03, seine=0.16 and trawl=0.26; NEFSC 2013) to get dead discards. Commercial discard proportions at age were obtained by applying age distributions from fishery dependent sampling or independent surveys that used comparable gear types.

Descriptions of data sources are listed in Table 1 of Appendix B6. Gear specific proportions at age were applied to dead discard estimates by gear and summed across all gears (see next section results).

Tag data used in the estimation came from the USFWS database. Tag returns included in the analyses were selected using multiple criteria to eliminate errors and obtain more consistent time series. Only the first tagging event was used; releases from Canada, data associated with duplicated tag numbers, and records where disposition, gear, date, and state/region were not recorded were dropped.

All commercial harvest data came from state reports and the new MRIP estimates came from the NOAA website. Total discards were estimated for the Chesapeake Bay, Delaware Bay and Ocean regions.

### B4.12.3 Commercial Dead Discards and Dead Discards Age Composition by Region

#### *B4.12.3.1 Chesapeake Bay Dead Discards and Dead Discards Age Composition*

The number of tags by fishery and disposition, commercial harvest and new estimates of recreational harvest and releases are shown in Table B6.5. There is a general decline in the number of tag returns over time (Figure B6.4). As a proportion of the total number of tag returns, the recreationally killed tag returns have been increasing over time, while the remaining categories have declined (Figure B6.4). To demonstrate the magnitude of change in the estimates of commercial total discards associated with changes in the MRIP harvest and releases, Equation 3 was used to calculate unadjusted (no smoothing of tags or CF) total discards for 1990-2015 using the old MRIP data and for 1990-2017 using the new MRIP data (Table B6.5).

The smoothed estimates of tag numbers are given in Table B6.6 and are compared to the observed values in Figure B6.5.

The estimates of unscaled commercial total discards are listed in Table B6.7 and are shown in Figure B6.6. The number of tags recovered by commercial gear type regardless of disposition by year is shown in Table B6.8. Number of annual returns has been declining and, in recent years, is low (≤32).

Estimates of unscaled commercial total discards apportioned by gear type for 1990-2017 are shown in Table B6.9. Dead discards are listed by gear type for 1990-2017 in Table B6.10. The number of unscaled dead discards-at-age matrix for year 1982-2017 is given in Table B6.11.

The remaining issue is whether the Chesapeake Bay estimates of total discards are realistic or not. If the new estimates are used, the proportion that those numbers represent of the total catch (discards +harvest) range between 63-95% (Figure B6.7). The proportion discarded seems unreasonably high. If the new estimates are scaled using the fraction reduction observed for the Delaware Bay when the new time series is compared to the 2002 and 2003 direct estimates, the range in proportions for Chesapeake Bay drops to 23-75% (Figure B6.7). Another way to look at the data is to calculate the ratio of total discards to harvest and these are shown in Figure B6.8 along with direct estimates from several states and gear types. The ratios using the unscaled new estimates were high compared to other estimates. Using the scaled estimates produces ratios in the range observed in other gears and states (Figure B6.8). Estimates of dead discards-at-age for the scaled total discards estimates are shown in Table B6.12. The SAS adopted the scaled estimates of dead discards for this assessment.

***B4.12.3.2 Ocean Region Dead Discards and Dead Discards Age Composition***

The number of tags by fishery and disposition, commercial harvest and new estimates of recreational harvest and releases are shown in Table B6.13. There is a general decline in the number of tag returns over time (Figure B6.9). As a proportion of the total number of tag returns, the recreationally killed tag returns have been increasing over time, while the remaining categories have declined (Figure B6.9). To demonstrate the magnitude of change in the estimates of commercial total discards associated with changes in the MRIP harvest and releases, Equation 3 was used to calculate unadjusted (no smoothing of tags or CF) total discards for 1990-2015 using the old MRIP data and for 1990-2017 using the new MRIP data (Table B6.13).

The smoothed estimates of tag numbers are given in Table B6.14 and are compared to the observed values in Figure B6.10.

The estimates of commercial total discards are listed in Table B6.15 and are shown in Figure B6.11. The number of tags recovered by gear type is shown by year in Table B6.16.

Estimates of commercial total discards apportioned by gear type for 1990-2017 are shown in Table B6.17. Dead discards are listed by gear type for 1990-2017 in Table B6.18. The number of dead discards-at-age matrix for year 1982-2017 is given in Table B6.19.

Comparison of the NMFS observer estimates of total discards for gillnets and trawls in the Ocean and the estimates from the tag-based method for the same gear type revealed the tag-based estimates are reasonable, particularly in the later years (Figure B6.12). These results suggested the Ocean estimates of total discards did not need to be adjusted.

***B4.12.3.3 Delaware Bay Dead Discards and Dead Discards Age Composition***

The number of tags by fishery and disposition, commercial harvest and new estimates of recreational harvest and releases are shown in Table B6.20. There is a general decline in the number of tag returns over time (Figure B6.13). As a proportion of the total number of tag returns, the recreationally killed tag returns have been generally increasing over time, while the remaining categories have declined

(Figure B6.13). To demonstrate the magnitude of change in the estimates of commercial total discards associated with changes in the MRIP harvest and releases, Equation 3 was used to calculate unadjusted (no smoothing of tags or CF) total discards for 1990-2015 using the old MRIP data and for 1990-2017 using the new MRIP data (Table B6.20).

Number of annual returns has been declining and, in recent years, is low (<36). The smoothed estimates of tag numbers are given in Table B6.21 and are compared to the observed values in Figure B6.14.

The unscaled and scaled estimates of commercial total discards are listed in Table B6.22 and the scaled estimates are shown in Figure B6.15. The numbers of tags recovered by commercial gear type regardless of disposition by year are shown in Table B6.23. Estimates of commercial total discards apportioned by gear type for 1990-2017 are shown in Table B6.24. Dead discards are listed by gear type for 1990-2017 (Table B6.25). The complete dead discards-at-age matrix for Delaware Bay for 1982-2017 is given in Table B6.26. The SAS adopted the scaled estimates of dead discards for this assessment.

### B4.13 Total Removals by Commercial Fisheries

From 2015 – 2017, total commercial removals (landings and discards) has averaged 713,000 fish, down from a peak of 1.6 million fish in 1998 (Figure B6.16). Landings have generally exceeded discards since the early 1990s; discards made up approximately 15% of total commercial removals coastwide from 2015 – 2017, with a lower proportion of discards estimated for the Chesapeake Bay fisheries than for the fisheries in the ocean and the other areas.

The Chesapeake Bay accounted for 74% of the commercial removals by number from 2015 – 2017; that proportion has varied between 70% and 80% since 2004.

### B4.14 Recreational Data Sources

Data on recreational catch and harvest of Atlantic striped bass is provided by the Marine Recreational Information Program (MRIP, formerly the Marine Recreational Fisheries Statistics Survey or MRFSS). MRIP encompasses a suite of regional angler survey programs conducted by federal and state partners, with the goal of providing information on recreational fishing activity within U.S. coastal waters. Broadly, survey programs within MRIP can be thought of as falling into two categories: effort surveys, geared towards assessing the number of fishing trips anglers take along some section of the U.S. coast, and intercept surveys, or surveys designed to assess the outcomes of individual angling trips (e.g. average number and size of fish harvested per trip). Information from these survey types are combined within a mathematical model to produce estimates of seasonal, annual, or regional recreational fishing activity.

During the 40-year history of the program, various modifications have been made to MRFSS/MRIP survey designs and associated mathematical models to improve comprehensiveness, accuracy, and precision of program products. Of particular interest for this stock assessment are recent modifications to relevant effort and intercept surveys.

Prior to 2018, estimates of angler effort (i.e. angler trips) used to calculate annual recreational catch and harvest of Atlantic striped bass were derived from the Coastal Household Telephone Survey (CHTS), a random-digit-dial telephone survey. A 2006 review by the National Research Council (NRC) confirmed general perceptions amongst coastal fishery managers that the CHTS had declined in effectiveness; in particular, the NRC review noted that the CHTS design was inefficient, suffered from coverage bias, and was experiencing declining response rates and associated increased potential for nonresponse bias (NRC 2006). The NRC review prompted a concerted effort to design and test a new effort survey program, which culminated with the adoption of the Fishing Effort Survey (FES) in 2018. The FES is a mail-based survey that offers several improvements over the CHTS – in particular, it leverages the National Saltwater Angler Registry created via the 2006 re-authorization of the federal Magnuson-Stevens Fishery Conservation and Management Act to produce an improved sampling frame that improves response rates and reduces coverage bias. The FES was implemented by federal and state partners using a multi-year transition plan. First, the CHTS and FES were conducted simultaneously for three years (2015-2017). The results of these years of "side-by-side" surveys were used to develop a calibration model, which in effect is able to convert historic CHTS estimates to the new FES "currency." The FES calibration model passed peer review in 2017 and is now available for management use. The CHTS was discontinued after 2017 and the FES survey alone is now used to estimate recreational effort on the U.S. coast.

The 2006 NRC review also noted issues with the Access Point Angler Intercept Survey (APAIS), the on-site intercept survey that collects information from individual anglers on the outcomes of their fishing trips (e.g. numbers and sizes of fish caught and harvested). The NRC review noted several shortcomings of the survey design that could bias results, in particular the probabilities used to select various sites for daily sampling and the temporal coverage of the survey. Subsequently, an improved APAIS sampling design was implemented starting in 2013. As with the transition from CHTS to FES for the effort portion of the study, the transition to a new intercept survey design necessitated a calibration model that could render historic (pre-2013) APAIS estimates comparable to contemporary APAIS estimates. Development of the APAIS calibration model was particularly challenging because, unlike in the CHTS/FES case, there were no years of "side-by-side" old vs. new APAIS survey results available to inform the calibration model. Despite this substantial challenge, an APAIS calibration model passed peer review in 2018 and became available for management use.

As of 2018, the necessary calibration models were available to adjust historic MRIP estimates of Atlantic striped bass recreational catch and harvest such that they become statistically comparable to current estimates produced by FES/revamped APAIS. This effort for Atlantic striped bass was part of a larger effort to create a re-calibrated MRIP time series for a host of important recreational species, a necessary effort given the need to incorporate single, statistically-consistent time series of recreational harvest into stock assessment models. This Atlantic striped bass stock assessment is one of the first stock assessments to incorporate re-calibrated MRIP data that reflects recent changes to effort and intercept survey methodologies.

Anecdotal evidence suggested that North Carolina, Virginia, and possibly other states have had sizeable wave-1 fisheries beginning in 1996; the wave-1 sampling that began in 2004 in North Carolina and the large number of wave-1 tag returns for North Carolina and Virginia supported this contention. However, MRFSS/MRIP did not sample in January and February (wave-1) north of South Carolina prior to 2004, so there were no estimates of wave 1 harvest in the MRFSS/MRIP dataset for 1996 – 2003; after 2003, wave-1 sampling began in North Carolina so there were estimates of harvest and live releases for North Carolina, but not Virginia. Harvest in wave-1 for North Carolina and Virginia in years without MFRSS/MRIP sampling was estimated back to 1996 using observed relationships between landings and tag returns. A linear regression was developed between the number of North Carolina tag returns during wave-1 and the MRIP estimates of recreational harvest for wave 1 from 2005 – 2017 (Figure B6.17). This relationship was used to predict wave-1 harvest from the number of wave-1 tag returns for North Carolina for 1996 – 2003 and for Virginia for 1996 – 2017 (Table B6.27). Live releases for the winter recreational fishery in North Carolina and Virginia were not estimated.

Most states use the length frequency distributions of harvested striped bass measured by MRIP to characterize the size composition of the recreational harvest. The MRIP measurements are converted from fork length (inches) to total length (inches) using conversion equations. Proportions-at-length are calculated and multiplied by the MRIP harvest numbers to obtain total number harvested-at-length. The sample sizes of harvested bass measured by MRIP were inadequate for estimation of length frequencies for some states; therefore, harvest length data collected from other sources (e.g., volunteer angler programs) were used to increase sample sizes (Table B6.28). Appendix B5 details the quota monitoring systems, commercial and recreational sampling programs, and methods used to develop commercial and recreational catch-at-age for each state.

Data on sizes of striped bass released alive come mostly from state-specific sampling or volunteer angling programs (Table B6.28). Proportions-at-length are calculated and multiplied by the MRIP dead releases numbers to obtain total number dead releases-at-length. For those programs that do not collect data on released fishes, the lengths of tagged fish released by anglers participating in the American Littoral Society's striped bass tagging program or from state-sponsored tagging programs are used.

Many states collect scale samples during state sampling programs designed to collect information on harvest and released striped bass from the recreational fishery. Age-length keys are developed and applied to harvest and dead release numbers-at-length. When sampling of the recreational fishery does not occur, age-length keys are constructed by using data on age-length from commercial sampling, fisheries-independent sampling, and/or striped bass tagging programs. For those states that do not collect scale samples, age-length keys are borrowed from neighboring states.

The age composition of the estimated wave 1 recreational fishery in North Carolina and Virginia was calculated from length-frequency data collected by MRIP and appropriate state age-length keys. Length-frequencies for the North Carolina winter harvest of 2004 - 2017 came from MRIP wave 1 data. Length-frequencies for the wave 1 harvests of 1996-2003 for North Carolina and 1996 – 2017 for Virginia came from wave 6 of the previous year for each state (e.g., the Virginia wave 6 length frequency of 1995 was used for the Virginia 1996 wave 1 landings). Lengths were converted to age for North Carolina with annual age-length keys from pooled New York and North Carolina data. The Virginia lengths were converted to age with annual Virginia age-length keys

## B4.15 Recreational Landings and Releases

### B4.15.1 Recreational Total Landings in Weight

Figure B6.1 shows the growth of the Atlantic coast recreational fisheries from 1982 through 2017. Harvest increased from 1,090 mt (2.4 million pounds) in 1984 to 29,510 mt (65 million pounds) in 2013 (Table B6.2). Harvest from 2004 – 2013 was relatively stable, averaging 24,718 mt (55 million pounds). Following the peak in 2013, harvest declined through 2017 to 17,190 mt (38 million pounds) (Figure B6.1).

### B4.15.2 Recreational Landings in Numbers

Recreational harvest of striped bass increased from a low of 264,000 fish in 1984 to a high of 5.4 million fish in 2010 (Table B6.3). Harvest was relatively steady from 2004 – 2014, averaging 4.7 million fish per year, but dropped to an average of 3.2 million fish for 2015 – 2017 with the implementation of Addendum IV (Figure B6.18). Harvest was generally highest in Maryland, New Jersey, New York, Virginia, and Massachusetts (Table B6.29). From 2004 – 2013, 32% of landings came from the Chesapeake Bay; after 2013, that percentage increased to 44%, possibly as a result of the strong 2011 year class moving through the population (Figure B6.18). The annual Atlantic coast harvest (in numbers) has been a small fraction of the total catch (harvest and releases, combined) since the 1980s because the live releases (B2s) have accounted for 85 to 90% of the annual catch in most years (see Section B6.6.4); in 2015 – 2017, only 9% of the total catch was landed.

### B4.15.3 Recreational Landings Age Composition

The age composition of the recreational harvest is dominated by ages 4 – 10 (Figure B6.19), with the Chesapeake Bay landing more younger fish (ages 3-6) and the ocean and other areas landing more older fish (ages 6-10) (Figure B6.20). Very few age-1-2 fish are landed by the recreational fishery.

### B4.15.4 Estimation of Releases

The number of striped bass that are caught and released alive (B2) is estimated by MRIP (Table B6.30). The live releases have accounted for 85 to 90% of the annual catch in most years (Figure B6.21); from 2015 – 2017, 91% of total catch was released alive. While landings of striped bass remained mostly stable from 2004 – 2014, the number of fish released alive peaked in 2006 at 53.5 million fish, and then dropped nearly 70% to 16.5 million fish in 2011. Releases have been increasing since then; live releases in 2015 – 2017 averaged 32.3 million fish per year.

Live releases are generally highest in Massachusetts, Maryland, New York, and New Jersey (Table B6.30). From 2004 – 2014, approximately 27% of live releases occurred in Chesapeake Bay; for 2015 – 2016, that number increased to 43%, then dropped to 24% in 2017, due to a combination of regulation changes and the strong 2011 year class entering the Chesapeake Bay fishery and then moving out to the coast.

### B4.15.5 Estimation of Release Mortalities

The number of releases that die due to the capture and release process is estimated by multiplying the total release numbers (B2) by an estimate of hooking mortality. While much work has been done on striped bass release mortality, the majority of it has been done in freshwater, where release mortality is higher than in saline water (RMC 1990; Lukacovic and Uphoff 2007). Since the recreational catch estimated by MRIP is taken in ocean or bay waters, the SAS reviewed studies conducted in saltwater or estuarine water (salinity > 5 ppt). Estimates of overall hooking mortality from these studies included 2% (RMC 1990), 9% (Diodati and Richards 1996; Caruso 2000), and 11% (Lukacovic and Uphoff 2007). However, hooking mortality was affected by factors such as temperature, salinity, hook type, hooking location, and angler experience. Lukacovic and Uphoff (2007) and Diodati and Richards (1996) found mortality rates of 26-27% under the worst conditions in their studies.

A meta-analysis of hooking mortality as a function of water temperature and salinity for studies conducted in salt and estuarine waters was attempted, but the available data were not informative enough to effectively model hooking mortality (NEFSC 2013). For this assessment, the SAS chose to use the overall 9% hooking mortality rates estimated by Diodati and Richards (1996), which was conducted in saltwater and covered a range of hook types, hooking locations, and angler experience levels. The 9% rate is also consistent with the other studies reviewed.

Estimates of the number of release mortalities are presented in Table B6.3. The numbers of fish that died from being released alive increased from 79,660 fish in 1984 to a peak of 4.8 million fish in 2006 before declining through 2011 to 1.5 million fish. Live releases increased after that, with the number of fish that died from being released averaging 2.9 million fish from 2015 – 2017.

### B4.15.6 Age Composition of Release Mortalities

The age composition of fish released alive is dominated by ages 2-5 (Figure B6.19). The Chesapeake Bay catches and releases a significantly higher proportion of age-1 fish, and the ocean and other areas catch and release a higher proportion of age 5+ fish, but both regions release predominately age-2-5 fish in similar proportions over the time series (Figure B6.20).

### B4.15.7 Comparison of Pre- and Post-Calibration MRIP Estimates

Calibrated estimates of Atlantic striped bass recreational catch and harvest are substantially different from prior MRIP estimates (Figure B6.22). As with other species, the major cause of the difference is the effort calibration; the calibration to account for changes in the APAIS design had a minimal effect compared to the FES calibration (Figure B6.22). Calibrated annual estimate of coastal striped bass harvest (numbers of fish) are on average-140% higher (range approximately 50%-400%) than historic uncalibrated estimates, while live releases averaged 160% higher (range 41% - 295%) (Figure B6.23). On a state by state basis, the pattern is generally similar to the coastwide numbers, with the calibrated numbers becoming increasingly higher than the uncalibrated numbers over time; however, the effect was more extreme in some states than others (Figures B6.24 and B6.25).

The elevation in catch and harvest estimates are not surprising, given analyses conducted during FES/CHTS side-by-side benchmarking that revealed that FES estimates of fishing effort were typically

3-5 times higher than those provided by CHTS. Despite the marked change in magnitude of catch and harvest estimates, the re-calibrated time series describe a similar trend over time in both catch and harvest.

The calibration did not have a significant effect on the length distribution of harvested striped bass. The annual mean length by state showed minor differences for some years and states, but was generally unchanged in recent years (Figure B6.26). The higher variability early in the time series (both from year to year and between calibration methods) is likely due to small sample sizes in those years (Table B6.28).

### B4.15.8 Unreported Catch from Inland Waters

The MRIP survey is a marine fishery survey, and thus does not cover the full extent of striped bass recreational fisheries that occur in rivers. For example, known inland striped bass fisheries occur in the Connecticut, Housatonic, and the Thames Rivers in Connecticut but are not surveyed by MRIP inland of I-95. Similarly, the recreational fishery for striped bass in the Hudson River in New York occurs up to rkm 254, but MRIP stops at rkm 74. There is not an equivalent survey that covers the inland portion of these fisheries on an annual basis, thus estimates of recreational catch are biased low because they only include the marine portion of the catch.

To examine the potential magnitude of this bias, the SAS examined periodic creel surveys conducted by state natural resource agencies and universities in the Connecticut River (Davis 2011), the Hudson River (NAI 2003 and 2007), and the Delaware River (Volstad 2006). Estimates of unreported catch for the years each survey was conducted were compared to estimates of catch from MRFSS/MRIP for the equivalent years.

This analysis suggested the bias is very low. At the individual state level, omitting the river harvest and loss made less than a 5% difference in estimates of total removals (harvest and dead discards) (Table B6.31). Bias to model inputs is even less when considering recreational losses in combination with commercial losses.

### B4.16 Total Removals by Recreational Fisheries

Total recreational removals include MRIP estimates of harvest, the MRIP estimates of live releases scaled by the 9% release mortality rate, and the model-based estimates of wave 1 harvest for NC and VA in years when MRIP did not sample during wave 1 (Table B6.27, Section B6.5). Total recreational striped bass removals averaged about half a million fish at the beginning of the time series; removals increased steadily from 260,000 fish in 1987 to a peak of 9.9 million fish in 2006 (Table B6.3, Figure B6.18). Recreational removals have declined since then. Recreational removals averaged 7.4 million fish from 2004 – 2014; with the implementation of Addendum IV, recreational removals have averaged 6.1 million fish from 2015 – 2017. Recreational harvest and releases showed different patterns after 2006, with releases declining faster initially and then increasing, and harvest staying relatively steady through 2013 before beginning to decline. From 2004 – 2014, release mortalities made up 36% of the total recreational removals; from 2015 – 2017, that increased to 48% of total recreational removals, due to a combination of more restrictive regulations and two strong year classes (2011 and 2014) recruiting to the fishery.

From 2004 – 2013, the Chesapeake Bay accounted for approximately 30% of total recreational removals. From 2014 – 2016, that number jumped to 43% as the strong 2011 year class entered the Chesapeake Bay fishery. In 2017, the Chesapeake Bay removals made up 32% of the total recreational removals, as the 2011 year class became more available to the coastal fisheries.

The age composition of the recreational removals consists primarily of ages 2-10. The age composition of 2015 – 2017 tended to be dominated by younger fish, with a lower proportion of age-7+ fish than the 2004 – 2014 age composition, again most likely due to the presence of the 2011 year class.

The majority of recreational removals occurred during July – December (waves 4-6, model period-3) and March - June (waves 2-3, model period-2). Very little of the removals occurred during January and February (wave 1, model period-1). From 2004 – 2014, approximately 4% of ocean removals occurred in wave 1, with 37% occurring in waves 2-3, and 59% occurring in waves 4-6. No wave 1 removals were estimated for the Chesapeake Bay, so waves 2-3 made up 20% of the recreational removals during this time period, and waves 4-6 made up 80% of the removals. From 2015 – 2017, no wave 1 harvest was observed in North Carolina ocean waters, and no tags were returned during this period from Virginia, so no wave 1 harvest was estimated. Anecdotal evidence from anglers suggested this was the result of low availability of striped bass in state waters during January and February for those years. From 2015 – 2017, 38% of recreational removals occurred in waves 2-3 for the ocean, and 31% for the Chesapeake Bay, with the remainder occurring during waves 4-6 for both regions.

### B4.17 Total Removals by Commercial and Recreational Fisheries

The recreational fishery has been the dominant source of fishing removals for striped bass for most of the time series (Table B6.3, Figure B6.27). From 2015 – 2017, recreational removals accounted for approximately 90% of the total striped bass removals, with the rest due to commercial landings and discards. Recreational removals have accounted for between 80% and 90% of total removals since 1985. Total removals peaked in 2006 at 11.1 million fish and have been declining since then (Table B6.3, Figure B6.27). From 2004 – 2014, total removals averaged 8.4 million fish; from 2015 – 2017, they averaged 6.8 million fish, due in part to the implementation of harvest reductions through Addendum IV in 2015.

Overall, most of the removals come from July – December (Figure B6.28); from 2015-2017, 66% of Chesapeake Bay removals and 62% of removals from the ocean and other areas occurred from July – December. In recent years, almost no removals have come from the ocean during January and February, and only about 4% of Chesapeake Bay removals occurred during those months.

### B4.18 Total Catch Weight at Age

Catch mean weight at age data, which is used to calculate total biomass and female SSB, was calculated for the period 1998-2002 using all available weight data from Massachusetts, New York, Maryland, Virginia, and New Hampshire (1998-2001), and adding data from Rhode Island and Delaware in 2002 (NEFSC 2008b). Mean weights at age for the 2003-2017 striped bass catches were determined as a result of the expansion of catch and weight at age. Data came from Maine and New Hampshire recreational harvest and discards; Massachusetts recreational and commercial catch; Rhode Island recreational and commercial catch; Connecticut recreational catch; New York recreational catch and commercial landings; New Jersey recreational catch; and Delaware, Maryland, Virginia, and North Carolina recreational and commercial catch. For ages 1-12, weighted mean weights at age were calculated as the sum of weight at age multiplied by the catch at age in numbers, divided by the sum of catch at age in numbers. Weights at age for ages 13 through 15+ were predicted from annual age-weight regressions using ages 1-12. Details of developing weights at age for 1982 to 1996 can be found in NEFSC Lab Ref. 98-03. Weights at age for 1982-2017 are presented in Table B6.34.

### B4.19 Total Catch Numbers at Age

The catch-at-age from commercial harvest, commercial discards, recreational harvest, and recreational release mortalities were combined to develop total removals-at-age matrices for the Chesapeake Bay (Table B6.32) and for the ocean fisheries (which included Delaware Bay and Long Island Sound) (Table B6.33) broken down by wave period to accommodate the seasonal time-step of the migration model. Total removals are made up predominately by ages 3-10. The age composition of removals in the Chesapeake Bay is dominated by younger fish (ages 2-6), while the age composition of removals from the ocean and other areas has a higher proportion of older fish (ages 4-10) (Figure B6.29).

The age composition of the Chesapeake Bay removals expands during waves 2-3 as mature fish move into the Chesapeake Bay to spawn; the proportion of the catch at older ages is lower during wave 1 and waves 4-6, but is not zero (Figure B6.30). The opposite is true for the ocean, where the proportion of catch at older ages is lower during waves 2-3 as compared to wave 1 and waves 4-6; the difference is not as pronounced for the ocean, since spawning adults from the Delaware Bay and Hudson River stocks are still present in the catch for this region during waves 2-3 (Figure B6.31.)

**TOR B3. USE AN AGE-BASED MODEL TO ESTIMATE ANNUAL FISHING MORTALITY, RECRUITMENT, TOTAL ABUNDANCE AND STOCK BIOMASS (TOTAL AND SPAWNING STOCK) FOR THE TIME SERIES AND ESTIMATE THEIR UNCERTAINTY. PROVIDE RETROSPECTIVE ANALYSIS OF THE MODEL RESULTS AND HISTORICAL RETROSPECTIVE. PROVIDE ESTIMATES OF EXPLOITATION BY STOCK COMPONENT AND SEX, WHERE POSSIBLE, AND FOR TOTAL STOCK COMPLEX.**

## B4.20 Two-Stock Statistical Catch-At-Age Model (2SCA; Primary Assessment Model)

***[SAW-66 Editor's Note: The SARC-66 peer review panel concluded that the two-stock statistical catch-at-age (2SCA) model presented to them was not acceptable to serve as a basis for fishery management advice. These particular sections are included in this report to document the analyses that were done for the peer review, but they are not recommended by SARC-66 as a basis for management. Instead, SARC-66 recommends the single stock, non-migration model described in Section B7.2.1 for management use.]***

The striped bass two-stock statistical catch-at-age (2SCA) model was created to allow the estimation of separate population characteristics for two stocks whose individuals are mixed in a common ("ocean") region but the stock catch composition in that region is unknown. The model is based on population dynamics observed for the Chesapeake Bay stock that is comprised of a resident population in the Chesapeake Bay and a migratory population that moves between the Chesapeake Bay and ocean region for spawning. For Stock-1 (the Chesapeake Bay stock), immigration of spawning individuals from the ocean to the Chesapeake Bay occurs during a specific period based on maturity schedules, and mature and immature individuals are allowed to return to the ocean based on emigration rates estimated from tag data. For Stock-2 (the Delaware Bay and Hudson River stocks combined), it is assumed that the ocean region encompass the river habitat and migrations are not explicitly modeled.

The structure was based on limitations of splitting data into periods and the remaining stock components (Figure B7.1). The ability to estimate the number of Chesapeake Bay stock striped bass that occur in the Chesapeake Bay and ocean region is based on catch data split into three periods to reflect changes in age structure due to migration and estimates of ocean-specific stock composition derived from historical tag data.

The model estimates stock-specific (Chesapeake Bay stock and Delaware Bay/Hudson River stock) recruitment, stock-, year-, period- and age-specific abundance and fishing mortality, different selectivity functions for the Chesapeake Bay and Ocean catch data and surveys with age composition data, catchability coefficients for surveys, and management reference points.

## B4.20.1 Description of Generalized Model Structure

The structure of the 2SCA model is region-, period- and aged-based and projects the population numbers-at-age forward through time given model estimates of recruitment, age-specific total mortality and migration rates.

### *B4.20.1.1 Stock-1 (Chesapeake Bay) Sub-model*

For Stock-1 (the Chesapeake Bay stock), there are six (2 regions x 3 periods) population numbers-at-age matrices of dimensions Y x A, where Y is the number of years and A is the oldest age group (Figure B7.2). The time horizon for striped bass is 1982-present since complete catch data are only available back to 1982. The initial population abundance-at-age of the Chesapeake Bay stock ($s$=1) in period-1 ($p=1$) of the first year ($y$=1982) for ages 2 through A in the Chesapeake Bay region ($N^{Bay}s,p,y,a$) can be estimated as individual parameters (user controls the number of estimates) or, if not estimated, they are calculated by:

$$N^{Bay}_{1,1,1982,a} = N^{Bay}_{1,1,1982,a-1} e^{-M^{Bay}_{1982,a-1} pm^{Bay}_1}$$

$$N^{Bay}_{1,1,1982,A} = N^{Bay}_{1,1,1982,a-1} e^{-M^{Bay}_{1982,a-1} pm^{Bay}_1} /(1 - e^{-M^{Bay}_{1982,A} pm^{Bay}_1})$$

where $M^{Bay}_{1982,a}$ is the natural mortality rate of age $a$ in the first year (1982) and $pm_1$ is the fraction of natural mortality that occurs during period-1 (Figure B7.2). In the current implementation of this model, ages 2-6 are estimated. The initial population abundance-at-age in the ocean region ($N^{ocean}$) in period-1 for ages 2 through A in the first year is determined from $N^{Bay}$ using estimates of emigration rates ($E$; see below):

$$N^{Ocean}_{1,1,1982,a} = N^{Bay}_{1,1,1982,a} \cdot E_{1982,a}$$

Recruitment (numbers of age-1 fish) in the Chesapeake Bay stock in year $y$ (Figures B7.2) is estimated as a log-normal deviation from average recruitment:

$$N_{1,1,y,1} = \hat{\bar{N}}_1 \cdot \exp^{\hat{e}_{1,y} - 0.5\hat{\sigma}^2_{1,R}}$$

where $N_{1,1,y,1}$ is the number of age-1 fish in the Chesapeake Bay stock at the beginning of period-1 in year $y$, $\hat{\bar{N}}1$ is the average recruitment parameter, $e_{1,y}$ are independent and identically distributed normal random variables with zero mean and constant variance and are constrained to sum to zero over all years, and $\sigma_{1,R}$ is the standard deviation for the log recruitment residuals which is calculated as:

$$\hat{\sigma}_{1,R} = \sqrt{\frac{\sum_{y} (\hat{e}_{1,y} - \hat{\bar{e}}_1)^2}{n_1 - 1}}$$

where $n_1$ is the number of estimated recruitment deviations for the Chesapeake Bay stock. The term $-0.5\sigma^2_{1,R}$ is a lognormal bias-correction to ensure that average is equal to the mean recruitment. The following penalty function is included in the total likelihood and is used to help constrain the recruitment deviations:

$$P_{rdev} = \lambda_R \sum_{y} \log_e(\hat{\sigma}_R) + \frac{\hat{e}_y^2}{2\hat{\sigma}_R^2}$$

where $\lambda_R$ is a user-specified weight (Maunder and Deriso 2003) and is set to 1 in the current implementation. All the Chesapeake Bay stock recruitment occurs in the Chesapeake Bay region.

Movement of Chesapeake Bay stock fish from the ocean to the Chesapeake Bay occurs instantaneously at the beginning of period-2. The abundance of age *a* fish in the Chesapeake Bay at the beginning of period-2 is given by:

$$N_{1,2,y,a}^{Bay} = N_{1,1,y,a}^{Bay} \cdot e^{-s_{y,a}^{Bay} F_{1,y}^{Bay} - M_{y,a}^{Bay} pm_1^{Bay}}$$

Estimation of fishing mortality for each region (Chesapeake Bay and ocean), period, year and age is accomplished by assuming that fishing mortality can be decomposed into yearly and age-specific components (separability):

$$\hat{F}_{p,y,a} = \hat{F}_{p,y} \cdot \hat{s}_{y,a}$$

where $F_{p,y}$ is the fully-recruited fishing mortality in period *p* of year *y* and $s_{ya}$ is the selectivity of age *a* in year *y*. The same selectivity is used in each period within year and region. The dimensions of each F-at-age matrix are Y x A. $F_{p,y}$s are modeled as separate parameters.

The number of fish that migrate from the ocean to the Chesapeake Bay (*OI*) is calculated as:

$$OI_{y,a} = N_{1,1,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{1,y}^{Ocean} - M_{y,a}^{Ocean} pm_1^{Ocean}} \left( f_{y,a}^{Ocean} \cdot m_a^{female} + (1 - f_{y,a}^{ocean}) \cdot m_a^{male} \right)$$

Where $N^{Ocean}_{1,1,y,a}$ is the number of fish of the Chesapeake Bay stock during period-1 in year *y* and of age *a*, $f_{y,a}$ is the proportion of females of age *a* during period-2 in year *y*, and $m^{female}$ and $m^{male}$ are proportion mature-at-age for each sex. It is assumed that all *OI* fish move into the Chesapeake Bay to spawn. Because migrating fish have natural mortality rates different from fish living in the Chesapeake Bay, *OI* fish are tracked in separate matrices. However, both resident fish and OI fish experience the same fishing mortality while in the Chesapeake Bay. The number of fish remaining in the ocean at the beginning of period-2 is:

$$N_{1,2,y,a}^{Ocean} = N_{1,1,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{1,y}^{Ocean} - M_{y,a}^{Ocean} pm_1^{Oean}} \cdot (1 - (f_{female,a}^{Ocean} \cdot m_{female,a}^{Ocean} + (1 - f_{female,a}^{Ocean}) \cdot m_{male,a}^{Ocean}))$$

The proportion of females at age *a* in the ocean at the beginning of period-1, -2 and -3 were derived from sampling (Section B5.3) and were assumed constant across years. The values are:

| | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1 | 0.513 | 0.366 | 0.261 | 0.191 | 0.189 | 0.236 | 0.303 | 0.389 | 0.477 | 0.560 | 0.636 | 0.702 | 0.755 | 0.786 | 0.940 |
| 2 | 0.608 | 0.484 | 0.377 | 0.293 | 0.237 | 0.269 | 0.381 | 0.502 | 0.591 | 0.659 | 0.708 | 0.750 | 0.791 | 0.820 | 0.910 |
| 3 | 0.513 | 0.366 | 0.261 | 0.191 | 0.189 | 0.236 | 0.303 | 0.389 | 0.477 | 0.560 | 0.636 | 0.702 | 0.755 | 0.786 | 0.940 |

The proportion mature at age for both sexes were derived from sampling (females; Section B5.1.7) and literature (males; NEFSC 2013) and were assumed constant across years. The values used are:

| | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| Female | 0 | 0 | 0 | 0.09 | 0.32 | 0.45 | 0.84 | 0.89 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Male | 0 | 0.5 | 0.75 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

The emigration of fish that have spawned and those that were resident in the Chesapeake Bay prior to spawning occurs at the beginning of period-3. Fish remaining in the Chesapeake Bay is calculated as:

$$N_{1,3,y,a}^{Bay} = N_{1,2,y,a}^{Bay} \cdot e^{-s_{y,a}^{Bay} F_{2,y}^{Bay} - M_{y,a}^{Bay} pm_2^{Bay}} \cdot (1 - E_a)$$

where $E_a$ are the probability of age *a* fish migrating to the ocean in year *y*. All remaining OI fish after experiencing fishing mortality in the Chesapeake Bay are assumed to move to the ocean. Therefore the number of fish present in the ocean at the beginning of period-3 is:

$$N_{1,3,y,a}^{Ocean} = N_{1,2,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{2,y}^{Ocean} - M_{y,a}^{Ocean} pm_2^{Ocean}} + OI_{y,a} e^{-s_{y,a}^{Bay} F_{2,y}^{Bay} - M_{y,a}^{Ocean} pm_2^{Ocean}}$$
$$+ N_{1,2,y,a}^{Bay} \cdot e^{-s_{y,a}^{Bay} F_{2,y}^{Bay} - M_{y,a}^{Bay} pm_2^{Bay}} \cdot E_a$$

The emigration probabilities ($E_a$) at age were estimated by using tag release-recapture data from Maryland DNR and New York DEC following methods of Dorazio et al. (1994) but estimating migration rates for age rather than length (Appendix B7). Because New York DEC did not age fish after 1995, only data through 1995 were used in the estimation. The estimates of migration rates from Maryland data were used following Dorazio et al. (1994). Emigration rate was assumed constant across years. The estimates of $E_a$ used in the model (Figure B7.3) are:

| Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 0.01379 | 0.02302 | 0.03820 | 0.06274 | 0.10138 | 0.15976 | 0.24269 | 0.35069 | 0.47652 | 0.60540 | 0.72112 | 0.81336 | 0.88017 | 0.92520 | 0.95430 |

The number of fish at the beginning of period-1 in the following year is calculated as:

$$N_{1,1,y+1,a+1}^{Bay} = N_{1,3,y,a}^{Bay} \cdot e^{-s_{y,a}^{Bay} F_{3,y}^{Bay} - M_{y,a}^{Bay} pm_3^{Bay}}$$
$$N_{1,1,y+1,A}^{Bay} = N_{1,3,y,a}^{Bay} \cdot e^{-s_{y,a}^{Bay} F_{3,y}^{Bay} - M_{y,a}^{Bay} pm_3^{Bay}} + N_{1,3,y,A}^{Bay} \cdot e^{-s_{y,A}^{Bay} F_{3,y}^{Bay} - M_{y,A}^{Bay} pm_3^{Bay}}$$

And

$$N_{1,1,y+1,a+1}^{Ocean} = N_{1,3,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{3,y}^{Ocean} - M_{y,a}^{Ocean} pm_3^{Ocean}}$$
$$N_{1,1,y+1,A}^{Ocean} = N_{1,3,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{3,y}^{Ocean} - M_{y,a}^{Ocean} pm_3^{Ocean}} + N_{1,3,y,A}^{Ocean} \cdot e^{-s_{y,A}^{Ocean} F_{3,y}^{Ocean} - M_{y,A}^{Ocean} pm_3^{Ocean}}$$

***Natural Mortality***

The model dynamics allow different natural mortality rates in each stock, region, year and age. Fish that do not migrate from the Chesapeake Bay region experience additional mortality (+0.12; Smith and Hoenig 2012) above the baseline (see below) when age-3 or older starting in 1997 due to the impact of a *Mycobacterium* outbreak in Chesapeake Bay (Gauthier et al. 2008). Those fish that migrate to the ocean region are assumed to experience baseline natural mortality due to observations that the *Myco* disease does not progress further and in many cases fish may actually heal (Vogelbein et al. 2006). When mature fish return to the Chesapeake Bay region to spawn, the baseline natural mortality is still applied because it is unlikely that fish will be re-infected and experience any ill effects from *Myco* during the short duration spent in the Chesapeake Bay. The baseline and *Myco*-adjusted natural mortality rates are:

| | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Region | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| Bay (1982-1996) | 1.13 | 0.68 | 0.45 | 0.33 | 0.25 | 0.19 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Bay (1997-2017) | 1.13 | 0.68 | 0.57 | 0.45 | 0.37 | 0.31 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| Ocean | 1.13 | 0.68 | 0.45 | 0.33 | 0.25 | 0.19 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |

The baseline natural mortality rates were derived from a curvilinear model fitted to tag-based Z estimates (assuming Z=M) for fish $\leq$ age-3 from New York and tag-based M estimates (Jiang et al. 2007) for striped bass from Maryland made for years prior to 1997 (ASMFC 2013).

### *B4.20.1.2 Stock-2 (the Delaware Bay/Hudson River mixed stock) Sub-model*

For Stock-2 (the Delaware Bay/Hudson River stock), there are three population numbers-at-age matrices of the same dimensions (Figure B7.4).The initial population abundance-at-age of the Delaware Bay/Hudson River stock (s=2) in period-1 for ages-2 through -7 in the first year (Figure B7.4) are estimated as individual parameters and the remaining values are calculated as:

$$N_{2,1,1982,a}^{Ocean} = N_{2,1,1982,a-1}^{Ocean} e^{-M_{1982,a-1}^{Ocean} pm_1^{Ocean}}$$

$$N_{2,1,1982,A}^{Ocean} = N_{2,1,1982,a-1}^{Ocean} e^{-M_{1982,a-1}^{Ocean} pm_1^{Ocean}} /(1 - e^{-M_{1982,A}^{Ocean} pm_1^{Ocean}})$$

Estimation of recruitment (numbers of age-1 bass) for the Delaware Bay/Hudson River stock is the same as the Chesapeake Bay stock:

$$N_{2,1,y,1} = \hat{\bar{N}}_2 \cdot \exp^{\hat{e}_{2,y} - 0.5\hat{\sigma}_{2,R}^2}$$

where $N_{2,1,y,1}$ is the number of age-1 fish of the Delaware Bay/Hudson River stock at the beginning of period-1 in year $y$, $\hat{N}2$ is the average recruitment parameter, $e_{2,y}$ are independent and identically distributed normal random variables with zero mean and constant variance and are constrained to sum to zero over all years, and $\sigma_{2,R}$ is the standard deviation for the log recruitment residuals which are calculated as described for the Chesapeake Bay stock. The same penalty for bias-correction was also applied to the Delaware Bay/Hudson River stock. All recruitment of the Delaware Bay/Hudson River stock is assumed to occur in the ocean.

No movement of fish from the Delaware Bay/Hudson River stock occurs, so the calculation of abundance-at-age is straight-forward. Abundance is calculated as:

Period-2
$$N_{2,2,y,a}^{Ocean} = N_{2,1,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{1,y}^{Ocean} - M_{y,a}^{Ocean} pm_1^{Ocean}}$$

Period-3 $$N_{2,3,y,a}^{Ocean} = N_{2,2,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{2,y}^{Ocean} - M_{y,a}^{Ocean} pm_2^{Ocean}}$$

Abundance at the beginning of period-1 in the following year is calculated as:

$$N_{2,1,y+1,a+1}^{Ocean} = N_{2,3,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{3,y}^{Ocean} - M_{y,a}^{Ocean} pm_3^{Ocean}}$$

$$N_{2,1,y+1,A}^{Ocean} = N_{2,3,y,a}^{Ocean} \cdot e^{-s_{y,a}^{Ocean} F_{3,y}^{Ocean} - M_{y,a}^{Ocean} pm_3^{Ocean}} + N_{2,3,y,A}^{Ocean} \cdot e^{-s_{y,A}^{Ocean} F_{3,y}^{Ocean} - M_{y,A}^{Ocean} pm_3^{Ocean}}$$

Natural mortality rates used for the Delaware Bay/Hudson River stock were the baseline values used for the ocean region of the Chesapeake Bay stock. The proportion of females-at-age and female maturity for the Delaware Bay/Hudson River stock used in the calculation of female SSB (see below) are:

| | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| Female Proportion | 0.530 | 0.560 | 0.560 | 0.520 | 0.570 | 0.650 | 0.730 | 0.810 | 0.880 | 0.920 | 0.950 | 0.970 | 0.999 | 0.999 | 0.999 |
| Female Maturity | 0.000 | 0.000 | 0.000 | 0.090 | 0.320 | 0.450 | 0.840 | 0.890 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

The proportions of females-at-age are different for the Delaware Bay/Hudson River stock because all ages are found in the ocean region, whereas those for the Chesapeake Bay stock represent only the segment of the population that has migrated.

***B4.20.1.3 Fishing Mortality Estimation***

A fishing mortality penalty for each region is imposed to ensure that extremely small Fs are not produced during the early phases of the estimation process:

$$P_{add} = \begin{cases} \text{phase} < 3, & 10 \cdot \sum_y (F_{p,y}^{Bay} - 0.15)^2 + \\ & 10 \cdot \sum_y (F_{p,y}^{Ocean} - 0.15)^2 \\ \text{phase} \geq 3, & 1e^{-12} \cdot \sum_y (F_{p,y}^{Bay} - 0.15)^2 + \\ & 1e^{-12} \cdot \sum_y (F_{p,y}^{Ocean} - 0.15)^2 \end{cases}$$

***B4.20.1.4 Catch Selectivity Estimation***

Multiple selectivity functions (logistic, Gompertz and Thompson's (1994) exponential-logistic equations) were included in the model for modeling catch selectivity in each region. The equations are:

Gompertz equation: $\hat{s}_a = \exp^{(-\exp^{-\hat{\beta}(a-\hat{\alpha})})}$

Logistic equation: $\hat{s}_a = \dfrac{1}{1+\exp^{-\hat{\beta}(a-\hat{\alpha})}}$

Thompson's (1994) exponential-logistic equation: $\hat{s}_a = \dfrac{1}{1-\hat{\gamma}} \cdot \left(\dfrac{1-\hat{\gamma}}{\hat{\gamma}}\right)^{\hat{\gamma}} \dfrac{\exp^{\hat{\alpha}\hat{\gamma}(\hat{\beta}-a)}}{1+\exp^{\hat{\alpha}(\hat{\beta}-a)}}$

where α, β,and γ are parameters to be estimated. To ensure at least one age had a maximum selectivity of 1, $s_a$ is divided by the maximum of $s_a$. In initial analyses, the three-parameter Thompson exponential-logistic equation was applied to all catch data to allow more flexible estimation of the selectivity pattern. If a resulting selectivity pattern was flat-topped, the Thompson function was replaced with the Gompertz or logistic function to save one parameter from being estimated. The final selectivity equations and the number of selectivity blocks used (based on major changes in management regulation for striped bass from previous assessments) were further refined by comparing residuals and AIC values from multiple model runs. The following are time blocks and selectivity functions used for the Chesapeake Bay and ocean regions in the base model run:

| Region | Time Block | Function |
|---|---|---|
| Bay | 1982-1989 | Gompertz |
| | 1990-1995 | Gompertz |
| | 1996-2017 | Gompertz |
| Ocean | 1982-1989 | Gompertz |
| | 1990-1996 | Gompertz |
| | 1997-2017 | Gompertz |

An additional time block for 2015-2017 was examined because of major changes to striped regulations in 2015. However, no difference between selectivity curves estimated for 2015-2017 and a 1996-2014 time block was observed, so the two periods were combined into one.

### *B4.20.1.5 Total Catch and Age Composition of Stocks*

Total catch and the age composition (proportions-at-age) in each period are the primary data from which fishing mortalities, selectivities, and recruitment numbers are estimated for each stock. Given estimates of F, M, and population numbers, predicted catch-at-age is computed from Baranov's catch equation (Ricker 1975).

For the Chesapeake Bay stock, predicted catch-at-age in each period in the Chesapeake Bay region is calculated by:

Period-3 $$\hat{C}^{Bay}_{1,1,y,a} = \frac{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{1,y}}{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{1,y} + M^{Bay}_{y,a} \cdot pm^{Bay}_1}(1 - e^{-\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{1,y} - M^{Bay}_{y,a} \cdot pm^{Bay}_1}) \cdot \hat{N}^{Bay}_{1,1,y,a}$$

Period-2

$$\hat{C}^{Bay}_{1,2,y,a} = \frac{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{2,y}}{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{2,y,a} + M^{Bay}_{y,a}\cdot pm^{Bay}_{2}}(1-e^{-\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{2,y} - M^{Bay}_{y,a}\cdot pm^{Bay}_{2}})\cdot \hat{N}^{Bay}_{1,2,y,a} + \frac{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{2,y,a}}{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{2,y} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{2}}(1-e^{-\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{2,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{2}})\cdot OI_{y,a}$$

Period-3

$$\hat{C}^{Bay}_{1,3,y,a} = \frac{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{3,y}}{\hat{s}^{Bay}_{y,a}\hat{F}^{Bay}_{3,y} + M^{Bay}_{y,a}\cdot pm^{Bay}_{3}}(1-e^{-\hat{s}^{Bay}_{1,y,a}\hat{F}^{Bay}_{3,y} - M^{Bay}_{y,a}\cdot pm^{Bay}_{3}})\cdot \hat{N}^{Bay}_{1,3,y,a}$$

Predicted catch-at-age in each period in the ocean region for the Chesapeake Bay stock is calculated by:

Period-3

$$\hat{C}^{Ocean}_{1,1,y,a} = \frac{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,y}}{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,y} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{1}}(1-e^{-\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{1}})\cdot \hat{N}^{Ocean}_{1,1,y,a}$$

Period-2

$$\hat{C}^{Ocean}_{1,2,y,a} = \frac{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{2,y}}{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{2,y,a} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{2}}(1-e^{-\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{2,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{2}})\cdot \hat{N}^{Ocean}_{1,2,y,a}$$

Period-3

$$\hat{C}^{Ocean}_{1,3,y,a} = \frac{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{3,y}}{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,3,y} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{3}}(1-e^{-\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{3,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{3}})\cdot \hat{N}^{Ocean}_{1,3,y,a}$$

For the Delaware Bay/Hudson River stock, predicted catch-at-age in each period is calculated by:

Period-3

$$\hat{C}^{Ocean}_{2,1,y,a} = \frac{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,y}}{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,y} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{1}}(1-e^{-\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{1}})\cdot \hat{N}^{Ocean}_{2,1,y,a}$$

Period-2

$$\hat{C}^{Ocean}_{2,2,y,a} = \frac{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{2,y}}{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{2,y,a} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{2}}(1-e^{-\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{2,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{2}})\cdot \hat{N}^{Ocean}_{2,2,y,a}$$

Period-3

$$\hat{C}^{Ocean}_{2,3,y,a} = \frac{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{3,y}}{\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{1,3,y} + M^{Ocean}_{y,a}\cdot pm^{Ocean}_{3}}(1-e^{-\hat{s}^{Ocean}_{y,a}\hat{F}^{Ocean}_{3,y} - M^{Ocean}_{y,a}\cdot pm^{Ocean}_{3}})\cdot \hat{N}^{Ocean}_{2,3,y,a}$$

Predicted catch-at-age data for the Chesapeake Bay stock and the Delaware Bay/Hudson River stock are then compared to the observed total catch and age composition through the equations:

Predicted Total Catch $$\hat{C}_{s,p,y} = \sum_{a} \hat{C}_{s,p,y,a}$$

Predicted Proportions of Catch-At-Age $$\hat{P}_{s,p,y,a} = \frac{\hat{C}_{s,p,y,a}}{\sum_{a} \hat{C}_{s,p,y,a}}$$

where $\hat{C}_{s,p,y}$ is the predicted total catch of stock *s* in period *p* of year *y* and $P_{s,p,y,a}$ is the predicted proportions of age *a* in the catch during year *y* for stock *s* during period *p*.

## B4.20.2 Stock-Specific Indices of Relative Abundance

### *B4.20.2.1 Aggregated Indices of Relative Abundance*

Stock-specific single-age or aggregated-age indices of relative abundance are incorporated into the model by linking them to corresponding age abundances, time of year and region.

For the Chesapeake Bay stock in the Chesapeake Bay region,

$$\hat{I}^{Bay}_{t,y,\Sigma a} = \hat{q}^{Bay}_{t} \cdot \sum_{a} \hat{N}^{Bay}_{1,p,y,a} \cdot \exp^{-d^{Bay}_{p,t} \cdot \left(\hat{s}^{Bay}_{y,a} \hat{F}^{Bay}_{p,y} + M^{Bay}_{y,a} \cdot pm^{Bay}_{p}\right)}$$

where $\hat{I}_{t,y,a}$ is the predicted index of survey *t* for single-age *a* or aggregated-ages (sum over *a*) in year *y* in the Chesapeake Bay region, $q_t$ is the catchability coefficient of index *t*, $N_{p,y,a}$ is the abundance of age *a* in year y at the beginning of period p in the Chesapeake Bay region, and $d_{p,t}$ is the fraction of period *p* that occurs before the survey is conducted. All qs are estimated as free parameters. The equation for the Delaware Bay/Hudson River stock is identical except that the indices are linked to stock-2 abundance (resides in the ocean region). Because age-0 abundance is not modeled, YOY and Age-1 indices are lagged ahead one year and linked to age-1 and age-2 abundances, respectively.

### *B4.20.2.2 Indices of Relative Abundance with Age Composition Data*

Stock-specific indices of relative abundance with age composition data are incorporated into the model by linking them to age abundances, time of year and region. For the Chesapeake Bay stock in the Chesapeake Bay, the general equation is:

$$\hat{I}^{Bay}_{t,y,\Sigma a} = \hat{q}^{Bay}_{t} \cdot \sum_{a} \hat{s}^{Bay}_{t,a} \cdot \hat{N}^{Bay}_{1,p,y,a} \cdot \exp^{-d^{Bay}_{p,t} \cdot \left(\hat{s}^{Bay}_{y,a} \hat{F}^{Bay}_{p,y} + M^{Bay}_{y,a} \cdot pm^{Bay}_{p}\right)}$$

where $s_{t,a}$ is the selectivity coefficient for age *a* in region *R* for survey *t*. For these surveys, multiple selectivity equations are available for modeling: Gompertz, logistic, gamma and Thompson's functions. All selectivity estimates are divided by the maximum selectivity at age to ensure at least one age had a maximum selectivity of 1. Total index by year is calculated by summing age-specific indices across age classes. The survey age composition is calculated by dividing the age-specific indices by the total index for a given year. The predicted age composition (proportions-at-age) of each survey is calculated as:

$$\hat{I}_{t,y,a}^{Bay} = \hat{q}_t^{Bay} \cdot \hat{s}_{t,a}^{Bay} \cdot \hat{N}_{p,y,a}^{Bay} \cdot \exp^{-d_{p,t}^{Bay} \cdot \left(\hat{s}_{y,a}^{Bay} \hat{F}_{p,y}^{Bay} + M_{y,a}^{Bay} \cdot pm_p^{Bay}\right)}$$

and predicted age composition (U) is calculated as:

$$\hat{U}_{t,y,a}^{Bay} = \frac{\hat{I}_{t,y,a}^{Bay}}{\sum_a \hat{I}_{t,y,a}^{Bay}}$$

The equations for the Delaware Bay/Hudson River stock are identical except there is no region superscript.

***B4.20.2.3 Mixed Stock Indices***

There are several surveys with age composition data that occur in the ocean and reflect the relative abundance of the Chesapeake Bay stock and the Delaware Bay/Hudson River stock complex in the ocean region. The predicted total index for the mixed stock surveys is calculated as:

$$\hat{I}_{t,y,\Sigma a} = \hat{q}_t \cdot \sum_a \hat{s}_{t,a} \cdot (\hat{N}_{1,p,y,a}^{Ocean} + \hat{N}_{2,p,y,a}) \cdot \exp^{-d_{p,t}^{Ocean} \cdot \left(\hat{s}_{y,a}^{Ocean} \hat{F}_{p,y}^{Ocean} + M_{y,a}^{Ocean} \cdot pm_p^{Ocean}\right)}$$

where the numbers-at-age *a* and year *y* for the Chesapeake Bay stock in the ocean and numbers-at-age *a* and year *y* for the Delaware Bay/Hudson River stock are summed. The predicted age composition is computed from the age-specific predicted indices:

$$\hat{I}_{t,y,a} = \hat{q}_t \cdot \hat{s}_{t,a} \cdot (\hat{N}_{1,p,y,a}^{Ocean} + \hat{N}_{2,p,y,a}) \cdot \exp^{-d_{p,t}^{Ocean} \cdot \left(\hat{s}_{y,a}^{Ocean} \hat{F}_{p,y}^{Ocean} + M_{y,a}^{Ocean} \cdot pm_p^{Ocean}\right)}$$

The predicted age composition (U) is calculated as described above.

***B4.20.2.4 Ocean Stock Composition***

In order to estimate the Chesapeake Bay stock numbers that occur in the ocean region, the stock composition of catches that occur in the ocean must be known. Unfortunately, there have been no long-term studies to determine the stock composition of fish in the ocean region. Therefore, observed stock composition (proportion of fish from Chesapeake Bay and proportion of fish from the Delaware Bay/Hudson River) was estimated externally by using tag release-recapture data from three state programs conducted in ocean waters (see Section B5.5). The values used in this assessment were derived for fish $\geq$ 28 inches (711 mm) total length which represent fish of ages 7 to 15+.

The observed stock composition (S) estimates for both stocks were compared to predicted values calculated as:

$$\hat{S}_{1,y} = \frac{\sum_{a=x}^{A} \hat{C}^{Ocean}_{1,3,y,a}}{\sum_{a=x} \hat{C}^{Ocean}_{1,3,y,a} + \hat{C}_{2,3,y,a}}$$

$$\hat{S}_{2,y} = 1 - \hat{S}_{1,y}$$

The stock composition estimates were treated as a multinomial index during estimation (see likelihood below).

**B4.20.3 Female Spawning Stock Biomass**

Female SSB (mt) in year *y* for each stock is calculated as:

Stock 1 (Chesapeake Bay):

$$SSB_{1,y} = \frac{\sum_{a=1}^{A} (\hat{N}^{Bay}_{1,2,y,a} \cdot f^{Bay}_{1,2,y,a} \cdot m^{female}_{a} \cdot w^{Bay}_{1,2,y,a}) + (\hat{N}^{Ocean}_{1,2,y,a} \cdot f^{Ocean}_{1,2,y,a} \cdot m^{female}_{a} w^{Ocean}_{1,2,y,a})}{1000}$$

Stock 2 (Delaware Bay/Hudson River):

$$SSB_{2,y} = \frac{\sum_{a=1}^{A} \hat{N}_{2,2,y,a} \cdot f_{2,2,y,a} \cdot m^{female}_{a} \cdot w^{Ocean}_{1,2,y,a}}{1000}$$

where *f* is the proportion of females at age, $m_a$ is the proportion mature at age *a* for females, and $w_{y,a}$ are Rivard weights at age *a* (kg). January-1 Rivard weights were calculated and adjusted to match the weights at the time of spawning by averaging the January-1 Rivard weight-at-age and the catch weight-at-age for the current year.

**B4.20.4 Likelihood for Total Catch and Survey Indices**

For total catch and survey indices, lognormal errors are assumed throughout and the concentrated likelihood, weighted for variation in each observation, is calculated. The generalized concentrated negative log-likelihood ($-L_l$) (Parma 2002; Deriso et al. 2007) is:

$$-L_l = 0.5 * \sum_i n_i * \ln\left(\frac{\sum_i RSS_i}{\sum_i n_i}\right)$$

where $n_i$ is the total number of observations and $RSS_i$ is the weighted residual sum-of-squares from dataset i. The weighted lognormal residual sum-of-squares ($RSS_f$) of total catch for period *p* is calculated as:

$$RSS_{s,p} = \lambda_{s,p} \sum_y \left( \frac{\ln\left(C_{s,p,y} + 1e^{-5}\right) - \ln\left(\hat{C}_{s,p,y} + 1e^{-5}\right)}{\phi_p CV_{s,p,y}} \right)^2$$

where $C_{s,p,y}$ is the observed catch of stock *s* during period *p* in year *y*, $\hat{C}_{s,p,y}$ is the predicted catch of stock s in period *p* in year *y*, $CV_{s,p,y}$ is the coefficient of variation for observed catch of stock *s* and period *p* in year *y*, $\phi_p$ is the CV weight and $\lambda_f$ is the relative weight (Parma 2002; Deriso et al. 2007). Similarly, the weighted lognormal residual sum-of-squares ($RSS_t$) of any relative abundance index *t* is calculated as:

$$RSS_t = \lambda_t \sum_y \left( \frac{\ln\left(I_{t,y} + 1e^{-5}\right) - \ln\left(\hat{I}_{t,y} + 1e^{-5}\right)}{\delta_{t,p} \cdot CV_{t,y}} \right)^2$$

where $I_{t,y}$ is the observed index t in year y, $\hat{I}_{t,y}$ is the predicted index in year y, $CV_{t,y}$ is the coefficient of variation for the observed index in year y, $\delta$ is the CV weight, and $\lambda_t$ is the relative weight.

### B4.20.5 Likelihood for Age Composition Data

For the catch and survey age compositions, multinomial error distributions are assumed throughout and the generalized negative log-likelihood for a catch age composition in period *p* is calculated as:

$$-L_p = \lambda_p \sum_y -n_{p,y} \sum_a P_{p,y,a} \cdot \ln\left(\hat{P}_{p,y,a} + 1e^{-7}\right)$$

where $n_{p,y}$ is the effective number of fish aged during period *p* in year y, $P_{p,y,a}$ is the observed proportion-at-age, and $\lambda_p$ is the relative weight. Similarly, the generalized age composition negative log-likelihood for survey *t* is:

$$-L_t = \lambda_t \sum_y -n_{t,y} \sum_a U_{t,y,a} \cdot \ln\left(\hat{U}_{t,y,a} + 1e^{-7}\right)$$

where $n_{t,y}$ is the effective sample size of fish aged in year *y* from survey *t*, and $U_{t,y,a}$ and $U_{t,y,a}$ are the observed and predicted proportions of age *a* in year *y* from survey *t*.

### B4.20.6 Likelihood for Stock Composition Data

Stock composition data were treated as a multinomial distribution:

$$-L_S = \sum_y -n_y \cdot \left(S_{1,y} \ln\left(\hat{S}_{1,y} + 1e^{-7}\right) + S_{2,y} \ln\left(\hat{S}_{2,y} + 1e^{-7}\right)\right)$$

### B4.20.7 Estimation of Effective Sample Sizes for Age Composition Data

The effective sample sizes (ESS) for the catch and survey age composition data, and stock composition data was estimated by using the equation 1.8 method of Francis (2011). The multiplier is applied to the input ESS and then input ESSs are replaced with the new computed values. The ADMB code for this method was taken from the NMFS ASAP program.

### B4.20.8 Total Log-likelihood of the Model

The total log-likelihood of the model is

$$\ell = -L_l^{Stock1} - L_l^{Stock2} - \sum_p L_p^{Stock1} - \sum_p L_p^{Stock2} - \sum_t L_t^{Stock1,U} - \sum_t L_t^{Stock2,U} - L_S + P_{rdev}^{Stock1} + P_{rdev}^{Stock2} + P_{add}$$

The total log-likelihood is used by the autodifferentiation routine in AD Model Builder to search for the "best" selectivity parameters, recruitment parameters (average or equation parameters and recruitment deviations), fishing mortality, and catchability coefficients that minimize the total log-likelihood. AD Model Builder allows the minimization process to occur in phases. During each phase, a subset of parameters is held fixed and minimization is done over another subset of parameters until eventually all parameters have been included. The estimation proceeds by first calculating $F_{y,a}$ using initial starting values for $F_y$ and $s_a$ (initial parameters estimates are used for the selectivity equations) for stock and period and, with M and initial values of average recruitment by year, the abundance matrices are filled.

### B4.20.9 Diagnostics

Model fit for all components were checked by using standardized residuals plots, and root mean square errors. Standardized residuals (r) for log-normal errors (total catch and survey indices) were calculated as:

$$r_y = \frac{\log I_y - \log \hat{I}_y}{\sqrt{\log_e(CV_y^2 + 1)}}$$

Root mean square error for lognormal errors were calculated as:

$$RMSE = \sqrt{\frac{\sum_y r_y^2}{n}}$$

For age and stock composition (multinomial) data, standardized residuals were calculated as:

$$r_{y,a} = \frac{P_{y,a} - \hat{P}_{y,a}}{\sqrt{\frac{\hat{P}_{y,a}(1-\hat{P}_{y,a})}{\hat{\bar{n}}_y}}}$$

where $n_y$ is the average effective sample size determined from the Francis (2011) method. The Akaike Information Criterion (AIC) was calculated as:

$$AIC = 2\ell + 2K$$

where K is the number of parameters estimated in the model.

## B4.20.10 Data Inputs for 2SCA Model

### *B4.20.10.1 Plus Group*

In previous assessments, an age-13+ plus-group was used for catch and indices data as an attempt to address the increase in scale-ageing bias after ages 12 or so. In this assessment, an age-15+ plus-group was used because the stock assessment committee believed obtaining better estimates of selectivity for older ages was more important than potential scale-ageing bias.

### *B4.20.10.2 Catch Data*

Total removals (recreational and commercial harvest numbers plus number of discards that die due to handling and release) and the proportions of catch-at-age of striped bass fisheries are the primary data used in the model. The removals data were partitioned into three periods (January-February; March-June; July-December) based on seasonal migration patterns and limitations of the MRIP data (estimates are for two-month periods) in an attempt to account for more realistic patterns in catches. As mentioned above, all selectivity time blocks corresponded to Amendment changes. Removals data were split into Chesapeake Bay and Ocean regions (Table B7.1). The Chesapeake Bay fleet includes commercial and recreational harvest and dead discards taken in the Chesapeake Bay by Maryland, Virginia, and the PRFC. The Ocean landings includes commercial and recreational harvest and dead discards taken in the Ocean, Delaware Bay, Long Island Sound, and Hudson River by Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina. The observed total removals and catch age compositions were generated from all state reported landings-at-age, and recreational dead discards-at-age. The total removals and age composition by region, period and year are listed in Table B7.1.

Total catch CVs for the Chesapeake Bay and Ocean were assumed equal to the PSEs of MRIP total harvest plus dead discards for the inclusive states since it is assumed that only the estimates of recreational harvest and dead discards have error. Only commercial harvest data were generally available during period-1 because the MRIP survey is not conducted in any state except North Carolina during this period. The variance of the combined recreational and dead discards estimates were calculated as:

$$Var(SR) = (PSE_H / 100 * H)^2 + (0.09^2 * (PSE_R / 100 * R)^2$$

where SR is the recreational fish harvest (H) plus dead releases (0.09*releases(R)) and PSE is the proportional standard error for the harvest and releases numbers. It is assumed that the commercial harvest numbers and dead releases are without error, so the CV of the total removals is:

$$CV = \sqrt{\mathrm{var}(SR)} / (H + 0.09R + CH + CD)$$

Because there are no estimates of recreational harvest and releases during period-1, the CVs of total catch were set to 0.2 (based on average found in other periods). If CVs were unrealistic (e.g., <0.01 during early years with small sample sizes) or missing due to no or low number of target species intercepts, the CV was set to 0.2 or was imputed by using CVs from surrounding years.

***B4.20.10.3 Young-of-the-Year and Age 1 Indices***

The index values for the YOY and age-1 indices are shown in Table B7.2. For the Chesapeake Bay stock, the MDVAYOY (1981-2016) and MD Age-1 indices (1981-2016) were incorporated into the model by linking them to corresponding age abundances and time of year. Because age-0 striped bass are not modeled, the YOY and Age-1 indices were advanced one year and are linked to age-1 and age-2 abundances, respectively, and are tuned to beginning of period-1 (January 1$^{st}$) (p=1, d=0; Table B7.4). For the Delaware Bay/Hudson River stock, the NYYOY (1985-2016), NY Age-1 (1984-2016), and NJYOY (1982-2016) indices were also advanced one year and are linked to age-1 and age-2 abundances, respectively, and are also tuned to January 1$^{st}$ (p=1, d=0; Table B7.4). Except for the MDVAYOY index, all YOY and age-1 indices are geometric means and corresponding CVs.

***B4.20.10.4 Age-1+ Indices***

Stock specific indices of age-1+ relative abundance are shown in Table B7.2; indices of age-1+ relative abundance for the mixed stock in the ocean are shown in Table B7.3. The age compositions for each age-1+ index are shown in Table B7.5. For the Chesapeake Bay stock, total index and age composition data from MDSSN (1985-2017) and the ChesMMAP (2002-2017) surveys are incorporated into the model by linking them to age abundances and the time of year (Table B7.4). Because the MDSSN survey estimates are corrected for mesh-size selectivity, it was determined by trial-and-error that only the selectivity value for ages 2 and 3 had to be estimated; for ages $\geq$ 4, selectivity was set to 1. The selectivity function selected for the ChesMMAP survey was the Gompertz equation. For the Delaware Bay/Hudson River stock, DESSN and DE30 indices were incorporated into the model by linking them to age abundance and time of years. Each survey had a total index and age composition associated with them. The Gompertz equation is used to estimate the selectivity pattern for the DESSN index because theory indicates that vulnerability to electric fields increases with surface area of the fish (Reynolds 1983). For the DE30 survey, the gamma function was selected as the best for describing the selectivity of this survey.

For the mixed stock ocean surveys, the NYOHS (1987-2006), NJTRL (1990-2017), CTLISTS (1986-2017), and the MRIP index (1982-2017) were used in the model (Table B7.3, Table B7.5). For the NYOHS survey, the Gompertz model was used to estimate the selectivity pattern. For the NJTRL and CTLISTS surveys, a gamma function was used to estimate the selectivity pattern. For MRIP, the Thompson exponential-logistic function was used to estimate selectivity.

#### *B4.20.10.5 Weights-At-Age*

Weights-at-age used to calculate biomass and female SSB were generated from catch weights-at-age and the Rivard algorithm described in the NEFSC's VPA/ADAPT program. Table B6.34 lists the weight-at-age for catch, January-1 and female SSB. It was assumed that the weights-at-age were the same for both stocks.

#### *B4.20.10.6 Starting Values*

Initial starting values for all parameters are given in Table B7.6 and were selected based on trial-and-error.

### B4.20.11 Model Specification for 2SCA Model

#### *B4.20.11.1 Phases*

Model parameters were solved in two phases. The parameter and phase are shown in Table B7.6.

#### *B4.20.11.2 Data Weighting*

Data weighting was accomplished by first running the model with all initial starting values with all lambda weights and CV weight = 1, and the ESS set to 20 for all composition data. The CV weights for the total removal data were then increased to force the model to better fit the observed data. After the model was re-run, the index CV weights were adjusted to obtain index RMSE values within the 95% confidence bound of RMSE for a given sample size assuming a normal distribution (N(0,1)). The model was re-run several times to adjust the RMSE values. Next, the initial effective sample sizes were adjusted once by using the Francis multipliers and the model was re-run. The RMSE index values for the indices were checked again to ensure the RMSE values still fell in the 95% confidence bounds; if not, the index CV weights were adjusted again and the model re-run.

### B4.20.12 Code Checking

The accuracy of the original model code was checked by simulating virtual populations for Stock-1 and Stock-2 in R and catch numbers, catch age composition, one aggregate and age compositions surveys for each stock and one mixed stock index were generated using the above model equations and known values of fishing mortality, natural mortality, recruitment, catch and survey selectivities, and catchability coefficients. The catch and survey data and known parameters were then input into the model and the model was run without minimization to check if the code produced the exact values of the simulated population. The model was then run with minimization to check estimation. Both trials showed that the model duplicated the simulated population quantities. All code is presented in B8.

### B4.20.13 Base Model Configuration and Results

The final model configuration CV weights and effective sample sizes used for all sources are shown in Table B7.7. There were 344 parameters estimated in the model.

### B4.20.14 Results

Resulting contributions to total likelihood are listed in Table B7.8. The converged total likelihood was 30,826.5 (Table B7.8). Estimates of fully-recruited fishing mortality for each region and period, recruitment, parameters of the selectivity functions for the selectivity periods, catchability coefficients for all surveys, parameters of the survey selectivity functions, and estimates of age abundance in the first year are given in Table B7.9 and are shown graphically in Figures B7.5-7.8.

Graphs depicting the observed and predicted values and residuals for the catch age composition, survey indices, and survey compositions are given in Appendix B9. The model fit the observed total removals in the Chesapeake Bay and ocean in each period and region well (Figure B7.6). For the Chesapeake Bay stock, observed age composition data for period-2 were fitted reasonably well, but older ages were not in periods 1 and 3 (Appendix B9 Figures 1-6). The ocean removals age composition in period-1 was poorly fitted (few removals and samples are made during this period), but those for period-2 and 3 were fitted reasonably well (Appendix B9 Figures 7- 11). The model tended to slightly over-estimate the ocean removals age composition at older ages in the latter years of the time series.

For the Chesapeake Bay stock, the observed MAYOY, VAYOY, MD Age-1, and ChesMMAP survey indices were predicted fairly well but less so for the MDSSN survey (Appendix B9 Figure 12). The NYYOY, NJYOY, NY Age-1 and DESSN indices for the Delaware Bay/Hudson River stock were fitted reasonably well, but less so for the DE30 survey. (Appendix B9 Figure 13 and 14). Based on residuals plots, the NYOHS index for the mixed ocean stocks was fitted poorly. Although a balanced residual pattern was observed for the NJTRL index, trends were not well predicted. The predicted indices for CTLISTS and MRIP surveys showed similar trends as the observed but peaks in the observed data were not matched well (Appendix B9 Figure 15). The estimated selectivity patterns for each age composition survey are shown in Appendix B9 Figure 16. For the Chesapeake Bay stock, the observed trends in age compositions for the MDSSN survey (Appendix B9 Figures 17 and 18) were predicted well by the model, while those for ChesMMAP (Appendix B9 Figures 19 and 20) were predicted less well. For the Delaware Bay/Hudson River stock, the DESSN age composition was predicted fairly well for intermediate ages (less so for older ages) (Appendix B9 Figure 21 and 22), whereas the predicted values for the DE30 survey were only fairly matched (Appendix B9 Figure 23 and 24). For the mixed ocean stock, NYOHS age composition was predicted fairly well (Appendix B9 Figures 25 and 26), NJTRL survey age composition was predicted poorly (Appendix B9 Figures 27 and 28), CTLISTS age composition was predicted fairly well (Appendix B9 Figures 29 and 30) and the MRIP age composition was predicted well (Appendix B9 Figures 31 and 32).

### *B4.20.14.1 Stock Composition Index*

The predicted stock composition for the Chesapeake Bay stock showed an increase in the Chesapeake Bay stock composition of the ocean catches (Figure B7.9). However, the predicted index showed the composition leveling off after 1995 at around 0.65, whereas the observed values for fish > 28 inches (711 mm) leveled off at higher proportions.

### *B4.20.14.2 Fishing Mortality*

Fully-recruited fishing mortality and fishing mortality-at-age by period and region is listed in Table B7.10. Except for period-1, the period fully-recruited F in 2017 was generally higher in ocean than in Chesapeake Bay. F was generally highest during period-3. Fishing mortality in the Chesapeake Bay and in the ocean region peaked at age-15 in most years since 1996-1997.

Annual fully-recruited F cannot be calculated by simply summing the fully-recruited F across periods because the period Fs are not additive. Instead, stock-specific fully-recruited Fs can be estimated by calculating age-specific exploitation rates using the stock total numbers-at-age at the beginning of period-1 and predicted catch numbers-at-age combined across periods and region and then solving for F using the catch equation. Since fish from the Chesapeake Bay stock are present in both the Chesapeake Bay and ocean regions, which have differential natural morality rates, an average M-at-age was used in solving for F. A combined-stock fully-recruited F can be calculated in the same way. The fully-recruited F was considered the largest value in the resulting F vector. Table B7.11 lists the estimates of fully-recruited exploitation rates and resulting F values for the Chesapeake Bay stock, the Delaware Bay/Hudson River stock and combined stocks. Fishing mortality was generally higher for the Delaware Bay/Hudson River stock (Chesapeake Bay stock $F_{2017}$=0.284; the Delaware Bay/Hudson River stock $F_{2017}$=0.394) and variation in F of both stocks was similar (Figure B7.10). The resulting fully-recruited Fs for combined stocks showed similar variation as the individual stock values but Fs were slightly higher than the Chesapeake Bay stock Fs (Figure B7.10). The combined fully-recruited F was estimated to be 0.305 in 2017.

### *B4.20.14.3 Population Abundance (January 1)*

The Chesapeake Bay stock population occurs in both the Chesapeake Bay and ocean regions. The movement of numbers between the Chesapeake Bay and ocean regions is shown in the abundance matrices in Table B7.12. Using only period-1 estimates and summing across regions, the striped bass abundance (ages 1+) increased steadily from 1982 through 1997 when it peaked around 483 million fish (Figure B7.11). The Chesapeake Bay stock total abundance fluctuated widely without trend through 2004. A general decline occurred after 2004 to 182 million fish in 2011. Abundance increased in 2012 and again in 2016. Abundance of ages-8+ increased from about 593,000 fish in 1986 to 15 million fish in 2004 (Figure B7.11). Ages-8+ abundance has been declining since 2005 and was estimated to be 5.5 million fish in 2017.

Abundance estimates by period and year for the Delaware Bay/Hudson River stock are listed in Table B7.13. Using only period-1 estimates, the striped bass abundance (ages 1+) for the Delaware Bay/Hudson River stock increased steadily from about 21 million fish in 1982 to its first peak at 158 million fish in 1994 (Figure B7.12). Total abundance of the Delaware Bay/Hudson River stock fluctuated widely without trend through 2004. A general decline in abundance occurred after 2004, and abundance in 2014 was estimated to be only 58 million fish. Age-1+ abundance increased in 2015-2017 to an average-123 million fish (Figure B7.12). Abundance of age-8+ increased from about 1 million fish in 1984 to 5.8 million fish in 2004 (Figure B7.12). Age-8+ abundance has been steadily declining since 2005 and was estimated at 2 million fish in 2017.

### *B4.20.14.4 Spawning Stock Biomass, Total Biomass and Stock-Recruitment Relationship*

For the Chesapeake Bay stock, female SSB grew steadily from 1982 through 2003 when it peaked at about 88 thousand mt (Table B7.14; Figure B7.13). Female SSB has declined since then and was estimated at 50 thousand metric tons (95% CI: 37,813-62,879) in 2017 (Table B7.14; Figure B7.13). For the Delaware Bay/Hudson River stock, female SSB grew steadily from 1986 through 2003 when it peaked at about 42 thousand mt (Table B7.15; Figure B7.13). Female SSB has declined since then and was estimated at 21 thousand metric tons (95% CI: 15,833-26,860) in 2017 (Table B7.15; Figure B7.13). The combined-stock female SSB showed similar trends (Figure B7.13).

Total biomass (January 1) for the Chesapeake Bay stock (Table B7.16) increased from 3,292 metric tons in 1982 to its peak at about 338,000 metric tons in 1999 (Figure B7.14). Total biomass has been declining since then (Figure B7.14). Total biomass (January 1) for the Delaware Bay/Hudson River stock (Table B7.17) increased from 20,000 metric tons in 1986 to its peak at about 128,000 metric tons in 1999 (Figure B7.14). Total biomass has been declining since then (Figure B7.14). The trends in total biomass were similar between stocks.

The stock-recruitment data derived for each stock is shown in Figure B7.15. External fitting of Beverton-Holt curves (assumed the correct functional form for striped bass) to these data were performed to determine equation parameters. The curve fit was good and parameters were reasonably precise for the Chesapeake Bay stock, but the fit for the Delaware Bay/Hudson River stock was not believable because the asymptotic recruitment was not reached until extremely high female SSB levels that have not been observed.

#### *B4.20.14.5 Retrospective Analysis*

Retrospective analysis plots and percent difference plots between the 2017 value of period fully-recruited fishing mortality for the Chesapeake Bay and ocean regions and recruit numbers and female SSB for the Chesapeake Bay stock and 2 and 2016-2010 peels are shown in Figures B7.16-18. Fully-recruited F in the Chesapeake Bay for periods 1-3 had low to moderate (in most recent years) retrospective bias and it appears that F is slightly over-estimated in terminal years (Figure B7.16). Fully-recruited F in the ocean for periods 1-3 also had low to moderate (in most recent years) retrospective bias but the pattern in bias was not consistent (Figure B7.17). Retrospective analysis of age-1 recruits showed that the terminal year estimate of age-1 abundance for both stocks were most uncertain (Figure B7.18). For the Chesapeake Bay stock, the terminal year is likely over-estimated (Figure B7.18), while the bias pattern for the Delaware Bay/Hudson River stock is not consistent (there is under- and over-estimation). Retrospective analysis of female SSB for the Chesapeake Bay stock showed that the female SSB can be highly under-estimated in early years (peels 2011, 2013 and 2014) (Figure B7.18). However, trends in bias near the terminal show that female SSB has low bias (<12%) and may be slightly under- or over-estimated. For the Delaware Bay/Hudson River stock, bias in female SSB was low (<15%) but there was no consistent pattern in the direction of bias (Figure B7.18).

### B4.20.15 Sensitivity Analysis

*Starting Values*

Starting values for the minimization routine are important to achieve proper convergence at the global minimum. The starting values were selected based on trial-and-error. Many runs were conducted to find values that appeared to be reliable and for which the global minimum was reached consistently. To further check the convergence properties of the model, 100 model runs were made, and for each run, starting values were randomly permuted by ±50%. A plot of total fully-recruited F in period-3 in 2017 and corresponding total log-likelihoods assessed convergence stability. The runs demonstrated that the starting values selected produced the smallest total likelihood (15069.2) in 77 out of 100 runs (Figure B7.19).

*Natural Mortality*

Striped bass residing in the Chesapeake Bay experience higher natural mortality after 1997 due to the advent of *Mycobacteriosis*. To examine the impact of this higher mortality on the results, a sensitivity run was made in which those higher natural mortality rates were substituted for the lower baseline values. (Figure B7.20). Using the lower natural mortality rates prior to 1997 in the Chesapeake Bay resulted in lower fishing mortality in the Chesapeake Bay, higher fishing mortality in the ocean, lower recruitment in the Chesapeake Bay stock and lower female SSB in both stocks (Figure B7.20).

*Effects of Deleting Survey Dataset*

The contribution of each survey data source to the results of the final model configuration was investigated by removing each dataset one-at-a-time and re-running the model. Very little change was observed when most indices were removed. The biggest changes resulted the MDSSN and MRIP surveys were removed (Figure B7.21). Without the MRIP index, the fully-recruited F in all periods and regions decreased and female SSB for both stocks increased particularly after 2003 (Figure B7.21). Without the MDSSN index, the magnitude of fully-recruited F increased slightly and the magnitude of the female SSB decreased for both stocks prior to 2012 (Figure B7.21).

*Effects of Effective Sample Sizes of Catch and Survey Multinomial Distributions*

The influence of the magnitude of average effective sample sizes of the catch and survey multinomial likelihoods on the estimates of fully-recruited fishing mortality, recruitment and female SSB was investigated. When the average effective sample sizes were increased or decreased by 50% of the original values, fully-recruited F and recruitment of both stocks changed very little (Figure B7.22). However, increasing ESS by 50% increased the female SSB slightly (more so for the Delaware Bay/Hudson River stock in the early part of the time series), whereas decreasing ESS produced the opposite effect (Figure B7.22).

*Effects of Changing the Female and Male Maturity Schedules*

Migration of the Chesapeake Bay stock fish back into the Chesapeake Bay region is controlled by the female and male maturity schedules. The impact of the maturity schedules were investigated by sliding the vector of proportions mature-at-age up or down one age. Fishing mortality and recruitment values changed very little except in the ocean during period-2 where decreasing the age increased F slightly and increasing age decreased F slightly (Figure B7.23). As expected, the biggest change happened to female SSB; sliding the vector down one age produced more female SSB, whereas sliding the maturity schedule up one age lowered the female SSB (Figure B7.23).

*Effects of Changing Emigration Probabilities*

The current vector of emigration probabilities for the Chesapeake Bay was derived using tag data released by Maryland DNR following Dorazio et al. (1994). Maryland tagging occurred through most of the estuary, so the distribution of tagging covered much of the striped bass distribution. The State of Virginia also tags fish in the Rappahannock River near the mouth of Chesapeake Bay, but these data were not used in this assessment because the emigration probabilities would probably not be representative of the whole stock residing in the Chesapeake Bay. However, SAS members were interested in the impacts of using Maryland and Virginia data, so estimates of emigration probabilities by age were made following the Dorazio et al. (1994) methods (Figure B7.3). The combined data estimated that emigration rates for younger ages were lower and rates for older ages were higher than the Maryland-only data. The effects of using the Maryland/Virginia probabilities are shown in Figure B7.24. Relative to the base model, fishing mortality in the Chesapeake Bay region declined while it increased in the ocean, recruitment numbers for both stocks increased slightly, and female SSB estimates for the Chesapeake Bay stock increased, while the Delaware Bay/Hudson River stock female SSB decreased in magnitude (Figure B7.24).

*Effects of the Stock Composition Index*

The results of the stock assessment are very sensitive to the inclusion of the stock composition index because it is used by the model to scale the recruitment and population estimates. The impact of not using the index is presented in Figure B7.25. Fishing mortality in the bay increased on average by 46%, 47%, and 47% during period-1, -2 and -3 respectively. Fishing mortality in the ocean decreased on average by 11%, 32% and 15% during period-1, -2 and -3, respectively. Chesapeake Bay stock recruitment decreased by 27% on average, and Delaware Bay/Hudson River stock recruitment increased by 72% on average (Figure B7.25). Female spawning stock of the Chesapeake Bay stock decreased on average by 40% and the Delaware Bay/Hudson River stock female spawning stock increased by an average of 101%.

A vector of stock composition estimates for >18” (457 mm) fish was also derived by the committee, but were not used for reasons discussed earlier. However, if this index was used only small changes to fishing mortality and recruitment estimates occurred (Figure B7.25). The biggest influence occurred in the Delaware Bay/Hudson River stock female SSB where biomass increased on average by 32% after 2000.

*Effects of Adjusting Commercial Dead Discards*

The results of this stock assessment used dead discards for the commercial fishery estimated from tag data and MRIP. The stock assessment subcommittee had decided to rescale the Delaware and Chesapeake Bay estimates of discards by a ratio derived by comparing direct estimates of Delaware Bay discards from 2002 and 2003 to estimates derived by the tag-based method. To explore the impact of not rescaling the discards estimates for these bays, the unadjusted dead discards were included and the model parameters were re-estimated (Figure B7.26). Using the unadjusted dead discards impacted the model results minimally. The fishing mortality for period-1 in the Chesapeake Bay changed the most, but only slight deceases in F were observed during the other periods and within the Chesapeake Bay and ocean regions. Female SSB prior to 1996 increased slightly and it declined slightly after 1999 (Figure B7.26).

### B4.20.16 Sources of Uncertainty

Accurate estimates of catch at age require that we know the total loss in numbers and that we apportion this loss correctly to age. The best data on loss comes from the directed recreational and commercial fisheries. Estimates of Virginia wave-1 recreational harvest are estimated by using North Carolina harvest and tag returns, and Virginia tag returns, because MRIP sampling is not conducted during this time. Recreational harvest data are lacking from large river systems such as the Connecticut River and Hudson River where striped bass are known to be harvested. There is less confidence in estimates of discards in commercial and recreational fisheries because little of the data is measured directly. Moreover, gear specific discard/release mortalities are assumed to be constant even though mortalities may vary with season and with changes in gear specifics such as increased use of circle hooks. The quality of data on age composition varies among fisheries and region. In most cases, fish in catches or discards are measured and length frequencies are converted to age frequencies with age length keys. States with large harvests usually sample fisheries directly and develop age length keys from the fishery and time of year of the fishery. However, states with small fisheries must often rely on length data from small samples or fishery independent collections or use age length keys developed by neighboring jurisdictions. The assignment of age to scales samples becomes less certain with increasing fish age ($\geq$

age-10). In addition, the same vector of emigration probabilities, female proportions-at-age, and maturity schedules are assumed constant over time which is unlikely.

Estimates of F and female SSB from 2SCA model at the beginning of the time series, not the terminal year, are the most uncertain estimates. However, retrospective analysis indicated that the terminal year estimates are only slightly biased (<15%).

### B4.21 Supporting Models

#### B4.21.1 Single stock, Non-Migration Statistical Catch-At-Age Model (SCA)

***[SAW-66 Editor's Note: The SARC-66 peer review panel SARC-66 recommends the single stock, non-migration model described in this section for management use.]***

The 2013 SCA model (NEFSC 2013) was used to estimate fishing mortality, abundance, and female SSB of striped bass during 1982-2017 from total removals-at-age and fisheries-dependent and fisheries-independent survey indices.

A summary of the model structure used in this assessment is listed in Table 1 of Appendix B10.

##### *B4.21.1.1 Data Inputs*

*Bridge building*
The 2013 model (NEFSC 2013) and data configuration were updated with data through 2016 that included uncalibrated recreational MRIP data (ASMFC 2017; Table B7.19). This same model was updated with calibrated MRIP data (Table B7.19). A base model was then constructed with the changes described below and summarized in Table B7.19 to make it comparable to the base case of the preferred 2SCA model.

*Plus Group*
The 13+ plus-group used in NEFSC (2013) was extended to a 15+ plus-group for catch and indices data. This extension represents a compromise between scale age bias that increases after about age-12, and more complete ocean fishery selection and Chesapeake Bay migration of fish by about age-15.

*Catch Data*
Total removals and the proportions of catch-at-age of striped bass fisheries are the primary data used in the model. The removals data were partitioned into two "fleets" in an attempt to account for more realistic patterns in fishing selectivity. For this assessment, the SAS was able to apportion commercial releases into Chesapeake Bay and Coast regions allowing for the elimination of a third commercial dead release "fleet"; this is a change from NEFSC (2013) that included the combined dead commercial

releases as a separate fleet. All selectivity time blocks corresponded to Amendment changes. Removals data were split into *Chesapeake Bay* and *Coast*, each with their respective commercial dead releases.

The Chesapeake Bay fleet includes commercial and recreational harvest and commercial and recreational dead releases taken in the Chesapeake Bay by Maryland, Virginia, and the PRFC. The Coast fleet includes commercial and recreational harvest and commercial and recreational dead releases taken in the coastal regions, Delaware Bay, Long Island Sound, and Hudson River by Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia and North Carolina. The observed total removals and catch age compositions were generated from all state reported landings-at-age, and recreational dead releases-at-age. The total removals and age composition by region were developed by summing the removals-at-age developed for the 2SCA model (Table B7.1) across the three periods in the 2SCA model.

Total catch CVs for the Chesapeake Bay and Coast fleets were assumed equal to the PSEs of MRIP total harvest plus dead releases for the inclusive states (Appendix B10). The CV of the combined harvest and dead releases estimates for each year was calculated as:

$$CV = \frac{\sqrt{(PSE_H / 100 * H)^2 + (0.09^2 * (PSE_R / 100 * R)^2)}}{H + R * 0.09}$$

The commercial landings were assumed errorless. There is error in the commercial dead releases, however it is unaccounted for in the fleet CVs (this is a departure from NEFSC (2013), where commercial dead releases were their own fleet). This represents a source of uncertainty in the assessment; see Data Weighting Section, below.

*Young-of-the-Year and Age-1 Indices*

Young-of-the-year (YOY) and yearlings (age-1) indices from New York (NYYOY: 1986-2017; NY Age-1: 1985-2017), New Jersey (NJYOY: 1982-2017), Maryland (MDYOY and MD Age-1: 1970-1981), and composite Maryland-Virginia (MDVAYOY: 1982-2017) were incorporated into the model by linking them to corresponding age abundances and time of year. Because age-0 striped bass are not modeled, the YOY and age-1 indices were advanced one year and are linked to age-1 and age-2 abundances, respectively, and are tuned to January 1st (p=0; Appendix B10). Except for the MDVAYOY index, all YOY and age-1 indices are geometric means and corresponding CVs. More information on these surveys can be found in Section B5.2 and ASMFC (1996).

*Aggregate and Age-Species Indices*

The aggregate indices (no or borrowed age data or other reasons) from the Marine Recreational Fisheries Statistics Survey (MRIP: 1988-2016) and Northeast Fisheries Science Center (NEFSC spring bottom trawl survey: 1991-2008) are used in the update of the NEFSC (2013) model by linking them to aggregate age abundances and the time of year (ASMFC 2017). All aggregate indices are geometric means of the survey estimate. The annual CVs for the MRIP index were calculated by dividing model estimates of standard errors by the index. CVs for the NMFS survey was estimated from survey data.

The age-aggregated indices and age composition data from NYOHS survey (1987-2006), NJTRL survey (1990-2017), MDSSN survey (1985-2017), DESSN (1996-2017), DE30 (1999, 2002-2017), CTLISTS (1987-2017), ChesMMAP (2002-2017), and Maine-North Carolina (recreational hook and line: 1982-2017) surveys are incorporated into the updated non-migration SCA model by linking them to age abundances and the time of year (Appendix B10). The Gompertz equation is used to estimate the selectivity pattern for the Delaware spawning stock survey because theory indicates that vulnerability to electric fields increases with surface area of the fish (Reynolds, 1983). The Gompertz model is also used to estimate the selectivity pattern on the MRIP survey index. The MDSSN survey estimates are corrected for mesh-size selectivity, only the selectivity value for age-2 had to be estimated (NEFSC 2013); for ages ≥ 3, selectivity was set to 1. For the NYOHS, CTLISTS, DE30, and ChesMMAP surveys the Thompson's exponential-logistic model is used to estimate the selectivity pattern. For the NJTRL survey, a gamma function is used to estimate the selectivity pattern.

*Starting Values*

Initial starting values for all parameters (Appendix B10) were carried forward from NEFSC (2013), where they were selected based on trial and error. As was the case in NEFSC (2013), the starting effective sample sizes for the age proportions in each fleet were set at 50, based on the coast-wide age samples.

For existing surveys with age composition data, final effective sample sizes from ASMFC (2017) were used as ESS starting values (calculated in NEFSC (2013) using methods in Pennington and Volstad (1994) and Pennington et al. (2002). For new age composition surveys, the average ESS of existing surveys was used (Table B7.19). The sensitivity of results to these starting values was explored (see below).

*Sex Proportions-at-age*

Female sex proportions-at-age are used to apportion the numbers-at-age to female numbers-at-age for calculation of female SSB. The sex proportions were derived from available state catch datasets and are unchanged from the previous assessment (NEFSC 2013). The proportions used were truncated to 13+ for the continuity run.

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proportion female | 0.53 | 0.56 | 0.56 | 0.52 | 0.57 | 0.65 | 0.73 | 0.81 | 0.88 | 0.92 | 0.95 | 0.97 | 1.00 | 1.00 | 1.00 |

*Female Maturity*

In the past the proportions mature-at-age for females in NEFSC (2013) were derived from literature values and field samples. These values were updated as described in Section B5.1.7 (female maturity).

Female maturity NEFSC (2013):

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proportion mature | 0.00 | 0.00 | 0.00 | 0.04 | 0.13 | 0.45 | 0.89 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Updated female maturity used for the present assessment:

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proportion female | 0.00 | 0.00 | 0.00 | 0.09 | 0.32 | 0.45 | 0.84 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

The SAS explored the sensitivity of the results to the change in female maturity.

*Natural Mortality*
Natural mortality is unchanged from the previous assessment (NEFSC 2013). Age-specific M for ages 1-6 were derived from a curvilinear model fitted to tag-based Z estimates (assuming Z=M) for fish ≤ age-3 from New York and tag-based M estimates (Jiang et al. 2007) for striped bass from Maryland made for years prior to 1997. The age-specific M estimates used in the base model are:

| Age | 1 | 2 | 3 | 4 | 5 | 6 | >7 |
|---|---|---|---|---|---|---|---|
| M | 1.13 | 0.68 | 0.45 | 0.33 | 0.25 | 0.19 | 0.15 |

### *B4.21.1.2 Model Specification*

*Catch Selectivity Functions*
In NEFSC (2013), four time blocks were used (Table B7.19). Each period designates a major change in management regulations of striped bass. In the current formulation, the same time blocks were used for each fleet. However, the usefulness of adding another time period (2015-2017: under Addendum IV) for each fleet was considered by comparing the AICc values of model fits with the additional period (each fleet added sequential) against the model fits without the extra period. The addition of the extra time period did not improve the fit of either fleet. The three-parameter Thompson exponential-logistic equation was applied to allow more flexible estimation of the selectivity pattern in each time block. If a resulting selectivity pattern was flat-topped, the Thompson function was replaced with a Gompertz function to save one parameter from being estimated.

*Stock-Recruitment Curve*
Based on literature reviews and committee opinion, the Beverton-Holt equation was selected as the appropriate stock recruitment relationship for striped bass. Internal model fits of this relationship were poor and so recruitment is estimated as a log-normal deviation from average recruitment. The SAS explored the sensitivity of the results to this assumption.

*Data Weighting*
Data weighting was accomplished by first running the model with all initial starting values, lambda weights = 1, and index CV weights = 1, and the ESS as noted in Table B7.19. The lambda weights for the total removal data were increased for the Chesapeake Bay and Coast to force the model to better fit the data. After the model was re-run, the index CV weights were adjusted to obtain index RMSE values within the 95% confidence bound of RMSE for a given sample size assuming a normal distribution (N(0,1)). The model was re-run several times to adjust the RMSE values. Next, the initial effective sample sizes were adjusted once by using the Francis multipliers and the model was re-run. The RMSE index values for the indices were checked again to ensure the RMSE values still fell in the 95% confidence bounds; if not, the index CV weights were adjusted again and the model re-run.

### *B4.21.1.3 Model Configuration and Results*

Based on the above analyses and recommendations from the ASMFC’s striped bass stock assessment and technical committees, the final model contained four catch selectivity periods for the Chesapeake

Bay and Coast fleets. All indices were used. The lambda weights of total catch for the Chesapeake Bay, Coast and Commercial Release fleets were increased by 2 to force the model to better fit the data in the early part of each time series. Except for the lambda weight of the total catch series, no other lambda weights were increased. The index CV weights, however, were adjusted and are shown in Appendix B10 along with the index RMSEs and 95% confidence bounds of the RMSE assuming N(0,1). The effective sample sizes from the Francis (2011) adjustment for catch and index age compositions were: Chesapeake Bay – 68.4, Coast – 71.1, NYOHS – 21.5, NJTRL – 5.2, MDSSN – 16.8, DESSN – 19.7, MRIP – 35.6, CTLIST – 12.4, DE30 – 7.3, and ChesMMAP – 10.8.

Resulting contributions to total likelihood, estimates of fully-recruited fishing mortality for each fleet, total fishing mortality, recruitment, parameters of the selectivity functions for the selectivity periods, catchability coefficients for all surveys, and parameters of the survey selectivity functions are given in Appendix B10 and are shown graphically in Figures B7.27-B7.30. Graphs depicting the observed and predicted values and residuals for the catch age composition, survey indices, and survey compositions are given in Appendix B10. The model fit the observed total catches (Figure B7.28) and catch age compositions (Appendix B10) well with few exceptions (e.g., age compositions of younger ages in fleet 2) and are generally similar to fits seen in NEFSC (2013). Model fits to the YOY indices were all generally reasonable (Appendix B10). The age-1 indices are not fit particularly well. The predicted trends matched the observed trends in age composition survey indices (except MDSSN and NYOHS), and predicted age survey age composition reasonably well (MDSSN) to poorly (NJTRL) (Appendix B10).

*Fishing Mortality*

Fully-recruited fishing mortality in 2017 for the Chesapeake Bay and Coast fleets was 0.068 and 0.262, respectively (Appendix B10) and always highest in the Coast fleet (Figure B7.27). The maximum total F-at-age in 2017 was 0.307, which occurred on ages 13-14 (Table 7 in Appendix B10). Average fishing mortality (unweighted) on ages 3-8, which are generally targeted in producer areas, was 0.173 (Table B7.20; Figure B7.31). An average F weighted by N was calculated for comparison to tagging results since the tag releases and recaptures are weighted by abundance as part of the experimental design. The 2017 F weighted by N for ages 7-13 (age-7 to compare with tagged fish ≥28" (711 mm)) was 0.267 (Table B7.20; Figure B7.31). An F weighted by N for ages 3-8, comparable to the direct enumeration estimate for Chesapeake Bay, was equal to 0.110 (Table B7.20; Figure B7.31).

Fishing mortality-at-age in 2017 for the two fleets is shown in Figure B7.32. Fishing mortality-at-age peaked at age-6 in the Chesapeake Bay fleet and age-15+ in the Coast fleet. The highest fishing mortality was attributed to the Coast fleet at ages ≥ 5 (Figure B7.32).

*Population Abundance (January 1)*

Striped bass abundance (1+) increased steadily from 1982 through 1997 when it peaked around 420 million fish (Table B7.21, Figure B7.30). Total abundance fluctuated without trend through 2004. From 2005-2009, age-1+ abundance declined to around 189 million fish. Total abundance increased to 351 million by 2016 before dropping to 249 million fish in 2017 (Figure B7.30). The increase in 2012 was due primarily to the abundant 2011 year class from Chesapeake Bay (Table B7.21). Abundance of age-8+ striped bass increased steadily through 2004 to 16.5 million fish. After 2004 age-8+ abundance oscillated and has been in decline since 2011 (Table B7.21; Figure B7.30). Age-8+ abundance in 2017 is estimated at 6.7 million fish, a value near the $30^{th}$ percentile of the time-series.

*Spawning Stock Biomass, Total Biomass and Stock-Recruitment Relationship*
Weights-at-age used to calculate female SSB were generated from catch weights-at-age and the Rivard algorithm described in the NEFSC's VPA/ADAPT program. Female SSB grew steadily from 1986 through 1996 after which female SSB dropped to just below levels observed in 1995. Female SSB grew steadily between 1999 and 2003 when it peaked at 114 thousand metric tons (Table B7.21, Figure B7.33). Female SSB has generally declined since then and was estimated at 68.5 metric tons (95% CI: 53,520-83,431 mt). The female SSB point estimate is approximately 23 thousand metric tons below the threshold level of 91.4 thousand metric tons ($SSB_{1995}$) and indicates that striped bass are overfished. The spawning stock numbers (Figure B7.33) have declined about the same pace as female SSB.

Total biomass (January 1) increased from 38 thousand metric tons in 1982 to its peak at 335 thousand metric tons in 1999 (Figure B7.33). Total biomass generally declined through 2015, but has since increased slightly in 2017 (Figure B7.33).

The stock-recruitment data derived in the model along with the deterministic externally fit Beverton-Holt curve is shown in Figure B7.34. As was the case with the Delaware Bay/Hudson River stock in the migration model (2SCA), asymptotic recruitment was not reached until high female SSB levels that have not been observed.

***B4.21.1.4 Retrospective Analysis***
Retrospective analysis plots and percent difference plots between 2017 and peels of the retrospective analysis are shown in Figure B7.35. Very little retrospective trend (+/-2%) was evident in the more recent estimates of fully-recruited total F, female SSB, and age-8+ abundance of SCA (Figure B7.35). Approximately 5 years of additional data are needed before the percent-difference from 2017 estimates increases to +/- 10 to 15%. Percent-difference from the most recent year of data in NEFSC (2013) ranged from 10-30%. The retrospective analysis of age-1 recruits showed that the terminal year estimate of age-1 abundance is most uncertain (Figure B7.35). The retrospective pattern suggests that fishing mortality is likely slightly over-estimated and could decrease with the addition of future years of data. Similar, but larger, retrospective trends have been observed in the previous assessment of striped bass using the ADAPT VPA (ASMFC 2005), the 2007 benchmark, and the 2013 benchmark.

***B4.21.1.5 Sensitivity Analysis***

*Starting Values*
To further check the convergence properties of the model, 100 model runs were made, and for each run, starting values were randomly permuted by +50%. A plot of total fully-recruited F in 2017 and corresponding total log-likelihoods assessed convergence stability. The runs demonstrated the stability of the results from the base model (Figure B7.36).

*Natural Mortality*
To determine if the potential impact of higher M due to the Mycobacterium outbreak in Chesapeake Bay, M for ages 3+ after 1996 was increased. Smith and Hoenig (MS 2012) estimated that M on ages 3-8 in Chesapeake Bay had increased from an assumed base-level of 0.15 to 0.27 (difference=0.12). This difference was added to the age-specific Ms for ages-3+ for years 1997-2017. Increasing M

produced lower estimates of fully-recruited F and higher estimates of female spawning biomass, Age-8+ abundance, and recruitment (Figure B7.37).

*Effects of Deleting Survey Dataset*
The contribution of each survey data source to the results of the final model configuration was investigated by removing each dataset one-at-a-time and re-running the model. Changes in the time series of F estimates for 1982-2017 between base run (all indices) and each one removed one-at-a-time were minor except when the MRIP and MDSSN indices were removed (Figure B7.38). Without the MRIP index, the fully-recruited F decreased and female SSB increased relative to the base run after about 1989 (Figure B7.38); the opposite is true without the MDSSN index (Figure B7.38). Recruitment estimates are unchanged when survey data sources are removed (Figure B7.38).

*Effects of Effective Sample Sizes of Catch and Survey Multinomial Distributions*
The influence of the magnitude of average effective sample sizes of the catch and survey multinomial likelihoods on the estimates age-8+ abundance, female SSB, recruitment, and fully-recruited fishing mortality was investigated. When the average effective sample sizes were increased or decreased by 20% of the original values, all estimates were virtually unchanged (Figure B7.39). Estimates were also virtually unchanged with a 50% increase in ESS (ESS150). Decreasing ESS by 50% (ESS50) raised age-8+ abundance and female SSB during the 1990s and decreased fully recruited fishing mortality slightly during the 1990s.

*Recruitment estimation method*
The influence of the method of recruitment estimation on the estimates age-8+ abundance, female SSB, recruitment, and fully-recruited fishing mortality was investigated. When the recruitment estimation method changed (lognormal deviations from mean recruitment (base) versus lognormal deviations from Beverton-Holt stock recruitment relationship) all estimates were virtually unchanged over the time series (Figure B7.40).

*Unadjusted commercial dead releases*
The influence on making adjustments to commercial dead releases on the estimates age-8+ abundance, female SSB, recruitment, and fully-recruited fishing mortality was investigated. Fully recruited fishing mortality, age-8+ abundance, and recruitment are virtually unchanged, though female SSB is slightly higher after about 2004 (Figure B7.41).

*Changes to female maturity*
The influence of female maturity schedule on estimates of age-8+ abundance, female SSB, recruitment, and fully-recruited fishing mortality was investigated by shifting the maturity curve left or right by one age, as well as using the curve from NEFSC (2013). Age-8+ abundance, fully recruited fishing mortality and recruitment were virtually unchanged with changes in maturity (Figure B7.42). Female SSB changed as expected with shifts in the maturity curve: higher female SSB when maturity schedule is shifted left as fish are assumed to mature at younger ages, and the opposite when maturity is shifted right. Using female maturity from NEFSC (2013) results in minor changes to female SSB.

### *B4.21.1.6 Sources of Uncertainty in SCA Model*

Accurate estimates of catch at age require that we know the total loss in numbers and that we apportion this loss correctly to age. The best data on loss comes from the directed recreational and commercial fisheries. Estimates of Virginia wave-1 recreational harvest are estimated by using North Carolina harvest and tag returns, and Virginia tag returns, because MRIP sampling is not conducted during this time. Recreational harvest data are lacking from large river systems such as the Connecticut River and Hudson River where striped bass are known to be harvested. There is less confidence in estimates of discards in commercial and recreational fisheries because little of the data is measured directly. Moreover, gear specific discard/release mortalities are assumed to be constant even though mortalities may vary with season and with changes in gear specifics such as increased use of circle hooks. The quality of data on age composition varies among fisheries and region. In most cases, fish in catches or discards are measured and length frequencies are converted to age frequencies with age length keys. States with large harvests usually sample fisheries directly and develop age length keys from the fishery and time of year of the fishery. However, states with small fisheries must often rely on length data from small samples or fishery independent collections or use age length keys developed by neighboring jurisdictions. The assignment of age to scales samples becomes less certain with increasing fish age (≥ age-10). Finally, as noted above, there is uncertainty in the estimates of commercial dead releases.

Estimates of F and population size from the catch at age analyses at the beginning of the time series, not the terminal year, are the most uncertain estimates. However, retrospective analysis indicated that the terminal year estimates are slightly, positively biased and may decrease somewhat with an additional year of data.

### B4.21.2 Age-Structured Assessment Program (ASAP)

A single stock unit model was developed using the statistical catch-at-age approach in the software package Age-Structured Assessment Program (ASAP; version 3.0.16). The basic concept (Legault and Restrepo 1998) is similar to the SCA model, however some of the options available and approaches in fitting the data are different. In the ASAP model, the indices consist of the MDSSN indices at ages 2 to 15+, MRIP CPUE at ages 3 to 15+, NY age-1, MD age-1, ChesMMAP indices at ages 2-15+, CTLISTS indices at ages 3 to 8, NJTRL indices at age-2 to 9, DESSN indices at ages 2-12, DE30 indices at ages 1-8, and a composite swept area estimate of age-0 among all three stocks (adjusted to abundance at Jan 1 in *t*+1). The ChesMMAP index selectivity was fit as a double logistic curve, the DESSN index as a single logistic curve and all others were fit as selectivity at age fixed as flat-top selectivity curves. A CV of 10% was applied to each of two fleets, distinguished as catch within Chesapeake Bay and catch along the coast beginning in 1982. The catch selectivity was separate for Chesapeake Bay and coast, with three Chesapeake Bay time blocks (1982-1989, 1990-1995 and 1996-2017) and three coast time blocks (1982-1984, 1985-1997, and 1998-2017). Chesapeake Bay selectivity block 1 was fit as a double-logistic function. SSB was defined as female SSB. Since ASAP does not accommodate sex ratio as an input, female maturity at age was multiplied by sex ratio at age (the same ratio as SCA) to produce female SSB output. Recruitment was estimated using recruitment deviations with steepness fixed at 1. Retrospective peels were done for 7-years and an MCMC run made using 1000 iterations with a thinning factor of 100. Recruitment in the MCMC was defined by the geometric mean of age-1 for years 1995-2015.

The results of the ASAP model mirrored the updated non-migration SCA results. In general, the ASAP model produced slightly higher F's in the beginning of the time series and comparable values since 2000. The terminal year F in ASAP equaled 0.27 compared to the non-migration SCA model of 0.31 (Figure B7.43). Total abundance was lower in the terminal year due in part to a smaller estimate of recruitment (Figure B7.44and B7.45). Estimates of female SSB were generally lower in ASAP which may be due to the differences in estimation for female only components of SSB (Figure B7.46). There were no issues of retrospective bias in the ASAP runs with Mohn's rho value less than 0.1 for estimates of female SSB (-0.081), F (0.094), abundance (-0.060) and recruitment (-0.10) (Table B7.22). The 90% CI of the median female SSB in 2017 (60,912 metric tons; Figure B7.47) was between 49,517 metric tons and 74,048 metric tons. The 90% CI for Fmult in 2017 (0.27) was between 0.21 and 0.35 (Figure B7.47).

## B4.22 Comparison of Model Results

### B4.22.1 Comparison of 2017 Continuity Model Results (three-fleet SCA) to 2018 Base SCA Model Results (two-fleet SCA)

As a historical retrospective of model results, the estimates of fully-recruited fishing mortality, female SSB, recruitment, and age-8+ abundance from the 2017 update assessment (continuity run of 2012 base run) are compared to the results of the 2018 base model of the non-migration SCA model in Figure B7.48. We also explored the impact of the calibrated MRIP estimates on model results through a quasi-continuity run where we updated the recreational catch and recreational dead release component of the 2017 update CAA (all other data sources were unchanged). Differences between the 2018 base run and the 2017 continuity run are provided in Figure B7.48.

From 1990 forward, the fully recruited F estimates in the base run are generally higher than the estimates from the 2017 update assessment or when calibrated MRIP estimates were included in the 2017 update. Female SSB is higher in the 2018 base run relative to the 2017 update (due to inclusion of calibrated MRIP estimates); inclusion of the calibrated MRIP estimates into the 2017 update result in higher female SSB estimates than those estimated in the 2018 base run. Commercial dead releases were not updated in the quasi-continuity run and likely account for this increase (see also Figure B7.41). Female SSB since 2000 declined more rapidly in the base run relative to the 2017 update with inclusion of calibrated MRIP estimates (Figure B7.48). Results of age-8+ abundance are similar to those described for female SSB. Estimates of recruitment are higher with the inclusion of calibrated MRIP data (compare Base and newMRIP with update2017 in Figure B7.48).

### B4.22.2 Comparison of 2018 2SCA Model Results (Primary Model) to 2017 Continuity Model Results (three-fleet SCA)

As a historical retrospective of model results, the estimates of fully-recruited fishing mortality for both stocks combined and combined female SSB from the 2018 2SCA model 2017 are compared to the results of the 2017 continuity update of the SCA model in Figure B7.49. The fully-recruited F estimates from the 2SCA model were similar in trends but values tended to be higher than the estimates from the 2017 model except during the late 1990s-early 2000s. The female SSB estimates from the 2SCA model were considerably higher than estimates from the 2017 continuity run, and the former showed a steeper decline since 2005 (Figure B7.49). These disparities in results are likely due to the effect of updated

MRIP estimates for striped bass. The 2SCA model includes the updated recreational harvest and dead releases whereas the 2017 SCA continuity run does not.

### B4.22.3 Comparison of 2018 2SCA Model Results (Primary Model) to 2018 Base SCA Model Results (two-fleet SCA)

The SCA model was updated with the new MRIP estimate of harvest and releases, and the number of fleets was reduced to two fleets because commercial dead discards were able to be updated prior to 2004 updated and split into Chesapeake Bay, Delaware Bay and Ocean region. The fully-recruited F estimates from the 2SCA model were similar in trends but values were higher prior to 1993 but lower after 1994 (Figure B7.49). The estimates of fully-recruited F in 2017 were nearly identical between the two models. The female SSB estimates from the 2SCA model were considerably higher than estimates from the two-fleet SCA after 1995. The 2SCA model showed a steeper decline beginning in 2005, whereas the two-fleet SCA model estimates did not begin to steeply decline until about 2012 (Figure B7.49).

### B4.22.4 Comparison of 2018 2SCA Model Results (Primary Model) to ASAP Model Results

As a confirmatory check of the SCA model output, an ASAP statistical catch-at-age model was applied to the catch-at-age data and relative abundance indices. The ASAP produced fully-recruited fishing mortality estimates that were similar in trend but slightly larger than the 2SCA estimates after 1996 (Figure B7.49). The trends in female spawning biomass were similar the 2SCA results but were lower in magnitude (Figure B7.49).

## TOR B4. USE TAGGING DATA TO ESTIMATE MORTALITY AND ABUNDANCE, AND PROVIDE SUGGESTIONS FOR FURTHER DEVELOPMENT.

### B4.23 Introduction

This report summarizes results of tagging analyses conducted by the striped bass Tagging Subcommittee (SBTS) of the Technical Committee. Tagging data were obtained from the United States Fish and Wildlife Service's (USFWS) Atlantic coast-wide striped bass tagging program through the 2017 tagging year. Tagging analyses include the calculation of annual exploitation rates as adjusted R/M ratios, descriptive statistics on length frequency distributions of releases (measured as mm total length, TL), and age frequency distributions of recaptures based on an aged subsample at the time of release. Additionally, rates of survival (S), instantaneous fishing mortality (F), and instantaneous natural mortality (M) are estimated using an instantaneous (mortality) rate, catch and release model (IRCR) based on a formulation of Jiang et al. (2007).

### B4.24 Description of Atlantic Coast-wide striped bass Tagging Program

Refer to Section B5.4.

### B4.25 Annual Exploitation Rates

Annual exploitation rates (μ) were developed for both ≥ 18-inch (457 mm) fish and ≥ 28-inch (711 mm) fish and were estimated as follows:

$\mu = ((R_k / \lambda_h) + (R_L * 0.09 / \lambda_R)) / M$

where:

$R_k$ = the number of killed recaptures;

$R_L$ = the number of recaptures released alive;

0.09 = release mortality rate estimated by Diodati and Richards (1996);

$\lambda_h$ = reporting rate of harvested fish;

$\lambda_R$ = reporting rate of released fish and;

M = the number of fish initially tagged and released;

The SBTS defined two categories of tag recoveries for the analysis: a) fish harvested and tag reported and, b) fish caught and released, and tag reported. Only first recapture events were used. The reporting rate estimates for harvested fish and released fish are those used in the IRCR analysis, as described below.

### B4.26 Instantaneous Rates Model

Hoenig et al. (1998) first described an instantaneous rates model, where observed recovery matrices from harvested fish were compared to expected recovery matrices to estimate model parameters using a maximum likelihood approach. Jiang et al. (2007) published an expanded version of the instantaneous rates model that accounted for the re-release of caught, tagged fish. Given that many of the tagging programs do not age all tagged fish, the SBTS elected to use an age-independent form of the "instantaneous rates – catch and release" (IRCR) model by Jiang et al. (2007). The model was programmed in AD Model Builder (ADMB) by Gary Nelson (Massachusetts DMF) and tested using data provided in Jiang (2005). A user-interface in EXCEL creates the required ADMB input file. Details of model algorithms are provided in Jiang et al. (2007) and ADMB code is available in NEFSC (2013).

Tag recovery matrices of harvested fish and released fish for each program used in the current assessment are presented in Appendix B11. The number of fish recaptured two or more times was examined to ensure that this phenomenon did not cause a bias in model results. Of 92,344 recaptured fish in the database, only 4% (3,695 fish) were recaptured two or more times. Datasets used in the analyses included only first recapture events.

Six biologically reasonable candidate models were formulated based primarily on historical changes in striped bass management (Table B8.1). In the previous assessment, model structure included six regulatory periods, but the current assessment includes a seventh regulatory period from 2015–2017 (Table B8.2). Support for the addition of the seventh regulatory period was based on IRCR results for each tagging program comparing both six and seven regulatory period models. QAICc was used to determine the model with the most support. For most programs, the seven period models received the most weight. Additionally, results did not differ much between the six period (continuity) models and the seven period models (Appendix B11). For each candidate model, the IRCR analysis estimates S, F, F' (mortality on tags recaptured and released), M, and associated standard errors. Model averaged estimates of S, F, F', and M, and associated unconditional standard errors account for model selection uncertainty.

Candidate models are fit to the tag recovery data and arranged in order of fit by an overdispersion-corrected second-order adjustment to the Akaike's information criterion (QAICc; Akaike 1973; Anderson et al 1994; Burnham and Anderson 2003). Parameters of the models define various patterns of mortality as follows:
The global model: i.e., the fully parameterized model which is a time-saturated model with fishing and tag mortalities estimated annually and natural mortality estimated in two periods described below;
Regulatory period models: three models parameterize mortalities as constant within time periods that are based on regulatory changes to the striped bass fishery between 1987 and 2017 (regulatory periods are explained in Table B8.2);
Terminal and penultimate year models: versions of the regulatory period models that estimate mortalities separately for the terminal year or constant for the terminal and penultimate year.

Currently, M is modeled as two time-periods (Tables B8.1 and B8.3), consistent with methods of the previous assessment (NEFSC 2013). This approach to modeling M is biologically-reasonable given evidence that natural mortality has increased within striped bass stocks in Chesapeake Bay (Kahn and Crecco 2006; Ottinger 2006; Panek and Bobo 2006; Pieper 2006). The increase in natural mortality has been linked to mycobacterial infections, but other explanations are possible, such as declines in forage fish populations and water quality.

### B4.26.1 Assumptions and Structure of the Model

Model assumptions based on an age-dependent IRCR (Jiang 2005) are modified below for the age-independent IRCR model used in the current analysis:
1) the sample is representative of the target population;
2) lengths of individuals are correctly measured;

3) there is no tag loss;
4) tagging induced mortality is negligible;
5) the year of tag recovery is correctly tabulated;
6) all individuals behave independently;
7) all tagged fish within the length category have the same annual survival and recovery rates;
8) natural mortality rate does not vary by fish length; and
9) the tag-reporting rate does not vary by fish length.

Similar to Hoenig et al. (1998), observed recovery matrices for the harvested, as well as caught and released fish, are compared to expected recovery matrices to estimate model parameters. The expected number of tag returns from harvested ($R_{i,y}$) and caught-and-released ($R'_{i,y}$) fish follow a multinomial distribution so that the full likelihood is the product multinomial of the cells (Hoenig et al. 1998). Tagged fish are assumed to be fully recruited to the fishery.
The expected number of tag returns from fish tagged and released in year *i* and harvested in year *y* is:

$$\hat{R}_{i,y} = N_i \hat{P}_{i,y}$$

where
$N_i$ = the number of fish tagged and released in year *i*; and
$\hat{P}_{i,y}$ = the probability that a fish tagged and released in year *i* will be harvested and its tag reported in year *y*.

and

$$\hat{P}_{i,y} = \begin{cases} \left(\prod_{v=i}^{y-1} \hat{S}_v\right)\left(1-\hat{S}_y\right)\dfrac{\hat{F}_y}{\hat{F}_y+\hat{F}_y^{'}+M}\hat{\lambda}_h & (when\ y > i) \\ \left(1-\hat{S}_y\right)\dfrac{\hat{F}_y}{\hat{F}_y+\hat{F}_y^{'}+M}\hat{\lambda}_h & (when\ y = i) \end{cases}$$

*and*

$$S_y = e^{-\hat{F}_y-\hat{F}_y^{'}-M},$$

where
$\hat{F}_y$ = instantaneous rate of fishing mortality on fish harvested in years *y*;
$\hat{F}'_y$ = instantaneous rate of fishing mortality on fish caught and released in years *y*;
M = instantaneous rate of natural mortality;
$\hat{\lambda}_h$ = tag reporting rate given that a tagged fish is harvested; and
$\hat{S}_y$ = annual survival rate in year *y* for tags on fish alive at the beginning of year *y*.

The expected number of tag returns from fish tagged and released in year *i* and caught and released in year *y* is:

$$\hat{R}'_{i,y} = N_i \hat{P}'_{i,y},$$

where

$N_i$ = the number of fish tagged and released in year *i*; and

$\hat{P}'_{i,y}$ = the probability that a fish tagged and released in year *i* will be caught and released and its tag reported in year *y*.

and

$$\hat{P}'_{i,y} = \begin{cases} \left(\prod_{v=i}^{y-1} \hat{S}_v\right)\left(1-\hat{S}_y\right)\dfrac{\hat{F}_y}{\hat{F}_y + \hat{F}'_y + M}\hat{\lambda}_r & (when\ y > i) \\ \left(1-\hat{S}_y\right)\dfrac{\hat{F}_y}{\hat{F}_y + \hat{F}'_y + M}\hat{\lambda}_r & (when\ y = i) \end{cases}$$

*and*

$$S_y = e^{-\hat{F}_y - \hat{F}'_y - M}.$$

The variable descriptions are the same as above for harvested fish with the exception of $\hat{\lambda}_r$ which is the tag reporting rate given that a tagged fish is caught and released.

### B4.26.2 Model Diagnostics

Model adequacy is a major concern when deriving inference from a model or a suite of models. Over-dispersion, inadequate data (such as low sample size) or poor model structure may cause a lack of model fit. Over-dispersion is expected in striped bass tagging data, given that a lack of independence may result from schooling behavior. Over-dispersion was corrected with a c-hat estimate calculated by dividing the pooled Pearson chi-square statistic by pooled degrees of freedom. The pooled Pearson chi-square was calculated by pooling expected cells (observed cells were pooled to match the expected cells) until the value was >2. Estimated over-dispersion parameters are reasonable within the range of $1 \leq$ c-hat $\leq 4$, but higher values provide evidence for a structural lack of fit (Burnham and Anderson 2002).

## B4.27 Coastal and Producer Area Programs Tagging Assessment

### B4.27.1 Reporting Rate

The reporting rate used throughout these calculations is the proportion of recaptured fish whose tag is reported to the USFWS. Prior to the 2013 assessment, a constant value of 0.43 was used, based on a high-reward tag study conducted on the Delaware River stock (Kahn and Shirey 2000), but employing tag returns from the whole Atlantic coast. A high reward tagging study was conducted in 2007 and 2008 by the four producer area programs with the goal of estimating the current tag-reporting rate for USFWS tags used in the striped bass tagging program. Data analysis revealed two major findings: tag reporting rate estimates varied widely by region of tag release and were dramatically different for commercial and recreational fishers. The results led the SBTS to conclude that it was no longer appropriate to use a single time-invariant tag-reporting rate for all tagging programs. Rather, tag-reporting rates would be calculated using the new information on fishery specific differences in tag reporting rate and regional differences in fishery composition following methods outlined in NEFSC (2013). The method used to calculate the current fishery sector-specific reporting rates allows for less than 100% of the high reward tags to be reported. This methodology (Appendix B9 of NEFSC 2013) contains additional sources of uncertainty that could influence the harvest and catch and release reporting rates used in the IRCR.

### B4.27.2 Methods for Estimation of S, F and M

Estimates of survival, fishing mortality, tag mortality, natural mortality, and the associated standard errors from each IRCR run were calculated as a weighted average across all models and the corresponding variance was calculated as a weighted average of unconditional variances (conditional on the set of models) in an EXCEL spreadsheet. Estimates were provided for fish ≥ 18 inches (457 mm; minimum size in Chesapeake Bay for all years of the commercial fishery and prior to 2015 for the recreational fishery) and for fish ≥ 28 inches (711 mm; minimum size standard for coastal fisheries).

Area fishing mortalities were calculated as mean values for the coastal and producer areas. Coastal F was calculated as the arithmetic mean of the coastal programs' values. The producer area F was calculated as a weighted mean of the producer area programs' values. The weights were based on each program area's proportional contribution to the coast-wide stock. The values are:
Hudson (0.13);
Delaware (0.09); and
Chesapeake Bay (0.78), subweighted with Maryland (0.67) and Virginia (0.33).

Variances associated with the area mean F estimates were calculated as additive variances. The additive variance for the unweighted coastal mean F was calculated as:

$$\mathrm{var}(\bar{x}_{coast}) = \sum w_i^2 \ \mathrm{var}(\bar{x}_{state})$$

where:
$w_i$ = (1 / number of coastal programs; will be equal for each program);
var($\bar{x}_{state}$) = individual state's variance of mean F.
The additive variance for the weighted producer area mean F was calculated as:

$$\mathrm{var}(\bar{x}_{producer}) = \sum w_i^2 \ \mathrm{var}(\bar{x}_{state})$$

where:
$w_i$ = 0.09 for Delaware;
$w_i$ = 0.13 for Hudson;
$w_i$ = 0.78 for Chesapeake Bay; with 0.67 for Maryland and 0.33 for Virginia;
var($\bar{x}_{state}$) = individual state's variance of the mean F.

95% confidence intervals were subsequently developed for each area's F. The coast-wide fishing mortality was calculated as the arithmetic mean of the coastal and producer area means. No associated variance was calculated.

### B4.27.3 Methods for Estimation of Stock Size

Stock size was estimated for fish $\geq$ 18 inches (457 mm) TL, corresponding roughly to 3-year-old and older striped bass and for fish $\geq$ 28 inches (711 mm) TL, corresponding roughly to 7-year-old and older fish. Estimates were developed using the annual exploitation rate ($\mu$) calculated above, averaged across all of the tagging programs, and a form of Baranov's catch equation:

Average stock size = catch / $\mu$

Since $\mu$ was based on an exploitation rate that included discard mortality from released fish, total catch (recreational and commercial harvest and dead discards) was used.

### B4.27.4 Coastal and Producer Area Programs Tagging Assessment Results and Discussion

Length frequencies (mm total length at the time of tagging) of fish tagged in 1987 through 2017 were tabulated by program (Table B8.4). The majority (60%) of tagged coastal fish ranged from 450-699 mm, and 34% were ≥ 700 mm. The majority (68%) of producer area tagged fish ranged from 450-699 mm, and 39% were ≥ 700 mm. For coastal programs, a higher percentage of larger fish (≥ 700 mm) have been tagged and released since 2007, a phenomenon influenced primarily by the NCCOOP program. Specifically, the percentage of tagged fish < 700 mm (73%) exceeded that for tagged fish ≥ 700 mm (27%) during 1987-2006, whereas the percentage of tagged fish < 700 (32%) was less than that for those ≥ 700 mm (68%) during 2007-2017. For producer area programs, the percentages of tagged fish for <700 and ≥ 700 mm length categories have remained relatively similar across the time series.

Age distributions of fish released during the entire time series and recaptured in 2017 were tabulated by program (Table B8.5). Ages are based on a subsample of the total number of tagged fish since not all programs age all tagged fish. Ages are read from scales taken at time of tagging. Coastal ages ranged from 3 to 18 and producer area ages ranged from 2 to 19 years.

Geographic distributions of 2017 recaptures from fish tagged and released during the last ten years of the time series were organized by state and month for each tagging program (Table B8.6). Striped bass tagged in the coastal programs were primarily recaptured in May through August along the Northeast coast. For the NCCOOP coastal program, a relatively high percentage of recaptures (40%) occurred in Maryland waters during April and May, likely reflecting the mixed stock status of this program. Recaptures from fish tagged and released by coastal programs generally shift south from their areas of release starting in October. Fish tagged by all of the coastal programs predominantly have recaptures in the southern part of the species range through the fall and winter.

Striped bass tagged by the producer area programs were a mixture of resident and migratory stocks. Thus, resident striped bass were most often recaptured in the producer area where they were tagged and recaptured there year-round (i.e. Maryland and Virginia fish were recaptured in Chesapeake Bay, DE/PA fish were recaptured in New Jersey and Delaware, and HUDSON fish were recaptured in New York). The migratory component tagged in the producer areas followed similar patterns as were observed in the coastal programs with recaptures in New England in summer and more southern reaches in winter.

### *B4.27.4.1 IRCR Model Selection and Diagnostics*

Model selection results differed among some programs, and between analyses of fish ≥ 28 inches (711 mm) and fish ≥ 18 inches (457 mm) (Table B8.9). For fish ≥ 28 inches (711 mm) from coastal programs, model averaged estimates of S and F for NYOHS, NYTRL, and NCCOOP were influenced by relatively high QAICc weights for Model 4 (a model with constant F and constant F’ for each regulatory period), whereas estimates for MADFW and NJDB were primarily influenced by Model 3 (a model with separate year estimates of F, and constant F’ for each regulatory period). For fish ≥ 28 inches (711 mm) from producer area programs, DE/PA and VARAP had the highest QAICc weights for model 4, but estimates for HUDSON and MDCB were heavily weighted by Models 5 and 6, respectively. The structure of Models 5 and 6 are similar to that of Model 4, but Model 5 has separate estimates of F and F' for the terminal year, and Model 6 has constant estimates of F and F’ for the penultimate and terminal years

For fish ≥ 18 inches (457 mm) from coastal programs, highest weights occurred for Model 3 (MADFW), Model 2 (NYOHS and NYTRL), and Model 4 (NJDB and NCCOOP). Model 2 is structured as constant F for each regulatory period, and F' estimated separately each year. For fish ≥ 18 inches (457 mm) from producer area programs, highest weights supported Model 5 (HUDSON), Model 3 (DE/PA and MDCB), and Model 4 (VARAP).

### *B4.27.4.2 Exploitation Rates*

Annual exploitation rates for fish ≥ 28 inches (711 mm) and ≥ 18 inches (457 mm) are presented by program and as an unweighted coast-wide mean (Tables B8.7 and B8.8). For both length groups, the highest exploitation rates are primarily between 1997 and 2000. For fish ≥ 28 inches (711 mm), the unweighted coast-wide mean peaked in 1997 at 0.24, but estimates were ≤ 0.10 for the last three years of the time series (2015–2017), including 0.08 for the terminal year of 2017. For fish ≥ 18 inches (457 mm), the unweighted coast-wide mean peaked in 1997 at 0.13 (considerably lower than that of fish≥ 28 inches (711 mm)), and estimates were ≤ 0.07 for the last three years of the time series (2015–2017), including 0.07 for the terminal year of 2017.

### *B4.27.4.3 Reporting Rates*

Fishery sector-specific tag reporting rates were from previous estimates of 0.11, 0.85 and 0.55 for commercial fishers, recreational fishers and unidentified fishers, respectively (NEFSC 2013). Separate, annual harvest and catch and release tag reporting rates were calculated by estimating fishery composition for each fish disposition (harvest or catch and release). Year specific tag reporting rates were highly variable and required further data aggregation based on methods from NEFSC (2013). Use of a three-year moving average was implemented to smooth the estimated time series of tag reporting rates in order to better capture the temporal trends in fishery composition and tag reporting rate (NEFSC 2013).

Following methods of the previous assessment (NEFSC 2013), a single time series of reporting rates was used for the coastal programs. For producer area programs, data from Virginia (VARAP), Maryland (MDCB) and Delaware (DE/PA) were pooled to boost sample size because these three regions all have significant exposure to commercial fisheries and the time series trends of their individual tag reporting rates were similar. The New York producer area program (HUDSON) used reporting rates generated from their own tagging data because their data showed an opposite trend for the catch and release reporting rate.

Tag reporting rates are known to have asymmetric errors, such that even small errors in our ability to estimate fishery sector-specific tag reporting rates are propagated into large errors in the harvest and catch and release tag reporting rate estimation. The fishery sector-specific estimates obtained are dependent on the assumptions of recreational high reward tag reporting rate as well as the weighting scheme used to estimate commercial recoveries, both of which could be incorrectly specified. This represents a significant source of error especially surrounding the commercial tag reporting rate since it is so low. Second, extrapolation of estimates of tag reporting rate through time can introduce two other potential sources of error. Behavior of the fishery sectors to tagging studies may change and the composition of the fishery may change. The method described above allows for the latter source of uncertainty, changes in the composition of the fishery, to be accounted for during extrapolation. Changes in behavior of the fishery sectors cannot be accounted for, however, and would require the use of periodic high reward tagging studies to re-estimate the fishery sector-specific tag reporting rates.

#### *B4.27.4.4 Survival Rates*

For striped bass ≥ 28 inches (711 mm), the 2017 IRCR survival rate estimates (and associated unconditional standard errors, SE) of coastal programs ranged from 0.47 (0.25) for NYTRL to 0.73 (0.01) for MADFW (Table B8.10). High SE values for the NYTRL estimates from 2015–2017 likely result from small sample sizes of tagged and recaptured fish of larger sizes during the final years of this program, as this program has not tagged fish since 2011 (making 2012 the terminal year for this program for input to the IRCR model). The unweighted average of survival estimates for 2017 (excluding the NYTRL estimate) was 0.69 (Table B8.11). The unweighted average of survival estimates has varied from 0.63–0.71 since 2000 (excluding 2015–2017 NYTRL estimates). The 2017 survival estimates for the producer areas ranged from 0.64 (MCDB and VARAP) to 0.66 (DE/PA; Table B8.10). The 2017 producer areas weighted average was 0.64, similar to the range of annual survival rates since 2001 (0.62–0.66; Table B8.11).

For striped bass ≥ 18 inches (457 mm), the 2017 IRCR survival rate estimates (and associated unconditional standard errors, SE) of coastal programs ranged from 0.56 (0.05) for NCCOOP to 0.73 (0.01) for MADFW (Table B8.12). An extremely high c-hat value (39.6) was estimated from the IRCR analysis of ≥ 18 inch (457 mm) fish of the NCCOOP program, suggesting a structural lack of fit issue, which renders IRCR results questionable for this program. The unweighted average of survival estimates for 2017 (excluding NCCOOP) was 0.68, and has varied from 0.64–0.72 since 2000 (Table B8.13). The 2017 survival estimates for the producer areas ranged from 0.52 (VARAP) to 0.64 (HUDSON; Table B8.12). The 2017 weighted average of S was 0.56 for producer area programs, similar to the range of annual estimates of S since 2001 (0.53–0.57; Table B8.13).

### *B4.27.4.5 Fishing Mortality*

For fish ≥ 28 inches (711 mm), the 2017 estimates of F among coastal programs (excluding NYTRL) ranged from 0.07 (NJDB) to 0.12 (NCCOOP) where the unweighted average F was 0.09 (Tables B8.14 and B8.15). Reasons for exclusion of the 2015–2017 NYTRL estimates from IRCR analyses were explained in the previous section on survival rates. The average annual estimate of F peaked at 0.24 in 1998, but has only varied between 0.09–0.16 since 2000. The 2017 F estimates for the producer area programs ranged from 0.06 (VARAP) to 0.16 (HUDSON) with a weighted average of 0.09 (Tables B8.14 and B8.15). The producer area estimates of F were influenced by the regulatory period models. The highest levels of fishing mortality were estimated in the late 1990's after the stock was declared recovered and have been declining since 2000.

For fish ≥ 18 inches (457 mm), the 2017 estimates of F among coastal programs (excluding NCCOOP) were similar, ranging from 0.06 (NYTRL) to 0.08 (MADFW) for an unweighted average of 0.07 (Tables B8.16 and B8.17). The average F has varied without trend ranging from 0.07 to 0.13 since 1995. The estimates of F for the producer area programs showed more variation, ranging from 0.06 (VARAP) to 0.12 (HUDSON) for a weighted average of 0.09 (Tables B8.16 and B8.17). Since the reopening of many of the fisheries in 1991, the average F increased with a peak (0.22) in 1998. It has declined since then and varied without trend between 0.09 and 0.15 since 2000.

### *B4.27.4.6 Natural Mortality*

For fish ≥ 28 inches (711 mm), the 2017 coastal program estimates of M (excluding NYTRL) ranged from 0.24 (MADFW) to 0.32 (NCCOOP) with an unweighted average was 0.27 (Tables B8.18 and B8.19). Reasons for exclusion of 2015–2017 IRCR estimates from NYTRL were explained previously under the Survival Rates section. The 2017 range of M values from the producer area programs was 0.27 (HUDSON) to 0.40 (VARAP) with a weighted mean of 0.35 (Tables B8.18 and B8.19). The highest mortality estimates were for Chesapeake Bay programs (VARAP and MDCB) where *Mycobacteriosis* is believed to be most prevalent.

For fish ≥ 18 inches (457 mm), the 2017 estimates of M from the coastal programs (excluding NCCOOP) ranged from 0.24 (MADFW) to 0.42 (NYTRL) with an unweighted average of 0.32 (Tables B8.20 and B8.21). Reasons for exclusion of NCCOOP results were explained previously under the Survival Rates section. Producer area estimates for 2017 ranged from 0.32 (HUDSON) to 0.60 (VARAP) with a weighted average of 0.49 (Tables B8.20 and B8.21). Average natural mortality estimates for fish ≥ 18 inches (457 mm) exceeded those of ≥ 28 inch (711 mm) fish for producer area programs, a finding heavily influenced by high natural mortality estimates from Chesapeake Bay programs.

The values of M in the second natural mortality period for both size groups are much higher than the commonly assumed, biologically based value of M=0.15. While the large inter-period variation and large estimates of M should be viewed with caution, the fact that all of the tagging programs show an increase in M between periods suggests that it is likely M has increased in the stock.

#### *B4.27.4.7 Stock Size*

The stock size estimates for fish ≥ 28 inches (711 mm) trended upward from 12.2 million in 1999 to 37.5 million in 2003. Estimates from 2004 to 2009 were without trend, ranging from 31.7 to 37.3 million. A peak of 48.3 million was reached in 2010, where estimates have since trended downward to the 2017 value of 22.4 million (Table B8.22 and Figure B8.1).

The stock size estimates for fish ≥ 18 inches (457 mm) trended upward from 1993 (25.7 million) to a peak in 2006 (142 million). Since 2006, estimates decreased to 60.8 million in 2012 before increasing to 102.6 million in 2015. Compared to 2016, the 2017 estimate increased from 85 million to 93.1 million (Table B8.22 and Figure B8.1).

## B4.28 Chesapeake Bay Resident Stock Tagging Assessment

Amendment 6 implemented a separate management program for the Chesapeake Bay due to the size availability of striped bass in this area. It also specified a separate fishing mortality target of 0.27 (ASMFC 2003). Since Addendum IV to Amendment 6, quotas have been fixed in Chesapeake Bay and this fishing mortality target is no longer being used for management. The striped bass fishery in Chesapeake Bay exploits the pre-migratory/resident striped bass population that consists of smaller fish (TL < 28 inches or 711 mm), mostly ages 3 through 6. Fishing mortality in Chesapeake Bay was calculated using data from the same Maryland and Virginia tagging programs described above. The migration rates reported by Dorazio et al. (1994) suggest that striped bass between 18 and 28 inches (457 and 711 mm) TL are predominantly resident fish. Maryland data have shown that males comprise 80-90% of the resident fish population. Therefore, the data were limited to male striped bass between 18 and 28 inches (457 and 711 mm) TL that were recaptured within Chesapeake Bay to estimate fishing mortality on resident fish.

### B4.28.1 Reporting Rate

Two high-reward tagging studies have been conducted in the Chesapeake Bay to determine a Chesapeake Bay-specific reporting rate. In 1993, a rate of 0.75 was estimated by Rugolo et al. (1994). The study was repeated in 1999 and resulted in a slightly lower estimate of 0.64 (Hornick et al. 2000). The value of 0.64 is used for the Chesapeake Bay analysis because it is the most recent area-specific value. Due to low sample sizes, a new Chesapeake Bay-specific reporting rate could not be calculated from the 2007-2008 high reward tagging study.

### B4.28.2 Methods for Estimation of F, M and S

Fishing mortality for resident striped bass in Chesapeake Bay was estimated following the previously described IRCR methods. Model structure for estimating M included two periods, 1987–1996 and 1997–2017. Before analysis, release and recapture data from Maryland and Virginia were combined to produce Chesapeake Bay-wide harvest and release input matrices for the IRCR (Appendix B11) and estimate Chesapeake Bay-wide annual exploitation rates.

### B4.28.3 Chesapeake Bay Resident Stock Tagging Assessment Results and Discussion

### *B4.28.3.1 IRCR Model Selection Diagnostics*

The regulatory period model (Model 4) received the highest QAICc weight (0.737) for Chesapeake Bay fish (Table B8.24). The c-hat estimate was 6.396. This is above the value of 4 suggested by Burnham and Anderson (2002) and may suggest structural issues with the model.

### *B4.28.3.2 Exploitation Rates*

Exploitation rate estimates for the Chesapeake Bay resident fish have remained relatively stable throughout the time series (Table B8.23). The 2017 exploitation rate was 0.06 which was an increase from the 2016 estimate. A small peak in exploitation rates can be seen in 2013 and 2014.

### *B4.28.3.3 Survival Rates*

The Chesapeake Bay-wide survival estimate for 2017 was 0.39 (Table B8.25). The estimates show a general decline over the time series, but have been stable since 1997, ranging from 0.39 to 0.40.

### *B4.28.3.4 Fishing Mortality*

Chesapeake Bay-wide estimates of F were all below the previously used target value of 0.27. Fishing mortality increased from near-zero values during the moratorium period, peaked at 0.11 (1995–1999), and has remained at 0.09 – 0.10 from 2000–2017. The 2017 estimate of F for the Chesapeake Bay was 0.09 (Table B8.25).

Low values of F in recent years are not consistent with the high levels of harvest in the Chesapeake Bay. The assumption that 18-28 inch (457-711 mm) males are all resident fish may be incorrect. If the fish are emigrating from the Chesapeake Bay at a smaller size and the tags are not recovered or not used in the analysis, the emigration will result in an over-inflated estimate of natural mortality. This in turn will lead to an underestimated fishing mortality. Tag reporting rates may also be too high. The last high reward tagging study was conducted in Chesapeake Bay in 1999. If tag reporting rates have decreased since then and we are using a tag reporting rate that is too high, this would also result in higher estimates of natural mortality and lower estimates of fishing mortality (see sensitivity analyses conducted in NEFSC 2013).

### *B4.28.3.5 Natural Mortality*

The Chesapeake Bay-wide estimate of natural mortality for 2017 was 0.83 (Table B8.25). Estimates of natural mortality for Chesapeake Bay fish increased from 0.25 during the first mortality period (1987-1996) to 0.83 during the second mortality period (1997-2017). Both values are substantially higher than the previously assumed, biologically based value of M=0.15. Very large inter-period variation and large estimates of M are not biologically reasonable and should be viewed with caution. Although the values of M for recent years seem excessively high, the overall trend of increasing M is supported by some field observations of *Mycobacteriosis* in the Chesapeake Bay and the results of the two-period M models by all of the other coastal programs.

## B4.29 Sources of Uncertainty in the Instantaneous Rates Model

The instantaneous rates approach is a reparameterization of the Brownie models. It has the advantage that it explicitly links the tag recovery rate (f) and annual survival (S) parameters. In the Brownie models, these are allowed to vary independently so that, from one year to the next, the tag recovery rate and the survival rate can both go up. This is unreasonable if the tag-reporting rate and the natural mortality rate are constant. An increase in f, and thus exploitation rate, should be accompanied by a decrease in the survival rate, unless the reporting rate or natural mortality rate has changed. In the instantaneous rates model, one specifies the tag-reporting rate and estimates F and M, or one specifies that M is constant and estimates F and the reporting rate.

It should be noted that the reporting rate is used mainly to apportion the total mortality into its F and M components. Sensitivity analyses conducted previously using Maryland data (NEFSC 2013) indicated that overestimating the reporting rate resulted in higher estimates of M and lower estimates of F. The survival estimates, however, were insensitive to misspecifications of the reporting rate. Even a 50% reduction in the reporting rate only resulted in a 6% decrease, on average, in the survival estimate. Whereas a 50% reduction in the reporting rate resulted in a 102% increase in fishing mortality and a 40% decrease in natural mortality.

The IRCR model contains the following assumptions:

- The sample is representative of the target population;
- Lengths of individuals are correctly measured;
- There is no tag loss;
- Tagging induced mortality is negligible;
- The year of tag recoveries is correctly tabulated;
- All individuals behave independently;
- All tagged fish within the length category have the same annual survival and recovery rates;
- Natural mortality rate does not vary by fish length; and
- The tag-reporting rate does not vary by fish length.

There is general consensus in the SBTS that effects of potential violations of model assumptions are minor. Reported rates of tag-induced mortality are low (0%, Goshorn et al. 1998; 1.3% Rugolo and Lange 1993). Reported rates of tag loss are also quite low (0% by Goshorn et al.1998; 2% by Dunning et al. 1987; 2.6% by Sprankle et al. 1996).

Other sources of uncertainty include the calculation of the 95% confidence intervals and the weighting of models each year. The confidence intervals for the area F estimates were calculated without inclusion of the covariance terms, which could not be estimated from these data. However, though the magnitude of these terms was unknown, they were assumed to be negligible. In addition, the IRCR may choose and weight the candidate models differently each year as that year's data are added to the recovery matrices.

### B4.30 Comparison of 2SCA Model Results to Tagging Model Results

The 2SCA model results are provided in Section B7.0 above. The average total mortality of the combined ocean and Chesapeake Bay stocks were calculated using the data in Table B7.11. The average values of total mortality for fish ≥28" for the Coast and Producer areas are plotted with the total mortality estimates for the ocean and the Chesapeake Bay stock from the 2SCA model in Figure B8.2. Increasing trends in total mortality (Z) were similar between the tag-based and 2SCA models, although the coastal tagging programs' Z estimates were slightly lower in magnitude through 2006 (Figure B8.2). After relatively stable Z estimates from 2006-2014, all model Z estimates indicated a decline in total instantaneous mortality in 2015 that has generally increased in recent years (Figure B8.2). An important aspect of these comparisons is that the estimates of total mortality made from different datasets and models are similar in magnitude and trend, verifying the results of the SCA model.

Comparisons were also made between the tag based abundance estimates and the period-3 abundance estimates from the 2SCA model (Figure B8.3). Period-3 was used as most of the catch occurs in this time block, aligning with the tag based model which estimates abundance based on catch. Additionally, the tag based model estimates average stock size which matches best to this mid-year abundance estimate. The tagging model estimates abundance for fish ≥18" and ≥28" which roughly corresponds with ages 3+ and 7+ from the 2SCA model. For ages 3+, the 2SCA estimates higher abundance early in the time series and lower abundance later in the time series when compared to the tagging model estimates. Both estimates, however, show similar trends with an increase in abundance through the late 1980s and early 1990s. Whereas the 2SCA model has peak age 3+ abundance in 1999 before decreasing, the tagging model population abundance peaks in 2010. For ages 7+, the 2SCA and tagging model estimate similar abundance estimates through 1996. The abundance estimates diverge starting in 2000 when the 2SCA model estimates lower numbers of 7+ fish compared to the tag based estimates. Both models show similar trends in age 7+ abundance, including a general decrease since 2010.

### B4.31 Suggestions for Further Development of Tag-based Mortality and Abundance Estimates

The primary research need for tagging analysis estimates of S, F, and M involves the issue of reporting rate. While there are uncertainties in the tag reporting rate estimates due to the assumptions used, other factors could also be affecting our tag reporting rate estimates. These include a possible decline in tag quality, which has resulted in tags being illegible; angler fatigue as the tagging program has existed since 1987 with no change in reward; and the decrease in tag returns, particularly from the commercial sector.

## TOR B5. UPDATE OR REDEFINE BIOLOGICAL REFERENCE POINTS (BRPS; POINT ESTIMATES OR PROXIES FOR $B_{MSY}$, $SSB_{MSY}$, $F_{MSY}$, MSY). DEFINE STOCK STATUS BASED ON BRPS BY STOCK COMPONENT WHERE POSSIBLE.

### B4.32 History of Current Reference Points

In the early 1990s, the status of Atlantic striped bass stocks was determined using annual tag-based estimates of survival and the associated fishing mortality. Fishing mortality rates that produced a sustainable population were estimated in simulation models developed by Rago and Dorazio, as well as Crecco, and described in the Amendment 4 source document (ASMFC 1990). Subsequent to Amendment 4, a relative index of female SSB was developed using a forward projecting model of age-0 recruits as determined by the time series of Maryland juvenile indices (ASMFC 1998). The female SSB index served as the basis for developing a biomass threshold for evaluation of the stock rebuilding status. The female SSB index increased to a level comparable to historic abundance in the 1960s and consequently, in 1995 striped bass was declared recovered. The modeling approach used for the female SSB index also served as the basis for the Crecco model for biological reference points, specifically $F_{MSY}$ (ASMFC 1998). The model applied a combination of minimum sizes (20" (508 mm) in producer areas and 28" (711 mm) on the coast) to define full recruitment to the fisheries. The biological reference point of $F_{MSY}$ = 0.40 was adopted in Amendment 5 and a target F of 0.31 was established with a subsequent addendum to the FMP. A lower target F of 0.28 for the producer areas was derived based on equivalent female SSB/R when the jurisdictions requested a reduction in their minimum size limit from 20 inches (508 mm) to 18 inches (457 mm). These values were compared against annual tag based estimates of F for determination of stock status.

In 1997, the Technical Committee adopted the results of a VPA model as the method for determination of stock status. Average F was calculated for the ages at full recruitment with age at full F based on the distributions of ages in the catch. The fully recruited F was defined as ages 4–13. Comparisons were made to target F (and $F_{MSY}$) which were products of the Crecco model.

In 2003, the ASMFC adopted Amendment 6 to the striped bass FMP. As part of the amendment, new biological reference points (female $SSB_{Target}$, female $SSB_{Threshold}$, $F_{target}$, and $F_{threshold}$) were established. $F_{MSY}$, estimated using a Shepherd/Sissenwine model, was adopted as $F_{threshold}$. An exploitation rate of 24%, or F=0.30 was chosen as $F_{target}$. Target F for the producer area, Chesapeake Bay, was reduced proportionately to 0.27. The $SSB_{Threshold}$ (14,000 mt) was chosen to be slightly greater than the female SSB in 1995 when the population was declared recovered. The $SSB_{Target}$ (17,500 mt) was 25% greater than the $SSB_{Threshold}$. No biomass targets were chosen specifically for Chesapeake Bay.

These biological reference point definitions were maintained for the 2007 assessment. Point estimates of $SSB_{Target}$ and $SSB_{Threshold}$ were calculated from the SCA model and updated in 2008. The $SSB_{threshold}$ equals 36,000 mt with an $SSB_{target}$ of 46,101 mt.

The estimate for $F_{MSY}$ was derived using the results of the 2007 assessment, updated in 2008, in which four stock-recruitment models were considered; a Ricker, a lognormal Ricker model, a Shepherd and a lognormal Shepherd model. The TC used a model averaging approach among the four results, producing an estimate of $F_{MSY}$ = 0.34 (range of 0.28-0.40). The $F_{target}$ remained the 24% exploitation rate, F=0.30.

In the 2013 assessment, the $SSB_{Target}$ and $SSB_{Threshold}$ definitions remained the same (1995 female SSB, and 125% of 1995 female SSB, respectively; NEFSC 2013) but were updated with the 2013 SCA model. The $SSB_{threshold}$ equaled 57,626 mt with an $SSB_{target}$ of 72,032 mt. However, F reference points were chosen to link the target and threshold Fs with the target and threshold female SSB values (NEFSC 2013). Using a stochastic projection drawing recruitment from empirical estimates and a distribution of starting population abundance at age, fishing mortality associated with the female SSB target and threshold were determined. Current $F_{target}$ = 0.18 and current $F_{threshold}$ = 0.22.

### B4.33 Updated Biological Reference Points

The Board tasked the SAS with developing a range of F and female SSB reference points as part of the 2018 Benchmark Stock Assessment and to develop threshold reference points (F and biomass) that consider the objectives of the FMP. They also asked the SAS to develop a range of target reference points (F and biomass) that would provide a range of risk that the Board would consider in achieving the objectives of the FMP.

The SAS explored both empirical and SPR-based reference points ($F_{20\%}$, $F_{30\%}$ and $F_{40\%}$ were calculated).

#### B4.33.1 Two-Stock SCA Model (2SCA)

***[SAW-66 Editor's Note: The SARC-66 peer review panel concluded that the two-stock statistical catch-at-age (2SCA) model presented to them was not acceptable to serve as a basis for fishery management advice. These particular sections are included in this report to document the analyses that were done for the peer review, but they are not recommended by SARC-66 as a basis for management. Instead, SARC-66 recommends the reference points (Section B9.2.2) and stock status determinations (Section B9.3.2) based on the single stock, non-migration model for management use.]***

The SA committee explored a number of different threshold reference points. These included SPR-based estimates of F20%, F30%, F40% (per Gabriel *et al.* 1989) and the female SSB associated with these quantities, and the F associated with the 1990, 1993 and 1995 female SSB (each representing differences in stock characteristics at the time). In addition, proportional stock density (PSD;

Anderson and Gutreuter 1983) values were calculated (using age instead of length) to determine what fraction of the population represents “quality” fish.

*Female Spawning Stock Per Recruit Analysis*

Because the dynamics of the Chesapeake Bay stock include migration, the calculation of SPR values was done through a projection model that included the same code as the operational assessment model. The SPR values were calculated using the most recent five-year average (2013 – 2017) for the sum of fully-recruited F across periods in the Chesapeake Bay and F in the ocean regions, the fraction of F that occurs during periods 1, 2 and 3 for the Chesapeake Bay and ocean regions, and weight-at-age for the female SSB; the average of 1990 – 2017 was used for recruitment. In addition, the same natural mortality, emigration probabilities, maturity schedules and catch selectivities for 2017 were used in the projections. Abundance of ages 2-15+ in the Chesapeake Bay and ocean regions for 2018 (derived using the numbers at age from the beginning of period-3 in 2017 and calculating the abundance in 2018 using the period-3 F and fraction of natural mortality) and average recruitment for age-1 are used as starting values and the population is projected 200 years at different levels of the sum of period Fs in the Chesapeake Bay and ocean. The %SPR is calculated by using the female SSB/average recruit of F in the Chesapeake Bay and ocean equal to 0. The sum of period fully-recruited Fs is required because that value is used to assign F to each period in the model. The sum of the period Fs does not represent the actual total F experienced by the stock but they are used as reference points because changes in actual total F would be difficult to translate to changes in F in the Chesapeake Bay and ocean regions for the Chesapeake Bay stock.

For the Delaware Bay/Hudson River stock, the SPR was determined similarly but the equations used are the standard exponential decay abundance and catch equations. Only sum of period Fs from the ocean region are used.

The values of F associated with SPR 20%, 30% and 40% were solved using the Newton method and projection model. For the Chesapeake Bay stock, the average ratio of the sums of period F between Chesapeake Bay and ocean regions over the most recent five years (2013-2017) was applied to F being estimated to maintain the difference between Chesapeake Bay and coast sums of period Fs.

*Determination of Associated Quantities from SPR analysis*

The female SSB associated with F20%, F30%, and F40% and fishing mortalities associated with the $SSB_{1993}$ and $SSB_{1995}$ estimates were determined through stochastic projections. Using the same dynamics models, starting values of abundance of ages 2-15+ in the Chesapeake Bay and ocean regions for 2018 are derived by re-sampling from a normal distribution parameterized with the abundance estimates and associated standard errors. For the Chesapeake Bay stock, age-1 numbers are stochastically generated by linking the recruitment to previous year’s female SSB using the fitted Beverton-Holt curve (Figure B7.15) and re-sampling errors from a normal distribution parameterized at mean of 0 and standard error equal to the residual standard deviation from the model fit before back-transformation of the log-transformed equation. The starting value for age-1 in the first year of the projection was the deterministic recruitment value associated with the $SSB_{2017}$ estimate. The female SSB was calculated in the same way as the stock assessment model.

For the Delaware Bay/Hudson River stock, the abundances of ages 2-15+ were generated in the same way as in the Chesapeake Bay stock model. However, a realistic stock-recruitment curve could not be determined for the Delaware Bay/Hudson River stock data to stochastically generate age-1 numbers. Therefore, two methods were examined. In the first method, the predicted age-1 numbers from original Beverton-Holt fitted equation (Figure B7.15) were used through median female SSB (27,950 mt), but for higher female SSB values, the median recruitment was used (Figure B9.1). This was termed a "hockey-stick" approach and was the SAS's preferred approach. The predicted values from the fitted Beverton-Holt equation were used because it described increasing trend in recruitment at the lower female SSB levels. In the second method, as a sensitivity analysis, the the Delaware Bay/Hudson River stock recruitment values were randomly re-sampled; hence, there was no link to female SSB.

To determine the female SSB associated with F20%, F30%, and F40%, the Chesapeake Bay and ocean sums of F were used to project the population 200 years. The projection was repeated 1,500 times to obtain the resulting distribution of female SSB in year 200.

To determine the sum of period Fs associated with the female SSB levels for years 1993 and 1995, the input F was manually varied to obtain the median female SSB values closest to the threshold values in year 200. Since two sums of F have to be varied in the Chesapeake Bay stock, a single F was applied to average of the last five years' proportion that the sum of F for the Chesapeake Bay (and sum of F for the ocean) represents of the total to derive the allocation to the Chesapeake Bay and ocean.

*Proportional Stock Density*

For each level of Chesapeake Bay and ocean fishing mortality used to determine SPRs, the PSD for quality fish was calculated. Quality fish was defined as fraction of fish age-10 and greater (age-10 average size = 38 inches or 965 mm) relative to the number of fish age-7 (average size=28 inches or 711 mm considered the stock base).

*Reference Points*

A contour plot of the percentage of maximum SPR for the Chesapeake Bay stock obtained at different levels of the sum of period Fs in the Chesapeake Bay and the ocean and the Fs associated with the three SPR levels and current Chesapeake Bay and ocean F are displayed on Figure B9.2 and listed in Table B9.1. Full F at SPR20% was estimated to be 0.288 for Chesapeake Bay and 0.342 for the ocean; for SPR30%, it was 0.196 for Chesapeake Bay and 0.233 for the ocean; for SPR40% it was 0.140 for the for Chesapeake Bay and 0.166 for the ocean. Figure B9.3 displays the resulting female SSB estimates (with 95% percentiles) for the projections associated with F20% (female SSB=54,864 mt), F30% (female SSB=84,209 mt), and F40% (111,433 mt). The 2017 estimate of female SSB (50,346 mt) is slightly below the female SSB associated with F20% (54,864 mt; Table B9.1). The F reference values associated with the female SSB estimates in years 1993 and 1995 are given in Table B9.1. Female $SSB_{2017}$ was slightly below the female $SSB_{1995}$ estimate, but above the estimate for 1993.

A contour plot of percent quality for the Chesapeake Bay stock obtained at different levels of the sum of period Fs in the Chesapeake Bay and ocean is shown in Figure B9.2. The percent quality of an unfished stock was estimated to be 62%. At F20%, 30% and 40%, the quality becomes 32.4%, 39.7%, and 45%, respectively. The 2017 estimate of percent quality (46.1%), above the value at F40%.

For the Delaware Bay/Hudson River stock, the percentage of maximum SPR plot and the resulting Fs associated with the three SPR levels are displayed on Figure B9.4 and listed in Table B9.1. Fs at SPR20%, 30% and 40% were estimated at 0.251, 0.168 and 0.118, respectively. The resulting female

SSB estimates for the projection method associated with F20%, F30%, and F40% under the "hockey-stick" stock-recruitment relationship and empirical approach are shown in Figures B9.5-6. At F20%, F30%, and F40%, the "hockey stick" method produced female SSB estimates of 38,493 mt, 57,791 mt, and 77,153 mt, respectively, and the empirical approach produced female SSB estimates of 62,587 mt and 83,906 mt, respectively. The 2017 estimate of female SSB (21,347 mt) was below all female SSB estimates associated with F% regardless of method. The F values associated with the annual female SSB estimates from 1993 and 1995 are given in Table B9.1 for the hockey-stick approach. Female SSB in 2017 was slightly below the female SSB estimate for 1995, but above the estimate for 1993.

*Comparison of Empirical and Model-Based Reference Points*

The current $SSB_{threshold}$ used in management, female $SSB_{1995}$, is approximately equal to the equilibrium female SSB associated with F20%SPR for the Chesapeake Bay stock (female $SSB_{1995}$ = 52,893 mt while female $SSB_{20\%SPR}$ = 54,864 mt). The maximum observed female SSB for the Chesapeake Bay stock (88,990 mt in 2003) was just slightly higher than the female SSB associated with F30% SPR (84,209 mt). Even when the stock was below female $SSB_{20\%SPR}$, it was still capable of producing near-average (1989, 1992) and very strong (1993) year classes. The Chesapeake Bay stock also has a relatively high percent stock quality in 2017, despite being below female $SSB_{20\%SPR.}$

For the mixed Delaware Bay/Hudson River stock, female $SSB_{1995}$ was below the female SSB associated with F20%SPR (female $SSB_{1995}$ = 24,683 mt while female $SSB_{20\%SPR}$ = 38,493 mt). The highest female SSB value in the time-series was 42,150 mt, slightly above the female $SSB_{20\%SPR}$ estimate and below the female $SSB_{30\%SPR}$ estimate.

**B4.33.2 Non-Migration SCA Model (single stock)**

***[SAW-66 Editor's Note: The SARC-66 peer review panel recommends the reference points (this section) and stock status determinations (Section 9.3.2) based on the single stock, non-migration model for management use.]***

Fishing mortality reference points associated with female SSB in 1995 were generated using projections described in NEFSC (2013), similar to the approach described above for the migration model. Briefly, to start the projections, abundance at age is randomly drawn from a normal distribution parameterized with the 2017 estimates of January 1 abundance-at-age and associated standard errors from the non-migration assessment model. The population is projected forward using the standard exponential decay model with selectivity from 2017 and 2017 adjusted Rivard weights at age for female SSB calculations. For the remaining years, selectivity was calculated as the geometric mean of 2013-2017 of total F at age, scaled to the highest F; spawning stock weights-at-age were calculated as the geometric mean of the 2013-2017 of adjusted Rivard weights-at-age. Age-1 recruitment was stochastically estimated using an approach similar to that described above for the Delaware Bay/Hudson River stock of the migration model ("hockey-stick" approach). That is, predicted age-1 numbers from a Beverton-Holt fitted equation were used through median female SSB (87,835 mt), but for higher female SSB values, the median recruitment (associated with female SSB > median female SSB) was used (Figure B9.7).

Residuals from the stock recruitment fit were randomly re-sampled and added to the deterministic predictions before back-transformation of the log-transformed equation. As a sensitivity run, estimates of recruitment from 1990 and later, when the stock was considered restored but not fully recovered, were randomly re-sampled; hence there was no link to female SSB. The population was projected for 100 years using 2,000 simulations. The input F was manually varied to obtain the median female SSB values closest to the 1995 female SSB value in year 100.

SPR-based reference points for the non-migration SCA, while similar to those developed for the migration model, were associated with unrealistic equilibrium female SSB levels. For example, fishing at F40% resulted in an equilibrium female SSB approximately two times the highest female SSB estimated in the time series. One potential explanation is that the non-migration model is not adequately capturing the sex-specific dynamics of Chesapeake Bay fish; although the Chesapeake Bay fishery has a high selectivity for immature fish, those fish are predominately male, as the immature females migrate to the ocean where they are not as vulnerable to the fishery. Thus, more female SSB is protected than the pooled selectivity and maturity curves would suggest. More reasonable equilibrium female SSB results were associated with lower maximum spawning potential ratios (e.g., F20% = 0.232); the fishery has generally operated at or above these levels since approximately 1995 (Figure B7.27). The SAS was not able to fully explain the dynamics associated with SPR-based reference points and therefore ultimately only considered empirical reference points associated with female SSB levels.

The base model estimate results in an $SSB_{Threshold}$ = female $SSB_{1995}$ = 91,436 mt and an $SSB_{Target}$ = 125% female $SSB_{1995}$ = 114,295 mt; female SSB in 2017 was 68,476 mt. Using the hockey-stick recruitment model, $F_{Threshold}$ = the projected F to maintain $SSB_{Threshold}$ = 0.240, and $F_{Target}$ = the projected F to maintain $SSB_{Target}$ = 0.197; F in 2017 was estimated to be 0.307. Using the empirical recruitment model, $F_{Threshold}$ = the projected F to maintain $SSB_{Threshold}$ = 0.248, and $F_{Target}$ = the projected F to maintain $SSB_{Target}$ = 0.204.

*Fleet Fishing mortality reference points*

The TORs for this assessment tasked the SAS with developing stock-specific reference points where possible. Stock-specific reference points cannot be developed from the non-migration SCA, but the SAS did develop fleet-specific reference points to provide regional management advice as a proxy. When each fleet fishes at its target F reference point, the maximum total F-at-age on the population is equal to the coastwide $F_{target}$.

The full F values for the target and threshold were calculated using a composite selectivity that used the geometric mean of the most recent five years of total F-at-age, divided by the maximum F-at-age to scale the curve to one. This essentially weights the selectivity pattern of each fleet (Coast and Chesapeake Bay) by the degree to which they are contributing to total fishing mortality on the population. The Chesapeake Bay fleet is dome-shaped, peaking at age-6, while the coast fleet is flat-topped, peaking at age-15+ (Figure B9.8).

To calculate the Chesapeake Bay-specific F reference point, the ratio of F-at-age-6 from the Chesapeake Bay fleet to total F-at-age-6 was calculated (using the mean of ratio for the last five years). This ratio was multiplied by the selectivity-at-age from the composite fleet at age-6 and the $F_{target}$ and $F_{threshold}$ values to obtain the full $F_{target}$ and threshold values for the Chesapeake Bay (Table B9.3).

For the Coast fleet, a similar approach was used (Table B9.3). Specifically, the ratio of total F-at-age-14 to fleet F-at-age-14 was used, and the reference points were corrected for the not quite full selectivity on age-14 for this fleet (0.99 as opposed to 1), since full selectivity in the ocean fleet occurs at age-15+.

The sum of the individual F targets exceeds the coast wide $F_{target}$ value. However, when the total F-at-age is calculated (by multiplying the individual fleet F reference points by their respective selectivities and summing at age), the maximum F-at-age is equal to the coast wide $F_{target}$ (Table B9.4).

**B4.34 Stock Status**
**B4.34.1 Two-Stock SCA Model (2SCA)**

***[SAW-66 Editor's Note: The SARC-66 peer review panel concluded that the two-stock statistical catch-at-age (2SCA) model presented to them was not acceptable to serve as a basis for fishery management advice. These particular sections are included in this report to document the analyses that were done for the peer review, but they are not recommended by SARC-66 as a basis for management. Instead, SARC-66 recommends the reference points (Section B9.2.2) and stock status determinations (Section B9.3.2) based on the single stock, non-migration model for management use.]***

The current $SSB_{threshold}$ for Atlantic striped bass is the 1995 estimate of female SSB. This definition is the same as the previous assessment, but BRPs were calculated separately for the Chesapeake Bay stock and the Delaware Bay/Hudson River stock. For this reason, it is not appropriate to compare current model estimates to previous model reference points). The $F_{threshold}$ is the F value that allows the population to achieve the long-term average female SSB equal to the $SSB_{threshold}$, assuming that recruitment will vary within the range observed in 1990-2017 period while other population parameters are constant. The sum of period Fs for the Chesapeake Bay and ocean and the female SSB in 2017 for each stock was compared to the reference generated from the SPR and projections methods.

Female $SSB_{2017}$ for the Chesapeake Bay stock was 50,346 mt, less than the $SSB_{threshold}$ of 52,893 mt, indicating the Chesapeake Bay stock is overfished (Figure B9.9). The associated $F_{threshold}$ was 0.297 for the Chesapeake Bay fishery and 0.353 for the ocean fishery; $F_{2017}$ was 0.255 in the Chesapeake Bay and 0.400 in the ocean, indicating the Chesapeake Bay stock is experiencing overfishing in the ocean but not in the Chesapeake Bay (Figure B9.9).

For the mixed Delaware Bay/Hudson River stock, female $SSB_{2017}$ was 21,347 mt, below the $SSB_{threshold}$ of 24,683 mt, indicating the Delaware Bay/Hudson River stock is overfished (Figure B9.10). $F_{2017}$ was 0.400, above the $F_{threshold}$ of 0.340, indicating the Delaware Bay/Hudson River stock is experiencing overfishing (Figure B9.10).

The probability of the 2017 F values exceeding the reference point Fs and the probability of 2017 female SSB falling below the SSB reference points were performed by using function *pgen* in R package *fishmethods*. The comparison between the 2017 values and the SPR SSB reference points were made assuming a log-normal error (since the projection values showed a skewed distribution), while the comparison between the 1995 and 1993 female SSB estimates and the 2017 female SSB estimate were made assuming a normal error given that only estimates of SE were available. Comparison among F reference points and 2017 values were made assuming a normal error for the 2017 F values but no error in F reference points.

Table B9.2 lists the probabilities of the 2017 management value exceeding the F and SSB reference points. For the Chesapeake Bay stock, there was a 15% probability that the F in the Chesapeake Bay exceeded the F threshold, and an 87% chance that the F in the ocean exceeded the F threshold. There was a 63% chance that female SSB was below the SSB threshold. For the DE Bay/Hudson River stock, there was a 93% chance that F in the ocean exceeded the F threshold, and an 83% chance that female SSB was below the SSB threshold.

The non-migration SCA model provided similar status determinations, with the coastal mixed stock complex being overfished relative to the current $SSB_{threshold}$ and experiencing overfishing relative to the current $F_{threshold}$. Fleet-specific F reference points indicated the Chesapeake Bay fleet was equal to its $F_{threshold}$ while the ocean fleet was above its $F_{threshold}$.

**B4.34.2 Non-Migration Model**

***[SAW-66 Editor's Note: The SARC-66 peer review panel recommends the reference points (Section B9.2.2) and stock status determinations (this section) based on the single stock, non-migration model for management use.]***

The current $SSB_{threshold}$ for Atlantic striped bass is the 1995 estimate of female SSB. This definition is the same as the previous assessment, but has been updated with data through 2017. The $F_{threshold}$ is the F value that allows the population to achieve the long-term average female SSB equal to the $SSB_{threshold}$. The F and female SSB in 2017 was compared to the reference values generated from the projections methods.

Female $SSB_{2017}$ for the stock was 68,476 mt, which is less than the SSB threshold of 91,436 mt, indicating the stock is overfished (Table B9.5, Figure B9.11). The associated F threshold was 0.240; $F_{2017}$ was 0.307 indicating the stock is experiencing overfishing (Table B9.5, Figure B9.11).

The probability of the 2017 F values exceeding the reference point Fs and the probability of 2017 female SSB being below the SSB reference points were performed by using function *pgen* in R package *fishmethods*. The comparison between the 2017 values and the 1993 and 1995 female SSB estimates were made assuming a normal error given that only estimates of SE were available. Comparison among F reference points and 2017 values were made assuming normal errors (SEs were available for both management values and reference points, so error was assumed for both).

Table B9.6 lists the probabilities of the 2017 management value exceeding the F and SSB reference points. For the coastwide stock, there was a 100% probability that SSB in 2017 was below the threshold. For the coastwide stock there was a 95% probability that F in 2017 exceeded the threshold (Table B9.6).

## TOR B6. PROVIDE ANNUAL PROJECTIONS OF CATCH AND BIOMASS UNDER ALTERNATIVE HARVEST SCENARIOS. PROJECTIONS SHOULD ESTIMATE AND REPORT ANNUAL PROBABILITIES OF EXCEEDING THRESHOLD BRPS FOR F AND PROBABILITIES OF FALLING BELOW THRESHOLD BRPS FOR BIOMASS.

***[SAW-66 Editor's Note: The SARC-66 peer review panel concluded that the two-stock statistical catch-at-age (2SCA) model presented to them was not acceptable to serve as a basis for fishery management advice. These particular sections are included in this report to document the analyses that were done for the peer review, but they are not recommended by SARC-66 as a basis for management. Instead, SARC-66 recommends the projections based on based on the single stock, non-migration model for management use; these are documented in Appendix B12.]***

### B4.35 Female Spawning Stock Biomass

Six-year projections of female SSB were made by using the same population dynamics equations used in the assessment model. The model projection began in year 2018 (assuming 2017 fishing mortalities for this year) and abundance-at-age data with associated standard errors, total fishing-at age, Rivard weights, natural mortality, female sex proportions-at-age, and female maturity-at-age from the model input. For each iteration of the simulation, the abundance-at-age in 2018 (calculated in the assessment using the 2017 January-1 abundances—at-age and fishing mortalities) was randomly drawn from a normal distribution parameterized with the 2018 estimates of January-1 abundance–at-age and associated standard errors and female SSB was calculated. For the Chesapeake Bay stock, the abundance of age-1 (recruits) in 2018 was determined from the Beverton-Holt equation by using the 2017 estimate of female SSB. For the remaining years, abundance of age-1 recruits were randomly generated using the estimated stock-recruitment Beverton-Holt relationship and applying log-normal errors.

For the Delaware Bay/Hudson River stock, abundance of age-1 recruits in 2018 was determined from the "hockey-stick" approach by using the 2017 estimate of female SSB or was randomly selected from the 1990-2017 recruit numbers for the empirical approach. For the remaining years, abundance of age-1 recruits were randomly generated using the "hockey-stick" approach applying log-normal errors estimate in the Beverton-Holt equation or was randomly selected from the 1990-2017 recruit numbers for the empirical approach.

Abundance-at-age >1 were calculated using fishing mortality-at-age and natural mortality-at-age used in the assessment. An age-15 plus-group was assumed. Female SSB was calculated by using average adjusted Rivard weight estimates from 2013-2017, sex proportions-at-age, female maturity-at-age, selectivity in 2017 and emigration probabilities. The fully-recruited fishing mortality in the simulation for the Chesapeake Bay stock was apportioned to Chesapeake Bay and ocean using average ratio of Chesapeake Bay and ocean F from 2013-2017 and then apportioned to period by using the average period proportions from 2013-2017.

For each year of the projection, the probability of female SSB going below the female SSB reference point was calculated using female SSB estimates from all iterations of the simulation and function *pgen* in R package *fishmethods* (assuming log-normal errors). Several F scenarios were investigated. For years >2018, simulations were performed using the current fully-recruited Fs for the Chesapeake Bay and ocean regions and F20%, F30% and F40%.

Results of the six-year projections are shown in Figure B10.1 for the Chesapeake Bay stock. When current F is assumed for all six years for the Chesapeake Bay stock, there was little change in mean female SSB over time and there were high probabilities of the female SSB values being below the SPR20%, SPR30%, SPR40%, and female $SSB_{1995}$ reference points (Figure B10.1). At F20% for years 2019-2023, the the Chesapeake Bay stock mean female SSB changed little through time. Female SSB increased and probabilities of being below the SPR20% and female $SSB_{1995}$ reference points declined in only later years of the projection when F30% and F40% were used.

For the Delaware Bay/Hudson River stock, there was very little change in mean female SSB over time at current F (0.4) using the "hockey-stick" or empirical approaches (Figures B10.2-3). The probability of female SSB being below the female SSB reference points was high for all reference points except female $SSB_{1993}$. As fishing mortality from years 2019-2023 declined with increasing F%SPR, female SSB increased over time and, regardless of method, the probability of being below the SPR20% reference point declined (Figures B10.2-3). However, the probability of the projected female SSB being below SPR30% and SPR40% was always high (Figures B10.2-3)

### B4.36 Catch Projections

Total catches (in numbers) achieved in each female SSB projection were saved to examine potential trends in catches over time. For the Chesapeake Bay stock, assuming the 2017 Fs occurred over time, average catches in the Chesapeake Bay and ocean regions increased slightly over time and the final Chesapeake Bay and ocean means were estimated to be 2.7 million and 1.7 million fish, respectively (Figure B10.4). Under F20%, catches in the Chesapeake Bay region increased slightly and remained stable but in the ocean region, catches increased slightly after an initial decline; final average catches in the Chesapeake Bay and ocean were 3.0 million and 1.5 million fish, respectively. Under F30%, there was an initial decline in landings (more so in the ocean region), but catches in the ocean increased slightly over time (Figure B10.4). Estimates of mean catches in 2023 for the Chesapeake Bay and ocean region were 2.2 million and 1.2 million fish, respectively. Under F40%, catches in the Chesapeake Bay region decline initially but remain stable through time, while catches in the ocean region drop initially but increased slightly over time (Figure B10.4). Estimates of mean catch in the final year under F40% were 1.7 million fish in the Chesapeake Bay region and 0.9 million fish in the ocean region.

For the Delaware Bay/Hudson River stock, assuming 2017 over time, catches declined slightly using the "hockey-stick" approach, but increased slightly over time using the empirical method (Figures 10.5-6). Estimates of final mean catch were 2.9 million and 3.4 million fish for the "hockey-stick" and empirical approaches, respectively. Under F20%, catch initially dropped then increased over time, but the projections using the empirical approach showing larger increases (Figure B10.5-6). Final average estimates under F20% were 2.3 million and 2.7 million fish for the "hockey-stick" and empirical approaches, respectively. Similar trends were observed under F30% and F40% (Figure B10.5-6). For the "hockey-stick" and empirical approaches, projected mean catches in 2023 were 1.8 million and 2.0 million fish under F30%, and 1.4 million and 1.5 million fish under F40% (Figure B10.5-6).

**TOR B7. REVIEW AND EVALUATE THE STATUS OF THE TECHNICAL COMMITTEE RESEARCH RECOMMENDATIONS LISTED IN THE MOST RECENT SARC REPORT. IDENTIFY NEW RESEARCH RECOMMENDATIONS. RECOMMEND TIMING AND FREQUENCY OF FUTURE ASSESSMENT UPDATES AND BENCHMARK ASSESSMENTS.**

### B4.37 Fishery-Dependent Priorities

High

- Continue collection of paired scale and otolith samples, particularly from larger striped bass, to facilitate development of otolith-based age-length keys and scale-otolith conversion matrices.
- Develop studies to provide information on gear specific (including recreational fishery) discard morality rates and to determine the magnitude of bycatch mortality.[1]
- Conduct study to directly estimate commercial discards in the Chesapeake Bay.
- Collect sex ratio information on the catch and improve methods for determining population sex ratio for use in estimates of female SSB and biological reference points.

Moderate

- Improve estimates of striped bass harvest removals in coastal areas during wave 1 and in inland waters of all jurisdictions year round.

### B4.38 Fishery-Independent Priorities

High

- Develop and index of relative abundance from the Hudson River Spawning Stock Biomass survey to better characterize the Delaware Bay/Hudson River stock.
- Improve the design of existing spawning stock surveys for Chesapeake Bay and Delaware Bay.

Moderate

- Develop a refined and cost-efficient, fisheries-independent coastal population index for striped bass stocks.
- Collect sex ratio information from fishery-independent sources to better characterize the population sex ratio.

### B4.39 Modeling / Quantitative Priorities

High

- Develop better estimates of tag reporting rates; for example, through a coastwide tagging study.
- Investigate changes in tag quality and potential impacts on reporting rate.
- Explore methods for combining tag results from programs releasing fish from different areas on different dates.
- Develop field or modeling studies to aid in estimation of natural mortality and other factors affecting the tag return rate.
- Compare M and F estimates from acoustic tagging programs to conventional tagging programs.

[1] Literature search and some modeling work completed

Moderate

- Examine methods to estimate temporal variation in natural mortality.

Low

- Evaluate truncated matrices to reduce bias in years with no tag returns and covariate based tagging models to account for potential differences from size or sex or other covariates.

### B4.40 Life History and Biology

High

- Continue in-depth analysis of migrations, stock compositions, sex ratio, etc. using mark-recapture data.[2]
- Continue evaluation of striped bass dietary needs and relation to health condition.
- Continue analysis to determine linkages between the *Mycobacteriosis* outbreak in Chesapeake Bay and sex ratio of Chesapeake spawning stock, Chesapeake juvenile production, and recruitment success into coastal fisheries.

Moderate

- Examine causes of different tag based survival estimates among programs estimating similar segments of the population.
- Continue to conduct research to determine limiting factors affecting recruitment and possible density implications.
- Conduct study to calculate the emigration rates from producer areas now that population levels are high and conduct multi-year study to determine inter-annual variation in emigration rates.

### B4.41 Striped Bass Research Priorities Identified as Being Met or Well in Progress

- ✓ Evaluate to what extent rising natural mortality among Chesapeake Bay striped bass affects the existing F and female SSB thresholds, which are based on a fixed M assumption (M = 0.15).
- ✓ Develop simulation models to look at the implications of overfishing definitions relative to development of a striped bass population that will provide "quality" fishing. Quality fishing must first be defined.
- ✓ Evaluate the stock status definitions relative to uncertainty in biological reference points.
- ✓ Develop a method to integrate catch-at-age and tagging models to produce a single estimate of F and stock status.[3]
- ✓ Develop a spatially and temporally explicit catch-at-age model incorporating tag based movement information.[4]
- ✓ Develop maturity ogives applicable to coastal migratory stocks.

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[2] Ongoing through Cooperative Winter Tagging Cruise and striped bass charter boat tagging trips. See Cooperative Winter Tagging Cruise 20 Year Report.
[3] Model developed, but the tagging data overwhelms the model. Issues remain with proper weighting
[4] Model developed with Chesapeake Bay and the rest of the coast as two stocks. External analysis of tagging data is used to inform the model but is not explicitly incorporated.

### B4.42 Timing of Assessment Updates and Next Benchmark Assessment

The Technical Committee recommends that the next benchmark stock assessment be conducted in five years in 2024, which will allow progress to be made on issues like state-specific scale-otolith conversion factors and directly incorporating tagging data into the 2SCA model.

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## B6.0 TABLES

Table B4.1. Summary of Atlantic striped bass commercial and recreational regulations in 2017. Source: 2018 ASMFC State Compliance Reports for Atlantic Striped Bass. Minimum sizes and slot size limits are in total length (TL). *Commercial quota reallocated to recreational bonus fish program.

| Commercial Regulations | | | |
|---|---|---|---|
| **STATE** | **SIZE LIMITS** | **SEASONAL QUOTA** | **OPEN SEASON** |
| ME | Commercial fishing prohibited | | |
| NH | Commercial fishing prohibited | | |
| MA | 34” minimum size | 869,813 lbs. Hook & line only | 6.23 until quota reached, Monday and Thursdays only; 15 fish/day with commercial boat permit; 2 fish/day with rod and reel permit (striped bass endorsement required for both permits) |
| RI | Floating fish trap (FFT): 26” minimum size<br>General category (GC; mostly rod & reel): 34” min. | Total: 181,449 lbs., split 39:61 between the FFT and GC. Gill netting prohibited. | FFT: 4.1 – 12.31, or until quota reached; unlimited possession limit until 70% of quota projected to be harvested, then 500 lbs/day<br>GC: 5.29-8.31, 9.8-12.31, or until quota reached. Closed Fridays and Saturdays during both seasons. 5 |
| CT* | Commercial fishing prohibited; bonus program: 22 – <28” slot size limit, 5.1 – 12.31 (voucher required) | | |
| NY | 28-38” minimum size (Hudson River closed to commercial harvest) | 795,795 lb. Pound nets, gill nets (6-8”stretched mesh), hook & line. | 6.1 – 12.15, or until quota reached. Limited entry permit only. |
| NJ* | Commercial fishing prohibited; bonus program: 1 fish at 24 – <28” slot size limit, 9.1 – 12.31 (permit required) | | |
| PA | Commercial fishing prohibited | | |
| DE | Gillnet: 28” minimum size, except 20” min in Del. Bay and River during spring season.<br>Hook and Line: 28” | Gillnet: 137,831 lbs.<br>Hook and line: 14,509 lbs. | Gillnet: 2.15-5.31 (2.15-3.30 for Nanticoke River) & 11.15-12.31; drift nets only 2.15-2.28 & 5.1-5.31; no fixed nets in Del. River. No trip limit.<br>Hook and Line: 4.1–12.31, 200 lbs/day trip limit |

(Table B4.1 continued – Summary of regulations in 2017)

| **Commercial Regulations** | | | |
|---|---|---|---|
| **STATE** | **SIZE LIMITS** | **SEASONAL QUOTA** | **OPEN SEASON** |
| MD | Ocean: 24” minimum<br>CB and Rivers: 18–36” | Ocean: 90,727 lbs.<br>CB and Rivers: 1,471,888 lbs. (part of Bay- wide quota). | Ocean: 1.1-5.31, 10.1-12.31, Mon- Fri<br>Bay Pound Net: 6.1-12.30, Mon-Sat<br>Bay Haul Seine: 6.1-12.29, Mon-Fri<br>Bay Hook & Line: 6.1-12.28, Mon-Thu<br>Bay Drift Gill Net: 1.2-2.28, 12.1-12.29, Mon-Thu |
| PRFC | 18-36” slot size limit 2.15-3.25 and 18” minimum size all other seasons | 583,362 lbs. (part of Bay-wide quota). Allocated by gear and season. | Hook & line: 1.1-3.25, 6.1-12.31<br>Pound Net & Other: 2.15-3.25, 6.1-12.15<br>Gill Net: 1.1-3.25, 11.13-12.31<br>Misc. Gear: 2.15-3.25, 6.1-12.15 |
| DC | Commercial fishing prohibited | | |
| VA | Bay and Rivers: 18” min size, and 18-28” slot size limit 3.26–6.15<br>Ocean: 28” min | Bay and Rivers: 1,064,997 lbs. (part of Bay- wide quota). Ocean: 136,141 lbs. ITQ- system for both areas. | Bay and Rivers: 1.16-12.31<br>Ocean: 1.16-12.31 |
| NC | Ocean: 28” | 360,360 lbs. (split between gear types). Number of fish allocated to each permit holder. Allocation varies by permit. | Seine fishery was open for 120 days, 150 fish/permit<br>Gill net fisher was open for 45 days, 50 fish/permit<br>Trawl fishery was open for 70 days, 100 fish/permit |

(Table B4.1 continued – Summary of regulations in 2017)

| Recreational Regulations | | | | |
|---|---|---|---|---|
| **STATE** | **SIZE LIMITS** | **BAG LIMIT** | **GEAR RESTRICTIONS** | **OPEN SEASONS** |
| ME | ≥ 28” minimum size | 1 fish/day | Hook & line only; circle hooks only when using live bait | All year, except spawning areas are closed 12.1 – 4.30 and catch and release only 5.1 – 6.30 |
| NH | ≥ 28” minimum size | 1 fish/day | Gaffing and culling prohibited | All year |
| MA | ≥ 28” minimum size | 1 fish/day | Hook & line only; no high- | All year |
| RI | ≥ 28” minimum size | 1 fish/day | None | All year |
| CT | ≥ 28” minimum size | 1 fish/day | Spearing and gaffing prohibited | All year |
| NY | Ocean and Delaware River: 28” minimum size<br>Hudson River: 18-28” slot limit, or ≥40” | 1 fish/day | Angling only. Spearing permitted in ocean waters. Catch and release only during closed season. | Ocean: 4.15 – 12.15<br>Hudson River: 4.1 – 11.30 Delaware River: All year |
| NJ | 1 fish at 28 to < 43”, and 1 fish ≥ 43” | | | Closed 1.1 – 2.28 in all waters except in the Atlantic Ocean, and 4.1 – 5.31 in the lower Delaware River and tributaries (spawning ground closure) |
| PA | Upstream from Calhoun St Bridge: 1 fish at ≥ 28” minimum size, year round<br>Downstream from Calhoun St Bridge: 1 fish at ≥ 28” minimum size, 1.1 – 3.31 and 6.1 – 12.31<br>2 fish at 21-25” slot size limit, 4.1 – 5.31 | | | |
| DE | 28” minimum size, no harvest 38-43” (inclusive) | 2 fish/day | Hook & line, spear (for divers) only. Circle hooks required in spawning season. | All year except 4.1-5.31 in spawning grounds (catch & release allowed). In Del. River, Bay & tributaries, may only harvest 20-25”slot from 7.1-8.31 |

(Table B4.1 continued – Summary of regulations in 2017). C&R = catch and release.

| Recreational Regulations | | | | |
|---|---|---|---|---|
| **STATE** | **SIZE LIMITS** | **BAG LIMIT** | **OTHER** | **OPEN SEASON** |
| MD | Ocean: 28-38” slot limit or ≥44”<br><br>CB Spring Trophy: 35” minimum size<br>CB Summer/Fall^: 20” minimum size and only one fish can be >28” | Ocean: 2 fish/day<br><br>CB Spring Trophy: 1 fish/day<br>CB Summer/Fall^: 2 fish/day | See compliance report for specifics. | Ocean: All year<br><br>CB: C&R only 1.1-4.14^<br>CB Spring Trophy: 4.15-5.15<br>Bay Summer/Fall: 5.16- |
| PRFC | Spring Trophy: 35” minimum size<br>Summer/Fall: 20” minimum size and only 1 fish can be >28” | Trophy: 1 fish/day<br>Summer/Fall: 2 fish/day | No more than two hooks or sets of hooks for each rod or line | Spring Trophy: 4.15 -5.15<br>Summer/Fall: 5.16-12.31 |
| DC | 20” minimum size and only one fish can be >28” | 2 fish/day | Hook & line only | 5.16-12.31 |
| VA | Ocean: 28”<br>Ocean Trophy: 36” minimum size<br><br>CB Trophy: 36” minimum size<br>CB Spring: 20-28” (with 1 fish >36”)<br>CB Fall: 20” minimum size and only one fish can be >28” | Ocean: 1 fish/day<br>Ocean Trophy: 1 fish/day<br><br>Bay Trophy: 1 fish/day<br>Bay Spring: 2 fish/day<br>Bay Fall: 2 fish/day | Hook & line, rod & reel, hand line only. Gaffing is illegal in Virginia marine waters. No possession in the spawning reaches of the Bay during trophy season | Ocean: 1.1-3.31, 5.16-12.31<br>Ocean Trophy: 5.1-5.15<br><br>Bay Trophy: 5.1-6.15<br>Bay Spring: 5.16-6.15<br>Bay Fall: 10.4-12.31 |
| NC | Ocean: 28” min size | Ocean: 1 fish/day | No gaffing allowed. | Ocean: All year |

^in Susquehanna Flats and Northeast River: C&R only from 1.1-5.3 and 1 fish/day at 20-26” slot size limit from 5.16-5.31

Table B5.1. Number of fish sampled by state and survey to develop female maturity curve.

| State | Survey | Months Sampled | N | Percent |
|---|---|---|---|---|
| Maryland | Spring Creel Survey | April-June | 252 | 58.9% |
| | Spring Gill Net Survey | April-May | 15 | 3.5% |
| | Striped Bass Pound Net Sampling | June-July | 19 | 4.4% |
| | Nanticoke Spring Pound Net and Fyke Net Survey | March | 2 | 0.5% |
| | Commercial Check Station Sampling | March | 3 | 0.7% |
| | Fish Health Hook & Line Survey | September-November | 5 | 1.2% |
| | Patapsco Gill Net Survey | June | 3 | 0.7% |
| | Shad Gill Net Survey (USFWS) | April-May | 8 | 1.9% |
| New Jersey | Delaware Bay Gill Net Survey | March-May | 15 | 3.5% |
| | Ocean Trawl Survey | April-May | 9 | 2.1% |
| | | October | 1 | 0.2% |
| | Headboat Sampling | December | 13 | 3.0% |
| | Herring Survey | May | 1 | 0.2% |
| Rhode Island | Fish Trap Survey | September-October | 59 | 13.8% |
| NEAMAP | Ocean Trawl Survey | May | 16 | 3.7% |
| | | September-October | 7 | 1.6% |
| Total | | | 428 | |

Table B5.2. Number of fish sampled by month to develop female maturity curve.

| Month | N | Percent |
|---|---|---|
| March | 15 | 3.5% |
| April | 80 | 18.7% |
| May | 151 | 35.3% |
| June | 84 | 19.6% |
| July | 13 | 3.0% |
| September | 16 | 3.7% |
| October | 54 | 12.6% |
| November | 2 | 0.5% |
| December | 13 | 3.0% |
| **Total** | **428** | |

Table B5.3. Number of fish sampled by age develop female maturity curve. Ages were calculated as for the full dataset analysis (e.g., fall developing fish had their ages advanced one year).

| **Age** | **N** | **Percent** |
|---|---|---|
| 2 | 3 | 0.7% |
| 3 | 13 | 3.0% |
| 4 | 45 | 10.5% |
| 5 | 131 | 30.6% |
| 6 | 56 | 13.1% |
| 7 | 32 | 7.5% |
| 8 | 36 | 8.4% |
| 9 | 13 | 3.0% |
| 10 | 28 | 6.5% |
| 11 | 44 | 10.3% |
| 12 | 14 | 3.3% |
| 13 | 8 | 1.9% |
| 14 | 4 | 0.9% |
| 16 | 1 | 0.2% |
| **Total** | **428** | |

Table B5.4. Comparison of maturity-at-age estimates from various studies. The maturity-at-age estimates used in the 2013 stock assessment are bolded.

| **Study** | Merriman (1941) a | Texas Instruments (1980) b | Specker et al. (1987) b | **Jones (1987)** | Berlinsky et al. (1995) | Data Subset (this study) | Full Dataset (this study) (Recommended) |
|---|---|---|---|---|---|---|---|
| **Area** | New England | Hudson | Coastwide | **MD and Hudson** | Rhode Island | Coastwide | Coastwide |
| **Timing** | April-Nov | | | | May-June, Sept-Nov | March-July | March-July, Sept-Dec |
| **Age** | | | | | | | |
| **3** | 0% | | | **0%** | 0% | 0% | 0% |
| **4** | 27% | 4% | 5% | **4%** | 12% | 7% | 9% |
| **5** | 74% | 21% | 15% | **13%** | 34% | 51% | 32% |
| **6** | 93% | 60% | 45% | **45%** | 77% | 66% | 45% |
| **7** | 100% | 89% | 100% | **89%** | 100% | 90% | 84% |
| **8** | 100% | 94% | 100% | **94%** | 100% | 94% | 89% |
| **9** | 100% | 100% | 100% | **100%** | 100% | 100% | 100% |

a: From Berlinksy et al 1995
b: From Jones 1987

Table B5.5. Indices of relative abundance for Age-1+ Atlantic striped bass.

| | MRIP CPUE | | CT LISTS | | NY OHS | | NJ OT | | DE SSN | | DE 30' | | MD SSN | | ChesMMAP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV |
| 1982 | 0.16 | 0.67 | | | | | | | | | | | | | | |
| 1983 | 0.38 | 0.93 | | | | | | | | | | | | | | |
| 1984 | 0.44 | 1.50 | | | | | | | | | | | | | | |
| 1985 | 0.12 | 0.72 | | | | | | | | | | | 4.88 | 0.25 | | |
| 1986 | 0.27 | 0.84 | | | | | | | | | | | 10.07 | 0.25 | | |
| 1987 | 0.46 | 1.02 | 0.05 | 0.32 | 3.83 | 0.11 | | | | | | | 7.15 | 0.25 | | |
| 1988 | 0.47 | 0.68 | 0.04 | 0.44 | 3.60 | 0.10 | | | | | | | 3.27 | 0.25 | | |
| 1989 | 0.44 | 0.72 | 0.06 | 0.30 | 2.58 | 0.13 | | | | | | | 3.96 | 0.25 | | |
| 1990 | 0.64 | 0.68 | 0.16 | 0.27 | 3.50 | 0.18 | 2.20 | 0.42 | | | 2.38 | 1.32 | 5.04 | 0.25 | | |
| 1991 | 0.79 | 0.64 | 0.15 | 0.25 | 3.28 | 0.19 | 2.72 | 0.35 | | | 0.32 | 0.24 | 4.61 | 0.25 | | |
| 1992 | 1.91 | 0.57 | 0.22 | 0.26 | 3.00 | 0.19 | 1.49 | 0.37 | | | 1.72 | 0.55 | 6.29 | 0.25 | | |
| 1993 | 1.78 | 0.49 | 0.27 | 0.18 | 3.32 | 0.11 | 1.60 | 0.38 | | | 2.93 | 1.17 | 6.25 | 0.25 | | |
| 1994 | 2.53 | 0.44 | 0.30 | 0.18 | 2.90 | 0.15 | 2.01 | 0.20 | | | 6.36 | 3.56 | 5.13 | 0.25 | | |
| 1995 | 3.63 | 0.49 | 0.59 | 0.14 | 2.84 | 0.18 | 13.94 | 0.11 | | | 16.47 | 5.20 | 4.62 | 0.25 | | |
| 1996 | 4.08 | 0.45 | 0.64 | 0.14 | 5.11 | 0.10 | 17.10 | 0.11 | 1.81 | 0.30 | 9.64 | 2.39 | 7.59 | 0.25 | | |
| 1997 | 4.59 | 0.45 | 0.86 | 0.12 | 4.84 | 0.14 | 17.08 | 0.11 | 2.16 | 0.32 | 4.32 | 1.92 | 3.83 | 0.25 | | |
| 1998 | 4.77 | 0.42 | 0.97 | 0.13 | 5.01 | 0.15 | 15.78 | 0.05 | 2.12 | 0.38 | 2.23 | 0.82 | 4.79 | 0.25 | | |
| 1999 | 4.58 | 0.42 | 1.11 | 0.11 | 3.46 | 0.16 | 9.57 | 0.06 | 1.47 | 0.26 | 12.48 | 4.09 | 4.02 | 0.25 | | |
| 2000 | 4.22 | 0.46 | 0.84 | 0.12 | 4.36 | 0.11 | 10.87 | 0.06 | 1.66 | 0.32 | 6.43 | 2.42 | 3.54 | 0.25 | | |
| 2001 | 3.44 | 0.41 | 0.61 | 0.15 | 3.47 | 0.15 | 3.91 | 0.16 | 1.88 | 0.39 | 3.48 | 1.19 | 2.87 | 0.25 | | |
| 2002 | 3.17 | 0.45 | 1.30 | 0.10 | 3.23 | 0.20 | 10.13 | 0.13 | 1.60 | 0.35 | 7.75 | 2.77 | 4.10 | 0.25 | 31.94 | 0.24 |
| 2003 | 2.97 | 0.46 | 0.87 | 0.11 | 4.24 | 0.19 | 14.36 | 0.04 | 3.21 | 0.42 | 2.53 | 0.99 | 4.50 | 0.25 | 77.74 | 0.16 |
| 2004 | 2.06 | 0.40 | 0.56 | 0.14 | 4.88 | 0.09 | 10.00 | 0.07 | 2.81 | 0.51 | 1.08 | 0.45 | 6.05 | 0.25 | 86.76 | 0.13 |
| 2005 | 2.60 | 0.42 | 1.17 | 0.12 | 3.91 | 0.14 | 28.06 | 0.10 | 1.77 | 0.31 | 2.60 | 1.07 | 4.96 | 0.25 | 146.19 | 0.16 |
| 2006 | 2.84 | 0.41 | 0.61 | 0.16 | 4.37 | 0.14 | 8.87 | 0.20 | 2.22 | 0.45 | 4.04 | 1.68 | 4.92 | 0.25 | 84.48 | 0.18 |
| 2007 | 1.92 | 0.40 | 1.02 | 0.12 | | | 14.14 | 0.12 | 1.78 | 0.72 | 1.98 | 0.76 | 2.14 | 0.25 | 71.86 | 0.18 |
| 2008 | 1.75 | 0.40 | 0.57 | 0.14 | | | 3.68 | 0.17 | 1.72 | 0.30 | 2.39 | 0.89 | 4.37 | 0.25 | 50.62 | 0.15 |
| 2009 | 1.61 | 0.38 | 0.60 | 0.18 | | | 12.76 | 0.12 | 1.25 | 0.24 | 1.22 | 0.42 | 5.70 | 0.25 | 20.89 | 0.24 |
| 2010 | 1.48 | 0.37 | 0.40 | 0.22 | | | 3.54 | 0.26 | 2.69 | 0.63 | 2.25 | 1.01 | 4.53 | 0.25 | 20.13 | 0.28 |
| 2011 | 1.16 | 0.38 | 0.48 | 0.21 | | | 7.16 | 0.09 | 3.25 | 0.78 | 1.15 | 0.46 | 4.58 | 0.25 | 27.31 | 0.17 |
| 2012 | 1.22 | 0.45 | 0.43 | 0.17 | | | 16.65 | 0.24 | 1.94 | 0.41 | 1.74 | 0.44 | 2.65 | 0.25 | 109.14 | 0.27 |
| 2013 | 2.21 | 0.36 | 0.67 | 0.13 | | | 8.84 | 0.20 | 2.10 | 0.42 | 1.44 | 0.45 | 4.42 | 0.25 | 74.21 | 0.20 |
| 2014 | 1.66 | 0.40 | 0.41 | 0.20 | | | 8.29 | 0.35 | 2.43 | 0.39 | 1.92 | 1.14 | 5.57 | 0.25 | 43.74 | 0.27 |
| 2015 | 1.62 | 0.42 | 0.20 | 0.24 | | | 0.77 | 0.35 | 0.86 | 0.18 | 2.93 | 1.45 | 7.34 | 0.25 | 55.26 | 0.29 |
| 2016 | 1.63 | 0.37 | 0.48 | 0.16 | | | 2.01 | 0.18 | 0.49 | 0.13 | 1.45 | 1.51 | 3.96 | 0.25 | 139.43 | 0.21 |
| 2017 | 2.96 | 0.39 | 0.34 | 0.25 | | | 18.25 | 0.12 | 1.75 | 0.42 | 1.66 | 0.78 | 5.46 | 0.25 | 148.20 | 0.27 |

Table B5.6. Unlagged indices of recruitment for Atlantic striped bass.

| | NY YOY | | NY Age-1 | | NJ YOY | | MD YOY | | MD Age-1 | | VA YOY | | MDVA YOY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV | Index | CV |
| 1982 | | | | | 0.10 | 0.05 | 3.57 | 0.23 | 0.02 | 0.51 | 2.71 | 0.46 | 52.77 | 0.43 |
| 1983 | | | | | 0.07 | 0.04 | 0.61 | 0.65 | 0.32 | 0.58 | 3.40 | 0.42 | 84.82 | 0.32 |
| 1984 | | | 0.96 | 0.23 | 0.37 | 0.10 | 1.64 | 0.43 | 0.00 | 0.20 | 4.47 | 0.31 | 64.35 | 0.38 |
| 1985 | 2.20 | 0.30 | 0.61 | 0.23 | 0.03 | 0.03 | 0.91 | 0.57 | 0.16 | 1.00 | 2.41 | 0.41 | 82.97 | 0.32 |
| 1986 | 4.65 | 0.60 | 0.30 | 0.09 | 0.32 | 0.07 | 1.34 | 0.44 | 0.03 | 0.25 | 4.74 | 0.28 | 65.11 | 0.37 |
| 1987 | 28.36 | 4.80 | 0.21 | 0.07 | 0.53 | 0.08 | 1.46 | 0.41 | 0.06 | 0.47 | 15.74 | 0.12 | 88.10 | 0.31 |
| 1988 | 49.28 | 5.20 | 0.81 | 0.22 | 0.35 | 0.05 | 0.73 | 0.65 | 0.07 | 0.46 | 7.64 | 0.24 | 204.03 | 0.29 |
| 1989 | 35.37 | 4.50 | 1.78 | 0.42 | 1.07 | 0.09 | 4.87 | 0.22 | 0.19 | 0.29 | 11.23 | 0.26 | 104.21 | 0.31 |
| 1990 | 35.53 | 4.70 | 0.37 | 0.09 | 1.05 | 0.08 | 1.03 | 0.49 | 0.33 | 0.24 | 7.34 | 0.35 | 110.92 | 0.27 |
| 1991 | 6.00 | 0.90 | 1.26 | 0.27 | 0.47 | 0.04 | 1.52 | 0.38 | 0.20 | 0.21 | 3.76 | 0.40 | 70.90 | 0.34 |
| 1992 | 16.93 | 1.80 | 1.34 | 0.29 | 1.18 | 0.06 | 2.34 | 0.30 | 0.15 | 0.22 | 7.32 | 0.34 | 69.92 | 0.34 |
| 1993 | 21.99 | 3.10 | 0.75 | 0.16 | 1.78 | 0.08 | 13.97 | 0.06 | 0.19 | 0.26 | 18.12 | 0.15 | 83.63 | 0.30 |
| 1994 | 23.61 | 2.50 | 1.43 | 0.35 | 0.96 | 0.06 | 6.40 | 0.14 | 0.78 | 0.25 | 10.48 | 0.26 | 233.65 | 0.26 |
| 1995 | 19.03 | 1.90 | 1.29 | 0.29 | 1.98 | 0.08 | 4.41 | 0.16 | 0.12 | 0.18 | 5.45 | 0.41 | 129.02 | 0.26 |
| 1996 | 12.12 | 1.40 | 1.54 | 0.39 | 1.70 | 0.08 | 17.61 | 0.05 | 0.08 | 0.28 | 23.00 | 0.12 | 107.18 | 0.31 |
| 1997 | 27.11 | 3.90 | 1.00 | 0.27 | 1.01 | 0.06 | 3.91 | 0.21 | 0.26 | 0.39 | 9.35 | 0.26 | 292.20 | 0.25 |
| 1998 | 16.10 | 2.00 | 2.10 | 0.58 | 1.31 | 0.08 | 5.50 | 0.14 | 0.17 | 0.23 | 13.25 | 0.19 | 107.68 | 0.27 |
| 1999 | 30.67 | 3.40 | 2.05 | 0.42 | 1.90 | 0.08 | 5.34 | 0.12 | 0.37 | 0.25 | 2.80 | 0.52 | 149.71 | 0.24 |
| 2000 | 6.88 | 1.10 | 1.56 | 0.38 | 1.78 | 0.08 | 7.42 | 0.11 | 0.26 | 0.18 | 16.18 | 0.18 | 127.57 | 0.33 |
| 2001 | 28.90 | 4.60 | 2.16 | 0.45 | 1.20 | 0.06 | 12.57 | 0.07 | 0.32 | 0.20 | 14.17 | 0.17 | 169.70 | 0.23 |
| 2002 | 14.72 | 1.50 | 2.53 | 0.46 | 0.53 | 0.05 | 2.20 | 0.34 | 0.79 | 0.18 | 3.98 | 0.42 | 221.79 | 0.28 |
| 2003 | 29.78 | 4.40 | 1.19 | 0.21 | 2.47 | 0.09 | 10.83 | 0.09 | 0.07 | 0.16 | 22.89 | 0.12 | 70.64 | 0.34 |
| 2004 | 8.73 | 0.90 | 2.41 | 0.45 | 1.13 | 0.07 | 4.85 | 0.16 | 0.74 | 0.33 | 12.70 | 0.18 | 231.43 | 0.21 |
| 2005 | 11.28 | 1.80 | 0.64 | 0.18 | 1.22 | 0.06 | 6.91 | 0.12 | 0.28 | 0.18 | 9.09 | 0.20 | 149.39 | 0.24 |
| 2006 | 5.83 | 0.70 | 2.02 | 0.43 | 0.67 | 0.05 | 1.78 | 0.37 | 0.28 | 0.22 | 10.10 | 0.27 | 154.67 | 0.24 |
| 2007 | 42.65 | 5.10 | 0.58 | 0.14 | 1.41 | 0.06 | 5.12 | 0.16 | 0.07 | 0.21 | 11.96 | 0.22 | 89.06 | 0.30 |
| 2008 | 19.04 | 2.10 | 1.24 | 0.27 | 1.26 | 0.07 | 1.26 | 0.45 | 0.31 | 0.30 | 7.97 | 0.29 | 135.30 | 0.25 |
| 2009 | 13.92 | 1.90 | 0.33 | 0.08 | 1.92 | 0.08 | 3.92 | 0.19 | 0.12 | 0.20 | 8.42 | 0.30 | 82.86 | 0.31 |
| 2010 | 25.62 | 3.40 | 0.45 | 0.11 | 1.30 | 0.06 | 2.54 | 0.26 | 0.17 | 0.27 | 9.07 | 0.23 | 103.97 | 0.28 |
| 2011 | 12.16 | 1.90 | 2.00 | 0.44 | 1.41 | 0.08 | 9.57 | 0.09 | 0.02 | 0.22 | 27.09 | 0.10 | 111.14 | 0.27 |
| 2012 | 9.85 | 1.40 | 0.90 | 0.18 | 0.34 | 0.04 | 0.49 | 0.66 | 0.35 | 0.51 | 2.68 | 0.58 | 274.26 | 0.21 |
| 2013 | 5.07 | 0.60 | 0.56 | 0.11 | 0.90 | 0.06 | 3.42 | 0.22 | 0.05 | 0.17 | 10.94 | 0.22 | 49.85 | 0.43 |
| 2014 | 24.60 | 2.60 | 0.82 | 0.16 | 1.65 | 0.07 | 4.06 | 0.19 | 0.12 | 0.37 | 11.30 | 0.20 | 116.33 | 0.26 |
| 2015 | 21.68 | 2.70 | 3.16 | 0.61 | 0.94 | 0.06 | 10.67 | 0.08 | 0.23 | 0.29 | 12.00 | 0.22 | 133.22 | 0.25 |
| 2016 | 10.93 | 1.50 | 2.00 | 0.39 | 1.41 | 0.07 | 1.25 | 0.45 | 0.42 | 0.13 | 8.74 | 0.33 | 183.47 | 0.30 |
| 2017 | 17.90 | 2.20 | 0.59 | 0.13 | 1.20 | 0.06 | 5.88 | 0.14 | 0.14 | 0.26 | 9.17 | 0.29 | 74.87 | 0.33 |

Table B5.7. Cross-correlation coefficients for Delaware 30’ trawl survey index.

| **DE 30' Trawl Winter vs. DE SSN** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| -0.088 | 0.034 | 0.186 | 0.179 | -0.071 | 0.228 | 0.419 | -0.056 | 0.074 | 0.07 | -0.236 | -0.128 | -0.031 | -0.118 | -0.025 | -0.054 | -0.113 | -0.029 | -0.045 | -0.031 | -0.063 |
| **DE 30' Trawl Winter vs. NJ Trawl** | | | | | | | | | | | | | | | | | | | | |
| -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 0.09 | 0.252 | 0.384 | 0.026 | -0.018 | 0.366 | 0.433 | 0.358 | 0.413 | 0.633 | 0.18 | 0.088 | 0.117 | -0.032 | -0.119 | -0.184 | -0.191 | -0.253 | -0.228 | -0.298 | -0.174 |
| **NJ YOY vs. DE 30' Trawl Winter** | | | | | | | | | | | | | | | | | | | | |
| -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| -0.046 | -0.122 | -0.245 | 0.086 | 0.035 | -0.269 | -0.128 | 0.129 | 0.099 | 0.138 | 0.317 | 0.347 | -0.115 | 0.028 | 0.363 | 0.041 | -0.128 | -0.133 | 0.286 | 0.036 | -0.058 |
| **MD YOY vs. DE 30' Trawl Winter** | | | | | | | | | | | | | | | | | | | | |
| -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| -0.109 | -0.1 | -0.183 | -0.033 | 0.24 | -0.202 | -0.114 | 0.28 | 0.255 | 0.241 | 0.2 | 0.519 | 0.105 | -0.046 | 0.094 | 0.11 | 0.127 | -0.066 | 0.076 | -0.019 | -0.16 |
| **MD AGE1 vs DE 30' Trawl Winter** | | | | | | | | | | | | | | | | | | | | |
| -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| -0.161 | -0.083 | 0.003 | -0.155 | 0.011 | 0.175 | -0.19 | -0.147 | 0.113 | 0.287 | 0.127 | -0.147 | 0.191 | 0.151 | 0.058 | 0.297 | 0.243 | 0.273 | -0.017 | 0.224 | -0.011 |

Table B5.8. Samples sizes and data sources of sex and age data by geographic area and sample season . Spring = March-June; Fall = July-December; N = number of fish of known sex only.

| Area | Season | N | Surveys |
|---|---|---|---|
| Chesapeake Bay | Spring | 12,038 | VA commercial sampling<br>PRFC commercial sampling<br>MD charter boat sampling<br>ChesMMAP trawl survey |
| Chesapeake Bay | Fall | 7,649 | VA commercial sampling<br>PRFC commercial sampling<br>ChesMMAP trawl survey |
| Ocean | Spring | 3,309 | VA commercial sampling<br>DE commercial sampling (Bay & inland bays)<br>MA diet study<br>MA otolith collection (carcass program)<br>NEAMAP trawl survey (RI, NY, MD, DE) |
| Ocean | Fall | 2,500 | VA commercial sampling<br>DE recreational sampling<br>DE commercial sampling<br>MA diet study<br>MA otolith collection (carcass program)<br>NEAMAP trawl survey (RI, NY, NJ, DE, MD, VA) |

Table B5.9. LOESS estimates of sex ratio by geographic region and period (Waves 2-3 = March-June; Waves 4-6 = July-December).

| | Chesapeake Bay | | Ocean | |
|---|---|---|---|---|
| **Age** | **Waves 2-3** | **Waves 4-6** | **Waves 2-3** | **Waves 4-6** |
| 1 | 0.61 | 0.51 | 0.61 | 0.67 |
| 2 | 0.48 | 0.37 | 0.71 | 0.78 |
| 3 | 0.38 | 0.26 | 0.77 | 0.84 |
| 4 | 0.29 | 0.19 | 0.78 | 0.83 |
| 5 | 0.24 | 0.19 | 0.72 | 0.77 |
| 6 | 0.27 | 0.24 | 0.64 | 0.76 |
| 7 | 0.38 | 0.30 | 0.64 | 0.78 |
| 8 | 0.50 | 0.39 | 0.68 | 0.81 |
| 9 | 0.59 | 0.48 | 0.75 | 0.83 |
| 10 | 0.66 | 0.56 | 0.82 | 0.86 |
| 11 | 0.71 | 0.64 | 0.85 | 0.91 |
| 12 | 0.75 | 0.70 | 0.84 | 0.87 |
| 13 | 0.79 | 0.76 | 0.83 | 0.82 |
| 14 | 0.82 | 0.79 | 0.83 | 0.83 |
| 15+ | 0.91 | 0.94 | 0.83 | 0.92 |

Table B5.10. Number of striped bass ≥18” (457 mm) TL a) released by each agency and b) recaptured between March 15 and June 15 by year and spawning region. Unknown fish were recaptured not in the producer area within the spawning season. Recapture records included both kept and released fish.

a) Number of releases by year and agency

| Year | MADFWELE | NCCOOP | NYDECCST | Total |
|---|---|---|---|---|
| 1987 | 0 | 0 | 1,668 | 1,668 |
| 1988 | 0 | 1,333 | 1,677 | 3,010 |
| 1989 | 23 | 1,156 | 846 | 2,025 |
| 1990 | 0 | 1,946 | 1,068 | 3,014 |
| 1991 | 388 | 1,779 | 1,071 | 3,238 |
| 1992 | 895 | 1,014 | 1,328 | 3,237 |
| 1993 | 675 | 527 | 1,731 | 2,933 |
| 1994 | 375 | 4,336 | 1,589 | 6,300 |
| 1995 | 433 | 639 | 689 | 1,761 |
| 1996 | 204 | 660 | 1,539 | 2,403 |
| 1997 | 317 | 1,348 | 1,138 | 2,803 |
| 1998 | 387 | 460 | 1,092 | 1,939 |
| 1999 | 469 | 271 | 1,063 | 1,803 |
| 2000 | 1,091 | 4,498 | 1,239 | 6,828 |
| 2001 | 456 | 2,383 | 1,050 | 3,889 |
| 2002 | 239 | 3,802 | 847 | 4,888 |
| 2003 | 655 | 1,906 | 794 | 3,355 |
| 2004 | 620 | 2,463 | 1,276 | 4,359 |
| 2005 | 604 | 3,960 | 831 | 5,395 |
| 2006 | 390 | 4,453 | 1,042 | 5,885 |
| 2007 | 530 | 370 | 1,411 | 2,311 |
| 2008 | 456 | 1,033 | 358 | 1,847 |
| 2009 | 501 | 146 | 197 | 844 |
| 2010 | 327 | 566 | 473 | 1,366 |
| 2011 | 504 | 107 | 188 | 799 |
| 2012 | 539 | 6 | 100 | 645 |
| 2013 | 486 | 2,006 | 56 | 2,548 |
| 2014 | 453 | 920 | 66 | 1,439 |
| 2015 | 348 | 1,375 | 58 | 1,781 |
| 2016 | 0 | 1,348 | 0 | 1,348 |
| Total | 12,365 | 46,811 | 26,485 | 85,661 |

b) Recaptures by year and spawning region, kept and released

| Year | Ches Bay | Not Ches Bay | Unknown | Total |
|---|---|---|---|---|
| 1987 | 0 | 0 | 0 | 0 |
| 1988 | 13 | 7 | 192 | 212 |
| 1989 | 10 | 32 | 280 | 322 |
| 1990 | 45 | 23 | 383 | 451 |
| 1991 | 44 | 38 | 470 | 552 |
| 1992 | 44 | 25 | 489 | 558 |
| 1993 | 35 | 32 | 516 | 583 |
| 1994 | 108 | 39 | 702 | 849 |
| 1995 | 91 | 38 | 614 | 743 |
| 1996 | 56 | 31 | 592 | 679 |
| 1997 | 57 | 25 | 628 | 710 |
| 1998 | 37 | 34 | 500 | 571 |
| 1999 | 31 | 29 | 394 | 454 |
| 2000 | 77 | 16 | 513 | 606 |
| 2001 | 66 | 18 | 508 | 592 |
| 2002 | 76 | 24 | 627 | 727 |
| 2003 | 75 | 23 | 518 | 616 |
| 2004 | 79 | 15 | 498 | 592 |
| 2005 | 102 | 25 | 437 | 564 |
| 2006 | 112 | 33 | 585 | 730 |
| 2007 | 58 | 17 | 404 | 479 |
| 2008 | 64 | 14 | 403 | 481 |
| 2009 | 57 | 15 | 300 | 372 |
| 2010 | 27 | 20 | 225 | 272 |
| 2011 | 24 | 12 | 222 | 258 |
| 2012 | 10 | 9 | 138 | 157 |
| 2013 | 35 | 21 | 239 | 295 |
| 2014 | 43 | 17 | 187 | 247 |
| 2015 | 38 | 15 | 197 | 250 |
| 2016 | 43 | 29 | 136 | 208 |
| Total | 1,557 | 676 | 11,897 | 14,130 |

Table B5.11. Number of striped bass ≥28” (711 mm) TL a) released by each agency and b) recaptured between March 15 and June 15 by year and spawning region. Unknown fish were recaptured not in the producer area within the spawning season. Recapture records included both kept and released fish.

a) Number of releases by year and agency

| Year | MADFWELE | NCCOOP | NYDECCST | Total |
|---|---|---|---|---|
| 1987 | 0 | 0 | 222 | 222 |
| 1988 | 0 | 194 | 351 | 545 |
| 1989 | 3 | 412 | 251 | 666 |
| 1990 | 0 | 323 | 291 | 614 |
| 1991 | 329 | 856 | 296 | 1,481 |
| 1992 | 649 | 434 | 247 | 1,330 |
| 1993 | 461 | 142 | 272 | 875 |
| 1994 | 217 | 480 | 376 | 1,073 |
| 1995 | 263 | 372 | 115 | 750 |
| 1996 | 120 | 557 | 85 | 762 |
| 1997 | 220 | 869 | 86 | 1,175 |
| 1998 | 311 | 106 | 88 | 505 |
| 1999 | 345 | 179 | 58 | 582 |
| 2000 | 704 | 165 | 97 | 966 |
| 2001 | 353 | 515 | 182 | 1,050 |
| 2002 | 172 | 789 | 149 | 1,110 |
| 2003 | 615 | 1,578 | 161 | 2,354 |
| 2004 | 499 | 783 | 75 | 1,357 |
| 2005 | 511 | 557 | 63 | 1,131 |
| 2006 | 323 | 2,113 | 28 | 2,464 |
| 2007 | 480 | 305 | 148 | 933 |
| 2008 | 385 | 923 | 26 | 1,334 |
| 2009 | 458 | 121 | 40 | 619 |
| 2010 | 309 | 411 | 150 | 870 |
| 2011 | 468 | 103 | 109 | 680 |
| 2012 | 495 | 5 | 11 | 511 |
| 2013 | 457 | 1,929 | 12 | 2,398 |
| 2014 | 431 | 918 | 12 | 1,361 |
| 2015 | 326 | 1,372 | 16 | 1,714 |
| 2016 | 0 | 1,345 | 0 | 1,345 |
| Total | 9,904 | 18,856 | 4,017 | 32,777 |

b) Recaptures by year and spawning region, kept and released

| Year | Ches Bay | Not Ches Bay | Unknown | Total |
|---|---|---|---|---|
| 1987 | 0 | 0 | 0 | 0 |
| 1988 | 0 | 2 | 40 | 42 |
| 1989 | 2 | 3 | 75 | 80 |
| 1990 | 3 | 6 | 103 | 112 |
| 1991 | 10 | 12 | 180 | 202 |
| 1992 | 10 | 11 | 212 | 233 |
| 1993 | 10 | 11 | 235 | 256 |
| 1994 | 17 | 11 | 218 | 246 |
| 1995 | 15 | 18 | 271 | 304 |
| 1996 | 14 | 13 | 245 | 272 |
| 1997 | 26 | 11 | 282 | 319 |
| 1998 | 12 | 17 | 219 | 248 |
| 1999 | 12 | 12 | 171 | 195 |
| 2000 | 9 | 9 | 118 | 136 |
| 2001 | 19 | 3 | 160 | 182 |
| 2002 | 9 | 10 | 193 | 212 |
| 2003 | 27 | 11 | 231 | 269 |
| 2004 | 30 | 7 | 244 | 281 |
| 2005 | 48 | 15 | 159 | 222 |
| 2006 | 61 | 17 | 270 | 348 |
| 2007 | 37 | 8 | 207 | 252 |
| 2008 | 50 | 7 | 248 | 305 |
| 2009 | 41 | 4 | 174 | 219 |
| 2010 | 17 | 12 | 149 | 178 |
| 2011 | 16 | 8 | 149 | 173 |
| 2012 | 6 | 8 | 89 | 103 |
| 2013 | 32 | 17 | 198 | 247 |
| 2014 | 41 | 14 | 176 | 231 |
| 2015 | 36 | 14 | 184 | 234 |
| 2016 | 42 | 29 | 126 | 197 |
| Total | 652 | 320 | 5,326 | 6,298 |

Table B5.12. Adjusted number of tag returns for fish ≥18” (457 mm) by stock and regulatory period (left) and associated stock composition (right), (a) with and (b) without fish of unknown stock. (CB = Chesapeake Bay; DR/HR = Delaware and Hudson rivers; UNK = unknown)

| a) | adjusted tag returns by regulatory period, including tags from unknown stocks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CB | DB/HR | UNK | CB | DB/HR | UNK | | |
| 1987-1989 | 5,376 | 1,526 | 8,390 | 0.35 | 0.10 | 0.55 | | |
| 1990-1994 | 5,761 | 3,170 | 46,127 | 0.10 | 0.06 | 0.84 | | |
| 1995-1999 | 3,589 | 2,217 | 49,516 | 0.06 | 0.04 | 0.90 | | |
| 2000-2002 | 3,550 | 1,046 | 29,910 | 0.10 | 0.03 | 0.87 | | |
| 2003-2006 | 5,939 | 1,489 | 37,017 | 0.13 | 0.03 | 0.83 | | |
| 2007-2014 | 6,144 | 1,970 | 38,573 | 0.13 | 0.04 | 0.83 | | |
| 2015-2016 | 1,737 | 641 | 6,063 | 0.21 | 0.08 | 0.72 | | |
| average | | | | 0.16 | 0.05 | 0.79 | | |

| b) | adjusted tag returns by regulatory period, excluding tags from unknown stocks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CB | DB/HU | CB | DB/HU | | | | |
| 1987-1989 | 5,376 | 1,526 | 0.78 | 0.22 | | | | |
| 1990-1994 | 5,761 | 3,170 | 0.65 | 0.35 | | | | |
| 1995-1999 | 3,589 | 2,217 | 0.62 | 0.38 | | | | |
| 2000-2002 | 3,550 | 1,046 | 0.77 | 0.23 | | | | |
| 2003-2006 | 5,939 | 1,489 | 0.80 | 0.20 | | | | |
| 2007-2014 | 6,144 | 1,970 | 0.76 | 0.24 | | | | |
| 2015-2016 | 1,737 | 641 | 0.73 | 0.27 | | | | |
| average | | | 0.73 | 0.27 | | | | |

Table B5.13. Adjusted number of tag returns for fish ≥28" (711 mm) by stock and regulatory period (left) and associated stock composition (right), (a) with and (b) without fish of unknown stock. (CB = Chesapeake Bay; DB/HR = Delaware Bay and Hudson River; UNK = unknown)

| a) | adjusted tag returns by regulatory period, including tags from unknown stocks | | | | | |
|---|---|---|---|---|---|---|
| | CB | DB/HU | UNK | CB | DB/HU | UNK |
| 1987-1989 | 157 | 108 | 1,535 | 0.09 | 0.06 | 0.85 |
| 1990-1994 | 954 | 750 | 12,933 | 0.07 | 0.05 | 0.88 |
| 1995-1999 | 861 | 698 | 16,373 | 0.05 | 0.04 | 0.91 |
| 2000-2002 | 713 | 310 | 6,519 | 0.09 | 0.04 | 0.86 |
| 2003-2006 | 2,980 | 552 | 12,528 | 0.19 | 0.03 | 0.78 |
| 2007-2014 | 4,821 | 819 | 19,287 | 0.19 | 0.03 | 0.77 |
| 2015-2016 | 1,675 | 412 | 4,288 | 0.26 | 0.06 | 0.67 |
| average | | | | 0.13 | 0.05 | 0.82 |

| b) | adjusted tag returns by regulatory period, excluding tags from unknown stocks | | | |
|---|---|---|---|---|
| | CB | DB/HU | CB | DB/HU |
| 1987-1989 | 157 | 108 | 0.59 | 0.41 |
| 1990-1994 | 954 | 750 | 0.56 | 0.44 |
| 1995-1999 | 861 | 698 | 0.55 | 0.45 |
| 2000-2002 | 713 | 310 | 0.70 | 0.30 |
| 2003-2006 | 2,980 | 552 | 0.84 | 0.16 |
| 2007-2014 | 4,821 | 819 | 0.85 | 0.15 |
| 2015-2016 | 1,675 | 412 | 0.80 | 0.20 |
| average | | | 0.70 | 0.30 |

Figure B6.1. Number of length and age samples from commercial fisheries by state and gear, 2000-2017.

| Year | MA | | RI | | | | NY | | DE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hook & Line | | Trap | | Hook & Line | | Mixed Gears | | Gillnet | | Hook & Line | |
| | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged |
| 2000 | 481 | 481 | 0 | 0 | 0 | 0 | 814 | 814 | 537 | 356 | 80 | 79 |
| 2001 | 540 | 193 | 139 | 135* | 0 | 0 | 839 | 839 | 374 | 137 | 56 | 56 |
| 2002 | 544 | 197 | 0 | 0 | 197 | 185* | 508 | 508 | 336 | 336 | 32 | 32 |
| 2003 | 628 | 249 | 314 | 314* | 185 | 185* | 524 | 524 | 593 | 521 | 35 | 34 |
| 2004 | 855 | 249 | 244 | 157 | 319 | 82 | 481 | 481 | 179 | 179 | 32 | 32 |
| 2005 | 742 | 251 | 412 | 412 | 492 | 490 | 185 | 185 | 144 | 144 | 6 | 6 |
| 2006 | 607 | 306 | 425 | 188 | 424 | 0 | 580 | 580 | 397 | 372 | 2 | 2 |
| 2007 | 328 | 328 | 132 | 132 | 350 | 0 | 753 | 734 | 394 | 385 | 21 | 21 |
| 2008 | 330 | 330 | 296 | 0 | 366 | 0 | 1,154 | 1,144 | 227 | 227 | 28 | 28 |
| 2009 | 321 | 321 | 371 | 0 | 348 | 0 | 655 | 655 | 221 | 221 | 144 | 10 |
| 2010 | 357 | 357 | 589 | 0 | 405 | 0 | 388 | 381 | 286 | 286 | 82 | 79 |
| 2011 | 414 | 358 | 265 | 125 | 360 | 48 | 535 | 534 | 148 | 148 | 82 | 82 |
| 2012 | 760 | 299 | 163 | 96 | 89 | 48 | 353 | | 150 | 146 | 63 | 63 |
| 2013 | 426 | 297 | 177 | 89 | 282 | 244 | 276 | 276 | 107 | 107 | 0 | 0 |
| 2014 | 804 | 587 | 44 | 45 | 151 | 139 | 420 | 413 | 181 | 181 | 0 | 0 |
| 2015 | 691 | 518 | 126 | 126 | 247 | 247 | 516 | 505 | 133 | 133 | 0 | 0 |
| 2016 | 700 | 681 | 39 | 38 | 112 | 112 | 404 | 381 | 178 | 170 | 28 | 28 |
| 2017 | 492 | 492 | 11 | 11 | 159 | 159 | 316 | 325 | 199 | 198 | 20 | 20 |

Table B6.1 (continued).

| Year | MD | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Gillnet | | Hook & Line | | Pound net/Haul Seine | | Trawl (Ocean) | |
| | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged |
| 2000 | 4,071 | | 1,932 | 209 | 633 | 209 | 0 | 0 |
| 2001 | 3,772 | 184 | 1,693 | 226 | 1,115 | 226 | 0 | 0 |
| 2002 | 4,091 | 165 | 1,697 | 217 | 1,080 | 217 | 0 | 0 |
| 2003 | 2,810 | 262 | 1,777 | 182 | 1,290 | 182 | 0 | 0 |
| 2004 | 3,591 | 193 | 1,965 | 256 | 853 | 156 | 0 | 0 |
| 2005 | 3,381 | 142 | 2,158 | 201 | 1,159 | 210 | 0 | 0 |
| 2006 | 2,974 | 183 | 2,106 | 196 | 944 | 196 | 560 | 127 |
| 2007 | 3,063 | 183 | 1,680 | 147 | 1,187 | 142 | 252 | 202 |
| 2008 | 3,621 | 211 | 1,626 | 148 | 884 | 170 | 244 | 119 |
| 2009 | 3,734 | 117 | 2,260 | 160 | 1,087 | 160 | 176 | 133 |
| 2010 | 3,108 | 119 | 1,790 | 157 | 1,528 | 158 | 107 | 242 |
| 2011 | 3,442 | 126 | 1,431 | 149 | 1,128 | 149 | 208 | 117 |
| 2012 | 3,800 | 122 | 1,988 | 198 | 788 | 198 | 629 | 210 |
| 2013 | 3,648 | 139 | 1,957 | 216 | 514 | 216 | 168 | 147 |
| 2014 | 3,471 | 149 | 2,311 | 216 | † | † | 160 | 145 |
| 2015 | 2,907 | 153 | 2,202 | 187 | † | † | 332 | 129 |
| 2016 | 3,665 | 159 | 2,213 | 204 | † | † | 25 | 149 |
| 2017 | 3,156 | | 1,988 | | † | † | 180 | |

†: MD pound net samples were combined with hook and line samples after 2013

Table B6.1 (continued).

| Year | VA | | | | | | | | PRFC | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gillnet (CB) | | Hook & Line (CB) | | Gillnet (Ocean) | | Pound/Fyke/Seine | | Mixed Gears | |
| | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged |
| 2000 | 392 | 835 | 40 | 51 | 1,024 | 502 | 506 | 468 | 491 | 491 |
| 2001 | 439 | 443 | 154 | 915 | 588 | 1,585 | 814 | 2,239 | 413 | 413 |
| 2002 | 608 | 1,544 | 189 | 1,015 | 371 | 2,180 | 655 | 2,036 | 285 | 285 |
| 2003 | 1,773 | 6,358 | 83 | 513 | 207 | 1,436 | 465 | 992 | 381 | 381 |
| 2004 | 515 | 3,224 | 65 | 382 | 72 | 600 | 594 | 2,169 | 533 | 533 |
| 2005 | 1,668 | 7,826 | 108 | 199 | 500 | 4,022 | 408 | 1,097 | 196 | 196 |
| 2006 | 1,744 | 4,066 | 143 | 683 | 867 | 2,431 | 345 | 871 | 452 | 452 |
| 2007 | 734 | 3,311 | 77 | 770 | 293 | 1,794 | 455 | 1,089 | 423 | 423 |
| 2008 | 857 | 4,640 | 44 | 345 | 517 | 4,729 | 223 | 541 | 329 | 329 |
| 2009 | 1,444 | 3,947 | 229 | 547 | 392 | 3,387 | 386 | 772 | 494 | 494 |
| 2010 | 1,902 | 4,021 | 119 | 264 | 445 | 2,829 | 394 | 696 | 562 | 562 |
| 2011 | 2,884 | 3,817 | 395 | 874 | 314 | 2,957 | 822 | 504 | 179 | 179 |
| 2012 | 1,302 | 345 | 144 | 71 | 343 | 250 | 405 | 136 | 514 | 514 |
| 2013 | 1,481 | 422 | 293 | 74 | 311 | 239 | 454 | 132 | 552 | 552 |
| 2014 | 3,270 | 462 | 255 | 62 | 473 | 293 | 994 | 35 | 395 | 395 |
| 2015 | 1,121 | 501 | 236 | 21 | 541 | 280 | 1,006 | 54 | 375 | 375 |
| 2016 | 2,541 | 580 | 401 | 211 | 561 | 299 | 1,365 | 581 | 350 | 350 |
| 2017 | 3,333 | 434 | 413 | 47 | 380 | 362 | 1,375 | 131 | 380 | 380 |

Table B6.1 (continued).

| Year | NC | | | | | |
|---|---|---|---|---|---|---|
| | Gillnet (Ocean) | | Trawl (Ocean) | | Haul Seine (Ocean) | |
| | Length Samples | Samples Aged | Length Samples | Samples Aged | Length Samples | Samples Aged |
| 2000 | 0 | 0 | 270 | 270 | 281 | 281 |
| 2001 | 69 | 69 | 103 | 103 | 161 | 161 |
| 2002 | 83 | 83 | 160 | 160 | 288 | 288 |
| 2003 | 170 | 170 | 239 | 239 | 0 | 0 |
| 2004 | 211 | 211 | 285 | 285 | 178 | 178 |
| 2005 | 186 | 186 | 33 | 33 | 299 | 299 |
| 2006 | 154 | 154 | 115 | 115 | 0 | 0 |
| 2007 | 232 | 101 | 461 | 204 | 64 | 64 |
| 2008 | 92 | 92 | 142 | 142 | 53 | 53 |
| 2009 | 28 | 28 | 151 | 151 | 0 | 0 |
| 2010 | 98 | 67 | 359 | 225 | 0 | 0 |
| 2011 | 163 | 98 | 226 | 121 | 0 | 0 |
| 2012 | 21 | 21 | 0 | 0 | 0 | 0 |
| 2013 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B6.2. Commercial and recreational landings in weight (metric tons and millions of pounds) of striped bass on the Atlantic coast. Estimates of recreational landings are not available prior to 1981.

| | Commercial | | Recreational | |
|---|---|---|---|---|
| Year | Metric tons | Millions of lbs | Metric tons | Millions of lbs |
| 1947 | 2,085 | 4.6 | - | - |
| 1948 | 2,726 | 6.0 | - | - |
| 1949 | 2,543 | 5.6 | - | - |
| 1950 | 3,128 | 6.9 | - | - |
| 1951 | 2,444 | 5.4 | - | - |
| 1952 | 2,148 | 4.7 | - | - |
| 1953 | 1,960 | 4.3 | - | - |
| 1954 | 1,759 | 3.9 | - | - |
| 1955 | 1,906 | 4.2 | - | - |
| 1956 | 1,686 | 3.7 | - | - |
| 1957 | 1,619 | 3.6 | - | - |
| 1958 | 2,266 | 5.0 | - | - |
| 1959 | 3,317 | 7.3 | - | - |
| 1960 | 3,524 | 7.8 | - | - |
| 1961 | 4,042 | 8.9 | - | - |
| 1962 | 3,567 | 7.9 | - | - |
| 1963 | 3,879 | 8.6 | - | - |
| 1964 | 3,558 | 7.8 | - | - |
| 1965 | 3,278 | 7.2 | - | - |
| 1966 | 3,820 | 8.4 | - | - |
| 1967 | 3,924 | 8.7 | - | - |
| 1968 | 4,169 | 9.2 | - | - |
| 1969 | 4,912 | 10.8 | - | - |
| 1970 | 3,999 | 8.8 | - | - |
| 1971 | 2,890 | 6.4 | - | - |
| 1972 | 4,012 | 8.8 | - | - |
| 1973 | 5,888 | 13.0 | - | - |
| 1974 | 4,536 | 10.0 | - | - |
| 1975 | 3,416 | 7.5 | - | - |
| 1976 | 2,494 | 5.5 | - | - |
| 1977 | 2,245 | 4.9 | - | - |
| 1978 | 1,764 | 3.9 | - | - |
| 1979 | 1,290 | 2.8 | - | - |
| 1980 | 1,895 | 4.2 | - | - |
| 1981 | 1,744 | 3.8 | - | - |

| | Commercial | | Recreational | |
|---|---|---|---|---|
| Year | Metric tons | Millions of lbs | Metric tons | Millions of lbs |
| 1982 | 991 | 2.2 | 1,844 | 4.1 |
| 1983 | 639 | 1.4 | 2,365 | 5.2 |
| 1984 | 1,105 | 2.4 | 1,090 | 2.4 |
| 1985 | 431 | 1.0 | 4,473 | 9.9 |
| 1986 | 68 | 0.2 | 1,255 | 2.8 |
| 1987 | 75 | 0.2 | 1,131 | 2.5 |
| 1988 | 130 | 0.3 | 1,097 | 2.4 |
| 1989 | 55 | 0.1 | 1,621 | 3.6 |
| 1990 | 310 | 0.7 | 3,723 | 8.2 |
| 1991 | 352 | 0.8 | 4,827 | 10.6 |
| 1992 | 652 | 1.4 | 5,408 | 11.9 |
| 1993 | 761 | 1.7 | 4,610 | 10.2 |
| 1994 | 781 | 1.7 | 6,692 | 14.8 |
| 1995 | 1,618 | 3.6 | 12,280 | 27.1 |
| 1996 | 2,019 | 4.5 | 12,994 | 28.6 |
| 1997 | 2,417 | 5.3 | 13,919 | 30.7 |
| 1998 | 2,636 | 5.8 | 13,475 | 29.7 |
| 1999 | 2,633 | 5.8 | 15,350 | 33.8 |
| 2000 | 2,735 | 6.0 | 15,478 | 34.1 |
| 2001 | 2,544 | 5.6 | 18,124 | 40.0 |
| 2002 | 2,529 | 5.6 | 19,001 | 41.9 |
| 2003 | 2,709 | 6.0 | 24,560 | 54.1 |
| 2004 | 2,882 | 6.4 | 24,594 | 54.2 |
| 2005 | 2,950 | 6.5 | 26,121 | 57.6 |
| 2006 | 2,731 | 6.0 | 22,986 | 50.7 |
| 2007 | 2,880 | 6.4 | 19,433 | 42.8 |
| 2008 | 2,985 | 6.6 | 25,703 | 56.7 |
| 2009 | 3,256 | 7.2 | 24,681 | 54.4 |
| 2010 | 3,154 | 7.0 | 27,909 | 61.5 |
| 2011 | 3,066 | 6.8 | 27,031 | 59.6 |
| 2012 | 2,973 | 6.6 | 24,157 | 53.3 |
| 2013 | 2,604 | 5.7 | 29,510 | 65.1 |
| 2014 | 2,808 | 6.2 | 21,749 | 47.9 |
| 2015 | 2,151 | 4.7 | 18,098 | 39.9 |
| 2016 | 2,178 | 4.8 | 19,817 | 43.7 |
| 2017 | 2,071 | 4.6 | 17,190 | 37.9 |

Table B6.3. Commercial and recreational removals of striped bass in numbers of fish.

| Year | Commercial Harvest | Commercial Discards | Recreational Harvest* | Recreational Release Mortalities† | Total |
|---|---|---|---|---|---|
| 1982 | 359,979 | 33,214 | 318,872 | 193,486 | 905,551 |
| 1983 | 271,958 | 47,984 | 615,844 | 111,924 | 1,047,711 |
| 1984 | 467,158 | 24,850 | 264,002 | 79,663 | 835,673 |
| 1985 | 69,288 | 29,555 | 732,002 | 94,682 | 925,527 |
| 1986 | 6,352 | 40,888 | 268,724 | 124,475 | 440,439 |
| 1987 | 3,727 | 29,785 | 114,351 | 145,471 | 293,334 |
| 1988 | 27,601 | 54,801 | 127,827 | 244,914 | 455,143 |
| 1989 | 3,908 | 87,813 | 161,791 | 406,866 | 660,378 |
| 1990 | 93,887 | 46,630 | 578,897 | 442,811 | 1,162,225 |
| 1991 | 114,170 | 90,439 | 798,260 | 715,552 | 1,718,422 |
| 1992 | 232,983 | 197,240 | 869,781 | 937,611 | 2,237,615 |
| 1993 | 314,522 | 116,921 | 789,037 | 812,488 | 2,032,966 |
| 1994 | 322,574 | 160,198 | 1,058,811 | 1,361,143 | 2,902,725 |
| 1995 | 537,342 | 187,185 | 2,287,578 | 2,010,689 | 5,022,794 |
| 1996 | 853,147 | 261,022 | 2,544,837 | 2,609,169 | 6,268,175 |
| 1997 | 1,076,561 | 331,383 | 3,001,559 | 2,978,716 | 7,388,220 |
| 1998 | 1,217,047 | 348,852 | 3,077,870 | 3,270,354 | 7,914,123 |
| 1999 | 1,223,372 | 332,101 | 3,330,322 | 3,161,882 | 8,047,676 |
| 2000 | 1,216,826 | 203,084 | 3,901,584 | 3,055,801 | 8,377,295 |
| 2001 | 929,394 | 174,926 | 4,212,411 | 2,454,617 | 7,771,349 |
| 2002 | 920,628 | 191,099 | 4,283,019 | 2,795,880 | 8,190,626 |
| 2003 | 862,381 | 129,813 | 5,021,287 | 2,852,116 | 8,865,597 |
| 2004 | 879,233 | 160,196 | 4,809,192 | 3,677,938 | 9,526,558 |
| 2005 | 969,808 | 145,094 | 4,551,590 | 3,444,770 | 9,111,262 |
| 2006 | 1,047,645 | 158,260 | 5,054,694 | 4,813,025 | 11,073,624 |
| 2007 | 1,014,707 | 166,397 | 4,177,242 | 2,944,764 | 8,303,111 |
| 2008 | 1,027,387 | 108,962 | 4,695,177 | 2,391,299 | 8,222,826 |
| 2009 | 1,053,530 | 128,191 | 4,901,115 | 1,943,488 | 8,026,323 |
| 2010 | 1,031,544 | 133,064 | 5,444,331 | 1,761,624 | 8,370,563 |
| 2011 | 944,669 | 87,924 | 5,048,912 | 1,482,139 | 7,563,643 |
| 2012 | 870,365 | 191,577 | 4,171,793 | 1,848,537 | 7,082,272 |
| 2013 | 784,379 | 112,097 | 5,215,393 | 2,393,952 | 8,505,821 |
| 2014 | 750,263 | 121,253 | 4,033,746 | 2,172,532 | 7,077,795 |
| 2015 | 622,079 | 101,343 | 3,085,724 | 2,307,133 | 6,116,279 |
| 2016 | 609,847 | 105,119 | 3,504,611 | 2,985,523 | 7,205,099 |
| 2017 | 592,576 | 108,475 | 2,934,292 | 3,423,544 | 7,058,888 |

* Includes estimates of Wave 1 harvest for VA and NC from tag releases for years with no MRIP sampling

† 9% release mortality applied to fish released alive

Table B6.4. Estimates of striped bass post release mortality from various commercial fishing gears. Bolded estimates were used to calculate gear specific post release morality for this assessment.

| Gear | Estimate | Source | Notes |
|---|---|---|---|
| Anchor Gill Net | 0.41 | ASMFC 2007 | New Jersey |
| | 0.47 | ASMFC 2007 | Delaware |
| | 0.41 | Clark and Kahn 2009 | Delaware Bay |
| | 0.43 | [1]Seagraves and Miller 1989 | |
| | 1.00 | Shepherd 2004 | |
| | 0.46 | This assessment | New Jersey gill net log books |
| **Anchor Gill Net Median** | **0.45** | | |
| Drift Gill Net | 0.03 | ASMFC 2007 | New Jersey |
| | 0.07 | ASMFC 2007 | Delaware |
| | 0.08 | [1]Seagraves and Miller 1989 | |
| | 0.06 | This assessment | New Jersey gill net log books |
| **Drift Gill Net Median** | **0.06** | | |
| Gill Net | 1.00 | ASMFC 2007 | Maine |
| | 0.47 | ASMFC 2007 | New York |
| **Gill Net median** | **0.74** | | |
| Hook and line | 0.08 | ASMFC 2007 | Massachusetts |
| | 0.13 | ASMFC 2007 | New York |
| | 0.08 | ASMFC 2007 | Delaware |
| | 0.08 | ASMFC 2007 | PRFC |
| | 0.09 | Caruso 2000 | |
| | **0.09** | **Diodati and Richards 1996** | |
| | 0.08 | [1]Diodati and Richards 1996 | |
| | 0.11 | Lukacovic and Uphoff 2007 | |
| | 0.02 | RMC 1990 | |
| | 0.28 | Millard et al. 2003 | Freshwater |
| | 0.06 | Nelson 1998 | Freshwater |
| Hook and line Median[2] | 0.08 | | |
| Otter Trawl | 1.00 | Shepherd 2004 | |
| Pound Net | 0.05 | [1]ASMFC 2007 | |
| | 0.01 | This assessment | Maryland pound net log books |
| **Pound Net Median** | **0.03** | | |
| Seine | 0.16 | Dunning et al. 1989 | Immediate mortality |
| | 0.15 | [1]NYDEP | |
| **Seine Median** | **0.16** | | |
| Traps | 0.05 | [1]Consensus opinion | |
| Trawl | 0.35 | [1]Crecco 1990 | |
| | 0.18 | Dunning et al. 1989 | Immediate mortality |
| **Trawl Median** | **0.26** | | |

[1]Used in 2007 Atlantic Striped Bass stock assessment
[2]Median from non-freshwater data sources

Table B6.5. Number of tags by disposition and commercial harvest and releases estimates used to calculate commercial discards for the Chesapeake Bay.

| | | | | | New MRIP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Commercial | Recreational | Recreational | | | | | Unadjusted |
| Year | Comm Killed | Comm Released | Rec Killed | Rec Released | Harvest | Harvest | Releases | LR | KT | CT/RT | CF | Total Discards |
| 1990 | 233 | 687 | 339 | 744 | 90,632 | 344,113 | 1,825,623 | 0.2634 | 0.6873 | 0.9234 | 0.3832 | 645,980 |
| 1991 | 173 | 610 | 617 | 1091 | 116,021 | 366,590 | 3,266,536 | 0.3165 | 0.2804 | 0.5591 | 1.1287 | 2,061,525 |
| 1992 | 255 | 215 | 932 | 1345 | 195,576 | 352,360 | 3,485,848 | 0.5550 | 0.2736 | 0.1599 | 2.0286 | 1,130,395 |
| 1993 | 229 | 489 | 992 | 752 | 272,421 | 331,869 | 2,932,861 | 0.8209 | 0.2308 | 0.6503 | 3.5559 | 6,781,600 |
| 1994 | 166 | 399 | 1108 | 867 | 275,876 | 560,271 | 4,673,894 | 0.4924 | 0.1498 | 0.4602 | 3.2866 | 7,069,354 |
| 1995 | 208 | 307 | 1117 | 633 | 377,377 | 1,027,739 | 5,754,152 | 0.3672 | 0.1862 | 0.4850 | 1.9719 | 5,502,984 |
| 1996 | 458 | 116 | 967 | 576 | 695,347 | 1,125,452 | 6,510,582 | 0.6178 | 0.4736 | 0.2014 | 1.3045 | 1,710,372 |
| 1997 | 683 | 142 | 817 | 524 | 847,968 | 1,260,838 | 10,178,428 | 0.6725 | 0.8360 | 0.2710 | 0.8045 | 2,219,011 |
| 1998 | 623 | 112 | 887 | 475 | 976,163 | 1,268,409 | 6,918,100 | 0.7696 | 0.7024 | 0.2358 | 1.0957 | 1,787,352 |
| 1999 | 667 | 88 | 600 | 295 | 989,689 | 1,365,709 | 8,759,677 | 0.7247 | 1.1117 | 0.2983 | 0.6519 | 1,703,392 |
| 2000 | 362 | 358 | 618 | 456 | 981,140 | 1,604,220 | 8,734,046 | 0.6116 | 0.5858 | 0.7851 | 1.0441 | 7,159,469 |
| 2001 | 292 | 138 | 591 | 301 | 705,691 | 1,294,357 | 6,145,194 | 0.5452 | 0.4941 | 0.4585 | 1.1035 | 3,108,948 |
| 2002 | 150 | 35 | 594 | 306 | 722,945 | 1,249,026 | 7,371,155 | 0.5788 | 0.2525 | 0.1144 | 2.2921 | 1,932,462 |
| 2003 | 343 | 89 | 509 | 269 | 658,248 | 1,657,555 | 10,970,911 | 0.3971 | 0.6739 | 0.3309 | 0.5893 | 2,139,074 |
| 2004 | 240 | 98 | 491 | 219 | 677,662 | 1,474,910 | 12,856,740 | 0.4595 | 0.4888 | 0.4475 | 0.9400 | 5,407,922 |
| 2005 | 78 | 96 | 382 | 161 | 752,006 | 1,298,593 | 9,580,429 | 0.5791 | 0.2042 | 0.5963 | 2.8361 | 16,201,195 |
| 2006 | 96 | 11 | 304 | 197 | 834,425 | 2,094,924 | 12,231,818 | 0.3983 | 0.3158 | 0.0558 | 1.2613 | 861,467 |
| 2007 | 53 | 8 | 212 | 106 | 800,333 | 1,617,626 | 7,578,540 | 0.4948 | 0.2500 | 0.0755 | 1.9790 | 1,131,937 |
| 2008 | 48 | 4 | 200 | 69 | 786,117 | 1,355,810 | 4,690,676 | 0.5798 | 0.2400 | 0.0580 | 2.4159 | 656,936 |
| 2009 | 41 | 9 | 222 | 54 | 825,281 | 1,802,545 | 4,838,475 | 0.4578 | 0.1847 | 0.1667 | 2.4790 | 1,999,134 |
| 2010 | 19 | 3 | 129 | 48 | 819,631 | 1,482,554 | 5,957,492 | 0.5529 | 0.1473 | 0.0625 | 3.7536 | 1,397,614 |
| 2011 | 18 | 10 | 141 | 44 | 722,489 | 1,389,294 | 3,823,146 | 0.5200 | 0.1277 | 0.2273 | 4.0736 | 3,539,580 |
| 2012 | 20 | 5 | 116 | 33 | 659,963 | 974,842 | 9,289,954 | 0.6770 | 0.1724 | 0.1515 | 3.9266 | 5,526,919 |
| 2013 | 13 | 3 | 170 | 43 | 579,235 | 1,434,543 | 7,130,621 | 0.4038 | 0.0765 | 0.0698 | 5.2802 | 2,626,801 |
| 2014 | 21 | 5 | 160 | 34 | 609,986 | 1,758,225 | 9,030,576 | 0.3469 | 0.1313 | 0.1471 | 2.6433 | 3,510,370 |
| 2015 | 31 | 2 | 105 | 57 | 497,809 | 1,315,657 | 10,215,851 | 0.3784 | 0.2952 | 0.0351 | 1.2816 | 459,386 |
| 2016 | 18 | 4 | 123 | 67 | 481,420 | 1,683,228 | 15,332,989 | 0.2860 | 0.1463 | 0.0597 | 1.9544 | 1,789,064 |
| 2017 | 26 | 6 | 144 | 73 | 459,094 | 1,201,949 | 9,044,625 | 0.3820 | 0.1806 | 0.0822 | 2.1155 | 1,572,620 |

| | | | | | Old MRIP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Commercial | Recreational | Recreational | | | | | Unadjusted |
| Year | CommK | CommR | RecK | RecR | Harvest | Harvest | Releases | LR | KT | CT/RT | CF | Total Discards |
| 1990 | 233 | 687 | 339 | 744 | 98,738 | 56,753 | 592,760 | 1.7398 | 0.6873 | 0.9234 | 2.5313 | 1,385,485 |
| 1991 | 173 | 610 | 617 | 1091 | 116,021 | 120,097 | 1,233,416 | 0.9661 | 0.2804 | 0.5591 | 3.4454 | 2,376,070 |
| 1992 | 255 | 215 | 932 | 1345 | 195,576 | 120,472 | 862,046 | 1.6234 | 0.2736 | 0.1599 | 5.9334 | 817,622 |
| 1993 | 229 | 489 | 992 | 752 | 272,421 | 174,868 | 1,640,829 | 1.5579 | 0.2308 | 0.6503 | 6.7485 | 7,200,462 |
| 1994 | 166 | 399 | 1108 | 867 | 275,876 | 326,284 | 2,968,711 | 0.8455 | 0.1498 | 0.4602 | 5.6435 | 7,710,298 |
| 1995 | 208 | 307 | 1117 | 633 | 377,377 | 492,323 | 2,709,430 | 0.7665 | 0.1862 | 0.4850 | 4.1164 | 5,409,131 |
| 1996 | 458 | 116 | 967 | 576 | 695,347 | 521,911 | 3,087,848 | 1.3323 | 0.4736 | 0.2014 | 2.8130 | 1,749,272 |
| 1997 | 683 | 142 | 817 | 524 | 847,968 | 651,472 | 4,961,501 | 1.3016 | 0.8360 | 0.2710 | 1.5570 | 2,093,415 |
| 1998 | 623 | 112 | 887 | 475 | 976,163 | 620,441 | 3,297,972 | 1.5733 | 0.7024 | 0.2358 | 2.2400 | 1,741,923 |
| 1999 | 667 | 88 | 600 | 295 | 839,325 | 553,137 | 3,250,098 | 1.5174 | 1.1117 | 0.2983 | 1.3650 | 1,323,366 |
| 2000 | 362 | 358 | 618 | 456 | 981,140 | 794,654 | 4,106,633 | 1.2347 | 0.5858 | 0.7851 | 2.1078 | 6,795,745 |
| 2001 | 292 | 138 | 591 | 301 | 705,691 | 651,455 | 3,393,064 | 1.0833 | 0.4941 | 0.4585 | 2.1925 | 3,410,669 |
| 2002 | 150 | 35 | 594 | 306 | 722,945 | 543,703 | 3,518,235 | 1.3297 | 0.2525 | 0.1144 | 5.2655 | 2,118,898 |
| 2003 | 343 | 89 | 509 | 269 | 658,248 | 890,136 | 5,551,823 | 0.7395 | 0.6739 | 0.3309 | 1.0974 | 2,015,720 |
| 2004 | 240 | 98 | 491 | 219 | 677,662 | 688,311 | 5,107,116 | 0.9845 | 0.4888 | 0.4475 | 2.0142 | 4,603,160 |
| 2005 | 78 | 96 | 382 | 161 | 752,007 | 757,596 | 5,038,483 | 0.9926 | 0.2042 | 0.5963 | 4.8613 | 14,604,876 |
| 2006 | 96 | 11 | 304 | 197 | 834,425 | 1,027,248 | 5,195,617 | 0.8123 | 0.3158 | 0.0558 | 2.5723 | 746,239 |
| 2007 | 53 | 8 | 212 | 106 | 799,631 | 984,914 | 3,886,633 | 0.8119 | 0.2500 | 0.0755 | 3.2475 | 952,596 |
| 2008 | 48 | 4 | 200 | 69 | 786,115 | 597,858 | 1,826,362 | 1.3149 | 0.2400 | 0.0580 | 5.4787 | 580,062 |
| 2009 | 41 | 9 | 222 | 54 | 825,281 | 722,161 | 1,722,000 | 1.1428 | 0.1847 | 0.1667 | 6.1878 | 1,775,901 |
| 2010 | 19 | 3 | 129 | 48 | 819,630 | 515,632 | 1,632,669 | 1.5896 | 0.1473 | 0.0625 | 10.7923 | 1,101,266 |
| 2011 | 18 | 10 | 141 | 44 | 722,489 | 541,797 | 1,264,123 | 1.3335 | 0.1277 | 0.2273 | 10.4458 | 3,001,081 |
| 2012 | 20 | 5 | 116 | 33 | 659,963 | 330,380 | 2,308,120 | 1.9976 | 0.1724 | 0.1515 | 11.5860 | 4,051,804 |
| 2013 | 13 | 3 | 170 | 43 | 579,235 | 556,875 | 2,550,154 | 1.0402 | 0.0765 | 0.0698 | 13.6020 | 2,420,038 |
| 2014 | 21 | 5 | 160 | 34 | 609,986 | 642,521 | 2,667,105 | 0.9494 | 0.1313 | 0.1471 | 7.2333 | 2,837,035 |
| 2015 | 31 | 2 | 105 | 57 | 497,809 | 500,465 | 3,911,768 | 0.9947 | 0.2952 | 0.0351 | 3.3691 | 462,429 |

LR=ratio of commercial landings to recreational harvest; KT=ratio of tags returned from commercially harvested fish to tags returned from recreationally harvested fish; CT = number of tags returned from discarded fish by commercial fishers; RT = number of tags returned from discarded fish by recreational anglers; CF=LR/KT.

Table B6.6. Predicted tag numbers from the GAM fit to Chesapeake Bay tag returns by disposition.

| Year | Comm Killed | Comm Released | Rec Killed | Rec Released |
|---|---|---|---|---|
| 1990 | 215.1 | 629.2 | 371.5 | 936.2 |
| 1991 | 207.8 | 511.9 | 591.8 | 979.3 |
| 1992 | 205.0 | 419.2 | 842.6 | 969.5 |
| 1993 | 206.3 | 347.6 | 1029.0 | 898.5 |
| 1994 | 221.3 | 288.6 | 1108.3 | 794.9 |
| 1995 | 278.8 | 238.4 | 1082.4 | 686.8 |
| 1996 | 400.5 | 199.3 | 986.0 | 591.6 |
| 1997 | 539.5 | 171.7 | 876.1 | 511.9 |
| 1998 | 594.7 | 152.8 | 772.1 | 446.8 |
| 1999 | 537.3 | 138.9 | 678.6 | 398.3 |
| 2000 | 414.9 | 124.7 | 619.7 | 362.4 |
| 2001 | 308.9 | 106.5 | 595.4 | 329.9 |
| 2002 | 254.0 | 86.2 | 570.6 | 296.0 |
| 2003 | 218.9 | 66.5 | 525.5 | 259.4 |
| 2004 | 170.8 | 48.1 | 461.3 | 219.9 |
| 2005 | 120.0 | 32.1 | 378.8 | 180.1 |
| 2006 | 83.5 | 20.3 | 296.8 | 141.2 |
| 2007 | 60.5 | 13.1 | 239.1 | 105.5 |
| 2008 | 44.6 | 9.0 | 204.6 | 77.5 |
| 2009 | 32.3 | 6.8 | 177.8 | 59.0 |
| 2010 | 23.8 | 5.5 | 152.3 | 47.8 |
| 2011 | 19.2 | 4.8 | 136.8 | 41.4 |
| 2012 | 17.3 | 4.3 | 136.9 | 38.6 |
| 2013 | 17.6 | 3.9 | 142.7 | 39.2 |
| 2014 | 19.5 | 3.8 | 138.3 | 43.0 |
| 2015 | 21.8 | 3.7 | 128.0 | 50.3 |
| 2016 | 23.3 | 3.8 | 126.3 | 60.6 |
| 2017 | 24.7 | 4.1 | 135.5 | 73.2 |

Table B6.7. Estimates of unscaled commercial total discards (numbers of fish) by year for Chesapeake Bay.

| Year | Number |
|---|---|
| 1990 | 558,168 |
| 1991 | 1,538,554 |
| 1992 | 3,438,837 |
| 1993 | 4,646,049 |
| 1994 | 4,184,633 |
| 1995 | 2,847,613 |
| 1996 | 3,336,623 |
| 1997 | 3,729,744 |
| 1998 | 2,364,229 |
| 1999 | 2,795,206 |
| 2000 | 2,744,379 |
| 2001 | 2,085,072 |
| 2002 | 2,790,765 |
| 2003 | 2,681,484 |
| 2004 | 3,486,128 |
| 2005 | 3,116,813 |
| 2006 | 2,493,946 |
| 2007 | 1,838,920 |
| 2008 | 1,452,759 |
| 2009 | 1,402,585 |
| 2010 | 2,433,416 |
| 2011 | 1,628,076 |
| 2012 | 5,479,817 |
| 2013 | 2,346,792 |
| 2014 | 1,935,558 |
| 2015 | 1,683,565 |
| 2016 | 1,510,643 |
| 2017 | 1,052,849 |

Table B6.8. The number of tags returns from Chesapeake Bay by year and commercial gear.

| Year | Anchor | Drift | Hook | Other | Pound | Seine | Total |
|---|---|---|---|---|---|---|---|
| 1990 | 132 | 31 | 13 | 9 | 731 | 3 | 919 |
| 1991 | 311 | 55 | 10 | 15 | 390 | 1 | 782 |
| 1992 | 231 | 81 | 8 | 20 | 128 | 2 | 470 |
| 1993 | 102 | 95 | 11 | 5 | 489 | 16 | 718 |
| 1994 | 75 | 53 | 10 | 5 | 404 | 18 | 565 |
| 1995 | 68 | 32 | 11 | 4 | 393 | 7 | 515 |
| 1996 | 178 | 46 | 14 | 1 | 323 | 5 | 567 |
| 1997 | 176 | 74 | 46 | 7 | 464 | 24 | 791 |
| 1998 | 94 | 51 | 26 | 4 | 534 | 26 | 735 |
| 1999 | 70 | 24 | 40 | 2 | 614 | 5 | 755 |
| 2000 | 64 | 33 | 27 | 3 | 593 | 0 | 720 |
| 2001 | 76 | 27 | 32 | 1 | 289 | 5 | 430 |
| 2002 | 29 | 10 | 11 | 0 | 135 | 0 | 185 |
| 2003 | 47 | 12 | 16 | 1 | 356 | 0 | 432 |
| 2004 | 40 | 31 | 28 | 1 | 238 | 0 | 338 |
| 2005 | 33 | 9 | 5 | 1 | 124 | 2 | 174 |
| 2006 | 27 | 8 | 11 | 1 | 60 | 0 | 107 |
| 2007 | 26 | 14 | 6 | 2 | 12 | 0 | 60 |
| 2008 | 16 | 19 | 10 | 0 | 7 | 0 | 52 |
| 2009 | 28 | 2 | 7 | 2 | 11 | 0 | 50 |
| 2010 | 9 | 1 | 5 | 1 | 6 | 0 | 22 |
| 2011 | 9 | 4 | 6 | 0 | 8 | 0 | 27 |
| 2012 | 7 | 3 | 13 | 0 | 2 | 0 | 25 |
| 2013 | 4 | 2 | 6 | 2 | 2 | 0 | 16 |
| 2014 | 10 | 7 | 4 | 0 | 4 | 1 | 26 |
| 2015 | 13 | 7 | 6 | 0 | 4 | 0 | 30 |
| 2016 | 9 | 1 | 5 | 2 | 4 | 0 | 21 |
| 2017 | 7 | 13 | 3 | 0 | 9 | 0 | 32 |

Table B6.9. Unscaled commercial total discards for Chesapeake Bay apportioned by gear

| Year | Anchor | Drift | Hook | Other | Pound | Seine | Total |
|---|---|---|---|---|---|---|---|
| 1990 | 80,172 | 18,828 | 7,896 | 5,466 | 443,984 | 1,822 | 558,168 |
| 1991 | 611,880 | 108,210 | 19,675 | 29,512 | 767,309 | 1,967 | 1,538,554 |
| 1992 | 1,690,152 | 592,651 | 58,533 | 146,333 | 936,534 | 14,633 | 3,438,837 |
| 1993 | 660,024 | 614,728 | 71,179 | 32,354 | 3,164,231 | 103,533 | 4,646,049 |
| 1994 | 555,482 | 392,541 | 74,064 | 37,032 | 2,992,198 | 133,316 | 4,184,633 |
| 1995 | 375,996 | 176,939 | 60,823 | 22,117 | 2,173,033 | 38,705 | 2,847,613 |
| 1996 | 1,047,476 | 270,696 | 82,386 | 5,885 | 1,900,757 | 29,423 | 3,336,623 |
| 1997 | 829,880 | 348,927 | 216,900 | 33,007 | 2,187,865 | 113,165 | 3,729,744 |
| 1998 | 302,364 | 164,049 | 83,633 | 12,867 | 1,717,684 | 83,633 | 2,364,229 |
| 1999 | 259,158 | 88,854 | 148,090 | 7,405 | 2,273,187 | 18,511 | 2,795,206 |
| 2000 | 243,945 | 125,784 | 102,914 | 11,435 | 2,260,301 | 0 | 2,744,379 |
| 2001 | 368,524 | 130,923 | 155,168 | 4,849 | 1,401,362 | 24,245 | 2,085,072 |
| 2002 | 437,471 | 150,852 | 165,937 | 0 | 2,036,504 | 0 | 2,790,765 |
| 2003 | 291,736 | 74,486 | 99,314 | 6,207 | 2,209,742 | 0 | 2,681,484 |
| 2004 | 412,560 | 319,734 | 288,792 | 10,314 | 2,454,729 | 0 | 3,486,128 |
| 2005 | 591,120 | 161,214 | 89,564 | 17,913 | 2,221,177 | 35,825 | 3,116,813 |
| 2006 | 629,314 | 186,463 | 256,387 | 23,308 | 1,398,475 | 0 | 2,493,946 |
| 2007 | 796,865 | 429,081 | 183,892 | 61,297 | 367,784 | 0 | 1,838,920 |
| 2008 | 447,003 | 530,816 | 279,377 | 0 | 195,564 | 0 | 1,452,759 |
| 2009 | 785,448 | 56,103 | 196,362 | 56,103 | 308,569 | 0 | 1,402,585 |
| 2010 | 995,488 | 110,610 | 553,049 | 110,610 | 663,659 | 0 | 2,433,416 |
| 2011 | 542,692 | 241,196 | 361,795 | 0 | 482,393 | 0 | 1,628,076 |
| 2012 | 1,534,349 | 657,578 | 2,849,505 | 0 | 438,385 | 0 | 5,479,817 |
| 2013 | 586,698 | 293,349 | 880,047 | 293,349 | 293,349 | 0 | 2,346,792 |
| 2014 | 744,445 | 521,112 | 297,778 | 0 | 297,778 | 74,445 | 1,935,558 |
| 2015 | 729,545 | 392,832 | 336,713 | 0 | 224,475 | 0 | 1,683,565 |
| 2016 | 647,418 | 71,935 | 359,677 | 143,871 | 287,741 | 0 | 1,510,643 |
| 2017 | 230,311 | 427,720 | 98,705 | 0 | 296,114 | 0 | 1,052,849 |

Table B6.10. Unscaled commercial dead discards for Chesapeake Bay by year and gear

| year | anchor | drift | hook | other | pound | seine | total |
|---|---|---|---|---|---|---|---|
| 1990 | 36,077 | 1,130 | 711 | 1,093 | 13,320 | 292 | 52,622 |
| 1991 | 275,346 | 6,493 | 1,771 | 5,902 | 23,019 | 315 | 312,846 |
| 1992 | 760,568 | 35,559 | 5,268 | 29,267 | 28,096 | 2,341 | 861,099 |
| 1993 | 297,011 | 36,884 | 6,406 | 6,471 | 94,927 | 16,565 | 458,264 |
| 1994 | 249,967 | 23,552 | 6,666 | 7,406 | 89,766 | 21,331 | 398,688 |
| 1995 | 169,198 | 10,616 | 5,474 | 4,423 | 65,191 | 6,193 | 261,096 |
| 1996 | 471,364 | 16,242 | 7,415 | 1,177 | 57,023 | 4,708 | 557,928 |
| 1997 | 373,446 | 20,936 | 19,521 | 6,601 | 65,636 | 18,106 | 504,246 |
| 1998 | 136,064 | 9,843 | 7,527 | 2,573 | 51,531 | 13,381 | 220,919 |
| 1999 | 116,621 | 5,331 | 13,328 | 1,481 | 68,196 | 2,962 | 207,919 |
| 2000 | 109,775 | 7,547 | 9,262 | 2,287 | 67,809 | 0 | 196,681 |
| 2001 | 165,836 | 7,855 | 13,965 | 970 | 42,041 | 3,879 | 234,546 |
| 2002 | 196,862 | 9,051 | 14,934 | 0 | 61,095 | 0 | 281,943 |
| 2003 | 131,281 | 4,469 | 8,938 | 1,241 | 66,292 | 0 | 212,222 |
| 2004 | 185,652 | 19,184 | 25,991 | 2,063 | 73,642 | 0 | 306,532 |
| 2005 | 266,004 | 9,673 | 8,061 | 3,583 | 66,635 | 5,732 | 359,687 |
| 2006 | 283,191 | 11,188 | 23,075 | 4,662 | 41,954 | 0 | 364,070 |
| 2007 | 358,589 | 25,745 | 16,550 | 12,259 | 11,034 | 0 | 424,177 |
| 2008 | 201,151 | 31,849 | 25,144 | 0 | 5,867 | 0 | 264,011 |
| 2009 | 353,451 | 3,366 | 17,673 | 11,221 | 9,257 | 0 | 394,968 |
| 2010 | 447,970 | 6,637 | 49,774 | 22,122 | 19,910 | 0 | 546,412 |
| 2011 | 244,211 | 14,472 | 32,562 | 0 | 14,472 | 0 | 305,716 |
| 2012 | 690,457 | 39,455 | 256,455 | 0 | 13,152 | 0 | 999,519 |
| 2013 | 264,014 | 17,601 | 79,204 | 58,670 | 8,800 | 0 | 428,289 |
| 2014 | 335,000 | 31,267 | 26,800 | 0 | 8,933 | 11,911 | 413,912 |
| 2015 | 328,295 | 23,570 | 30,304 | 0 | 6,734 | 0 | 388,903 |
| 2016 | 291,338 | 4,316 | 32,371 | 28,774 | 8,632 | 0 | 365,432 |
| 2017 | 103,640 | 25,663 | 8,883 | 0 | 8,883 | 0 | 147,070 |

Table B6.11. Unscaled commercial dead discards for Chesapeake Bay by year and age.

| | Age | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | Total |
| 1982 | 0 | 0 | 12,610 | 1,139 | 1,036 | 2 | 26 | 21 | 15 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 14,856 |
| 1983 | 0 | 0 | 40,700 | 2,927 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43,630 |
| 1984 | 0 | 0 | 17,551 | 2,001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19,552 |
| 1985 | 0 | 0 | 3,790 | 19,163 | 199 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23,166 |
| 1986 | 0 | 0 | 3,000 | 5,645 | 20,222 | 3,917 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32,784 |
| 1987 | 0 | 8 | 899 | 794 | 6,633 | 6,669 | 1,925 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16,940 |
| 1988 | 0 | 18 | 2,666 | 10,190 | 10,620 | 7,239 | 5,340 | 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36,123 |
| 1989 | 0 | 28 | 3,594 | 17,501 | 16,297 | 10,668 | 5,559 | 1,501 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55,149 |
| 1990 | 0 | 45 | 1,483 | 5,374 | 13,497 | 13,468 | 11,399 | 6,333 | 942 | 61 | 14 | 4 | 2 | 0 | 0 | 0 | 52,622 |
| 1991 | 0 | 401 | 6,324 | 32,742 | 107,225 | 83,963 | 54,432 | 23,587 | 3,535 | 488 | 107 | 32 | 10 | 0 | 0 | 0 | 312,846 |
| 1992 | 0 | 358 | 7,430 | 72,356 | 274,138 | 231,781 | 170,083 | 79,941 | 22,308 | 1,871 | 599 | 203 | 30 | 0 | 0 | 0 | 861,099 |
| 1993 | 0 | 793 | 23,122 | 37,249 | 64,042 | 170,092 | 103,137 | 38,907 | 15,202 | 3,399 | 1,737 | 492 | 72 | 19 | 0 | 0 | 458,264 |
| 1994 | 0 | 0 | 32,911 | 30,986 | 79,125 | 160,940 | 66,819 | 14,818 | 9,372 | 2,658 | 713 | 169 | 173 | 5 | 0 | 0 | 398,688 |
| 1995 | 0 | 196 | 40,850 | 73,047 | 41,771 | 52,170 | 38,788 | 10,577 | 2,019 | 882 | 422 | 305 | 65 | 3 | 0 | 0 | 261,096 |
| 1996 | 0 | 167 | 51,603 | 223,832 | 116,765 | 66,483 | 34,077 | 22,051 | 11,311 | 11,080 | 11,956 | 6,483 | 1,135 | 983 | 0 | 0 | 557,928 |
| 1997 | 0 | 150 | 9,432 | 125,240 | 191,334 | 106,360 | 42,249 | 16,423 | 7,112 | 2,376 | 1,616 | 1,240 | 412 | 300 | 0 | 0 | 504,246 |
| 1998 | 0 | 5 | 99 | 17,178 | 83,377 | 55,940 | 27,929 | 12,010 | 8,294 | 5,254 | 3,005 | 2,716 | 1,686 | 2,363 | 449 | 614 | 220,919 |
| 1999 | 0 | 576 | 26,556 | 69,347 | 41,901 | 31,842 | 14,021 | 8,497 | 6,304 | 3,482 | 2,459 | 1,077 | 1,358 | 499 | 0 | 0 | 207,919 |
| 2000 | 0 | 46 | 28,936 | 55,784 | 63,372 | 26,006 | 9,976 | 5,742 | 3,290 | 1,601 | 1,323 | 324 | 252 | 13 | 6 | 10 | 196,681 |
| 2001 | 0 | 1 | 1,630 | 35,784 | 87,577 | 68,989 | 13,119 | 8,473 | 6,521 | 5,272 | 4,288 | 1,782 | 736 | 262 | 112 | 0 | 234,546 |
| 2002 | 0 | 2,994 | 36,102 | 71,784 | 35,465 | 45,932 | 39,479 | 21,252 | 12,044 | 9,850 | 3,835 | 2,505 | 261 | 295 | 65 | 79 | 281,943 |
| 2003 | 0 | 483 | 4,101 | 27,034 | 57,350 | 53,054 | 14,267 | 15,765 | 10,252 | 10,379 | 8,982 | 5,794 | 1,979 | 2,260 | 379 | 142 | 212,222 |
| 2004 | 0 | 3,574 | 53,356 | 75,648 | 62,421 | 36,579 | 23,279 | 24,945 | 11,485 | 7,200 | 3,555 | 3,622 | 447 | 248 | 173 | 0 | 306,532 |
| 2005 | 0 | 0 | 3,336 | 53,707 | 123,590 | 81,476 | 29,214 | 20,660 | 15,389 | 14,635 | 6,401 | 5,308 | 3,223 | 1,676 | 597 | 478 | 359,687 |
| 2006 | 0 | 0 | 1,692 | 85,900 | 101,686 | 88,931 | 29,515 | 12,133 | 10,712 | 9,834 | 12,477 | 2,975 | 3,555 | 2,677 | 402 | 1,581 | 364,070 |
| 2007 | 0 | 0 | 3,710 | 93,510 | 146,226 | 58,669 | 40,896 | 20,249 | 13,886 | 15,256 | 13,295 | 9,290 | 1,311 | 3,182 | 2,423 | 2,273 | 424,177 |
| 2008 | 0 | 0 | 1,207 | 37,225 | 82,536 | 63,622 | 20,637 | 15,494 | 10,165 | 5,758 | 9,498 | 8,100 | 7,351 | 1,529 | 318 | 571 | 264,011 |
| 2009 | 0 | 0 | 1,153 | 60,698 | 125,154 | 87,176 | 44,455 | 13,525 | 16,622 | 10,625 | 9,899 | 9,924 | 3,887 | 8,433 | 735 | 2,683 | 394,968 |
| 2010 | 0 | 0 | 3,574 | 42,643 | 222,430 | 156,125 | 56,980 | 18,090 | 11,466 | 7,443 | 6,895 | 4,314 | 3,414 | 6,516 | 3,578 | 2,944 | 546,412 |
| 2011 | 0 | 0 | 2,039 | 35,832 | 62,716 | 72,967 | 39,325 | 21,056 | 17,401 | 12,968 | 10,900 | 5,984 | 5,372 | 5,022 | 4,847 | 9,288 | 305,716 |
| 2012 | 0 | 0 | 9,841 | 122,886 | 266,171 | 267,106 | 123,160 | 76,665 | 27,235 | 27,019 | 21,019 | 13,452 | 8,828 | 1,866 | 5,601 | 28,670 | 999,519 |
| 2013 | 0 | 0 | 4,646 | 70,827 | 113,633 | 93,442 | 47,382 | 23,812 | 13,710 | 9,937 | 13,581 | 5,935 | 10,009 | 9,736 | 1,838 | 9,803 | 428,289 |
| 2014 | 0 | 0 | 0 | 19,029 | 50,742 | 105,444 | 78,603 | 64,406 | 24,964 | 20,109 | 22,920 | 14,727 | 2,423 | 3,068 | 2,128 | 5,349 | 413,912 |
| 2015 | 0 | 0 | 0 | 12,581 | 136,041 | 69,056 | 30,642 | 21,013 | 19,510 | 16,620 | 18,758 | 20,040 | 26,167 | 6,257 | 3,038 | 9,181 | 388,903 |
| 2016 | 0 | 0 | 309 | 23,179 | 58,034 | 113,158 | 34,625 | 30,591 | 18,376 | 15,832 | 12,224 | 19,705 | 17,187 | 13,767 | 4,025 | 4,419 | 365,432 |
| 2017 | 0 | 0 | 82 | 9,108 | 44,728 | 15,194 | 32,295 | 12,289 | 10,172 | 4,166 | 4,287 | 3,380 | 4,832 | 2,910 | 2,665 | 964 | 147,070 |

Table B6.12. Scaled commercial dead discards for Chesapeake Bay by year and age.

| | Age | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | Total |
| 1982 | 0 | 0 | 12,610 | 1,139 | 1,036 | 2 | 26 | 21 | 15 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 14,856 |
| 1983 | 0 | 0 | 40,700 | 2,927 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43,630 |
| 1984 | 0 | 0 | 17,551 | 2,001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19,552 |
| 1985 | 0 | 0 | 3,790 | 19,163 | 199 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23,166 |
| 1986 | 0 | 0 | 3,000 | 5,645 | 20,222 | 3,917 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32,784 |
| 1987 | 0 | 8 | 899 | 794 | 6,633 | 6,669 | 1,925 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16,940 |
| 1988 | 0 | 18 | 2,666 | 10,190 | 10,620 | 7,239 | 5,340 | 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36,123 |
| 1989 | 0 | 28 | 3,594 | 17,501 | 16,297 | 10,668 | 5,559 | 1,501 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55,149 |
| 1990 | 0 | 7 | 243 | 880 | 2,211 | 2,206 | 1,867 | 1,037 | 154 | 10 | 2 | 1 | 0 | 0 | 0 | 0 | 8,620 |
| 1991 | 0 | 66 | 1,036 | 5,364 | 17,565 | 13,755 | 8,917 | 3,864 | 579 | 80 | 18 | 5 | 2 | 0 | 0 | 0 | 51,250 |
| 1992 | 0 | 59 | 1,217 | 11,853 | 44,909 | 37,970 | 27,863 | 13,096 | 3,654 | 306 | 98 | 33 | 5 | 0 | 0 | 0 | 141,064 |
| 1993 | 0 | 130 | 3,788 | 6,102 | 10,491 | 27,864 | 16,896 | 6,374 | 2,490 | 557 | 285 | 81 | 12 | 3 | 0 | 0 | 75,072 |
| 1994 | 0 | 0 | 5,392 | 5,076 | 12,962 | 26,365 | 10,946 | 2,427 | 1,535 | 435 | 117 | 28 | 28 | 1 | 0 | 0 | 65,313 |
| 1995 | 0 | 32 | 6,692 | 11,967 | 6,843 | 8,546 | 6,354 | 1,733 | 331 | 145 | 69 | 50 | 11 | 0 | 0 | 0 | 42,772 |
| 1996 | 0 | 27 | 8,454 | 36,668 | 19,128 | 10,891 | 5,583 | 3,612 | 1,853 | 1,815 | 1,959 | 1,062 | 186 | 161 | 0 | 0 | 91,399 |
| 1997 | 0 | 25 | 1,545 | 20,517 | 31,344 | 17,424 | 6,921 | 2,690 | 1,165 | 389 | 265 | 203 | 67 | 49 | 0 | 0 | 82,605 |
| 1998 | 0 | 1 | 16 | 2,814 | 13,659 | 9,164 | 4,575 | 1,967 | 1,359 | 861 | 492 | 445 | 276 | 387 | 74 | 101 | 36,191 |
| 1999 | 0 | 94 | 4,350 | 11,360 | 6,864 | 5,216 | 2,297 | 1,392 | 1,033 | 570 | 403 | 176 | 222 | 82 | 0 | 0 | 34,061 |
| 2000 | 0 | 8 | 4,740 | 9,138 | 10,382 | 4,260 | 1,634 | 941 | 539 | 262 | 217 | 53 | 41 | 2 | 1 | 2 | 32,220 |
| 2001 | 0 | 0 | 267 | 5,862 | 14,347 | 11,302 | 2,149 | 1,388 | 1,068 | 864 | 702 | 292 | 121 | 43 | 18 | 0 | 38,423 |
| 2002 | 0 | 491 | 5,914 | 11,760 | 5,810 | 7,524 | 6,467 | 3,481 | 1,973 | 1,614 | 628 | 410 | 43 | 48 | 11 | 13 | 46,188 |
| 2003 | 0 | 79 | 672 | 4,429 | 9,395 | 8,691 | 2,337 | 2,583 | 1,680 | 1,700 | 1,471 | 949 | 324 | 370 | 62 | 23 | 34,766 |
| 2004 | 0 | 585 | 8,741 | 12,393 | 10,226 | 5,992 | 3,814 | 4,086 | 1,881 | 1,180 | 582 | 593 | 73 | 41 | 28 | 0 | 50,216 |
| 2005 | 0 | 0 | 547 | 8,798 | 20,246 | 13,347 | 4,786 | 3,384 | 2,521 | 2,397 | 1,049 | 870 | 528 | 274 | 98 | 78 | 58,924 |
| 2006 | 0 | 0 | 277 | 14,072 | 16,658 | 14,569 | 4,835 | 1,988 | 1,755 | 1,611 | 2,044 | 487 | 582 | 439 | 66 | 259 | 59,641 |
| 2007 | 0 | 0 | 608 | 15,319 | 23,955 | 9,611 | 6,700 | 3,317 | 2,275 | 2,499 | 2,178 | 1,522 | 215 | 521 | 397 | 372 | 69,488 |
| 2008 | 0 | 0 | 198 | 6,098 | 13,521 | 10,423 | 3,381 | 2,538 | 1,665 | 943 | 1,556 | 1,327 | 1,204 | 250 | 52 | 94 | 43,250 |
| 2009 | 0 | 0 | 189 | 9,943 | 20,503 | 14,281 | 7,282 | 2,216 | 2,723 | 1,741 | 1,622 | 1,626 | 637 | 1,382 | 120 | 440 | 64,703 |
| 2010 | 0 | 0 | 585 | 6,986 | 36,438 | 25,576 | 9,334 | 2,963 | 1,878 | 1,219 | 1,130 | 707 | 559 | 1,067 | 586 | 482 | 89,513 |
| 2011 | 0 | 0 | 334 | 5,870 | 10,274 | 11,953 | 6,442 | 3,449 | 2,851 | 2,124 | 1,786 | 980 | 880 | 823 | 794 | 1,522 | 50,082 |
| 2012 | 0 | 0 | 1,612 | 20,131 | 43,604 | 43,757 | 20,176 | 12,559 | 4,462 | 4,426 | 3,443 | 2,204 | 1,446 | 306 | 918 | 4,697 | 163,740 |
| 2013 | 0 | 0 | 761 | 11,603 | 18,615 | 15,308 | 7,762 | 3,901 | 2,246 | 1,628 | 2,225 | 972 | 1,640 | 1,595 | 301 | 1,606 | 70,162 |
| 2014 | 0 | 0 | 0 | 3,117 | 8,313 | 17,274 | 12,877 | 10,551 | 4,090 | 3,294 | 3,755 | 2,413 | 397 | 503 | 349 | 876 | 67,807 |
| 2015 | 0 | 0 | 0 | 2,061 | 22,286 | 11,313 | 5,020 | 3,442 | 3,196 | 2,723 | 3,073 | 3,283 | 4,287 | 1,025 | 498 | 1,504 | 63,710 |
| 2016 | 0 | 0 | 51 | 3,797 | 9,507 | 18,537 | 5,672 | 5,011 | 3,010 | 2,594 | 2,003 | 3,228 | 2,815 | 2,255 | 659 | 724 | 59,865 |
| 2017 | 0 | 0 | 13 | 1,492 | 7,327 | 2,489 | 5,291 | 2,013 | 1,666 | 682 | 702 | 554 | 792 | 477 | 437 | 158 | 24,093 |

Table B6.13. Number of tags by disposition and commercial harvest and releases estimates used to calculate commercial discards for the ocean.

| | | | | | New MRIP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Commercial | Recreational | Recreational | | | | | Unadjusted |
| Year | Comm Killed | Comm Released | Rec Killed | Rec Released | Harvest | Harvest | Releases | LR | KT | CT/RT | CF | Total Discards |
| 1990 | 13 | 63 | 165 | 984 | 25,290 | 202,532 | 2,976,214 | 0.1249 | 0.0788 | 0.0640 | 1.5849 | 301,994 |
| 1991 | 28 | 60 | 255 | 785 | 35,705 | 396,348 | 4,433,364 | 0.0901 | 0.1098 | 0.0764 | 0.8204 | 278,006 |
| 1992 | 39 | 36 | 298 | 773 | 47,716 | 477,534 | 6,587,374 | 0.0999 | 0.1309 | 0.0466 | 0.7635 | 234,233 |
| 1993 | 47 | 46 | 390 | 792 | 36,933 | 423,208 | 5,779,901 | 0.0873 | 0.1205 | 0.0581 | 0.7241 | 243,096 |
| 1994 | 28 | 27 | 322 | 911 | 41,277 | 474,094 | 10,027,897 | 0.0871 | 0.0870 | 0.0296 | 1.0013 | 297,576 |
| 1995 | 54 | 21 | 539 | 744 | 138,434 | 1,084,510 | 16,093,577 | 0.1276 | 0.1002 | 0.0282 | 1.2741 | 578,765 |
| 1996 | 37 | 78 | 739 | 963 | 131,369 | 1,268,534 | 21,831,887 | 0.1036 | 0.0501 | 0.0810 | 2.0684 | 3,657,573 |
| 1997 | 62 | 45 | 767 | 686 | 151,464 | 1,464,866 | 22,248,787 | 0.1034 | 0.0808 | 0.0656 | 1.2791 | 1,866,849 |
| 1998 | 68 | 22 | 719 | 638 | 179,115 | 1,561,869 | 28,456,680 | 0.1147 | 0.0946 | 0.0345 | 1.2126 | 1,189,851 |
| 1999 | 61 | 15 | 547 | 510 | 219,427 | 1,614,780 | 25,426,851 | 0.1359 | 0.1115 | 0.0294 | 1.2185 | 911,271 |
| 2000 | 44 | 35 | 456 | 559 | 229,210 | 1,923,986 | 24,546,001 | 0.1191 | 0.0965 | 0.0626 | 1.2346 | 1,897,492 |
| 2001 | 53 | 21 | 627 | 602 | 221,692 | 2,449,329 | 20,547,075 | 0.0905 | 0.0845 | 0.0349 | 1.0708 | 767,481 |
| 2002 | 45 | 25 | 595 | 559 | 192,602 | 2,487,808 | 23,130,298 | 0.0774 | 0.0756 | 0.0447 | 1.0236 | 1,058,909 |
| 2003 | 32 | 11 | 733 | 618 | 180,864 | 2,861,203 | 19,953,425 | 0.0632 | 0.0437 | 0.0178 | 1.4480 | 514,257 |
| 2004 | 68 | 24 | 710 | 589 | 204,612 | 2,839,900 | 27,117,501 | 0.0720 | 0.0958 | 0.0407 | 0.7523 | 831,233 |
| 2005 | 54 | 17 | 589 | 560 | 190,626 | 2,923,559 | 27,663,804 | 0.0652 | 0.0917 | 0.0304 | 0.7112 | 597,262 |
| 2006 | 43 | 14 | 630 | 555 | 185,656 | 2,535,626 | 40,181,707 | 0.0732 | 0.0683 | 0.0252 | 1.0727 | 1,087,322 |
| 2007 | 29 | 17 | 555 | 415 | 189,574 | 2,139,285 | 23,774,366 | 0.0886 | 0.0523 | 0.0410 | 1.6959 | 1,651,639 |
| 2008 | 55 | 6 | 541 | 355 | 188,848 | 2,807,578 | 20,783,249 | 0.0673 | 0.1017 | 0.0169 | 0.6616 | 232,408 |
| 2009 | 49 | 8 | 468 | 347 | 192,419 | 2,589,584 | 15,812,661 | 0.0743 | 0.1047 | 0.0231 | 0.7097 | 258,722 |
| 2010 | 32 | 5 | 510 | 273 | 187,187 | 3,622,452 | 13,025,310 | 0.0517 | 0.0627 | 0.0183 | 0.8236 | 196,467 |
| 2011 | 29 | 8 | 421 | 189 | 183,977 | 3,330,997 | 11,941,641 | 0.0552 | 0.0689 | 0.0423 | 0.8018 | 405,289 |
| 2012 | 31 | 10 | 302 | 131 | 159,143 | 2,850,682 | 10,635,561 | 0.0558 | 0.1026 | 0.0763 | 0.5439 | 441,544 |
| 2013 | 43 | 13 | 348 | 159 | 164,309 | 3,347,768 | 18,509,785 | 0.0491 | 0.1236 | 0.0818 | 0.3972 | 601,125 |
| 2014 | 24 | 3 | 270 | 94 | 138,948 | 2,133,709 | 14,129,123 | 0.0651 | 0.0889 | 0.0319 | 0.7326 | 330,352 |
| 2015 | 26 | 6 | 231 | 128 | 107,977 | 1,619,083 | 14,803,506 | 0.0667 | 0.1126 | 0.0469 | 0.5925 | 411,155 |
| 2016 | 33 | 4 | 270 | 119 | 118,136 | 1,657,194 | 17,350,595 | 0.0713 | 0.1222 | 0.0336 | 0.5833 | 340,162 |
| 2017 | 31 | 4 | 278 | 124 | 124,032 | 1,568,681 | 28,397,719 | 0.0791 | 0.1115 | 0.0323 | 0.7091 | 649,537 |

| | | | | | Old MRIP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Commercial | Recreational | Recreational | | | | | Unadjusted |
| Year | CommK | CommR | RecK | RecR | Harvest | Harvest | Releases | LR | KT | CT/RT | CF | Total Discards |
| 1990 | 13 | 63 | 165 | 984 | 24,678 | 93,709 | 1,003,326 | 0.2633 | 0.0788 | 0.0640 | 3.3425 | 214,710 |
| 1991 | 28 | 60 | 255 | 785 | 34,946 | 130,931 | 1,767,284 | 0.2669 | 0.1098 | 0.0764 | 2.4307 | 328,336 |
| 1992 | 39 | 36 | 298 | 773 | 47,831 | 167,365 | 2,396,563 | 0.2858 | 0.1309 | 0.0466 | 2.1837 | 243,729 |
| 1993 | 47 | 46 | 390 | 792 | 36,752 | 234,778 | 2,567,873 | 0.1565 | 0.1205 | 0.0581 | 1.2989 | 193,728 |
| 1994 | 28 | 27 | 322 | 911 | 42,226 | 226,455 | 4,759,563 | 0.1865 | 0.0870 | 0.0296 | 2.1444 | 302,490 |
| 1995 | 54 | 21 | 539 | 744 | 143,535 | 524,118 | 6,838,334 | 0.2739 | 0.1002 | 0.0282 | 2.7335 | 527,619 |
| 1996 | 37 | 78 | 739 | 963 | 131,596 | 608,424 | 8,996,683 | 0.2163 | 0.0501 | 0.0810 | 4.3199 | 3,147,960 |
| 1997 | 62 | 45 | 767 | 686 | 152,287 | 833,089 | 10,527,112 | 0.1828 | 0.0808 | 0.0656 | 2.2614 | 1,561,611 |
| 1998 | 68 | 22 | 719 | 638 | 178,153 | 700,506 | 11,376,812 | 0.2543 | 0.0946 | 0.0345 | 2.6891 | 1,054,929 |
| 1999 | 61 | 15 | 547 | 510 | 216,515 | 706,473 | 8,985,309 | 0.3065 | 0.1115 | 0.0294 | 2.7482 | 726,281 |
| 2000 | 44 | 35 | 456 | 559 | 227,388 | 1,044,268 | 12,436,023 | 0.2177 | 0.0965 | 0.0626 | 2.2567 | 1,757,141 |
| 2001 | 53 | 21 | 627 | 602 | 216,149 | 1,193,280 | 9,800,153 | 0.1811 | 0.0845 | 0.0349 | 2.1429 | 732,585 |
| 2002 | 45 | 25 | 595 | 559 | 191,748 | 1,140,165 | 9,964,368 | 0.1682 | 0.0756 | 0.0447 | 2.2237 | 990,937 |
| 2003 | 32 | 11 | 733 | 618 | 185,773 | 1,408,927 | 8,758,101 | 0.1319 | 0.0437 | 0.0178 | 3.0203 | 470,829 |
| 2004 | 68 | 24 | 710 | 589 | 207,559 | 1,584,270 | 11,561,379 | 0.1310 | 0.0958 | 0.0407 | 1.3679 | 644,418 |
| 2005 | 54 | 17 | 589 | 560 | 195,412 | 1,534,056 | 12,600,720 | 0.1274 | 0.0917 | 0.0304 | 1.3894 | 531,480 |
| 2006 | 43 | 14 | 630 | 555 | 190,187 | 1,541,808 | 17,644,390 | 0.1234 | 0.0683 | 0.0252 | 1.8073 | 804,385 |
| 2007 | 29 | 17 | 555 | 415 | 192,764 | 1,346,144 | 11,677,751 | 0.1432 | 0.0523 | 0.0410 | 2.7405 | 1,310,958 |
| 2008 | 55 | 6 | 541 | 355 | 193,090 | 1,622,835 | 10,237,509 | 0.1190 | 0.1017 | 0.0169 | 1.1704 | 202,505 |
| 2009 | 49 | 8 | 468 | 347 | 196,860 | 1,137,632 | 5,988,532 | 0.1730 | 0.1047 | 0.0231 | 1.6527 | 228,184 |
| 2010 | 32 | 5 | 511 | 273 | 191,590 | 1,355,994 | 4,462,445 | 0.1413 | 0.0626 | 0.0183 | 2.2562 | 184,402 |
| 2011 | 29 | 8 | 421 | 189 | 188,540 | 1,553,363 | 4,424,993 | 0.1214 | 0.0689 | 0.0423 | 1.7620 | 330,031 |
| 2012 | 31 | 10 | 302 | 131 | 163,788 | 1,085,364 | 2,715,914 | 0.1509 | 0.1026 | 0.0763 | 1.4701 | 304,787 |
| 2013 | 43 | 13 | 348 | 159 | 168,313 | 1,505,499 | 5,704,753 | 0.1118 | 0.1236 | 0.0818 | 0.9048 | 422,019 |
| 2014 | 24 | 3 | 270 | 95 | 141,565 | 1,059,339 | 4,248,782 | 0.1336 | 0.0889 | 0.0316 | 1.5034 | 201,713 |
| 2015 | 26 | 6 | 231 | 128 | 108,960 | 665,644 | 4,337,197 | 0.1637 | 0.1126 | 0.0469 | 1.4543 | 295,675 |

LR=ratio of commercial landings to recreational harvest; KT=ratio of tags returned from commercially harvested fish to tags returned from recreationally harvested fish; CT = number of tags returned from discarded fish by commercial fishers; RT = number of tags returned from discarded fish by recreational anglers; CF=LR/KT.

Table B6.14. Predicted tag numbers from the GAM fit to Ocean tag returns by disposition.

| Year | Comm Killed | Comm Released | Rec Killed | Rec Released |
|---|---|---|---|---|
| 1990 | 21.5 | 60.0 | 173.0 | 904.0 |
| 1991 | 25.5 | 54.4 | 238.2 | 851.4 |
| 1992 | 30.0 | 49.4 | 304.5 | 824.0 |
| 1993 | 34.6 | 44.8 | 346.4 | 821.6 |
| 1994 | 39.2 | 40.6 | 399.9 | 825.3 |
| 1995 | 43.5 | 36.8 | 523.6 | 814.6 |
| 1996 | 47.4 | 33.4 | 683.4 | 776.5 |
| 1997 | 50.4 | 30.3 | 751.6 | 710.3 |
| 1998 | 52.4 | 27.5 | 681.0 | 638.5 |
| 1999 | 53.2 | 24.9 | 568.6 | 589.4 |
| 2000 | 52.9 | 22.6 | 523.7 | 571.0 |
| 2001 | 52.0 | 20.5 | 562.9 | 573.3 |
| 2002 | 50.8 | 18.6 | 634.2 | 583.8 |
| 2003 | 49.4 | 16.9 | 686.1 | 591.4 |
| 2004 | 48.0 | 15.3 | 686.0 | 585.0 |
| 2005 | 46.3 | 13.9 | 639.5 | 558.0 |
| 2006 | 44.5 | 12.6 | 599.8 | 508.9 |
| 2007 | 42.6 | 11.4 | 569.6 | 444.3 |
| 2008 | 40.7 | 10.4 | 528.5 | 377.1 |
| 2009 | 38.7 | 9.4 | 500.9 | 312.1 |
| 2010 | 36.7 | 8.5 | 471.0 | 249.0 |
| 2011 | 34.9 | 7.7 | 406.0 | 194.7 |
| 2012 | 33.4 | 7.0 | 346.1 | 156.7 |
| 2013 | 32.1 | 6.4 | 308.6 | 133.4 |
| 2014 | 30.9 | 5.8 | 272.7 | 120.7 |
| 2015 | 30.0 | 5.2 | 251.7 | 116.5 |
| 2016 | 29.2 | 4.7 | 258.5 | 117.5 |
| 2017 | 28.6 | 4.3 | 276.4 | 119.7 |

Table B6.15. Estimates of commercial total discards (numbers of fish) by year for Ocean region.

| Year | Number |
|---|---|
| 1990 | 198,674 |
| 1991 | 238,536 |
| 1992 | 400,710 |
| 1993 | 275,054 |
| 1994 | 438,360 |
| 1995 | 1,117,315 |
| 1996 | 1,403,636 |
| 1997 | 1,463,037 |
| 1998 | 1,825,262 |
| 1999 | 1,562,572 |
| 2000 | 1,145,702 |
| 2001 | 719,481 |
| 2002 | 712,351 |
| 2003 | 499,420 |
| 2004 | 730,232 |
| 2005 | 618,845 |
| 2006 | 981,249 |
| 2007 | 724,449 |
| 2008 | 498,916 |
| 2009 | 457,432 |
| 2010 | 295,201 |
| 2011 | 304,033 |
| 2012 | 275,118 |
| 2013 | 416,634 |
| 2014 | 387,344 |
| 2015 | 371,743 |
| 2016 | 441,303 |
| 2017 | 780,489 |

Table B6.16. The number of tags returns from Ocean by year and commercial gear.

| Year | Anchor | Drift | Hook | Other | Pound | Seine | Trawl | Total |
|---|---|---|---|---|---|---|---|---|
| 1990 | 22 | 2 | 24 | 1 | 20 | 3 | 4 | 76 |
| 1991 | 14 | 1 | 45 | 2 | 14 | 1 | 11 | 88 |
| 1992 | 10 | 4 | 38 | 2 | 13 | 6 | 2 | 75 |
| 1993 | 11 | 4 | 36 | 5 | 20 | 6 | 11 | 93 |
| 1994 | 13 | 0 | 23 | 3 | 4 | 4 | 8 | 55 |
| 1995 | 8 | 6 | 41 | 1 | 12 | 4 | 3 | 75 |
| 1996 | 12 | 2 | 44 | 2 | 47 | 2 | 6 | 115 |
| 1997 | 13 | 7 | 67 | 1 | 2 | 3 | 14 | 107 |
| 1998 | 16 | 7 | 50 | 1 | 8 | 1 | 7 | 90 |
| 1999 | 20 | 3 | 52 | 1 | 0 | 0 | 0 | 76 |
| 2000 | 7 | 5 | 45 | 2 | 6 | 1 | 13 | 79 |
| 2001 | 18 | 2 | 42 | 2 | 5 | 0 | 5 | 74 |
| 2002 | 18 | 6 | 36 | 4 | 0 | 1 | 5 | 70 |
| 2003 | 11 | 1 | 26 | 0 | 3 | 0 | 2 | 43 |
| 2004 | 11 | 2 | 62 | 0 | 7 | 0 | 10 | 92 |
| 2005 | 7 | 9 | 35 | 1 | 9 | 6 | 4 | 71 |
| 2006 | 1 | 6 | 38 | 1 | 7 | 0 | 4 | 57 |
| 2007 | 0 | 3 | 26 | 0 | 5 | 0 | 12 | 46 |
| 2008 | 4 | 1 | 39 | 0 | 10 | 0 | 7 | 61 |
| 2009 | 5 | 1 | 41 | 0 | 4 | 0 | 6 | 57 |
| 2010 | 4 | 2 | 24 | 0 | 4 | 0 | 3 | 37 |
| 2011 | 2 | 1 | 27 | 1 | 4 | 0 | 2 | 37 |
| 2012 | 0 | 2 | 34 | 3 | 2 | 0 | 0 | 41 |
| 2013 | 0 | 1 | 50 | 2 | 1 | 0 | 2 | 56 |
| 2014 | 1 | 1 | 20 | 2 | 0 | 0 | 3 | 27 |
| 2015 | 0 | 2 | 21 | 1 | 5 | 0 | 3 | 32 |
| 2016 | 1 | 1 | 33 | 0 | 1 | 0 | 1 | 37 |
| 2017 | 0 | 0 | 30 | 1 | 2 | 0 | 2 | 35 |

Table B6.17. Commercial total discards for Ocean apportioned to gear.

| Year | Anchor | Drift | Hook | Other | Pound | Seine | Trawl | Total |
|---|---|---|---|---|---|---|---|---|
| 1990 | 57,511 | 5,228 | 62,739 | 2,614 | 52,283 | 7,842 | 10,457 | 198,674 |
| 1991 | 37,949 | 2,711 | 121,979 | 5,421 | 37,949 | 2,711 | 29,817 | 238,536 |
| 1992 | 53,428 | 21,371 | 203,026 | 10,686 | 69,456 | 32,057 | 10,686 | 400,710 |
| 1993 | 32,533 | 11,830 | 106,473 | 14,788 | 59,151 | 17,745 | 32,533 | 275,054 |
| 1994 | 103,612 | 0 | 183,314 | 23,911 | 31,881 | 31,881 | 63,761 | 438,360 |
| 1995 | 119,180 | 89,385 | 610,799 | 14,898 | 178,770 | 59,590 | 44,693 | 1,117,315 |
| 1996 | 146,466 | 24,411 | 537,043 | 24,411 | 573,660 | 24,411 | 73,233 | 1,403,636 |
| 1997 | 177,752 | 95,713 | 916,107 | 13,673 | 27,346 | 41,020 | 191,425 | 1,463,037 |
| 1998 | 324,491 | 141,965 | 1,014,034 | 20,281 | 162,245 | 20,281 | 141,965 | 1,825,262 |
| 1999 | 411,203 | 61,680 | 1,069,128 | 20,560 | 0 | 0 | 0 | 1,562,572 |
| 2000 | 101,518 | 72,513 | 652,615 | 29,005 | 87,015 | 14,503 | 188,533 | 1,145,702 |
| 2001 | 175,009 | 19,445 | 408,354 | 19,445 | 48,614 | 0 | 48,614 | 719,481 |
| 2002 | 183,176 | 61,059 | 366,352 | 40,706 | 0 | 10,176 | 50,882 | 712,351 |
| 2003 | 127,759 | 11,614 | 301,975 | 0 | 34,843 | 0 | 23,229 | 499,420 |
| 2004 | 87,310 | 15,875 | 492,113 | 0 | 55,561 | 0 | 79,373 | 730,232 |
| 2005 | 61,013 | 78,445 | 305,065 | 8,716 | 78,445 | 52,297 | 34,865 | 618,845 |
| 2006 | 17,215 | 103,289 | 654,166 | 17,215 | 120,504 | 0 | 68,860 | 981,249 |
| 2007 | 0 | 47,247 | 409,471 | 0 | 78,744 | 0 | 188,987 | 724,449 |
| 2008 | 32,716 | 8,179 | 318,979 | 0 | 81,789 | 0 | 57,253 | 498,916 |
| 2009 | 40,126 | 8,025 | 329,030 | 0 | 32,100 | 0 | 48,151 | 457,432 |
| 2010 | 31,914 | 15,957 | 191,482 | 0 | 31,914 | 0 | 23,935 | 295,201 |
| 2011 | 16,434 | 8,217 | 221,862 | 8,217 | 32,868 | 0 | 16,434 | 304,033 |
| 2012 | 0 | 13,420 | 228,147 | 20,131 | 13,420 | 0 | 0 | 275,118 |
| 2013 | 0 | 7,440 | 371,995 | 14,880 | 7,440 | 0 | 14,880 | 416,634 |
| 2014 | 14,346 | 14,346 | 286,921 | 28,692 | 0 | 0 | 43,038 | 387,344 |
| 2015 | 0 | 23,234 | 243,956 | 11,617 | 58,085 | 0 | 34,851 | 371,743 |
| 2016 | 11,927 | 11,927 | 393,595 | 0 | 11,927 | 0 | 11,927 | 441,303 |
| 2017 | 21,094 | 21,094 | 632,829 | 21,094 | 42,189 | 0 | 42,189 | 780,489 |

Table B6.18. Commercial dead discards for Ocean by year and gear.

| Year | Anchor | Drift | Hook | Other | Pound | Seine | Trawl | Total |
|---|---|---|---|---|---|---|---|---|
| 1990 | 25,880 | 314 | 5,647 | 523 | 1,568 | 1,255 | 2,719 | 37,905 |
| 1991 | 17,077 | 163 | 10,978 | 1,084 | 1,138 | 434 | 7,752 | 38,627 |
| 1992 | 24,043 | 1,282 | 18,272 | 2,137 | 2,084 | 5,129 | 2,778 | 55,725 |
| 1993 | 14,640 | 710 | 9,583 | 2,958 | 1,775 | 2,839 | 8,459 | 40,962 |
| 1994 | 46,626 | 0 | 16,498 | 4,782 | 956 | 5,101 | 16,578 | 90,541 |
| 1995 | 53,631 | 5,363 | 54,972 | 2,980 | 5,363 | 9,534 | 11,620 | 143,463 |
| 1996 | 65,910 | 1,465 | 48,334 | 4,882 | 17,210 | 3,906 | 19,041 | 160,747 |
| 1997 | 79,988 | 5,743 | 82,450 | 2,735 | 820 | 6,563 | 49,771 | 228,070 |
| 1998 | 146,021 | 8,518 | 91,263 | 4,056 | 4,867 | 3,245 | 36,911 | 294,881 |
| 1999 | 185,041 | 3,701 | 96,222 | 4,112 | 0 | 0 | 0 | 289,076 |
| 2000 | 45,683 | 4,351 | 58,735 | 5,801 | 2,610 | 2,320 | 49,019 | 168,520 |
| 2001 | 78,754 | 1,167 | 36,752 | 3,889 | 1,458 | 0 | 12,640 | 134,660 |
| 2002 | 82,429 | 3,664 | 32,972 | 8,141 | 0 | 1,628 | 13,229 | 142,063 |
| 2003 | 57,491 | 697 | 27,178 | 0 | 1,045 | 0 | 6,040 | 92,451 |
| 2004 | 39,290 | 952 | 44,290 | 0 | 1,667 | 0 | 20,637 | 106,836 |
| 2005 | 27,456 | 4,707 | 27,456 | 1,743 | 2,353 | 8,367 | 9,065 | 81,147 |
| 2006 | 7,747 | 6,197 | 58,875 | 3,443 | 3,615 | 0 | 17,903 | 97,781 |
| 2007 | 0 | 2,835 | 36,852 | 0 | 2,362 | 0 | 49,137 | 91,186 |
| 2008 | 14,722 | 491 | 28,708 | 0 | 2,454 | 0 | 14,886 | 61,260 |
| 2009 | 18,057 | 482 | 29,613 | 0 | 963 | 0 | 12,519 | 61,633 |
| 2010 | 14,361 | 957 | 17,233 | 0 | 957 | 0 | 6,223 | 39,732 |
| 2011 | 7,395 | 493 | 19,968 | 1,643 | 986 | 0 | 4,273 | 34,758 |
| 2012 | 0 | 805 | 20,533 | 4,026 | 403 | 0 | 0 | 25,767 |
| 2013 | 0 | 446 | 33,480 | 2,976 | 223 | 0 | 3,869 | 40,994 |
| 2014 | 6,456 | 861 | 25,823 | 5,738 | 0 | 0 | 11,190 | 50,068 |
| 2015 | 0 | 1,394 | 21,956 | 2,323 | 1,743 | 0 | 9,061 | 36,477 |
| 2016 | 5,367 | 716 | 35,424 | 0 | 358 | 0 | 3,101 | 44,965 |
| 2017 | 9,492 | 1,266 | 56,955 | 4,219 | 1,266 | 0 | 10,969 | 84,166 |

Table B6.19. Commercial dead discards for Ocean by year and age.

| | Age | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | Total |
| 1982 | 0 | 1 | 8,749 | 2,936 | 3,942 | 912 | 290 | 193 | 118 | 110 | 84 | 107 | 181 | 116 | 144 | 413 | 18,296 |
| 1983 | 0 | 0 | 2,322 | 554 | 659 | 368 | 95 | 21 | 17 | 11 | 12 | 16 | 27 | 46 | 31 | 83 | 4,260 |
| 1984 | 0 | 0 | 2,869 | 456 | 706 | 513 | 337 | 95 | 37 | 18 | 10 | 6 | 8 | 18 | 63 | 140 | 5,275 |
| 1985 | 0 | 0 | 808 | 3,534 | 758 | 652 | 250 | 122 | 37 | 12 | 17 | 20 | 16 | 6 | 55 | 88 | 6,376 |
| 1986 | 0 | 0 | 96 | 1,373 | 4,388 | 1,354 | 305 | 118 | 114 | 47 | 12 | 12 | 31 | 25 | 27 | 200 | 8,104 |
| 1987 | 0 | 0 | 184 | 961 | 4,621 | 5,071 | 1,513 | 230 | 84 | 44 | 7 | 7 | 7 | 8 | 16 | 49 | 12,802 |
| 1988 | 0 | 0 | 1,846 | 3,981 | 4,870 | 4,141 | 2,864 | 304 | 169 | 50 | 19 | 6 | 2 | 15 | 10 | 34 | 18,313 |
| 1989 | 0 | 0 | 3,055 | 8,937 | 7,857 | 6,085 | 3,623 | 1,815 | 389 | 166 | 118 | 23 | 15 | 21 | 22 | 76 | 32,202 |
| 1990 | 0 | 0 | 448 | 3,957 | 10,683 | 9,490 | 7,148 | 3,906 | 1,626 | 403 | 174 | 27 | 3 | 8 | 6 | 25 | 37,905 |
| 1991 | 0 | 17 | 1,619 | 4,107 | 12,411 | 9,155 | 5,066 | 3,562 | 1,366 | 973 | 154 | 60 | 24 | 2 | 20 | 91 | 38,627 |
| 1992 | 0 | 4 | 856 | 6,027 | 13,076 | 12,064 | 8,506 | 5,586 | 5,619 | 2,518 | 1,025 | 111 | 85 | 20 | 47 | 181 | 55,725 |
| 1993 | 0 | 0 | 1,228 | 2,965 | 5,375 | 10,409 | 7,598 | 4,057 | 3,611 | 3,161 | 1,698 | 609 | 132 | 25 | 18 | 76 | 40,962 |
| 1994 | 0 | 0 | 3,137 | 5,616 | 13,265 | 28,906 | 15,346 | 6,357 | 6,569 | 5,449 | 3,364 | 1,268 | 605 | 125 | 96 | 438 | 90,541 |
| 1995 | 0 | 0 | 43,778 | 27,958 | 14,725 | 16,968 | 14,860 | 6,652 | 4,552 | 5,636 | 4,114 | 2,140 | 1,206 | 525 | 151 | 199 | 143,463 |
| 1996 | 0 | 0 | 9,171 | 50,065 | 17,660 | 13,368 | 14,950 | 22,064 | 13,523 | 9,352 | 5,246 | 2,459 | 2,142 | 325 | 129 | 294 | 160,747 |
| 1997 | 0 | 0 | 3,402 | 18,809 | 40,512 | 25,496 | 17,953 | 15,919 | 31,425 | 21,836 | 19,955 | 15,538 | 8,777 | 4,716 | 2,249 | 1,484 | 228,070 |
| 1998 | 0 | 0 | 1,944 | 19,632 | 64,572 | 43,312 | 32,625 | 24,692 | 30,332 | 31,771 | 19,008 | 13,966 | 6,019 | 3,729 | 1,441 | 1,838 | 294,881 |
| 1999 | 0 | 0 | 21,921 | 79,475 | 38,508 | 39,605 | 37,388 | 26,431 | 20,601 | 11,782 | 6,746 | 2,542 | 2,692 | 862 | 137 | 386 | 289,076 |
| 2000 | 0 | 0 | 2,003 | 14,349 | 33,099 | 23,125 | 24,038 | 42,495 | 15,920 | 6,124 | 4,122 | 2,451 | 513 | 116 | 100 | 65 | 168,520 |
| 2001 | 0 | 0 | 660 | 7,119 | 27,419 | 31,975 | 30,146 | 13,974 | 14,137 | 5,482 | 1,628 | 1,341 | 442 | 259 | 67 | 11 | 134,660 |
| 2002 | 0 | 0 | 1,516 | 2,735 | 7,757 | 21,847 | 21,866 | 21,152 | 18,745 | 15,950 | 17,885 | 5,919 | 2,961 | 3,525 | 144 | 62 | 142,063 |
| 2003 | 122 | 591 | 3,111 | 3,522 | 4,270 | 7,682 | 9,058 | 24,232 | 13,781 | 9,381 | 7,146 | 3,068 | 2,116 | 1,362 | 359 | 2,650 | 92,451 |
| 2004 | 0 | 18 | 963 | 4,167 | 7,148 | 10,486 | 16,446 | 18,469 | 24,545 | 13,033 | 4,555 | 4,761 | 1,499 | 125 | 608 | 13 | 106,836 |
| 2005 | 0 | 157 | 3,102 | 7,070 | 7,614 | 12,945 | 11,744 | 12,129 | 8,596 | 8,406 | 5,367 | 2,475 | 569 | 616 | 289 | 68 | 81,147 |
| 2006 | 0 | 0 | 120 | 2,510 | 2,121 | 15,738 | 19,266 | 12,783 | 14,898 | 9,743 | 8,654 | 6,131 | 2,588 | 2,916 | 202 | 111 | 97,781 |
| 2007 | 0 | 46 | 1,231 | 3,763 | 12,654 | 17,434 | 22,792 | 12,733 | 8,261 | 5,205 | 3,009 | 1,574 | 1,661 | 764 | 46 | 12 | 91,186 |
| 2008 | 0 | 0 | 82 | 828 | 2,322 | 13,192 | 9,942 | 15,862 | 7,803 | 4,145 | 2,174 | 1,904 | 1,461 | 1,027 | 363 | 155 | 61,260 |
| 2009 | 0 | 0 | 108 | 463 | 1,654 | 4,710 | 21,739 | 8,736 | 12,250 | 4,714 | 1,927 | 1,868 | 1,712 | 1,129 | 429 | 194 | 61,633 |
| 2010 | 0 | 0 | 74 | 640 | 981 | 2,516 | 7,194 | 13,896 | 4,618 | 4,720 | 2,325 | 999 | 800 | 510 | 403 | 56 | 39,732 |
| 2011 | 0 | 0 | 252 | 619 | 1,550 | 2,456 | 5,770 | 7,700 | 7,344 | 2,729 | 2,990 | 1,205 | 637 | 611 | 433 | 463 | 34,758 |
| 2012 | 0 | 0 | 194 | 1,024 | 1,815 | 3,721 | 5,388 | 5,397 | 4,066 | 2,434 | 555 | 388 | 240 | 209 | 185 | 152 | 25,767 |
| 2013 | 0 | 0 | 248 | 1,353 | 2,707 | 4,578 | 10,076 | 6,911 | 6,290 | 4,799 | 2,825 | 391 | 333 | 182 | 101 | 199 | 40,994 |
| 2014 | 0 | 0 | 28 | 924 | 3,049 | 6,397 | 8,557 | 12,253 | 5,808 | 4,379 | 3,665 | 2,638 | 783 | 613 | 219 | 755 | 50,068 |
| 2015 | 0 | 0 | 5 | 175 | 1,676 | 5,884 | 8,326 | 6,615 | 4,242 | 3,258 | 2,776 | 1,787 | 1,028 | 261 | 169 | 274 | 36,477 |
| 2016 | 0 | 0 | 683 | 707 | 955 | 9,553 | 14,039 | 6,250 | 3,305 | 1,795 | 1,724 | 1,667 | 1,245 | 1,350 | 359 | 1,333 | 44,965 |
| 2017 | 0 | 0 | 972 | 2,017 | 2,416 | 11,936 | 28,295 | 16,310 | 5,711 | 2,335 | 3,958 | 2,052 | 2,830 | 1,953 | 1,412 | 1,970 | 84,166 |

Table B6.20. Number of tags by disposition and commercial harvest and releases estimates used to calculate commercial discards for Delaware Bay.

| | | | | | New MRIP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Comm Killed | Comm Released | Rec Killed | Rec Released | Commercial Harvest | Recreational Harvest | Recreational Releases | LR | KT | CT/RT | CF | Unadjusted Total Discards |
| 1990 | 1 | 30 | 2 | 46 | 647 | 32,252 | 118,286 | 0.0201 | 0.5000 | 0.6522 | 0.0401 | 3,096 |
| 1991 | 3 | 27 | 2 | 42 | 2,751 | 35,324 | 250,683 | 0.0779 | 1.5000 | 0.6429 | 0.0519 | 8,367 |
| 1992 | 2 | 14 | 2 | 19 | 2,496 | 39,888 | 344,682 | 0.0626 | 1.0000 | 0.7368 | 0.0626 | 15,892 |
| 1993 | 9 | 21 | 9 | 56 | 3,918 | 33,958 | 314,877 | 0.1154 | 1.0000 | 0.3750 | 0.1154 | 13,623 |
| 1994 | 3 | 15 | 20 | 59 | 4,458 | 24,445 | 422,025 | 0.1824 | 0.1500 | 0.2542 | 1.2158 | 130,451 |
| 1995 | 5 | 12 | 35 | 68 | 4,962 | 175,331 | 493,262 | 0.0283 | 0.1429 | 0.1765 | 0.1981 | 17,245 |
| 1996 | 15 | 15 | 65 | 91 | 19,514 | 95,448 | 648,302 | 0.2044 | 0.2308 | 0.1648 | 0.8859 | 94,672 |
| 1997 | 14 | 10 | 46 | 52 | 30,128 | 62,420 | 669,636 | 0.4827 | 0.3043 | 0.1923 | 1.5859 | 204,226 |
| 1998 | 11 | 3 | 65 | 69 | 28,497 | 94,134 | 962,491 | 0.3027 | 0.1692 | 0.0435 | 1.7889 | 74,859 |
| 1999 | 4 | 9 | 58 | 53 | 31,050 | 166,252 | 945,489 | 0.1868 | 0.0690 | 0.1698 | 2.7081 | 434,803 |
| 2000 | 4 | 5 | 52 | 37 | 22,284 | 280,162 | 673,300 | 0.0795 | 0.0769 | 0.1351 | 1.0340 | 94,083 |
| 2001 | 9 | 5 | 71 | 66 | 30,980 | 353,006 | 581,256 | 0.0878 | 0.1268 | 0.0758 | 0.6923 | 30,486 |
| 2002 | 5 | 1 | 51 | 38 | 24,813 | 272,696 | 563,885 | 0.0910 | 0.0980 | 0.0263 | 0.9281 | 13,772 |
| 2003 | 6 | 2 | 98 | 71 | 31,460 | 266,776 | 765,845 | 0.1179 | 0.0612 | 0.0282 | 1.9261 | 41,553 |
| 2004 | 2 | 5 | 60 | 42 | 27,939 | 293,487 | 891,735 | 0.0952 | 0.0333 | 0.1190 | 2.8559 | 303,179 |
| 2005 | 4 | 1 | 39 | 36 | 26,036 | 264,262 | 1,030,990 | 0.0985 | 0.1026 | 0.0278 | 0.9606 | 27,510 |
| 2006 | 1 | 2 | 34 | 38 | 30,052 | 253,414 | 1,064,535 | 0.1186 | 0.0294 | 0.0526 | 4.0320 | 225,906 |
| 2007 | 2 | 0 | 33 | 29 | 31,199 | 189,277 | 1,366,689 | 0.1648 | 0.0606 | 0.0000 | 2.7197 | 0 |
| 2008 | 4 | 4 | 17 | 25 | 31,738 | 217,794 | 1,096,070 | 0.1457 | 0.2353 | 0.1600 | 0.6193 | 108,613 |
| 2009 | 1 | 2 | 44 | 48 | 21,588 | 308,089 | 943,174 | 0.0701 | 0.0227 | 0.0417 | 3.0831 | 121,163 |
| 2010 | 3 | 2 | 44 | 29 | 19,736 | 289,232 | 590,801 | 0.0682 | 0.0682 | 0.0690 | 1.0008 | 40,777 |
| 2011 | 1 | 3 | 52 | 37 | 20,462 | 286,070 | 703,420 | 0.0715 | 0.0192 | 0.0811 | 3.7195 | 212,136 |
| 2012 | 0 | 0 | 38 | 31 | 15,577 | 220,775 | 613,785 | 0.0706 | 0.0000 | 0.0000 | 0.0000 | 0 |
| 2013 | 1 | 3 | 12 | 34 | 17,552 | 375,448 | 959,064 | 0.0467 | 0.0833 | 0.0882 | 0.5610 | 47,473 |
| 2014 | 0 | 0 | 16 | 36 | 14,747 | 141,811 | 979,551 | 0.1040 | 0.0000 | 0.0000 | 0.0000 | 0 |
| 2015 | 1 | 1 | 11 | 11 | 10,930 | 150,986 | 615,457 | 0.0724 | 0.0909 | 0.0909 | 0.7963 | 44,554 |
| 2016 | 0 | 0 | 9 | 15 | 8,730 | 164,190 | 488,897 | 0.0532 | 0.0000 | 0.0000 | 0.0000 | 0 |
| 2017 | 1 | 0 | 2 | 16 | 9,450 | 163,663 | 597,038 | 0.0577 | 0.5000 | 0.0000 | 0.1155 | 0 |

| | | | | | Old MRIP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | CommK | CommR | RecK | RecR | Commercial Harvest | Recreational Harvest | Recreational Releases | LR | KT | CT/RT | CF | Unadjusted Total Discards |
| 1990 | 1 | 30 | 2 | 46 | 647 | 12,780 | 57,507 | 0.0506 | 0.5000 | 0.6522 | 0.1013 | 3,799 |
| 1991 | 3 | 27 | 2 | 42 | 2,751 | 11,440 | 60,345 | 0.2405 | 1.5000 | 0.6429 | 0.1603 | 6,220 |
| 1992 | 2 | 14 | 2 | 19 | 2,496 | 12,342 | 108,788 | 0.2022 | 1.0000 | 0.7368 | 0.2022 | 16,210 |
| 1993 | 9 | 21 | 9 | 56 | 3,918 | 19,072 | 135,865 | 0.2054 | 1.0000 | 0.3750 | 0.2054 | 10,465 |
| 1994 | 3 | 15 | 20 | 59 | 4,458 | 12,427 | 202,565 | 0.3587 | 0.1500 | 0.2542 | 2.3915 | 123,163 |
| 1995 | 5 | 12 | 35 | 68 | 4,962 | 72,742 | 196,099 | 0.0682 | 0.1429 | 0.1765 | 0.4775 | 16,525 |
| 1996 | 15 | 15 | 65 | 91 | 19,514 | 44,778 | 204,137 | 0.4358 | 0.2308 | 0.1648 | 1.8884 | 63,543 |
| 1997 | 14 | 10 | 46 | 52 | 30,128 | 30,734 | 229,726 | 0.9803 | 0.3043 | 0.1923 | 3.2209 | 142,293 |
| 1998 | 11 | 3 | 65 | 69 | 28,497 | 31,242 | 253,584 | 0.9122 | 0.1692 | 0.0435 | 5.3900 | 59,427 |
| 1999 | 4 | 9 | 58 | 53 | 31,050 | 60,184 | 279,314 | 0.5159 | 0.0690 | 0.1698 | 7.4809 | 354,823 |
| 2000 | 4 | 5 | 52 | 37 | 22,284 | 124,778 | 266,154 | 0.1786 | 0.0769 | 0.1351 | 2.3217 | 83,504 |
| 2001 | 9 | 5 | 71 | 66 | 30,980 | 167,671 | 251,280 | 0.1848 | 0.1268 | 0.0758 | 1.4576 | 27,747 |
| 2002 | 5 | 1 | 51 | 38 | 24,813 | 124,082 | 210,452 | 0.2000 | 0.0980 | 0.0263 | 2.0397 | 11,296 |
| 2003 | 6 | 2 | 98 | 71 | 31,460 | 112,908 | 301,412 | 0.2786 | 0.0612 | 0.0282 | 4.5510 | 38,640 |
| 2004 | 2 | 5 | 60 | 42 | 27,939 | 122,550 | 384,837 | 0.2280 | 0.0333 | 0.1190 | 6.8394 | 313,341 |
| 2005 | 4 | 1 | 39 | 36 | 26,036 | 114,977 | 439,695 | 0.2264 | 0.1026 | 0.0278 | 2.2078 | 26,966 |
| 2006 | 1 | 2 | 34 | 38 | 30,052 | 132,683 | 503,291 | 0.2265 | 0.0294 | 0.0526 | 7.7008 | 203,986 |
| 2007 | 2 | 0 | 33 | 29 | 31,199 | 76,868 | 545,639 | 0.4059 | 0.0606 | 0.0000 | 6.6969 | 0 |
| 2008 | 4 | 4 | 17 | 25 | 31,738 | 89,617 | 447,118 | 0.3542 | 0.2353 | 0.1600 | 1.5052 | 107,677 |
| 2009 | 1 | 2 | 44 | 48 | 21,588 | 79,910 | 260,282 | 0.2702 | 0.0227 | 0.0417 | 11.8867 | 128,913 |
| 2010 | 3 | 2 | 44 | 29 | 19,736 | 86,776 | 162,967 | 0.2274 | 0.0682 | 0.0690 | 3.3357 | 37,491 |
| 2011 | 1 | 3 | 52 | 37 | 20,462 | 110,729 | 243,363 | 0.1848 | 0.0192 | 0.0811 | 9.6092 | 189,611 |
| 2012 | 0 | 0 | 38 | 31 | 15,577 | 65,375 | 167,858 | 0.2383 | 0.0000 | 0.0000 | 0.0000 | 0 |
| 2013 | 1 | 3 | 12 | 34 | 17,552 | 112,515 | 248,118 | 0.1560 | 0.0833 | 0.0882 | 1.8720 | 40,983 |
| 2014 | 0 | 0 | 16 | 36 | 14,747 | 61,210 | 349,164 | 0.2409 | 0.0000 | 0.0000 | 0.0000 | 0 |
| 2015 | 1 | 1 | 11 | 11 | 10,930 | 69,794 | 175,220 | 0.1566 | 0.0909 | 0.0909 | 1.7226 | 27,440 |

LR=ratio of commercial landings to recreational harvest; KT=ratio of tags returned from commercially harvested fish to tags returned from recreationally harvested fish; CT = number of tags returned from discarded fish by commercial fishers; RT = number of tags returned from discarded fish by recreational anglers; CF=LR/KT.

Table B6.21. Predicted tag numbers from the GAM fit to Delaware Bay tag returns by disposition.

| Year | Comm Killed | Comm Released | Rec Killed | Rec Released |
|---|---|---|---|---|
| 1990 | 1.8 | 26.7 | 1.6 | 38.8 |
| 1991 | 2.6 | 22.6 | 2.0 | 41.7 |
| 1992 | 3.4 | 19.2 | 3.4 | 44.9 |
| 1993 | 4.4 | 16.3 | 7.8 | 48.4 |
| 1994 | 5.5 | 13.8 | 18.5 | 52.0 |
| 1995 | 6.5 | 11.7 | 35.4 | 55.1 |
| 1996 | 7.3 | 9.9 | 51.1 | 57.1 |
| 1997 | 7.7 | 8.3 | 58.3 | 57.9 |
| 1998 | 7.7 | 7.1 | 58.7 | 57.5 |
| 1999 | 7.2 | 6.0 | 58.5 | 56.1 |
| 2000 | 6.6 | 5.1 | 59.0 | 54.2 |
| 2001 | 5.9 | 4.3 | 61.4 | 52.0 |
| 2002 | 5.1 | 3.7 | 68.0 | 49.6 |
| 2003 | 4.4 | 3.2 | 70.5 | 47.0 |
| 2004 | 3.7 | 2.8 | 59.3 | 44.4 |
| 2005 | 3.1 | 2.4 | 44.1 | 41.8 |
| 2006 | 2.6 | 2.1 | 33.5 | 39.5 |
| 2007 | 2.2 | 1.8 | 27.8 | 37.4 |
| 2008 | 1.9 | 1.6 | 27.7 | 35.7 |
| 2009 | 1.6 | 1.4 | 34.8 | 34.1 |
| 2010 | 1.3 | 1.2 | 44.7 | 32.4 |
| 2011 | 1.0 | 1.0 | 43.9 | 30.4 |
| 2012 | 0.8 | 0.8 | 31.1 | 28.2 |
| 2013 | 0.7 | 0.7 | 19.9 | 25.6 |
| 2014 | 0.5 | 0.5 | 14.4 | 22.9 |
| 2015 | 0.5 | 0.4 | 11.0 | 20.1 |
| 2016 | 0.4 | 0.3 | 6.5 | 17.7 |
| 2017 | 0.4 | 0.2 | 2.6 | 15.5 |

B6.22. Estimates of commercial total discards (numbers of fish) by year for Delaware Bay.

| Year | Unscaled Number | Scaled Number |
|---|---|---|
| 1990 | 1,462 | 240 |
| 1991 | 8,257 | 1,353 |
| 1992 | 9,041 | 1,481 |
| 1993 | 21,518 | 3,525 |
| 1994 | 69,179 | 11,333 |
| 1995 | 16,182 | 2,651 |
| 1996 | 160,453 | 26,285 |
| 1997 | 351,539 | 57,589 |
| 1998 | 273,790 | 44,852 |
| 1999 | 151,996 | 24,900 |
| 2000 | 44,722 | 7,326 |
| 2001 | 44,130 | 7,229 |
| 2002 | 50,637 | 8,295 |
| 2003 | 98,289 | 16,102 |
| 2004 | 84,491 | 13,841 |
| 2005 | 82,427 | 13,503 |
| 2006 | 85,276 | 13,970 |
| 2007 | 137,001 | 22,443 |
| 2008 | 105,027 | 17,205 |
| 2009 | 59,587 | 9,762 |
| 2010 | 51,806 | 8,487 |
| 2011 | 71,701 | 11,746 |
| 2012 | 49,544 | 8,116 |
| 2013 | 36,465 | 5,974 |
| 2014 | 64,450 | 10,558 |
| 2015 | 21,713 | 3,557 |
| 2016 | 6,917 | 1,133 |
| 2017 | 2,927 | 480 |

Table B6.23. The number of tags returns from Delaware Bay by year and commercial gear.

| Year | Anchor | Drift | Hook | Other | Pound | Total |
|---|---|---|---|---|---|---|
| 1990 | 30 | 1 | 0 | 0 | 0 | 31 |
| 1991 | 27 | 2 | 0 | 1 | 0 | 30 |
| 1992 | 10 | 6 | 0 | 0 | 0 | 16 |
| 1993 | 14 | 12 | 1 | 2 | 1 | 30 |
| 1994 | 15 | 2 | 0 | 0 | 1 | 18 |
| 1995 | 13 | 4 | 0 | 0 | 0 | 17 |
| 1996 | 21 | 4 | 2 | 1 | 2 | 30 |
| 1997 | 18 | 4 | 1 | 1 | 0 | 24 |
| 1998 | 12 | 1 | 1 | 0 | 0 | 14 |
| 1999 | 10 | 3 | 0 | 0 | 0 | 13 |
| 2000 | 6 | 3 | 0 | 0 | 0 | 9 |
| 2001 | 7 | 7 | 0 | 0 | 0 | 14 |
| 2002 | 4 | 1 | 0 | 1 | 0 | 6 |
| 2003 | 2 | 5 | 1 | 0 | 0 | 8 |
| 2004 | 3 | 4 | 0 | 0 | 0 | 7 |
| 2005 | 4 | 1 | 0 | 0 | 0 | 5 |
| 2006 | 0 | 3 | 0 | 0 | 0 | 3 |
| 2007 | 1 | 1 | 0 | 0 | 0 | 2 |
| 2008 | 4 | 3 | 1 | 0 | 0 | 8 |
| 2009 | 1 | 2 | 0 | 0 | 0 | 3 |
| 2010 | 5 | 0 | 0 | 0 | 0 | 5 |
| 2011 | 2 | 1 | 1 | 0 | 0 | 4 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 1 | 3 | 0 | 0 | 0 | 4 |
| 2014 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 1 | 0 | 0 | 1 | 0 | 2 |
| 2016 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 1 | 0 | 0 | 0 | 0 | 1 |

Table B6.24. Scaled commercial total discards for Delaware Bay apportioned by gear.

| Year | Anchor | Drift | Hook | Other | Pound | Total |
|---|---|---|---|---|---|---|
| 1990 | 232 | 8 | 0 | 0 | 0 | 240 |
| 1991 | 1,217 | 90 | 0 | 45 | 0 | 1,353 |
| 1992 | 926 | 555 | 0 | 0 | 0 | 1,481 |
| 1993 | 1,645 | 1,410 | 118 | 235 | 118 | 3,525 |
| 1994 | 9,444 | 1,259 | 0 | 0 | 630 | 11,333 |
| 1995 | 2,027 | 624 | 0 | 0 | 0 | 2,651 |
| 1996 | 18,400 | 3,505 | 1,752 | 876 | 1,752 | 26,285 |
| 1997 | 43,191 | 9,598 | 2,400 | 2,400 | 0 | 57,589 |
| 1998 | 38,445 | 3,204 | 3,204 | 0 | 0 | 44,852 |
| 1999 | 19,154 | 5,746 | 0 | 0 | 0 | 24,900 |
| 2000 | 4,884 | 2,442 | 0 | 0 | 0 | 7,326 |
| 2001 | 3,615 | 3,615 | 0 | 0 | 0 | 7,229 |
| 2002 | 5,530 | 1,383 | 0 | 1,383 | 0 | 8,295 |
| 2003 | 4,025 | 10,063 | 2,013 | 0 | 0 | 16,102 |
| 2004 | 5,932 | 7,909 | 0 | 0 | 0 | 13,841 |
| 2005 | 10,802 | 2,701 | 0 | 0 | 0 | 13,503 |
| 2006 | 0 | 13,970 | 0 | 0 | 0 | 13,970 |
| 2007 | 11,222 | 11,222 | 0 | 0 | 0 | 22,443 |
| 2008 | 8,603 | 6,452 | 2,151 | 0 | 0 | 17,205 |
| 2009 | 3,254 | 6,508 | 0 | 0 | 0 | 9,762 |
| 2010 | 8,487 | 0 | 0 | 0 | 0 | 8,487 |
| 2011 | 5,873 | 2,937 | 2,937 | 0 | 0 | 11,746 |
| 2012 | 4,058 | 4,058 | 0 | 0 | 0 | 8,116 |
| 2013 | 1,493 | 4,480 | 0 | 0 | 0 | 5,974 |
| 2014 | 7,039 | 3,519 | 0 | 0 | 0 | 10,558 |
| 2015 | 1,778 | 0 | 0 | 1,778 | 0 | 3,557 |
| 2016 | 567 | 567 | 0 | 0 | 0 | 1,133 |
| 2017 | 480 | 0 | 0 | 0 | 0 | 480 |

Table B6.25. Scaled commercial dead discards for Delaware Bay by year and gear.

| Year | Anchor | Drift | Hook | Other | Pound | Total |
|---|---|---|---|---|---|---|
| 1990 | 104 | 0 | 0 | 0 | 0 | 105 |
| 1991 | 548 | 5 | 0 | 9 | 0 | 562 |
| 1992 | 417 | 33 | 0 | 0 | 0 | 450 |
| 1993 | 740 | 85 | 11 | 47 | 4 | 886 |
| 1994 | 4,250 | 76 | 0 | 0 | 19 | 4,344 |
| 1995 | 912 | 37 | 0 | 0 | 0 | 950 |
| 1996 | 8,280 | 210 | 158 | 175 | 53 | 8,876 |
| 1997 | 19,436 | 576 | 216 | 480 | 0 | 20,708 |
| 1998 | 17,300 | 192 | 288 | 0 | 0 | 17,781 |
| 1999 | 8,619 | 345 | 0 | 0 | 0 | 8,964 |
| 2000 | 2,198 | 147 | 0 | 0 | 0 | 2,344 |
| 2001 | 1,627 | 217 | 0 | 0 | 0 | 1,843 |
| 2002 | 2,489 | 83 | 0 | 277 | 0 | 2,848 |
| 2003 | 1,811 | 604 | 181 | 0 | 0 | 2,596 |
| 2004 | 2,669 | 475 | 0 | 0 | 0 | 3,144 |
| 2005 | 4,861 | 162 | 0 | 0 | 0 | 5,023 |
| 2006 | 0 | 838 | 0 | 0 | 0 | 838 |
| 2007 | 5,050 | 673 | 0 | 0 | 0 | 5,723 |
| 2008 | 3,871 | 387 | 194 | 0 | 0 | 4,452 |
| 2009 | 1,464 | 390 | 0 | 0 | 0 | 1,855 |
| 2010 | 3,819 | 0 | 0 | 0 | 0 | 3,819 |
| 2011 | 2,643 | 176 | 264 | 0 | 0 | 3,083 |
| 2012 | 1,826 | 243 | 0 | 0 | 0 | 2,070 |
| 2013 | 672 | 269 | 0 | 0 | 0 | 941 |
| 2014 | 3,167 | 211 | 0 | 0 | 0 | 3,379 |
| 2015 | 800 | 0 | 0 | 356 | 0 | 1,156 |
| 2016 | 255 | 34 | 0 | 0 | 0 | 289 |
| 2017 | 216 | 0 | 0 | 0 | 0 | 216 |

Table B6.26. Scaled commercial dead discards for Delaware Bay by year and age.

| | Age | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | Total |
| 1982 | 0 | 0 | 26 | 3 | 15 | 9 | 2 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 61 |
| 1983 | 0 | 0 | 45 | 3 | 9 | 25 | 7 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 95 |
| 1984 | 0 | 0 | 11 | 0 | 2 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 |
| 1985 | 0 | 0 | 1 | 6 | 1 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 0 | 0 | 0 | 2 | 11 | 18 | 7 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| 1988 | 0 | 0 | 0 | 6 | 28 | 119 | 129 | 50 | 20 | 7 | 4 | 0 | 0 | 0 | 0 | 0 | 365 |
| 1989 | 0 | 0 | 6 | 4 | 7 | 131 | 170 | 75 | 41 | 17 | 2 | 4 | 4 | 2 | 0 | 0 | 462 |
| 1990 | 0 | 0 | 3 | 13 | 17 | 24 | 25 | 14 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 105 |
| 1991 | 0 | 0 | 14 | 50 | 120 | 155 | 99 | 55 | 36 | 10 | 9 | 14 | 0 | 0 | 0 | 0 | 562 |
| 1992 | 0 | 0 | 7 | 76 | 92 | 121 | 86 | 29 | 22 | 7 | 7 | 3 | 0 | 0 | 0 | 0 | 450 |
| 1993 | 0 | 0 | 7 | 130 | 196 | 265 | 174 | 40 | 30 | 23 | 14 | 5 | 2 | 1 | 0 | 0 | 886 |
| 1994 | 0 | 0 | 420 | 638 | 561 | 1,038 | 1,003 | 466 | 99 | 56 | 49 | 10 | 5 | 0 | 0 | 0 | 4,344 |
| 1995 | 0 | 0 | 158 | 136 | 100 | 194 | 225 | 87 | 25 | 8 | 6 | 4 | 5 | 2 | 0 | 0 | 950 |
| 1996 | 0 | 0 | 622 | 2,466 | 1,368 | 1,344 | 1,498 | 942 | 396 | 130 | 93 | 5 | 11 | 0 | 0 | 0 | 8,876 |
| 1997 | 0 | 2 | 1,009 | 2,448 | 7,113 | 4,145 | 2,402 | 1,468 | 811 | 389 | 576 | 265 | 39 | 41 | 0 | 0 | 20,708 |
| 1998 | 0 | 0 | 1,071 | 4,086 | 3,702 | 3,369 | 2,299 | 1,041 | 836 | 642 | 257 | 246 | 82 | 148 | 0 | 0 | 17,781 |
| 1999 | 0 | 22 | 2,471 | 1,484 | 1,072 | 2,171 | 800 | 331 | 287 | 146 | 85 | 50 | 39 | 5 | 0 | 0 | 8,964 |
| 2000 | 0 | 0 | 420 | 322 | 583 | 458 | 303 | 151 | 43 | 29 | 7 | 6 | 23 | 0 | 0 | 0 | 2,344 |
| 2001 | 0 | 0 | 41 | 565 | 279 | 247 | 356 | 186 | 75 | 48 | 11 | 23 | 13 | 0 | 0 | 0 | 1,843 |
| 2002 | 0 | 0 | 192 | 769 | 345 | 568 | 455 | 228 | 113 | 112 | 45 | 22 | 0 | 0 | 0 | 0 | 2,848 |
| 2003 | 0 | 0 | 12 | 54 | 239 | 1,222 | 701 | 232 | 33 | 27 | 35 | 14 | 9 | 19 | 0 | 0 | 2,596 |
| 2004 | 0 | 0 | 13 | 67 | 308 | 1,579 | 896 | 268 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,144 |
| 2005 | 0 | 0 | 58 | 837 | 1,759 | 1,186 | 452 | 313 | 148 | 139 | 45 | 45 | 27 | 9 | 4 | 0 | 5,023 |
| 2006 | 0 | 0 | 0 | 0 | 0 | 131 | 403 | 119 | 70 | 32 | 29 | 8 | 27 | 19 | 0 | 0 | 838 |
| 2007 | 0 | 0 | 0 | 0 | 0 | 298 | 1,478 | 2,189 | 491 | 492 | 196 | 28 | 370 | 182 | 0 | 0 | 5,723 |
| 2008 | 0 | 0 | 2 | 8 | 445 | 522 | 2,092 | 913 | 251 | 117 | 22 | 56 | 22 | 0 | 0 | 0 | 4,452 |
| 2009 | 0 | 0 | 0 | 0 | 0 | 59 | 839 | 302 | 277 | 101 | 92 | 42 | 76 | 67 | 0 | 0 | 1,855 |
| 2010 | 0 | 0 | 0 | 13 | 240 | 1,229 | 1,803 | 254 | 187 | 40 | 13 | 40 | 0 | 0 | 0 | 0 | 3,819 |
| 2011 | 0 | 0 | 3 | 8 | 18 | 107 | 313 | 635 | 683 | 728 | 424 | 145 | 19 | 0 | 0 | 0 | 3,083 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 143 | 371 | 500 | 471 | 314 | 186 | 43 | 29 | 14 | 0 | 0 | 2,070 |
| 2013 | 0 | 0 | 0 | 0 | 9 | 86 | 276 | 276 | 208 | 66 | 0 | 19 | 0 | 0 | 0 | 0 | 941 |
| 2014 | 0 | 0 | 0 | 0 | 37 | 260 | 598 | 538 | 715 | 303 | 204 | 297 | 167 | 167 | 37 | 56 | 3,379 |
| 2015 | 0 | 0 | 0 | 0 | 0 | 62 | 236 | 407 | 238 | 147 | 13 | 26 | 13 | 11 | 2 | 0 | 1,156 |
| 2016 | 0 | 0 | 0 | 0 | 0 | 2 | 23 | 30 | 45 | 47 | 64 | 47 | 21 | 8 | 2 | 2 | 289 |
| 2017 | 0 | 0 | 0 | 0 | 0 | 28 | 39 | 61 | 31 | 17 | 15 | 17 | 7 | 0 | 2 | 0 | 216 |

Table B6.27. Estimates of wave-1 recreational harvest for Virginia and North Carolina.
* Estimates of wave-1 harvest from 2004 - 2017 for NC come from MRIP; all other estimates were developed from tag returns for this assessment.

| Year | VA | NC* |
|---|---|---|
| 1996 | 12,395 | 43,006 |
| 1997 | 110,414 | 103,022 |
| 1998 | 117,954 | 35,504 |
| 1999 | 140,574 | 43,006 |
| 2000 | 72,714 | 20,500 |
| 2001 | 72,714 | 43,006 |
| 2002 | 117,954 | 155,536 |
| 2003 | 72,714 | 163,038 |
| 2004 | 200,893 | 206,892 |
| 2005 | 65,174 | 153,206 |
| 2006 | 170,733 | 122,791 |
| 2007 | 231,053 | 68,750 |
| 2008 | 313,992 | 35,506 |
| 2009 | 200,893 | 6,548 |
| 2010 | 50,094 | 34,303 |
| 2011 | 42,555 | 207,504 |
| 2012 | 125,494 | 0 |
| 2013 | 57,634 | 0 |
| 2014 | 0 | 0 |
| 2015 | 0 | 0 |
| 2016 | 0 | 0 |
| 2017 | 0 | 0 |

Table B6.28. Sample sizes by year, state, and source to describe the length and age composition of recreational harvest and releases of Atlantic striped bass. Supplemental samples come from programs like volunteer angler logbook, state creel surveys, and the American Littoral Society volunteer angler tagging program.

| | ME | | | | NH | | | MA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MRIP | | Supplemental | | MRIP | | Supplemental | MRIP | | Supplemental | |
| Year | Harvest | Released | Harvest | Released | Harvest | Released | Combined | Harvest | Released | Harvest | Released |
| 1982 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 92 | 0 | 0 | 0 |
| 1983 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| 1985 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| 1987 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 20 | 0 | 0 | 0 |
| 1988 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 42 | 0 | 0 | 1 |
| 1989 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 0 | 12 |
| 1990 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 36 | 0 | 0 | 276 |
| 1991 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 66 | 0 | 0 | 170 |
| 1992 | 10 | 0 | 0 | 0 | 8 | 0 | 0 | 130 | 0 | 0 | 146 |
| 1993 | 0 | 0 | 0 | 0 | 8 | 0 | 312 | 168 | 0 | 0 | 155 |
| 1994 | 12 | 0 | 0 | 0 | 10 | 0 | 640 | 200 | 0 | 0 | 231 |
| 1995 | 14 | 0 | 0 | 0 | 92 | 0 | 2,454 | 230 | 0 | 0 | 215 |
| 1996 | 10 | 0 | 14 | 3,076 | 28 | 0 | 6,041 | 216 | 0 | 0 | 288 |
| 1997 | 84 | 0 | 287 | 4,362 | 66 | 0 | 4,614 | 404 | 0 | 0 | 173 |
| 1998 | 176 | 0 | 569 | 6,099 | 82 | 0 | 7,050 | 426 | 0 | 0 | 91 |
| 1999 | 114 | 0 | 735 | 6,062 | 56 | 0 | 4,003 | 202 | 0 | 0 | 73 |
| 2000 | 158 | 0 | 961 | 7,853 | 32 | 0 | 5,354 | 124 | 0 | 0 | 9 |
| 2001 | 290 | 0 | 844 | 5,013 | 104 | 0 | 4,245 | 398 | 0 | 0 | 16 |
| 2002 | 226 | 0 | 505 | 4,812 | 138 | 0 | 6,024 | 524 | 0 | 0 | 90 |
| 2003 | 162 | 0 | 601 | 6,128 | 192 | 0 | 3,531 | 448 | 0 | 377 | 1,914 |
| 2004 | 61 | 0 | 615 | 7,238 | 45 | 3 | 3,722 | 120 | 0 | 388 | 2,504 |
| 2005 | 74 | 0 | 577 | 8,555 | 50 | 1 | 3,865 | 263 | 1 | 331 | 2,005 |
| 2006 | 57 | 0 | 384 | 7,654 | 25 | 32 | 5,412 | 237 | 8 | 148 | 1,570 |
| 2007 | 85 | 0 | 457 | 5,970 | 17 | 1 | 4,134 | 104 | 0 | 176 | 1,344 |
| 2008 | 76 | 0 | 425 | 1,665 | 27 | 0 | 1,652 | 59 | 3 | 236 | 1,313 |
| 2009 | 81 | 0 | 265 | 1,152 | 37 | 0 | 1,626 | 72 | 0 | 375 | 1,258 |
| 2010 | 37 | 0 | 223 | 1,294 | 45 | 0 | 968 | 50 | 1 | 388 | 1,229 |
| 2011 | 36 | 0 | 151 | 1,081 | 76 | 0 | 1,299 | 61 | 0 | 696 | 1,506 |
| 2012 | 11 | 0 | 79 | 916 | 70 | 4 | 1,612 | 60 | 1 | 537 | 1,248 |
| 2013 | 48 | 0 | 233 | 1,897 | 80 | 5 | 1,368 | 311 | 2 | 364 | 1,057 |
| 2014 | 76 | 0 | 226 | 1,297 | 53 | 0 | 1,899 | 233 | 0 | 317 | 1,245 |
| 2015 | 9 | 0 | 62 | 1,491 | 18 | 0 | 1,606 | 212 | 0 | 327 | 1,245 |
| 2016 | 22 | 0 | 44 | 2,854 | 19 | 19 | 3,780 | 110 | 1 | 279 | 1,748 |
| 2017 | 38 | 0 | 90 | 2,657 | 77 | 1 | 7,096 | 215 | 2 | 0 | 484 |

Table B6.28 (cont.)

| | RI | | | | CT | | | | NY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MRIP | | Supplemental | | MRIP | | Supplemental | | MRIP | | Supplemental | |
| Year | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released |
| 1982 | 4 | 0 | 0 | 0 | 36 | 0 | 0 | 1 | 4 | 0 | 0 | 0 |
| 1983 | 6 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 58 | 0 | 0 | 0 |
| 1984 | 2 | 0 | 0 | 1 | 8 | 0 | 62 | 390 | 26 | 0 | 0 | 0 |
| 1985 | 0 | 0 | 0 | 1 | 2 | 0 | 42 | 719 | 22 | 0 | 440 | 3 |
| 1986 | 6 | 0 | 0 | 1 | 4 | 0 | 0 | 376 | 22 | 0 | 549 | 13 |
| 1987 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 431 | 20 | 0 | 1,175 | 16 |
| 1988 | 12 | 0 | 0 | 8 | 10 | 0 | 0 | 582 | 18 | 0 | 1,543 | 49 |
| 1989 | 18 | 0 | 0 | 45 | 14 | 0 | 0 | 963 | 30 | 0 | 2,317 | 248 |
| 1990 | 12 | 0 | 0 | 1,149 | 20 | 0 | 0 | 2,010 | 50 | 0 | 3,690 | 3,759 |
| 1991 | 74 | 0 | 0 | 1,537 | 12 | 0 | 0 | 3,151 | 146 | 0 | 2,819 | 3,635 |
| 1992 | 88 | 0 | 0 | 1,445 | 40 | 0 | 0 | 3,241 | 126 | 0 | 2,677 | 4,361 |
| 1993 | 194 | 0 | 0 | 1,248 | 74 | 0 | 11 | 3,294 | 246 | 0 | 3,889 | 5,395 |
| 1994 | 80 | 0 | 0 | 1,686 | 36 | 0 | 83 | 2,981 | 196 | 0 | 3,575 | 5,170 |
| 1995 | 206 | 0 | 0 | 2,879 | 56 | 0 | 225 | 6,125 | 120 | 0 | 2,858 | 4,790 |
| 1996 | 200 | 0 | 0 | 3,584 | 126 | 0 | 560 | 7,313 | 224 | 0 | 0 | 6,263 |
| 1997 | 250 | 0 | 0 | 3,480 | 160 | 0 | 524 | 9,684 | 164 | 0 | 0 | 6,905 |
| 1998 | 260 | 0 | 0 | 4,980 | 138 | 0 | 442 | 9,853 | 164 | 0 | 0 | 6,731 |
| 1999 | 122 | 0 | 0 | 2,671 | 70 | 0 | 379 | 7,295 | 220 | 0 | 0 | 6,513 |
| 2000 | 100 | 0 | 0 | 2,825 | 96 | 0 | 276 | 6,088 | 104 | 0 | 0 | 5,619 |
| 2001 | 264 | 0 | 0 | 2,350 | 120 | 0 | 257 | 5,503 | 144 | 0 | 0 | 6,094 |
| 2002 | 350 | 0 | 0 | 2,261 | 72 | 0 | 278 | 6,519 | 162 | 0 | 0 | 6,038 |
| 2003 | 430 | 0 | 0 | 2,473 | 378 | 0 | 337 | 4,557 | 348 | 0 | 0 | 6,140 |
| 2004 | 114 | 0 | 0 | 2,588 | 66 | 10 | 217 | 5,964 | 205 | 62 | 0 | 5,150 |
| 2005 | 87 | 0 | 0 | 3,350 | 71 | 17 | 283 | 7,015 | 364 | 64 | 0 | 5,992 |
| 2006 | 38 | 1 | 0 | 4,334 | 50 | 20 | 167 | 9,250 | 278 | 76 | 0 | 5,958 |
| 2007 | 64 | 2 | 0 | 2,194 | 44 | 24 | 197 | 8,215 | 462 | 199 | 0 | 4,865 |
| 2008 | 31 | 0 | 0 | 1,440 | 33 | 24 | 146 | 4,456 | 513 | 155 | 0 | 3,429 |
| 2009 | 27 | 0 | 0 | 2,017 | 45 | 17 | 157 | 2,901 | 511 | 74 | 0 | 2,337 |
| 2010 | 24 | 3 | 0 | 1,329 | 83 | 12 | 134 | 1,218 | 676 | 172 | 0 | 2,265 |
| 2011 | 8 | 0 | 0 | 683 | 59 | 10 | 133 | 1,301 | 338 | 64 | 0 | 2,092 |
| 2012 | 21 | 0 | 0 | 674 | 68 | 10 | 190 | 1,669 | 340 | 95 | 0 | 2,165 |
| 2013 | 65 | 0 | 108 | 2,183 | 71 | 14 | 119 | 1,294 | 281 | 23 | 0 | 2,322 |
| 2014 | 40 | 1 | 6 | 556 | 42 | 0 | 95 | 1,038 | 97 | 50 | 0 | 1,896 |
| 2015 | 20 | 0 | 1 | 287 | 43 | 2 | 64 | 756 | 102 | 51 | 0 | 1,162 |
| 2016 | 17 | 0 | 0 | 745 | 87 | 1 | 64 | 1,454 | 151 | 39 | 0 | 2,559 |
| 2017 | 65 | 3 | 4 | 583 | 74 | 21 | 69 | 1,747 | 270 | 156 | 0 | 3,323 |

Table B6.28 (cont.)

| | NJ | | | | DE | | | | MD | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MRIP | | Supplemental | | MRIP | | Supplemental | | MRIP | | Supplemental | |
| Year | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released |
| 1982 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 1983 | 14 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 146 | 0 | 0 | 0 |
| 1984 | 4 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| 1985 | 12 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| 1986 | 18 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| 1987 | 2 | 0 | 0 | 18 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1988 | 10 | 0 | 0 | 29 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 1989 | 8 | 0 | 0 | 74 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1990 | 58 | 0 | 0 | 1,694 | 22 | 0 | 0 | 237 | 2 | 0 | 0 | 31 |
| 1991 | 116 | 0 | 0 | 1,807 | 30 | 0 | 0 | 277 | 210 | 0 | 0 | 34 |
| 1992 | 78 | 0 | 0 | 1,459 | 16 | 0 | 0 | 281 | 246 | 0 | 481 | 54 |
| 1993 | 22 | 0 | 0 | 2,240 | 44 | 0 | 0 | 268 | 288 | 0 | 667 | 36 |
| 1994 | 44 | 0 | 0 | 2,680 | 42 | 0 | 0 | 386 | 170 | 0 | 783 | 102 |
| 1995 | 154 | 0 | 163 | 2,719 | 80 | 0 | 0 | 207 | 454 | 0 | 477 | 766 |
| 1996 | 142 | 0 | 0 | 5,454 | 212 | 0 | 0 | 180 | 880 | 0 | 1,102 | 2,895 |
| 1997 | 86 | 0 | 0 | 4,463 | 244 | 0 | 0 | 407 | 978 | 0 | 455 | 5,166 |
| 1998 | 112 | 0 | 471 | 5,628 | 320 | 0 | 0 | 640 | 1,080 | 0 | 112 | 2,124 |
| 1999 | 168 | 0 | 5,939 | 15,703 | 214 | 0 | 0 | 308 | 652 | 0 | 129 | 4,095 |
| 2000 | 158 | 0 | 15,051 | 17,883 | 252 | 0 | 0 | 334 | 912 | 0 | 1,099 | 2,959 |
| 2001 | 720 | 0 | 25,898 | 23,332 | 282 | 0 | 0 | 210 | 696 | 0 | 406 | 893 |
| 2002 | 464 | 0 | 29,615 | 25,492 | 362 | 0 | 0 | 119 | 890 | 0 | 731 | 287 |
| 2003 | 694 | 0 | 32,229 | 30,588 | 292 | 0 | 0 | 209 | 1,674 | 0 | 1,349 | 1,386 |
| 2004 | 357 | 58 | 20,562 | 25,635 | 280 | 10 | 0 | 301 | 767 | 253 | 479 | 651 |
| 2005 | 352 | 38 | 13,696 | 29,799 | 194 | 22 | 0 | 187 | 1,249 | 336 | 1,023 | 864 |
| 2006 | 195 | 38 | 20,112 | 59,816 | 108 | 27 | 0 | 195 | 1,211 | 256 | 10,340 | 6,155 |
| 2007 | 133 | 86 | 11,762 | 35,533 | 79 | 20 | 0 | 109 | 923 | 124 | 9,178 | 7,702 |
| 2008 | 176 | 31 | 6,375 | 19,787 | 74 | 3 | 0 | 128 | 838 | 2 | 8,646 | 4,125 |
| 2009 | 294 | 40 | 7,542 | 13,601 | 140 | 14 | 0 | 119 | 972 | 67 | 9,187 | 725 |
| 2010 | 269 | 22 | 9,467 | 7,884 | 92 | 0 | 0 | 172 | 1,134 | 8 | 8,029 | 790 |
| 2011 | 213 | 102 | 10,417 | 9,530 | 82 | 2 | 0 | 67 | 994 | 16 | 8,227 | 2,583 |
| 2012 | 112 | 0 | 1,127 | 3,181 | 88 | 0 | 63 | 43 | 332 | 22 | 4,869 | 1,819 |
| 2013 | 235 | 105 | 611 | 3,116 | 117 | 0 | 0 | 56 | 191 | 1 | 6,089 | 1,908 |
| 2014 | 218 | 79 | 379 | 2,549 | 52 | 0 | 0 | 53 | 431 | 0 | 3,813 | 1,710 |
| 2015 | 291 | 94 | 13,760 | 21,252 | 26 | 0 | 0 | 51 | 394 | 16 | 2,041 | 2,999 |
| 2016 | 189 | 14 | 12,990 | 14,942 | 11 | 0 | 26 | 3 | 806 | 10 | 2,185 | 1,492 |
| 2017 | 175 | 35 | 0 | 1,186 | 31 | 0 | 0 | 8 | 1,001 | 32 | 635 | 1,454 |

Table B6.28 (cont.)

| | VA | | | | NC-OCEAN | | | |
|---|---|---|---|---|---|---|---|---|
| | MRIP | | Supplemental | | MRIP | | Supplemental | |
| Year | Harvest | Released | Harvest | Released | Harvest | Released | Harvest | Released |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 1989 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1990 | 124 | 0 | 0 | 24 | 0 | 0 | 0 | 1 |
| 1991 | 98 | 0 | 0 | 13 | 2 | 0 | 0 | 488 |
| 1992 | 86 | 0 | 0 | 53 | 2 | 0 | 0 | 425 |
| 1993 | 428 | 0 | 0 | 61 | 2 | 0 | 0 | 0 |
| 1994 | 814 | 0 | 0 | 327 | 38 | 0 | 0 | 10 |
| 1995 | 1,162 | 0 | 0 | 169 | 138 | 0 | 0 | 7 |
| 1996 | 1,010 | 0 | 0 | 527 | 270 | 0 | 0 | 11 |
| 1997 | 1,680 | 0 | 0 | 391 | 458 | 0 | 0 | 11 |
| 1998 | 1,294 | 0 | 0 | 273 | 544 | 0 | 0 | 5 |
| 1999 | 1,162 | 0 | 0 | 195 | 364 | 0 | 0 | 6 |
| 2000 | 586 | 0 | 0 | 183 | 226 | 0 | 0 | 12 |
| 2001 | 1,722 | 0 | 0 | 130 | 534 | 0 | 0 | 51 |
| 2002 | 1,248 | 0 | 0 | 105 | 636 | 0 | 0 | 51 |
| 2003 | 956 | 0 | 0 | 64 | 1,228 | 0 | 0 | 35 |
| 2004 | 631 | 149 | 0 | 35 | 1,800 | 0 | 0 | 47 |
| 2005 | 480 | 162 | 0 | 36 | 1,106 | 0 | 0 | 4 |
| 2006 | 642 | 253 | 0 | 136 | 372 | 0 | 0 | 0 |
| 2007 | 402 | 84 | 0 | 125 | 375 | 0 | 0 | 4 |
| 2008 | 574 | 43 | 0 | 56 | 303 | 0 | 0 | 0 |
| 2009 | 461 | 10 | 0 | 173 | 67 | 0 | 0 | 1 |
| 2010 | 255 | 1 | 0 | 8 | 95 | 0 | 0 | 8 |
| 2011 | 264 | 18 | 0 | 39 | 609 | 0 | 0 | 11 |
| 2012 | 148 | 7 | 0 | 81 | 0 | 0 | 0 | 0 |
| 2013 | 18 | 3 | 0 | 7 | 0 | 0 | 0 | 0 |
| 2014 | 106 | 17 | 0 | 30 | 0 | 0 | 0 | 0 |
| 2015 | 85 | 2 | 0 | 75 | 0 | 0 | 0 | 0 |
| 2016 | 88 | 2 | 0 | 4 | 0 | 3 | 0 | 0 |
| 2017 | 81 | 0 | 0 | 6 | 0 | 2 | 0 | 0 |

Table B6.29. Recreational harvest of striped bass in numbers of fish by state and year.

| Year | ME | NH | MA | RI | CT | NY | NJ | DE | MD | VA | NC (ocean only) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 2,074 | 0 | 116,679 | 9,897 | 107,289 | 69,071 | 12,444 | 0 | 1,418 | 0 | 0 | 318,872 |
| 1983 | 19,715 | 1,046 | 43,403 | 13,383 | 34,743 | 168,372 | 242,892 | 3,732 | 88,559 | 0 | 0 | 615,845 |
| 1984 | 0 | 0 | 12,742 | 4,413 | 9,075 | 86,512 | 53,831 | 33,525 | 63,904 | 0 | 0 | 264,002 |
| 1985 | 30,812 | 0 | 542,492 | 12,873 | 20,384 | 31,576 | 80,923 | 0 | 10,315 | 2,627 | 0 | 732,002 |
| 1986 | 0 | 0 | 48,955 | 5,754 | 761 | 78,338 | 83,311 | 0 | 49,634 | 1,972 | 0 | 268,725 |
| 1987 | 0 | 1,309 | 30,782 | 13,207 | 998 | 31,283 | 15,332 | 0 | 2,639 | 18,802 | 0 | 114,352 |
| 1988 | 0 | 581 | 28,138 | 9,233 | 5,313 | 29,705 | 43,567 | 0 | 7,145 | 3,635 | 510 | 127,827 |
| 1989 | 5,113 | 0 | 43,594 | 10,087 | 10,681 | 62,204 | 30,113 | 0 | 0 | 0 | 0 | 161,792 |
| 1990 | 6,201 | 486 | 20,502 | 6,265 | 7,569 | 67,999 | 123,039 | 2,723 | 75,216 | 342,591 | 0 | 652,591 |
| 1991 | 10,488 | 538 | 51,070 | 16,637 | 7,843 | 203,104 | 131,106 | 9,854 | 117,890 | 248,700 | 1,032 | 798,262 |
| 1992 | 10,568 | 4,416 | 229,178 | 40,023 | 11,706 | 76,700 | 134,557 | 7,594 | 177,912 | 174,448 | 2,680 | 869,782 |
| 1993 | 1,260 | 5,036 | 116,384 | 26,913 | 35,761 | 140,472 | 100,923 | 19,222 | 113,610 | 228,922 | 531 | 789,034 |
| 1994 | 6,894 | 8,915 | 159,592 | 13,715 | 23,295 | 200,322 | 67,142 | 8,373 | 232,344 | 332,059 | 9,830 | 1,062,481 |
| 1995 | 3,953 | 7,376 | 124,301 | 70,949 | 75,820 | 250,266 | 671,399 | 25,751 | 491,182 | 550,103 | 16,479 | 2,287,579 |
| 1996 | 4,108 | 10,966 | 156,550 | 100,605 | 95,872 | 511,611 | 301,235 | 59,721 | 564,192 | 663,246 | 76,729 | 2,544,835 |
| 1997 | 43,029 | 29,883 | 365,611 | 124,705 | 149,048 | 450,464 | 171,173 | 29,050 | 552,444 | 909,916 | 176,237 | 3,001,560 |
| 1998 | 65,289 | 14,812 | 500,885 | 91,112 | 114,068 | 383,847 | 289,197 | 51,001 | 620,500 | 861,395 | 85,763 | 3,077,870 |
| 1999 | 37,524 | 9,851 | 327,086 | 116,607 | 88,247 | 450,929 | 657,133 | 28,328 | 532,507 | 989,468 | 92,641 | 3,330,322 |
| 2000 | 77,288 | 6,047 | 306,179 | 156,757 | 84,019 | 494,552 | 939,771 | 88,295 | 810,884 | 893,290 | 44,500 | 3,901,583 |
| 2001 | 91,867 | 23,547 | 551,039 | 149,778 | 78,154 | 364,153 | 1,267,491 | 70,583 | 577,350 | 890,529 | 147,921 | 4,212,412 |
| 2002 | 135,246 | 28,089 | 723,458 | 181,481 | 92,467 | 439,271 | 957,601 | 65,712 | 464,444 | 978,943 | 216,309 | 4,283,022 |
| 2003 | 99,745 | 41,278 | 797,161 | 226,438 | 181,743 | 678,437 | 942,759 | 75,697 | 816,849 | 943,593 | 217,588 | 5,021,288 |
| 2004 | 118,305 | 22,104 | 666,703 | 159,551 | 134,502 | 458,148 | 1,042,093 | 66,567 | 668,513 | 1,094,195 | 378,510 | 4,809,191 |

Table B6.29 (continued)

| Year | ME | NH | MA | RI | CT | NY | NJ | DE | MD | VA | NC (ocean only) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 118,323 | 35,481 | 536,057 | 195,579 | 202,636 | 854,633 | 958,051 | 48,814 | 819,052 | 582,494 | 200,468 | 4,551,588 |
| 2006 | 140,869 | 20,865 | 483,188 | 129,264 | 168,265 | 614,759 | 972,248 | 44,454 | 1,342,325 | 1,004,276 | 134,184 | 5,054,697 |
| 2007 | 95,474 | 8,146 | 471,873 | 135,771 | 163,871 | 602,845 | 722,165 | 17,171 | 1,127,310 | 749,328 | 83,288 | 4,177,242 |
| 2008 | 133,379 | 11,884 | 514,063 | 73,408 | 132,755 | 1,169,854 | 791,013 | 67,707 | 779,701 | 984,535 | 36,876 | 4,695,175 |
| 2009 | 146,496 | 17,291 | 694,992 | 138,356 | 100,267 | 574,187 | 1,141,495 | 64,775 | 1,104,647 | 912,057 | 6,548 | 4,901,111 |
| 2010 | 37,299 | 21,383 | 808,175 | 162,049 | 170,199 | 1,449,043 | 1,091,368 | 61,374 | 1,151,822 | 418,678 | 72,941 | 5,444,331 |
| 2011 | 48,517 | 54,202 | 873,495 | 202,238 | 91,104 | 1,005,255 | 1,038,895 | 43,663 | 1,112,978 | 370,959 | 207,610 | 5,048,916 |
| 2012 | 31,379 | 37,303 | 1,010,564 | 130,689 | 137,125 | 927,502 | 742,420 | 51,319 | 719,623 | 383,870 | 0 | 4,171,794 |
| 2013 | 73,345 | 63,157 | 658,713 | 308,312 | 269,563 | 902,451 | 1,324,244 | 70,635 | 1,185,023 | 359,950 | 0 | 5,215,393 |
| 2014 | 86,409 | 16,522 | 523,530 | 171,984 | 131,829 | 804,490 | 501,948 | 26,171 | 1,639,631 | 131,231 | 0 | 4,033,745 |
| 2015 | 14,434 | 10,037 | 485,316 | 67,036 | 140,783 | 406,786 | 600,270 | 41,895 | 1,111,503 | 207,666 | 0 | 3,085,726 |
| 2016 | 14,180 | 17,627 | 230,070 | 128,354 | 63,334 | 697,675 | 659,574 | 5,892 | 1,545,586 | 138,142 | 4,177 | 3,504,611 |
| 2017 | 22,042 | 37,724 | 392,347 | 59,581 | 94,536 | 472,322 | 625,909 | 27,785 | 1,091,644 | 110,402 | 0 | 2,934,292 |

Table B6.30. Recreational live releases of striped bass in numbers of fish by state and year.

| Year | ME | NH | MA | RI | CT | NY | NJ | DE | MD | VA | NC (ocean only) | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 878 | 0 | 21,240 | 19,733 | 1,582,883 | 35,245 | 235,170 | 0 | 254,697 | 0 | 0 | 2,149,846 |
| 1983 | 0 | 0 | 36,425 | 19,483 | 0 | 2,919 | 436,787 | 0 | 741,546 | 6,436 | 0 | 1,243,596 |
| 1984 | 3,821 | 0 | 209,272 | 72,850 | 60,535 | 96,885 | 104,110 | 0 | 308,879 | 28,789 | 0 | 885,141 |
| 1985 | 184,589 | 541 | 54,321 | 113,835 | 44,536 | 196,141 | 57,459 | 3,448 | 388,689 | 8,465 | 0 | 1,052,024 |
| 1986 | 5,304 | 0 | 445,610 | 12,096 | 14,936 | 300,813 | 0 | 0 | 590,024 | 14,275 | 0 | 1,383,058 |
| 1987 | 44,790 | 2,781 | 233,065 | 175,420 | 141,250 | 542,668 | 98,455 | 75,047 | 249,920 | 52,943 | 0 | 1,616,339 |
| 1988 | 23,238 | 8,001 | 440,173 | 48,534 | 58,663 | 220,376 | 1,284,424 | 18,144 | 597,509 | 22,208 | 0 | 2,721,270 |
| 1989 | 46,830 | 5,582 | 480,527 | 137,508 | 332,551 | 880,716 | 1,677,034 | 13,516 | 390,794 | 555,671 | 0 | 4,520,729 |
| 1990 | 84,536 | 18,928 | 1,251,060 | 228,155 | 183,001 | 761,055 | 538,129 | 28,805 | 1,329,371 | 497,083 | 0 | 4,920,123 |
| 1991 | 255,185 | 10,480 | 1,290,442 | 95,542 | 583,522 | 1,408,805 | 853,856 | 174,707 | 2,530,214 | 746,997 | 833 | 7,950,583 |
| 1992 | 118,369 | 52,946 | 3,019,869 | 333,474 | 369,603 | 1,636,620 | 1,275,954 | 123,497 | 2,887,007 | 599,637 | 928 | 10,417,904 |
| 1993 | 869,780 | 34,584 | 1,942,334 | 233,449 | 495,019 | 1,551,336 | 716,324 | 223,141 | 2,679,070 | 279,561 | 3,041 | 9,027,639 |
| 1994 | 519,236 | 110,759 | 4,667,318 | 436,863 | 909,634 | 2,441,685 | 1,095,898 | 236,605 | 4,124,106 | 572,352 | 9,360 | 15,123,816 |
| 1995 | 730,658 | 449,304 | 8,427,142 | 1,312,627 | 1,172,138 | 2,196,189 | 1,864,417 | 307,705 | 4,489,612 | 1,363,030 | 28,169 | 22,340,991 |
| 1996 | 3,054,277 | 433,720 | 8,215,707 | 1,116,565 | 2,646,911 | 3,392,882 | 2,767,848 | 316,632 | 4,734,249 | 2,117,661 | 194,319 | 28,990,771 |
| 1997 | 2,055,833 | 483,000 | 10,675,648 | 2,106,159 | 2,030,841 | 2,206,113 | 2,684,369 | 250,618 | 7,912,299 | 2,490,298 | 201,673 | 33,096,851 |
| 1998 | 1,548,605 | 524,365 | 17,386,770 | 2,259,833 | 2,045,196 | 1,870,788 | 2,780,442 | 533,373 | 4,969,391 | 2,163,289 | 255,219 | 36,337,271 |
| 1999 | 1,204,445 | 320,028 | 13,434,701 | 1,461,672 | 1,305,096 | 3,683,885 | 4,206,024 | 356,988 | 6,231,220 | 2,644,849 | 283,109 | 35,132,017 |
| 2000 | 1,336,509 | 411,645 | 13,743,428 | 1,658,204 | 2,053,940 | 2,913,955 | 2,446,717 | 356,349 | 6,476,653 | 2,385,261 | 170,686 | 33,953,347 |
| 2001 | 1,392,284 | 299,789 | 10,222,067 | 1,136,163 | 2,521,228 | 1,852,884 | 2,533,992 | 387,588 | 5,002,275 | 1,846,231 | 79,024 | 27,273,525 |
| 2002 | 2,422,385 | 594,303 | 13,532,846 | 1,666,550 | 1,413,214 | 1,444,586 | 2,152,449 | 270,781 | 5,552,322 | 1,927,684 | 88,218 | 31,065,338 |
| 2003 | 1,410,725 | 560,843 | 9,787,679 | 1,356,103 | 2,104,479 | 2,644,941 | 2,246,065 | 465,896 | 8,731,485 | 2,322,166 | 59,799 | 31,690,181 |
| 2004 | 1,597,067 | 592,935 | 13,338,234 | 1,898,916 | 1,413,910 | 4,567,726 | 3,685,431 | 373,239 | 8,748,126 | 4,262,565 | 387,827 | 40,865,976 |
| 2005 | 4,729,060 | 1,001,141 | 9,042,756 | 2,052,415 | 4,171,667 | 3,468,230 | 3,078,017 | 560,086 | 7,492,120 | 2,468,828 | 210,903 | 38,275,223 |

Table B6.30 (continued).

| Year | ME | NH | MA | RI | CT | NY | NJ | DE | MD | VA | NC (ocean only) | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 8,059,186 | 889,216 | 19,278,587 | 2,094,270 | 2,015,969 | 4,407,045 | 3,604,691 | 685,331 | 9,023,958 | 3,374,899 | 44,907 | 53,478,059 |
| 2007 | 1,926,571 | 450,980 | 10,839,699 | 1,484,857 | 1,862,914 | 3,010,505 | 4,673,420 | 597,361 | 5,660,371 | 2,184,762 | 28,155 | 32,719,595 |
| 2008 | 1,156,915 | 197,041 | 7,495,514 | 777,838 | 5,062,515 | 2,782,160 | 3,668,079 | 632,685 | 3,222,361 | 1,547,375 | 27,512 | 26,569,995 |
| 2009 | 674,170 | 124,428 | 5,989,390 | 1,069,924 | 2,426,767 | 2,261,982 | 3,503,107 | 444,439 | 4,011,041 | 1,072,205 | 16,857 | 21,594,310 |
| 2010 | 521,578 | 161,120 | 5,089,524 | 619,352 | 1,416,463 | 3,035,987 | 2,436,192 | 256,325 | 5,389,724 | 586,323 | 61,015 | 19,573,603 |
| 2011 | 452,780 | 191,235 | 4,035,634 | 621,395 | 1,570,511 | 2,691,662 | 2,447,021 | 337,788 | 3,484,488 | 389,191 | 246,502 | 16,468,207 |
| 2012 | 656,576 | 164,369 | 3,629,394 | 1,291,714 | 892,480 | 2,427,500 | 1,822,075 | 357,725 | 9,001,233 | 288,933 | 7,301 | 20,539,300 |
| 2013 | 984,636 | 295,427 | 4,670,185 | 2,574,410 | 2,311,900 | 3,955,599 | 4,349,144 | 272,788 | 6,676,485 | 503,041 | 5,855 | 26,599,470 |
| 2014 | 1,023,302 | 315,614 | 6,425,469 | 437,611 | 739,568 | 2,784,141 | 2,840,153 | 529,957 | 8,303,529 | 737,784 | 2,122 | 24,139,250 |
| 2015 | 823,891 | 262,425 | 4,470,735 | 1,653,332 | 1,760,810 | 3,681,877 | 2,439,859 | 309,048 | 8,523,539 | 1,709,298 | 0 | 25,634,814 |
| 2016 | 2,161,647 | 819,225 | 6,299,215 | 1,416,267 | 1,208,170 | 3,738,838 | 1,808,167 | 217,931 | 13,780,632 | 1,637,663 | 84,726 | 33,172,481 |
| 2017 | 2,719,207 | 1,417,708 | 12,865,678 | 1,543,148 | 4,993,204 | 2,760,840 | 2,316,365 | 254,050 | 7,788,168 | 1,332,604 | 48,410 | 38,039,382 |

Table B6.31. Estimates of unreported recreational catch from inland waters of the Connecticut River (A), Hudson River (B), and Delaware Bay (C).

A.

| Year | Disposition | Connecticut River | | MRFSS/MRIP CT | Corrected State Total | (Percent)[a] Bias |
|---|---|---|---|---|---|---|
| | | Partial Year Estimate | Full Year Estimate | | | |
| 1997 | Catch | 25,941 | 38,530 | | | |
| | Harvest | 1,965 | 2,345 | 149,048 | 151,393 | 1.6 |
| | Discards | | 36,185 | | | |
| | Discard Loss | | 3,257 | 182,776 | 186,032 | 1.8 |
| | Total Kill | | 5,602 | 331,823 | 337,425 | 1.7 |
| 1998 | Catch | 42,095 | 62,524 | | | |
| | Harvest | 1,225 | 1,462 | 114,068 | 115,530 | 1.3 |
| | Discards | | 61,062 | | | |
| | Discard Loss | | 5,496 | 184,068 | 189,563 | 3.0 |
| | Total Kill | | 6,958 | 298,135 | 305,093 | 2.3 |
| 2008 - 2009 | Catch | | 39,699 | | | |
| | Harvest | | 2,112 | 233,022 | 235,134 | 0.9 |
| | Discards | | 37,587 | | | |
| | Discard Loss | | 3,383 | 674,035 | 677,418 | 0.5 |
| | Total Kill | | 5,495 | 907,058 | 912,552 | 0.6 |

[a] Calculated as (unreported inland losses/total unreported and reported losses)*100
Discard loss estimated using 9% release mortality.

Table B6.31 (continued).

B.

| Year | Disposition | Hudson River > rkm 74 | MRFSS/MRIP NY | Corrected State Total | Percent[a] Bias |
|---|---|---|---|---|---|
| 2001 | Catch | 35,018 | | | |
| | Harvest | 6,693 | 364,152 | 370,845 | 1.8 |
| | Discards | 28,325 | | | |
| | Discard Loss | 2,549 | 166,760 | 169,309 | 1.5 |
| | Total Kill | 9,242 | 530,912 | 540,154 | 1.7 |
| 2005 | Catch | 45,022 | | | |
| | Harvest | 8,827 | 854,633 | 863,460 | 1.0 |
| | Discards | 36,195 | | | |
| | Discard Loss | 3,258 | 312,141 | 315,398 | 1.0 |
| | Total Kill | 12,085 | 1,166,774 | 1,178,859 | 1.0 |

C.

| Year | Disposition | DE River | MRFSS / MRIP | | | Corrected State Total | Percent[a] Bias |
|---|---|---|---|---|---|---|---|
| | | | NJ | DE | States Combined | | |
| 2002 | Catch | 47,671 | | | | | |
| | Kill | 582 | 957,600 | 65,712 | 1,023,312 | 1,023,894 | 0.1 |
| | Discards | 47,089 | | | | | |
| | Discard Loss | 3,767 | 193,720 | 24,370 | 218,091 | 221,858 | 1.7 |
| | Total Kill | 4,349 | 1,151,321 | 90,082 | 1,241,403 | 1,245,752 | 0.3 |

[a] Calculated as (unreported inland losses/total unreported and reported losses)*100
Discard loss estimated using 9% release mortality.

Table B6.32. Total striped bass removals at age in numbers of fish from the Chesapeake Bay by year . Total removals include commercial harvest, commercial dead discards, recreational harvest, and recreational release mortalities.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 19 | 44,400 | 125,179 | 49,543 | 6,686 | 1,354 | 232 | 198 | 20 | 74 | 322 | 481 | 15 | 39 | 80 |
| 1983 | 255 | 98,071 | 94,370 | 120,103 | 5,885 | 6,822 | 4,992 | 4,111 | 400 | 426 | 533 | 1,179 | 267 | 444 | 133 |
| 1984 | 0 | 74,107 | 366,352 | 27,899 | 7,435 | 2,061 | 327 | 34 | 0 | 12 | 34 | 16 | 0 | 48 | 0 |
| 1985 | 2,637 | 10,757 | 25,844 | 8,471 | 450 | 132 | 128 | 23 | 34 | 22 | 6 | 20 | 35 | 20 | 109 |
| 1986 | 0 | 23,363 | 28,178 | 39,104 | 8,974 | 452 | 241 | 129 | 36 | 0 | 0 | 0 | 20 | 61 | 90 |
| 1987 | 2,111 | 16,325 | 12,542 | 5,829 | 7,251 | 729 | 42 | 23 | 20 | 2 | 2 | 0 | 4 | 22 | 39 |
| 1988 | 37 | 21,927 | 31,331 | 21,057 | 24,706 | 19,453 | 4,004 | 487 | 22 | 23 | 0 | 2 | 2 | 11 | 39 |
| 1989 | 40 | 30,204 | 8,362 | 13,239 | 8,203 | 13,992 | 8,780 | 2,241 | 4 | 2 | 0 | 2 | 2 | 0 | 20 |
| 1990 | 868 | 40,218 | 52,721 | 79,170 | 157,440 | 247,627 | 62,936 | 15,092 | 2,984 | 1,977 | 844 | 703 | 508 | 234 | 325 |
| 1991 | 3,447 | 66,159 | 122,805 | 101,829 | 140,848 | 225,576 | 92,950 | 17,720 | 9,782 | 4,625 | 2,028 | 1,312 | 899 | 567 | 639 |
| 1992 | 2,530 | 25,909 | 187,363 | 219,793 | 196,071 | 195,047 | 120,474 | 35,193 | 6,080 | 3,999 | 90 | 50 | 199 | 298 | 436 |
| 1993 | 2,297 | 43,722 | 86,204 | 258,186 | 254,646 | 144,299 | 88,028 | 49,334 | 12,626 | 3,285 | 1,587 | 374 | 320 | 263 | 493 |
| 1994 | 1,102 | 15,320 | 164,035 | 346,728 | 392,870 | 180,736 | 117,834 | 57,345 | 34,153 | 11,479 | 4,449 | 2,967 | 242 | 26 | 126 |
| 1995 | 32 | 101,619 | 324,020 | 449,636 | 385,938 | 312,025 | 195,032 | 94,304 | 62,353 | 25,217 | 13,308 | 7,616 | 2,368 | 1,643 | 4,580 |
| 1996 | 10,532 | 45,005 | 720,727 | 527,498 | 485,121 | 335,136 | 215,684 | 87,200 | 41,284 | 22,452 | 15,844 | 3,440 | 1,602 | 794 | 1,116 |
| 1997 | 94,710 | 244,460 | 453,271 | 1,069,711 | 445,855 | 367,698 | 178,125 | 145,042 | 83,325 | 45,813 | 18,358 | 10,189 | 5,202 | 650 | 251 |
| 1998 | 8,457 | 160,198 | 638,210 | 848,220 | 607,780 | 293,069 | 132,155 | 88,600 | 71,736 | 50,529 | 22,618 | 12,170 | 6,064 | 5,820 | 1,653 |
| 1999 | 5,657 | 69,497 | 579,431 | 750,129 | 616,467 | 646,216 | 219,826 | 92,858 | 79,781 | 47,785 | 42,036 | 21,154 | 14,986 | 4,111 | 4,536 |
| 2000 | 60,728 | 230,891 | 197,199 | 822,440 | 977,845 | 498,323 | 347,956 | 123,466 | 53,791 | 55,326 | 28,909 | 17,764 | 9,093 | 7,075 | 2,699 |
| 2001 | 80,120 | 183,957 | 292,883 | 423,544 | 603,150 | 354,952 | 241,637 | 196,246 | 60,681 | 52,447 | 40,163 | 35,624 | 14,310 | 8,517 | 1,334 |
| 2002 | 32,764 | 300,878 | 248,794 | 399,917 | 460,460 | 466,808 | 326,708 | 137,940 | 160,825 | 51,138 | 34,435 | 19,014 | 14,958 | 4,678 | 16,071 |
| 2003 | 79 | 443,222 | 496,391 | 512,771 | 466,400 | 364,541 | 335,399 | 204,058 | 185,807 | 178,348 | 64,942 | 38,758 | 21,822 | 10,880 | 10,986 |
| 2004 | 165,908 | 165,711 | 784,517 | 671,371 | 314,684 | 285,981 | 243,344 | 216,803 | 154,110 | 113,638 | 112,879 | 48,305 | 25,736 | 12,932 | 12,172 |
| 2005 | 19,466 | 422,712 | 230,891 | 677,372 | 522,957 | 207,902 | 154,185 | 117,564 | 198,255 | 144,007 | 135,030 | 78,819 | 31,483 | 12,136 | 20,295 |

Table B6.32 (continued).

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 69,310 | 277,229 | 812,716 | 655,788 | 874,123 | 470,188 | 184,393 | 147,176 | 140,963 | 172,800 | 98,001 | 67,226 | 59,102 | 18,189 | 40,951 |
| 2007 | 15,534 | 147,508 | 191,272 | 1,082,451 | 488,189 | 473,831 | 188,277 | 115,567 | 117,939 | 101,568 | 112,992 | 60,849 | 27,720 | 19,919 | 23,995 |
| 2008 | 71,673 | 38,119 | 151,817 | 412,398 | 837,252 | 241,012 | 247,864 | 140,136 | 62,514 | 98,004 | 84,846 | 116,959 | 42,851 | 37,013 | 45,565 |
| 2009 | 9,512 | 178,104 | 141,393 | 694,469 | 667,021 | 596,688 | 126,137 | 170,692 | 132,600 | 62,626 | 88,490 | 81,795 | 98,348 | 37,434 | 56,485 |
| 2010 | 19,509 | 30,084 | 477,167 | 449,996 | 596,449 | 511,013 | 453,943 | 105,233 | 106,625 | 54,932 | 21,821 | 26,081 | 26,551 | 29,237 | 24,294 |
| 2011 | 53,092 | 118,536 | 154,602 | 716,958 | 309,362 | 378,873 | 301,332 | 206,542 | 62,471 | 83,506 | 45,460 | 24,269 | 22,583 | 15,404 | 29,202 |
| 2012 | 248,396 | 247,847 | 364,555 | 285,474 | 529,166 | 297,112 | 219,316 | 90,482 | 114,697 | 44,997 | 70,929 | 24,837 | 24,140 | 31,127 | 74,900 |
| 2013 | 2,311 | 245,136 | 439,285 | 633,111 | 418,875 | 397,763 | 160,867 | 103,305 | 97,243 | 130,893 | 37,539 | 42,872 | 9,598 | 6,667 | 21,532 |
| 2014 | 18,708 | 41,765 | 944,405 | 667,897 | 751,576 | 279,114 | 182,408 | 74,111 | 72,792 | 63,894 | 83,157 | 10,468 | 17,662 | 4,591 | 21,714 |
| 2015 | 220,791 | 209,169 | 116,239 | 875,347 | 499,886 | 191,442 | 144,601 | 140,994 | 65,224 | 109,219 | 70,544 | 77,645 | 16,467 | 34,686 | 28,044 |
| 2016 | 210,075 | 262,907 | 297,913 | 404,176 | 1,380,769 | 401,046 | 132,161 | 67,508 | 71,891 | 48,599 | 91,869 | 87,801 | 98,586 | 13,295 | 35,000 |
| 2017 | 47,317 | 185,636 | 269,659 | 336,137 | 528,667 | 685,419 | 131,799 | 79,810 | 45,042 | 49,239 | 33,055 | 53,570 | 25,430 | 18,510 | 9,860 |

Table B6.33. Total striped bass removals at age in numbers of fish from the ocean and other areas by year. Total removals include commercial harvest, commercial dead discards, recreational harvest, and recreational release mortalities.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 1,054 | 66,168 | 145,091 | 175,396 | 65,744 | 21,374 | 9,872 | 7,681 | 4,877 | 11,350 | 18,625 | 29,046 | 13,525 | 21,047 | 86,060 |
| 1983 | 5,004 | 33,837 | 92,902 | 92,543 | 159,133 | 138,200 | 56,057 | 37,172 | 1,897 | 7,298 | 48,762 | 5,848 | 6,105 | 4,390 | 20,574 |
| 1984 | 2,473 | 18,757 | 32,938 | 75,539 | 73,481 | 77,590 | 29,679 | 13,084 | 4,427 | 5,905 | 2,153 | 2,668 | 4,325 | 8,003 | 6,334 |
| 1985 | 276 | 16,794 | 46,142 | 64,426 | 210,097 | 234,929 | 216,046 | 18,748 | 3,553 | 3,642 | 7,857 | 4,322 | 4,012 | 7,510 | 15,322 |
| 1986 | 280 | 3,457 | 40,424 | 99,937 | 34,720 | 69,461 | 13,546 | 18,011 | 5,269 | 1,348 | 1,840 | 1,437 | 1,664 | 3,651 | 11,961 |
| 1987 | 1,540 | 18,213 | 34,631 | 30,567 | 28,769 | 14,131 | 18,462 | 20,859 | 16,227 | 7,813 | 2,884 | 5,699 | 4,069 | 7,248 | 20,344 |
| 1988 | 5,521 | 53,521 | 42,149 | 36,274 | 34,712 | 45,988 | 28,534 | 24,289 | 24,291 | 7,713 | 6,186 | 2,080 | 7,300 | 3,814 | 9,668 |
| 1989 | 9,083 | 74,934 | 99,690 | 44,528 | 47,572 | 34,357 | 49,674 | 34,679 | 37,958 | 23,877 | 12,968 | 3,128 | 11,005 | 8,101 | 28,583 |
| 1990 | 319 | 34,594 | 47,797 | 57,613 | 58,698 | 72,739 | 90,357 | 103,920 | 38,346 | 15,125 | 8,095 | 4,800 | 6,232 | 9,942 | 23,696 |
| 1991 | 839 | 71,513 | 91,859 | 110,795 | 80,577 | 50,381 | 77,528 | 123,902 | 190,817 | 50,136 | 10,516 | 9,615 | 2,915 | 13,284 | 42,559 |
| 1992 | 6,486 | 33,992 | 106,549 | 127,411 | 140,675 | 91,993 | 89,366 | 168,048 | 186,432 | 178,372 | 30,210 | 15,447 | 6,710 | 15,504 | 46,890 |
| 1993 | 347 | 46,298 | 82,390 | 117,984 | 103,626 | 100,110 | 73,765 | 87,877 | 138,148 | 162,229 | 107,413 | 25,305 | 7,098 | 4,231 | 30,482 |
| 1994 | 4,966 | 68,226 | 138,201 | 115,399 | 178,750 | 162,769 | 102,705 | 146,176 | 226,809 | 199,007 | 102,807 | 88,574 | 7,525 | 4,903 | 30,166 |
| 1995 | 4,694 | 719,011 | 306,038 | 176,618 | 144,391 | 313,269 | 218,367 | 322,716 | 338,850 | 244,546 | 154,175 | 58,820 | 27,925 | 3,579 | 10,106 |
| 1996 | 1,463 | 48,258 | 570,829 | 360,554 | 318,635 | 370,484 | 617,809 | 480,413 | 339,671 | 259,741 | 188,990 | 120,168 | 34,091 | 13,803 | 29,379 |
| 1997 | 25,929 | 432,960 | 475,679 | 739,712 | 315,231 | 340,733 | 313,431 | 408,397 | 384,955 | 263,904 | 224,988 | 113,258 | 107,271 | 55,521 | 23,445 |
| 1998 | 22,974 | 316,381 | 521,575 | 834,812 | 819,143 | 555,884 | 438,366 | 525,050 | 352,205 | 193,181 | 197,248 | 75,984 | 37,497 | 51,693 | 24,361 |
| 1999 | 1,982 | 70,272 | 683,909 | 856,414 | 694,509 | 765,917 | 503,883 | 480,831 | 289,141 | 262,465 | 120,513 | 70,757 | 28,315 | 13,500 | 10,345 |
| 2000 | 2,731 | 64,576 | 502,366 | 541,864 | 827,093 | 684,898 | 778,945 | 755,128 | 335,063 | 224,305 | 111,952 | 56,452 | 31,528 | 15,438 | 10,887 |
| 2001 | 12,886 | 84,136 | 203,644 | 466,378 | 1,083,082 | 1,118,948 | 869,643 | 585,660 | 234,611 | 175,458 | 193,708 | 62,433 | 49,053 | 24,575 | 17,114 |
| 2002 | 15,330 | 325,516 | 357,065 | 512,354 | 494,406 | 1,031,961 | 820,864 | 701,761 | 613,846 | 240,425 | 209,759 | 92,434 | 50,918 | 35,064 | 13,652 |
| 2003 | 2,597 | 282,356 | 450,699 | 353,717 | 611,063 | 597,119 | 1,035,743 | 830,482 | 530,412 | 354,536 | 200,275 | 127,275 | 74,448 | 44,251 | 36,372 |
| 2004 | 1,836 | 108,355 | 1,059,726 | 698,049 | 513,006 | 619,491 | 711,573 | 924,127 | 603,348 | 382,507 | 286,737 | 143,763 | 67,356 | 47,670 | 30,922 |
| 2005 | 8,042 | 663,364 | 388,084 | 847,007 | 887,302 | 618,755 | 632,106 | 505,926 | 608,666 | 368,702 | 287,524 | 132,152 | 90,335 | 51,390 | 48,833 |

Table B6.33 (continued).

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 4,248 | 238,095 | 1,851,519 | 493,341 | 874,629 | 738,828 | 439,996 | 503,545 | 472,608 | 571,451 | 359,928 | 217,930 | 105,849 | 46,059 | 67,445 |
| 2007 | 4,421 | 233,599 | 564,027 | 834,402 | 494,794 | 729,385 | 478,703 | 335,161 | 399,931 | 418,638 | 263,206 | 244,668 | 70,025 | 37,447 | 27,090 |
| 2008 | 14,749 | 87,354 | 380,365 | 457,238 | 1,030,338 | 516,571 | 985,716 | 622,672 | 288,696 | 421,816 | 256,184 | 182,364 | 201,782 | 57,492 | 91,468 |
| 2009 | 2,497 | 152,279 | 167,730 | 276,822 | 405,065 | 1,252,209 | 510,006 | 720,776 | 387,329 | 274,331 | 243,942 | 178,602 | 187,784 | 54,616 | 70,539 |
| 2010 | 743 | 51,057 | 329,163 | 157,070 | 333,964 | 688,774 | 1,481,556 | 532,475 | 630,912 | 477,853 | 211,987 | 197,545 | 148,562 | 120,888 | 75,079 |
| 2011 | 19,083 | 130,059 | 227,690 | 316,897 | 226,480 | 695,444 | 853,319 | 1,170,147 | 422,077 | 367,585 | 173,700 | 117,326 | 118,617 | 100,166 | 102,862 |
| 2012 | 1,638 | 226,478 | 265,838 | 157,867 | 439,150 | 391,625 | 600,298 | 731,628 | 781,298 | 217,623 | 193,811 | 161,699 | 86,603 | 95,518 | 63,224 |
| 2013 | 1,433 | 245,541 | 491,335 | 416,061 | 348,165 | 630,372 | 654,969 | 608,936 | 630,487 | 1,020,017 | 246,226 | 124,365 | 123,948 | 80,977 | 135,991 |
| 2014 | 1,190 | 30,718 | 563,451 | 414,485 | 344,927 | 379,265 | 437,672 | 315,485 | 347,094 | 392,707 | 245,864 | 130,323 | 75,349 | 67,314 | 97,694 |
| 2015 | 2,549 | 45,715 | 102,714 | 671,973 | 537,918 | 379,063 | 346,113 | 270,098 | 238,673 | 215,637 | 178,890 | 123,635 | 67,403 | 48,631 | 86,969 |
| 2016 | 23,077 | 525,865 | 201,226 | 132,723 | 810,620 | 530,906 | 207,987 | 191,664 | 181,117 | 148,957 | 175,848 | 177,555 | 127,326 | 61,287 | 105,345 |
| 2017 | 2,095 | 664,238 | 720,747 | 278,816 | 471,469 | 975,076 | 472,777 | 261,024 | 112,078 | 155,253 | 114,285 | 130,235 | 95,126 | 51,186 | 55,331 |

Table B6.34. Catch weights-at-age (A) and derived Rivard weights for spawning stock biomass (B) and January-1 biomass (C).

| A. | Catch Weight-at-Age (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 0.13 | 0.64 | 1.09 | 1.54 | 2.42 | 3.75 | 4.83 | 5.79 | 6.20 | 8.68 | 10.80 | 11.20 | 13.36 | 15.21 | 17.12 |
| 1983 | 0.20 | 0.55 | 0.94 | 1.37 | 2.37 | 3.29 | 3.77 | 5.36 | 6.01 | 8.10 | 9.57 | 10.39 | 12.35 | 14.11 | 15.92 |
| 1984 | 0.24 | 0.60 | 1.69 | 1.62 | 2.67 | 3.39 | 5.07 | 5.65 | 6.76 | 7.76 | 8.41 | 12.65 | 12.94 | 14.70 | 16.52 |
| 1985 | 0.06 | 0.61 | 1.07 | 1.66 | 2.19 | 3.59 | 4.91 | 5.46 | 6.77 | 7.45 | 9.00 | 10.69 | 11.97 | 13.51 | 15.08 |
| 1986 | 0.14 | 0.57 | 1.27 | 2.40 | 2.44 | 3.12 | 3.95 | 5.05 | 5.44 | 6.09 | 7.75 | 9.16 | 9.78 | 10.90 | 12.03 |
| 1987 | 0.20 | 0.77 | 1.41 | 2.11 | 2.50 | 2.91 | 3.61 | 4.74 | 5.52 | 6.49 | 7.77 | 9.78 | 10.38 | 11.69 | 13.03 |
| 1988 | 0.31 | 0.91 | 1.10 | 1.98 | 3.12 | 4.02 | 4.38 | 4.70 | 5.24 | 5.62 | 8.58 | 10.40 | 10.55 | 11.80 | 13.07 |
| 1989 | 0.16 | 0.83 | 1.22 | 2.23 | 3.06 | 4.53 | 5.37 | 6.23 | 6.04 | 8.68 | 8.94 | 9.74 | 11.17 | 12.31 | 13.46 |
| 1990 | 0.08 | 0.89 | 1.14 | 2.05 | 2.35 | 3.83 | 4.91 | 5.96 | 5.70 | 5.97 | 7.44 | 9.08 | 9.58 | 10.54 | 11.51 |
| 1991 | 0.21 | 0.92 | 1.29 | 2.17 | 2.62 | 3.17 | 4.81 | 5.64 | 6.46 | 6.24 | 9.46 | 8.30 | 10.12 | 11.17 | 12.23 |
| 1992 | 0.10 | 0.69 | 1.31 | 1.93 | 2.81 | 3.67 | 4.90 | 5.79 | 6.96 | 8.15 | 9.77 | 12.44 | 13.49 | 15.33 | 17.23 |
| 1993 | 0.07 | 0.76 | 1.31 | 1.99 | 2.77 | 3.58 | 4.80 | 6.11 | 7.03 | 8.01 | 9.53 | 10.76 | 12.22 | 13.70 | 15.20 |
| 1994 | 0.24 | 1.05 | 1.69 | 2.21 | 2.85 | 3.50 | 4.94 | 6.20 | 6.80 | 7.53 | 9.73 | 10.69 | 11.92 | 13.29 | 14.69 |
| 1995 | 0.28 | 0.70 | 1.35 | 2.18 | 2.77 | 3.65 | 5.38 | 6.16 | 7.27 | 8.86 | 7.57 | 9.73 | 10.96 | 12.08 | 13.20 |
| 1996 | 0.14 | 1.05 | 1.47 | 2.32 | 3.23 | 4.52 | 6.39 | 7.11 | 7.81 | 9.20 | 9.31 | 10.10 | 11.88 | 13.03 | 14.17 |
| 1997 | 0.13 | 0.62 | 1.18 | 2.46 | 2.81 | 3.64 | 4.51 | 5.07 | 6.73 | 9.17 | 9.94 | 10.24 | 12.29 | 13.80 | 15.35 |
| 1998 | 0.39 | 0.77 | 1.20 | 1.62 | 2.25 | 2.95 | 4.69 | 5.66 | 6.82 | 7.03 | 7.76 | 9.87 | 10.82 | 12.10 | 13.41 |
| 1999 | 0.62 | 0.90 | 1.11 | 1.44 | 1.91 | 2.51 | 3.36 | 5.03 | 6.56 | 7.85 | 8.69 | 9.76 | 11.67 | 13.33 | 15.04 |
| 2000 | 0.37 | 0.55 | 1.10 | 1.45 | 1.96 | 2.79 | 3.89 | 5.09 | 7.11 | 7.37 | 9.70 | 10.70 | 12.68 | 14.56 | 16.51 |
| 2001 | 0.16 | 0.38 | 1.12 | 1.75 | 2.21 | 3.25 | 4.12 | 5.02 | 6.36 | 7.79 | 8.65 | 8.29 | 10.42 | 11.64 | 12.87 |
| 2002 | 0.12 | 0.31 | 1.06 | 1.51 | 2.18 | 3.17 | 4.19 | 5.48 | 6.03 | 7.56 | 9.09 | 9.75 | 11.53 | 13.05 | 14.62 |
| 2003 | 0.10 | 0.60 | 1.00 | 1.40 | 2.20 | 3.20 | 4.10 | 5.20 | 6.10 | 7.20 | 8.50 | 9.40 | 10.94 | 12.33 | 13.76 |
| 2004 | 0.23 | 0.33 | 0.84 | 1.40 | 2.43 | 3.11 | 4.14 | 5.17 | 6.07 | 7.12 | 8.18 | 9.03 | 10.55 | 11.85 | 13.18 |
| 2005 | 0.13 | 0.50 | 1.14 | 1.64 | 2.22 | 3.23 | 4.18 | 5.64 | 6.38 | 7.21 | 8.51 | 10.00 | 11.30 | 12.74 | 14.21 |
| 2006 | 0.18 | 0.38 | 0.81 | 1.35 | 1.96 | 2.80 | 3.84 | 5.35 | 6.70 | 7.41 | 8.58 | 9.40 | 11.29 | 12.81 | 14.37 |
| 2007 | 0.10 | 0.46 | 0.94 | 1.30 | 2.10 | 3.07 | 4.31 | 5.32 | 6.89 | 7.84 | 9.39 | 10.12 | 12.16 | 13.82 | 15.54 |
| 2008 | 0.21 | 0.45 | 1.04 | 1.43 | 2.14 | 3.47 | 5.05 | 5.51 | 6.69 | 8.26 | 9.19 | 9.82 | 11.77 | 13.24 | 14.74 |
| 2009 | 0.26 | 0.62 | 1.03 | 1.41 | 1.92 | 3.29 | 4.49 | 5.74 | 6.87 | 7.73 | 8.81 | 9.47 | 11.35 | 12.76 | 14.20 |
| 2010 | 0.16 | 0.70 | 1.11 | 1.41 | 1.99 | 3.34 | 4.27 | 5.21 | 6.27 | 7.65 | 8.97 | 9.15 | 11.09 | 12.49 | 13.91 |
| 2011 | 0.20 | 0.52 | 1.04 | 1.55 | 2.00 | 3.08 | 4.10 | 5.13 | 6.41 | 7.54 | 8.20 | 9.98 | 11.34 | 12.85 | 14.40 |
| 2012 | 0.08 | 0.48 | 1.01 | 1.67 | 2.30 | 3.25 | 4.44 | 5.88 | 6.57 | 8.31 | 9.05 | 10.41 | 12.12 | 13.69 | 15.31 |
| 2013 | 0.19 | 0.49 | 0.96 | 1.39 | 2.27 | 3.38 | 4.14 | 5.30 | 6.69 | 7.55 | 9.26 | 10.44 | 12.12 | 13.78 | 15.49 |
| 2014 | 0.49 | 0.55 | 0.89 | 1.27 | 2.15 | 3.07 | 4.28 | 5.30 | 6.99 | 8.43 | 9.17 | 11.91 | 13.50 | 15.55 | 17.69 |
| 2015 | 0.15 | 0.29 | 0.92 | 1.59 | 2.50 | 3.75 | 4.56 | 5.69 | 6.97 | 7.69 | 8.95 | 10.54 | 11.96 | 13.48 | 15.03 |
| 2016 | 0.17 | 0.43 | 0.78 | 1.25 | 2.17 | 3.40 | 4.75 | 6.05 | 7.06 | 8.92 | 10.03 | 11.23 | 13.42 | 15.31 | 17.26 |
| 2017 | 0.21 | 0.48 | 1.06 | 1.59 | 2.49 | 3.28 | 4.46 | 5.31 | 6.38 | 8.57 | 9.78 | 10.81 | 13.06 | 14.85 | 16.07 |

Table B6.34. (continued).

| B. | Adjusted Rivard weight-at-age for female SSB (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 0.09 | 0.58 | 1.03 | 1.38 | 2.24 | 3.75 | 4.71 | 5.74 | 5.80 | 8.47 | 10.91 | 10.93 | 13.19 | 14.73 | 17.12 |
| 1983 | 0.15 | 0.38 | 0.85 | 1.29 | 2.13 | 3.05 | 3.76 | 5.22 | 5.95 | 7.58 | 9.34 | 10.49 | 12.05 | 13.92 | 15.92 |
| 1984 | 0.19 | 0.46 | 1.28 | 1.41 | 2.26 | 3.10 | 4.55 | 5.11 | 6.38 | 7.28 | 8.33 | 11.80 | 12.25 | 14.08 | 16.52 |
| 1985 | 0.03 | 0.48 | 0.93 | 1.67 | 2.03 | 3.33 | 4.48 | 5.36 | 6.47 | 7.27 | 8.67 | 10.07 | 12.14 | 13.36 | 15.08 |
| 1986 | 0.09 | 0.32 | 1.06 | 1.96 | 2.22 | 2.86 | 3.86 | 5.01 | 5.44 | 6.25 | 7.67 | 9.12 | 10.00 | 11.16 | 12.03 |
| 1987 | 0.14 | 0.50 | 1.12 | 1.86 | 2.47 | 2.78 | 3.48 | 4.53 | 5.40 | 6.21 | 7.31 | 9.23 | 10.06 | 11.18 | 13.03 |
| 1988 | 0.24 | 0.62 | 1.01 | 1.82 | 2.83 | 3.57 | 3.95 | 4.40 | 5.11 | 5.59 | 8.00 | 9.67 | 10.35 | 11.43 | 13.07 |
| 1989 | 0.10 | 0.65 | 1.13 | 1.87 | 2.74 | 4.13 | 5.00 | 5.70 | 5.67 | 7.65 | 7.96 | 9.44 | 10.97 | 11.85 | 13.46 |
| 1990 | 0.04 | 0.58 | 1.05 | 1.80 | 2.32 | 3.62 | 4.81 | 5.81 | 5.83 | 5.99 | 7.73 | 9.04 | 9.62 | 10.70 | 11.51 |
| 1991 | 0.16 | 0.50 | 1.18 | 1.85 | 2.46 | 2.94 | 4.54 | 5.45 | 6.33 | 6.10 | 8.43 | 8.08 | 9.85 | 10.75 | 12.23 |
| 1992 | 0.06 | 0.51 | 1.20 | 1.75 | 2.63 | 3.37 | 4.39 | 5.53 | 6.60 | 7.69 | 8.73 | 11.62 | 11.95 | 13.82 | 17.23 |
| 1993 | 0.04 | 0.46 | 1.12 | 1.79 | 2.53 | 3.37 | 4.49 | 5.78 | 6.70 | 7.73 | 9.16 | 10.50 | 12.27 | 13.65 | 15.20 |
| 1994 | 0.18 | 0.53 | 1.38 | 1.94 | 2.61 | 3.30 | 4.56 | 5.82 | 6.62 | 7.40 | 9.27 | 10.39 | 11.62 | 13.02 | 14.69 |
| 1995 | 0.20 | 0.54 | 1.27 | 2.05 | 2.62 | 3.43 | 4.83 | 5.83 | 6.99 | 8.29 | 7.56 | 9.73 | 10.89 | 12.04 | 13.20 |
| 1996 | 0.10 | 0.75 | 1.22 | 2.03 | 2.93 | 4.00 | 5.56 | 6.63 | 7.36 | 8.67 | 9.20 | 9.40 | 11.30 | 12.48 | 14.17 |
| 1997 | 0.08 | 0.43 | 1.15 | 2.16 | 2.68 | 3.53 | 4.51 | 5.37 | 6.82 | 8.81 | 9.75 | 10.00 | 11.70 | 13.30 | 15.35 |
| 1998 | 0.32 | 0.49 | 1.02 | 1.50 | 2.30 | 2.91 | 4.40 | 5.35 | 6.33 | 6.95 | 8.09 | 9.89 | 10.67 | 12.15 | 13.41 |
| 1999 | 0.64 | 0.73 | 1.01 | 1.38 | 1.83 | 2.44 | 3.25 | 4.94 | 6.32 | 7.58 | 8.24 | 9.22 | 11.19 | 12.65 | 15.04 |
| 2000 | 0.37 | 0.57 | 1.05 | 1.36 | 1.81 | 2.54 | 3.49 | 4.59 | 6.52 | 7.16 | 9.20 | 10.16 | 11.88 | 13.77 | 16.51 |
| 2001 | 0.14 | 0.38 | 0.94 | 1.56 | 1.99 | 2.86 | 3.74 | 4.71 | 6.02 | 7.61 | 8.31 | 8.62 | 10.49 | 11.89 | 12.87 |
| 2002 | 0.08 | 0.26 | 0.82 | 1.40 | 2.06 | 2.90 | 3.93 | 5.10 | 5.76 | 7.24 | 8.75 | 9.46 | 10.62 | 12.34 | 14.62 |
| 2003 | 0.07 | 0.40 | 0.75 | 1.31 | 2.00 | 2.91 | 3.84 | 4.93 | 5.94 | 6.89 | 8.25 | 9.32 | 10.63 | 12.13 | 13.76 |
| 2004 | 0.19 | 0.24 | 0.77 | 1.29 | 2.12 | 2.85 | 3.88 | 4.88 | 5.84 | 6.85 | 7.92 | 8.89 | 10.25 | 11.62 | 13.18 |
| 2005 | 0.10 | 0.41 | 0.84 | 1.39 | 1.98 | 3.01 | 3.88 | 5.22 | 6.05 | 6.91 | 8.14 | 9.51 | 10.68 | 12.15 | 14.21 |
| 2006 | 0.14 | 0.29 | 0.72 | 1.29 | 1.87 | 2.64 | 3.68 | 5.03 | 6.42 | 7.14 | 8.21 | 9.17 | 10.96 | 12.42 | 14.37 |
| 2007 | 0.07 | 0.36 | 0.75 | 1.15 | 1.88 | 2.74 | 3.87 | 4.90 | 6.47 | 7.54 | 8.85 | 9.71 | 11.40 | 13.14 | 15.54 |
| 2008 | 0.16 | 0.31 | 0.85 | 1.29 | 1.89 | 3.06 | 4.46 | 5.18 | 6.32 | 7.89 | 8.83 | 9.71 | 11.34 | 12.96 | 14.74 |
| 2009 | 0.20 | 0.47 | 0.84 | 1.31 | 1.78 | 2.95 | 4.21 | 5.56 | 6.50 | 7.46 | 8.67 | 9.40 | 10.95 | 12.51 | 14.20 |
| 2010 | 0.12 | 0.55 | 0.96 | 1.30 | 1.83 | 2.91 | 4.00 | 5.02 | 6.13 | 7.45 | 8.64 | 9.06 | 10.66 | 12.19 | 13.91 |
| 2011 | 0.16 | 0.39 | 0.94 | 1.43 | 1.83 | 2.76 | 3.90 | 4.90 | 6.09 | 7.20 | 8.06 | 9.72 | 10.75 | 12.39 | 14.40 |
| 2012 | 0.05 | 0.39 | 0.86 | 1.48 | 2.08 | 2.88 | 4.05 | 5.37 | 6.18 | 7.79 | 8.65 | 9.81 | 11.54 | 13.06 | 15.31 |
| 2013 | 0.15 | 0.31 | 0.81 | 1.28 | 2.10 | 3.07 | 3.90 | 5.07 | 6.48 | 7.29 | 9.01 | 10.07 | 11.67 | 13.34 | 15.49 |
| 2014 | 0.56 | 0.42 | 0.77 | 1.18 | 1.93 | 2.85 | 4.03 | 4.98 | 6.52 | 7.96 | 8.74 | 11.18 | 12.66 | 14.61 | 17.69 |
| 2015 | 0.12 | 0.33 | 0.81 | 1.38 | 2.11 | 3.26 | 4.13 | 5.30 | 6.51 | 7.51 | 8.82 | 10.18 | 11.95 | 13.48 | 15.03 |
| 2016 | 0.13 | 0.33 | 0.61 | 1.16 | 2.01 | 3.15 | 4.48 | 5.64 | 6.69 | 8.39 | 9.39 | 10.61 | 12.64 | 14.39 | 17.26 |
| 2017 | 0.18 | 0.37 | 0.85 | 1.33 | 2.10 | 2.96 | 4.17 | 5.16 | 6.29 | 8.16 | 9.56 | 10.61 | 12.58 | 14.48 | 16.07 |

Table B6.34. Continued

| C. | Jan-1 Rivard weight-at-age (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 0.06 | 0.53 | 0.97 | 1.24 | 2.08 | 3.74 | 4.58 | 5.68 | 5.42 | 8.27 | 11.01 | 10.67 | 13.01 | 14.26 | 17.12 |
| 1983 | 0.12 | 0.27 | 0.78 | 1.22 | 1.91 | 2.82 | 3.76 | 5.09 | 5.90 | 7.09 | 9.11 | 10.59 | 11.76 | 13.73 | 15.92 |
| 1984 | 0.15 | 0.35 | 0.96 | 1.23 | 1.91 | 2.83 | 4.08 | 4.62 | 6.02 | 6.83 | 8.25 | 11.00 | 11.60 | 13.48 | 16.52 |
| 1985 | 0.02 | 0.38 | 0.80 | 1.67 | 1.88 | 3.10 | 4.08 | 5.26 | 6.18 | 7.10 | 8.36 | 9.48 | 12.31 | 13.22 | 15.08 |
| 1986 | 0.06 | 0.18 | 0.88 | 1.60 | 2.01 | 2.61 | 3.77 | 4.98 | 5.45 | 6.42 | 7.60 | 9.08 | 10.23 | 11.42 | 12.03 |
| 1987 | 0.09 | 0.33 | 0.90 | 1.64 | 2.45 | 2.66 | 3.36 | 4.33 | 5.28 | 5.94 | 6.88 | 8.71 | 9.75 | 10.69 | 13.03 |
| 1988 | 0.19 | 0.43 | 0.92 | 1.67 | 2.57 | 3.17 | 3.57 | 4.12 | 4.98 | 5.57 | 7.46 | 8.99 | 10.16 | 11.07 | 13.07 |
| 1989 | 0.07 | 0.51 | 1.05 | 1.57 | 2.46 | 3.76 | 4.65 | 5.22 | 5.33 | 6.74 | 7.09 | 9.14 | 10.78 | 11.40 | 13.46 |
| 1990 | 0.02 | 0.38 | 0.97 | 1.58 | 2.29 | 3.42 | 4.72 | 5.66 | 5.96 | 6.00 | 8.04 | 9.01 | 9.66 | 10.85 | 11.51 |
| 1991 | 0.12 | 0.27 | 1.07 | 1.57 | 2.32 | 2.73 | 4.29 | 5.26 | 6.20 | 5.96 | 7.52 | 7.86 | 9.58 | 10.34 | 12.23 |
| 1992 | 0.04 | 0.38 | 1.10 | 1.58 | 2.47 | 3.10 | 3.94 | 5.28 | 6.27 | 7.26 | 7.81 | 10.85 | 10.58 | 12.45 | 17.23 |
| 1993 | 0.02 | 0.28 | 0.95 | 1.61 | 2.31 | 3.17 | 4.20 | 5.47 | 6.38 | 7.47 | 8.81 | 10.25 | 12.33 | 13.60 | 15.20 |
| 1994 | 0.14 | 0.27 | 1.13 | 1.70 | 2.38 | 3.11 | 4.21 | 5.46 | 6.45 | 7.28 | 8.83 | 10.09 | 11.32 | 12.74 | 14.69 |
| 1995 | 0.14 | 0.41 | 1.19 | 1.92 | 2.47 | 3.23 | 4.34 | 5.52 | 6.71 | 7.76 | 7.55 | 9.73 | 10.82 | 12.00 | 13.20 |
| 1996 | 0.07 | 0.54 | 1.01 | 1.77 | 2.65 | 3.54 | 4.83 | 6.18 | 6.94 | 8.18 | 9.08 | 8.74 | 10.75 | 11.95 | 14.17 |
| 1997 | 0.05 | 0.29 | 1.11 | 1.90 | 2.55 | 3.43 | 4.52 | 5.69 | 6.92 | 8.46 | 9.56 | 9.76 | 11.14 | 12.81 | 15.35 |
| 1998 | 0.26 | 0.32 | 0.86 | 1.38 | 2.35 | 2.88 | 4.13 | 5.05 | 5.88 | 6.88 | 8.44 | 9.90 | 10.53 | 12.20 | 13.41 |
| 1999 | 0.66 | 0.59 | 0.92 | 1.31 | 1.76 | 2.38 | 3.15 | 4.86 | 6.09 | 7.32 | 7.82 | 8.70 | 10.73 | 12.01 | 15.04 |
| 2000 | 0.37 | 0.58 | 0.99 | 1.27 | 1.68 | 2.31 | 3.12 | 4.14 | 5.98 | 6.95 | 8.73 | 9.64 | 11.12 | 13.03 | 16.51 |
| 2001 | 0.11 | 0.37 | 0.78 | 1.39 | 1.79 | 2.52 | 3.39 | 4.42 | 5.69 | 7.44 | 7.98 | 8.97 | 10.56 | 12.15 | 12.87 |
| 2002 | 0.05 | 0.22 | 0.63 | 1.30 | 1.95 | 2.65 | 3.69 | 4.75 | 5.50 | 6.93 | 8.41 | 9.18 | 9.78 | 11.66 | 14.62 |
| 2003 | 0.06 | 0.27 | 0.56 | 1.22 | 1.82 | 2.64 | 3.61 | 4.67 | 5.78 | 6.59 | 8.02 | 9.24 | 10.33 | 11.92 | 13.76 |
| 2004 | 0.16 | 0.18 | 0.71 | 1.18 | 1.84 | 2.62 | 3.64 | 4.60 | 5.62 | 6.59 | 7.67 | 8.76 | 9.96 | 11.39 | 13.18 |
| 2005 | 0.08 | 0.34 | 0.61 | 1.17 | 1.76 | 2.80 | 3.61 | 4.83 | 5.74 | 6.62 | 7.78 | 9.04 | 10.10 | 11.59 | 14.21 |
| 2006 | 0.11 | 0.22 | 0.64 | 1.24 | 1.79 | 2.49 | 3.52 | 4.73 | 6.15 | 6.88 | 7.87 | 8.94 | 10.63 | 12.03 | 14.37 |
| 2007 | 0.05 | 0.29 | 0.60 | 1.03 | 1.68 | 2.45 | 3.47 | 4.52 | 6.07 | 7.25 | 8.34 | 9.32 | 10.69 | 12.50 | 15.54 |
| 2008 | 0.12 | 0.21 | 0.69 | 1.16 | 1.67 | 2.70 | 3.94 | 4.87 | 5.97 | 7.54 | 8.49 | 9.60 | 10.92 | 12.69 | 14.74 |
| 2009 | 0.16 | 0.36 | 0.68 | 1.21 | 1.66 | 2.65 | 3.95 | 5.38 | 6.15 | 7.19 | 8.53 | 9.33 | 10.56 | 12.26 | 14.20 |
| 2010 | 0.09 | 0.43 | 0.83 | 1.21 | 1.68 | 2.53 | 3.75 | 4.84 | 6.00 | 7.25 | 8.33 | 8.98 | 10.25 | 11.90 | 13.91 |
| 2011 | 0.13 | 0.29 | 0.85 | 1.31 | 1.68 | 2.48 | 3.70 | 4.68 | 5.78 | 6.88 | 7.92 | 9.46 | 10.19 | 11.94 | 14.40 |
| 2012 | 0.03 | 0.31 | 0.72 | 1.32 | 1.89 | 2.55 | 3.70 | 4.91 | 5.81 | 7.30 | 8.26 | 9.24 | 11.00 | 12.46 | 15.31 |
| 2013 | 0.11 | 0.20 | 0.68 | 1.18 | 1.95 | 2.79 | 3.67 | 4.85 | 6.27 | 7.04 | 8.77 | 9.72 | 11.23 | 12.92 | 15.49 |
| 2014 | 0.64 | 0.32 | 0.66 | 1.10 | 1.73 | 2.64 | 3.80 | 4.68 | 6.09 | 7.51 | 8.32 | 10.50 | 11.87 | 13.73 | 17.69 |
| 2015 | 0.09 | 0.38 | 0.71 | 1.19 | 1.78 | 2.84 | 3.74 | 4.93 | 6.08 | 7.33 | 8.69 | 9.83 | 11.94 | 13.49 | 15.03 |
| 2016 | 0.10 | 0.25 | 0.48 | 1.07 | 1.86 | 2.92 | 4.22 | 5.25 | 6.34 | 7.88 | 8.78 | 10.03 | 11.90 | 13.53 | 17.26 |
| 2017 | 0.16 | 0.28 | 0.68 | 1.11 | 1.77 | 2.67 | 3.89 | 5.02 | 6.21 | 7.78 | 9.34 | 10.41 | 12.11 | 14.12 | 16.07 |

Table B7.1. Total removals, proportion at age, and associated coefficients of variations of Atlantic striped bass by region and model period. (Period 1=January-February; Period 2=March-June; Period 3=July-December)

*Chesapeake Bay*

Total Bay Removals (Period 1)

| Year | Total | 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+ | CV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 78,294 | 0.0000 | 0.1621 | 0.5802 | 0.2535 | 0.0025 | 0.0014 | 0.0001 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1983 | 53,134 | 0.0000 | 0.3097 | 0.5834 | 0.1025 | 0.0045 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1984 | 65,708 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1985 | 10 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1986 | 10 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1987 | 10 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1988 | 10 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1989 | 10 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1990 | 10 | 0.0000 | 0.5355 | 0.4143 | 0.0441 | 0.0061 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1991 | 35,331 | 0.0005 | 0.0079 | 0.0570 | 0.2124 | 0.3378 | 0.1842 | 0.1468 | 0.0436 | 0.0095 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1992 | 173,383 | 0.0002 | 0.0037 | 0.0879 | 0.2911 | 0.2318 | 0.2285 | 0.1186 | 0.0319 | 0.0055 | 0.0008 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1993 | 159,632 | 0.0004 | 0.0111 | 0.0504 | 0.3451 | 0.3506 | 0.1069 | 0.0828 | 0.0322 | 0.0141 | 0.0014 | 0.0013 | 0.0017 | 0.0006 | 0.0003 | 0.0010 | 0.200 |
| 1994 | 140,042 | 0.0000 | 0.0156 | 0.0286 | 0.1541 | 0.4003 | 0.2599 | 0.0998 | 0.0339 | 0.0044 | 0.0028 | 0.0004 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1995 | 169,003 | 0.0001 | 0.0154 | 0.0393 | 0.1944 | 0.3405 | 0.2887 | 0.0842 | 0.0248 | 0.0065 | 0.0054 | 0.0007 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.200 |
| 1996 | 251,598 | 0.0000 | 0.0105 | 0.0747 | 0.1396 | 0.2778 | 0.2495 | 0.1718 | 0.0456 | 0.0155 | 0.0103 | 0.0030 | 0.0011 | 0.0002 | 0.0002 | 0.0000 | 0.200 |
| 1997 | 356,833 | 0.0000 | 0.0019 | 0.0300 | 0.3826 | 0.2461 | 0.2215 | 0.0736 | 0.0287 | 0.0088 | 0.0046 | 0.0010 | 0.0005 | 0.0003 | 0.0002 | 0.0002 | 0.200 |
| 1998 | 329,607 | 0.0000 | 0.0003 | 0.0389 | 0.2145 | 0.5014 | 0.1390 | 0.0514 | 0.0208 | 0.0176 | 0.0085 | 0.0039 | 0.0022 | 0.0007 | 0.0004 | 0.0005 | 0.200 |
| 1999 | 156,811 | 0.0001 | 0.0170 | 0.0735 | 0.1947 | 0.2764 | 0.3017 | 0.0845 | 0.0235 | 0.0148 | 0.0043 | 0.0037 | 0.0023 | 0.0009 | 0.0008 | 0.0017 | 0.200 |
| 2000 | 339,383 | 0.0000 | 0.0045 | 0.0108 | 0.2063 | 0.3322 | 0.2708 | 0.1313 | 0.0289 | 0.0078 | 0.0055 | 0.0013 | 0.0002 | 0.0004 | 0.0000 | 0.0000 | 0.200 |
| 2001 | 153,487 | 0.0000 | 0.0004 | 0.0178 | 0.2133 | 0.3748 | 0.2463 | 0.0720 | 0.0451 | 0.0136 | 0.0080 | 0.0061 | 0.0015 | 0.0006 | 0.0006 | 0.0000 | 0.200 |
| 2002 | 242,151 | 0.0006 | 0.0078 | 0.0157 | 0.1270 | 0.3032 | 0.2805 | 0.1706 | 0.0362 | 0.0306 | 0.0144 | 0.0059 | 0.0033 | 0.0025 | 0.0004 | 0.0013 | 0.200 |
| 2003 | 155,179 | 0.0001 | 0.0014 | 0.0546 | 0.2092 | 0.3761 | 0.1146 | 0.1024 | 0.0502 | 0.0348 | 0.0371 | 0.0096 | 0.0055 | 0.0021 | 0.0011 | 0.0011 | 0.200 |
| 2004 | 189,334 | 0.0008 | 0.0126 | 0.0734 | 0.2183 | 0.2252 | 0.0759 | 0.1271 | 0.1130 | 0.0599 | 0.0351 | 0.0374 | 0.0107 | 0.0073 | 0.0021 | 0.0010 | 0.200 |
| 2005 | 274,805 | 0.0000 | 0.0007 | 0.0462 | 0.3612 | 0.3692 | 0.1133 | 0.0255 | 0.0236 | 0.0217 | 0.0131 | 0.0125 | 0.0066 | 0.0033 | 0.0012 | 0.0020 | 0.200 |
| 2006 | 292,351 | 0.0000 | 0.0003 | 0.0635 | 0.2197 | 0.3658 | 0.2133 | 0.0432 | 0.0185 | 0.0265 | 0.0256 | 0.0131 | 0.0061 | 0.0025 | 0.0013 | 0.0006 | 0.200 |
| 2007 | 207,048 | 0.0000 | 0.0007 | 0.0212 | 0.3431 | 0.1105 | 0.2522 | 0.0838 | 0.0538 | 0.0506 | 0.0385 | 0.0315 | 0.0070 | 0.0040 | 0.0025 | 0.0005 | 0.200 |
| 2008 | 226,448 | 0.0000 | 0.0002 | 0.0222 | 0.1212 | 0.4275 | 0.0933 | 0.0964 | 0.0490 | 0.0213 | 0.0413 | 0.0405 | 0.0465 | 0.0222 | 0.0091 | 0.0093 | 0.200 |
| 2009 | 278,804 | 0.0000 | 0.0002 | 0.0171 | 0.2759 | 0.3949 | 0.1841 | 0.0219 | 0.0276 | 0.0213 | 0.0173 | 0.0160 | 0.0080 | 0.0114 | 0.0032 | 0.0011 | 0.200 |
| 2010 | 264,690 | 0.0000 | 0.0006 | 0.0699 | 0.2559 | 0.2788 | 0.2205 | 0.0992 | 0.0465 | 0.0148 | 0.0053 | 0.0016 | 0.0027 | 0.0018 | 0.0013 | 0.0011 | 0.200 |
| 2011 | 213,651 | 0.0000 | 0.0010 | 0.0549 | 0.1455 | 0.2598 | 0.2333 | 0.1208 | 0.0872 | 0.0240 | 0.0327 | 0.0126 | 0.0088 | 0.0073 | 0.0053 | 0.0067 | 0.200 |
| 2012 | 278,515 | 0.0000 | 0.0019 | 0.0357 | 0.1333 | 0.3412 | 0.1768 | 0.1111 | 0.0362 | 0.0627 | 0.0261 | 0.0432 | 0.0121 | 0.0077 | 0.0043 | 0.0077 | 0.200 |
| 2013 | 182,910 | 0.0000 | 0.0011 | 0.0406 | 0.1454 | 0.3585 | 0.2438 | 0.0789 | 0.0426 | 0.0291 | 0.0340 | 0.0091 | 0.0072 | 0.0041 | 0.0021 | 0.0035 | 0.200 |
| 2014 | 173,168 | 0.0000 | 0.0000 | 0.0138 | 0.0930 | 0.3291 | 0.2409 | 0.1512 | 0.0816 | 0.0464 | 0.0282 | 0.0093 | 0.0014 | 0.0017 | 0.0008 | 0.0026 | 0.200 |
| 2015 | 100,248 | 0.0000 | 0.0000 | 0.0224 | 0.1724 | 0.1259 | 0.2049 | 0.1839 | 0.1443 | 0.0493 | 0.0557 | 0.0175 | 0.0155 | 0.0038 | 0.0013 | 0.0032 | 0.200 |
| 2016 | 139,514 | 0.0000 | 0.0001 | 0.0327 | 0.0727 | 0.2613 | 0.2163 | 0.2381 | 0.0946 | 0.0354 | 0.0136 | 0.0120 | 0.0108 | 0.0078 | 0.0017 | 0.0030 | 0.200 |
| 2017 | 127,232 | 0.0000 | 0.0000 | 0.0288 | 0.1929 | 0.1057 | 0.2664 | 0.1711 | 0.1272 | 0.0578 | 0.0158 | 0.0114 | 0.0092 | 0.0060 | 0.0059 | 0.0018 | 0.200 |

Table B7.1 Continued (Chesapeake Bay).

| | | | | | | | Total Bay Removals (Period 2) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ | CV |
| 1982 | 86,437 | 0.0002 | 0.3059 | 0.3597 | 0.2389 | 0.0646 | 0.0143 | 0.0025 | 0.0021 | 0.0002 | 0.0009 | 0.0037 | 0.0056 | 0.0002 | 0.0005 | 0.0009 | 0.2 |
| 1983 | 88,070 | 0.0029 | 0.4959 | 0.2465 | 0.1125 | 0.0473 | 0.0290 | 0.0212 | 0.0234 | 0.0045 | 0.0025 | 0.0001 | 0.0119 | 0.0001 | 0.0021 | 0.0000 | 0.2 |
| 1984 | 56,356 | 0.0000 | 0.4030 | 0.4794 | 0.0790 | 0.0261 | 0.0068 | 0.0045 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0009 | 0.0000 | 0.2 |
| 1985 | 30,199 | 0.0003 | 0.1652 | 0.7234 | 0.0818 | 0.0118 | 0.0044 | 0.0042 | 0.0008 | 0.0011 | 0.0007 | 0.0002 | 0.0006 | 0.0012 | 0.0006 | 0.0036 | 0.2 |
| 1986 | 54,640 | 0.0000 | 0.1257 | 0.2340 | 0.6141 | 0.0126 | 0.0056 | 0.0028 | 0.0016 | 0.0004 | 0.0000 | 0.0000 | 0.0000 | 0.0004 | 0.0011 | 0.0016 | 0.2 |
| 1987 | 34,942 | 0.0152 | 0.3382 | 0.3136 | 0.1352 | 0.1906 | 0.0033 | 0.0007 | 0.0005 | 0.0006 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0006 | 0.0011 | 0.2 |
| 1988 | 15,228 | 0.0000 | 0.0659 | 0.2250 | 0.2566 | 0.2016 | 0.2372 | 0.0082 | 0.0004 | 0.0002 | 0.0015 | 0.0000 | 0.0002 | 0.0002 | 0.0008 | 0.0026 | 0.2 |
| 1989 | 16,735 | 0.0000 | 0.0703 | 0.2389 | 0.2079 | 0.1940 | 0.1667 | 0.1190 | 0.0014 | 0.0002 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0000 | 0.0012 | 0.2 |
| 1990 | 50,835 | 0.0000 | 0.0619 | 0.2068 | 0.1496 | 0.1650 | 0.1509 | 0.1149 | 0.1394 | 0.0036 | 0.0015 | 0.0002 | 0.0002 | 0.0023 | 0.0005 | 0.0032 | 0.110 |
| 1991 | 89,334 | 0.0357 | 0.1133 | 0.2259 | 0.1091 | 0.0979 | 0.1369 | 0.1291 | 0.0905 | 0.0487 | 0.0026 | 0.0017 | 0.0000 | 0.0009 | 0.0022 | 0.0056 | 0.110 |
| 1992 | 95,952 | 0.0004 | 0.0236 | 0.3401 | 0.2020 | 0.0963 | 0.1188 | 0.0916 | 0.0597 | 0.0342 | 0.0226 | 0.0006 | 0.0005 | 0.0021 | 0.0031 | 0.0045 | 0.110 |
| 1993 | 80,246 | 0.0000 | 0.0318 | 0.0942 | 0.3348 | 0.1831 | 0.0902 | 0.0846 | 0.0763 | 0.0479 | 0.0315 | 0.0155 | 0.0010 | 0.0026 | 0.0026 | 0.0040 | 0.110 |
| 1994 | 120,710 | 0.0000 | 0.0205 | 0.0830 | 0.1642 | 0.3318 | 0.1911 | 0.0685 | 0.0679 | 0.0448 | 0.0162 | 0.0086 | 0.0015 | 0.0007 | 0.0002 | 0.0010 | 0.110 |
| 1995 | 325,039 | 0.0000 | 0.0048 | 0.0409 | 0.0874 | 0.1114 | 0.2422 | 0.2463 | 0.1114 | 0.0842 | 0.0365 | 0.0209 | 0.0128 | 0.0001 | 0.0000 | 0.0009 | 0.165 |
| 1996 | 303,468 | 0.0000 | 0.0068 | 0.0769 | 0.1239 | 0.1680 | 0.1691 | 0.2161 | 0.1344 | 0.0580 | 0.0243 | 0.0162 | 0.0048 | 0.0009 | 0.0000 | 0.0005 | 0.085 |
| 1997 | 433,509 | 0.0018 | 0.0399 | 0.1136 | 0.2472 | 0.1237 | 0.0825 | 0.0872 | 0.1273 | 0.0894 | 0.0577 | 0.0160 | 0.0105 | 0.0029 | 0.0004 | 0.0001 | 0.054 |
| 1998 | 418,993 | 0.0041 | 0.0297 | 0.1440 | 0.1918 | 0.2224 | 0.1159 | 0.0668 | 0.0578 | 0.0598 | 0.0476 | 0.0357 | 0.0159 | 0.0062 | 0.0020 | 0.0003 | 0.104 |
| 1999 | 464,322 | 0.0019 | 0.0104 | 0.1107 | 0.1668 | 0.1970 | 0.2382 | 0.0956 | 0.0388 | 0.0503 | 0.0333 | 0.0270 | 0.0169 | 0.0071 | 0.0030 | 0.0030 | 0.044 |
| 2000 | 597,322 | 0.0074 | 0.0091 | 0.0404 | 0.1720 | 0.2465 | 0.2017 | 0.1550 | 0.0680 | 0.0323 | 0.0271 | 0.0169 | 0.0126 | 0.0057 | 0.0024 | 0.0028 | 0.099 |
| 2001 | 382,452 | 0.0015 | 0.0010 | 0.0471 | 0.1229 | 0.2075 | 0.1393 | 0.1418 | 0.1732 | 0.0549 | 0.0373 | 0.0350 | 0.0181 | 0.0160 | 0.0029 | 0.0015 | 0.125 |
| 2002 | 318,952 | 0.0003 | 0.0413 | 0.0646 | 0.1330 | 0.2182 | 0.1633 | 0.1226 | 0.0830 | 0.0830 | 0.0313 | 0.0199 | 0.0115 | 0.0093 | 0.0071 | 0.0116 | 0.086 |
| 2003 | 713,802 | 0.0000 | 0.0175 | 0.0479 | 0.0934 | 0.1183 | 0.1398 | 0.1608 | 0.1118 | 0.1011 | 0.1221 | 0.0384 | 0.0261 | 0.0130 | 0.0055 | 0.0042 | 0.086 |
| 2004 | 582,611 | 0.0289 | 0.0148 | 0.1006 | 0.1097 | 0.0806 | 0.0782 | 0.0767 | 0.1349 | 0.1099 | 0.0966 | 0.0939 | 0.0393 | 0.0203 | 0.0091 | 0.0064 | 0.097 |
| 2005 | 762,307 | 0.0065 | 0.0172 | 0.0309 | 0.0897 | 0.1194 | 0.0700 | 0.0784 | 0.0823 | 0.1595 | 0.1299 | 0.1120 | 0.0682 | 0.0178 | 0.0063 | 0.0120 | 0.187 |
| 2006 | 674,558 | 0.0008 | 0.0067 | 0.0974 | 0.0779 | 0.1671 | 0.1111 | 0.0640 | 0.0736 | 0.1065 | 0.1344 | 0.0698 | 0.0455 | 0.0301 | 0.0091 | 0.0059 | 0.122 |
| 2007 | 620,569 | 0.0012 | 0.0186 | 0.0326 | 0.1974 | 0.0967 | 0.1281 | 0.1077 | 0.0607 | 0.0818 | 0.0858 | 0.0919 | 0.0450 | 0.0189 | 0.0214 | 0.0122 | 0.139 |
| 2008 | 421,009 | 0.0001 | 0.0008 | 0.0216 | 0.1421 | 0.2726 | 0.0827 | 0.0913 | 0.0722 | 0.0576 | 0.0614 | 0.0577 | 0.0855 | 0.0264 | 0.0131 | 0.0148 | 0.129 |
| 2009 | 548,011 | 0.0006 | 0.0284 | 0.0306 | 0.1350 | 0.1295 | 0.1880 | 0.0573 | 0.0918 | 0.1069 | 0.0448 | 0.0690 | 0.0369 | 0.0517 | 0.0117 | 0.0177 | 0.146 |
| 2010 | 468,418 | 0.0000 | 0.0034 | 0.1138 | 0.1227 | 0.1713 | 0.1242 | 0.1622 | 0.0365 | 0.0657 | 0.0628 | 0.0280 | 0.0302 | 0.0320 | 0.0279 | 0.0192 | 0.097 |
| 2011 | 591,641 | 0.0012 | 0.0060 | 0.0467 | 0.1973 | 0.1450 | 0.1160 | 0.1061 | 0.1517 | 0.0485 | 0.0834 | 0.0477 | 0.0203 | 0.0104 | 0.0070 | 0.0126 | 0.110 |
| 2012 | 487,148 | 0.0008 | 0.0134 | 0.1015 | 0.0910 | 0.1466 | 0.1203 | 0.1361 | 0.0978 | 0.1411 | 0.0490 | 0.0554 | 0.0160 | 0.0089 | 0.0118 | 0.0104 | 0.116 |
| 2013 | 725,765 | 0.0000 | 0.0187 | 0.0825 | 0.2204 | 0.1421 | 0.1565 | 0.0596 | 0.0492 | 0.0666 | 0.1109 | 0.0235 | 0.0375 | 0.0092 | 0.0069 | 0.0163 | 0.086 |
| 2014 | 565,949 | 0.0003 | 0.0025 | 0.1046 | 0.1428 | 0.1894 | 0.1024 | 0.0886 | 0.0358 | 0.0578 | 0.0718 | 0.1365 | 0.0162 | 0.0281 | 0.0057 | 0.0173 | 0.108 |
| 2015 | 614,938 | 0.0004 | 0.0029 | 0.0268 | 0.2552 | 0.1121 | 0.0727 | 0.0442 | 0.0444 | 0.0407 | 0.0854 | 0.0800 | 0.1137 | 0.0243 | 0.0554 | 0.0418 | 0.127 |
| 2016 | 1,212,630 | 0.0092 | 0.0103 | 0.0551 | 0.0436 | 0.4260 | 0.0949 | 0.0408 | 0.0165 | 0.0257 | 0.0295 | 0.0646 | 0.0692 | 0.0790 | 0.0103 | 0.0254 | 0.136 |
| 2017 | 851,873 | 0.0015 | 0.0210 | 0.0630 | 0.1355 | 0.1481 | 0.3077 | 0.0602 | 0.0391 | 0.0264 | 0.0464 | 0.0340 | 0.0591 | 0.0277 | 0.0203 | 0.0099 | 0.134 |

Table B7.1 Continued (Chesapeake Bay).

| | | Total Bay Removals (Period 3) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ | CV |
| 1982 | 63,911 | 0.0000 | 0.0824 | 0.7614 | 0.1416 | 0.0143 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1983 | 196,785 | 0.0000 | 0.1928 | 0.2117 | 0.5323 | 0.0075 | 0.0217 | 0.0159 | 0.0104 | 0.0000 | 0.0010 | 0.0027 | 0.0007 | 0.0013 | 0.0013 | 0.0007 | 0.2 |
| 1984 | 356,261 | 0.0000 | 0.0455 | 0.8761 | 0.0577 | 0.0156 | 0.0047 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1985 | 18,487 | 0.1421 | 0.3121 | 0.2162 | 0.3245 | 0.0051 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1986 | 46,009 | 0.0000 | 0.3585 | 0.3346 | 0.1206 | 0.1800 | 0.0032 | 0.0019 | 0.0009 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1987 | 9,997 | 0.1581 | 0.4510 | 0.1583 | 0.1104 | 0.0590 | 0.0613 | 0.0016 | 0.0004 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1988 | 107,875 | 0.0003 | 0.1940 | 0.2587 | 0.1590 | 0.2006 | 0.1469 | 0.0360 | 0.0045 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1989 | 68,357 | 0.0006 | 0.4246 | 0.0638 | 0.1428 | 0.0725 | 0.1639 | 0.0993 | 0.0324 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2 |
| 1990 | 612,811 | 0.0014 | 0.0605 | 0.0689 | 0.1168 | 0.2432 | 0.3916 | 0.0932 | 0.0131 | 0.0046 | 0.0031 | 0.0014 | 0.0011 | 0.0006 | 0.0003 | 0.0003 | 0.065 |
| 1991 | 666,521 | 0.0004 | 0.0837 | 0.1510 | 0.1269 | 0.1803 | 0.3103 | 0.1144 | 0.0121 | 0.0076 | 0.0066 | 0.0028 | 0.0020 | 0.0012 | 0.0006 | 0.0002 | 0.065 |
| 1992 | 724,195 | 0.0034 | 0.0318 | 0.1926 | 0.2070 | 0.2025 | 0.1989 | 0.1258 | 0.0331 | 0.0026 | 0.0023 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.065 |
| 1993 | 705,786 | 0.0032 | 0.0558 | 0.1000 | 0.2497 | 0.2607 | 0.1700 | 0.0964 | 0.0540 | 0.0092 | 0.0008 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.065 |
| 1994 | 1,068,659 | 0.0010 | 0.0100 | 0.1404 | 0.2857 | 0.2777 | 0.1135 | 0.0894 | 0.0415 | 0.0263 | 0.0086 | 0.0031 | 0.0026 | 0.0001 | 0.0000 | 0.0000 | 0.065 |
| 1995 | 1,485,648 | 0.0000 | 0.0656 | 0.2047 | 0.2614 | 0.1967 | 0.1242 | 0.0678 | 0.0363 | 0.0228 | 0.0084 | 0.0043 | 0.0023 | 0.0016 | 0.0011 | 0.0029 | 0.062 |
| 1996 | 1,958,369 | 0.0054 | 0.0206 | 0.3465 | 0.2322 | 0.1860 | 0.1129 | 0.0546 | 0.0178 | 0.0101 | 0.0064 | 0.0052 | 0.0009 | 0.0006 | 0.0004 | 0.0005 | 0.063 |
| 1997 | 2,372,318 | 0.0396 | 0.0955 | 0.1658 | 0.3482 | 0.1283 | 0.1066 | 0.0481 | 0.0336 | 0.0175 | 0.0081 | 0.0047 | 0.0023 | 0.0016 | 0.0002 | 0.0001 | 0.044 |
| 1998 | 2,198,679 | 0.0031 | 0.0672 | 0.2570 | 0.3171 | 0.1589 | 0.0904 | 0.0397 | 0.0262 | 0.0186 | 0.0126 | 0.0029 | 0.0022 | 0.0015 | 0.0022 | 0.0006 | 0.047 |
| 1999 | 2,573,338 | 0.0019 | 0.0241 | 0.2007 | 0.2495 | 0.1872 | 0.1898 | 0.0630 | 0.0277 | 0.0210 | 0.0123 | 0.0112 | 0.0050 | 0.0045 | 0.0010 | 0.0011 | 0.043 |
| 2000 | 2,496,799 | 0.0225 | 0.0897 | 0.0678 | 0.2602 | 0.2875 | 0.1145 | 0.0844 | 0.0292 | 0.0127 | 0.0149 | 0.0074 | 0.0041 | 0.0022 | 0.0023 | 0.0004 | 0.058 |
| 2001 | 2,053,627 | 0.0387 | 0.0894 | 0.1325 | 0.1674 | 0.2270 | 0.1285 | 0.0859 | 0.0599 | 0.0183 | 0.0180 | 0.0126 | 0.0139 | 0.0039 | 0.0036 | 0.0004 | 0.051 |
| 2002 | 2,114,284 | 0.0154 | 0.1352 | 0.1061 | 0.1545 | 0.1501 | 0.1640 | 0.1165 | 0.0486 | 0.0600 | 0.0178 | 0.0126 | 0.0069 | 0.0054 | 0.0011 | 0.0057 | 0.058 |
| 2003 | 2,465,425 | 0.0000 | 0.1746 | 0.1840 | 0.1678 | 0.1312 | 0.1002 | 0.0830 | 0.0472 | 0.0439 | 0.0346 | 0.0146 | 0.0078 | 0.0050 | 0.0028 | 0.0032 | 0.053 |
| 2004 | 2,556,145 | 0.0583 | 0.0605 | 0.2785 | 0.2215 | 0.0881 | 0.0884 | 0.0683 | 0.0457 | 0.0308 | 0.0198 | 0.0200 | 0.0091 | 0.0049 | 0.0028 | 0.0032 | 0.050 |
| 2005 | 1,935,963 | 0.0075 | 0.2115 | 0.1005 | 0.2633 | 0.1707 | 0.0638 | 0.0452 | 0.0250 | 0.0365 | 0.0214 | 0.0239 | 0.0129 | 0.0088 | 0.0036 | 0.0055 | 0.056 |
| 2006 | 3,121,246 | 0.0220 | 0.0873 | 0.2334 | 0.1727 | 0.2097 | 0.1066 | 0.0412 | 0.0295 | 0.0197 | 0.0239 | 0.0151 | 0.0111 | 0.0122 | 0.0037 | 0.0118 | 0.066 |
| 2007 | 2,339,997 | 0.0063 | 0.0581 | 0.0712 | 0.3799 | 0.1732 | 0.1462 | 0.0445 | 0.0285 | 0.0242 | 0.0172 | 0.0211 | 0.0134 | 0.0065 | 0.0026 | 0.0070 | 0.072 |
| 2008 | 1,980,565 | 0.0362 | 0.0190 | 0.0695 | 0.1642 | 0.3159 | 0.0934 | 0.0947 | 0.0498 | 0.0169 | 0.0317 | 0.0259 | 0.0356 | 0.0135 | 0.0149 | 0.0188 | 0.063 |
| 2009 | 2,314,978 | 0.0040 | 0.0702 | 0.0518 | 0.2348 | 0.2099 | 0.1911 | 0.0383 | 0.0487 | 0.0294 | 0.0144 | 0.0200 | 0.0256 | 0.0289 | 0.0130 | 0.0201 | 0.069 |
| 2010 | 2,199,827 | 0.0089 | 0.0129 | 0.1843 | 0.1476 | 0.2011 | 0.1793 | 0.1599 | 0.0345 | 0.0327 | 0.0110 | 0.0038 | 0.0051 | 0.0050 | 0.0072 | 0.0068 | 0.122 |
| 2011 | 1,716,900 | 0.0305 | 0.0668 | 0.0671 | 0.3315 | 0.0979 | 0.1517 | 0.1239 | 0.0572 | 0.0167 | 0.0158 | 0.0085 | 0.0060 | 0.0087 | 0.0059 | 0.0118 | 0.077 |
| 2012 | 1,902,311 | 0.1304 | 0.1266 | 0.1604 | 0.1072 | 0.1907 | 0.0995 | 0.0642 | 0.0172 | 0.0150 | 0.0073 | 0.0168 | 0.0072 | 0.0093 | 0.0127 | 0.0356 | 0.076 |
| 2013 | 1,838,323 | 0.0013 | 0.1258 | 0.2024 | 0.2429 | 0.1361 | 0.1303 | 0.0561 | 0.0325 | 0.0237 | 0.0241 | 0.0102 | 0.0078 | 0.0012 | 0.0007 | 0.0049 | 0.061 |
| 2014 | 2,495,143 | 0.0074 | 0.0162 | 0.3538 | 0.2288 | 0.2354 | 0.0719 | 0.0425 | 0.0159 | 0.0128 | 0.0074 | 0.0017 | 0.0004 | 0.0006 | 0.0005 | 0.0046 | 0.102 |
| 2015 | 2,085,113 | 0.1058 | 0.0995 | 0.0468 | 0.3363 | 0.2006 | 0.0605 | 0.0475 | 0.0476 | 0.0169 | 0.0245 | 0.0094 | 0.0029 | 0.0006 | 0.0002 | 0.0010 | 0.059 |
| 2016 | 2,251,451 | 0.0884 | 0.1112 | 0.1006 | 0.1515 | 0.3677 | 0.1136 | 0.0220 | 0.0152 | 0.0159 | 0.0049 | 0.0053 | 0.0011 | 0.0008 | 0.0003 | 0.0017 | 0.070 |
| 2017 | 1,520,046 | 0.0303 | 0.1104 | 0.1397 | 0.1290 | 0.2560 | 0.2562 | 0.0387 | 0.0199 | 0.0100 | 0.0051 | 0.0017 | 0.0013 | 0.0007 | 0.0003 | 0.0008 | 0.081 |

Table B7.1 continued (ocean and other areas)

Total Ocean Removals (Period 1)

| Year | Total | 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+ | CV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 3,544 | 0.0000 | 0.0465 | 0.0156 | 0.0210 | 0.0229 | 0.0377 | 0.0462 | 0.0548 | 0.0638 | 0.1810 | 0.1902 | 0.1544 | 0.0367 | 0.1001 | 0.0293 | 0.224 |
| 1983 | 1,454 | 0.0000 | 0.0172 | 0.0040 | 0.0049 | 0.0033 | 0.0009 | 0.0003 | 0.0002 | 0.0290 | 0.1260 | 0.2994 | 0.1935 | 0.1074 | 0.1069 | 0.1068 | 0.224 |
| 1984 | 560 | 0.0000 | 0.0267 | 0.0042 | 0.0155 | 0.0334 | 0.1801 | 0.1028 | 0.0665 | 0.0663 | 0.0466 | 0.0555 | 0.1770 | 0.1306 | 0.0292 | 0.0656 | 0.224 |
| 1985 | 10 | 0.0000 | 0.0267 | 0.0042 | 0.0155 | 0.0334 | 0.1801 | 0.1028 | 0.0665 | 0.0663 | 0.0466 | 0.0555 | 0.1770 | 0.1306 | 0.0292 | 0.0656 | 0.450 |
| 1986 | 10 | 0.0000 | 0.0267 | 0.0042 | 0.0155 | 0.0334 | 0.1801 | 0.1028 | 0.0665 | 0.0663 | 0.0466 | 0.0555 | 0.1770 | 0.1306 | 0.0292 | 0.0656 | 0.397 |
| 1987 | 10 | 0.0000 | 0.0267 | 0.0042 | 0.0155 | 0.0334 | 0.1801 | 0.1028 | 0.0665 | 0.0663 | 0.0466 | 0.0555 | 0.1770 | 0.1306 | 0.0292 | 0.0656 | 0.267 |
| 1988 | 10 | 0.0000 | 0.0267 | 0.0042 | 0.0155 | 0.0334 | 0.1801 | 0.1028 | 0.0665 | 0.0663 | 0.0466 | 0.0555 | 0.1770 | 0.1306 | 0.0292 | 0.0656 | 0.222 |
| 1989 | 10 | 0.0000 | 0.0267 | 0.0042 | 0.0155 | 0.0334 | 0.1801 | 0.1028 | 0.0665 | 0.0663 | 0.0466 | 0.0555 | 0.1770 | 0.1306 | 0.0292 | 0.0656 | 0.194 |
| 1990 | 2,258 | 0.0000 | 0.0076 | 0.0673 | 0.1814 | 0.1649 | 0.2000 | 0.2015 | 0.1167 | 0.0352 | 0.0207 | 0.0040 | 0.0001 | 0.0001 | 0.0001 | 0.0004 | 0.200 |
| 1991 | 2,416 | 0.0001 | 0.0126 | 0.0322 | 0.1036 | 0.0928 | 0.0767 | 0.1883 | 0.1843 | 0.1934 | 0.0758 | 0.0171 | 0.0056 | 0.0047 | 0.0008 | 0.0120 | 0.418 |
| 1992 | 7,360 | 0.0000 | 0.0053 | 0.0381 | 0.0857 | 0.0847 | 0.1061 | 0.1734 | 0.2190 | 0.1623 | 0.0825 | 0.0228 | 0.0117 | 0.0032 | 0.0012 | 0.0041 | 0.364 |
| 1993 | 7,061 | 0.0000 | 0.0151 | 0.0379 | 0.0683 | 0.1308 | 0.0954 | 0.0795 | 0.3214 | 0.1806 | 0.0603 | 0.0076 | 0.0016 | 0.0003 | 0.0002 | 0.0009 | 0.212 |
| 1994 | 16,936 | 0.0000 | 0.0258 | 0.0453 | 0.1002 | 0.2171 | 0.1447 | 0.1311 | 0.1543 | 0.0902 | 0.0488 | 0.0283 | 0.0069 | 0.0034 | 0.0007 | 0.0032 | 0.212 |
| 1995 | 23,255 | 0.0000 | 0.1513 | 0.0967 | 0.0510 | 0.0591 | 0.0726 | 0.0627 | 0.1186 | 0.2285 | 0.1095 | 0.0293 | 0.0146 | 0.0037 | 0.0017 | 0.0007 | 0.212 |
| 1996 | 55,683 | 0.0000 | 0.0004 | 0.0055 | 0.0733 | 0.0366 | 0.1371 | 0.2910 | 0.2598 | 0.0582 | 0.0891 | 0.0303 | 0.0094 | 0.0090 | 0.0002 | 0.0001 | 0.212 |
| 1997 | 261,370 | 0.0000 | 0.0019 | 0.0395 | 0.1005 | 0.0963 | 0.1146 | 0.1784 | 0.1739 | 0.1122 | 0.0739 | 0.0521 | 0.0423 | 0.0103 | 0.0034 | 0.0006 | 0.212 |
| 1998 | 193,508 | 0.0000 | 0.0074 | 0.0965 | 0.1747 | 0.0920 | 0.1439 | 0.1264 | 0.1150 | 0.1065 | 0.0743 | 0.0416 | 0.0060 | 0.0103 | 0.0038 | 0.0015 | 0.212 |
| 1999 | 256,537 | 0.0000 | 0.0210 | 0.1276 | 0.1914 | 0.0886 | 0.1125 | 0.1133 | 0.1242 | 0.1050 | 0.0729 | 0.0278 | 0.0031 | 0.0045 | 0.0057 | 0.0022 | 0.212 |
| 2000 | 116,647 | 0.0000 | 0.0013 | 0.0182 | 0.0851 | 0.0734 | 0.2529 | 0.1956 | 0.1277 | 0.0974 | 0.0551 | 0.0528 | 0.0224 | 0.0037 | 0.0119 | 0.0026 | 0.212 |
| 2001 | 180,078 | 0.0000 | 0.0007 | 0.0076 | 0.0408 | 0.0788 | 0.0862 | 0.1550 | 0.1721 | 0.1390 | 0.1447 | 0.1061 | 0.0223 | 0.0149 | 0.0108 | 0.0211 | 0.212 |
| 2002 | 332,905 | 0.0000 | 0.0009 | 0.0062 | 0.0175 | 0.0601 | 0.0899 | 0.0994 | 0.2116 | 0.2117 | 0.1718 | 0.1020 | 0.0176 | 0.0064 | 0.0027 | 0.0022 | 0.212 |
| 2003 | 265,163 | 0.0003 | 0.0028 | 0.0098 | 0.0321 | 0.0182 | 0.0390 | 0.1318 | 0.2016 | 0.2543 | 0.1472 | 0.0872 | 0.0424 | 0.0093 | 0.0033 | 0.0208 | 0.212 |
| 2004 | 461,332 | 0.0000 | 0.0126 | 0.0056 | 0.0069 | 0.0071 | 0.0118 | 0.1773 | 0.1891 | 0.2254 | 0.1745 | 0.1022 | 0.0518 | 0.0196 | 0.0109 | 0.0051 | 0.212 |
| 2005 | 254,027 | 0.0000 | 0.0009 | 0.0040 | 0.0037 | 0.0085 | 0.0150 | 0.0159 | 0.0705 | 0.2113 | 0.2100 | 0.1731 | 0.1229 | 0.0923 | 0.0363 | 0.0355 | 0.205 |
| 2006 | 306,638 | 0.0000 | 0.0000 | 0.0009 | 0.0038 | 0.0088 | 0.0164 | 0.0468 | 0.1413 | 0.2613 | 0.2103 | 0.1771 | 0.0714 | 0.0357 | 0.0153 | 0.0109 | 0.423 |
| 2007 | 346,001 | 0.0000 | 0.0119 | 0.0263 | 0.0589 | 0.0823 | 0.0872 | 0.0499 | 0.0612 | 0.1521 | 0.2010 | 0.1432 | 0.0723 | 0.0319 | 0.0122 | 0.0097 | 0.223 |
| 2008 | 386,020 | 0.0000 | 0.0000 | 0.0045 | 0.0203 | 0.0239 | 0.0358 | 0.0417 | 0.0375 | 0.0687 | 0.1627 | 0.1846 | 0.1538 | 0.0926 | 0.0357 | 0.1380 | 0.181 |
| 2009 | 231,173 | 0.0000 | 0.0000 | 0.0004 | 0.0034 | 0.0130 | 0.0301 | 0.0795 | 0.1094 | 0.0942 | 0.1628 | 0.1414 | 0.1257 | 0.1046 | 0.0683 | 0.0675 | 0.099 |
| 2010 | 104,570 | 0.0000 | 0.0020 | 0.0072 | 0.0130 | 0.0241 | 0.0322 | 0.0706 | 0.1373 | 0.0974 | 0.2151 | 0.1227 | 0.0826 | 0.0773 | 0.0529 | 0.0658 | 0.280 |
| 2011 | 285,517 | 0.0000 | 0.0000 | 0.0059 | 0.0089 | 0.0234 | 0.0965 | 0.1481 | 0.2387 | 0.1076 | 0.1443 | 0.0501 | 0.0410 | 0.0360 | 0.0302 | 0.0692 | 0.173 |
| 2012 | 129,646 | 0.0000 | 0.0229 | 0.1295 | 0.1811 | 0.0821 | 0.0884 | 0.0762 | 0.0922 | 0.0201 | 0.0333 | 0.0124 | 0.0443 | 0.0719 | 0.0584 | 0.0873 | 0.191 |
| 2013 | 64,042 | 0.0000 | 0.0035 | 0.0120 | 0.0269 | 0.0465 | 0.0281 | 0.0247 | 0.0222 | 0.0525 | 0.0657 | 0.2486 | 0.1290 | 0.1648 | 0.0995 | 0.0760 | 0.191 |
| 2014 | 624 | 0.0000 | 0.0001 | 0.0044 | 0.0148 | 0.0621 | 0.1378 | 0.1968 | 0.2003 | 0.1098 | 0.0760 | 0.1295 | 0.0149 | 0.0256 | 0.0064 | 0.0215 | 0.190 |
| 2015 | 2,578 | 0.0000 | 0.0000 | 0.0011 | 0.0106 | 0.0376 | 0.0583 | 0.0516 | 0.1530 | 0.1623 | 0.1813 | 0.1337 | 0.1886 | 0.0156 | 0.0034 | 0.0031 | 0.190 |
| 2016 | 525 | 0.0000 | 0.0039 | 0.0040 | 0.0104 | 0.1140 | 0.1862 | 0.0804 | 0.0952 | 0.0461 | 0.0794 | 0.0790 | 0.1258 | 0.1461 | 0.0021 | 0.0274 | 0.190 |
| 2017 | 47 | 0.0000 | 0.0045 | 0.0093 | 0.0111 | 0.0549 | 0.1573 | 0.0806 | 0.0375 | 0.0156 | 0.1161 | 0.0594 | 0.1962 | 0.0651 | 0.0408 | 0.1517 | 0.190 |

Table B7.1 continued (ocean and other areas)

| | | | | | | | | Total Ocean Removals (Period 2) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ | CV |
| 1982 | 402,796 | 0.0000 | 0.1176 | 0.2884 | 0.3425 | 0.1186 | 0.0330 | 0.0116 | 0.0021 | 0.0012 | 0.0064 | 0.0110 | 0.0276 | 0.0051 | 0.0156 | 0.0193 | 0.164 |
| 1983 | 153,618 | 0.0000 | 0.0135 | 0.2486 | 0.3375 | 0.1876 | 0.0319 | 0.0079 | 0.0009 | 0.0004 | 0.0378 | 0.0065 | 0.0194 | 0.0120 | 0.0139 | 0.0822 | 0.191 |
| 1984 | 47,525 | 0.0000 | 0.0499 | 0.1072 | 0.2220 | 0.2656 | 0.1167 | 0.0984 | 0.0212 | 0.0147 | 0.0024 | 0.0019 | 0.0138 | 0.0104 | 0.0550 | 0.0208 | 0.273 |
| 1985 | 98,602 | 0.0012 | 0.0859 | 0.2291 | 0.1497 | 0.1721 | 0.0894 | 0.1003 | 0.0607 | 0.0220 | 0.0143 | 0.0148 | 0.0192 | 0.0065 | 0.0132 | 0.0215 | 0.345 |
| 1986 | 52,376 | 0.0000 | 0.0067 | 0.0706 | 0.1932 | 0.1487 | 0.1307 | 0.0694 | 0.1093 | 0.0542 | 0.0157 | 0.0299 | 0.0180 | 0.0058 | 0.0400 | 0.1076 | 0.460 |
| 1987 | 27,453 | 0.0096 | 0.0936 | 0.2316 | 0.2283 | 0.1589 | 0.0801 | 0.0610 | 0.0458 | 0.0365 | 0.0132 | 0.0049 | 0.0093 | 0.0051 | 0.0041 | 0.0181 | 0.347 |
| 1988 | 51,609 | 0.0007 | 0.0916 | 0.0998 | 0.1296 | 0.1432 | 0.1650 | 0.1264 | 0.0909 | 0.0749 | 0.0287 | 0.0101 | 0.0083 | 0.0081 | 0.0111 | 0.0116 | 0.210 |
| 1989 | 88,185 | 0.0322 | 0.1888 | 0.1392 | 0.0776 | 0.0878 | 0.0526 | 0.1360 | 0.0859 | 0.0365 | 0.0057 | 0.0316 | 0.0013 | 0.0665 | 0.0329 | 0.0252 | 0.196 |
| 1990 | 125,624 | 0.0024 | 0.0385 | 0.0763 | 0.0999 | 0.1122 | 0.1488 | 0.1959 | 0.1818 | 0.0565 | 0.0319 | 0.0223 | 0.0152 | 0.0061 | 0.0042 | 0.0080 | 0.193 |
| 1991 | 180,448 | 0.0034 | 0.0796 | 0.1172 | 0.1013 | 0.1055 | 0.0736 | 0.1268 | 0.1644 | 0.1613 | 0.0394 | 0.0111 | 0.0037 | 0.0033 | 0.0011 | 0.0083 | 0.181 |
| 1992 | 343,463 | 0.0014 | 0.0168 | 0.0788 | 0.1078 | 0.1241 | 0.0947 | 0.0962 | 0.1571 | 0.1367 | 0.1233 | 0.0202 | 0.0065 | 0.0010 | 0.0073 | 0.0280 | 0.193 |
| 1993 | 303,391 | 0.0006 | 0.0360 | 0.0925 | 0.1228 | 0.0886 | 0.0889 | 0.0650 | 0.1005 | 0.1185 | 0.1394 | 0.0921 | 0.0309 | 0.0042 | 0.0021 | 0.0178 | 0.120 |
| 1994 | 442,272 | 0.0005 | 0.0223 | 0.1008 | 0.0967 | 0.1419 | 0.1437 | 0.0797 | 0.1003 | 0.1216 | 0.1233 | 0.0376 | 0.0138 | 0.0047 | 0.0020 | 0.0111 | 0.098 |
| 1995 | 618,268 | 0.0026 | 0.3531 | 0.1383 | 0.0672 | 0.0411 | 0.0540 | 0.0450 | 0.0403 | 0.0670 | 0.0860 | 0.0587 | 0.0249 | 0.0171 | 0.0017 | 0.0030 | 0.120 |
| 1996 | 872,055 | 0.0001 | 0.0177 | 0.2367 | 0.0924 | 0.0827 | 0.0987 | 0.1570 | 0.1059 | 0.0800 | 0.0530 | 0.0381 | 0.0188 | 0.0063 | 0.0050 | 0.0075 | 0.073 |
| 1997 | 1,195,157 | 0.0148 | 0.1379 | 0.1276 | 0.1949 | 0.0732 | 0.0702 | 0.0633 | 0.0892 | 0.0694 | 0.0543 | 0.0468 | 0.0214 | 0.0202 | 0.0122 | 0.0046 | 0.073 |
| 1998 | 1,531,062 | 0.0124 | 0.0934 | 0.1111 | 0.1496 | 0.1748 | 0.1144 | 0.0911 | 0.0877 | 0.0602 | 0.0284 | 0.0394 | 0.0135 | 0.0062 | 0.0148 | 0.0029 | 0.091 |
| 1999 | 1,398,371 | 0.0006 | 0.0165 | 0.1491 | 0.1747 | 0.1185 | 0.1411 | 0.1050 | 0.1172 | 0.0765 | 0.0600 | 0.0217 | 0.0119 | 0.0040 | 0.0030 | 0.0003 | 0.078 |
| 2000 | 1,534,611 | 0.0013 | 0.0197 | 0.1172 | 0.1186 | 0.1830 | 0.1513 | 0.1500 | 0.1371 | 0.0537 | 0.0337 | 0.0142 | 0.0105 | 0.0044 | 0.0020 | 0.0034 | 0.087 |
| 2001 | 1,547,433 | 0.0070 | 0.0353 | 0.0430 | 0.0908 | 0.2159 | 0.2334 | 0.1671 | 0.0851 | 0.0409 | 0.0228 | 0.0327 | 0.0090 | 0.0099 | 0.0045 | 0.0026 | 0.062 |
| 2002 | 2,239,772 | 0.0045 | 0.0641 | 0.0833 | 0.1019 | 0.0875 | 0.2088 | 0.1559 | 0.1288 | 0.0867 | 0.0287 | 0.0254 | 0.0119 | 0.0075 | 0.0030 | 0.0018 | 0.064 |
| 2003 | 2,047,652 | 0.0009 | 0.0744 | 0.0812 | 0.0574 | 0.1016 | 0.1102 | 0.2153 | 0.1552 | 0.0839 | 0.0522 | 0.0260 | 0.0177 | 0.0107 | 0.0092 | 0.0042 | 0.069 |
| 2004 | 1,975,686 | 0.0006 | 0.0146 | 0.2087 | 0.0879 | 0.0694 | 0.1076 | 0.1137 | 0.1575 | 0.0964 | 0.0589 | 0.0416 | 0.0188 | 0.0118 | 0.0072 | 0.0053 | 0.190 |
| 2005 | 2,303,488 | 0.0021 | 0.0963 | 0.0510 | 0.1176 | 0.1609 | 0.1251 | 0.1247 | 0.0945 | 0.1027 | 0.0526 | 0.0400 | 0.0096 | 0.0108 | 0.0087 | 0.0034 | 0.114 |
| 2006 | 2,773,284 | 0.0011 | 0.0582 | 0.2900 | 0.0555 | 0.1102 | 0.0958 | 0.0572 | 0.0690 | 0.0675 | 0.0864 | 0.0463 | 0.0324 | 0.0075 | 0.0086 | 0.0142 | 0.092 |
| 2007 | 2,287,969 | 0.0017 | 0.0541 | 0.1292 | 0.1634 | 0.0982 | 0.1293 | 0.1018 | 0.0639 | 0.0752 | 0.0650 | 0.0386 | 0.0545 | 0.0107 | 0.0092 | 0.0052 | 0.086 |
| 2008 | 1,644,954 | 0.0034 | 0.0284 | 0.0985 | 0.0774 | 0.2008 | 0.0898 | 0.1582 | 0.1064 | 0.0534 | 0.0538 | 0.0456 | 0.0376 | 0.0216 | 0.0149 | 0.0103 | 0.097 |
| 2009 | 1,668,795 | 0.0003 | 0.0435 | 0.0354 | 0.0586 | 0.0817 | 0.2476 | 0.1161 | 0.1753 | 0.0922 | 0.0476 | 0.0350 | 0.0276 | 0.0267 | 0.0049 | 0.0076 | 0.085 |
| 2010 | 1,682,917 | 0.0001 | 0.0144 | 0.0628 | 0.0325 | 0.0707 | 0.1507 | 0.2743 | 0.0873 | 0.1057 | 0.0748 | 0.0360 | 0.0332 | 0.0239 | 0.0210 | 0.0124 | 0.109 |
| 2011 | 1,868,859 | 0.0035 | 0.0360 | 0.0524 | 0.0618 | 0.0434 | 0.1375 | 0.1707 | 0.2170 | 0.0813 | 0.0707 | 0.0376 | 0.0206 | 0.0242 | 0.0281 | 0.0153 | 0.089 |
| 2012 | 1,478,412 | 0.0005 | 0.0427 | 0.0421 | 0.0342 | 0.0860 | 0.0985 | 0.1739 | 0.1794 | 0.1833 | 0.0529 | 0.0400 | 0.0227 | 0.0174 | 0.0183 | 0.0081 | 0.112 |
| 2013 | 2,277,937 | 0.0003 | 0.0585 | 0.0708 | 0.0365 | 0.0371 | 0.1266 | 0.1380 | 0.1274 | 0.1395 | 0.1663 | 0.0516 | 0.0157 | 0.0118 | 0.0076 | 0.0123 | 0.111 |
| 2014 | 1,290,527 | 0.0004 | 0.0106 | 0.1609 | 0.0796 | 0.0524 | 0.0986 | 0.1091 | 0.0821 | 0.1087 | 0.1295 | 0.0635 | 0.0451 | 0.0172 | 0.0194 | 0.0230 | 0.111 |
| 2015 | 1,447,431 | 0.0001 | 0.0112 | 0.0434 | 0.1897 | 0.1250 | 0.1027 | 0.1347 | 0.0920 | 0.0878 | 0.0722 | 0.0507 | 0.0366 | 0.0167 | 0.0105 | 0.0267 | 0.105 |
| 2016 | 1,383,980 | 0.0051 | 0.1558 | 0.0432 | 0.0385 | 0.1478 | 0.1297 | 0.0720 | 0.0714 | 0.0683 | 0.0502 | 0.0621 | 0.0494 | 0.0526 | 0.0315 | 0.0224 | 0.137 |
| 2017 | 1,504,735 | 0.0004 | 0.1842 | 0.1196 | 0.0529 | 0.1207 | 0.2281 | 0.1181 | 0.0452 | 0.0202 | 0.0224 | 0.0234 | 0.0246 | 0.0178 | 0.0099 | 0.0124 | 0.095 |

Table B7.1 continued (ocean and other areas)

| | | | | | | | | Total Ocean Removals (Period 3) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ | CV |
| 1982 | 270,570 | 0.0039 | 0.0689 | 0.1067 | 0.1381 | 0.0661 | 0.0294 | 0.0186 | 0.0245 | 0.0155 | 0.0300 | 0.0499 | 0.0643 | 0.0419 | 0.0532 | 0.2890 | 0.218 |
| 1983 | 554,650 | 0.0090 | 0.0572 | 0.0986 | 0.0734 | 0.2349 | 0.2403 | 0.0989 | 0.0668 | 0.0032 | 0.0024 | 0.0853 | 0.0047 | 0.0074 | 0.0038 | 0.0141 | 0.442 |
| 1984 | 309,271 | 0.0080 | 0.0529 | 0.0900 | 0.2101 | 0.1967 | 0.2326 | 0.0807 | 0.0389 | 0.0119 | 0.0186 | 0.0066 | 0.0062 | 0.0121 | 0.0174 | 0.0172 | 0.190 |
| 1985 | 755,075 | 0.0002 | 0.0110 | 0.0312 | 0.0658 | 0.2558 | 0.2995 | 0.2730 | 0.0169 | 0.0018 | 0.0030 | 0.0085 | 0.0032 | 0.0045 | 0.0082 | 0.0175 | 0.556 |
| 1986 | 254,629 | 0.0011 | 0.0122 | 0.1442 | 0.3527 | 0.1058 | 0.2459 | 0.0389 | 0.0483 | 0.0095 | 0.0021 | 0.0011 | 0.0019 | 0.0053 | 0.0061 | 0.0248 | 0.334 |
| 1987 | 204,003 | 0.0063 | 0.0767 | 0.1386 | 0.1191 | 0.1196 | 0.0585 | 0.0823 | 0.0961 | 0.0746 | 0.0365 | 0.0135 | 0.0267 | 0.0193 | 0.0350 | 0.0973 | 0.187 |
| 1988 | 280,431 | 0.0196 | 0.1740 | 0.1319 | 0.1055 | 0.0974 | 0.1336 | 0.0785 | 0.0699 | 0.0728 | 0.0222 | 0.0202 | 0.0059 | 0.0245 | 0.0116 | 0.0323 | 0.233 |
| 1989 | 431,951 | 0.0145 | 0.1349 | 0.2024 | 0.0872 | 0.0922 | 0.0688 | 0.0872 | 0.0627 | 0.0804 | 0.0541 | 0.0236 | 0.0070 | 0.0119 | 0.0120 | 0.0610 | 0.192 |
| 1990 | 444,390 | 0.0000 | 0.0669 | 0.0856 | 0.1005 | 0.0995 | 0.1206 | 0.1469 | 0.1819 | 0.0701 | 0.0249 | 0.0119 | 0.0065 | 0.0123 | 0.0212 | 0.0511 | 0.103 |
| 1991 | 744,371 | 0.0003 | 0.0767 | 0.0949 | 0.1240 | 0.0824 | 0.0496 | 0.0728 | 0.1260 | 0.2166 | 0.0576 | 0.0114 | 0.0120 | 0.0031 | 0.0176 | 0.0551 | 0.111 |
| 1992 | 893,262 | 0.0067 | 0.0316 | 0.0887 | 0.1005 | 0.1091 | 0.0657 | 0.0616 | 0.1259 | 0.1548 | 0.1516 | 0.0259 | 0.0147 | 0.0071 | 0.0145 | 0.0417 | 0.113 |
| 1993 | 776,850 | 0.0002 | 0.0454 | 0.0696 | 0.1033 | 0.0976 | 0.0933 | 0.0688 | 0.0710 | 0.1299 | 0.1539 | 0.1022 | 0.0205 | 0.0075 | 0.0046 | 0.0323 | 0.074 |
| 1994 | 1,117,775 | 0.0042 | 0.0518 | 0.0831 | 0.0635 | 0.1005 | 0.0866 | 0.0584 | 0.0887 | 0.1534 | 0.1285 | 0.0767 | 0.0737 | 0.0048 | 0.0036 | 0.0225 | 0.054 |
| 1995 | 2,401,581 | 0.0013 | 0.2070 | 0.0909 | 0.0558 | 0.0490 | 0.1158 | 0.0787 | 0.1229 | 0.1216 | 0.0786 | 0.0488 | 0.0180 | 0.0072 | 0.0010 | 0.0034 | 0.110 |
| 1996 | 2,826,551 | 0.0005 | 0.0116 | 0.1288 | 0.0976 | 0.0865 | 0.0979 | 0.1644 | 0.1322 | 0.0943 | 0.0738 | 0.0545 | 0.0365 | 0.0099 | 0.0033 | 0.0081 | 0.047 |
| 1997 | 2,768,884 | 0.0030 | 0.0967 | 0.1130 | 0.1736 | 0.0732 | 0.0819 | 0.0690 | 0.0926 | 0.0985 | 0.0649 | 0.0561 | 0.0277 | 0.0291 | 0.0145 | 0.0064 | 0.042 |
| 1998 | 3,241,784 | 0.0012 | 0.0530 | 0.1026 | 0.1765 | 0.1646 | 0.1089 | 0.0847 | 0.1137 | 0.0739 | 0.0417 | 0.0397 | 0.0167 | 0.0080 | 0.0087 | 0.0061 | 0.049 |
| 1999 | 3,197,844 | 0.0003 | 0.0131 | 0.1384 | 0.1761 | 0.1583 | 0.1688 | 0.1026 | 0.0891 | 0.0485 | 0.0500 | 0.0260 | 0.0167 | 0.0067 | 0.0025 | 0.0029 | 0.058 |
| 2000 | 3,291,969 | 0.0002 | 0.0104 | 0.0973 | 0.1063 | 0.1633 | 0.1286 | 0.1598 | 0.1609 | 0.0733 | 0.0505 | 0.0255 | 0.0115 | 0.0074 | 0.0033 | 0.0016 | 0.053 |
| 2001 | 3,453,819 | 0.0006 | 0.0085 | 0.0393 | 0.0922 | 0.2127 | 0.2149 | 0.1688 | 0.1225 | 0.0423 | 0.0330 | 0.0359 | 0.0129 | 0.0090 | 0.0046 | 0.0027 | 0.051 |
| 2002 | 2,942,679 | 0.0018 | 0.0617 | 0.0572 | 0.0946 | 0.0946 | 0.1816 | 0.1490 | 0.1165 | 0.1186 | 0.0404 | 0.0404 | 0.0204 | 0.0108 | 0.0093 | 0.0030 | 0.053 |
| 2003 | 3,218,529 | 0.0002 | 0.0402 | 0.0876 | 0.0707 | 0.1237 | 0.1122 | 0.1740 | 0.1427 | 0.0905 | 0.0648 | 0.0385 | 0.0248 | 0.0156 | 0.0076 | 0.0069 | 0.051 |
| 2004 | 3,761,449 | 0.0002 | 0.0196 | 0.1714 | 0.1386 | 0.0991 | 0.1067 | 0.1077 | 0.1398 | 0.0821 | 0.0493 | 0.0419 | 0.0220 | 0.0093 | 0.0076 | 0.0048 | 0.070 |
| 2005 | 3,580,673 | 0.0009 | 0.1233 | 0.0753 | 0.1606 | 0.1437 | 0.0913 | 0.0952 | 0.0755 | 0.0889 | 0.0542 | 0.0423 | 0.0220 | 0.0118 | 0.0062 | 0.0089 | 0.071 |
| 2006 | 3,905,548 | 0.0003 | 0.0196 | 0.2681 | 0.0866 | 0.1450 | 0.1198 | 0.0683 | 0.0688 | 0.0526 | 0.0684 | 0.0454 | 0.0272 | 0.0190 | 0.0045 | 0.0063 | 0.061 |
| 2007 | 2,501,528 | 0.0002 | 0.0423 | 0.1037 | 0.1760 | 0.0966 | 0.1613 | 0.0914 | 0.0670 | 0.0701 | 0.0801 | 0.0501 | 0.0379 | 0.0138 | 0.0048 | 0.0047 | 0.069 |
| 2008 | 3,563,831 | 0.0026 | 0.0114 | 0.0608 | 0.0904 | 0.1939 | 0.0996 | 0.1990 | 0.1216 | 0.0489 | 0.0759 | 0.0308 | 0.0172 | 0.0366 | 0.0054 | 0.0060 | 0.075 |
| 2009 | 2,984,561 | 0.0007 | 0.0267 | 0.0364 | 0.0597 | 0.0890 | 0.2788 | 0.0998 | 0.1350 | 0.0710 | 0.0527 | 0.0512 | 0.0347 | 0.0399 | 0.0103 | 0.0141 | 0.066 |
| 2010 | 3,650,141 | 0.0001 | 0.0073 | 0.0610 | 0.0277 | 0.0582 | 0.1183 | 0.2774 | 0.1017 | 0.1213 | 0.0903 | 0.0379 | 0.0364 | 0.0275 | 0.0219 | 0.0129 | 0.074 |
| 2011 | 2,887,078 | 0.0044 | 0.0217 | 0.0444 | 0.0689 | 0.0481 | 0.1423 | 0.1704 | 0.2412 | 0.0829 | 0.0673 | 0.0309 | 0.0232 | 0.0219 | 0.0135 | 0.0189 | 0.076 |
| 2012 | 2,806,241 | 0.0003 | 0.0571 | 0.0666 | 0.0299 | 0.1074 | 0.0836 | 0.1188 | 0.1620 | 0.1809 | 0.0481 | 0.0474 | 0.0436 | 0.0184 | 0.0217 | 0.0142 | 0.087 |
| 2013 | 3,416,843 | 0.0002 | 0.0328 | 0.0964 | 0.0969 | 0.0763 | 0.0996 | 0.0992 | 0.0929 | 0.0906 | 0.1864 | 0.0330 | 0.0235 | 0.0253 | 0.0168 | 0.0302 | 0.075 |
| 2014 | 2,552,384 | 0.0003 | 0.0067 | 0.1394 | 0.1222 | 0.1086 | 0.0987 | 0.1163 | 0.0821 | 0.0810 | 0.0884 | 0.0642 | 0.0283 | 0.0208 | 0.0166 | 0.0266 | 0.101 |
| 2015 | 1,865,972 | 0.0013 | 0.0158 | 0.0214 | 0.2130 | 0.1913 | 0.1234 | 0.0809 | 0.0731 | 0.0596 | 0.0593 | 0.0564 | 0.0376 | 0.0232 | 0.0179 | 0.0259 | 0.109 |
| 2016 | 2,216,999 | 0.0072 | 0.1399 | 0.0638 | 0.0358 | 0.2733 | 0.1585 | 0.0488 | 0.0419 | 0.0391 | 0.0358 | 0.0406 | 0.0492 | 0.0246 | 0.0080 | 0.0335 | 0.097 |
| 2017 | 3,054,955 | 0.0005 | 0.1267 | 0.1770 | 0.0652 | 0.0949 | 0.2068 | 0.0966 | 0.0632 | 0.0267 | 0.0398 | 0.0259 | 0.0305 | 0.0224 | 0.0119 | 0.0120 | 0.087 |

Table B7.2. Stock-specific index values and coefficients of variation for the indices of relative abundance used in the model for Stock-1 (A) and Stock-2 (B).

| A. Stock-1 (Chesapeake Bay) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | MDVA YOY | CV | MD Age 1 | CV | MD SSN | CV | ChesMMA P | CV |
| 1982 | 52.77 | 0.430 | 0.02 | 0.510 | | | | |
| 1983 | 84.82 | 0.322 | 0.02 | 0.580 | | | | |
| 1984 | 64.35 | 0.385 | 0.32 | 0.200 | | | | |
| 1985 | 82.97 | 0.321 | 0.01 | 1.000 | 4.88 | 0.25 | | |
| 1986 | 65.11 | 0.367 | 0.16 | 0.250 | 10.07 | 0.25 | | |
| 1987 | 88.10 | 0.311 | 0.03 | 0.470 | 7.15 | 0.25 | | |
| 1988 | 204.03 | 0.294 | 0.06 | 0.460 | 3.27 | 0.25 | | |
| 1989 | 104.21 | 0.305 | 0.07 | 0.290 | 3.96 | 0.25 | | |
| 1990 | 110.92 | 0.266 | 0.19 | 0.240 | 5.04 | 0.25 | | |
| 1991 | 70.90 | 0.339 | 0.33 | 0.210 | 4.61 | 0.25 | | |
| 1992 | 69.92 | 0.339 | 0.20 | 0.220 | 6.29 | 0.25 | | |
| 1993 | 83.63 | 0.304 | 0.15 | 0.260 | 6.25 | 0.25 | | |
| 1994 | 233.65 | 0.263 | 0.19 | 0.250 | 5.13 | 0.25 | | |
| 1995 | 129.02 | 0.262 | 0.78 | 0.180 | 4.62 | 0.25 | | |
| 1996 | 107.18 | 0.307 | 0.12 | 0.280 | 7.59 | 0.25 | | |
| 1997 | 292.20 | 0.253 | 0.08 | 0.390 | 3.83 | 0.25 | | |
| 1998 | 107.68 | 0.266 | 0.26 | 0.230 | 4.79 | 0.25 | | |
| 1999 | 149.71 | 0.236 | 0.17 | 0.250 | 4.02 | 0.25 | | |
| 2000 | 127.57 | 0.327 | 0.37 | 0.180 | 3.54 | 0.25 | | |
| 2001 | 169.70 | 0.233 | 0.26 | 0.200 | 2.87 | 0.25 | | |
| 2002 | 221.79 | 0.279 | 0.32 | 0.180 | 4.1 | 0.25 | 31.94 | 0.24 |
| 2003 | 70.64 | 0.337 | 0.79 | 0.160 | 4.5 | 0.25 | 77.74 | 0.16 |
| 2004 | 231.43 | 0.213 | 0.07 | 0.330 | 6.05 | 0.25 | 86.76 | 0.13 |
| 2005 | 149.39 | 0.239 | 0.74 | 0.180 | 4.96 | 0.25 | 146.19 | 0.16 |
| 2006 | 154.67 | 0.242 | 0.28 | 0.220 | 4.92 | 0.25 | 84.48 | 0.18 |
| 2007 | 89.06 | 0.301 | 0.28 | 0.210 | 2.14 | 0.25 | 71.86 | 0.18 |
| 2008 | 135.30 | 0.247 | 0.07 | 0.300 | 4.37 | 0.25 | 50.62 | 0.15 |
| 2009 | 82.86 | 0.313 | 0.31 | 0.200 | 5.7 | 0.25 | 20.89 | 0.24 |
| 2010 | 103.97 | 0.278 | 0.12 | 0.270 | 4.53 | 0.25 | 20.13 | 0.28 |
| 2011 | 111.14 | 0.271 | 0.17 | 0.223 | 4.58 | 0.25 | 27.31 | 0.17 |
| 2012 | 274.26 | 0.209 | 0.02 | 0.510 | 2.65 | 0.25 | 109.14 | 0.27 |
| 2013 | 49.85 | 0.434 | 0.35 | 0.170 | 4.42 | 0.25 | 74.21 | 0.2 |
| 2014 | 116.33 | 0.261 | 0.05 | 0.370 | 5.57 | 0.25 | 43.74 | 0.27 |
| 2015 | 133.22 | 0.248 | 0.12 | 0.285 | 7.34 | 0.25 | 55.26 | 0.29 |
| 2016 | 183.47 | 0.302 | 0.23 | 0.130 | 3.96 | 0.25 | 139.43 | 0.21 |
| 2017 | 74.87 | 0.327 | 0.42 | 0.260 | 5.46 | 0.25 | 148.2 | 0.27 |

Table B7.2 (continued).

| B. Stock-2 (DE Bay/Hudson River) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | NY YOY | CV | NY Age 1 | CV | NJ YOY | CV | DE SSN | CV | DE 30 | CV |
| 1982 | | | | | | | | | | |
| 1983 | | | | | 1.09 | 0.543 | | | | |
| 1984 | | | | | 1.34 | 0.669 | | | | |
| 1985 | | | 0.96 | 0.237 | 0.52 | 0.258 | | | | |
| 1986 | 2.20 | 0.136 | 0.61 | 0.377 | 1.97 | 0.984 | | | | |
| 1987 | 4.65 | 0.129 | 0.30 | 0.293 | 0.42 | 0.209 | | | | |
| 1988 | 28.36 | 0.169 | 0.21 | 0.310 | 0.31 | 0.157 | | | | |
| 1989 | 49.28 | 0.106 | 0.81 | 0.277 | 0.31 | 0.155 | | | | |
| 1990 | 35.37 | 0.127 | 1.78 | 0.237 | 0.18 | 0.088 | | | 2.38 | 1.32 |
| 1991 | 35.53 | 0.132 | 0.37 | 0.250 | 0.16 | 0.081 | | | 0.32 | 0.24 |
| 1992 | 6.00 | 0.150 | 1.26 | 0.217 | 0.18 | 0.090 | | | 1.72 | 0.55 |
| 1993 | 16.93 | 0.106 | 1.34 | 0.219 | 0.11 | 0.053 | | | 2.93 | 1.17 |
| 1994 | 21.99 | 0.141 | 0.75 | 0.217 | 0.09 | 0.044 | | | 6.36 | 3.56 |
| 1995 | 23.61 | 0.106 | 1.43 | 0.247 | 0.13 | 0.063 | | | 16.47 | 5.20 |
| 1996 | 19.03 | 0.100 | 1.29 | 0.225 | 0.09 | 0.043 | 1.81 | 0.30 | 9.64 | 2.39 |
| 1997 | 12.12 | 0.116 | 1.54 | 0.250 | 0.09 | 0.044 | 2.16 | 0.32 | 4.32 | 1.92 |
| 1998 | 27.11 | 0.144 | 1.00 | 0.274 | 0.12 | 0.060 | 2.12 | 0.38 | 2.23 | 0.82 |
| 1999 | 16.10 | 0.124 | 2.10 | 0.276 | 0.12 | 0.058 | 1.47 | 0.26 | 12.48 | 4.09 |
| 2000 | 30.67 | 0.111 | 2.05 | 0.203 | 0.08 | 0.041 | 1.66 | 0.32 | 6.43 | 2.42 |
| 2001 | 6.88 | 0.160 | 1.56 | 0.242 | 0.10 | 0.048 | 1.88 | 0.39 | 3.48 | 1.19 |
| 2002 | 28.90 | 0.159 | 2.16 | 0.209 | 0.11 | 0.053 | 1.60 | 0.35 | 7.75 | 2.77 |
| 2003 | 14.72 | 0.102 | 2.53 | 0.182 | 0.19 | 0.097 | 3.21 | 0.42 | 2.53 | 0.99 |
| 2004 | 29.78 | 0.148 | 1.19 | 0.176 | 0.07 | 0.036 | 2.81 | 0.51 | 1.08 | 0.45 |
| 2005 | 8.73 | 0.103 | 2.41 | 0.186 | 0.13 | 0.064 | 1.77 | 0.31 | 2.60 | 1.07 |
| 2006 | 11.28 | 0.160 | 0.64 | 0.274 | 0.10 | 0.052 | 2.22 | 0.45 | 4.04 | 1.68 |
| 2007 | 5.83 | 0.120 | 2.02 | 0.215 | 0.15 | 0.075 | 1.78 | 0.72 | 1.98 | 0.76 |
| 2008 | 42.65 | 0.120 | 0.58 | 0.242 | 0.09 | 0.044 | 1.72 | 0.30 | 2.39 | 0.89 |
| 2009 | 19.04 | 0.110 | 1.24 | 0.214 | 0.11 | 0.054 | 1.25 | 0.24 | 1.22 | 0.42 |
| 2010 | 13.92 | 0.136 | 0.33 | 0.237 | 0.09 | 0.043 | 2.69 | 0.63 | 2.25 | 1.01 |
| 2011 | 25.62 | 0.133 | 0.45 | 0.232 | 0.10 | 0.048 | 3.25 | 0.78 | 1.15 | 0.46 |
| 2012 | 12.16 | 0.156 | 2.00 | 0.221 | 0.11 | 0.057 | 1.94 | 0.41 | 1.74 | 0.44 |
| 2013 | 9.85 | 0.142 | 0.90 | 0.195 | 0.24 | 0.119 | 2.10 | 0.42 | 1.44 | 0.45 |
| 2014 | 5.07 | 0.118 | 0.56 | 0.206 | 0.13 | 0.067 | 2.43 | 0.39 | 1.92 | 1.14 |
| 2015 | 24.60 | 0.106 | 0.82 | 0.198 | 0.08 | 0.041 | 0.86 | 0.18 | 2.93 | 1.45 |
| 2016 | 21.68 | 0.125 | 3.16 | 0.194 | 0.13 | 0.064 | 0.49 | 0.13 | 1.45 | 1.51 |
| 2017 | 10.93 | 0.137 | 2.00 | 0.194 | 0.10 | 0.050 | 1.75 | 0.42 | 1.66 | 0.78 |

Table B7.3. Index values and coefficients of variation for the indices of relative abundance used in the model for the mixed stock ocean population.

| Year | NY OHS | CV | NJ OT | CV | CT LISTS | CV | MRIP | CV |
|---|---|---|---|---|---|---|---|---|
| 1982 | | | | | | | 0.16 | 0.67 |
| 1983 | | | | | | | 0.38 | 0.93 |
| 1984 | | | | | | | 0.44 | 1.50 |
| 1985 | | | | | | | 0.12 | 0.72 |
| 1986 | | | | | | | 0.27 | 0.84 |
| 1987 | 3.83 | 0.11 | | | 0.053 | 0.32 | 0.46 | 1.02 |
| 1988 | 3.6 | 0.1 | | | 0.036 | 0.44 | 0.47 | 0.68 |
| 1989 | 2.58 | 0.13 | | | 0.063 | 0.30 | 0.44 | 0.72 |
| 1990 | 3.5 | 0.18 | 2.20 | 0.419 | 0.162 | 0.27 | 0.64 | 0.68 |
| 1991 | 3.28 | 0.19 | 2.72 | 0.353 | 0.146 | 0.25 | 0.79 | 0.64 |
| 1992 | 3 | 0.19 | 1.49 | 0.371 | 0.22 | 0.26 | 1.91 | 0.57 |
| 1993 | 3.32 | 0.11 | 1.60 | 0.382 | 0.273 | 0.18 | 1.78 | 0.49 |
| 1994 | 2.9 | 0.15 | 2.01 | 0.197 | 0.296 | 0.18 | 2.53 | 0.44 |
| 1995 | 2.84 | 0.18 | 13.94 | 0.105 | 0.594 | 0.14 | 3.63 | 0.49 |
| 1996 | 5.11 | 0.1 | 17.10 | 0.109 | 0.635 | 0.14 | 4.08 | 0.45 |
| 1997 | 4.84 | 0.14 | 17.08 | 0.106 | 0.855 | 0.12 | 4.59 | 0.45 |
| 1998 | 5.01 | 0.15 | 15.78 | 0.055 | 0.972 | 0.13 | 4.77 | 0.42 |
| 1999 | 3.46 | 0.16 | 9.57 | 0.064 | 1.105 | 0.11 | 4.58 | 0.42 |
| 2000 | 4.36 | 0.11 | 10.87 | 0.061 | 0.84 | 0.12 | 4.22 | 0.46 |
| 2001 | 3.47 | 0.15 | 3.91 | 0.162 | 0.607 | 0.15 | 3.44 | 0.41 |
| 2002 | 3.23 | 0.2 | 10.13 | 0.132 | 1.304 | 0.10 | 3.17 | 0.45 |
| 2003 | 4.24 | 0.19 | 14.36 | 0.036 | 0.871 | 0.11 | 2.97 | 0.46 |
| 2004 | 4.88 | 0.09 | 10.00 | 0.068 | 0.556 | 0.14 | 2.06 | 0.40 |
| 2005 | 3.91 | 0.14 | 28.06 | 0.099 | 1.172 | 0.12 | 2.60 | 0.42 |
| 2006 | 4.37 | 0.14 | 8.87 | 0.195 | 0.612 | 0.16 | 2.84 | 0.41 |
| 2007 | | | 14.14 | 0.121 | 1.02 | 0.12 | 1.92 | 0.40 |
| 2008 | | | 3.68 | 0.165 | 0.568 | 0.14 | 1.75 | 0.40 |
| 2009 | | | 12.76 | 0.125 | 0.598 | 0.18 | 1.61 | 0.38 |
| 2010 | | | 3.54 | 0.263 | 0.397 | 0.22 | 1.48 | 0.37 |
| 2011 | | | 7.16 | 0.088 | 0.476 | 0.21 | 1.16 | 0.38 |
| 2012 | | | 16.65 | 0.239 | 0.433 | 0.17 | 1.22 | 0.45 |
| 2013 | | | 8.84 | 0.202 | 0.674 | 0.13 | 2.21 | 0.36 |
| 2014 | | | 8.29 | 0.351 | 0.408 | 0.20 | 1.66 | 0.40 |
| 2015 | | | 0.77 | 0.351 | 0.197 | 0.24 | 1.62 | 0.42 |
| 2016 | | | 2.01 | 0.181 | 0.482 | 0.16 | 1.63 | 0.37 |
| 2017 | | | 18.25 | 0.124 | 0.340 | 0.25 | 2.96 | 0.39 |

Table B7.4. The fraction of total mortality (d) that occurs during period *p* prior to the survey and ages to which survey indices are linked.

| Survey | Period | d | Linked Ages |
|---|---|---|---|
| **Stock 1** | | | |
| MDVA YOY | 1 | 0 | 1 |
| MD Age 1 | 1 | 0 | 2 |
| MD SSN | 2 | 0 | 2-15+ |
| ChesMMAP | 3 | 0 | 1-15+ |
| | | | |
| **Stock 2** | | | |
| NY YOY | 1 | 0 | 1 |
| NY Age 1 | 1 | 0 | 2 |
| NJ YOY | 1 | 0 | 1 |
| DE SSN | 2 | 0 | 2-15+ |
| DE 30 | 3 | 0.7 | 1-15+ |
| | | | |
| **Mixed Ocean** | | | |
| NY OHS | 3 | 0.5 | 2-13 |
| NJ OT | 2 | 0.1 | 2-15+ |
| CT LISTS | 2 | 0.25 | 1-15+ |
| MRIP | 3 | 0 | 1-15+ |

Table B7.5. Age composition data for the age-specific indices used in the model.

Stock 1

MD SSN

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | | | | | | | | | | | | | | | |
| 1983 | | | | | | | | | | | | | | | |
| 1984 | | | | | | | | | | | | | | | |
| 1985 | -1 | 0.287778 | 0.625909 | 0.065442 | 0.009833 | 0.002702 | 0.004461 | 6.38E-05 | 0.000873 | 0.000118 | 8.59E-05 | 0.000728 | 0.000528 | 4.12E-05 | 0.001438 |
| 1986 | -1 | 0.22861 | 0.259305 | 0.494191 | 0.003995 | 0.005303 | 0.002014 | 0.002911 | 0.00275 | 0 | 0 | 0 | 2.55E-05 | 8.71E-06 | 0.000885 |
| 1987 | -1 | 0.198916 | 0.360882 | 0.16101 | 0.246379 | 0.025061 | 0.003022 | 0.003623 | 0.000334 | 0 | 0 | 0 | 3.73E-05 | 0.000384 | 0.000352 |
| 1988 | -1 | 0.124604 | 0.237121 | 0.217815 | 0.1742 | 0.227794 | 0.004053 | 0 | 0.000122 | 0.013284 | 0 | 0 | 0 | 8.57E-05 | 0.000922 |
| 1989 | -1 | 0.083745 | 0.390805 | 0.203485 | 0.114941 | 0.123191 | 0.083143 | 0.000418 | 0.000167 | 5.64E-05 | 0 | 0 | 4.86E-05 | 0 | 0 |
| 1990 | -1 | 0.155024 | 0.31399 | 0.239079 | 0.095904 | 0.068052 | 0.063593 | 0.059202 | 0.001692 | 0.000239 | 0.000186 | 0.001049 | 0.001441 | 0.0002 | 0.000347 |
| 1991 | -1 | 0.159172 | 0.416128 | 0.134943 | 0.102062 | 0.057954 | 0.056369 | 0.041537 | 0.022908 | 0.000889 | 0.003195 | 0 | 0.001226 | 0.00122 | 0.002395 |
| 1992 | -1 | 0.043706 | 0.35149 | 0.244069 | 0.093249 | 0.111103 | 0.068249 | 0.04621 | 0.021727 | 0.011205 | 0.005228 | 0 | 0.001499 | 0.001922 | 0.000343 |
| 1993 | -1 | 0.065484 | 0.211133 | 0.299398 | 0.141098 | 0.0815 | 0.083028 | 0.059351 | 0.036112 | 0.011866 | 0.004967 | 0.001336 | 0.002291 | 0.002255 | 0.000181 |
| 1994 | -1 | 0.052272 | 0.201645 | 0.190982 | 0.229623 | 0.115854 | 0.066216 | 0.083517 | 0.034226 | 0.016657 | 0.005963 | 0.00245 | 0.000595 | 0 | 0 |
| 1995 | -1 | 0.10818 | 0.25374 | 0.147982 | 0.131788 | 0.111632 | 0.086612 | 0.054091 | 0.042593 | 0.025052 | 0.020825 | 0.00759 | 0.009915 | 0 | 0 |
| 1996 | -1 | 0.005219 | 0.485193 | 0.134586 | 0.045753 | 0.091611 | 0.084875 | 0.055672 | 0.046676 | 0.02206 | 0.02003 | 0.006176 | 0.002149 | 0 | 0 |
| 1997 | -1 | 0.095998 | 0.116811 | 0.365915 | 0.121369 | 0.054597 | 0.049397 | 0.057766 | 0.069281 | 0.029807 | 0.025862 | 0.00853 | 0.003207 | 0.00146 | 0 |
| 1998 | -1 | 0.075334 | 0.298349 | 0.068357 | 0.311779 | 0.067492 | 0.027617 | 0.038657 | 0.036153 | 0.03137 | 0.019034 | 0.020673 | 0.003617 | 0.000909 | 0.000658 |
| 1999 | -1 | 0.021351 | 0.429258 | 0.196457 | 0.145851 | 0.091332 | 0.02919 | 0.017474 | 0.02861 | 0.012887 | 0.012064 | 0.007048 | 0.002847 | 0.005352 | 0.000278 |
| 2000 | -1 | 0.040529 | 0.15786 | 0.293746 | 0.135352 | 0.162961 | 0.070427 | 0.038916 | 0.023296 | 0.023452 | 0.019658 | 0.020872 | 0.004311 | 0.007127 | 0.001492 |
| 2001 | -1 | 0.01714 | 0.136099 | 0.209925 | 0.185197 | 0.080558 | 0.10135 | 0.115896 | 0.040301 | 0.042297 | 0.032249 | 0.021141 | 0.012191 | 0.004111 | 0.001547 |
| 2002 | -1 | 0.206519 | 0.099473 | 0.096983 | 0.2093 | 0.10425 | 0.085466 | 0.08066 | 0.057346 | 0.020385 | 0.014192 | 0.008734 | 0.012696 | 0.002906 | 0.001091 |
| 2003 | -1 | 0.034967 | 0.247514 | 0.118641 | 0.078561 | 0.151897 | 0.114649 | 0.061307 | 0.059356 | 0.064515 | 0.032656 | 0.015938 | 0.01365 | 0.005606 | 0.000743 |
| 2004 | -1 | 0.047641 | 0.319131 | 0.200163 | 0.069996 | 0.057165 | 0.073321 | 0.078065 | 0.0497 | 0.038238 | 0.038123 | 0.011068 | 0.006967 | 0.006047 | 0.004376 |
| 2005 | -1 | 0.13311 | 0.208924 | 0.148101 | 0.194784 | 0.048923 | 0.052151 | 0.043816 | 0.055346 | 0.041107 | 0.035221 | 0.022866 | 0.005949 | 0.002044 | 0.007658 |
| 2006 | -1 | 0.015263 | 0.524255 | 0.081428 | 0.096688 | 0.059413 | 0.030084 | 0.025763 | 0.037434 | 0.043813 | 0.026727 | 0.02234 | 0.018804 | 0.005531 | 0.012458 |
| 2007 | -1 | 0.036773 | 0.10509 | 0.354955 | 0.06948 | 0.071417 | 0.062923 | 0.034383 | 0.04207 | 0.046757 | 0.074696 | 0.03718 | 0.014231 | 0.025293 | 0.024754 |
| 2008 | -1 | 0.007457 | 0.196794 | 0.247893 | 0.256926 | 0.038626 | 0.052551 | 0.045106 | 0.025807 | 0.027427 | 0.022994 | 0.032021 | 0.030644 | 0.00748 | 0.008273 |
| 2009 | -1 | 0.070362 | 0.073779 | 0.268449 | 0.090599 | 0.242478 | 0.037102 | 0.039737 | 0.054784 | 0.015722 | 0.027774 | 0.021244 | 0.041078 | 0.008465 | 0.008427 |
| 2010 | -1 | 0.016564 | 0.330448 | 0.111209 | 0.143373 | 0.111507 | 0.121263 | 0.014737 | 0.030612 | 0.022497 | 0.008736 | 0.01129 | 0.013076 | 0.021888 | 0.042801 |
| 2011 | -1 | 0.050136 | 0.159998 | 0.269913 | 0.098969 | 0.124932 | 0.082979 | 0.098026 | 0.021959 | 0.019959 | 0.017142 | 0.017106 | 0.008814 | 0.009362 | 0.020706 |
| 2012 | -1 | 0.057371 | 0.196488 | 0.087593 | 0.089546 | 0.067423 | 0.087227 | 0.085397 | 0.09458 | 0.028096 | 0.062436 | 0.051209 | 0.016438 | 0.025496 | 0.050699 |
| 2013 | -1 | 0.080569 | 0.130785 | 0.240418 | 0.102641 | 0.116583 | 0.062439 | 0.065501 | 0.047739 | 0.063404 | 0.013159 | 0.026761 | 0.011364 | 0.009624 | 0.029013 |
| 2014 | -1 | 0.015294 | 0.501374 | 0.094553 | 0.105235 | 0.042818 | 0.059061 | 0.017576 | 0.036126 | 0.027208 | 0.044914 | 0.004218 | 0.01876 | 0.004105 | 0.028758 |
| 2015 | -1 | 0.025979 | 0.009989 | 0.624595 | 0.063157 | 0.068696 | 0.033082 | 0.028836 | 0.021464 | 0.030906 | 0.026566 | 0.027916 | 0.008955 | 0.013867 | 0.015993 |
| 2016 | -1 | 0.168239 | 0.135552 | 0.046928 | 0.413003 | 0.060555 | 0.039455 | 0.012314 | 0.015557 | 0.013546 | 0.023519 | 0.019971 | 0.023501 | 0.002879 | 0.024978 |
| 2017 | -1 | 0.117019 | 0.212599 | 0.061273 | 0.137128 | 0.251167 | 0.040573 | 0.032527 | 0.020994 | 0.02749 | 0.021427 | 0.044578 | 0.013326 | 0.009019 | 0.010879 |

CHESMAP

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1983 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1984 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1985 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1986 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1987 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1988 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1989 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1990 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1991 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1992 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1993 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1994 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1995 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1996 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1997 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1998 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1999 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2000 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2001 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2002 | 0.349036 | 0.336188 | 0.072805 | 0.059957 | 0.008565 | 0.109208 | 0.027837 | 0.006424 | 0.019272 | 0.002141 | 0.004283 | 0.004283 | 0 | 0 | 0 |
| 2003 | 0.008143 | 0.405537 | 0.250814 | 0.118893 | 0.027687 | 0.035831 | 0.063518 | 0.027687 | 0.016287 | 0.039088 | 0.001629 | 0 | 0.004886 | 0 | 0 |
| 2004 | 0.316647 | 0.105937 | 0.334109 | 0.112922 | 0.022119 | 0.020955 | 0.023283 | 0.029104 | 0.009313 | 0.008149 | 0.010477 | 0.001164 | 0 | 0.001164 | 0.004657 |
| 2005 | 0.034339 | 0.804176 | 0.046404 | 0.068677 | 0.022738 | 0.002784 | 0.006497 | 0.001856 | 0.006497 | 0.003248 | 0.000928 | 0.001856 | 0 | 0 | 0 |
| 2006 | 0.054627 | 0.167224 | 0.61427 | 0.013378 | 0.054627 | 0.021182 | 0.014493 | 0.005574 | 0.011148 | 0.021182 | 0.006689 | 0.010033 | 0.004459 | 0.001115 | 0 |
| 2007 | 0.003448 | 0.367241 | 0.256897 | 0.289655 | 0.015517 | 0.041379 | 0.012069 | 0.001724 | 0 | 0.003448 | 0.001724 | 0.005172 | 0.001724 | 0 | 0 |
| 2008 | 0.091295 | 0.065817 | 0.390658 | 0.123142 | 0.26327 | 0.002123 | 0.019108 | 0.019108 | 0.004246 | 0.004246 | 0.002123 | 0 | 0.004246 | 0.002123 | 0.008493 |
| 2009 | 0.016181 | 0.679612 | 0.061489 | 0.106796 | 0.029126 | 0.071197 | 0.003236 | 0.012945 | 0.009709 | 0 | 0 | 0.003236 | 0.006472 | 0 | 0 |
| 2010 | 0.056537 | 0.077739 | 0.618375 | 0.028269 | 0.070671 | 0.010601 | 0.102473 | 0 | 0.017668 | 0.007067 | 0.003534 | 0 | 0 | 0.003534 | 0.003534 |
| 2011 | 0.242754 | 0.286232 | 0.119565 | 0.192029 | 0.018116 | 0.054348 | 0.028986 | 0.039855 | 0.003623 | 0.003623 | 0 | 0 | 0.003623 | 0 | 0.007246 |
| 2012 | 0.693811 | 0.131379 | 0.102063 | 0.016287 | 0.038002 | 0.002172 | 0.008686 | 0.004343 | 0.001086 | 0 | 0.001086 | 0 | 0.001086 | 0 | 0 |
| 2013 | 0 | 0.663295 | 0.180636 | 0.059249 | 0.018786 | 0.036127 | 0 | 0.014451 | 0.004335 | 0.018786 | 0 | 0.001445 | 0 | 0 | 0.00289 |
| 2014 | 0.078534 | 0.015707 | 0.818499 | 0.04363 | 0.017452 | 0.010471 | 0.006981 | 0 | 0.001745 | 0.00349 | 0.00349 | 0 | 0 | 0 | 0 |
| 2015 | 0.354887 | 0.195489 | 0.039098 | 0.353383 | 0.027068 | 0.01203 | 0.004511 | 0.004511 | 0.001504 | 0.003008 | 0 | 0.003008 | 0 | 0 | 0.001504 |
| 2016 | 0.471848 | 0.354481 | 0.06027 | 0.001586 | 0.097542 | 0.004758 | 0.002379 | 0.000793 | 0.000793 | 0 | 0.001586 | 0.001586 | 0.001586 | 0.000793 | 0 |
| 2017 | 0.0320 | 0.5908 | 0.2199 | 0.0285 | 0.0000 | 0.1106 | 0.0084 | 0.0063 | 0.0007 | 0.0007 | 0.0000 | 0.0021 | 0.0000 | 0.0000 | 0.0000 |

Table B7.5 (continued).

Stock 2

DE SSN

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1983 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1984 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1985 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1986 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1987 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1988 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1989 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1990 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1991 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1992 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1993 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1994 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1995 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1996 | -1 | 0.0060 | 0.4170 | 0.1920 | 0.0610 | 0.0850 | 0.0760 | 0.0640 | 0.0580 | 0.0150 | 0.0090 | 0.0090 | 0.0090 | -1 | -1 |
| 1997 | -1 | 0.0930 | 0.0740 | 0.3910 | 0.1370 | 0.0510 | 0.0640 | 0.0730 | 0.0320 | 0.0300 | 0.0230 | 0.0090 | 0.0230 | -1 | -1 |
| 1998 | -1 | 0.0400 | 0.0870 | 0.0980 | 0.3470 | 0.0900 | 0.0610 | 0.1050 | 0.0950 | 0.0340 | 0.0250 | 0.0080 | 0.0110 | -1 | -1 |
| 1999 | -1 | 0.0000 | 0.1050 | 0.1440 | 0.1770 | 0.2350 | 0.0720 | 0.0540 | 0.0760 | 0.0580 | 0.0510 | 0.0140 | 0.0140 | -1 | -1 |
| 2000 | -1 | 0.0360 | 0.0360 | 0.2100 | 0.1710 | 0.1380 | 0.2230 | 0.0660 | 0.0300 | 0.0390 | 0.0320 | 0.0100 | 0.0100 | -1 | -1 |
| 2001 | -1 | 0.0060 | 0.1150 | 0.1000 | 0.1850 | 0.1100 | 0.1400 | 0.2000 | 0.0500 | 0.0150 | 0.0400 | 0.0200 | 0.0200 | -1 | -1 |
| 2002 | -1 | 0.0340 | 0.0710 | 0.1910 | 0.1780 | 0.1570 | 0.1130 | 0.0890 | 0.0970 | 0.0260 | 0.0160 | 0.0100 | 0.0180 | -1 | -1 |
| 2003 | -1 | 0.0200 | 0.0970 | 0.0970 | 0.1340 | 0.0890 | 0.1110 | 0.1250 | 0.1050 | 0.1210 | 0.0340 | 0.0280 | 0.0380 | -1 | -1 |
| 2004 | -1 | 0.0070 | 0.1660 | 0.2310 | 0.0980 | 0.0680 | 0.0540 | 0.1120 | 0.0780 | 0.0810 | 0.0440 | 0.0140 | 0.0470 | -1 | -1 |
| 2005 | -1 | 0.0960 | 0.1570 | 0.1680 | 0.1980 | 0.0810 | 0.0460 | 0.0300 | 0.0360 | 0.0610 | 0.0360 | 0.0460 | 0.0460 | -1 | -1 |
| 2006 | -1 | 0.0595 | 0.2007 | 0.0967 | 0.1413 | 0.1413 | 0.0706 | 0.0520 | 0.0409 | 0.0483 | 0.0483 | 0.0372 | 0.0632 | -1 | -1 |
| 2007 | -1 | 0.0061 | 0.0887 | 0.3700 | 0.1804 | 0.1009 | 0.0734 | 0.0306 | 0.0245 | 0.0306 | 0.0275 | 0.0398 | 0.0275 | -1 | -1 |
| 2008 | -1 | 0.0299 | 0.0329 | 0.1257 | 0.3024 | 0.1467 | 0.1317 | 0.0449 | 0.0359 | 0.0359 | 0.0269 | 0.0449 | 0.0419 | -1 | -1 |
| 2009 | -1 | 0.1296 | 0.1014 | 0.0930 | 0.1803 | 0.1352 | 0.0901 | 0.0789 | 0.0366 | 0.0338 | 0.0169 | 0.0282 | 0.0761 | -1 | -1 |
| 2010 | -1 | 0.1469 | 0.2041 | 0.1204 | 0.1143 | 0.1224 | 0.0898 | 0.0469 | 0.0429 | 0.0245 | 0.0224 | 0.0204 | 0.0449 | -1 | -1 |
| 2011 | -1 | 0.0220 | 0.0550 | 0.1890 | 0.1720 | 0.1300 | 0.0950 | 0.1140 | 0.0950 | 0.0450 | 0.0300 | 0.0120 | 0.0410 | -1 | -1 |
| 2012 | -1 | 0.1538 | 0.2985 | 0.2062 | 0.0308 | 0.0338 | 0.0185 | 0.0677 | 0.0338 | 0.0185 | 0.0154 | 0.0554 | 0.0677 | -1 | -1 |
| 2013 | -1 | 0.0382 | 0.0795 | 0.0572 | 0.0684 | 0.1701 | 0.1590 | 0.1335 | 0.1145 | 0.0636 | 0.0334 | 0.0270 | 0.0556 | -1 | -1 |
| 2014 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2015 | -1 | 0.0496 | 0.0780 | 0.1560 | 0.2199 | 0.1064 | 0.0922 | 0.0426 | 0.0213 | 0.0638 | 0.0851 | 0.0355 | 0.0496 | -1 | -1 |
| 2016 | -1 | 0.0000 | 0.0051 | 0.1020 | 0.3010 | 0.2602 | 0.1224 | 0.0510 | 0.0357 | 0.0102 | 0.0357 | 0.0102 | 0.0663 | -1 | -1 |
| 2017 | -1 | 0.109948 | 0.151832 | 0.13089 | 0.115183 | 0.120419 | 0.17801 | 0.062827 | 0.036649 | 0.026178 | 0.041885 | 0.020942 | 0 | -1 | -1 |

DE 30 Trawl

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1983 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1984 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1985 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1986 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1987 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1988 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1989 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1990 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1991 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1992 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1993 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1994 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1995 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1996 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1997 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1998 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1999 | 0.101438 | 0.227636 | 0.27476 | 0.242209 | 0.072652 | 0.047356 | 0.01804 | 0.006554 | 0.006162 | 0.003195 | 0 | 0 | 0 | 0 | 0 |
| 2000 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2001 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2002 | 0.215007 | 0.290314 | 0.176497 | 0.068182 | 0.056818 | 0.125 | 0.056818 | 0 | 0 | 0 | 0.011364 | 0 | 0 | 0 | 0 |
| 2003 | 0.132479 | 0.295543 | 0.442712 | 0.076085 | 0.009972 | 0.026591 | 0.006648 | 0.009972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 0.14375 | 0.20625 | 0.150699 | 0.1559 | 0.035892 | 0.068396 | 0.054117 | 0.079904 | 0.051454 | 0.025798 | 0.019129 | 0.008712 | 0 | 0 | 0 |
| 2005 | 0.295704 | 0.331853 | 0.05206 | 0.059996 | 0.128438 | 0.05677 | 0.058924 | 0.007095 | 0.005091 | 0.003084 | 0.000649 | 0 | 0.000337 | 0 | 0 |
| 2006 | 0.000529 | 0.075378 | 0.245824 | 0.486512 | 0.091749 | 0.044362 | 0.014255 | 0.01885 | 0.015012 | 0.005536 | 0.001369 | 0.000624 | 0 | 0 | 0 |
| 2007 | 0.11 | 0.158056 | 0.202778 | 0.245833 | 0.116352 | 0.10744 | 0.016497 | 0.009604 | 0.011562 | 0.011099 | 0.007444 | 0 | 0.003333 | 0 | 0 |
| 2008 | 0.02381 | 0.165344 | 0.202381 | 0.276266 | 0.128177 | 0.082738 | 0.039944 | 0.08134 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 0.174851 | 0.168899 | 0.0625 | 0.010417 | 0.092566 | 0.128587 | 0.126188 | 0.052119 | 0.034308 | 0.107662 | 0.005445 | 0 | 0.005208 | 0.015625 | 0.015625 |
| 2010 | 0.168582 | 0.306513 | 0.363985 | 0.015326 | 0.034483 | 0.039591 | 0.011221 | 0.026546 | 0.002919 | 0.024266 | 0.001642 | 0 | 0.001642 | 0.003284 | 0 |
| 2011 | 0.651882 | 0.122312 | 0.075269 | 0.075269 | 0 | 0 | 0 | 0.011649 | 0.006272 | 0.024194 | 0.006272 | 0.005376 | 0 | 0 | 0.021505 |
| 2012 | 0.386992 | 0.161789 | 0.134146 | 0.04878 | 0.109756 | 0.087979 | 0.020035 | 0.031359 | 0.019164 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 0 | 0.355848 | 0.159522 | 0.053298 | 0.025523 | 0.067457 | 0.070568 | 0.098199 | 0.072616 | 0.046507 | 0.018981 | 0.019444 | 0.012037 | 0 | 0 |
| 2014 | 0.574405 | 0.104167 | 0.156006 | 0.064069 | 0.03273 | 0.024674 | 0.009354 | 0.01369 | 0.004393 | 0.002622 | 0 | 0.002976 | 0.000992 | 0.004464 | 0.005456 |
| 2015 | 0.356473 | 0.180113 | 0.033737 | 0.087251 | 0.173699 | 0.070135 | 0.042308 | 0.031895 | 0 | 0.009756 | 0.004878 | 0.004878 | 0 | 0 | 0.004878 |
| 2016 | 0.763942 | 0.201967 | 0 | 0.000812 | 0.001623 | 0.010552 | 0.003247 | 0.003247 | 0.003247 | 0 | 0 | 0 | 0 | 0 | 0.011364 |
| 2017 | 0.230 | 0.659 | 0.169 | 0.016 | 0.004 | 0.005 | 0.016 | 0.006 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Table B7.5 (continued).

Mixed stock Ocean

NYOHS

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1983 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1984 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1985 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1986 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1987 | -1 | 0.031815908 | 0.194997499 | 0.35927964 | 0.27883942 | 0.088344172 | 0.034917459 | 0.006703352 | 0.00170085 | 0 | 0.0006003 | 0 | 0.002801401 | -1 | -1 |
| 1988 | -1 | 0.226314733 | 0.269670815 | 0.19520273 | 0.166599759 | 0.085407467 | 0.021878764 | 0.014452027 | 0.003914091 | 0.002107587 | 0.000702529 | 0 | 0.013749498 | -1 | -1 |
| 1989 | -1 | 0.183612141 | 0.269458079 | 0.148051688 | 0.159871782 | 0.102674547 | 0.093759391 | 0.021736953 | 0.003005109 | 0.002003406 | 0.003005109 | 0.002003406 | 0.010818391 | -1 | -1 |
| 1990 | -1 | 0.060787842 | 0.295640872 | 0.306238752 | 0.113877225 | 0.098480304 | 0.055688862 | 0.044391122 | 0.015796841 | 0.00579884 | 0.0009998 | 0 | 0.00229954 | -1 | -1 |
| 1991 | -1 | 0.207145002 | 0.3668568 | 0.24407085 | 0.051936355 | 0.016611628 | 0.025317722 | 0.04162914 | 0.023016111 | 0.006304413 | 0.002001401 | 0.003602522 | 0.011508056 | -1 | -1 |
| 1992 | -1 | 0.079207921 | 0.416641664 | 0.257725773 | 0.121112111 | 0.03290329 | 0.01430143 | 0.0170017 | 0.0250025 | 0.01750175 | 0.00320032 | 0.00580058 | 0.00960096 | -1 | -1 |
| 1993 | -1 | 0.156691729 | 0.387769424 | 0.291528822 | 0.070275689 | 0.032882206 | 0.009423559 | 0.009022556 | 0.011528822 | 0.013132832 | 0.007017544 | 0.002506266 | 0.008220551 | -1 | -1 |
| 1994 | -1 | 0.141353383 | 0.271177945 | 0.156591479 | 0.134937343 | 0.083408521 | 0.054736842 | 0.037593985 | 0.022255639 | 0.040701754 | 0.01273183 | 0.024160401 | 0.020350877 | -1 | -1 |
| 1995 | -1 | 0.246305419 | 0.270935961 | 0.255554439 | 0.072383633 | 0.066150598 | 0.035387554 | 0.012365537 | 0.005428772 | 0.012365537 | 0.011561275 | 0.003116518 | 0.008444757 | -1 | -1 |
| 1996 | -1 | 0.083208321 | 0.747574757 | 0.114211421 | 0.03280328 | 0.00940094 | 0.00730073 | 0.00270027 | 0.00130013 | 0.00070007 | 0 | 0.00050005 | 0.00030003 | -1 | -1 |
| 1997 | -1 | 0.206279372 | 0.242475752 | 0.450754925 | 0.066893311 | 0.01839816 | 0.00369963 | 0.00369963 | 0.00389961 | 0.00169983 | 0.00069993 | 0.00089991 | 0.00059994 | -1 | -1 |
| 1998 | -1 | 0.18767507 | 0.297018808 | 0.171468587 | 0.285614246 | 0.036614646 | 0.009103641 | 0.005802321 | 0.00290116 | 0.00020008 | 0.0010004 | 0.0015006 | 0.00110044 | -1 | -1 |
| 1999 | -1 | 0.069818692 | 0.628768907 | 0.172493239 | 0.059501152 | 0.043874587 | 0.005008514 | 0.003205449 | 0.004607833 | 0.00350596 | 0.003906641 | 0.000701192 | 0.004607833 | -1 | -1 |
| 2000 | -1 | 0.127529553 | 0.193348026 | 0.434582248 | 0.15437788 | 0.036465638 | 0.036866359 | 0.004107393 | 0.003907033 | 0.001602885 | 0.001803246 | 0.001001803 | 0.004407934 | -1 | -1 |
| 2001 | -1 | 0.052452452 | 0.455755756 | 0.147547548 | 0.213113113 | 0.073573574 | 0.027427427 | 0.019419419 | 0.003203203 | 0.003903904 | 0.001101101 | 0 | 0.002502503 | -1 | -1 |
| 2002 | -1 | 0.323373107 | 0.226712123 | 0.184798957 | 0.080717938 | 0.073698987 | 0.057354858 | 0.019853605 | 0.019853605 | 0.00130352 | 0.004812995 | 0.001804873 | 0.005715432 | -1 | -1 |
| 2003 | -1 | 0.202442932 | 0.365138166 | 0.1252503 | 0.092310773 | 0.040648779 | 0.064677613 | 0.050660793 | 0.022727273 | 0.017721266 | 0.012615138 | 0.000901081 | 0.004905887 | -1 | -1 |
| 2004 | -1 | 0.0501 | 0.5698 | 0.2734 | 0.0628 | 0.0222 | 0.0076 | 0.0061 | 0.0036 | 0.0011 | 0.0014 | 0.0017 | 0.0002 | -1 | -1 |
| 2005 | -1 | 0.244375562 | 0.127987201 | 0.412558744 | 0.136986301 | 0.03359664 | 0.01379862 | 0.00349965 | 0.0089991 | 0.00649935 | 0.00349965 | 0.00369963 | 0.00449955 | -1 | -1 |
| 2006 | -1 | 0.063906391 | 0.635963596 | 0.072807281 | 0.161016102 | 0.04240424 | 0.01440144 | 0.00570057 | 0.00250025 | 0.00030003 | 0.0010001 | 0 | 0 | -1 | -1 |
| 2007 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2008 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2009 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2010 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2011 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2012 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2013 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2014 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2015 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2016 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 2017 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |

NJ Trawl

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1983 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1984 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1985 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1986 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1987 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1988 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1989 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1990 | -1 | 0.0769 | 0.1788 | 0.2360 | 0.1014 | 0.1420 | 0.1012 | 0.0754 | 0.0614 | 0.0178 | 0.0075 | 0.0016 | 0.0000 | 0 | 0 |
| 1991 | -1 | 0.1912 | 0.2824 | 0.1155 | 0.0207 | 0.0197 | 0.0977 | 0.0985 | 0.0644 | 0.0682 | 0.0417 | 0.0000 | 0.0000 | 0 | 0 |
| 1992 | -1 | 0.0455 | 0.6779 | 0.0484 | 0.0234 | 0.0276 | 0.0639 | 0.0425 | 0.0541 | 0.0167 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 1993 | -1 | 0.5333 | 0.0633 | 0.1477 | 0.1048 | 0.0934 | 0.0458 | 0.0035 | 0.0000 | 0.0000 | 0.0083 | 0.0000 | 0.0000 | 0 | 0 |
| 1994 | -1 | 0.2196 | 0.4400 | 0.1204 | 0.0801 | 0.0458 | 0.0343 | 0.0214 | 0.0272 | 0.0112 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 1995 | -1 | 0.5945 | 0.2731 | 0.0349 | 0.0375 | 0.0300 | 0.0154 | 0.0071 | 0.0048 | 0.0011 | 0.0016 | 0.0000 | 0.0000 | 0 | 0 |
| 1996 | -1 | 0.1112 | 0.7608 | 0.0622 | 0.0260 | 0.0209 | 0.0137 | 0.0046 | 0.0006 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 1997 | -1 | 0.3683 | 0.0885 | 0.3190 | 0.1223 | 0.0476 | 0.0240 | 0.0125 | 0.0080 | 0.0045 | 0.0023 | 0.0010 | 0.0015 | 6.24E-05 | 0.000302 |
| 1998 | -1 | 0.5920 | 0.1024 | 0.0526 | 0.1161 | 0.0599 | 0.0355 | 0.0200 | 0.0129 | 0.0053 | 0.0026 | 0.0002 | 0.0004 | 0 | 0 |
| 1999 | -1 | 0.0221 | 0.3828 | 0.1815 | 0.1894 | 0.1435 | 0.0457 | 0.0180 | 0.0120 | 0.0051 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 2000 | -1 | 0.1981 | 0.0915 | 0.1178 | 0.1707 | 0.1841 | 0.1099 | 0.0483 | 0.0340 | 0.0228 | 0.0122 | 0.0073 | 0.0027 | 0.000315 | 0.000187 |
| 2001 | -1 | 0.1798 | 0.1680 | 0.1251 | 0.2662 | 0.1613 | 0.0635 | 0.0256 | 0.0084 | 0.0021 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 2002 | -1 | 0.0192 | 0.0072 | 0.0539 | 0.1373 | 0.2506 | 0.2202 | 0.1415 | 0.0940 | 0.0301 | 0.0193 | 0.0167 | 0.0084 | 0.001665 | 0 |
| 2003 | -1 | 0.4955 | 0.0902 | 0.0267 | 0.0737 | 0.0784 | 0.1113 | 0.0587 | 0.0286 | 0.0239 | 0.0058 | 0.0032 | 0.0011 | 0.001129 | 0.001943 |
| 2004 | -1 | 0.1493 | 0.5719 | 0.0580 | 0.0347 | 0.0548 | 0.0442 | 0.0396 | 0.0230 | 0.0154 | 0.0032 | 0.0023 | 0.0037 | 0 | 0 |
| 2005 | -1 | 0.6556 | 0.1126 | 0.0585 | 0.0883 | 0.0360 | 0.0254 | 0.0104 | 0.0067 | 0.0029 | 0.0012 | 0.0008 | 0.0002 | 0.0008 | 0.0008 |
| 2006 | -1 | 0.0814 | 0.0982 | 0.0579 | 0.2676 | 0.2435 | 0.1019 | 0.0689 | 0.0448 | 0.0255 | 0.0052 | 0.0036 | 0.0007 | 0.000727 | 0 |
| 2007 | -1 | 0.2326 | 0.1724 | 0.2994 | 0.0833 | 0.1196 | 0.0562 | 0.0185 | 0.0099 | 0.0062 | 0.0014 | 0.0001 | 0.0003 | 0 | 0 |
| 2008 | -1 | 0.1205 | 0.0737 | 0.0902 | 0.3544 | 0.0932 | 0.1213 | 0.0793 | 0.0311 | 0.0156 | 0.0117 | 0.0046 | 0.0022 | 0.000937 | 0.001241 |
| 2009 | -1 | 0.1000 | 0.0003 | 0.0222 | 0.1499 | 0.4446 | 0.0889 | 0.1016 | 0.0532 | 0.0287 | 0.0082 | 0.0024 | 0.0000 | 0 | 0 |
| 2010 | -1 | 0.0291 | 0.0104 | 0.0063 | 0.0533 | 0.1934 | 0.4811 | 0.0986 | 0.0752 | 0.0294 | 0.0106 | 0.0073 | 0.0028 | 0.002407 | 0 |
| 2011 | -1 | 0.1118 | 0.0858 | 0.0757 | 0.0223 | 0.1092 | 0.1635 | 0.2821 | 0.0825 | 0.0594 | 0.0076 | 0.0000 | 0.0000 | 0 | 0 |
| 2012 | -1 | 0.2201 | 0.0750 | 0.0392 | 0.0757 | 0.0515 | 0.1069 | 0.1750 | 0.2056 | 0.0412 | 0.0099 | 0.0000 | 0.0000 | 0 | 0 |
| 2013 | -1 | 0.6483 | 0.1400 | 0.0064 | 0.0134 | 0.0433 | 0.0340 | 0.0547 | 0.0388 | 0.0187 | 0.0015 | 0.0006 | 0.0003 | 0 | 0 |
| 2014 | -1 | 0.0707 | 0.8030 | 0.1263 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 2015 | -1 | 0.3333 | 0.6667 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0 | 0 |
| 2016 | -1 | 0.5922 | 0.1442 | 0.0568 | 0.0371 | 0.0337 | 0.0387 | 0.0292 | 0.0200 | 0.0201 | 0.0141 | 0.0075 | 0.0050 | 0.001344 | 0.000223 |
| 2017 | -1 | 0.1699 | 0.5363 | 0.0465 | 0.0255 | 0.0965 | 0.0627 | 0.0488 | 0.0017 | 0.0017 | 0.0077 | 0.0028 | 0.0000 | 0 | 0 |

Table B7.5 (continued).

Mixed stock Ocean

CT Trawl

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1983 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1984 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1985 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1986 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1987 | 0.0577 | 0.1178 | 0.1572 | 0.2614 | 0.1924 | 0.1185 | 0.0585 | 0.0184 | 0.0138 | 0.0022 | 0.0000 | 0.0022 | 0.0000 | 0.0000 | 0.0000 |
| 1988 | 0.0420 | 0.2951 | 0.2572 | 0.2149 | 0.1092 | 0.0409 | 0.0121 | 0.0205 | 0.0067 | 0.0013 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1989 | 0.1298 | 0.4128 | 0.1846 | 0.0000 | 0.0909 | 0.0000 | 0.1364 | 0.0455 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1990 | 0.0533 | 0.6286 | 0.1611 | 0.0496 | 0.0155 | 0.0367 | 0.0218 | 0.0137 | 0.0099 | 0.0039 | 0.0059 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1991 | 0.0279 | 0.3662 | 0.2157 | 0.1463 | 0.0321 | 0.0194 | 0.0584 | 0.0549 | 0.0499 | 0.0189 | 0.0067 | 0.0013 | 0.0023 | 0.0000 | 0.0000 |
| 1992 | 0.0411 | 0.1471 | 0.2764 | 0.2506 | 0.1482 | 0.0239 | 0.0315 | 0.0422 | 0.0270 | 0.0090 | 0.0026 | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| 1993 | 0.0310 | 0.0530 | 0.1573 | 0.2962 | 0.1254 | 0.1206 | 0.0721 | 0.1081 | 0.0119 | 0.0092 | 0.0047 | 0.0103 | 0.0001 | 0.0000 | 0.0000 |
| 1994 | 0.0029 | 0.1006 | 0.1804 | 0.2547 | 0.2304 | 0.1184 | 0.0524 | 0.0223 | 0.0170 | 0.0145 | 0.0055 | 0.0010 | 0.0000 | 0.0000 | 0.0000 |
| 1995 | 0.0479 | 0.7499 | 0.0755 | 0.0390 | 0.0235 | 0.0338 | 0.0063 | 0.0147 | 0.0009 | 0.0000 | 0.0070 | 0.0014 | 0.0000 | 0.0000 | 0.0000 |
| 1996 | 0.0208 | 0.0011 | 0.5691 | 0.1971 | 0.0994 | 0.0279 | 0.0443 | 0.0137 | 0.0139 | 0.0064 | 0.0036 | 0.0027 | 0.0000 | 0.0000 | 0.0000 |
| 1997 | 0.1523 | 0.3143 | 0.2360 | 0.1282 | 0.0413 | 0.0535 | 0.0302 | 0.0197 | 0.0158 | 0.0022 | 0.0039 | 0.0019 | 0.0008 | 0.0000 | 0.0000 |
| 1998 | 0.0560 | 0.4681 | 0.2639 | 0.0847 | 0.1055 | 0.0153 | 0.0044 | 0.0013 | 0.0005 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1999 | 0.0180 | 0.2171 | 0.2669 | 0.1308 | 0.1246 | 0.1681 | 0.0436 | 0.0174 | 0.0053 | 0.0042 | 0.0023 | 0.0016 | 0.0000 | 0.0000 | 0.0000 |
| 2000 | 0.0094 | 0.3876 | 0.1974 | 0.0582 | 0.1086 | 0.0777 | 0.0472 | 0.0822 | 0.0177 | 0.0060 | 0.0036 | 0.0020 | 0.0011 | 0.0000 | 0.0013 |
| 2001 | 0.0659 | 0.2167 | 0.2568 | 0.0947 | 0.1970 | 0.0977 | 0.0450 | 0.0201 | 0.0039 | 0.0004 | 0.0015 | 0.0001 | 0.0003 | 0.0001 | 0.0000 |
| 2002 | 0.2940 | 0.2842 | 0.0815 | 0.0836 | 0.0454 | 0.1053 | 0.0594 | 0.0196 | 0.0198 | 0.0028 | 0.0037 | 0.0000 | 0.0000 | 0.0008 | 0.0000 |
| 2003 | 0.0214 | 0.4410 | 0.2255 | 0.1097 | 0.0848 | 0.0442 | 0.0380 | 0.0182 | 0.0085 | 0.0064 | 0.0020 | 0.0002 | 0.0000 | 0.0000 | 0.0000 |
| 2004 | 0.0194 | 0.2438 | 0.2513 | 0.1387 | 0.0899 | 0.1009 | 0.0565 | 0.0553 | 0.0214 | 0.0123 | 0.0058 | 0.0047 | 0.0000 | 0.0000 | 0.0000 |
| 2005 | 0.0450 | 0.5050 | 0.1030 | 0.2490 | 0.0622 | 0.0154 | 0.0113 | 0.0029 | 0.0036 | 0.0014 | 0.0010 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| 2006 | 0.0022 | 0.0922 | 0.5205 | 0.1257 | 0.1758 | 0.0481 | 0.0175 | 0.0086 | 0.0033 | 0.0038 | 0.0011 | 0.0006 | 0.0004 | 0.0000 | 0.0000 |
| 2007 | 0.0090 | 0.0615 | 0.2351 | 0.4289 | 0.1183 | 0.1043 | 0.0272 | 0.0102 | 0.0038 | 0.0004 | 0.0003 | 0.0011 | 0.0000 | 0.0000 | 0.0000 |
| 2008 | 0.1269 | 0.0906 | 0.2189 | 0.1402 | 0.2723 | 0.0391 | 0.0668 | 0.0262 | 0.0095 | 0.0049 | 0.0005 | 0.0005 | 0.0036 | 0.0000 | 0.0000 |
| 2009 | 0.0430 | 0.3277 | 0.1213 | 0.2397 | 0.1024 | 0.1444 | 0.0101 | 0.0083 | 0.0011 | 0.0014 | 0.0004 | 0.0002 | 0.0000 | 0.0000 | 0.0000 |
| 2010 | 0.0035 | 0.0147 | 0.2207 | 0.1505 | 0.2759 | 0.1284 | 0.1605 | 0.0234 | 0.0141 | 0.0071 | 0.0003 | 0.0008 | 0.0000 | 0.0000 | 0.0000 |
| 2011 | 0.0162 | 0.0171 | 0.0551 | 0.3639 | 0.0921 | 0.1895 | 0.0966 | 0.1285 | 0.0167 | 0.0134 | 0.0036 | 0.0022 | 0.0020 | 0.0010 | 0.0020 |
| 2012 | 0.2476 | 0.2802 | 0.1091 | 0.0793 | 0.1524 | 0.0328 | 0.0339 | 0.0282 | 0.0244 | 0.0035 | 0.0050 | 0.0017 | 0.0020 | 0.0000 | 0.0000 |
| 2013 | 0.0976 | 0.2649 | 0.3015 | 0.1172 | 0.0453 | 0.0928 | 0.0161 | 0.0144 | 0.0248 | 0.0126 | 0.0087 | 0.0009 | 0.0022 | 0.0004 | 0.0004 |
| 2014 | 0.0072 | 0.0444 | 0.5509 | 0.2926 | 0.0337 | 0.0030 | 0.0055 | 0.0095 | 0.0170 | 0.0165 | 0.0140 | 0.0035 | 0.0015 | 0.0002 | 0.0005 |
| 2015 | 0.0540 | 0.0752 | 0.0823 | 0.5106 | 0.1048 | 0.0289 | 0.0174 | 0.0180 | 0.0257 | 0.0322 | 0.0257 | 0.0193 | 0.0039 | 0.0019 | 0.0000 |
| 2016 | 0.4277 | 0.3150 | 0.0599 | 0.0319 | 0.1357 | 0.0111 | 0.0032 | 0.0021 | 0.0030 | 0.0030 | 0.0033 | 0.0032 | 0.0006 | 0.0002 | 0.0002 |
| 2017 | 0.1082 | 0.5954 | 0.1251 | 0.0765 | 0.0414 | 0.0384 | 0.0075 | 0.0021 | 0.0021 | 0.0019 | 0.0002 | 0.0013 | 0.0000 | 0.0000 | 0.0000 |

MRIP

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0.026 | 0.283 | 0.154 | 0.141 | 0.053 | 0.019 | 0.010 | 0.012 | 0.006 | 0.014 | 0.025 | 0.030 | 0.022 | 0.030 | 0.176 |
| 1983 | 0.061 | 0.189 | 0.154 | 0.098 | 0.174 | 0.154 | 0.061 | 0.041 | 0.002 | 0.001 | 0.051 | 0.002 | 0.003 | 0.002 | 0.008 |
| 1984 | 0.041 | 0.182 | 0.202 | 0.201 | 0.123 | 0.112 | 0.038 | 0.020 | 0.006 | 0.009 | 0.004 | 0.004 | 0.006 | 0.019 | 0.032 |
| 1985 | 0.002 | 0.081 | 0.134 | 0.086 | 0.207 | 0.231 | 0.209 | 0.015 | 0.002 | 0.003 | 0.006 | 0.002 | 0.003 | 0.006 | 0.012 |
| 1986 | 0.001 | 0.020 | 0.283 | 0.360 | 0.110 | 0.114 | 0.017 | 0.028 | 0.009 | 0.001 | 0.000 | 0.002 | 0.005 | 0.005 | 0.042 |
| 1987 | 0.012 | 0.144 | 0.252 | 0.193 | 0.171 | 0.063 | 0.047 | 0.038 | 0.027 | 0.011 | 0.005 | 0.006 | 0.004 | 0.007 | 0.020 |
| 1988 | 0.032 | 0.279 | 0.200 | 0.152 | 0.130 | 0.101 | 0.041 | 0.027 | 0.016 | 0.006 | 0.003 | 0.001 | 0.004 | 0.002 | 0.005 |
| 1989 | 0.022 | 0.201 | 0.290 | 0.114 | 0.126 | 0.092 | 0.072 | 0.030 | 0.021 | 0.013 | 0.004 | 0.001 | 0.002 | 0.002 | 0.009 |
| 1990 | 0.000 | 0.149 | 0.171 | 0.128 | 0.098 | 0.117 | 0.140 | 0.117 | 0.041 | 0.015 | 0.004 | 0.002 | 0.003 | 0.004 | 0.011 |
| 1991 | 0.001 | 0.160 | 0.191 | 0.202 | 0.105 | 0.058 | 0.076 | 0.081 | 0.078 | 0.023 | 0.005 | 0.003 | 0.001 | 0.004 | 0.012 |
| 1992 | 0.013 | 0.061 | 0.165 | 0.171 | 0.157 | 0.080 | 0.073 | 0.120 | 0.080 | 0.052 | 0.009 | 0.004 | 0.002 | 0.003 | 0.009 |
| 1993 | 0.000 | 0.085 | 0.128 | 0.179 | 0.140 | 0.119 | 0.079 | 0.063 | 0.087 | 0.067 | 0.036 | 0.007 | 0.002 | 0.001 | 0.007 |
| 1994 | 0.008 | 0.089 | 0.142 | 0.097 | 0.140 | 0.127 | 0.075 | 0.086 | 0.106 | 0.070 | 0.029 | 0.019 | 0.002 | 0.002 | 0.010 |
| 1995 | 0.003 | 0.406 | 0.166 | 0.088 | 0.050 | 0.070 | 0.039 | 0.049 | 0.049 | 0.038 | 0.025 | 0.011 | 0.004 | 0.001 | 0.002 |
| 1996 | 0.001 | 0.017 | 0.208 | 0.163 | 0.136 | 0.100 | 0.147 | 0.084 | 0.065 | 0.035 | 0.024 | 0.013 | 0.003 | 0.001 | 0.002 |
| 1997 | 0.005 | 0.179 | 0.191 | 0.282 | 0.106 | 0.061 | 0.040 | 0.038 | 0.034 | 0.022 | 0.018 | 0.009 | 0.008 | 0.004 | 0.002 |
| 1998 | 0.001 | 0.086 | 0.163 | 0.256 | 0.222 | 0.092 | 0.062 | 0.053 | 0.027 | 0.015 | 0.012 | 0.005 | 0.002 | 0.002 | 0.002 |
| 1999 | 0.001 | 0.016 | 0.232 | 0.295 | 0.167 | 0.120 | 0.051 | 0.057 | 0.021 | 0.022 | 0.010 | 0.005 | 0.002 | 0.001 | 0.001 |
| 2000 | 0.000 | 0.021 | 0.193 | 0.169 | 0.244 | 0.135 | 0.101 | 0.075 | 0.028 | 0.017 | 0.008 | 0.004 | 0.003 | 0.001 | 0.001 |
| 2001 | 0.001 | 0.023 | 0.097 | 0.148 | 0.287 | 0.195 | 0.122 | 0.062 | 0.020 | 0.014 | 0.015 | 0.006 | 0.005 | 0.002 | 0.001 |
| 2002 | 0.005 | 0.156 | 0.138 | 0.161 | 0.103 | 0.173 | 0.098 | 0.063 | 0.054 | 0.013 | 0.016 | 0.009 | 0.005 | 0.005 | 0.001 |
| 2003 | 0.000 | 0.105 | 0.219 | 0.137 | 0.164 | 0.080 | 0.115 | 0.082 | 0.042 | 0.026 | 0.013 | 0.008 | 0.005 | 0.003 | 0.002 |
| 2004 | 0.000 | 0.043 | 0.366 | 0.224 | 0.098 | 0.082 | 0.057 | 0.059 | 0.029 | 0.014 | 0.014 | 0.007 | 0.002 | 0.003 | 0.001 |
| 2005 | 0.002 | 0.247 | 0.143 | 0.250 | 0.149 | 0.060 | 0.043 | 0.031 | 0.031 | 0.018 | 0.013 | 0.006 | 0.003 | 0.002 | 0.002 |
| 2006 | 0.001 | 0.035 | 0.476 | 0.138 | 0.162 | 0.089 | 0.027 | 0.020 | 0.014 | 0.016 | 0.010 | 0.006 | 0.004 | 0.001 | 0.001 |
| 2007 | 0.000 | 0.089 | 0.215 | 0.334 | 0.114 | 0.106 | 0.040 | 0.025 | 0.023 | 0.023 | 0.015 | 0.010 | 0.004 | 0.001 | 0.001 |
| 2008 | 0.006 | 0.028 | 0.145 | 0.203 | 0.312 | 0.095 | 0.090 | 0.049 | 0.019 | 0.022 | 0.010 | 0.006 | 0.010 | 0.002 | 0.002 |
| 2009 | 0.002 | 0.078 | 0.102 | 0.149 | 0.154 | 0.271 | 0.059 | 0.069 | 0.031 | 0.025 | 0.020 | 0.014 | 0.016 | 0.004 | 0.006 |
| 2010 | 0.000 | 0.026 | 0.219 | 0.091 | 0.135 | 0.118 | 0.189 | 0.051 | 0.054 | 0.041 | 0.018 | 0.019 | 0.015 | 0.016 | 0.008 |
| 2011 | 0.015 | 0.075 | 0.147 | 0.188 | 0.077 | 0.146 | 0.106 | 0.122 | 0.040 | 0.031 | 0.015 | 0.011 | 0.011 | 0.007 | 0.008 |
| 2012 | 0.001 | 0.178 | 0.202 | 0.068 | 0.146 | 0.106 | 0.067 | 0.075 | 0.076 | 0.020 | 0.019 | 0.018 | 0.008 | 0.010 | 0.007 |
| 2013 | 0.001 | 0.079 | 0.228 | 0.213 | 0.157 | 0.086 | 0.054 | 0.040 | 0.041 | 0.064 | 0.011 | 0.007 | 0.008 | 0.005 | 0.008 |
| 2014 | 0.001 | 0.016 | 0.326 | 0.243 | 0.185 | 0.046 | 0.043 | 0.028 | 0.027 | 0.028 | 0.020 | 0.011 | 0.007 | 0.006 | 0.011 |
| 2015 | 0.002 | 0.035 | 0.045 | 0.359 | 0.243 | 0.101 | 0.046 | 0.035 | 0.031 | 0.030 | 0.028 | 0.018 | 0.009 | 0.008 | 0.010 |
| 2016 | 0.014 | 0.275 | 0.125 | 0.060 | 0.269 | 0.114 | 0.025 | 0.021 | 0.020 | 0.015 | 0.019 | 0.021 | 0.009 | 0.004 | 0.010 |
| 2017 | 0.001 | 0.214 | 0.269 | 0.104 | 0.103 | 0.143 | 0.055 | 0.027 | 0.012 | 0.017 | 0.014 | 0.017 | 0.013 | 0.006 | 0.005 |

Table B7.6. Starting values for two-stock statistical catch-at-age (2SCA) model parameters.

| Stock | Category | ADMB Name | Lower | Upper | Start | Phase |
|---|---|---|---|---|---|---|
| 1 | Mean recruitment | s1_bay_logavg_R | -25 | 28 | 18 | 1 |
| 1 | Recruitment devs | s1_bay_log_devR | -15 | 15 | | 2 |
| 1 | N Bay in first year | s1_bay_logNyr1 | -25 | 28 | 18 | 2 |
| 1 | F in bay | s1_bay_log_F | -23 | 1.1 | -2.99 | 1 |
| 1 | Catch selectivity | s1_bay_select_gompertz_a | -1 | 150 | 3.105 | 1 |
| 1 | Catch selectivity | s1_bay_select_gompertz_b | 0.01 | 150 | 0.915 | 1 |
| 1 | Catch selectivity | s1_bay_select_logistic_a | -150 | 150 | 1.4 | 1 |
| 1 | Catch selectivity | s1_bay_select_logistic_b | -150 | 150 | 4 | 1 |
| 1 | Catch selectivity | s1_bay_select_thompson_a | -20 | 0 | -3.81 | 1 |
| 1 | Catch selectivity | s1_bay_select_thompson_b | -25 | 25 | 3 | 1 |
| 1 | Catch selectivity | s1_bay_select_thompson_c | 1E-10 | 1 | 0.9 | 1 |
| 1 | YOY/Age 1 Catchability Coefficients | s1_bay_logq_agg | -40 | 0 | -17 | 2 |
| 1 | AC Surveys Catchability Coefficients | s1_bay_logq_ac | -40 | 0 | -15 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_gompertz_a | -1 | 150 | 3.105 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_gompertz_b | 0.01 | 150 | 0.915 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_logistic_a | -150 | 150 | 1.4 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_logistic_b | -150 | 150 | 4 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_thompson_a | -20 | 0 | -3.81 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_thompson_b | -25 | 25 | 3 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_thompson_c | 1E-10 | 1 | 0.9 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_gamma_a | -150 | 150 | 3 | 2 |
| 1 | AC Surveys selectivity | s1_bay_ac_gamma_b | -150 | 150 | 1 | 2 |
| 2 | Mean recruitment | s2_logavg_R | -25 | 28 | 17 | 1 |
| 2 | Recruitment devs | s2_log_devR | -20 | 20 | | 2 |
| 2 | N ocean I first year | s2_logNyr1 | -25 | 28 | 18 | 2 |
| 2 | YOY/Age 1 Catchability Coefficients | s2_logq_agg | -40 | 0 | -9.1 | 2 |
| 2 | AC Surveys Catchability Coefficients | s2_logq_ac | -40 | 0 | -9.1 | 2 |
| 2 | AC Surveys selectivity | s2_ac_gompertz_a | -1 | 150 | 3.105 | 2 |
| 2 | AC Surveys selectivity | s2_ac_gompertz_b | 0.01 | 150 | 0.915 | 2 |
| 2 | AC Surveys selectivity | s2_ac_logistic_a | -150 | 150 | 1.4 | 2 |
| 2 | AC Surveys selectivity | s2_ac_logistic_b | -150 | 150 | 4 | 2 |
| 2 | AC Surveys selectivity | s2_ac_thompson_a | -20 | 0 | -3.81 | 2 |
| 2 | AC Surveys selectivity | s2_ac_thompson_b | -25 | 25 | 3 | 2 |
| 2 | AC Surveys selectivity | s2_ac_thompson_c | 1E-10 | 1 | 0.9 | 2 |
| 2 | AC Surveys selectivity | s2_ac_gamma_a | -150 | 150 | 3 | 2 |
| 2 | AC Surveys selectivity | s2_ac_gamma_b | -150 | 150 | 1 | 2 |
| Mixed Ocean | F in Ocean | coast_log_F | -23 | 1.1 | -2.99 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_gompertz_a | -1 | 150 | 3.105 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_gompertz_b | 0.01 | 150 | 0.915 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_logistic_a | -150 | 150 | 1.4 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_logistic_b | -150 | 150 | 4 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_thompson_a | -20 | 0 | -3.81 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_thompson_b | -25 | 25 | 3 | 1 |
| Mixed Ocean | Catch selectivity | coast_select_thompson_c | 1E-10 | 1 | 0.9 | 1 |
| Mixed Ocean | AC Surveys Catchability Coefficients | coast_logq_ac | -40 | 0 | -15 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_gompertz_a | -20 | 150 | 3.105 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_gompertz_b | 0.01 | 150 | 0.915 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_logistic_a | -150 | 150 | 1.4 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_logistic_b | -150 | 150 | 4 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_thompson_a | -20 | 0 | -3.81 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_thompson_b | -25 | 25 | 3 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_thompson_c | 1E-10 | 1 | 0.9 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_gamma_a | -150 | 150 | 3 | 2 |
| Mixed Ocean | AC Surveys selectivity | coast_ac_gamma_b | -150 | 150 | 1 | 2 |

Table B7.7. CV weights, residual mean square error (RMSE), and effective sample sizes for total removals, removals at age, indices, and index age composition data by stock for 2SCA model.

Stock 1

| Total Removals | | | |
|---|---|---|---|
| Period | CV Weights | RMSE | Average ESS |
| 1 | 1.3 | 0.083 | 4 |
| 2 | 1.2 | 0.081 | 31 |
| 3 | 0.45 | 0.075 | 13 |

| Indices | CV weights | RMSE | Average ESS |
|---|---|---|---|
| MDVAYOY | 0.4 | 0.84 | |
| MD Age 1 | 1 | 1.02 | |
| MDSSN | 1.5 | 0.96 | 34.4 |
| CHESMAP | 0.6 | 1.03 | 14.2 |

Stock 2

| Indices | CV weights | RMSE | Average ESS |
|---|---|---|---|
| NY YOY | 1.7 | 1.03 | |
| NY Age 1 | 0.5 | 0.98 | |
| NJ YOY | 2 | 0.85 | |
| DE SSN | 0.35 | 1 | 20 |
| DE 30 Trawl | 0.7 | 0.99 | 7.5 |

Mixed Stock (Ocean)

| Total Removals | | | |
|---|---|---|---|
| Period | CV Weights | RMSE | Average ESS |
| 1 | 1 | 0.1038 | 5 |
| 2 | 0.5 | 0.0965 | 15.9 |
| 3 | 0.3 | 0.0776 | 24.6 |

| Indices | CV weights | RMSE | Average ESS |
|---|---|---|---|
| NY OHS* | 5 | 0.49 | 16.2 |
| NJ Trawl | 1.8 | 1.00 | 4.6 |
| CT Trawl | 0.65 | 1.00 | 7.8 |
| MRIP | 0.5 | 0.99 | 18.8 |

* purposely down-weighted to ignore total index, but allow use of the age composition data

Table B7.8. Likelihood components with respective contributions from base model run for 2SCA model.

| Components | -LogL |
|---|---|
| Stock 1 Total Removals (All Periods) RSS | 11.6437 |
| Ocean Total Removals RSS (All Periods) RSS | 17.8379 |
| Stock 1 YOY and Age 1 Indices RSS | 584.784 |
| Stock 2 YOY and Age 1 Indices RSS | 1117.37 |
| Stock 1 Age-Specific Indices RSS | 371.258 |
| Stock 2 Age_Specific Indices RSS | 736.139 |
| Mixed Stock Age_Specific Indices RSS | 1474.95 |
| Concentrated Likelihood | 555.087 |
| | |
| Stock 1 Removals Age Composition Likelihood | 3618.13 |
| Ocean Removals Age Composition Likelihood | 4008.7 |
| Stock 1 Age-Specific Indices Age Composition Likelihood | 2618.26 |
| Stock 2 Age -Specific Indices Age Composition Likelihood | 1221.44 |
| Mixed Stock Age -Specific Indices Age Composition Likelihood | 2730.75 |
| Stock Composition Likelihood | 259.813 |
| Composition Data Total Likelihood | 14457.1 |
| | |
| Total Likelihood | 15069.2 |
| Number of Parameters Estimates | 344 |
| | |
| AIC | 30826.5 |

Table B7.9 2SCA model parameter estimates and associated standard deviations of base model configuration.

Stock 1 Bay

| Year | F (Period 1) | SD | CV | F (Period 2) | SD | CV | F (Period 3) | SD | CV |
|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0.1039 | 0.0761 | 0.7330 | 0.1275 | 0.0837 | 0.6570 | 0.1387 | 0.0494 | 0.3560 |
| 1983 | 0.0417 | 0.0337 | 0.8080 | 0.0793 | 0.0580 | 0.7320 | 0.2342 | 0.0759 | 0.3240 |
| 1984 | 0.0194 | 0.0159 | 0.8210 | 0.0185 | 0.0139 | 0.7530 | 0.1650 | 0.0553 | 0.3350 |
| 1985 | 0.0000 | 0.0000 | 0.7590 | 0.0050 | 0.0036 | 0.7170 | 0.0038 | 0.0011 | 0.3010 |
| 1986 | 0.0000 | 0.0000 | 0.7540 | 0.0062 | 0.0044 | 0.7190 | 0.0064 | 0.0019 | 0.2890 |
| 1987 | 0.0000 | 0.0000 | 0.7510 | 0.0029 | 0.0020 | 0.7050 | 0.0010 | 0.0003 | 0.2810 |
| 1988 | 0.0000 | 0.0000 | 0.7500 | 0.0010 | 0.0007 | 0.6970 | 0.0091 | 0.0025 | 0.2780 |
| 1989 | 0.0000 | 0.0000 | 0.7490 | 0.0009 | 0.0006 | 0.6960 | 0.0048 | 0.0013 | 0.2740 |
| 1990 | 0.0000 | 0.0000 | 0.7560 | 0.0041 | 0.0017 | 0.4010 | 0.0769 | 0.0128 | 0.1670 |
| 1991 | 0.0026 | 0.0020 | 0.7660 | 0.0059 | 0.0024 | 0.4020 | 0.0700 | 0.0116 | 0.1650 |
| 1992 | 0.0116 | 0.0092 | 0.7950 | 0.0052 | 0.0021 | 0.4000 | 0.0633 | 0.0103 | 0.1630 |
| 1993 | 0.0093 | 0.0073 | 0.7840 | 0.0037 | 0.0015 | 0.3970 | 0.0544 | 0.0084 | 0.1540 |
| 1994 | 0.0074 | 0.0057 | 0.7730 | 0.0051 | 0.0020 | 0.3950 | 0.0778 | 0.0113 | 0.1450 |
| 1995 | 0.0081 | 0.0063 | 0.7740 | 0.0141 | 0.0089 | 0.6300 | 0.1004 | 0.0144 | 0.1430 |
| 1996 | 0.0148 | 0.0115 | 0.7750 | 0.0132 | 0.0041 | 0.3090 | 0.1614 | 0.0204 | 0.1260 |
| 1997 | 0.0175 | 0.0134 | 0.7650 | 0.0166 | 0.0034 | 0.2040 | 0.1774 | 0.0200 | 0.1130 |
| 1998 | 0.0142 | 0.0105 | 0.7410 | 0.0155 | 0.0058 | 0.3740 | 0.1513 | 0.0170 | 0.1130 |
| 1999 | 0.0063 | 0.0046 | 0.7380 | 0.0154 | 0.0026 | 0.1710 | 0.1656 | 0.0179 | 0.1080 |
| 2000 | 0.0130 | 0.0094 | 0.7210 | 0.0195 | 0.0069 | 0.3520 | 0.1607 | 0.0188 | 0.1170 |
| 2001 | 0.0065 | 0.0048 | 0.7350 | 0.0127 | 0.0055 | 0.4370 | 0.1417 | 0.0155 | 0.1090 |
| 2002 | 0.0110 | 0.0080 | 0.7230 | 0.0107 | 0.0033 | 0.3040 | 0.1628 | 0.0183 | 0.1130 |
| 2003 | 0.0078 | 0.0056 | 0.7270 | 0.0246 | 0.0074 | 0.3010 | 0.2125 | 0.0232 | 0.1090 |
| 2004 | 0.0101 | 0.0073 | 0.7260 | 0.0210 | 0.0071 | 0.3380 | 0.2349 | 0.0256 | 0.1090 |
| 2005 | 0.0146 | 0.0105 | 0.7190 | 0.0271 | 0.0169 | 0.6240 | 0.1771 | 0.0201 | 0.1140 |
| 2006 | 0.0146 | 0.0106 | 0.7220 | 0.0243 | 0.0101 | 0.4180 | 0.2660 | 0.0326 | 0.1230 |
| 2007 | 0.0106 | 0.0078 | 0.7350 | 0.0231 | 0.0110 | 0.4770 | 0.1919 | 0.0247 | 0.1290 |
| 2008 | 0.0117 | 0.0086 | 0.7350 | 0.0159 | 0.0071 | 0.4470 | 0.1653 | 0.0199 | 0.1200 |
| 2009 | 0.0155 | 0.0114 | 0.7320 | 0.0220 | 0.0111 | 0.5030 | 0.2122 | 0.0263 | 0.1240 |
| 2010 | 0.0163 | 0.0117 | 0.7200 | 0.0199 | 0.0067 | 0.3370 | 0.2245 | 0.0391 | 0.1740 |
| 2011 | 0.0153 | 0.0111 | 0.7220 | 0.0275 | 0.0104 | 0.3770 | 0.2147 | 0.0288 | 0.1340 |
| 2012 | 0.0222 | 0.0160 | 0.7180 | 0.0244 | 0.0096 | 0.3950 | 0.2701 | 0.0367 | 0.1360 |
| 2013 | 0.0153 | 0.0111 | 0.7290 | 0.0383 | 0.0115 | 0.2990 | 0.2667 | 0.0343 | 0.1280 |
| 2014 | 0.0138 | 0.0104 | 0.7480 | 0.0304 | 0.0114 | 0.3750 | 0.3180 | 0.0533 | 0.1670 |
| 2015 | 0.0078 | 0.0059 | 0.7540 | 0.0340 | 0.0150 | 0.4420 | 0.2552 | 0.0355 | 0.1390 |
| 2016 | 0.0110 | 0.0082 | 0.7510 | 0.0667 | 0.0308 | 0.4620 | 0.2859 | 0.0427 | 0.1490 |
| 2017 | 0.0100 | 0.0075 | 0.7510 | 0.0504 | 0.0239 | 0.4740 | 0.1942 | 0.0319 | 0.1640 |

Ocean

| Year | F (Period 1) | SD | CV | F (Period 2) | SD | CV | F (Period 3) | SD | CV |
|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0.0008 | 0.0006 | 0.6580 | 0.1077 | 0.0294 | 0.2730 | 0.0841 | 0.0203 | 0.2420 |
| 1983 | 0.0003 | 0.0002 | 0.6590 | 0.0402 | 0.0125 | 0.3110 | 0.1511 | 0.0544 | 0.3600 |
| 1984 | 0.0001 | 0.0001 | 0.6580 | 0.0124 | 0.0052 | 0.4180 | 0.0907 | 0.0201 | 0.2220 |
| 1985 | 0.0000 | 0.0000 | 1.2950 | 0.0240 | 0.0123 | 0.5110 | 0.1768 | 0.0720 | 0.4070 |
| 1986 | 0.0000 | 0.0000 | 1.1430 | 0.0125 | 0.0085 | 0.6770 | 0.0636 | 0.0202 | 0.3180 |
| 1987 | 0.0000 | 0.0000 | 0.7740 | 0.0058 | 0.0030 | 0.5140 | 0.0424 | 0.0087 | 0.2060 |
| 1988 | 0.0000 | 0.0000 | 0.6440 | 0.0098 | 0.0032 | 0.3240 | 0.0483 | 0.0112 | 0.2320 |
| 1989 | 0.0000 | 0.0000 | 0.5640 | 0.0147 | 0.0044 | 0.3020 | 0.0599 | 0.0117 | 0.1960 |
| 1990 | 0.0004 | 0.0003 | 0.5940 | 0.0335 | 0.0109 | 0.3260 | 0.0876 | 0.0165 | 0.1890 |
| 1991 | 0.0004 | 0.0004 | 1.2050 | 0.0421 | 0.0130 | 0.3090 | 0.1190 | 0.0224 | 0.1880 |
| 1992 | 0.0009 | 0.0010 | 1.0540 | 0.0689 | 0.0220 | 0.3190 | 0.1198 | 0.0223 | 0.1860 |
| 1993 | 0.0007 | 0.0005 | 0.6240 | 0.0559 | 0.0136 | 0.2430 | 0.0866 | 0.0144 | 0.1660 |
| 1994 | 0.0015 | 0.0009 | 0.6240 | 0.0697 | 0.0151 | 0.2160 | 0.1042 | 0.0160 | 0.1530 |
| 1995 | 0.0017 | 0.0011 | 0.6250 | 0.0844 | 0.0201 | 0.2380 | 0.2023 | 0.0354 | 0.1750 |
| 1996 | 0.0038 | 0.0024 | 0.6300 | 0.1072 | 0.0213 | 0.1990 | 0.2102 | 0.0324 | 0.1540 |
| 1997 | 0.0134 | 0.0086 | 0.6470 | 0.0931 | 0.0128 | 0.1370 | 0.1436 | 0.0124 | 0.0860 |
| 1998 | 0.0088 | 0.0056 | 0.6420 | 0.1078 | 0.0169 | 0.1570 | 0.1549 | 0.0139 | 0.0900 |
| 1999 | 0.0114 | 0.0075 | 0.6560 | 0.0915 | 0.0130 | 0.1420 | 0.1419 | 0.0132 | 0.0930 |
| 2000 | 0.0045 | 0.0028 | 0.6220 | 0.0969 | 0.0146 | 0.1500 | 0.1372 | 0.0122 | 0.0890 |
| 2001 | 0.0067 | 0.0042 | 0.6240 | 0.0966 | 0.0116 | 0.1200 | 0.1383 | 0.0118 | 0.0860 |
| 2002 | 0.0125 | 0.0079 | 0.6320 | 0.1438 | 0.0175 | 0.1210 | 0.1164 | 0.0099 | 0.0850 |
| 2003 | 0.0095 | 0.0059 | 0.6220 | 0.1383 | 0.0178 | 0.1280 | 0.1278 | 0.0107 | 0.0840 |
| 2004 | 0.0194 | 0.0131 | 0.6750 | 0.1631 | 0.0482 | 0.2960 | 0.1555 | 0.0144 | 0.0930 |
| 2005 | 0.0097 | 0.0059 | 0.6090 | 0.1660 | 0.0304 | 0.1830 | 0.1538 | 0.0144 | 0.0940 |
| 2006 | 0.0148 | 0.0204 | 1.3850 | 0.1992 | 0.0308 | 0.1550 | 0.1760 | 0.0159 | 0.0900 |
| 2007 | 0.0141 | 0.0092 | 0.6520 | 0.1686 | 0.0252 | 0.1490 | 0.1155 | 0.0111 | 0.0960 |
| 2008 | 0.0158 | 0.0083 | 0.5260 | 0.1217 | 0.0195 | 0.1600 | 0.1662 | 0.0163 | 0.0980 |
| 2009 | 0.0097 | 0.0028 | 0.2900 | 0.1280 | 0.0184 | 0.1440 | 0.1437 | 0.0134 | 0.0930 |
| 2010 | 0.0044 | 0.0035 | 0.7900 | 0.1384 | 0.0235 | 0.1700 | 0.1843 | 0.0178 | 0.0960 |
| 2011 | 0.0128 | 0.0062 | 0.4850 | 0.1765 | 0.0261 | 0.1480 | 0.1596 | 0.0157 | 0.0990 |
| 2012 | 0.0064 | 0.0034 | 0.5410 | 0.1512 | 0.0264 | 0.1750 | 0.1654 | 0.0176 | 0.1060 |
| 2013 | 0.0034 | 0.0019 | 0.5460 | 0.2551 | 0.0443 | 0.1740 | 0.2308 | 0.0244 | 0.1060 |
| 2014 | 0.0000 | 0.0000 | 0.5490 | 0.1636 | 0.0303 | 0.1850 | 0.1867 | 0.0234 | 0.1260 |
| 2015 | 0.0002 | 0.0001 | 0.5500 | 0.1811 | 0.0323 | 0.1790 | 0.1425 | 0.0192 | 0.1350 |
| 2016 | 0.0000 | 0.0000 | 0.5500 | 0.1662 | 0.0366 | 0.2200 | 0.1699 | 0.0224 | 0.1320 |
| 2017 | 0.0000 | 0.0000 | 0.5510 | 0.1661 | 0.0287 | 0.1730 | 0.2337 | 0.0313 | 0.1340 |

Table B7.9 (continued).

Catch Selectivity Parameters

Stock 1 Bay

| Time Block | Parameters | Estimate | SD | CV |
|---|---|---|---|---|
| 1982-1989 | α | 2.466 | 0.111 | 0.045 |
| | β | 1.292 | 0.110 | 0.085 |
| 1990-1995 | α | 3.777 | 0.229 | 0.061 |
| | β | 0.724 | 0.078 | 0.108 |
| 1996-2017 | α | 4.544 | 0.152 | 0.033 |
| | β | 0.545 | 0.028 | 0.052 |

Ocean

| Time Block | Parameters | Estimate | SD | CV |
|---|---|---|---|---|
| 1982-1989 | α | 3.464 | 0.262 | 0.076 |
| | β | 0.687 | 0.085 | 0.124 |
| 1990-1996 | α | 5.469 | 0.554 | 0.101 |
| | β | 0.385 | 0.050 | 0.129 |
| 1997-2017 | α | 4.467 | 0.224 | 0.05 |
| | β | 0.489 | 0.037 | 0.076 |

Catchability Coefficents

| Survey | Estimate | SD | CV |
|---|---|---|---|
| MDVA YOY | 9.6289E-07 | 6.55E-08 | 0.068 |
| MD Age 1 | 5.527E-09 | 6.6E-10 | 0.119 |
| MDSSN | 1.1124E-07 | 2.15E-08 | 0.193 |
| CHESMAP | 8.2089E-07 | 1.03E-07 | 0.125 |
| NY YOY | 3.1424E-07 | 3.67E-08 | 0.117 |
| NY Age 1 | 7.1092E-08 | 5.15E-09 | 0.072 |
| NJ YOY | 2.2136E-08 | 1.63E-09 | 0.074 |
| DE SSN | 1.2274E-07 | 1.48E-08 | 0.12 |
| DE 30 Trawl | 9.217E-08 | 1.68E-08 | 0.182 |
| NY OHS | 2.254E-07 | 9.69E-08 | 0.43 |
| NJ Trawl | 4.0752E-07 | 5.04E-08 | 0.124 |
| CT Trawl | 2.0651E-08 | 1.71E-09 | 0.083 |
| MRIP | 6.1254E-08 | 4.16E-09 | 0.068 |

Age-Specific Survey Selectivity Parameters

Stock 1 Bay

| Survey | Parameters | Estimate | SD | CV |
|---|---|---|---|---|
| MD SSN | Age 2 | 0.092 | 0.01 | 0.111 |
| | Age 3 | 0.608 | 0.044 | 0.072 |
| CHESMAP | α | 1.268 | 0.111 | 0.087 |
| | β | 2.164 | 0.697 | 0.322 |

Stock 2

| Survey | Parameters | Estimate | SD | CV |
|---|---|---|---|---|
| DE SSN | α | 3.693 | 0.222 | 0.06 |
| | β | 0.708 | 0.079 | 0.113 |
| DE Trawl | α | 1.081 | 0.357 | 0.33 |
| | β | 0.215 | 0.107 | 0.496 |

Mixed Stock Ocean

| Survey | Parameters | Estimate | SD | CV |
|---|---|---|---|---|
| NYOHS | α | -4.771 | 0.160 | 0.034 |
| | β | 2.369 | 0.047 | 0.02 |
| | γ | 0.932 | 0.008 | 0.009 |
| NJ Trawl | α | 3.732 | 0.480 | 0.129 |
| | β | 0.633 | 0.122 | 0.193 |
| CT Trawl | α | 3.830 | 0.347 | 0.091 |
| | β | 0.809 | 0.103 | 0.128 |
| MRIP | α | -3.385 | 0.512 | 0.151 |
| | β | 2.391 | 0.122 | 0.051 |
| | γ | 0.980 | 0.008 | 0.008 |

| Age | Stock 1 Bay N | SD | CV |
|---|---|---|---|
| 2 | 1,188,000 | 260,880 | 0.220 |
| 3 | 637,850 | 146,780 | 0.230 |
| 4 | 179,730 | 58,361 | 0.325 |
| 5 | 47,538 | 25,557 | 0.538 |
| 6 | 6,457 | 3,288 | 0.509 |

| Age | Stock 2 N | SD | CV |
|---|---|---|---|
| 2 | 4,935,500 | 711,360 | 0.144 |
| 3 | 2,127,200 | 335,240 | 0.158 |
| 4 | 1,645,000 | 253,300 | 0.154 |
| 5 | 666,430 | 140,660 | 0.211 |
| 6 | 320,090 | 90,705 | 0.283 |
| 7 | 252,890 | 36,739 | 0.145 |

Table B7.9 (continued).

| | Stock 1 | | | Stock 2 | | |
|---|---|---|---|---|---|---|
| Year | Recruitment | SD | CV | Recruitment | SD | CV |
| 1982 | 14,161,000 | 1,983,200 | 0.140 | 10,402,000 | 1,842,700 | 0.177 |
| 1983 | 44,721,000 | 4,707,200 | 0.105 | 15,521,000 | 2,577,600 | 0.166 |
| 1984 | 36,269,000 | 4,133,200 | 0.114 | 17,977,000 | 2,513,200 | 0.140 |
| 1985 | 49,861,000 | 5,232,600 | 0.105 | 15,058,000 | 2,469,300 | 0.164 |
| 1986 | 55,819,000 | 5,886,500 | 0.105 | 13,289,000 | 2,226,600 | 0.168 |
| 1987 | 63,572,000 | 6,746,900 | 0.106 | 20,311,000 | 3,042,200 | 0.150 |
| 1988 | 73,788,000 | 7,780,800 | 0.105 | 29,487,000 | 3,956,500 | 0.134 |
| 1989 | 106,110,000 | 10,248,000 | 0.097 | 38,177,000 | 4,746,400 | 0.124 |
| 1990 | 139,480,000 | 12,766,000 | 0.092 | 39,908,000 | 5,230,100 | 0.131 |
| 1991 | 93,716,000 | 10,564,000 | 0.113 | 39,761,000 | 5,087,800 | 0.128 |
| 1992 | 92,593,000 | 11,287,000 | 0.122 | 42,251,000 | 5,568,900 | 0.132 |
| 1993 | 120,520,000 | 13,927,000 | 0.116 | 51,097,000 | 6,162,000 | 0.121 |
| 1994 | 280,110,000 | 23,938,000 | 0.085 | 123,090,000 | 10,882,000 | 0.088 |
| 1995 | 214,990,000 | 21,901,000 | 0.102 | 67,587,000 | 7,942,800 | 0.118 |
| 1996 | 251,270,000 | 24,379,000 | 0.097 | 91,451,000 | 9,263,400 | 0.101 |
| 1997 | 312,280,000 | 26,875,000 | 0.086 | 92,195,000 | 9,503,000 | 0.103 |
| 1998 | 181,850,000 | 19,078,000 | 0.105 | 57,049,000 | 7,071,000 | 0.124 |
| 1999 | 149,900,000 | 16,432,000 | 0.110 | 65,037,000 | 7,317,600 | 0.113 |
| 2000 | 116,150,000 | 14,219,000 | 0.122 | 58,943,000 | 6,566,000 | 0.111 |
| 2001 | 189,030,000 | 18,138,000 | 0.096 | 80,859,000 | 8,164,400 | 0.101 |
| 2002 | 214,210,000 | 19,756,000 | 0.092 | 89,076,000 | 8,546,800 | 0.096 |
| 2003 | 101,300,000 | 12,994,000 | 0.128 | 52,680,000 | 5,979,400 | 0.114 |
| 2004 | 343,710,000 | 25,984,000 | 0.076 | 116,560,000 | 9,767,700 | 0.084 |
| 2005 | 159,230,000 | 16,077,000 | 0.101 | 55,011,000 | 6,400,400 | 0.116 |
| 2006 | 159,050,000 | 15,638,000 | 0.098 | 49,215,000 | 5,660,100 | 0.115 |
| 2007 | 81,587,000 | 10,544,000 | 0.129 | 30,424,000 | 4,248,000 | 0.140 |
| 2008 | 147,310,000 | 14,888,000 | 0.101 | 49,343,000 | 5,393,900 | 0.109 |
| 2009 | 70,282,000 | 9,679,500 | 0.138 | 30,957,000 | 4,033,600 | 0.130 |
| 2010 | 105,280,000 | 12,912,000 | 0.123 | 38,610,000 | 4,665,000 | 0.121 |
| 2011 | 98,198,000 | 13,435,000 | 0.137 | 59,425,000 | 6,459,500 | 0.109 |
| 2012 | 310,270,000 | 33,332,000 | 0.107 | 53,356,000 | 6,809,400 | 0.128 |
| 2013 | 50,745,000 | 10,157,000 | 0.200 | 21,811,000 | 3,647,300 | 0.167 |
| 2014 | 80,544,000 | 13,952,000 | 0.173 | 29,982,000 | 4,647,200 | 0.155 |
| 2015 | 151,110,000 | 24,772,000 | 0.164 | 86,320,000 | 11,104,000 | 0.129 |
| 2016 | 260,990,000 | 54,000,000 | 0.207 | 102,130,000 | 16,897,000 | 0.165 |
| 2017 | 81,958,000 | 26,133,000 | 0.319 | 52,409,000 | 12,230,000 | 0.233 |

Table B7.10. Fishing mortality for ages 1-15+ by region, period, and year from 2SCA base model.

| Bay Fishing Mortality (Period 1/Wave 1) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | 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+ |
| 1982 | 0.104 | 0.000 | 0.017 | 0.063 | 0.091 | 0.100 | 0.103 | 0.104 | 0.104 | 0.104 | 0.104 | 0.104 | 0.104 | 0.104 | 0.104 | 0.104 |
| 1983 | 0.042 | 0.000 | 0.007 | 0.025 | 0.036 | 0.040 | 0.041 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| 1984 | 0.019 | 0.000 | 0.003 | 0.012 | 0.017 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| 1985 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1986 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1987 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1988 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1989 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1990 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1991 | 0.003 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| 1992 | 0.012 | 0.000 | 0.000 | 0.002 | 0.005 | 0.008 | 0.010 | 0.011 | 0.011 | 0.011 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| 1993 | 0.009 | 0.000 | 0.000 | 0.002 | 0.004 | 0.006 | 0.008 | 0.008 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 |
| 1994 | 0.007 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.006 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| 1995 | 0.008 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.007 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 |
| 1996 | 0.015 | 0.000 | 0.000 | 0.001 | 0.004 | 0.007 | 0.009 | 0.011 | 0.013 | 0.014 | 0.014 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 |
| 1997 | 0.017 | 0.000 | 0.000 | 0.002 | 0.005 | 0.008 | 0.011 | 0.013 | 0.015 | 0.016 | 0.017 | 0.017 | 0.017 | 0.017 | 0.017 | 0.017 |
| 1998 | 0.014 | 0.000 | 0.000 | 0.001 | 0.004 | 0.007 | 0.009 | 0.011 | 0.012 | 0.013 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| 1999 | 0.006 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 2000 | 0.013 | 0.000 | 0.000 | 0.001 | 0.003 | 0.006 | 0.008 | 0.010 | 0.011 | 0.012 | 0.012 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 |
| 2001 | 0.007 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.007 | 0.007 | 0.007 |
| 2002 | 0.011 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.008 | 0.009 | 0.010 | 0.010 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| 2003 | 0.008 | 0.000 | 0.000 | 0.001 | 0.002 | 0.004 | 0.005 | 0.006 | 0.007 | 0.007 | 0.007 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 |
| 2004 | 0.010 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.006 | 0.008 | 0.009 | 0.009 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| 2005 | 0.015 | 0.000 | 0.000 | 0.001 | 0.004 | 0.007 | 0.009 | 0.011 | 0.013 | 0.013 | 0.014 | 0.014 | 0.014 | 0.014 | 0.015 | 0.015 |
| 2006 | 0.015 | 0.000 | 0.000 | 0.001 | 0.004 | 0.007 | 0.009 | 0.011 | 0.013 | 0.013 | 0.014 | 0.014 | 0.014 | 0.015 | 0.015 | 0.015 |
| 2007 | 0.011 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.008 | 0.009 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.011 | 0.011 |
| 2008 | 0.012 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.009 | 0.010 | 0.011 | 0.011 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 |
| 2009 | 0.016 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.016 |
| 2010 | 0.016 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.013 | 0.014 | 0.015 | 0.015 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| 2011 | 0.015 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| 2012 | 0.022 | 0.000 | 0.000 | 0.002 | 0.006 | 0.010 | 0.014 | 0.017 | 0.019 | 0.020 | 0.021 | 0.022 | 0.022 | 0.022 | 0.022 | 0.022 |
| 2013 | 0.015 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| 2014 | 0.014 | 0.000 | 0.000 | 0.001 | 0.004 | 0.006 | 0.009 | 0.011 | 0.012 | 0.013 | 0.013 | 0.013 | 0.014 | 0.014 | 0.014 | 0.014 |
| 2015 | 0.008 | 0.000 | 0.000 | 0.001 | 0.002 | 0.004 | 0.005 | 0.006 | 0.007 | 0.007 | 0.007 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 |
| 2016 | 0.011 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.008 | 0.009 | 0.010 | 0.010 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| 2017 | 0.010 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.006 | 0.008 | 0.009 | 0.009 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |

Table B7.10 (continued).

| | | Bay Fishing Mortality (Period 2/Waves 2-3) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | 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+ |
| 1982 | 0.127 | 0.000 | 0.021 | 0.077 | 0.111 | 0.123 | 0.126 | 0.127 | 0.127 | 0.127 | 0.127 | 0.127 | 0.127 | 0.127 | 0.127 | 0.127 |
| 1983 | 0.079 | 0.000 | 0.013 | 0.048 | 0.069 | 0.076 | 0.078 | 0.079 | 0.079 | 0.079 | 0.079 | 0.079 | 0.079 | 0.079 | 0.079 | 0.079 |
| 1984 | 0.019 | 0.000 | 0.003 | 0.011 | 0.016 | 0.018 | 0.018 | 0.018 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| 1985 | 0.005 | 0.000 | 0.001 | 0.003 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 1986 | 0.006 | 0.000 | 0.001 | 0.004 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 1987 | 0.003 | 0.000 | 0.000 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| 1988 | 0.001 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1989 | 0.001 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1990 | 0.004 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| 1991 | 0.006 | 0.000 | 0.000 | 0.001 | 0.003 | 0.004 | 0.005 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 1992 | 0.005 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 1993 | 0.004 | 0.000 | 0.000 | 0.001 | 0.002 | 0.002 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| 1994 | 0.005 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 1995 | 0.014 | 0.000 | 0.000 | 0.002 | 0.006 | 0.009 | 0.012 | 0.013 | 0.013 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| 1996 | 0.013 | 0.000 | 0.000 | 0.001 | 0.003 | 0.006 | 0.008 | 0.010 | 0.011 | 0.012 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 |
| 1997 | 0.017 | 0.000 | 0.000 | 0.002 | 0.004 | 0.008 | 0.011 | 0.013 | 0.014 | 0.015 | 0.016 | 0.016 | 0.016 | 0.016 | 0.017 | 0.017 |
| 1998 | 0.015 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| 1999 | 0.015 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| 2000 | 0.020 | 0.000 | 0.000 | 0.002 | 0.005 | 0.009 | 0.012 | 0.015 | 0.017 | 0.018 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.020 |
| 2001 | 0.013 | 0.000 | 0.000 | 0.001 | 0.003 | 0.006 | 0.008 | 0.010 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.013 | 0.013 | 0.013 |
| 2002 | 0.011 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.008 | 0.009 | 0.010 | 0.010 | 0.010 | 0.011 | 0.011 | 0.011 | 0.011 |
| 2003 | 0.025 | 0.000 | 0.000 | 0.002 | 0.006 | 0.011 | 0.016 | 0.019 | 0.021 | 0.023 | 0.023 | 0.024 | 0.024 | 0.024 | 0.025 | 0.025 |
| 2004 | 0.021 | 0.000 | 0.000 | 0.002 | 0.005 | 0.010 | 0.013 | 0.016 | 0.018 | 0.019 | 0.020 | 0.020 | 0.021 | 0.021 | 0.021 | 0.021 |
| 2005 | 0.027 | 0.000 | 0.000 | 0.003 | 0.007 | 0.012 | 0.017 | 0.021 | 0.023 | 0.025 | 0.026 | 0.026 | 0.027 | 0.027 | 0.027 | 0.027 |
| 2006 | 0.024 | 0.000 | 0.000 | 0.002 | 0.006 | 0.011 | 0.016 | 0.019 | 0.021 | 0.022 | 0.023 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 |
| 2007 | 0.023 | 0.000 | 0.000 | 0.002 | 0.006 | 0.011 | 0.015 | 0.018 | 0.020 | 0.021 | 0.022 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| 2008 | 0.016 | 0.000 | 0.000 | 0.002 | 0.004 | 0.007 | 0.010 | 0.012 | 0.014 | 0.015 | 0.015 | 0.015 | 0.016 | 0.016 | 0.016 | 0.016 |
| 2009 | 0.022 | 0.000 | 0.000 | 0.002 | 0.006 | 0.010 | 0.014 | 0.017 | 0.019 | 0.020 | 0.021 | 0.021 | 0.022 | 0.022 | 0.022 | 0.022 |
| 2010 | 0.020 | 0.000 | 0.000 | 0.002 | 0.005 | 0.009 | 0.013 | 0.015 | 0.017 | 0.018 | 0.019 | 0.019 | 0.020 | 0.020 | 0.020 | 0.020 |
| 2011 | 0.027 | 0.000 | 0.001 | 0.003 | 0.007 | 0.013 | 0.018 | 0.021 | 0.024 | 0.025 | 0.026 | 0.027 | 0.027 | 0.027 | 0.027 | 0.027 |
| 2012 | 0.024 | 0.000 | 0.000 | 0.002 | 0.006 | 0.011 | 0.016 | 0.019 | 0.021 | 0.022 | 0.023 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 |
| 2013 | 0.038 | 0.000 | 0.001 | 0.004 | 0.010 | 0.018 | 0.024 | 0.030 | 0.033 | 0.035 | 0.036 | 0.037 | 0.038 | 0.038 | 0.038 | 0.038 |
| 2014 | 0.030 | 0.000 | 0.001 | 0.003 | 0.008 | 0.014 | 0.019 | 0.023 | 0.026 | 0.028 | 0.029 | 0.030 | 0.030 | 0.030 | 0.030 | 0.030 |
| 2015 | 0.034 | 0.000 | 0.001 | 0.003 | 0.009 | 0.016 | 0.022 | 0.026 | 0.029 | 0.031 | 0.032 | 0.033 | 0.033 | 0.034 | 0.034 | 0.034 |
| 2016 | 0.067 | 0.000 | 0.001 | 0.007 | 0.017 | 0.031 | 0.043 | 0.052 | 0.058 | 0.061 | 0.064 | 0.065 | 0.066 | 0.066 | 0.067 | 0.067 |
| 2017 | 0.050 | 0.000 | 0.001 | 0.005 | 0.013 | 0.023 | 0.032 | 0.039 | 0.043 | 0.046 | 0.048 | 0.049 | 0.050 | 0.050 | 0.050 | 0.050 |

Table B7.10 (continued).

| | | Bay Fishing Mortality (Period 3/Waves 4-6) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | 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+ |
| 1982 | 0.139 | 0.000 | 0.022 | 0.084 | 0.121 | 0.134 | 0.137 | 0.138 | 0.139 | 0.139 | 0.139 | 0.139 | 0.139 | 0.139 | 0.139 | 0.139 |
| 1983 | 0.234 | 0.000 | 0.038 | 0.142 | 0.204 | 0.226 | 0.232 | 0.234 | 0.234 | 0.234 | 0.234 | 0.234 | 0.234 | 0.234 | 0.234 | 0.234 |
| 1984 | 0.165 | 0.000 | 0.027 | 0.100 | 0.144 | 0.159 | 0.163 | 0.164 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 |
| 1985 | 0.004 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| 1986 | 0.006 | 0.000 | 0.001 | 0.004 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 1987 | 0.001 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1988 | 0.009 | 0.000 | 0.001 | 0.006 | 0.008 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 |
| 1989 | 0.005 | 0.000 | 0.001 | 0.003 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 1990 | 0.077 | 0.000 | 0.002 | 0.013 | 0.033 | 0.051 | 0.063 | 0.070 | 0.073 | 0.075 | 0.076 | 0.077 | 0.077 | 0.077 | 0.077 | 0.077 |
| 1991 | 0.070 | 0.000 | 0.002 | 0.012 | 0.030 | 0.046 | 0.057 | 0.064 | 0.067 | 0.068 | 0.069 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 |
| 1992 | 0.063 | 0.000 | 0.002 | 0.011 | 0.027 | 0.042 | 0.052 | 0.057 | 0.060 | 0.062 | 0.063 | 0.063 | 0.063 | 0.063 | 0.063 | 0.063 |
| 1993 | 0.054 | 0.000 | 0.001 | 0.009 | 0.023 | 0.036 | 0.045 | 0.049 | 0.052 | 0.053 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 |
| 1994 | 0.078 | 0.000 | 0.002 | 0.013 | 0.033 | 0.051 | 0.064 | 0.071 | 0.074 | 0.076 | 0.077 | 0.077 | 0.078 | 0.078 | 0.078 | 0.078 |
| 1995 | 0.100 | 0.000 | 0.003 | 0.017 | 0.043 | 0.066 | 0.082 | 0.091 | 0.096 | 0.098 | 0.099 | 0.100 | 0.100 | 0.100 | 0.100 | 0.100 |
| 1996 | 0.161 | 0.000 | 0.003 | 0.016 | 0.042 | 0.074 | 0.103 | 0.125 | 0.139 | 0.148 | 0.154 | 0.157 | 0.159 | 0.160 | 0.161 | 0.161 |
| 1997 | 0.177 | 0.000 | 0.003 | 0.018 | 0.046 | 0.082 | 0.113 | 0.137 | 0.153 | 0.163 | 0.169 | 0.173 | 0.175 | 0.176 | 0.177 | 0.177 |
| 1998 | 0.151 | 0.000 | 0.003 | 0.015 | 0.040 | 0.070 | 0.097 | 0.117 | 0.130 | 0.139 | 0.144 | 0.147 | 0.149 | 0.150 | 0.151 | 0.151 |
| 1999 | 0.166 | 0.000 | 0.003 | 0.016 | 0.043 | 0.076 | 0.106 | 0.128 | 0.143 | 0.152 | 0.158 | 0.161 | 0.163 | 0.165 | 0.165 | 0.166 |
| 2000 | 0.161 | 0.000 | 0.003 | 0.016 | 0.042 | 0.074 | 0.103 | 0.124 | 0.138 | 0.148 | 0.153 | 0.157 | 0.159 | 0.160 | 0.160 | 0.161 |
| 2001 | 0.142 | 0.000 | 0.003 | 0.014 | 0.037 | 0.065 | 0.090 | 0.109 | 0.122 | 0.130 | 0.135 | 0.138 | 0.140 | 0.141 | 0.141 | 0.142 |
| 2002 | 0.163 | 0.000 | 0.003 | 0.016 | 0.043 | 0.075 | 0.104 | 0.126 | 0.140 | 0.150 | 0.155 | 0.159 | 0.161 | 0.162 | 0.162 | 0.163 |
| 2003 | 0.212 | 0.000 | 0.004 | 0.021 | 0.056 | 0.098 | 0.136 | 0.164 | 0.183 | 0.195 | 0.203 | 0.207 | 0.210 | 0.211 | 0.212 | 0.212 |
| 2004 | 0.235 | 0.000 | 0.004 | 0.023 | 0.061 | 0.108 | 0.150 | 0.181 | 0.202 | 0.216 | 0.224 | 0.229 | 0.232 | 0.233 | 0.234 | 0.235 |
| 2005 | 0.177 | 0.000 | 0.003 | 0.017 | 0.046 | 0.081 | 0.113 | 0.137 | 0.153 | 0.163 | 0.169 | 0.172 | 0.175 | 0.176 | 0.177 | 0.177 |
| 2006 | 0.266 | 0.000 | 0.005 | 0.026 | 0.070 | 0.122 | 0.170 | 0.205 | 0.229 | 0.244 | 0.254 | 0.259 | 0.262 | 0.264 | 0.265 | 0.266 |
| 2007 | 0.192 | 0.000 | 0.004 | 0.019 | 0.050 | 0.088 | 0.122 | 0.148 | 0.165 | 0.176 | 0.183 | 0.187 | 0.189 | 0.191 | 0.191 | 0.192 |
| 2008 | 0.165 | 0.000 | 0.003 | 0.016 | 0.043 | 0.076 | 0.106 | 0.128 | 0.142 | 0.152 | 0.158 | 0.161 | 0.163 | 0.164 | 0.165 | 0.165 |
| 2009 | 0.212 | 0.000 | 0.004 | 0.021 | 0.055 | 0.098 | 0.135 | 0.164 | 0.183 | 0.195 | 0.202 | 0.207 | 0.209 | 0.211 | 0.212 | 0.212 |
| 2010 | 0.224 | 0.000 | 0.004 | 0.022 | 0.059 | 0.103 | 0.143 | 0.173 | 0.193 | 0.206 | 0.214 | 0.219 | 0.221 | 0.223 | 0.224 | 0.224 |
| 2011 | 0.215 | 0.000 | 0.004 | 0.021 | 0.056 | 0.099 | 0.137 | 0.166 | 0.185 | 0.197 | 0.205 | 0.209 | 0.212 | 0.213 | 0.214 | 0.215 |
| 2012 | 0.270 | 0.000 | 0.005 | 0.027 | 0.071 | 0.124 | 0.172 | 0.208 | 0.233 | 0.248 | 0.258 | 0.263 | 0.266 | 0.268 | 0.269 | 0.270 |
| 2013 | 0.267 | 0.000 | 0.005 | 0.026 | 0.070 | 0.123 | 0.170 | 0.206 | 0.230 | 0.245 | 0.254 | 0.260 | 0.263 | 0.265 | 0.266 | 0.267 |
| 2014 | 0.318 | 0.000 | 0.006 | 0.031 | 0.083 | 0.146 | 0.203 | 0.245 | 0.274 | 0.292 | 0.303 | 0.310 | 0.314 | 0.316 | 0.317 | 0.318 |
| 2015 | 0.255 | 0.000 | 0.005 | 0.025 | 0.067 | 0.117 | 0.163 | 0.197 | 0.220 | 0.234 | 0.243 | 0.249 | 0.252 | 0.253 | 0.255 | 0.255 |
| 2016 | 0.286 | 0.000 | 0.005 | 0.028 | 0.075 | 0.131 | 0.182 | 0.221 | 0.246 | 0.263 | 0.273 | 0.278 | 0.282 | 0.284 | 0.285 | 0.286 |
| 2017 | 0.194 | 0.000 | 0.004 | 0.019 | 0.051 | 0.089 | 0.124 | 0.150 | 0.167 | 0.178 | 0.185 | 0.189 | 0.191 | 0.193 | 0.194 | 0.194 |

Table B7.10 (continued).

| | | Ocean Fishing Mortality (Period 1/Wave 1) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | 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+ |
| 1982 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1983 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1984 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1985 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1986 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1987 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1988 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1989 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1990 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1991 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1992 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1993 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1994 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1995 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| 1996 | 0.004 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 |
| 1997 | 0.013 | 0.000 | 0.000 | 0.002 | 0.004 | 0.006 | 0.008 | 0.010 | 0.011 | 0.012 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 |
| 1998 | 0.009 | 0.000 | 0.000 | 0.001 | 0.003 | 0.004 | 0.006 | 0.007 | 0.007 | 0.008 | 0.008 | 0.008 | 0.009 | 0.009 | 0.009 | 0.009 |
| 1999 | 0.011 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.007 | 0.009 | 0.010 | 0.010 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| 2000 | 0.004 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| 2001 | 0.007 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.007 | 0.007 | 0.007 | 0.007 |
| 2002 | 0.012 | 0.000 | 0.000 | 0.002 | 0.004 | 0.006 | 0.008 | 0.009 | 0.010 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| 2003 | 0.010 | 0.000 | 0.000 | 0.001 | 0.003 | 0.004 | 0.006 | 0.007 | 0.008 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.010 |
| 2004 | 0.019 | 0.000 | 0.001 | 0.003 | 0.006 | 0.009 | 0.012 | 0.015 | 0.016 | 0.018 | 0.018 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| 2005 | 0.010 | 0.000 | 0.000 | 0.001 | 0.003 | 0.004 | 0.006 | 0.007 | 0.008 | 0.009 | 0.009 | 0.009 | 0.009 | 0.010 | 0.010 | 0.010 |
| 2006 | 0.015 | 0.000 | 0.001 | 0.002 | 0.004 | 0.007 | 0.009 | 0.011 | 0.012 | 0.013 | 0.014 | 0.014 | 0.014 | 0.015 | 0.015 | 0.015 |
| 2007 | 0.014 | 0.000 | 0.001 | 0.002 | 0.004 | 0.007 | 0.009 | 0.011 | 0.012 | 0.013 | 0.013 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| 2008 | 0.016 | 0.000 | 0.001 | 0.002 | 0.005 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.015 | 0.015 | 0.016 | 0.016 | 0.016 | 0.016 |
| 2009 | 0.010 | 0.000 | 0.000 | 0.001 | 0.003 | 0.005 | 0.006 | 0.007 | 0.008 | 0.009 | 0.009 | 0.009 | 0.010 | 0.010 | 0.010 | 0.010 |
| 2010 | 0.004 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| 2011 | 0.013 | 0.000 | 0.000 | 0.002 | 0.004 | 0.006 | 0.008 | 0.010 | 0.011 | 0.012 | 0.012 | 0.012 | 0.013 | 0.013 | 0.013 | 0.013 |
| 2012 | 0.006 | 0.000 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 2013 | 0.003 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| 2014 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2015 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2016 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2017 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Table B7.10 (continued).

| | | Ocean Fishing Mortality (Period 2/Waves 2-3) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | 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+ |
| 1982 | 0.108 | 0.000 | 0.007 | 0.027 | 0.054 | 0.076 | 0.090 | 0.099 | 0.103 | 0.105 | 0.107 | 0.107 | 0.107 | 0.108 | 0.108 | 0.108 |
| 1983 | 0.040 | 0.000 | 0.003 | 0.010 | 0.020 | 0.028 | 0.034 | 0.037 | 0.038 | 0.039 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| 1984 | 0.012 | 0.000 | 0.001 | 0.003 | 0.006 | 0.009 | 0.010 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| 1985 | 0.024 | 0.000 | 0.002 | 0.006 | 0.012 | 0.017 | 0.020 | 0.022 | 0.023 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 |
| 1986 | 0.013 | 0.000 | 0.001 | 0.003 | 0.006 | 0.009 | 0.011 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.013 | 0.013 | 0.013 |
| 1987 | 0.006 | 0.000 | 0.000 | 0.001 | 0.003 | 0.004 | 0.005 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 1988 | 0.010 | 0.000 | 0.001 | 0.002 | 0.005 | 0.007 | 0.008 | 0.009 | 0.009 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| 1989 | 0.015 | 0.000 | 0.001 | 0.004 | 0.007 | 0.010 | 0.012 | 0.013 | 0.014 | 0.014 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| 1990 | 0.034 | 0.000 | 0.001 | 0.003 | 0.006 | 0.010 | 0.015 | 0.020 | 0.024 | 0.027 | 0.029 | 0.031 | 0.032 | 0.033 | 0.033 | 0.034 |
| 1991 | 0.042 | 0.000 | 0.001 | 0.003 | 0.007 | 0.013 | 0.019 | 0.025 | 0.030 | 0.033 | 0.036 | 0.038 | 0.040 | 0.041 | 0.042 | 0.042 |
| 1992 | 0.069 | 0.000 | 0.002 | 0.005 | 0.012 | 0.021 | 0.031 | 0.041 | 0.048 | 0.055 | 0.059 | 0.063 | 0.065 | 0.067 | 0.068 | 0.069 |
| 1993 | 0.056 | 0.000 | 0.001 | 0.004 | 0.010 | 0.017 | 0.025 | 0.033 | 0.039 | 0.044 | 0.048 | 0.051 | 0.053 | 0.054 | 0.055 | 0.056 |
| 1994 | 0.070 | 0.000 | 0.002 | 0.005 | 0.012 | 0.022 | 0.032 | 0.041 | 0.049 | 0.055 | 0.060 | 0.063 | 0.066 | 0.068 | 0.069 | 0.070 |
| 1995 | 0.084 | 0.000 | 0.002 | 0.007 | 0.015 | 0.026 | 0.038 | 0.050 | 0.059 | 0.067 | 0.073 | 0.077 | 0.080 | 0.082 | 0.083 | 0.084 |
| 1996 | 0.107 | 0.000 | 0.002 | 0.008 | 0.019 | 0.033 | 0.049 | 0.063 | 0.075 | 0.085 | 0.092 | 0.098 | 0.101 | 0.104 | 0.106 | 0.107 |
| 1997 | 0.093 | 0.000 | 0.003 | 0.012 | 0.027 | 0.043 | 0.058 | 0.070 | 0.078 | 0.084 | 0.088 | 0.090 | 0.091 | 0.092 | 0.093 | 0.093 |
| 1998 | 0.108 | 0.000 | 0.004 | 0.014 | 0.031 | 0.050 | 0.068 | 0.081 | 0.091 | 0.097 | 0.101 | 0.104 | 0.106 | 0.107 | 0.107 | 0.108 |
| 1999 | 0.091 | 0.000 | 0.003 | 0.012 | 0.026 | 0.043 | 0.057 | 0.069 | 0.077 | 0.082 | 0.086 | 0.088 | 0.090 | 0.091 | 0.091 | 0.091 |
| 2000 | 0.097 | 0.000 | 0.003 | 0.013 | 0.028 | 0.045 | 0.061 | 0.073 | 0.082 | 0.087 | 0.091 | 0.094 | 0.095 | 0.096 | 0.097 | 0.097 |
| 2001 | 0.097 | 0.000 | 0.003 | 0.013 | 0.028 | 0.045 | 0.061 | 0.073 | 0.081 | 0.087 | 0.091 | 0.093 | 0.095 | 0.096 | 0.096 | 0.097 |
| 2002 | 0.144 | 0.001 | 0.005 | 0.019 | 0.041 | 0.067 | 0.090 | 0.108 | 0.121 | 0.130 | 0.135 | 0.139 | 0.141 | 0.142 | 0.143 | 0.144 |
| 2003 | 0.138 | 0.001 | 0.005 | 0.018 | 0.040 | 0.064 | 0.087 | 0.104 | 0.116 | 0.125 | 0.130 | 0.133 | 0.136 | 0.137 | 0.138 | 0.138 |
| 2004 | 0.163 | 0.001 | 0.006 | 0.021 | 0.047 | 0.076 | 0.102 | 0.123 | 0.137 | 0.147 | 0.153 | 0.157 | 0.160 | 0.161 | 0.162 | 0.163 |
| 2005 | 0.166 | 0.001 | 0.006 | 0.022 | 0.048 | 0.077 | 0.104 | 0.125 | 0.140 | 0.150 | 0.156 | 0.160 | 0.163 | 0.164 | 0.165 | 0.166 |
| 2006 | 0.199 | 0.001 | 0.007 | 0.026 | 0.057 | 0.093 | 0.125 | 0.150 | 0.168 | 0.180 | 0.187 | 0.192 | 0.195 | 0.197 | 0.198 | 0.199 |
| 2007 | 0.169 | 0.001 | 0.006 | 0.022 | 0.048 | 0.078 | 0.106 | 0.127 | 0.142 | 0.152 | 0.159 | 0.163 | 0.165 | 0.167 | 0.168 | 0.169 |
| 2008 | 0.122 | 0.001 | 0.004 | 0.016 | 0.035 | 0.057 | 0.076 | 0.092 | 0.102 | 0.110 | 0.114 | 0.117 | 0.119 | 0.121 | 0.121 | 0.122 |
| 2009 | 0.128 | 0.001 | 0.005 | 0.017 | 0.037 | 0.060 | 0.080 | 0.096 | 0.108 | 0.115 | 0.120 | 0.124 | 0.126 | 0.127 | 0.128 | 0.128 |
| 2010 | 0.138 | 0.001 | 0.005 | 0.018 | 0.040 | 0.064 | 0.087 | 0.104 | 0.117 | 0.125 | 0.130 | 0.134 | 0.136 | 0.137 | 0.138 | 0.138 |
| 2011 | 0.176 | 0.001 | 0.006 | 0.023 | 0.051 | 0.082 | 0.111 | 0.133 | 0.149 | 0.159 | 0.166 | 0.170 | 0.173 | 0.175 | 0.176 | 0.176 |
| 2012 | 0.151 | 0.001 | 0.005 | 0.020 | 0.043 | 0.070 | 0.095 | 0.114 | 0.127 | 0.136 | 0.142 | 0.146 | 0.148 | 0.150 | 0.151 | 0.151 |
| 2013 | 0.255 | 0.001 | 0.009 | 0.033 | 0.073 | 0.119 | 0.160 | 0.192 | 0.215 | 0.230 | 0.240 | 0.246 | 0.250 | 0.253 | 0.254 | 0.255 |
| 2014 | 0.164 | 0.001 | 0.006 | 0.021 | 0.047 | 0.076 | 0.103 | 0.123 | 0.138 | 0.148 | 0.154 | 0.158 | 0.160 | 0.162 | 0.163 | 0.164 |
| 2015 | 0.181 | 0.001 | 0.006 | 0.023 | 0.052 | 0.084 | 0.114 | 0.136 | 0.152 | 0.163 | 0.170 | 0.175 | 0.178 | 0.179 | 0.180 | 0.181 |
| 2016 | 0.166 | 0.001 | 0.006 | 0.022 | 0.048 | 0.077 | 0.104 | 0.125 | 0.140 | 0.150 | 0.156 | 0.160 | 0.163 | 0.165 | 0.166 | 0.166 |
| 2017 | 0.166 | 0.001 | 0.006 | 0.022 | 0.048 | 0.077 | 0.104 | 0.125 | 0.140 | 0.150 | 0.156 | 0.160 | 0.163 | 0.165 | 0.166 | 0.166 |

Table B7.10 (continued).

| Ocean Fishing Mortality (Period 3/Waves 4-6) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | 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+ |
| 1982 | 0.084 | 0.000 | 0.005 | 0.021 | 0.042 | 0.059 | 0.071 | 0.077 | 0.081 | 0.082 | 0.083 | 0.084 | 0.084 | 0.084 | 0.084 | 0.084 |
| 1983 | 0.151 | 0.001 | 0.010 | 0.038 | 0.076 | 0.107 | 0.127 | 0.138 | 0.145 | 0.148 | 0.149 | 0.150 | 0.151 | 0.151 | 0.151 | 0.151 |
| 1984 | 0.091 | 0.000 | 0.006 | 0.023 | 0.045 | 0.064 | 0.076 | 0.083 | 0.087 | 0.089 | 0.090 | 0.090 | 0.090 | 0.091 | 0.091 | 0.091 |
| 1985 | 0.177 | 0.001 | 0.012 | 0.045 | 0.089 | 0.125 | 0.148 | 0.162 | 0.169 | 0.173 | 0.175 | 0.176 | 0.176 | 0.177 | 0.177 | 0.177 |
| 1986 | 0.064 | 0.000 | 0.004 | 0.016 | 0.032 | 0.045 | 0.053 | 0.058 | 0.061 | 0.062 | 0.063 | 0.063 | 0.063 | 0.064 | 0.064 | 0.064 |
| 1987 | 0.042 | 0.000 | 0.003 | 0.011 | 0.021 | 0.030 | 0.036 | 0.039 | 0.041 | 0.041 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| 1988 | 0.048 | 0.000 | 0.003 | 0.012 | 0.024 | 0.034 | 0.041 | 0.044 | 0.046 | 0.047 | 0.048 | 0.048 | 0.048 | 0.048 | 0.048 | 0.048 |
| 1989 | 0.060 | 0.000 | 0.004 | 0.015 | 0.030 | 0.042 | 0.050 | 0.055 | 0.057 | 0.059 | 0.059 | 0.060 | 0.060 | 0.060 | 0.060 | 0.060 |
| 1990 | 0.088 | 0.000 | 0.002 | 0.007 | 0.015 | 0.027 | 0.040 | 0.052 | 0.062 | 0.069 | 0.075 | 0.080 | 0.083 | 0.085 | 0.087 | 0.088 |
| 1991 | 0.119 | 0.000 | 0.003 | 0.009 | 0.021 | 0.037 | 0.054 | 0.070 | 0.084 | 0.094 | 0.103 | 0.108 | 0.113 | 0.116 | 0.118 | 0.119 |
| 1992 | 0.120 | 0.000 | 0.003 | 0.009 | 0.021 | 0.037 | 0.054 | 0.071 | 0.084 | 0.095 | 0.103 | 0.109 | 0.113 | 0.116 | 0.118 | 0.120 |
| 1993 | 0.087 | 0.000 | 0.002 | 0.007 | 0.015 | 0.027 | 0.039 | 0.051 | 0.061 | 0.069 | 0.075 | 0.079 | 0.082 | 0.084 | 0.086 | 0.087 |
| 1994 | 0.104 | 0.000 | 0.002 | 0.008 | 0.018 | 0.032 | 0.047 | 0.061 | 0.073 | 0.083 | 0.090 | 0.095 | 0.099 | 0.101 | 0.103 | 0.104 |
| 1995 | 0.202 | 0.001 | 0.005 | 0.016 | 0.036 | 0.063 | 0.092 | 0.119 | 0.142 | 0.161 | 0.174 | 0.184 | 0.191 | 0.196 | 0.200 | 0.202 |
| 1996 | 0.210 | 0.001 | 0.005 | 0.016 | 0.037 | 0.065 | 0.095 | 0.124 | 0.148 | 0.167 | 0.181 | 0.191 | 0.199 | 0.204 | 0.208 | 0.210 |
| 1997 | 0.144 | 0.001 | 0.005 | 0.019 | 0.041 | 0.067 | 0.090 | 0.108 | 0.121 | 0.129 | 0.135 | 0.139 | 0.141 | 0.142 | 0.143 | 0.144 |
| 1998 | 0.155 | 0.001 | 0.006 | 0.020 | 0.044 | 0.072 | 0.097 | 0.117 | 0.130 | 0.140 | 0.146 | 0.150 | 0.152 | 0.153 | 0.154 | 0.155 |
| 1999 | 0.142 | 0.001 | 0.005 | 0.018 | 0.041 | 0.066 | 0.089 | 0.107 | 0.120 | 0.128 | 0.134 | 0.137 | 0.139 | 0.141 | 0.141 | 0.142 |
| 2000 | 0.137 | 0.001 | 0.005 | 0.018 | 0.039 | 0.064 | 0.086 | 0.103 | 0.116 | 0.124 | 0.129 | 0.132 | 0.135 | 0.136 | 0.137 | 0.137 |
| 2001 | 0.138 | 0.001 | 0.005 | 0.018 | 0.040 | 0.064 | 0.087 | 0.104 | 0.116 | 0.125 | 0.130 | 0.134 | 0.136 | 0.137 | 0.138 | 0.138 |
| 2002 | 0.116 | 0.001 | 0.004 | 0.015 | 0.033 | 0.054 | 0.073 | 0.088 | 0.098 | 0.105 | 0.109 | 0.112 | 0.114 | 0.115 | 0.116 | 0.116 |
| 2003 | 0.128 | 0.001 | 0.005 | 0.017 | 0.037 | 0.059 | 0.080 | 0.096 | 0.108 | 0.115 | 0.120 | 0.123 | 0.125 | 0.127 | 0.127 | 0.128 |
| 2004 | 0.155 | 0.001 | 0.006 | 0.020 | 0.045 | 0.072 | 0.097 | 0.117 | 0.131 | 0.140 | 0.146 | 0.150 | 0.152 | 0.154 | 0.155 | 0.155 |
| 2005 | 0.154 | 0.001 | 0.005 | 0.020 | 0.044 | 0.072 | 0.096 | 0.116 | 0.129 | 0.139 | 0.145 | 0.148 | 0.151 | 0.152 | 0.153 | 0.154 |
| 2006 | 0.176 | 0.001 | 0.006 | 0.023 | 0.050 | 0.082 | 0.110 | 0.132 | 0.148 | 0.159 | 0.166 | 0.170 | 0.173 | 0.174 | 0.175 | 0.176 |
| 2007 | 0.115 | 0.001 | 0.004 | 0.015 | 0.033 | 0.054 | 0.072 | 0.087 | 0.097 | 0.104 | 0.109 | 0.112 | 0.113 | 0.114 | 0.115 | 0.115 |
| 2008 | 0.166 | 0.001 | 0.006 | 0.022 | 0.048 | 0.077 | 0.104 | 0.125 | 0.140 | 0.150 | 0.156 | 0.160 | 0.163 | 0.165 | 0.166 | 0.166 |
| 2009 | 0.144 | 0.001 | 0.005 | 0.019 | 0.041 | 0.067 | 0.090 | 0.108 | 0.121 | 0.130 | 0.135 | 0.139 | 0.141 | 0.142 | 0.143 | 0.144 |
| 2010 | 0.184 | 0.001 | 0.007 | 0.024 | 0.053 | 0.086 | 0.116 | 0.139 | 0.155 | 0.166 | 0.173 | 0.178 | 0.181 | 0.183 | 0.184 | 0.184 |
| 2011 | 0.160 | 0.001 | 0.006 | 0.021 | 0.046 | 0.074 | 0.100 | 0.120 | 0.134 | 0.144 | 0.150 | 0.154 | 0.157 | 0.158 | 0.159 | 0.160 |
| 2012 | 0.165 | 0.001 | 0.006 | 0.021 | 0.047 | 0.077 | 0.104 | 0.125 | 0.139 | 0.149 | 0.156 | 0.160 | 0.162 | 0.164 | 0.165 | 0.165 |
| 2013 | 0.231 | 0.001 | 0.008 | 0.030 | 0.066 | 0.107 | 0.145 | 0.174 | 0.194 | 0.208 | 0.217 | 0.223 | 0.226 | 0.229 | 0.230 | 0.231 |
| 2014 | 0.187 | 0.001 | 0.007 | 0.024 | 0.053 | 0.087 | 0.117 | 0.141 | 0.157 | 0.168 | 0.176 | 0.180 | 0.183 | 0.185 | 0.186 | 0.187 |
| 2015 | 0.143 | 0.001 | 0.005 | 0.018 | 0.041 | 0.066 | 0.089 | 0.107 | 0.120 | 0.129 | 0.134 | 0.138 | 0.140 | 0.141 | 0.142 | 0.143 |
| 2016 | 0.170 | 0.001 | 0.006 | 0.022 | 0.049 | 0.079 | 0.107 | 0.128 | 0.143 | 0.153 | 0.160 | 0.164 | 0.167 | 0.168 | 0.169 | 0.170 |
| 2017 | 0.234 | 0.001 | 0.008 | 0.030 | 0.067 | 0.109 | 0.147 | 0.176 | 0.197 | 0.211 | 0.220 | 0.226 | 0.229 | 0.231 | 0.233 | 0.234 |

Table B7.11. Stock-specific and combined stock fully-recruited F for years 1982-2017. Shown are the fully-recruited exploitation rates and natural mortality rates used to solve for F.

| | | | Stock 1 | | | | |
|---|---|---|---|---|---|---|---|
| Year | Stock mu | SD | CV | Stock F | SD | CV | Avg M |
| 1982 | 0.261 | 0.080 | 0.307 | 0.336 | 0.103 | 0.307 | 0.19 |
| 1983 | 0.235 | 0.058 | 0.246 | 0.297 | 0.073 | 0.246 | 0.19 |
| 1984 | 0.132 | 0.031 | 0.231 | 0.157 | 0.036 | 0.231 | 0.19 |
| 1985 | 0.149 | 0.054 | 0.361 | 0.174 | 0.063 | 0.361 | 0.15 |
| 1986 | 0.061 | 0.017 | 0.287 | 0.067 | 0.019 | 0.287 | 0.15 |
| 1987 | 0.040 | 0.008 | 0.194 | 0.044 | 0.008 | 0.194 | 0.15 |
| 1988 | 0.043 | 0.010 | 0.222 | 0.047 | 0.011 | 0.222 | 0.15 |
| 1989 | 0.053 | 0.010 | 0.188 | 0.058 | 0.011 | 0.188 | 0.15 |
| 1990 | 0.079 | 0.014 | 0.174 | 0.089 | 0.015 | 0.174 | 0.15 |
| 1991 | 0.106 | 0.018 | 0.170 | 0.121 | 0.020 | 0.170 | 0.15 |
| 1992 | 0.106 | 0.018 | 0.169 | 0.121 | 0.021 | 0.169 | 0.15 |
| 1993 | 0.078 | 0.012 | 0.154 | 0.088 | 0.013 | 0.154 | 0.15 |
| 1994 | 0.094 | 0.013 | 0.141 | 0.107 | 0.015 | 0.141 | 0.15 |
| 1995 | 0.176 | 0.027 | 0.152 | 0.210 | 0.032 | 0.152 | 0.15 |
| 1996 | 0.183 | 0.024 | 0.132 | 0.219 | 0.029 | 0.132 | 0.15 |
| 1997 | 0.145 | 0.013 | 0.091 | 0.174 | 0.016 | 0.091 | 0.21 |
| 1998 | 0.148 | 0.013 | 0.089 | 0.179 | 0.016 | 0.089 | 0.21 |
| 1999 | 0.141 | 0.013 | 0.092 | 0.169 | 0.016 | 0.092 | 0.21 |
| 2000 | 0.135 | 0.012 | 0.087 | 0.161 | 0.014 | 0.087 | 0.21 |
| 2001 | 0.132 | 0.011 | 0.086 | 0.157 | 0.014 | 0.086 | 0.21 |
| 2002 | 0.118 | 0.011 | 0.096 | 0.140 | 0.013 | 0.096 | 0.21 |
| 2003 | 0.136 | 0.012 | 0.089 | 0.163 | 0.015 | 0.089 | 0.21 |
| 2004 | 0.162 | 0.017 | 0.105 | 0.197 | 0.021 | 0.105 | 0.21 |
| 2005 | 0.158 | 0.018 | 0.116 | 0.191 | 0.022 | 0.116 | 0.21 |
| 2006 | 0.176 | 0.022 | 0.127 | 0.216 | 0.028 | 0.127 | 0.21 |
| 2007 | 0.129 | 0.015 | 0.119 | 0.154 | 0.018 | 0.119 | 0.21 |
| 2008 | 0.163 | 0.016 | 0.096 | 0.199 | 0.019 | 0.096 | 0.21 |
| 2009 | 0.146 | 0.014 | 0.098 | 0.176 | 0.017 | 0.098 | 0.21 |
| 2010 | 0.170 | 0.015 | 0.087 | 0.208 | 0.018 | 0.087 | 0.21 |
| 2011 | 0.165 | 0.016 | 0.097 | 0.201 | 0.020 | 0.097 | 0.21 |
| 2012 | 0.161 | 0.016 | 0.100 | 0.196 | 0.020 | 0.100 | 0.21 |
| 2013 | 0.216 | 0.020 | 0.092 | 0.272 | 0.025 | 0.092 | 0.21 |
| 2014 | 0.176 | 0.020 | 0.113 | 0.217 | 0.025 | 0.113 | 0.21 |
| 2015 | 0.147 | 0.016 | 0.108 | 0.178 | 0.019 | 0.108 | 0.21 |
| 2016 | 0.192 | 0.030 | 0.158 | 0.239 | 0.038 | 0.158 | 0.21 |
| 2017 | 0.224 | 0.030 | 0.133 | 0.284 | 0.038 | 0.133 | 0.21 |

Table B7.11 (continued).

| | | | Stock 2 | | | | |
|---|---|---|---|---|---|---|---|
| Year | Stock mu | SD | CV | Stock F | SD | CV | Avg M |
| 1982 | 0.163 | 0.032 | 0.196 | 0.192 | 0.038 | 0.196 | 0.15 |
| 1983 | 0.158 | 0.042 | 0.268 | 0.186 | 0.050 | 0.268 | 0.15 |
| 1984 | 0.088 | 0.018 | 0.202 | 0.100 | 0.020 | 0.202 | 0.15 |
| 1985 | 0.164 | 0.054 | 0.327 | 0.194 | 0.063 | 0.327 | 0.15 |
| 1986 | 0.066 | 0.019 | 0.286 | 0.074 | 0.021 | 0.286 | 0.15 |
| 1987 | 0.042 | 0.008 | 0.196 | 0.047 | 0.009 | 0.196 | 0.15 |
| 1988 | 0.051 | 0.010 | 0.203 | 0.056 | 0.011 | 0.203 | 0.15 |
| 1989 | 0.065 | 0.011 | 0.173 | 0.073 | 0.013 | 0.173 | 0.15 |
| 1990 | 0.104 | 0.019 | 0.185 | 0.119 | 0.022 | 0.185 | 0.15 |
| 1991 | 0.136 | 0.024 | 0.177 | 0.158 | 0.028 | 0.177 | 0.15 |
| 1992 | 0.158 | 0.029 | 0.184 | 0.187 | 0.034 | 0.184 | 0.15 |
| 1993 | 0.123 | 0.020 | 0.166 | 0.141 | 0.024 | 0.166 | 0.15 |
| 1994 | 0.148 | 0.022 | 0.152 | 0.173 | 0.026 | 0.152 | 0.15 |
| 1995 | 0.229 | 0.034 | 0.149 | 0.282 | 0.042 | 0.149 | 0.15 |
| 1996 | 0.252 | 0.035 | 0.137 | 0.315 | 0.043 | 0.137 | 0.15 |
| 1997 | 0.204 | 0.018 | 0.089 | 0.247 | 0.022 | 0.089 | 0.15 |
| 1998 | 0.219 | 0.020 | 0.090 | 0.268 | 0.024 | 0.090 | 0.15 |
| 1999 | 0.200 | 0.018 | 0.090 | 0.242 | 0.022 | 0.090 | 0.15 |
| 2000 | 0.196 | 0.017 | 0.088 | 0.236 | 0.021 | 0.088 | 0.15 |
| 2001 | 0.198 | 0.016 | 0.079 | 0.239 | 0.019 | 0.079 | 0.15 |
| 2002 | 0.222 | 0.019 | 0.084 | 0.272 | 0.023 | 0.084 | 0.15 |
| 2003 | 0.224 | 0.019 | 0.083 | 0.274 | 0.023 | 0.083 | 0.15 |
| 2004 | 0.267 | 0.038 | 0.141 | 0.337 | 0.048 | 0.141 | 0.15 |
| 2005 | 0.261 | 0.026 | 0.100 | 0.328 | 0.033 | 0.100 | 0.15 |
| 2006 | 0.300 | 0.030 | 0.099 | 0.389 | 0.038 | 0.099 | 0.15 |
| 2007 | 0.241 | 0.024 | 0.098 | 0.299 | 0.029 | 0.098 | 0.15 |
| 2008 | 0.242 | 0.022 | 0.090 | 0.301 | 0.027 | 0.090 | 0.15 |
| 2009 | 0.227 | 0.019 | 0.085 | 0.279 | 0.024 | 0.085 | 0.15 |
| 2010 | 0.257 | 0.023 | 0.089 | 0.323 | 0.029 | 0.089 | 0.15 |
| 2011 | 0.274 | 0.024 | 0.088 | 0.348 | 0.030 | 0.088 | 0.15 |
| 2012 | 0.256 | 0.025 | 0.096 | 0.320 | 0.031 | 0.096 | 0.15 |
| 2013 | 0.360 | 0.033 | 0.093 | 0.486 | 0.045 | 0.093 | 0.15 |
| 2014 | 0.273 | 0.029 | 0.106 | 0.346 | 0.037 | 0.106 | 0.15 |
| 2015 | 0.257 | 0.029 | 0.114 | 0.322 | 0.037 | 0.114 | 0.15 |
| 2016 | 0.264 | 0.033 | 0.124 | 0.333 | 0.041 | 0.124 | 0.15 |
| 2017 | 0.304 | 0.032 | 0.105 | 0.394 | 0.041 | 0.105 | 0.15 |

Table B7.11 (continued).

| Combined Stocks | | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Stock mu | SD | CV | Stock F | SD | CV | Avg M |
| 1982 | 0.165 | 0.031 | 0.190 | 0.195 | 0.037 | 0.190 | 0.15 |
| 1983 | 0.159 | 0.042 | 0.266 | 0.188 | 0.050 | 0.266 | 0.15 |
| 1984 | 0.089 | 0.018 | 0.201 | 0.100 | 0.020 | 0.201 | 0.15 |
| 1985 | 0.164 | 0.054 | 0.328 | 0.193 | 0.063 | 0.328 | 0.15 |
| 1986 | 0.066 | 0.019 | 0.285 | 0.074 | 0.021 | 0.285 | 0.15 |
| 1987 | 0.042 | 0.008 | 0.195 | 0.047 | 0.009 | 0.195 | 0.15 |
| 1988 | 0.051 | 0.010 | 0.203 | 0.056 | 0.011 | 0.203 | 0.15 |
| 1989 | 0.065 | 0.011 | 0.172 | 0.072 | 0.012 | 0.172 | 0.15 |
| 1990 | 0.103 | 0.019 | 0.185 | 0.118 | 0.022 | 0.185 | 0.15 |
| 1991 | 0.135 | 0.024 | 0.176 | 0.157 | 0.028 | 0.176 | 0.15 |
| 1992 | 0.156 | 0.029 | 0.182 | 0.184 | 0.034 | 0.182 | 0.15 |
| 1993 | 0.120 | 0.020 | 0.165 | 0.138 | 0.023 | 0.165 | 0.15 |
| 1994 | 0.142 | 0.021 | 0.149 | 0.165 | 0.025 | 0.149 | 0.15 |
| 1995 | 0.221 | 0.032 | 0.147 | 0.271 | 0.040 | 0.147 | 0.15 |
| 1996 | 0.227 | 0.029 | 0.129 | 0.279 | 0.036 | 0.129 | 0.15 |
| 1997 | 0.165 | 0.015 | 0.088 | 0.201 | 0.018 | 0.088 | 0.21 |
| 1998 | 0.169 | 0.014 | 0.085 | 0.206 | 0.017 | 0.085 | 0.21 |
| 1999 | 0.154 | 0.014 | 0.088 | 0.186 | 0.016 | 0.088 | 0.21 |
| 2000 | 0.146 | 0.012 | 0.081 | 0.177 | 0.014 | 0.081 | 0.21 |
| 2001 | 0.145 | 0.011 | 0.075 | 0.174 | 0.013 | 0.075 | 0.21 |
| 2002 | 0.145 | 0.012 | 0.084 | 0.174 | 0.015 | 0.084 | 0.21 |
| 2003 | 0.157 | 0.012 | 0.079 | 0.191 | 0.015 | 0.079 | 0.21 |
| 2004 | 0.188 | 0.019 | 0.101 | 0.233 | 0.023 | 0.101 | 0.21 |
| 2005 | 0.183 | 0.017 | 0.093 | 0.226 | 0.021 | 0.093 | 0.21 |
| 2006 | 0.205 | 0.022 | 0.108 | 0.257 | 0.028 | 0.108 | 0.21 |
| 2007 | 0.157 | 0.012 | 0.077 | 0.190 | 0.015 | 0.077 | 0.21 |
| 2008 | 0.178 | 0.016 | 0.088 | 0.220 | 0.019 | 0.088 | 0.21 |
| 2009 | 0.167 | 0.013 | 0.076 | 0.204 | 0.016 | 0.076 | 0.21 |
| 2010 | 0.194 | 0.015 | 0.078 | 0.240 | 0.019 | 0.078 | 0.21 |
| 2011 | 0.196 | 0.016 | 0.083 | 0.243 | 0.020 | 0.083 | 0.21 |
| 2012 | 0.188 | 0.016 | 0.084 | 0.232 | 0.019 | 0.084 | 0.21 |
| 2013 | 0.258 | 0.021 | 0.083 | 0.334 | 0.028 | 0.083 | 0.21 |
| 2014 | 0.202 | 0.020 | 0.100 | 0.252 | 0.025 | 0.100 | 0.21 |
| 2015 | 0.175 | 0.020 | 0.113 | 0.215 | 0.024 | 0.113 | 0.21 |
| 2016 | 0.209 | 0.027 | 0.130 | 0.262 | 0.034 | 0.130 | 0.21 |
| 2017 | 0.238 | 0.028 | 0.118 | 0.305 | 0.036 | 0.118 | 0.21 |

Table B7.12. Estimates of abundance for ages 1-15+ by period and region for Stock 1 (Chesapeake Bay stock).

| | | Stock 1 Bay Population (Period 1) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 16,258,843 | 14,160,900 | 1,188,030 | 637,849 | 179,733 | 47,538 | 6,457 | 5,340 | 4,596 | 3,956 | 3,405 | 2,931 | 2,522 | 2,171 | 1,869 | 11,546 |
| 1983 | 50,218,334 | 44,720,800 | 4,509,180 | 554,014 | 312,667 | 87,735 | 23,298 | 3,111 | 2,407 | 1,775 | 1,231 | 799 | 486 | 280 | 155 | 397 |
| 1984 | 53,104,265 | 36,268,900 | 14,240,500 | 2,107,790 | 274,016 | 154,606 | 43,616 | 11,390 | 1,423 | 943 | 561 | 293 | 134 | 55 | 20 | 18 |
| 1985 | 69,653,677 | 49,861,200 | 11,551,500 | 6,821,920 | 1,143,240 | 154,725 | 89,002 | 24,793 | 6,065 | 649 | 347 | 155 | 57 | 18 | 5 | 2 |
| 1986 | 82,527,515 | 55,819,100 | 15,884,500 | 5,709,380 | 4,161,540 | 764,478 | 107,374 | 61,308 | 16,020 | 3,360 | 290 | 117 | 37 | 9 | 2 | 0 |
| 1987 | 96,100,783 | 63,571,800 | 17,782,500 | 7,846,140 | 3,474,730 | 2,773,450 | 528,552 | 73,681 | 39,462 | 8,841 | 1,495 | 97 | 28 | 6 | 1 | 0 |
| 1988 | 112,344,299 | 73,788,000 | 20,252,500 | 8,796,000 | 4,800,490 | 2,333,420 | 1,933,730 | 365,848 | 47,841 | 21,968 | 3,968 | 506 | 23 | 4 | 1 | 0 |
| 1989 | 151,411,387 | 106,107,000 | 23,507,000 | 10,007,900 | 5,361,590 | 3,206,450 | 1,617,300 | 1,330,330 | 236,090 | 26,469 | 9,799 | 1,334 | 120 | 4 | 0 | 0 |
| 1990 | 198,977,506 | 139,480,000 | 33,803,300 | 11,624,300 | 6,116,570 | 3,595,010 | 2,231,850 | 1,117,500 | 862,271 | 131,199 | 11,859 | 3,309 | 318 | 19 | 0 | 0 |
| 1991 | 170,872,701 | 93,716,300 | 44,433,200 | 16,694,700 | 7,029,600 | 3,981,250 | 2,384,530 | 1,451,220 | 676,757 | 446,033 | 54,611 | 3,718 | 733 | 47 | 2 | 0 |
| 1992 | 164,709,480 | 92,592,900 | 29,854,700 | 21,946,100 | 10,100,300 | 4,580,520 | 2,645,180 | 1,553,740 | 880,892 | 350,924 | 186,123 | 17,163 | 825 | 109 | 4 | 0 |
| 1993 | 190,984,593 | 120,525,000 | 29,496,800 | 14,744,900 | 13,273,600 | 6,576,750 | 3,040,010 | 1,721,240 | 941,705 | 456,055 | 146,199 | 58,397 | 3,804 | 122 | 10 | 0 |
| 1994 | 358,906,935 | 280,109,000 | 38,395,200 | 14,573,100 | 8,937,750 | 8,690,020 | 4,401,720 | 1,998,830 | 1,055,320 | 493,482 | 192,371 | 46,450 | 13,108 | 571 | 12 | 1 |
| 1995 | 348,363,641 | 214,994,000 | 89,232,200 | 18,957,800 | 8,798,760 | 5,794,590 | 5,728,800 | 2,840,540 | 1,200,370 | 541,095 | 203,561 | 59,754 | 10,192 | 1,924 | 54 | 1 |
| 1996 | 390,668,911 | 251,268,000 | 68,487,600 | 44,020,600 | 11,382,200 | 5,626,180 | 3,739,050 | 3,600,260 | 1,656,460 | 596,750 | 216,250 | 61,238 | 12,696 | 1,449 | 176 | 3 |
| 1997 | 468,912,773 | 312,277,000 | 80,033,300 | 33,780,100 | 26,496,600 | 7,299,090 | 3,609,050 | 2,302,300 | 2,027,660 | 786,361 | 225,947 | 61,316 | 12,224 | 1,692 | 124 | 9 |
| 1998 | 362,095,846 | 181,848,000 | 99,463,300 | 39,458,700 | 17,994,100 | 14,983,100 | 4,110,650 | 1,943,300 | 1,130,540 | 837,597 | 258,755 | 55,635 | 10,624 | 1,414 | 125 | 6 |
| 1999 | 300,855,212 | 149,896,000 | 57,922,200 | 49,065,900 | 21,082,600 | 10,256,900 | 8,557,660 | 2,257,030 | 977,057 | 479,485 | 283,470 | 65,598 | 9,931 | 1,266 | 108 | 6 |
| 2000 | 242,973,229 | 116,154,000 | 47,744,600 | 28,570,100 | 26,199,200 | 11,997,400 | 5,841,160 | 4,679,730 | 1,129,240 | 412,126 | 161,328 | 71,430 | 11,637 | 1,176 | 96 | 5 |
| 2001 | 292,693,226 | 189,025,000 | 36,996,800 | 23,547,300 | 15,246,200 | 14,885,700 | 6,813,490 | 3,181,980 | 2,330,520 | 473,855 | 137,900 | 40,420 | 12,598 | 1,370 | 89 | 5 |
| 2002 | 329,225,395 | 214,208,000 | 60,209,600 | 18,257,500 | 12,606,100 | 8,736,130 | 8,580,600 | 3,789,150 | 1,624,730 | 1,005,610 | 163,342 | 35,633 | 7,357 | 1,531 | 107 | 4 |
| 2003 | 228,813,331 | 101,297,000 | 68,229,300 | 29,699,800 | 9,751,440 | 7,178,970 | 4,981,500 | 4,700,650 | 1,899,880 | 686,970 | 339,218 | 41,269 | 6,338 | 874 | 117 | 5 |
| 2004 | 440,756,306 | 343,713,000 | 32,263,100 | 33,618,300 | 15,768,500 | 5,466,280 | 3,981,410 | 2,625,770 | 2,249,550 | 762,564 | 219,224 | 80,909 | 6,922 | 709 | 63 | 5 |
| 2005 | 318,689,607 | 159,226,000 | 109,470,000 | 15,890,700 | 17,812,000 | 8,790,770 | 3,002,390 | 2,070,640 | 1,236,360 | 886,698 | 238,692 | 51,251 | 13,295 | 759 | 50 | 3 |
| 2006 | 290,662,661 | 159,051,000 | 50,714,700 | 53,964,600 | 8,458,620 | 10,053,100 | 4,934,220 | 1,609,170 | 1,011,110 | 507,539 | 289,832 | 58,368 | 8,817 | 1,527 | 56 | 2 |
| 2007 | 199,628,123 | 81,586,700 | 50,654,600 | 24,960,800 | 28,482,100 | 4,667,760 | 5,423,600 | 2,503,120 | 735,232 | 385,378 | 153,278 | 65,286 | 9,233 | 930 | 103 | 2 |
| 2008 | 234,788,154 | 147,313,000 | 25,985,800 | 24,967,700 | 13,277,800 | 16,047,000 | 2,611,850 | 2,894,320 | 1,215,910 | 300,064 | 125,186 | 37,240 | 11,158 | 1,053 | 68 | 5 |
| 2009 | 163,518,641 | 70,282,100 | 46,921,500 | 12,816,100 | 13,324,300 | 7,544,810 | 9,114,760 | 1,423,130 | 1,441,780 | 510,382 | 100,437 | 31,375 | 6,570 | 1,314 | 80 | 3 |
| 2010 | 175,453,456 | 105,279,000 | 22,384,700 | 23,117,400 | 6,801,220 | 7,459,640 | 4,175,000 | 4,789,630 | 678,518 | 576,286 | 162,150 | 23,846 | 5,237 | 732 | 94 | 4 |
| 2011 | 167,849,737 | 98,198,200 | 33,530,800 | 11,026,300 | 12,254,600 | 3,796,850 | 4,107,240 | 2,178,680 | 2,264,460 | 268,672 | 181,264 | 38,100 | 3,939 | 577 | 52 | 4 |
| 2012 | 377,060,313 | 310,266,000 | 31,275,700 | 16,517,700 | 5,846,930 | 6,846,910 | 2,093,550 | 2,147,620 | 1,032,550 | 899,091 | 84,752 | 42,719 | 6,312 | 435 | 41 | 2 |
| 2013 | 183,256,220 | 50,744,800 | 98,812,400 | 15,390,000 | 8,707,740 | 3,216,590 | 3,673,860 | 1,054,080 | 972,343 | 389,564 | 268,596 | 18,877 | 6,681 | 658 | 29 | 2 |
| 2014 | 162,810,423 | 80,543,800 | 16,160,900 | 48,619,800 | 8,110,380 | 4,785,950 | 1,723,100 | 1,845,540 | 475,926 | 365,725 | 115,999 | 59,622 | 2,942 | 694 | 44 | 1 |
| 2015 | 219,110,201 | 151,114,000 | 25,650,100 | 7,945,700 | 25,516,100 | 4,408,890 | 2,514,680 | 842,663 | 806,663 | 172,637 | 104,773 | 24,737 | 8,919 | 293 | 44 | 2 |
| 2016 | 344,500,004 | 260,992,000 | 48,127,100 | 12,626,300 | 4,196,980 | 14,110,000 | 2,387,280 | 1,282,180 | 387,382 | 309,569 | 52,519 | 23,780 | 3,944 | 948 | 20 | 2 |
| 2017 | 207,022,227 | 81,958,200 | 83,115,800 | 23,661,700 | 6,625,600 | 2,280,780 | 7,409,560 | 1,166,550 | 559,890 | 140,369 | 88,585 | 11,187 | 3,553 | 393 | 60 | 1 |

Table B7.12 (continued).

| | | Stock 1 Bay Population (Period 2) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 13,598,918 | 11,728,500 | 1,045,840 | 558,470 | 158,010 | 43,449 | 6,225 | 5,800 | 5,471 | 5,314 | 5,002 | 4,635 | 4,217 | 3,771 | 3,327 | 20,888 |
| 1983 | 41,999,881 | 37,042,200 | 4,005,340 | 504,258 | 291,867 | 87,037 | 25,055 | 4,056 | 3,790 | 3,751 | 3,589 | 3,410 | 3,183 | 2,910 | 2,611 | 16,824 |
| 1984 | 45,195,985 | 30,042,400 | 12,694,700 | 1,942,100 | 261,590 | 159,105 | 49,664 | 16,479 | 2,637 | 2,612 | 2,512 | 2,427 | 2,319 | 2,171 | 1,987 | 13,282 |
| 1985 | 59,436,783 | 41,302,200 | 10,329,700 | 6,359,220 | 1,105,340 | 162,396 | 104,524 | 37,964 | 12,314 | 2,089 | 1,992 | 1,929 | 1,869 | 1,788 | 1,675 | 11,783 |
| 1986 | 70,826,740 | 46,237,500 | 14,204,500 | 5,321,300 | 4,012,820 | 784,374 | 121,822 | 87,945 | 29,953 | 9,849 | 1,549 | 1,450 | 1,391 | 1,343 | 1,284 | 9,658 |
| 1987 | 82,883,721 | 52,659,400 | 15,901,700 | 7,313,090 | 3,351,490 | 2,842,870 | 591,053 | 104,239 | 72,801 | 25,688 | 7,996 | 1,249 | 1,166 | 1,117 | 1,078 | 8,783 |
| 1988 | 97,317,865 | 61,121,900 | 18,110,500 | 8,198,440 | 4,630,730 | 2,394,050 | 2,162,810 | 509,311 | 87,608 | 63,590 | 21,305 | 6,600 | 1,029 | 960 | 919 | 8,113 |
| 1989 | 130,956,495 | 87,893,300 | 21,020,700 | 9,328,000 | 5,172,270 | 3,291,020 | 1,811,480 | 1,853,420 | 425,695 | 76,136 | 52,516 | 17,515 | 5,414 | 843 | 786 | 7,400 |
| 1990 | 172,279,832 | 115,537,000 | 30,228,000 | 10,834,600 | 5,899,950 | 3,687,610 | 2,496,400 | 1,552,880 | 1,544,930 | 367,503 | 62,338 | 42,721 | 14,203 | 4,385 | 683 | 6,628 |
| 1991 | 151,449,340 | 77,629,300 | 39,730,800 | 15,553,700 | 6,775,550 | 4,088,260 | 2,683,010 | 2,051,890 | 1,246,380 | 1,293,350 | 293,376 | 49,528 | 33,802 | 11,203 | 3,451 | 5,740 |
| 1992 | 147,306,397 | 76,698,300 | 26,688,700 | 20,414,400 | 9,698,290 | 4,678,240 | 2,961,920 | 2,195,710 | 1,628,980 | 1,026,730 | 1,009,010 | 226,766 | 38,015 | 25,824 | 8,532 | 6,980 |
| 1993 | 170,169,556 | 99,835,600 | 26,370,400 | 13,721,300 | 12,757,200 | 6,724,810 | 3,408,320 | 2,437,680 | 1,750,850 | 1,345,820 | 802,420 | 780,542 | 174,114 | 29,047 | 19,670 | 11,783 |
| 1994 | 311,165,328 | 232,026,000 | 34,327,400 | 13,565,800 | 8,596,940 | 8,896,540 | 4,942,680 | 2,839,270 | 1,974,900 | 1,476,600 | 1,077,870 | 638,441 | 617,934 | 137,374 | 22,866 | 24,713 |
| 1995 | 307,406,529 | 178,088,000 | 79,776,900 | 17,645,300 | 8,461,120 | 5,932,130 | 6,437,620 | 4,045,610 | 2,259,550 | 1,636,880 | 1,162,530 | 842,855 | 496,521 | 478,705 | 106,138 | 36,670 |
| 1996 | 344,495,718 | 208,134,000 | 61,227,200 | 40,970,600 | 10,940,500 | 5,749,750 | 4,184,590 | 5,079,400 | 3,063,010 | 1,754,970 | 1,190,080 | 829,727 | 593,696 | 346,813 | 332,581 | 98,801 |
| 1997 | 410,064,471 | 258,668,000 | 71,545,300 | 30,811,500 | 24,952,800 | 7,307,320 | 3,960,360 | 3,199,620 | 3,719,090 | 2,307,750 | 1,246,060 | 833,325 | 574,704 | 408,007 | 237,050 | 293,585 |
| 1998 | 324,279,695 | 150,630,000 | 88,920,100 | 36,002,700 | 16,990,200 | 15,116,900 | 4,584,170 | 2,808,200 | 2,221,870 | 2,744,070 | 1,652,270 | 901,714 | 606,196 | 418,532 | 296,966 | 385,807 |
| 1999 | 272,707,198 | 124,165,000 | 51,789,900 | 44,803,000 | 19,944,300 | 10,412,600 | 9,634,310 | 3,312,810 | 1,973,160 | 1,649,980 | 1,959,900 | 1,186,360 | 648,820 | 436,112 | 300,813 | 490,133 |
| 2000 | 224,103,058 | 96,214,000 | 42,684,500 | 26,070,700 | 24,744,600 | 12,152,300 | 6,596,100 | 6,954,790 | 2,332,840 | 1,480,110 | 1,195,450 | 1,432,480 | 870,193 | 476,050 | 319,729 | 579,216 |
| 2001 | 264,537,708 | 156,577,000 | 33,079,800 | 21,501,100 | 14,423,800 | 15,122,800 | 7,727,850 | 4,794,070 | 4,916,950 | 1,755,260 | 1,073,070 | 873,348 | 1,049,490 | 637,507 | 348,444 | 657,219 |
| 2002 | 295,847,970 | 177,436,000 | 53,830,400 | 16,663,600 | 11,911,400 | 8,852,090 | 9,686,590 | 5,660,210 | 3,415,680 | 3,720,070 | 1,276,160 | 784,900 | 640,096 | 768,923 | 466,622 | 735,229 |
| 2003 | 214,175,666 | 83,908,200 | 61,004,100 | 27,115,700 | 9,222,240 | 7,287,150 | 5,642,210 | 7,067,290 | 4,047,460 | 2,614,490 | 2,758,760 | 955,863 | 590,189 | 481,481 | 577,984 | 902,549 |
| 2004 | 387,466,328 | 284,710,000 | 28,845,300 | 30,686,200 | 14,904,500 | 5,546,810 | 4,516,420 | 3,980,980 | 4,870,780 | 2,990,700 | 1,872,240 | 1,996,500 | 694,374 | 428,760 | 349,454 | 1,073,310 |
| 2005 | 289,488,427 | 131,892,000 | 97,865,300 | 14,498,400 | 16,816,600 | 8,903,580 | 3,400,760 | 3,146,450 | 2,707,690 | 3,552,890 | 2,115,070 | 1,337,560 | 1,430,960 | 497,524 | 306,853 | 1,016,790 |
| 2006 | 263,872,423 | 131,747,000 | 45,338,500 | 49,235,500 | 7,984,660 | 10,169,000 | 5,563,480 | 2,414,660 | 2,169,650 | 1,986,160 | 2,507,060 | 1,500,970 | 950,390 | 1,015,760 | 352,697 | 936,936 |
| 2007 | 186,803,903 | 67,581,200 | 45,288,100 | 22,782,600 | 26,916,200 | 4,733,040 | 6,144,200 | 3,789,860 | 1,602,760 | 1,541,360 | 1,368,710 | 1,743,950 | 1,046,820 | 662,305 | 706,840 | 895,958 |
| 2008 | 213,915,266 | 122,024,000 | 23,232,300 | 22,786,400 | 12,544,500 | 16,265,900 | 2,957,950 | 4,384,540 | 2,649,910 | 1,204,100 | 1,123,370 | 1,008,110 | 1,289,020 | 773,726 | 489,080 | 1,182,360 |
| 2009 | 154,489,055 | 58,216,900 | 41,946,700 | 11,692,000 | 12,575,000 | 7,628,220 | 10,260,400 | 2,123,770 | 3,054,300 | 1,959,970 | 854,493 | 800,912 | 719,287 | 918,659 | 550,654 | 1,187,790 |
| 2010 | 163,015,540 | 87,205,900 | 20,011,100 | 21,088,400 | 6,418,720 | 7,550,820 | 4,720,300 | 7,233,100 | 1,464,040 | 2,260,110 | 1,406,340 | 619,840 | 583,055 | 523,534 | 667,931 | 1,262,350 |
| 2011 | 155,711,769 | 81,340,700 | 29,975,900 | 10,059,400 | 11,566,800 | 3,842,220 | 4,639,730 | 3,284,020 | 4,876,640 | 1,050,320 | 1,560,850 | 977,462 | 431,400 | 405,323 | 363,384 | 1,337,620 |
| 2012 | 328,138,455 | 257,002,000 | 27,956,300 | 15,059,000 | 5,509,120 | 6,908,450 | 2,356,550 | 3,229,960 | 2,229,600 | 3,543,230 | 738,864 | 1,108,050 | 695,773 | 306,895 | 287,973 | 1,206,690 |
| 2013 | 171,021,812 | 42,033,500 | 88,336,500 | 14,040,600 | 8,220,590 | 3,259,830 | 4,171,880 | 1,615,640 | 2,164,070 | 1,608,850 | 2,483,750 | 524,030 | 788,757 | 495,106 | 218,109 | 1,060,600 |
| 2014 | 150,030,462 | 66,717,100 | 14,448,000 | 44,362,600 | 7,657,380 | 4,843,400 | 1,947,050 | 2,789,930 | 1,042,990 | 1,481,720 | 1,060,700 | 1,644,320 | 346,867 | 521,014 | 326,367 | 841,024 |
| 2015 | 195,013,245 | 125,173,000 | 22,933,800 | 7,254,360 | 24,135,100 | 4,483,240 | 2,869,790 | 1,302,420 | 1,821,830 | 734,693 | 1,014,880 | 735,239 | 1,143,570 | 241,062 | 361,549 | 808,712 |
| 2016 | 299,599,615 | 216,189,000 | 43,028,200 | 11,524,200 | 3,966,680 | 14,331,000 | 2,722,860 | 1,986,420 | 883,344 | 1,334,820 | 523,501 | 731,745 | 532,022 | 827,220 | 174,176 | 844,427 |
| 2017 | 187,951,205 | 67,888,900 | 74,311,100 | 21,598,300 | 6,263,760 | 2,318,580 | 8,470,890 | 1,819,770 | 1,288,840 | 616,549 | 900,574 | 356,618 | 499,508 | 362,731 | 563,057 | 692,028 |

Table B7.12 (continued).

| | | Stock 1 Bay Population (Period 3) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 9,317,059 | 7,935,100 | 795,931 | 425,851 | 116,761 | 30,171 | 3,924 | 2,979 | 2,197 | 1,524 | 989 | 602 | 347 | 192 | 103 | 388 |
| 1983 | 28,839,701 | 25,063,100 | 3,075,130 | 395,438 | 223,619 | 61,926 | 15,793 | 1,937 | 1,285 | 764 | 399 | 183 | 75 | 28 | 10 | 15 |
| 1984 | 32,123,286 | 20,328,600 | 9,842,360 | 1,582,060 | 210,683 | 118,211 | 32,099 | 7,706 | 825 | 441 | 198 | 73 | 22 | 6 | 1 | 1 |
| 1985 | 42,313,899 | 27,948,100 | 8,026,300 | 5,223,630 | 904,618 | 122,117 | 67,672 | 17,334 | 3,635 | 314 | 126 | 40 | 10 | 2 | 0 | 0 |
| 1986 | 50,718,618 | 31,287,600 | 11,034,800 | 4,368,480 | 3,289,380 | 602,651 | 81,542 | 42,809 | 9,591 | 1,622 | 106 | 30 | 6 | 1 | 0 | 0 |
| 1987 | 59,439,654 | 35,633,300 | 12,360,000 | 6,015,540 | 2,754,510 | 2,193,400 | 402,722 | 51,621 | 23,704 | 4,281 | 546 | 25 | 5 | 1 | 0 | 0 |
| 1988 | 69,626,903 | 41,359,800 | 14,081,100 | 6,751,520 | 3,811,750 | 1,848,760 | 1,476,140 | 256,796 | 28,792 | 10,659 | 1,451 | 131 | 4 | 0 | 0 | 0 |
| 1989 | 92,627,643 | 59,475,500 | 16,344,100 | 7,682,180 | 4,257,670 | 2,540,710 | 1,234,710 | 933,881 | 142,097 | 12,844 | 3,584 | 345 | 21 | 0 | 0 | 0 |
| 1990 | 121,369,655 | 78,181,400 | 23,503,600 | 8,921,270 | 4,852,290 | 2,843,190 | 1,699,600 | 782,220 | 517,389 | 63,462 | 4,324 | 853 | 55 | 2 | 0 | 0 |
| 1991 | 108,390,758 | 52,529,900 | 30,891,100 | 12,802,900 | 5,566,130 | 3,139,510 | 1,809,340 | 1,011,770 | 404,374 | 214,824 | 19,825 | 954 | 126 | 5 | 0 | 0 |
| 1992 | 104,848,583 | 51,899,900 | 20,751,100 | 16,806,000 | 7,969,270 | 3,592,290 | 1,993,530 | 1,075,110 | 522,198 | 167,651 | 67,015 | 4,367 | 141 | 12 | 0 | 0 |
| 1993 | 119,360,811 | 67,556,400 | 20,504,400 | 11,298,800 | 10,489,900 | 5,170,710 | 2,298,160 | 1,195,090 | 560,257 | 218,679 | 52,836 | 14,914 | 650 | 13 | 1 | 0 |
| 1994 | 214,430,388 | 157,006,000 | 26,690,400 | 11,168,200 | 7,064,970 | 6,834,620 | 3,329,030 | 1,388,510 | 628,174 | 236,750 | 69,559 | 11,870 | 2,242 | 63 | 1 | 0 |
| 1995 | 215,787,560 | 120,507,000 | 62,013,500 | 14,503,900 | 6,926,160 | 4,528,030 | 4,298,210 | 1,955,790 | 707,885 | 257,127 | 72,898 | 15,122 | 1,726 | 209 | 4 | 0 |
| 1996 | 242,171,165 | 140,838,000 | 47,600,600 | 33,715,200 | 8,979,480 | 4,404,680 | 2,806,400 | 2,475,470 | 974,064 | 282,462 | 77,083 | 15,418 | 2,138 | 157 | 12 | 0 |
| 1997 | 285,605,329 | 175,032,000 | 55,618,900 | 24,350,700 | 19,654,600 | 5,366,540 | 2,541,180 | 1,483,830 | 1,117,030 | 348,579 | 75,411 | 14,453 | 1,927 | 171 | 8 | 0 |
| 1998 | 229,171,558 | 101,927,000 | 69,127,400 | 28,456,600 | 13,363,100 | 11,038,500 | 2,902,520 | 1,256,730 | 625,181 | 372,798 | 86,724 | 13,170 | 1,682 | 144 | 8 | 0 |
| 1999 | 191,381,561 | 84,018,200 | 40,262,100 | 35,413,000 | 15,689,500 | 7,584,440 | 6,073,510 | 1,468,670 | 544,048 | 214,985 | 95,736 | 15,651 | 1,585 | 130 | 7 | 0 |
| 2000 | 155,167,504 | 65,104,600 | 33,180,900 | 20,598,100 | 19,441,800 | 8,827,080 | 4,116,810 | 3,019,620 | 622,906 | 182,942 | 53,922 | 16,862 | 1,838 | 119 | 6 | 0 |
| 2001 | 179,530,912 | 105,951,000 | 25,717,900 | 16,999,300 | 11,353,400 | 11,019,700 | 4,843,240 | 2,074,480 | 1,300,440 | 212,941 | 46,682 | 9,666 | 2,016 | 141 | 6 | 0 |
| 2002 | 200,911,707 | 120,066,000 | 41,852,000 | 13,177,200 | 9,381,210 | 6,459,720 | 6,089,560 | 2,465,520 | 904,640 | 450,856 | 55,162 | 8,501 | 1,174 | 157 | 7 | 0 |
| 2003 | 146,148,635 | 56,777,500 | 47,417,200 | 21,412,900 | 7,236,600 | 5,282,290 | 3,511,280 | 3,033,490 | 1,048,150 | 304,989 | 113,395 | 9,744 | 1,001 | 89 | 7 | 0 |
| 2004 | 261,227,804 | 192,653,000 | 22,422,400 | 24,241,400 | 11,706,100 | 4,024,630 | 2,808,810 | 1,696,290 | 1,242,520 | 338,976 | 73,379 | 19,128 | 1,095 | 72 | 4 | 0 |
| 2005 | 200,975,102 | 89,245,900 | 76,065,200 | 11,446,300 | 13,186,300 | 6,440,700 | 2,103,770 | 1,326,720 | 676,654 | 390,318 | 79,088 | 11,991 | 2,081 | 76 | 3 | 0 |
| 2006 | 182,299,654 | 89,148,300 | 35,240,900 | 38,882,200 | 6,266,470 | 7,374,890 | 3,463,480 | 1,033,230 | 554,685 | 223,980 | 96,285 | 13,693 | 1,384 | 154 | 4 | 0 |
| 2007 | 129,566,286 | 45,729,600 | 35,202,500 | 17,994,000 | 21,129,800 | 3,432,560 | 3,819,840 | 1,613,780 | 405,181 | 170,896 | 51,177 | 15,395 | 1,457 | 94 | 7 | 0 |
| 2008 | 144,921,197 | 82,569,800 | 18,060,900 | 18,009,700 | 9,865,880 | 11,833,400 | 1,846,640 | 1,874,730 | 673,586 | 133,805 | 42,040 | 8,833 | 1,771 | 107 | 4 | 0 |
| 2009 | 105,025,491 | 39,393,200 | 32,605,900 | 9,235,470 | 9,874,750 | 5,538,380 | 6,403,650 | 914,763 | 791,903 | 225,524 | 33,411 | 7,371 | 1,032 | 133 | 5 | 0 |
| 2010 | 108,453,730 | 59,009,200 | 15,555,600 | 16,660,900 | 5,042,280 | 5,479,360 | 2,935,780 | 3,081,990 | 373,125 | 254,970 | 54,011 | 5,609 | 824 | 74 | 6 | 0 |
| 2011 | 103,826,253 | 55,039,900 | 23,298,400 | 7,941,570 | 9,069,530 | 2,780,390 | 2,875,880 | 1,394,730 | 1,238,130 | 118,146 | 59,996 | 8,905 | 616 | 58 | 3 | 0 |
| 2012 | 220,682,266 | 173,903,000 | 21,729,900 | 11,892,200 | 4,323,000 | 5,005,250 | 1,462,390 | 1,370,860 | 562,736 | 394,002 | 27,952 | 9,948 | 983 | 44 | 3 | 0 |
| 2013 | 120,943,852 | 28,442,100 | 68,644,800 | 11,072,700 | 6,426,450 | 2,343,870 | 2,554,870 | 669,224 | 526,749 | 169,626 | 87,997 | 4,366 | 1,033 | 65 | 2 | 0 |
| 2014 | 103,747,338 | 45,144,600 | 11,228,900 | 35,012,700 | 6,000,080 | 3,502,300 | 1,205,370 | 1,180,110 | 259,887 | 160,605 | 38,340 | 13,915 | 459 | 70 | 3 | 0 |
| 2015 | 133,225,895 | 84,699,200 | 17,822,900 | 5,723,370 | 18,889,200 | 3,230,080 | 1,761,920 | 539,871 | 441,441 | 75,986 | 34,712 | 5,787 | 1,396 | 29 | 3 | 0 |
| 2016 | 204,801,618 | 146,280,000 | 33,419,000 | 9,062,680 | 3,077,930 | 10,168,000 | 1,634,760 | 799,005 | 205,533 | 131,835 | 16,814 | 5,372 | 596 | 92 | 1 | 0 |
| 2017 | 133,480,840 | 45,936,600 | 57,733,000 | 17,012,400 | 4,881,000 | 1,656,710 | 5,130,180 | 736,708 | 301,517 | 60,735 | 28,832 | 2,570 | 546 | 39 | 4 | 0 |

Table B7.12 (continued).

| Stock 1 Ocean Population (Period 1) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 94,520 | 0 | 27,351 | 24,365 | 11,276 | 4,819 | 1,032 | 1,296 | 1,612 | 1,885 | 2,061 | 2,113 | 2,052 | 1,911 | 1,729 | 11,019 |
| 1983 | 172,924 | 0 | 63,035 | 26,941 | 27,929 | 13,614 | 6,035 | 1,343 | 1,732 | 2,144 | 2,500 | 2,731 | 2,799 | 2,716 | 2,530 | 16,875 |
| 1984 | 388,369 | 0 | 199,037 | 82,577 | 28,361 | 29,795 | 14,596 | 6,547 | 1,436 | 1,753 | 2,026 | 2,201 | 2,246 | 2,173 | 2,018 | 13,603 |
| 1985 | 635,111 | 0 | 161,481 | 264,248 | 100,281 | 30,741 | 32,519 | 16,161 | 7,203 | 1,492 | 1,696 | 1,822 | 1,859 | 1,816 | 1,713 | 12,080 |
| 1986 | 970,836 | 0 | 221,923 | 213,836 | 318,621 | 112,310 | 31,627 | 33,008 | 16,129 | 6,739 | 1,298 | 1,370 | 1,389 | 1,368 | 1,315 | 9,903 |
| 1987 | 1,470,956 | 0 | 248,564 | 296,192 | 270,067 | 401,378 | 140,364 | 37,963 | 38,627 | 17,497 | 6,703 | 1,184 | 1,168 | 1,140 | 1,105 | 9,005 |
| 1988 | 2,151,095 | 0 | 283,114 | 332,271 | 375,308 | 342,598 | 514,262 | 178,806 | 46,095 | 43,232 | 17,876 | 6,262 | 1,032 | 979 | 942 | 8,318 |
| 1989 | 3,034,318 | 0 | 328,604 | 378,335 | 420,344 | 473,517 | 434,717 | 651,853 | 219,999 | 51,594 | 44,046 | 16,624 | 5,431 | 861 | 806 | 7,588 |
| 1990 | 4,208,242 | 0 | 472,509 | 438,756 | 476,794 | 526,103 | 593,935 | 542,974 | 792,669 | 245,689 | 52,076 | 40,509 | 14,250 | 4,479 | 700 | 6,799 |
| 1991 | 5,732,331 | 0 | 621,075 | 632,169 | 558,246 | 607,035 | 671,541 | 750,437 | 662,064 | 881,457 | 246,411 | 47,089 | 33,939 | 11,443 | 3,538 | 5,887 |
| 1992 | 7,049,221 | 0 | 417,249 | 830,240 | 800,539 | 699,900 | 752,938 | 816,801 | 877,830 | 706,272 | 851,227 | 215,722 | 38,195 | 26,394 | 8,752 | 7,163 |
| 1993 | 8,323,849 | 0 | 412,244 | 557,608 | 1,050,070 | 1,000,820 | 863,038 | 906,827 | 946,657 | 928,509 | 678,309 | 742,947 | 174,875 | 29,682 | 20,172 | 12,090 |
| 1994 | 9,865,952 | 0 | 536,673 | 551,431 | 707,748 | 1,323,940 | 1,252,090 | 1,059,580 | 1,073,790 | 1,025,270 | 915,356 | 609,313 | 621,433 | 140,485 | 23,468 | 25,375 |
| 1995 | 12,030,207 | 0 | 1,247,180 | 717,452 | 698,434 | 888,234 | 1,643,960 | 1,520,660 | 1,237,380 | 1,143,070 | 991,502 | 806,185 | 499,796 | 489,734 | 108,957 | 37,663 |
| 1996 | 13,400,637 | 0 | 956,894 | 1,663,150 | 900,498 | 857,598 | 1,061,200 | 1,889,390 | 1,656,740 | 1,214,290 | 1,010,240 | 793,073 | 598,333 | 355,458 | 342,093 | 101,680 |
| 1997 | 14,952,749 | 0 | 1,118,290 | 1,275,930 | 2,087,500 | 1,105,190 | 1,023,480 | 1,217,670 | 2,060,130 | 1,627,130 | 1,073,190 | 805,654 | 585,090 | 422,254 | 246,186 | 305,055 |
| 1998 | 16,742,942 | 0 | 1,390,060 | 1,489,810 | 1,546,610 | 2,475,330 | 1,279,110 | 1,145,680 | 1,308,970 | 2,019,120 | 1,455,880 | 878,186 | 616,572 | 431,506 | 307,043 | 399,065 |
| 1999 | 17,635,031 | 0 | 809,434 | 1,850,780 | 1,803,000 | 1,761,110 | 2,756,980 | 1,378,440 | 1,186,750 | 1,237,150 | 1,752,030 | 1,165,260 | 662,953 | 450,989 | 311,850 | 508,305 |
| 2000 | 18,318,275 | 0 | 667,254 | 1,078,530 | 2,247,260 | 2,070,080 | 1,951,630 | 2,971,490 | 1,429,760 | 1,122,930 | 1,074,030 | 1,405,650 | 884,824 | 489,119 | 329,190 | 596,528 |
| 2001 | 18,672,221 | 0 | 517,057 | 889,107 | 1,309,340 | 2,578,300 | 2,292,360 | 2,082,790 | 3,058,210 | 1,346,090 | 971,994 | 861,625 | 1,070,780 | 656,639 | 359,563 | 678,366 |
| 2002 | 19,068,822 | 0 | 841,452 | 689,029 | 1,079,720 | 1,503,040 | 2,857,100 | 2,448,110 | 2,135,320 | 2,870,520 | 1,163,590 | 779,533 | 657,147 | 796,671 | 484,304 | 763,286 |
| 2003 | 19,572,884 | 0 | 953,643 | 1,121,460 | 836,639 | 1,239,810 | 1,671,570 | 3,070,830 | 2,545,540 | 2,029,410 | 2,520,990 | 948,575 | 604,572 | 497,480 | 598,138 | 934,227 |
| 2004 | 19,074,925 | 0 | 450,942 | 1,270,340 | 1,359,200 | 956,382 | 1,366,780 | 1,773,010 | 3,133,860 | 2,366,900 | 1,738,260 | 2,005,740 | 718,790 | 447,446 | 365,235 | 1,122,040 |
| 2005 | 18,826,558 | 0 | 1,529,920 | 599,855 | 1,530,520 | 1,531,620 | 1,029,810 | 1,404,350 | 1,748,260 | 2,809,620 | 1,955,570 | 1,334,290 | 1,468,190 | 514,286 | 317,617 | 1,052,650 |
| 2006 | 18,061,715 | 0 | 708,735 | 2,035,320 | 723,176 | 1,727,550 | 1,652,670 | 1,059,470 | 1,385,020 | 1,566,310 | 2,322,400 | 1,503,850 | 980,022 | 1,055,320 | 366,930 | 974,942 |
| 2007 | 17,130,785 | 0 | 707,891 | 941,740 | 2,442,610 | 809,071 | 1,843,780 | 1,678,380 | 1,032,340 | 1,221,720 | 1,271,380 | 1,748,400 | 1,079,190 | 687,709 | 734,889 | 931,685 |
| 2008 | 16,680,238 | 0 | 363,217 | 943,067 | 1,141,270 | 2,789,570 | 890,558 | 1,948,990 | 1,710,300 | 957,193 | 1,045,940 | 1,012,920 | 1,331,370 | 804,821 | 509,372 | 1,231,650 |
| 2009 | 16,035,868 | 0 | 655,682 | 483,249 | 1,138,080 | 1,291,790 | 3,021,740 | 920,622 | 1,922,860 | 1,529,700 | 786,257 | 798,329 | 738,137 | 949,718 | 569,994 | 1,229,710 |
| 2010 | 15,405,618 | 0 | 312,850 | 873,103 | 585,097 | 1,298,490 | 1,419,450 | 3,189,700 | 931,490 | 1,767,860 | 1,290,820 | 615,149 | 595,343 | 538,439 | 687,777 | 1,300,050 |
| 2011 | 14,432,282 | 0 | 468,552 | 415,934 | 1,050,540 | 657,779 | 1,392,520 | 1,451,090 | 3,118,140 | 826,750 | 1,442,580 | 977,454 | 444,076 | 420,338 | 377,329 | 1,389,200 |
| 2012 | 13,443,719 | 0 | 437,082 | 623,147 | 500,804 | 1,182,600 | 707,338 | 1,427,610 | 1,427,360 | 2,785,380 | 680,297 | 1,101,870 | 711,764 | 316,234 | 297,103 | 1,245,130 |
| 2013 | 13,412,529 | 0 | 1,380,960 | 581,340 | 750,980 | 565,255 | 1,276,740 | 728,525 | 1,407,380 | 1,276,950 | 2,294,460 | 520,769 | 804,949 | 508,711 | 224,360 | 1,091,150 |
| 2014 | 11,886,742 | 0 | 225,793 | 1,830,060 | 689,946 | 818,192 | 577,828 | 1,224,560 | 668,011 | 1,165,320 | 975,370 | 1,628,350 | 352,816 | 533,552 | 334,599 | 862,345 |
| 2015 | 11,155,363 | 0 | 358,459 | 300,124 | 2,201,380 | 775,840 | 877,460 | 588,321 | 1,188,730 | 585,374 | 938,786 | 729,903 | 1,164,030 | 246,919 | 370,719 | 829,318 |
| 2016 | 11,037,296 | 0 | 672,661 | 477,053 | 362,139 | 2,487,200 | 838,159 | 904,013 | 581,423 | 1,068,240 | 485,824 | 727,229 | 541,684 | 847,269 | 178,572 | 865,830 |
| 2017 | 11,207,188 | 0 | 1,161,590 | 894,031 | 572,886 | 404,620 | 2,629,320 | 836,208 | 853,503 | 495,832 | 837,371 | 354,788 | 508,706 | 371,533 | 577,253 | 709,547 |

Table B7.12 (continued).

| | | Stock 1 Ocean Population (Period 2) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 52,739 | 0 | 21,727 | 19,815 | 8,051 | 2,429 | 419 | 159 | 140 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 101,563 | 0 | 50,075 | 21,912 | 19,946 | 6,863 | 2,451 | 164 | 151 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 267,420 | 0 | 158,119 | 67,167 | 20,257 | 15,023 | 5,928 | 802 | 125 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 446,173 | 0 | 128,285 | 214,942 | 71,631 | 15,501 | 13,208 | 1,979 | 626 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 652,756 | 0 | 176,302 | 173,937 | 227,594 | 56,632 | 12,846 | 4,042 | 1,403 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 898,718 | 0 | 197,466 | 240,926 | 192,911 | 202,394 | 57,013 | 4,649 | 3,359 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 1,170,814 | 0 | 224,914 | 270,273 | 268,086 | 172,755 | 208,882 | 21,895 | 4,009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 1,383,348 | 0 | 261,053 | 307,742 | 300,255 | 238,771 | 176,573 | 79,820 | 19,134 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 1,714,644 | 0 | 375,371 | 356,878 | 340,554 | 265,253 | 241,197 | 66,472 | 68,919 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 2,134,552 | 0 | 493,396 | 514,199 | 398,735 | 306,063 | 272,721 | 91,872 | 57,566 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 2,413,273 | 0 | 331,468 | 675,280 | 571,740 | 352,824 | 305,700 | 99,964 | 76,297 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 2,579,270 | 0 | 327,493 | 453,539 | 749,980 | 504,546 | 350,429 | 110,994 | 82,289 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 2,778,693 | 0 | 426,334 | 448,489 | 505,420 | 667,291 | 508,233 | 129,634 | 93,292 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 3,481,390 | 0 | 990,761 | 583,507 | 498,746 | 447,653 | 667,219 | 186,018 | 107,486 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 3,992,171 | 0 | 760,120 | 1,352,440 | 642,810 | 431,942 | 430,302 | 230,847 | 143,710 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 4,700,345 | 0 | 887,982 | 1,036,060 | 1,485,430 | 553,840 | 412,250 | 147,614 | 177,169 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 5,428,522 | 0 | 1,103,960 | 1,210,450 | 1,101,980 | 1,243,080 | 516,686 | 139,364 | 113,002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 5,694,445 | 0 | 642,777 | 1,503,220 | 1,283,700 | 883,335 | 1,111,840 | 167,347 | 102,226 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 5,328,669 | 0 | 530,002 | 876,784 | 1,603,190 | 1,041,670 | 790,497 | 362,644 | 123,882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 4,808,275 | 0 | 410,668 | 722,584 | 933,487 | 1,296,070 | 927,218 | 253,762 | 264,486 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 4,381,981 | 0 | 668,177 | 559,559 | 768,506 | 753,528 | 1,151,460 | 296,977 | 183,774 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 4,154,735 | 0 | 757,345 | 911,086 | 595,995 | 622,414 | 674,923 | 373,347 | 219,625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 3,862,667 | 0 | 357,993 | 1,030,710 | 965,509 | 477,918 | 548,441 | 213,958 | 268,138 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 4,298,702 | 0 | 1,214,990 | 487,318 | 1,090,250 | 768,853 | 415,757 | 170,718 | 150,816 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 4,507,024 | 0 | 562,743 | 1,652,380 | 514,391 | 865,150 | 665,093 | 128,299 | 118,968 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 4,504,144 | 0 | 562,086 | 764,622 | 1,737,750 | 405,304 | 742,309 | 203,349 | 88,724 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 4,002,504 | 0 | 288,387 | 765,526 | 811,527 | 1,396,310 | 358,150 | 235,828 | 146,776 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 3,870,153 | 0 | 520,713 | 392,586 | 810,687 | 648,451 | 1,219,930 | 111,912 | 165,874 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 3,074,054 | 0 | 248,498 | 709,784 | 417,411 | 653,414 | 574,953 | 389,283 | 80,711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2011 | 2,792,517 | 0 | 372,061 | 337,763 | 747,656 | 329,709 | 561,076 | 175,979 | 268,273 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 | 2,388,863 | 0 | 347,152 | 506,456 | 357,078 | 594,563 | 286,161 | 173,977 | 123,476 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 3,118,605 | 0 | 1,096,940 | 472,660 | 535,911 | 284,580 | 517,481 | 88,981 | 122,052 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 3,016,101 | 0 | 179,377 | 1,488,590 | 492,830 | 412,566 | 234,696 | 149,946 | 58,096 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 3,024,249 | 0 | 284,769 | 244,119 | 1,572,400 | 391,188 | 356,369 | 72,032 | 103,372 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 2,936,943 | 0 | 534,381 | 388,039 | 258,677 | 1,254,150 | 340,435 | 110,695 | 50,566 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 3,507,855 | 0 | 922,798 | 727,215 | 409,218 | 204,029 | 1,067,970 | 102,395 | 74,230 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B7.12 (continued)

| | Stock 1 Ocean Population (Period 3) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 250,187 | 110,947 | 38,058 | 35,728 | 16,747 | 7,258 | 1,585 | 2,016 | 2,505 | 2,926 | 3,199 | 3,280 | 3,184 | 2,966 | 2,683 | 17,103 |
| 1983 | 603,334 | 350,427 | 117,163 | 36,901 | 37,901 | 18,402 | 8,173 | 1,778 | 2,183 | 2,532 | 2,755 | 2,813 | 2,723 | 2,530 | 2,285 | 14,768 |
| 1984 | 917,535 | 284,230 | 373,452 | 128,498 | 37,941 | 39,286 | 19,177 | 8,437 | 1,755 | 1,998 | 2,148 | 2,193 | 2,143 | 2,021 | 1,854 | 12,402 |
| 1985 | 1,389,813 | 390,765 | 303,906 | 417,268 | 144,722 | 40,605 | 42,107 | 20,442 | 8,602 | 1,663 | 1,759 | 1,786 | 1,759 | 1,691 | 1,585 | 11,153 |
| 1986 | 1,985,612 | 437,457 | 417,861 | 343,698 | 488,708 | 166,363 | 44,037 | 44,133 | 20,044 | 7,689 | 1,359 | 1,341 | 1,309 | 1,269 | 1,214 | 9,131 |
| 1987 | 2,798,280 | 498,218 | 468,112 | 475,071 | 412,723 | 600,436 | 203,746 | 51,651 | 48,527 | 20,084 | 7,038 | 1,160 | 1,101 | 1,059 | 1,023 | 8,331 |
| 1988 | 3,863,920 | 578,284 | 533,214 | 532,873 | 572,129 | 509,683 | 746,464 | 247,854 | 58,242 | 49,772 | 18,795 | 6,142 | 974 | 911 | 873 | 7,710 |
| 1989 | 5,344,762 | 831,573 | 618,835 | 606,210 | 639,365 | 702,077 | 627,859 | 902,555 | 280,436 | 59,517 | 46,327 | 16,302 | 5,125 | 801 | 747 | 7,033 |
| 1990 | 7,219,914 | 1,093,110 | 889,941 | 703,836 | 727,068 | 781,861 | 858,688 | 751,406 | 1,010,460 | 284,714 | 54,733 | 39,619 | 13,400 | 4,152 | 647 | 6,279 |
| 1991 | 8,797,741 | 734,462 | 1,169,620 | 1,011,770 | 842,955 | 885,202 | 948,061 | 1,014,910 | 827,744 | 1,008,390 | 257,624 | 45,883 | 31,840 | 10,589 | 3,264 | 5,428 |
| 1992 | 10,272,748 | 725,654 | 785,555 | 1,327,230 | 1,205,550 | 1,014,890 | 1,052,940 | 1,095,010 | 1,088,820 | 804,060 | 887,870 | 210,230 | 35,834 | 24,426 | 8,074 | 6,605 |
| 1993 | 11,971,247 | 944,560 | 776,264 | 892,262 | 1,585,460 | 1,457,350 | 1,211,890 | 1,218,000 | 1,174,520 | 1,056,830 | 707,632 | 724,804 | 164,355 | 27,514 | 18,640 | 11,166 |
| 1994 | 15,036,945 | 2,195,230 | 1,010,380 | 881,717 | 1,067,000 | 1,923,930 | 1,753,240 | 1,418,210 | 1,325,820 | 1,160,880 | 950,602 | 592,373 | 582,584 | 129,950 | 21,640 | 23,389 |
| 1995 | 17,422,736 | 1,684,910 | 2,347,450 | 1,145,430 | 1,048,160 | 1,280,200 | 2,277,530 | 2,011,810 | 1,509,020 | 1,278,550 | 1,017,580 | 775,432 | 463,966 | 448,764 | 99,542 | 34,392 |
| 1996 | 19,494,432 | 1,969,160 | 1,801,230 | 2,656,910 | 1,352,660 | 1,237,720 | 1,473,100 | 2,513,330 | 2,033,340 | 1,366,770 | 1,040,780 | 763,747 | 555,290 | 325,440 | 312,206 | 92,749 |
| 1997 | 21,569,043 | 2,447,260 | 2,103,860 | 1,973,280 | 3,041,950 | 1,549,600 | 1,378,550 | 1,571,940 | 2,456,060 | 1,786,230 | 1,083,480 | 763,405 | 535,451 | 381,532 | 221,775 | 274,670 |
| 1998 | 22,550,910 | 1,425,120 | 2,614,660 | 2,303,770 | 2,171,240 | 3,357,590 | 1,670,380 | 1,437,330 | 1,519,220 | 2,171,560 | 1,453,000 | 829,819 | 565,855 | 391,859 | 278,147 | 361,360 |
| 1999 | 23,016,742 | 1,174,720 | 1,522,980 | 2,866,610 | 2,542,740 | 2,362,540 | 3,571,780 | 1,714,890 | 1,364,050 | 1,315,780 | 1,731,580 | 1,093,810 | 605,968 | 408,388 | 281,782 | 459,124 |
| 2000 | 23,198,341 | 910,279 | 1,255,280 | 1,669,170 | 3,162,700 | 2,768,890 | 2,496,110 | 3,655,020 | 1,628,600 | 1,185,700 | 1,056,680 | 1,317,630 | 809,730 | 443,976 | 298,261 | 540,315 |
| 2001 | 23,808,222 | 1,481,380 | 972,840 | 1,376,640 | 1,844,300 | 3,452,790 | 2,935,940 | 2,554,130 | 3,476,180 | 1,420,820 | 956,991 | 809,499 | 983,468 | 598,653 | 327,285 | 617,306 |
| 2002 | 24,219,217 | 1,678,730 | 1,582,150 | 1,063,680 | 1,511,770 | 1,999,550 | 3,632,420 | 2,994,930 | 2,412,610 | 3,017,970 | 1,140,720 | 729,123 | 601,046 | 723,467 | 439,134 | 691,917 |
| 2003 | 23,588,468 | 793,850 | 1,792,920 | 1,730,630 | 1,170,000 | 1,643,700 | 2,112,380 | 3,719,050 | 2,841,110 | 2,102,560 | 2,438,170 | 876,514 | 546,707 | 446,806 | 536,435 | 837,636 |
| 2004 | 24,211,932 | 2,693,630 | 847,455 | 1,955,770 | 1,888,640 | 1,254,510 | 1,702,440 | 2,118,380 | 3,452,030 | 2,425,190 | 1,664,730 | 1,838,830 | 645,663 | 399,350 | 325,527 | 999,787 |
| 2005 | 23,051,665 | 1,247,820 | 2,875,250 | 923,902 | 2,129,200 | 2,011,690 | 1,282,980 | 1,676,080 | 1,921,680 | 2,875,690 | 1,873,290 | 1,225,410 | 1,322,700 | 460,573 | 284,090 | 941,310 |
| 2006 | 22,067,353 | 1,246,450 | 1,331,430 | 3,129,610 | 1,003,550 | 2,267,660 | 2,061,000 | 1,270,380 | 1,527,230 | 1,606,160 | 2,223,950 | 1,378,690 | 880,953 | 942,980 | 327,458 | 869,852 |
| 2007 | 20,488,043 | 639,382 | 1,330,430 | 1,450,820 | 3,400,660 | 1,064,870 | 2,304,190 | 2,010,950 | 1,137,120 | 1,251,180 | 1,217,120 | 1,604,340 | 971,561 | 615,584 | 657,038 | 832,798 |
| 2008 | 20,379,053 | 1,154,470 | 682,979 | 1,456,310 | 1,597,810 | 3,699,530 | 1,123,570 | 2,348,850 | 1,896,530 | 984,561 | 1,006,150 | 934,109 | 1,204,950 | 724,332 | 457,912 | 1,106,990 |
| 2009 | 19,174,626 | 550,788 | 1,232,970 | 746,526 | 1,595,790 | 1,719,760 | 3,838,400 | 1,118,770 | 2,150,710 | 1,583,940 | 759,066 | 737,233 | 668,248 | 854,767 | 512,408 | 1,105,250 |
| 2010 | 18,482,784 | 825,053 | 588,222 | 1,347,450 | 817,827 | 1,719,270 | 1,791,160 | 3,861,100 | 1,040,720 | 1,836,100 | 1,253,030 | 571,865 | 542,839 | 488,157 | 622,861 | 1,177,130 |
| 2011 | 16,987,732 | 769,557 | 880,490 | 640,293 | 1,459,990 | 863,338 | 1,735,130 | 1,734,940 | 3,434,170 | 846,815 | 1,380,110 | 895,009 | 398,630 | 375,088 | 336,302 | 1,237,870 |
| 2012 | 17,526,757 | 2,431,480 | 821,589 | 960,877 | 699,007 | 1,562,550 | 888,695 | 1,718,160 | 1,582,120 | 2,871,140 | 655,856 | 1,017,890 | 644,933 | 284,891 | 267,349 | 1,120,220 |
| 2013 | 15,874,829 | 397,671 | 2,592,410 | 890,307 | 1,030,920 | 729,038 | 1,556,310 | 856,672 | 1,525,540 | 1,294,660 | 2,180,860 | 475,225 | 721,233 | 453,299 | 199,696 | 970,988 |
| 2014 | 14,385,513 | 631,202 | 424,477 | 2,824,440 | 965,277 | 1,084,560 | 727,290 | 1,474,630 | 738,362 | 1,197,460 | 937,796 | 1,502,470 | 319,630 | 480,745 | 301,158 | 776,016 |
| 2015 | 13,983,148 | 1,184,250 | 673,653 | 461,980 | 3,055,610 | 1,014,900 | 1,087,030 | 697,677 | 1,298,250 | 595,491 | 896,337 | 669,995 | 1,050,270 | 221,660 | 332,457 | 743,588 |
| 2016 | 14,715,856 | 2,045,260 | 1,263,710 | 733,435 | 501,008 | 3,224,670 | 1,022,940 | 1,045,520 | 616,664 | 1,052,090 | 448,717 | 646,084 | 473,107 | 736,268 | 155,006 | 751,377 |
| 2017 | 14,147,695 | 642,276 | 2,182,820 | 1,375,780 | 793,872 | 526,129 | 3,223,370 | 974,552 | 914,825 | 494,488 | 784,672 | 320,036 | 451,452 | 328,146 | 509,340 | 625,937 |

Table B7.13. Estimates of age-specific abundance by period and year for Stock 2 (Delaware Bay/Hudson River stock).

| | | Stock 2 Population (Period 1) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 21,911,862 | 10,402,200 | 4,935,470 | 2,127,200 | 1,644,960 | 666,431 | 320,088 | 252,886 | 217,661 | 187,343 | 161,248 | 138,787 | 119,455 | 102,816 | 88,495 | 546,822 |
| 1983 | 25,685,466 | 15,521,200 | 3,357,420 | 2,469,220 | 1,291,820 | 1,073,790 | 452,968 | 225,154 | 182,439 | 155,791 | 133,541 | 114,698 | 98,617 | 84,834 | 72,998 | 450,976 |
| 1984 | 29,143,810 | 17,977,300 | 5,009,660 | 1,679,850 | 1,499,960 | 843,742 | 730,424 | 318,924 | 162,599 | 130,721 | 111,172 | 95,096 | 81,591 | 70,114 | 60,299 | 372,359 |
| 1985 | 27,707,694 | 15,057,700 | 5,804,650 | 2,520,980 | 1,043,500 | 1,024,000 | 610,888 | 553,866 | 249,727 | 126,782 | 101,702 | 86,396 | 73,860 | 63,353 | 54,433 | 335,858 |
| 1986 | 25,544,447 | 13,289,300 | 4,859,870 | 2,902,540 | 1,527,810 | 678,400 | 692,019 | 426,782 | 396,609 | 177,356 | 89,656 | 71,763 | 60,895 | 52,030 | 44,615 | 274,802 |
| 1987 | 32,238,343 | 20,311,400 | 4,291,450 | 2,449,920 | 1,815,440 | 1,057,280 | 500,677 | 536,832 | 342,589 | 317,376 | 141,695 | 71,569 | 57,262 | 48,579 | 41,503 | 254,771 |
| 1988 | 43,714,232 | 29,487,300 | 6,559,870 | 2,167,310 | 1,543,200 | 1,274,020 | 795,848 | 397,614 | 442,096 | 281,575 | 260,584 | 116,278 | 58,716 | 46,971 | 39,847 | 243,003 |
| 1989 | 56,564,692 | 38,177,100 | 9,522,960 | 3,310,810 | 1,361,790 | 1,077,650 | 952,343 | 626,819 | 324,504 | 359,949 | 228,971 | 211,768 | 94,465 | 47,693 | 38,151 | 229,719 |
| 1990 | 63,320,349 | 39,908,200 | 12,328,400 | 4,801,140 | 2,071,620 | 943,139 | 796,221 | 739,761 | 503,894 | 260,070 | 288,019 | 183,066 | 169,242 | 75,479 | 38,104 | 213,994 |
| 1991 | 66,634,454 | 39,760,900 | 12,885,700 | 6,228,490 | 3,032,810 | 1,457,780 | 707,404 | 623,102 | 592,729 | 398,175 | 203,267 | 223,262 | 141,056 | 129,847 | 57,736 | 192,196 |
| 1992 | 71,202,411 | 42,251,300 | 12,836,200 | 6,504,100 | 3,922,370 | 2,119,200 | 1,079,990 | 543,657 | 487,657 | 455,408 | 301,507 | 152,241 | 165,888 | 104,212 | 95,548 | 183,133 |
| 1993 | 82,246,750 | 51,097,000 | 13,638,700 | 6,474,930 | 4,087,040 | 2,727,180 | 1,556,340 | 819,426 | 418,463 | 367,311 | 337,204 | 220,394 | 110,246 | 119,327 | 74,611 | 198,578 |
| 1994 | 158,714,180 | 123,089,000 | 16,497,000 | 6,887,020 | 4,083,280 | 2,864,990 | 2,031,800 | 1,205,980 | 648,199 | 325,645 | 282,171 | 256,536 | 166,486 | 82,860 | 89,368 | 203,844 |
| 1995 | 128,953,979 | 67,587,300 | 39,735,300 | 8,324,260 | 4,332,410 | 2,846,190 | 2,113,350 | 1,551,610 | 936,093 | 493,154 | 243,866 | 208,809 | 188,199 | 121,384 | 60,151 | 211,903 |
| 1996 | 147,772,317 | 91,451,100 | 21,808,900 | 19,998,500 | 5,191,130 | 2,960,280 | 2,027,300 | 1,533,160 | 1,126,780 | 657,752 | 337,623 | 163,719 | 138,198 | 123,297 | 78,958 | 175,620 |
| 1997 | 155,125,760 | 92,194,500 | 29,505,500 | 10,968,100 | 12,439,900 | 3,526,630 | 2,087,320 | 1,449,050 | 1,092,130 | 773,731 | 438,769 | 220,364 | 105,174 | 87,780 | 77,695 | 159,117 |
| 1998 | 123,691,833 | 57,049,000 | 29,749,500 | 14,815,200 | 6,770,250 | 8,325,210 | 2,444,740 | 1,475,630 | 1,033,220 | 761,532 | 531,490 | 298,485 | 148,988 | 70,834 | 58,978 | 158,776 |
| 1999 | 122,508,804 | 65,037,300 | 18,407,000 | 14,926,300 | 9,119,650 | 4,503,230 | 5,714,100 | 1,705,300 | 1,035,380 | 707,604 | 513,126 | 354,366 | 197,685 | 98,261 | 46,596 | 142,906 |
| 2000 | 115,041,951 | 58,942,900 | 20,986,800 | 9,244,150 | 9,219,820 | 6,112,320 | 3,129,360 | 4,052,860 | 1,220,730 | 725,148 | 488,368 | 350,793 | 240,801 | 133,825 | 66,363 | 127,713 |
| 2001 | 134,055,910 | 80,859,400 | 19,020,800 | 10,542,100 | 5,714,670 | 6,190,590 | 4,259,970 | 2,228,330 | 2,914,970 | 859,497 | 503,319 | 335,846 | 239,822 | 164,020 | 90,946 | 131,630 |
| 2002 | 147,646,887 | 89,076,500 | 26,092,800 | 9,553,520 | 6,514,520 | 3,833,750 | 4,308,430 | 3,027,650 | 1,599,040 | 2,047,150 | 594,941 | 345,141 | 228,932 | 162,869 | 111,132 | 150,512 |
| 2003 | 116,004,759 | 52,680,300 | 28,740,600 | 13,091,100 | 5,879,860 | 4,331,650 | 2,629,880 | 3,003,070 | 2,122,460 | 1,094,020 | 1,377,910 | 396,229 | 228,324 | 150,811 | 107,011 | 171,534 |
| 2004 | 170,622,183 | 116,559,000 | 16,997,100 | 14,417,900 | 8,054,010 | 3,906,340 | 2,967,340 | 1,829,680 | 2,100,550 | 1,448,510 | 734,408 | 915,132 | 261,372 | 149,974 | 98,799 | 182,068 |
| 2005 | 124,710,548 | 55,010,700 | 37,597,200 | 8,507,780 | 8,798,850 | 5,256,030 | 2,599,430 | 1,985,300 | 1,221,120 | 1,360,230 | 919,196 | 459,962 | 568,395 | 161,495 | 92,365 | 172,495 |
| 2006 | 106,484,561 | 49,214,500 | 17,744,800 | 18,824,700 | 5,197,800 | 5,756,160 | 3,511,470 | 1,748,470 | 1,333,500 | 796,442 | 869,834 | 580,331 | 288,047 | 354,147 | 100,305 | 164,055 |
| 2007 | 79,749,496 | 30,424,400 | 15,871,000 | 8,865,590 | 11,410,900 | 3,341,930 | 3,738,770 | 2,273,990 | 1,122,120 | 826,533 | 482,251 | 518,773 | 342,801 | 169,128 | 207,163 | 154,147 |
| 2008 | 88,980,706 | 49,343,100 | 9,815,360 | 7,955,380 | 5,438,380 | 7,532,000 | 2,265,370 | 2,564,530 | 1,563,720 | 751,365 | 543,638 | 313,540 | 334,815 | 220,227 | 108,343 | 230,938 |
| 2009 | 71,308,424 | 30,956,600 | 15,918,400 | 4,919,010 | 4,876,530 | 3,584,020 | 5,092,520 | 1,548,500 | 1,756,180 | 1,042,190 | 491,738 | 351,616 | 201,279 | 213,932 | 140,306 | 215,603 |
| 2010 | 72,843,573 | 38,610,200 | 9,987,790 | 7,983,940 | 3,024,040 | 3,234,380 | 2,448,550 | 3,530,110 | 1,078,390 | 1,192,680 | 695,952 | 324,803 | 230,644 | 131,458 | 139,345 | 231,291 |
| 2011 | 92,496,980 | 59,425,200 | 12,454,600 | 5,001,260 | 4,879,230 | 1,979,620 | 2,163,180 | 1,649,380 | 2,375,290 | 704,730 | 764,295 | 440,349 | 203,862 | 144,034 | 81,837 | 230,113 |
| 2012 | 91,929,302 | 53,355,800 | 19,167,200 | 6,231,640 | 3,047,780 | 3,174,190 | 1,310,600 | 1,437,350 | 1,091,730 | 1,523,990 | 442,802 | 473,763 | 270,621 | 124,613 | 87,748 | 189,475 |
| 2013 | 61,108,072 | 21,811,100 | 17,211,500 | 9,599,130 | 3,810,370 | 1,997,500 | 2,126,960 | 885,111 | 970,121 | 715,907 | 980,210 | 281,253 | 298,533 | 169,678 | 77,890 | 172,809 |
| 2014 | 58,780,640 | 29,981,800 | 7,030,720 | 8,568,680 | 5,744,140 | 2,381,140 | 1,238,790 | 1,294,200 | 527,108 | 553,042 | 396,330 | 532,432 | 150,940 | 159,008 | 89,953 | 132,357 |
| 2015 | 113,298,700 | 86,320,200 | 9,670,370 | 3,517,630 | 5,220,840 | 3,735,370 | 1,575,410 | 822,411 | 855,741 | 337,800 | 347,058 | 245,353 | 326,775 | 92,139 | 96,738 | 134,866 |
| 2016 | 146,070,142 | 102,131,000 | 27,845,000 | 4,842,890 | 2,150,660 | 3,420,980 | 2,502,130 | 1,063,450 | 554,765 | 560,803 | 217,121 | 220,285 | 154,492 | 204,736 | 57,549 | 144,281 |
| 2017 | 109,651,782 | 52,408,700 | 32,943,500 | 13,938,500 | 2,956,170 | 1,404,250 | 2,278,370 | 1,675,950 | 710,705 | 359,791 | 356,455 | 136,216 | 137,060 | 95,627 | 126,319 | 124,169 |

Table B7.13 (continued).

| Stock 2 Population (Period 2) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 19,270,314 | 8,616,580 | 4,406,430 | 1,973,070 | 1,556,270 | 638,852 | 309,891 | 246,452 | 212,115 | 182,566 | 157,135 | 135,246 | 116,407 | 100,193 | 86,237 | 532,870 |
| 1983 | 22,317,089 | 12,856,900 | 2,997,630 | 2,290,610 | 1,222,480 | 1,029,710 | 438,721 | 219,525 | 177,875 | 151,893 | 130,199 | 111,828 | 96,148 | 82,711 | 71,171 | 439,688 |
| 1984 | 25,227,152 | 14,891,400 | 4,472,870 | 1,558,420 | 1,419,590 | 809,233 | 707,578 | 311,012 | 158,565 | 127,477 | 108,413 | 92,736 | 79,566 | 68,374 | 58,802 | 363,117 |
| 1985 | 24,161,600 | 12,473,000 | 5,182,720 | 2,338,830 | 987,658 | 982,210 | 591,846 | 540,191 | 243,561 | 123,652 | 99,191 | 84,262 | 72,036 | 61,788 | 53,089 | 327,566 |
| 1986 | 22,362,440 | 11,008,100 | 4,339,170 | 2,692,820 | 1,446,050 | 650,714 | 670,449 | 416,244 | 386,816 | 172,977 | 87,442 | 69,991 | 59,391 | 50,745 | 43,514 | 268,017 |
| 1987 | 27,914,282 | 16,824,800 | 3,831,660 | 2,272,900 | 1,718,280 | 1,014,140 | 485,071 | 523,577 | 334,131 | 309,540 | 138,196 | 69,802 | 55,848 | 47,380 | 40,478 | 248,480 |
| 1988 | 37,587,242 | 24,425,700 | 5,857,030 | 2,010,720 | 1,460,620 | 1,222,030 | 771,041 | 387,797 | 431,180 | 274,622 | 254,150 | 113,407 | 57,266 | 45,812 | 38,863 | 237,004 |
| 1989 | 48,551,935 | 31,623,800 | 8,502,640 | 3,071,590 | 1,288,920 | 1,033,670 | 922,658 | 611,342 | 316,492 | 351,062 | 223,318 | 206,539 | 92,133 | 46,516 | 37,209 | 224,047 |
| 1990 | 54,565,423 | 33,057,700 | 11,007,400 | 4,454,090 | 1,960,620 | 904,532 | 771,256 | 721,317 | 491,308 | 253,564 | 280,806 | 178,477 | 164,997 | 73,586 | 37,148 | 208,623 |
| 1991 | 57,670,127 | 32,935,700 | 11,505,000 | 5,778,300 | 2,870,330 | 1,398,130 | 685,241 | 607,588 | 577,947 | 388,232 | 198,186 | 217,678 | 137,526 | 126,596 | 56,290 | 187,383 |
| 1992 | 61,708,770 | 34,998,500 | 11,460,600 | 6,033,730 | 3,711,870 | 2,032,140 | 1,045,890 | 529,948 | 475,310 | 443,841 | 293,830 | 148,358 | 161,652 | 101,549 | 93,105 | 178,447 |
| 1993 | 71,098,429 | 42,325,800 | 12,177,200 | 6,006,750 | 3,867,820 | 2,615,280 | 1,507,320 | 798,844 | 407,917 | 358,031 | 328,668 | 214,807 | 107,448 | 116,297 | 72,716 | 193,531 |
| 1994 | 134,832,485 | 101,960,000 | 14,729,000 | 6,388,680 | 3,863,760 | 2,746,820 | 1,967,150 | 1,175,180 | 631,540 | 317,234 | 274,854 | 249,866 | 162,149 | 80,699 | 87,035 | 198,518 |
| 1995 | 111,968,573 | 55,985,300 | 35,476,600 | 7,721,780 | 4,099,330 | 2,728,580 | 2,045,880 | 1,511,760 | 911,874 | 480,321 | 237,492 | 203,333 | 183,253 | 118,189 | 58,566 | 206,315 |
| 1996 | 127,694,371 | 75,752,000 | 19,470,600 | 18,548,200 | 4,910,090 | 2,836,180 | 1,960,770 | 1,492,010 | 1,096,070 | 639,605 | 328,224 | 159,132 | 134,308 | 119,816 | 76,724 | 170,642 |
| 1997 | 134,196,920 | 76,364,400 | 26,331,700 | 10,158,000 | 11,729,300 | 3,361,740 | 2,005,390 | 1,399,140 | 1,053,260 | 745,592 | 422,593 | 212,170 | 101,243 | 84,488 | 74,775 | 153,129 |
| 1998 | 108,629,879 | 47,254,400 | 26,553,700 | 13,729,000 | 6,391,830 | 7,952,820 | 2,355,500 | 1,429,690 | 1,000,270 | 736,858 | 514,094 | 288,653 | 144,060 | 68,486 | 57,019 | 153,499 |
| 1999 | 107,159,764 | 53,870,600 | 16,428,100 | 13,827,300 | 8,603,450 | 4,296,560 | 5,496,500 | 1,648,960 | 1,000,150 | 683,064 | 495,111 | 341,828 | 190,657 | 94,757 | 44,931 | 137,796 |
| 2000 | 100,917,291 | 48,824,100 | 18,735,300 | 8,571,260 | 8,715,290 | 5,850,720 | 3,023,350 | 3,939,540 | 1,186,130 | 704,404 | 474,316 | 340,662 | 233,830 | 129,946 | 64,438 | 124,005 |
| 2001 | 116,399,190 | 66,977,500 | 16,978,800 | 9,771,970 | 5,398,530 | 5,919,530 | 4,109,950 | 2,162,410 | 2,827,060 | 833,244 | 487,818 | 325,449 | 232,374 | 158,916 | 88,113 | 127,526 |
| 2002 | 127,837,887 | 73,782,000 | 23,286,800 | 8,848,920 | 6,143,950 | 3,656,030 | 4,141,670 | 2,925,340 | 1,543,290 | 1,974,300 | 573,492 | 332,596 | 220,569 | 156,900 | 107,051 | 144,979 |
| 2003 | 102,007,500 | 43,635,600 | 25,652,500 | 12,130,200 | 5,550,090 | 4,136,540 | 2,532,770 | 2,908,050 | 2,053,560 | 1,057,910 | 1,331,930 | 382,917 | 220,621 | 145,710 | 103,385 | 165,717 |
| 2004 | 146,588,911 | 96,543,000 | 15,165,500 | 13,342,500 | 7,580,750 | 3,713,220 | 2,840,070 | 1,758,620 | 2,015,470 | 1,388,230 | 703,314 | 875,967 | 250,111 | 143,486 | 94,514 | 174,159 |
| 2005 | 109,545,919 | 45,565,900 | 33,557,300 | 7,883,160 | 8,304,970 | 5,018,910 | 2,503,190 | 1,922,250 | 1,181,310 | 1,315,130 | 888,386 | 444,438 | 549,130 | 156,007 | 89,221 | 166,617 |
| 2006 | 93,786,853 | 40,764,000 | 15,835,300 | 17,431,100 | 4,898,890 | 5,483,440 | 3,370,670 | 1,686,450 | 1,284,510 | 766,502 | 836,656 | 557,992 | 276,896 | 340,389 | 96,399 | 157,659 |
| 2007 | 70,980,483 | 25,200,400 | 14,163,400 | 8,209,980 | 10,756,800 | 3,184,570 | 3,590,340 | 2,194,420 | 1,081,500 | 795,936 | 464,144 | 499,122 | 329,744 | 162,664 | 199,228 | 148,235 |
| 2008 | 77,844,216 | 40,870,300 | 8,758,760 | 7,365,420 | 5,124,050 | 7,171,540 | 2,173,060 | 2,471,560 | 1,504,910 | 722,418 | 522,373 | 301,157 | 321,513 | 211,446 | 104,013 | 221,696 |
| 2009 | 63,102,094 | 25,641,700 | 14,207,900 | 4,557,860 | 4,602,780 | 3,422,290 | 4,903,890 | 1,499,290 | 1,698,900 | 1,007,610 | 475,244 | 339,741 | 194,453 | 206,657 | 135,527 | 208,252 |
| 2010 | 63,962,045 | 31,981,900 | 8,916,260 | 7,402,820 | 2,858,580 | 3,096,000 | 2,365,650 | 3,431,490 | 1,047,850 | 1,158,600 | 675,947 | 315,432 | 223,975 | 127,651 | 135,306 | 224,584 |
| 2011 | 79,897,134 | 49,221,800 | 11,115,100 | 4,632,170 | 4,601,180 | 1,887,520 | 2,078,950 | 1,593,190 | 2,291,730 | 679,418 | 736,476 | 424,186 | 196,340 | 138,703 | 78,802 | 221,569 |
| 2012 | 79,734,209 | 44,195,800 | 17,109,700 | 5,776,600 | 2,879,430 | 3,035,640 | 1,264,690 | 1,395,160 | 1,059,080 | 1,477,850 | 429,290 | 459,235 | 262,297 | 120,772 | 85,041 | 183,624 |
| 2013 | 54,331,954 | 18,066,800 | 15,365,500 | 8,901,640 | 3,602,960 | 1,912,960 | 2,056,290 | 861,055 | 943,469 | 696,098 | 952,961 | 273,412 | 290,194 | 164,934 | 75,710 | 167,971 |
| 2014 | 51,723,573 | 24,835,300 | 6,277,420 | 7,949,520 | 5,436,700 | 2,283,930 | 1,200,150 | 1,262,210 | 514,078 | 539,369 | 386,531 | 519,268 | 147,208 | 155,076 | 87,729 | 129,084 |
| 2015 | 96,628,504 | 71,502,900 | 8,634,210 | 3,263,400 | 4,941,220 | 3,582,660 | 1,526,150 | 802,007 | 834,498 | 329,411 | 338,437 | 239,257 | 318,656 | 89,849 | 94,334 | 131,515 |
| 2016 | 124,794,075 | 84,599,600 | 24,861,600 | 4,492,950 | 2,035,560 | 3,281,330 | 2,424,090 | 1,037,170 | 541,053 | 546,941 | 211,754 | 214,839 | 150,673 | 199,675 | 56,126 | 140,714 |
| 2017 | 95,740,344 | 43,412,500 | 29,413,800 | 12,931,400 | 2,797,970 | 1,346,940 | 2,207,350 | 1,634,570 | 693,157 | 350,907 | 347,654 | 132,852 | 133,676 | 93,266 | 123,199 | 121,103 |

Table B7.13 (continued).

| | | Stock 2 Population (Period 3) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | 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+ |
| 1982 | 14,695,932 | 5,909,380 | 3,488,180 | 1,652,580 | 1,320,930 | 544,708 | 265,717 | 212,403 | 182,005 | 156,291 | 134,362 | 115,577 | 99,448 | 85,582 | 73,656 | 455,113 |
| 1983 | 16,901,884 | 8,820,080 | 2,383,410 | 1,951,600 | 1,073,310 | 920,868 | 398,134 | 201,272 | 162,817 | 138,915 | 119,022 | 102,205 | 87,865 | 75,581 | 65,034 | 401,770 |
| 1984 | 19,061,738 | 10,217,000 | 3,562,810 | 1,337,130 | 1,263,820 | 738,020 | 657,257 | 292,494 | 149,047 | 119,794 | 101,865 | 87,129 | 74,753 | 64,236 | 55,243 | 341,140 |
| 1985 | 18,482,450 | 8,557,320 | 4,125,120 | 2,000,830 | 874,185 | 888,460 | 544,422 | 502,652 | 226,413 | 114,887 | 92,136 | 78,259 | 66,899 | 57,380 | 49,300 | 304,188 |
| 1986 | 17,284,390 | 7,552,700 | 3,456,290 | 2,310,390 | 1,287,320 | 593,414 | 622,721 | 391,429 | 363,568 | 162,538 | 82,154 | 65,753 | 55,793 | 47,670 | 40,877 | 251,773 |
| 1987 | 21,139,572 | 11,543,900 | 3,053,370 | 1,953,410 | 1,534,800 | 929,207 | 453,074 | 495,384 | 316,063 | 292,765 | 130,699 | 66,013 | 52,815 | 44,807 | 38,280 | 234,985 |
| 1988 | 28,021,497 | 16,758,700 | 4,666,150 | 1,726,350 | 1,302,070 | 1,116,570 | 717,796 | 365,590 | 406,326 | 258,738 | 239,424 | 106,831 | 53,944 | 43,153 | 36,607 | 223,248 |
| 1989 | 36,022,882 | 21,696,900 | 6,771,680 | 2,633,920 | 1,146,180 | 941,195 | 855,410 | 573,748 | 296,851 | 329,172 | 209,359 | 193,614 | 86,364 | 43,602 | 34,878 | 210,010 |
| 1990 | 40,788,001 | 22,679,300 | 8,768,210 | 3,823,770 | 1,746,030 | 823,615 | 712,986 | 672,715 | 456,451 | 234,864 | 259,505 | 164,665 | 152,048 | 67,755 | 34,184 | 191,903 |
| 1991 | 43,467,470 | 22,594,900 | 9,162,780 | 4,957,320 | 2,552,350 | 1,269,700 | 631,023 | 563,810 | 533,734 | 357,175 | 181,813 | 199,279 | 125,715 | 115,603 | 51,365 | 170,903 |
| 1992 | 46,547,778 | 24,007,500 | 9,121,860 | 5,165,750 | 3,285,060 | 1,830,180 | 951,455 | 484,039 | 430,728 | 399,718 | 263,385 | 132,534 | 144,058 | 90,343 | 82,732 | 158,437 |
| 1993 | 53,420,627 | 29,035,200 | 9,695,050 | 5,147,810 | 3,430,920 | 2,364,870 | 1,379,340 | 735,250 | 373,052 | 325,781 | 297,931 | 194,180 | 96,939 | 104,777 | 65,450 | 174,077 |
| 1994 | 97,682,834 | 69,940,100 | 11,723,000 | 5,469,320 | 3,419,020 | 2,473,260 | 1,788,910 | 1,072,890 | 571,997 | 285,524 | 246,214 | 223,059 | 144,398 | 71,740 | 77,280 | 176,122 |
| 1995 | 84,641,430 | 38,401,300 | 28,226,900 | 6,603,090 | 3,618,070 | 2,445,680 | 1,848,130 | 1,368,270 | 817,398 | 427,292 | 210,065 | 179,102 | 160,936 | 103,578 | 51,252 | 180,367 |
| 1996 | 95,575,289 | 51,955,200 | 15,483,700 | 15,833,200 | 4,316,280 | 2,524,250 | 1,753,020 | 1,332,380 | 966,887 | 558,796 | 284,677 | 137,289 | 115,436 | 102,707 | 65,647 | 145,820 |
| 1997 | 100,633,730 | 52,375,400 | 20,921,500 | 8,637,990 | 10,230,900 | 2,961,730 | 1,775,550 | 1,240,800 | 926,326 | 652,089 | 368,262 | 184,468 | 87,898 | 73,285 | 64,825 | 132,707 |
| 1998 | 83,534,616 | 32,407,900 | 21,086,900 | 11,652,600 | 5,551,950 | 6,958,910 | 2,066,470 | 1,253,990 | 868,941 | 635,995 | 441,870 | 247,442 | 123,288 | 58,550 | 48,716 | 131,094 |
| 1999 | 82,009,964 | 36,948,000 | 13,053,500 | 11,760,800 | 7,507,940 | 3,788,230 | 4,871,600 | 1,464,180 | 880,851 | 598,297 | 432,131 | 297,675 | 165,796 | 82,329 | 39,017 | 119,618 |
| 2000 | 77,386,777 | 33,486,000 | 14,883,900 | 7,285,160 | 7,593,740 | 5,145,520 | 2,670,520 | 3,483,820 | 1,039,880 | 613,979 | 411,874 | 295,109 | 202,260 | 112,297 | 55,654 | 107,064 |
| 2001 | 87,621,668 | 45,936,600 | 13,488,600 | 8,306,000 | 4,704,180 | 5,206,710 | 3,630,960 | 1,912,670 | 2,479,080 | 726,464 | 423,711 | 282,008 | 201,057 | 137,371 | 76,123 | 110,134 |
| 2002 | 95,235,861 | 50,593,100 | 18,468,800 | 7,475,500 | 5,281,830 | 3,145,890 | 3,552,270 | 2,497,160 | 1,300,600 | 1,649,550 | 476,489 | 275,362 | 182,207 | 129,433 | 88,236 | 119,434 |
| 2003 | 78,131,488 | 29,922,100 | 20,349,100 | 10,254,900 | 4,778,890 | 3,568,550 | 2,179,900 | 2,492,780 | 1,738,720 | 888,322 | 1,112,430 | 318,725 | 183,244 | 120,864 | 85,686 | 137,277 |
| 2004 | 107,625,244 | 66,195,000 | 12,019,500 | 11,243,600 | 6,481,220 | 3,166,620 | 2,406,700 | 1,479,640 | 1,671,230 | 1,139,930 | 573,873 | 711,884 | 202,750 | 116,134 | 76,423 | 140,740 |
| 2005 | 83,488,865 | 31,242,000 | 26,593,300 | 6,640,510 | 7,094,460 | 4,274,280 | 2,117,340 | 1,613,750 | 977,140 | 1,077,060 | 722,893 | 360,170 | 443,873 | 125,903 | 71,934 | 134,252 |
| 2006 | 71,437,643 | 27,945,500 | 12,534,200 | 14,620,300 | 4,145,250 | 4,598,310 | 2,792,390 | 1,380,870 | 1,033,220 | 609,238 | 659,874 | 437,936 | 216,652 | 265,823 | 75,193 | 122,887 |
| 2007 | 55,175,341 | 17,278,300 | 11,223,100 | 6,913,450 | 9,181,960 | 2,708,780 | 3,031,910 | 1,838,600 | 892,600 | 650,312 | 376,749 | 403,460 | 265,853 | 130,934 | 160,206 | 119,127 |
| 2008 | 59,252,918 | 28,027,900 | 6,952,070 | 6,240,140 | 4,433,070 | 6,234,790 | 1,889,870 | 2,145,250 | 1,292,110 | 615,760 | 443,150 | 254,719 | 271,426 | 178,297 | 87,644 | 186,722 |
| 2009 | 48,817,279 | 17,584,000 | 11,274,700 | 3,858,370 | 3,974,930 | 2,966,570 | 4,248,030 | 1,295,200 | 1,450,970 | 853,991 | 400,792 | 285,614 | 163,150 | 173,177 | 113,485 | 174,300 |
| 2010 | 48,648,111 | 21,930,800 | 7,072,870 | 6,258,250 | 2,461,300 | 2,670,750 | 2,035,930 | 2,941,250 | 887,120 | 972,783 | 564,496 | 262,526 | 186,011 | 105,873 | 112,130 | 186,022 |
| 2011 | 58,912,486 | 33,747,100 | 8,805,140 | 3,896,680 | 3,918,730 | 1,599,650 | 1,746,960 | 1,326,980 | 1,878,970 | 551,188 | 593,395 | 340,293 | 157,081 | 110,781 | 62,872 | 176,666 |
| 2012 | 59,462,316 | 30,304,500 | 13,566,100 | 4,875,350 | 2,470,160 | 2,603,100 | 1,079,710 | 1,184,350 | 887,002 | 1,226,570 | 354,210 | 377,508 | 215,115 | 98,904 | 69,580 | 150,157 |
| 2013 | 41,499,865 | 12,382,600 | 12,138,100 | 7,412,240 | 3,000,250 | 1,562,960 | 1,644,810 | 675,974 | 723,999 | 526,069 | 713,090 | 203,309 | 214,940 | 121,864 | 55,855 | 123,805 |
| 2014 | 39,400,497 | 17,028,300 | 4,975,120 | 6,698,490 | 4,647,440 | 1,947,250 | 1,016,680 | 1,061,550 | 426,084 | 442,686 | 315,235 | 421,784 | 119,271 | 125,449 | 70,899 | 104,259 |
| 2015 | 69,696,396 | 49,022,300 | 6,838,700 | 2,743,600 | 4,202,790 | 3,029,760 | 1,278,750 | 665,688 | 681,550 | 266,133 | 271,509 | 191,088 | 253,791 | 71,435 | 74,921 | 104,381 |
| 2016 | 90,628,912 | 58,005,200 | 19,702,100 | 3,784,620 | 1,738,770 | 2,794,260 | 2,050,200 | 870,593 | 447,471 | 447,859 | 172,278 | 174,073 | 121,770 | 161,115 | 45,243 | 113,360 |
| 2017 | 72,375,220 | 29,765,500 | 23,309,600 | 10,892,800 | 2,390,040 | 1,147,020 | 1,866,910 | 1,372,070 | 573,276 | 287,343 | 282,848 | 107,646 | 108,035 | 75,257 | 99,312 | 97,563 |

Table B7.14. Estimates of age-specific female spawning stock biomass (mt) by year for Stock 1 (Chesapeake Bay stock).

| Year | Total | 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+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 572.8 | 0.0 | 0.0 | 0.0 | 4.8 | 8.1 | 3.5 | 9.5 | 14.5 | 18.5 | 28.9 | 38.3 | 36.1 | 39.1 | 39.6 | 331.9 |
| 1983 | 451.2 | 0.0 | 0.0 | 0.0 | 8.9 | 17.3 | 13.1 | 6.0 | 10.4 | 15.1 | 20.8 | 27.0 | 28.3 | 28.6 | 30.0 | 245.6 |
| 1984 | 426.6 | 0.0 | 0.0 | 0.0 | 9.0 | 35.8 | 28.7 | 31.8 | 7.6 | 11.8 | 14.6 | 17.7 | 23.6 | 21.8 | 23.2 | 201.0 |
| 1985 | 506.3 | 0.0 | 0.0 | 0.0 | 42.8 | 33.0 | 66.5 | 74.0 | 38.1 | 9.8 | 11.7 | 14.8 | 16.3 | 17.8 | 18.5 | 162.8 |
| 1986 | 816.2 | 0.0 | 0.0 | 0.0 | 176.6 | 157.2 | 61.5 | 140.5 | 84.0 | 38.3 | 7.8 | 9.9 | 11.0 | 11.0 | 11.9 | 106.4 |
| 1987 | 1,667.1 | 0.0 | 0.0 | 0.0 | 140.3 | 633.2 | 281.2 | 148.6 | 183.4 | 98.9 | 40.1 | 8.1 | 9.4 | 9.2 | 10.0 | 104.8 |
| 1988 | 3,646.5 | 0.0 | 0.0 | 0.0 | 190.0 | 612.4 | 1,319.6 | 813.3 | 213.8 | 231.6 | 96.2 | 46.9 | 8.6 | 8.1 | 8.7 | 97.2 |
| 1989 | 8,304.1 | 0.0 | 0.0 | 0.0 | 218.2 | 818.1 | 1,282.1 | 3,741.2 | 1,337.9 | 307.5 | 324.4 | 123.8 | 44.4 | 7.6 | 7.7 | 91.2 |
| 1990 | 12,832.7 | 0.0 | 0.0 | 0.0 | 239.5 | 772.5 | 1,545.2 | 3,013.0 | 4,928.5 | 1,517.8 | 300.9 | 293.3 | 111.7 | 34.6 | 6.0 | 69.9 |
| 1991 | 18,262.1 | 0.0 | 0.0 | 0.0 | 283.5 | 922.1 | 1,375.7 | 3,823.0 | 3,779.2 | 5,839.5 | 1,445.3 | 371.1 | 237.3 | 90.4 | 30.7 | 64.3 |
| 1992 | 26,014.2 | 0.0 | 0.0 | 0.0 | 383.4 | 1,130.9 | 1,752.2 | 3,981.9 | 5,038.3 | 4,849.3 | 6,273.5 | 1,759.9 | 383.9 | 253.0 | 97.7 | 110.2 |
| 1993 | 34,374.7 | 0.0 | 0.0 | 0.0 | 517.7 | 1,559.0 | 2,011.0 | 4,515.4 | 5,671.8 | 6,453.1 | 5,020.6 | 6,357.5 | 1,589.8 | 292.3 | 222.3 | 164.1 |
| 1994 | 43,356.9 | 0.0 | 0.0 | 0.0 | 377.4 | 2,123.0 | 2,857.1 | 5,346.3 | 6,447.5 | 7,012.9 | 6,462.6 | 5,261.9 | 5,580.6 | 1,308.6 | 246.5 | 332.5 |
| 1995 | 52,893.2 | 0.0 | 0.0 | 0.0 | 392.1 | 1,425.4 | 3,879.8 | 8,097.5 | 7,413.8 | 8,218.8 | 7,819.2 | 5,669.5 | 4,200.9 | 4,274.2 | 1,058.4 | 443.6 |
| 1996 | 65,158.5 | 0.0 | 0.0 | 0.0 | 501.8 | 1,542.7 | 2,930.4 | 11,636.6 | 11,372.4 | 9,249.6 | 8,355.9 | 6,783.6 | 4,850.8 | 3,214.7 | 3,437.2 | 1,282.9 |
| 1997 | 65,818.1 | 0.0 | 0.0 | 0.0 | 1,225.6 | 1,799.2 | 2,461.8 | 5,988.8 | 11,251.5 | 11,312.5 | 8,899.4 | 7,227.7 | 4,996.7 | 3,914.8 | 2,611.0 | 4,129.0 |
| 1998 | 63,648.4 | 0.0 | 0.0 | 0.0 | 590.1 | 3,290.3 | 2,428.0 | 5,277.8 | 6,865.7 | 12,685.6 | 9,394.2 | 6,512.0 | 5,215.2 | 3,662.3 | 2,988.4 | 4,738.9 |
| 1999 | 64,798.4 | 0.0 | 0.0 | 0.0 | 635.5 | 1,826.2 | 4,318.8 | 4,633.4 | 5,677.8 | 7,659.1 | 12,190.9 | 8,742.2 | 5,205.0 | 4,002.8 | 3,152.0 | 6,754.6 |
| 2000 | 73,606.6 | 0.0 | 0.0 | 0.0 | 778.6 | 2,118.1 | 3,122.4 | 10,564.3 | 6,294.1 | 7,131.3 | 7,049.6 | 11,803.5 | 7,696.9 | 4,636.1 | 3,648.1 | 8,763.6 |
| 2001 | 74,715.0 | 0.0 | 0.0 | 0.0 | 521.3 | 2,889.0 | 4,130.4 | 7,855.7 | 13,691.3 | 7,826.2 | 6,743.8 | 6,506.6 | 7,881.3 | 5,484.4 | 3,432.0 | 7,753.1 |
| 2002 | 83,640.7 | 0.0 | 0.0 | 0.0 | 386.8 | 1,750.0 | 5,215.3 | 9,722.2 | 10,305.3 | 15,887.2 | 7,629.2 | 6,155.9 | 5,276.0 | 6,695.0 | 4,769.2 | 9,848.6 |
| 2003 | 88,990.5 | 0.0 | 0.0 | 0.0 | 279.2 | 1,399.8 | 3,057.1 | 11,902.8 | 11,831.7 | 11,547.7 | 15,714.8 | 7,079.8 | 4,792.8 | 4,196.2 | 5,806.2 | 11,382.3 |
| 2004 | 88,182.6 | 0.0 | 0.0 | 0.0 | 445.0 | 1,130.1 | 2,416.5 | 6,819.1 | 14,185.4 | 13,038.2 | 10,629.0 | 14,205.0 | 5,381.4 | 3,603.8 | 3,362.8 | 12,966.4 |
| 2005 | 88,608.9 | 0.0 | 0.0 | 0.0 | 541.4 | 1,696.6 | 1,924.7 | 5,411.8 | 8,479.7 | 16,102.0 | 12,126.0 | 9,782.6 | 11,859.1 | 4,359.0 | 3,088.4 | 13,237.7 |
| 2006 | 83,334.1 | 0.0 | 0.0 | 0.0 | 239.4 | 1,825.9 | 2,738.9 | 3,899.5 | 6,503.7 | 9,517.9 | 14,841.2 | 11,078.3 | 7,593.9 | 9,127.1 | 3,627.4 | 12,341.0 |
| 2007 | 81,303.3 | 0.0 | 0.0 | 0.0 | 720.6 | 854.6 | 3,156.0 | 6,466.4 | 4,702.5 | 7,459.3 | 8,566.0 | 13,872.3 | 8,859.3 | 6,191.5 | 7,694.7 | 12,760.2 |
| 2008 | 82,260.3 | 0.0 | 0.0 | 0.0 | 374.6 | 2,953.4 | 1,696.1 | 8,630.1 | 8,218.0 | 5,694.7 | 7,364.2 | 8,004.0 | 10,909.3 | 7,193.3 | 5,251.1 | 15,971.6 |
| 2009 | 77,617.0 | 0.0 | 0.0 | 0.0 | 380.7 | 1,302.9 | 5,635.3 | 3,912.6 | 10,078.2 | 9,495.1 | 5,280.3 | 6,237.8 | 5,891.7 | 8,247.6 | 5,703.9 | 15,450.9 |
| 2010 | 77,141.8 | 0.0 | 0.0 | 0.0 | 194.3 | 1,328.9 | 2,578.7 | 12,776.1 | 4,389.7 | 10,354.8 | 8,687.3 | 4,813.7 | 4,605.5 | 4,578.1 | 6,745.5 | 16,089.2 |
| 2011 | 73,124.8 | 0.0 | 0.0 | 0.0 | 382.4 | 676.6 | 2,399.1 | 5,637.5 | 14,259.9 | 4,773.2 | 9,319.1 | 7,077.3 | 3,653.2 | 3,573.7 | 3,728.1 | 17,644.6 |
| 2012 | 74,447.4 | 0.0 | 0.0 | 0.0 | 189.6 | 1,384.9 | 1,272.5 | 5,780.6 | 7,169.3 | 16,366.1 | 4,775.0 | 8,609.2 | 5,946.6 | 2,905.1 | 3,116.4 | 16,932.0 |
| 2013 | 69,022.6 | 0.0 | 0.0 | 0.0 | 245.2 | 662.8 | 2,424.9 | 2,807.3 | 6,617.6 | 7,829.1 | 15,059.8 | 4,246.9 | 6,925.2 | 4,738.4 | 2,410.8 | 15,054.6 |
| 2014 | 63,770.1 | 0.0 | 0.0 | 0.0 | 210.0 | 894.8 | 1,036.5 | 4,967.1 | 3,117.6 | 7,244.5 | 7,014.1 | 12,914.4 | 3,381.0 | 5,408.1 | 3,949.5 | 13,632.4 |
| 2015 | 55,164.2 | 0.0 | 0.0 | 0.0 | 771.2 | 914.9 | 1,774.0 | 2,403.1 | 5,837.1 | 3,601.3 | 6,345.4 | 5,832.8 | 10,147.0 | 2,362.4 | 4,037.9 | 11,137.1 |
| 2016 | 57,033.9 | 0.0 | 0.0 | 0.0 | 106.7 | 2,785.1 | 1,628.9 | 3,985.9 | 3,022.2 | 6,735.8 | 3,659.8 | 6,181.5 | 4,921.0 | 8,573.5 | 2,076.9 | 13,356.6 |
| 2017 | 50,345.7 | 0.0 | 0.0 | 0.0 | 193.7 | 472.1 | 4,783.9 | 3,412.6 | 4,048.3 | 2,932.0 | 6,131.8 | 3,069.3 | 4,618.4 | 3,742.0 | 6,753.8 | 10,187.7 |

Table B7.15. Estimates of age-specific female spawning stock biomass (mt) by year for Stock 2 (DE Bay/Hudson River stock).

| Year | Total | 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+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 18,680.3 | 0.0 | 0.0 | 0.0 | 100.7 | 261.2 | 339.5 | 711.2 | 877.2 | 931.7 | 1,224.6 | 1,401.1 | 1,234.1 | 1,307.9 | 1,257.5 | 9,033.8 |
| 1983 | 14,613.7 | 0.0 | 0.0 | 0.0 | 74.0 | 399.7 | 391.0 | 506.8 | 669.7 | 795.9 | 907.5 | 992.2 | 978.4 | 986.9 | 980.5 | 6,931.1 |
| 1984 | 13,193.6 | 0.0 | 0.0 | 0.0 | 93.9 | 333.6 | 641.6 | 867.8 | 583.7 | 715.6 | 726.1 | 734.0 | 910.5 | 829.4 | 819.5 | 5,937.9 |
| 1985 | 12,542.9 | 0.0 | 0.0 | 0.0 | 77.1 | 363.9 | 577.1 | 1,482.6 | 941.1 | 704.1 | 663.5 | 694.2 | 703.5 | 742.4 | 702.4 | 4,891.0 |
| 1986 | 9,880.3 | 0.0 | 0.0 | 0.0 | 132.7 | 263.0 | 560.0 | 984.4 | 1,398.4 | 828.8 | 503.1 | 510.2 | 525.4 | 502.5 | 480.6 | 3,191.2 |
| 1987 | 10,579.6 | 0.0 | 0.0 | 0.0 | 149.5 | 457.8 | 395.1 | 1,117.5 | 1,090.9 | 1,470.5 | 789.5 | 484.8 | 499.9 | 472.0 | 448.1 | 3,204.1 |
| 1988 | 11,787.4 | 0.0 | 0.0 | 0.0 | 124.3 | 630.7 | 805.1 | 940.3 | 1,367.7 | 1,235.0 | 1,308.2 | 862.1 | 537.1 | 469.6 | 439.8 | 3,067.6 |
| 1989 | 14,573.9 | 0.0 | 0.0 | 0.0 | 112.7 | 517.4 | 1,113.7 | 1,872.5 | 1,301.6 | 1,752.5 | 1,571.9 | 1,561.9 | 843.3 | 505.2 | 436.3 | 2,984.7 |
| 1990 | 14,626.7 | 0.0 | 0.0 | 0.0 | 165.2 | 382.7 | 816.9 | 2,128.5 | 2,056.6 | 1,300.5 | 1,546.8 | 1,311.0 | 1,447.6 | 700.5 | 393.3 | 2,377.1 |
| 1991 | 15,627.8 | 0.0 | 0.0 | 0.0 | 248.2 | 628.4 | 589.6 | 1,692.9 | 2,269.8 | 2,163.0 | 1,112.3 | 1,743.6 | 1,077.4 | 1,234.0 | 599.1 | 2,269.6 |
| 1992 | 18,863.8 | 0.0 | 0.0 | 0.0 | 303.1 | 976.4 | 1,032.0 | 1,428.1 | 1,894.1 | 2,579.2 | 2,078.8 | 1,231.0 | 1,821.5 | 1,201.4 | 1,273.8 | 3,044.3 |
| 1993 | 19,637.5 | 0.0 | 0.0 | 0.0 | 324.5 | 1,207.2 | 1,485.7 | 2,198.7 | 1,700.3 | 2,110.0 | 2,338.4 | 1,870.2 | 1,094.7 | 1,413.1 | 982.3 | 2,912.4 |
| 1994 | 21,977.1 | 0.0 | 0.0 | 0.0 | 350.6 | 1,305.3 | 1,899.5 | 3,284.5 | 2,647.8 | 1,848.2 | 1,871.7 | 2,200.0 | 1,633.8 | 928.2 | 1,121.5 | 2,886.1 |
| 1995 | 24,683.4 | 0.0 | 0.0 | 0.0 | 392.4 | 1,302.9 | 2,053.2 | 4,479.1 | 3,832.0 | 2,953.0 | 1,811.9 | 1,460.3 | 1,729.6 | 1,274.1 | 698.0 | 2,696.8 |
| 1996 | 28,654.9 | 0.0 | 0.0 | 0.0 | 465.6 | 1,514.5 | 2,293.6 | 5,082.4 | 5,239.7 | 4,142.7 | 2,619.3 | 1,390.1 | 1,224.3 | 1,340.9 | 947.7 | 2,393.9 |
| 1997 | 27,991.1 | 0.0 | 0.0 | 0.0 | 1,187.3 | 1,642.5 | 2,072.3 | 3,871.5 | 4,078.9 | 4,476.8 | 3,424.9 | 1,965.1 | 982.0 | 978.7 | 984.4 | 2,326.9 |
| 1998 | 27,950.3 | 0.0 | 0.0 | 0.0 | 447.7 | 3,337.5 | 2,008.0 | 3,859.2 | 3,856.1 | 4,106.4 | 3,288.9 | 2,218.7 | 1,381.7 | 723.5 | 685.8 | 2,037.1 |
| 1999 | 28,067.1 | 0.0 | 0.0 | 0.0 | 554.0 | 1,436.5 | 3,926.6 | 3,288.7 | 3,563.8 | 3,800.4 | 3,452.1 | 2,676.3 | 1,704.4 | 1,050.0 | 562.7 | 2,051.7 |
| 2000 | 33,960.1 | 0.0 | 0.0 | 0.0 | 553.2 | 1,936.5 | 2,244.3 | 8,422.3 | 3,923.1 | 4,042.0 | 3,123.8 | 2,977.4 | 2,303.9 | 1,527.8 | 878.7 | 2,027.1 |
| 2001 | 37,193.0 | 0.0 | 0.0 | 0.0 | 393.7 | 2,147.6 | 3,443.0 | 4,955.8 | 9,599.0 | 4,410.9 | 3,417.2 | 2,569.4 | 1,943.4 | 1,650.4 | 1,037.3 | 1,625.4 |
| 2002 | 41,689.0 | 0.0 | 0.0 | 0.0 | 402.9 | 1,376.1 | 3,509.1 | 7,053.6 | 5,677.2 | 10,007.1 | 3,820.1 | 2,763.4 | 2,024.5 | 1,649.1 | 1,307.7 | 2,098.2 |
| 2003 | 42,151.8 | 0.0 | 0.0 | 0.0 | 339.2 | 1,510.9 | 2,153.8 | 6,855.8 | 7,293.6 | 5,528.7 | 8,440.1 | 3,002.8 | 1,994.8 | 1,533.0 | 1,241.3 | 2,258.0 |
| 2004 | 40,668.4 | 0.0 | 0.0 | 0.0 | 456.6 | 1,433.9 | 2,369.4 | 4,186.1 | 7,088.7 | 7,134.1 | 4,432.3 | 6,593.4 | 2,157.9 | 1,455.9 | 1,087.0 | 2,273.2 |
| 2005 | 39,793.7 | 0.0 | 0.0 | 0.0 | 539.2 | 1,811.1 | 2,202.5 | 4,576.0 | 4,445.8 | 7,005.5 | 5,644.7 | 3,436.4 | 5,065.7 | 1,649.9 | 1,073.3 | 2,343.7 |
| 2006 | 36,998.3 | 0.0 | 0.0 | 0.0 | 296.7 | 1,874.9 | 2,605.0 | 3,803.0 | 4,657.7 | 4,328.8 | 5,494.2 | 4,354.6 | 2,462.7 | 3,692.1 | 1,184.9 | 2,243.7 |
| 2007 | 35,345.7 | 0.0 | 0.0 | 0.0 | 581.4 | 1,092.3 | 2,881.9 | 5,206.8 | 3,823.1 | 4,530.2 | 3,218.8 | 4,196.5 | 3,106.0 | 1,835.6 | 2,592.1 | 2,281.0 |
| 2008 | 37,413.8 | 0.0 | 0.0 | 0.0 | 308.8 | 2,471.4 | 1,945.4 | 6,758.1 | 5,621.7 | 4,016.2 | 3,793.7 | 2,526.9 | 3,028.5 | 2,373.0 | 1,334.7 | 3,235.6 |
| 2009 | 36,751.6 | 0.0 | 0.0 | 0.0 | 281.5 | 1,113.4 | 4,238.1 | 3,870.4 | 6,808.5 | 5,764.8 | 3,259.8 | 2,798.0 | 1,772.9 | 2,239.6 | 1,677.8 | 2,926.9 |
| 2010 | 36,944.1 | 0.0 | 0.0 | 0.0 | 174.4 | 1,031.0 | 2,012.4 | 8,417.9 | 3,792.0 | 6,253.1 | 4,631.1 | 2,589.8 | 1,969.2 | 1,347.5 | 1,633.2 | 3,092.7 |
| 2011 | 33,733.8 | 0.0 | 0.0 | 0.0 | 307.0 | 630.9 | 1,679.2 | 3,805.4 | 8,095.3 | 3,638.9 | 4,878.6 | 3,247.6 | 1,850.7 | 1,476.3 | 966.2 | 3,157.8 |
| 2012 | 32,626.3 | 0.0 | 0.0 | 0.0 | 199.9 | 1,153.9 | 1,064.8 | 3,466.6 | 4,102.4 | 8,031.9 | 3,075.8 | 3,772.1 | 2,495.2 | 1,380.0 | 1,099.9 | 2,783.8 |
| 2013 | 29,322.0 | 0.0 | 0.0 | 0.0 | 216.4 | 733.6 | 1,846.4 | 2,057.6 | 3,448.7 | 3,968.0 | 6,393.1 | 2,341.0 | 2,835.6 | 1,905.4 | 1,000.2 | 2,576.0 |
| 2014 | 24,377.1 | 0.0 | 0.0 | 0.0 | 301.3 | 803.1 | 999.4 | 3,122.8 | 1,846.6 | 3,096.0 | 2,829.4 | 4,309.0 | 1,596.9 | 1,943.1 | 1,268.8 | 2,260.7 |
| 2015 | 22,027.2 | 0.0 | 0.0 | 0.0 | 318.0 | 1,379.2 | 1,456.7 | 2,031.4 | 3,187.8 | 1,886.8 | 2,337.9 | 2,004.1 | 3,146.4 | 1,062.9 | 1,259.2 | 1,956.8 |
| 2016 | 22,613.1 | 0.0 | 0.0 | 0.0 | 110.3 | 1,201.6 | 2,232.4 | 2,847.6 | 2,198.7 | 3,219.6 | 1,633.8 | 1,915.6 | 1,550.8 | 2,498.1 | 799.9 | 2,404.8 |
| 2017 | 21,347.1 | 0.0 | 0.0 | 0.0 | 174.1 | 515.7 | 1,912.0 | 4,176.6 | 2,579.3 | 1,943.2 | 2,610.7 | 1,206.5 | 1,375.2 | 1,161.4 | 1,766.2 | 1,926.2 |

Table B7.16. January-1 total biomass-at-age for Stock 1 (Chesapeake Bay stock).

| Year | Total | 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+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 3,292 | 895 | 642 | 644 | 237 | 109 | 28 | 30 | 35 | 32 | 45 | 56 | 49 | 53 | 51 | 386 |
| 1983 | 8,031 | 5,164 | 1,223 | 451 | 416 | 194 | 83 | 17 | 21 | 23 | 26 | 32 | 35 | 35 | 37 | 275 |
| 1984 | 13,910 | 5,460 | 5,002 | 2,112 | 373 | 353 | 165 | 73 | 13 | 16 | 18 | 21 | 26 | 26 | 27 | 225 |
| 1985 | 14,465 | 971 | 4,482 | 5,678 | 2,083 | 349 | 376 | 167 | 70 | 13 | 14 | 17 | 18 | 23 | 23 | 182 |
| 1986 | 21,585 | 3,332 | 2,979 | 5,213 | 7,179 | 1,765 | 363 | 355 | 160 | 55 | 10 | 11 | 13 | 14 | 15 | 119 |
| 1987 | 35,929 | 5,961 | 5,920 | 7,300 | 6,130 | 7,777 | 1,782 | 375 | 338 | 139 | 49 | 9 | 10 | 11 | 12 | 117 |
| 1988 | 57,383 | 13,979 | 8,761 | 8,401 | 8,648 | 6,866 | 7,761 | 1,944 | 387 | 325 | 122 | 50 | 9 | 10 | 10 | 109 |
| 1989 | 68,731 | 7,198 | 12,091 | 10,944 | 9,056 | 9,058 | 7,714 | 9,210 | 2,382 | 416 | 363 | 127 | 51 | 9 | 9 | 102 |
| 1990 | 77,930 | 3,290 | 12,934 | 11,734 | 10,427 | 9,434 | 9,674 | 7,831 | 9,363 | 2,246 | 384 | 352 | 131 | 43 | 8 | 78 |
| 1991 | 99,955 | 10,857 | 12,223 | 18,566 | 11,934 | 10,634 | 8,341 | 9,450 | 7,045 | 8,237 | 1,795 | 382 | 272 | 110 | 37 | 72 |
| 1992 | 116,192 | 3,359 | 11,523 | 25,004 | 17,200 | 13,039 | 10,537 | 9,343 | 9,281 | 6,624 | 7,527 | 1,818 | 423 | 280 | 109 | 123 |
| 1993 | 124,072 | 2,178 | 8,245 | 14,549 | 23,127 | 17,521 | 12,379 | 11,030 | 10,332 | 8,833 | 6,156 | 7,062 | 1,832 | 367 | 274 | 184 |
| 1994 | 181,712 | 39,364 | 10,555 | 17,141 | 16,412 | 23,848 | 17,604 | 12,862 | 11,615 | 9,790 | 8,060 | 5,789 | 6,405 | 1,597 | 299 | 373 |
| 1995 | 221,722 | 31,086 | 37,086 | 23,425 | 18,229 | 16,535 | 23,779 | 18,925 | 13,448 | 11,307 | 9,276 | 6,538 | 4,962 | 5,321 | 1,308 | 497 |
| 1996 | 248,705 | 16,716 | 37,654 | 46,342 | 21,737 | 17,205 | 16,985 | 26,512 | 20,491 | 12,562 | 10,031 | 7,759 | 5,343 | 3,838 | 4,089 | 1,441 |
| 1997 | 264,842 | 16,681 | 23,909 | 39,021 | 54,356 | 21,458 | 15,884 | 15,893 | 23,267 | 16,695 | 10,994 | 8,291 | 5,832 | 4,723 | 3,155 | 4,682 |
| 1998 | 278,946 | 46,686 | 31,909 | 35,320 | 27,017 | 41,074 | 15,518 | 12,763 | 12,325 | 16,798 | 11,794 | 7,877 | 6,212 | 4,557 | 3,746 | 5,350 |
| 1999 | 337,684 | 98,672 | 34,796 | 47,072 | 30,084 | 21,140 | 26,889 | 11,446 | 10,510 | 10,460 | 14,894 | 9,620 | 5,856 | 4,854 | 3,746 | 7,645 |
| 2000 | 271,279 | 42,408 | 28,270 | 29,500 | 36,089 | 23,633 | 17,989 | 23,908 | 10,583 | 9,180 | 8,590 | 12,889 | 8,644 | 5,454 | 4,292 | 9,850 |
| 2001 | 229,434 | 21,728 | 14,066 | 19,179 | 22,970 | 31,262 | 22,982 | 17,850 | 23,813 | 10,355 | 8,260 | 7,202 | 9,715 | 6,948 | 4,369 | 8,734 |
| 2002 | 214,172 | 11,496 | 13,597 | 12,025 | 17,798 | 19,999 | 30,274 | 23,017 | 17,866 | 21,326 | 9,201 | 6,860 | 6,103 | 7,804 | 5,650 | 11,158 |
| 2003 | 209,154 | 5,576 | 18,564 | 17,161 | 12,898 | 15,344 | 17,572 | 28,017 | 20,750 | 15,705 | 18,846 | 7,935 | 5,647 | 5,146 | 7,134 | 12,858 |
| 2004 | 247,495 | 53,617 | 5,943 | 24,768 | 20,266 | 11,846 | 13,989 | 16,011 | 24,785 | 17,582 | 12,900 | 16,014 | 6,358 | 4,463 | 4,159 | 14,793 |
| 2005 | 222,782 | 12,107 | 37,642 | 10,114 | 22,703 | 18,198 | 11,297 | 12,529 | 14,422 | 21,229 | 14,516 | 10,785 | 13,399 | 5,202 | 3,682 | 14,957 |
| 2006 | 216,143 | 17,909 | 11,429 | 35,638 | 11,391 | 21,121 | 16,422 | 9,398 | 11,331 | 12,748 | 17,961 | 12,287 | 8,844 | 11,232 | 4,416 | 14,015 |
| 2007 | 191,783 | 3,846 | 14,780 | 15,481 | 31,734 | 9,222 | 17,827 | 14,526 | 7,989 | 9,757 | 10,325 | 15,129 | 10,142 | 7,361 | 9,184 | 14,481 |
| 2008 | 203,994 | 18,004 | 5,589 | 17,922 | 16,717 | 31,418 | 9,455 | 19,070 | 14,260 | 7,501 | 8,835 | 8,914 | 12,892 | 8,796 | 6,463 | 18,157 |
| 2009 | 196,521 | 11,137 | 17,167 | 9,054 | 17,513 | 14,642 | 32,203 | 9,251 | 18,115 | 12,552 | 6,376 | 7,078 | 6,947 | 10,041 | 6,987 | 17,458 |
| 2010 | 181,470 | 9,344 | 9,683 | 19,902 | 8,901 | 14,671 | 14,167 | 29,907 | 7,787 | 14,063 | 10,533 | 5,321 | 5,392 | 5,526 | 8,189 | 18,083 |
| 2011 | 167,990 | 12,677 | 9,807 | 9,763 | 17,452 | 7,481 | 13,616 | 13,432 | 25,192 | 6,330 | 11,165 | 8,043 | 4,239 | 4,288 | 4,505 | 19,999 |
| 2012 | 157,560 | 10,029 | 9,826 | 12,422 | 8,366 | 15,161 | 7,141 | 13,221 | 12,078 | 21,390 | 5,584 | 9,455 | 6,634 | 3,482 | 3,704 | 19,067 |
| 2013 | 153,454 | 5,667 | 19,837 | 10,842 | 11,207 | 7,363 | 13,803 | 6,539 | 11,544 | 10,452 | 18,052 | 4,734 | 7,889 | 5,722 | 2,899 | 16,903 |
| 2014 | 193,915 | 51,301 | 5,297 | 33,316 | 9,717 | 9,688 | 6,074 | 11,677 | 5,358 | 9,319 | 8,196 | 14,045 | 3,736 | 6,341 | 4,594 | 15,255 |
| 2015 | 146,861 | 13,388 | 9,804 | 5,866 | 32,972 | 9,238 | 9,632 | 5,354 | 9,847 | 4,607 | 7,651 | 6,555 | 11,531 | 2,951 | 5,000 | 12,464 |
| 2016 | 157,085 | 26,525 | 12,394 | 6,232 | 4,889 | 30,829 | 9,404 | 9,227 | 5,089 | 8,733 | 4,245 | 6,596 | 5,470 | 10,090 | 2,417 | 14,946 |
| 2017 | 152,058 | 13,099 | 23,965 | 16,583 | 8,013 | 4,742 | 26,802 | 7,798 | 7,096 | 3,951 | 7,201 | 3,419 | 5,333 | 4,505 | 8,152 | 11,400 |

Table B7.17. January-1 total biomass-at-age for Stock 2 (Delaware Bay/Hudson River stock).

| Year | Total | 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+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 29,466 | 657 | 2,606 | 2,068 | 2,042 | 1,383 | 1,197 | 1,159 | 1,237 | 1,016 | 1,333 | 1,528 | 1,274 | 1,338 | 1,262 | 9,364 |
| 1983 | 24,424 | 1,792 | 898 | 1,915 | 1,579 | 2,051 | 1,278 | 847 | 928 | 919 | 946 | 1,045 | 1,045 | 998 | 1,002 | 7,181 |
| 1984 | 24,654 | 2,706 | 1,735 | 1,620 | 1,851 | 1,614 | 2,070 | 1,303 | 750 | 787 | 759 | 785 | 898 | 813 | 813 | 6,151 |
| 1985 | 23,169 | 293 | 2,221 | 2,020 | 1,748 | 1,929 | 1,891 | 2,260 | 1,314 | 784 | 722 | 722 | 700 | 780 | 720 | 5,065 |
| 1986 | 20,439 | 793 | 899 | 2,555 | 2,448 | 1,365 | 1,809 | 1,607 | 1,975 | 967 | 576 | 545 | 553 | 532 | 510 | 3,305 |
| 1987 | 23,434 | 1,904 | 1,409 | 2,196 | 2,972 | 2,590 | 1,334 | 1,802 | 1,482 | 1,676 | 842 | 492 | 499 | 474 | 444 | 3,318 |
| 1988 | 30,336 | 5,586 | 2,799 | 1,995 | 2,578 | 3,269 | 2,523 | 1,420 | 1,821 | 1,403 | 1,451 | 868 | 528 | 477 | 441 | 3,177 |
| 1989 | 33,749 | 2,590 | 4,830 | 3,488 | 2,133 | 2,653 | 3,580 | 2,912 | 1,695 | 1,918 | 1,544 | 1,501 | 864 | 514 | 435 | 3,091 |
| 1990 | 34,645 | 941 | 4,652 | 4,670 | 3,276 | 2,159 | 2,726 | 3,489 | 2,851 | 1,550 | 1,730 | 1,471 | 1,525 | 729 | 413 | 2,463 |
| 1991 | 41,311 | 4,606 | 3,496 | 6,674 | 4,770 | 3,378 | 1,931 | 2,674 | 3,119 | 2,471 | 1,212 | 1,678 | 1,108 | 1,244 | 597 | 2,351 |
| 1992 | 46,524 | 1,533 | 4,886 | 7,140 | 6,189 | 5,233 | 3,349 | 2,143 | 2,574 | 2,853 | 2,188 | 1,189 | 1,800 | 1,103 | 1,190 | 3,156 |
| 1993 | 47,847 | 924 | 3,760 | 6,156 | 6,599 | 6,306 | 4,936 | 3,439 | 2,290 | 2,343 | 2,518 | 1,942 | 1,130 | 1,471 | 1,014 | 3,019 |
| 1994 | 71,448 | 17,298 | 4,472 | 7,805 | 6,948 | 6,823 | 6,326 | 5,072 | 3,536 | 2,099 | 2,053 | 2,265 | 1,680 | 938 | 1,139 | 2,993 |
| 1995 | 83,485 | 9,773 | 16,287 | 9,911 | 8,316 | 7,042 | 6,816 | 6,733 | 5,164 | 3,311 | 1,893 | 1,577 | 1,831 | 1,314 | 722 | 2,798 |
| 1996 | 91,561 | 6,084 | 11,825 | 20,286 | 9,187 | 7,855 | 7,173 | 7,404 | 6,969 | 4,562 | 2,761 | 1,487 | 1,208 | 1,326 | 943 | 2,489 |
| 1997 | 95,017 | 4,925 | 8,693 | 12,209 | 23,656 | 9,004 | 7,157 | 6,542 | 6,216 | 5,352 | 3,713 | 2,107 | 1,027 | 978 | 995 | 2,442 |
| 1998 | 99,861 | 14,646 | 9,412 | 12,779 | 9,361 | 19,586 | 7,039 | 6,097 | 5,220 | 4,478 | 3,656 | 2,518 | 1,476 | 746 | 719 | 2,128 |
| 1999 | 127,723 | 42,812 | 10,905 | 13,799 | 11,988 | 7,921 | 13,579 | 5,369 | 5,029 | 4,312 | 3,754 | 2,770 | 1,720 | 1,055 | 559 | 2,149 |
| 2000 | 107,453 | 21,520 | 12,255 | 9,198 | 11,697 | 10,269 | 7,224 | 12,664 | 5,048 | 4,337 | 3,396 | 3,061 | 2,322 | 1,489 | 865 | 2,109 |
| 2001 | 92,899 | 9,295 | 7,132 | 8,274 | 7,929 | 11,082 | 10,752 | 7,555 | 12,881 | 4,890 | 3,746 | 2,682 | 2,151 | 1,732 | 1,105 | 1,695 |
| 2002 | 88,273 | 4,780 | 5,811 | 6,063 | 8,472 | 7,488 | 11,404 | 11,173 | 7,598 | 11,263 | 4,125 | 2,904 | 2,102 | 1,592 | 1,296 | 2,200 |
| 2003 | 86,524 | 2,900 | 7,712 | 7,289 | 7,163 | 7,895 | 6,946 | 10,826 | 9,907 | 6,325 | 9,079 | 3,176 | 2,111 | 1,557 | 1,276 | 2,361 |
| 2004 | 99,643 | 18,183 | 3,088 | 10,236 | 9,530 | 7,205 | 7,762 | 6,660 | 9,671 | 8,138 | 4,840 | 7,023 | 2,290 | 1,493 | 1,125 | 2,400 |
| 2005 | 89,852 | 4,183 | 12,750 | 5,218 | 10,327 | 9,266 | 7,283 | 7,158 | 5,901 | 7,812 | 6,081 | 3,580 | 5,141 | 1,631 | 1,071 | 2,451 |
| 2006 | 84,798 | 5,541 | 3,944 | 11,980 | 6,448 | 10,320 | 8,755 | 6,158 | 6,306 | 4,896 | 5,981 | 4,564 | 2,576 | 3,764 | 1,207 | 2,358 |
| 2007 | 73,606 | 1,434 | 4,567 | 5,299 | 11,709 | 5,627 | 9,171 | 7,900 | 5,072 | 5,018 | 3,495 | 4,327 | 3,194 | 1,808 | 2,589 | 2,396 |
| 2008 | 77,960 | 6,031 | 2,082 | 5,502 | 6,305 | 12,563 | 6,115 | 10,098 | 7,620 | 4,482 | 4,101 | 2,661 | 3,215 | 2,404 | 1,375 | 3,405 |
| 2009 | 76,786 | 4,905 | 5,744 | 3,349 | 5,905 | 5,939 | 13,513 | 6,112 | 9,455 | 6,412 | 3,536 | 2,999 | 1,878 | 2,259 | 1,720 | 3,061 |
| 2010 | 71,220 | 3,427 | 4,261 | 6,623 | 3,644 | 5,418 | 6,201 | 13,231 | 5,216 | 7,155 | 5,045 | 2,705 | 2,071 | 1,347 | 1,659 | 3,217 |
| 2011 | 68,333 | 7,672 | 3,592 | 4,267 | 6,400 | 3,324 | 5,355 | 6,104 | 11,117 | 4,073 | 5,255 | 3,488 | 1,929 | 1,467 | 977 | 3,313 |
| 2012 | 60,065 | 1,725 | 5,939 | 4,516 | 4,017 | 5,993 | 3,341 | 5,315 | 5,360 | 8,848 | 3,232 | 3,914 | 2,500 | 1,370 | 1,094 | 2,902 |
| 2013 | 56,999 | 2,436 | 3,408 | 6,516 | 4,515 | 3,889 | 5,930 | 3,247 | 4,706 | 4,490 | 6,904 | 2,467 | 2,902 | 1,906 | 1,006 | 2,677 |
| 2014 | 65,970 | 19,096 | 2,273 | 5,659 | 6,343 | 4,116 | 3,270 | 4,922 | 2,469 | 3,366 | 2,976 | 4,430 | 1,585 | 1,887 | 1,235 | 2,341 |
| 2015 | 52,808 | 7,647 | 3,645 | 2,502 | 6,211 | 6,656 | 4,473 | 3,077 | 4,223 | 2,053 | 2,545 | 2,131 | 3,213 | 1,100 | 1,305 | 2,027 |
| 2016 | 57,567 | 10,380 | 7,072 | 2,303 | 2,306 | 6,354 | 7,295 | 4,488 | 2,914 | 3,554 | 1,712 | 1,935 | 1,549 | 2,435 | 779 | 2,491 |
| 2017 | 61,747 | 8,376 | 9,368 | 9,413 | 3,291 | 2,480 | 6,083 | 6,526 | 3,568 | 2,235 | 2,772 | 1,272 | 1,427 | 1,158 | 1,784 | 1,995 |

Table B7.18. Sensitivity analysis results for 2018 non-migration SCA assessment model.

| | 2018 Base model | | Continuity | | Quasi-continuity | | ESS 50% decrease | | ESS 50% increase | | Increase M after 1996 | | No adj comm. rel. | | Mean R method | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB |
| 1982 | 0.202 | 17,465 | 0.858 | 5,759 | 0.858 | 13,893 | 0.199 | 18,621 | 0.202 | 16,967 | 0.143 | 25,983 | 0.200 | 17,784 | 0.194 | 18,578 |
| 1983 | 0.153 | 14,397 | 0.153 | 4,719 | 0.139 | 11,070 | 0.151 | 15,482 | 0.154 | 13,940 | 0.103 | 22,519 | 0.150 | 14,695 | 0.152 | 15,333 |
| 1984 | 0.071 | 14,518 | 0.162 | 5,294 | 0.078 | 11,947 | 0.064 | 15,650 | 0.075 | 14,015 | 0.043 | 23,636 | 0.068 | 14,860 | 0.070 | 15,356 |
| 1985 | 0.193 | 15,204 | 0.099 | 6,335 | 0.208 | 14,010 | 0.169 | 16,462 | 0.212 | 14,606 | 0.116 | 25,350 | 0.187 | 15,601 | 0.199 | 15,953 |
| 1986 | 0.054 | 14,011 | 0.062 | 6,568 | 0.060 | 13,582 | 0.048 | 15,363 | 0.058 | 13,293 | 0.031 | 24,543 | 0.052 | 14,451 | 0.053 | 14,491 |
| 1987 | 0.032 | 17,298 | 0.030 | 7,891 | 0.034 | 16,646 | 0.029 | 18,947 | 0.034 | 16,413 | 0.018 | 30,569 | 0.031 | 17,879 | 0.031 | 17,830 |
| 1988 | 0.038 | 23,022 | 0.046 | 11,254 | 0.041 | 23,859 | 0.035 | 25,188 | 0.040 | 21,875 | 0.021 | 40,673 | 0.037 | 23,840 | 0.037 | 23,657 |
| 1989 | 0.049 | 34,681 | 0.048 | 18,190 | 0.053 | 38,140 | 0.046 | 37,753 | 0.052 | 33,042 | 0.028 | 61,441 | 0.048 | 35,968 | 0.048 | 35,582 |
| 1990 | 0.071 | 40,426 | 0.086 | 22,619 | 0.081 | 45,851 | 0.062 | 43,808 | 0.077 | 38,616 | 0.036 | 72,351 | 0.067 | 42,013 | 0.068 | 41,489 |
| 1991 | 0.101 | 47,252 | 0.073 | 27,350 | 0.089 | 54,218 | 0.089 | 51,029 | 0.109 | 45,210 | 0.048 | 86,620 | 0.095 | 49,248 | 0.097 | 48,573 |
| 1992 | 0.121 | 59,746 | 0.058 | 33,971 | 0.104 | 65,403 | 0.107 | 64,400 | 0.130 | 57,188 | 0.056 | 113,559 | 0.119 | 62,234 | 0.117 | 61,513 |
| 1993 | 0.095 | 66,807 | 0.077 | 40,856 | 0.083 | 75,033 | 0.085 | 71,486 | 0.102 | 64,164 | 0.043 | 131,842 | 0.092 | 69,012 | 0.092 | 68,847 |
| 1994 | 0.123 | 74,994 | 0.091 | 46,612 | 0.105 | 83,314 | 0.112 | 79,668 | 0.132 | 72,306 | 0.054 | 152,218 | 0.121 | 77,085 | 0.120 | 77,263 |
| 1995 | 0.223 | 80,943 | 0.126 | 57,954 | 0.190 | 100,383 | 0.201 | 85,236 | 0.238 | 78,393 | 0.092 | 171,173 | 0.216 | 82,750 | 0.217 | 83,302 |
| 1996 | 0.290 | 90,559 | 0.115 | 65,462 | 0.243 | 106,224 | 0.268 | 94,846 | 0.306 | 87,882 | 0.114 | 207,437 | 0.291 | 92,245 | 0.282 | 93,063 |
| 1997 | 0.225 | 86,031 | 0.194 | 66,710 | 0.172 | 101,519 | 0.226 | 90,057 | 0.226 | 83,445 | 0.105 | 210,476 | 0.231 | 87,127 | 0.221 | 88,395 |
| 1998 | 0.233 | 80,682 | 0.176 | 57,693 | 0.179 | 92,848 | 0.236 | 82,934 | 0.234 | 78,952 | 0.113 | 188,049 | 0.236 | 81,081 | 0.229 | 82,589 |
| 1999 | 0.215 | 80,339 | 0.151 | 57,868 | 0.166 | 94,995 | 0.220 | 81,746 | 0.216 | 78,963 | 0.108 | 180,244 | 0.216 | 80,687 | 0.212 | 82,102 |
| 2000 | 0.213 | 92,760 | 0.191 | 67,623 | 0.172 | 111,810 | 0.219 | 92,964 | 0.213 | 91,832 | 0.111 | 196,469 | 0.212 | 93,423 | 0.210 | 94,499 |
| 2001 | 0.211 | 98,063 | 0.180 | 67,540 | 0.168 | 115,930 | 0.216 | 96,858 | 0.211 | 97,829 | 0.113 | 194,084 | 0.210 | 99,254 | 0.208 | 99,436 |
| 2002 | 0.227 | 110,108 | 0.171 | 74,859 | 0.179 | 130,481 | 0.232 | 107,847 | 0.226 | 110,272 | 0.126 | 207,537 | 0.226 | 111,709 | 0.224 | 111,476 |
| 2003 | 0.242 | 112,431 | 0.199 | 77,385 | 0.195 | 133,961 | 0.248 | 109,526 | 0.242 | 112,907 | 0.136 | 203,259 | 0.239 | 114,325 | 0.240 | 113,638 |
| 2004 | 0.269 | 108,533 | 0.233 | 75,514 | 0.219 | 130,905 | 0.276 | 105,410 | 0.268 | 109,154 | 0.153 | 190,797 | 0.266 | 110,792 | 0.266 | 109,558 |
| 2005 | 0.264 | 107,706 | 0.244 | 75,878 | 0.221 | 132,254 | 0.272 | 104,471 | 0.263 | 108,392 | 0.151 | 186,797 | 0.261 | 110,312 | 0.261 | 108,663 |
| 2006 | 0.310 | 101,725 | 0.277 | 70,859 | 0.251 | 125,478 | 0.321 | 98,435 | 0.308 | 102,467 | 0.177 | 174,189 | 0.305 | 104,487 | 0.307 | 102,553 |
| 2007 | 0.229 | 100,084 | 0.241 | 69,165 | 0.192 | 124,502 | 0.238 | 96,416 | 0.228 | 100,965 | 0.132 | 172,185 | 0.227 | 103,251 | 0.227 | 100,823 |
| 2008 | 0.242 | 106,791 | 0.242 | 68,248 | 0.199 | 127,239 | 0.252 | 102,517 | 0.240 | 107,908 | 0.141 | 179,891 | 0.237 | 110,315 | 0.240 | 107,371 |
| 2009 | 0.234 | 106,473 | 0.196 | 67,339 | 0.197 | 128,421 | 0.243 | 101,650 | 0.232 | 107,806 | 0.139 | 175,578 | 0.230 | 110,365 | 0.233 | 106,820 |
| 2010 | 0.272 | 106,860 | 0.188 | 66,748 | 0.219 | 125,900 | 0.283 | 101,617 | 0.271 | 108,330 | 0.165 | 172,597 | 0.269 | 110,949 | 0.272 | 106,953 |
| 2011 | 0.275 | 100,557 | 0.224 | 67,741 | 0.224 | 123,409 | 0.284 | 95,204 | 0.274 | 102,051 | 0.168 | 160,514 | 0.268 | 104,582 | 0.276 | 100,318 |
| 2012 | 0.270 | 99,821 | 0.185 | 68,540 | 0.218 | 123,154 | 0.277 | 94,526 | 0.269 | 101,228 | 0.166 | 157,484 | 0.275 | 104,190 | 0.272 | 99,130 |
| 2013 | 0.363 | 90,175 | 0.240 | 65,497 | 0.279 | 113,324 | 0.371 | 85,624 | 0.364 | 91,265 | 0.223 | 140,778 | 0.358 | 93,439 | 0.369 | 89,022 |
| 2014 | 0.279 | 80,586 | 0.214 | 63,491 | 0.226 | 105,849 | 0.283 | 76,897 | 0.281 | 81,260 | 0.169 | 127,969 | 0.278 | 83,675 | 0.285 | 78,908 |
| 2015 | 0.239 | 72,721 | 0.148 | 59,609 | 0.184 | 98,060 | 0.242 | 70,177 | 0.241 | 72,933 | 0.147 | 115,067 | 0.239 | 75,424 | 0.245 | 70,587 |
| 2016 | 0.272 | 76,164 | 0.181 | 63,642 | 0.216 | 101,816 | 0.274 | 74,142 | 0.274 | 76,045 | 0.169 | 118,089 | 0.272 | 78,720 | 0.280 | 73,381 |
| 2017 | 0.297 | 70,992 | - | - | - | - | 0.301 | 69,605 | 0.299 | 70,623 | 0.187 | 109,089 | 0.293 | 73,061 | 0.308 | 67,765 |

Table B7.19. Comparison of continuity run and updated base run of the non-migration SCA model.

| Data Source | Continuity Run | Bridge Run | 2018 Base |
|---|---|---|---|
| Recreational data | Uncalibrated MRIP | Calibrated MRIP | Calibrated MRIP |
| Terminal year | 2016 | 2016 | 2017 |
| Fleets | 3:<br>- Ches. Bay (Rec harvest, dead rel., comm. harvest); starting ESS: 32<br>- Coast (Rec harvest, dead rel., comm. harvest); starting ESS: 47<br>- Dead comm. releases (CB and Ocean); starting ESS: 23 | | 2:<br>- Ches. Bay (Rec harvest, dead rel., comm. Harvest, comm dead rel.); starting ESS: 50<br>- Coast (Rec harvest, dead rel., comm. Harvest, comm dead rel.); starting ESS: 50 |
| Selectivity blocks<br><br>Selectivities:<br>T = Thompson, G = Gompertz, E = Exponential | -Fleet 1 (CB): 1982-1984 (T), 1985-1989 (T), 1990-1995 (T), 1996-2016 (T)<br><br>-Fleet 2 (coast): 1982-1984 (T), 1985-1989 (G), 1990-1996 (G), 1997-2016 (G)<br><br>- Fleet 3 (dead comm rel): 1982-1984 (E), 1985-1989 (T), 1990-1996 (T), 1997-2002 (T), 2003-2016 (T) | | -Fleet 1 (CB): 1982-1984 (T), 1985-1989 (T), 1990-1995 (T), 1996-2017 (T)<br><br>-Fleet 2 (coast): 1982-1984 (G), 1985-1989 (G), 1990-1996 (G), 1997-2017 (G) |
| Commercial dead discard method | Raw tags | | Smoothed and adjusted tags |
| Age aggregated indices | 9:<br>- NY YOY<br>- NJ YOY<br>- MD YOY<br>- VA YOY<br>- NY Age 1<br>- MD Age 1<br>- MRIP<br>- CT Trawl<br>- NEFSC Trawl | | 6:<br>- NY YOY<br>- NJ YOY<br>- MD YOY<br>- Composite YOY<br>- NY Age 1<br>- MD Age 1 |

Table B7.19 (continued).

| Data Source | Continuity Run Bridge Run | 2018 Base |
|---|---|---|
| Age composition surveys (with starting ESS) | 5:<br>- NY OHS Trawl (19)<br>- NJ Trawl (5)<br>- MD SSN (18)<br>- DE SSN (25)<br>- VA Poundnet (8) | 8:<br>- NY OHS Trawl (19.1)<br>- NJ Trawl (4.8)<br>- MD SSN (17.6)<br>- DE SSN (25.2)<br>- MRIP (16.8)<br>- CT Trawl (16.8)<br>- DE 30' Trawl (16.8)<br>- ChesMMAP Trawl (16.8) |
| Female maturity | NEFSC (2013) | Guiliano (2017) |
| Female sex ratio | NEFSC (2013) | NEFSC (2013) |
| Natural mortality | NEFSC (2013) | NEFSC (2013) |
| Plus group | 13+ | 15+ |

Table B7.20. Average total fishing mortality from the non-migration SCA model for various age ranges and weighting schemes.

| Year | Unweighted Avg. 3-8 | Unweighted Avg. 8-11 | N-weighted Avg. 3-8 | N-weighted Avg. 7-11 | Unweighted Avg 7-13 | N-weighted Avg 7-13 |
|---|---|---|---|---|---|---|
| 1982 | 0.136 | 0.169 | 0.103 | 0.168 | 0.169 | 0.168 |
| 1983 | 0.118 | 0.139 | 0.100 | 0.138 | 0.139 | 0.139 |
| 1984 | 0.061 | 0.059 | 0.063 | 0.059 | 0.059 | 0.059 |
| 1985 | 0.089 | 0.169 | 0.043 | 0.147 | 0.169 | 0.151 |
| 1986 | 0.026 | 0.046 | 0.015 | 0.041 | 0.046 | 0.041 |
| 1987 | 0.015 | 0.026 | 0.009 | 0.024 | 0.026 | 0.024 |
| 1988 | 0.019 | 0.032 | 0.013 | 0.029 | 0.032 | 0.029 |
| 1989 | 0.023 | 0.041 | 0.016 | 0.036 | 0.041 | 0.036 |
| 1990 | 0.043 | 0.056 | 0.031 | 0.054 | 0.056 | 0.055 |
| 1991 | 0.053 | 0.076 | 0.036 | 0.073 | 0.077 | 0.073 |
| 1992 | 0.062 | 0.091 | 0.041 | 0.087 | 0.093 | 0.088 |
| 1993 | 0.051 | 0.073 | 0.037 | 0.071 | 0.074 | 0.071 |
| 1994 | 0.067 | 0.095 | 0.050 | 0.092 | 0.097 | 0.093 |
| 1995 | 0.111 | 0.170 | 0.078 | 0.160 | 0.173 | 0.165 |
| 1996 | 0.118 | 0.219 | 0.065 | 0.194 | 0.221 | 0.201 |
| 1997 | 0.128 | 0.205 | 0.084 | 0.194 | 0.205 | 0.196 |
| 1998 | 0.129 | 0.213 | 0.083 | 0.200 | 0.212 | 0.203 |
| 1999 | 0.123 | 0.200 | 0.080 | 0.187 | 0.199 | 0.189 |
| 2000 | 0.124 | 0.200 | 0.096 | 0.182 | 0.199 | 0.184 |
| 2001 | 0.117 | 0.195 | 0.094 | 0.180 | 0.195 | 0.182 |
| 2002 | 0.127 | 0.211 | 0.102 | 0.195 | 0.210 | 0.196 |
| 2003 | 0.141 | 0.228 | 0.103 | 0.212 | 0.227 | 0.214 |
| 2004 | 0.152 | 0.250 | 0.100 | 0.237 | 0.249 | 0.239 |
| 2005 | 0.146 | 0.244 | 0.103 | 0.231 | 0.244 | 0.234 |
| 2006 | 0.176 | 0.290 | 0.106 | 0.276 | 0.289 | 0.280 |
| 2007 | 0.131 | 0.215 | 0.092 | 0.200 | 0.214 | 0.203 |
| 2008 | 0.133 | 0.224 | 0.103 | 0.205 | 0.224 | 0.209 |
| 2009 | 0.138 | 0.221 | 0.119 | 0.208 | 0.220 | 0.211 |
| 2010 | 0.158 | 0.257 | 0.126 | 0.235 | 0.256 | 0.238 |
| 2011 | 0.158 | 0.260 | 0.135 | 0.243 | 0.259 | 0.245 |
| 2012 | 0.160 | 0.257 | 0.121 | 0.245 | 0.256 | 0.247 |
| 2013 | 0.206 | 0.343 | 0.132 | 0.328 | 0.342 | 0.333 |
| 2014 | 0.173 | 0.271 | 0.101 | 0.258 | 0.269 | 0.261 |
| 2015 | 0.148 | 0.232 | 0.113 | 0.221 | 0.231 | 0.225 |
| 2016 | 0.176 | 0.268 | 0.140 | 0.255 | 0.266 | 0.258 |
| 2017 | 0.173 | 0.287 | 0.110 | 0.263 | 0.286 | 0.267 |

Table B7.21. Female SSB, recruitment, and abundance estimates from the non-migration SCA model.

| Year | Female SSB (mt) | Recruitment (Millions of age-1 fish) | Total Abundance (Millions of fish) | Total Age 8+ Abundance (Millions of fish) |
|---|---|---|---|---|
| 1982 | 19,112 | 37.9 | 56.5 | 1.8 |
| 1983 | 16,090 | 75.4 | 98.4 | 1.5 |
| 1984 | 16,211 | 65.6 | 103.1 | 1.3 |
| 1985 | 16,866 | 72.6 | 114.9 | 1.5 |
| 1986 | 15,369 | 69.9 | 118.0 | 1.7 |
| 1987 | 18,962 | 72.1 | 123.7 | 2.2 |
| 1988 | 25,288 | 97.0 | 152.3 | 2.6 |
| 1989 | 38,239 | 108.0 | 174.2 | 3.5 |
| 1990 | 44,866 | 126.3 | 202.3 | 5.7 |
| 1991 | 52,912 | 100.8 | 188.5 | 7.0 |
| 1992 | 67,439 | 108.0 | 194.1 | 8.2 |
| 1993 | 75,906 | 132.4 | 221.0 | 8.7 |
| 1994 | 85,180 | 283.5 | 382.1 | 9.3 |
| 1995 | 91,436 | 182.5 | 334.9 | 10.4 |
| 1996 | 101,396 | 232.2 | 378.3 | 10.7 |
| 1997 | 95,812 | 257.9 | 419.4 | 10.7 |
| 1998 | 87,835 | 144.3 | 322.2 | 10.1 |
| 1999 | 86,218 | 149.7 | 300.3 | 9.6 |
| 2000 | 97,695 | 127.0 | 267.5 | 10.0 |
| 2001 | 100,859 | 195.5 | 322.6 | 13.8 |
| 2002 | 112,163 | 224.7 | 366.7 | 14.1 |
| 2003 | 113,602 | 138.3 | 295.7 | 15.4 |
| 2004 | 109,072 | 312.2 | 449.0 | 16.5 |
| 2005 | 107,971 | 162.3 | 345.1 | 14.3 |
| 2006 | 101,869 | 136.4 | 293.2 | 12.9 |
| 2007 | 100,065 | 92.7 | 228.9 | 10.9 |
| 2008 | 106,656 | 129.2 | 242.3 | 11.7 |
| 2009 | 106,094 | 77.5 | 189.6 | 12.9 |
| 2010 | 106,261 | 104.9 | 198.0 | 11.9 |
| 2011 | 99,768 | 147.9 | 238.7 | 14.7 |
| 2012 | 98,798 | 214.4 | 316.4 | 13.2 |
| 2013 | 88,864 | 65.4 | 193.7 | 11.6 |
| 2014 | 78,999 | 92.6 | 184.9 | 8.8 |
| 2015 | 70,858 | 186.9 | 272.2 | 8.2 |
| 2016 | 73,924 | 239.6 | 351.3 | 7.1 |
| 2017 | 68,476 | 108.8 | 249.2 | 6.7 |

Table B7.22. Mohn's rho values from 7-year retrospective runs for ASAP model.

| Estimated Parameter | Mohn's Rho |
|---|---|
| Average F (age 8-13) | 0.094 |
| SSB | -0.081 |
| Jan 1 biomass | -0.049 |
| Exploitable biomass | -0.066 |
| Total stock numbers | -0.060 |
| Stock number age 1 | -0.100 |
| Stock number age 2 | -0.088 |
| Stock number age 3 | -0.069 |
| Stock number age 4 | -0.079 |
| Stock number age 5 | -0.033 |
| Stock number age 6 | -0.053 |
| Stock number age 7 | -0.060 |
| Stock number age 8 | -0.075 |
| Stock number age 9 | -0.078 |
| Stock number age 10 | -0.079 |
| Stock number age 11 | -0.080 |
| Stock number age 12 | -0.079 |
| Stock number age 13 | -0.079 |
| Stock number age 14 | -0.077 |
| Stock number age 15+ | -0.078 |

Table B8.1. Candidate models used in separate IRCR analyses of recovery matrices of striped bass tagged at ≥ 28 inches (711 mm) and ≥18 inches (457 mm) by coastal and producer area programs, and 18–28 inch (457-711 mm) male striped bass tagged in Chesapeake Bay. Analyses include model structure with seven regulatory periods, with a terminal regulatory period of 2015-2017.

| Model | Model structure | Description |
|---|---|---|
| 1 | Fy; F'y; M(2p) | Global model. F and F' estimated each year, 2 M periods |
| 2 | F88-89, F90-94, F95-99, F00-02, F03-06, F07-14, F15-17, F'y; M(2p) | Constant F for each regulatory period, F' estimated each year, 2 M periods |
| 3 | Fy, F'88-89, F'90-94, F'95-99, F'00-02, F'03-06, F'07-14, F'15-17; M(2p) | F estimated each year, constant F' for each regulatory period, 2 M periods |
| 4 | F88-89, F90-94, F95-99, F00-02, F03-06, F07-14, F15-17; F'88-89, F'90-94, F'95-99, F'00-02, F'03-06, F'07-14, F'15-17; M(2p) | Constant F for each regulatory period, constant F' for each regulatory period, 2 M periods |
| 5 | F88-89, F90-94, F95-99, F00-02, F03-06, F07-14, F15-16, F17; F'88-89, F'90-94, F'95-99, F'00-02, F'03-06, F'07-14, F'15-16, F'17; M(2p) | Constant F and F' for each regulatory period, but final regulatory period with separate estimates of F and F' for the terminal year, 2 M periods |
| 6 | F88-89, F90-94, F95-99, F00-02, F03-06, F07-14, F15, F16-17; F'88-89, F'90-94, F'95-99, F'00-02, F'03-06, F'07-14, F'15, F'16-17; M(2p) | Constant F and F' for each regulatory period, but final regulatory period modeled with separate estimates for F15 and F'15 and constant estimates for F16-17 and F'16-17, 2 M periods |

Table B8.2. Explanation of seven regulatory periods used in candidate model sets for IRCR analyses of tag recovery data. Analyses include striped bass tagged at ≥ 28 inches (711 mm) and ≥ 18 inches (457 mm) by coastal and producer area tagging programs, and 18–28 inch (457-711 mm) male striped bass tagged in Chesapeake Bay.

| Regulatory period | Explanation |
|---|---|
| 1988-1989 | Partial moratorium and large minimum size limits. |
| 1990-1994 | Interim fishery under Amendment 4: Commercial fisheries reopen in some states at 80% of historical harvest. Preferred size limit reduced to 28" on coast and 18" in Hudson and Chesapeake Bay. Combination of size limits, seasons, and bag limits used to attain target fishing mortality rate. |
| 1995-1999 | Fully recovered fishery under Amendment 5: Target F=0.33. Recreational fisheries: 20" minimum size, minimum size, 1 fish creel limit, variable season lengths in the producer areas (Chesapeake Bay, Hudson River,) and 28" 2 fish creel limit, 365 day season along the coast. Commercial fisheries: flexible quota, same size limits as the recreational fishery. Establishes quotas based on size limits and has paybacks for quota overages. Target reduced to F=0.31 in 1997, minimum size limits maintained. |
| 2000-2002 | Addendum IV to Amendment 5: reduce F on age 8 and older striped bass by 14% through creel and size limits. Credit was given to states already more conservative. |
| 2003-2006 | Amendment 6: Target F - 0.30. Coastal commercial quotas increased to 100% of historical harvest. Some states' minimum size limits increased to 28" on the coast. |
| 2007-2014 | Change in reporting rate. |
| 2015-2017 | Addendum IV to Amendment 6; establish new F reference points. |

Table B8.3. Two time periods of natural mortality (M) as estimated in the IRCR analysis of six candidate models for each striped bass tagging program. 28” = 711 mm; 18” = 457 mm.

| Tagging | Striped bass ≥ 28" | | Striped bass ≥ 18" | |
|---|---|---|---|---|
| programs | M1 | M2 | M1 | M2 |
| *Coastal programs* | | | | |
| MADFW | 1992-1998 | 1999-2017 | 1992-1998 | 1999-2017 |
| NYOHS/TRL | 1988-2004 | 2005-2017 | 1988 -1998 | 1999-2017 |
| NJDB | 1989-2002 | 2003-2017 | 1989-2001 | 2002-2017 |
| NCCOOP | 1988-1999 | 2000-2017 | 1988-1999 | 2000-2017 |
| *Producer programs* | | | | |
| HUDSON | 1988-2000 | 2001-2017 | 1988-2001 | 2002-2017 |
| DE/PA | 1993-2002 | 2003-2017 | 1993-2002 | 2003-2017 |
| MDCB | 1987-2000 | 2001-2017 | 1987-1998 | 1999-2017 |
| VARAP | 1990-1997 | 1998-2017 | 1990-1997 | 1998-2017 |

Table B8.4. Total length frequencies of striped bass tagged in 1987–2017 for coastal and producer area programs.

*Coastal Programs*

MADFW

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300-349 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 350-399 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400-449 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 450-499 | | | | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 500-549 | | | | | 2 | 5 | 12 | 1 | 0 | 1 | 3 | 0 | 0 | 2 | 2 | 4 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 4 |
| 550-599 | | | | | 7 | 28 | 33 | 29 | 17 | 8 | 7 | 2 | 2 | 19 | 4 | 13 | 0 | 1 | 2 | 1 | 0 | 1 | 6 | 0 | 3 | 2 | 0 | 2 | 1 | 5 | 9 |
| 600-649 | | | | | 27 | 59 | 60 | 42 | 57 | 21 | 27 | 9 | 16 | 50 | 19 | 10 | 3 | 12 | 12 | 15 | 6 | 10 | 2 | 0 | 10 | 5 | 2 | 3 | 1 | 28 | 21 |
| 650-699 | | | | | 18 | 119 | 89 | 68 | 74 | 45 | 37 | 16 | 55 | 89 | 58 | 21 | 26 | 40 | 39 | 35 | 23 | 39 | 27 | 14 | 13 | 21 | 14 | 13 | 16 | 124 | 35 |
| 700-749 | | | | | 35 | 102 | 97 | 73 | 93 | 38 | 79 | 11 | 75 | 143 | 99 | 60 | 93 | 65 | 64 | 53 | 59 | 76 | 68 | 42 | 59 | 47 | 58 | 22 | 32 | 174 | 86 |
| 750-799 | | | | | 56 | 106 | 80 | 72 | 61 | 26 | 60 | 13 | 51 | 142 | 93 | 51 | 167 | 118 | 80 | 60 | 69 | 78 | 75 | 89 | 96 | 55 | 54 | 43 | 49 | 103 | 92 |
| 800-849 | | | | | 83 | 159 | 78 | 52 | 69 | 27 | 32 | 11 | 24 | 74 | 81 | 37 | 154 | 164 | 139 | 83 | 61 | 84 | 85 | 76 | 131 | 123 | 82 | 90 | 55 | 77 | 62 |
| 850-899 | | | | | 79 | 151 | 81 | 19 | 32 | 19 | 28 | 13 | 8 | 35 | 45 | 15 | 98 | 92 | 121 | 68 | 72 | 62 | 87 | 44 | 98 | 133 | 84 | 95 | 70 | 63 | 24 |
| 900-949 | | | | | 45 | 91 | 85 | 10 | 14 | 5 | 19 | 4 | 10 | 20 | 19 | 13 | 54 | 37 | 65 | 48 | 71 | 48 | 76 | 30 | 45 | 101 | 86 | 84 | 68 | 54 | 18 |
| 950-999 | | | | | 25 | 38 | 37 | 7 | 13 | 7 | 12 | 5 | 6 | 14 | 18 | 5 | 24 | 19 | 35 | 19 | 50 | 35 | 48 | 17 | 28 | 36 | 40 | 59 | 42 | 55 | 18 |
| 1000-1049 | | | | | 7 | 19 | 18 | 4 | 6 | 4 | 6 | 3 | 4 | 8 | 10 | 7 | 15 | 10 | 16 | 4 | 24 | 12 | 14 | 11 | 9 | 13 | 18 | 21 | 13 | 25 | 11 |
| 1050-1099 | | | | | 2 | 5 | 3 | 0 | 2 | 1 | 6 | 0 | 1 | 1 | 8 | 2 | 15 | 5 | 5 | 2 | 7 | 7 | 10 | 4 | 7 | 4 | 2 | 16 | 1 | 2 | 0 |
| >1099 | | | | | 2 | 13 | 4 | 0 | 2 | 0 | 0 | 0 | 1 | 3 | 1 | 0 | 7 | 4 | 3 | 1 | 6 | 3 | 3 | 0 | 5 | 3 | 3 | 4 | 0 | 0 | 0 |

NYOHS (1987–2006), NYTRL (2007–2011)

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| 200-249 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| 250-299 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| 300-349 | 14 | 23 | 10 | 1 | 0 | 2 | 0 | 0 | 39 | 5 | 12 | 6 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| 350-399 | 19 | 50 | 46 | 8 | 8 | 12 | 11 | 6 | 347 | 138 | 157 | 158 | 18 | 57 | 3 | 46 | 2 | 16 | 39 | 25 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| 400-449 | 64 | 135 | 65 | 116 | 110 | 72 | 172 | 52 | 366 | 745 | 300 | 312 | 261 | 196 | 39 | 346 | 117 | 236 | 229 | 204 | 3 | 0 | 12 | 0 | 0 | | | | | | |
| 450-499 | 119 | 281 | 135 | 193 | 311 | 209 | 488 | 313 | 146 | 540 | 403 | 225 | 543 | 174 | 169 | 249 | 207 | 352 | 188 | 307 | 25 | 1 | 7 | 0 | 0 | | | | | | |
| 500-549 | 205 | 240 | 153 | 262 | 411 | 337 | 519 | 381 | 165 | 352 | 371 | 227 | 285 | 255 | 259 | 118 | 194 | 378 | 191 | 281 | 246 | 44 | 13 | 7 | 0 | | | | | | |
| 550-599 | 272 | 305 | 157 | 351 | 311 | 354 | 284 | 259 | 141 | 160 | 192 | 257 | 118 | 346 | 175 | 116 | 70 | 267 | 188 | 145 | 430 | 132 | 34 | 16 | 1 | | | | | | |
| 600-649 | 517 | 314 | 143 | 372 | 147 | 234 | 183 | 162 | 111 | 107 | 82 | 185 | 63 | 256 | 138 | 98 | 46 | 158 | 95 | 109 | 259 | 74 | 17 | 81 | 4 | | | | | | |
| 650-699 | 401 | 303 | 153 | 242 | 82 | 100 | 162 | 114 | 46 | 65 | 54 | 111 | 48 | 122 | 85 | 88 | 34 | 43 | 43 | 47 | 212 | 31 | 18 | 106 | 11 | | | | | | |
| 700-749 | 215 | 214 | 137 | 175 | 79 | 61 | 114 | 114 | 22 | 26 | 22 | 50 | 10 | 54 | 39 | 57 | 52 | 23 | 17 | 20 | 110 | 21 | 17 | 107 | 31 | | | | | | |
| 750-799 | 84 | 107 | 95 | 139 | 102 | 58 | 95 | 66 | 23 | 17 | 13 | 18 | 11 | 25 | 47 | 39 | 31 | 18 | 15 | 6 | 35 | 8 | 11 | 45 | 26 | | | | | | |
| 800-849 | 17 | 58 | 43 | 79 | 79 | 50 | 58 | 62 | 25 | 11 | 10 | 13 | 6 | 14 | 37 | 36 | 25 | 15 | 4 | 1 | 17 | 5 | 8 | 11 | 32 | | | | | | |
| 850-899 | 11 | 21 | 33 | 62 | 63 | 40 | 43 | 53 | 17 | 12 | 19 | 10 | 7 | 7 | 20 | 11 | 23 | 5 | 8 | 2 | 5 | 1 | 6 | 7 | 10 | | | | | | |
| 900-949 | 6 | 7 | 14 | 27 | 43 | 31 | 33 | 43 | 12 | 8 | 6 | 6 | 9 | 2 | 23 | 4 | 18 | 6 | 9 | 2 | 5 | 6 | 6 | 4 | 1 | | | | | | |
| 950-999 | 1 | 2 | | 9 | 18 | 17 | 18 | 25 | 10 | 5 | 9 | 8 | 6 | 6 | 11 | 5 | 4 | 2 | 3 | 1 | 2 | 1 | 1 | 3 | 3 | | | | | | |
| 1000-1049 | 0 | 1 | 2 | 1 | 5 | 7 | 9 | 24 | 11 | 3 | 11 | 1 | 4 | | 3 | 2 | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| 1050-1099 | 2 | 3 | 2 | 1 | 2 | 8 | 2 | 12 | 5 | 2 | 3 | 4 | 5 | 2 | | 2 | 2 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 1 | | | | | | |
| >1099 | 2 | 23 | 7 | 4 | 17 | 13 | 10 | 24 | 4 | 2 | 1 | 0 | 3 | 3 | 4 | 1 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |

Table B8.4 (continued).

NJDB

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300-349 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 350-399 | | | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400-449 | | | 0 | 0 | 2 | 2 | 2 | 11 | 3 | 3 | 6 | 0 | 1 | 2 | 15 | 3 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 450-499 | | | 1 | 0 | 23 | 20 | 45 | 58 | 10 | 23 | 16 | 6 | 16 | 22 | 52 | 17 | 7 | 7 | 9 | 2 | 0 | 2 | 12 | 4 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 500-549 | | | 29 | 5 | 100 | 61 | 221 | 215 | 38 | 88 | 57 | 95 | 139 | 270 | 148 | 98 | 91 | 50 | 133 | 25 | 7 | 14 | 117 | 30 | 8 | 12 | 1 | 15 | 25 | 14 | 9 |
| 550-599 | | | 156 | 37 | 82 | 152 | 570 | 545 | 139 | 178 | 79 | 208 | 435 | 698 | 506 | 243 | 357 | 127 | 342 | 190 | 29 | 169 | 376 | 116 | 17 | 41 | 20 | 52 | 93 | 27 | 12 |
| 600-649 | | | 167 | 40 | 52 | 247 | 501 | 590 | 448 | 382 | 112 | 209 | 682 | 722 | 661 | 523 | 667 | 279 | 335 | 495 | 140 | 357 | 778 | 253 | 53 | 66 | 51 | 41 | 40 | 14 | 6 |
| 650-699 | | | 78 | 15 | 24 | 188 | 214 | 488 | 524 | 561 | 70 | 148 | 385 | 395 | 363 | 518 | 428 | 448 | 143 | 469 | 395 | 294 | 535 | 379 | 118 | 22 | 81 | 16 | 20 | 14 | 2 |
| 700-749 | | | 23 | 9 | 9 | 67 | 100 | 281 | 428 | 398 | 33 | 77 | 81 | 181 | 211 | 222 | 296 | 432 | 88 | 153 | 316 | 241 | 224 | 246 | 219 | 14 | 47 | 2 | 7 | 8 | 0 |
| 750-799 | | | 12 | 3 | 6 | 17 | 14 | 81 | 170 | 213 | 19 | 28 | 29 | 66 | 190 | 85 | 206 | 272 | 59 | 65 | 119 | 146 | 92 | 103 | 225 | 5 | 18 | 1 | 1 | 4 | 0 |
| 800-849 | | | 7 | 1 | 2 | 12 | 10 | 21 | 37 | 70 | 11 | 21 | 15 | 34 | 117 | 79 | 83 | 164 | 33 | 37 | 35 | 98 | 70 | 38 | 87 | 13 | 8 | 2 | 1 | 5 | 1 |
| 850-899 | | | 1 | 0 | 0 | 3 | 4 | 10 | 17 | 24 | 8 | 14 | 11 | 5 | 46 | 28 | 35 | 60 | 14 | 18 | 34 | 59 | 26 | 17 | 24 | 7 | 9 | 0 | 0 | 3 | 0 |
| 900-949 | | | 0 | 0 | 0 | 0 | 1 | 2 | 7 | 5 | 0 | 4 | 3 | 4 | 14 | 11 | 19 | 13 | 5 | 10 | 8 | 25 | 6 | 6 | 2 | 2 | 5 | 1 | 0 | 8 | 1 |
| 950-999 | | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 2 | 2 | 2 | 3 | 1 | 2 | 5 | 1 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 11 | 2 |
| 1000-1049 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 1050-1099 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 1 |
| >1099 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 |

NCCOOP

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300-349 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 14 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 350-399 | | 0 | 0 | 10 | 0 | 0 | 0 | 31 | 1 | 18 | 0 | 0 | 0 | 90 | 3 | 3 | 0 | 20 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400-449 | | 3 | 0 | 43 | 0 | 1 | 2 | 211 | 3 | 5 | 3 | 2 | 0 | 1321 | 42 | 204 | 0 | 180 | 191 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 450-499 | | 26 | 0 | 85 | 0 | 27 | 16 | 483 | 9 | 4 | 27 | 64 | 0 | 2274 | 274 | 812 | 0 | 340 | 722 | 48 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 500-549 | | 116 | 11 | 219 | 8 | 70 | 44 | 853 | 26 | 6 | 59 | 82 | 1 | 1671 | 472 | 967 | 2 | 505 | 917 | 319 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 550-599 | | 301 | 104 | 369 | 45 | 74 | 65 | 1033 | 48 | 7 | 98 | 98 | 9 | 463 | 367 | 681 | 22 | 408 | 824 | 632 | 4 | 12 | 2 | 16 | 0 | 0 | 0 | 0 | 2 | 1 | 0 |
| 600-649 | | 403 | 270 | 529 | 232 | 116 | 113 | 855 | 68 | 20 | 124 | 70 | 28 | 121 | 414 | 356 | 80 | 242 | 604 | 646 | 11 | 18 | 3 | 41 | 0 | 1 | 9 | 0 | 0 | 1 | 0 |
| 650-699 | | 251 | 293 | 377 | 494 | 254 | 129 | 595 | 101 | 49 | 140 | 34 | 44 | 95 | 296 | 211 | 151 | 179 | 338 | 544 | 35 | 64 | 15 | 77 | 3 | 0 | 43 | 1 | 0 | 1 | 0 |
| 700-749 | | 127 | 239 | 169 | 465 | 153 | 66 | 329 | 115 | 113 | 185 | 29 | 35 | 83 | 199 | 294 | 396 | 195 | 257 | 535 | 49 | 102 | 22 | 106 | 15 | 0 | 127 | 9 | 7 | 1 | 0 |
| 750-799 | | 52 | 127 | 86 | 294 | 127 | 39 | 121 | 95 | 162 | 263 | 30 | 64 | 40 | 180 | 230 | 500 | 262 | 182 | 431 | 57 | 134 | 28 | 118 | 27 | 0 | 167 | 25 | 30 | 11 | 6 |
| 800-849 | | 20 | 64 | 56 | 161 | 95 | 26 | 53 | 69 | 143 | 226 | 21 | 33 | 26 | 90 | 177 | 361 | 196 | 124 | 492 | 52 | 171 | 25 | 77 | 38 | 1 | 323 | 84 | 86 | 35 | 10 |
| 850-899 | | 8 | 25 | 38 | 58 | 67 | 18 | 34 | 63 | 84 | 132 | 16 | 23 | 20 | 53 | 88 | 209 | 103 | 40 | 430 | 65 | 148 | 27 | 68 | 16 | 1 | 453 | 188 | 151 | 114 | 42 |
| 900-949 | | 5 | 10 | 15 | 19 | 26 | 8 | 17 | 28 | 42 | 60 | 6 | 22 | 13 | 36 | 30 | 95 | 43 | 14 | 222 | 46 | 175 | 10 | 29 | 6 | 1 | 425 | 253 | 361 | 263 | 83 |
| 950-999 | | 1 | 6 | 7 | 2 | 6 | 4 | 8 | 10 | 20 | 23 | 2 | 7 | 6 | 12 | 14 | 53 | 24 | 3 | 93 | 24 | 115 | 6 | 20 | 1 | 1 | 223 | 172 | 402 | 374 | 166 |
| 1000-1049 | | 4 | 0 | 4 | 1 | 0 | 0 | 4 | 6 | 5 | 12 | 5 | 4 | 3 | 6 | 6 | 28 | 6 | 0 | 46 | 14 | 52 | 3 | 7 | 0 | 0 | 109 | 85 | 207 | 330 | 260 |
| 1050-1099 | | 4 | 3 | 1 | 0 | 0 | 0 | 1 | 2 | 5 | 2 | 2 | 0 | 1 | 1 | 3 | 6 | 1 | 2 | 7 | 7 | 26 | 3 | 5 | 1 | 0 | 74 | 45 | 73 | 126 | 178 |
| >1099 | | 15 | 4 | 2 | 0 | 0 | 0 | 3 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | 3 | 3 | 3 | 1 | 9 | 3 | 15 | 2 | 0 | 0 | 1 | 53 | 58 | 56 | 91 | 135 |

Table B8.4 (continued).

*Producer Area Programs*

HUDSON

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300-349 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 350-399 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400-449 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 450-499 | | 58 | 18 | 31 | 25 | 37 | 30 | 22 | 20 | 52 | 4 | 23 | 34 | 23 | 36 | 77 | 46 | 87 | 129 | 53 | 72 | 111 | 17 | 50 | 6 | 2 | 30 | 16 | 61 | 81 | 63 |
| 500-549 | | 74 | 33 | 51 | 28 | 91 | 83 | 38 | 25 | 55 | 7 | 31 | 75 | 52 | 80 | 96 | 141 | 120 | 186 | 75 | 65 | 150 | 18 | 85 | 22 | 17 | 34 | 14 | 75 | 97 | 47 |
| 550-599 | | 134 | 57 | 69 | 35 | 117 | 90 | 40 | 33 | 55 | 10 | 27 | 68 | 89 | 100 | 82 | 169 | 119 | 129 | 96 | 68 | 134 | 22 | 74 | 19 | 23 | 38 | 7 | 87 | 149 | 59 |
| 600-649 | | 143 | 63 | 74 | 28 | 93 | 111 | 63 | 34 | 81 | 12 | 20 | 52 | 103 | 113 | 48 | 140 | 150 | 135 | 96 | 72 | 146 | 21 | 78 | 17 | 29 | 61 | 10 | 70 | 172 | 64 |
| 650-699 | | 112 | 90 | 90 | 50 | 84 | 74 | 83 | 44 | 112 | 17 | 51 | 53 | 74 | 126 | 78 | 168 | 122 | 134 | 76 | 63 | 134 | 24 | 87 | 27 | 31 | 36 | 16 | 34 | 119 | 60 |
| 700-749 | | 80 | 103 | 112 | 73 | 94 | 84 | 86 | 63 | 135 | 20 | 67 | 60 | 69 | 120 | 62 | 156 | 110 | 137 | 114 | 49 | 100 | 33 | 58 | 27 | 44 | 47 | 32 | 74 | 50 | 55 |
| 750-799 | | 83 | 81 | 114 | 79 | 120 | 94 | 54 | 95 | 188 | 25 | 90 | 91 | 91 | 114 | 47 | 164 | 137 | 150 | 143 | 68 | 131 | 60 | 76 | 50 | 85 | 91 | 85 | 99 | 54 | 48 |
| 800-849 | | 57 | 75 | 123 | 98 | 168 | 130 | 70 | 108 | 135 | 41 | 92 | 109 | 112 | 118 | 40 | 128 | 126 | 108 | 147 | 108 | 106 | 80 | 100 | 42 | 158 | 162 | 126 | 177 | 81 | 79 |
| 850-899 | | 33 | 68 | 58 | 69 | 160 | 120 | 86 | 82 | 126 | 46 | 109 | 98 | 118 | 99 | 32 | 93 | 116 | 94 | 148 | 102 | 118 | 99 | 86 | 50 | 127 | 180 | 137 | 239 | 175 | 115 |
| 900-949 | | 16 | 41 | 41 | 35 | 97 | 76 | 58 | 67 | 78 | 31 | 93 | 56 | 63 | 68 | 16 | 71 | 61 | 55 | 94 | 46 | 58 | 86 | 79 | 38 | 105 | 128 | 54 | 135 | 207 | 146 |
| 950-999 | | 16 | 22 | 13 | 16 | 35 | 36 | 28 | 37 | 36 | 15 | 52 | 64 | 34 | 51 | 12 | 49 | 67 | 38 | 43 | 21 | 27 | 31 | 44 | 27 | 56 | 54 | 38 | 53 | 86 | 73 |
| 1000-1049 | | 17 | 12 | 3 | 4 | 25 | 6 | 12 | 13 | 13 | 10 | 28 | 24 | 11 | 28 | 5 | 37 | 32 | 17 | 28 | 11 | 12 | 13 | 18 | 8 | 19 | 19 | 12 | 17 | 21 | 33 |
| 1050-1099 | | 2 | 5 | 2 | 6 | 12 | 4 | 3 | 4 | 3 | 2 | 12 | 11 | 7 | 10 | 1 | 8 | 18 | 10 | 14 | 6 | 4 | 2 | 5 | 2 | 6 | 6 | 4 | 5 | 5 | 10 |
| >1099 | | 1 | 1 | 2 | 0 | 2 | 2 | 0 | 3 | 0 | 1 | 3 | 3 | 0 | 6 | 1 | 9 | 8 | 3 | 3 | 4 | 5 | 1 | 0 | 3 | 3 | 1 | 0 | 4 | 6 | 0 |

DE/PA

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300-349 | | | | | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 350-399 | | | | | 0 | 0 | 2 | 20 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400-449 | | | | | 2 | 0 | 27 | 50 | 34 | 134 | 137 | 64 | 71 | 76 | 68 | 78 | 81 | 62 | 36 | 139 | 133 | 83 | 40 | 86 | 79 | 126 | 28 | 19 | 92 | 42 | 71 |
| 450-499 | | | | | 4 | 0 | 46 | 47 | 43 | 93 | 187 | 114 | 91 | 136 | 127 | 105 | 78 | 51 | 73 | 126 | 115 | 114 | 79 | 82 | 139 | 160 | 96 | 29 | 101 | 87 | 53 |
| 500-549 | | | | | 4 | 0 | 63 | 76 | 52 | 47 | 113 | 161 | 80 | 144 | 160 | 122 | 79 | 63 | 62 | 133 | 82 | 79 | 67 | 81 | 169 | 144 | 117 | 14 | 68 | 87 | 50 |
| 550-599 | | | | | 6 | 0 | 37 | 62 | 78 | 26 | 82 | 122 | 65 | 129 | 179 | 137 | 95 | 47 | 47 | 80 | 46 | 77 | 41 | 72 | 140 | 106 | 146 | 23 | 53 | 88 | 72 |
| 600-649 | | | | | 10 | 14 | 32 | 30 | 81 | 38 | 35 | 76 | 46 | 66 | 130 | 71 | 84 | 39 | 24 | 61 | 24 | 54 | 38 | 43 | 71 | 79 | 97 | 19 | 27 | 52 | 49 |
| 650-699 | | | | | 22 | 26 | 36 | 28 | 48 | 15 | 19 | 46 | 35 | 51 | 81 | 35 | 44 | 21 | 18 | 20 | 20 | 37 | 26 | 25 | 44 | 48 | 71 | 17 | 22 | 33 | 35 |
| 700-749 | | | | | 5 | 8 | 20 | 24 | 57 | 22 | 13 | 38 | 18 | 29 | 66 | 43 | 47 | 16 | 15 | 20 | 10 | 27 | 24 | 31 | 49 | 34 | 48 | 7 | 17 | 15 | 9 |
| 750-799 | | | | | 1 | 3 | 13 | 18 | 49 | 32 | 30 | 33 | 14 | 37 | 42 | 29 | 57 | 22 | 14 | 21 | 18 | 24 | 14 | 32 | 40 | 30 | 34 | 6 | 16 | 13 | 10 |
| 800-849 | | | | | 0 | 0 | 10 | 14 | 33 | 29 | 21 | 48 | 24 | 24 | 47 | 25 | 64 | 29 | 17 | 29 | 16 | 11 | 24 | 26 | 21 | 25 | 34 | 6 | 6 | 9 | 5 |
| 850-899 | | | | | 0 | 1 | 8 | 6 | 19 | 23 | 31 | 37 | 23 | 20 | 34 | 28 | 57 | 40 | 20 | 36 | 24 | 21 | 16 | 21 | 30 | 27 | 36 | 12 | 14 | 4 | 9 |
| 900-949 | | | | | 1 | 2 | 6 | 5 | 7 | 6 | 9 | 33 | 17 | 20 | 17 | 9 | 35 | 26 | 14 | 32 | 31 | 20 | 14 | 18 | 18 | 21 | 38 | 10 | 17 | 13 | 7 |
| 950-999 | | | | | 0 | 3 | 4 | 10 | 7 | 2 | 1 | 12 | 12 | 14 | 11 | 11 | 16 | 16 | 13 | 21 | 16 | 24 | 21 | 11 | 16 | 15 | 27 | 6 | 18 | 11 | 15 |
| 1000-1049 | | | | | 0 | 0 | 3 | 3 | 8 | 3 | 2 | 7 | 2 | 5 | 13 | 5 | 8 | 8 | 11 | 14 | 5 | 11 | 8 | 4 | 11 | 12 | 26 | 2 | 9 | 12 | 11 |
| 1050-1099 | | | | | 0 | 0 | 0 | 0 | 2 | 1 | 4 | 1 | 3 | 1 | 6 | 3 | 5 | 8 | 2 | 4 | 4 | 4 | 5 | 6 | 6 | 12 | 16 | 1 | 3 | 8 | 6 |
| >1099 | | | | | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 4 | 4 | 7 | 9 | 2 | 6 | 6 | 4 | 5 | 16 | 8 | 1 | 11 | 6 | 5 |

Table B8.4 (continued).

MDCB

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | 1 | 9 | 0 | 6 | 4 | 2 | 2 | 3 | 5 | 0 | 1 | 0 | 2 | 3 | 1 | 3 | 0 | 0 | 8 | 2 | 3 | 3 | 0 | 6 | 2 | 2 | 2 | 3 | 1 | 3 | 2 |
| 300-349 | 46 | 75 | 35 | 9 | 35 | 39 | 22 | 19 | 36 | 23 | 10 | 6 | 23 | 27 | 8 | 21 | 16 | 22 | 87 | 35 | 30 | 18 | 5 | 29 | 20 | 24 | 15 | 110 | 16 | 58 | 66 |
| 350-399 | 124 | 170 | 139 | 13 | 116 | 108 | 105 | 38 | 103 | 160 | 35 | 37 | 56 | 60 | 31 | 34 | 31 | 45 | 84 | 99 | 49 | 29 | 31 | 46 | 46 | 43 | 28 | 153 | 163 | 48 | 101 |
| 400-449 | 248 | 221 | 290 | 43 | 177 | 206 | 229 | 136 | 154 | 260 | 203 | 135 | 102 | 252 | 125 | 71 | 86 | 122 | 188 | 135 | 187 | 117 | 73 | 54 | 140 | 63 | 88 | 112 | 428 | 184 | 154 |
| 450-499 | 322 | 440 | 242 | 99 | 135 | 227 | 351 | 223 | 105 | 265 | 239 | 353 | 221 | 292 | 253 | 254 | 114 | 115 | 311 | 152 | 153 | 117 | 172 | 139 | 220 | 63 | 130 | 144 | 299 | 399 | 247 |
| 500-549 | 501 | 549 | 323 | 117 | 141 | 184 | 400 | 307 | 126 | 148 | 158 | 183 | 132 | 271 | 200 | 291 | 150 | 64 | 155 | 104 | 59 | 69 | 127 | 177 | 260 | 72 | 108 | 118 | 155 | 154 | 269 |
| 550-599 | 377 | 575 | 580 | 168 | 187 | 175 | 241 | 288 | 137 | 121 | 58 | 78 | 38 | 84 | 116 | 129 | 96 | 65 | 48 | 58 | 39 | 41 | 76 | 67 | 179 | 65 | 96 | 87 | 139 | 87 | 153 |
| 600-649 | 173 | 372 | 610 | 232 | 251 | 241 | 201 | 206 | 184 | 120 | 26 | 41 | 24 | 35 | 60 | 96 | 68 | 39 | 37 | 34 | 33 | 31 | 63 | 52 | 117 | 53 | 91 | 54 | 99 | 65 | 128 |
| 650-699 | 46 | 170 | 336 | 238 | 321 | 333 | 332 | 205 | 235 | 149 | 59 | 37 | 21 | 39 | 41 | 46 | 40 | 43 | 26 | 24 | 17 | 38 | 43 | 42 | 56 | 30 | 99 | 45 | 69 | 49 | 78 |
| 700-749 | 17 | 72 | 146 | 139 | 173 | 186 | 264 | 290 | 206 | 254 | 60 | 51 | 12 | 56 | 62 | 49 | 44 | 38 | 31 | 26 | 14 | 26 | 50 | 34 | 66 | 19 | 60 | 37 | 45 | 44 | 54 |
| 750-799 | 7 | 39 | 58 | 43 | 98 | 61 | 102 | 102 | 133 | 287 | 90 | 54 | 23 | 58 | 89 | 53 | 47 | 48 | 58 | 32 | 23 | 16 | 34 | 41 | 93 | 29 | 27 | 31 | 38 | 31 | 39 |
| 800-849 | 1 | 11 | 32 | 32 | 42 | 47 | 49 | 49 | 78 | 156 | 56 | 59 | 38 | 39 | 101 | 56 | 52 | 87 | 62 | 53 | 22 | 19 | 43 | 21 | 48 | 54 | 48 | 25 | 24 | 12 | 13 |
| 850-899 | 0 | 5 | 12 | 39 | 44 | 45 | 84 | 55 | 52 | 63 | 48 | 40 | 30 | 37 | 83 | 63 | 67 | 76 | 68 | 49 | 30 | 28 | 32 | 27 | 23 | 37 | 50 | 53 | 20 | 10 | 15 |
| 900-949 | 0 | 1 | 0 | 32 | 51 | 81 | 83 | 59 | 39 | 52 | 44 | 24 | 33 | 32 | 61 | 52 | 53 | 60 | 57 | 38 | 48 | 32 | 35 | 20 | 15 | 37 | 30 | 55 | 26 | 19 | 22 |
| 950-999 | 1 | 1 | 0 | 9 | 22 | 45 | 59 | 38 | 29 | 47 | 24 | 17 | 21 | 18 | 43 | 42 | 42 | 34 | 28 | 45 | 30 | 19 | 33 | 24 | 26 | 35 | 34 | 43 | 61 | 43 | 37 |
| 1000-1049 | 3 | 2 | 0 | 4 | 6 | 13 | 37 | 19 | 37 | 41 | 17 | 9 | 15 | 8 | 28 | 14 | 20 | 14 | 21 | 18 | 17 | 13 | 20 | 17 | 11 | 28 | 31 | 16 | 35 | 47 | 65 |
| 1050-1099 | 4 | 3 | 2 | 3 | 4 | 7 | 9 | 4 | 10 | 17 | 7 | 6 | 7 | 5 | 8 | 6 | 6 | 14 | 8 | 12 | 11 | 8 | 16 | 13 | 6 | 15 | 16 | 16 | 17 | 23 | 48 |
| >1099 | 7 | 16 | 3 | 7 | 6 | 11 | 15 | 2 | 4 | 6 | 3 | 2 | 2 | 2 | 4 | 6 | 3 | 7 | 4 | 8 | 5 | 4 | 3 | 12 | 11 | 13 | 17 | 16 | 17 | 24 | 24 |

VARAP

| TL (mm) | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <199 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200-249 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250-299 | | 83 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300-349 | | 119 | 87 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 64 |
| 350-399 | | 74 | 110 | 93 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 86 | 79 |
| 400-449 | | 133 | 84 | 390 | 169 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 137 | 90 |
| 450-499 | | 277 | 97 | 461 | 356 | 0 | 0 | 0 | 83 | 103 | 277 | 242 | 317 | 350 | 118 | 39 | 107 | 154 | 184 | 211 | 368 | 177 | 131 | 256 | 36 | 124 | 93 | 76 | 128 | 245 | 71 |
| 500-549 | | 633 | 142 | 209 | 770 | 0 | 0 | 0 | 60 | 60 | 183 | 303 | 259 | 680 | 212 | 83 | 203 | 212 | 198 | 179 | 379 | 137 | 173 | 444 | 46 | 229 | 152 | 56 | 69 | 273 | 93 |
| 550-599 | | 407 | 322 | 167 | 502 | 3 | 1 | 1 | 120 | 44 | 39 | 76 | 105 | 326 | 143 | 52 | 123 | 220 | 137 | 79 | 263 | 97 | 205 | 514 | 59 | 238 | 135 | 24 | 38 | 142 | 88 |
| 600-649 | | 174 | 233 | 229 | 311 | 62 | 225 | 35 | 132 | 58 | 7 | 5 | 7 | 34 | 39 | 15 | 20 | 153 | 77 | 15 | 109 | 36 | 103 | 324 | 60 | 188 | 95 | 24 | 9 | 54 | 25 |
| 650-699 | | 59 | 122 | 153 | 157 | 23 | 150 | 32 | 80 | 38 | 3 | 1 | 3 | 9 | 14 | 3 | 0 | 46 | 37 | 4 | 2 | 2 | 11 | 29 | 18 | 103 | 38 | 23 | 8 | 13 | 8 |
| 700-749 | | 24 | 49 | 85 | 90 | 7 | 79 | 18 | 43 | 26 | 4 | 9 | 13 | 53 | 15 | 9 | 30 | 43 | 20 | 16 | 25 | 5 | 19 | 41 | 22 | 48 | 23 | 12 | 7 | 11 | 4 |
| 750-799 | | 25 | 27 | 43 | 33 | 5 | 25 | 15 | 29 | 17 | 15 | 13 | 25 | 71 | 41 | 37 | 78 | 180 | 24 | 19 | 78 | 9 | 29 | 73 | 31 | 42 | 21 | 9 | 3 | 8 | 4 |
| 800-849 | | 5 | 20 | 69 | 44 | 6 | 14 | 11 | 36 | 22 | 24 | 18 | 29 | 67 | 59 | 26 | 74 | 198 | 71 | 35 | 101 | 12 | 50 | 66 | 41 | 48 | 18 | 28 | 4 | 3 | 1 |
| 850-899 | | 2 | 16 | 71 | 105 | 10 | 22 | 23 | 54 | 6 | 40 | 31 | 26 | 61 | 70 | 26 | 75 | 109 | 79 | 36 | 202 | 13 | 43 | 92 | 31 | 61 | 35 | 41 | 6 | 2 | 1 |
| 900-949 | | 4 | 5 | 33 | 89 | 8 | 42 | 20 | 29 | 3 | 45 | 23 | 25 | 38 | 38 | 9 | 55 | 82 | 46 | 41 | 220 | 14 | 47 | 78 | 30 | 58 | 65 | 55 | 15 | 10 | 5 |
| 950-999 | | 3 | 0 | 22 | 40 | 5 | 43 | 26 | 19 | 1 | 46 | 31 | 19 | 26 | 22 | 6 | 44 | 41 | 29 | 25 | 154 | 15 | 32 | 62 | 23 | 35 | 38 | 64 | 21 | 29 | 7 |
| 1000-1049 | | 0 | 0 | 5 | 13 | 0 | 15 | 8 | 11 | 0 | 27 | 14 | 11 | 28 | 14 | 8 | 27 | 22 | 15 | 6 | 44 | 4 | 16 | 42 | 11 | 18 | 15 | 19 | 12 | 26 | 2 |
| 1050-1099 | | 0 | 0 | 2 | 3 | 1 | 3 | 3 | 2 | 0 | 9 | 14 | 5 | 17 | 7 | 2 | 8 | 13 | 2 | 1 | 13 | 2 | 7 | 12 | 1 | 13 | 14 | 14 | 4 | 7 | 7 |
| >1099 | | 1 | 1 | 1 | 4 | 0 | 2 | 3 | 1 | 0 | 2 | 5 | 9 | 8 | 5 | 0 | 9 | 4 | 2 | 1 | 3 | 1 | 2 | 17 | 7 | 17 | 18 | 9 | 3 | 5 | 3 |

Table B8.5. Ages at time of release for tagged striped bass captured in 2017 (except NYOHS/TRL is for 2012, the last year fish were tagged for that program).

| Program | Age at release | |
|---|---|---|
| | Minimum | Maximum |
| *Coastal* | | |
| MADFW | 3 | 15 |
| NYOHS/TRL | 3 | 12 |
| NJDB | 4 | 11 |
| NCCOOP | 7 | 18 |
| *Producer Area* | | |
| HUDSON | 2 | 18 |
| DE/PA | 3 | 11 |
| MDCB | 2 | 18 |
| VARAP | 3 | 19 |

Table B8.6. Distribution of tag recaptures by state and month, based on 2017 recaptures from fish tagged and released during 2008-2017 (except NYOHS/NYTRL, which is based on 2012 recaptures from fish tagged and released during 2008-2012). Data are presented separately for each tagging program.

*Coastal Programs*

MADFW

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | | | | | | 0 |
| MA | | | | | 3 | 10 | 8 | 11 | 4 | | | | 36 |
| RI | | | | | 2 | 4 | | | | 1 | | | 7 |
| CT | | | | 1 | 1 | 1 | 1 | | | | | | 4 |
| NY | | | | 5 | 1 | | 3 | 1 | 1 | | 2 | 1 | 14 |
| NJ | | | | 2 | | | | | | | 8 | 1 | 11 |
| PA | | | | | | | | | | | | | 0 |
| DE | | | | | | | | | | | | | 0 |
| MD | | | | 5 | 2 | | | | | | | | 7 |
| VA | | | | 2 | 1 | | | | | | | | 3 |
| NC | | | | | | | | | | | | | 0 |
| UN | | | | | 1 | | 1 | | | | | | 2 |
| Total | 0 | 0 | 0 | 15 | 11 | 15 | 13 | 12 | 5 | 1 | 10 | 2 | 84 |

NYOHS/NYTRL*

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | | | | | | 0 |
| MA | | | | | 5 | 2 | 2 | 2 | 1 | | 2 | | 14 |
| RI | | | | | | 1 | 1 | | 1 | | | | 3 |
| CT | | | | | | | 1 | | | | | | 1 |
| NY | | | | | 1 | 4 | | 2 | 1 | 4 | | | 12 |
| NJ | | | | 3 | | | | | | | 2 | 1 | 6 |
| PA | | | | | | | | | | | | | 0 |
| DE | | | | | | | | | | | | 1 | 1 |
| MD | | | | 2 | | | | | | | | | 2 |
| VA | | | | | | | | | | | | | 0 |
| NC | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 0 | 5 | 6 | 7 | 4 | 4 | 3 | 4 | 4 | 2 | 39 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.6 (continued).

*Coastal Programs*

NJDB

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | | | | | | 0 |
| MA | | | | | | | 3 | | | 1 | | | 4 |
| RI | | | | | | | | | | 1 | | | 1 |
| CT | | | | | | | | | | | | | 0 |
| NY | | | | | 2 | 1 | | | | | | | 3 |
| NJ | | | | | 1 | | | | | | 1 | 1 | 3 |
| PA | | | | | | | | | | | | | 0 |
| DE | | | | | 1 | | | | | | | | 1 |
| MD | | | | | 1 | | | | | | | | 1 |
| VA | 1 | | | | | | | | | | | | 1 |
| NC | | | | | | | | | | | | | 0 |
| Total | 1 | 0 | 0 | 0 | 5 | 1 | 3 | 0 | 0 | 2 | 1 | 1 | 14 |

NCCOOP

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | 1 | | | | | | | 1 |
| NH | | | | | | | 1 | 1 | | | | | 2 |
| MA | | | | | 7 | 6 | 15 | 30 | 7 | 2 | | | 67 |
| RI | | | | | 4 | 4 | 2 | 6 | | | | | 16 |
| CT | | | | | 1 | 3 | 2 | 1 | 1 | | | | 8 |
| NY | | | | 1 | 3 | 9 | 10 | 6 | 2 | 3 | 7 | | 41 |
| NJ | | | | 2 | 3 | 2 | | | | 1 | 10 | 3 | 21 |
| PA | | | | 1 | | | | | | | | | 1 |
| DE | | | 1 | 1 | | | | | | | | | 2 |
| MD | | | | 20 | 4 | | | | | 1 | 1 | 1 | 27 |
| VA | | | 2 | 1 | | | | | | | | | 3 |
| NC | | | | | | | | | | | 1 | | 1 |
| Total | 0 | 0 | 3 | 26 | 22 | 25 | 30 | 44 | 10 | 7 | 19 | 4 | 190 |

Table B8.6 (continued).

*Producer Area Programs*

HUDSON

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | 1 | | | | | 1 |
| MA | | | | | 2 | 10 | 12 | 24 | 6 | 1 | | | 55 |
| RI | | | | | 1 | 7 | 3 | 1 | 1 | 1 | | | 14 |
| CT | | | | | | 3 | 3 | 3 | 1 | | | | 10 |
| NY | | | | 5 | 33 | 14 | 6 | 3 | 4 | 6 | 6 | | 77 |
| NJ | | | | 5 | 1 | 1 | | | | 1 | 7 | 9 | 24 |
| PA | | | | | | | | | | | | | 0 |
| DE | | | | | | | | | | | | | 0 |
| MD | | | | | | | | | | | | | 0 |
| VA | | | | | | | | | | | | | 0 |
| NC | | | | | | | | | | | | | 0 |
| Total | 0 | 0 | 0 | 10 | 37 | 35 | 24 | 32 | 12 | 9 | 13 | 9 | 181 |

DE/PA

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | | | | | | 0 |
| MA | | | | | 2 | | 2 | 1 | 2 | | | | 7 |
| RI | | | | | | | | | | | | | 0 |
| CT | | | | | | | | | 1 | 2 | | | 3 |
| NY | | | | | | 2 | | 1 | | | 1 | | 4 |
| NJ | | | | 1 | 2 | 7 | 1 | | | | | | 11 |
| PA | | | | | 1 | | | | | | | | 1 |
| DE | | | | 1 | 1 | | 1 | | | 1 | 1 | | 5 |
| MD | 1 | | | | 3 | 9 | 3 | 3 | | 1 | 1 | 3 | 24 |
| VA | | | | | | | | | | | 1 | | 1 |
| NC | | | | | | | | | | | | | 0 |
| Total | 1 | 0 | 0 | 2 | 9 | 18 | 7 | 5 | 3 | 4 | 4 | 3 | 56 |

Table B8.6 (continued).

*Producer Area Programs*

MDCB

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | | | | | | 0 |
| MA | | | | | 1 | 1 | | 5 | 1 | | | | 8 |
| RI | | | | | | 2 | | 2 | | | | | 4 |
| CT | | | | | | | | | | 1 | | | 1 |
| NY | | | | | 1 | | 1 | | | | | | 2 |
| NJ | | | | | | 1 | | | | | 4 | | 5 |
| PA | | | | | | | | | | | | | 0 |
| DE | | | | | 1 | | | | | | | | 1 |
| MD | | 2 | | 3 | 17 | 28 | 23 | 26 | 9 | 9 | 8 | 3 | 128 |
| DC | | | | 1 | | 1 | | 1 | | | | | 3 |
| VA | | | 1 | | | | | | | 1 | | | 2 |
| NC | | | | | | | | | | | | | 0 |
| Total | 0 | 2 | 1 | 4 | 20 | 33 | 24 | 34 | 10 | 11 | 12 | 3 | 154 |

VARAP

| State | Jan. | Feb. | Mar | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ME | | | | | | | | | | | | | 0 |
| NH | | | | | | | | | | | | | 0 |
| MA | | | | | 2 | | 1 | 2 | | | | | 5 |
| RI | | | | | | | | 1 | | | | | 1 |
| CT | | | | | | | 1 | | | | | | 1 |
| NY | | | | | | | | | | | | | 0 |
| NJ | | | | | 1 | | | | | | 1 | | 2 |
| PA | | | | | | | | | | | | | 0 |
| DE | | | | | | | | | | | | | 0 |
| MD | | | | | 1 | | 1 | 2 | | | 1 | | 5 |
| VA | | 1 | 2 | 6 | 3 | 8 | | 1 | | 5 | 4 | 3 | 33 |
| NC | | | | | | | | | | | | | 0 |
| Total | 0 | 1 | 2 | 6 | 7 | 8 | 3 | 6 | 0 | 5 | 6 | 3 | 47 |

Table B8.7. Annual exploitation rates of ≥ 28 inch (711 mm) striped bass calculated with adjusted R/M ratios. The ratio (R/M) is the proportion of recovered tags (R) from fish harvested or killed to the total number of tags released (M). The number of recovered tags from harvested or killed fish is adjusted by reporting rate and by a 9% mortality rate of fish released alive.

| | Coastal Programs | | | | Producer Area Programs | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | MADFW | NYOHS/ NYTRL* | NJDB | NCCOOP | HUDSON | DE/PA | MDCB | VARAP | Mean |
| 1987 | | | | | | | | | |
| 1988 | | 0.05 | | 0.08 | 0.10 | | 0.04 | | 0.07 |
| 1989 | | 0.05 | 0.02 | 0.04 | 0.07 | | 0.04 | | 0.04 |
| 1990 | | 0.07 | 0.05 | 0.09 | 0.11 | | 0.09 | 0.09 | 0.08 |
| 1991 | | 0.15 | 0.18 | 0.07 | 0.11 | | 0.12 | 0.12 | 0.13 |
| 1992 | 0.04 | 0.13 | 0.02 | 0.13 | 0.13 | | 0.12 | 0.13 | 0.10 |
| 1993 | 0.05 | 0.14 | 0.09 | 0.12 | 0.16 | 0.14 | 0.12 | 0.13 | 0.12 |
| 1994 | 0.04 | 0.09 | 0.05 | 0.08 | 0.12 | 0.09 | 0.12 | 0.08 | 0.08 |
| 1995 | 0.04 | 0.22 | 0.11 | 0.14 | 0.15 | 0.14 | 0.20 | 0.21 | 0.15 |
| 1996 | 0.08 | 0.14 | 0.20 | 0.11 | 0.22 | 0.30 | 0.17 | 0.00 | 0.15 |
| 1997 | 0.17 | 0.35 | 0.25 | 0.18 | 0.29 | 0.29 | 0.23 | 0.12 | 0.24 |
| 1998 | 0.07 | 0.17 | 0.35 | 0.20 | 0.21 | 0.29 | 0.23 | 0.25 | 0.22 |
| 1999 | 0.09 | 0.34 | 0.08 | 0.22 | 0.22 | 0.16 | 0.21 | 0.19 | 0.19 |
| 2000 | 0.12 | 0.14 | 0.13 | 0.06 | 0.12 | 0.29 | 0.15 | 0.08 | 0.14 |
| 2001 | 0.07 | 0.10 | 0.14 | 0.15 | 0.11 | 0.25 | 0.09 | 0.07 | 0.12 |
| 2002 | 0.07 | 0.22 | 0.10 | 0.11 | 0.15 | 0.18 | 0.08 | 0.11 | 0.13 |
| 2003 | 0.09 | 0.15 | 0.13 | 0.10 | 0.11 | 0.13 | 0.08 | 0.11 | 0.11 |
| 2004 | 0.08 | 0.14 | 0.14 | 0.11 | 0.15 | 0.17 | 0.07 | 0.06 | 0.11 |
| 2005 | 0.06 | 0.23 | 0.14 | 0.06 | 0.12 | 0.13 | 0.09 | 0.08 | 0.11 |
| 2006 | 0.08 | 0.11 | 0.12 | 0.10 | 0.10 | 0.17 | 0.11 | 0.11 | 0.11 |
| 2007 | 0.04 | 0.00 | 0.11 | 0.16 | 0.11 | 0.12 | 0.07 | 0.08 | 0.09 |
| 2008 | 0.06 | 0.09 | 0.12 | 0.16 | 0.12 | 0.09 | 0.09 | 0.13 | 0.11 |
| 2009 | 0.09 | 0.01 | 0.19 | 0.03 | 0.14 | 0.18 | 0.14 | 0.04 | 0.10 |
| 2010 | 0.06 | 0.12 | 0.11 | 0.06 | 0.13 | 0.18 | 0.08 | 0.04 | 0.10 |
| 2011 | 0.07 | 0.06 | 0.10 | 0.18 | 0.16 | 0.09 | 0.11 | 0.06 | 0.10 |
| 2012 | 0.04 | 0.08 | 0.11 | 0.39 | 0.10 | 0.17 | 0.06 | 0.05 | 0.13 |
| 2013 | 0.07 | | 0.29 | 0.11 | 0.14 | 0.15 | 0.10 | 0.04 | 0.13 |
| 2014 | 0.09 | | 0.00 | 0.10 | 0.09 | 0.20 | 0.15 | 0.04 | 0.10 |
| 2015 | 0.04 | | 0.00 | 0.10 | 0.07 | 0.08 | 0.05 | 0.03 | 0.05 |
| 2016 | 0.07 | | 0.12 | 0.10 | 0.09 | 0.12 | 0.13 | 0.06 | 0.10 |
| 2017 | 0.08 | | 0.00 | 0.09 | 0.15 | 0.18 | 0.03 | 0.06 | 0.08 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.8. Annual exploitation rates of ≥ 18-inch (457 mm) striped bass calculated with adjusted R/M ratios. The ratio (R/M) is the proportion of recovered tags (R) from fish harvested or killed to the total number of tags released (M). The number of recovered tags from harvested or killed fish is adjusted by reporting rate and by a 9% mortality rate of fish released alive.

| | Coast Programs | | | | Producer Area Programs | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | HUDSON | DE/PA | MDCB | VARAP | Mean |
| 1987 | | | | | | | 0.01 | | |
| 1988 | | 0.02 | | 0.05 | 0.05 | | 0.02 | | 0.03 |
| 1989 | | 0.03 | 0.04 | 0.03 | 0.05 | | 0.01 | | 0.03 |
| 1990 | | 0.04 | 0.07 | 0.07 | 0.08 | | 0.07 | 0.04 | 0.06 |
| 1991 | | 0.07 | 0.03 | 0.08 | 0.08 | | 0.10 | 0.05 | 0.07 |
| 1992 | 0.04 | 0.05 | 0.04 | 0.14 | 0.10 | | 0.13 | 0.13 | 0.09 |
| 1993 | 0.04 | 0.05 | 0.03 | 0.11 | 0.10 | 0.10 | 0.11 | 0.07 | 0.08 |
| 1994 | 0.04 | 0.03 | 0.03 | 0.08 | 0.09 | 0.11 | 0.12 | 0.08 | 0.07 |
| 1995 | 0.03 | 0.06 | 0.06 | 0.14 | 0.12 | 0.12 | 0.19 | 0.09 | 0.10 |
| 1996 | 0.06 | 0.04 | 0.09 | 0.11 | 0.16 | 0.14 | 0.17 | 0.02 | 0.10 |
| 1997 | 0.12 | 0.05 | 0.08 | 0.16 | 0.22 | 0.12 | 0.21 | 0.09 | 0.13 |
| 1998 | 0.08 | 0.03 | 0.12 | 0.14 | 0.17 | 0.14 | 0.22 | 0.09 | 0.12 |
| 1999 | 0.06 | 0.06 | 0.06 | 0.21 | 0.14 | 0.09 | 0.17 | 0.09 | 0.11 |
| 2000 | 0.08 | 0.04 | 0.07 | 0.08 | 0.09 | 0.13 | 0.15 | 0.05 | 0.09 |
| 2001 | 0.05 | 0.05 | 0.09 | 0.11 | 0.08 | 0.13 | 0.11 | 0.08 | 0.09 |
| 2002 | 0.07 | 0.06 | 0.05 | 0.11 | 0.07 | 0.11 | 0.10 | 0.06 | 0.08 |
| 2003 | 0.07 | 0.06 | 0.07 | 0.10 | 0.08 | 0.11 | 0.10 | 0.07 | 0.08 |
| 2004 | 0.07 | 0.04 | 0.10 | 0.10 | 0.10 | 0.12 | 0.08 | 0.06 | 0.08 |
| 2005 | 0.05 | 0.04 | 0.08 | 0.05 | 0.06 | 0.08 | 0.09 | 0.05 | 0.06 |
| 2006 | 0.07 | 0.03 | 0.05 | 0.09 | 0.07 | 0.09 | 0.11 | 0.08 | 0.07 |
| 2007 | 0.04 | 0.02 | 0.09 | 0.13 | 0.07 | 0.05 | 0.07 | 0.06 | 0.07 |
| 2008 | 0.06 | 0.05 | 0.07 | 0.15 | 0.07 | 0.06 | 0.09 | 0.06 | 0.08 |
| 2009 | 0.07 | 0.05 | 0.06 | 0.04 | 0.11 | 0.09 | 0.14 | 0.06 | 0.08 |
| 2010 | 0.06 | 0.07 | 0.06 | 0.06 | 0.08 | 0.08 | 0.11 | 0.03 | 0.07 |
| 2011 | 0.07 | 0.05 | 0.08 | 0.17 | 0.13 | 0.05 | 0.11 | 0.05 | 0.09 |
| 2012 | 0.04 | 0.08 | 0.07 | 0.33 | 0.09 | 0.09 | 0.10 | 0.05 | 0.10 |
| 2013 | 0.07 | | 0.14 | 0.10 | 0.12 | 0.09 | 0.14 | 0.06 | 0.10 |
| 2014 | 0.09 | | 0.02 | 0.11 | 0.08 | 0.16 | 0.17 | 0.04 | 0.10 |
| 2015 | 0.04 | | 0.02 | 0.10 | 0.05 | 0.03 | 0.11 | 0.05 | 0.05 |
| 2016 | 0.08 | | 0.11 | 0.10 | 0.05 | 0.05 | 0.09 | 0.03 | 0.07 |
| 2017 | 0.07 | | 0.00 | 0.09 | 0.11 | 0.09 | 0.08 | 0.03 | 0.07 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.9. Akaike weights used to derive model-averaged parameter estimates from IRCR analyses of striped bass tagged at ≥ 28 inches (711 mm) and ≥18 inches (457 mm) by coastal and producer area programs (see Table B8.1 for model descriptions).

| | Coastal Programs | | | | | Producer Area Programs | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | MADFW | NYOHS | NYTRL* | NJDB | NCCOOP | HUDSON | DE/PA | MDCB | VARAP |
| ≥ 28 inches | | | | | | | | | |
| 1 | 0.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 |
| 3 | 0.999 | 0.175 | 0.006 | 0.988 | 0.000 | 0.002 | 0.005 | 0.000 | 0.000 |
| 4 | 0.000 | 0.640 | 0.736 | 0.000 | 0.590 | 0.001 | 0.495 | 0.204 | 0.793 |
| 5 | 0.000 | 0.085 | 0.142 | 0.000 | 0.124 | 0.944 | 0.352 | 0.037 | 0.102 |
| 6 | 0.001 | 0.099 | 0.115 | 0.000 | 0.286 | 0.052 | 0.148 | 0.758 | 0.105 |
| ≥ 18 inches | | | | | | | | | |
| 1 | 0.000 | 0.463 | 0.367 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.000 | 0.536 | 0.633 | 0.203 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 |
| 3 | 1.000 | 0.001 | 0.000 | 0.081 | 0.000 | 0.002 | 1.000 | 1.000 | 0.007 |
| 4 | 0.000 | 0.000 | 0.000 | 0.452 | 0.771 | 0.003 | 0.000 | 0.000 | 0.834 |
| 5 | 0.000 | 0.000 | 0.000 | 0.147 | 0.114 | 0.975 | 0.000 | 0.000 | 0.078 |
| 6 | 0.000 | 0.000 | 0.000 | 0.089 | 0.115 | 0.018 | 0.000 | 0.000 | 0.081 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.10. Model-averaged estimates of survival (S) and unconditional standard error (SE) from IRCR analyses of striped bass (≥ 28 inches; 711 mm) tagged by coastal and producer areas programs.

| | Coastal Programs | | | | | | | | Producer Area Programs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MADFW | | NYOHS/ NYTRL* | | NJDB | | NCCOOP | | HUDSON | | DE/PA | | MDCB | | VARAP | |
| Year | S | SE | S | SE | S | SE | S | SE | S | SE | S | SE | S | SE | S | SE |
| 1987 | | | | | | | | | | | | | 0.85 | 0.01 | | |
| 1988 | | | 0.89 | 0.01 | | | 0.83 | 0.02 | 0.83 | 0.02 | | | 0.85 | 0.01 | | |
| 1989 | | | 0.89 | 0.01 | 0.92 | 0.01 | 0.83 | 0.02 | 0.83 | 0.02 | | | 0.85 | 0.01 | | |
| 1990 | | | 0.79 | 0.02 | 0.82 | 0.07 | 0.78 | 0.02 | 0.77 | 0.01 | | | 0.76 | 0.01 | 0.69 | 0.03 |
| 1991 | | | 0.78 | 0.02 | 0.62 | 0.10 | 0.78 | 0.02 | 0.77 | 0.01 | | | 0.76 | 0.01 | 0.69 | 0.03 |
| 1992 | 0.88 | 0.02 | 0.79 | 0.01 | 0.92 | 0.01 | 0.78 | 0.02 | 0.77 | 0.01 | | | 0.76 | 0.01 | 0.69 | 0.03 |
| 1993 | 0.85 | 0.02 | 0.78 | 0.02 | 0.83 | 0.04 | 0.78 | 0.02 | 0.77 | 0.01 | 0.76 | 0.04 | 0.76 | 0.01 | 0.69 | 0.03 |
| 1994 | 0.84 | 0.02 | 0.79 | 0.01 | 0.88 | 0.02 | 0.78 | 0.02 | 0.77 | 0.01 | 0.76 | 0.04 | 0.76 | 0.01 | 0.69 | 0.03 |
| 1995 | 0.82 | 0.02 | 0.70 | 0.02 | 0.83 | 0.02 | 0.75 | 0.02 | 0.71 | 0.01 | 0.68 | 0.02 | 0.68 | 0.01 | 0.65 | 0.03 |
| 1996 | 0.76 | 0.02 | 0.70 | 0.02 | 0.75 | 0.02 | 0.75 | 0.02 | 0.71 | 0.01 | 0.68 | 0.02 | 0.68 | 0.01 | 0.65 | 0.03 |
| 1997 | 0.75 | 0.02 | 0.68 | 0.02 | 0.76 | 0.02 | 0.75 | 0.02 | 0.71 | 0.01 | 0.68 | 0.02 | 0.68 | 0.01 | 0.65 | 0.03 |
| 1998 | 0.77 | 0.02 | 0.68 | 0.03 | 0.67 | 0.03 | 0.75 | 0.02 | 0.71 | 0.01 | 0.68 | 0.02 | 0.68 | 0.01 | 0.55 | 0.02 |
| 1999 | 0.66 | 0.02 | 0.68 | 0.04 | 0.76 | 0.03 | 0.75 | 0.02 | 0.71 | 0.01 | 0.68 | 0.02 | 0.68 | 0.01 | 0.55 | 0.02 |
| 2000 | 0.66 | 0.02 | 0.76 | 0.03 | 0.80 | 0.02 | 0.64 | 0.01 | 0.80 | 0.01 | 0.71 | 0.03 | 0.78 | 0.01 | 0.60 | 0.02 |
| 2001 | 0.72 | 0.01 | 0.76 | 0.03 | 0.78 | 0.02 | 0.64 | 0.01 | 0.66 | 0.01 | 0.71 | 0.03 | 0.62 | 0.01 | 0.60 | 0.02 |
| 2002 | 0.69 | 0.02 | 0.76 | 0.02 | 0.81 | 0.02 | 0.64 | 0.01 | 0.66 | 0.01 | 0.60 | 0.02 | 0.62 | 0.01 | 0.60 | 0.02 |
| 2003 | 0.69 | 0.02 | 0.78 | 0.03 | 0.64 | 0.01 | 0.63 | 0.01 | 0.65 | 0.01 | 0.62 | 0.02 | 0.62 | 0.01 | 0.61 | 0.02 |
| 2004 | 0.70 | 0.01 | 0.79 | 0.02 | 0.64 | 0.01 | 0.63 | 0.01 | 0.65 | 0.01 | 0.62 | 0.02 | 0.62 | 0.01 | 0.61 | 0.02 |
| 2005 | 0.70 | 0.01 | 0.59 | 0.03 | 0.63 | 0.02 | 0.63 | 0.01 | 0.65 | 0.01 | 0.62 | 0.02 | 0.62 | 0.01 | 0.61 | 0.02 |
| 2006 | 0.71 | 0.01 | 0.59 | 0.03 | 0.67 | 0.02 | 0.63 | 0.01 | 0.65 | 0.01 | 0.62 | 0.02 | 0.62 | 0.01 | 0.61 | 0.02 |
| 2007 | 0.73 | 0.01 | 0.58 | 0.05 | 0.65 | 0.02 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2008 | 0.70 | 0.01 | 0.58 | 0.08 | 0.63 | 0.02 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2009 | 0.69 | 0.01 | 0.58 | 0.08 | 0.61 | 0.02 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2010 | 0.72 | 0.01 | 0.58 | 0.08 | 0.63 | 0.02 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2011 | 0.70 | 0.01 | 0.58 | 0.08 | 0.64 | 0.02 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2012 | 0.73 | 0.01 | 0.58 | 0.08 | 0.67 | 0.02 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2013 | 0.71 | 0.01 | 0.58 | 0.08 | 0.64 | 0.03 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2014 | 0.72 | 0.01 | 0.58 | 0.08 | 0.65 | 0.03 | 0.62 | 0.01 | 0.65 | 0.01 | 0.64 | 0.02 | 0.63 | 0.01 | 0.63 | 0.02 |
| 2015 | 0.75 | 0.01 | 0.49 | 0.20 | 0.69 | 0.03 | 0.64 | 0.01 | 0.70 | 0.01 | 0.65 | 0.03 | 0.66 | 0.02 | 0.63 | 0.02 |
| 2016 | 0.71 | 0.01 | 0.45 | 0.25 | 0.68 | 0.03 | 0.64 | 0.01 | 0.69 | 0.01 | 0.66 | 0.02 | 0.64 | 0.02 | 0.63 | 0.02 |
| 2017 | 0.73 | 0.01 | 0.47 | 0.25 | 0.72 | 0.03 | 0.64 | 0.01 | 0.65 | 0.01 | 0.66 | 0.03 | 0.64 | 0.02 | 0.64 | 0.03 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.11. Tag-based estimates of survival (from IRCR analyses) for ≥ 28 inch (711 mm) striped bass, including an unweighted average for coastal programs, a weighted average for producer area programs, and 95% confidence intervals.

| | Coastal programs | | | | | | | Producer area programs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | Unweighted average** | 95% LCI | 95% UCI | HUDSON | DE/PA | MDCB | VARAP | Weighted average*** | 95% LCI | 95% UCI |
| 1987 | | | | | | | | | | 0.85 | | 0.85 | 0.83 | 0.88 |
| 1988 | | 0.89 | | 0.83 | 0.86 | 0.81 | 0.91 | 0.83 | | 0.85 | | 0.85 | 0.83 | 0.87 |
| 1989 | | 0.89 | 0.92 | 0.83 | 0.88 | 0.82 | 0.94 | 0.83 | | 0.85 | | 0.85 | 0.83 | 0.87 |
| 1990 | | 0.79 | 0.82 | 0.78 | 0.80 | 0.66 | 0.94 | 0.77 | | 0.76 | 0.69 | 0.74 | 0.72 | 0.76 |
| 1991 | | 0.78 | 0.62 | 0.78 | 0.73 | 0.52 | 0.93 | 0.77 | | 0.76 | 0.69 | 0.74 | 0.72 | 0.76 |
| 1992 | 0.88 | 0.79 | 0.92 | 0.78 | 0.84 | 0.78 | 0.90 | 0.77 | | 0.76 | 0.69 | 0.74 | 0.72 | 0.76 |
| 1993 | 0.85 | 0.78 | 0.83 | 0.78 | 0.81 | 0.71 | 0.91 | 0.77 | 0.76 | 0.76 | 0.69 | 0.74 | 0.73 | 0.76 |
| 1994 | 0.84 | 0.79 | 0.88 | 0.78 | 0.82 | 0.76 | 0.88 | 0.77 | 0.76 | 0.76 | 0.69 | 0.74 | 0.73 | 0.76 |
| 1995 | 0.82 | 0.70 | 0.83 | 0.75 | 0.77 | 0.70 | 0.85 | 0.71 | 0.68 | 0.68 | 0.65 | 0.68 | 0.66 | 0.70 |
| 1996 | 0.76 | 0.70 | 0.75 | 0.75 | 0.74 | 0.66 | 0.81 | 0.71 | 0.68 | 0.68 | 0.65 | 0.68 | 0.66 | 0.70 |
| 1997 | 0.75 | 0.68 | 0.76 | 0.75 | 0.74 | 0.65 | 0.82 | 0.71 | 0.68 | 0.68 | 0.65 | 0.68 | 0.66 | 0.70 |
| 1998 | 0.77 | 0.68 | 0.67 | 0.75 | 0.72 | 0.62 | 0.81 | 0.71 | 0.68 | 0.68 | 0.55 | 0.65 | 0.63 | 0.67 |
| 1999 | 0.66 | 0.68 | 0.76 | 0.75 | 0.71 | 0.61 | 0.81 | 0.71 | 0.68 | 0.68 | 0.55 | 0.65 | 0.63 | 0.67 |
| 2000 | 0.66 | 0.76 | 0.80 | 0.64 | 0.71 | 0.63 | 0.80 | 0.80 | 0.71 | 0.78 | 0.60 | 0.73 | 0.71 | 0.75 |
| 2001 | 0.72 | 0.76 | 0.78 | 0.64 | 0.73 | 0.65 | 0.80 | 0.66 | 0.71 | 0.62 | 0.60 | 0.63 | 0.61 | 0.65 |
| 2002 | 0.69 | 0.76 | 0.81 | 0.64 | 0.72 | 0.65 | 0.80 | 0.66 | 0.60 | 0.62 | 0.60 | 0.62 | 0.60 | 0.64 |
| 2003 | 0.69 | 0.78 | 0.64 | 0.63 | 0.68 | 0.61 | 0.76 | 0.65 | 0.62 | 0.62 | 0.61 | 0.62 | 0.60 | 0.64 |
| 2004 | 0.70 | 0.79 | 0.64 | 0.63 | 0.69 | 0.63 | 0.76 | 0.65 | 0.62 | 0.62 | 0.61 | 0.62 | 0.60 | 0.64 |
| 2005 | 0.70 | 0.59 | 0.63 | 0.63 | 0.64 | 0.57 | 0.71 | 0.65 | 0.62 | 0.62 | 0.61 | 0.62 | 0.60 | 0.64 |
| 2006 | 0.71 | 0.59 | 0.67 | 0.63 | 0.65 | 0.58 | 0.73 | 0.65 | 0.62 | 0.62 | 0.61 | 0.62 | 0.60 | 0.64 |
| 2007 | 0.73 | 0.58 | 0.65 | 0.62 | 0.65 | 0.55 | 0.75 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2008 | 0.70 | 0.58 | 0.63 | 0.62 | 0.63 | 0.47 | 0.80 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2009 | 0.69 | 0.58 | 0.61 | 0.62 | 0.63 | 0.46 | 0.79 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2010 | 0.72 | 0.58 | 0.63 | 0.62 | 0.64 | 0.47 | 0.80 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2011 | 0.70 | 0.58 | 0.64 | 0.62 | 0.64 | 0.47 | 0.80 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2012 | 0.73 | 0.58 | 0.67 | 0.62 | 0.65 | 0.49 | 0.82 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2013 | 0.71 | 0.58 | 0.64 | 0.62 | 0.64 | 0.47 | 0.81 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2014 | 0.72 | 0.58 | 0.65 | 0.62 | 0.64 | 0.47 | 0.82 | 0.65 | 0.64 | 0.63 | 0.63 | 0.63 | 0.61 | 0.65 |
| 2015 | 0.75 | 0.49 | 0.69 | 0.64 | 0.69 | 0.62 | 0.76 | 0.70 | 0.65 | 0.66 | 0.63 | 0.66 | 0.63 | 0.68 |
| 2016 | 0.71 | 0.45 | 0.68 | 0.64 | 0.68 | 0.60 | 0.75 | 0.69 | 0.66 | 0.64 | 0.63 | 0.65 | 0.63 | 0.67 |
| 2017 | 0.73 | 0.47 | 0.72 | 0.64 | 0.69 | 0.62 | 0.76 | 0.65 | 0.66 | 0.64 | 0.64 | 0.64 | 0.62 | 0.67 |

*NYOHS 1988-2007, NYTRL 2008-2017

** Unweighted average of coastal program for 2015-2017 excludes NYTRL owing to issues of small sample size.

*** Weighting scheme: Hudson (0.13); Delaware (0.09); Chesapeake Bay (0.78), where MD (0.67) and VA (0.33)

Table B8.12. Model-averaged estimates of survival (S) and unconditional standard error (SE) from IRCR analyses of striped bass (≥ 18 inches; 457 mm) tagged by coastal and producer areas programs.

| | Coastal Programs | | | | | | | | Producer Area Programs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MADFW | | NYOHS/ NYTRL* | | NJDB | | NCCOOP | | HUDSON | | DE/PA | | MDCB | | VARAP | |
| Year | S | SE | S | SE | S | SE | S | SE | S | SE | S | SE | S | SE | S | SE |
| 1987 | | | | | | | | | | | | | 0.83 | 0.01 | | |
| 1988 | | | 0.84 | 0.01 | | | 0.79 | 0.04 | 0.82 | 0.01 | | | 0.83 | 0.01 | | |
| 1989 | | | 0.84 | 0.01 | 0.85 | 0.02 | 0.79 | 0.04 | 0.82 | 0.01 | | | 0.83 | 0.01 | | |
| 1990 | | | 0.80 | 0.01 | 0.84 | 0.01 | 0.73 | 0.03 | 0.77 | 0.01 | | | 0.77 | 0.01 | 0.64 | 0.02 |
| 1991 | | | 0.79 | 0.01 | 0.84 | 0.01 | 0.73 | 0.03 | 0.77 | 0.01 | | | 0.74 | 0.01 | 0.64 | 0.02 |
| 1992 | 0.87 | 0.02 | 0.80 | 0.01 | 0.84 | 0.01 | 0.73 | 0.03 | 0.77 | 0.01 | | | 0.69 | 0.01 | 0.64 | 0.02 |
| 1993 | 0.85 | 0.01 | 0.79 | 0.01 | 0.84 | 0.01 | 0.73 | 0.03 | 0.77 | 0.01 | 0.75 | 0.03 | 0.71 | 0.01 | 0.64 | 0.02 |
| 1994 | 0.84 | 0.01 | 0.81 | 0.01 | 0.84 | 0.01 | 0.73 | 0.03 | 0.77 | 0.01 | 0.72 | 0.03 | 0.71 | 0.01 | 0.64 | 0.02 |
| 1995 | 0.84 | 0.01 | 0.79 | 0.01 | 0.77 | 0.01 | 0.70 | 0.04 | 0.71 | 0.01 | 0.74 | 0.02 | 0.66 | 0.01 | 0.62 | 0.02 |
| 1996 | 0.79 | 0.02 | 0.78 | 0.01 | 0.77 | 0.01 | 0.70 | 0.04 | 0.71 | 0.01 | 0.51 | 0.03 | 0.68 | 0.01 | 0.62 | 0.02 |
| 1997 | 0.77 | 0.02 | 0.78 | 0.01 | 0.77 | 0.01 | 0.70 | 0.04 | 0.71 | 0.01 | 0.72 | 0.02 | 0.65 | 0.01 | 0.62 | 0.02 |
| 1998 | 0.79 | 0.02 | 0.78 | 0.01 | 0.77 | 0.01 | 0.70 | 0.04 | 0.71 | 0.01 | 0.70 | 0.02 | 0.63 | 0.02 | 0.49 | 0.02 |
| 1999 | 0.68 | 0.01 | 0.64 | 0.01 | 0.77 | 0.01 | 0.70 | 0.04 | 0.71 | 0.01 | 0.74 | 0.02 | 0.47 | 0.01 | 0.49 | 0.02 |
| 2000 | 0.68 | 0.02 | 0.66 | 0.01 | 0.78 | 0.01 | 0.58 | 0.03 | 0.79 | 0.01 | 0.72 | 0.02 | 0.50 | 0.01 | 0.50 | 0.02 |
| 2001 | 0.73 | 0.01 | 0.65 | 0.01 | 0.78 | 0.01 | 0.58 | 0.03 | 0.79 | 0.01 | 0.73 | 0.02 | 0.52 | 0.01 | 0.50 | 0.02 |
| 2002 | 0.69 | 0.01 | 0.65 | 0.02 | 0.66 | 0.01 | 0.58 | 0.03 | 0.65 | 0.01 | 0.58 | 0.01 | 0.54 | 0.01 | 0.50 | 0.02 |
| 2003 | 0.69 | 0.01 | 0.64 | 0.02 | 0.64 | 0.01 | 0.58 | 0.03 | 0.65 | 0.01 | 0.55 | 0.02 | 0.51 | 0.01 | 0.50 | 0.02 |
| 2004 | 0.70 | 0.01 | 0.65 | 0.02 | 0.64 | 0.01 | 0.58 | 0.03 | 0.65 | 0.01 | 0.56 | 0.02 | 0.53 | 0.01 | 0.50 | 0.02 |
| 2005 | 0.70 | 0.01 | 0.66 | 0.01 | 0.64 | 0.01 | 0.58 | 0.03 | 0.65 | 0.01 | 0.56 | 0.02 | 0.54 | 0.01 | 0.50 | 0.02 |
| 2006 | 0.71 | 0.01 | 0.66 | 0.01 | 0.65 | 0.01 | 0.58 | 0.03 | 0.65 | 0.01 | 0.56 | 0.02 | 0.53 | 0.01 | 0.50 | 0.02 |
| 2007 | 0.73 | 0.01 | 0.67 | 0.02 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.59 | 0.02 | 0.56 | 0.01 | 0.52 | 0.02 |
| 2008 | 0.71 | 0.01 | 0.60 | 0.03 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.59 | 0.02 | 0.55 | 0.02 | 0.52 | 0.02 |
| 2009 | 0.69 | 0.01 | 0.60 | 0.03 | 0.65 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.56 | 0.02 | 0.52 | 0.02 | 0.52 | 0.02 |
| 2010 | 0.72 | 0.01 | 0.59 | 0.04 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.57 | 0.02 | 0.54 | 0.02 | 0.52 | 0.02 |
| 2011 | 0.69 | 0.01 | 0.60 | 0.03 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.59 | 0.02 | 0.53 | 0.01 | 0.52 | 0.02 |
| 2012 | 0.73 | 0.01 | 0.59 | 0.04 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.59 | 0.02 | 0.55 | 0.01 | 0.52 | 0.02 |
| 2013 | 0.71 | 0.01 | 0.59 | 0.04 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.58 | 0.02 | 0.53 | 0.01 | 0.52 | 0.02 |
| 2014 | 0.71 | 0.01 | 0.61 | 0.03 | 0.64 | 0.01 | 0.57 | 0.04 | 0.64 | 0.01 | 0.58 | 0.02 | 0.51 | 0.02 | 0.52 | 0.02 |
| 2015 | 0.74 | 0.01 | 0.60 | 0.05 | 0.69 | 0.02 | 0.56 | 0.04 | 0.67 | 0.01 | 0.59 | 0.02 | 0.54 | 0.01 | 0.52 | 0.02 |
| 2016 | 0.70 | 0.01 | 0.57 | 0.09 | 0.69 | 0.02 | 0.56 | 0.04 | 0.67 | 0.01 | 0.60 | 0.02 | 0.54 | 0.01 | 0.52 | 0.02 |
| 2017 | 0.73 | 0.01 | 0.62 | 0.05 | 0.69 | 0.02 | 0.56 | 0.05 | 0.64 | 0.01 | 0.60 | 0.02 | 0.55 | 0.01 | 0.52 | 0.02 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.13. Tag-based estimates of survival (from IRCR analyses) for ≥ 18 inch (457 mm) striped bass, including an unweighted average for coastal programs, a weighted average for producer area programs, and 95% confidence intervals.

| | Coastal programs | | | | | | | Producer area programs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | Unweighted average** | 95% LCI | 95% UCI | HUDSON | DE/PA | MDCB | VARAP | Weighted average*** | 95% LCI | 95% UCI |
| 1987 | | | | | | | | | | 0.83 | | 0.83 | 0.82 | 0.84 |
| 1988 | | 0.84 | | 0.78 | 0.84 | 0.82 | 0.85 | 0.82 | | 0.83 | | 0.82 | 0.81 | 0.83 |
| 1989 | | 0.84 | 0.85 | 0.78 | 0.84 | 0.81 | 0.88 | 0.82 | | 0.83 | | 0.83 | 0.82 | 0.84 |
| 1990 | | 0.80 | 0.84 | 0.73 | 0.82 | 0.79 | 0.85 | 0.77 | | 0.77 | 0.64 | 0.74 | 0.72 | 0.75 |
| 1991 | | 0.79 | 0.84 | 0.73 | 0.81 | 0.78 | 0.85 | 0.77 | | 0.74 | 0.64 | 0.71 | 0.70 | 0.73 |
| 1992 | 0.87 | 0.80 | 0.84 | 0.73 | 0.84 | 0.79 | 0.88 | 0.77 | | 0.69 | 0.64 | 0.69 | 0.67 | 0.70 |
| 1993 | 0.85 | 0.79 | 0.84 | 0.73 | 0.83 | 0.79 | 0.87 | 0.77 | 0.75 | 0.71 | 0.64 | 0.70 | 0.69 | 0.72 |
| 1994 | 0.84 | 0.81 | 0.84 | 0.73 | 0.83 | 0.79 | 0.87 | 0.77 | 0.72 | 0.71 | 0.64 | 0.70 | 0.69 | 0.72 |
| 1995 | 0.84 | 0.79 | 0.77 | 0.70 | 0.80 | 0.76 | 0.84 | 0.71 | 0.74 | 0.66 | 0.62 | 0.66 | 0.65 | 0.68 |
| 1996 | 0.79 | 0.78 | 0.77 | 0.70 | 0.78 | 0.74 | 0.82 | 0.71 | 0.51 | 0.68 | 0.62 | 0.65 | 0.64 | 0.67 |
| 1997 | 0.77 | 0.78 | 0.77 | 0.70 | 0.77 | 0.73 | 0.82 | 0.71 | 0.72 | 0.65 | 0.62 | 0.66 | 0.64 | 0.67 |
| 1998 | 0.79 | 0.78 | 0.77 | 0.70 | 0.78 | 0.73 | 0.83 | 0.71 | 0.70 | 0.63 | 0.49 | 0.61 | 0.59 | 0.63 |
| 1999 | 0.68 | 0.64 | 0.77 | 0.70 | 0.70 | 0.66 | 0.74 | 0.71 | 0.74 | 0.47 | 0.49 | 0.53 | 0.52 | 0.55 |
| 2000 | 0.68 | 0.66 | 0.78 | 0.58 | 0.71 | 0.66 | 0.75 | 0.79 | 0.72 | 0.50 | 0.50 | 0.56 | 0.54 | 0.58 |
| 2001 | 0.73 | 0.65 | 0.78 | 0.58 | 0.72 | 0.68 | 0.76 | 0.79 | 0.73 | 0.52 | 0.50 | 0.57 | 0.55 | 0.59 |
| 2002 | 0.69 | 0.65 | 0.66 | 0.58 | 0.67 | 0.62 | 0.71 | 0.65 | 0.58 | 0.54 | 0.50 | 0.55 | 0.53 | 0.56 |
| 2003 | 0.69 | 0.64 | 0.64 | 0.58 | 0.66 | 0.61 | 0.71 | 0.65 | 0.55 | 0.51 | 0.50 | 0.53 | 0.51 | 0.55 |
| 2004 | 0.70 | 0.65 | 0.64 | 0.58 | 0.66 | 0.62 | 0.71 | 0.65 | 0.56 | 0.53 | 0.50 | 0.54 | 0.53 | 0.56 |
| 2005 | 0.70 | 0.66 | 0.64 | 0.58 | 0.67 | 0.62 | 0.71 | 0.65 | 0.56 | 0.54 | 0.50 | 0.55 | 0.53 | 0.56 |
| 2006 | 0.71 | 0.66 | 0.65 | 0.58 | 0.67 | 0.63 | 0.71 | 0.65 | 0.56 | 0.53 | 0.50 | 0.54 | 0.52 | 0.56 |
| 2007 | 0.73 | 0.67 | 0.64 | 0.57 | 0.68 | 0.64 | 0.72 | 0.64 | 0.59 | 0.56 | 0.52 | 0.56 | 0.54 | 0.58 |
| 2008 | 0.71 | 0.60 | 0.64 | 0.57 | 0.65 | 0.58 | 0.72 | 0.64 | 0.59 | 0.55 | 0.52 | 0.55 | 0.54 | 0.57 |
| 2009 | 0.69 | 0.60 | 0.65 | 0.57 | 0.65 | 0.57 | 0.72 | 0.64 | 0.56 | 0.52 | 0.52 | 0.54 | 0.52 | 0.56 |
| 2010 | 0.72 | 0.59 | 0.64 | 0.57 | 0.65 | 0.57 | 0.73 | 0.64 | 0.57 | 0.54 | 0.52 | 0.55 | 0.53 | 0.57 |
| 2011 | 0.69 | 0.60 | 0.64 | 0.57 | 0.64 | 0.57 | 0.72 | 0.64 | 0.59 | 0.53 | 0.52 | 0.55 | 0.53 | 0.57 |
| 2012 | 0.73 | 0.59 | 0.64 | 0.57 | 0.66 | 0.57 | 0.74 | 0.64 | 0.59 | 0.55 | 0.52 | 0.56 | 0.54 | 0.57 |
| 2013 | 0.71 | 0.59 | 0.64 | 0.57 | 0.65 | 0.55 | 0.74 | 0.64 | 0.58 | 0.53 | 0.52 | 0.55 | 0.53 | 0.57 |
| 2014 | 0.71 | 0.61 | 0.64 | 0.57 | 0.66 | 0.58 | 0.73 | 0.64 | 0.58 | 0.51 | 0.52 | 0.53 | 0.51 | 0.55 |
| 2015 | 0.74 | 0.60 | 0.69 | 0.56 | 0.68 | 0.57 | 0.79 | 0.67 | 0.59 | 0.54 | 0.52 | 0.55 | 0.54 | 0.57 |
| 2016 | 0.70 | 0.57 | 0.69 | 0.56 | 0.65 | 0.47 | 0.83 | 0.67 | 0.60 | 0.54 | 0.52 | 0.56 | 0.54 | 0.58 |
| 2017 | 0.73 | 0.62 | 0.69 | 0.56 | 0.68 | 0.58 | 0.78 | 0.64 | 0.60 | 0.55 | 0.52 | 0.56 | 0.54 | 0.58 |

*NYOHS 1988-2007, NYTRL 2008-2017

** Unweighted average of coastal programs excludes NCCOOP estimates owing to model diagnostic issue of a high c-hat estimate.

*** Weighting scheme: Hudson (0.13); Delaware (0.09); Chesapeake Bay (0.78), where MD (0.67) and VA (0.33)

Table B8.14. Model-averaged estimates of instantaneous fishing mortality (F) and unconditional standard error (SE) from IRCR analyses of striped bass (≥ 28 inches; 711 mm) tagged by coastal and producer areas programs.

| | Coastal Programs | | | | | | | | Producer Area Programs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MADFW | | NYOHS/ NYTRL* | | NJDB | | NCCOOP | | HUDSON | | DE/PA | | MDCB | | VARAP | |
| Year | F | SE | F | SE | F | SE | F | SE | F | SE | F | SE | F | SE | F | SE |
| 1987 | | | | | | | | | | | | | 0.03 | 0.01 | | |
| 1988 | | | 0.04 | 0.01 | | | 0.05 | 0.02 | 0.09 | 0.02 | | | 0.03 | 0.01 | | |
| 1989 | | | 0.04 | 0.01 | 0.00 | 0.00 | 0.05 | 0.02 | 0.09 | 0.02 | | | 0.03 | 0.01 | | |
| 1990 | | | 0.15 | 0.03 | 0.11 | 0.08 | 0.12 | 0.01 | 0.16 | 0.01 | | | 0.13 | 0.01 | 0.14 | 0.02 |
| 1991 | | | 0.17 | 0.02 | 0.39 | 0.16 | 0.12 | 0.01 | 0.16 | 0.01 | | | 0.13 | 0.01 | 0.14 | 0.02 |
| 1992 | 0.03 | 0.02 | 0.16 | 0.02 | 0.00 | 0.00 | 0.12 | 0.01 | 0.16 | 0.01 | | | 0.13 | 0.01 | 0.14 | 0.02 |
| 1993 | 0.06 | 0.01 | 0.17 | 0.02 | 0.11 | 0.05 | 0.12 | 0.01 | 0.16 | 0.01 | 0.16 | 0.05 | 0.13 | 0.01 | 0.14 | 0.02 |
| 1994 | 0.08 | 0.01 | 0.16 | 0.02 | 0.05 | 0.02 | 0.12 | 0.01 | 0.16 | 0.01 | 0.16 | 0.05 | 0.13 | 0.01 | 0.14 | 0.02 |
| 1995 | 0.09 | 0.02 | 0.29 | 0.03 | 0.11 | 0.02 | 0.18 | 0.02 | 0.26 | 0.01 | 0.27 | 0.03 | 0.25 | 0.01 | 0.20 | 0.03 |
| 1996 | 0.17 | 0.02 | 0.29 | 0.03 | 0.21 | 0.02 | 0.18 | 0.02 | 0.26 | 0.01 | 0.27 | 0.03 | 0.25 | 0.01 | 0.20 | 0.03 |
| 1997 | 0.19 | 0.02 | 0.31 | 0.03 | 0.19 | 0.03 | 0.18 | 0.02 | 0.26 | 0.01 | 0.27 | 0.03 | 0.25 | 0.01 | 0.20 | 0.03 |
| 1998 | 0.16 | 0.02 | 0.32 | 0.05 | 0.33 | 0.04 | 0.18 | 0.02 | 0.26 | 0.01 | 0.27 | 0.03 | 0.25 | 0.01 | 0.20 | 0.03 |
| 1999 | 0.18 | 0.03 | 0.32 | 0.06 | 0.19 | 0.03 | 0.18 | 0.02 | 0.26 | 0.01 | 0.27 | 0.03 | 0.25 | 0.01 | 0.20 | 0.03 |
| 2000 | 0.17 | 0.03 | 0.20 | 0.03 | 0.15 | 0.03 | 0.13 | 0.02 | 0.14 | 0.01 | 0.22 | 0.02 | 0.12 | 0.01 | 0.11 | 0.02 |
| 2001 | 0.08 | 0.02 | 0.20 | 0.03 | 0.17 | 0.02 | 0.13 | 0.02 | 0.14 | 0.01 | 0.22 | 0.02 | 0.12 | 0.01 | 0.11 | 0.02 |
| 2002 | 0.13 | 0.02 | 0.20 | 0.03 | 0.14 | 0.02 | 0.13 | 0.02 | 0.14 | 0.01 | 0.22 | 0.02 | 0.12 | 0.01 | 0.11 | 0.02 |
| 2003 | 0.14 | 0.02 | 0.18 | 0.04 | 0.17 | 0.02 | 0.13 | 0.01 | 0.16 | 0.01 | 0.19 | 0.02 | 0.12 | 0.01 | 0.10 | 0.01 |
| 2004 | 0.11 | 0.02 | 0.17 | 0.03 | 0.17 | 0.02 | 0.13 | 0.01 | 0.16 | 0.01 | 0.19 | 0.02 | 0.12 | 0.01 | 0.10 | 0.01 |
| 2005 | 0.11 | 0.02 | 0.17 | 0.03 | 0.19 | 0.02 | 0.13 | 0.01 | 0.16 | 0.01 | 0.19 | 0.02 | 0.12 | 0.01 | 0.10 | 0.01 |
| 2006 | 0.11 | 0.01 | 0.16 | 0.03 | 0.13 | 0.02 | 0.13 | 0.01 | 0.16 | 0.01 | 0.19 | 0.02 | 0.12 | 0.01 | 0.10 | 0.01 |
| 2007 | 0.07 | 0.01 | 0.19 | 0.06 | 0.16 | 0.02 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2008 | 0.12 | 0.01 | 0.11 | 0.03 | 0.19 | 0.02 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2009 | 0.13 | 0.02 | 0.11 | 0.03 | 0.23 | 0.03 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.02 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2010 | 0.09 | 0.01 | 0.11 | 0.03 | 0.20 | 0.02 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2011 | 0.12 | 0.02 | 0.11 | 0.03 | 0.17 | 0.02 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2012 | 0.07 | 0.01 | 0.11 | 0.03 | 0.14 | 0.02 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2013 | 0.10 | 0.01 | 0.11 | 0.03 | 0.17 | 0.03 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2014 | 0.09 | 0.01 | 0.11 | 0.03 | 0.16 | 0.04 | 0.15 | 0.01 | 0.16 | 0.01 | 0.16 | 0.01 | 0.11 | 0.01 | 0.06 | 0.01 |
| 2015 | 0.05 | 0.01 | 0.28 | 0.32 | 0.11 | 0.04 | 0.12 | 0.01 | 0.09 | 0.01 | 0.14 | 0.03 | 0.06 | 0.02 | 0.06 | 0.01 |
| 2016 | 0.11 | 0.01 | 0.67 | 3.67 | 0.12 | 0.04 | 0.12 | 0.01 | 0.09 | 0.01 | 0.13 | 0.03 | 0.09 | 0.01 | 0.06 | 0.01 |
| 2017 | 0.08 | 0.01 | 0.63 | 3.67 | 0.07 | 0.04 | 0.12 | 0.01 | 0.16 | 0.02 | 0.12 | 0.03 | 0.09 | 0.01 | 0.06 | 0.02 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.15. Tag-based estimates of instantaneous fishing mortality (from IRCR analyses) for ≥ 28-inch (711 mm) striped bass, including an unweighted average for coastal programs, a weighted average for producer area programs, and 95% confidence intervals.

| | Coastal programs | | | | | | | Producer area programs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | Unweighted average** | 95% LCI | 95% UCI | HUDSON | DE/PA | MDCB | VARAP | Weighted average*** | 95% LCI | 95% UCI |
| 1987 | | | | | | | | | | 0.03 | | 0.03 | 0.01 | 0.05 |
| 1988 | | 0.04 | | 0.05 | 0.05 | -0.01 | 0.10 | 0.09 | | 0.03 | | 0.04 | 0.02 | 0.06 |
| 1989 | | 0.04 | 0.00 | 0.05 | 0.03 | -0.02 | 0.08 | 0.09 | | 0.03 | | 0.04 | 0.02 | 0.06 |
| 1990 | | 0.15 | 0.11 | 0.12 | 0.13 | -0.04 | 0.30 | 0.16 | | 0.13 | 0.14 | 0.14 | 0.12 | 0.16 |
| 1991 | | 0.17 | 0.39 | 0.12 | 0.23 | -0.10 | 0.55 | 0.16 | | 0.13 | 0.14 | 0.14 | 0.12 | 0.16 |
| 1992 | 0.03 | 0.16 | 0.00 | 0.12 | 0.08 | 0.03 | 0.13 | 0.16 | | 0.13 | 0.14 | 0.14 | 0.12 | 0.16 |
| 1993 | 0.06 | 0.17 | 0.11 | 0.12 | 0.11 | 0.00 | 0.23 | 0.16 | 0.16 | 0.13 | 0.14 | 0.14 | 0.12 | 0.16 |
| 1994 | 0.08 | 0.16 | 0.05 | 0.12 | 0.10 | 0.04 | 0.16 | 0.16 | 0.16 | 0.13 | 0.14 | 0.14 | 0.12 | 0.16 |
| 1995 | 0.09 | 0.29 | 0.11 | 0.17 | 0.17 | 0.08 | 0.25 | 0.26 | 0.27 | 0.25 | 0.20 | 0.24 | 0.22 | 0.26 |
| 1996 | 0.17 | 0.29 | 0.21 | 0.17 | 0.21 | 0.13 | 0.30 | 0.26 | 0.27 | 0.25 | 0.20 | 0.24 | 0.22 | 0.26 |
| 1997 | 0.19 | 0.31 | 0.19 | 0.17 | 0.22 | 0.11 | 0.32 | 0.26 | 0.27 | 0.25 | 0.20 | 0.24 | 0.22 | 0.26 |
| 1998 | 0.16 | 0.32 | 0.33 | 0.17 | 0.24 | 0.11 | 0.37 | 0.26 | 0.27 | 0.25 | 0.20 | 0.24 | 0.22 | 0.26 |
| 1999 | 0.18 | 0.32 | 0.19 | 0.17 | 0.22 | 0.07 | 0.36 | 0.26 | 0.27 | 0.25 | 0.20 | 0.24 | 0.22 | 0.26 |
| 2000 | 0.17 | 0.20 | 0.15 | 0.13 | 0.16 | 0.06 | 0.27 | 0.14 | 0.22 | 0.12 | 0.11 | 0.13 | 0.11 | 0.15 |
| 2001 | 0.08 | 0.20 | 0.17 | 0.13 | 0.15 | 0.06 | 0.24 | 0.14 | 0.22 | 0.12 | 0.11 | 0.13 | 0.11 | 0.15 |
| 2002 | 0.13 | 0.20 | 0.14 | 0.13 | 0.15 | 0.06 | 0.24 | 0.14 | 0.22 | 0.12 | 0.11 | 0.13 | 0.11 | 0.15 |
| 2003 | 0.14 | 0.18 | 0.17 | 0.13 | 0.16 | 0.06 | 0.25 | 0.16 | 0.19 | 0.12 | 0.10 | 0.12 | 0.11 | 0.14 |
| 2004 | 0.11 | 0.17 | 0.17 | 0.13 | 0.15 | 0.08 | 0.22 | 0.16 | 0.19 | 0.12 | 0.10 | 0.12 | 0.11 | 0.14 |
| 2005 | 0.11 | 0.17 | 0.19 | 0.13 | 0.15 | 0.07 | 0.23 | 0.16 | 0.19 | 0.12 | 0.10 | 0.12 | 0.11 | 0.14 |
| 2006 | 0.11 | 0.16 | 0.13 | 0.13 | 0.13 | 0.05 | 0.22 | 0.16 | 0.19 | 0.12 | 0.10 | 0.12 | 0.11 | 0.14 |
| 2007 | 0.07 | 0.19 | 0.16 | 0.15 | 0.14 | 0.02 | 0.27 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2008 | 0.12 | 0.11 | 0.19 | 0.15 | 0.14 | 0.06 | 0.23 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2009 | 0.13 | 0.11 | 0.23 | 0.15 | 0.15 | 0.06 | 0.24 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2010 | 0.09 | 0.11 | 0.20 | 0.15 | 0.14 | 0.05 | 0.22 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2011 | 0.12 | 0.11 | 0.17 | 0.15 | 0.14 | 0.05 | 0.22 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2012 | 0.07 | 0.11 | 0.14 | 0.15 | 0.12 | 0.03 | 0.20 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2013 | 0.10 | 0.11 | 0.17 | 0.15 | 0.13 | 0.04 | 0.23 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2014 | 0.09 | 0.11 | 0.16 | 0.15 | 0.13 | 0.02 | 0.23 | 0.16 | 0.16 | 0.11 | 0.06 | 0.11 | 0.10 | 0.12 |
| 2015 | 0.05 | 0.28 | 0.11 | 0.12 | 0.09 | 0.01 | 0.17 | 0.09 | 0.14 | 0.06 | 0.06 | 0.07 | 0.05 | 0.09 |
| 2016 | 0.11 | 0.67 | 0.12 | 0.12 | 0.12 | 0.03 | 0.21 | 0.09 | 0.13 | 0.09 | 0.06 | 0.08 | 0.07 | 0.10 |
| 2017 | 0.08 | 0.63 | 0.07 | 0.12 | 0.09 | 0.01 | 0.17 | 0.16 | 0.12 | 0.09 | 0.06 | 0.09 | 0.07 | 0.11 |

*NYOHS 1988-2007, NYTRL 2008-2017

** Unweighted average of coastal program for 2015-2017 excludes NYTRL owing to issues of small sample size.

*** Weighting scheme: Hudson (0.13); Delaware (0.09); Chesapeake Bay (0.78), where MD (0.67) and VA (0.33)

Table B8.16. Model-averaged estimates of instantaneous fishing mortality (F) and unconditional standard error (SE) from IRCR analyses of striped bass (≥ 18 inches; 457 mm) tagged by coastal and producer areas programs.

| | Coastal Programs | | | | | | | | Producer Area Programs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MADFW | | NYOHS/ NYTRL* | | NJDB | | NCCOOP | | HUDSON | | DE/PA | | MDCB | | VARAP | |
| Year | F | SE | F | SE | F | SE | F | SE | F | SE | F | SE | F | SE | F | SE |
| 1987 | | | | | | | | | | | | | 0.00 | 0.00 | | |
| 1988 | | | 0.01 | 0.01 | | | 0.02 | 0.03 | 0.05 | 0.01 | | | 0.01 | 0.00 | | |
| 1989 | | | 0.01 | 0.00 | 0.02 | 0.02 | 0.02 | 0.03 | 0.05 | 0.01 | | | 0.00 | 0.00 | | |
| 1990 | | | 0.06 | 0.01 | 0.04 | 0.01 | 0.10 | 0.03 | 0.11 | 0.01 | | | 0.08 | 0.01 | 0.08 | 0.01 |
| 1991 | | | 0.07 | 0.01 | 0.04 | 0.01 | 0.10 | 0.03 | 0.11 | 0.01 | | | 0.12 | 0.01 | 0.08 | 0.01 |
| 1992 | 0.03 | 0.01 | 0.06 | 0.01 | 0.03 | 0.01 | 0.10 | 0.03 | 0.11 | 0.01 | | | 0.18 | 0.01 | 0.08 | 0.01 |
| 1993 | 0.05 | 0.01 | 0.07 | 0.01 | 0.03 | 0.01 | 0.10 | 0.03 | 0.11 | 0.01 | 0.11 | 0.04 | 0.17 | 0.01 | 0.08 | 0.01 |
| 1994 | 0.07 | 0.01 | 0.06 | 0.01 | 0.03 | 0.01 | 0.10 | 0.03 | 0.11 | 0.01 | 0.14 | 0.04 | 0.16 | 0.01 | 0.08 | 0.01 |
| 1995 | 0.07 | 0.01 | 0.09 | 0.01 | 0.12 | 0.01 | 0.15 | 0.04 | 0.20 | 0.01 | 0.11 | 0.02 | 0.23 | 0.02 | 0.11 | 0.01 |
| 1996 | 0.13 | 0.01 | 0.09 | 0.01 | 0.12 | 0.01 | 0.15 | 0.04 | 0.20 | 0.01 | 0.48 | 0.06 | 0.21 | 0.02 | 0.11 | 0.01 |
| 1997 | 0.15 | 0.02 | 0.10 | 0.01 | 0.13 | 0.01 | 0.15 | 0.04 | 0.20 | 0.01 | 0.14 | 0.03 | 0.25 | 0.02 | 0.11 | 0.01 |
| 1998 | 0.13 | 0.02 | 0.09 | 0.01 | 0.13 | 0.01 | 0.15 | 0.04 | 0.20 | 0.01 | 0.18 | 0.03 | 0.28 | 0.02 | 0.11 | 0.01 |
| 1999 | 0.13 | 0.02 | 0.09 | 0.01 | 0.12 | 0.01 | 0.15 | 0.04 | 0.20 | 0.01 | 0.12 | 0.02 | 0.25 | 0.03 | 0.11 | 0.01 |
| 2000 | 0.13 | 0.02 | 0.07 | 0.01 | 0.11 | 0.01 | 0.11 | 0.03 | 0.10 | 0.01 | 0.14 | 0.02 | 0.20 | 0.02 | 0.08 | 0.01 |
| 2001 | 0.07 | 0.01 | 0.07 | 0.01 | 0.12 | 0.01 | 0.11 | 0.03 | 0.10 | 0.01 | 0.13 | 0.02 | 0.16 | 0.02 | 0.08 | 0.01 |
| 2002 | 0.13 | 0.02 | 0.08 | 0.01 | 0.11 | 0.01 | 0.11 | 0.03 | 0.10 | 0.01 | 0.10 | 0.02 | 0.12 | 0.02 | 0.08 | 0.01 |
| 2003 | 0.12 | 0.02 | 0.09 | 0.02 | 0.13 | 0.01 | 0.11 | 0.02 | 0.11 | 0.00 | 0.16 | 0.02 | 0.17 | 0.02 | 0.09 | 0.01 |
| 2004 | 0.11 | 0.01 | 0.09 | 0.01 | 0.13 | 0.01 | 0.11 | 0.02 | 0.11 | 0.00 | 0.13 | 0.02 | 0.14 | 0.02 | 0.09 | 0.01 |
| 2005 | 0.11 | 0.01 | 0.07 | 0.01 | 0.13 | 0.01 | 0.11 | 0.02 | 0.11 | 0.00 | 0.13 | 0.02 | 0.12 | 0.02 | 0.09 | 0.01 |
| 2006 | 0.10 | 0.01 | 0.07 | 0.01 | 0.13 | 0.01 | 0.11 | 0.02 | 0.11 | 0.00 | 0.13 | 0.02 | 0.14 | 0.02 | 0.09 | 0.01 |
| 2007 | 0.07 | 0.01 | 0.06 | 0.01 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.08 | 0.02 | 0.09 | 0.02 | 0.06 | 0.01 |
| 2008 | 0.10 | 0.01 | 0.08 | 0.02 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.09 | 0.02 | 0.11 | 0.02 | 0.06 | 0.01 |
| 2009 | 0.12 | 0.01 | 0.09 | 0.01 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.13 | 0.02 | 0.16 | 0.02 | 0.06 | 0.01 |
| 2010 | 0.08 | 0.01 | 0.10 | 0.02 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.12 | 0.02 | 0.13 | 0.02 | 0.06 | 0.01 |
| 2011 | 0.13 | 0.02 | 0.09 | 0.01 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.08 | 0.02 | 0.13 | 0.02 | 0.06 | 0.01 |
| 2012 | 0.07 | 0.01 | 0.10 | 0.02 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.09 | 0.02 | 0.10 | 0.02 | 0.06 | 0.01 |
| 2013 | 0.10 | 0.01 | 0.11 | 0.04 | 0.14 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.09 | 0.02 | 0.13 | 0.02 | 0.06 | 0.01 |
| 2014 | 0.09 | 0.01 | 0.07 | 0.03 | 0.13 | 0.01 | 0.13 | 0.03 | 0.12 | 0.00 | 0.10 | 0.02 | 0.19 | 0.03 | 0.06 | 0.01 |
| 2015 | 0.05 | 0.01 | 0.09 | 0.05 | 0.07 | 0.02 | 0.14 | 0.05 | 0.07 | 0.01 | 0.09 | 0.02 | 0.13 | 0.02 | 0.06 | 0.01 |
| 2016 | 0.11 | 0.01 | 0.15 | 0.13 | 0.07 | 0.02 | 0.15 | 0.05 | 0.08 | 0.01 | 0.06 | 0.02 | 0.12 | 0.02 | 0.06 | 0.01 |
| 2017 | 0.08 | 0.01 | 0.06 | 0.07 | 0.07 | 0.02 | 0.15 | 0.06 | 0.12 | 0.01 | 0.07 | 0.02 | 0.11 | 0.01 | 0.06 | 0.01 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.17. Tag-based estimates of instantaneous fishing mortality (from IRCR analyses) for ≥ 18- inch (457 mm) striped bass, including an unweighted average for coastal programs, a weighted average for producer area programs, and 95% confidence intervals.

| | Coastal programs | | | | | | | Producer area programs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | Unweighted average** | 95% LCI | 95% UCI | HUDSON | DE/PA | MDCB | VARAP | Weighted average*** | 95% LCI | 95% UCI |
| 1987 | | | | | | | | | | 0.00 | | 0.00 | 0.00 | 0.01 |
| 1988 | | 0.01 | | 0.03 | 0.01 | 0.00 | 0.02 | 0.05 | | 0.01 | | 0.02 | 0.01 | 0.02 |
| 1989 | | 0.01 | 0.02 | 0.03 | 0.01 | -0.02 | 0.05 | 0.05 | | 0.00 | | 0.01 | 0.01 | 0.01 |
| 1990 | | 0.06 | 0.04 | 0.10 | 0.05 | 0.02 | 0.07 | 0.11 | | 0.08 | 0.08 | 0.08 | 0.07 | 0.09 |
| 1991 | | 0.07 | 0.04 | 0.10 | 0.05 | 0.03 | 0.08 | 0.11 | | 0.12 | 0.08 | 0.11 | 0.10 | 0.12 |
| 1992 | 0.03 | 0.06 | 0.03 | 0.10 | 0.04 | 0.01 | 0.08 | 0.11 | | 0.18 | 0.08 | 0.14 | 0.13 | 0.16 |
| 1993 | 0.05 | 0.07 | 0.03 | 0.10 | 0.05 | 0.02 | 0.09 | 0.11 | 0.11 | 0.17 | 0.08 | 0.13 | 0.11 | 0.15 |
| 1994 | 0.07 | 0.06 | 0.03 | 0.10 | 0.05 | 0.02 | 0.08 | 0.11 | 0.14 | 0.16 | 0.08 | 0.13 | 0.12 | 0.14 |
| 1995 | 0.07 | 0.09 | 0.12 | 0.14 | 0.09 | 0.06 | 0.12 | 0.20 | 0.11 | 0.23 | 0.11 | 0.19 | 0.17 | 0.20 |
| 1996 | 0.13 | 0.09 | 0.12 | 0.14 | 0.11 | 0.08 | 0.15 | 0.20 | 0.48 | 0.21 | 0.11 | 0.21 | 0.19 | 0.23 |
| 1997 | 0.15 | 0.10 | 0.13 | 0.14 | 0.13 | 0.08 | 0.17 | 0.20 | 0.14 | 0.25 | 0.11 | 0.20 | 0.18 | 0.22 |
| 1998 | 0.13 | 0.09 | 0.13 | 0.14 | 0.12 | 0.07 | 0.16 | 0.20 | 0.18 | 0.28 | 0.11 | 0.22 | 0.19 | 0.24 |
| 1999 | 0.13 | 0.09 | 0.12 | 0.14 | 0.12 | 0.07 | 0.16 | 0.20 | 0.12 | 0.25 | 0.11 | 0.19 | 0.17 | 0.22 |
| 2000 | 0.13 | 0.07 | 0.11 | 0.11 | 0.10 | 0.06 | 0.15 | 0.10 | 0.14 | 0.20 | 0.08 | 0.15 | 0.13 | 0.17 |
| 2001 | 0.07 | 0.07 | 0.12 | 0.11 | 0.09 | 0.05 | 0.12 | 0.10 | 0.13 | 0.16 | 0.08 | 0.13 | 0.11 | 0.15 |
| 2002 | 0.13 | 0.08 | 0.11 | 0.11 | 0.11 | 0.06 | 0.15 | 0.10 | 0.10 | 0.12 | 0.08 | 0.11 | 0.09 | 0.12 |
| 2003 | 0.12 | 0.09 | 0.13 | 0.11 | 0.11 | 0.06 | 0.17 | 0.11 | 0.16 | 0.17 | 0.09 | 0.14 | 0.12 | 0.16 |
| 2004 | 0.11 | 0.09 | 0.13 | 0.11 | 0.11 | 0.07 | 0.15 | 0.11 | 0.13 | 0.14 | 0.09 | 0.12 | 0.10 | 0.14 |
| 2005 | 0.11 | 0.07 | 0.13 | 0.11 | 0.11 | 0.07 | 0.15 | 0.11 | 0.13 | 0.12 | 0.09 | 0.11 | 0.09 | 0.13 |
| 2006 | 0.10 | 0.07 | 0.13 | 0.11 | 0.10 | 0.06 | 0.14 | 0.11 | 0.13 | 0.14 | 0.09 | 0.12 | 0.10 | 0.14 |
| 2007 | 0.07 | 0.06 | 0.13 | 0.13 | 0.09 | 0.05 | 0.13 | 0.12 | 0.08 | 0.09 | 0.06 | 0.09 | 0.07 | 0.11 |
| 2008 | 0.10 | 0.08 | 0.13 | 0.13 | 0.10 | 0.06 | 0.15 | 0.12 | 0.09 | 0.11 | 0.06 | 0.10 | 0.07 | 0.12 |
| 2009 | 0.12 | 0.09 | 0.13 | 0.13 | 0.11 | 0.07 | 0.16 | 0.12 | 0.13 | 0.16 | 0.06 | 0.12 | 0.10 | 0.15 |
| 2010 | 0.08 | 0.10 | 0.13 | 0.13 | 0.10 | 0.05 | 0.16 | 0.12 | 0.12 | 0.13 | 0.06 | 0.11 | 0.09 | 0.13 |
| 2011 | 0.13 | 0.09 | 0.13 | 0.13 | 0.12 | 0.07 | 0.16 | 0.12 | 0.08 | 0.13 | 0.06 | 0.11 | 0.09 | 0.13 |
| 2012 | 0.07 | 0.10 | 0.13 | 0.13 | 0.10 | 0.04 | 0.16 | 0.12 | 0.09 | 0.10 | 0.06 | 0.09 | 0.07 | 0.11 |
| 2013 | 0.10 | 0.11 | 0.14 | 0.13 | 0.11 | 0.03 | 0.20 | 0.12 | 0.09 | 0.13 | 0.06 | 0.11 | 0.09 | 0.13 |
| 2014 | 0.09 | 0.07 | 0.13 | 0.13 | 0.10 | 0.04 | 0.16 | 0.12 | 0.10 | 0.19 | 0.06 | 0.14 | 0.11 | 0.16 |
| 2015 | 0.05 | 0.09 | 0.07 | 0.14 | 0.07 | -0.04 | 0.18 | 0.07 | 0.09 | 0.13 | 0.06 | 0.10 | 0.08 | 0.12 |
| 2016 | 0.11 | 0.15 | 0.07 | 0.14 | 0.11 | -0.16 | 0.38 | 0.08 | 0.06 | 0.12 | 0.06 | 0.09 | 0.07 | 0.11 |
| 2017 | 0.08 | 0.06 | 0.07 | 0.15 | 0.07 | -0.07 | 0.20 | 0.12 | 0.07 | 0.11 | 0.06 | 0.09 | 0.07 | 0.11 |

*NYOHS 1988-2007, NYTRL 2008-2017

** Unweighted average of coastal programs excludes NCCOOP estimates owing to model diagnostic issue of a high c-hat estimate.

*** Weighting scheme: Hudson (0.13); Delaware (0.09); Chesapeake Bay (0.78), where MD (0.67) and VA (0.33)

Table B8.18. Model-averaged estimates of instantaneous natural mortality (M) and unconditional standard error (SE) from IRCR analyses of striped bass (≥ 28 inches; 711 mm) tagged by coastal and producer areas programs.

| | Coastal Programs | | | | | | | | Producer Area Programs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MADFW | | NYOHS/ NYTRL* | | NJDB | | NCCOOP | | HUDSON | | DE/PA | | MDCB | | VARAP | |
| Year | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE |
| 1987 | | | | | | | | | | | | | 0.13 | 0.01 | | |
| 1988 | | | 0.06 | 0.01 | | | 0.11 | 0.02 | 0.08 | 0.01 | | | 0.13 | 0.01 | | |
| 1989 | | | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | | | 0.13 | 0.01 | | |
| 1990 | | | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | | | 0.13 | 0.01 | 0.22 | 0.03 |
| 1991 | | | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | | | 0.13 | 0.01 | 0.22 | 0.03 |
| 1992 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | | | 0.13 | 0.01 | 0.22 | 0.03 |
| 1993 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.22 | 0.03 |
| 1994 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.22 | 0.03 |
| 1995 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.22 | 0.03 |
| 1996 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.22 | 0.03 |
| 1997 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.22 | 0.03 |
| 1998 | 0.09 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.40 | 0.03 |
| 1999 | 0.24 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.11 | 0.02 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.40 | 0.03 |
| 2000 | 0.24 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.32 | 0.01 | 0.08 | 0.01 | 0.11 | 0.02 | 0.13 | 0.01 | 0.40 | 0.03 |
| 2001 | 0.24 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.11 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2002 | 0.24 | 0.01 | 0.06 | 0.01 | 0.07 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2003 | 0.24 | 0.01 | 0.06 | 0.01 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2004 | 0.24 | 0.01 | 0.06 | 0.01 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2005 | 0.24 | 0.01 | 0.36 | 0.04 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2006 | 0.24 | 0.01 | 0.36 | 0.04 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2007 | 0.24 | 0.01 | 0.36 | 0.04 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2008 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2009 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2010 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2011 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2012 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2013 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2014 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2015 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2016 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |
| 2017 | 0.24 | 0.01 | 0.43 | 0.12 | 0.26 | 0.01 | 0.32 | 0.01 | 0.27 | 0.01 | 0.29 | 0.02 | 0.36 | 0.02 | 0.40 | 0.03 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.19. Tag-based estimates of instantaneous natural mortality (from IRCR analyses) for ≥ 28-inch (711 mm) striped bass, including an unweighted average for coastal programs, a weighted average for producer area programs, and 95% confidence intervals.

| | Coastal programs | | | | | | | Producer area programs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | Unweighted average** | 95% LCI | 95% UCI | HUDSON | DE/PA | MDCB | VARAP | Weighted average*** | 95% LCI | 95% UCI |
| 1987 | | | | | | | | | | 0.13 | | 0.13 | 0.11 | 0.14 |
| 1988 | | 0.06 | | 0.12 | 0.09 | 0.05 | 0.13 | 0.08 | | 0.13 | | 0.12 | 0.10 | 0.13 |
| 1989 | | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.12 | 0.08 | | 0.13 | | 0.12 | 0.10 | 0.13 |
| 1990 | | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.12 | 0.08 | | 0.13 | 0.22 | 0.15 | 0.13 | 0.17 |
| 1991 | | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.12 | 0.08 | | 0.13 | 0.22 | 0.15 | 0.13 | 0.17 |
| 1992 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | | 0.13 | 0.22 | 0.15 | 0.13 | 0.17 |
| 1993 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | 0.11 | 0.13 | 0.22 | 0.14 | 0.12 | 0.16 |
| 1994 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | 0.11 | 0.13 | 0.22 | 0.14 | 0.12 | 0.16 |
| 1995 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | 0.11 | 0.13 | 0.22 | 0.14 | 0.12 | 0.16 |
| 1996 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | 0.11 | 0.13 | 0.22 | 0.14 | 0.12 | 0.16 |
| 1997 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | 0.11 | 0.13 | 0.22 | 0.14 | 0.12 | 0.16 |
| 1998 | 0.09 | 0.06 | 0.07 | 0.12 | 0.08 | 0.04 | 0.13 | 0.08 | 0.11 | 0.13 | 0.40 | 0.19 | 0.17 | 0.21 |
| 1999 | 0.24 | 0.06 | 0.07 | 0.12 | 0.12 | 0.07 | 0.17 | 0.08 | 0.11 | 0.13 | 0.40 | 0.19 | 0.17 | 0.21 |
| 2000 | 0.24 | 0.06 | 0.07 | 0.32 | 0.17 | 0.13 | 0.22 | 0.08 | 0.11 | 0.13 | 0.40 | 0.19 | 0.17 | 0.21 |
| 2001 | 0.24 | 0.06 | 0.07 | 0.32 | 0.17 | 0.13 | 0.22 | 0.27 | 0.11 | 0.36 | 0.40 | 0.33 | 0.31 | 0.36 |
| 2002 | 0.24 | 0.06 | 0.07 | 0.32 | 0.17 | 0.13 | 0.22 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2003 | 0.24 | 0.06 | 0.26 | 0.32 | 0.22 | 0.17 | 0.27 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2004 | 0.24 | 0.06 | 0.26 | 0.32 | 0.22 | 0.17 | 0.27 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2005 | 0.24 | 0.36 | 0.26 | 0.32 | 0.29 | 0.21 | 0.38 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2006 | 0.24 | 0.36 | 0.26 | 0.32 | 0.29 | 0.21 | 0.38 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2007 | 0.24 | 0.36 | 0.26 | 0.32 | 0.29 | 0.21 | 0.38 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2008 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2009 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2010 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2011 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2012 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2013 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2014 | 0.24 | 0.43 | 0.26 | 0.32 | 0.31 | 0.08 | 0.54 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2015 | 0.24 | 0.43 | 0.26 | 0.32 | 0.27 | 0.23 | 0.32 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2016 | 0.24 | 0.43 | 0.26 | 0.32 | 0.27 | 0.23 | 0.32 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |
| 2017 | 0.24 | 0.43 | 0.26 | 0.32 | 0.27 | 0.23 | 0.32 | 0.27 | 0.29 | 0.36 | 0.40 | 0.35 | 0.32 | 0.37 |

*NYOHS 1988-2007, NYTRL 2008-2017

** Unweighted average of coastal program for 2015-2017 excludes NYTRL owing to issues of small sample size.

*** Weighting scheme: Hudson (0.13); Delaware (0.09); Chesapeake Bay (0.78), where MD (0.67) and VA (0.33)

Table B8.20. Model-averaged estimates of instantaneous natural mortality (M) and unconditional standard error (SE) from IRCR analyses of striped bass (≥ 18 inches; 457 mm) tagged by coastal and producer areas programs.

| | Coastal Programs | | | | | | | | Producer Area Programs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MADFW | | NYOHS/ NYTRL* | | NJDB | | NCCOOP | | HUDSON | | DE/PA | | MDCB | | VARAP | |
| Year | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE | M | SE |
| 1987 | | | | | | | | | | | | | 0.17 | 0.01 | | |
| 1988 | | | 0.15 | 0.01 | | | 0.20 | 0.04 | 0.13 | 0.01 | | | 0.17 | 0.01 | | |
| 1989 | | | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | | | 0.17 | 0.01 | | |
| 1990 | | | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | | | 0.17 | 0.01 | 0.36 | 0.03 |
| 1991 | | | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | | | 0.17 | 0.01 | 0.36 | 0.03 |
| 1992 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | | | 0.17 | 0.01 | 0.36 | 0.03 |
| 1993 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.17 | 0.01 | 0.36 | 0.03 |
| 1994 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.17 | 0.01 | 0.36 | 0.03 |
| 1995 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.17 | 0.01 | 0.36 | 0.03 |
| 1996 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.17 | 0.01 | 0.36 | 0.03 |
| 1997 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.17 | 0.01 | 0.36 | 0.03 |
| 1998 | 0.10 | 0.01 | 0.15 | 0.01 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.17 | 0.01 | 0.60 | 0.03 |
| 1999 | 0.24 | 0.01 | 0.34 | 0.02 | 0.12 | 0.01 | 0.20 | 0.04 | 0.13 | 0.01 | 0.17 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2000 | 0.24 | 0.01 | 0.34 | 0.02 | 0.12 | 0.01 | 0.43 | 0.05 | 0.13 | 0.01 | 0.17 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2001 | 0.24 | 0.01 | 0.34 | 0.02 | 0.12 | 0.01 | 0.43 | 0.05 | 0.13 | 0.01 | 0.17 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2002 | 0.24 | 0.01 | 0.34 | 0.02 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2003 | 0.24 | 0.01 | 0.34 | 0.02 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2004 | 0.24 | 0.01 | 0.34 | 0.02 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2005 | 0.24 | 0.01 | 0.34 | 0.02 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2006 | 0.24 | 0.01 | 0.34 | 0.02 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2007 | 0.24 | 0.01 | 0.34 | 0.02 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2008 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2009 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2010 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2011 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2012 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2013 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2014 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2015 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2016 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |
| 2017 | 0.24 | 0.01 | 0.42 | 0.05 | 0.30 | 0.01 | 0.43 | 0.05 | 0.32 | 0.01 | 0.44 | 0.02 | 0.49 | 0.02 | 0.60 | 0.03 |

*NYOHS (1988–2007), NYTRL (2008–2012)

Table B8.21. Tag-based estimates of instantaneous natural mortality (from IRCR analyses) for ≥ 18-inch (457 mm) striped bass, including an unweighted average for coastal programs, a weighted average for producer area programs, and 95% confidence intervals.

| | Coastal programs | | | | | | | Producer area programs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | MADMF | NYOHS/ NYTRL* | NJDB | NCCOOP | Unweighted average** | 95% LCI | 95% UCI | HUDSON | DE/PA | MDCB | VARAP | Weighted average*** | 95% LCI | 95% UCI |
| 1987 | | | | | | | | | | 0.17 | | 0.17 | 0.16 | 0.18 |
| 1988 | | 0.15 | | 0.20 | 0.15 | 0.13 | 0.16 | 0.13 | | 0.17 | | 0.17 | 0.16 | 0.18 |
| 1989 | | 0.15 | 0.12 | 0.20 | 0.14 | 0.11 | 0.16 | 0.13 | | 0.17 | | 0.17 | 0.16 | 0.18 |
| 1990 | | 0.15 | 0.12 | 0.20 | 0.14 | 0.11 | 0.16 | 0.13 | | 0.17 | 0.36 | 0.22 | 0.20 | 0.24 |
| 1991 | | 0.15 | 0.12 | 0.20 | 0.14 | 0.11 | 0.16 | 0.13 | | 0.17 | 0.36 | 0.22 | 0.20 | 0.24 |
| 1992 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | | 0.17 | 0.36 | 0.22 | 0.20 | 0.24 |
| 1993 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | 0.17 | 0.17 | 0.36 | 0.22 | 0.20 | 0.23 |
| 1994 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | 0.17 | 0.17 | 0.36 | 0.22 | 0.20 | 0.23 |
| 1995 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | 0.17 | 0.17 | 0.36 | 0.22 | 0.20 | 0.23 |
| 1996 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | 0.17 | 0.17 | 0.36 | 0.22 | 0.20 | 0.23 |
| 1997 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | 0.17 | 0.17 | 0.36 | 0.22 | 0.20 | 0.23 |
| 1998 | 0.10 | 0.15 | 0.12 | 0.20 | 0.12 | 0.09 | 0.16 | 0.13 | 0.17 | 0.17 | 0.60 | 0.28 | 0.26 | 0.29 |
| 1999 | 0.24 | 0.34 | 0.12 | 0.20 | 0.24 | 0.19 | 0.28 | 0.13 | 0.17 | 0.49 | 0.60 | 0.44 | 0.42 | 0.47 |
| 2000 | 0.24 | 0.34 | 0.12 | 0.43 | 0.24 | 0.19 | 0.28 | 0.13 | 0.17 | 0.49 | 0.60 | 0.44 | 0.42 | 0.47 |
| 2001 | 0.24 | 0.34 | 0.12 | 0.43 | 0.24 | 0.19 | 0.28 | 0.13 | 0.17 | 0.49 | 0.60 | 0.44 | 0.42 | 0.47 |
| 2002 | 0.24 | 0.34 | 0.30 | 0.43 | 0.30 | 0.25 | 0.34 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2003 | 0.24 | 0.34 | 0.30 | 0.43 | 0.30 | 0.25 | 0.34 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2004 | 0.24 | 0.34 | 0.30 | 0.43 | 0.30 | 0.25 | 0.34 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2005 | 0.24 | 0.34 | 0.30 | 0.43 | 0.30 | 0.25 | 0.34 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2006 | 0.24 | 0.34 | 0.30 | 0.43 | 0.30 | 0.25 | 0.34 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2007 | 0.24 | 0.34 | 0.30 | 0.43 | 0.30 | 0.25 | 0.34 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2008 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2009 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2010 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2011 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2012 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2013 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2014 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2015 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2016 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |
| 2017 | 0.24 | 0.42 | 0.30 | 0.43 | 0.32 | 0.23 | 0.42 | 0.32 | 0.44 | 0.49 | 0.60 | 0.49 | 0.47 | 0.51 |

*NYOHS 1988-2007, NYTRL 2008-2017

** Unweighted average of coastal programs excludes NCCOOP estimates owing to model diagnostic issue of a high c-hat estimate.

*** Weighting scheme: Hudson (0.13); Delaware (0.09); Chesapeake Bay (0.78), where MD (0.67) and VA (0.33)

Table B8.22. Coastwide annual exploitation rates and stock size estimates for age-3+ and 7+ from the IRCR model. F is calculated as an unweighted average of producer and coastal programs' means.

| | Age 3+ | | | Age 7+ | | |
|---|---|---|---|---|---|---|
| Year | Exploitation | Kill (includes discards) | Total stock size (thousands) | Exploitation | Kill (includes discards) | Total stock size (thousands) |
| 1988 | 0.03 | 374.1 | 11113 | 0.07 | 118.5 | 1724 |
| 1989 | 0.03 | 491.0 | 15453 | 0.04 | 221.0 | 4980 |
| 1990 | 0.06 | 1159.9 | 19051 | 0.08 | 386.1 | 4738 |
| 1991 | 0.07 | 1576.5 | 22805 | 0.13 | 651.8 | 5134 |
| 1992 | 0.09 | 2168.7 | 24226 | 0.10 | 903.8 | 9127 |
| 1993 | 0.08 | 1940.3 | 25675 | 0.12 | 792.9 | 6691 |
| 1994 | 0.07 | 2816.8 | 38249 | 0.08 | 1137.3 | 13656 |
| 1995 | 0.10 | 4197.4 | 41479 | 0.15 | 1785.5 | 11819 |
| 1996 | 0.10 | 6162.5 | 62432 | 0.15 | 2473.5 | 16005 |
| 1997 | 0.13 | 6590.0 | 50659 | 0.24 | 2382.1 | 10087 |
| 1998 | 0.12 | 7405.6 | 59552 | 0.22 | 2286.9 | 10316 |
| 1999 | 0.11 | 7899.8 | 71582 | 0.19 | 2306.8 | 12234 |
| 2000 | 0.09 | 8017.8 | 92697 | 0.14 | 2965.8 | 21625 |
| 2001 | 0.09 | 7409.8 | 86408 | 0.12 | 2863.2 | 23219 |
| 2002 | 0.08 | 7516.3 | 94419 | 0.13 | 3544.5 | 27786 |
| 2003 | 0.08 | 8137.5 | 98940 | 0.11 | 4284.8 | 37491 |
| 2004 | 0.08 | 9084.7 | 108806 | 0.11 | 4137.9 | 36219 |
| 2005 | 0.06 | 7997.7 | 127677 | 0.11 | 3617.4 | 31684 |
| 2006 | 0.07 | 10484.7 | 142016 | 0.11 | 3713.6 | 32658 |
| 2007 | 0.07 | 7902.0 | 120989 | 0.09 | 3043.7 | 34948 |
| 2008 | 0.08 | 8010.9 | 105391 | 0.11 | 3983.9 | 37332 |
| 2009 | 0.08 | 7683.9 | 97855 | 0.10 | 3482.5 | 33734 |
| 2010 | 0.07 | 8269.2 | 124281 | 0.10 | 4725.6 | 48316 |
| 2011 | 0.09 | 7242.9 | 80550 | 0.10 | 4216.6 | 40588 |
| 2012 | 0.10 | 6357.9 | 60752 | 0.13 | 3627.1 | 28809 |
| 2013 | 0.10 | 8011.4 | 77880 | 0.13 | 4236.4 | 32652 |
| 2014 | 0.10 | 6985.4 | 73375 | 0.10 | 2640.3 | 27275 |
| 2015 | 0.05 | 5638.1 | 102649 | 0.05 | 2263.5 | 43625 |
| 2016 | 0.07 | 6183.2 | 85056 | 0.10 | 2023.8 | 20251 |
| 2017 | 0.07 | 6159.6 | 93107 | 0.08 | 1893.6 | 22435 |

Table B8.23. Annual exploitation rates (*u*) of 18–28 inch (457-711 mm) male striped bass from tagging programs of Chesapeake Bay (adjusted for a hooking mortality rate of 0.09 and a reporting rate of 0.64).

| Year | *u* |
|---|---|
| 1987 | 0.01 |
| 1988 | 0.01 |
| 1989 | 0.00 |
| 1990 | 0.03 |
| 1991 | 0.05 |
| 1992 | 0.09 |
| 1993 | 0.07 |
| 1994 | 0.08 |
| 1995 | 0.09 |
| 1996 | 0.08 |
| 1997 | 0.08 |
| 1998 | 0.09 |
| 1999 | 0.06 |
| 2000 | 0.06 |
| 2001 | 0.08 |
| 2002 | 0.07 |
| 2003 | 0.06 |
| 2004 | 0.06 |
| 2005 | 0.05 |
| 2006 | 0.06 |
| 2007 | 0.05 |
| 2008 | 0.05 |
| 2009 | 0.08 |
| 2010 | 0.04 |
| 2011 | 0.08 |
| 2012 | 0.06 |
| 2013 | 0.10 |
| 2014 | 0.11 |
| 2015 | 0.08 |
| 2016 | 0.04 |
| 2017 | 0.06 |

Table B8.24. Akaike weights used to derive model-averaged parameter estimates from IRCR analyses of male striped bass tagged at 18–28 inches (457-711 mm) in Chesapeake Bay (see Table B8.1 for model descriptions).

| Model | QAICc Wgts |
|---|---|
| 1 | 0.000 |
| 2 | 0.000 |
| 3 | 0.000 |
| **4** | **0.737** |
| 5 | 0.104 |
| 6 | 0.159 |

Table B8.25. Rate estimates of survival (S), instantaneous fishing mortality (F), and instantaneous natural mortality (M) of 18–28 inch (457-711 mm) male striped bass in Chesapeake Bay. The IRCR models were structured with two periods of M (1987–1996 and 1997–2017) and used a tag-reporting rate of 0.64.

| Year | S | SE | F | SE | M | SE |
|---|---|---|---|---|---|---|
| 1987 | 0.77 | 0.01 | 0.00 | 0.00 | 0.25 | 0.02 |
| 1988 | 0.77 | 0.01 | 0.00 | 0.00 | 0.25 | 0.02 |
| 1989 | 0.77 | 0.01 | 0.00 | 0.00 | 0.25 | 0.02 |
| 1990 | 0.71 | 0.02 | 0.09 | 0.01 | 0.25 | 0.02 |
| 1991 | 0.71 | 0.02 | 0.09 | 0.01 | 0.25 | 0.02 |
| 1992 | 0.71 | 0.02 | 0.09 | 0.01 | 0.25 | 0.02 |
| 1993 | 0.71 | 0.02 | 0.09 | 0.01 | 0.25 | 0.02 |
| 1994 | 0.71 | 0.02 | 0.09 | 0.01 | 0.25 | 0.02 |
| 1995 | 0.69 | 0.02 | 0.11 | 0.01 | 0.25 | 0.02 |
| 1996 | 0.69 | 0.02 | 0.11 | 0.01 | 0.25 | 0.02 |
| 1997 | 0.39 | 0.02 | 0.11 | 0.01 | 0.83 | 0.05 |
| 1998 | 0.39 | 0.02 | 0.11 | 0.01 | 0.83 | 0.05 |
| 1999 | 0.39 | 0.02 | 0.11 | 0.01 | 0.83 | 0.05 |
| 2000 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2001 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2002 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2003 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2004 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2005 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2006 | 0.39 | 0.02 | 0.10 | 0.02 | 0.83 | 0.05 |
| 2007 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2008 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2009 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2010 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2011 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2012 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2013 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2014 | 0.40 | 0.02 | 0.09 | 0.01 | 0.83 | 0.05 |
| 2015 | 0.39 | 0.02 | 0.10 | 0.03 | 0.83 | 0.05 |
| 2016 | 0.39 | 0.02 | 0.09 | 0.02 | 0.83 | 0.05 |
| 2017 | 0.39 | 0.02 | 0.09 | 0.02 | 0.83 | 0.05 |

Table B9.1 Reference points derived from SPR analysis and selected annual SSB levels for Stock 1 (top) and Stock 2 (bottom). Numbers in parentheses represent standard error of the parameters.

| | Stock 1 (Chesapeake Bay) | | | | | |
|---|---|---|---|---|---|---|
| | Model-Based BRPs | | | | | |
| | Bay $F_{ref}$ | Ocean $F_{ref}$ | 2017 Bay F | 2017 Ocean F | $SSB_{ref}$ [95% CI] | 2017 SSB |
| SPR20% | 0.288 | 0.342 | 0.255 (0.041) | 0.400 (0.042) | 54,864 [42,310 - 73,611] | 50,346 (6,394) |
| SPR30% | 0.196 | 0.233 | 0.255 (0.041) | 0.400 (0.042) | 84,209 [65,741 - 109,333] | 50,346 (6,394) |
| SPR40% | 0.140 | 0.166 | 0.255 (0.041) | 0.400 (0.042) | 111,432 [88,305 - 144,914] | 50,346 (6,394) |
| | Empirical BRPs | | | | | |
| | Bay $F_{ref}$ | Ocean $F_{ref}$ | 2017 Bay F | 2017 Ocean F | $SSB_{ref}$ [95% CI] | 2017 SSB |
| SSB1993 | 0.411 | 0.489 | 0.255 (0.041) | 0.400 (0.042) | 34,375 (2,747) | 50,346 (6,394) |
| SSB1995 | 0.297 | 0.353 | 0.255 (0.041) | 0.400 (0.042) | 52,893 (3,856) | 50,346 (6,394) |

| | Stock 2 (DE Bay/Hudson River) | | | |
|---|---|---|---|---|
| | Hockey-stick recruitment | | | |
| | Model-Based BRPs | | | |
| | Ocean $F_{ref}$ | $SSB_{ref}$ [95% CI] | 2017 Ocean F | 2017 SSB |
| SPR20% | 0.251 | 38,493 [28,294 - 52,842] | 0.400 (0.042) | 21,347 (2,813) |
| SPR30% | 0.168 | 57,791 [43,816 - 79,288] | 0.400 (0.042) | 21,347 (2,813) |
| SPR40% | 0.118 | 77,153 [57,575 - 103,588] | 0.400 (0.042) | 21,347 (2,813) |
| | Empirical BRPs | | | |
| | Ocean $F_{ref}$ | $SSB_{ref}$ | 2017 Ocean F | 2017 SSB |
| SSB1993 | 0.362 | 19,638 (2086) | 0.400 (0.042) | 21,347 (2,813) |
| SSB1995 | 0.340 | 24,683 (2192) | 0.400 (0.042) | 21,347 (2,813) |

Table B9.1 (continued).

| | Stock 2 (DE Bay/Hudson River) | | | |
|---|---|---|---|---|
| | Empirical recruitment | | | |
| | Model-Based BRPs | | | |
| | Ocean $F_{ref}$ | $SSB_{ref}$ [95% CI] | 2017 Ocean F | 2017 SSB |
| SPR20% | 0.251 | 41,955 [32,078 - 53,108] | 0.400 (0.042) | 21,347 (2,813) |
| SPR30% | 0.168 | 62,587 [49,034 - 78,561] | 0.400 (0.042) | 21,347 (2,813) |
| SPR40% | 0.118 | 83,905 [66,103 - 101,567] | 0.400 (0.042) | 21,347 (2,813) |
| | | | | |
| | Empirical BRPs | | | |
| | Ocean $F_{ref}$ | $SSB_{ref}$ | 2017 Ocean F | 2017 SSB |
| SSB1993 | 0.460 | 19,638 (2086) | 0.400 (0.042) | 21,347 (2,813) |
| SSB1995 | 0.387 | 24,683 (2192) | 0.400 (0.042) | 21,347 (2,813) |

Table B9.2. Probabilities of 2017 management values exceeding corresponding reference points for the Chesapeake Bay stock (top) and the DE Bay/Hudson River stock (bottom).

| | Stock 1 (Chesapeake Bay) | | |
|---|---|---|---|
| | Model-Based BRPs | | |
| | P(Bay $F_{2017}$>$F_{ref}$) | P(Ocean $F_{2017}$>$F_{ref}$) | P($SSB_{2017}$<$SSB_{ref}$) |
| SPR20% | 0.21 | 0.92 | 0.68 |
| SPR30% | 0.92 | 1.00 | 0.99 |
| SPR40% | 0.99 | 1.00 | 0.99 |
| | Empirical BRPs | | |
| | P(Bay $F_{2017}$>$F_{ref}$) | P(Ocean $F_{2017}$>$F_{ref}$) | P($SSB_{2017}$<$SSB_{ref}$) |
| SSB1993 | 0.00 | 0.01 | 0.01 |
| SSB1995 | 0.15 | 0.87 | 0.63 |

| | Stock 2 (Delaware Bay/Hudson River) | | | |
|---|---|---|---|---|
| | Model-Based BRPs | | | |
| | Hockey-Stick Approach | | Empirical Approach | |
| | P(Ocean $F_{2017}$>$F_{ref}$) | P($SSB_{2017}$< $SSB_{ref}$) | P(Ocean $F_{2017}$>$F_{ref}$) | P($SSB_{2017}$<$SSB_{ref}$) |
| SPR20% | 0.99 | 0.99 | 0.99 | 1.00 |
| SPR30% | 1.00 | 1.00 | 1.00 | 1.00 |
| SPR40% | 1.00 | 1.00 | 1.00 | 1.00 |
| | Empirical BRPs | | | |
| | Hockey-Stick Approach | | Empirical Approach | |
| | P(Ocean $F_{2017}$>$F_{ref}$) | P($SSB_{2017}$<$SSB_{ref}$) | P(Ocean $F_{2017}$>$F_{ref}$) | P($SSB_{2017}$<$SSB_{ref}$) |
| SSB1993 | 0.82 | 0.31 | 0.08 | 0.31 |
| SSB1995 | 0.93 | 0.83 | 0.62 | 0.83 |

Table B9.3. Fleet reference point calculations for non-migration SCA model.

| Year | Total F@A6 | CB fleet F@A6 | annual ratio | Ratio of means | Relative to 1995 SSB F target | Relative to 1995 SSB F threshold | 2017 F |
|---|---|---|---|---|---|---|---|
| 2013 | 0.248 | 0.079 | 0.318 | | | | |
| 2014 | 0.209 | 0.089 | 0.427 | | | | |
| 2015 | 0.178 | 0.075 | 0.419 | 0.393 | 0.056 | 0.068 | 0.068 |
| 2016 | 0.212 | 0.100 | 0.472 | | | | |
| 2017 | 0.209 | 0.068 | 0.327 | | | | |

| Year | Total F@A14 | Coast fleet F@A14 | annual ratio | Ratio of means | F target | F threshold | |
|---|---|---|---|---|---|---|---|
| 2013 | 0.368 | 0.314 | 0.854 | | | | |
| 2014 | 0.282 | 0.221 | 0.785 | | | | |
| 2015 | 0.242 | 0.192 | 0.790 | 0.806 | 0.159 | 0.194 | 0.262 |
| 2016 | 0.276 | 0.208 | 0.753 | | | | |
| 2017 | 0.307 | 0.260 | 0.849 | | | | |
| Coast wide | | | | | 0.197 | 0.240 | |

Table B9.4. Fleet and total F-at-age values (relative to female $SSB_{1995}$) when fishing at the target for the non-migration SCA model.

| | Selectivity | | | F ref pt at age (Fleet F ref pt * Flt sel) | | |
|---|---|---|---|---|---|---|
| Age | Composite | Coast fleet | CB fleet | Coast fleet | CB fleet | Total F |
| 1 | 0.006 | 0.003 | 0.012 | 0.000 | 0.001 | 0.001 |
| 2 | 0.038 | 0.022 | 0.070 | 0.004 | 0.005 | 0.009 |
| 3 | 0.163 | 0.088 | 0.323 | 0.017 | 0.022 | 0.039 |
| 4 | 0.395 | 0.213 | 0.787 | 0.041 | 0.053 | 0.095 |
| 5 | 0.585 | 0.375 | 0.996 | 0.073 | 0.067 | 0.140 |
| 6 | 0.718 | 0.537 | 1.000 | 0.104 | 0.068 | 0.172 |
| 7 | 0.819 | 0.675 | 0.960 | 0.131 | 0.065 | 0.196 |
| 8 | 0.892 | 0.781 | 0.915 | 0.152 | 0.062 | 0.214 |
| 9 | 0.942 | 0.858 | 0.871 | 0.167 | 0.059 | 0.226 |
| 10 | 0.973 | 0.910 | 0.829 | 0.177 | 0.056 | 0.233 |
| 11 | 0.990 | 0.946 | 0.790 | 0.184 | 0.053 | 0.237 |
| 12 | 0.998 | 0.969 | 0.751 | 0.188 | 0.051 | 0.239 |
| 13 | 1.000 | 0.984 | 0.715 | 0.191 | 0.048 | 0.240 |
| 14 | 0.998 | 0.994 | 0.681 | 0.193 | 0.046 | 0.239 |
| 15 | 0.994 | 1.000 | 0.648 | 0.194 | 0.044 | 0.238 |
| | | | | | **Max F at age** | **0.240** |
| | Fleet F Thresholds (relative to 1995 SSB) | | | 0.194 | 0.068 | |
| | Coastwide F threshold | | | | | 0.240 |

Table B9.5. Reference points derived from the non-migration model for selected annual SSB levels for Atlantic striped bass under different assumptions about recruitment.

| | Hockey-stick recruitment | | | | |
|---|---|---|---|---|---|
| | F ref (CV) | SSB ref (SE) | | 2017 F (SE) | 2017 SSB (SE) |
| SSB 1993 | 0.278 (0.077) | 75,906 (5,025) | | 0.307 (0.034) | 68,476 (7,630) |
| SSB 1995 | 0.240 (0.087) | 91,436 (5,499) | | 0.307 (0.034) | 68,476 (7,630) |

| | Empirical recruitment | | | | |
|---|---|---|---|---|---|
| | F ref (CV) | SSB ref (SE) | | 2017 F (SE) | 2017 SSB (SE) |
| SSB 1993 | 0.287 (0.094) | 75,906 (5,025) | | 0.307 (0.034) | 68,476 (7,630) |
| SSB 1995 | 0.248 (0.101) | 91,436 (5,499) | | 0.307 (0.034) | 68,476 (7,630) |

Table B9.6. Probabilities of 2017 F and SSB estimates exceeding their respective reference points for Atlantic striped bass from the non-migration model under different assumptions about recruitment.

| | Hockey-stick recruitment | | Empirical recruitment | |
|---|---|---|---|---|
| | $p(F_{2017} > F_{ref})$ | $p(SSB_{2017} < SSB_{ref})$ | $p(F_{2017} > F_{ref})$ | $p(SSB_{2017} < SSB_{ref})$ |
| SSB 1995 | 0.759 | 0.839 | 0.678 | 0.839 |
| SSB 1993 | 0.952 | 0.999 | 0.925 | 0.99 |

## B7.0 FIGURES


Figure B4.1. Coastal migratory striped bass management area [East Coast of the United States, excluding the Exclusive Economic Zone (3-200 nautical miles offshore)]: coastal and estuarine areas of all states from Maine through North Carolina.

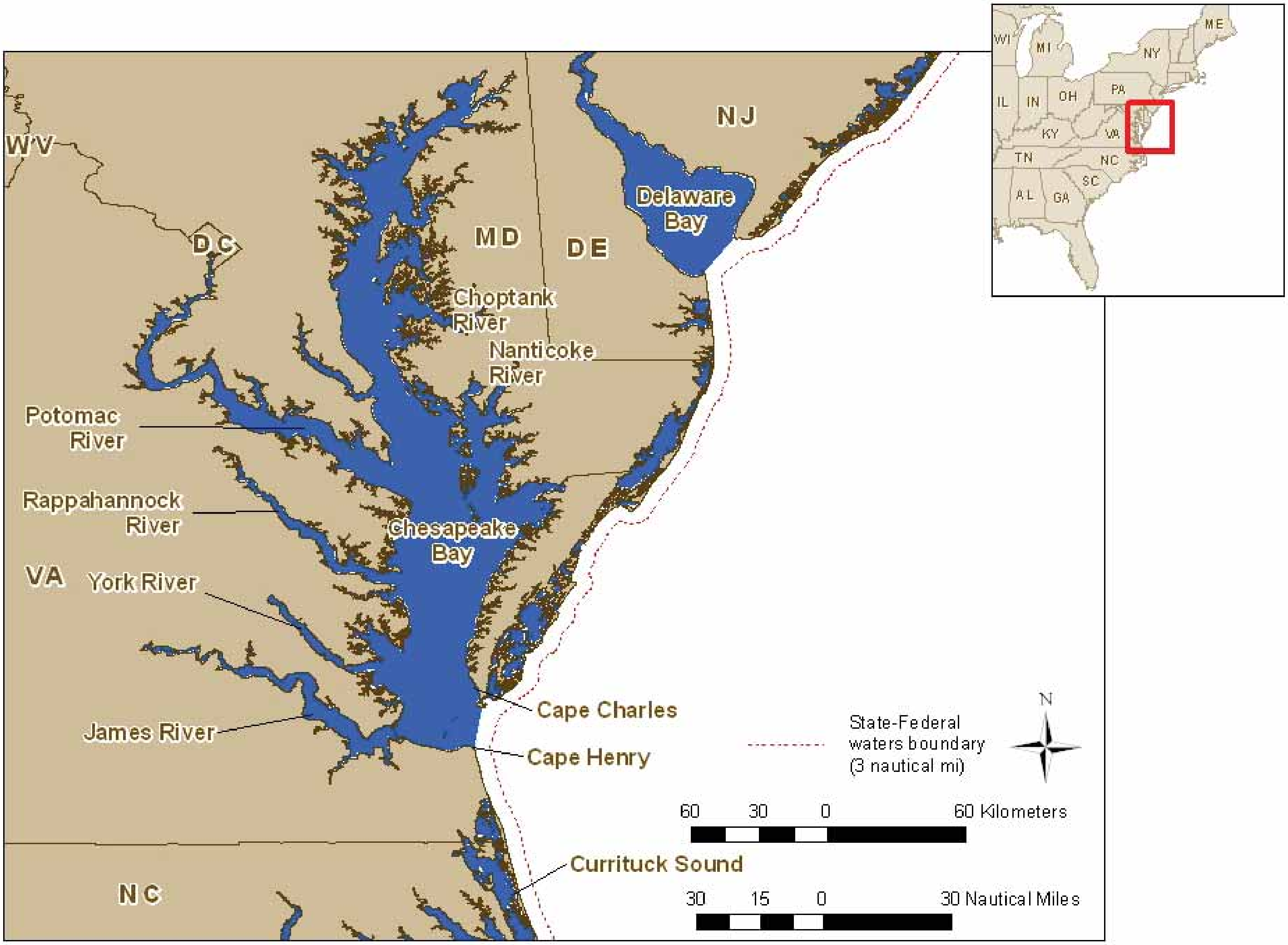



Figure B4.2. Geography of the Chesapeake Bay.

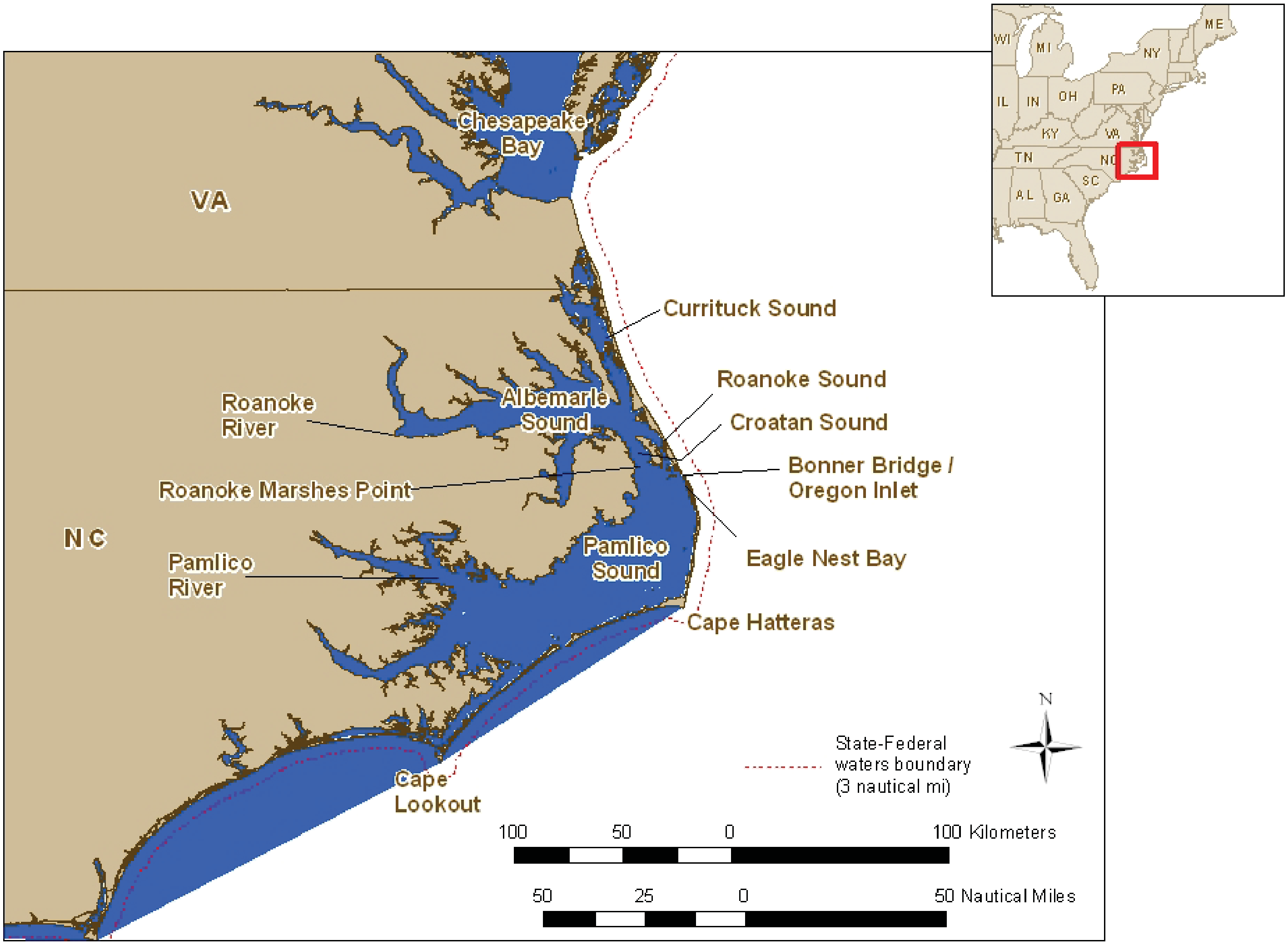



Figure B4.3 Geography of the Albemarle Sound-Roanoke River region.

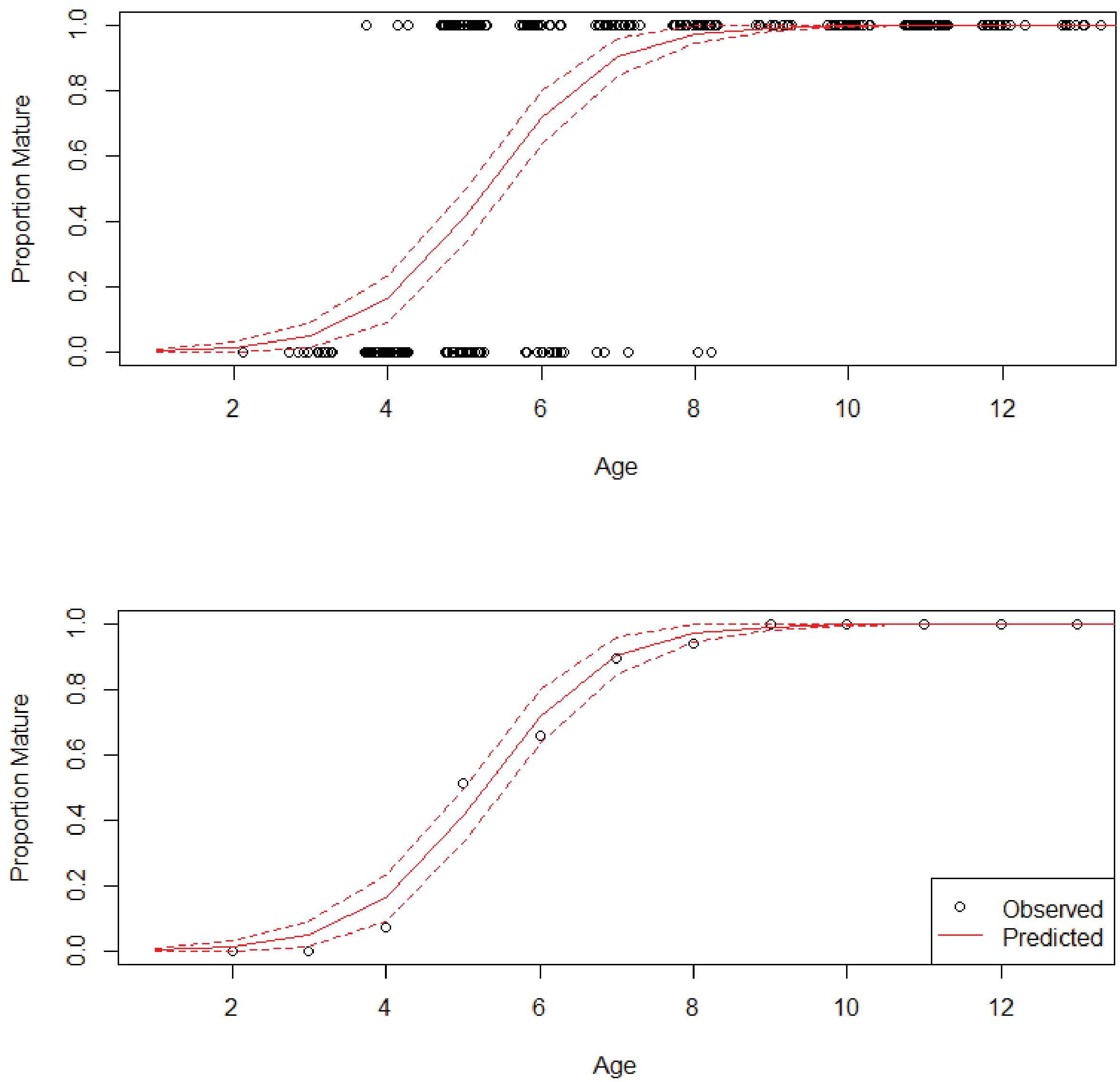



Figure B5.1. Estimated proportions mature, by age, for the March-July dataset. Developing fish are considered not imminently spawning. Top figure shows the sample size and maturity status for each fish sampled, by age, and bottom figure shows the overall observed proportion mature.

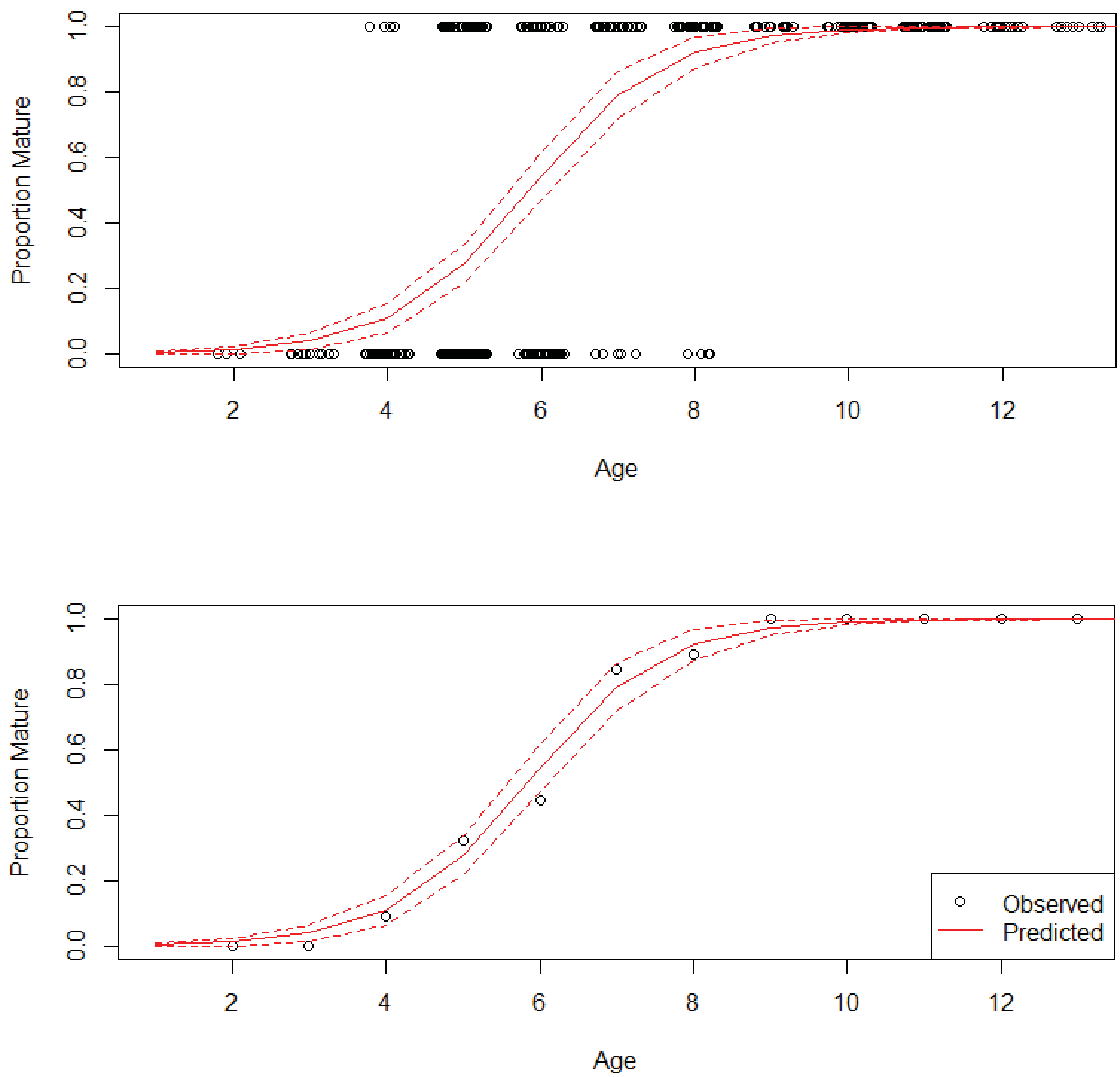



Figure B5.2. Estimated proportions mature, by age, for the full dataset. Developing fish are considered not imminently spawning. Top figure shows the sample size and maturity status for each fish sampled, by age, and bottom figure shows the overall observed proportion mature.

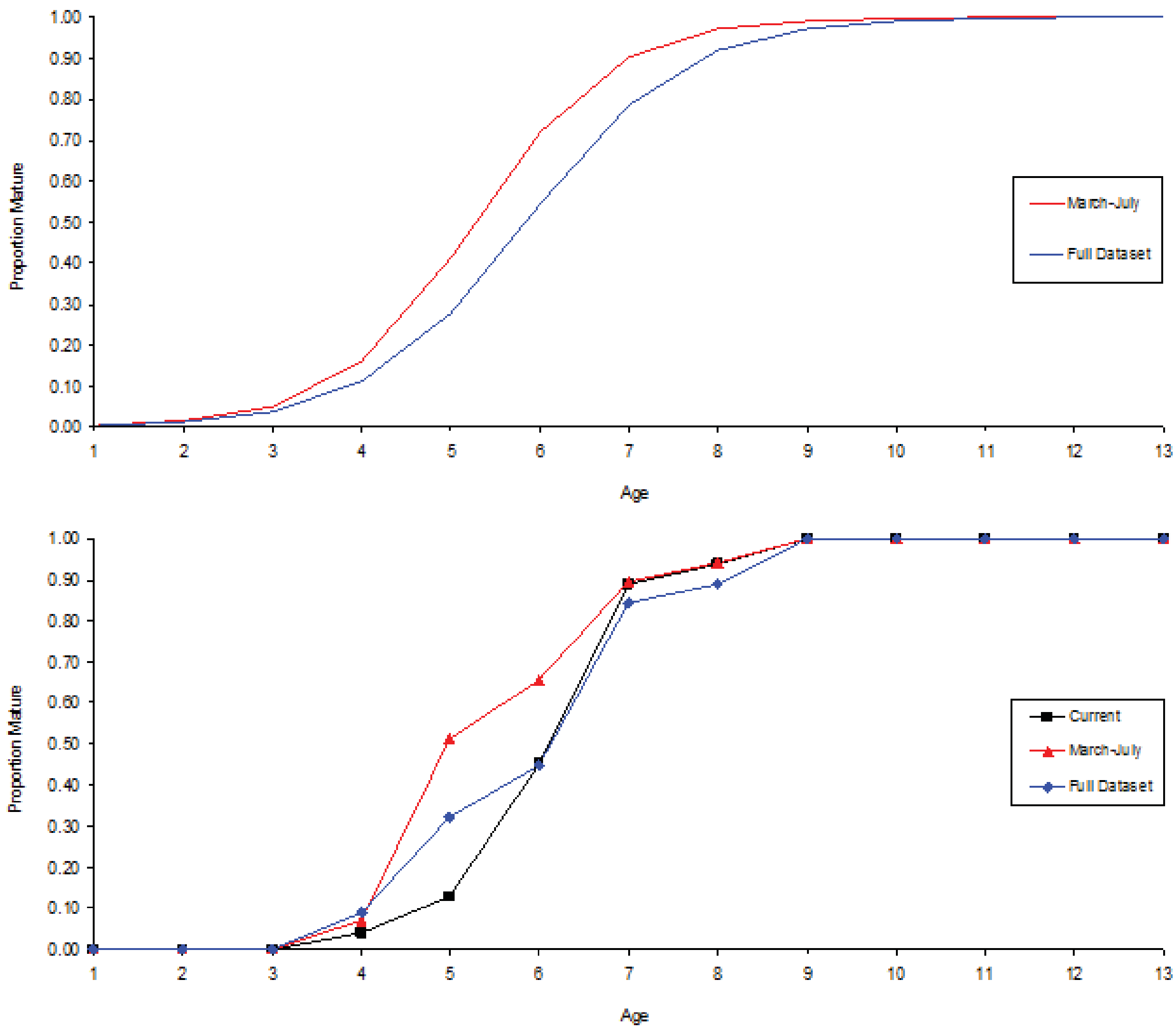



Figure B5.3. Comparison of the maturity-at-age estimates between the different data subsets. Developing fish are classified as not imminently spawning. Top panel compares the logistic regression estimates. Bottom panel shows the observed proportions with the estimates used in the 2013 benchmark assessment (NEFSC 2013).

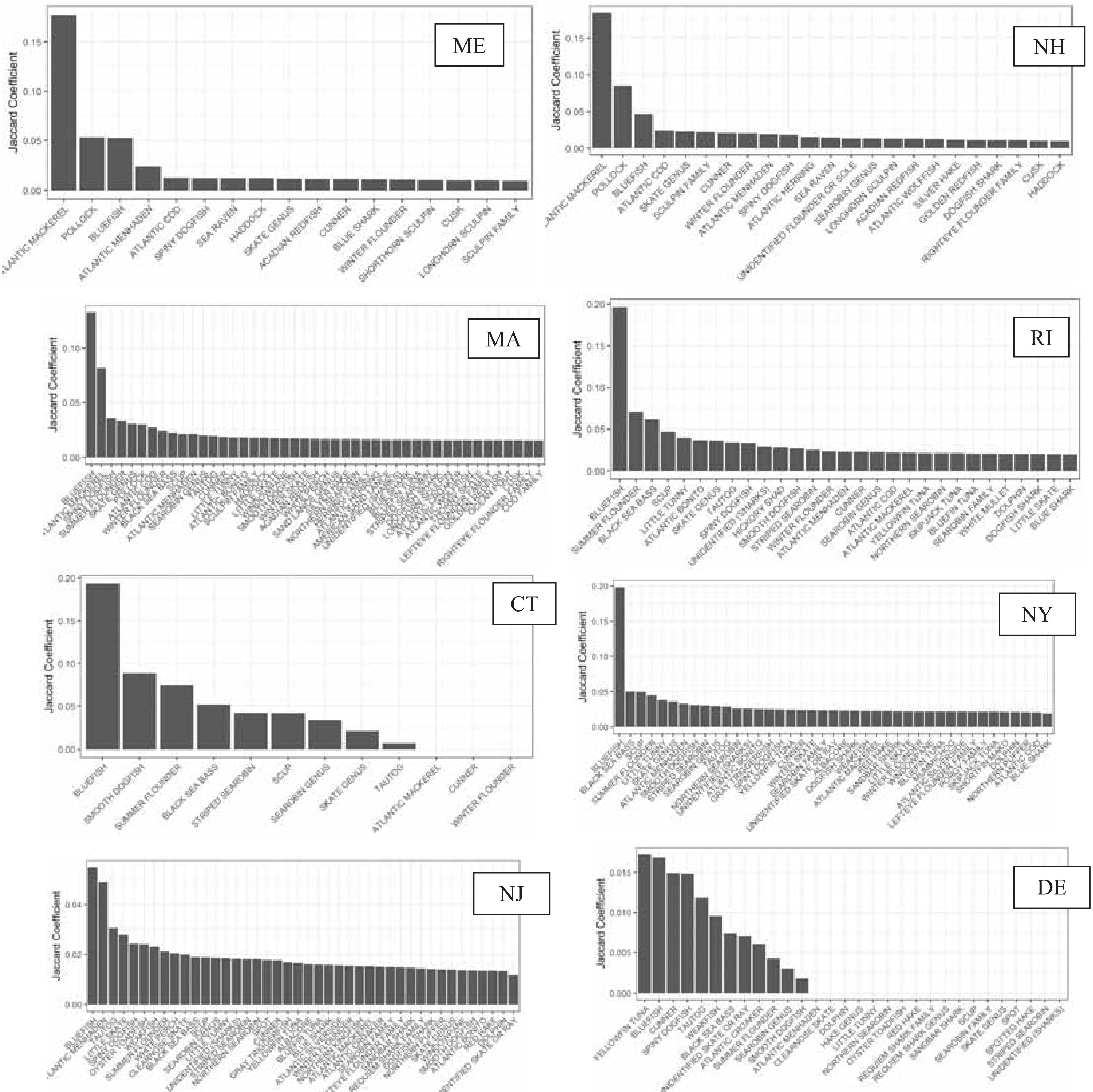



Figure B5.4. Jaccard coefficients for commonly caught recreational species by state. Higher coefficients indicate the species is caught more often with striped bass.

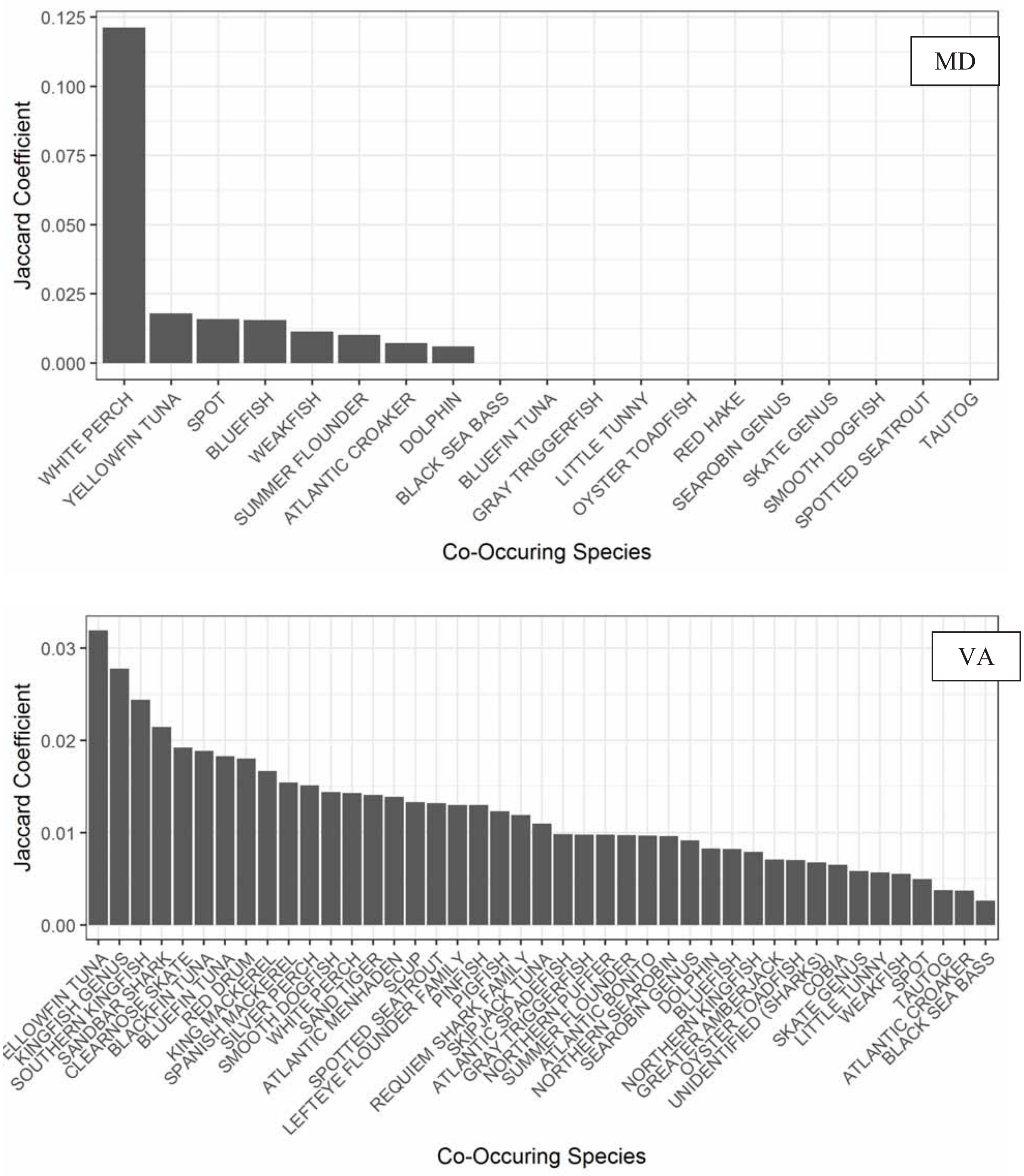



Figure B5.4. (cont.).

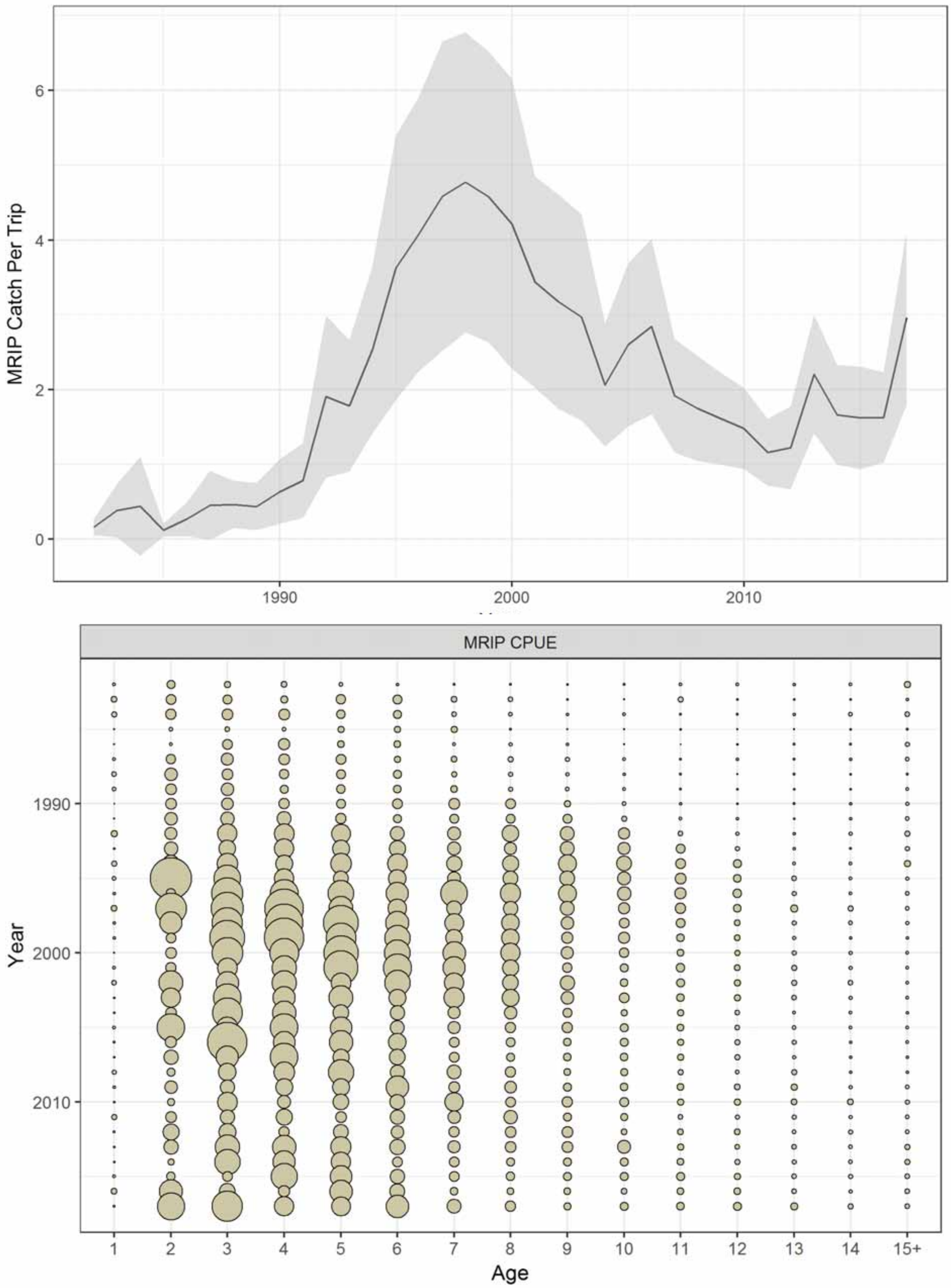



Figure B5.5. MRIP catch per trip (top) and age composition (bottom). Shaded area on top plot indicates 95% confidence intervals.

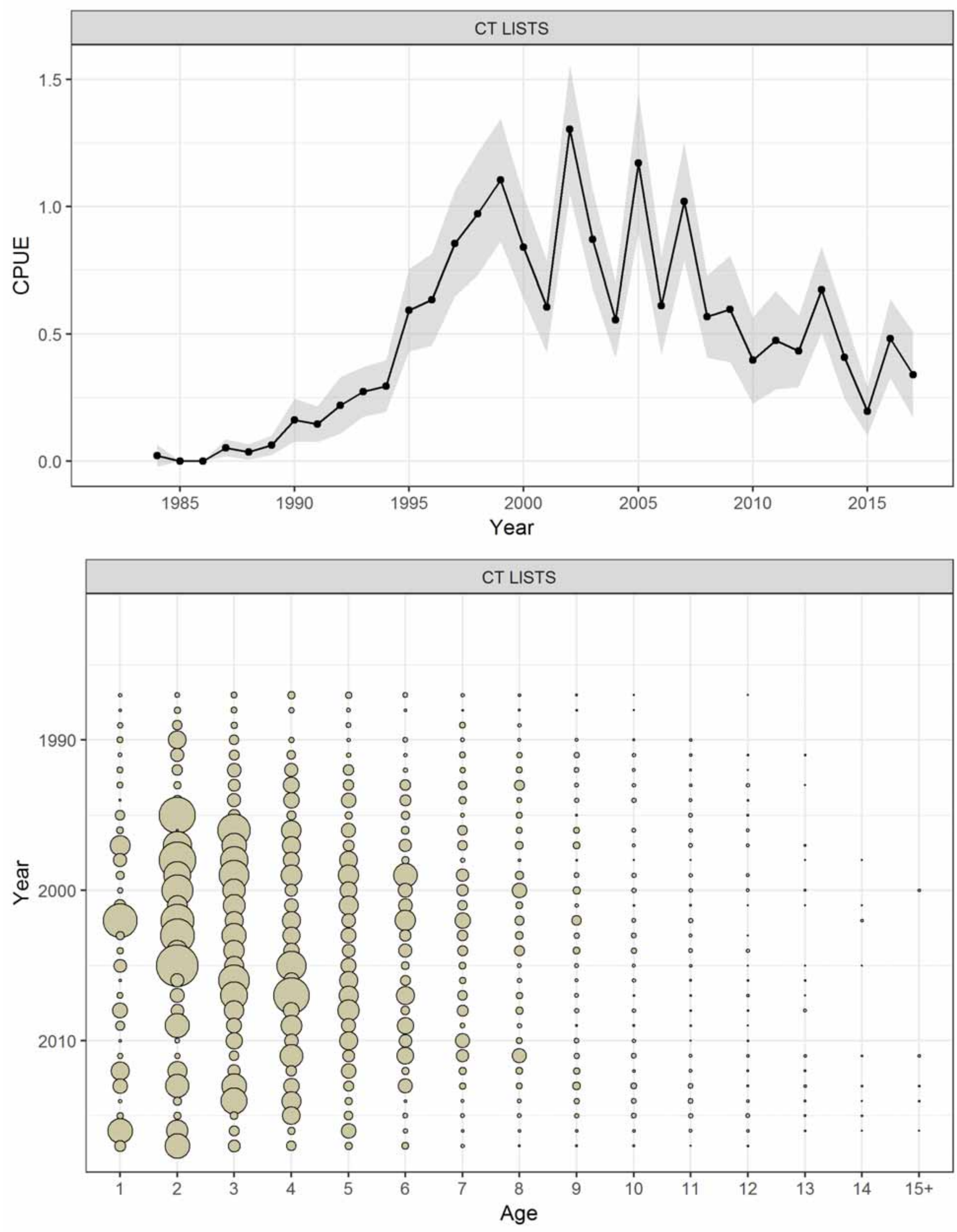



Figure B5.6. Connecticut Long Island Trawl Survey catch-per-tow (top) and age composition (bottom). Shaded area on top plot indicates 95% confidence intervals.

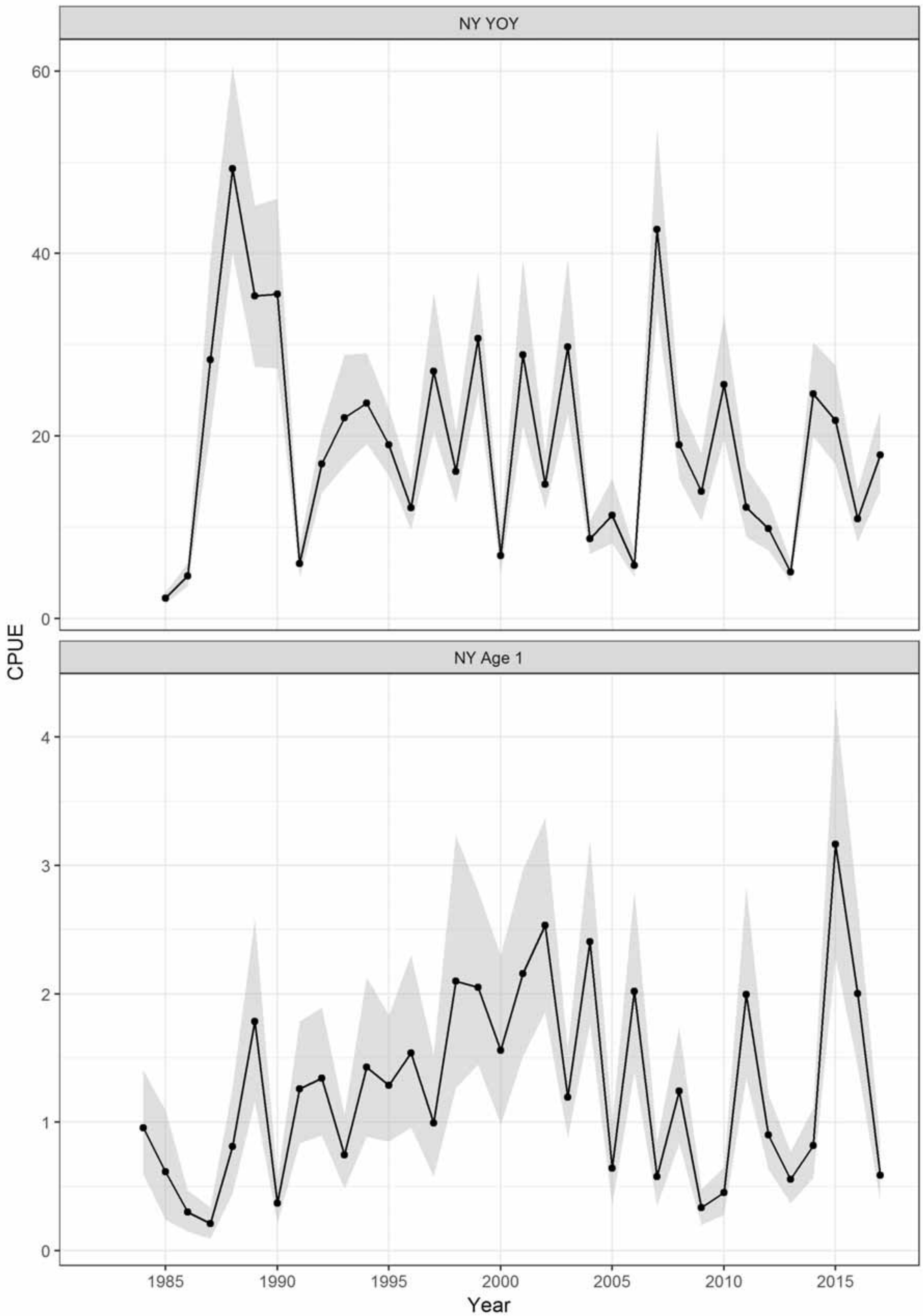
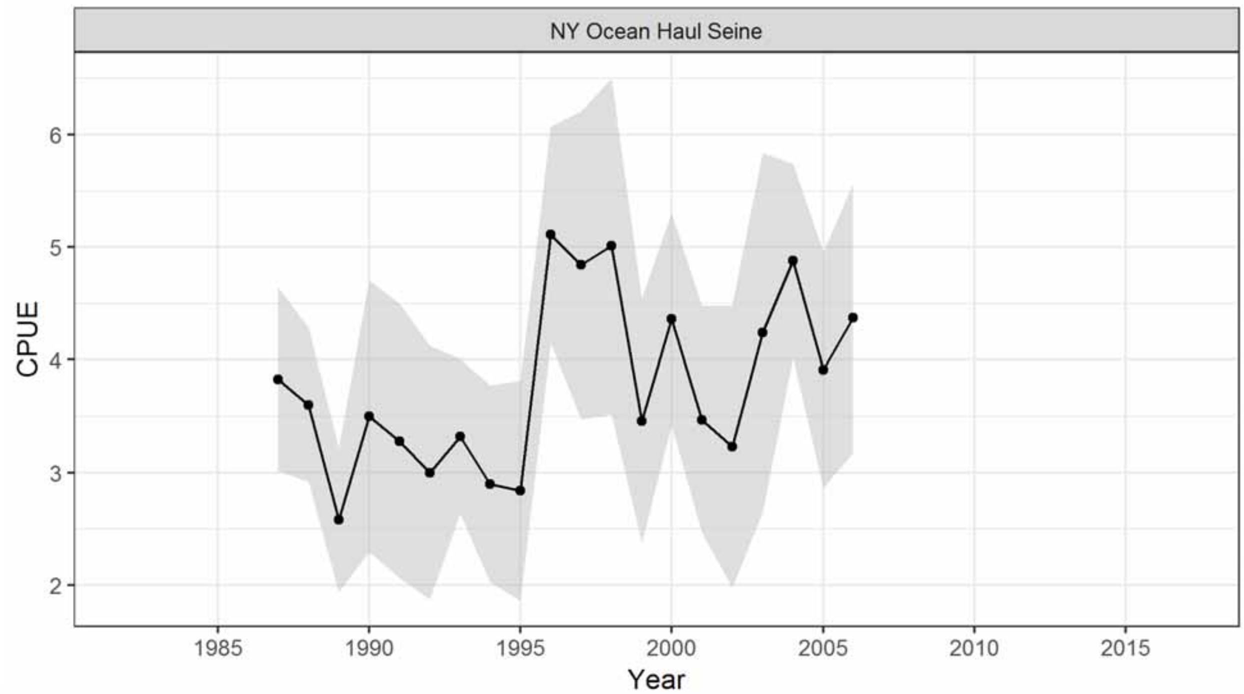


Figure B5.7. New York Hudson River young-of-year index (top) and Wester Long Island Age-1 index (bottom). Shaded area indicates 95% confidence intervals.



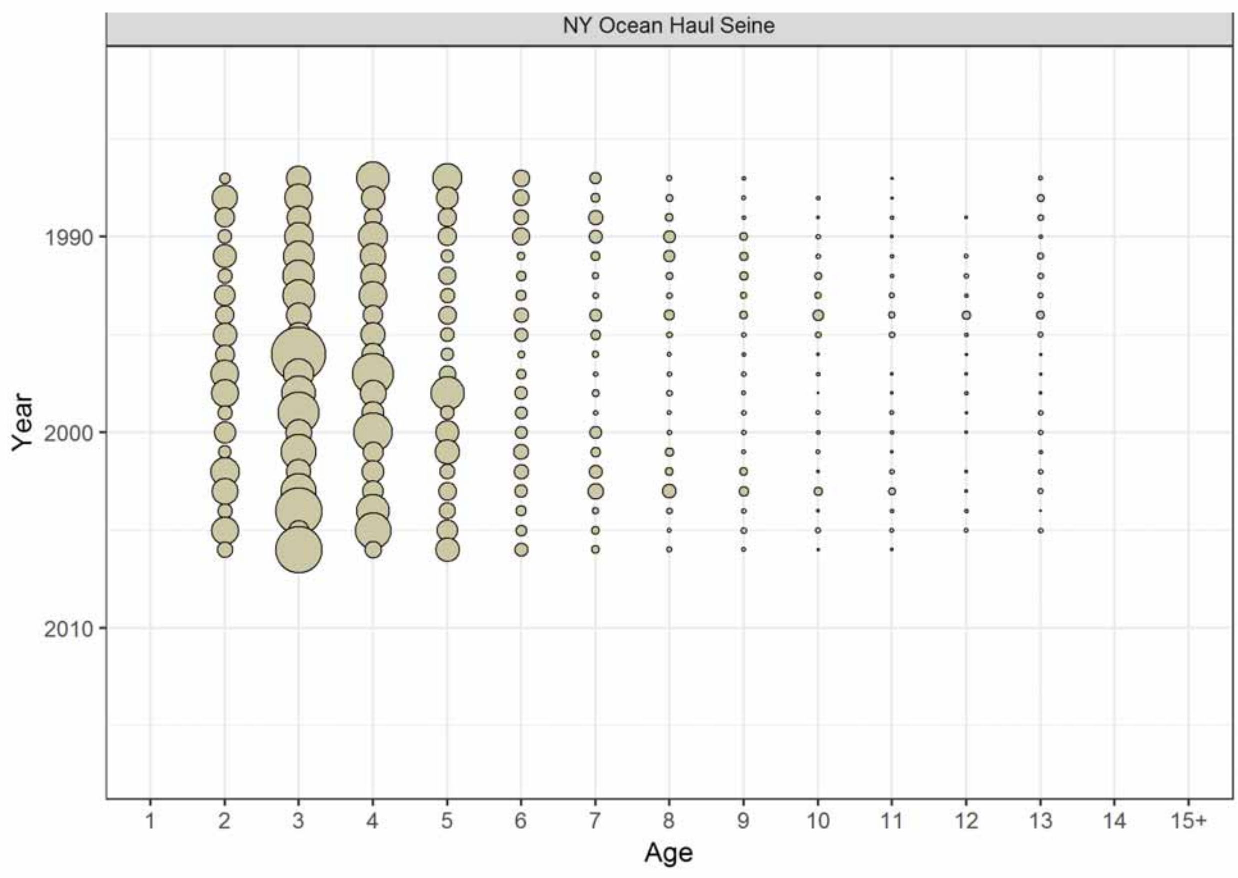




Figure B5.8. NY Ocean Haul Seine catch per haul (top) and age composition (bottom). Shaded area on top plot represents 95% confidence intervals.

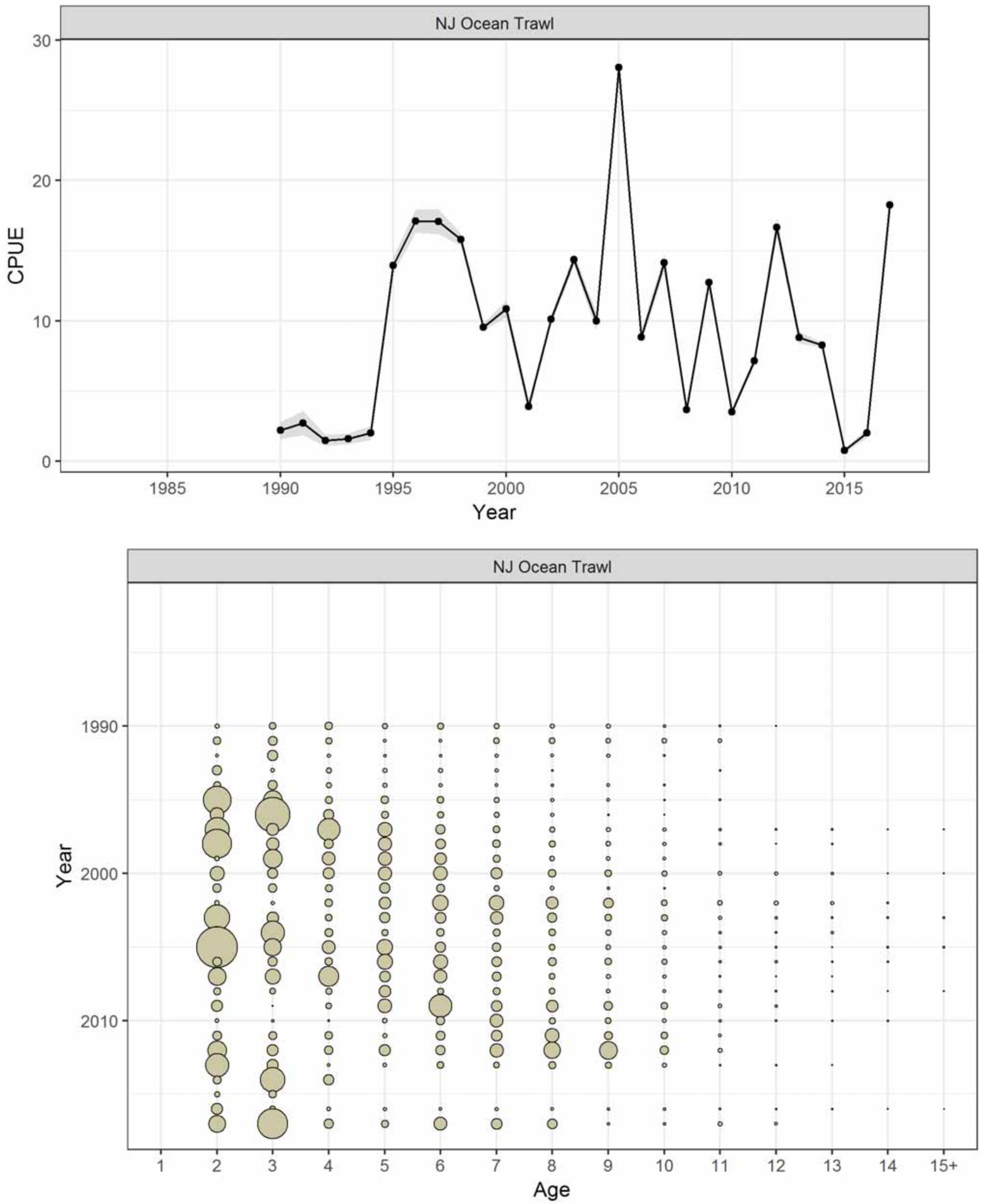



Figure B5.9. New Jersey Ocean Trawl catch per tow (top) and age composition (bottom). Shaded area on top plot indicates 95% confidence intervals.

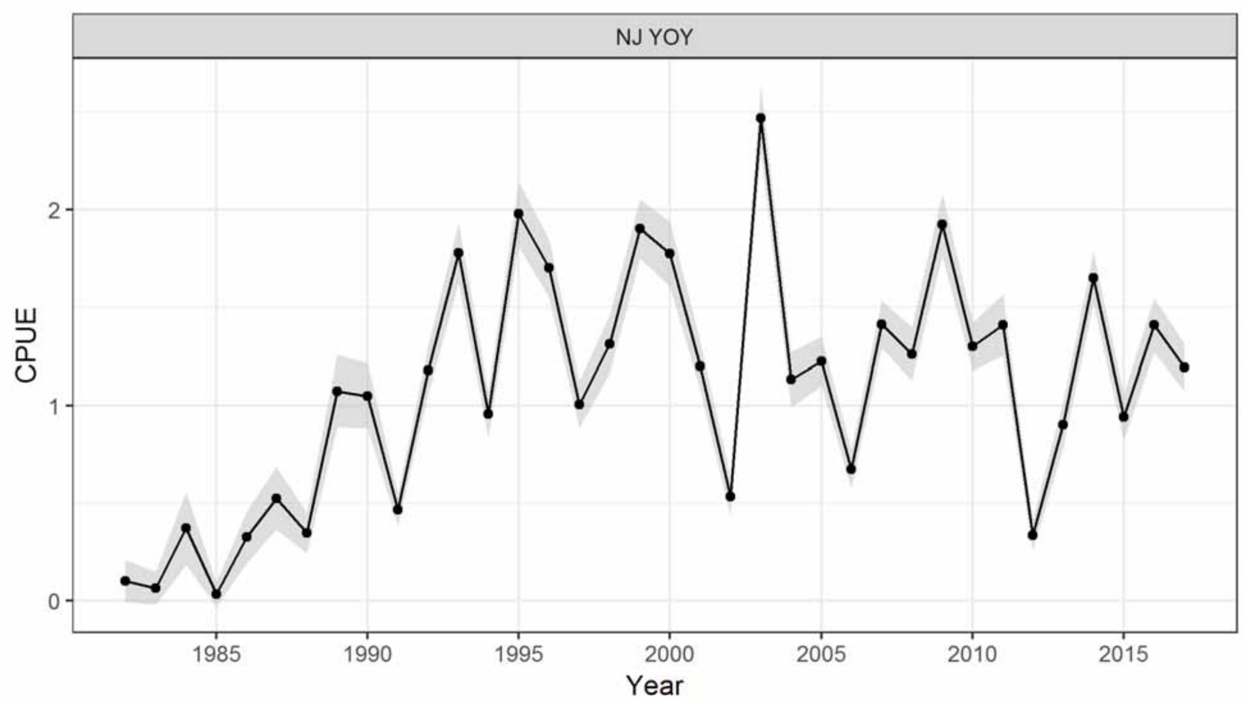



Figure B5.10. New Jersey young-of-year index with 95% confidence intervals.

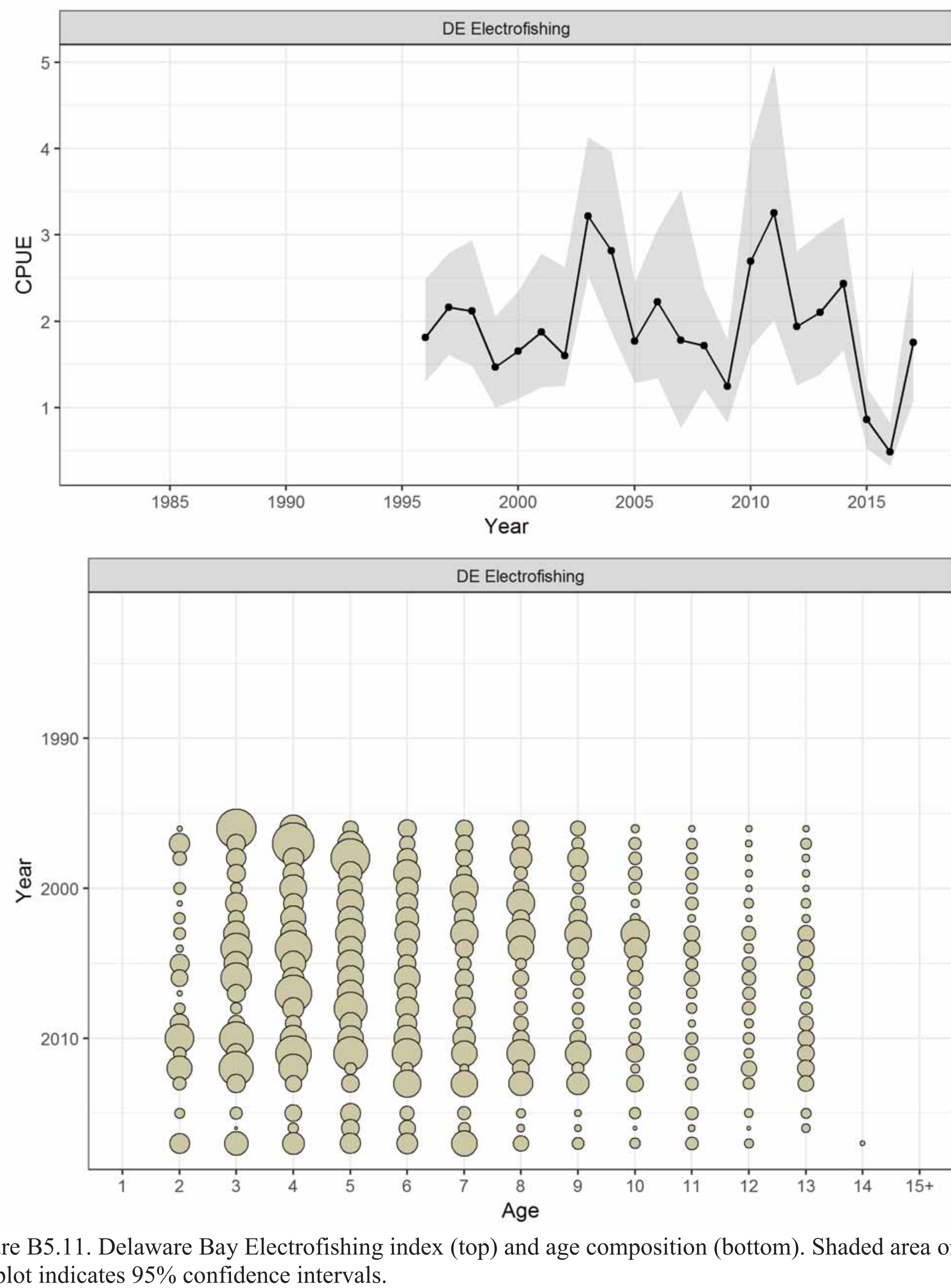



Figure B5.11. Delaware Bay Electrofishing index (top) and age composition (bottom). Shaded area on top plot indicates 95% confidence intervals.

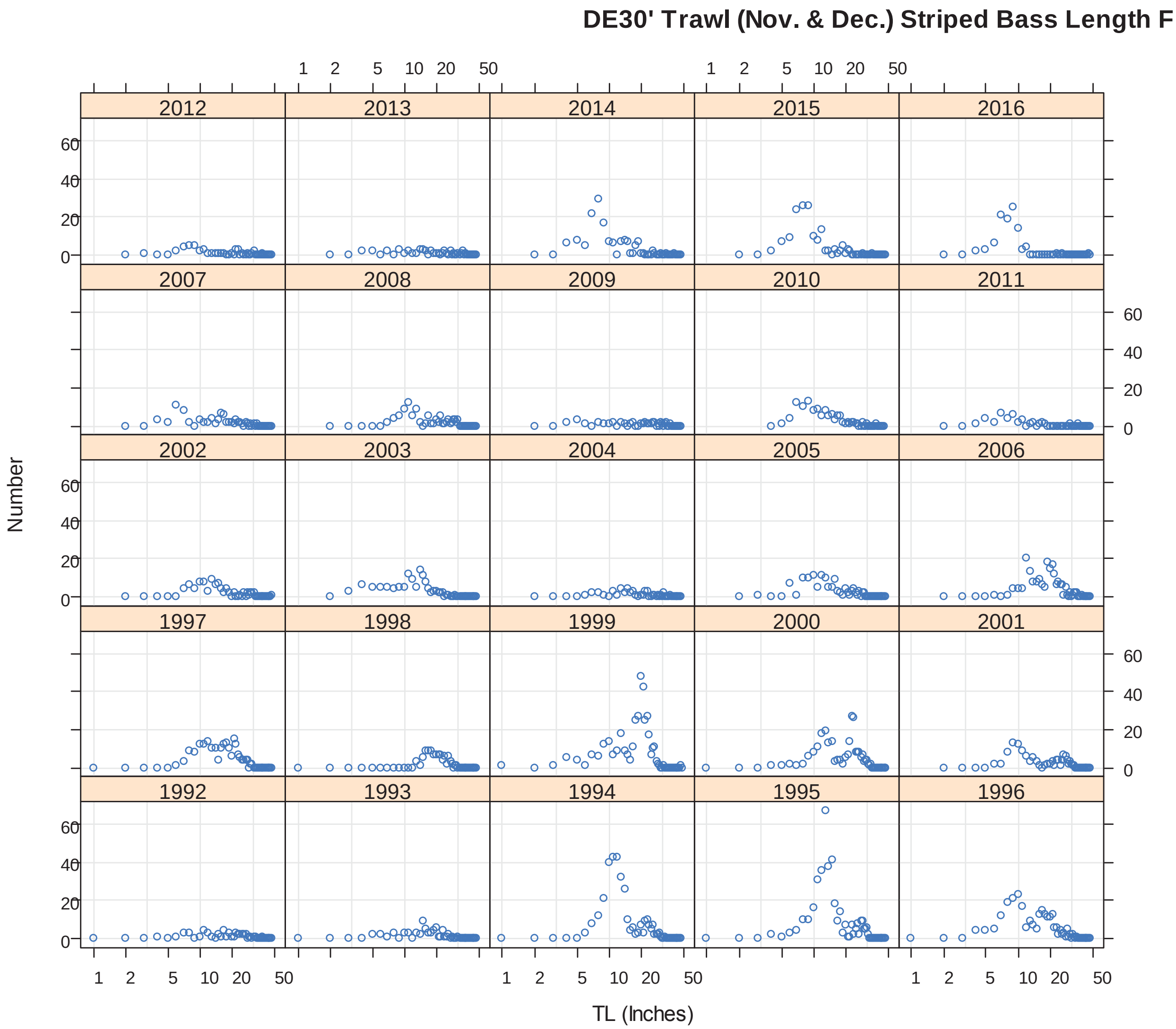
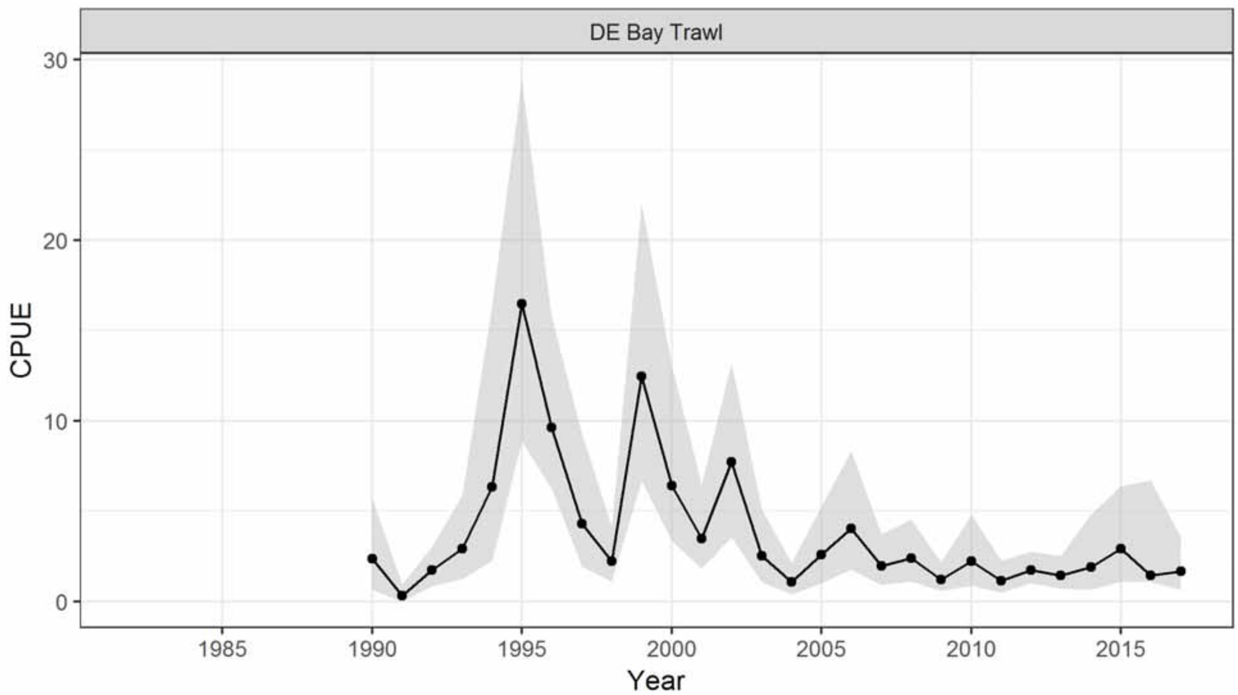



Figure B5.12. Length frequency of striped bass captured by the Delaware Bay 30' Trawl survey by year. (1-inch = 2.5 cm).



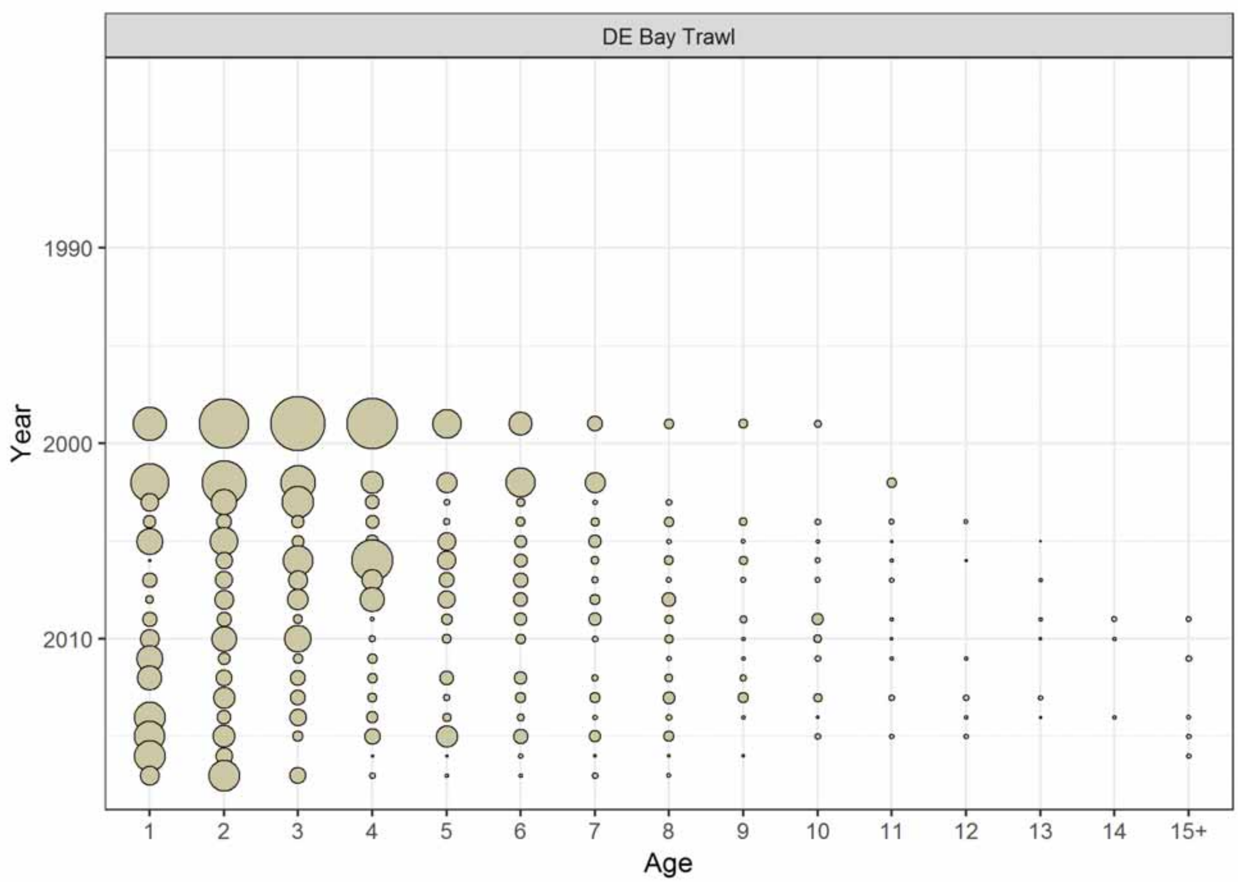




Figure B5.13. Delaware Bay 30’ Trawl index (top) and age composition (bottom). Shaded area on top plot indicates 95% confidence intervals.

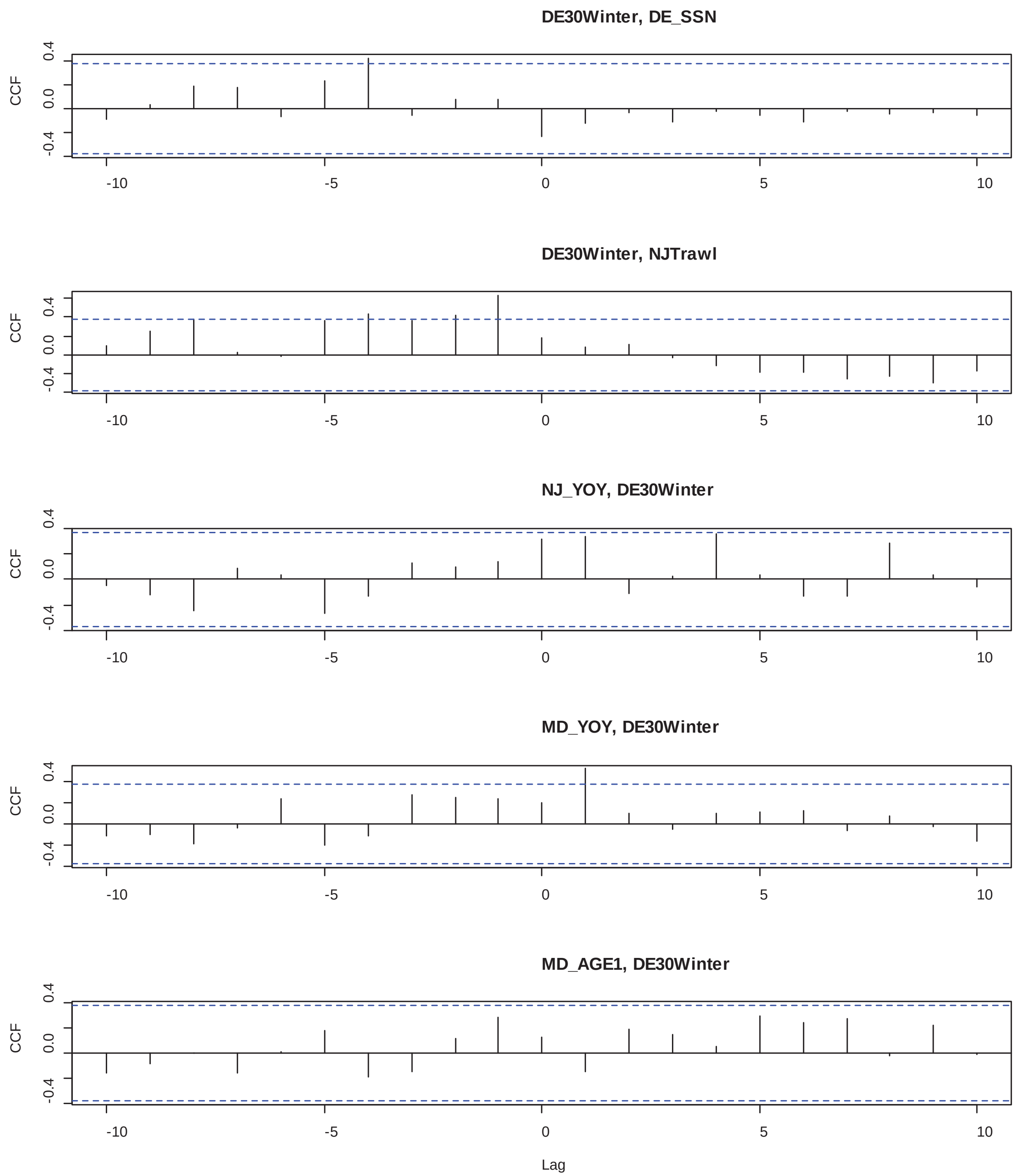



Figure B5.14. Cross-correlations of the Delaware Bay 30' Trawl winter survey and other mid-Atlantic surveys for striped bass (DESSN, NJ Trawl, NJYOY, MDYOY, and MD Age-1) through 2016. Significant correlations at any lag in time are above the blue 95 % significance line. Only negative lags in time are considered biologically relevant. The title denotes if the DE30' winter survey was used as the x or y variable (x, y).

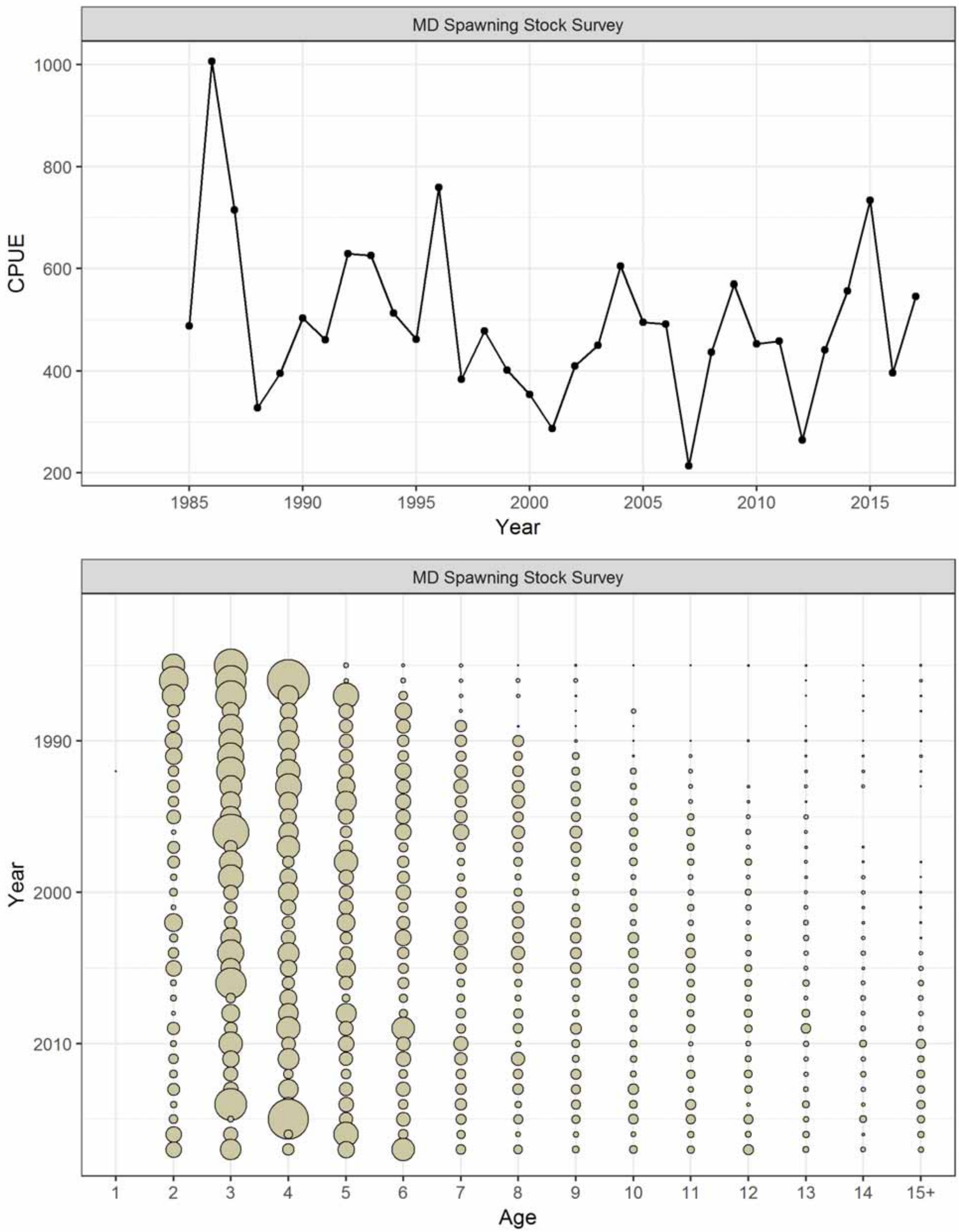



Figure B5.15. Maryland Spawning Stock index (top) and age composition (bottom).

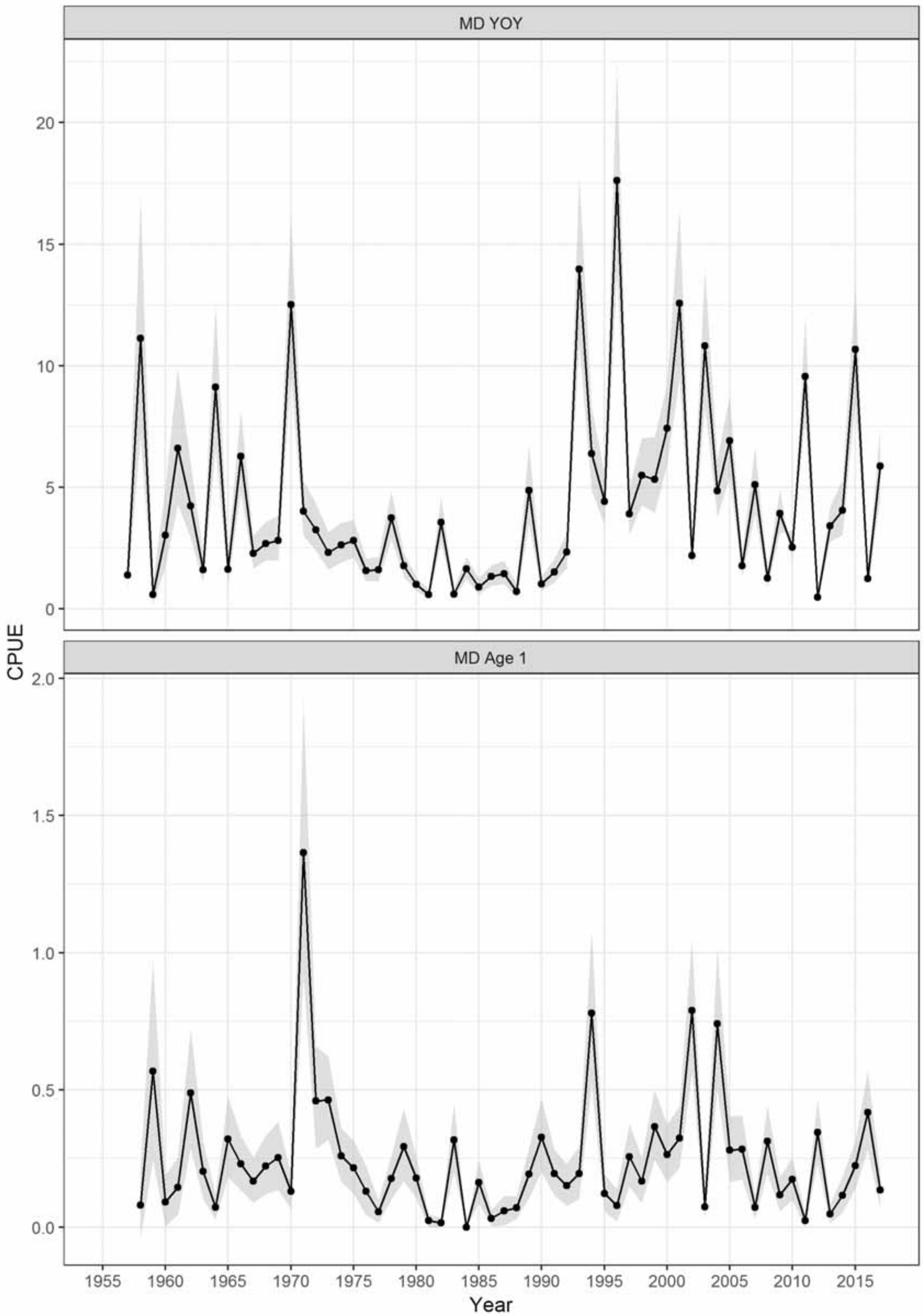



Figure B5.16. Maryland young-of-year (top) and age-1 (bottom) indices for striped bass. Shaded area on plot indicates 95% confidence intervals.

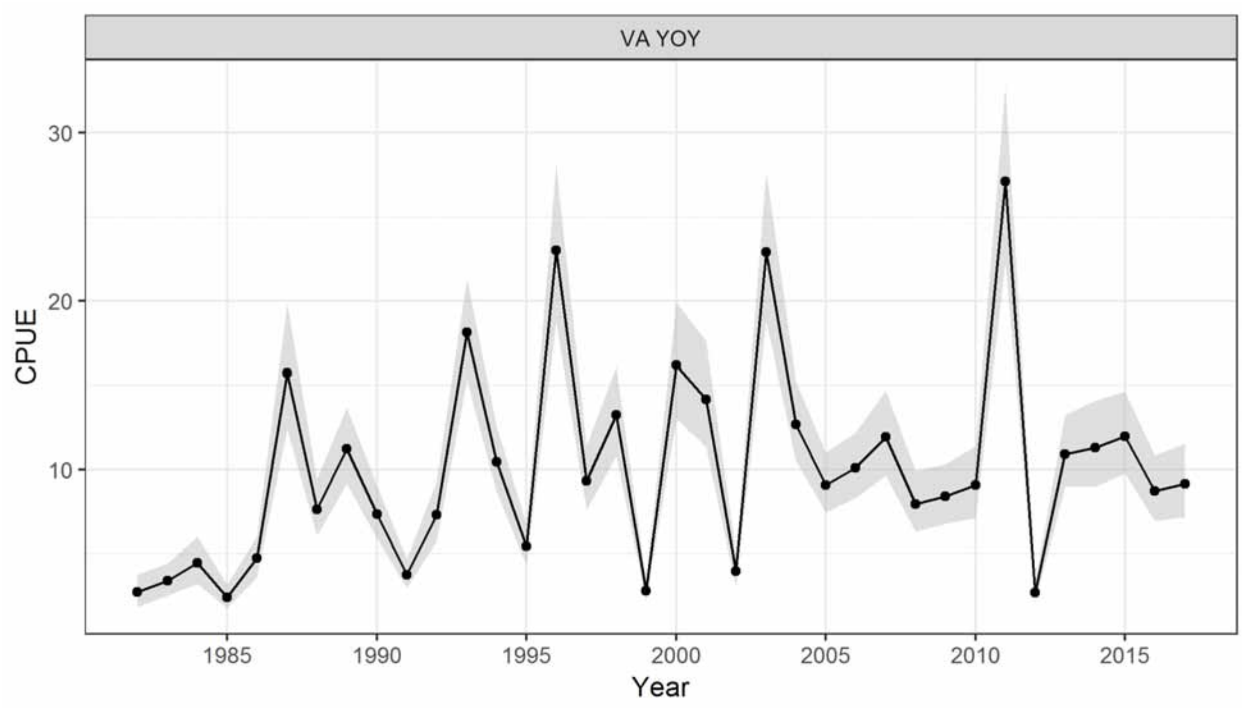
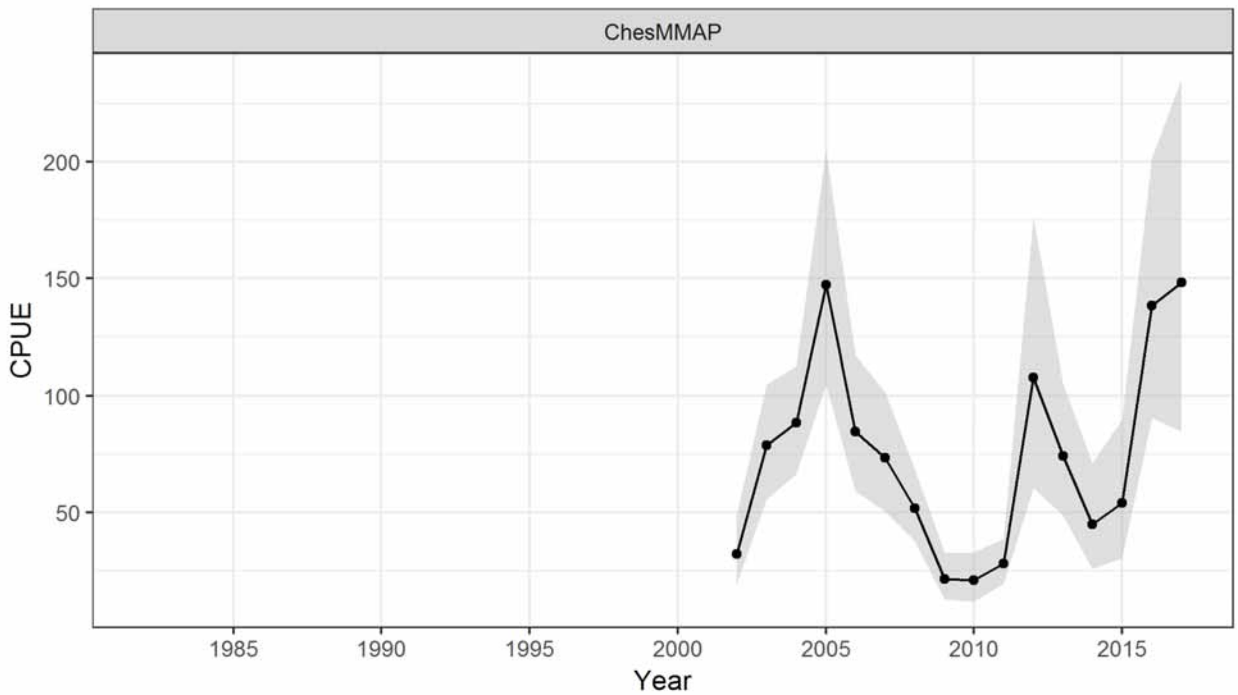



Figure B5.17. Virginia young-of-year index with 95% confidence intervals.



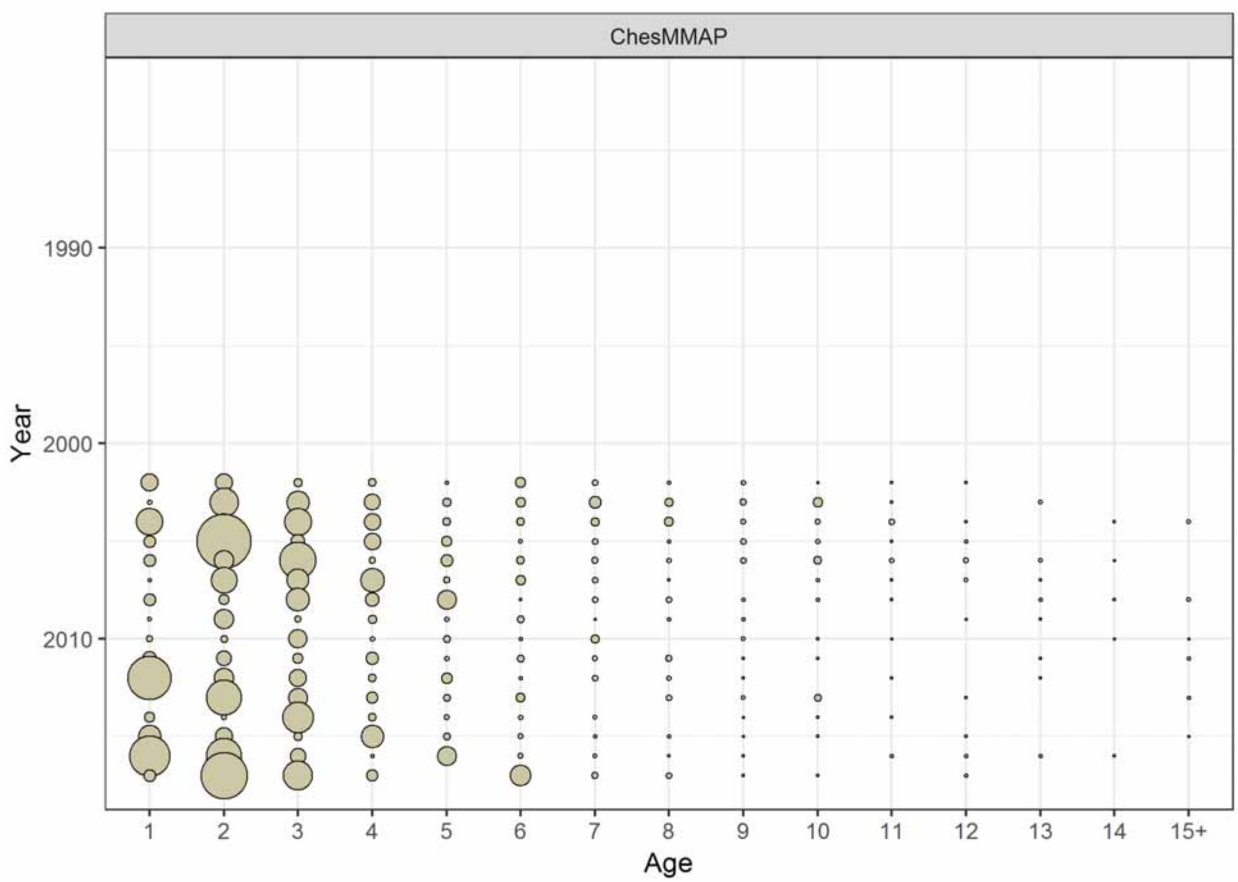
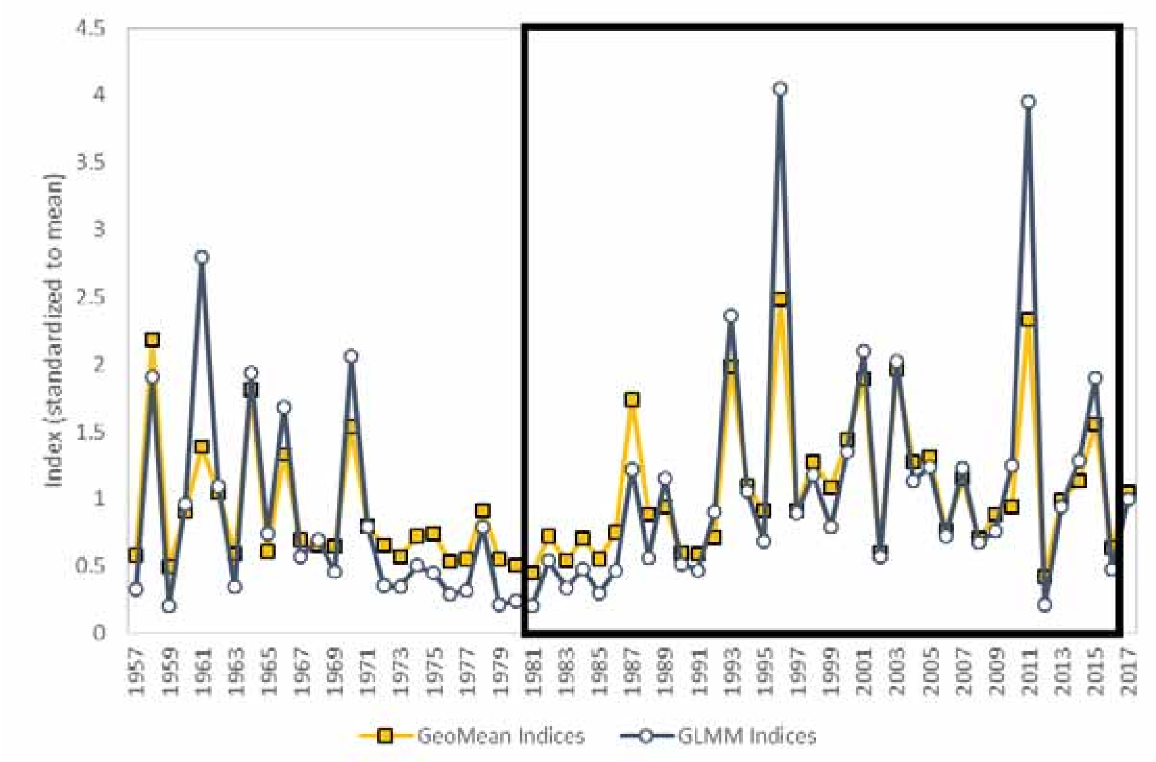




Figure B5.18. ChesMMAP index (top) and age composition (bottom). Shaded area on top plot indicates 95% confidence intervals.



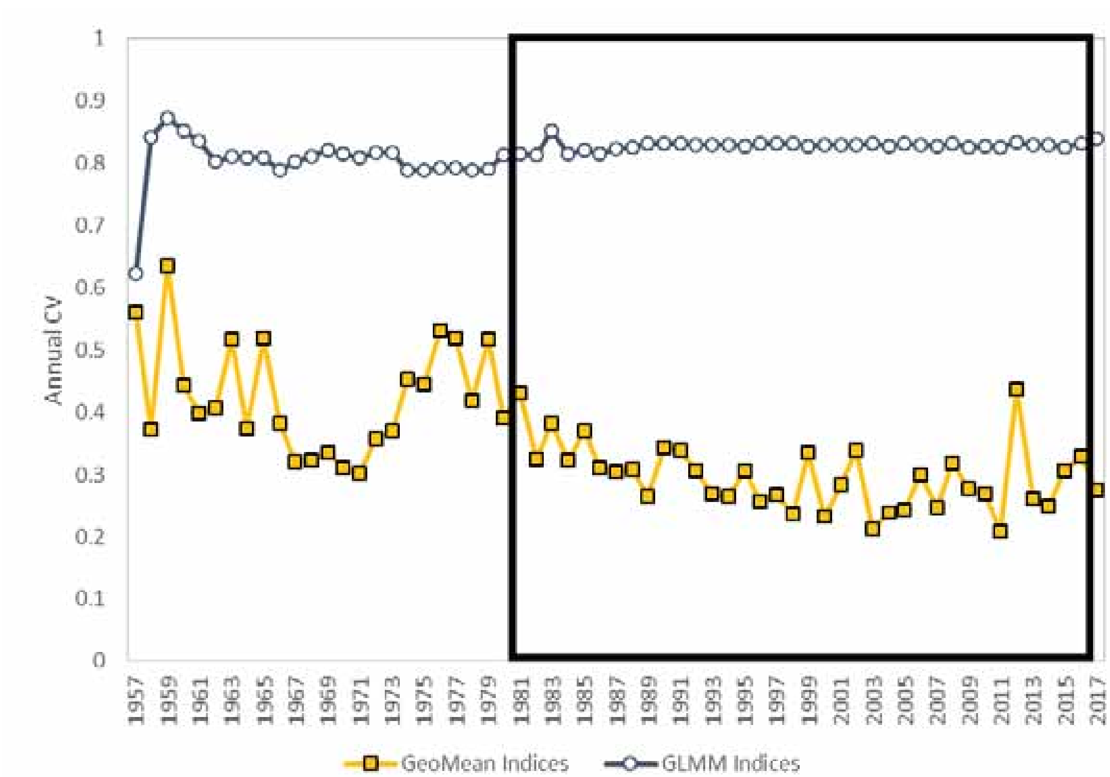




Figure B5.19. Comparison of composite young-of-year index trends (top) and CVs (bottom) for the Chesapeake Bay developed using two different methods to derive the input indices. The solid black box on each plot indicates the years included in the assessment models.

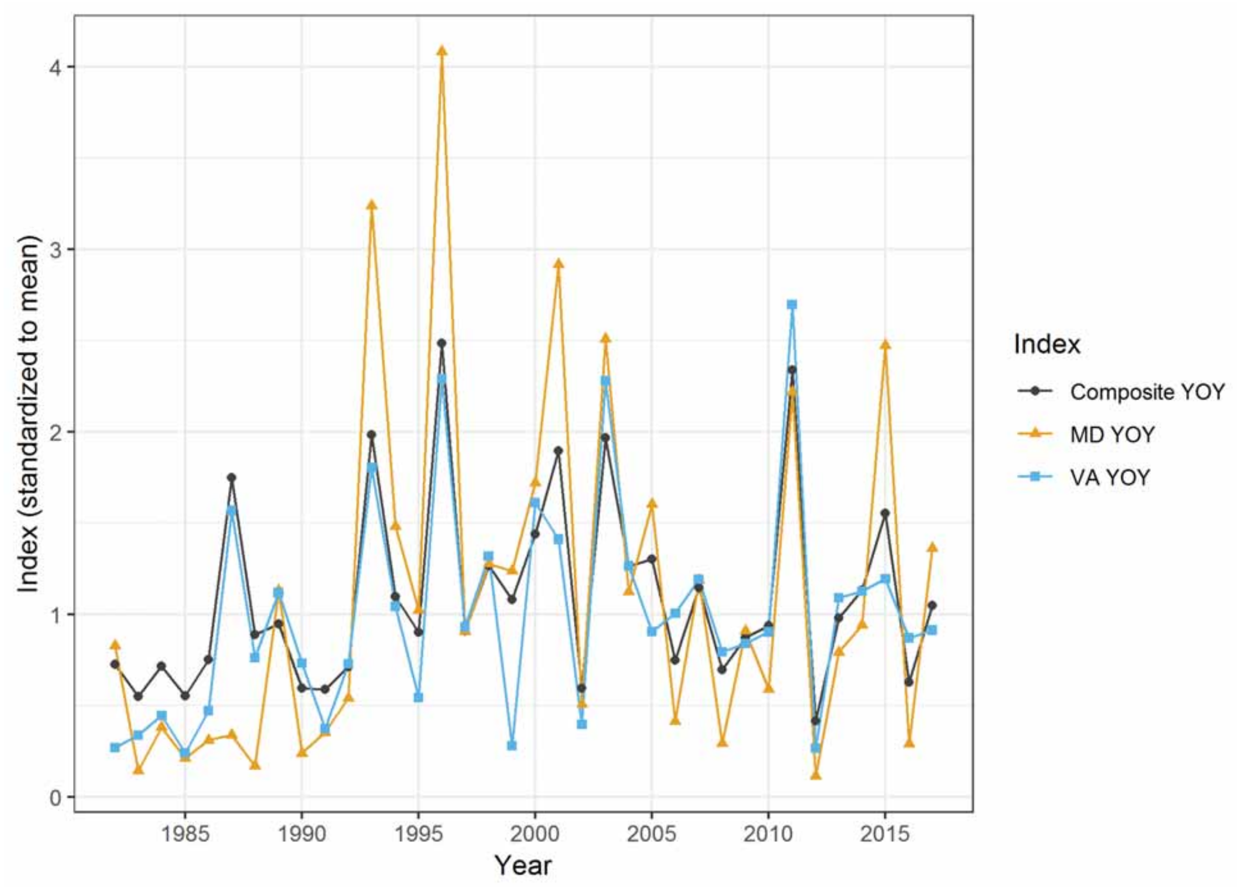



Figure B5.20. Composite Chesapeake Bay young-of-year index plotted with Maryland and Virginia young-of-year indices.

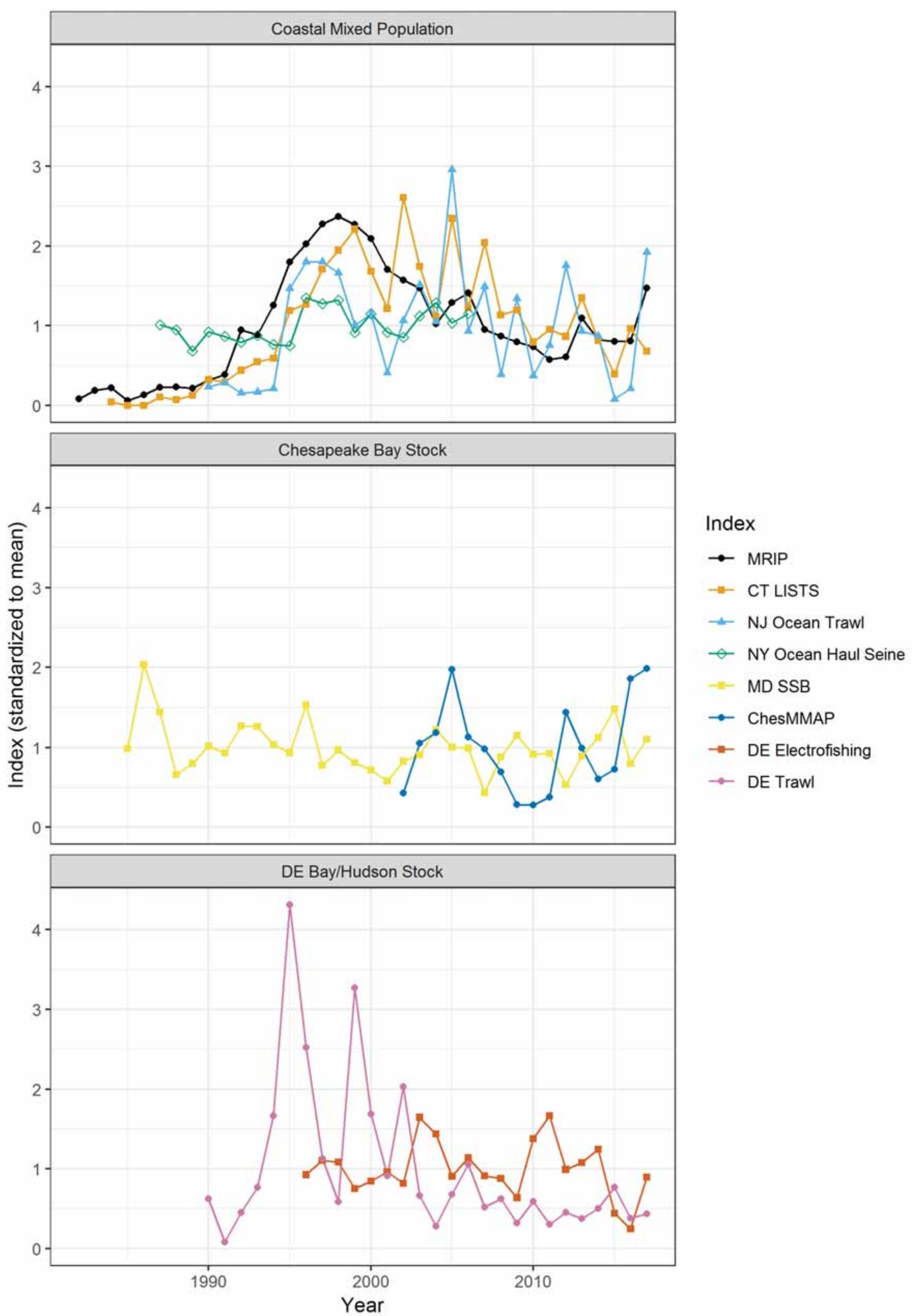



Figure B5.21. Comparison of indices of relative age-1+ abundance for striped bass by stock component.

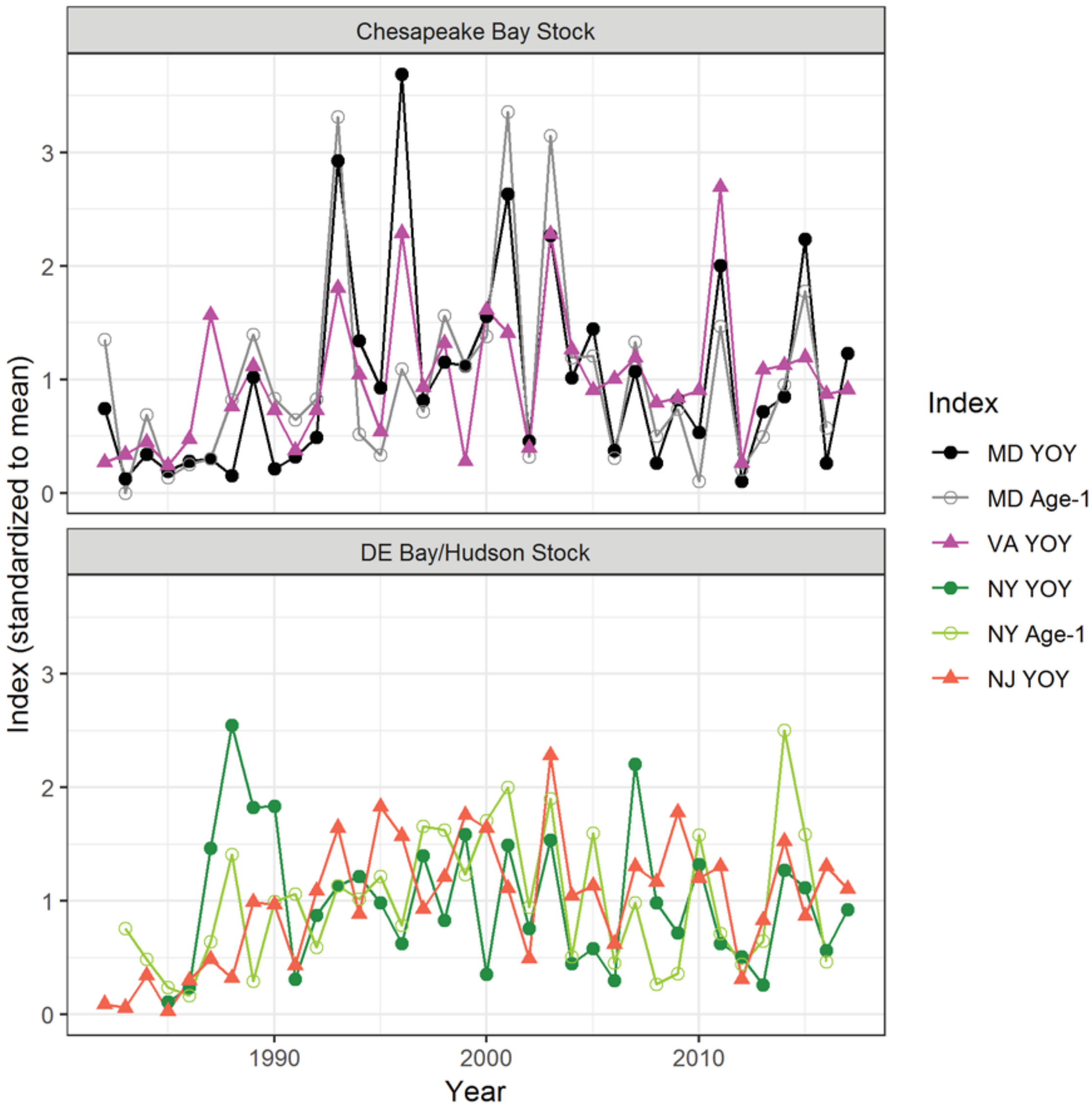



Figure B5.22. Comparison of striped bass recruitment indices by stock. Age-1 indices have been lagged back one year to be more easily compared to the young-of-year indices.

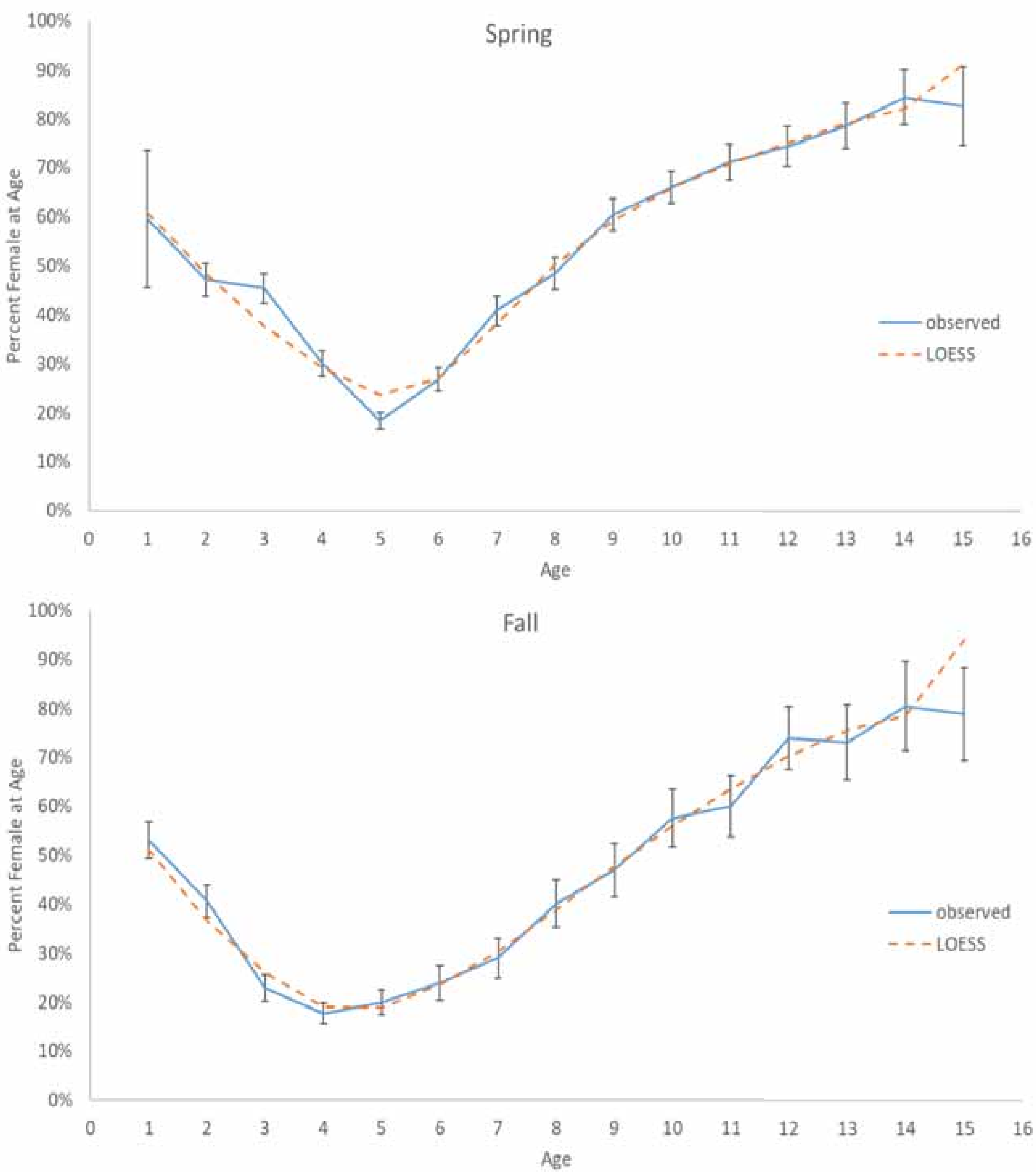



Figure B5.23. Comparison of observed sex ratio-at-age and the LOESS estimate for Chesapeake Bay by season.

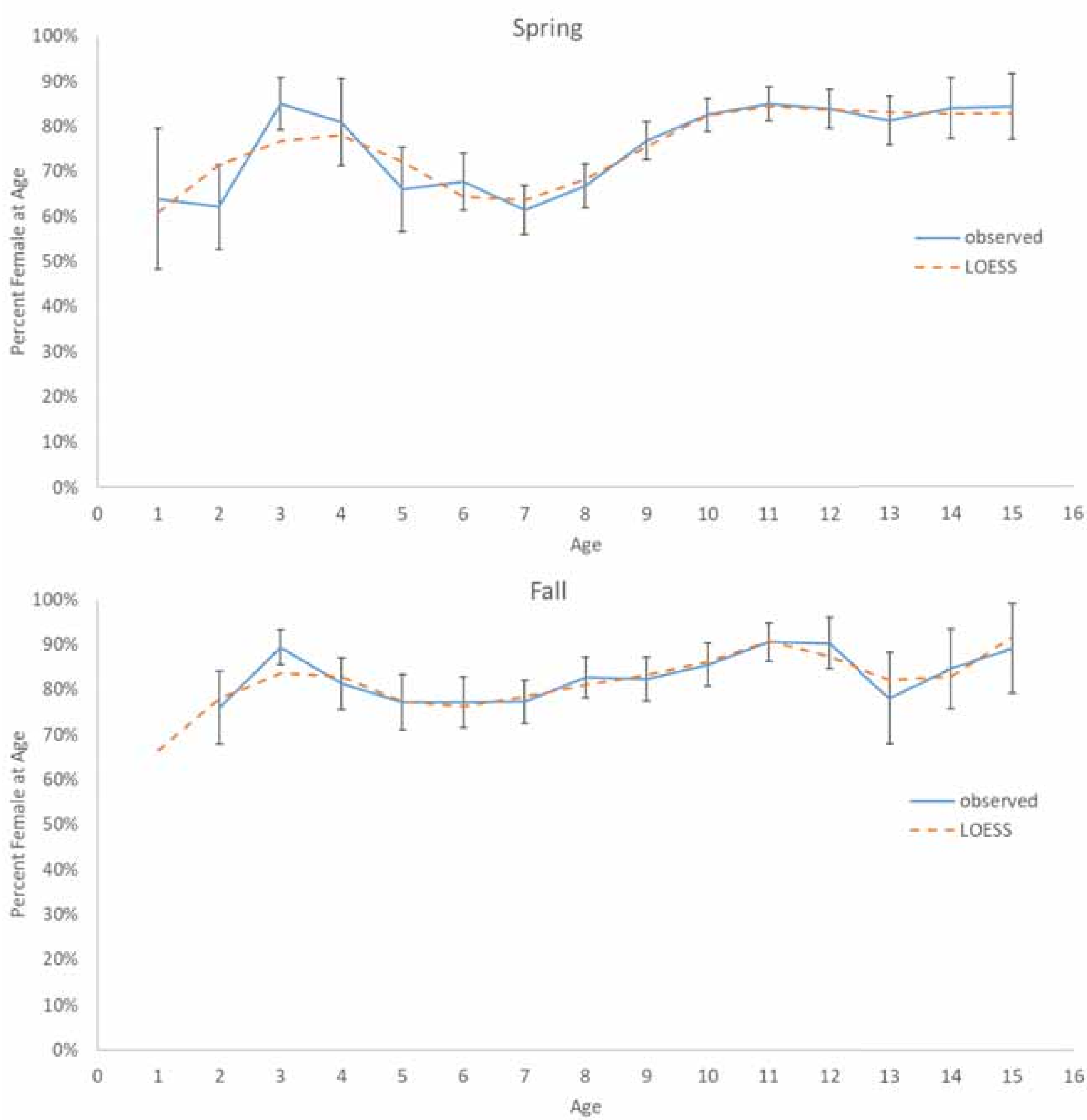



Figure B5.24. Comparison of observed sex ratio-at-age and the LOESS estimate for the ocean stock by season.

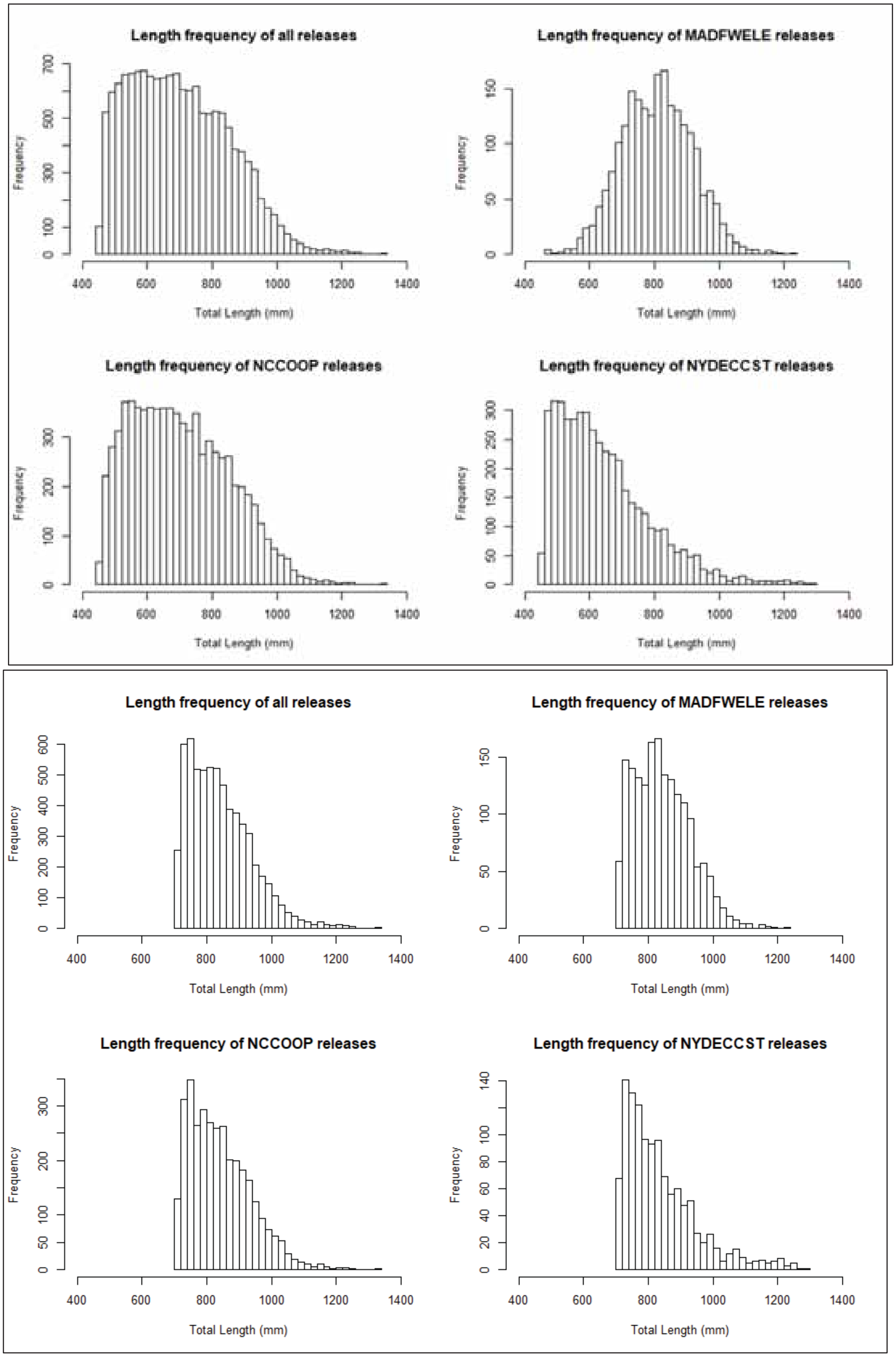



Figure B5.25. Length frequency of all tagged releases and releases by agency that were ≥ 18” (457 mm) TL (top) and ≥ 28” (711 mm) TL (bottom).

Retained record if:

- Event = 1;
- Days at large ≥ 10;
- Release size cut off ≥ 457 mm TL or ≥711 mm TL, depending on scenario.
- Fish must have been confirmed to have been alive during at least one spawning period after release (Kneebone et al. 2014)

Spawning indicated by:

- If recapture = Hudson River NOAA code between March 15th and June 15th.
- If recapture = Delaware River and Tributaries NOAA code between March 15th and June15th.
- If recapture = Chesapeake Bay and Tributaries NOAA code between March 15th and June15th.

Adjusted tag returns by reporting rates (rr) and exploitation rate (Hansen and Jacobsen 2003):

- Fish of known stock [note that F and reporting rates only available through 2011; we carried those terminal values forward]:
  - Assume separate harvest and discard reporting rates:

    raw $tags_{AD}$ ÷ harvest or release $rr_{AD}$ ÷ $[1-\exp(-F_A)]$, where A = parent spawning system and D = fish disposition
- Fish of unknown stock:
  - When applying disposition-specific reporting rates to recaptures:
    - Use mean harvest reporting rate across all years (across all PSSs)
    - Use mean release reporting rate across all years (across all PSSs)
    - Use mean exploitation across all years (across all PSSs)
- Time blocks
  - Regulatory period: 1987-1989, 1990-1994, 1995-1999, 2000-2002, 2003-2006, 2007-2014, and 2015-2016

Figure B5.26. Summary of stock composition estimation methods.

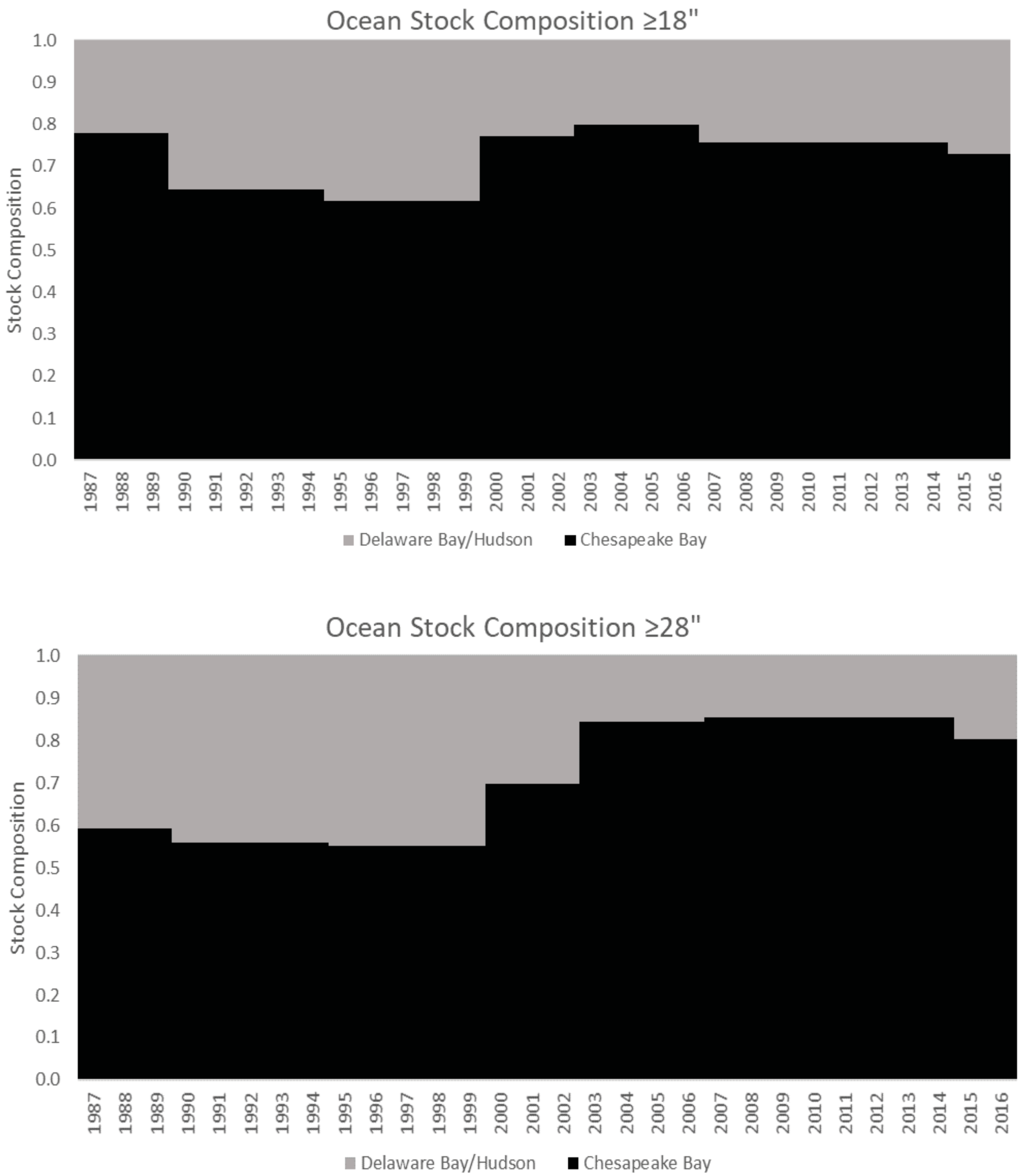



Figure B5.27. Ocean stock composition of fished striped bass ≥ 18” (457 mm, top) and fished striped bass ≥ 28” (711 mm, bottom) based on adjusted recaptures.

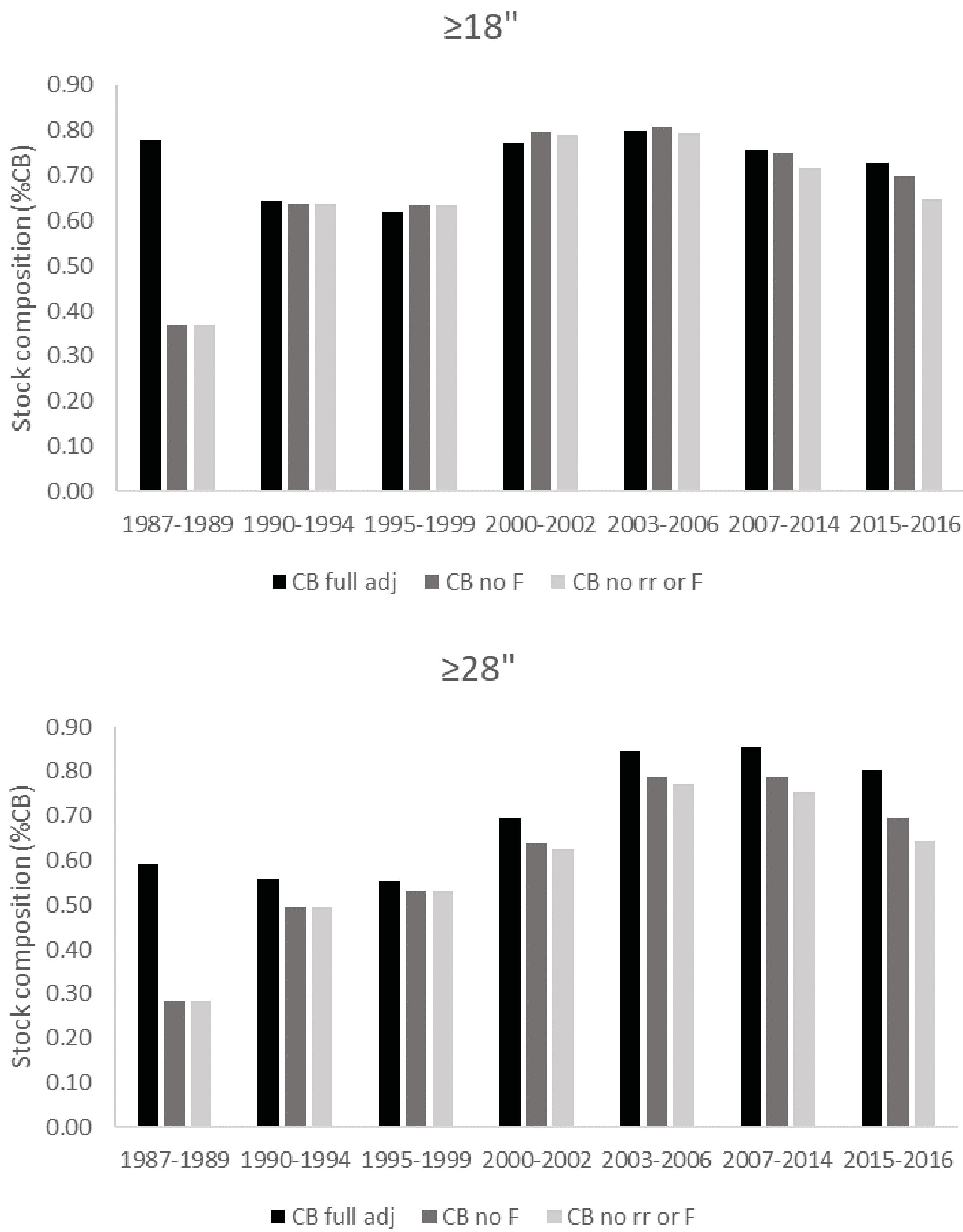



Figure B5.28. Influence of reporting rate and F estimates on stock composition estimates by regulatory time block, for fish ≥18” TL (457 mm, top) and fish ≥28” TL (711 mm, bottom).

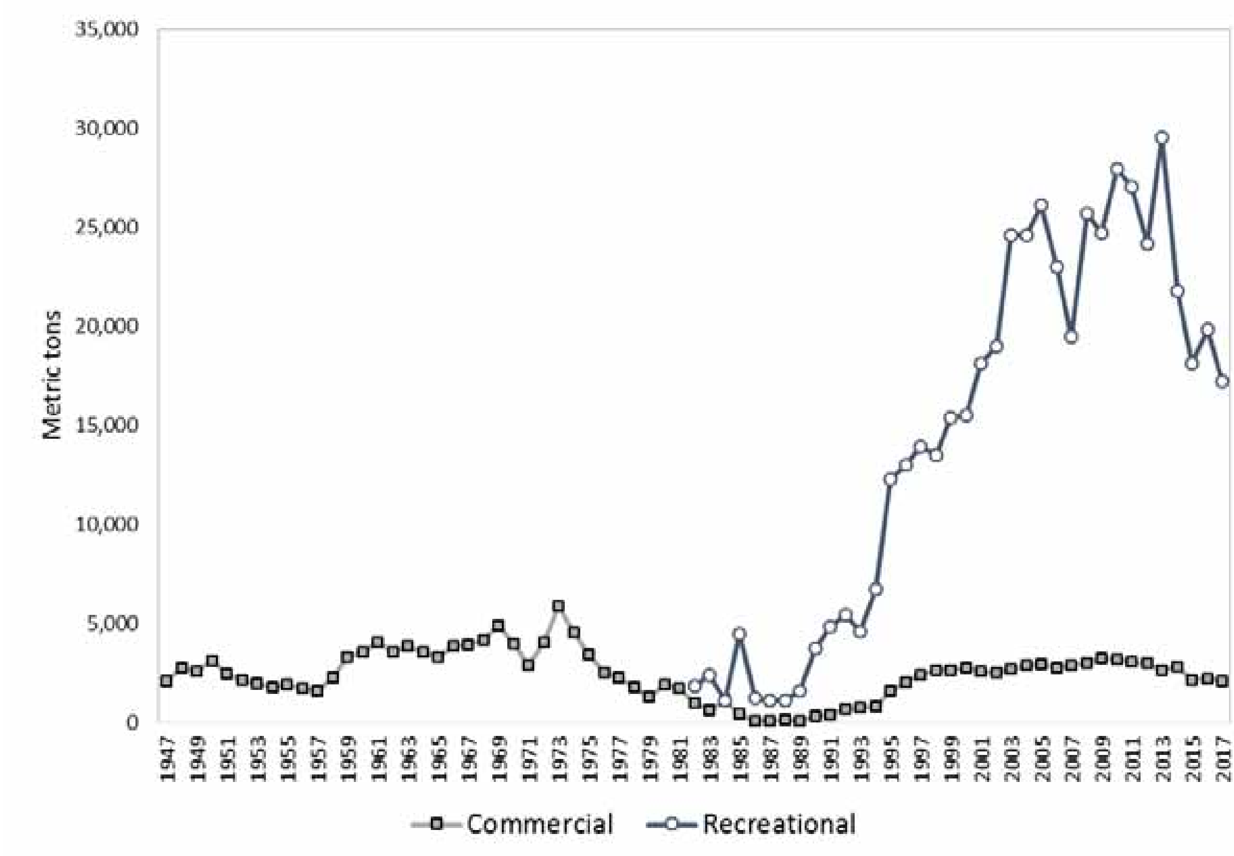



Figure B6.1. Commercial and recreational landings in weight (mt) of striped bass on the Atlantic coast. Estimates of recreational landings are not available prior to 1981.

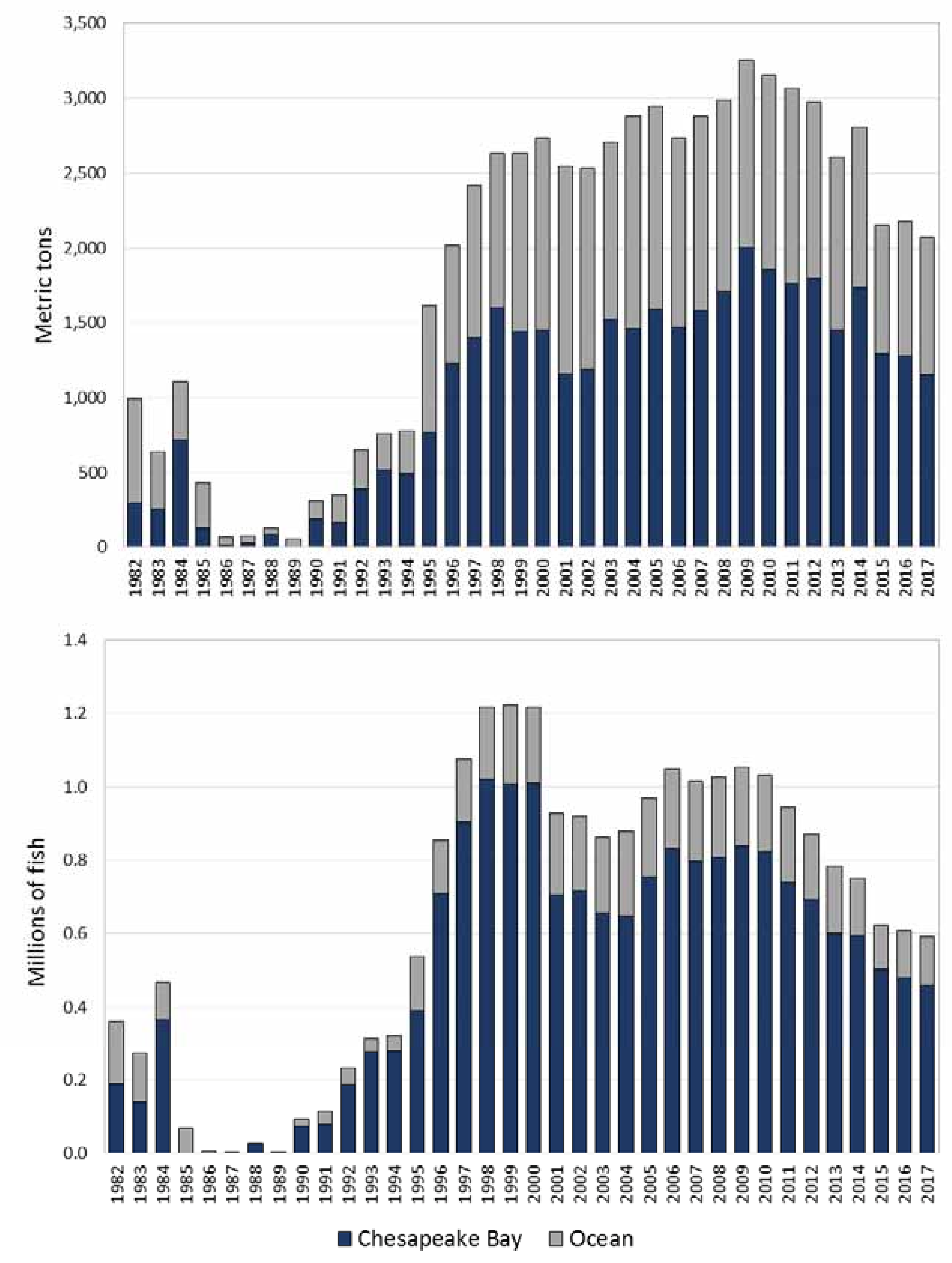



Figure B6.2. Commercial harvest of striped bass by region in weight (top) and numbers of fish (bottom).

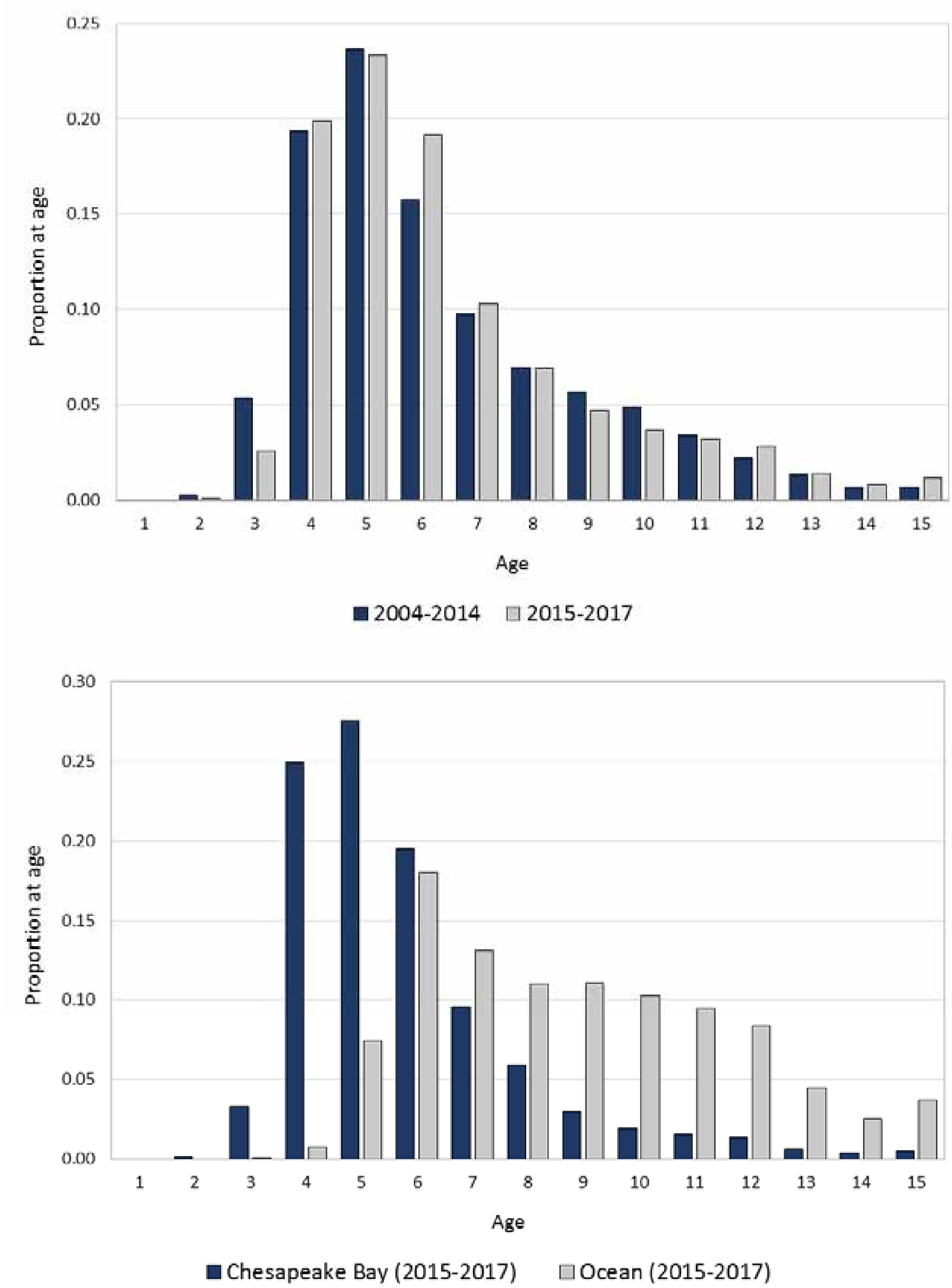



Figure B6.3. Proportion at age in the commercial harvest by management period (top) and region (bottom).

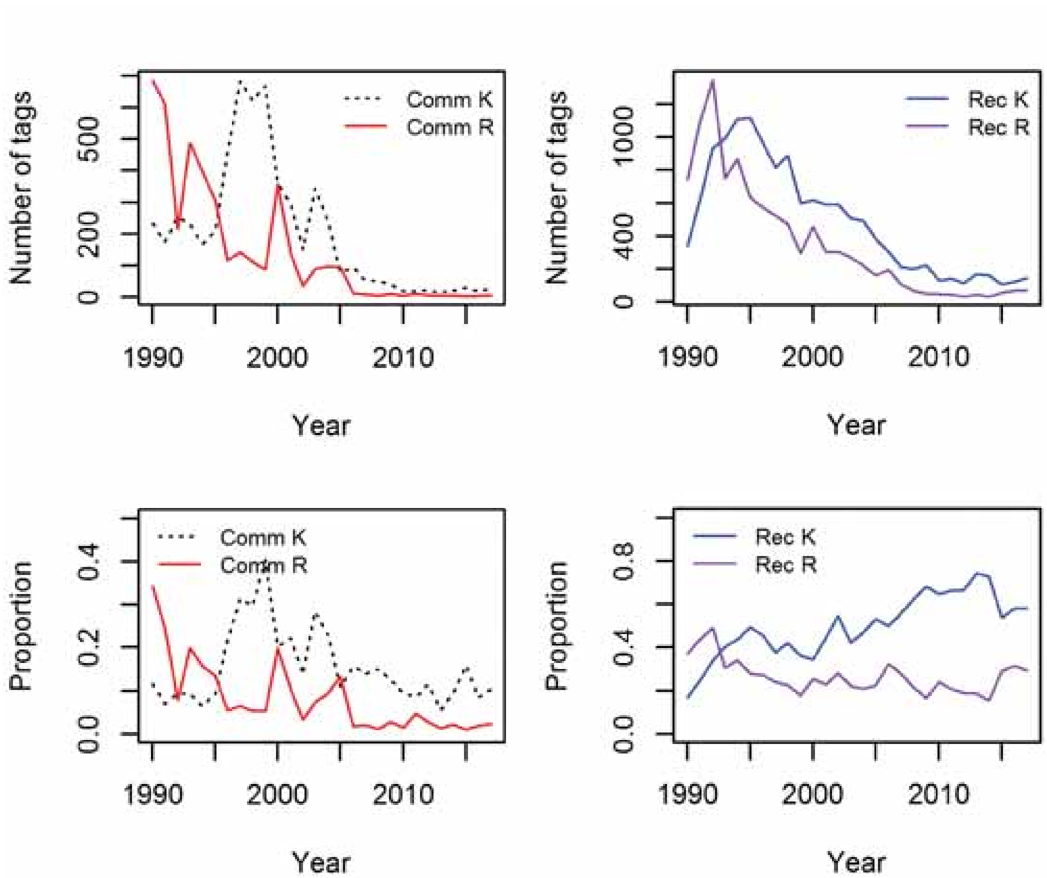



Figure B6.4. Numbers (top row) and proportions (bottom row) of tags returned by disposition and fishery category for Chesapeake Bay. K=killed/harvested, R=released alive.

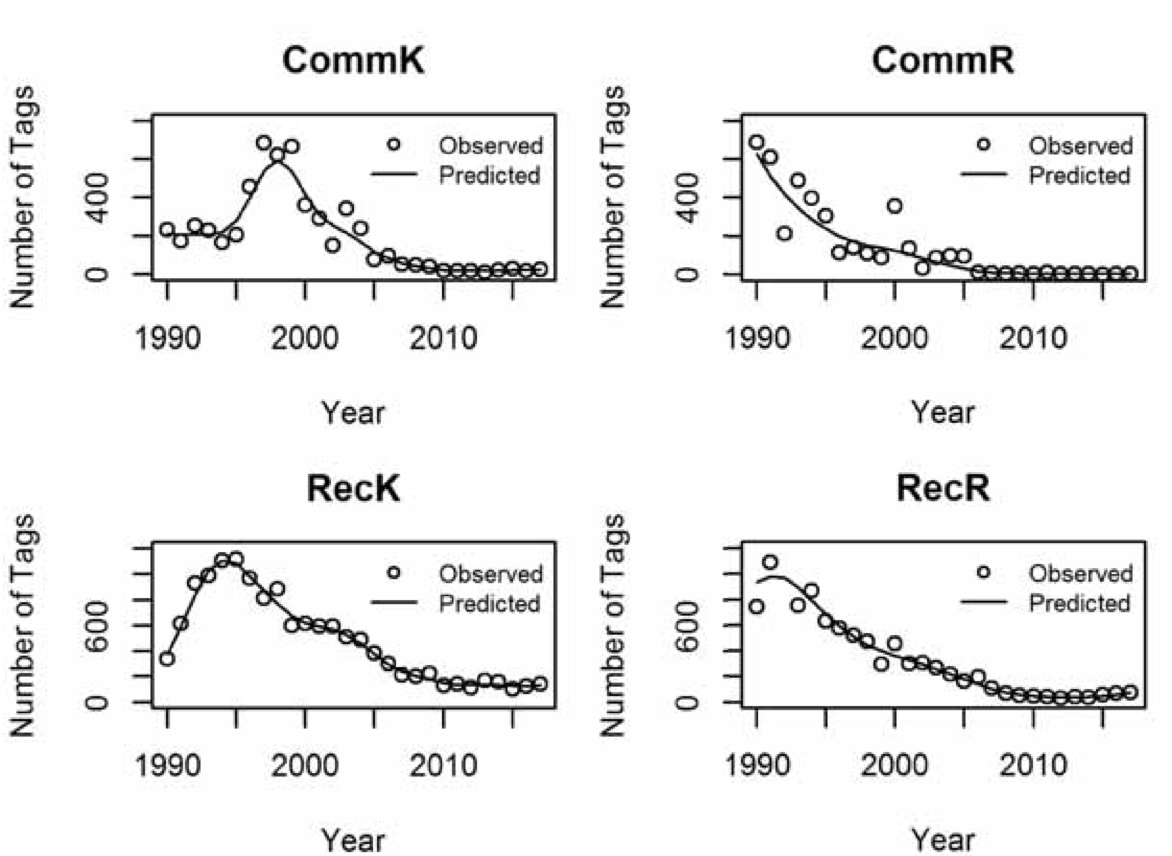



Figure B6.5. Observed and predicted tag numbers from the GAM fits for Chesapeake Bay by fishery and disposition. K=killed/harvested, R=released alive.

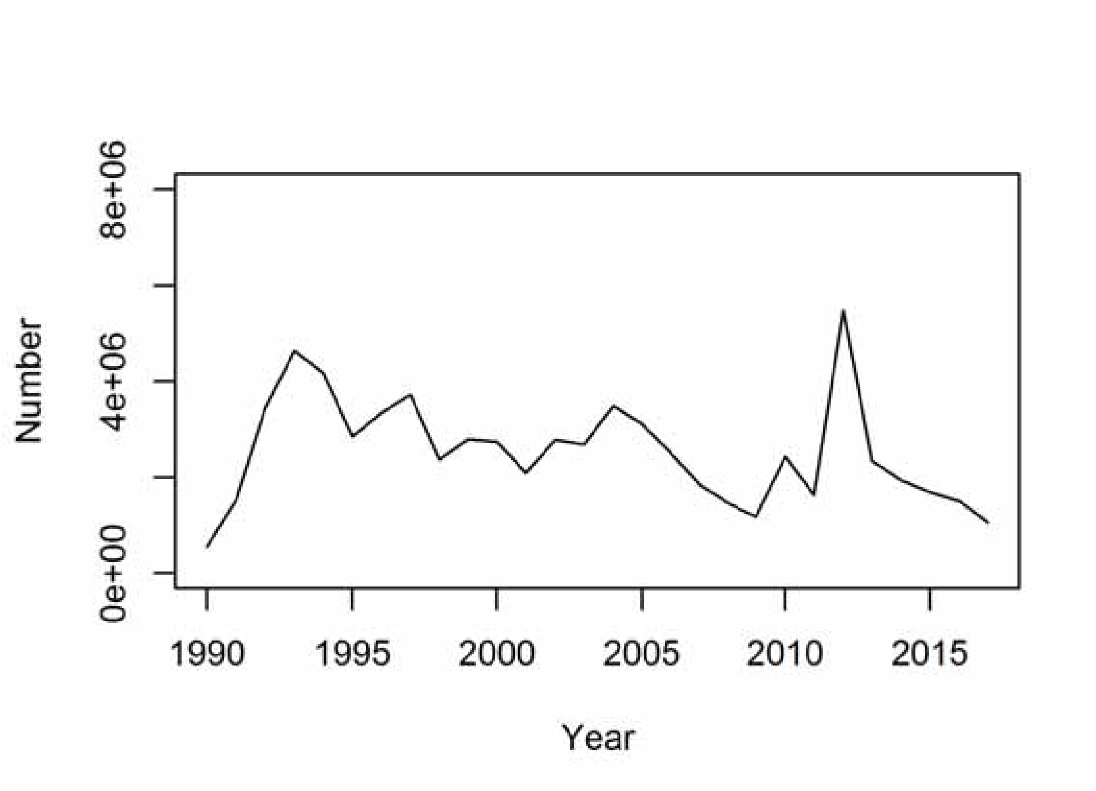



Figure B6.6. Estimates of unscaled commercial total discards for Chesapeake Bay, 1982-2017.

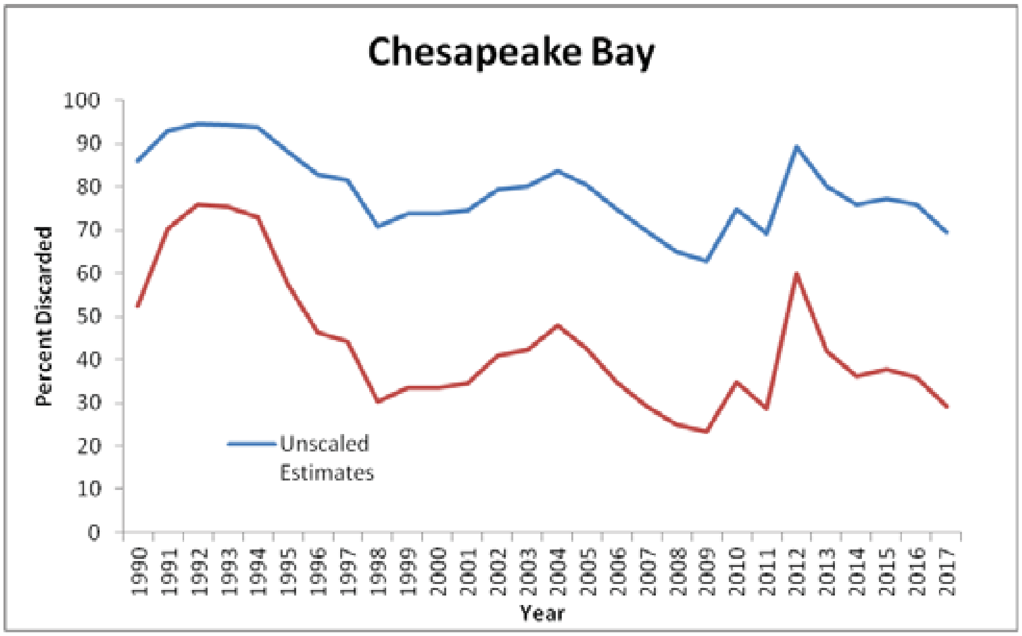



Figure B6.7. Comparison of the percentage of total catch between the unscaled and scaled estimates (red line) of total discards for Chesapeake Bay. Percent discarded = total discards/(harvest + total discards)*100.

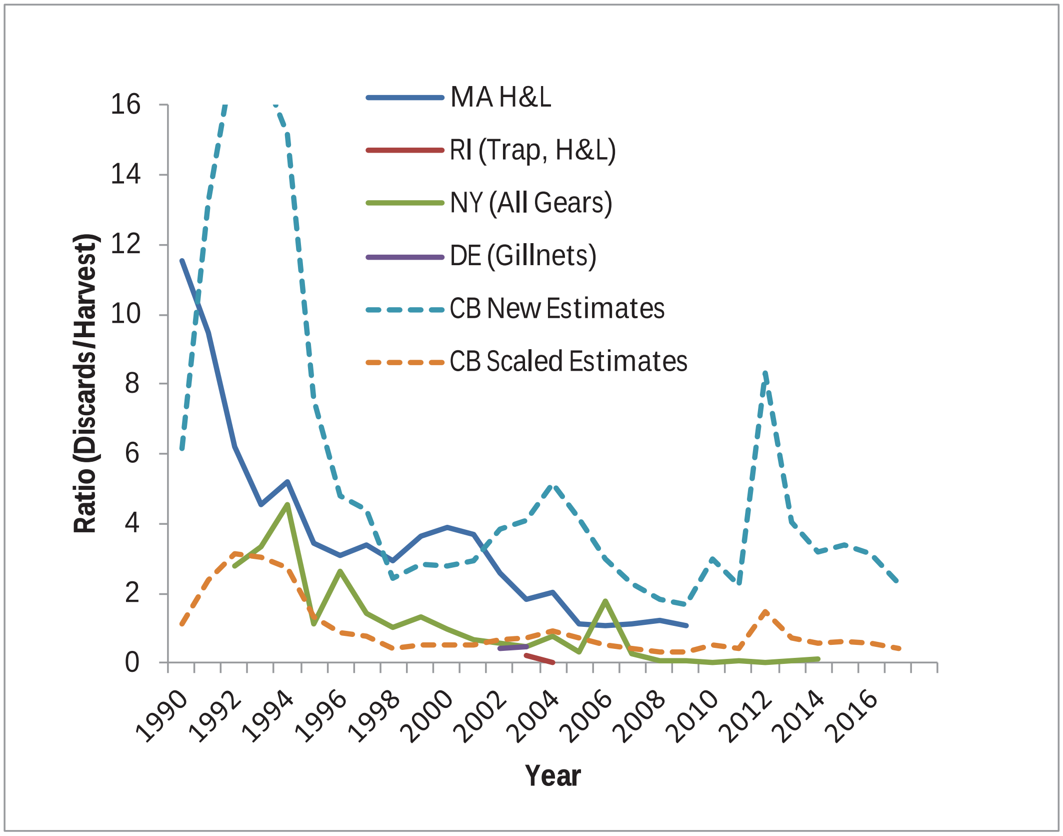



Figure B6.8. Comparison of estimates of total discards-to-harvest ratios for Chesapeake Bay from this assessment (new and scaled) and from Massachusetts, Rhode Island, New York and Delaware fisheries from other studies.

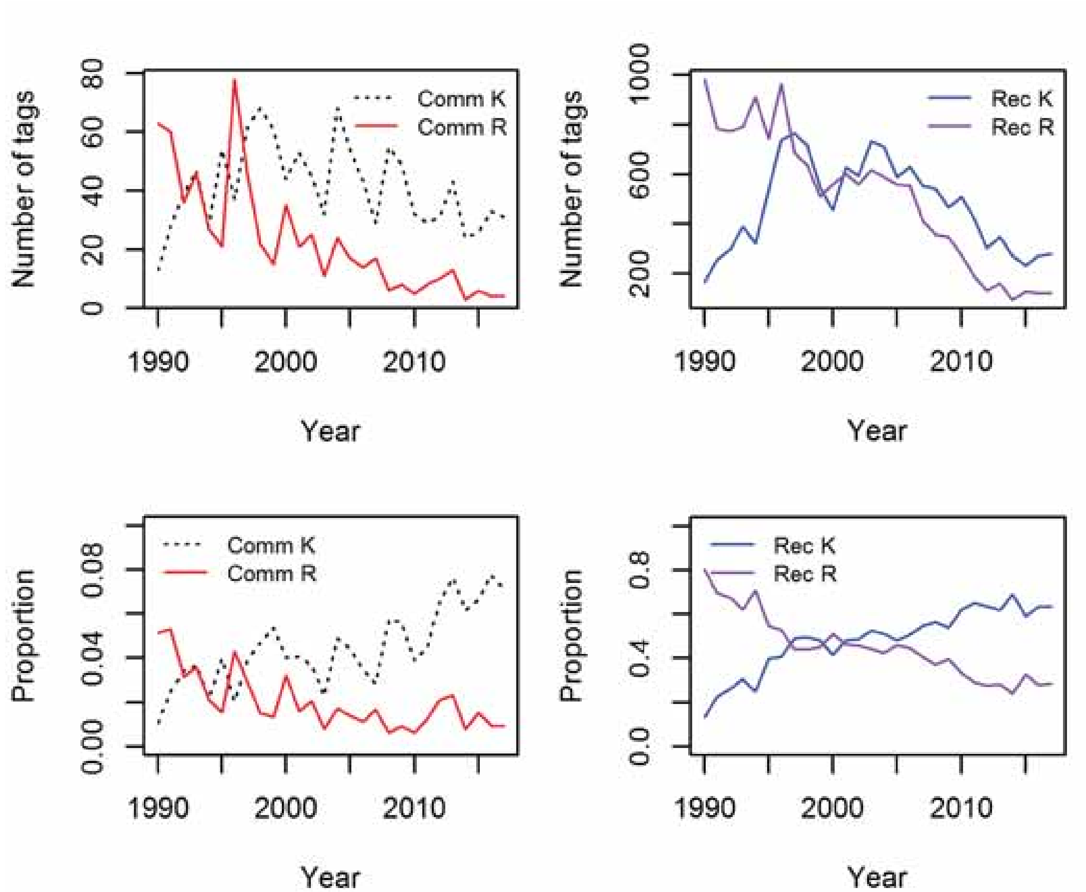



Figure B6.9. Numbers (top row) and proportions (bottom row) of tags returned by disposition and fishery category for the Ocean region. K=killed/harvested, R=released alive.

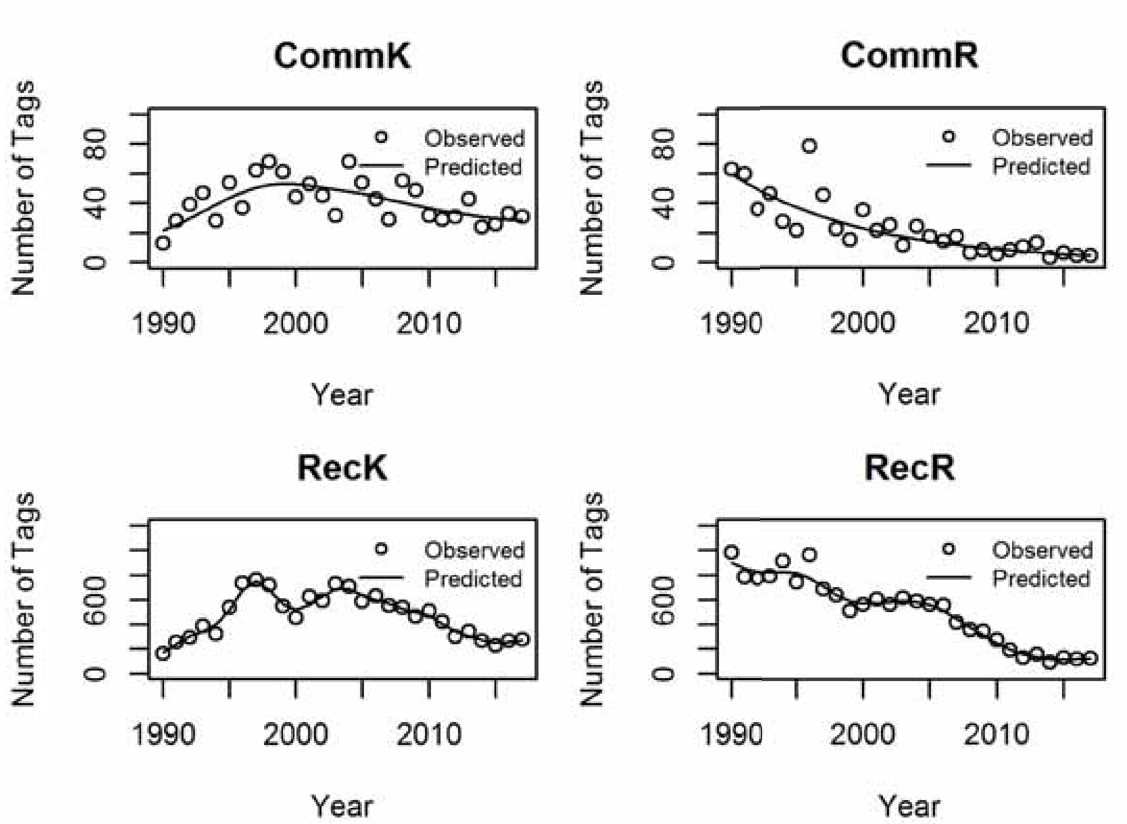



Figure B6.10. Observed and predicted tag numbers from the GAM fits for the Ocean region by fishery and disposition. K=killed/harvested, R=released alive

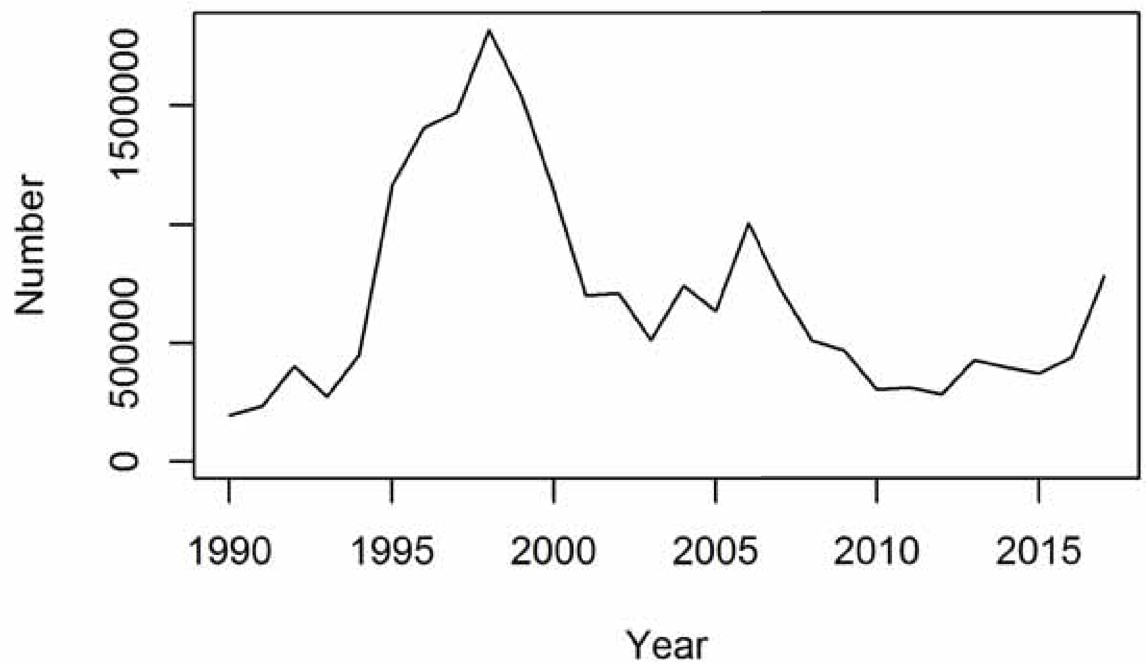



Figure B6.11. Estimates of commercial total discards for the Ocean region, 1990-2017.

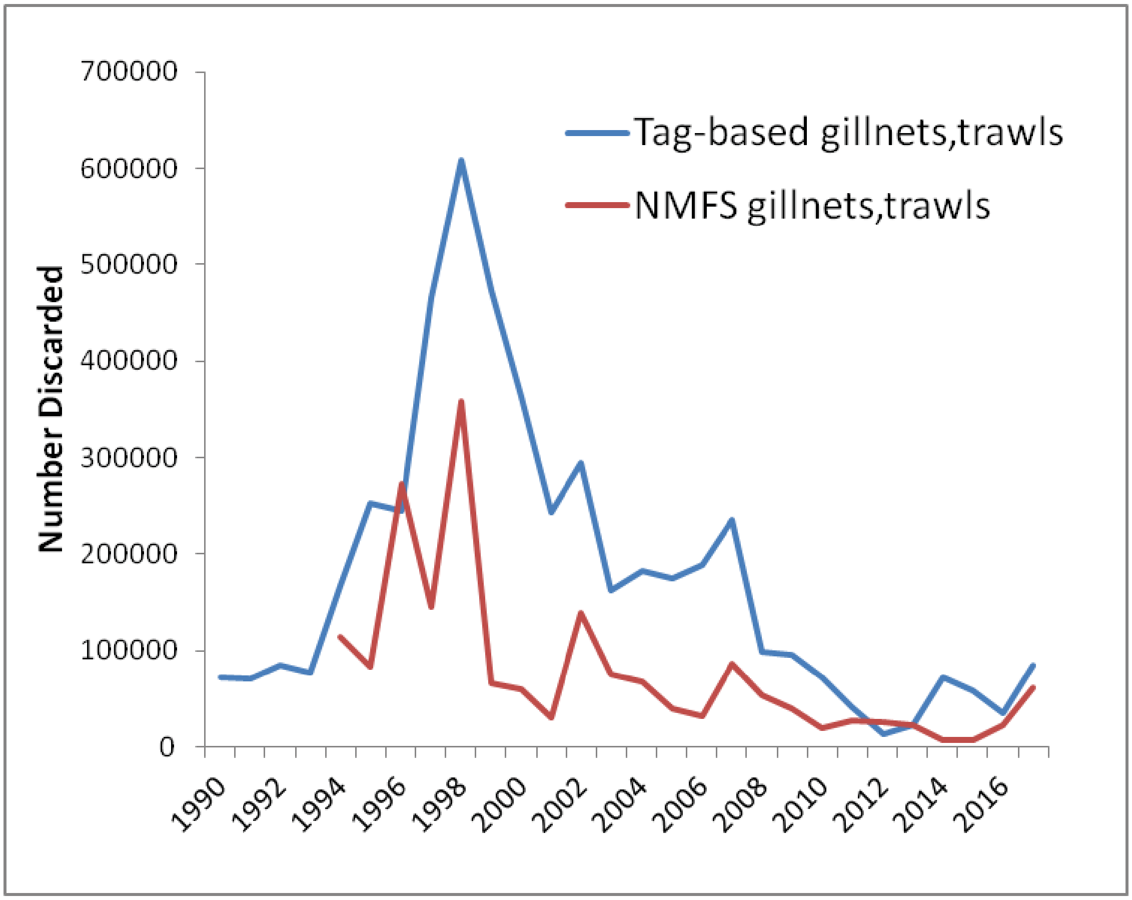



Figure B6.12. Comparison of total number of striped bass discarded in the Ocean region estimated by the tag-based method and NMFS observer program.

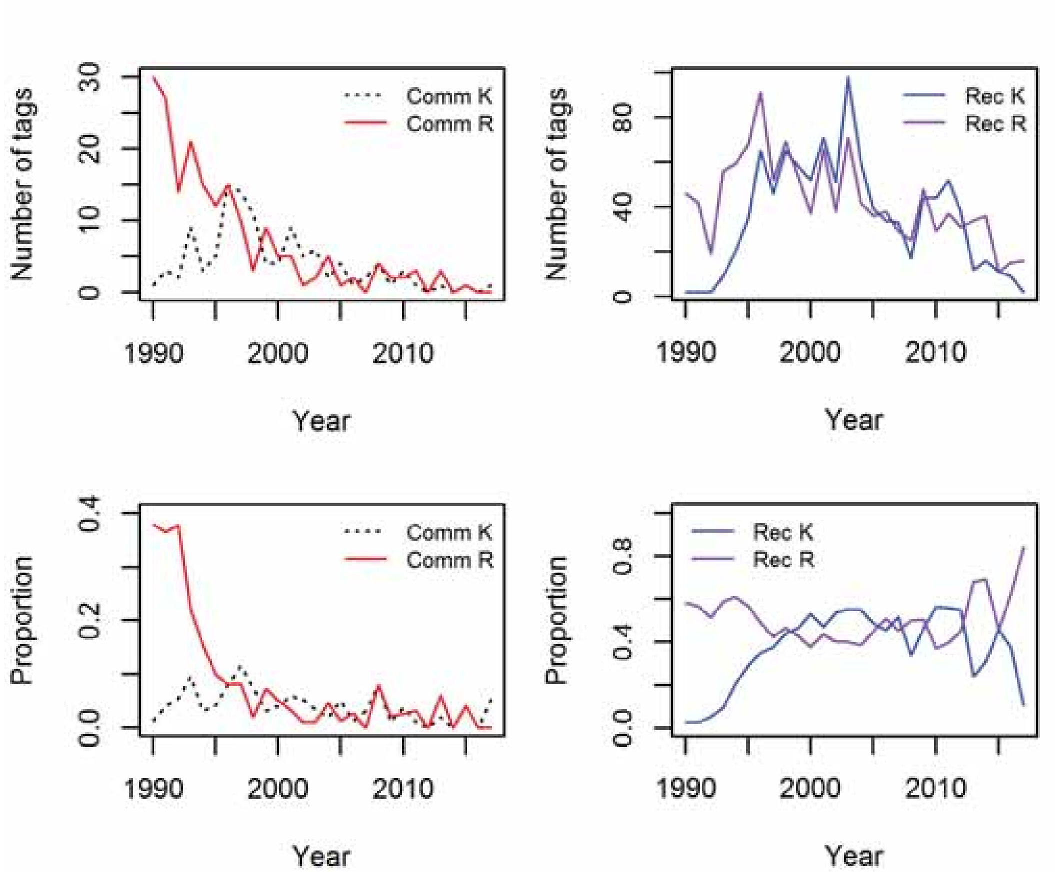



Figure B6.13. Numbers (top row) and proportions (bottom row) of tags returned by disposition and fishery category for Delaware Bay. K=killed/harvested, R=released alive.

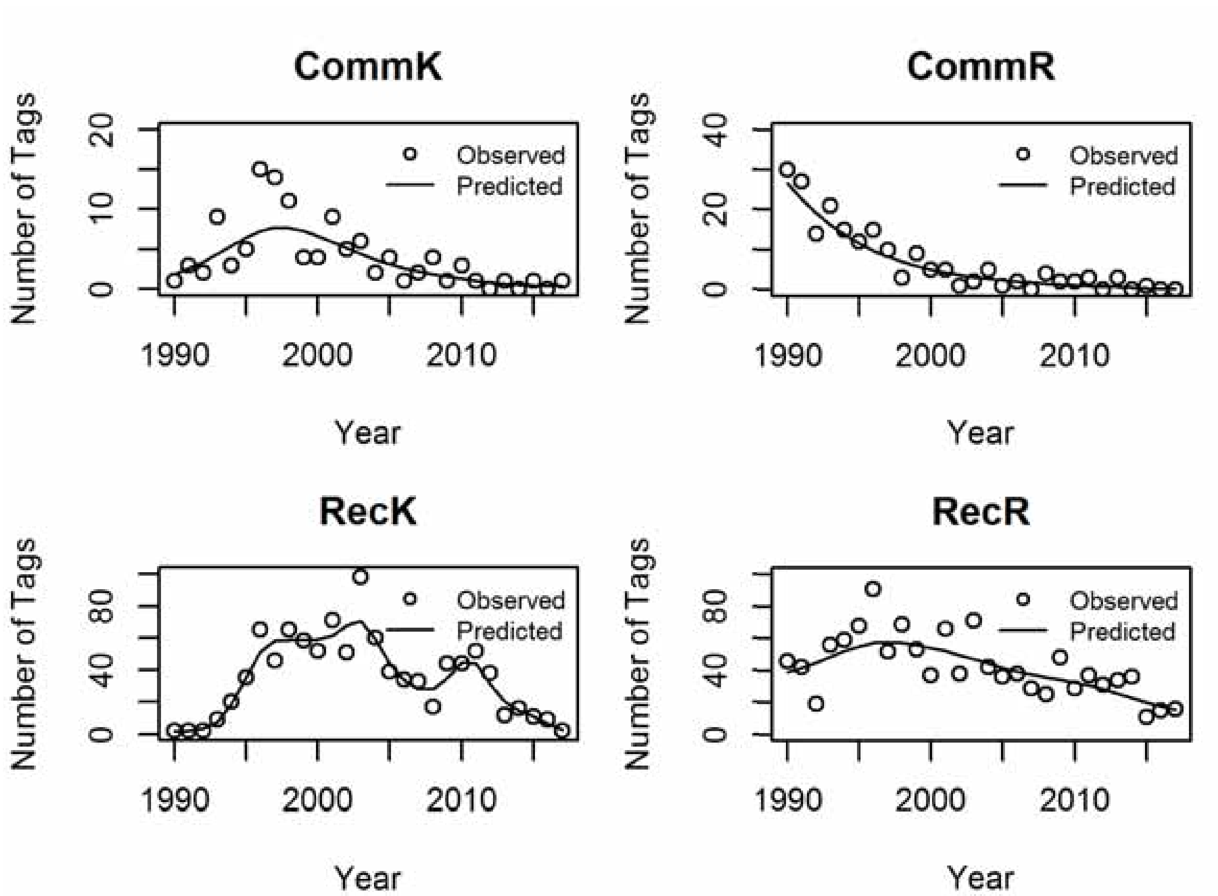



Figure B6.14. Observed and predicted tag numbers from the GAM fits for Delaware Bay by fishery and disposition=killed/harvested, R=released alive.

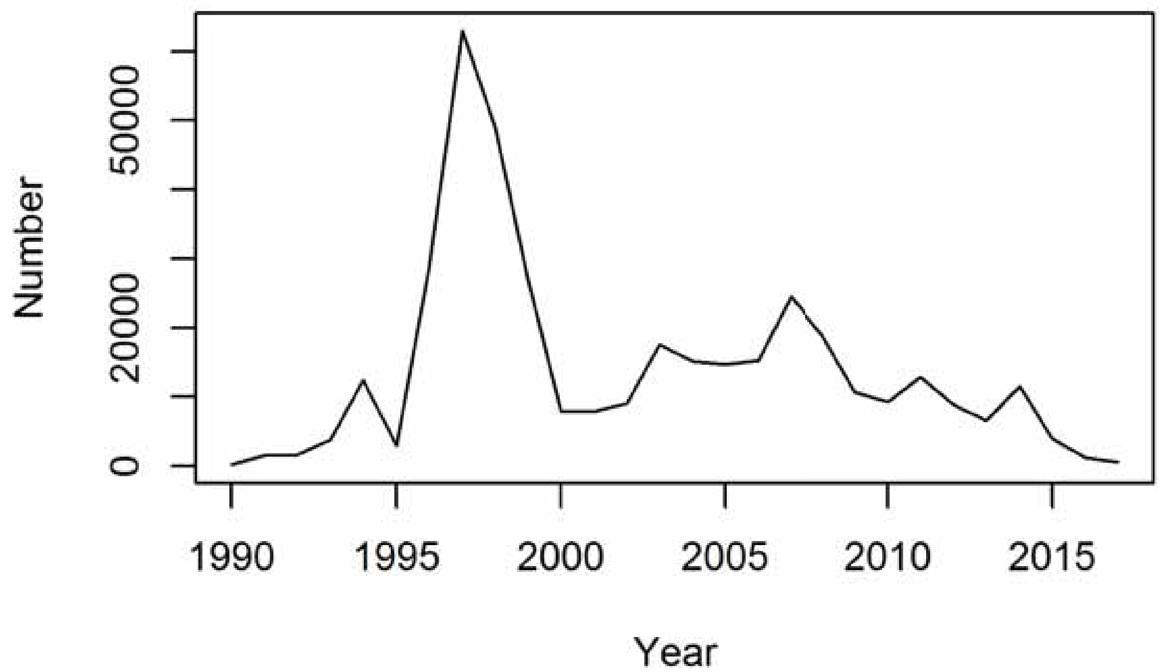



Figure B6.15. Scaled estimates of commercial total discards for Delaware Bay, 1990-2017.

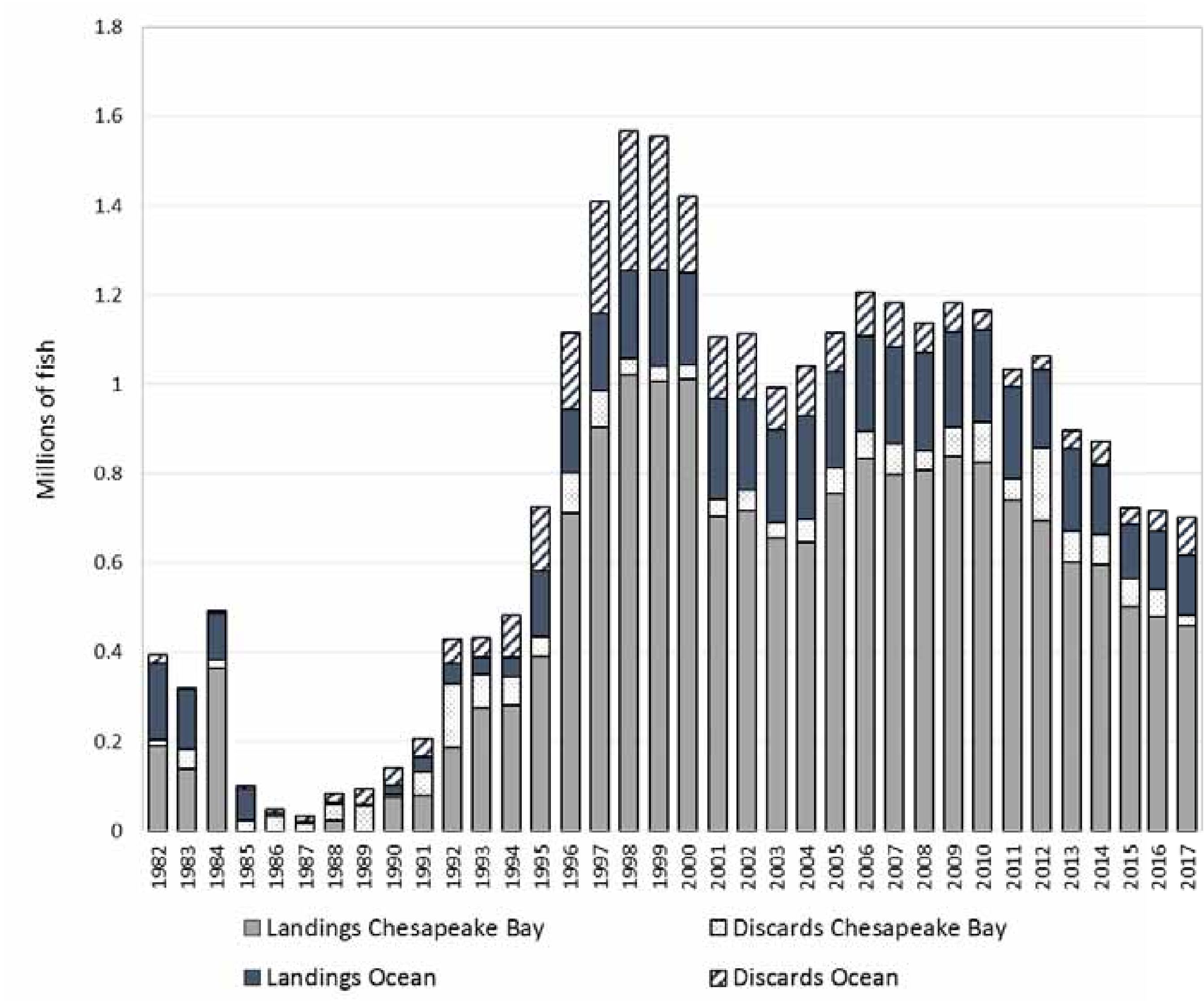



Figure B6.16. Total commercial removals of striped bass by region and disposition.

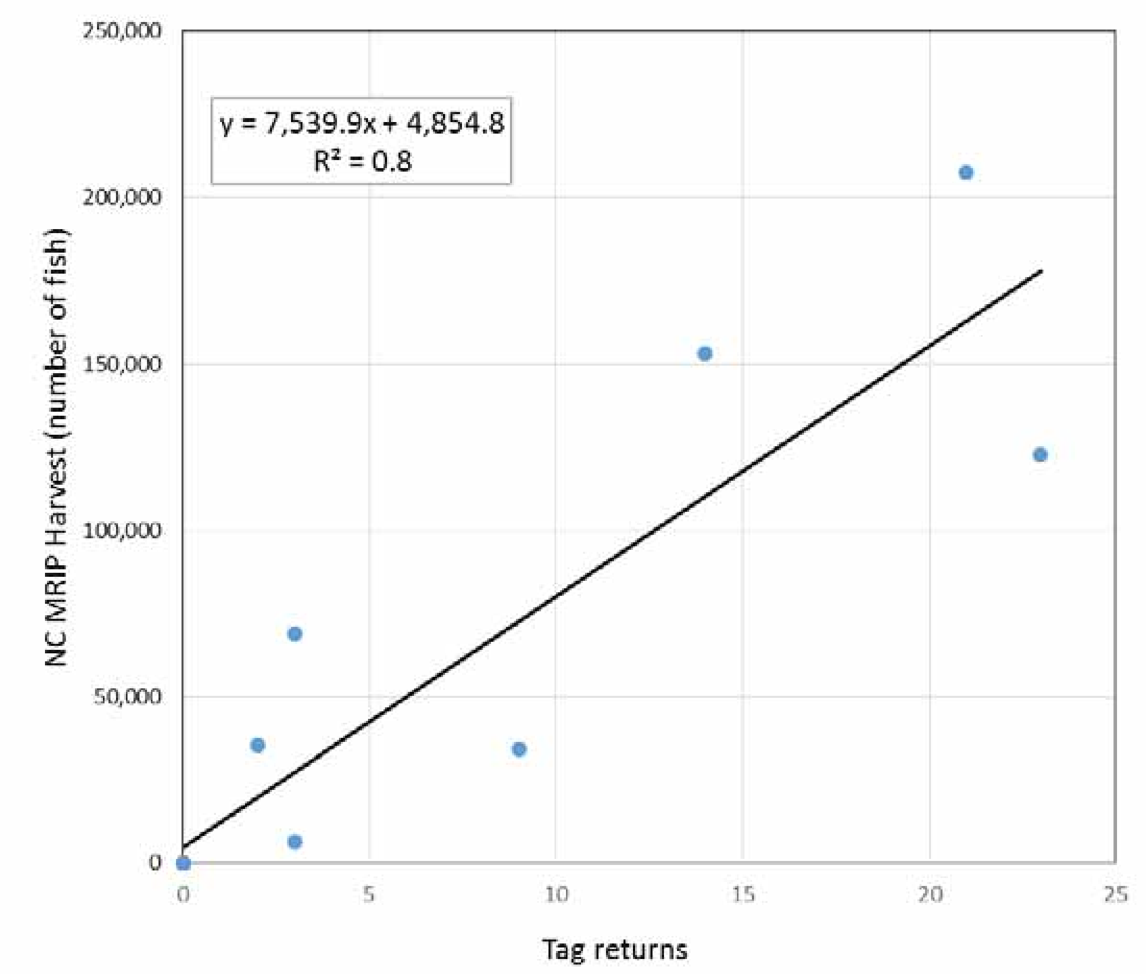



Figure B6.17. Relationship between North Carolina Wave-1 recreational harvest and number of Wave-1 tag returns in a given year, 2005-2017.

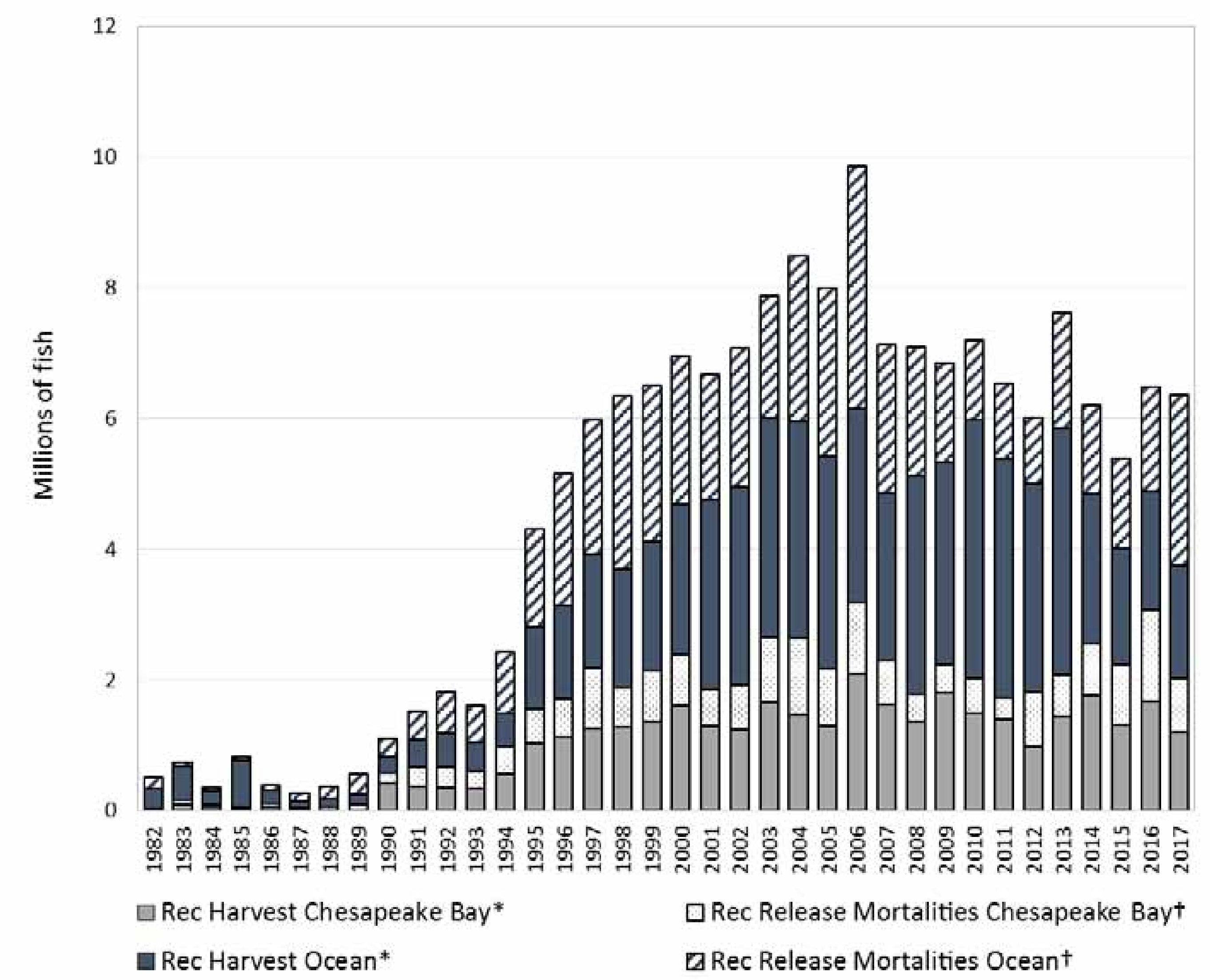



Figure B6.18. Recreational removals of striped bass by year and region. * Harvest includes estimates of Wave-1 harvest for North Carolina and Virginia. † Release mortality of 9% applied to live releases.

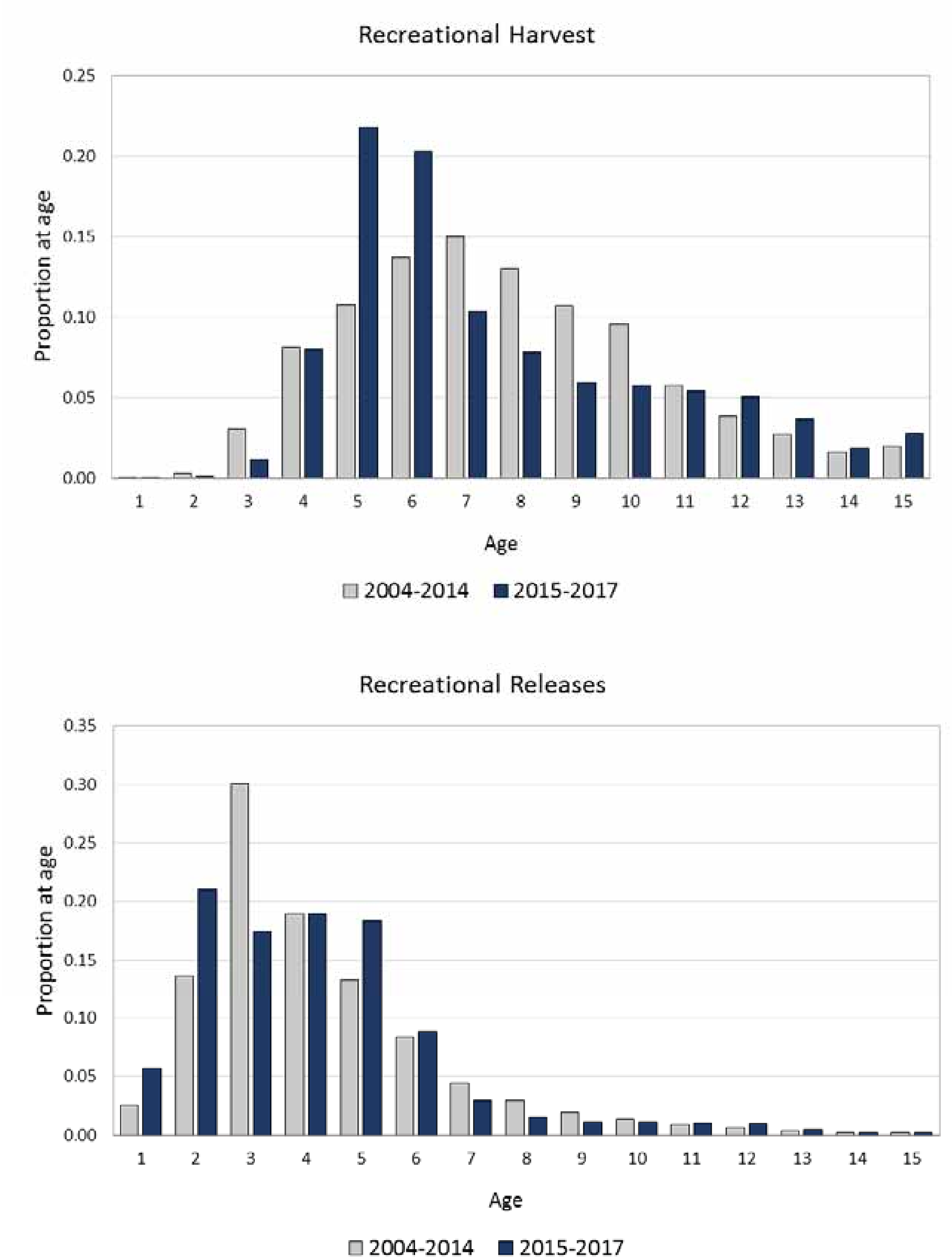
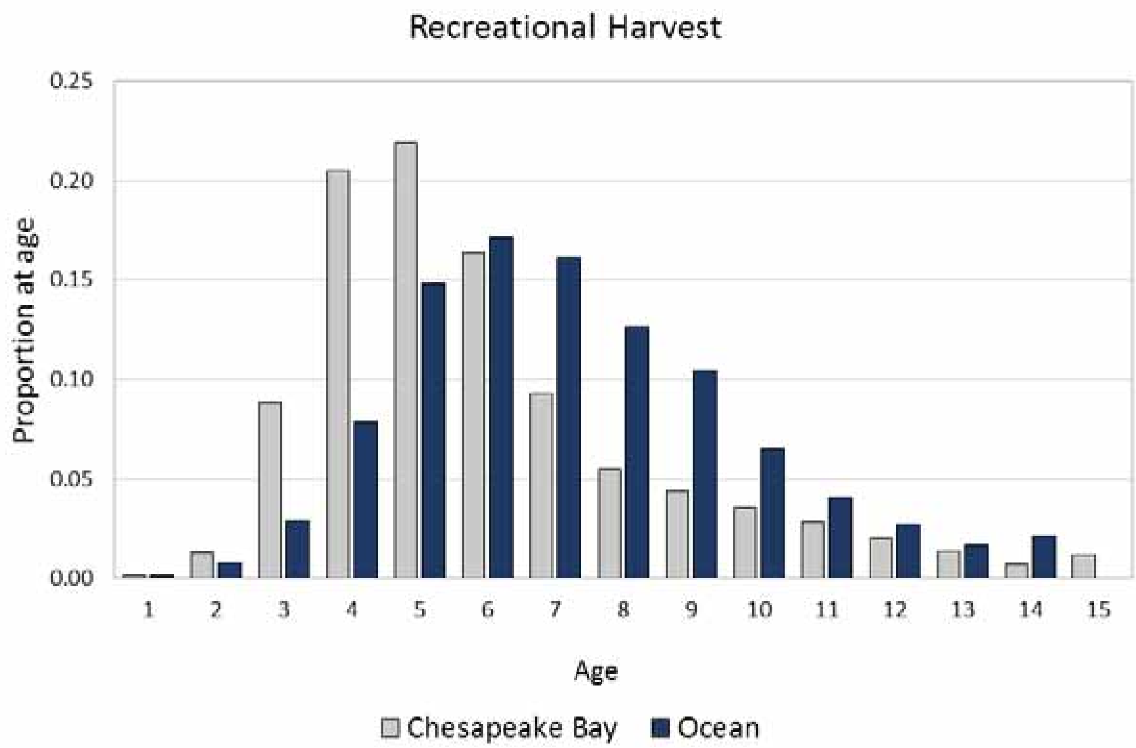



Figure B6.19. Age composition of recreational harvest (top) and recreational releases (bottom) by management period.



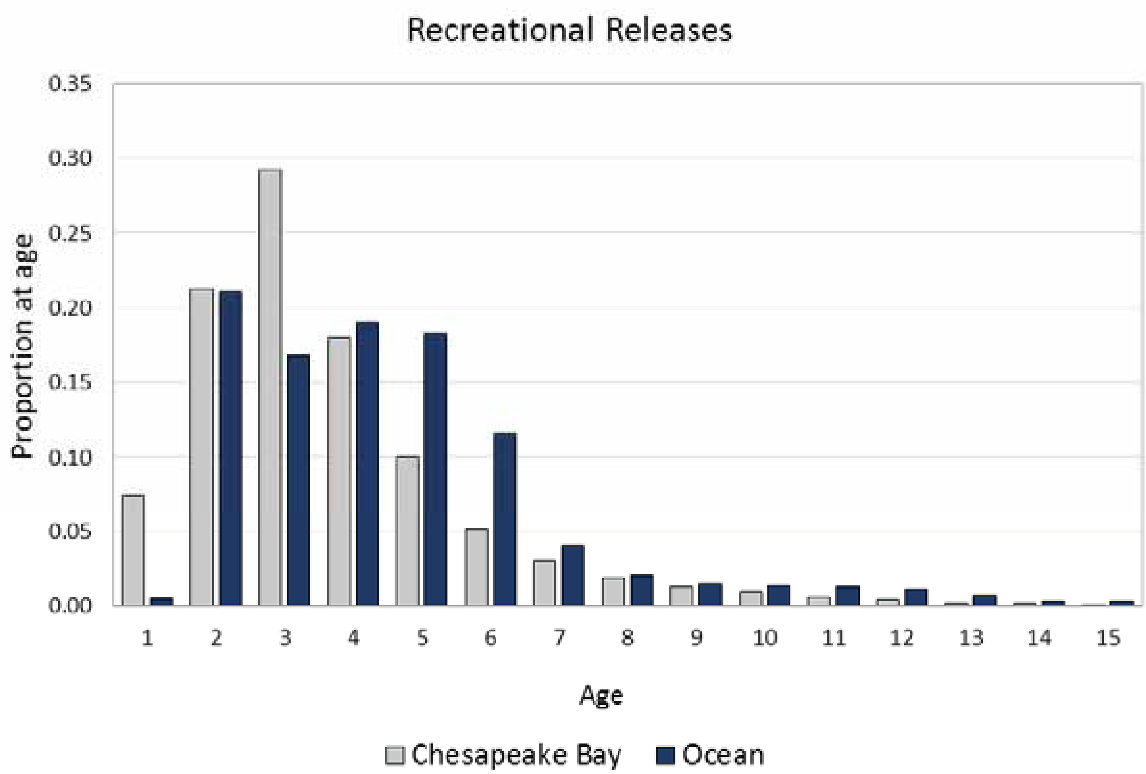




Figure B6.20. Proportion-at-age for recreational harvest (top) and recreational releases (bottom) by region (all years combined).

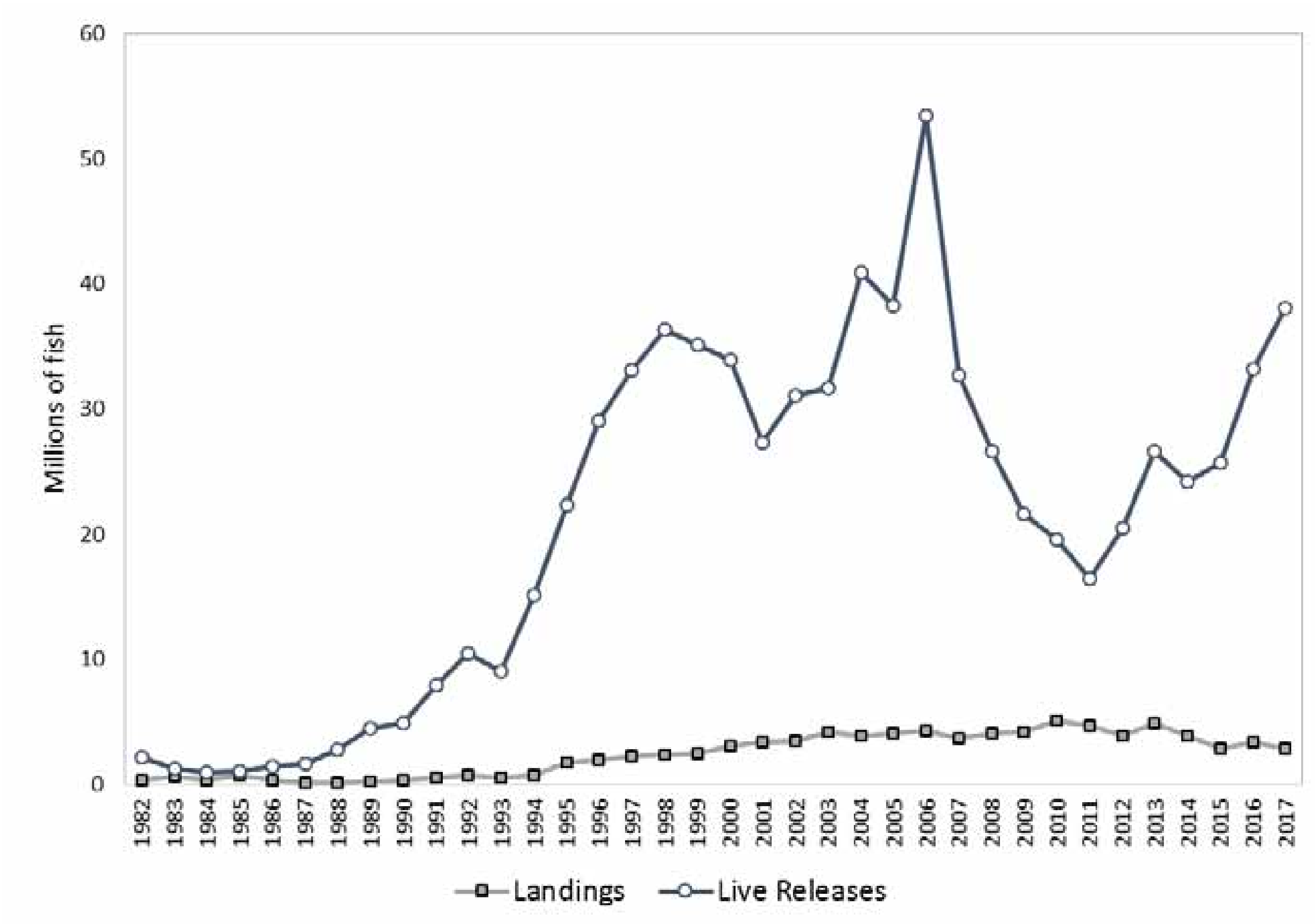



Figure B6.21. Total recreational catch of striped bass on the Atlantic coast by disposition.

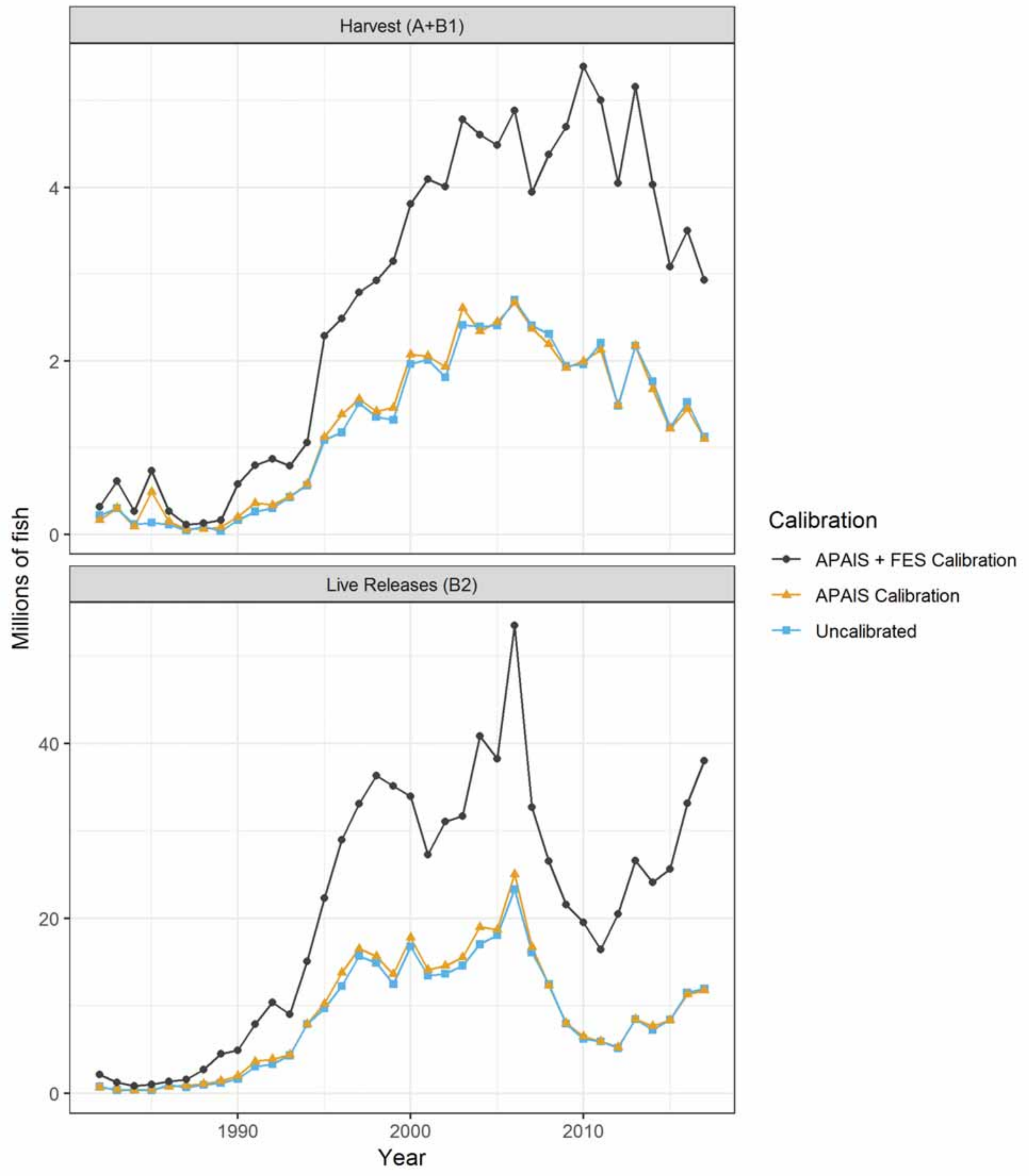



Figure B6.22. Comparison of calibrated and uncalibrated estimates of recreational striped bass harvest (top) and live releases (bottom) used in the assessment.

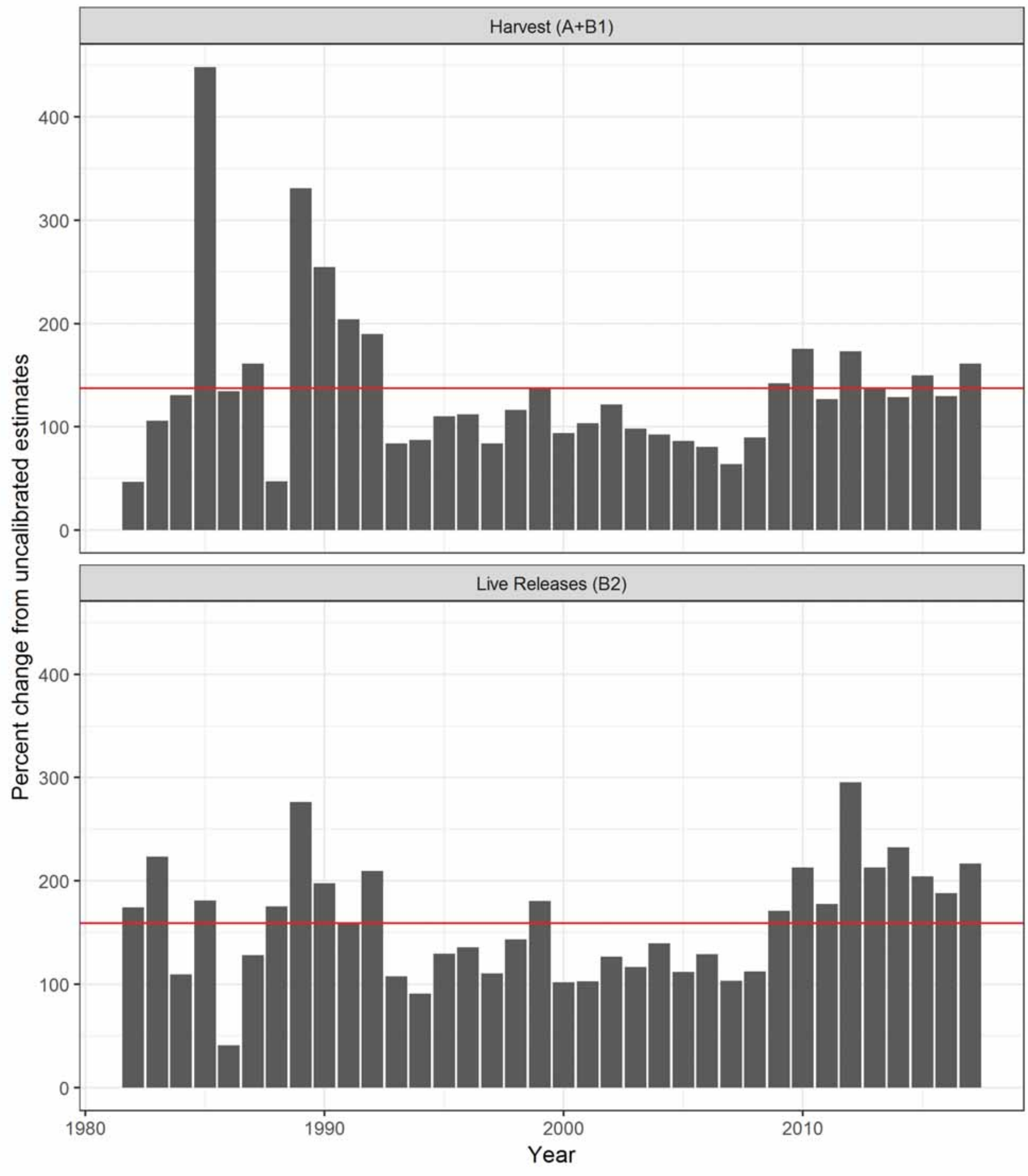



Figure B6.23. Percent difference between calibrated and uncalibrated estimates of recreational striped bass harvest (top) and live releases (bottom) used in the assessment. Red line indicates time series average percent difference.

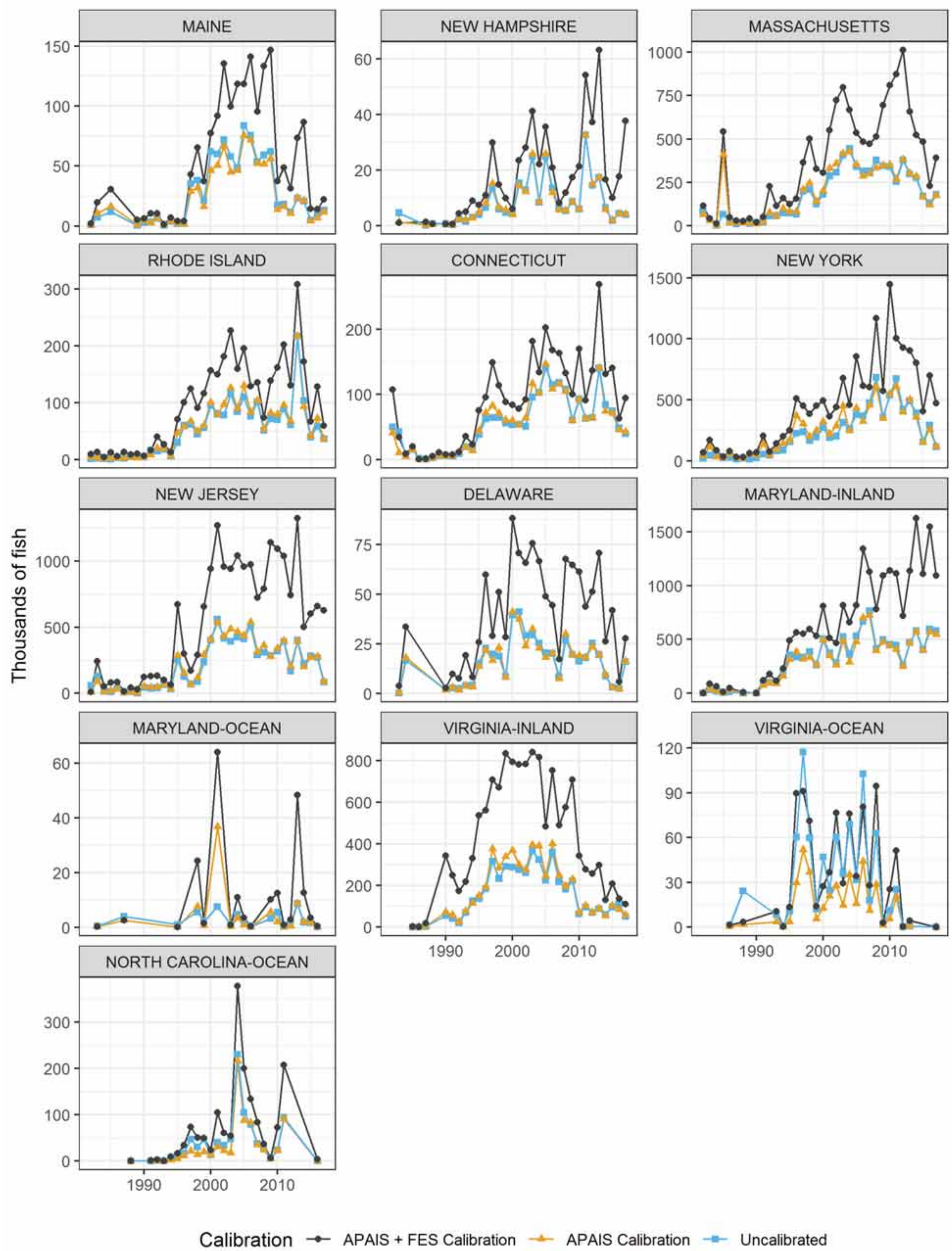



Figure B6.24. Comparison of calibrated and uncalibrated estimates of recreational harvest by state.

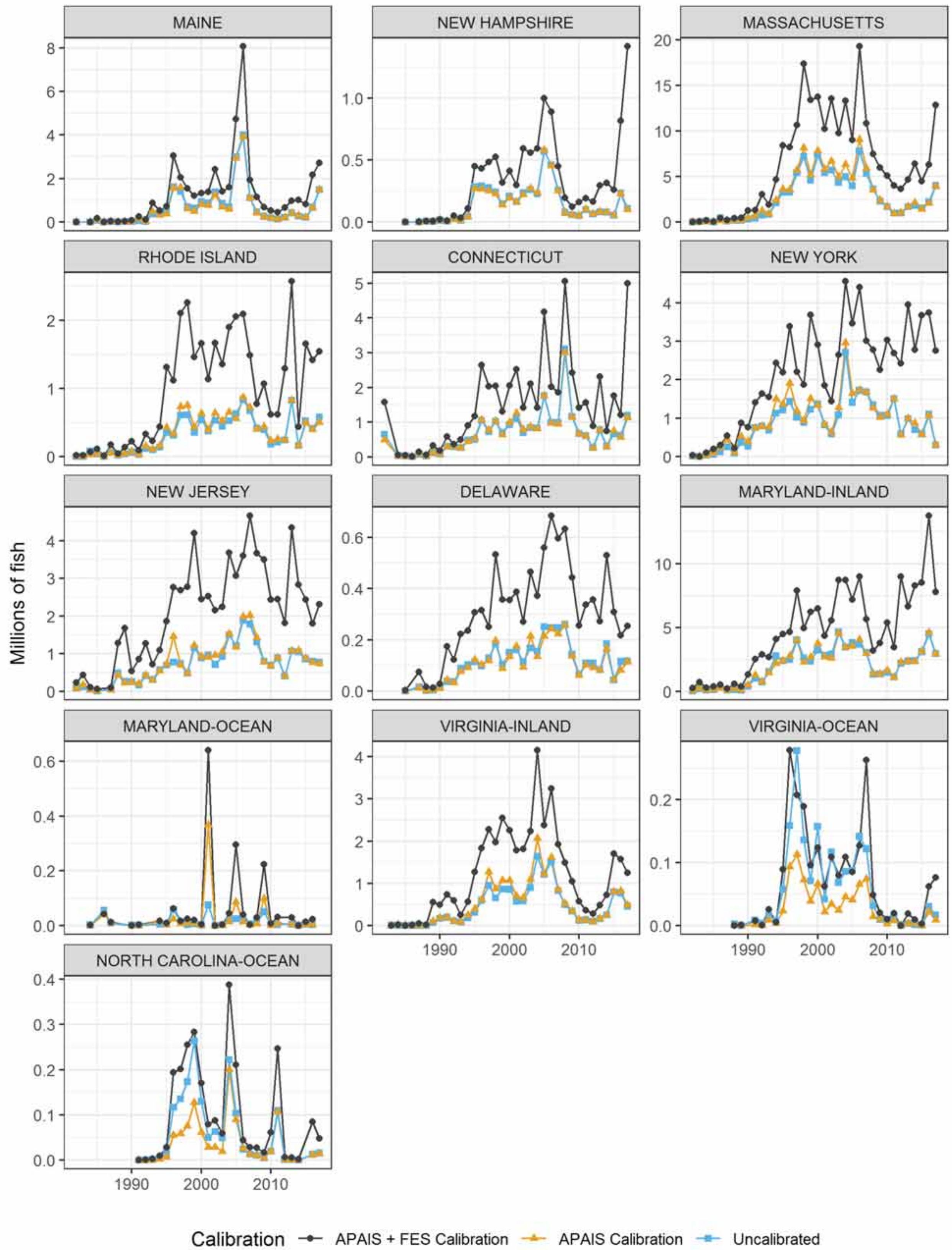



Figure B6.25. Comparison of calibrated and uncalibrated estimates of recreational live releases by state.

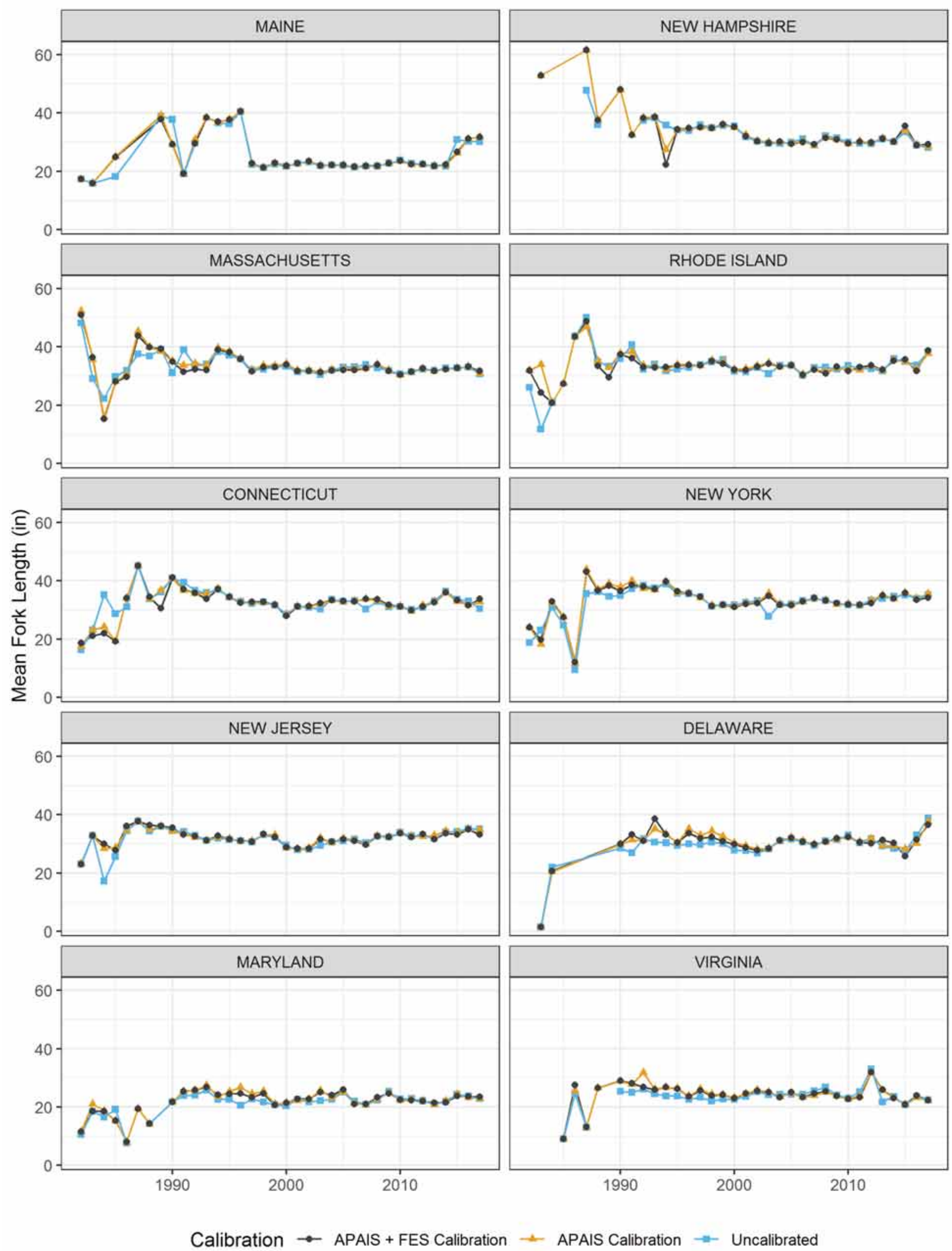



Figure B6.26. Comparison of calibrated and uncalibrated mean lengths of recreationally harvested striped bass by state.

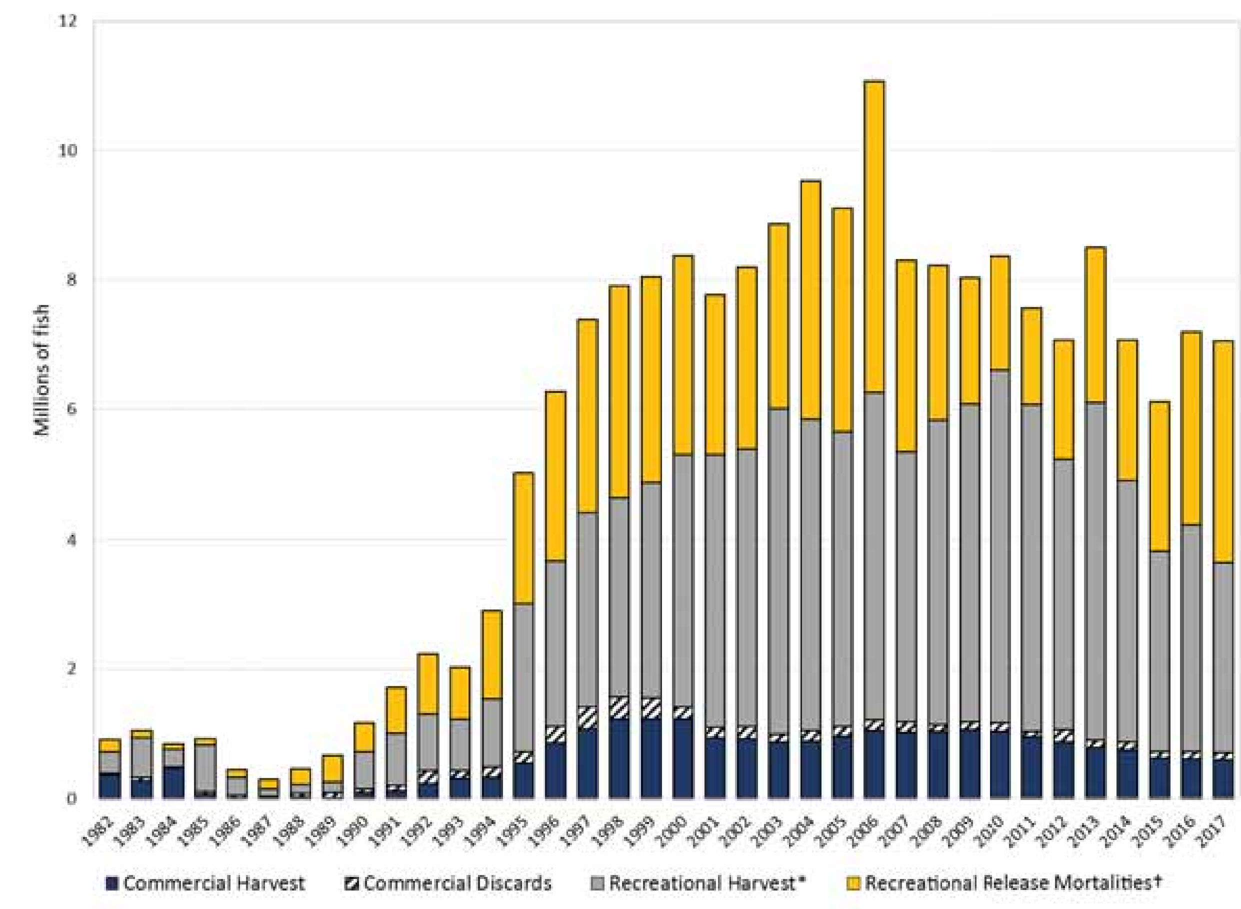



Figure B6.27. Total removals of striped bass on the Atlantic coast by sector.* Recreational harvest includes estimates of Wave-1 harvest for North Carolina and Virginia. † Release mortality of 9% applied to live releases.

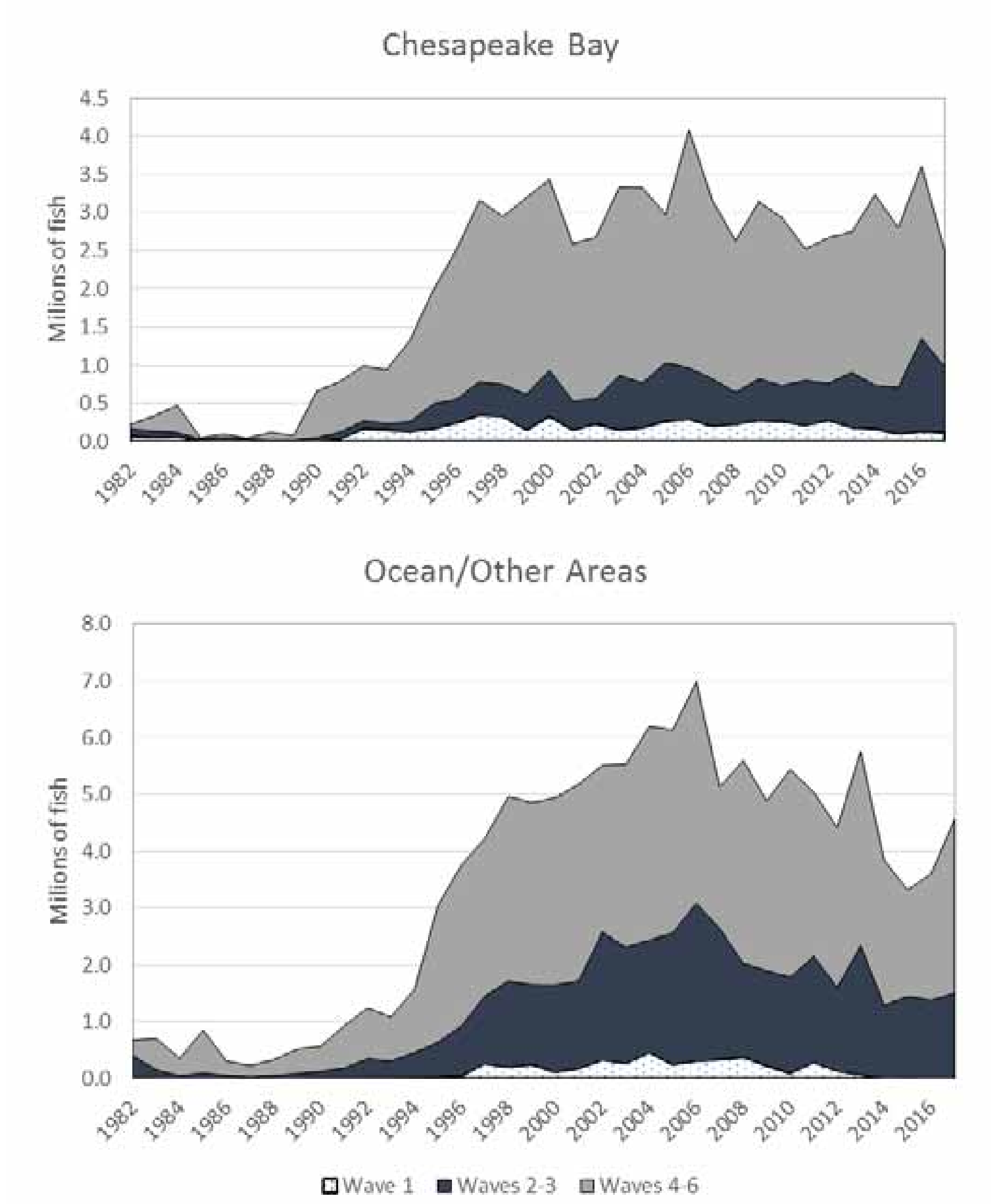



Figure B6.28. Total removals of striped bass by wave period for the Chesapeake Bay (top) and ocean and other areas (bottom).

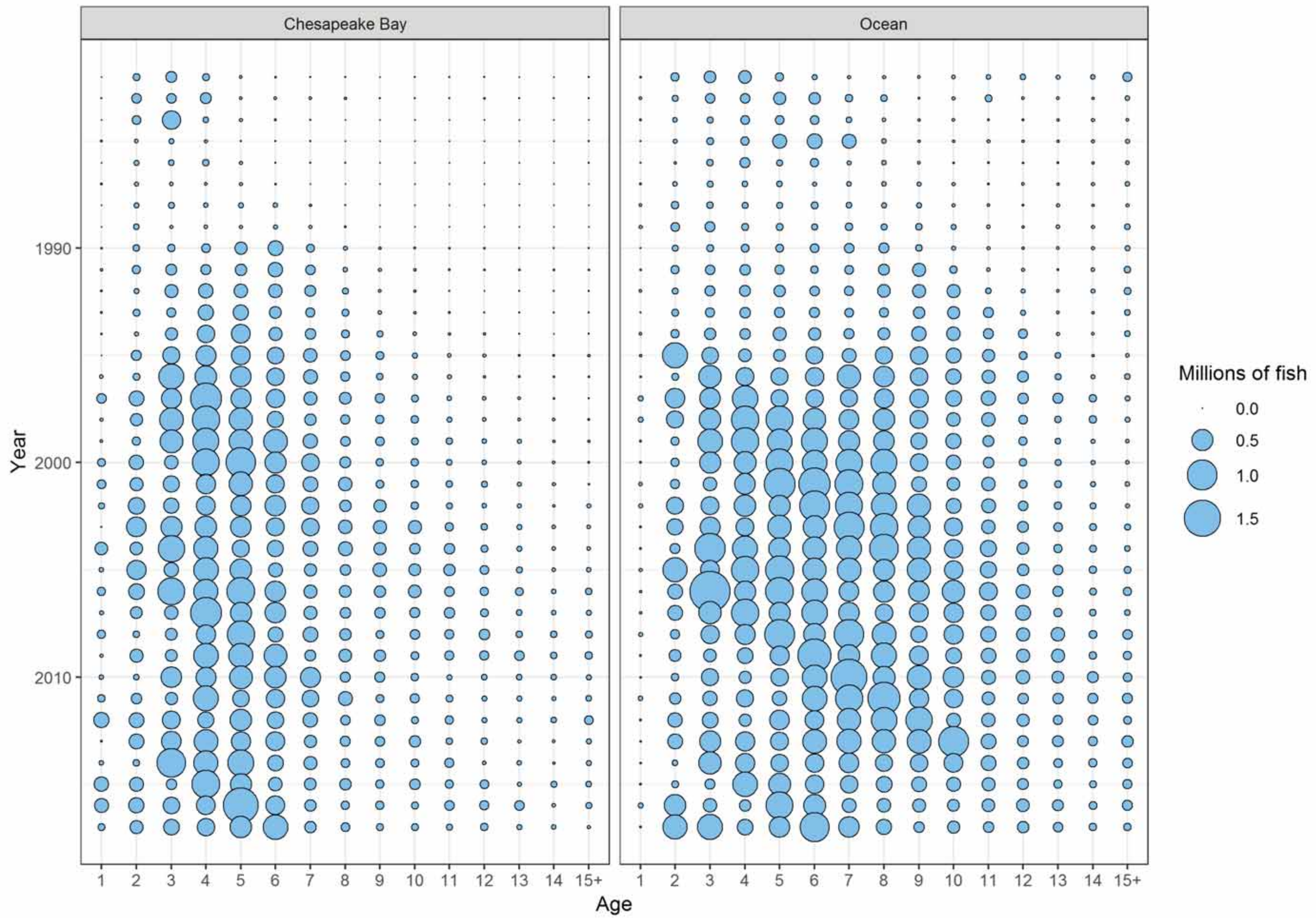



Figure B6.29. Annual total removals at age of striped bass by region.

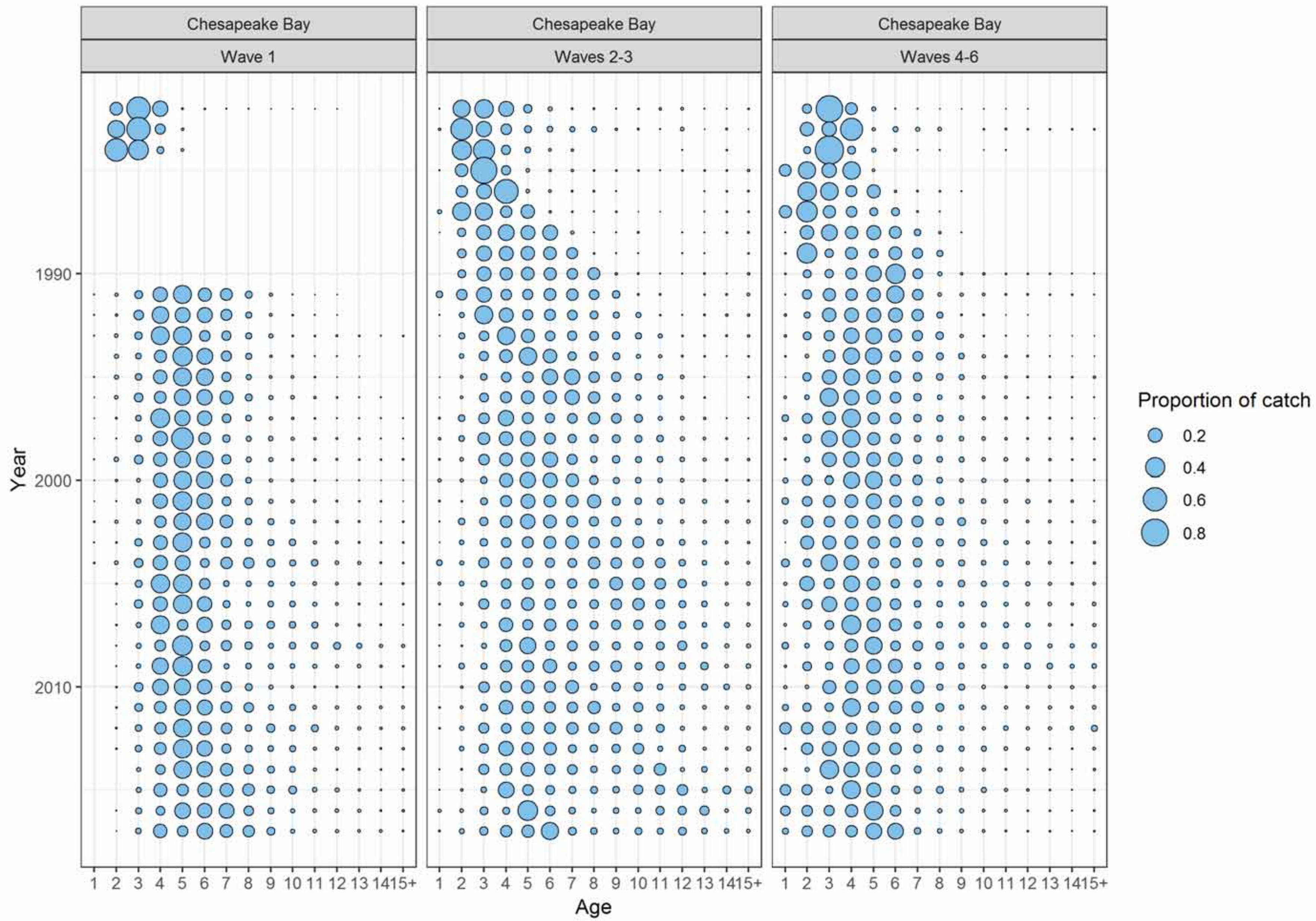



Figure B6.30. Proportion at age in the total removals by year and wave period for the Chesapeake Bay.

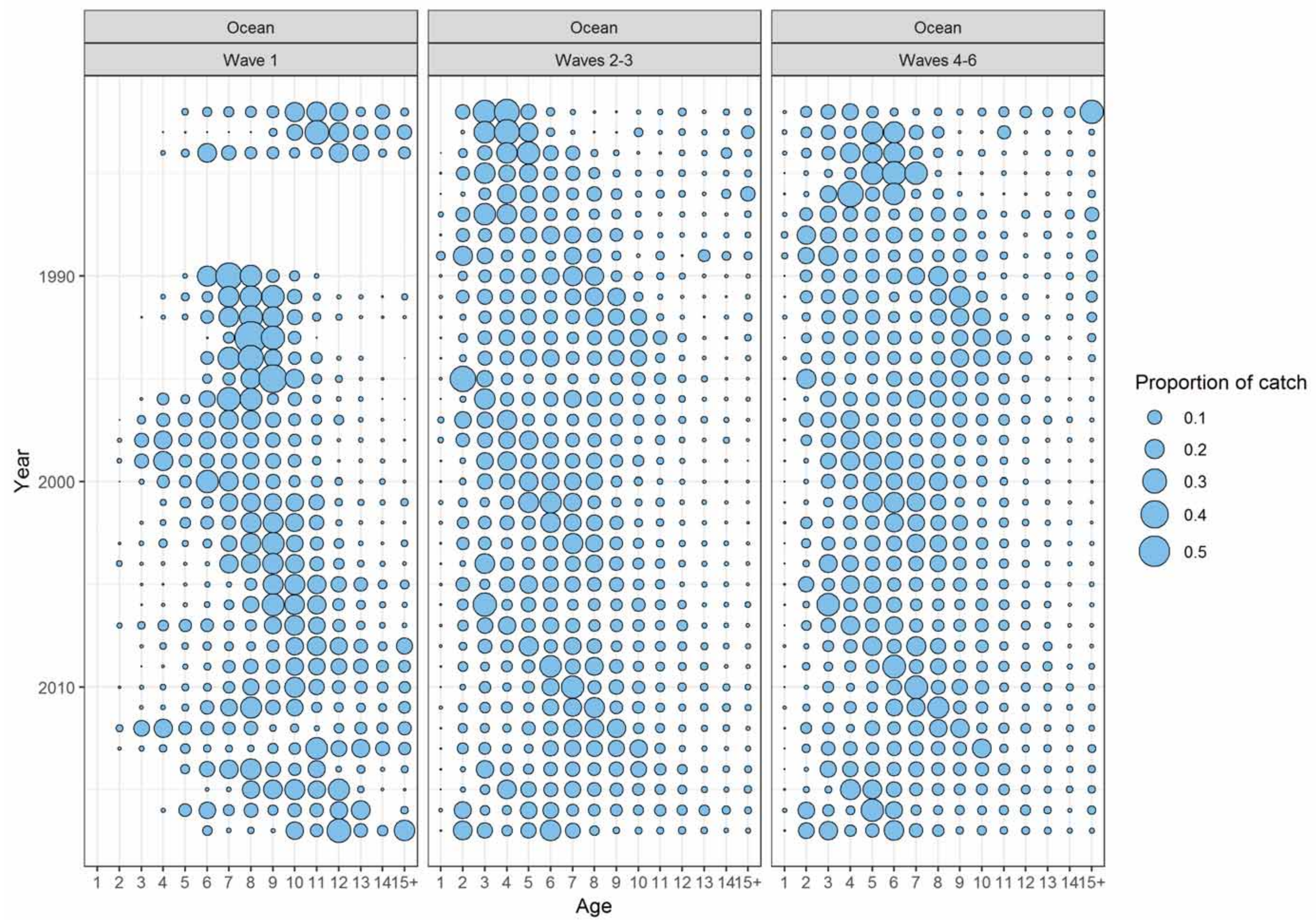



Figure B6.31. Proportion at age in the total removals by year and wave period for the ocean region.

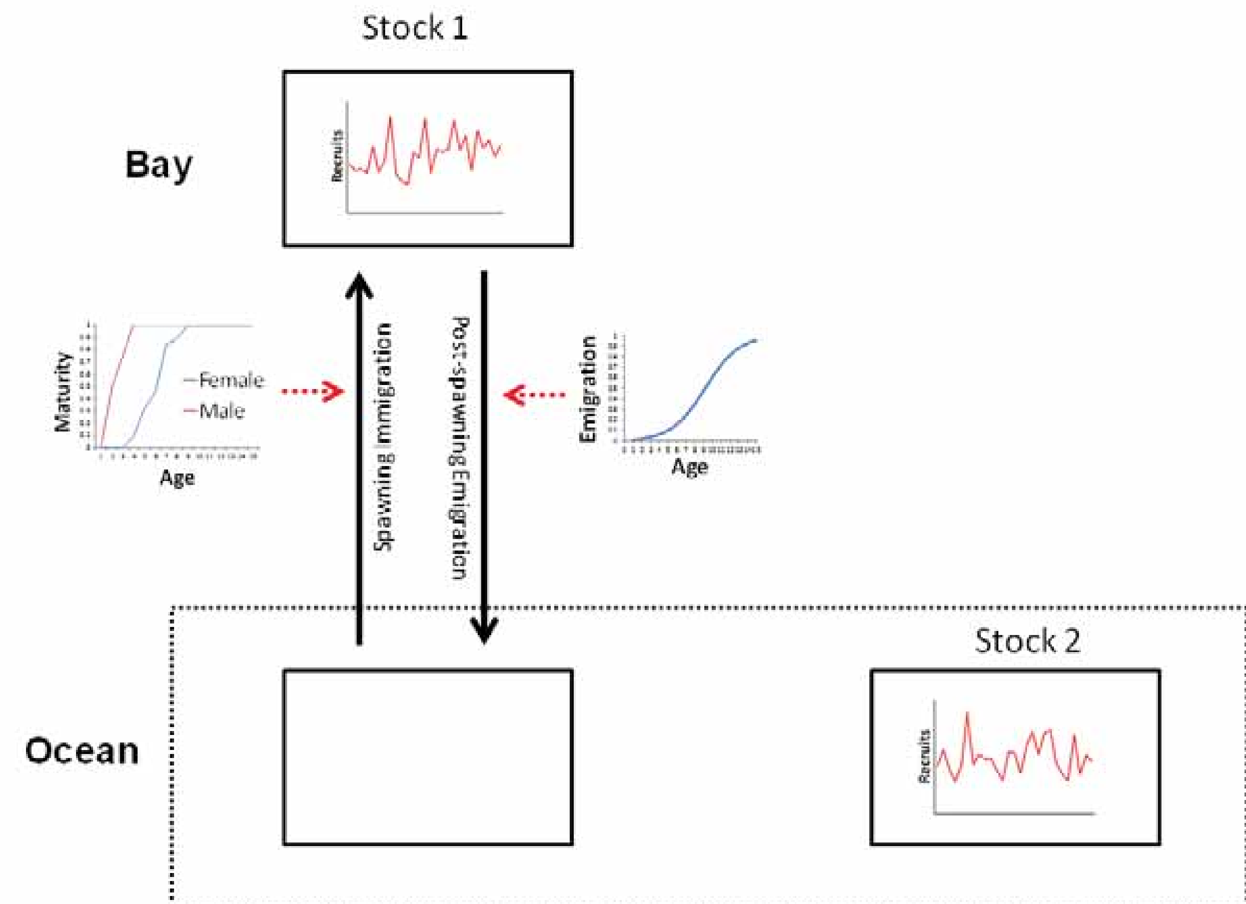



Figure B7.1. Depiction of the general population dynamics of the two-stock model.

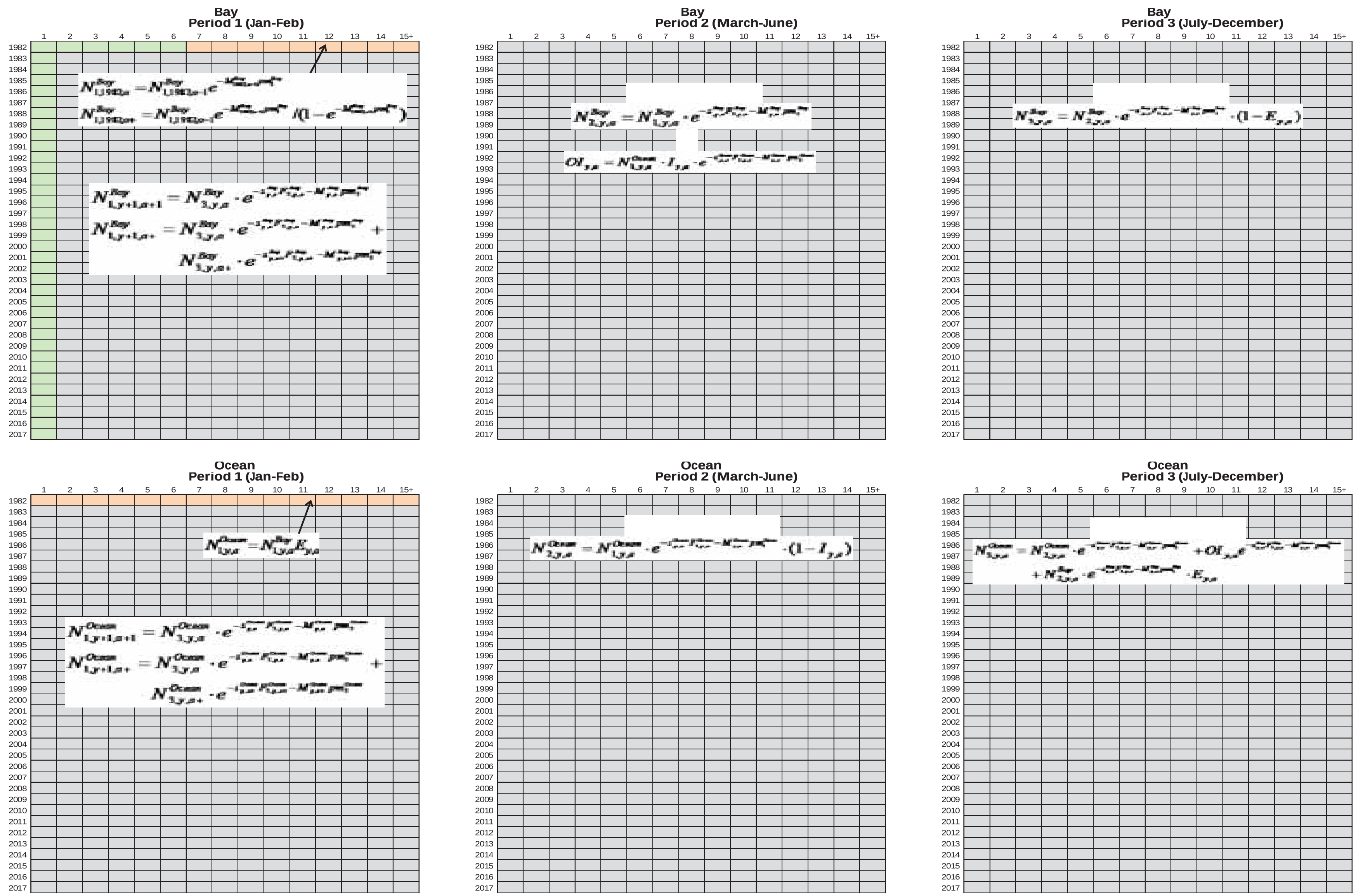



Figure B 7.2. Schematic of the abundance calculations for Stock-1 (the Chesapeake Bay stock)..

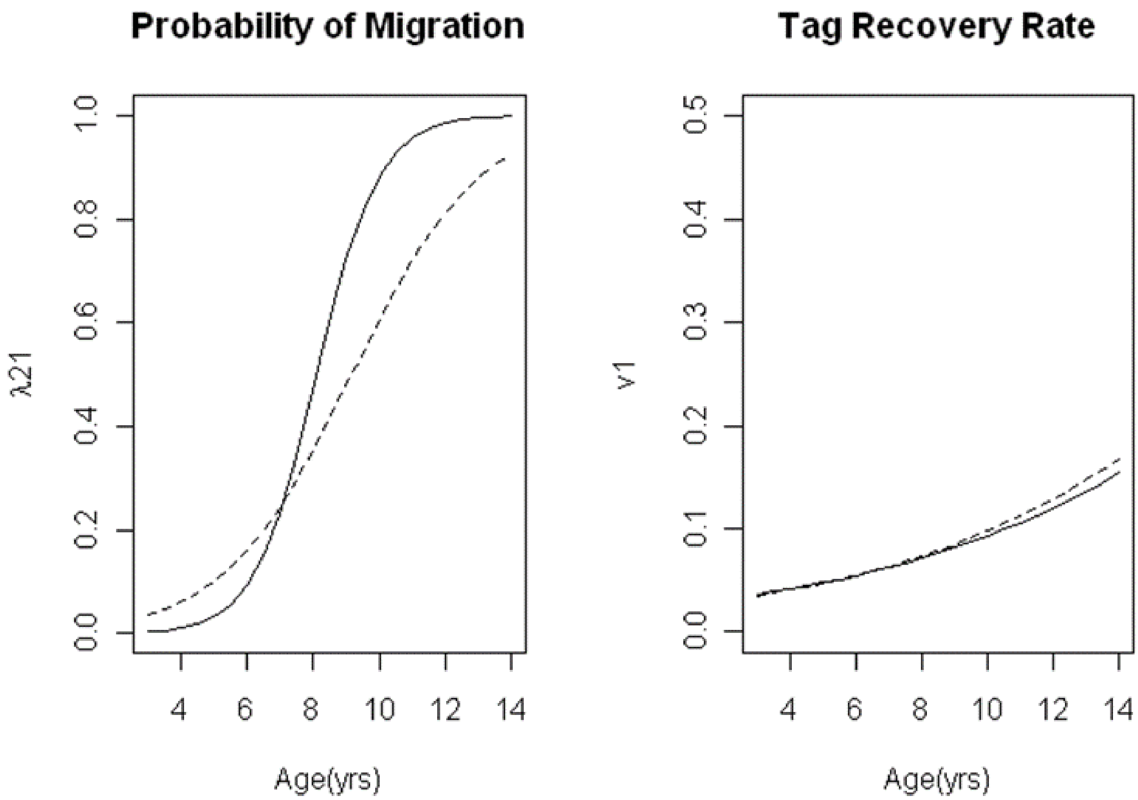



Figure B7.3. Estimates of emigration probabilities (λ21) and tag recovery rate (v1) at-age derived from Dorazio et al. (1994) methodology using 1988-1995 Maryland only data (dashed line) and combined Maryland and Virginia data (solid line).

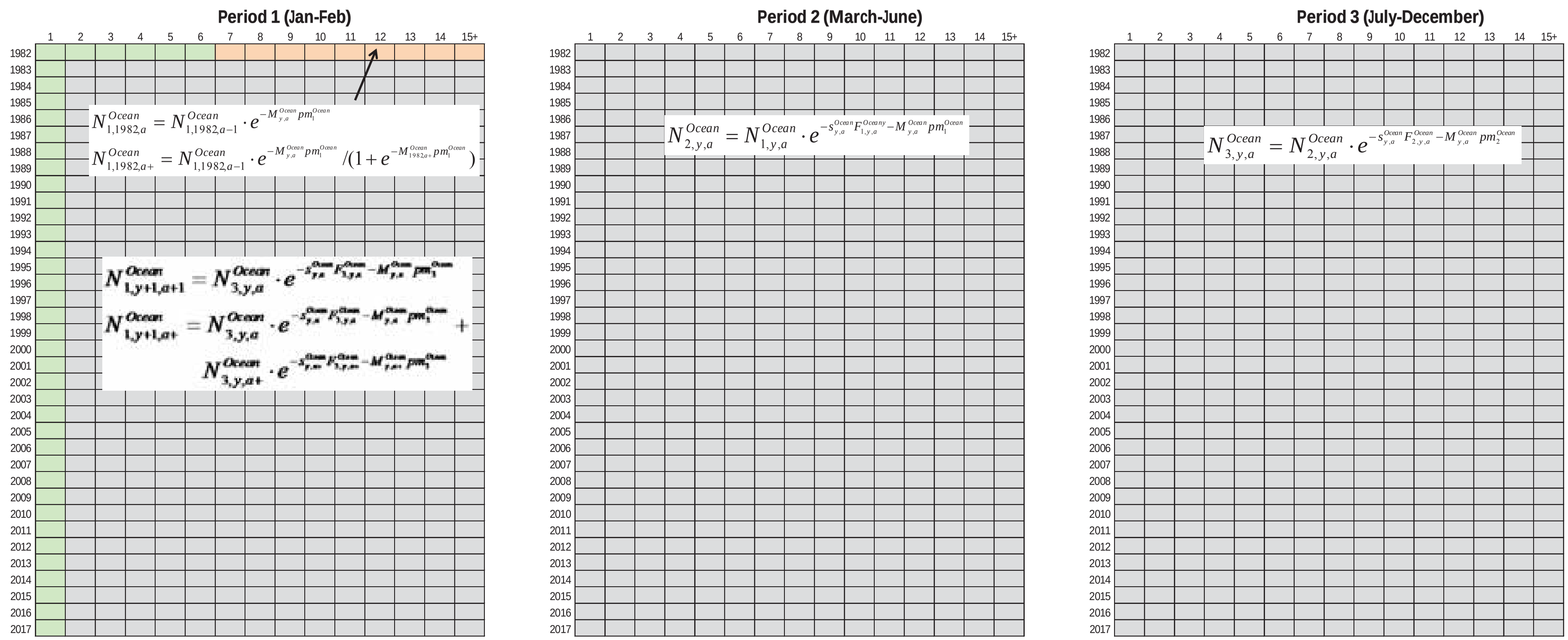



Figure B7.4. Schematic of abundance calculations for Stock-2 (the Delaware Bay/Hudson River).

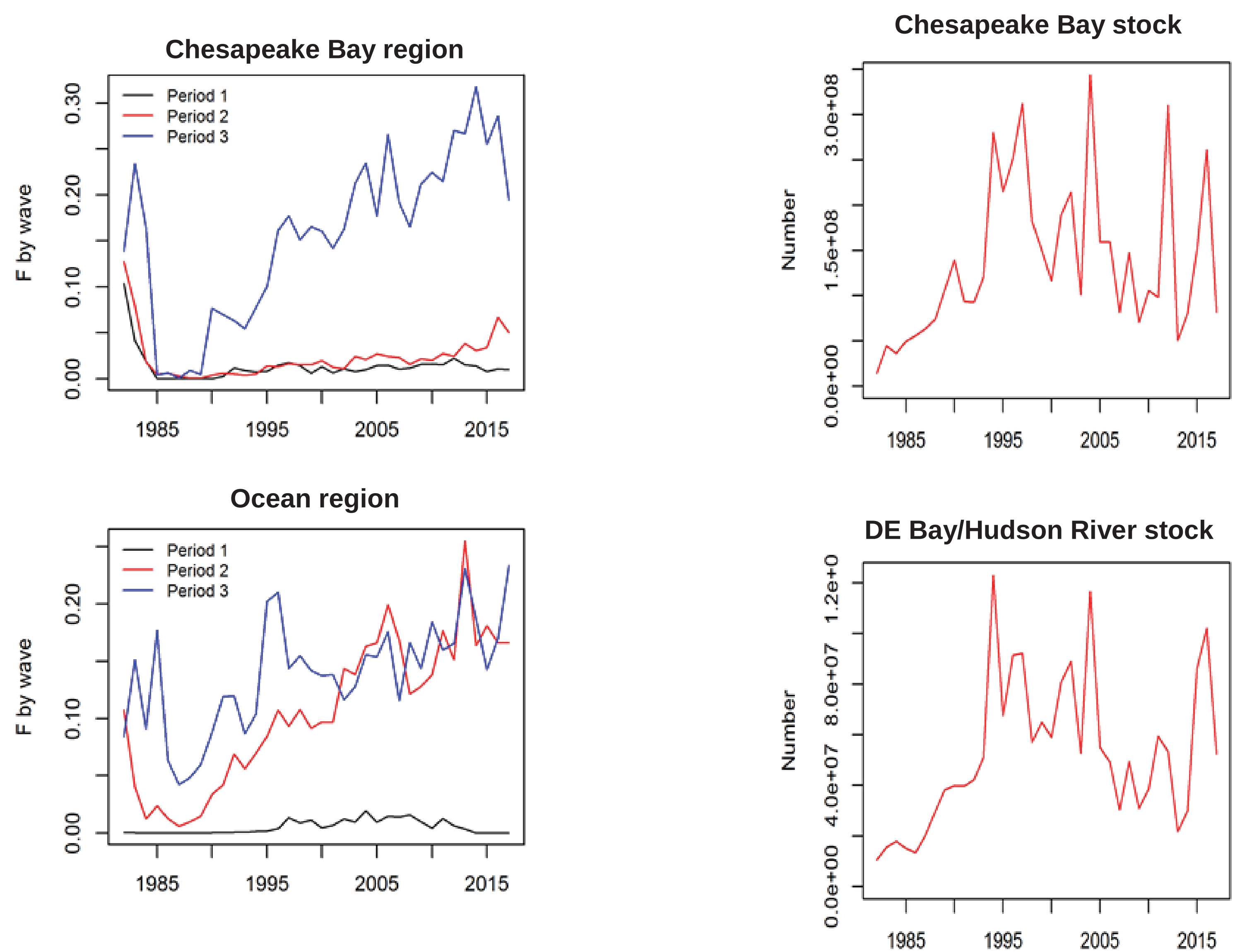



Figure B7.5. Annual estimates of fully-recruited fishing mortality by region and period (left) and annual recruitment (age-1 numbers) (right) by stock.

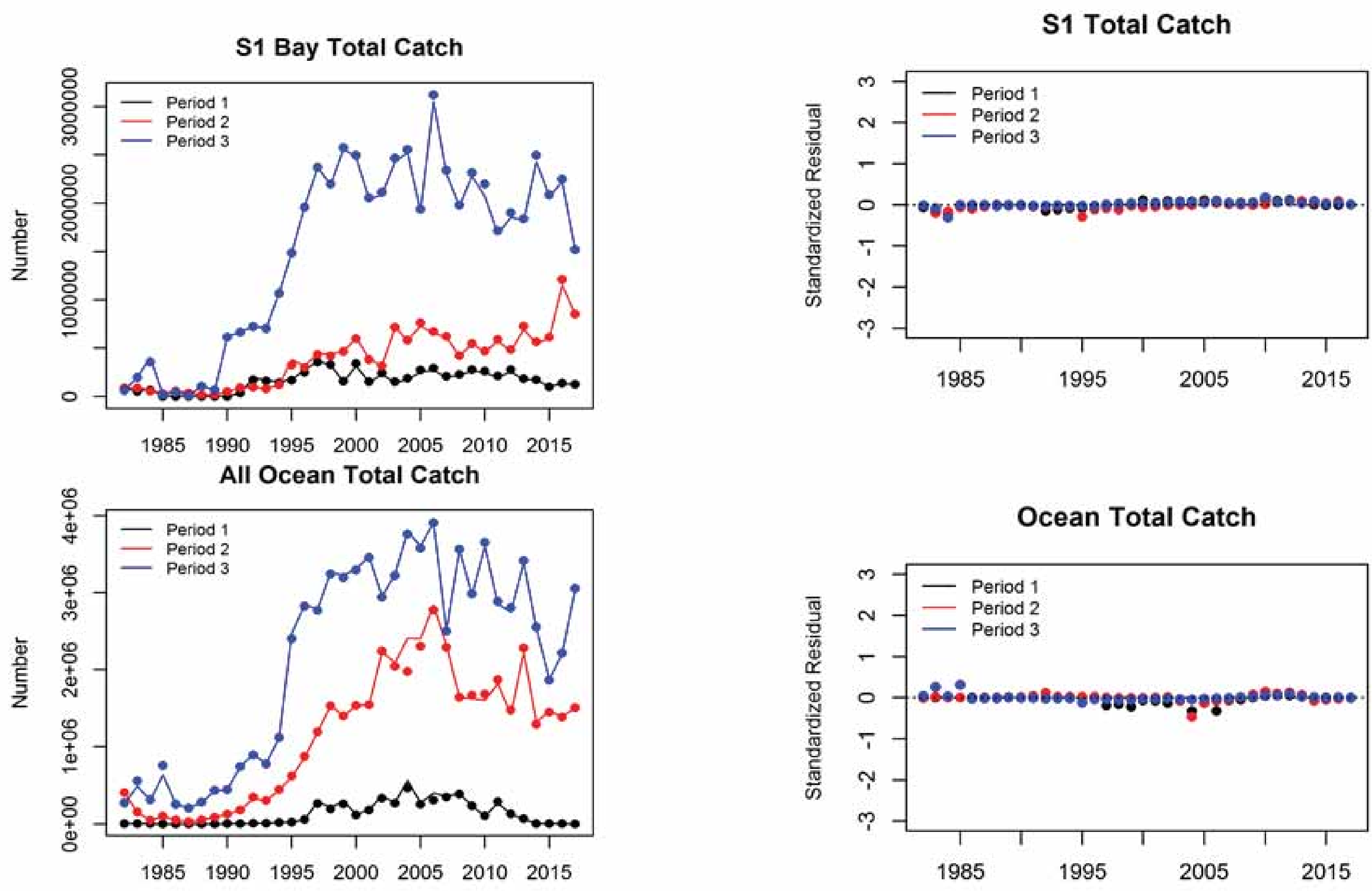



Figure B7.6. Comparison of observed (dot) and predicted (lines) estimates of total catch by region, period and year (left), and standardized residual plots (right).

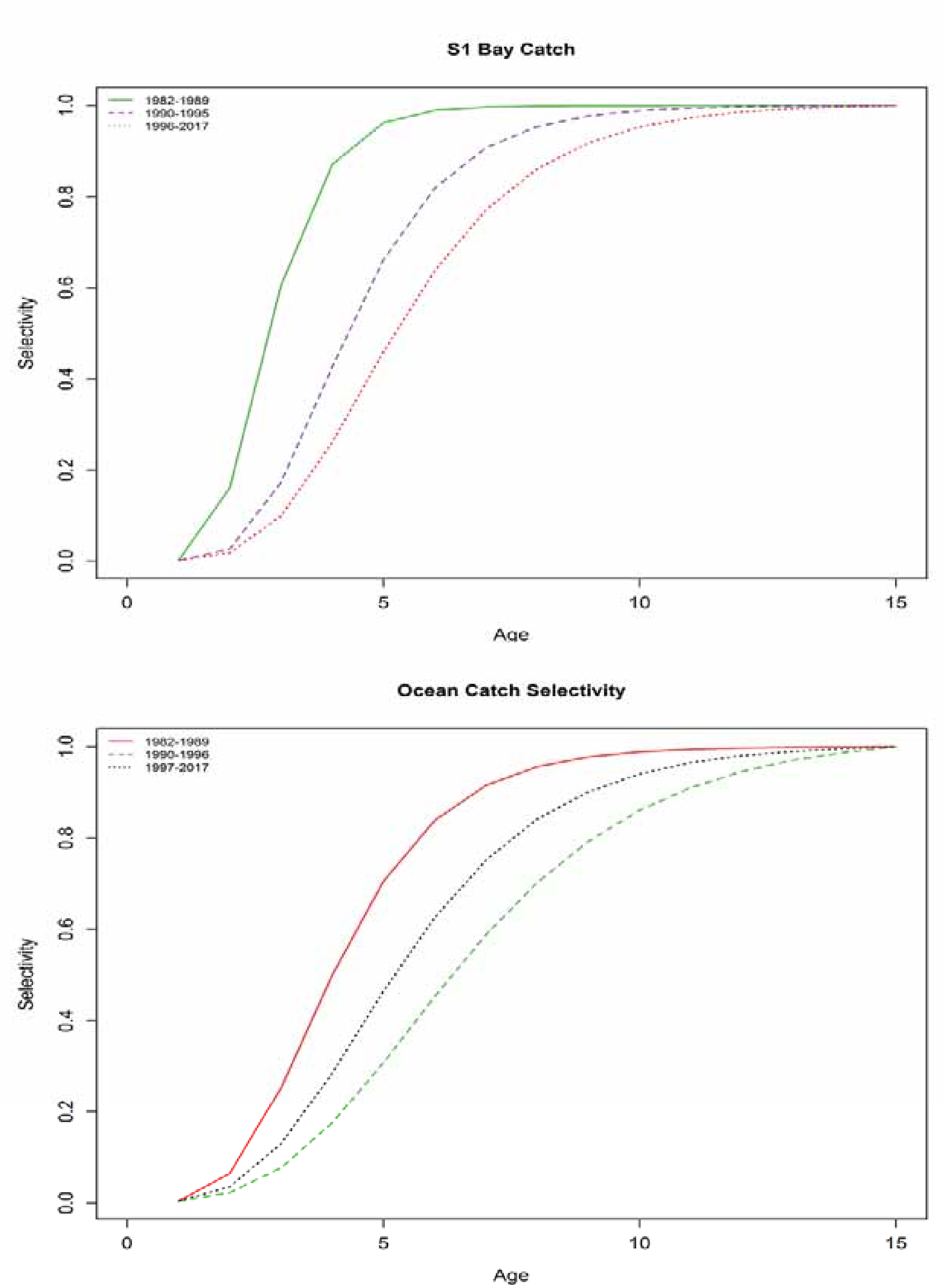



Figure B7.7. Selectivity patterns estimated for the Chesapeake Bay and Ocean fleets by time block and age.

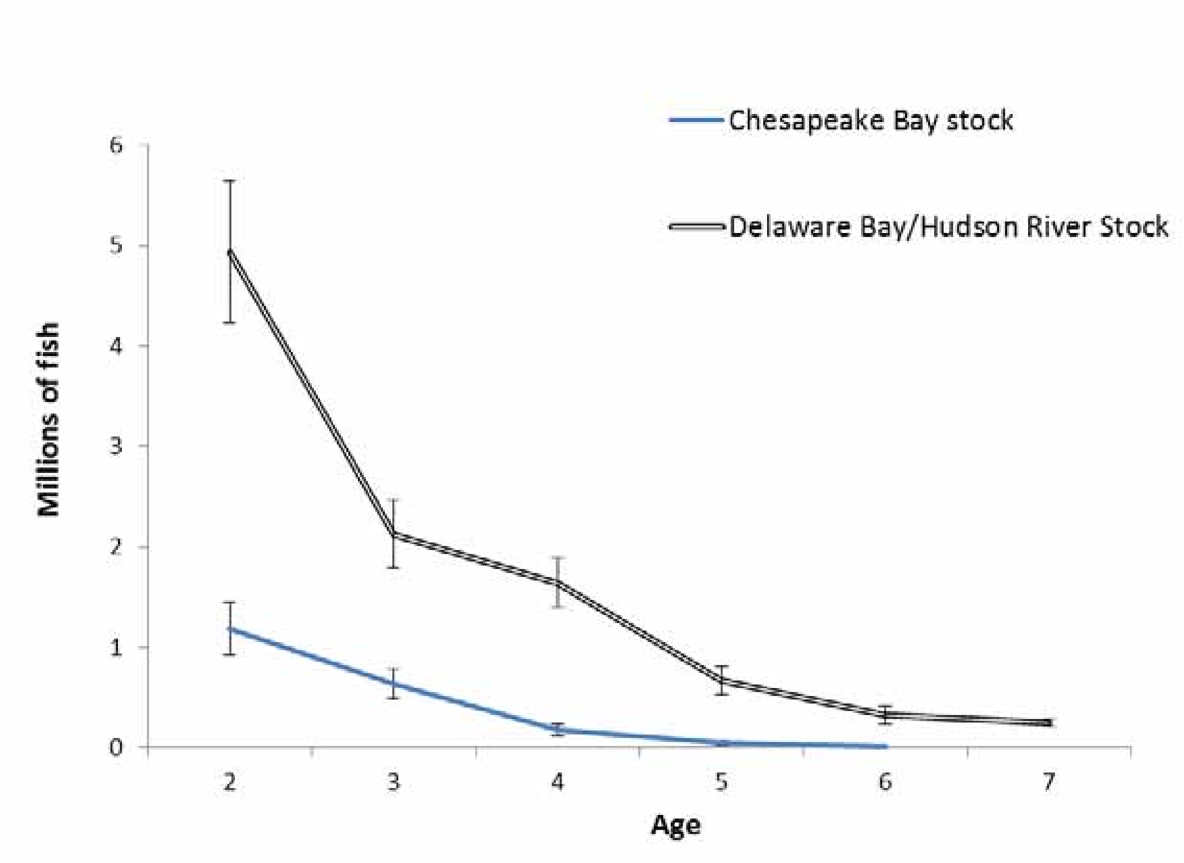



Figure B7.8. Estimates of abundance-at-age in the first year for the Chesapeake Bay stock in the Chesapeake Bay and the Delaware Bay/Hudson River stock in the ocean. Error bars indicate ±1 standard error.

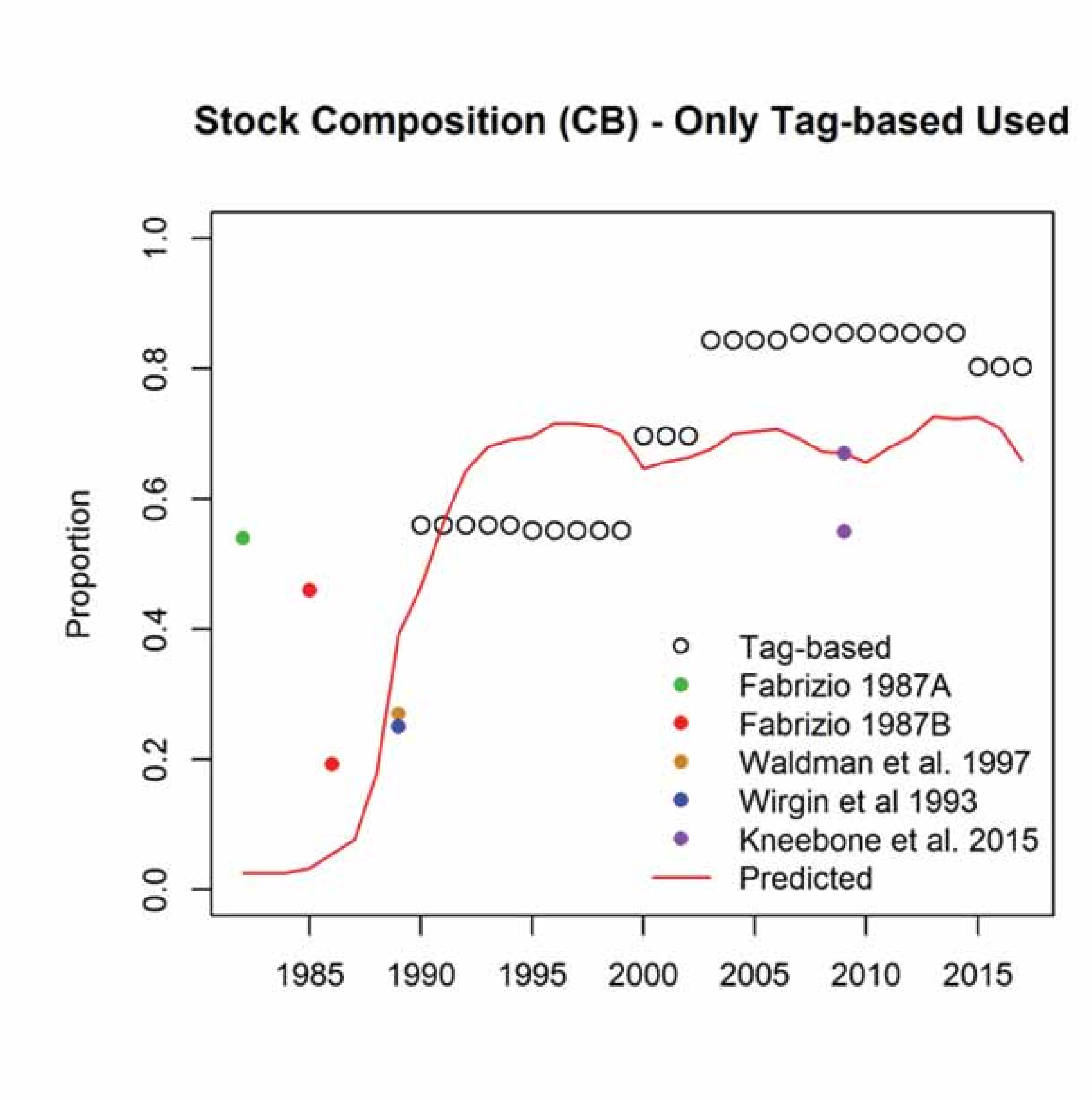



Figure B7.9. Observed versus predicted stock composition for the Chesapeake Bay stock. Literature values not used in the model fitting are indicted by the solid circles for comparison.

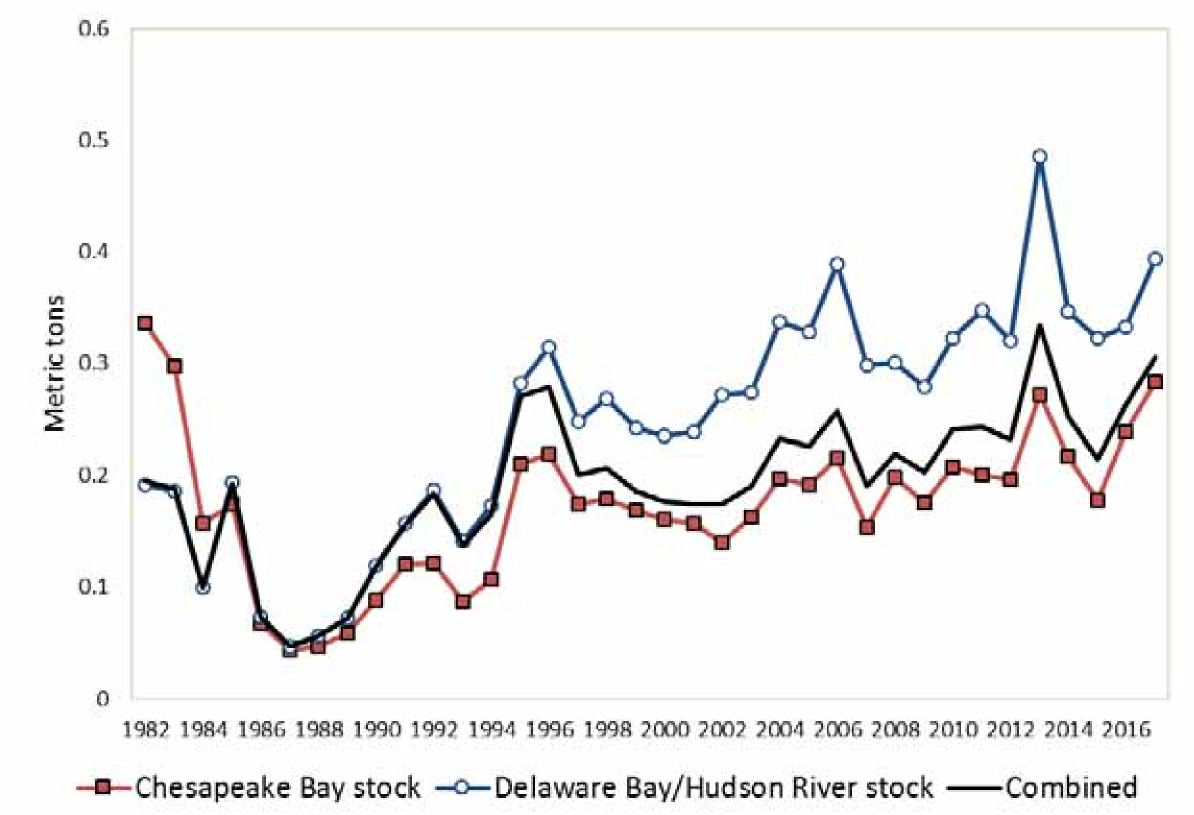



Figure B7.10. Estimates of fully-recruited fishing mortality (F) for the Chesapeake Bay stock and the Delaware Bay/Hudson River stock, and for both stocks combined.

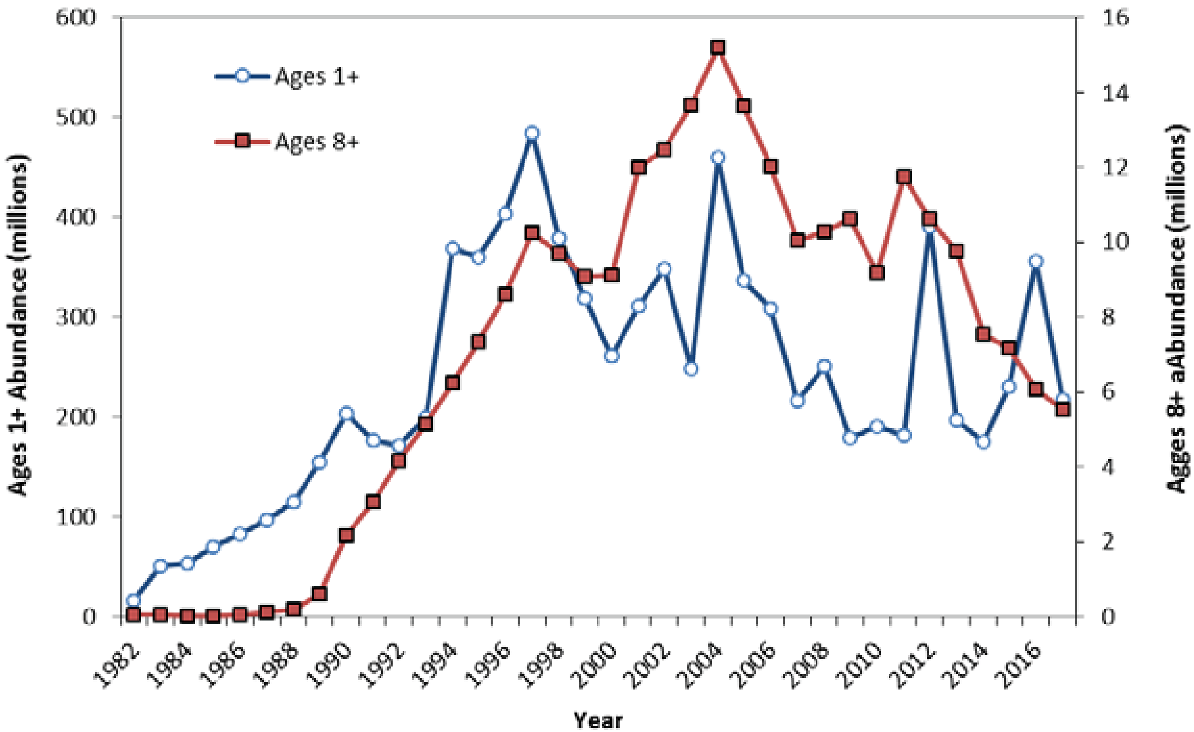



Figure B7.11. Estimates of population abundance of the Chesapeake Bay stock for ages 1+ and ages 8+.

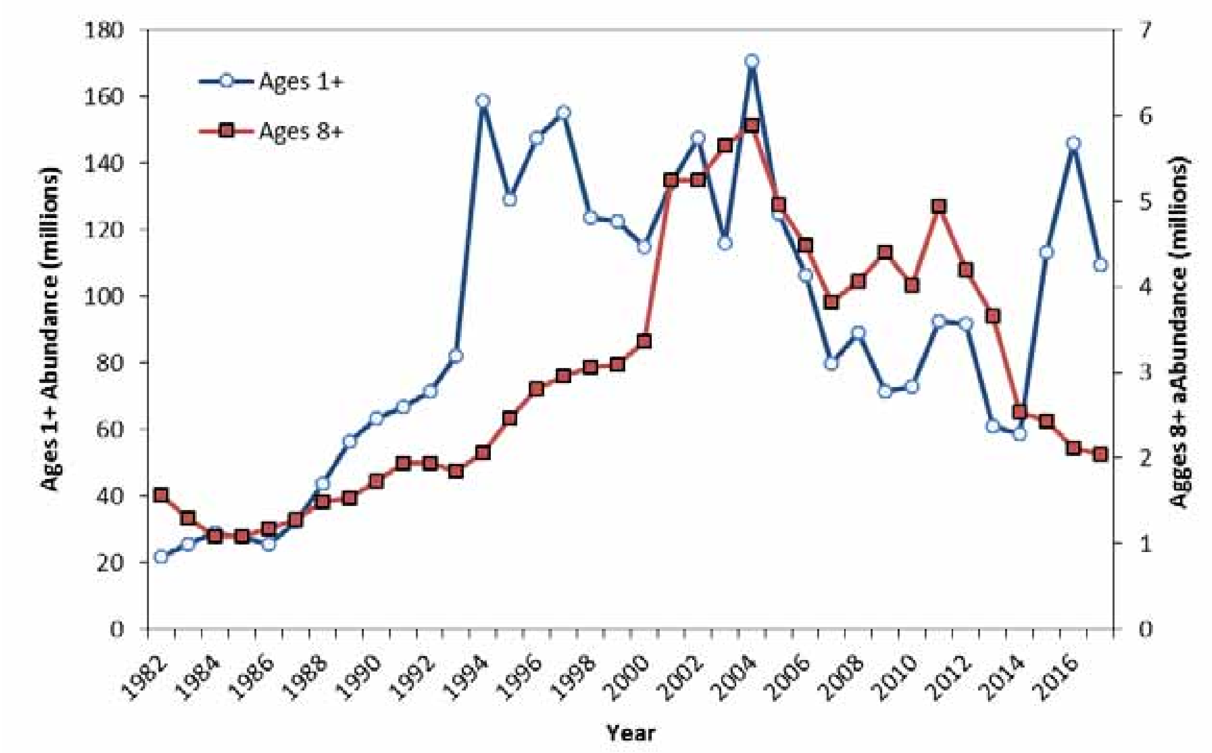



Figure B7.12. Estimates of population abundance of the Delaware River/Hudson Bay stock for ages 1+ and ages 8+.

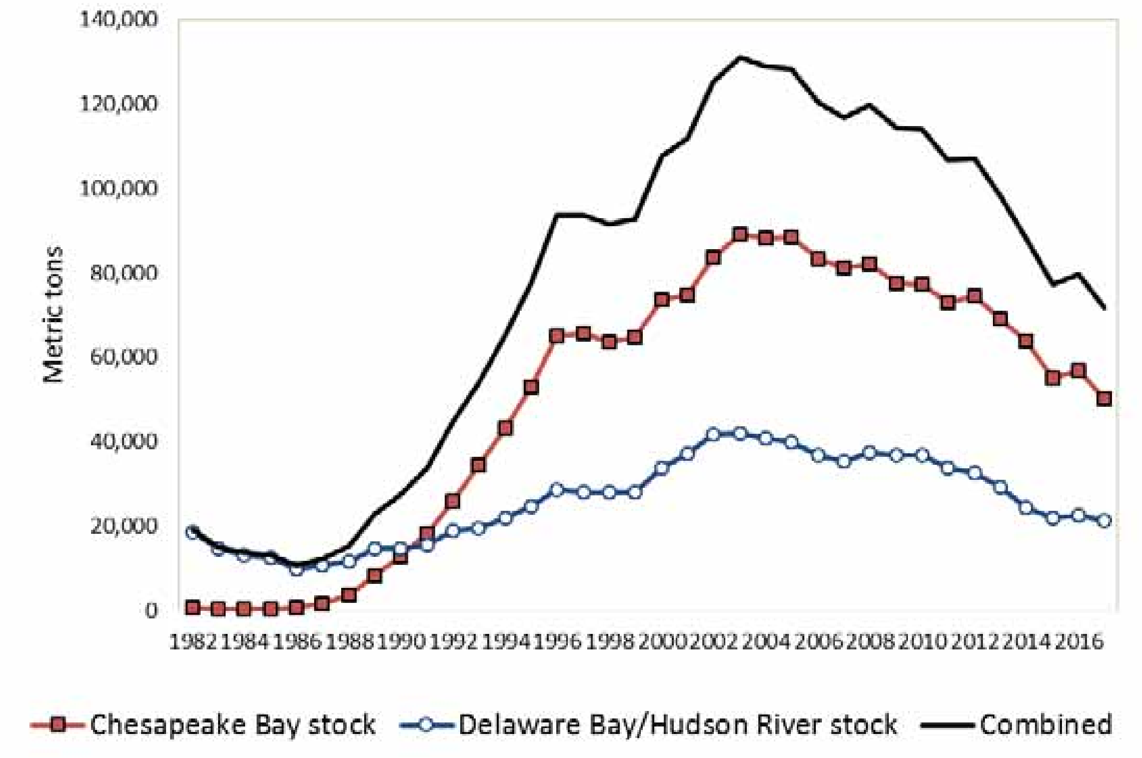



Figure B7.13. Estimates of female spawning stock biomass for Stock-1 (Chesapeake Bay stock) and Stock-2 (Delaware Bay/Hudson River stock) plotted with the combined total female spawning stock biomass.

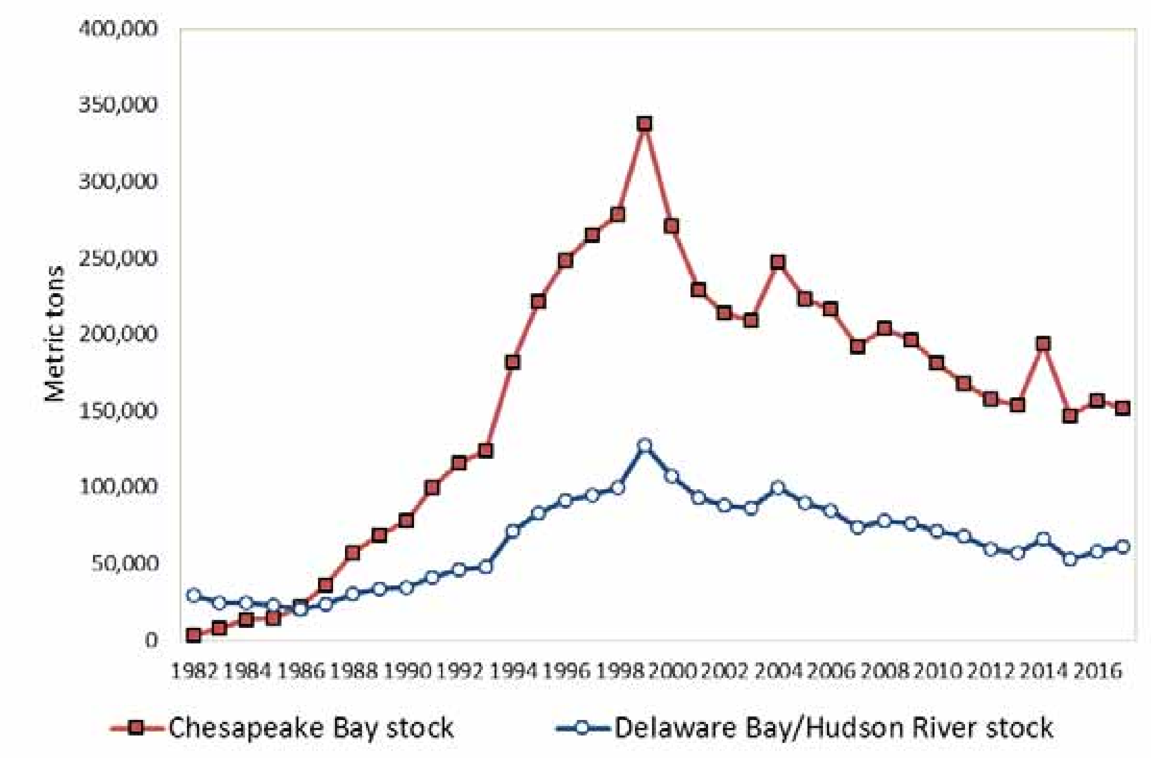
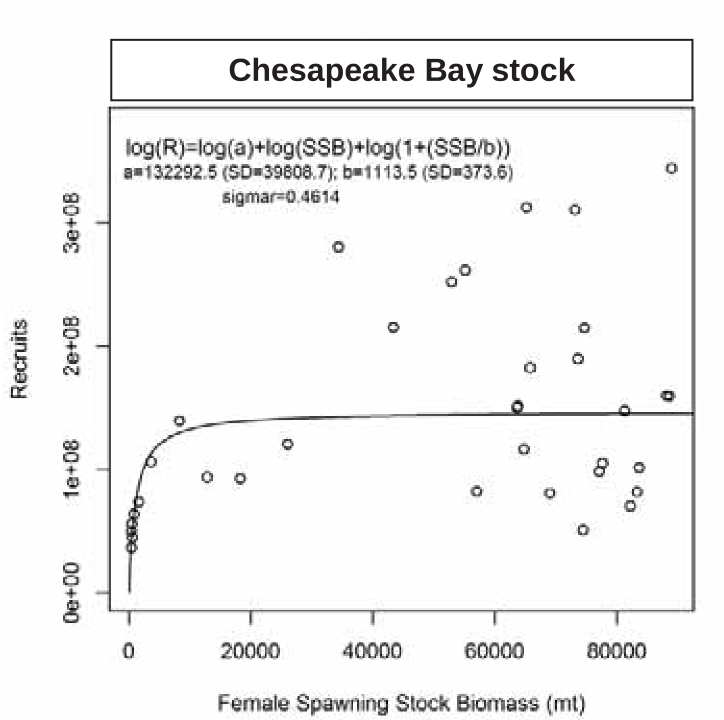



Figure B7.14. Estimates of total January 1 biomass for Stock-1 (Chesapeake Bay stock) and Stock-2 (Delaware Bay/Hudson River stock).



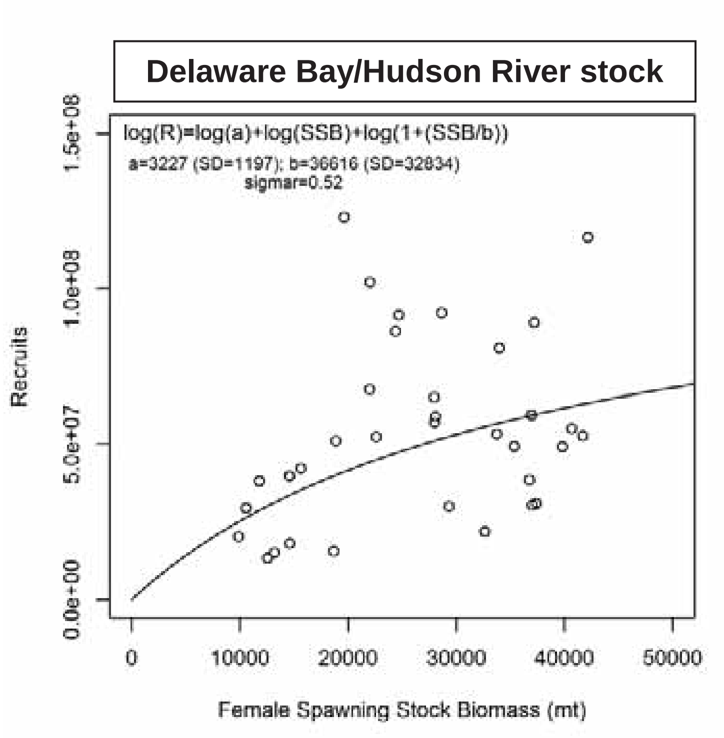




Figure B7.15. Estimates of recruits versus female spawning stock biomass for the Chesapeake Bay stock (top) and the Delaware Bay/Hudson River stock (bottom).

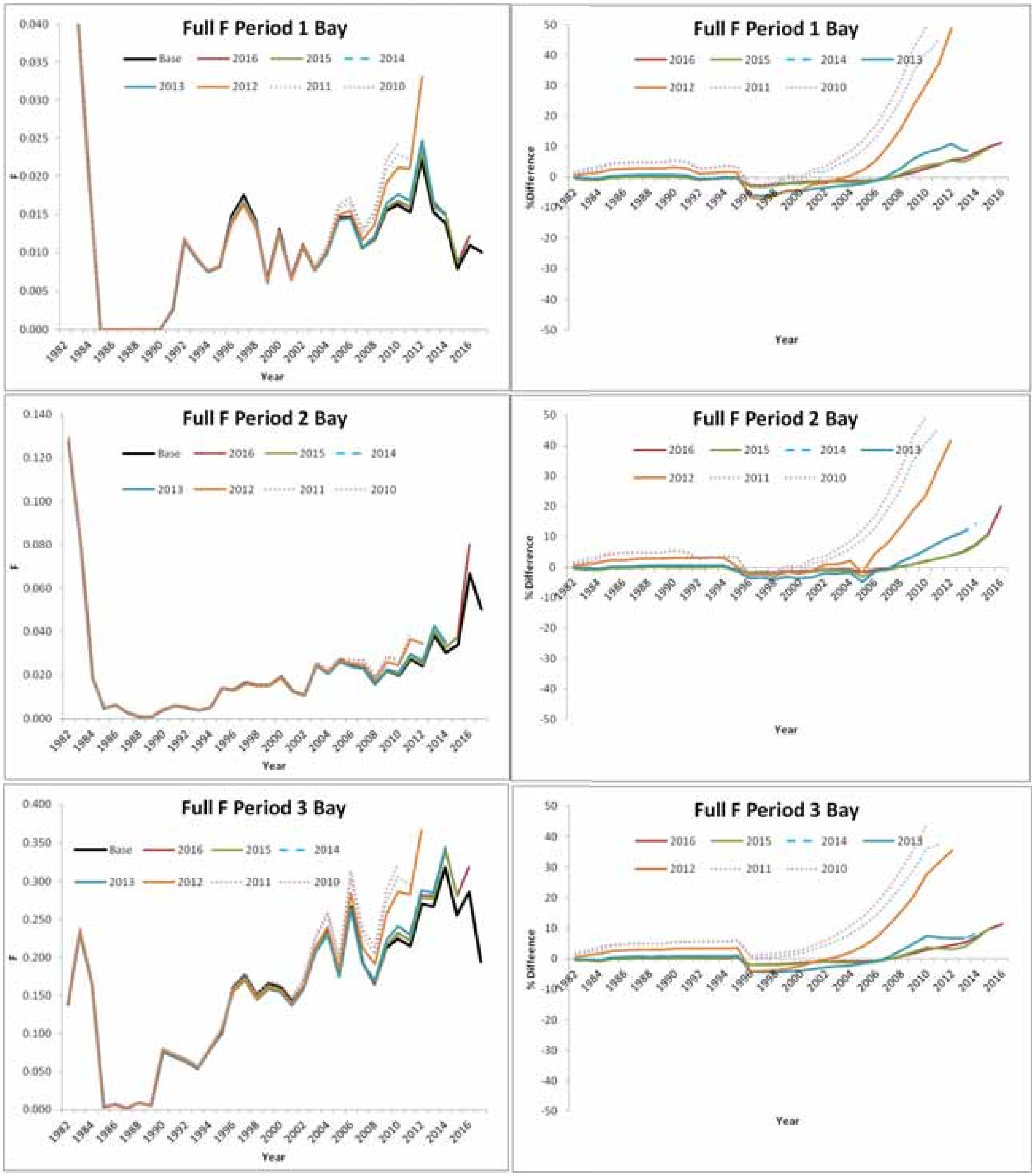



Figure B7.16. Retrospective analyses for fully-recruited fishing mortality (F) in periods 1-3 for the Chesapeake Bay region.

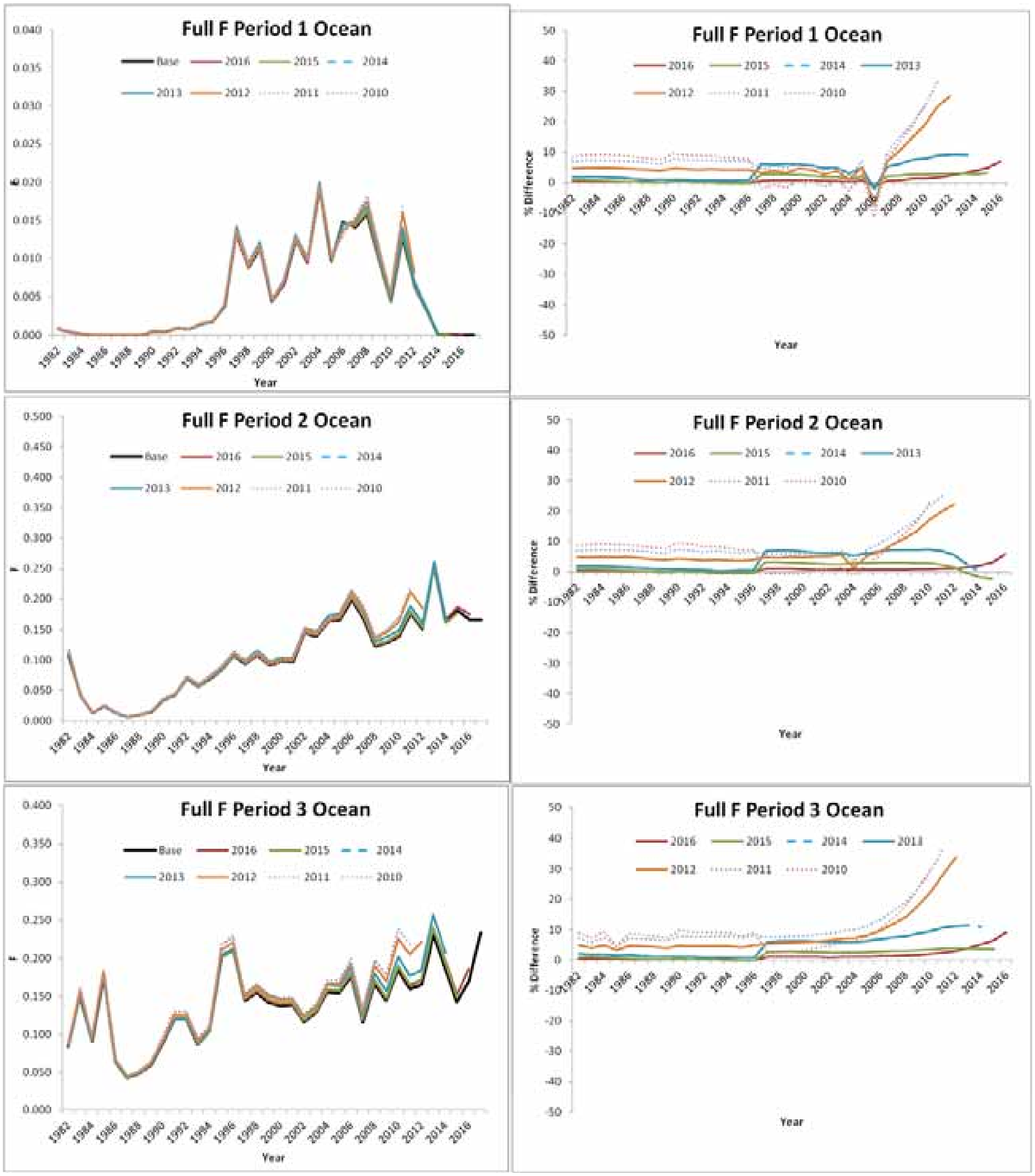



Figure B7.17. Retrospective analyses for fully-recruited fishing mortality (F) in periods 1-3 for the ocean region.

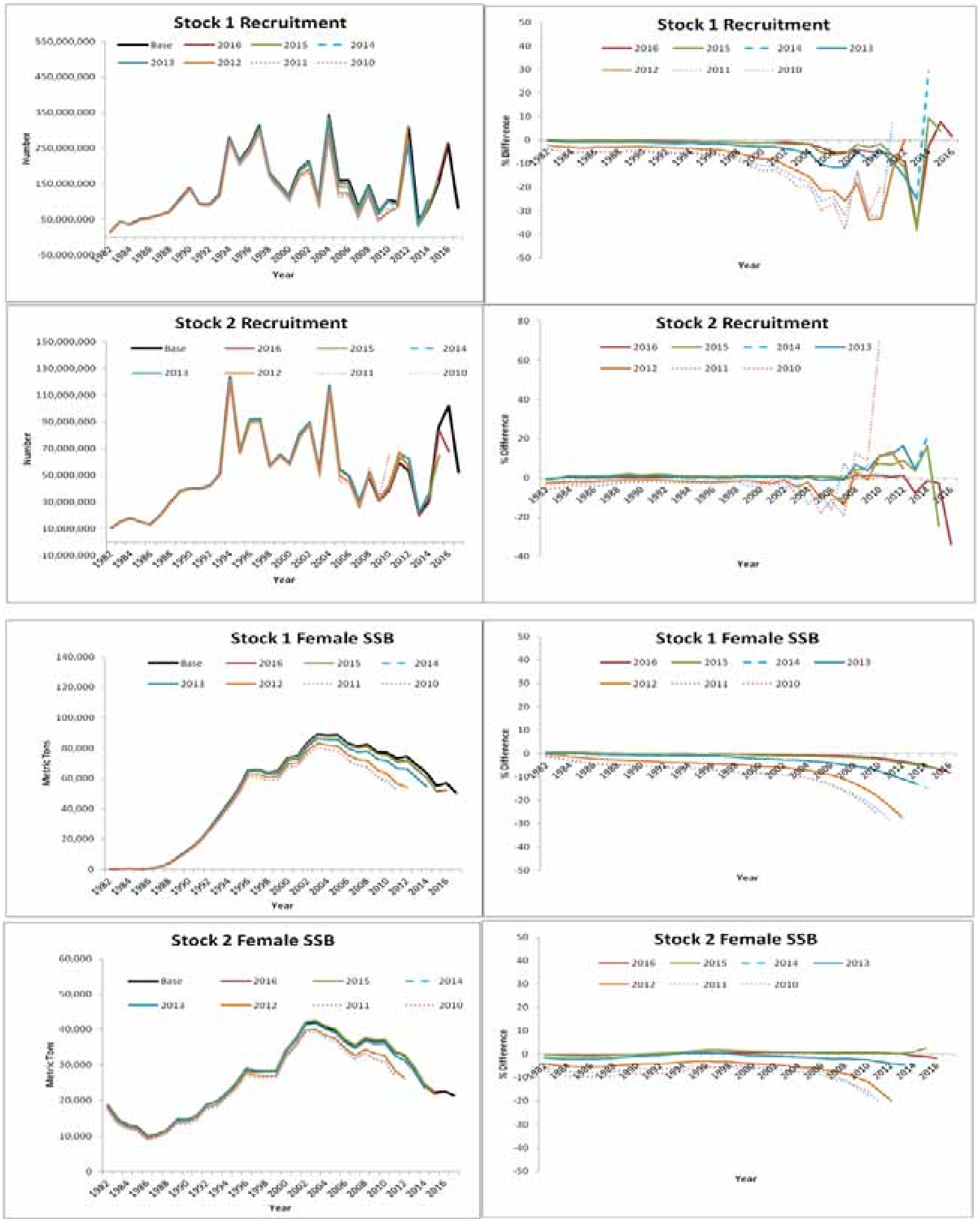



Figure B7.18. Retrospective analyses for Stock-1 (Chesapeake Bay stock) and Stock-2 (Delaware Bay/Hudson River stock) recruitment and female spawning stock biomass.

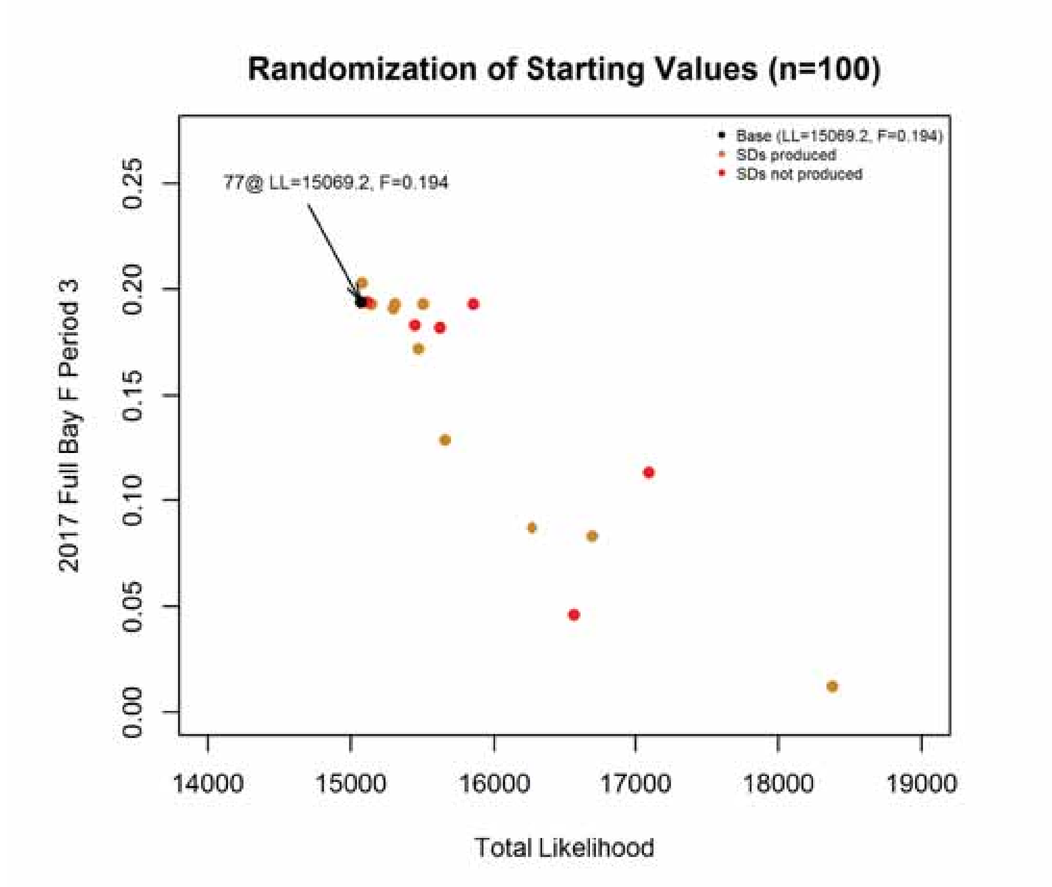



Figure B7.19. Biplot of fully-recruited fishing mortality in the Chesapeake Bay for period-3 versus total likelihood.

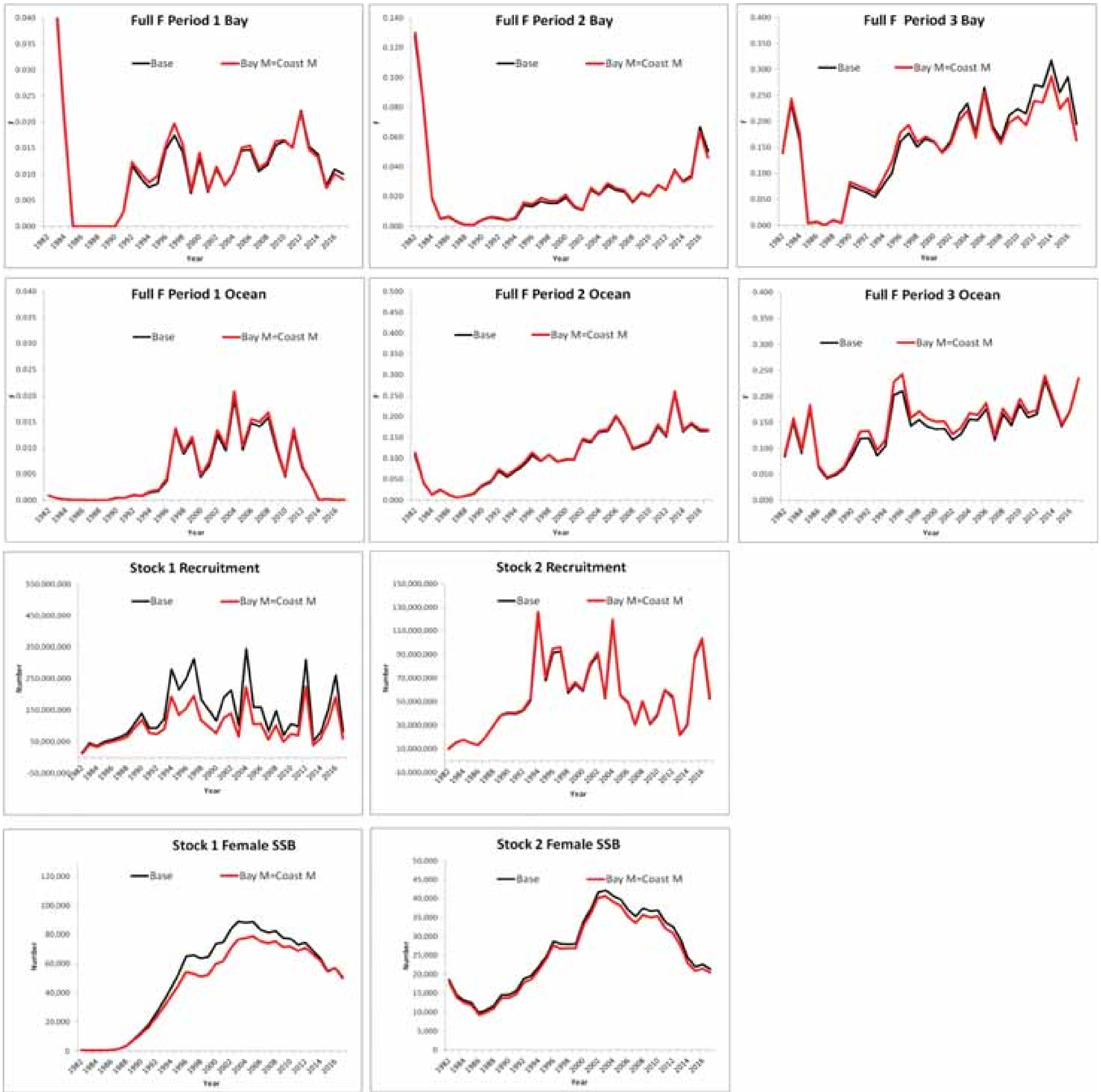



Figure B7.20. Results of sensitivity analysis of natural mortality (M) rates used in the Chesapeake Bay region.

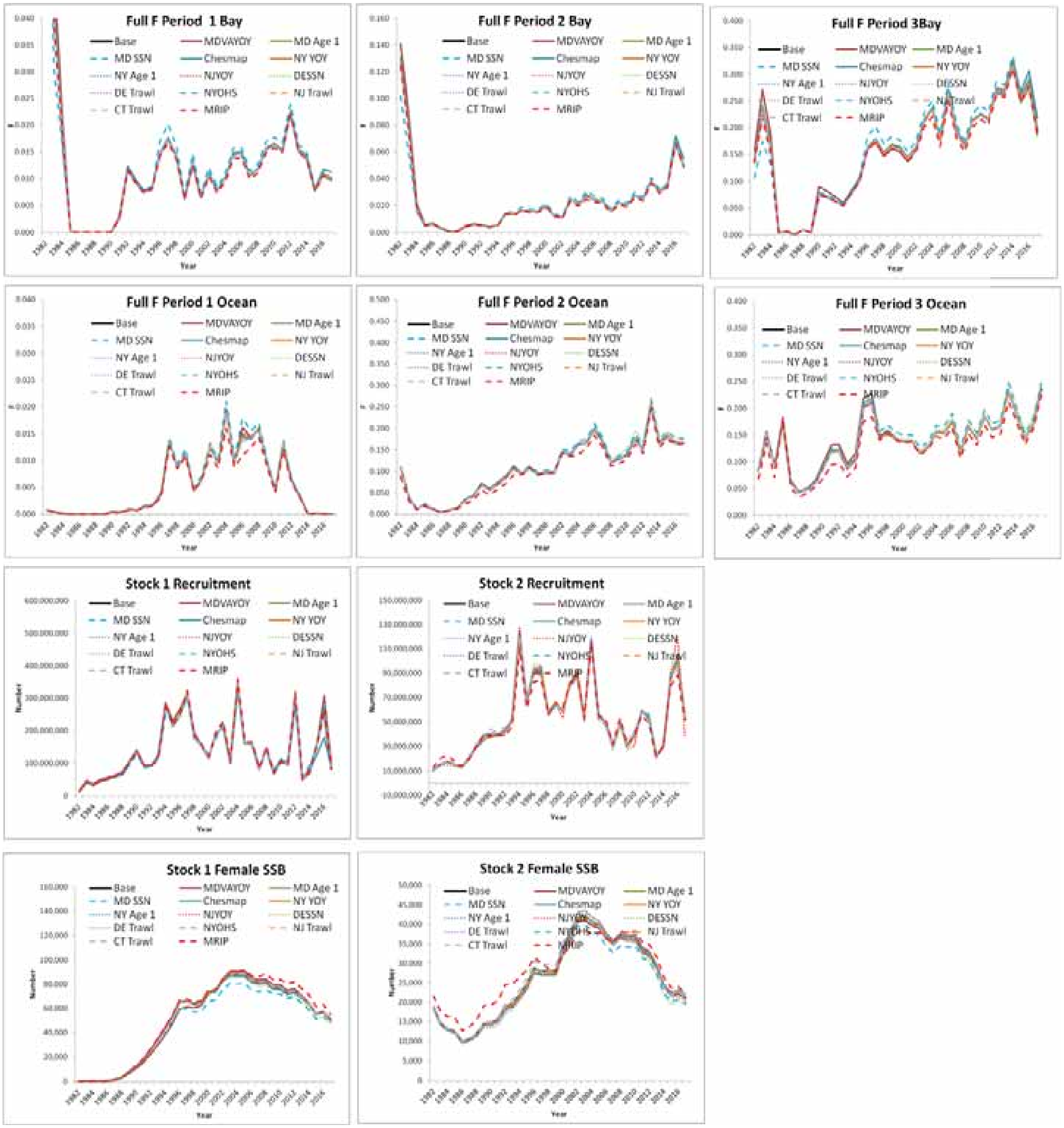



Figure B7.21. Results of sensitivity analysis of deleting one survey-at-a-time.Stock-1 = Chesapeake Bay stock; Stock-2 = Delaware Bay/Hudson River stock

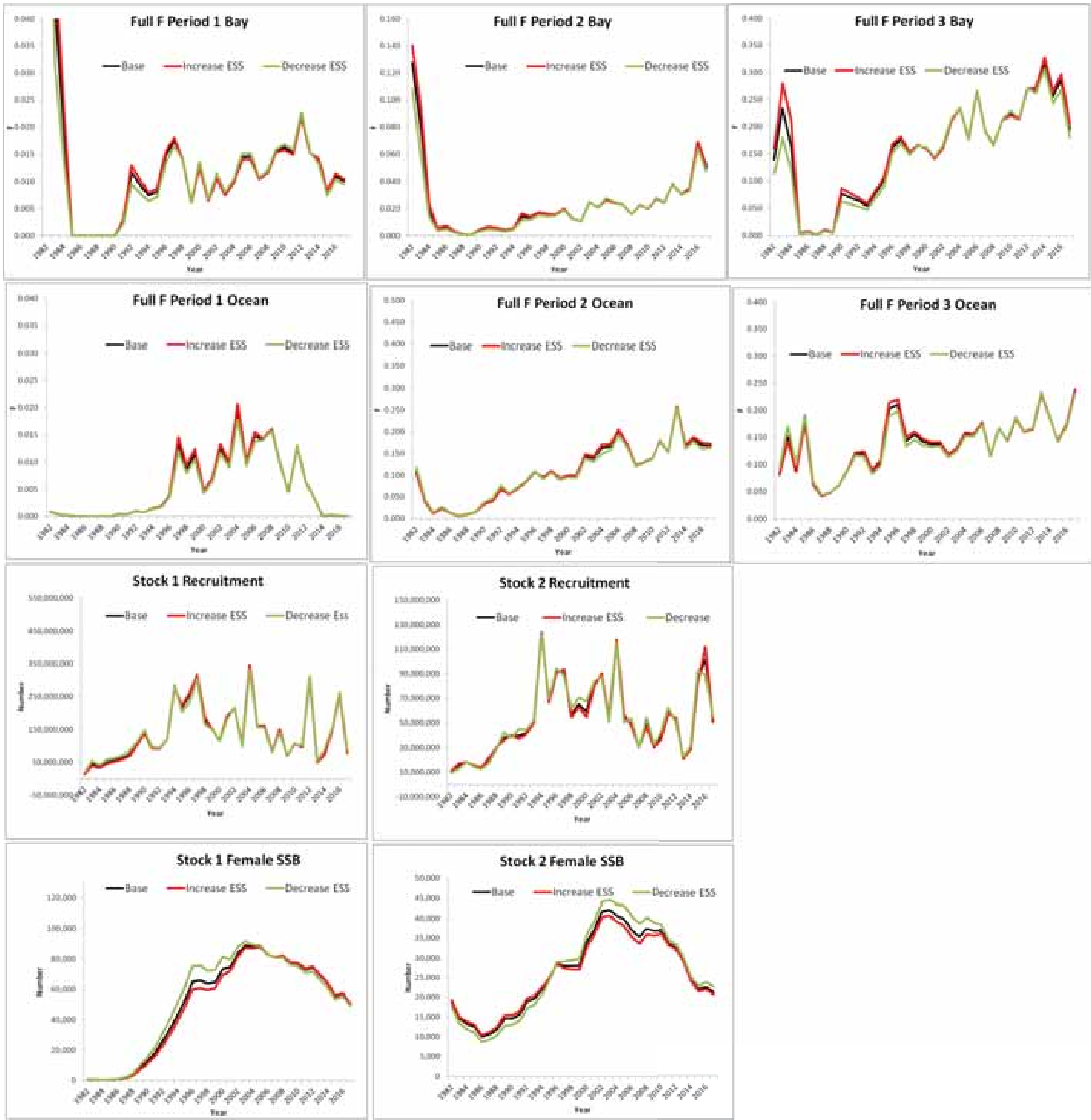



Figure B7.22. Results of sensitivity analysis of increasing or decreasing the effective sample size of composition data. Stock-1 = Chesapeake Bay stock; Stock-2 = Delaware Bay/Hudson River stock

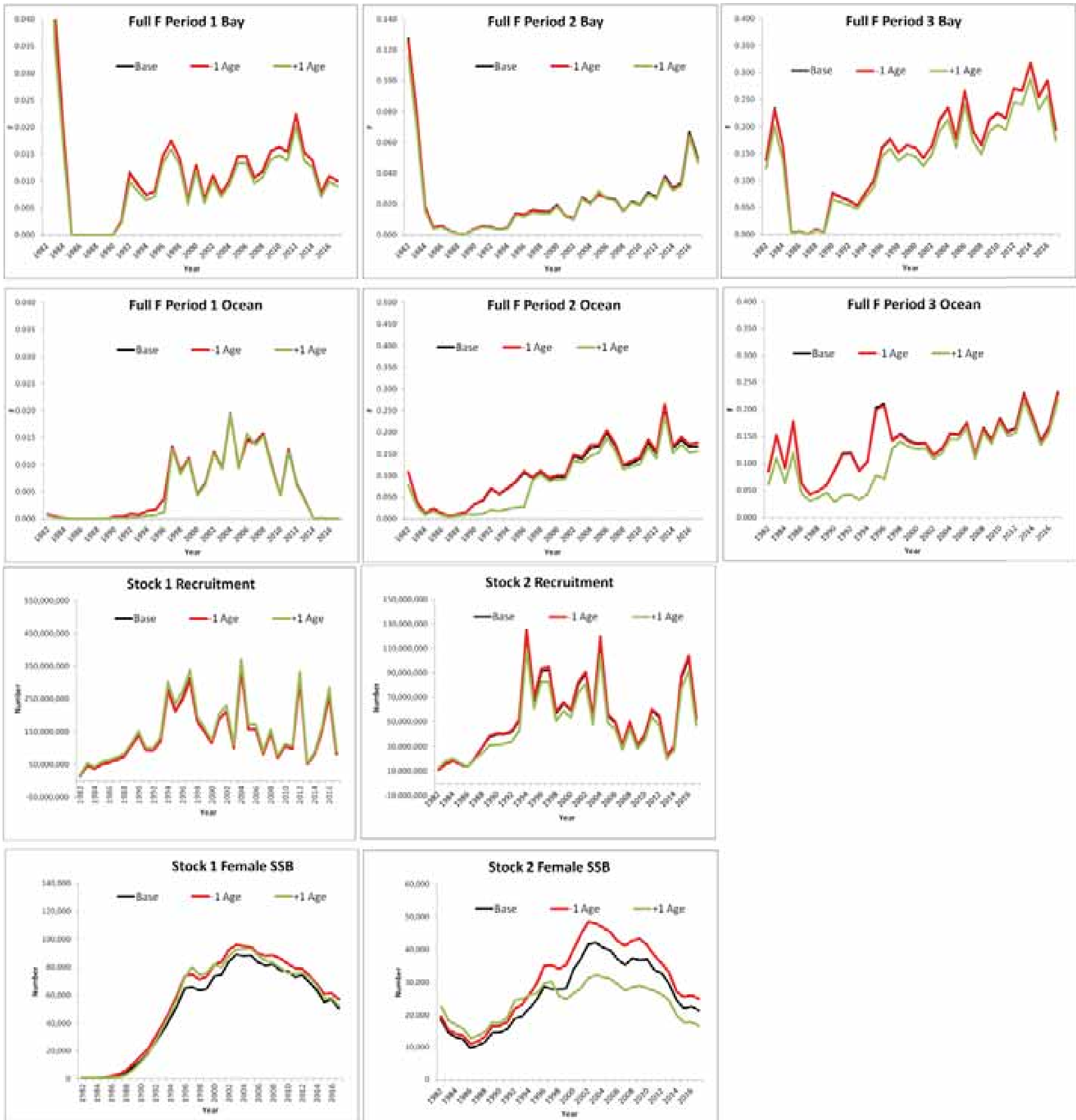



Figure B7.23. Results of sensitivity analysis of female and male maturity schedules. Stock-1 = Chesapeake Bay stock; Stock-2 = Delaware Bay/Hudson River stock

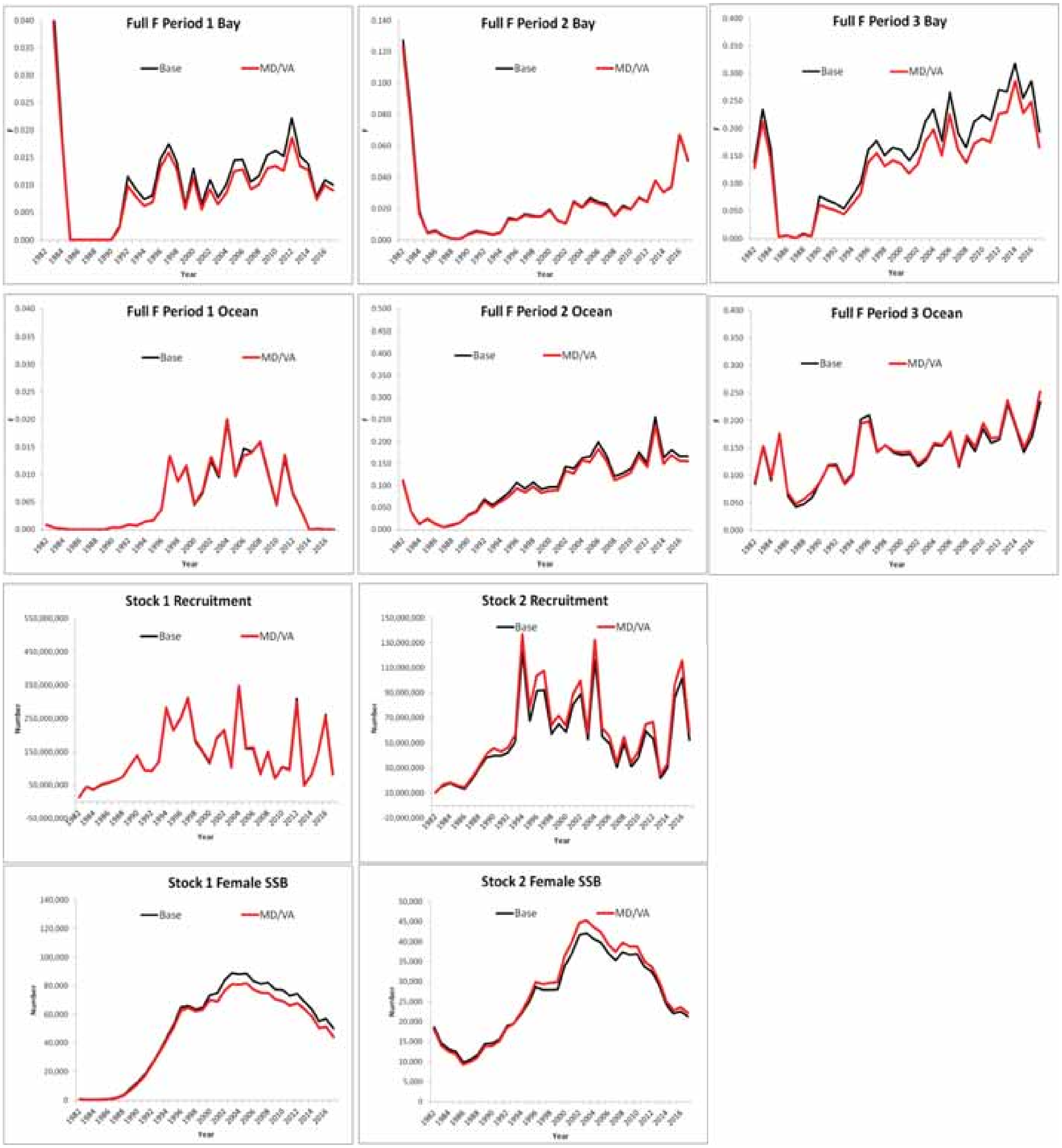



Figure B7.24. Results of sensitivity analysis of emigration probabilities-at-age.Stock-1 = Chesapeake Bay stock; Stock-2 = Delaware Bay/Hudson River stock

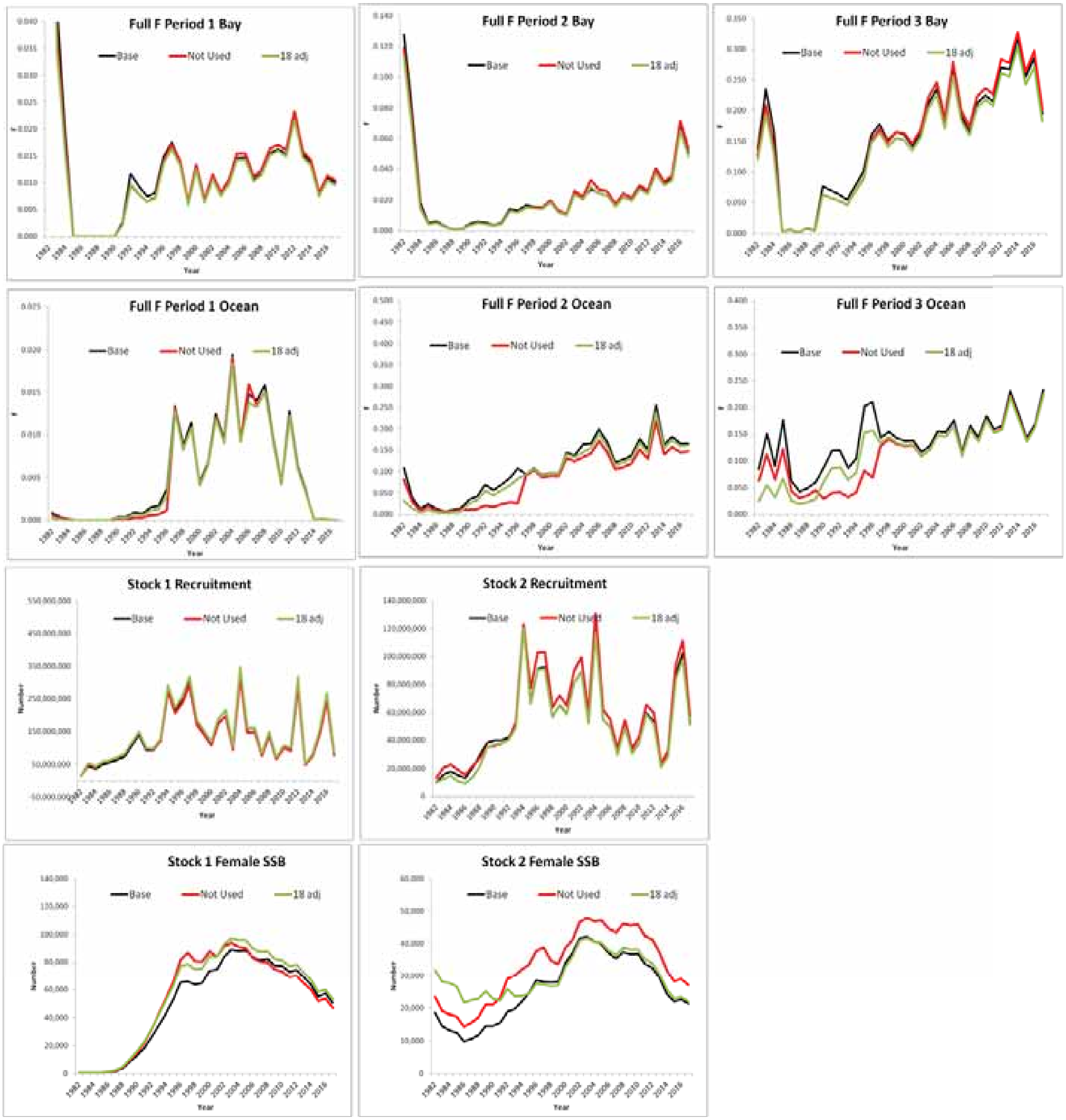



Figure B7.25. Results of sensitivity analysis of the stock composition index.Stock-1 = Chesapeake Bay stock; Stock-2 = Delaware Bay/Hudson River stock

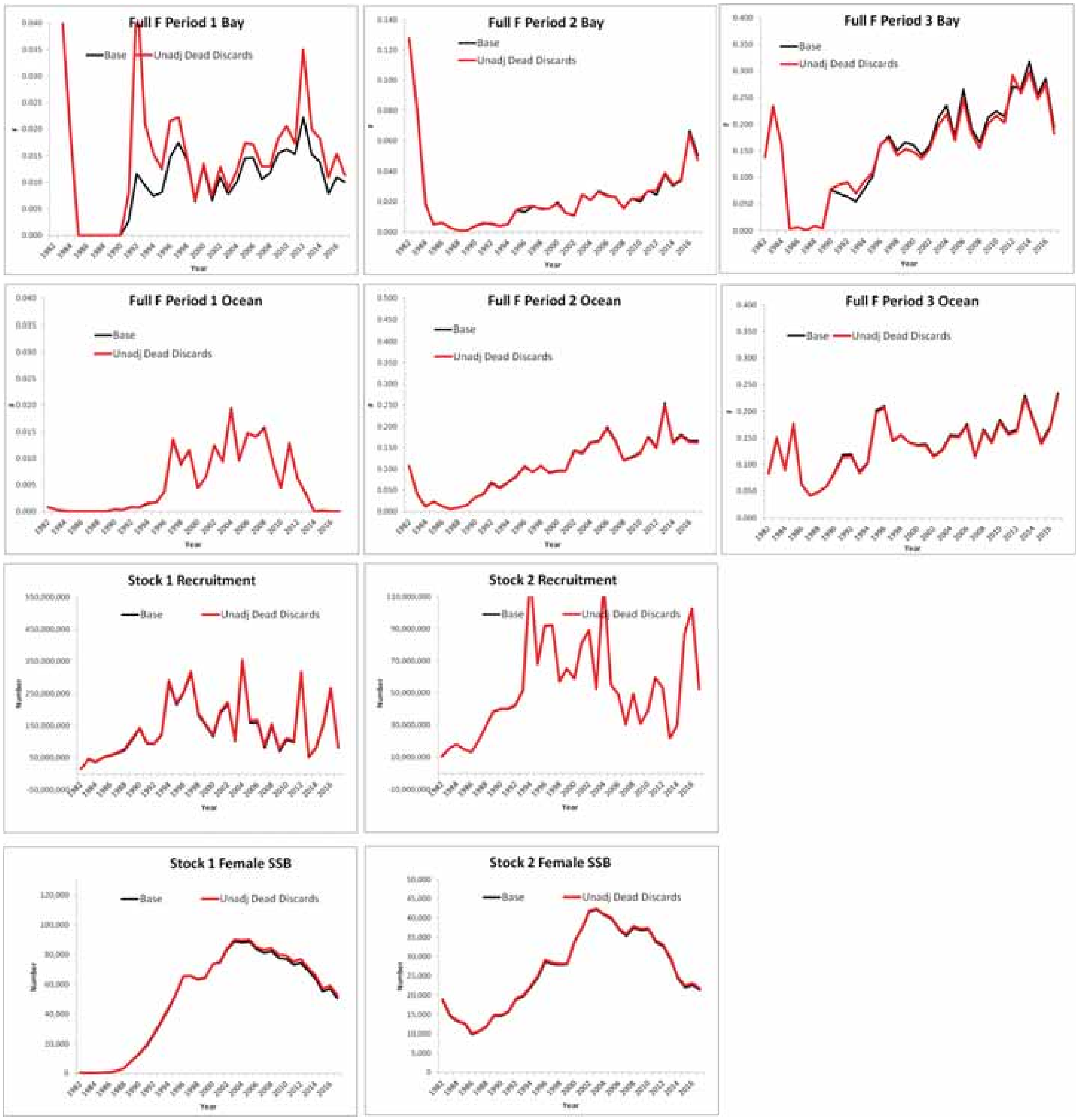



Figure B7.26. Results of sensitivity analysis of the commercial dead discard estimates. Stock-1 = Chesapeake Bay stock; Stock-2 = Delaware Bay/Hudson River stock

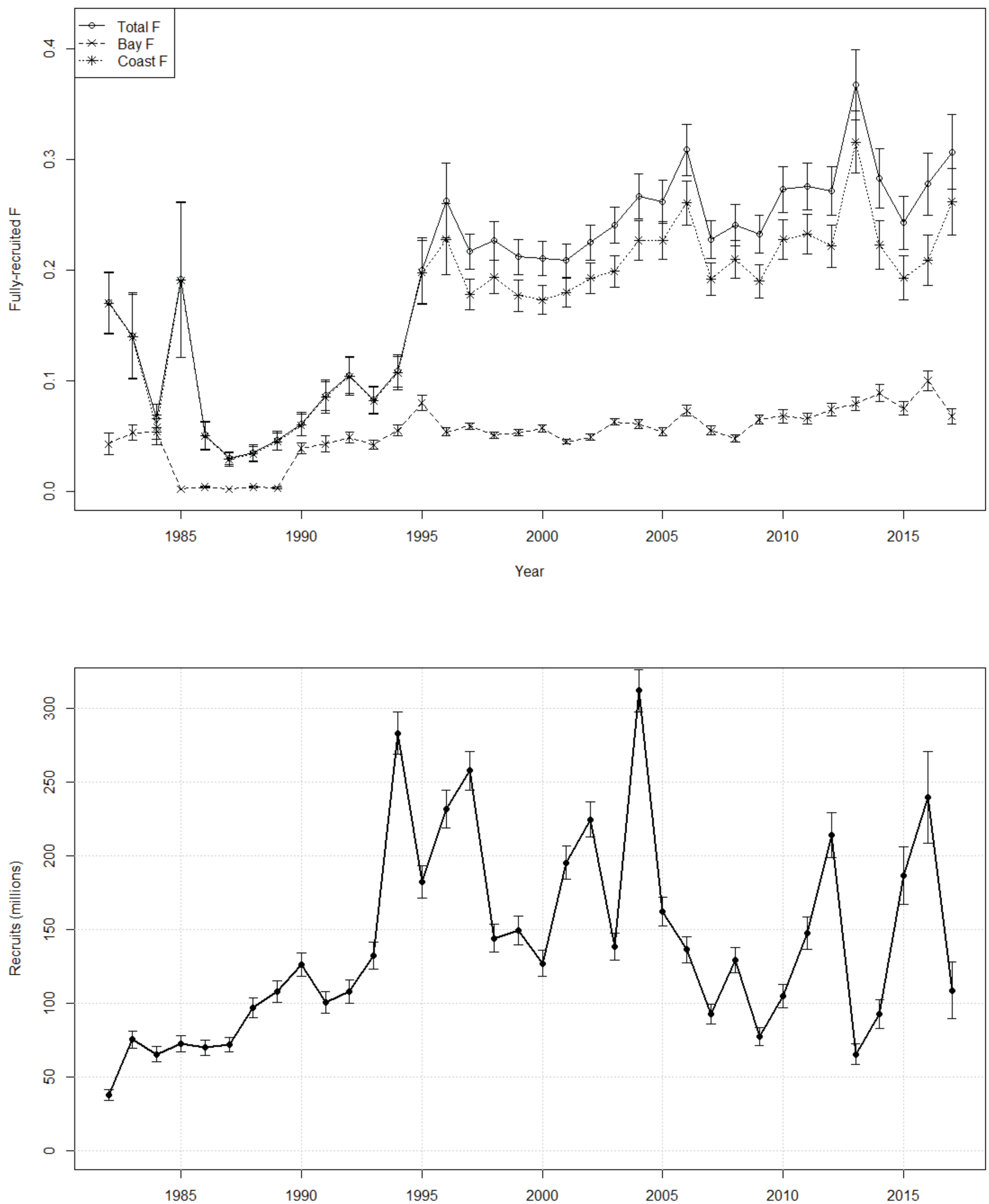



Figure B7.27. Estimates of total and fleet-specific fully-recruited fishing mortality (F) (top) and recruitment (bottom) from the non-migration SCA base model run. Error bars indicate one standard deviation.

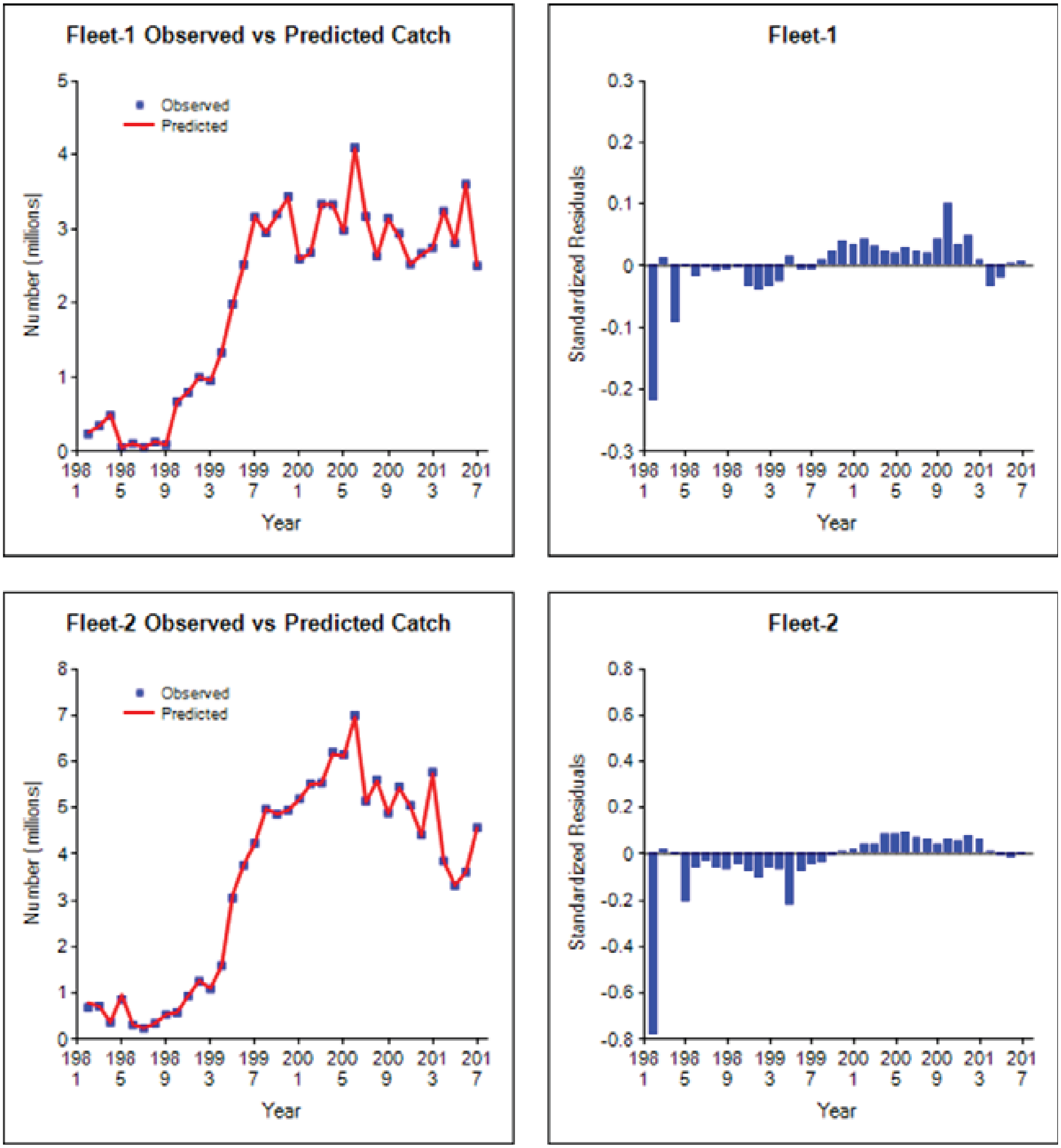
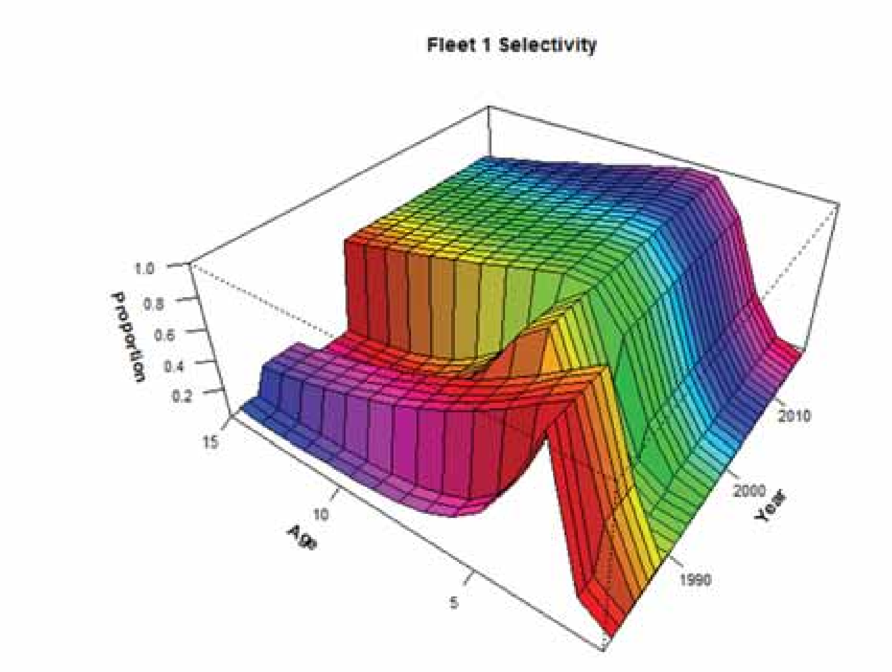



Figure B7.28. Observed and predicted total catch and standardized residuals by fleet for the non-migration SCA (Fleet 1 = Bay, Fleet 2 = Coast).



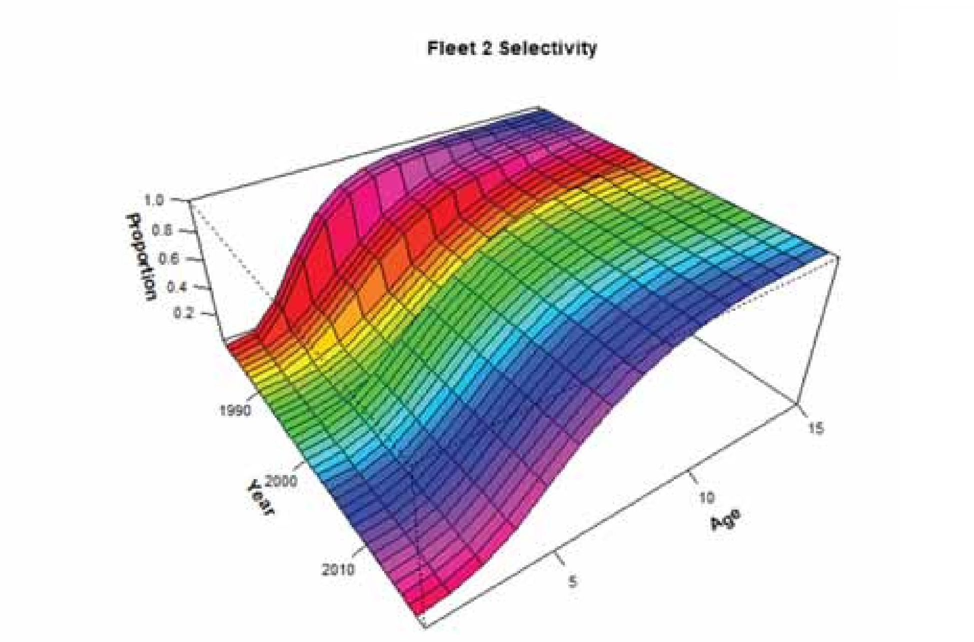




Figure B7.29. Catch selectivity patterns by fleet for the non-migration SCA (Fleet 1 = Bay, Fleet 2 = Coast).

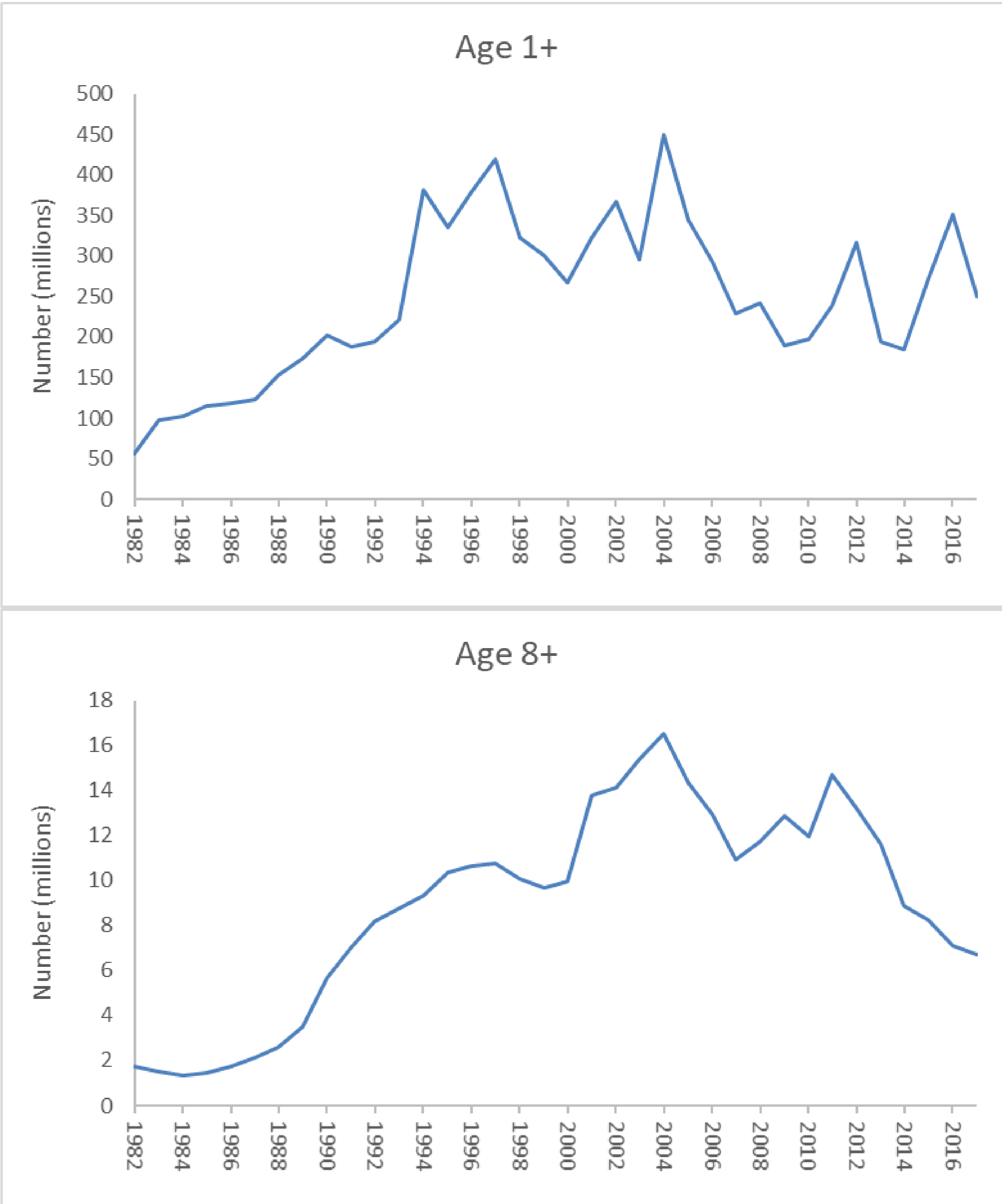



Figure B7.30. Estimates of January-1 total (age 1+) and 8+ abundance for 1982-2017 from the non-migration SCA.

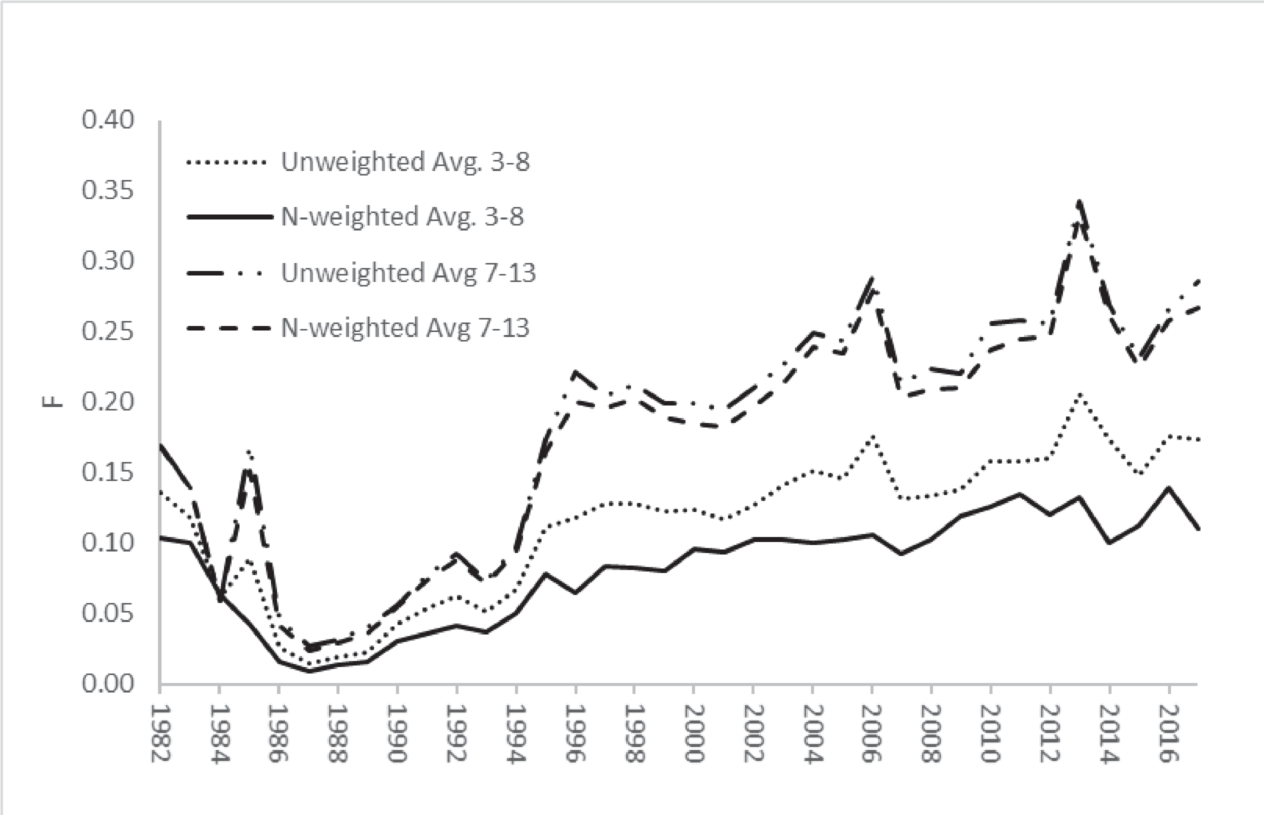



Figure B7.31. Comparison of fishing mortality estimates from the non-migration SCA model.

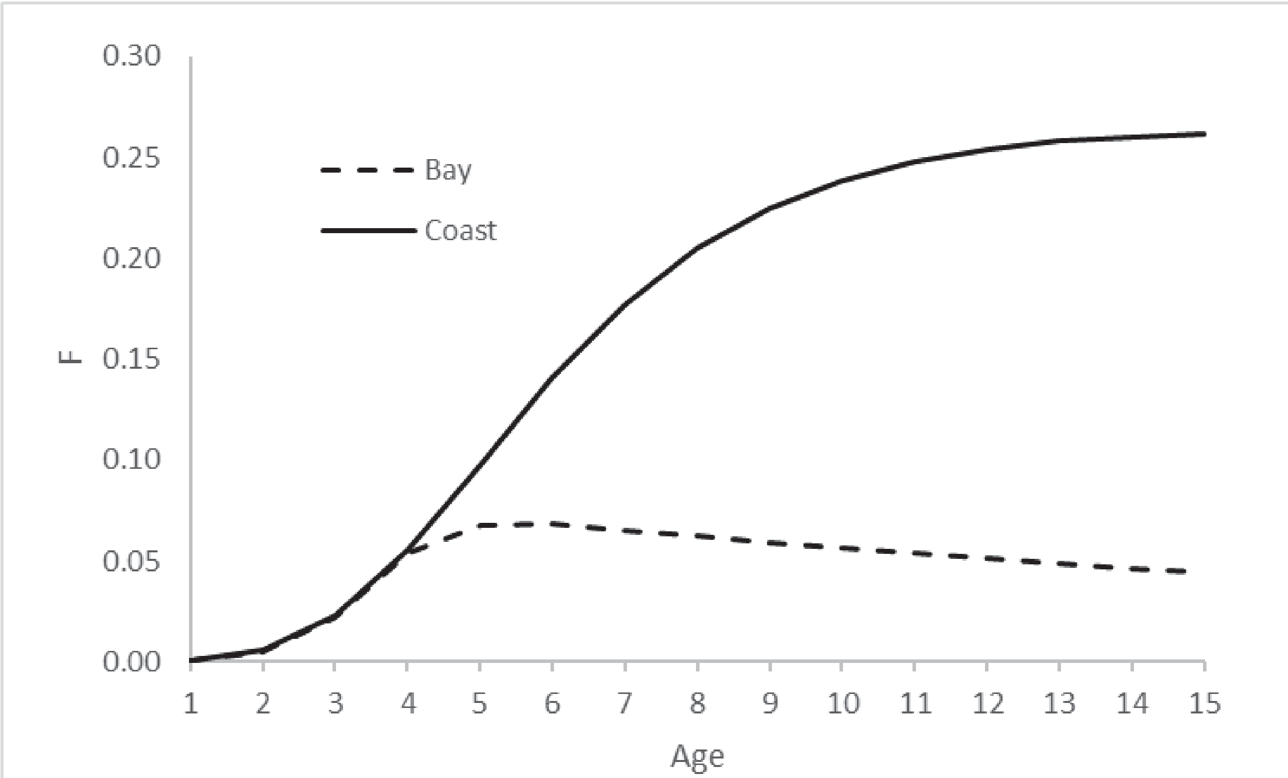



Figure B7.32. Fishing mortality at age in 2017 for the Chesapeake Bay and Coast fleets from the non-migration SCA model.

A)

B)

C)

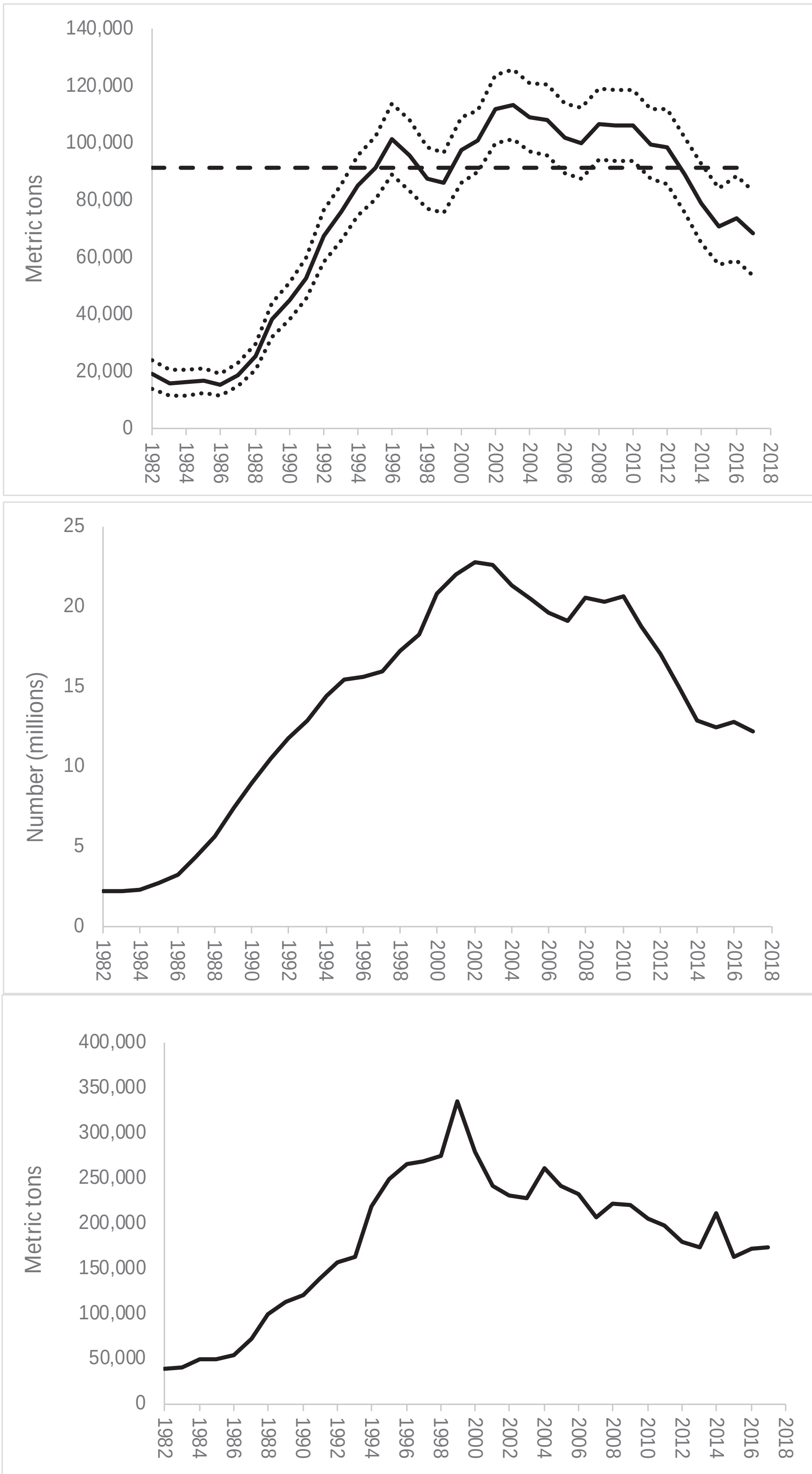



Figure B7.33. Estimates of (A) female spawning stock biomass by year (solid line), (B) female spawning stock numbers, and (C) total January-1 biomass from the non-migration SCA. Dotted lines equal 95% confidence intervals. Dashed horizontal line is the female spawning stock reference point (1995 value).

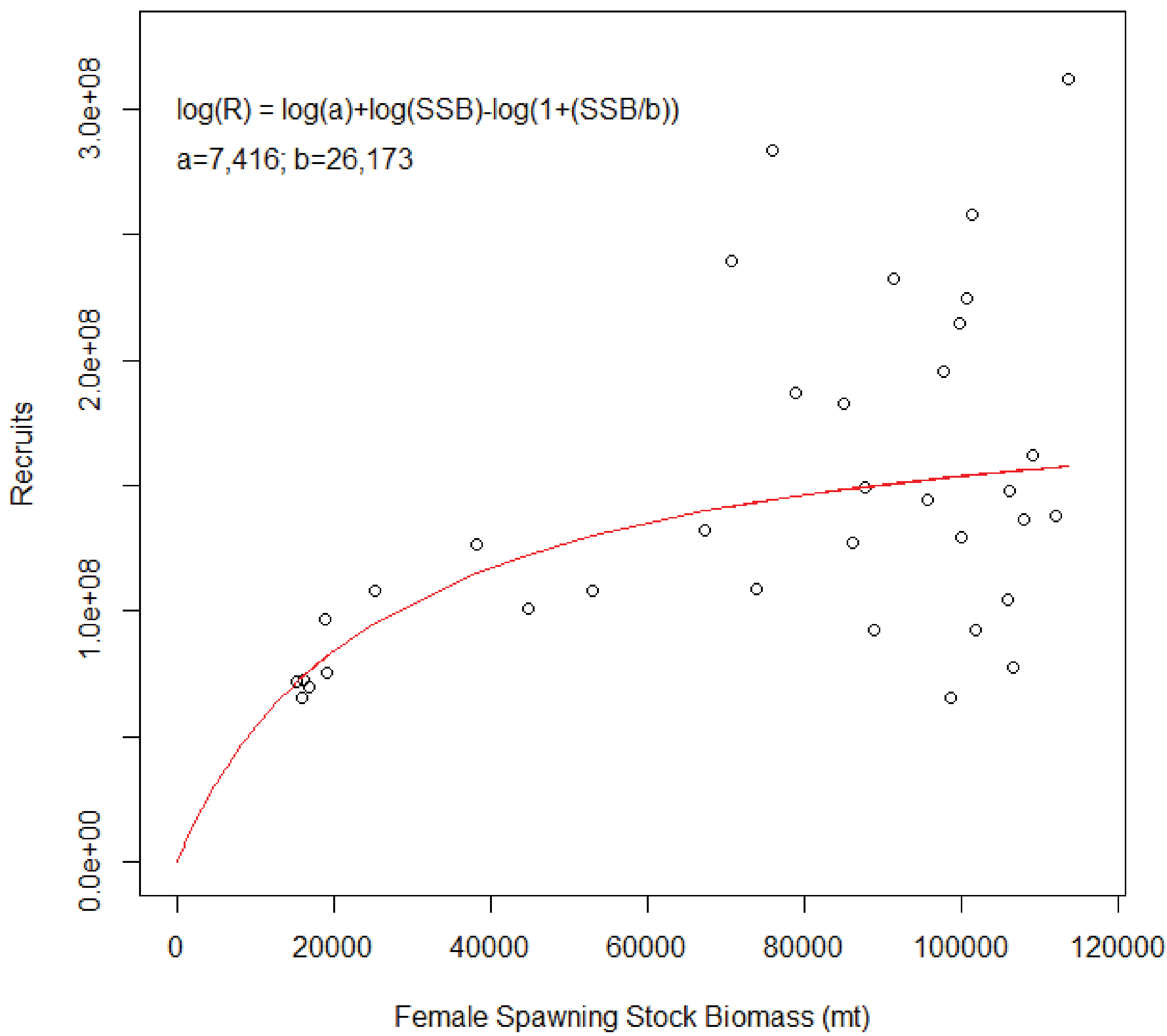



Figure B7.34. Estimates of recruits versus female spawning stock biomass from the non-migration SCA.

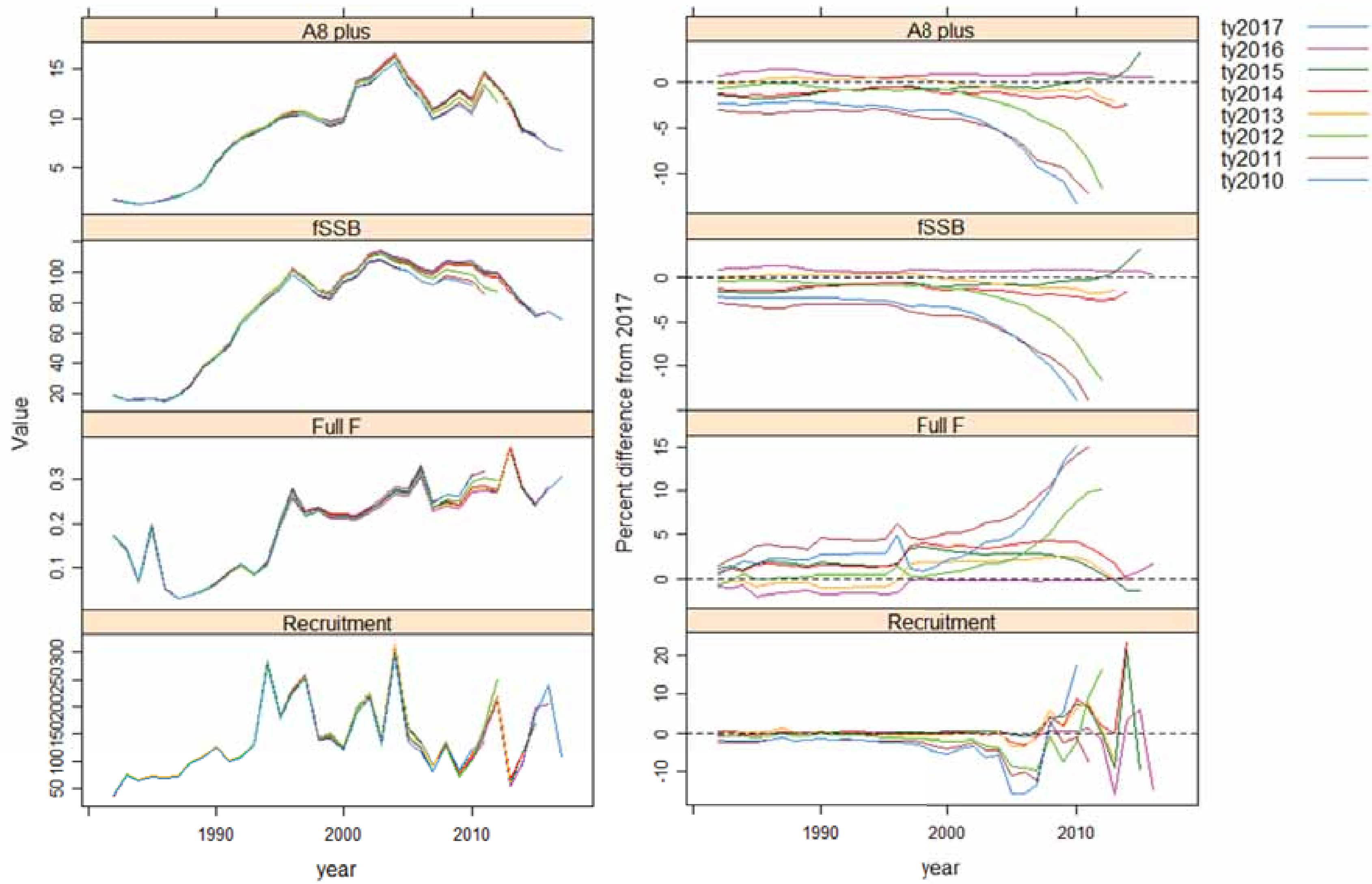



Figure B7.35. Retrospective analysis from the non-migration SCA for fully-recruited F, female spawning stock biomass (fSSB, thousand mt), Age 8+ abundance (million fish), and recruitment (millions of age-1 fish).

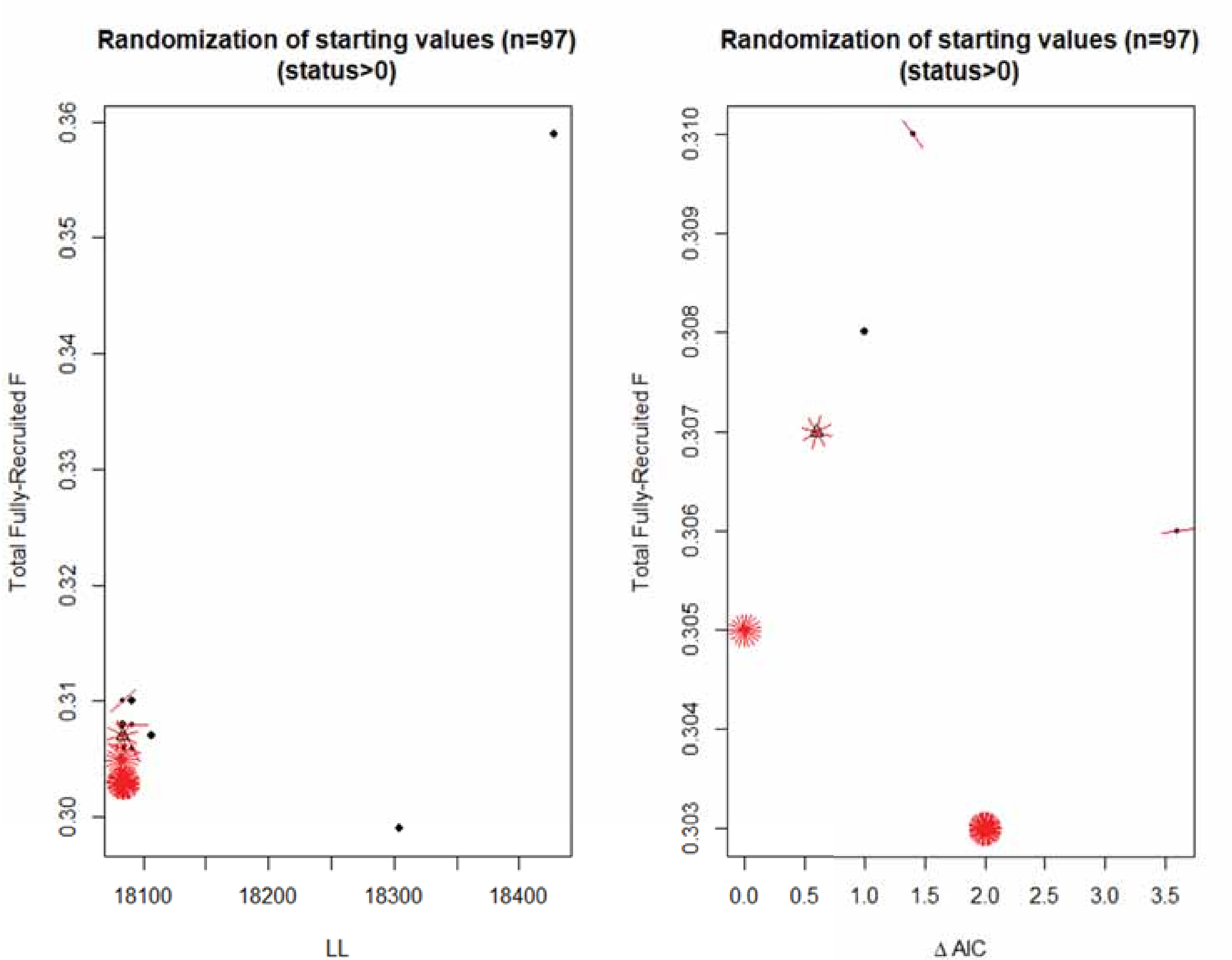



Figure B7.36. Sunflower plot results from 100 runs of the non-migration SCA model in which starting values were randomly permuted by +50%. Overlapping data points are represented by equi-angular red rays. Open triangle represents the total likelihood and F produced by the base model. In three runs the Hessian did not invert (status = 0).

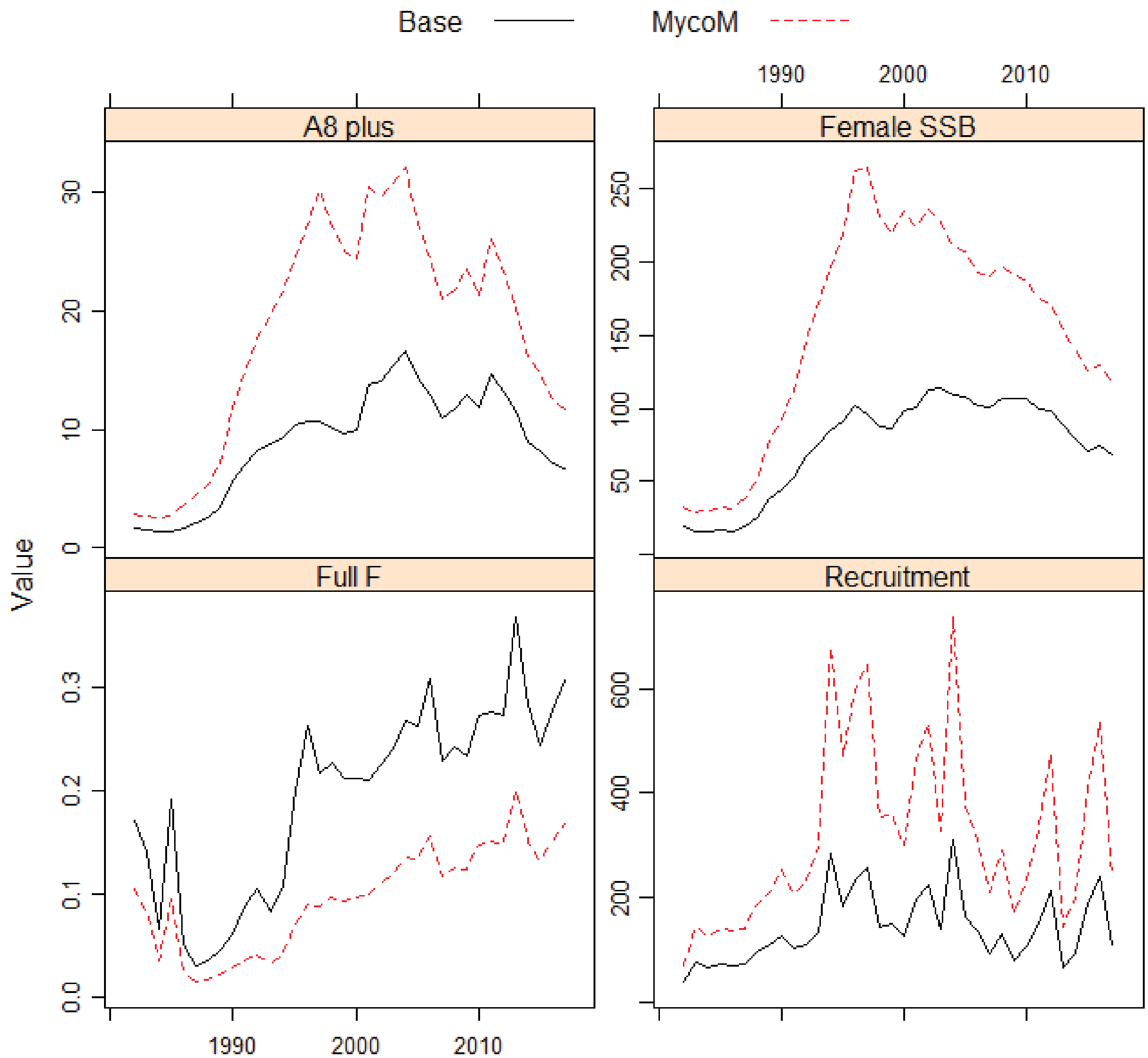



Figure B7.37. Comparison of results from the non-migration SCA model with time-constant age-specific natural mortality (M) with results when M is increased on ages-3+ after 1996.

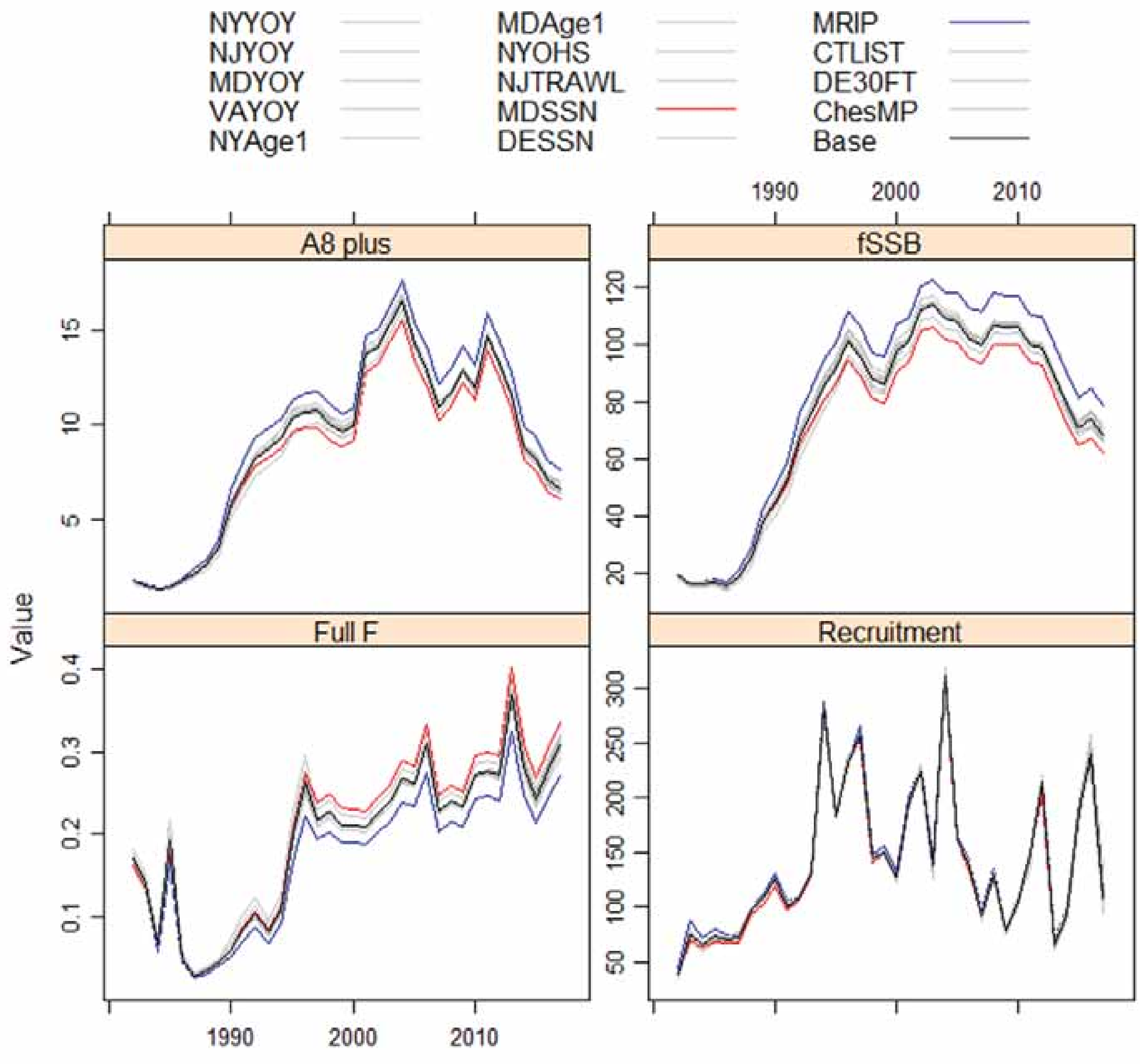



Figure B7.38. Comparison of results of sensitivity runs when data from each survey were deleted one-at-a-time from the final non-migration SCA model configuration. Units are the same as in Figure B7.35. The base run and two most influential surveys are highlighted with alternate colors.

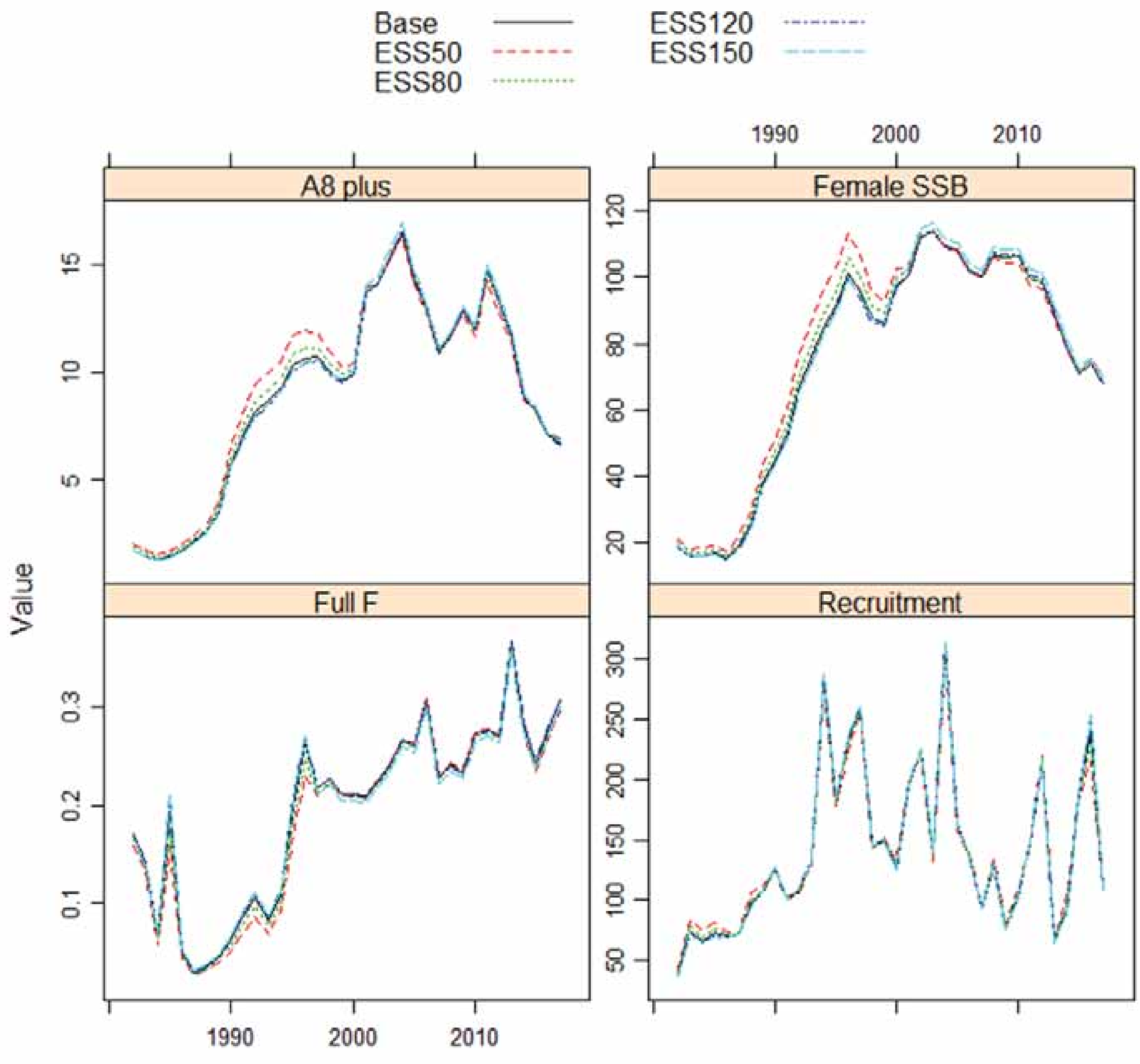



Figure B7.39. Comparison of results of the non-migration SCA model when the average effective sample sizes for the catch and survey multinomial likelihoods were increased (ESS120; ESS150) and decreased (ESS80; ESS50) by 20% and 50% of the original values.

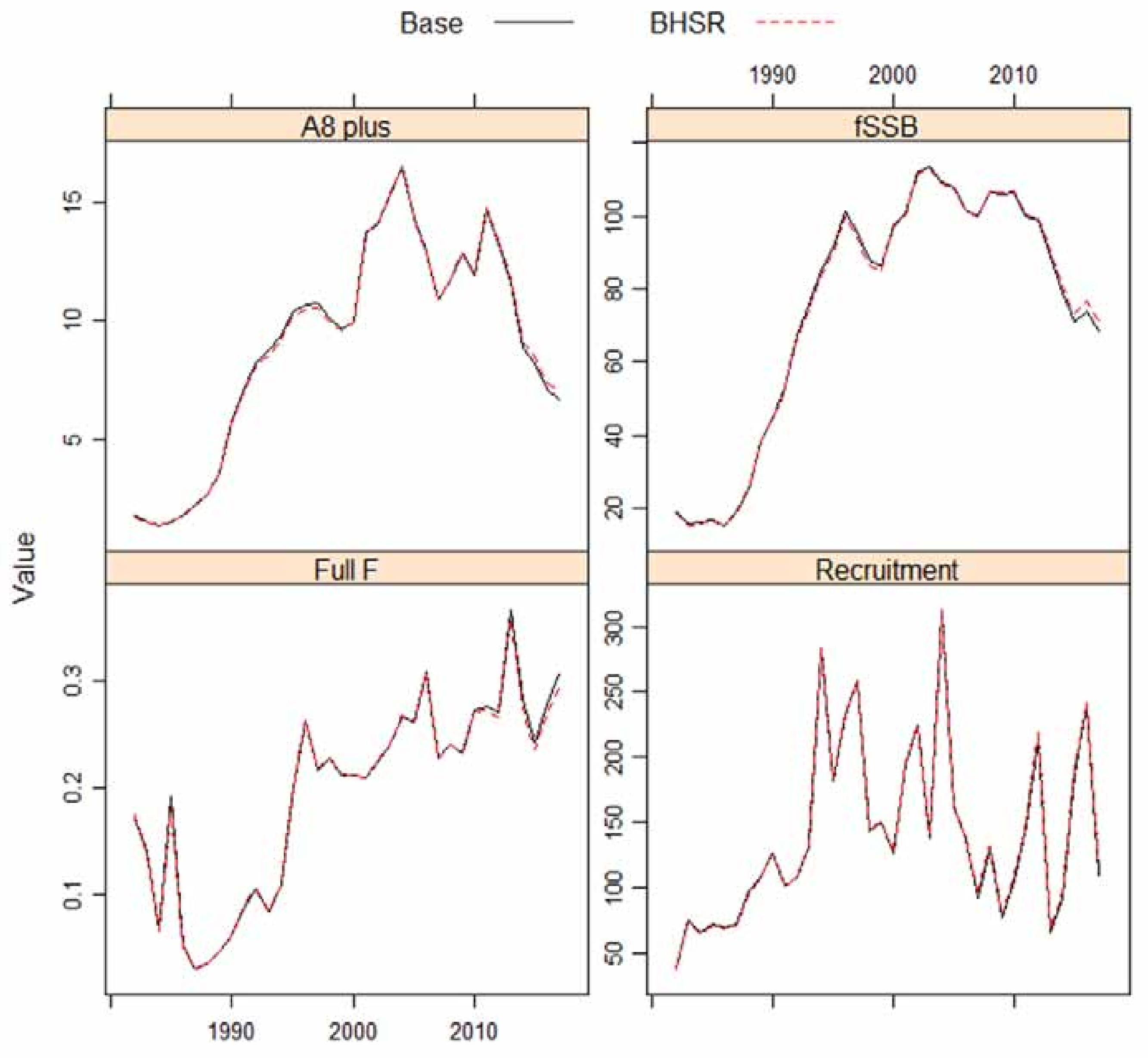



Figure B7.40. Comparison of results from the non-migration SCA model when recruitment is estimated as lognormal deviations from Beverton-Holt stock recruitment relationship (BHSR) or as lognormal deviations from mean recruitment (Base). Units are the same as in Figure B7.35.

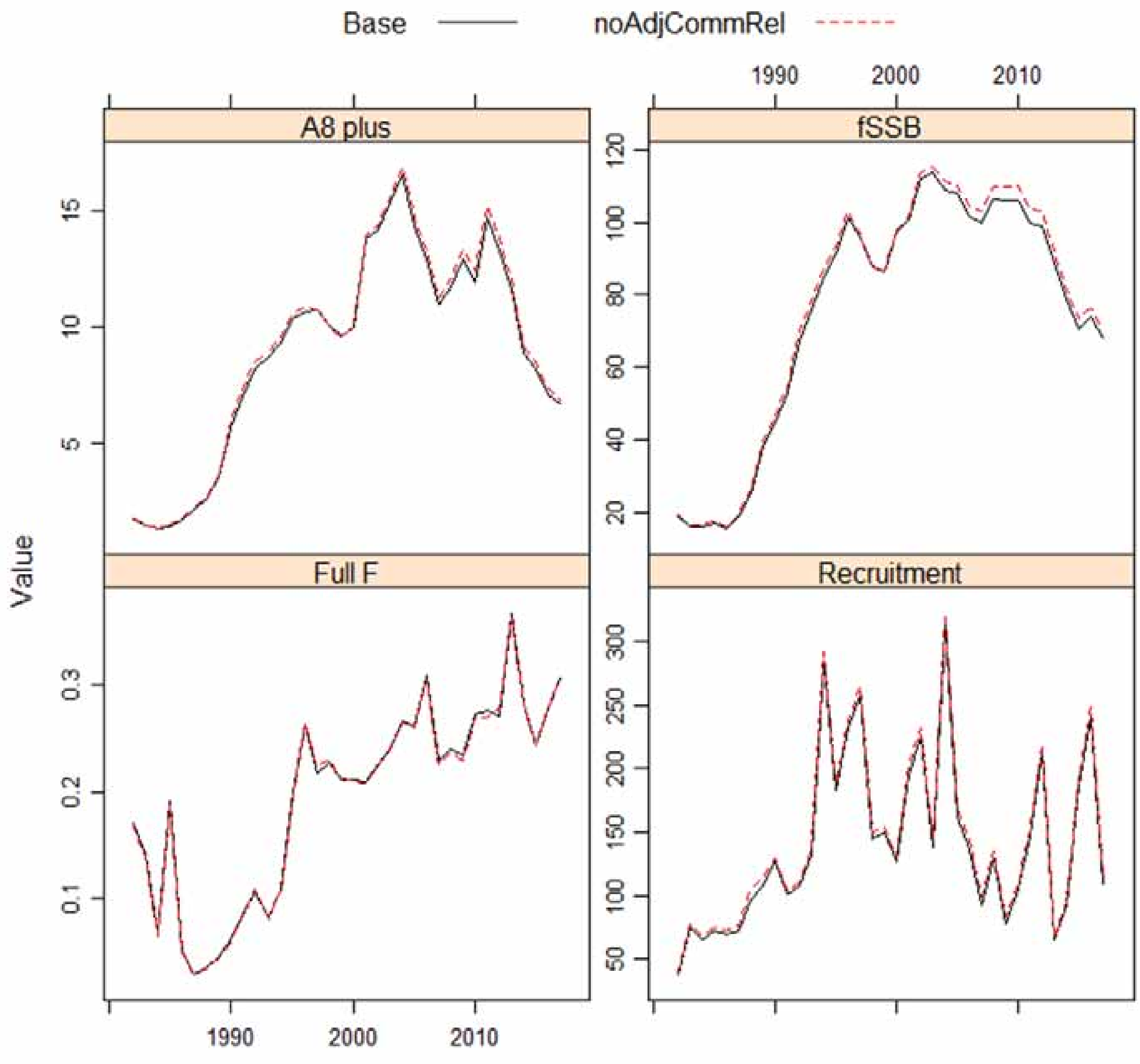



Figure B7.41. Comparison of results from the non-migration SCA model when commercial dead releases are estimated with adjustments (Base) or without (noAdjCommRel). Units are the same as in Figure B7.35.

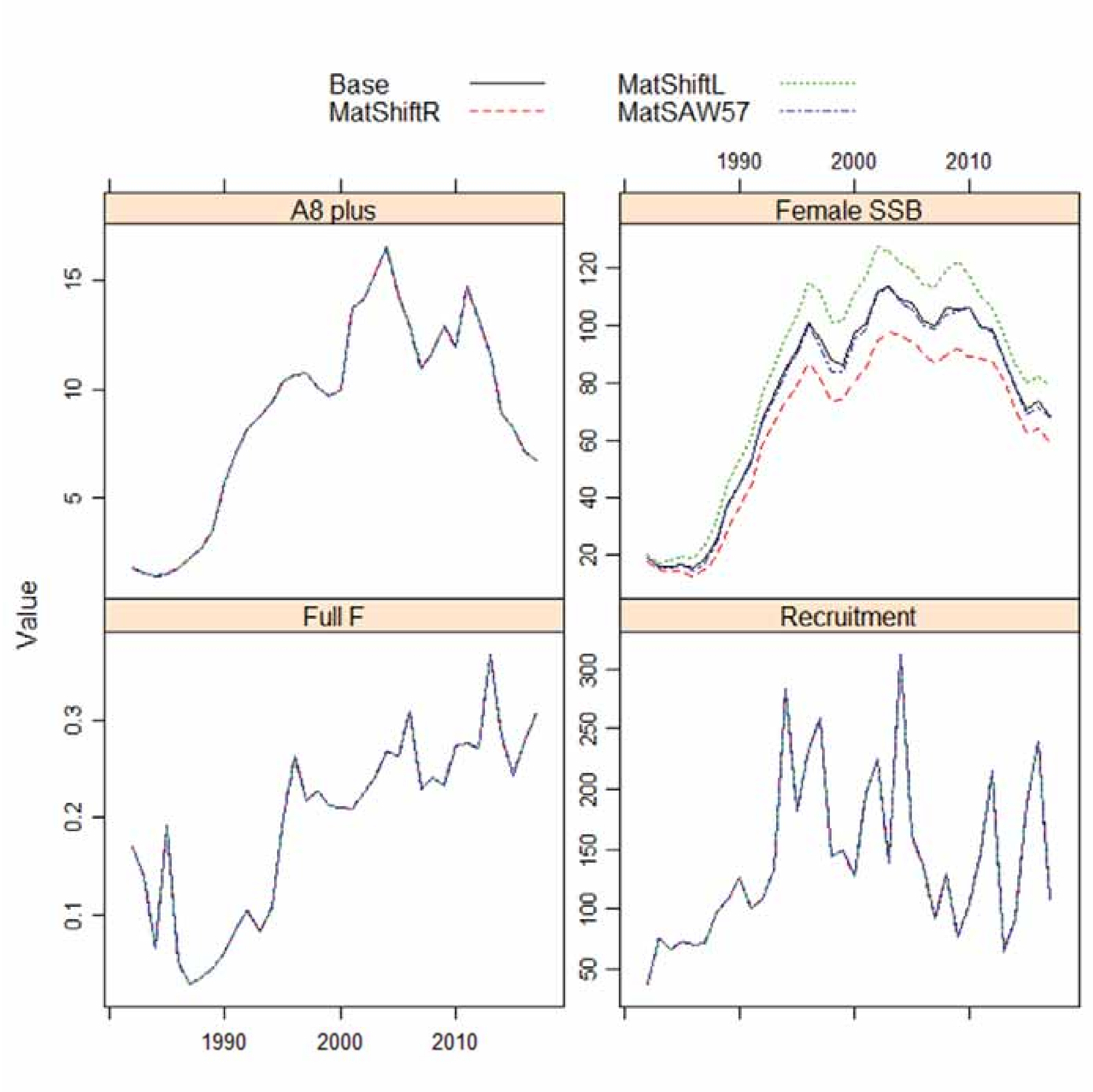



Figure B7.42. Comparison of results from the non-migration SCA model when maturity curve from NEFSC (2013) is used, or 2018 curve is shifted left (MatShiftLeft) or right (MatShiftRight).Units are the same as in Figure B7.35.

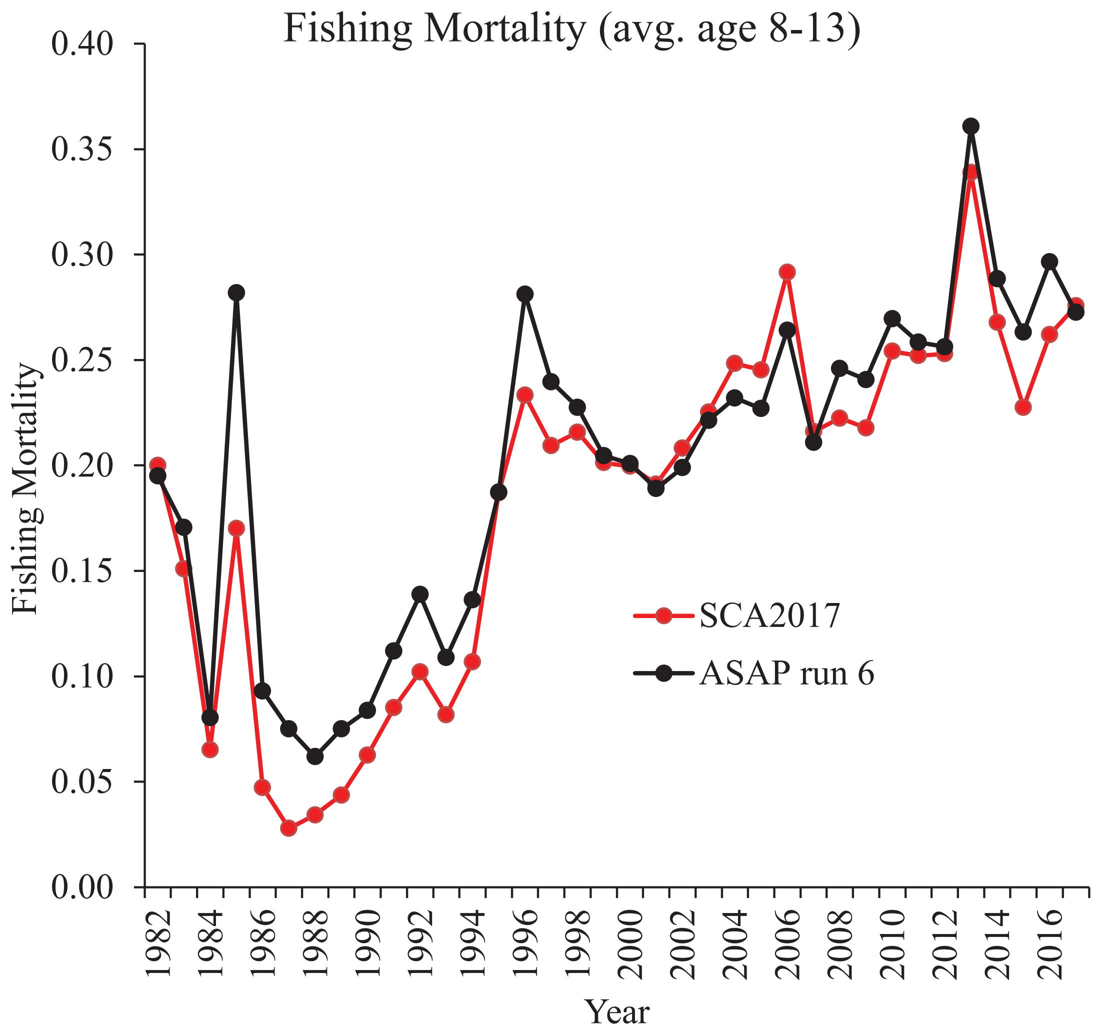



Figure B7.43. Fishing mortality (F) from ASAP compared to the non-migration SCA model, 1982-2017.

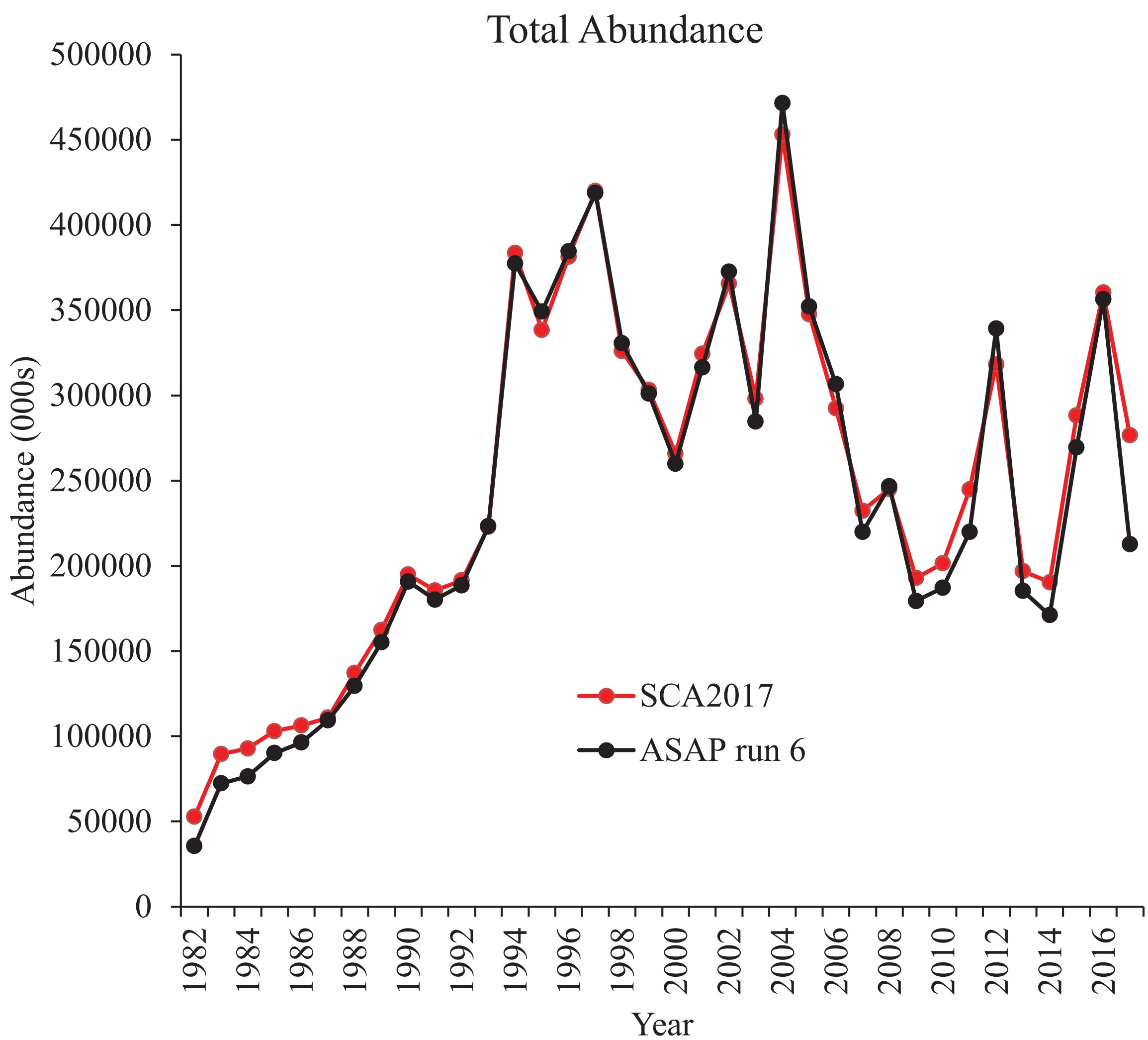



Figure B7.44. Total abundance from ASAP compared to the non-migration SCA model, 1982-2017.

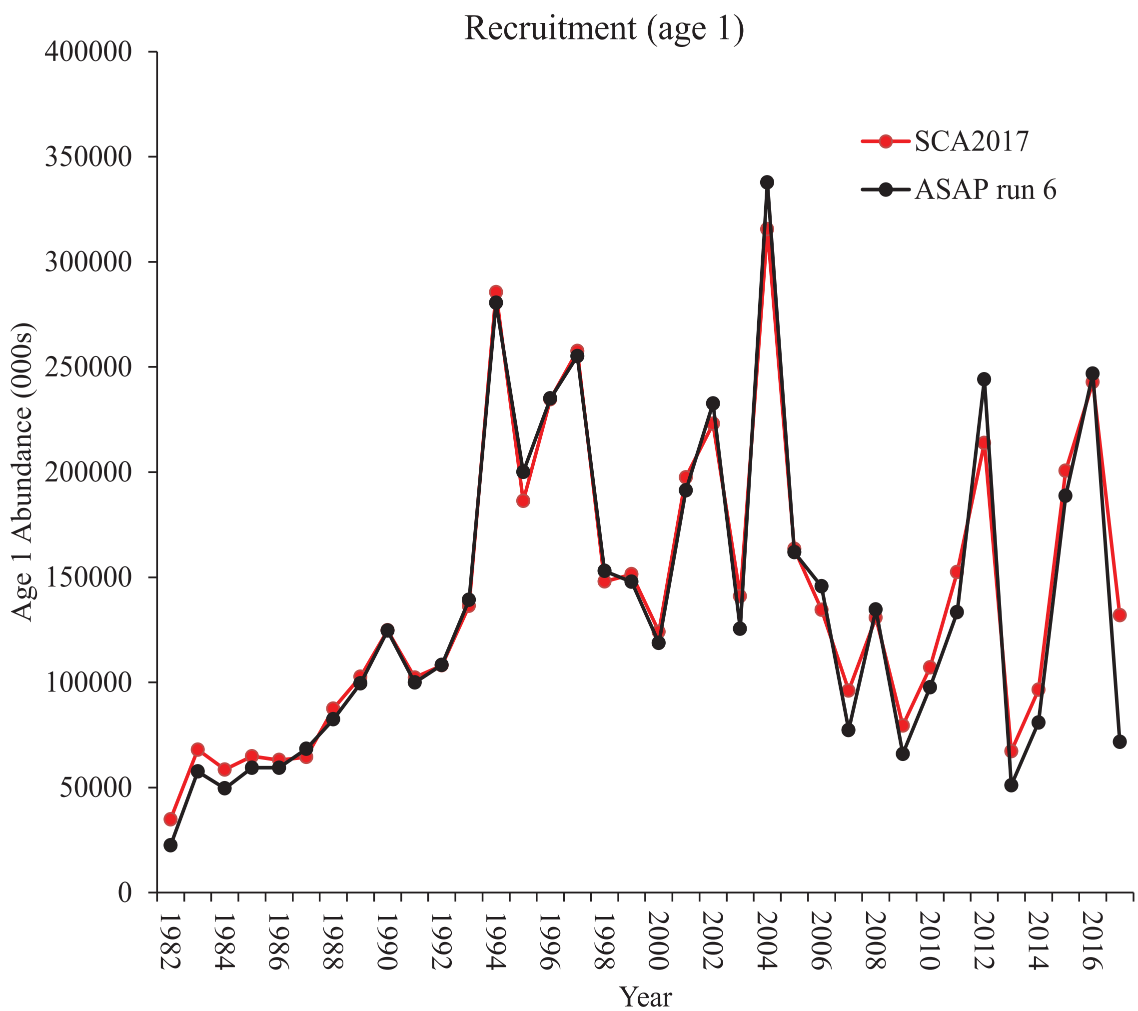



Figure B7.45. Recruitment (Age-1 fish) from ASAP compared to the non-migration SCA model, 1982-2017.

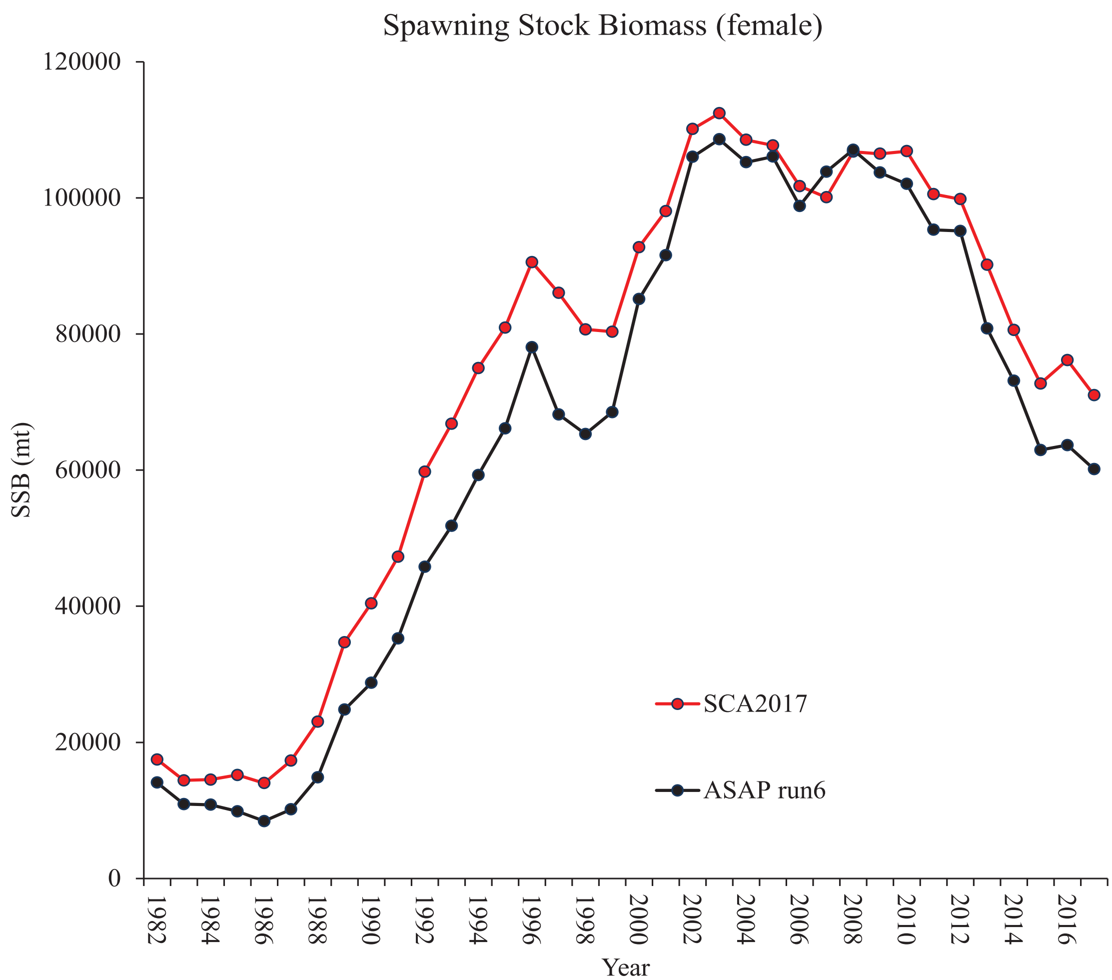



Figure B7.46 Female spawning stock biomass (SSB) from ASAP compared to the non-migration SCA model, 1982-2017.

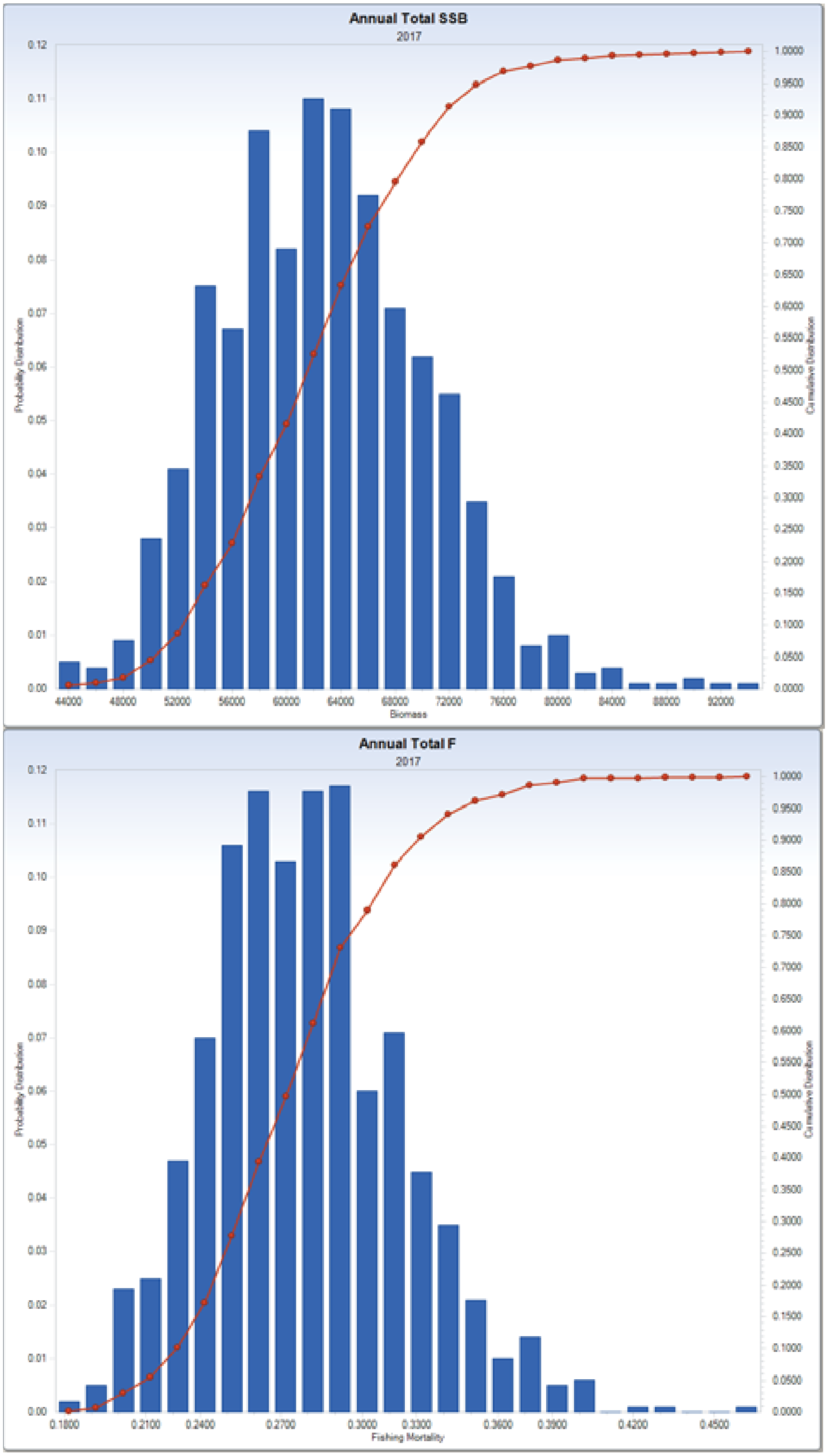



Figure B7.47. Total female spawning stock biomass (SSB; top) and fishing mortality (F; bottom) in 2017 from ASAP with probability distribution bars (primary Y-axis) and cumulative distribution curve (secondary Y-axis).

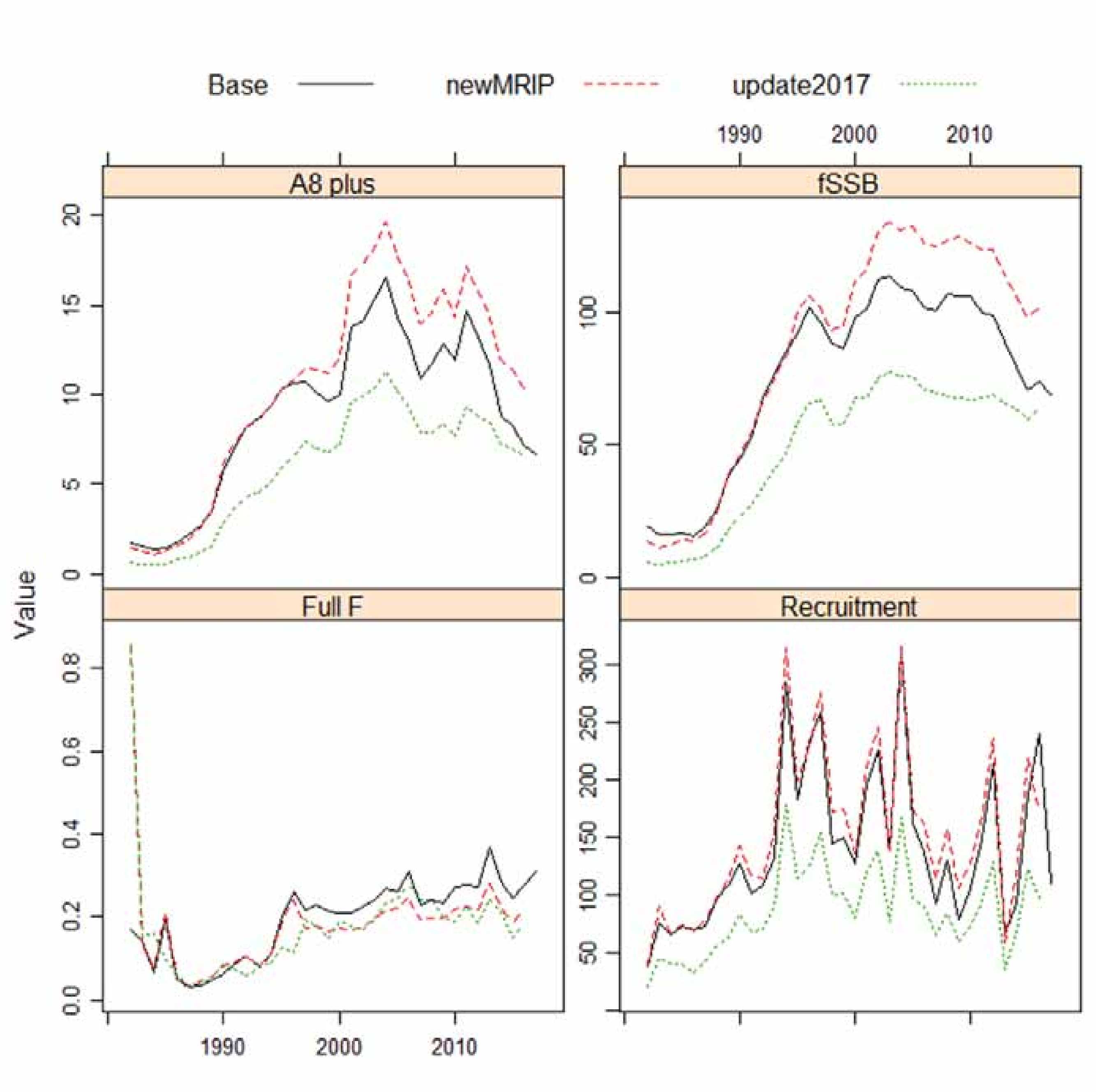



Figure B7.48. Comparison of results from the 2017 update assessment (update2017; continuity run), the 2017 model with the new MRIP data (newMRIP), and the 2018 base run (base) of the non-SCA migration model. Units are the same as in Figure B7.10.

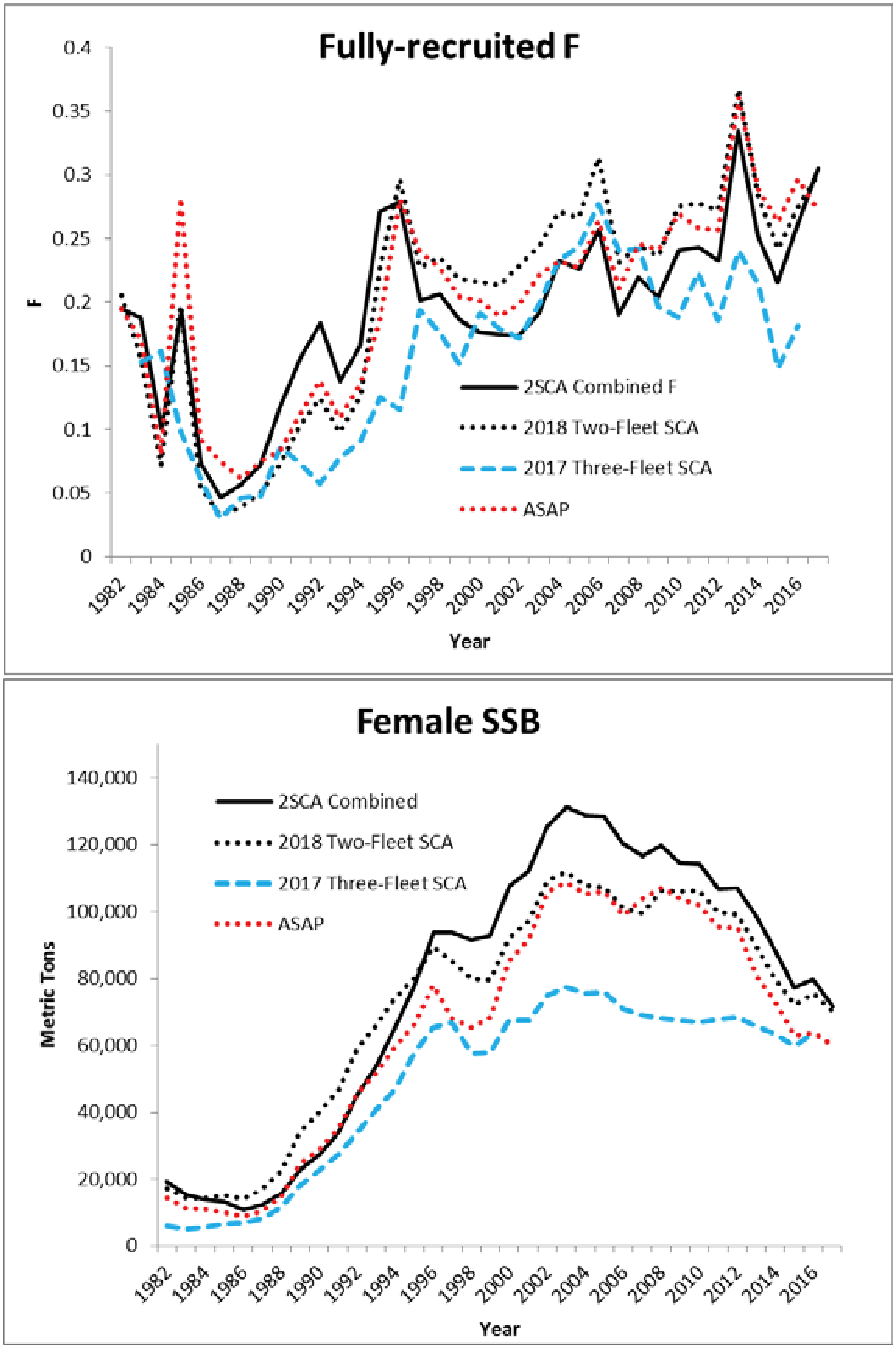



Figure B7.49. Comparison of fishing mortality (F; top) and spawning stock biomass (SSB; bottom) estimates from the preferred 2SCA model, and the continuity run (2017 3-fleet SCA), base non-migration SCA (2018 2-fleet SCA), and ASAP.

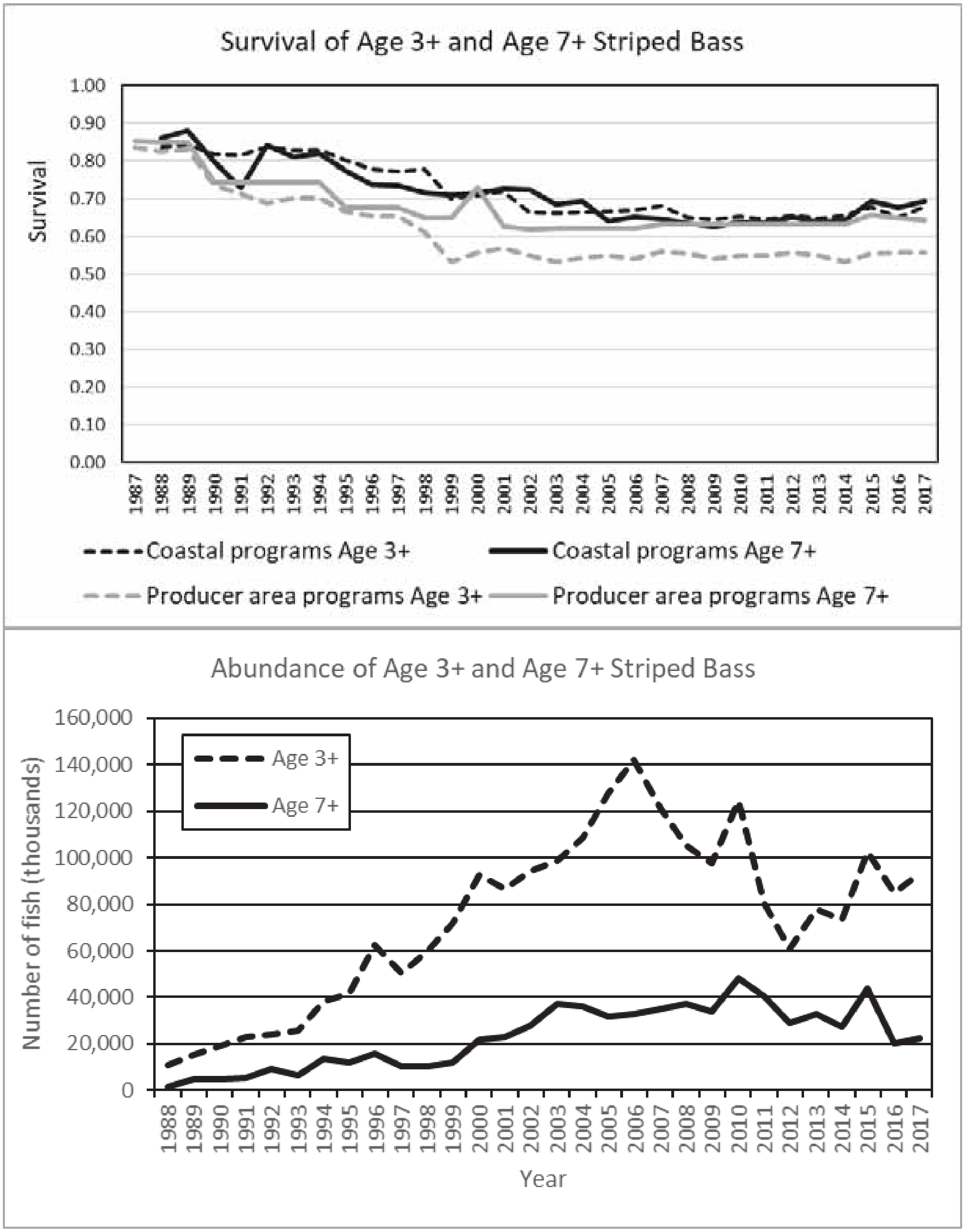



Figure B8.1. Comparison of survival (top) and stock size estimates (bottom) from IRCR tagging model for fish age seven and older (comparable to fish ≥ 28 inches (711 mm)) and age three and older (comparable to fish ≥ 18 inches (457 mm)). Stock size calculated via Kill = μ * Stock Size.

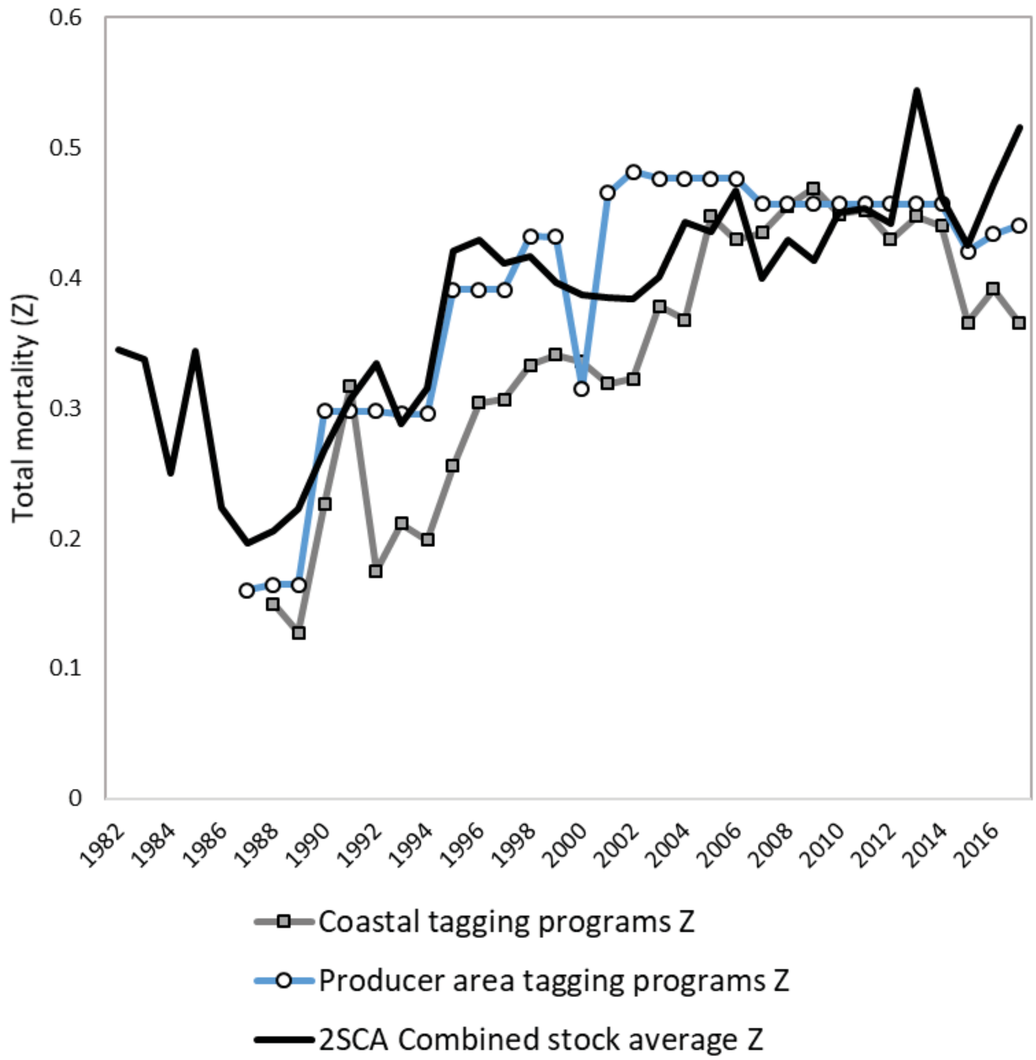
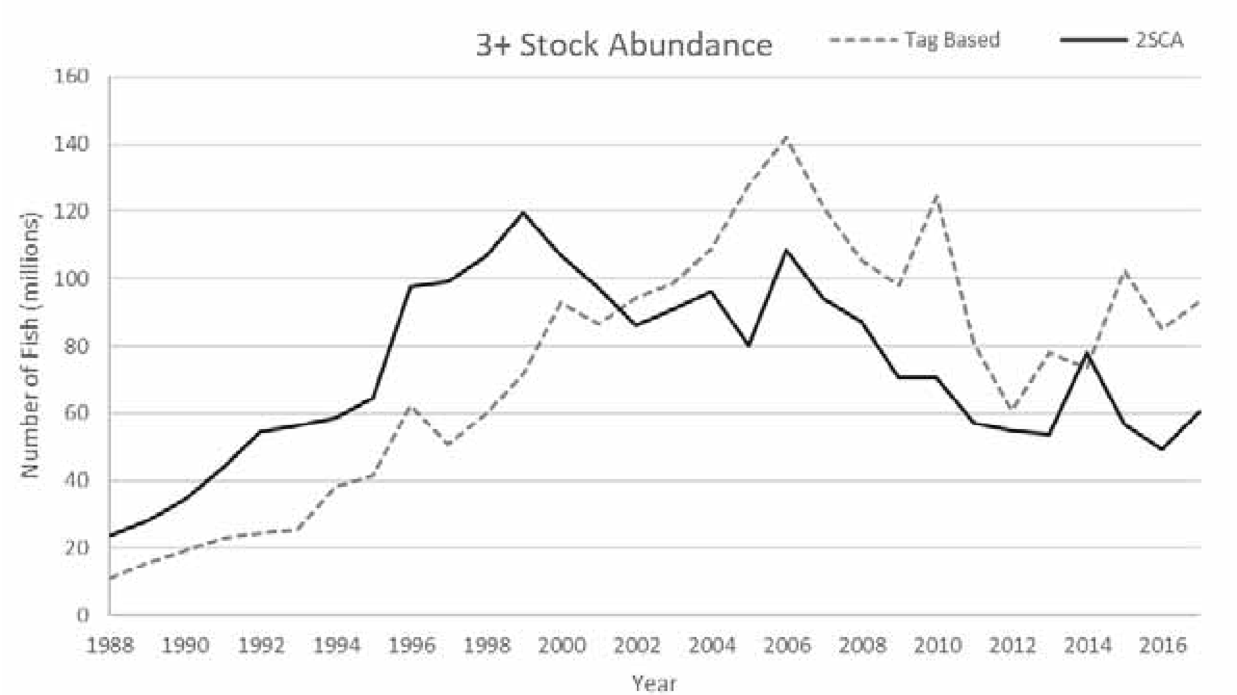



Figure B8.2. Comparison of Z estimates from the tagging models (≥28”; 711 mm) and the 2SCA assessment model.



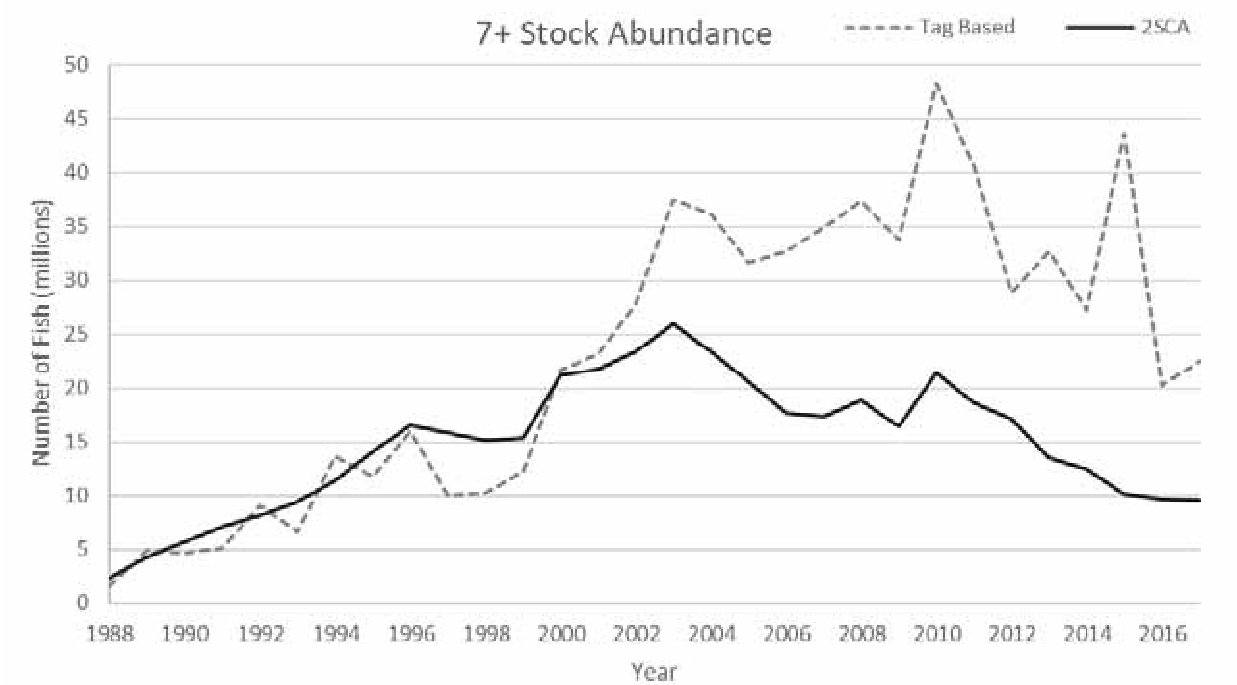




Figure B8.3. Comparison of stock abundance estimates from the tagging analysis and the 2SCA assessment model.

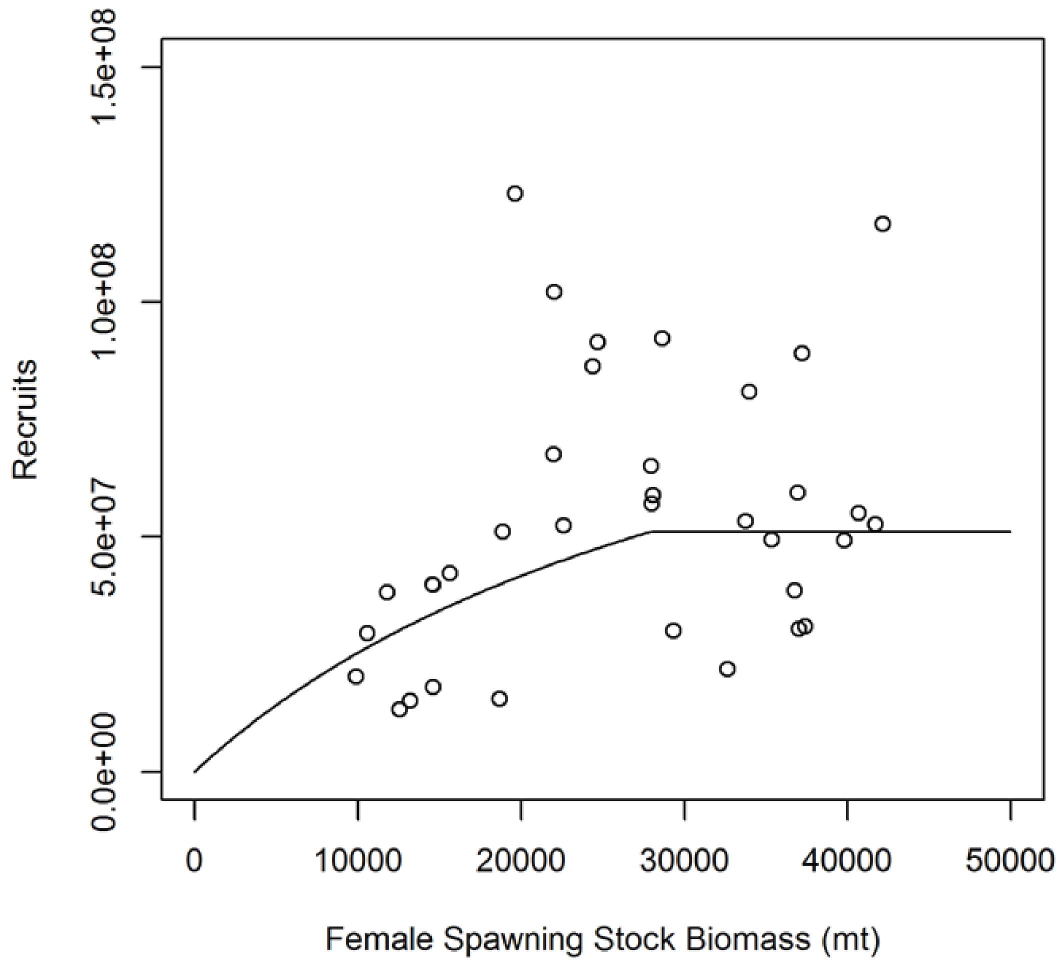



Figure B9.1. The “hockey-stick” female spawning stock biomass-recruitment relationship for the Delaware Bay/Hudson River stock.

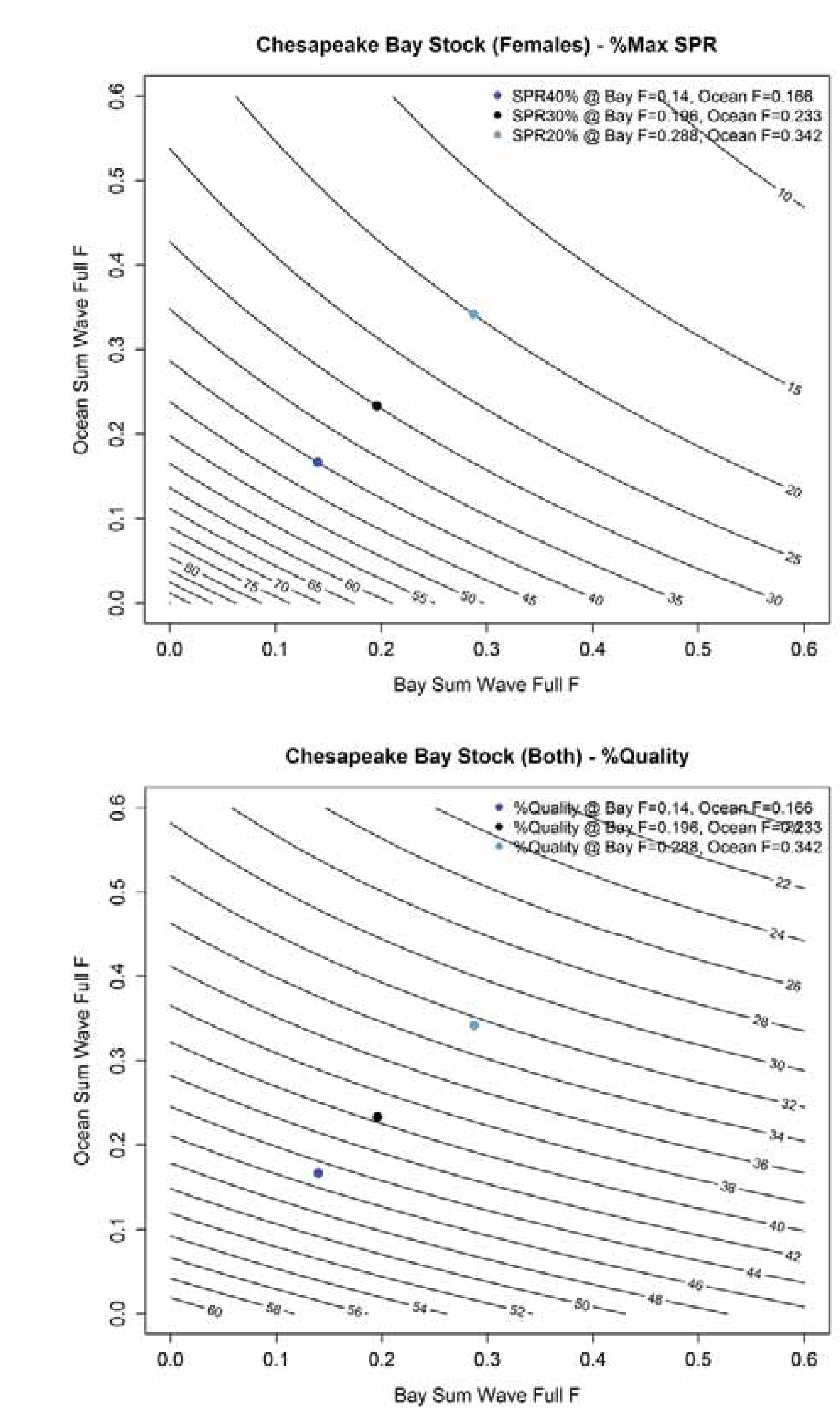



Figure B9.2. The female spawning biomass per recruit analysis (top) and percent quality analysis (bottom) for Stock-1 (Chesapeake Bay) for different levels of sum of period Fs for the Chesapeake Bay and ocean regions.

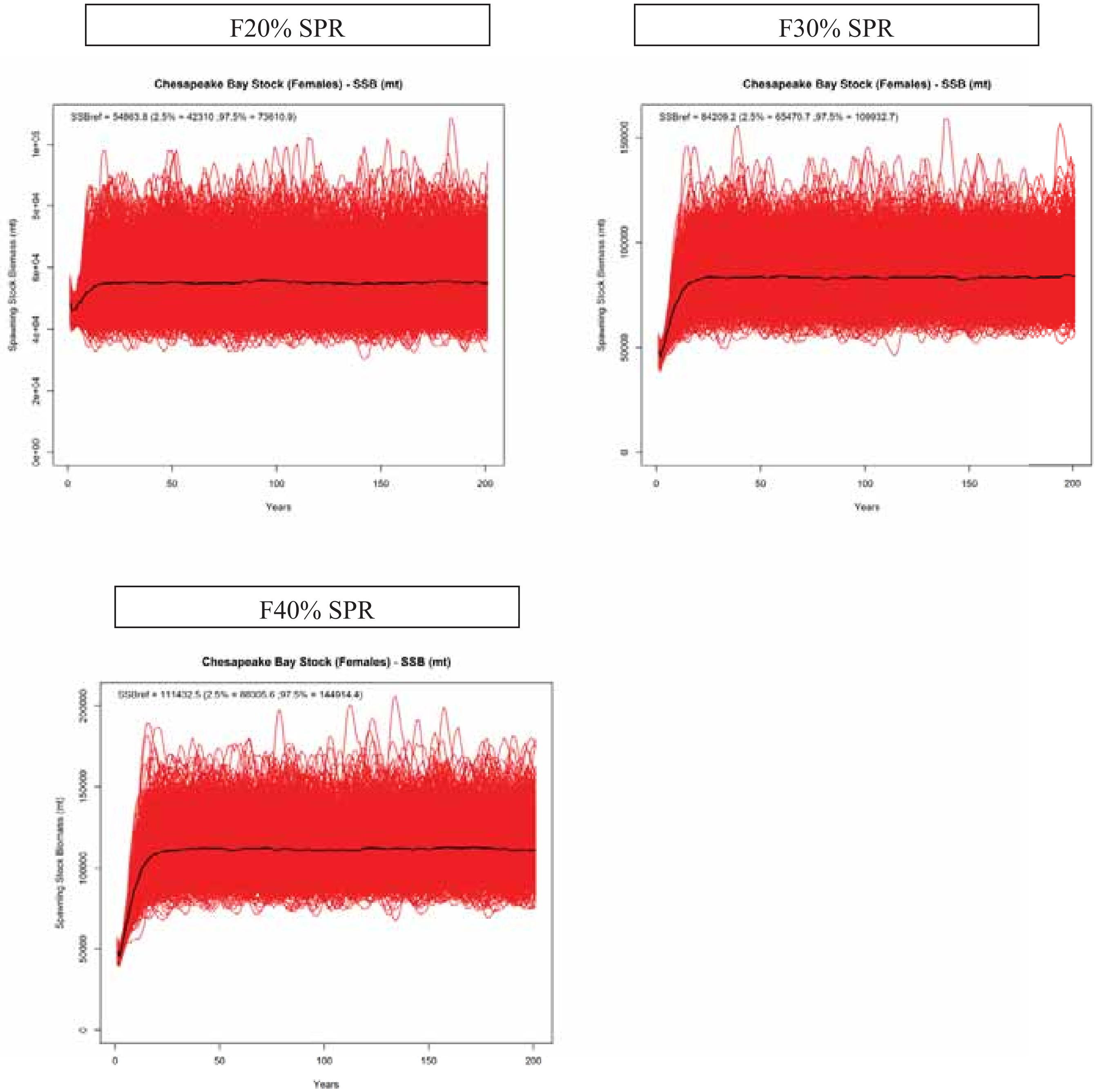



Figure B9.3. Plots of stochastic projection for the Chesapeake Bay stock using F20%, F30% and F40%.

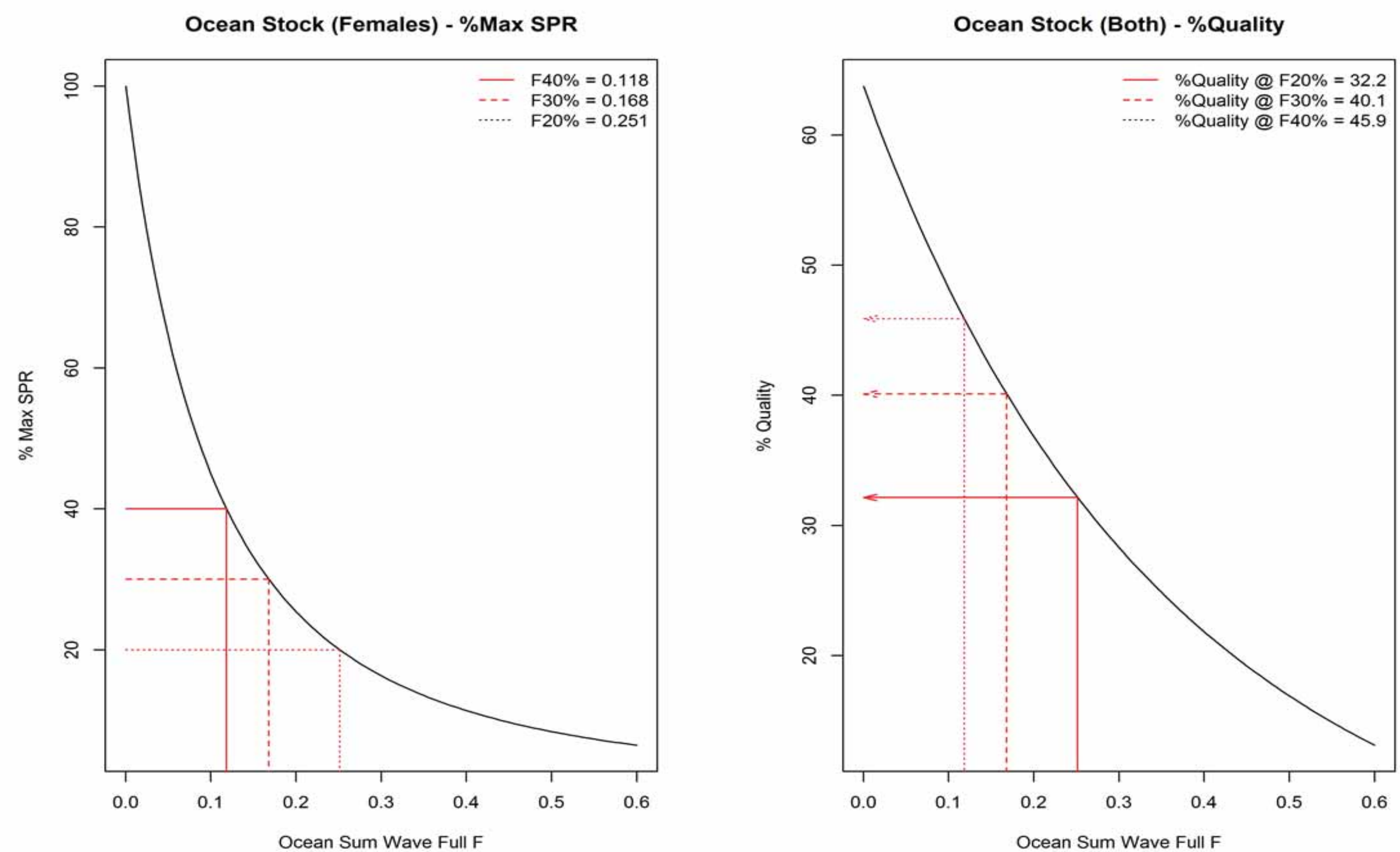



Figure B9.4. The spawning biomass per recruit analysis (left) and percent quality analysis (right) for the Delaware Bay/Hudson River stock in the ocean under different levels of sum of period fishing mortality rates (Fs)

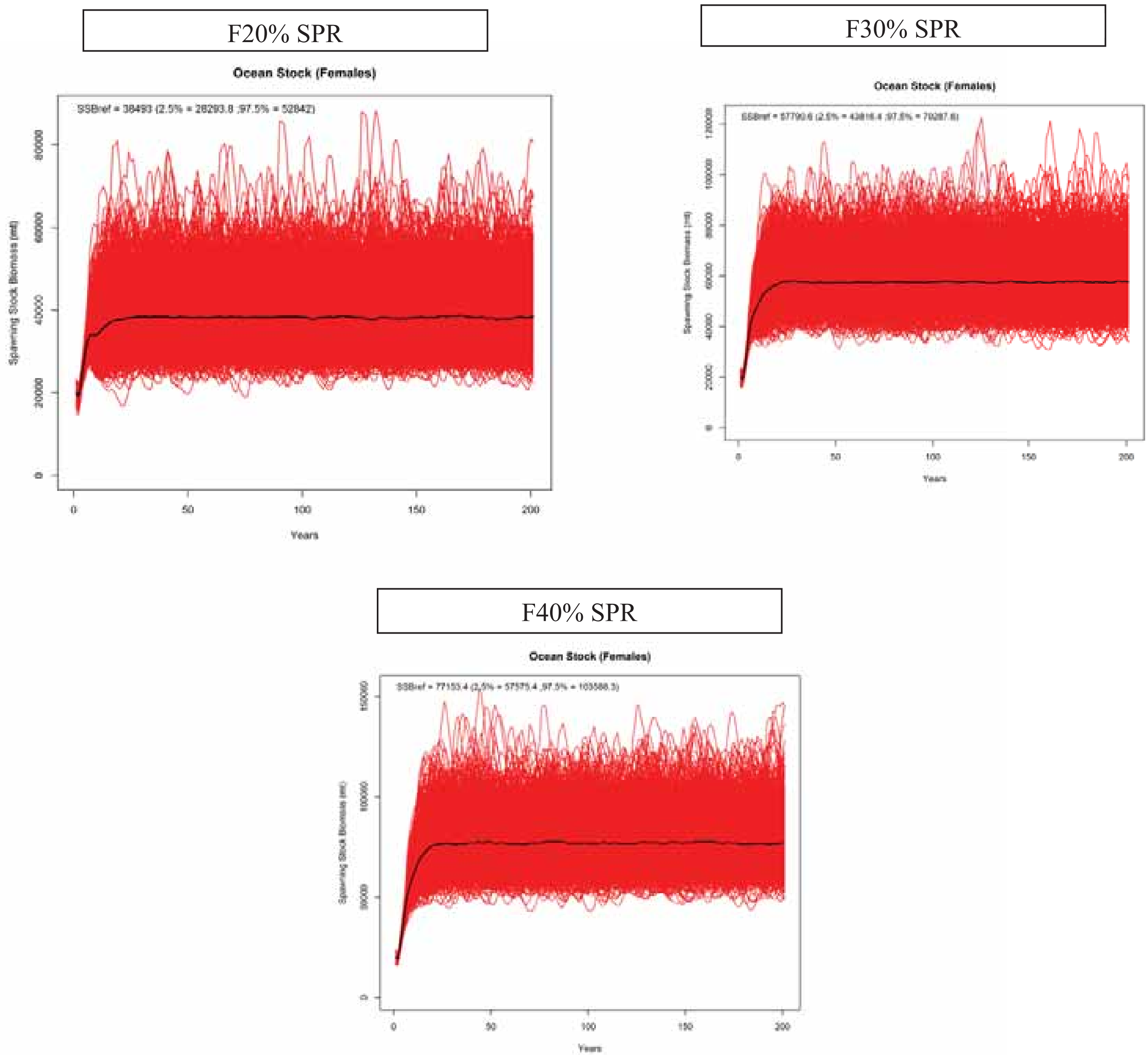



Figure B9.5. Plots of stochastic projection for the Delaware Bay/Hudson River stock using F20%, F30% and F40% under the hockey-stick female spawning stock biomass-recruitment relationship.

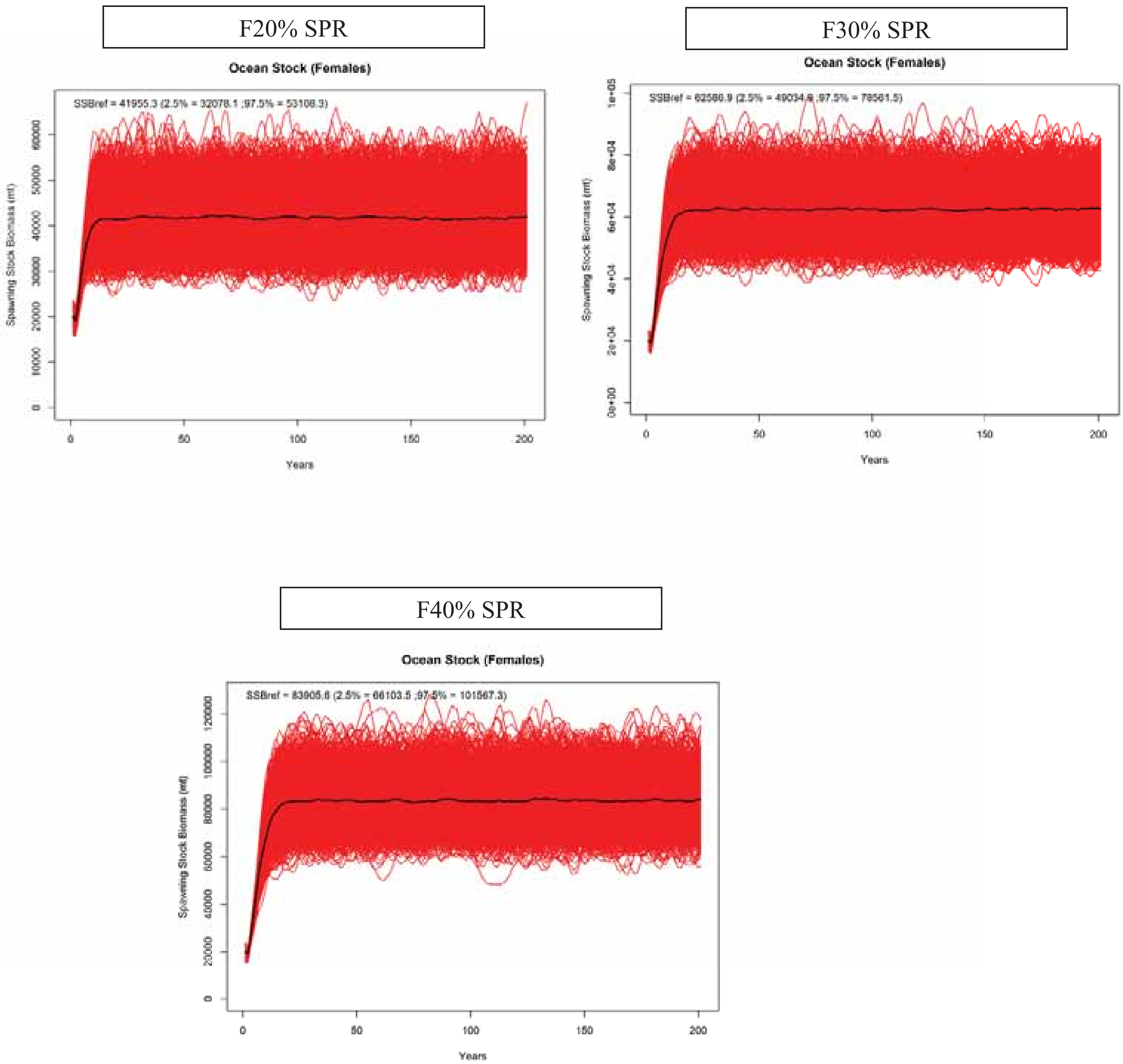



Figure B9.6. Plots of stochastic projection for the Delaware Bay/Hudson River stock using F20%, F30% and F40% under the empirical approach to the female spawning stock biomass-recruitment relationship.

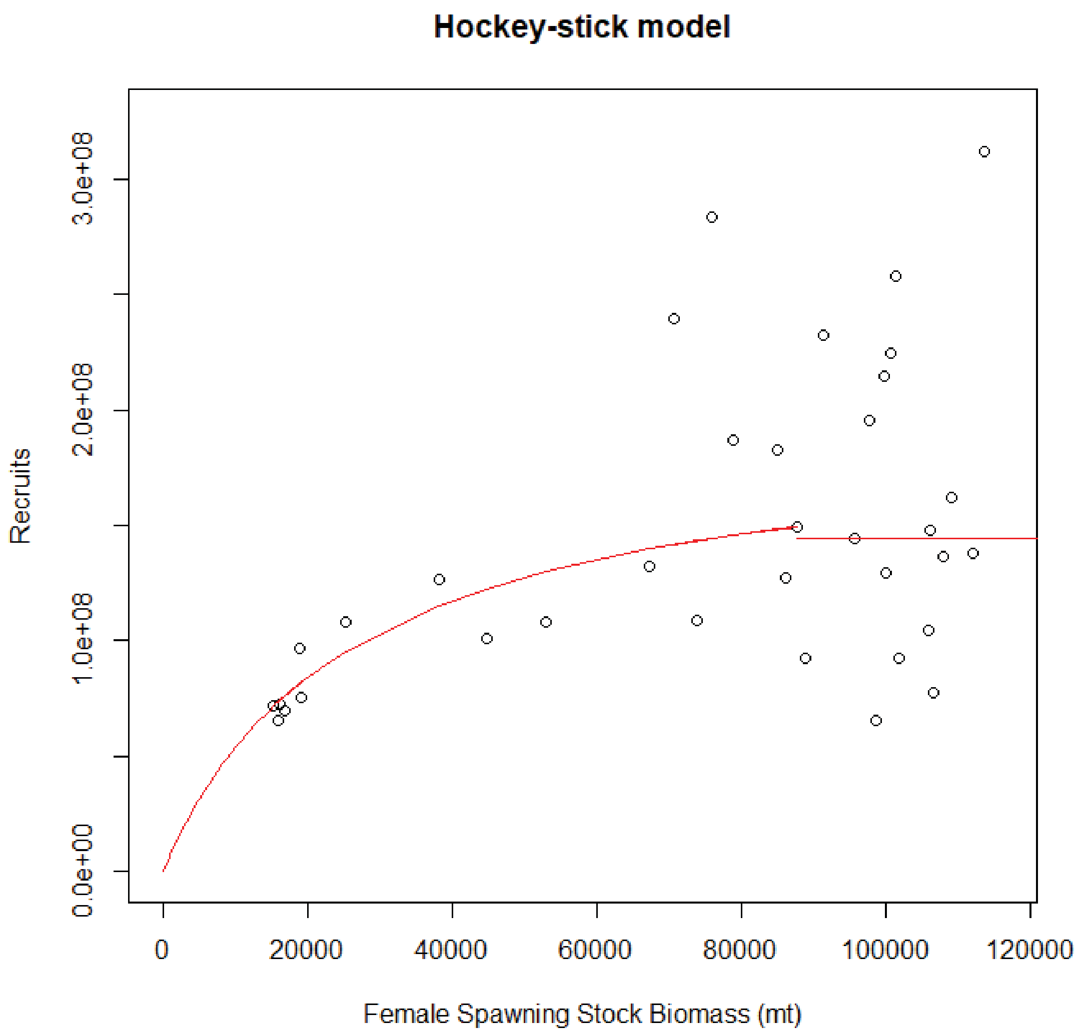



Figure B9.7. Beverton Holt, hockey-stick female spawning stock biomass-recruitment relationship used for non-migration SCA.

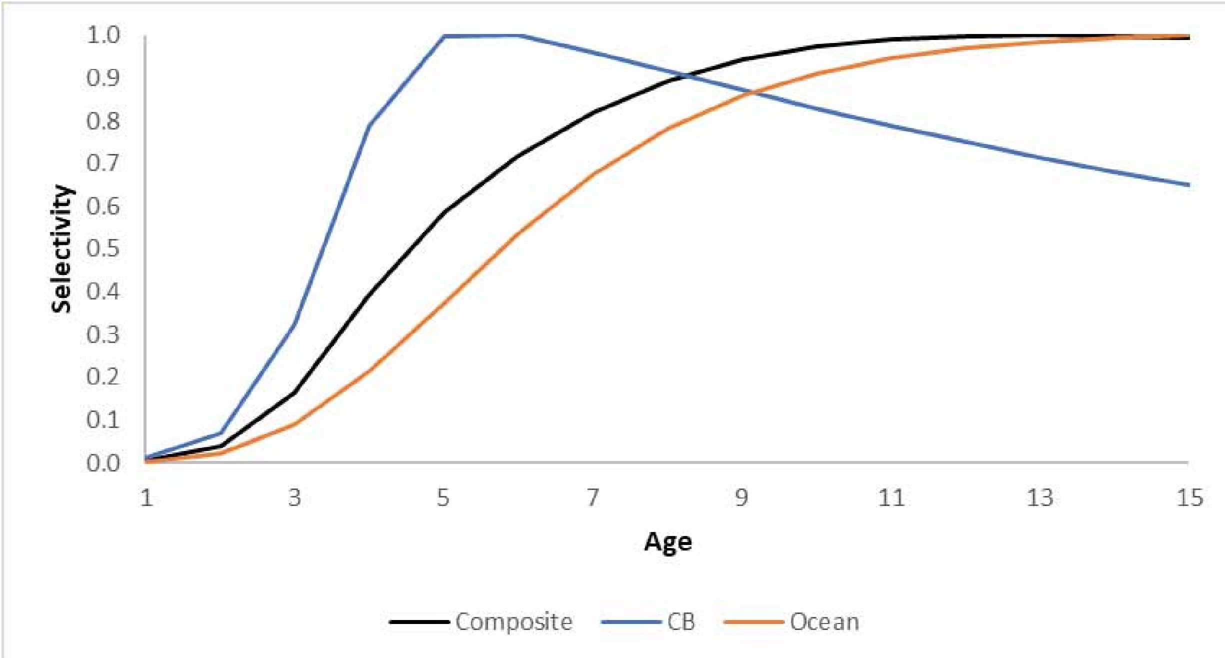



Figure B9.8. Composite selectivity curve used to calculate the fishing mortality rate (F) reference points for the non-migration SCA developed from the selectivities of the two fleets in the model.

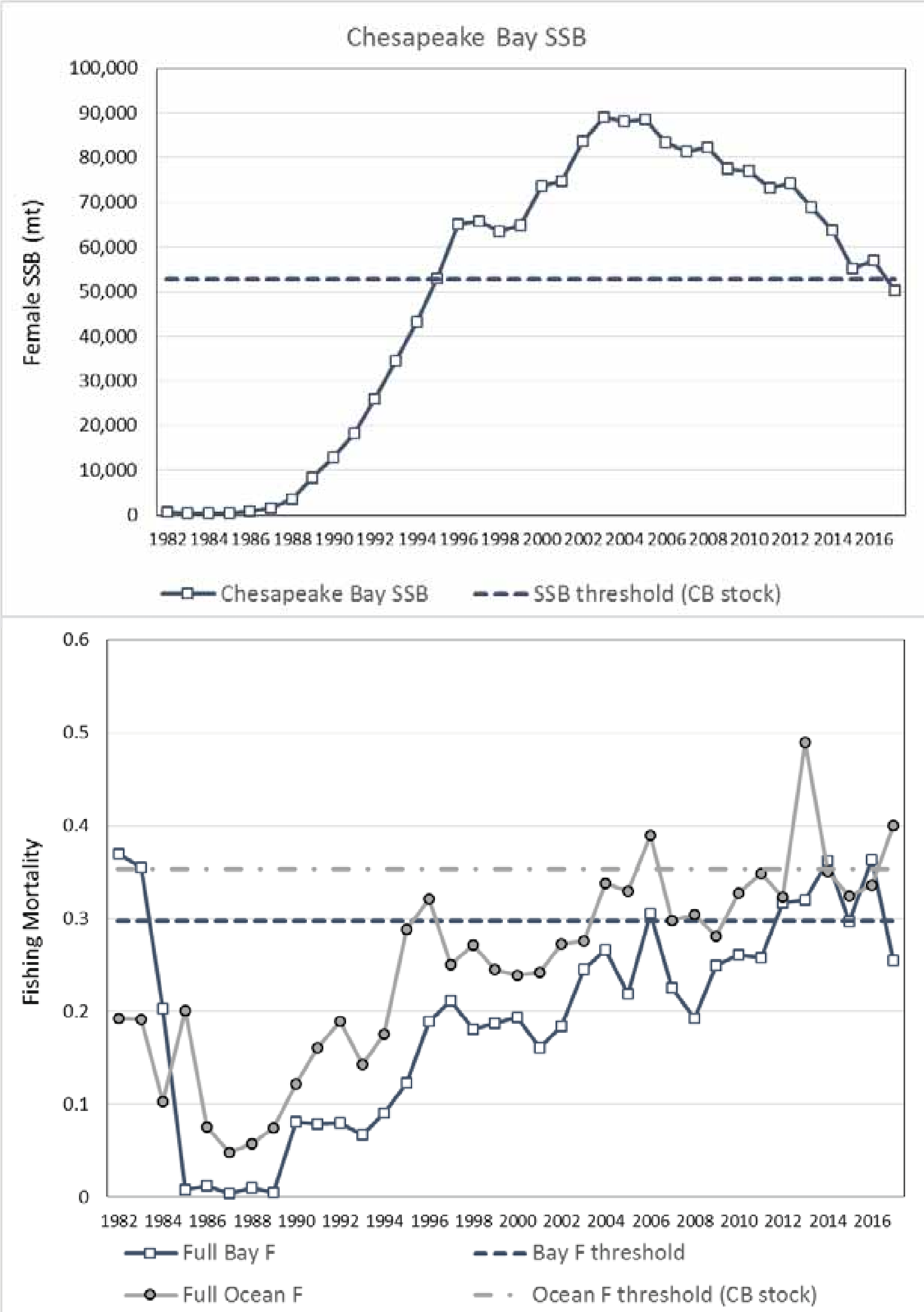



Figure B9.9. Status of the Chesapeake Bay stock relative to current $SSB_{threshold}$ (top) and $F_{threshold}$ (bottom) reference points.

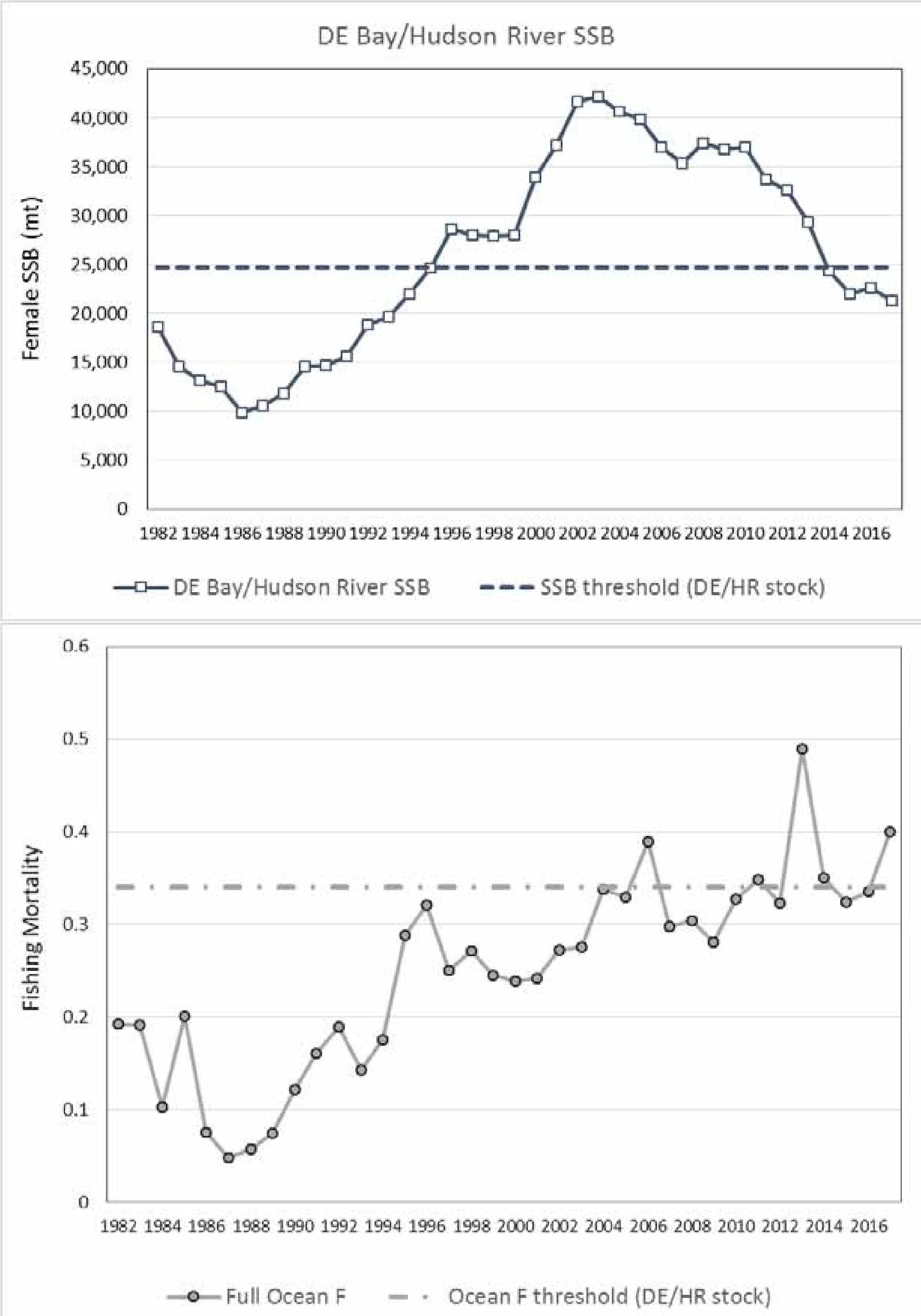
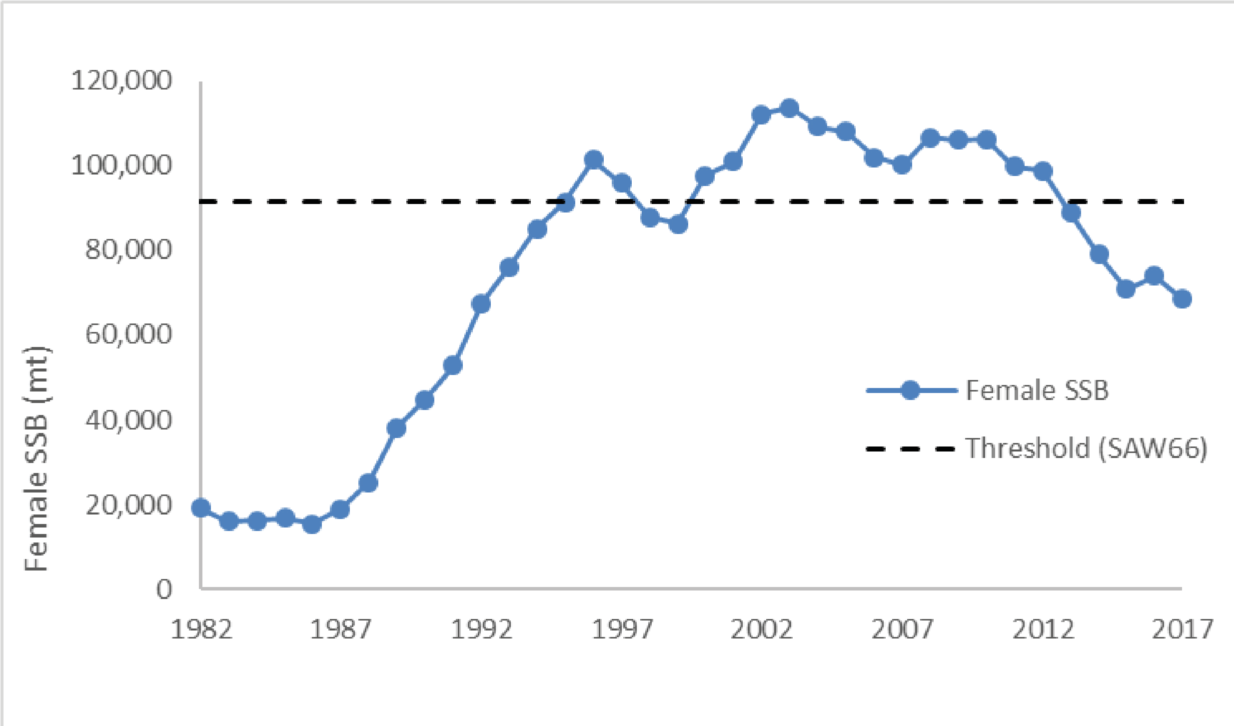



Figure B9.10. Status of the Delaware Bay/Hudson River stock relative to current $SSB_{threshold}$ (top) and $F_{threshold}$ (bottom) reference points.



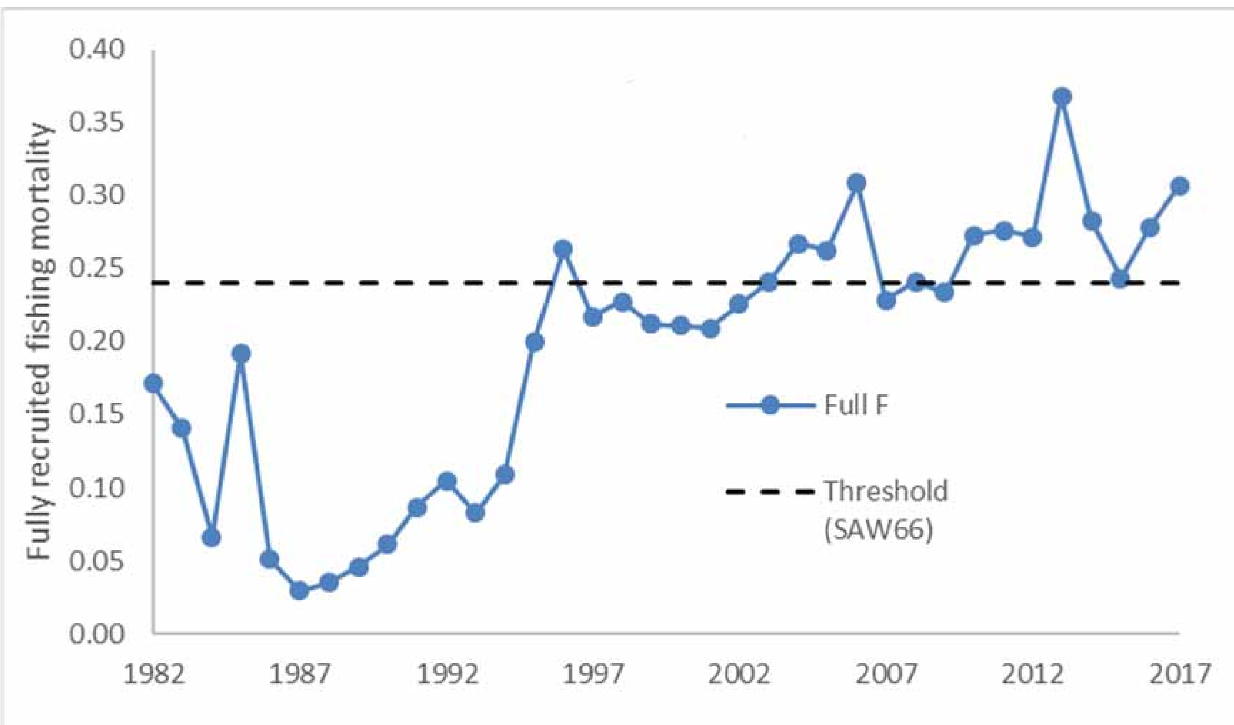
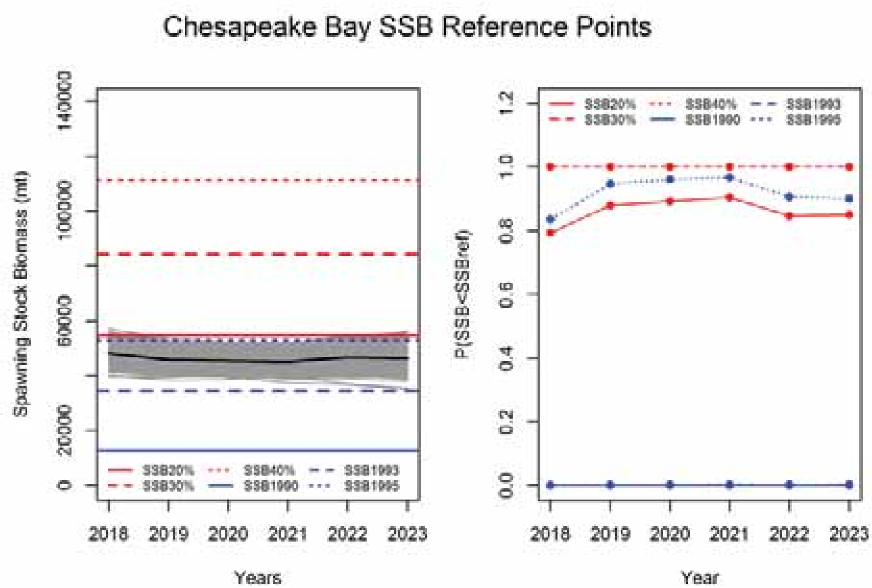




Figure B9.11. Status of Atlantic striped bass from the non-migration model relative to current $SSB_{threshold}$ (top) and $F_{threshold}$ (bottom) reference points.

Fishing at Current Fs ($F_{2017}$ Bay = 0.255; $F_{2017}$ Coast=0.400)




Fishing at F20% (2018=Current Fs; Projection: Bay = 0.288; Ocean=0.342)

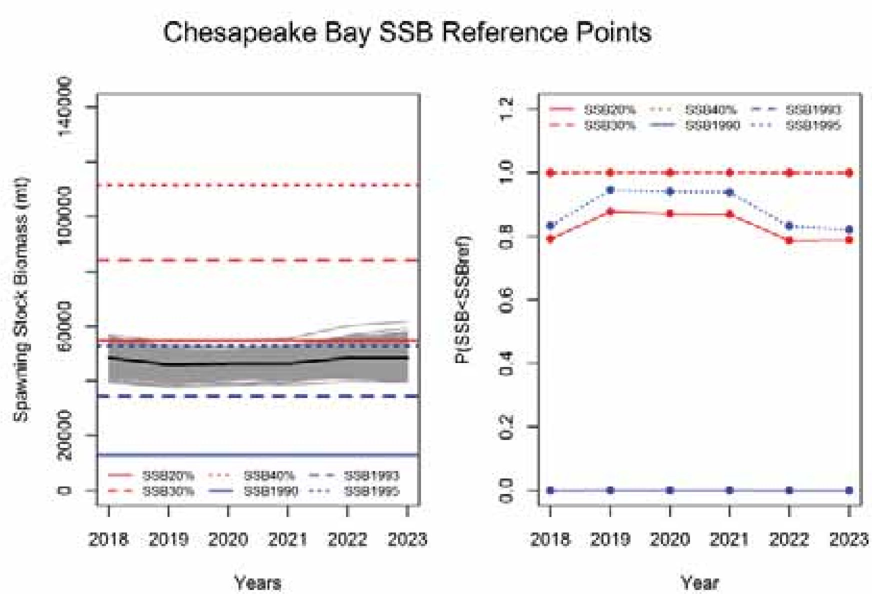
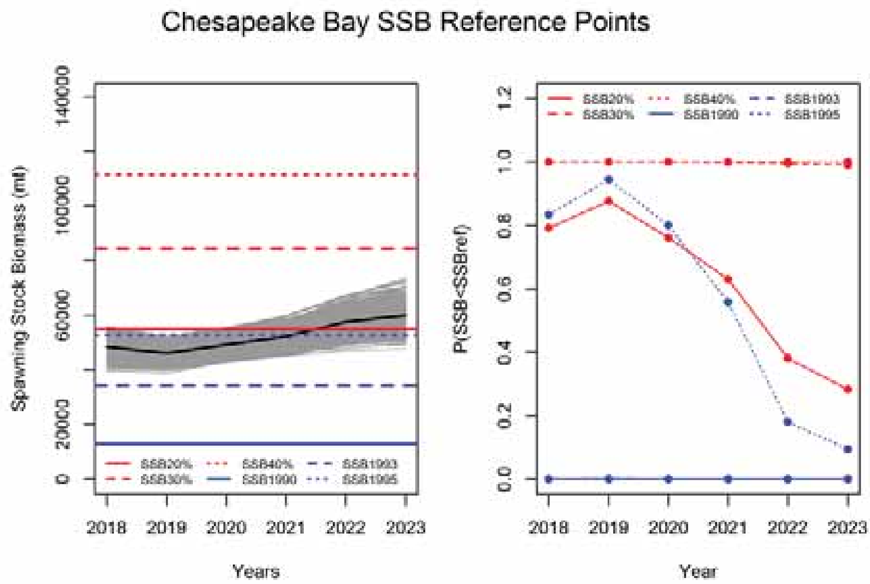



Figure B10.1. Short-term projections of total spawning stock biomass (SSB) and probability of annual total SSB being below the SSB reference points under different fishing scenarios for the Chesapeake Bay stock.

Fishing at F30% (2018=Current Fs; Projection: Bay = 0.196, Ocean=0.233)




Fishing at F40% (2018=Current Fs; Projection: Bay=0.144, Ocean=0.166)

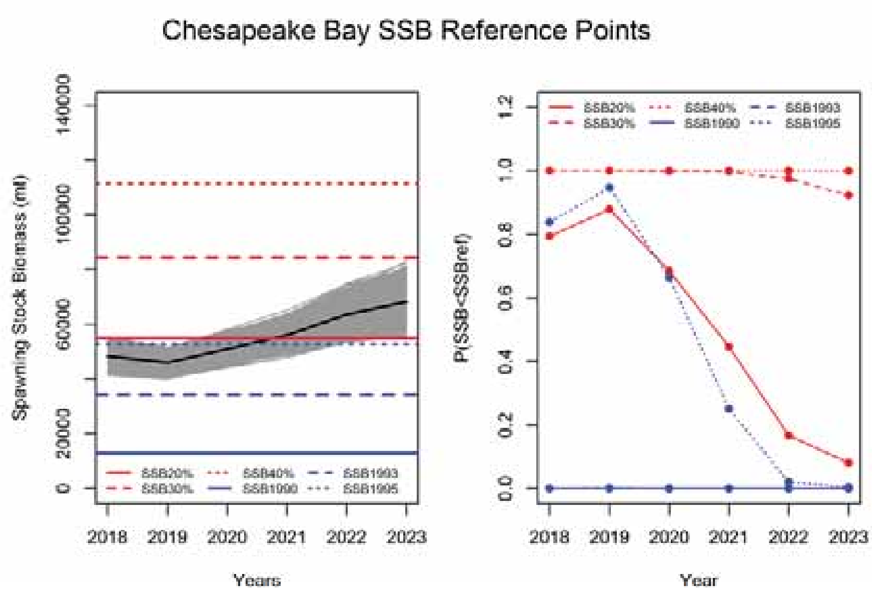
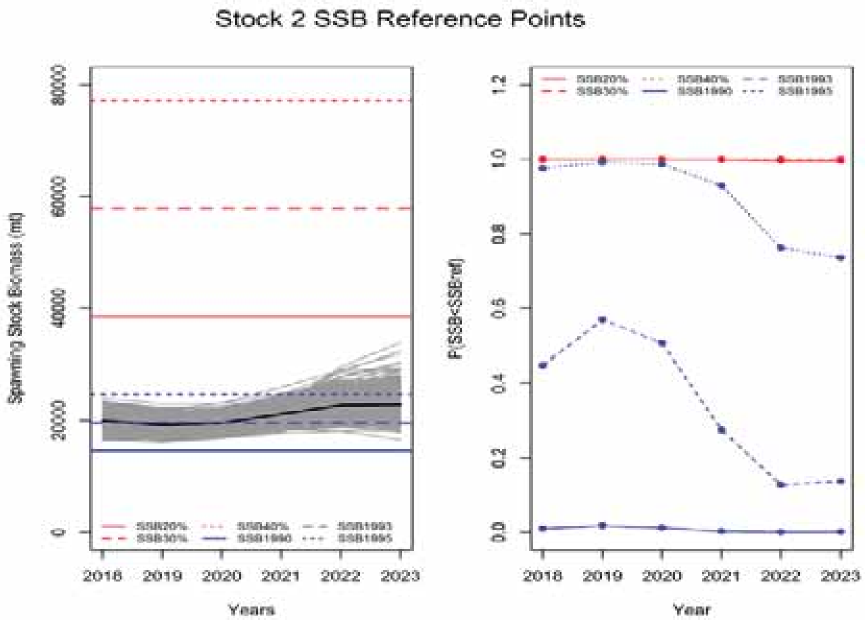



Figure B10.1 (cont.)

Fishing at current F; Ocean=0.400




F20% (2018=Current F; Projection: 0.251)

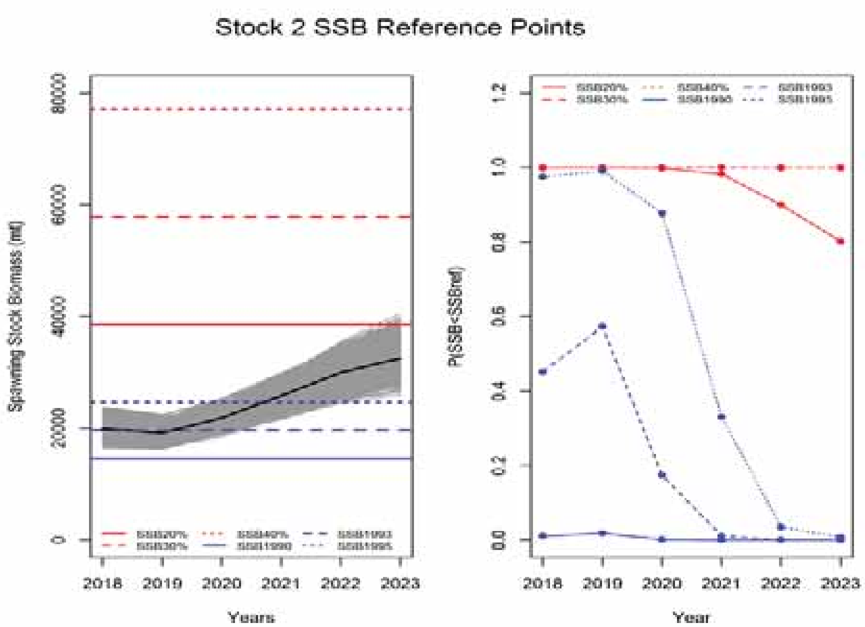
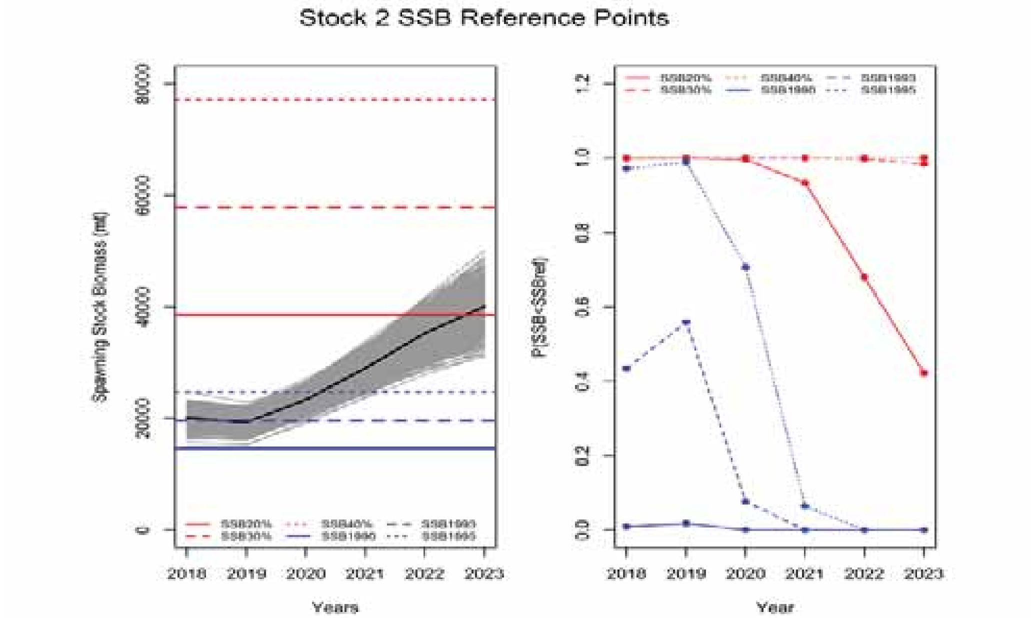



Figure B10.2. Short-term projections of total spawning stock biomass (SSB) and probability of annual total SSB being below SSB reference points under different fishing scenarios for the Delaware Bay/Hudson River stock (Stock 2) using the Hockey-Stick female spawning stock biomass-recruitment method.

F30% (2018=Current F; Projection: 0.168)




F40% (2018=Current F; Projection: 0.118)

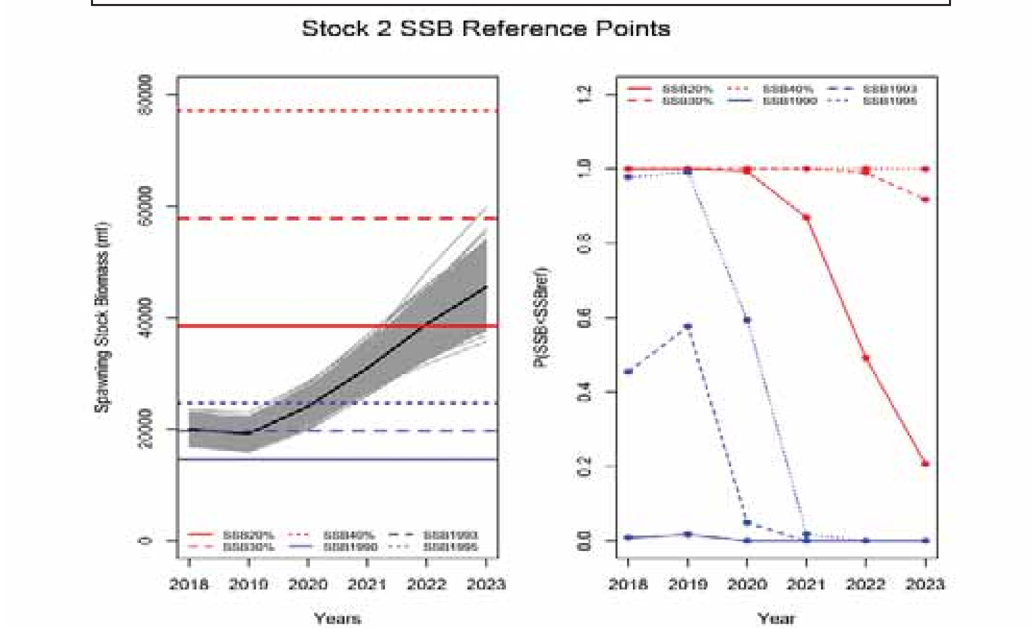
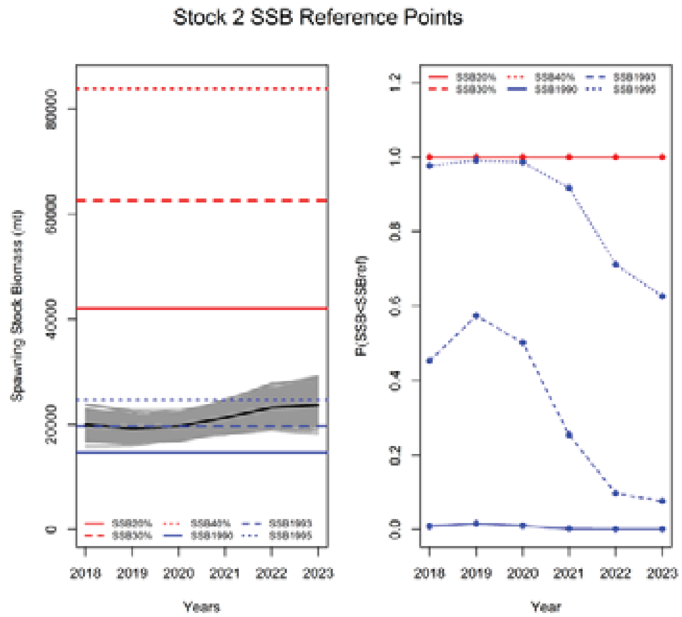



Figure B10.2 (cont.)

Fishing at current F; Ocean=0.400




F20% (2018=Current F; Projection: 0.251)

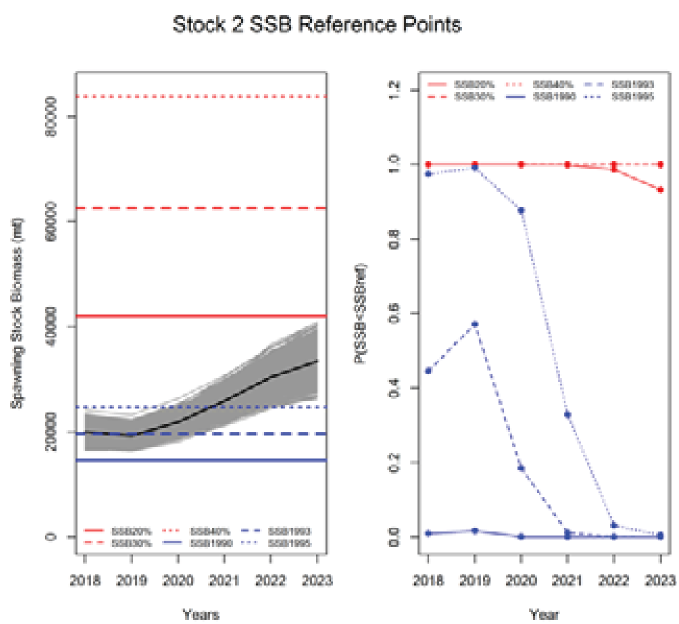
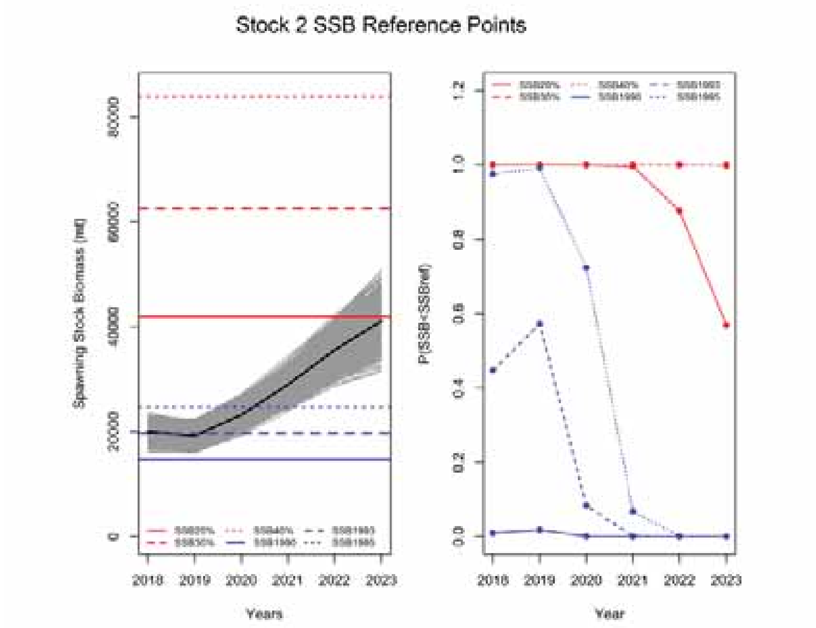



Figure B10.3. Short-term projections of total spawning stock biomass (SSB) and probability of annual total SSB being below SSB reference points under different fishing scenarios for the Delaware Bay/Hudson River stock (Stock 2) using the empirical female spawning stock biomass-recruitment method.

F30% (2018=Current F; Projection: 0.168)




F40% (2018=Current F; Projection: 0.118)

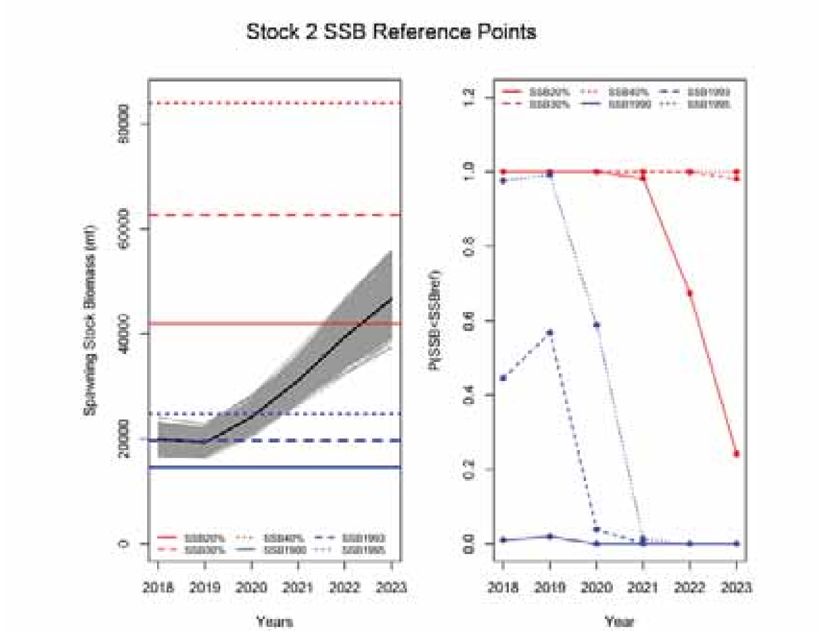



Figure B10.3 (cont.)

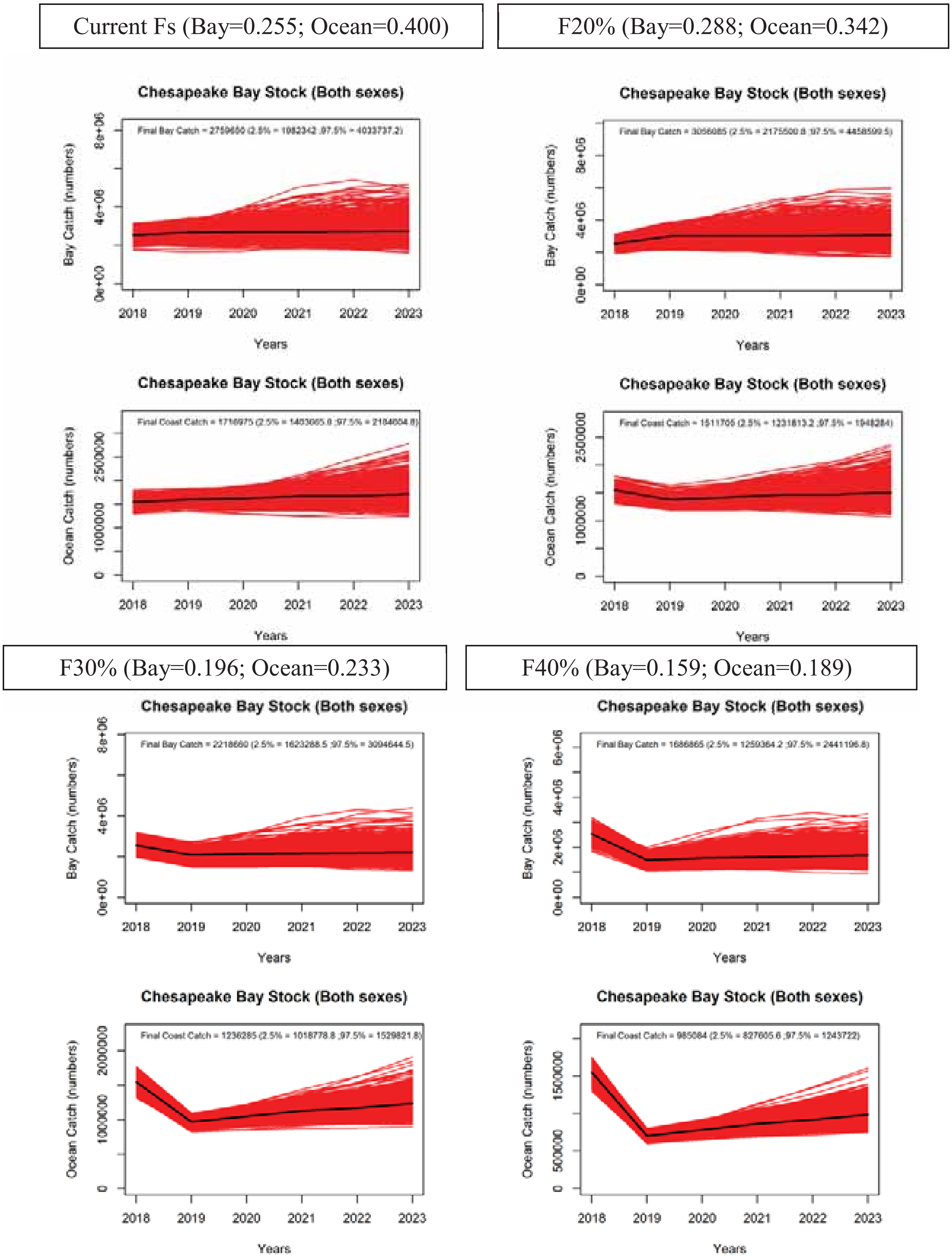



Figure B10.4. Projected total catch from the Chesapeake Bay stock under different fishing mortality scenarios. $F_{2018}$ was assumed equal to $F_{2017}$ in all scenarios.

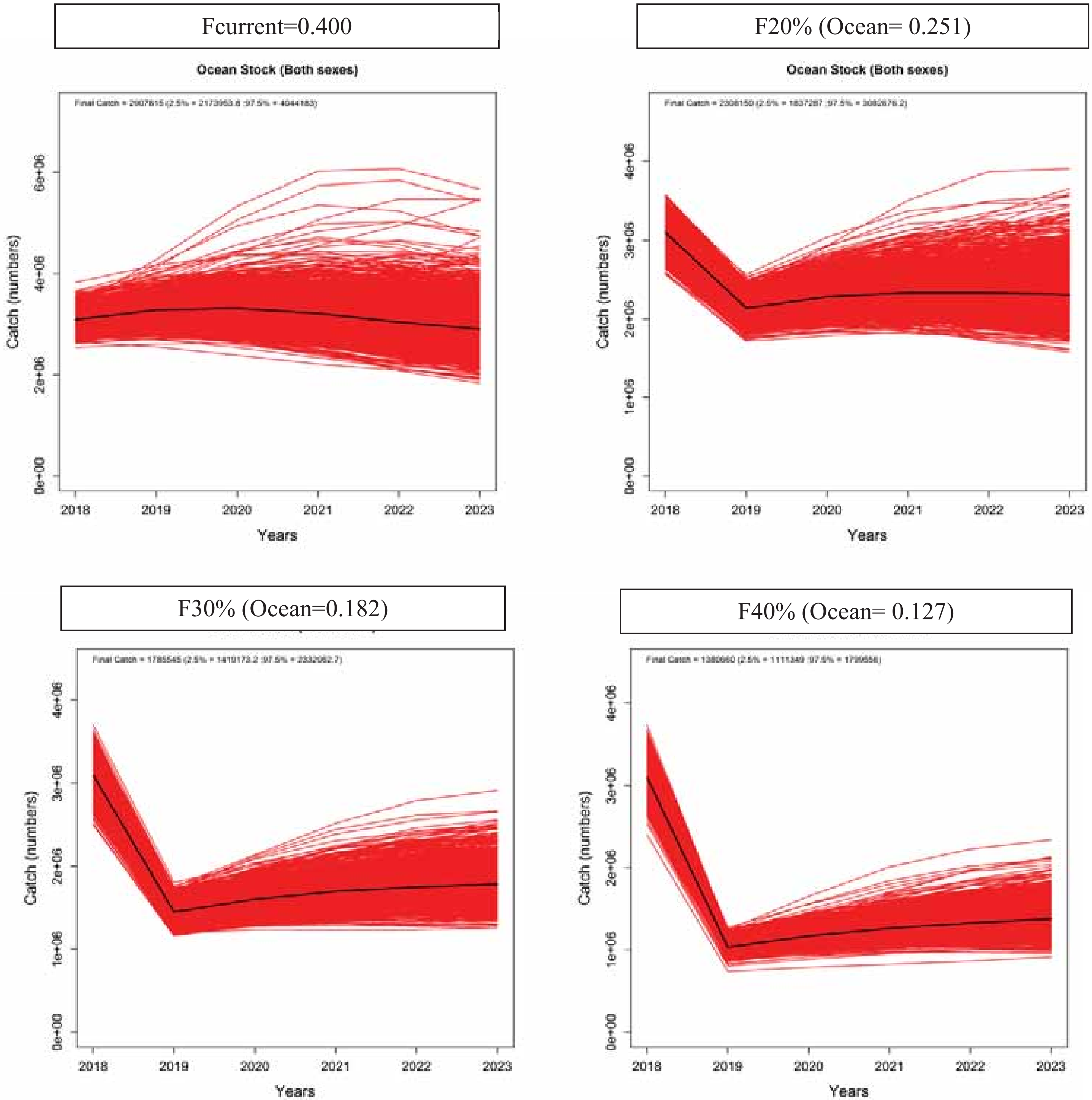



Figure B10.5. Projected total catch from the Delaware Bay/Hudson River stock under different fishing mortality scenarios using the hockey-stick female spawning stock biomass-recruitment approach. $F_{2018}$ was assumed equal to $F_{2017}$ in all scenarios.

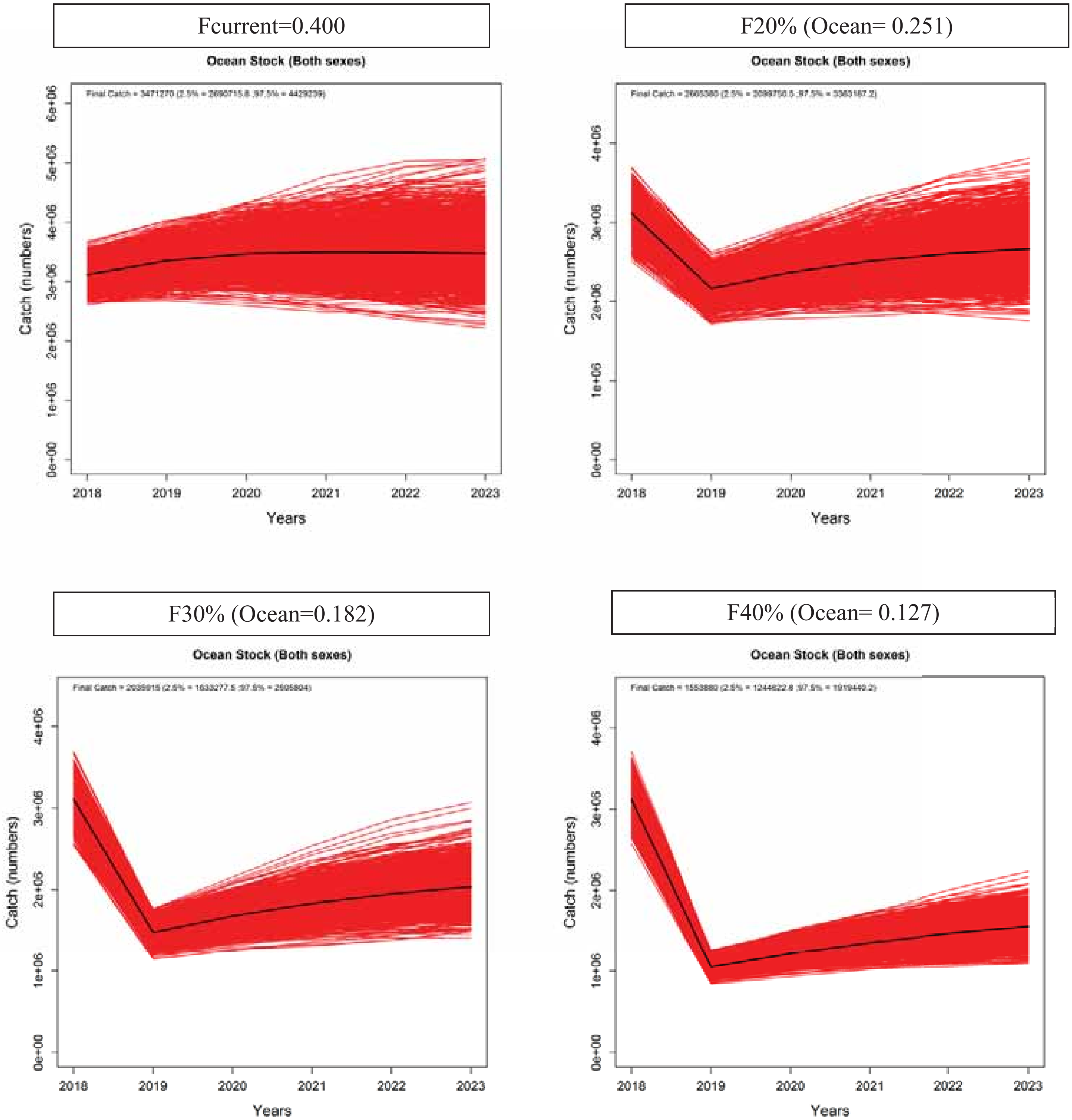



Figure B10.6. Projected total catch from the Delaware Bay/Hudson River stock under different fishing mortality scenarios using the empirical female spawning stock biomass-recruitment approach.

**B. Atlantic Striped Bass Stock Assessment Report Appendices**

List of Appendices

# Appendix B1: Growth, sex ratios, and maximum ages by state and through years

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July 31, 2018

# Introduction

This study attempted to identify temporal and spatial patterns in Striped Bass life history along Atlantic ocean. Three objectives are to examine: 1) growth rates, 2) the maximum ages, and 3) sex ratios. Because of my lacks of knowledges on fisheries activities and managements of each state, I will try to avoid any discussion and speculation on what caused the results observed in this study.

# Methods

## Data collection

The biological data with ages and total lengths (cm) were collected by eight states, DE, MA, MD, NJ, NY, PA, RI, and VA. However, the time series of the data varied among the states. MA has the longest time series from 1982 to 2016 whereas VA has the shortest one from 1998 to 2016. By finishing this writing, no state has updated its biological data with 2017 ages at ASMFCftp site. Some states provided only scale ages whereas others provided both scale and otolith ages. However, none of the states provided the entire time series of otolith ages. Therefore, this study was using the best age which is defined by the SAS as follows: the otolith age is used as the final age when an otolith age is available and the scale age is used as the final age when an otolith age is not available for a fish. The best age is always referred to as "age" and the total length as "length" hereafter.

## Growths

Before examining the growths, I used the boxplot() function in R to remove any outliers by age and sex, assuming that length at age is normally distributed. The data without any outliers were used for further growth analyses. Before examining the temporal and spatial patterns in growth, I used Kimura likelihood ratio test (Kimura 1980) to examine the difference in growth between females and males. More specifically, I used the vblrt() function in R fishmethods package by Gary Nelson to conduct Kimura test. When it was found that the female and male growths were significantly different, all further growth analyses were sex-specific.

I used von Bertalanffy growth model (Quinn and Deriso 1999) to fit the length-age data by state, sex, and year in order to identify any temporal patterns in sex-specific growth within each state. When no temporal pattern was identified, all the years were pooled within each state and the von Bertalanffy growth model was used to fit the year-pooled data within each state to examine spatial variations in growth among the states. I first eyeballed any potential temporal and spatial growth patterns, then used Kimura likelihood ratio test to examine them.

## Maximum ages

The maximum age may also provide useful information about the life history of a fish population. For example, Hoenig (1983) presented a method using the maximum age to estimate the total mortality ($Z$) of a fish population. Although the observed maximum age in the catch of Striped Bass may also be influenced by the fisheries management, it still provides some information on the life history of the Striped Bass stock. I examined the maximum ages using the sex-pooled data by state and through years.

## Sex ratios

I examined the sex ratios by state and through years. Such sex ratios indicate only the female to male ratios in the catches by each state and through years, instead of the sex ratio of the stock.

# Results

## Growths

Kimura test indicates that there is a significant difference in growth between female and male Striped Bass across states and years (Figure 1). Therefore, further growth analyses were sex-specific. In general, I couldn't find any temporal growth pattern within each state (Figure 2, 3, 4, 5, 6, 7, and 8 (Due to the small sample sizes, convergence didn't occur, as a result, no sex- and year-specific growth curves were obtained for RI)). However, in some years, the growth rates were more unique than in other years. For example, MA female growth in 2004 deviated from other years and was much slower (Figure 2 upper panel). The similar situation could be observed in NJ female 1995 (Figure 5 upper panel) and VA female 2004 growth (Figure 8 upper panel). I don't know what caused such suddenly slower growths just in one year for females within a couple of states, but it might be worth to find out the reasons.

There look like suddenly slower growths occurring in some years in some states but the growth curves appeared more like straight lines due to short age ranges (NY female 1986 in Figure 3 uppper panel and NJ female 2000 in Figure 5 upper panel). I have no way to know if those straight lines have reached their growth plateaus or will continue going up. As a result, I don't put them in my discussions. I also ignored one situation where most of years were not converged. For example, in MA (Figure 2 lower panel) and NJ (Figure 5 lower panel) male growths, most years were not converged, therefore, I couldn't compare if MA male 2006 grew slower and NJ male 2016 grew faster than other years.

Since there is no obvious temporal pattern in growth through years within each state except occasional annual growth changes, I pooled years by state to examine spatial patterns in sex-specific growth among states (Figure 9). I found that only two pairs of growths were not significantly different, MD female vs NJ female (Figure 10 upper panel), and NY female vs VA female (Figure 11 upper panel). Because the rest of paired growths were all significantly different, it seems easier to conclude that there are spatial patterns in growth across states. More specifically, MA has the highest growth rates for both females and males whereas VA has the lowest ones (except with NY females). Other states may fall between MA and VA.

## Maximum ages

The maximum ages varied through years within each state with some states' more fluctuated than others (Figure 12). In general, all the states' maximum ages were either above or close to their mean maximum age during the past three years except MA and RI. MA maximum ages tended to decrease through years before 2014 whereas RI time series is too short to draw any conclusion. The obvious temporal patterns occurred in NJ and VA, both states' maximum ages had tendency to increase through years. In addition, VA has the highest mean maximum age across years, probably because more otolith ages were used in VA data, and scale-age more likely underestimated ages of older Striped Bass whereas otolith-age provided more accurate age estimates of older Striped Bass (Secor et al. 1995 and Liao et al. 2013).

## Sex ratios

The sex ratio in this study is one female versus number of males observed in catch, assuming that the biological data from each state represents the sex ratio in its catch. In general, MA has the lowest sex ratio (0.039) whereas MD has the highest (11.916) (Figure 13). MD and VA sex ratios dropped below their averages since 2001 and 2000, respectively. Some states' sex ratios suddenly increased away above their averages in certain years, most likely due to small sample sizes (such as DE 1991 and NJ 1990). However, NY 2002 sex ratio suddenly increased while its sample size was not small, probably due to a change in fisheries activities, instead of a change of the sex ratio of the stock (I am guessing). Except the sudden changes discussed previously, the sex ratios were relatively consistent through years in DE, MA, NJ, NY, and PA. RI has only three year data with small sample sizes, therefore, no conclusion can be drawn from them.

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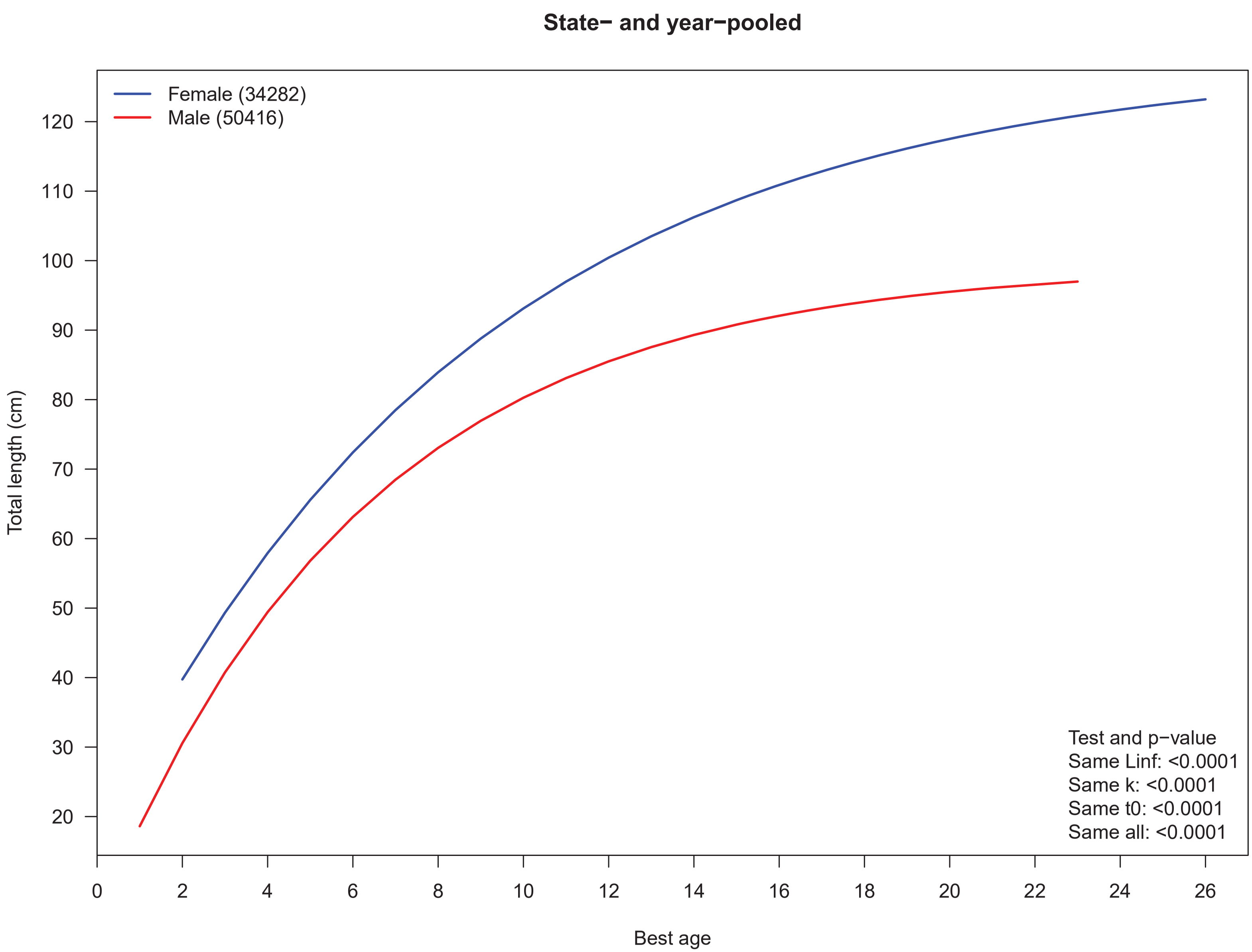


Figure 1: Kimura likelihood ratio test (Legend at bottom-right) indicates that there is a significant difference in growth between female and male Striped Bass while all states and years data are combined. The number in parentheses is the sample size from each sex.

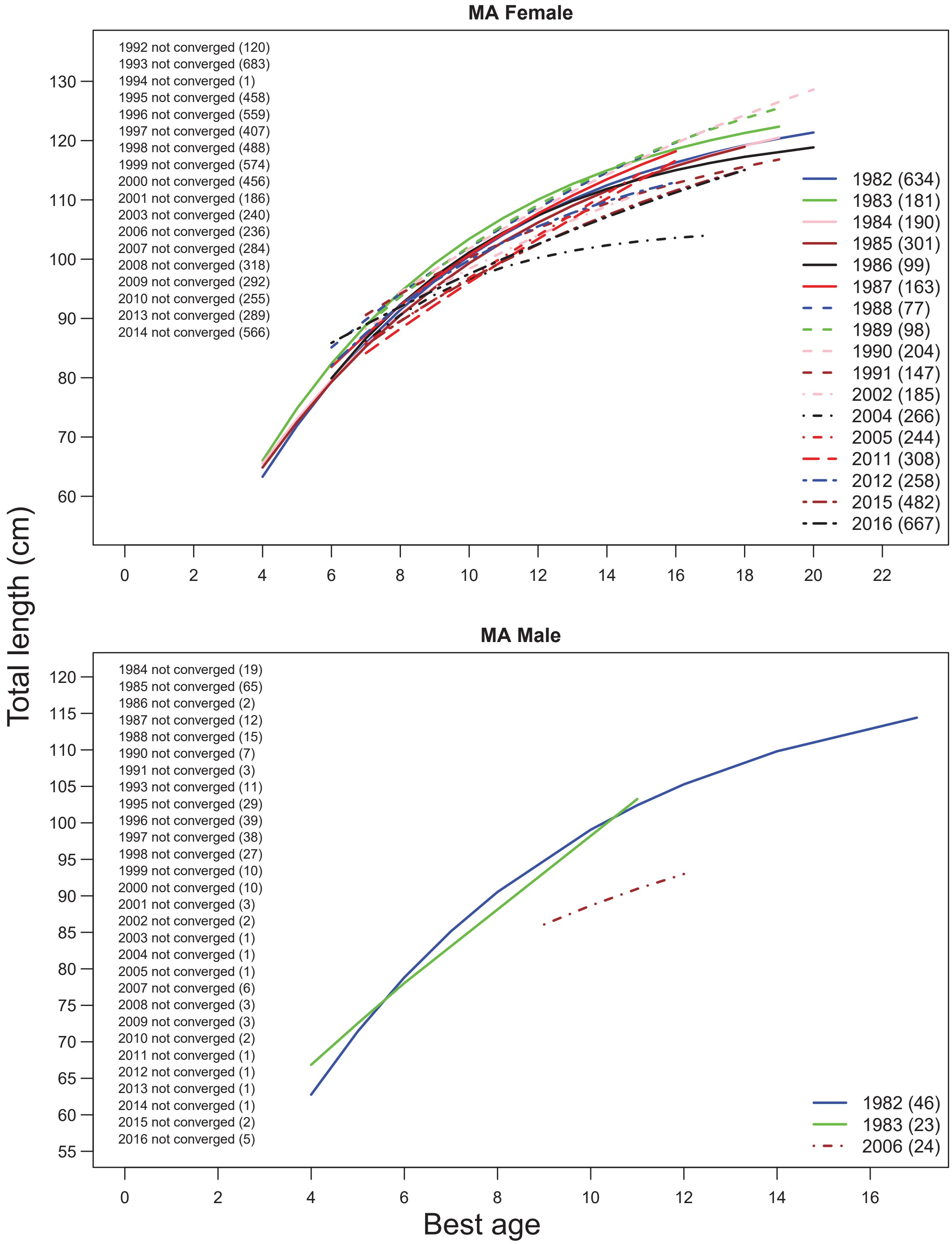


Figure 2: MA growths by sex and year. The number in parentheses is the sample size from each year.

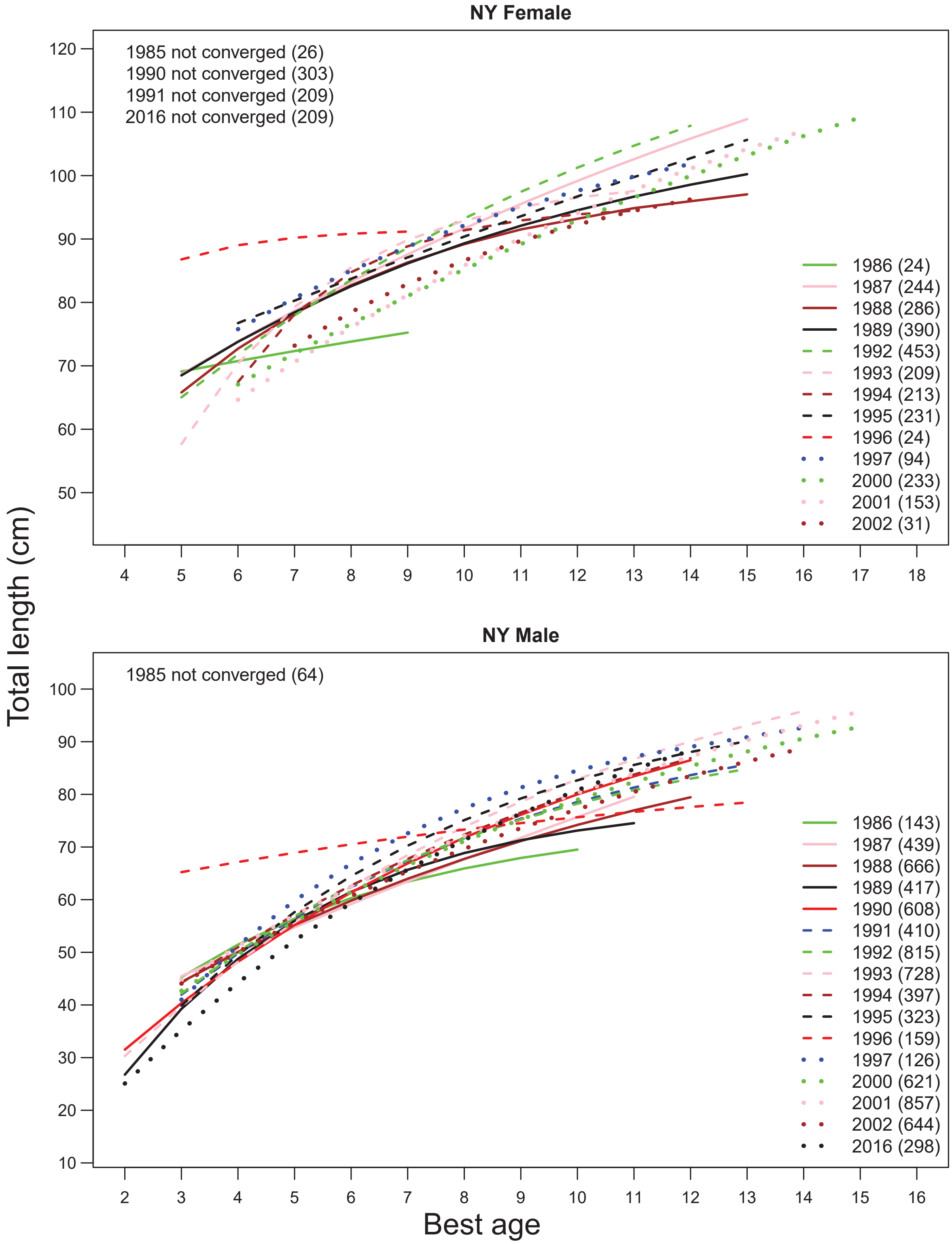


Figure 3: NY growths by sex and year. The number in parentheses is the sample size from each year.

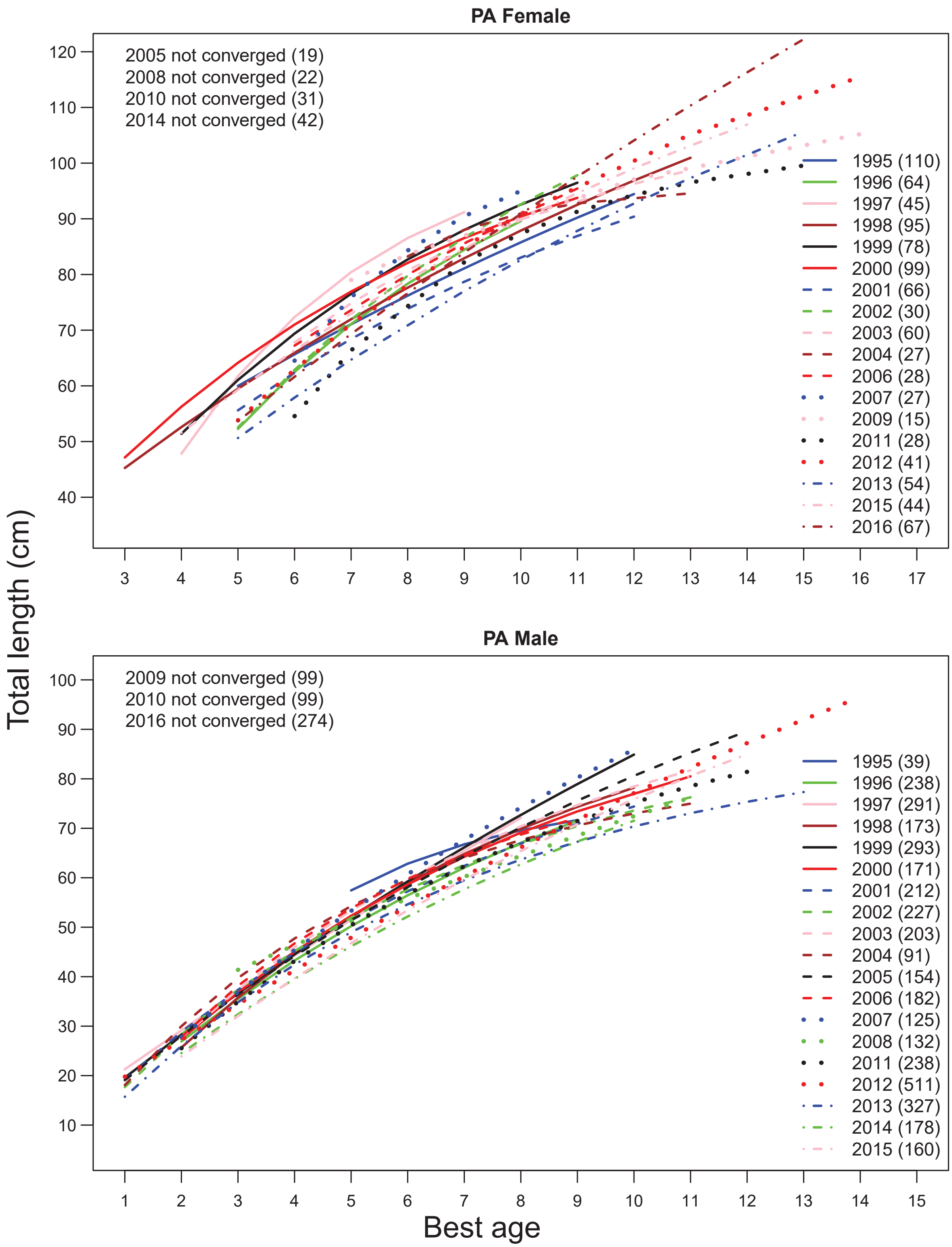


Figure 4: PA growths by sex and year.

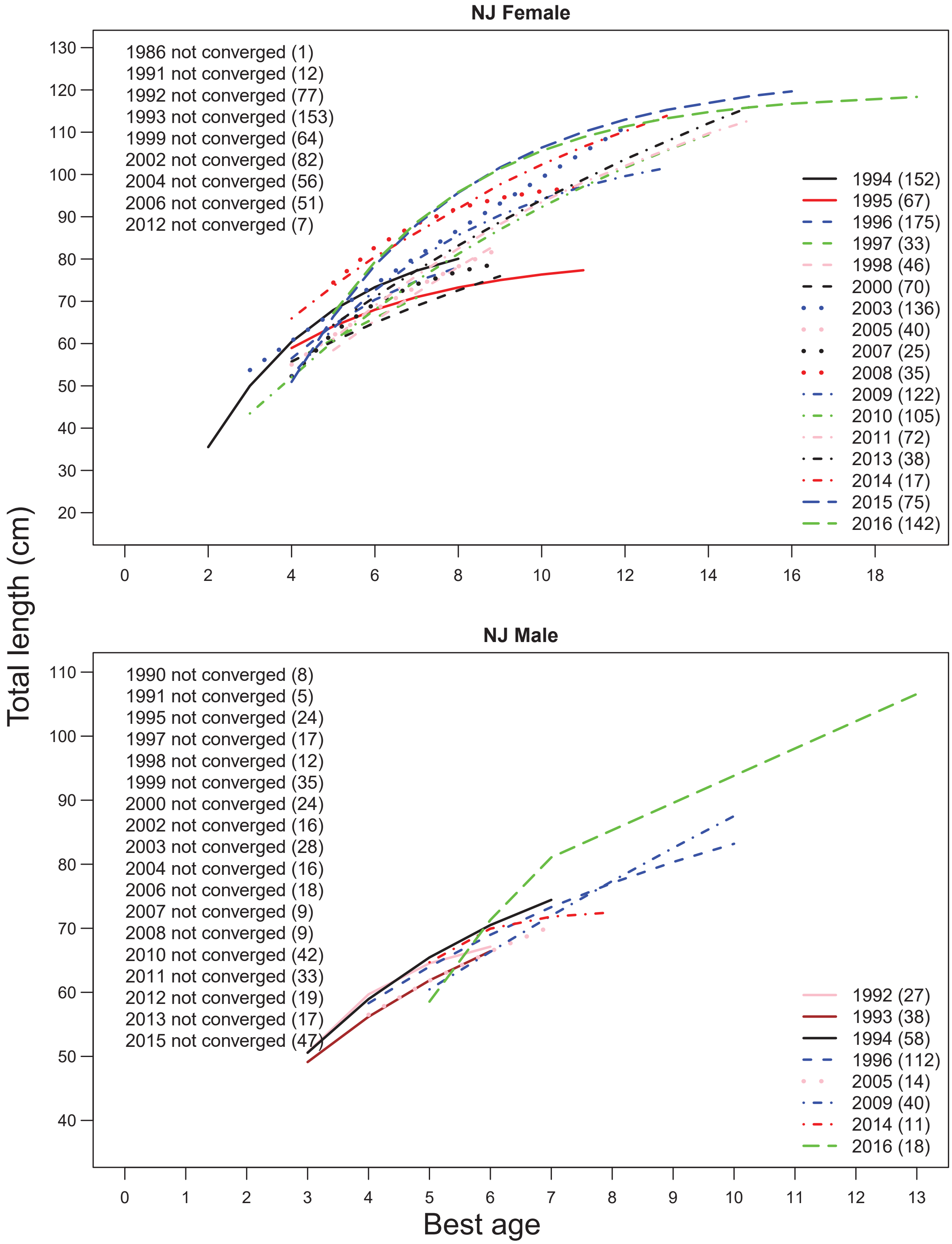


Figure 5: NJ growths by sex and year. The number in parentheses is the sample size from each year.

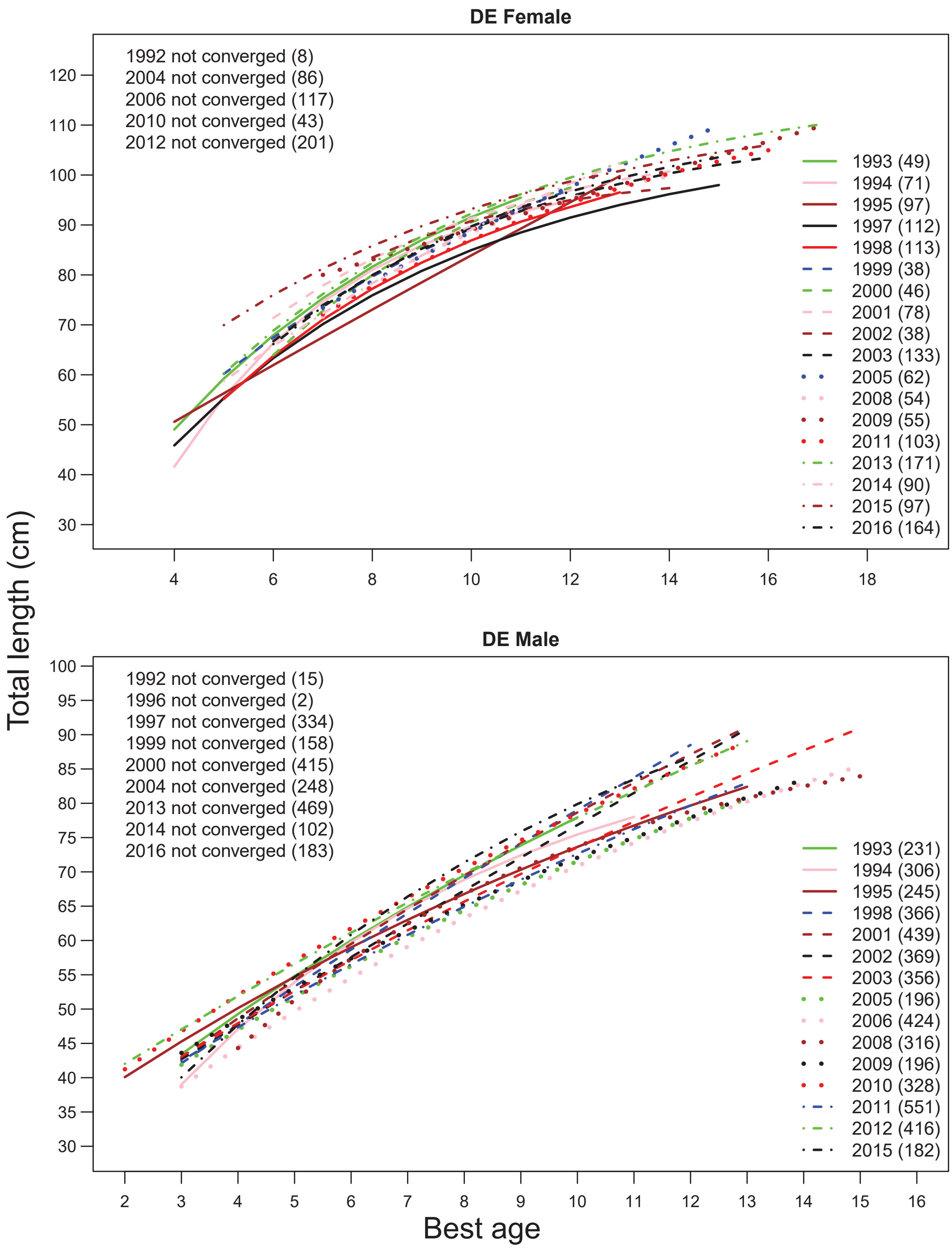


Figure 6: DE growths by sex and year. The number in parentheses is the sample size from each year.

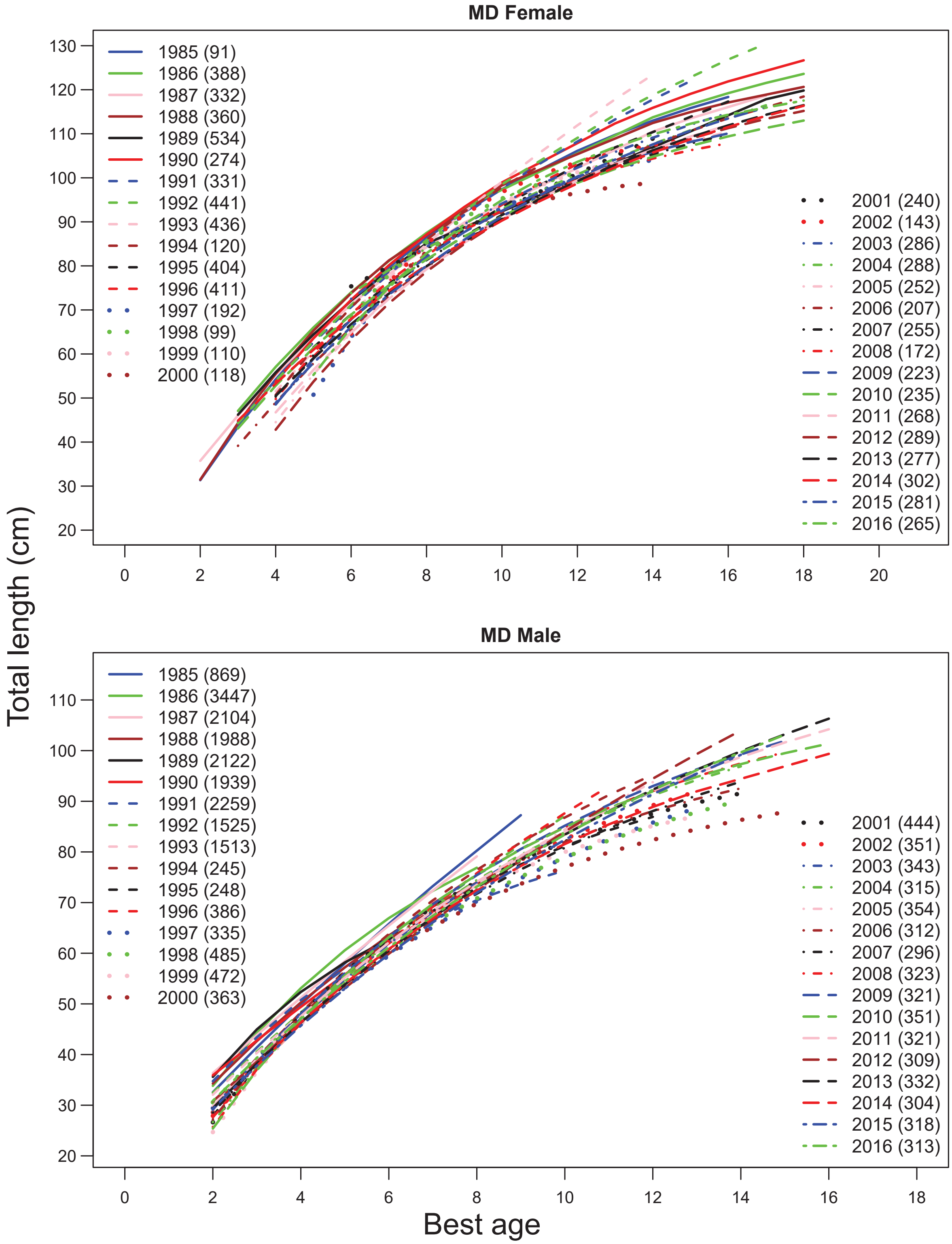


Figure 7: MD growths by sex and year. The number in parentheses is the sample size from each year.

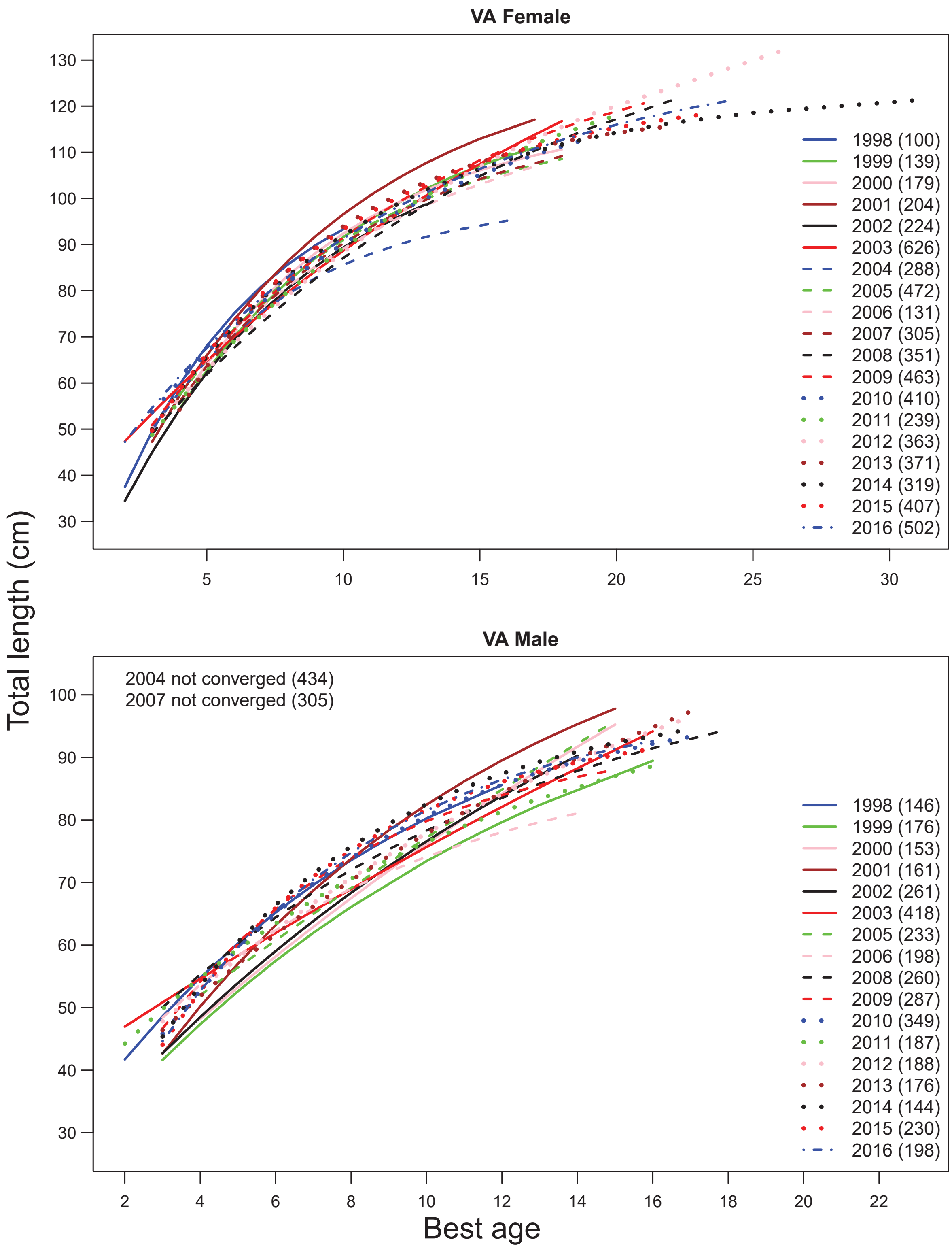


Figure 8: VA growths by sex and year. The number in parentheses is the sample size from each year.

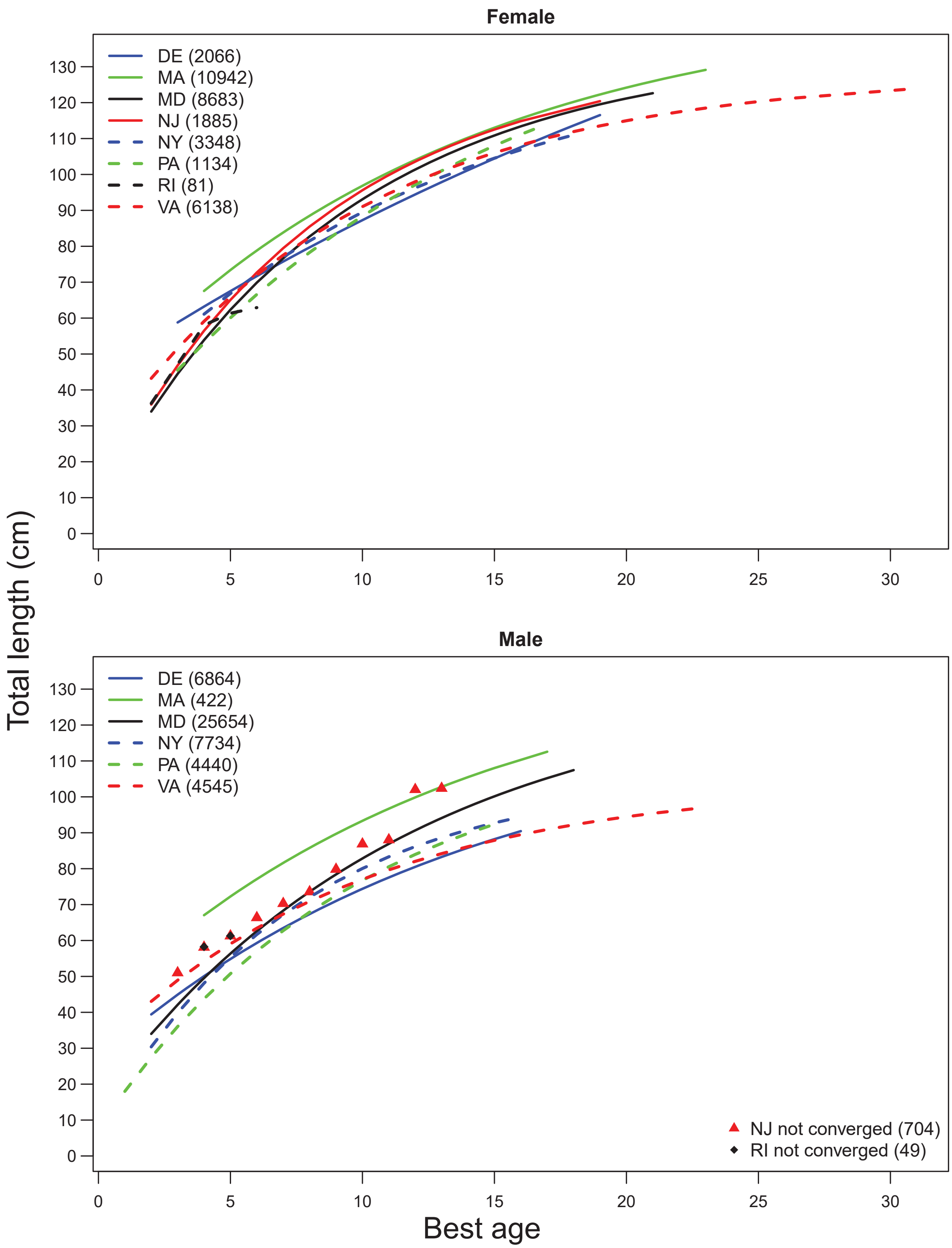


Figure 9: Year-pooled growths by state and sex. The number in parentheses is the sample size from each state with all years pooled.

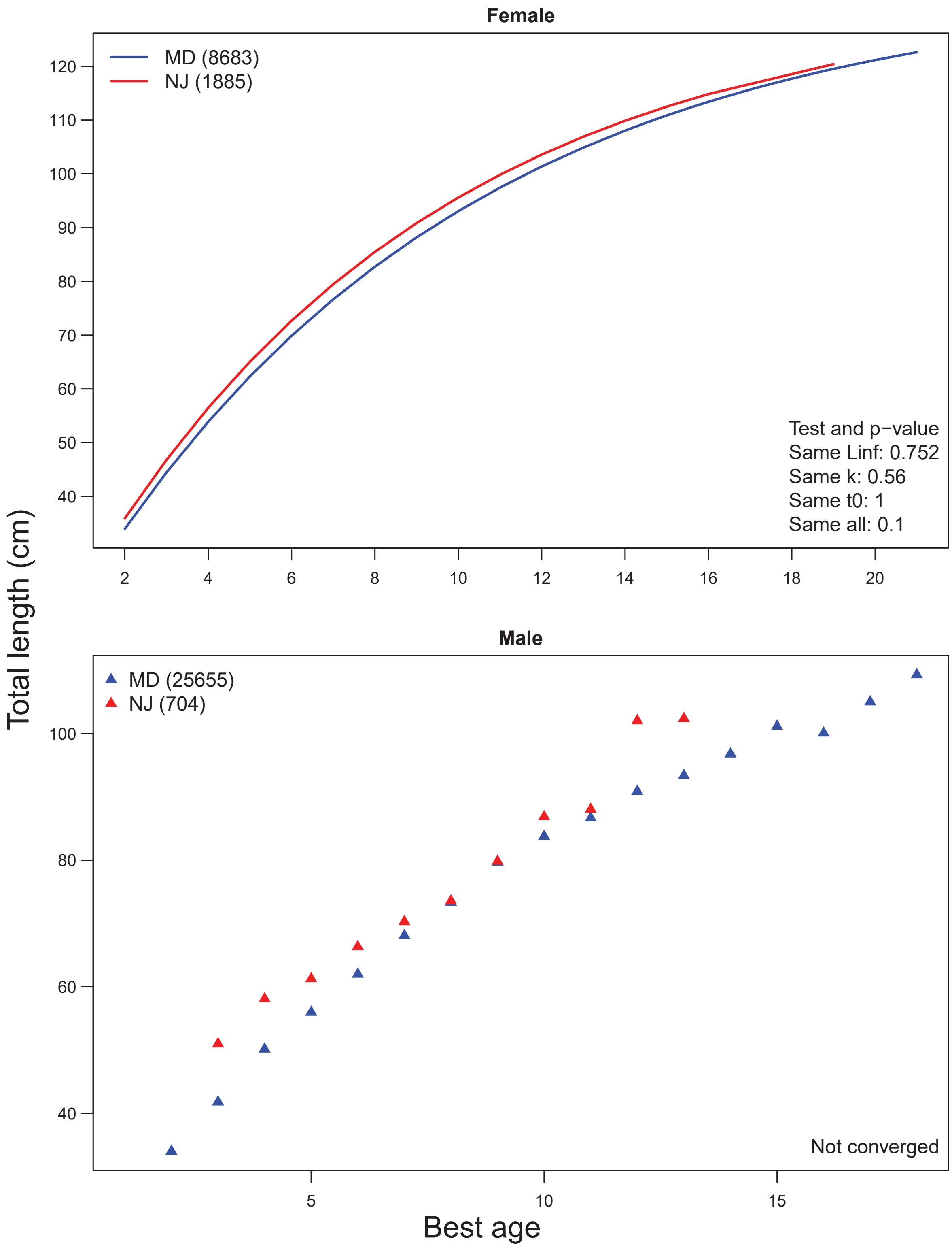


Figure 10: Kimura likelihood ratio test (Legend at bottom-right) indicates that there is no significant difference in the female growth between MD and NJ (Upper panel). The number in parentheses is the sample size from each state.

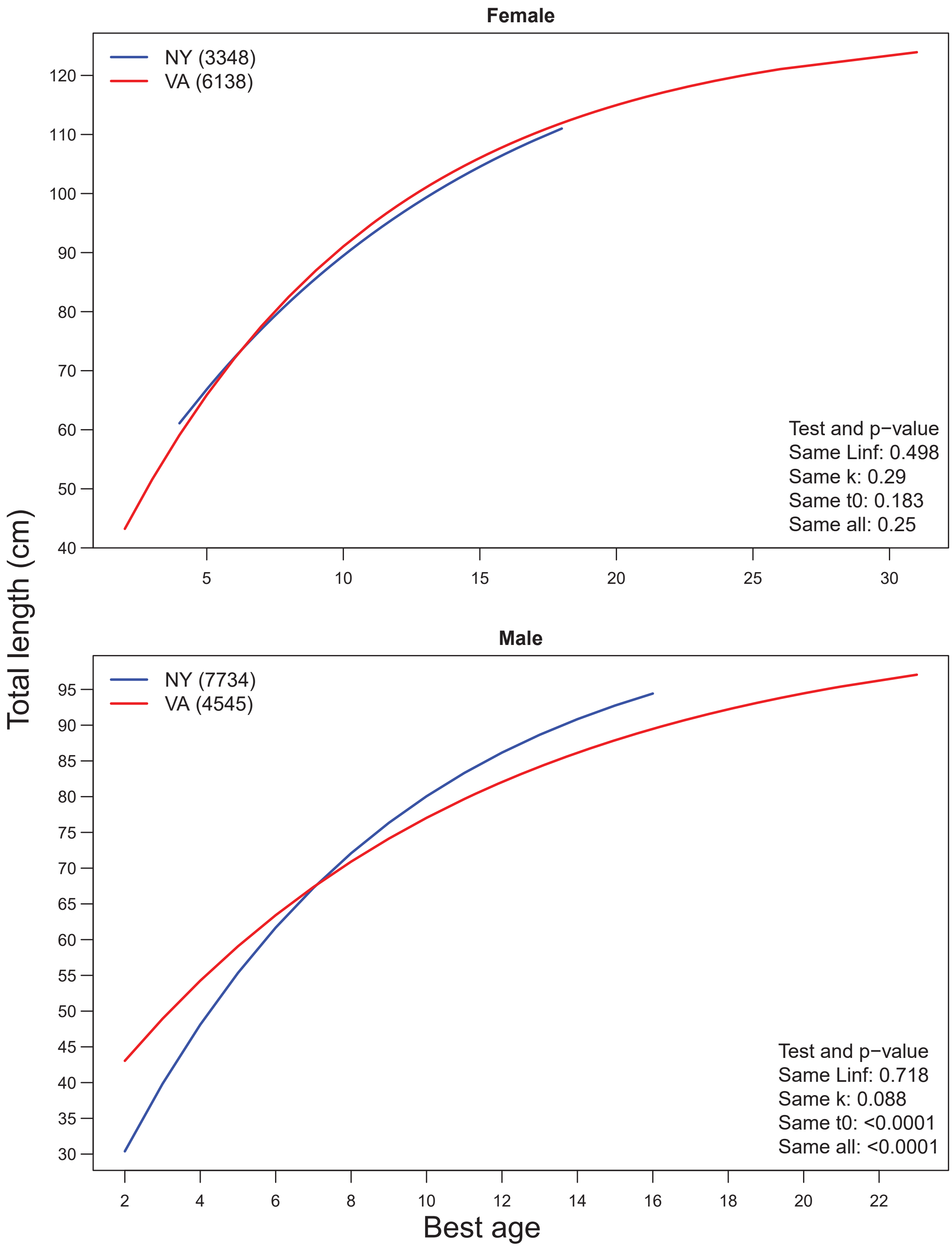


Figure 11: Kimura likelihood ratio test (Legend at bottom-right) indicates that there is no significant difference in the female growth between NY and VA (Upper panel) whereas there is a significant difference in the male growth between two states (Lower panel). The number in parentheses is the sample size from each state.

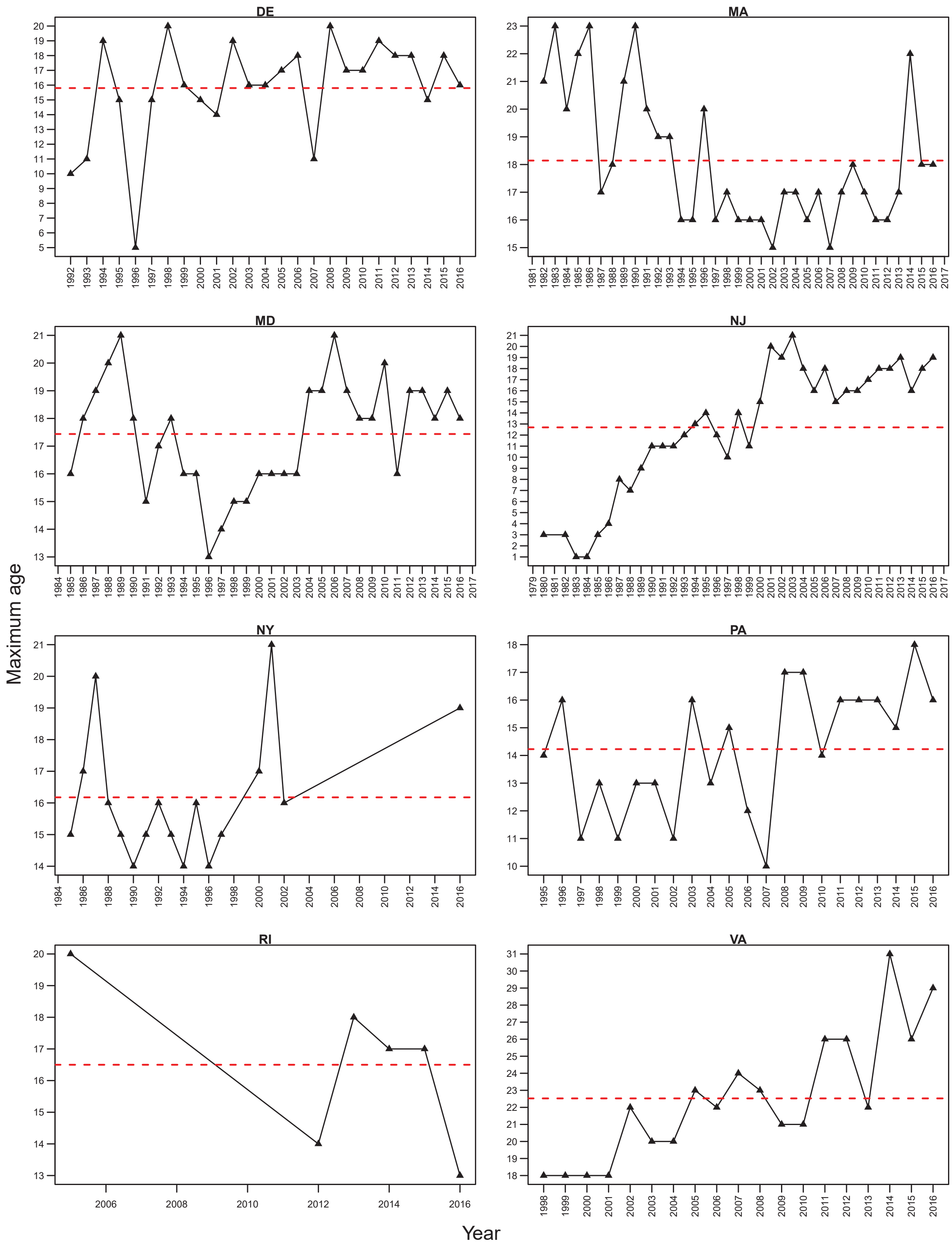


Figure 12: Maximum ages by state and through years. The red dash line is the mean maximum age across years.

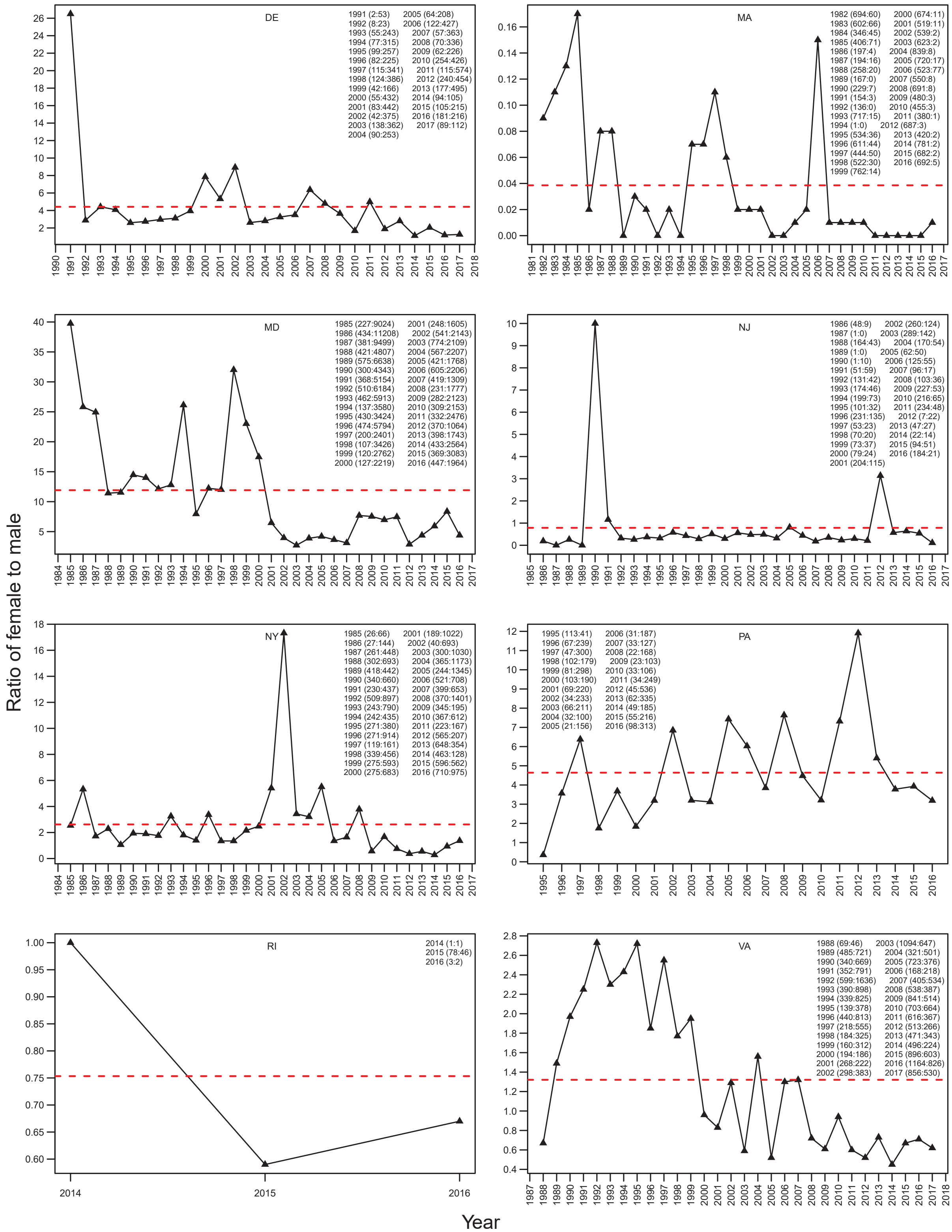


Figure 13: Sex ratios by state and through years. The numbers in parentheses are the sample size of female and male, respectively, from each year. The red dash line is the mean sex ratio across years.

**Appendix B2: Update to the Female Striped Bass Maturity Schedule**

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Maryland Department of Natural Resources

2017

## Introduction

The 2013 striped bass benchmark stock assessment (Northeast Fisheries Science Center 2013) lists development of maturity ogives applicable to coastal migratory stocks as a moderate level research priority. The current female striped bass maturity schedule used in the stock assessment is based on a 1987 white paper by Phil Jones (Table 1).

In the white paper, data for ages 4-6 were from the Maryland spawning stock gill net survey from 1985-1987, while data for ages 7-8 appear to be from a Texas Instruments study (Texas Instruments Inc. 1980) done on the Hudson River from 1976-1979. The Maryland study estimated maturity at age by dividing female CPUE from the spawning stock survey by male CPUE while assuming the natural and fishing mortality were the same between the sexes and that all males were mature. The assumption of equivalent mortality between the sexes was valid during the time period of the study due to the moratorium. The Texas Instruments study used a gonadosomatic index (ovary weight divided by fish weight) to separate immature from mature female fish.

Both methods use an indirect, rather than histological approach, to estimate female maturity at age and the work has not been updated since the stock was rebuilt. The estimated female maturity at age is improved by using newer, standardized, and more detailed histological techniques that reflect the dynamics of a restored stock.

This report summarizes the work conducted from 2014-2016 to update the maturity schedule. The secondary goal of calculating fecundity estimates will be completed at a later date.

## Methods

### *Determining Sampling Targets*

In an attempt to sample all ages of females in the population, length group targets were established after reviewing past female age frequencies (Table 2) and length frequencies (Figure 1) from the Maryland spring creel survey. Based on sample sizes from five years of creel survey sampling, it was determined that three years of sampling (2014-2016) would be required to achieve adequate sample sizes.

The majority of the sampling effort (68%) was on fish between 520-879 mm TL. Using Maryland's 2012 and 2013 spring age-length keys, these fish should be between 5-8 years old. Sampling was focused on this size/age range to adequately characterize the steepest part of the current maturity ogive (Figure 2). However, samples were also collected at smaller and larger sizes where fish were expected to be mostly immature or all mature, respectively. The proposed target sample sizes, by 20 mm length group, as well as the number sampled, are shown in Table 3 and Figure 3. The length groups in this table and figure are midpoints (i.e. the 610 length group goes from 600-619 mm).

### *Sample Collection Procedures*

The primary source of fish was the Maryland Department of Natural Resources (MDNR) spring creel survey, since all fish encountered were already dead and the harvest over the April through June survey included both resident and migratory fish within the spawning period (Table 4). Additional fish from the

Chesapeake Bay spawning stock were collected from the spawning stock survey and other surveys in Maryland's portion of the Bay.

While the low sample sizes in the 590-830 mm length groups observed in the spring creel survey sampling (Figure 1) could be due to the two different regulatory periods during the spring (trophy season through May 15 and summer/fall season after) and angler behavior, it is also possible that fish in this size range are immature migratory females that have not yet returned to the Chesapeake Bay to spawn. By using only samples from the Chesapeake Bay, the results may be biased towards immature, premigratory fish and mature, migratory fish, while lacking immature migratory females that remain on the coast. To minimize this bias, complementary sampling was conducted by coastal states to fill in missing length groups. The New Jersey Bureau of Marine Fisheries, Rhode Island Division of Fish and Wildlife, and the Northeast Area Monitoring and Assessment Program (NEAMAP) contributed samples from their routine surveys (Table 4). Ovaries were collected from the various surveys in the months of March through July and September through December during pre-spawn, spawning and post-spawn periods (Table 5). Total length (mm TL), weight (kg), visual (macroscopic) maturity stage, and external anomalies were recorded from all fish. Scales were collected to assign ages to fish sampled, as scale ages for striped bass are generally accurate through age ten (ASMFC 2013). Maryland does not have the ability to process and read striped bass otoliths, however, otoliths were collected for future validation.

Histological procedures followed the methods from Boyd (2011). Both ovaries were carefully removed from the body cavity and weighed. One ovary was retained in cold 10% buffered formalin for up to two weeks, depending on ovary size. Formalin was used for preservation on all surveys with the exception of NEAMAP where Normalin was used. Large ovaries were cut in half and remained in formalin for a longer time to ensure complete fixation. After fixation was complete, a 4 mm thick ovary cross-section was placed into one or more labeled, standard histological cassettes and stored in 70% ethanol.

*Histological Procedures*

The MDNR Diagnostics & Histology Laboratory at the Cooperative Oxford Laboratory prepared MH&E-stained histological slides of ovary tissues. Detailed laboratory procedures for the processing of ovary slides can be found in Boyd (2011).

Slides were viewed under 40X or 100X magnification through a dissecting scope, and maturity stages were assigned according to the categories defined in Brown-Peterson et al. (2011) (Table 6). Slides were examined by three biologists to determine the final maturity stage. If there was disagreement between the readers, the slides were viewed and discussed until a final stage was agreed upon.

*Analytical Procedures*

Brown-Peterson et al. (2011) defines immature fish as a gonadotropin independent phase and "fish enter the reproductive cycle when gonadal growth and gamete development first become gonadotropin dependent (i.e., the fish become sexually mature and enter the developing phase)" (Figure 4). While a striped bass may enter the developing phase and be physiologically mature, it does not necessarily indicate that the fish will spawn in the upcoming spawning season (Olsen and Rulifson 1992; Berlinsky et al. 1995; Boyd 2011). For this reason, the data were analyzed in two ways: as the percent mature (with developing through regenerating phases designated as mature) and as percent spawning (spawning capable through regressing phases indicating spawning is imminent or completed).

Ovary slides from fish collected in the fall/winter were essentially all immature or developing fish, with 89% of samples in the developing phase. As stated above, these fish may or may not spawn in the following spawning season. For this reason, the data were also analyzed using a subset of data from the spring and summer, a time period when spawning was occurring or just completed and the full dataset.

For samples collected from March through July, ages were calculated as the sample year minus the assigned year class. Calculation of ages for fish collected in the fall and winter (September through December) were done slightly differently. If a fish was determined to be immature in the fall/winter, it was immature the previous spring and age was calculated as above. Similarly, if a fish was regressing or regenerating in the fall/winter, it was assumed to have spawned the previous spring and age was also calculated as sample year minus year class. Difficulty arose with fish in the developing phase in the fall/winter with no readily apparent indications of previous spawning (e.g. thickened ovarian walls and/or muscle bundles). Therefore, if a fish was in the developing phase, it may or may not have spawned in the previous year. For these fish, we make the assumption that the observed developing phase is in preparation for the upcoming spawning season. For this reason, ages of fish in the developing phase from the fall and winter were advanced one year.

The maturity at age data were analyzed using logistic regression by specifying the logit link in a binomial generalized linear model (GLM) in R (R Core Team 2016).

Results

Over three years, 428 ovary samples were collected and were useable for this study (Figure 3). Of these, 307 were from Maryland's Chesapeake Bay (71.7%) and 121 were from coastal surveys (28.3%, Table 4). Lengths of all females sampled ranged from 350 to 1223 mm TL (mean=697 mm, SE=8.7 mm). Chesapeake Bay fish ranged from 350 to 1223 mm TL (mean=731 mm, SE=10.8 mm) and females sampled on the coast ranged from 350 to 1030 mm TL (mean=610 mm, SE=10.6 mm).

Ages ranged from 2 to 16, with 31% of fish from the above average 2011 year-class. The majority of fish sampled were between ages 4 and 6 (54.2%, Table 7). Sampling targets put the most sampling effort on fish approximately ages 5-8 (68%) in order to characterize the steepest part of the maturity ogive. For our dataset, 59.6% of the samples were from this age range.

Of the 428 fish sampled, 32 were immature (7.5%), 157 were developing (36.7%), 84 were spawning capable (19.6%), 12 were actively spawning (2.8%), 117 were regressing (27.3%), and 26 were regenerating (6.1%).

*March-July Dataset*

Most studies that examine maturity collect samples during the months of spawning. This data subset used data from March-July as spawning in Chesapeake Bay, where most of these samples were from, is known to occur into early June (Mansueti and Hollis 1963; Hollis 1967). Additionally, through July, fish that had spawned the previous spring were easily identified as being in the regressing and regenerating phases and more samples of small, immature fish were collected from pound nets. Of the 343 fish sampled in this time period, 302 were from Chesapeake Bay and 41 were from coastal states (16 from Delaware Bay, 9 from the New Jersey Ocean Trawl, and 16 from NEAMAP).

When developing fish were identified as mature, the age at 50% maturity was 3.59 years old (Figure 5). When developing fish were identified as not spawning imminently, the age at 50% maturity was 5.27 years old (Figure 6).

*Full Dataset*

The final dataset analyzed used data from throughout the year (March through December). This dataset included more fish from the coast, specifically samples from Rhode Island, but had the complication of how to define developing fish. Of the 428 fish sampled, 307 were from Chesapeake Bay and 121 were from coastal areas (see Table 4 for more information on sample sizes from specific surveys).

When developing fish were classified as mature, the age at 50% maturity was 3.63 years old (Figure 7). When developing fish were identified as not imminently spawning, the age at 50% maturity was 5.84 years old (Figure 8).

Discussion

The methods recommended in Brown-Peterson et al. (2011) were put forward in an effort to standardize terminology and reproductive phases across a wide variety of fish species. While the inclusion of developing fish as mature makes sense from a physiological standpoint (in the sense that that is the first reproductive phase to be gonadotropin dependent), it does not make sense from a stock assessment perspective for striped bass. Boyd (2011) specifies that for striped bass, fish in the developing phase may not necessarily spawn in the upcoming spawning season and therefore, we believe it makes more sense to treat these fish as not yet part of the spawning stock. Additionally, when developing fish were considered mature, the age of 50% maturity was very low, ranging from 3.6 -3.9 years old depending on the dataset used. This age at 50% maturity is much lower than the age that the Maryland spawning stock survey starts seeing any females on the spawning grounds. Since 1994, no females younger than age four have been caught in the spawning stock survey and only 12 four year olds have been caught in that time. We recommend using a maturity curve where developing fish are considered immature/not imminently spawning.

In general, the logistic regression equations estimate higher maturity-at-age up through age 6 as compared to the maturity schedule currently used in the stock assessment and similar maturity at age for ages 7 and above. The observed proportions mature at age for ages 4-6 are also higher than the values used currently (Table 8). Some of these differences are likely due to methodology. The previous estimates of maturity-at-age were calculated using CPUE data from the Maryland spawning stock survey and a GSI developed from fish on the Hudson River. This study utilizes histology to determine maturity which is known to be more accurate (West 1990). Additionally, those studies were conducted in the mid- to late-1980s and may have been reflective of a depressed stock. However, our observed proportions mature at age for ages 4 and 5 using the full dataset are similar to Berlinsky et al. (1995).

Despite our best efforts to include fish from the coast, it is also possible that some bias was still introduced. First, we continued to observe a bimodal distribution in our length samples (Figure 3). While this could partially be due to poor recruitment in the year classes that would span those sizes, it is also possible that we are still missing some migratory, immature fish. Second, as most of the fish were collected from the Maryland spring creel survey, these fish were subject to the minimum recreational sizes in the Chesapeake Bay (18” minimum in 2014 and 20” minimum in 2015 and 2016). To assess whether the samples were biased by the recreational size limits, comparisons were made to the length frequency sampled from Maryland’s summer/fall pound net and checkstation surveys in 2014-2016. These surveys should provide some estimate of the overall size distribution of age 4 and 5 fish in the Bay as pound nets are not size selective and the pound net survey samples both legal and sublegal fish in proportion to their availability in the net. The size frequencies, though, are sexes-combined as sex cannot be determined at that time of year and it is known that female striped bass tend to be larger at age than male striped bass after age 3 (Mansueti 1961; Mansueti and Hollis 1963; ASMFC 2013). Comparing the size frequency of samples at age from the maturity study to those collected in the pound net survey, it appears that age 4 fish sampled on the coast were larger than those sampled in the Bay (Figure 9). Most of the coastal fish were sampled in the fall from Rhode Island and may be indicative of larger age 4 fish migrating to the coast while smaller age 4 fish remain in the Bay (Dorazio et al. 1994). The Bay samples, however, generally align with the pound net survey samples indicating that the Bay sampling was not biased by the recreational size limits. Sampling of age 5 fish also showed no evidence of bias though differences in the length frequencies sampled were still observed between the Bay and coast with coastal age 5 fish being larger than Chesapeake Bay age 5 fish.

Assuming the Striped Bass Technical Committee and Stock Assessment Subcommittee (SAS) agrees with our suggestion to use a maturity curve where developing fish are considered immature/not imminently spawning, decisions would still need to be made on which dataset and results to use. Studies are often recommended to be done either prior to spawning (Hunter and Macewicz 2003) or prior to and during the spawning season (Murua et al. 2003). This would align best with our March-July data subset or possibly even a smaller subset. However, consideration must also be given to the distribution of fish across the study area, particularly when immature and mature individuals occur in different areas (Berlinsky et al. 1995; Hunter and Macewicz 2003; Murua et al. 2003). It is for this reason that Berlinsky et al. (1995) sampled during the spring and fall feeding migrations even though this required an assumption that maturations rates were not significantly different among stocks.

The March-July dataset includes more immature fish and spans the entire spawning season in Chesapeake Bay which is known to occur into June. However, using this smaller dataset reduces the overall sample size and the number of coastal fish included in the dataset. Use of the full dataset includes all of the fish collected coastwide, including those immature migratory females we may be missing within the Bay; however, some error is likely added by classifying older, developing fish as not imminently spawning. An examination of Figure 8, however, indicates that this is likely not an issue as most of the fish sampled above age 6 were classified as spawning capable or regressing/regenerating. This is likely due to our focus on smaller coastal fish that were between ages 5-8. To aid in deciding which dataset and results to use, a comparison of the logistic regression estimates of maturity-at-age for these two datasets as well as a comparison of the observed proportions mature-at-age in shown in Figure 10. <u>We would recommend using the full dataset.</u>

Acknowledgements

This study was a joint effort that included several state agencies and other programs within MD DNR. First we would like to thank Jacob Boyd of the North Carolina Division of Marine Fisheries for his consultation, advice, and histology slide expertise as we started on this project. We'd also like to thank Heather Corbett and her staff at New Jersey Department of Environmental Protection - Bureau of Marine Fisheries, Nicole Lengyel and her staff at Rhode Island Department of Environmental Management - Division of Fish and Wildlife, and Virginia Institute of Marine Science staff that run the NEAMAP cruises (Jameson Gregg, James Gartland, Rob Latour) for helping us collect additional ovaries from fish along the Atlantic coast. Additional thanks go to the MD Fish and Wildlife Health Program staff, Mark Matsche and Kevin Rosemary, for their demonstrations and knowledge on dissection and histology techniques. Finally we are very grateful for Chris Dungan and his staff (former lab manager Jud Blazek and current manager Laurinda Serafin) in the Diagnostics and Histology Laboratory for processing our many samples and providing guidance and insight throughout the study. We truly appreciate all the cooperation we received along the way.

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Table 1. Current female maturity schedule used for the striped bass stock assessment.

| Age | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|
| Proportion Mature | 0.04 | 0.13 | 0.45 | 0.89 | 0.94 | 1.0 |

Table 2. Number of female striped bass, by age and year, collected during the Maryland spring creel survey, 2009-2013.

| Age | 2009 | 2010 | 2011 | 2012 | 2013 | Average |
|---|---|---|---|---|---|---|
| 3 | 1 | 6 | 1 | 0 | 1 | 2 |
| 4 | 7 | 6 | 33 | 17 | 17 | 16 |
| 5 | 7 | 7 | 19 | 25 | 9 | 13 |
| 6 | 7 | 3 | 3 | 31 | 26 | 14 |
| 7 | 4 | 17 | 7 | 16 | 3 | 9 |
| 8 | 18 | 12 | 42 | 13 | 6 | 18 |
| 9 | 40 | 29 | 14 | 30 | 18 | 26 |
| 10 | 11 | 27 | 39 | 3 | 28 | 22 |
| 11 | 10 | 15 | 15 | 8 | 4 | 10 |
| 12 | 8 | 13 | 6 | 1 | 11 | 8 |
| 13 | 12 | 12 | 6 | 0 | 3 | 7 |
| 14 | 6 | 19 | 2 | 0 | 2 | 6 |
| 15 | 3 | 4 | 6 | 2 | 1 | 3 |
| 16 | 3 | 3 | 1 | 0 | 0 | 1 |
| 17 | 1 | 0 | 0 | 1 | 1 | 1 |
| 18 | 1 | 0 | 0 | 0 | 0 | 0 |
| Totals | 139 | 173 | 194 | 147 | 130 | 157 |

Table 3. Targets and sample sizes for maturity schedule survey, along with deficits when targets were not met.

| Length Group | Target | 2014 Samples | 2015 Samples | 2016 Samples | Total Samples | Deficit |
|---|---|---|---|---|---|---|
| 350 | | 1 | 2 | 0 | 3 | |
| 370 | | 1 | 1 | 0 | 2 | |
| 390 | | 0 | 0 | 0 | 0 | |
| 410 | | 2 | 6 | 3 | 11 | |
| 430 | 10 | 1 | 4 | 1 | 6 | 4 |
| 450 | 10 | 2 | 0 | 1 | 3 | 7 |
| 470 | 10 | 7 | 1 | 3 | 11 | |
| 490 | 10 | 6 | 1 | 3 | 10 | |
| 510 | 10 | 4 | 5 | 3 | 12 | |
| 530 | 15 | 2 | 5 | 10 | 17 | |
| 550 | 15 | 8 | 10 | 7 | 25 | |
| 570 | 15 | 6 | 20 | 4 | 30 | |
| 590 | 15 | 4 | 22 | 7 | 33 | |
| 610 | 15 | 1 | 19 | 9 | 29 | |
| 630 | 15 | 3 | 10 | 4 | 17 | |
| 650 | 15 | 6 | 10 | 3 | 19 | |
| 670 | 15 | 4 | 4 | 4 | 12 | 3 |
| 690 | 15 | 2 | 7 | 2 | 11 | 4 |
| 710 | 15 | 2 | 4 | 3 | 9 | 6 |
| 730 | 15 | 4 | 4 | 1 | 9 | 6 |
| 750 | 15 | 0 | 3 | 3 | 6 | 9 |
| 770 | 15 | 3 | 4 | 2 | 9 | 6 |
| 790 | 15 | 0 | 5 | 4 | 9 | 6 |
| 810 | 15 | 4 | 4 | 0 | 8 | 7 |
| 830 | 15 | 2 | 4 | 3 | 9 | 6 |
| 850 | 15 | 5 | 6 | 2 | 13 | 2 |
| 870 | 15 | 5 | 7 | 4 | 16 | |
| 890 | 10 | 6 | 5 | 0 | 11 | |
| 910 | 10 | 7 | 5 | 0 | 12 | |
| 930 | 10 | 7 | 4 | 0 | 11 | |
| 950 | 10 | 7 | 4 | 0 | 11 | |
| 970 | 10 | 6 | 1 | 5 | 12 | |
| 990 | 10 | 5 | 3 | 3 | 11 | |
| 1010 | 3 | 1 | 3 | 1 | 5 | |
| 1030 | 3 | 2 | 0 | 2 | 4 | |
| 1050 | 3 | 0 | 3 | 1 | 4 | |
| 1070 | 3 | 0 | 3 | 0 | 3 | |
| 1090 | 3 | 1 | 1 | 1 | 3 | |
| 1110 | | 0 | 1 | 0 | 1 | |
| 1130 | | 0 | 0 | 0 | 0 | |
| 1150 | | 0 | 0 | 0 | 0 | |
| 1170 | | 0 | 0 | 0 | 0 | |
| 1190 | | 0 | 0 | 0 | 0 | |
| 1210 | | 0 | 0 | 0 | 0 | |
| 1230 | | 0 | 1 | 0 | 1 | |
| Totals | 395 | 127 | 202 | 99 | 428 | 66 |

Table 4. Number of fish sampled by state and survey.

| State | Survey | Months Sampled | n | Percent |
|---|---|---|---|---|
| Maryland | | | | |
| | Spring Creel Survey | April-June | 252 | 58.9% |
| | Spring Gill Net Survey | April-May | 15 | 3.5% |
| | Striped Bass Pound Net Sampling | June-July | 19 | 4.4% |
| | Nanticoke Spring Pound Net and Fyke Net Survey | March | 2 | 0.5% |
| | Commercial Check Station Sampling | March | 3 | 0.7% |
| | Fish Health Hook & Line Survey | September-November | 5 | 1.2% |
| | Patapsco Gill Net Survey | June | 3 | 0.7% |
| | Shad Gill Net Survey (USFWS) | April-May | 8 | 1.9% |
| New Jersey | | | | |
| | Delaware Bay Gill Net Survey | March-May | 15 | 3.5% |
| | Ocean Trawl Survey | April-May | 9 | 2.1% |
| | | October | 1 | 0.2% |
| | Headboat Sampling | December | 13 | 3.0% |
| | Herring Survey | May | 1 | 0.2% |
| Rhode Island | | | | |
| | Fish Trap Survey | September-October | 59 | 13.8% |
| NEAMAP | | | | |
| | Ocean Trawl Survey | May | 16 | 3.7% |
| | | September-October | 7 | 1.6% |
| Total | | | 428 | |

Table 5. Number of fish sampled by month.

| Month | n | Percent |
|---|---|---|
| March | 15 | 3.5% |
| April | 80 | 18.7% |
| May | 151 | 35.3% |
| June | 84 | 19.6% |
| July | 13 | 3.0% |
| September | 16 | 3.7% |
| October | 54 | 12.6% |
| November | 2 | 0.5% |
| December | 13 | 3.0% |
| Total | 428 | |

Table 6. Macroscopic and histological description of maturity phases used in the analysis. From Table 2 of Brown-Peterson et al. (2011). Abbreviations used in descriptions: CA = cortical alveolar; GVBD = germinal vesicle breakdown; GVM = germinal vesicle migration; OM = oocyte maturation; PG = primary growth; POF = postovulatory follicle complex; Vtg1 = primary vitellogenic; Vtg2 = secondary vitellogenic; Vtg3 = tertiary vitellogenic.

| Phase | Macroscopic and Histological Features |
|---|---|
| **Immature** (never spawned) | Small ovaries, often clear, blood vessels indistinct. Only oogonia and PG oocytes present. No atresia or muscle bundles. Thin ovarian wall and little space between oocytes. |
| **Developing** (ovaries beginning to develop but not yet ready to spawn) | Enlarging ovaries, blood vessels becoming more distinct. PG, CA, Vtg1, and Vtg2 oocytes present. Not evidence of POFs or Vtg3 oocytes. Some atresia can be present.<br><br>*Early Developing subphase*: PG and CA oocytes only. |
| **Spawning Capable** (fish are developmentally and physiologically able to spawn in this cycle) | Large ovaries, blood vessels prominent. Individual oocytes visible macroscopically. Vtg3 oocytes present or POFs present in batch spawners. Atresia of vitellogenic and/or hydrated oocytes may be present. Early stages of OM can be present.<br><br>*Actively Spawning subphase*: oocytes undergoing late GVM, GVBD, hydration, or ovulation. |
| **Regressing** (cessation of spawning) | Flaccid ovaries, blood vessels prominent. Atresia (any stage) and POFs present. Some CA and/or vitellogenic (Vtg1, Vtg2) oocytes present. |
| **Regenerating** (sexually mature, reproductively inactive) | Small ovaries, blood vessels reduced but present. Only oogonia and PG oocytes present. Muscle bundles, enlarged blood vessels, thick ovarian wall and/or gamma/delta atresia or old, degenerating POFs may be present. |

Table 7. Number of fish sampled by age. Ages were calculated as for the full dataset analysis (e.g. fall developing fish had their ages advanced one year).

| Age | n | Percent |
|---|---|---|
| 2 | 3 | 0.7% |
| 3 | 13 | 3.0% |
| 4 | 45 | 10.5% |
| 5 | 131 | 30.6% |
| 6 | 56 | 13.1% |
| 7 | 32 | 7.5% |
| 8 | 36 | 8.4% |
| 9 | 13 | 3.0% |
| 10 | 28 | 6.5% |
| 11 | 44 | 10.3% |
| 12 | 14 | 3.3% |
| 13 | 8 | 1.9% |
| 14 | 4 | 0.9% |
| 16 | 1 | 0.2% |
| Total | 428 | |

Table 8. Comparison of maturity at age estimates from various studies. The current maturity-at-age estimates used in the stock assessment are bolded.

| Study | Merriman (1941) [a] | Texas Instruments (1980) [b] | Specker et al. (1987) [b] | **Jones (1987)** | Berlinsky et al. (1995) | Data Subset (this study) | Full Dataset (this study) |
|---|---|---|---|---|---|---|---|
| Area | New England | Hudson | Coastwide | **MD and Hudson** | Rhode Island | Coastwide | Coastwide |
| Timing | April-Nov | | | | May-June, Sept-Nov | March-July | March-July, Sept-Dec |
| Age | | | | | | | |
| 3 | 0% | | | **0%** | 0% | 0% | 0% |
| 4 | 27% | 4% | 5% | **4%** | 12% | 7% | 9% |
| 5 | 74% | 21% | 15% | **13%** | 34% | 51% | 32% |
| 6 | 93% | 60% | 45% | **45%** | 77% | 66% | 45% |
| 7 | 100% | 89% | 100% | **89%** | 100% | 90% | 84% |
| 8 | 100% | 94% | 100% | **94%** | 100% | 94% | 89% |
| 9 | 100% | 100% | 100% | **100%** | 100% | 100% | 100% |

a: From Berlinksy et al 1995

b: From Jones 1987

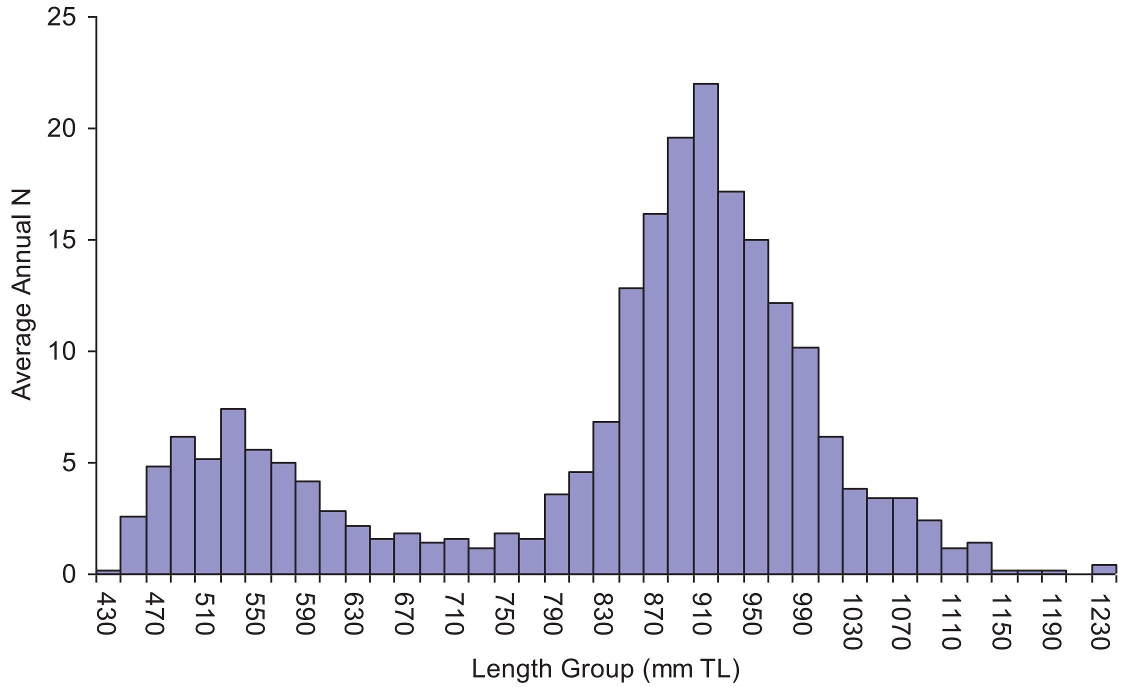



Figure 1. Average annual sample size of female fish by length group from the Maryland spring creel survey, 2009-2013.

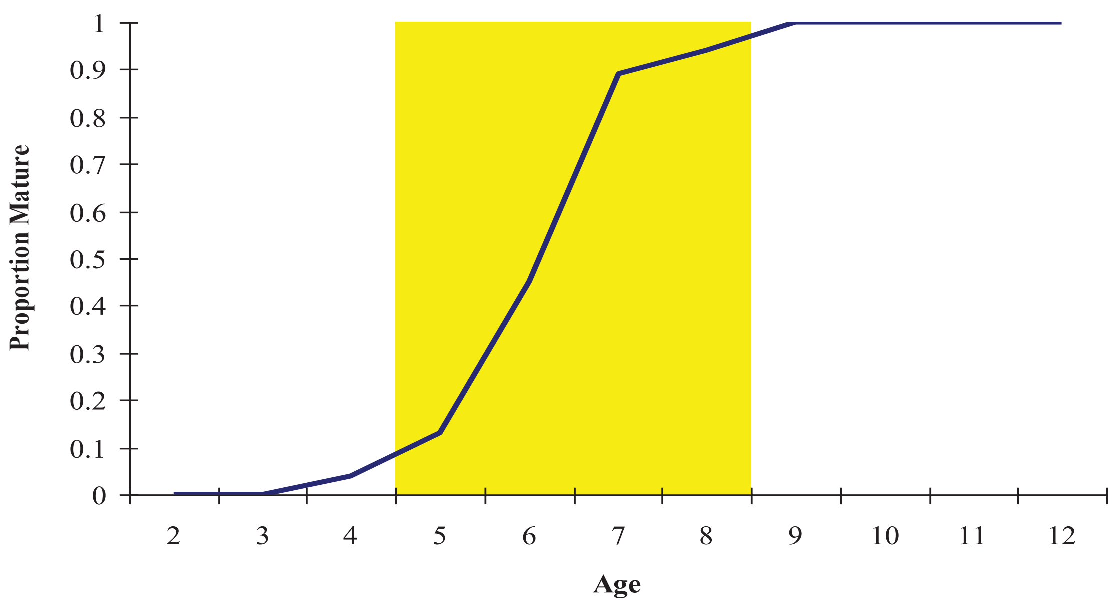



Figure 2. Current maturity ogive for female striped bass. The highlighted area indicates the age range where sampling effort was focused.

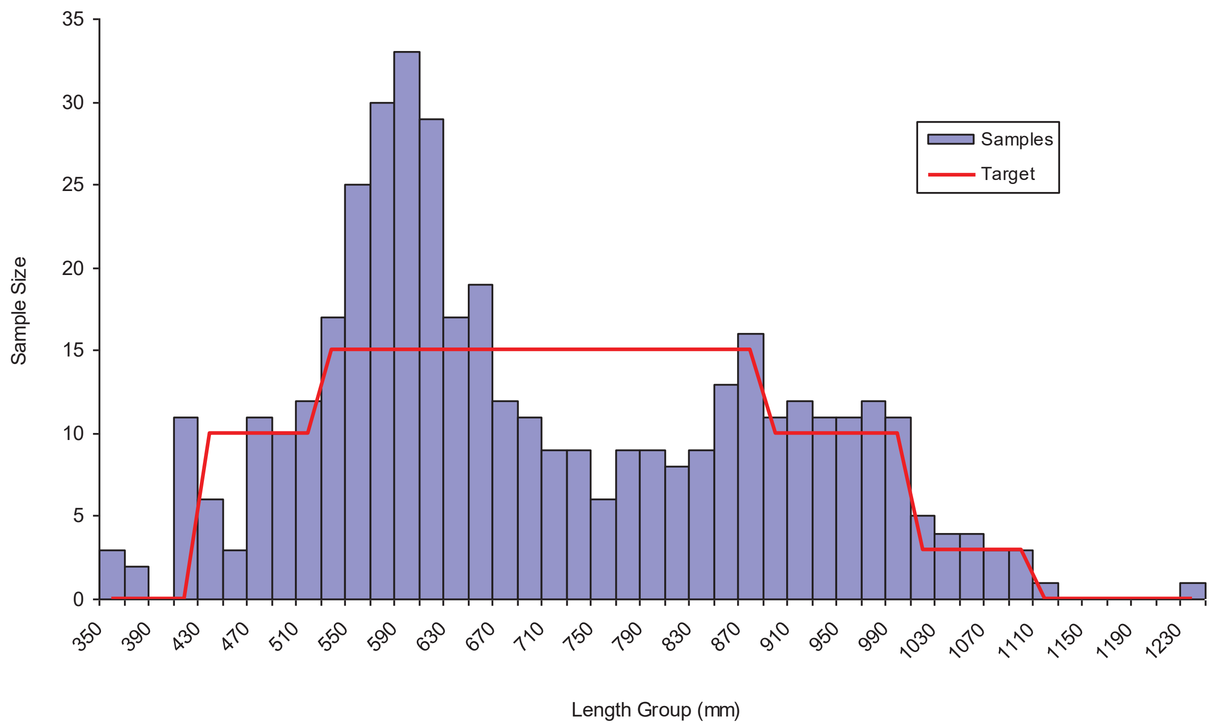



Figure 3. Samples collected vs. targets.

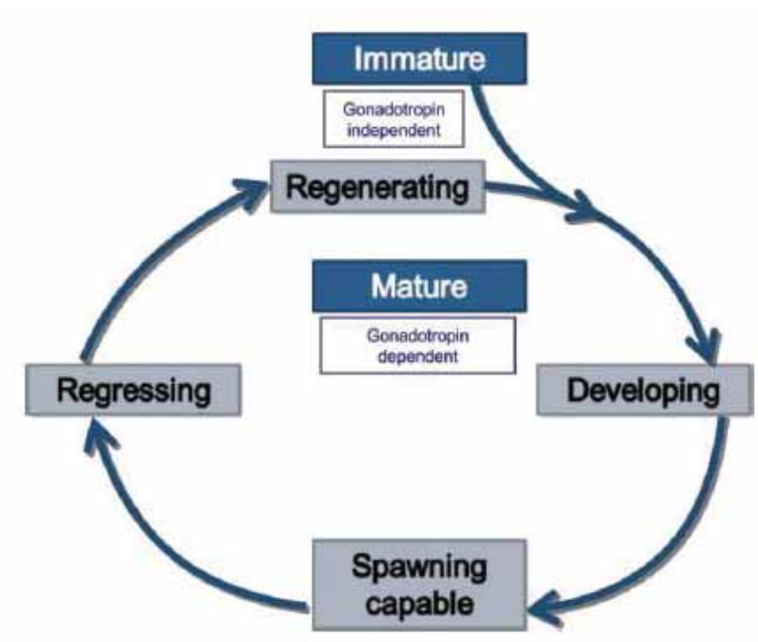
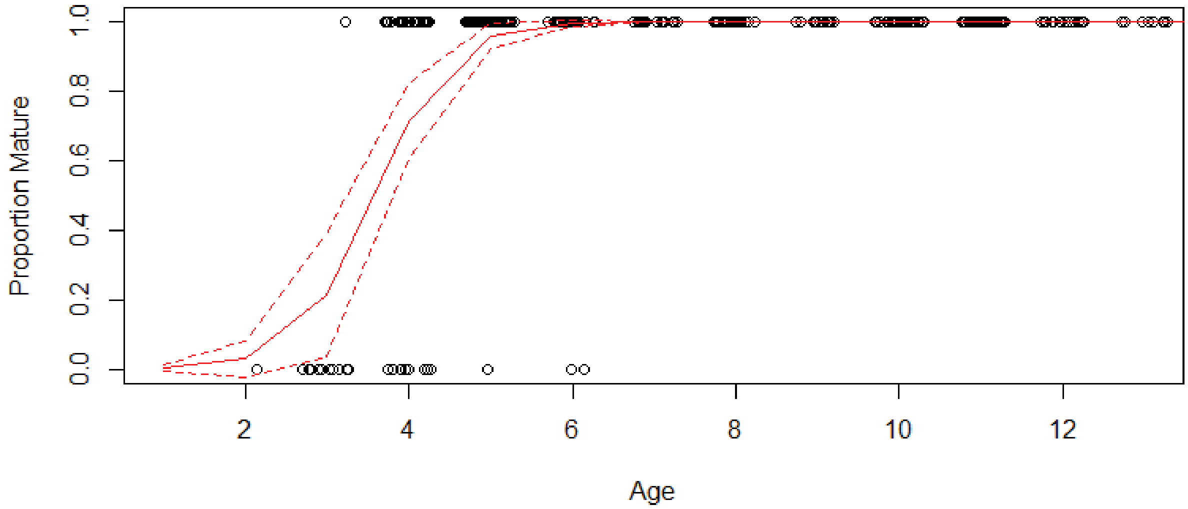



Figure 4. Conceptual model of fish reproductive phase terminology. Figure from Brown-Peterson et al. 2011.



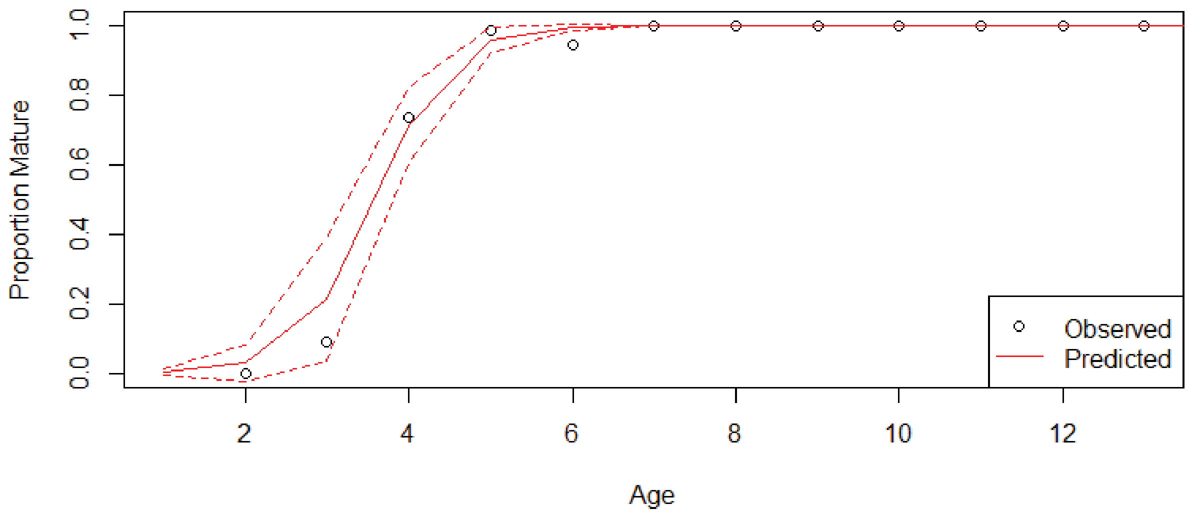
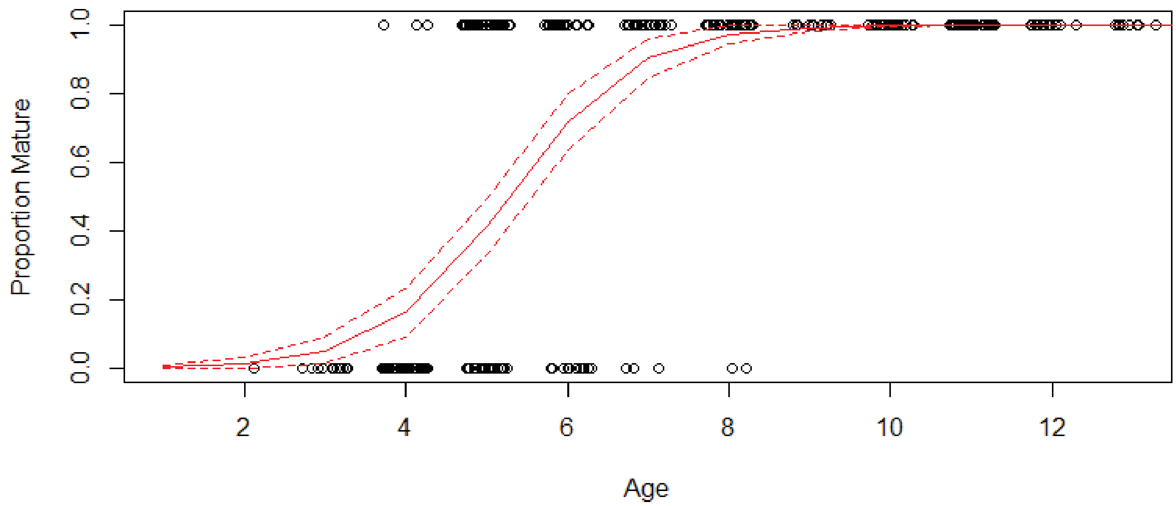




Figure 5. Estimated proportions mature, by age, for the March-July dataset when developing fish are considered mature. Top figure shows the sample size and maturity status for each fish sampled, by age, and bottom figure shows the overall observed proportion mature.



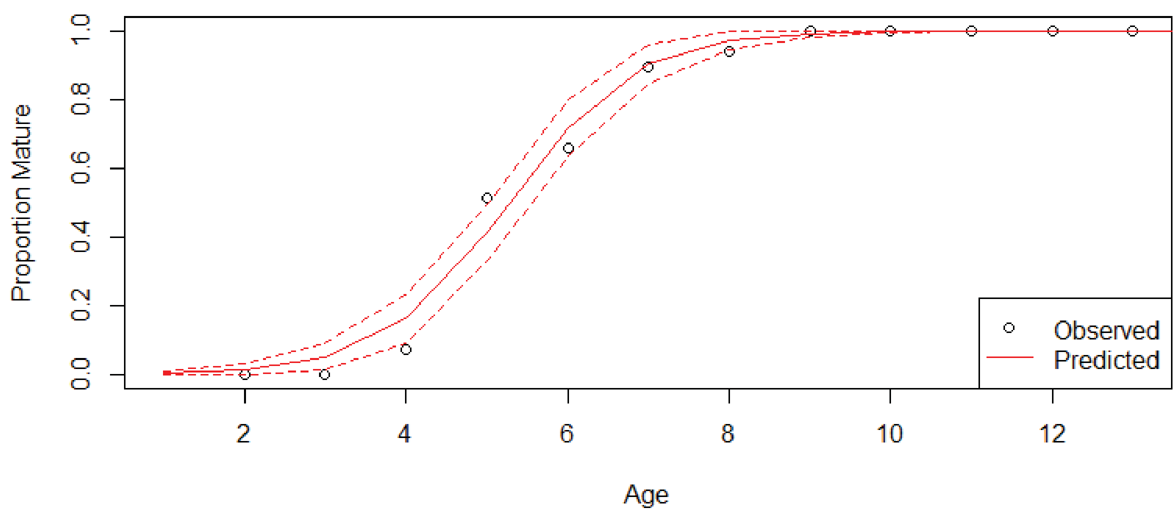
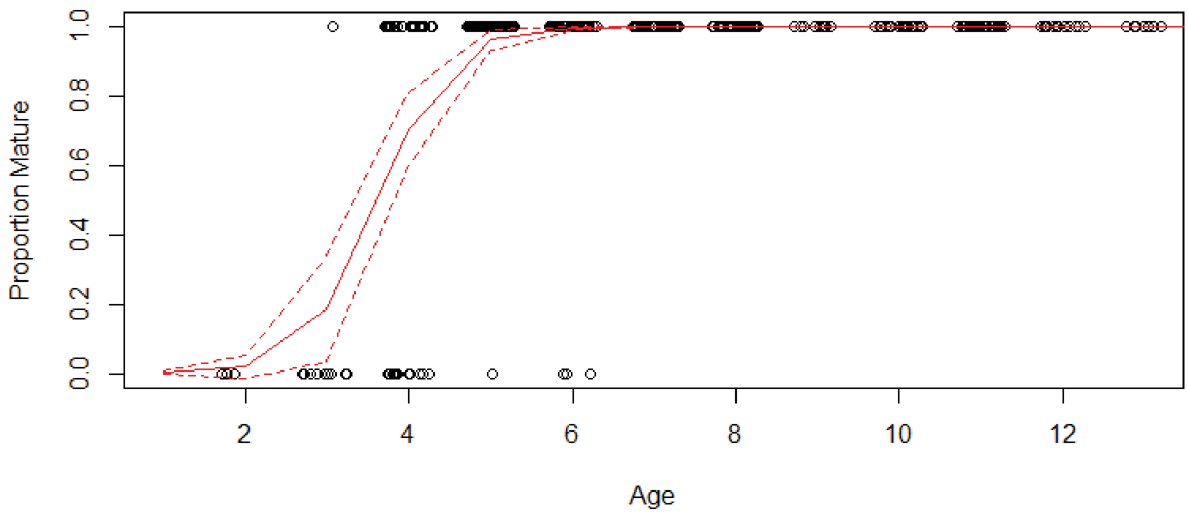




Figure 6. Estimated proportions mature, by age, for the March-July dataset when developing fish are considered not imminently spawning. Top figure shows the sample size and maturity status for each fish sampled, by age, and bottom figure shows the overall observed proportion mature.



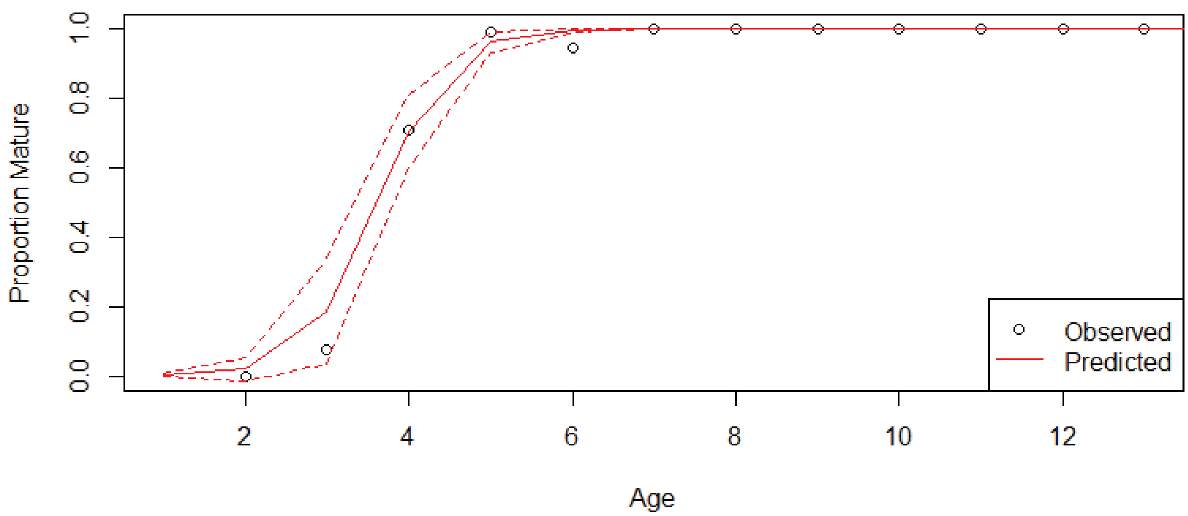




Figure 7. Estimated proportions mature, by age, for the full dataset when developing fish are considered mature. Top figure shows the sample size and maturity status for each fish sampled, by age, and bottom figure shows the overall observed proportion mature.

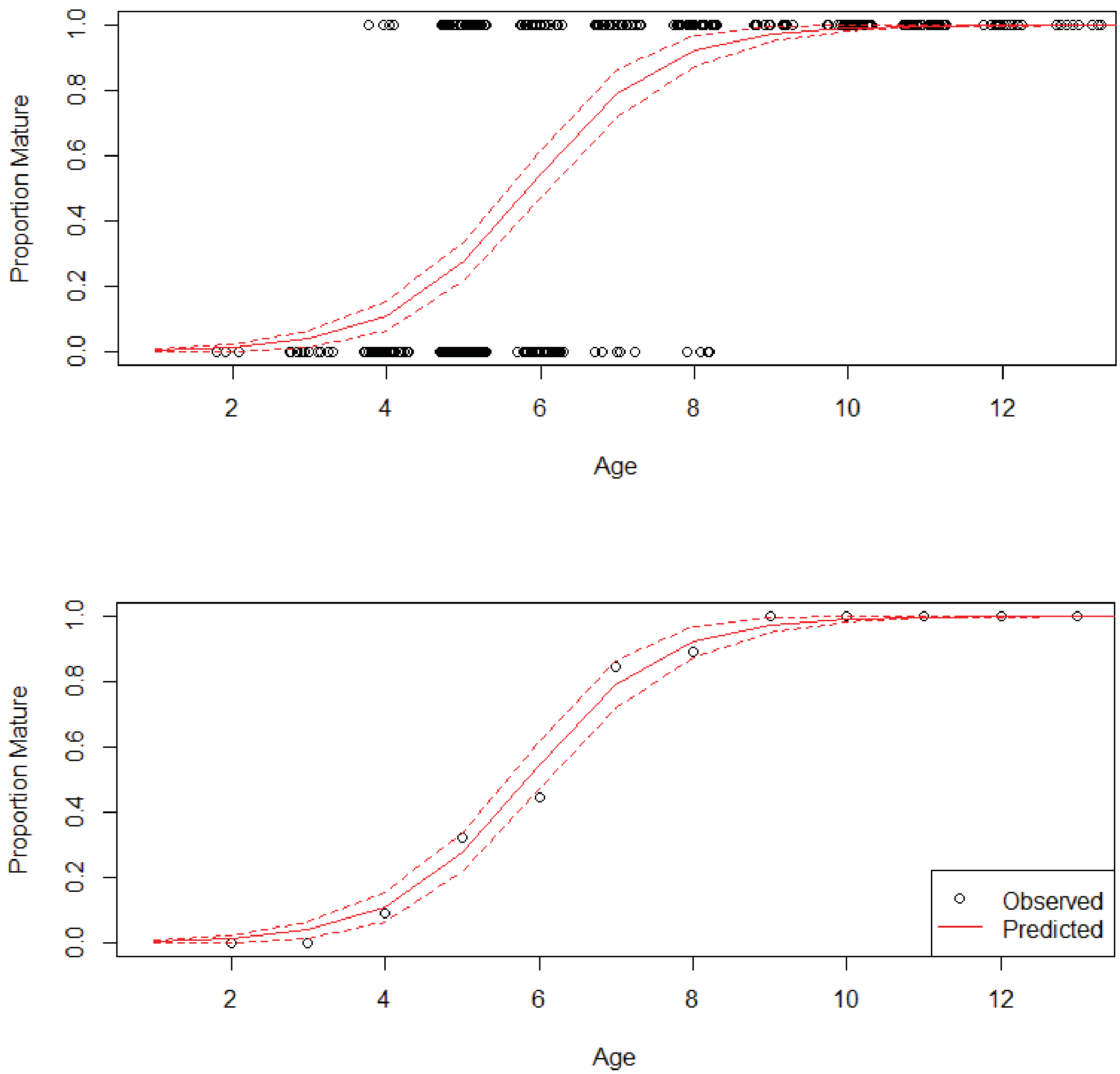



Figure 8. Estimated proportions mature, by age, for the full dataset when developing fish are considered not imminently spawning. Top figure shows the sample size and maturity status for each fish sampled, by age, and bottom figure shows the overall observed proportion mature.

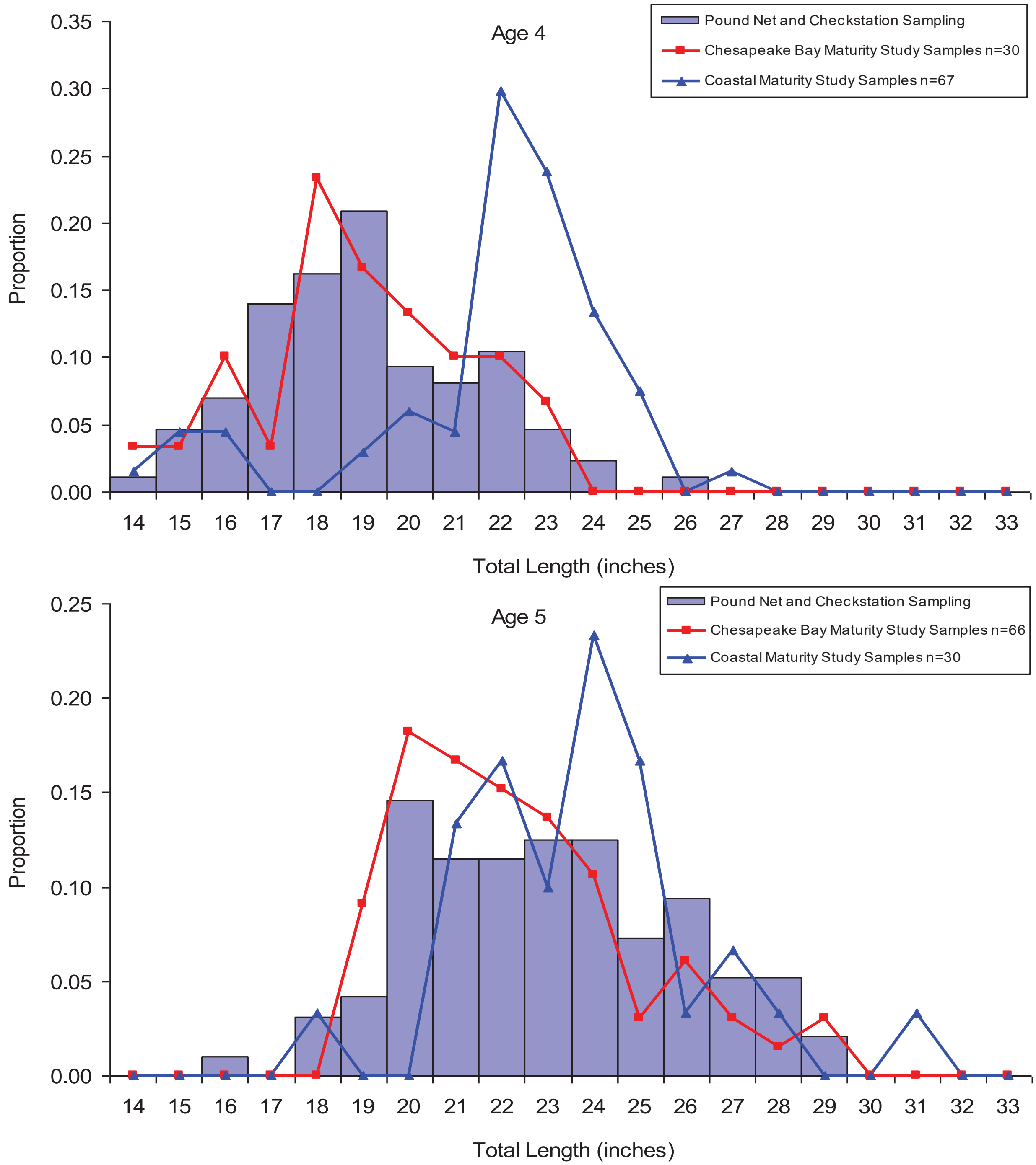



Figure 9. Comparison of the length frequencies, at age, from the summer/fall pound net and checkstation surveys (2014-2016, sexes combined) and fish sampled for the maturity study (2014-2016).

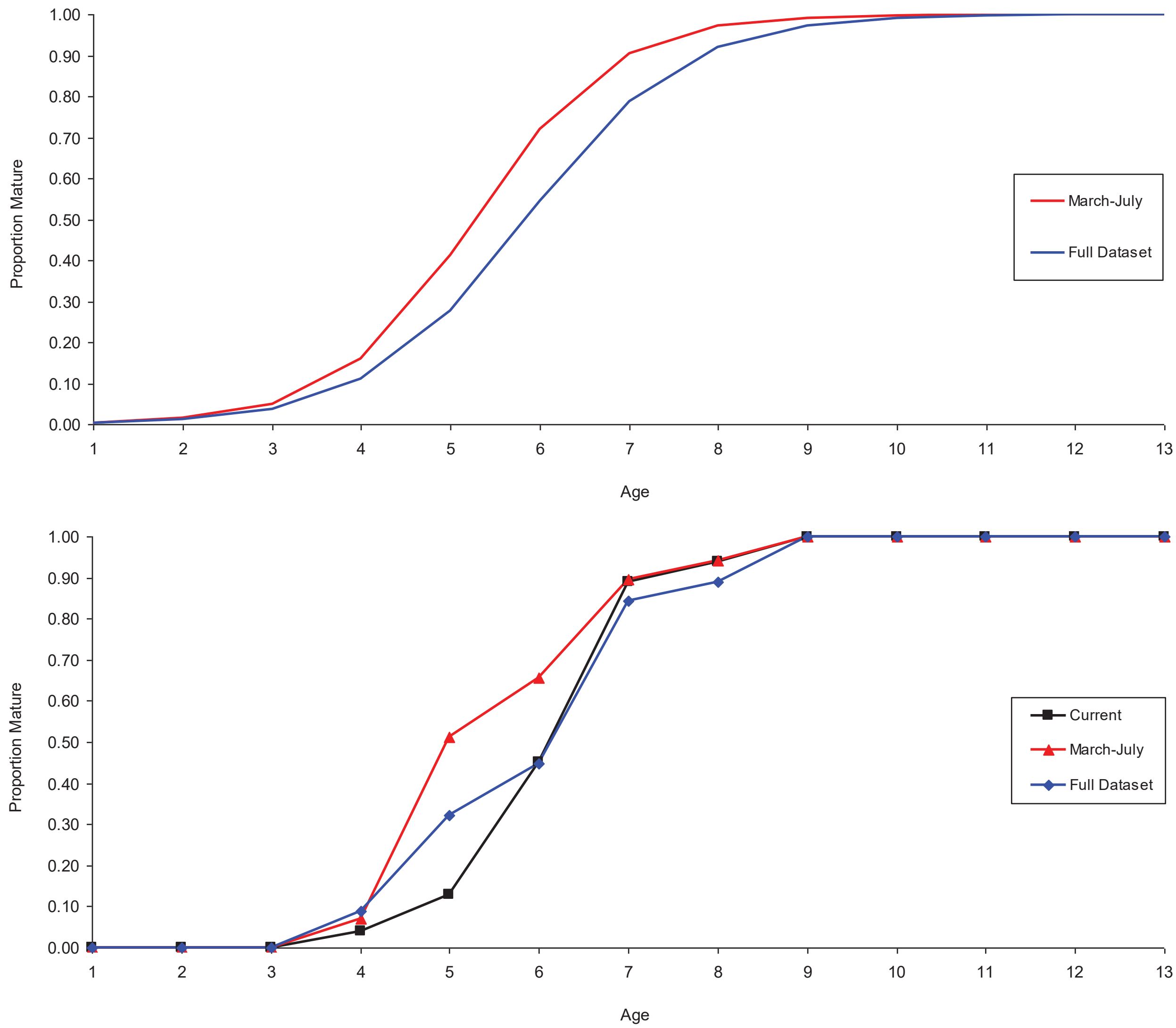



Figure 10. Comparison of the maturity at age estimates between the different data subsets when developing fish are classified as not imminently spawning. Top panel compares the logistic regression estimates. Bottom panel compares the observed proportions.

**Appendix B3. Development of Age-specific Natural Mortality Rates for Striped Bass**

Gary Nelson
Massachusetts Division of Marine Fisheries

Lorenzen (1996)

The Lorenzen (1996) M-weight equation was used to generate Ms-at-age. Weights-at-age were estimated by fitting a curvilinear model (W=a*Age^b) to coast-wide mean weights-at-age available from the stock assessment (Figure 1). Since we are interested in obtaining baseline estimates of M, I used only weights-at age from 1991-1996 in the model fitting. The weights were used in the Lorenzen equation (3.0*weight^-0.288) but scaled to grams before use. The resulting unscaled M estimates were then re-scaled to 1.4% survival at the maximum age of 31 using a spreadsheet formulation provided by Doug Vaughan.

Empirical Estimates

I also derived an M-age equation by fitting another curvilinear model to empirical estimates of M for ages 1-6. The New York Western Long Island tagging program provides annual estimates of instantaneous total mortality rates (Z) for ages 1, 2, and 3-4 by using MARK and the bias-correction method for live releases (Table 1). Since fishing mortality is unlikely a large component of Z, I assumed that M=Z. Based on the proportions of fish released alive by anglers (age 1: avg. 0.83; age 2: avg. 0.94; age 3-4: 0.88; max for all ages =1.0), this assumption is not unrealistic. I averaged estimates from 1991-1996 over each age. I also obtained estimates of M for ages 3, 4, 5 and 6 from 1991-1996 using the Jiang et al. (2007) data and age-dependent model. I re-estimated M for each age (Jiang originally estimated M for ages 3-5 combined and age 6 separately) using program IRATE (Table 2). To aid in model fitting, I assumed a constant M at age 7 using either the assumed SASC M=0.15 or the average M prior to 1997 derived by tagging programs for bass >= 28 inches (Table 3). For ages greater than 7, the estimate of M was assumed the predicted M at age 7 since the equations predicted steep drops in M after age 7. The model (M=a+b/age+c/age^2) was fitted assuming log-normal errors and using least-squares.

Results

The Lorenzen unscaled and scaled estimates of natural mortality are shown in Table 4 and are plotted in Figure 2. The unscaled Lorenzen estimates were much lower than the estimates of M from WLI striped bass at ages 1 and 2, were close to the estimates of M for ages 3-6 for WLI and Jiang, and were generally higher than the assumed SASC constant M of 0.15 through age 22. Scaling the Lorenzen estimates lower the estimates of M for ages 1-6 considerably (Table 4; Figure 2). M estimates for ages >10 were lower than the assumed SASC constant of M=0.15.

The equations estimated using the WLI and Jiang data were:

Assuming M=0.15 at age 7,

$$M = -0.108 + \frac{1.919}{Age} + \frac{-0.683}{Age^2}$$

Assuming M=Avg. Tag M at age 7,

$$M = -0.179 + \frac{2.229}{Age} + \frac{-1.005}{Age^2}$$

The equation estimates of M were much higher at ages 1-4 than either Lorenzen method (Figure 2).

The stock assessment committee chose to use the curve fit/M=0.15 estimates in the SCA model because they thought the estimates were more realistic than the Lorenzen estimates and M for ages <7 were based on tag model estimates prior to the suspected increase in Mycobacterium related mortality in Chesapeake Bay.

Table 1. NY West Long Island Z estimates for 1991-1996 using MARK and bias-correction methods.

| | | Age | |
|---|---|---|---|
| Year | 1 | 2 | 3-4 |
| 1991 | 1.17 | 0.62 | 0.31 |
| 1992 | 1.20 | 0.68 | 0.21 |
| 1993 | 1.15 | 0.63 | 0.30 |
| 1994 | 1.19 | 0.76 | 0.39 |
| 1995 | 1.16 | 0.72 | 0.30 |
| 1996 | 1.16 | 0.84 | 0.30 |
| Average | 1.17 | 0.71 | 0.30 |

Table 2. Re-estimated age-specific M estimates from Jiang et al. (2007) data and model.

| Age | M |
|---|---|
| 3 | 0.44 |
| 4 | 0.43 |
| 5 | 0.36 |
| 6 | 0.152 |

Table 3. Estimated M of 28 inch bass and greater (age 7+) for period prior to 1997 by state programs.

| State | M |
|---|---|
| MA | 0.10 |
| NYOHS/Trawl | 0.10 |
| NJ | 0.07 |
| NC | 0.16 |
| HUD | 0.09 |
| DE/PA | 0.10 |
| MD | 0.14 |

Table 4. Resulting M estimates from the Lorenzen and curve fitting methods.

| | Lorenzen (1996) | | Curve Fit | |
|---|---|---|---|---|
| Age | Unscaled | Scaled | M=0.15 | Avg. Tag M |
| 1 | 0.64 | 0.40 | 1.13 | 1.11 |
| 2 | 0.47 | 0.29 | 0.68 | 0.71 |
| 3 | 0.39 | 0.24 | 0.45 | 0.47 |
| 4 | 0.34 | 0.21 | 0.33 | 0.33 |
| 5 | 0.31 | 0.19 | 0.25 | 0.24 |
| 6 | 0.28 | 0.18 | 0.19 | 0.17 |
| 7 | 0.26 | 0.16 | 0.15 | 0.13 |
| 8 | 0.25 | 0.15 | 0.15 | 0.13 |
| 9 | 0.23 | 0.15 | 0.15 | 0.13 |
| 10 | 0.22 | 0.14 | 0.15 | 0.13 |
| 11 | 0.21 | 0.13 | 0.15 | 0.13 |
| 12 | 0.20 | 0.13 | 0.15 | 0.13 |
| 13 | 0.20 | 0.12 | 0.15 | 0.13 |
| 14 | 0.19 | 0.12 | 0.15 | 0.13 |
| 15 | 0.18 | 0.12 | 0.15 | 0.13 |
| 16 | 0.18 | 0.11 | 0.15 | 0.13 |
| 17 | 0.17 | 0.11 | 0.15 | 0.13 |
| 18 | 0.17 | 0.11 | 0.15 | 0.13 |
| 19 | 0.17 | 0.10 | 0.15 | 0.13 |
| 20 | 0.16 | 0.10 | 0.15 | 0.13 |
| 21 | 0.16 | 0.10 | 0.15 | 0.13 |
| 22 | 0.15 | 0.10 | 0.15 | 0.13 |
| 23 | 0.15 | 0.09 | 0.15 | 0.13 |
| 24 | 0.15 | 0.09 | 0.15 | 0.13 |
| 25 | 0.15 | 0.09 | 0.15 | 0.13 |
| 26 | 0.14 | 0.09 | 0.15 | 0.13 |
| 27 | 0.14 | 0.09 | 0.15 | 0.13 |
| 28 | 0.14 | 0.09 | 0.15 | 0.13 |
| 29 | 0.14 | 0.09 | 0.15 | 0.13 |
| 30 | 0.13 | 0.08 | 0.15 | 0.13 |
| 31 | 0.13 | 0.08 | 0.15 | 0.13 |

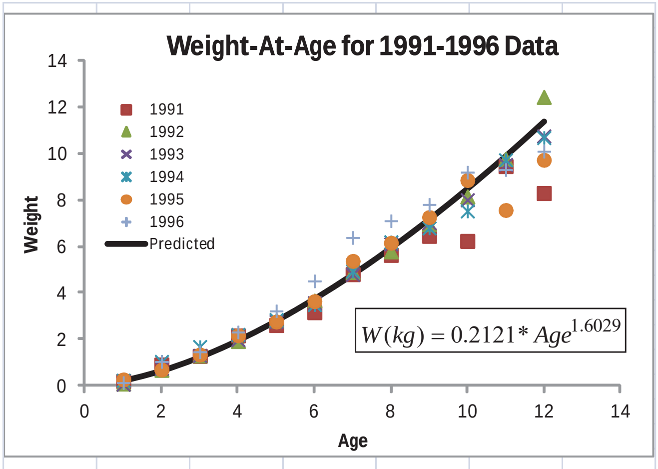



Figure 1. Observed versus predicted weights-at-age.

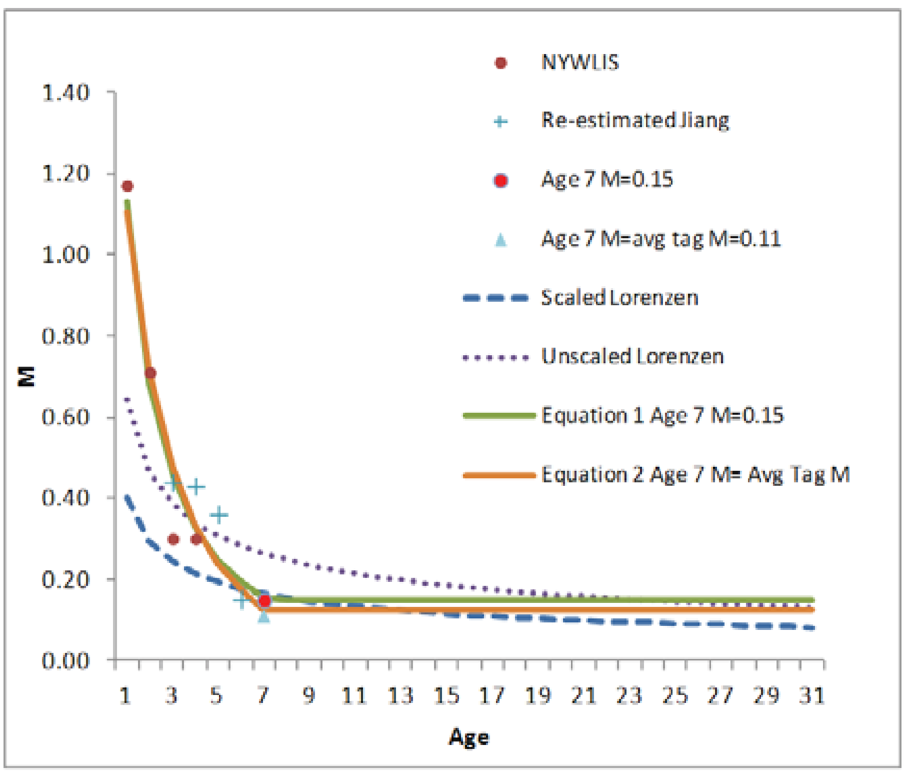



Figure 2. Comparison of estimates of age-specific Ms.

**Appendix B4. Report of the Striped Bass VPA Indices Workshop**

Baltimore, MD
July 28 & 29, 2004

## List of Participants

| NAME | AGENCY | ADDRESS |
|---|---|---|
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## Workshop Purpose

***Impetus***: "An objective discrimination of which tuning indices to include or withhold from the model should be integrated in the next assessment." 36th SAW Advisory

***Goal***: Develop criteria for the inclusion/exclusion of current and future indices for aggregate or age-specific (≥age 2+) used in the striped bass virtual population model.

***Objectives***: Critically evaluate the survey design and precision of the index, and validate each index by comparing it to other area indices. If applicable, determine how the survey design should be modified to be more valuable.

## Background: The Role of Indices in the VPA

Indices are used in the tuning process as a relative index of abundance (abundance at age). Some surveys provide an aggregrate index and others provide an age specific index. Some may be appropriate for aggregation due to precision; others are more precise as an age-specific index.

ADAPT uses the entire time series to determine relative abundance of the cohort in the terminal year. The longer the time series the more information the model has to produce an estimate. After the model produces the estimate, the stock assessment subcommittee evaluates the correlation of the index to the known abundance as the VPA has estimated it.

## Evaluation Criteria

The Workshop participants began the discussion with the some suggested guidelines provided by Gary Nelson prior to the meeting. The guidelines are as follows:

a. Have a sampling design
b. Have an acceptable level of precision (if applicable)
c. Has it been validated? (i.e., is it correlated with indices of abundance of other life stages, etc.)

The sampling design should be appropriate to achieve the objectives of the survey. Additionally, the sampling design should produce a precise estimate. Further indication of a good index is the validation of the survey, comparing it to another index that shows similar trends. There should be a correlation between indices sampling similar portions of the coastwide stock. If an age class can be followed through time, it is also indicative of a good survey.

Taking Gary's suggestions a step further, John Hoenig developed a set of discussion points regarding the index. The following list includes the John points plus additional comments from other participants.

1) Correlation of an index with the VPA is not an appropriate evaluation criterion unless the index pertains to the whole stock. (If substocks in the North go up, as reflected in three indices, and substocks in the South go down, as reflected in one index, you'd get a biased

picture if you eliminated the southern index just because it disagreed with the average (which is dominated by the North)).

2) Validity of sampling design can be used to determine inclusion. An index should not be evaluated based on an inappropriate variance. The appropriate variance can be determined based on the survey's sampling design. For example, if one site is sampled repeatedly (e.g., a pound net) the sample size is one (i.e., one site).

3) The number of sites and the number of days sampled may be useful criteria; a minimum number of fish sampled might be appropriate *in combination* with other factors (number of sites, etc.)

4) All indices should be treated "equally" to be "fair".
    a. If you evaluate one index you should evaluate all of them.
    b. You can kick out indices but there must be a way to reinstate them and there must be a way to introduce new indices that is "fair" in the sense of holding the index to the same standards as other indices.

5) If you want to make a change to the set of indices, it is important to do two assessments in parallel – one the old way and one the new way for several (e.g., 3) years. Otherwise, you can't distinguish between changes in stock perception due to methodology and changes due to stock dynamics.

6) If an index represents only a portion of the stock complex then it should receive a weight less than one. The stock assessment subcommittee has typically weighted the indices according to how well they fit the VPA, e.g., using iteratively reweighted least squares.

7) If an index is unique in representing a particular portion of the stock complex, then it may be desirable to retain the index even if it is not perfect.

8) The primary criterion thus would appear to be whether an index tracks weak and strong year classes well. An index can be considered poor if year-to-year changes in catchability obscure abundance trends.
    a. In looking for year effects, it is not appropriate to look at the residuals from the VPA unless the index being evaluated pertains to the whole stock.
    b. If one plots age-specific indices versus time, then synchronous peaks and valleys (all indices going up and down together) is problematic.

9) If age-specific indices are problematic, the program might still provide an aggregate index

10) Validation of one index against another index from the area provides support for the two indices.

Some of the indices used in the VPA assessment are age-specific and some are age-aggregated indices. It might be necessary to develop different criteria for the two kinds of indices. Before eliminating an age-specific index, the survey should be considered as an aggregated index. The problem with the index may be the ageing. It could still track the stock appropriately as an aggregate.

The Stock Assessment Subcommittee currently uses iterative reweighting for the surveys, meaning the survey weighting is based on how well the index fits the estimate produced by the VPA. The VPA is currently used to derive a single estimate of the fishing mortality on the coastal migratory stock. Ideally, there would be stock specific VPAs that are combined into one coastwide assessment.

If you believe that the particular index gives you reliable representation of the dynamics and abundance of the species in the particular area, then an estimate of variability of the index is needed. Also, you need to know if the same index is representative of the stock coastwide because we are looking for an ideal index of relative abundance that would be truly representative of the stock coastwide. An alternative to the VPA's iterative reweighting would be to assign weights to each index based on an assumed contribution to the overall coastwide migratory stock.

There is some concern about apriori weighting because an index may represent the local stock accurately. Also, as the stocks have rebuilt over time the contribution to the coastal stock has increased. There is uncertainty as to how this can be accounted for in the apriori weighting.

## Review of Sampling Program and Indices

The participant agreed to many of the points in John Hoenig's list, but not all. The group decided to continue with a review of the sampling programs. The evaluation criteria would be further refined as the surveys are reviewed.

***Massachusetts – Commercial CPUE Index (Gary Nelson)***

The Massachusetts Commercial catch per unit effort index has been used in the VPA assessment since the Striped Bass Stock Assessment Subcommittee has used the VPA. The unit of effort has changed over the course of the time series. The method for calculating the CPUE has changed over time with different MA DMF personnel. The time series has been recalculated using a consistent methodology.

The index is really a measure of commercial harvest per effort or an estimate of the number of fish sold per trip. It uses the weight of the fish reported by the dealer and the average weight of the fish measured in the fish house. The average is then weighted by the total fish (whole fish) landed in each county. The total weight reported is an absolute (no variance), but the average weight is estimated so the variance is included. The number of trips comes from the required catch reports. Fishermen must submit catch reports to receive a license for the following year. Catch reports include information such as hours fished, number of fish sold and released by month, and dealer transactions. This survey is used as an age aggregated index and age-specific index.

The sampling design is not ideal for this index because the sampling is dependent on which fish house lands striped bass. Three counties in Massachusetts make up about 80% of the total landings. The information gathered in the fish house does not provide information about the trip, whether it was landed as a direct or indirect take. Most of the Massachusetts striped bass fishermen are weekend warriors.

There are a few problems with the survey design. Permits are issued to the boat, not individuals. Therefore, an average trip per boat is estimated not per fishermen. The number of fishermen is not collected. In Massachusetts, this fishery is hook and line only and has a trip limit of 40 fish per day. There could be five guys on a boat for one hour catching 40 fish or one guy out there all day catching 40 fish.

The catch per effort per trip is not well defined because the information is not collected. There are over 4,300 people permitted but Massachusetts only receives 100-200 voluntary logs with trip dates, numbers caught, hours fished per trip. The average hours fished is estimate from the logbooks. Average hours fished contributes to variability in the survey. There can be hours fished with zero catch. Even though commercial fishermen are required to submit catch reports, not all submit the report despite the penalty of losing the permit in the next year. So Gary has to impute the fish caught using the information he does have. Additional information may be available through the VTR data for commercial fishermen holding a federal permit.

This survey has a multiple stage sampling design, meaning it needs a randomly sample a fish house and then randomly sample the fish. The variance estimate is conditional on assumption of random sample, but sample may not be representative. The fish that end up in the fish houses are random, but the selection of which fish house is sampled is not random. Therefore, we do not know if the sample is representative of all the catch because it is not random. Bootstrapping does not confer validity on an index.

The group discussed the difficulty of setting one standard for all the surveys – the protocol for variation estimation will depend on the survey design, therefore will not be consistent across all surveys. The index should not be thrown out because it's not perfect, especially if there is not another index to replace it and its representative of the area.

The number of trips is declining because the quota is filling more quickly. There is a jump in the CPUE from 1994-1995 because there was a change in the minimum size and the commercial quota also increased. The group is not confident that the CPUE represents the population, particularly the fishery has capped out the quota since 2000. Also, in a representative catch, the cohorts can be followed through the samples. The 1993 yearclass was strong and it cannot be followed through the MA CPUE. One suggestion was to apply a length frequency to the ageing samples for a more representative sample.

For an age-specific index, Massachusetts could randomly pick a fish box to collect samples. The proportion of ages in a sample could be applied to the aggregate index. Massachusetts had to cut down on the sizes of age samples from the fish house due to personnel cut backs.

***Connecticut Recreational CPUE and Trawl Survey***
Connecticut submitted information regarding the trawl survey, but did not provide information on the recreational catch per unit effort. Additionally, there was no representative from Connecticut in attendance at the Workshop. The Connecticut surveys were not reviewed at this time.

***New York Long Island Ocean Haul Seine Survey (Vic Vecchio)***
Originally, the survey had 10 sampling locations that consisted of inshore sandy sites. The locations were randomly sampled from October to November. After the commercial striped bass fishery reopened, commercial trawls were prohibited from state waters. Some localities prohibit NY DEC from accessing traditional sampling sites. In New York, fishermen are not allowed to use ocean haul seine survey to commercially catch striped bass, but can use to fish for other species. The estimates derived from 10 sampling locations were compared to the results with fewer sampling locations. There was no difference in the ages in the catch. Additionally, funding has been reduced impacting the sampling dates and actual survey catch. The dates of the older survey have been standardized.

In reviewing the time series, it is interesting to note that the catch jumped in 1996-1998 due to the 1993 and 1996 yearclasses. Also, in some cases the coefficient of variance exceeded the catch. Bootstrapping would be appropriate for the New York data.

Age samples are taken from every fish measured in the survey. New York is able to produce an estimate of geometric mean catch at age for each survey year. The CV is then calculated for the catch at age and an averaged from 1997-2003 is produced. The survey is not very good at catching the larger fish, so the sample sizes for the older fish are pretty small.

The survey samples a mixed stock. To evaluate the survey, the ocean haul seine survey was correlated to the YOY index. Out of 13 age groups, 11 had positive correlation, but only 6 had a significant correlation.

***New Jersey Trawl Survey (Tom Baum)***
The New Jersey trawl survey has a stratified random sampling design. The survey occurs in April and October. Decreases in funding have led to reductions in annual sampling effort, from 60 to 45 seine hauls. New Jersey's survey was not designed to sample striped bass survey; it was originally for sampling groundfish. Striped bass are tagged when feasible.

In a typical year, there are 30-40 tows in 18 strata, which comes out to about 2 tows per site. The CVs are pretty low in the later half of the time series. The high CVs in the latter half of the time series could be attributed to low sample sizes at each stratum. The standard error should be checked to determine if it was calculated for a stratified random design.

The survey is used as an age aggregated index, aggregating ages from 2-13. April and October are used as separate age aggregated indices because the length frequencies differ significantly, representing different stock composition. April survey is more consistent and therefore probably the better candidate for an age-specific index. New Jersey has an age-length key for every year, so most of the information is available for switching over to an age-specific index. If the survey measures all of the fish caught, then it could be used as an age-aggregated index. It is possible to get age specific data, but New Jersey is not likely to produce the data.

To reduce the variance, some of the strata should be thrown out because no striped bass were caught in that location. The strata should only be removed from the index if there were no striped bass throughout the time series. The variance can be a problem with fixed station trawl surveys because there is no random element to the survey.

***Delaware Trawl Survey (Des Kahn)***
The Delaware trawl survey began during the 1960's, but the exact start date is not well documented. The survey collects weight rather than numbers of fish (kilograms per tow of striped bass). The time series is disjointed because a different vessel was used in the first two segments of the time series. In 2002, the survey began using a new custom-built stern rig trawler. Comparative tows were conducted to get a handle on the catchability of the two vessels.

The trawl survey uses a fixed sampling scheme. It was selected due to the lack of towable bottom in Delaware Bay. The index was conducted the whole year. Due to the number of zero tows, the data was jackknifed – used for situations were the distribution assumptions may not be true. Jackknife does not deal with the lack of distribution of the data; it does assume that the sample is representative of the population from which it is drawn.

The sample size is the number of months that were sampled. In some years, the trawl survey did not operate in March. In each month, the fixed sites were sample nine times.

The trawl survey is used as an aggregate index in the VPA (age 2-7). There is age data available from 1998 forward. To validate the index, it should be compared to another mixed stock index. The lagged juvenile index is often used to confirm trends.

***Delaware Spawning Stock Survey (Greg Murphy)***
The Delaware River spawning stock survey collects age, size, sex, and abundance estimates for striped bass. The survey began in 1991 experimenting with three different collection methods and has continued using electrofishing since 1994. The survey divided the Delaware River into two zones based on river access. There are twelve Delaware stations and fourteen Pennsylvania stations. Over time, some of the stations have been lost due to development.

The stations cannot be considered random, but the observations at each station are random. The survey has a multistage lattice design. The strata are sampled independently of another (i.e. sampling does not affect other sites). The lattice survey design imposes a structure to control the number of times each area sampled.

Another challenge that confronts the survey has been the moving salt line, which can restrict the sample areas upstream where electrofishing is effective. Reviewing its correlation to other life stages, such as a juvenile survey, could validate this survey.

***Maryland Spawning Stock Survey (Linda Barker)***
The objective of the Maryland's spring gillnet survey is to characterize the Chesapeake Bay portion of the spawning stock biomass and provide a relative abundance at age. The survey area at one time covered the Chesapeake Bay, Choptank River and Potomac River, but the Choptank River has since been dropped from the survey. A stratified random design is used to sample the spawning areas.

The group discussed the survey's sampling design to determine if it was truly randomly stratified. Because Maryland DNR samples the same site twice in some days, the design can be referred to as two-stage cluster sampling. It is important to correctly identify the sampling design to properly calculate the variance.

For each sample, all of the striped bass are measured, all females are aged, but only males greater than 700 mm are aged and smaller males are subsampled. Since 2000, approximately 500 fish are aged per year. The group recommended developing area and sex specific age length keys. MD DNR should also look into applying selectivity coefficients.

The survey has revealed that it does not accurately capture the spawning stock biomass as it collects samples of fish ages 2-8. There is a very low variance for ages less than 8 years old and higher variable estimates for ages greater than 8 years old. The number of age 8+ appearing in the survey has increased since the moratorium. The fish caught in the survey are mostly males (age 2-8) and the ages 10 and greater are mostly females. The data is representative of the behavior of the fish, capturing mostly males. The CPUE provides a decent relative abundance at age, but it is not doing a good job of characterizing the spawning stock survey.

***Virginia Pound Net Survey (Phil Sadler)***

Since 1991, Virginia Marine Institute of Science has conducted the Viginia pound net survey. The pound net survey takes place on the striped bass spawning grounds in the Rappahannock River between river miles 44-47. VIMS has the option of sampling up to four commercial nets. The upper and lower nets are used for this survey and the middle nets are used for tagging. VIMS alternates sampling between the upper and lower nets. The sampling occurs from March 30 to May 3, when the females are on the spawning ground. The pound nets are checked twice a week, but are fishing constantly. When the samples are collected, the fish are sexed and measured, scales are taken from every fish, and a subsample of otoliths.

The sex ratio in the catch tends to be two males to every female. The females captured in the survey are generally ages 4 and older and males are age 3 and older. There appears to be no bias in net catchability.

There are several periods where no fish were caught. By averaging the CPUE data, the estimate is low. To eliminate the zero effect, VIMS could graph CPUE by date and determine the area under the curve.

The Workshop participants had a lengthy discussion on the Virginia pound net survey because it is an example of a survey that was removed in recent stock assessment due to poor performance in the VPA. The Virginia pound net survey provides an estimate of catch in the commercial fishery. If a variance is estimated, it is not an estimate of the striped bass abundance rather it is the variance for the commercial catch. The workshop participants suggested several ways to evaluate the survey. Local juvenile surveys can be used for validation. A longitudinal catch curve can also be applied to investigate year effects, specifically to detect downward trends. The catch curves explain how often the striped bass are seen and if the patterns are explainable. VIMS should also examine the temporal window and the spatial window to evaluate the survey design.

***NEFSC Trawl Survey (Gary Shepherd)***

The NEFSC trawl survey uses a stratified random design and assumes that time is irrelevant. The index samples fish from Nova Scotia to North Carolina. It is an eight-week cruise, completed in four two-week legs. Fishing occurs 24 hours per day. The survey did not really start to encounter striped bass until 1991. The survey has shown a general upward trend since 1990. The catch distribution tends to very from year to year and the sizes encountered are also variable.

The NEFSC trawl survey data would be a good candidate for an age-specific index. An age-length key from the New Jersey March-April gillnet survey could be applied to the NEFSC samples. The NEFSC survey is important because it is the only survey to cover the range of the coastal migratory stock. For a good index, the NEFSC would need 400 ageing samples. The fish are encountered in different locations in different years. So the appropriate key needs to applied to the samples. For the fish encountered in the southern range, an age-length key could be derived from the North Carolina Cooperative Cruise.

**VPA Output Compared to the Indices**

The group reviewed the ADAPT VPA output from last year's assessment to each of the indices reviewed during the workshop. The VPA predicted the indices very well when there weren't many striped bass. As the stock increased, the variance went up with the mean. If one of the criteria for inclusion was the index must follow the same trend as the VPA, then none of the indices would be used. The coastal indices should carry the same signal as the VPA output because they characterize the coastal migratory stock. Some of the indices may not align with the VPA because they were down weighted.

Several of the indices show spikes. The spikes should be compared to other indices to determine if there is correlation. The coastal indices should be reviewed to determine if there are spikes that correlate with one another or the VPA output. To determine the validation of the indices, it would be helpful to know how the VPA weighs the indices.

The stock assessment subcommittee has typically used the bootstrap estimates to determine the variation in the surveys. All of the surveys are entered into the VPA and the bootstrap estimates determine if it is appropriate to include each index.

On the other hand, the VPA produces an estimate of the overall stock complex abundance. To use the VPA to evaluate the indices may mean eliminating an index that does not track the overall stock complex, but tracks local trends accurately. An index should not be removed without a legitimate reason for removing the index. The effect of each index on the VPA should be analyzed.

**General Overview of Survey Issues**

The sampling design of each survey was a common theme for discussion during the review of the indices. There tends to be two separate types of programs. The first group includes the

NEFSC trawl survey and the Maryland Spawning Stock Survey. These two surveys are randomized over space. The second group includes other programs such as MA CPUE, which is a census of commercial catch rates, but fishermen are not fishing over random fish. The New York ocean haul seine survey is not randomized over space. The Virginia pound net survey uses two nets over fixed locations. Delaware is randomized, but only 30% can be sampled.

There is confidence that the Maryland spawning stock survey and the NEFSC trawl survey are catching a representative sample of the population because both surveys are randomized over space. Both surveys can get a valid variance. The sampling design of the other surveys may not be randomized; therefore it cannot be assumed that the surveys are a good representation of the stock. Without randomization, the estimate of variance for each survey may not be appropriate.

The Virginia pound provides a good estimate of the fishermen's catch rate, but the variance is not very useful. The NEFSC survey is not designed to catch striped bass and does catch a lot of striped bass. The variance is only useful for qualitative purposes. Variance estimates are for the survey index.

In addition to variance, age information is collected through the indices, despite some of the ageing error issues. Another important measure for the indices is the ability to track cohorts over time. There needs to be confidence that the survey is tracking cohort abundance in a logical trend. Catchability can influence the ability of a survey to track a cohort over time. If the design of the survey changes, the catchability can change.

A survey could reflect logical trends for 8 of the 10 years, straying from the trend in the remaining two years. Those two years could be eliminated if there was adequate evidence that is was due to abnormal climatic conditions influencing fish abundance.

To verify a cohort trend, the survey can be compared to a local young of the year index. States would need to be careful about using the index to validate the juvenile survey and vice versa. In some areas, a young of the year index may not be available for comparison. In these situations, a catch curve could be applied to the cohort. Longitudinal catch curves could be used, not to estimate mortality rates, but to see if there is trend that is useful.

Ideally, the stock assessment will include the same indices as in previous years and then a separate run is made to remove more questionable indices. There should be some guidelines for removing an index from the model run or at the very least an explanation provided in the assessment report. To evaluate an index for inclusion, one could plot the indices by year for each cohort. If one of the indices has a dramatically different trend, the index is not tracking things well. It is important to remember that an index can be valid for a local area, but not for the stock complex. It may track a different trend or a local stock. For example, Chesapeake Bay recruitment correlates well with the Delaware River recruitment, but not the Hudson River.

Striped bass is a stock complex measured by local indices, but the stock complex abundance is supposed to be annually evaluated.

**Recommendations for criteria to evaluate the VPA indices**

The Workshop participants developed a list of evaluation steps that should be applied to each index. The state agencies should use the evaluation list for each state survey. Each program should be analyzed to determine if the survey is conducted at the appropriate time of year, i.e. bracketing the correct spawning period. Similarly, the survey design should be reviewed by the state to determine if the sampling area is correct. If the state determines there is a lot of noise in the data, the state should attempt to refine the data. For instance, if some of the stations catch striped bass consistently and others do not, can something be done to refine these data? The states should identify if the indices are sex-specific indices or age-specific due to survey design. Because a self-evaluation by each state could be subjective, the Technical Committee should evaluate the state's program evaluation and make a recommendation to the Striped Bass Stock Assessment Subcommittee.

1. Evaluate design and best method to evaluate uncertainty of index.
2. Assess the index and/or improve the index to get the best signal.
3. Validate the index before use in the VPA.
    a. Sensitivity of the VPA results to the influence each index.
    b. Validate an index to a JAI, where possible.
    c. Longitudinal catch curves, to determine the cohort trends.
    d. Plots of age specific index v. year to see if cohorts are moving in a specific direction.
4. Evaluation by the agency conducting the survey
    a. Rank (weight) index
    b. Criticisms/Supporting Evidence
5. Evaluate by the Striped Bass Technical Committee
    a. Evaluate index based on survey design, precision, and ability to track cohorts or portion of the stock targeted.
    b. Provide recommendations to the Striped Bass Stock Assessment Subcommittee on which indices should be used in the assessment.

The Workshop participants developed a matrix in Excel that includes the important components for evaluating each index (sampling design, time of year, tracking stock or catch, etc.). Also included in the matrix are recommendations to improve and evaluate the survey.

**RPOSE: TO ESTIMATE FINAL YEAR ABUNDANCE**

| SURVEY | SINCE | SAMPLING DESIGN | TIME OF YEAR | STOCK OR CATCH | WHAT STOCK? | AGES | VARIANCE? |
|---|---|---|---|---|---|---|---|
| NMFS (TOTAL, REC HARVEST) | | SURVEY | ALL | CATCH | MIXED | | YES?? |
| NEFSC CRUISE | | STRAT RANDOM | SPRING/FALL | STOCK | MIXED | | YES |
| MASS COMM CATCH | | NONE | ALL | CATCH/HARVEST | MIXED | | |
| RI - FLOATING TRAPS? | | | | | | | |
| CONN TRAWL SURVEY | | | | STOCK | MIXED | | |
| CONN REC CATCH | | | | CATCH | MIXED | | |
| NY HAUL SEINE | | FIXED STATION | FALL | STOCK | MIXED | | |
| NY HUDSON SPAWN SURVEY | | STRAT RANDOM | | STOCK | HUDSON | 5-10 | YES |
| PA RIVER SURVEY | | | | | | | |
| NJ TRAWL SURVEY | | STRAT RANDOM | SPRING | STOCK | MIXED | | YES? |
| NJ REC CATCH | | NONE | ALL | CATCH | MIXED | | NO |
| DEL RIVER SURVEY | | CLUSTER?? | SPRING | STOCK | DEL | | |
| DEL TRAWL SURVEY | | FIXED STATION | ALL | STOCK | MIXED | | |
| MD JI | | FIXED STATIONS | SUMMER | STOCK | CBAY | | |
| MD SPRING GILLNET SURVEY | 1985 | STRAT RANDOM | SPRING | STOCK | CBAY | | |
| VA POUND NETS | 1991 | FIXED STATIONS | | CATCH | RAPP | 3+ | YES/NO |

| SURVEY | EVALUATION/CRITERIA | RECOMMENDATIONS |
|---|---|---|
| NMFS (TOTAL, REC HARVEST) | | Define what an index would be using total catch and effort |
| NEFSC CRUISE | | Age fish samples from trawls; review strata choices |
| MASS COMM CATCH | | Standardize minimum length numbers; compare lengths of subsamples to length of all; examine applying age-length keys;develop index with total catch; adjust index for covariates; examine whether change in week-end warrior composition |
| RI - FLOATING TRAPS? | | see if data is available for development of an index |
| CONN TRAWL SURVEY | | segregate into age-specific indices; use age-length key instead of VB equation |
| CONN REC CATCH | | Describe and evaluate |
| NY HAUL SEINE | AGAINST TOTAL JI? NY JI? | resestimate precision using bootstrap; compare index at age to Jis individually |
| NY HUDSON SPAWN SURVEY | | Describe and evaluate; generate age-specific indices with appropriate variance |
| PA RIVER SURVEY | | Describe and evaluate |
| NJ TRAWL SURVEY | | Examine strata choices; generate age-specific indices using April data |
| NJ REC CATCH | | determine if development of an index is possible |
| DEL RIVER SURVEY | | investigate area under curve method for possible spatial distribution issues; examine temporal disitribution within strata; compare upper river index to PA survey |
| DEL TRAWL SURVEY | | change biomass index to numbers; generate age-specific indices; compare indices to VPA for age 1 |
| MD JI | AGAINST LAGGED CATCH | |
| MD SPRING GILLNET SURVEY | | examine first vs second set;review impact of sex-specific catchabilities |
| VA POUND NETS | AGAINST JI, LONG CATCH CURVES, YEAR EFFECTS, CATCH VS. TEMPORAL WINDOW | AGAINST JI, LONG CATCH CURVES, YEAR EFFECTS, CATCH VS. TEMPORAL WINDOW; examine flow regimes; compare index to MDs |

## Summary of Responses To Workshop Recommendation

| Survey | Index Type | In VPA? | Workshop Recommendations | Recommendations Addressed? | PSE Range | Attempted Validation? |
|---|---|---|---|---|---|---|
| NEFSC | Age-specific: ages 3-11 | Yes | Age fish samples in trawl;review strata choices | No | No PSEs provided for age-specific indices. Untransformed, aggregate index PSEs (91-04): range= 0.13-0.58, mean=0.29 | No |
| MA Comm Catch | Aggregate and age-specific commercial Index | Yes | Standardize min. length numbers; compare lengths of subsamples to length of all; examine applying age-length keys; develop index with total catch; adjust covariate; examine week-end warrior composition | Yes A total catch index was developed using covariates, making most recommendations moot. | Old index age 7-12 average PSE: 7-0.51,8-0.23,9-0.13, 10-0.13,11-0.18,12-0.23. New Index age7-12 PSE (for 2000): 7- 0.05, 8-0.08, 9-0.10,10-0.11,11-0.15,12-0.22 | Yes, correlation of aggregate indices to other aggregate indices (MRFSS, NYOHS, NJ, CT) but no significant correlations of new age indices to other programs; only 1996 YC could be tracked over only three years; influence of age-specific and aggregate index on VPA results increased. |
| RI – Floating Traps | ? | No | See if data is available for development of an index | No | None | No |
| CT Trawl Survey | Aggregate Index (spring) | Yes | Segregate into age-specific indices using age-length keys instead of VB equation | No | Ln transformed, aggregate index PSEs: range=0.1-0.5, mean=0.20 | No |

| Survey | Index Type | In VPA? | Workshop Recommendations | Recommendations Addressed? | PSE Range | Attempted Validation? |
|---|---|---|---|---|---|---|
| CT Rec Catch | Age-specific: ages 2-11 | Yes | Describe and evaluate | No | None | No |
| NY Ocean Haul Seine | Age-specific Index: ages: 3-13+ | Yes | Re-estimate precision using bootstrap; compare index at age to juvenile indices individually | Yes | Aggregate PSEs:mean=0.08; Age-specific PSEs: 2-0.17,3-0.11,4-0.13,5-0.16,6-0.22,7-0.23,8-0.39,9-0.51 | Yes, strong correlations between CB juvenile index and indices for ages 2-5; not so for older ages. |
| NY Hudson Spawn Survey | ? | No | Describe and evaluate; generate age-specific indices | No, but survey would be inappropriate | None | No |
| PA River Survey | Electrofishing survey | No | Describe and evaluate | No | None | No |
| NJ Trawl Survey | Aggregate Index | Yes | Examine strata choices; generate age-specific indices using April data | No | Aggregate index PSEs (91-03): range 0.18-0.69, average 0.38 | No |
| NJ Rec Catch | RecCatch/Effort | No | Determine if development of an index is possible | No | None | No |

| Survey | Index Type | In VPA? | Workshop Recommendations | Recommendations Addressed? | PSE Range | Attempted Validation? |
|---|---|---|---|---|---|---|
| DE Spawning stock River Survey | Electrofishing aggregate and age-specific: ages 2-15 | No | Investigate area under the curve method for possible spatial distribution issues; examine temporal distribution within strata; compare upper river index to PA survey | Yes – claims multistage lattice design addresses spatial and temporal distribution issues. | Aggregate PSEs (96-03): mean=0.20. Age-specific mean PSEs: 2-0.52,3-0.3,4-0.31,5-0.29,6-0.27,7-0.27,8-0.26,9-0.27,10-0.36,11-0.34,12-0.47, 13-0.46 | Yes, compared age-specific indices to NJ juvenile fish index and found 6 out of 14 were significantly correlated. However, only 3 of nine comparisons between DE and PA surveys were significantly correlated. |
| DE Trawl Survey | Aggregate Index | No | Change biomass index to number; generate age-specific indices; compare indices to VPA for age 1 | Some – developed numbers index using GLM | Aggregate mean PSE (91-04): 0.29 (I calculated from Table 3) | No |
| MD Spring Gillnet Survey | Age-specific 2-13+ | Yes | Examine first vs second set;review impact of sex-specific catchabilities | In progress, showed differences in catchability and visibility | Age-specific mean PSEs (91-04):2-0.11, 3-0.02, 4-0.02,5-0.03,6-0.03,7-0.03,8-0.04,9-0.06,10-0.14,11-0.10,12-0.10,13-0.71 | No |

| Survey | Index Type | In VPA? | Workshop Recommendations | Recommendations Addressed? | PSE Range | Attempted Validation? |
|---|---|---|---|---|---|---|
| VA Pound Net Survey | Fixed Pounds Net | No | Validate Index against MD and VA juveniles indices; examine year effects,; use longitudinal catch curves; examine catch versus temporal window, flow regimes. | Yes – no relationship between river flow and index; Mar 30-3May window better for inter-annual assessment of stock | Can't be calculated due to fixed sites | Yes, compared age-specific indices for age 3 8 to VA JI index but found poor correlation; weak correlation for age 9-10; high correlation between age 11-12 index and JI; there were no correlations between index and MD juvenile indices. |

## Appendix B5. Atlantic Striped Bass Commercial and Recreational Monitoring and Development of Removals at Age

1. **Commercial Monitoring**

## State Commercial Landings Monitoring Programs

*Massachusetts*

Fish dealers are required to obtain special authorization from the Division of Marine Fisheries (DMF) in addition to standard seafood dealer permits to purchase striped bass directly from fishermen. Dealer reporting requirements include weekly reporting to the DMF or Standard Atlantic Fisheries Information System (SAFIS) of all striped bass purchases. If sent to DMF, all harvest information is entered into SAFIS by DMF personnel. Harvest is tallied weekly to determine proximity of harvest to the quota cap. Following the close of the season, dealers are also required to provide a written transcript consisting of purchase dates, number of fish, pounds of fish, and names and permit numbers of fishermen from whom they purchased. Fishermen must have a DMF commercial fishing permit (of any type) and a special striped bass fishing endorsement to sell their catch. They are required to file catch reports at the end of the season, which include the name of the dealer(s) that they sell to and extensive information describing their catch composition and catch rates. If an angler does not file a report, they cannot obtain a permit in the next year.

*Rhode Island*

Commercial harvest is reported through Interactive Voice Recording (IVR) and SAFIS. The IVR is a phone-in system designed to monitor quota-managed species, including striped bass. The reported data are aggregated by dealer and include gear, pounds landed, and date landed. SAFIS collects trip level data over the web in accordance with data standards developed by the Atlantic Coastal Cooperative Statistics Survey (ACCSP). Specific data fields include: vessel name, vessel identification (state registration or US Coast Guard Documentation Number), RI commercial license number, port landed, species, reported quantity, unit of measure, date landed, and price. The commercial harvest reported for RI is considered a complete census. The RI Division of Fish and Wildlife (DFW) has a harvester logbook for the commercial finfish and crustacean fishery sectors that collects catch and effort statistics and the associated gear types, gear sets, and areas fished as well as validates data reported by dealers and commercial fishermen.

*New York*

New York's annual quota (in pounds) is converted into a total number of fish, based on the mean weight of striped bass sampled during state monitoring efforts in the prior year. Each participant in the fishery is issued a fixed number of tags and a set of trip report forms. The regulations governing the fishery require that a commercial harvester tag each legal fish taken within the slot limit for sale, and that report forms are completed whenever any fishing trips are taken. Forms include all the data fields as described in the Rhode Island and Virginia sections of this appendix, as well as fields for area and depth fished, amount of fish harvested in both pounds and count, and specific serial numbers of tags used for each trip. If no trips were taken for an entire month, harvesters must submit a monthly "did not fish" report. All reports are due within 15 days from the end of each month. At the conclusion of the commercial season, any unused tags must be returned to the department. Each participant's harvest records are examined to account for all tags issued. A complete census of the commercial harvest is reported to NMFS each year, and information is also sent to the ACCSP for inclusion to the Data Warehouse.

*Delaware*

Each fisherman has an Individual Transferable Quota (ITQ), for which they are issued tags by the Division of Fish and Wildlife (DFW). Tags are tamper-proof and serial numbered in accordance with the recommendations of the ASMFC's Law Enforcement Committee. Each harvested fish must be tagged by the fisher and then tagged by a certified weigh station, which must report daily to a real-time quota monitoring system. Fishers must also submit a seasonal catch log.

*Potomac River Fisheries Commission (DC)*

Mandatory reports of daily activity are submitted on a weekly basis. Failure to report can, and has, resulted in the loss of licenses. Harvest numbers are considered a complete census since all fishermen must report. Each fisherman is given a report book with one sheet for each fishing week at the beginning of the year. He/she records daily harvest (in pounds by market size category and the number of striped bass ID tags used, i.e. the number of fish harvested), amount of gear used (effort), the area of the river where the fish were caught and the port or creek of landing. The buyer records the average selling price and the estimated discards are reported for the week. The reports are mailed to the PRFC weekly and entered into the system and reported to NMFS via the Virginia Marine Resources Commission (VMRC).

*Maryland*

All commercially harvested striped bass are required to be tagged by the fishermen prior to landing with serial numbered, tamper evident tags inserted in the mouth and out through the operculum. These tags verify the harvester and easily identify legally harvested fish to the public and law enforcement. Each harvest day and prior to sale, all tagged striped bass are required to pass through a commercial fishery check station. Check station employees, acting as representatives of MD Department of Natural Resources (DNR), count, weigh, and verify that all fish are tagged. The check stations are required to call daily and report the total pounds of striped bass checked the previous day, as well as keep daily written logs detailing the activity of each fisherman, which are returned weekly by mail. Individual fishermen are required to report their striped bass harvest on monthly fishing reports and to return their striped bass permit to DNR at the end of the season.

*Virginia*

All permitted commercial harvesters of striped bass must report the previous month's harvesting activities to VMRC no later than the 5$^{th}$ day of the following month, in accordance with the VMRC regulation that governs the mandatory harvester reporting program. This regulation requires that the monthly catch report and daily catch records shall include the name and signature of the registered commercial fisherman and his license registration number, buyer or private sale information, date of harvest, city or county of landing, water body fished, gear type and amount used, number of hours gear fished, number of hours watermen fished, number of crew on board including captain, species harvested, market category, and live weight or processed weight of species harvested, and vessel identification (Coast Guard documentation number, VA license number or Hull/VIN number). Any information on the price paid for the catch may be provided voluntarily. In addition, all permitted commercial harvesters of striped bass must record and report daily striped bass tag use and specify the number of tags used on striped bass harvested in either the Chesapeake Area or Coastal Area. Daily striped bass tag use on striped bass harvested from either the Chesapeake area or Coastal area, within any month, must be recorded on forms provided by the Commission and must accompany the monthly catch report submitted no later than the 5$^{th}$ day of the following month. Any buyer permitted to purchase striped bass harvested from Virginia tidal waters must provide written reports to VMRC of daily purchases and harvest information on forms provided by VMRC. Such information shall include the date of the purchase; buyer and harvester striped bass permit numbers, and harvester Commercial Fisherman Registration License number. In addition, for each different purchase of striped bass harvested from Virginia waters, the buyer shall record the gear type, water area fished, city or county of landing, weight of whole fish, and number and type of tags (Chesapeake area or Coastal area) that applies to that harvest. These reports shall be completed in full and submitted monthly to VMRC no later than the 5$^{th}$ day of the following month. In addition, during the month of December, each permitted buyer shall call the VMRC interactive Voice Recording System, on a daily basis, to report his name and permit number, date, pounds of Chesapeake area striped bass purchased, and pounds of Coastal area striped bass purchased.

*North Carolina*
Commercial harvest is monitored real time through dealer reporting on a daily basis. Dealers report total numbers of fish and total pounds each day. Each fish must have a Division of Marine Fisheries (DMF) tag affixed through mouth and gills upon processing at the fish house. However, the final numbers and pounds used in reports come from the NC DMF trip ticket program. The trip ticket program collects gear data, species data, and total pounds per species each time a commercial fisherman makes a sale at a fish house.

**Commercial Harvest Length-Frequencies**

Data on length and weight of commercially harvested striped bass are collected through various state-specific sampling programs described below.

*Massachusetts*
Commercial port samplers visit fish houses throughout the state during the commercial season and measure striped bass being sold. All fish present on a given day are sampled or if there are too many, a sub-sample of totes containing fish are randomly selected. The number measured (TL and FL) and weighted (pounds) is based on the discretion of the port sampler. Approximately, 500-700 fish are measured each season. The length information collected is used the generate length distributions of harvested fish.

*Rhode Island*
Dockside samples are collected from commercial floating fish trap and rod and reel fisheries. Every individual striped bass observed is measured for fork length (inches) and weighed (pounds). Sampling begins in May or June and continues through October, when the majority of commercial fishing for striped bass in Rhode Island takes place. The low possession limit, especially in the rod and reel fishery, limits the number of striped bass available for sampling on any given day. The proportion of striped bass at length caught in the commercial fisheries is assumed equal to the proportion of striped bass at length sampled from the commercial harvest. The length frequency distributions are estimated separately for the trap and rod and reel fisheries and generally about 185-492 fish are measured per year per gear type. The total number of striped bass commercial harvest is estimated for each fishery by using the sample numbers and weights to extrapolate to the total weight landed. The estimated total number and the proportions at length are multiplied to compute the estimated number at length for each gear.

*New York*

Each week during the open season, staff from the Bureau of Marine Resources visit wholesale markets (packing houses), retail markets, or intercept commercial harvesters at marinas or gas docks to sample striped bass caught for commercial purposes. The open geographic area is limited in size, therefore only a few large wholesale markets/packing houses are worth visiting. The information recorded from each fish includes the tag number, fork length, total length, and weight. A sample of scales is collected from each fish. Each year, approximately 1,000 samples are collected.

*Delaware*

Commercial harvest is sampled at certified, permitted weigh stations. Real-time quotas are monitored to determine sampling frequency, both temporally and spatially. Random sub-sampling includes fork and total length, weight, sex, and scale sample for age determination. Additionally, striped bass are purchased throughout the commercial season for stomach content analysis and otolith age determination.

*Potomac River Fisheries Commission (DC)*

A random sample (weekly or monthly) is purchased from local fish buyers. The samples are transported to Virginia Institute of marine Sciences (VIMS), where length, weight, sex and age (scales) are recorded. The recent average monthly harvest is used to establish a target sampling frequency and sample sizes. Samples are processed by professionally trained people at VIMS.

*Maryland*

Pound net sampling occurs during five rounds from May through October. Each round is 10 to 11 days long. Maryland waters of the Chesapeake Bay are subdivided into three regions; the Upper Bay (Susquehanna Flats south to the Bay Bridge), the Middle Bay (Bay Bridge south to a line stretching between Cove Point and Swan Harbor), and the Lower Bay (Cove Point/Swan Harbor south to the Virginia line. For each round, an optimum number of fish to be sampled is determined for each Bay region. At each net sampled, data recorded includes latitude and longitude, date the net was last fished, depth, surface salinity, surface water temperature, air temperature, secchi depth (m), and whether the net was fully or partially sampled. If the net is fully sampled, all striped bass (including sub-legal fish) are measured for total length (mm TL) and, healthy, legal-size fish (≥457 mm total length) are tagged with USFWS internal anchor streamer tags. If the pound net is partially sampled, legal-size striped bass are targeted for tagging. Check stations across Maryland are randomly sampled for pound net and hook-and-line harvested fish each month from June through November. For pound nets, sample targets of fish per month are established for June through August and for September through November. For hook-and-line, a sample target of fish per month is established over the six-month season.

*Virginia*

VMRC has been collecting striped bass biological data since 1988. The field sampling program is designed to sample striped bass harvests, in general proportion to the extent and timing of these harvests within specific water areas. Since 2003, VMRC has managed its Coastal Area and Chesapeake Area harvests by two different ITQ systems, and data collections procedures are intended to ensure adequate representation of both harvest areas. Samples of biological data are collected from seafood buyers' place of business or dockside from offloaded striped bass caught by pound nets or haul seines. Infrequently, some gill net or commercial hook-and-line fishermen's harvests may be sampled directly. At a majority of the sites, striped bass are sampled from a 50-pound box that was previously boxed and iced. At other sites, recently landed fish are randomly sampled directly from the culling table. For each specimen, length is measured using an electronic fish measuring board (FMB), with the accuracy of +/- 2.5 millimeters, and weight is recorded directly to the FMB, from an Ohaus scale, accurate to the nearest 0.01 pound. A sub-sample of fork lengths are taken, but all striped bass are measured for total length (natural) from the tip of the fish snout to the end of its caudal fin. Sub-samples of sex information and fish hard parts (scales and otoliths) are also collected, on a 1-inch interval basis. Generally, only 40-50% of striped bass sampled for scales are also sampled for otoliths. Supplementary data is collected for each biological sample, such as date of collection, harvest location, market grade, harvest area, and gear type.

*North Carolina*
Samples are collected by DMF personnel at the fish houses or on the beach for the beach seine fishery. DMF sets a target to collect length, weight, sex (Sykes method), and scale samples from 300 fish per gear type, which is usually about 6% of the total harvest.

**Commercial Age Samples**

The primary ageing structures for striped bass are scales. All states with commercial striped bass fisheries collected samples on a routine basis. Descriptions of the sampling programs are below.

*Massachusetts*
Commercial port samplers visit fish houses throughout the commercial season and collect scale samples from striped bass being sold. Generally, scale samples from 500-800 fish are collected each season. The proportion that each age comprised the total samples is estimated from a sub-sample of 250-350 fish which guarantees a precision of ±7-10% at $\alpha = 0.05$. Weighted proportions at age are generated by weighting the age proportions sampled in each county by county harvest. Scales are impressed in plastic using a heated press and aged by projecting impressions on a microfiche machine.

*Rhode Island*
Scales are removed from the first 25 striped bass that are weighed and measured in a given sample in the commercial dockside sampling program. A sample of scales (typically seven or more) is removed from the area behind the pectoral fin and then cataloged for ageing. The number of age samples taken range from 185 to 492 per year per gear type.

*New York*
A sample of scales is collected from each fish sampled by staff from the Bureau of Marine Resources (as described in the previous New York section). Each year, approximately 1,000 age samples are collected. Scales are pressed into clear acetate and age assignment is completed by a minimum of two readers. Age assignments are compared for agreement. Disagreements are settled by a group reading or repress of the sample. Samples for which no agreement can be reached are discarded from the set.

*Delaware*
Commercial harvest is sampled at certified, permitted weigh stations. Real-time quotas are monitored to determine sampling frequency, both temporally and spatially. Random sub-sampling includes fork and total length, weight, sex, and scale sample for age determination. Additionally, striped bass are

purchased throughout the commercial season for stomach content analysis and otolith age determination.

*Potomac River Fisheries Commission (DC)*
A random sample (weekly or monthly) is purchased from local fish buyers. The samples are transported to VIMS, where length, weight, sex and age (scales) are recorded. The recent average monthly harvest are used to establish a target sampling frequency and sample sizes. The sample is 'worked-up' by professionally trained people at VIMS.

*Maryland*
Age composition of the pound net and hook-and-line fisheries is estimated via two-stage sampling (Kimura 1977, Quinn and Deriso 1999). The first stage refers to total length samples taken during the surveys, which was assumed to be a random sample of the commercial harvest. In this case, the length frequencies from hook-and-line and pound net check stations were combined with the pound net tagging length frequency. In stage 2, a random sub-sample of scales was aged which were selected in proportion to the length frequency of the initial sample. The total number of scales to be aged was determined using a Vartot analysis which is a derived index measuring the precision of an age-length key (Kimura 1977, Lai 1987). Regardless of the sample size indicated by the Vartot analysis, 10 fish in each length category over 700 mm TL were aged. Year-class was determined by reading acetate impressions of the scales placed in microfiche readers, and age was calculated by subtracting year-class from collection year. The resulting ages were used to construct an age-length key.

*Virginia*
VMRC has been collecting striped bass biological data since 1988. The field sampling program is designed to sample striped bass harvests, in general proportion to the extent and timing of these harvests within specific water areas. Since 2003, Virginia has managed its Coastal Area and Chesapeake Area harvests by two different ITQ systems, and data collections procedures are intended to ensure adequate representation of both harvest areas. Samples of biological data are collected from seafood buyers' place of business or dockside from offloaded striped bass caught by pound nets or haul seines. Infrequently, some gill net or commercial hook-and-line fisherman's harvests may be sampled directly. At a majority of the sites, striped bass are sampled from a 50-pound box that was previously boxed and iced. At other sites, recently landed fish are randomly sampled directly from the culling table. For each specimen, length is measured using an electronic fish measuring board (FMB), with the accuracy of +/- 2.5 millimeters, and weight is recorded directly to the FMB, from an Ohaus scale, accurate to the nearest 0.01 pound. A sub-sample of fork lengths are taken, but all striped bass are measured for total length (natural) from the tip of the fish snout to the end of its caudal fin. Sub-samples of sex information and fish hard parts (scales and otoliths) are also collected, on a 1-inch interval basis. Generally, only 40-50% of striped bass sampled for scales are also sampled for otoliths. Supplementary data is collected for each biological sample, such as date of collection, harvest location, market grade, harvest area, and gear type.

*North Carolina*
Scales are obtained from striped bass above the lateral line and below the dorsal fin, pressed on acetate sheets using a Carver heated hydraulic press and read by DMF personnel on a microfiche reader. Age is assigned using ASMFC striped bass ageing guidelines. A sub-sample of 15 fish per sex per 25 mm size group are aged. Year class is then assigned to the remainder of the sample.

## Commercial Harvest-At-Age

Commercial harvest at age are usually estimated by applying corresponding length-frequency distributions and age-length keys to the reported number of fish landed by the commercial fisheries in each state. State-specific descriptions of the estimation procedures are below. For the 2018 Benchmark Assessment, the removals-at-age were developed on a seasonal scale to match the time step of the assessment model: January – February (Period 1), March – June (Period 2), and July-December (Period 3). When the biological sampling was adequate, length frequencies were developed by gear and period; for Maryland and Virginia, length frequencies were also developed by area: Chesapeake Bay and ocean.

*Massachusetts*
The proportion that each age comprises the total samples of harvested fish was estimated from a sub-sample of 250-350 fish which guarantees a precision of $\pm$10% at $\alpha$= 0.05. Weighted proportions at age were generated by weighting the age proportions sampled in each county by county harvest. The number of fish harvested was then multiplied by the proportions-at-age to get numbers harvested-at-age.

*Rhode Island*
Gear-specific age-length keys were computed based on the length and age samples collected from the commercial dockside sampling program. In years when no RI age data was available, a combined MA and NY age-length key was used. The keys were applied to the commercial length frequencies to estimate the catch-at-age for each gear and period; when there were less than 5 lengths per gear and period, the lengths were pooled first across periods, then across gears. The numbers at age were summed over gear types to provide an estimate of the total commercial catch-at-age for each period.

*New York*
Sampling is conducted weekly throughout the open season and open geographic area; length frequencies were developed by period, pooled over gears for 1998 forward. Historical catch-at-length data was available by gear and season from 1982-1984.

*Delaware*
The DFW develops age-length keys by commercial gear type. Landings in the commercial hook and line commercial fishery comprise a very low proportion of the total commercial landings. Therefore, age samples from this fishery are supplemented with age samples from recreational hook and line striped bass to formulate an age-length key specific to harvest from this gear type.

*Potomac River Fisheries Commission (DC)*
Harvest is apportioned via ageing of the commercial samples from 1998 – 2017; prior to 1998, commercial samples from Virginia were applied to PRFC landings. All sampled fish are aged. Age frequencies were developed by period, pooled over gears. No age data (except fish < 18”) are collected for released fish. Also included is information on the For-Hire fisheries, as the PRFC considers party, charter, guide and other such boats as commercial operations that carry recreational fishermen. PRFC requires a commercial license for the captain and requires him to have a sport fishing decal (license) for his boat that exempts his passengers from needing to be individually licensed. Captains use a

logbook system to report their boats' catch and estimates of the released fish. PRFC also cooperates with the NMFS "For-Hire" Survey by providing a monthly list of boats and captains licensed to carry fee-paying passengers in the Potomac. This allows NMFS to include the PRFC boats in their database and to survey them. At present, NMFS is unable to produce a separate catch and release estimate for the Potomac, but the information on the total harvest is included in the MD and VA estimate. Since, the PRFC, MD and VA all share in one overall Chesapeake Bay F-base management system, there is no immediate need for a Potomac River sub-total for the "For-Hire" fishery.

*Maryland*
The harvest-at-age for each fishery is calculated by applying the age-length key developed from the hook-and-line and pound net data to the length frequencies observed in each fisheries and expanding the resulting age distribution to the harvest. This was done by period and area (Chesapeake Bay and ocean).

*Virginia*
Commercial harvest at age was estimated using tag returns (commercial harvest tags) in waves 1, 2-3 and 4-6 (2001-2017). All commercially harvested Striped Bass in Virginia are required to be commercially tagged which are reported to VMRC and audited through buyer reports. Prior to 2001 (1988-2000), total harvest (pounds) and average weight (pounds) by gear category and area was used to estimate harvest (number of fish) by year. Prior to 1988, Virginia did not collect biological data from the commercial sector.

Length frequencies were developed using biological sampling data collected during waves 1, waves 2-3 and waves 4-6 by gear types and area. Gear types were split into three different categories: 1.) Non-selective gear types (Pound net, Haul seine, Fyke net) 2.) Selective gear types (Gill nets) 3.) Other gear types (Hook and line and Trotline). Proportions at length were applied to numbers of fish harvested by gear type, area and wave period. If length frequencies were small (< 5 length observations), that wave period would be expanded out to half a year to receive a better representation of harvest at length that is occurring during that wave period. If length information was still lacking for that gear category, a yearly LF specific to that gear category would be used to fill in missing length information. If length information was simply not available that year for that gear category, a length frequency would be generated from other gear types within that wave period and area.

Harvest at lengths were distributed across ages using ALK's by wave period and area. If age information was missing for a specific length or multiple lengths, an annual ALK would be used to fill in the missing age information.

*North Carolina*
Total pounds landed is obtained from trip ticket program. Then year classes are apportioned to harvest by period based on the percentage of pounds per year class as observed in the sample taken from fish houses. Numbers of fish per year class are then assigned using the average weight per fish per year class as observed in the sample.

## 2. Recreational Fishery Monitoring Programs

## Recreational Harvest and Releases

Information on harvest and release numbers, harvest weights, and sizes of harvested bass from 1982-2018 come from the National Marine Fisheries Service's Marine Recreational Fisheries Statistics Survey (MRFSS/MRIP). The MRFSS/MRIP data collection consisted of a stratified intercept survey of anglers at fishing access sites that obtains numbers of fish harvested and released per angler trip, and a telephone survey that derives numbers of angler trips. Estimation of harvest and catch per trip from intercept data considered intercepts at a location as independent samples. Estimates of harvest and release numbers are derived on a bi-monthly basis. With the establishment of the Marine Recreational Information Program (MRIP), estimates are now made assuming intercepts at a site represent a cluster of samples. Re-estimation of the entire catch time series using the new effort and intercept calibration factors methodology occurred in 2018 and is the standard used presently. The timeline of MRIP changes can be found at http://www.st.nmfs.noaa.gov/recreational-fisheries/in-depth/making-improvements-mrip-initiative/history-timeline/index.

## Recreational Length-Frequencies of Harvested Fish

Most states use the length frequency distributions of harvested striped bass measured by the MRFSS/MRIP. The MRFSS/MRIP measurements are converted from fork length (inches) to total length (inches) using conversion equations. Proportions-at-length are calculated and multiplied by the MRFSS/MRIP harvest numbers to obtain total number harvest-at-length. The sample sizes of harvested bass measured by MRFSS/MRIP may be inadequate for estimation of length frequencies; therefore, some states use length data from other sources (e.g., volunteer angler programs) to increase sample sizes. Descriptions of these programs are below.

*Maine*
A volunteer angler program targets avid striped bass fishermen as a means of collecting additional length data. Though this has increased the sample size of the MRFSS, it still overlooks lengths and weights on sub-legal or released stripers. Because many anglers opt for catch and release, field interviewers actually see limited numbers of fish. An angler using the Volunteer Angler Logbook (VAL) records information about fish harvested or released during each trip for themselves and any fishing companions. Information about each trip is also recorded, including time spent fishing, area fished, number of anglers, and target species. At the end of the season each angler mails his/her logbook to the Department of Marine Resources (DMR), which is then copied and sent back to the angler.

*Massachusetts*
For released and harvested fish, volunteer recreational anglers are solicited to collect length and scale samples from striped bass that they captured each month (May-October). Each person is asked to collect a minimum of 5 scales from at least 10 fish per month, place the scales in marked coin envelopes, and record the disposition of each fish (released or harvested), fishing mode (boat or shore-based fishing), and location. Over 1,200 samples are received each year from over 30 anglers. Starting in 2005, DMF began using the MRFSS/MRIP length data and the volunteer angler harvest length data to estimate the length structure of harvested fish. This is done by first generating the percentages-at–length from MRFSS/MRIP and volunteer program by fishing mode and then averaging the proportions-at-length across programs. DMF then estimates the harvest by fishing

mode and applies the numbers to the correct proportions-at-length to get harvest numbers at length and fishing mode, and then sums across modes to get total numbers harvested-at-length. The volunteer angler data adds about 200-400 extra measurements to estimate harvest length distributions.

*Connecticut*

The Volunteer Angler Survey (VAS) is designed to collect fishing trip and catch information from marine recreational (hook and line) anglers who volunteer to record their angling activities via a logbook. VAS anglers contribute valuable fisheries-specific information concerning striped bass, fluke, bluefish, scup, tautog, and other important finfish species used in monitoring and assessing fish populations inhabiting Connecticut marine waters. The survey logbook is easy to fill out. Each participating angler is assigned a personal code number for confidentiality. Recording instructions are provided on the inside cover of the logbook. Upon completion, anglers tape the pre-postage paid logbook shut and drop it off in the mail. Anglers that send in logbooks are rewarded with a VAS cooler and updated results of the program. After all the logbooks are computer entered and error checked, the logbooks are returned to each participant for their own records. The CT Fisheries Division has annually supplemented the MRFSS/MRIP survey with about 2,000-3,000 length measurements from the angler survey.

*New York*

Prior to 2011, the MRFSS/MRIP length data were not used in any fashion. Instead, the American Littoral Society's (ALS) release data were used to estimate length distribution of both harvested fish (>28") and released fish (B2 sub-legal <28"). The sample sizes are about 5,000 fish each year.

*New Jersey*

New Jersey collects information on harvested fish through the Striped Bass Bonus Program (SBBP). NJ's historical commercial quota forms the basis of this program where a recreational angler can apply online for a non-transferrable permit to harvest one additional striped bass per day measuring not less than 28 inches. Upon harvest and prior to transportation, the angler is required to immediately fill out a non-transferable permit with the following information: date, location, caught, and length. This harvest information is submitted online (mandatory harvest reporting) to the NJ Bureau of Marine Fisheries for monitoring and analysis.

*Maryland*

There are two additional sources for size frequency data: a volunteer angler survey and the DNR creel survey during the spring trophy season. Neither of the additional surveys employ statistical design. The volunteer angler survey is described in the next MD section. The DNR creel survey was initiated in 2002. The survey samples access sites (docks and marinas) with the largest volume of recreational angler traffic during the spring trophy season (mid-April to mid-May). The number of intercepted boats has varied from 137 to 181, number of anglers from 180 to 461, and the number of examined fish from 460 to 510. Biological data collected during the survey includes total length, weight, sex, spawning condition, and age (both scales and otoliths are collected). Other fishing statistics are collected, such as number of hours fished, number of lines fished, boat type, number of anglers per boat, number of fish kept, and number of fish released.

**Recreational Length-Frequencies of Released Fish**

Data on sizes of released striped bass come mostly from state-specific sampling programs. Proportions-at-length are calculated and multiplied by the MRFSS/MRIP dead discard numbers to obtain total number released dead-at-length. Descriptions of these programs are below.

*Maine*
Release data are collected through the Volunteer Angler Survey, as described in the previous Maine section. DMR has annually supplemented the MRFSS survey with about 1,200 – 9,200 length measurements from the Volunteer Angler Survey.

*New Hampshire*
The Fish and Game Department (FGD) uses a striped bass volunteer angler survey for anglers fishing in New Hampshire. Roughly 30-50 volunteer anglers per year report information about each striped bass fishing trip they take that originates in NH. They are asked to measure every striped bass they catch (both harvested and released fish) to the nearest inch. Volunteers report on roughly 500-1700 trips each year and provide usable measurements on 1,000-7,000 fish each year. About 95% of the measured fish are released.

*Massachusetts*
For released and harvested fish, volunteer recreational anglers are solicited to collect length and scale samples from striped bass that they captured each month (May-October). Each person is asked to collect a minimum of 5 scales from at least 10 fish per month, place the scales in marked coin envelopes, and record the disposition of the each fish (released or harvested), and fishing mode. Over 2,200 samples are received each year from over 100 anglers. Approximately 1,000-1,500 lengths of released striped bass are reported each year.

*Rhode Island*
The size structure of striped bass released from Rhode Island's recreational fishery is based on the American Littoral Society's (ALS) release data for Rhode Island by year.

*Connecticut*
Release data come from the Volunteer Angler Survey, as described in the previous Connecticut section. About 2000-3000 length measurements of released fishes are obtained each year.

*New York*
The ALS release data are used to estimate length distribution. The ALS tags are released all around the marine district of New York all year long. Because fish can be tagged at any size, the Bureau of Marine Resources gets both legal and sub-legal length distributions, both within and outside NY's open recreational season. Thus, the length distribution for harvested fish is from the fish >28 in, and the length distribution for the released fish is from the sub-legal (i.e., <28).

*New Jersey*
Lengths of released striped bass are collected through a volunteer angler survey (VAS), as described in the previous New Jersey section. It is important to note that, although the VAS is primarily administered through the SBBP, the VAS and the SBBP are independent data sources. Someone does not need to harvest a Bonus fish or have a Bonus Permit in order to participate in, fill out, and submit their logbooks. There is a broad range of participant avidity and apparent skill level – from someone

that fishes once or twice a year and does not catch/harvest a single bass to someone that fishes 100 days of the year. The only ‘screening/removal’ of logbooks for analysis the Bureau of Marine Fisheries conducts is to ensure the logbooks are filled out correctly and contain the proper information. Information on the size composition of harvested and released fish as well as effort (by trip and even hours), CPUE and fishing mode are available by region. (The state is broken down into 26 different regions and each location provided by the fisherman is assigned to one of those areas.) The VAS survey was initiated in 1990 when the NJ Fish and Wildlife initiated the SBBP. VAS provides about 500-1500 length measurements on released fish per year.

In addition to the VAS, length information is also collected through Party/Charter Boat Logbooks, administered through the SBBBP. Each boat that signs up to participate in the SBBP is mailed a logbook as well as the instructions on how to fill it out properly. A Private/Charter boat does not need to use or harvest any SBBP fish to fill out or participate in the logbook survey but they do need to be a participant in the SBBP. Boat owners are asked to fill out a daily trip logbook for each trip they take when targeting striped bass, even if no striped bass are caught; they are not asked to record striped bass information when they are making trips targeting other species. They are asked to record the date, location fished, number of patrons, number of hours fished, lengths of released fish (longest length to the nearest inch), number of released fish, lengths of harvested fish, and number of harvested fish. Logbooks must be completed even if no Bonus Cards are used or all bonus cards have been used for the year. All logbooks are returned by the end of the season. Private/Charter Boat Logbooks were first collected in 1997 and have continued ever since. Much of this data has never been looked at closely or analyzed but all of the information has been entered, checked, and screened for incorrect information.

*Delaware*
Number at length of recreational discards are acquired annually from the American Littoral Society’s tag release database for Delaware River, Delaware Bay, and the near shore waters of the Atlantic Ocean adjacent to Delaware Bay.

*Maryland*
There are two additional sources for size frequency data: a volunteer angler survey and the DNR creel survey during the spring trophy season. Neither of the additional surveys employs statistical design. The DNR creel survey is described in the previous MD section. Maryland DNR has conducted a volunteer angler survey to obtain information on size structure of kept and released striped bass in the recreational fishery since 2000. The areas and time periods covered are defined by the number of responses received from anglers. Anglers are asked to provide information on the date of fishing, number of hours fished, number of anglers in the party, and method of fishing. Anglers also record the total number of striped bass kept and the total number of striped bass released and measure and record the length for the first twenty striped bass caught. A separate form is filled for each trip even if no fish are caught. If more than one survey participant is fishing on the same boat, only one designated individual is asked to fill out the survey form for the group for that day to avoid duplication. The data are submitted to MD DNR either on paper forms or via internet entry. Participation varies from year to year, which is reflected in the total number of entries. The number of reported trips varies between 200 and 300 and the total number of measured fish varies approximately from 600 to 2000 per year. Volunteer angler survey data are combined with the MRFSS/MRIP information and MD DNR Spring Trophy Survey to characterize size frequency distribution of recreational harvest by wave. Volunteer

survey data are the only source for the characterization of the discards. The volunteer survey does not provide age information.

*Virginia*
Data on releases are derived from the MD DNR Volunteer Logbook Survey described above.

*North Carolina*
North Carolina does not collect information on size of releases. Usually, release length frequency data that reflect the release sizes in NC are borrowed from other states.

**Recreational Age Data**

Many states collect scale samples during state sampling programs designed to collect information on harvest and released striped bass from the recreational fishery (described above). For those states that do not collect scale samples, age-length keys are usually borrowed from neighboring states. Detailed descriptions of how age samples are collected are given below.

*Massachusetts*
For released and harvested fish, volunteer recreational anglers are solicited to collect length and scale samples from striped bass that they capture each month (May-October). Each person is asked to collect a minimum of 5 scales from at least 10 fish per month and record the disposition of the each fish (released or harvested) and fishing mode. Over 2,200 samples are received each year from over 100 anglers. The size frequency of released fishes by mode are used to allocate MRFSS/MRIP release numbers by mode among size classes. A sub-sample of all scale samples collected (about 450-520 fish/yr) are aged and combined with commercial samples (250 fish/yr) and tagging samples (about 150-300 fish/yr) to produce an age-length key used to convert the MRFSS/MRIP size distribution into age classes. Recreational scale samples are selected using a weighted random design based on the total number of striped bass caught in each wave and mode stratum (as determined by MRFSS/MRIP).

*New York*
An age-length key is created using data from NY's combined projects: the cooperative angler survey, western Long Island beach seine survey, and a fall Ocean Haul Seine/Ocean Trawl survey. The cooperative angler (fishery-dependent) data is from both kept and released fish, but the geographical distribution of the samples are biased towards the Western Long Island Sound. Samples are at the pleasure of the cooperating fishers, collected - nearly all year long. Each year, anglers contribute anywhere from 500 to 5,000 samples, over a fairly wide range of sizes. The Western Long Island beach seine survey is a multi-species, fishery-independent survey conducted at fixed sampling sites in bays around the north and south shores of Long Island. Most of the samples are of small juvenile fish, but some larger adult fish are caught. Each year the beach seine survey contributes approximately 1,000 length/age samples collected over the months of April through November. The fall Ocean Haul seine survey is a fishery-independent survey conducted at fixed survey sites. The geographic distribution of sampling is biased towards the eastern South Shore of Long Island, during the months of September through December. The Ocean Trawl Survey replaced the Ocean Haul Seine Survey in 2007. It covers the geographic area of the entire south shore of Long Island, during the month of November. Each year, about 1,000 samples are collected. The survey samples the adult coastal

migratory mixed striped bass stocks. The age-length key created is applied to both legal and sub-legal fish (assumed harvest and discards), broken down into two six-month seasonal keys.

*New Jersey*
New Jersey collects age (scale) samples from harvested and released fish through a biological sampling program. In 2010, New Jersey instituted new protocols for targeting fishing tournaments and party/charter boats in the spring and fall in order to streamline the collection process and eliminate duplicate data or data not being used for the coastal assessment. A recent decrease in sample sizes necessitated a change in the methods used to collect samples resulting in the development of a new long-term plan. This information is collected, monitored, entered and analyzed by the NJ Bureau of Marine Fisheries.

*Delaware*
Recreational age data is compiled from directed fishery sampling in the summer slot season (July 1 – Aug 31) and the fall recreational fishery. Length, sex, scales, and otoliths are acquired from each fish, and when available, weight.

*Maryland*
Direct age data are available from the creel survey of the trophy fishery only. Both scales and otoliths are collected from the fish examined in creel survey. For periods not covered by the creel survey, an age-length key developed from the samples of commercially harvested fish is applied to recreational length frequency to characterize age structure of the recreational harvest.

*Virginia*
Most age data are collected from the commercial fishery. The sampling group will sometimes sample from one or more recreational tournaments, but not in every year. In 2004, there were two length and age samples; no sampling of tournaments occurred in 2005.

**Recreational Harvest-At-Age**

Recreational harvest-at-age is usually estimated by applying corresponding length-frequency distributions expanded to total numbers of harvest-at-length and age-length keys to the MRFSS/MRIP number of fish harvested by the recreational anglers in each state. For the 2018 Benchmark Assessment, the removals-at-age were developed on a seasonal scale to match the time step of the assessment model: January – February (Wave 1/Period 1), March – June (Waves 2-3/Period 2), and July-December (Waves 4-6/Period 3). State-specific descriptions of the estimation procedures are below. For the states of North Carolina and Delaware through Maine, these state-specific procedures were applied from the mid-1990s onward, when sample sizes were adequate to describe the length frequencies of the harvest and releases by state and model period (see Table B6.28 in the main assessment report for annual length sample sizes by state). For the first 10-15 years of the time series, lengths were pooled on a regional basis: New Jersey through Maine, Maryland through New Jersey, and North Carolina with Virginia ocean waters and New York. The pooled regional length frequencies were adjusted to account for differences in minimum sizes across states and applied to each state’s harvest by period. The pooled length frequencies included both MRFSS/MRIP lengths and supplemental lengths collected from state programs such as volunteer angler logbooks and state creel surveys.

*Maine*
DMR uses age-length data collected by MA DMF. The age-length key is applied to the Volunteer Angler Survey lengths, which is then applied to MRFSS/MRIP estimates of harvested fish.

*New Hampshire*
FGD uses age-length data collected by MA DMF. The age-length key is applied to the Volunteer Angler Survey lengths, which is then applied to MRFSS/MRIP estimates of harvested fish.

*Massachusetts*
Harvest numbers-at-age are generated by applying total numbers of harvested fish by length to the age-length key as described above.

*Rhode Island*
Age-length data collected by NY DEC and MA DMF are combined to create annual age-length keys. The combined NY-MA age-length key is applied to the expanded length frequencies from RI's recreational fishery to estimate recreational harvest-at-age on an annual basis.

*Connecticut*
The Fisheries Division uses age-length keys from Long Island Sound provided by NY DEC and applies the numbers-at-length obtained from the volunteer angler survey.

*New York*
The MRFSS/MRIP numbers of harvest and releases by wave are disaggregated by the ALS length frequency distribution (calculated by wave). The numbers at length are added by wave together into two seasonal length distributions. The seasonal length distributions are multiplied by the seasonal length/age keys created (see above) for legal (i.e., >28 inches, harvest) and sub-legal (i.e., <28 inches, releases) fish. The length distributions are adjusted, due to the conversion of ALS data from fork length to total length and the "gaps" which result, by averaging the values before and after the interval with no observed frequency. Next, the numbers are added for each season. Occasionally there is a need to re-adjust for the actual numbers of harvest or releases from MRFSS/MRIP due to the adjustments and rounding.

*New Jersey*
New Jersey used the length frequency information gained from the NJ Striped Bass Volunteer Angler Survey to characterize the length structure of NJ's recreational harvest of striped bass and the MRFSS harvest data by period to expand the length frequency data. A variety of age sources were used to develop NJ's age-length key by season. For the spring key, age data from NJ's Delaware Bay Striped Bass Tagging Survey (occurs in March – May), NJ's January, April and June cruises of the Ocean Trawl Survey, and spring harvested and released striped bass from tournament and party/charter boat biological sampling were used. To develop NJ's fall age-length key, age data from the August and October cruises of the Ocean Trawl Survey and fall harvested and released fish from the tournament and party/charter boat biological sampling are utilized. The appropriate seasonal age-length key is then expanded to the length frequency information to develop NJ's striped bass harvest by age and season.

*Delaware*

Delaware's recreational harvest at age data was developed from the known harvest of 3 distinct sectors of the fishery. Spring landings numbers, lengths, and weights were acquired from MRIP Wave 2 and 3 reports. Age at length was derived from the DFW's spawning stock survey in April and May. Delaware's summer slot (20" - 26") landings numbers, lengths, and weights were acquired from MRIP Wave 4 reports. Age at length was derived from DFW's sampling of harvested slot fish during July and August. Recreational harvest (landings, weight, and lengths) for the remainder of the calendar year was acquired from MRIP Wave 5 and 6 reports. Age at length data is derived from DFW sampling of recreationally caught fish during October through December.

*Potomac River Fisheries Commission (DC)*

Recreational harvest from PRFC waters was included with the MRIP estimates for Virginia and Maryland.

*Maryland*

Length frequency of recreational harvest was characterized using MRIP, Volunteer Angler Survey, and creel survey length data. The age-length key derived from the spring spawning survey was applied to length frequency for waves 2 and 3. For waves 4–6, an age length key derived from samples of commercial harvest was used. Length frequency data from the NC winter tagging cruise were used to supplement MRIP and VAS data for ocean harvest. For the earliest years of the time series, commercial and fishery independent length data were used to supplement MRIP length data, when sample sizes were insufficient.

*Virginia*

Recreational harvest estimates were provided using the new and old MRIP length-frequency (LF) distributions (Waves 2-3, Waves 4-6) from Inland (Chesapeake Bay) and Coastal waters (Ocean). Biological sampling data, collected from Virginia's commercial fishery (by year), were used to estimate the conversion factor from fork length to total length (inch).

Harvest at length (TL) was distributed across ages using proportions of length at age from ALK's (commercial data) derived from biological data collected during that wave-period and by area (Chesapeake Bay and Ocean). If age-specific information was not available, an annual ALK was used to fill in missing age information for those lengths.

If an annual ALK did not account for all lengths in the LF distribution, a multi-year ALK (1988-2016) was used to proportion out the harvest at age for those few lengths with missing age data. Recreational harvest without length information was not included in the exercise.

Virginia's Wave-1 coastal fishery was expanded to CAA by applying the proportions at length from the previous year's Wave-6 coastal fishery to Virginia's wave-1 coastal harvest estimates predicted from the updated Wave-1 coastal tag-return model (2005-2017).

Since 2013, Virginia and North Carolina have not had a wave-1 or wave-6 fishery in coastal waters. Maryland's LF distribution from their wave-6 coastal fishery in the previous year was used to expand CAA for Virginia's coastal wave-1 fishery in the following years (2014-2017).

*North Carolina*
The NY age-length key is used along with MRIP harvest at length estimates for North Carolina to apportion harvest numbers into age classes by period. When less than 5 lengths were available for a given period, the annual length frequency was used. For years where Wave-1 harvest was estimated from tag returns and not by MRIP sampling, the MRIP harvest-at-length values from Wave 6 of the previous year was used to described the length frequency of the Wave 1 harvest.

**Recreational Dead Discards-at-Age**

A 9% release mortality rate was applied to the total live release estimate for each state to calculate the dead discards. The number of dead discards-at-age was estimated by applying corresponding total numbers of dead discards-at-length to age-length keys. For the 2018 Benchmark Assessment, the removals-at-age were developed on a seasonal scale to match the time step of the assessment model: January – February (Wave 1/Period 1), March – June (Waves 2-3/Period 2), and July-December (Waves 4-6/Period 3). State-specific descriptions of the estimation procedures are below. As with the recreational harvest, for the states of North Carolina and Delaware through Maine, these state-specific procedures were applied from the mid-1990s onward, when sample sizes were adequate to describe the length frequencies of the harvest and releases by state and model period (see Table B6.28 in the main assessment report for annual length sample sizes by state). For the first 10-15 years of the time series, lengths were pooled on a regional basis: New Jersey through Maine, Maryland through New Jersey, and North Carolina with Virginia ocean waters and New York. The pooled length frequencies were developed from supplemental data collected from state programs such as volunteer angler logbooks and state creel surveys, as well as from the American Littoral Society (ALS) volunteer tagging program. Starting in 2004, MRIP began sampling fish released alive on charter boat trips, and these data were used to supplement the state and ALS release length data.

*Maine*
DMR used age-length data collected by MA DMF. These data are applied to the Maine Volunteer Angler Survey lengths for each period, which was then applied to the dead discard estimates.

*New Hampshire*
New Hampshire used age-length data collected by MA DMF. These data are applied to the New Hampshire Volunteer Angler Survey lengths for each period, which were then applied to the dead discard estimates.

*Massachusetts*
Dead discards-at-age were generated by applying total numbers of discards-at-length by period to the age-length key described above.

*Rhode Island*
Age-length data collected by NY DEC and MA DMF are combined to create annual age-length keys. The combined NY-MA age-length key is applied to the expanded length frequencies from Rhode Island's recreational fishery to estimate recreational releases-at-age on an annual basis.

*Connecticut*

The Fisheries Division used age-length keys from Long Island Sound provided by NY DEC applied to the dead discards numbers-at-length by period.

*New York*
The ALS length frequency by period was applied to MRIP numbers of dead releases by period, and a seasonal or annual age-length key was applied to develop the dead releases at age.

*New Jersey*
New Jersey used the length frequency information gained from the New Jersey Striped Bass Volunteer Angler Survey to characterize the length structure of NJ's recreational removals of striped bass and the MRIP release data by period to expand the length frequency data. A variety of age sources were then used to develop NJ's age-length key by season. For the spring key, age data from NJ's Delaware Bay Striped Bass Tagging Survey (occurs in March – May), NJ's January, April and June cruises of the Ocean Trawl Survey, and spring harvested and released striped bass from tournament and party/charter boat biological sampling were used. To develop NJ's fall age-length key, age data from the August and October cruises of the Ocean Trawl Survey and fall harvested and released fish from the tournament and party/charter boat biological sampling were utilized. The appropriate seasonal age-length key was then expanded to the length frequency information to develop NJ's striped bass dead releases by age and period.

*Delaware*
Dead discards at age for Delaware were calculated by applying the length frequency of released fish from ALS data to the MRIP estimates of dead releases by period. Seasonal age-length keys developed from fishery independent sampling were applied to the length frequencies to develop the dead discards at age.

*Maryland*
Length frequency of recreational releases was characterized using MRFSS/MRIP, VAS, and creel survey length data. The age-length key derived from the spring spawning survey was applied to length frequency for waves 2 and 3. For waves 4–6, an age-length key derived from samples of commercial harvest was used. Length frequency data from the NC winter tagging cruise were used to supplement MRIP and VAS data for ocean harvest.

*Virginia*
Virginia Inland releases (B2) were expanded to CAA using length-frequencies and age-length keys provided from Maryland's volunteer angler survey (1995-2017). Prior to 1995, Virginia inland releases were estimated using length-frequencies and age-length keys from Maryland's commercial fishery (1982-1994).

Virginia's coastal releases were expanded to CAA using the same methods adopted by Maryland.

*North Carolina*
The NY age-length key is used, along with length frequencies, to apportion release numbers into age classes.

DE-Catch at Age Data Sources for DB CAA written by E. Hale

Based on an investigation of historical data sources, it was determined that the commercial and recreational removals from Delaware and New Jersey could not be split into Delaware Bay and ocean waters as was done for the Chesapeake Bay prior to 2002.

A pair-wise analysis conducted by the States of New Jersey and Delaware was conducted in order to estimate total Delaware Bay catch at age. Recreational landings and length frequency data of directed harvest (A + B1) were collected from the MRIP program, using data downloaded from 2004-2016 and a custom query for landings from 1989-2003 (T. Sminkey, pers. comm.). Total length was converted from fork length provided by MRIP using annual regression coefficients from pooled biological characterization data for both states. Recreational harvest data for total number released alive (B2) were similarly collected by both the MRIP webpage and a custom query for those time periods. Length frequency data from the New Jersey volunteer angler program were used to extrapolate recreational dead discards for the State of Delaware. Commercial harvest by number was not available in the State of Delaware prior to 2002. Based on commercial harvester reports, directed harvest was estimated by area (coastal vs. Delaware Bay) from 2002-2016. Length frequency information collected by DEDFW commercial subsampling was applied to the total commercial harvest to estimate catch at age. Unfortunately, length frequency data for commercial subsampling in 2005, 2008 and 2009 were derived from mean values, as raw data could not be found. Age length keys were developed from all available biological characterization data pooled for both states and applied to both sectors (commercial and recreational). Landings were then summed across fishery sectors and states to estimate total Delaware Bay harvest. Overall, total harvest in Delaware Bay appears to be principally driven by the State of New Jersey. Total number landed in both the recreational and commercial fisheries of Delaware appear more stable. However, recreational landings do decline after 2012 with a slight uptick in 2016.

## Appendix B6. Supplemental Commercial Discard Materials

This appendix contains:

1. Summary of the GAM fit to tag numbers
2. Summary of data sources to develop commercial discards-at-age

Appendix Table 1. Summary of the GAM fit to tag numbers for Commercial Discards Estimation.

```
Formula:
log(outsfit$CommK) ~ s(outsfit$year, bs = "tp", k = 20)

Parametric coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 4.64341  0.05666  81.95  <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
         edf Ref.df   F p-value
s(outsfit$year) 8.597 10.61 44.31 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.945  Deviance explained = 96.3%
GCV = 0.13676 Scale est. = 0.089885 n = 28
```

```
Formula:
log(outsfit$CommR) ~ s(outsfit$year, bs = "tp", k = 20)

Parametric coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.6708   0.1147  31.99  <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
         edf Ref.df   F p-value
s(outsfit$year) 4.753 5.926 41.76 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.901  Deviance explained = 91.9%
GCV = 0.46398 Scale est. = 0.36865  n = 28
```

```
Formula:
log(outsfit$RecK) ~ s(outsfit$year, bs = "tp", k = 20)

Parametric coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 5.90480  0.02455  240.5  <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
         edf Ref.df   F p-value
s(outsfit$year) 10.09 12.35 81.07 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.974  Deviance explained = 98.4%
GCV = 0.02796 Scale est. = 0.016881 n = 28
```

```
Formula:
log(outsfit$RecR) ~ s(outsfit$year, bs = "tp", k = 20)

Parametric coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 5.28153  0.03365   157  <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
         edf Ref.df   F p-value
s(outsfit$year) 6.83  8.48 136.9 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.977  Deviance explained = 98.3%
GCV = 0.044011 Scale est. = 0.031705 n = 28
```

Appendix Table 2. Sources of age data used to develop commercial discards-at-age.

| | | | |
|---|---|---|---|
| 2017 | | | |
| Notes | Chesapeal | Anchor Gil | VA commercial spring gillnet 2017 in compliance report |
| | | Drift Gill | MD Comm- Bay GillNet landings spreadsheet 2017 |
| | | H&L | from MD com Summ ITQ at age in "MD SB Compliance 2017.xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in "VIMS_CPUE_Summary_spring 1991_2017 for ASMFC |
| | | Trawl | No trawl fishery in CB (used to use Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | Gary calculated by filling in proportions-at-age for a given length interval with n<10, predicted proportions for multinomial model. |
| | | Drift | Gary calculated by filling in proportions-at-age for a given length interval with n<10, predicted proportions for multinomial model. |
| | | H&L | Gary calculated by filling in proportions-at-age for a given length interval with n<10, predicted proportions for multinomial model. |
| | | Other | Average of Anchor, drift, H&L standardized to sum to 1 |
| | | Pound | same as above |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring) coastal gill net landings 2017 |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring) coastal gill net landings 2017 |
| | | H&L | Developed from an average commercial length selectivity curve (2005-2014) applied to rec release lengths |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) 2016 |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial). Usually NC comm landings - mixed fishery with trawl info (landings wt only comm) are added but value is 0 for 2016 |
| | | Other | Average of all gears standardized to 1 |
| 2016 | | | |
| Notes | Chesapeal | Anchor Gil | VA commercial spring gillnet 2016 in compliance report |
| | | Drift Gill | MD Comm- Bay GillNet landings spreadsheet 2016 |
| | | H&L | from MD com Summ ITQ at age in "MD SB Compliance 2016.xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in "VIMS_CPUE_Summary_spring 1991_2016 for ASMFC |
| | | Trawl | No trawl fishery in CB (used to use Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring 2016 |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring 2016 |
| | | H&L | from DE CAA spreadsheet for H&L Fall 2016 |
| | | Other | Average of Anchor, drift, H&L standardized to sum to 1 |
| | | Pound | same as above |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring) coastal gill net landings 2016 |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring) coastal gill net landings 2016 |
| | | H&L | Developed from an average commercial length selectivity curve (2005-2014) applied to rec release lengths |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) 2016 |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial). Usually NC comm landings - mixed fishery with trawl info (landings wt only comm) are added but value is 0 for 2016 |
| | | Other | Average of all other gears standardized to 1 |
| 2015 | | | |
| Notes | Chesapeal | Anchor Gil | VA commercial spring gillnet 2015 in compliance report |
| | | Drift Gill | MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com Summ ITQ at age in "MD SB Compliance 2015.xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in 11in "VIMS_CPUE_Summary_spring 1991_2015 for ASMFC |
| | | Trawl | No trawl fishery in CB (used to use Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | | H&L | from DE CAA spreadsheet for H&L Fall |
| | | Other | Average of Anchor, drift, H&L standardized to sum to 1 |
| | | Pound | Same as above |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | Developed from an average commercial length selectivity curve (2005-2014) applied to rec release lengths |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial). Usually NC comm landings - mixed fishery with trawl info (landings wt only comm) are added but value is 0 for 2015 |
| | | Other | Average of all other gears standardized to 1 |
| 2014 | | | |
| Notes | Chesapeal | Anchor Gil | VIMS commercial spring gillnet 2014 (VA independent GN sampling stopped) |
| | | Drift Gill | MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com Summ ITQ at age in "MD SB Compliance 2014.xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in 11in "VIMS_CPUE_Summary_spring 1991_2014 for ASMFC |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | | H&L | from DE CAA spreadsheet for H&L Fall |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | MA discards at age 2014 in spreadsheet |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of all other gears |
| 2013 | | | |
| Notes | Chesapeal | Anchor Gil | VIMS fish independent in Rapp and James"VIMS_SSB_1991_2013 |
| | | Drift Gill | MD Discard estimates for 11 in MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com H&L harvest at age in "MD SB Compliance 2013.xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in 11in "VIMS_CPUE Summary 1991_2013" |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | | H&L | from DE CAA spreadsheet for H&L Fall |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | MA commercial discards at age 2013 in spreadsheet |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of all other gears |

| | | | |
|---|---|---|---|
| 2012 | | | |
| Notes | Chesapeal | Anchor Gil | VIMS fish independent in Rapp and James in 12 in "VIMS_length_frequency_spring1991_2012forVMRC" |
| | | Drift Gill | MD Discard estimates for 12 in MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com H&L harvest at age in "MD SB Compliance 12xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in 12in "VIMS_length_frequency_spring 1991_2012 for VMRC |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | | H&L | from DE CAA spreadsheet for H&L Fall |
| | | Other | average(anchor and H&L) standardized to 1 |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | MA discards at age 2012 in spreadsheet |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of all other gears |

| | | | |
|---|---|---|---|
| 2011 | | | |
| Notes | Chesapeal | Anchor Gil | VIMS fish independent in Rapp and James in 11 in "VIMS_length_frequency_spring1991_2011forVMRC" |
| | | Drift Gill | MD Discard estimates for 11 in MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com H&L harvest at age in "MD SB Compliance 11.xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in 11in "VIMS_length_frequency_spring 1991_2011 for VMRC |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of Anchor, drift, H&L and Pound standardized to sum to 1 |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | | H&L | from DE CAA spreadsheet for H&L Fall |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | MA discards at age 2011 in spreadsheet |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |
| | | Other | Average of all other gears |

| | | | |
|---|---|---|---|
| 2010 | | | |
| Notes | Chesapeal | Anchor Gil | VA fish independent in Rapp and James in 10 in "VIMS_length_frequency_spring1991_2010forVMRC" |
| | | Drift Gill | MD Discard estimates for 2010 in MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com H&L harvest at age in "MD Data 2010.xls" |
| | | Pound Net | from VA Pound independent data Rapp River in 2010 in "VIMS_length_frequency_spring 1991_2010for VMRC |
| | | Other | Average of Anchor, drift, H&L and Pound |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | MA discards at age 2010 in spreadsheet |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |

| | | | |
|---|---|---|---|
| 2009 | | | |
| Notes | Chesapeal | Anchor Gil | VIMS fish independent in Rapp and James in 09 in "VIMS_length_frequency_spring1991_2009forVMRC" |
| | | Drift Gill | MD Discard estimates for 09 in MD Comm- Bay GillNet landings spreadsheet |
| | | H&L | from MD com H&L harvest at age in "MD Data 2009xls" |
| | | Pound Net | from VIMS Pound independent data Rapp River in 09in "VIMS_length_frequency_spring 1991_2009 for VMRC |
| | | Other | Average of Anchor, drift, H&L and Pound |
| | Delaware I | Anchor | from DE CAA spreadsheet for comm gill net landings - spring |
| | | Drift | from DE CAA spreadsheet for comm gill net landings - spring |
| | Coast | Anchor | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | Drift | combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings |
| | | H&L | MA discards at age 2009 in spreadsheet |
| | | Pounds | RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI) |
| | | Trawl | Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm) |

2008

VA Anchor Gill Spring, VA Anchor Gill Fall, MD Drift Gill, MD Hook & Line, VA Pound Net Spring, VA Pound Net Fall, and MD Pound Net catch at age are all from summary state spreadsheets.
PRFC catch at age estimated from MD gear specific age structure and PRFC annual report data by gear.
DE Total catch at age from Comm CAA matrix, breakdown to gear: 0.79 anchor, 0.21 drift, from G Shepherd for 2008
Coast trawl from Shepherd bycatch summary "com disc OT len.xls" and alk in 2008 NY alk for CA, WLI, and ocean trawl.
Coast Ancl combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings
Coast Drift combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings
Coast H&L from MA H&L discard at age in 07 MA CAA worksheet
Coast Pound from RI pound net 07 CAA worksheet

2007

VA Anchor Gill Spring, VA Anchor Gill Fall, MD Drift Gill, MD Hook & Line, VA Pound Net Spring, VA Pound Net Fall, and MD Pound Net catch at age are all from summary state spreadsheets.
PRFC catch at age estimated from MD gear specific age structure and PRFC annual report data by gear for pound and H&L.

DE Total catch at age from Comm CAA matrix, breakdown to gear: 0.79 anchor, 0.21 drift, from G Shepherd for 2008
Coast trawl from Shepherd bycatch summary "com disc OT len.xls" and alk in 207 NY alk for CA, WLI, and ocean trawl.
Coast Ancl combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings
Coast Drift combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings
Coast H&L from MA H&L discard at age in 07 MA CAA worksheet
Coast Pound from RI pound net 07 CAA worksheet

2006

Bay Anchor Gill from VA fish independent in Rapp and James in 06 in "VIMS_monitor_size_freq.xls"
2006 Bay Drift Gill from MD Discard estimates for 06 in MD Comm- Bay GillNet landings spreadsheet
Bay H&L from MD H&L harvest at age inMD_SB_Compliance2006.xls: Sheet=Comm-HLPN"
Bay Pound from VA Pound independent data Rapp River in 06 in "VIMS_monitor_size_freq.xls"
DE Bay Anchor & Drift Gill from DE CAA spreadsheet for comm gill net landings - combined spring and fall
Coast Anchor Gill fror combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings
Coast Drift Gill from combined MD (comm - Atl gillnet trawl) and VA (coastal gill net spring, fall) coastal gill net landings
Coast H&L from MA H&L discard at age in "MA1 Data 2006.xls"
Coast Pound from RI float trap landings in the RI CAA spreadsheet (no pound net specifc info in RI)
Coast Trawl from Combined NY comm landings - mixed fishery with trawl landings (landing # known commercial) and NC comm landings - mixed fishery with trawl info (landings wt only comm)

2005

Notes
Bay Anchor Gill from VA fish independent in Rapp and James in 05 in "VIMS_length_weight_data_2005.xls" DE Bay spring gill provoded by DE in Table 9 of "DE 2006 SB CAA Data.xls"
Bay Drift Gill MD Discard estimates for 05 from kill at age estimates in "MD-SB_Compliance2005: Sheet=comm Bay gill net"
Bay H&L from MD H&L harvest at age inMD_SB_Compliance2005.xls: Sheet=Comm-HLPN"
Bay Pound from VA Pound independent data Rapp River in 05 in "VIMS_length_weight_data.xls"
Coast Anchor gill from Shepherd bycatch length frequency and NY July-December age-length key - see page Coast Gillnet Discards Age Prop"
Coast Drift gillfrom Shepherd bycatch length frequency and NY July-December age-length key - see page Coast Gillnet Discards Age Prop"
Coast H&L from "MA Data 2005, sheet - commercial discard # know.xls"
Coast Pound from RI pound discard at age in "RI SB 2004 - sheet catch-age summary.xls" since there were no estimates for 2005
Coast trawl from Shepherd bycatch length frequency and NY July-December age-length key - see page Coast Trawl Discards Age Prop"

2004

Notes
Bay Anchor Gill from VA fish independent in Rapp and James in 04 in "VIMS_lengthr_weight_data.xls" DE Bay spring gill provoded by DE in Table 9 of "DE 03 Data.xls"
Bay Drift Gill MD Discard estimates for 04 from kill at age estimates in "comm Bay gill net.xls"
Bay H&L from MD H&L harvest at age in "comm_HLPN.xls"
Bay Pound from VA Pound independent data Rapp River in 04 in "VIMS_length_weight_data.xls"
Coast Anchor gill from Shepherd bycatch summary in "sbass-comm discards.xls"
Coast Drift gill from Shepherd bycatch summary in "sbass-comm discards.xls"
Coast H&L from "MA Data 2004, sheet - commercial discard # know.xls"
Coast Pound from RI pound discard at age in "RI SB 2004 - sheet catch-age summary.xls"
Coast trawl from Shepherd "comm discard at age.xls"

2003

Notes
Bay Anchor Gill from VA fish independent in Rapp and James in 03 in "VIMS_monitor_size_freq.xls" DE Bay spring gill provoded by DE in Table 9 of "DE 03 Data.xls"
Bay Drift Gill MD Discard estimates for 03 in "mdgillnet discards at age.xls"
Bay H&L from VA com H&L harvest at age in "VA1 Data 2003.xls"
Bay Pound from VA Pound independent data Rapp River in 03 in "VIMS_monitor_size_freq.xls"
Coast Anchor gill from Shepherd bycatch summary in "sbass-comm discards.xls"
Coast Drift gill from Shepherd bycatch summary in "sbass-comm discards.xls"
Coast H&L from MA H&L discard at age in "Copy of MA1 Data 2003.xls"
Coast Pound from RI pound discard at age in "RI Data Calcs.xls"
Coast trawl from Shepherd bycatch summary in "sbass-comm discards.xls"

1982-2002

Age Frequencies from All Comm Discards.xls (under 2003 striped bass assmnt)
CB
CB Copied matrices; for seines, used Pound matrix
Other - took average across gears Anchor, Drift Pound and HL then standadized to 1
Anchor is VA gillnet
Used Drift for Anchor in 1988-1989
DE
DE anchor - used average Anchor (mostly MD) in spreadsheet from All Comm Discards
1991 Hook used MD hook
2008,2011 Hook from Coast H&L
1991, 1993,1996,1997, 2002 Other - Anchor
1993,1994, 1996 Pound = CB pound

For Coast - for HL 1982-1996 (Rec Release age comp), 1997-2002 Commrel age comps

Pound RI new 2000-2001 CAA
2001 Drift - MD wintr Drift
2001,2002 Trawl NY Commlandings
2000 Trawl - NY and NC combined (2000 Catch - 2001 Assessment)
POUND 1982-1983 ri_cat & ny_cat, 1984 ri_cat; used 1985 for 1986
Seine and Pound net 1987-2000 NY Ocean Haul Seine
Seine = 1982-1984 NY Haul Seine, 1985= Seine 1984, 1986 = Pound Net
1997 trawl AR97commCAA
COAST TRAWL Combined NY 1982-1985 from ny_cat in 1997-2000, checked
COAST TRAWL 1999 from NY1999 1997-2000, checked
COAST RAWL 1997 & 1998 NYCOmmHARV+NC Comm HAR from REVISION_CAA1997to1998 in 1997-2000, checked
COAST TRAWL 1990-1996 sum NY+ NC harvest from CAA_com1999 in 1997-2000,checked
TRAWLS 1986-1989 Used Other

**Appendix B7: Tag Recovery Estimates of Migration of Striped Bass from Chesapeake and Delaware Bays**

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March 2010

## Introduction

A spatial model for striped bass will require emigration and immigration rates to move numbers of striped bass among defined management areas. The only published estimates of emigration rates are due to Dorazio et al. (1994) who used Chesapeake Bay and Hudson River tag data from 1988-1991 to estimate the probability of Chesapeake Bay fish migrating to north of Cape May ("northern region") by fish body size. The spatial stock assessment will be age-based; thus, estimates of migration probabilities in relationship to age will be required. In this paper, I explore the use of the Dorazio method to develop migration probabilities based on age. In addition, I re-estimate the migration probabilities based on length to determine if migration probabilities might have changed between two periods (1988-1995 and 1996-2004).

## Methods

Release and recapture data for the Hudson River, Chesapeake Bay, and Delaware Bay from 1988 to 2004 were extracted from the USFWS Access database using SQL code. With no information about QA/QC selection criteria provided in Dorazio et al. (1994), I used all data extracted except recapture information with event>1 to eliminate duplicates. Tag recapture locations were coded to specify southern (south of Cape May, NJ) and northern (north of Cape May, NJ) recapture regions defined by Dorazio et al. (1994).

I developed the statistical model specified by Dorazio et al. (1994) in AD Model Builder (ADMB) and followed his analytic approach (see the paper for a complete description of the methods). In his approach, the probability of migration ($\lambda_{21}$) from a spawning bay to the northern region and the tag recovery rate ($v_1$) in northern rate are estimated (Hudson River migration to southern region is rare, so the migration probability is set to 0). Tag fates are coded as 1 if recovered in the northern region or 0 if recovered in the southern region or not recovered at all .

To estimate the $\lambda_{21}$ and $v_1$ and the effects of *size*, *age* and *year* on the migration and recovery rates, logistic models for binary data are used. *Size* (TL in m) and *age* are considered continuous explanatory variables, while *year* is considered a categorical variable (reference cell coding is used in the design matrix). Because it is unlikely that the spatial model will contain sex-specific components, I did not include sex as an explanatory variable.

For $\lambda_{21}$, the model is:

$$\hat{\lambda}_{21} = \frac{1}{1+\exp^{(\alpha+\sum_j \beta_i Year_i + \gamma \cdot size\ (or\ age)}}$$

where $\alpha$ is a constant, $\beta_i$ is the coefficient for year $i$, and $\gamma$ is the coefficient for size (or age) (based on reference coding Y*ear* is coded as either 0 (if not year) or 1 (if year) and the first year is used as the reference year).

For $v_1$,

$$\hat{v}_1 = \frac{1}{1+\exp^{(\alpha+\sum_j \beta_i Year_i + \gamma \cdot size\ (or\ age))}}$$

The parameters are estimated by using the method of maximum likelihood. The log-likelihood for the model is

$$l = \sum_{i=1}^{N1} y_i \log_e(\hat{v}_1) + (1-y_i)\log e(1-\hat{v}_1) + \sum_{i=1}^{N2} y_i \log_e(\hat{\lambda}_{21}\hat{v}_1) + (1-y_i)\log_e(1-\hat{\lambda}_{21}\hat{v}_1)$$

where $N1$ is fish tagged and released in the Hudson River, $y_i$ is $i$th observation (0 or 1), and $N2$ is the fish tagged and released in the spawning bay. The “best” model for the combination of explanatory variables was chosen based on the Akaike’s information criterion, examination of deviance and Pearson residual plots, and the precise (CVs) of parameter estimates. Seven models were included in the analysis:

| Model | $v_1$ | $\Lambda_{21}$ |
|---|---|---|
| 1 | Null | Null |
| 2 | TL (or Age) | Null |
| 3 | TL (or Age) | TL (or Age) |
| 4 | TL (or Age) | TL (or Age), Year |
| 5 | TL (or Age), Year | Null |
| 6 | TL (or Age), Year | TL (or Age) |
| 7 | TL (or Age), Year | TL (or Age), Year |

A null model contains only the equation constant (α). I used likelihood ratio tests to determine if model differed from the null or each other.

To test if the ADMB Builder code was correct, I estimated the parameters of the “best” model (model 8) of Dorazio et al. (1994) using data from 1988-1991and compared the results to the published estimates in Table 3 of the paper. The results are shown in Table 1 and show that the ADMB model produced estimates close to the published results (differences are probably due to my inability to extract exactly the same dataset used in the paper).

In Dorazio et al. (1994), recaptures from April-November of the same release year are used to estimate the model parameters. Results from our (MA DMF) temperature and acoustic tagging studies indicate that migration of striped bass in northern Massachusetts to the south waters begins near the end of September. It is possible that fish migrating in October and November may reach the southern region and the recaptures may be interpreted as fish that have never migrated north when combined over all months. To avoid this problem, I used data from April-September only.

Age data for Hudson River released fish were only available from 1988 to 1995. In addition, not all released fish were aged. Therefore, the dataset used when *age* was included as an explanatory variable was different in size and no analyses could be conducted for 1996-2004. For Delaware Bay, analyses include data only from 1992-1995 because age data were not available prior to 1992 and release/recapture information from the New Jersey DEP and DE tagging programs were used.

In the original paper, Dorazio et al. (1994) apparently used only tag release data from the Maryland DNR tagging program. Tagging has been also conducted by the State of Virginia in the Rappahannock River since 1990. I made separate analyses including the Virginia data to see if the additional information could improve estimates.

## Results

*Chesapeake Bay (Maryland Data Only)*

1988-1995

Explanatory variables of total length and year in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The model with the lowest AIC value for 1988-1995 was model 6 (Table 2). However, examination of the parameter coefficients of variation (CV) showed that the precision of most estimates was very poor (CVs>1); therefore, model 3 (total length incorporated in the tag recovery and migration probability sub-models) was selected as the “best” model (Table 3). The parameter estimates from model 3 are given in Table 2. The predicted migration probabilities from model 3 show that as striped bass size increases, the probability of migration increases (Figure 1A). However, when compared to the original predicted migration probabilities from Dorazio et al. (Figure 1A), the new model predicted lower probability at the same length. Plots of residuals (Figure 2A) show reasonable fit, although the use of total length in meters produces many length bins in which Y=0.

Explanatory variables of age and year in models 2-5 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). Models 6 and 7 were not different from model 1. The model with the lowest AIC value for 1988-1995 was model 3 which includes *age* as an explanatory variable in tag recovery rate and migration probability sub-models (Table 2). Model output showed that the probability of migration and tag recovery rate increased with age (Figure 1B; Table 3). Plots of residuals (Figure 2B) show reasonable fit.

1996-2004

Explanatory variables in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The model with the lowest AIC value for 1996-2004 was model 3 (Table 2). Parameter estimates from model 3 are given in Table 2. The predicted migration probabilities from model 3 show that as striped bass size increases, the probability of migration increases (Figure 3A). However, when compared to the predicted migration probabilities from 1988-1994, the model predicted lower migration probability and lower tag recovery rate at the same length (Figure 3A). Plots of residuals (Figure 3B) show reasonable fit.

*Chesapeake Bay (Maryland and Virginia Data)*

1988-1995

Explanatory variables of total length and year in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The model with the lowest AIC value for 1988-1995 was model 6 (Table 4). However, examination of the parameter coefficients of variation (CV) showed that the precision of most estimates was very poor (CVs>1). Model 7 was the next lowest AIC, but had very low precision estimates too. Therefore, model 3 (total length incorporated in the tag recovery and migration probability sub-models) was selected as the "best" model (Table 4). The parameter estimates from model 3 are given in Table 5. The predicted migration probabilities from model 3 show that as striped bass size increases, the probability of migration increases (Figure 4A) and, incorporating Virginia data, produced similar patterns as the model using only MD data (Figure 4A). Plots of residuals (Figure 4B) show reasonable fit, although the use of total length in meters produces many length bins in which Y=0.

Explanatory variables of age and year in models 2-5 and 7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). Models 6 was not different from model 1. The model with the lowest AIC value for 1988-1995 was model 3 which includes *age* as an explanatory variable in tag recovery rate and migration probability sub-models (Table 4). Model output showed that the probability of migration and tag recovery rate increases with age (Figure 5A; Table 5). There was considerable difference in migration probabilities between this model and the best model that used only MD data (Figure 5A). Plots of residuals (Figure 5B) show reasonable fit.

1996-2004

Explanatory variables in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The model with the lowest AIC value for 1996-2004 was model 3 (Table 4). Parameter estimates from model 3 are given in Table 5. The predicted migration probabilities from model 3 show that as striped bass size increases, the probability of migration increases (Figure 6A). However, when compared to the predicted migration probabilities using only MD data, the model predicted higher migration probability and lower tag recovery rate at the same length (Figure 6B). Plots of residuals (Figure 6B) show reasonable fit.

*Delaware Bay*

<u>1992-1995</u>

Explanatory variables of total length and year in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The model with the lowest AIC value for 1992-1995 was model 2 where total length was included in the tag recovery sub-model only (Table 6). The parameter estimates from model 2 are given in Table 7. The Model output shows that the probability of migration is constant across size (Figure 7A). Plots of residuals (Figure 7B) show a systematic trend which indicate a general lack of fit. The relatively few years of data is probably responsible for the lack of fit.

Explanatory variables of age and year in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The model with the lowest AIC value for 1992-1995 was model 3; however, comparison of model 2 and model 3 using a likelihood ratio test indicated not significant differences between the models. Thus, based on the rule of parsimony, model 2 should be selected. Model 2 includes *age* as an explanatory variable in tag recovery rate sub-model only (Table 6). The model output shows that the probabilities of migration is constant across age (Figure 8A). Plots of residuals (Figure 8B) show reasonable fit.

<u>1996-2004</u>

Explanatory variables of total length and year in models 2-7 accounted for significant amounts of variation when compared to model 1 ($p \leq 0.001$). The models with the lowest AIC value for 1988-1995 were models 6 and 7 (Table 6). However, examination of the parameter coefficients of variation (CV) of each showed that the precision of most estimates was very poor (CVs>1); therefore, model 3 (total length incorporated in the tag recovery and migration probability sub-models) was selected as the "best" model (Table 6). The parameter estimates from model 3 are given in Table 7. The model output shows that as striped bass size increases, the probabilities of migration increases (Figure 9A). Plots of residuals (Figure 9B) show reasonable fit.

**Discussion**

The analyses presented should be considered preliminary. The results suggest estimation of migration probabilities based on age is possible. I need to consult lead state personnel to discuss what data to include in each analysis, and to develop criteria for scrutinizing data. NY may have age data for post-1995 releases, and estimation of migration probabilities post-1995 may be possible. I'll try to get those data. In their paper, Dorazio et al. (2004) wrote that they used total length in centimeters in their modeling, but they actually used total length in meters. It would be wiser to use centimeters because it would allow improved assessment of the residuals by creating length bins that could have positive values associated with each bin. Some of the odd patterns observed in the residual plots are due to zeros in the meter bins. Also, other model fit assessment techniques need to be examined (eg., Hosmer-Lemeshow tests).

Table 1. Parameters of model 8 of Dorazio et al. (1994) re-estimated using the ADMB program. Dorazio parameters are used to predict the probability of not migrating. To get probability of migration, signs are reversed (see Figure 5 of Dorazio et al., 1994).

| Parameter | Dorazio | ADMB |
|---|---|---|
| Tag recovery rate $v_1$ | | |
| Constant | -4.10 | 4.06 |
| Effect of total length (m) | 1.91 | -1.89 |
| Effect of 1989 | 0.25 | -0.27 |
| Effect of 1990 | 0.57 | -0.56 |
| Effect of 1991 | 0.45 | -0.44 |
| Migration rate $\lambda_{21}$ | | |
| Constant | -15.5 | 15.2 |
| Effect of total length (m) | 19.1 | -18.6 |

Table 2. Comparison of models to examine the effects of striped bass total length (TL; m) or age (years), and year of recovery (Year) on the rates of migration $\lambda_{21}$ from Chesapeake Bay (MD) to the northern region (Apr-Sept recoveries), and tag recovery $v_1$ in the northern region for 1998-1995 and 1996-2004. *n* is the number of parameters, *-LL* is the log-likelihood, and *AIC* is the Akaike's Information Criterion.

1988-1995

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 2354.8 | 4713.5 |
| 2 | TL | Null | 3 | 2220.5 | 4447.0 |
| 3 | TL | TL | 4 | 2152.5 | 4312.7 |
| 4 | TL | TL, Year | 11 | 2148.1 | 4318.2 |
| 5 | TL, Year | Null | 10 | 2204.5 | 4428.9 |
| 6 | TL, Year | TL | 11 | 2141.7 | 4305.5 |
| 7 | TL, Year | TL, Year | 18 | 2136.6 | 4309.2 |

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 1999.0 | 4002.0 |
| 2 | Age | Null | 3 | 1949.2 | 3904.3 |
| 3 | Age | Age | 4 | 1932.1 | 3872.2 |
| 4 | Age | Age, Year | 11 | 1928.8 | 3879.7 |
| 5 | Age, Year | Null | 10 | 1936.5 | 3893.0 |
| 6 | Age, Year | Age | 11 | 1990.4 | 4003.2 |
| 7 | Age, Year | Age, Year | 18 | 1991.9 | 4019.8 |

1996-2004

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 2625.9 | 5255.9 |
| 2 | TL | Null | 3 | 2536.7 | 5079.3 |
| 3 | TL | TL | 4 | 2466.6 | 4941.2 |
| 4 | TL | TL, Year | 12 | 2462.5 | 4949.0 |
| 5 | TL, Year | Null | 11 | 2529.0 | 5080.0 |
| 6 | TL, Year | TL | 12 | 2460.0 | 4944.0 |
| 7 | TL, Year | TL, Year | 19 | 2455.7 | 4951.3 |

Table 3. Maximum-likelihood estimates of the parameters from the "best" model for 1988-1995 and 1996-2004 MD data only when total length or age is used as an explanatory variable.

| Parameter | Estimate | SE | CV |
|---|---|---|---|
| **1988-1995** | | | |
| Tag recovery rate $v_1$ | | | |
| Constant | 4.149 | 0.247 | 0.059 |
| Effect of TL (m) | -2.104 | 0.311 | 0.148 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 13.022 | 1.660 | 0.127 |
| Effect of TL (m) | -15.376 | 2.299 | 0.149 |
| Tag recovery rate $v_1$ | | | |
| Constant | 3.784 | 0.200 | 0.053 |
| Effect of Age (yrs) | -0.156 | 0.024 | 0.152 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 4.792 | 0.802 | 0.167 |
| Effect of Age (yrs) | -0.522 | 0.114 | 0.219 |
| **1996-2004** | | | |
| Tag recovery rate $v_1$ | | | |
| Constant | 3.957 | 0.234 | 0.059 |
| Effect of TL (m) | -1.738 | 0.297 | 0.171 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 8.738 | 0.777 | 0.089 |
| Effect of TL (m) | -9.220 | 1.012 | 0.110 |

Table 4. Comparison of models to examine the effects of striped bass total length (m) or age (years), and year of recovery (Year) on the rates of migration $\lambda_{21}$ from Chesapeake Bay (MD and VA) to the northern region, and tag recovery $v_1$ in the northern region by period. *n* is the number of parameters, *-LL* is the log-likelihood, and *AIC* is the Akaike's Information Criterion.

1988-1995

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 2677.4 | 5358.8 |
| 2 | TL | Null | 3 | 2475.9 | 4957.9 |
| 3 | TL | TL | 4 | 2374.3 | 4756.7 |
| 4 | TL | TL, Year | 11 | 2370.2 | 4762.4 |
| 5 | TL, Year | Null | 10 | 2459.8 | 4939.5 |
| 6 | TL, Year | TL | 11 | 2364.4 | 4750.8 |
| 7 | TL, Year | TL, Year | 18 | 2358.2 | 4752.4 |

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 2632.2 | 5268.4 |
| 2 | Age | Null | 3 | 2482.4 | 4970.9 |
| 3 | Age | Age | 4 | 2383.2 | 4774.4 |
| 4 | Age | Age, Year | 11 | 2384.1 | 4790.2 |
| 5 | Age, Year | Null | 10 | 2478.6 | 4977.3 |
| 6 | Age, Year | Age | 11 | 2663.9 | 5349.8 |
| 7 | Age, Year | Age, Year | 18 | 2404.3 | 4844.7 |

1996-2004

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 3297.5 | 6599.0 |
| 2 | TL | Null | 3 | 3114.5 | 6235.1 |
| 3 | TL | TL | 4 | 3009.9 | 6027.8 |
| 4 | TL | TL, Year | 12 | 3004.6 | 6033.3 |
| 5 | TL, Year | Null | 11 | 3109.5 | 6241.1 |
| 6 | TL, Year | TL | 12 | 3004.6 | 6032.9 |
| 7 | TL, Year | TL, Year | 20 | 2995.8 | 6031.5 |

Table 5. Maximum-likelihood estimates of the parameters from the "best" model for 1988-1995 and 1996-2004 MD and VA data when total length or age is used as an explanatory variable.

| Parameter | Estimate | SE | CV |
|---|---|---|---|
| **1988-1995** | | | |
| Tag recovery rate $v_1$ | | | |
| Constant | 4.116 | 0.236 | 0.057 |
| Effect of TL (m) | -2.059 | 0.293 | 0.142 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 13.944 | 1.403 | 0.100 |
| Effect of TL (m) | -16.729 | 1.940 | 0.116 |
| Tag recovery rate $v_1$ | | | |
| Constant | 3.718 | 0.192 | 0.052 |
| Effect of Age | -0.144 | 0.022 | 0.153 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 8.702 | 0.799 | 0.092 |
| Effect of Age | -1.071 | 0.122 | 0.114 |
| **1996-2004** | | | |
| Tag recovery rate $v_1$ | | | |
| Constant | 3.799 | 0.225 | 0.059 |
| Effect of TL (m) | -1.510 | 0.284 | 0.188 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 9.213 | 0.712 | 0.077 |
| Effect of TL (m) | -10.387 | 0.971 | 0.093 |

Table 6. Comparison of models to examine the effects of striped bass total length (m) or age (years), and year of recovery (Year) on the rates of migration $\lambda_{21}$ from Chesapeake Bay (MD and VA) to the northern region, and tag recovery $v_1$ in the northern region by period. *n* is the number of parameters, *-LL* is the log-likelihood, and *AIC* is the Akaike's Information Criterion.

1992-1995

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 2481.4 | 4966.8 |
| 2 | TL | Null | 3 | 2463.4 | 4932.7 |
| 3 | TL | TL | 4 | 2463.0 | 4934.0 |
| 4 | TL | TL, Year | 7 | 2461.6 | 4937.3 |
| 5 | TL, Year | Null | 6 | 2460.6 | 4933.1 |
| 6 | TL, Year | TL | 7 | 2460.4 | 4934.7 |
| 7 | TL, Year | TL, Year | 10 | 2457.6 | 4935.2 |

| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 1443.3 | 2890.6 |
| 2 | Age | Null | 3 | 1430.4 | 2866.8 |
| 3 | Age | Age | 4 | 1428.9 | 2865.8 |
| 4 | Age | Age, Year | 7 | 1432.3 | 2878.7 |
| 5 | Age, Year | Null | 6 | 1429.6 | 2871.1 |
| 6 | Age, Year | Age | 7 | 1428.1 | 2870.3 |
| 7 | Age, Year | Age, Year | 10 | 1428.4 | 2876.8 |

1996-2004

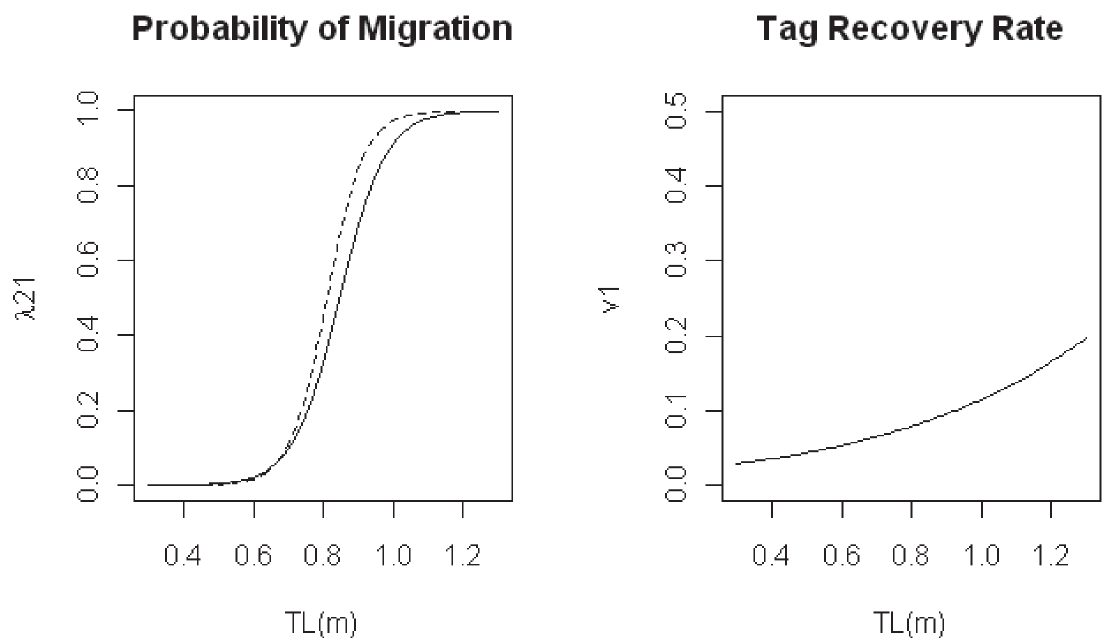
| Model | $v_1$ | $\Lambda_{21}$ | *n* | *-LL* | *AIC* |
|---|---|---|---|---|---|
| 1 | Null | Null | 2 | 6255.5 | 12515.0 |
| 2 | TL | Null | 3 | 6216.8 | 12439.5 |
| 3 | TL | TL | 4 | 6193.7 | 12395.7 |
| 4 | TL | TL, Year | 12 | 6188.7 | 12401.5 |
| 5 | TL, Year | Null | 11 | 6206.9 | 12435.7 |
| 6 | TL, Year | TL | 12 | 6183.3 | 12390.5 |
| 7 | TL, Year | TL, Year | 20 | 6177.6 | 12395.3 |

Table 7. Maximum-likelihood estimates of the parameters from the "best" model for 1992-1995 and 1996-2004 DE data when total length or age is used as an explanatory variable.

| Parameter | Estimate | SE | CV |
|---|---|---|---|
| 1992-1995 | | | |
| Tag recovery rate $v_1$ | | | |
| Constant | 4.131 | 0.287 | 0.069 |
| Effect of length (m) | -2.278 | 0.386 | 0.169 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | -1.442 | 0.438 | 0.304 |
| Tag recovery rate $v_1$ | | | |
| Constant | 3.242 | 0.209 | 0.065 |
| Effect of age | -0.122 | 0.023 | 0.196 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | -0.441 | 0.303 | 0.686 |
| 1996-2004 | | | |
| Tag recovery rate $v_1$ | | | |
| Constant | 3.568 | 0.182 | 0.051 |
| Effect of length (m) | -1.274 | 0.260 | 0.204 |
| Migration rate $\lambda_{21}$ | | | |
| Constant | 15.238 | 3.236 | 0.212 |
| Effect of length (m) | -31.241 | 6.733 | 0.216 |

Figure 1. A) Predicted migration probabilities ($\lambda_{21}$) using 1988-1995 MD data only (solid line) compared to predicted probabilities from Dorazio et al. (1994)(dashed line), and tag recovery rate ($v_1$) by total length, and B) predicted migration probabilities ($\lambda_{21}$) and tag recovery rate ($v_1$) using 1988-1995 MD data only by age.

A.




B.

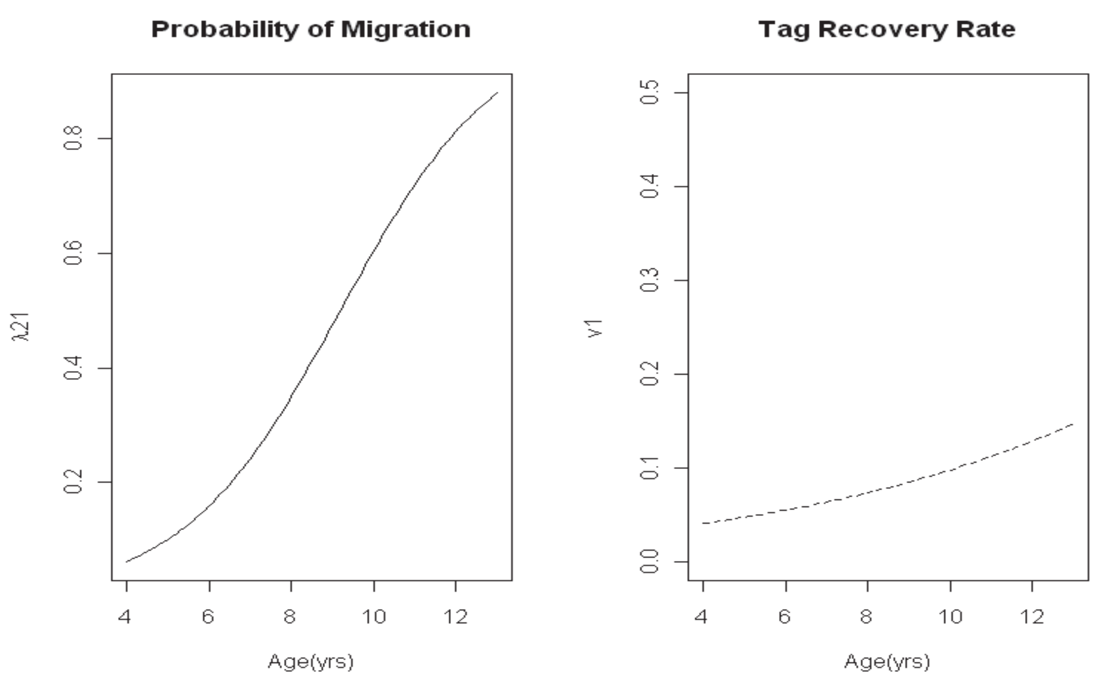
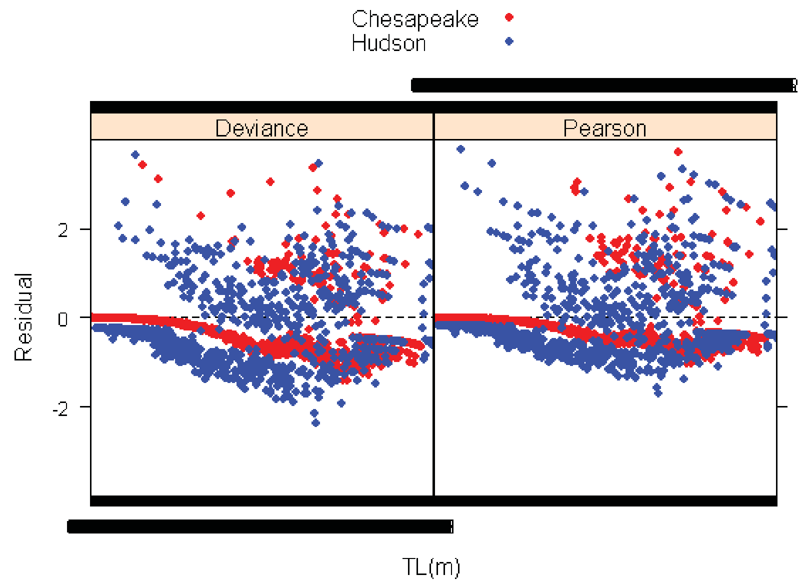


Figure 2. Plots of deviance and Pearson residuals for 1988-1995 MD only data from the "best " models when A) total length or B) age was used as an explanatory variable.

A.




B.

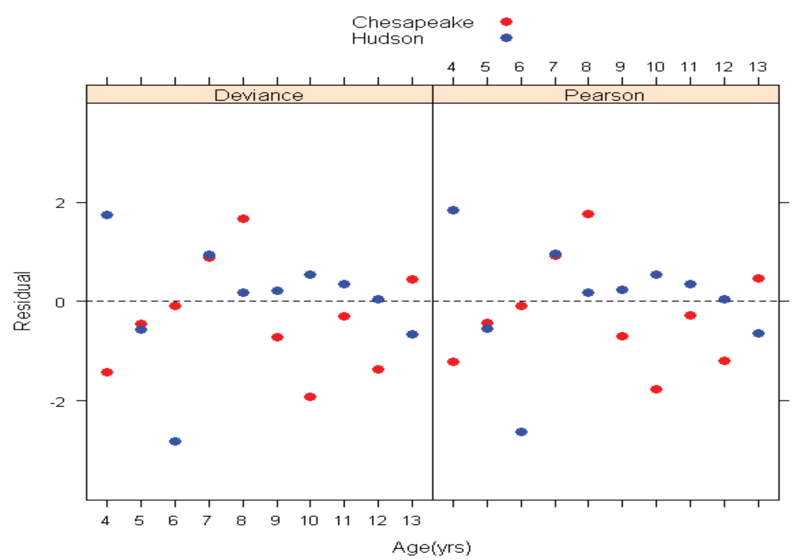
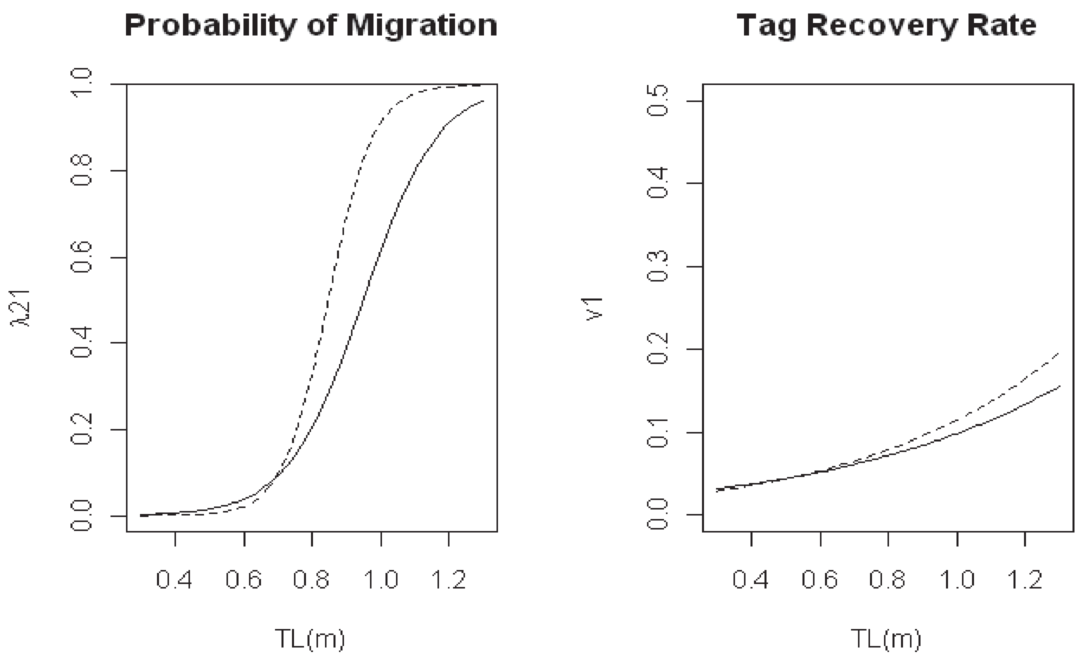


Figure 3. A). Predicted migration probabilities ($\lambda_{21}$) and tag recovery rate ($v_1$) by total length using 1996-2004 MD data only (solid line) compared to predicted probabilities from 1988-1995 (dashed line), and B) plots of deviance and Pearson residuals.

A.




B.

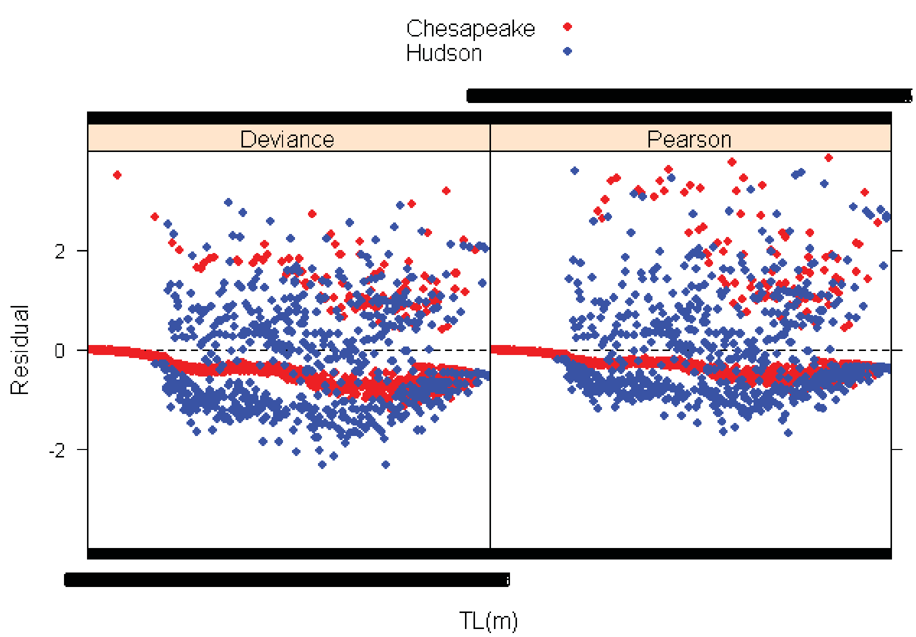
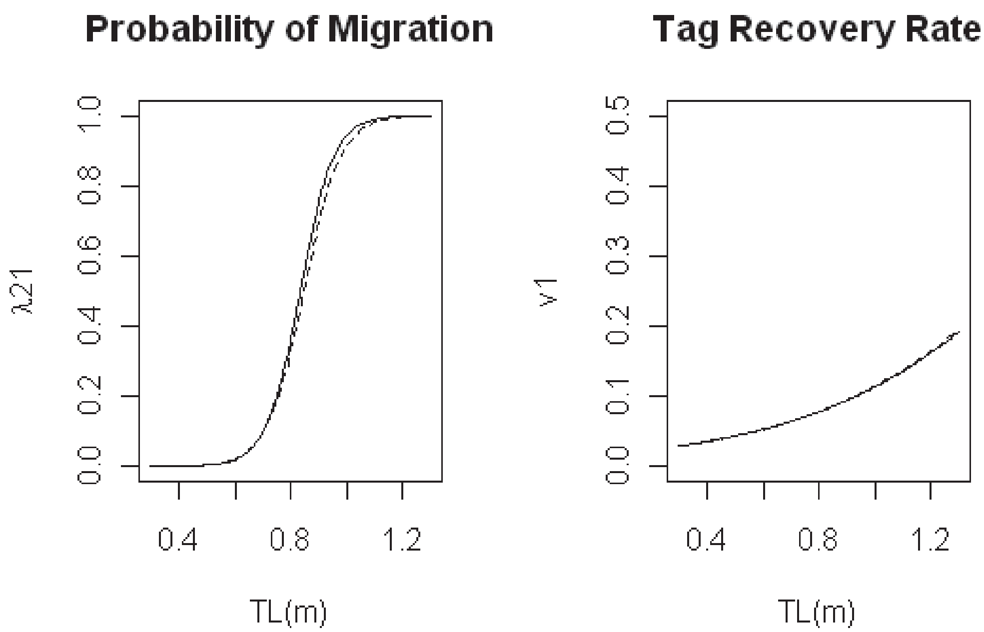


Figure 4. A) Predicted migration probabilities ($\lambda_{21}$) ) and tag recovery rate ($v_1$) using 1988-1995 MD and VA data (solid line) compared to predicted probabilities using MD data only (dashed line) by total length, and B) plots of deviance and Pearson residuals.

A.




B.

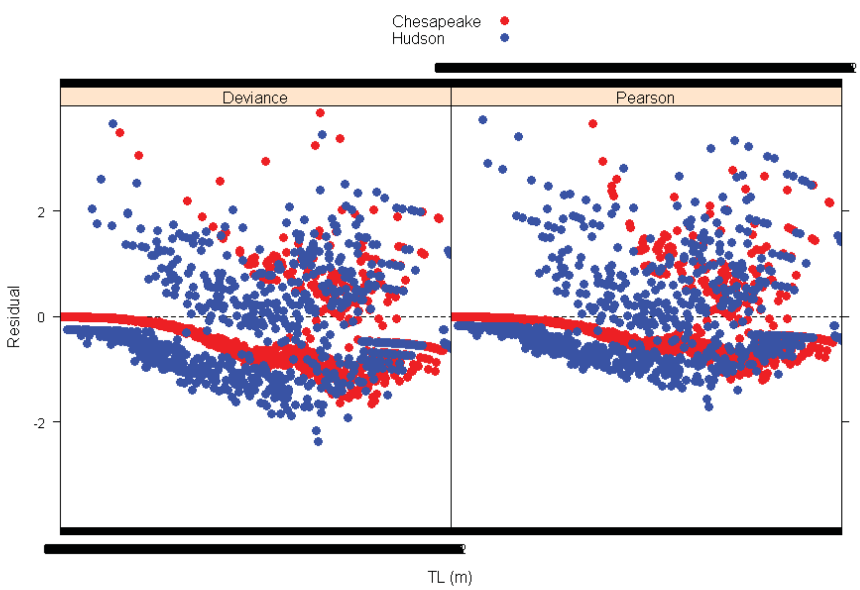
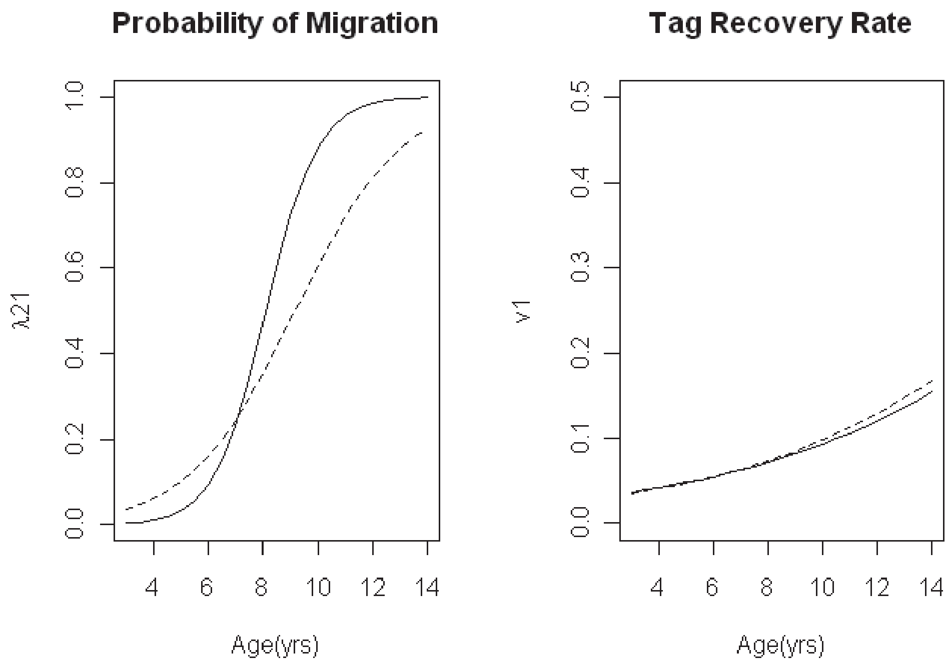


Figure 5. A) Predicted migration probabilities ($\lambda_{21}$) ) and tag recovery rate ($v_1$) using 1988-1995 MD and VA data (solid line) compared to predicted probabilities using MD data only (dashed line) by age, and B) plots of deviance and Pearson residuals.

A.




B.

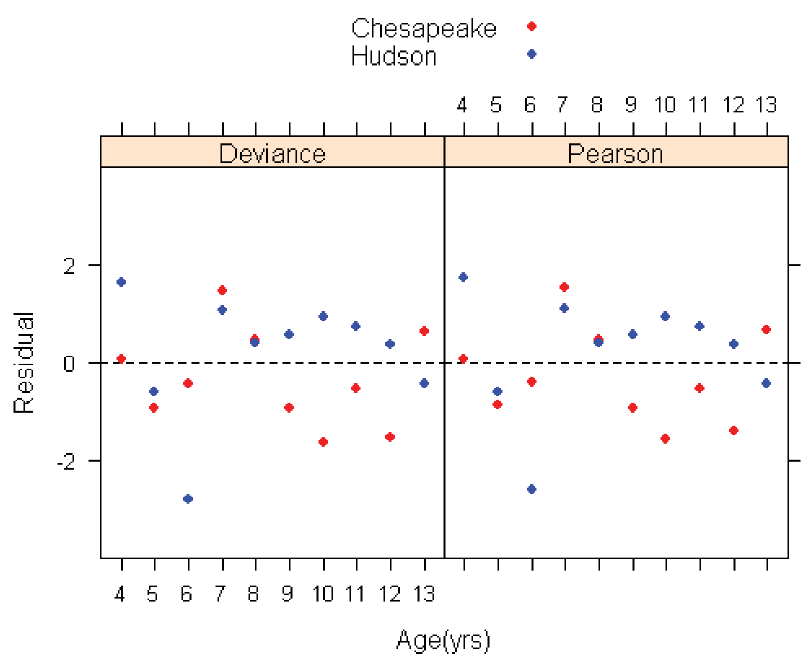
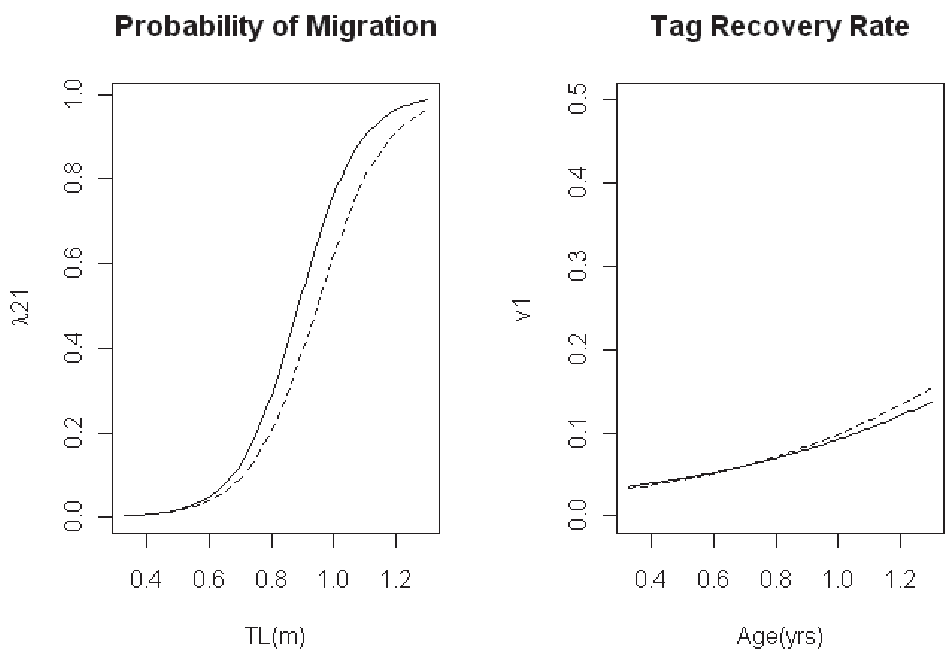


Figure 6. A) Predicted migration probabilities ($\lambda_{21}$) ) and tag recovery rate ($v_1$) using 1996-2004 MD and VA data (solid line) compared to predicted probabilities using MD data only (dashed line) by total length, and B) plots of deviance and Pearson residuals.

A.




B.

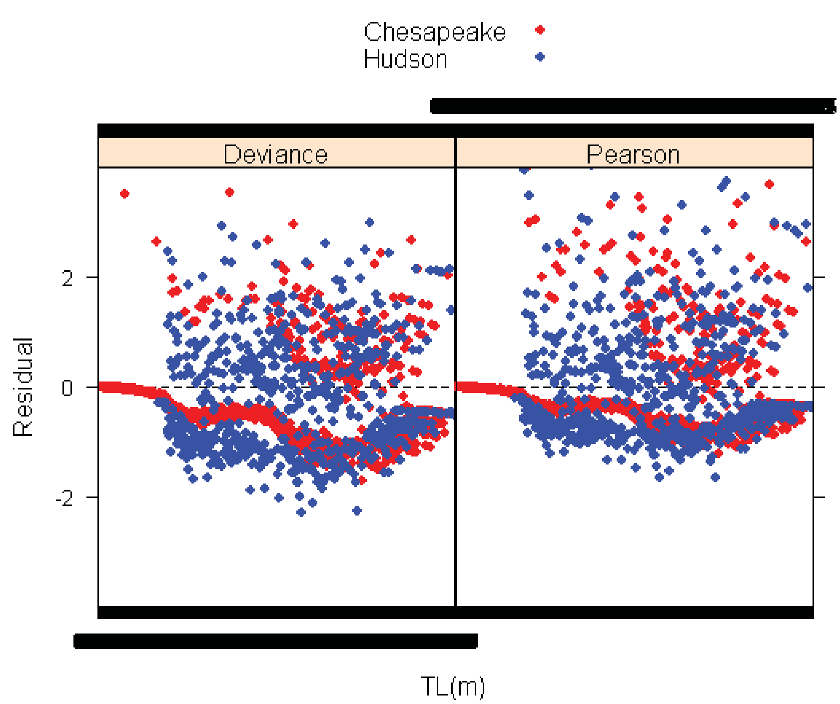
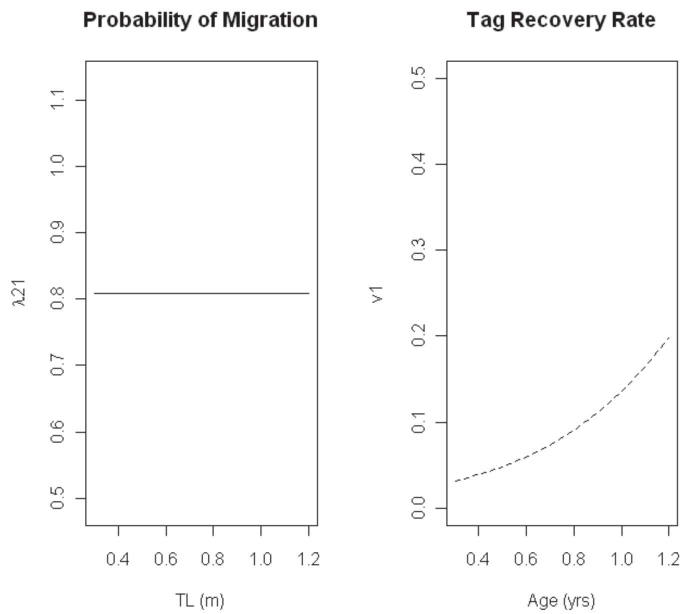


Figure 7. A) Predicted migration probabilities ($\lambda_{21}$) and tag recovery rate ($v_1$) using 1992-1995 DE/NJ data by total length, and B) plots of deviance and Pearson residuals.

A.




B.

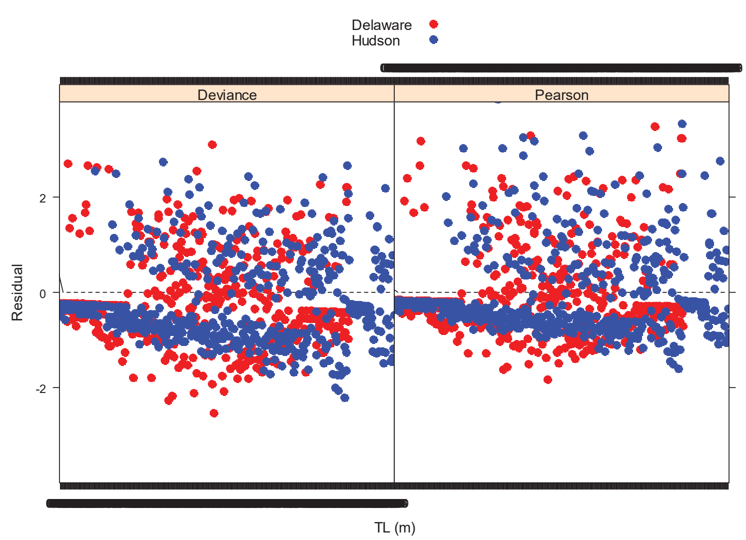
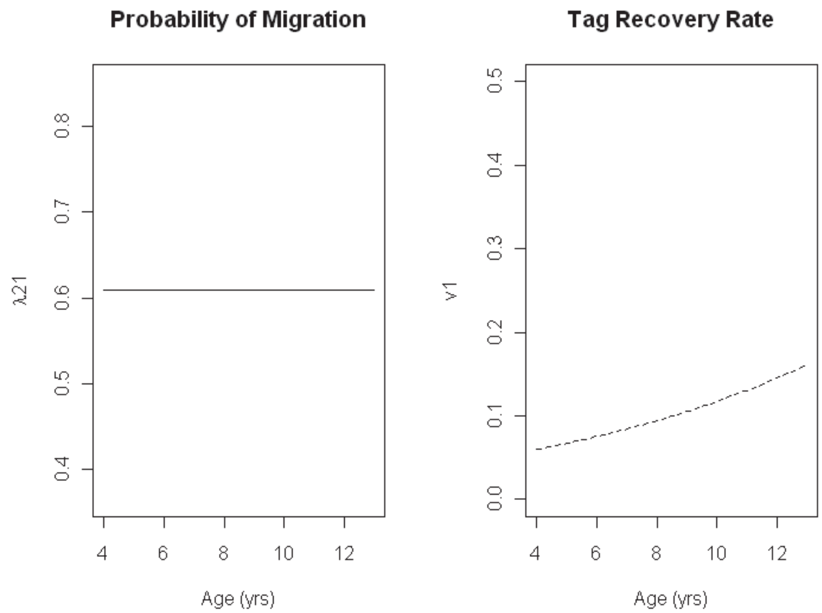


Figure 8. A) Predicted migration probabilities ($\lambda_{21}$) and tag recovery rate ($v_1$) using 1992-1995 DE/NJ data by age, and B) plots of deviance and Pearson residuals.

A.




B.

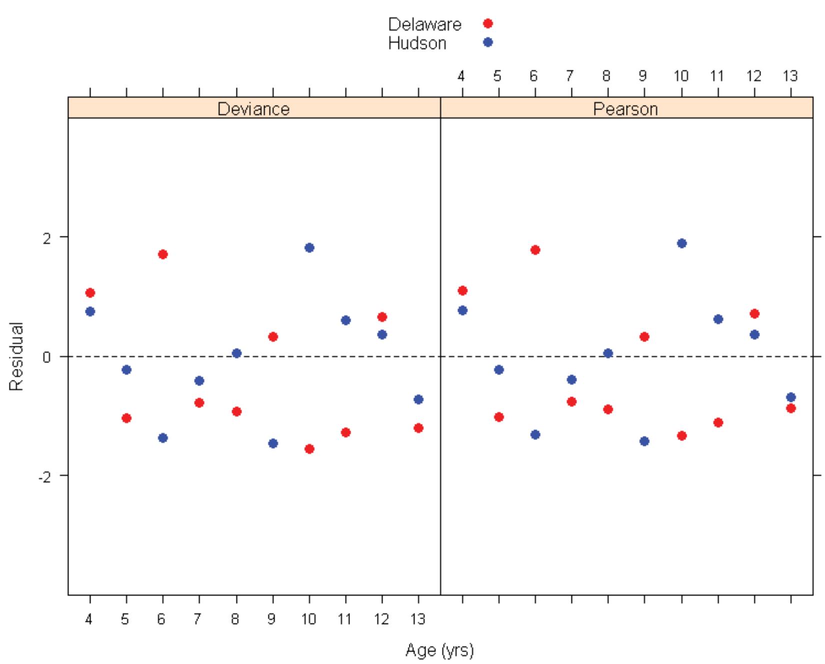
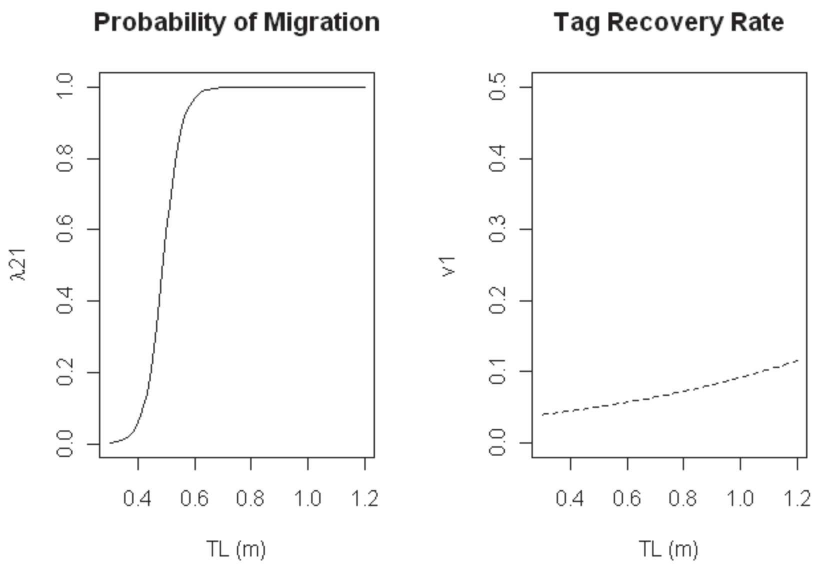
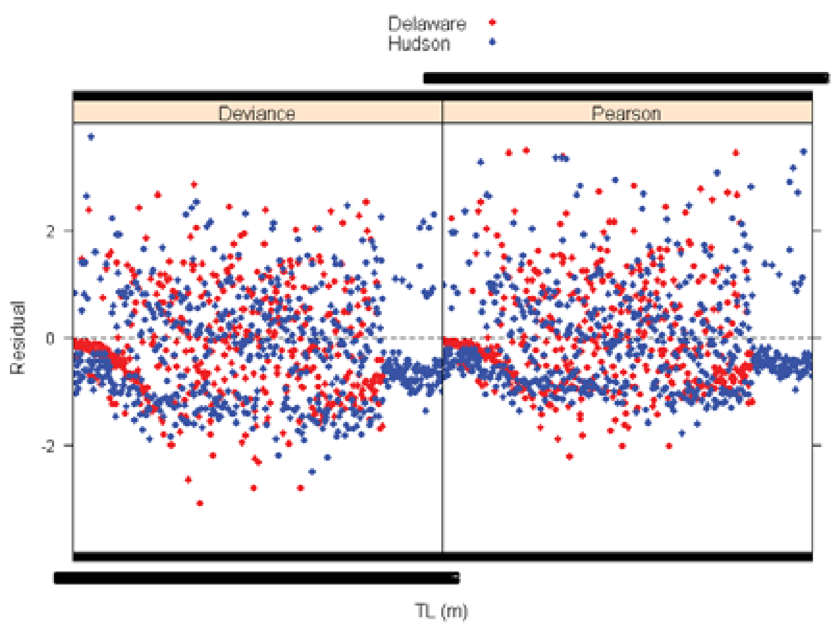


Figure 9. A) Predicted migration probabilities ($\lambda_{21}$) and tag recovery rate ($v_1$) using 1996-2004 DE/NJ data by total length, and B) plots of deviance and Pearson residuals.

A.




B.



**Appendix B8. ADMB Code for the Striped Bass Two-Stock Statistical Catch-At-Age (2SCA) Model**

```
//-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>
//
//           Striped Bass Two-Stock Statistical Catch-At-Age Model
//           Gary A. Nelson
//           Massachusetts Division of Marine Fisheries
//           Gloucester, MA 01930
//
//           Code for the calculation of effective sample size using the Francis (2011) method
//                         copied from ASAP written by Chris Legault, NMFS.
//-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>-><>
TOP_OF_MAIN_SECTION
 arrmblsize=1000000;
GLOBALS_SECTION
 #include <string.h>
 #include<ctime>
 #include <admodel.h>
 #include <iostream>
  char hh[2];
  using namespace std;
  void find_and_replace(string& source, string const& find, string const& replace)
  {
    for(string::size_type i = 0; (i = source.find(find, i)) != string::npos;)
    {
        source.replace(i, find.length(), replace);
        i += replace.length();
    }
  };
  string dir;
  string dirnew;
DATA_SECTION
 //!!ad_comm::change_datafile_name("mig2stockmodel.dat");
 init_adstring dirfirst;
 init_int substructure;
 init_int ncoastwaves;
 init_int styr;
 init_int endyr;
 init_int nages;
 //Stock 1
 init_matrix s1_bay_total_catch(styr,endyr,1,substructure);
 init_matrix s1_bay_total_catch_CV(styr,endyr,1,substructure);
 init_vector s1_bay_total_catch_lambda_wgts(1,substructure);
 init_matrix s1_bay_catch_paa_ess(styr,endyr,1,substructure);
 init_3darray s1_bay_catch_paa(1,substructure,styr,endyr,1,nages);//Proportions-at-age for Bay Period 1
 init_vector s1_bay_catch_paa_lambda_wgts(1,substructure);
 init_number s1_bay_reg_nperiods;//this has to be the number of rows of reg periods
 init_matrix s1_bay_select_years_type(1,s1_bay_reg_nperiods,1,4);//wave group (1,2,3) styr endyr type
 init_int s1_bay_sel_phase;
 init_int s1_bay_nagg;
 init_vector s1_bay_use_agg(1,s1_bay_nagg);
 init_vector s1_bay_agg_index_lambda_wgts(1,s1_bay_nagg);
 init_vector s1_bay_agg_time(1,s1_bay_nagg);
 init_vector s1_bay_agg_ages(1,s1_bay_nagg);
 init_int s1_bay_agg_phase;
 init_matrix s1_bay_agg_index(styr,endyr,1,s1_bay_nagg);//index
 init_matrix s1_bay_agg_index_CV(styr,endyr,1,s1_bay_nagg);//index
 init_int s1_bay_nac;
 init_vector s1_bay_use_ac(1,s1_bay_nac);
 init_vector s1_bay_ac_index_lambda_wgts(1,s1_bay_nac);
 init_vector s1_bay_ac_time(1,s1_bay_nac);
 init_vector s1_bay_ac_sel_type(1,s1_bay_nac);
 init_int s1_bay_ac_phase;
 init_matrix s1_bay_ac_index(styr,endyr,1,s1_bay_nac);
 init_matrix s1_bay_ac_index_CV(styr,endyr,1,s1_bay_nac);
 init_matrix s1_bay_ac_index_paa_ess(styr,endyr,1,s1_bay_nac);
 init_3darray s1_bay_ac_index_paa(1,s1_bay_nac,styr,endyr,1,nages);
 init_vector s1_bay_ac_index_paa_lambda_wgts(1,s1_bay_nac);
```

```
init_int s1_bay_ac_sel_phase;
init_vector s1_bay_pM(1,substructure);
init_matrix s1_bay_M(styr,endyr,1,nages); //M-at-age for bay
init_matrix s1_female_mat(styr,endyr,1,nages);
init_matrix s1_male_mat(styr,endyr,1,nages);
init_3darray s1_bay_prop_female(1,substructure,styr,endyr,1,nages);
init_matrix s1_bay_weight_at_age(styr,endyr,1,nages);
init_matrix s1_test_emig_probs(styr,endyr,1,nages);
//Everything else
init_int s2_nagg;
init_vector s2_use_agg(1,s2_nagg);
init_vector s2_agg_index_lambda_wgts(1,s2_nagg);
init_vector s2_agg_time(1,s2_nagg);
init_vector s2_agg_ages(1,s2_nagg);
init_int s2_agg_phase;
init_matrix s2_agg_index(styr,endyr,1,s2_nagg);//index
init_matrix s2_agg_index_CV(styr,endyr,1,s2_nagg);//index
init_int s2_nac;
init_vector s2_use_ac(1,s2_nac);
init_vector s2_ac_index_lambda_wgts(1,s2_nac);
init_vector s2_ac_time(1,s2_nac);
init_vector s2_ac_sel_type(1,s2_nac);
init_int s2_ac_phase;
init_matrix s2_ac_index(styr,endyr,1,s2_nac);
init_matrix s2_ac_index_CV(styr,endyr,1,s2_nac);
init_matrix s2_ac_index_paa_ess(styr,endyr,1,s2_nac);
init_3darray s2_ac_index_paa(1,s2_nac,styr,endyr,1,nages);
init_vector s2_ac_index_paa_lambda_wgts(1,s2_nac);
init_int s2_ac_sel_phase;
init_matrix s2_female_mat(styr,endyr,1,nages);
init_matrix s2_male_mat(styr,endyr,1,nages);
 //Observed combined coast
init_matrix coast_total_catch(styr,endyr,1,ncoastwaves);
init_matrix coast_total_catch_CV(styr,endyr,1,ncoastwaves);
init_vector coast_total_catch_lambda_wgts(1,ncoastwaves);
init_matrix coast_catch_paa_ess(styr,endyr,1,ncoastwaves);
init_3darray coast_catch_paa(1,ncoastwaves,styr,endyr,1,nages);//Proportions-at-age for Coast Period 1
init_vector coast_catch_paa_lambda_wgts(1,ncoastwaves);
init_number coast_reg_nperiods;
init_matrix coast_select_years_type(1,coast_reg_nperiods,1,4);//wave group (1,2,3) styr endyr type
init_int coast_sel_phase;
init_int coast_nagg;
init_vector coast_use_agg(1,coast_nagg);
init_vector coast_agg_index_lambda_wgts(1,coast_nagg);
init_vector coast_agg_time(1,coast_nagg);
init_vector coast_agg_ages(1,coast_nagg);
init_int coast_agg_phase;
init_matrix coast_agg_index(styr,endyr,1,coast_nagg);//index
init_matrix coast_agg_index_CV(styr,endyr,1,coast_nagg);//index
init_int coast_nac;
init_vector coast_use_ac(1,coast_nac);
init_vector coast_ac_index_lambda_wgts(1,coast_nac);
init_vector coast_ac_time(1,coast_nac);
init_vector coast_ac_sel_type(1,coast_nac);
init_int coast_ac_phase;
init_matrix coast_ac_index(styr,endyr,1,coast_nac);
init_matrix coast_ac_index_CV(styr,endyr,1,coast_nac);
init_matrix coast_ac_index_paa_ess(styr,endyr,1,coast_nac);
init_3darray coast_ac_index_paa(1,coast_nac,styr,endyr,1,nages);
init_vector coast_ac_index_paa_lambda_wgts(1,coast_nac);
init_int coast_ac_sel_phase;
init_vector coast_pM(1,substructure);
init_matrix coast_pF(styr,endyr,1,substructure);
init_matrix coast_M(styr,endyr,1,nages);
init_3darray coast_prop_female(1,substructure,styr,endyr,1,nages);
init_matrix coast_weight_at_age(styr,endyr,1,nages);
```

```
init_int use_stockcomp;
init_int stock_comp_time;
init_vector stock_comp_ess(styr,endyr);
init_matrix stock_composition(styr,endyr,1,2);
init_number stock_comp_lambda_wgt;
init_int stock_comp_firstage;
init_int stock_comp_lastage;
init_int biascor;
init_number s1_Rdev_lambda;
init_number s2_Rdev_lambda;
init_number n_s1_bay_Nyr1;
init_number n_s1_coast_Nyr1;
init_number n_s2_Nyr1;
init_number s1_bay_logavgR_low;init_number s1_bay_logavgR_up;init_number s1_bay_logavgR_start;init_int s1_bay_R_phase;
init_number s1_bay_Rdevs_low; init_number s1_bay_Rdevs_up;init_int s1_bay_devR_phase;
init_number s1_bay_logNyr1_low;init_number s1_bay_logNyr1_up;init_number s1_bay_logNyr1_start;init_int s1_bay_logNyr1_phase;
init_number s1_coast_logNyr1_low;init_number s1_coast_logNyr1_up;init_number s1_coast_logNyr1_start; init_int s1_coast_logNyr1_phase;
init_number s1_bay_logF_low;init_number s1_bay_logF_up;init_number s1_bay_logF_start; init_int s1_bay_logF_phase;
init_number s1_bay_catch_gompertz_a_low;init_number s1_bay_catch_gompertz_a_up;init_number s1_bay_catch_gompertz_a_start;
init_number s1_bay_catch_gompertz_b_low;init_number s1_bay_catch_gompertz_b_up;init_number s1_bay_catch_gompertz_b_start;
init_number s1_bay_catch_logistic_a_low;init_number s1_bay_catch_logistic_a_up;init_number s1_bay_catch_logistic_a_start;
init_number s1_bay_catch_logistic_b_low;init_number s1_bay_catch_logistic_b_up;init_number s1_bay_catch_logistic_b_start;
init_number s1_bay_catch_thompson_a_low;init_number s1_bay_catch_thompson_a_up;init_number s1_bay_catch_thompson_a_start;
init_number s1_bay_catch_thompson_b_low;init_number s1_bay_catch_thompson_b_up;init_number s1_bay_catch_thompson_b_start;
init_number s1_bay_catch_thompson_c_low;init_number s1_bay_catch_thompson_c_up;init_number s1_bay_catch_thompson_c_start;
init_number s1_bay_log_q_agg_low;init_number s1_bay_log_q_agg_up;init_number s1_bay_log_q_agg_start;
init_number s1_bay_log_q_ac_low;init_number s1_bay_log_q_ac_up;init_number s1_bay_log_q_ac_start;
init_number s1_bay_ac_gompertz_a_low;init_number s1_bay_ac_gompertz_a_up;init_number s1_bay_ac_gompertz_a_start;
init_number s1_bay_ac_gompertz_b_low;init_number s1_bay_ac_gompertz_b_up;init_number s1_bay_ac_gompertz_b_start;
init_number s1_bay_ac_logistic_a_low;init_number s1_bay_ac_logistic_a_up;init_number s1_bay_ac_logistic_a_start;
init_number s1_bay_ac_logistic_b_low;init_number s1_bay_ac_logistic_b_up;init_number s1_bay_ac_logistic_b_start;
init_number s1_bay_ac_thompson_a_low;init_number s1_bay_ac_thompson_a_up;init_number s1_bay_ac_thompson_a_start;
init_number s1_bay_ac_thompson_b_low;init_number s1_bay_ac_thompson_b_up;init_number s1_bay_ac_thompson_b_start;
init_number s1_bay_ac_thompson_c_low;init_number s1_bay_ac_thompson_c_up;init_number s1_bay_ac_thompson_c_start;
init_number s1_bay_ac_gamma_a_low;init_number s1_bay_ac_gamma_a_up;init_number s1_bay_ac_gamma_a_start;
init_number s1_bay_ac_gamma_b_low;init_number s1_bay_ac_gamma_b_up;init_number s1_bay_ac_gamma_b_start;
init_number s2_logavgR_low;init_number s2_logavgR_up;init_number s2_logavgR_start;init_int s2_R_phase;
init_number s2_Rdevs_low; init_number s2_Rdevs_up;init_int s2_devR_phase;
init_number s2_logNyr1_low;init_number s2_logNyr1_up;init_number s2_logNyr1_start;init_int s2_logNyr1_phase;
init_number s2_log_q_agg_low;init_number s2_log_q_agg_up;init_number s2_log_q_agg_start;
init_number s2_log_q_ac_low;init_number s2_log_q_ac_up;init_number s2_log_q_ac_start;
init_number s2_ac_gompertz_a_low;init_number s2_ac_gompertz_a_up;init_number s2_ac_gompertz_a_start;
init_number s2_ac_gompertz_b_low;init_number s2_ac_gompertz_b_up;init_number s2_ac_gompertz_b_start;
init_number s2_ac_logistic_a_low;init_number s2_ac_logistic_a_up;init_number s2_ac_logistic_a_start;
init_number s2_ac_logistic_b_low;init_number s2_ac_logistic_b_up;init_number s2_ac_logistic_b_start;
init_number s2_ac_thompson_a_low;init_number s2_ac_thompson_a_up;init_number s2_ac_thompson_a_start;
init_number s2_ac_thompson_b_low;init_number s2_ac_thompson_b_up;init_number s2_ac_thompson_b_start;
init_number s2_ac_thompson_c_low;init_number s2_ac_thompson_c_up;init_number s2_ac_thompson_c_start;
init_number s2_ac_gamma_a_low;init_number s2_ac_gamma_a_up;init_number s2_ac_gamma_a_start;
init_number s2_ac_gamma_b_low;init_number s2_ac_gamma_b_up;init_number s2_ac_gamma_b_start;
init_number coast_logF_low;init_number coast_logF_up;init_number coast_logF_start; init_int coast_logF_phase;
init_number coast_catch_gompertz_a_low;init_number coast_catch_gompertz_a_up;init_number coast_catch_gompertz_a_start;
init_number coast_catch_gompertz_b_low;init_number coast_catch_gompertz_b_up;init_number coast_catch_gompertz_b_start;
init_number coast_catch_logistic_a_low;init_number coast_catch_logistic_a_up;init_number coast_catch_logistic_a_start;
init_number coast_catch_logistic_b_low;init_number coast_catch_logistic_b_up;init_number coast_catch_logistic_b_start;
init_number coast_catch_thompson_a_low;init_number coast_catch_thompson_a_up;init_number coast_catch_thompson_a_start;
init_number coast_catch_thompson_b_low;init_number coast_catch_thompson_b_up;init_number coast_catch_thompson_b_start;
init_number coast_catch_thompson_c_low;init_number coast_catch_thompson_c_up;init_number coast_catch_thompson_c_start;
init_number coast_plusgroup_low;init_number coast_plusgroup_up;init_number coast_plusgroup_start;
init_number coast_log_q_agg_low;init_number coast_log_q_agg_up;init_number coast_log_q_agg_start;
init_number coast_log_q_ac_low;init_number coast_log_q_ac_up;init_number coast_log_q_ac_start;
init_number coast_ac_gompertz_a_low;init_number coast_ac_gompertz_a_up;init_number coast_ac_gompertz_a_start;
init_number coast_ac_gompertz_b_low;init_number coast_ac_gompertz_b_up;init_number coast_ac_gompertz_b_start;
init_number coast_ac_logistic_a_low;init_number coast_ac_logistic_a_up;init_number coast_ac_logistic_a_start;
init_number coast_ac_logistic_b_low;init_number coast_ac_logistic_b_up;init_number coast_ac_logistic_b_start;
init_number coast_ac_thompson_a_low;init_number coast_ac_thompson_a_up;init_number coast_ac_thompson_a_start;
```

```
init_number coast_ac_thompson_b_low;init_number coast_ac_thompson_b_up;init_number coast_ac_thompson_b_start;
init_number coast_ac_thompson_c_low;init_number coast_ac_thompson_c_up;init_number coast_ac_thompson_c_start;
init_number coast_ac_gamma_a_low;init_number coast_ac_gamma_a_up;init_number coast_ac_gamma_a_start;
init_number coast_ac_gamma_b_low;init_number coast_ac_gamma_b_up;init_number coast_ac_gamma_b_start;
init_int altcoast_Nyr1;
init_int pickRmethod;// 3 choices 0=avg and devs for each; 1=use s1avgr and s1Rfrac for stock 2; 2=use absoulte estimates of recruit
abundance
init_number s1Rfrac;
init_int estmig;
init_matrix absrecruit(styr,endyr,1,2); // Absoulte estimates of recruitment CB, DE& HR combined
init_vector s2_fem_sex(1,nages);
int a;
int y;
int p;
int t;
int cnt;
int cnt1;
int cnt2;
int cnt3;
int cnt4;
int realage;
int regperiod;
int wvgroup;
int wvtime;
int ndiffbaycoast;
int used_cnt;
int n_parms;
//Determine number of two and three parm curves for each period
//stock 1
number s1_bay_sel_ngompertz;
number s1_bay_sel_nlogistic;
number s1_bay_sel_nthompson;
number s1_bay_sel_gompertz_fit;
number s1_bay_sel_logistic_fit;
number s1_bay_sel_thompson_fit;
number s1_bay_ac_sel_ngompertz;
number s1_bay_ac_sel_nlogistic;
number s1_bay_ac_sel_nthompson;
number s1_bay_ac_sel_nuser;
number s1_bay_ac_sel_ngamma;
number s1_bay_ac_sel_gompertz_fit;
number s1_bay_ac_sel_logistic_fit;
number s1_bay_ac_sel_thompson_fit;
number s1_bay_ac_sel_gamma_fit;
number s1_bay_ac_sel_user_fit;
number s1_bay_nagg_used;
number s1_bay_nac_used;
int s1_bay_wv3_count;
 //Stock 2
number s2_nagg_used;
number s2_nac_used;
number s2_ac_sel_ngompertz;
number s2_ac_sel_nlogistic;
number s2_ac_sel_nthompson;
number s2_ac_sel_ngamma;
number s2_ac_sel_gompertz_fit;
number s2_ac_sel_logistic_fit;
number s2_ac_sel_thompson_fit;
number s2_ac_sel_gamma_fit;
//Coast
number coast_sel_ngompertz;
number coast_sel_nlogistic;
number coast_sel_nthompson;
number coast_sel_gompertz_fit;
number coast_sel_logistic_fit;
number coast_sel_thompson_fit;
```

```
number coast_ac_sel_ngompertz;
number coast_ac_sel_nlogistic;
number coast_ac_sel_nthompson;
number coast_ac_sel_ngamma;
number coast_ac_sel_gompertz_fit;
number coast_ac_sel_logistic_fit;
number coast_ac_sel_thompson_fit;
number coast_ac_sel_gamma_fit;
number s1_est_emig_prob_fit;
number coast_nagg_used;
number coast_nac_used;
number coast_cnt_gompertz;
number coast_cnt_logistic;
number coast_cnt_thompson;
number bay_cnt_gompertz;
number bay_cnt_logistic;
number bay_cnt_thompson;
number logs1Rfrac;
int coast_wv3_count;
int df;
int nyr1cnt;
LOCAL_CALCS
 dirnew=dirfirst;
 find_and_replace(dirnew, "*", " ");
 logs1Rfrac=log((1.-s1Rfrac)/s1Rfrac);
 df=0;
 //s1 avg R & Devs
 df+=1+(endyr-styr+1);
 //Number of Yr1 in Bay ages
 df+=n_s1_bay_Nyr1;
 //If estimates how many ages in coast
 if(altcoast_Nyr1>0) df+=n_s1_coast_Nyr1;
 //Fs by wave
 df+=substructure*(endyr-styr+1);
  //S1_bay Catch selectivity
 s1_bay_sel_ngompertz=0;
 s1_bay_sel_nlogistic=0;
 s1_bay_sel_nthompson=0;
 s1_bay_wv3_count=0;
 s1_bay_sel_gompertz_fit=s1_bay_sel_phase;
 s1_bay_sel_logistic_fit=s1_bay_sel_phase;
 s1_bay_sel_thompson_fit=s1_bay_sel_phase;
 for(regperiod=1;regperiod<=s1_bay_reg_nperiods;regperiod++){
  if(s1_bay_select_years_type(regperiod,1)==3) s1_bay_wv3_count+=1;
  if(s1_bay_select_years_type(regperiod,4)==1) s1_bay_sel_ngompertz+=1;
  if(s1_bay_select_years_type(regperiod,4)==2) s1_bay_sel_nlogistic+=1;
  if(s1_bay_select_years_type(regperiod,4)==3) s1_bay_sel_nthompson+=1;
  }
  if(s1_bay_sel_ngompertz==0) s1_bay_sel_gompertz_fit=-1;
  if(s1_bay_sel_nlogistic==0) s1_bay_sel_logistic_fit=-1;
  if(s1_bay_sel_nthompson==0) s1_bay_sel_thompson_fit=-1;
 //Number fo catch selctivty parm
  df+=s1_bay_sel_ngompertz*2;
  df+=s1_bay_sel_nlogistic*2;
  df+=(s1_bay_sel_nthompson*3);
 //s1_agg
  s1_bay_nagg_used=0;
  for(t=1;t<=s1_bay_nagg;t++){
     if(s1_bay_use_agg(t)>0) s1_bay_nagg_used+=1;
  }
  if(s1_bay_nagg_used==0) s1_bay_agg_phase=-1;
  //Add qs for agg
  df+=s1_bay_nagg_used;
  s1_bay_nac_used=0;
  for(t=1;t<=s1_bay_nac;t++){
     if(s1_bay_use_ac(t)>0) s1_bay_nac_used+=1;
```

```
  }
   if(s1_bay_nac_used==0) s1_bay_ac_phase=-1;
   df+=s1_bay_nac_used;
//s1_bay Age Comp survey selcticivities
s1_bay_ac_sel_ngompertz=0;
s1_bay_ac_sel_nlogistic=0;
s1_bay_ac_sel_nthompson=0;
s1_bay_ac_sel_ngamma=0;
s1_bay_ac_sel_nuser=0;
s1_bay_ac_sel_gompertz_fit=s1_bay_ac_sel_phase;
s1_bay_ac_sel_logistic_fit=s1_bay_ac_sel_phase;
s1_bay_ac_sel_thompson_fit=s1_bay_ac_sel_phase;
s1_bay_ac_sel_gamma_fit=s1_bay_ac_sel_phase;
s1_bay_ac_sel_user_fit=s1_bay_ac_sel_phase;
for(t=1;t<=s1_bay_nac;t++){
 if(s1_bay_ac_sel_type(t)==0 && s1_bay_use_ac(t)>0) s1_bay_ac_sel_nuser+=1;
 if(s1_bay_ac_sel_type(t)==1 && s1_bay_use_ac(t)>0) s1_bay_ac_sel_ngompertz+=1;
 if(s1_bay_ac_sel_type(t)==2 && s1_bay_use_ac(t)>0) s1_bay_ac_sel_nlogistic+=1;
 if(s1_bay_ac_sel_type(t)==3 && s1_bay_use_ac(t)>0) s1_bay_ac_sel_nthompson+=1;
 if(s1_bay_ac_sel_type(t)==4 && s1_bay_use_ac(t)>0) s1_bay_ac_sel_ngamma+=1;
}
//acselct parms
 df+=s1_bay_ac_sel_nuser*2;
 df+=s1_bay_ac_sel_ngompertz*2;
 df+=s1_bay_ac_sel_nlogistic*2;
 df+=s1_bay_ac_sel_nthompson*3;
 df+=s1_bay_ac_sel_ngamma*2;

 if(s1_bay_ac_sel_nuser==0) s1_bay_ac_sel_user_fit=-1;
 if(s1_bay_ac_sel_ngompertz==0) s1_bay_ac_sel_gompertz_fit=-1;
 if(s1_bay_ac_sel_nlogistic==0) s1_bay_ac_sel_logistic_fit=-1;
 if(s1_bay_ac_sel_nthompson==0) s1_bay_ac_sel_thompson_fit=-1;
 if(s1_bay_ac_sel_ngamma==0) s1_bay_ac_sel_gamma_fit=-1;
 //Stock 2
  df+=1+(endyr-styr+1);
  df+=n_s2_Nyr1;
 s2_nagg_used=0;
 for(t=1;t<=s2_nagg;t++){
    if(s2_use_agg(t)>0) s2_nagg_used+=1;
 }
   if(s2_nagg_used==0) s2_agg_phase=-1;
 df+=s2_nagg_used;
s2_nac_used=0;
for(t=1;t<=s2_nac;t++){
    if(s2_use_ac(t)>0) s2_nac_used+=1;
 }
 if(s2_nac_used==0) s2_ac_phase=-1;
  df+=s2_nac_used;
s2_ac_sel_ngompertz=0;
s2_ac_sel_nlogistic=0;
s2_ac_sel_nthompson=0;
s2_ac_sel_ngamma=0;
s2_ac_sel_gompertz_fit=s2_ac_sel_phase;
s2_ac_sel_logistic_fit=s2_ac_sel_phase;
s2_ac_sel_thompson_fit=s2_ac_sel_phase;
s2_ac_sel_gamma_fit=s2_ac_sel_phase;
for(t=1;t<=s2_nac;t++){
 if(s2_ac_sel_type(t)==1 && s2_use_ac(t)>0) s2_ac_sel_ngompertz+=1;
 if(s2_ac_sel_type(t)==2 && s2_use_ac(t)>0) s2_ac_sel_nlogistic+=1;
 if(s2_ac_sel_type(t)==3 && s2_use_ac(t)>0) s2_ac_sel_nthompson+=1;
 if(s2_ac_sel_type(t)==4 && s2_use_ac(t)>0) s2_ac_sel_ngamma+=1.;
}
 df+=s2_ac_sel_ngompertz*2;
 df+=s2_ac_sel_nlogistic*2;
 df+=s2_ac_sel_nthompson*3;
 df+=s2_ac_sel_ngamma*2;
```

```
 if(s2_ac_sel_ngompertz==0) s2_ac_sel_gompertz_fit=-1;
 if(s2_ac_sel_nlogistic==0) s2_ac_sel_logistic_fit=-1;
 if(s2_ac_sel_nthompson==0) s2_ac_sel_thompson_fit=-1;
 if(s2_ac_sel_ngamma==0) s2_ac_sel_gamma_fit=-1;
 //Coast
 df+=ncoastwaves*(endyr-styr+1);//F by wave
 coast_sel_ngompertz=0;
 coast_sel_nlogistic=0;
 coast_sel_nthompson=0;
 coast_sel_gompertz_fit=coast_sel_phase;
 coast_sel_logistic_fit=coast_sel_phase;
 coast_sel_thompson_fit=coast_sel_phase;
 coast_wv3_count=0;
 for(regperiod=1;regperiod<=coast_reg_nperiods;regperiod++){
 if(coast_select_years_type(regperiod,1)==3) coast_wv3_count+=1;
  if(coast_select_years_type(regperiod,4)==1) coast_sel_ngompertz+=1.;
  if(coast_select_years_type(regperiod,4)==2) coast_sel_nlogistic+=1.;
  if(coast_select_years_type(regperiod,4)==3) coast_sel_nthompson+=1.;
 }
 //coast catch selectivity
 df+=coast_sel_ngompertz*2;
 df+=coast_sel_nlogistic*2;
 df+=coast_sel_nthompson*3;
 if(coast_sel_ngompertz==0) coast_sel_gompertz_fit=-1;
 if(coast_sel_nlogistic==0) coast_sel_logistic_fit=-1;
 if(coast_sel_nthompson==0) coast_sel_thompson_fit=-1;
  coast_nagg_used=0;
  for(t=1;t<=coast_nagg;t++){
    if(coast_use_agg(t)>0) coast_nagg_used+=1;
  }
  if(coast_nagg_used==0) coast_agg_phase=-1;
 df+=coast_nagg_used;
coast_nac_used=0;
for(t=1;t<=coast_nac;t++){
    if(coast_use_ac(t)>0) coast_nac_used+=1;
 }
if(coast_nac_used==0) coast_ac_phase=-1;
df+=coast_nac_used;
coast_ac_sel_ngompertz=0;
coast_ac_sel_nlogistic=0;
coast_ac_sel_nthompson=0;
coast_ac_sel_ngamma=0;
coast_ac_sel_gompertz_fit=s1_bay_ac_sel_phase;
coast_ac_sel_logistic_fit=s1_bay_ac_sel_phase;
coast_ac_sel_thompson_fit=s1_bay_ac_sel_phase;
coast_ac_sel_gamma_fit=s1_bay_ac_sel_phase;
for(t=1;t<=coast_nac;t++){
 if(coast_ac_sel_type(t)==1 && coast_use_ac(t)>0) coast_ac_sel_ngompertz+=1;
 if(coast_ac_sel_type(t)==2 && coast_use_ac(t)>0) coast_ac_sel_nlogistic+=1;
 if(coast_ac_sel_type(t)==3 && coast_use_ac(t)>0) coast_ac_sel_nthompson+=1;
 if(coast_ac_sel_type(t)==4 && coast_use_ac(t)>0) coast_ac_sel_ngamma+=1;
}
 df+=coast_ac_sel_ngompertz*2;
 df+=coast_ac_sel_nlogistic*2;
 df+=coast_ac_sel_nthompson*3;
 df+=coast_ac_sel_ngamma*2;
 if(coast_ac_sel_ngompertz==0) coast_ac_sel_gompertz_fit=-1;
 if(coast_ac_sel_nlogistic==0) coast_ac_sel_logistic_fit=-1;
 if(coast_ac_sel_nthompson==0) coast_ac_sel_thompson_fit=-1;
 if(coast_ac_sel_ngamma==0) coast_ac_sel_gamma_fit=-1;
if(altcoast_Nyr1<=0){
 s1_coast_logNyr1_phase=-1;
}
if(pickRmethod==1){
 s2_R_phase=-1;
}
```

```
 if(pickRmethod==2){
  s2_devR_phase=-1;
  s2_R_phase=-1;
  s1_bay_R_phase=-1;
  s1_bay_devR_phase=-1;
 }
 if(estmig>0) df+=1;
 n_parms=df;
 //Number of transformed parameters
 //s1_R
 df+=endyr-styr+1;

 //s2 R
 df+=endyr-styr+1;
 //S1_bay Nyr1
 df+=n_s1_bay_Nyr1;
 //if estimating coast NYR1
 // n_s1_coast_Nyr1
 //s2_Nyr1
 df+=n_s2_Nyr1;
 //s1 bay F
 df+=substructure*(endyr-styr+1);
 //coast F
 df+=ncoastwaves*(endyr-styr+1);
 df+=s1_bay_nac_used;
 df+=s2_nac_used;
 df+=coast_nac_used;
 df+=s1_bay_nagg_used;
 df+=s2_nagg_used;
 df+=coast_nagg_used;
 df+=2*(endyr-styr+1);
 nyr1cnt=df+1;//df+1
 df+=9*nages;
 df+=(endyr-styr+1);//s1_mu_full
 df+=(endyr-styr+1);//s2_mu_full
 df+=(endyr-styr+1);//comb_mu_full
END_CALCS
 !!cout<<df<<endl;
 !!cout<<nyr1cnt<<endl;
 matrix sigma(1,df,1,df+1);
 !! set_covariance_matrix(sigma);
PARAMETER_SECTION
 //Stock1
 init_bounded_number s1_bay_log_avgR(s1_bay_logavgR_low,s1_bay_logavgR_up,s1_bay_R_phase);
 init_bounded_dev_vector s1_bay_log_Rdev(styr,endyr,s1_bay_Rdevs_low,s1_bay_Rdevs_up,s1_bay_devR_phase);
 init_bounded_vector s1_bay_log_N1(1,n_s1_bay_Nyr1,s1_bay_logNyr1_low,s1_bay_logNyr1_up,s1_bay_logNyr1_phase);
 init_bounded_vector s1_coast_log_N1(1,n_s1_coast_Nyr1,s1_coast_logNyr1_low,s1_coast_logNyr1_up,s1_coast_logNyr1_phase);
 init_bounded_matrix s1_bay_log_F(styr,endyr,1,substructure,s1_bay_logF_low,s1_bay_logF_up,s1_bay_logF_phase);//Estimate F for each
period
 init_bounded_vector
s1_bay_select_gompertz_a(1,s1_bay_sel_ngompertz,s1_bay_catch_gompertz_a_low,s1_bay_catch_gompertz_a_up,s1_bay_sel_gompertz_fit);
 init_bounded_vector
s1_bay_select_gompertz_b(1,s1_bay_sel_ngompertz,s1_bay_catch_gompertz_b_low,s1_bay_catch_gompertz_b_up,s1_bay_sel_gompertz_fit)
;
 init_bounded_vector
s1_bay_select_logistic_a(1,s1_bay_sel_nlogistic,s1_bay_catch_logistic_a_low,s1_bay_catch_logistic_a_up,s1_bay_sel_logistic_fit);
 init_bounded_vector
s1_bay_select_logistic_b(1,s1_bay_sel_nlogistic,s1_bay_catch_logistic_b_low,s1_bay_catch_logistic_b_up,s1_bay_sel_logistic_fit);
 init_bounded_vector
s1_bay_select_thompson_a(1,s1_bay_sel_nthompson,s1_bay_catch_thompson_a_low,s1_bay_catch_thompson_a_up,s1_bay_sel_thompson_
fit);
 init_bounded_vector
s1_bay_select_thompson_b(1,s1_bay_sel_nthompson,s1_bay_catch_thompson_b_low,s1_bay_catch_thompson_b_up,s1_bay_sel_thompson_
fit);
```

```
 init_bounded_vector
s1_bay_select_thompson_c(1,s1_bay_sel_nthompson,s1_bay_catch_thompson_c_low,s1_bay_catch_thompson_c_up,s1_bay_sel_thompson_f
it);
 init_bounded_vector s1_bay_log_q_agg(1,s1_bay_nagg_used,s1_bay_log_q_agg_low,s1_bay_log_q_agg_up,s1_bay_agg_phase);
 init_bounded_vector s1_bay_log_q_ac(1,s1_bay_nac_used,s1_bay_log_q_ac_low,s1_bay_log_q_ac_up,s1_bay_ac_phase);
 init_bounded_vector
s1_bay_ac_sel_gompertz_a(1,s1_bay_ac_sel_ngompertz,s1_bay_ac_gompertz_a_low,s1_bay_ac_gompertz_a_up,s1_bay_ac_sel_gompertz_fit
);
 init_bounded_vector
s1_bay_ac_sel_gompertz_b(1,s1_bay_ac_sel_ngompertz,s1_bay_ac_gompertz_b_low,s1_bay_ac_gompertz_b_up,s1_bay_ac_sel_gompertz_fit
);
 init_bounded_vector
s1_bay_ac_sel_logistic_a(1,s1_bay_ac_sel_nlogistic,s1_bay_ac_logistic_a_low,s1_bay_ac_logistic_a_up,s1_bay_ac_sel_logistic_fit);
 init_bounded_vector
s1_bay_ac_sel_logistic_b(1,s1_bay_ac_sel_nlogistic,s1_bay_ac_logistic_b_low,s1_bay_ac_logistic_b_up,s1_bay_ac_sel_logistic_fit);
 init_bounded_vector
s1_bay_ac_sel_thompson_a(1,s1_bay_ac_sel_nthompson,s1_bay_ac_thompson_a_low,s1_bay_ac_thompson_a_up,s1_bay_ac_sel_thompson
_fit);
 init_bounded_vector
s1_bay_ac_sel_thompson_b(1,s1_bay_ac_sel_nthompson,s1_bay_ac_thompson_b_low,s1_bay_ac_thompson_b_up,s1_bay_ac_sel_thompson
_fit);
 init_bounded_vector
s1_bay_ac_sel_thompson_c(1,s1_bay_ac_sel_nthompson,s1_bay_ac_thompson_c_low,s1_bay_ac_thompson_c_up,s1_bay_ac_sel_thompson_
fit);
 init_bounded_vector
s1_bay_ac_sel_gamma_a(1,s1_bay_ac_sel_ngamma,s1_bay_ac_gamma_a_low,s1_bay_ac_gamma_a_up,s1_bay_ac_sel_gamma_fit);
 init_bounded_vector
s1_bay_ac_sel_gamma_b(1,s1_bay_ac_sel_ngamma,s1_bay_ac_gamma_b_low,s1_bay_ac_gamma_b_up,s1_bay_ac_sel_gamma_fit);
 init_bounded_number s1_bay_ac_sel_user_a(0,1,s1_bay_ac_sel_user_fit);
 init_bounded_number s1_bay_ac_sel_user_b(0,1,s1_bay_ac_sel_user_fit);
 init_bounded_number s2_log_avgR(s2_logavgR_low,s2_logavgR_up,s2_R_phase);
 init_bounded_dev_vector s2_log_Rdev(styr,endyr,s2_Rdevs_low,s2_Rdevs_up,s2_devR_phase);
 init_bounded_vector s2_log_N1(1,n_s2_Nyr1,s2_logNyr1_low,s2_logNyr1_up,s2_logNyr1_phase);
 init_bounded_vector s2_log_q_agg(1,s2_nagg_used,s2_log_q_agg_low,s2_log_q_agg_up,s2_agg_phase);
 init_bounded_vector s2_log_q_ac(1,s2_nac_used,s2_log_q_ac_low,s2_log_q_ac_up,s2_ac_phase);
 init_bounded_vector s2_ac_sel_gompertz_a(1,s2_ac_sel_ngompertz,s2_ac_gompertz_a_low,s2_ac_gompertz_a_up,s2_ac_sel_gompertz_fit);
 init_bounded_vector s2_ac_sel_gompertz_b(1,s2_ac_sel_ngompertz,s2_ac_gompertz_b_low,s2_ac_gompertz_b_up,s2_ac_sel_gompertz_fit);
 init_bounded_vector s2_ac_sel_logistic_a(1,s2_ac_sel_nlogistic,s2_ac_logistic_a_low,s2_ac_logistic_a_up,s2_ac_sel_logistic_fit);
 init_bounded_vector s2_ac_sel_logistic_b(1,s2_ac_sel_nlogistic,s2_ac_logistic_b_low,s2_ac_logistic_b_up,s2_ac_sel_logistic_fit);
 init_bounded_vector
s2_ac_sel_thompson_a(1,s2_ac_sel_nthompson,s2_ac_thompson_a_low,s2_ac_thompson_a_up,s2_ac_sel_thompson_fit);
 init_bounded_vector
s2_ac_sel_thompson_b(1,s2_ac_sel_nthompson,s2_ac_thompson_b_low,s2_ac_thompson_b_up,s2_ac_sel_thompson_fit);
 init_bounded_vector
s2_ac_sel_thompson_c(1,s2_ac_sel_nthompson,s2_ac_thompson_c_low,s2_ac_thompson_c_up,s2_ac_sel_thompson_fit);
 init_bounded_vector s2_ac_sel_gamma_a(1,s2_ac_sel_ngamma,s2_ac_gamma_a_low,s2_ac_gamma_a_up,s2_ac_sel_gamma_fit);
 init_bounded_vector s2_ac_sel_gamma_b(1,s2_ac_sel_ngamma,s2_ac_gamma_b_low,s2_ac_gamma_b_up,s2_ac_sel_gamma_fit);
 init_bounded_matrix coast_log_F(styr,endyr,1,ncoastwaves,coast_logF_low,coast_logF_up,coast_logF_phase);
 init_bounded_vector
coast_select_gompertz_a(1,coast_sel_ngompertz,coast_catch_gompertz_a_low,coast_catch_gompertz_a_up,coast_sel_gompertz_fit);
 init_bounded_vector
coast_select_gompertz_b(1,coast_sel_ngompertz,coast_catch_gompertz_b_low,coast_catch_gompertz_b_up,coast_sel_gompertz_fit);
 init_bounded_vector
coast_select_logistic_a(1,coast_sel_nlogistic,coast_catch_logistic_a_low,coast_catch_logistic_a_up,coast_sel_logistic_fit);
 init_bounded_vector
coast_select_logistic_b(1,coast_sel_nlogistic,coast_catch_logistic_b_low,coast_catch_logistic_b_up,coast_sel_logistic_fit);
 init_bounded_vector
coast_select_thompson_a(1,coast_sel_nthompson,coast_catch_thompson_a_low,coast_catch_thompson_a_up,coast_sel_thompson_fit);
 init_bounded_vector
coast_select_thompson_b(1,coast_sel_nthompson,coast_catch_thompson_b_low,coast_catch_thompson_b_up,coast_sel_thompson_fit);
 init_bounded_vector
coast_select_thompson_c(1,coast_sel_nthompson,coast_catch_thompson_c_low,coast_catch_thompson_c_up,coast_sel_thompson_fit);
 init_bounded_vector coast_log_q_agg(1,coast_nagg_used,coast_log_q_agg_low,coast_log_q_agg_up,coast_agg_phase);
 init_bounded_vector coast_log_q_ac(1,coast_nac_used,coast_log_q_ac_low,coast_log_q_ac_up,coast_ac_phase);
 init_bounded_vector
coast_ac_sel_gompertz_a(1,coast_ac_sel_ngompertz,coast_ac_gompertz_a_low,coast_ac_gompertz_a_up,coast_ac_sel_gompertz_fit);
```

```
 init_bounded_vector
coast_ac_sel_gompertz_b(1,coast_ac_sel_ngompertz,coast_ac_gompertz_b_low,coast_ac_gompertz_b_up,coast_ac_sel_gompertz_fit);
 init_bounded_vector
coast_ac_sel_logistic_a(1,coast_ac_sel_nlogistic,coast_ac_logistic_a_low,coast_ac_logistic_a_up,coast_ac_sel_logistic_fit);
 init_bounded_vector
coast_ac_sel_logistic_b(1,coast_ac_sel_nlogistic,coast_ac_logistic_b_low,coast_ac_logistic_b_up,coast_ac_sel_logistic_fit);
 init_bounded_vector
coast_ac_sel_thompson_a(1,coast_ac_sel_nthompson,coast_ac_thompson_a_low,coast_ac_thompson_a_up,coast_ac_sel_thompson_fit);
 init_bounded_vector
coast_ac_sel_thompson_b(1,coast_ac_sel_nthompson,coast_ac_thompson_b_low,coast_ac_thompson_b_up,coast_ac_sel_thompson_fit);
 init_bounded_vector
coast_ac_sel_thompson_c(1,coast_ac_sel_nthompson,coast_ac_thompson_c_low,coast_ac_thompson_c_up,coast_ac_sel_thompson_fit);
 init_bounded_vector
coast_ac_sel_gamma_a(1,coast_ac_sel_ngamma,coast_ac_gamma_a_low,coast_ac_gamma_a_up,coast_ac_sel_gamma_fit);
 init_bounded_vector
coast_ac_sel_gamma_b(1,coast_ac_sel_ngamma,coast_ac_gamma_b_low,coast_ac_gamma_b_up,coast_ac_sel_gamma_fit);
 init_bounded_number s1_emig_a(0,1,estmig);
 //Stock 1
 matrix s1_bay_pred_total_catch(styr,endyr,1,substructure);
 3darray s1_bay_pred_catch_caa(1,substructure,styr,endyr,1,nages);
 3darray s1_bay_pred_catch_paa(1,substructure,styr,endyr,1,nages);
 3darray s1_bay_F(1,substructure,styr,endyr,1,nages);
 3darray s1_bay_Z(1,substructure,styr,endyr,1,nages);
 3darray s1_bay_select_at_age(1,substructure,styr,endyr,1,nages);
 matrix s1_bay_pred_agg_index(styr,endyr,1,s1_bay_nagg_used);
 matrix s1_coast_pred_total_catch(styr,endyr,1,substructure);
 3darray s1_coast_pred_catch_caa(1,substructure,styr,endyr,1,nages);
 matrix s1_bay_pred_migrants_catch_caa(styr,endyr,1,nages);
 3darray s1_coast_pred_catch_paa(1,substructure,styr,endyr,1,nages);
 3darray s1_coast_F(1,substructure,styr,endyr,1,nages);
 3darray s1_coast_Z(1,substructure,styr,endyr,1,nages);
 matrix s1_bay_N(styr,endyr,1,nages);
 matrix s1_bay_Nwv23(styr,endyr,1,nages);
 matrix s1_bay_Nwv46(styr,endyr,1,nages);
 matrix s1_bay_emigrants(styr,endyr,1,nages);
 matrix s1_coast_N(styr,endyr,1,nages);
 matrix s1_coast_Nwv23(styr,endyr,1,nages);
 matrix s1_coast_Nwv46(styr,endyr,1,nages);
 matrix s1_coast_immigrants(styr,endyr,1,nages);
 matrix s1_coast_immigrants_female(styr,endyr,1,nages);
 matrix s1_coast_immigrants_male(styr,endyr,1,nages);
 matrix s1_bay_ac_select_at_age(1,s1_bay_nac_used,1,nages);
 3darray s1_bay_pred_ac_index_paa(1,s1_bay_nac_used,styr,endyr,1,nages);
 matrix s1_bay_pred_ac_index(styr,endyr,1,s1_bay_nac_used);
 matrix s1_ssb(styr,endyr,1,nages);
 number s1_bay_max;
 vector s1_bay_total_catch_RSS(1,substructure);
 number s1_bay_total_catch_wgted_RSS;
 vector s1_bay_catch_paa_like(1,substructure);
 number s1_bay_catch_paa_wgted_like;
 vector s1_bay_agg_index_RSS(1,s1_bay_nagg_used);
 number s1_bay_agg_index_wgted_RSS;
 vector s1_bay_ac_index_RSS(1,s1_bay_nac_used);
 number s1_bay_ac_index_wgted_RSS;
 vector s1_bay_ac_index_paa_like(1,s1_bay_nac_used);
 number s1_bay_ac_index_paa_wgted_like;
 matrix s1_emig_probs(styr,endyr,1,nages);
 //stock 3
 matrix s2_N(styr,endyr,1,nages);
 3darray s2_F(1,substructure,styr,endyr,1,nages);
 3darray s2_Z(1,substructure,styr,endyr,1,nages);
 matrix s2_Nwv23(styr,endyr,1,nages);
 matrix s2_Nwv46(styr,endyr,1,nages);
 matrix s2_ssb(styr,endyr,1,nages);
 matrix s2_pred_agg_index(styr,endyr,1,s2_nagg_used);
 vector s2_agg_index_RSS(1,s2_nagg_used);
```

```
number s2_agg_index_wgted_RSS;
vector s2_ac_index_RSS(1,s2_nac_used);
number s2_ac_index_wgted_RSS;
vector s2_ac_index_paa_like(1,s2_nac_used);
number s2_ac_index_paa_wgted_like;
matrix s2_ac_select_at_age(1,s2_nac_used,1,nages);
3darray s2_pred_ac_index_paa(1,s2_nac_used,styr,endyr,1,nages);
matrix s2_pred_ac_index(styr,endyr,1,s2_nac_used);
3darray s2_pred_catch_caa(1,substructure,styr,endyr,1,nages);
matrix s2_pred_total_catch(styr,endyr,1,substructure);
number s2_max;
//Combined coast
number coast_max;
matrix coast_pred_total_catch(styr,endyr,1,ncoastwaves);
3darray coast_pred_catch_caa(1,ncoastwaves,styr,endyr,1,nages);
3darray coast_pred_catch_paa(1,ncoastwaves,styr,endyr,1,nages);
3darray coast_select_at_age(1,ncoastwaves,styr,endyr,1,nages);
3darray coast_F(1,substructure,styr,endyr,1,nages);
3darray coast_Z(1,substructure,styr,endyr,1,nages);
matrix coast_pred_agg_index(styr,endyr,1,coast_nagg_used);
matrix coast_pred_ac_index(styr,endyr,1,coast_nac_used);
3darray coast_pred_ac_index_paa(1,coast_nac_used,styr,endyr,1,nages);
matrix coast_ac_select_at_age(1,coast_nac_used,1,nages);
vector coast_total_catch_RSS(1,ncoastwaves);
number coast_total_catch_wgted_RSS;
vector coast_catch_paa_like(1,ncoastwaves);
number coast_catch_paa_wgted_like;
vector coast_agg_index_RSS(1,coast_nagg_used);
number coast_agg_index_wgted_RSS;
vector coast_ac_index_RSS(1,coast_nac_used);
number coast_ac_index_wgted_RSS;
vector coast_ac_index_paa_like(1,coast_nac_used);
number coast_ac_index_paa_wgted_like;
number stock_comp_like;
number stock_comp_wgted_like;
matrix stock_comp_predicted(styr,endyr,1,3);
//Residuals
matrix s1_bay_total_catch_resid(styr,endyr,1,substructure);
matrix coast_total_catch_resid(styr,endyr,1,ncoastwaves);
matrix s1_bay_total_catch_std_resid(styr,endyr,1,substructure);
matrix coast_total_catch_std_resid(styr,endyr,1,ncoastwaves);
vector s1_bay_total_catch_RMSE(1,substructure);
vector coast_total_catch_RMSE(1,ncoastwaves);
3darray s1_bay_std_resid_catch_paa(1,substructure,styr,endyr,1,nages);
3darray coast_std_resid_catch_paa(1,ncoastwaves,styr,endyr,1,nages);
3darray s1_bay_std_resid_index_paa(1,s1_bay_nac_used,styr,endyr,1,nages);
3darray s2_std_resid_index_paa(1,s2_nac_used,styr,endyr,1,nages);
3darray coast_std_resid_index_paa(1,coast_nac_used,styr,endyr,1,nages);
matrix s1_bay_resid_agg(styr,endyr,1,s1_bay_nagg_used);
matrix s2_resid_agg(styr,endyr,1,s2_nagg_used);
matrix coast_resid_agg(styr,endyr,1,coast_nagg_used);
matrix s1_bay_std_resid_agg(styr,endyr,1,s1_bay_nagg_used);
matrix s2_std_resid_agg(styr,endyr,1,s2_nagg_used);
matrix coast_std_resid_agg(styr,endyr,1,coast_nagg_used);
vector s1_bay_RMSE_agg(1,s1_bay_nagg_used);
vector s2_RMSE_agg(1,s2_nagg_used);
vector coast_RMSE_agg(1,coast_nagg_used);
matrix stock_comp_std_resid(styr,endyr,1,3);
matrix s1_bay_resid_ac(styr,endyr,1,s1_bay_nac_used);
matrix s2_resid_ac(styr,endyr,1,s2_nac_used);
matrix coast_resid_ac(styr,endyr,1,coast_nac_used);
matrix s1_bay_std_resid_ac(styr,endyr,1,s1_bay_nac_used);
matrix s2_std_resid_ac(styr,endyr,1,s2_nac_used);
matrix coast_std_resid_ac(styr,endyr,1,coast_nac_used);
vector s1_bay_RMSE_ac(1,s1_bay_nac_used);
vector s2_RMSE_ac(1,s2_nac_used);
```

```
vector coast_RMSE_ac(1,coast_nac_used);
number SSB;
number sumcatch;
number sumage;
number sumdo;
number adds;
number diff2;
number pgroup;
number wvfraction;
number fpen;
number recpen;
number concll;
number ntotals;
number s1_recvar;
number s2_recvar;
vector s1_Neff_stage2_mult_catch(1,substructure);
vector coast_Neff_stage2_mult_catch(1,ncoastwaves);
number coast_Neff_stage2_mult_stock_comp;
vector s1_Neff_stage2_mult_index(1,s1_bay_nac_used);
vector s2_Neff_stage2_mult_index(1,s2_nac_used);
vector coast_Neff_stage2_mult_index(1,coast_nac_used);
vector mean_age_obs(styr,endyr);
vector mean_age_pred(styr,endyr);
vector mean_age_pred2(styr,endyr);
vector mean_age_resid(styr,endyr);
vector mean_age_sigma(styr,endyr);
number mean_age_x;
number mean_age_n;
number mean_age_delta;
number mean_age_mean;
number mean_age_m2;
vector logit(1,nages);
matrix s1_outpt_agg(styr,endyr,1,s1_bay_nagg_used);
matrix s2_outpt_agg(styr,endyr,1,s2_nagg_used);
matrix coast_outpt_agg(styr,endyr,1,coast_nagg_used);
matrix s1_outpt_ac(styr,endyr,1,s1_bay_nac_used);
matrix s2_outpt_ac(styr,endyr,1,s2_nac_used);
matrix coast_outpt_ac(styr,endyr,1,coast_nac_used);
3darray s1_outpt_ac_paa(1,s1_bay_nac_used,styr,endyr,1,nages);
3darray s2_outpt_ac_paa(1,s2_nac_used,styr,endyr,1,nages);
3darray coast_outpt_ac_paa(1,coast_nac_used,styr,endyr,1,nages);
matrix tempmat(styr,endyr,1,nages);
matrix s1_bay_ssb_wgts(styr,endyr,1,nages);
matrix coast_ssb_wgts(styr,endyr,1,nages);
matrix W2(styr,endyr,1,nages);
vector sumssb(1,nages);
matrix s1_mu(styr,endyr,1,nages);
matrix s1_avgM(styr,endyr,1,nages);
vector mu_max_age(styr,endyr);
matrix s2_mu(styr,endyr,1,nages);
matrix comb_mu(styr,endyr,1,nages);
number FF;
number ssq;
sdreport_vector s1_bay_R(styr,endyr);
sdreport_vector s2_R(styr,endyr);
sdreport_vector s1_bay_Nyr1(1,n_s1_bay_Nyr1);
//sdreport_vector s1_coast_Nyr1(1,nages);
sdreport_vector s2_Nyr1(1,n_s2_Nyr1);
sdreport_matrix s1_bay_fullF(styr,endyr,1,substructure);
sdreport_matrix coast_fullF(styr,endyr,1,ncoastwaves);
sdreport_vector s1_bay_q_ac(1,s1_bay_nac_used);
sdreport_vector s2_q_ac(1,s2_nac_used);
sdreport_vector coast_q_ac(1,coast_nac_used);
sdreport_vector s1_bay_q_agg(1,s1_bay_nagg_used);
sdreport_vector s2_q_agg(1,s2_nagg_used);
//sdreport_vector coast_q_agg(1,coast_nagg_used);
```

```
 sdreport_vector s1_femSSB(styr,endyr);
 sdreport_vector s2_femSSB(styr,endyr);
 sdreport_vector s1_bay_proj_N(1,nages);
 sdreport_vector s1_bay_proj_N_female(1,nages);
 sdreport_vector s1_bay_proj_N_male(1,nages);
 sdreport_vector s1_coast_proj_N(1,nages);
 sdreport_vector s1_coast_proj_N_female(1,nages);
 sdreport_vector s1_coast_proj_N_male(1,nages);
 sdreport_vector s2_proj_N(1,nages);
 sdreport_vector s2_proj_N_female(1,nages);
 sdreport_vector s2_proj_N_male(1,nages);
 sdreport_vector s1_mu_full(styr,endyr);
 sdreport_vector s2_mu_full(styr,endyr);
 sdreport_vector comb_mu_full(styr,endyr);
 objective_function_value f;
INITIALIZATION_SECTION
  s1_bay_log_F s1_bay_logF_start;
  coast_log_F coast_logF_start;
RUNTIME_SECTION
 maximum_function_evaluations 100000,100000,100000; //number of evaluation in each phase
 convergence_criteria 1e-5,1e-10,1e-15; //convergence criterion for each phase
PRELIMINARY_CALCS_SECTION
 s1_bay_pred_catch_caa.initialize();
 s1_coast_pred_catch_caa.initialize();
 s1_bay_F.initialize();
 s1_bay_Z.initialize();
 s1_coast_F.initialize();
 s1_coast_Z.initialize();
 s1_bay_N.initialize();
 s1_bay_Nwv23.initialize();
 s1_bay_Nwv46.initialize();
 s1_coast_N.initialize();
 s1_coast_Nwv23.initialize();
 s1_coast_Nwv46.initialize();
 s2_N.initialize();
 s2_Nwv23.initialize();
 s2_Nwv46.initialize();
 //SSB Rivard weights
 //Stock 1
  for(a=2;a<=nages-1;a++){
   for(y=styr+1;y<=endyr;y++){
     W2(y,a)=(log(s1_bay_weight_at_age(y,a))+log(s1_bay_weight_at_age(y-1,a-1)))/2;
    }
   }
 for(y=styr;y<=endyr-1;y++){
     W2(y,1)=2*log(s1_bay_weight_at_age(y,1))-W2(y+1,2);
    }
 for(a=1;a<=nages-2;a++){
     W2(styr,a)=2*log(s1_bay_weight_at_age(styr,a))-W2(styr+1,a+1);
   }
 W2(styr,nages-1)=(log(s1_bay_weight_at_age(styr,nages-1))+log(s1_bay_weight_at_age(styr,nages-2)))/2;
 W2(endyr,1)=2*log(s1_bay_weight_at_age(endyr,1))-W2(endyr,2);
 for(y=styr;y<=endyr;y++){
     W2(y,nages)=log(s1_bay_weight_at_age(y,nages));
    }
 for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
    //rwgts(y,a)=exp(W2(y,a));
     s1_bay_ssb_wgts(y,a)=exp((W2(y,a)+log(s1_bay_weight_at_age(y,a)))/2); // Added 4-3-2013
   }
  }
  //Coast
  for(a=2;a<=nages-1;a++){
   for(y=styr+1;y<=endyr;y++){
     W2(y,a)=(log(coast_weight_at_age(y,a))+log(coast_weight_at_age(y-1,a-1)))/2;
    }
```

```
  }
for(y=styr;y<=endyr-1;y++){
    W2(y,1)=2*log(coast_weight_at_age(y,1))-W2(y+1,2);
   }
for(a=1;a<=nages-2;a++){
    W2(styr,a)=2*log(coast_weight_at_age(styr,a))-W2(styr+1,a+1);
  }
W2(styr,nages-1)=(log(coast_weight_at_age(styr,nages-1))+log(coast_weight_at_age(styr,nages-2)))/2;
W2(endyr,1)=2*log(coast_weight_at_age(endyr,1))-W2(endyr,2);
for(y=styr;y<=endyr;y++){
    W2(y,nages)=log(coast_weight_at_age(y,nages));
   }
for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  //rwgts(y,a)=exp(W2(y,a));
    coast_ssb_wgts(y,a)=exp((W2(y,a)+log(coast_weight_at_age(y,a)))/2); // Added 4-3-2013
  }
 }
s1_bay_log_avgR=s1_bay_logavgR_start;
s1_bay_log_N1=s1_bay_logNyr1_start;
s1_bay_select_gompertz_a=s1_bay_catch_gompertz_a_start;
s1_bay_select_gompertz_b=s1_bay_catch_gompertz_b_start;
s1_bay_select_logistic_a=s1_bay_catch_logistic_a_start;
s1_bay_select_logistic_b=s1_bay_catch_logistic_b_start;
s1_bay_select_thompson_a=s1_bay_catch_thompson_a_start;
s1_bay_select_thompson_b=s1_bay_catch_thompson_b_start;
s1_bay_select_thompson_c=s1_bay_catch_thompson_c_start;
s1_bay_ac_sel_gompertz_a=s1_bay_ac_gompertz_a_start;
s1_bay_ac_sel_gompertz_b=s1_bay_ac_gompertz_b_start;
s1_bay_ac_sel_logistic_a=s1_bay_ac_logistic_a_start;
s1_bay_ac_sel_logistic_b=s1_bay_ac_logistic_b_start;
s1_bay_ac_sel_thompson_a=s1_bay_ac_thompson_a_start;
s1_bay_ac_sel_thompson_b=s1_bay_ac_thompson_b_start;
s1_bay_ac_sel_thompson_c=s1_bay_ac_thompson_c_start;
s1_bay_ac_sel_gamma_a=s1_bay_ac_gamma_a_start;
s1_bay_ac_sel_gamma_b=s1_bay_ac_gamma_b_start;
s1_bay_ac_sel_user_a=0.2;
s1_bay_ac_sel_user_b=0.4;
s1_bay_log_q_agg=s1_bay_log_q_agg_start;
s1_bay_log_q_ac=s1_bay_log_q_ac_start;
//s1_coast_log_N1=s1_coast_logNyr1_start;
s2_log_N1=s2_logNyr1_start;
s2_log_avgR=s2_logavgR_start;
s2_log_q_agg=s2_log_q_agg_start;
s2_log_q_ac=s2_log_q_ac_start;
s2_ac_sel_gompertz_a=s2_ac_gompertz_a_start;
s2_ac_sel_gompertz_b=s2_ac_gompertz_b_start;
s2_ac_sel_logistic_a=s2_ac_logistic_a_start;
s2_ac_sel_logistic_b=s2_ac_logistic_b_start;
s2_ac_sel_thompson_a=s2_ac_thompson_a_start;
s2_ac_sel_thompson_b=s2_ac_thompson_b_start;
s2_ac_sel_thompson_c=s2_ac_thompson_c_start;
s2_ac_sel_gamma_a=s2_ac_gamma_a_start;
s2_ac_sel_gamma_b=s2_ac_gamma_b_start;
coast_select_gompertz_a=coast_catch_gompertz_a_start;
coast_select_gompertz_b=coast_catch_gompertz_b_start;
coast_select_logistic_a=coast_catch_logistic_a_start;
coast_select_logistic_b=coast_catch_logistic_b_start;
coast_select_thompson_a=coast_catch_thompson_a_start;
coast_select_thompson_b=coast_catch_thompson_b_start;
coast_select_thompson_c=coast_catch_thompson_c_start;
//coast_plusgroup=coast_plusgroup_start;
coast_log_q_agg=coast_log_q_agg_start;
coast_log_q_ac=coast_log_q_ac_start;
coast_ac_sel_gompertz_a=coast_ac_gompertz_a_start;
coast_ac_sel_gompertz_b=coast_ac_gompertz_b_start;
```

```
 coast_ac_sel_logistic_a=coast_ac_logistic_a_start;
 coast_ac_sel_logistic_b=coast_ac_logistic_b_start;
 coast_ac_sel_thompson_a=coast_ac_thompson_a_start;
 coast_ac_sel_thompson_b=coast_ac_thompson_b_start;
 coast_ac_sel_thompson_c=coast_ac_thompson_c_start;
 coast_ac_sel_gamma_a=coast_ac_gamma_a_start;
 coast_ac_sel_gamma_b=coast_ac_gamma_b_start;
 if(estmig>0){
 s1_emig_a=0.013;
  }

PROCEDURE_SECTION
  moveprobs();
 s1_calc_selectivities();
 coast_calc_selectivities();
 coast_calc_mortalities();
 s1_calc_mortalities();
 s2_calc_mortalities();
 s1_calc_N_C();
 s2_calc_N_C();
 s1_bay_predict_indices();
 s2_predict_indices();
 coast_predict_indices();
 s1_likelihood();
 s2_likelihood();
 coast_likelihood();
 fit_stock_composition();
 mu_at_age();
 evaluate_the_objective_function();

FUNCTION print
 cout<<"STOCK 1-----------------"<<endl;
 cout<<s1_bay_log_avgR<<endl;;
 cout<<s1_bay_log_Rdev<<endl;
 cout<<"Rdev bounds"<<endl;
 cout<<s1_bay_logavgR_low<<" "<<s1_bay_logavgR_up<<" "<<s1_bay_R_phase<<endl;
 cout<<s1_bay_log_N1<<endl;
 //cout<<s1_coast_log_N1<<endl;
 cout<<s1_bay_log_F<<endl;
 //Selectivities
 cout<<s1_bay_select_gompertz_a<<endl;
 cout<<s1_bay_select_gompertz_b<<endl;
 cout<<s1_bay_select_logistic_a<<endl;
 cout<<s1_bay_select_logistic_b<<endl;
 cout<<s1_bay_select_thompson_a<<endl;
 cout<<s1_bay_select_thompson_b<<endl;
 cout<< s1_bay_select_thompson_c<<endl;
 cout<< s1_bay_log_q_agg<<endl;
 cout<< s1_bay_log_q_ac<<endl;
 cout<< s1_bay_ac_sel_gompertz_a<<endl;
 cout<< s1_bay_ac_sel_gompertz_b<<endl;
 cout<< s1_bay_ac_sel_logistic_a<<endl;
 cout<< s1_bay_ac_sel_logistic_b<<endl;
 cout<< s1_bay_ac_sel_thompson_a<<endl;
 cout<< s1_bay_ac_sel_thompson_b<<endl;
 cout<< s1_bay_ac_sel_thompson_c<<endl;
 cout<< s1_bay_ac_sel_gamma_a<<endl;
 cout<< s1_bay_ac_sel_gamma_b<<endl;
  //stock3
 cout<<"s2-----------------"<<endl;
 cout<< s2_log_avgR<<endl;
 cout<< s2_log_Rdev<<endl;
 cout<< s2_log_N1<<endl;
 cout<< s2_log_q_agg<<endl;
 cout<< s2_log_q_ac<<endl;
 cout<< s2_ac_sel_gompertz_a<<endl;
```

```
 cout<< s2_ac_sel_gompertz_b<<endl;
 cout<< s2_ac_sel_logistic_a<<endl;
 cout<< s2_ac_sel_logistic_b<<endl;
 cout<< s2_ac_sel_thompson_a<<endl;
 cout<< s2_ac_sel_thompson_b<<endl;
 cout<< s2_ac_sel_thompson_c<<endl;
 cout<< s2_ac_sel_gamma_a<<endl;
 cout<< s2_ac_sel_gamma_b<<endl;
 cout<<"COAST-----------------"<<endl;
 cout<< coast_log_F<<endl;
 cout<< coast_select_gompertz_a<<endl;
 cout<< coast_select_gompertz_b<<endl;
 cout<< coast_select_logistic_a<<endl;
 cout<< coast_select_logistic_b<<endl;
 cout<< coast_select_thompson_a<<endl;
 cout<< coast_select_thompson_b<<endl;
 cout<< coast_select_thompson_c<<endl;
 //cout<< coast_plusgroup<<endl;
 cout<< coast_log_q_agg<<endl;
 cout<< coast_log_q_ac<<endl;
 cout<< coast_ac_sel_gompertz_a<<endl;
 cout<< coast_ac_sel_gompertz_b<<endl;
 cout<< coast_ac_sel_logistic_a<<endl;
 cout<< coast_ac_sel_logistic_b<<endl;
 cout<< coast_ac_sel_thompson_a<<endl;
 cout<< coast_ac_sel_thompson_b<<endl;
 cout<< coast_ac_sel_thompson_c<<endl;
 cout<< coast_ac_sel_gamma_a<<endl;
 cout<< coast_ac_sel_gamma_b<<endl;
  cout<<"Likelihood weights"<<endl;
 cout<<s1_bay_total_catch_wgted_RSS<<endl;
 cout<<s1_bay_agg_index_wgted_RSS<<endl;
 cout<<s1_bay_ac_index_wgted_RSS<<endl;
 cout<<s2_agg_index_wgted_RSS<<endl;
 cout<<coast_catch_paa_wgted_like<<endl;
 cout<<coast_agg_index_wgted_RSS<<endl;
 cout<<coast_ac_index_wgted_RSS<<endl;
 cout<<s1_bay_catch_paa_wgted_like<<endl;
 cout<<s1_bay_ac_index_paa_wgted_like<<endl;
  cout<<coast_total_catch_wgted_RSS<<endl;
 cout<<coast_catch_paa_wgted_like<<endl;
 cout<<coast_ac_index_paa_wgted_like<<endl;
 cout<<stock_comp_wgted_like<<endl;
 cout<<coast_total_catch<<endl;
FUNCTION moveprobs
 if(estmig>0){
   for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
    if(a<10) s1_emig_probs(y,a)=s1_test_emig_probs(y,a);
     if(a>=10) s1_emig_probs(y,a)=s1_emig_a;
     }
    }
  }
 if(estmig<=0) s1_emig_probs=s1_test_emig_probs;

FUNCTION s1_calc_selectivities

 //---------------------------stock 1 bay-------------------
 bay_cnt_gompertz=0.;
 bay_cnt_logistic=0.;
 bay_cnt_thompson=0.;
  //checked 2/26/2018
   for(regperiod=1;regperiod<=s1_bay_reg_nperiods;regperiod++){
       if(s1_bay_select_years_type(regperiod,4)==1) bay_cnt_gompertz+=1;
       if(s1_bay_select_years_type(regperiod,4)==2) bay_cnt_logistic+=1;
       if(s1_bay_select_years_type(regperiod,4)==3) bay_cnt_thompson+=1;
```

```
      for(y=styr;y<=endyr;y++){
       if(y>=s1_bay_select_years_type(regperiod,2) && y<=s1_bay_select_years_type(regperiod,3)){
        if(s1_bay_select_years_type(regperiod,4)==1){//Gompertz
          s1_bay_max=0;
          for(a=1;a<=nages;a++){
           s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=mfexp(-1.*mfexp(-
1.*s1_bay_select_gompertz_b(bay_cnt_gompertz)*(a-s1_bay_select_gompertz_a(bay_cnt_gompertz))));
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)<0.)
s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=0.;
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)>1.)
s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=1.;
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)>s1_bay_max)
s1_bay_max=s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a);
          }

s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y)=s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y)/s1_bay_ma
x;
        }
      if(s1_bay_select_years_type(regperiod,4)==2){//Logistic
          s1_bay_max=0;
          for(a=1;a<=nages;a++){
           s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=1./(1.+mfexp(-1.*s1_bay_select_logistic_b(bay_cnt_logistic)*(a-
s1_bay_select_logistic_a(bay_cnt_logistic))));
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)<0.)
s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=0.;
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)>1.)
s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=1.;
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)>s1_bay_max)
s1_bay_max=s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a);
          }

s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y)=s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y)/s1_bay_ma
x;
       }
      if(s1_bay_select_years_type(regperiod,4)==3){//Thompson
          s1_bay_max=0;
          for(a=1;a<=nages;a++){
           s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=(1./(1.-s1_bay_select_thompson_c(bay_cnt_thompson)))*pow((1.-
s1_bay_select_thompson_c(bay_cnt_thompson))/
           s1_bay_select_thompson_c(bay_cnt_thompson),s1_bay_select_thompson_c(bay_cnt_thompson))*
           (mfexp(s1_bay_select_thompson_a(bay_cnt_thompson)*s1_bay_select_thompson_c(bay_cnt_thompson)*
           (s1_bay_select_thompson_b(bay_cnt_thompson)-double(a)))/
           (1.+mfexp(s1_bay_select_thompson_a(bay_cnt_thompson)*(s1_bay_select_thompson_b(bay_cnt_thompson)-double(a)))));
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)<0.)
s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=0.;
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)>1.)
s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)=1.;
           if(s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a)>s1_bay_max)
s1_bay_max=s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y,a);
          }

s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y)=s1_bay_select_at_age(s1_bay_select_years_type(regperiod,1),y)/s1_bay_ma
x;
       }
      }
     }//y
    }//regperiod
   if(s1_bay_wv3_count==0){
   s1_bay_select_at_age(2)=s1_bay_select_at_age(1);
   s1_bay_select_at_age(3)=s1_bay_select_at_age(1);
  }

FUNCTION coast_calc_selectivities
 coast_cnt_gompertz=0.;
 coast_cnt_logistic=0.;
 coast_cnt_thompson=0.;
```

```
 //checked 3/2/2018
  for(regperiod=1;regperiod<=coast_reg_nperiods;regperiod++){
       if(coast_select_years_type(regperiod,4)==1) coast_cnt_gompertz+=1;
       if(coast_select_years_type(regperiod,4)==2) coast_cnt_logistic+=1;
       if(coast_select_years_type(regperiod,4)==3) coast_cnt_thompson+=1;
    for(y=styr;y<=endyr;y++){
      if(y>=coast_select_years_type(regperiod,2) && y<=coast_select_years_type(regperiod,3)){
       if(coast_select_years_type(regperiod,4)==1){//Gompertz
          coast_max=0;
          for(a=1;a<=nages;a++){
           coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=mfexp(-1.*mfexp(-
1.*coast_select_gompertz_b(coast_cnt_gompertz)*(a-coast_select_gompertz_a(coast_cnt_gompertz))));
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)<0)
coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=0.;
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)>1)
coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=1.;
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)>coast_max)
coast_max=coast_select_at_age(coast_select_years_type(regperiod,1),y,a);
          }
          coast_select_at_age(coast_select_years_type(regperiod,1),y)=coast_select_at_age(coast_select_years_type(regperiod,1),y)/coast_max;
       }
       if(coast_select_years_type(regperiod,4)==2){//Logistic
          coast_max=0;
          for(a=1;a<=nages;a++){
           coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=1./(1.+mfexp(-1.*coast_select_logistic_b(coast_cnt_logistic)*(a-
coast_select_logistic_a(coast_cnt_logistic))));
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)<0)
coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=0.;
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)>1)
coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=1.;
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)>coast_max)
coast_max=coast_select_at_age(coast_select_years_type(regperiod,1),y,a);
          }
          coast_select_at_age(coast_select_years_type(regperiod,1),y)=coast_select_at_age(coast_select_years_type(regperiod,1),y)/coast_max;
       }
       if(coast_select_years_type(regperiod,4)==3){//Thompson
          coast_max=0;
          for(a=1;a<=nages;a++){
           coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=(1./(1.-coast_select_thompson_c(coast_cnt_thompson)))*pow((1-
coast_select_thompson_c(coast_cnt_thompson))/coast_select_thompson_c(coast_cnt_thompson),coast_select_thompson_c(coast_cnt_thom
pson))*

(mfexp(coast_select_thompson_a(coast_cnt_thompson)*coast_select_thompson_c(coast_cnt_thompson)*(coast_select_thompson_b(coast_c
nt_thompson)-double(a)))/
           (1+mfexp(coast_select_thompson_a(coast_cnt_thompson)*(coast_select_thompson_b(coast_cnt_thompson)-double(a)))));
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)<0)
coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=0.;
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)>1)
coast_select_at_age(coast_select_years_type(regperiod,1),y,a)=1.;
           if(coast_select_at_age(coast_select_years_type(regperiod,1),y,a)>coast_max)
coast_max=coast_select_at_age(coast_select_years_type(regperiod,1),y,a);
          }
          coast_select_at_age(coast_select_years_type(regperiod,1),y)=coast_select_at_age(coast_select_years_type(regperiod,1),y)/coast_max;
       }
      }
     }//y
    }//regperiod
   if(ncoastwaves==3 & coast_wv3_count==0){
    coast_select_at_age(2)=coast_select_at_age(1);
    coast_select_at_age(3)=coast_select_at_age(1);
  }
FUNCTION coast_calc_mortalities

 //checked 2/26/2018
  if(substructure==ncoastwaves){
    for(wvgroup=1;wvgroup<=substructure;wvgroup++){
```

```
      for(y=styr;y<=endyr;y++){
       coast_fullF(y,wvgroup)=mfexp(coast_log_F(y,wvgroup));
       for(a=1;a<=nages;a++){
       coast_F(wvgroup,y,a)=mfexp(coast_log_F(y,wvgroup))*coast_select_at_age(wvgroup,y,a);
       coast_Z(wvgroup,y,a)=coast_F(wvgroup,y,a)+coast_M(y,a)*coast_pM(wvgroup);
       }
      }
     }
   }
  if(substructure>ncoastwaves){
    ndiffbaycoast=0;
    for(wvgroup=1;wvgroup<=substructure;wvgroup++){
      if(ncoastwaves>ndiffbaycoast) ndiffbaycoast+=1;
       for(y=styr;y<=endyr;y++){
        coast_fullF(y,ndiffbaycoast)=mfexp(coast_log_F(y,ndiffbaycoast))*coast_pF(y,wvgroup);
        for(a=1;a<=nages;a++){
          coast_F(wvgroup,y,a)=mfexp(coast_log_F(y,ndiffbaycoast))*coast_pF(y,wvgroup)*coast_select_at_age(ndiffbaycoast,y,a);
          coast_Z(wvgroup,y,a)=coast_F(wvgroup,y,a)+coast_M(y,a)*coast_pM(wvgroup);
        }
       }
    }
   }

FUNCTION s1_calc_mortalities
  //checked 2/26/2018
  for(wvgroup=1;wvgroup<=substructure;wvgroup++){
    for(y=styr;y<=endyr;y++){
      s1_bay_fullF(y,wvgroup)=mfexp(s1_bay_log_F(y,wvgroup));
      for(a=1;a<=nages;a++){
        s1_bay_F(wvgroup,y,a)=mfexp(s1_bay_log_F(y,wvgroup))*s1_bay_select_at_age(wvgroup,y,a);
        s1_bay_Z(wvgroup,y,a)=s1_bay_F(wvgroup,y,a)+s1_bay_M(y,a)*s1_bay_pM(wvgroup);
      }
    }
  }
  s1_coast_F=coast_F;
  s1_coast_Z=coast_Z;

FUNCTION s1_calc_N_C
   for(y=styr;y<=endyr;y++){
     if(pickRmethod<=1){
      s1_bay_N(y,1)=mfexp(s1_bay_log_avgR+s1_bay_log_Rdev(y));
      s1_bay_R(y)=s1_bay_N(y,1);
     }
    if(pickRmethod==2){
     s1_bay_N(y,1)=absrecruit(y,1);
     s1_bay_R(y)=s1_bay_Z(1,y,1);

    }
   }
  //Abundance in first year
 p=2+n_s1_bay_Nyr1-1;
 for(a=2;a<=p;a++) s1_bay_N(styr,a)=mfexp(s1_bay_log_N1(a-1));
   s1_bay_Nyr1=mfexp(s1_bay_log_N1);
  if(p<nages){
  for(a=p+1;a<=nages;a++){
    if(a<nages) s1_bay_N(styr,a)=s1_bay_N(styr,a-1)*mfexp(-s1_bay_M(styr,a-1));
    if(a==nages) s1_bay_N(styr,a)=(s1_bay_N(styr,a-1)*mfexp(-s1_bay_M(styr,a-1)))/(1-mfexp(-s1_bay_M(styr,a)));
   }
 }
 if(altcoast_Nyr1>0){
  p=2+n_s1_coast_Nyr1-1;
  s1_coast_N(styr,1)=0;
  for(a=2;a<=p;a++) s1_coast_N(styr,a)=mfexp(s1_coast_log_N1(a-1));
  if(p<nages){
   for(a=p+1;a<=nages;a++){
    if(a<nages) s1_coast_N(styr,a)=s1_coast_N(styr,a-1)*mfexp(-coast_M(styr,a-1));
```

```
//Plus group
   if(a==nages) s1_coast_N(styr,a)=(s1_coast_N(styr,a-1)*mfexp(-coast_M(styr,a-1)))/(1-mfexp(-coast_M(styr,a)));
  }
 }
}
if(altcoast_Nyr1<=0){
 for(a=2;a<=nages;a++) s1_coast_N(styr,a)=s1_bay_N(styr,a)*s1_test_emig_probs(styr,a);
 }

 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
      //Checked 1/31/2018
      s1_bay_pred_catch_caa(1,y,a)=s1_bay_F(1,y,a)/s1_bay_Z(1,y,a)*(1.-mfexp(-s1_bay_Z(1,y,a)))*s1_bay_N(y,a);
      //checked
      s1_bay_Nwv23(y,a)=mfexp(-s1_bay_Z(1,y,a))*s1_bay_N(y,a);
      //checked
      s1_bay_pred_catch_caa(2,y,a)=s1_bay_F(2,y,a)/s1_bay_Z(2,y,a)*(1.-mfexp(-s1_bay_Z(2,y,a)))*s1_bay_Nwv23(y,a);
      //checked
      s1_bay_Nwv46(y,a)=mfexp(-s1_bay_Z(2,y,a))*s1_bay_Nwv23(y,a)*(1.-s1_emig_probs(y,a));
      //checked
      s1_bay_emigrants(y,a)=mfexp(-s1_bay_Z(2,y,a))*s1_bay_Nwv23(y,a)*s1_emig_probs(y,a);
      //checked
      s1_bay_pred_catch_caa(3,y,a)=s1_bay_F(3,y,a)/s1_bay_Z(3,y,a)*(1.-mfexp(-s1_bay_Z(3,y,a)))*s1_bay_Nwv46(y,a);
     //Coast catch from wv 1
      //checked
      s1_coast_pred_catch_caa(1,y,a)=s1_coast_F(1,y,a)/(s1_coast_F(1,y,a)+coast_M(y,a)*coast_pM(1))*(1.-mfexp(-s1_coast_F(1,y,a)-
coast_M(y,a)*coast_pM(1)))*s1_coast_N(y,a);
     //Numbers for period 2
     //checked
      s1_coast_Nwv23(y,a)=(s1_coast_N(y,a)*coast_prop_female(1,y,a)*(1.-s1_female_mat(y,a))+s1_coast_N(y,a)*(1.-
coast_prop_female(1,y,a))*(1.-s1_male_mat(y,a)))*
         mfexp(-s1_coast_F(1,y,a)-coast_M(y,a)*coast_pM(1));
      //checked
      s1_coast_immigrants(y,a)=(s1_coast_N(y,a)*s1_female_mat(y,a)*coast_prop_female(1,y,a)+s1_coast_N(y,a)*s1_male_mat(y,a)*
        (1.-coast_prop_female(1,y,a)))*mfexp(-s1_coast_F(1,y,a)-coast_M(y,a)*coast_pM(1));
      s1_coast_immigrants_female(y,a)=(s1_coast_N(y,a)*s1_female_mat(y,a)*coast_prop_female(1,y,a))*mfexp(-s1_coast_F(1,y,a)-
coast_M(y,a)*coast_pM(1));
      s1_coast_immigrants_male(y,a)=(s1_coast_N(y,a)*s1_male_mat(y,a)*(1.-coast_prop_female(1,y,a)))*mfexp(-s1_coast_F(1,y,a)-
coast_M(y,a)*coast_pM(1));
      //Coastal catch for period two to all catches
     //checked
      s1_coast_pred_catch_caa(2,y,a)=s1_coast_F(2,y,a)/(s1_coast_F(2,y,a)+coast_M(y,a)*coast_pM(2))*(1.-mfexp(-s1_coast_F(2,y,a)-
coast_M(y,a)*coast_pM(2)))*s1_coast_Nwv23(y,a);
     //Add imigrants catches to bay catches in period 2
     //checked

s1_bay_pred_catch_caa(2,y,a)=s1_bay_pred_catch_caa(2,y,a)+s1_coast_immigrants(y,a)*s1_bay_F(2,y,a)/(s1_bay_F(2,y,a)+coast_M(y,a)*coast
_pM(2))*(1.-mfexp(-s1_bay_F(2,y,a)-coast_M(y,a)*coast_pM(2)));
      s1_bay_pred_migrants_catch_caa(y,a)=s1_coast_immigrants(y,a)*s1_bay_F(2,y,a)/(s1_bay_F(2,y,a)+coast_M(y,a)*coast_pM(2))*(1.-
mfexp(-s1_bay_F(2,y,a)-coast_M(y,a)*coast_pM(2)));
       // wv 46
      //checked
      s1_coast_Nwv46(y,a)=s1_coast_Nwv23(y,a)*mfexp(-s1_coast_F(2,y,a)-coast_M(y,a)*coast_pM(2));
      s1_coast_Nwv46(y,a)=s1_coast_Nwv46(y,a)+s1_coast_immigrants(y,a)*mfexp(-s1_bay_F(2,y,a)-
coast_M(y,a)*coast_pM(2))+s1_bay_emigrants(y,a);
         //checked
      s1_coast_pred_catch_caa(3,y,a)=s1_coast_F(3,y,a)/(s1_coast_F(3,y,a)+coast_M(y,a)*coast_pM(3))*(1.-mfexp(-s1_coast_F(3,y,a)-
coast_M(y,a)*coast_pM(3)))*s1_coast_Nwv46(y,a);
  }//a
  if(y<endyr){
   for(a=2;a<=nages;a++){
    //Checked
    s1_bay_N(y+1,a)=s1_bay_Nwv46(y,a-1)*mfexp(-s1_bay_Z(3,y,a-1));
    s1_coast_N(y+1,a)=s1_coast_Nwv46(y,a-1)*mfexp(-s1_coast_F(3,y,a-1)-coast_M(y,a-1)*coast_pM(3));
   }
   s1_bay_N(y+1,nages)= s1_bay_N(y+1,nages)+s1_bay_Nwv46(y,nages)*mfexp(-s1_bay_Z(3,y,nages));
```

```
   s1_coast_N(y+1,nages)=s1_coast_N(y+1,nages)+s1_coast_Nwv46(y,nages)*mfexp(-s1_coast_F(3,y,nages)-
coast_M(y,nages)*coast_pM(3));    }
  for(a=1;a<=nages;a++){
   //SSB at beginning of wave2
   s1_ssb(y,a)=(s1_bay_N(y,a)*mfexp(-s1_bay_F(1,y,a)-
s1_bay_M(y,a)*s1_bay_pM(1))*s1_bay_prop_female(1,y,a)*s1_female_mat(y,a)*s1_bay_ssb_wgts(y,a)/1000)+
   (s1_coast_N(y,a)*s1_female_mat(y,a)*coast_prop_female(1,y,a)*mfexp(-s1_coast_F(1,y,a)-
coast_M(y,a)*coast_pM(1))*coast_ssb_wgts(y,a)/1000);
  }
 }//y loop
 //Predicted total catch by wave group
 for(wvgroup=1;wvgroup<=substructure;wvgroup++){
  for(y=styr;y<=endyr;y++){
   s1_bay_pred_total_catch(y,wvgroup)=sum(s1_bay_pred_catch_caa(wvgroup,y));
   s1_coast_pred_total_catch(y,wvgroup)=sum(s1_coast_pred_catch_caa(wvgroup,y));
  }
 }
  //Calculate s1_bay_total_catch_paa//checked 2/27/2018
  for(t=1;t<=substructure;t++){



    for(y=styr;y<=endyr;y++){
      s1_bay_max=0.;
       for(a=1;a<=nages;a++) s1_bay_max+=s1_bay_pred_catch_caa(t,y,a);
         s1_bay_pred_catch_paa(t,y)=s1_bay_pred_catch_caa(t,y)/s1_bay_max;
     }
   }
  for(t=1;t<=substructure;t++){
    for(y=styr;y<=endyr;y++){
      s1_bay_max=0.;
       for(a=1;a<=nages;a++) s1_bay_max+=s1_coast_pred_catch_caa(t,y,a);
         s1_coast_pred_catch_paa(t,y)=s1_coast_pred_catch_caa(t,y)/s1_bay_max;
     }
   }
  s1_femSSB=rowsum(s1_ssb);
  for(a=1;a<=nages;a++){
   s1_bay_proj_N(a)=s1_bay_Nwv46(endyr,a)*mfexp(-s1_bay_Z(3,endyr,a));
   s1_bay_proj_N_female(a)=s1_bay_Nwv46(endyr,a)*mfexp(-s1_bay_Z(3,endyr,a))*s1_bay_prop_female(3,endyr,a);
   s1_bay_proj_N_male(a)=s1_bay_Nwv46(endyr,a)*mfexp(-s1_bay_Z(3,endyr,a))*(1.-s1_bay_prop_female(3,endyr,a));
   s1_coast_proj_N(a)=s1_coast_Nwv46(endyr,a)*mfexp(-coast_Z(3,endyr,a));
   s1_coast_proj_N_female(a)=s1_coast_Nwv46(endyr,a)*mfexp(-coast_Z(3,endyr,a))*coast_prop_female(3,endyr,a);
   s1_coast_proj_N_male(a)=s1_coast_Nwv46(endyr,a)*mfexp(-coast_Z(3,endyr,a))*(1.-coast_prop_female(3,endyr,a));
  }
FUNCTION s2_calc_mortalities
  //checked 2/26/2018
     s2_F=coast_F;
     s2_Z=coast_Z;

FUNCTION s2_calc_N_C
   for(y=styr;y<=endyr;y++){
    if(pickRmethod==0){
      s2_N(y,1)=mfexp(s2_log_avgR+s2_log_Rdev(y));
      s2_R(y)=s2_N(y,1);
     }
    if(pickRmethod==1){
      s2_N(y,1)=mfexp(s1_bay_log_avgR+logs1Rfrac+s2_log_Rdev(y));
      s2_R(y)=s2_N(y,1);
    }
    if(pickRmethod==2){
      s2_N(y,1)=absrecruit(y,2);
     s2_R(y)=coast_Z(1,y,1);
    }
   }
    p=2+n_s2_Nyr1-1;
    for(a=2;a<=p;a++) s2_N(styr,a)=mfexp(s2_log_N1(a-1));
    s2_Nyr1=mfexp(s2_log_N1);
    if(p<nages){
     for(a=p+1;a<=nages;a++){
```

```
   if(a<nages) s2_N(styr,a)=s2_N(styr,a-1)*mfexp(-coast_M(styr,a-1));
   if(a==nages) s2_N(styr,a)=(s2_N(styr,a-1)*mfexp(-coast_M(styr,a-1)))/(1.-mfexp(-coast_M(styr,a)));
  }
 }
  for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
     //Checked 1/31/2018
     s2_pred_catch_caa(1,y,a)=s2_F(1,y,a)/s2_Z(1,y,a)*(1.-mfexp(-s2_Z(1,y,a)))*s2_N(y,a);
     s2_Nwv23(y,a)=mfexp(-s2_Z(1,y,a))*s2_N(y,a);
     s2_pred_catch_caa(2,y,a)=s2_F(2,y,a)/s2_Z(2,y,a)*(1.-mfexp(-s2_Z(2,y,a)))*s2_Nwv23(y,a);
     s2_Nwv46(y,a)=mfexp(-s2_Z(2,y,a))*s2_Nwv23(y,a);
     s2_pred_catch_caa(3,y,a)=s2_F(3,y,a)/s2_Z(3,y,a)*(1.-mfexp(-s2_Z(3,y,a)))*s2_Nwv46(y,a);
    }//a
   if(y<endyr){
    for(a=2;a<=nages;a++) s2_N(y+1,a)=s2_Nwv46(y,a-1)*mfexp(-s2_Z(3,y,a-1));
    s2_N(y+1,nages)= s2_N(y+1,nages)+s2_Nwv46(y,nages)*mfexp(-s2_Z(3,y,nages));
   }
   for(a=1;a<=nages;a++){
    s2_ssb(y,a)=s2_Nwv23(y,a)*s2_female_mat(y,a)*s2_fem_sex(a)*coast_ssb_wgts(y,a)/1000;
   }
 }//y loop
 for(a=1;a<=nages;a++){
  s2_proj_N(a)=s2_Nwv46(endyr,a)*mfexp(-s2_Z(3,endyr,a));
  s2_proj_N_female(a)=s2_Nwv46(endyr,a)*mfexp(-s2_Z(3,endyr,a))*s2_fem_sex(a);
  s2_proj_N_male(a)=s2_Nwv46(endyr,a)*mfexp(-s2_Z(3,endyr,a))*(1.-s2_fem_sex(a));
 }
//Predicted total catch by wave group
 for(wvgroup=1;wvgroup<=substructure;wvgroup++){
  for(y=styr;y<=endyr;y++) s2_pred_total_catch(y,wvgroup)=sum(s2_pred_catch_caa(wvgroup,y));
 }
  s2_femSSB=rowsum(s2_ssb);

FUNCTION s1_bay_predict_indices
 //---------------------Aggregate Indices Include YOY
 //checked 2/26/2018
  if(s1_bay_nagg_used>0){
  s1_bay_q_agg=mfexp(s1_bay_log_q_agg);
   cnt=0;
  for(t=1;t<=s1_bay_nagg;t++){
   if(s1_bay_use_agg(t)==1){
    cnt+=1;
    adds=0;
    realage=0;
    diff2=0;
    wvtime=0;
    wvfraction=0;
    for(y=styr;y<=endyr;y++){
      if (s1_bay_agg_index(y,t)>=0.){ //Skip missing values (-1)
                realage=(int)floor(s1_bay_agg_ages(t));
                diff2=int(ceil(s1_bay_agg_ages(t)*100)-(floor(s1_bay_agg_ages(t))*100));
        wvtime=int(floor(s1_bay_agg_time(t)*100)/100);
        wvfraction=s1_bay_agg_time(t)-floor(s1_bay_agg_time(t));
                pgroup=0;
                for (a=realage;a<=diff2;a++){
         if(wvtime==1) pgroup+=s1_bay_N(y,a)*mfexp(-1.*wvfraction*s1_bay_Z(wvtime,y,a));
         if(wvtime==2) pgroup+=s1_bay_Nwv23(y,a)*mfexp(-1.*wvfraction*s1_bay_Z(wvtime,y,a))+
           s1_coast_immigrants(y,a)*mfexp(wvfraction*(-s1_bay_F(wvtime,y,a)-coast_M(y,a)*coast_pM(wvtime)));
         if(wvtime==3) pgroup+=s1_bay_Nwv46(y,a)*mfexp(-1.*wvfraction*s1_bay_Z(wvtime,y,a));
         }
                 s1_bay_pred_agg_index(y,cnt)=mfexp(s1_bay_log_q_agg(cnt))*pgroup;
      }//agg_surv_indices>=0
      if (s1_bay_agg_index(y,t)==-1) s1_bay_pred_agg_index(y,cnt)=-1;
    }//y loop
  }
 }//t loop
 }
```

```
 if(s1_bay_nac_used>0){
  s1_bay_q_ac=mfexp(s1_bay_log_q_ac);
  cnt=0;cnt1=0;cnt2=0;cnt3=0;used_cnt=0;
  for(t=1;t<=s1_bay_nac;t++){
   if(s1_bay_use_ac(t)==1){
     used_cnt+=1;
     s1_bay_max=0;
    for(a=1;a<=nages;a++){
     if(s1_bay_ac_sel_type(t)==0){
         if(a==1) s1_bay_ac_select_at_age(used_cnt,a)=0.;
         if(a==2) s1_bay_ac_select_at_age(used_cnt,a)=s1_bay_ac_sel_user_a;
         if(a==3) s1_bay_ac_select_at_age(used_cnt,a)=s1_bay_ac_sel_user_b;
         if(a>3) s1_bay_ac_select_at_age(used_cnt,a)=1.0;
          if(s1_bay_ac_select_at_age(used_cnt,a)>=s1_bay_max) s1_bay_max=s1_bay_ac_select_at_age(used_cnt,a);
     }
     if(s1_bay_ac_sel_type(t)==1){
          if(a==1) cnt+=1;
          s1_bay_ac_select_at_age(used_cnt,a)=mfexp(-1.*mfexp(-1.*s1_bay_ac_sel_gompertz_b(cnt)*(double(a)-
s1_bay_ac_sel_gompertz_a(cnt))));
          if(s1_bay_ac_select_at_age(used_cnt,a)>=s1_bay_max) s1_bay_max=s1_bay_ac_select_at_age(used_cnt,a);
      }
      if(s1_bay_ac_sel_type(t)==2){
          if(a==1) cnt1+=1;
          s1_bay_ac_select_at_age(used_cnt,a)=1./(1.+mfexp(-1.*s1_bay_ac_sel_logistic_b(cnt1)*(double(a)-s1_bay_ac_sel_logistic_a(cnt1))));
          if(s1_bay_ac_select_at_age(used_cnt,a)>=s1_bay_max) s1_bay_max=s1_bay_ac_select_at_age(used_cnt,a);
      }
       if(s1_bay_ac_sel_type(t)==4){
          if(a==1) cnt2+=1;
          s1_bay_ac_select_at_age(used_cnt,a)=pow(double(a),s1_bay_ac_sel_gamma_a(cnt2))*mfexp(-
1.*s1_bay_ac_sel_gamma_b(cnt2)*double(a));
          if(s1_bay_ac_select_at_age(used_cnt,a)>s1_bay_max) s1_bay_max=s1_bay_ac_select_at_age(used_cnt,a);
      }
      if(s1_bay_ac_sel_type(t)==3){
          if(a==1) cnt3+=1;
          s1_bay_ac_select_at_age(used_cnt,a)=(1./(1.-s1_bay_ac_sel_thompson_c(cnt3)))*pow((1-s1_bay_ac_sel_thompson_c(cnt3))/

s1_bay_ac_sel_thompson_c(cnt3),s1_bay_ac_sel_thompson_c(cnt3))*(mfexp(s1_bay_ac_sel_thompson_a(cnt3)*s1_bay_ac_sel_thompson_c(c
nt3)*(s1_bay_ac_sel_thompson_b(cnt3)-double(a)))/
               (1+mfexp(s1_bay_ac_sel_thompson_a(cnt3)*(s1_bay_ac_sel_thompson_b(cnt3)-double(a)))));
          if(s1_bay_ac_select_at_age(used_cnt,a)>=s1_bay_max) s1_bay_max=s1_bay_ac_select_at_age(used_cnt,a);
      }
    }//a
    s1_bay_ac_select_at_age(used_cnt)=s1_bay_ac_select_at_age(used_cnt)/s1_bay_max;
   }
  }//t
 //Checked 2/27/2018
 //Calculate age comp surveys predicted age comps
  cnt=0;
  for(t=1;t<=s1_bay_nac;t++){
    if(s1_bay_use_ac(t)==1){
          cnt+=1;
          wvtime=int(floor(s1_bay_ac_time(t)*100)/100);
          wvfraction=s1_bay_ac_time(t)-floor(s1_bay_ac_time(t));
        for(y=styr;y<=endyr;y++){
          for(a=1;a<=nages;a++){
             s1_bay_pred_ac_index_paa(cnt,y,a)=0;
              if(wvtime==1)
s1_bay_pred_ac_index_paa(cnt,y,a)=s1_bay_ac_select_at_age(cnt,a)*mfexp(s1_bay_log_q_ac(cnt))*s1_bay_N(y,a)*mfexp(-
1.*wvfraction*s1_bay_Z(wvtime,y,a));
              if(wvtime==2) s1_bay_pred_ac_index_paa(cnt,y,a)=s1_bay_ac_select_at_age(cnt,a)*mfexp(s1_bay_log_q_ac(cnt))*
              (s1_bay_Nwv23(y,a)*mfexp(-1.*wvfraction*s1_bay_Z(wvtime,y,a))+
              s1_coast_immigrants(y,a)*mfexp(wvfraction*(-s1_bay_F(wvtime,y,a)-coast_M(y,a)*coast_pM(wvtime))));
              if(wvtime==3)
s1_bay_pred_ac_index_paa(cnt,y,a)=s1_bay_ac_select_at_age(cnt,a)*mfexp(s1_bay_log_q_ac(cnt))*s1_bay_Nwv46(y,a)*mfexp(-
1.*wvfraction*s1_bay_Z(wvtime,y,a));
          }//a loop
```

```
      }//y loop
    }
 }//t loop
 used_cnt=0;
 for(t=1;t<=s1_bay_nac;t++){
   if(s1_bay_use_ac(t)==1){
     //sum for index
     used_cnt+=1;
    for(y=styr;y<=endyr;y++){
      s1_bay_pred_ac_index(y,used_cnt)=0;
      for(a=1;a<=nages;a++){
        if(s1_bay_ac_index_paa(t,y,a)>=0) s1_bay_pred_ac_index(y,used_cnt)+=s1_bay_pred_ac_index_paa(used_cnt,y,a);
      }
     }
     for(y=styr;y<=endyr;y++)
s1_bay_pred_ac_index_paa(used_cnt,y)=s1_bay_pred_ac_index_paa(used_cnt,y)/sum(s1_bay_pred_ac_index_paa(used_cnt,y));
   }
 }//if surveys>0
}//if s1_bay_nac>0

FUNCTION s2_predict_indices
 if(s2_nagg_used>0){
   s2_q_agg=mfexp(s2_log_q_agg);
   cnt=0;
  for(t=1;t<=s2_nagg;t++){
   if(s2_use_agg(t)==1){
     cnt+=1;
     adds=0;
     realage=0;
     diff2=0;
     wvtime=0;
     wvfraction=0;
     for(y=styr;y<=endyr;y++){
       if(s2_agg_index(y,t)>=0.){ //Skip missing values (-1)
                 realage=(int)floor(s2_agg_ages(t));
                 diff2=int(ceil(s2_agg_ages(t)*100)-(floor(s2_agg_ages(t))*100));
         wvtime=int(floor(s2_agg_time(t)*100)/100);
         wvfraction=s2_agg_time(t)-floor(s2_agg_time(t));
                 pgroup=0;
                 for(a=realage;a<=diff2;a++){
          if(wvtime==1) pgroup+=s2_N(y,a)*mfexp(-1.*wvfraction*coast_Z(wvtime,y,a));
          if(wvtime==2) pgroup+=s2_Nwv23(y,a)*mfexp(-1.*wvfraction*coast_Z(wvtime,y,a));
          if(wvtime==3) pgroup+=s2_Nwv46(y,a)*mfexp(-1.*wvfraction*coast_Z(wvtime,y,a));
         }
                s2_pred_agg_index(y,cnt)=mfexp(s2_log_q_agg(cnt))*pgroup;
      }//agg_surv_indices>=0
      if(s2_agg_index(y,t)==-1) s2_pred_agg_index(y,cnt)=-1;
    }//y loop
   }
  }//t loop
 }
 //Calculate age comp surveys predicted age comps
  if(s2_nac_used>0){
   s2_q_ac=mfexp(s2_log_q_ac);
   cnt=0;cnt1=0;cnt2=0;cnt3=0;used_cnt=0;
  for(t=1;t<=s2_nac;t++){
   if(s2_use_ac(t)==1){
    used_cnt+=1;
     s2_max=0;
    for(a=1;a<=nages;a++){
     if(s2_ac_sel_type(t)==1){
        if(a==1) cnt+=1;
        s2_ac_select_at_age(used_cnt,a)=mfexp(-1.*mfexp(-1.*s2_ac_sel_gompertz_b(cnt)*(double(a)-s2_ac_sel_gompertz_a(cnt))));
        if(s2_ac_select_at_age(used_cnt,a)>=s2_max) s2_max=s2_ac_select_at_age(used_cnt,a);
     }
      if(s2_ac_sel_type(t)==2){
```

```
        if(a==1) cnt1+=1;
        s2_ac_select_at_age(used_cnt,a)=1./(1.+mfexp(-1.*s2_ac_sel_logistic_b(cnt1)*(double(a)-s2_ac_sel_logistic_a(cnt1))));
        if(s2_ac_select_at_age(used_cnt,a)>=s2_max) s2_max=s2_ac_select_at_age(used_cnt,a);
    }
     if(s2_ac_sel_type(t)==4){
        if(a==1) cnt2+=1;
        s2_ac_select_at_age(used_cnt,a)=pow(double(a),s2_ac_sel_gamma_a(cnt2))*mfexp(-1.*s2_ac_sel_gamma_b(cnt2)*double(a));
       if(s2_ac_select_at_age(used_cnt,a)>s2_max) s2_max=s2_ac_select_at_age(used_cnt,a);
    }
    if(s2_ac_sel_type(t)==3){
        if(a==1) cnt3+=1;
        s2_ac_select_at_age(used_cnt,a)=(1./(1.-s2_ac_sel_thompson_c(cnt3)))*pow((1-s2_ac_sel_thompson_c(cnt3))/

s2_ac_sel_thompson_c(cnt3),s2_ac_sel_thompson_c(cnt3))*(mfexp(s2_ac_sel_thompson_a(cnt3)*s2_ac_sel_thompson_c(cnt3)*(s2_ac_sel_th
ompson_b(cnt3)-double(a)))/
             (1+mfexp(s2_ac_sel_thompson_a(cnt3)*(s2_ac_sel_thompson_b(cnt3)-double(a)))));
        if(s2_ac_select_at_age(used_cnt,a)>=s2_max) s2_max=s2_ac_select_at_age(used_cnt,a);
    }
   }//a
   s2_ac_select_at_age(used_cnt)=s2_ac_select_at_age(used_cnt)/s2_max;
  }
 }//t

  used_cnt=0;
 for(t=1;t<=s2_nac;t++){
   if(s2_use_ac(t)==1){
         used_cnt+=1;
         wvtime=int(floor(s2_ac_time(t)*100)/100);
         wvfraction=s2_ac_time(t)-floor(s2_ac_time(t));
      for(y=styr;y<=endyr;y++){
        for(a=1;a<=nages;a++){
           s2_pred_ac_index_paa(used_cnt,y,a)=0;
           if(wvtime==1)
s2_pred_ac_index_paa(used_cnt,y,a)=s2_ac_select_at_age(used_cnt,a)*mfexp(s2_log_q_ac(used_cnt))*s2_N(y,a)*mfexp(-
1.*wvfraction*s2_Z(wvtime,y,a));
           if(wvtime==2)
s2_pred_ac_index_paa(used_cnt,y,a)=s2_ac_select_at_age(used_cnt,a)*mfexp(s2_log_q_ac(used_cnt))*s2_Nwv23(y,a)*mfexp(-
1.*wvfraction*s2_Z(wvtime,y,a));
           if(wvtime==3)
s2_pred_ac_index_paa(used_cnt,y,a)=s2_ac_select_at_age(used_cnt,a)*mfexp(s2_log_q_ac(used_cnt))*s2_Nwv46(y,a)*mfexp(-
1.*wvfraction*s2_Z(wvtime,y,a));
        }//a loop
       }//y loop
   }
 }//t loop

 used_cnt=0;
 for(t=1;t<=s2_nac;t++){
   if(s2_use_ac(t)==1){
   //sum for index
    used_cnt+=1;
    for(y=styr;y<=endyr;y++){
       s2_pred_ac_index(y,used_cnt)=0;
       for(a=1;a<=nages;a++){
         if(t==1){
             if(s2_ac_index_paa(t,y,a)>=0) s2_pred_ac_index(y,used_cnt)+=s2_pred_ac_index_paa(used_cnt,y,a);
         }
         if(t==2){ //to calculate
            if(s2_ac_index(y,t)>=0) s2_pred_ac_index(y,used_cnt)+=s2_pred_ac_index_paa(used_cnt,y,a);
         }
       }
     }
     //convert to proportions at age
     for(y=styr;y<=endyr;y++)
s2_pred_ac_index_paa(used_cnt,y)=s2_pred_ac_index_paa(used_cnt,y)/sum(s2_pred_ac_index_paa(used_cnt,y));
   }
```

```
  }//if surveys>0
 }//if s2_nac_used>0

FUNCTION coast_predict_indices
 if(coast_nagg_used>0){
  //coast_q_agg=mfexp(coast_log_q_agg);
 //Checked 3/9/2018
  cnt=0;
  for(t=1;t<=coast_nagg;t++){
   if(coast_use_agg(t)==1){
    cnt+=1;
    adds=0;
    realage=0;
    diff2=0;
    wvtime=0;
    wvfraction=0;
    for(y=styr;y<=endyr;y++){
      if(coast_agg_index(y,t)>=0.){ //Skip missing values (-1)
                realage=(int)floor(coast_agg_ages(t));
                diff2=int(ceil(coast_agg_ages(t)*100)-(floor(coast_agg_ages(t))*100));
          wvtime=int(floor(coast_agg_time(t)*100)/100);
          wvfraction=coast_agg_time(t)-floor(coast_agg_time(t));
                pgroup=0;
                for(a=realage;a<=diff2;a++){
          if(wvtime==1) pgroup+=(s1_coast_N(y,a)+s2_N(y,a))*mfexp(-1.*wvfraction*coast_Z(wvtime,y,a));
          if(wvtime==2) pgroup+=(s1_coast_Nwv23(y,a)+s2_Nwv23(y,a))*mfexp(-1.*wvfraction*coast_Z(wvtime,y,a));
          if(wvtime==3) pgroup+=(s1_coast_Nwv46(y,a)+s2_Nwv46(y,a))*mfexp(-1.*wvfraction*coast_Z(wvtime,y,a));
          }
                 coast_pred_agg_index(y,cnt)=mfexp(coast_log_q_agg(cnt))*pgroup;
       }//agg_surv_indices>=0
       if(coast_agg_index(y,t)==-1) coast_pred_agg_index(y,cnt)=-1;
    }//y loop
   }
  }//t loop
 }
 //Checked 3/9/2018
 if(coast_nac_used>0){
   coast_q_ac=mfexp(coast_log_q_ac);
  cnt=0;cnt1=0;cnt2=0;cnt3=0;used_cnt=0;
  for(t=1;t<=coast_nac;t++){
   if(coast_use_ac(t)==1){
   used_cnt+=1;
    coast_max=0;
    for(a=1;a<=nages;a++){
    if(coast_ac_sel_type(t)==1){
        if(a==1) cnt+=1;
        coast_ac_select_at_age(used_cnt,a)=mfexp(-1.*mfexp(-1.*coast_ac_sel_gompertz_b(cnt)*(double(a)-coast_ac_sel_gompertz_a(cnt))));
        if(coast_ac_select_at_age(used_cnt,a)>=coast_max) coast_max=coast_ac_select_at_age(used_cnt,a);
     }
     if(coast_ac_sel_type(t)==2){
        if(a==1) cnt1+=1;
        coast_ac_select_at_age(used_cnt,a)=1./(1.+mfexp(-1.*coast_ac_sel_logistic_b(cnt1)*(double(a)-coast_ac_sel_logistic_a(cnt1))));
        if(coast_ac_select_at_age(used_cnt,a)>=coast_max) coast_max=coast_ac_select_at_age(used_cnt,a);
     }
      if(coast_ac_sel_type(t)==4){
        if(a==1) cnt2+=1;
        coast_ac_select_at_age(used_cnt,a)=pow(double(a),coast_ac_sel_gamma_a(cnt2))*mfexp(-1.*coast_ac_sel_gamma_b(cnt2)*double(a));
       if(coast_ac_select_at_age(used_cnt,a)>coast_max) coast_max=coast_ac_select_at_age(used_cnt,a);
     }
     if(coast_ac_sel_type(t)==3){
        if(a==1) cnt3+=1;
        coast_ac_select_at_age(used_cnt,a)=(1./(1.-coast_ac_sel_thompson_c(cnt3)))*pow((1-coast_ac_sel_thompson_c(cnt3))/

coast_ac_sel_thompson_c(cnt3),coast_ac_sel_thompson_c(cnt3))*(mfexp(coast_ac_sel_thompson_a(cnt3)*coast_ac_sel_thompson_c(cnt3)*(
coast_ac_sel_thompson_b(cnt3)-double(a)))/
           (1+mfexp(coast_ac_sel_thompson_a(cnt3)*(coast_ac_sel_thompson_b(cnt3)-double(a)))));
```

```
        if(coast_ac_select_at_age(used_cnt,a)>=coast_max) coast_max=coast_ac_select_at_age(used_cnt,a);
     }
    }//a
    coast_ac_select_at_age(used_cnt)=coast_ac_select_at_age(used_cnt)/coast_max;
   }
  }//t
 //Checked 2/27/2018
 //Calculate age comp surveys predicted age comps
  cnt=0;
  for(t=1;t<=coast_nac;t++){
    if(coast_use_ac(t)==1){
      cnt+=1;
      wvtime=int(floor(coast_ac_time(t)*100)/100);
      wvfraction=coast_ac_time(t)-floor(coast_ac_time(t));
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
        coast_pred_ac_index_paa(cnt,y,a)=0;
        if(wvtime==1)
coast_pred_ac_index_paa(cnt,y,a)=coast_ac_select_at_age(cnt,a)*mfexp(coast_log_q_ac(cnt))*(s1_coast_N(y,a)+s2_N(y,a))*mfexp(-
1.*wvfraction*coast_Z(wvtime,y,a));
        if(wvtime==2)
coast_pred_ac_index_paa(cnt,y,a)=coast_ac_select_at_age(cnt,a)*mfexp(coast_log_q_ac(cnt))*(s1_coast_Nwv23(y,a)+s2_Nwv23(y,a))*mfexp(
-1.*wvfraction*coast_Z(wvtime,y,a));
        if(wvtime==3)
coast_pred_ac_index_paa(cnt,y,a)=coast_ac_select_at_age(cnt,a)*mfexp(coast_log_q_ac(cnt))*(s1_coast_Nwv46(y,a)+s2_Nwv46(y,a))*mfexp(
-1.*wvfraction*coast_Z(wvtime,y,a));
      }//a loop
     }//y loop
    }
  }//t loop
  used_cnt=0;
  for(t=1;t<=coast_nac;t++){
    if(coast_use_ac(t)==1){
    used_cnt+=1;
    //sum for index
     for(y=styr;y<=endyr;y++){
       coast_pred_ac_index(y,used_cnt)=0;
        for(a=1;a<=nages;a++){
          if(coast_ac_index_paa(t,y,a)>=0) coast_pred_ac_index(y,used_cnt)+=coast_pred_ac_index_paa(used_cnt,y,a);
        }
      }
     for(y=styr;y<=endyr;y++)
coast_pred_ac_index_paa(used_cnt,y)=coast_pred_ac_index_paa(used_cnt,y)/sum(coast_pred_ac_index_paa(used_cnt,y));
   }
  }//if surveys>0
 }//if coast_nac>0

FUNCTION s1_likelihood
 cnt=0;
 //CALCULATE s1_bay_total_catch_like(nbaywaves)
  //Checked 3/9/2018
    s1_bay_total_catch_wgted_RSS=0;
    for(t=1;t<=substructure;t++){
     s1_bay_total_catch_RSS(t)=0.;
     for(y=styr;y<=endyr;y++){
      if(s1_bay_total_catch(y,t)>=0.){
       s1_bay_total_catch_RSS(t)+=square(log((s1_bay_total_catch(y,t)+0.00001)/
       (s1_bay_pred_total_catch(y,t)+0.00001))/s1_bay_total_catch_CV(y,t));
        cnt+=1;
      }
     }
   }
  for(t=1;t<=substructure;t++) s1_bay_total_catch_wgted_RSS+=s1_bay_total_catch_RSS(t)*s1_bay_total_catch_lambda_wgts(t);
  //Checked 3/9/2018
  s1_bay_catch_paa_wgted_like=0;
  for(t=1;t<=substructure;t++){
```

```
  s1_bay_catch_paa_like(t)=0.;
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(s1_bay_catch_paa(t,y,a)>=0.){
    s1_bay_catch_paa_like(t)-=s1_bay_catch_paa_ess(y,t)*s1_bay_catch_paa(t,y,a)*log(s1_bay_pred_catch_paa(t,y,a)+1e-7);
   }
  }
 }
}
for(t=1;t<=substructure;t++) s1_bay_catch_paa_wgted_like+=s1_bay_catch_paa_like(t)*s1_bay_catch_paa_lambda_wgts(t);
//Calculate aggregate survey //checked calculations 3/09/2018
 s1_bay_agg_index_wgted_RSS=0;
 used_cnt=0;
 if(s1_bay_nagg_used>0){
  for(t=1;t<=s1_bay_nagg;t++){
    if(s1_bay_use_agg(t)==1){
     used_cnt+=1;
     s1_bay_agg_index_RSS(used_cnt)=0;
    for(y=styr;y<=endyr;y++){
         if(s1_bay_agg_index(y,t)>=0.){
      s1_bay_agg_index_RSS(used_cnt)+=square(log((s1_bay_agg_index(y,t)+0.00001)/(s1_bay_pred_agg_index(y,used_cnt)+0.00001))/
       s1_bay_agg_index_CV(y,t));
         }
    }
   }
  }
 used_cnt=0;
 for(t=1;t<=s1_bay_nagg;t++){
  if(s1_bay_use_agg(t)==1){
    used_cnt+=1;
    s1_bay_agg_index_wgted_RSS+=s1_bay_agg_index_RSS(used_cnt)*s1_bay_agg_index_lambda_wgts(t);
  }
 }
}
// CALCULATE SURVEY WITH AGE COMPOSITIONS checked computation 3/09/2018
s1_bay_ac_index_wgted_RSS=0;
used_cnt=0;
if(s1_bay_nac_used>0){
 for(t=1;t<=s1_bay_nac;t++){
  if(s1_bay_use_ac(t)==1){
    used_cnt+=1;
    s1_bay_ac_index_RSS(used_cnt)=0;
    for(y=styr;y<=endyr;y++){
    if(s1_bay_ac_index(y,t)>=0.){
     s1_bay_ac_index_RSS(used_cnt)+=square(log((s1_bay_ac_index(y,t)+0.00001)/(s1_bay_pred_ac_index(y,used_cnt)+0.00001))/
      s1_bay_ac_index_CV(y,t));
        cnt+=1;
   }
   }
  }
 }
used_cnt=0;
for(t=1;t<=s1_bay_nac;t++){
  if(s1_bay_use_ac(t)==1){
   used_cnt+=1;
   s1_bay_ac_index_wgted_RSS+=s1_bay_ac_index_RSS(used_cnt)*s1_bay_ac_index_lambda_wgts(t);
  }
}
//checked computation 3/9/2018
s1_bay_ac_index_paa_wgted_like=0;used_cnt=0;
for(t=1;t<=s1_bay_nac;t++){
   if(s1_bay_use_ac(t)==1){
     used_cnt+=1;
     s1_bay_ac_index_paa_like(used_cnt)=0;
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
```

```
          if(s1_bay_ac_index_paa(t,y,a)>=0.){
           s1_bay_ac_index_paa_like(used_cnt)-=s1_bay_ac_index_paa_ess(y,t)*s1_bay_ac_index_paa(t,y,a)*
           log(s1_bay_pred_ac_index_paa(used_cnt,y,a)+1e-7);
          }
         }
       }
     }
   }
   used_cnt=0;
   for(t=1;t<=s1_bay_nac;t++){
       if(s1_bay_use_ac(t)==1){
       used_cnt+=1;
       s1_bay_ac_index_paa_wgted_like+=s1_bay_ac_index_paa_like(used_cnt)*s1_bay_ac_index_paa_lambda_wgts(t);
     }
   }
  }// used

FUNCTION s2_likelihood
 //checked 4/27/2018
  s2_agg_index_wgted_RSS=0;used_cnt=0;
  if(s2_nagg_used>0){
    for(t=1;t<=s2_nagg;t++){
      if(s2_use_agg(t)==1){
       used_cnt+=1;
       s2_agg_index_RSS(used_cnt)=0;
       for(y=styr;y<=endyr;y++){
                   if(s2_agg_index(y,t)>=0.){
            s2_agg_index_RSS(used_cnt)+=square(log((s2_agg_index(y,t)+0.00001)/(s2_pred_agg_index(y,used_cnt)+0.00001))/
              s2_agg_index_CV(y,t));
              cnt+=1;
                    }
       }
     }
    }
 used_cnt=0;
 for(t=1;t<=s2_nagg;t++){
  if(s2_use_agg(t)==1){
   used_cnt+=1;
   s2_agg_index_wgted_RSS+=s2_agg_index_RSS(used_cnt)*s2_agg_index_lambda_wgts(t);
  }
 }
 }//used
 // CALCULATE SURVEY WITH AGE COMPOSITIONS checked computation 4/27/2018
  s2_ac_index_wgted_RSS=0;used_cnt=0;
  if(s2_nac_used>0){
   for(t=1;t<=s2_nac;t++){
     if(s2_use_ac(t)==1){
      used_cnt+=1;
      s2_ac_index_RSS(used_cnt)=0;
      for(y=styr;y<=endyr;y++){
      if(s2_ac_index(y,t)>=0.){
        s2_ac_index_RSS(used_cnt)+=square(log((s2_ac_index(y,t)+0.00001)/(s2_pred_ac_index(y,used_cnt)+0.00001))/
        s2_ac_index_CV(y,t));
        cnt+=1;
      }
     }
    }
   }
  used_cnt=0;
  for(t=1;t<=s2_nac;t++){
    if(s2_use_ac(t)==1){
    used_cnt+=1;
    s2_ac_index_wgted_RSS+=s2_ac_index_RSS(used_cnt)*s2_ac_index_lambda_wgts(t);
    }
  }
  //checked computation 4/27/2018
```

```
 s2_ac_index_paa_wgted_like=0;used_cnt=0;
 for(t=1;t<=s2_nac;t++){
   if(s2_use_ac(t)==1){
    used_cnt+=1;
     s2_ac_index_paa_like(used_cnt)=0;
     for(y=styr;y<=endyr;y++){
        for(a=1;a<=nages;a++){
          if(s2_ac_index_paa(t,y,a)>=0.){
           s2_ac_index_paa_like(used_cnt)-=s2_ac_index_paa_ess(y,t)*s2_ac_index_paa(t,y,a)*
           log(s2_pred_ac_index_paa(used_cnt,y,a)+1e-7);
         }
        }
     }
   }
 }
 used_cnt=0;
 for(t=1;t<=s2_nac;t++){
  if(s2_use_ac(t)==1){
   used_cnt+=1;
  s2_ac_index_paa_wgted_like+=s2_ac_index_paa_like(used_cnt)*s2_ac_index_paa_lambda_wgts(t);
  }
 }
 }//used

FUNCTION coast_likelihood
  coast_total_catch_wgted_RSS=0;
  coast_catch_paa_wgted_like=0;
  //total catch
  if(ncoastwaves==substructure){ //cehcked 3/9/2018
     for(t=1;t<=substructure;t++){
      coast_total_catch_RSS(t)=0.;
      for(y=styr;y<=endyr;y++){
        if(coast_total_catch(y,t)>=0.){
         coast_total_catch_RSS(t)+=square(log((coast_total_catch(y,t)+0.00001)/
          ((s1_coast_pred_total_catch(y,t)+s2_pred_total_catch(y,t))
          +0.00001))/coast_total_catch_CV(y,t));
         coast_pred_total_catch(y,t)=s1_coast_pred_total_catch(y,t)+s2_pred_total_catch(y,t);
          cnt+=1;
     }
    }
   }
   for(t=1;t<=substructure;t++) coast_total_catch_wgted_RSS+=coast_total_catch_RSS(t)*coast_total_catch_lambda_wgts(t);
 //catch proprtions at age
   for(t=1;t<=substructure;t++){
     for(y=styr;y<=endyr;y++){
       for(a=1;a<=nages;a++) coast_pred_catch_caa(t,y,a)=(s1_coast_pred_catch_caa(t,y,a)+
          s2_pred_catch_caa(t,y,a));
     }
    }
    for(t=1;t<=substructure;t++){
     for(y=styr;y<=endyr;y++){
       coast_max=0;
       for(a=1;a<=nages;a++) coast_max+=coast_pred_catch_caa(t,y,a);//using coast_max as sum
       coast_pred_catch_paa(t,y)=coast_pred_catch_caa(t,y)/coast_max;
    }
   }
  //checked 3/9/2018
   for(t=1;t<=substructure;t++){
       coast_catch_paa_like(t)=0.;
       for(y=styr;y<=endyr;y++){
         for(a=1;a<=nages;a++){
           if(coast_catch_paa(t,y,a)>=0.){
            coast_catch_paa_like(t)-=coast_catch_paa_ess(y,t)*coast_catch_paa(t,y,a)*log(coast_pred_catch_paa(t,y,a)+1e-7);
          }
        }
      }
```

```
  }
  for(t=1;t<=substructure;t++) coast_catch_paa_wgted_like+=coast_catch_paa_like(t)*coast_catch_paa_lambda_wgts(t);
}//ncoastwaves==nbaywaves

if(ncoastwaves<substructure){//1 caa
      //Checked 4/27/2018
      for(y=styr;y<=endyr;y++){
        sumcatch=0.;
        for(t=1;t<=substructure;t++) sumcatch+=s1_coast_pred_total_catch(y,t)+s2_pred_total_catch(y,t);
          coast_pred_total_catch(y,ncoastwaves)=sumcatch;
      }
      coast_total_catch_RSS(ncoastwaves)=0.;
      coast_total_catch_wgted_RSS=0.;
      for(y=styr;y<=endyr;y++){
        if(coast_total_catch(y,ncoastwaves)>=0.){
          coast_total_catch_RSS(ncoastwaves)+=square(log((coast_total_catch(y,ncoastwaves)+0.00001)/
          (coast_pred_total_catch(y,ncoastwaves)+0.00001))/coast_total_catch_CV(y,ncoastwaves));
          cnt+=1;
        }
      }
      coast_total_catch_wgted_RSS+=coast_total_catch_RSS(ncoastwaves)*coast_total_catch_lambda_wgts(ncoastwaves);

  //Catch proportions at age
  //checked 4/27/2018
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
       sumcatch=0;
       for(t=1;t<=substructure;t++) sumcatch+=s1_coast_pred_catch_caa(t,y,a)+s2_pred_catch_caa(t,y,a);
       coast_pred_catch_caa(ncoastwaves,y,a)=sumcatch;
     }
    }

   for(y=styr;y<=endyr;y++){
     coast_max=0;
     for(a=1;a<=nages;a++) coast_max+=coast_pred_catch_caa(ncoastwaves,y,a);
      coast_pred_catch_paa(ncoastwaves,y)=coast_pred_catch_caa(ncoastwaves,y)/coast_max;
   }
   coast_catch_paa_like(ncoastwaves)=0.;
   coast_catch_paa_wgted_like=0.;
   for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
      if(coast_catch_paa(ncoastwaves,y,a)>=0.){
       coast_catch_paa_like(ncoastwaves)-=coast_catch_paa_ess(y,ncoastwaves)*coast_catch_paa(ncoastwaves,y,a)*
           log(coast_pred_catch_paa(ncoastwaves,y,a)+1e-7);
      }
     }
   }
  coast_catch_paa_wgted_like+=coast_catch_paa_like(ncoastwaves)*coast_catch_paa_lambda_wgts(ncoastwaves);
}//if ncoastwaves<nbaywaves
//Calculate aggregate survey checked 4/27/2018
  coast_agg_index_wgted_RSS=0;used_cnt=0;
  if(coast_nagg_used>0){
   for(t=1;t<=coast_nagg;t++){
     if(coast_use_agg(t)==1){
      used_cnt+=1;
      coast_agg_index_RSS(used_cnt)=0;
     for(y=styr;y<=endyr;y++){
                 if(coast_agg_index(y,t)>=0.){
          coast_agg_index_RSS(used_cnt)+=square(log((coast_agg_index(y,t)+0.00001)/(coast_pred_agg_index(y,used_cnt)+0.00001))/
             coast_agg_index_CV(y,t));
                   cnt+=1;
                 }
     }
    }
   }
 used_cnt=0;
```

```
 for(t=1;t<=coast_nagg;t++){
   if(coast_use_agg(t)==1){
      used_cnt+=1;
      coast_agg_index_wgted_RSS+=coast_agg_index_RSS(used_cnt)*coast_agg_index_lambda_wgts(t);
   }
 }
}
 // CALCULATE SURVEY WITH AGE COMPOSITIONS checked computation 4/27/2018
 coast_ac_index_wgted_RSS=0;used_cnt=0;
 if(coast_nac_used>0){
   for(t=1;t<=coast_nac;t++){
     if(coast_use_ac(t)==1){
     used_cnt+=1;
     coast_ac_index_RSS(used_cnt)=0;
     for(y=styr;y<=endyr;y++){
        if(coast_ac_index(y,t)>=0.){
          coast_ac_index_RSS(used_cnt)+=square(log((coast_ac_index(y,t)+0.00001)/(coast_pred_ac_index(y,used_cnt)+0.00001))/
          coast_ac_index_CV(y,t));
          cnt+=1;
        }
      }
    }
  }
  used_cnt=0;
  for(t=1;t<=coast_nac;t++){
    if(coast_use_ac(t)==1){
     used_cnt+=1;
       coast_ac_index_wgted_RSS+=coast_ac_index_RSS(used_cnt)*coast_ac_index_lambda_wgts(t);
   }
 }
 //checked computation 4/27/2018
 coast_ac_index_paa_wgted_like=0;used_cnt=0;
 for(t=1;t<=coast_nac;t++){
        if(coast_use_ac(t)==1){
          used_cnt+=1;
          coast_ac_index_paa_like(used_cnt)=0;
          for(y=styr;y<=endyr;y++){
            for(a=1;a<=nages;a++){
             if(coast_ac_index_paa(t,y,a)>=0.){
               coast_ac_index_paa_like(used_cnt)-=coast_ac_index_paa_ess(y,t)*coast_ac_index_paa(t,y,a)*
               log(coast_pred_ac_index_paa(used_cnt,y,a)+1e-7);
             }
           }
         }
       }
  }
 used_cnt=0;
   for(t=1;t<=coast_nac;t++){
     if(coast_use_ac(t)==1){
        used_cnt+=1;
       coast_ac_index_paa_wgted_like+=coast_ac_index_paa_like(used_cnt)*coast_ac_index_paa_lambda_wgts(t);
      }
    }
 }//used

FUNCTION fit_stock_composition
//checked 3/12/2018
 stock_comp_like=0;
 stock_comp_wgted_like=0;
 stock_comp_predicted=-1;
   for(y=styr;y<=endyr;y++){
    if(stock_comp_time==1){
      for(a=stock_comp_firstage;a<=stock_comp_lastage;a++){
        stock_comp_predicted(y,1)+=s1_coast_pred_catch_caa(1,y,a);
        stock_comp_predicted(y,2)+=s2_pred_catch_caa(1,y,a);
      }
```

```
    }
    if(stock_comp_time==2){
     for(a=stock_comp_firstage;a<=stock_comp_lastage;a++){
       stock_comp_predicted(y,1)+=s1_coast_pred_catch_caa(2,y,a);
       stock_comp_predicted(y,2)+=s2_pred_catch_caa(2,y,a);
     }
    }
    if(stock_comp_time==3){
     for(a=stock_comp_firstage;a<=stock_comp_lastage;a++){
      stock_comp_predicted(y,1)+=s1_coast_pred_catch_caa(3,y,a);
      stock_comp_predicted(y,2)+=s2_pred_catch_caa(3,y,a);
     }
   }
  }
  for(y=styr;y<=endyr;y++){
    adds=0;
    adds=stock_comp_predicted(y,1)+stock_comp_predicted(y,2);
    stock_comp_predicted(y,1)=stock_comp_predicted(y,1)/adds;
    stock_comp_predicted(y,2)=stock_comp_predicted(y,2)/adds;
  }
  for(y=styr;y<=endyr;y++){
        for(p=1;p<=2;p++){
          if(stock_composition(y,p)>=0.){
           stock_comp_like-=stock_comp_ess(y)*stock_composition(y,p)*log(stock_comp_predicted(y,p)+1e-7);
          }
       }
    }
  stock_comp_wgted_like=stock_comp_like*stock_comp_lambda_wgt;
FUNCTION mu_at_age
    s1_mu=0;
   for(t=1;t<=substructure;t++){
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){

s1_mu(y,a)=s1_mu(y,a)+s1_coast_pred_catch_paa(t,y,a)*s1_coast_pred_total_catch(y,t)+s1_bay_pred_catch_paa(t,y,a)*s1_bay_pred_total_c
atch(y,t);
     }
    }
   }
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
      s1_mu(y,a)=s1_mu(y,a)/(s1_bay_N(y,a)+s1_coast_N(y,a));
     }
     s1_mu_full(y)=max(s1_mu(y));
   }
   //S2
    s2_mu=0;
   for(t=1;t<=substructure;t++){
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
      s2_mu(y,a)=s2_mu(y,a)+s2_pred_catch_caa(t,y,a);
     }
    }
   }
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
      s2_mu(y,a)=s2_mu(y,a)/s2_N(y,a);
     }
     s2_mu_full(y)=max(s2_mu(y));
   }
   //Combined
    comb_mu=0;
   for(t=1;t<=substructure;t++){
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
      comb_mu(y,a)=comb_mu(y,a)+s2_pred_catch_caa(t,y,a)+s1_bay_pred_catch_caa(t,y,a)+s1_coast_pred_catch_caa(t,y,a);
```

```
    }
   }
  }
   for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     comb_mu(y,a)=comb_mu(y,a)/(s1_bay_N(y,a)+s1_coast_N(y,a)+s2_N(y,a));
    }
    comb_mu_full(y)=max(comb_mu(y));
  }

FUNCTION evaluate_the_objective_function
 f=0.;
 concll=0.5*cnt*log((s1_bay_total_catch_wgted_RSS+s1_bay_agg_index_wgted_RSS+
 s1_bay_ac_index_wgted_RSS+s2_agg_index_wgted_RSS+s2_ac_index_wgted_RSS+coast_total_catch_wgted_RSS+
 coast_agg_index_wgted_RSS+coast_ac_index_wgted_RSS)/cnt);
 f+=concll;
 f+=s1_bay_catch_paa_wgted_like+s1_bay_ac_index_paa_wgted_like+
     s2_ac_index_paa_wgted_like+coast_catch_paa_wgted_like+coast_ac_index_paa_wgted_like;
  if(use_stockcomp>0) f+=stock_comp_wgted_like;
      s1_recvar=0;s2_recvar=0;recpen=0;
 if(biascor==1){
   s1_recvar=norm2(s1_bay_log_Rdev(styr,endyr)-(sum(s1_bay_log_Rdev(styr,endyr))/(endyr-styr+1)))/(endyr-styr+1-1.0);
    s2_recvar=norm2(s2_log_Rdev(styr,endyr)-(sum(s2_log_Rdev(styr,endyr))/(endyr-styr+1)))/(endyr-styr+1-1.0);
   if(current_phase()==2) f+=norm2(s1_bay_log_Rdev)+norm2(s2_log_Rdev);
    if(current_phase()>2){
       for(y=styr;y<=endyr;y++){
         recpen+=s1_Rdev_lambda*(log(sqrt(s1_recvar))+square(s1_bay_log_Rdev(y))/2*s1_recvar);
         recpen+=s2_Rdev_lambda*(log(sqrt(s2_recvar))+square(s2_log_Rdev(y))/2*s2_recvar);
       }
      f+=recpen;
     }
  }
  if(biascor==0){
    f+=s1_Rdev_lambda*norm2(s1_bay_log_Rdev)+s2_Rdev_lambda*norm2(s2_log_Rdev);
  }
 //CALCULATE PENALTY CONSTRAINT FOR F
  fpen=0;
  if(current_phase()<3){
    fpen=10.*norm2(mfexp(coast_log_F)-0.15);
    fpen+=10.*norm2(mfexp(s1_bay_log_F)-0.15);
   }
   else{
    fpen=0.000000000001*norm2(mfexp(coast_log_F)-0.15);
    fpen+=0.000000000001*norm2(mfexp(s1_bay_log_F)-0.15);
   }
  f+=fpen;
REPORT_SECTION
    report<<"s1_bay_total_catch_wgted_RSS: "<<s1_bay_total_catch_wgted_RSS<<endl;
      report<<"coast_total_catch_wgted_RSS: "<<coast_total_catch_wgted_RSS<<endl;
    report<<"s1_bay_agg_index_catch_wgted_RSS: "<<s1_bay_agg_index_wgted_RSS<<endl;
      report<<"s2_agg_index_catch_wgted_RSS: "<<s2_agg_index_wgted_RSS<<endl;
    report<<"coast_agg_index_catch_wgted_RSS: "<<coast_agg_index_wgted_RSS<<endl;
    report<<"s1_bay_ac_index_catch_wgted_RSS: "<<s1_bay_ac_index_wgted_RSS<<endl;
      report<<"s2_ac_index_catch_wgted_RSS: "<<s2_ac_index_wgted_RSS<<endl;
    report<<"coast_ac_index_catch_wgted_RSS: "<<coast_ac_index_wgted_RSS<<endl;
    report<<"Concentrated_Likelihood: "<<0.5*cnt*log((s1_bay_total_catch_wgted_RSS+s1_bay_agg_index_wgted_RSS+
    s1_bay_ac_index_wgted_RSS+s2_agg_index_wgted_RSS+s2_ac_index_wgted_RSS+coast_total_catch_wgted_RSS+
    coast_agg_index_wgted_RSS+coast_ac_index_wgted_RSS)/cnt)<<endl;
   report<<"s1_bay_catch_paa_wgted_like: "<<s1_bay_catch_paa_wgted_like<<endl;
     report<<"coast_catch_paa_wgted_like: "<<coast_catch_paa_wgted_like<<endl;
   report<<"s1_bay_ac_index_paa_wgted_like: "<<s1_bay_ac_index_paa_wgted_like<<endl;
      report<<"s2_ac_index_paa_wgted_like: "<<s2_ac_index_paa_wgted_like<<endl;
   report<<"coast_ac_index_paa_wgted_like: "<<coast_ac_index_paa_wgted_like<<endl;
    if(use_stockcomp>0)report<<"stock_comp_wgted_like: "<<stock_comp_wgted_like<<endl;
    if(use_stockcomp>0) report<<"PAA_Total_Likelihood: "<<s1_bay_catch_paa_wgted_like+s1_bay_ac_index_paa_wgted_like+
     s2_ac_index_paa_wgted_like+coast_catch_paa_wgted_like+
```

```
      coast_ac_index_paa_wgted_like+stock_comp_wgted_like<<endl;
     if(use_stockcomp==0) report<<"PAA_Total_Likelihood: "<<s1_bay_catch_paa_wgted_like+s1_bay_ac_index_paa_wgted_like+
      s2_ac_index_paa_wgted_like+coast_catch_paa_wgted_like+
      coast_ac_index_paa_wgted_like<<endl;
     report<<"Total_Likelihood: "<<f<<endl;
     report<<"Number_parms: "<<n_parms<<endl;
     report<<"AIC: "<<2*f+2*n_parms<<endl;
FINAL_SECTION
    //Below will go in final section
     std::string u;
    u=dirnew + "\\R.out";
   const char* dir = u.c_str();
    ofstream ofs(dir);
    for(y=styr;y<=endyr;y++){
    ofs<<s1_bay_N(y,1)<<" "<<s2_N(y,1)<<endl;
    }
    ofs.close();

  u=dirnew + "\\s1_bay_N_p.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_N(y,a)<<" ";
    if(a==nages) ofs<<s1_bay_N(y,a)<<endl;
  }
 }
 ofs.close();


 u=dirnew + "\\s2_N_p.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s2_N(y,a)<<" ";
   if(a==nages) ofs<<s2_N(y,a)<<endl;
 }
 }
 ofs.close();

  u=dirnew + "\\s1_bay_N_p_female.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_N(y,a)*s1_bay_prop_female(1,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_N(y,a)*s1_bay_prop_female(1,y,a)<<endl;
  }
 }
  ofs.close();
  u=dirnew + "\\s1_bay_N_p_male.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_N(y,a)*(1.-s1_bay_prop_female(1,y,a))<<" ";
    if(a==nages) ofs<<s1_bay_N(y,a)*(1.-s1_bay_prop_female(1,y,a))<<endl;
  }
 }
  ofs.close();
  u=dirnew + "\\s1_bay_Nwv23_p.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
```

```
   if(a<nages) ofs<<s1_bay_Nwv23(y,a)+s1_coast_immigrants(y,a)<<" ";
   if(a==nages) ofs<<s1_bay_Nwv23(y,a)+s1_coast_immigrants(y,a)<<endl;
 }
}
ofs.close();
 u=dirnew + "\\s1_bay_migrants_caa.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_pred_migrants_catch_caa(y,a)<<" ";
   if(a==nages) ofs<<s1_bay_pred_migrants_catch_caa(y,a)<<endl;
 }
}
ofs.close();
 u=dirnew + "\\s1_bay_Nwv23_p_female.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_Nwv23(y,a)*s1_bay_prop_female(2,y,a)+s1_coast_immigrants_female(y,a)<<" ";
   if(a==nages) ofs<<s1_bay_Nwv23(y,a)*s1_bay_prop_female(2,y,a)+s1_coast_immigrants_female(y,a)<<endl;
 }
}
 ofs.close();
 u=dirnew + "\\s1_bay_Nwv23_p_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_Nwv23(y,a)*(1.-s1_bay_prop_female(2,y,a))+s1_coast_immigrants_male(y,a)<<" ";
   if(a==nages) ofs<<s1_bay_Nwv23(y,a)*(1.-s1_bay_prop_female(2,y,a))+s1_coast_immigrants_male(y,a)<<endl;
 }
}
 ofs.close();

u=dirnew + "\\s2_N_p_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_N(y,a)*s2_fem_sex(a)<<" ";
  if(a==nages) ofs<<s2_N(y,a)*s2_fem_sex(a)<<endl;
}
}
ofs.close();

 u=dirnew + "\\s2_N_p_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_N(y,a)*(1.-s2_fem_sex(a))<<" ";
  if(a==nages) ofs<<s2_N(y,a)*(1.-s2_fem_sex(a))<<endl;
  }
 }
ofs.close();

 u=dirnew + "\\s1_coast_N_p.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s1_coast_N(y,a)<<" ";
  if(a==nages) ofs<<s1_coast_N(y,a)<<endl;
  }
```

```
 }
 ofs.close();

  u=dirnew + "\\s1_coast_N_p_female.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s1_coast_N(y,a)*coast_prop_female(1,y,a)<<" ";
  if(a==nages) ofs<<s1_coast_N(y,a)*coast_prop_female(1,y,a)<<endl;
  }
 }
 ofs.close();

 ofs.close();
 u=dirnew + "\\s1_coast_N_p_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s1_coast_N(y,a)*(1.-coast_prop_female(1,y,a))<<" ";
  if(a==nages) ofs<<s1_coast_N(y,a)*(1.-coast_prop_female(1,y,a))<<endl;
  }
 }
 ofs.close();

 u=dirnew + "\\s1_bay_Nwv46_p_female.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_Nwv46(y,a)*s1_bay_prop_female(3,y,a)<<" ";
   if(a==nages) ofs<<s1_bay_Nwv46(y,a)*s1_bay_prop_female(3,y,a)<<endl;
 }
}
 ofs.close();
 u=dirnew + "\\s1_bay_Nwv46_p_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_Nwv46(y,a)*(1.-s1_bay_prop_female(3,y,a))<<" ";
   if(a==nages) ofs<<s1_bay_Nwv46(y,a)*(1.-s1_bay_prop_female(3,y,a))<<endl;
 }
}
 ofs.close();


 u=dirnew + "\\s2_Nwv23_p.out";
 dir = u.c_str();
 ofs.open(dir);
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_Nwv23(y,a)<<" ";
  if(a==nages) ofs<<s2_Nwv23(y,a)<<endl;
}
}
 ofs.close();
 u=dirnew + "\\s2_Nwv23_p_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_Nwv23(y,a)*s2_fem_sex(a)<<" ";
  if(a==nages) ofs<<s2_Nwv23(y,a)*s2_fem_sex(a)<<endl;
}
```

```
}
ofs.close();

 u=dirnew + "\\s2_Nwv23_p_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_Nwv23(y,a)*(1.-s2_fem_sex(a))<<" ";
  if(a==nages) ofs<<s2_Nwv23(y,a)*(1.-s2_fem_sex(a))<<endl;
  }
 }
ofs.close();
 u=dirnew + "\\s1_bay_Nwv46_p.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_Nwv46(y,a)<<" ";
   if(a==nages) ofs<<s1_bay_Nwv46(y,a)<<endl;
 }
}
ofs.close();

u=dirnew + "\\s2_Nwv46_p.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_Nwv46(y,a)<<" ";
  if(a==nages) ofs<<s2_Nwv46(y,a)<<endl;
}
}
ofs.close();

u=dirnew + "\\s2_Nwv46_p_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_Nwv46(y,a)*s2_fem_sex(a)<<" ";
  if(a==nages) ofs<<s2_Nwv46(y,a)*s2_fem_sex(a)<<endl;
}
}
ofs.close();

 u=dirnew + "\\s2_Nwv46_p_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_Nwv46(y,a)*(1.-s2_fem_sex(a))<<" ";
  if(a==nages) ofs<<s2_Nwv46(y,a)*(1.-s2_fem_sex(a))<<endl;
  }
 }
ofs.close();

 u=dirnew + "\\s1_coast_Nwv46_p.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s1_coast_Nwv46(y,a)<<" ";
  if(a==nages) ofs<<s1_coast_Nwv46(y,a)<<endl;
  }
 }
```

```
ofs.close();

u=dirnew + "\\s1_coast_Nwv46_p_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
 for(a=1;a<=nages;a++){
 if(a<nages) ofs<<s1_coast_Nwv46(y,a)*coast_prop_female(3,y,a)<<" ";
 if(a==nages) ofs<<s1_coast_Nwv46(y,a)*coast_prop_female(3,y,a)<<endl;
 }
}
ofs.close();

u=dirnew + "\\s1_coast_Nwv46_p_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
 for(a=1;a<=nages;a++){
 if(a<nages) ofs<<s1_coast_Nwv46(y,a)*(1.-coast_prop_female(3,y,a))<<" ";
 if(a==nages) ofs<<s1_coast_Nwv46(y,a)*(1.-coast_prop_female(3,y,a))<<endl;
 }
}
ofs.close();

u=dirnew + "\\s1_coast_Nwv23_p.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
 for(a=1;a<=nages;a++){
 if(a<nages) ofs<<s1_coast_Nwv23(y,a)<<" ";
 if(a==nages) ofs<<s1_coast_Nwv23(y,a)<<endl;
 }
}
ofs.close();

u=dirnew + "\\s1_coast_Nwv23_p_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
 for(a=1;a<=nages;a++){
 if(a<nages) ofs<<s1_coast_Nwv23(y,a)*coast_prop_female(2,y,a)<<" ";
 if(a==nages) ofs<<s1_coast_Nwv23(y,a)*coast_prop_female(2,y,a)<<endl;
 }
}
ofs.close();

u=dirnew + "\\s1_coast_Nwv23_p_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
 for(a=1;a<=nages;a++){
 if(a<nages) ofs<<s1_coast_Nwv23(y,a)*(1.-coast_prop_female(2,y,a))<<" ";
 if(a==nages) ofs<<s1_coast_Nwv23(y,a)*(1.-coast_prop_female(2,y,a))<<endl;
 }
}
ofs.close();

 u=dirnew + "\\s1_bay_F.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
 for(p=1;p<=substructure;p++){
  if(p<substructure) ofs<<mfexp(s1_bay_log_F(y,p))<<" ";
  if(p==substructure) ofs<<mfexp(s1_bay_log_F(y,p))<<endl;
 }
}
```

```
ofs.close();

 u=dirnew + "\\coast_F.out";
 dir = u.c_str();
 ofs.open(dir);
 for(y=styr;y<=endyr;y++){
  for(p=1;p<=ncoastwaves;p++){
   if(p<ncoastwaves) ofs<<mfexp(coast_log_F(y,p))<<" ";
   if(p==ncoastwaves) ofs<<mfexp(coast_log_F(y,p))<<endl;
 }
}
ofs.close();
  u=dirnew + "\\s1_femSSB.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s1_ssb(y,a)<<" ";
  if(a==nages) ofs<<s1_ssb(y,a)<<endl;
  }
 }
 ofs.close();

  u=dirnew + "\\s2_femSSB.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
  if(a<nages) ofs<<s2_ssb(y,a)<<" ";
  if(a==nages) ofs<<s2_ssb(y,a)<<endl;
  }
 }
 ofs.close();


//Aggregate indices qs
 if(s1_bay_nagg_used>0){
 u=dirnew + "\\s1_bay_agg_qs.out";
 dir = u.c_str();
 ofs.open(dir);
  used_cnt=0;
 for(y=1;y<=s1_bay_nagg;y++){
 if(s1_bay_use_agg(y)<=0) ofs<<"-99999"<<endl;
 if(s1_bay_use_agg(y)==1){
    used_cnt+=1;
   ofs<<mfexp(s1_bay_log_q_agg(used_cnt))<<endl;
  }
 }
 ofs.close();
 }
 if(s2_nagg_used>0){
  u=dirnew + "\\s2_agg_qs.out";
  dir = u.c_str();
  ofs.open(dir);
  used_cnt=0;
  for(y=1;y<=s2_nagg;y++){
   if(s2_use_agg(y)<=0) ofs<<"-99999"<<endl;
   if(s2_use_agg(y)==1){
    used_cnt+=1;
   ofs<<mfexp(s2_log_q_agg(used_cnt))<<endl;
   }
  }
  ofs.close();
 }

 if(coast_nagg_used>0){
```

```
 u=dirnew + "\\coast_agg_qs.out";
 dir = u.c_str();
 ofs.open(dir);
  used_cnt=0;
 for(y=1;y<=coast_nagg;y++){
   if(coast_use_agg(y)<=0) ofs<<"-99999"<<endl;
   if(coast_use_agg(y)==1){
    used_cnt+=1;
   ofs<<mfexp(coast_log_q_agg(y))<<endl;
  }
 }
 ofs.close();
 }
//Age Comp indices qs
if(s1_bay_nac_used>0){
 u=dirnew + "\\s1_bay_ac_qs.out";
 dir = u.c_str();
 ofs.open(dir);
 used_cnt=0;
  for(y=1;y<=s1_bay_nac;y++){
   if(s1_bay_use_ac(y)<=0) ofs<<"-99999"<<endl;
   if(s1_bay_use_ac(y)==1){
    used_cnt+=1;
    ofs<<mfexp(s1_bay_log_q_ac(used_cnt))<<endl;
   }
 }
 ofs.close();
}
if(s2_nac_used>0){
 u=dirnew + "\\s2_ac_qs.out";
 dir = u.c_str();
 ofs.open(dir);
   used_cnt=0;
   for(y=1;y<=s2_nac;y++){
   if(s2_use_ac(y)<=0) ofs<<"-99999"<<endl;
   if(s2_use_ac(y)==1){
     used_cnt+=1;
     ofs<<mfexp(s2_log_q_ac(used_cnt))<<endl;
   }
  }
 ofs.close();
 }
 if(coast_nac_used>0){
  u=dirnew + "\\coast_ac_qs.out";
 dir = u.c_str();
 ofs.open(dir);
 used_cnt=0;
 for(y=1;y<=coast_nac;y++){
   if(coast_use_ac(y)<=0) ofs<<"-99999"<<endl;
   if(coast_use_ac(y)==1){
    used_cnt+=1;
    ofs<<mfexp(coast_log_q_ac(used_cnt))<<endl;
   }
  }
 ofs.close();
 }
 if(s1_bay_nagg_used>0){
 u=dirnew + "\\s1_pred_agg_indices.out";
 dir = u.c_str();
 ofs.open(dir);
 for(y=styr;y<=endyr;y++){
    used_cnt=0;
   for(t=1;t<=s1_bay_nagg;t++){
     if(s1_bay_use_agg(t)==1){
       used_cnt+=1;
      if(t<s1_bay_nagg) ofs<<s1_bay_pred_agg_index(y,used_cnt)<<" ";
```

```
      if(t==s1_bay_nagg) ofs<<s1_bay_pred_agg_index(y,used_cnt)<<endl;
     }
     if(s1_bay_use_agg(t)<=0){
      if(t<s1_bay_nagg) ofs<<"-99999"<<" ";
      if(t==s1_bay_nagg) ofs<<"-99999"<<endl;
     }
   }
  }
  ofs.close();
 }
  if(s2_nagg_used>0){
  u=dirnew + "\\s2_pred_agg_indices.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
     used_cnt=0;
   for(t=1;t<=s2_nagg;t++){
     if(s2_use_agg(t)==1){
       used_cnt+=1;
      if(t<s2_nagg) ofs<<s2_pred_agg_index(y,used_cnt)<<" ";
      if(t==s2_nagg) ofs<<s2_pred_agg_index(y,used_cnt)<<endl;
     }
     if(s2_use_agg(t)<=0){
      if(t<s2_nagg) ofs<<"-99999"<<" ";
      if(t==s2_nagg) ofs<<"-99999"<<endl;
     }
   }
  }
  ofs.close();
  }
  if(coast_nagg_used>0){
  u=dirnew + "\\coast_pred_agg_indices.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
     used_cnt=0;
   for(t=1;t<=coast_nagg;t++){
     if(coast_use_agg(t)==1){
       used_cnt+=1;
      if(t<coast_nagg) ofs<<coast_pred_agg_index(y,used_cnt)<<" ";
      if(t==coast_nagg) ofs<<coast_pred_agg_index(y,used_cnt)<<endl;
     }
     if(coast_use_agg(t)<=0){
      if(t<coast_nagg) ofs<<"-99999"<<" ";
      if(t==coast_nagg) ofs<<"-99999"<<endl;
     }
   }
  }
  ofs.close();
  }
  if(s1_bay_nac_used>0){
  u=dirnew + "\\s1_bay_pred_ac_indices.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
     used_cnt=0;
   for(a=1;a<=s1_bay_nac;a++){
     if(s1_bay_use_ac(a)==1){
     used_cnt+=1;
      if(a<s1_bay_nac) ofs<<s1_bay_pred_ac_index(y,used_cnt)<<" ";
      if(a==s1_bay_nac) ofs<<s1_bay_pred_ac_index(y,used_cnt)<<endl;
     }
     if(s1_bay_use_ac(a)<=0){
      if(a<s1_bay_nac) ofs<<"-99999"<<" ";
      if(a==s1_bay_nac) ofs<<"-99999"<<endl;
     }
```

```
   }
  }
  ofs.close();
  }
  if(s2_nac_used>0){
  u=dirnew + "\\s2_pred_ac_indices.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
   used_cnt=0;
    for(a=1;a<=s2_nac;a++){
      if(s2_use_ac(a)==1){
       used_cnt+=1;
       if(a<s2_nac) ofs<<s2_pred_ac_index(y,used_cnt)<<" ";
       if(a==s2_nac) ofs<<s2_pred_ac_index(y,used_cnt)<<endl;
      }
      if(s2_use_ac(a)<=0){
       if(a<s2_nac) ofs<<"-99999"<<" ";
       if(a==s2_nac) ofs<<"-99999"<<endl;
      }
    }
  }
  ofs.close();
  }
  if(coast_nac_used>0){
  u=dirnew + "\\coast_pred_ac_indices.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
   used_cnt=0;
    for(a=1;a<=coast_nac;a++){
      if(coast_use_ac(a)==1){
       used_cnt+=1;
       if(a<coast_nac) ofs<<coast_pred_ac_index(y,used_cnt)<<" ";
       if(a==coast_nac) ofs<<coast_pred_ac_index(y,used_cnt)<<endl;
      }
      if(coast_use_ac(a)<=0){
       if(a<coast_nac) ofs<<"-99999"<<" ";
       if(a==coast_nac) ofs<<"-99999"<<endl;
      }
    }
  }
 ofs.close();
 }

  // Predicted Catches
  u=dirnew + "\\s1_bay_pred_total_catch.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<s1_bay_pred_total_catch<<endl;
  ofs.close();


  u=dirnew + "\\s1_coast_pred_total_catch.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<s1_coast_pred_total_catch<<endl;
  ofs.close();


  u=dirnew + "\\s2_pred_total_catch.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<s2_pred_total_catch<<endl;
  ofs.close();
```

```
u=dirnew + "\\coast_pred_total_catch.out";
dir = u.c_str();
ofs.open(dir);
ofs<<coast_pred_total_catch<<endl;
ofs.close();

u=dirnew + "\\s1_bay_pred_catch_caa1.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(1,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(1,y,a)<<endl;
   }
  }

ofs.close();
u=dirnew + "\\s1_bay_pred_catch_caa1_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(1,y,a)*s1_bay_prop_female(1,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(1,y,a)*s1_bay_prop_female(1,y,a)<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_bay_pred_catch_caa1_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(1,y,a)*(1.-s1_bay_prop_female(1,y,a))<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(1,y,a)*(1.-s1_bay_prop_female(1,y,a))<<endl;
   }
  }
ofs.close();


u=dirnew + "\\s1_bay_pred_catch_caa2.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(2,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(2,y,a)<<endl;
   }
  }
ofs.close();
u=dirnew + "\\s1_bay_pred_catch_caa2_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(2,y,a)*s1_bay_prop_female(2,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(2,y,a)*s1_bay_prop_female(2,y,a)<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_bay_pred_catch_caa2_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
```

```
    if(a<nages) ofs<<s1_bay_pred_catch_caa(2,y,a)*(1.-s1_bay_prop_female(2,y,a))<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(2,y,a)*(1.-s1_bay_prop_female(2,y,a))<<endl;
   }
  }
ofs.close();



u=dirnew + "\\s1_bay_pred_catch_caa3.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(3,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(3,y,a)<<endl;
   }
  }
ofs.close();
u=dirnew + "\\s1_bay_pred_catch_caa3_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(3,y,a)*s1_bay_prop_female(3,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(3,y,a)*s1_bay_prop_female(3,y,a)<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_bay_pred_catch_caa3_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_caa(3,y,a)*(1.-s1_bay_prop_female(3,y,a))<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_caa(3,y,a)*(1.-s1_bay_prop_female(3,y,a))<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_bay_pred_catch_paa.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++){
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_pred_catch_paa(t,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_pred_catch_paa(t,y,a)<<endl;
   }
  }
 }
ofs.close();

 u=dirnew + "\\s1_coast_pred_catch_paa.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++){
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_paa(t,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_paa(t,y,a)<<endl;
   }
  }
  }
ofs.close();
```

```
 u=dirnew + "\\s1_coast_pred_catch_caa1.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(1,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(1,y,a)<<endl;
   }
  }

ofs.close();
u=dirnew + "\\s1_coast_pred_catch_caa1_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(1,y,a)*coast_prop_female(1,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(1,y,a)*coast_prop_female(1,y,a)<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_coast_pred_catch_caa1_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(1,y,a)*(1.-coast_prop_female(1,y,a))<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(1,y,a)*(1.-coast_prop_female(1,y,a))<<endl;
   }
  }
ofs.close();


u=dirnew + "\\s1_coast_pred_catch_caa2.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(2,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(2,y,a)<<endl;
   }
  }
ofs.close();
u=dirnew + "\\s1_coast_pred_catch_caa2_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(2,y,a)*coast_prop_female(2,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(2,y,a)*coast_prop_female(2,y,a)<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_coast_pred_catch_caa2_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(2,y,a)*(1.-coast_prop_female(2,y,a))<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(2,y,a)*(1.-coast_prop_female(2,y,a))<<endl;
   }
  }
ofs.close();
```

```
u=dirnew + "\\s1_coast_pred_catch_caa3.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(3,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(3,y,a)<<endl;
   }
  }
ofs.close();
u=dirnew + "\\s1_coast_pred_catch_caa3_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(3,y,a)*coast_prop_female(3,y,a)<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(3,y,a)*coast_prop_female(3,y,a)<<endl;
   }
  }
ofs.close();

 u=dirnew + "\\s1_coast_pred_catch_caa3_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(3,y,a)*(1.-coast_prop_female(3,y,a))<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(3,y,a)*(1.-coast_prop_female(3,y,a))<<endl;
   }
  }
ofs.close();

u=dirnew + "\\s1_bay_Z_at_age.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++){
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_Z(t,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_Z(t,y,a)<<endl;
   }
  }
}
ofs.close();
u=dirnew + "\\s1_bay_F_at_age.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++){
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_bay_F(t,y,a)<<" ";
    if(a==nages) ofs<<s1_bay_F(t,y,a)<<endl;
   }
  }
}
ofs.close();

  u=dirnew + "\\s2_pred_catch_caa1.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(1,y,a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(1,y,a)<<endl;
```

```
   }
  }
 ofs.close();
  u=dirnew + "\\s2_pred_catch_caa2.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(2,y,a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(2,y,a)<<endl;
   }
  }
 ofs.close();
  u=dirnew + "\\s2_pred_catch_caa3.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(3,y,a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(3,y,a)<<endl;
   }
  }
 ofs.close();


 u=dirnew + "\\s2_pred_catch_caa1_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(1,y,a)*s2_fem_sex(a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(1,y,a)*s2_fem_sex(a)<<endl;
   }
  }
 ofs.close();
u=dirnew + "\\s2_pred_catch_caa2_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(2,y,a)*s2_fem_sex(a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(2,y,a)*s2_fem_sex(a)<<endl;
   }
  }
 ofs.close();
u=dirnew + "\\s2_pred_catch_caa3_female.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(3,y,a)*s2_fem_sex(a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(3,y,a)*s2_fem_sex(a)<<endl;
   }
  }
 ofs.close();



 u=dirnew + "\\s2_pred_catch_caa1_male.out";
dir = u.c_str();
ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(1,y,a)*(1.-s2_fem_sex(a))<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(1,y,a)*(1.-s2_fem_sex(a))<<endl;
   }
```

```
  }

 ofs.close();

  u=dirnew + "\\s2_pred_catch_caa2_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s2_pred_catch_caa(2,y,a)*(1.-s2_fem_sex(a))<<" ";
     if(a==nages) ofs<<s2_pred_catch_caa(2,y,a)*(1.-s2_fem_sex(a))<<endl;
    }
  }

 ofs.close();

  u=dirnew + "\\s2_pred_catch_caa3_male.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s2_pred_catch_caa(3,y,a)*(1.-s2_fem_sex(a))<<" ";
     if(a==nages) ofs<<s2_pred_catch_caa(3,y,a)*(1.-s2_fem_sex(a))<<endl;
    }
  }
 ofs.close();


 u=dirnew + "\\coast_pred_catch_paa.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=ncoastwaves;t++){
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<coast_pred_catch_paa(t,y,a)<<" ";
     if(a==nages) ofs<<coast_pred_catch_paa(t,y,a)<<endl;
    }
  }
 }
 ofs.close();


 u=dirnew + "\\s1_coast_pred_catch_caa.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s1_coast_pred_catch_caa(t,y,a)<<" ";
     if(a==nages) ofs<<s1_coast_pred_catch_caa(t,y,a)<<endl;
    }
  }
 }
 ofs.close();

 u=dirnew + "\\s1_coast_pred_catch_caa_female.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s1_coast_pred_catch_caa(t,y,a)*coast_prop_female(t,y,a)<<" ";
     if(a==nages) ofs<<s1_coast_pred_catch_caa(t,y,a)*coast_prop_female(t,y,a)<<endl;
    }
  }
 }
```

```
 ofs.close();

 u=dirnew + "\\s1_coast_pred_catch_caa_male.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s1_coast_pred_catch_caa(t,y,a)*(1.-coast_prop_female(t,y,a))<<" ";
    if(a==nages) ofs<<s1_coast_pred_catch_caa(t,y,a)*(1.-coast_prop_female(t,y,a))<<endl;
   }
  }
 }
 ofs.close();


 u=dirnew + "\\s2_pred_catch_caa.out";
 dir = u.c_str();
 ofs.open(dir);
for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(t,y,a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(t,y,a)<<endl;
   }
  }
 }
 ofs.close();

 u=dirnew + "\\s2_pred_catch_caa_female.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(t,y,a)*s2_fem_sex(a)<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(t,y,a)*s2_fem_sex(a)<<endl;
   }
  }
 }
 ofs.close();
 u=dirnew + "\\s2_pred_catch_caa_male.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<s2_pred_catch_caa(t,y,a)*(1.-s2_fem_sex(a))<<" ";
    if(a==nages) ofs<<s2_pred_catch_caa(t,y,a)*(1.-s2_fem_sex(a))<<endl;
   }
  }
 }
ofs.close();
if(s1_bay_nac_used>0){
 u=dirnew + "\\s1_bay_pred_ac_index_paa.out";
 dir = u.c_str();
 ofs.open(dir);
 used_cnt=0;
 for(t=1;t<=s1_bay_nac;t++){
   if(s1_bay_use_ac(t)==1) used_cnt+=1;
      for(y=styr;y<=endyr;y++){
       for(a=1;a<=nages;a++){
        if(s1_bay_use_ac(t)==1){
          if(a<nages) ofs<<s1_bay_pred_ac_index_paa(used_cnt,y,a)<<" ";
          if(a==nages) ofs<<s1_bay_pred_ac_index_paa(used_cnt,y,a)<<endl;
        }
```

```
       if(s1_bay_use_ac(t)<=0){
        if(a<nages) ofs<<"-99999"<<" ";
        if(a==nages) ofs<<"-99999"<<endl;
       }
      }
     }
}
ofs.close();
}
if(s2_nac_used>0){
u=dirnew + "\\s2_pred_ac_index_paa.out";
dir = u.c_str();
ofs.open(dir);
  used_cnt=0;
  for(t=1;t<=s2_nac;t++){
   if(s2_use_ac(t)==1) used_cnt+=1;
      for(y=styr;y<=endyr;y++){
       for(a=1;a<=nages;a++){
        if(s2_use_ac(t)==1){
          if(a<nages) ofs<<s2_pred_ac_index_paa(used_cnt,y,a)<<" ";
          if(a==nages) ofs<<s2_pred_ac_index_paa(used_cnt,y,a)<<endl;
        }
       if(s2_use_ac(t)<=0){
        if(a<nages) ofs<<"-99999"<<" ";
        if(a==nages) ofs<<"-99999"<<endl;
       }
      }
     }
}
ofs.close();
}
if(coast_nac_used>0){
u=dirnew + "\\coast_pred_ac_index_paa.out";
dir = u.c_str();
ofs.open(dir);
 used_cnt=0;
for(t=1;t<=coast_nac;t++){
   if(coast_use_ac(t)==1) used_cnt+=1;
      for(y=styr;y<=endyr;y++){
       for(a=1;a<=nages;a++){
        if(coast_use_ac(t)==1){
          if(a<nages) ofs<<coast_pred_ac_index_paa(used_cnt,y,a)<<" ";
          if(a==nages) ofs<<coast_pred_ac_index_paa(used_cnt,y,a)<<endl;
        }
       if(coast_use_ac(t)<=0){
        if(a<nages) ofs<<"-99999"<<" ";
        if(a==nages) ofs<<"-99999"<<endl;
       }
      }
     }
} ofs.close();
}

u=dirnew + "\\s1_bay_select_at_age.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++){
 for(y=styr;y<=endyr;y++){
  for(a=1;a<=nages;a++){
   if(a<nages) ofs<<s1_bay_select_at_age(t,y,a)<<" ";
   if(a==nages) ofs<<s1_bay_select_at_age(t,y,a)<<endl;
   }
  }
 }
ofs.close();
```

```
u=dirnew + "\\coast_select_at_age.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=ncoastwaves;t++){
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<coast_select_at_age(t,y,a)<<" ";
    if(a==nages) ofs<<coast_select_at_age(t,y,a)<<endl;
   }
  }
}
ofs.close();

if(s1_bay_nac_used>0){
 u=dirnew + "\\s1_bay_ac_select_at_age.out";
dir = u.c_str();
ofs.open(dir);
   used_cnt=0;
 for(t=1;t<=s1_bay_nac;t++){
   if(s1_bay_use_ac(t)==1) used_cnt+=1;
   for(a=1;a<=nages;a++){
    if(s1_bay_use_ac(t)==1){
      if(a<nages) ofs<<s1_bay_ac_select_at_age(used_cnt,a)<<" ";
      if(a==nages) ofs<<s1_bay_ac_select_at_age(used_cnt,a)<<endl;
    }
    if(s1_bay_use_ac(t)<=0){
      if(a<nages) ofs<<"-99999"<<" ";
      if(a==nages) ofs<<"-99999"<<endl;
    }
  }
 }
 ofs.close();
 }
if(s2_nac_used>0){
 u=dirnew + "\\s2_ac_select_at_age.out";
dir = u.c_str();
ofs.open(dir);
  used_cnt=0;
 for(t=1;t<=s2_nac;t++){
  if(s2_use_ac(t)==1) used_cnt+=1;
   for(a=1;a<=nages;a++){
    if(s2_use_ac(t)==1){
      if(a<nages) ofs<<s2_ac_select_at_age(used_cnt,a)<<" ";
      if(a==nages) ofs<<s2_ac_select_at_age(used_cnt,a)<<endl;
    }
    if(s2_use_ac(t)<=0){
      if(a<nages) ofs<<"-99999"<<" ";
      if(a==nages) ofs<<"-99999"<<endl;
    }
  }
 }
ofs.close();
}
if(coast_nac_used>0){
u=dirnew + "\\coast_ac_select_at_age.out";
dir = u.c_str();
ofs.open(dir);
  used_cnt=0;
 for(t=1;t<=coast_nac;t++){
  if(coast_use_ac(t)==1) used_cnt+=1;
   for(a=1;a<=nages;a++){
    if(coast_use_ac(t)==1){
      if(a<nages) ofs<<coast_ac_select_at_age(used_cnt,a)<<" ";
      if(a==nages) ofs<<coast_ac_select_at_age(used_cnt,a)<<endl;
    }
    if(coast_use_ac(t)<=0){
```

```
      if(a<nages) ofs<<"-99999"<<" ";
      if(a==nages) ofs<<"-99999"<<endl;
    }
  }
 }
 ofs.close();
 }
 u=dirnew + "\\stock_composition_predicted.out";
 dir = u.c_str();
 ofs.open(dir);
 for(y=styr;y<=endyr;y++){
    ofs<<stock_comp_predicted(y)<<endl;
  }
 ofs.close();

//############### Residuals ####################
 //*********************************************************************************************
 // Compute Standardized Residuals for Total Catch
//*********************************************************************************************
 //----------------------------Stock 1-------------------------------

  for(t=1;t<=substructure;t++){
   sumdo=0;
  for(y=styr;y<=endyr;y++){
       if(s1_bay_total_catch(y,t)<0.) s1_bay_total_catch_resid(y,t)=0;
       if(s1_bay_total_catch(y,t)>=0.){
          s1_bay_total_catch_resid(y,t)=log(s1_bay_total_catch(y,t)+1e-5)-log(s1_bay_pred_total_catch(y,t)+1e-5);
          sumdo+=1;
        }
    }
//Calculate standardized residuals
 for(y=styr;y<=endyr;y++){
       if(s1_bay_total_catch(y,t)>=0.){
          s1_bay_total_catch_std_resid(y,t)=s1_bay_total_catch_resid(y,t)/sqrt(log(square(s1_bay_total_catch_CV(y,t)+1)));
         }
        if(s1_bay_total_catch(y,t)<0.) s1_bay_total_catch_std_resid(y,t)=-99999.0;
  }
// Calculate RMSE
  adds=0;
  for(y=styr;y<=endyr;y++){
    if(s1_bay_total_catch(y,t)>=0.) adds+=square(s1_bay_total_catch_std_resid(y,t));
    }
   s1_bay_total_catch_RMSE(t)=sqrt(adds/sumdo);
  }//t

   u=dirnew +"\\S1_total_catch_RMSE.out";
   dir = u.c_str();
   ofs.open(dir);
    for(t=1;t<=substructure;t++) ofs<<s1_bay_total_catch_RMSE(t)<<endl;
    ofs.close();

   u=dirnew +"\\S1_total_catch_std_resid.out";
   dir = u.c_str();
   ofs.open(dir);
    for(y=styr;y<=endyr;y++){
      for(t=1;t<=substructure;t++){
       if(t<substructure) ofs<<s1_bay_total_catch_std_resid(y,t)<<" ";
       if(t==substructure) ofs<<s1_bay_total_catch_std_resid(y,t)<<endl;
      }
    }
     ofs.close();

      //----------------------------Coast-------------------------------
   for(t=1;t<=ncoastwaves;t++){
    sumdo=0;
    for(y=styr;y<=endyr;y++){
```

```
      if(coast_total_catch(y,t)<0.) coast_total_catch_resid(y,t)=0;
      if(coast_total_catch(y,t)>=0.){
        coast_total_catch_resid(y,t)=log(coast_total_catch(y,t)+1e-5)-log(coast_pred_total_catch(y,t)+1e-5);
        sumdo+=1;
       }
   }
  //Calculate standardized residuals
  for(y=styr;y<=endyr;y++){
      if(coast_total_catch(y,t)>=0.){
        coast_total_catch_std_resid(y,t)=coast_total_catch_resid(y,t)/sqrt(log(square(coast_total_catch_CV(y,t)+1)));
       }
       if(coast_total_catch(y,t)<0.) coast_total_catch_std_resid(y,t)=-99999.0;
  }
 // Calculate RMSE
  adds=0;
  for(y=styr;y<=endyr;y++){
    if(coast_total_catch(y,t)>=0.) adds+=square(coast_total_catch_std_resid(y,t));
   }
   coast_total_catch_RMSE(t)=sqrt(adds/sumdo);
 }//t

   u=dirnew +"\\Coast_total_catch_RMSE.out";
   dir = u.c_str();
   ofs.open(dir);
    for(t=1;t<=ncoastwaves;t++) ofs<<coast_total_catch_RMSE(t)<<endl;
    ofs.close();

   u=dirnew +"\\Coast_total_catch_std_resid.out";
   dir = u.c_str();
   ofs.open(dir);
    for(y=styr;y<=endyr;y++){
      for(t=1;t<=ncoastwaves;t++){
       if(t<ncoastwaves) ofs<<coast_total_catch_std_resid(y,t)<<" ";
       if(t==ncoastwaves) ofs<<coast_total_catch_std_resid(y,t)<<endl;
      }
    }
     ofs.close();

 //############### Residuals #####################
 //**************************************************************************************************
 // Compute Standardized Residuals for Aggregate indices
//**************************************************************************************************
 //----------------------------Stock 1-------------------------------
 if(s1_bay_nagg_used>0){
  used_cnt=0;
  for(t=1;t<=s1_bay_nagg;t++){
   if(s1_bay_use_agg(t)==1){
     used_cnt+=1;
     sumdo=0;
     for(y=styr;y<=endyr;y++){
      if(s1_bay_agg_index(y,t)<0.) s1_bay_resid_agg(y,used_cnt)=0;
      if(s1_bay_agg_index(y,t)>=0.){
        s1_bay_resid_agg(y,used_cnt)=log(s1_bay_agg_index(y,t)+1e-5)-log(s1_bay_pred_agg_index(y,used_cnt)+1e-5);
        sumdo+=1;
       }
    }
 //Calculate standardized residuals
    for(y=styr;y<=endyr;y++){
      if(s1_bay_agg_index(y,t)>=0.){
        s1_bay_std_resid_agg(y,used_cnt)=s1_bay_resid_agg(y,used_cnt)/sqrt(log(square(s1_bay_agg_index_CV(y,t)+1)));
       }
       if(s1_bay_agg_index(y,t)<0.) s1_bay_std_resid_agg(y,used_cnt)=-99999.0;
  }
// Calculate RMSE
  adds=0;
  for(y=styr;y<=endyr;y++){
```

```
    if(s1_bay_agg_index(y,t)>=0.) adds+=square(s1_bay_std_resid_agg(y,used_cnt));
    }
  s1_bay_RMSE_agg(used_cnt)=sqrt(adds/sumdo);
 }
}

  u=dirnew +"\\S1_RMSE_agg.out";
   dir = u.c_str();
   ofs.open(dir);
    used_cnt=0;
    for(t=1;t<=s1_bay_nagg;t++){
     if(s1_bay_use_agg(t)==1){
       used_cnt+=1;
       ofs<<s1_bay_RMSE_agg(used_cnt)<<endl;
     }
     if(s1_bay_use_agg(t)<=0) ofs<<"-99999"<<endl;
    }
    ofs.close();

   u=dirnew +"\\S1_std_resid_agg.out";
   dir = u.c_str();
   ofs.open(dir);
    for(y=styr;y<=endyr;y++){
     used_cnt=0;
      for(t=1;t<=s1_bay_nagg;t++){
        if(s1_bay_use_agg(t)==1){
         used_cnt+=1;
         if(t<s1_bay_nagg) ofs<<s1_bay_std_resid_agg(y,used_cnt)<<" ";
         if(t==s1_bay_nagg) ofs<<s1_bay_std_resid_agg(y,used_cnt)<<endl;
        }
        if(s1_bay_use_agg(t)<=0){
         if(t<s1_bay_nagg) ofs<<"-99999"<<" ";
         if(t==s1_bay_nagg) ofs<<"-99999"<<endl;
        }
     }
   }
     ofs.close();
}//indices used


 //----------------------------  Stock 2 ------------------------------
 if(s2_nagg_used>0){
   used_cnt=0;
    for(t=1;t<=s2_nagg;t++){
     if(s2_use_agg(t)==1){
     used_cnt+=1;
     sumdo=0;
     for(y=styr;y<=endyr;y++){
        if(s2_agg_index(y,t)<0.) s2_resid_agg(y,used_cnt)=0;
        if(s2_agg_index(y,t)>=0.){
           s2_resid_agg(y,used_cnt)=log(s2_agg_index(y,t)+1e-5)-log(s2_pred_agg_index(y,used_cnt)+1e-5);
           sumdo+=1;
         }
     }
    //Calculate standardized residuals
    for(y=styr;y<=endyr;y++){
        if(s2_agg_index(y,t)>=0.){
           s2_std_resid_agg(y,used_cnt)=s2_resid_agg(y,used_cnt)/sqrt(log(square(s2_agg_index_CV(y,t)+1)));
          }
         if(s2_agg_index(y,t)<0.) s2_std_resid_agg(y,used_cnt)=-99999.0;
  }
  // Calculate RMSE
  adds=0;
  for(y=styr;y<=endyr;y++){
    if(s2_agg_index(y,t)>=0.) adds+=square(s2_std_resid_agg(y,used_cnt));
    }
```

```
 s2_RMSE_agg(used_cnt)=sqrt(adds/sumdo);
 }
}
 u=dirnew +"\\S2_RMSE_agg.out";
  dir = u.c_str();
  ofs.open(dir);
   used_cnt=0;
   for(t=1;t<=s2_nagg;t++){
    if(s2_use_agg(t)==1){
      used_cnt+=1;
      ofs<<s2_RMSE_agg(used_cnt)<<endl;
    }
    if(s2_use_agg(t)<=0) ofs<<"-99999"<<endl;
   }
   ofs.close();

  u=dirnew +"\\S2_std_resid_agg.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
     used_cnt=0;
     for(t=1;t<=s2_nagg;t++){
       if(s2_use_agg(t)==1){
        used_cnt+=1;
        if(t<s2_nagg) ofs<<s2_std_resid_agg(y,used_cnt)<<" ";
        if(t==s2_nagg) ofs<<s2_std_resid_agg(y,used_cnt)<<endl;
       }
       if(s2_use_agg(t)<=0){
        if(t<s2_nagg) ofs<<"-99999"<<" ";
        if(t==s2_nagg) ofs<<"-99999"<<endl;
       }
   }
  }
    ofs.close();
}//any indices used

//----------------------------  Coast ------------------------------
 if(coast_nagg_used>0){
  used_cnt=0;
  for(t=1;t<=coast_nagg;t++){
   if(coast_use_agg(t)==1){
   used_cnt+=1;
   sumdo=0;
 for(y=styr;y<=endyr;y++){
       if(coast_agg_index(y,t)<0.) coast_resid_agg(y,used_cnt)=0;
       if(coast_agg_index(y,t)>=0.){
          coast_resid_agg(y,used_cnt)=log(coast_agg_index(y,t)+1e-5)-log(coast_pred_agg_index(y,used_cnt)+1e-5);
          sumdo+=1;
        }
   }
 //Calculate standardized residuals
   for(y=styr;y<=endyr;y++){
       if(coast_agg_index(y,t)>=0.){
          coast_std_resid_agg(y,used_cnt)=coast_resid_agg(y,used_cnt)/sqrt(log(square(coast_agg_index_CV(y,t)+1)));
         }
        if(coast_agg_index(y,t)<0.) coast_std_resid_agg(y,used_cnt)=-99999.0;
    }
 // Calculate RMSE
   adds=0;
   for(y=styr;y<=endyr;y++){
    if(coast_agg_index(y,t)>=0.) adds+=square(coast_std_resid_agg(y,used_cnt));
   }
   coast_RMSE_agg(used_cnt)=sqrt(adds/sumdo);
  }
 }
 u=dirnew +"\\Coast_RMSE_agg.out";
```

```
   dir = u.c_str();
   ofs.open(dir);
    used_cnt=0;
    for(t=1;t<=coast_nagg;t++){
     if(coast_use_agg(t)==1){
       used_cnt+=1;
       ofs<<coast_RMSE_agg(used_cnt)<<endl;
     }
     if(coast_use_agg(t)<=0) ofs<<"-99999"<<endl;
    }
    ofs.close();

   u=dirnew +"\\Coast_std_resid_agg.out";
   dir = u.c_str();
   ofs.open(dir);

    for(y=styr;y<=endyr;y++){
       used_cnt=0;
      for(t=1;t<=coast_nagg;t++){
        if(coast_use_agg(t)==1){
         used_cnt+=1;
         if(t<coast_nagg) ofs<<coast_std_resid_agg(y,used_cnt)<<" ";
         if(t==coast_nagg) ofs<<coast_std_resid_agg(y,used_cnt)<<endl;
        }
        if(coast_use_agg(t)<=0){
         if(t<coast_nagg) ofs<<"-99999"<<" ";
         if(t==coast_nagg) ofs<<"-99999"<<endl;
        }

    }
   }
     ofs.close();
}//any indices used

 //**************************************************************************************************
 // Compute Standardized Residuals for AC Surveys indices
 //**************************************************************************************************
 //------------------------ Stock 1----------------------------------
 if(s1_bay_nac_used>0){
  used_cnt=0;
  for(t=1;t<=s1_bay_nac;t++){
   if(s1_bay_use_ac(t)==1){
   sumdo=0;used_cnt+=1;
   for(y=styr;y<=endyr;y++){
        if(s1_bay_ac_index(y,t)<0.) s1_bay_resid_ac(y,used_cnt)=0;
        if(s1_bay_ac_index(y,t)>=0.){
          s1_bay_resid_ac(y,used_cnt)=log(s1_bay_ac_index(y,t)+1e-5)-log(s1_bay_pred_ac_index(y,used_cnt)+1e-5);
          sumdo+=1;
         }
    }
//Calculate standardized residuals
    for(y=styr;y<=endyr;y++){
        if(s1_bay_ac_index(y,t)>=0.){
          s1_bay_std_resid_ac(y,used_cnt)=s1_bay_resid_ac(y,used_cnt)/sqrt(log(square(s1_bay_ac_index_CV(y,t)+1)));
         }
         if(s1_bay_ac_index(y,t)<0.) s1_bay_std_resid_ac(y,used_cnt)=-99999.0;
    }
// Calculate RMSE
    adds=0;
   for(y=styr;y<=endyr;y++){
     if(s1_bay_ac_index(y,used_cnt)>=0.) adds+=square(s1_bay_std_resid_ac(y,used_cnt));
     }
   s1_bay_RMSE_ac(used_cnt)=sqrt(adds/sumdo);
 }
}
```

```
  u=dirnew +"\\S1_RMSE_ac.out";
   dir = u.c_str();
   ofs.open(dir);
    used_cnt=0;
    for(t=1;t<=s1_bay_nac;t++){
     if(s1_bay_use_ac(t)==1){
       used_cnt+=1;
       ofs<<s1_bay_RMSE_ac(used_cnt)<<endl;
     }
     if(s1_bay_use_ac(t)<=0) ofs<<"-99999"<<endl;
    }
    ofs.close();

    u=dirnew +"\\S1_std_resid_ac.out";
    dir = u.c_str();
    ofs.open(dir);
    for(y=styr;y<=endyr;y++){
         used_cnt=0;
      for(t=1;t<=s1_bay_nac;t++){
        if(s1_bay_use_ac(t)==1){
          used_cnt+=1;
          if(t<s1_bay_nac) ofs<<s1_bay_std_resid_ac(y,used_cnt)<<" ";
          if(t==s1_bay_nac) ofs<<s1_bay_std_resid_ac(y,used_cnt)<<endl;
       }
        if(s1_bay_use_ac(t)<=0){
          if(t<s1_bay_nac) ofs<<"-99999"<<" ";
          if(t==s1_bay_nac) ofs<<"-99999"<<endl;
       }
    }
   }
     ofs.close();
  }//any indicies used



 //----------------------- Stock 2----------------------------------
if(s2_nac_used>0){
 used_cnt=0;
 for(t=1;t<=s2_nac;t++){
  if(s2_use_ac(t)==1){
   used_cnt+=1;
  sumdo=0;
  for(y=styr;y<=endyr;y++){
        if(s2_ac_index(y,t)<0.) s2_resid_ac(y,used_cnt)=0;
        if(s2_ac_index(y,t)>=0.){
           s2_resid_ac(y,used_cnt)=log(s2_ac_index(y,t)+1e-5)-log(s2_pred_ac_index(y,used_cnt)+1e-5);
           sumdo+=1;
         }
    }
//Calculate standardized residuals
    for(y=styr;y<=endyr;y++){
       if(s2_ac_index(y,t)>=0.){
           s2_std_resid_ac(y,used_cnt)=s2_resid_ac(y,used_cnt)/sqrt(log(square(s2_ac_index_CV(y,t)+1)));
          }
         if(s2_ac_index(y,t)<0.) s2_std_resid_ac(y,used_cnt)=-99999.0;
   }
// Calculate RMSE
   adds=0;
  for(y=styr;y<=endyr;y++){
   if(s2_ac_index(y,t)>=0.) adds+=square(s2_std_resid_ac(y,used_cnt));
    }
  s2_RMSE_ac(used_cnt)=sqrt(adds/sumdo);
  }
 }
    u=dirnew +"\\S2_RMSE_ac.out";
   dir = u.c_str();
```

```
    ofs.open(dir);
     used_cnt=0;
     for(t=1;t<=s2_nac;t++){
      if(s2_use_ac(t)==1){
        used_cnt+=1;
        ofs<<s2_RMSE_ac(used_cnt)<<endl;
      }
      if(s2_use_ac(t)<=0) ofs<<"-99999"<<endl;
     }
     ofs.close();

     u=dirnew +"\\S2_std_resid_ac.out";
     dir = u.c_str();
     ofs.open(dir);
     for(y=styr;y<=endyr;y++){
         used_cnt=0;
       for(t=1;t<=s2_nac;t++){
         if(s2_use_ac(t)==1){
           used_cnt+=1;
           if(t<s2_nac) ofs<<s2_std_resid_ac(y,used_cnt)<<" ";
           if(t==s2_nac) ofs<<s2_std_resid_ac(y,used_cnt)<<endl;
        }
         if(s2_use_ac(t)<=0){
           if(t<s2_nac) ofs<<"-99999"<<" ";
           if(t==s2_nac) ofs<<"-99999"<<endl;
        }
     }
    }
      ofs.close();
 }//any indicies used

 //------------------------ Coast-----------------------------------
 if(coast_nac_used>0){
 used_cnt=0;
  for(t=1;t<=coast_nac;t++){
    if(coast_use_ac(t)==1){
    used_cnt+=1;
    sumdo=0;
    for(y=styr;y<=endyr;y++){
          if(coast_ac_index(y,t)<0.) coast_resid_ac(y,used_cnt)=0;
          if(coast_ac_index(y,t)>=0.){
             coast_resid_ac(y,used_cnt)=log(coast_ac_index(y,t)+1e-5)-log(coast_pred_ac_index(y,used_cnt)+1e-5);
             sumdo+=1;
           }
     }
 //Calculate standardized residuals
     for(y=styr;y<=endyr;y++){
          if(coast_ac_index(y,t)>=0.){
             coast_std_resid_ac(y,used_cnt)=coast_resid_ac(y,used_cnt)/sqrt(log(square(coast_ac_index_CV(y,t)+1)));
            }
           if(coast_ac_index(y,t)<0.) coast_std_resid_ac(y,used_cnt)=-99999.0;
    }
// Calculate RMSE
    adds=0;
   for(y=styr;y<=endyr;y++){
     if(coast_ac_index(y,t)>=0.) adds+=square(coast_std_resid_ac(y,used_cnt));
     }
   coast_RMSE_ac(used_cnt)=sqrt(adds/sumdo);
  }
 }

      u=dirnew +"\\Coast_RMSE_ac.out";
    dir = u.c_str();
    ofs.open(dir);
     used_cnt=0;
     for(t=1;t<=coast_nac;t++){
```

```
      if(coast_use_ac(t)==1){
        used_cnt+=1;
        ofs<<coast_RMSE_ac(used_cnt)<<endl;
      }
      if(coast_use_ac(t)<=0) ofs<<"-99999"<<endl;
     }
     ofs.close();

     u=dirnew +"\\Coast_std_resid_ac.out";
     dir = u.c_str();
     ofs.open(dir);
     for(y=styr;y<=endyr;y++){
         used_cnt=0;
       for(t=1;t<=coast_nac;t++){
         if(coast_use_ac(t)==1){
           used_cnt+=1;
           if(t<coast_nac) ofs<<coast_std_resid_ac(y,used_cnt)<<" ";
           if(t==coast_nac) ofs<<coast_std_resid_ac(y,used_cnt)<<endl;
        }
         if(coast_use_ac(t)<=0){
           if(t<coast_nac) ofs<<"-99999"<<" ";
           if(t==coast_nac) ofs<<"-99999"<<endl;
        }
     }
    }
      ofs.close();
 }//any indices used

//*************************************************************************************************
//   Standardized Residuals for Catch Age Comp
//*************************************************************************************************
 //Stock 1

  for(t=1;t<=substructure;t++){
     sprintf(hh,"%i",t);
      u=dirnew +"\\S1_Wave_" + hh + "_std_resid_catch_paa.out";
     dir = u.c_str();
     ofs.open(dir);
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
        if(s1_bay_catch_paa(t,y,a)>=0.){
           s1_bay_std_resid_catch_paa(t,y,a)=((s1_bay_catch_paa(t,y,a)+1e-5)-(s1_bay_pred_catch_paa(t,y,a)+1e-
5))/sqrt(((s1_bay_pred_catch_paa(t,y,a)+1e-5)*(1-(s1_bay_pred_catch_paa(t,y,a)+1e-5)))/s1_bay_catch_paa_ess(y,t));
        }
       if(s1_bay_catch_paa(t,y,a)<0.) s1_bay_std_resid_catch_paa(t,y,a)=-99999.;
       if(a<nages) ofs<<s1_bay_std_resid_catch_paa(t,y,a)<<" ";
       if(a==nages) ofs<<s1_bay_std_resid_catch_paa(t,y,a)<<endl;
      }
    }
    ofs.close();
  }

   //Coast
  for(t=1;t<=ncoastwaves;t++){
     sprintf(hh,"%i",t);
     u=dirnew +"\\Coast_Wave_" + hh + "_std_resid_catch_paa.out";
     dir = u.c_str();
     ofs.open(dir);
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
        if(coast_catch_paa(t,y,a)>=0.){
           coast_std_resid_catch_paa(t,y,a)=((coast_catch_paa(t,y,a)+1e-5)-(coast_pred_catch_paa(t,y,a)+1e-
5))/sqrt(((coast_pred_catch_paa(t,y,a)+1e-5)*(1-(coast_pred_catch_paa(t,y,a)+1e-5)))/coast_catch_paa_ess(y,t));
        }
       if(coast_catch_paa(t,y,a)<0.) coast_std_resid_catch_paa(t,y,a)=-99999.;
       if(a<nages) ofs<<coast_std_resid_catch_paa(t,y,a)<<" ";
```

```
      if(a==nages) ofs<<coast_std_resid_catch_paa(t,y,a)<<endl;
     }
    }
   ofs.close();
  }

 //################## Standardized Residuals for Age COmp Surveys Age Comps
  //Stock 1
 if(s1_bay_nac_used>0){
  used_cnt=0;
  for(t=1;t<=s1_bay_nac;t++){
     sprintf(hh,"%i",t);
     u=dirnew +"\\S1_AC" + hh + "_std_resid_AC.out";
     dir = u.c_str();
     ofs.open(dir);
     if(s1_bay_use_ac(t)==1) used_cnt+=1;
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
      if(s1_bay_use_ac(t)==1){
          if(s1_bay_ac_index_paa(t,y,a)>=0.){
           s1_bay_std_resid_index_paa(used_cnt,y,a)=((s1_bay_ac_index_paa(t,y,a)+1e-5)-(s1_bay_pred_ac_index_paa(used_cnt,y,a)+1e-
5))/sqrt(((s1_bay_pred_ac_index_paa(used_cnt,y,a)+1e-5)*(1-(s1_bay_pred_ac_index_paa(used_cnt,y,a)+1e-
5)))/s1_bay_ac_index_paa_ess(y,t));
          }
          if(s1_bay_ac_index_paa(t,y,a)<0.) s1_bay_std_resid_index_paa(used_cnt,y,a)=-99999.;
          if(a<nages) ofs<<s1_bay_std_resid_index_paa(used_cnt,y,a)<<" ";
         if(a==nages) ofs<<s1_bay_std_resid_index_paa(used_cnt,y,a)<<endl;
      }
      if(s1_bay_use_ac(t)<=0){
        if(a<nages) ofs<<"-99999"<<" ";
        if(a==nages) ofs<<"-99999"<<endl;
      }
     }
    }
  ofs.close();
 }
 }


  //Stock 2
 if(s2_nac_used>0){
  used_cnt=0;
  for(t=1;t<=s2_nac;t++){
     sprintf(hh,"%i",t);
     u=dirnew +"\\S2_AC" + hh + "_std_resid_AC.out";
     dir = u.c_str();
     ofs.open(dir);
     if(s2_use_ac(t)==1) used_cnt+=1;
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
      if(s2_use_ac(t)==1){
          if(s2_ac_index_paa(t,y,a)>=0.){
           s2_std_resid_index_paa(used_cnt,y,a)=((s2_ac_index_paa(t,y,a)+1e-5)-(s2_pred_ac_index_paa(used_cnt,y,a)+1e-
5))/sqrt(((s2_pred_ac_index_paa(used_cnt,y,a)+1e-5)*(1-(s2_pred_ac_index_paa(used_cnt,y,a)+1e-5)))/s2_ac_index_paa_ess(y,t));
          }
          if(s2_ac_index_paa(t,y,a)<0.) s2_std_resid_index_paa(used_cnt,y,a)=-99999.;
          if(a<nages) ofs<<s2_std_resid_index_paa(used_cnt,y,a)<<" ";
         if(a==nages) ofs<<s2_std_resid_index_paa(used_cnt,y,a)<<endl;
      }
      if(s2_use_ac(t)<=0){
        if(a<nages) ofs<<"-99999"<<" ";
        if(a==nages) ofs<<"-99999"<<endl;
      }
     }
    }
  ofs.close();
```

```
 }
}


 //Coast
 if(coast_nac_used>0){
  used_cnt=0;
   for(t=1;t<=coast_nac;t++){
     sprintf(hh,"%i",t);
     u=dirnew +"\\Coast_AC" + hh + "_std_resid_AC.out";
     dir = u.c_str();
     ofs.open(dir);
     if(coast_use_ac(t)==1) used_cnt+=1;
     for(y=styr;y<=endyr;y++){
      for(a=1;a<=nages;a++){
      if(coast_use_ac(t)==1){
          if(coast_ac_index_paa(t,y,a)>=0.){
           coast_std_resid_index_paa(used_cnt,y,a)=((coast_ac_index_paa(t,y,a)+1e-5)-(coast_pred_ac_index_paa(used_cnt,y,a)+1e-
5))/sqrt(((coast_pred_ac_index_paa(used_cnt,y,a)+1e-5)*(1-(coast_pred_ac_index_paa(used_cnt,y,a)+1e-5)))/coast_ac_index_paa_ess(y,t));
          }
          if(coast_ac_index_paa(t,y,a)<0.) coast_std_resid_index_paa(used_cnt,y,a)=-99999.;
          if(a<nages) ofs<<coast_std_resid_index_paa(used_cnt,y,a)<<" ";
         if(a==nages) ofs<<coast_std_resid_index_paa(used_cnt,y,a)<<endl;
      }
      if(coast_use_ac(t)<=0){
        if(a<nages) ofs<<"-99999"<<" ";
        if(a==nages) ofs<<"-99999"<<endl;
      }
     }
    }
   ofs.close();
  }
 }
  //Stock Composition

     u=dirnew +"\\stock_comp_std_resid.out";
     dir = u.c_str();
     ofs.open(dir);
     for(y=styr;y<=endyr;y++){
      for(p=1;p<=2;p++){
        if(stock_composition(y,p)>0.){
          stock_comp_std_resid(y,p)=((stock_composition(y,p)+1e-5)-(stock_comp_predicted(y,p)+1e-5))/sqrt(((stock_comp_predicted(y,p)+1e-
5)*(1-(stock_comp_predicted(y,p)+1e-5)))/stock_comp_ess(y));
        }
       if(stock_composition(y,p)<0.) stock_comp_std_resid(y,p)=-99999.;
       if(p<2) ofs<<stock_comp_std_resid(y,p)<<" ";
       if(p==2) ofs<<stock_comp_std_resid(y,p)<<endl;
      }
    }
   ofs.close();


  //***************************************************************************************************
  // Effective Sample Sizes - Francis (2011) method equation 1.8
  //***************************************************************************************************
 // Compute Francis (2011) stage 2 multiplier for multinomial to adjust input Neff
 // Francis, R.I.C.C. 2011. Data weighting in statistical fisheries stock assessment models. CJFAS 68: 1124-1138
 // Code from ASAP3
 // Stock 1 Catch
   s1_Neff_stage2_mult_catch=1;
   for (t=1;t<=substructure;t++){
   mean_age_obs=0.0;
   mean_age_pred=0.0;
   mean_age_pred2=0.0;
   mean_age_resid=0.0;
   for(y=styr;y<=endyr;y++){
```

```
    for(a=1;a<=nages;a++){
      if(s1_bay_catch_paa(t,y,a)>=0.){
        mean_age_obs(y)+=s1_bay_catch_paa(t,y,a)*a;
        mean_age_pred(y)+=s1_bay_pred_catch_paa(t,y,a)*a;
        mean_age_pred2(y)+=s1_bay_pred_catch_paa(t,y,a)*a*a;
      }
    }
  }
  mean_age_resid=mean_age_obs-mean_age_pred;
  mean_age_sigma=sqrt(mean_age_pred2-elem_prod(mean_age_pred,mean_age_pred));
  mean_age_n=0.0;
  mean_age_mean=0.0;
  mean_age_m2=0.0;
  for(y=styr;y<=endyr;y++){
     if (s1_bay_total_catch(y,t)>=0.){
         mean_age_x=mean_age_resid(y)*sqrt(s1_bay_catch_paa_ess(y,t))/mean_age_sigma(y);
         mean_age_n+=1.0;
         mean_age_delta=mean_age_x-mean_age_mean;
         mean_age_mean+= mean_age_delta/mean_age_n;
         mean_age_m2+= mean_age_delta*(mean_age_x-mean_age_mean);
     }
  }
  if ((mean_age_n > 0) && (mean_age_m2 > 0)) s1_Neff_stage2_mult_catch(t)=1.0/(mean_age_m2/(mean_age_n-1.0));
}

//Coast
  coast_Neff_stage2_mult_catch=1.;
  for (t=1;t<=ncoastwaves;t++){
  mean_age_obs=0.0;
  mean_age_pred=0.0;
  mean_age_pred2=0.0;
  mean_age_resid=0.0;
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
      if(coast_catch_paa(t,y,a)>=0.){
        mean_age_obs(y)+=coast_catch_paa(t,y,a)*a;
        mean_age_pred(y)+=coast_pred_catch_paa(t,y,a)*a;
        mean_age_pred2(y)+=coast_pred_catch_paa(t,y,a)*a*a;
      }
    }
  }
  mean_age_resid=mean_age_obs-mean_age_pred;
  mean_age_sigma=sqrt(mean_age_pred2-elem_prod(mean_age_pred,mean_age_pred));
  mean_age_n=0.0;
  mean_age_mean=0.0;
  mean_age_m2=0.0;
  for(y=styr;y<=endyr;y++){
     if (coast_total_catch(y,t)>=0.){
         mean_age_x=mean_age_resid(y)*sqrt(coast_catch_paa_ess(y,t))/mean_age_sigma(y);
         mean_age_n+=1.0;
         mean_age_delta=mean_age_x-mean_age_mean;
         mean_age_mean+= mean_age_delta/mean_age_n;
         mean_age_m2+= mean_age_delta*(mean_age_x-mean_age_mean);
     }
  }
  if ((mean_age_n > 0) && (mean_age_m2 > 0)) coast_Neff_stage2_mult_catch(t)=1.0/(mean_age_m2/(mean_age_n-1.0));
}

//Stock 1 Indices
if(s1_bay_nac_used>0){
   s1_Neff_stage2_mult_index=1;
   used_cnt=0;
  for (t=1;t<=s1_bay_nac;t++){
    if(s1_bay_use_ac(t)>=1) used_cnt+=1;
    if (s1_bay_use_ac(t)>=1) {
     mean_age_obs=0.0;
```

```
    mean_age_pred=0.0;
    mean_age_pred2=0.0;
    mean_age_resid=0.0;
   for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
      if(s1_bay_ac_index_paa(t,y,a)>=0.){
        mean_age_obs(y)+=s1_bay_ac_index_paa(t,y,a)*a;
        mean_age_pred(y)+=s1_bay_pred_ac_index_paa(used_cnt,y,a)*a;
        mean_age_pred2(y)+=s1_bay_pred_ac_index_paa(used_cnt,y,a)*a*a;
      }
    }
  }
  mean_age_resid=mean_age_obs-mean_age_pred;
  mean_age_sigma=sqrt(mean_age_pred2-elem_prod(mean_age_pred,mean_age_pred));
  mean_age_n=0.0;
  mean_age_mean=0.0;
  mean_age_m2=0.0;
  for(y=styr;y<=endyr;y++){
    if (s1_bay_ac_index(y,t)>=0.){
        mean_age_x=mean_age_resid(y)*sqrt(s1_bay_ac_index_paa_ess(y,t))/mean_age_sigma(y);
        mean_age_n+=1.0;
        mean_age_delta=mean_age_x-mean_age_mean;
        mean_age_mean+=mean_age_delta/mean_age_n;
        mean_age_m2+=mean_age_delta*(mean_age_x-mean_age_mean);
    }
  }
  if ((mean_age_n > 0) && (mean_age_m2 > 0)) s1_Neff_stage2_mult_index(used_cnt)=1.0/(mean_age_m2/(mean_age_n-1.0));
 }
 }
}//used
 //Stock 2 Indices

if(s2_nac_used>0){
  s2_Neff_stage2_mult_index=1;
  used_cnt=0;
  for (t=1;t<=s2_nac;t++){
    if(s2_use_ac(t)==1) used_cnt+=1;
    if (s2_use_ac(t)>=1.) {
     mean_age_obs=0.0;
     mean_age_pred=0.0;
     mean_age_pred2=0.0;
     mean_age_resid=0.0;
   for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
      if(s2_ac_index_paa(t,y,a)>=0.){
        mean_age_obs(y)+=s2_ac_index_paa(t,y,a)*a;
        mean_age_pred(y)+=s2_pred_ac_index_paa(used_cnt,y,a)*a;
        mean_age_pred2(y)+=s2_pred_ac_index_paa(used_cnt,y,a)*a*a;
      }
    }
  }
  mean_age_resid=mean_age_obs-mean_age_pred;
  mean_age_sigma=sqrt(mean_age_pred2-elem_prod(mean_age_pred,mean_age_pred));
  mean_age_n=0.0;
  mean_age_mean=0.0;
  mean_age_m2=0.0;
  for(y=styr;y<=endyr;y++){
   // if(s2_ac_index(y,t)>=0.){
      if(s2_ac_index_paa_ess(y,t)>=0.){//de trawl recode
        mean_age_x=mean_age_resid(y)*sqrt(s2_ac_index_paa_ess(y,t))/mean_age_sigma(y);
        mean_age_n+=1.0;
        mean_age_delta=mean_age_x-mean_age_mean;
        mean_age_mean+=mean_age_delta/mean_age_n;
        mean_age_m2+=mean_age_delta*(mean_age_x-mean_age_mean);
    }
  }
```

```
  if ((mean_age_n > 0) && (mean_age_m2 > 0)) s2_Neff_stage2_mult_index(used_cnt)=1.0/(mean_age_m2/(mean_age_n-1.0));
 }
}
}//used

 //Coast Indices
if(coast_nac_used>0){
 used_cnt=0;
 coast_Neff_stage2_mult_index=1;
 for (t=1;t<=coast_nac;t++){
  if (coast_use_ac(t)>=1) used_cnt+=1;
  if (coast_use_ac(t)>=1.){
     mean_age_obs=0.0;
     mean_age_pred=0.0;
     mean_age_pred2=0.0;
     mean_age_resid=0.0;
   for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
      if(coast_ac_index_paa(t,y,a)>=0.){
        mean_age_obs(y)+=coast_ac_index_paa(t,y,a)*a;
        mean_age_pred(y)+=coast_pred_ac_index_paa(used_cnt,y,a)*a;
        mean_age_pred2(y)+=coast_pred_ac_index_paa(used_cnt,y,a)*a*a;
      }
    }
  }
  mean_age_resid=mean_age_obs-mean_age_pred;
  mean_age_sigma=sqrt(mean_age_pred2-elem_prod(mean_age_pred,mean_age_pred));
  mean_age_n=0.0;
  mean_age_mean=0.0;
  mean_age_m2=0.0;
  for(y=styr;y<=endyr;y++){
   if (coast_ac_index(y,t)>=0.){
        mean_age_x=mean_age_resid(y)*sqrt(coast_ac_index_paa_ess(y,t))/mean_age_sigma(y);
        mean_age_n+=1.0;
        mean_age_delta=mean_age_x-mean_age_mean;
        mean_age_mean+=mean_age_delta/mean_age_n;
        mean_age_m2+=mean_age_delta*(mean_age_x-mean_age_mean);
     }
  }

  if ((mean_age_n > 0) && (mean_age_m2 > 0)) coast_Neff_stage2_mult_index(used_cnt)=1.0/(mean_age_m2/(mean_age_n-1.0));
 }
}
}
 //Stock Compostion
if(use_stockcomp>0){
  coast_Neff_stage2_mult_stock_comp=0;
     mean_age_obs=0.0;
     mean_age_pred=0.0;
     mean_age_pred2=0.0;
     mean_age_resid=0.0;
   for(y=styr;y<=endyr;y++){
    for(p=1;p<=2;p++){
      if(stock_composition(y,1)>0.){
        mean_age_obs(y)+=stock_composition(y,p)*p;
        mean_age_pred(y)+=stock_comp_predicted(y,p)*p;
        mean_age_pred2(y)+=stock_comp_predicted(y,p)*p*p;
      }
    }
  }
  mean_age_resid=mean_age_obs-mean_age_pred;
  mean_age_sigma=sqrt(mean_age_pred2-elem_prod(mean_age_pred,mean_age_pred));
  mean_age_n=0.0;
  mean_age_mean=0.0;
  mean_age_m2=0.0;
  for(y=styr;y<=endyr;y++){
```

```
   if (stock_composition(y,1)>0.){
       mean_age_x=mean_age_resid(y)*sqrt(stock_comp_ess(y))/mean_age_sigma(y);
       mean_age_n+=1.0;
       mean_age_delta=mean_age_x-mean_age_mean;
       mean_age_mean+=mean_age_delta/mean_age_n;
       mean_age_m2+=mean_age_delta*(mean_age_x-mean_age_mean);
    }
 }
 if ((mean_age_n > 0) && (mean_age_m2 > 0)) coast_Neff_stage2_mult_stock_comp=1.0/(mean_age_m2/(mean_age_n-1.0));
}

u=dirnew +"\\S1_Francis_Catch.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++) ofs<<s1_Neff_stage2_mult_catch(t)<<endl;
ofs.close();
u=dirnew +"\\Coast_Francis_Catch.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=ncoastwaves;t++) ofs<<coast_Neff_stage2_mult_catch(t)<<endl;
ofs.close();

if(s1_bay_nac_used>0){
 u=dirnew +"\\S1_Francis_AC.out";
 dir = u.c_str();
 ofs.open(dir);
 used_cnt=0;
 for(t=1;t<=s1_bay_nac;t++){
  if(s1_bay_use_ac(t)==1){
   used_cnt+=1;
   ofs<<s1_Neff_stage2_mult_index(used_cnt)<<endl;
  }
  if(s1_bay_use_ac(t)<=0) ofs<<"-99999"<<endl;
 }
ofs.close();
}
if(s2_nac_used>0){
u=dirnew +"\\s2_Francis_AC.out";
dir = u.c_str();
ofs.open(dir);
used_cnt=0;
for(t=1;t<=s2_nac;t++){
 if(s2_use_ac(t)==1){
 used_cnt+=1;
 ofs<<s2_Neff_stage2_mult_index(used_cnt)<<endl;
 }
if(s2_use_ac(t)<=0) ofs<<"-99999"<<endl;
}
ofs.close();
}
if(coast_nac_used>0){
u=dirnew +"\\Coast_Francis_AC.out";
dir = u.c_str();
ofs.open(dir);
used_cnt=0;
for(t=1;t<=coast_nac;t++){
 if(coast_use_ac(t)==1){
   used_cnt+=1;
   ofs<<coast_Neff_stage2_mult_index(used_cnt)<<endl;
 }
 if(coast_use_ac(t)<=0) ofs<<"-99999"<<endl;
}
 ofs.close();
}

u=dirnew +"\\Stock_Comp_Francis.out";
```

```
 dir = u.c_str();
 ofs.open(dir);
 ofs<<coast_Neff_stage2_mult_stock_comp<<endl;
 ofs.close();

 ofs.close();

 u=dirnew + "\\s1_emig_probs.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s1_emig_probs(y,a)<<" ";
     if(a==nages) ofs<<s1_emig_probs(y,a)<<endl;
    }
   }
 ofs.close();

 u=dirnew + "\\s1_ssb_wgts.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s1_bay_ssb_wgts(y,a)<<" ";
     if(a==nages) ofs<<s1_bay_ssb_wgts(y,a)<<endl;
    }
   }
 ofs.close();

 u=dirnew + "\\coast_ssb_wgts.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<coast_ssb_wgts(y,a)<<" ";
     if(a==nages) ofs<<coast_ssb_wgts(y,a)<<endl;
    }
   }
 ofs.close();


//################# Ouput observed data ########################
  u=dirnew +"\\s1_bay_total_catch.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<s1_bay_total_catch<<endl;
  ofs.close();

  u=dirnew +"\\s1_bay_catch_paa.out";
  dir = u.c_str();
  ofs.open(dir);
  for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<s1_bay_catch_paa(t,y,a)<<" ";
     if(a==nages) ofs<<s1_bay_catch_paa(t,y,a)<<endl;
    }
   }
 }
 ofs.close();

  u=dirnew +"\\s1_bay_agg_index.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(t=1;t<=s1_bay_nagg;t++){
```

```
     if(t<s1_bay_nagg) ofs<<s1_bay_agg_index(y,t)<<" ";
     if(t==s1_bay_nagg) ofs<<s1_bay_agg_index(y,t)<<endl;
   }
  }
 ofs.close();

 u=dirnew +"\\s1_bay_ac_index.out";
 dir = u.c_str();
 ofs.open(dir);
 for(y=styr;y<=endyr;y++){
   for(t=1;t<=s1_bay_nac;t++){
     if(t<s1_bay_nac) ofs<<s1_bay_ac_index(y,t)<<" ";
     if(t==s1_bay_nac) ofs<<s1_bay_ac_index(y,t)<<endl;
   }
  }
 ofs.close();


  u=dirnew +"\\s1_bay_ac_index_paa.out";
 dir = u.c_str();
 ofs.open(dir);
  for(t=1;t<=s1_bay_nac;t++){
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
       if(a<nages) ofs<<s1_bay_ac_index_paa(t,y,a)<<" ";
      if(a==nages) ofs<<s1_bay_ac_index_paa(t,y,a)<<endl;
  }
 }
 }
ofs.close();

 u=dirnew +"\\s2_agg_index.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(t=1;t<=s2_nagg;t++){
     if(t<s2_nagg) ofs<<s2_agg_index(y,t)<<" ";
     if(t==s2_nagg) ofs<<s2_agg_index(y,t)<<endl;
   }
  }
 ofs.close();

 u=dirnew +"\\s2_ac_index.out";
 dir = u.c_str();
 ofs.open(dir);
    for(y=styr;y<=endyr;y++){
     for(t=1;t<=s2_nac;t++){
     if(t<s2_nac) ofs<<s2_ac_index(y,t)<<" ";
     if(t==s2_nac) ofs<<s2_ac_index(y,t)<<endl;
    }
  }
ofs.close();

 u=dirnew +"\\s2_ac_index_paa.out";
 dir = u.c_str();
 ofs.open(dir);
  for(t=1;t<=s2_nac;t++){
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
       if(a<nages) ofs<<s2_ac_index_paa(t,y,a)<<" ";
      if(a==nages) ofs<<s2_ac_index_paa(t,y,a)<<endl;
    }
  }
 }
ofs.close();
//COAST
```

```
 u=dirnew +"\\coast_total_catch.out";
 dir = u.c_str();
 ofs.open(dir);
 ofs<<coast_total_catch<<endl;
 ofs.close();

 u=dirnew +"\\coast_catch_paa.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=ncoastwaves;t++){
 for(y=styr;y<=endyr;y++){
   for(a=1;a<=nages;a++){
    if(a<nages) ofs<<coast_catch_paa(t,y,a)<<" ";
    if(a==nages) ofs<<coast_catch_paa(t,y,a)<<endl;
   }
  }
}
ofs.close();

 u=dirnew +"\\coast_agg_index.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(t=1;t<=coast_nagg;t++){
      if(t<coast_nagg) ofs<<coast_agg_index(y,t)<<" ";
      if(t==coast_nagg) ofs<<coast_agg_index(y,t)<<endl;
    }
   }
 ofs.close();

 u=dirnew +"\\coast_ac_index.out";
 dir = u.c_str();
 ofs.open(dir);
  for(y=styr;y<=endyr;y++){
    for(t=1;t<=coast_nac;t++){
      if(t<coast_nac) ofs<<coast_ac_index(y,t)<<" ";
      if(t==coast_nac) ofs<<coast_ac_index(y,t)<<endl;
    }
   }
 ofs.close();


  u=dirnew +"\\coast_ac_index_paa.out";
 dir = u.c_str();
 ofs.open(dir);
  for(t=1;t<=coast_nac;t++){
    for(y=styr;y<=endyr;y++){
     for(a=1;a<=nages;a++){
       if(a<nages) ofs<<coast_ac_index_paa(t,y,a)<<" ";
      if(a==nages) ofs<<coast_ac_index_paa(t,y,a)<<endl;
    }
  }
 }
ofs.close();


 u=dirnew +"\\stock_composition.out";
 dir = u.c_str();
 ofs.open(dir);
 ofs<<stock_composition<<endl;
 ofs.close();

 u=dirnew +"\\SSB.out";
 dir = u.c_str();
 ofs.open(dir);
 for(y=styr;y<=endyr;y++){
```

```
 ofs<<s1_femSSB(y)<<" "<<s2_femSSB(y)<<endl;
 }
 ofs.close();

//-------------------------------For reference points-----------------------
 u=dirnew +"\\s1_bay_N_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 p=nyr1cnt;
 for(a=1;a<=nages;a++){
   ofs<<s1_bay_Nwv46(endyr,a)*mfexp(-s1_bay_Z(3,endyr,a))<<" "<<sigma(p,1)<<endl;
  p+=1;
 }
 ofs.close();

u=dirnew +"\\s1_bay_N_female_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 for(a=1;a<=nages;a++){
   ofs<<s1_bay_Nwv46(endyr,a)*mfexp(-s1_bay_Z(3,endyr,a))*s1_bay_prop_female(3,endyr,a)<<" "<<sigma(p,1)<<endl;
   p+=1;
 }
 ofs.close();

u=dirnew +"\\s1_bay_N_male_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 for(a=1;a<=nages;a++){
   ofs<<s1_bay_Nwv46(endyr,a)*mfexp(-s1_bay_Z(3,endyr,a))*(1.-s1_bay_prop_female(3,endyr,a))<<" "<<sigma(p,1)<<endl;
   p+=1;
 }
 ofs.close();

 u=dirnew +"\\s1_coast_N_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 for(a=1;a<=nages;a++){
   ofs<<s1_coast_Nwv46(endyr,a)*mfexp(-coast_Z(3,endyr,a))<<" "<<sigma(p,1)<<endl;
   p+=1;
 }
 ofs.close();

 u=dirnew +"\\s1_coast_N_female_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 for(a=1;a<=nages;a++){
   ofs<<s1_coast_Nwv46(endyr,a)*mfexp(-coast_Z(3,endyr,a))*coast_prop_female(3,endyr,a)<<" "<<sigma(p,1)<<endl;
   p+=1;
 }
 ofs.close();

 u=dirnew +"\\s1_coast_N_male_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 for(a=1;a<=nages;a++){
   ofs<<s1_coast_Nwv46(endyr,a)*mfexp(-coast_Z(3,endyr,a))*(1.-coast_prop_female(3,endyr,a))<<" "<<sigma(p,1)<<endl;
   p+=1;
   }
 ofs.close();


 u=dirnew +"\\s2_N_refpt.out";
 dir = u.c_str();
 ofs.open(dir);
 for(a=1;a<=nages;a++){
 ofs<<s2_Nwv46(endyr,a)*mfexp(-s2_Z(3,endyr,a))<<" "<<sigma(p,1)<<endl;
```

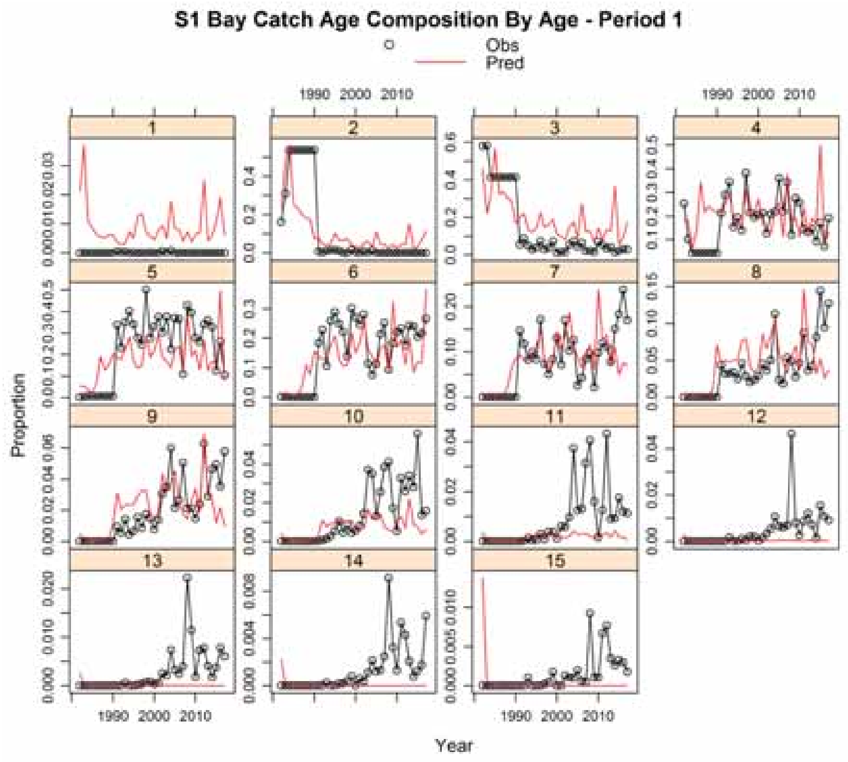
```
p+=1;
 }
ofs.close();

u=dirnew +"\\s2_N_female_refpt.out";
dir = u.c_str();
ofs.open(dir);
for(a=1;a<=nages;a++){
 ofs<<s2_Nwv46(endyr,a)*mfexp(-s2_Z(3,endyr,a))*s2_fem_sex(a)<<" "<<sigma(p,1)<<endl;
 p+=1;
  }
ofs.close();

u=dirnew +"\\s2_N_male_refpt.out";
dir = u.c_str();
ofs.open(dir);
for(a=1;a<=nages;a++){
  ofs<<s2_Nwv46(endyr,a)*mfexp(-s2_Z(3,endyr,a))*(1.-s2_fem_sex(a))<<" "<<sigma(p,1)<<endl;
 p+=1;
  }
ofs.close();
u=dirnew +"\\s1_bay_select_at_age_refpt.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=substructure;t++){
  ofs<<s1_bay_select_at_age(t,endyr)<<endl;
}
ofs.close();
u=dirnew +"\\coast_select_at_age_refpt.out";
dir = u.c_str();
ofs.open(dir);
for(t=1;t<=ncoastwaves;t++){
  ofs<<coast_select_at_age(t,endyr)<<endl;
}
ofs.close();

u=dirnew +"\\s1_R_refpt.out";
dir = u.c_str();
ofs.open(dir);
  for(y=styr;y<=endyr;y++){
     if(y<endyr) ofs<<s1_bay_N(y,1)<<" ";
     if(y==endyr) ofs<<s1_bay_N(y,1)<<endl;
    }
ofs.close();

u=dirnew +"\\s2_R_refpt.out";
dir = u.c_str();
ofs.open(dir);
  for(y=styr;y<=endyr;y++){
     if(y<endyr) ofs<<s2_N(y,1)<<" ";
     if(y==endyr) ofs<<s2_N(y,1)<<endl;
    }
ofs.close();
 u=dirnew +"\\s1_femssb_refpt.out";
dir = u.c_str();
ofs.open(dir);
  ofs<<sum(s1_ssb(endyr))<<endl;
ofs.close();

u=dirnew +"\\s2_femssb_refpt.out";
dir = u.c_str();
ofs.open(dir);
   ofs<<sum(s2_ssb(endyr))<<endl;
ofs.close();

u=dirnew +"\\s1_F_refpt.out";
```

```
  dir = u.c_str();
  ofs.open(dir);
    ofs<<sum(s1_bay_fullF(endyr))<<" "<<sum(coast_fullF(endyr))<<endl;
  ofs.close();

  u=dirnew +"\\s2_F_refpt.out";
  dir = u.c_str();
  ofs.open(dir);
    ofs<<sum(coast_fullF(endyr))<<endl;
  ofs.close();

  u=dirnew +"\\s1_mu_at_age.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<s1_mu<<endl;
  ofs.close();

    //Average M at age
   for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     s1_avgM(y,a)=(s1_bay_M(y,a)+coast_M(y,a))/2;
    }
   }
 //checked 8/21/2018
  u=dirnew +"\\s1_stock_mu_F.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
    pgroup=0;
     for(a=1;a<=nages;a++){
      pgroup=s1_mu(y,a);
      if(pgroup==max(s1_mu(y))) cnt1=a;
     }
     FF=max(s1_mu(y));
     diff2=FF/2;
     cnt=0;
     sumdo=0.00001;
   while(cnt==0){
    ssq=max(s1_mu(y))-(FF/(FF+s1_avgM(y,cnt1))*(1-mfexp(-FF-s1_avgM(y,cnt1))));
   if(fabs(ssq)<=sumdo) cnt=1;
    if(cnt==0){
      if(ssq>0) FF=FF+diff2;
		if(ssq<0) FF=FF-diff2;
		  diff2=diff2/2;
     }
   }
   ofs<<max(s1_mu(y))<<" "<<sigma(p,1)<<" "<<sigma(p,1)/max(s1_mu(y))<<" "<<FF<<"
"<<sqrt(square(sigma(p,1))*square(FF/max(s1_mu(y))))<<" "<<sqrt(square(sigma(p,1))*square(FF/max(s1_mu(y))))/FF<<"
"<<s1_avgM(y,cnt1)<<endl;
   p+=1;
   }
   ofs.close();

 //Stock 2
  u=dirnew +"\\s2_mu_at_age.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<s2_mu<<endl;
  ofs.close();

   //checked 8/21/2018
  u=dirnew +"\\s2_stock_mu_F.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
    pgroup=0;
```

```
      for(a=1;a<=nages;a++){
        pgroup=s2_mu(y,a);
        if(pgroup==max(s2_mu(y))) cnt1=a;
      }
      FF=max(s2_mu(y));
      diff2=FF/2;
      cnt=0;
      sumdo=0.00001;
    while(cnt==0){
     ssq=max(s2_mu(y))-(FF/(FF+coast_M(y,cnt1))*(1-mfexp(-FF-coast_M(y,cnt1))));
    if(fabs(ssq)<=sumdo) cnt=1;
     if(cnt==0){
       if(ssq>0) FF=FF+diff2;
                 if(ssq<0) FF=FF-diff2;
                   diff2=diff2/2;
      }
   }
   ofs<<max(s2_mu(y))<<" "<<sigma(p,1)<<" "<<sigma(p,1)/max(s2_mu(y))<<" "<<FF<<"
"<<sqrt(square(sigma(p,1))*square(FF/max(s2_mu(y))))<<" "<<sqrt(square(sigma(p,1))*square(FF/max(s2_mu(y))))/FF<<"
"<<coast_M(y,cnt1)<<endl;
   p+=1;
   }
   ofs.close();
  //Combined Stocks
  u=dirnew +"\\comb_mu_at_age.out";
  dir = u.c_str();
  ofs.open(dir);
  ofs<<comb_mu<<endl;
  ofs.close();

   //checked 8/21/2018
  u=dirnew +"\\comb_stock_mu_F.out";
  dir = u.c_str();
  ofs.open(dir);
   for(y=styr;y<=endyr;y++){
     pgroup=0;
      for(a=1;a<=nages;a++){
        pgroup=comb_mu(y,a);
        if(pgroup==max(comb_mu(y))) cnt1=a;
      }
      FF=max(comb_mu(y));
      diff2=FF/2;
      cnt=0;
      sumdo=0.00001;
    while(cnt==0){
     ssq=max(comb_mu(y))-(FF/(FF+s1_avgM(y,cnt1))*(1-mfexp(-FF-s1_avgM(y,cnt1))));
    if(fabs(ssq)<=sumdo) cnt=1;
     if(cnt==0){
       if(ssq>0) FF=FF+diff2;
                 if(ssq<0) FF=FF-diff2;
                   diff2=diff2/2;
      }
   }
   ofs<<max(comb_mu(y))<<" "<<sigma(p,1)<<" "<<sigma(p,1)/max(comb_mu(y))<<" "<<FF<<"
"<<sqrt(square(sigma(p,1))*square(FF/max(comb_mu(y))))<<" "<<sqrt(square(sigma(p,1))*square(FF/max(comb_mu(y))))/FF<<"
"<<s1_avgM(y,cnt1)<<endl;
   p+=1;
   }
   ofs.close();

   u=dirnew +"\\number_of_output_parameters.out";
   dir = u.c_str();
   ofs.open(dir);
   ofs<<df<<endl;
   ofs.close();
```

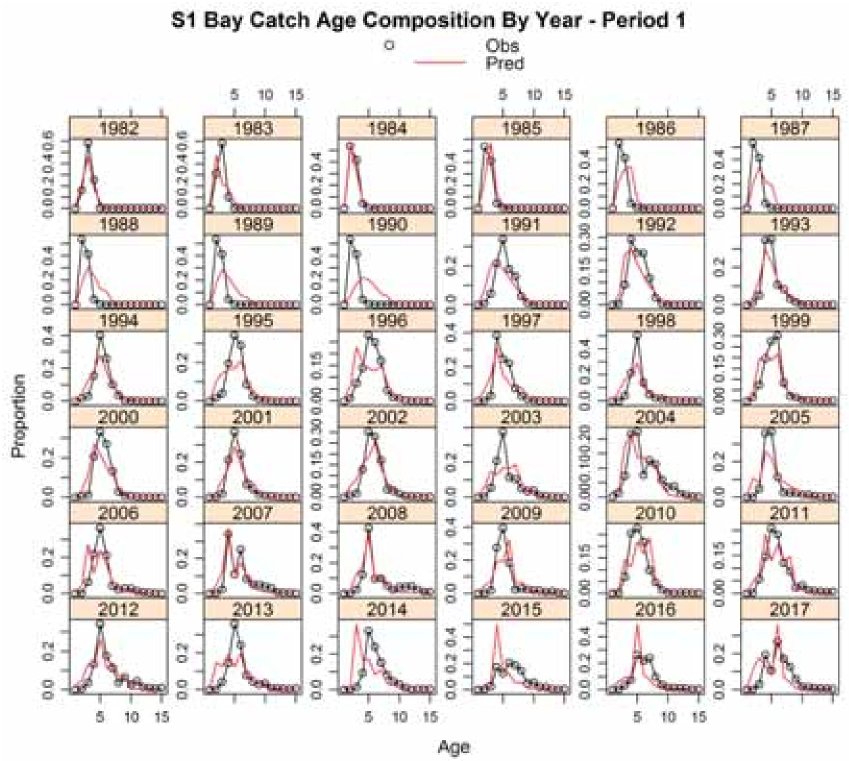
```
  u=dirnew +"\\run.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr;y++){
  ofs<<max(s1_bay_F(1,y))<<" "<<max(s1_bay_F(2,y))<<" "<<max(s1_bay_F(3,y))<<" "<<max(coast_F(1,y))<<" "<<max(coast_F(2,y))<<"
"<<max(coast_F(3,y))<<" "<<s1_bay_R(y)<<" "<<s2_R(y)<<" "<<s1_femSSB(y)<<" "<<s2_femSSB(y)<<endl;
  }
  ofs.close();

  u=dirnew +"\\s1_sr.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr-1;y++){
    ofs<<sum(s1_ssb(y))<<" "<<s1_bay_R(y+1)<<endl;
  }
  ofs.close();

  u=dirnew +"\\s2_sr.out";
  dir = u.c_str();
  ofs.open(dir);
  for(y=styr;y<=endyr-1;y++){
    ofs<<sum(s2_ssb(y))<<" "<<s2_R(y+1)<<endl;
  }
  ofs.close();
  u=dirnew + "\\coast_F_at_age.out";
 dir = u.c_str();
 ofs.open(dir);
 for(t=1;t<=substructure;t++){
  for(y=styr;y<=endyr;y++){
    for(a=1;a<=nages;a++){
     if(a<nages) ofs<<coast_F(t,y,a)<<" ";
     if(a==nages) ofs<<coast_F(t,y,a)<<endl;
    }
   }
 }
 ofs.close();
```

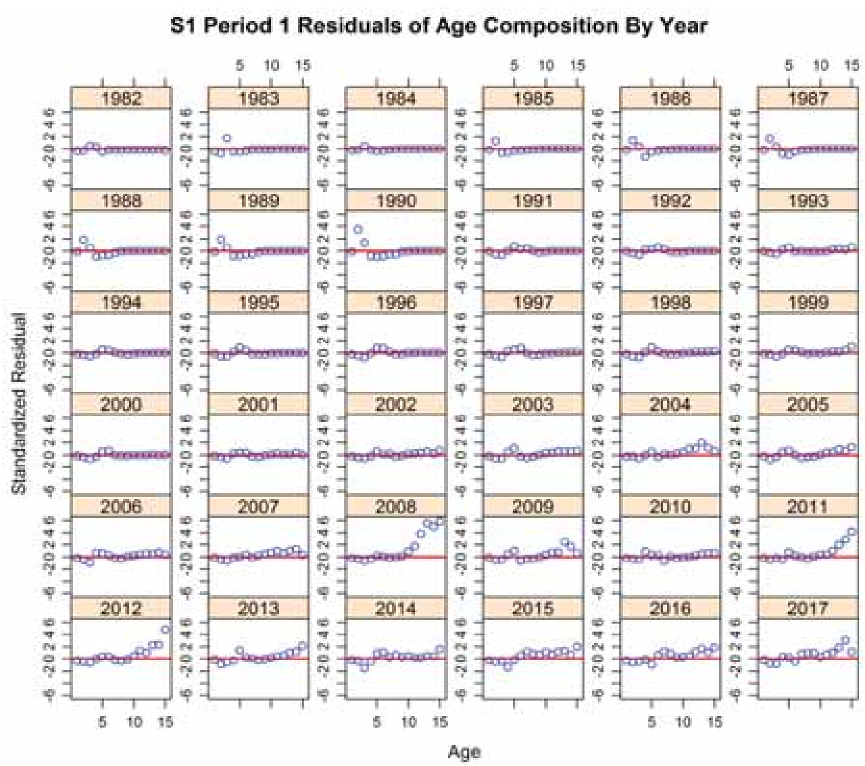
**Appendix B9: Diagnostic Plots from the 2SCA Model for Atlantic Striped Bass**



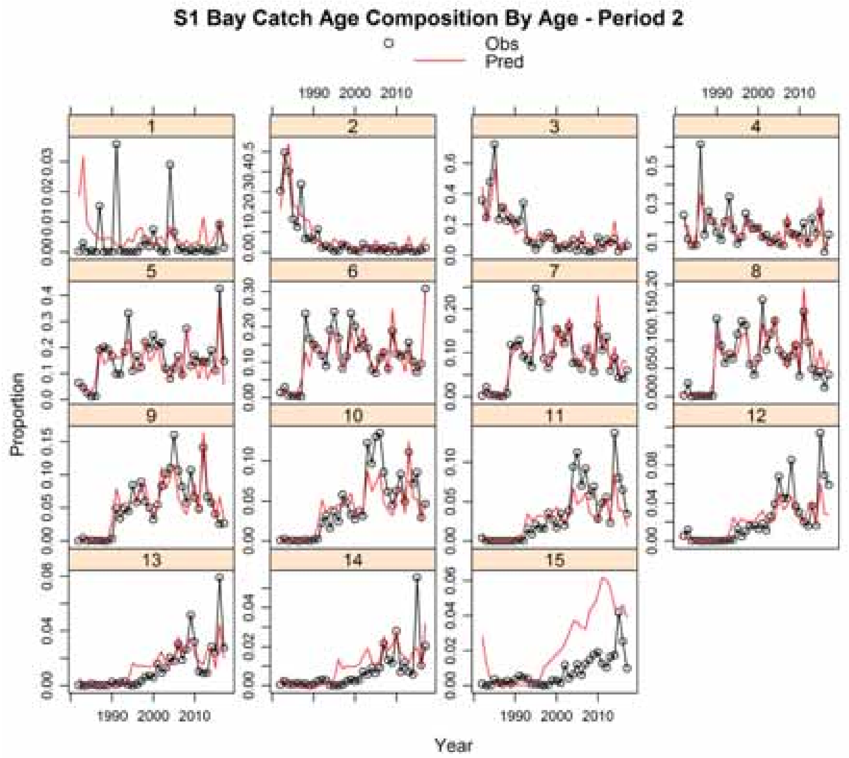


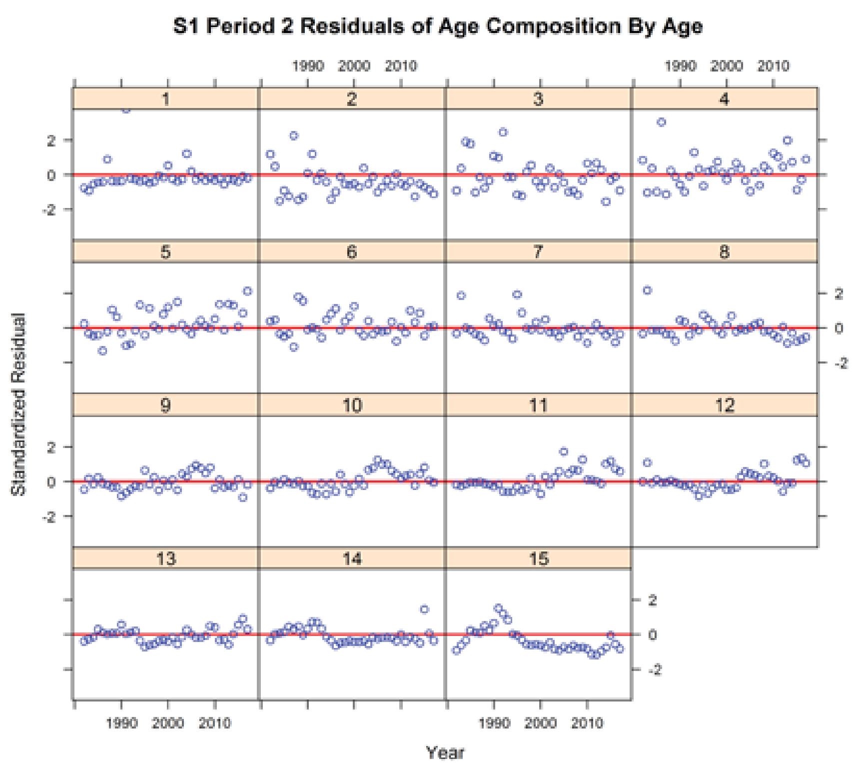
Appendix Figure 1. Observed and predicted estimate of total removal age composition by age and standardized residuals for Stock 1 Bay during period 1.



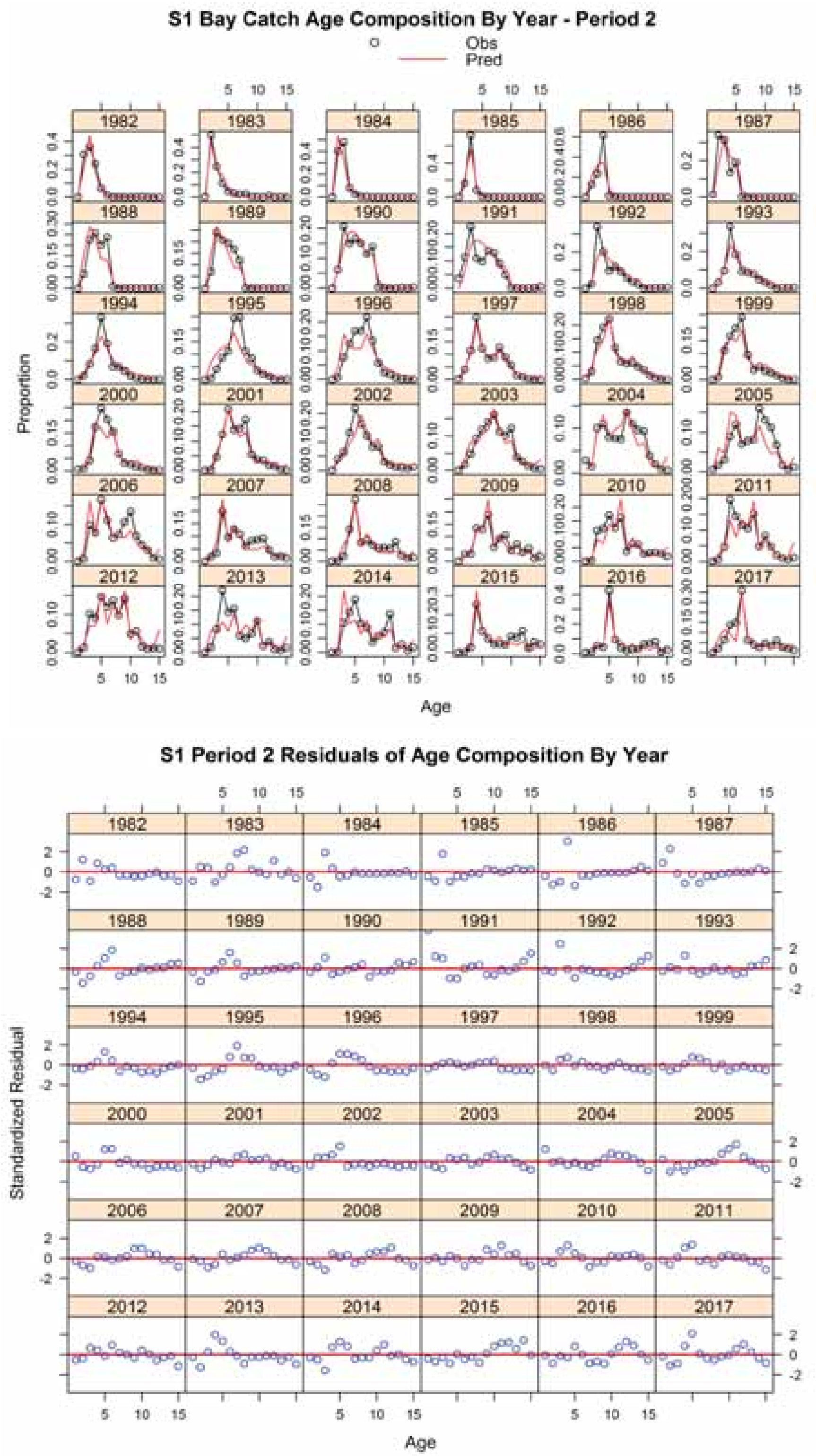




Appendix Figure 2. Observed and predicted estimate of total removal age composition by year and standardized residuals for Stock 1 Bay during period 1.

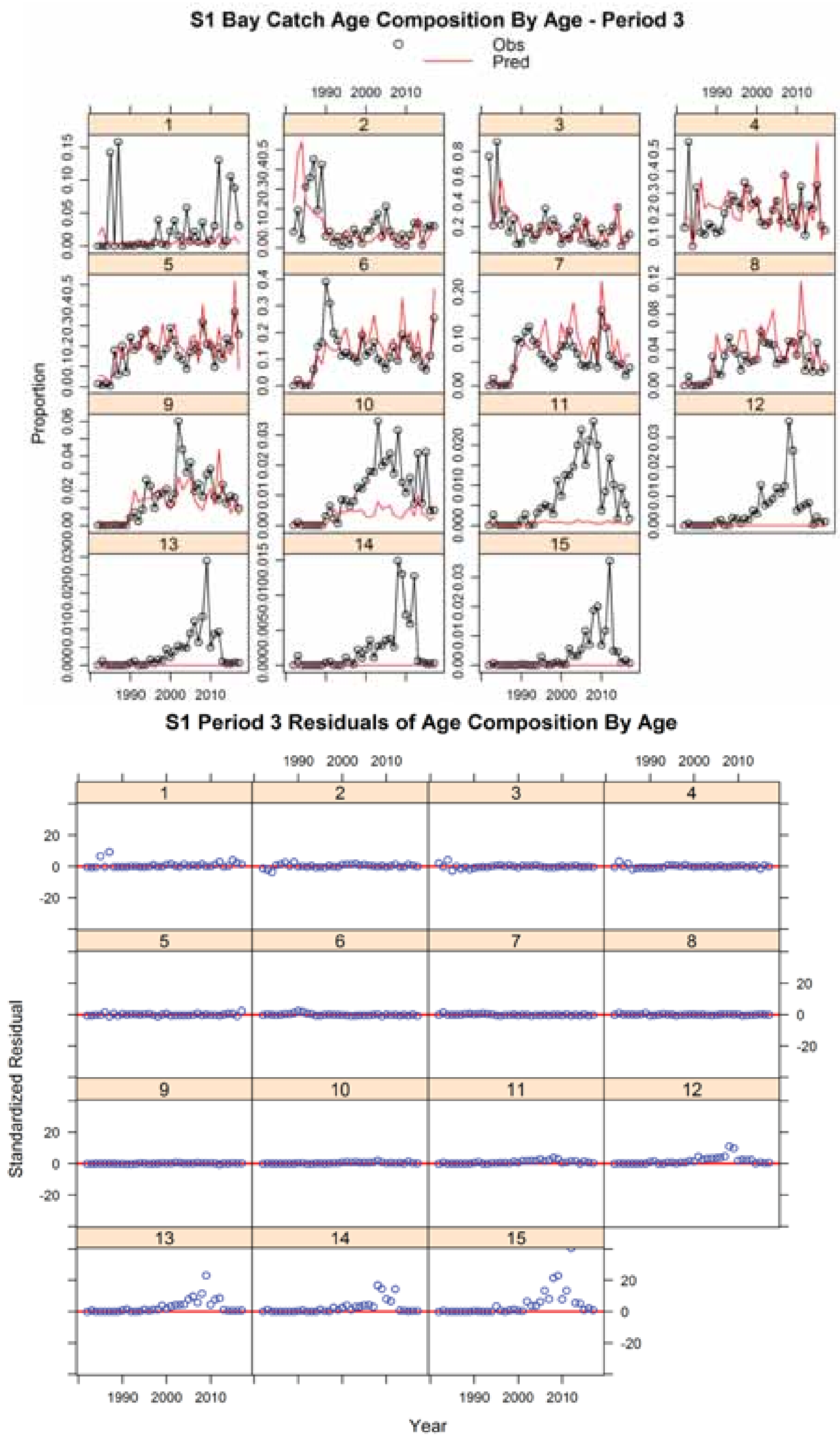


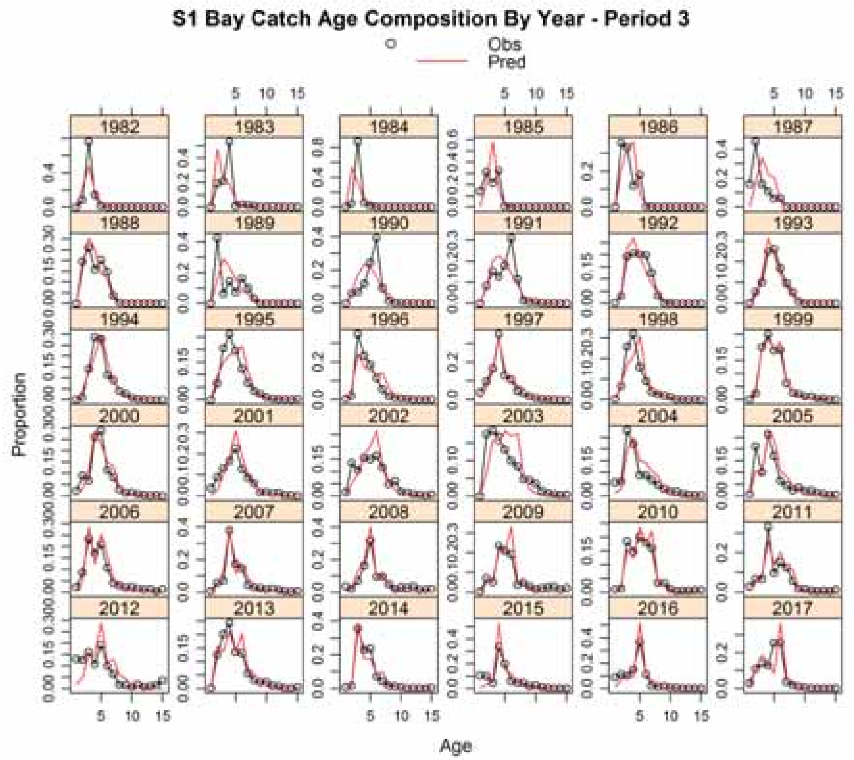

Appendix Figure 3. Observed and predicted estimate of total removal age composition by age and standardized residuals for Stock 1 Bay during period 2.

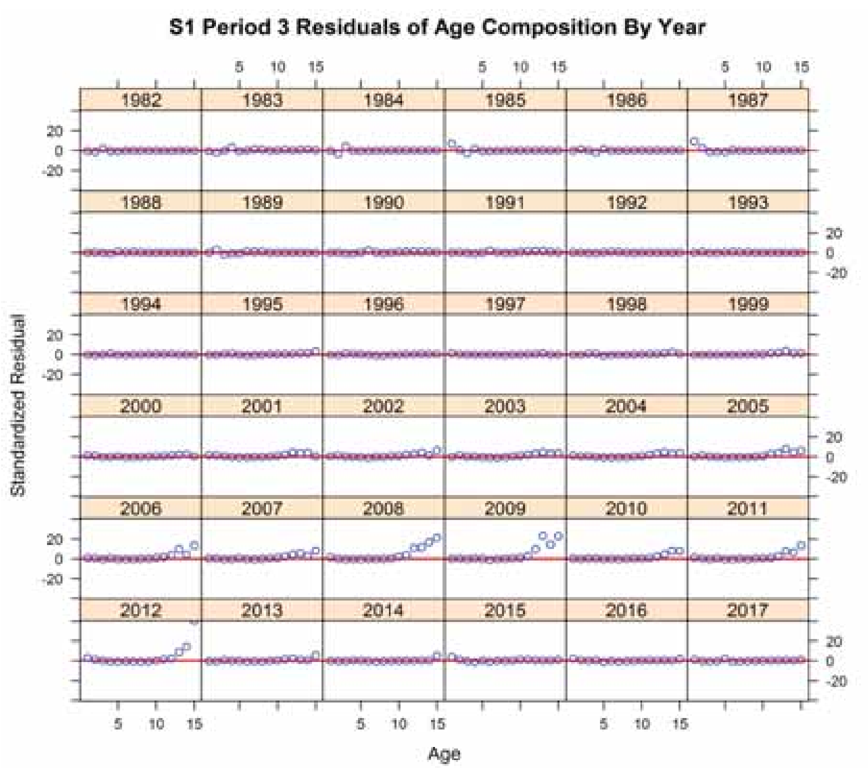



Appendix Figure 4. Observed and predicted estimate of total removal age composition by year and standardized residuals for Stock 1 Bay during period 2.

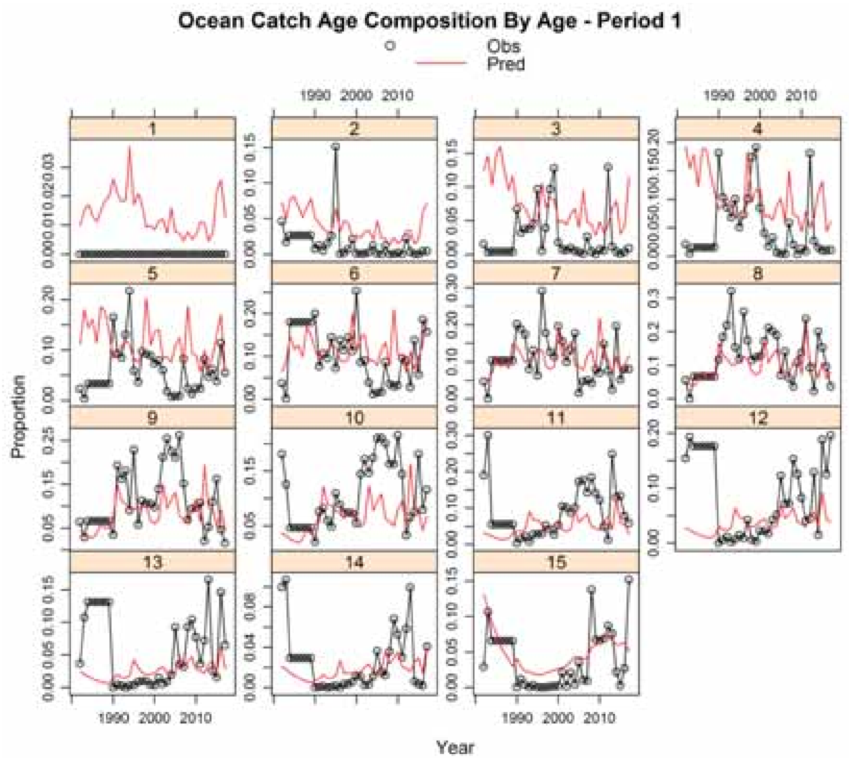


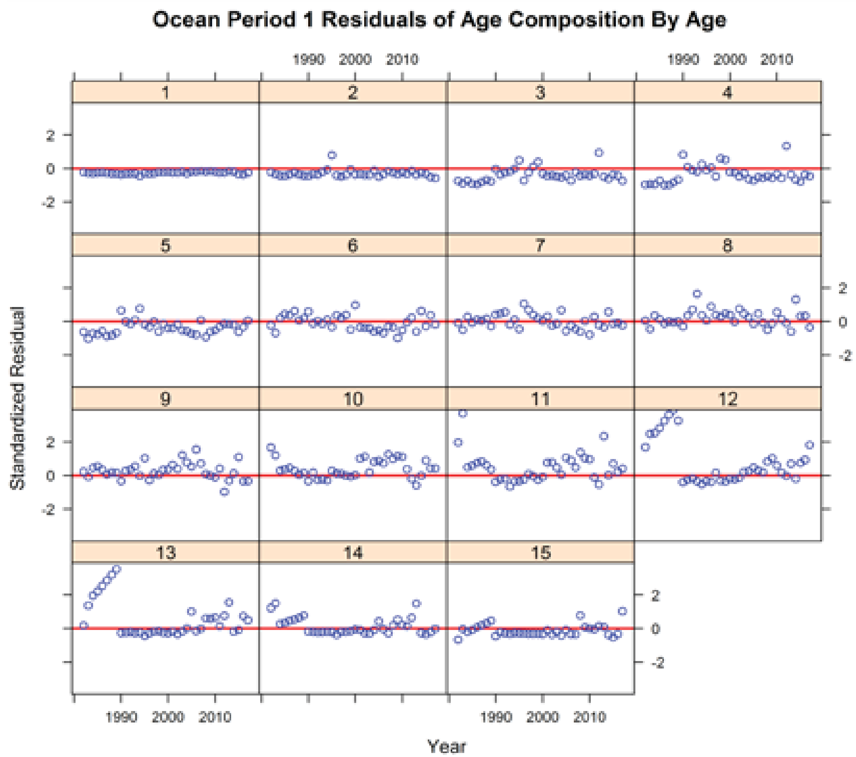

Appendix Figure 5. Observed and predicted estimate of total removal age composition by age and standardized residuals for Stock 1 Bay during period 3.



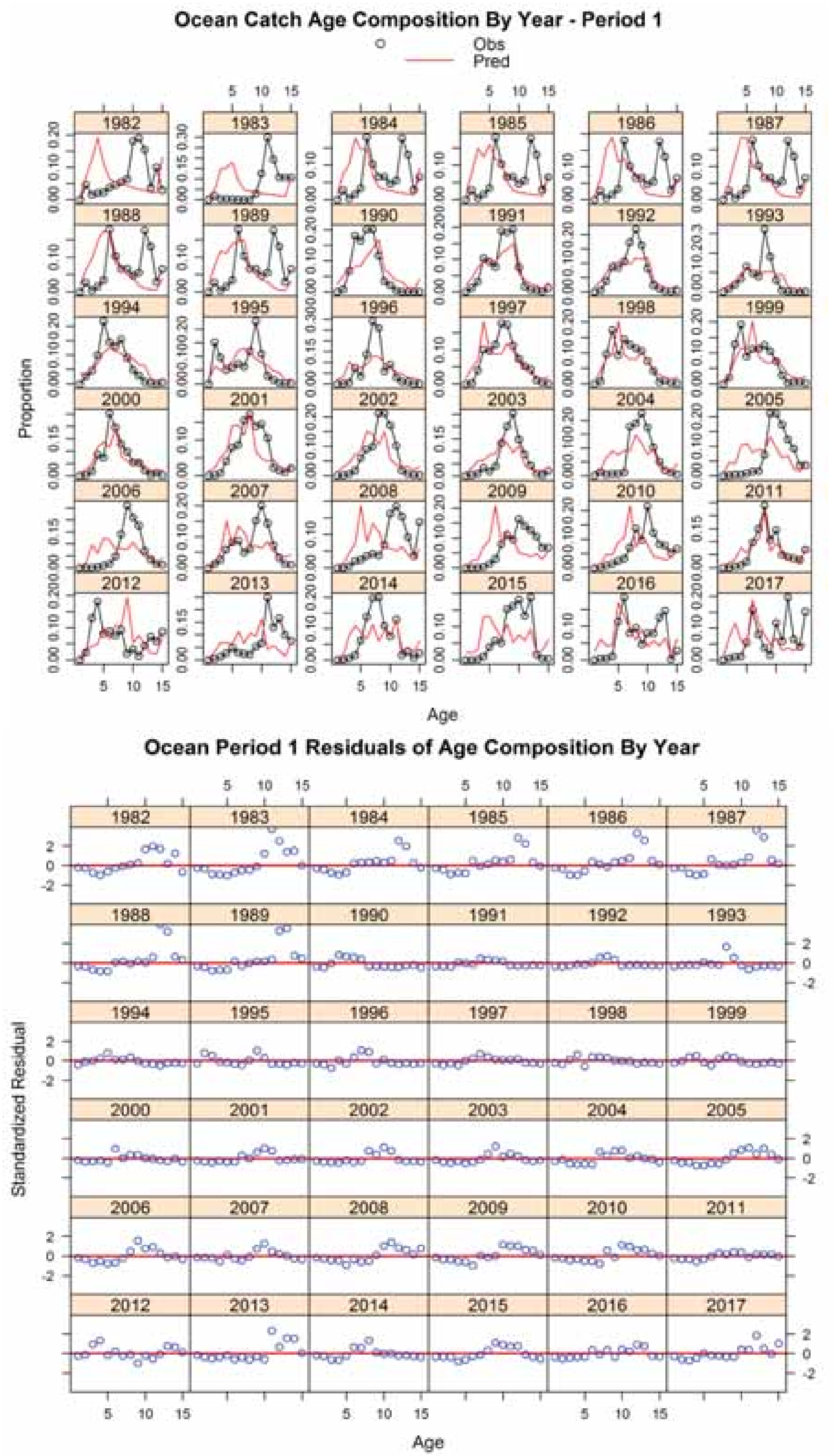




Appendix Figure 6. Observed and predicted estimate of total removal age composition by year and standardized residuals for Stock 1 Bay during period 3.

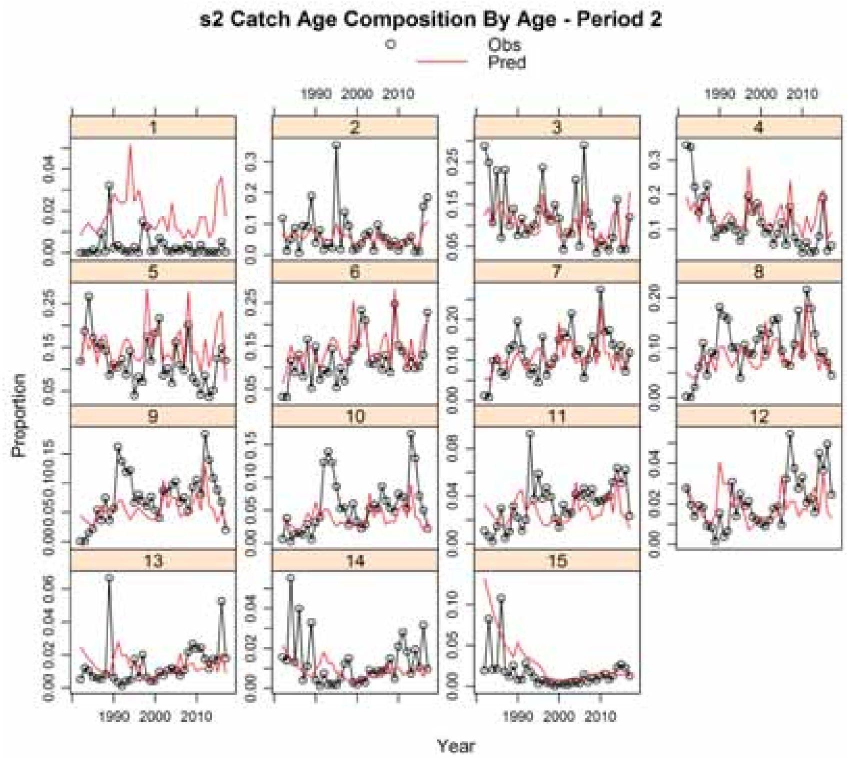


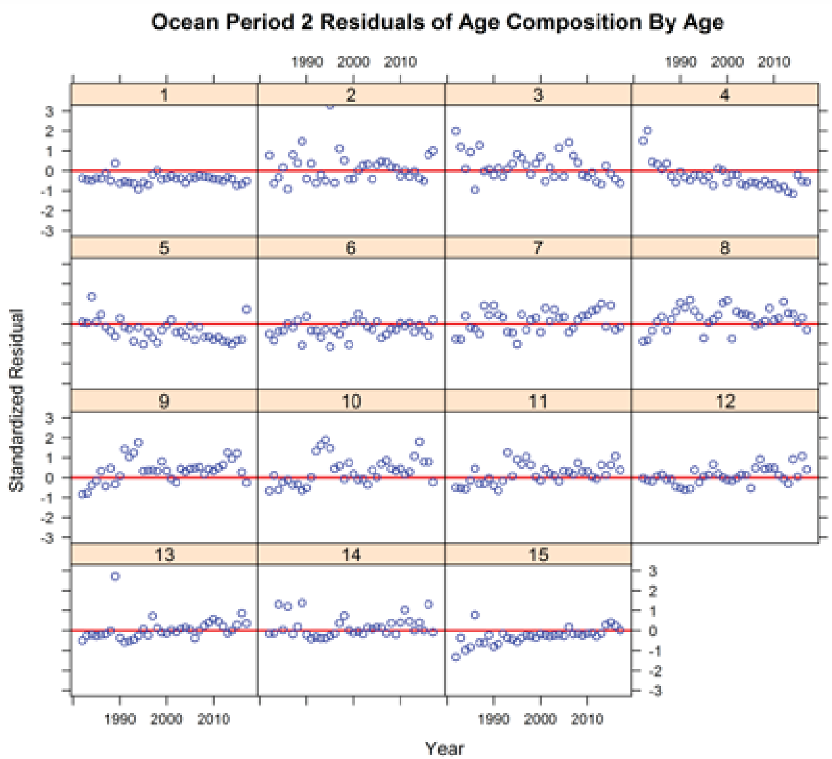




Appendix Figure 7. Observed and predicted estimate of total removal age composition by age and standardized residuals for Ocean during period 1.

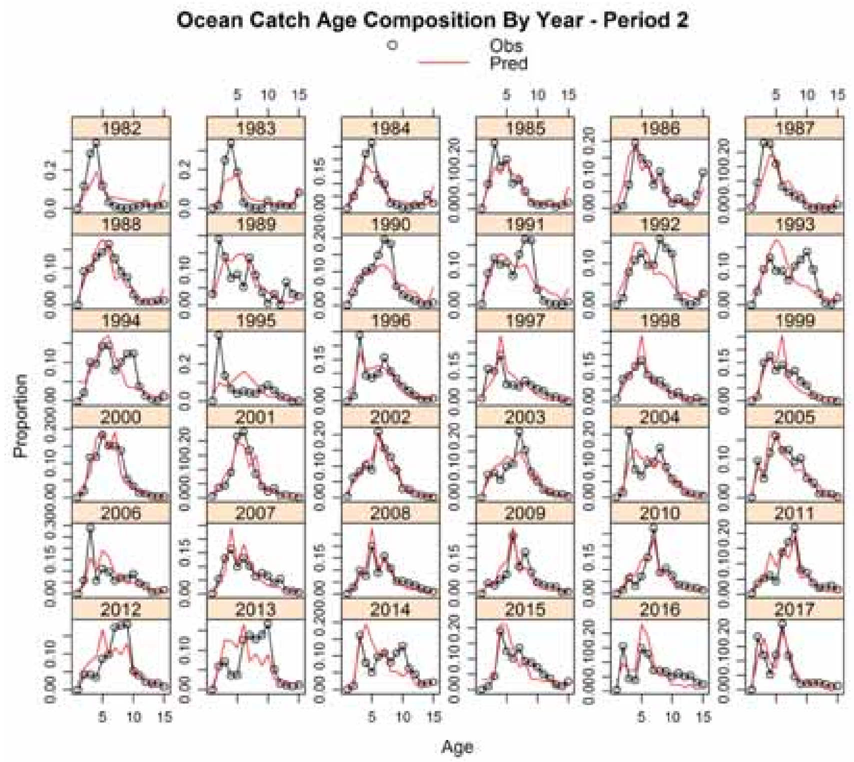


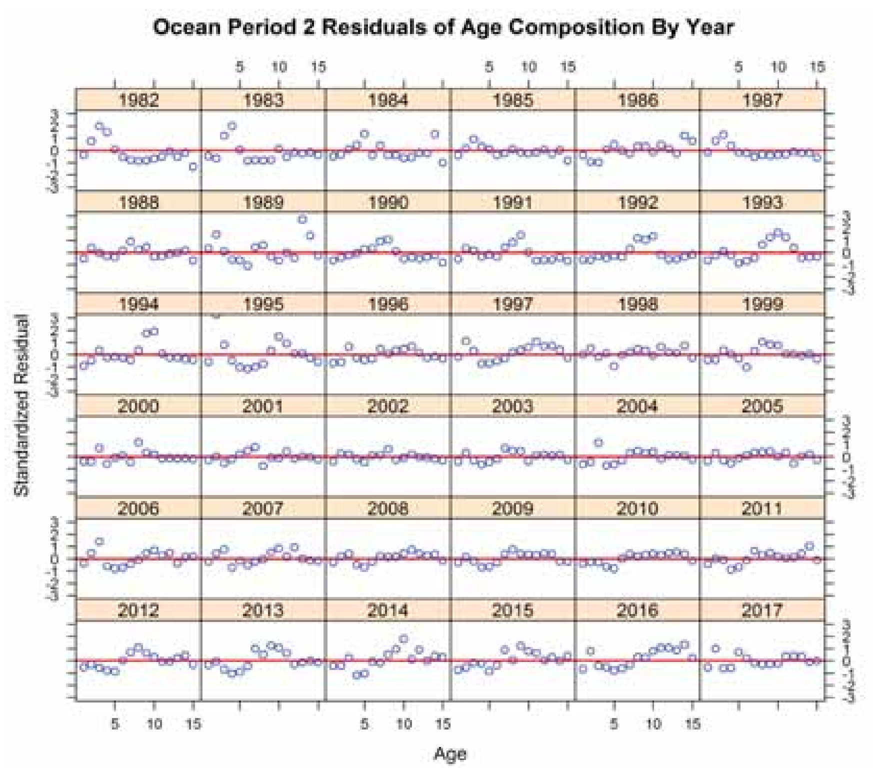

Appendix Figure 8. Observed and predicted estimate of total removal age composition by year and standardized residuals for Ocean during period 1.



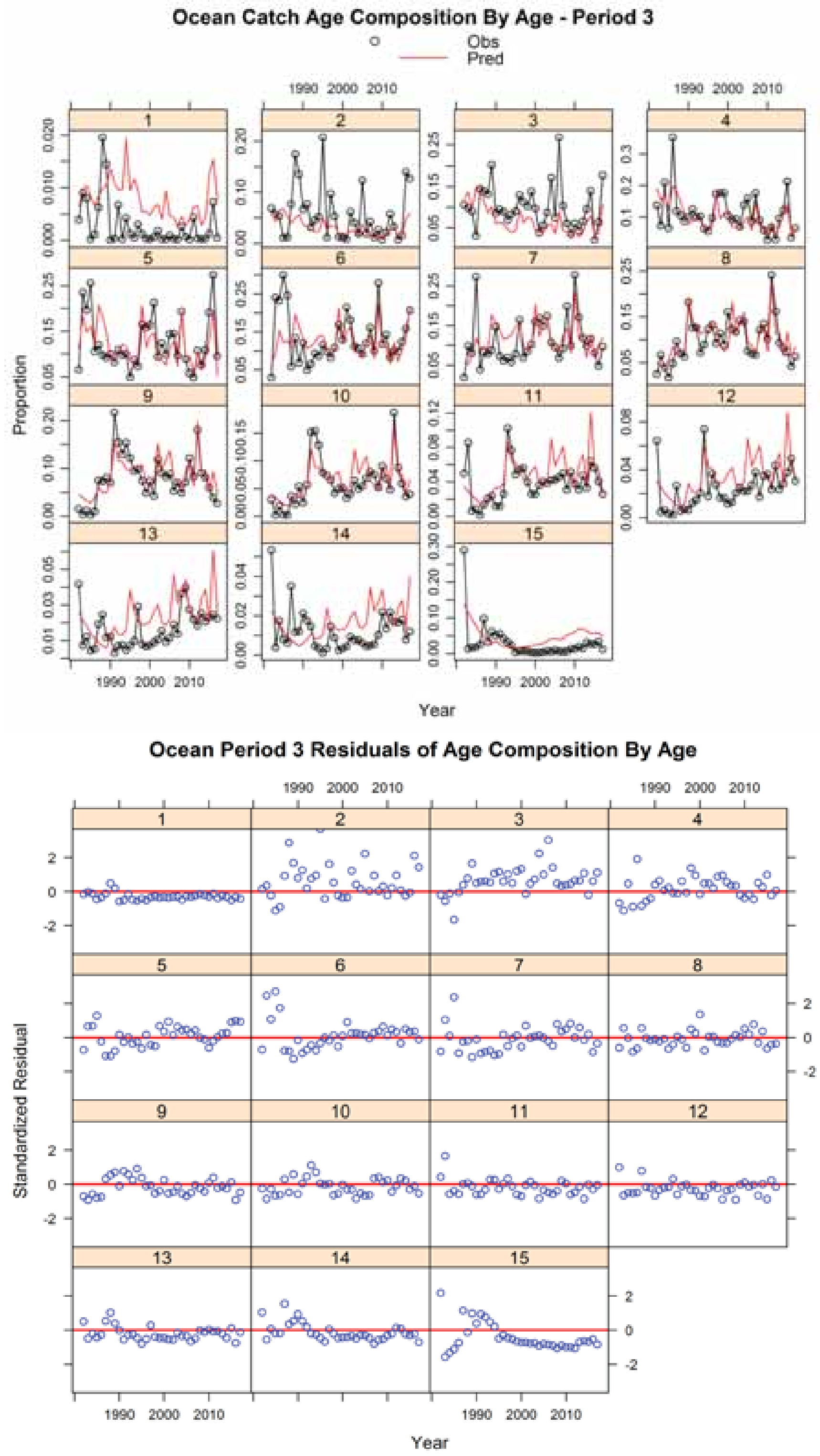




Appendix Figure 9. Observed and predicted estimate of total removal age composition by age and standardized residuals for Ocean during period 2.

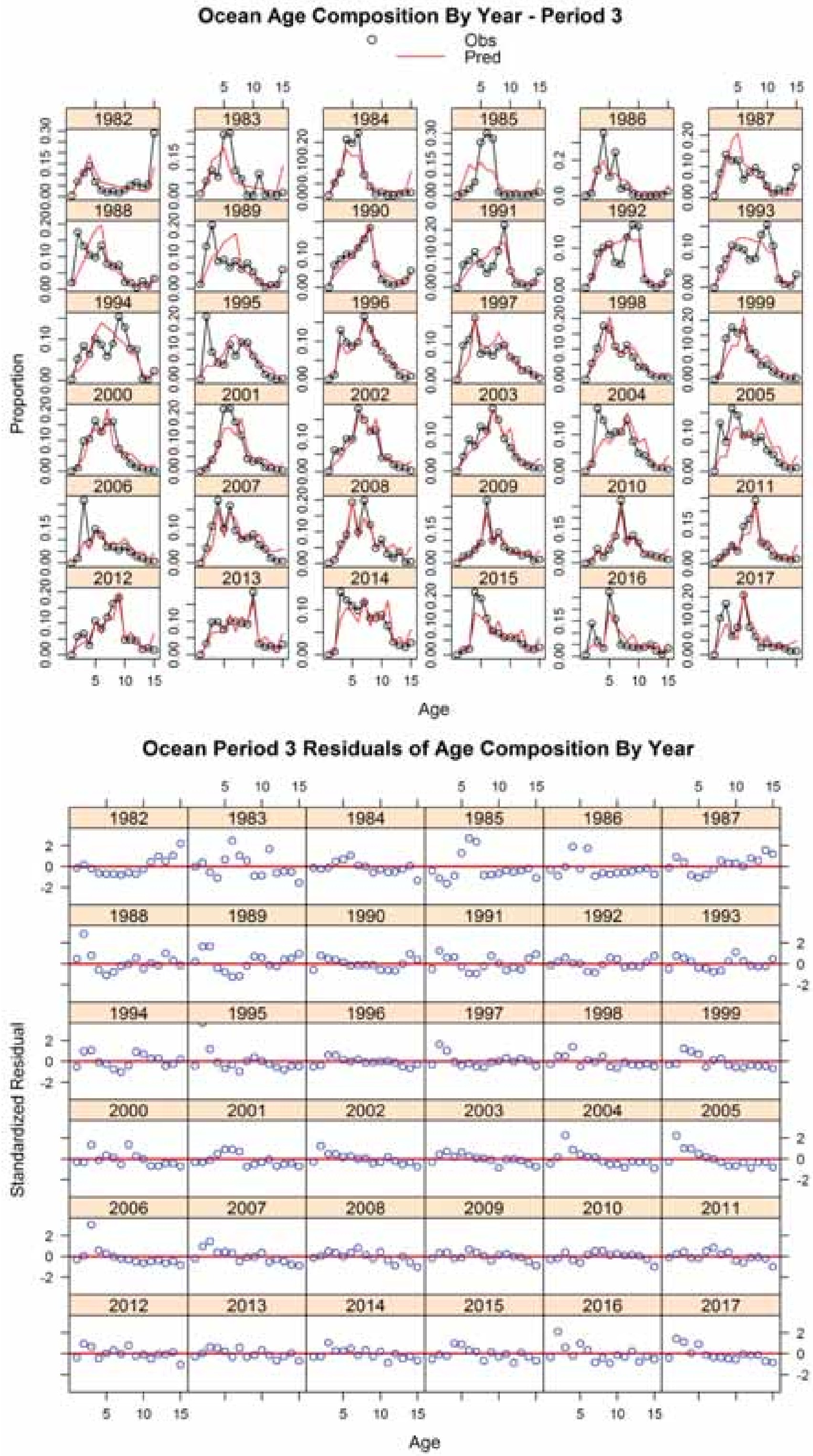


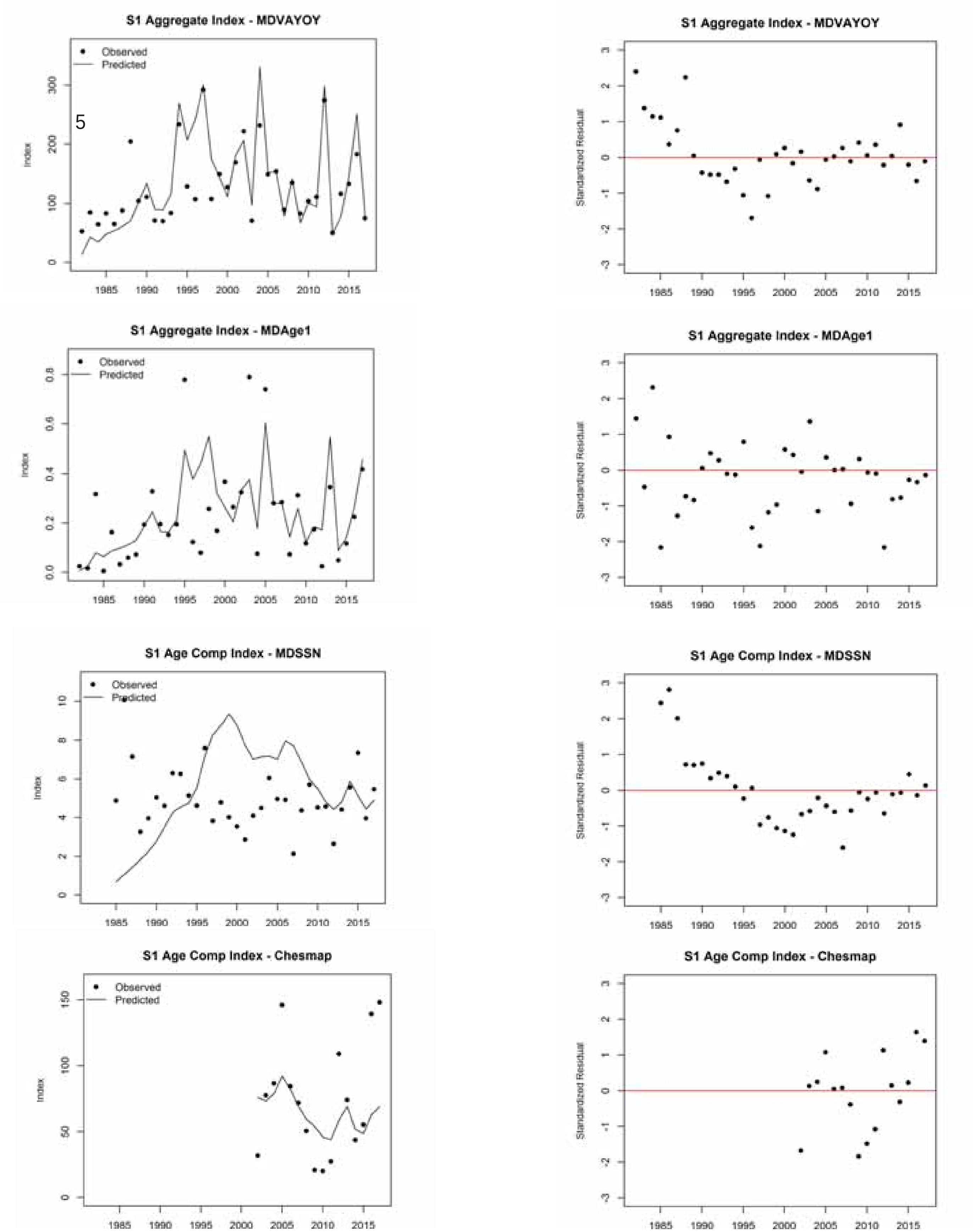

Appendix Figure 10. Observed and predicted estimate of total removal age composition by year and standardized residuals for Ocean during period 2.



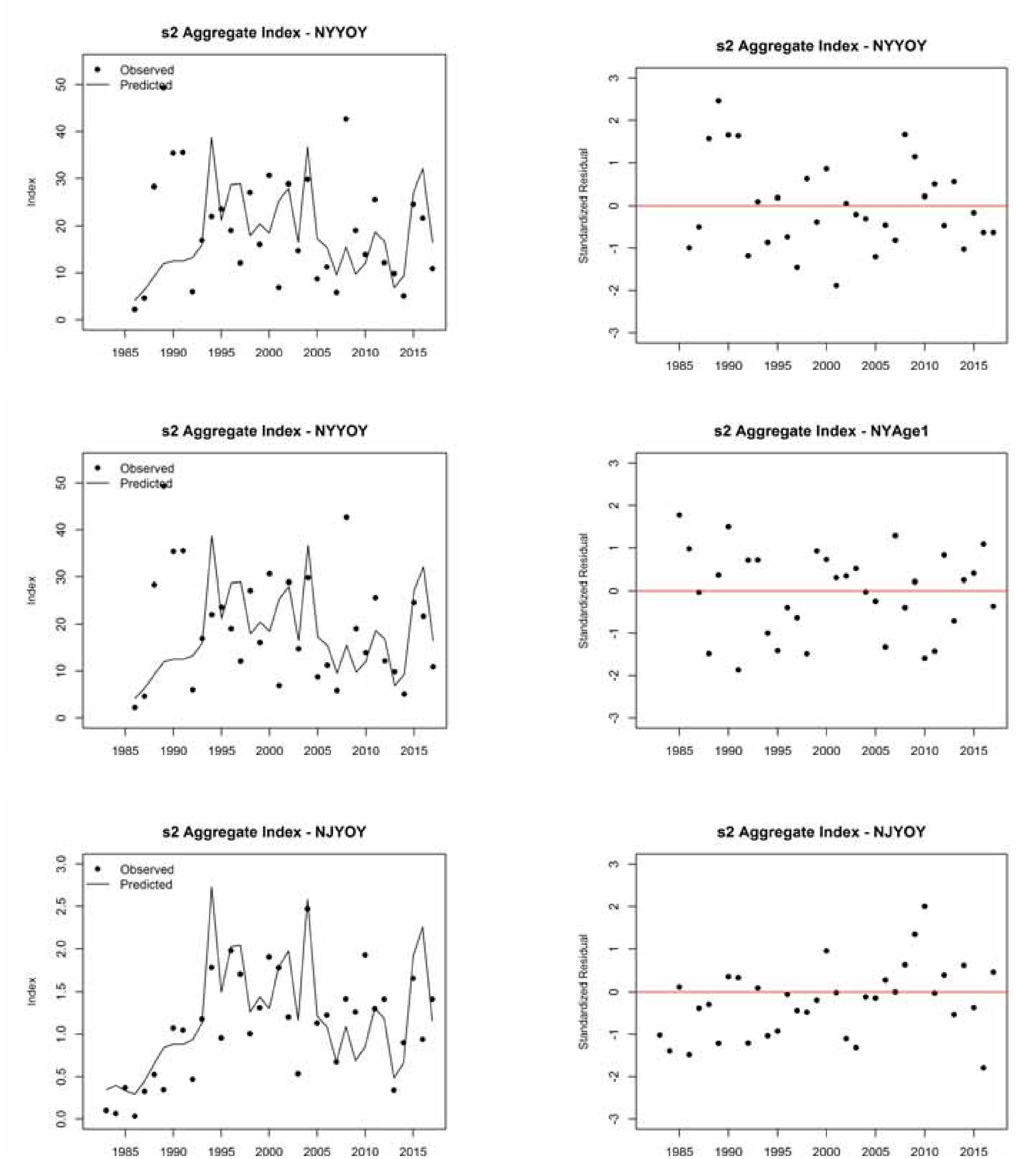

Appendix Figure 8. Observed and predicted estimate of total removal age composition by age and standardized residuals for Ocean during period 3.



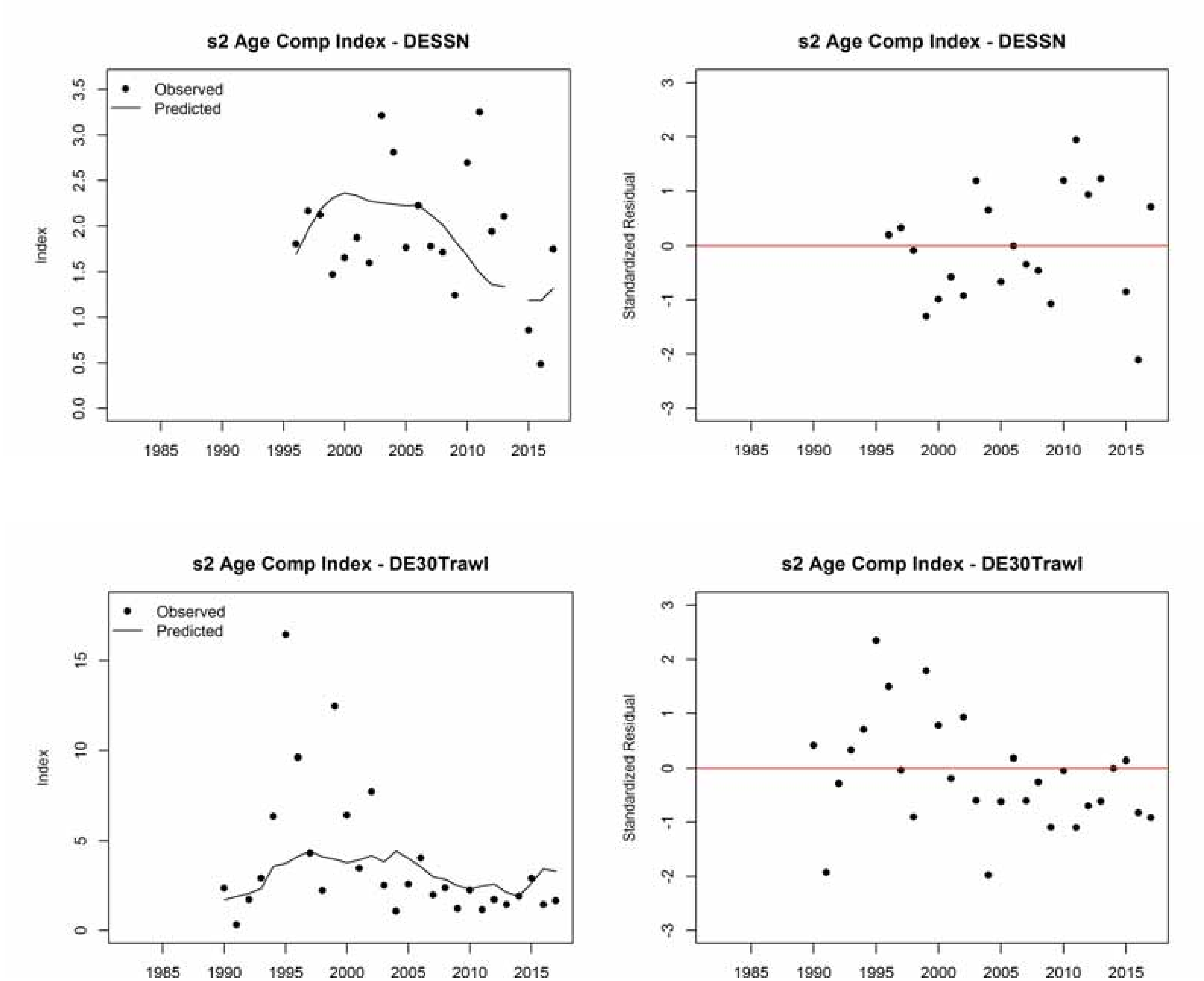

Appendix Figure 11. Observed and predicted estimate of total removal age composition by year and standardized residuals for Ocean during period 3.



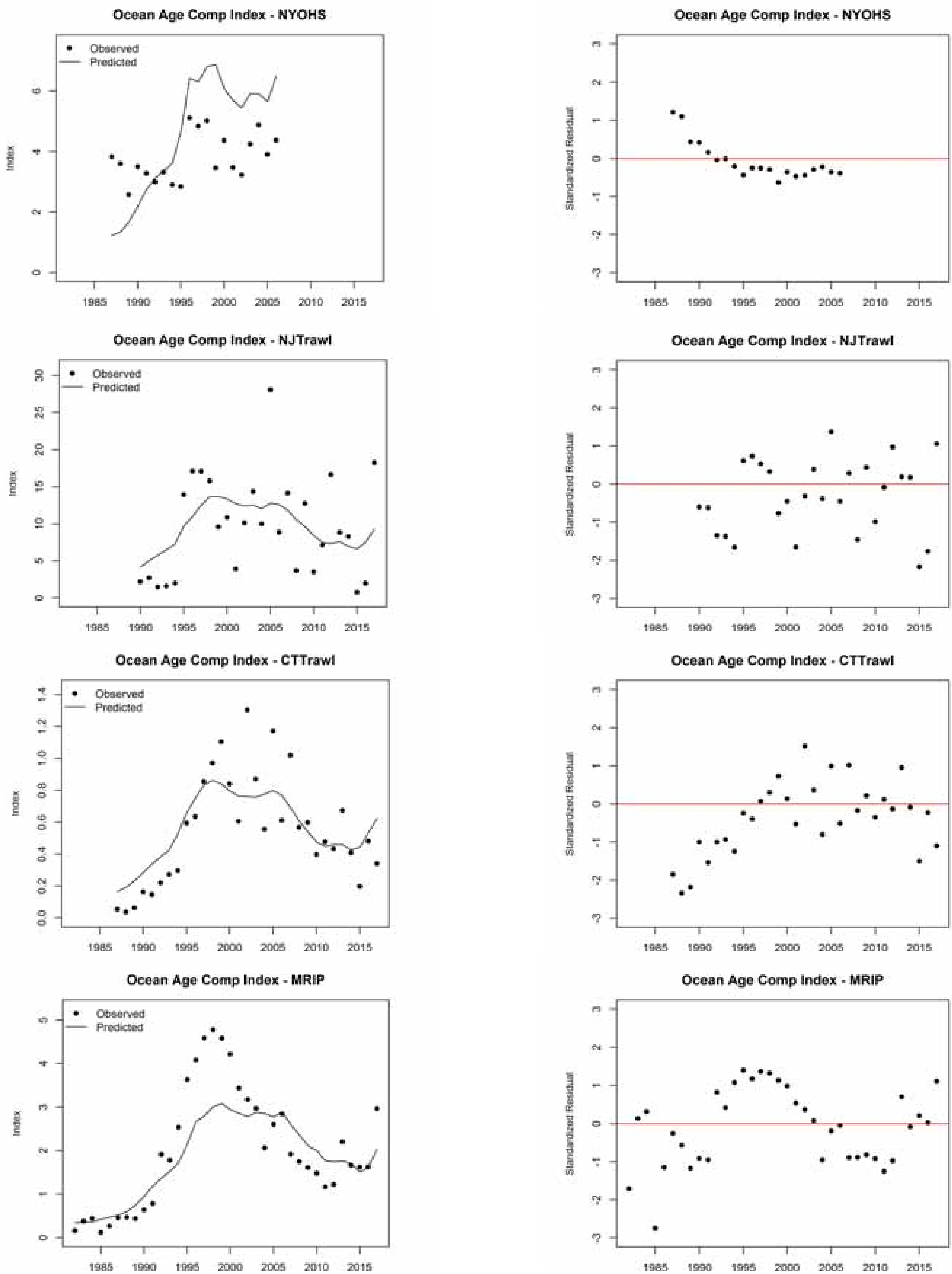

Appendix Figure 12. Observed and predicted indices for Stock 1 in the bay and standardized residual plots.



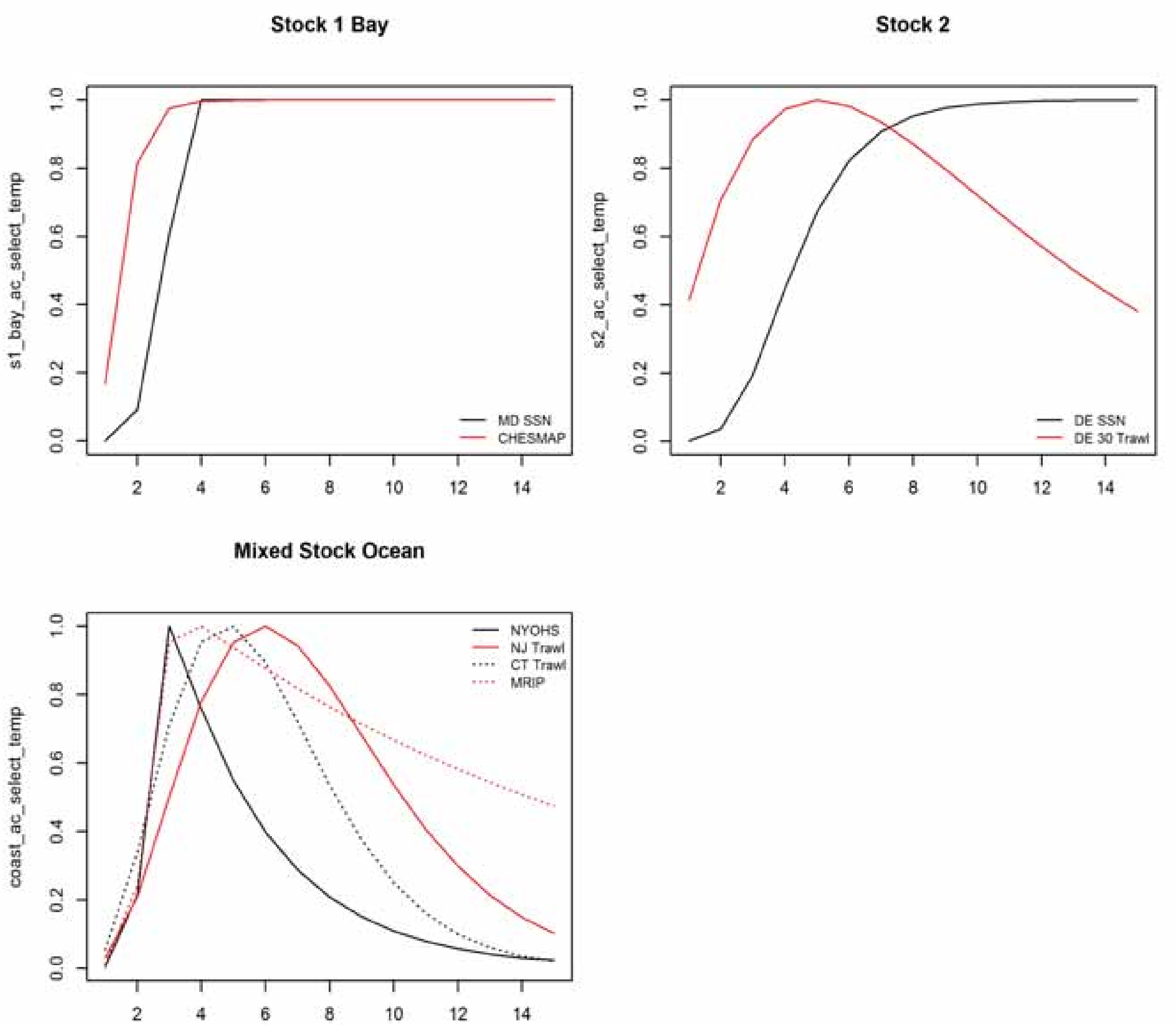

Appendix Figure 13. Observed and predicted YOY and age 1 indices for Stock 2 and standardized residual plots.



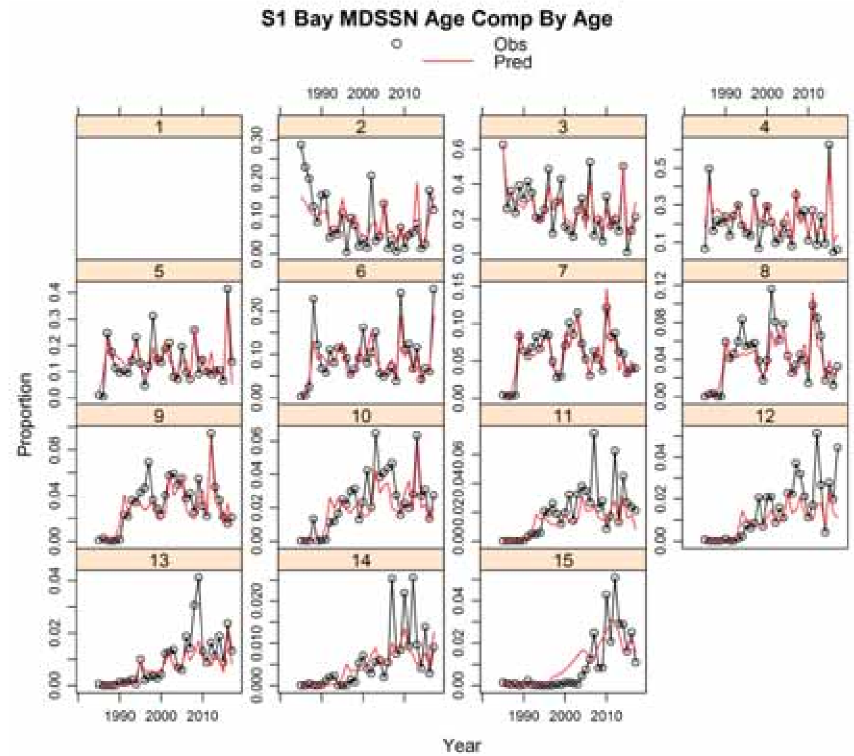

Appendix Figure 14. Observed and predicted age composition survey indices for Stock 2 and standardized residual plots.

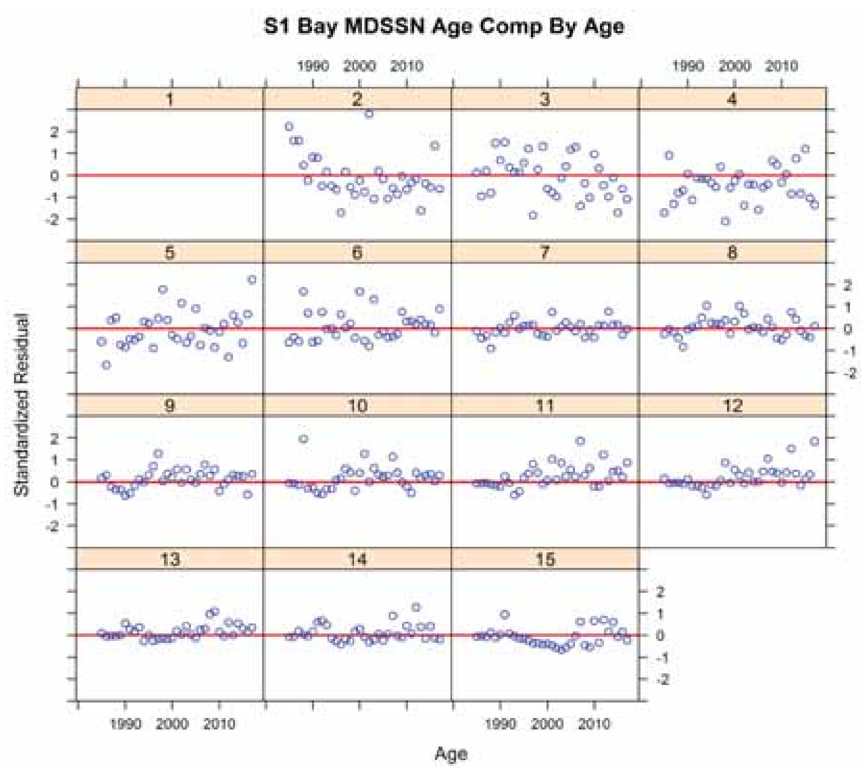



Appendix Figure 15. Observed and predicted age composition survey indices for Mixed Stock and standardized residual plots.

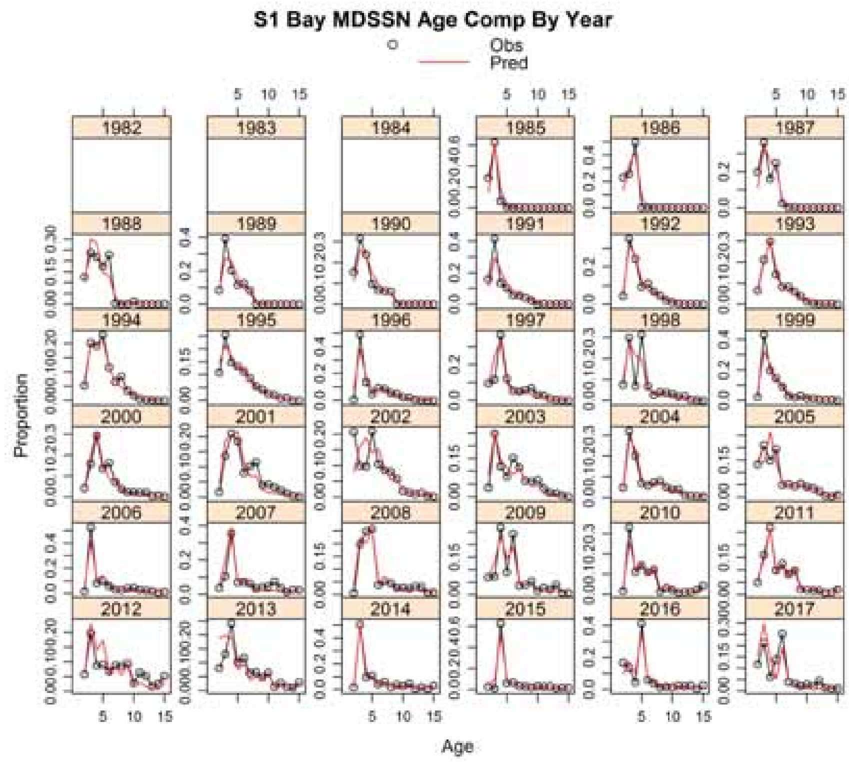


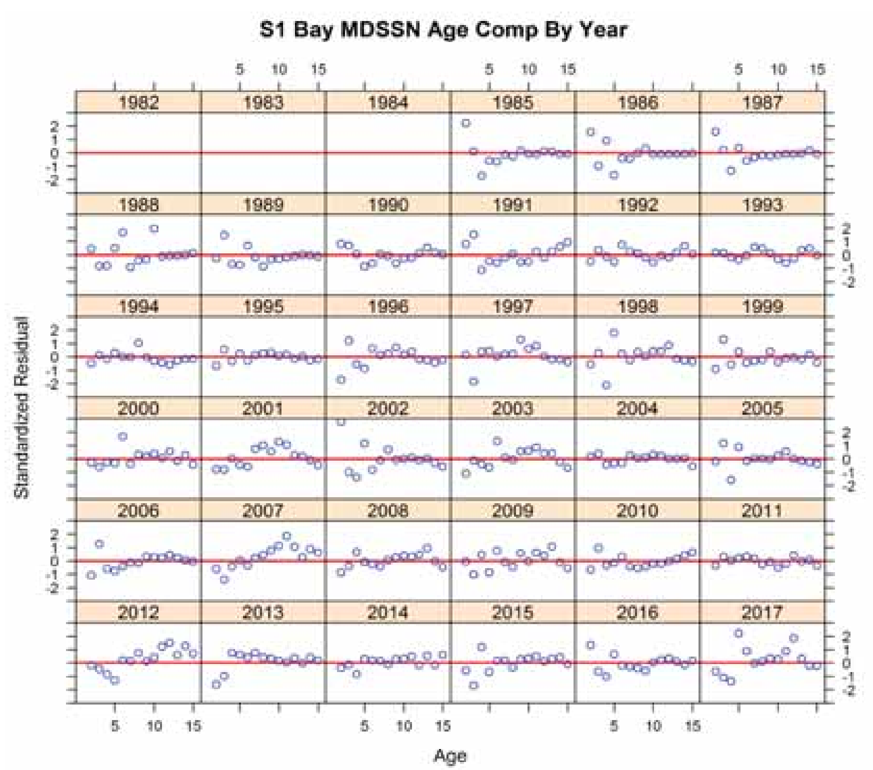

Appendix Figure 16. Selectivity pattern estimated for each age composition survey.



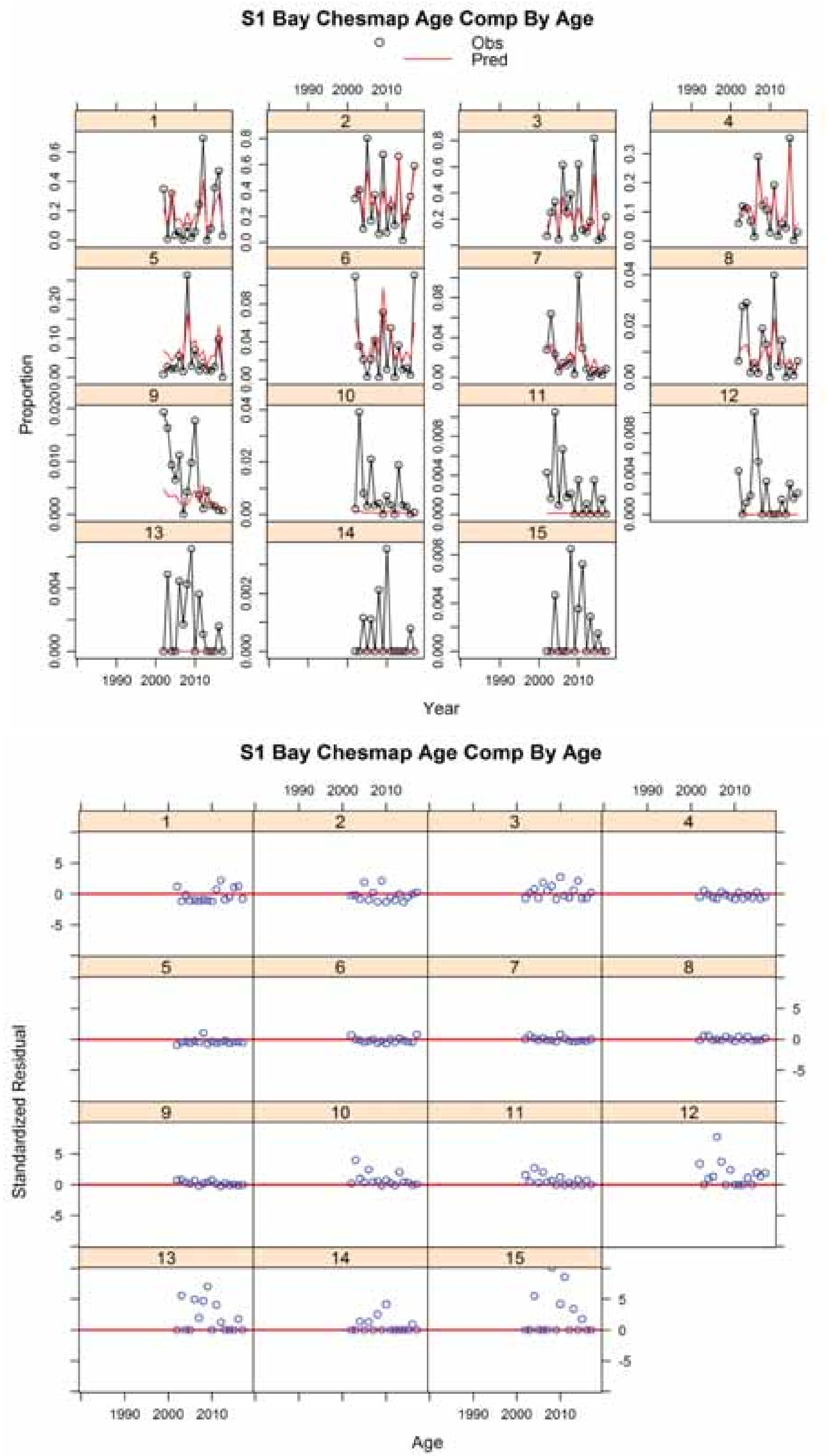




Appendix Figure 17. Observed and predicted age composition for the MDSSN surveys in stock 1 bay by age and standardized residual plots .

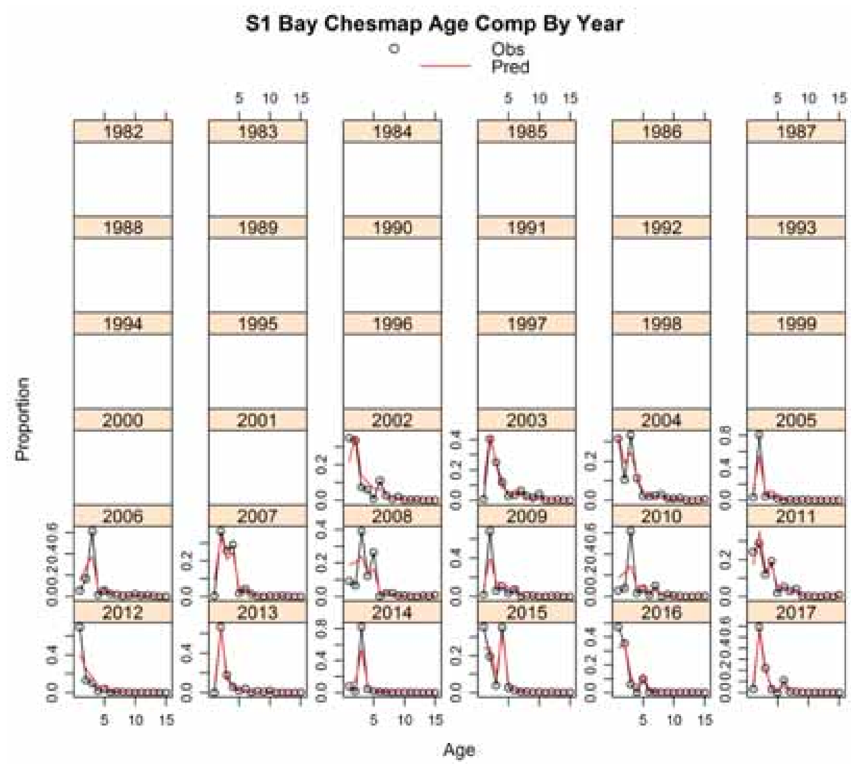


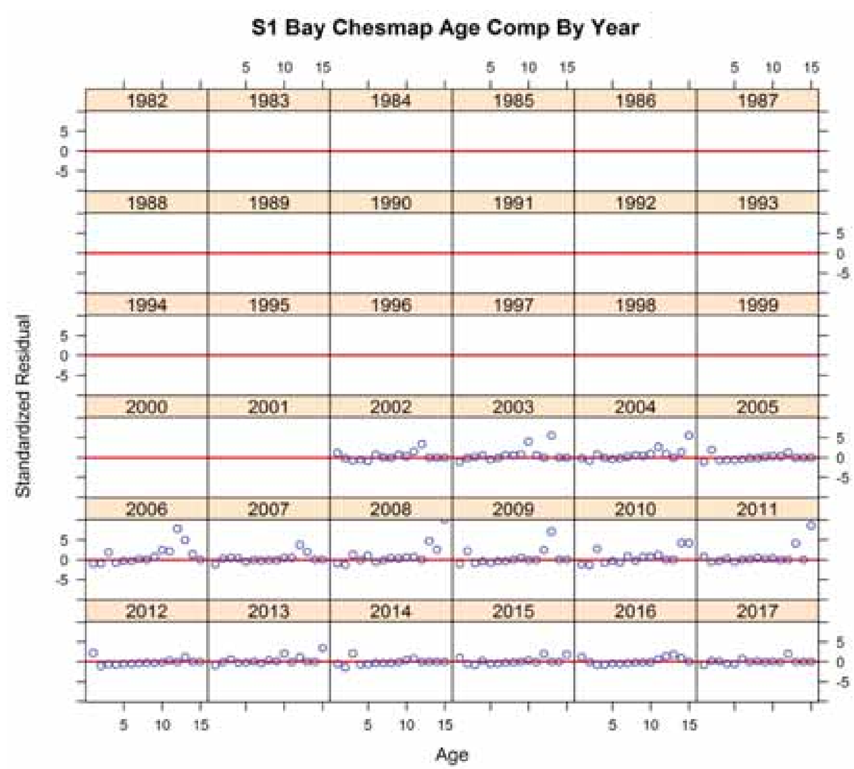




Appendix Figure 18. Observed and predicted age composition for the MDSSN surveys in stock 1 bay by year and standardized residual plots .

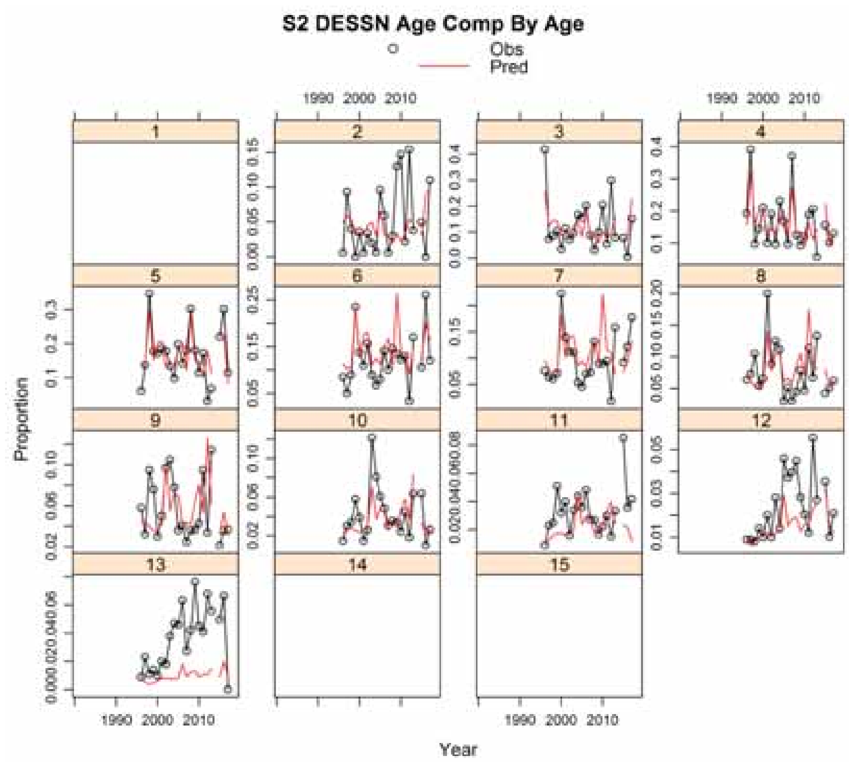


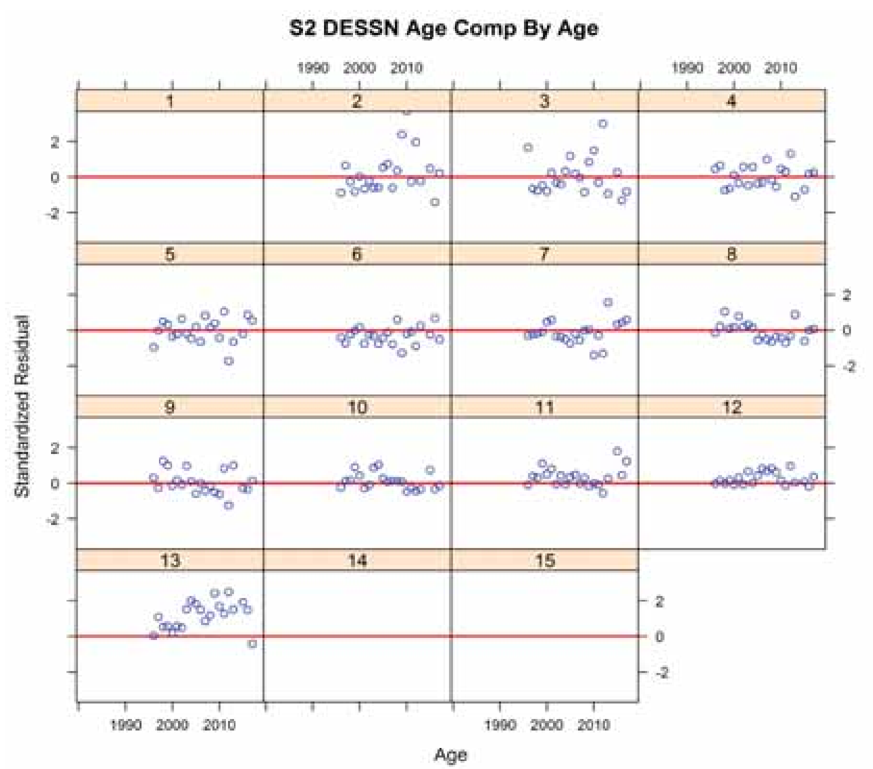

Appendix Figure 19. Observed and predicted age composition for the CHESMAP survey in stock 1 bay by age and standardized residual plots .



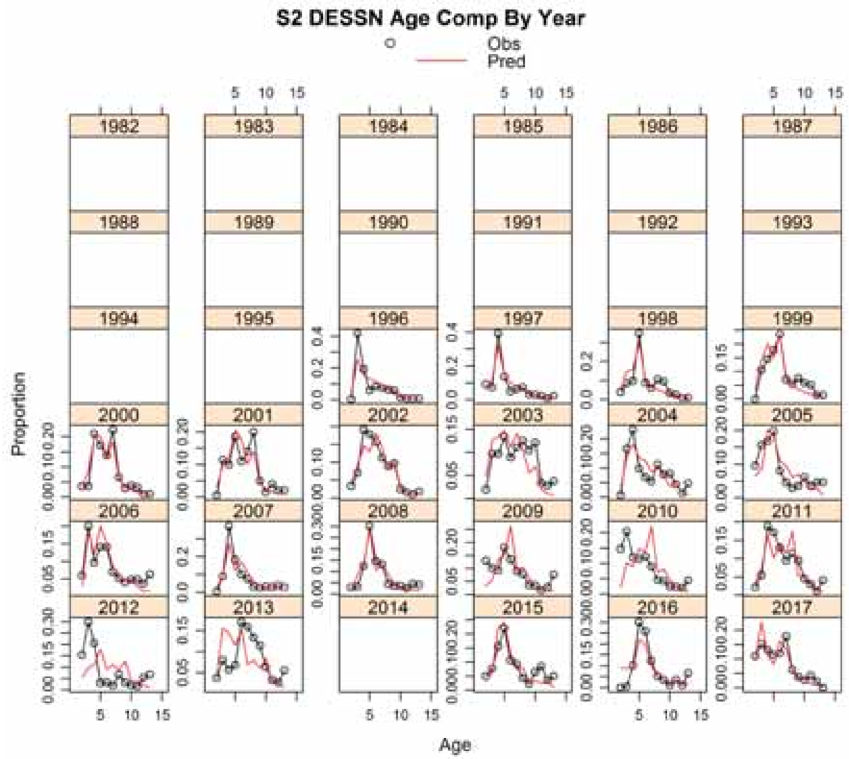



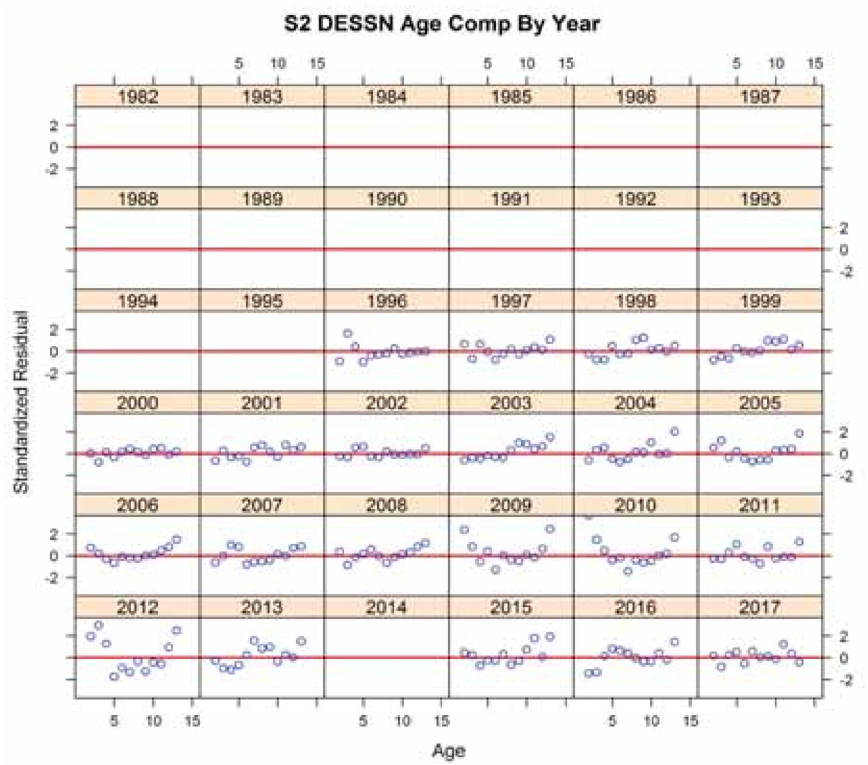

Appendix Figure 20. Observed and predicted age composition for the CHESMAP survey in stock 1 bay by year and standardized residual plots .



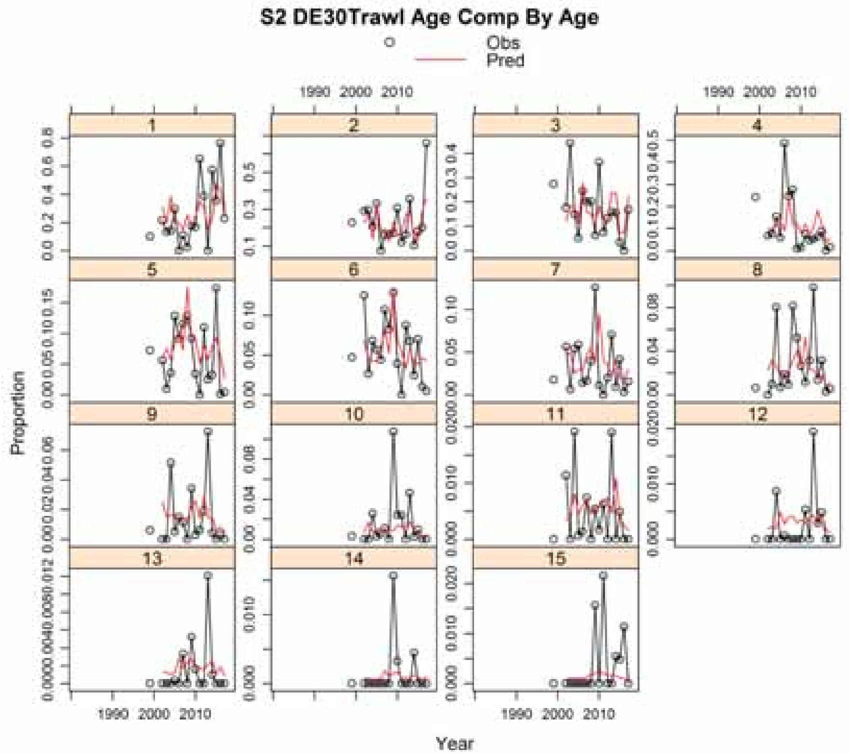



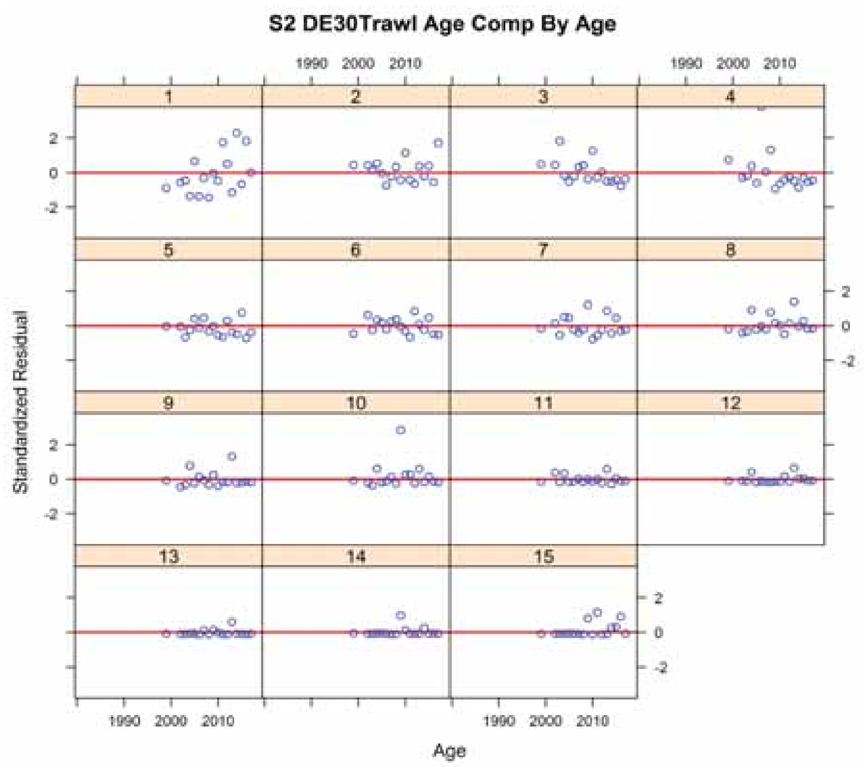

Appendix Figure 21. Observed and predicted age composition for the DESSN survey in stock 2 by age and standardized residual plots.



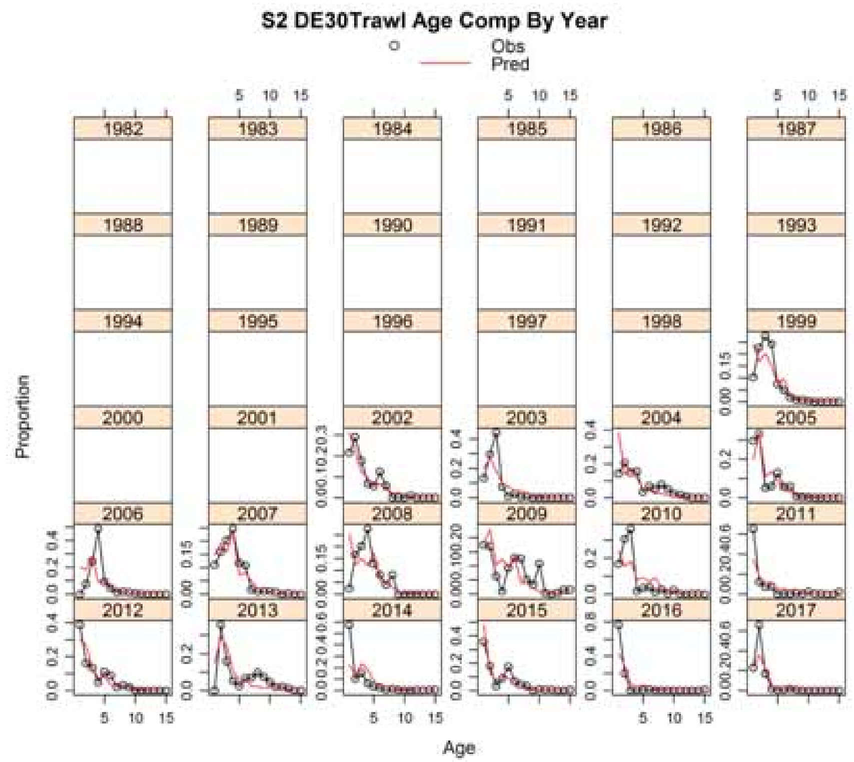



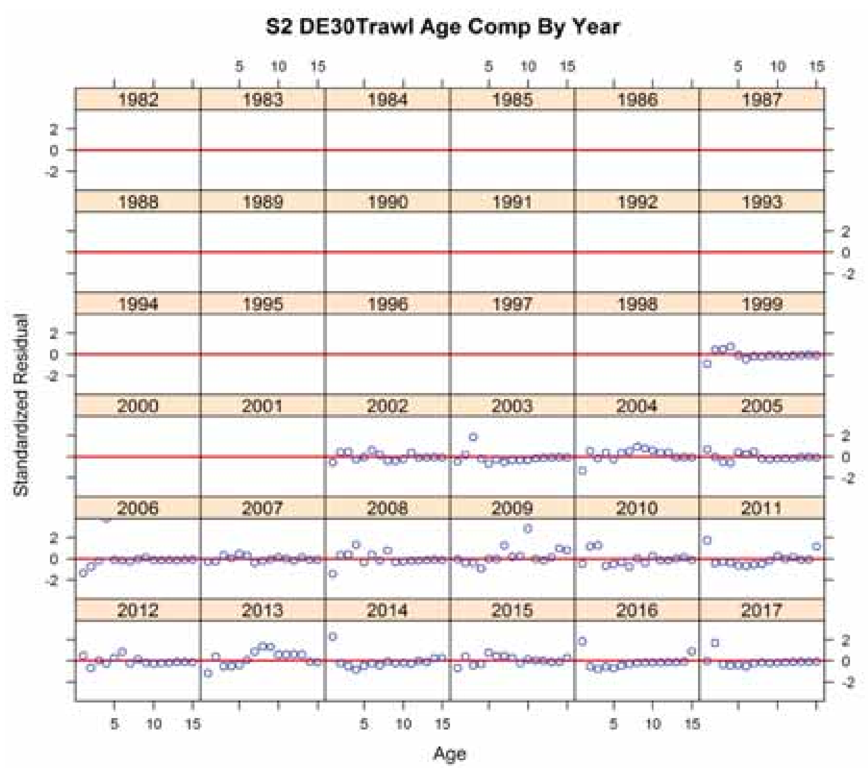

Appendix Figure 22. Observed and predicted age composition for the DESSN survey in stock 2 by year and standardized residual plots.



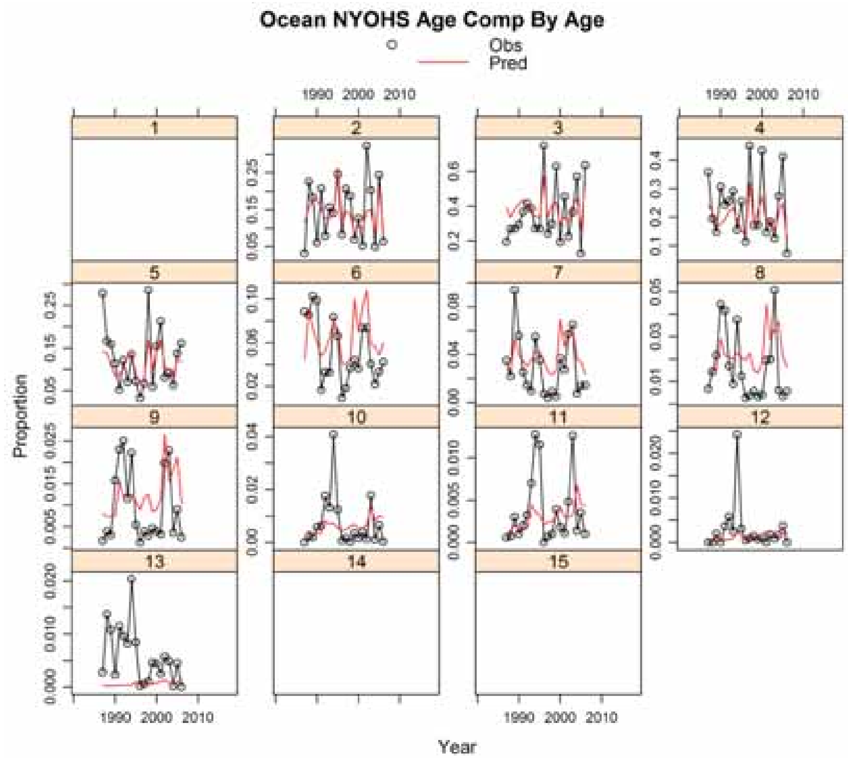



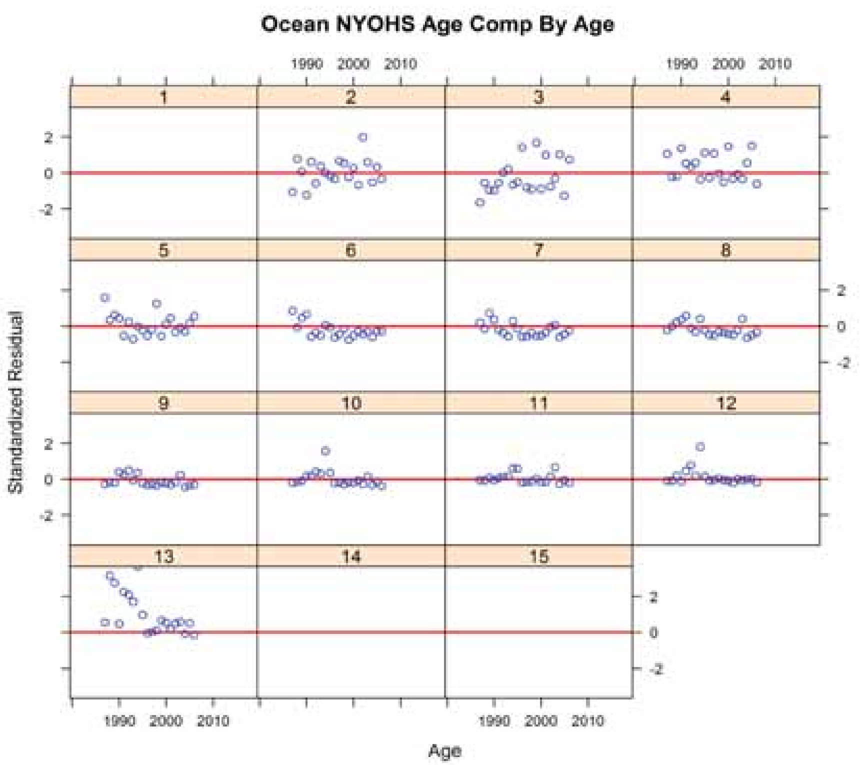

Appendix Figure 23. Observed and predicted age composition for the DE 30' Trawl survey in stock 2 by age and standardized residual plots.



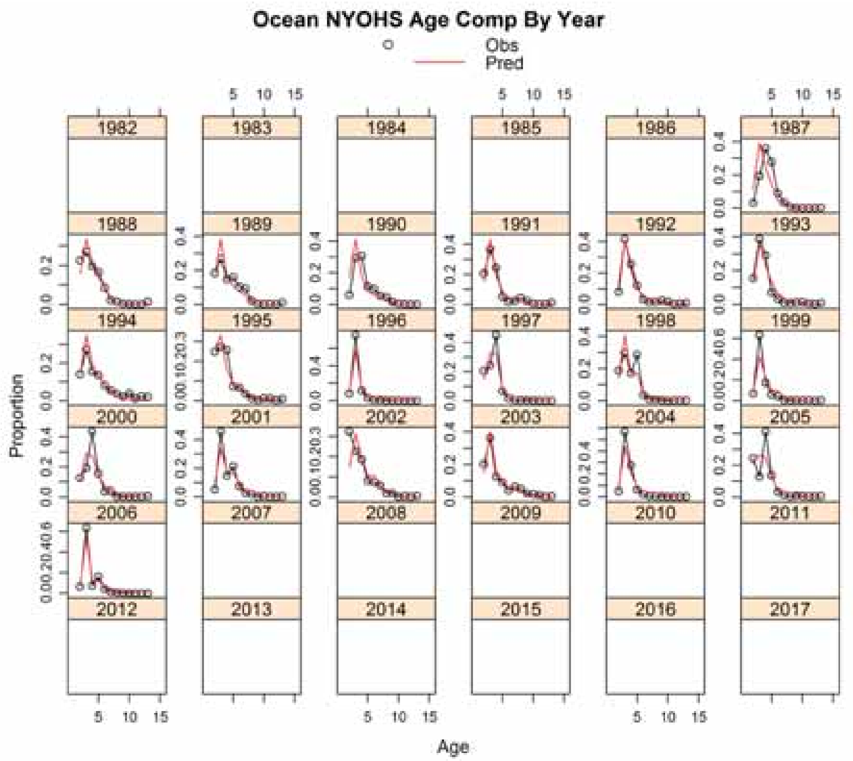



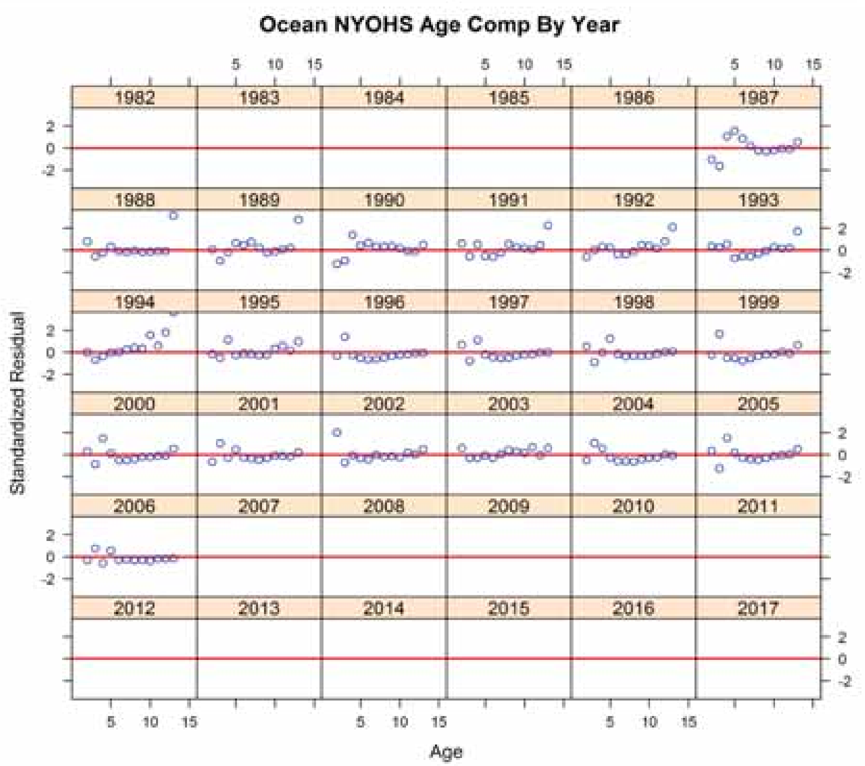

Appendix Figure 24. Observed and predicted age composition for the DE 30’ Trawl survey in stock 2 by year and standardized residual plots.



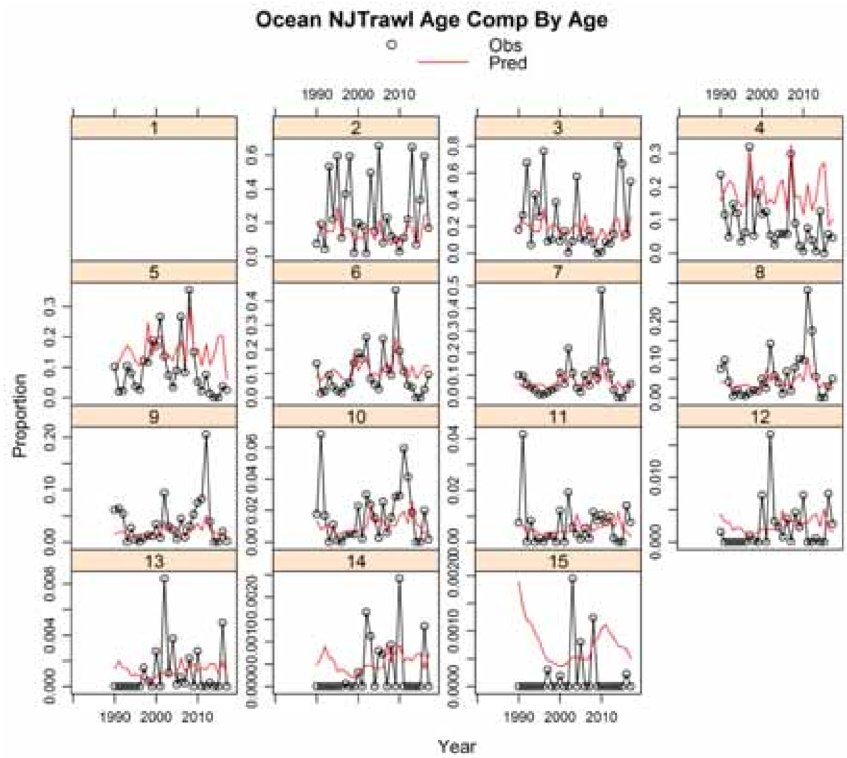



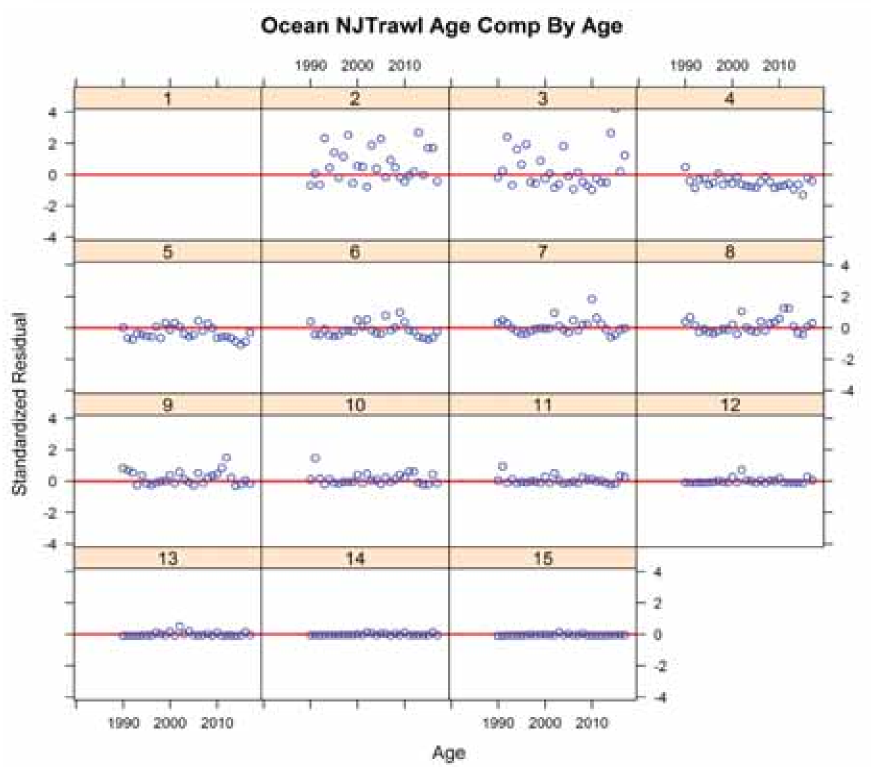

Appendix Figure 25. Observed and predicted age composition for the NY OHS survey in mixed ocean stock by age and standardized residual plots.



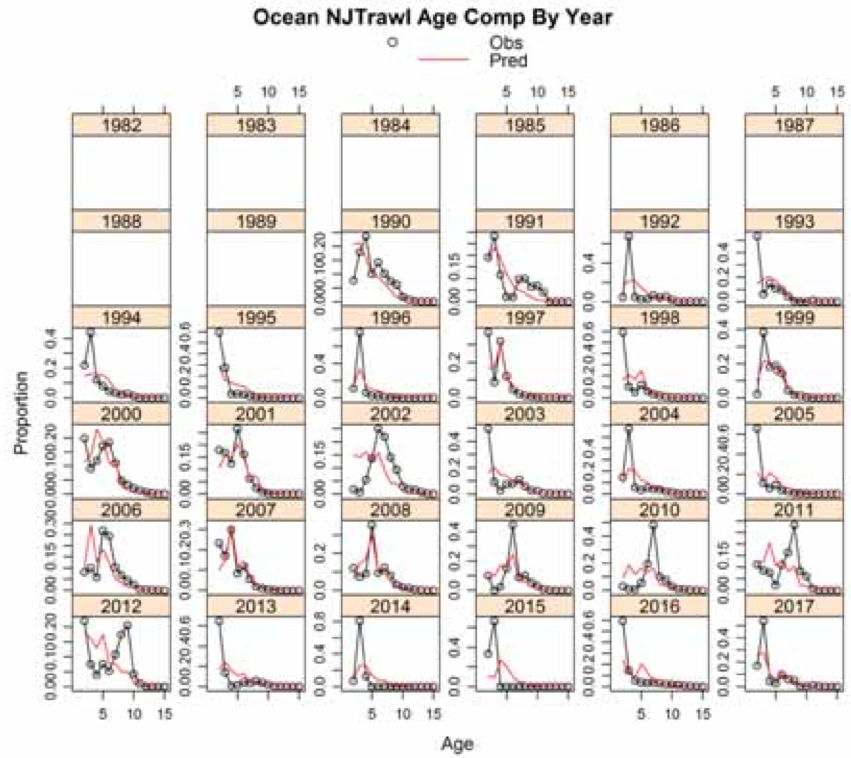



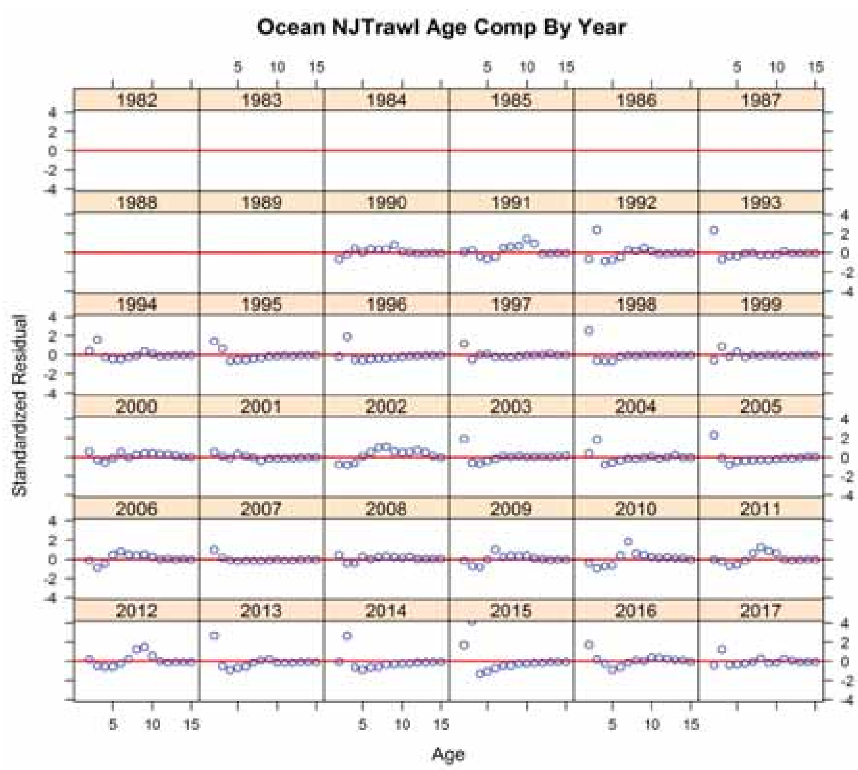

Appendix Figure 26. Observed and predicted age composition for the NY OHS survey in mixed ocean stock by year and standardized residual plots.



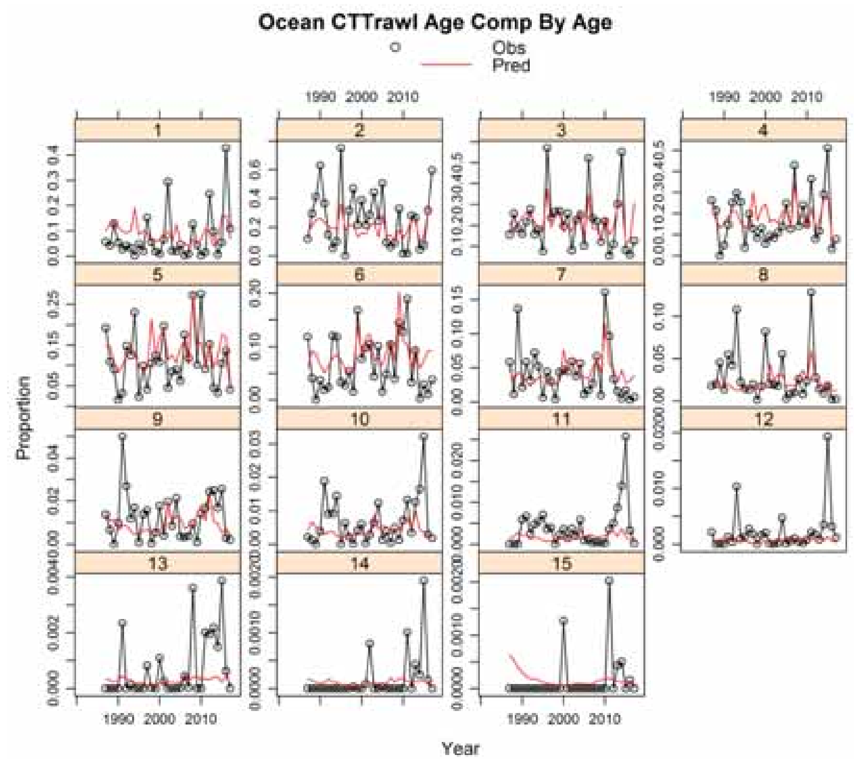



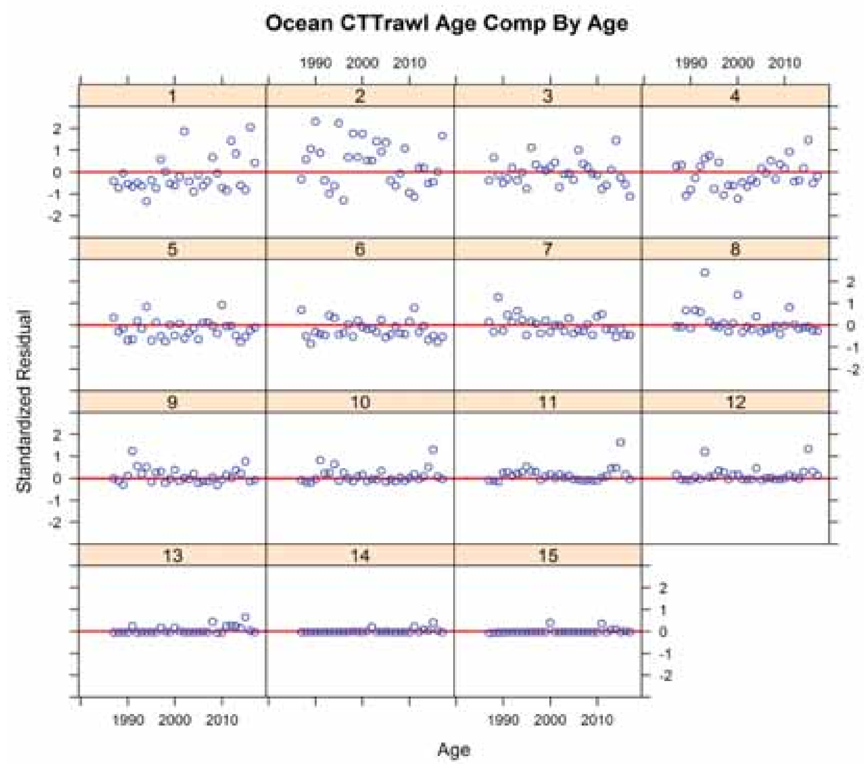

Appendix Figure 27. Observed and predicted age composition for the NJ Trawl survey in mixed ocean stock by age and standardized residual plots.



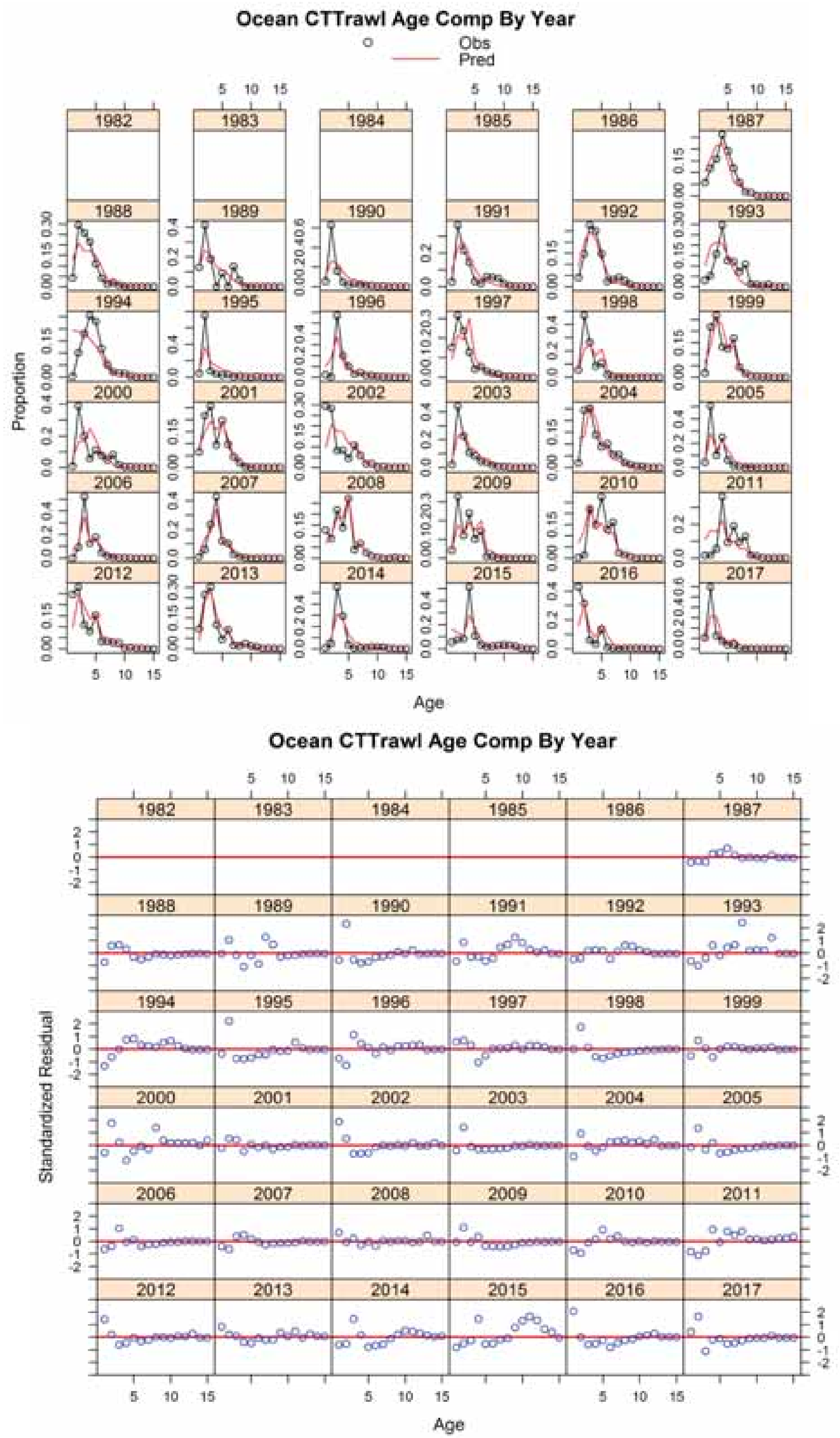




Appendix Figure 28. Observed and predicted age composition for the NJ Trawl survey in mixed ocean stock by year and standardized residual plots.

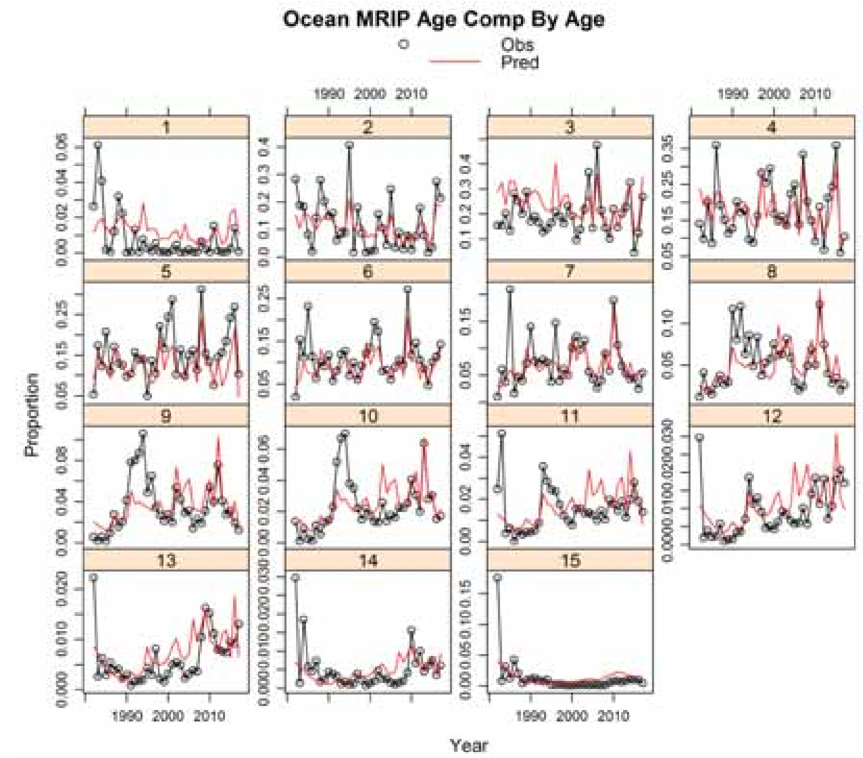


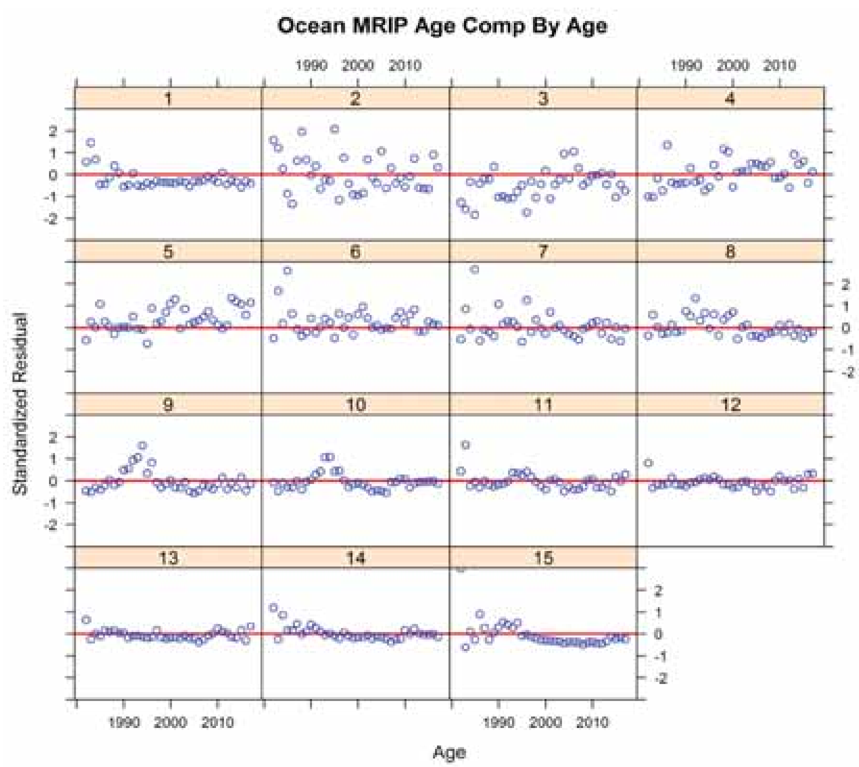




Appendix Figure 29. Observed and predicted age composition for the CT Trawl survey in mixed ocean stock by age and standardized residual plots.

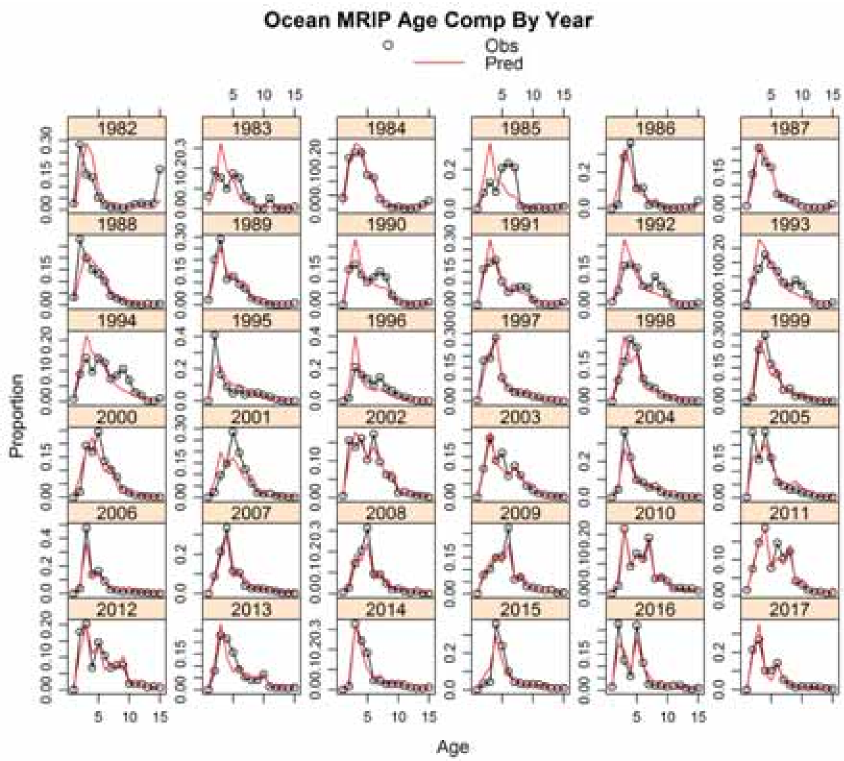


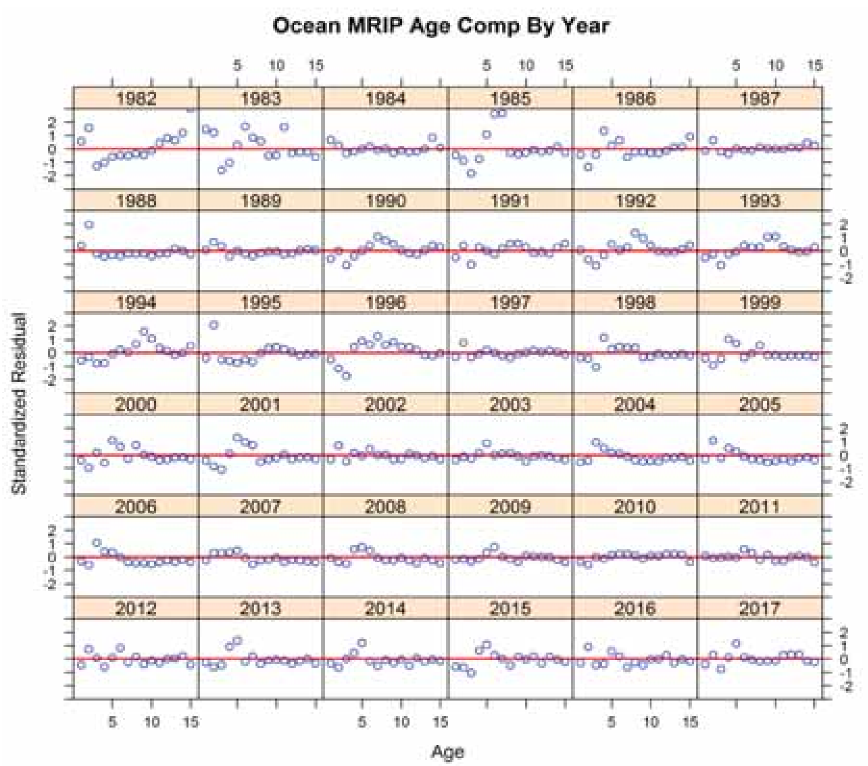

Appendix Figure 30. Observed and predicted age composition for the CT Trawl survey in mixed ocean stock by year and standardized residual plots.




Appendix Figure 31. Observed and predicted age composition for the MRIP survey in mixed ocean stock by age and standardized residual plots.




Appendix Figure 32. Observed and predicted age composition for the MRIP survey in mixed ocean stock by year and standardized residual plots.

**Appendix B10. Model Structure, Parameterization, Diagnostic Plots, and Output for the Non-Migration SCA Model for Atlantic Striped Bass**

Table 1. Model structure, equation, and data inputs used in this assessment.

| General Definitions | Symbol | Description/Definition |
|---|---|---|
| Year Index | $y$ | $y$ = {1982,..,2017} for catch. $y$ = {1970,..,2017} for indices. |
| Age Index | $a$ | $a$ = {1,..,15+} |
| Fleet Index | $f$ | $f$ = {1: Chesapeake Bay, 2: Coast } |
| Indices Index: | $t$ | $t$ = {1,..,14} |
| **Input Data** | **Symbol** | **Description/Definition** |
| Observed Fleet Catch | $C_{f,y}$ | Reported number of striped bass killed each year ($y$) by fleet (f) |
| Coefficient of Variation for Fleets | $CV_{f,y}$ | Calculated from MRIP harvest and releases estimates with associated proportional standard errors (commercial harvest from census – no error) |
| Observed Fleet Age Compositions | $P_{f,y,a}$ | Proportion-at-age ($a$) for each year ($y$) and fleet ($f$) |
| Observed Total Indices of Relative Abundance | $I_{t,y}$ | Reported by various states.<br>YOY and Age 1 Indices: 6<br>Indices with Age Composition: 8 (1 fishery-dependent; 7 fishery-independent) |
| Coefficient of Variation for Indices | $CV_{t,y}$ | Calculated from indices and associated standard errors |
| Observed Age Compositions of Indices of Relative Abundance | $P_{t,y,a}$ | Proportion-at-age ($a$) for each year ($y$) and index ($t$) |
| Effective Sample Size | $\hat{\hat{n}}$ | Starting Values<br>Fleets: Bay – 50, Ocean – 50<br>Indices: NYOHS – 19.1, NJ Trawl – 4.8, MDSSN – 17.6, DESSN – 25.2, MRIP – 16.8, CTLIST – 16.8, DE30FT – 16.8, ChesMP – 16.8.<br><br>The multiplier from equation 1.8 method of Francis (2011) is used to adjust the starting values. |

Table 1 cont.

| Population Model | Symbol | Equation |
|---|---|---|
| Age-1 numbers | $\hat{N}_{y,1}$ | $N_{1,1,y,1} = \hat{\bar{N}}_1 \cdot \exp^{\hat{e}_{1,y} - 0.5\hat{\sigma}^2_{1,R}}$ <br> $\hat{\sigma}_R = \sqrt{\frac{\sum_y (\hat{e}_y - \hat{\bar{e}})^2}{n-1}}$ <br> where $e_y$ are independent and identically distributed normal random variables with zero mean and constant variance and are constrained to sum to zero over all years |
| Abundance-at-Age | $\hat{N}_{y,a}$ | First year (ages 2-A in 1970): $\hat{N}_{y,a} = \hat{N}_{y,a-1} \exp^{-\hat{F}_{1982a-1} - M_{1982a-1}}$ <br> Rest of years (ages 2-14): $\hat{N}_{y,a} = \hat{N}_{y-1,a-1} \exp^{-\hat{F}_{y-1,a-1} - M_{y-1,a-1}}$ |
| Plus-group abundance-at-age | $\hat{N}_{y,A}$ | $\hat{N}_{y,A} = \hat{N}_{y-1,A-1} \exp^{-\hat{F}_{y-1,A-1} - M_{y-1,A-1}} + \hat{N}_{y-1,A} \exp^{-\hat{F}_{y-1,A} - M_{y-1,A}}$ |
| Fishing Mortality | $\hat{F}_{f,y,a}$ | $\hat{F}_{f,y,a} = \hat{F}_{f,y} \cdot \hat{s}_{f,a}$ where $F_{f,y}$ and $s_{f,a}$ are estimated parameters |
| Total Mortality | $\hat{Z}_{y,a}$ | $Z_{y,a} = F_{y,a} + M_{y,a}$ |
| Fleet Selectivity | $\hat{s}_{f,a}$ | Fleet 1 (Chespeake Bay): 1982-1984, 1985-1989, 1990-1995, 1996-2017 <br> $\hat{s}_a = \frac{1}{1-\hat{\gamma}} \cdot \left(\frac{1-\hat{\gamma}}{\hat{\gamma}}\right)^{\hat{\gamma}} \frac{\exp^{\hat{\alpha}\hat{\gamma}(\hat{\beta}-a)}}{1+\exp^{\hat{\alpha}(\hat{\beta}-a)}}$ <br> Fleet 2 (Coast): 1982-1984, 1985-1989, 1990-1996, 1997-2017 <br> $\hat{s}_a = \exp^{(-\exp^{-\hat{\beta}(a-\hat{\alpha})})}$ |
| Predicted Catch-At-Age | $\hat{C}_{f,y,a}$ | $\hat{C}_{f,y,a} = \frac{\hat{F}_{f,y,a}}{\hat{F}_{f,y,a} + M_{y,a}} \cdot (1 - \exp^{-\hat{F}_{y,a} - M_{y,a}}) \cdot \hat{N}_{y,a}$ |

Table 1 cont.

| Population Model | Symbol | Equation |
|---|---|---|
| Predicted Total Catch | $\hat{C}_{f,y}$ | $\hat{C}_{f,y} = \sum_a \hat{C}_{f,y,a}$ |
| Predicted Proportions of Catch-At-Age | $\hat{P}_{f,y,a}$ | $\hat{P}_{f,y,a} = \frac{\hat{C}_{f,y,a}}{\sum_a \hat{C}_{f,y,a}}$ |
| Predicted Aggregated Indices of Relative Abundance | $\hat{I}_{t,y,\sum a}$ | $\hat{I}_{t,y,\Sigma a} = \hat{q}_t \cdot \sum_a \hat{N}_{y,a} \cdot \exp^{-p_t \cdot Z_{y,a}}$ <br> where $q_t$ is the estimated catchability coefficient of index $t$ and $p_t$ is the fraction of the year when the survey takes place. |
| Predicted Age-Specific Indices of Relative Abundance | $\hat{I}_{t,y,a}$ | $\hat{I}_{t,y,a} = \hat{q}_t \cdot \hat{s}_{t,a} \cdot \hat{N}_{y,a} \cdot \exp^{-p_t \cdot \hat{Z}_{y,a}}$ |
| Predicted Total Indices of Relative Abundance with Age Composition Data | $\hat{I}_{t,y}$ | $\hat{I}_{t,y} = \hat{q}_t \sum_a \hat{s}_{t,a} \cdot \hat{N}_{y,a} \cdot \exp^{-p_t \cdot \hat{Z}_{y,a}}$ |
| Predicted Age Composition of Survey | $\hat{U}_{t,y,a}$ | $\hat{U}_{t,y,a} = \frac{\hat{I}_{t,y,a}}{\sum_a \hat{I}_{t,y,a}}$ |
| Female Spawning Stock Biomass (metric tons) | $SSB_y$ | $SSB_y = \sum_{a=1}^{A} N_{y,a} \cdot sr_a \cdot m_a \cdot w_{y,a} / 1000$ |

Table 1 cont.

| Likelihood | Symbol | Equation |
|---|---|---|
| Concentrated Lognormal Likelihood for Fleet Catch (F) and Indices of Relative Abundance (T) | $-L_F$; $-L_T$ | $-L_F = 0.5 * \sum_f n_f * \ln\left(\frac{\sum_f RSS_f}{\sum_f n_f}\right)$; $-L_T = 0.5 * \sum_t n_t * \ln\left(\frac{\sum_t RSS_t}{\sum_t n_t}\right)$<br>where<br>$RSS_f = \lambda_f \sum_y \left(\frac{\ln(C_{f,y} + 1e^{-5}) - \ln(\hat{C}_{f,y} + 1e^{-5})}{\delta_f \cdot CV_{f,y}}\right)^2$<br>$RSS_t = \lambda_t \sum_y \left(\frac{\ln(I_{t,y} + 1e^{-5}) - \ln(\hat{I}_{t,y} + 1e^{-5})}{\delta_t \cdot CV_{t,y}}\right)^2$<br>$CV_{f,y}$ and $CV_{t,y}$ are the annual coefficient of variation for the observed total catch (f) and index (t) in year $y$, $\delta_f$ and $\delta_t$ is the CV weights for total catch $f$ and index $t$ , and $\lambda_t$ and $\lambda_f$ are relative weights. |
| Multinomial fleet catch (FC) and index (TC) age compositions | $-L_{FC}$; $-L_{TC}$ | $-L_{FC} = \lambda_f \sum_y -n_{f,y} \sum_a P_{f,y,a} \cdot \ln(\hat{P}_{f,y,a} + 1e^{-7})$<br>$-L_{TC} = \lambda_t \sum_y -n_{t,y} \sum_a U_{t,y,a} \cdot \ln(\hat{U}_{t,y,a} + 1e^{-7})$<br>where $\lambda_f$ and $\lambda_t$ are a user-defined weighting factors and $n_y$ are the effective sample sizes. |
| Constraints Added To Total Likelihood | $P_{n1}, P_{rdev}, P_{fadd}$ | $P_{n1} = \lambda_{n1}(\hat{N}_{y,1} - N^e_{y,1})^2$ - forces $N_{1,1}$ to follow S-R curve<br>$P_{rdev} = \lambda_R \sum_y \log_e(\hat{\sigma}_R) + \frac{\hat{e}_y^2}{2\hat{\sigma}_R^2}$ - for bias correction to constrain deviations<br>$P_{f_{add}} = \begin{cases} \text{phase} < 3, & 10 \cdot \sum_y (F_{f,y} - 0.15)^2 \\ \text{phase} \geq 3, & 0.000001 \cdot \sum_y (F_{f,y} - 0.15)^2 \end{cases}$ - avoid small F values at start |

Table 1 cont.

| Diagnostics | Symbol | Equation |
|---|---|---|
| Standardized residuals (lognormal – catch and surveys) | $r_{f,y,a}$ or $r_{t,y,a}$ | $r_{t,y}=\frac{\log I_{t,y}-\log\hat{I}_{t,y}}{\sqrt{\log_e((\delta_t CV_{t,y})^2+1)}}$ <br> $r_{f,y}=\frac{\log C_{f,y}-\log\hat{C}_{f,y}}{\sqrt{\log_e(CV_{f,y}^2+1)}}$ |
| Standardized residuals (age compositions – catch and surveys) | $ra_{f,y,a}$ or $ra_{t,y,a}$ | $ra_{f,y,a}=\frac{P_{f,y,a}-\hat{P}_{f,y,a}}{\sqrt{\frac{\hat{P}_{f,y,a}(1-\hat{P}_{f,y,a})}{\hat{\bar{n}}_f}}}$ <br> $ra_{t,y,a}=\frac{P_{t,y,a}-\hat{P}_{t,y,a}}{\sqrt{\frac{\hat{P}_{t,y,a}(1-\hat{P}_{t,y,a})}{\hat{\bar{n}}_t}}}$ |
| Root mean square error | *RMSE* | Total catch <br> $RMSE_f=\sqrt{\frac{\sum_y r_{f,y}^2}{n_f}}$ <br> Index <br> $RMSE_t=\sqrt{\frac{\sum_y r_{t,y}^2}{n_t}}$ |

Table 2. Total removals and associated coefficients of variation and age proportions of total removals of striped bass split into Chesapeake Bay and Coast, 1982-2017.

| | Chesapeake Bay | | Age Proportions | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | CV | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 228,642 | 0.360 | 0.00009 | 0.19419 | 0.54749 | 0.21668 | 0.02924 | 0.00592 | 0.00101 | 0.00087 | 0.00009 | 0.00033 | 0.00141 | 0.00211 | 0.00006 | 0.00017 | 0.00035 |
| 1983 | 337,990 | 0.121 | 0.00075 | 0.29016 | 0.27921 | 0.35534 | 0.01741 | 0.02018 | 0.01477 | 0.01216 | 0.00118 | 0.00126 | 0.00158 | 0.00349 | 0.00079 | 0.00131 | 0.00039 |
| 1984 | 478,326 | 0.345 | 0.00000 | 0.15493 | 0.76590 | 0.05833 | 0.01554 | 0.00431 | 0.00068 | 0.00007 | 0.00000 | 0.00003 | 0.00007 | 0.00003 | 0.00000 | 0.00010 | 0.00000 |
| 1985 | 48,686 | 0.254 | 0.05417 | 0.22096 | 0.53083 | 0.17399 | 0.00925 | 0.00271 | 0.00262 | 0.00048 | 0.00069 | 0.00045 | 0.00012 | 0.00040 | 0.00072 | 0.00040 | 0.00223 |
| 1986 | 100,649 | 0.558 | 0.00000 | 0.23213 | 0.27997 | 0.38852 | 0.08916 | 0.00449 | 0.00240 | 0.00128 | 0.00036 | 0.00000 | 0.00000 | 0.00000 | 0.00020 | 0.00060 | 0.00089 |
| 1987 | 44,939 | 0.444 | 0.04697 | 0.36326 | 0.27908 | 0.12971 | 0.16136 | 0.01621 | 0.00094 | 0.00051 | 0.00044 | 0.00004 | 0.00004 | 0.00000 | 0.00008 | 0.00049 | 0.00086 |
| 1988 | 123,103 | 0.348 | 0.00030 | 0.17812 | 0.25451 | 0.17105 | 0.20069 | 0.15802 | 0.03253 | 0.00396 | 0.00018 | 0.00018 | 0.00000 | 0.00002 | 0.00002 | 0.00009 | 0.00032 |
| 1989 | 85,092 | 0.358 | 0.00047 | 0.35495 | 0.09827 | 0.15559 | 0.09640 | 0.16443 | 0.10319 | 0.02633 | 0.00005 | 0.00002 | 0.00000 | 0.00002 | 0.00002 | 0.00000 | 0.00024 |
| 1990 | 663,647 | 0.203 | 0.00131 | 0.06060 | 0.07944 | 0.11930 | 0.23723 | 0.37313 | 0.09483 | 0.02274 | 0.00450 | 0.00298 | 0.00127 | 0.00106 | 0.00077 | 0.00035 | 0.00049 |
| 1991 | 791,186 | 0.250 | 0.00436 | 0.08362 | 0.15522 | 0.12870 | 0.17802 | 0.28511 | 0.11748 | 0.02240 | 0.01236 | 0.00585 | 0.00256 | 0.00166 | 0.00114 | 0.00072 | 0.00081 |
| 1992 | 993,530 | 0.135 | 0.00255 | 0.02608 | 0.18858 | 0.22122 | 0.19735 | 0.19632 | 0.12126 | 0.03542 | 0.00612 | 0.00403 | 0.00009 | 0.00005 | 0.00020 | 0.00030 | 0.00044 |
| 1993 | 945,663 | 0.117 | 0.00243 | 0.04623 | 0.09116 | 0.27302 | 0.26928 | 0.15259 | 0.09309 | 0.05217 | 0.01335 | 0.00347 | 0.00168 | 0.00040 | 0.00034 | 0.00028 | 0.00052 |
| 1994 | 1,329,411 | 0.100 | 0.00083 | 0.01152 | 0.12339 | 0.26081 | 0.29552 | 0.13595 | 0.08864 | 0.04314 | 0.02569 | 0.00864 | 0.00335 | 0.00223 | 0.00018 | 0.00002 | 0.00010 |
| 1995 | 1,979,690 | 0.084 | 0.00002 | 0.05133 | 0.16367 | 0.22712 | 0.19495 | 0.15761 | 0.09852 | 0.04764 | 0.03150 | 0.01274 | 0.00672 | 0.00385 | 0.00120 | 0.00083 | 0.00231 |
| 1996 | 2,513,435 | 0.082 | 0.00419 | 0.01791 | 0.28675 | 0.20987 | 0.19301 | 0.13334 | 0.08581 | 0.03469 | 0.01643 | 0.00893 | 0.00630 | 0.00137 | 0.00064 | 0.00032 | 0.00044 |
| 1997 | 3,161,870 | 0.064 | 0.02970 | 0.07732 | 0.14336 | 0.33832 | 0.14101 | 0.11629 | 0.05634 | 0.04587 | 0.02635 | 0.01449 | 0.00581 | 0.00322 | 0.00165 | 0.00021 | 0.00008 |
| 1998 | 2,947,279 | 0.066 | 0.00287 | 0.05435 | 0.21654 | 0.28780 | 0.20622 | 0.09944 | 0.04484 | 0.03006 | 0.02434 | 0.01714 | 0.00767 | 0.00413 | 0.00206 | 0.00197 | 0.00056 |
| 1999 | 3,193,323 | 0.063 | 0.00141 | 0.02176 | 0.18145 | 0.23491 | 0.19305 | 0.20236 | 0.06884 | 0.02908 | 0.02498 | 0.01496 | 0.01316 | 0.00662 | 0.00469 | 0.00129 | 0.00142 |
| 2000 | 3,433,504 | 0.078 | 0.01769 | 0.06725 | 0.05743 | 0.23953 | 0.28480 | 0.14514 | 0.10134 | 0.03596 | 0.01567 | 0.01611 | 0.00842 | 0.00517 | 0.00265 | 0.00206 | 0.00079 |
| 2001 | 2,589,566 | 0.068 | 0.03094 | 0.07104 | 0.11310 | 0.16356 | 0.23292 | 0.13707 | 0.09331 | 0.07578 | 0.02343 | 0.02025 | 0.01551 | 0.01376 | 0.00553 | 0.00329 | 0.00052 |
| 2002 | 2,675,387 | 0.075 | 0.01225 | 0.11246 | 0.09299 | 0.14948 | 0.17211 | 0.17448 | 0.12212 | 0.05156 | 0.06011 | 0.01911 | 0.01287 | 0.00711 | 0.00559 | 0.00175 | 0.00601 |
| 2003 | 3,334,406 | 0.064 | 0.00002 | 0.13292 | 0.14887 | 0.15378 | 0.13988 | 0.10933 | 0.10059 | 0.06120 | 0.05572 | 0.05349 | 0.01948 | 0.01162 | 0.00654 | 0.00326 | 0.00329 |
| 2004 | 3,328,090 | 0.074 | 0.04985 | 0.04979 | 0.23573 | 0.20173 | 0.09455 | 0.08593 | 0.07312 | 0.06514 | 0.04631 | 0.03415 | 0.03392 | 0.01451 | 0.00773 | 0.00389 | 0.00366 |
| 2005 | 2,973,074 | 0.102 | 0.00655 | 0.14218 | 0.07766 | 0.22784 | 0.17590 | 0.06993 | 0.05186 | 0.03954 | 0.06668 | 0.04844 | 0.04542 | 0.02651 | 0.01059 | 0.00408 | 0.00683 |
| 2006 | 4,088,156 | 0.081 | 0.01695 | 0.06781 | 0.19880 | 0.16041 | 0.21382 | 0.11501 | 0.04510 | 0.03600 | 0.03448 | 0.04227 | 0.02397 | 0.01644 | 0.01446 | 0.00445 | 0.01002 |
| 2007 | 3,167,613 | 0.094 | 0.00490 | 0.04657 | 0.06038 | 0.34172 | 0.15412 | 0.14959 | 0.05944 | 0.03648 | 0.03723 | 0.03206 | 0.03567 | 0.01921 | 0.00875 | 0.00629 | 0.00758 |
| 2008 | 2,628,022 | 0.082 | 0.02727 | 0.01450 | 0.05777 | 0.15692 | 0.31859 | 0.09171 | 0.09432 | 0.05332 | 0.02379 | 0.03729 | 0.03229 | 0.04450 | 0.01631 | 0.01408 | 0.01734 |
| 2009 | 3,141,793 | 0.082 | 0.00303 | 0.05669 | 0.04500 | 0.22104 | 0.21231 | 0.18992 | 0.04015 | 0.05433 | 0.04221 | 0.01993 | 0.02817 | 0.02603 | 0.03130 | 0.01191 | 0.01798 |
| 2010 | 2,932,935 | 0.150 | 0.00665 | 0.01026 | 0.16269 | 0.15343 | 0.20336 | 0.17423 | 0.15477 | 0.03588 | 0.03635 | 0.01873 | 0.00744 | 0.00889 | 0.00905 | 0.00997 | 0.00828 |
| 2011 | 2,522,192 | 0.089 | 0.02105 | 0.04700 | 0.06130 | 0.28426 | 0.12266 | 0.15022 | 0.11947 | 0.08189 | 0.02477 | 0.03311 | 0.01802 | 0.00962 | 0.00895 | 0.00611 | 0.01158 |
| 2012 | 2,667,975 | 0.1184 | 0.09310 | 0.09290 | 0.13664 | 0.10700 | 0.19834 | 0.11136 | 0.08220 | 0.03391 | 0.04299 | 0.01687 | 0.02659 | 0.00931 | 0.00905 | 0.01167 | 0.02807 |
| 2013 | 2,746,998 | 0.0709 | 0.00084 | 0.08924 | 0.15991 | 0.23047 | 0.15248 | 0.14480 | 0.05856 | 0.03761 | 0.03540 | 0.04765 | 0.01367 | 0.01561 | 0.00349 | 0.00243 | 0.00784 |
| 2014 | 3,234,259 | 0.1107 | 0.00578 | 0.01291 | 0.29200 | 0.20651 | 0.23238 | 0.08630 | 0.05640 | 0.02291 | 0.02251 | 0.01976 | 0.02571 | 0.00324 | 0.00546 | 0.00142 | 0.00671 |
| 2015 | 2,800,299 | 0.0846 | 0.07885 | 0.07470 | 0.04151 | 0.31259 | 0.17851 | 0.06836 | 0.05164 | 0.05035 | 0.02329 | 0.03900 | 0.02519 | 0.02773 | 0.00588 | 0.01239 | 0.01001 |
| 2016 | 3,603,596 | 0.0988 | 0.05830 | 0.07296 | 0.08267 | 0.11216 | 0.38316 | 0.11129 | 0.03667 | 0.01873 | 0.01995 | 0.01349 | 0.02549 | 0.02436 | 0.02736 | 0.00369 | 0.00971 |
| 2017 | 2,499,152 | 0.0983 | 0.01893 | 0.07428 | 0.10790 | 0.13450 | 0.21154 | 0.27426 | 0.05274 | 0.03193 | 0.01802 | 0.01970 | 0.01323 | 0.02144 | 0.01018 | 0.00741 | 0.00395 |

Table 2 cont.

| | Coast | | Age Proportions | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total | CV | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 676,910 | 0.182 | 0.00156 | 0.09775 | 0.21434 | 0.25911 | 0.09712 | 0.03158 | 0.01458 | 0.01135 | 0.00720 | 0.01677 | 0.02752 | 0.04291 | 0.01998 | 0.03109 | 0.12714 |
| 1983 | 709,721 | 0.431 | 0.00705 | 0.04768 | 0.13090 | 0.13039 | 0.22422 | 0.19472 | 0.07898 | 0.05238 | 0.00267 | 0.01028 | 0.06871 | 0.00824 | 0.00860 | 0.00619 | 0.02899 |
| 1984 | 357,356 | 0.242 | 0.00692 | 0.05249 | 0.09217 | 0.21138 | 0.20562 | 0.21712 | 0.08305 | 0.03661 | 0.01239 | 0.01652 | 0.00602 | 0.00747 | 0.01210 | 0.02239 | 0.01773 |
| 1985 | 853,676 | 0.541 | 0.00032 | 0.01967 | 0.05405 | 0.07547 | 0.24611 | 0.27520 | 0.25308 | 0.02196 | 0.00416 | 0.00427 | 0.00920 | 0.00506 | 0.00470 | 0.00880 | 0.01795 |
| 1986 | 307,006 | 0.302 | 0.00091 | 0.01126 | 0.13167 | 0.32552 | 0.11309 | 0.22625 | 0.04412 | 0.05867 | 0.01716 | 0.00439 | 0.00599 | 0.00468 | 0.00542 | 0.01189 | 0.03896 |
| 1987 | 231,440 | 0.183 | 0.00659 | 0.07870 | 0.14963 | 0.13207 | 0.12430 | 0.06106 | 0.07977 | 0.09012 | 0.07011 | 0.03376 | 0.01246 | 0.02462 | 0.01758 | 0.03131 | 0.08790 |
| 1988 | 332,024 | 0.215 | 0.01658 | 0.16119 | 0.12694 | 0.10925 | 0.10455 | 0.13851 | 0.08594 | 0.07315 | 0.07316 | 0.02323 | 0.01863 | 0.00627 | 0.02199 | 0.01149 | 0.02912 |
| 1989 | 520,134 | 0.176 | 0.01746 | 0.14407 | 0.19166 | 0.08561 | 0.09146 | 0.06606 | 0.09550 | 0.06667 | 0.07298 | 0.04591 | 0.02493 | 0.00601 | 0.02116 | 0.01557 | 0.05495 |
| 1990 | 572,259 | 0.101 | 0.00053 | 0.06045 | 0.08352 | 0.10068 | 0.10257 | 0.12711 | 0.15790 | 0.18160 | 0.06701 | 0.02643 | 0.01415 | 0.00839 | 0.01089 | 0.01737 | 0.04141 |
| 1991 | 927,235 | 0.104 | 0.00090 | 0.07712 | 0.09907 | 0.11949 | 0.08690 | 0.05434 | 0.08361 | 0.13363 | 0.20579 | 0.05407 | 0.01134 | 0.01037 | 0.00314 | 0.01433 | 0.04590 |
| 1992 | 1,244,083 | 0.106 | 0.00521 | 0.02732 | 0.08564 | 0.10241 | 0.11308 | 0.07394 | 0.07183 | 0.13508 | 0.14985 | 0.14338 | 0.02428 | 0.01242 | 0.00539 | 0.01246 | 0.03769 |
| 1993 | 1,087,299 | 0.068 | 0.00032 | 0.04258 | 0.07577 | 0.10851 | 0.09531 | 0.09207 | 0.06784 | 0.08082 | 0.12706 | 0.14920 | 0.09879 | 0.02327 | 0.00653 | 0.00389 | 0.02803 |
| 1994 | 1,576,982 | 0.052 | 0.00315 | 0.04326 | 0.08764 | 0.07318 | 0.11335 | 0.10322 | 0.06513 | 0.09269 | 0.14382 | 0.12620 | 0.06519 | 0.05617 | 0.00477 | 0.00311 | 0.01913 |
| 1995 | 3,043,104 | 0.100 | 0.00154 | 0.23628 | 0.10057 | 0.05804 | 0.04745 | 0.10294 | 0.07176 | 0.10605 | 0.11135 | 0.08036 | 0.05066 | 0.01933 | 0.00918 | 0.00118 | 0.00332 |
| 1996 | 3,754,288 | 0.044 | 0.00039 | 0.01285 | 0.15205 | 0.09604 | 0.08487 | 0.09868 | 0.16456 | 0.12796 | 0.09048 | 0.06919 | 0.05034 | 0.03201 | 0.00908 | 0.00368 | 0.00783 |
| 1997 | 4,225,412 | 0.042 | 0.00614 | 0.10247 | 0.11258 | 0.17506 | 0.07460 | 0.08064 | 0.07418 | 0.09665 | 0.09110 | 0.06246 | 0.05325 | 0.02680 | 0.02539 | 0.01314 | 0.00555 |
| 1998 | 4,962,590 | 0.050 | 0.00387 | 0.06375 | 0.10510 | 0.16822 | 0.16506 | 0.11201 | 0.08833 | 0.10580 | 0.07097 | 0.03893 | 0.03975 | 0.01531 | 0.00756 | 0.01042 | 0.00491 |
| 1999 | 4,852,752 | 0.053 | 0.00041 | 0.01448 | 0.14093 | 0.17648 | 0.14312 | 0.15783 | 0.10383 | 0.09908 | 0.05958 | 0.05409 | 0.02483 | 0.01458 | 0.00583 | 0.00278 | 0.00213 |
| 2000 | 4,942,552 | 0.049 | 0.00042 | 0.01307 | 0.10164 | 0.10963 | 0.16734 | 0.13857 | 0.15760 | 0.15278 | 0.06779 | 0.04538 | 0.02265 | 0.01142 | 0.00638 | 0.00312 | 0.00220 |
| 2001 | 5,181,056 | 0.042 | 0.00243 | 0.01624 | 0.03931 | 0.09002 | 0.20905 | 0.21597 | 0.16785 | 0.11304 | 0.04528 | 0.03387 | 0.03739 | 0.01205 | 0.00947 | 0.00474 | 0.00330 |
| 2002 | 5,515,347 | 0.044 | 0.00278 | 0.05902 | 0.06474 | 0.09290 | 0.08964 | 0.18711 | 0.14883 | 0.12724 | 0.11130 | 0.04359 | 0.03803 | 0.01676 | 0.00923 | 0.00636 | 0.00248 |
| 2003 | 5,531,222 | 0.044 | 0.00045 | 0.05105 | 0.08148 | 0.06395 | 0.11048 | 0.10795 | 0.18725 | 0.15014 | 0.09589 | 0.06410 | 0.03621 | 0.02301 | 0.01346 | 0.00800 | 0.00658 |
| 2004 | 6,198,467 | 0.082 | 0.00030 | 0.01748 | 0.17097 | 0.11262 | 0.08276 | 0.09994 | 0.11480 | 0.14909 | 0.09734 | 0.06171 | 0.04626 | 0.02319 | 0.01087 | 0.00769 | 0.00499 |
| 2005 | 6,138,085 | 0.064 | 0.00129 | 0.10807 | 0.06323 | 0.13799 | 0.14456 | 0.10081 | 0.10298 | 0.08242 | 0.09916 | 0.06007 | 0.04684 | 0.02153 | 0.01472 | 0.00837 | 0.00796 |
| 2006 | 6,985,468 | 0.054 | 0.00061 | 0.03408 | 0.26505 | 0.07062 | 0.12521 | 0.10577 | 0.06299 | 0.07208 | 0.06766 | 0.08181 | 0.05153 | 0.03120 | 0.01515 | 0.00659 | 0.00965 |
| 2007 | 5,135,385 | 0.058 | 0.00084 | 0.04549 | 0.10983 | 0.16248 | 0.09635 | 0.14203 | 0.09322 | 0.06526 | 0.07788 | 0.08152 | 0.05125 | 0.04764 | 0.01364 | 0.00729 | 0.00528 |
| 2008 | 5,594,805 | 0.063 | 0.00264 | 0.01561 | 0.06799 | 0.08173 | 0.18416 | 0.09233 | 0.17618 | 0.11129 | 0.05160 | 0.07539 | 0.04579 | 0.03260 | 0.03607 | 0.01028 | 0.01635 |
| 2009 | 4,884,529 | 0.055 | 0.00051 | 0.03118 | 0.03434 | 0.05667 | 0.08293 | 0.25636 | 0.10441 | 0.14756 | 0.07930 | 0.05616 | 0.04994 | 0.03656 | 0.03844 | 0.01118 | 0.01444 |
| 2010 | 5,437,592 | 0.064 | 0.00013 | 0.00939 | 0.06053 | 0.02889 | 0.06142 | 0.12667 | 0.27247 | 0.09792 | 0.11603 | 0.08788 | 0.03899 | 0.03633 | 0.02732 | 0.02223 | 0.01381 |
| 2011 | 5,041,449 | 0.059 | 0.00378 | 0.02580 | 0.04516 | 0.06286 | 0.04492 | 0.13795 | 0.16926 | 0.23211 | 0.08372 | 0.07291 | 0.03445 | 0.02327 | 0.02353 | 0.01987 | 0.02040 |
| 2012 | 4,414,299 | 0.0725 | 0.00037 | 0.05131 | 0.06022 | 0.03576 | 0.09948 | 0.08872 | 0.13599 | 0.16574 | 0.17699 | 0.04930 | 0.04391 | 0.03663 | 0.01962 | 0.02164 | 0.01432 |
| 2013 | 5,758,822 | 0.0643 | 0.00025 | 0.04264 | 0.08532 | 0.07225 | 0.06046 | 0.10946 | 0.11373 | 0.10574 | 0.10948 | 0.17712 | 0.04276 | 0.02160 | 0.02152 | 0.01406 | 0.02361 |
| 2014 | 3,843,397 | 0.0799 | 0.00027 | 0.00799 | 0.14660 | 0.10784 | 0.08975 | 0.09868 | 0.11388 | 0.08209 | 0.09031 | 0.10218 | 0.06397 | 0.03391 | 0.01960 | 0.01751 | 0.02542 |
| 2015 | 3,315,571 | 0.0777 | 0.00064 | 0.01379 | 0.03098 | 0.20267 | 0.16224 | 0.11433 | 0.10439 | 0.08146 | 0.07199 | 0.06504 | 0.05395 | 0.03729 | 0.02033 | 0.01467 | 0.02623 |
| 2016 | 3,601,311 | 0.0841 | 0.00635 | 0.14602 | 0.05588 | 0.03685 | 0.22509 | 0.14742 | 0.05775 | 0.05322 | 0.05029 | 0.04136 | 0.04883 | 0.04930 | 0.03536 | 0.01702 | 0.02925 |
| 2017 | 4,559,686 | 0.0693 | 0.00045 | 0.14568 | 0.15807 | 0.06115 | 0.10340 | 0.21385 | 0.10369 | 0.05725 | 0.02458 | 0.03405 | 0.02506 | 0.02856 | 0.02086 | 0.01123 | 0.01213 |

Table 3. The fraction of total mortality (p) that occurs prior to the survey and ages to which survey indices are linked.

| Survey | p | Linked Ages |
|---|---|---|
| Age-specific | | |
| NY YOY | 0 | 1 (Jan 1st) |
| NJ YOY | 0 | 1 (Jan 1st) |
| MD YOY | 0 | 1 (Jan 1st) |
| Composite YOY | 0 | 1 (Jan 1st) |
| MD Age 1 | 0 | 2 (Jan 1st) |
| VA Age 1 | 0 | 2 (Jan 1st) |
| | | |
| Indices with age composition | | |
| NY OHS | 0.75 | 2-13+ |
| NJ Trawl | 0.25 | 2-15+ |
| MD SSN | 0.25 | 2-15+ |
| DE SSN | 0.25 | 2-13+ |
| MRIP | 0.50 | 1-15+ |
| CT Trawl | 0.33 | 1-15+ |
| DE 30' Trawl | 0.90 | 1-15+ |
| ChesMMAP | 0.50 | 1-15+ |

Table 4. Starting values for model parameters.

| Parameter(s) | Equation | ADMB Name | Phase | Start Value | Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Yr 1, Age 1 N or Avg N (log) | | log_R | 1 | 10 | 0.27 | 25 |
| R Deviation (log) | | log_R_dev | 2 | 0 | -15 | 15 |
| Fishing Mortality (log) | | log_F | 2 | -1.6 | -20 | 2.31 |
| Aggregate qs (log) | | agg_qs | 6 | -16 | -50 | 0 |
| AgeComp qs (log) | | ac_qs | 6 | -16 | -50 | 0 |
| Catch Selectivity | Gompertz | flgom_a | 4 | 3 | -20 | 150 |
| Catch Selectivity | Gompertz | flgom_b | 4 | 1 | -20 | 150 |
| Catch Selectivity | Thompson | flthom_a | 4 | -3.81 | -20 | 0 |
| Catch Selectivity | Thompson | flthom_b | 4 | 3 | -25 | 25 |
| Catch Selectivity | Thompson | flthom_c | 4 | 0.9 | 1.00E-28 | 0.9999 |
| Catch Selectivity | Exponential | flexp_a | 4 | 0.1 | -150 | 150 |
| Catch Selectivity | Exponential | flexp_b | 4 | 1 | -150 | 150 |
| AC Selectivity | Gompertz | acgom_a | 5 | 3 | -20 | 150 |
| AC Selectivity | Gompertz | acgom_b | 5 | 1 | -20 | 150 |
| AC Selectivity | Gamma | acgam_a | 5 | 3 | -150 | 150 |
| AC Selectivity | Gamma | acgam_b | 5 | 1 | -150 | 150 |
| AC Selectivity | Thompson | acthom_a | 5 | -3.81 | -20 | 0 |
| AC Selectivity | Thompson | acthom_b | 5 | 2.32 | -25 | 25 |
| AC Selectivity | Thompson | acthom_c | 5 | 0.9 | 1.00E-28 | 0.9999 |
| AC Selectivity | User-Defined | userparms | 5.00 | 0.60 | 0.00 | 1.00 |

Table 5. Sample size (n), CV weight (Weight), residual mean square error (RMSE) and 95% confidence bounds for N(0,1) by index.

| | | | | Percentile | |
|---|---|---|---|---|---|
| Index | n | Weight | RMSE | 2.50% | 97.50% |
| NYYOY | 32 | 3.03 | 1.00 | 0.757 | 1.248 |
| NJYOY | 35 | 1.75 | 0.99 | 0.768 | 1.239 |
| MDYOY | 12 | 2.10 | 1.04 | 0.592 | 1.379 |
| Comp. YOY | 36 | 0.98 | 1.01 | 0.771 | 1.236 |
| NYAge1 | 33 | 3.13 | 1.02 | 0.761 | 1.245 |
| MDAge1 | 48 | 3.32 | 1.04 | 0.804 | 1.207 |
| NYOHS | 20 | 2.38 | 1.03 | 0.687 | 1.304 |
| NJTRAWL | 28 | 24.00 | 1.01 | 0.738 | 1.263 |
| MDSSN | 33 | 2.40 | 1.03 | 0.761 | 1.245 |
| DESSN | 21 | 0.95 | 1.01 | 0.695 | 1.298 |
| MRIP | 36 | 0.97 | 0.98 | 0.771 | 1.236 |
| CTLIST | 31 | 1.60 | 0.99 | 0.752 | 1.252 |
| DE30FT | 17 | 0.91 | 0.99 | 0.659 | 1.326 |
| ChesMP | 16 | 2.85 | 1.00 | 0.648 | 1.335 |

Table 6. Likelihood components with respective contributions from base model run.

| Likelihood Components | Weight | RSS |
|---|---|---|
| Fleet 1 Total Catch | 2 | 0.17 |
| Fleet 2 Total Catch | 2 | 1.60 |
| Aggregate Abundance Indices | | |
| Survey 1 | 1 | 24.94 |
| Survey 2 | 1 | 26.40 |
| Survey 3 | 1 | 11.10 |
| Survey 4 | 1 | 35.38 |
| Survey 5 | 1 | 26.95 |
| Survey 6 | 1 | 23.51 |
| Age Comp Abundance Indices | | |
| Survey 1 | 1 | 20.49 |
| Survey 2 | 1 | 20.57 |
| Survey 3 | 1 | 29.65 |
| Survey 4 | 1 | 19.78 |
| Survey 5 | 1 | 30.28 |
| Survey 6 | 1 | 23.62 |
| Survey 7 | 1 | 14.11 |
| Survey 8 | 1 | 13.42 |
| | | |
| Total RSS | | 321.98 |
| No. of Obs | | 470 |
| Conc. Likel. | | -88.89 |
| | | |
| Age Composition Data | | Likelihood |
| Fleet 1 Age Comp | 1 | 4,907.58 |
| Fleet 2 Age Comp | 1 | 6,163.06 |
| Survey 1 | 1 | 715.00 |
| Survey 2 | 1 | 276.91 |
| Survey 3 | 1 | 1,135.95 |
| Survey 4 | 1 | 949.68 |
| Survey 5 | 1 | 2,762.74 |
| Survey 6 | 1 | 723.24 |
| Survey 7 | 1 | 241.12 |
| Survey 8 | 1 | 321.19 |
| | | |
| Recr Devs | 1 | 42.97 |
| | | |
| Total Likelihood | | 18,083.4 |
| AIC | | 36,514.7 |

Table 6.1. Final average effective sample sizes for fleets and age composition data.

Age Composition

| Fleet/Index | $n_{eff}$ |
|---|---|
| Bay Fleet | 68.4 |
| Ocean Fleet | 71.1 |
| NYOHS | 21.5 |
| NJTRAWL | 5.2 |
| MDSSN | 16.8 |
| DESSN | 19.7 |
| MRIP | 35.6 |
| CTLIST | 12.4 |
| DE30FT | 7.3 |
| ChesMP | 10.8 |

Table 7. Parameter estimates and associated standard deviations of base model configuration.

| | Bay | | | Coast | | | Total | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | SD | CV | Full F | SD | CV | Full F | SD | CV | Recruitment | SD | CV |
| 1982 | 0.043 | 0.010 | 0.24 | 0.170 | 0.028 | 0.16 | 0.171 | 0.028 | 0.16 | 37,879,000 | 3,486,900 | 0.09 |
| 1983 | 0.053 | 0.007 | 0.13 | 0.140 | 0.038 | 0.28 | 0.141 | 0.038 | 0.27 | 75,360,000 | 5,813,600 | 0.08 |
| 1984 | 0.054 | 0.012 | 0.23 | 0.058 | 0.011 | 0.19 | 0.066 | 0.013 | 0.19 | 65,572,000 | 5,086,500 | 0.08 |
| 1985 | 0.002 | 0.000 | 0.17 | 0.191 | 0.070 | 0.37 | 0.192 | 0.070 | 0.37 | 72,586,000 | 5,287,900 | 0.07 |
| 1986 | 0.004 | 0.001 | 0.34 | 0.050 | 0.013 | 0.26 | 0.051 | 0.013 | 0.25 | 69,913,000 | 4,976,300 | 0.07 |
| 1987 | 0.002 | 0.000 | 0.27 | 0.029 | 0.006 | 0.20 | 0.030 | 0.006 | 0.20 | 72,076,000 | 4,965,900 | 0.07 |
| 1988 | 0.004 | 0.001 | 0.22 | 0.034 | 0.007 | 0.21 | 0.035 | 0.007 | 0.20 | 96,975,000 | 6,565,300 | 0.07 |
| 1989 | 0.003 | 0.001 | 0.22 | 0.045 | 0.008 | 0.18 | 0.046 | 0.008 | 0.18 | 107,990,000 | 7,259,900 | 0.07 |
| 1990 | 0.039 | 0.005 | 0.14 | 0.060 | 0.010 | 0.17 | 0.061 | 0.010 | 0.17 | 126,280,000 | 7,943,500 | 0.06 |
| 1991 | 0.043 | 0.007 | 0.16 | 0.085 | 0.014 | 0.16 | 0.087 | 0.014 | 0.16 | 100,830,000 | 7,351,600 | 0.07 |
| 1992 | 0.049 | 0.005 | 0.11 | 0.104 | 0.017 | 0.16 | 0.105 | 0.017 | 0.16 | 107,980,000 | 7,906,800 | 0.07 |
| 1993 | 0.042 | 0.004 | 0.10 | 0.082 | 0.012 | 0.15 | 0.083 | 0.012 | 0.15 | 132,390,000 | 8,927,000 | 0.07 |
| 1994 | 0.055 | 0.005 | 0.09 | 0.107 | 0.015 | 0.14 | 0.109 | 0.015 | 0.14 | 283,460,000 | 14,113,000 | 0.05 |
| 1995 | 0.080 | 0.007 | 0.08 | 0.198 | 0.029 | 0.15 | 0.200 | 0.030 | 0.15 | 182,470,000 | 11,035,000 | 0.06 |
| 1996 | 0.054 | 0.004 | 0.07 | 0.228 | 0.032 | 0.14 | 0.263 | 0.034 | 0.13 | 232,190,000 | 12,798,000 | 0.06 |
| 1997 | 0.059 | 0.003 | 0.06 | 0.178 | 0.014 | 0.08 | 0.217 | 0.016 | 0.07 | 257,890,000 | 13,378,000 | 0.05 |
| 1998 | 0.051 | 0.003 | 0.06 | 0.194 | 0.015 | 0.08 | 0.227 | 0.018 | 0.08 | 144,270,000 | 9,598,300 | 0.07 |
| 1999 | 0.053 | 0.003 | 0.06 | 0.177 | 0.014 | 0.08 | 0.212 | 0.016 | 0.07 | 149,660,000 | 9,653,400 | 0.07 |
| 2000 | 0.057 | 0.003 | 0.06 | 0.173 | 0.013 | 0.08 | 0.211 | 0.015 | 0.07 | 127,030,000 | 8,900,000 | 0.07 |
| 2001 | 0.045 | 0.002 | 0.05 | 0.180 | 0.013 | 0.07 | 0.209 | 0.015 | 0.07 | 195,510,000 | 11,133,000 | 0.06 |
| 2002 | 0.049 | 0.003 | 0.06 | 0.193 | 0.014 | 0.07 | 0.225 | 0.016 | 0.07 | 224,710,000 | 12,010,000 | 0.05 |
| 2003 | 0.063 | 0.003 | 0.06 | 0.199 | 0.014 | 0.07 | 0.241 | 0.016 | 0.07 | 138,320,000 | 9,204,800 | 0.07 |
| 2004 | 0.061 | 0.004 | 0.06 | 0.227 | 0.018 | 0.08 | 0.267 | 0.020 | 0.08 | 312,200,000 | 14,213,000 | 0.05 |
| 2005 | 0.054 | 0.004 | 0.07 | 0.227 | 0.017 | 0.08 | 0.262 | 0.020 | 0.07 | 162,320,000 | 9,753,700 | 0.06 |
| 2006 | 0.073 | 0.005 | 0.06 | 0.261 | 0.020 | 0.08 | 0.309 | 0.023 | 0.08 | 136,410,000 | 8,822,400 | 0.07 |
| 2007 | 0.055 | 0.004 | 0.07 | 0.192 | 0.015 | 0.08 | 0.228 | 0.017 | 0.07 | 92,700,000 | 6,966,700 | 0.08 |
| 2008 | 0.048 | 0.003 | 0.06 | 0.210 | 0.017 | 0.08 | 0.241 | 0.019 | 0.08 | 129,210,000 | 8,552,900 | 0.07 |
| 2009 | 0.065 | 0.004 | 0.06 | 0.190 | 0.015 | 0.08 | 0.233 | 0.017 | 0.07 | 77,468,000 | 6,110,700 | 0.08 |
| 2010 | 0.068 | 0.006 | 0.10 | 0.228 | 0.018 | 0.08 | 0.273 | 0.020 | 0.08 | 104,880,000 | 7,923,000 | 0.08 |
| 2011 | 0.066 | 0.005 | 0.07 | 0.233 | 0.018 | 0.08 | 0.276 | 0.021 | 0.08 | 147,890,000 | 10,927,000 | 0.07 |
| 2012 | 0.074 | 0.006 | 0.09 | 0.222 | 0.019 | 0.09 | 0.272 | 0.022 | 0.08 | 214,390,000 | 15,307,000 | 0.07 |
| 2013 | 0.079 | 0.006 | 0.07 | 0.316 | 0.028 | 0.09 | 0.368 | 0.032 | 0.09 | 65,411,000 | 7,069,100 | 0.11 |
| 2014 | 0.089 | 0.008 | 0.09 | 0.223 | 0.022 | 0.10 | 0.283 | 0.027 | 0.10 | 92,612,000 | 9,659,500 | 0.10 |
| 2015 | 0.075 | 0.006 | 0.09 | 0.193 | 0.020 | 0.10 | 0.243 | 0.024 | 0.10 | 186,910,000 | 19,611,000 | 0.11 |
| 2016 | 0.100 | 0.009 | 0.09 | 0.209 | 0.023 | 0.11 | 0.278 | 0.028 | 0.10 | 239,580,000 | 31,100,000 | 0.13 |
| 2017 | 0.068 | 0.007 | 0.10 | 0.262 | 0.030 | 0.11 | 0.307 | 0.034 | 0.11 | 108,810,000 | 19,312,000 | 0.18 |

Table 7 cont.

| Catch Selectivtiy Parameters | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bay | | | | Ocean | | | |
| | Estimate | SD | CV | | Estimate | SD | CV |
| 1982-1984 | | | | 1982-1984 | | | |
| α | -5.114 | 0.200 | 0.039 | α | 3.543 | 0.202 | 0.057 |
| β | 2.504 | 0.050 | 0.020 | β | 0.798 | 0.084 | 0.105 |
| ϒ | 0.882 | 0.018 | 0.021 | | | | |
| 1985-1989 | | | | 1985-1989 | | | |
| α | -4.103 | 0.436 | 0.106 | α | 4.876 | 0.404 | 0.083 |
| β | 2.150 | 0.072 | 0.033 | β | 0.454 | 0.049 | 0.108 |
| ϒ | 0.965 | 0.012 | 0.012 | | | | |
| 1990-1995 | | | | 1990-1995 | | | |
| α | -2.068 | 0.108 | 0.052 | α | 6.110 | 0.509 | 0.083 |
| β | 4.451 | 0.198 | 0.045 | β | 0.348 | 0.035 | 0.101 |
| ϒ | 0.816 | 0.035 | 0.043 | | | | |
| 1996-2017 | | | | 1997-2017 | | | |
| α | -1.840 | 0.078 | 0.042 | α | 4.985 | 0.185 | 0.037 |
| β | 3.525 | 0.096 | 0.027 | β | 0.449 | 0.024 | 0.053 |
| ϒ | 0.973 | 0.010 | 0.010 | | | | |

| Survey Selectivity Parameters | | | |
|---|---|---|---|
| NYOHS | Estimate | SD | CV |
| α | -6.236 | 0.133 | 0.021 |
| β | 2.260 | 0.029 | 0.013 |
| ϒ | 0.966 | 0.005 | 0.005 |
| NJ Trawl | | | |
| α | 1.551 | 0.583 | 0.376 |
| β | 0.251 | 0.123 | 0.490 |
| MDSSN | | | |
| $s_2$ | 0.137 | 0.021 | 0.152 |
| DE SSN | | | |
| α | 3.962 | 0.308 | 0.078 |
| β | 0.579 | 0.089 | 0.154 |
| MRIP | | | |
| α | 2.610 | 0.073 | 0.028 |
| β | 1.053 | 0.061 | 0.058 |
| CT Trawl | | | |
| α | -2.849 | 0.308 | 0.108 |
| β | 2.116 | 0.122 | 0.058 |
| ϒ | 0.964 | 0.014 | 0.014 |
| DE Trawl | | | |
| α | -1.285 | 0.773 | 0.602 |
| β | 1.563 | 0.775 | 0.496 |
| ϒ | 0.948 | 0.082 | 0.086 |
| ChesMMAP | | | |
| α | -4.211 | 0.903 | 0.214 |
| β | 2.344 | 0.133 | 0.057 |
| ϒ | 0.947 | 0.019 | 0.020 |

| Catchability Coefficients | | | |
|---|---|---|---|
| Survey | Estimate | SD | CV |
| NYYOY | 1.17E-07 | 1.14E-01 | 0.01 |
| NJYOY | 7.90E-09 | 7.24E-02 | 0.00 |
| MDYOY | 1.36E-07 | 1.67E-01 | 0.01 |
| Comp. YOY | 9.15E-07 | 4.51E-02 | 0.00 |
| NYAge1 | 1.50E-08 | 8.10E-02 | 0.00 |
| MDAge1 | 9.33E-09 | 1.87E-01 | 0.01 |
| NYOHS | 1.12E-07 | 8.74E-02 | 0.01 |
| NJTRAWL | 1.40E-07 | 1.28E-01 | 0.01 |
| MDSSN | 7.80E-08 | 9.21E-02 | 0.01 |
| DESSN | 5.32E-08 | 1.31E-01 | 0.01 |
| MRIP | 4.12E-08 | 7.92E-02 | 0.01 |
| CTLIST | 7.52E-09 | 9.36E-02 | 0.01 |
| DE30FT | 2.76E-08 | 1.92E-01 | 0.01 |
| ChesMMAP | 1.25E-06 | 1.37E-01 | 0.01 |

Table 8. Average total fishing mortality for various age ranges and weighting schemes.

| Year | Unweighted Avg. 3-8 | Unweighted Avg. 8-11 | N-weighted Avg. 3-8 | N-weighted Avg. 7-11 | Unweighted Avg 7-13 | N-weighted Avg 7-13 |
|---|---|---|---|---|---|---|
| 1982 | 0.136 | 0.169 | 0.103 | 0.168 | 0.169 | 0.168 |
| 1983 | 0.118 | 0.139 | 0.100 | 0.138 | 0.139 | 0.139 |
| 1984 | 0.061 | 0.059 | 0.063 | 0.059 | 0.059 | 0.059 |
| 1985 | 0.089 | 0.169 | 0.043 | 0.147 | 0.169 | 0.151 |
| 1986 | 0.026 | 0.046 | 0.015 | 0.041 | 0.046 | 0.041 |
| 1987 | 0.015 | 0.026 | 0.009 | 0.024 | 0.026 | 0.024 |
| 1988 | 0.019 | 0.032 | 0.013 | 0.029 | 0.032 | 0.029 |
| 1989 | 0.023 | 0.041 | 0.016 | 0.036 | 0.041 | 0.036 |
| 1990 | 0.043 | 0.056 | 0.031 | 0.054 | 0.056 | 0.055 |
| 1991 | 0.053 | 0.076 | 0.036 | 0.073 | 0.077 | 0.073 |
| 1992 | 0.062 | 0.091 | 0.041 | 0.087 | 0.093 | 0.088 |
| 1993 | 0.051 | 0.073 | 0.037 | 0.071 | 0.074 | 0.071 |
| 1994 | 0.067 | 0.095 | 0.050 | 0.092 | 0.097 | 0.093 |
| 1995 | 0.111 | 0.170 | 0.078 | 0.160 | 0.173 | 0.165 |
| 1996 | 0.118 | 0.219 | 0.065 | 0.194 | 0.221 | 0.201 |
| 1997 | 0.128 | 0.205 | 0.084 | 0.194 | 0.205 | 0.196 |
| 1998 | 0.129 | 0.213 | 0.083 | 0.200 | 0.212 | 0.203 |
| 1999 | 0.123 | 0.200 | 0.080 | 0.187 | 0.199 | 0.189 |
| 2000 | 0.124 | 0.200 | 0.096 | 0.182 | 0.199 | 0.184 |
| 2001 | 0.117 | 0.195 | 0.094 | 0.180 | 0.195 | 0.182 |
| 2002 | 0.127 | 0.211 | 0.102 | 0.195 | 0.210 | 0.196 |
| 2003 | 0.141 | 0.228 | 0.103 | 0.212 | 0.227 | 0.214 |
| 2004 | 0.152 | 0.250 | 0.100 | 0.237 | 0.249 | 0.239 |
| 2005 | 0.146 | 0.244 | 0.103 | 0.231 | 0.244 | 0.234 |
| 2006 | 0.176 | 0.290 | 0.106 | 0.276 | 0.289 | 0.280 |
| 2007 | 0.131 | 0.215 | 0.092 | 0.200 | 0.214 | 0.203 |
| 2008 | 0.133 | 0.224 | 0.103 | 0.205 | 0.224 | 0.209 |
| 2009 | 0.138 | 0.221 | 0.119 | 0.208 | 0.220 | 0.211 |
| 2010 | 0.158 | 0.257 | 0.126 | 0.235 | 0.256 | 0.238 |
| 2011 | 0.158 | 0.260 | 0.135 | 0.243 | 0.259 | 0.245 |
| 2012 | 0.160 | 0.257 | 0.121 | 0.245 | 0.256 | 0.247 |
| 2013 | 0.206 | 0.343 | 0.132 | 0.328 | 0.342 | 0.333 |
| 2014 | 0.173 | 0.271 | 0.101 | 0.258 | 0.269 | 0.261 |
| 2015 | 0.148 | 0.232 | 0.113 | 0.221 | 0.231 | 0.225 |
| 2016 | 0.176 | 0.268 | 0.140 | 0.255 | 0.266 | 0.258 |
| 2017 | 0.173 | 0.287 | 0.110 | 0.263 | 0.286 | 0.267 |

## Table 9. Total fishing mortality-at-age and fishing mortality-at-age by fleet.

Total Fishing Mortality

| | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 0.000 | 0.012 | 0.079 | 0.110 | 0.138 | 0.155 | 0.164 | 0.168 | 0.169 | 0.170 | 0.170 | 0.170 | 0.170 | 0.170 | 0.171 |
| 1983 | 0.000 | 0.012 | 0.083 | 0.101 | 0.119 | 0.131 | 0.136 | 0.138 | 0.139 | 0.140 | 0.140 | 0.140 | 0.140 | 0.140 | 0.141 |
| 1984 | 0.000 | 0.009 | 0.066 | 0.061 | 0.060 | 0.060 | 0.060 | 0.060 | 0.059 | 0.059 | 0.059 | 0.059 | 0.058 | 0.058 | 0.059 |
| 1985 | 0.001 | 0.006 | 0.021 | 0.046 | 0.077 | 0.107 | 0.133 | 0.153 | 0.167 | 0.176 | 0.182 | 0.186 | 0.189 | 0.191 | 0.192 |
| 1986 | 0.000 | 0.003 | 0.009 | 0.015 | 0.023 | 0.030 | 0.037 | 0.042 | 0.045 | 0.047 | 0.049 | 0.050 | 0.050 | 0.050 | 0.051 |
| 1987 | 0.000 | 0.001 | 0.004 | 0.008 | 0.013 | 0.017 | 0.021 | 0.024 | 0.026 | 0.027 | 0.028 | 0.029 | 0.029 | 0.029 | 0.030 |
| 1988 | 0.000 | 0.003 | 0.007 | 0.012 | 0.017 | 0.022 | 0.026 | 0.029 | 0.032 | 0.033 | 0.034 | 0.035 | 0.035 | 0.035 | 0.035 |
| 1989 | 0.000 | 0.002 | 0.007 | 0.013 | 0.020 | 0.027 | 0.033 | 0.037 | 0.040 | 0.042 | 0.044 | 0.045 | 0.045 | 0.045 | 0.046 |
| 1990 | 0.000 | 0.002 | 0.009 | 0.029 | 0.054 | 0.056 | 0.054 | 0.054 | 0.055 | 0.056 | 0.057 | 0.059 | 0.060 | 0.060 | 0.061 |
| 1991 | 0.000 | 0.002 | 0.010 | 0.035 | 0.064 | 0.069 | 0.070 | 0.072 | 0.075 | 0.078 | 0.080 | 0.083 | 0.084 | 0.086 | 0.087 |
| 1992 | 0.001 | 0.003 | 0.012 | 0.040 | 0.073 | 0.080 | 0.082 | 0.085 | 0.089 | 0.093 | 0.097 | 0.100 | 0.102 | 0.104 | 0.105 |
| 1993 | 0.000 | 0.002 | 0.010 | 0.033 | 0.061 | 0.066 | 0.067 | 0.068 | 0.071 | 0.074 | 0.077 | 0.079 | 0.081 | 0.082 | 0.083 |
| 1994 | 0.001 | 0.003 | 0.013 | 0.044 | 0.081 | 0.087 | 0.088 | 0.090 | 0.094 | 0.097 | 0.101 | 0.103 | 0.106 | 0.107 | 0.109 |
| 1995 | 0.001 | 0.005 | 0.022 | 0.070 | 0.128 | 0.143 | 0.148 | 0.157 | 0.166 | 0.175 | 0.183 | 0.189 | 0.194 | 0.197 | 0.200 |
| 1996 | 0.001 | 0.007 | 0.030 | 0.072 | 0.108 | 0.138 | 0.166 | 0.191 | 0.212 | 0.229 | 0.241 | 0.250 | 0.256 | 0.260 | 0.263 |
| 1997 | 0.001 | 0.008 | 0.035 | 0.084 | 0.125 | 0.154 | 0.176 | 0.193 | 0.204 | 0.211 | 0.215 | 0.217 | 0.217 | 0.217 | 0.216 |
| 1998 | 0.001 | 0.008 | 0.034 | 0.082 | 0.123 | 0.155 | 0.180 | 0.198 | 0.211 | 0.219 | 0.224 | 0.226 | 0.227 | 0.227 | 0.227 |
| 1999 | 0.001 | 0.008 | 0.033 | 0.079 | 0.119 | 0.148 | 0.170 | 0.187 | 0.198 | 0.205 | 0.209 | 0.211 | 0.212 | 0.212 | 0.211 |
| 2000 | 0.001 | 0.008 | 0.034 | 0.081 | 0.121 | 0.150 | 0.171 | 0.187 | 0.198 | 0.205 | 0.209 | 0.210 | 0.211 | 0.211 | 0.210 |
| 2001 | 0.001 | 0.007 | 0.030 | 0.074 | 0.112 | 0.142 | 0.165 | 0.182 | 0.193 | 0.201 | 0.206 | 0.208 | 0.209 | 0.209 | 0.209 |
| 2002 | 0.001 | 0.008 | 0.033 | 0.080 | 0.121 | 0.153 | 0.178 | 0.196 | 0.208 | 0.217 | 0.221 | 0.224 | 0.225 | 0.225 | 0.225 |
| 2003 | 0.001 | 0.009 | 0.038 | 0.092 | 0.138 | 0.170 | 0.195 | 0.213 | 0.226 | 0.233 | 0.238 | 0.240 | 0.241 | 0.241 | 0.240 |
| 2004 | 0.001 | 0.009 | 0.040 | 0.097 | 0.146 | 0.183 | 0.212 | 0.233 | 0.248 | 0.257 | 0.263 | 0.266 | 0.267 | 0.267 | 0.267 |
| 2005 | 0.001 | 0.009 | 0.037 | 0.091 | 0.139 | 0.176 | 0.205 | 0.227 | 0.242 | 0.251 | 0.257 | 0.261 | 0.262 | 0.262 | 0.262 |
| 2006 | 0.002 | 0.011 | 0.047 | 0.113 | 0.170 | 0.213 | 0.246 | 0.270 | 0.287 | 0.298 | 0.304 | 0.307 | 0.309 | 0.309 | 0.308 |
| 2007 | 0.001 | 0.008 | 0.035 | 0.084 | 0.127 | 0.158 | 0.183 | 0.201 | 0.213 | 0.221 | 0.225 | 0.228 | 0.228 | 0.228 | 0.228 |
| 2008 | 0.001 | 0.008 | 0.034 | 0.083 | 0.127 | 0.161 | 0.188 | 0.208 | 0.222 | 0.231 | 0.236 | 0.239 | 0.241 | 0.241 | 0.241 |
| 2009 | 0.001 | 0.009 | 0.038 | 0.091 | 0.136 | 0.167 | 0.190 | 0.208 | 0.220 | 0.227 | 0.231 | 0.233 | 0.233 | 0.233 | 0.232 |
| 2010 | 0.001 | 0.010 | 0.042 | 0.102 | 0.153 | 0.190 | 0.219 | 0.240 | 0.254 | 0.264 | 0.269 | 0.272 | 0.273 | 0.272 | 0.272 |
| 2011 | 0.001 | 0.010 | 0.042 | 0.101 | 0.153 | 0.191 | 0.220 | 0.242 | 0.257 | 0.267 | 0.272 | 0.275 | 0.276 | 0.276 | 0.276 |
| 2012 | 0.001 | 0.010 | 0.044 | 0.106 | 0.157 | 0.193 | 0.221 | 0.241 | 0.255 | 0.264 | 0.269 | 0.271 | 0.272 | 0.271 | 0.270 |
| 2013 | 0.002 | 0.013 | 0.053 | 0.129 | 0.197 | 0.248 | 0.289 | 0.319 | 0.340 | 0.353 | 0.361 | 0.365 | 0.367 | 0.368 | 0.367 |
| 2014 | 0.002 | 0.011 | 0.048 | 0.118 | 0.172 | 0.209 | 0.236 | 0.256 | 0.269 | 0.277 | 0.281 | 0.283 | 0.283 | 0.282 | 0.280 |
| 2015 | 0.001 | 0.010 | 0.041 | 0.100 | 0.147 | 0.178 | 0.202 | 0.219 | 0.231 | 0.238 | 0.241 | 0.243 | 0.243 | 0.242 | 0.241 |
| 2016 | 0.002 | 0.012 | 0.051 | 0.123 | 0.178 | 0.212 | 0.237 | 0.255 | 0.266 | 0.273 | 0.277 | 0.278 | 0.277 | 0.276 | 0.274 |
| 2017 | 0.002 | 0.011 | 0.045 | 0.110 | 0.166 | 0.209 | 0.242 | 0.267 | 0.284 | 0.295 | 0.302 | 0.305 | 0.307 | 0.307 | 0.306 |

Table 9 cont.

Chesapeake Bay

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0.000 | 0.006 | 0.043 | 0.025 | 0.014 | 0.007 | 0.004 | 0.002 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 |
| 1983 | 0.000 | 0.007 | 0.053 | 0.031 | 0.017 | 0.009 | 0.005 | 0.003 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 |
| 1984 | 0.000 | 0.008 | 0.054 | 0.032 | 0.017 | 0.009 | 0.005 | 0.003 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 |
| 1985 | 0.000 | 0.001 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 |
| 1986 | 0.000 | 0.002 | 0.004 | 0.004 | 0.003 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1987 | 0.000 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1988 | 0.000 | 0.002 | 0.004 | 0.004 | 0.003 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 1989 | 0.000 | 0.001 | 0.003 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 |
| 1990 | 0.000 | 0.001 | 0.005 | 0.021 | 0.039 | 0.034 | 0.024 | 0.017 | 0.011 | 0.008 | 0.005 | 0.004 | 0.002 | 0.002 | 0.001 |
| 1991 | 0.000 | 0.001 | 0.006 | 0.024 | 0.043 | 0.038 | 0.027 | 0.018 | 0.012 | 0.009 | 0.006 | 0.004 | 0.003 | 0.002 | 0.001 |
| 1992 | 0.000 | 0.001 | 0.007 | 0.027 | 0.049 | 0.042 | 0.030 | 0.020 | 0.014 | 0.010 | 0.007 | 0.004 | 0.003 | 0.002 | 0.001 |
| 1993 | 0.000 | 0.001 | 0.006 | 0.023 | 0.042 | 0.036 | 0.026 | 0.018 | 0.012 | 0.008 | 0.006 | 0.004 | 0.003 | 0.002 | 0.001 |
| 1994 | 0.000 | 0.001 | 0.007 | 0.030 | 0.055 | 0.048 | 0.034 | 0.023 | 0.016 | 0.011 | 0.007 | 0.005 | 0.003 | 0.002 | 0.002 |
| 1995 | 0.000 | 0.002 | 0.011 | 0.044 | 0.080 | 0.070 | 0.049 | 0.034 | 0.023 | 0.016 | 0.011 | 0.007 | 0.005 | 0.003 | 0.002 |
| 1996 | 0.001 | 0.004 | 0.017 | 0.042 | 0.053 | 0.054 | 0.052 | 0.049 | 0.047 | 0.045 | 0.042 | 0.040 | 0.038 | 0.037 | 0.035 |
| 1997 | 0.001 | 0.004 | 0.019 | 0.046 | 0.058 | 0.059 | 0.056 | 0.054 | 0.051 | 0.049 | 0.046 | 0.044 | 0.042 | 0.040 | 0.038 |
| 1998 | 0.001 | 0.004 | 0.017 | 0.040 | 0.051 | 0.051 | 0.049 | 0.047 | 0.045 | 0.042 | 0.040 | 0.038 | 0.037 | 0.035 | 0.033 |
| 1999 | 0.001 | 0.004 | 0.017 | 0.041 | 0.052 | 0.053 | 0.051 | 0.048 | 0.046 | 0.044 | 0.042 | 0.040 | 0.038 | 0.036 | 0.034 |
| 2000 | 0.001 | 0.004 | 0.018 | 0.045 | 0.056 | 0.057 | 0.054 | 0.052 | 0.049 | 0.047 | 0.045 | 0.043 | 0.040 | 0.039 | 0.037 |
| 2001 | 0.001 | 0.003 | 0.015 | 0.036 | 0.045 | 0.045 | 0.043 | 0.041 | 0.039 | 0.037 | 0.036 | 0.034 | 0.032 | 0.031 | 0.029 |
| 2002 | 0.001 | 0.003 | 0.016 | 0.039 | 0.049 | 0.049 | 0.047 | 0.045 | 0.043 | 0.041 | 0.039 | 0.037 | 0.035 | 0.034 | 0.032 |
| 2003 | 0.001 | 0.004 | 0.020 | 0.050 | 0.063 | 0.063 | 0.061 | 0.058 | 0.055 | 0.053 | 0.050 | 0.048 | 0.045 | 0.043 | 0.041 |
| 2004 | 0.001 | 0.004 | 0.020 | 0.048 | 0.061 | 0.061 | 0.059 | 0.056 | 0.053 | 0.051 | 0.048 | 0.046 | 0.044 | 0.042 | 0.040 |
| 2005 | 0.001 | 0.004 | 0.017 | 0.042 | 0.054 | 0.054 | 0.052 | 0.049 | 0.047 | 0.045 | 0.042 | 0.040 | 0.038 | 0.037 | 0.035 |
| 2006 | 0.001 | 0.005 | 0.024 | 0.057 | 0.073 | 0.073 | 0.070 | 0.067 | 0.063 | 0.060 | 0.058 | 0.055 | 0.052 | 0.050 | 0.047 |
| 2007 | 0.001 | 0.004 | 0.018 | 0.044 | 0.055 | 0.055 | 0.053 | 0.051 | 0.048 | 0.046 | 0.044 | 0.042 | 0.040 | 0.038 | 0.036 |
| 2008 | 0.001 | 0.003 | 0.016 | 0.038 | 0.048 | 0.048 | 0.047 | 0.044 | 0.042 | 0.040 | 0.038 | 0.036 | 0.035 | 0.033 | 0.031 |
| 2009 | 0.001 | 0.005 | 0.021 | 0.051 | 0.064 | 0.065 | 0.062 | 0.059 | 0.056 | 0.054 | 0.051 | 0.049 | 0.046 | 0.044 | 0.042 |
| 2010 | 0.001 | 0.005 | 0.022 | 0.053 | 0.067 | 0.068 | 0.065 | 0.062 | 0.059 | 0.056 | 0.053 | 0.051 | 0.048 | 0.046 | 0.044 |
| 2011 | 0.001 | 0.005 | 0.021 | 0.052 | 0.065 | 0.066 | 0.063 | 0.060 | 0.057 | 0.054 | 0.052 | 0.049 | 0.047 | 0.045 | 0.043 |
| 2012 | 0.001 | 0.005 | 0.024 | 0.058 | 0.074 | 0.074 | 0.071 | 0.068 | 0.065 | 0.062 | 0.059 | 0.056 | 0.053 | 0.051 | 0.048 |
| 2013 | 0.001 | 0.006 | 0.026 | 0.062 | 0.079 | 0.079 | 0.076 | 0.072 | 0.069 | 0.065 | 0.062 | 0.059 | 0.056 | 0.054 | 0.051 |
| 2014 | 0.001 | 0.006 | 0.029 | 0.070 | 0.089 | 0.089 | 0.086 | 0.082 | 0.078 | 0.074 | 0.070 | 0.067 | 0.064 | 0.061 | 0.058 |
| 2015 | 0.001 | 0.005 | 0.024 | 0.059 | 0.074 | 0.075 | 0.072 | 0.068 | 0.065 | 0.062 | 0.059 | 0.056 | 0.053 | 0.051 | 0.048 |
| 2016 | 0.001 | 0.007 | 0.032 | 0.079 | 0.100 | 0.100 | 0.096 | 0.092 | 0.087 | 0.083 | 0.079 | 0.075 | 0.072 | 0.068 | 0.065 |
| 2017 | 0.001 | 0.005 | 0.022 | 0.054 | 0.068 | 0.068 | 0.065 | 0.062 | 0.059 | 0.057 | 0.054 | 0.051 | 0.049 | 0.046 | 0.044 |

Table 9 cont.

Coast

| | Age | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1982 | 0.000 | 0.006 | 0.036 | 0.085 | 0.125 | 0.148 | 0.160 | 0.165 | 0.168 | 0.169 | 0.170 | 0.170 | 0.170 | 0.170 | 0.170 |
| 1983 | 0.000 | 0.005 | 0.030 | 0.070 | 0.102 | 0.121 | 0.131 | 0.136 | 0.138 | 0.139 | 0.139 | 0.139 | 0.140 | 0.140 | 0.140 |
| 1984 | 0.000 | 0.002 | 0.012 | 0.029 | 0.043 | 0.051 | 0.055 | 0.057 | 0.058 | 0.058 | 0.058 | 0.058 | 0.058 | 0.058 | 0.058 |
| 1985 | 0.001 | 0.005 | 0.019 | 0.044 | 0.075 | 0.106 | 0.132 | 0.152 | 0.166 | 0.175 | 0.182 | 0.186 | 0.188 | 0.190 | 0.191 |
| 1986 | 0.000 | 0.001 | 0.005 | 0.011 | 0.020 | 0.028 | 0.034 | 0.040 | 0.043 | 0.046 | 0.047 | 0.048 | 0.049 | 0.050 | 0.050 |
| 1987 | 0.000 | 0.001 | 0.003 | 0.007 | 0.012 | 0.016 | 0.020 | 0.023 | 0.025 | 0.027 | 0.028 | 0.028 | 0.029 | 0.029 | 0.029 |
| 1988 | 0.000 | 0.001 | 0.003 | 0.008 | 0.014 | 0.019 | 0.024 | 0.027 | 0.030 | 0.032 | 0.033 | 0.033 | 0.034 | 0.034 | 0.034 |
| 1989 | 0.000 | 0.001 | 0.004 | 0.010 | 0.018 | 0.025 | 0.031 | 0.036 | 0.039 | 0.041 | 0.043 | 0.044 | 0.045 | 0.045 | 0.045 |
| 1990 | 0.000 | 0.001 | 0.003 | 0.008 | 0.014 | 0.022 | 0.030 | 0.037 | 0.043 | 0.048 | 0.052 | 0.055 | 0.057 | 0.059 | 0.060 |
| 1991 | 0.000 | 0.001 | 0.005 | 0.011 | 0.021 | 0.032 | 0.043 | 0.053 | 0.062 | 0.069 | 0.075 | 0.079 | 0.082 | 0.084 | 0.085 |
| 1992 | 0.000 | 0.002 | 0.006 | 0.013 | 0.025 | 0.038 | 0.052 | 0.065 | 0.075 | 0.084 | 0.090 | 0.095 | 0.099 | 0.102 | 0.104 |
| 1993 | 0.000 | 0.001 | 0.004 | 0.011 | 0.020 | 0.030 | 0.041 | 0.051 | 0.059 | 0.066 | 0.071 | 0.075 | 0.078 | 0.080 | 0.082 |
| 1994 | 0.000 | 0.002 | 0.006 | 0.014 | 0.026 | 0.040 | 0.054 | 0.067 | 0.078 | 0.086 | 0.093 | 0.098 | 0.102 | 0.105 | 0.107 |
| 1995 | 0.001 | 0.003 | 0.011 | 0.026 | 0.047 | 0.073 | 0.099 | 0.123 | 0.143 | 0.160 | 0.172 | 0.182 | 0.189 | 0.194 | 0.198 |
| 1996 | 0.001 | 0.004 | 0.012 | 0.030 | 0.055 | 0.084 | 0.115 | 0.142 | 0.166 | 0.184 | 0.199 | 0.210 | 0.218 | 0.224 | 0.228 |
| 1997 | 0.000 | 0.004 | 0.016 | 0.038 | 0.067 | 0.096 | 0.120 | 0.139 | 0.153 | 0.162 | 0.168 | 0.172 | 0.175 | 0.177 | 0.178 |
| 1998 | 0.000 | 0.004 | 0.017 | 0.041 | 0.073 | 0.104 | 0.131 | 0.151 | 0.166 | 0.176 | 0.183 | 0.188 | 0.191 | 0.192 | 0.194 |
| 1999 | 0.000 | 0.004 | 0.016 | 0.038 | 0.066 | 0.095 | 0.120 | 0.138 | 0.152 | 0.161 | 0.168 | 0.172 | 0.174 | 0.176 | 0.177 |
| 2000 | 0.000 | 0.004 | 0.015 | 0.037 | 0.065 | 0.093 | 0.117 | 0.135 | 0.149 | 0.158 | 0.164 | 0.168 | 0.171 | 0.172 | 0.173 |
| 2001 | 0.000 | 0.004 | 0.016 | 0.038 | 0.067 | 0.096 | 0.121 | 0.140 | 0.154 | 0.164 | 0.170 | 0.174 | 0.177 | 0.179 | 0.180 |
| 2002 | 0.000 | 0.004 | 0.017 | 0.041 | 0.072 | 0.104 | 0.130 | 0.151 | 0.166 | 0.176 | 0.183 | 0.187 | 0.190 | 0.192 | 0.193 |
| 2003 | 0.001 | 0.004 | 0.018 | 0.042 | 0.074 | 0.107 | 0.134 | 0.155 | 0.170 | 0.181 | 0.188 | 0.192 | 0.195 | 0.197 | 0.199 |
| 2004 | 0.001 | 0.005 | 0.020 | 0.048 | 0.085 | 0.122 | 0.153 | 0.177 | 0.194 | 0.206 | 0.214 | 0.220 | 0.223 | 0.225 | 0.227 |
| 2005 | 0.001 | 0.005 | 0.020 | 0.048 | 0.085 | 0.122 | 0.153 | 0.177 | 0.195 | 0.207 | 0.215 | 0.220 | 0.224 | 0.226 | 0.227 |
| 2006 | 0.001 | 0.006 | 0.023 | 0.056 | 0.098 | 0.140 | 0.176 | 0.204 | 0.224 | 0.237 | 0.246 | 0.253 | 0.256 | 0.259 | 0.261 |
| 2007 | 0.000 | 0.004 | 0.017 | 0.041 | 0.072 | 0.103 | 0.130 | 0.150 | 0.165 | 0.175 | 0.182 | 0.186 | 0.189 | 0.191 | 0.192 |
| 2008 | 0.001 | 0.005 | 0.018 | 0.045 | 0.078 | 0.112 | 0.141 | 0.164 | 0.180 | 0.191 | 0.198 | 0.203 | 0.206 | 0.208 | 0.210 |
| 2009 | 0.000 | 0.004 | 0.017 | 0.041 | 0.071 | 0.102 | 0.128 | 0.149 | 0.163 | 0.173 | 0.180 | 0.184 | 0.187 | 0.189 | 0.190 |
| 2010 | 0.001 | 0.005 | 0.020 | 0.049 | 0.085 | 0.122 | 0.154 | 0.178 | 0.195 | 0.207 | 0.215 | 0.221 | 0.224 | 0.226 | 0.228 |
| 2011 | 0.001 | 0.005 | 0.021 | 0.050 | 0.087 | 0.125 | 0.157 | 0.182 | 0.200 | 0.212 | 0.220 | 0.226 | 0.229 | 0.232 | 0.233 |
| 2012 | 0.001 | 0.005 | 0.020 | 0.047 | 0.083 | 0.119 | 0.150 | 0.174 | 0.191 | 0.202 | 0.210 | 0.215 | 0.219 | 0.221 | 0.222 |
| 2013 | 0.001 | 0.007 | 0.028 | 0.067 | 0.118 | 0.170 | 0.213 | 0.247 | 0.271 | 0.288 | 0.299 | 0.306 | 0.311 | 0.314 | 0.316 |
| 2014 | 0.001 | 0.005 | 0.020 | 0.047 | 0.083 | 0.119 | 0.150 | 0.174 | 0.191 | 0.203 | 0.211 | 0.216 | 0.219 | 0.221 | 0.223 |
| 2015 | 0.000 | 0.004 | 0.017 | 0.041 | 0.072 | 0.103 | 0.130 | 0.151 | 0.165 | 0.176 | 0.182 | 0.187 | 0.190 | 0.192 | 0.193 |
| 2016 | 0.001 | 0.005 | 0.018 | 0.045 | 0.078 | 0.112 | 0.141 | 0.163 | 0.179 | 0.190 | 0.198 | 0.202 | 0.206 | 0.208 | 0.209 |
| 2017 | 0.001 | 0.006 | 0.023 | 0.056 | 0.098 | 0.141 | 0.177 | 0.205 | 0.225 | 0.239 | 0.248 | 0.254 | 0.258 | 0.260 | 0.262 |

Table 10. Estimates of January 1 population abundance by age.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | Total | 8+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 37,879,200 | 8,310,650 | 4,230,280 | 2,646,920 | 933,938 | 392,682 | 319,102 | 197,426 | 171,890 | 276,834 | 193,339 | 303,476 | 167,049 | 121,274 | 320,574 | 56,464,634 | 1,751,862 |
| 1983 | 75,360,100 | 12,234,300 | 4,162,130 | 2,492,180 | 1,704,500 | 633,455 | 278,010 | 233,147 | 143,697 | 124,910 | 201,043 | 140,374 | 220,321 | 121,274 | 320,574 | 98,370,015 | 1,505,340 |
| 1984 | 65,571,900 | 24,340,000 | 6,124,170 | 2,442,040 | 1,619,410 | 1,178,240 | 459,696 | 208,830 | 174,723 | 107,594 | 93,500 | 150,479 | 105,069 | 164,913 | 330,482 | 103,071,046 | 1,335,590 |
| 1985 | 72,586,400 | 21,179,400 | 12,215,600 | 3,654,990 | 1,652,210 | 1,187,850 | 917,533 | 372,663 | 169,359 | 141,752 | 87,315 | 75,892 | 122,156 | 85,300 | 401,920 | 114,850,340 | 1,456,357 |
| 1986 | 69,912,900 | 23,433,600 | 10,668,300 | 7,628,970 | 2,510,560 | 1,191,650 | 882,222 | 691,235 | 275,323 | 123,400 | 102,315 | 62,631 | 54,217 | 87,040 | 346,286 | 117,970,649 | 1,742,447 |
| 1987 | 72,076,500 | 22,579,700 | 11,837,100 | 6,742,550 | 5,403,280 | 1,911,380 | 956,010 | 731,944 | 570,728 | 226,556 | 101,314 | 83,880 | 51,299 | 44,383 | 354,568 | 123,671,193 | 2,164,673 |
| 1988 | 96,974,800 | 23,280,600 | 11,423,100 | 7,514,200 | 4,808,210 | 4,154,810 | 1,553,510 | 805,631 | 615,028 | 478,587 | 189,720 | 84,765 | 70,139 | 42,881 | 333,372 | 152,329,353 | 2,620,123 |
| 1989 | 107,989,000 | 31,321,200 | 11,763,900 | 7,229,740 | 5,340,300 | 3,682,660 | 3,361,650 | 1,302,620 | 673,344 | 512,885 | 398,512 | 157,828 | 70,476 | 58,297 | 312,646 | 174,175,058 | 3,486,608 |
| 1990 | 126,282,000 | 34,878,300 | 15,833,200 | 7,449,520 | 5,132,850 | 4,078,000 | 2,965,110 | 2,800,510 | 1,080,350 | 556,699 | 423,141 | 328,329 | 129,919 | 57,982 | 305,035 | 202,300,945 | 5,681,965 |
| 1991 | 100,831,000 | 40,778,800 | 17,635,100 | 10,009,800 | 5,201,120 | 3,788,440 | 3,187,840 | 2,417,490 | 2,284,060 | 880,335 | 453,022 | 343,869 | 266,500 | 105,350 | 293,997 | 188,476,723 | 7,044,623 |
| 1992 | 107,985,000 | 32,557,000 | 20,607,900 | 11,127,300 | 6,950,100 | 3,799,970 | 2,923,320 | 2,559,510 | 1,937,140 | 1,824,770 | 701,144 | 359,821 | 272,508 | 210,821 | 315,254 | 194,131,558 | 8,180,968 |
| 1993 | 132,385,000 | 34,864,400 | 16,446,000 | 12,981,100 | 7,685,920 | 5,029,430 | 2,899,470 | 2,318,440 | 2,023,490 | 1,525,120 | 1,430,770 | 547,794 | 280,308 | 211,810 | 407,887 | 221,036,939 | 8,745,619 |
| 1994 | 283,461,000 | 42,746,500 | 17,620,800 | 10,381,400 | 9,025,440 | 5,629,360 | 3,891,710 | 2,334,720 | 1,863,450 | 1,621,840 | 1,218,840 | 1,140,470 | 435,713 | 222,582 | 491,137 | 382,084,962 | 9,328,752 |
| 1995 | 182,467,000 | 91,515,500 | 21,588,300 | 11,087,900 | 7,142,310 | 6,483,970 | 4,265,980 | 3,068,980 | 1,836,820 | 1,460,730 | 1,266,510 | 948,577 | 885,106 | 337,411 | 551,296 | 334,906,390 | 10,355,430 |
| 1996 | 232,186,000 | 58,887,500 | 46,121,200 | 13,471,700 | 7,435,800 | 4,895,610 | 4,648,810 | 3,165,180 | 2,257,930 | 1,338,540 | 1,054,990 | 907,797 | 675,803 | 627,645 | 626,976 | 378,301,481 | 10,654,861 |
| 1997 | 257,890,000 | 74,906,300 | 29,613,000 | 28,544,400 | 9,012,800 | 5,196,820 | 3,526,040 | 3,388,540 | 2,249,750 | 1,571,480 | 916,318 | 713,308 | 608,346 | 450,103 | 831,194 | 419,418,399 | 10,729,039 |
| 1998 | 144,271,000 | 83,209,600 | 37,644,500 | 18,239,200 | 18,866,000 | 6,194,100 | 3,683,670 | 2,544,030 | 2,405,310 | 1,579,420 | 1,095,650 | 636,355 | 494,428 | 421,434 | 888,339 | 322,173,036 | 10,064,966 |
| 1999 | 149,660,000 | 46,552,300 | 41,824,900 | 23,210,000 | 12,085,700 | 12,986,400 | 4,386,540 | 2,648,770 | 1,796,140 | 1,677,000 | 1,092,350 | 754,146 | 436,893 | 339,088 | 898,430 | 300,348,657 | 9,642,817 |
| 2000 | 127,026,000 | 48,292,400 | 23,405,300 | 25,812,500 | 15,415,500 | 8,358,220 | 9,264,470 | 3,184,870 | 1,891,720 | 1,268,440 | 1,175,900 | 762,779 | 525,501 | 304,199 | 862,112 | 267,549,911 | 9,975,521 |
| 2001 | 195,511,000 | 40,987,000 | 24,275,600 | 14,431,400 | 17,105,300 | 10,634,800 | 5,951,700 | 6,718,640 | 2,273,260 | 1,335,780 | 889,638 | 821,557 | 531,927 | 366,251 | 813,534 | 322,647,387 | 13,750,587 |
| 2002 | 224,713,000 | 63,092,900 | 20,617,000 | 15,015,000 | 9,636,690 | 11,907,400 | 7,633,870 | 4,345,200 | 4,822,030 | 1,612,460 | 940,344 | 623,441 | 574,317 | 371,447 | 823,881 | 366,728,980 | 14,113,120 |
| 2003 | 138,321,000 | 72,510,400 | 31,718,100 | 12,720,300 | 9,965,940 | 6,647,900 | 8,451,910 | 5,501,860 | 3,074,810 | 3,369,500 | 1,117,650 | 648,634 | 428,917 | 394,672 | 821,502 | 295,693,095 | 15,357,545 |
| 2004 | 312,204,000 | 44,625,100 | 36,411,700 | 19,470,300 | 8,339,100 | 6,764,340 | 4,638,290 | 5,986,390 | 3,826,350 | 2,112,070 | 2,296,510 | 758,342 | 439,141 | 290,183 | 823,463 | 448,985,279 | 16,532,449 |
| 2005 | 162,318,000 | 100,718,000 | 22,398,100 | 22,310,600 | 12,708,100 | 5,612,090 | 4,658,210 | 3,229,690 | 4,080,310 | 2,570,110 | 1,405,430 | 1,519,700 | 500,361 | 289,400 | 734,153 | 345,052,254 | 14,329,154 |
| 2006 | 136,410,000 | 52,369,300 | 50,578,800 | 13,757,300 | 14,648,000 | 8,615,970 | 3,893,330 | 3,266,390 | 2,215,990 | 2,757,910 | 1,720,380 | 935,257 | 1,008,040 | 331,404 | 677,846 | 293,185,917 | 12,913,217 |
| 2007 | 92,700,400 | 43,996,400 | 26,244,200 | 30,784,600 | 8,834,550 | 9,623,040 | 5,759,930 | 2,620,620 | 2,145,520 | 1,431,410 | 1,762,550 | 1,092,580 | 592,019 | 637,262 | 638,322 | 228,863,403 | 10,920,283 |
| 2008 | 129,214,000 | 29,910,400 | 22,108,900 | 16,161,600 | 20,338,900 | 6,059,840 | 6,792,620 | 4,129,890 | 1,845,610 | 1,492,620 | 988,091 | 1,211,140 | 749,006 | 405,487 | 873,970 | 242,282,074 | 11,695,814 |
| 2009 | 77,468,200 | 41,693,400 | 15,031,900 | 13,624,300 | 10,695,800 | 13,955,000 | 4,266,640 | 4,844,880 | 2,887,030 | 1,272,380 | 1,019,800 | 671,421 | 820,501 | 506,706 | 865,393 | 189,623,351 | 12,888,111 |
| 2010 | 104,883,000 | 24,992,900 | 20,938,600 | 9,230,320 | 8,938,500 | 7,273,090 | 9,767,710 | 3,035,400 | 3,387,610 | 1,995,170 | 872,923 | 696,763 | 457,841 | 559,201 | 936,033 | 197,965,061 | 11,940,941 |
| 2011 | 147,889,000 | 33,833,100 | 12,538,500 | 12,802,300 | 5,993,210 | 5,975,290 | 4,974,170 | 6,755,470 | 2,055,330 | 2,260,940 | 1,319,470 | 574,226 | 457,103 | 300,064 | 980,552 | 238,708,725 | 14,703,155 |
| 2012 | 214,390,000 | 47,706,300 | 16,974,000 | 7,667,930 | 8,316,890 | 4,006,780 | 4,083,410 | 3,434,640 | 4,563,800 | 1,367,920 | 1,490,490 | 864,980 | 375,336 | 298,436 | 836,522 | 316,377,434 | 13,232,124 |
| 2013 | 65,410,700 | 69,153,100 | 23,925,500 | 10,361,700 | 4,959,370 | 5,535,610 | 2,730,780 | 2,817,230 | 2,322,030 | 3,043,340 | 904,390 | 980,635 | 567,768 | 246,203 | 745,338 | 193,703,694 | 11,626,934 |
| 2014 | 92,611,600 | 21,092,500 | 34,598,100 | 14,462,800 | 6,544,530 | 3,171,970 | 3,570,620 | 1,760,420 | 1,762,370 | 1,422,830 | 1,840,120 | 542,474 | 585,663 | 338,436 | 591,091 | 184,895,524 | 8,843,404 |
| 2015 | 186,912,000 | 29,867,000 | 10,567,000 | 21,017,200 | 9,243,360 | 4,290,580 | 2,129,060 | 2,427,370 | 1,173,450 | 1,159,440 | 928,617 | 1,195,820 | 351,905 | 379,869 | 604,032 | 272,246,703 | 8,220,503 |
| 2016 | 239,584,000 | 60,294,000 | 14,988,000 | 6,466,180 | 13,673,000 | 6,217,020 | 2,969,060 | 1,497,500 | 1,678,290 | 802,078 | 786,959 | 627,887 | 807,234 | 237,502 | 665,004 | 351,293,714 | 7,102,454 |
| 2017 | 108,810,000 | 77,257,600 | 30,192,300 | 9,083,670 | 4,109,320 | 8,912,970 | 4,158,250 | 2,016,020 | 998,963 | 1,106,670 | 525,307 | 513,671 | 409,412 | 526,600 | 590,437 | 249,211,190 | 6,687,080 |

Table 11. Estimates of female spawning stock biomass (metric tons).

| | Age | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | Total | SE |
| 1982 | 0 | 0 | 0 | 152 | 347 | 398 | 862 | 764 | 821 | 2,019 | 1,874 | 3,010 | 2,060 | 1,671 | 5,135 | 19,112 | 2,567 |
| 1983 | 0 | 0 | 0 | 134 | 602 | 523 | 603 | 824 | 707 | 817 | 1,674 | 1,341 | 2,492 | 1,584 | 4,789 | 16,090 | 2,266 |
| 1984 | 0 | 0 | 0 | 144 | 611 | 997 | 1,213 | 727 | 928 | 682 | 700 | 1,629 | 1,218 | 2,196 | 5,165 | 16,211 | 2,260 |
| 1985 | 0 | 0 | 0 | 255 | 559 | 1,076 | 2,365 | 1,350 | 903 | 887 | 672 | 692 | 1,385 | 1,065 | 5,659 | 16,866 | 2,185 |
| 1986 | 0 | 0 | 0 | 627 | 932 | 932 | 1,978 | 2,368 | 1,250 | 672 | 706 | 525 | 513 | 920 | 3,945 | 15,369 | 1,872 |
| 1987 | 0 | 0 | 0 | 526 | 2,243 | 1,460 | 1,938 | 2,269 | 2,574 | 1,228 | 668 | 712 | 490 | 471 | 4,384 | 18,962 | 2,065 |
| 1988 | 0 | 0 | 0 | 573 | 2,281 | 4,066 | 3,576 | 2,425 | 2,624 | 2,337 | 1,368 | 754 | 689 | 465 | 4,132 | 25,288 | 2,338 |
| 1989 | 0 | 0 | 0 | 566 | 2,457 | 4,164 | 9,767 | 5,079 | 3,186 | 3,421 | 2,856 | 1,369 | 733 | 654 | 3,987 | 38,239 | 3,057 |
| 1990 | 0 | 0 | 0 | 561 | 1,989 | 4,034 | 8,282 | 11,097 | 5,244 | 2,902 | 2,941 | 2,725 | 1,182 | 587 | 3,321 | 44,866 | 3,243 |
| 1991 | 0 | 0 | 0 | 773 | 2,139 | 3,040 | 8,394 | 8,972 | 12,021 | 4,666 | 3,426 | 2,543 | 2,477 | 1,069 | 3,392 | 52,912 | 3,639 |
| 1992 | 0 | 0 | 0 | 812 | 3,052 | 3,493 | 7,436 | 9,625 | 10,618 | 12,172 | 5,483 | 3,820 | 3,067 | 2,744 | 5,116 | 67,439 | 4,635 |
| 1993 | 0 | 0 | 0 | 973 | 3,247 | 4,625 | 7,544 | 9,134 | 11,269 | 10,251 | 11,764 | 5,270 | 3,248 | 2,729 | 5,852 | 75,906 | 5,025 |
| 1994 | 0 | 0 | 0 | 841 | 3,917 | 5,061 | 10,262 | 9,232 | 10,236 | 10,409 | 10,111 | 10,824 | 4,767 | 2,727 | 6,792 | 85,180 | 5,351 |
| 1995 | 0 | 0 | 0 | 945 | 3,101 | 6,025 | 11,852 | 12,083 | 10,570 | 10,422 | 8,500 | 8,361 | 8,999 | 3,791 | 6,789 | 91,436 | 5,499 |
| 1996 | 0 | 0 | 0 | 1,137 | 3,617 | 5,305 | 14,823 | 14,127 | 13,626 | 9,936 | 8,562 | 7,681 | 7,085 | 7,262 | 8,236 | 101,396 | 6,260 |
| 1997 | 0 | 0 | 0 | 2,570 | 4,004 | 4,967 | 9,123 | 12,250 | 12,597 | 11,868 | 7,906 | 6,443 | 6,629 | 5,572 | 11,883 | 95,812 | 6,372 |
| 1998 | 0 | 0 | 0 | 1,136 | 7,201 | 4,883 | 9,295 | 9,151 | 12,491 | 9,408 | 7,838 | 5,679 | 4,909 | 4,763 | 11,083 | 87,835 | 5,494 |
| 1999 | 0 | 0 | 0 | 1,330 | 3,677 | 8,586 | 8,186 | 8,816 | 9,324 | 10,902 | 7,971 | 6,282 | 4,556 | 3,998 | 12,591 | 86,218 | 5,452 |
| 2000 | 0 | 0 | 0 | 1,457 | 4,642 | 5,741 | 18,530 | 9,839 | 10,128 | 7,789 | 9,579 | 7,004 | 5,816 | 3,905 | 13,265 | 97,695 | 5,878 |
| 2001 | 0 | 0 | 0 | 937 | 5,651 | 8,250 | 12,769 | 21,320 | 11,233 | 8,728 | 6,548 | 6,405 | 5,200 | 4,059 | 9,758 | 100,859 | 5,532 |
| 2002 | 0 | 0 | 0 | 876 | 3,300 | 9,332 | 17,210 | 14,917 | 22,781 | 10,003 | 7,273 | 5,325 | 5,674 | 4,264 | 11,209 | 112,163 | 6,106 |
| 2003 | 0 | 0 | 0 | 691 | 3,306 | 5,220 | 18,597 | 18,205 | 14,952 | 19,852 | 8,145 | 5,449 | 4,236 | 4,446 | 10,503 | 113,602 | 6,194 |
| 2004 | 0 | 0 | 0 | 1,042 | 2,922 | 5,204 | 10,287 | 19,576 | 18,256 | 12,346 | 16,024 | 6,063 | 4,171 | 3,123 | 10,057 | 109,072 | 6,140 |
| 2005 | 0 | 0 | 0 | 1,287 | 4,164 | 4,557 | 10,339 | 11,309 | 20,192 | 15,156 | 10,079 | 12,999 | 4,956 | 3,261 | 9,672 | 107,971 | 6,348 |
| 2006 | 0 | 0 | 0 | 739 | 4,534 | 6,122 | 8,153 | 10,972 | 11,573 | 16,731 | 12,395 | 7,677 | 10,188 | 3,797 | 8,989 | 101,869 | 6,241 |
| 2007 | 0 | 0 | 0 | 1,480 | 2,755 | 7,141 | 12,771 | 8,641 | 11,377 | 9,241 | 13,789 | 9,574 | 6,279 | 7,789 | 9,228 | 100,065 | 6,373 |
| 2008 | 0 | 0 | 0 | 866 | 6,373 | 5,014 | 17,347 | 14,380 | 9,551 | 10,081 | 7,706 | 10,600 | 7,887 | 4,883 | 11,968 | 106,656 | 6,430 |
| 2009 | 0 | 0 | 0 | 740 | 3,161 | 11,140 | 10,285 | 18,099 | 15,378 | 8,120 | 7,811 | 5,692 | 8,351 | 5,891 | 11,427 | 106,094 | 6,306 |
| 2010 | 0 | 0 | 0 | 500 | 2,699 | 5,702 | 22,311 | 10,206 | 16,963 | 12,671 | 6,640 | 5,674 | 4,520 | 6,316 | 12,059 | 106,261 | 6,295 |
| 2011 | 0 | 0 | 0 | 758 | 1,817 | 4,447 | 11,061 | 22,167 | 10,211 | 13,879 | 9,356 | 5,011 | 4,548 | 3,441 | 13,073 | 99,768 | 6,322 |
| 2012 | 0 | 0 | 0 | 472 | 2,866 | 3,108 | 9,445 | 12,360 | 23,011 | 9,085 | 11,343 | 7,622 | 4,014 | 3,610 | 11,864 | 98,798 | 6,768 |
| 2013 | 0 | 0 | 0 | 551 | 1,717 | 4,554 | 6,033 | 9,493 | 12,176 | 18,757 | 7,108 | 8,792 | 6,077 | 3,014 | 10,592 | 88,864 | 6,782 |
| 2014 | 0 | 0 | 0 | 710 | 2,083 | 2,430 | 8,211 | 5,866 | 9,372 | 9,642 | 14,130 | 5,445 | 6,859 | 4,575 | 9,676 | 78,999 | 7,098 |
| 2015 | 0 | 0 | 0 | 1,201 | 3,229 | 3,778 | 5,030 | 8,634 | 6,251 | 7,444 | 7,226 | 10,968 | 3,905 | 4,758 | 8,434 | 70,858 | 6,786 |
| 2016 | 0 | 0 | 0 | 310 | 4,529 | 5,264 | 7,576 | 5,646 | 9,155 | 5,731 | 6,496 | 5,982 | 9,440 | 3,165 | 10,629 | 73,924 | 7,574 |
| 2017 | 0 | 0 | 0 | 502 | 1,423 | 7,094 | 9,871 | 6,955 | 5,120 | 7,681 | 4,404 | 4,880 | 4,752 | 7,037 | 8,758 | 68,476 | 7,630 |

Table 12. Sensitivity analysis results for 2018 assessment model.

| | 2018 Base model | | Continuity | | Quasi-continuity | | ESS 50% decrease | | ESS 50% increase | | Increase M after 1996 | | No adj comm. rel. | | BHSR method | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB | Full F | SSB |
| 1982 | 0.171 | 19,112 | 0.858 | 5,759 | 0.858 | 13,893 | 0.159 | 21,428 | 0.168 | 19,037 | 0.105 | 32,443 | 0.169 | 19,462 | 0.175 | 18,459 |
| 1983 | 0.141 | 16,090 | 0.153 | 4,719 | 0.139 | 11,070 | 0.131 | 18,303 | 0.139 | 15,944 | 0.082 | 28,825 | 0.138 | 16,417 | 0.139 | 15,547 |
| 1984 | 0.066 | 16,211 | 0.162 | 5,294 | 0.078 | 11,947 | 0.058 | 18,506 | 0.068 | 15,981 | 0.035 | 30,379 | 0.064 | 16,579 | 0.066 | 15,766 |
| 1985 | 0.192 | 16,866 | 0.099 | 6,335 | 0.208 | 14,010 | 0.158 | 19,272 | 0.211 | 16,482 | 0.094 | 32,380 | 0.187 | 17,282 | 0.181 | 16,507 |
| 1986 | 0.051 | 15,369 | 0.062 | 6,568 | 0.060 | 13,582 | 0.043 | 17,753 | 0.053 | 14,810 | 0.024 | 31,344 | 0.049 | 15,820 | 0.050 | 15,235 |
| 1987 | 0.030 | 18,962 | 0.030 | 7,891 | 0.034 | 16,646 | 0.026 | 21,807 | 0.031 | 18,301 | 0.014 | 38,948 | 0.029 | 19,557 | 0.030 | 18,812 |
| 1988 | 0.035 | 25,288 | 0.046 | 11,254 | 0.041 | 23,859 | 0.031 | 29,025 | 0.037 | 24,511 | 0.017 | 51,742 | 0.034 | 26,130 | 0.035 | 25,079 |
| 1989 | 0.046 | 38,239 | 0.048 | 18,190 | 0.053 | 38,140 | 0.040 | 43,697 | 0.048 | 37,217 | 0.022 | 78,184 | 0.044 | 39,571 | 0.046 | 37,870 |
| 1990 | 0.061 | 44,866 | 0.086 | 22,619 | 0.081 | 45,851 | 0.051 | 51,166 | 0.064 | 43,761 | 0.029 | 92,358 | 0.058 | 46,519 | 0.062 | 44,328 |
| 1991 | 0.087 | 52,912 | 0.073 | 27,350 | 0.089 | 54,218 | 0.071 | 60,333 | 0.091 | 51,615 | 0.035 | 111,219 | 0.082 | 54,993 | 0.088 | 52,154 |
| 1992 | 0.105 | 67,439 | 0.058 | 33,971 | 0.104 | 65,403 | 0.086 | 77,031 | 0.110 | 65,730 | 0.041 | 146,627 | 0.109 | 70,018 | 0.106 | 66,377 |
| 1993 | 0.083 | 75,906 | 0.077 | 40,856 | 0.083 | 75,033 | 0.069 | 86,357 | 0.087 | 74,102 | 0.032 | 170,654 | 0.080 | 78,185 | 0.084 | 74,585 |
| 1994 | 0.109 | 85,180 | 0.091 | 46,612 | 0.105 | 83,314 | 0.091 | 96,339 | 0.113 | 83,293 | 0.041 | 196,112 | 0.107 | 87,323 | 0.110 | 83,639 |
| 1995 | 0.200 | 91,436 | 0.126 | 57,954 | 0.190 | 100,383 | 0.168 | 102,449 | 0.209 | 89,683 | 0.070 | 218,365 | 0.194 | 93,260 | 0.201 | 89,794 |
| 1996 | 0.263 | 101,396 | 0.115 | 65,462 | 0.243 | 106,224 | 0.229 | 113,000 | 0.270 | 99,754 | 0.089 | 261,793 | 0.266 | 103,080 | 0.264 | 99,723 |
| 1997 | 0.217 | 95,812 | 0.194 | 66,710 | 0.172 | 101,519 | 0.210 | 106,894 | 0.211 | 94,497 | 0.087 | 264,650 | 0.224 | 96,834 | 0.218 | 94,338 |
| 1998 | 0.227 | 87,835 | 0.176 | 57,693 | 0.179 | 92,848 | 0.222 | 95,664 | 0.220 | 87,599 | 0.095 | 231,438 | 0.231 | 88,090 | 0.228 | 86,717 |
| 1999 | 0.212 | 86,218 | 0.151 | 57,868 | 0.166 | 94,995 | 0.209 | 92,645 | 0.205 | 86,615 | 0.093 | 219,525 | 0.213 | 86,387 | 0.213 | 85,263 |
| 2000 | 0.211 | 97,695 | 0.191 | 67,623 | 0.172 | 111,810 | 0.210 | 102,683 | 0.204 | 98,917 | 0.096 | 234,204 | 0.210 | 98,150 | 0.212 | 96,821 |
| 2001 | 0.209 | 100,859 | 0.180 | 67,540 | 0.168 | 115,930 | 0.208 | 103,226 | 0.203 | 102,697 | 0.099 | 223,565 | 0.208 | 101,854 | 0.210 | 100,251 |
| 2002 | 0.225 | 112,163 | 0.171 | 74,859 | 0.179 | 130,481 | 0.224 | 113,391 | 0.219 | 114,521 | 0.110 | 235,898 | 0.225 | 113,559 | 0.226 | 111,598 |
| 2003 | 0.241 | 113,602 | 0.199 | 77,385 | 0.195 | 133,961 | 0.239 | 113,897 | 0.234 | 116,108 | 0.120 | 228,035 | 0.238 | 115,303 | 0.241 | 113,149 |
| 2004 | 0.267 | 109,072 | 0.233 | 75,514 | 0.219 | 130,905 | 0.266 | 108,940 | 0.260 | 111,494 | 0.135 | 212,353 | 0.265 | 111,151 | 0.268 | 108,745 |
| 2005 | 0.262 | 107,971 | 0.244 | 75,878 | 0.221 | 132,254 | 0.262 | 107,857 | 0.255 | 110,380 | 0.133 | 207,243 | 0.260 | 110,403 | 0.263 | 107,711 |
| 2006 | 0.309 | 101,869 | 0.277 | 70,859 | 0.251 | 125,478 | 0.309 | 101,770 | 0.299 | 104,170 | 0.156 | 193,003 | 0.304 | 104,471 | 0.308 | 101,709 |
| 2007 | 0.228 | 100,065 | 0.241 | 69,165 | 0.192 | 124,502 | 0.230 | 99,692 | 0.221 | 102,484 | 0.116 | 190,487 | 0.227 | 103,078 | 0.228 | 100,002 |
| 2008 | 0.241 | 106,656 | 0.242 | 68,248 | 0.199 | 127,239 | 0.243 | 105,766 | 0.234 | 109,099 | 0.125 | 197,369 | 0.237 | 110,041 | 0.240 | 106,716 |
| 2009 | 0.233 | 106,094 | 0.196 | 67,339 | 0.197 | 128,421 | 0.235 | 104,490 | 0.227 | 108,593 | 0.124 | 191,581 | 0.230 | 109,854 | 0.232 | 106,342 |
| 2010 | 0.273 | 106,261 | 0.188 | 66,748 | 0.219 | 125,900 | 0.274 | 104,107 | 0.265 | 108,761 | 0.147 | 187,545 | 0.270 | 110,225 | 0.270 | 106,732 |
| 2011 | 0.276 | 99,768 | 0.224 | 67,741 | 0.224 | 123,409 | 0.277 | 97,425 | 0.269 | 102,226 | 0.150 | 174,521 | 0.270 | 103,658 | 0.273 | 100,526 |
| 2012 | 0.272 | 98,798 | 0.185 | 68,540 | 0.218 | 123,154 | 0.270 | 96,648 | 0.265 | 101,213 | 0.149 | 171,381 | 0.278 | 103,008 | 0.267 | 99,968 |
| 2013 | 0.368 | 88,864 | 0.240 | 65,497 | 0.279 | 113,324 | 0.362 | 87,355 | 0.358 | 91,089 | 0.199 | 153,530 | 0.363 | 91,954 | 0.360 | 90,422 |
| 2014 | 0.283 | 78,999 | 0.214 | 63,491 | 0.226 | 105,849 | 0.276 | 78,459 | 0.276 | 81,121 | 0.151 | 140,560 | 0.282 | 81,890 | 0.275 | 81,031 |
| 2015 | 0.243 | 70,858 | 0.148 | 59,609 | 0.184 | 98,060 | 0.235 | 71,232 | 0.237 | 72,602 | 0.131 | 125,916 | 0.243 | 73,367 | 0.236 | 73,220 |
| 2016 | 0.278 | 73,924 | 0.181 | 63,642 | 0.216 | 101,816 | 0.267 | 75,217 | 0.272 | 75,614 | 0.151 | 129,207 | 0.278 | 76,284 | 0.268 | 76,868 |
| 2017 | 0.307 | 68,476 | - | - | - | - | 0.296 | 70,458 | 0.299 | 69,904 | 0.167 | 119,119 | 0.303 | 70,371 | 0.295 | 71,750 |

Figure 1 Schematic abundance calculations.

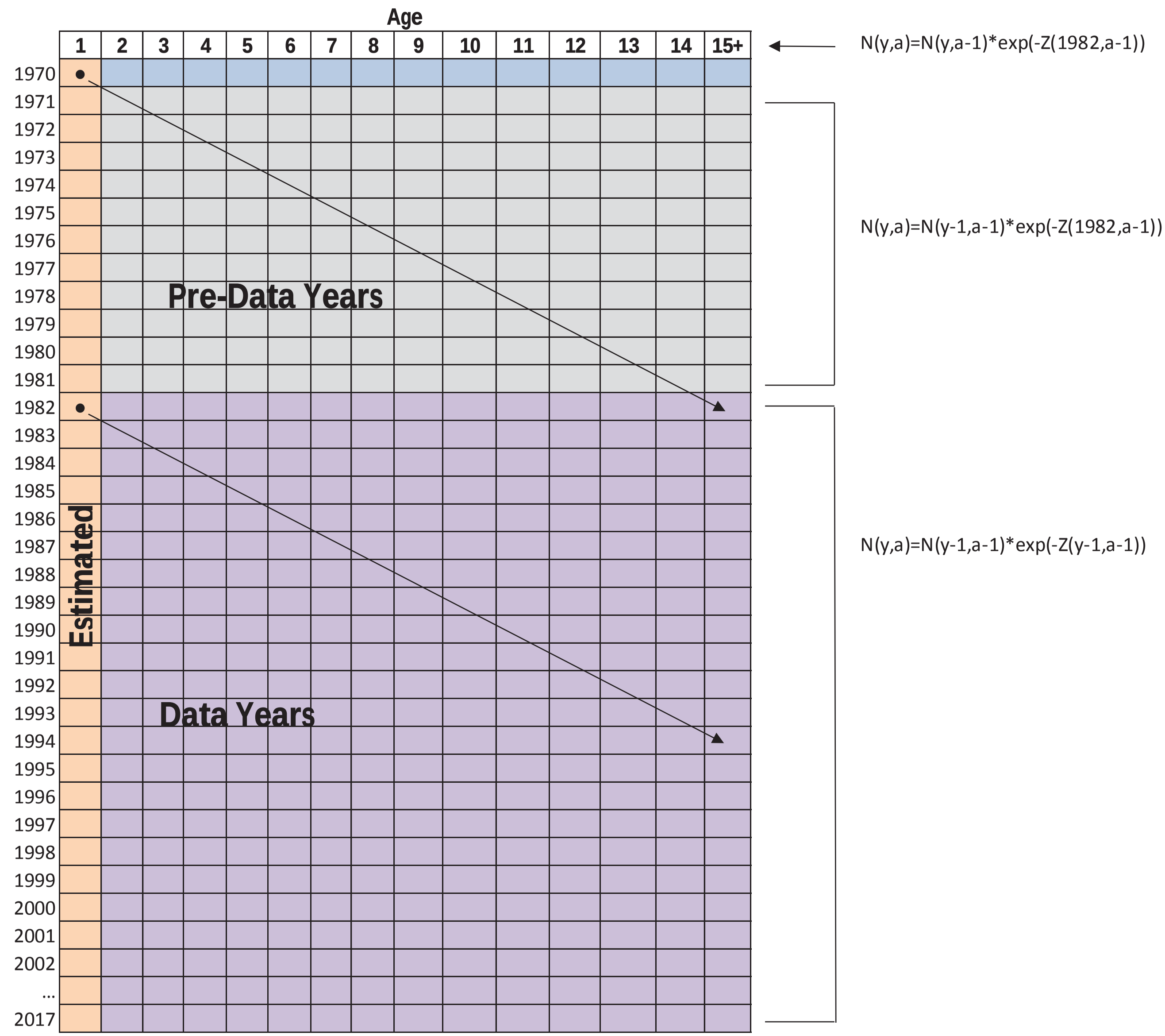


Figure 2. Selectivity pattern estimated for each age composition survey.

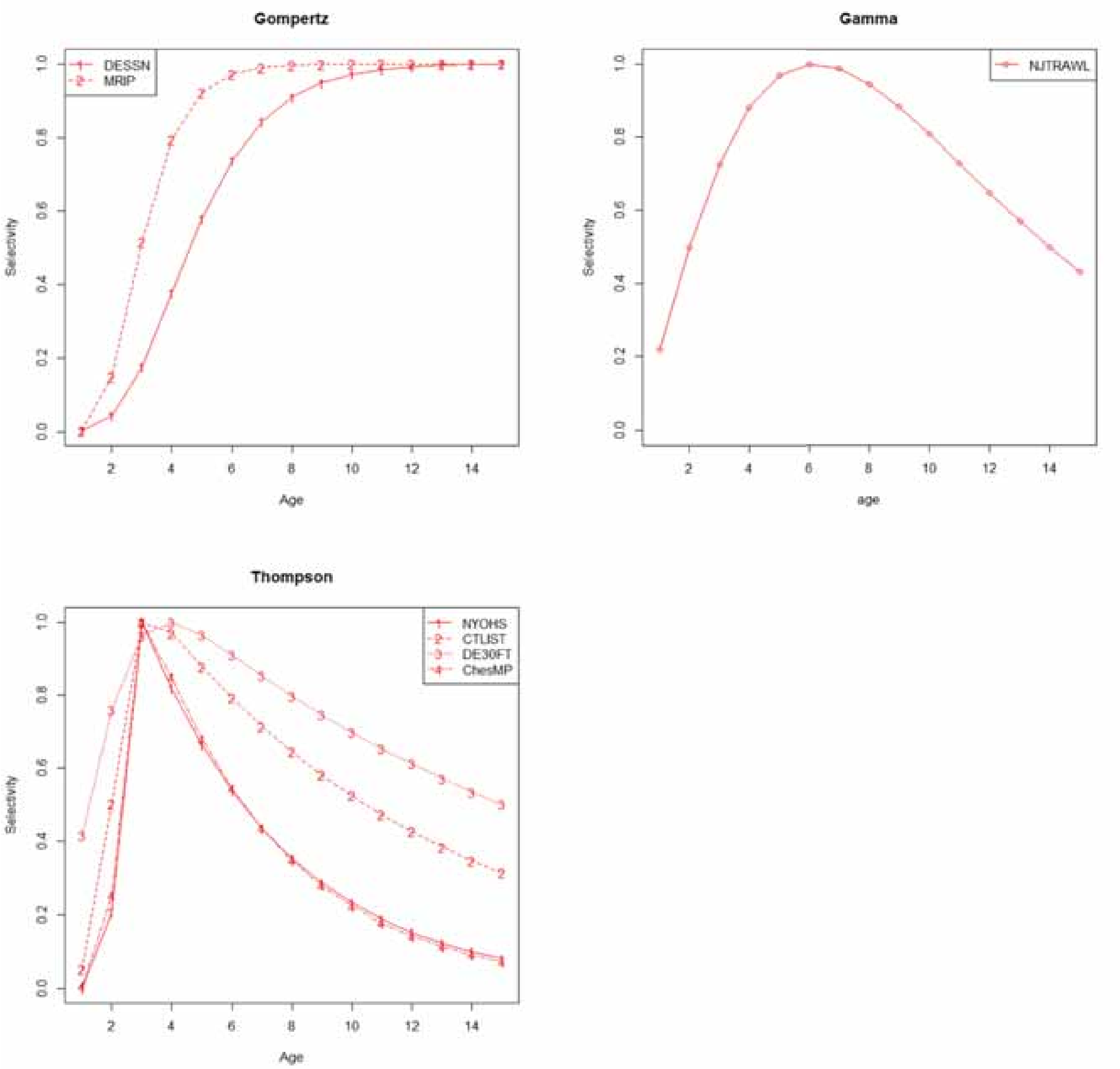
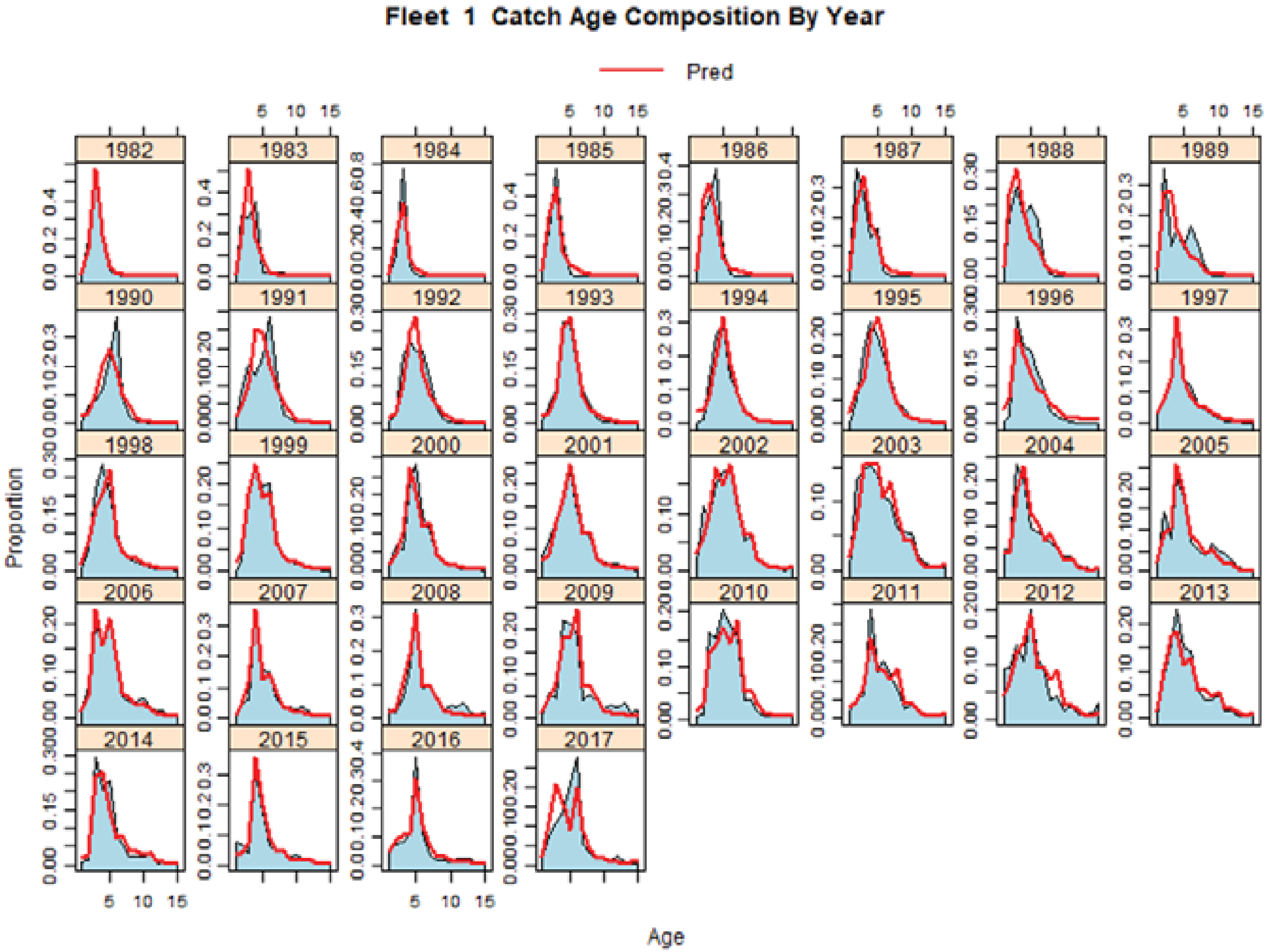


Figure 3. Plots of observed and predicted catch proportions-at-age by year for each fleet.



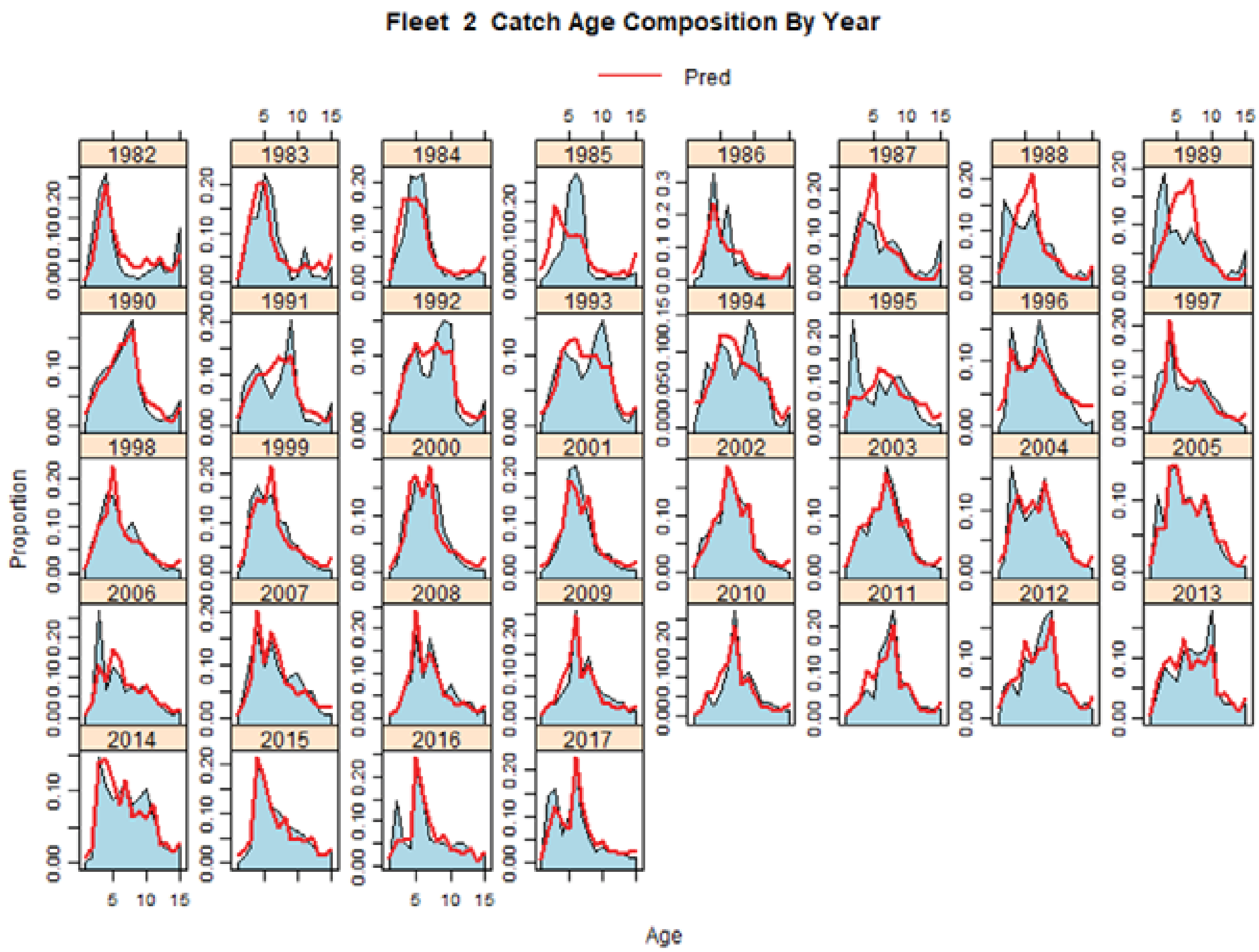
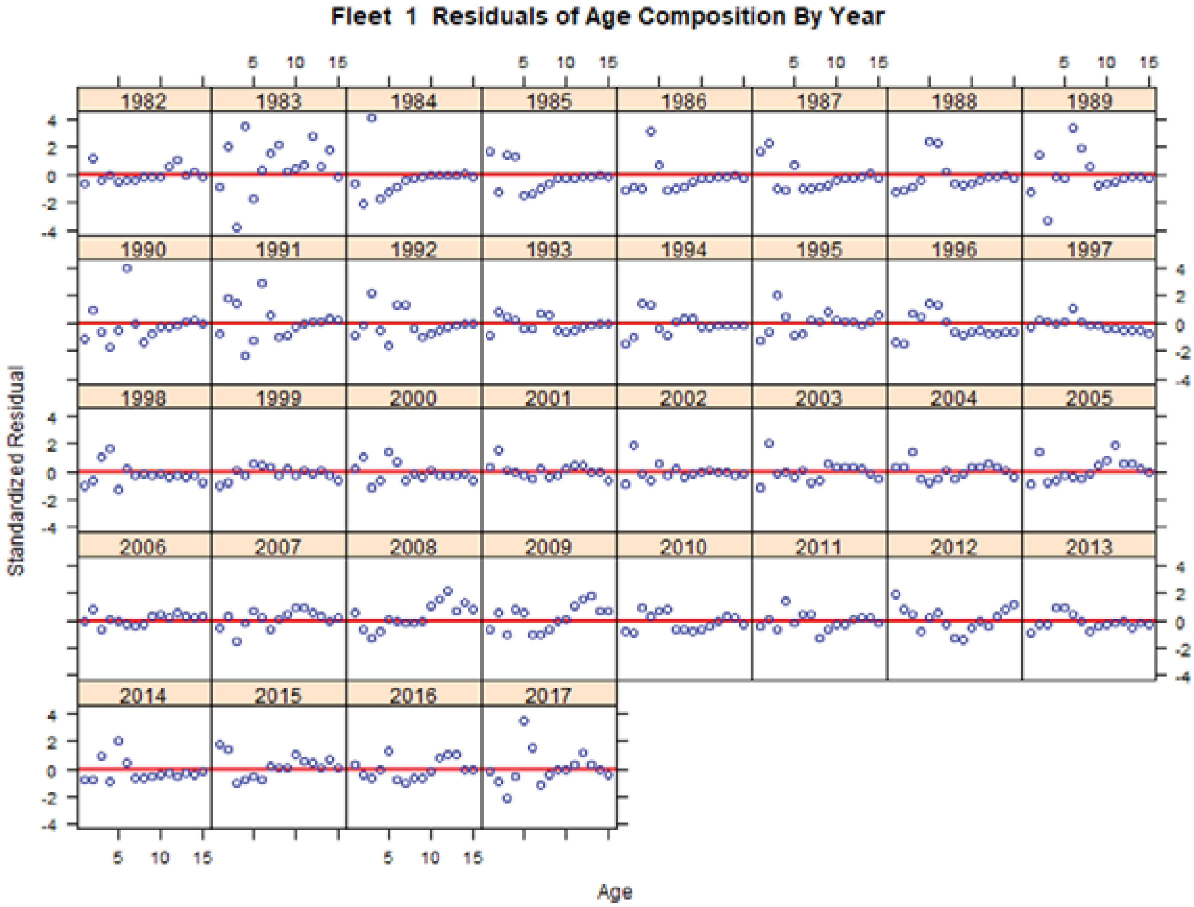

Fleet 2 Catch Age Composition By Year
Pred
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Proportion
Age

Figure 4. Standardized residuals of catch proportions-at-age by year for each fleet.



Fleet 2 Residuals of Age Composition By Year

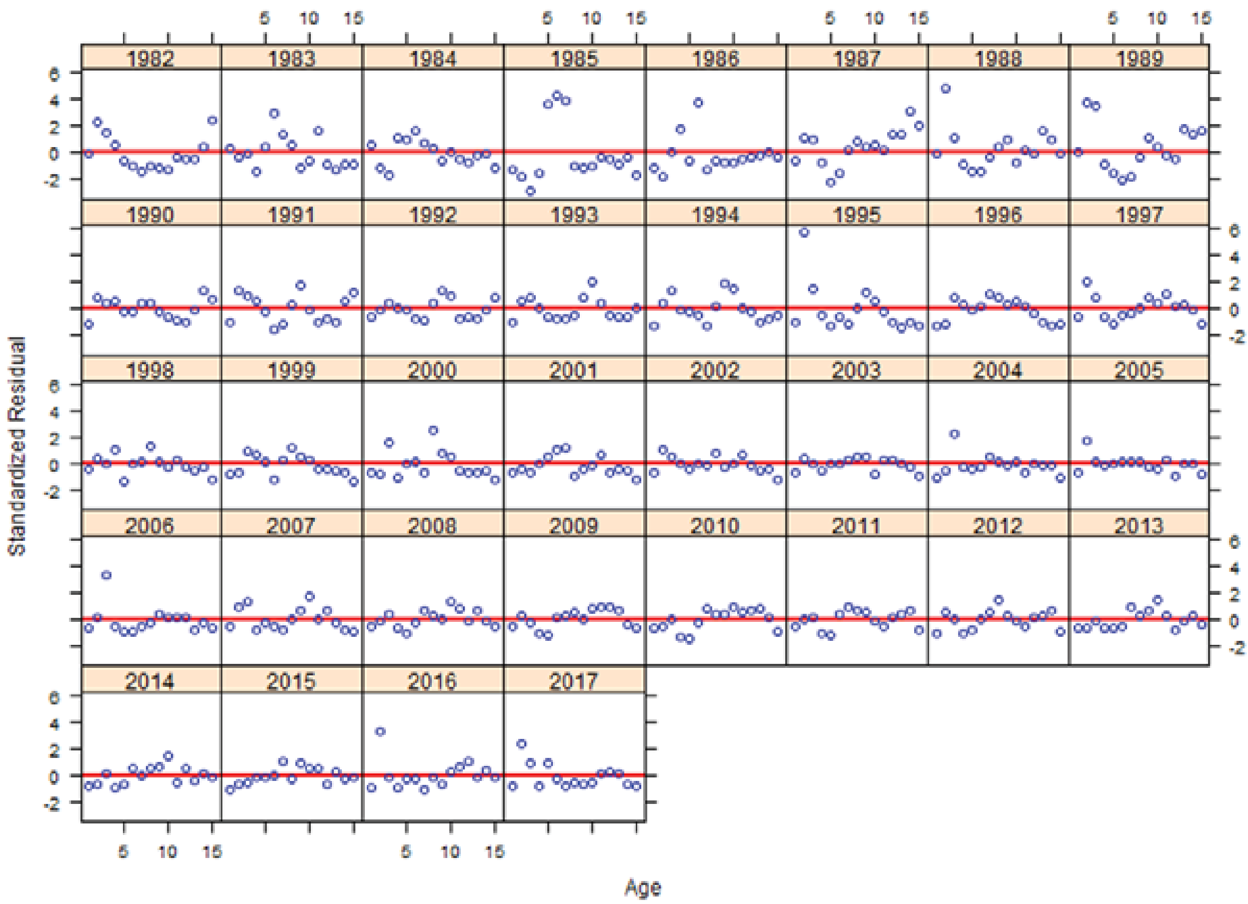
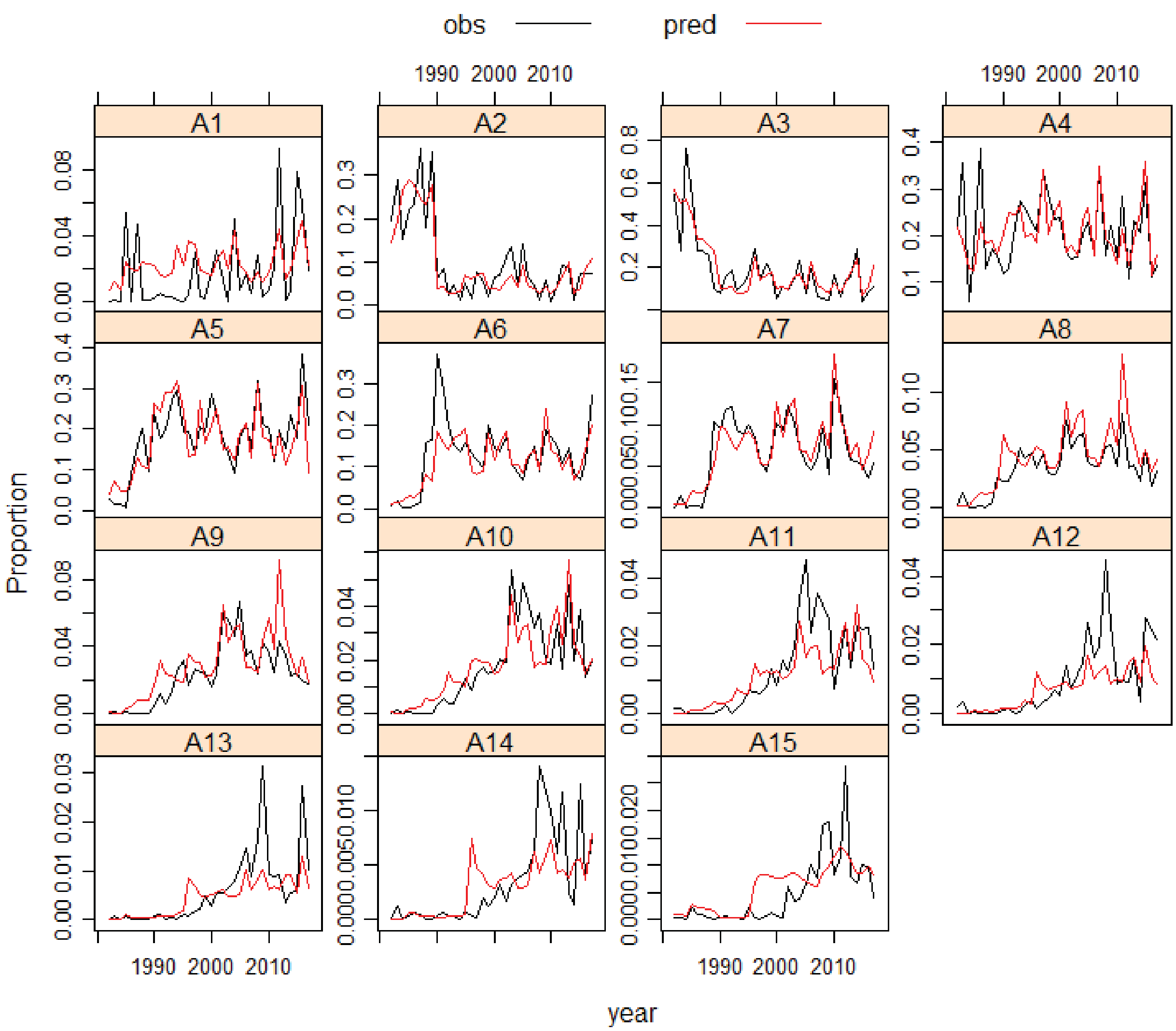


Figure 5. Observed and predicted catch proportions-at-age by age for each fleet.

Fleet 1:



Fleet 2:

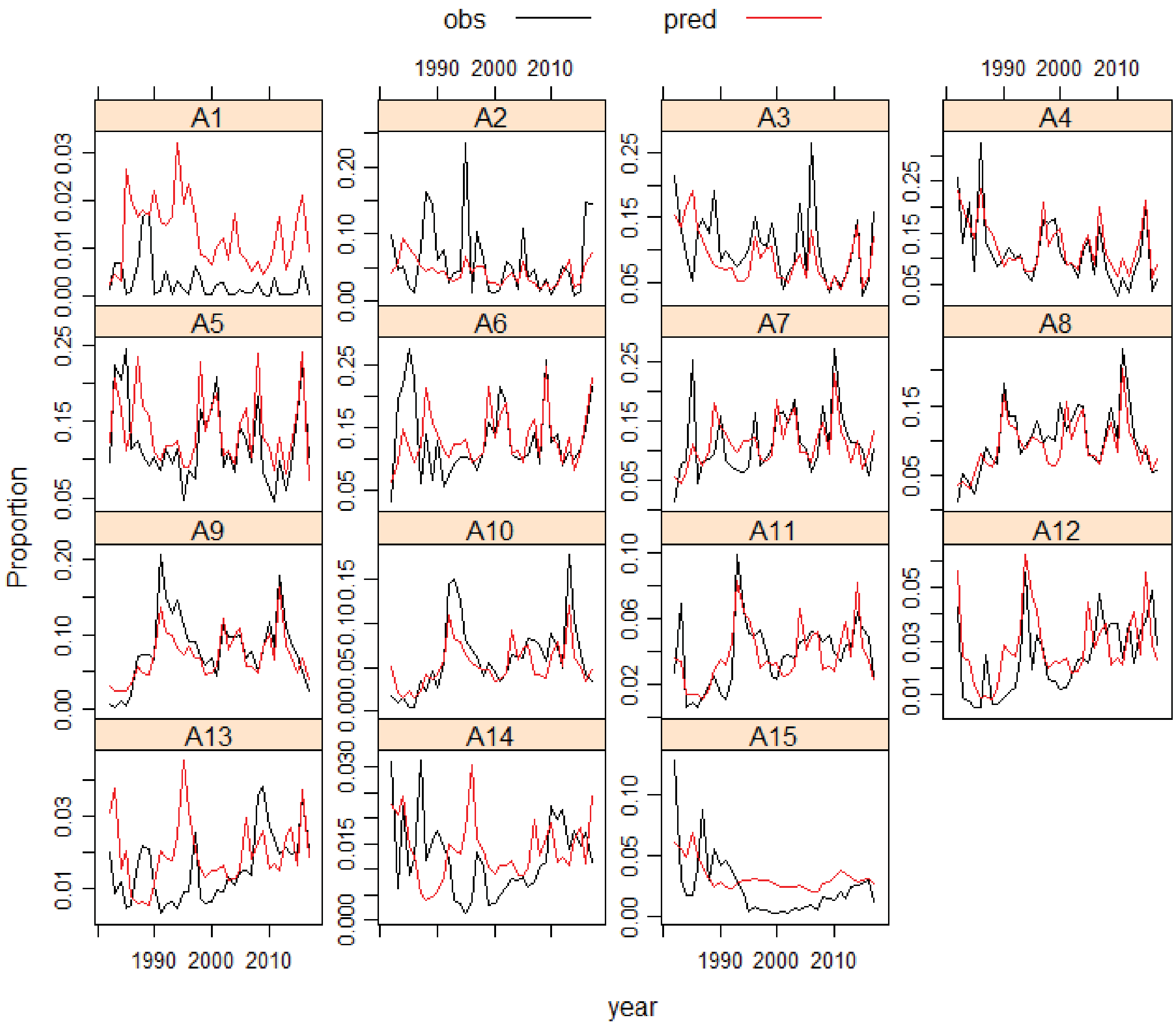
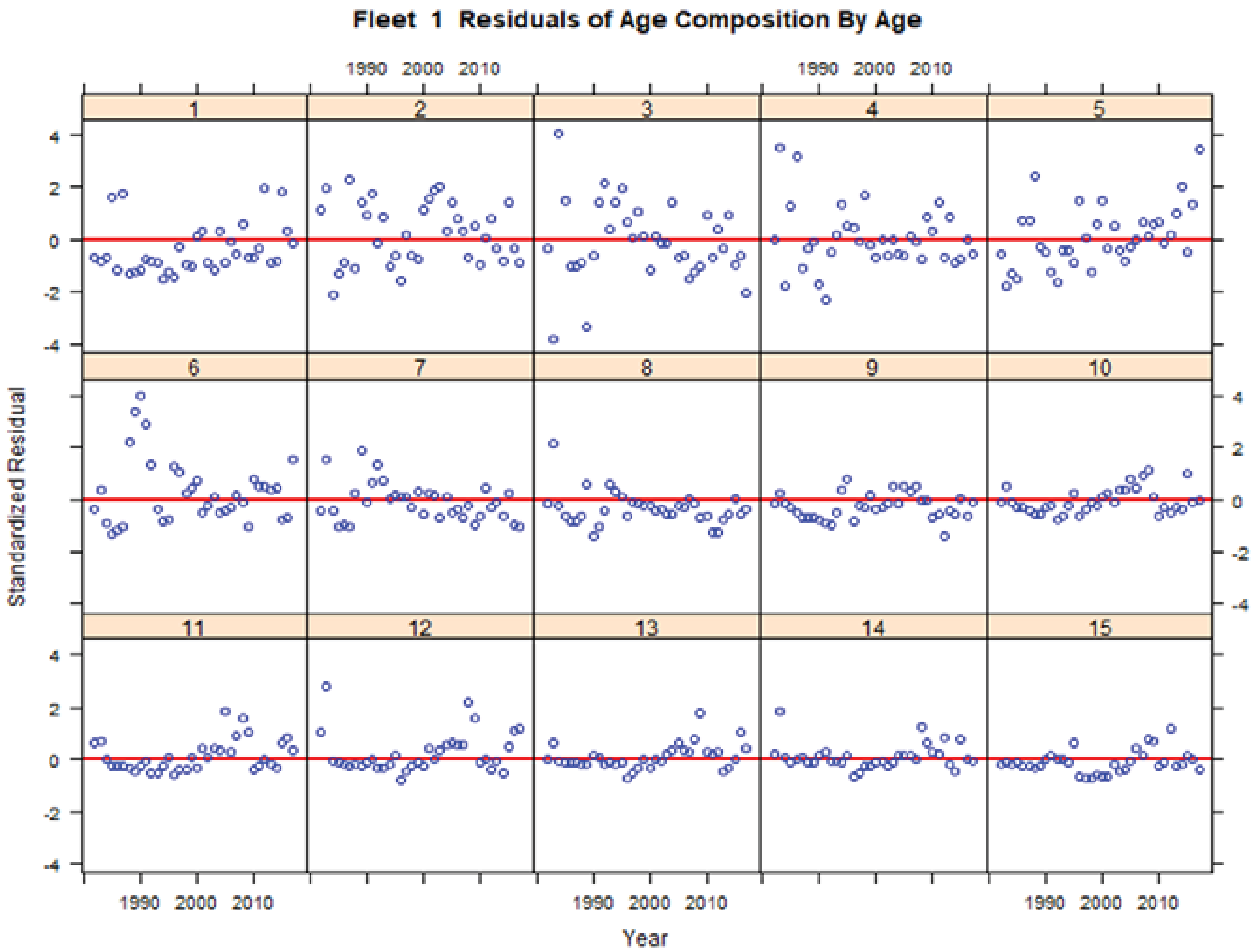
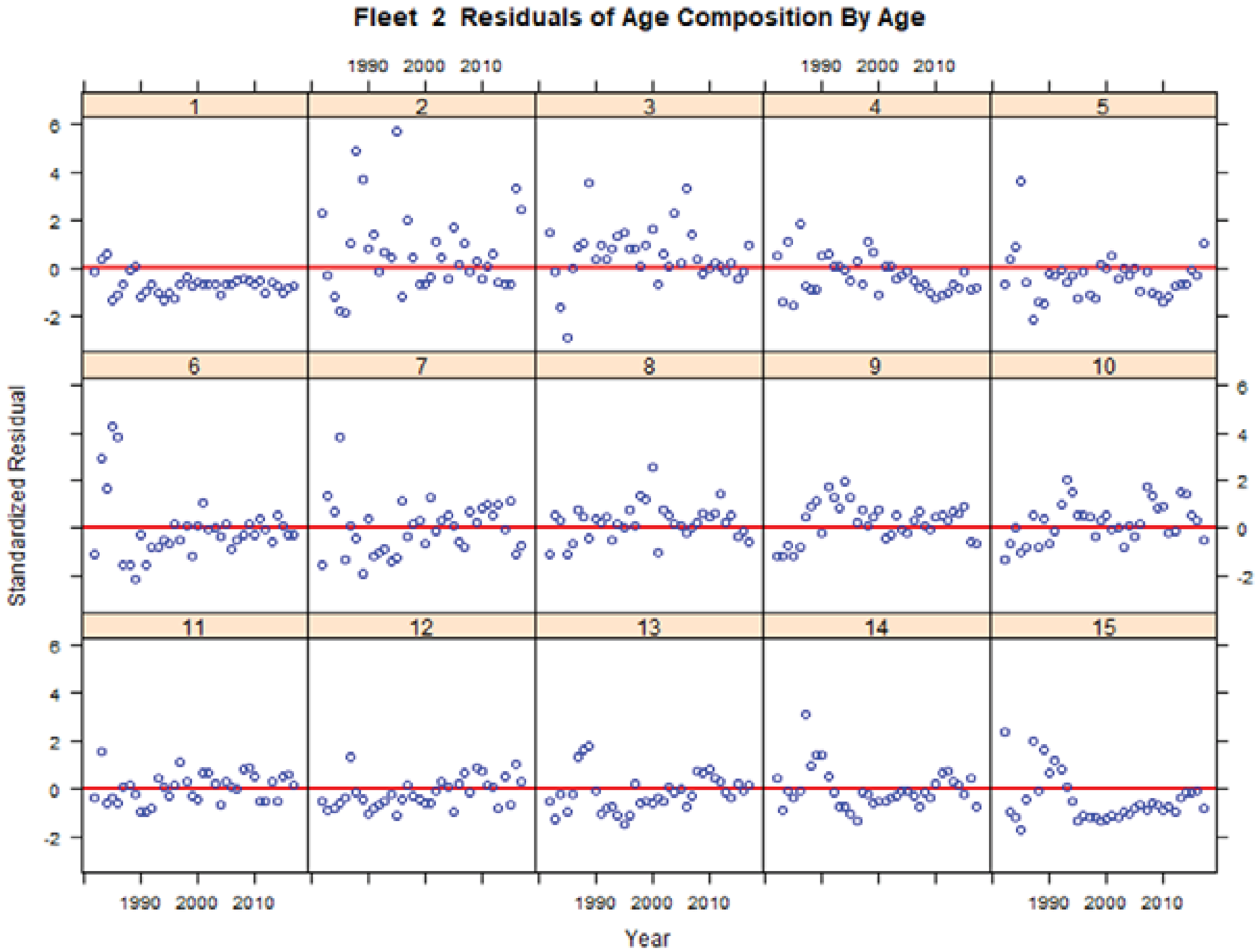

obs
pred
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
1990 2000 2010
Proportion
year

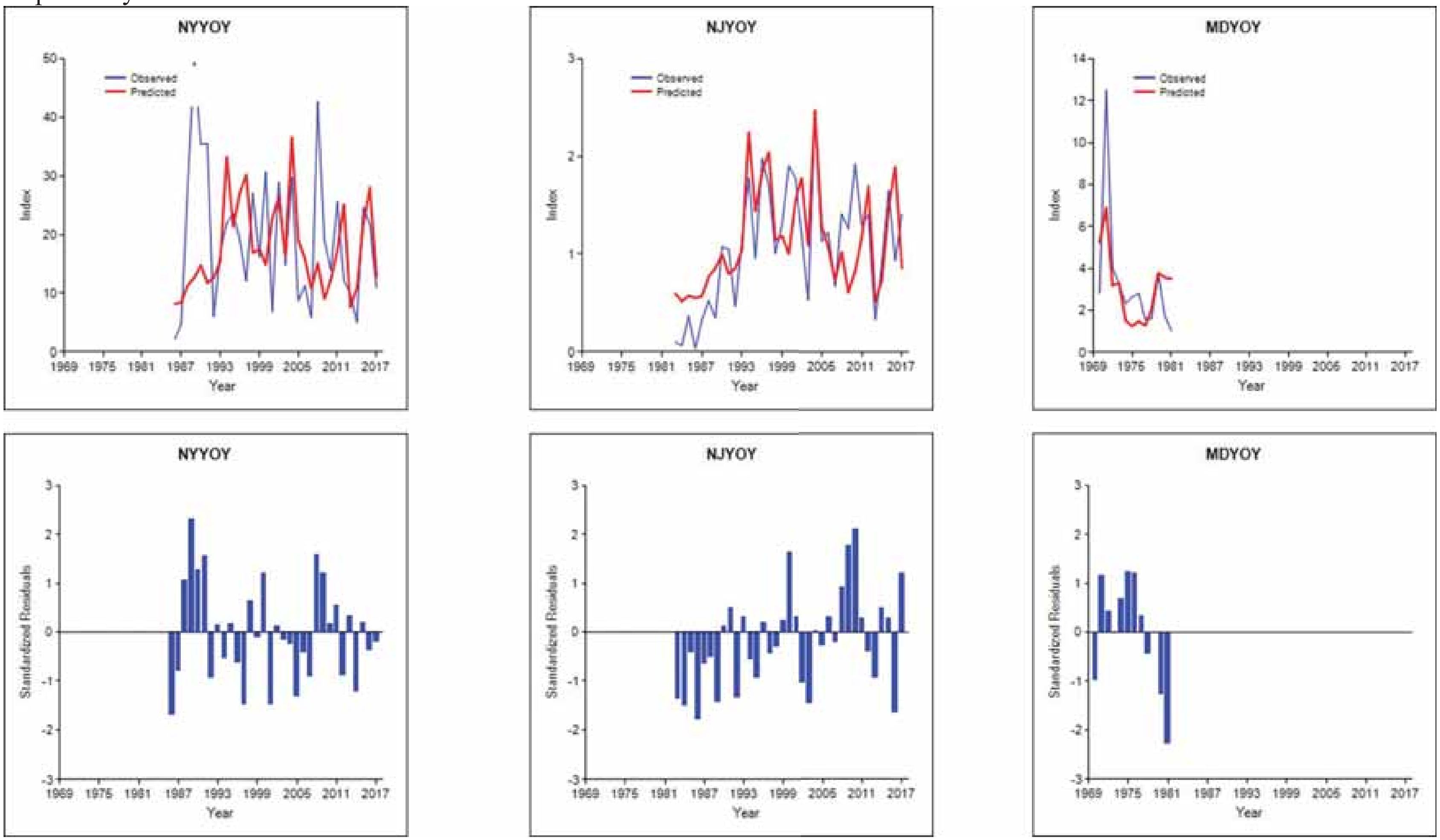
Figure 6. Standardized residuals of catch proportions-at-age by age.

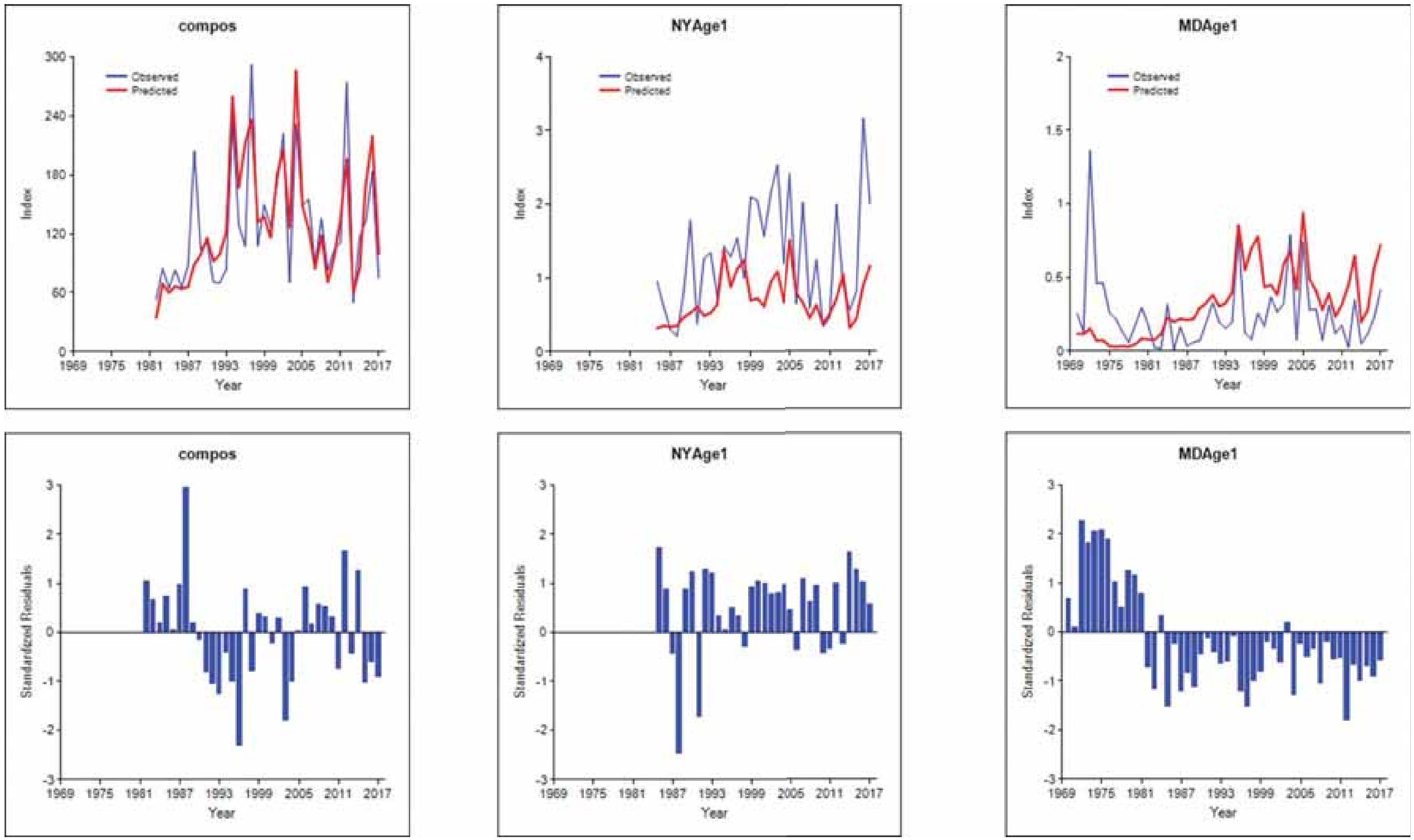




Fleet 2 Residuals of Age Composition By Age
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Standardized Residual
Year
1990
2000
2010
6
4
2
0
-2

Figure 7. Observed and predicted values and standardized residuals for young-of-the-year and yearling surveys tuned to Age 1 and 2, respectively.





compos
Observed
Predicted
Index
Year
compos
Standardized Residuals
Year
NYAge1
Observed
Predicted
Index
Year
NYAge1
Standardized Residuals
Year
MDAge1
Observed
Predicted
Index
Year
MDAge1
Standardized Residuals
Year

Figure 8. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the NYOHS survey.

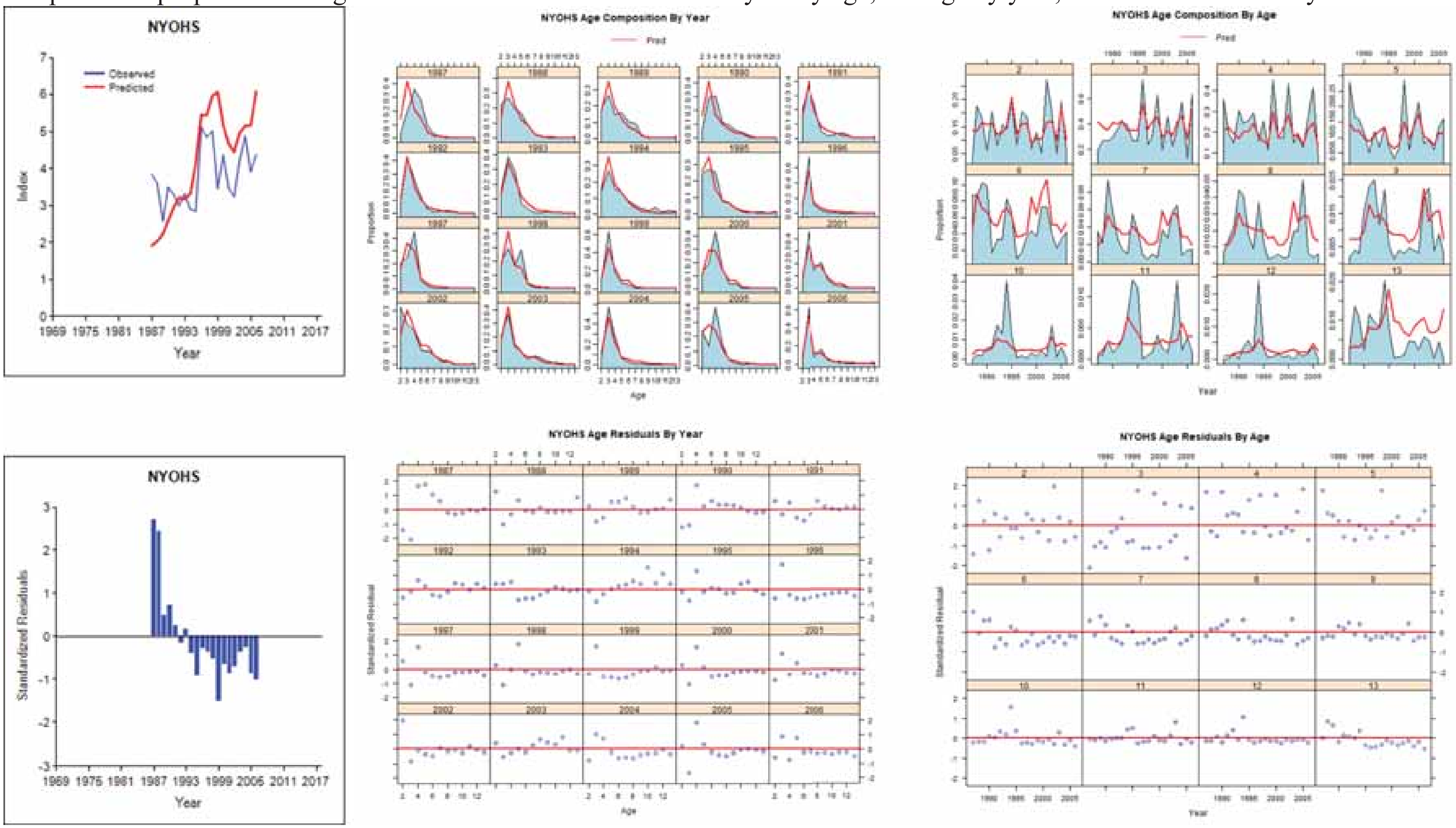


Figure 9. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the NJTRAWL survey.

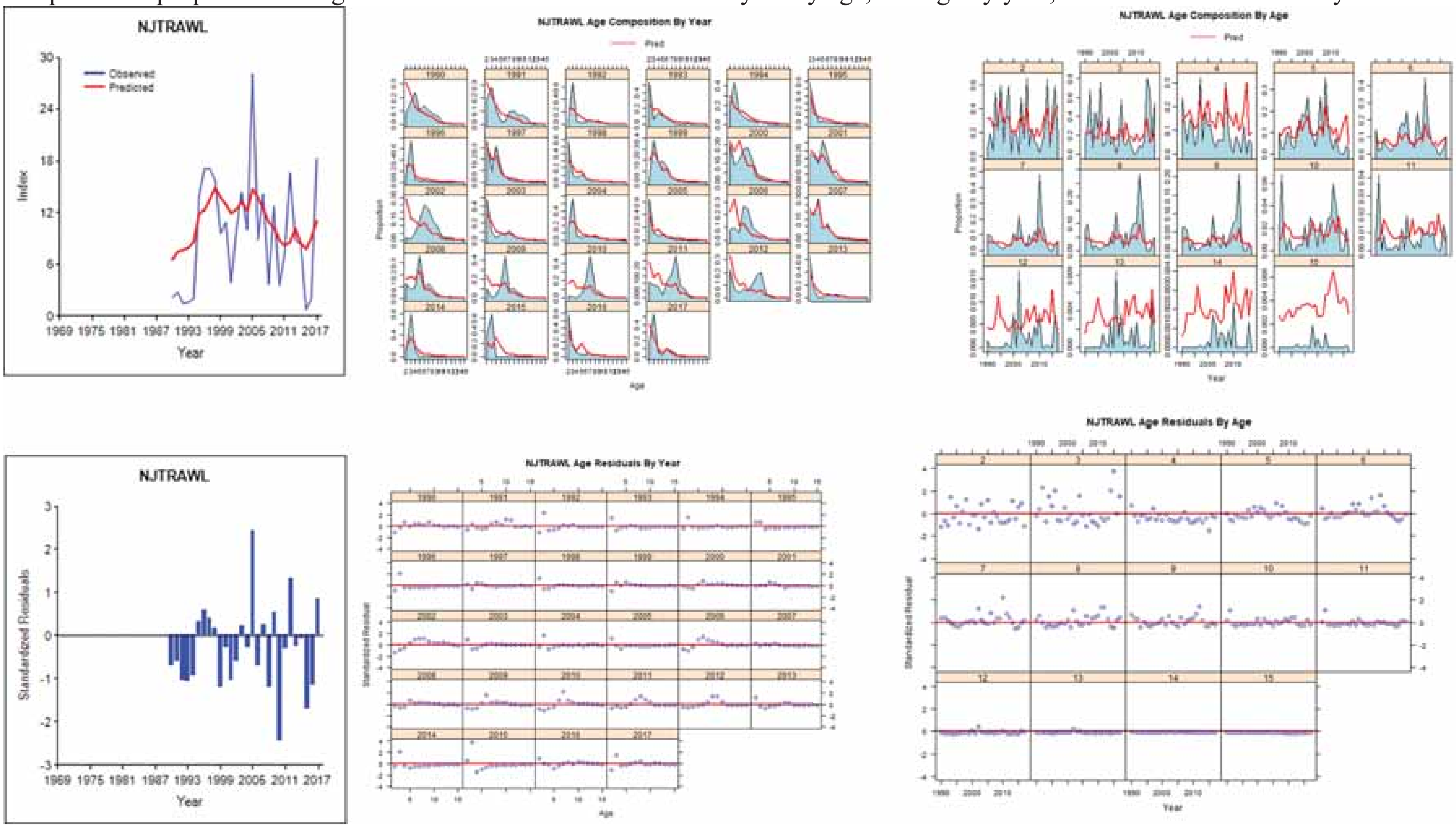


Figure 10. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the MDSSN survey.

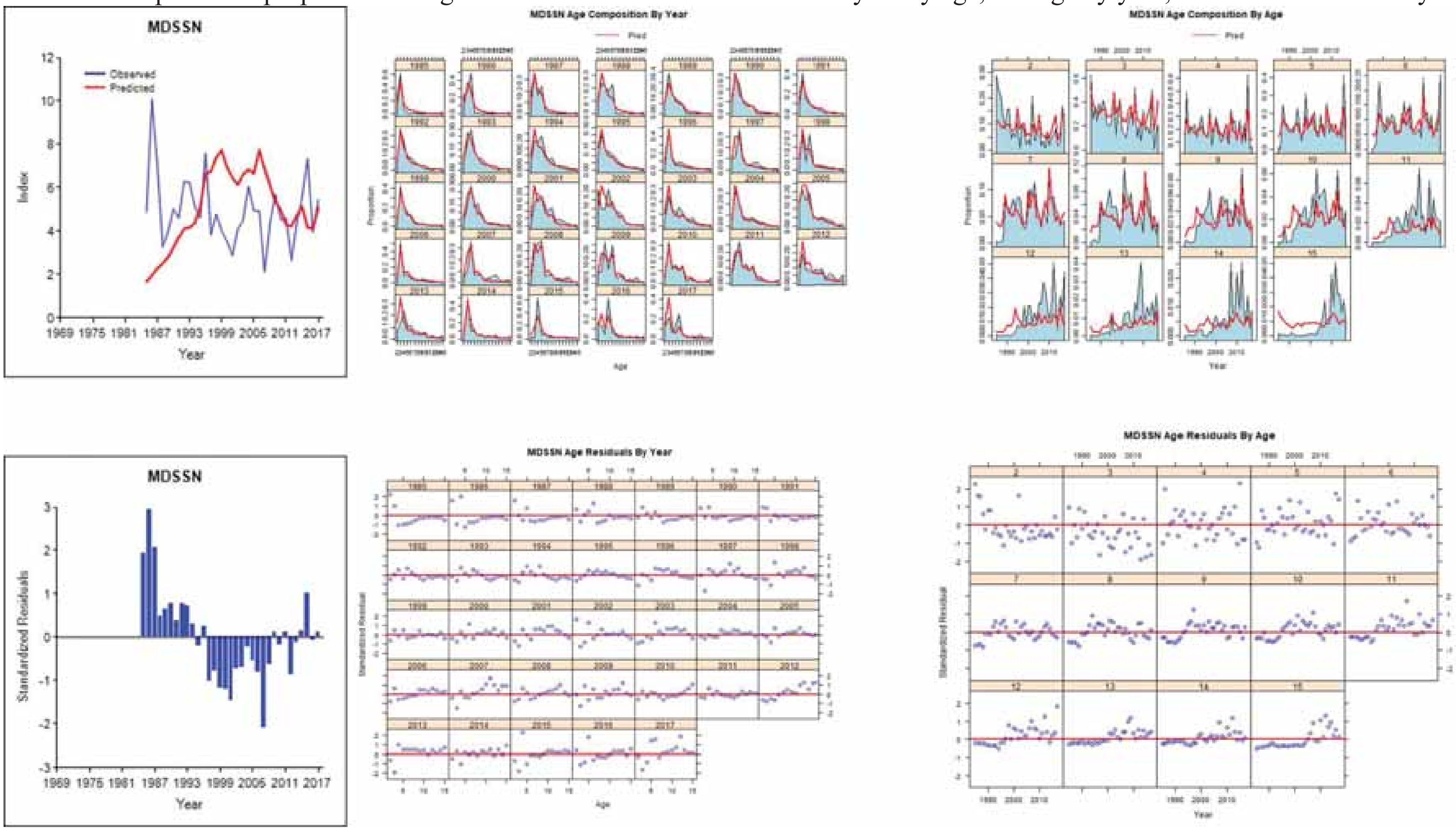


Figure 11. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the DESSN survey.

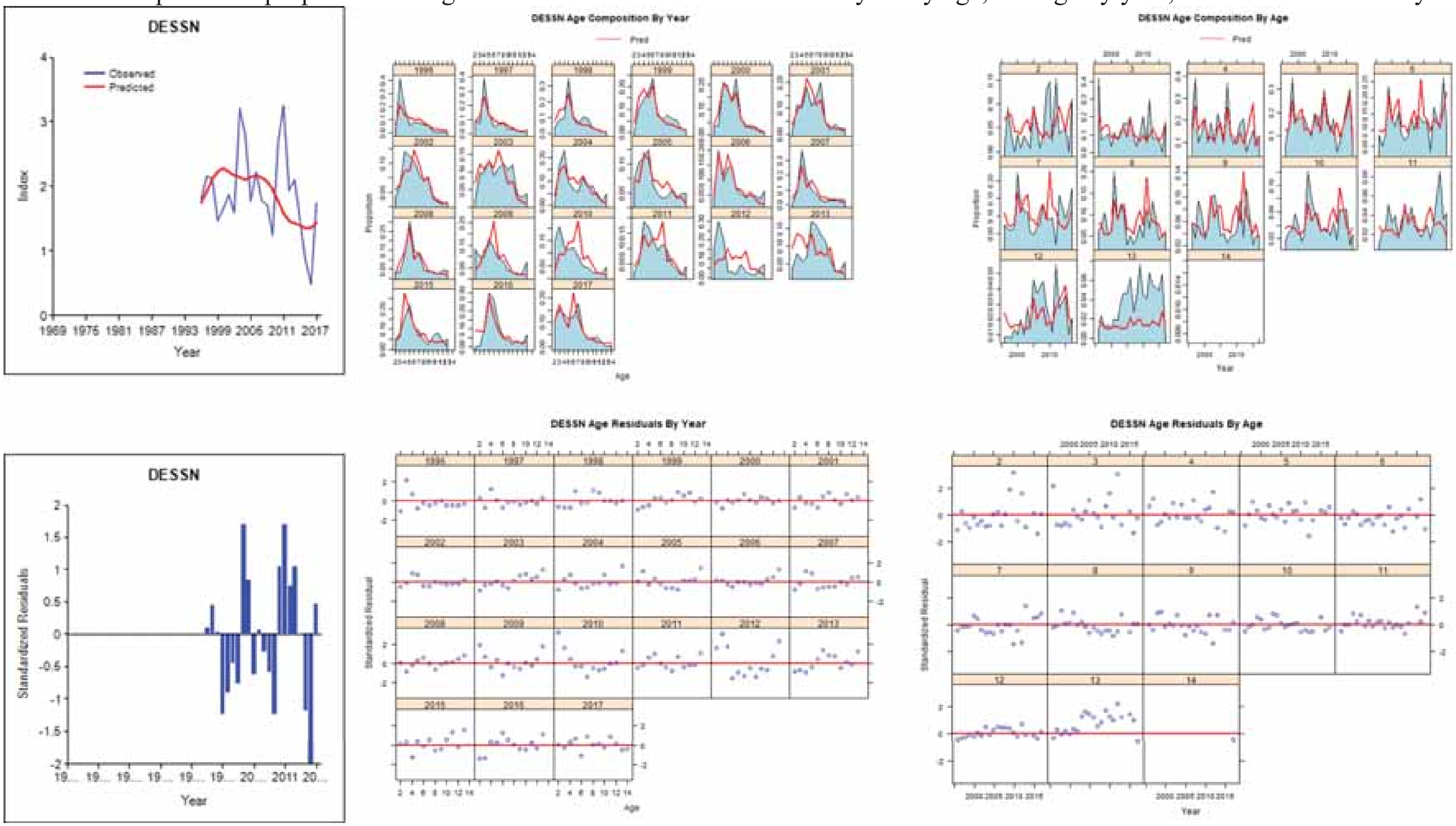


Figure 12. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the MRIP survey.

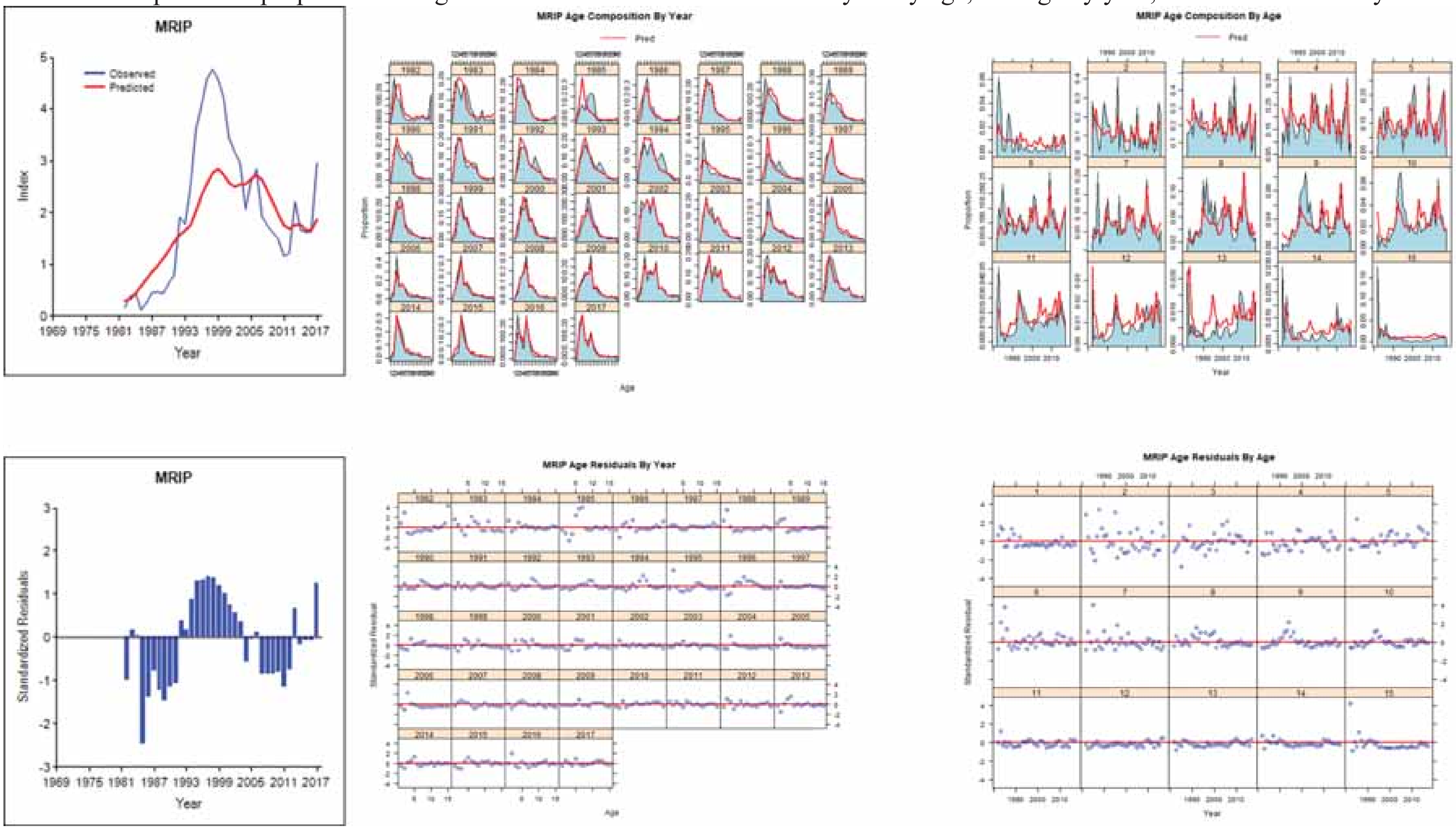


Figure 13. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the CTLIST survey.

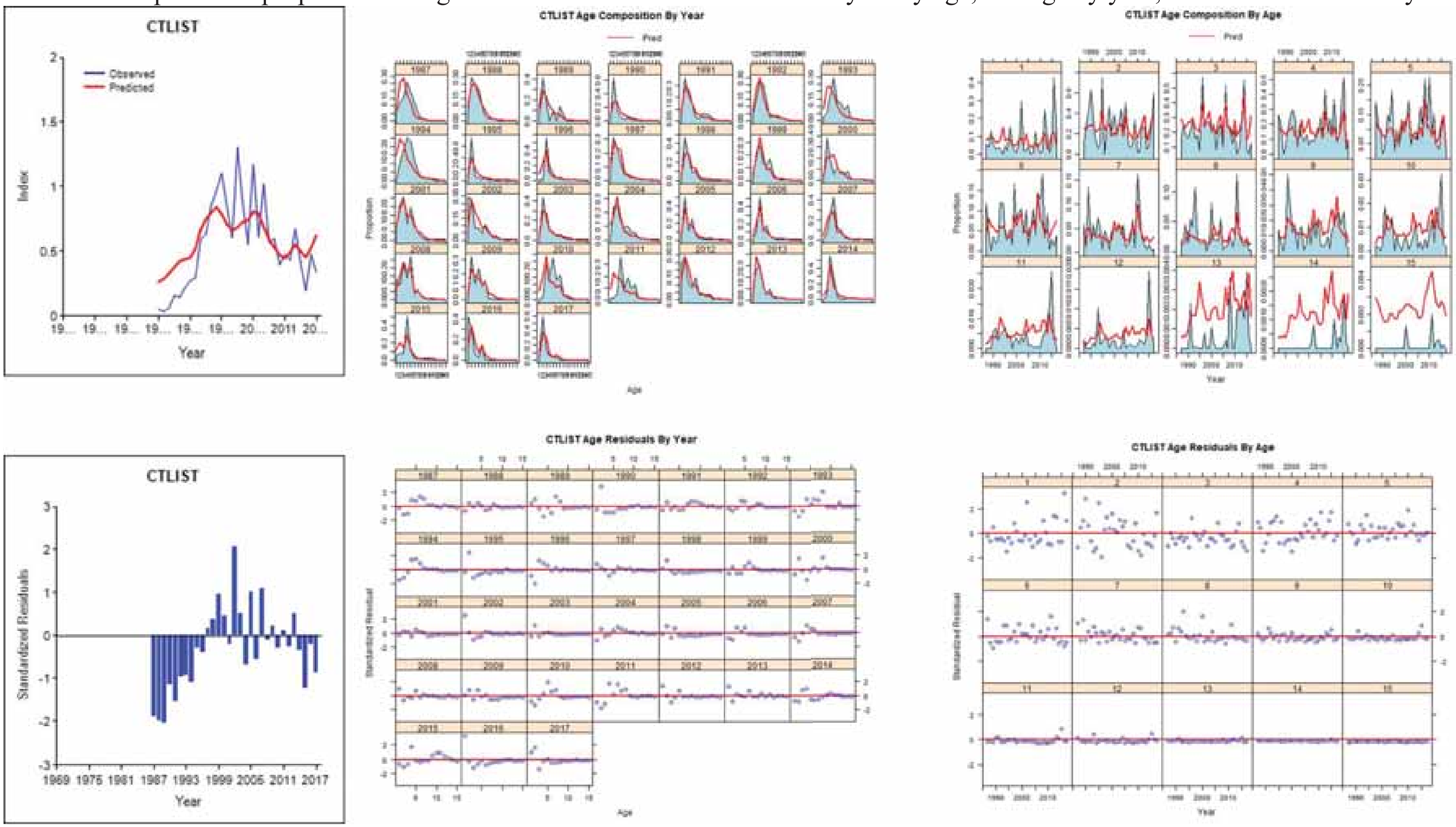
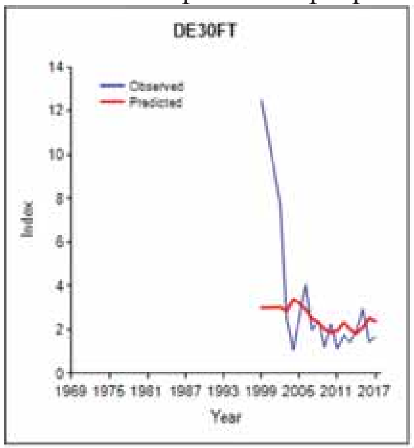
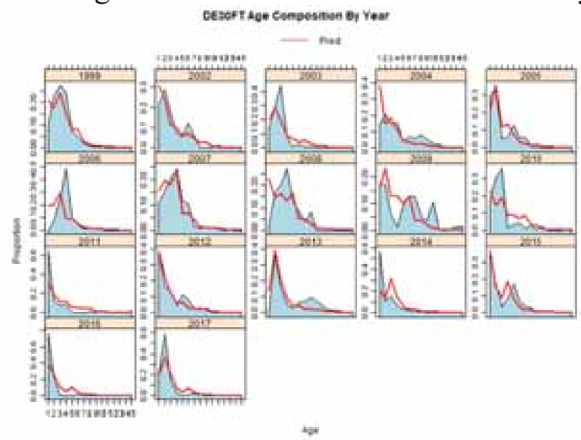
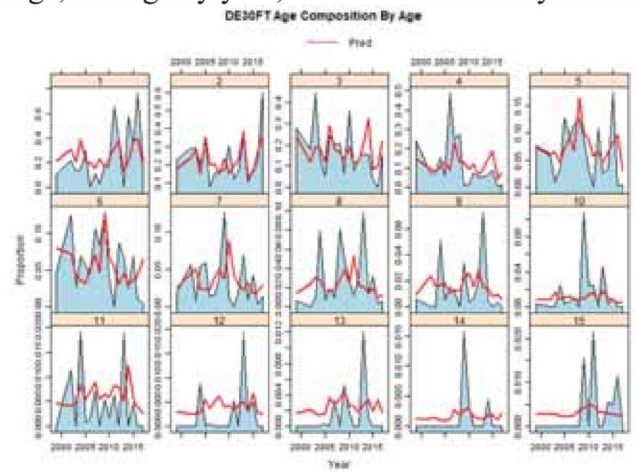
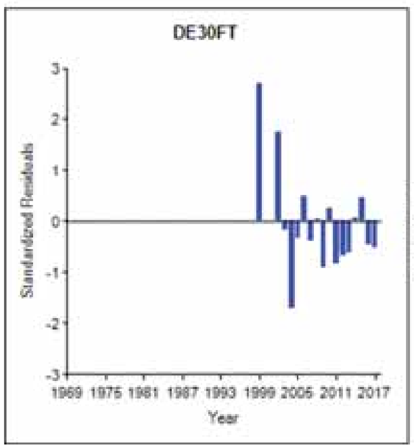


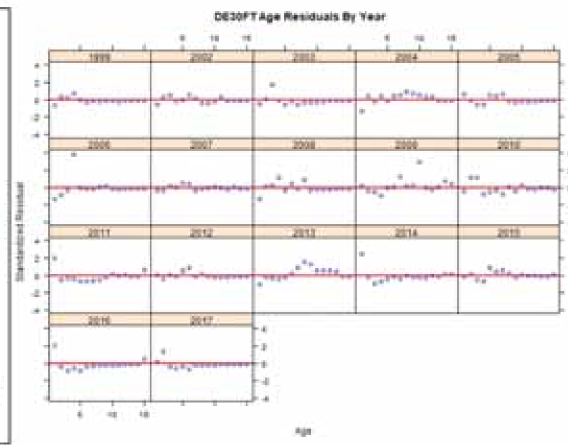
Figure 14. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the DE30 survey.



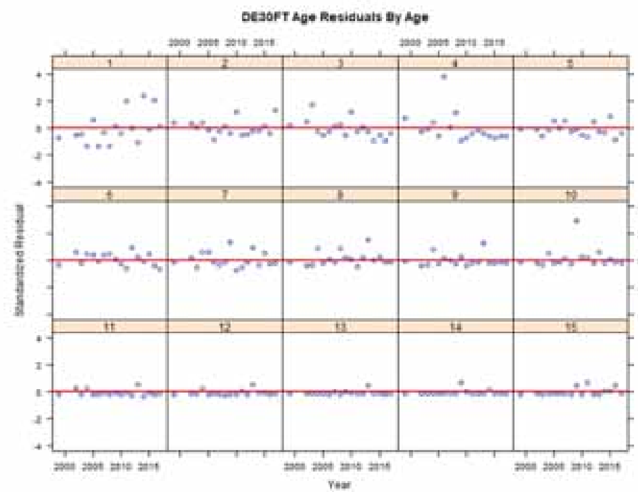
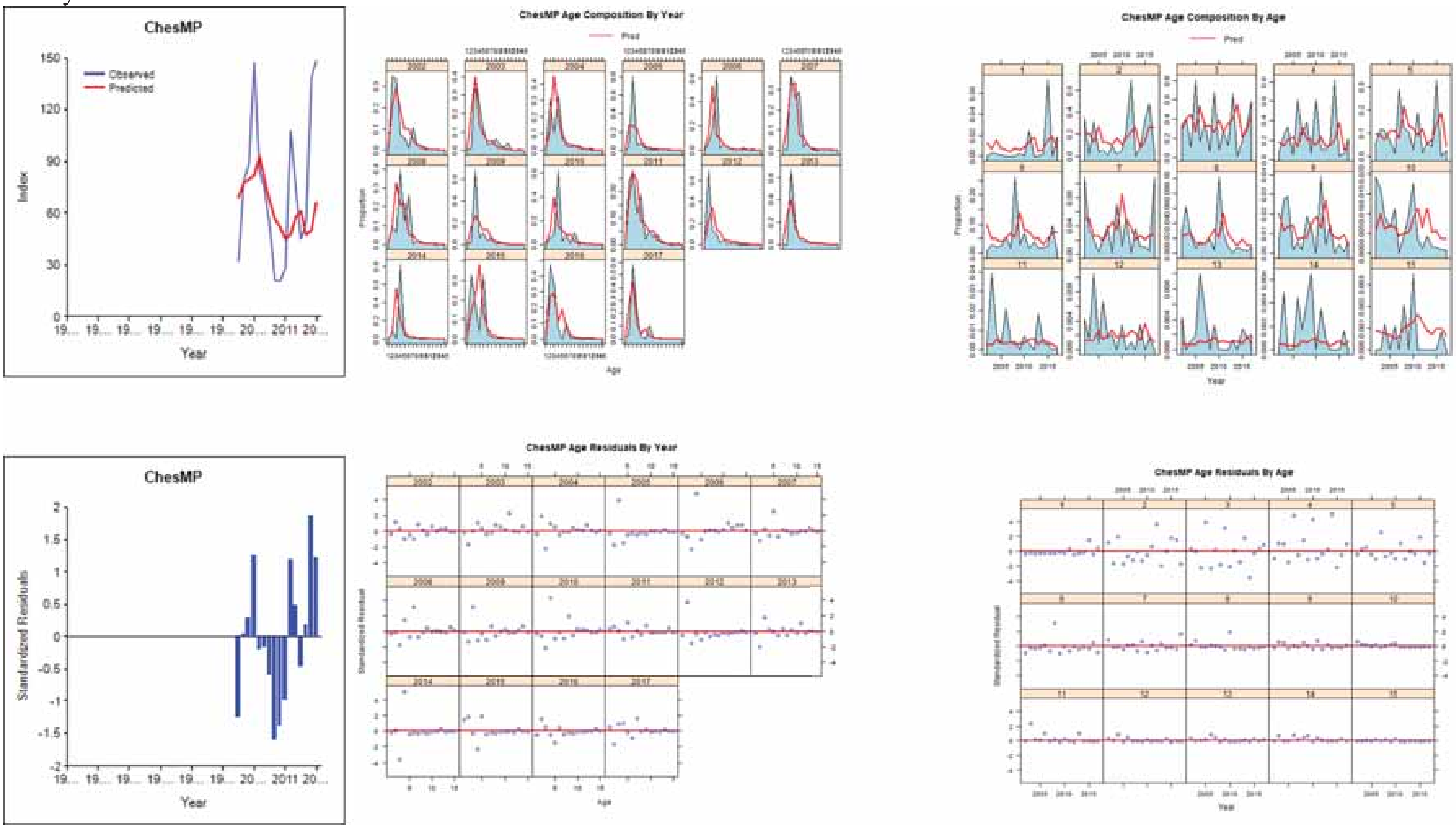



Figure 15. Observed and predicted values of the total index and standardized residuals for surveys with age composition data; observed and predicted proportions-at-age and standardized residual for each year by age, and age by year, for the ChesMMAP survey.



**APPENDIX B11. Supplemental Tagging Model Materials**

This appendix contains:

1. An analysis of the effect of new MRIP estimates on the tag reporting rate
2. Input matrices for each tagging program by size class
3. Plots of survival estimates by program and size class with and without an additional regulatory period

**Effect of New MRIP Estimates on the Tag Reporting Rate**

Angela Giuliano
October 1, 2018

Appendix B9 of the 2013 benchmark stock assessment (NEFSC 2013) documents the estimation of the current tag reporting rate used by the Striped Bass Tagging Subcommittee (TSC) in their tagging model analyses. These reporting rates are based on a high reward tagging study conducted in 2007 and 2008. Based on initial analysis in 2009, it appeared that the assumption that 100% of the high reward tags (HRTs) encountered were reported was violated. To overcome this, the TSC used the multicomponent fishery model to estimate the tag reporting rate (proposed by Paulik (1961), Kimura (1976), and Hearn et al. (1999) and described by Pollock et al. (2002)). This method allowed for the assumption that 100% of the HRTs encountered by the recreational sector were reported and was generalizable to allow for less than 100% of the HRTs from the recreational sector to be returned. In addition to knowing how many standard and HRTs were recaptured by sector, this method also used the ratio of recreational and commercial landings as a weighting factor. With the new estimates of recreational harvest by MRIP (Table 1), the analysis for estimating the tag reporting rate was repeated, assuming that the commercial landings numbers did not change.

The first step of the analysis was to calculate the estimated recreational tag reporting rate ($\lambda_{rechat}$, Eq. 2 in Appendix B9). As this value was calculated using the numbers of recreationally caught standard tags and HRTs, this value did not change from the previous analysis, assuming as before that 90% of the HRTs were returned by the recreational sector (Table 2). Y is defined as the ratio of the proportion of total landings due to the recreational sector to the proportion of total landings due to the commercial sector. As the proportion of total landings due to the recreational fishery has increased with the new MRIP estimates and the proportion of landings due to the commercial fishery has decreased, Y has increased (Table 2). Using $\lambda_{rechat}$, Y, and the ratio of commercial to recreational standard tag returns (Eq. 3 in Appendix B9), the commercial tag reporting rate ($\lambda_{comhat}$) is estimated. The commercial tag reporting rate, estimated using the new MRIP estimates, increased compared to the commercial tag reporting rate estimated previously (Table 2). The unknown tag reporting rate ($\lambda_{unknown}$) is calculated as the overall standard tag reporting rate, based on the actual and expected numbers of recreational and commercial tag returns. With the increase in the commercial tag reporting rate, the overall standard tag reporting rate also increased when compared to the previous estimate (Table 2).

As tag reporting rates were found to differ not only by sector but by region as well, separate tag reporting rate estimates were calculated for coastal states and producer areas (Appendix B9 in NEFSC 2013). Using the new recreational and commercial tag reporting rates estimated above, the single coastal reporting rate was recalculated (Table 3). With the higher commercial tag reporting rate, the overall estimated harvest and catch and release tag reporting rates also increased.

Similar results were observed with the producer area tag reporting rates, using the Maryland/Virginia/Delaware combined tag reporting rate as an example (Figure 1). With the increased commercial tag reporting rate, the overall harvest and catch and release tag reporting rates increased when estimated using the new MRIP harvest estimates.

The TSC discussed these results as their September 2018 meeting. The committee consensus was that it is unlikely that the tag reporting rates have increased through time as using the new MRIP based estimates would suggest given the length of the tagging time series, the possibility of angler fatigue, and concerns with the tag quality in recent years. Base tagging model runs used in the assessment used the previously calculated tag reporting rates (NEFSC 2013), not the ones estimated using the new MRIP estimates.

Literature Cited

Hearn, W.S., T. Polecheck, K.H. Pollock and W. Whitelaw. 1999. Estimation of tag reporting rates in age-structured multi-component fisheries where one component has observers. Canadian Journal of Fisheries and Aquatic Sciences 56:1255-1265.

Kimura, D.K. 1976. Estimating the total number of marked fish present in a catch. Transactions of the American Fisheries Society. 105:664-668.

NEFSC (Northeast Fisheries Science Center). 2013. 57th Northeast Regional Stock Assessment Workshop (57th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 13-16; 967 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/

Paulik, G.J. 1961. Detection of incomplete reporting of tags. Journal of the Fisheries Research Board of Canada 18:817-832.

Pollock, K.H., J.M. Hoenig, W.S. Hearn and B. Calingaert. 2002. Tag reporting rate estimation: II. Use of high-reward tagging and observers in multicomponent fisheries. N. Am. J. Fish. Manage. 22:727-736.

Table 1. Commercial and recreational landings for 2007 and 2008 used in the tag reporting rate analysis. VA recreational landings include wave 1 estimates. Commercial landings, in numbers of fish, remained constant but MRIP landings changed.

| | Commercial Landings | | | | Old MRIP Landings | | | | New MRIP Landings | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | DE | MD | NY | VA | DE | MD | NY | VA | DE | MD | NY | VA |
| 2007 | 30,717 | 598,495 | 78,287 | 140,602 | 10,096 | 679,024 | 370,722 | 366,964 | 17,171 | 1,127,310 | 602,845 | 749,328 |
| 2008 | 31,866 | 594,655 | 73,263 | 134,603 | 16,994 | 442,280 | 448,271 | 396,650 | 67,708 | 779,700 | 1,169,855 | 984,535 |

Table 2. Comparison of old and new estimates of the sector specific tag reporting rates and ratio of recreational landings to commercial landings (Y).

| Variable | Old Estimate | New Estimate |
|---|---|---|
| $\lambda_{rechat}$ | 0.85 | 0.85 |
| Y | 1.62 | 3.27 |
| $\lambda_{comhat}$ | 0.11 | 0.26 |
| $\lambda_{unknown}$ | 0.55 | 0.71 |

Table 3. Comparison of coastal program tag reporting rates estimated using old and new MRIP estimates.

| | | | | |
|---|---|---|---|---|
| Reporting rates used in original 2012 calcs | | | | |
| **comm** | **0.11** | | | |
| rec | 0.85 | | | |
| | | | | |
| Harvest Reporting Rate | | | Catch and Release Reporting Rate | |
| comm std recaps | 65 | | comm std recaps | 5 |
| rec std recaps | 522 | | rec std recaps | 175 |
| obs recaps | 587 | | obs recaps | 180 |
| Adj Comm | 590 | | Adj Comm | 45 |
| Adj Rec | 614 | | Adj Rec | 206 |
| Adj Recaps | 1204 | | Adj Recaps | 251 |
| **Reporting Rate (λ)** | **0.51** | | **Reporting Rate (λ)** | **0.72** |

| | | | | |
|---|---|---|---|---|
| Updated reporting rates with MRIP updates | | | | |
| **comm** | **0.26** | | | |
| rec | 0.85 | | | |
| | | | | |
| Harvest Reporting Rate | | | Catch and Release Reporting Rate | |
| comm std recaps | 65 | | comm std recaps | 5 |
| rec std recaps | 522 | | rec std recaps | 175 |
| obs recaps | 587 | | obs recaps | 180 |
| Adj Comm | 250.0 | | Adj Comm | 19.2 |
| Adj Rec | 614.1 | | Adj Rec | 205.9 |
| Adj Recaps | 864.1 | | Adj Recaps | 225.1 |
| **Reporting Rate (λ)** | **0.68** | | **Reporting Rate (λ)** | **0.80** |

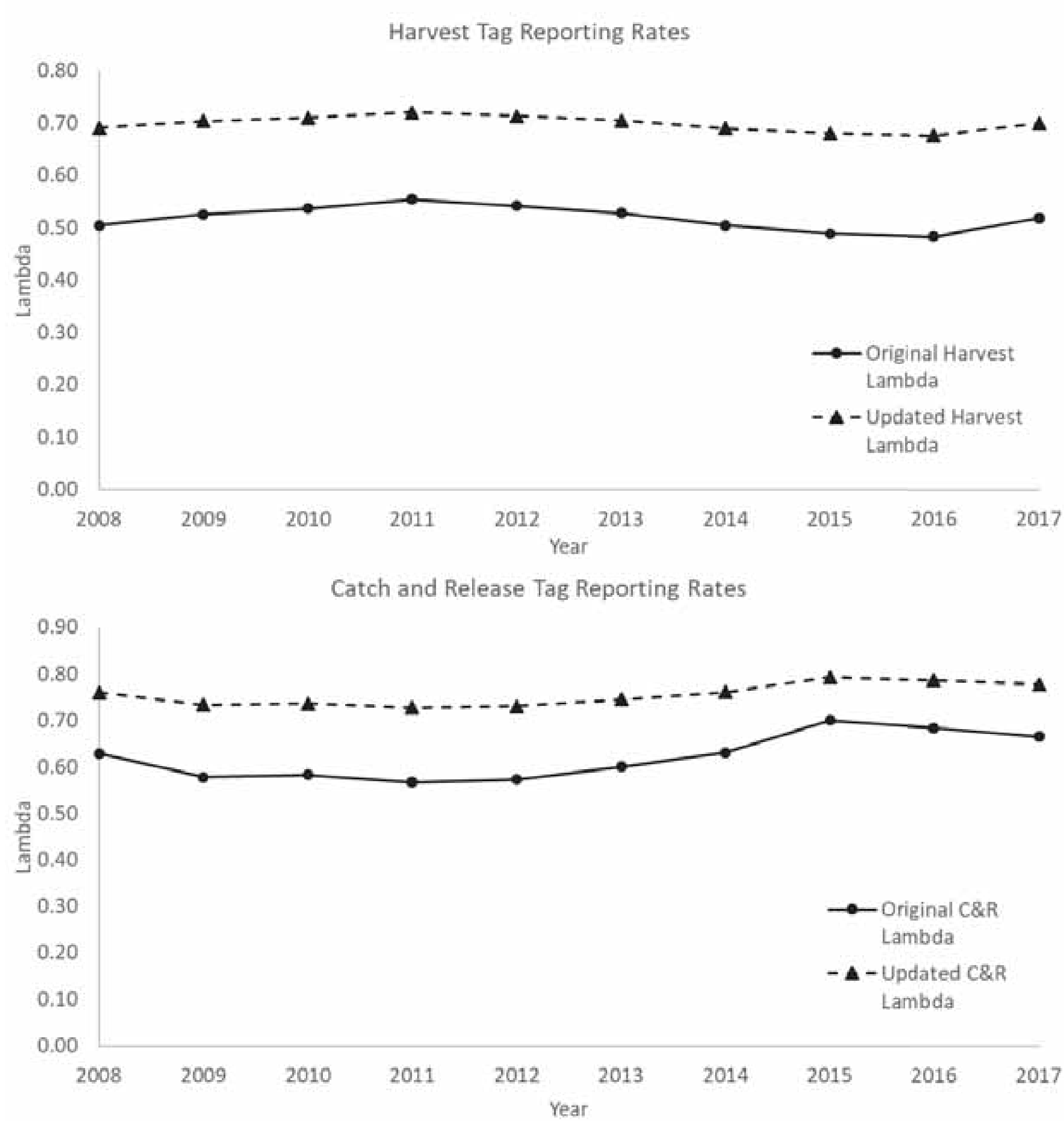



Figure 1. Maryland/Virginia/Delaware combined harvest (top) and catch and release (bottom) tag reporting rates using the old/original MRIP estimates and the updated/new MRIP estimates.

## Input matrices of harvested and released recaptures for IRCR analyses of ≥ 28 and ≥ 18 inch striped bass tagged by each program.

## Coastal Programs

### MADFW ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 329 | 1992 | 4 | 8 | 9 | 10 | 8 | 4 | 1 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 645 | 1993 | | 12 | 20 | 13 | 21 | 20 | 12 | 9 | 3 | 1 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 460 | 1994 | | | 6 | 14 | 26 | 17 | 13 | 7 | 2 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 219 | 1995 | | | | 3 | 9 | 8 | 4 | 2 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 271 | 1996 | | | | | 8 | 8 | 13 | 6 | 8 | 1 | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 118 | 1997 | | | | | | 8 | 4 | 2 | 3 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 1998 | | | | | | | 6 | 14 | 5 | 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 1999 | | | | | | | | 2 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 163 | 2000 | | | | | | | | | 9 | 3 | 5 | 3 | 3 | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 413 | 2001 | | | | | | | | | | 12 | 18 | 10 | 9 | 9 | 3 | 0 | 2 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 351 | 2002 | | | | | | | | | | | 10 | 12 | 11 | 6 | 5 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 172 | 2003 | | | | | | | | | | | | 8 | 3 | 5 | 4 | 0 | 0 | 5 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 615 | 2004 | | | | | | | | | | | | | 24 | 18 | 9 | 9 | 7 | 5 | 0 | 4 | 1 | 0 | 1 | 0 | 1 | 0 |
| 501 | 2005 | | | | | | | | | | | | | | 17 | 20 | 9 | 13 | 3 | 2 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| 515 | 2006 | | | | | | | | | | | | | | | 19 | 9 | 13 | 11 | 11 | 1 | 1 | 3 | 2 | 0 | 2 | 0 |
| 322 | 2007 | | | | | | | | | | | | | | | | 7 | 15 | 10 | 1 | 4 | 1 | 1 | 0 | 1 | 1 | 0 |
| 480 | 2008 | | | | | | | | | | | | | | | | | 15 | 19 | 13 | 7 | 5 | 3 | 3 | 1 | 0 | 0 |
| 385 | 2009 | | | | | | | | | | | | | | | | | | 17 | 10 | 20 | 0 | 10 | 1 | 0 | 2 | 2 |
| 458 | 2010 | | | | | | | | | | | | | | | | | | | 13 | 17 | 16 | 6 | 2 | 0 | 4 | 1 |
| 308 | 2011 | | | | | | | | | | | | | | | | | | | | 10 | 6 | 8 | 4 | 2 | 2 | 0 |
| 468 | 2012 | | | | | | | | | | | | | | | | | | | | | 9 | 11 | 8 | 3 | 3 | 2 |
| 553 | 2013 | | | | | | | | | | | | | | | | | | | | | | 20 | 17 | 7 | 9 | 3 |
| 458 | 2014 | | | | | | | | | | | | | | | | | | | | | | | 21 | 11 | 11 | 7 |
| 432 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | 8 | 18 | 8 |
| 326 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | 12 | 9 |
| 510 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | 21 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 329 | 1992 | 12 | 14 | 5 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 645 | 1993 | | 15 | 16 | 12 | 5 | 1 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 460 | 1994 | | | 13 | 6 | 5 | 4 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 219 | 1995 | | | | 11 | 4 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 271 | 1996 | | | | | 12 | 5 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 118 | 1997 | | | | | | 7 | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 1998 | | | | | | | 8 | 6 | 3 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 1999 | | | | | | | | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 163 | 2000 | | | | | | | | | 1 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 413 | 2001 | | | | | | | | | | 6 | 5 | 6 | 2 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 351 | 2002 | | | | | | | | | | | 14 | 2 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 172 | 2003 | | | | | | | | | | | | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 615 | 2004 | | | | | | | | | | | | | 6 | 7 | 4 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 501 | 2005 | | | | | | | | | | | | | | 8 | 5 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 515 | 2006 | | | | | | | | | | | | | | | 11 | 4 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 322 | 2007 | | | | | | | | | | | | | | | | 3 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 480 | 2008 | | | | | | | | | | | | | | | | | 6 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 385 | 2009 | | | | | | | | | | | | | | | | | | 4 | 3 | 7 | 1 | 1 | 1 | 0 | 0 | 0 |
| 458 | 2010 | | | | | | | | | | | | | | | | | | | 7 | 3 | 1 | 2 | 2 | 2 | 1 | 1 |
| 308 | 2011 | | | | | | | | | | | | | | | | | | | | 6 | 4 | 3 | 2 | 1 | 0 | 0 |
| 468 | 2012 | | | | | | | | | | | | | | | | | | | | | 7 | 6 | 2 | 3 | 0 | 0 |
| 553 | 2013 | | | | | | | | | | | | | | | | | | | | | | 11 | 2 | 3 | 2 | 2 |
| 458 | 2014 | | | | | | | | | | | | | | | | | | | | | | | 3 | 6 | 2 | 3 |
| 432 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | 7 | 6 | 2 |
| 326 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 3 |
| 510 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |

NYOHS/NYTRL* ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 213 | 1988 | 3 | 3 | 5 | 8 | 2 | 4 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 342 | 1989 | | 4 | 11 | 10 | 9 | 10 | 5 | 4 | 1 | 3 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 245 | 1990 | | | 6 | 8 | 6 | 3 | 3 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 280 | 1991 | | | | 16 | 13 | 6 | 4 | 5 | 2 | 4 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 286 | 1992 | | | | | 13 | 13 | 7 | 14 | 4 | 3 | 5 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 235 | 1993 | | | | | | 13 | 8 | 12 | 5 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251 | 1994 | | | | | | | 8 | 11 | 18 | 16 | 8 | 4 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 353 | 1995 | | | | | | | | 31 | 26 | 18 | 15 | 6 | 5 | 1 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 1996 | | | | | | | | | 6 | 5 | 7 | 6 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 1997 | | | | | | | | | | 10 | 4 | 4 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82 | 1998 | | | | | | | | | | | 6 | 4 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83 | 1999 | | | | | | | | | | | | 12 | 4 | 3 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 2000 | | | | | | | | | | | | | 3 | 5 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 93 | 2001 | | | | | | | | | | | | | | 4 | 5 | 7 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 2002 | | | | | | | | | | | | | | | 17 | 8 | 4 | 0 | 3 | 0 | 4 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 146 | 2003 | | | | | | | | | | | | | | | | 10 | 4 | 6 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 153 | 2004 | | | | | | | | | | | | | | | | | 10 | 2 | 2 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 64 | 2005 | | | | | | | | | | | | | | | | | | 7 | 3 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 57 | 2006 | | | | | | | | | | | | | | | | | | | 3 | 6 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 2007 | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 144 | 2008 | | | | | | | | | | | | | | | | | | | | | 4 | 9 | 7 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| 26 | 2009 | | | | | | | | | | | | | | | | | | | | | | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 142 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 6 | 4 | 2 | 0 | 0 | 3 | 0 |
| 102 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 1 | 1 | 3 | 0 | 0 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 213 | 1988 | 22 | 13 | 9 | 2 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 342 | 1989 | | 31 | 17 | 15 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 245 | 1990 | | | 16 | 9 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 280 | 1991 | | | | 18 | 11 | 6 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 286 | 1992 | | | | | 27 | 11 | 8 | 4 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 235 | 1993 | | | | | | 15 | 4 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251 | 1994 | | | | | | | 17 | 6 | 3 | 5 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 353 | 1995 | | | | | | | | 24 | 11 | 6 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 1996 | | | | | | | | | 9 | 0 | 6 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 1997 | | | | | | | | | | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82 | 1998 | | | | | | | | | | | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83 | 1999 | | | | | | | | | | | | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 2000 | | | | | | | | | | | | | 4 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 93 | 2001 | | | | | | | | | | | | | | 4 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 2002 | | | | | | | | | | | | | | | 13 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 146 | 2003 | | | | | | | | | | | | | | | | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 153 | 2004 | | | | | | | | | | | | | | | | | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 64 | 2005 | | | | | | | | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57 | 2006 | | | | | | | | | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 2007 | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 144 | 2008 | | | | | | | | | | | | | | | | | | | | | 5 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 26 | 2009 | | | | | | | | | | | | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 142 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 102 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 |

*NYOHS (1988–2007), NYTRL (2008–2012)

NJDB ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 35 | 1989 | 0 | 2 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 1990 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 1991 | | | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76 | 1992 | | | | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91 | 1993 | | | | | 3 | 1 | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 308 | 1994 | | | | | | 5 | 9 | 10 | 11 | 9 | 4 | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 552 | 1995 | | | | | | | 22 | 30 | 18 | 16 | 10 | 5 | 3 | 3 | 4 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 589 | 1996 | | | | | | | | 47 | 18 | 30 | 12 | 6 | 5 | 3 | 3 | 6 | 2 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 68 | 1997 | | | | | | | | | 7 | 2 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 126 | 1998 | | | | | | | | | | 19 | 5 | 5 | 2 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 101 | 1999 | | | | | | | | | | | 3 | 3 | 5 | 1 | 0 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 233 | 2000 | | | | | | | | | | | | 13 | 15 | 8 | 9 | 6 | 4 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 522 | 2001 | | | | | | | | | | | | | 33 | 26 | 21 | 14 | 6 | 5 | 1 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 359 | 2002 | | | | | | | | | | | | | | 16 | 12 | 11 | 9 | 2 | 3 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 564 | 2003 | | | | | | | | | | | | | | | 34 | 13 | 19 | 5 | 7 | 4 | 4 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 847 | 2004 | | | | | | | | | | | | | | | | 52 | 30 | 17 | 17 | 15 | 11 | 4 | 3 | 0 | 2 | 0 | 0 | 1 | 0 |
| 180 | 2005 | | | | | | | | | | | | | | | | | 12 | 5 | 7 | 3 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 225 | 2006 | | | | | | | | | | | | | | | | | | 13 | 7 | 9 | 6 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 434 | 2007 | | | | | | | | | | | | | | | | | | | 23 | 22 | 12 | 11 | 6 | 2 | 0 | 1 | 0 | 0 | 0 |
| 518 | 2008 | | | | | | | | | | | | | | | | | | | | 30 | 27 | 18 | 12 | 8 | 1 | 2 | 2 | 0 | 0 |
| 337 | 2009 | | | | | | | | | | | | | | | | | | | | | 33 | 10 | 10 | 6 | 2 | 2 | 1 | 0 | 0 |
| 339 | 2010 | | | | | | | | | | | | | | | | | | | | | | 18 | 13 | 4 | 6 | 1 | 3 | 2 | 0 |
| 525 | 2011 | | | | | | | | | | | | | | | | | | | | | | | 28 | 13 | 13 | 8 | 0 | 4 | 2 |
| 39 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0 | 1 | 1 | 0 | 0 |
| 75 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | 11 | 5 | 3 | 0 | 0 |
| 6 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 8 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 |
| 51 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 2 |
| 6 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 35 | 1989 | 4 | 1 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 1990 | | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 1991 | | | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76 | 1992 | | | | 7 | 5 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91 | 1993 | | | | | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 308 | 1994 | | | | | | 21 | 16 | 6 | 5 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 552 | 1995 | | | | | | | 33 | 21 | 14 | 11 | 4 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 589 | 1996 | | | | | | | | 35 | 17 | 15 | 1 | 3 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 1997 | | | | | | | | | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 126 | 1998 | | | | | | | | | | 2 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 101 | 1999 | | | | | | | | | | | 6 | 3 | 1 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 233 | 2000 | | | | | | | | | | | | 9 | 3 | 4 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 522 | 2001 | | | | | | | | | | | | | 19 | 12 | 3 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 359 | 2002 | | | | | | | | | | | | | | 11 | 11 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 564 | 2003 | | | | | | | | | | | | | | | 24 | 15 | 8 | 4 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 847 | 2004 | | | | | | | | | | | | | | | | 42 | 18 | 4 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 180 | 2005 | | | | | | | | | | | | | | | | | 11 | 5 | 4 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 225 | 2006 | | | | | | | | | | | | | | | | | | 12 | 3 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 434 | 2007 | | | | | | | | | | | | | | | | | | | 15 | 5 | 5 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 518 | 2008 | | | | | | | | | | | | | | | | | | | | 17 | 6 | 7 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 337 | 2009 | | | | | | | | | | | | | | | | | | | | | 8 | 6 | 3 | 1 | 1 | 0 | 1 | 0 | 0 |
| 339 | 2010 | | | | | | | | | | | | | | | | | | | | | | 8 | 8 | 1 | 0 | 0 | 0 | 0 | 0 |
| 525 | 2011 | | | | | | | | | | | | | | | | | | | | | | | 16 | 17 | 6 | 1 | 0 | 2 | 0 |
| 39 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 |
| 75 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0 | 1 | 0 | 0 |
| 6 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 8 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 |
| 51 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0 |
| 6 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |

## NCCOOP ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 188 | 1988 | 5 | 3 | 4 | 0 | 6 | 3 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 409 | 1989 | | 6 | 7 | 7 | 11 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 321 | 1990 | | | 11 | 6 | 11 | 5 | 1 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 856 | 1991 | | | | 23 | 19 | 23 | 20 | 16 | 5 | 11 | 7 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 89 | 1992 | | | | | 22 | 11 | 7 | 10 | 7 | 6 | 7 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 141 | 1993 | | | | | | 6 | 3 | 5 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 480 | 1994 | | | | | | | 14 | 16 | 7 | 6 | 5 | 6 | 1 | 3 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 372 | 1995 | | | | | | | | 21 | 13 | 16 | 11 | 5 | 2 | 2 | 5 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 557 | 1996 | | | | | | | | | 26 | 17 | 12 | 3 | 3 | 3 | 4 | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 868 | 1997 | | | | | | | | | | 67 | 31 | 16 | 9 | 11 | 0 | 3 | 3 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 106 | 1998 | | | | | | | | | | | 9 | 7 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 179 | 1999 | | | | | | | | | | | | 17 | 5 | 5 | 2 | 0 | 2 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 163 | 2000 | | | | | | | | | | | | | 4 | 6 | 1 | 2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 515 | 2001 | | | | | | | | | | | | | | 33 | 18 | 11 | 3 | 9 | 6 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 789 | 2002 | | | | | | | | | | | | | | | 39 | 31 | 20 | 13 | 7 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1575 | 2003 | | | | | | | | | | | | | | | | 75 | 53 | 29 | 15 | 12 | 7 | 6 | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 784 | 2004 | | | | | | | | | | | | | | | | | 40 | 18 | 15 | 11 | 5 | 3 | 2 | 4 | 0 | 0 | 1 | 0 | 0 | 0 |
| 557 | 2005 | | | | | | | | | | | | | | | | | | 17 | 16 | 10 | 5 | 4 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2113 | 2006 | | | | | | | | | | | | | | | | | | | 107 | 80 | 46 | 25 | 22 | 11 | 7 | 9 | 2 | 0 | 2 | 4 |
| 305 | 2007 | | | | | | | | | | | | | | | | | | | | 24 | 20 | 9 | 3 | 6 | 4 | 1 | 0 | 0 | 0 | 0 |
| 923 | 2008 | | | | | | | | | | | | | | | | | | | | | 73 | 39 | 27 | 15 | 7 | 2 | 4 | 3 | 2 | 0 |
| 121 | 2009 | | | | | | | | | | | | | | | | | | | | | | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 410 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 12 | 9 | 5 | 3 | 2 | 0 | 0 | 0 |
| 103 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 9 | 3 | 3 | 1 | 0 | 1 | 0 |
| 5 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 |
| 1929 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 103 | 64 | 29 | 27 | 16 |
| 918 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 48 | 22 | 19 | 9 |
| 1372 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 66 | 39 | 28 |
| 1345 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 67 | 52 |
| 880 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 40 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 188 | 1988 | 14 | 8 | 5 | 3 | 4 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 409 | 1989 | | 18 | 13 | 11 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 321 | 1990 | | | 14 | 13 | 5 | 3 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 856 | 1991 | | | | 51 | 20 | 25 | 14 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 89 | 1992 | | | | | 24 | 18 | 7 | 4 | 1 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 141 | 1993 | | | | | | 11 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 480 | 1994 | | | | | | | 27 | 9 | 2 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 372 | 1995 | | | | | | | | 22 | 3 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 557 | 1996 | | | | | | | | | 9 | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 868 | 1997 | | | | | | | | | | 21 | 13 | 9 | 5 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 106 | 1998 | | | | | | | | | | | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 179 | 1999 | | | | | | | | | | | | 3 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 163 | 2000 | | | | | | | | | | | | | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 515 | 2001 | | | | | | | | | | | | | | 14 | 5 | 4 | 2 | 2 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 789 | 2002 | | | | | | | | | | | | | | | 13 | 12 | 2 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1575 | 2003 | | | | | | | | | | | | | | | | 32 | 12 | 9 | 9 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 784 | 2004 | | | | | | | | | | | | | | | | | 18 | 8 | 11 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 557 | 2005 | | | | | | | | | | | | | | | | | | 8 | 5 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2113 | 2006 | | | | | | | | | | | | | | | | | | | 46 | 25 | 11 | 6 | 7 | 1 | 2 | 0 | 0 | 0 | 0 | 0 |
| 305 | 2007 | | | | | | | | | | | | | | | | | | | | 7 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 923 | 2008 | | | | | | | | | | | | | | | | | | | | | 26 | 14 | 5 | 5 | 1 | 2 | 2 | 0 | 0 | 0 |
| 121 | 2009 | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 410 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 4 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 103 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 0 | 0 | 0 | 1 | 0 | 0 |
| 5 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| 1929 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 41 | 13 | 13 | 5 | 5 |
| 918 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 10 | 1 | 2 |
| 1372 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 34 | 14 | 7 |
| 1345 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | 14 |
| 880 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 |

## HUDSON ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 277 | 1988 | 11 | 9 | 7 | 9 | 6 | 3 | 2 | 1 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 387 | 1989 | | 9 | 13 | 9 | 4 | 5 | 7 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 445 | 1990 | | | 17 | 14 | 11 | 9 | 4 | 4 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 364 | 1991 | | | | 15 | 14 | 8 | 6 | 9 | 5 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 699 | 1992 | | | | | 35 | 27 | 16 | 11 | 11 | 10 | 7 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536 | 1993 | | | | | | 33 | 16 | 10 | 16 | 10 | 5 | 5 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 381 | 1994 | | | | | | | 17 | 24 | 21 | 8 | 6 | 4 | 4 | 4 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 461 | 1995 | | | | | | | | 27 | 23 | 20 | 18 | 10 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 681 | 1996 | | | | | | | | | 63 | 43 | 27 | 12 | 2 | 7 | 2 | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 184 | 1997 | | | | | | | | | | 22 | 7 | 8 | 5 | 3 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 530 | 1998 | | | | | | | | | | | 47 | 29 | 13 | 7 | 13 | 5 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 503 | 1999 | | | | | | | | | | | | 45 | 13 | 21 | 9 | 12 | 4 | 2 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 485 | 2000 | | | | | | | | | | | | | 27 | 18 | 13 | 8 | 8 | 6 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 576 | 2001 | | | | | | | | | | | | | | 32 | 23 | 12 | 6 | 5 | 8 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 196 | 2002 | | | | | | | | | | | | | | | 16 | 8 | 7 | 2 | 5 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 677 | 2003 | | | | | | | | | | | | | | | | 39 | 35 | 25 | 10 | 11 | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 649 | 2004 | | | | | | | | | | | | | | | | | 55 | 25 | 24 | 14 | 5 | 2 | 4 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 574 | 2005 | | | | | | | | | | | | | | | | | | 40 | 29 | 16 | 8 | 4 | 7 | 0 | 3 | 1 | 0 | 1 | 0 | 0 |
| 707 | 2006 | | | | | | | | | | | | | | | | | | | 44 | 30 | 29 | 9 | 8 | 9 | 3 | 2 | 2 | 0 | 0 | 0 |
| 399 | 2007 | | | | | | | | | | | | | | | | | | | | 26 | 20 | 10 | 5 | 6 | 4 | 1 | 2 | 0 | 2 | 0 |
| 540 | 2008 | | | | | | | | | | | | | | | | | | | | | 33 | 26 | 19 | 8 | 1 | 0 | 0 | 0 | 0 | 0 |
| 396 | 2009 | | | | | | | | | | | | | | | | | | | | | | 31 | 25 | 13 | 4 | 4 | 2 | 1 | 0 | 0 |
| 458 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 37 | 19 | 8 | 2 | 4 | 1 | 0 | 1 |
| 243 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 23 | 12 | 8 | 4 | 1 | 1 | 1 |
| 597 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 30 | 25 | 13 | 8 | 3 | 4 |
| **676** | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 44 | 20 | 9 | 9 | 7 |
| 484 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 20 | 10 | 9 | 8 |
| 789 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | 20 | 17 |
| 665 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 30 | 28 |
| 548 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 37 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 277 | 1988 | 14 | 21 | 11 | 2 | 4 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 387 | 1989 | | 33 | 16 | 7 | 5 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 445 | 1990 | | | 45 | 16 | 16 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 364 | 1991 | | | | 23 | 17 | 5 | 4 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 699 | 1992 | | | | | 54 | 30 | 18 | 10 | 2 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 536 | 1993 | | | | | | 42 | 20 | 13 | 4 | 5 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 381 | 1994 | | | | | | | 26 | 8 | 5 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 461 | 1995 | | | | | | | | 23 | 11 | 10 | 3 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 681 | 1996 | | | | | | | | | 26 | 24 | 6 | 6 | 1 | 2 | 2 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 184 | 1997 | | | | | | | | | | 7 | 4 | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 530 | 1998 | | | | | | | | | | | 19 | 16 | 4 | 2 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 503 | 1999 | | | | | | | | | | | | 20 | 9 | 6 | 3 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 485 | 2000 | | | | | | | | | | | | | 18 | 6 | 9 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 576 | 2001 | | | | | | | | | | | | | | 16 | 16 | 2 | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 196 | 2002 | | | | | | | | | | | | | | | 4 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 677 | 2003 | | | | | | | | | | | | | | | | 25 | 9 | 10 | 7 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 649 | 2004 | | | | | | | | | | | | | | | | | 19 | 9 | 10 | 4 | 2 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 574 | 2005 | | | | | | | | | | | | | | | | | | 19 | 15 | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 707 | 2006 | | | | | | | | | | | | | | | | | | | 17 | 10 | 7 | 4 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 |
| 399 | 2007 | | | | | | | | | | | | | | | | | | | | 9 | 7 | 5 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 540 | 2008 | | | | | | | | | | | | | | | | | | | | | 16 | 8 | 3 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 396 | 2009 | | | | | | | | | | | | | | | | | | | | | | 13 | 11 | 4 | 2 | 3 | 1 | 0 | 1 | 0 |
| 458 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 11 | 10 | 5 | 4 | 1 | 1 | 1 | 1 |
| 243 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 7 | 3 | 1 | 1 | 0 | 1 |
| 597 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 12 | 13 | 8 | 2 | 6 | 3 |
| **676** | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 22 | 20 | 13 | 5 | 1 |
| 484 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 | 20 | 14 | 5 |
| 789 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 12 | 19 | 9 |
| 665 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 13 | 9 |
| 548 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 |

DE/PA ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 52 | 1993 | 3 | 5 | 1 | 4 | 3 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81 | 1994 | | 3 | 6 | 4 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 173 | 1995 | | | 10 | 7 | 2 | 6 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 1996 | | | | 14 | 3 | 4 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107 | 1997 | | | | | 13 | 6 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 205 | 1998 | | | | | | 25 | 7 | 5 | 2 | 4 | 3 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107 | 1999 | | | | | | | 7 | 10 | 2 | 1 | 3 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 148 | 2000 | | | | | | | | 20 | 10 | 2 | 3 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 2001 | | | | | | | | | 27 | 10 | 9 | 5 | 4 | 4 | 0 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 139 | 2002 | | | | | | | | | | 13 | 5 | 2 | 3 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 286 | 2003 | | | | | | | | | | | 19 | 14 | 8 | 6 | 2 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 168 | 2004 | | | | | | | | | | | | 15 | 8 | 5 | 3 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 2005 | | | | | | | | | | | | | 7 | 6 | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 180 | 2006 | | | | | | | | | | | | | | 16 | 7 | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 125 | 2007 | | | | | | | | | | | | | | | 8 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 140 | 2008 | | | | | | | | | | | | | | | | 6 | 5 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 127 | 2009 | | | | | | | | | | | | | | | | | 12 | 6 | 4 | 1 | 2 | 0 | 0 | 0 | 0 |
| 147 | 2010 | | | | | | | | | | | | | | | | | | 14 | 3 | 0 | 2 | 0 | 1 | 2 | 1 |
| 185 | 2011 | | | | | | | | | | | | | | | | | | | 9 | 8 | 3 | 1 | 3 | 1 | 0 |
| 184 | 2012 | | | | | | | | | | | | | | | | | | | | 17 | 1 | 1 | 1 | 1 | 0 |
| 256 | 2013 | | | | | | | | | | | | | | | | | | | | | 20 | 10 | 8 | 1 | 0 |
| 49 | 2014 | | | | | | | | | | | | | | | | | | | | | | 5 | 2 | 3 | 0 |
| 107 | 2015 | | | | | | | | | | | | | | | | | | | | | | | 4 | 1 | 0 |
| 88 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 4 |
| 76 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | 7 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 52 | 1993 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81 | 1994 | | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 173 | 1995 | | | 7 | 5 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 1996 | | | | 4 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107 | 1997 | | | | | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 205 | 1998 | | | | | | 6 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107 | 1999 | | | | | | | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 148 | 2000 | | | | | | | | 4 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 2001 | | | | | | | | | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 139 | 2002 | | | | | | | | | | 0 | 7 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 286 | 2003 | | | | | | | | | | | 12 | 8 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 168 | 2004 | | | | | | | | | | | | 3 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 2005 | | | | | | | | | | | | | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 180 | 2006 | | | | | | | | | | | | | | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 125 | 2007 | | | | | | | | | | | | | | | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 140 | 2008 | | | | | | | | | | | | | | | | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 127 | 2009 | | | | | | | | | | | | | | | | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 147 | 2010 | | | | | | | | | | | | | | | | | | 6 | 4 | 1 | 1 | 0 | 0 | 0 | 1 |
| 185 | 2011 | | | | | | | | | | | | | | | | | | | 5 | 2 | 0 | 1 | 2 | 0 | 0 |
| 184 | 2012 | | | | | | | | | | | | | | | | | | | | 1 | 1 | 0 | 0 | 1 | 0 |
| 256 | 2013 | | | | | | | | | | | | | | | | | | | | | 7 | 5 | 0 | 0 | 2 |
| 49 | 2014 | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 107 | 2015 | | | | | | | | | | | | | | | | | | | | | | | 2 | 2 | 0 |
| 88 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 3 |
| 76 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | 1 |

## MDCB ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 29 | 1987 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 129 | 1988 | | 2 | 1 | 3 | 7 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 1989 | | | 3 | 7 | 3 | 3 | 2 | 1 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 305 | 1990 | | | | 10 | 8 | 5 | 3 | 1 | 3 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 395 | 1991 | | | | | 19 | 10 | 13 | 3 | 7 | 3 | 4 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 436 | 1992 | | | | | | 21 | 15 | 11 | 14 | 4 | 8 | 6 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 627 | 1993 | | | | | | | 31 | 25 | 30 | 13 | 14 | 7 | 8 | 1 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 548 | 1994 | | | | | | | | 25 | 27 | 20 | 16 | 10 | 8 | 4 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 529 | 1995 | | | | | | | | | 45 | 24 | 19 | 12 | 4 | 5 | 2 | 2 | 3 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 862 | 1996 | | | | | | | | | | 62 | 35 | 39 | 15 | 6 | 7 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 335 | 1997 | | | | | | | | | | | 33 | 19 | 15 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 242 | 1998 | | | | | | | | | | | | 23 | 13 | 2 | 3 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 177 | 1999 | | | | | | | | | | | | | 16 | 5 | 6 | 2 | 1 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 248 | 2000 | | | | | | | | | | | | | | 18 | 12 | 0 | 4 | 4 | 1 | 0 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 469 | 2001 | | | | | | | | | | | | | | | 21 | 10 | 10 | 5 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 324 | 2002 | | | | | | | | | | | | | | | | 13 | 18 | 5 | 6 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 324 | 2003 | | | | | | | | | | | | | | | | | 14 | 9 | 8 | 6 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 367 | 2004 | | | | | | | | | | | | | | | | | | 13 | 7 | 9 | 2 | 3 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 334 | 2005 | | | | | | | | | | | | | | | | | | | 16 | 11 | 6 | 4 | 2 | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 0 |
| 270 | 2006 | | | | | | | | | | | | | | | | | | | | 14 | 4 | 4 | 4 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 190 | 2007 | | | | | | | | | | | | | | | | | | | | | 6 | 4 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 155 | 2008 | | | | | | | | | | | | | | | | | | | | | | 6 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 255 | 2009 | | | | | | | | | | | | | | | | | | | | | | | 18 | 7 | 1 | 2 | 0 | 1 | 1 | 0 | 0 |
| 198 | 2010 | | | | | | | | | | | | | | | | | | | | | | | | 8 | 0 | 3 | 1 | 1 | 0 | 0 | 0 |
| 285 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | | 17 | 6 | 4 | 2 | 0 | 0 | 2 |
| 262 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 4 | 3 | 0 | 1 | 1 |
| 298 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 7 | 3 | 3 | 3 |
| 279 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 21 | 3 | 2 | 4 |
| 274 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | 5 | 6 |
| 240 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | 4 |
| 302 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 29 | 1987 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 129 | 1988 | | 4 | 7 | 4 | 7 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 1989 | | | 6 | 10 | 14 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 305 | 1990 | | | | 13 | 8 | 7 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 395 | 1991 | | | | | 26 | 13 | 7 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 436 | 1992 | | | | | | 23 | 15 | 8 | 2 | 3 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 627 | 1993 | | | | | | | 29 | 18 | 11 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 548 | 1994 | | | | | | | | 27 | 15 | 4 | 0 | 5 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 529 | 1995 | | | | | | | | | 18 | 7 | 6 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 862 | 1996 | | | | | | | | | | 37 | 19 | 7 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 335 | 1997 | | | | | | | | | | | 8 | 7 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 242 | 1998 | | | | | | | | | | | | 7 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 177 | 1999 | | | | | | | | | | | | | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 248 | 2000 | | | | | | | | | | | | | | 3 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 469 | 2001 | | | | | | | | | | | | | | | 10 | 9 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 324 | 2002 | | | | | | | | | | | | | | | | 5 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 324 | 2003 | | | | | | | | | | | | | | | | | 8 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 367 | 2004 | | | | | | | | | | | | | | | | | | 4 | 2 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 334 | 2005 | | | | | | | | | | | | | | | | | | | 5 | 4 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 270 | 2006 | | | | | | | | | | | | | | | | | | | | 3 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 190 | 2007 | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 155 | 2008 | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 255 | 2009 | | | | | | | | | | | | | | | | | | | | | | | 3 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 198 | 2010 | | | | | | | | | | | | | | | | | | | | | | | | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| 285 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 262 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 4 | 0 | 0 | 0 | 0 |
| 298 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 2 | 1 | 0 | 0 |
| 279 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 4 | 1 | 0 |
| 274 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 1 | 0 |
| 240 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 |
| 302 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 |

VARAP ≥ 28”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 303 | 1990 | 10 | 2 | 6 | 1 | 3 | 5 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 390 | 1991 | | 19 | 10 | 12 | 9 | 2 | 1 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 1992 | | | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 213 | 1993 | | | | 11 | 11 | 5 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 123 | 1994 | | | | | 4 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 211 | 1995 | | | | | | 18 | 6 | 5 | 2 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 1996 | | | | | | | 0 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 212 | 1997 | | | | | | | | 11 | 12 | 6 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 157 | 1998 | | | | | | | | | 16 | 9 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 162 | 1999 | | | | | | | | | | 13 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 365 | 2000 | | | | | | | | | | | 13 | 11 | 6 | 5 | 3 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 269 | 2001 | | | | | | | | | | | | 9 | 8 | 2 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 122 | 2002 | | | | | | | | | | | | | 7 | 3 | 5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400 | 2003 | | | | | | | | | | | | | | 23 | 13 | 3 | 1 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 688 | 2004 | | | | | | | | | | | | | | | 21 | 8 | 8 | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 284 | 2005 | | | | | | | | | | | | | | | | 12 | 7 | 5 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 2006 | | | | | | | | | | | | | | | | | 10 | 2 | 4 | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 840 | 2007 | | | | | | | | | | | | | | | | | | 33 | 22 | 11 | 2 | 4 | 0 | 1 | 1 | 1 | 0 | 0 |
| 75 | 2008 | | | | | | | | | | | | | | | | | | | 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 242 | 2009 | | | | | | | | | | | | | | | | | | | | 5 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 483 | 2010 | | | | | | | | | | | | | | | | | | | | | 11 | 5 | 4 | 2 | 0 | 1 | 0 | 1 |
| 191 | 2011 | | | | | | | | | | | | | | | | | | | | | | 6 | 2 | 0 | 0 | 1 | 0 | 0 |
| 325 | 2012 | | | | | | | | | | | | | | | | | | | | | | | 9 | 4 | 1 | 1 | 0 | 0 |
| 244 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 3 | 3 | 0 | 0 |
| 247 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | 5 | 2 | 3 | 0 |
| **75** | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 |
| 99 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 1 |
| 33 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 303 | 1990 | 16 | 6 | 9 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 390 | 1991 | | 20 | 11 | 6 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 1992 | | | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 213 | 1993 | | | | 10 | 7 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 123 | 1994 | | | | | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 211 | 1995 | | | | | | 7 | 2 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 1996 | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 212 | 1997 | | | | | | | | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 157 | 1998 | | | | | | | | | 6 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 162 | 1999 | | | | | | | | | | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 365 | 2000 | | | | | | | | | | | 9 | 7 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 269 | 2001 | | | | | | | | | | | | 7 | 4 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 122 | 2002 | | | | | | | | | | | | | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400 | 2003 | | | | | | | | | | | | | | 8 | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 688 | 2004 | | | | | | | | | | | | | | | 15 | 2 | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 284 | 2005 | | | | | | | | | | | | | | | | 4 | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 2006 | | | | | | | | | | | | | | | | | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 840 | 2007 | | | | | | | | | | | | | | | | | | 12 | 7 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 75 | 2008 | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 242 | 2009 | | | | | | | | | | | | | | | | | | | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 483 | 2010 | | | | | | | | | | | | | | | | | | | | | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | 2011 | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 325 | 2012 | | | | | | | | | | | | | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 |
| 244 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 |
| 247 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 2 | 0 | 2 |
| **75** | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 |
| 99 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 |
| 33 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |

## MADFW ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 387 | 1992 | 5 | 10 | 9 | 10 | 10 | 4 | 2 | 2 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 890 | 1993 | | 14 | 22 | 13 | 26 | 22 | 14 | 11 | 4 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 675 | 1994 | | | 9 | 15 | 27 | 23 | 16 | 8 | 3 | 2 | 3 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 377 | 1995 | | | | 4 | 10 | 14 | 7 | 4 | 3 | 2 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 440 | 1996 | | | | | 9 | 10 | 14 | 7 | 13 | 2 | 4 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 202 | 1997 | | | | | | 9 | 4 | 3 | 3 | 1 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 317 | 1998 | | | | | | | 10 | 14 | 5 | 5 | 4 | 5 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87 | 1999 | | | | | | | | 2 | 3 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 253 | 2000 | | | | | | | | | 9 | 5 | 8 | 3 | 3 | 2 | 1 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 599 | 2001 | | | | | | | | | | 12 | 24 | 13 | 11 | 14 | 5 | 0 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 455 | 2002 | | | | | | | | | | | 15 | 13 | 12 | 8 | 5 | 5 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 238 | 2003 | | | | | | | | | | | | 8 | 3 | 5 | 7 | 1 | 0 | 5 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 655 | 2004 | | | | | | | | | | | | | 24 | 18 | 9 | 9 | 7 | 5 | 0 | 4 | 1 | 0 | 1 | 0 | 1 | 0 |
| 568 | 2005 | | | | | | | | | | | | | | 18 | 20 | 10 | 15 | 3 | 2 | 5 | 1 | 0 | 0 | 0 | 0 | 1 |
| 581 | 2006 | | | | | | | | | | | | | | | 19 | 9 | 13 | 12 | 11 | 2 | 2 | 3 | 2 | 0 | 2 | 0 |
| 389 | 2007 | | | | | | | | | | | | | | | | 7 | 15 | 14 | 3 | 4 | 2 | 1 | 0 | 1 | 1 | 0 |
| 530 | 2008 | | | | | | | | | | | | | | | | | 15 | 19 | 13 | 9 | 5 | 3 | 4 | 1 | 0 | 0 |
| 456 | 2009 | | | | | | | | | | | | | | | | | | 17 | 11 | 24 | 1 | 10 | 2 | 0 | 2 | 2 |
| 501 | 2010 | | | | | | | | | | | | | | | | | | | 13 | 18 | 16 | 8 | 2 | 0 | 4 | 1 |
| 326 | 2011 | | | | | | | | | | | | | | | | | | | | 11 | 6 | 8 | 4 | 2 | 3 | 0 |
| 504 | 2012 | | | | | | | | | | | | | | | | | | | | | 9 | 12 | 8 | 3 | 4 | 2 |
| 596 | 2013 | | | | | | | | | | | | | | | | | | | | | | 21 | 18 | 8 | 9 | 3 |
| 487 | 2014 | | | | | | | | | | | | | | | | | | | | | | | 22 | 11 | 11 | 7 |
| 454 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | 8 | 19 | 9 |
| 348 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | 13 | 9 |
| 710 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | 23 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 387 | 1992 | 15 | 15 | 5 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 890 | 1993 | | 21 | 24 | 18 | 9 | 2 | 4 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 675 | 1994 | | | 24 | 10 | 15 | 4 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 377 | 1995 | | | | 17 | 13 | 2 | 1 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 440 | 1996 | | | | | 24 | 12 | 9 | 5 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 202 | 1997 | | | | | | 13 | 6 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 317 | 1998 | | | | | | | 11 | 8 | 4 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87 | 1999 | | | | | | | | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 253 | 2000 | | | | | | | | | 2 | 3 | 4 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 599 | 2001 | | | | | | | | | | 10 | 6 | 8 | 3 | 1 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 455 | 2002 | | | | | | | | | | | 15 | 3 | 4 | 5 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 238 | 2003 | | | | | | | | | | | | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 655 | 2004 | | | | | | | | | | | | | 6 | 8 | 4 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 568 | 2005 | | | | | | | | | | | | | | 11 | 5 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 581 | 2006 | | | | | | | | | | | | | | | 12 | 5 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 389 | 2007 | | | | | | | | | | | | | | | | 4 | 8 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 530 | 2008 | | | | | | | | | | | | | | | | | 7 | 7 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 456 | 2009 | | | | | | | | | | | | | | | | | | 6 | 3 | 7 | 1 | 1 | 1 | 0 | 0 | 0 |
| 501 | 2010 | | | | | | | | | | | | | | | | | | | 9 | 3 | 1 | 2 | 2 | 2 | 1 | 0 |
| 326 | 2011 | | | | | | | | | | | | | | | | | | | | 7 | 5 | 3 | 2 | 1 | 0 | 0 |
| 504 | 2012 | | | | | | | | | | | | | | | | | | | | | 8 | 9 | 2 | 3 | 0 | 0 |
| 596 | 2013 | | | | | | | | | | | | | | | | | | | | | | 13 | 2 | 3 | 2 | 2 |
| 487 | 2014 | | | | | | | | | | | | | | | | | | | | | | | 6 | 8 | 3 | 3 |
| 454 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | 7 | 7 | 2 |
| 348 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | 7 | 4 |
| 710 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | 16 |

## NYOHS/NYTRL* ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1610 | 1988 | 7 | 6 | 16 | 22 | 10 | 16 | 8 | 10 | 6 | 4 | 4 | 4 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1608 | 1989 | | 9 | 23 | 19 | 12 | 29 | 13 | 13 | 6 | 7 | 3 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 804 | 1990 | | | 9 | 16 | 9 | 5 | 4 | 2 | 4 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 985 | 1991 | | | | 25 | 15 | 17 | 9 | 13 | 10 | 10 | 6 | 4 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 998 | 1992 | | | | | 16 | 16 | 10 | 21 | 10 | 9 | 12 | 5 | 1 | 1 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1247 | 1993 | | | | | | 19 | 11 | 16 | 10 | 12 | 4 | 7 | 3 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1643 | 1994 | | | | | | | 15 | 22 | 39 | 34 | 25 | 23 | 7 | 7 | 2 | 2 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1505 | 1995 | | | | | | | | 32 | 39 | 33 | 27 | 14 | 10 | 4 | 7 | 6 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 659 | 1996 | | | | | | | | | 9 | 11 | 17 | 14 | 1 | 0 | 2 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1080 | 1997 | | | | | | | | | | 18 | 12 | 12 | 3 | 5 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1101 | 1998 | | | | | | | | | | | 11 | 15 | 8 | 7 | 4 | 4 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1040 | 1999 | | | | | | | | | | | | 24 | 16 | 23 | 15 | 6 | 9 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 998 | 2000 | | | | | | | | | | | | | 12 | 14 | 7 | 18 | 6 | 4 | 2 | 1 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1200 | 2001 | | | | | | | | | | | | | | 22 | 24 | 24 | 12 | 7 | 8 | 4 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 968 | 2002 | | | | | | | | | | | | | | | 24 | 17 | 12 | 3 | 7 | 1 | 7 | 3 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 |
| 756 | 2003 | | | | | | | | | | | | | | | | 18 | 7 | 15 | 9 | 1 | 1 | 3 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 |
| 661 | 2004 | | | | | | | | | | | | | | | | | 11 | 5 | 3 | 6 | 2 | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1149 | 2005 | | | | | | | | | | | | | | | | | | 16 | 8 | 10 | 9 | 5 | 3 | 4 | 1 | 1 | 0 | 1 | 0 | 0 |
| 681 | 2006 | | | | | | | | | | | | | | | | | | | 7 | 13 | 16 | 11 | 2 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| 867 | 2007 | | | | | | | | | | | | | | | | | | | | 4 | 4 | 7 | 5 | 8 | 5 | 2 | 2 | 1 | 0 | 0 |
| 1340 | 2008 | | | | | | | | | | | | | | | | | | | | | 18 | 25 | 23 | 13 | 12 | 5 | 2 | 0 | 0 | 0 |
| 268 | 2009 | | | | | | | | | | | | | | | | | | | | | | 5 | 5 | 4 | 2 | 4 | 0 | 1 | 0 | 0 |
| 119 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 4 | 2 | 2 | 1 | 0 | 0 | 2 | 0 |
| 364 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 11 | 9 | 7 | 2 | 0 | 4 | 0 |
| 120 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 2 | 1 | 3 | 0 | 0 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1610 | 1988 | 107 | 61 | 42 | 20 | 16 | 12 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1608 | 1989 | | 152 | 92 | 57 | 19 | 17 | 10 | 4 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 804 | 1990 | | | 57 | 21 | 9 | 7 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 985 | 1991 | | | | 52 | 32 | 25 | 12 | 3 | 5 | 6 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 998 | 1992 | | | | | 66 | 27 | 16 | 10 | 3 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1247 | 1993 | | | | | | 58 | 24 | 11 | 10 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1643 | 1994 | | | | | | | 101 | 32 | 22 | 18 | 2 | 5 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1505 | 1995 | | | | | | | | 69 | 43 | 28 | 9 | 5 | 1 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 659 | 1996 | | | | | | | | | 38 | 11 | 11 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1080 | 1997 | | | | | | | | | | 66 | 17 | 8 | 5 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1101 | 1998 | | | | | | | | | | | 54 | 17 | 4 | 4 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1040 | 1999 | | | | | | | | | | | | 40 | 13 | 15 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 998 | 2000 | | | | | | | | | | | | | 43 | 15 | 12 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1200 | 2001 | | | | | | | | | | | | | | 53 | 20 | 10 | 5 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 968 | 2002 | | | | | | | | | | | | | | | 53 | 11 | 7 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 756 | 2003 | | | | | | | | | | | | | | | | 31 | 13 | 7 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 661 | 2004 | | | | | | | | | | | | | | | | | 29 | 12 | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1149 | 2005 | | | | | | | | | | | | | | | | | | 61 | 17 | 11 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 681 | 2006 | | | | | | | | | | | | | | | | | | | 43 | 13 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 867 | 2007 | | | | | | | | | | | | | | | | | | | | 45 | 13 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1340 | 2008 | | | | | | | | | | | | | | | | | | | | | 52 | 29 | 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 268 | 2009 | | | | | | | | | | | | | | | | | | | | | | 17 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 119 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 7 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 364 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 14 | 3 | 2 | 0 | 0 | 0 | 0 |
| 120 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 1 | 0 | 0 | 0 |

*NYOHS (1988–2007), NYTRL (2008–2012)

NJDB ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 473 | 1989 | 3 | 7 | 11 | 1 | 7 | 4 | 4 | 1 | 0 | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 1990 | | 2 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 297 | 1991 | | | 2 | 2 | 0 | 3 | 2 | 5 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 765 | 1992 | | | | 8 | 10 | 2 | 7 | 8 | 4 | 5 | 3 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1680 | 1993 | | | | | 11 | 8 | 33 | 32 | 23 | 15 | 10 | 7 | 4 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2287 | 1994 | | | | | | 21 | 45 | 69 | 52 | 44 | 24 | 20 | 6 | 8 | 6 | 1 | 4 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1819 | 1995 | | | | | | | 38 | 63 | 59 | 40 | 30 | 13 | 10 | 8 | 7 | 4 | 3 | 3 | 3 | 2 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1941 | 1996 | | | | | | | | 64 | 55 | 60 | 33 | 24 | 22 | 10 | 7 | 11 | 2 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 405 | 1997 | | | | | | | | | 11 | 6 | 4 | 2 | 3 | 5 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 811 | 1998 | | | | | | | | | | 37 | 17 | 29 | 22 | 9 | 7 | 4 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1796 | 1999 | | | | | | | | | | | 34 | 56 | 47 | 29 | 23 | 17 | 20 | 10 | 4 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2397 | 2000 | | | | | | | | | | | | 65 | 89 | 53 | 59 | 34 | 19 | 9 | 10 | 5 | 2 | 4 | 3 | 1 | 1 | 0 | 0 | 1 | 0 |
| 2305 | 2001 | | | | | | | | | | | | | 80 | 65 | 64 | 31 | 29 | 14 | 5 | 6 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1828 | 2002 | | | | | | | | | | | | | | 40 | 40 | 42 | 24 | 14 | 8 | 8 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2190 | 2003 | | | | | | | | | | | | | | | 61 | 58 | 52 | 19 | 21 | 16 | 9 | 4 | 3 | 3 | 2 | 2 | 0 | 1 | 0 |
| 1856 | 2004 | | | | | | | | | | | | | | | | 83 | 54 | 40 | 27 | 27 | 17 | 7 | 3 | 0 | 4 | 0 | 0 | 2 | 0 |
| 1162 | 2005 | | | | | | | | | | | | | | | | | 38 | 25 | 25 | 13 | 11 | 10 | 1 | 2 | 0 | 0 | 0 | 1 | 0 |
| 1466 | 2006 | | | | | | | | | | | | | | | | | | 33 | 38 | 37 | 28 | 14 | 12 | 8 | 3 | 1 | 0 | 1 | 0 |
| 1090 | 2007 | | | | | | | | | | | | | | | | | | | 46 | 41 | 24 | 26 | 15 | 8 | 2 | 1 | 0 | 0 | 0 |
| 1407 | 2008 | | | | | | | | | | | | | | | | | | | | 48 | 50 | 46 | 32 | 11 | 6 | 7 | 3 | 1 | 0 |
| 2239 | 2009 | | | | | | | | | | | | | | | | | | | | | 57 | 63 | 52 | 25 | 15 | 11 | 3 | 3 | 1 |
| 1195 | 2010 | | | | | | | | | | | | | | | | | | | | | | 33 | 27 | 28 | 26 | 7 | 4 | 3 | 2 |
| 755 | 2011 | | | | | | | | | | | | | | | | | | | | | | | 31 | 18 | 20 | 11 | 0 | 5 | 2 |
| 184 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | 6 | 1 | 1 | 2 | 2 | 1 |
| 241 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 13 | 3 | 0 | 0 |
| 130 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 0 |
| 188 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 2 |
| 121 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 3 |
| 35 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 473 | 1989 | 47 | 34 | 19 | 9 | 6 | 4 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 1990 | | 15 | 1 | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 297 | 1991 | | | 20 | 8 | 7 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 765 | 1992 | | | | 53 | 32 | 21 | 6 | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1680 | 1993 | | | | | 111 | 60 | 30 | 30 | 9 | 5 | 4 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2287 | 1994 | | | | | | 145 | 87 | 82 | 30 | 16 | 5 | 0 | 1 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1819 | 1995 | | | | | | | 121 | 104 | 42 | 35 | 7 | 4 | 7 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1941 | 1996 | | | | | | | | 139 | 76 | 42 | 9 | 7 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 405 | 1997 | | | | | | | | | 35 | 12 | 9 | 2 | 2 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 811 | 1998 | | | | | | | | | | 59 | 21 | 13 | 6 | 5 | 4 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1796 | 1999 | | | | | | | | | | | 99 | 52 | 23 | 16 | 5 | 4 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2397 | 2000 | | | | | | | | | | | | 142 | 62 | 22 | 14 | 5 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2305 | 2001 | | | | | | | | | | | | | 135 | 51 | 27 | 11 | 5 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1828 | 2002 | | | | | | | | | | | | | | 66 | 55 | 15 | 9 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2190 | 2003 | | | | | | | | | | | | | | | 127 | 67 | 27 | 13 | 2 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1856 | 2004 | | | | | | | | | | | | | | | | 113 | 51 | 16 | 6 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1162 | 2005 | | | | | | | | | | | | | | | | | 78 | 23 | 10 | 5 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1466 | 2006 | | | | | | | | | | | | | | | | | | 81 | 34 | 13 | 3 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1090 | 2007 | | | | | | | | | | | | | | | | | | | 57 | 15 | 11 | 3 | 5 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1407 | 2008 | | | | | | | | | | | | | | | | | | | | 66 | 28 | 14 | 6 | 4 | 0 | 2 | 0 | 0 | 0 |
| 2239 | 2009 | | | | | | | | | | | | | | | | | | | | | 136 | 57 | 19 | 10 | 3 | 1 | 1 | 0 | 0 |
| 1195 | 2010 | | | | | | | | | | | | | | | | | | | | | | 45 | 24 | 14 | 6 | 0 | 1 | 0 | 1 |
| 755 | 2011 | | | | | | | | | | | | | | | | | | | | | | | 25 | 20 | 6 | 1 | 0 | 2 | 0 |
| 184 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 7 | 1 | 0 | 0 | 0 |
| 241 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 3 | 3 | 0 | 0 |
| 130 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 3 | 1 | 0 |
| 188 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | 1 | 1 |
| 121 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 0 |
| 35 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |

NCCOOP ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1323 | 1988 | 17 | 3 | 17 | 25 | 31 | 16 | 9 | 10 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1153 | 1989 | | 11 | 11 | 10 | 12 | 6 | 2 | 2 | 2 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1946 | 1990 | | | 50 | 46 | 31 | 25 | 7 | 11 | 8 | 7 | 3 | 6 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1779 | 1991 | | | | 56 | 46 | 40 | 32 | 29 | 14 | 19 | 7 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1007 | 1992 | | | | | 56 | 36 | 19 | 20 | 11 | 10 | 8 | 7 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 527 | 1993 | | | | | | 22 | 9 | 10 | 8 | 7 | 5 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4341 | 1994 | | | | | | | 136 | 106 | 73 | 52 | 45 | 24 | 8 | 6 | 2 | 5 | 2 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 639 | 1995 | | | | | | | | 35 | 15 | 23 | 17 | 8 | 3 | 2 | 6 | 1 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 661 | 1996 | | | | | | | | | 29 | 17 | 13 | 3 | 4 | 3 | 4 | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347 | 1997 | | | | | | | | | | 87 | 42 | 19 | 11 | 13 | 0 | 3 | 3 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 460 | 1998 | | | | | | | | | | | 26 | 12 | 6 | 9 | 2 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 271 | 1999 | | | | | | | | | | | | 24 | 8 | 5 | 3 | 0 | 2 | 2 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4539 | 2000 | | | | | | | | | | | | | 147 | 61 | 35 | 17 | 12 | 6 | 4 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2387 | 2001 | | | | | | | | | | | | | | 111 | 58 | 46 | 17 | 16 | 9 | 3 | 1 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 0 |
| 3813 | 2002 | | | | | | | | | | | | | | | 187 | 109 | 54 | 26 | 16 | 8 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1906 | 2003 | | | | | | | | | | | | | | | | 85 | 57 | 30 | 15 | 13 | 8 | 7 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2468 | 2004 | | | | | | | | | | | | | | | | | 119 | 63 | 35 | 19 | 8 | 5 | 2 | 4 | 1 | 0 | 1 | 0 | 0 | 0 |
| 3960 | 2005 | | | | | | | | | | | | | | | | | | 91 | 40 | 22 | 7 | 8 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 1 |
| 4453 | 2006 | | | | | | | | | | | | | | | | | | | 188 | 120 | 67 | 44 | 33 | 18 | 11 | 11 | 5 | 1 | 2 | 5 |
| 370 | 2007 | | | | | | | | | | | | | | | | | | | | 24 | 22 | 10 | 3 | 6 | 4 | 1 | 0 | 0 | 0 | 0 |
| 1033 | 2008 | | | | | | | | | | | | | | | | | | | | | 78 | 42 | 29 | 15 | 7 | 2 | 4 | 3 | 2 | 0 |
| 146 | 2009 | | | | | | | | | | | | | | | | | | | | | | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 566 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 16 | 9 | 8 | 4 | 2 | 0 | 0 | 1 |
| 107 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 9 | 3 | 3 | 1 | 0 | 1 | 0 |
| 6 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 104 | 64 | 29 | 27 | 17 |
| 920 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 49 | 22 | 19 | 9 |
| 1375 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 67 | 39 | 28 |
| 1348 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 67 | 52 |
| 881 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 40 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1323 | 1988 | 100 | 49 | 29 | 18 | 17 | 4 | 5 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1153 | 1989 | | 42 | 29 | 19 | 8 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1946 | 1990 | | | 91 | 55 | 21 | 21 | 8 | 2 | 5 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1779 | 1991 | | | | 91 | 45 | 43 | 24 | 5 | 6 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1007 | 1992 | | | | | 55 | 23 | 14 | 9 | 2 | 3 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 527 | 1993 | | | | | | 25 | 14 | 9 | 3 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4341 | 1994 | | | | | | | 193 | 86 | 25 | 18 | 11 | 6 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 639 | 1995 | | | | | | | | 27 | 6 | 2 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 661 | 1996 | | | | | | | | | 12 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347 | 1997 | | | | | | | | | | 38 | 22 | 9 | 6 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 460 | 1998 | | | | | | | | | | | 21 | 14 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 271 | 1999 | | | | | | | | | | | | 7 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4539 | 2000 | | | | | | | | | | | | | 147 | 33 | 12 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2387 | 2001 | | | | | | | | | | | | | | 70 | 28 | 15 | 8 | 2 | 6 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3813 | 2002 | | | | | | | | | | | | | | | 100 | 43 | 14 | 9 | 4 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1906 | 2003 | | | | | | | | | | | | | | | | 40 | 15 | 9 | 11 | 3 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2468 | 2004 | | | | | | | | | | | | | | | | | 64 | 27 | 18 | 7 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3960 | 2005 | | | | | | | | | | | | | | | | | | 47 | 19 | 4 | 5 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4453 | 2006 | | | | | | | | | | | | | | | | | | | 126 | 54 | 21 | 9 | 9 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 370 | 2007 | | | | | | | | | | | | | | | | | | | | 10 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1033 | 2008 | | | | | | | | | | | | | | | | | | | | | 26 | 14 | 5 | 5 | 1 | 2 | 2 | 0 | 0 | 0 |
| 146 | 2009 | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 566 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 5 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 107 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 0 | 0 | 0 | 1 | 0 | 0 |
| 6 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 45 | 13 | 13 | 5 | 5 |
| 920 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 10 | 1 | 2 |
| 1375 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 34 | 14 | 7 |
| 1348 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | 14 |
| 881 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 |

## HUDSON ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 826 | 1988 | 14 | 14 | 12 | 15 | 7 | 6 | 3 | 6 | 5 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 669 | 1989 | | 10 | 16 | 10 | 5 | 7 | 9 | 4 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 783 | 1990 | | | 19 | 17 | 12 | 11 | 4 | 6 | 2 | 4 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 546 | 1991 | | | | 15 | 15 | 9 | 8 | 9 | 6 | 3 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1135 | 1992 | | | | | 40 | 31 | 16 | 13 | 18 | 14 | 11 | 6 | 3 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 940 | 1993 | | | | | | 34 | 22 | 16 | 24 | 13 | 8 | 5 | 3 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 643 | 1994 | | | | | | | 20 | 25 | 27 | 13 | 9 | 5 | 4 | 4 | 3 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 628 | 1995 | | | | | | | | 30 | 25 | 23 | 19 | 11 | 2 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1069 | 1996 | | | | | | | | | 67 | 47 | 40 | 18 | 3 | 9 | 5 | 3 | 5 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 241 | 1997 | | | | | | | | | | 22 | 7 | 8 | 6 | 3 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 698 | 1998 | | | | | | | | | | | 49 | 35 | 14 | 8 | 14 | 5 | 1 | 1 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 798 | 1999 | | | | | | | | | | | | 47 | 18 | 25 | 10 | 15 | 6 | 4 | 3 | 1 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 846 | 2000 | | | | | | | | | | | | | 32 | 20 | 23 | 13 | 12 | 9 | 5 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1069 | 2001 | | | | | | | | | | | | | | 40 | 30 | 15 | 13 | 9 | 9 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 597 | 2002 | | | | | | | | | | | | | | | 19 | 11 | 11 | 6 | 6 | 5 | 4 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1379 | 2003 | | | | | | | | | | | | | | | | 54 | 57 | 35 | 16 | 15 | 6 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1273 | 2004 | | | | | | | | | | | | | | | | | 65 | 38 | 32 | 18 | 5 | 4 | 5 | 3 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1325 | 2005 | | | | | | | | | | | | | | | | | | 46 | 34 | 23 | 9 | 8 | 10 | 0 | 4 | 2 | 0 | 1 | 0 | 0 |
| 1130 | 2006 | | | | | | | | | | | | | | | | | | | 46 | 33 | 34 | 14 | 11 | 9 | 4 | 3 | 2 | 0 | 0 | 0 |
| 755 | 2007 | | | | | | | | | | | | | | | | | | | | 29 | 31 | 15 | 7 | 6 | 6 | 1 | 2 | 2 | 3 | 0 |
| 1236 | 2008 | | | | | | | | | | | | | | | | | | | | | 42 | 37 | 32 | 10 | 10 | 3 | 2 | 1 | 1 | 2 |
| 507 | 2009 | | | | | | | | | | | | | | | | | | | | | | 31 | 26 | 13 | 6 | 4 | 2 | 1 | 0 | 0 |
| 840 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 40 | 24 | 11 | 6 | 5 | 1 | 0 | 1 |
| 338 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 25 | 12 | 9 | 4 | 2 | 1 | 1 |
| 705 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 30 | 25 | 15 | 8 | 3 | 4 |
| **887** | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 48 | 23 | 10 | 13 | 8 |
| 551 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 20 | 12 | 9 | 8 |
| 1130 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 28 | 24 | 18 |
| 1303 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 33 | 33 |
| 852 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 43 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 826 | 1988 | 41 | 49 | 32 | 11 | 11 | 8 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 669 | 1989 | | 49 | 30 | 12 | 8 | 3 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 783 | 1990 | | | 71 | 30 | 22 | 11 | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 546 | 1991 | | | | 42 | 29 | 7 | 6 | 2 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1135 | 1992 | | | | | 76 | 38 | 27 | 14 | 5 | 6 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 940 | 1993 | | | | | | 66 | 38 | 20 | 8 | 9 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 643 | 1994 | | | | | | | 39 | 16 | 7 | 5 | 1 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 628 | 1995 | | | | | | | | 30 | 16 | 12 | 4 | 1 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1069 | 1996 | | | | | | | | | 53 | 36 | 16 | 10 | 3 | 2 | 2 | 2 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 241 | 1997 | | | | | | | | | | 10 | 6 | 5 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 698 | 1998 | | | | | | | | | | | 25 | 20 | 4 | 2 | 8 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 798 | 1999 | | | | | | | | | | | | 29 | 17 | 7 | 4 | 2 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 846 | 2000 | | | | | | | | | | | | | 42 | 13 | 12 | 16 | 8 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1069 | 2001 | | | | | | | | | | | | | | 44 | 31 | 10 | 3 | 3 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 597 | 2002 | | | | | | | | | | | | | | | 26 | 9 | 8 | 2 | 4 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1379 | 2003 | | | | | | | | | | | | | | | | 66 | 28 | 19 | 12 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1273 | 2004 | | | | | | | | | | | | | | | | | 53 | 25 | 15 | 9 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1325 | 2005 | | | | | | | | | | | | | | | | | | 57 | 30 | 14 | 9 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1130 | 2006 | | | | | | | | | | | | | | | | | | | 36 | 28 | 12 | 7 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 0 |
| 755 | 2007 | | | | | | | | | | | | | | | | | | | | 22 | 19 | 9 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1236 | 2008 | | | | | | | | | | | | | | | | | | | | | 48 | 21 | 13 | 4 | 3 | 1 | 1 | 1 | 0 | 0 |
| 507 | 2009 | | | | | | | | | | | | | | | | | | | | | | 20 | 14 | 5 | 3 | 5 | 1 | 0 | 1 | 0 |
| 840 | 2010 | | | | | | | | | | | | | | | | | | | | | | | 25 | 15 | 7 | 6 | 1 | 1 | 1 | 1 |
| 338 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | 10 | 9 | 4 | 1 | 2 | 0 | 1 |
| 705 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | 13 | 16 | 8 | 3 | 7 | 3 |
| **887** | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | 26 | 25 | 13 | 5 | 1 |
| 551 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | 13 | 22 | 15 | 5 |
| 1130 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 17 | 22 | 12 |
| 1303 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 32 | 20 |
| 852 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 21 |

DE/PA ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 265 | 1993 | 10 | 9 | 3 | 9 | 4 | 3 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 313 | 1994 | | 14 | 10 | 7 | 6 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 477 | 1995 | | | 22 | 96 | 4 | 10 | 2 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 313 | 1996 | | | | 17 | 5 | 5 | 3 | 6 | 2 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 513 | 1997 | | | | | 24 | 12 | 8 | 4 | 4 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 715 | 1998 | | | | | | 39 | 13 | 11 | 9 | 5 | 8 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 407 | 1999 | | | | | | | 15 | 13 | 5 | 4 | 4 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 651 | 2000 | | | | | | | | 38 | 22 | 9 | 5 | 3 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 902 | 2001 | | | | | | | | | 54 | 21 | 25 | 8 | 7 | 4 | 1 | 2 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 616 | 2002 | | | | | | | | | | 35 | 21 | 4 | 7 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 657 | 2003 | | | | | | | | | | | 38 | 20 | 11 | 7 | 3 | 0 | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 384 | 2004 | | | | | | | | | | | | 23 | 9 | 6 | 3 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 326 | 2005 | | | | | | | | | | | | | 12 | 6 | 2 | 2 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 583 | 2006 | | | | | | | | | | | | | | 27 | 10 | 7 | 4 | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 393 | 2007 | | | | | | | | | | | | | | | 9 | 7 | 1 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 484 | 2008 | | | | | | | | | | | | | | | | 13 | 7 | 6 | 2 | 1 | 3 | 0 | 0 | 0 | 0 |
| 375 | 2009 | | | | | | | | | | | | | | | | | 17 | 7 | 6 | 1 | 3 | 0 | 0 | 0 | 0 |
| 447 | 2010 | | | | | | | | | | | | | | | | | | 17 | 6 | 1 | 2 | 0 | 1 | 2 | 1 |
| 746 | 2011 | | | | | | | | | | | | | | | | | | | 17 | 11 | 3 | 2 | 5 | 1 | 0 |
| 707 | 2012 | | | | | | | | | | | | | | | | | | | | 31 | 9 | 8 | 4 | 1 | 0 |
| 788 | 2013 | | | | | | | | | | | | | | | | | | | | | 35 | 16 | 11 | 4 | 2 |
| 150 | 2014 | | | | | | | | | | | | | | | | | | | | | | 12 | 2 | 3 | 0 |
| 367 | 2015 | | | | | | | | | | | | | | | | | | | | | | | 4 | 1 | 0 |
| 426 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | 10 | 6 |
| 331 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | 14 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 265 | 1993 | 13 | 10 | 2 | 2 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 313 | 1994 | | 16 | 12 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 477 | 1995 | | | 29 | 20 | 9 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 313 | 1996 | | | | 18 | 10 | 6 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 513 | 1997 | | | | | 23 | 26 | 12 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 715 | 1998 | | | | | | 35 | 11 | 5 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 407 | 1999 | | | | | | | 17 | 8 | 5 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 651 | 2000 | | | | | | | | 28 | 25 | 8 | 8 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 902 | 2001 | | | | | | | | | 36 | 19 | 11 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 616 | 2002 | | | | | | | | | | 15 | 20 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 657 | 2003 | | | | | | | | | | | 31 | 15 | 5 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 384 | 2004 | | | | | | | | | | | | 11 | 4 | 4 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 326 | 2005 | | | | | | | | | | | | | 27 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 583 | 2006 | | | | | | | | | | | | | | 32 | 8 | 4 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 393 | 2007 | | | | | | | | | | | | | | | 15 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 484 | 2008 | | | | | | | | | | | | | | | | 25 | 13 | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 375 | 2009 | | | | | | | | | | | | | | | | | 21 | 6 | 2 | 1 | 0 | 1 | 1 | 0 | 0 |
| 447 | 2010 | | | | | | | | | | | | | | | | | | 22 | 11 | 1 | 2 | 1 | 1 | 0 | 1 |
| 746 | 2011 | | | | | | | | | | | | | | | | | | | 39 | 10 | 4 | 4 | 2 | 0 | 0 |
| 707 | 2012 | | | | | | | | | | | | | | | | | | | | 27 | 7 | 1 | 0 | 1 | 0 |
| 788 | 2013 | | | | | | | | | | | | | | | | | | | | | 31 | 24 | 2 | 2 | 0 |
| 150 | 2014 | | | | | | | | | | | | | | | | | | | | | | 5 | 4 | 1 | 1 |
| 367 | 2015 | | | | | | | | | | | | | | | | | | | | | | | 10 | 4 | 0 |
| 426 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | 15 | 9 |
| 331 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | 10 |

MDCB ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1409 | 1987 | 1 | 9 | 0 | 21 | 21 | 24 | 20 | 8 | 8 | 6 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2240 | 1988 | | 7 | 3 | 30 | 41 | 48 | 25 | 14 | 19 | 7 | 10 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2343 | 1989 | | | 4 | 53 | 65 | 64 | 34 | 22 | 18 | 11 | 4 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1365 | 1990 | | | | 35 | 37 | 34 | 16 | 11 | 7 | 4 | 10 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1452 | 1991 | | | | | 57 | 56 | 44 | 14 | 22 | 10 | 10 | 5 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1615 | 1992 | | | | | | 85 | 57 | 40 | 26 | 12 | 11 | 8 | 10 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2154 | 1993 | | | | | | | 98 | 83 | 63 | 39 | 33 | 19 | 15 | 3 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1824 | 1994 | | | | | | | | 90 | 94 | 45 | 39 | 28 | 17 | 7 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1353 | 1995 | | | | | | | | | 106 | 61 | 40 | 20 | 11 | 8 | 3 | 2 | 5 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1680 | 1996 | | | | | | | | | | 117 | 70 | 66 | 23 | 10 | 8 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 841 | 1997 | | | | | | | | | | | 72 | 43 | 23 | 6 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 919 | 1998 | | | | | | | | | | | | 84 | 28 | 10 | 7 | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 592 | 1999 | | | | | | | | | | | | | 42 | 23 | 10 | 3 | 1 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 931 | 2000 | | | | | | | | | | | | | | 64 | 23 | 11 | 7 | 7 | 2 | 1 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1104 | 2001 | | | | | | | | | | | | | | | 55 | 21 | 20 | 8 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1134 | 2002 | | | | | | | | | | | | | | | | 55 | 48 | 16 | 7 | 1 | 4 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 791 | 2003 | | | | | | | | | | | | | | | | | 43 | 24 | 11 | 9 | 2 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 682 | 2004 | | | | | | | | | | | | | | | | | | 28 | 15 | 10 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 876 | 2005 | | | | | | | | | | | | | | | | | | | 40 | 26 | 10 | 5 | 3 | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 0 |
| 605 | 2006 | | | | | | | | | | | | | | | | | | | | 30 | 9 | 5 | 6 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 457 | 2007 | | | | | | | | | | | | | | | | | | | | | 14 | 8 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 429 | 2008 | | | | | | | | | | | | | | | | | | | | | | 17 | 8 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| 718 | 2009 | | | | | | | | | | | | | | | | | | | | | | | 52 | 11 | 6 | 3 | 0 | 2 | 1 | 0 | 0 |
| 668 | 2010 | | | | | | | | | | | | | | | | | | | | | | | | 37 | 11 | 6 | 2 | 2 | 1 | 0 | 0 |
| 1098 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | | 66 | 15 | 8 | 5 | 1 | 0 | 2 |
| 538 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | 28 | 10 | 9 | 4 | 2 | 1 |
| 811 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | | 58 | 20 | 5 | 6 | 4 |
| 714 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 61 | 13 | 6 | 4 |
| 981 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 50 | 23 | 12 |
| 950 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 40 | 21 |
| 1154 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 43 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1409 | 1987 | 52 | 34 | 25 | 21 | 21 | 23 | 9 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2240 | 1988 | | 84 | 59 | 56 | 35 | 23 | 18 | 8 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2343 | 1989 | | | 74 | 73 | 47 | 33 | 15 | 11 | 5 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1365 | 1990 | | | | 48 | 31 | 28 | 9 | 4 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1452 | 1991 | | | | | 57 | 50 | 20 | 17 | 9 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1615 | 1992 | | | | | | 80 | 39 | 24 | 17 | 8 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2154 | 1993 | | | | | | | 71 | 61 | 31 | 17 | 7 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1824 | 1994 | | | | | | | | 87 | 45 | 22 | 8 | 9 | 4 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1353 | 1995 | | | | | | | | | 62 | 31 | 11 | 7 | 5 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1680 | 1996 | | | | | | | | | | 84 | 38 | 13 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 841 | 1997 | | | | | | | | | | | 36 | 17 | 2 | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 919 | 1998 | | | | | | | | | | | | 45 | 11 | 9 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 592 | 1999 | | | | | | | | | | | | | 18 | 13 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 931 | 2000 | | | | | | | | | | | | | | 42 | 8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1104 | 2001 | | | | | | | | | | | | | | | 37 | 11 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1134 | 2002 | | | | | | | | | | | | | | | | 29 | 12 | 5 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 791 | 2003 | | | | | | | | | | | | | | | | | 20 | 6 | 4 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 682 | 2004 | | | | | | | | | | | | | | | | | | 17 | 5 | 3 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 876 | 2005 | | | | | | | | | | | | | | | | | | | 16 | 6 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 605 | 2006 | | | | | | | | | | | | | | | | | | | | 16 | 5 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 457 | 2007 | | | | | | | | | | | | | | | | | | | | | 8 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 429 | 2008 | | | | | | | | | | | | | | | | | | | | | | 6 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 718 | 2009 | | | | | | | | | | | | | | | | | | | | | | | 9 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 668 | 2010 | | | | | | | | | | | | | | | | | | | | | | | | 14 | 4 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1098 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 3 | 0 | 1 | 0 | 1 | 0 |
| 538 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 4 | 0 | 0 | 1 | 0 |
| 811 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | 5 | 1 | 0 | 0 |
| 714 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 5 | 1 | 0 |
| 981 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | 2 | 2 |
| 950 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 18 | 6 |
| 1154 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 29 |

VARAP ≥ 18”

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1466 | 1990 | 21 | 19 | 25 | 10 | 8 | 9 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2481 | 1991 | | 47 | 38 | 22 | 14 | 3 | 1 | 2 | 1 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 130 | 1992 | | | 7 | 4 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 621 | 1993 | | | | 18 | 17 | 12 | 3 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 195 | 1994 | | | | | 6 | 7 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 698 | 1995 | | | | | | 24 | 12 | 9 | 4 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 377 | 1996 | | | | | | | 3 | 10 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 712 | 1997 | | | | | | | | 26 | 17 | 10 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 784 | 1998 | | | | | | | | | 28 | 16 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 853 | 1999 | | | | | | | | | | 30 | 7 | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1767 | 2000 | | | | | | | | | | | 42 | 25 | 11 | 7 | 3 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 797 | 2001 | | | | | | | | | | | | 31 | 13 | 6 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 315 | 2002 | | | | | | | | | | | | | 10 | 3 | 6 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 852 | 2003 | | | | | | | | | | | | | | 31 | 20 | 4 | 5 | 3 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1477 | 2004 | | | | | | | | | | | | | | | 45 | 14 | 6 | 6 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 921 | 2005 | | | | | | | | | | | | | | | | 25 | 18 | 7 | 1 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 668 | 2006 | | | | | | | | | | | | | | | | | 26 | 4 | 6 | 5 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1961 | 2007 | | | | | | | | | | | | | | | | | | 62 | 35 | 16 | 4 | 5 | 0 | 1 | 1 | 1 | 0 | 0 |
| 523 | 2008 | | | | | | | | | | | | | | | | | | | 15 | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 867 | 2009 | | | | | | | | | | | | | | | | | | | | 26 | 7 | 2 | 2 | 0 | 1 | 0 | 0 | 0 |
| 2050 | 2010 | | | | | | | | | | | | | | | | | | | | | 28 | 7 | 9 | 2 | 0 | 1 | 0 | 1 |
| 416 | 2011 | | | | | | | | | | | | | | | | | | | | | | 12 | 4 | 0 | 0 | 1 | 0 | 0 |
| 1222 | 2012 | | | | | | | | | | | | | | | | | | | | | | | 33 | 12 | 5 | 2 | 0 | 0 |
| 760 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | 23 | 8 | 7 | 1 | 0 |
| 454 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 3 | 4 | 0 |
| **313** | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 4 | 2 |
| 798 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 | 5 |
| 307 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1466 | 1990 | 61 | 46 | 17 | 12 | 2 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2481 | 1991 | | 82 | 42 | 28 | 13 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 130 | 1992 | | | 5 | 4 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 621 | 1993 | | | | 22 | 20 | 3 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 195 | 1994 | | | | | 6 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 698 | 1995 | | | | | | 21 | 8 | 8 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 377 | 1996 | | | | | | | 10 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 712 | 1997 | | | | | | | | 12 | 8 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 784 | 1998 | | | | | | | | | 21 | 7 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 853 | 1999 | | | | | | | | | | 19 | 15 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1767 | 2000 | | | | | | | | | | | 50 | 23 | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 797 | 2001 | | | | | | | | | | | | 16 | 10 | 7 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 315 | 2002 | | | | | | | | | | | | | 6 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 852 | 2003 | | | | | | | | | | | | | | 12 | 6 | 8 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1477 | 2004 | | | | | | | | | | | | | | | 23 | 6 | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 921 | 2005 | | | | | | | | | | | | | | | | 13 | 9 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 668 | 2006 | | | | | | | | | | | | | | | | | 18 | 7 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1961 | 2007 | | | | | | | | | | | | | | | | | | 33 | 11 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 523 | 2008 | | | | | | | | | | | | | | | | | | | 6 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 867 | 2009 | | | | | | | | | | | | | | | | | | | | 14 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2050 | 2010 | | | | | | | | | | | | | | | | | | | | | 14 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 416 | 2011 | | | | | | | | | | | | | | | | | | | | | | 5 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1222 | 2012 | | | | | | | | | | | | | | | | | | | | | | | 16 | 4 | 0 | 0 | 0 | 0 |
| 760 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | 6 | 2 | 1 | 0 | 0 |
| 454 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 2 | 0 | 3 |
| **313** | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | 0 | 0 |
| 798 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 | 0 |
| 307 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |

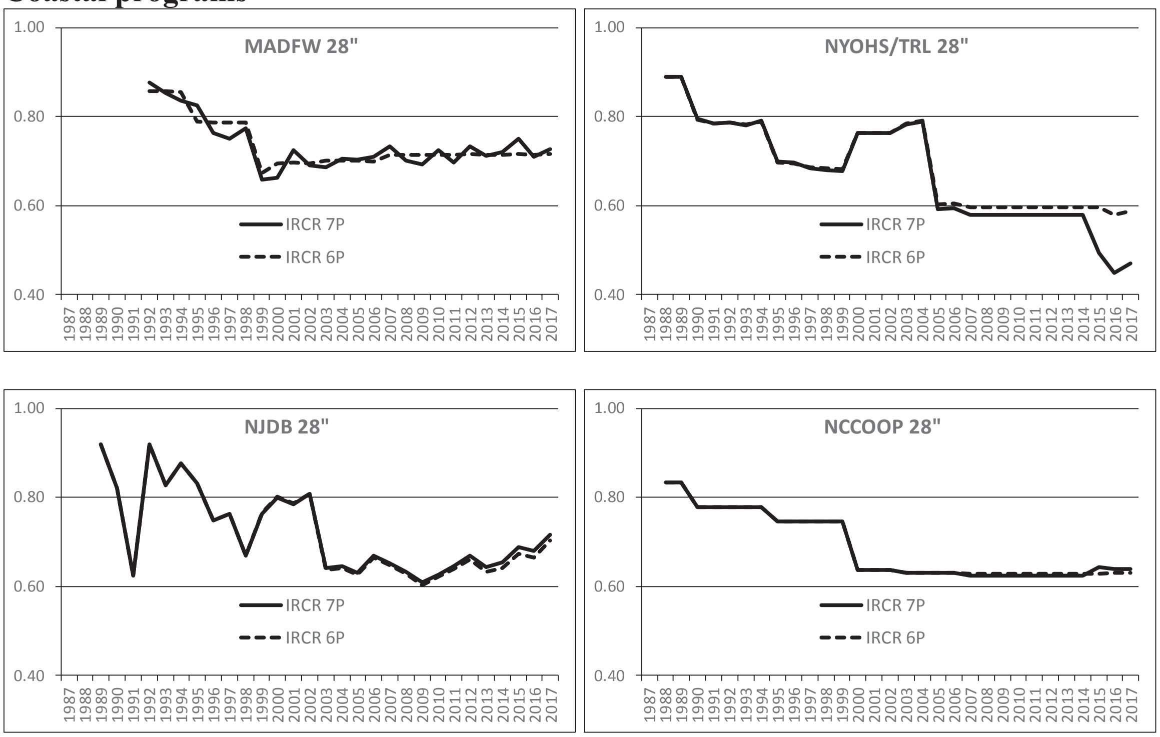
## Chesapeake Bay 18–28" males (data combined from MDCB and VARAP)

| Tagged | | Harvested recaptures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1308 | 1987 | 1 | 6 | 0 | 18 | 19 | 21 | 17 | 6 | 7 | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1852 | 1988 | | 4 | 2 | 23 | 26 | 37 | 23 | 10 | 12 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1916 | 1989 | | | 1 | 39 | 51 | 57 | 30 | 19 | 9 | 6 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1172 | 1990 | | | | 22 | 28 | 26 | 11 | 10 | 4 | 3 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1080 | 1991 | | | | | 34 | 43 | 29 | 9 | 10 | 4 | 5 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1149 | 1992 | | | | | | 62 | 41 | 26 | 9 | 5 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1627 | 1993 | | | | | | | 66 | 54 | 34 | 18 | 15 | 10 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1255 | 1994 | | | | | | | | 58 | 63 | 19 | 16 | 15 | 8 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1125 | 1995 | | | | | | | | | 61 | 31 | 16 | 7 | 5 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 982 | 1996 | | | | | | | | | | 48 | 31 | 24 | 6 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 955 | 1997 | | | | | | | | | | | 48 | 26 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1274 | 1998 | | | | | | | | | | | | 69 | 22 | 6 | 4 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1075 | 1999 | | | | | | | | | | | | | 39 | 20 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2034 | 2000 | | | | | | | | | | | | | | 75 | 21 | 16 | 5 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1120 | 2001 | | | | | | | | | | | | | | | 53 | 17 | 10 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 996 | 2002 | | | | | | | | | | | | | | | | 42 | 26 | 12 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 899 | 2003 | | | | | | | | | | | | | | | | | 35 | 20 | 5 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1068 | 2004 | | | | | | | | | | | | | | | | | | 36 | 12 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1136 | 2005 | | | | | | | | | | | | | | | | | | | 38 | 25 | 4 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 792 | 2006 | | | | | | | | | | | | | | | | | | | | 30 | 5 | 1 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1344 | 2007 | | | | | | | | | | | | | | | | | | | | | 37 | 14 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 702 | 2008 | | | | | | | | | | | | | | | | | | | | | | 22 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1018 | 2009 | | | | | | | | | | | | | | | | | | | | | | | 53 | 7 | 7 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1935 | 2010 | | | | | | | | | | | | | | | | | | | | | | | | 45 | 13 | 6 | 1 | 1 | 1 | 0 | 0 |
| 996 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | | 53 | 7 | 4 | 2 | 1 | 0 | 0 |
| 1099 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | 44 | 13 | 9 | 4 | 0 | 0 |
| 928 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | | 56 | 12 | 3 | 3 | 1 |
| 611 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 42 | 11 | 5 | 0 |
| 901 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 47 | 22 | 8 |
| 1329 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 32 | 18 |
| 1071 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 39 |

| Tagged | | Released recaptures (event 1 only) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1308 | 1987 | 49 | 31 | 18 | 18 | 16 | 21 | 8 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1852 | 1988 | | 64 | 42 | 37 | 25 | 18 | 11 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1916 | 1989 | | | 53 | 50 | 26 | 24 | 8 | 8 | 5 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1172 | 1990 | | | | 41 | 22 | 17 | 6 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1080 | 1991 | | | | | 38 | 31 | 15 | 12 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1149 | 1992 | | | | | | 56 | 17 | 12 | 13 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1627 | 1993 | | | | | | | 38 | 42 | 18 | 11 | 5 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1255 | 1994 | | | | | | | | 54 | 27 | 14 | 4 | 3 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1125 | 1995 | | | | | | | | | 51 | 19 | 9 | 4 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 982 | 1996 | | | | | | | | | | 46 | 19 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 955 | 1997 | | | | | | | | | | | 37 | 13 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1274 | 1998 | | | | | | | | | | | | 47 | 11 | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1075 | 1999 | | | | | | | | | | | | | 29 | 18 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2034 | 2000 | | | | | | | | | | | | | | 70 | 17 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1120 | 2001 | | | | | | | | | | | | | | | 36 | 3 | 6 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 996 | 2002 | | | | | | | | | | | | | | | | 26 | 8 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 899 | 2003 | | | | | | | | | | | | | | | | | 14 | 5 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1068 | 2004 | | | | | | | | | | | | | | | | | | 20 | 4 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1136 | 2005 | | | | | | | | | | | | | | | | | | | 20 | 5 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 792 | 2006 | | | | | | | | | | | | | | | | | | | | 25 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1344 | 2007 | | | | | | | | | | | | | | | | | | | | | 26 | 6 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 702 | 2008 | | | | | | | | | | | | | | | | | | | | | | 12 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1018 | 2009 | | | | | | | | | | | | | | | | | | | | | | | 18 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1935 | 2010 | | | | | | | | | | | | | | | | | | | | | | | | 20 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 996 | 2011 | | | | | | | | | | | | | | | | | | | | | | | | | 13 | 2 | 0 | 0 | 0 | 1 | 0 |
| 1099 | 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | 17 | 2 | 0 | 0 | 1 | 0 |
| 928 | 2013 | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 | 3 | 1 | 0 | 0 |
| 611 | 2014 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 1 | 0 | 0 |
| 901 | 2015 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | 1 | 2 |
| 1329 | 2016 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 28 | 5 |
| 1071 | 2017 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 24 |

## Plots of Survival Estimates With and Without an Additional Regulatory Period

### Coastal programs




### Producer area programs

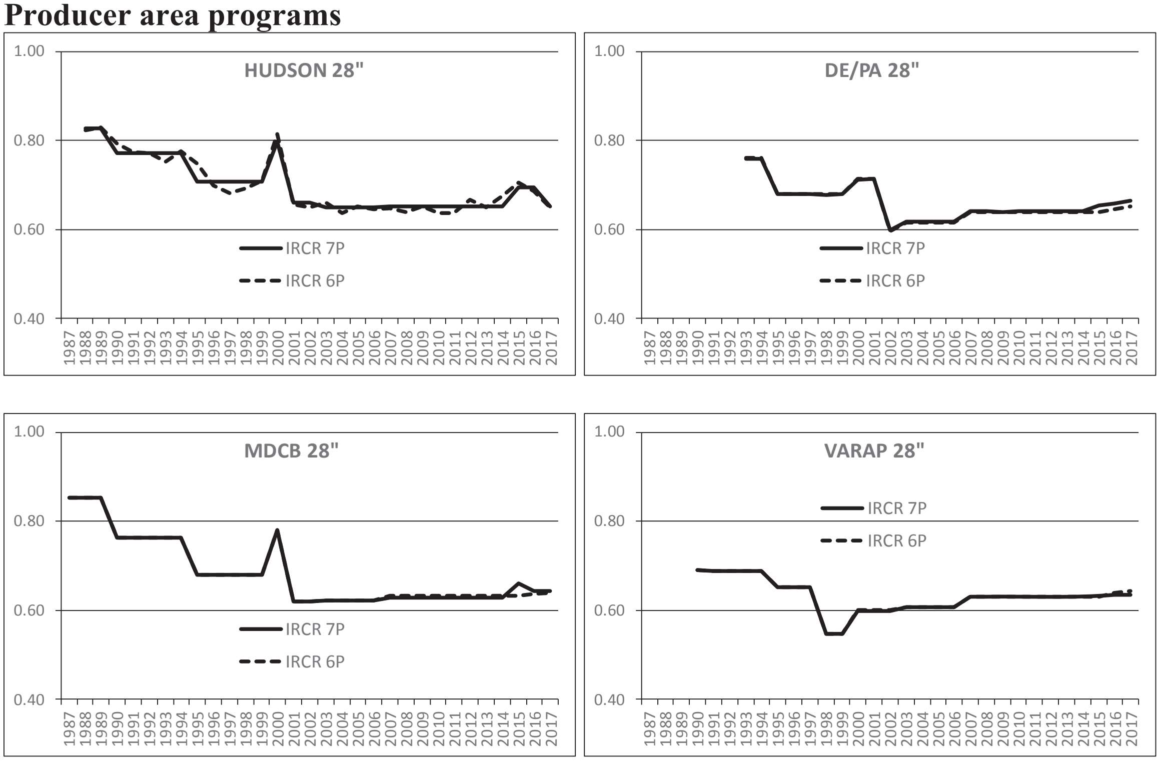
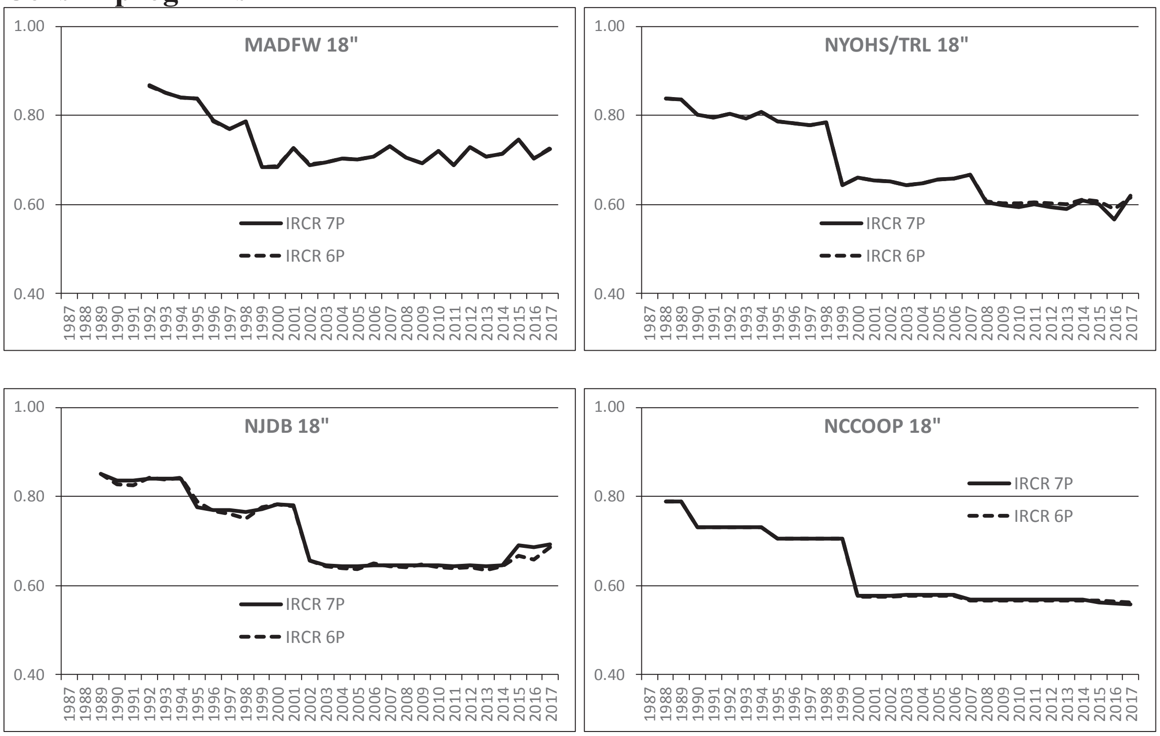



Figure 1. Survival estimates from IRCR analyses of fish tagged at ≥ 28 inches. Model averaged estimates are from separate analyses of (1) candidate models structured with seven regulatory periods (IRCR 7P) and (2) candidate models structured with six regulatory periods (IRCR 6P).

## Coastal programs

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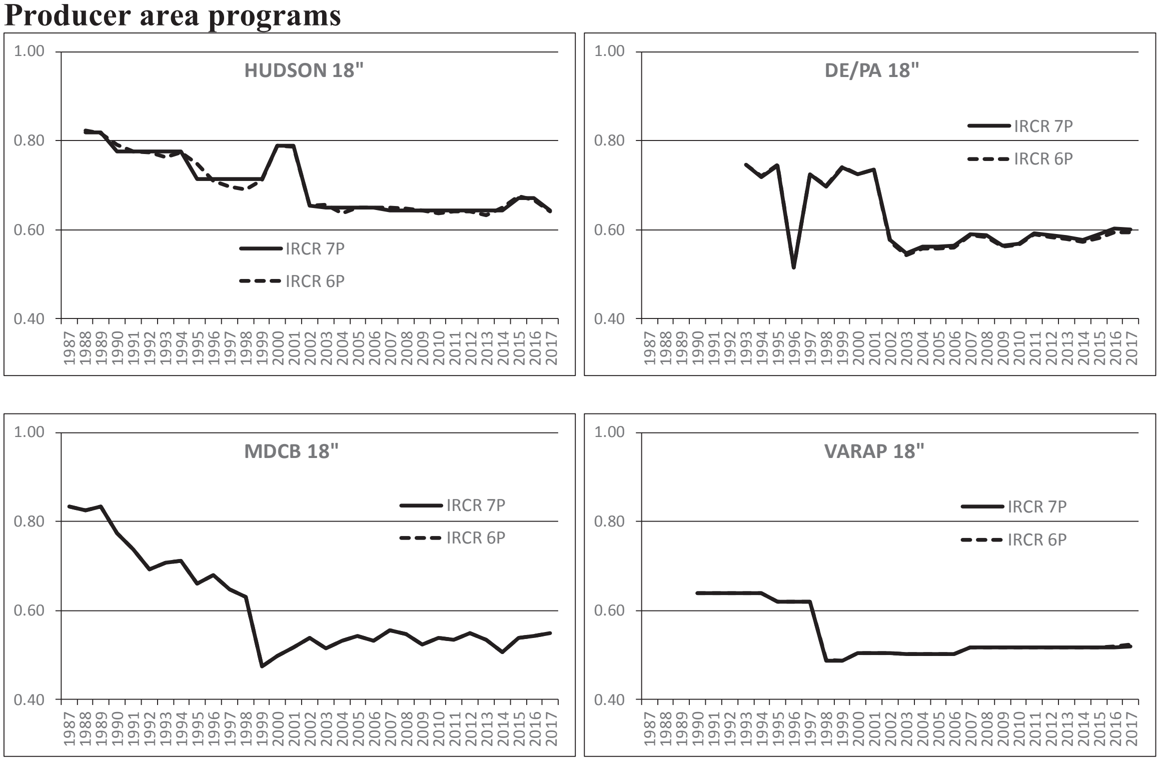
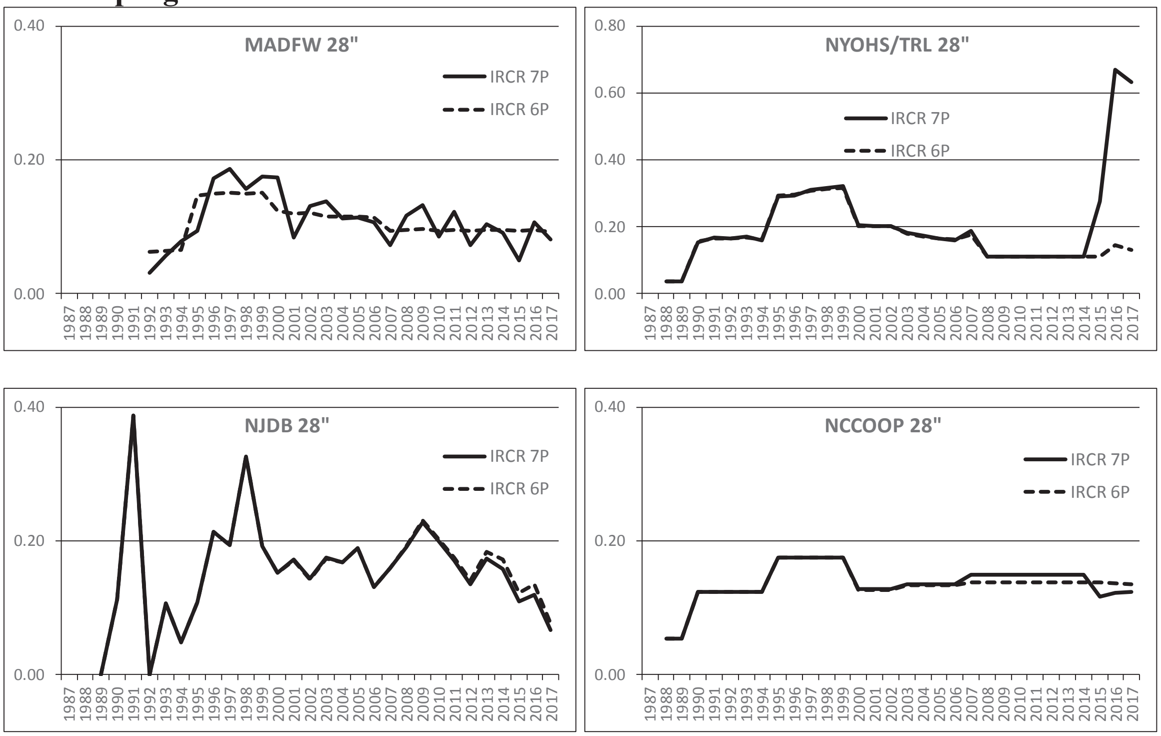



Figure 2. Survival estimates from IRCR analyses of fish tagged at ≥ 18 inches. Model averaged estimates are from separate analyses of (1) candidate models structured with seven regulatory periods (IRCR 7P) and (2) candidate models structured with six regulatory periods (IRCR 6P).

## Coastal programs




## Producer area programs

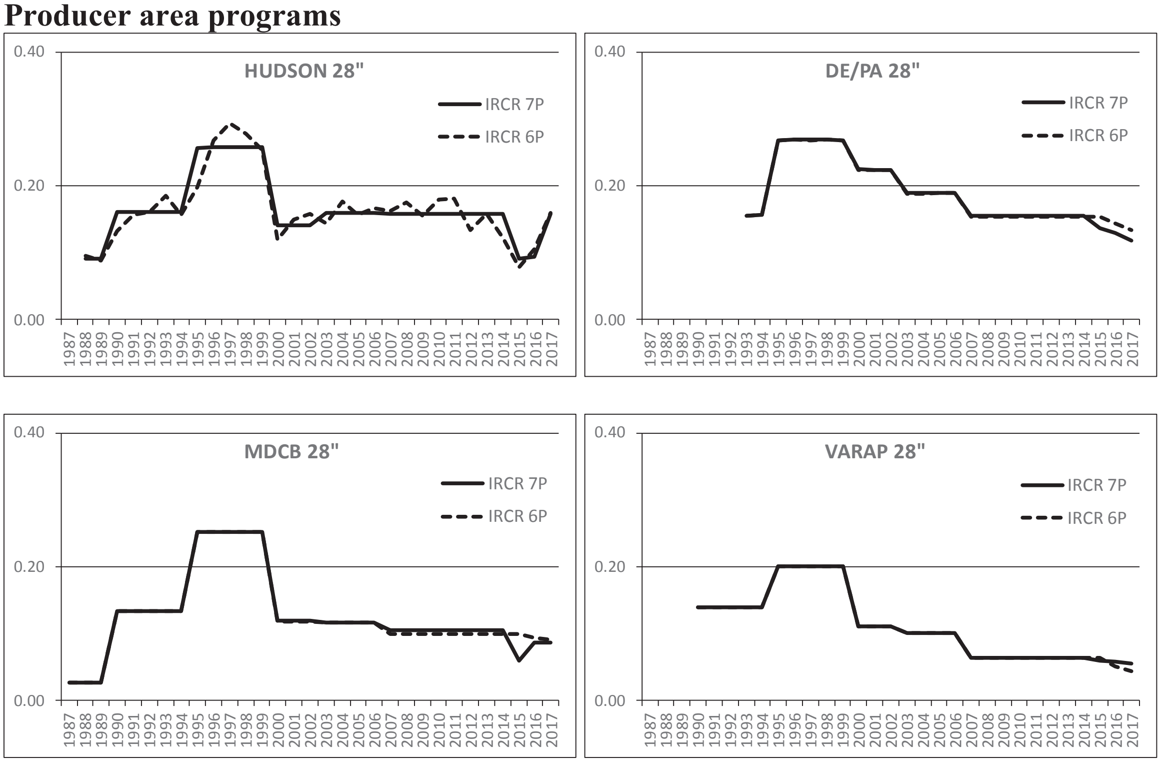
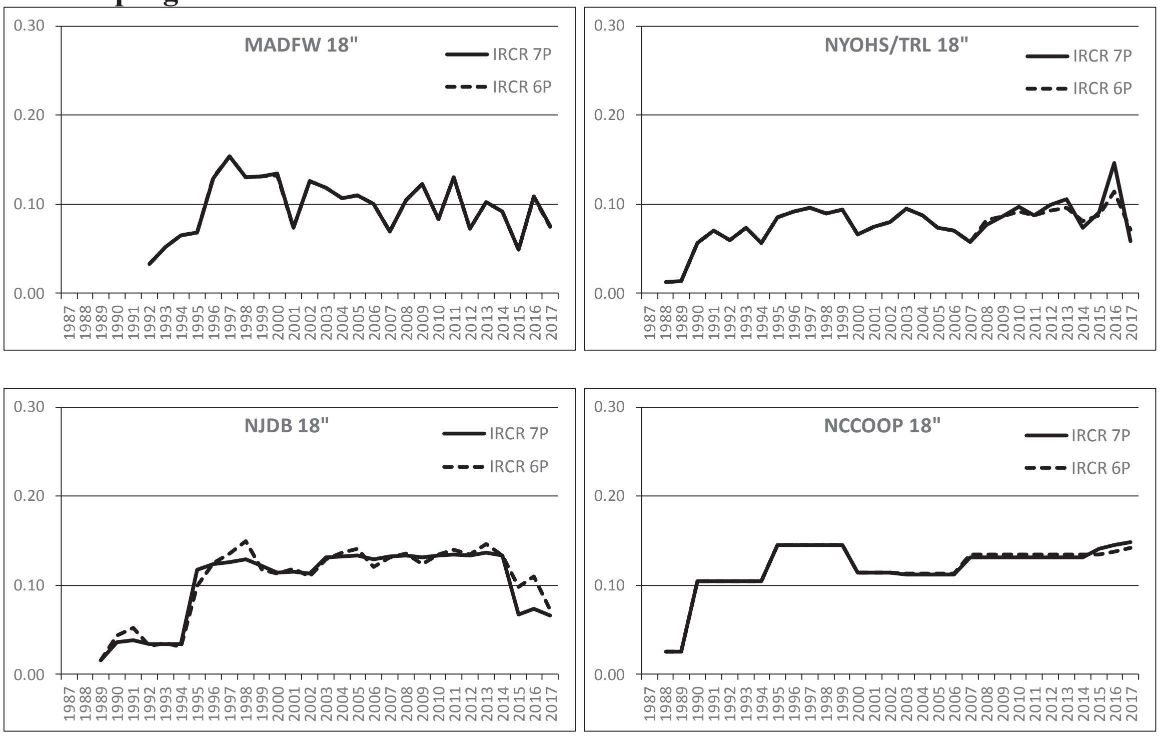



Figure 3. Instantaneous fishing mortality rate estimates from IRCR analyses of fish tagged at ≥ 28 inches. Model averaged estimates are from separate analyses of (1) candidate models structured with seven regulatory periods (IRCR 7P) and (2) candidate models structured with six regulatory periods (IRCR 6P).

## Coastal programs

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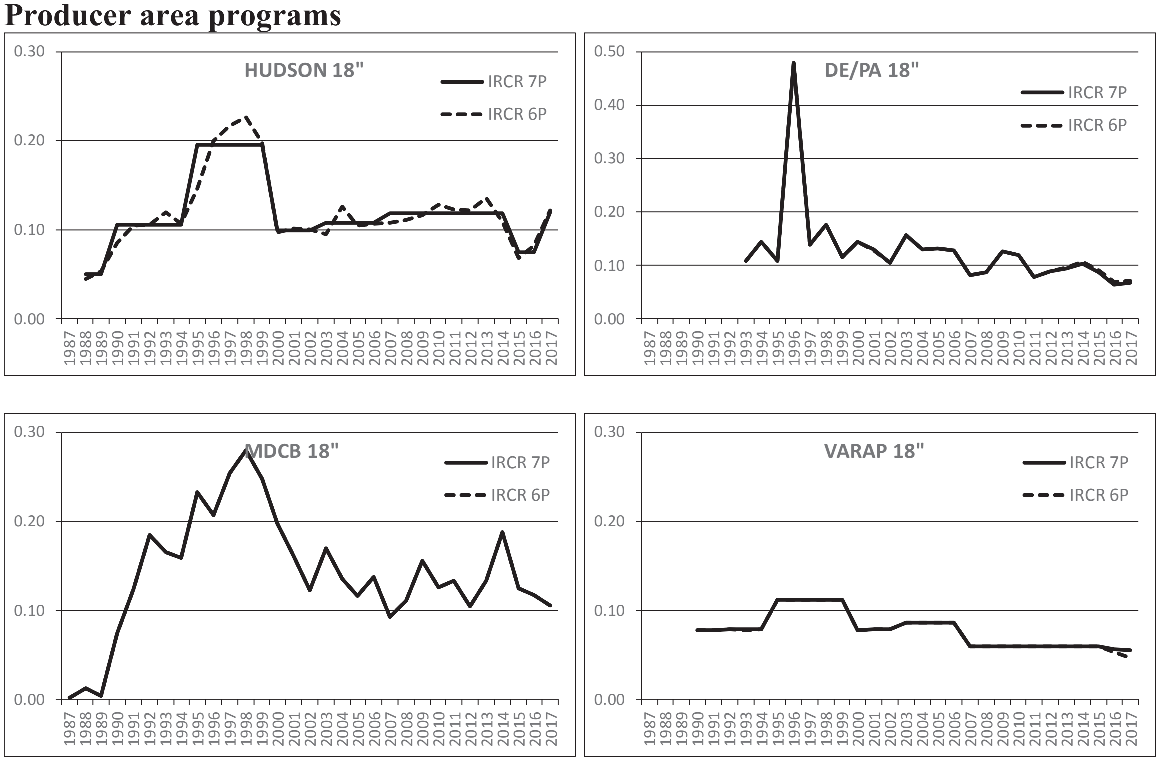
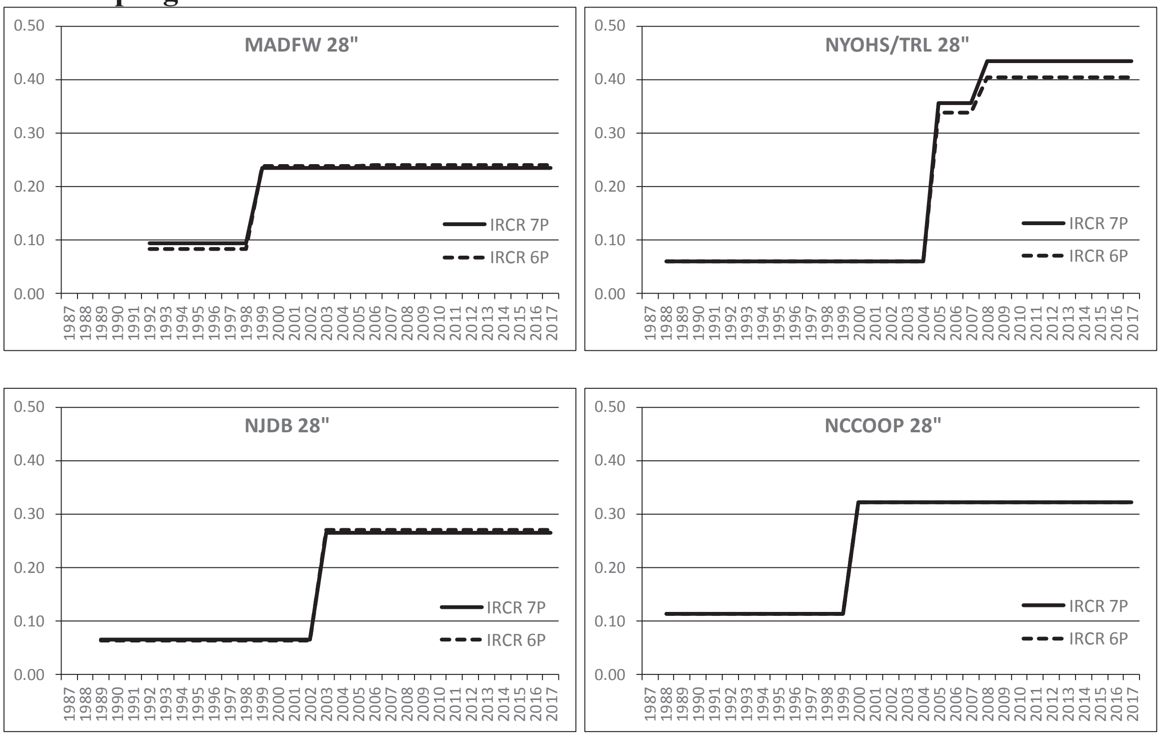



Figure 4. Instantaneous fishing mortality rate estimates from IRCR analyses of fish tagged at ≥ 18 inches. Model averaged estimates are from separate analyses of (1) candidate models structured with seven regulatory periods (IRCR 7P) and (2) candidate models structured with six regulatory periods (IRCR 6P).

## Coastal programs




## Producer area programs

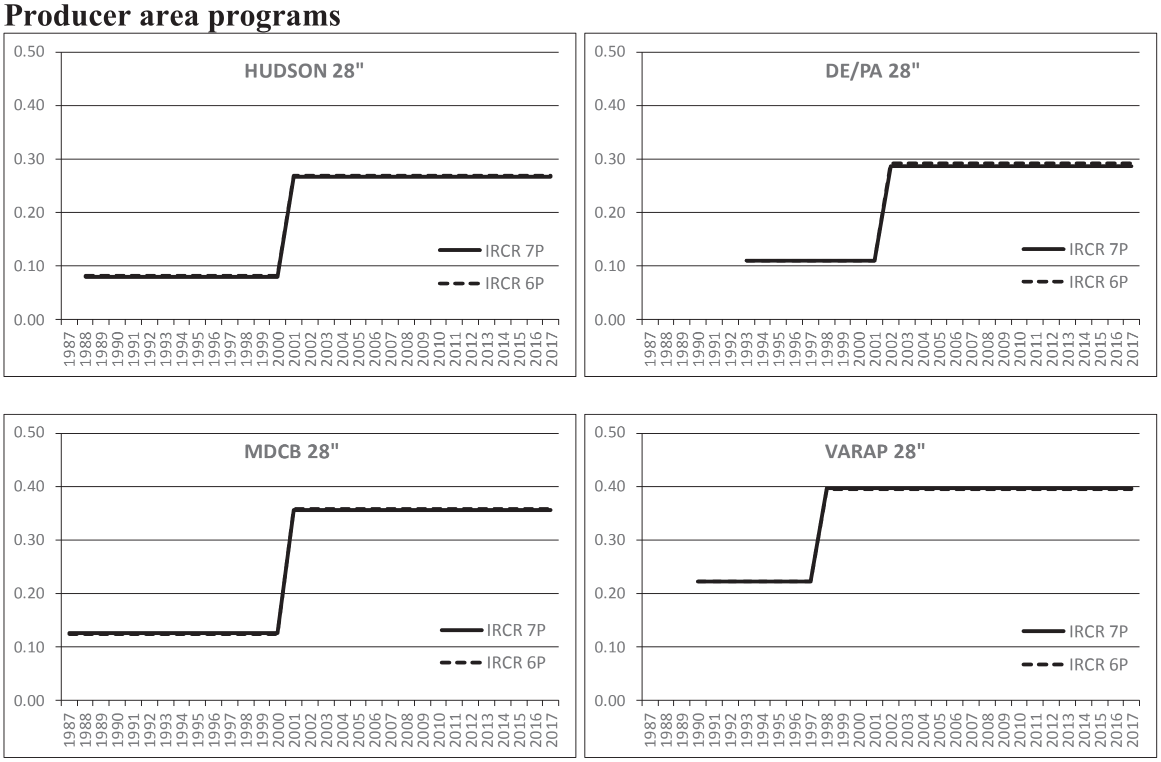
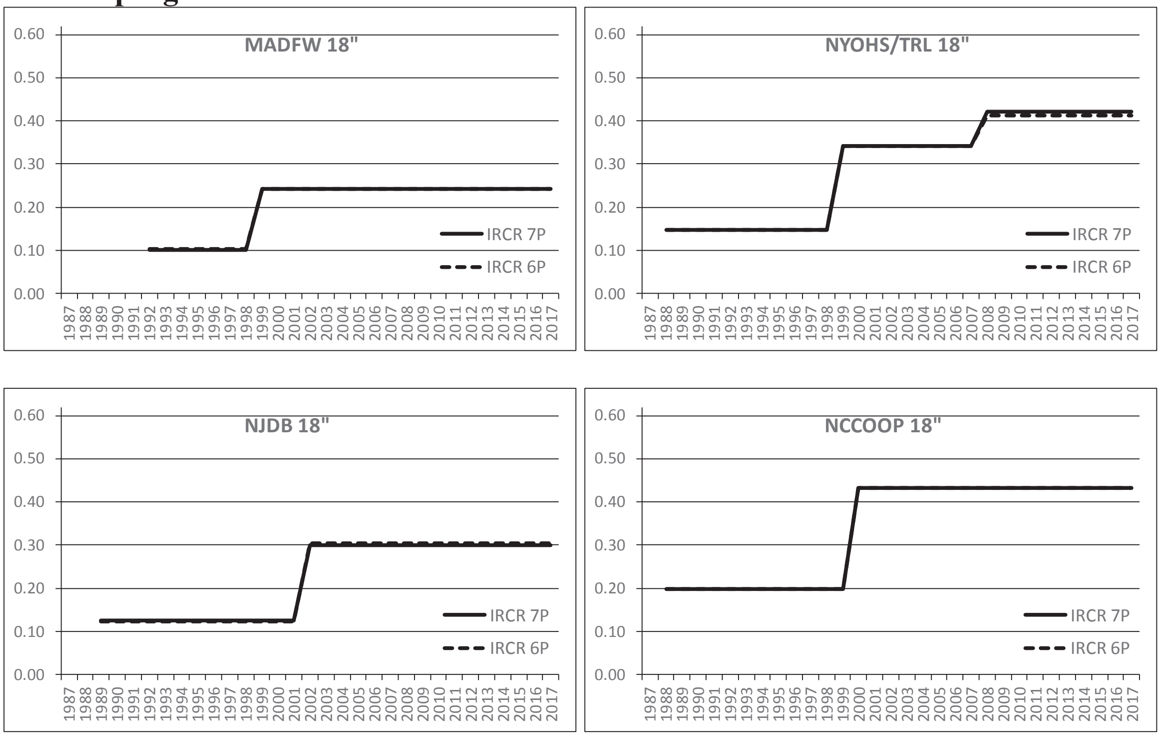



Figure 5. Instantaneous natural mortality rate estimates from IRCR analyses of fish tagged at ≥ 28 inches. Model averaged estimates are from separate analyses of (1) candidate models structured with seven regulatory periods (IRCR 7P) and (2) candidate models structured with six regulatory periods (IRCR 6P).

## Coastal programs




## Producer area programs

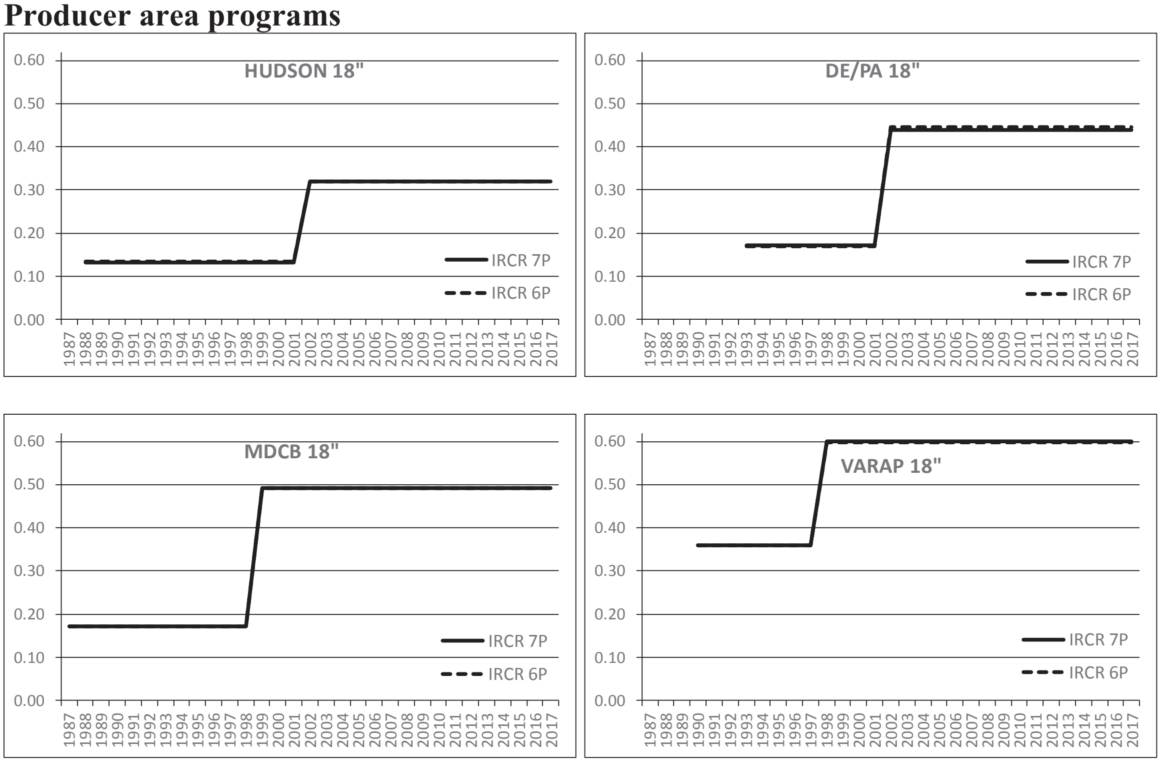



Figure 6. Instantaneous natural mortality rate estimates from IRCR analyses of fish tagged at ≥ 18 inches. Model averaged estimates are from separate analyses of (1) candidate models structured with seven regulatory periods (IRCR 7P) and (2) candidate models structured with six regulatory periods (IRCR 6P).

**Appendix B12: TOR #6 (projections) for the non-migration SCA model.**

The SARC66 peer review panel concluded that the two-stock statistical catch-at-age (2SCA) model presented to them was not acceptable to serve as a basis for fishery management advice. Instead, SARC66 recommends the use of the single-stock non-migration model for management use. Although the projections from the non-migration SCA were available to be reviewed at the SAW/SARC workshop, they were not part of the draft report, and are provided here as an appendix.

## PROVIDE ANNUAL PROJECTIONS OF CATCH AND BIOMASS UNDER ALTERNATIVE HARVEST SCENARIOS. PROJECTIONS SHOULD ESTIMATE AND REPORT ANNUAL PROBABILITIES OF EXCEEDING THRESHOLD BRPS FOR F AND PROBABILITIES OF FALLING BELOW THRESHOLD BRPS FOR BIOMASS. (TOR #6)

### B10.1 Female Spawning Stock Biomass (SSB) and Fishing Mortality (F)

Several scenarios were run to investigate changes in female SSB over six-year projections. In the first scenario, the changes in SSB and F relative to their threshold reference points were examined by projecting the population forward assuming the catch taken in 2017 (7,058,838 fish) was also taken during 2018-2023. In the second scenario, the population was projected assuming the F observed in 2017 (0.307) was the same in 2018-2023. In the third and fourth scenarios, the population was projected assuming fishing mortality in 2018-2023 was equal to F associated with the 1993 and 1995 SSB thresholds assuming a Beverton-Holt stock recruitment relationship and empirical recruitment.

For each scenario, the model begins in year 2017 with known January-1 abundance-at-age data with associated standard errors from the SCA assessment model, the fully-recruited F estimate in 2017 (F=0.307), selectivity-at-age in 2017, Rivard weights in 2017, natural mortality, female sex proportions-at-age, and female maturity-at-age are used to calculate female SSB as modeled in the SCA model. For 2018, the January-1 abundance-at-age is calculated from the known values of 2017 abundance-at-age, selectivity and fully-recruited F. For the remaining years, the January-1 abundance-at-age is projected and is calculated by using the previous year's abundance-at-age, selectivity, F, and natural mortality following the standard exponential decay model. In the constant catch scenario, the fully-recruited F in 2018-2023 is estimated by using an iterative approach in which catch-at-age is calculated by using the catch equation given a January-1 abundance-at-age, F, and selectivity-at-age. The sum of age-specific catches are then compared to the assumed constant catch for 2018-2023. This procedure is repeated by changing fully-recruited F until the square of the log difference between predicted catch and total catch is minimized. Given the value of fully-recruited F, SSB for the current year is then calculated. For the constant F scenarios, total catch is calculated each year from the January-1 abundances and the current year F.

For each iteration of the simulation, the abundance-at-age in 2017 is randomly drawn from a normal distribution parameterized with the 2017 estimates of January-1 abundance–at-age and associated standard errors from the SCA assessment model. For the remaining years, abundance of age-1 recruits is either randomly selected from the 1990-2017 recruitment estimates (empirical recruitment approach) or predicted from the hockey-stick Beverton-Holt stock recruitment relationship (BHSR approach) described under TOR #5. An age-15 plus-group is assumed. For years 2018-2023, selectivity-at-age is assumed equal to the geometric mean selectivity for years 2013-2017. Female spawning stock biomass was calculated by using geometric mean Rivard weight estimates from 2013-2017, sex proportions-at-age, and female maturity-at-age.

For each year of the projection, the probability of SSB being below the SSB reference point was calculated from 10,000 simulations using function *pgen* in R package *fishmethods*. The SSB reference point was the 1993 or 1995 SSB estimate and the error of the estimates of current SSB and SSB reference point were incorporated in the calculation of probability. Similarly, the probability of current F being above the F reference point was calculated from 10,000 simulations as well.

**B10.2 Results**

If the total fully-recruited F was assumed equal to the 2017 value (0.307) during 2018-2023, the probability of female SSB being below the 1995 SSB reference point, assuming BHSR, is 100% (Figure 1). The probability of female SSB being below the 1993 SSB reference point, again assuming BHSR, is always above 90%. If F is lowered during 2018-2023 to 0.240 or 0.278 (Fs associated with 1995 and 1993 SSB, respectively), the probability that female SSB is below the 1995 reference point remains above 95% (Figure 1). The probability that female SSB is below the 1993 reference point remains above 75% when F = 0.278, but drops to 23% in 2023 when F = 0.240. Under the constant catch scenario, the probabilities of female SSB being below the 1995 or 1993 SSB reference points, assuming BHSR, are similar to those from fishing at the F threshold (F = 0.240) (Figure 1).

If the constant catch of 7,058,838 fish was maintained during 2018-2023, the probability of being above the 1995 F reference point is greater than 50%; the probability of F being below the 1993 F reference point is below 50% from 2019-2023 (Figure 2).

Results from projections that assumed the empirical recruitment model (Figures 3 and 4) were similar to the hockey-stick recruitment results.

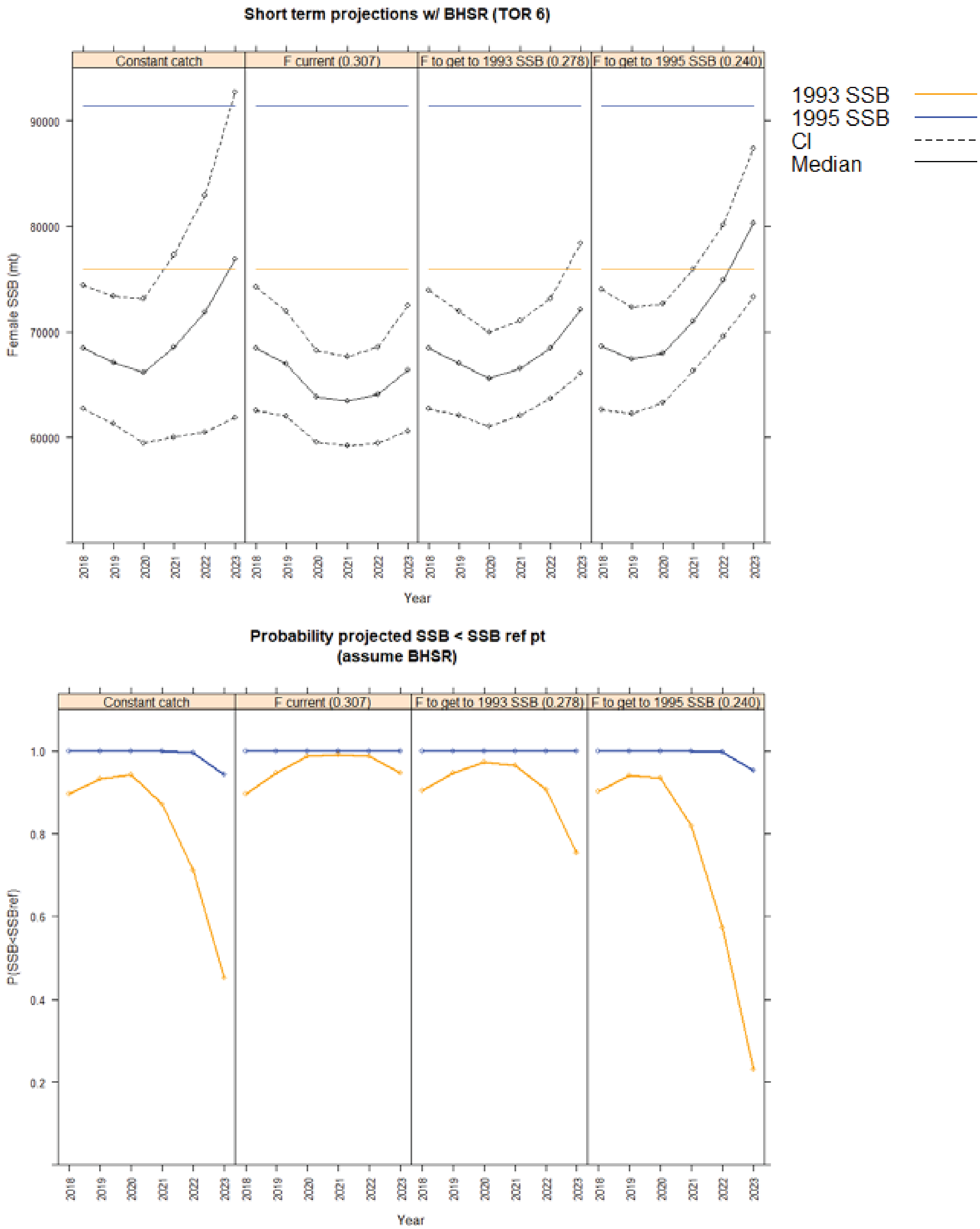



Figure 1. Short term projections of female spawning stock biomass with 95% confidence intervals (top) and probability of female SSB being below SSB reference points (bottom) under different fishing scenarios using Beverton Holt stock recruitment (BHSR).

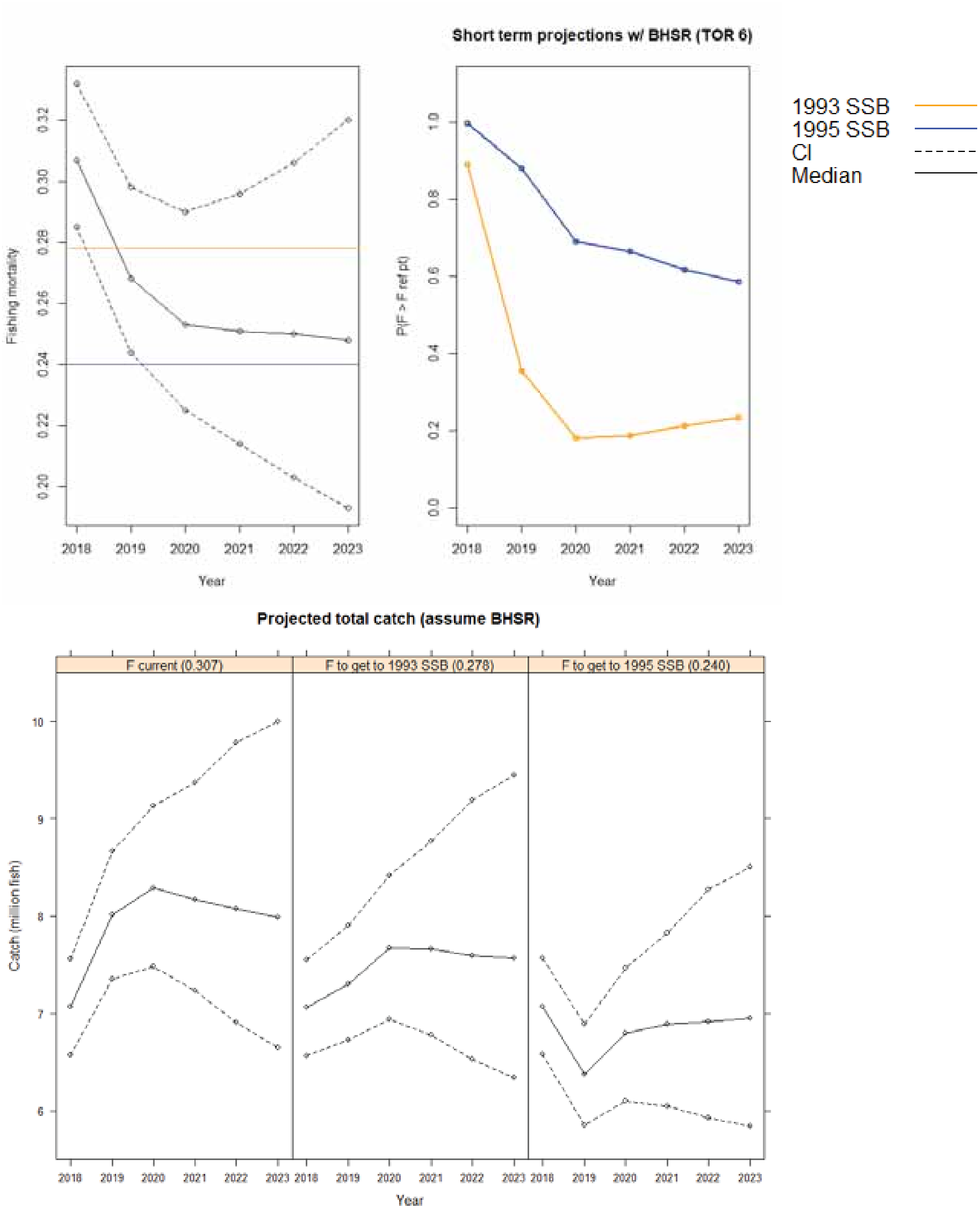



Figure 2. Probability of F being above the F reference points for the constant catch scenario (top) and projected total catch under different F scenarios (bottom) using Beverton Holt stock recruitment (BHSR).

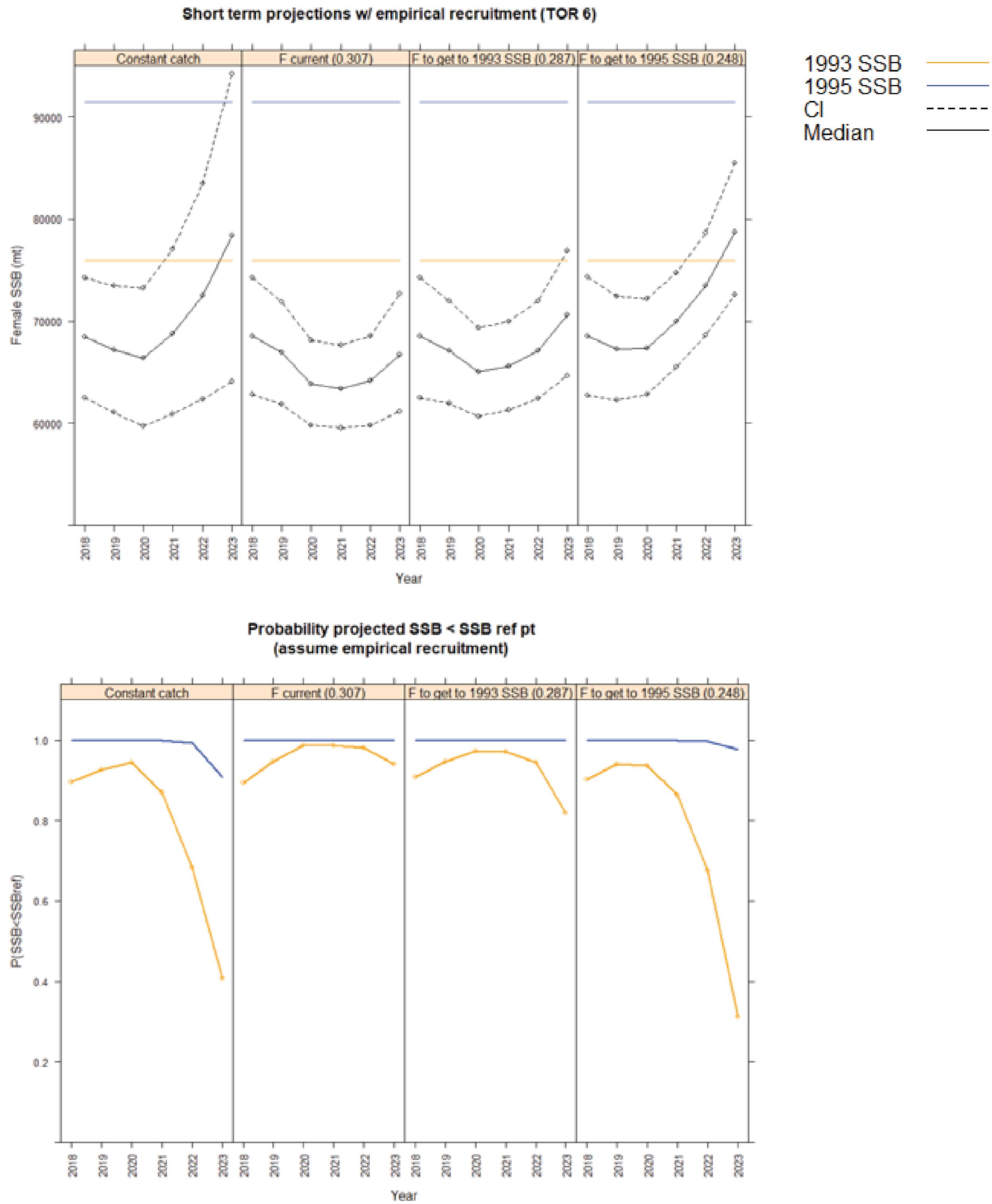



Figure 3. Short term projections of female spawning stock biomass with 95% confidence intervals (top) and probability of female SSB being below SSB reference points (bottom) under different fishing scenarios using empirical recruitment.

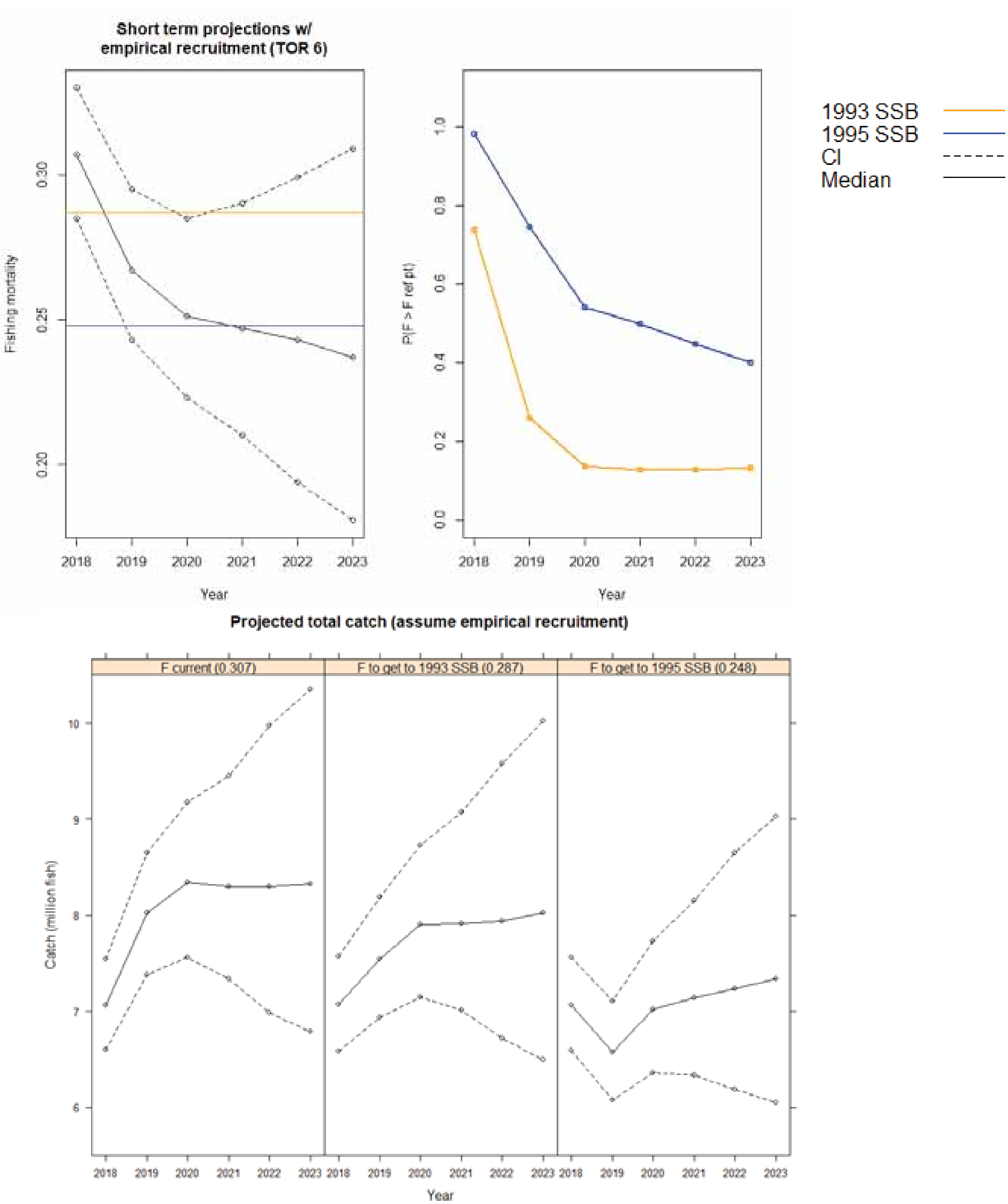



Figure 4. Probability of F being above the F reference points for the constant catch scenario (top) and projected total catch under different F scenarios (bottom) using empirical recruitment.

**Appendix B13. Additional analysis for striped bass requested at SARC 66**

The SARC 66 Review Panel expressed concerns about the way overfishing status was determined for the striped bass two-stock statistical catch-at-age (2SCA) model. The 2SCA model estimated F for a Chesapeake Bay fleet and an ocean fleet. The Striped Bass Stock Assessment Subcommittee (SAS) calculated an F threshold for each fleet and determined overfishing status for each fleet relative to its F threshold (see Section B9.2.1 and B9.3 in the main assessment report for more details).

The Panel recommended developing a single overfishing determination for the Chesapeake Bay stock by projecting the population forward under status quo F (i.e., maintaining $F_{2017}$ for each fleet) and determining where the population stabilized relative to the SSB threshold and unfished SSB. If the population stabilized below the SSB threshold, then overfishing would be occurring; if the population stabilized at or above the SSB threshold, then overfishing would not be occurring. This approach would avoid having two overfishing status determinations for one stock, and provide a simpler metric than trying to calculate a single F value for the combined fleets, each of which operated on different components of the Chesapeake Bay stock of striped bass.

The results showed that both the Chesapeake Bay stock and the Delaware Bay/Hudson River stock were experiencing overfishing relative to the current threshold definitions (Table 1).

Table 1. Results of the projection-based approach to determine overfishing status for the striped bass 2SCA model.

| Chesapeake Bay (Stock1) | | | |
|---|---|---|---|
| Reference point definition | Reference Point Value (Std. dev) | $SSB_{Status\ quo\ F}$ (Std. dev) | p($SSB_{Status\ quo\ F} < SSB_{Ref}$) |
| SSB 1995 | 52,893 (3,856) | 38,882 (5,849) | 0.97 |
| SSB 1993 | 34,375 (2,747) | 38,882 (5,849) | 0.21 |

| DE Bay/Hudson River (Stock 2) | | | |
|---|---|---|---|
| Reference point definition | Reference Point Value (Std. dev) | $SSB_{Status\ quo\ F}$ (Std. dev) | p($SSB_{Status\ quo\ F} < SSB_{Ref}$) |
| SSB 1995 | 24,683 (2,193) | 14,779 (2182) | 0.99 |
| SSB 1993 | 19,637 (2,086) | 14,779 (2182) | 0.94 |

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