2005 Stock Assessment Report for Atlantic Striped Bass:

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

A report prepared by the
Striped Bass Technical Committee
for the Atlantic Striped Bass Management Board

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ATLANTIC STATES MARINE FISHERIES COMMISSION

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

2005 Atlantic Striped Bass Advisory Report

Status of the Stock

Fishing Mortality Rates: Based on VPA results**,** average age 8-11 fishing mortality in 2004 is estimated at F=0.40 which is below the Amendment 6 threshold of 0.41 but exceeds the target of 0.30. However, it is the consensus of the Technical Committee members that this is likely an overestimate of the 2004 F given the uncertainly with the terminal year estimate from the VPA and the systematic positive bias observed in the retrospective analysis. The 2003 value of F from this year's VPA is 0.29, which is substantially lower than the terminal year F from last years VPA run of 0.62. This is due not only to the addition of another years worth of data but also due to the modified suite of tuning indices used in the this years VPA and the inclusion of wave 1 (Jan./Feb.) estimates of recreational harvest mortality from NC and VA for 1996 – 2004 (see Data and Uncertainty section below).

The 2004 tagged based estimates of F using, stock-specific, model-based estimates of fishing mortality and a constant M of 0.15, were as follows. For fish greater than 28 inches, the coast-wide average F was estimated as 0.29 and specific tagging program values ranged from 0.02 in the New York ocean haul survey (NYOHS) to 0.31 in the Maryland (MD) tagging program. This value was similar to the VPA F weighted by N value for age 7-11 fish of 0.32. For fish greater than 18 inches, the coast-wide average F was 0.29 and specific tagging program values ranging from 0.06 in the Virginia spawning stock (VARAP) program to 0.68 in the New Jersey Delaware Bay (NJDEL) program. This tag-based F estimate was greater than the VPA F weighted by N value for age 3-11 fish of 0.15.

The 2004 tagged based estimates of F using, stock-specific, catch-equations for fish greater than 28 inches, indicated the coast-wide average F was 0.14, and specific tagging program values ranged from 0.09 in the VARAP program to 0.26 in the Delaware and Pennsylvania (DE-PA) tagging program. These F estimates were less than the VPA F weight by N, for age 7-11 fish, of 0.32. For fish greater than 18 inches, the coast-wide average was 0.11, and specific tagging program F estimates that ranged from 0.05 in three different programs to 0.17 in the MD program. This tag-based F estimate is similar to the VPA F weighted by N value for age 3-11 fish of 0.15.

Chesapeake Bay fishing mortality in 2004 is estimated as F=0.16 by the direct enumeration study. This F represents mortality during the June 2003 – June 2004 period, so it is not directly comparable to the average, weighted (by N) VPA calendar-year F on age 3-8 striped bass that is equal to 0.12.

Exploitation Rates: Based on the tagging programs, R/M estimates produced by 5 (VARAP, NCOOP, MD, NYHUD, and DE/PA) out of 8 programs have shown a decline in exploitation rates since the late 1990's. During the same period, the NYOHS and MA tagging programs have showed no trend and the NJDEL program has shown an increase in exploitation in recent years.

Stock Size: The estimate of total abundance for January 1, 2005 from the ADAPT VPA is 65.3 million age-1 and older fish. This estimate is about 1.2 million fish lower than the 2004 abundance but 10% higher than the average stock size for the previous five years. Population estimates were calculated for the first time this year from tag based F estimates using the catch equation. The 2004 population estimate of age 3+ fish was 48.5 million fish that is roughly 8 million fish higher than the 2003 estimate. This estimate is higher than the ADAPT VPA estimate of 39.2 million age 3+ fish at the beginning of 2004.

The abundance of older fish (age 13+ from the ADAPT VPA) in the stock has also increased from 382,000 fish at the beginning of 2003 to 547,000 fish on January 1, 2005.

Spawning Stock Biomass (SSB): The female spawning stock biomass for 2004 is estimated at 55 million pounds which is above the recommended biomass threshold of 30.9 millions pounds (13,956 mt) and the target SSB of 38.6 million pounds (17,500 mt). SSB has declined by 9% since 2002 when it peaked at 60.6 million pounds.

Recruitment: Recruitment of the 2004 cohort for all stocks combined is 12.7 million age-1 fish, which is close to the average age-1 recruitment observed since the stocks were declared recovered in 1995

Catch: Total catch in numbers including landings and discards increased from 3.9 million fish in 2002 to 5.2 million fish in 2004, a 33.3 % increase in losses since implementation of Amendment 6. The 2004 catch was also above the 1997-2003 average of 4.36 million fish. Ages 3 to 7 represented 59%, and ages 8+ represented 36% of the total catch in 2004. The strong 1996, 2000, and 2001 year-classes dominated the catch, accounting for 41% of total catch. Total catch of age 8+ fish increased from 1.4 million fish in 2002 to 1.8 million fish in 2004 (the highest level recorded in the time series) and the proportion of 8+ fish in the catch increased to 36% in 2004 from 30% in 2003.

Recreational harvest (2.4 million fish) and discards (17.2 million fish) accounted for 72.5% of the total 2004 catch. Virginia recreational fisheries harvested 19.6% of total recreational landings, followed by New Jersey (17.7%), Massachusetts (17.1%), Maryland (13.2%), North Carolina (13.2%), and NY (10.2%). The remaining states each landed 5% or less of the total recreational landings.

Estimates of Wave 1 (January-February) recreational harvest in North Carolina and Virginia from 1996-2004 were included in the catch at age for the first time this year. The estimates ranged from 7,544 in 2000 to 177,288 fish during 2004 in North Carolina and 5,985 fish in 1996 to 155,616 fish in 2004 in Virginia. These Wave 1 harvest estimates represented between 2% and 14% of the total coast-wide recreational harvest during those years.

Commercial harvest (0.91 million fish) and discards (0.51 million fish) accounted for 27.5% of the total 2004 catch. Maryland commercial fisheries harvested 50.8% of the total commercial landings, followed by VA (16.3%), PRFC (10.1%), NY (7.8%), and MA (6.7%). The remaining states each landed 4% or less of the total commercial landings.

Data and Uncertainty: A formal review of abundance indices used in former assessments was initiated by ASMFC at a workshop in July of 2004. This workshop developed a set of evaluation criteria (Appendix A) and tasked states with a review of indices. The resulting review led to a revision and elimination of some indices formerly used in the ADAPT VPA. Both the Striped Bass Technical Committee and the Management Board approved of the criteria and of the review. The indices underwent further review based on residual patterns following initial model runs. This is a standard annual procedure that led to the elimination of additional indices for the 2005 analysis.

A winter fishery (January-February) for striped bass has developed off of North Carolina and Virginia since the mid-1990's. MRFSS estimates are not available from this time of year in Virginia and are only available for 2004 in North Carolina. Landings were estimated for these fisheries back to 1996 using observed relationships between landings and tag returns. These estimates were included in the catch at age matrix of the ADAPT VPA for the first time this year.

A variety of concerns were expressed by some members of the Technical Committee concerning input data for the assessment including the accuracy of aging older fish, the methods used to estimate commercial and recreational discards, the methods used to estimate NC and VA recreational harvest in Wave 1 dating back to 1996 and about the MRFSS estimates in general.

Uncertainties expressed by some members of the Technical Committee concerning the ADAPT VPA model include potential violations of some of the model assumptions such as the assumption that the catch at age is measured with out error. Concerns about the model output included the validity of bootstrap generated error estimates for terminal year F as calculated by ADAPT, the significant discrepancies between VPA estimates using old and new indices, and the retrospective bias (positive for F; negative for SSB) in the terminal year estimate that was apparent in most VPA runs for striped bass over the past few years. Some members felt that a correction to the terminal year estimate of F should be made using the average bias shown in this year's VPA run. However, other Technical Committee members were concerned about doing this because the direction and magnitude of the bias could change in next years VPA run.

Most Technical Committee members expressed the need for a more current estimate of the tag reporting rate used in the tag based estimates. The estimate currently being used is 0.43 and was based on a study in 1999 conducted on the Delaware River spawning stock. If the 1999 estimate is higher than the current tag reporting rate, the exploitation rate and the F estimate are underestimated. If the rate is lower than the current reporting rate, then F estimates are overestimated. A research grant proposal is currently in submission to conduct a coast-wide high reward tagging study to develop a more current estimate of the reporting rate that applies to a wider geographical area. Some TC members suggested this type of study should be conducted at regular intervals (e.g. every 3 years).

Concerns mentioned about the survival estimates from the Brownie models included the variability of the year specific estimates of survival depending on the most recent year of reported tag returns that were included in the analysis. Some TC members mentioned concern that the assumption of mixing and dispersal was not being adequately met. Others felt that concern had been addressed by an analysis of the Virginia Rappahannock tag data by John Hoenig that indicated only very minor violations of the assumption of complete mixing, which did not affect the results of the analysis.

There is concern expressed by some TC members about the use of a constant value of natural mortality (M) despite the presence of analyses suggesting an increase in M in Chesapeake Bay in recent years. To address this concern, the Tag Committee used the catch equation method that allows for development of estimates of F without the use of a constant M value. The TC expressed the need for variance estimates for the F values from the catch equation method and this will be addressed in 2006. Some TC members expressed uncertainties about the recent reduction in the exploitation rate estimates used in the catch equation since the adoption of Amendment 6 in 2003 that showed a 10-25% decline in exploitation despite a 33% increase in the total commercial and recreational losses (harvest plus discards) during the past two years. Others felt concerned about moving forward with the use of the catch equation method before further exploration concerning potential non-mixing of newly tagged animals was conducted.

Management Advice

Based on the available assessment information, it is the consensus of the Technical Committee that overfishing is not occurring and that the population is not overfished. However, there are differing opinions within the Technical Committee concerning where the 2004 fish mortality rate was in relation to the Amendment 6 target of 0.30. It is also the consensus of the Technical Committee that the abundance of older striped bass, age 13 and older, has increased since the adoption of Amendment 6 in 2003.

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I. Introduction

This report summarizes results of catch-age based virtual population analyses (VPA) of Atlantic striped bass for 2004. The VPA analysis provides estimates of fishing mortality, stock abundance, and biomass for the mixed coastal stock.

The first analytical assessment of Atlantic striped bass stocks using 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.

A formal review of abundance indices used in former assessments was initiated by ASMFC at a workshop in July of 2004 (ASMFC 2004). This workshop developed a set of evaluation criteria (Appendix A) and tasked states with a review of indices. The resulting review led to a revision and elimination of some indices formerly used in ADAPT. Both the Striped Bass Technical Committee and the Management Board approved of the criteria and of the review. The indices underwent further review based on residual patterns following initial model runs. This is a standard annual procedure that led to the elimination of additional indices for the 2005 analysis.

II. Catch-at-Age Virtual Population Analysis

Data Summary

Catch at age was estimated using standard methods described in the previous assessment documents (ASMFC 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. Length frequencies of recreational discards were based on volunteer angler logbook and American Littoral Society data. State specific age-length keys were applied, where possible, to length frequencies to estimate number of fish at age landed or discarded by the recreational fishery. State specific methods for estimating age composition of commercial landings, recreational landings, and recreational discards are provided in individual state compliance reports to ASMFC for 2004. State specific data sources for estimates of recreational discard age composition are also summarized in Table 1a

Commercial Fishery in 2004

Commercial landings in 2004 totaled 907 thousand fish or 3.3 thousand MT (7.2 million lbs) (Table 1b). Landings increased 4.4% in numbers (38 thousand fish) and 2.2% in weight (70 MT) compared to 2003. Overall, commercial harvest represented 18% of total losses in number in 2004 (Table 2, Figure 1). The greatest portion of the commercial harvest occurred in the Chesapeake Region (Maryland, PRFC, and Virginia). The harvest in these jurisdictions accounted for 77% by number (Table 3) and 58% by weight of the total commercial harvest in

2004. Harvest increased in all coastal states with commercial fisheries except Virginia and Delaware (Table 3). Age 4 made up the highest percentage of commercial landings (21%) and ages 4-8 comprised 68% of the harvest (Table 4). Most (77%) of the harvest in the Chesapeake Region was ages 3-7 (Table 4, Figure 2). Peak harvest of fish in the rest of the coastal states was at age 8; more than half of the coastal harvest (54%) was ages 8-10.

Direct measurements of commercial discards of striped bass in 2004 were only available for fisheries in the Hudson River Estuary. Discard estimates for fisheries in Chesapeake Bay and coastal locations since 1982 and for Delaware Bay in 2004, were based on the ratio of tags reported from discarded fish in the commercial fishery to tags reported from discarded fish in the recreational fishery, scaled by total recreational discards:

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

where:
CD = unadjusted estimate of the number of fish discarded by commercial fishery,
RD = number of fish discarded by recreational fishery, estimates provided by the NOAA Marine Recreational Fisheries Survey (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 are allocated to fishing gears based on the relative 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 in a given year. Tag return data and release mortality by gear for 2004 are given in Table 5. Starting in 1998, the Technical Committee attempted to improve the estimate of commercial discards by calculating tag return ratios and discards separately for Chesapeake Bay and the coast. A separate estimate for Delaware Bay was added in 2004. The ratio of tags from fish discarded by commercial fishermen to tags returned from fish discarded by recreational fishermen in 2004 was 0.47 in Chesapeake Bay, 0.12 in Delaware Bay, and 0.04 along the coast (ME - NC)(Table 6).

Expanding recreational discards to commercial discards based on reported tag returns assumes equal reporting tag rates in commercial and recreational fisheries. To evaluate this assumption we examined the ratio of tags recovered by commercial and recreational fisheries for landed fish. If the availability of tagged fish to commercial and recreational fisheries is equal, the ratio of tags recovered by commercial and recreational fisheries should be close to the ratio of landings. This was not the case suggesting a lower reporting rate by the commercial fishery in some locations and years (Table 6). To correct for this bias, we calculated a correction factor by dividing the three-year mean of ratios of commercial to recreational landings by the three-year mean of ratios of tags returned by the two fisheries. Since only one year of data for Delaware Bay was available, we used the mean of the correction factors for the coast and Chesapeake Bay. The correction factors for 2004 were 1.41 for Chesapeake Bay, 1.77 for the coast (Table 6), and 1.59 for Delaware Bay.

In summary, we calculated commercial discard losses for all fisheries except those in the Hudson River by multiplying recreational discards by the commercial/recreational tag ratio from discarded fish, then by the corresponding correction factor, apportioning discards among gears, and finally by multiplying by appropriate gear specific discard mortalities. Total commercial discards for 2004 were estimated as 519 thousand fish, representing 10.0 % of total removals in number (Table 2, Figure 1).

Commercial discard proportions at age were obtained by applying age distributions from fishery dependent sampling or independent surveys using comparable gear (Table 7a). Gear specific proportions at age were applied to discard estimates by gear and expanded estimates summed across all gears. Most commercial discards were fish of ages 3-8 (Table 7b). Discards were higher in 2004 than in 2003 and the third highest since 1982 (Figure 3).

Total commercial striped bass removals (landings and discards) were 1.43 million fish in 2004 (Table 2). Although total removals in 2004 exceeded those in 2003, they remain below the peak in 1997 (Figure 4). Landings have generally exceeded discards since the mid 1990's (Figure 3). Commercial losses in 2004 was dominated by age 4 (2000 year class) fish (Figure 5).

Recreational Fishery in 2004

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). MRFSS did not sample in January and February (wave-1) prior to 2004 when sampling began in North Carolina waters. Therefore, there was little information for the winter fishery (Jan, Feb) that has developed off of North Carolina and Virginia since the mid 1990's. We estimated landings for these fisheries back to 1996 using observed relationships between landings and tag returns (Appendix B). For North Carolina, we used the ratio of estimated landings to tag returns in wave-1 of 2004 and annual tag returns in wave-1 to estimate annual landings in January and February. For Virginia waters, we used the 1996-2004 mean ratio of landings and tag returns in wave-6 and annual tag returns in wave-1 to estimate landings in January and February. Methods and results are summarized in Appendix C.

We estimated age composition of the January/February recreational fishery in North Carolina and Virginia from length-frequency data collected by MRFSS and appropriate state age-length keys. Length-frequencies for the North Carolina winter harvest of 2004 came from data in wave-6 of 2003 and wave-1 of 2004. That for the winter harvests of 1996-2003 came from wave-6 of year t-1. We converted lengths to age for North Carolina with a combined age-length key from New York and North Carolina. Length-frequencies for the Virginia winter harvest in 1996-2004 came from MRFSS data in wave-6 of year t-1. We converted the Virginia lengths to age with a Virginia age-length key. Estimates of wave-1 harvest at age for North Carolina and Virginia were added to the existing CAA matrix for 1996 through 2004. We did not estimate discards for the winter recreational fishery in North Carolina or Virginia.

Total landings in 2004 (MRFSS A+B1 and estimated winter landings) were estimated at 2.4 million fish totaling 11.9 thousand MT (26.1 million pounds) (Table 1b). Landings decreased slightly compared to 2003 (Table 1b). Overall, recreational harvest represented 46.0 % by number of all losses in 2004 (Table 2, Figure 1). The states with the highest landings were Massachusetts, New York, New Jersey, Maryland, Virginia, and North Carolina (Table 8). Landings in Virginia made up 19.6 % of the total and were the highest of all states. Striped bass ages six through 10 comprised 62.6% of landings (Table 9, Figure 6). Highest landings occurred for age eight (1996 year class) which made up 16.8 % of the total (Figure 6). Fish harvested in the recreational fishery were generally larger than those harvested in the commercial fishery (Figure 7).

Recreational discards (B2) increased in 2004 to 17.2 million fish (Table 2) compared to 14.6 million fish in 2003. Discard losses due to hooking mortality (0.08*released fish) were estimated at 1.4 million fish in 2004 (Table 2). The states with the greatest number of discards were Massachusetts and Maryland (Table 10). Recreational discards represented 27% by number of total losses (Table 2). Discard losses of the 2001 year class (Age 3) were the highest (38.5 %) among all cohorts in 2004 (Table 10, Figure 6)

Total recreational striped bass removals (landings and discards) in 2004 were 3.76 million fish (Table 11). Total removals were highest in Massachusetts, New Jersey, Maryland, and Virginia. The catch was dominated by ages 3, 4, and 8 (41.8% of total) (Figure 8). Total recreational discard and landings losses have generally increased since 1982, with intermittent declines in 1998-1999 and 2001-2002 (Figure 9). Recreational removals in 2004 were the highest of the time series. The proportion of recreational removals caused by discards has remained relatively stable since 2001(Figure 10).

Total Catch at Age

The above components were totaled by year to produce the overall catch at age matrix for VPA input (Table 12). The total removal of striped bass in 2004 was 5.2 million fish and reflects a 7.2 % and a 33% increase from 2003 and 2002. More importantly, removals of fish age 8+ increased in 2004 by 28.5% and a 32.9 % compared to 2003 and 2002. Total removals in 2004 were the highest since 1982 (Figure 11). Ages three, four, and eight sustained the highest losses in 2004 (Figure 12). Ages 5 and 7 comprised the greatest proportion of the catch in 2003.

Weight at Age

Catch weight at age information was updated for the period 1998-2002 using all available weight data from MA, NY, MD, VA, NH, and CT (1998-2001) and adding data from RI and DE in 2002 (Appendix D). Mean weights at age for the 2003 and 2004 striped bass catches were determined as a result of the expansion of catch and weight at age. Data came from Maine and New Hampshire recreational harvest and discards; Massachusetts recreational and commercial catch; Rhode Island recreational and commercial catch, Connecticut recreational catch, New York recreational catch and commercial landings; New Jersey recreational catch; and Delaware, Maryland, Virginia, and North Carolina recreational and commercial catch. Weighted mean weights at age were calculated as the sum of weight at age multiplied by the catch at age in numbers, divided by the sum of catch at age in numbers. Details of developing weights at age for 1982 to 1996 can be found in NEFSC Lab Ref. 98-03. Weights at age for 1982-2004 are presented in Table 13.

Survey Indices

The ADAPT model requires indices of abundance to be measured either at the beginning or the middle of the 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 their age increased by one. All juvenile survey indices were advanced forward to the January 1 of the following year and the index was assigned age 1

Based on criteria developed at the VPA indices workshop and the recommendations by the Striped Bass Technical Committee, we made significant changes to many survey indices available for input into the VPA in 2004. The NEFSC spring inshore survey was reduced from age-specific indices to an aggregate index, and was truncated at 1991 due to missed sampling of inshore survey strata prior to 1991. The Massachusetts commercial age-specific harvest-per-trip indices were redeveloped as age-specific (ages 5-13+) total catch-per-hour indices. The New Jersey trawl aggregate index was further apportioned into age-specific geometric mean indices for age 2-9+. Due to large proportional standard errors of the New York ocean haul seine survey indices for age>9, the 13+ age-specific index was aggregated to a 9+ group. The Virginia pound net survey was eliminated from the input because few analyses conducted could support its continued use as an index that reflected striped bass abundance. Two new indices were added to the input: age-specific (ages 2-10+) Delaware River spawning stock indices and a coast-wide MRFSS aggregate index. The MRFSS index was based on data only from private boats that fished in the ocean during waves 3-6 (Appendix E). There were no changes made to the Connecticut aggregate trawl index, Connecticut age-specific recreational catch indices, the Maryland spawning stock age-specific indices or any indices for YOY (age 0) in Maryland, Virginia, New Jersey, and New York, or for juveniles (age 1) in Maryland and Long Island, New York. The changes resulted in a total of 62 indices for use in initial runs of ADAPT (Table 14).

Among the fisheries-dependent indices, trends in the MA Commercial indices and CT Recreational CPUE suggest steady population levels since the mid 90s, while the coast-wide MRFSS index suggests a decline since 1998 (Figure 13).

The fishery-independent indices for combined ages generally show a stable, high level of population abundance punctuated by strong year classes (Figure 13). The strong 1993, 1996 and 2001 year classes contributed to the annual variability in the NY, DE, NJ and NEFSC survey results. There was fair correspondence between the NJ and DE trawl surveys (Figure 14).

Indices of young-of-the-year show low to moderate recruitment in the Chesapeake Bay, Delaware Bay, and the Hudson River in 2004 (Figure 15). The high 2003 MD and VA index continues as age one in 2004. The high numbers of age one striped bass in the Western Long Island survey in 2004 suggests the possibility that there was high survival of the 2003 year class in New York coastal waters (Figure 15).

ADAPT Virtual Population Analysis

Catch at Age and Indices

Initial runs of ADAPT for the 2005 assessment used a combination of 62 age-specific and age aggregated fishery independent and fishery dependent indices discussed above and in Table 14. Residual plots showed systematic trends in residuals for some survey indices and this led to a rejection of the MA commercial catch per hour indices for ages 8-13, MD spawning stock indices for ages 3 and 4, the DE trawl index, and the DE spawning stock index for age 2. Furthermore, the MA commercial indices failure to track strong year classes provided additional justification for exclusion from analysis. The remaining 52 indices were used in the final run of ADAPT. Indices included the MA commercial catch per hour indices ages 5-7, MD SSB index for ages 7-13+, NY Ocean Haul seine ages 3-8 and aggregated for 9=13, CT CPUE for ages 2-9, NEFSC aggregated for ages 2-9, young-of-year (age 0) in Maryland, Virginia, New York and New Jersey, age 1 index for Maryland and Long Island, New York, CT trawl aggregated for ages 4-6, DE spawning stock for ages 4-9, and aggregated for 10-13, the NJ trawl index for ages 2-8 and aggregated for 9-13, and a MRFSS index for aggregated ages 2-13 (Table 14).

The 2003 assessment (through fishing year 2002) concluded that the 13+ age configuration of the ADAPT model produced the most accurate estimates of F and stock size in the presence of age error/bias in the catch-at-age and survey indices (Striped Bass Stock Assessment Committee 2003). This configuration was continued for the 2004 and 2005 assessments.

An iterative re-weighting of the survey indices was applied to the model.

Partial Recruitment Vector

A flat top partial recruitment vector was assumed for the ADAPT model. Initial PR values were calculated using the three year geometric mean fishing mortality for each age from the previous ADAPT model scaled to the highest value of F among all ages.

Model Configuration

This year's ADAPT run used the same input options as last year's assessment: full F in terminal year was calculated using classic method; F at oldest true age for all years, including terminal year was calculated using Heincke's method and ages 8 through 11 were used to calculate the oldest true age. Plus group abundance was calculated using the backward method and the model assumed a flat topped partial recruitment.

ADAPT Results

Fishing Mortality

The 2004 average fishing mortality rate (F) for fully recruited ages 8 through 11 equaled 0.40 and was above the current target (0.30)(Table 15, Figure 16). This represents a dramatic drop in F on fully recruited ages from that reported for 2003 (reported as F = 0.62 in 2004, SBSASC 2004). However, this may reflect the shift in model indices or the addition of winter harvest estimates for NC and VA. The 2003 value of F in the current run was 0.29 suggesting an increase in 2004. Fishing mortality in 2004 on ages 3-8, which are generally targeted in producer areas, was F = 0.16. Among the individual age groups, the highest value of F (0.50) was estimated for 9 year old fish (1996 year class) (Table 16, Figure 17). Estimates of F in 2004 were generally higher for ages eight and above than for younger ages. We did not include bootstrap generated error estimates for terminal year F values because we have concerns about validity of such estimates as calculated by ADAPT. An F weighted by N was calculated for comparison to tagging results in 2004 since the tag releases and recaptures are weighted by abundance as part of the experimental design. The 2004 VPA F weighted by N for ages 7-11 (age 7 to compare with tagged fish > 28") was 0.32 (Table 15). An F weighted by N for ages 3-8, comparable to the direct enumeration estimate for Chesapeake Bay, was equal to 0.12 (Table 15).

The iterative re-weight option used in ADAPT applies extra weight to those indices which have the best model fit. The indices assigned the highest weights were the CT CPUE ages 4-9, the CT trawl aggregate index, the Delaware spawning stock indices, the MA commercial indices, and the MRFSS index (Table 17).

Population Abundance (January 1)

Striped bass abundance increased steadily from 1982 through 1997 when it reached a level around 60 million fish (Table 18a, Figure 18). Total abundance declined to 54 million fish in 2000 and then increased to 65 million fish in 2005. The 2003 cohort remained strong at 19 million fish at age 2 in 2005 and exceeded the size of the strong 1993 and 2001year classes at 2. Estimates of abundance obtained this year were higher than those reported in 2004 (SBSAC 2004). Error estimates for abundance at age for 2005 were lowest for ages 7-9 (Table 18b).

Abundance of striped bass age 8+ increased steadily through 2002 to 6.6 million. It has since fluctuated without obvious trend around 6.2 million fish through the present (Table 18a, Figure 18). The 1 Jan 2005 estimate was 5.9 million fish.

Spawning Stock Biomass

Female spawning stock biomass (SSB) grew steadily from 1982 through 2002 when it peaked at about 27 thousand metric tons (Table19, Figure 19). Female SSB has declined since then and was estimated at 24.9 thousand metric tons in 2004, assuming 1:1 male- female ratio. The estimated SSB remained above the threshold level of 1995, which was estimated as 14.6 thousand metric tons. Again, values obtained in the 2005 analysis exceeded those obtained in 2004 (SBSAC 2004).

Retrospective Patterns

A retrospective analysis was conducted on the VPA results extending back to 1999, in order to determine trends in estimation of F, total abundance, recruitment, and female SSB in the terminal year. The retrospective evaluation was made using the iterative re-weighting option, which assumes the chi-weights from the terminal year estimate are equivalent in all subsequent years. The analysis revealed that average fishing mortality estimates for ages 8-11 were overestimated prior to 2003 (Figure 20a).   However, the terminal year estimate for 2003 was identical to that obtained for 2003 made the next year. There was no significant bias in terminal year estimates of total abundance (Figure 20b) or recruitment (Figure 21a). A slightly negative bias occurred in terminal year estimates of female SSB (Figure21b)

Sensitivity Runs

Sensitivity runs made in the 2004 assessment (ASMFC 2004) indicated that the model was relatively insensitive to the inclusion or exclusion of indices. This year however, the use of revised indices led to a dramatic change in estimates of population parameters compared to those made in 2004. For comparative purposes, we made an ADAPT run using last year's indices updated for 2004. Use of last year's configuration of indices resulted in higher estimates of F and lower estimates of age 8+ abundance from the mid 1990's through the present (Figure 22). The estimate of F for 2004 using last year's configuration of indices was 0.67 suggesting an increase in F over 2003. Divergence in estimates using new and old configuration of indices increased through the time period.

Sources of Uncertainty

The ADAPT virtual population analysis model used in this assessment assumes that the catch at age input data are measured without error, the recruitment vector is constant after the age of full recruitment, and that changes in abundance indices reflect changes in population abundance. All of these assumptions may be violated to some degree as used for striped bass.

Accurate estimates of catch at age require that we know the total loss in number and that we apportion this loss correctly to age. The best data on loss comes from the directed recreational and commercial fisheries. The exception in this year's assessment was estimates of harvest in the winter fishery that has developed off of North Carolina and Virginia. MRFSS data were generally not available for this time of year and we estimated harvest for these fisheries using relationships between harvest and tag returns. There is less confident in estimates of discard losses in commercial and recreational fisheries because little of the data is measured directly. Moreover, gear specific release mortalities are assumed to be constant even though mortalities may vary with season and with changes in gear specifics such as increased use of circle hooks. The quality of data on age composition varies among fisheries and region. In most cases, fish in catches or discards are measured and length frequencies are converted to age frequencies with age length keys. States with large harvests usually sample fisheries directly and develop age length keys from the fishery and time of year of the fishery. However, states with small fisheries must often rely on length data from small samples or fishery independent collections and use age length keys developed by neighboring jurisdictions. Finally, the assignment of age to samples becomes less certain with increasing fish age. The ADAPT runs made last year (ASMFC 2004) were sensitive to large changes (40%) in the catch at age input. The addition the winter harvest in this year's analyses also affected the outcome.

The abundance indices used this year's analysis were improved through a reasoned and objective evaluation process described in ASMFC 2004 and in Appendix A. The review reduced the number of indices and the number of indices at age, especially for fish age eight and older. This year's ADAPT VPA analysis was highly sensitive to the selection of indices, especially to those for the older ages. There is clearly a need to develop additional indices of abundance for older fish in the fished subset of the population.

Estimates of F and population size from the catch at age analyses employed for striped bass are most uncertain for the terminal year. Retrospective analyses conducted in prior striped bass assessments usually suggested a positive bias in the terminal year estimates of F and a negative bias in terminal estimates of population size. Although similar results were obtained this year, bias was less, especially for the 2003 terminal year estimate. It is possible that the bias has become less of a problem with improved accounting of losses to the population and improved abundance indices.

Summary

The striped bass population remains at high level of abundance due, in part, to strong incoming cohorts. The fully exploited population abundance (age 8+) decreased since last year, but has been relatively stable since about 2001. Average fishing mortality for fully recruited ages (8-11) in 2004 was estimated at 0.40. The F estimate for 2003 was 0.29 which is much lower than the F for the same year (0.62) estimated in the 2004 assessment (SBSASC 2004). However, this difference is due, in part, to a change in tuning indices and the addition of winter harvest in NC and VA. Estimates of F increased from 2003 to 2004 in ADAPT outputs for both the new and the old indices. The 2004 fully recruited fishing mortality estimate is above the target of 0.3. Average fishing mortality for ages 7-11 weighted by N was 0.32 and for ages 3-8 weighted by N was 0.12. Spawning stock biomass has decreased from levels in 2002 and 2003, but remains well above the 1995 threshold level.

III. Tagging Program Analyses

Introduction

This report summarizes the results of analysis by the ASMFC Striped Bass Tagging Subcommittee (SBTS) of tagging data from the U.S.F.W.S. Cooperative Striped Bass Tagging Program through the 2004 tagging year. These results now include two different sets of estimates of instantaneous fishing mortality (F) rates, one of which is based on the protocol previously employed by the SBTS (Smith et al. 2000), where we employ tag recovery models to estimate annual survival; survival is then converted to total instantaneous mortality, Z. Estimates of survival are corrected for bias due to live release of striped bass, because the tag recovery models assume all recoveries are of dead animals (Smith et al. 2000). The final step is subtraction of an assumed constant value of natural mortality, M, to estimate F.

The new protocol, introduced into our report for the fist time, is based on a formulation of Baranov's catch equation in Ricker (1975) and was proposed by Pollock et al. (1991). Crecco (2003) first applied this method to the striped bass tag results, as well as to combinations of tag and virtual population estimates. In this protocol, we do not assume a constant value of M. Instead, F is estimated as a function of both Z and the exploitation rate, μ. Following F estimation, M is estimated by subtraction of F from Z. Also presented are length structure of tagged striped bass, age structure of recaptures, geographic distributions of recaptures by month, and estimates of catch and exploitation rates by program.

A second change in the report is that we have added a new regulatory period to our period models, extending them from 3 periods to 4 periods. The new period is based on Addendum 1 to Amendment 6, which began in 2000, with a goal of reducing F on larger fish. Analysis of this change was conducted in advance by V. Vecchio, NY DEC, for the SBTS. The new period provided generally better fits to the tag-recovery data than the previous 3 period models.

Finally, we present two time series of Atlantic coastwide total abundance estimates for age 3+ striped bass, and two time series of estimates of age 7+ striped bass. These are based on the form of the catch equation: Kill = F * (average N). One series is produced using the F estimates generated assuming constant M, and the other set of estimates was based on the F series produced via the catch equation.

Description of Tagging Programs

Eight tagging programs provided information for this report, and have been in progress for at least 11 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.

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 2004, a total of 426,576 striped bass have been tagged and released, with 75,930 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) and elaborated for striped bass in Smith et al. (2000). 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 (Table 20; 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.

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 - 2004). Four regulatory periods are defined as follows: moratorium years (1987-1989), an interim fishery (1990-1994), a full fishery under Amendment 5 (1995 – 1999) and the recent changes introduced in 2000, which were designed to reduce F on older fish (2000-2004). Given the importance of recent years for management, we also 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, 1995-2003). 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 within regulatory periods {S(Tp)r(Tp), S(Tp)r(t), S(Tp)r(p)} support increasing or decreasing monotonic trends in survival within 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 over-dispersion 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. A weighted average of unconditional variances (conditional on the set of models) is 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),

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

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).

Estimates of F based on constant M

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).

Estimates of F based on exploitation rate and the catch equation

Ricker (1975, p. 11) presents a formulation of Baranov's catch equation which he recommends for Type 2 fisheries, in which fishing and natural mortality occur concurrently. This is the case for striped bass, where the fishery operates over much of the year. The equation is set up to solve for the exploitation rate, μ. Pollock et al. (1991) solve the same formulation for F as follows:

$$F = \mu/A*Z,$$

where A = (1 – S), the annual total mortality rate. We obtain Z from the bias-corrected survival rates developed from the MARK tag-recovery models described above. Instead of assuming that M is constant and subtracting it from Z, however, we rely on the catch equation, which shows that F is a function of both the exploitation rate and Z. Essentially, this formulation is a ratio equation, showing that the ratio of μ to A equals the ratio of F to Z. We have estimates of the exploitation rate (see below), Z and A, with the latter two simple functions of the survival rate estimates obtained via the tag-recovery models. Once F is estimated, we can estimate M by subtracting F from Z. This is the approach used by Crecco (2003).

Encounter and exploitation rates

In addition to estimates of S and F, we estimated annual catch rates and annual exploitation rates for two length groups (>= 18 inches and >= 28 inches) with tag recoveries of striped bass released by eight agencies (1987 - 2004) of the Cooperative Striped Bass Tagging Program. Each time series of annual catch rates and annual exploitation rates reflects trends in total catch rate (including releases) and harvest rate, respectively. Estimates of annual catch rates and annual exploitation rates are independent among years; fish at large after the first recovery-year are not used in the analysis. All of the estimates are calculated using a tag reporting rate estimate of 0.43 from a 2000 study conducted on the Delaware River stock, but employing tag returns from the whole Atlantic coast. This estimate is identical to one developed independently and presented in Smith et al. (2000). The reporting rate is the proportion of tagged, recaptured fish whose tag is actually reported to the U. S. F and W. S. Thus we assume that the same tag reporting rate was operative along the whole coast. Annual catch rates and annual exploitation rates are adjusted R/M ratios as described below, where R is the number of tags reported as recaptured over the year from the number tagged at the beginning of the year (the recovery rate) and M is the number of fish tagged or marked at the beginning of the year (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

Stock size estimation

Using the form of Baranov's catch equation, catch = F * (average stock size), we were able to estimate stock size since we have estimates of total kill and estimates of F. Note that the total kill includes discards, which are generally of the same magnitude as the total landings in number. These estimates were developed for 18 inch plus fish, which in practice is usually fish 18" or above, corresponding roughly to 3 year old and older striped bass.

Two separate time series of stock sizes were developed. The first was based on the F estimates that assumed constant M for 18 inch plus fish, while the second was based on the estimates generated via the catch equation. Since the F estimates are based on total survival for the constant M estimates, and in the case of the catch equation estimates, exploitation rate that includes discard mortality from released fish that were recaptured, the total kill is the correct variable to employ here.

Tagging Assessment Results

Exploitation Rate and Total Catch Rate

The exploitation rate estimates for 28 inch fish are presented by program and as an unweighted mean (Table 20a). For 2004, the two Chesapeake Bay programs, Virginia and Maryland, had the lowest estimates of 0.08. The highest estimate was from the Delaware River stock, but it was only 0.22. For the whole time series, coastwide average exploitation rates peaked from 1997 and 1998 at 0.24 and have declined substantially since then. The coastwide, unweighted average for 2004 was 0.13.

The total catch rates on the coast averaged 0.19 for 2004 (Table 20b). This is continues a declining trend since a peak of 0.34 in 1991. The catch rate estimate for 1997 was 0.31, over 50% of the 2004 estimate. The difference between the total catch rate and the exploitation rate suggests that the live release rate was 0.06. This estimate could be biased low because anglers may be less likely to notice tags on fish they have released. They could also be less likely to recover tags they do notice, since they are releasing the fish. This value of 0.06 is the estimate of release rate since 1997. Prior to 1997, the release rate estimate was substantially higher, as high as 0.21 in 1991.

For 18 inch plus fish, exploitation rate was lower than for 28 inch fish, and declined to 0.09 in 2004 (Table 20c). Catch rate for 18 inch plus fish was also slightly lower than for 28 inch fish, and for 2004 = 0.17 (Table 20d). These two values for 2004 were again part of a continuing decline.

Fish >= 28 inches: Estimates of F assuming constant M and stock size of fish aged 7+

Uncorrected survival and F estimates, together with the bias-corrected estimates and confidence intervals for bias-corrected fishing mortality are presented by program in Table 21. The models receiving the higher weights in the final estimate are shown by program in Table 22.

Summaries of the F estimates assuming constant M are in Table 23. The 2004 estimates of F for the four mixed-stock coastal programs (Massachusetts, New York Ocean Haul, New Jersey, and

North Carolina winter trawl) were 0.10, 0.02, 0.72, and 0.26, respectively, with an unweighted-mean F of 0.27 (Table 23). The New Jersey Delaware Bay estimates are very erratic among years and the 2004 value of 0.72 has a large influence on the coastal average and the coastwide average. This is the highest F estimate in the time series for the coastal programs. The 2004 estimates for producer area programs Hudson River, Delaware River, and Chesapeake Bay (HUDSON, DE/PA, MDDNR, VARAP) were 0.27, 0.32, 0.34, and 0.25, respectively, with a weighted mean fishing mortality (F) of 0.31, again the highest in the time series. The Delaware River and Maryland Chesapeake estimates were relatively high, with the Hudson and Virginia estimates at a lower level. The average of the coastal and producer programs is the coastwide 2004 estimate for the fully-recruited fish, assuming constant M, F =0.29. While this estimate is the highest in the time series, it is still slightly below the target F = 0.30. Variation in these F rates as additional data has been added is portrayed in Figure 23.

Stock size estimates of 7+ fish developed using this series of F estimates increased to 10.5 million in 2002, then declined slightly to 8.2 million in 2004 (Table 23).

Fish >= 28 inches: Estimates of F from the catch equation

Estimates of fully-recruited F for 2004 from the catch equation average only about half the level of the constant M estimates. The 2004 estimates of F for the four mixed-stock coastal programs (Massachusetts, New York Ocean Haul, New Jersey, and North Carolina winter trawl) were 0.10, 0.10, 0.23, and 0.15, respectively, with an unweighted-mean F of 0.15 (Tables 24, 25). The New Jersey estimate was the highest for 2004, as in the constant M estimates, because the survival estimate was low (Table 21). The 2004 estimates for producer area programs Hudson River, Delaware River, and Chesapeake Bay were 0.22, 0.26, 0.11 and 0.09, respectively, with a weighted mean fishing mortality (F) of 0.13 (Table 25). The average of the coastal and producer programs is the coastwide 2004 estimate for the fully-recruited fish, assuming constant M, and equals 0.14 (Table 25). The estimates of total abundance obtained with the catch equation F estimates are higher than those obtained with the constant M estimates, because the F estimates are lower, so if the same kill occurs with a lower F, it implies the total stock is larger. These estimates peak in 2004 at 17 million age 7+ fish (Table 25).

18 inch plus fish: Estimates of F assuming constant M and stock size estimates from 1990-2004

Estimates of uncorrected survival and fishing mortality by program, assuming constant M, with bias-corrected estimates of these parameters are in Table 26. The F estimates produced under this method were almost as high as those for fully recruited fish for the producer areas, while the coastal program estimates were actually slightly higher than those for the 28 inch coastal F estimates. These estimates were much higher than F estimates produced for 18 inch plus fish using the catch equation method.

Table 27 presents the weights used in averaging the models into the final survival estimates presented in Table 26. F estimates are summarized and stock size estimates are presented in Table 28. The 2004 estimates for producer area programs of Hudson River, Delaware River, Maryland Chesapeake Bay, and Virginia Rappahannock River are 0.25, 0.29, 0.36 and 0.06, respectively, with the average F = 0.26. Among producer areas, the Maryland estimates were the highest, at 0.36 for 2004. The coastal program F estimates are erratic, except for the

Massachusetts results, which are very low and stable. Results of coastal programs in terms of F estimates for 2004 for Massachusetts, New York Long Island, New Jersey Delaware Bay, and North Carolina winter trawl are 0.10, 0.30, 0.68 and 0.18, with an average of 0.31. The coastwide averages, including both coastal and producer areas, have the highest F estimate in 2000 at F = 0.40, then decline to F = 0.29 for 2004, identical to that for the 28 inch fish.

Estimated stock sizes using these F estimates are somewhat erratic, with the peak year in 1995 at 48 million fish (Table 28), due to the very low estimate of F = 0.06 in 1995. Since 1997, the estimates were more stable and lower, ranging between 12.5 and 15.8 million. The 2004 estimate is the largest of this recent period at 18 million.

18 inch plus fish: estimates of F using the catch equation and stock size estimates from 1990-2004

Using the catch equation method, the estimates of fishing mortality were lower for 18 inch plus fish than they were assuming constant natural mortality (Tables 29, 30). The producer area average for 2004 was 0.13 and the coastal average was 0.08. These results are lower than those made with an assumption of constant M because they do not assume that M = 0.15 and they are dependent on the exploitation rate estimates, which are generally relatively low for 18 inch plus fish. With this method, the coastwide F estimate for 18 inch plus fish in 2004 was only F = 0.11. The peak F estimates in this time series occurred in 1997-1998 at F = 0.16. F has declined in recent years Table 30.

The stock size estimates computed from this F series are more reasonable than the previous set of estimates in that they exhibit more stability (Table 30). A moderately consistent stock growth is apparent, with some declines, until about 2000, when stock growth becomes rapid. The estimate for 2004 is the highest in the time series at 48.5 million fish.

Length frequency, age, and geographic distribution of recaptures

Total length frequencies of fish tagged in 2004 and age distributions of fish recaptured in 2004 were tabulated by program (Tables 31 and 32). 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 18 inch plus 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 2004 (from fish tagged and released during the full time series) were depicted by state and month (Table 33).

Sources of uncertainty in the tag-based estimates of fishing mortality rate

Confidence intervals have not yet been developed for the estimates based on the catch equation, but will be implemented for next years report.

Violations of the basic assumptions have been investigated in detail for the Virginia tag data set and only very minor violations of the assumption of complete mixing was detected, which did not affect the results of the analysis (J. Hoenig, personal communication). The major concern is that the tagged fish be representative of the stocks.

The estimate of reporting rate employed needs to be re-estimated. This is the rate at which tags are reported in, once tagged fish are recaptured. The current estimate of 0.43 was based on a study in 1999 conducted on the Delaware River spawning stock, employing tag returns from the Atlantic Coast (Kahn and Shirey 2000). If the estimate is too high, then the exploitation rate and the F estimate would be underestimated.. If the rate is too low, then F would be overestimated. A research grant proposal is currently in submission to conduct a high reward tagging study to develop a more current estimate of the reporting rate.

The assumption of constant natural mortality has been contradicted for the Chesapeake Bay stock by two alternative analyses (Crecco 2003, Hoenig, personal communication), both of which found that natural mortality had increased for the resident stock. The catch equation method introduced in this report was used to avoid the assumption of a constant value of M.

Finally, the estimates of F vary somewhat from year-to-year as additional tag returns are added in subsequent years. This variation primarily occurs during the most recent years F estimates. Some of the coastal programs results for 18 inch plus fish are fairly erratic and seem to lack some credibility, but the Tagging Subcommittee has not been able to determine a cause or violation of assumptions as the source of the erratic estimates.

IV. Discussion

Two major modifications were made this year to the input data for the 2005 VPA which resulted in considerable modifications to the estimates of fishing mortality, spawning stock biomass and population estimates compared to last years VPA run. For the first time, estimates of recreational harvest in NC and VA during Wave 1 (January and February) were included the catch at age. In addition, the Technical Committee modified the suite of tuning indices used in the VPA this year following a comprehensive review of the various indices over the past two years. With these changes plus the inclusion of 2004 data, the 2003 estimate of F declined from 0.62 in last years VPA to 0.29 in this years run. In addition, SSB and total abundance estimates were higher in this year's VPA run.

Another major change to this year's assessment is the utilization of Baranov's catch equation with the tagging data to develop estimates of F. By using the Z values from the Brownie models and μ from R/M, F estimates could be developed without the assumption of a constant M. Additionally, abundance estimates could be calculated using the tagging data for comparison with the VPA abundance estimates.

Coastwide fishing mortality estimates of F for 2004 from tagging estimates and the VPA were all bellow the Amendment 6 threshold value of F = 0.41. Therefore, it was the **consensus of the Technical Committee that overfishing was not occurring on the coastal migratory population of striped bass**. **However, there were differing opinions within the Technical Committee concerning where the 2004 fish mortality rate was in relation to the Amendment 6 target of 0.30.** The differing opinions were the result of the wide distribution in the 2004 coastwide estimates of F from the tagging program and the VPA. The tagging program included a coastwide average of F = 0.14 for fish over 28 inches using the new catch equation method and 0.29 using the traditional method that used a constant value of M. The 2004 estimate of F from the VPA was 0.40. However, retrospective analysis showed a positive bias with terminal year F estimates from the VPA suggesting that the 2004 value may prove to be lower in subsequent years.

There is currently not a consensus on the Technical Committee as to the reason for the discrepancies between the estimates of F. The most prominent reasons discussed are the evidence of an increase in natural mortality (M) in Chesapeake Bay and the potential for a decrease in the tag reporting rate in recent years. An increase in natural mortality above the assumed value of M=0.15 would result in overestimates of F's from the VPA and the tag based method using a constant value of M. A significant decrease in the tag reporting rate below the current estimate of 0.43 could result in an under estimate of F with the two tag based estimates.

Comparison of the time series of F estimates from the VPA and the two tagging program methods showed similarities and differences depending on the method used, time frame looked at and size range of fish included in the analysis. Estimates of F on fully recruited fish using assumed age 7+ fish (fish $\geq$ 28 inches) from the tagging program and age 7-11 weighted by N from the VPA were very similar for all three methods from 1990 to 2001. However, they began to diverge after that with the VPA and constant M tagging method showing increases in F while the catch equation tagging method showed a slight decrease (Figure 24). Estimates of F on age 3 and older fish were very similar when comparing the VPA and catch equation tagging estimates throughout the time series while estimates using the constant M tagging method were more variable as well as consistently higher in value subsequent to 1997 (Figure 25).

Comparison of the time series of population estimates from the three methods presented in this assessment also showed similarities and differences depending on the method and age range of fish. For fish age 3 and older, the VPA and catch equation tagging method showed a general trend of increasing abundance through the 1990's followed by a short term decline and a subsequent increase in abundance in 2003 and 2004 (Figure 26). Using the constant M tagging method, population estimates for age 3+ fish were erratic through the early to mid-1990's followed by a leveling off since 1997 at levels considerably below the estimates from the catch equation tagging method and the VPA. For the age 7+ segment of the striped bass population, abundance estimates from all three methods were similar from 1990 to 2001. Since then, the trend for VPA and constant M tag method estimates have been relatively flat while estimates using the catch equation method with the tagging data have increase substantially (Figure 27).

SSB estimates are available from the VPA and the 2004 estimate of 24.9 thousand metric tons is above both the threshold and target values from Amendment 6. Therefore, it was the **consensus of the Technical Committee that the population is not overfished.**

Finally, VPA estimates of age 12+ and 13+ striped bass show an increasing trend in abundance since 2003 (Figure 28). **It was the consensus of the Technical Committee that the abundance of older striped bass has increased since the adoption of Amendment 6 in 2003.**

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V. Figures

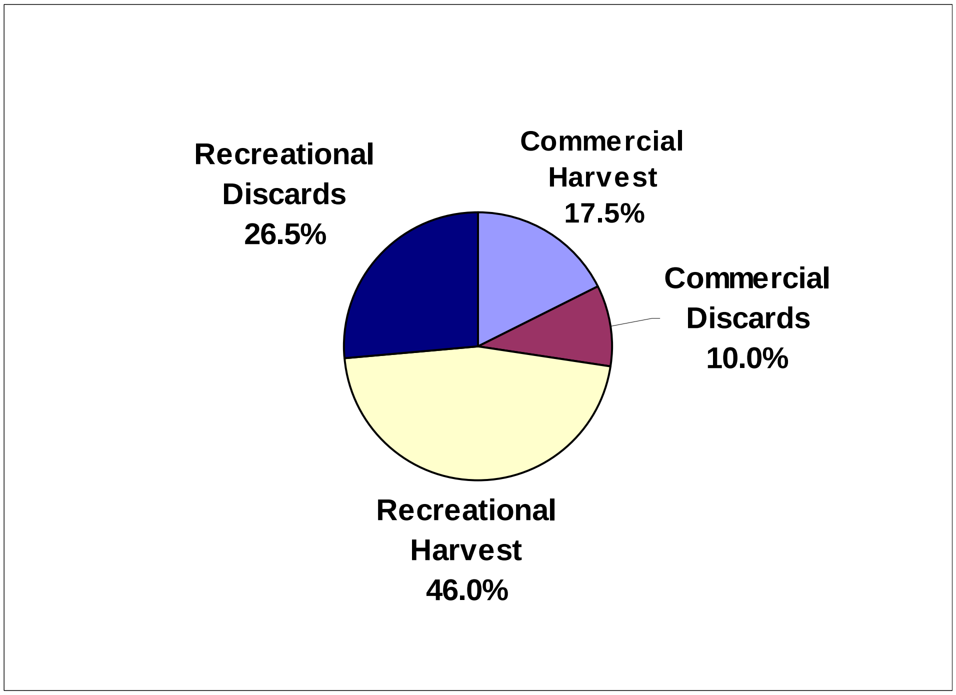


Figure 1. Proportions of 2004 striped bass mortalities by fishery component.

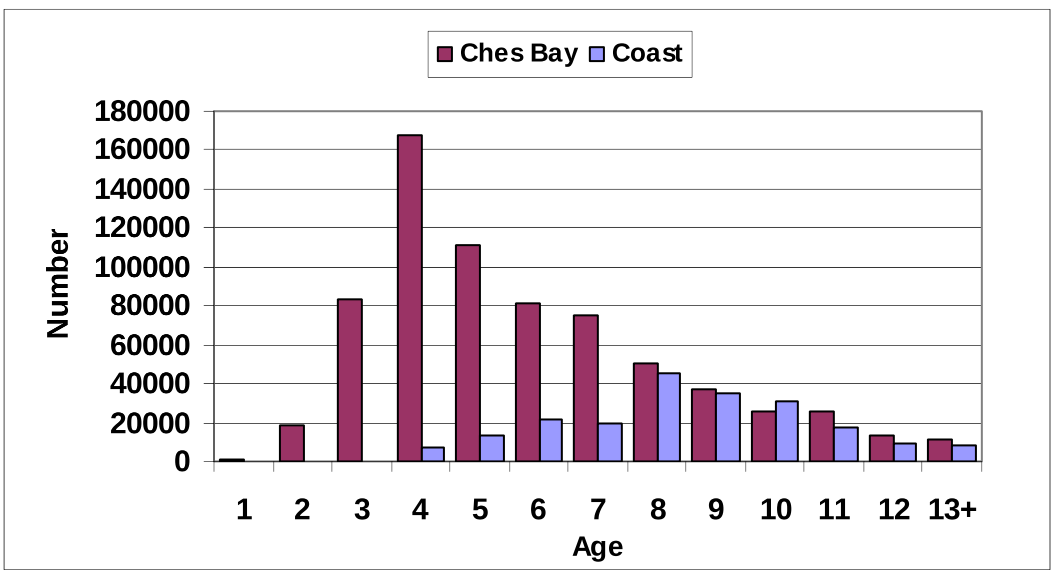


Figure 2. Commercial harvest of striped bass at age in Chesapeake Bay and in non-Bay states in 2004.

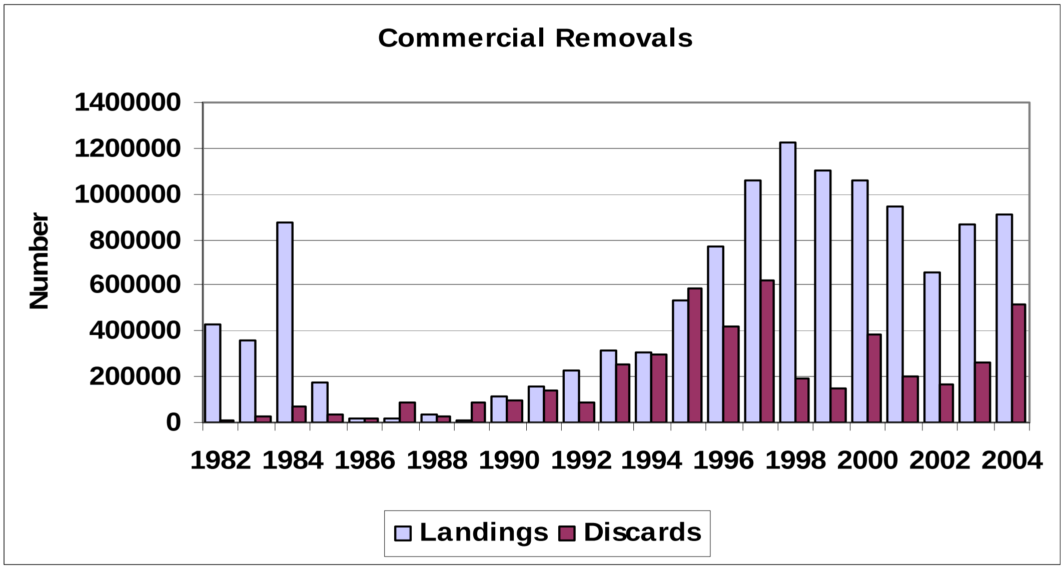


Figure 3. Commercial removals of Atlantic striped bass, 1982-2004.

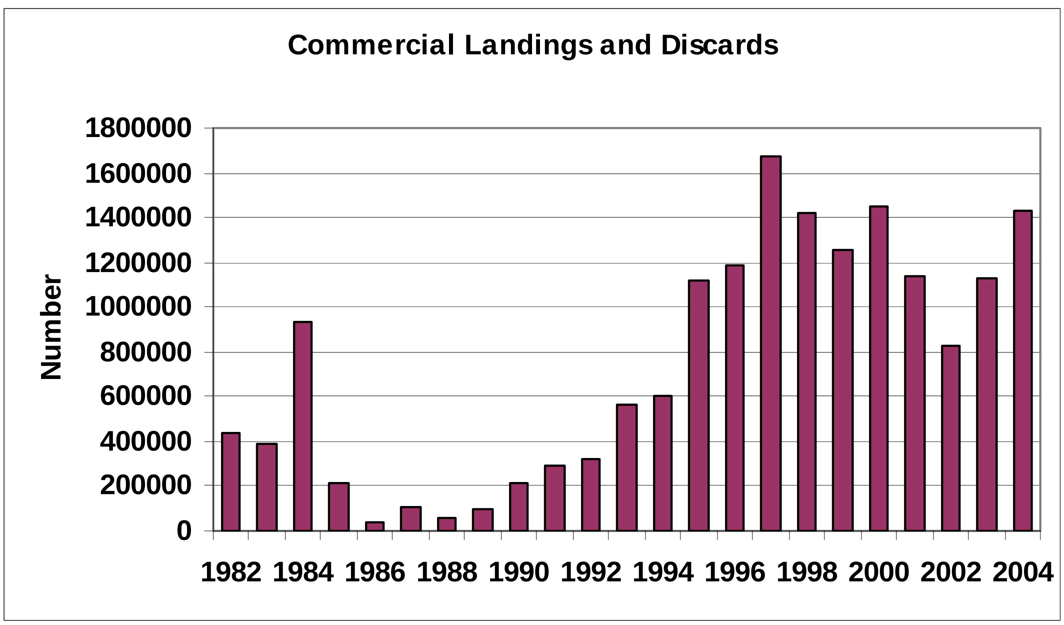


Figure 4. Total commercial removals of Atlantic striped bass (landings and discards), 1982-2004.

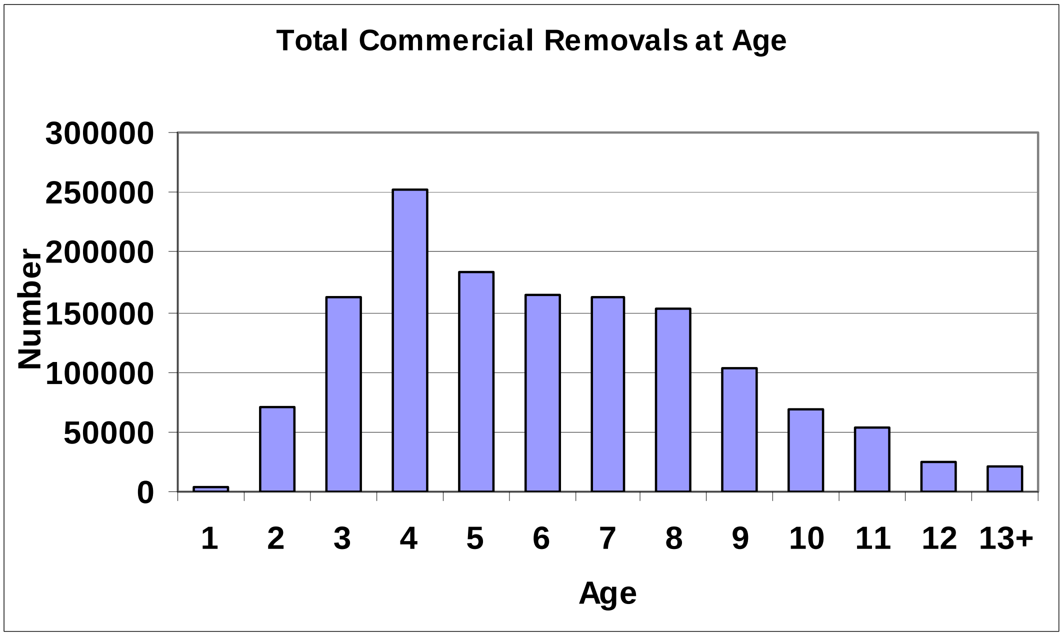


Figure 5. Total commercial removals at age in 2004.

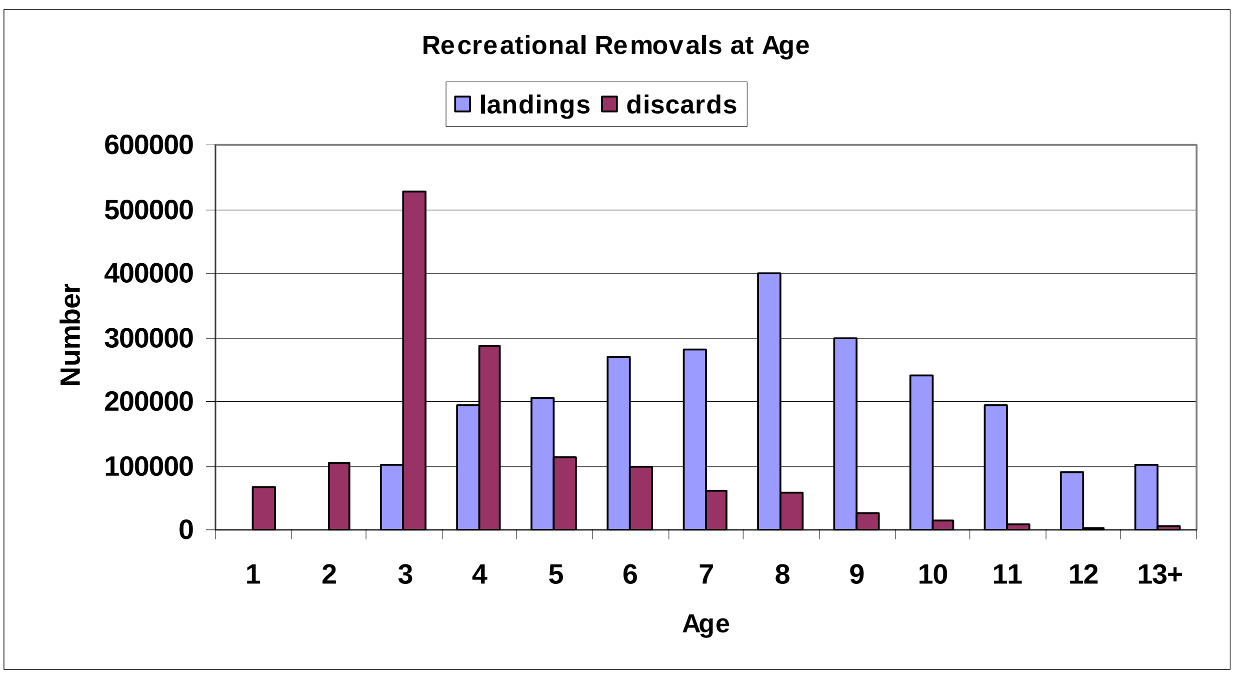


Figure 6. Recreational removals (landings and discard) of Atlantic striped bass at age in 2004.

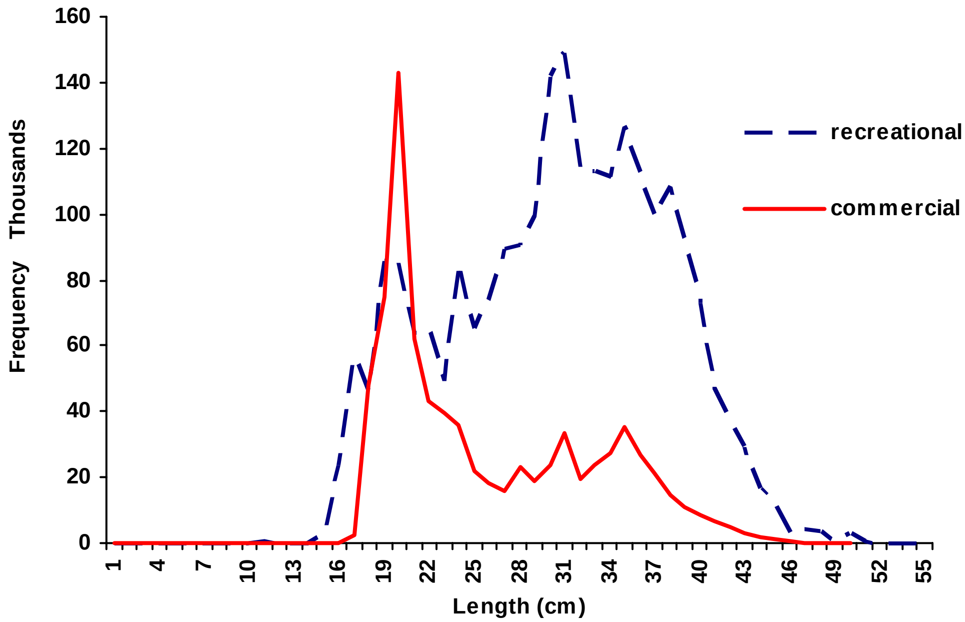


Figure 7. Length composition of total recreational and commercial striped bass landings, 2004.

Figure 8. Total Recreational removals at age of Atlantic striped bass in 2004.

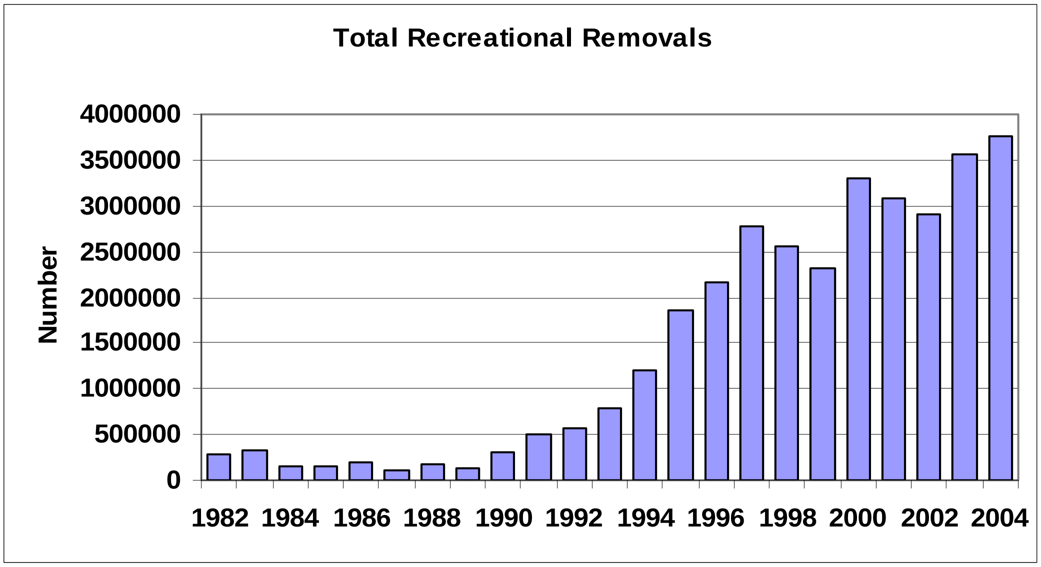


Figure 9. Total recreational removals of Atlantic striped bass (landings and discards), 1982-2004.

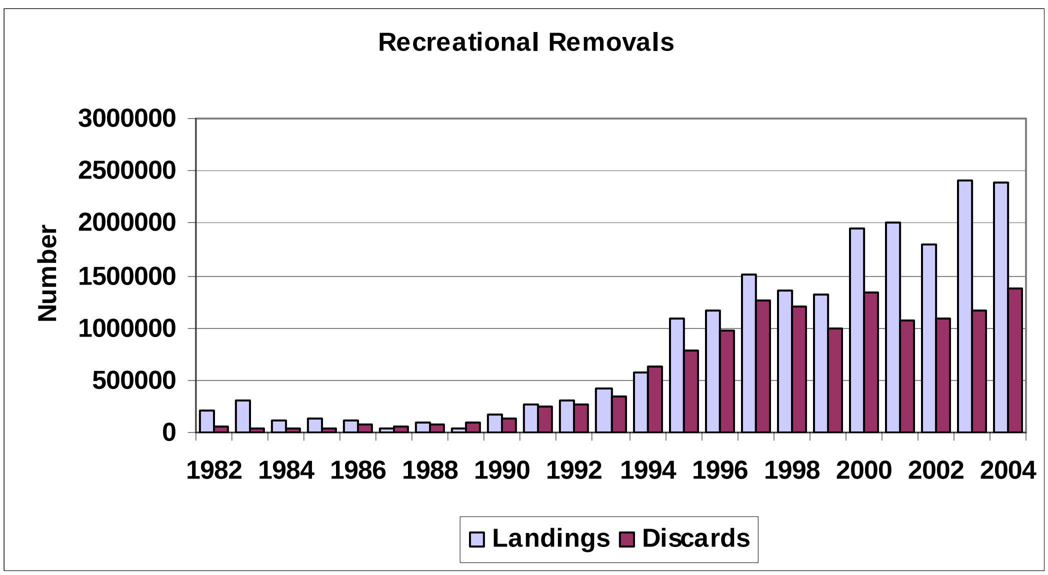


Figure 10. Recreational removals of Atlantic striped bass, 1982-2004

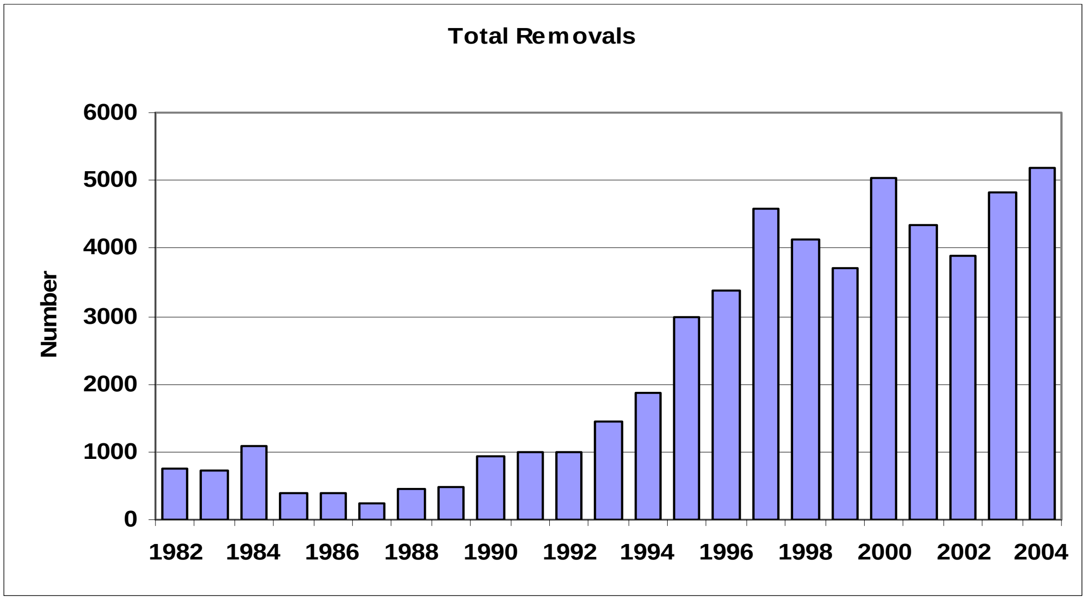


Figure 11. Recreational and commercial removals (landings and discard) in number of Atlantic striped bass, 1982 - 2004.

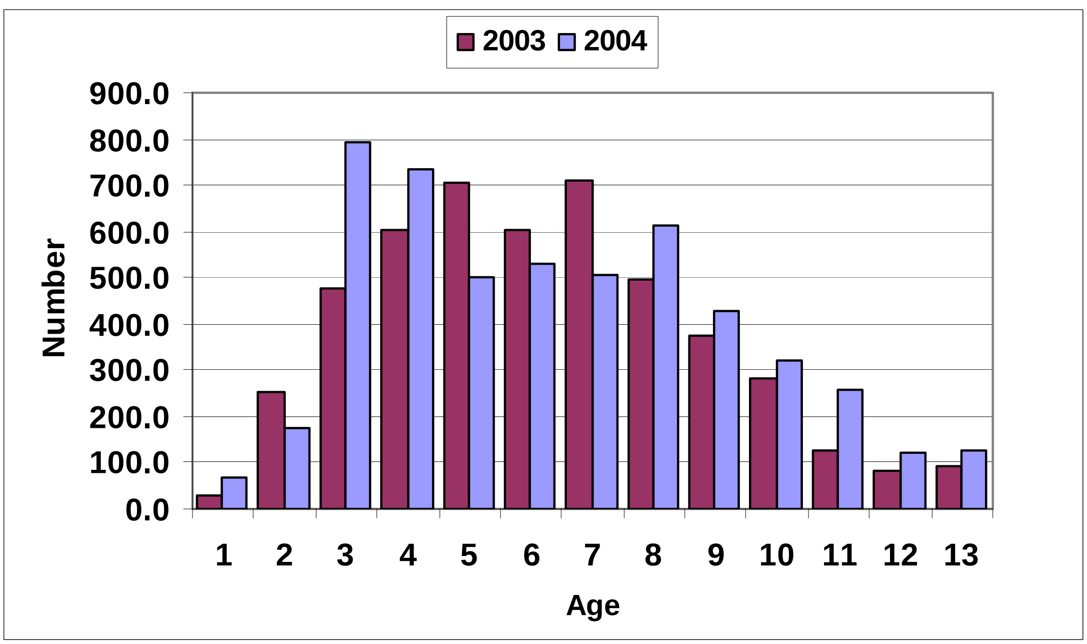


Figure 12. Recreational and commercial removals (landings and discard) at age in number for 2003 and 2004.

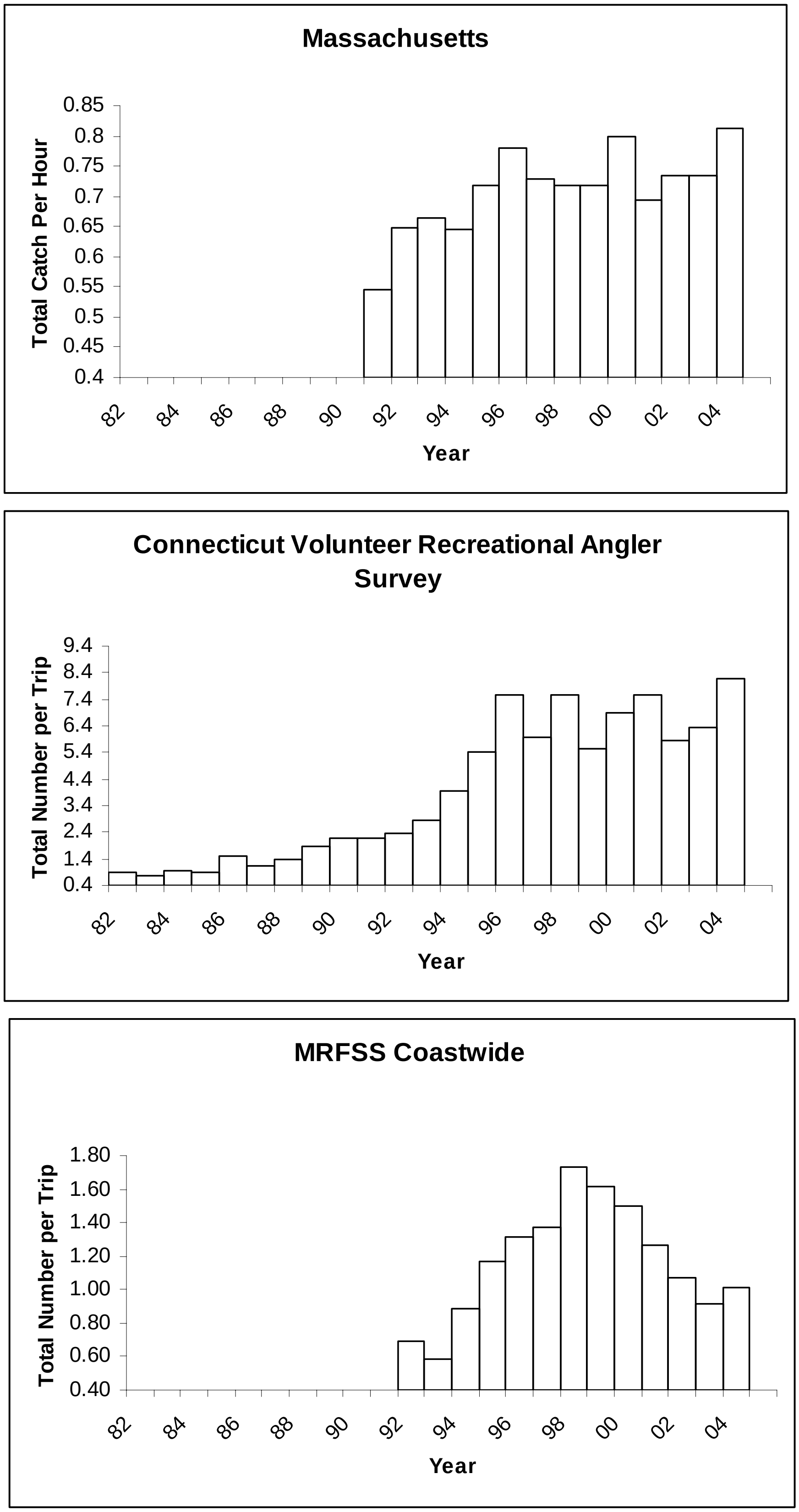


Figure 13. Fishery-dependent striped bass indices, combined ages.

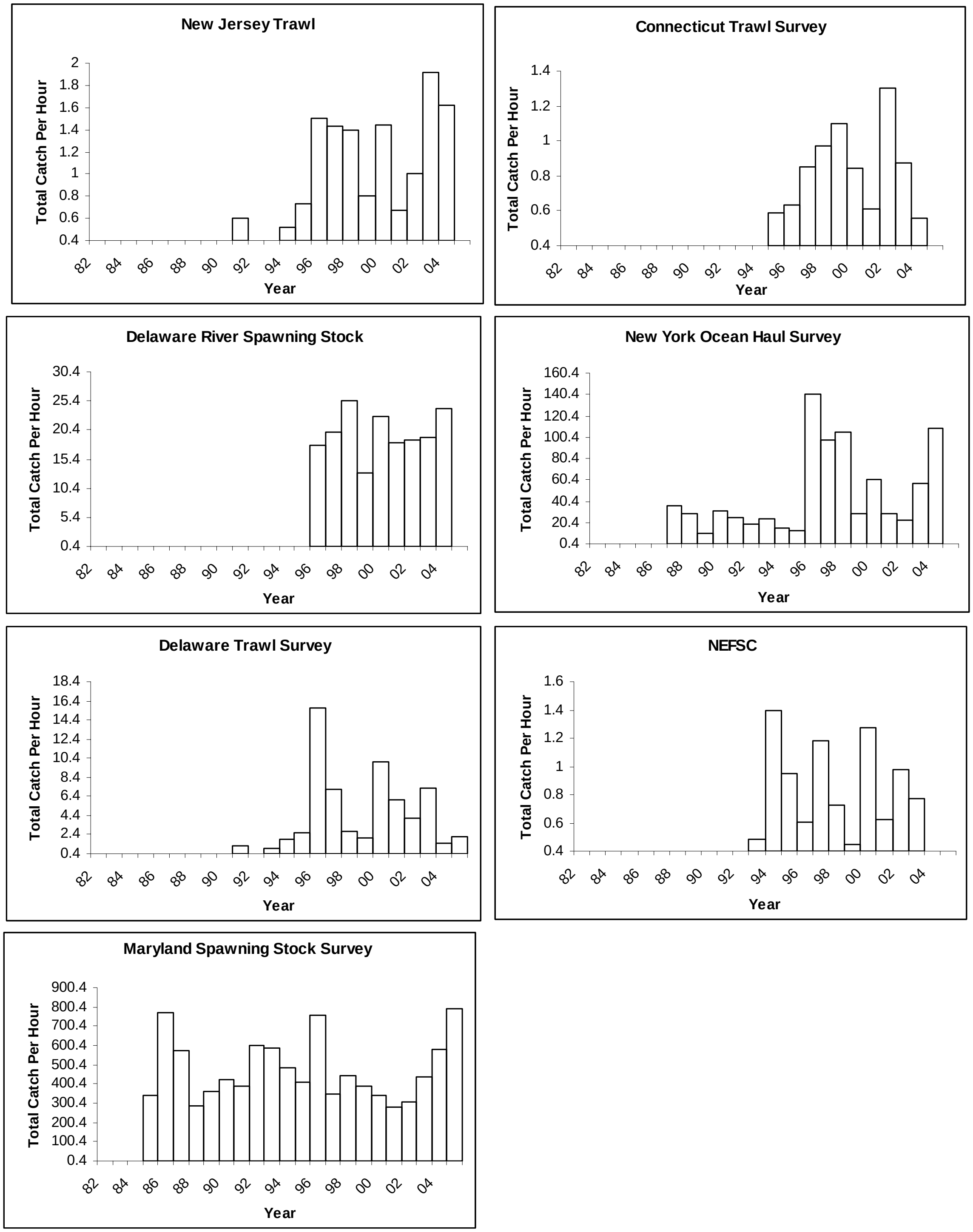


Figure 14. Fishery-independent surveys of striped bass abundance, combined ages.

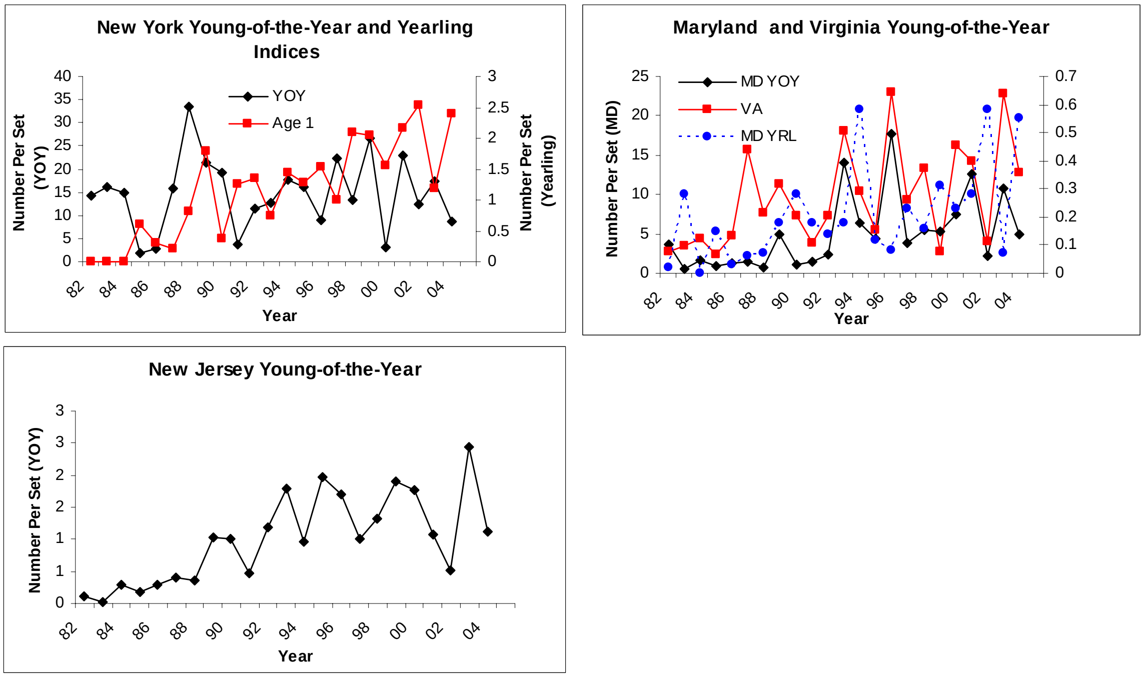


Figure 15. Young-of-the-year and yearling indices, 1982-2004.

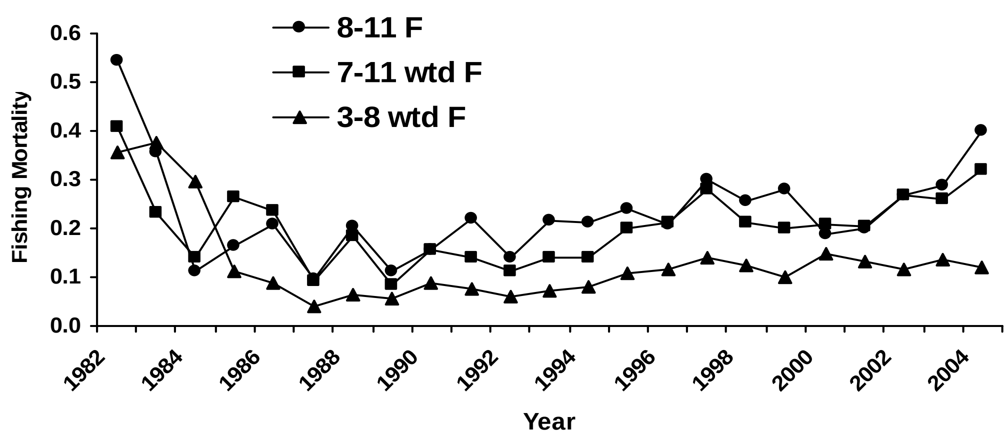


Figure 16. Striped bass fishing mortality estimates from ADAPT model.

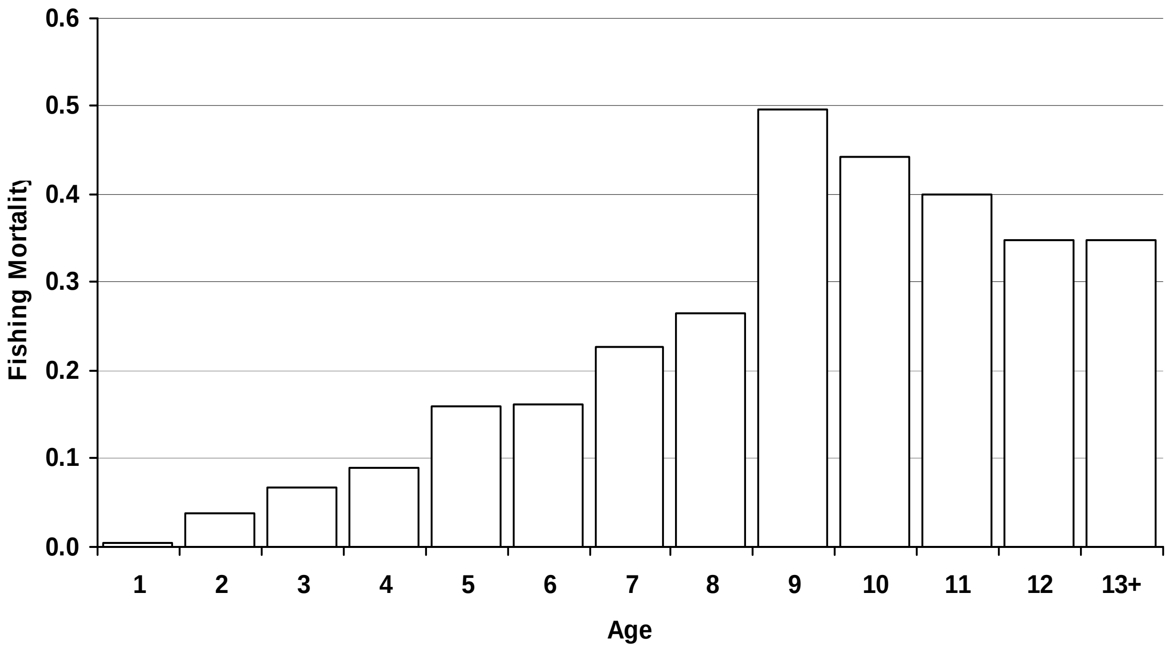


Figure 17. 2004 Fishing mortality at age estimated from ADAPT VPA.

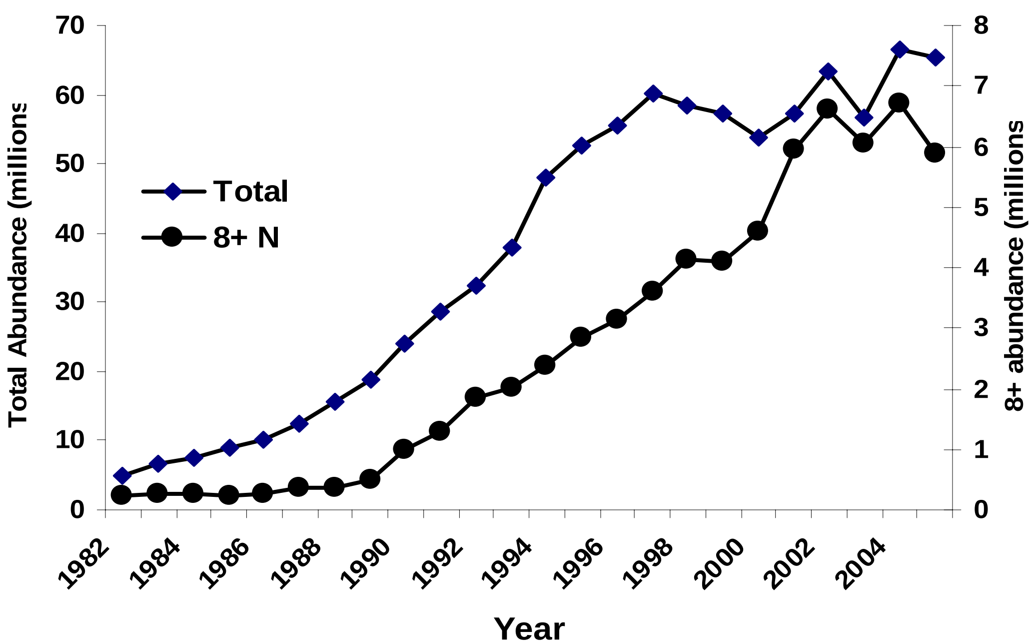


Figure 18. Striped bass population abundance estimates from 2004 ADAPT model

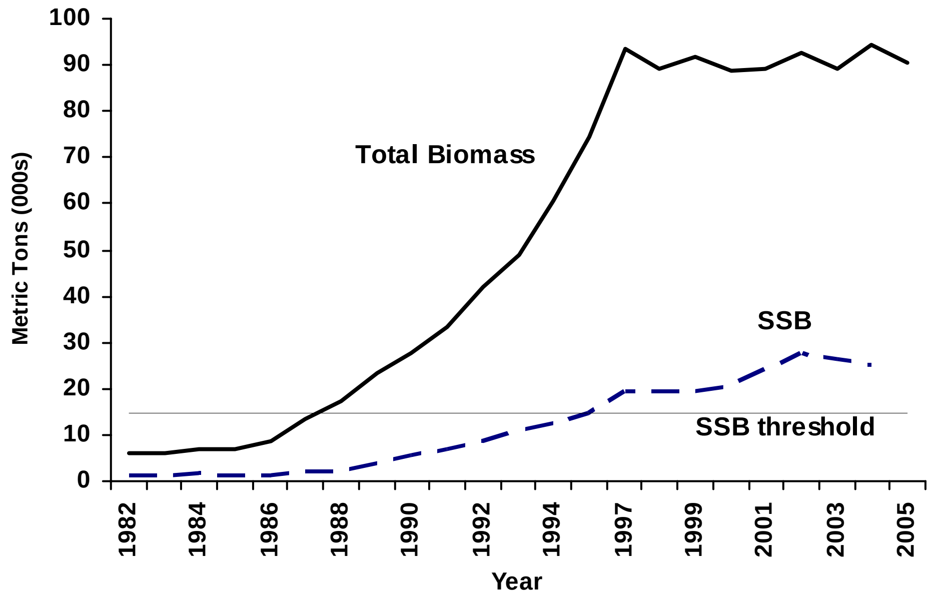
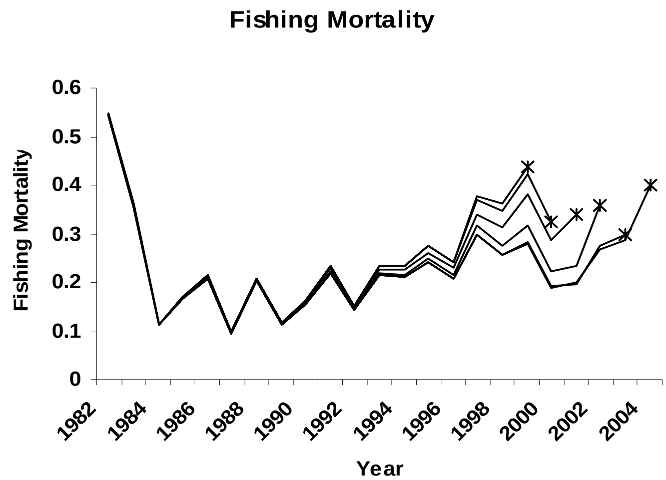


Figure 19. Striped bass female spawning stock biomass (000s mt) and Jan. 1 total biomass (000s mt) from 2004 assessment.



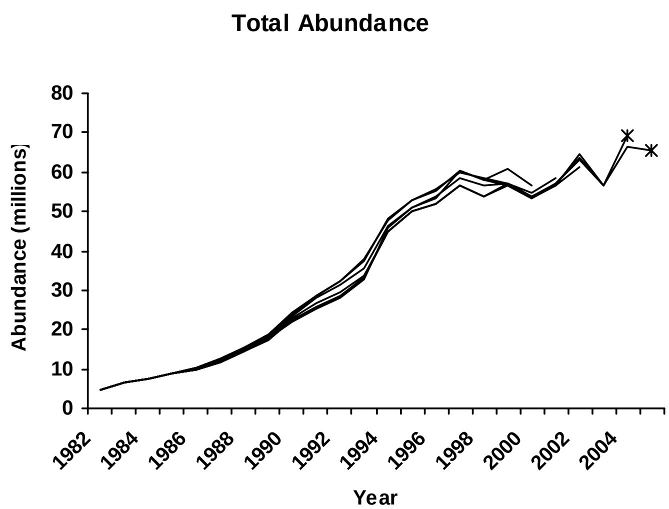
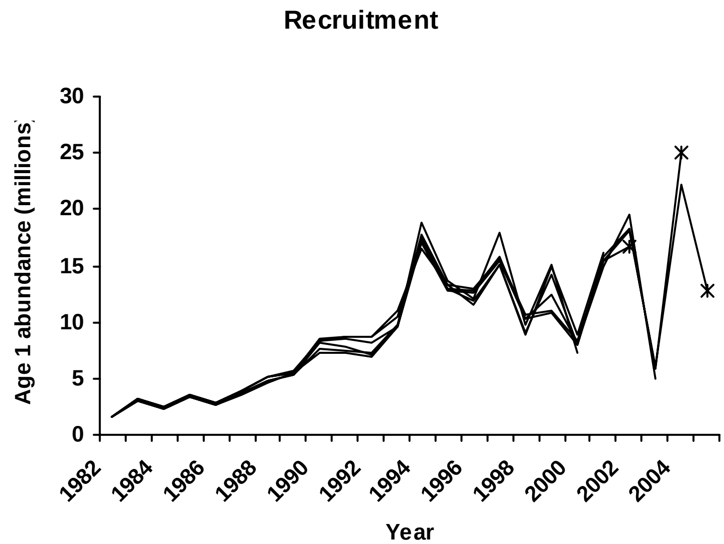


Figure 20. Retrospective analysis of fishing mortality and abundance from the 2004 striped bass VPA.



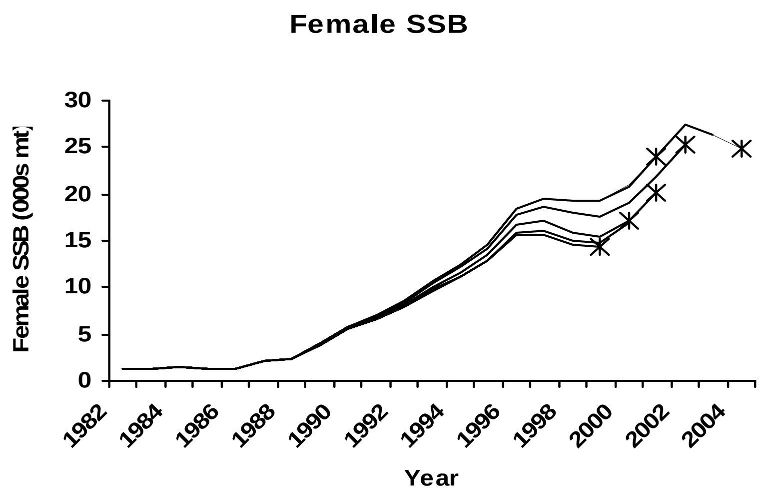
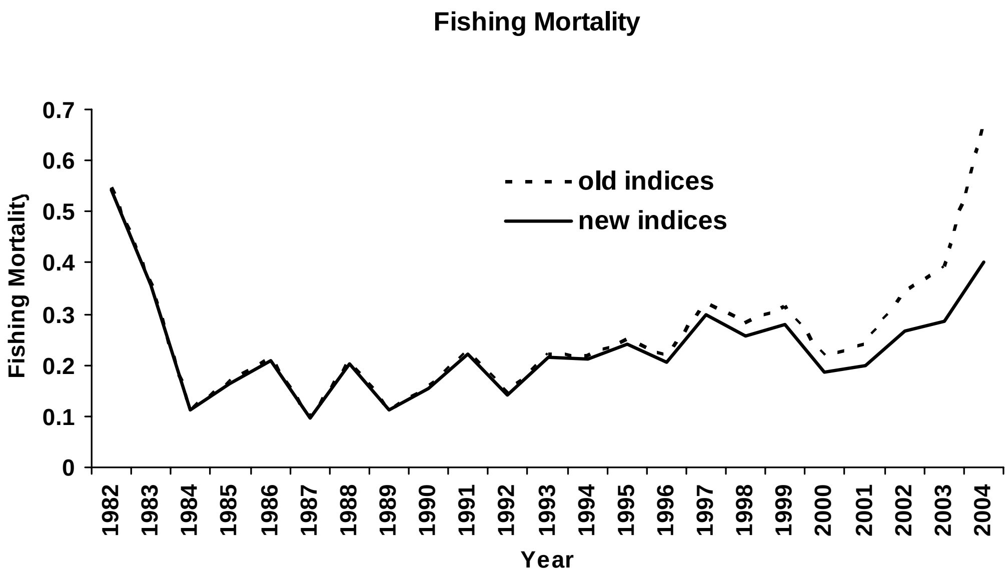


Figure 21. Retrospective analysis of recruitment and female SSB from the 2004 striped bass VPA.



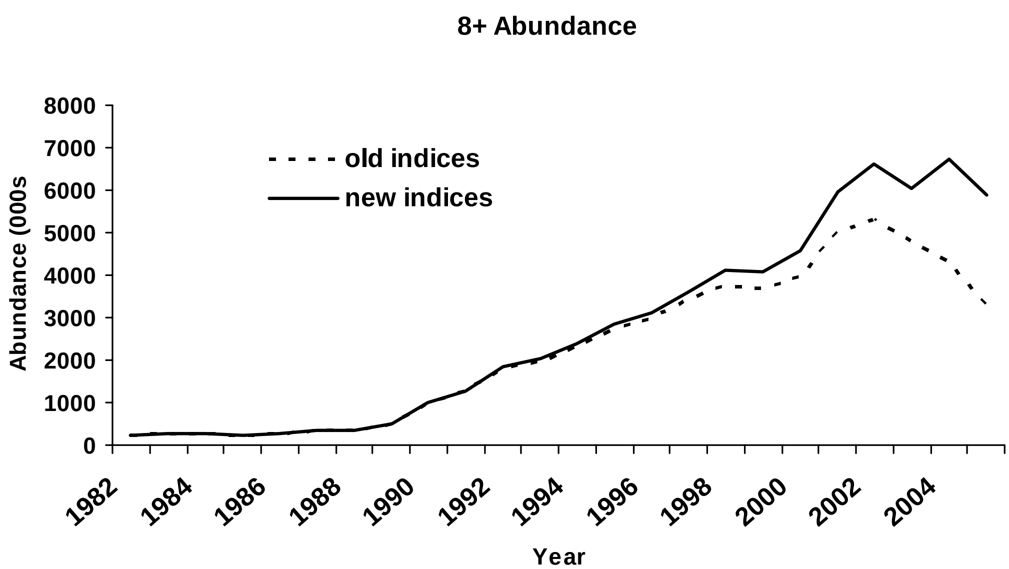


Figure 22. Differences in assessment results resulting from changes in tuning indices used in VPA. Old indices as used in 2004 assessment. New indices as used in 2005 assessment.

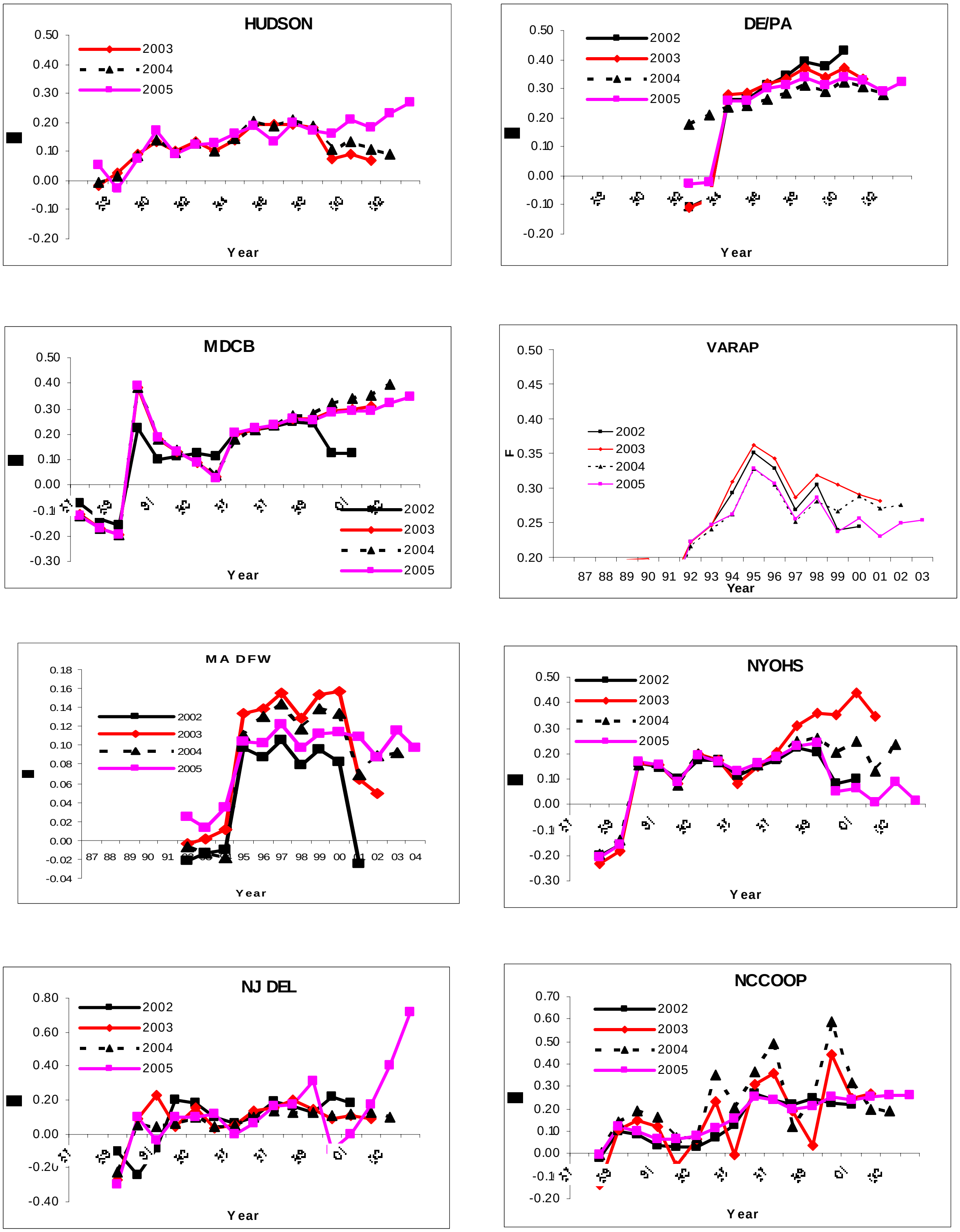


Figure 23. Year-to-year variation in F estimates for 28 inch Fish & Wildlife generated with the constant M method. Labels refer to the year that estimates were reported. Note variation in the vertical axis among charts.

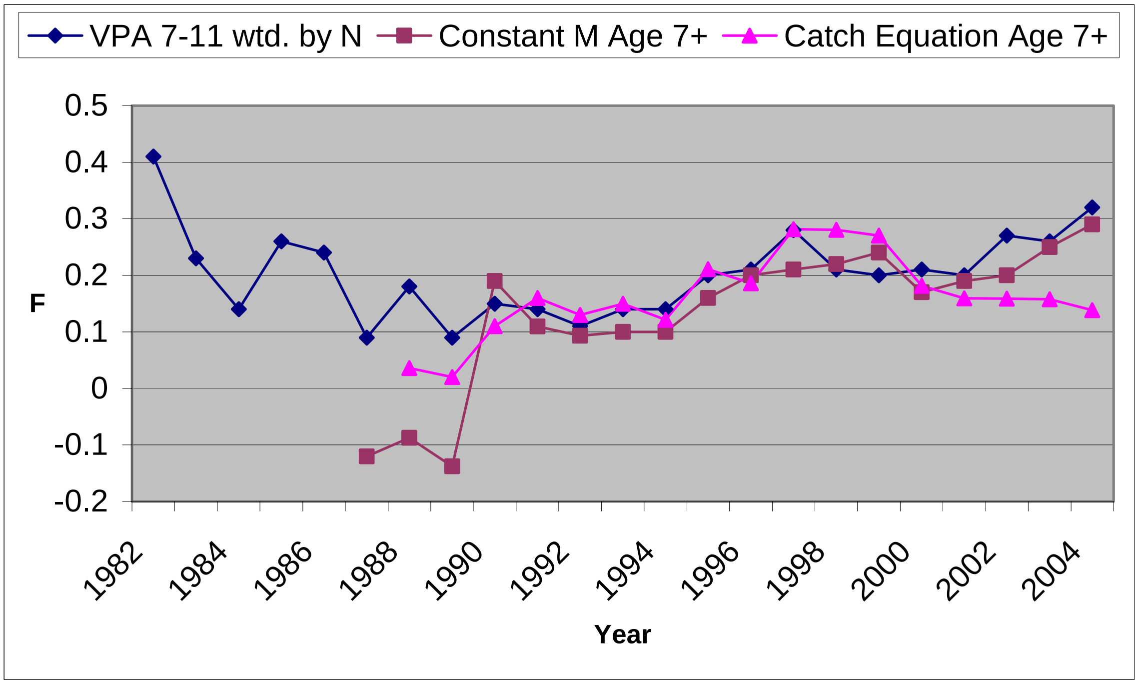


Figure 24. Estimates of F for Atlantic coast striped bass for age 7-11 fish from the VPA and age 7+ fish from the tagging program using the catch equation and constant M methods.

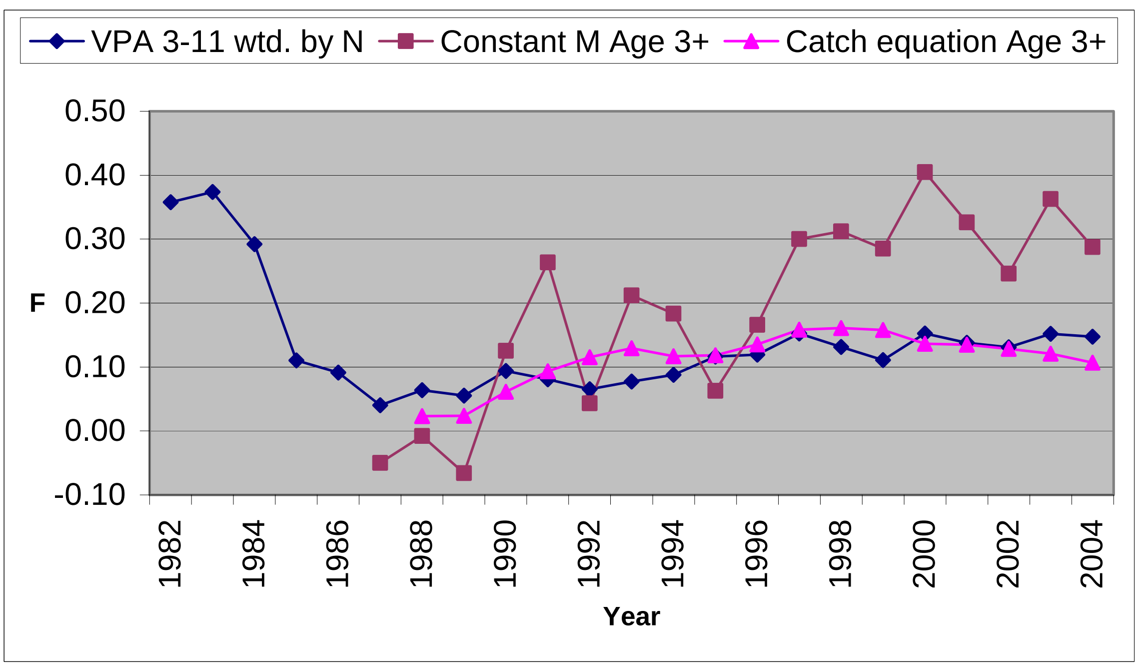


Figure 25. Estimates of F for Atlantic coast striped bass for age 3-11 fish from the VPA and age 3+ fish from the tagging program using the catch equation and constant M methods.

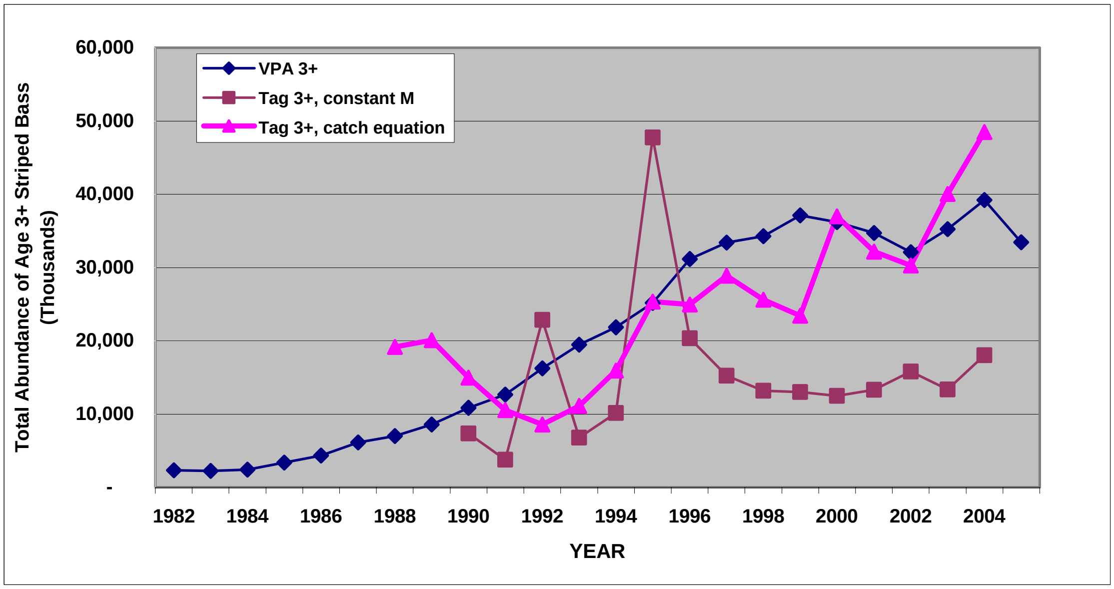


Figure 26. Population estimates of age 3+ striped bass from the VPA as well as the tagging program using the catch equation and constant M methods.

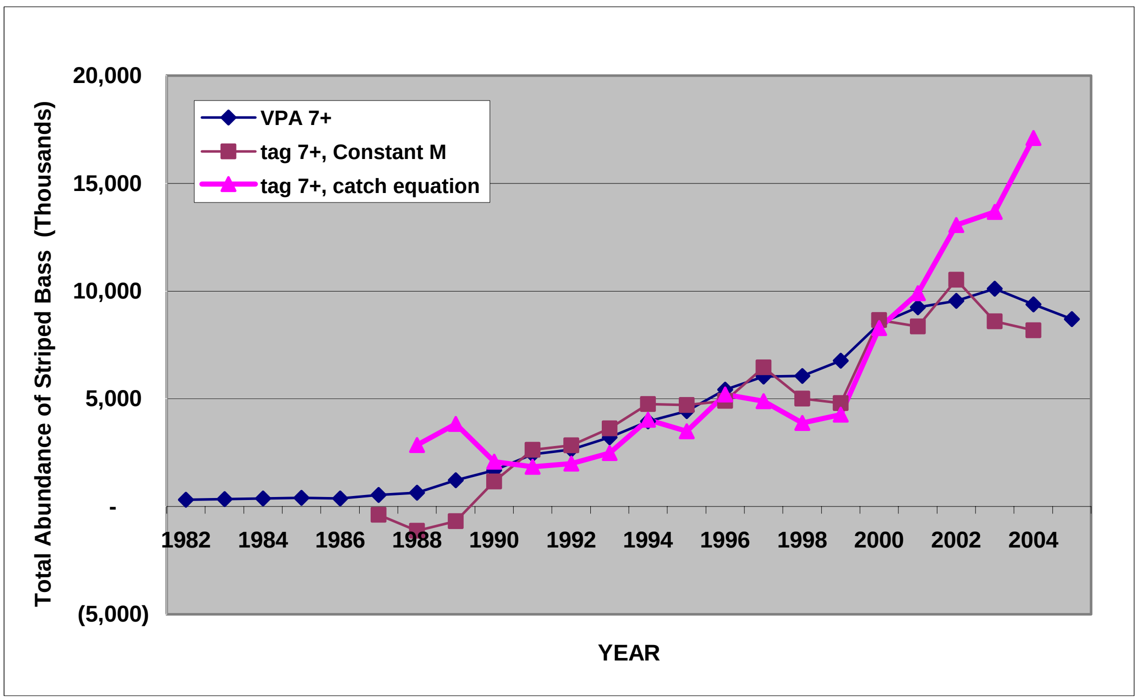


Figure 27. Population estimates of age 7+ striped bass from the VPA as well as the tagging program using the catch equation and constant M methods.

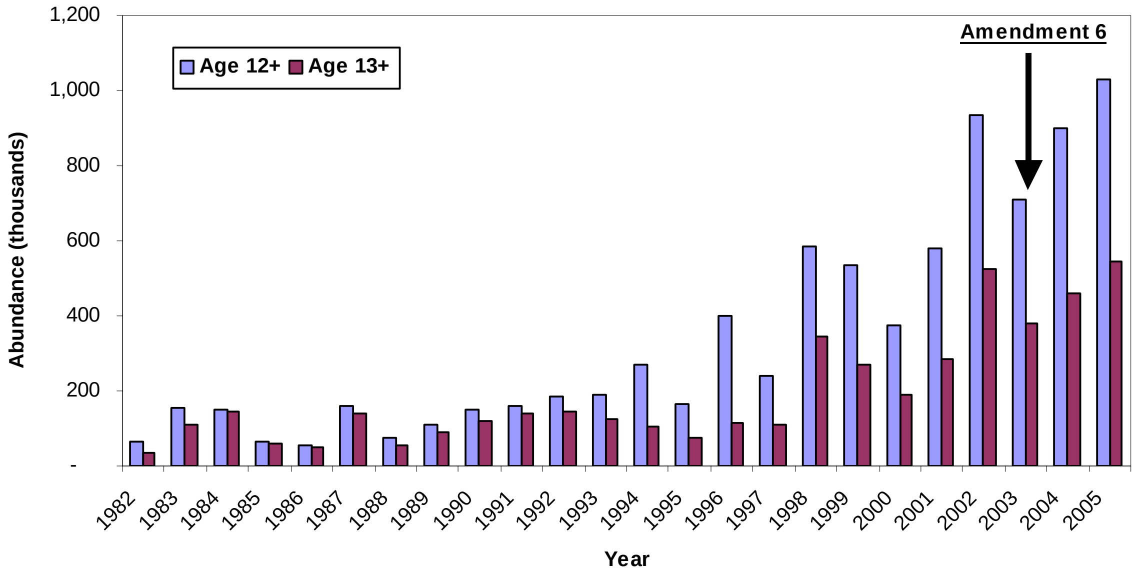


Figure 28. Estimates of age 12+ and 13+ abundance of Atlantic coast striped bass from the VPA.

VI. Tables

Table 1a. Data sources by state for estimating striped bass age structure of recreational discards in 2004.

State	Number	Length Frequency	Age Length Key
ME	MRFSS B2 * 0.08	ME Volunteer angler log books	MA key from volunteer angler, tagging, and commercial monitoring programs
NH	MRFSS B2 * 0.08	NH Volunteer angler log books	MA key from volunteer angler, tagging, and commercial monitoring programs
MA	MRFSS B2 * 0.08	MA Volunteer angler log data	MA key from volunteer angler, tagging, and commercial monitoring programs
RI	MRFSS B2 * 0.08	ALS Tag length data	NY Ocean haul seine and MA hook and line monitoring data
CT	MRFSS B2 * 0.08	CT Volunteer angler log books	NY Western LI Sound volunteer angler program
NY	MRFSS B2 * 0.08	ALS Tag length data	NY Western LI Sound Angler log books, Commercial monitoring, NY Ocean Haul Seine
NJ	MRFSS B2 * 0.08	NJ Volunteer angler log books for Bonus Fish Program	Spring - Delaware Bay tagging, April ocean trawl survey, & spring Bonus fish program Fall - October ocean trawl survey & fall Bonus Fish Program
DE	MRFSS B2 * 0.08	NJ Volunteer angler log books for Bonus Fish Program	Spring - Delaware River spawning stock survey & commercial gill net monitoring Fall - NJ October ocean trawl survey & fall Bonus Fish Program
MD	MRFSS B2 * 0.08	Spring and fall MD Volunteer angler log books	Spring - MD gill net survey Fall - Commercial check station data
VA	MRFSS B2 * 0.08	Spring and fall MD Volunteer angler log books	Spring - MD gill net survey Fall - Commercial check station data
NC	MRFSS B2 * 0.08	Not available - See footnote	Not used - See footnote

Table 1b. Total Atlantic Coast harvest of striped bass in metric tons and numbers from 1982 through 2004.

	Commercial		Recreational		Total	
Year	MT	N	MT	N	MT	N
1982	998	428,630	1,146	217,256	2,145	645,886
1983	649	357,541	1,220	299,444	1,869	656,985
1984	1,110	870,871	581	114,463	1,691	985,334
1985	437	174,621	373	133,522	810	308,143
1986	68	17,681	502	114,623	570	132,304
1987	63	13,552	388	43,755	452	57,307
1988	117	33,310	572	86,705	689	120,015
1989	91	7,402	333	37,562	424	44,964
1990	314	115,636	1,012	163,242	1,326	278,878
1991	669	153,798	1,656	262,469	2,325	416,267
1992	652	230,714	1,830	300,180	2,482	530,894
1993	796	312,860	2,569	428,719	3,364	741,579
1994	807	307,443	3,081	565,167	3,888	872,610
1995	1,559	534,914	5,648	1,089,223	7,207	1,624,137
1996	1,227	766,518	6,091	1,199,253	7,318	1,965,771
1997	2,685	1,058,181	7,769	1,646,971	10,454	2,705,152
1998	2,943	1,223,828	6,098	1,468,542	9,041	2,692,370
1999	2,994	1,103,783	6,713	1,448,800	9,707	2,552,583
2000	3,029	1,057,711	8,214	2,012,685	11,243	3,070,396
2001	3,124	941,733	9,016	2,085,126	12,140	3,026,859
2002	2,692	654,062	9,023	1,970,495	11,715	2,624,557
2003	3,227	868,987	10,936	2,536,272	14,163	3,405,259
2004	3,297	907,328	11,874	2,381,823	15,171	3,289,151

Table 2. Total 2004 striped bass harvest and discard in numbers (A) and percent of total by fishery (B).

A

Fishery component	Harvest	Bycatch	Discards	Total Removals
Recreational	2,381,823	17,167,874	1,373,430	3,755,253
Commercial	907,328	4,108,753	518,847	1,426,175
Total	3,289,151	21,276,627	1,800,051	5,181,428

B

Fishery component	Harvest	Discards	Total Removals
Recreational	46.0	26.5	72.5
Commercial	17.5	10.0	27.5
Total	63.5	36.5	100.0

Table 3. Commercial landings in number of Atlantic striped bass by state, 1982-2004.

	State									
Year	ME	MA	RI	CT	NY	DE	MD	PRFC	VA	NC	Total
1982		26,183	52,896	207	74,935	12,794	189,089	54,421	14,905	3,200	428,630
1983		9,528	48,173	83	66,334	5,806	147,079	63,171	15,962	1,405	357,541
1984		5,838	8,878	192	70,472	12,832	392,696	372,924	6,507	532	870,871
1985	90	7,601	7,173	350	52,048	1,359		82,550	23,450		174,621
1986		3,797	2,668					10,965	251		17,681
1987		3,284	23					9,884	361		13,552
1988		3,388						19,334	10,588		33,310
1989		7,402									7,402
1990		5,927	784		11,784	698	534	38,884	56,222	803	115,636
1991		9,901	3,596		15,426	3,091	31,880	44,521	44,970	413	153,798
1992		11,532	9,095		20,150	2,703	119,286	23,291	42,912	1,745	230,714
1993		13,099	6,294		11,181	4,273	211,089	24,451	39,059	3,414	312,860
1994		11,066	4,512		15,212	4,886	208,914	25,196	32,382	5,275	307,443
1995		44,965	19,722		43,704	5,565	280,051	29,308	88,274	23,325	534,914
1996		38,354	18,570		39,707	20,660	415,272	46,309	184,495	3,151	766,518
1997		44,841	7,061		37,852	33,223	656,416	87,643	165,583	25,562	1,058,181
1998		43,315	8,835		45,149	31,386	780,893	93,299	204,911	16,040	1,223,828
1999		40,838	11,559		49,795	34,841	650,022	90,575	205,143	21,010	1,103,783
2000		40,256	9,418		54,894	25,188	627,777	91,471	202,227	6,480	1,057,711
2001		40,248	10,917		58,296	34,373	538,808	87,809	148,346	22,936	941,733
2002		44,897	11,653		47,142	30,440	296,635	80,300	127,211	15,784	654,062
2003		55,433	15,497		68,354	31,530	439,482	83,090	161,778	13,823	868,987
2004		60,632	15,867		70,367	28,406	461,064	91,980	147,998	31,014	907,328

Table 4. Atlantic Coast striped bass commercial harvest in numbers at age by state in 2004.

	Age													
	1	2	3	4	5	6	7	8	9	10	11	12	13+	total
MA						242	2,368	12,414	13,139	12,824	8,224	5,131	6,291	60,633
RI		5	104	678	1,618	1,887	3,337	2,690	2,147	1,685	683	534	499	15,867
NY			298	5,802	8,182	11,306	10,116	19,340	8,629	3,868	1,488	1,190	149	70,367
DE			1	365	3,292	7,894	2,527	6,909	2,929	3,099	1,024	290	75	28,406
MD		10	56,997	143,502	94,104	62,309	59,185	26,758	10,122	3,687	3,433	329	628	461,064
VA			2,150	6,158	7,442	11,992	9,323	20,255	25,205	20,959	20,728	12,751	11,033	147,998
PRFC			23,615	29,486	26,923	7,259	1,562	1,930	827	368				91,980
NC							790	3,971	7,664	9,119	5,699	2,319	1,452	31,014
Total		15	83,165	186,002	141,562	102,891	89,208	94,267	70,661	55,610	41,279	22,544	20,126	907,329

Table 5. Recovery of tagged striped bass by commercial gear in 2004 and assumed gear specific release mortalities.

	Commercial Gear							
	Anchor Gill Net	Drift Gill Net	Hook&Line	Other	Pound Net	Seine	Trawl	Total
Number								
Chesapeake Bay	46	42	28	1	334			451
Coast	11	1	65	1	8		11	97
Delaware Bay	3	4						7
Percent								
Chesapeake Bay	0.10	0.09	0.06	0.00	0.74			
Coast	0.11	0.01	0.67	0.01	0.08		0.12	
Delaware Bay	0.43	0.57						
Release Mortality	0.43	0.08	0.08	0.20	0.05	0.15	0.35	

Table 6. Ratios of commercial and recreational landings and tag recaptures from released and kept fish in Chesapeake Bay and the Atlantic Coast.

		Ches Bay			Coast			DE Bay		
		Com	Rec	Ratio	Com	Rec	Ratio	Com	Rec	Ratio
2002	Landings	504,146	603,250	0.84	116,847	1,193,019	0.10			
	Landed tags	181	609	0.30	48	636	0.08			
	Discard tags	41	316	0.13	25	600	0.04			
2003	Landings	662,518	886,330	0.75	203,171	1,519,377	0.13			
	Landed tags	407	523	0.78	34	774	0.04			
	Discard tags	79	279	0.28	13	649	0.02			
2004	Landings	677,662	730,222	0.93	228,003	1,443,282	0.16	28,406	179,657	0.16
	Landed tags	348	497	0.70	74	731	0.10	2	59	0.03
	Discard tags	104	221	0.47	23	600	0.04	5	42	0.12
Three year mean of landings ratios (02-04)				0.84			0.13			
Three year mean of landings tags (02-04)				0.59			0.07			
Correction factor				1.41			1.77			1.59

Table 7a. Data sources for estimating striped bass age structure of commercial discards in 2004.

Gear	Data source	Data type	conversion to age
Coastal gill net	NEFC Observer Program for 2004 (N=52 fish)	len-freq	state age-len key
Coastal Hook and Line	H&L discards MA 2004 compliance report	age structure	
Coastal Pound Net	Trap net discards RI 2004 compliance report	age structure	
Coastal Otter Trawl	NEFC Observer Program for 2004 (N=666 fish)	len-freq	state age-len key
Ches Bay Anchor Gill Net	FI sampling, James & Rappahannock R. VA 2004 compliance report	age structure	
Ches Bay Drift Gill Net	Drift gill net havest MD 2004 compliance report	age structure	
Ches Bay Hook and Line	H&L and pound net harvest MD 2004 compliance report	age structure	
Ches Bay Pound Net	FI sampling, Rappahannock R. VA 2004 compliance report	age structure	
Del Bay Gill Net	NJ Del. Bay tagging program USFWS coastwide tagging database	len-freq	state age-len key

Table 7b. Atlantic Coast striped bass commercial discards in numbers at age, 2004.

	Age													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13+	
Coast	28	1,211	3,966	7,788	11,164	17,768	18,957	25,146	13,615	4,664	4,937	1,657	748	111,650
Ches. Bay	2,956	51,833	75,072	66,281	40,487	24,198	30,617	15,307	9,838	5,195	5,527	719	328	328,358
Del. Bay			341	3,709	7,866	19,303	18,275	17,063	8,362	2,378	645	193	123	78,258
Hudson				128	171	144	62	37	27	5	3	3	1	581
Total	2,984	53,044	79,379	77,906	59,688	61,413	67,911	57,553	31,842	12,242	11,112	2,572	1,200	518,847

Table 8. Total Atlantic Coast striped bass recreational harvest in numbers by state, 1982-2004.

	State											
Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	Total
1982	929		83,933	1,757	50,081	21,278	58,294		984			217,256
1983	7,212	4,576	39,316	1,990	42,826	43,731	127,912	135	31,746			299,444
1984			3,481	1,230	5,678	57,089	13,625	16,571	16,789			114,463
1985	11,862		66,019	670	15,350	23,107	13,145		2,965	404		133,522
1986			29,434	3,291	1,760	27,477	36,999		14,077	1,585		114,623
1987		90	10,807	2,399	522	14,191	9,279		4,025	2,442		43,755
1988		647	21,050	5,226	2,672	20,230	12,141		133	24,259	347	86,705
1989	738		13,044	4,303	5,777	12,388	1,312					37,562
1990	2,912	617	20,515	4,677	6,082	24,799	44,878	2,009	736	56,017		163,242
1991	3,265	274	20,799	17,193	4,907	54,502	38,300	2,741	77,873	42,224	391	262,469
1992	6,357	2,213	57,084	14,945	9,154	45,162	41,426	2,400	99,354	21,118	967	300,180
1993	612	1,540	58,511	17,826	19,253	78,560	64,935	4,055	104,682	78,481	264	428,719
1994	3,771	3,023	74,538	5,915	16,929	87,225	34,877	4,140	199,378	127,945	7,426	565,167
1995	2,189	3,902	73,806	29,997	38,261	155,821	254,055	15,361	355,237	149,103	11,491	1,089,223
1996	1,893	6,461	68,300	60,074	62,840	225,428	127,952	22,867	337,415	250,731	35,291	1,199,252
1997	35,259	13,546	199,373	62,162	64,639	236,287	67,800	19,706	334,068	518,483	95,648	1,646,971
1998	38,094	5,929	207,952	44,890	64,215	181,031	88,973	18,758	391,824	383,786	43,089	1,468,541
1999	21,102	4,641	126,755	56,320	55,805	197,672	237,010	8,772	263,191	411,873	65,659	1,448,800
2000	62,186	4,262	181,295	95,496	53,191	259,085	402,302	39,543	506,462	389,126	19,737	2,012,685
2001	59,947	15,291	288,032	80,125	54,165	189,710	560,208	41,195	382,557	355,020	58,876	2,085,126
2002	71,907	12,857	308,749	78,190	51,060	200,547	416,455	29,149	282,429	411,248	107,904	1,970,495
2003	56,871	24,878	407,100	115,471	94,361	313,761	391,842	29,522	525,191	455,812	121,463	2,536,272
2004	36,091	10,057	406,590	73,964	72,368	242,840	421,009	23,884	313,914	467,389	313,717	2,381,823

Table 9. Total Atlantic Coast striped bass recreational harvest in numbers at age by state in 2004.

	Age													
	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
ME			7,070	15,219	8,177	4,570	426	374	10	34	58	42	111	36,091
NH			24	81	1,028	2,475	2,575	2,070	577	434	376	150	267	10,057
MA			0	1,853	17,009	51,155	84,664	104,031	52,101	37,072	27,774	10,565	20,366	406,590
RI			32	410	2,308	6,148	9,072	16,606	12,320	9,121	6,484	3,451	8,013	73,964
CT			0	550	4,862	9,717	11,246	17,548	13,810	6,824	5,687	1,432	693	72,368
NY			0	3,017	14,609	35,953	32,689	54,090	38,947	17,285	27,113	16,336	2,802	242,840
NJ			7,435	44,277	71,076	59,623	48,676	89,110	46,245	24,100	12,234	6,670	11,564	421,009
DE			81	449	1,506	3,347	4,481	7,515	2,774	2,202	625	331	573	23,884
MD	184	504	37,187	64,959	30,130	45,539	37,143	23,820	20,816	20,323	18,580	7,464	7,266	313,914
VA			50,531	64,144	54,412	49,684	45,462	57,838	49,270	30,262	31,735	14,323	19,729	467,389
NC							4,907	28,392	63,094	92,888	64,496	30,320	29,619	313,717
Total	184	504	102,358	194,959	205,118	268,209	281,342	401,393	299,965	240,546	195,160	91,084	101,002	2,381,823

Table 10. Total Atlantic Coast striped bass recreational discards in numbers at age by state, 2004.

	Age														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
ME			640	31,084	14,537	5,440	3,953	1,395	1,373	356	216	99	42	70	59,207
NH			178	7,101	3,764	1,961	1,518	487	405	94	71	46	22	51	15,699
MA			3,723	172,783	99,295	55,749	50,651	30,496	31,946	11,096	7,046	3,814	1,404	2,280	470,284
RI		23	5,179	24,557	10,705	5,170	3,405	823	361	54					50,278
CT		1,409	12,014	27,652	14,401	6,978	7,225	3,623	5,195	3,728	1,795	1,570	539	1,026	87,156
NY		102	17,352	49,495	19,127	8,246	6,811	3,413	4,635	3,441	1,524	2,337	1,320	0	117,804
NJ	15	2,220	7,202	27,683	28,580	12,690	8,628	8,179	7,352	3,543	1,727	881	416	638	109,755
DE				1,630	3,229	1,861	1,711	832	1,083	578	493	251	114	199	11,981
MD		41,446	38,828	120,428	59,545	9,200	8,785	8,026	3,773	1,636	79			18	291,764
VA		19,969	19,283	58,195	28,040	4,121	3,714	3,419	1,459	692	22			5	138,919
NC		85	1,047	7,697	4,306	2,176	1,859	1,095	1,159	505	280	198	85	92	20,584
Total	15	65,254	105,446	528,305	285,531	113,594	98,259	61,789	58,742	25,724	13,253	9,197	3,942	4,380	1,373,430

Table 11. Total Atlantic Coast striped bass recreational harvest and discards in number at age by state, 2004.

	Age														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
ME			640	38,153	29,757	13,617	8,523	1,821	1,747	366	250	157	85	181	95,298
NH			178	7,124	3,845	2,988	3,992	3,063	2,475	671	506	422	173	318	25,756
MA			3,723	172,783	101,148	72,758	101,806	115,160	135,977	63,197	44,118	31,588	11,969	22,647	876,874
RI		23	5,179	24,589	11,115	7,479	9,553	9,894	16,967	12,374	9,121	6,484	3,451	8,013	124,242
CT		1,409	12,014	27,652	14,951	11,840	16,942	14,869	22,743	17,538	8,619	7,257	1,971	1,719	159,524
NY		102	17,352	49,495	22,144	22,855	42,764	36,102	58,725	42,388	18,809	29,450	17,656	2,802	360,644
NJ	15	2,220	7,202	35,118	72,858	83,766	68,250	56,855	96,461	49,788	25,827	13,115	7,085	12,202	530,764
DE				1,711	3,678	3,367	5,058	5,313	8,597	3,353	2,695	876	445	772	35,865
MD		41,630	39,332	157,614	124,504	39,330	54,324	45,169	27,593	22,452	20,402	18,580	7,464	7,284	605,679
VA		19,969	19,283	108,726	92,184	58,533	53,397	48,882	59,297	49,962	30,285	31,735	14,323	19,734	606,308
NC		85	1,047	7,697	4,306	2,176	1,859	6,002	29,552	63,599	93,168	64,694	30,405	29,711	334,301
TOTAL	15	65,438	105,950	630,663	480,490	318,711	366,468	343,131	460,135	325,689	253,799	204,357	95,025	105,382	3,755,253

Table 12. Total Atlantic Coast striped bass catch at age, including recreational and commercial harvest and discards, 1982-2004. Numbers in thousands.

	Age													
	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1982	1.8	105.6	256.7	220.8	58.4	19.2	24.2	16.8	11.7	10.6	11	13.7	15.7	766.2
1983	3.6	110.3	178.2	193.1	150	39.3	18.7	4.1	2.9	3.7	4.6	5.6	13.6	727.7
1984	5.6	542.8	302.7	82.4	60.4	51.7	18.3	4.7	2.1	2.1	0.7	0.3	11.1	1084.9
1985	1.3	72.5	102	40.5	58.7	43.1	43.5	17.3	6.4	3.4	1	0.8	10.3	400.8
1986	11.3	21	63.8	132.9	49.9	32	20.4	24	9.2	5.3	3.4	1.6	10.1	384.9
1987	1.4	10.9	37.6	51.4	67.3	25	13.2	6.5	6.4	3	1.5	2	12.9	239.1
1988	2.6	30.9	41.8	63.2	107.1	97.9	40.6	24.4	14	5.8	3.7	3.3	9.6	444.9
1989	0.7	36	79.7	68.2	104.9	95.4	45.7	21	10.4	3.8	3.2	2	8.9	479.9
1990	2.1	46.2	124.5	187.8	173.2	165.2	104.1	67.9	20.7	7.3	5.1	3.5	13.7	921.3
1991	1.8	72.8	145.3	208.7	162	101.4	91.3	82.9	58.8	24.1	14.2	2.8	22.3	988.4
1992	2.9	45.8	199.7	189.2	177.1	109.5	62.4	67.8	58.4	44.8	9.3	4.1	15.9	986.9
1993	0.3	69.6	185.3	327.3	288.5	185.4	86.6	67.3	82.6	76.2	41.1	9.3	17.5	1437
1994	5.7	145.4	348.8	290.6	367.8	232.4	135.4	86.7	99.9	81	36	22.3	14.6	1866.6
1995	4.1	433.5	470.8	456.1	405.3	489.9	214.5	196.0	153.8	90.6	53.4	17.5	14.2	2999.7
1996	1.0	98.8	649.4	650.1	542.9	468.7	442.2	209.6	136.8	68.9	42.5	46.3	19.0	3376.2
1997	3.3	291.5	602.0	971.2	685.3	655.7	458.6	415.7	223.5	140.6	70.0	34.0	28.7	4580.2
1998	26.4	183.4	485.4	706.7	1125.0	510.9	280.4	265.0	215.5	113.8	95.1	45.2	65.5	4118.3
1999	8.4	108.3	419.6	648.8	642.2	730.2	351.8	238.9	205.4	148.4	104.5	48.6	49.2	3704.4
2000	38.0	323.9	419.9	989.2	1021.2	780.4	738.1	311.9	160.6	141.5	59.6	29.3	30.8	5044.4
2001	34.7	161.9	431.5	605.4	830.6	696.7	576.8	480.4	205.8	119.6	103.0	49.6	48.0	4344.0
2002	24.5	207.0	226.9	254.0	450.2	651.5	668.6	497.7	341.5	260.2	109.6	86.5	111.3	3889.5
2003	28.4	254.6	476.4	601.6	707.8	604.3	708.1	494.1	374.2	284.2	127.9	80.9	93.7	4836.2
2004	68.5	159.1	793.9	745.3	520.6	531.1	500.5	612.2	428.3	321.7	256.8	120.2	126.8	5184.8

Table 13. Mean weight at age (kg) of harvested and discarded Atlantic striped bass, 1982-2004.

	Age												
Year	1	2	3	4	5	6	7	8	9	10	11	12	13/13+
1982	0.13	0.64	1.09	1.54	2.42	3.75	4.83	5.79	6.20	8.68	10.80	11.20	14.05
1983	0.20	0.55	0.94	1.37	2.37	3.29	3.77	5.36	6.01	8.10	9.57	10.39	11.11
1984	0.24	0.60	1.69	1.62	2.67	3.39	5.07	5.65	6.76	7.76	8.41	12.65	12.38
1985	0.06	0.61	1.07	1.66	2.19	3.59	4.91	5.46	6.77	7.45	9.00	10.69	13.91
1986	0.14	0.57	1.27	2.40	2.44	3.12	3.95	5.05	5.44	6.09	7.75	9.16	12.78
1987	0.20	0.77	1.41	2.11	2.50	2.91	3.61	4.74	5.52	6.49	7.77	9.78	13.15
1988	0.31	0.91	1.10	1.98	3.12	4.02	4.38	4.70	5.24	5.62	8.58	10.40	13.27
1989	0.16	0.83	1.22	2.23	3.06	4.53	5.37	6.23	6.04	8.68	8.94	9.74	13.36
1990	0.08	0.89	1.14	2.05	2.35	3.83	4.91	5.96	5.70	5.97	7.44	9.08	12.60
1991	0.21	0.92	1.29	2.17	2.62	3.17	4.81	5.64	6.46	6.24	9.46	8.30	14.22
1992	0.10	0.69	1.31	1.93	2.81	3.67	4.90	5.79	6.96	8.15	9.77	12.44	13.97
1993	0.07	0.76	1.31	1.99	2.77	3.58	4.80	6.11	7.03	8.01	9.53	10.76	14.55
1994	0.24	1.05	1.69	2.21	2.85	3.50	4.94	6.20	6.80	7.53	9.73	10.69	12.73
1995	0.28	0.70	1.35	2.18	2.77	3.65	5.38	6.16	7.27	8.86	7.57	9.73	16.66
1996	0.14	1.05	1.47	2.32	3.23	4.52	6.39	7.11	7.81	9.20	9.31	10.10	13.70
1997	0.13	0.62	1.18	2.46	2.81	3.64	4.51	5.07	6.73	9.17	9.94	10.24	14.78
1998	0.39	0.77	1.20	1.62	2.25	2.95	4.69	5.66	6.82	7.03	7.76	9.87	11.87
1999	0.62	0.90	1.11	1.44	1.91	2.51	3.36	5.03	6.56	7.85	8.69	9.76	11.98
2000	0.37	0.55	1.10	1.45	1.96	2.79	3.89	5.09	7.11	7.37	9.70	10.70	13.55
2001	0.16	0.38	1.12	1.75	2.21	3.25	4.12	5.02	6.36	7.79	8.65	8.29	10.87
2002	0.12	0.31	1.06	1.51	2.18	3.17	4.19	5.48	6.03	7.56	9.09	9.75	11.52
2003	0.10	0.60	1.00	1.40	2.20	3.20	4.10	5.20	6.10	7.20	8.50	9.40	11.00
2004	0.23	0.33	0.84	1.40	2.43	3.11	4.14	5.17	6.07	7.12	8.18	9.03	10.71

Table 14. Indices of abundance for Atlantic striped bass adjusted to appropriate 1 January measurement time, 1982-2005. Indicesused in the final ADAPT run are highlighted in bold.

Index	**MACOM**	**MACOM**	**MACOM**	MACOM	MACOM	MACOM	MACOM	MACOM	MACOM	MDSSN	MDSSN
Age	**5**	**6**	**7**	8	9	10	11	12	13+	3	4
Date Tuned	**mean**	**mean**	**mean**	mean	mean	mean	mean	mean	mean	1-Jan	1-Jan
Index Type	**number**	**number**	**number**	number	number	number	number	number	number	number	number
Year											
1982	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	303.6	31.9
1986	-	-	-	-	-	-	-	-	-	260.0	495.8
1987	-	-	-	-	-	-	-	-	-	251.7	111.1
1988	-	-	-	-	-	-	-	-	-	73.6	70.7
1989	-	-	-	-	-	-	-	-	-	152.5	80.4
1990	-	-	-	-	-	-	-	-	-	158.1	120.3
1991	**0.064**	**0.064**	**0.07**	0.11	0.12	0.07	0.02	0.01	0.03	191.1	62.2
1992	**0.039**	**0.05**	**0.07**	0.14	0.17	0.11	0.02	0.01	0.03	218.7	152.6
1993	**0.048**	**0.054**	**0.05**	0.08	0.16	0.15	0.07	0.01	0.04	132.0	186.0
1994	**0.044**	**0.065**	**0.05**	0.07	0.14	0.14	0.08	0.03	0.03	103.5	97.3
1995	**0.023**	**0.046**	**0.08**	0.14	0.14	0.13	0.08	0.05	0.03	117.2	67.3
1996	**0.026**	**0.05**	**0.09**	0.17	0.16	0.14	0.08	0.04	0.03	368.3	102.2
1997	**0.032**	**0.055**	**0.09**	0.21	0.10	0.11	0.07	0.03	0.03	46.3	134.6
1998	**0.06**	**0.068**	**0.09**	0.15	0.14	0.08	0.07	0.03	0.03	142.8	32.7
1999	**0.037**	**0.067**	**0.06**	0.08	0.15	0.15	0.08	0.05	0.04	174.2	80.1
2000	**0.037**	**0.073**	**0.12**	0.11	0.17	0.15	0.08	0.03	0.03	50.7	107.6
2001	**0.095**	**0.085**	**0.15**	0.13	0.09	0.05	0.05	0.02	0.02	39.1	52.3
2002	**0.065**	**0.173**	**0.11**	0.12	0.09	0.05	0.05	0.03	0.04	41.5	38.5
2003	**0.072**	**0.079**	**0.17**	0.13	0.12	0.07	0.04	0.04	0.02	110.0	47.8
2004	**0.073**	**0.118**	**0.15**	0.20	0.10	0.07	0.04	0.02	0.04	179.1	121.7

Table 14 cont'd.

Index	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	NYOHS	NYOHS
Age	5	6	7	8	9	10	11	12	13+	3	4
Date Tuned	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan
Index Type	number	number	number	number	number	number	number	number	number	number	number
Year											
1982	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-
1985	4.5	1.2	1.7	0	0.3	0.1	0	0.2	0.7	-	-
1986	4.1	5.3	2.1	3	3	0	0	0	0.9	-	-
1987	188.8	1.8	1.6	4.2	0.2	0	0	0	10.8	-	-
1988	57.7	77.4	1.4	0	0	4.3	0	0	0.4	1.13	6.93
1989	45.5	48.9	33.3	0.2	0.1	0	0	0	0	6.41	7.64
1990	48.3	34.3	32	29.8	0.9	0.1	0.1	0.5	1	1.86	2.73
1991	47.1	26.7	26.1	19.2	10.7	0.4	1.5	0	2.3	1.89	9.19
1992	58.8	70.1	43.2	29.4	13.9	7.3	3.3	0	2.4	5.23	9.26
1993	88.5	51.2	52.2	37.5	23	7.7	3.2	0.8	3	1.49	7.84
1994	118	59.6	34.1	43.1	17.8	8.7	3.1	1.3	0.3	3.81	9.43
1995	60.9	51.8	40.2	25.1	19.8	11.6	9.7	3.5	4.7	2.22	4.26
1996	34.7	69.5	64.4	42.3	35.4	16.7	15.2	4.7	1.6	3.2	3.52
1997	46	21.7	19.7	25.8	22.3	12.3	12	3.7	1.8	11.75	105.61
1998	149.3	32.3	13.2	18.5	17.3	15	9.1	9.9	2.5	20.24	23.79
1999	56.8	35.3	11.4	6.6	11.1	5.2	5.1	2.7	1.2	19.6	31.02
2000	50.3	58.2	27.2	14.1	8.1	7.9	7.8	4.9	5.5	1.97	17.75
2001	51.6	23.2	28.5	38	13.2	11.9	9.8	5.5	4.7	7.79	11.81
2002	83.3	34	29.9	31.6	22.8	7.4	4.1	5.4	5.5	1.49	12.94
2003	37.1	61.5	56.8	30.8	27.5	34.4	9.9	10.6	10.9	7.33	5.14
2004	41	32.9	43.9	46.5	37.2	26.4	27.3	8.1	15.5	11.51	20.76
2005	77.3	39.4	38.5	45.1	34.4	34.9	34.2	9.9	9	5.46	62.09

Table 14 cont'd

Index	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NEFSC	YOYNY	YOYNJ	YOYMD	YOYVA	YRLLI
Age	5	6	7	8	9:13	2:09	1	1	1	1	2
Date Tuned	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan
Index Type	number	number	number	number	number	number	number	number	number	number	number
Year											
1982	-	-	-	-	-	-	8.86	-	0.59	1.56	-
1983	-	-	-	-	-	-	14.17	0.12	3.57	2.71	-
1984	-	-	-	-	-	-	16.25	0.03	0.61	3.4	-
1985	-	-	-	-	-	-	15	0.29	1.64	4.47	-
1986	-	-	-	-	-	-	1.92	0.18	0.91	2.41	0.61
1987	-	-	-	-	-	-	2.92	0.28	1.34	4.74	0.3
1988	12.77	9.91	3.14	1.24	0.42	-	15.9	0.41	1.46	15.74	0.21
1989	5.53	4.72	2.42	0.62	0.99	-	33.46	0.35	0.73	7.64	0.81
1990	1.5	1.62	1.04	0.95	0.43	-	21.35	1.03	4.87	11.23	1.78
1991	9.52	3.54	3.06	1.73	2.15	0.235	19.08	1	1.03	7.34	0.37
1992	6.16	1.31	0.42	0.64	2.22	0.237	3.6	0.47	1.52	3.76	1.26
1993	4.85	2.28	0.62	0.27	1.47	0.481	11.43	1.19	2.34	7.35	1.34
1994	7.09	1.71	0.8	0.23	1.25	1.394	12.59	1.78	13.97	18.11	0.75
1995	2.46	2.12	1.31	0.86	2.48	0.952	17.64	0.96	6.4	10.48	1.43
1996	3.32	0.94	0.86	0.46	0.69	0.602	16.23	1.98	4.41	5.45	1.29
1997	16.13	4.64	1.33	1.03	0.78	1.182	8.93	1.7	17.61	23	1.54
1998	44.23	6.56	1.81	0.36	1.13	0.729	22.3	1.01	3.91	9.35	1
1999	17.91	29.83	3.82	0.95	1.31	0.448	13.39	1.31	5.5	13.25	2.1
2000	4.87	1.68	1.24	0.14	0.58	1.274	26.64	1.9	5.34	2.8	2.05
2001	26.54	9.43	2.23	2.25	1.03	0.623	3.16	1.77	7.42	16.18	1.56
2002	4.19	6.05	2.09	0.78	0.85	0.981	22.98	1.07	12.57	14.17	2.16
2003	4.19	1.83	1.67	1.3	1.21	0.774	12.32	0.51	2.2	3.98	2.53
2004	7.12	5.25	2.31	3.68	6.23	0.335	17.36	2.43	10.83	22.89	1.19
2005	29.79	6.84	2.42	0.83	1.54	0.404	8.81	1.13	4.85	12.7	2.41

Table 14 cont'd.

Index	YRLMD	DETRWL	CTTRL	DESSN	DESSN	DESSN	DESSN	DESSN	DESSN	DESSN	DESSN
Age	2	2:08	4:06	2	3	4	5	6	7	8	9
Date Tuned	1-Jan	mean	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan
Index Type	number	number	number	number	number	number	number	number	number	number	number
Year											
1982	0.02	0.19	0	-	-	-	-	-	-	-	-
1983	0.02	0.01	0	-	-	-	-	-	-	-	-
1984	0.28	0.01	0.02	-	-	-	-	-	-	-	-
1985	0	0.01	0	-	-	-	-	-	-	-	-
1986	0.15	0	0	-	-	-	-	-	-	-	-
1987	0.03	0	0.05	-	-	-	-	-	-	-	-
1988	0.06	0	0.04	-	-	-	-	-	-	-	-
1989	0.07	0	0.06	-	-	-	-	-	-	-	-
1990	0.18	0	0.16	-	-	-	-	-	-	-	-
1991	0.28	1.17	0.15	-	-	-	-	-	-	-	-
1992	0.18	0.23	0.22	-	-	-	-	-	-	-	-
1993	0.14	0.89	0.27	-	-	-	-	-	-	-	-
1994	0.18	1.96	0.3	-	-	-	-	-	-	-	-
1995	0.58	2.59	0.59	-	-	-	-	-	-	-	-
1996	0.12	15.65	0.63	0.1	7.7	3.5	1.1	1.6	1.4	1.2	1.1
1997	0.08	7.2	0.85	2.0	1.6	8.6	3	1.1	1.4	1.6	0.7
1998	0.23	2.73	0.97	1.1	2.4	2.7	9.6	2.5	1.7	2.9	2.6
1999	0.16	2.04	1.1	0.0	1.6	2.2	2.7	3.6	1.1	0.8	1.2
2000	0.31	10.05	0.84	0.9	0.9	5.2	4.3	3.4	5.6	1.6	0.7
2001	0.23	6.03	0.61	0.1	2.3	2	3.7	2.2	2.8	4	1
2002	0.28	4.17	1.3	0.7	1.4	3.8	3.6	3.2	2.3	1.8	1.9
2003	0.58	7.21	0.87	0.5	2.4	2.4	3.3	2.2	2.7	3.1	2.6
2004	0.07	1.45	0.56	0.2	4.9	6.8	2.9	2	1.6	3.3	2.3
2005	0.55	2.14	0	0.0	0.0	0	0	0	0	0	0

Table 14 cont'd.

Index	DESSN	NJTRL	NJTRL	NJTRL	NJTRL	NJTRL	NJTRL	NJTRL	NJTRL	MRFSS	CTCPUE
Age	10:13	2	3	4	5	6	7	8	9:13	2:13	2
Date Tuned	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	mean	mean
Index Type	number	number	number	number	number	number	number	number	number	number	number
Year											
1982	-	-	-	-	-	-	-	-	-	-	0.33
1983	-	-	-	-	-	-	-	-	-	-	0.4
1984	-	-	-	-	-	-	-	-	-	-	0.12
1985	-	-	-	-	-	-	-	-	-	-	0.06
1986	-	-	-	-	-	-	-	-	-	-	0.08
1987	-	-	-	-	-	-	-	-	-	-	0.04
1988	-	-	-	-	-	-	-	-	-	0.36	0.02
1989	-	0.04	0.06	0	0.02	0.01	0	0	0.01	0.27	0.27
1990	-	0.02	0.06	0.01	0.12	0.04	0.01	0.03	0.02	0.23	0.17
1991	-	0.17	0.17	0.01	0.01	0.09	0.08	0.01	0.06	0.39	0.15
1992	-	0.07	0.13	0.02	0.02	0.02	0.02	0	0	0.7	0.17
1993	-	0.08	0.11	0.05	0.03	0.04	0.01	0.01	0	0.58	0.07
1994	-	0.15	0.19	0.08	0.05	0.03	0.02	0.01	0.01	0.88	0.21
1995	-	0.48	0.13	0.05	0.03	0.02	0.01	0.01	0.01	1.17	0.6
1996	0.75	0.24	0.87	0.24	0.09	0.03	0.02	0.01	0	1.31	0.47
1997	1.89	0.27	0.59	0.34	0.16	0.05	0.02	0.01	0.01	1.37	0.18
1998	2.15	0.62	0.27	0.06	0.18	0.12	0.08	0.04	0.04	1.73	0.21
1999	2.09	0.06	0.26	0.15	0.21	0.09	0.03	0.01	0.01	1.61	0.38
2000	2.28	0.22	0.2	0.23	0.4	0.24	0.11	0.04	0.01	1.5	0
2001	1.9	0.1	0.11	0.13	0.2	0.07	0.03	0.02	0.01	1.26	0.89
2002	1.42	0.01	0.02	0.07	0.21	0.36	0.23	0.08	0.03	1.07	1.41
2003	5.44	0.58	0.46	0.08	0.24	0.19	0.24	0.1	0.04	0.91	1.33
2004	5.5	0.3	0.84	0.15	0.07	0.1	0.07	0.06	0.05	1.01	1.07
2005	0	0	0	0	0	0	0	0	0	0	0

Table 14 cont'd.

Index	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE
Age	3	4	5	6	7	8	9
Date Tuned	mean	mean	mean	mean	mean	mean	mean
Index Type	number	number	number	number	number	number	number
Year							
1982	0.21	0.11	0.09	0.08	0.04	0.02	0.01
1983	0.19	0.08	0.04	0.03	0.01	0	0
1984	0.33	0.23	0.14	0.05	0.04	0.01	0
1985	0.32	0.22	0.12	0.09	0.04	0.03	0.01
1986	0.2	0.47	0.45	0.18	0.05	0.01	0.05
1987	0.24	0.34	0.2	0.14	0.06	0.04	0.03
1988	0.52	0.28	0.18	0.15	0.12	0.05	0.03
1989	0.48	0.47	0.16	0.18	0.13	0.09	0.03
1990	0.58	0.56	0.27	0.12	0.13	0.15	0.13
1991	0.67	0.43	0.35	0.14	0.07	0.09	0.13
1992	0.48	0.57	0.29	0.23	0.11	0.1	0.16
1993	0.7	0.62	0.49	0.28	0.22	0.1	0.08
1994	0.61	0.88	0.46	0.57	0.36	0.23	0.16
1995	1.2	1.34	0.59	0.59	0.32	0.18	0.19
1996	1.09	2.39	0.9	0.84	0.38	0.6	0.37
1997	1.11	1.28	1.64	0.58	0.31	0.23	0.21
1998	2.29	1.53	0.74	1.59	0.43	0.21	0.17
1999	0.43	1.28	0.37	0.39	0.6	0.62	0.41
2000	0.01	0.65	1.04	1.11	2.46	0.55	0.3
2001	0.67	0.56	2.24	1.12	0.67	0.65	0.41
2002	1.13	0.58	1.61	0.22	0.2	0.26	0.19
2003	1.36	0.63	0.75	0.41	0.39	0.38	0.34
2004	2.45	1.75	0.62	0.65	0.32	0.5	0.32
2005	0	0	0	0	0	0	0

Table 15. Average F estimates (ages 8-11, 3-11) weighted by N.

Year	**Avg. F 8-11**	**Avg. F 3-11**	**wtd 7-11**	**wtd 3-8**
1982	0.54	0.36	0.41	0.36
1983	0.36	0.37	0.23	0.37
1984	0.11	0.29	0.14	0.30
1985	0.16	0.11	0.26	0.11
1986	0.21	0.09	0.24	0.09
1987	0.10	0.04	0.09	0.04
1988	0.20	0.06	0.18	0.06
1989	0.11	0.06	0.09	0.06
1990	0.15	0.09	0.15	0.09
1991	0.22	0.08	0.14	0.07
1992	0.14	0.07	0.11	0.06
1993	0.22	0.08	0.14	0.07
1994	0.21	0.09	0.14	0.08
1995	0.24	0.12	0.20	0.11
1996	0.21	0.12	0.21	0.12
1997	0.30	0.15	0.28	0.14
1998	0.26	0.13	0.21	0.12
1999	0.28	0.11	0.20	0.10
2000	0.19	0.15	0.21	0.15
2001	0.20	0.14	0.20	0.13
2002	0.27	0.13	0.27	0.12
2003	0.29	0.15	0.26	0.14
2004	0.40	0.15	0.32	0.12

Table 16. Estimated fishing mortality (F) at age.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
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
2	0.12	0.09	0.24	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3	0.38	0.29	0.38	0.06	0.04	0.02	0.02	0.03	0.04	0.04	0.04	0.03
4	0.37	0.52	0.20	0.07	0.10	0.04	0.03	0.04	0.09	0.07	0.06	0.07
5	0.28	0.44	0.29	0.20	0.12	0.06	0.10	0.06	0.14	0.10	0.08	0.12
6	0.19	0.29	0.25	0.32	0.15	0.07	0.12	0.12	0.13	0.11	0.08	0.10
7	0.33	0.26	0.20	0.33	0.24	0.08	0.16	0.07	0.18	0.09	0.09	0.08
8	0.59	0.08	0.09	0.28	0.29	0.10	0.20	0.11	0.14	0.20	0.08	0.12
9	0.67	0.18	0.05	0.17	0.22	0.11	0.32	0.12	0.14	0.16	0.20	0.13
10	0.71	0.44	0.18	0.10	0.19	0.10	0.13	0.13	0.11	0.23	0.16	0.40
11	0.20	0.73	0.13	0.11	0.14	0.07	0.16	0.09	0.23	0.30	0.12	0.21
12	0.64	0.14	0.09	0.20	0.25	0.10	0.21	0.11	0.13	0.18	0.12	0.16
13+	0.64	0.14	0.09	0.20	0.25	0.10	0.21	0.11	0.13	0.18	0.12	0.16

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
2	0.02	0.03	0.01	0.03	0.01	0.01	0.04	0.02	0.02	0.02	0.04
3	0.06	0.06	0.06	0.07	0.06	0.04	0.06	0.06	0.04	0.05	0.07
4	0.06	0.10	0.11	0.12	0.10	0.10	0.12	0.11	0.04	0.14	0.09
5	0.10	0.11	0.16	0.16	0.18	0.12	0.21	0.13	0.11	0.16	0.16
6	0.13	0.18	0.16	0.27	0.16	0.16	0.20	0.20	0.14	0.19	0.16
7	0.10	0.16	0.23	0.23	0.17	0.15	0.23	0.21	0.28	0.21	0.23
8	0.10	0.19	0.21	0.33	0.19	0.20	0.19	0.22	0.26	0.33	0.26
9	0.25	0.26	0.18	0.35	0.27	0.21	0.19	0.17	0.22	0.31	0.50
10	0.18	0.35	0.17	0.28	0.28	0.29	0.20	0.20	0.32	0.27	0.44
11	0.31	0.16	0.26	0.24	0.29	0.43	0.17	0.21	0.27	0.24	0.40
12	0.16	0.23	0.19	0.33	0.23	0.22	0.19	0.20	0.26	0.31	0.35
13+	0.16	0.23	0.19	0.33	0.23	0.22	0.19	0.20	0.26	0.31	0.35

Table 17. 2004 Iterative re-weighting factors.

index	age	chi wt.	rank	index	age	chi wt.	rank
CT CPUE	2	0.92	49	MD SSN	11	1.61	36
CT CPUE	3	0.87	50	MD SSN	12	3.69	15
CT CPUE	4	4.51	11	MD SSN	13+	1.50	37
CT CPUE	5	2.41	25	MRFSS	2-13+	11.62	2
CT CPUE	6	2.16	26	NEFSC	2-13+	3.54	17
CT CPUE	7	2.82	24	NJ TRL	2	0.99	45
CT CPUE	8	3.46	18	NJ TRL	3	1.84	30
CT CPUE	9	3.62	16	NJ TRL	4	1.80	31
CT TRL	4-6	3.06	20	NJ TRL	5	1.41	39
DE SSN	3	4.53	10	NJ TRL	6	1.68	34
DE SSN	4	6.59	6	NJ TRL	7	1.35	40
DE SSN	5	5.33	8	NJ TRL	8	1.85	29
DE SSN	6	17.45	1	NJ TRL	9-13+	0.97	48
DE SSN	7	8.08	4	NY OHS	3	1.86	28
DE SSN	8	7.28	5	NY OHS	4	2.03	27
DE SSN	9	4.47	12	NY OHS	5	1.47	38
DE SSN	10-13+	4.56	9	NY OHS	6	1.12	44
MA COM	5	3.43	19	NY OHS	7	1.33	41
MA COM	6	5.83	7	NY OHS	8	0.83	51
MA COM	7	8.80	3	NY OHS	9-13+	1.24	42
MD SSN	5	1.73	33	MD YOY	1	2.87	22
MD SSN	6	1.63	35	NJ YOY	1	2.87	23
MD SSN	7	1.74	32	NY YOY	1	1.24	43
MD SSN	8	0.98	47	VA YOY	1	4.02	14
MD SSN	9	0.98	46	LI YRL	2	4.16	13
MD SSN	10	0.81	52	MD YRL	2	2.89	21

Table 18a. Estimated population size at age in thousands.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	1,534	3,181	2,401	3,579	2,763	3,944	5,219	5,609	8,419	8,644	8,706	11,065
2	997	1,318	2,735	2,062	3,080	2,368	3,393	4,489	4,827	7,244	7,438	7,491
3	866	760	1,033	1,852	1,707	2,631	2,028	2,892	3,831	4,112	6,168	6,360
4	758	508	490	610	1,500	1,410	2,230	1,707	2,415	3,182	3,405	5,123
5	259	449	260	345	487	1,168	1,166	1,861	1,406	1,905	2,545	2,755
6	121	169	248	168	243	373	943	905	1,504	1,050	1,490	2,027
7	92	86	109	166	105	180	298	721	690	1,142	810	1,181
8	40	57	57	77	102	71	142	219	578	498	898	639
9	25	19	45	45	50	66	55	100	169	435	352	710
10	22	11	14	37	33	35	51	35	76	126	320	249
11	65	9	6	10	29	23	27	38	26	59	86	234
12	31	46	4	5	8	22	19	20	30	18	38	66
13+	35	111	145	60	49	140	54	89	118	142	146	124
Total	4,846	6,727	7,547	9,016	10,155	12,430	15,625	18,685	24,090	28,556	32,401	38,023
8+	218	253	271	234	271	357	348	501	997	1,278	1,840	2,022

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	16,562	13,338	12,932	15,586	10,625	10,982	8,261	15,490	18,024	5,976	22,275	12,721
2	9,523	14,250	11,476	11,130	13,412	9,121	9,444	7,075	13,300	15,490	5,117	19,107
3	6,383	8,061	11,863	9,786	9,309	11,373	7,750	7,829	5,940	11,256	13,097	4,240
4	5,302	5,171	6,502	9,609	7,866	7,563	9,401	6,282	6,339	4,902	9,247	10,537
5	4,107	4,294	4,028	4,995	7,372	6,116	5,909	7,176	4,846	5,220	3,663	7,280
6	2,104	3,194	3,321	2,965	3,665	5,305	4,669	4,142	5,408	3,755	3,838	2,687
7	1,573	1,596	2,296	2,425	1,946	2,682	3,890	3,298	2,921	4,051	2,673	2,813
8	936	1,228	1,175	1,568	1,663	1,416	1,983	2,666	2,305	1,896	2,833	1,833
9	488	726	876	818	966	1,187	998	1,418	1,851	1,524	1,176	1,871
10	535	327	482	627	498	632	831	710	1,031	1,277	966	617
11	144	386	198	351	410	323	407	585	501	647	837	535
12	163	91	282	131	238	265	182	295	408	330	438	482
13+	107	74	116	111	345	269	191	286	525	382	462	547
Total	47,926	52,736	55,550	60,102	58,315	57,233	53,917	57,251	63,397	56,707	66,622	65,270
8+	2,373	2,832	3,129	3,606	4,120	4,092	4,592	5,960	6,621	6,056	6,712	5,885

Table 18b. Estimates of stock size (abundance in thousands), standard error, and coefficients of variation (CV) for Atlantic striped bass on 1 Jan 2005.

Age	Abundance (thousands)	Standard Error	CV
1	12,721	3622.0	0.285
2	19,107	4071.1	0.213
3	4,240	895.7	0.211
4	10,537	1734.6	0.165
5	7,280	993.2	0.136
6	2,687	395.9	0.147
7	2,813	262.1	0.093
8	1,833	182.0	0.099
9	1,871	213.0	0.114
10	617	121.7	0.197
11	535	121.7	0.228

Table 19. Estimated female spawning stock population biomass at age (metric tons).

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
4	17	11	12	20	46	44	71	51	72	95	102
5	33	51	30	40	60	176	183	282	197	271	386
6	95	100	147	108	134	212	633	720	1,089	607	981
7	174	134	186	277	163	253	444	1,409	1,355	2,057	1,340
8	97	129	117	177	222	137	257	506	1,444	1,149	2,103
9	62	53	130	130	128	164	127	251	473	1,264	1,029
10	82	36	45	124	98	98	133	110	216	351	1,087
11	335	38	24	40	103	76	96	128	98	205	317
12	152	228	21	21	33	89	78	87	127	66	192
13+	222	581	848	393	289	864	334	562	696	947	959
Total	1,266	1,361	1,556	1,326	1,273	2,110	2,353	4,103	5,765	7,009	8,494

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4	157	171	187	217	344	205	188	225	164	156	112	206
5	390	599	651	651	777	1,054	658	602	784	580	580	408
6	1,363	1,386	2,167	2,475	2,119	2,224	2,657	2,263	2,195	3,023	2,084	2,085
7	2,082	2,774	2,888	4,589	4,533	3,349	3,523	5,032	4,638	4,438	6,059	3,974
8	1,546	2,261	2,975	3,184	3,860	3,689	3,015	3,601	5,158	4,772	3,832	5,581
9	2,128	1,460	2,259	2,839	2,601	2,629	3,371	2,786	3,776	4,740	4,067	2,943
10	850	1,820	1,168	1,847	2,459	1,584	2,138	2,696	2,466	3,295	3,897	2,875
11	961	586	1,363	835	1,562	1,600	1,153	1,661	2,176	1,952	2,409	2,880
12	316	772	410	1,153	591	1,096	1,075	819	1,235	1,738	1,407	1,726
13+	843	638	570	741	755	1,903	1,498	1,210	1,449	2,805	1,939	2,260
Total	10,633	12,465	14,637	18,529	19,598	19,332	19,272	20,894	24,038	27,497	26,384	24,936

Table 20. 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, 1995-2003)
* Periods (p)	1 = {1987-1989}, 2 = {1990-1994}, 3 = {1995- 1999} 4 = {2000-2004}
** Periods (d)	1 = {1987-1989}, 2 = {1990-1994}, 3 = {1995- 1999}, 4 = {2000-2002}, 5 = 2004
*** Periods (v)	1 = {1987-1989}, 2 = {1990-1994}, 3 = {1995- 1999}, 4 = {2000-2002}, 5 = {2003-2004}

Table 20a. R/M estimates of exploitation rates of 28 inch fish from tagging programs. Exploitation rate is the proportion of tagged fish that were harvested or killed (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	**MEAN**
1987	*	*	*	*	*	*	*	*	
1988	*	0.05	0.06	*	*	0.07	*	0.05	**0.06**
1989	0.02	0.04	0.05	*	*	0.04	*	0.05	**0.04**
1990	0.04	0.07	0.09	*	0.26	0.08	*	0.07	**0.10**
1991	0.18	0.12	0.07	*	0.36	0.12	*	0.08	**0.16**
1992	0.02	0.11	0.14	0.04	0.37	0.12	*	0.10	**0.13**
1993	0.09	0.14	0.11	0.07	0.37	0.12	0.17	0.11	**0.15**
1994	0.05	0.08	0.10	0.03	0.25	0.11	0.12	0.08	**0.10**
1995	0.10	0.20	0.14	0.05	0.41	0.20	0.14	0.13	**0.17**
1996	0.20	0.14	0.12	0.08	0.18	0.17	0.31	0.16	**0.17**
1997	0.23	0.29	0.21	0.13	0.38	0.23	0.27	0.22	**0.24**
1998	0.35	0.17	0.20	0.07	0.45	0.20	0.28	0.17	**0.24**
1999	0.08	0.29	0.24	0.09	0.28	0.32	0.15	0.14	**0.20**
2000	0.14	0.18	0.06	0.13	0.25	0.17	0.30	0.09	**0.17**
2001	0.14	0.11	0.15	0.07	0.23	0.11	0.26	0.10	**0.15**
2002	0.11	0.23	0.12	0.08	0.29	0.10	0.24	0.08	**0.15**
2003	0.14	0.15	0.12	0.11	0.22	0.10	0.16	0.10	**0.14**
2004	0.16	0.15	0.12	0.09	0.08	0.08	0.21	0.18	**0.13**

* Years when few or no striped bass were tagged and released.
** NYOHS and MA have fall tagging programs, and recapture interval of terminal year (2003) is fall 2002 to fall 2003; NCCOOP is a winter tagging program (Jan./Feb.) with recapture interval of terminal year (2003) from January 2003 to January 2004; others are spring tagging programs with recapture interval of terminal year (2003) from spring 2003 to spring 2004.

Table 20b. R/M estimates of catch rates of 28 inch fish from tagging programs. Catch rate is the proportion of tagged striped bass that were caught, but may have been released (with reporting rate adjustment of 0.43).

Year	NJDB	NYOHS**	NCCOOP	MA**	VA Rap	MDCB	DE/PA	NYHUD	**MEAN**
1987	*	*	*	*	*	0.08	*	*	**0.08**
1988	*	0.26	0.22	*	*	0.11	*	0.15	**0.19**
1989	0.27	0.23	0.14	*	*	0.10	*	0.21	**0.19**
1990	0.52	0.21	0.18	*	0.49	0.18	*	0.27	**0.31**
1991	0.47	0.24	0.20	*	0.58	0.28	*	0.25	**0.34**
1992	0.20	0.33	0.27	0.11	0.58	0.24	*	0.24	**0.28**
1993	0.20	0.27	0.28	0.13	0.57	0.21	0.24	0.27	**0.27**
1994	0.21	0.21	0.22	0.10	0.36	0.22	0.20	0.21	**0.22**
1995	0.23	0.33	0.28	0.16	0.55	0.27	0.21	0.23	**0.28**
1996	0.33	0.31	0.16	0.18	0.21	0.25	0.41	0.27	**0.26**
1997	0.34	0.35	0.26	0.22	0.44	0.28	0.29	0.31	**0.31**
1998	0.38	0.17	0.26	0.15	0.60	0.23	0.34	0.25	**0.30**
1999	0.21	0.34	0.27	0.16	0.37	0.38	0.19	0.22	**0.27**
2000	0.22	0.33	0.13	0.14	0.39	0.20	0.36	0.20	**0.24**
2001	0.22	0.20	0.21	0.11	0.33	0.15	0.28	0.19	**0.21**
2002	0.18	0.38	0.15	0.16	0.36	0.13	0.24	0.18	**0.22**
2003	0.23	0.21	0.16	0.12	0.30	0.16	0.25	0.20	**0.20**
2004	0.26	0.26	0.17	0.11	0.13	0.11	0.25	0.27	**0.19**

* Years when few or no striped bass were tagged and released.
** See footnote in Table 11.

Table 20c. R/M estimates of exploitation rates of 18 inch fish from tagging programs. Exploitation rate is the proportion of tagged fish that were harvested or killed (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	**MEAN**
1987	*	*	*	*	*	0.01	*	*	**0.01**
1988	*	0.02	0.04	*	*	0.01	*	0.10	**0.05**
1989	0.03	0.03	0.03	*	*	0.01	*	0.07	**0.04**
1990	0.07	0.04	0.07	*	0.17	0.07	*	0.11	**0.09**
1991	0.03	0.06	0.08	*	0.14	0.10	*	0.11	**0.09**
1992	0.03	0.04	0.15	0.04	0.31	0.13	*	0.13	**0.12**
1993	0.03	0.05	0.11	0.05	0.23	0.11	0.12	0.17	**0.11**
1994	0.03	0.04	0.10	0.03	0.25	0.12	0.12	0.12	**0.10**
1995	0.06	0.05	0.14	0.04	0.19	0.18	0.13	0.16	**0.12**
1996	0.09	0.03	0.12	0.06	0.14	0.17	0.16	0.23	**0.12**
1997	0.08	0.04	0.17	0.09	0.20	0.20	0.09	0.29	**0.14**
1998	0.12	0.03	0.17	0.08	0.15	0.19	0.14	0.22	**0.14**
1999	0.05	0.05	0.22	0.06	0.13	0.16	0.12	0.22	**0.13**
2000	0.07	0.03	0.10	0.08	0.13	0.13	0.14	0.13	**0.10**
2001	0.09	0.05	0.12	0.05	0.18	0.12	0.14	0.14	**0.11**
2002	0.06	0.06	0.12	0.09	0.16	0.12	0.14	0.19	**0.12**
2003	0.07	0.04	0.11	0.08	0.15	0.13	0.13	0.14	**0.11**
2004	0.12	0.04	0.12	0.09	0.07	0.10	0.12	0.04	**0.09**

* Years when few or no striped bass were tagged and released.

** NYOHS and MA have fall tagging programs, and recapture interval of terminal year (2003) is fall 2002 to fall 2003; NCCOOP is a winter tagging program (Jan./Feb.) with recapture interval of terminal year (2003) from January 2003 to January 2004; others are spring tagging programs with recapture interval of terminal year (2003) from spring 2003 to spring 2004.

Table 20d. R/M estimates of catch rates of 18 inch fish from tagging programs. Catch rate is the proportion of tagged striped bass that were caught, but may have been released (with reporting rate adjustment of 0.43).

Year	NJDB	NYOHS**	NCCOOP	MA**	VA Rap	MDCB	DE/PA	NYHUD	**MEAN**
1987	*	*	*	*	*	0.16	*	*	**0.16**
1988	*	0.17	0.21	*	*	0.10	*	0.21	**0.17**
1989	0.25	0.23	0.12	*	*	0.08	*	0.25	**0.19**
1990	0.38	0.20	0.18	*	0.38	0.15	*	0.32	**0.27**
1991	0.20	0.17	0.20	*	0.28	0.19	*	0.24	**0.21**
1992	0.18	0.19	0.28	0.13	0.54	0.25	*	0.30	**0.26**
1993	0.17	0.14	0.22	0.11	0.40	0.18	0.23	0.34	**0.22**
1994	0.17	0.17	0.21	0.11	0.37	0.22	0.25	0.26	**0.22**
1995	0.20	0.15	0.24	0.14	0.30	0.28	0.28	0.27	**0.23**
1996	0.24	0.17	0.16	0.18	0.25	0.27	0.26	0.32	**0.23**
1997	0.25	0.15	0.23	0.18	0.27	0.29	0.19	0.37	**0.24**
1998	0.27	0.15	0.32	0.15	0.24	0.28	0.26	0.29	**0.25**
1999	0.17	0.14	0.27	0.11	0.23	0.23	0.20	0.30	**0.21**
2000	0.20	0.14	0.17	0.10	0.23	0.23	0.24	0.21	**0.19**
2001	0.21	0.14	0.18	0.09	0.28	0.19	0.22	0.20	**0.19**
2002	0.13	0.18	0.18	0.16	0.25	0.17	0.19	0.24	**0.19**
2003	0.18	0.11	0.16	0.10	0.21	0.18	0.25	0.21	**0.18**
2004	0.25	0.14	0.17	0.11	0.11	0.16	0.18	0.22	**0.17**

* Years when few or no striped bass were tagged and released.

** See footnote in Table 13.

Table 21. Survival (S) and fishing mortality (F) rates of striped bass ≥ 28 inches, based on the assumption of constant natural mortality, adjusted for the bias due to live release of recaptured fish. Diagnostic statistic c-hat and bootstrap goodness of fit probability are presented for each dataset (see Methods).

Coast Programs

Massachusetts; C-hat = 1.17; bootstrap GOF probability = 0.68 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	0.77	0.11	0.05	0.75	-0.08	0.84	**0.02**	-0.06	0.14
1993	0.77	0.11	0.07	0.57	-0.09	0.85	**0.01**	-0.07	0.12
1994	0.78	0.10	0.06	0.52	-0.07	0.83	**0.03**	-0.05	0.15
1995	0.73	0.16	0.06	0.38	-0.05	0.78	**0.10**	0.05	0.16
1996	0.73	0.16	0.09	0.26	-0.06	0.78	**0.10**	0.05	0.16
1997	0.73	0.16	0.07	0.22	-0.04	0.76	**0.12**	0.07	0.19
1998	0.73	0.17	0.09	0.28	-0.07	0.78	**0.10**	0.04	0.17
1999	0.73	0.17	0.08	0.28	-0.05	0.77	**0.11**	0.05	0.19
2000	0.74	0.15	0.07	0.21	-0.04	0.77	**0.11**	0.04	0.22
2001	0.74	0.15	0.05	0.33	-0.04	0.77	**0.11**	0.03	0.21
2002	0.74	0.14	0.07	0.32	-0.06	0.79	**0.09**	0.01	0.19
2003	0.75	0.14	0.05	0.18	-0.02	0.77	**0.12**	0.03	0.23
2004	0.76	0.12	0.05	0.22	-0.03	0.78	**0.10**	0.00	0.24

New York - Ocean Haul Seine

C-hat adjustment = 1.09; bootstrap GOF probability = 0.19 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	0.81	0.06	0.12	0.90	-0.24	1.06	**-0.21**	-0.31	-0.05
1989	0.81	0.06	0.10	0.86	-0.19	1.01	**-0.16**	-0.25	0.00
1990	0.63	0.31	0.09	0.66	-0.14	0.73	**0.17**	0.12	0.22
1991	0.63	0.31	0.11	0.53	-0.15	0.74	**0.16**	0.11	0.21
1992	0.63	0.31	0.15	0.54	-0.20	0.79	**0.09**	0.04	0.14
1993	0.63	0.31	0.11	0.43	-0.12	0.71	**0.19**	0.14	0.25
1994	0.63	0.31	0.11	0.49	-0.13	0.73	**0.17**	0.12	0.22
1995	0.65	0.28	0.15	0.34	-0.14	0.76	**0.13**	0.07	0.19
1996	0.65	0.28	0.13	0.30	-0.11	0.73	**0.16**	0.11	0.23
1997	0.65	0.28	0.14	0.21	-0.09	0.71	**0.19**	0.13	0.25
1998	0.65	0.28	0.10	0.19	-0.05	0.68	**0.23**	0.17	0.29
1999	0.65	0.28	0.14	0.10	-0.04	0.68	**0.24**	0.18	0.30
2000	0.75	0.13	0.13	0.22	-0.08	0.82	**0.05**	-0.06	0.21
2001	0.75	0.13	0.10	0.24	-0.06	0.81	**0.07**	-0.04	0.23
2002	0.75	0.13	0.11	0.40	-0.12	0.85	**0.01**	-0.10	0.17
2003	0.76	0.13	0.08	0.21	-0.04	0.79	**0.09**	-0.03	0.26
2004	0.76	0.12	0.11	0.36	-0.10	0.85	**0.02**	-0.11	0.21

Table 21 cont'd.

New Jersey - Delaware Bay
C-hat adjustment = 1.0 bootstrap GOF probability = 0.772 for the fully 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	0.89	-0.04	0.11	1.00	-0.23	1.16	**-0.29**	-0.37	-0.11
1990	0.67	0.25	0.12	0.50	-0.15	0.78	**0.10**	-0.12	0.49
1991	0.66	0.27	0.22	0.38	-0.27	0.90	**-0.04**	-0.22	0.23
1992	0.65	0.28	0.08	1.00	-0.17	0.78	**0.10**	-0.03	0.27
1993	0.64	0.29	0.10	0.77	-0.17	0.78	**0.10**	0.00	0.23
1994	0.63	0.31	0.10	0.79	-0.17	0.77	**0.12**	-0.03	0.31
1995	0.73	0.16	0.10	0.61	-0.15	0.86	**0.00**	-0.10	0.14
1996	0.70	0.21	0.13	0.42	-0.14	0.81	**0.06**	-0.01	0.15
1997	0.66	0.27	0.09	0.42	-0.10	0.73	**0.17**	0.11	0.22
1998	0.62	0.33	0.16	0.30	-0.14	0.72	**0.18**	0.10	0.27
1999	0.58	0.39	0.10	0.30	-0.08	0.63	**0.31**	0.16	0.49
2000	0.88	-0.02	0.10	0.30	-0.07	0.95	**-0.10**	-0.17	0.04
2001	0.80	0.07	0.10	0.29	-0.07	0.86	**0.00**	-0.06	0.09
2002	0.68	0.23	0.08	0.34	-0.06	0.73	**0.17**	0.08	0.27
2003	0.53	0.49	0.09	0.35	-0.08	0.58	**0.40**	0.17	0.72
2004	0.38	0.83	0.11	0.36	-0.10	0.42	**0.72**	0.24	1.40

North Carolina - Cooperative Trawl Cruise
C-hat adjustment = 1.187; bootstrap GOF probability = 0.032 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	0.72	0.17	0.09	0.76	-0.16	0.87	-0.01	**-0.16**	0.26
1989	0.69	0.23	0.06	0.73	-0.10	0.76	0.12	**-0.01**	0.31
1990	0.70	0.21	0.08	0.60	-0.11	0.78	0.10	**0.03**	0.18
1991	0.70	0.21	0.09	0.68	-0.14	0.81	0.06	**0.00**	0.14
1992	0.71	0.19	0.11	0.45	-0.12	0.81	0.07	**-0.01**	0.16
1993	0.70	0.21	0.09	0.53	-0.12	0.80	0.08	**0.01**	0.16
1994	0.69	0.22	0.08	0.49	-0.10	0.77	0.12	**0.03**	0.21
1995	0.67	0.25	0.11	0.35	-0.09	0.74	0.15	**0.05**	0.27
1996	0.65	0.28	0.06	0.20	-0.03	0.67	0.25	**0.18**	0.33
1997	0.64	0.29	0.10	0.20	-0.05	0.68	0.24	**0.16**	0.33
1998	0.65	0.28	0.11	0.26	-0.08	0.70	0.20	**0.12**	0.30
1999	0.65	0.28	0.10	0.24	-0.06	0.70	0.21	**0.11**	0.35
2000	0.64	0.30	0.05	0.36	-0.04	0.67	0.25	**0.13**	0.40
2001	0.64	0.29	0.09	0.23	-0.05	0.68	0.24	**0.14**	0.36
2002	0.65	0.28	0.07	0.20	-0.03	0.67	0.25	**0.14**	0.38
2003	0.63	0.31	0.07	0.27	-0.05	0.66	0.26	**0.13**	0.42
2004	0.64	0.30	0.07	0.23	-0.04	0.66	0.26	**0.13**	0.43

Table 21 cont'd.

Producer Area Programs

Delaware / Pennsylvania - Delaware River
C-hat = 1.00; bootstrap GOF probability = 0.384 for the fully 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)
1993	0.84	0.06	0.106	0.33	-0.090	0.92	**-0.07**	-0.34	0.30
1994	0.83	0.07	0.108	0.29	-0.081	0.91	**-0.05**	-0.33	0.34
1995	0.59	0.38	0.117	0.35	-0.107	0.65	**0.27**	0.18	0.37
1996	0.59	0.38	0.138	0.28	-0.109	0.66	**0.26**	0.17	0.36
1997	0.59	0.38	0.108	0.28	-0.079	0.64	**0.30**	0.22	0.39
1998	0.59	0.38	0.145	0.17	-0.074	0.63	**0.31**	0.22	0.40
1999	0.59	0.38	0.079	0.21	-0.042	0.61	**0.34**	0.26	0.43
2000	0.59	0.38	0.136	0.17	-0.068	0.63	**0.31**	0.23	0.41
2001	0.59	0.38	0.117	0.12	-0.040	0.61	**0.34**	0.26	0.44
2002	0.59	0.38	0.100	0.18	-0.048	0.62	**0.34**	0.25	0.43
2003	0.59	0.39	0.108	0.32	-0.090	0.64	**0.29**	0.18	0.41
2004	0.59	0.38	0.108	0.22	-0.064	0.63	**0.31**	0.16	0.47

Maryland - Chesapeake Bay Spring Spawning Stock
C-hat = 1.0; bootstrap GOF probability = 0.83 for the fully 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	0.97	-0.12	0.03		0.00	0.97	**-0.12**	-0.14	-0.04
1988	0.96	-0.11	0.04	0.67	-0.06	1.02	**-0.17**	-0.19	-0.14
1989	0.95	-0.10	0.05	0.79	-0.09	1.04	**-0.19**	-0.21	-0.16
1990	0.53	0.49	0.07	0.57	-0.09	0.58	**0.39**	0.26	0.54
1991	0.59	0.38	0.12	0.59	-0.18	0.72	**0.18**	0.11	0.26
1992	0.65	0.29	0.11	0.51	-0.14	0.75	**0.13**	0.08	0.19
1993	0.70	0.21	0.10	0.46	-0.11	0.79	**0.09**	0.03	0.16
1994	0.75	0.14	0.09	0.47	-0.11	0.84	**0.03**	-0.05	0.13
1995	0.65	0.29	0.12	0.26	-0.08	0.70	**0.20**	0.12	0.29
1996	0.64	0.29	0.10	0.28	-0.07	0.69	**0.22**	0.16	0.29
1997	0.64	0.30	0.11	0.22	-0.07	0.68	**0.24**	0.19	0.29
1998	0.63	0.31	0.10	0.19	-0.05	0.66	**0.26**	0.22	0.31
1999	0.63	0.32	0.12	0.18	-0.06	0.67	**0.26**	0.20	0.31
2000	0.62	0.33	0.08	0.19	-0.04	0.65	**0.29**	0.22	0.37
2001	0.61	0.34	0.07	0.25	-0.05	0.64	**0.29**	0.20	0.39
2002	0.61	0.34	0.06	0.36	-0.05	0.64	**0.29**	0.18	0.43
2003	0.60	0.35	0.07	0.20	-0.03	0.63	**0.32**	0.18	0.49
2004	0.60	0.36	0.05	0.17	-0.02	0.61	**0.34**	0.19	0.55

Table 21 cont'd.

Virginia - Rappahannock River
C-hat adjustment = 1.289; bootstrap GOF probability = 0.17 for the fully 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	0.62	0.32	0.09	0.58	-0.13	0.72	**0.19**	0.12	0.26
1991	0.62	0.32	0.09	0.56	-0.13	0.72	**0.18**	0.12	0.25
1992	0.62	0.32	0.12	0.53	-0.17	0.75	**0.13**	0.07	0.20
1993	0.62	0.32	0.10	0.35	-0.09	0.69	**0.22**	0.16	0.30
1994	0.62	0.32	0.08	0.32	-0.07	0.67	**0.25**	0.18	0.32
1995	0.61	0.34	0.13	0.20	-0.08	0.66	**0.26**	0.19	0.35
1996	0.61	0.34	0.05	0.13	-0.02	0.62	**0.33**	0.25	0.41
1997	0.61	0.34	0.08	0.17	-0.04	0.63	**0.31**	0.23	0.39
1998	0.61	0.34	0.13	0.22	-0.09	0.67	**0.26**	0.18	0.34
1999	0.61	0.35	0.10	0.20	-0.06	0.65	**0.29**	0.21	0.38
2000	0.63	0.31	0.08	0.35	-0.07	0.68	**0.24**	0.15	0.34
2001	0.63	0.31	0.07	0.30	-0.05	0.67	**0.26**	0.17	0.36
2002	0.63	0.31	0.09	0.30	-0.08	0.68	**0.23**	0.14	0.33
2003	0.63	0.31	0.09	0.25	-0.06	0.67	**0.25**	0.16	0.36
2004	0.64	0.30	0.06	0.29	-0.04	0.67	**0.25**	0.15	0.38

Hudson River
C-hat adjustment = 1.223; bootstrap GOF probability = 0.206 for the fully 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	0.72	0.18	0.09	0.56	-0.12	0.82	**0.05**	-0.06	0.24
1989	0.72	0.18	0.11	0.74	-0.19	0.88	**-0.03**	-0.14	0.17
1990	0.63	0.31	0.13	0.66	-0.21	0.80	**0.08**	0.02	0.12
1991	0.63	0.31	0.10	0.50	-0.13	0.72	**0.17**	0.12	0.21
1992	0.63	0.31	0.13	0.58	-0.19	0.78	**0.09**	0.05	0.14
1993	0.63	0.30	0.13	0.49	-0.16	0.76	**0.13**	0.08	0.17
1994	0.64	0.30	0.12	0.52	-0.16	0.76	**0.13**	0.08	0.18
1995	0.65	0.28	0.11	0.38	-0.11	0.73	**0.16**	0.13	0.21
1996	0.65	0.28	0.13	0.25	-0.09	0.71	**0.19**	0.16	0.23
1997	0.65	0.28	0.16	0.32	-0.14	0.75	**0.13**	0.10	0.18
1998	0.65	0.29	0.13	0.23	-0.08	0.70	**0.20**	0.16	0.24
1999	0.64	0.29	0.13	0.31	-0.11	0.73	**0.17**	0.13	0.21
2000	0.68	0.24	0.08	0.36	-0.07	0.73	**0.16**	0.11	0.26
2001	0.66	0.26	0.07	0.26	-0.05	0.70	**0.21**	0.14	0.29
2002	0.65	0.28	0.11	0.35	-0.09	0.72	**0.18**	0.09	0.24
2003	0.63	0.31	0.10	0.33	-0.08	0.68	**0.23**	0.10	0.28
2004	0.61	0.35	0.12	0.25	-0.08	0.66	**0.27**	0.10	0.31

Table 22. Akaike weights based on the statistical fit of the tag-recapture data to the various models in the suite. These weights are used to obtain the weighted model-averaged estimates of survival. Results are for striped bass tagged at ≥ 28 inches.

Coast Programs

Model	MADFW	NYOHS	NJDEL	NCCOOP
{S(.)r(.)}	0.0002	0.00528	0.0023	0
{S(.)r(p)}	0.0002	0.00693	0.0004	**0.1252**
{S(.)r(t)}	**0.1330**	0.00013	**0.3707**	0.01188
{S(p)r(p)}	0.0329	**0.15060**	0.0004	**0.36732**
{S(p)r(t)}	**0.1921**	0.01215	**0.1559**	0.01759
{S(d)r(p)}	0.0361	**0.14352**	0.0003	**0.13588**
{S(v)r(p)}	0.0188	**0.17721**	0.0022	**0.16327**
{S(Tp)r(t)}	**0.1610**	0.00387	0.0818	0.02038
{S(Tp)r(Tp)}	0.0161	**0.40906**	0.0387	0.07094
{S(Tp)r(p)}	0.0165	0.06350	0.0230	0.03688
{S(t)r(p)}	**0.3924**	0.00531	**0.3049**	0.00103
{S(t)r(t)}	0.0006	0.02244	0.0194	0.04963

Producer Area Programs

Model	DE/PA	HUDSON	MDCB	VARAP
{S(.)r(.)}	0.088	0.0000	0	0.02657
{S(.)r(p)}	0.039	**0.1842**	0	**0.55075**
{S(.)r(t)}	0.000	0.0008	0	0.00044
{S(p)r(p)}	**0.430**	**0.2088**	0.01861	**0.23871**
{S(p)r(t)}	0.000	0.0004	0.0006	0.00011
{S(d)r(p)}	**0.184**	**0.1251**	0.0368	**0.11287**
{S(v)r(p)}	**0.158**	**0.1115**	0.00733	0.04137
S(Va)r(va)	NA	NA	NA	0.00701
{S(Tp)r(t)}	0.000	0.0009	**0.72424**	0.00002
{S(Tp)r(Tp)}	0.039	0.0878	**0.20179**	0.00183
{S(Tp)r(p)}	0.061	**0.2691**	0.00564	0.02027
{S(t)r(p)}	0.000	0.0115	0.00467	0.00004
{S(t)r(t)}	0.000	0.0000	0.00031	0

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, 95-04)

Table 23. Summary table, based on the assumption of constant natural mortality, with estimates of annual instantaneous fishing mortality, F, of striped bass ≥ 28 inches by individual program, averaged over all coastal programs, with a weighted average over producer areas and with an overall coastwide estimate. Estimates of coastwide abundance of age 7+ striped bass from 1987-2004 are also provided.

Year	MADFW	NYOHS	NJDEL	NCCOOP	Unweighted average	lower 95% CI	upper 95% CI
1988				-0.01	**-0.01**		
1989			-0.29	0.12	**-0.09**		
1990		0.17	0.10	0.10	**0.12**		
1991		0.16	-0.04	0.06	**0.06**		
1992	0.02	0.09	0.10	0.07	**0.07**	0.00	0.17
1993	0.01	0.19	0.10	0.08	**0.10**	0.00	0.28
1994	0.03	0.17	0.12	0.12	**0.11**	0.01	0.31
1995	0.10	0.13	0.00	0.15	**0.10**	0.05	0.21
1996	0.10	0.16	0.06	0.25	**0.14**	0.08	0.31
1997	0.12	0.19	0.17	0.24	**0.18**	0.11	0.42
1998	0.10	0.23	0.18	0.20	**0.18**	0.01	0.44
1999	0.11	0.24	0.31	0.21	**0.22**	0.12	0.28
2000	0.11	0.05	-0.10	0.25	**0.08**	0.09	0.50
2001	0.11	0.07	0.00	0.24	**0.10**	0.04	0.41
2002	0.09	0.01	0.17	0.25	**0.13**	0.02	0.29
2003	0.12	0.09	0.40	0.26	**0.22**	0.02	0.29
2004	0.10	0.02	0.72	0.26	**0.27**	0.03	0.33

Producer Area Programs

Year	HUDSON	DE/PA	MDCB	VARAP	Weighted average*	lower 95% CI	upper 95% CI
1987			-0.12		**-0.12**		
1988	0.05		-0.17		**-0.17**		
1989	-0.03		-0.19		**-0.19**		
1990	0.08		0.39	0.19	**0.26**		
1991	0.17		0.18	0.18	**0.17**		
1992	0.09		0.13	0.13	**0.12**		
1993	0.13	-0.07	0.09	0.22	**0.11**	0.06	0.23
1994	0.13	-0.05	0.03	0.25	**0.09**	0.03	0.22
1995	0.16	0.27	0.20	0.26	**0.22**	0.13	0.29
1996	0.19	0.26	0.22	0.33	**0.25**	0.18	0.32
1997	0.13	0.30	0.24	0.31	**0.25**	0.19	0.32
1998	0.20	0.31	0.26	0.26	**0.26**	0.20	0.32
1999	0.17	0.34	0.26	0.29	**0.26**	0.20	0.35
2000	0.16	0.31	0.29	0.24	**0.26**	0.20	0.38
2001	0.21	0.34	0.29	0.26	**0.28**	0.20	0.42
2002	0.18	0.34	0.29	0.23	**0.27**	0.17	0.44
2003	0.23	0.29	0.32	0.25	**0.29**	0.17	0.50
2004	0.27	0.31	0.34	0.25	**0.31**	0.17	0.50

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

Table 23 cont'd. Constant M coastwide fishing mortality rates and total abundance estimates.

Unweighted average F estimate of coastal and producer area estimates and estimated total abundance of age 7+ Atlantic striped bass based on F estimates that assume constant natural mortality.

Year	Fishing Mortality	Age 7+ CAA Thousands	Total number of age 7+, Thousands.
1987	**-0.12**	45.5	**-383**
1988	**-0.09**	101.4	**-1133**
1989	**-0.14**	95	**-680**
1990	**0.19**	222.3	**1,163**
1991	**0.11**	296.4	**2,636**
1992	**0.09**	262.7	**2,843**
1993	**0.10**	380.6	**3,626**
1994	**0.10**	475.9	**4,758**
1995	**0.16**	740	**4,716**
1996	**0.20**	965.3	**4,908**
1997	**0.21**	1371.1	**6,457**
1998	**0.22**	1080.5	**5,000**
1999	**0.24**	1146.8	**4,800**
2000	**0.17**	1471.8	**8,652**
2001	**0.19**	1583.2	**8,355**
2002	**0.20**	2075.4	**10,532**
2003	**0.25**	2163.1	**8,599**
2004	**0.29**	2376.2	**8,187**

Table 24. Estimates of fishing mortality for 28 inch striped bass based on Baranov's catch equation without assuming constant natural mortality, based on the exploitation rates (Table 20) and the bias-adjusted estimates of survival (Table 22). The tables also present annual estimates of instantaneous natural mortality, M. Column headings are S: annual bias-corrected survival rate, Z: total instantaneous mortality, A: annual percentage mortality expressed as a proportion, U: annual exploitation rate, F: instantaneous fishing mortality rate and M: instantaneous natural mortality rate.

Producer areas

Maryland - Chesapeake Bay Spring Spawning Stock

Year	Z	A	U	F	M
1988	-0.02	-0.02	0.07	**0.07**	-0.10
1989	-0.04	-0.04	0.04	**0.04**	-0.08
1990	0.54	0.42	0.08	**0.11**	0.43
1991	0.33	0.28	0.12	**0.15**	0.19
1992	0.28	0.25	0.12	**0.14**	0.14
1993	0.24	0.21	0.12	**0.13**	0.10
1994	0.18	0.16	0.11	**0.12**	0.06
1995	0.35	0.30	0.20	**0.24**	0.11
1996	0.37	0.31	0.17	**0.20**	0.17
1997	0.39	0.32	0.23	**0.28**	0.10
1998	0.41	0.34	0.20	**0.24**	0.17
1999	0.41	0.33	0.32	**0.39**	0.01
2000	0.44	0.35	0.17	**0.21**	0.23
2001	0.44	0.36	0.11	**0.13**	0.31
2002	0.44	0.36	0.10	**0.12**	0.32
2003	0.47	0.37	0.10	**0.13**	0.34
2004	0.49	0.39	0.08	**0.11**	0.39
Average	0.34	0.28	0.14	**0.17**	0.17

Virginia - Rappahannock River Spring Spawning Stock

Year	Z	A	U	F	M
1988					
1989					
1990	0.34	0.28	0.26	**0.31**	0.03
1991	0.33	0.28	0.36	**0.43**	-0.10
1992	0.28	0.25	0.37	**0.42**	-0.14
1993	0.37	0.31	0.37	**0.44**	-0.07
1994	0.40	0.33	0.25	**0.31**	0.09
1995	0.41	0.34	0.41	**0.50**	-0.09
1996	0.48	0.38	0.18	**0.22**	0.26
1997	0.46	0.37	0.38	**0.47**	-0.01
1998	0.41	0.33	0.45	**0.55**	-0.15
1999	0.44	0.35	0.28	**0.35**	0.09
2000	0.39	0.32	0.25	**0.31**	0.08
2001	0.41	0.33	0.23	**0.27**	0.13
2002	0.38	0.32	0.29	**0.35**	0.03
2003	0.40	0.33	0.22	**0.26**	0.14
2004	0.40	0.33	0.08	**0.09**	0.31
Average	0.39	0.32	0.29	**0.35**	0.04

Delaware River, Delaware, New Jersey, Pennsylvania Spring Spawning Stock

Year	Z	A	U	F	M
1988					
1989					
1990					
1991					
1992					
1993	0.08	0.11	0.17	**0.18**	-0.06
1994	0.10	0.12	0.12	**0.12**	0.01
1995	0.42	0.34	0.14	**0.17**	0.25
1996	0.41	0.33	0.31	**0.38**	0.02
1997	0.45	0.36	0.27	**0.33**	0.12
1998	0.46	0.37	0.28	**0.34**	0.12
1999	0.49	0.39	0.15	**0.19**	0.30
2000	0.46	0.37	0.30	**0.37**	0.09
2001	0.49	0.39	0.26	**0.33**	0.16
2002	0.48	0.38	0.24	**0.30**	0.18
2003	0.44	0.36	0.16	**0.20**	0.25
2004	0.46	0.37	0.21	**0.26**	0.20
Average	0.40	0.33	0.22	**0.26**	0.14

Hudson River Spring Spawning Stock

Year	Z	A	U	F	M
1988	0.20	0.18	0.10	**0.11**	0.09
1989	0.12	0.11	0.07	**0.07**	0.05
1990	0.23	0.20	0.11	**0.12**	0.11
1991	0.32	0.27	0.11	**0.13**	0.19
1992	0.24	0.21	0.13	**0.15**	0.09
1993	0.27	0.24	0.17	**0.19**	0.08
1994	0.28	0.24	0.12	**0.13**	0.14
1995	0.31	0.26	0.16	**0.18**	0.13
1996	0.34	0.29	0.23	**0.27**	0.07
1997	0.28	0.25	0.29	**0.33**	-0.05
1998	0.35	0.29	0.22	**0.26**	0.09
1999	0.32	0.27	0.22	**0.25**	0.07
2000	0.31	0.27	0.13	**0.15**	0.16
2001	0.36	0.30	0.14	**0.16**	0.20
2002	0.33	0.28	0.19	**0.23**	0.11
2003	0.38	0.32	0.13	**0.16**	0.22
2004	0.42	0.34	0.18	**0.22**	0.19
Average	0.30	0.26	0.16	**0.18**	0.11

Table 24 cont'd.

Coastal Programs

Massachusetts Fall Tagging

Year	Z	A	U	F	M
1988					
1989					
1990					
1991					
1992	0.17	0.16	0.04	**0.04**	0.14
1993	0.16	0.15	0.07	**0.07**	0.09
1994	0.18	0.17	0.03	**0.03**	0.15
1995	0.25	0.22	0.05	**0.06**	0.19
1996	0.25	0.22	0.08	**0.10**	0.16
1997	0.27	0.24	0.13	**0.14**	0.13
1998	0.25	0.22	0.07	**0.08**	0.17
1999	0.26	0.23	0.09	**0.10**	0.17
2000	0.26	0.23	0.13	**0.15**	0.12
2001	0.26	0.23	0.07	**0.08**	0.18
2002	0.24	0.21	0.08	**0.09**	0.15
2003	0.27	0.23	0.11	**0.12**	0.14
2004	0.25	0.22	0.09	**0.10**	0.14
Average	0.24	0.21	0.08	**0.09**	0.15

New York Ocean Haul Seine Fall Tagging

Year	Z	A	U	F	M
1988	-0.06	0.19	0.05	**-0.02**	-0.04
1989	-0.01	0.19	0.04	**0.00**	-0.01
1990	0.32	0.37	0.07	**0.06**	0.26
1991	0.31	0.37	0.12	**0.10**	0.21
1992	0.24	0.37	0.11	**0.07**	0.17
1993	0.34	0.37	0.14	**0.12**	0.22
1994	0.32	0.37	0.08	**0.07**	0.25
1995	0.28	0.35	0.20	**0.16**	0.12
1996	0.31	0.35	0.14	**0.12**	0.19
1997	0.34	0.35	0.29	**0.28**	0.05
1998	0.38	0.35	0.17	**0.18**	0.20
1999	0.39	0.35	0.29	**0.33**	0.06
2000	0.20	0.25	0.18	**0.14**	0.06
2001	0.22	0.25	0.11	**0.09**	0.12
2002	0.16	0.25	0.23	**0.14**	0.01
2003	0.24	0.24	0.15	**0.14**	0.09
2004	0.17	0.24	0.15	**0.10**	0.07
Average	0.24	0.31	0.15	**0.12**	0.12

New Jersey Delaware Bay February-April

Year	Z	A	U	F	M
1988					
1989	-0.14	-0.16	0.02	**0.02**	-0.16
1990	0.25	0.22	0.04	**0.05**	0.20
1991	0.11	0.10	0.18	**0.19**	-0.08
1992	0.25	0.22	0.02	**0.02**	0.23
1993	0.25	0.22	0.09	**0.10**	0.15
1994	0.27	0.23	0.05	**0.06**	0.21
1995	0.15	0.14	0.10	**0.11**	0.04
1996	0.21	0.19	0.20	**0.22**	-0.01
1997	0.32	0.27	0.23	**0.27**	0.05
1998	0.33	0.28	0.35	**0.41**	-0.08
1999	0.46	0.37	0.08	**0.10**	0.36
2000	0.05	0.05	0.14	**0.14**	-0.09
2001	0.15	0.14	0.14	**0.15**	0.00
2002	0.32	0.27	0.11	**0.13**	0.19
2003	0.55	0.42	0.14	**0.18**	0.37
2004	0.87	0.58	0.16	**0.23**	0.63
Average	0.27	0.22	0.13	**0.15**	0.13

North Carolina Co-op Winter Cruise

Year	Z	A	U	F	M
1988	0.14	0.13	0.06	**0.07**	0.08
1989	0.27	0.24	0.05	**0.05**	0.22
1990	0.25	0.22	0.09	**0.10**	0.15
1991	0.21	0.19	0.07	**0.08**	0.13
1992	0.22	0.19	0.14	**0.16**	0.06
1993	0.23	0.20	0.11	**0.13**	0.10
1994	0.27	0.23	0.10	**0.12**	0.15
1995	0.30	0.26	0.14	**0.17**	0.14
1996	0.40	0.33	0.12	**0.15**	0.25
1997	0.39	0.32	0.21	**0.25**	0.14
1998	0.35	0.30	0.20	**0.24**	0.11
1999	0.36	0.30	0.24	**0.28**	0.08
2000	0.40	0.33	0.06	**0.08**	0.33
2001	0.39	0.32	0.15	**0.18**	0.21
2002	0.40	0.33	0.12	**0.14**	0.26
2003	0.41	0.34	0.12	**0.15**	0.26
2004	0.41	0.34	0.12	**0.15**	0.26
Average	0.32	0.27	0.12	**0.15**	0.17

Table 25. Summary table of F estimates based on Baranov's catch equation without assuming constant natural mortality of striped bass ≥ 28 inches by individual program, averaged over all coastal programs, with a weighted average over producter areas and with an overall coastwide estimate. Estimates of coastwide abundance of age 7+ striped bass from 1987-2004 are also provided.

Coast Programs

Year	MADFW	NYOHS	NJDEL	NCCOOP	Unweighted average
1988		-0.02		0.07	**0.03**
1989		0.00	0.02	0.05	**0.02**
1990		0.06	0.05	0.10	**0.07**
1991		0.10	0.19	0.08	**0.12**
1992	0.02	0.07	0.02	0.16	**0.07**
1993	0.01	0.12	0.10	0.13	**0.09**
1994	0.03	0.07	0.06	0.12	**0.07**
1995	0.10	0.16	0.11	0.17	**0.13**
1996	0.10	0.12	0.22	0.15	**0.15**
1997	0.12	0.28	0.27	0.25	**0.23**
1998	0.10	0.18	0.41	0.24	**0.23**
1999	0.11	0.33	0.10	0.28	**0.21**
2000	0.11	0.14	0.14	0.08	**0.12**
2001	0.11	0.09	0.15	0.18	**0.13**
2002	0.09	0.14	0.13	0.14	**0.13**
2003	0.12	0.14	0.18	0.15	**0.15**
2004	0.10	0.10	0.23	0.15	**0.15**

Producer Area Programs

Year	HUDSON	DE/PA	MDCB	VARAP	Weighted average*
1987					
1988	0.05		0.07		**0.05**
1989	0.05		0.04		**0.03**
1990	0.08		0.11	0.31	**0.15**
1991	0.10		0.15	0.43	**0.20**
1992	0.11		0.14	0.42	**0.20**
1993	0.13	0.18	0.13	0.44	**0.22**
1994	0.10	0.12	0.12	0.31	**0.17**
1995	0.15	0.17	0.24	0.50	**0.29**
1996	0.19	0.38	0.20	0.22	**0.22**
1997	0.25	0.33	0.28	0.47	**0.33**
1998	0.21	0.34	0.24	0.55	**0.33**
1999	0.17	0.19	0.39	0.35	**0.33**
2000	0.11	0.37	0.21	0.31	**0.24**
2001	0.12	0.33	0.13	0.27	**0.19**
2002	0.10	0.30	0.12	0.35	**0.19**
2003	0.12	0.20	0.13	0.26	**0.17**
2004	0.22	0.26	0.11	0.09	**0.13**

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

Table 25 cont'd.

Coastwide Average Fishing Mortality Rate - Unweighted average of producer and coastal program mean fishing mortality rates obtained via the catch equation. Estimated total abundance of Atlantic coast striped bass ages 7+ obtained via the equation, Total Kill = F * Total Abundance, solving for total abundance.

Year	Fishing Mortality	Age 7+ CAA, Thousands	Total Abundance ages 7+, Thousands
1988	**0.04**	101.4	2,849
1989	**0.02**	95	3,827
1990	**0.11**	222.3	2,075
1991	**0.16**	296.4	1,844
1992	**0.13**	262.7	1,994
1993	**0.15**	380.6	2,486
1994	**0.12**	475.9	4,027
1995	**0.21**	740	3,486
1996	**0.19**	965.3	5,201
1997	**0.28**	1371.1	4,893
1998	**0.28**	1080.5	3,877
1999	**0.27**	1146.8	4,256
2000	**0.18**	1471.8	8,280
2001	**0.16**	1583.2	9,907
2002	**0.16**	2075.4	13,066
2003	**0.16**	2163.1	13,672
2004	**0.14**	2376.2	17,099

Table 26. Survival (S) and fishing mortality (F) rates of striped bass ≥ 18 inches assuming constant natural mortality, adjusted bias due to live release of recaptured fish. Diagnostic statistics c-hat and bootstrap goodness-of-fit are provided for each program.

<u>Producer Area Programs</u>

-
Hudson River
C-hat adjustment = 1.236; bootstrap GOF probability = 0.302 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	0.74	0.15	0.07	0.75	-0.11	0.83	**0.04**	-0.06	0.15
1989	0.72	0.18	0.09	0.79	-0.16	0.85	**0.01**	-0.08	0.17
1990	0.62	0.32	0.11	0.73	-0.19	0.77	**0.11**	0.04	0.16
1991	0.64	0.30	0.10	0.62	-0.15	0.75	**0.14**	0.08	0.18
1992	0.64	0.30	0.10	0.65	-0.16	0.76	**0.13**	0.08	0.17
1993	0.64	0.29	0.11	0.57	-0.14	0.75	**0.14**	0.10	0.19
1994	0.65	0.28	0.10	0.60	-0.13	0.75	**0.14**	0.09	0.20
1995	0.67	0.25	0.09	0.44	-0.10	0.75	**0.14**	0.09	0.21
1996	0.66	0.26	0.11	0.34	-0.10	0.73	**0.16**	0.13	0.21
1997	0.65	0.27	0.13	0.38	-0.12	0.75	**0.14**	0.09	0.21
1998	0.65	0.27	0.11	0.28	-0.08	0.72	**0.19**	0.14	0.23
1999	0.65	0.27	0.10	0.35	-0.09	0.72	**0.18**	0.12	0.22
2000	0.68	0.23	0.08	0.46	-0.09	0.75	**0.14**	0.09	0.22
2001	0.67	0.25	0.07	0.37	-0.06	0.71	**0.19**	0.13	0.25
2002	0.65	0.29	0.07	0.43	-0.08	0.70	**0.21**	0.10	0.31
2003	0.63	0.30	0.09	0.46	-0.10	0.70	**0.20**	0.08	0.28
2004	0.61	0.34	0.09	0.38	-0.09	0.67	**0.25**	-0.01	0.56

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Delaware River; C-hat = 1.00; bootstrap GOF probability = 0.76 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)
1993	0.64	0.30	0.099	0.39	-0.0909	0.71	**0.20**	0.05	0.37
1994	0.63	0.31	0.106	0.55	-0.142	0.73	**0.16**	0.03	0.31
1995	0.61	0.34	0.118	0.50	-0.148	0.72	**0.18**	0.12	0.25
1996	0.61	0.35	0.121	0.44	-0.137	0.70	**0.20**	0.14	0.27
1997	0.61	0.34	0.078	0.52	-0.096	0.68	**0.24**	0.17	0.30
1998	0.62	0.36	0.104	0.48	-0.12	0.69	**0.23**	0.16	0.30
1999	0.61	0.354	0.087	0.47	-0.10	0.68	**0.24**	0.18	0.31
2000	0.60	0.37	0.098	0.46	-0.11	0.67	**0.25**	0.18	0.33
2001	0.60	0.37	0.072	0.56	-0.09	0.66	**0.27**	0.20	0.34
2002	0.60	0.36	0.080	0.35	-0.07	0.65	**0.29**	0.22	0.37
2003	0.59	0.38	0.107	0.46	-0.12	0.67	**0.25**	0.14	0.37
2004	0.60	0.36	0.077	0.38	-0.02	0.65	**0.29**	0.20	0.39

Table 26, cont'd.

Maryland - Chesapeake Bay Spring Spawning Stock
C-hat adjustment = 1.157; bootstrap GOF probability = 0.05 for the fully 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	0.81	0.06	0.07	0.95	-0.15	0.95	**-0.10**	0.05	-0.18
1988	0.84	0.02	0.04	0.84	-0.08	0.91	**-0.06**	0.00	-0.10
1989	0.87	-0.01	0.03	0.93	-0.07	0.94	**-0.08**	0.03	-0.15
1990	0.64	0.30	0.06	0.58	-0.07	0.69	**0.22**	0.29	0.16
1991	0.64	0.30	0.08	0.45	-0.09	0.70	**0.21**	0.26	0.17
1992	0.63	0.31	0.11	0.43	-0.12	0.71	**0.19**	0.22	0.15
1993	0.62	0.32	0.09	0.38	-0.08	0.68	**0.23**	0.28	0.19
1994	0.62	0.33	0.10	0.43	-0.11	0.69	**0.22**	0.29	0.15
1995	0.63	0.31	0.12	0.32	-0.10	0.70	**0.20**	0.32	0.10
1996	0.61	0.35	0.11	0.35	-0.10	0.67	**0.25**	0.31	0.18
1997	0.58	0.40	0.11	0.27	-0.08	0.63	**0.31**	0.36	0.26
1998	0.55	0.46	0.11	0.25	-0.07	0.59	**0.38**	0.48	0.29
1999	0.52	0.51	0.11	0.21	-0.06	0.55	**0.44**	0.62	0.29
2000	0.48	0.59	0.10	0.36	-0.09	0.52	**0.50**	0.69	0.34
2001	0.50	0.55	0.08	0.33	-0.06	0.53	**0.48**	0.59	0.38
2002	0.53	0.49	0.07	0.32	-0.06	0.56	**0.43**	0.59	0.29
2003	0.55	0.45	0.08	0.24	-0.05	0.58	**0.40**	0.67	0.19
2004	0.58	0.40	0.07	0.25	-0.04	0.60	**0.36**	0.75	0.11

Virginia - Rappahannock River
C-hat adjustment = 1.49; bootstrap GOF probability = 0.092 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	0.80	0.07	0.111	0.481	-0.14	0.93	**-0.08**	-0.231	0.296
1991	0.30	1.06	0.063	0.524	-0.08	0.32	**0.98**	0.560	1.489
1992	0.79	0.09	0.124	0.408	-0.14	0.92	**-0.06**	-0.267	0.791
1993	0.60	0.36	0.088	0.456	-0.11	0.67	**0.25**	-0.048	0.799
1994	0.57	0.41	0.086	0.381	-0.09	0.62	**0.32**	0.006	0.874
1995	0.69	0.22	0.077	0.262	-0.05	0.73	**0.17**	-0.080	0.716
1996	0.62	0.32	0.056	0.274	-0.04	0.65	**0.28**	0.004	0.807
1997	0.56	0.43	0.068	0.330	-0.06	0.59	**0.37**	0.091	0.809
1998	0.41	0.74	0.064	0.362	-0.06	0.44	**0.68**	0.362	1.086
1999	0.37	0.84	0.078	0.286	-0.06	0.40	**0.78**	0.472	1.154
2000	0.42	0.72	0.067	0.436	-0.07	0.45	**0.64**	0.371	0.972
2001	0.46	0.63	0.072	0.367	-0.07	0.49	**0.55**	0.211	1.044
2002	0.64	0.29	0.067	0.368	-0.06	0.69	**0.22**	-0.068	0.847
2003	0.72	0.18	0.068	0.271	-0.05	0.76	**0.13**	-0.116	0.797
2004	0.78	0.10	0.054	0.268	-0.04	0.81	**0.06**	-0.100	0.437

Table 26, cont'd.

Coastal Programs

North Carolina - Cooperative Trawl Cruise
C-hat adjustment = 2.214; bootstrap GOF probability < 0.001 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	0.907	-0.259	0.095	0.875	-0.186	1.115	**-0.26**	-0.281	-0.230
1989	0.605	0.262	0.046	0.858	-0.086	0.662	**0.26**	0.089	0.499
1990	0.564	0.311	0.070	0.665	-0.106	0.631	**0.31**	0.130	0.548
1991	0.611	0.210	0.091	0.574	-0.125	0.698	**0.21**	0.053	0.418
1992	0.770	-0.017	0.107	0.453	-0.121	0.875	**-0.02**	-0.186	0.373
1993	0.765	0.008	0.093	0.451	-0.103	0.853	**0.01**	-0.154	0.357
1994	0.560	0.316	0.083	0.544	-0.107	0.627	**0.32**	0.039	0.748
1995	0.846	-0.089	0.100	0.402	-0.101	0.941	**-0.09**	-0.214	0.315
1996	0.575	0.369	0.057	0.254	-0.035	0.595	**0.37**	0.177	0.628
1997	0.522	0.446	0.087	0.240	-0.053	0.551	**0.45**	0.182	0.818
1998	0.621	0.241	0.110	0.283	-0.082	0.676	**0.24**	0.023	0.582
1999	0.865	-0.076	0.097	0.274	-0.069	0.929	**-0.08**	-0.174	0.187
2000	0.343	0.855	0.066	0.413	-0.064	0.366	**0.85**	0.630	1.110
2001	0.514	0.446	0.078	0.354	-0.067	0.551	**0.45**	0.248	0.696
2002	0.592	0.315	0.074	0.317	-0.057	0.628	**0.32**	0.108	0.612
2003	0.494	0.506	0.071	0.272	-0.047	0.519	**0.51**	0.205	0.936
2004	0.685	0.177	0.074	0.280	-0.051	0.721	**0.18**	0.001	0.461

New Jersey - Delaware Bay
C-hat adjustment = 1.00; bootstrap GOF probability = 0.496 for the fully parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery	% Released	bias	S(adj.)	**F(adj.)**	LCLM (F)	UCLM (F)
1989	0.88	-0.02	0.11	0.92	-0.22	1.12	**-0.27**	-0.24	0.64
1990	0.83	0.04	0.11	0.83	-0.21	1.04	**-0.19**	-0.21	0.72
1991	0.58	0.39	0.08	0.77	-0.14	0.68	**0.24**	0.17	0.56
1992	0.64	0.30	0.07	0.88	-0.13	0.74	**0.16**	0.17	0.34
1993	0.55	0.45	0.08	0.84	-0.15	0.64	**0.29**	0.32	0.43
1994	0.68	0.23	0.08	0.86	-0.15	0.80	**0.07**	0.13	0.18
1995	0.78	0.10	0.09	0.66	-0.13	0.90	**-0.05**	0.02	0.07
1996	0.75	0.14	0.11	0.60	-0.16	0.90	**-0.04**	-0.02	0.18
1997	0.53	0.48	0.09	0.50	-0.11	0.59	**0.37**	0.33	0.60
1998	0.72	0.18	0.12	0.47	-0.14	0.84	**0.02**	0.05	0.20
1999	0.65	0.27	0.08	0.50	-0.09	0.72	**0.18**	0.22	0.31
2000	0.70	0.20	0.09	0.50	-0.10	0.78	**0.09**	0.14	0.23
2001	0.78	0.10	0.09	0.46	-0.10	0.87	**-0.01**	0.02	0.19
2002	0.57	0.41	0.06	0.42	-0.06	0.61	**0.34**	0.35	0.52
2003	0.48	0.59	0.09	0.48	-0.10	0.53	**0.48**	0.46	0.68
2004	0.39	0.80	0.11	0.43	-0.11	0.44	**0.68**	0.58	0.97

Table 26, cont'd.

Massachusetts fall tagging program
C-hat = 1.13, bootstrap GOF probability = 0.62

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	0.77	0.11	0.05	0.76	-0.09	0.85	**0.02**	-0.04	0.09
1993	0.77	0.11	0.06	0.59	-0.08	0.84	**0.03**	-0.03	0.10
1994	0.77	0.11	0.05	0.58	-0.07	0.83	**0.04**	-0.02	0.11
1995	0.75	0.14	0.06	0.47	-0.06	0.80	**0.08**	0.03	0.12
1996	0.75	0.14	0.09	0.43	-0.09	0.83	**0.04**	0.00	0.09
1997	0.75	0.14	0.06	0.28	-0.04	0.78	**0.10**	0.06	0.15
1998	0.75	0.14	0.08	0.33	-0.07	0.80	**0.07**	0.03	0.12
1999	0.75	0.14	0.06	0.32	-0.04	0.78	**0.10**	0.06	0.15
2000	0.76	0.13	0.05	0.24	-0.03	0.78	**0.10**	0.05	0.16
2001	0.76	0.13	0.04	0.35	-0.03	0.78	**0.09**	0.04	0.16
2002	0.76	0.13	0.06	0.29	-0.04	0.79	**0.08**	0.03	0.15
2003	0.76	0.13	0.04	0.23	-0.02	0.78	**0.10**	0.04	0.18
2004	0.76	0.12	0.05	0.22	-0.02	0.78	**0.10**	0.03	0.18

New York Ocean Haul Seine
C-hat adjustment = 1.82; bootstrap GOF probability = 0 for the fully parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery	% Released	bias	S(adj.)	**F(adj.)**	LCLM (F)	UCLM (F)
1988	0.550	0.45	0.077	0.94	-0.16	0.653	**0.28**	0.123	0.464
1989	0.908	-0.05	0.092	0.93	-0.19	1.120	**-0.26**	-0.279	-0.245
1990	0.551	0.45	0.073	0.82	-0.13	0.636	**0.30**	0.137	0.510
1991	0.756	0.13	0.080	0.69	-0.13	0.866	**-0.01**	-0.149	0.250
1992	0.932	-0.08	0.069	0.72	-0.11	1.050	**-0.20**	-0.212	-0.183
1993	0.492	0.56	0.055	0.62	-0.08	0.533	**0.48**	0.311	0.680
1994	0.680	0.24	0.062	0.71	-0.10	0.755	**0.13**	-0.008	0.329
1995	0.938	-0.09	0.063	0.55	-0.08	1.020	**-0.17**	-0.180	-0.156
1996	0.792	0.08	0.058	0.61	-0.08	0.861	**0.00**	-0.142	0.307
1997	0.600	0.36	0.051	0.56	-0.07	0.642	**0.29**	0.087	0.594
1998	0.489	0.57	0.054	0.57	-0.07	0.526	**0.49**	0.267	0.782
1999	0.676	0.24	0.056	0.49	-0.06	0.722	**0.18**	-0.027	0.529
2000	0.588	0.38	0.047	0.59	-0.06	0.626	**0.32**	0.091	0.653
2001	0.593	0.37	0.053	0.51	-0.06	0.632	**0.31**	0.072	0.672
2002	0.890	-0.03	0.065	0.52	-0.08	0.965	**-0.11**	-0.227	1.326
2003	0.428	0.70	0.044	0.43	-0.04	0.447	**0.65**	0.248	1.243
2004	0.595	0.37	0.061	0.48	-0.07	0.639	**0.30**	0.147	0.491

Table 27. Akaike weights based on the statistical fit of the tag-recapture data to the various models in the suite. These weights are used to obtain the weighted model-averaged estimates of survival. Results are for striped bass tagged at ≥ 18 inches.

Producer Area Programs

Model	HUDSON	DE/PA	MDCB	VARAP
{S(.)r(.)}	0.0000	0	0	0
{S(.)r(p)}	0.0323	0.000	0	0.000
{S(.)r(t)}	0.0028	**0.581**	0	0
{S(p)r(p)}	**0.1671**	0.000	0	0.000
{S(p)r(t)}	0.0013	**0.273**	**0.19661**	0
{S(d)r(p)}	**0.1364**	0.000	0	0.000
{S(v)r(p)}	0.0978	0.002	0	0.000
S(Va)r(va)	NA	NA	0	0.000
{S(Tp)r(t)}	0.0086	0.059	**0.77902**	0.064
{S(Tp)r(Tp)}	0.0891	0.000	0	0.005
{S(Tp)r(p)}	**0.3054**	0.000	0	0.000
{S(t)r(p)}	**0.1582**	0.083	0.00034	0
{S(t)r(t)}	0.0011	0.001	0.02403	**0.930**

Coastal Programs

Model	MA FALL	NY LI OHS	NJ DB FEB-APR	NC COOP
{S(.)r(.)}	0	0.00	0.000	0.000
{S(.)r(p)}	**0.558**	0.00	0.000	0.000
{S(.)r(t)}	0.053	0.00	0.000	0.000
{S(p)r(p)}	**0.174**	0.00	0.000	0.000
{S(p)r(t)}	0.026	0.00	0.000	0.000
{S(d)r(p)}	0.080	0.00	0.000	0.000
{S(v)r(p)}	0.077	0.00	0.000	0.000
{S(Tp)r(t)}	0.003	***	0.0469	0.014
{S(Tp)r(Tp)}	0.002	***	0.00	**0.157**
{S(Tp)r(p)}	0.014	0.00	0.00	0.000
{S(t)r(p)}	0.013	***	0.00	0.000
{S(t)r(t)}	0.000	**1.00**	**0.95**	**0.829**

Table 28. Summary table, based on the assumption of constant natural mortality, with estimates of annual instantaneous fishing mortality, F, of striped bass ≥ 18 inches by individual program, averaged over all coastal programs, with a weighted average over producer areas and with an overall coastwide estimate. Estimates of coastwide abundance of age 3+ striped bass from 1987-2004 are also provided.

Producer Area Programs*

Year	HUDSON	DE/PA	MDCB	VARAP	Weighted Average
1987			-0.10		**-0.05**
1988	0.04		-0.06		**-0.02**
1989	0.01		-0.08		**-0.04**
1990	0.11		0.22	-0.08	**0.11**
1991	0.14		0.21	0.98	**0.38**
1992	0.13		0.19	-0.06	**0.10**
1993	0.14	0.20	0.23	0.25	**0.22**
1994	0.14	0.16	0.22	0.32	**0.23**
1995	0.14	0.18	0.20	0.17	**0.18**
1996	0.16	0.20	0.25	0.28	**0.24**
1997	0.14	0.24	0.31	0.37	**0.30**
1998	0.19	0.23	0.38	0.68	**0.42**
1999	0.18	0.24	0.44	0.78	**0.48**
2000	0.14	0.25	0.50	0.64	**0.47**
2001	0.19	0.27	0.48	0.55	**0.44**
2002	0.21	0.29	0.43	0.22	**0.34**
2003	0.20	0.25	0.40	0.13	**0.29**
2004	0.25	0.29	0.36	0.06	**0.26**

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

Coast Programs

Year	MADFW	NYOHS	NJDEL	NCCOOP	Unweighted average
1987					
1988		0.28		-0.26	**0.01**
1989		-0.26	-0.27	0.26	**-0.09**
1990		0.30	-0.19	0.31	**0.14**
1991		-0.01	0.24	0.21	**0.15**
1992	0.02	-0.20	0.16	-0.02	**-0.01**
1993	0.03	0.48	0.29	0.01	**0.20**
1994	0.04	0.13	0.07	0.32	**0.14**
1995	0.08	-0.17	-0.05	-0.09	**-0.06**
1996	0.04	0.00	-0.04	0.37	**0.09**
1997	0.10	0.29	0.37	0.45	**0.30**
1998	0.07	0.49	0.02	0.24	**0.21**
1999	0.10	0.18	0.18	-0.08	**0.09**
2000	0.10	0.32	0.09	0.85	**0.34**
2001	0.09	0.31	-0.01	0.45	**0.21**
2002	0.08	-0.11	0.34	0.32	**0.16**

2003	0.10	0.65	0.48	0.51	**0.44**
2004	0.10	0.30	0.68	0.18	**0.31**

Table 28 cont'd.

Unweighted average F estimate of coastal and producer area estimates and estimated total abundance of age 3+ Atlantic striped bass based on F estimates that assume constant natural mortality.

Year	Fishing Mortality	Total Kill inc. discards	Total Stock Size (3 + yrs. old) Thousands
1987	**-0.05**		
1988	**-0.01**		
1989	**-0.07**		
1990	**0.13**	921	7,358
1991	**0.26**	988	3,747
1992	**0.04**	987	22,865
1993	**0.21**	1,437	6,780
1994	**0.18**	1,867	10,161
1995	**0.06**	3,000	47,743
1996	**0.17**	3,376	20,346
1997	**0.30**	4,580	15,251
1998	**0.31**	4,118	13,188
1999	**0.29**	3,704	12,981
2000	**0.40**	5,044	12,466
2001	**0.33**	4,344	13,317
2002	**0.25**	3,890	15,793
2003	**0.36**	4,836	13,339
2004	**0.29**	5,185	18,037

Table 29. Estimates of fishing mortality for 18 inch plus striped bass based on Baranov's catch equation without assuming constant natural mortality, based on the exploitation rates (Table 20) and the bias-adjusted estimates of survival (Table 22). The tables also present annual estimates of instantaneous natural mortality, M. Column headings are S: annual bias-corrected survival rate, Z: total instantaneous mortality, A: annual percentage mortality expressed as a proportion, U: annual exploitation rate, F: instantaneous fishing mortality rate and M: instantaneous natural mortality rate.

Producer Areas

Maryland Chesapeake Bay Spring Spawning Stock

Year	Z	A	U	F	M
1987	0.05	0.05	0.01	**0.01**	0.05
1988	0.09	0.09	0.01	**0.01**	0.08
1989	0.07	0.06	0.01	**0.01**	0.06
1990	0.37	0.31	0.07	**0.08**	0.29
1991	0.36	0.30	0.10	**0.12**	0.24
1992	0.34	0.29	0.13	**0.15**	0.18
1993	0.38	0.32	0.11	**0.13**	0.25
1994	0.37	0.31	0.12	**0.14**	0.23
1995	0.35	0.30	0.18	**0.22**	0.13
1996	0.40	0.33	0.17	**0.20**	0.20
1997	0.46	0.37	0.20	**0.25**	0.21
1998	0.53	0.41	0.19	**0.25**	0.28
1999	0.59	0.45	0.16	**0.22**	0.38
2000	0.65	0.48	0.13	**0.18**	0.47
2001	0.63	0.47	0.12	**0.16**	0.47
2002	0.58	0.44	0.12	**0.15**	0.43
2003	0.55	0.42	0.13	**0.17**	0.38
2004	0.51	0.40	0.10	**0.13**	0.38
Average	**0.40**	**0.32**	**0.11**	**0.14**	**0.28**

Virginia Rappahanock River Spring Spawning Stock Survey

Year	Z	A	U	F	M
1988					
1989					
1990	0.07	0.07	0.17	**0.18**	-0.11
1991	1.13	0.68	0.14	**0.23**	0.90
1992	0.09	0.08	0.31	**0.32**	-0.23
1993	0.40	0.33	0.23	**0.28**	0.12
1994	0.47	0.38	0.25	**0.31**	0.16
1995	0.32	0.27	0.19	**0.22**	0.09
1996	0.43	0.35	0.14	**0.17**	0.26
1997	0.52	0.41	0.20	**0.25**	0.27
1998	0.83	0.56	0.15	**0.23**	0.60
1999	0.93	0.60	0.13	**0.20**	0.73
2000	0.79	0.55	0.13	**0.18**	0.60
2001	0.70	0.51	0.18	**0.25**	0.46
2002	0.37	0.31	0.16	**0.19**	0.19
2003	0.28	0.24	0.15	**0.17**	0.11
2004	0.21	0.19	0.07	**0.08**	0.13
Average	**0.50**	**0.37**	**0.17**	**0.22**	**0.29**

Delaware River: Delaware, Pennsylvania, New Jersey.
Spring Spawning Stock

Year	Z	A	U	F	M
1988					
1989					
1990					
1991					
1992					
1993	0.35	0.29	0.12	**0.15**	0.20
1994	0.31	0.27	0.12	**0.14**	0.17
1995	0.33	0.28	0.13	**0.16**	0.17
1996	0.36	0.30	0.16	**0.19**	0.17
1997	0.39	0.32	0.09	**0.11**	0.27
1998	0.37	0.31	0.14	**0.17**	0.20
1999	0.39	0.32	0.12	**0.14**	0.25
2000	0.40	0.33	0.14	**0.17**	0.23
2001	0.42	0.34	0.14	**0.17**	0.25
2002	0.43	0.35	0.14	**0.18**	0.25
2003	0.40	0.33	0.13	**0.16**	0.24
2004	0.43	0.35	0.12	**0.15**	0.28
Average	**0.38**	**0.32**	**0.13**	**0.16**	**0.22**

Hudson River Spring Spawning Stock Survey

Year	Z	A	U	F	M
1988	0.19	0.17	0.05	**0.05**	0.13
1989	0.16	0.15	0.05	**0.05**	0.11
1990	0.26	0.23	0.07	**0.08**	0.17
1991	0.29	0.25	0.08	**0.10**	0.19
1992	0.27	0.24	0.10	**0.11**	0.16
1993	0.29	0.25	0.11	**0.13**	0.16
1994	0.29	0.25	0.08	**0.10**	0.19
1995	0.29	0.25	0.13	**0.15**	0.14
1996	0.31	0.27	0.16	**0.19**	0.12
1997	0.29	0.25	0.22	**0.25**	0.04
1998	0.33	0.28	0.17	**0.20**	0.13
1999	0.33	0.28	0.14	**0.17**	0.16
2000	0.29	0.25	0.09	**0.11**	0.18
2001	0.34	0.29	0.10	**0.12**	0.22
2002	0.36	0.30	0.08	**0.10**	0.26
2003	0.35	0.30	0.10	**0.12**	0.24
2004	0.40	0.33	0.04	**0.05**	0.35
Average	**0.30**	**0.26**	**0.15**	**0.17**	**0.12**

Table 29 cont'd.

Coastal Areas

Massachusetts Fall Tagging

Year	Z	A	U	F	M
1992	0.17	0.15	0.04	**0.04**	0.13
1993	0.18	0.16	0.05	**0.06**	0.12
1994	0.19	0.17	0.03	**0.04**	0.15
1995	0.23	0.20	0.04	**0.04**	0.18
1996	0.19	0.17	0.06	**0.07**	0.12
1997	0.25	0.22	0.09	**0.10**	0.15
1998	0.22	0.20	0.08	**0.09**	0.13
1999	0.25	0.22	0.06	**0.07**	0.18
2000	0.25	0.22	0.08	**0.10**	0.15
2001	0.24	0.22	0.05	**0.06**	0.19
2002	0.23	0.21	0.09	**0.10**	0.13
2003	0.25	0.22	0.08	**0.09**	0.16
2004	0.25	0.22	0.09	**0.10**	0.15
Average	0.22	0.20	0.06	**0.07**	0.15

New York Ocean Haul Seine Fall Tagging

Year	Z	A	U	F	M
1988	0.43	0.35	0.02	**0.03**	0.40
1989	-0.11	-0.12	0.03	**0.03**	-0.14
1990	0.45	0.36	0.04	**0.05**	0.40
1991	0.14	0.13	0.06	**0.06**	0.08
1992	-0.05	-0.05	0.04	**0.04**	-0.09
1993	0.63	0.47	0.05	**0.06**	0.56
1994	0.28	0.25	0.04	**0.04**	0.24
1995	-0.02	-0.02	0.05	**0.05**	-0.07
1996	0.15	0.14	0.03	**0.03**	0.12
1997	0.44	0.36	0.04	**0.04**	0.40
1998	0.64	0.47	0.03	**0.04**	0.60
1999	0.33	0.28	0.05	**0.06**	0.27
2000	0.47	0.37	0.03	**0.04**	0.43
2001	0.46	0.37	0.05	**0.06**	0.40
2002	0.04	0.04	0.06	**0.07**	-0.03
2003	0.80	0.55	0.04	**0.05**	0.75
2004	0.45	0.36	0.04	**0.05**	0.40
Average	0.33	0.25	0.04	**0.05**	0.28

North Carolina Co-operative Winter Cruise

Year	Z	A	U	F	M
1988	-0.11	-0.11	0.04	**0.04**	-0.15
1989	0.41	0.34	0.03	**0.04**	0.37
1990	0.46	0.37	0.07	**0.09**	0.37
1991	0.36	0.30	0.08	**0.10**	0.26
1992	0.13	0.12	0.15	**0.16**	-0.03
1993	0.16	0.15	0.11	**0.12**	0.04
1994	0.47	0.37	0.10	**0.12**	0.35
1995	0.06	0.06	0.14	**0.15**	-0.09
1996	0.52	0.40	0.12	**0.15**	0.37
1997	0.60	0.45	0.17	**0.23**	0.37
1998	0.39	0.32	0.17	**0.20**	0.19
1999	0.07	0.07	0.22	**0.23**	-0.15
2000	1.00	0.63	0.10	**0.16**	0.85
2001	0.60	0.45	0.12	**0.15**	0.44
2002	0.47	0.37	0.12	**0.15**	0.31
2003	0.66	0.48	0.11	**0.16**	0.50
2004	0.33	0.28	0.12	**0.14**	0.19

New Jersey Delaware Bay February-April

Year	Z	A	U	F	M
1988	0.43	0.35	0.02	**0.03**	0.40
1989	-0.11	-0.12	0.03	**0.03**	-0.14
1990	0.45	0.36	0.04	**0.05**	0.40
1991	0.14	0.13	0.06	**0.06**	0.08
1992	-0.05	-0.05	0.04	**0.04**	-0.09
1993	0.63	0.47	0.05	**0.06**	0.56
1994	0.28	0.25	0.04	**0.04**	0.24
1995	-0.02	-0.02	0.05	**0.05**	-0.07
1996	0.15	0.14	0.03	**0.03**	0.12
1997	0.44	0.36	0.04	**0.04**	0.40
1998	0.64	0.47	0.03	**0.04**	0.60
1999	0.33	0.28	0.05	**0.06**	0.27
2000	0.47	0.37	0.03	**0.04**	0.43
2001	0.46	0.37	0.05	**0.06**	0.40
2002	0.04	0.04	0.06	**0.07**	-0.03
2003	0.80	0.55	0.04	**0.05**	0.75
2004	0.45	0.36	0.04	**0.05**	0.40

Table 30. Summaries of tag-based estimates of annual instantaneous fishing mortality if striped bass ≥ 18 inches based on the catch equation without assuming constant natural mortality. The table also provides estimates of stock size coastwide of striped bass ages 3+ by solving the equation Kill=F*(average stock size). Estimates are adjusted for bias caused by live release of recaptured fish.

Producer Area Programs*

Year	HUDSON	DE/PA	MDCB	VARAP	Average
1987					
1988	0.05		0.01		**0.01**
1989	0.05		0.01		**0.01**
1990	0.08		0.01	0.18	**0.06**
1991	0.10		0.08	0.23	**0.11**
1992	0.11		0.12	0.32	**0.16**
1993	0.13	0.15	0.15	0.28	**0.18**
1994	0.10	0.14	0.13	0.31	**0.17**
1995	0.15	0.16	0.14	0.22	**0.16**
1996	0.19	0.19	0.22	0.17	**0.20**
1997	0.25	0.11	0.20	0.25	**0.21**
1998	0.20	0.17	0.25	0.23	**0.23**
1999	0.17	0.14	0.25	0.20	**0.22**
2000	0.11	0.17	0.22	0.18	**0.19**
2001	0.12	0.17	0.18	0.25	**0.19**
2002	0.10	0.18	0.16	0.19	**0.16**
2003	0.12	0.16	0.15	0.17	**0.15**
2004	0.05	0.15	0.17	0.08	**0.13**

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

Coast Programs

Year	MADFW	NYOHS	NJDEL	NCCOOP	Unweighted average
1987					
1988		0.03		0.04	**0.03**
1989		0.03	0.03	0.04	**0.03**
1990		0.05	0.05	0.09	**0.06**
1991		0.06	0.06	0.10	**0.07**
1992	0.04	0.04	0.04	0.16	**0.07**
1993	0.06	0.06	0.06	0.12	**0.08**
1994	0.04	0.04	0.04	0.12	**0.06**
1995	0.04	0.05	0.05	0.15	**0.07**
1996	0.07	0.03	0.03	0.15	**0.07**
1997	0.10	0.04	0.04	0.23	**0.10**
1998	0.09	0.04	0.04	0.20	**0.09**
1999	0.07	0.06	0.06	0.23	**0.10**
2000	0.10	0.04	0.04	0.16	**0.08**
2001	0.06	0.06	0.06	0.15	**0.08**
2002	0.10	0.07	0.07	0.15	**0.10**
2003	0.09	0.05	0.05	0.16	**0.09**
2004	0.10	0.05	0.05	0.14	**0.08**

Table 30 cont'd.
Coastwide Fishing Mortality Rate obtained using the catch equation
and obtaining an unweighted average of Coastal and producer area estimates for all fish.
Coastwide stock size estimates obtained using Kill = F * (average stock size).

Year	Fishing Mortality	Total Loss includes discards	Total Stock Size, Thousands
1987			
1988	**0.02**	445	19,189
1989	**0.02**	480	20,071
1990	**0.06**	921	14,978
1991	**0.09**	988	10,566
1992	**0.12**	987	8,561
1993	**0.13**	1,437	11,114
1994	**0.12**	1,867	15,944
1995	**0.12**	3,000	25,345
1996	**0.14**	3,376	24,945
1997	**0.16**	4,580	28,873
1998	**0.16**	4,118	25,607
1999	**0.16**	3,704	23,423
2000	**0.14**	5,044	36,980
2001	**0.14**	4,344	32,154
2002	**0.13**	3,890	30,305
2003	**0.12**	4,836	40,036
2004	**0.11**	5,185	48,485

Table 31. Total length frequencies of fish tagged in 2004 by program.

	Coast Programs				**Producer Area Programs**			
TL	MADFW	NYOHS	NJDEP	NCCOOP	DE/PA	MDCB	VARAP	HUDSON
199								
249		0	0					
299		0	0					
349		0	0	20		23		
399		14	0	180		47		
449		219	0	340	63	122		1
499		342	7	505	51	113	155	88
549		351	50	408	63	63	212	119
599		251	129	242	47	65	220	118
649	3	150	279	178	38	39	153	150
699	26	42	449	195	21	43	46	120
749	93	24	433	262	16	38	43	109
799	167	17	281	196	22	49	179	136
849	153	15	169	103	29	86	198	124
899	98	5	69	43	40	76	109	115
949	54	6	15	24	26	60	82	60
999	24	2	3	6	16	34	41	65
1049	15	2	1	2	8	15	22	30
1099	15	1	0	1	8	13	13	17
>1099	7	2	0	2	4	7	4	5
Total	655	1443	1885	2707	452	893	1477	1257

Table 32. Age frequencies of tagged fish recaptured in 2004 by program.

	Coast Programs				**Producer Area Programs**			
AGE	MADFW	NYOHS	NJDEP		DE/PA	MDCB	VARAP	HUDSON
1								
2		1				0		
3		16	3		4	0		
4		15	53		4	0	13	
5	1	14	186		4	0	24	
6	1	13	151		7	0	18	
7	7	29	76		6	1	13	
8	8	16	33		13	1	18	
9	7	11	12		14	0	10	
10	4	19			16	2	18	
11	6	4	1		19	4	6	
12	7	2			7	0	8	
13	3	2			3	3	7	
14	2	3			2	3	2	
15	2	3			5	6		
16	1	2			1	0		
17		2				1	2	
18		1				0		
19		3				1		
20	1					0		
21								
22								
Total	50	156	515		105	22	139	

Table 33. Distribution of tag recaptures by state (program) and month.

Coast Programs

Massachusetts (recaptures in 2004 from fish tagged and released during 1992-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME													0
NH													0
MA						4	10	7	5				26
RI						1		1		1			3
CT													0
NY					3	4				2	2	1	12
NJ			1	2	2	2			1	1	7		16
DE													0
MD			1	2	3						1		7
VA	2		2								4	3	11
NC	1	2		1							1	1	6
Total	3	2	4	5	8	11	10	8	6	4	15	5	81

New York - Ocean Haul Seine (recaptures in 2004 from fish tagged/release during 1988-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME								1	1	1			3
NH						3	1	1					5
MA					7	14	6	6	1				34
RI					2	4	3	2		4			15
CT					1	3	2	1	1	2			10
NY			1	6	10	11	2	3	2	1	8		44
NJ			1	3	6					3	1	2	16
PA													0
DE					1						1	1	3
MD				5	1								6
VA	2		1	1							2	4	10
NC	2	1	1							1	1	1	7
Total	4	1	4	15	28	35	14	14	5	12	13	8	153

Table 33 cont'd.

New Jersey - Delaware Bay (recaptures in 2004 from fish tagged/release during 1989-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME						4	7	3	3			1	18
NH						2	1	3					6
MA					11	41	44	34	17	4			151
RI					6	12	3	6	2	2			31
CT					7	4	5	1	3	3			23
NY				1	18	15	11	13	9	21	19	2	109
NJ		1		9	34	6	5		1	10	31	7	104
PA					1								1
DE				2	1					2	2	1	8
MD				8	7					1	2		18
VA	3	4	1	1							2	3	14
NC	6	2			1						1	6	16
Total	9	7	1	21	86	84	76	60	35	43	57	20	499

North Carolina - Cooperative Trawl Cruise
(recaptures in 2004 from fish tagged and released during 1992-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME						1							1
NH					1	1							2
MA					6	16	23	10	7	1			63
RI					2	5	6	2					15
CT					2	5	3			1			11
NY					5	4		4	5	8			26
NJ					8	7	6	1		1	6		29
PA													0
DE						1	1			1	1		4
MD		4	1	11	20	36	21	15	13	7	5	1	134
VA	8	3	5	2	13	6	3			16	17	18	91
NC	9	8	8					1		2		6	34
Total	17	15	14	13	57	82	63	33	25	37	29	25	410

Table 33 cont'd.

Producer Area Programs

Delaware / Pennsylvania - Delaware River
(recaptures in 2004 from fish tagged and released during 1992-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME					1		1						2
NH													0
MA						4	4	6	3				17
RI									1	1			2
CT													0
NY					1	3	1	1			1		7
NJ			2		7	11	5	1	1	7	12	1	47
PA					2								2
DE				1	2				1	3	4		11
MD				4		3			2		4		13
VA												2	2
NC	4	1	1		1								7
Total	4	1	3	5	14	21	11	8	8	11	21	3	110

Maryland - Chesapeake Bay Spring Spawning Stock
(recaptures in 2004 from fish tagged and released during 1992-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME													0
NH													0
MA					1	2	7	6	3	1			20
RI								2					2
CT						2	1						3
NY						2		3		1			6
NJ				1	1					1	1		4
PA													0
DE						1		1			1		3
MD	1	1	1	1	8	12	13	6	9	10	6	1	69
VA		1	2		1	2	1	1	1	5	5	7	26
NC	5		1									1	7
Total	6	2	4	2	11	21	22	19	13	18	13	9	140

Table 33 cont'd.

Virginia - Rappahannock River (recaptures in 2004 from fish tagged and released during 1992-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NH						1							1
MA					2	3	8	2	1				16
RI						1	2	1	1				5
CT							1		1				2
NY					4	4	2	1	2	4	2		19
NJ					2	1	1				2		6
DE						2				1	1		4
MD				1	5	12	6			2			26
VA				11	9	9	3	1		7	8	8	56
NC												2	2
Total	0	0	0	12	22	33	23	5	5	14	13	10	137

Hudson River
(recaptures in 2004 from fish tagged and released during 1992-2004)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME								1	2		1		4
NH													0
MA					1	7	13	14	4	1	1		41
RI						6	5	3	3	1	1		19
CT				1	1	7	6	4	2	2	1		24
NY				5	37	15	16	10	11	19	10	1	124
NJ					2	13	3			4	20	4	46
PA													0
DE											1		1
MD						1				1			2
VA	1	1										5	7
NC	3							1				5	9
Total	4	1	0	6	41	49	43	33	22	28	35	15	277

Appendix A. Criteria to evaluate the VPA indices

(Approved and accepted by SB TC)

The Workshop participants developed a list of evaluation steps that should be applied to each index. The state agencies should use the evaluation list for each state survey. Each program should be analyzed to determine if the survey is conducted at the appropriate time of year, i.e. bracketing the correct spawning period. Similarly, the survey design should be reviewed by the state to determine if the sampling area is correct. If the state determines there is a lot of noise in the data, the state should attempt to refine the data. For instance, if some of the stations catch striped bass consistently and others do not, can something be done to refine these data? The states should identify if the indices are sex-specific indices or age-specific due to survey design. Because a self-evaluation by each state could be subjective, the Technical Committee should evaluate the state's program evaluation and make a recommendation to the Striped Bass Stock Assessment Subcommittee.

1. Evaluate design and best method to evaluate uncertainty of index.
2. Assess the index and/or improve the index to get the best signal.
3. Validate the index before use in the VPA.
    a. Sensitivity of the VPA results to the influence each index.
    b. Validate an index to a JAI, where possible.
    c. Longitudinal catch curves, to determine the cohort trends.
    d. Plots of age specific index v. year to see if cohorts are moving in a specific direction.
4. Evaluation by the agency conducting the survey
    a. Rank (weight) index
    b. Criticisms/Supporting Evidence
5. Evaluate by the Striped Bass Technical Committee
    a. Evaluate index based on survey design, precision, and ability to track cohorts or portion of the stock targeted.
    b. Provide recommendations to the Striped Bass Stock Assessment Subcommittee on which indices should be used in the assessment.

Appendix B. Estimation of Wave-1 Harvest in North Carolina and Virginia

DT: 7/11/2005

TO: ASMFC Striped Bass Technical Committee

FR: Joseph Grist, ASMFC

RE: MRFSS North Carolina Wave-1 2004 harvest

Introduction

During the March 2005 Striped Bass Technical Committee (STB TC) meeting, the results for the 2004 wave-1 North Carolina (NC) harvest were reported. This was the first time wave-1 was directly sampled by the Marine Recreational Fisheries Statistics Survey (MRFSS), and the results were both predictable and a cause for concern. A total of 177,288 striped bass (equivalent to 3,615,670 lb) were harvested during wave-1 in North Carolina.

Anecdotal knowledge has suggested that North Carolina, Virginia, and possibly other states had a sizeable wave-1 fishery. The 2004 wave-1 harvest values for North Carolina and the wave-1 tag return data (Figure 1) for North Carolina and Virginia support this suggestion. However, information is still lacking on what the previous annual harvest rates were, as well as the level of exploitation in Virginia and elsewhere during wave-1. The STB TC requested an examination of the data that included suggestions for how to incorporate these data efficiently into the coastwide STB assessment.

The goal of this analysis is to determine if tag return data during wave-6 and wave-2 are correlated with the reported total catch and, if so, if a proxy ratio may be utilized to back-calculate wave-1 data for North Carolina and Virginia.

Data

Striped bass tag return data from North Carolina and Virginia were provided by the U.S. Fish and Wildlife Service (USFWS). Data were queried from the MRFSS website (http://www.st.nmfs.gov/st1/recreational/queries/effort/effort_time_series.html) on July 11, 2005 for North Carolina and Virginia, having selected variables by harvest (A+B1), all oceans combined, and all modes combined.

Methods

Tag return and MRFSS data were merged by wave and by year and were analyzed for each state. SAS 9.1 was utilized to calculate Pearson's correlation coefficient (PROC CORR), generate linear regressions, and conduct ANOVA or analysis of variance (PROC REG) to test for similarities between tag return and total catch data by wave. Only wave-6 (November and December) and Wave-2 (March and April) data were analyzed.
Results

North Carolina

Tag returns were positively correlated with total catch (0.5828) during wave-6 (Figure 2). ANOVA indicated significant evidence (*p*-value = 0.0366) that total catch could explain the proportion of tag returns during wave-6.

Tag returns were positively correlated with total catch (0.9518) during wave-2 (Figure 3). ANOVA indicated significant evidence (*p*-value < 0.0001) that total catch could explain the proportion of tag returns during wave-2.

Virginia

Tag returns were positively correlated with total catch (0.5827) during wave-6 (Figure 4). Although ANOVA did not indicate statistically significant evidence (*p*-value = 0.0599) that total catch could explain the proportion of tag returns during wave 6, the given p-value indicates suggestive, but inconclusive, evidence that the null hypothesis is false, possibly representing biological significance.

Tag returns were slightly negatively correlated with total catch (-0.4007) during wave-2 (Figure 5). ANOVA did not indicate significant evidence (*p*-value = 0.4311) that total catch could explain the proportion of tag returns during wave-2. However, the tag return data were not consistent from year to year and a negative correlation was expected.

Summary

The 2004 wave-1 total catch for North Carolina corresponds with observed recreational effort that begins during wave-6 and continues into wave-1 throughout the coastal waters of northeastern North Carolina and southeastern Virginia (Sara Winslow, NCDMF, personal communication).

Analysis indicates that tag return data can be used to explain total catch in wave-6 and wave-2 in North Carolina. If the assumption that wave-1 follows a similar trend is acceptable by the STB TC, then wave-1 data before 2004 could be back-calculated for North Carolina striped bass harvest. There are two possible methods for back-calculation (Figure 6). One would be using the direct 2004 ratio of tag returns to reported total catch. The other would be to use the combined ratio of tag returns to total catch for both wave-6 and wave-2.

Correlation analysis for Virginia did indicate total catch could be explained by tag returns, although ANOVA did not provide strong evidence for or against the reported correlation. However, tag return evidence does show a wave-1 striped bass fishery is occurring in Virginia (Figure 1), and using the wave-6 mean ratio of tag returns to reported total catch for 1996-2004 could be utilized to back-calculate the wave-1 striped bass recreational fishery (Figure 7).

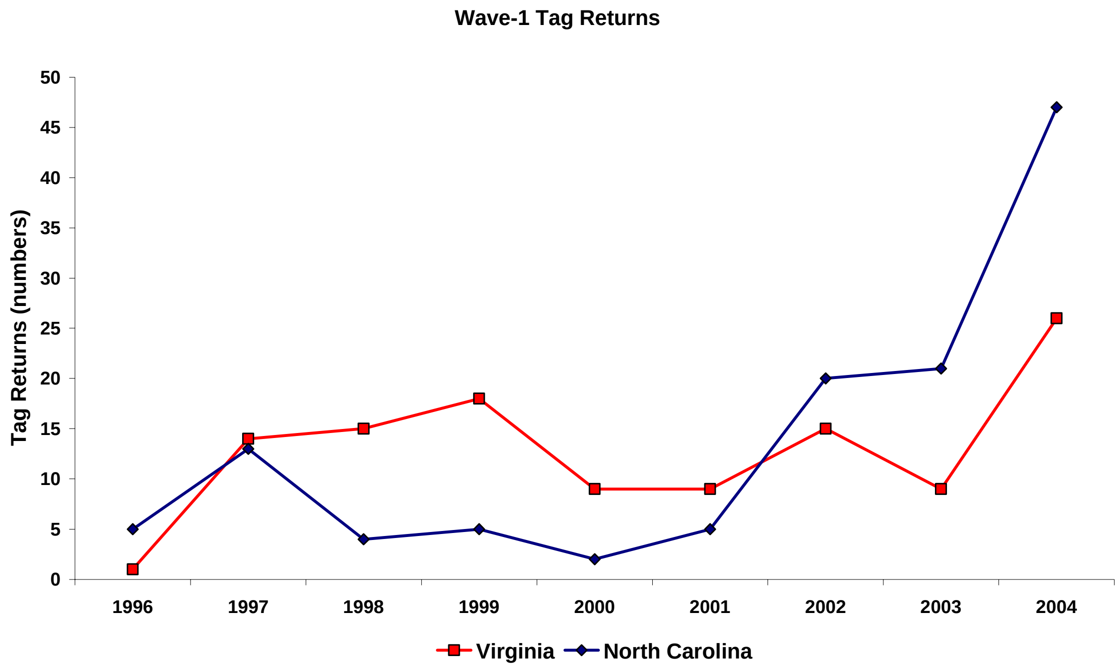

Figure 1. Wave-1 tag returns for Virginia and North Carolina.

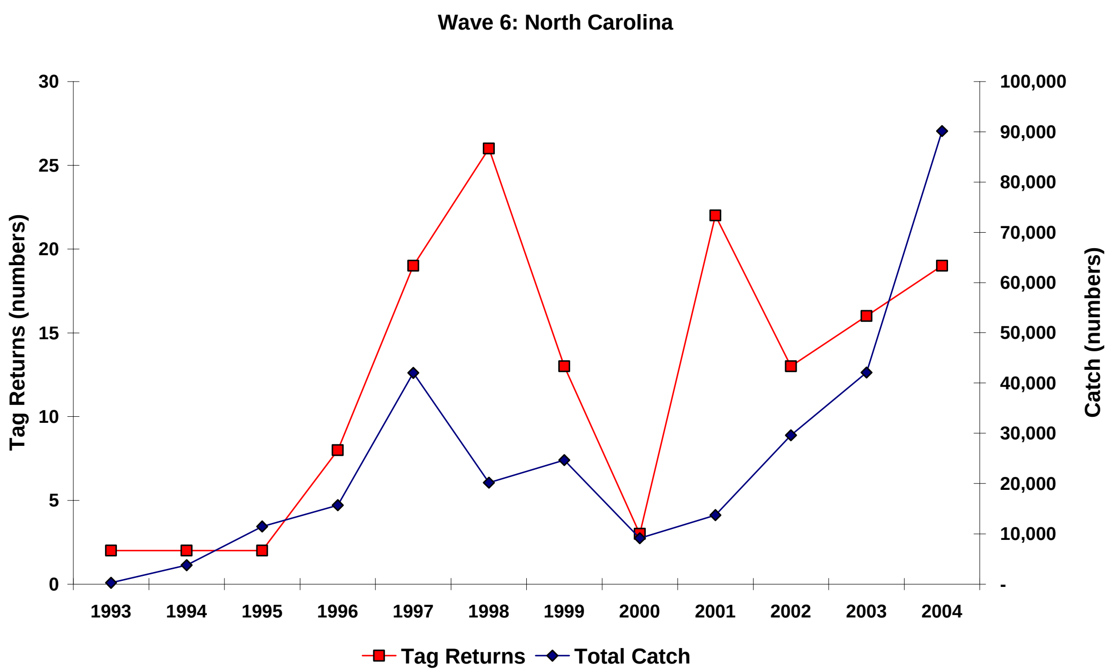

Figure 2. Wave-6 tag returns versus total catch for North Carolina.

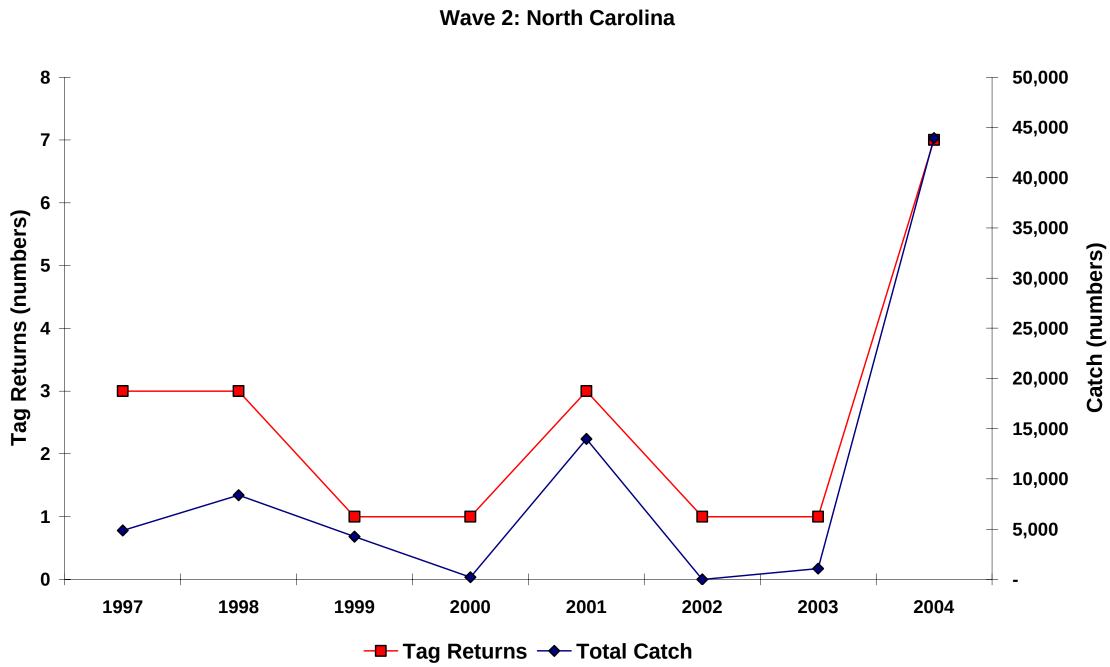

Figure 3. Wave-2 tag returns versus total catch for North Carolina.

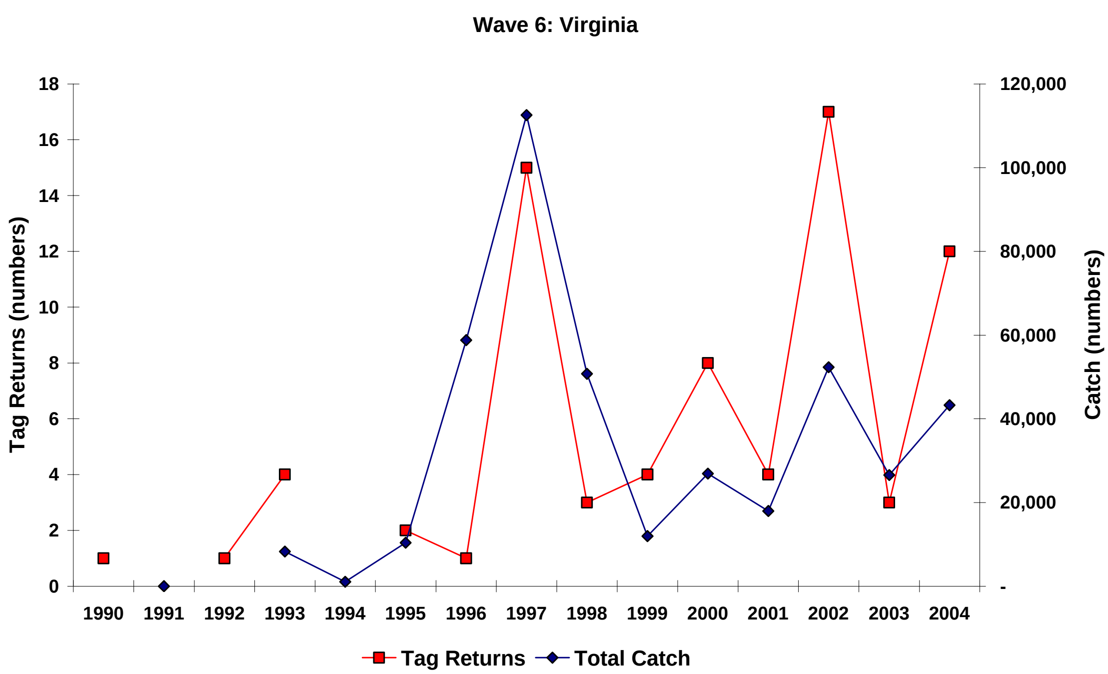

Figure 4. Wave-6 tag returns versus total catch for Virginia.

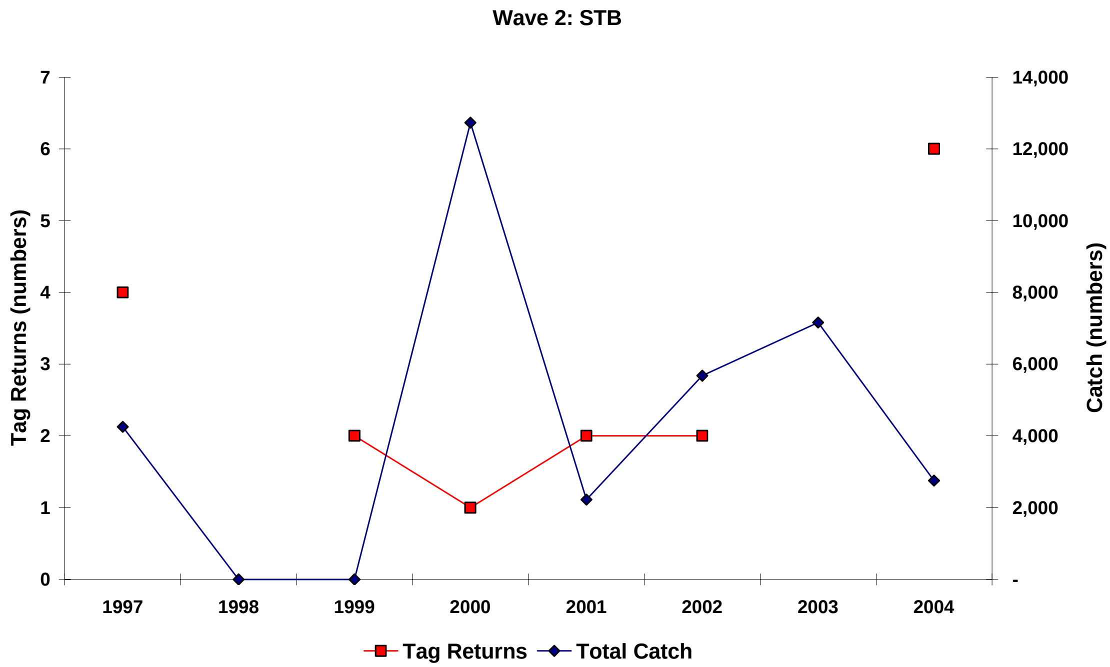

Figure 5. Wave-2 tag returns versus total catch for Virginia.

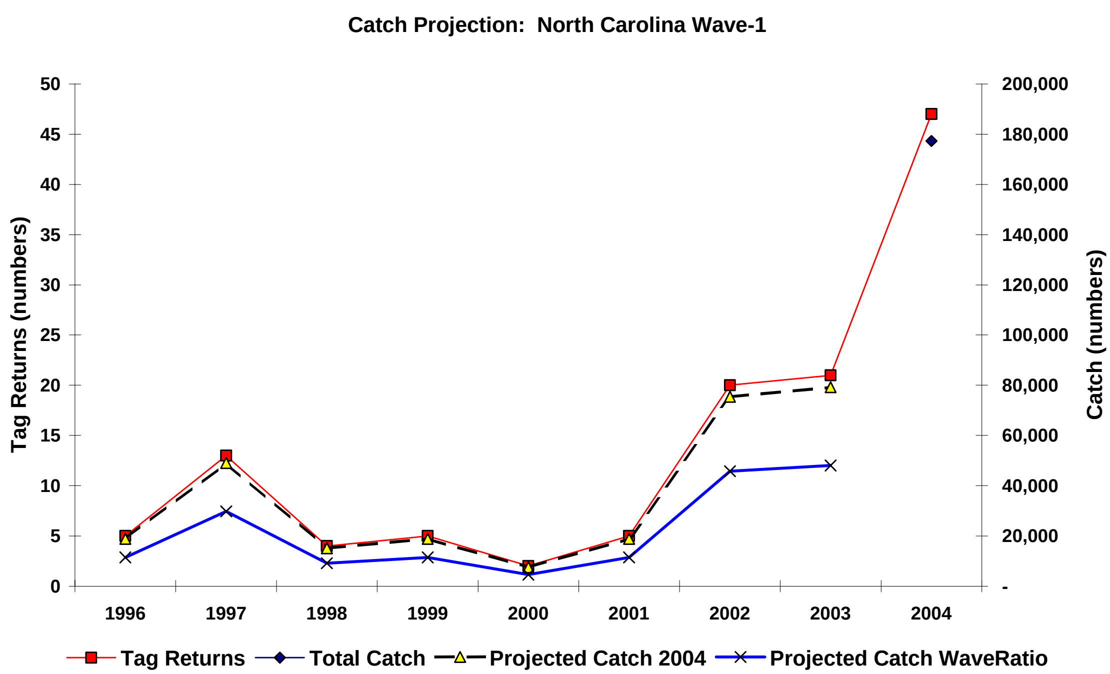

Figure 6. Comparison of catch projections for North Carolina wave-1.

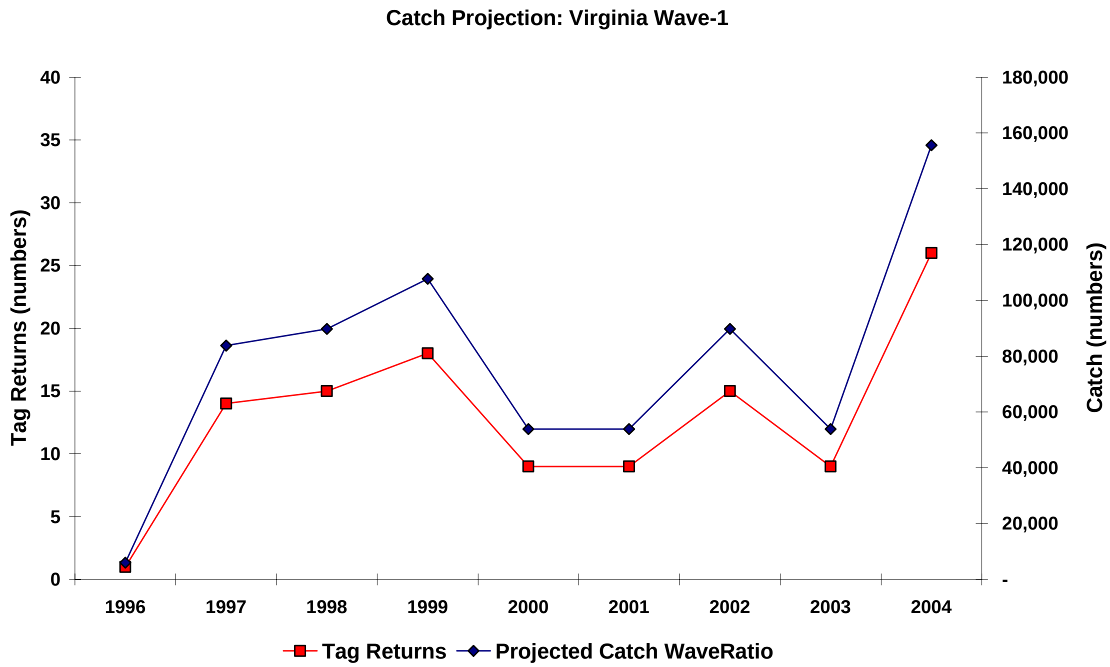

Figure 7. Catch projection for Virginia wave-1.

Appendix C. Wave-1 Total Recreational Catch for North Carolina and Virginia: Final Calculations

DT: August 10, 2005
TO: Striped Bass Stock Assessment Sub-Committee
FR: Joseph Grist, ASMFC

RE: Wave-1 total recreational catch for NC and VA final calculations

Based on the report presented to the Striped Bass TC on July 11, 2005 concerning the North Carolina and Virginia MRFSS wave-1 recreational catch, Table 1 contains calculations for total catch for each state.

North Carolina: Wave-1 total catch for 1996-2003 is based on the NC specific 2004 wave-1 ratio of tag returns to MRFSS total catch numbers. There were 47 tags returned during the wave-1 fishery period for the ocean fishery. The MRFSS reported catch (A+B1) was 177,288 striped bass during the same period. This resulted in a 2004 ratio tags to catch of 0.000265. This ratio was applied to the wave-1 tag returns for the NC ocean fishery to provide a back-calculated total catch for wave-1 in NC.

Virginia: Unlike NC, a 2004 wave-1 total catch was not reported. However, analysis of the tag returns suggested that a winter fishery similar to that of North Carolina occurred off VA during 2004. The July 11th report to the TC did indicate that VA wave-6 tag returns were positively correlated to catch and implied biological significance, though wave-2 analysis did not. Personal communication with Sara Winslow (NCDMF) confirmed that the winter fishery begins in the latter half of wave-6 and continues into wave-1 in northeastern NC, and similar trends would be expected for southeastern VA. Anecdotally, this suggested that wave-6 and wave-1 catch would show some level of correlation in fishing activity. Using known wave-1 tag returns, a mean ratio (0.000167) of tag returns to catch for VA wave-6, 1996-2004, was utilized to back-calculate the total wave-1 catch.

Table 1. Wave-1 catch values for North Carolina and Virginia, 1996-2004.

Year	**Total catch values (projected)**	
	NC	VA
1996	18,860	5,985
1997	49,037	83,793
1998	15,088	89,778
1999	18,860	107,734
2000	7,544	53,867
2001	18,860	53,867
2002	75,442	89,778
2003	79,214	53,867
2004	177,288*	155,616

*actual catch

Appendix D. Analysis and Discussion of the 1998-2002 Striped Bass Coastwide Weight-at-Age

Analysis and Discussion of the
1998-2002 Striped Bass Coastwide Weight-at-Age

Prepared for the
Striped Bass Stock Assessment Sub-Committee Meeting
August 9 – 11, 2005

Linda S. Barker
Maryland DNR Fisheries Service

Introduction

A crucial element of the yearly catch-age based virtual population analyses (VPA) of Atlantic striped bass is the calculation of biomass of the mixed coastal stock. This calculation requires coastwide weight-at-age (WAA). The coastwide WAA has consistently been calculated as a weighted mean:

State WAA = Σ (state WAA * % state CAA by numbers) Eqn. 1

Coastwide WAA = Σ (State WAA * state % coastwide CAA) Eqn. 2

The current VPA analysis uses a time series dating back to 1982. The yearly values were not calculated on a yearly basis, however. In 1997, the values for 1982-1997 were developed. These values were developed using data from all states, subdividing each year into quarterly time periods to account for growth, and weighting by numbers of fish. (Details of developing weights at age for 1982 to 1996 can be found in NEFSC Lab Ref. 98-03.) Coastwide WAA was not re-calculated in 1998 or 1999. Instead, the 1997 values were used as these years' values. The 2000, 2001 and 2002 coastwide WAA were developed at the Stock Assessment Subcommittee Workshops, weighted by total weight of fish, using readily available data sets. Therefore, the methodology and data sets used for these calculations were not consistent, either with the methodology used for the 1982-1997 WAA or with each other. The 2000-2002 values showed an apparent decline in WAA, but it was impossible to determine if this apparent trend was due to the change in method or a true change in WAA.

In 2004, a standardized report format was developed that calculated WAA as part of the CAA calculations. The 2003 coastwide WAA was developed using all states' data:

- Maine and New Hampshire recreational harvest and discards,
- Massachusetts recreational and commercial catch,
- Rhode Island recreational and commercial catch,
- Connecticut recreational catch,
- New York recreational catch and commercial landings,
- New Jersey recreational catch,

- Delaware recreational and commercial catch,
- Maryland recreational and commercial catch,
- Virginia recreational and commercial catch, and
- North Carolina recreational and commercial catch.

An apparent decline was observed between the 2001and 2002 coastwide WAA – only 2 of 13 age-classes of harvested fish did not show a reduction in WAA (Table 1). Due to concerns about this apparent decrease in coastwide WAA and the inability to compare 1998-2002 with the rest of the time series, the subcommittee decided to re-calculate these coastwide WAA values.

Methods: Recalculation of the 1998-2002 values.

All states were requested to provide the 1998-2002 time series of WAA, landings and discards. Because information was not received from all states, it was decided to develop the coastwide WAA from information for states with greatest catch. For 1998-2001, the coastwide WAA was calculated using the 5 major harvester states (MA, NY, NJ, MD, VA), NH and CT (Table 2). For 2002, data were available to include RI and DE (Table 3). WAA was calculated as the weighted mean, weighted by numbers for commercial harvest, recreational harvest, and recreational discard. Annual state removals were taken from the time series tables for commercial harvest, recreational harvest and recreational discard numbers in the 2004 coastwide compliance report summary prepared by Gary Sheppard if not provided by state. WAA for the nearest neighboring state was used if that state's WAA was not available. The oldest age group was designated "13+", and 1982-1997 "13+" values were recalculated as the arithmetic averages of 13- to 15-year-old age class values. A constraint imposed by the 1998-2002 data was that an annual time frame was used for all calculations, as opposed to the finer time frame used in the 1982-1997 and 2003 calculations. The time series matrix of WAA including re-calculated values is presented in Table 4.

Discussion

The apparent decrease in WAA from 2000 - 2002 within the "old" WAA time series. Most age classes showed a decrease between 2000 and 2002 (14 of 15 age-classes) (Table 2). However, examination of the development of the WAA revealed that this decrease was due to differences in the development of the values. Because average WAA greater for coastal than Chesapeake Bay states for all harvested age classes, calculations are skewed if the harvest proportion is not used in the WAA calculations.

Evaluation of the apparent decline between 2001-2002 values. The 1982-1997 coastwide WAA time series was developed using all states' data. In contrast, the 2001 coastwide WAA was developed without data from RI, CT, MD and NC. Due to comparatively low harvest, RI, CT and NC do not contribute strongly to the coastwide WAA. However, the exclusion of MD data from the 2001 calculation had a major influence on the coastwide value. Without the MD numbers factoring in to the average, the coastwide WAA was disproportionately weighted by MA (Figure 1, Table 5). This is significant because MD is a Chesapeake Bay harvest state and MA is a coastal harvest state. Based on data from 1982-1997, the majority of fish harvested in Chesapeake Bay (ages 3–11) were, on average, 2.6 kg (5.7 lb) smaller than coastal fish (Table 6). The unnaturally strong contribution of MA in the 2001 WAA, followed by the strong contribution of MD fish in the 2002 WAA, certainly contributed to the observed decline in the coastwide WAA.

Patterns in WAA from 2000 – 2003 within the recalculated WAA time series. Coastwide WAA values for 2000 to 2002 were recalculated using a consistent method that was considered functionally equivalent to the method used for earlier calculations. Although a subset of states was used, these states constitute the majority of the harvest and therefore maintained the overall harvest proportion throughout the WAA calculations. In contrast to the earlier values, these values showed a consistent increase across the 2000–2003 time frame (Table 4). Between 2000 and 2001, 11 of the 13 age classes showed an increase in WAA, between 2002 and 2003, 12 of the 13 age classes showed an increase in WAA. The 2003 WAA was developed from information provided by all states for the 2003 stock assessment. Comparison of the 2003 WAA against the mean values for 2000-2002 showed an increase in 11 of 13 age classes.

Comparison of "old" vs. recalculated WAA values from 2000 – 2002. Although the recalculated WAA values showed an increase across the 2000-2003 time frame, these values were lower than the mean of the 1982-1996 time series (Table 7).

Future Work.

Future years' WAA will be calculated from information provided in stock assessment "Compliance Report Template", and will therefore include all states' data. No recommendations are suggested to improve calculation methodology for future years.

It would be useful to determine if there truly was a decrease between the 1982-96 WAA and the 1998-2003 WAA. However, data are not available to recalculate 1982-2002 WAA using the current method, nor are data available to recalculate 2000-03 using the earlier method.

Figure 1. **Composition of Striped Bass Coastwide WAA by State.**
1982-1997 coastwide WAA shows a fairly even distribution from the 5 major harvest (by numbers) states (MA, NY, NJ, MD, VA). 2001 WAA is dominated by MA. 2002 WAA shows a strong contribution from MD and VA (Chesapeake Bay harvest states).

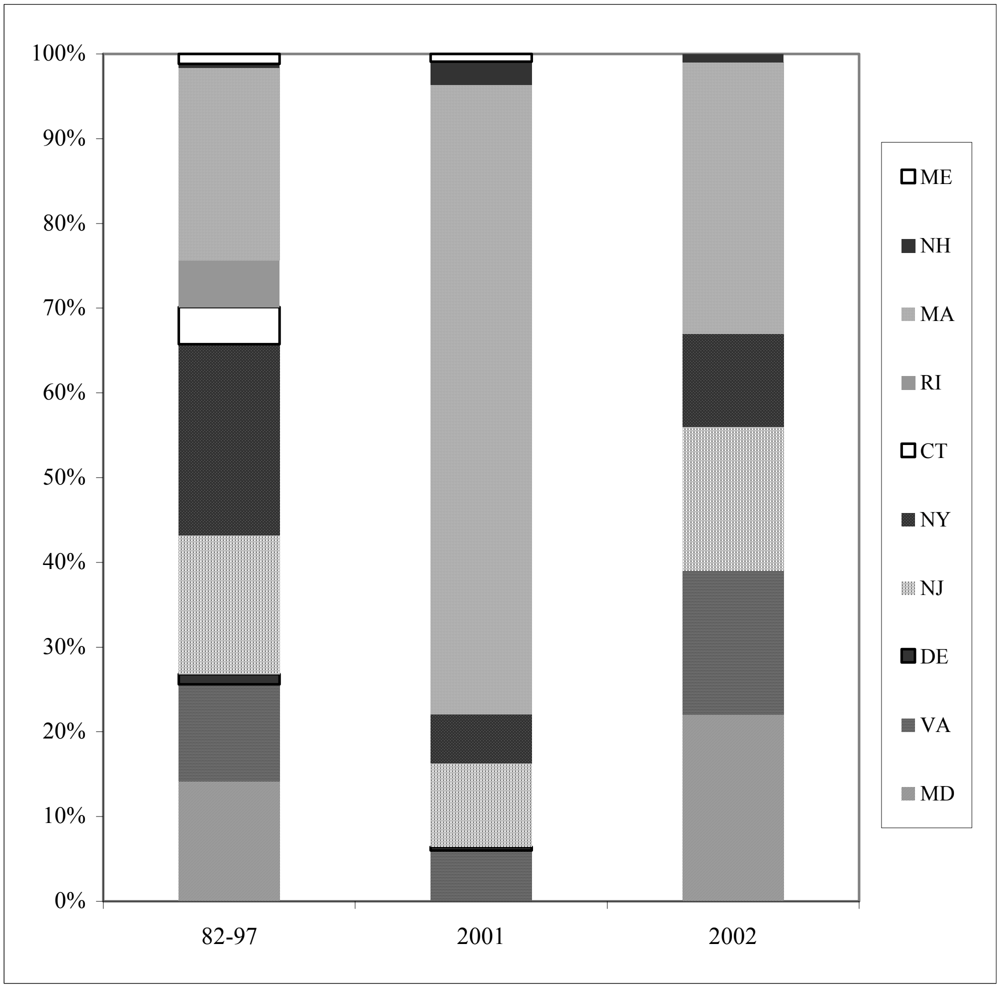

Table 1. Striped Bass Coastwide WAA (kg) Time Series Used for the 2002 Stock Assessment. 1997-1999 values are identical. Note the apparent decline in WAA between 2001-2002.

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1982	0.13	0.64	1.09	1.54	2.42	3.75	4.83	5.79	6.20	8.68	10.80	11.20	12.97	13.26	15.91
1983	0.20	0.55	0.94	1.37	2.37	3.29	3.77	5.36	6.01	8.10	9.57	10.39	11.11	11.10	11.12
1984	0.24	0.60	1.69	1.62	2.67	3.39	5.07	5.65	6.76	7.76	8.41	12.65	10.65	11.75	14.75
1985	0.06	0.61	1.07	1.66	2.19	3.59	4.91	5.46	6.77	7.45	9.00	10.69	11.42	14.34	15.98
1986	0.14	0.57	1.27	2.40	2.44	3.12	3.95	5.05	5.44	6.09	7.75	9.16	10.97	11.55	15.83
1987	0.20	0.77	1.41	2.11	2.50	2.91	3.61	4.74	5.52	6.49	7.77	9.78	11.38	11.62	16.46
1988	0.31	0.91	1.10	1.98	3.12	4.02	4.38	4.70	5.24	5.62	8.58	10.40	11.50	11.31	17.00
1989	0.16	0.83	1.22	2.23	3.06	4.53	5.37	6.23	6.04	8.68	8.94	9.74	13.04	9.93	17.11
1990	0.08	0.89	1.14	2.05	2.35	3.83	4.91	5.96	5.70	5.97	7.44	9.08	9.36	10.80	17.65
1991	0.21	0.92	1.29	2.17	2.62	3.17	4.81	5.64	6.46	6.24	9.46	8.30	9.62	15.96	17.09
1992	0.10	0.69	1.31	1.93	2.81	3.67	4.90	5.79	6.96	8.15	9.77	12.44	13.10	11.15	17.65
1993	0.07	0.76	1.31	1.99	2.77	3.58	4.80	6.11	7.03	8.01	9.53	10.76	14.45	13.85	15.36
1994	0.24	1.05	1.69	2.21	2.85	3.50	4.94	6.20	6.80	7.53	9.73	10.69	11.38	9.06	17.75
1995	0.28	0.70	1.35	2.18	2.77	3.65	5.38	6.16	7.27	8.86	7.57	9.73	13.97	15.65	20.37
1996	0.14	1.05	1.47	2.32	3.23	4.52	6.39	7.11	7.81	9.20	9.31	10.10	11.36	12.45	17.30
1997	0.13	0.62	1.18	2.46	2.81	3.64	4.51	5.07	6.73	9.17	9.94	10.24	11.94	14.49	17.92
1998	0.13	0.62	1.18	2.46	2.81	3.64	4.51	5.07	6.73	9.17	9.94	10.24	11.94	14.49	17.92
1999	0.13	0.62	1.18	2.46	2.81	3.64	4.51	5.07	6.73	9.17	9.94	10.24	11.94	14.49	17.92
2000	0.14	1.05	1.47	2.32	3.23	4.52	6.39	7.11	7.81	9.20	9.31	10.10	11.36	12.45	17.30
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	3.30	4.16	5.48	6.36	7.45	8.75	8.89	9.99	11.03	13.95

Table 2. Revised Time Series of Striped Bass Coastwide WAA (kg).

Year	Age												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13+**
1982	0.1	0.6	1.1	1.5	2.4	3.7	4.8	5.8	6.2	8.7	10.8	11.2	14.0
1983	0.2	0.6	0.9	1.4	2.4	3.3	3.8	5.4	6.0	8.1	9.6	10.4	11.1
1984	0.2	0.6	1.7	1.6	2.7	3.4	5.1	5.7	6.8	7.8	8.4	12.7	12.4
1985	0.1	0.6	1.1	1.7	2.2	3.6	4.9	5.5	6.8	7.4	9.0	10.7	13.9
1986	0.1	0.6	1.3	2.4	2.4	3.1	4.0	5.0	5.4	6.1	7.8	9.2	12.8
1987	0.2	0.8	1.4	2.1	2.5	2.9	3.6	4.7	5.5	6.5	7.8	9.8	13.2
1988	0.3	0.9	1.1	2.0	3.1	4.0	4.4	4.7	5.2	5.6	8.6	10.4	13.3
1989	0.2	0.8	1.2	2.2	3.1	4.5	5.4	6.2	6.0	8.7	8.9	9.7	13.4
1990	0.1	0.9	1.1	2.1	2.4	3.8	4.9	6.0	5.7	6.0	7.4	9.1	12.6
1991	0.2	0.9	1.3	2.2	2.6	3.2	4.8	5.6	6.5	6.2	9.5	8.3	14.2
1992	0.1	0.7	1.3	1.9	2.8	3.7	4.9	5.8	7.0	8.2	9.8	12.4	14.0
1993	0.1	0.8	1.3	2.0	2.8	3.6	4.8	6.1	7.0	8.0	9.5	10.8	14.6
1994	0.2	1.1	1.7	2.2	2.9	3.5	4.9	6.2	6.8	7.5	9.7	10.7	12.7
1995	0.3	0.7	1.3	2.2	2.8	3.7	5.4	6.2	7.3	8.9	7.6	9.7	16.7
1996	0.1	1.0	1.5	2.3	3.2	4.5	6.4	7.1	7.8	9.2	9.3	10.1	13.7
1997	0.1	0.6	1.2	2.5	2.8	3.6	4.5	5.1	6.7	9.2	9.9	10.2	14.8
1998	0.4	0.8	1.2	1.6	2.2	2.9	4.7	5.7	6.8	7.0	7.8	9.9	11.9
1999	0.6	0.9	1.1	1.4	1.9	2.5	3.4	5.0	6.6	7.8	8.7	9.8	12.0
2000	0.4	0.6	1.1	1.5	2.0	2.8	3.9	5.1	7.1	7.4	9.7	10.7	13.6
2001	0.2	0.4	1.1	1.8	2.2	3.2	4.1	5.0	6.4	7.8	8.6	8.3	10.9
2002	0.1	0.3	1.1	1.5	2.2	3.2	4.2	5.5	6.0	7.6	9.1	9.7	11.5

Table 3. Comparison of 2001& 2002 Data Used to Develop Striped Bass Coastwide WAA.

STATE	2001			2002		
	SURVEYS	% WAA	% HARVEST	SURVEYS	% WAA	% HARVEST
ME	COMM (harv, discards)	1	1	X	0	2
NH	COMM (harv, discards)	3	1	REC	1	1
MA	COMBINED	74	16	COMBINED	32	20
RI	X	0	5	X	0	5
CT	X	0	3	X	0	3
NY	COMM & REC	6	13	COMM & REC	11	13
NJ	REC	10	23	REC	17	19
DE	COMM	<1	2	X	0	1
MD	X	0	17	COMM (C.BAY)	22	15
VA	COMM & REC	6	17	COMM & REC	17	19
NC	X	0	3	X	0	3

Table 4. Comparison of Average Striped Bass WAA (lb) for "Coastal" (MA, NY, NJ) and "Chesapeake Bay" (MD and VA) States, based 1982-1997 Values.

Age	Coastal	CBay	Δ
1	1.8		
2	1.9	2.3	-0.4
3	3.3	2.4	0.9
4	4.7	2.7	2.0
5	6.7	3.5	3.2
6	8.3	5.5	2.8
7	10.1	7.4	2.8
8	12.9	10.4	2.5
9	14.9	12.3	2.6
10	17.4	14.1	3.4
11	20.4	17.3	3.0
12	22.8	14.9	7.8
13	24.9	17.7	7.2
14	27.9	19.4	8.5
15	35.1	15.8	19.4

Table 5. Information Used to Calculate 1998-2002 Striped Bass Coastwide WAA.

REMOVAL	YEARS	HARVEST-AT-AGE	Pre-calculated WAA
NH Rec landings	98-02	supplied	used MA
NH Rec discards	98-02	supplied	used MA
MA Rec landings	98-02	supplied	supplied
MA Rec discards	98-02	supplied	supplied
MA Com landings	98-02	supplied	supplied
MA Com discards	98-02	supplied	supplied
RI Com landings	2002	supplied	used MA
RI Rec landings	2002	supplied	used MA
RI Rec discards	2002	supplied	used MA
CT Rec landings	98-02	GaryN CAA[3]	used MA
CT Rec discards	98-00,02	GaryN CAA[3]	used MA
NY all	98-00		
NY Com landings	01-02	01,02 Ann. Rpts.	01,02 Ann. Rpts.
NY Rec landings	01-02	01,02 Ann. Rpts.	01,02 Ann. Rpts.
NY Rec discards	01-02	01,02 Ann. Rpts.	01,02 Ann. Rpts.
NJ Rec landings	98-01		
NJ Rec discards	98-01	% of harvest #s[1]	% of harvest WAA[2]
NJ ALL	2002	supplied	supplied
Del Com landings	2002	GaryN CAA[3]	used NY
Del Rec landings	2002	GaryN CAA[3]	used NJ
MD Com landings	98-02	supplied	supplied
MD Rec landings	98-02		
MD Rec discards	98-02		
VA Com landings	98-00,02	GaryN CAA[3]	used MD
VA Rec landings	98-00,02	GaryN CAA[3]	used MD
VA Rec discards	98-00,02	GaryN CAA[3]	used MD
VA ALL	2001	GaryN CAA[3]	used MD

[1] (rec harvest-at-age)*(rec discard-at-age)/(total harvest)
[2] Ages 2-5: discard WAA = 0.8*harvest WAA, Ages 6+: discard WAA = 0.9*harvest WAA
[3] Coastwide summary CAA document supplied by Gary Nelson

Table 6. Removals Used to Calculate 1998-2002 Striped Bass Coastwide WAA.

1998	1999	2000	2001	2002
NH Rec landings NH Rec discards	NH Rec landings NH Rec discards	NH Rec landings NH Rec discards	NH Rec landings NH Rec discards	NH Rec landings NH Rec discards
MA Rec landings MA Rec discards MA Com landings MA Com discards	MA Rec landings MA Rec discards MA Com landings MA Com discards	MA Rec landings MA Rec discards MA Com landings MA Com discards	MA Rec landings MA Rec discards MA Com landings MA Com discards	MA Rec landings MA Rec discards MA Com landings MA Com discards
				RI Com landings RI Rec landings RI Rec discards
CT Rec landings CT Rec discards	CT Rec landings CT Rec discards	CT Rec landings CT Rec discards	CT Rec landings	CT Rec landings CT Rec discards
NY all	NY all	NY ALL	NY Com landings NY Rec landings NY Rec discards	NY Com landings NY Rec landings NY Rec discards
NJ Rec landings NJ Rec discards	NJ Rec landings NJ Rec discards	NJ Rec landings NJ Rec discards	NJ Rec landings NJ Rec discards	NJ ALL
				Del Com landings Del Rec landings
MD Com landings MD Rec landings MD Rec discards	MD Com landings MD Rec landings MD Rec discards	MD Com landings MD Rec landings MD Rec discards	MD Com landings MD Rec landings MD Rec discards	MD Com landings MD Rec landings MD Rec discards
VA Com landings VA Rec landings VA Rec discards	VA Com landings VA Rec landings VA Rec discards	VA Com landings VA Rec landings VA Rec discards	VA ALL	VA Com landings VA Rec landings VA Rec discards

[1] (rec harvest-at-age)*(rec discard-at-age)/(total harvest)
[2] Ages 2-5: discard WAA = 0.8*harvest WAA, Ages 6+: discard WAA = 0.9*harvest WAA
[3] Coastwide summary CAA document supplied by Gary Nelson

Table 7. Comparison of "Old" and "New", or Recalculated Striped Bass Coastwide WAA (kg) for 2000-2003.

	YEAR AGE	1	2	3	4	5	6	7	8	9	10	11	12	13/13+	14	15
OLD	**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
	MEAN 00-02	0.36	0.83	1.30	2.18	2.84	3.82	5.02	5.89	6.97	8.61	9.33	9.74	11.10	12.66	16.39
	Δ 2002 - 2001	0.69	0.19	0.08	-0.71	-0.34	-0.33	-0.35	0.41	-0.37	-1.72	-1.19	-1.35	-1.95	-3.46	-3.97
	Δ 2002 - 2000	0.68	-0.24	-0.22	-0.57	-0.76	-1.22	-2.23	-1.63	-1.45	-1.75	-0.56	-1.21	-1.37	-1.42	-3.35
NEW	**2000**	0.2	0.6	0.9	1.4	1.9	2.8	4	4.9	6.1	6	8.8	9.8	12.8		
	2001	0.1	0.4	0.8	1.7	2.2	3.2	4	5	5.9	7.2	8.1	7.4	10.6		
	2002	0.1	0.3	1.1	1.5	2.2	3.2	4.2	5.5	6.0	7.6	9.1	9.7	11.5		
	2003	0.1	0.6	1.0	1.4	2.2	3.2	4.1	5.2	6.1	7.2	8.5	9.4	11		
NEW VS. OLD	**Δ 2000(N) - 2000(O)**	0.06	-0.45	-0.57	-0.92	-1.33	-1.72	-2.39	-2.21	-1.71	-3.2	-0.51	-0.3	1.44		
	Δ 2001(N) - 2001(O)	-0.03	-0.22	-0.37	-0.76	-0.61	-0.43	-0.51	-0.07	-0.83	-1.97	-1.84	-2.84	-1.34		
	Δ 2002(N) - 2002(O)	-0.72	-0.51	-0.15	-0.25	-0.27	-0.10	0.04	0.02	-0.36	0.15	0.35	0.81	-0.16		
	MEAN 82-96	0.2	0.8	1.3	2.0	2.7	3.6	4.8	5.7	6.4	7.5	8.9	10.3	13.5		
	Δ 2003 - MEAN 82-96	-0.07	-0.17	-0.29	-0.58	-0.48	-0.43	-0.7	-0.53	-0.3	-0.32	-0.41	-0.94	-2.5		

Negative values emphasized by italics.

Appendix E. A Coastwide MRFSS Index

Methods

Generalized linear modelling (McCullagh and Nelder, 1989) was used to derive annual mean catch-per-hour estimates by adjusting the number of caught fish per trip for the classification variables of state, year, two-month sampling wave, number of days fished in the past 12 months (as a measure of avidity), and number of hours fished. In the analyses, I used only data from anglers who said they targeted striped bass to insure methods used among anglers are as consistent as possible and to identify those targeting anglers that did not catch striped bass (zero catches). Also, only data from private boats fishing in the Ocean during waves 3-6 from 1988 to 2004 were used.

A delta-lognormal model (Lo et al., 1992) was selected as the best approach to estimate year effects after examination of model dispersion (Terceiro, 2003) and standardized residual deviance versus linear predictor plots (McCullagh and Nelder, 1989). In the delta-lognormal model, catch data is decomposed into catch success/failure and positive catch components. Each component is analyzed separately using appropriate statistical techniques and then the statistical models are recombined to obtain estimates of the variable of interest. The catch success/failure was modelled as a binary response to the categorical variables using multiple logistic regression.

$$\log it(p) = \log(p/1-p) = \alpha + \sum_{i=1}^{n} \beta_i X_i + \varepsilon$$

where p is the probability of catching a fish, α is the intercept, β_i is the slope coefficient of the *i*th factor, X_i is the *i*th categorical variable (coded as 0 or 1), and ε is the error term. PROC LOGISTIC (SAS, 2000) was used to estimate parameters, and goodness-of-fit was assessed using concordance measures and the Hosmer-Lemeshow test (SAS, 2000).

Positive catches, transformed using the natural logarithm, were modelled assuming a normal error distribution using PROC GLM.

$$\log(y) = \alpha + \sum_{i=1}^{n} \beta_i X_i + \varepsilon$$

where *y* is the observed positive catch, β_i ,and X_i are the same symbols as defined earlier, and ε is the normal error term. Any variable not significant at α=0.05 with type-III (partial) sum of squares was dropped from the initial GLM model and the analysis was repeated. First-order interactions were considered in the initial analyses but it was not always possible to generate annual means by the least-square methods with some interactions included (see Searle et al., 1980); therefore, only main effects were considered.

The annual index of striped bass releases was estimated by combining the two component models. The estimate in year *i* from the models is given by

$$\hat{\mathbf{I}}_{\mathbf{i}} = \hat{\mathbf{p}}_{\mathbf{i}} * \hat{\mathbf{y}}_{\mathbf{i}}$$

where p_i and y_i are the predicted annual responses from the logistic and GLM. p_i is

$$\hat{\mathbf{p}}_{\mathbf{i}} = \frac{\exp(\hat{\alpha} + \hat{\beta}_{\mathbf{i}})}{1 + \exp(\hat{\alpha} + \hat{\beta}_{\mathbf{i}})}$$

calculated by

and y_i is calculated by

$$\hat{\mathbf{y}}_{\mathbf{i}} = \exp(\mathbf{LSM}_{\mathbf{i}} + \sigma^2 / 2)$$

where LSM_i is the least squares mean for year *i* and σ^2 is the mean square error.

Results

See Table 1 and 2 for the logistic and GLM outputs. Figure 1 is the index.

Gary Nelson
August 2005

Table 1. Logistic regression output .

The LOGISTIC Procedure

Model Information

Data Set	WORK.GREG
Response Variable	fish
Number of Response Levels	2
Model	binary logit

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

The LOGISTIC Procedure

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	39866.962	35611.685
SC	39875.252	35993.037
-2 Log L	39864.962	35519.685

R-Square 0.1372 Max-rescaled R-Square 0.1850

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	4345.2772	45	<.0001
Score	4036.5689	45	<.0001
Wald	3497.0463	45	<.0001

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
ST	10	1081.0620	<.0001
YEAR	16	978.3635	<.0001
WAVE	3	123.4292	<.0001
AREA_X	1	7.4265	0.0064
FFDAYS12	14	746.4967	<.0001
NUM_HRSF	1	1085.2290	<.0001

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.3372	21.2414	0.0040	0.9498
ST	9	1	12.2184	146.1	0.0070	0.9333
ST	10	1	-0.1587	21.2415	0.0001	0.9940
ST	23	1	-0.2962	21.2414	0.0002	0.9889
ST	24	1	-11.5237	155.7	0.0055	0.9410
ST	25	1	0.2298	21.2413	0.0001	0.9914
ST	33	1	-0.4359	21.2414	0.0004	0.9836

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The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
ST	34	1	-0.3430	21.2414	0.0003	

0.9871
0.9574
0.9759
0.9901
<.0001
<.0001
<.0001
<.0001
<.0001
<.0001
0.0992
<.0001
<.0001
<.0001
<.0001
<.0001
<.0001
<.0001
<.0001
0.0009
<.0001
0.1808
<.0001
0.0064
<.0001
<.0001
<.0001
<.0001
0.7484
0.1440
0.8193
0.0170
0.3849
0.6564
0.0004
0.0008
0.0006
0.2024
<.0001

ST	36	1	1.1345	21.2413	0.0029
ST	37	1	-0.6415	21.2415	0.0009
ST	44	1	-0.2648	21.2413	0.0002
YEAR	1988	1	-0.8334	0.1435	33.7481
YEAR	1989	1	-0.9190	0.1316	48.7483
YEAR	1990	1	-1.1577	0.1010	131.4949
YEAR	1991	1	-0.7938	0.0733	117.3083
YEAR	1992	1	-0.4884	0.0605	65.2007
YEAR	1993	1	-0.2823	0.0553	26.0993
YEAR	1994	1	0.0882	0.0535	2.7185
YEAR	1995	1	0.3101	0.0487	40.6102
YEAR	1996	1	0.4545	0.0477	90.6630
YEAR	1997	1	0.4584	0.0439	109.2775
YEAR	1998	1	0.6835	0.0448	233.1300
YEAR	1999	1	0.6541	0.0477	188.3026
YEAR	2000	1	0.6240	0.0507	151.3509
YEAR	2001	1	0.4612	0.0410	126.2967
YEAR	2002	1	0.4055	0.0505	64.4420
YEAR	2003	1	0.1549	0.0466	11.0659
WAVE	3	1	0.2164	0.0266	66.2843
WAVE	4	1	-0.0319	0.0238	1.7912
WAVE	5	1	-0.2054	0.0229	80.4647
AREA_X	1	1	0.0429	0.0157	7.4265
FFDAYS12	0	1	-0.8178	0.0422	375.0404
FFDAYS12	10	1	-0.6060	0.0451	180.4223
FFDAYS12	20	1	-0.3029	0.0449	45.4748
FFDAYS12	30	1	-0.2894	0.0499	33.6695
FFDAYS12	40	1	-0.0180	0.0560	0.1029
FFDAYS12	50	1	-0.0764	0.0523	2.1349
FFDAYS12	60	1	0.0158	0.0693	0.0522
FFDAYS12	70	1	0.1926	0.0807	5.6996
FFDAYS12	80	1	-0.0928	0.1068	0.7549
FFDAYS12	90	1	-0.0552	0.1240	0.1979
FFDAYS12	100	1	0.2013	0.0566	12.6289
FFDAYS12	150	1	0.3078	0.0919	11.2079
FFDAYS12	200	1	0.4412	0.1293	11.6511
FFDAYS12	250	1	0.3365	0.2639	1.6251
NUM_HRSF		1	0.2253	0.00684	1085.2290

Association of Predicted Probabilities and Observed

Responses

Percent Concordant	71.9	Somers' D	0.441
Percent Discordant	27.8	Gamma	0.442
Percent Tied	0.3	Tau-a	0.213
Pairs	209763914	c	0.720

Table 2. GLM output

The GLM Procedure

Class Level Information

Class	Levels	Values
YEAR	17	1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
WAVE	4	3 4 5 6
ST	11	9 10 23 24 25 33 34 36 37 44 51
AREA_X	2	1 2
MODE_FX	1	7
FFDAYS12	15	0 10 20 30 40 50 60 70 80 90 100 150 200 250 300

Number of Observations Read 12082
Number of Observations Used 12082

Dependent Variable: logtot

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	44	1090.02228	24.77323	32.74	<.0001
Error	12037	9108.70262	0.75673		
Corrected Total	12081	10198.72490			

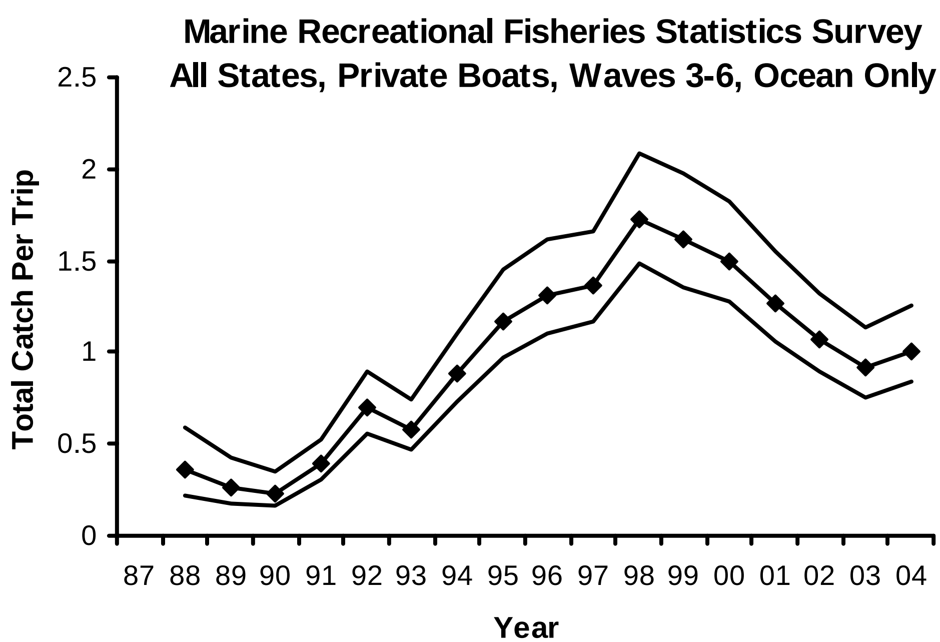
R-Square	Coeff Var	Root MSE	logtot Mean
0.106878	83.19786	0.869900	1.045579

Source	DF	Type I SS	Mean Square	F Value	Pr > F
ST	10	258.0235556	25.8023556	34.10	<.0001
YEAR	16	155.8872713	9.7429545	12.88	<.0001
WAVE	3	76.5444416	25.5148139	33.72	<.0001
FFDAYS12	14	288.3477562	20.5962683	27.22	<.0001
NUM_HRSF	1	311.2192537	311.2192537	411.27	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
ST	10	221.1009308	22.1100931	29.22	<.0001
YEAR	16	150.8842719	9.4302670	12.46	<.0001
WAVE	3	73.8469641	24.6156547	32.53	<.0001
FFDAYS12	14	291.5233657	20.8230976	27.52	<.0001
NUM_HRSF	1	311.2192537	311.2192537	411.27	<.0001

The GLM Procedure
Least Squares Means

YEAR	logtot LSMEAN	Standard Error	Pr > |t|
1988	0.87115273	0.12364562	<.0001
1989	0.64504701	0.11751929	<.0001
1990	0.73978321	0.09831961	<.0001
1991	0.92486174	0.07810480	<.0001
1992	1.22925291	0.07121558	<.0001
1993	0.87196348	0.06831894	<.0001
1994	0.99212787	0.06668443	<.0001
1995	1.10485998	0.06469854	<.0001
1996	1.11781190	0.06316001	<.0001
1997	1.15689303	0.06223858	<.0001
1998	1.23720682	0.06133543	<.0001
1999	1.18550815	0.06266735	<.0001
2000	1.13429729	0.06397751	<.0001
2001	1.07562958	0.06191667	<.0001
2002	0.94729993	0.06493991	<.0001
2003	0.97453148	0.06407868	<.0001
2004	1.05500478	0.06371743	<.0001



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