2003 Atlantic Striped Bass Advisory Report

State of the Stock

Stock Size: The estimate of total abundance for January 1, 2003 is 44.7 million age-1 and older fish due to the poor 2002 year-class. This estimate is about 397 fish lower than the average stock size for the previous five years and 13.6% lower than the 2002 abundance.

Spawning Stock Biomass (SSB): The female spawning stock biomass for 2002 is estimated at 49.2 million pounds which is well above the recommended biomass threshold of 30.8 millions pounds (13,956 mt).

Recruitment: Recruitment of the 2002 cohort for all stocks combined is 3.6 million age-1 fish and is comparable to the 1987 estimate (3.5 million fish). Preliminary survey indices for young-of-the-year striped bass for 2003 in Chesapeake Bay indicate that the 2003 year-class is large.

Fishing Mortality Rates: Based on VPA results**, t**he average fishing mortality rate (F) on ages 4-11 was 0.29 for 2002 and 0.31 in 2001. The Amendment 5 target F for this age grouping is 0.31 and the threshold is Fmsy = 0.38. Amendment 6 reference points are based on a fully recruited fishing mortality, which requires comparison to the fully recruited ages in the assessment. Partial recruitment results indicate that ages 8-11 are fully recruited in 2002, thus the comparison of estimated and target fishing mortality should be based on the average for these ages. Average age 8-11 fishing mortality in 2002 is estimated at F=0.35 which exceeds the Amendment 6 target of 0.30, but is below the threshold of 0.41.

Based on spawning area tagging programs, stock-specific, model-based estimates of fishing mortality in 2002, for fish greater than twenty-eight inches total length, were 0.31 for the Maryland portion of the Chesapeake Bay; 0.28 for the Rappahannock River; 0.33 for the Delaware River, and 0.07 for the Hudson River. Based on coastal tagging programs, fishing mortality estimated ranged from 0.05 for MA to 0.35 for the New York Ocean Haul Seine. The F estimates for the time series from the New York Ocean Haul Seine, North Carolina Coop, Delaware River, Maryland/Chesapeake Bay, and Virginia Rappahannock programs were similar in trend and magnitude (average F in 2002=0.31) to the F (N-weighted) estimates (F in 2002 = 0.33) produced in the VPA. The tag-based F estimates from the Massachusetts, New Jersey, and Hudson River programs, however, were much lower (average F in 2002 =0.07) than the VPA estimates and showed declining trends in fishing mortality.

Chesapeake Bay fishing mortality in 2002 is estimated at F=0.22 by the direct enumeration study. This F represents mortality during the June 2002 – June 2003 period, so is not directly comparable to the average, weighted (by N) VPA calendar-year F on age 3-8 striped bass.

Exploitation Rates: Based on the tagging programs, R/M estimates produced by 5 (New York Ocean Haul Seine, Hudson River, Delaware River, Maryland/Chesapeake Bay, and Virginia Rappahannock) out of 8 programs were generally similar in magnitude to the exploitation rates derived using F estimates from the current ADAPT assessment for years 1990-1999. However since

2000, the R/M estimates have declined, indicating exploitation has decreased. Among the programs with 2002 estimates, the Delaware River has an estimate comparable to the VPA results (0.24 vs VPA exploitation rate of 0.26). The remaining programs have an average 2002 estimate of 0.13.

Catch: Total catch in numbers including landings and discards dropped about 13%, from 4.3 million fish in 2001 to 3.8 million fish in 2002. The 2002 catch was slightly below the 1996-2001 average of 4.0 million. Ages 4 to 7 represented 60% of the total catch, and ages 8+ represented 25%. The 1996 year-class dominated, accounting for 20% of total catch. The proportion of 8 and older fish in the catch increased to 23% in 2001 from 25% in 2002. Total pounds of striped bass landed in 2002 was 2.5 million which represents a decline of 16% compared to pounds landed in 2001.

Recreational landings (1.8 million fish) and discards (1.1 million fish) accounted for 78% of the total 2002 catch, an increase of 7% compared to 2001 catches. New Jersey recreational fisheries landed 23.9% of total recreational landings, followed by VA (17.4%), MA (16.9%), MD (15.5%), and NY (11%). The remaining states each landed 4% or less of the total recreational landings.

Commercial landings (0.6 million fish) and discards (0.1 million fish) accounted for 22% of the total 2002 catch. Maryland commercial fisheries landed 45% of the total commercial landings, followed by VA (19.4%), PRFC (12.2%), NY (7.2%), and MA (6.9%). The remaining states each landed 4% or less of the total commercial landings. Commercial landings have been declining since 1998.

Data and Uncertainty: No new data sources are included in this year's assessment. Tuning indices are similar to those used in past years, with some minor adjustments to the tuning date and the range of ages, although several age-specific indices (Virginia Pound Net, Maryland SSN at age 2, and NEFSC ages 2, 12-13+) were deleted due to low precision of the estimates or lack of cohort coherence through time.

The uncertainty associated with ageing striped bass with scales still remains a problem. Attendees of the ASMFC striped bass ageing workshop in March, 2003 made many recommendations on how to improve scale impressions, but also agreed that ageing bias is an issue after ages 10-12. Recommendations to develop conversion keys using scale-otolith ages, or to use otoliths as a primary ageing structure were made, and a subcommittee was formed to determine the feasibility of using either approach. Their results are due in March 2004.

The sensitivity of the VPA model to changes in the plus grouping was addressed. The 13+ model configuration was selected over the 12+ configuration as representing the “best” estimates of fishing mortality and abundance, but the choice was a compromise. However, the choice was supported later by simulation results that examined the effects of real ageing error on the VPA estimates.

The bootstrap estimates of terminal F in 2002 have a very skewed distribution with most values concentrated in the range of 0.1 to 1.0, and a small number of relatively large values ranging from 1 to 3.2. Based on this distribution, full F in 2002 was between 0.20 and 1.58 with an 80%

probability. The bootstrap results should be viewed cautiously, since high values of F on the range of 0.6- 3.2 do not seem to be realistic.

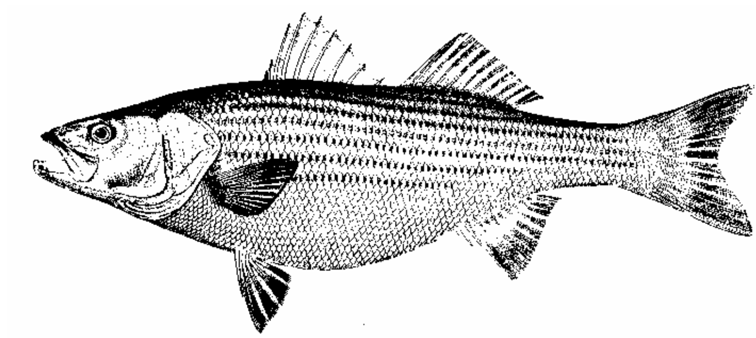
Management Advice

Although there is uncertainty in the estimates of F from the VPA and tagging programs, the TC has concluded that the stock is not being overfished and overfishing is not occurring based on current available information. However, the TC recommends that the Board consider this uncertainty prior to instituting any management action.

Fishing mortality for ages 4-11 based on the current VPA assessment is below the Amendment 5 target. The fully recruited fishing mortality under Amendment 6 is F=0.35 for ages 8-11 which exceeds the fishing target, but not the threshold , and suggests that fishing mortality may need to be reduced on these older age classes.

2003 Stock Assessment Report for Atlantic Striped Bass:

Catch-at-Age Based VPA & Tag Release/Recovery Based Survival Estimation



Report# SBTC-2003-3
Prepared by the
Striped Bass Technical Committee
for the Atlantic Striped Bass Management Board

November 2003

Healthy, self-sustaining populations of all Atlantic coast fish species or successful restoration well in progress by the year 2015

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I. Introduction

The Atlantic Coast striped bass stock is assessed with two separate methods: 1) catch-age based virtual population analysis, and 2) tag release-recovery based survival estimation. Each program is presented in this report as separate segments. The VPA analysis, prepared by the Striped Bass Stock Assessment Subcommittee (SBSASC), is used to evaluate fishing mortality for the mixed coastal stock and provide estimates of abundance and biomass. The tagging analysis, prepared by the Striped Bass Tagging Subcommittee, is used to evaluate fishing mortality for specific stocks and averaged results are used to develop a mixed stock mortality estimate.

II. Catch-at-Age-Based VPA Analysis

The first analytical assessment 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). The assessment methodology utilized NEFSC ADAPT version of VPA and remained unchanged until 2002. The stock status and assessment procedures were reviewed once more at the 36th SAW in December 2002. This report represents the update of the stock status assessment with the inclusion of the 2002 catch and survey data.

Data Summary

Commercial Fishery in 2002

Commercial landings in 2002 totaled 654,000 fish and 2,723 mt (5,998,794 pounds) (Table 1 and 2). The landings represented a decline of 30.6% in numbers (288,000 fish) but only 3.6% in weight (103 mt) compared to 2001 (Table 3). This decline was primarily due to the reduction in harvest in the Chesapeake Region (Maryland, PRFC, and Virginia), which accounted for most of the commercial harvest, 82% by number (Table 4) and 65% by weight. Overall, commercial harvest represented 26% by number and 24% by weight of total harvest in 2002, and 22 % of total catch in number (harvest + discard) (Figure 1, Table 2). Commercial harvest was comprised primarily of fish ages 4 to 6 (61% of commercial harvest). Ages 3 through 8 comprised 78.5% of the harvest (Table 4).

Direct measurements of commercial discards of striped bass were not available. For the period 1982-97, estimates were based on the tag recovery ratio of commercial to recreational discarded fish tag, scaled by total recreational discards:

$$CD = RD*(CT/RT)$$

where:

CD = an 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 (MRFSS).

CT = number of tags returned from discarded fish by commercial fishermen,

RT = number of tags returned from discarded fish by recreational fishermen.

Total discards were allocated to fishing gears based on the number of tags recovered by each gear. Discards by fishing gear were multiplied by gear specific release mortalities and summed to estimate total number of fish killed. The Technical Committee attempted to improve the estimate of commercial discards for the 1998-2001 period by accounting for spatial distribution of different fishing gear and effort. The ratio of tags recovered in commercial and recreational fisheries and corresponding discards were calculated separately for Chesapeake Bay and the coast (Table 5). An average ratio of tags returned by commercial and recreational fishery in 1999-2002 was 0.65 for Chesapeake Bay and 0.10 for the coast. The average ratio of numbers of fish landed was different, 1.18 for the Chesapeake Bay and 0.12 for the coast.

An attempt was made to adjust for bias created by the assumption of equal reporting rates between commercial and recreational fishers inherent in this method. Assuming that availability of tagged fish to commercial and recreational fishery is equal, the ratio of tags recovered by commercial and recreational fisheries should be close to the ratio of landings. A significant difference in ratios of tags and landings suggests lower reporting rate by commercial fishery, especially in Chesapeake Bay area. To correct for this bias, a correction factor was calculated by dividing a ratio of commercial to recreational landings by the ratio of tags returned by two fisheries. A correction factor for Chesapeake Bay and coast was estimated as 1.81 and 1.23. Finally, commercial discards were calculated by multiplying recreational discards by the commercial/recreational tag ratio and by the corresponding correction factor. Commercial discards for the Hudson and Delaware Rivers were estimated separately based on at sea sampling. Total commercial discards losses for 2002 were estimated as 168,201 fish, representing 4.5% of total removals in number (Figure 1, Table 2, Table 6).

Commercial discard proportions-at-age were obtained by applying age distributions from fishery-dependent and independent surveys using comparable gear. These proportions-at-age were applied to discard estimates by gear and expanded estimates summed across all gears. Total commercial discards were dominated by fish of ages 3 to 6 (Table 6).

Recreational Fishery in 2002

Recreational statistics were collected as part of the MRFSS (Marine Recreational Fishery Statistics Survey) program. Details of the assessment methodology can be found on the MRFSS web site (http://www.st.nmfs.gov/st1/recreational/the_mrfss.html). Landings (A+B1) in 2002 were estimated at 1,828,367 fish totaling 18.52 million pounds (8,409 mt) (Table 1, Table 2). The landings represent a decrease of 183,500 fish (9.1%) and 480 mt (5.4%) compared to 2001 (Table 1). Overall, recreational harvest represented 48.5% by number of the reported total catch (Figure 1). Striped bass of age 4 to 8 comprised 76% of landings. The states landing the largest proportion were New Jersey, Massachusetts, Virginia, Maryland and New York (Table 7, Figure 2). Recreational discards (B2's) increased slightly in 2002 to 13.8 million fish (Table 2) compared to 13.5 million fish in 2001. Application of an 8% hooking mortality rate resulted in estimated losses of 1.1 million fish (Table 2). The states with the largest proportion of the overall discards were Massachusetts and Maryland (Table 8). Recreational discards represented 30% of the total catch by number (Figure 1, Table 2). Discards-at-age declined steadily from age 2 to 15, except for the 1996 year class, which had the highest numbers discarded among all cohorts in 2000-2002. Total recreational losses of striped bass in 2002 was 2.95 million fish. The losses were dominated by ages 4 to 9 (77% of total). Total recreational discard and landings losses have been growing steadily since 1982, although intermittent declines occurred in 1998-1999 (Table 9, Figure 3).

Total Catch at Age

The above components are totaled by year to produce the overall catch-at-age matrix for the VPA input (Table 10). The total losses of striped bass in 2002 were 3.6 million fish, a decline from 4.3 million fish in 2001. The decline in harvest occurred primarily in ages 2-5 (Figure 4). At the same time there was an increase in the number of harvested fish of age 6 (1996 year class) and 9 (1993 year class).

Weight at Age

Weight-at-age information was updated for the period 2000-2002. Mean weights at age for the 2002 striped bass catch were determined from data collected in several states. The available data were from Maine and New Hampshire recreational harvest and discards; Massachusetts recreational and commercial catch; New York recreational catch and commercial landings; New Jersey recreational catch; Delaware and Maryland commercial catch and Virginia recreational and commercial catch. Weighted mean weights at age were calculated as the sum of weight at age multiplied by the catch-at-age numbers, divided by the sum of catch in numbers. The estimated weights at age for 1999 were applied to 1997 and 1998 where weight data were unavailable. Details of developing weights at age for 1982 to 1996 can be found in NEFSC Lab Ref. 98-03. Weights at age for 1982-2002 are presented in Table 11.

Survey indices

Striped bass indices of abundances were available from fisheries-independent and fisheries-dependent surveys. These indices for combined ages generally show a stable, high level of population abundance punctuated by strong year classes (Figure 5). Multiple age, fishery-independent surveys were the VA pound nets, MD gillnet, CT trawl survey, NY ocean haul seine index, NJ trawl index, DE trawl survey and the NEFSC spring bottom trawl survey. The decline seen in the VA survey may be due to changes in availability to the gear. The strong 1993, 1996 and 2001 year classes contributed to the annual variability in the NY, DE, NJ and NEFSC survey results. Among the fisheries-dependent indices, the MA CPUE and CT CPUE suggest steady population levels since the mid 90's. The declining trend in the Hudson River shad by-catch CPUE appears to result from changes in fishing practices rather than declining abundance of striped bass.

Indices of recruitment show poor recruitment in the Chesapeake Bay and Delaware Bay in 2002 but average recruitment in the Hudson River. The very strong 2001 MD index continues as age one in 2002. The high numbers of age one striped bass in the Western Long Island index in recent years suggests the possibility that there is additional age 0 production in New York coastal waters that is not reflected in the Hudson River indices.

ADAPT Model Formulation

Catch at Age

A catch-at-age matrix was developed using standard methods described in the previous assessment documents (Anon 2002). Commercial landings at age were estimated by applying corresponding length frequency distributions and age length keys to the reported number of fish landed by the commercial fishery in each state. Length frequencies of recreational landings were based on a combination of MRFSS length samples and volunteer angler logbooks. State specific age-length keys were applied to length frequencies to estimate number of fish at age landed by recreational fishery. Age composition of the recreational discards was estimated using lengths available from volunteer angler logbooks and American Littoral Society data.

Currently all states agencies use striped bass scales to estimate age. Up to 18 age classes were reported in catch-at-age tables provided by the states. In the past, the assessment committee considered 15 age groups in VPA analyses, beginning with age one and ending with a 15 plus group that included fish of age 15 and older. However, the Technical Committee raised concerns about a problem ageing striped bass in the last assessment document (Anon, 2002). Several recent studies (Secor et al., 1995; Bobko, 2002; King and Fowler, 2002) have indicated that scales may not provide a reliable age estimate for older fish, beginning with ages 10 to 12. In a recent ASMFC-sponsored workshop on striped bass ageing, participants determined from scales of known-age fish that readers were most accurate when fish were generally < 12 years of age (although some agencies were confident they could age accurately to 15 years). The age estimates of striped bass collected by most state agencies contain errors due to the difficulty of ageing using scales (Anon, 2003). In an attempt to correct for ageing errors and potential bias in the stock assessment, runs of ADAPT using four plus-group configurations (i.e., 12+, 13+, 14+, and 15+) have been made by the stock assessment subcommittee.

Partial Recruitment Vector

Prior assessments considered only flat top partial recruitment (rising from 0 to 1 and remaining constant afterwards). In this assessment a dome shaped PR was explored in addition to the flat top at the request of the SARC. PR values for a flat top model were obtained by calculating the three year geometric mean fishing mortality for each age from the previous ADAPT assessment and dividing it by highest value of F among all ages. The integrated catch-at-age model (ICA) was used to estimate the dome-shaped partial recruitment vector for the ADAPT runs. The major differences between ICA and ADAPT are that catch-at-age data are assumed to be measured with error and the fishing mortality of each age group is a product of annual fishing mortality and an age specific constant (separability coefficient), which is estimated as a parameter in the ICA model. In general, the separability coefficient concept is analogous to that of partial recruitment, assuming that differences in F among different age groups are determined by age. We used the run for 15+ to estimate the PR vector. Depending on the choice of first age at full recruitment, ICA can estimate selectivity values >1. Therefore, the selectivity pattern was standardized to a maximum of 1 by dividing the highest value of the series into the remaining values

Fishery Independent Indices

A number of state and federal, fishery-independent surveys were available to derive age specific indices of striped bass abundance for the assessment. These included the Maryland gillnet survey of the spawning population (ages 2-15+), Virginia pound net CPUE (ages 2-15), New York ocean haul seine (ages 3-15+), NEFSC spring inshore survey (ages 3-15+), three age-aggregated trawl indices from Connecticut (ages 2-6), New Jersey (ages 2+) and Delaware (ages 2-7). The juvenile surveys produce indices of young-of-year (age 0) in Maryland, Virginia, New York and New Jersey as well as age 1 index for Maryland and Long Island, New York.

Fishery Dependent Indices

Fishery-dependent indices included Massachusetts commercial catch per hour fished (ages 8-15+), Connecticut volunteer angler catch per trip (ages 2-15+), and the Hudson River shad fishery by-catch of spawning striped bass age-aggregate index (age 8+).

Selection of Indices for Tuning

The SBSASC reviewed all tuning indices and eliminated some of them as not suitable. MD SSB index age 2 was eliminated because it was inconsistent with the presumed dynamics of individual year classes based on comparison with indices for older ages. NEFSC spring trawl survey data set has very few fish of age 12 and older. The committee decided that the sample size of fish 12 years and older is insufficient to develop a representative index of relative abundance for these age classes. Consequently, indices for ages 12 through 15 were eliminated from the analysis. Indices of relative abundance of fish in Virginia pound net survey were also eliminated because of significant correlation of most age group indices within each year, suggesting either an aging problem or a problem of sample design relative to fish availability. The ADAPT model requires indices of abundance to be measured either at the beginning or the middle of they year. Consequently, indices from surveys conducted in the spring were assigned sampling date of January 1. Indices measured in summer were assigned to the middle of the year, and those collected in the fall were assigned to the January 1 of the following year with the age increase by one. All juvenile survey indices were advanced forward to the January 1 of the following year and the index was assigned age 1. An iterative re-weighting of the survey indices was used in the ADAPT runs to adjust for variable contributions of each stock unit.

Sensitivity Analysis of Formulation Variations

In addition to four plus-group configurations, a variety of input options in ADAPT model were considered, resulting in 24 different model formulations for each plus group. The stock assessment subcommittee used the most recent ADAPT software developed by the Northeast Fisheries Science Center (NFT VPA/ADAPT Version 2.1). The latest version allows the user several options in dealing with the calculation of F in the oldest true age of the terminal year, in the years prior to the terminal year and the full F in the terminal year. These are critical elements in the analysis since the values can influence the calculations back through the time series. The SBSAC made sensitivity runs of all the option combinations in the plus groups 12+, 13+, 14+ and 15+. The ages used for the calculation of F on the oldest true age were three age groups less than the oldest true age (oldest true age is one age group less than the plus group (*a*); therefore the ages of oldest true age calculations were *a*-5 to *a*-2).

The first set of options to be selected in the new version of ADAPT involve selecting among three methods for determining the fully recruited F in the terminal year, which can be done using the 1) classic method, which is the average across fully recruited ages within the year but restricted to the ages with stock estimates in year t+1 (needed to estimate F in terminal year); 2) average method, which is the average F in the terminal year for ages with stock estimates in T+1, weighted by input PR at age. This approach may incorporate all age groups for which there are stock estimates in T+1; and 3) a modified Heincke method which is similar to averaging except it requires only fully recruited ages.

The second option explored was the method for calculating F on the oldest true age class in years prior to the terminal year. The user may choose an F based on 1) the average F across a specified range of ages (from fully recruited ages to one age less than the oldest true age) within the year, or 2) the Heincke method between years; again, this involves fully recruited ages less than the oldest true age.

The third suite of options involves calculation of the oldest true F in the terminal year. In this situation the user has two options. The first option involves the calculation of F based on 1) the fully-recruited F (calculated under the option chosen above) multiplied by the input PR for the oldest true age, or 2) the same approach as chosen for the years prior to the terminal year (either the arithmetic average or Heincke method). In many of the methods chosen, the input PR and the ages chosen to represent full F can have a significant impact on the values. Details of the methods are provided in the help files of the NFT software package. Thus for each plus group (4) and PR vector (2), 12 different combinations of calculations methods were explored.

Results of the sensitivity runs

Estimates of F and abundance varied considerably among each of the runs. For example, average fishing mortality for ages 8 and older (approximate range of fully recruited ages) ranged from 0.23 to 0.41 (Table 12, Figure 6) and total estimated population size from 45 million to 53 million. Generally, the more age groups combined in the plus group, the lower the corresponding fishing mortality estimates for all age classes as well as their means. Conversely, the more age groups in the plus group, the larger the estimate of cohort size. There was some variation of fishing mortality estimates depending on specific ADAPT model options selected within each of the plus groups, such as specific method of calculation of full F in the terminal year or F for last true age (Figure 7), but those differences were less significant than the differences in F among plus groups. Although estimates of F and N were similar between runs with flat-top and the dome-shaped PR vectors, the SBSASC chose the flat-top over the dome-shaped runs based, not only on the lowest residual sum of squares, but because ADAPT does not computationally handle a dome-shaped PR well, and the dome-shaped pattern was essentially eliminated as the plus-group age decreased from 15+ to 12+.

Selection of Plus-Group Configuration

Because of the complicated nature of the VPA model, it has been extremely difficult for the subcommittee to determine which configuration is best since the actual ageing errors and bias for ages older than 12 years are unknown. The accuracy of ADAPT estimates of fishing mortality and abundance resulting from ageing errors was investigated by examining changes in F and abundance estimates after applying ageing errors to simulated, unbiased population, catch, and survey data, and configuring the ADAPT runs with different plus-groups. Based on the magnitude and trends in relative errors, the 13+ configuration produced the most accurate estimates under the presence of ageing error/bias in the catch-at-age and survey indices. Relative errors in total abundance, abundance at age for ages 1-10 during the 1982-1990 and 1991-2000 periods, and average F for ages 3-8 and 8-10 were the lowest and most consistent among the plus-group configurations (Figure 8). Based on this analysis the committee selected a 13 plus group formulation as the least likely to produce bias in estimates of F and N, given current knowledge on ageing error.

Final ADAPT Formulation

Based on the 13+ model run with the lowest residual sum of squares (best fit), the selected model formulation included the following: full F in terminal year calculated using classic method, F at oldest true age for all years, including terminal year is calculated using Heincke's method. Ages 9 through 11 were used to calculate F for oldest true age. Plus group abundance was calculated using backward method and with a flat topped partial recruitment.

ADAPT Assessment Results

Fishing Mortality

The 2002 average fishing mortality rate (F) for ages 8-11 equaled 0.35 which is above the Amendment 5 and 6 targets of 0.31 and 0.30, respectively, but below the overfishing threshold of 0.38 under Amendment 5 or 0.41 under Amendment 6. (Table 13, Figure 9). Average fishing mortality for ages 4 through 11, which has been reported as average F in previous assessments, was 0.29 (Table 13,

Figure 10). The current assessment uses ages 8 through 11 because they more accurately reflect the ages fully recruited to the fishery. Fishing mortality on ages 3-8, which are generally targeted in producer areas, was 0.21 (Table 13, Figure 11). Among the individual age groups the highest value of 0.41 was estimated for 9 year old fish (1993 year class (Table 14)). An 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 VPA F weighted by N for ages 7-11 (age 7 to compare with tagged fish > 28") was 0.33. The choice of the 13+ run also resulted in higher estimates of F in the early years of the time series. Estimate of age 8-11 F in 1982 equalled 0.55.

A bootstrap procedure was used to estimate variation in fully-recruited fishing mortality (ages 8-11). Bootstrap estimates of F seem to have a very skewed distribution with most values concentrated in the range of 0.1 to 1.0, and a small number of relatively large values ranging from 1 to 3.2. Based on this distribution, full F in 2002 was between 0.20 and 1.58 with an 80% probability (Figure 12). The bootstrap results should be viewed cautiously, since high values of F on the range of 0.6- 3.2 do not seem to be realistic. These high estimates are likely to be the results of large bias in estimates of F for ages 8 and 9 (percent bias in bootstrap results was 190% and 116% correspondingly). In addition, the process of iterative re-weighting applied to the bootstrap run created situations where the indices are inappropriately weighted, resulting in bias results. Analysis of bootstrap results for the entire time series indicated that variance in F estimates gets much smaller back in time and the distribution of the estimates seems to be distributed normally around the mean for all years except for the terminal year. The SBSASC decided that although the boostrap results may properly characterize uncertainty in F values in the terminal year, the F estimates calculated by ADAPT would be the most appropriate ones to characterize fishing mortality in 2002 as single point estimates.

Partial Recruitment

In previous years, age at full F varied between ages 7 and 10 (Table 15). Full recruitment estimated as the back-calculated partial recruitment fell in the same range in 2002 with PR = 1 at age 9 (1993 year class)(Table 15). It appears that a strong year class such as 1993 tends to have a higher selectivity by the fishery than the other less abundant year classes.

Population Abundance (January 1)

Striped bass abundance has been increasing steadily since 1982 and reached a level around 45 million fish by 1996 (Table 16, Figure 13) and remained at this general level with some inter-annual variation until 2002. Population abundance peaked in 2002 to 52 million fish but declined to about 44 million fish in 2003 due to a poor 2002 year class. Recruitment of the 2002 year class was estimated to be 3.6 million fish compared to the average of 7.3 million for 1982-2002 (Figure 15). At the same time the 2001 year class was estimated at 16.9 million fish (age 2), which exceeds the size of the strong 1993 year class. However, this estimate has large confidence intervals and will be likely be modified in future assessments. The 1993 year class remains the most abundant among the exploited cohorts for the time series. Bootstrap estimates of population abundance are shown in Figure 14.

Spawning Stock Biomass

All VPA runs indicated that female spawning stock biomass (SSB) has been growing steadily since 1982 and stabilized at about 20 thousand metric tons by 1999-2001 (Table 17, Figure 16). Female SSB remained at a very high level, estimated at 22.3 thousand mt in 2002, assuming 1:1 male-female ratio.

Retrospective Patterns

A retrospective analysis was conducted on the VPA results with successive terminal years extending back to 1997, in order to determine trends in estimation of F or total abundance in the terminal year. The analysis revealed that there was slight retrospective bias in average fishing mortality estimates for ages 8-11 (Figure 17). There was a tendency of F underestimation, but the bias was very small. Conversely, there was slight overestimation of total population abundance.

Comparison to the 2001 and 2002 Assessments

In the following comparisons, current results are compared to the results from the 2001 and 2002 assessments. As reminder, the plus-group configurations used in those reports were 15+ in 2001, and 12+ and 13+ from the 2002 assessment. Current average F estimates for ages 3-8 are slightly higher in the early years of the time series than the estimates of F reported in the 2001 and 2002 for the 15+ and 13+ configurations, respectively; however, correspondence increases as the terminal year is approached (Figure 18). Compared to the 2002 results for the 12+ configurations, current average F estimate for 3-8 are higher (Figure 18). Average Fs for ages 8-11 estimated during the early time series in 2003 are slightly lower than those reported in 2002 for the 13+ configuration, but are higher than those reported in 2001 (Figure 18). Current estimates of F for ages 8-11 near the terminal year are more similar to the Fs reported in 2001, but they remain higher than the 2002 estimates for the 13+ configuration until 1999 Current average F for ages 8-11 are much higher than the reported F for the 12+ configuration in 2002 (Figure 18); however, the F for the 12+ configuration is calculated based on ages 7-10 (age 7 is not fully-recruited) and are not directly comparable. (Figure 18). Current estimates of total abundance (1+) near the terminal year are slightly lower than those produced using the 15+ configuration in 2001 or using the 13+ configuration in 2002, although the 2001 and 2002 estimates of abundance are nearly identical (Figure 19). Abundance estimates produced in 2002 using the 12+ configuration are much higher than those produced in the current assessment (Figure 19). Current spawning stock biomass estimates are similar to those reported in 2001 and 2002, although the estimates using the 12+ configuration are higher (Figure 19).

Summary

Striped bass population remains at high level of abundance. Average fishing mortality for fully recruited ages (8+) in 2002 was 0.35 which is above the Amendment 5 and 6 targets of 0.31 and 0.30, respectively, but below the overfishing threshold of 0.38 under Amendment 5 or 0.41 under Amendment 6. Average fishing mortality for ages 4-11 was 0.29 and for ages 3-8 F=0.21. Spawning stock biomass remains at record high levels for 1982-2002 time series. The stock can be considered fully exploited.

III. TAGGING PROGRAM ANALYSIS

Introduction

This report summarizes results from analyses of tagging data from the U.S.F.W.S. Cooperative Striped Bass Tagging Program. The results include estimates of instantaneous fishing mortality (F) and survival (S) rates. Estimates of F and S are provided with and without correction for live release bias. Also, included are QAICc estimates used for model selection and model averaging, length structure of tag releases, age structure of recaptures, geographic distributions of recaptures by month, and estimates of catch and exploitation rates by program.

Description of Tagging Programs

Nine tagging programs provided information for this report, and have been in progress for at least 10 years. Most producer area and coastal programs tag striped bass (mostly >= 18 inches total length) during routine state monitoring programs. Producer area tagging programs operate mainly during spring spawning, and use many capture gears, such as pound nets, gill nets, seines and electroshocking. Producer area programs are as follows: 1. Delaware and Pennsylvania (DE-PA) with fish tagged primarily in April and May, 2. Hudson River (HUDSON) with fish tagged in May, 3. Maryland (MDDNR) with fish tagged primarily in April and May, and 4. Virginia spawning stock program (VARAP) with fish tagged in the Rappahannock River during April and May. Coastal programs tag striped bass from mixed stocks during fall, winter, or early spring and use several gears including hook & line, seine, gill net, and otter trawl. The coastal tagging programs are as follows: 1. Massachusetts (MADFW) with fish tagged during fall months, 2. North Carolina winter trawl survey (NCCOOP) with fish tagged primarily in January, 3. New Jersey Delaware Bay (NJDEL) with fish tagged in March and April, and 4. New York ocean haul survey (NYOHS) with fish tagged during fall months. Striped bass (including those < 18 inches) are tagged during the Western Long Island Survey (NYDEC-WLI) from May through October in bays along the western end of Long Island, New York.

Tag release and recapture data are exchanged between the U.S. Fish and Wildlife Service (USFWS) office in Annapolis, MD, and the cooperating tagging agencies. The USFWS maintains the tag release/recovery database and provides rewards to fishermen who report the recapture of tagged fish. Through July of 2003, a total of 403,747 striped bass have been tagged and released, with 73,663 recaptures reported and recorded in the USFWS database (Tina McCrobie, personal comm.).

Data Analysis

The Striped Bass Tagging Committee’s analysis protocol is based on assumptions described in Brownie et al. (1985). The tag recovery data is analyzed in program MARK (White, 1999). Important assumptions of the tagging programs (as reported in Brownie 1985) are as follows:

1. The sample is representative of the target population.
2. There is no tag loss.
3. Survival rates are not affected by the tagging itself.
4. The year of tag recoveries is correctly tabulated.

Other assumptions related to the modeling component of the analyses include:

5. The fate of each tagged fish is independent of the fate of other tagged fish.
6. The fate of a given tagged fish is a multinomial random variable.
7. All tagged individuals of an identifiable class (age, sex) in the sample have the same annual survival and recovery rates.

The analysis protocol follows an information-theoretic approach based on Kullback-Leibler information theory and Akaike’s information criterion (Burnham and Anderson 2003), and involves the following steps. First, a set of biologically-reasonable candidate models are identified prior to analysis (Box 1; see section on *Justification of candidate models*). Various patterns of survival and recovery are used to parameterize the candidate models. These models allow parameters to be constant, time specific, or allow time to be modeled as a continuous variable. Other models allow time periods to coincide with changes in regulatory regimes.

Box 1. Candidate models used in the analyses of striped bass tag recoveries.

S(.) r(.)	Constant survival and reporting
S(t) r(t)	Time specific survival and reporting
S(.) r(t)	Constant survival and time specific reporting
S(p) r(t)	*Regulatory period based survival and time specific reporting
S(p) r(p)	*Regulatory period based survival and reporting
S(.) r(p)	*Constant survival and regulatory period based reporting
S(t) r(p)	*Time specific survival and regulatory period reporting
S(d) r(p)	**Regulatory period based survival with unique terminal year and regulatory period based reporting
S(v) r(p)	***Regulatory period based survival with 2 terminal years unique and regulatory period based reporting
S(Tp) r(Tp)	*Linear trend within regulatory period for both survival and reporting
S(Tp) r(p)	*Linear trend within regulatory period survival and regulatory period based reporting (no trend)
S(Tp) r(t)	*Linear trend within regulatory period survival and time specific reporting (no trend)
S(Va) r(Va)	Three period model for VA program (1990-1992, 1993-1994, 1995-2002)

* Periods (p): 1={1987-1989}, 2={1990-1994}, 3={1995-2002}

** Periods (d): 1={1987-1989}, 2={1990-1994}, 3={1995-2001}, 4={2002}

***Periods (v): 1={1987-1989}, 2={1990-1994}, 3={1995-2000}, 4={2001-2002}

Justification of candidate models

Candidate models (selected before analysis) are based on biologically-reasonable hypotheses. The global model {S(t)r(t), i.e., full parameterized model} is a time saturated model, and is used to estimate over-dispersion and model fit statistics (see section on *Diagnostic procedures*). Models that parameterize survival as constant within time periods {S(p)r(p), S(p)r(t), S(d)r(p), and S(v)r(p)}are based on regulatory changes within the time series (1987 - 2002). Three regulatory periods are defined as follows: moratorium years (1987-1989), an interim fishery (1990-1994), and a full fishery (1995 - 2002). Given the importance of recent years (2001 and 2002) within the 8-year full fishery period, we model the terminal year separately {S(d)r(p)}and the most recent two years separately {S(v)r(p)}. The Virginia tagging program models an additional period-specific model (1990-1992, 1993-1994, 1995-2002). Although changes within the striped bass fishery are addressed with time and period-specific models, we believe that constant models are also reasonable. Selection of a constant model {S(.)r(.), S(.)r(p), S(.)r(t)} does not mean *"no"* variation in survival across the time series, but suggests that year-to-year variation in annual survival is "...relatively small in relation to the information contained in the sample data" (Burnham and Anderson 2003).

Models parameterized with covariates are also included within the candidate set. Selection of models with time as a covariate {S(Tp)r(Tp), S(Tp)r(t), S(Tp)r(p)} support increasing or decreasing monotonic trends in survival. These models are reasonable given increases in fishing effort during the time series. There is a concern that trend models may over or underestimate the terminal year estimate of survival, and analyses of simulated data are needed to address this issue.

Diagnostic procedures

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. If overdispersion is detected, then an estimate of the variance inflation factor (i.e., c-hat) is used to adjust AICc (after adjustment, AICc is called QAICc; Anderson et al 1994). We estimate c-hat by dividing the observed Pearson Chi-square value (goodness-of-fit statistic of the global model) by the expected Pearson Chi-square value (derived from a bootstrap analysis of the global model). The goodness-of-fit probability of the global model is examined with a bootstrap-derived p-value based on model deviance (Burnham and Anderson 2003). A low p-value (< 0.15) and a large estimate of c-hat (> 4), in part, imply inadequate model structure (Burnham and Anderson 2003). A low bootstrap-derived p-value (< 0.15) combined with a moderate estimate of c-hat (>1 and < 4) supports over-dispersion (and not inadequate model structure). Over-dispersion is corrected with c-hat adjustment (as described above).

Estimates of survival

The tagging committee calculates maximum likelihood estimates of the multinomial parameters of survival and recovery based on an observed matrix of recaptures (using Program MARK). Candidate models are fit to the tag recovery data and arranged in order of fit by the second-order adjustment to Akaike's information criterion (AICc) (Akaike, 1973; Burnham and Anderson, 1992). Annual survival rates are estimated for two size groups (fish >= 18 inches TL and fish >= 28 inches TL). Annual survival is calculated as a weighted average across all models, where weight is a function of model fit (Buckland et al. 1997). Model averaging eliminates the need to select the single "best" model, allowing the uncertainty of model selection to be incorporated into the variance of parameter estimates (Burnham and Anderson 2003). Survival is inestimable for the terminal year in the fully time saturated {S(t)r(t)} model, so the time saturated model is excluded from the model averaged survival estimate for the terminal year only. A weighted average of unconditional variances (conditional on the set of models) are estimated for the model-averaged estimates of survival (Buckland et al. 1997).

Bias-adjusted estimates of survival

Because we model dead recoveries, survival estimates are adjusted by annual estimates of live-release bias (Smith et al. 2000),

$$bias = -\left[\frac{\theta \cdot P_L \cdot \frac{f}{\lambda}}{(1-(1-\theta \cdot P_L)\frac{f}{\lambda}} \right],$$

where θ = 0.92 (based on an 8% hook-and-release mortality rate, Diodati and Richards 1996), P_L = annual proportion of tagged striped bass released alive, f = annual recovery rate estimated with a Brownie recovery model (Brownie et al. 1985), and λ = reporting rate. Annual and geographic-based reporting rates are desirable, but unavailable; consequently we use a constant reporting rate of 0.43 based on a high-reward tag study of the recreational fishery in Delaware Bay (Kahn and Shirey 2000). Gear-specific tagging mortality is not included in bias adjustment because estimates are unavailable for most gears types, such as trawls, pound nets, gill nets, and electrofishing. Estimates of tag-induced mortality are low (0%, Goshorn et al. 1998; 1.3% Rugolo and Lange 1993) and excluded from bias adjustments. Additionally, we do not correct for tag loss given low estimates of 0% (Goshorn et al. 1998), 2% (Dunning et al. 1987), and 2.6% (Sprankle et al. 1996).

Estimation of Fishing Mortality

For each tagging program, instantaneous fishing mortality (F) is estimated by converting the adjusted survival (S) to total mortality (Z) and subtracting a constant value (M = 0.15) for natural mortality, where F= - LN(S) - 0.15. Using this technique, natural mortality is held fixed, and any change in total mortality (Z) results in an equal change in fishing mortality (F). Uncertainty in estimates of F (95% confidence intervals) are calculated from model-averaged unconditional variances of the adjusted survival estimates. We estimate an average F for coastal programs, and a weighted-average of F for producer area programs. Weights for producer area averages (based on the estimated proportion of fish contributed to the coast-wide stock, G. Shepherd, pers. comm. and D. Kahn, pers. comm.) are as follows: Hudson (0.13); Delaware (0.09); and Chesapeake Bay (0.78), with MD (0.67) and VA (0.33).

Estimation of Encounter and Exploitation Rates

In addition to estimates of S and F, we estimated annual catch rates and annual exploitation rates for three length groups (>= 18 inch, 18-28 inch, and >= 28 inch) with tag recoveries of striped bass released by seven agencies (1987 - 2002) of the Cooperative Striped Bass Tagging Program. Each time series of annual catch rates and annual exploitation rates reflects trends in fishing effort and exploitation, respectively, but do not include any assumptions about natural mortality or depend on estimates of survival. Estimates of annual catch rates and annual exploitation rates are independent among years. Fish at large for more than one year are not used in the analysis, and each tagged fish is assigned a 365-day recovery period. Consequently, recovery periods for this approach differ from those used for survival analysis, and may influence comparisons between the two methods. Annual catch rates and annual exploitation rates are adjusted R/M ratios as described below (reporting rate = 0.43, hooking mortality rate = 0.08, R_k = killed recaptures, R_L = recaptures released alive):

(1) Annual catch rate = (R / 0.43) / M

(2) Annual exploitation rate = ((R_k + R_L * 0.08) / 0.43) / M

Tagging Assessment Results

Estimates of F (fish tagged and released at >= 28 inches)

The 2002 estimates for producer area programs Hudson River, Delaware River, and Chesapeake Bay (HUDSON, DE/PA, MDDNR, VARAP) were 0.07, 0.33, 0.31, and 0.28, respectively, with a weighted mean fishing mortality (F) of 0.27 (Tables 18 and 19; Figure 20). The 2002 estimates of F for the four mixed-stock coastal programs (Massachusetts, New York Ocean Haul, New Jersey, and North Carolina winter trawl) were 0.05, 0.35, 0.09, and 0.27, respectively, with an unweighted-mean F of 0.19 (Table 18; Figure 20).

Estimates of F (fish tagged and released at >= 18 inches)

The 2002 estimates for producer area programs of Hudson River, Delaware River, and Maryland Chesapeake Bay were 0.06, 0.37, 0.68, respectively (Table 20 and 21; Figure 21). Results for the Virginia Rappahannock River program are unreported, given unrealistic year-to-year variation within the time series of F estimates. Additionally, large year-to-year difference occurred in the time series of estimates from mixed-stock coastal programs, and these estimates are not reported. Modeling issues with the >= 18 group are addressed in the Discussion section.

Estimates of Z for juvenile striped bass (Western Long Island Survey)

The Western Long Island Survey of New York obtains tag-based information for juvenile striped bass. These data provide estimates of Z for three age categories (ages 1, 2, and 3+). Estimates of Z support a decrease in mortality from age 1 to age 3+, where estimates range from 1.28, 0.78, and 0.24, respectively (Table 22). Corresponding bias-adjusted survival estimates for ages 1, 2, and 3+ are 0.28, 0.46, and 0.78, respectively (Table 22).

Live release bias adjustment

Bias-adjusted estimates of survival are used to estimate F, and incorporate estimates of the proportion of fish released alive, a constant hooking mortality rate (0.08), and a constant reporting rate (0.43). For most tagging programs, the proportion of live releases and live-release bias have decreased over time (Tables 19 and 21). Averages of the proportion of fish released alive for the >= 18 inch group (estimated separately for coastal and producer areas) exceed estimates for the >= 28 inch group (Table 23).

Model selection and diagnostics

Akaike weights were used to calculate the model averaged survival estimates for each program (Tables 24 and 25). In general, best fitting models for the 2002 assessment inferred regulatory period or trends in survival or reporting. Based on the goodness-of-fit bootstrap method, the time saturated models fit the data well (p>0.20) for all programs reported, except for the >= 28 inch size group (p = 0.03) of the North Carolina winter trawl survey (Tables 19 and 21). The estimate of c-hat, however, was below 3 for the North Carolina program and supports an overdispersion (not inadequate model structure) contribution to lack of fit. Although overdispersion in the North Carolina winter trawl data was adjusted with c-hat, the estimates depicted large year-to-year variation similar to analyses of the >= 18 inch group.

Length frequency, age, and geographic distribution of recaptures

Total length frequencies of fish tagged in 2002 and age distributions of fish recaptured in 2002 were tabulated by program (Tables 26 and 27). Total length frequencies represent the length of fish at the time of tagging. Age distributions are based on a subsample of the total number of tagged fish, because not all fish are aged. Ages (from scales) estimated at the time of tagging are adjusted to the recovery date. For each tagging program, geographic distributions of all recaptures during 2002 (from fish tagged and released during the full time series) were depicted by state and month (Table 28).

Catch and exploitation rates

Overall increases in annual catch rates and annual exploitation rates from 1987 - 1997 or 1987 - 1998 suggest an increase in fishing pressure over that part of the time series (Tables 29–34). This increase during the first part of the time series is consistent with regulatory changes to the fishery, but recent estimates (i.e., the previous three years) of annual catch rates and annual exploitation rates do not support large increases for most tagging programs.

Tagging Assessment Discussion

Fishing mortality and exploitation (>= 28 inch group)

For fishes >= 28 inches, estimates of F for the four producer area programs (HUDSON, DE-PA, MDDNR, and VARAP) have increased across the first part of the time series, but have remained relatively constant across the last three years. The weighted average of producer areas receives highest weight from the MDDNR estimates, and a trend model for MDDNR supported a slight increase in F. Weighted averages of the four producer area programs, however, have remained constant among recent years (F = 0.27). Consequently, analyses of tagging data for fish >= 28 inches do not support a recent increase in fishing mortality. Likewise, catch rates and exploitation rates of >=28 inch fish from producer areas do not support an increase in harvest or exploitation, where rates were typically highest during 1996–1999. Unlike producer areas, estimates of F for the >= 28 inch group vary among coastal programs. Estimates from MA and NJ have been consistently low throughout the time series. A trend model received highest weight for NYOHS and supports an increase in F across the last 8 years of the time series. The year-specific model was the best approximating model to the NCCOOP data, and caused unrealistic year-to-year variation in F estimates (see discussion below for the >= 18 inch group). Retrospectively, the trend model (for NYOHS) and the year-specific model (for NCCOOP) caused estimates for the time series this year to be inconsistent with those of last year's assessment. The year-specific model (for NCCOOP) also causes high standard errors, and this is reflected in the wide 95% CIs of unweighted averages. Preliminary analyses with truncated matrices (for NYOHS) and covariate-based models (for NCCOOP) reduced problems, but require further analyses.

Fishing mortality and exploitation (>= 18 inch group)

For the >= 18 inch group, fishing mortality estimates have increased, and typically exceed estimates of F for the >= 28 inch group. A trend model received highest weight for fish tagged at >=18 for MDDNR and for DE-PA data. Although the MARK model estimates for MDDNR suggest a large increase in F over time, the trend could not be substantiated by other information (i.e., direct enumeration, etc.) and, therefore, may be unrealistic. Technical committee members believe that the increasing trend in F may be the result of an increase in natural mortality in Chesapeake Bay, changes in emigration from the Bay, or simply a by-product of model misspecification. The 2002 estimates from the >= 18 group were questionable for three of the mixed-stock coastal programs (NCCOOP, NJDEL, NYOHS) and for one producer area program (VARAP). Specifically, large unrealistic year-to-year differences in survival estimates for these programs resulted from inference from the year-specific model {S(t)r(t)}. In previous assessments, results for the >= 18 inch group of mixed-stock coastal programs were excluded due to issues addressed above, and were excluded from the 2002 assessment. Further analyses are needed to resolve these modeling and data issues associated with analysis of the >= 18 inch groups.

Tag analyses of younger year classes

Striped bass (< 18 inches) are tagged during the Western Long Island Survey (NYDEC-WLI) from May through October in bays along the western end of Long Island, New York. These data support higher mortality for younger year classes. These results are not unexpected, but have implications for the use of a constant natural mortality rate of 0.15. In analyses of older fish, we use a constant natural mortality of 0.15 in the conversion of survival estimates to F estimates. Additional research is needed to address methods of estimating natural mortality to avoid biases associated with constant values.

Exploitation rates

For many tagging programs, upward trends in exploitation rates for the first half of the time series are consistent with trends in F from survival rate analysis. For the latter part of the time series, however, downward or no trends in catch rates and exploitation rates for many programs are supported by year-independent tagging data, but are inconsistent with many trends from survival rate analysis. Exploitation estimates are based on fish recaptured within one year after release, and are independent among years. Fishing mortality estimates (from survival rate analysis) include recoveries after one year post-release, so the number of fishes captured within the 2nd and 3rd year post-release influence discrepancies between the two methods. Additional analyses, including exploring the sensitivities of the results to varying hooking mortality and reporting rates, are needed to address differences between the two methods.

Length frequency, age, and geographic distribution of recaptures

Total length frequencies were plotted for fish tagged and released by program for 2002 (Table 26), as well as age frequencies of 2002 recaptures (Table 27). The length frequency data show the relative differences within and between fish tagged on the coast and in producer area programs. The bimodal length frequencies of producer area programs are probably related to differences between sexes or differences between resident fish and coastal migrants. The coast programs exhibit single modes, likely related to differences in program design and gear type. In general, the Massachusetts program (which captures fish with hook and line) tags and releases larger fish than other coastal programs, whereas the North Carolina trawl survey often tags and releases smaller fish than other programs (except WLI). Age distributions of recaptured fish are problematic since few programs assign ages to all tagged fish. Hence, fish not aged at release cannot be assigned an age at recapture. Geographic distributions of recaptures by state and month during 2002 depict northward spring movements followed by southward returns during fall (Table 28). These geographic patterns are consistent across programs and reflect migration and fishing effort.

Sources of uncertainty

There are several sources of uncertainty associated with the estimation of survival and recovery parameters in the tagging analysis for striped bass. The primary source involves the violation of assumptions basic to all tag recovery modeling, as mentioned earlier in this text. Others involve post-hoc methods (Smith et al., 2000) employed to correct for live release bias, as well as the use of a contemporary reporting rate to adjust retrospective recaptures. The application of a constant value for natural mortality across all groups and time does not allow for potential changes in natural mortality, and dictates that changes in survival result only in changes in fishing mortality. In addition, trend models may over- or underestimate F from recent years, and need further evaluation. Also, time saturated models for tag programs of NCCOOP, NJDEP, and NYOHS produce erratic estimates across the time series (particularly for the >= 18 inch group) and need further evaluation.

Resolution of many of these issues requires further evaluation, and may require a change in the analysis protocol or the suite of candidate models used by the tagging committee. Additional research is needed to investigate differences in release mortality associated with different capture gears. Also, alternative methods to directly determine instantaneous fishing mortality (F) should be explored. Some solutions may take longer, as the state of the theoretical science is generally in advance of any practical application. Our modeling and analysis approach is consistent with the current literature on mark-recapture techniques. Despite concerns listed or discussed above, we believe that methods and results for the >= 28 inch group are robust and reliable, but a tagging meeting to address issues (listed below) before the next assessment would be timely and beneficial.

IV. Status of Individual Stocks

A coast-wide stock of striped bass is comprised of several populations, primarily Hudson River, Delaware Bay and Chesapeake Bay. It is equally important to maintain individual stock at healthy level so that over-fishing does not occur at the local level. For that purpose we report estimates of fishing mortality and population characteristics for each individual stock.

Chesapeake Bay

Fishing mortality

Tag-based estimates of fishing mortality in 2002 for the Chesapeake Bay stock were available from the Maryland spring tagging program, Virginia pound net spring tagging in Rappahannock River and the direct enumeration study conducted through the calendar year of June 2002-June 2003. For fish $\geq$28 inches, the spring data based estimates were 0.31 for Maryland and 0. 28 for Virginia. These values were comparable but lower than the N-weighted VPA F estimate of 0.34 on ages 8-11. Spring tag based estimates for striped bass 18 inches and larger indicate much higher fishing mortality (F=0.68) and overall increasing trend in F in recent years, assuming constant natural mortality of M=0.15. However, recent analysis by V. Crecco (2003) suggests that overall increase in total mortality may be attributed to an increase in natural rather than fishing mortality.

A direct enumeration study to estimate the bay-wide fishing mortality based on the tag release and recovery data is conducted by Maryland and Virginia since 1993. The multiple release design and analysis used in this study was reported in Hebert et. al. 1997; Goshorn et al. 1998; Goshorn et al. 1999; Goshorn et al. 2000; Hornick et al. 2000; Hornick et al. 2001, Hornick et al. 2002. Striped bass were tagged and released throughout the Chesapeake Bay prior to and during the recreational fishing seasons for each respective jurisdiction during six release rounds in Maryland, and three in Virginia. Jurisdictional regions within the Chesapeake Bay were open for recreational striped bass fisheries for a combined total of approximately 31 weeks (6/1/01 - 12/31/01) during the 2002 fall season. All tagging was done cooperatively with commercial watermen. Tag recoveries were handled and recorded by each management jurisdiction and by the U. S. Fish and Wildlife Service (USFWS). USFWS internal anchor tags were applied to 8,699 striped bass. A logistic model was applied to tag recovery and release data. The proportion of the number of recovered tags to the number of tags released was the response variable and the explanatory variables consisted of one categorical variable (interval number, which accounted for unequal interval lengths) and two binary variables, disposition and angler type. Estimates of exploitation for the recreational/charter season were converted to instantaneous rates for each round and summed across intervals to determine F for the recreational/charter fishery (F_R). This estimate was then adjusted to include the Chesapeake Bay resident portion of the commercial and recreational fisheries that occurred during summer 2001, winter 2001-2002 and during spring of 2002, respectively. The expanded estimates of total F were calculated based on weighting of recreational/charter estimates of F_R by proportional additions of spring recreational or commercial harvest in numbers. The estimate of the Chesapeake Bay-wide F (F_{Bay}) for 2002 is F_{Bay}= 0.22. Non-harvest mortality (0.10) was added to the point estimate of F = 0.12 to obtain the final estimate of bay-wide fishing mortality of F_{Bay} = 0.22 for 2002.

Spawning stock

Spawning stock relative abundance (ages 8+) measured through the Maryland spawning stock survey has been increasing since 1999. The 2002 index for eight year and older spawners was 77.2, well above the 19 year average of 52.5. The 2003 value for 8+ fish was equal to the historically highest value of 116, observed in 1996.

Recruitment

Both Maryland and Virginia index of YOY striped bass abundance (geometric mean) in 2002 was well below the 1957-2001 average (Figure 5). Preliminary data indicated that the 2003 was an excellent recruitment year (MD JI=10.83;VA=22.85), similar to the very strong 2001 year class (MD JI=12.57;VA=14.17).

Hudson River

Fishing mortality

Data from 2001 and 2002 have resulted in questionable conclusions. Tag-based S values have been increasing since 1997, with F's decreasing steadily over the same time series. Current F values estimated from tagging have been less than 0.1. The lower confidence intervals of these values are less than zero which makes all recent values of F suspect. NY staff is currently examining the tag analysis methods to evaluate these results.

Spawning stock

Spawning stock relative abundance (gillnet CPUE; ages 8+) increased slightly in 2001 to 633.2; however, the index is still below the 1985-2000 average of 746.9. The Hudson spawning stock survey was not conducted in 2002 so no spawning stock abundance data is available for 2002.

Recruitment

The Hudson River index of YOY striped bass abundance (geometric mean) decreased to 12.3 in 2002. The 2002 value is slightly below the 1982-2001 average of 14.6, indicating that the 2002 year class was not large.

Delaware River

Fishing mortality

Tag-recapture data is employed in two analyses, a Petersen exploitation estimate and an estimate of F based on survival modeling with MARK program software. The two sets of estimates have been the highest on the coast for the last several years. Both estimates, when translated into F, are F weighted by N. The exploitation estimate for 2002 was 24%, which translates into $F_{2001} = 0.29$. The 2002 F estimate from the MARK program with trend models included was $F_{2002} = 0.37$. If trend models are eliminated, the MARK estimate as $F_{2002} = 0.26$.

Spawning stock

The spawning stock survey occurs in April and May on the spawning grounds in the tidal freshwater Delaware River from Wilmington through Philadelphia. Two agencies co-operate in this survey, which tags fish and develops Catch Per Unit Effort estimates of abundance in standardized surveys. The Delaware Division of Fish and Wildlife (DDFW) employs electrofishing gear in a formal systematic sampling design (this type of design is randomized), while the Pennsylvania Fish and Boat Commission (PFBC) also employs electrofishing gear, but in a fixed design. Trends in overall abundance are flat from 1995-2001 for the PFBC and indicate a slow decline in the DDFW estimates for the period 1996-2002. However, the 2003 samples had an increase in mean catch per station. Catch rate of females in particular was markedly increased over recent years. Females of age 10 (1993 year class) were the most abundant. Males ranged to over 1000 mm, with ages to 16 years. Overall abundance of males appeared lower than females. Recent years have seen larger catches of larger males with a decline in catches of smaller males.

Recruitment

A YOY survey is conducted annually by the New Jersey Division of Fish, Game and Wildlife employing a beach seine. The geometric mean index was extremely low at the beginning of the time series in 1980, then gradually climbed to a value of 1.03 in 1989. Since then, it has fluctuated without trend between about 1.00 and 2.00. The 2002 index was low, at 0.51, but the 2003 index will apparently be a record high value. The Delaware River stock suffers high levels of entrainment mortality from the Salem Nuclear Generating Station. This mortality on YOY larvae and juveniles has been estimated as averaging 32% per year, in the worst case of no compensatory increase in survival of those YOY fish escaping entrainment and impingement.

IV. Discussion

<u>VPA Analysis</u>

The results of the VPA analysis indicate that the overall fishing mortality (0.35) for fully-recruited ages 8-11 in 2002 exceeded the F target of 0.30 under Amendment 6, but the population is not overfished since F is below the threshold of 0.41. Recruitment of age 1 bass was at record levels in 2001 and 2002, but may be low in 2003. The spawning stock biomass estimates are at the highest level in the time series, but appear to be leveling-off. Removals by the recreational fishery (harvest and dead discards) are high but may be declining.

The sensitivity of the VPA model to changes in the plus grouping was addressed during the SBSASC meeting. The SBSASC selected the 13+ model configuration over the 12+ configuration as representing the “best” estimates of fishing mortality and abundance, but the choice was a compromise between members of the SBSASC. However, the choice was supported later by simulation results that examined the effects of real ageing error on the VPA estimates. The Technical Committee agreed with the selection.

The variablility exhibited in the bootstrap results was of concern to the Technical Committee. The bootstrap methodology is used to measure uncertainty about the estimate of fishing mortality and abundance. The SBSASC examined the various tuning indices and their influences in an attempt to identify potential errors under the process of iterative re-weighting. The SBSASC could not resolve this issue and recommends that further investigations of the precision and validity of tuning indices currently used in the assessment are made in the future.

<u>Tag Analysis</u>

The tagging programs produced MARK model-derived estimates of F for ≥28 inch striped bass that formed two, distinct groups based on similarity of trends. The F estimates from the New York Ocean Haul Seine, North Carolina Coop, Delaware River, Maryland/Chesapeake Bay, and Virginia Rappahannock programs indicated that fishing mortality generally has been increasing over time (average F in 2002=0.31). The tag-based F estimates from the Massachusetts, New Jersey, and Hudson River programs, however, were much lower and showed a declining trend in fishing mortality (average F in 2002 =0.07). The R/M estimates for New York Ocean Haul Seine, Hudson River, Delaware River, Maryland/Chesapeake Bay, and Virginia Rappahannock were generally similar in magnitude to the exploitation rates derived using F estimates from the current ADAPT assessment for years 1990-1999. However since 2000, the R/M estimates have declined, indicating exploitation has decreased.

There are several sources of uncertainty associated with the estimation of survival and recovery parameters in the tagging analysis for striped bass. The primary source involves the violation of assumptions basic to all tag recovery modeling, as mentioned earlier in this text. Others involve post-hoc methods employed to correct for live release bias, as well as the use of a contemporary reporting rate to adjust retrospective recaptures. The application of a constant value for natural mortality across all groups and time does not allow for potential changes in natural mortality, and dictates that changes in survival result only in changes in fishing mortality. In addition, trend models may over- or underestimate F from recent years, and need further evaluation. Also, time saturated models for tag programs of NCCOOP, NJDEP, and NYOHS produce erratic estimates across the time series (particularly for the >= 18 inch group) and need further evaluation.

Resolution of many of these issues requires further evaluation, and may require a change in the analysis protocol or the suite of candidate models used by the tagging committee. Additional research is needed to investigate differences in release mortality associated with different capture gears. Also, alternative methods to directly determine instantaneous fishing mortality (F) should be explored. Some solutions may take longer, as the state of the theoretical science is generally in advance of any practical application. Our modeling and analysis approach is consistent with the current literature on mark-recapture techniques. Despite concerns listed or discussed above, we believe that methods and results for the >= 28 inch group are robust and reliable, but a tagging meeting to address issues (listed below) before the next assessment would be timely and beneficial.

TAG-VPA F Comparison

The annual stock assessment of striped bass has traditionally wrestled with the comparison of tag based estimates of fishing mortality and estimates from catch at age models. Simple comparisons of the tag average against the VPA results can lead to misleading conclusions given the complexities of each model. The simple conclusion is that the tag and catch model results arrive at different estimates of fishing mortality. A more detailed examination of the model results actually shows similarities in the results.

The tag models identify fully recruited fish as greater than 28” and are divided into coastal and producer area programs. These larger fish tagged in the producer areas are considered coastal migratory individuals. The residence time of these fish is limited to the spawning period and they are subjected to a fishery during that period. Therefore it is reasonable to conclude that the annual survival estimates of fish tagged in the estuaries and on the coast should produce comparable results.

For comparison to the VPA, the most recent age-length data suggests age 7 encompasses the majority of 28” bass (from 2003 annual state reports). Therefore the appropriate comparison is between 28” and greater tag estimates and the VPA F weighted by N for ages 7 to 11.

There is also some concern about the variations in length of fish tagged among programs. Figure 22 shows the length frequencies of 2002 releases. MA, NY haul seine and the Hudson program released the smallest fish, followed by NC and DE/PA with MD and VA releasing the largest fish.

Examination of tag based Fs among programs show two general trends (Figure 23 and 24). NYOHS, NCCOOP, DE/PA, MDCB and VA results are comparable with an increasing trend and 2002 estimates averaging 0.31, similar to the 2002 VPA estimate of 0.31. A second group with MA, NJ/DEL and Hudson have values peaking in 1998 at an average of 0.18 then declining to 0.07 in 2002. There is no clear reason for the differences. Overall, there is a great deal of variation among tagging estimates but at least one group of programs is comparable to the VPA results.

The R/M estimates provide an alternative approach to calculating exploitation rates. Two programs with fall releases do not have complete data to calculate 2002 estimates. The R/M estimates produced by 5 (NYOHS, HUDSON, DE/PA, VARAP, MDCB) out of 8 programs were generally similar in magnitude to the exploitation rates derived using F estimates from the current ADAPT assessment for year 1990-1999 (Figure 25). Since 2000, R/M estimates have indicated exploitation has decreased. Among the programs with 2002 estimates, one program (DE/PA) has an estimate comparable to the VPA results (0.24 vs VPA exploitation rate of 0.26)(Figure 25). The remaining programs have an average 2002 estimate of 0.13.

V. Concerns

The uncertainty associated with ageing striped bass with scales still remains a problem. Attendees of the ASMFC striped bass ageing workshop in March, 2003 made many recommendations on how to improve scale impressions, but also agreed that ageing bias is an issue after age 10-12. Recommendations to develop conversion keys using scale-otolith ages, or to use otoliths as a primary ageing structure were made, and a subcommittee was formed to determine the feasibility of using either approach. Their results are due in March 2004.

Some members of the Technical Committee were concerned that the VPA is not adequately robust when dealing with a mixed stock such as coastal striped bass. Other methods that are capable of directly accounting for mixed stock management units should be explored in the future. Some members were also concerned that the tag based estimates of survival among coastal programs were so variable. It is possible that the assumption of mixing and dispersal is not being adequately met to provide a comprehensive estimate of mortality.

Some members of the Technical Committee were concerned that the distribution of larger striped bass has shifted to offshore waters as the population has increased in abundance. Since the EEZ is closed to harvest and there is limited fishery independent survey data for older striped bass beyond state waters, these fish may not be represented in the assessment. Low tag recovery of fish tagged in MA may be an indication of shifting distribution.

The Technical Committee noted the need to investigate the bootstrap results on F and examine the survey indices. The 2002 assessment shows very different results from last year's assessment due, in part, to code changes between the NEFSC FACT and NFT VPA versions. The Technical Committee was concerned about the level of uncertainty and number of outliers in the bootstrap results. The bootstrap on the population estimates is also skewed but not as dramatically as the F estimates. Some members questioned if the uncertainty relates the F estimates and ageing error on ages 8 and 9. The Stock Assessment Subcommittee will investigate the bootstrap results further before next year's assessment. The Technical Committee has begun to conduct additional analyses to reduce the number of indices used in the assessment, and criteria are being developed that would be objectively used for the inclusion/exclusion of current and future indices.

The Technical Committee noted the need to conduct further analyses on the $\geq$18 inches. Trend models may over- or underestimate F from recent years, and need further evaluation. This pertains particularly to the MDNR tagging programs. Technical committee members believe the increasing trend in F may be the result of an increase in natural mortality in Chesapeake Bay, changes in emigration rates, or simply a by-product of model misspecification. More analyses will be required to resolve these issues.

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Table 1. Total Atlantic Coast harvest of striped bass in metric tons and numbers from 1982 to 2002.

Year	Commercial		Recreational		*Total*	
	MT	N	MT	N	MT	N
1982	992	428,630	1,144	217,256	2,136	645,886
1983	639	357,541	1,217	299,444	1,856	656,985
1984	1,104	870,871	579	114,463	1,683	985,334
1985	4,312	174,621	372	133,522	4,684	308,143
1986	68	17,681	501	114,623	569	132,304
1987	63	13,552	388	43,755	451	57,307
1988	117	33,310	570	86,725	687	120,035
1989	91	7,402	332	37,562	423	44,964
1990	313	115,636	1,010	163,242	1,323	278,878
1991	460	153,798	1,653	262,469	2,113	416,267
1992	638	230,714	1,830	300,180	2,468	530,894
1993	777	312,860	2,564	428,719	3,341	741,579
1994	805	307,443	3,084	565,167	3,889	872,610
1995	1,555	534,914	5,675	1,089,183	7,230	1,624,097
1996	2,178	766,518	6,003	1,175,112	8,181	1,941,630
1997	2,679	1,058,181	7,267	1,515,296	9,946	2,573,477
1998	2,936	1,223,828	5,771	1,366,353	8,707	2,590,181
1999	2,941	1,103,812	6,245	1,319,794	9,186	2,423,606
2000	3,003	1,051,275	7,756	1,924,001	10,759	2,975,276
2001	2,826	941,733	8,889	2,012,314	11,715	2,954,047
2002	2,723	654,062	8,409	1,828,367	11,132	2,482,429
abs change	-103	-287,671	-480	-183,947	-583	-471,618
% change	-3.64	-30.55	-5.40	-9.14	-4.98	-15.97

Table 2. Total 2002 striped bass discard and harvest in numbers (A) and % of total by fishery component (B).

A.

Fishery Component	Discard	Discard Losses	Harvest	Total Catch
Recreational	13,715,207	1,118,538	1,828,367	2,946,905
Commercial	1,084,765	168,201	654,062	822,264
Scientific			1,317	1,317
Total	14,799,972	1,286,739	2,483,746	3,770,486

B.

Fishery Component	Discard Losses	Harvest	Total Catch
Recreational	29.67%	48.49%	78.16%
Commercial	4.46%	17.35%	21.81%
Total	34.13%	65.84%	99.97%

Table 3. Atlantic coast striped bass commercial landings in numbers at age, 1982-2002.

Year	Age														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1982	0	45,129	200,221	117,158	22,927	5,035	3,328	2,861	1,871	4,407	5,837	7,639	2,509	2,810	6,898	428,630
1983	0	54,348	120,639	120,999	38,278	7,416	1,954	677	607	1,690	1,314	2,375	2,656	1,856	2,733	357,541
1984	0	478,268	270,140	55,598	30,580	21,688	6,441	1,744	1,020	771	146	279	1,096	1,042	2,058	870,871
1985	0	53,699	45,492	7,545	9,448	19,248	21,569	6,581	3,692	1,514	466	607	493	894	3,373	174,621
1986	0	639	6,020	3,207	180	703	1,425	1,199	546	182	105	220	288	963	2,004	17,681
1987	0	0	3,087	4,265	1,618	252	1,104	1,075	448	233	95	273	302	235	565	13,552
1988	0	0	2,086	3,961	15,491	6,469	2,803	539	541	218	266	108	250	41	537	33,310
1989	0	0	0	0	0	139	1,111	959	1,007	631	475	164	343	444	2,129	7,402
1990	0	650	12,551	48,024	29,596	15,122	3,111	2,357	1,147	519	272	130	428	322	1,407	115,636
1991	0	2,082	22,430	44,723	41,048	21,614	8,546	4,412	4,816	1,163	269	125	80	553	1,937	153,798
1992	0	640	32,277	58,009	46,661	41,581	22,186	11,514	8,746	6,314	1,062	464	169	346	745	230,714
1993	0	1,848	21,073	93,868	87,447	42,112	32,485	13,829	8,396	6,420	3,955	763	184	76	404	312,860
1994	0	1,179	22,873	71,614	101,512	48,269	28,530	14,886	8,902	5,323	2,513	1,250	198	68	326	307,443
1995	0	6,726	35,190	114,519	134,709	98,471	38,918	34,191	37,324	21,827	8,364	3,166	997	363	149	534,914
1996	0	557	50,102	127,825	179,031	161,361	120,693	51,995	29,907	18,864	11,663	9,674	2,264	1,134	1,449	766,518
1997	0	335	96,860	293,511	225,218	201,397	103,129	60,000	33,262	18,888	11,811	7,861	2,753	2,178	978	1,058,181
1998	0	3,122	65,861	209,898	526,183	192,473	70,124	59,604	44,017	25,365	14,592	5,878	3,837	1,387	1,487	1,223,828
1999	0	7,344	93,998	233,720	275,305	235,925	76,755	47,252	54,777	35,387	24,006	9,883	6,832	1,836	795	1,103,812
2000	0	0	50,392	217,214	308,615	183,048	127,913	56,940	38,767	42,264	15,849	5,434	2,614	1,593	633	1,051,275
2001	0	165	86,190	189,602	240,736	138,678	86,825	92,095	33,367	31,165	21,960	12,759	4,962	2,564	665	941,733
2002	209	1,076	42,700	140,166	148,605	110,374	60,436	53,728	36,312	22,496	16,592	9,634	5,335	5,145	1,256	654,062

Table 4. Atlantic Coast striped bass commercial harvest in numbers at age by state in 2002.

State	Age															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	total
Maine																0
New Hampshire																0
Massachusetts							2,506	7,521	6,837	7,749	8,205	5,242	3,646	2,279	912	44,897
Rhode Island	0	0	0	133	1,220	3,768	1,723	769	441	328	882	825	769	483	312	11,653
Connecticut																0
New York			0	947	3,313	12,969	9,656	8,141	9,182	2,177	568	189	0	0		47,142
New Jersey																0
Delaware		17	484	2,281	8,598	12,387	3,883	1,903	887							30,440
Maryland	0	0	38,586	98,682	76,593	44,249	23,147	8,424	3,897	1,086	909	800	262			296,635
PRFC				29,021	33,529	12,115	4,226	845	282	0	282					80,300
Virgina		209	1,059	3,630	9,103	25,351	24,885	15,230	25,130	9,024	5,083	3,410	2,183	563	2,351	127,211
North Carolina							64	995	5,762	6,073	2,336	395	95	32	32	15,784
Total	0	226	40,129	134,693	132,357	110,840	70,091	43,828	52,418	26,437	18,265	10,861	6,955	3,357	3,607	654,062

Table 5. Ratios of tags returned by commercial and recreational fisheries on Chesapeake Bay and coast.

CHESAPEAKE BAY					COAST			
YEAR	Com tags returned	Rec tags returned	com/rec tag RATIO	com/rec landings RATIO	Com tags returned	Rec tags returned	com/reg tag RATIO	com/rec landings RATIO
1999	689	597	1.15	1.67	65	564	0.12	0.17
2000	381	615	0.62	1.09	47	471	0.10	0.11
2001	346	588	0.59	1.13	54	622	0.09	0.10
2002	154	600	0.26	0.84	49	611	0.08	0.10
Average			0.65	1.18			0.10	0.12

Table 6. Atlantic coast striped bass commercial discard losses in numbers at age, 1982-2002*.

	age															
year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**total**
1982	0	31,645	3,644	11,456	5,623	1,291	2,397	1,014	369	92	85	0	0	7	0	57,624
1983	0	24,067	1,453	2,878	7,761	2,311	610	610	262	174	0	0	0	0	0	40,127
1984	0	33,575	1,611	5,812	9,734	11,272	2,815	117	586	66	0	52	0	0	0	65,639
1985	0	7,728	30,472	5,939	10,891	3,395	2,742	1,045	261	131	131	0	0	0	0	62,734
1986	0	5,841	20,758	100,067	27,989	13,315	4,295	1,415	346	0	0	0	0	0	0	174,024
1987	0	4,206	14,382	28,597	51,389	16,940	6,520	1,319	1,011	395	111	86	111	0	0	125,066
1988	0	6,142	22,593	36,616	70,959	71,694	23,232	9,116	3,110	1,653	218	195	24	0	0	245,552
1989	0	13,854	50,240	49,029	83,396	82,757	33,479	15,502	6,342	705	1,409	1,409	663	41	0	338,827
1990	0	14,526	68,713	80,935	111,888	115,702	71,600	36,256	5,948	1,539	1,401	1,503	0	0	0	510,011
1991	79	12,632	37,009	64,210	77,335	56,894	36,912	24,857	6,610	4,071	6,542	16	0	0	0	327,167
1992	117	3,698	34,218	36,746	44,412	34,688	14,798	11,179	3,398	2,356	991	0	0	0	0	186,601
1993	0	7,449	50,160	79,011	95,116	63,487	20,941	15,351	9,270	4,606	1,651	536	260	0	0	347,839
1994	0	31,770	47,169	45,081	88,122	84,570	39,229	12,524	6,223	3,674	712	415	30	0	0	359,518
1995	0	72,822	75,520	53,551	94,158	121,592	61,447	19,083	7,569	4,269	2,290	2,346	807	0	0	515,454
1996	0	27,133	114,085	76,336	61,884	58,787	30,835	14,916	6,148	3,989	159	502	50	0	0	394,824
1997	476	7,108	64,352	61,871	30,602	20,951	14,002	6,592	1,963	4,309	2,658	801	1,060	0	0	216,743
1998	0	13,233	53,899	98,510	83,288	29,197	12,970	12,591	7,860	4,372	3,891	2,419	3,311	124	367	326,031
1999	984	58,076	49,894	43,744	55,740	14,477	5,213	3,704	1,980	1,304	648	612	240	3	0	236,620
2000	196	178,457	189,933	157,291	62,699	33,918	26,938	7,831	4,111	3,876	801	863	41	17	25	666,996
2001	0	2,638	58,079	77,958	88,808	29,410	18,877	11,613	9,664	6,371	4,778	1,957	737	10	0	310,900
2002	1,700	20,888	42,641	21,409	28,791	23,720	12,381	6,854	5,645	2,255	1,522	149	173	33	43	168,201

* The following estimates of discrad mortality by gear were used in calculation od discard losses: 43% for anchor gillnets, 8% for drift gillnets (Seagraves and Miller), 8% for hook and line (Diodati and Richards), 35% for trawl (Crecco, 1990), 15% for seine (NYDEP estimate), 5% for traps (TC consensus).

Table 7. Total Atlantic coast striped bass recreational harvest in numbers at age by state, 2002.

	Age															
State	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	total
Maine	0	0	2,787	21,293	17,841	25,212	3,179	476	550	36	190	139	151	24	30	71,907
New Hampshire	0	0	0	156	1,645	4,920	2,650	1,868	1,075	246	183	69	32	12	0	12,857
Massachusetts	0	0	0	1,074	10,392	65,932	59,855	67,607	42,652	20,817	18,834	9,318	6,925	2,436	3,740	309,582
Rhode Island	0	0	160	5,640	26,790	17,736	14,068	7,814	2,432	1,950	779	346	257	84	0	78,056
Connecticut	0	0	39	1,928	17,323	10,351	4,991	6,036	5,729	635	1,122	1,440	658	544	264	51,060
New York	0	0	0	465	8,904	51,784	54,094	28,497	33,060	4,237	9,077	6,216	2,094	1,892	227	200,547
New Jersey	0	0	1,757	29,045	63,526	111,748	97,267	59,604	39,935	16,523	9,178	3,933	2,256	1,210	566	436,548
Delaware	0	0	2,154	6,198	11,110	1,044	3,709	3,415	1,606	764	1,209	562	276	51	0	32,098
Maryland	0	0	22,463	61,051	68,432	49,678	36,306	21,368	13,384	3,543	2,923	1,732	3,023	60	98	284,060
PRFC(charter)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Virgina	0	1,519	6,279	19,205	40,479	72,667	59,313	26,890	44,846	15,483	11,524	7,247	3,891	1,296	8,551	319,190
North Carolina	0	0	0	518	0	330	1,988	2,658	10,267	6,284	5,020	2,485	1,732	201	980	32,462
Total	0	1,519	35,638	146,572	266,441	411,402	337,420	226,234	195,536	70,518	60,039	33,487	21,296	7,809	14,456	1,828,367

Table 8. Total Atlantic coast striped bass recreational discard losses in numbers at age by state, 2002.

	Age															
State	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	total
Maine	395	15,091	34,903	24,133	7,840	16,531	7,382	2,823	1,767	238	169	67	27	11	0	111,376
New Hampshire		3,664	4,673	3,961	1,929	2,642	911	480	349	98	130	86	68	38	12	19,040
Massachusetts		10,091	29,183	50,494	57,568	139,835	69,590	48,020	28,589	8,454	7,810	3,958	2,512	1,124	304	457,532
Rhode Island	549	19,841	8,502	5,990	3,450	2,962	961	80	97	0	0	0	0	0	0	42,509
Connecticut	6,712	16,716	13,393	6,865	19,060	2,564	2,393	3,127	2,241	763	534	458	686	280	482	76,274
New York	427	9,285	8,409	8,029	4,990	6,440	5,067	2,460	1,671	314	497	334	110	121	40	48,194
New Jersey	838	8,527	9,223	13,510	9,321	8,238	4,675	2,246	1,314	413	206	71	37	6	2	58,626
Delaware		1,699	1,625	2,167	1,361	1,130	631	290	160	59	33	11	6	1	0	9,173
Maryland	11,482	83,798	60,032	30,917	15,496	11,863	10,038	6,713	2,189	620	284	136	345	121	253	234,287
PRFC																0
Virgina	2,771	20,222	14,487	7,461	3,740	2,863	2,422	1,620	528	150	68	33	83	29	61	56,538
North Carolina	105	859	838	698	567	887	473	308	177	50	44	23	18	8	5	5,062
Total	23,280	189,792	185,267	154,225	125,323	195,953	104,543	68,167	39,082	11,159	9,774	5,178	3,893	1,739	1,159	1,118,533

Table 9. Total Atlantic coast striped bass recreational harvest and discard losses in numbers at age by state, 2002.

	Age															
State	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	total
Maine	395	15,091	37,690	45,426	25,681	41,744	10,561	3,298	2,316	273	358	206	179	34	30	183,283
New Hampshire	0	3,664	4,673	4,117	3,574	7,562	3,561	2,348	1,424	345	313	155	100	50	12	31,897
Massachusetts	0	10,091	29,183	51,568	67,960	205,767	129,445	115,627	71,241	29,271	26,644	13,276	9,437	3,560	4,044	767,114
Rhode Island	549	19,841	8,662	11,630	30,240	20,698	15,029	7,894	2,529	1,950	779	346	257	84	0	42,509
Connecticut	6,712	16,716	13,432	8,793	36,383	12,915	7,384	9,163	7,970	1,398	1,656	1,898	1,344	824	746	127,334
New York	427	9,285	8,409	8,494	13,894	58,224	59,161	30,957	34,731	4,551	9,574	6,550	2,204	2,013	267	248,741
New Jersey	838	8,527	10,980	42,554	72,847	119,986	101,942	61,850	41,250	16,935	9,383	4,004	2,294	1,216	568	495,178
Delaware	0	1,699	3,779	8,365	12,471	2,174	4,339	3,705	1,766	823	1,242	573	282	52	0	41,271
Maryland	11,482	83,798	82,494	91,968	83,928	61,540	46,344	28,082	15,573	4,163	3,207	1,868	3,368	181	351	518,348
PRFC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Virgina	2,771	21,741	20,766	26,666	44,219	75,530	61,735	28,510	45,374	15,633	11,592	7,280	3,974	1,325	8,612	375,728
North Carolina	105	859	838	1,215	567	1,216	2,461	2,967	10,443	6,334	5,065	2,508	1,750	209	985	5,062
Total	23,280	191,311	220,905	300,796	391,764	607,355	441,963	294,401	234,617	81,676	69,813	38,665	25,188	9,549	15,616	2,946,905

Table 10. Total Atlantic coast striped bass catch at age, including recreational and commercial harvest and discard losses,1982- 2002.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1982	1,810	105,555	256,699	220,835	58,429	19,180	24,213	16,802	11,692	10,593	11,017	13,668	3,447	4,093	8,131	766,165
1983	3,625	110,327	178,236	193,141	150,019	39,286	18,713	4,125	2,895	3,709	4,581	5,644	4,876	4,059	4,613	727,849
1984	5,563	542,751	302,698	82,425	60,374	51,680	18,280	4,668	2,117	2,078	693	336	2,183	4,241	4,715	1,084,802
1985	1,311	72,529	101,959	40,483	58,703	43,106	43,522	17,283	6,351	3,404	1,043	827	522	917	8,882	400,844
1986	11,332	21,009	63,841	132,875	49,899	31,972	20,367	23,997	9,191	5,260	3,355	1,564	875	2,524	6,717	384,778
1987	1,368	10,915	37,629	51,422	67,260	25,041	13,204	6,490	6,384	2,982	1,448	1,968	3,302	2,086	7,528	239,026
1988	2,566	30,882	41,755	63,222	107,100	97,917	40,598	24,411	13,995	5,773	3,676	3,251	2,426	3,032	4,102	444,706
1989	729	35,994	79,655	68,244	104,896	95,437	45,645	21,026	10,423	3,758	3,234	1,965	1,915	1,608	5,325	479,855
1990	2,123	46,231	124,469	187,830	173,215	165,168	104,079	67,871	20,695	7,256	5,061	3,507	3,949	3,397	6,325	921,176
1991	1,792	72,836	145,252	208,716	161,950	101,438	91,311	82,920	58,757	24,090	14,173	2,755	2,624	3,304	16,402	988,318
1992	2,914	45,769	199,651	189,219	177,132	109,523	62,419	67,781	58,384	44,782	9,301	4,070	1,723	4,925	9,294	986,887
1993	287	69,633	185,306	327,330	288,512	185,379	86,551	67,337	82,587	76,145	41,133	9,327	4,553	1,173	11,731	1,436,983
1994	5,655	145,422	348,825	290,641	367,749	232,389	135,432	86,698	99,882	80,962	36,013	22,302	3,359	1,523	9,743	1,866,595
1995	3,838	426,821	459,079	447,829	391,341	470,669	204,809	190,869	151,640	88,555	52,246	16,455	9,524	1,925	3,459	2,919,060
1996	465	92,673	639,954	634,993	533,768	457,572	436,529	208,439	140,109	67,719	42,043	44,663	13,733	4,387	2,501	3,319,547
1997	2,533	285,466	486,449	850,321	615,973	593,847	405,508	372,316	200,317	120,479	59,642	29,987	12,282	7,774	4,794	4,047,687
1998	26,421	183,404	485,409	706,672	1,125,019	510,938	280,434	265,002	215,493	113,842	95,070	45,172	32,836	14,886	17,771	4,118,368
1999	9,210	116,452	433,400	656,249	651,804	714,112	336,562	226,801	193,497	138,519	97,623	45,054	25,687	13,018	6,991	3,664,980
2000	37,977	323,937	419,860	989,188	1,021,208	780,437	738,105	311,870	160,636	141,488	59,631	29,301	15,191	8,190	7,370	5,044,390
2001	34,742	161,922	431,514	605,354	830,556	696,646	576,745	480,387	205,831	119,546	102,964	49,634	25,783	12,289	9,883	4,343,798
2002	25,189	213,284	306,307	462,780	569,670	741,606	514,862	355,018	276,601	106,444	87,934	48,450	30,696	14,726	16,916	3,770,486

Table 11. Atlantic striped bass weight at age, 1982-2002.

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1982	0.128	0.644	1.093	1.536	2.423	3.749	4.831	5.788	6.204	8.678	10.803	11.2	12.967	13.261	15.913
1983	0.201	0.551	0.939	1.371	2.371	3.287	3.771	5.355	6.012	8.103	9.568	10.394	11.105	11.104	11.123
1984	0.236	0.597	1.687	1.615	2.667	3.391	5.067	5.654	6.759	7.76	8.41	12.653	10.646	11.749	14.752
1985	0.059	0.608	1.065	1.655	2.194	3.593	4.908	5.464	6.769	7.449	8.997	10.685	11.422	14.335	15.977
1986	0.139	0.573	1.273	2.398	2.442	3.118	3.951	5.048	5.443	6.094	7.753	9.155	10.974	11.548	15.832
1987	0.195	0.771	1.414	2.11	2.497	2.911	3.612	4.736	5.517	6.488	7.765	9.777	11.381	11.616	16.46
1988	0.309	0.914	1.101	1.976	3.115	4.017	4.38	4.695	5.238	5.616	8.584	10.395	11.497	11.308	17.004
1989	0.157	0.829	1.224	2.225	3.058	4.525	5.366	6.231	6.035	8.681	8.941	9.741	13.035	9.926	17.114
1990	0.084	0.888	1.137	2.052	2.35	3.832	4.907	5.963	5.701	5.973	7.439	9.079	9.357	10.8	17.648
1991	0.213	0.919	1.291	2.171	2.622	3.172	4.809	5.64	6.46	6.241	9.464	8.298	9.622	15.96	17.086
1992	0.096	0.688	1.305	1.934	2.807	3.667	4.9	5.786	6.96	8.154	9.767	12.437	13.103	11.15	17.646
1993	0.074	0.761	1.308	1.991	2.771	3.581	4.796	6.112	7.031	8.005	9.53	10.759	14.448	13.854	15.361
1994	0.238	1.051	1.689	2.211	2.854	3.502	4.939	6.201	6.795	7.53	9.733	10.691	11.375	9.062	17.752
1995	0.276	0.703	1.347	2.178	2.77	3.65	5.381	6.159	7.266	8.863	7.568	9.731	13.973	15.645	20.366
1996	0.138	1.049	1.47	2.317	3.225	4.52	6.386	7.114	7.814	9.2	9.308	10.095	11.356	12.446	17.3
1997	0.128	0.616	1.175	2.463	2.806	3.635	4.507	5.066	6.729	9.166	9.935	10.242	11.937	14.492	17.924
1998	0.128	0.616	1.175	2.463	2.806	3.635	4.507	5.066	6.729	9.166	9.935	10.242	11.937	14.492	17.924
1999	0.128	0.616	1.175	2.463	2.806	3.635	4.507	5.066	6.729	9.166	9.935	10.242	11.937	14.492	17.924
2000	0.14	1.05	1.47	2.32	3.23	4.52	6.39	7.11	7.81	9.2	9.31	10.1	11.36	12.45	17.3
2001	0.13	0.62	1.17	2.46	2.81	3.63	4.51	5.07	6.73	9.17	9.94	10.24	11.94	14.49	17.92
2002	0.82	0.81	1.25	1.75	2.47	3.3	4.16	5.48	6.36	7.45	8.75	8.89	9.99	11.03	13.95

Table 12. Average fishing mortality for age 8-11 for different PR vectors and plus groups.

PR shape	flat top				dome			
year	15+	14+	13+	12+	15+	14+	13+	12+
1982	0.11	0.35	0.57	0.58	0.13	0.35	0.57	0.58
1983	0.05	0.20	0.35	0.27	0.07	0.20	0.35	0.27
1984	0.03	0.06	0.11	0.16	0.04	0.06	0.11	0.16
1985	0.09	0.13	0.19	0.20	0.10	0.13	0.19	0.20
1986	0.13	0.20	0.25	0.23	0.14	0.20	0.25	0.23
1987	0.09	0.12	0.12	0.08	0.11	0.11	0.12	0.08
1988	0.21	0.23	0.26	0.14	0.22	0.23	0.26	0.14
1989	0.14	0.15	0.15	0.08	0.19	0.15	0.15	0.08
1990	0.25	0.24	0.21	0.11	0.27	0.24	0.21	0.11
1991	0.34	0.32	0.30	0.17	0.37	0.32	0.31	0.17
1992	0.28	0.23	0.18	0.13	0.30	0.23	0.19	0.13
1993	0.42	0.34	0.27	0.18	0.47	0.34	0.27	0.18
1994	0.34	0.30	0.26	0.19	0.34	0.30	0.26	0.19
1995	0.34	0.31	0.29	0.25	0.37	0.31	0.29	0.25
1996	0.32	0.33	0.26	0.19	0.35	0.33	0.26	0.19
1997	0.34	0.34	0.35	0.27	0.37	0.34	0.34	0.27
1998	0.43	0.39	0.36	0.25	0.46	0.39	0.36	0.25
1999	0.41	0.40	0.38	0.26	0.42	0.41	0.37	0.27
2000	0.31	0.32	0.32	0.24	0.33	0.32	0.31	0.24
2001	0.42	0.42	0.40	0.27	0.35	0.43	0.39	0.28
2002	0.41	0.39	0.35	0.23	0.37	0.41	0.35	0.23

Table 13. Average fishing mortality for different age groups based on 13 group run with flat top PR.

	Average F			
Year	ages 8-11	ages 5-11	ages 4- 11	ages 3-8
1982	0.55	0.44	0.43	0.37
1983	0.34	0.35	0.37	0.33
1984	0.11	0.18	0.18	0.25
1985	0.18	0.24	0.22	0.23
1986	0.24	0.22	0.21	0.17
1987	0.11	0.10	0.09	0.07
1988	0.24	0.20	0.18	0.13
1989	0.14	0.12	0.11	0.08
1990	0.19	0.18	0.17	0.13
1991	0.29	0.21	0.20	0.11
1992	0.18	0.14	0.13	0.08
1993	0.27	0.20	0.19	0.10
1994	0.26	0.20	0.19	0.11
1995	0.28	0.23	0.22	0.15
1996	0.25	0.24	0.23	0.19
1997	0.34	0.30	0.28	0.22
1998	0.35	0.30	0.28	0.20
1999	0.38	0.30	0.28	0.18
2000	0.31	0.31	0.29	0.25
2001	0.39	0.34	0.31	0.24
2002	0.35	0.31	0.29	0.21

Table 14. Fishing mortality at age for 13 plus group run with flat top PR.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
2	0.13	0.10	0.26	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.01	0.03	0.02	0.02	0.04	0.03	0.02
3	0.39	0.32	0.41	0.07	0.04	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.07	0.08	0.08	0.07	0.07	0.06	0.08	0.07	0.08
4	0.39	0.53	0.23	0.08	0.11	0.04	0.03	0.05	0.10	0.08	0.07	0.08	0.07	0.11	0.15	0.13	0.13	0.12	0.19	0.15	0.10
5	0.30	0.46	0.30	0.24	0.13	0.07	0.11	0.07	0.15	0.11	0.09	0.13	0.11	0.13	0.18	0.21	0.24	0.15	0.26	0.22	0.19
6	0.20	0.31	0.27	0.34	0.18	0.08	0.14	0.13	0.14	0.12	0.10	0.12	0.14	0.20	0.21	0.30	0.25	0.23	0.26	0.27	0.30
7	0.36	0.29	0.22	0.36	0.25	0.10	0.18	0.08	0.20	0.10	0.09	0.10	0.12	0.17	0.27	0.27	0.21	0.24	0.37	0.30	0.31
8	0.58	0.09	0.10	0.32	0.33	0.11	0.26	0.13	0.16	0.22	0.10	0.13	0.13	0.22	0.25	0.37	0.27	0.25	0.35	0.41	0.29
9	0.61	0.17	0.06	0.19	0.26	0.13	0.35	0.16	0.17	0.20	0.23	0.15	0.27	0.33	0.24	0.38	0.36	0.31	0.27	0.39	0.41
10	0.71	0.37	0.17	0.12	0.22	0.12	0.15	0.14	0.15	0.29	0.21	0.50	0.21	0.39	0.22	0.32	0.36	0.39	0.36	0.31	0.33
11	0.31	0.74	0.10	0.11	0.16	0.08	0.21	0.11	0.27	0.47	0.16	0.29	0.44	0.19	0.31	0.29	0.42	0.56	0.27	0.46	0.37
12	0.65	0.25	0.09	0.16	0.25	0.13	0.25	0.15	0.17	0.22	0.22	0.23	0.24	0.35	0.23	0.35	0.36	0.33	0.31	0.35	0.38
13+	0.65	0.25	0.09	0.16	0.25	0.13	0.25	0.15	0.17	0.22	0.22	0.23	0.24	0.35	0.23	0.35	0.36	0.33	0.31	0.35	0.38

Table 15. Back calculated partial recruitment from 13 plus run, flat PR .

							Year														
AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.00
2	0.18	0.14	0.65	0.11	0.02	0.04	0.03	0.06	0.04	0.03	0.04	0.02	0.05	0.11	0.03	0.09	0.05	0.03	0.12	0.07	0.04
3	0.55	0.43	1.00	0.19	0.14	0.13	0.07	0.21	0.15	0.09	0.17	0.08	0.16	0.22	0.25	0.18	0.17	0.11	0.22	0.15	0.19
4	0.54	0.72	0.55	0.23	0.35	0.34	0.10	0.29	0.38	0.18	0.29	0.16	0.17	0.29	0.50	0.35	0.30	0.22	0.51	0.32	0.23
5	0.42	0.63	0.73	0.65	0.40	0.58	0.33	0.43	0.57	0.24	0.39	0.27	0.26	0.33	0.60	0.55	0.59	0.27	0.72	0.48	0.47
6	0.28	0.42	0.66	0.93	0.57	0.66	0.40	0.82	0.52	0.25	0.42	0.24	0.33	0.51	0.68	0.80	0.60	0.41	0.72	0.59	0.73
7	0.51	0.39	0.54	1.00	0.76	0.80	0.53	0.52	0.74	0.22	0.40	0.20	0.26	0.44	0.89	0.72	0.51	0.43	1.00	0.65	0.77
8	0.82	0.12	0.25	0.88	1.00	0.87	0.76	0.80	0.61	0.48	0.41	0.26	0.29	0.57	0.81	0.98	0.65	0.45	0.96	0.88	0.70
9	0.85	0.24	0.14	0.52	0.81	1.00	1.00	1.00	0.64	0.42	1.00	0.31	0.62	0.83	0.79	1.00	0.86	0.55	0.73	0.84	1.00
10	1.00	0.50	0.43	0.33	0.67	0.96	0.45	0.87	0.58	0.62	0.92	1.00	0.48	1.00	0.73	0.84	0.86	0.69	0.99	0.67	0.82
11	0.44	1.00	0.25	0.31	0.49	0.66	0.59	0.71	1.00	1.00	0.70	0.58	1.00	0.49	1.00	0.78	1.00	1.00	0.74	1.00	0.91
12	0.92	0.33	0.21	0.43	0.75	0.99	0.73	0.96	0.62	0.46	0.96	0.46	0.55	0.89	0.77	0.93	0.86	0.60	0.84	0.77	0.94
13+	0.92	0.33	0.21	0.43	0.75	0.99	0.73	0.96	0.62	0.46	0.96	0.46	0.55	0.89	0.77	0.93	0.86	0.60	0.84	0.77	0.94

Table 16. Estimated population size at age

	Year																					
AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	1,445	2,915	2,243	3,300	2,633	3,481	4,634	5,137	7,573	7,125	7,612	8,412	13,083	10,957	10,792	10,668	8,231	9,590	6,186	15,061	16,929	3,607
2	927	1,242	2,506	1,925	2,839	2,256	2,995	3,986	4,421	6,517	6,131	6,549	7,240	11,255	9,428	9,288	9,180	7,060	8,246	5,289	12,931	14,547
3	856	700	967	1,655	1,590	2,424	1,932	2,549	3,397	3,762	5,541	5,235	5,572	6,097	9,292	8,028	7,730	7,731	5,969	6,797	4,402	10,932
4	740	500	438	553	1,330	1,309	2,052	1,624	2,120	2,809	3,103	4,584	4,334	4,473	4,822	7,405	6,460	6,204	6,253	4,749	5,451	3,506
5	245	433	253	301	439	1,022	1,079	1,707	1,335	1,651	2,224	2,496	3,643	3,461	3,436	3,563	5,587	4,906	4,732	4,467	3,527	4,263
6	114	157	235	162	205	332	817	830	1,373	988	1,271	1,750	1,881	2,795	2,617	2,463	2,497	3,769	3,620	3,129	3,077	2,509
7	85	81	99	154	99	146	262	613	626	1,028	757	993	1,335	1,404	1,970	1,829	1,572	1,677	2,584	2,394	2,050	1,964
8	41	51	52	68	93	67	114	188	485	443	801	594	774	1,024	1,019	1,293	1,200	1,094	1,133	1,543	1,528	1,289
9	27	20	40	41	43	58	51	75	142	355	304	626	449	586	705	685	769	788	732	687	885	987
10	22	13	14	33	29	28	44	31	55	104	251	208	463	294	364	477	404	463	500	482	402	507
11	44	9	8	10	25	20	21	32	23	41	67	175	109	323	171	251	299	243	271	299	304	247
12	31	28	4	6	8	18	16	15	25	15	22	49	112	60	230	109	161	170	119	178	163	181
13+	35	67	143	77	50	118	46	67	97	123	86	92	74	55	106	90	233	172	126	172	209	218
Total	4,612	6,216	7,001	8,285	9,383	11,279	14,063	16,854	21,672	24,960	28,170	31,763	39,068	42,785	44,953	46,150	44,324	43,868	40,470	45,248	51,858	44,757

Table 17. Estimated female spawning population biomass at age.

	Year																				
AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	21	13	13	18	60	53	77	69	82	115	114	173	181	184	210	323	282	271	271	207	238
5	36	61	41	40	66	157	206	321	191	265	383	422	636	586	673	697	1,088	964	920	872	691
6	90	107	166	121	134	205	694	794	1,111	664	989	1,326	1,391	2,142	2,481	2,314	2,358	3,566	3,413	2,948	2,891
7	168	125	207	309	163	222	478	1,381	1,276	2,074	1,556	1,996	2,761	3,146	5,187	4,815	4,162	4,428	6,738	6,285	5,373
8	100	121	131	161	203	140	233	518	1,274	1,092	2,053	1,602	2,120	2,758	3,164	3,965	3,716	3,394	3,481	4,715	4,726
9	77	55	128	128	108	149	124	213	380	1,070	985	2,064	1,412	1,962	2,558	2,452	2,760	2,842	2,649	2,458	3,160
10	86	48	52	114	82	86	115	128	155	299	954	754	1,624	1,193	1,561	2,024	1,709	1,951	2,109	2,044	1,701
11	219	40	31	44	90	74	86	136	81	176	306	770	483	1,143	736	1,080	1,272	1,018	1,168	1,267	1,298
12	153	133	23	30	34	84	77	69	105	60	128	245	558	271	1,079	504	747	790	557	826	753
13+	236	346	929	543	336	831	330	486	702	911	640	643	533	471	777	653	1,689	1,249	913	1,248	1,511
Total	1,183	1,047	1,719	1,506	1,274	1,999	2,417	4,113	5,355	6,723	8,105	9,994	11,697	13,852	18,424	18,824	19,781	20,472	22,217	22,867	22,339

Table 18. Tag-based estimates of annual instantaneous fishing mortality of striped bass >= 28 inches. Estimates are adjusted for live-release bias, hooking mortality (0.08), and reporting rate (0.43).

Coast Programs

Year	MADFW	NYOHS	NJDEL	NCCOOP	Unweighted average	lower 95% CI	upper 95% CI
1988		-0.24		0.00			
1989		-0.18	0.00	0.11			
1990		0.16	0.09	0.15			
1991		0.16	0.23	0.12			
1992	0.00	0.08	0.04	0.00	0.03	-0.08	0.21
1993	0.00	0.20	0.15	0.06	0.10	-0.01	0.26
1994	0.01	0.17	0.04	0.23	0.11	-0.02	0.28
1995	0.13	0.08	0.05	0.00	0.06	-0.03	0.26
1996	0.14	0.15	0.14	0.31	0.18	0.09	0.29
1997	0.16	0.20	0.16	0.36	0.22	0.10	0.35
1998	0.13	0.31	0.20	0.19	0.21	0.09	0.37
1999	0.15	0.36	0.14	0.04	0.17	0.06	0.40
2000	0.16	0.35	0.09	0.44	0.26	0.09	0.47
2001	0.06	0.44	0.11	0.25	0.21	0.05	0.45
2002	0.05	0.35	0.09	0.27	0.19	0.02	0.44

Producer Area Programs

Year	HUDSON	DE/PA	MDCB	VARAP	Weighted average*	lower 95% CI	upper 95% CI
1987			0.00				
1988	0.00		0.00				
1989	0.03		0.00				
1990	0.09		0.39	0.20			
1991	0.13		0.18	0.20			
1992	0.10		0.13	0.16			
1993	0.13	0.00	0.09	0.22	0.12	0.07	0.26
1994	0.10	0.00	0.03	0.25	0.09	0.02	0.24
1995	0.14	0.28	0.20	0.31	0.23	0.14	0.34
1996	0.19	0.29	0.22	0.36	0.26	0.20	0.36
1997	0.19	0.32	0.23	0.34	0.26	0.21	0.36
1998	0.20	0.33	0.26	0.29	0.27	0.21	0.36
1999	0.18	0.37	0.26	0.32	0.27	0.20	0.39
2000	0.08	0.34	0.29	0.31	0.27	0.16	0.42
2001	0.09	0.37	0.30	0.29	0.27	0.13	0.46
2002	0.07	0.33	0.31	0.28	0.27	0.12	0.52

* Weighting Scheme: Hudson (0.13); Delaware (0.09);
Chesapeake Bay (0.78), where MD (0.67) and VA (0.33).

Table 19. Survival (S) and fishing mortality (F) rates of striped bass >= 28 inches, including estimates adjusted (adj.) for reporting rate (0.433), bias from live releases, and hooking mortality (0.08).

Coast Programs

Massachusetts; C-hat = 1; bootstrap GOF probability = 0.572 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1992	0.795	0.080	0.048	0.750	-0.080	0.864	-0.004	-0.080	0.104
1993	0.792	0.084	0.064	0.541	-0.080	0.860	0.001	-0.071	0.100
1994	0.795	0.079	0.055	0.515	-0.065	0.851	0.011	-0.063	0.115
1995	0.713	0.188	0.061	0.366	-0.053	0.753	0.134	0.075	0.202
1996	0.709	0.194	0.088	0.245	-0.055	0.750	0.138	0.083	0.202
1997	0.708	0.196	0.080	0.193	-0.039	0.736	0.156	0.099	0.221
1998	0.708	0.196	0.090	0.284	-0.064	0.756	0.129	0.072	0.196
1999	0.704	0.201	0.077	0.242	-0.046	0.738	0.153	0.087	0.232
2000	0.709	0.193	0.071	0.208	-0.036	0.736	0.157	0.096	0.228
2001	0.779	0.099	0.047	0.308	-0.034	0.807	0.065	-0.029	0.204
2002	0.771	0.110	0.077	0.315	-0.059	0.820	0.049	-0.049	0.195

New York - Ocean Haul Seine
C-hat adjustment = 1.06; bootstrap GOF probability = 0.324 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1988	0.825	0.042	0.120	0.900	-0.242	1.089	-0.235	-0.337	-0.037
1989	0.829	0.038	0.102	0.860	-0.197	1.032	-0.181	-0.281	0.012
1990	0.631	0.310	0.089	0.660	-0.137	0.731	0.163	0.052	0.301
1991	0.627	0.316	0.112	0.530	-0.147	0.735	0.158	0.075	0.253
1992	0.633	0.308	0.144	0.540	-0.201	0.792	0.084	0.017	0.159
1993	0.623	0.323	0.109	0.430	-0.118	0.706	0.198	0.120	0.288
1994	0.627	0.317	0.111	0.490	-0.135	0.725	0.172	0.067	0.300
1995	0.684	0.230	0.147	0.340	-0.140	0.795	0.079	-0.019	0.203
1996	0.659	0.267	0.134	0.300	-0.111	0.741	0.149	0.071	0.243
1997	0.636	0.302	0.151	0.210	-0.095	0.703	0.202	0.128	0.287
1998	0.599	0.362	0.104	0.190	-0.053	0.633	0.308	0.210	0.423
1999	0.576	0.402	0.145	0.100	-0.045	0.603	0.356	0.224	0.517
2000	0.555	0.439	0.133	0.220	-0.083	0.605	0.352	0.159	0.607
2001	0.519	0.505	0.103	0.240	-0.065	0.555	0.439	0.185	0.788
2002	0.496	0.552	0.165	0.400	-0.186	0.609	0.346	0.035	0.796

Table 19. Continued.

New Jersey - Delaware Bay
C-hat adjustment = 1.06; bootstrap GOF probability = 0.324 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1989	0.879	-0.021	0.102	1.000	-0.220	1.127	-0.270	-0.361	0.003
1990	0.711	0.191	0.095	0.430	-0.100	0.790	0.086	-0.098	0.421
1991	0.507	0.529	0.201	0.440	-0.259	0.685	0.229	-0.133	0.812
1992	0.665	0.258	0.098	0.920	-0.197	0.828	0.038	-0.117	0.263
1993	0.611	0.343	0.104	0.730	-0.175	0.740	0.151	-0.031	0.404
1994	0.674	0.244	0.110	0.740	-0.188	0.831	0.036	-0.077	0.183
1995	0.697	0.210	0.105	0.590	-0.148	0.819	0.050	-0.030	0.148
1996	0.644	0.291	0.132	0.410	-0.143	0.751	0.137	0.056	0.231
1997	0.668	0.254	0.091	0.410	-0.091	0.735	0.158	0.088	0.240
1998	0.610	0.344	0.166	0.270	-0.133	0.704	0.201	0.061	0.380
1999	0.684	0.230	0.116	0.270	-0.083	0.746	0.143	0.052	0.255
2000	0.723	0.175	0.094	0.330	-0.078	0.784	0.094	-0.012	0.240
2001	0.716	0.183	0.100	0.280	-0.072	0.772	0.109	0.012	0.236
2002	0.736	0.156	0.072	0.360	-0.062	0.785	0.092	-0.015	0.244

North Carolina - Cooperative Trawl Cruise
C-hat adjustment = 1.276; bootstrap GOF probability = 0.030 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1988	0.814	0.056	0.106	0.714	-0.177	0.988	-0.138	-0.282	0.250
1989	0.698	0.209	0.060	0.703	-0.095	0.771	0.110	-0.071	0.421
1990	0.662	0.263	0.075	0.611	-0.107	0.741	0.150	-0.018	0.402
1991	0.660	0.266	0.089	0.664	-0.138	0.765	0.118	-0.027	0.319
1992	0.803	0.069	0.106	0.449	-0.118	0.911	-0.057	-0.206	0.325
1993	0.715	0.186	0.092	0.529	-0.117	0.809	0.062	-0.079	0.280
1994	0.617	0.333	0.077	0.509	-0.093	0.680	0.235	-0.015	0.656
1995	0.785	0.092	0.104	0.342	-0.091	0.863	-0.003	-0.182	0.523
1996	0.615	0.336	0.054	0.211	-0.027	0.632	0.309	0.148	0.526
1997	0.570	0.412	0.095	0.201	-0.050	0.600	0.361	0.085	0.797
1998	0.654	0.275	0.112	0.261	-0.078	0.709	0.194	-0.032	0.589
1999	0.773	0.107	0.101	0.244	-0.064	0.827	0.041	-0.153	0.626
2000	0.530	0.484	0.050	0.354	-0.041	0.553	0.442	0.108	0.984
2001	0.637	0.301	0.094	0.218	-0.053	0.673	0.246	0.002	0.676
2002	0.638	0.300	0.065	0.198	-0.031	0.658	0.268	0.090	0.529

Table 19. Continued.

Producer Area Programs

Delaware / Pennsylvania - Delaware River
C-hat = 1; bootstrap GOF probability = 0.565 for the full parameterized model.

With trend models included:

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1993	0.872	-0.014	0.106	0.330	-0.090	0.959	-0.108	-0.217	0.322
1994	0.857	0.004	0.108	0.286	-0.081	0.933	-0.080	-0.205	0.430
1995	0.581	0.393	0.117	0.350	-0.107	0.651	0.280	0.179	0.398
1996	0.578	0.398	0.136	0.280	-0.107	0.647	0.285	0.192	0.391
1997	0.576	0.402	0.109	0.280	-0.080	0.626	0.318	0.231	0.416
1998	0.573	0.406	0.143	0.170	-0.072	0.618	0.331	0.245	0.430
1999	0.571	0.410	0.075	0.210	-0.039	0.594	0.370	0.277	0.477
2000	0.568	0.415	0.142	0.170	-0.072	0.613	0.340	0.237	0.460
2001	0.570	0.412	0.122	0.120	-0.042	0.595	0.369	0.237	0.528
2002	0.587	0.382	0.101	0.180	-0.049	0.618	0.332	0.148	0.581

Maryland - Chesapeake Bay Spring Spawning Stock
C-hat = 1; bootstrap GOF probability = 0.85 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1987	0.969	-0.118	0.034		0.000	0.969	-0.118	-0.142	-0.035
1988	0.960	-0.109	0.041	0.670	-0.062	1.023	-0.173	-0.192	-0.137
1989	0.949	-0.097	0.052	0.790	-0.091	1.044	-0.193	-0.212	-0.162
1990	0.532	0.482	0.070	0.570	-0.092	0.585	0.386	0.257	0.537
1991	0.589	0.379	0.123	0.590	-0.178	0.717	0.183	0.112	0.261
1992	0.646	0.287	0.113	0.510	-0.143	0.754	0.133	0.083	0.187
1993	0.698	0.209	0.099	0.460	-0.113	0.787	0.090	0.027	0.163
1994	0.746	0.143	0.093	0.470	-0.106	0.835	0.031	-0.047	0.131
1995	0.649	0.282	0.115	0.260	-0.081	0.706	0.198	0.103	0.314
1996	0.643	0.291	0.097	0.280	-0.070	0.691	0.219	0.151	0.297
1997	0.637	0.301	0.111	0.220	-0.066	0.682	0.233	0.181	0.290
1998	0.630	0.312	0.100	0.190	-0.050	0.663	0.260	0.198	0.330
1999	0.624	0.322	0.122	0.180	-0.061	0.665	0.259	0.168	0.366
2000	0.618	0.331	0.080	0.190	-0.038	0.643	0.292	0.166	0.450
2001	0.612	0.341	0.072	0.250	-0.045	0.640	0.296	0.135	0.512
2002	0.606	0.351	0.052	0.350	-0.043	0.633	0.307	0.111	0.589

Table 19. Continued.

Virginia - Rappahannock River
C-hat adjustment = 1.11948; bootstrap GOF probability = 0.22 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1990	0.623	0.323	0.086	0.583	-0.119	0.707	0.196	0.112	0.294
1991	0.624	0.322	0.091	0.527	-0.116	0.706	0.199	0.118	0.291
1992	0.624	0.321	0.123	0.489	-0.153	0.737	0.156	0.077	0.246
1993	0.630	0.312	0.099	0.341	-0.086	0.689	0.222	0.135	0.324
1994	0.630	0.312	0.084	0.304	-0.064	0.673	0.246	0.156	0.353
1995	0.590	0.377	0.124	0.189	-0.065	0.632	0.310	0.221	0.412
1996	0.591	0.377	0.046	0.130	-0.014	0.599	0.362	0.276	0.460
1997	0.591	0.376	0.080	0.162	-0.033	0.611	0.343	0.259	0.439
1998	0.592	0.375	0.138	0.213	-0.084	0.646	0.286	0.201	0.384
1999	0.592	0.375	0.104	0.200	-0.055	0.626	0.318	0.231	0.418
2000	0.593	0.373	0.078	0.341	-0.065	0.634	0.305	0.216	0.409
2001	0.610	0.345	0.073	0.298	-0.053	0.644	0.291	0.173	0.435
2002	0.612	0.342	0.082	0.286	-0.058	0.649	0.282	0.154	0.441

Hudson River
C-hat adjustment = 1.1183; bootstrap GOF probability = 0.295 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1988	0.770	0.112	0.091	0.560	-0.122	0.877	-0.018	-0.128	0.156
1989	0.680	0.236	0.110	0.740	-0.189	0.839	0.026	-0.117	0.231
1990	0.621	0.326	0.132	0.661	-0.212	0.788	0.088	0.001	0.190
1991	0.657	0.270	0.104	0.500	-0.128	0.754	0.133	0.050	0.232
1992	0.627	0.317	0.135	0.578	-0.195	0.779	0.100	0.031	0.178
1993	0.628	0.315	0.132	0.489	-0.166	0.753	0.134	0.062	0.217
1994	0.654	0.275	0.122	0.521	-0.160	0.778	0.101	0.025	0.189
1995	0.667	0.255	0.115	0.374	-0.112	0.751	0.137	0.067	0.218
1996	0.645	0.289	0.127	0.256	-0.090	0.709	0.195	0.134	0.262
1997	0.608	0.347	0.156	0.316	-0.142	0.709	0.194	0.092	0.315
1998	0.647	0.285	0.130	0.234	-0.086	0.708	0.195	0.125	0.276
1999	0.640	0.296	0.129	0.312	-0.109	0.719	0.180	0.098	0.276
2000	0.742	0.148	0.080	0.358	-0.070	0.798	0.076	-0.041	0.251
2001	0.742	0.148	0.085	0.260	-0.056	0.786	0.091	-0.024	0.265
2002	0.735	0.158	0.097	0.350	-0.086	0.804	0.068	-0.047	0.237

Table 20. Tag-based estimates of annual instantaneous fishing mortality of striped bass >= 18 inches. Estimates are adjusted for live-release bias, hooking mortality (0.08), and reporting rate (0.43).

Producer Area Programs*

Year	HUDSON	with trend model DE/PA	without trend model DE/PA	MDCB
1987				0.00
1988	0.00			0.00
1989	0.09			0.00
1990	0.12			0.22
1991	0.11			0.21
1992	0.11			0.19
1993	0.13	0.12	0.17	0.23
1994	0.10	0.16	0.12	0.22
1995	0.12	0.15	0.19	0.20
1996	0.18	0.19	0.23	0.25
1997	0.20	0.24	0.24	0.32
1998	0.20	0.24	0.23	0.39
1999	0.19	0.28	0.25	0.46
2000	0.06	0.29	0.23	0.50
2001	0.05	0.29	0.22	0.60
2002	0.06	0.37	0.26	0.68

* Results from Rappahannock River, VA, tagging program excluded (see text explanation)

Table 21. Survival (S) and fishing mortality (F) rates of striped bass >= 18 inches including estimates adjusted (adj.) for reporting rate (0.433), bias from live releases, and hooking mortality (0.08).

Producer Area Programs

Delaware River; C-hat = 1; bootstrap GOF probability = 0.745 for the full parameterized model.
Model-averaged estimates with trend models:

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1993	0.688	0.224	0.099	0.390	-0.097	0.762	0.122	-0.073	0.464
1994	0.632	0.308	0.106	0.550	-0.141	0.736	0.156	-0.020	0.409
1995	0.633	0.307	0.118	0.500	-0.149	0.744	0.146	0.034	0.286
1996	0.620	0.328	0.118	0.440	-0.133	0.715	0.186	0.096	0.290
1997	0.613	0.339	0.078	0.520	-0.096	0.679	0.237	0.169	0.314
1998	0.595	0.368	0.103	0.470	-0.120	0.677	0.240	0.174	0.313
1999	0.587	0.383	0.085	0.470	-0.096	0.649	0.283	0.198	0.380
2000	0.575	0.404	0.095	0.460	-0.108	0.644	0.290	0.170	0.435
2001	0.563	0.425	0.093	0.560	-0.125	0.643	0.291	0.129	0.498
2002	0.551	0.447	0.083	0.350	-0.071	0.593	0.373	0.165	0.652

Model-averaged estimates without trend models:

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1993	0.654	0.275	0.099	0.390	-0.097	0.725	0.171	0.025	0.373
1994	0.651	0.279	0.106	0.550	-0.141	0.764	0.119	-0.025	0.313
1995	0.605	0.353	0.118	0.500	-0.149	0.713	0.189	0.126	0.259
1996	0.600	0.361	0.118	0.440	-0.133	0.683	0.231	0.161	0.305
1997	0.610	0.344	0.078	0.520	-0.096	0.677	0.241	0.169	0.321
1998	0.598	0.364	0.103	0.470	-0.120	0.687	0.226	0.151	0.309
1999	0.604	0.354	0.085	0.470	-0.096	0.673	0.246	0.185	0.316
2000	0.604	0.354	0.095	0.460	-0.108	0.681	0.234	0.173	0.302
2001	0.604	0.354	0.093	0.560	-0.125	0.692	0.218	0.152	0.286
2002	0.614	0.338	0.083	0.350	-0.071	0.663	0.262	0.183	0.350

Table 21. Continued.

Maryland - Chesapeake Bay Spring Spawning Stock
C-hat adjustment = 1.11; bootstrap GOF probability = 0.21 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1987	0.800	0.073	0.070	0.95	-0.145	0.936	-0.08	-0.174	0.057
1988	0.841	0.023	0.042	0.84	-0.077	0.911	-0.06	-0.101	0.002
1989	0.879	-0.021	0.034	0.93	-0.068	0.943	-0.09	-0.155	0.026
1990	0.638	0.299	0.055	0.58	-0.073	0.689	0.22	0.158	0.296
1991	0.635	0.305	0.082	0.45	-0.089	0.697	0.21	0.168	0.257
1992	0.629	0.314	0.111	0.43	-0.120	0.715	0.19	0.157	0.217
1993	0.624	0.322	0.090	0.38	-0.084	0.681	0.23	0.194	0.277
1994	0.619	0.330	0.099	0.43	-0.106	0.693	0.22	0.153	0.289
1995	0.634	0.305	0.118	0.32	-0.100	0.705	0.20	0.135	0.273
1996	0.605	0.353	0.110	0.35	-0.100	0.672	0.25	0.197	0.302
1997	0.575	0.404	0.114	0.27	-0.082	0.626	0.32	0.275	0.365
1998	0.539	0.468	0.112	0.25	-0.075	0.583	0.39	0.338	0.445
1999	0.509	0.525	0.109	0.21	-0.062	0.543	0.46	0.389	0.538
2000	0.477	0.591	0.096	0.36	-0.086	0.522	0.50	0.397	0.615
2001	0.444	0.662	0.080	0.33	-0.065	0.474	0.60	0.455	0.755
2002	0.412	0.736	0.070	0.33	-0.056	0.437	0.68	0.499	0.884

Hudson River
C-hat adjustment = 1.09725; bootstrap GOF probability = 0.525 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1988	0.773	0.107	0.067	0.745	-0.112	0.871	-0.012	-0.089	0.094
1989	0.662	0.262	0.088	0.790	-0.157	0.785	0.092	-0.015	0.227
1990	0.613	0.339	0.112	0.735	-0.193	0.760	0.125	0.050	0.210
1991	0.656	0.271	0.103	0.621	-0.152	0.774	0.106	0.041	0.181
1992	0.643	0.292	0.105	0.649	-0.162	0.767	0.115	0.057	0.180
1993	0.646	0.286	0.106	0.563	-0.145	0.756	0.130	0.069	0.198
1994	0.671	0.249	0.095	0.596	-0.135	0.776	0.104	0.039	0.179
1995	0.687	0.226	0.095	0.431	-0.101	0.764	0.119	0.061	0.186
1996	0.646	0.288	0.113	0.342	-0.101	0.718	0.182	0.127	0.242
1997	0.616	0.334	0.128	0.376	-0.128	0.707	0.197	0.121	0.283
1998	0.642	0.293	0.113	0.287	-0.087	0.703	0.202	0.132	0.282
1999	0.648	0.284	0.099	0.346	-0.087	0.710	0.193	0.118	0.280
2000	0.740	0.151	0.079	0.460	-0.087	0.811	0.060	-0.012	0.151
2001	0.760	0.125	0.077	0.374	-0.069	0.817	0.053	-0.018	0.144
2002	0.752	0.135	0.074	0.434	-0.076	0.814	0.056	-0.018	0.151

Table 22. Time series of survival (S) and total mortality (Z) estimates adjusted for live release bias. Results are for age 1, 2, and older striped bass tagged during Western Long Island survey.
Reporting Rate (DE) = 0.433

Bootstrap GOF S(a*t) r(a*t) prob = 0.51; c-hat = 1.

Models and AICc weights used to derive model averaged parameter estimates given by Program MARK. All other models tested had delta AIC > 7, and AICc weight < 0.01.

Model	AICc Weights
S(a) r(a*v)	0.45
S(a) r(a*p)	0.40
S(a) r(a*d)	0.12
S(a) r(a*t)	0.02

Age 1 Survival

Year	S(unadj.)	Z(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	Z(adj.)	LCLM (Z) Z(adj.)	UCLM (Z) Z(adj.)
1988	0.277	1.29	0.02	1.00	-0.053	0.292	1.23	1.01	1.47
1989	0.277	1.29	0.01	1.00	-0.024	0.283	1.26	1.04	1.50
1990	0.277	1.29	0.06	0.87	-0.116	0.313	1.16	0.94	1.40
1991	0.277	1.29	0.03	0.91	-0.056	0.293	1.23	1.01	1.47
1992	0.277	1.29	0.01	0.80	-0.017	0.281	1.27	1.05	1.51
1993	0.277	1.29	0.03	0.88	-0.066	0.296	1.22	1.00	1.46
1994	0.277	1.29	0.02	0.86	-0.034	0.286	1.25	1.03	1.49
1995	0.277	1.29	0.01	0.75	-0.019	0.282	1.27	1.05	1.50
1996	0.277	1.29	0.01	0.77	-0.022	0.283	1.26	1.04	1.50
1997	0.277	1.29	0.07	1.00	-0.155	0.327	1.12	0.90	1.36
1998	0.277	1.29	0.02	1.00	-0.040	0.288	1.24	1.03	1.48
1999	0.277	1.29	0.01	1.00	-0.027	0.284	1.26	1.04	1.50
2000	0.277	1.29	0.02	0.94	-0.041	0.288	1.24	1.02	1.48
2001	0.277	1.29	0.00	0.81	-0.007	0.279	1.28	1.06	1.52

Table 22. Continued.

Age 2 Survival

Year	S(unadj.)	Z(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	Z(adj.)	LCLM (Z) Z(adj.)	UCLM (Z) Z(adj.)
1988	0.408	0.90	0.04	1.00	-0.097	0.452	0.79	0.62	1.00
1989	0.408	0.90	0.06	0.96	-0.128	0.468	0.76	0.58	0.96
1990	0.408	0.90	0.08	0.93	-0.155	0.483	0.73	0.55	0.93
1991	0.408	0.90	0.08	1.00	-0.170	0.492	0.71	0.53	0.91
1992	0.408	0.90	0.06	0.93	-0.124	0.466	0.76	0.59	0.97
1993	0.408	0.90	0.08	1.00	-0.163	0.487	0.72	0.54	0.92
1994	0.408	0.90	0.03	0.90	-0.056	0.432	0.84	0.66	1.04
1995	0.408	0.90	0.09	0.91	-0.172	0.493	0.71	0.53	0.91
1996	0.408	0.90	0.04	0.89	-0.076	0.442	0.82	0.64	1.02
1997	0.408	0.90	0.07	0.80	-0.120	0.464	0.77	0.59	0.97
1998	0.408	0.90	0.03	0.65	-0.048	0.429	0.85	0.67	1.05
1999	0.408	0.90	0.03	0.82	-0.045	0.427	0.85	0.67	1.05
2000	0.408	0.90	0.06	0.92	-0.119	0.463	0.77	0.59	0.97
2001	0.408	0.90	0.06	0.84	-0.109	0.458	0.78	0.60	0.98

Age 3+ Survival

Year	S(unadj.)	Z(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	Z(adj.)	LCLM (Z) Z(adj.)	UCLM (Z) Z(adj.)
1988	0.604	0.50	0.07	1.00	-0.161	0.719	0.33	0.26	0.40
1989	0.604	0.50	0.14	0.92	-0.289	0.849	0.16	0.10	0.24
1990	0.604	0.50	0.13	0.87	-0.265	0.822	0.20	0.13	0.27
1991	0.604	0.50	0.09	0.94	-0.177	0.734	0.31	0.24	0.38
1992	0.604	0.50	0.11	0.87	-0.222	0.776	0.25	0.19	0.33
1993	0.604	0.50	0.07	1.00	-0.153	0.713	0.34	0.27	0.41
1994	0.604	0.50	0.03	1.00	-0.070	0.649	0.43	0.37	0.51
1995	0.604	0.50	0.07	0.73	-0.121	0.687	0.38	0.31	0.45
1996	0.604	0.50	0.07	0.73	-0.116	0.683	0.38	0.32	0.46
1997	0.604	0.50	0.05	0.58	-0.066	0.647	0.44	0.37	0.51
1998	0.604	0.50	0.11	0.56	-0.147	0.707	0.35	0.28	0.42
1999	0.604	0.50	0.05	0.56	-0.057	0.641	0.45	0.38	0.52
2000	0.604	0.50	0.06	0.75	-0.101	0.671	0.40	0.33	0.47
2001	0.604	0.50	0.11	1.00	-0.230	0.784	0.24	0.18	0.32

Table 23. Averages of annual estimates of the proportion of fish released alive for coastal and producer area tagging programs.

Year	>= 18 inch group Coastal program average	Producer area average	All programs ave	>= 28 inch group Coastal program average	Producer area average	All programs ave
1987		0.95	0.95			
1988		0.79	0.79	0.71	0.62	0.65
1989	0.88	0.86	0.87	0.85	0.76	0.81
1990	0.76	0.61	0.67	0.52	0.60	0.57
1991	0.68	0.53	0.59	0.55	0.54	0.54
1992	0.70	0.50	0.60	0.71	0.53	0.62
1993	0.61	0.45	0.52	0.60	0.40	0.49
1994	0.66	0.49	0.57	0.59	0.40	0.48
1995	0.50	0.38	0.43	0.43	0.29	0.35
1996	0.43	0.35	0.39	0.29	0.24	0.26
1997	0.40	0.37	0.39	0.25	0.24	0.25
1998	0.42	0.34	0.38	0.25	0.20	0.23
1999	0.39	0.33	0.36	0.21	0.23	0.22
2000	0.44	0.43	0.43	0.28	0.26	0.27
2001	0.42	0.41	0.41	0.26	0.23	0.25
2002	0.38	0.37	0.38	0.32	0.29	0.30

Table 24. Akaike weights used to derive model averaged parameter estimates. Results are for striped bass tagged at >= 28 inches.

Coast Programs

Model	MADFW	NYOHS	NJDEL	NCCOOP
{S(.)r(.)}	0.0001	0.00014	0.0003	0.0000
{S(.)r(p)}	0.0005	0.00033	0.0000	0.0005
{S(.)r(t)}	0.0265	0.00001	0.1059	0.0574
{S(p)r(p)}	0.0169	0.06462	0.0004	0.0200
{S(p)r(t)}	**0.1371**	0.00331	**0.1044**	**0.1361**
{S(d)r(p)}	0.0062	0.02931	0.0029	**0.1141**
{S(v)r(p)}	**0.6944**	0.04382	0.0137	0.0129
{S(Tp)r(t)}	0.0215	0.02067	0.0428	**0.1073**
{S(Tp)r(Tp)}	0.0041	**0.77417**	0.0194	0.0179
{S(Tp)r(p)}	0.0030	0.00879	0.0102	0.0031
{S(t)r(p)}	0.0896	0.00124	**0.6932**	0.0031
{S(t)r(t)}	0.0001	0.05359	0.0047	**0.5276**

Producer Area Programs

Model	DE/PA	HUDSON	MDCB	VARAP
{S(.)r(.)}	0.0129	0.0000	0.0000	**0.1632**
{S(.)r(p)}	0.0058	0.0000	0.0000	**0.1558**
{S(.)r(t)}	0.0003	0.0827	0.0000	0.0255
{S(p)r(p)}	**0.3862**	0.0000	0.0000	**0.2088**
{S(p)r(t)}	0.0045	**0.1273**	0.0007	0.0122
{S(d)r(p)}	**0.2707**	0.0000	0.0000	0.0795
{S(v)r(p)}	**0.1574**	0.0003	0.0000	**0.2141**
S(Va)r(va)	***	***	***	0.0611
{S(Tp)r(t)}	0.0035	0.0511	**0.9703**	0.0030
{S(Tp)r(Tp)}	**0.1032**	0.0009	0.0237	0.0258
{S(Tp)r(p)}	0.0535	0.0001	0.0000	0.0467
{S(t)r(p)}	0.0020	**0.7349**	0.0052	0.0030
{S(t)r(t)}	0.0001	0.0028	0.0001	0.0014

Model Descriptions

S(.) r(.)	Constant survival and reporting
S(t) r(t)	Time specific survival and reporting
S(.) r(t)	Constant survival and time specific reporting
S(p) r(t)	Regulatory period based survival and time specific reporting
S(p) r(p)	Regulatory period based survival and reporting
S(.) r(p)	Constant survival and regulatory period based reporting
S(t) r(p)	Time specific survival and regulatory period based reporting
S(d) r(p)	Regulatory period survival with terminal year unique and regulatory period reporting
S(v) r(p)	Regulatory period survival with 2 terminal years unique and regulatory period reporting
S(Tp) r(Tp)	Linear trend within regulatory period on both survival and reporting
S(Tp) r(p)	Linear trend within regulatory period survival and regulatory period reporting (no trend)
S(Tp) r(t)	Linear trend within regulatory period survival and time specific reporting (no trend)
S(Va)r(Va)	Three period model for VA program (90-92, 93-94, 95-02)

Table 25. Akaike weights used to derive model averaged parameter estimates. Results are for Striped bass >= 18 inches. Models are described in Table 8.

<u>Producer Area Programs</u>

Model	HUDSON	DE/PA with trend	DE/PA without trend	MDCB
{S(.)r(.)}	0.0000	0.00002	0.00004	0.0000
{S(.)r(p)}	0.0000	0.00003	0.00005	0.0000
{S(.)r(t)}	0.0308	**0.22606**	**0.44759**	0.0000
{S(p)r(p)}	0.0000	0.00167	0.00331	0.0000
{S(p)r(t)}	0.0348	**0.21153**	**0.41883**	0.0070
{S(d)r(p)}	0.0003	0.02388	0.04729	0.0000
{S(v)r(p)}	0.0001	0.00289	0.00573	0.0000
{S(Tp)r(t)}	0.0261	**0.36151**		**0.9767**
{S(Tp)r(Tp)}	0.0003	0.13285		0.0000
{S(Tp)r(p)}	0.0000	0.00059		0.0000
{S(t)r(p)}	**0.9053**	0.02972	0.05884	0.0000
{S(t)r(t)}	0.0024	0.00926	0.01833	0.0163

Table 26. Total length frequencies of fish tagged in 2002 by program (except data for WLI from 2001).

	Coast Programs				**Producer Area Programs**				NYDEC
TL	MADFW	NYOHS	NJDEP	NCCOOP	DE/PA	MDCB	VARAP	HUDSON	WLI
199									86
249		0			0				126
299		0			0	4			72
349		2			0	21		0	29
399		45		3	0	33		0	30
449		332	3	112	78	73		0	22
499	1	241	17	424	105	257	39	78	21
549	4	120	98	515	122	291	83	96	12
599	13	115	243	362	137	125	52	82	8
649	10	91	523	193	72	96	15	48	3
699	21	84	518	111	35	45	3	78	
749	60	58	222	154	42	50	9	62	
799	51	37	85	120	29	54	37	47	1
849	37	37	79	84	25	56	26	40	
899	15	12	28	43	28	62	26	32	
949	13	4	11	17	9	52	9	16	
999	5	5	2	6	11	41	6	12	
1049	7	2	1	4	5	14	8	5	
1099	0	2		2	3	6	2	1	
>1099	2	1		3	1	6		1	
Total	239	1188	1830	2153	702	1286	315	598	324

Table 27. Age frequencies of tagged fish recaptured in 2002 by program (except data for WLI from 2001)

	Coast Programs			**Producer Area Programs**			NYDEC
AGE	MADFW	NYOHS	NJDEP	DE/PA	MDCB	VARAP	WLI
1							1
2		2					19
3		5	3	4	1		10
4		22	21	10	1	6	6
5		15	58	15	4	9	5
6	3	55	74	18	4	10	2
7	11	28	71	22	8	6	
8	11	23	68	21	9	6	
9	6	29	32	28	12	9	2
10	6	6	26	10	7	15	
11	5	12	15	1	6	5	
12	3	4	12	8	5	3	
13	4	3	7	4	2	0	
14	3	6	6	2	5	1	
15	1	2			2	2	
16	1	1				1	
17		1		1	1		
18		1					
19	1	1					
20		1					
Total	55	216	393	144	67	73	45

Table 28. Distribution of tag recaptures by state (program) and month.

Coast Programs

Massachusetts (recaptures in 2002 from fish tagged and released during 1992-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME								4					4
NH						1							1
MA						8	14	7	4	1			34
RI						1					1		2
CT				1	1								2
NY					7					2	2	1	12
NJ			1	1	4					1	4	1	12
DE			2	1							1		4
MD				1	1						1		3
VA		2	1								2	2	7
NC				1									
Total	0	2	4	5	13	10	14	11	4	4	11	4	81

New York - Ocean Haul Seine (recaptures in 2002 from fish tagged/release during 1988-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME						1	9	3					13
NH					1	1	2	2					6
MA				1	4	13	11	6	4	2			41
RI					2	9	4	4	4				23
CT	1				3	4	4	1					13
NY	2		1	5	14	12	5		6	7	14	3	69
NJ	3	1	2	4	7	2				4	7	6	36
PA													0
DE			1	1	1						1	1	5
MD		1			1							1	3
VA	2	1	1	1								1	6
NC	1												1
Total	9	3	5	12	33	42	35	16	14	13	22	12	216

Table 28. Continued.

New Jersey - Delaware Bay (recaptures in 2002 from fish tagged/release during 1989-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME					1	6	5	3	1				16
NH					1	2		2					5
MA					11	33	26	18	9	2			99
RI					6	12	7	5	5	3	1		39
CT					5	7	7	3	4				26
NY				3	30	15	5	6	10	11	9	3	92
NJ	1		4	11	16	8	3		1	13	31	6	94
PA													0
DE	1				1					1	5	3	11
MD	1		1	7	4		1			1	2		17
VA		4								1	2	9	16
NC	1	1										2	4
Total	4	5	5	21	75	83	54	37	30	32	50	23	419

North Carolina - Cooperative Trawl Cruise
(recaptures in 2002 from fish tagged/release during 1988-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME					1	1							2
NH													0
MA					4	14	14	12	2	1			47
RI					1	5	1						7
CT							1	1		1			3
NY					4	4	3	3	5	3			22
NJ				1	2	2			1	3	9		18
PA													0
DE		1	1	1	1	1		1					6
MD	1	4	7	11	13	39	12	13	9	22	9	5	145
VA	2	9	6	2	7	2	2		1	15	35	19	100
NC	3	12	1	3				1			1	3	24
Total	6	26	15	18	33	68	33	31	18	45	54	27	374

Table 28. Continued.

Producer Area Programs

Delaware / Pennsylvania - Delaware River
(recaptures in 2002 from fish tagged/release during 1993-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME								4					4
NH						1							1
MA						8	14	7	4	1			34
RI						1					1		2
CT				1	1								2
NY					7					2	2	1	12
NJ			1	1	4					1	4	1	12
PA													0
DE			2	1							1		4
MD				1	1						1		3
VA		2	1								2	2	7
NC				1									1
Total	0	2	4	5	13	10	14	11	4	4	11	4	82

Maryland - Chesapeake Bay Spring Spawning Stock
(recaptures in 2002 from fish tagged/release during 1987-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME													0
NH													0
MA						1	4	5	2				12
RI					1		2		1				4
CT						1	2	1					4
NY					3	3	1	1		1			9
NJ						3							3
PA													0
DE				1				1					2
MD		1		1	16	15	20	8	14	5	9	1	90
VA	3	1	1		1	1			1	4	17	7	36
NC	5										1	2	8
Total	8	2	1	2	21	24	29	16	18	10	27	10	168

Table 28. Continued.

Virginia - Rappahannock River (recaptures in 2002 from fish tagged/release during 1990-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
MA					2	4	2	1					9
RI							1		2				3
CT					2								2
NY					3	4	2		2	2	1		14
NJ					3	1				1			5
MD	1			1	2	4	4		1		2		15
VA	1	2	3	3	1	2	3			5	2	4	26
NC												2	2
													0
Total	2	2	3	4	13	15	12	1	5	8	5	6	76

Hudson River
(recaptures in 2002 from fish tagged/release during 1988-2002)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME						1			1				2
NH							1						1
MA						3	13	9		1			26
RI						3	4	3	1		2		13
CT						5	5	6					16
NY				7	38	25	7	3	2	8	9	6	105
NJ	1		1	1	3	4	5		1	3	10	1	30
PA													0
DE													0
MD											1		1
VA	1	2	1								2		6
NC			1	1							1	2	5
Total	2	2	3	9	41	41	35	21	5	12	25	9	205

Table 28. Continued.

Western Long Island Program

Distribution of tag recaptures by state and month for all recaptures 1988 - 2001

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NB								1	1				2
ME					1	3	2	5	1				12
NH													0
MA					5	14	10	2	3	3		1	38
RI				3	5	2		1	3	3	1		18
CT			1		6	3	2	2	2	4	1	1	22
NY	5	3	8	34	54	67	63	63	85	119	73	16	590
NJ		1	1	1	3		1	3	1	3	11	3	28
PA													0
DE												1	1
MD	1		1	1	2					2	1		8
VA	1		1							1		1	4
NC												1	1
Total	7	4	12	39	76	89	78	77	96	135	87	24	724

Table 29. R/M estimates of exploitation rates of >= 28 inch striped bass from tagging programs (with reporting rate adjustment of 0.43, and hooking mortality rate adjustment of 0.08).

Year	NJDB	NYOHS	NCCOOP	MA	VA Rap	MDCB	DE/PA	NYHUD
1987	*	0.049	*	*	0.031	0.006	*	*
1988	*	0.038	0.078	*	0.132	0.040	*	0.110
1989	0.019	0.062	0.045	*	0.007	0.037	*	0.083
1990	0.041	0.065	0.080	*	0.090	0.084	*	0.135
1991	0.334	0.133	0.074	0.044	0.125	0.135	*	0.102
1992	0.073	0.140	0.134	0.066	0.121	0.116	0.178	0.152
1993	0.087	0.139	0.112	0.038	0.163	0.119	0.213	0.172
1994	0.054	0.199	0.088	0.052	0.103	0.115	0.121	0.118
1995	0.103	0.144	0.142	0.089	0.298	0.204	0.154	0.153
1996	0.196	0.475	0.116	0.140	0.040	0.169	0.337	0.232
1997	0.255	0.133	0.196	0.098	0.192	0.239	0.323	0.335
1998	0.316	0.341	0.202	0.084	0.324	0.205	0.300	0.218
1999	0.128	0.258	0.236	0.137	0.232	0.200	0.177	0.225
2000	0.127	0.059	0.062	0.070	0.112	0.170	0.322	0.139
2001	0.153	0.332	0.154	0.086	0.100	0.109	0.280	0.143
2002	0.109	**	0.117	**	0.133	0.089	0.236	0.181

* Years when few or no striped bass were tagged and released.
** NYOHS and MA have fall tagging programs, and recapture interval of terminal year (2001) is fall 2001 to fall 2002; NCCOOP is a winter tagging program (Jan./Feb.) with recapture interval of terminal year (2002) from January 2002 to January 2003; others are spring tagging programs with recapture interval of terminal year (2002) from spring 2002 to spring 2003.

Table 30. R/M estimates of catch rates of >= 28 inch striped bass from tagging programs. (with reporting rate adjustment of 0.43)

Year	NJDB	NYOHS	NCCOOP	MA	VA Rap	MDCB	DE/PA	NYHUD
1987	*	0.284	*	*	0.388	0.080	*	*
1988	*	0.217	0.244	*	0.312	0.090	*	0.220
1989	0.233	0.215	0.141	*	0.090	0.095	*	0.285
1990	0.517	0.215	0.173	*	0.203	0.176	*	0.362
1991	0.620	0.345	0.204	0.148	0.212	0.271	*	0.250
1992	0.214	0.268	0.263	0.125	0.216	0.226	0.179	0.302
1993	0.204	0.273	0.278	0.106	0.266	0.219	0.326	0.348
1994	0.242	0.352	0.208	0.161	0.191	0.225	0.201	0.256
1995	0.232	0.267	0.275	0.187	0.336	0.270	0.252	0.250
1996	0.328	0.589	0.154	0.241	0.074	0.261	0.409	0.330
1997	0.445	0.133	0.249	0.203	0.228	0.298	0.345	0.437
1998	0.351	0.392	0.263	0.155	0.423	0.240	0.353	0.304
1999	0.276	0.258	0.273	0.151	0.273	0.236	0.197	0.315
2000	0.210	0.152	0.128	0.101	0.166	0.197	0.396	0.217
2001	0.227	0.503	0.212	0.171	0.170	0.155	0.312	0.218
2002	0.175	**	0.150	**	0.234	0.122	0.268	0.225

* Years when few or no striped bass were tagged and released.
** See footnote in Table 29.

Table 31. R/M estimates of exploitation rates of >= 18 inch striped bass from tagging programs (with reporting rate adjustment of 0.43, and hooking mortality rate adjustment of 0.08).

Year	NJDB	NYOHS	NCCOOP	MA	VA Rap	MDCB	DE/PA	NYHUD
1987	*	0.022	*	*	0.051	0.022	*	*
1988	*	0.030	0.044	*	0.132	0.017	*	0.060
1989	0.031	0.035	0.032	*	0.046	0.013	*	0.059
1990	0.094	0.044	0.070	*	0.120	0.068	*	0.094
1991	0.044	0.053	0.084	0.045	0.075	0.101	0.031	0.077
1992	0.048	0.046	0.151	0.055	0.063	0.133	0.133	0.105
1993	0.028	0.047	0.106	0.040	0.114	0.110	0.116	0.123
1994	0.034	0.063	0.085	0.040	0.102	0.119	0.119	0.085
1995	0.057	0.035	0.139	0.064	0.196	0.193	0.126	0.132
1996	0.095	0.058	0.109	0.109	0.132	0.173	0.158	0.170
1997	0.090	0.032	0.163	0.103	0.200	0.202	0.150	0.250
1998	0.119	0.055	0.144	0.056	0.149	0.201	0.147	0.177
1999	0.054	0.041	0.219	0.090	0.153	0.158	0.117	0.152
2000	0.068	0.046	0.083	0.050	0.087	0.134	0.147	0.101
2001	0.092	0.082	0.116	0.093	0.115	0.119	0.145	0.098
2002	0.058	**	0.120	**	0.093	0.109	0.139	0.078

* Years when few or no striped bass were tagged and released.
** NYOHS and MA have fall tagging programs, and recapture interval of terminal year (2001) is fall 2001 to fall 2002; NCCOOP is a winter tagging program (Jan./Feb.) with recapture interval of terminal year (2002) from January 2002 to January 2003; others are spring tagging programs with recapture interval of terminal year (2002) from spring 2002 to spring 2003.

Table 32. R/M estimates of catch rates of >= 18 inch striped bass from tagging programs. (with reporting rate adjustment of 0.43)

Year	NJDB	NYOHS	NCCOOP	MA	VA Rap	MDCB	DE/PA	NYHUD
1987	*	0.175	*	*	0.080	0.156	*	*
1988	*	0.239	0.212	*	0.274	0.100	*	0.192
1989	0.273	0.193	0.119	*	0.205	0.082	*	0.232
1990	0.443	0.174	0.179	*	0.279	0.131	*	0.293
1991	0.195	0.200	0.198	0.149	0.157	0.185	0.100	0.272
1992	0.213	0.142	0.279	0.114	0.125	0.234	0.211	0.238
1993	0.174	0.187	0.207	0.123	0.214	0.184	0.253	0.285
1994	0.185	0.153	0.195	0.142	0.179	0.216	0.226	0.214
1995	0.202	0.139	0.232	0.182	0.255	0.285	0.258	0.223
1996	0.256	0.187	0.151	0.235	0.190	0.287	0.233	0.288
1997	0.269	0.141	0.224	0.197	0.239	0.298	0.255	0.356
1998	0.278	0.150	0.237	0.104	0.219	0.293	0.265	0.260
1999	0.181	0.149	0.274	0.107	0.216	0.223	0.192	0.233
2000	0.195	0.141	0.153	0.088	0.135	0.230	0.269	0.205
2001	0.218	0.185	0.178	0.162	0.259	0.191	0.242	0.200
2002	0.137	**	0.177	**	0.263	0.163	0.202	0.167

* Years when few or no striped bass were tagged and released.
** See footnote in Table 15.

Table 33. R/M estimates of exploitation rates of 18-28 inch striped bass from tagging programs (with reporting rate adjustment of 0.43, and hooking mortality rate adjustment of 0.08).

Year	NJDB	NYOHS	NCCOOP	MA	VA Rap	MDCB	DE/PA	NYHUD
1987	*	0.018	*	*	0.051	0.022	*	*
1988	*	0.028	0.039	*	0.132	0.015	*	0.033
1989	0.032	0.023	0.025	*	0.050	0.010	*	0.022
1990	0.098	0.035	0.068	*	0.128	0.064	*	0.025
1991	0.029	0.020	0.094	0.049	0.066	0.089	0.035	0.025
1992	0.045	0.023	0.164	0.026	0.055	0.139	0.119	0.036
1993	0.025	0.029	0.103	0.043	0.087	0.105	0.090	0.052
1994	0.031	0.009	0.085	0.023	0.102	0.120	0.118	0.037
1995	0.037	0.017	0.134	0.027	0.149	0.185	0.110	0.070
1996	0.051	0.027	0.072	0.053	0.154	0.178	0.040	0.055
1997	0.057	0.025	0.101	0.115	0.209	0.178	0.097	0.010
1998	0.083	0.029	0.127	0.000	0.069	0.199	0.086	0.048
1999	0.049	0.031	0.184	0.002	0.133	0.140	0.095	0.029
2000	0.062	0.045	0.084	0.005	0.078	0.121	0.097	0.047
2001	0.075	0.058	0.105	0.115	0.122	0.126	0.103	0.045
2002	0.045	**	0.121	**	0.078	0.117	0.108	0.027

* Years when few or no striped bass were tagged and released.
** NYOHS and MA have fall tagging programs, and recapture interval of terminal year (2001) is fall 2001 to fall 2002; NCCOOP is a winter tagging program (Jan./Feb.) with recapture interval of terminal year (2002) from January 2002 to January 2003; others are spring tagging programs with recapture interval of terminal year (2002) from spring 2002 to spring 2003.

Table 34. R/M estimates of catch rates of 18-28 inch striped bass from tagging programs. (with reporting rate adjustment of 0.43)

Year	NJDB	NYOHS	NCCOOP	MA	VA Rap	MDCB	DE/PA	NYHUD
1987	*	0.158	*	*	0.079	0.158	*	*
1988	*	0.244	0.207	*	0.273	0.101	*	0.178
1989	0.277	0.184	0.107	*	0.219	0.081	*	0.149
1990	0.437	0.156	0.180	*	0.301	0.119	*	0.180
1991	0.173	0.141	0.194	0.158	0.149	0.154	0.113	0.319
1992	0.213	0.111	0.292	0.085	0.112	0.238	0.221	0.146
1993	0.173	0.171	0.181	0.163	0.188	0.170	0.234	0.198
1994	0.176	0.073	0.193	0.118	0.161	0.213	0.236	0.154
1995	0.189	0.118	0.174	0.178	0.219	0.296	0.263	0.144
1996	0.225	0.158	0.134	0.229	0.219	0.318	0.118	0.214
1997	0.235	0.142	0.180	0.189	0.254	0.299	0.228	0.132
1998	0.265	0.128	0.230	0.000	0.128	0.314	0.231	0.125
1999	0.176	0.144	0.278	0.028	0.202	0.218	0.190	0.094
2000	0.194	0.140	0.154	0.062	0.124	0.243	0.234	0.189
2001	0.216	0.151	0.169	0.135	0.302	0.218	0.221	0.179
2002	0.128	**	0.185	**	0.275	0.180	0.182	0.140

* Years when few or no striped bass were tagged and released.
** See footnote in Table 33.

Figure 1.Proportions of recreational and commercial fishery in 2002 catch in numbers.

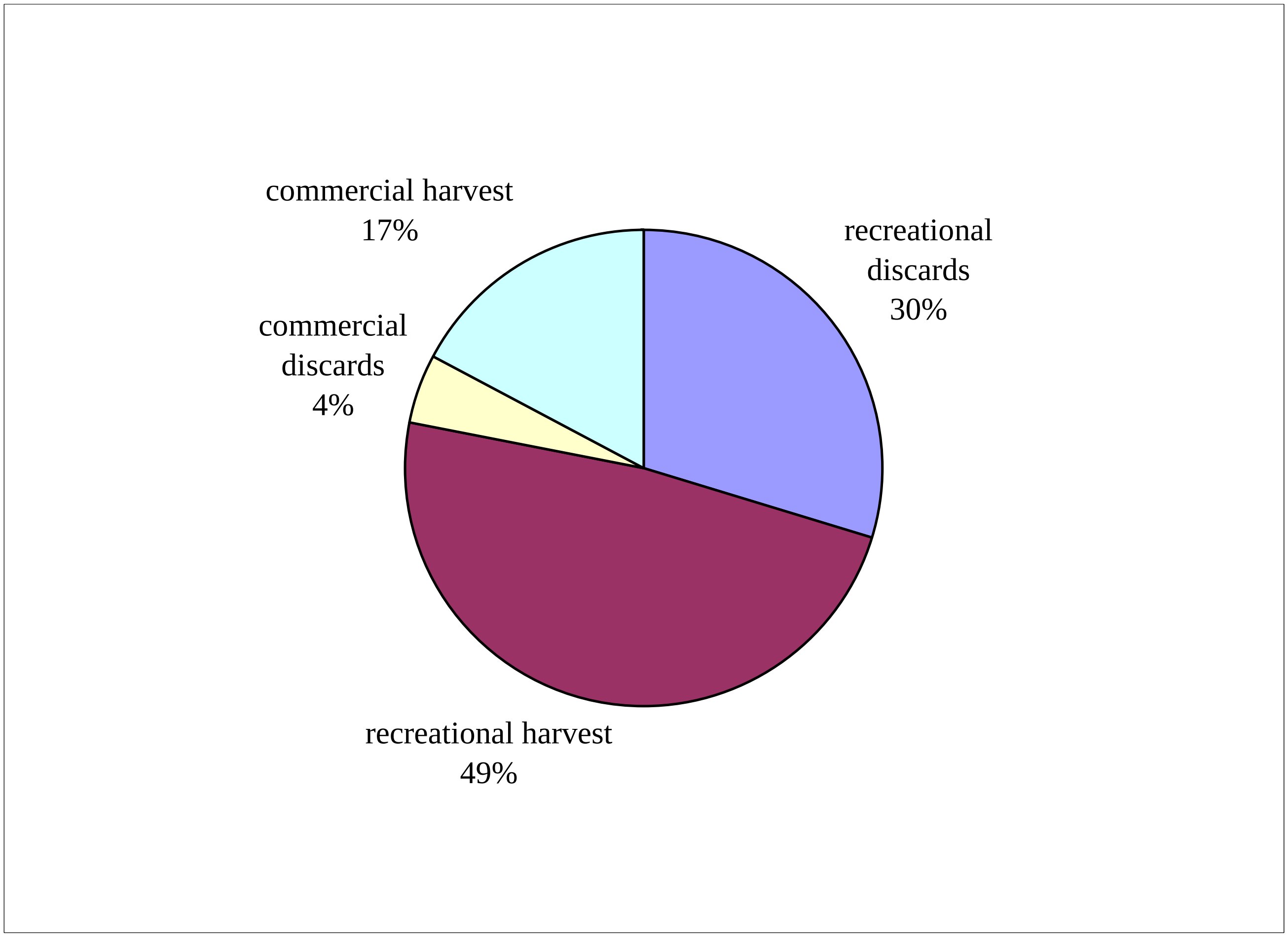
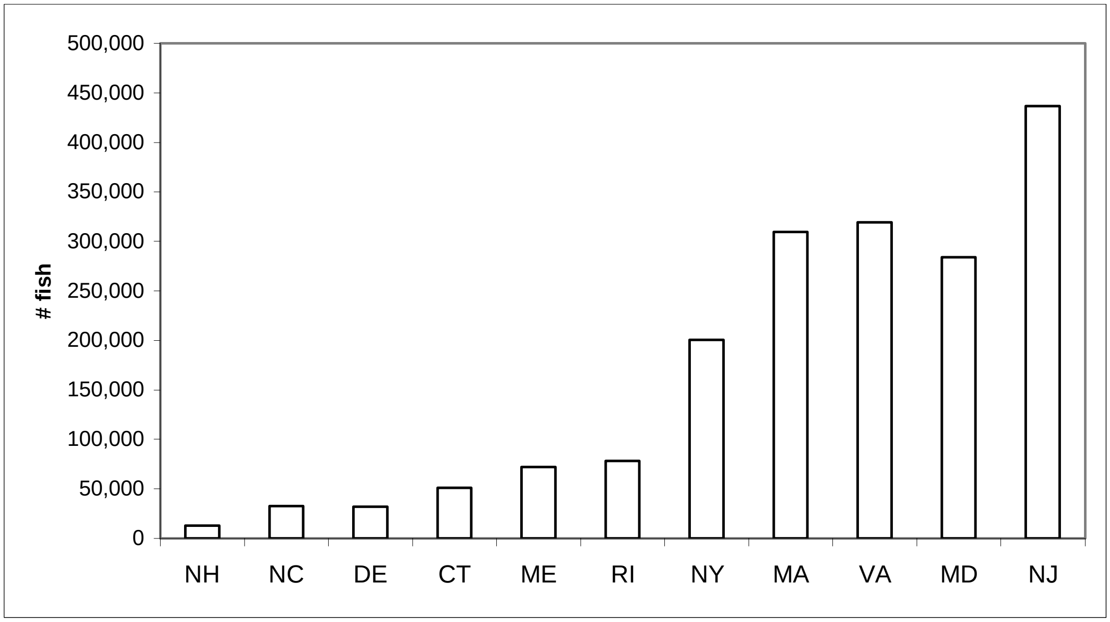


Figure 2. Recreational harvest in numbers and weight by state for 2002.



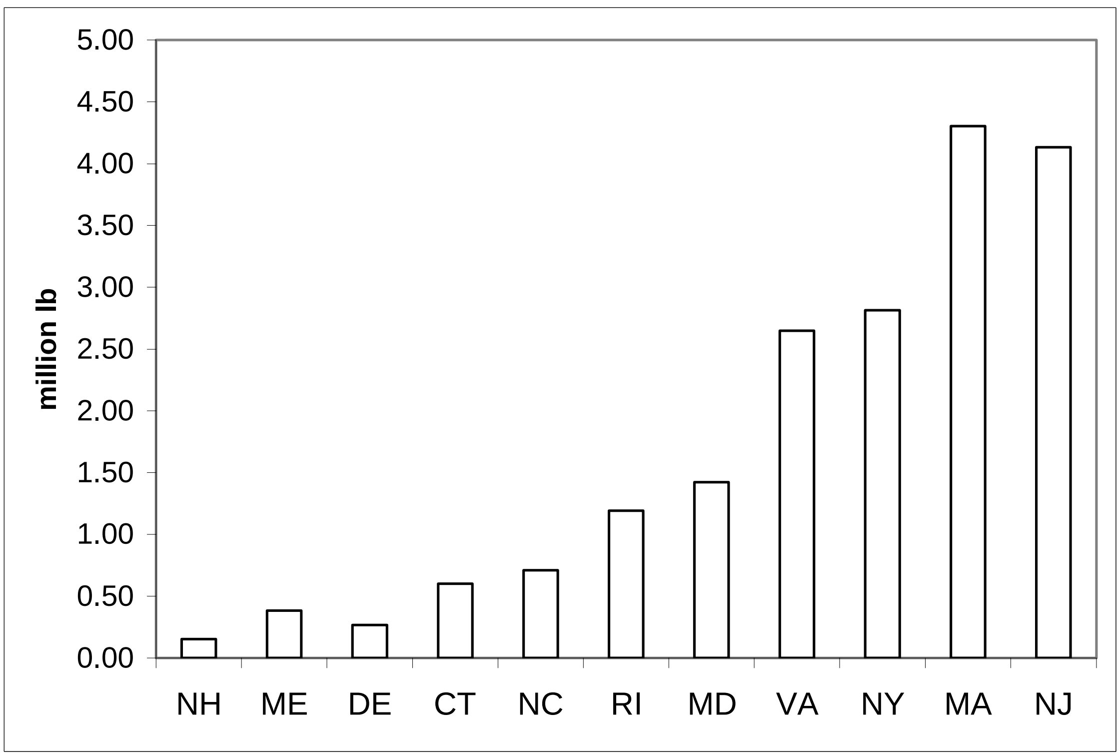


Figure 3. Recreational striped bass catch (harvest and dead discards) in number for 1982-2002.

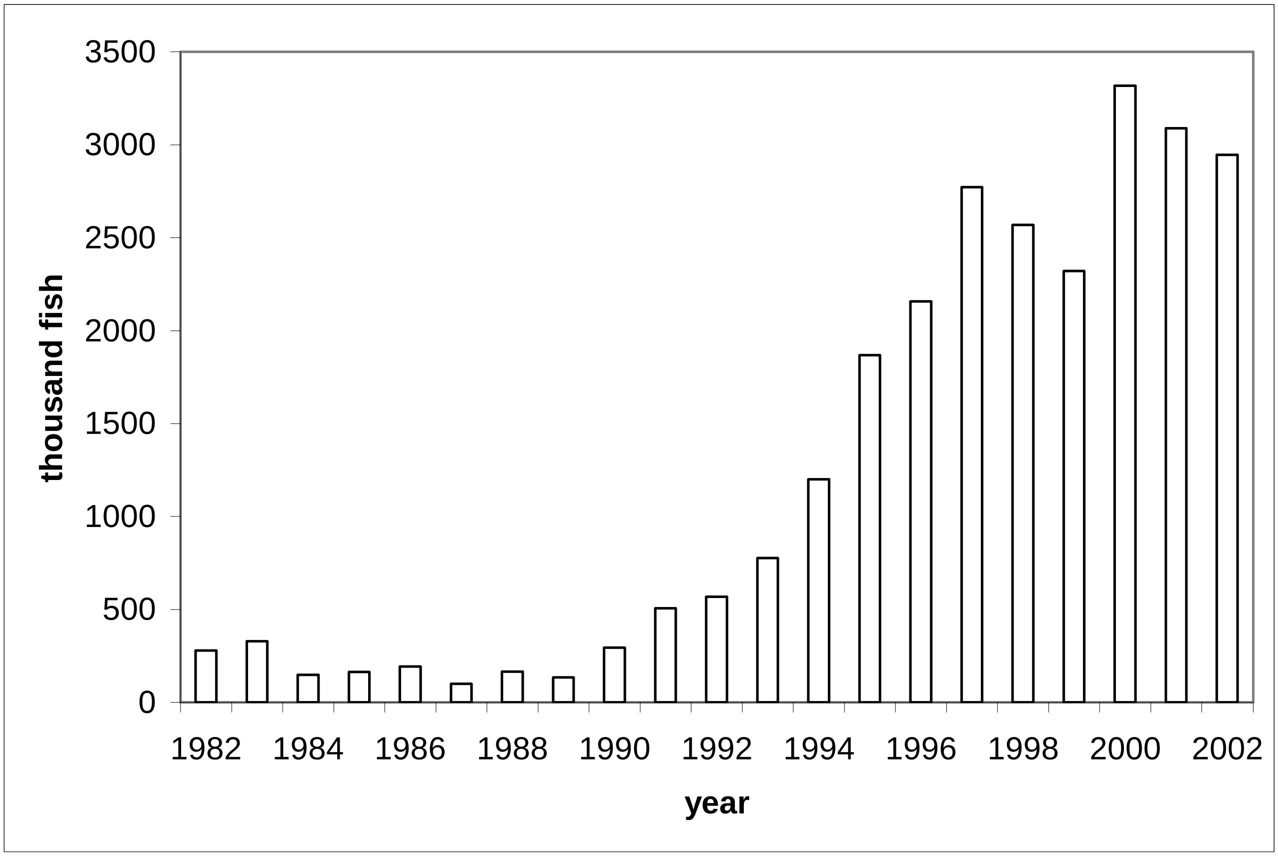


Figure 4. Recreational and commercial catch (harvest and discard) in number in 2002 and 2001.

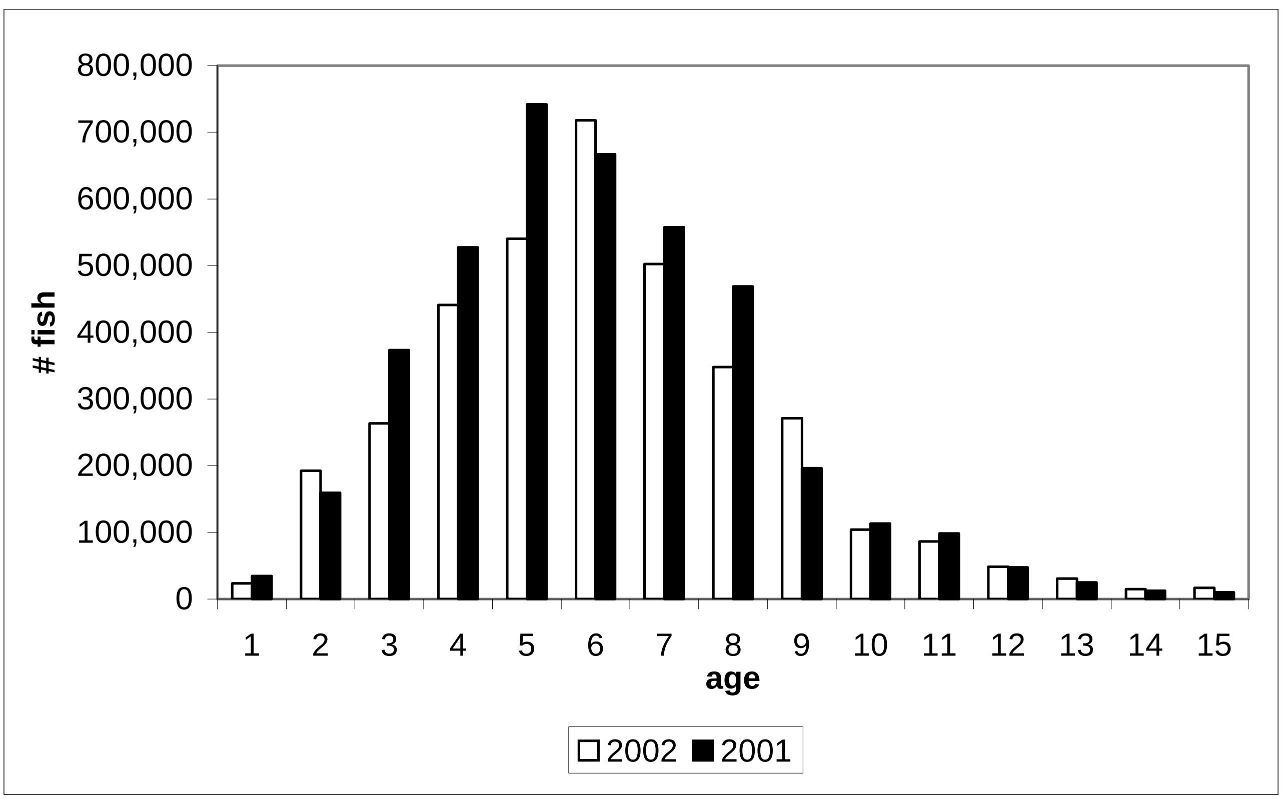
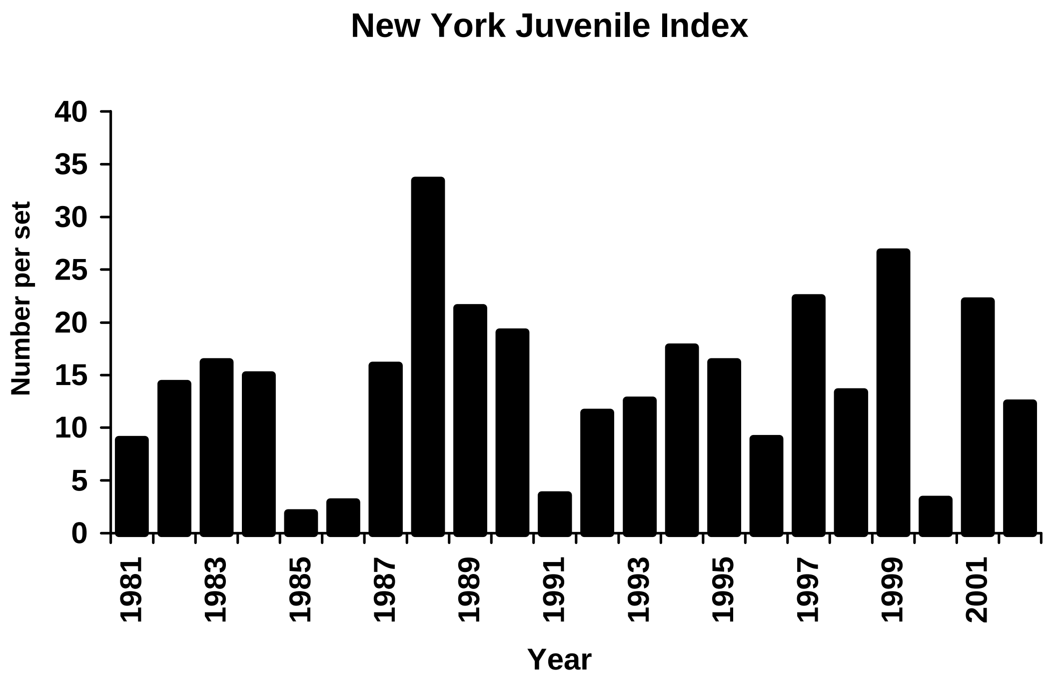


Figure 5. Striped indices of abundance



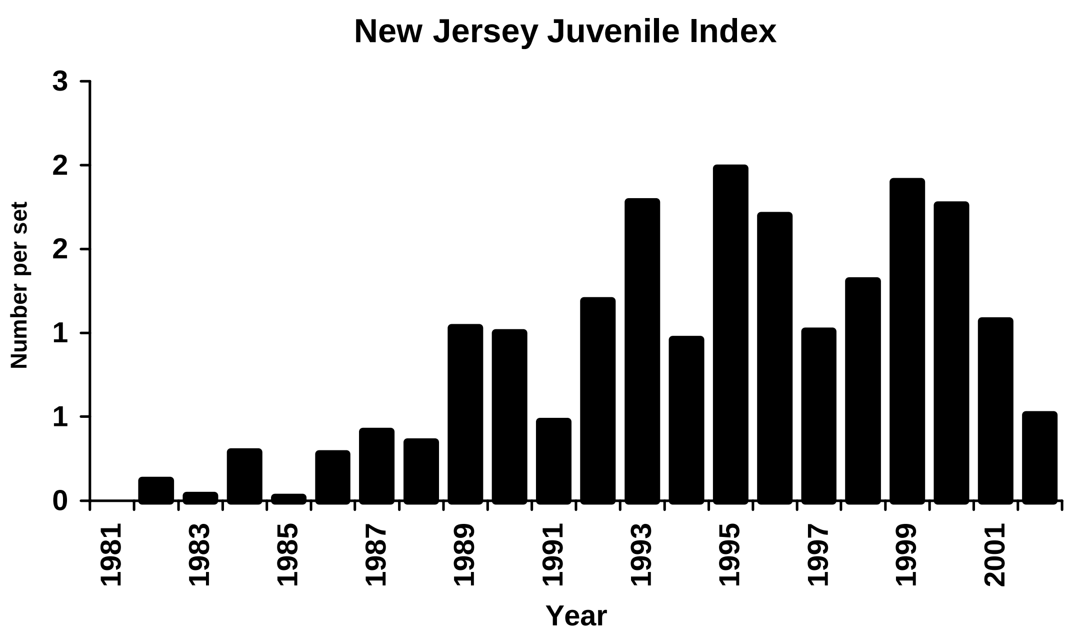


Figure 5 continues

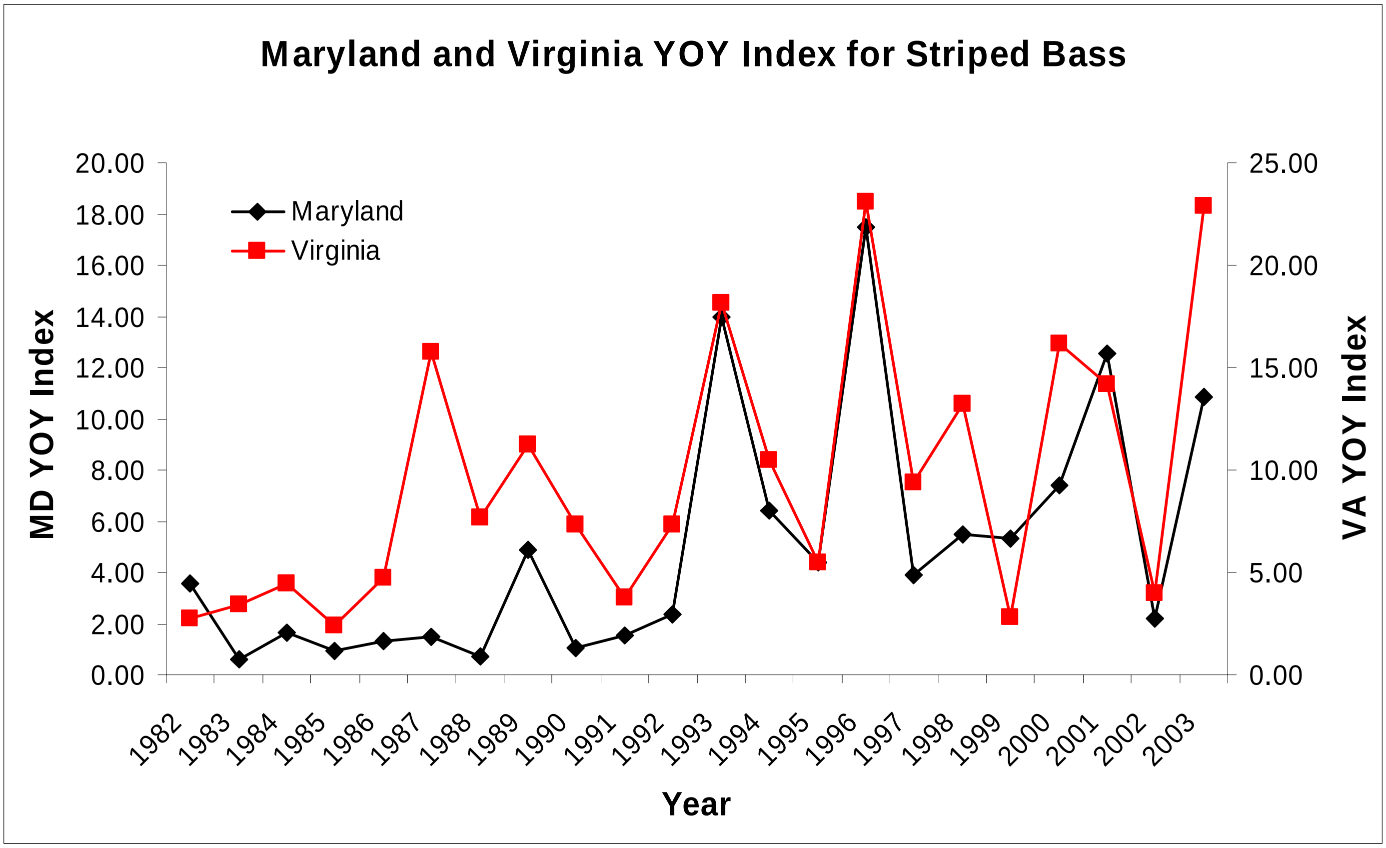
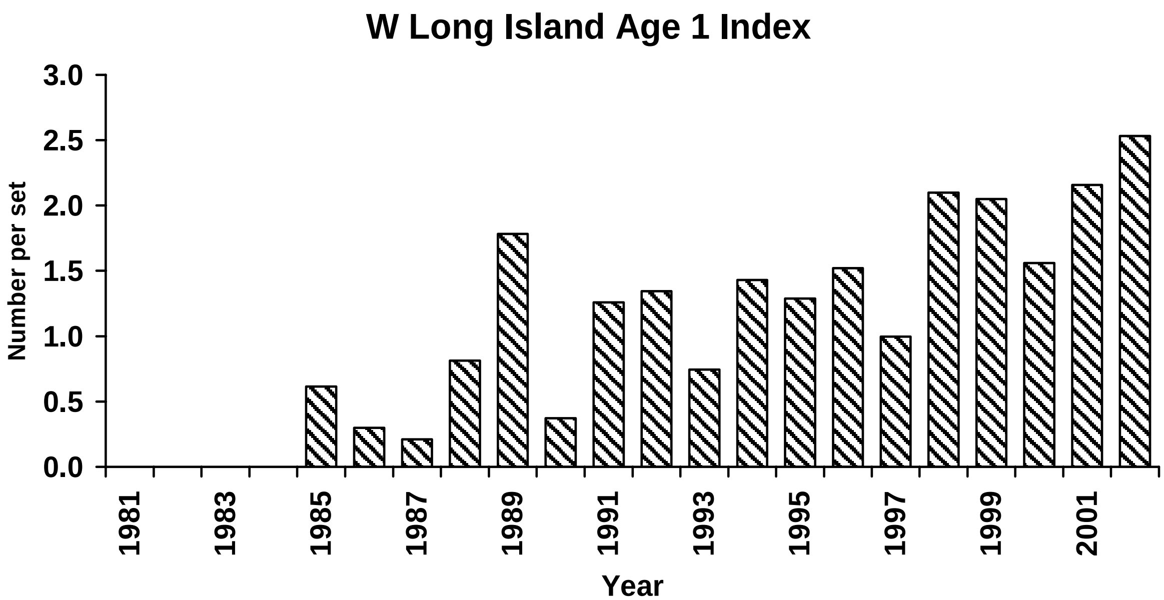


Figure 5 continues



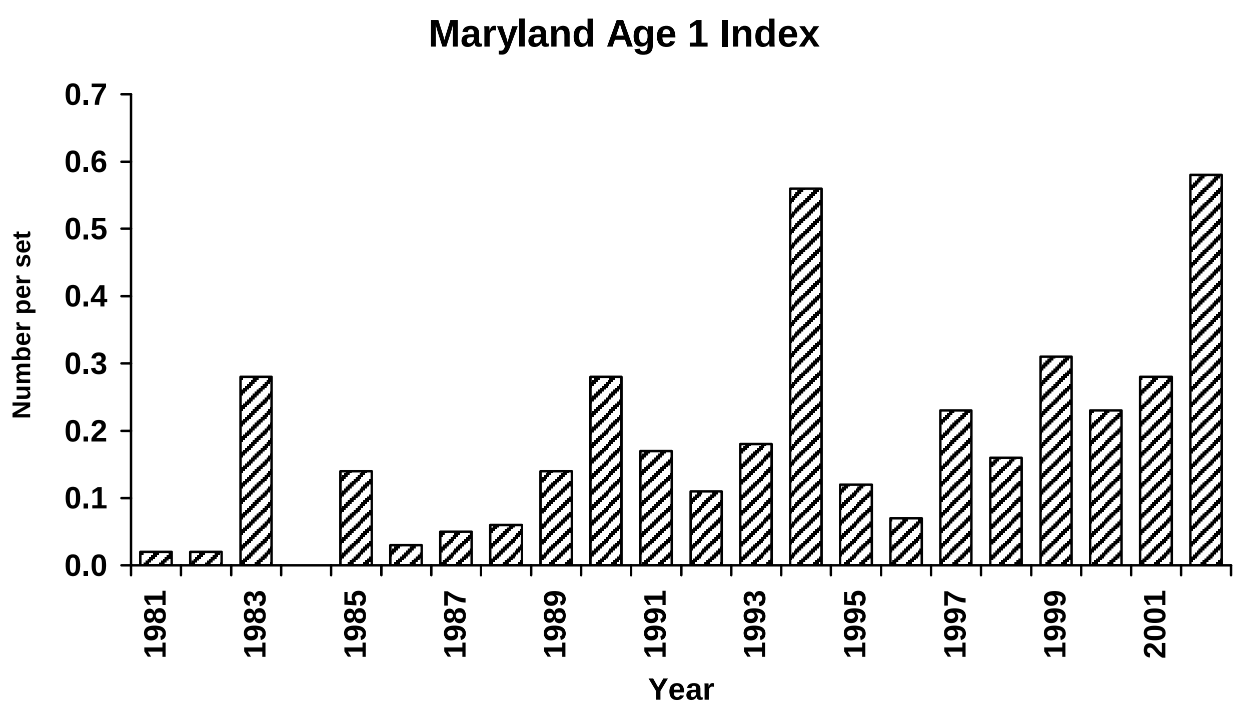
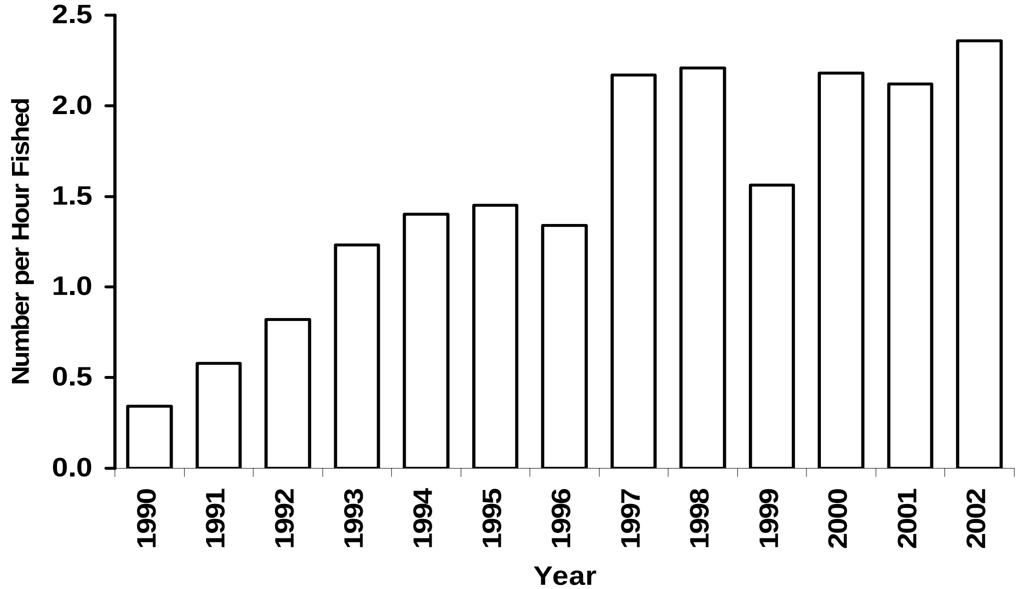


Figure 5 continues

MA Commercial CPUE



CT Volunteer Angler CPUE

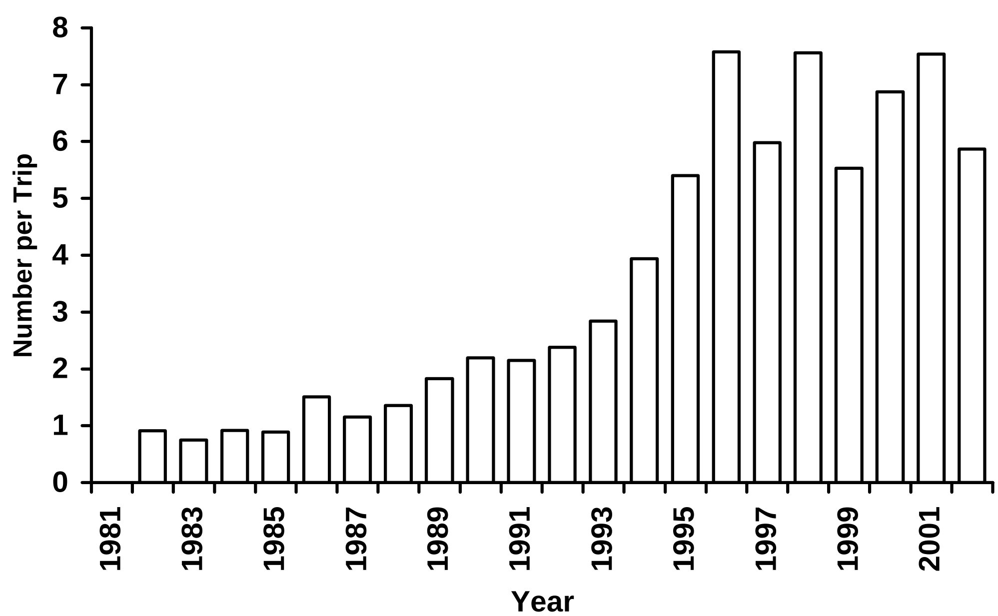
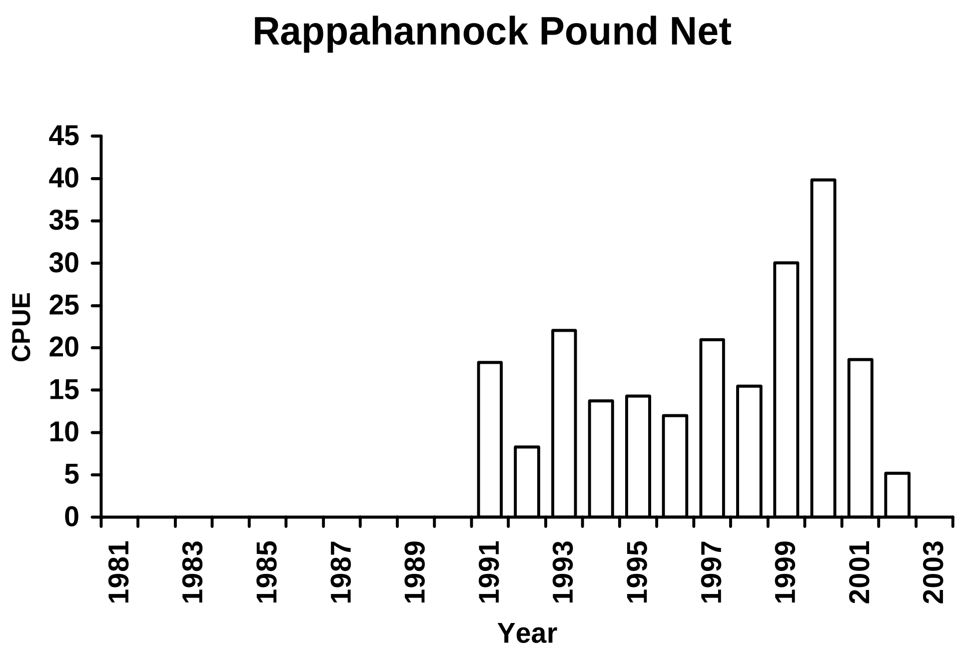
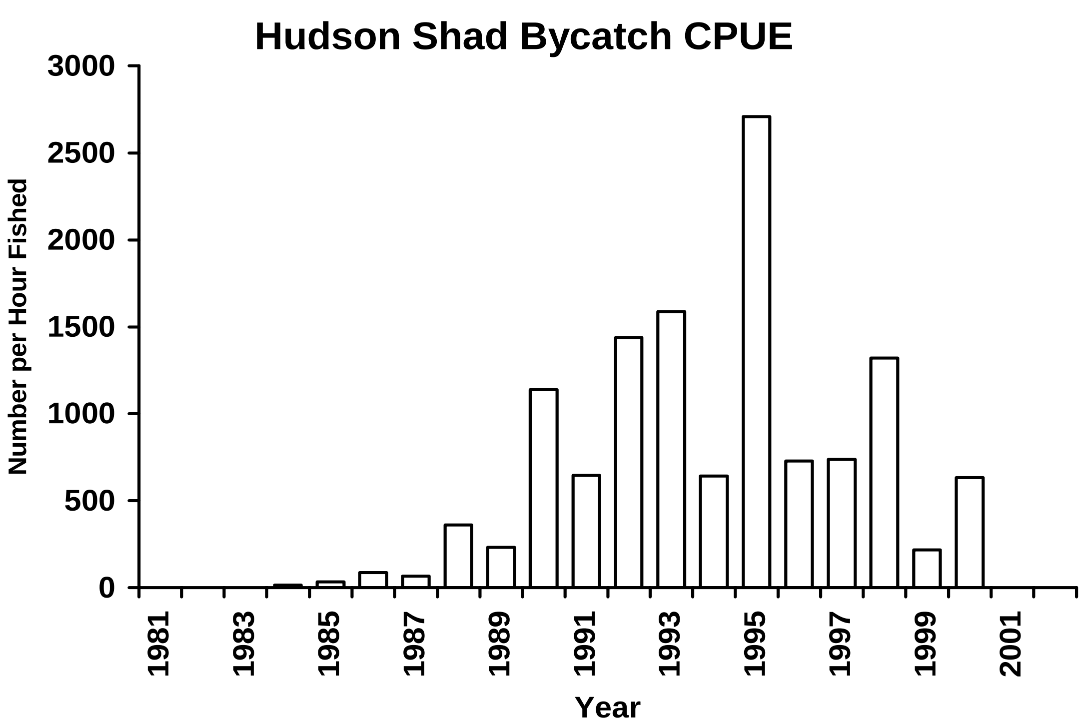


Figure 5 continues





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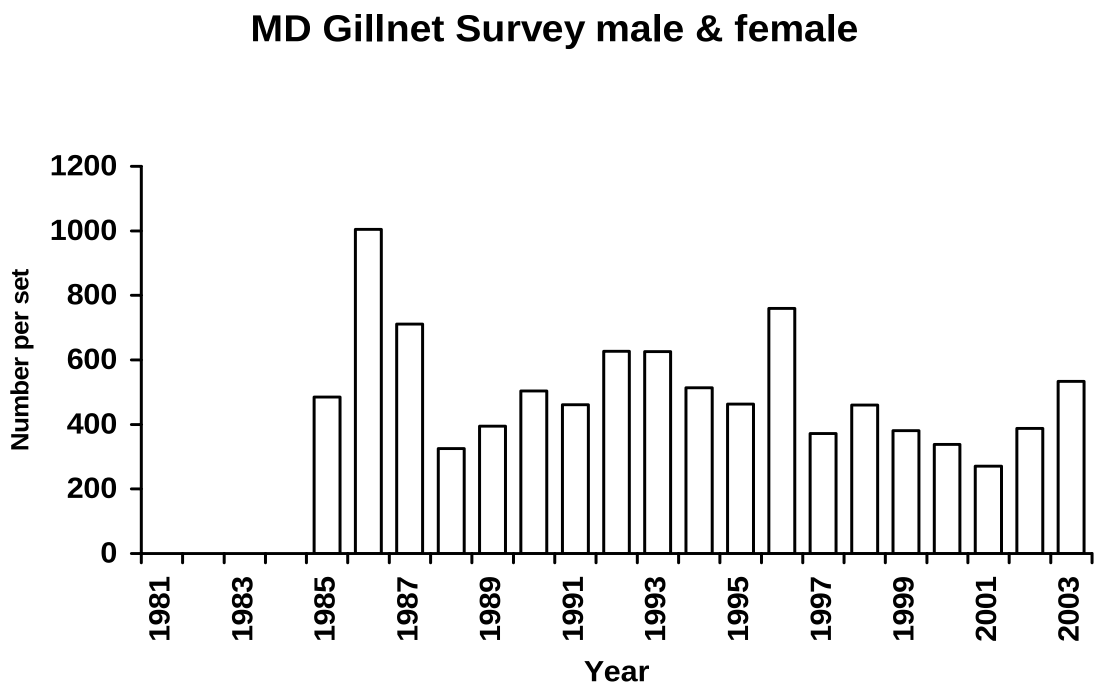

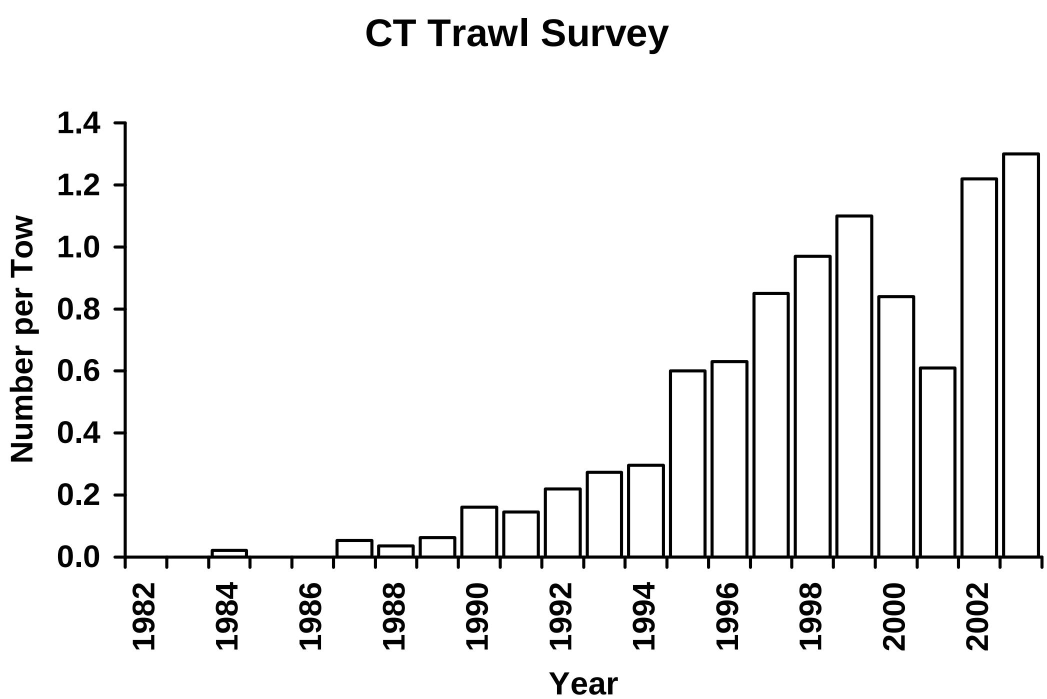

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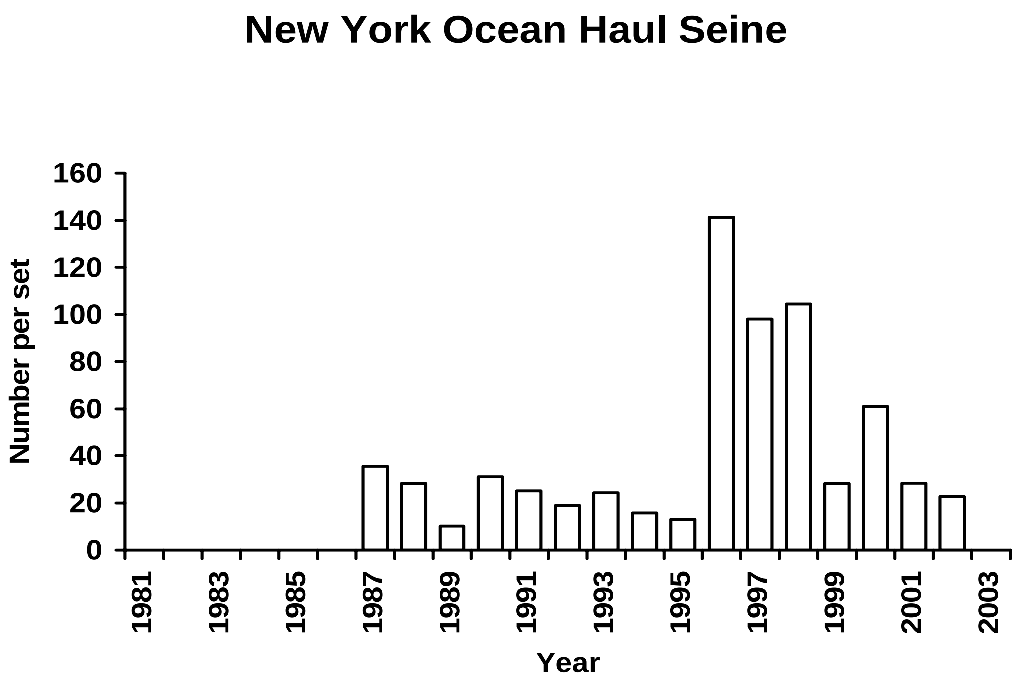

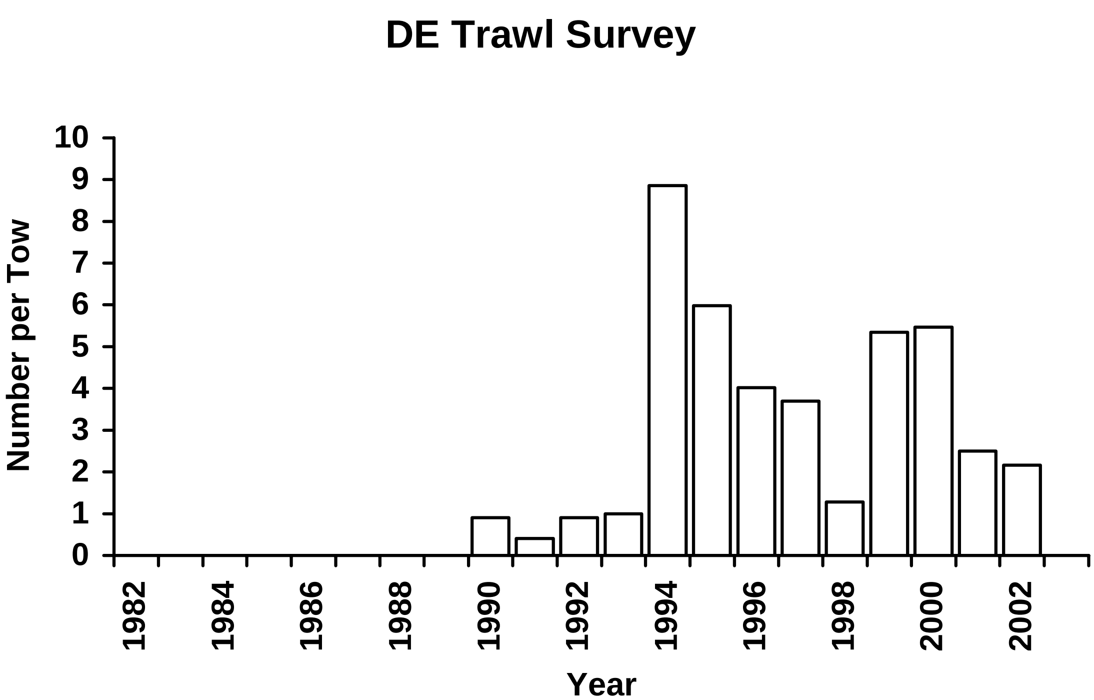

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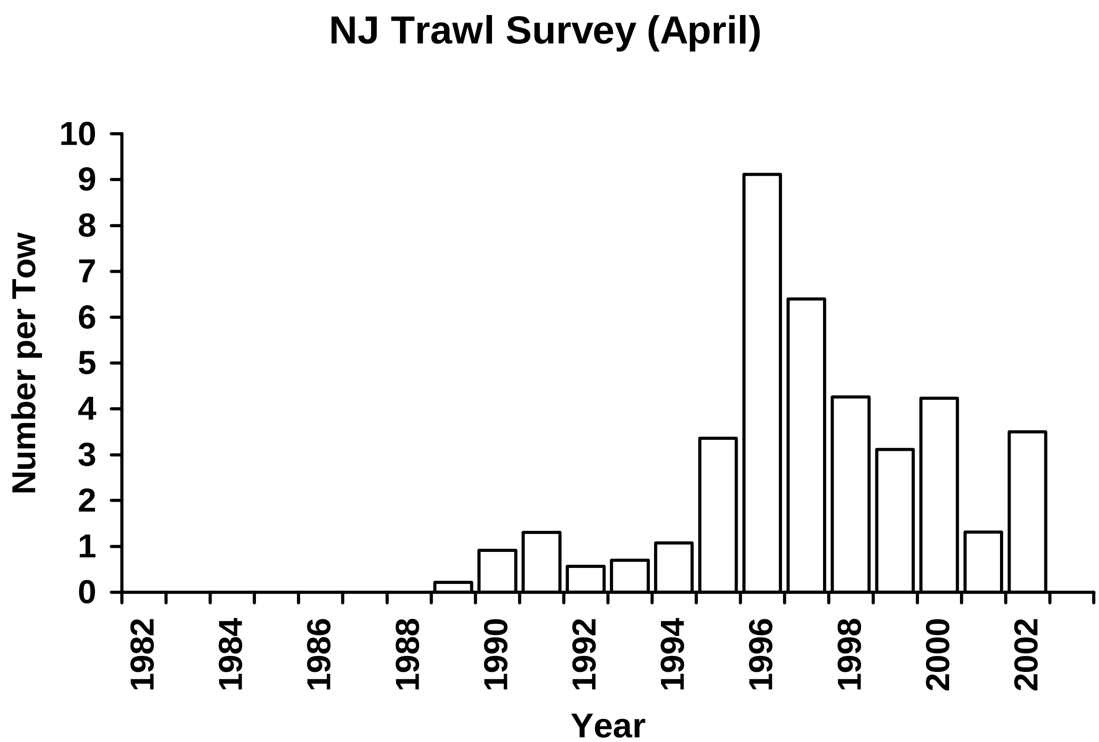


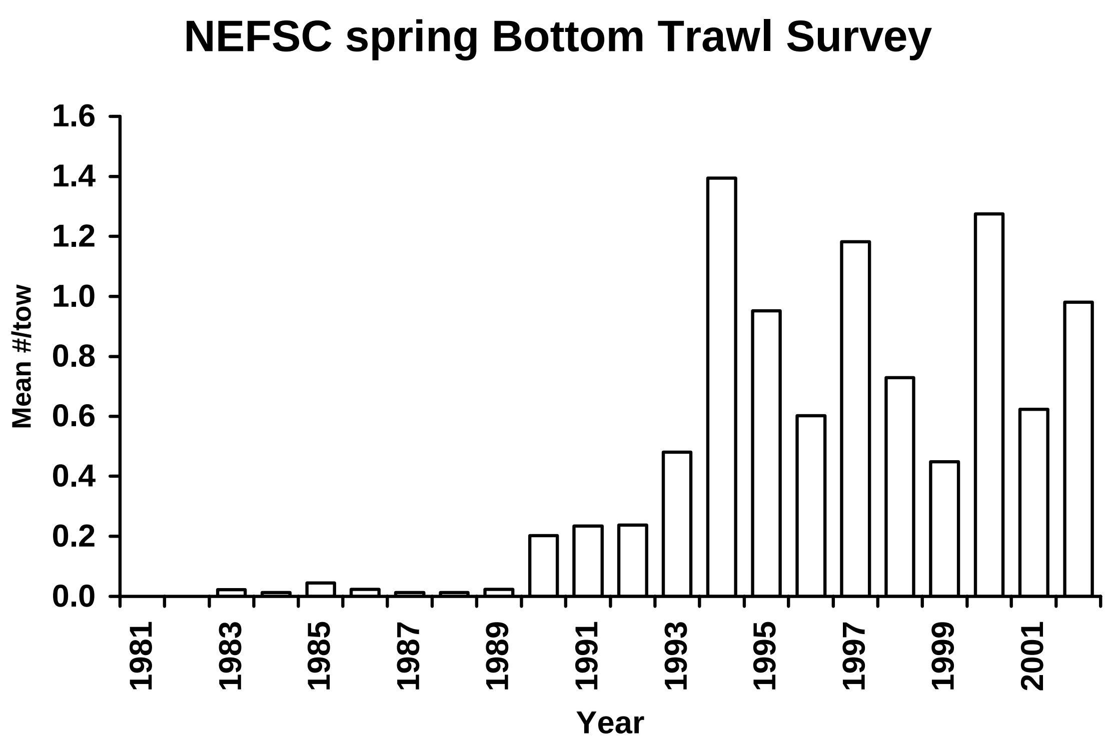
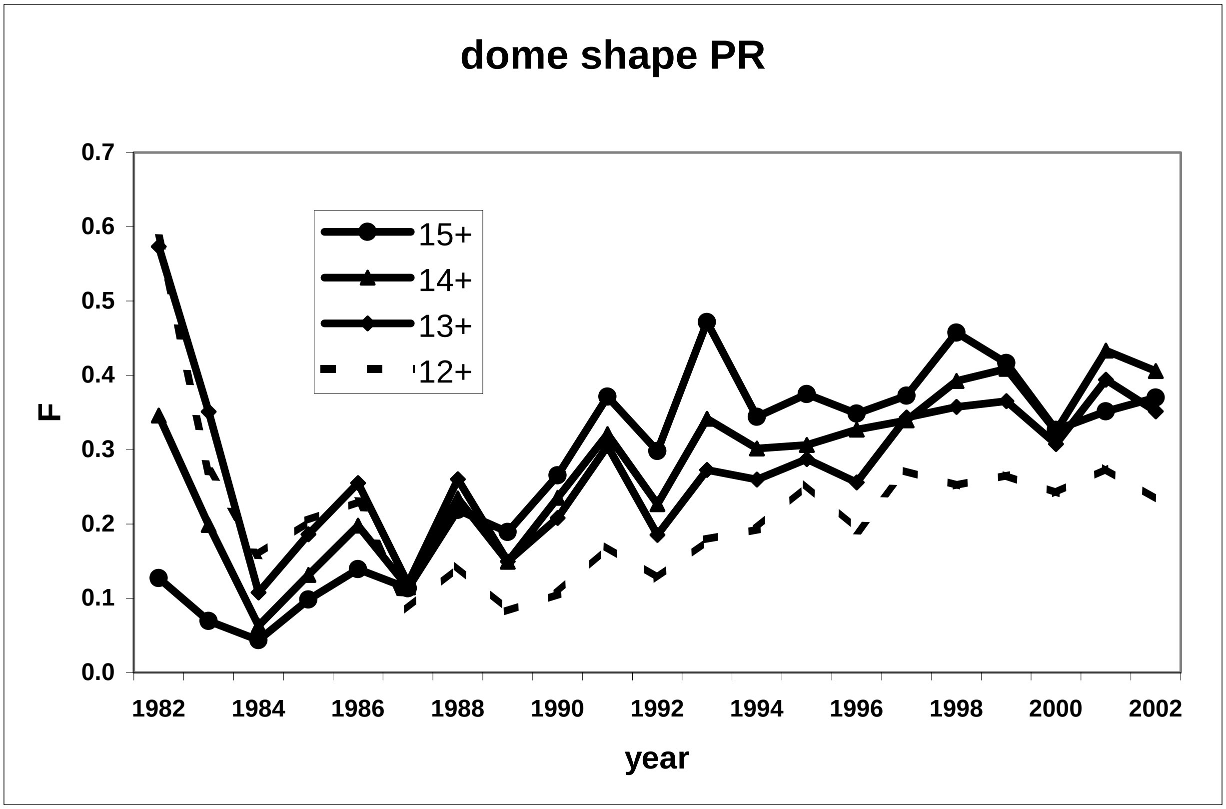


Figure 6. Striped bass fishing mortality from the 2002 ADAPT for ages 8+ for different plus group size (12+ through 15+) and dome and flat top partial recruitment vector.



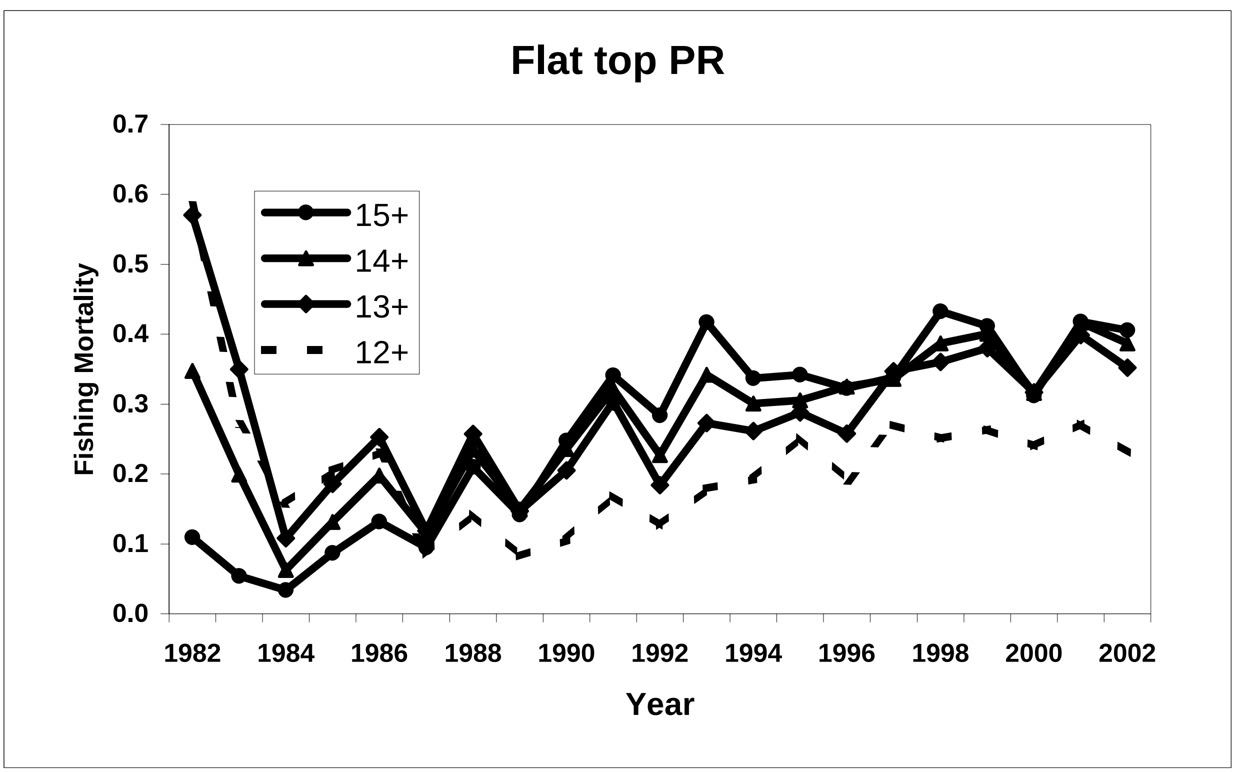


Figure 7. Striped bass fishing mortality for ages 8-11 (13+ group) estimated using 24 various estimation methods for the oldest true age F and full F in the terminal year within the ADAPT model .

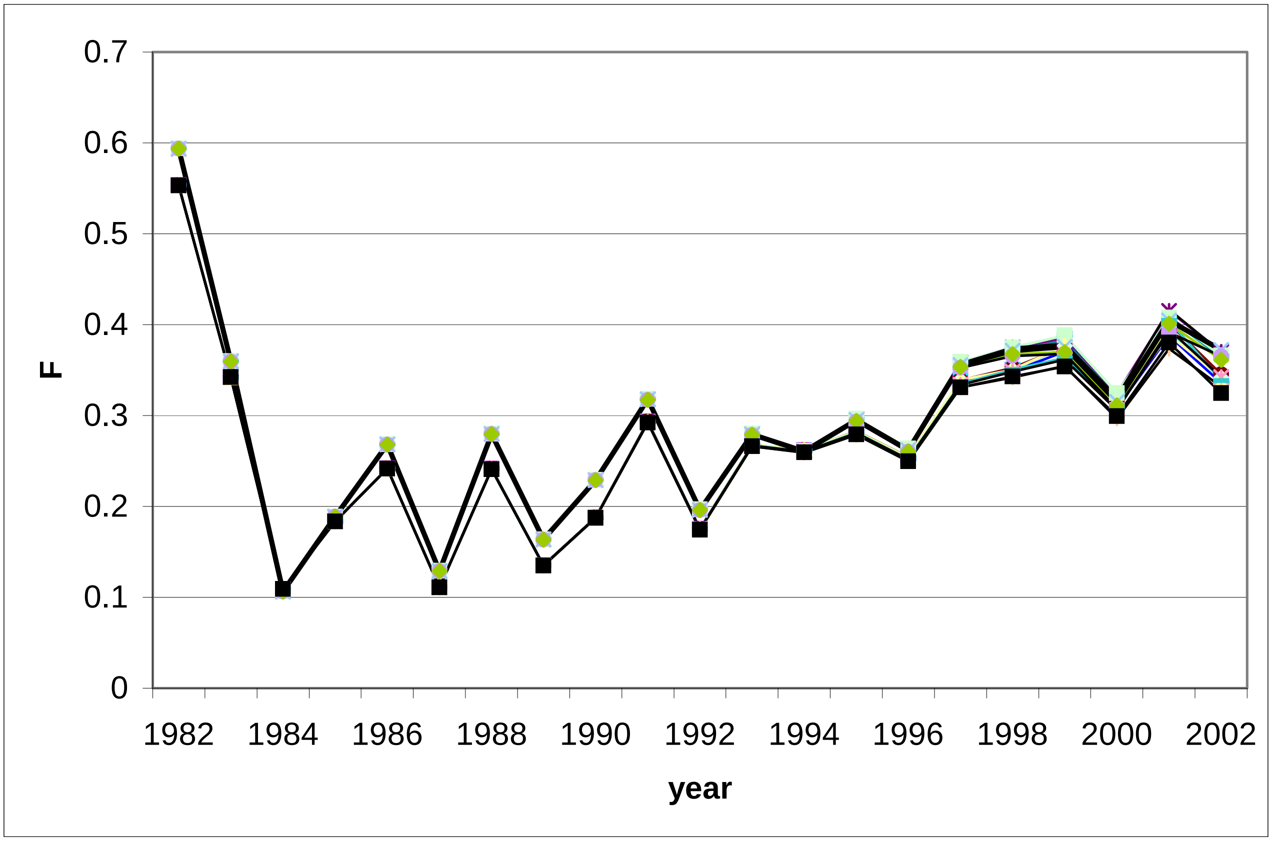


Figure 8. Relative error of average fishing mortality for ages 8-10 by plus group over the 19 year time period for each bias scenario.

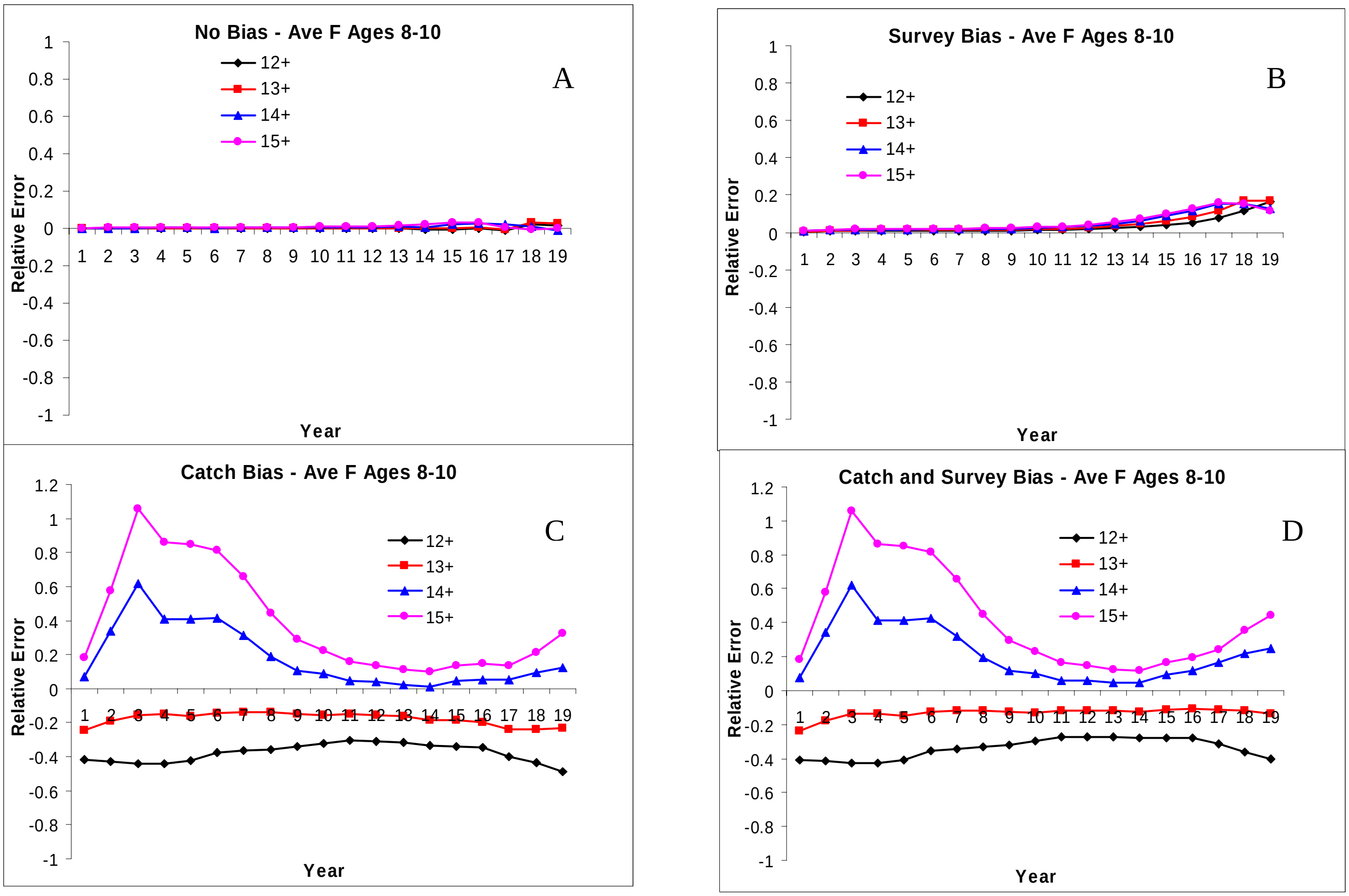


Figure 9. Striped bass fishing mortality from the 2002 ADAPT for ages 8-11 (13+ run).

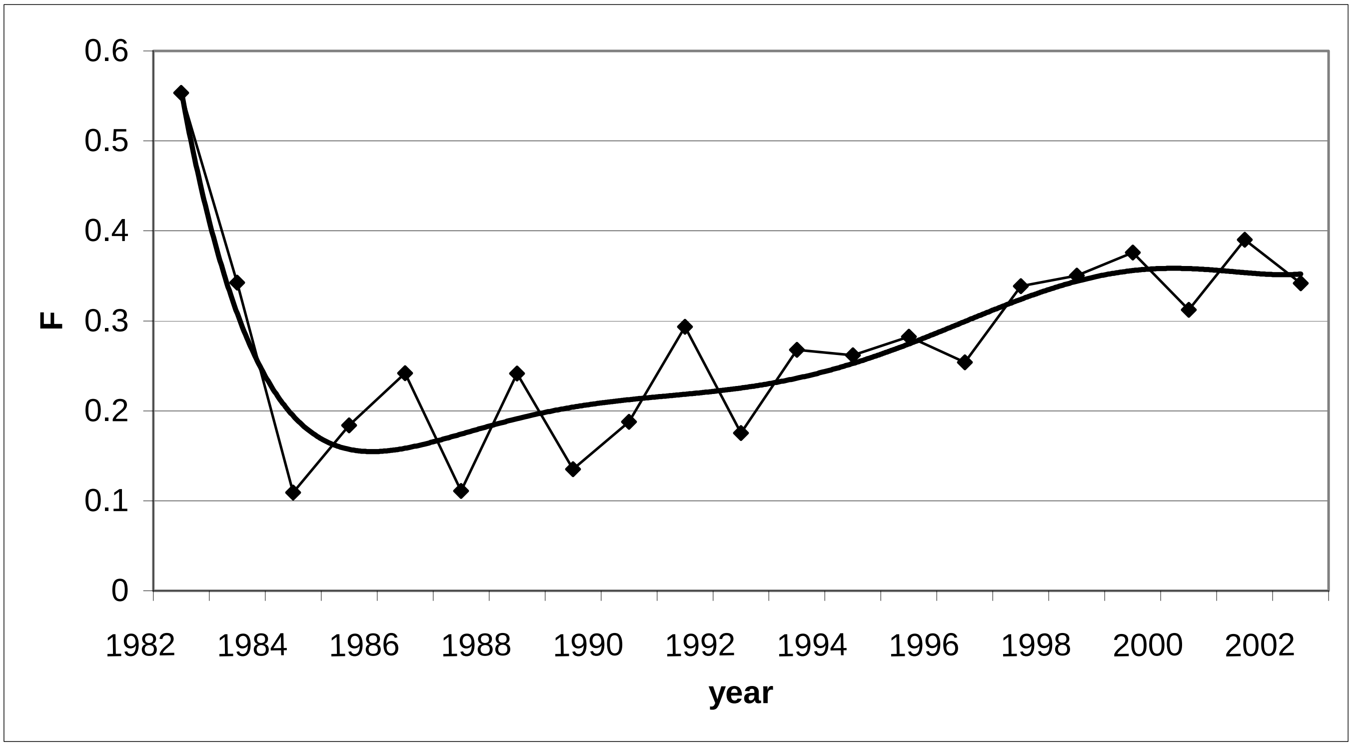


Figure 10. Striped bass fishing mortality from the 2002 ADAPT for ages 4-11 (13+ run).

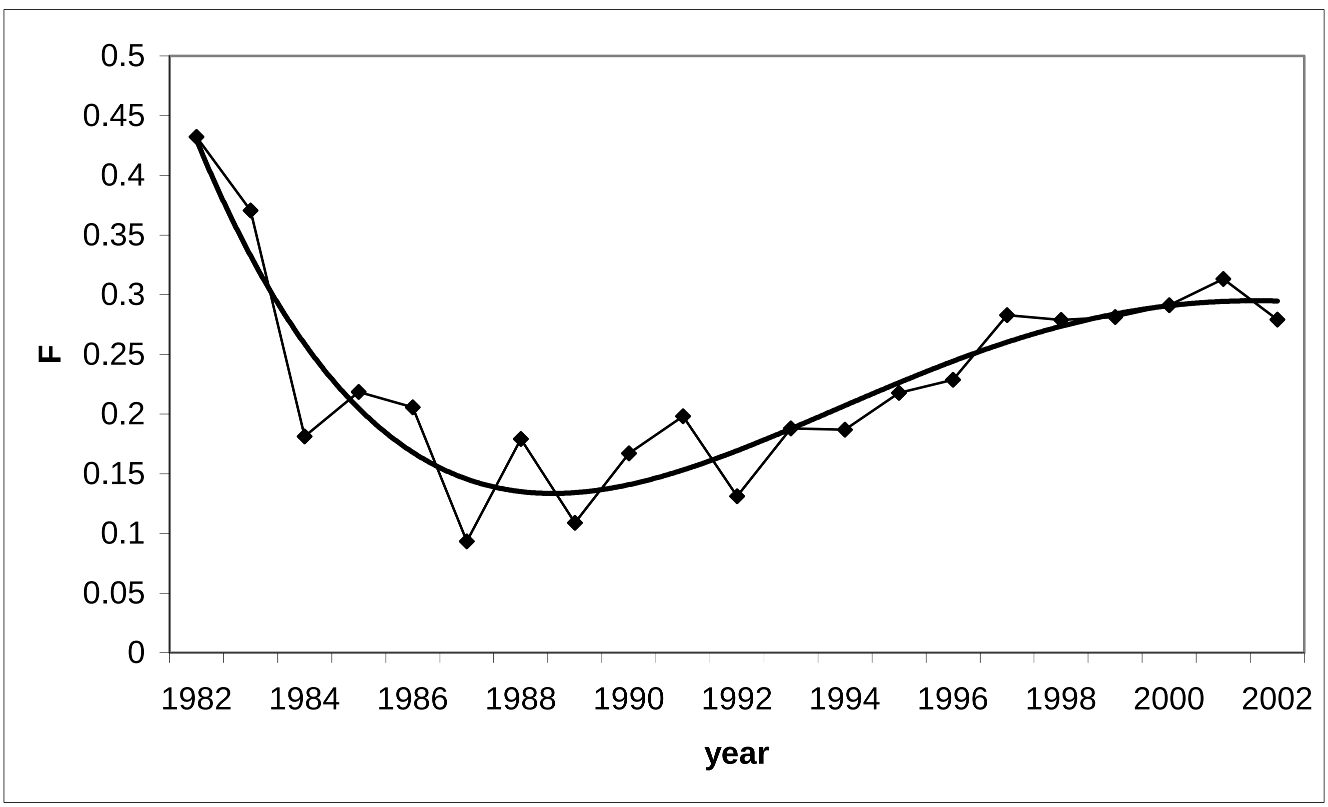


Figure 11. Striped bass fishing mortality from the 2002 ADAPT for ages 3 through 8, 13+ group.

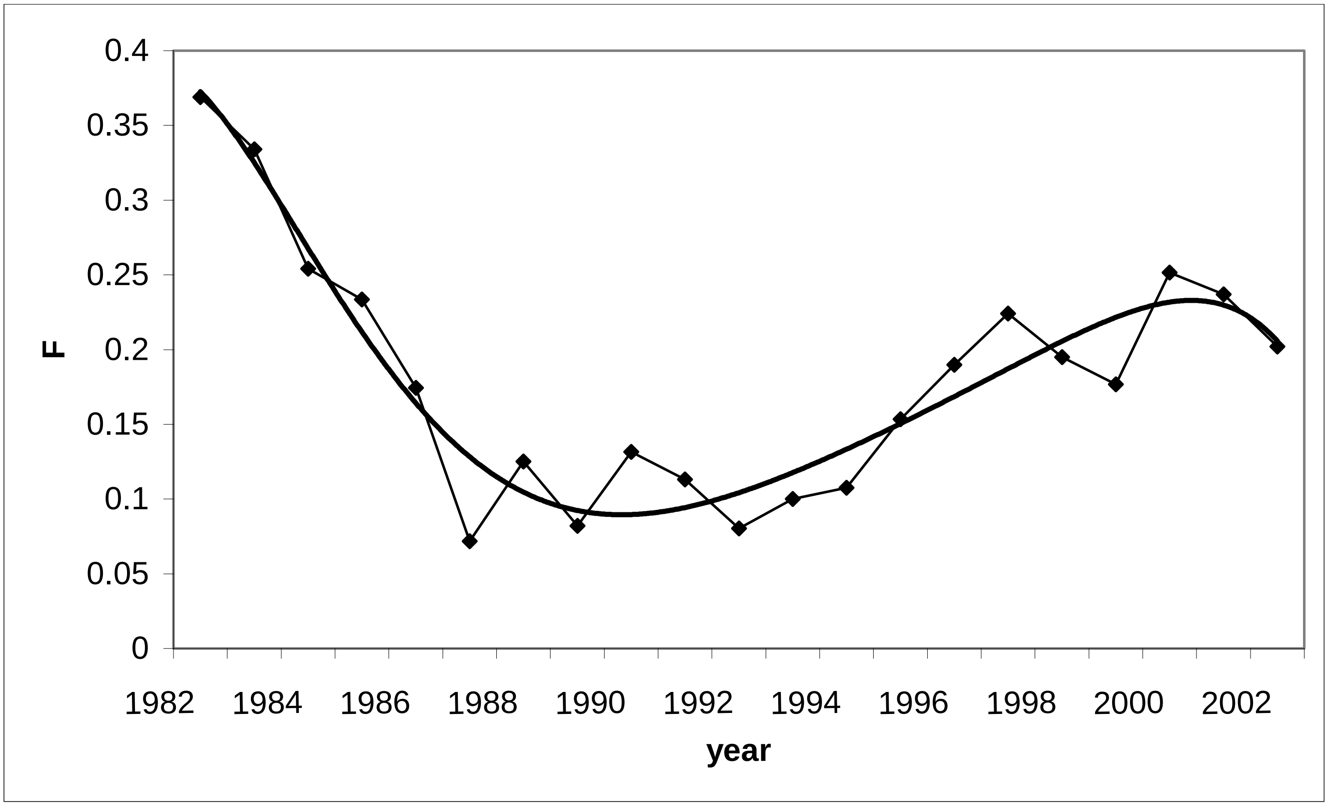


Figure 12. Distribution of VPA fishing mortality estimates on fully recruited ages (8-11) based on 500 bootstrap iterations. 80% confidence intervals are shown by dash lines.

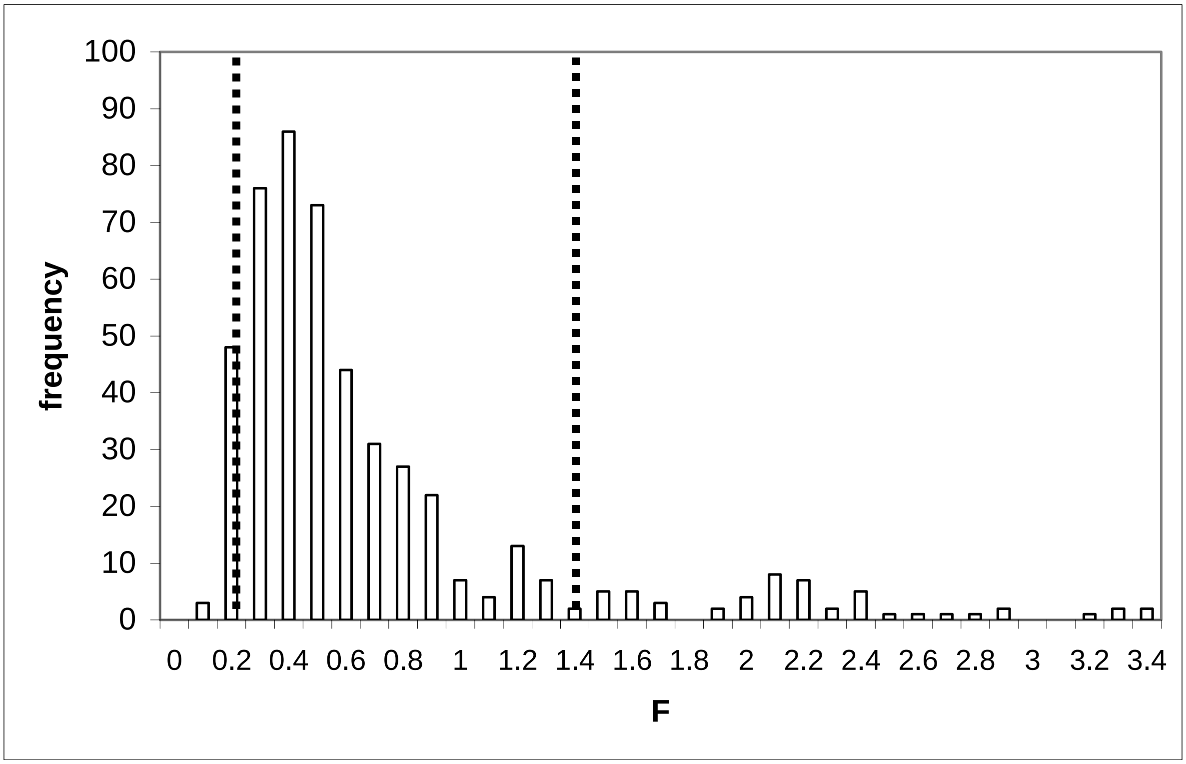


Figure 13. Population size (ages 1-13+) estimates from VPA.

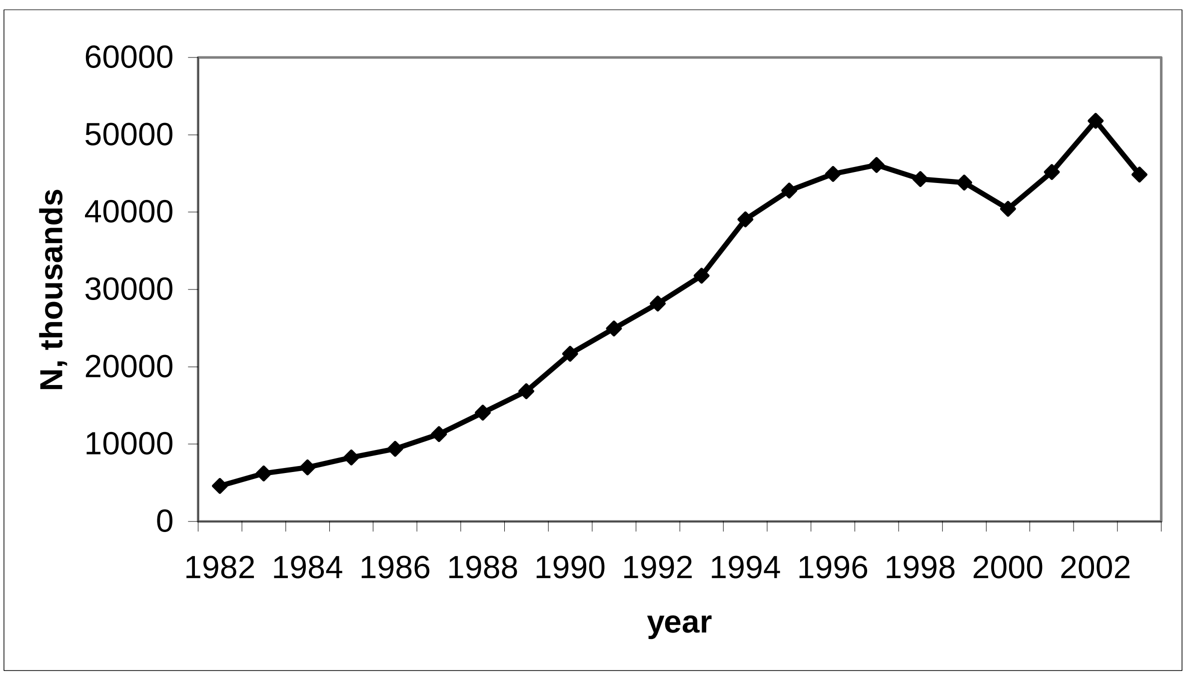


Figure 14. Population size (1+) probability distribution for January 1 2003 based on 500 bootstrap iterations of VPA model. 80% confidence intervals are shown by dash lines.

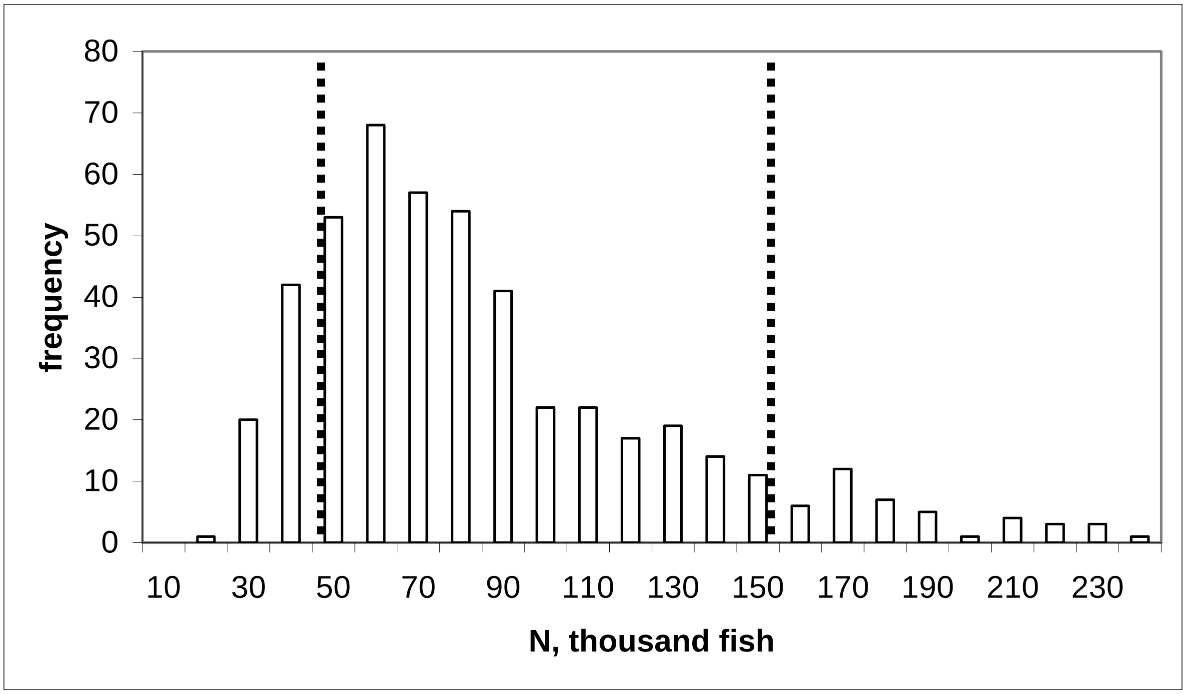


Figure 15. Recruitment (Age 1).estimates from VPA model.

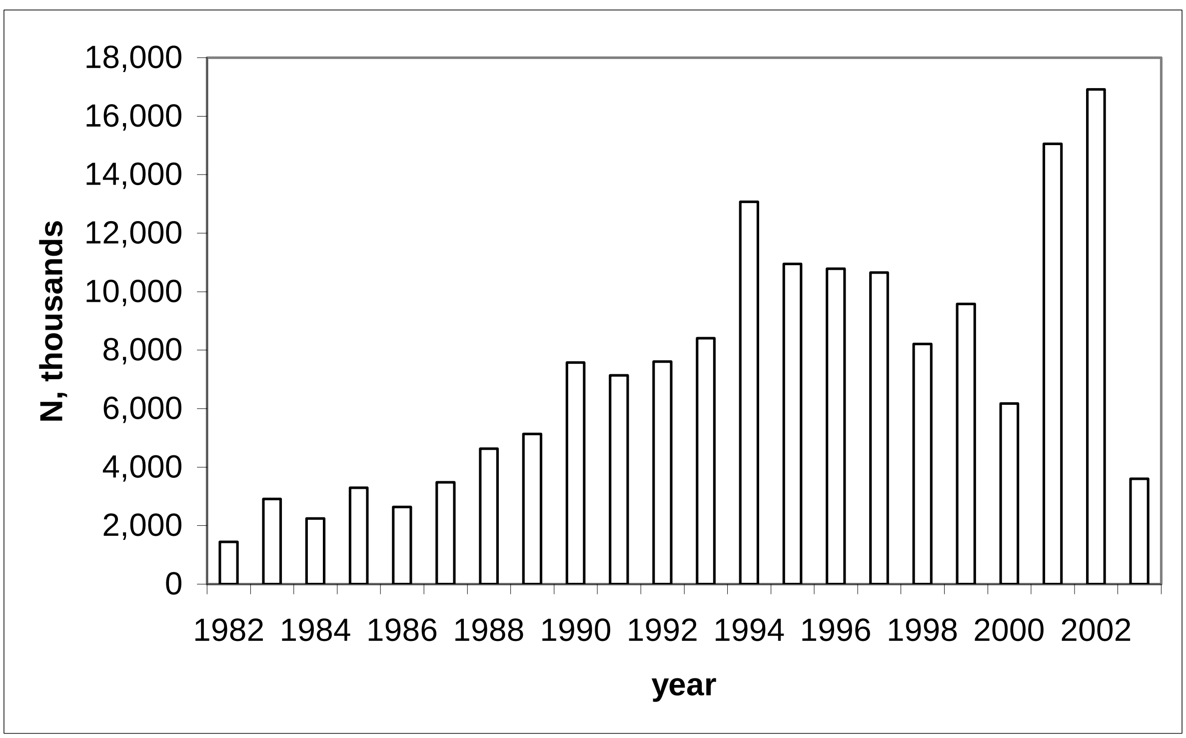


Figure 16. Female spawning stock biomass from VPA model.

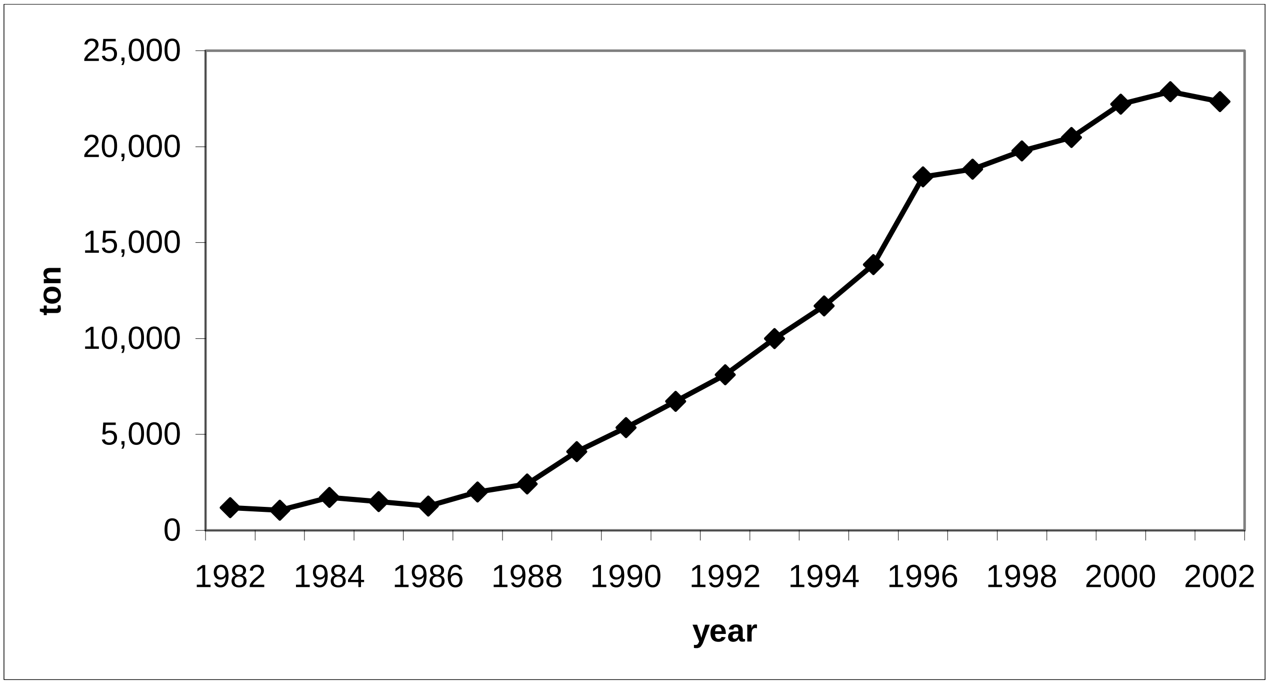


Figure 17. Retrospective plot of average F for ages 8-11.

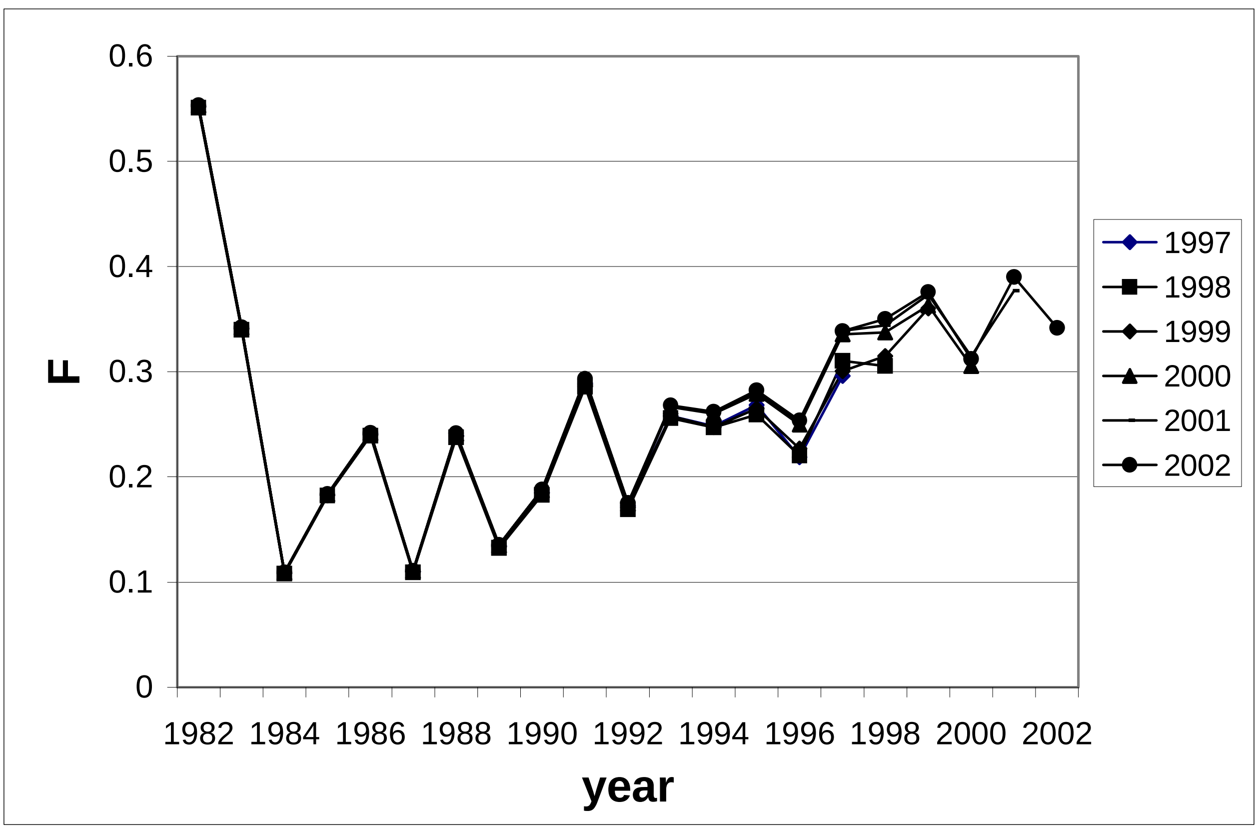
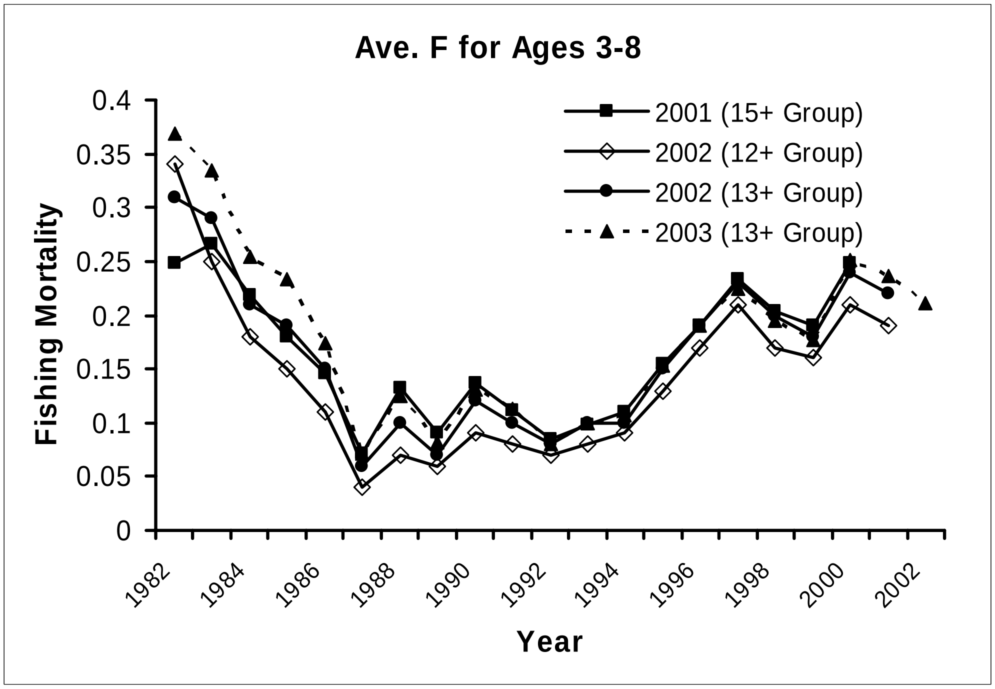


Figure 18. Comparison of F estimates reported in the 2001, 2002, and current (2003) assessments.



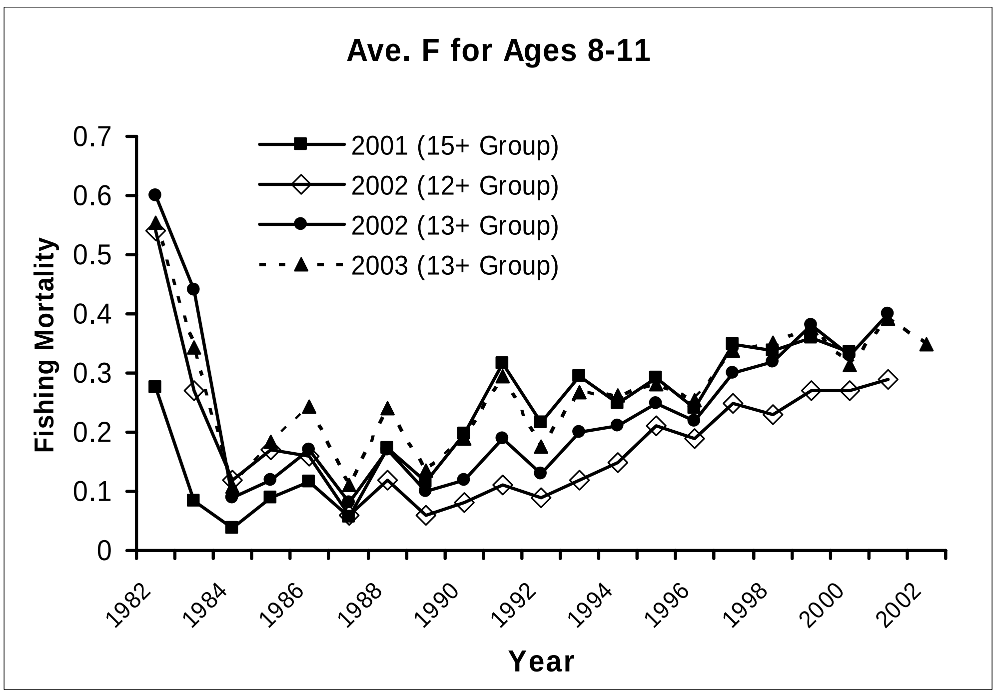
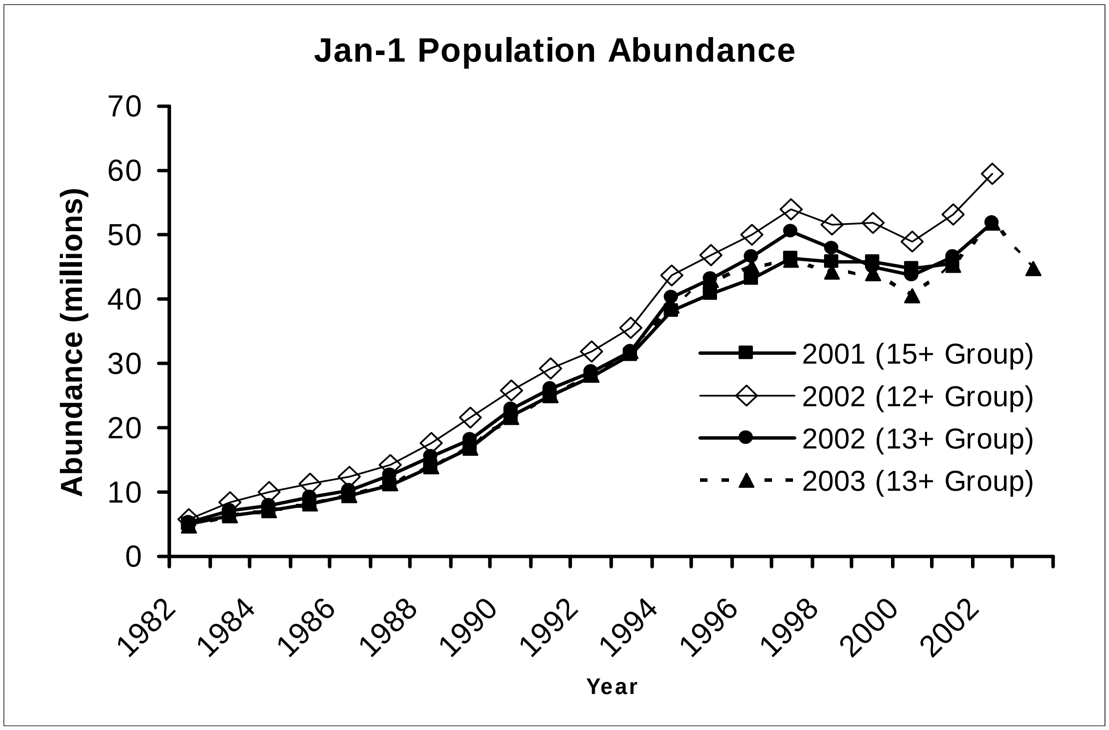


Figure 19. Comparison of total abundance (1+) and spawning stock biomass reported in the 2001, 2002, and current (2003) assessments.



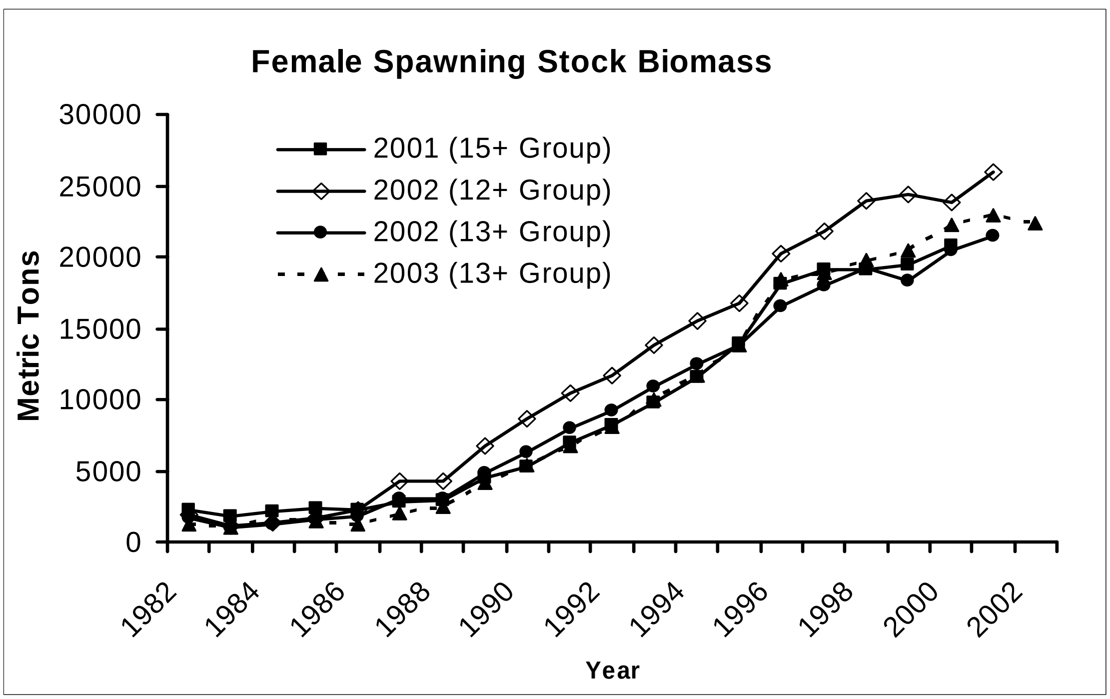


Figure 20. Tag-based estimates of annual instantaneous fishing mortality of striped bass >=28 inches.

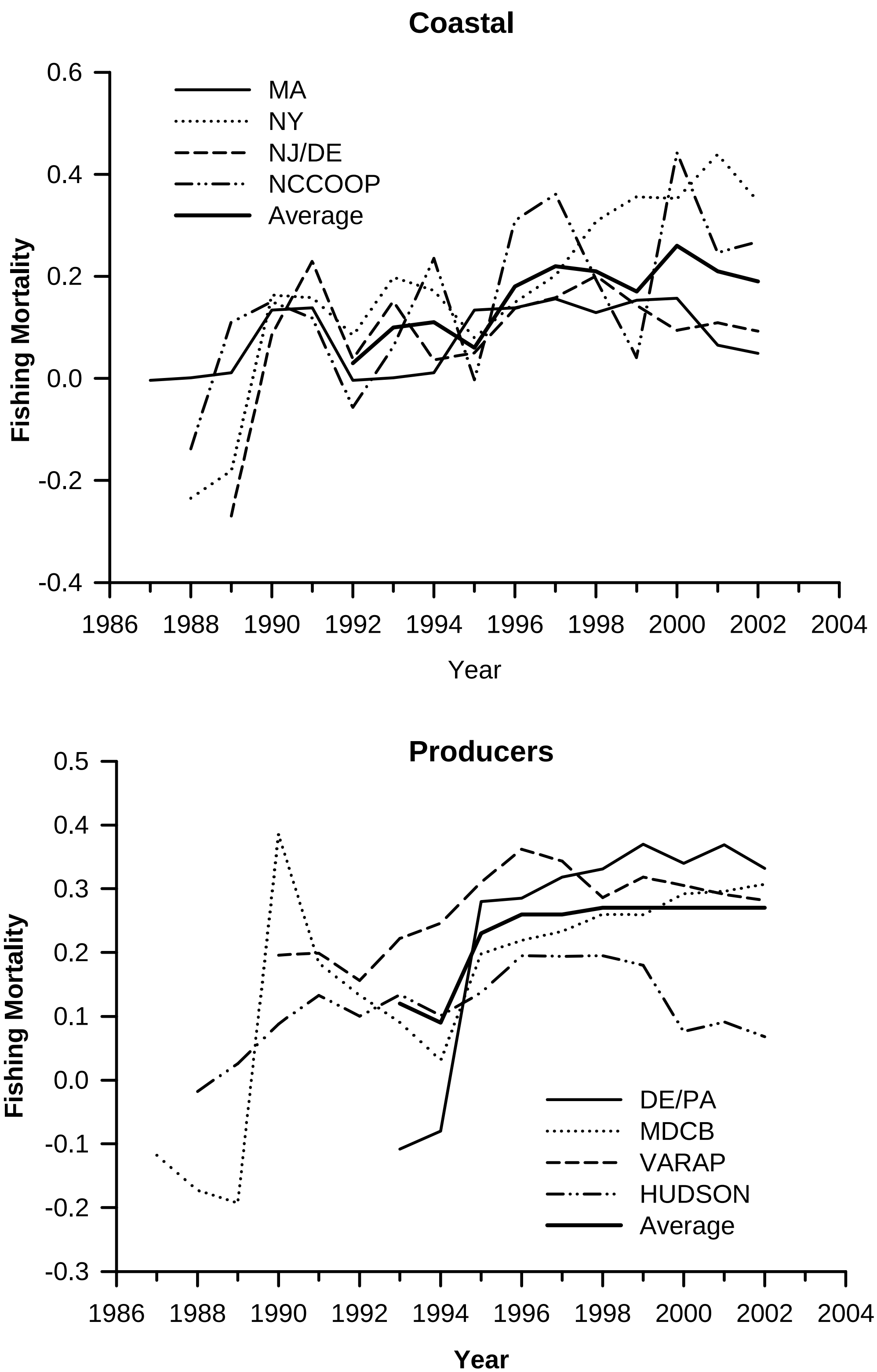


Figure 21 Tag-based estimates of annual instantaneous fishing mortality of striped bass >=18 inches.

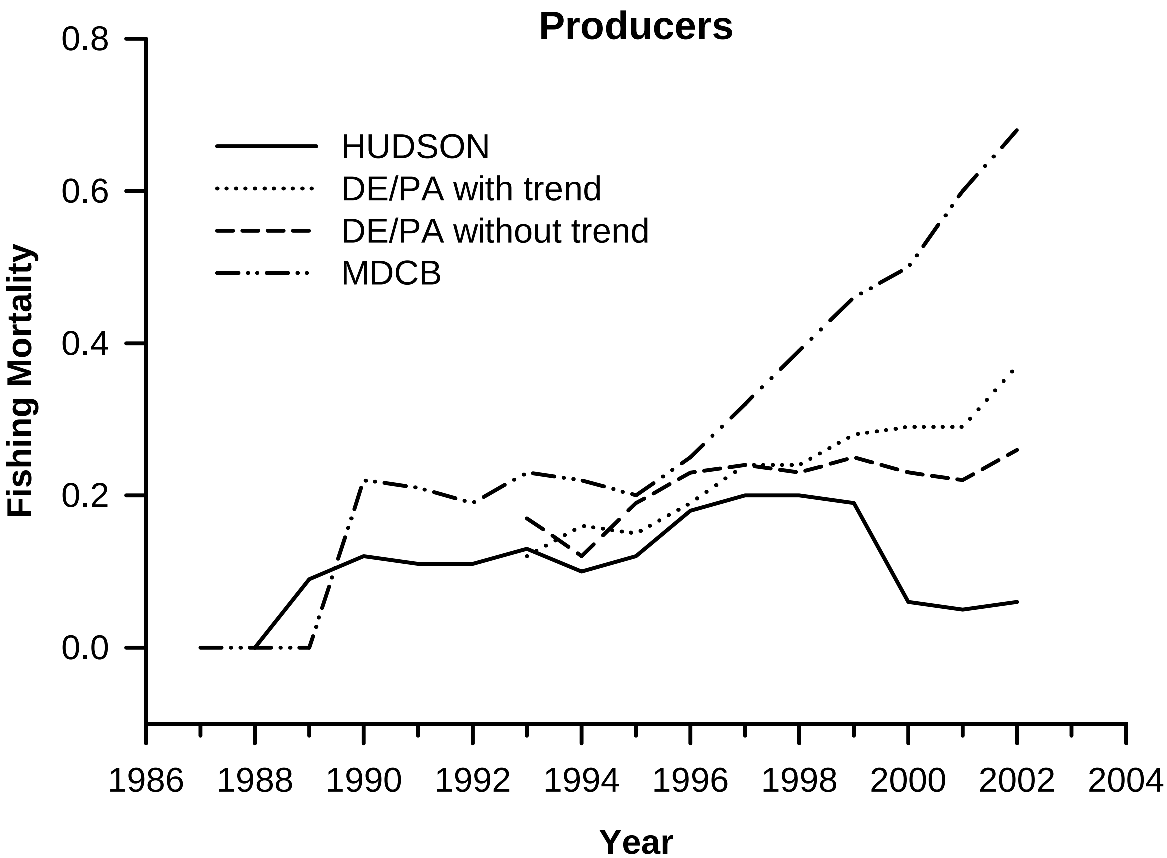


Figure 22. Length frequencies of 2002 marked striped bass > 700 mm.

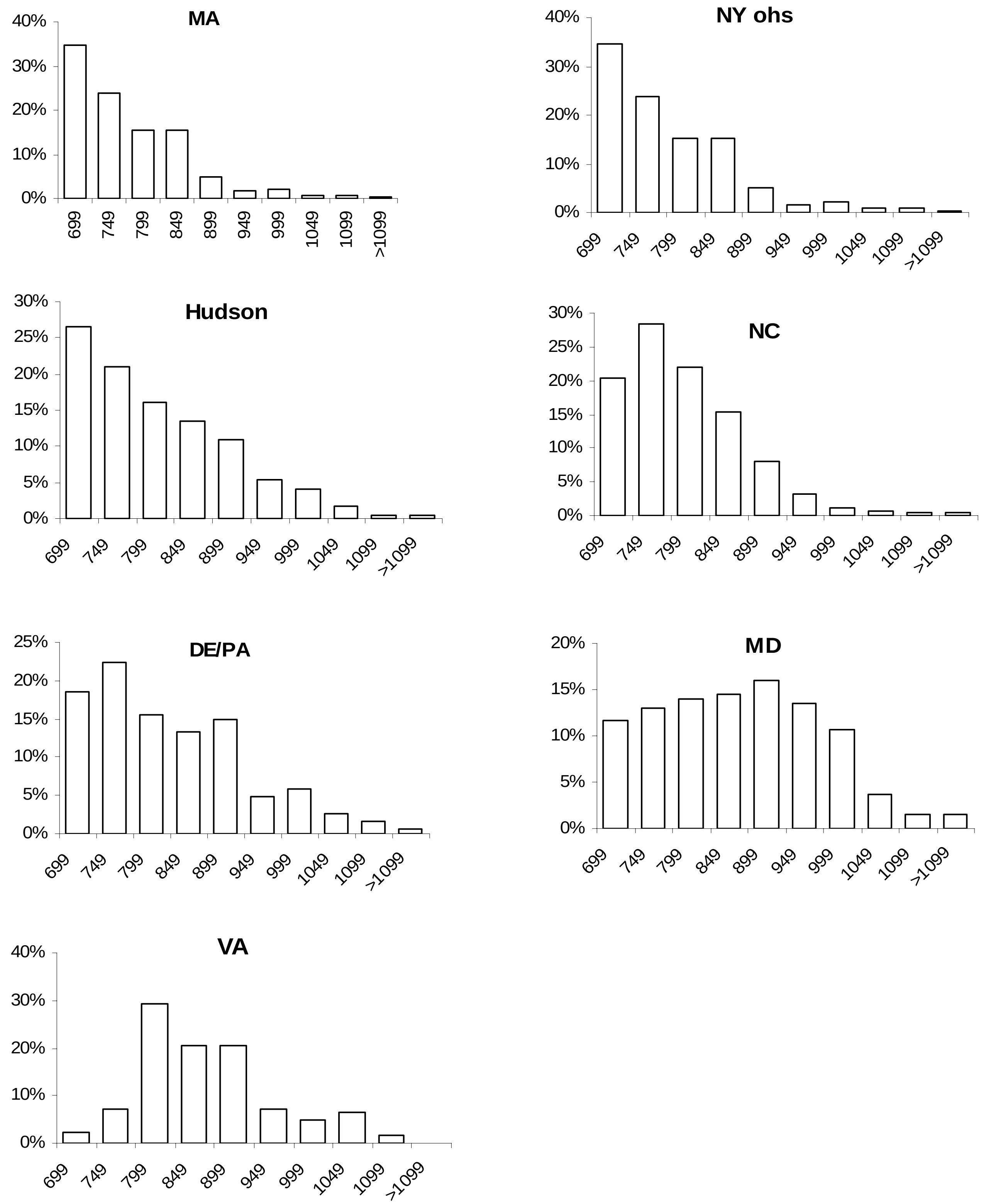


Figure 23. Comparison of N-weighted ages 7-11 VPA and tag-based (≥28") F estimates.

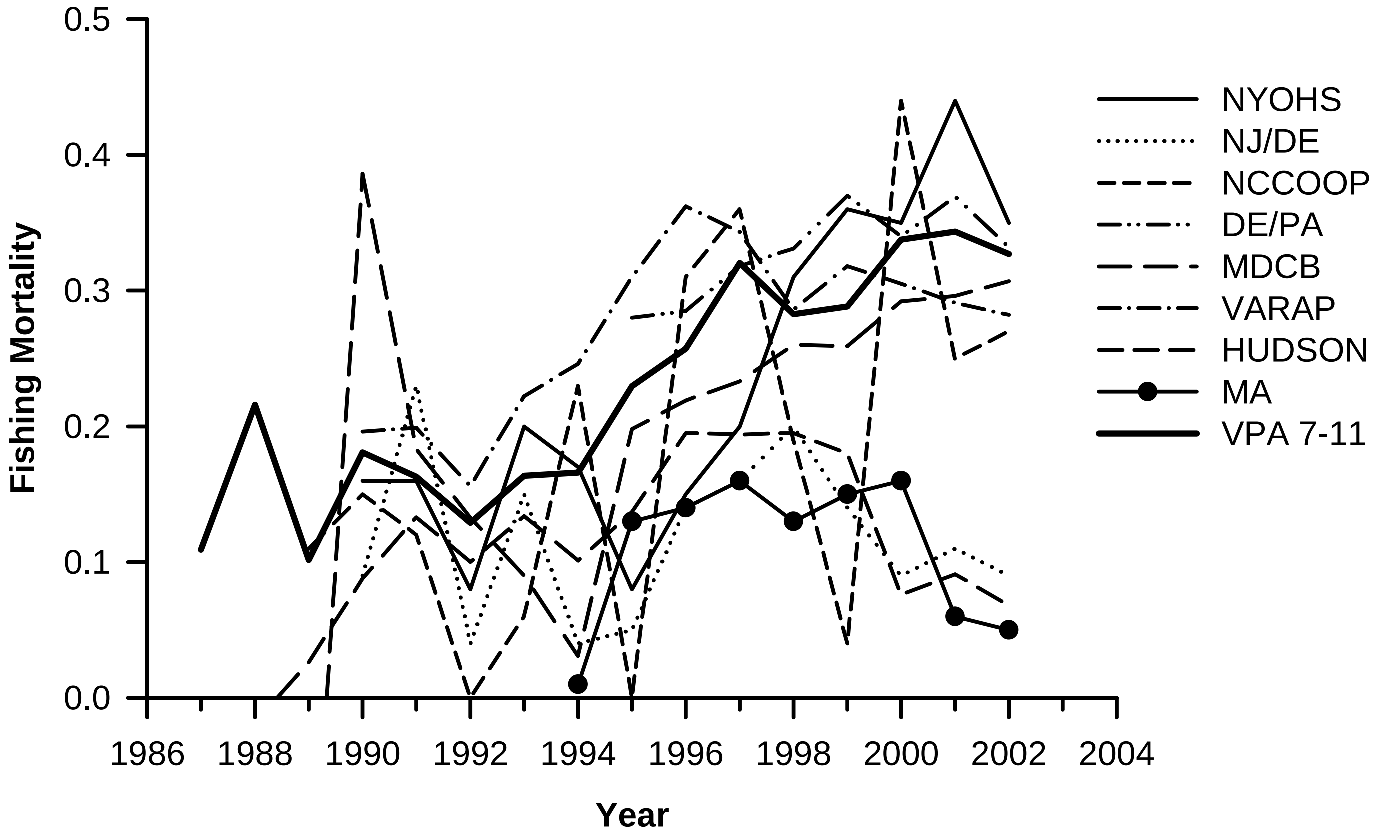


Figure 24. Age 7-11 VPA F (weighted by N) and mean ± 95% CI from ≥ 28" tag based Fs.

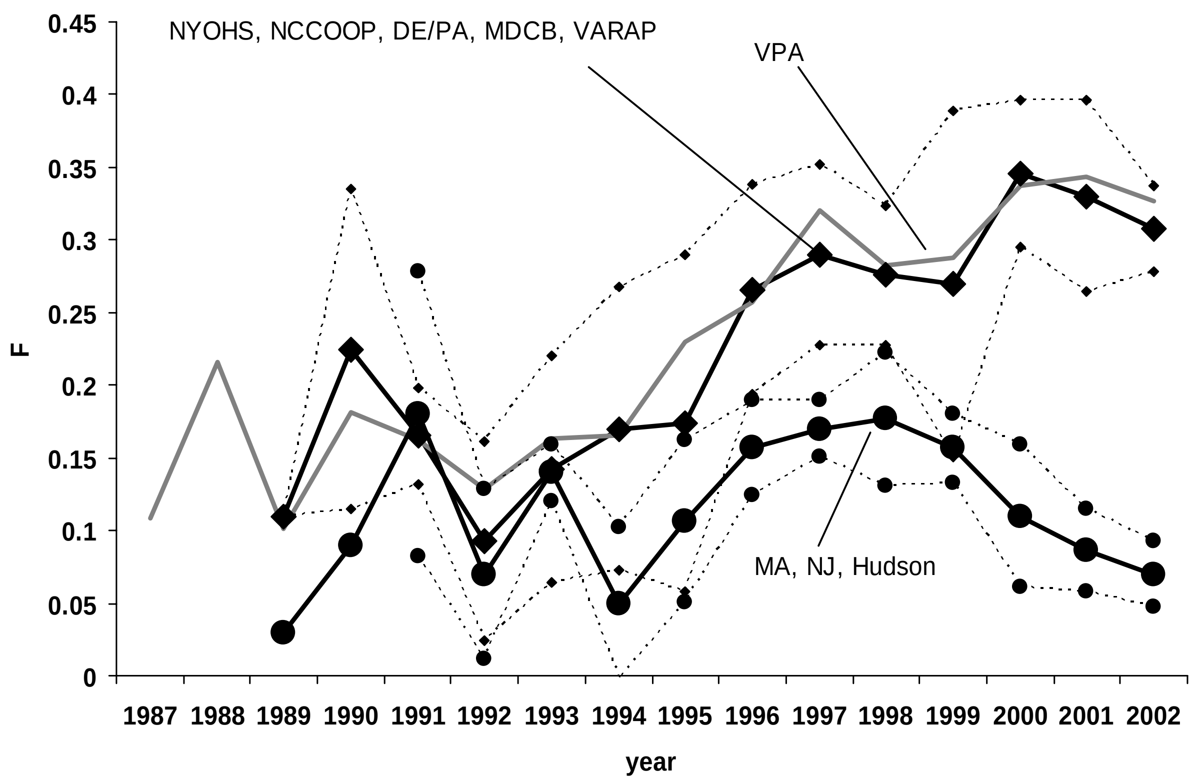


Figure 25. R/M based estimates of exploitation rate for each tagging program, and the VPA (N weighted) exploitation (converted from F).