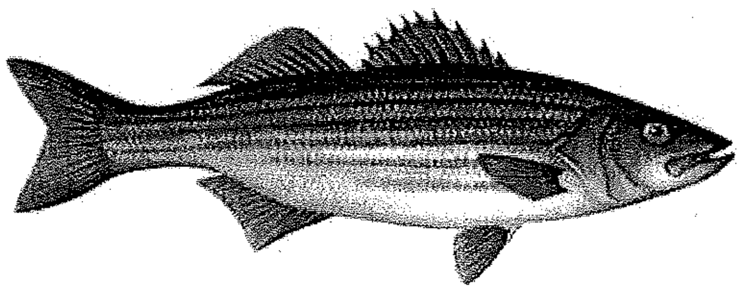
2005 Stock Assessment Report for Atlantic Striped Bass:

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

November 2005

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 54.8 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.

Atlantic States Marine Fisheries Commission

2004 Catch -Age Based Virtual Population Analyses

for

Atlantic Striped Bass

A report prepared by the
Striped Bass Stock Assessment Subcommittee
for the
Striped Bass Technical Committee's Approval

October 20, 2005

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.

Catch at Age

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. State specific age-length keys were applied, where possible, to length frequencies to estimate number of fish at age landed by the recreational fishery. Age composition of the recreational discards was estimated using lengths available from volunteer angler logbooks and American Littoral Society data. State specific methods for estimating age composition of commercial landings, recreational landings, and recreational discards are provided in individual state compliance report to ASMFC for 2004 and are 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 (19%) and ages 3-8 comprised 74% of the harvest (Table 4). Most (74%) 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). The commercial catch 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 1). Landings decreased slightly compared to 2003 (Table 1). 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, Figure 1) 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, Figure 1). 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

Data inputs and model configuration

- 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.

ADPT 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.

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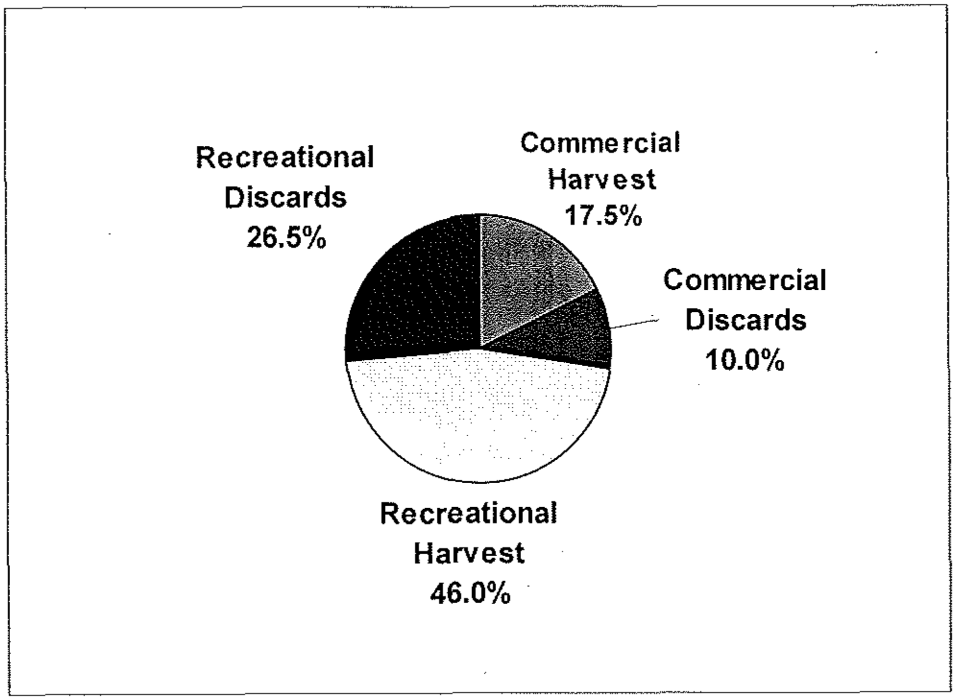


Figure 1. Proportions of 2004 striped bass mortalities by fishery component.

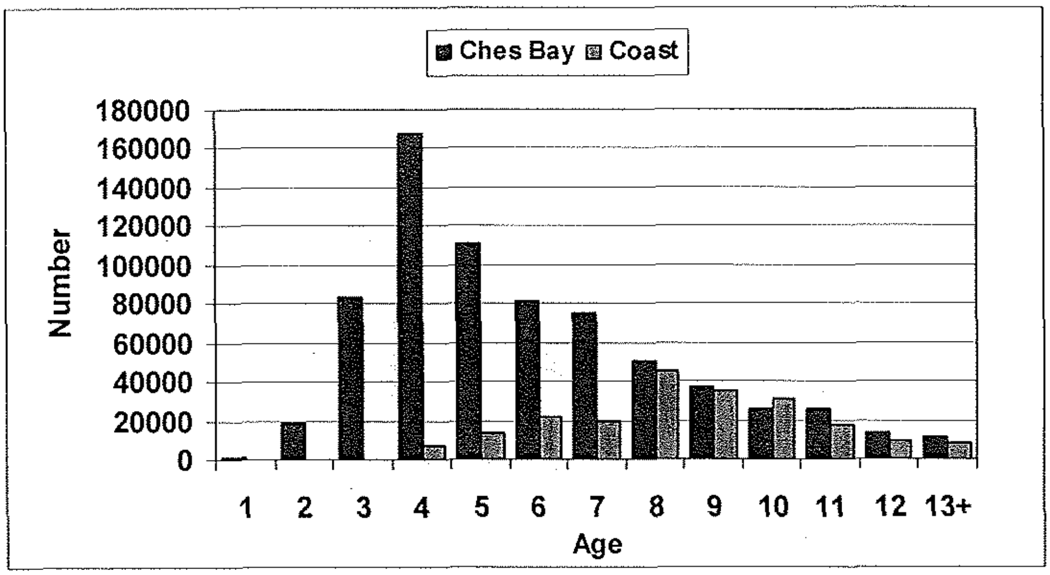


Figure 2. Commercial harvest of striped bass at age in Chesapeake Bay and in non-Bay states in 2004.

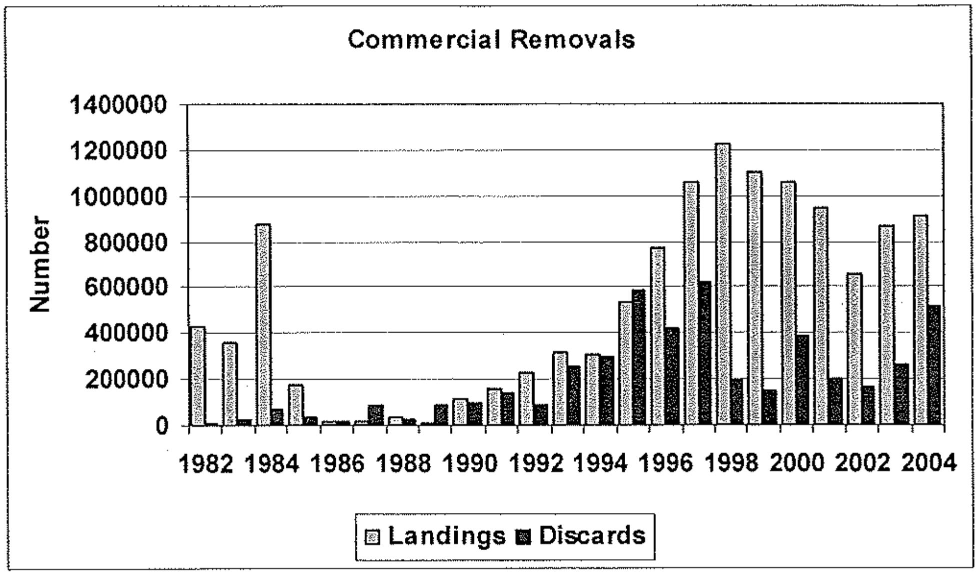


Figure 3. Commercial removals of Atlantic striped bass, 1982-2004.

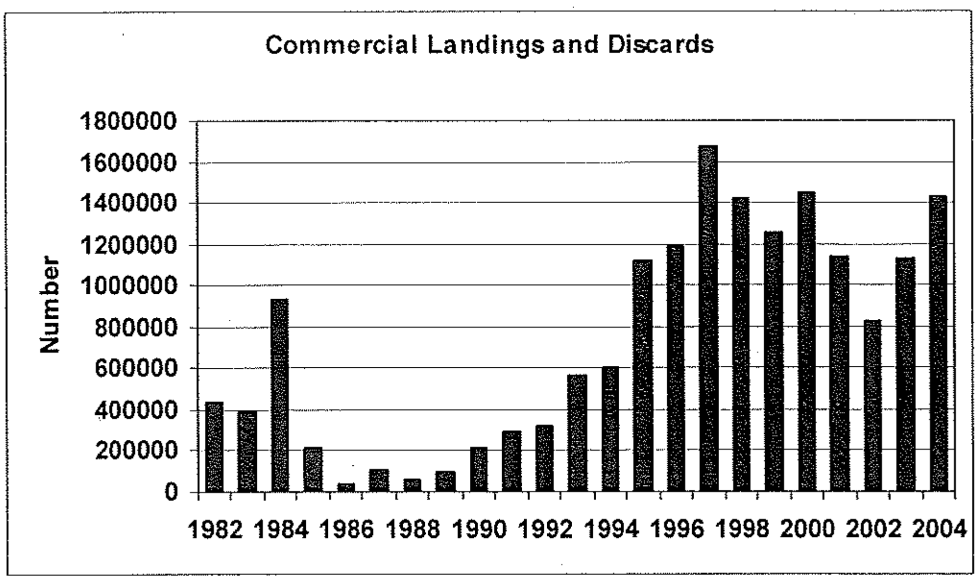


Figure 4. Total commercial removals of Atlantic striped bass (landings and discards), 1982-2004.

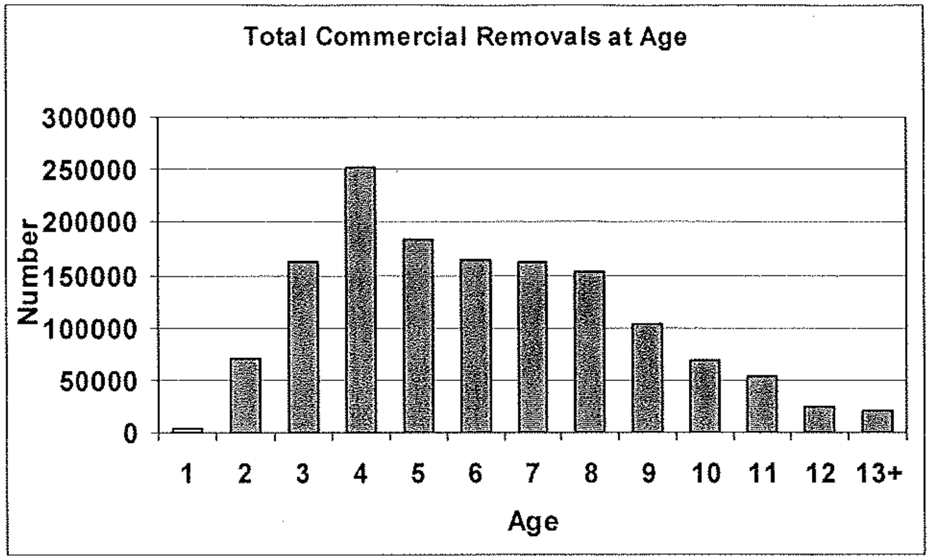


Figure 5. Total commercial removals at age in 2004.

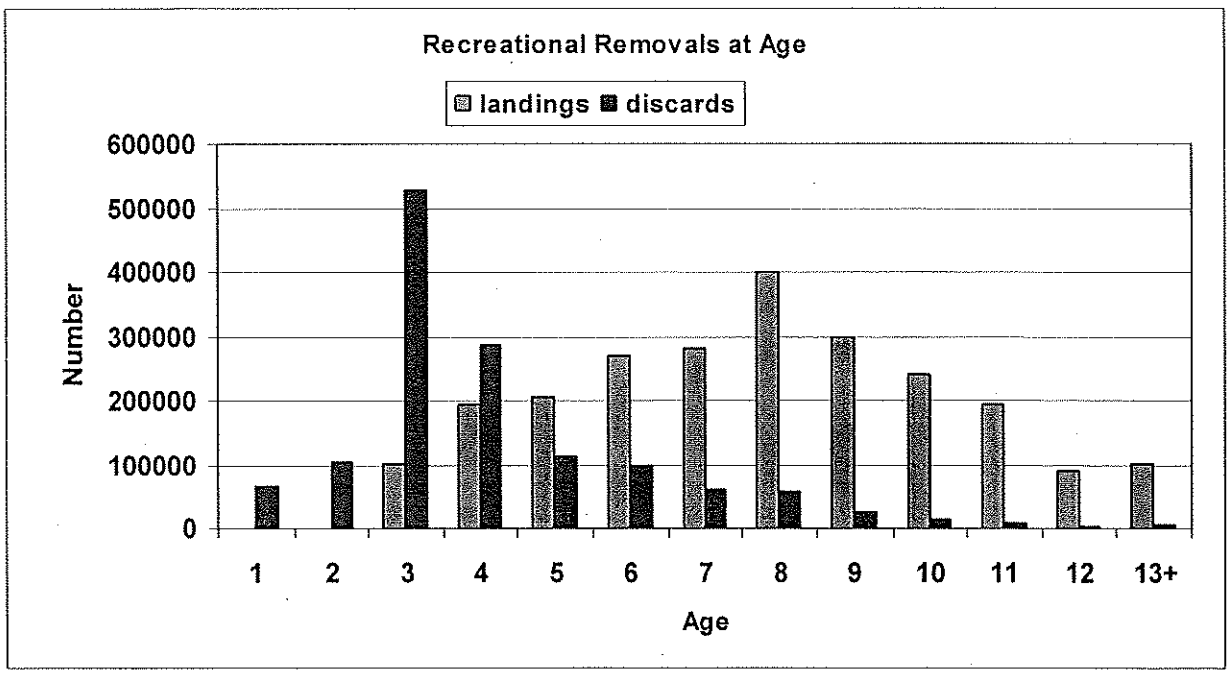


Figure 6. Recreational removals (landings and discard) of Atlantic striped bass at age in 2004.

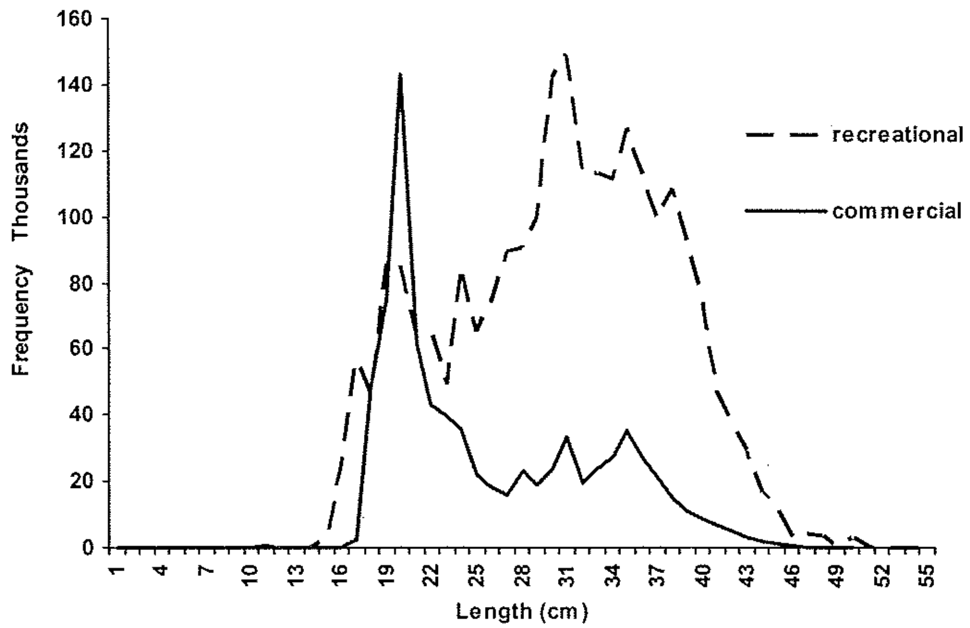


Figure 7. Length composition of total recreational and commercial striped bass landings, 2004.

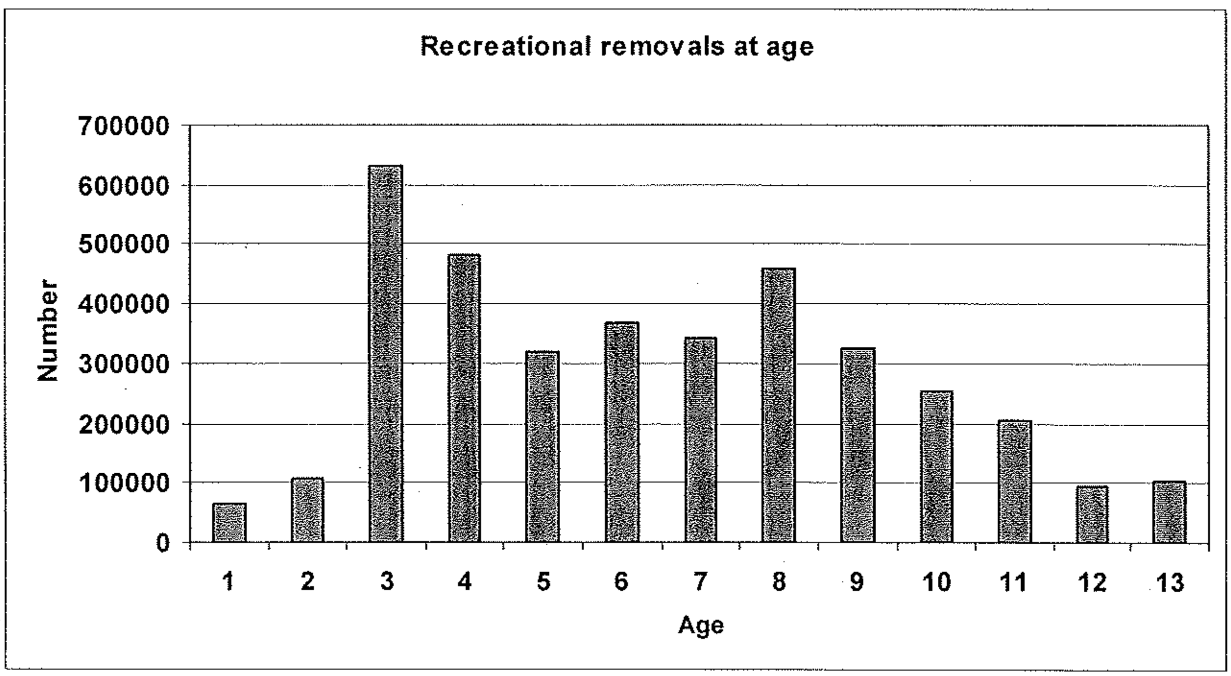


Figure 8. Total Recreational removals at age of Atlantic striped bass in 2004.

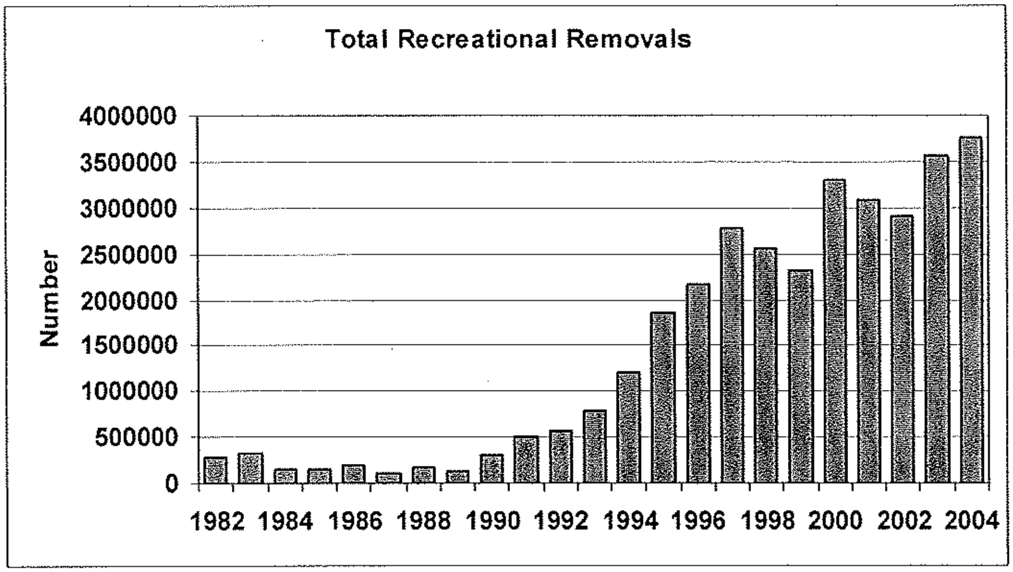


Figure 9. Total recreational removals of Atlantic striped bass (landings and discards), 1982-2004.

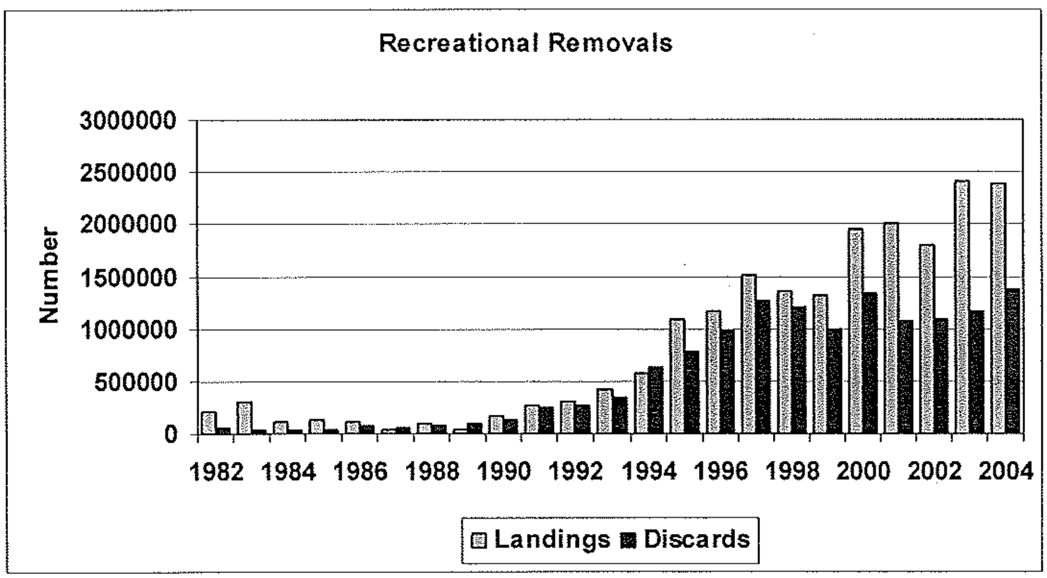


Figure 10. Recreational removals of Atlantic striped bass, 1982-2004

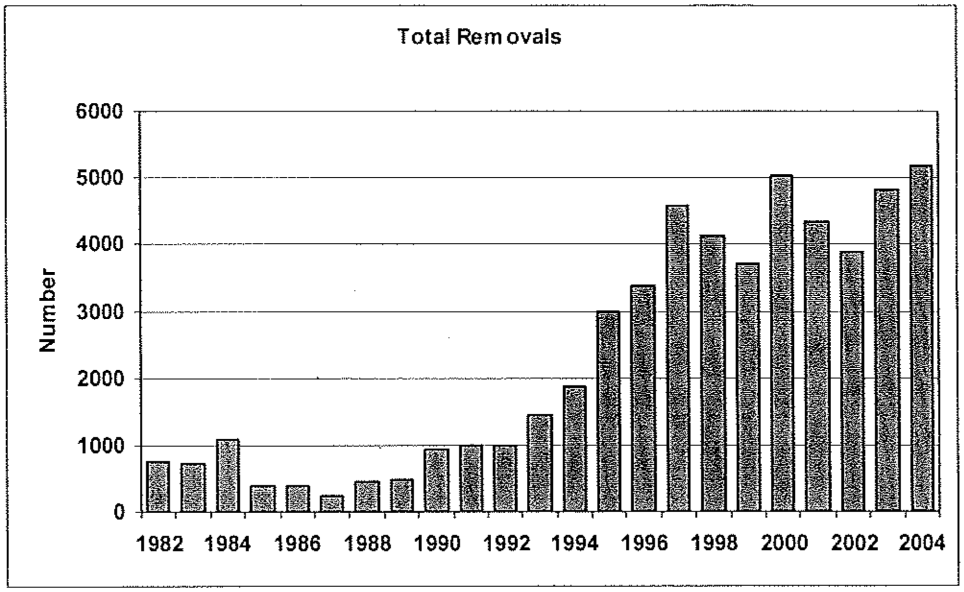


Figure 11. Recreational and commercial removals (landings and discard) in number of Atlantic striped bass, 1982 - 2004.

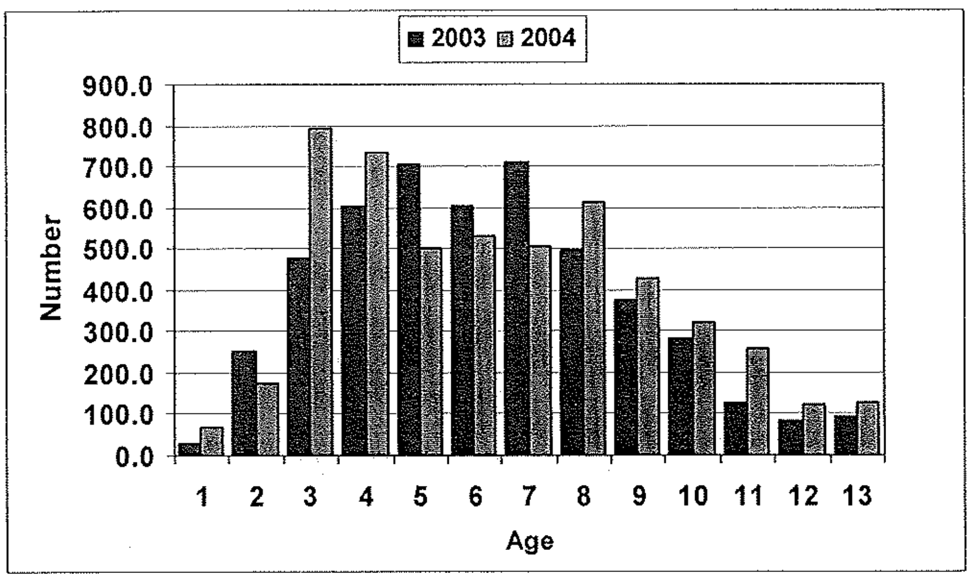


Figure 12. Recreational and commercial removals (landings and discard) at age in number in 2003 and 2004.

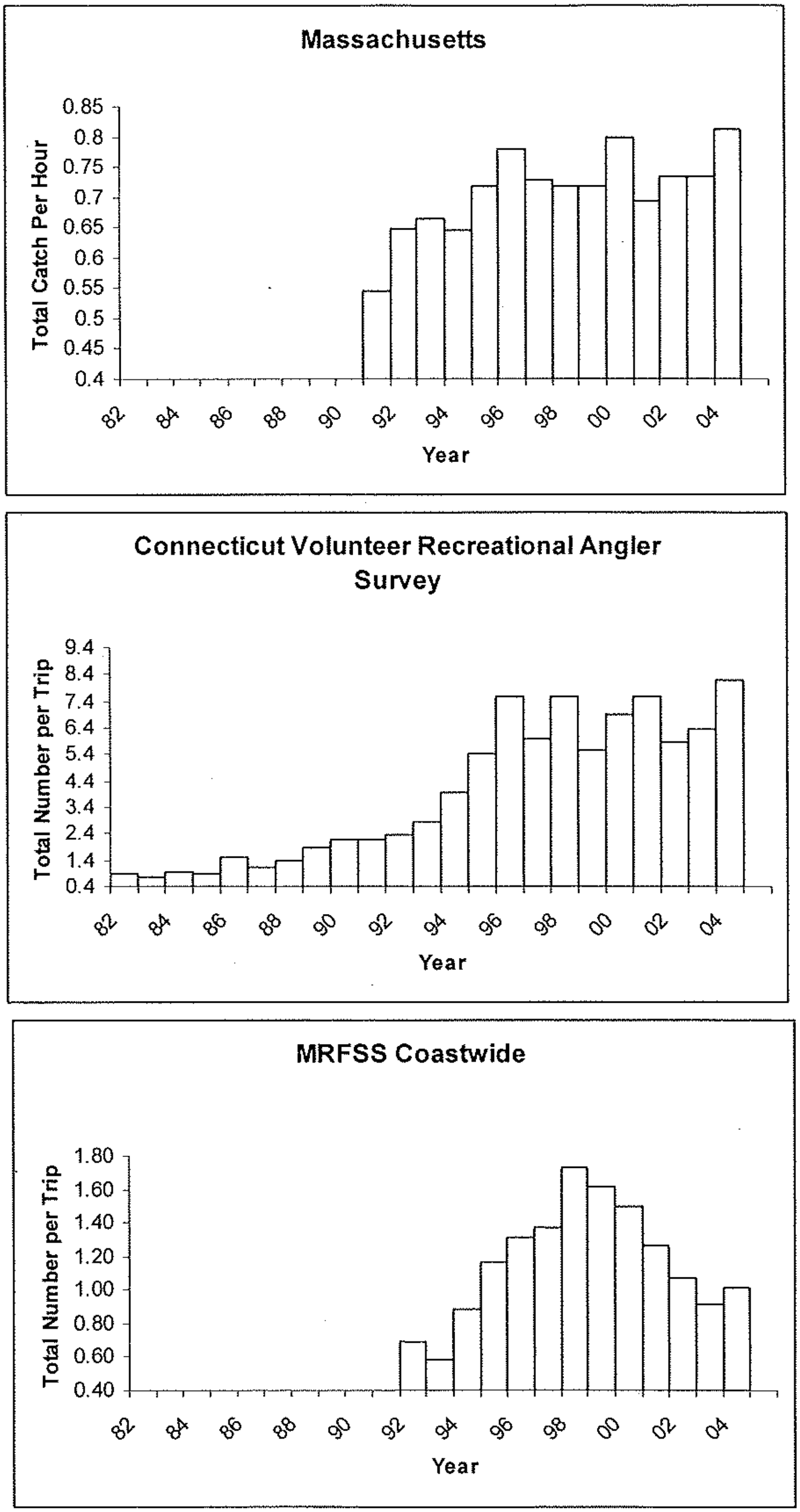


Figure 13. Fishery-dependent striped bass indices, combined ages.

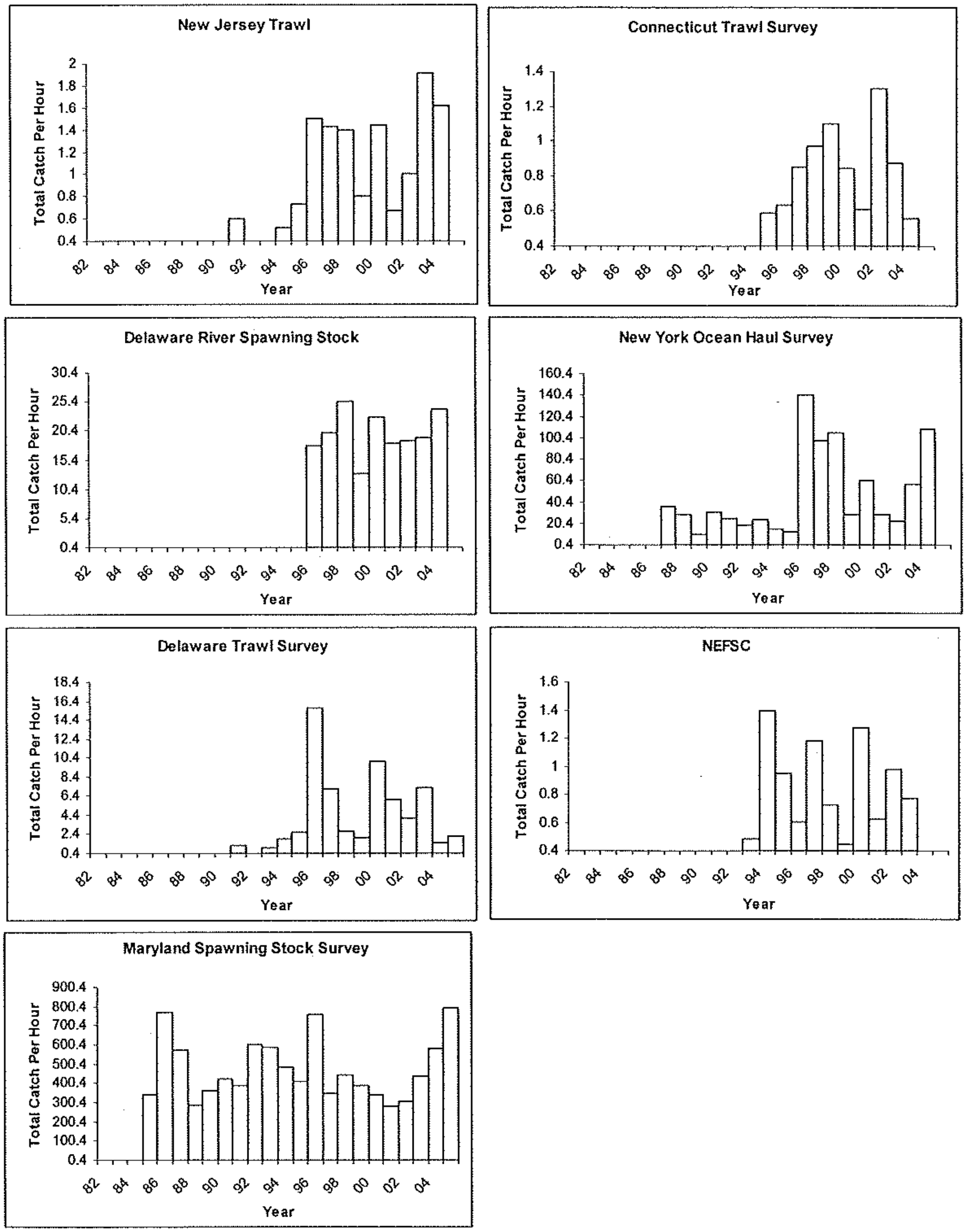


Figure 14. Fishery-independent surveys of striped bass abundance, combined ages.

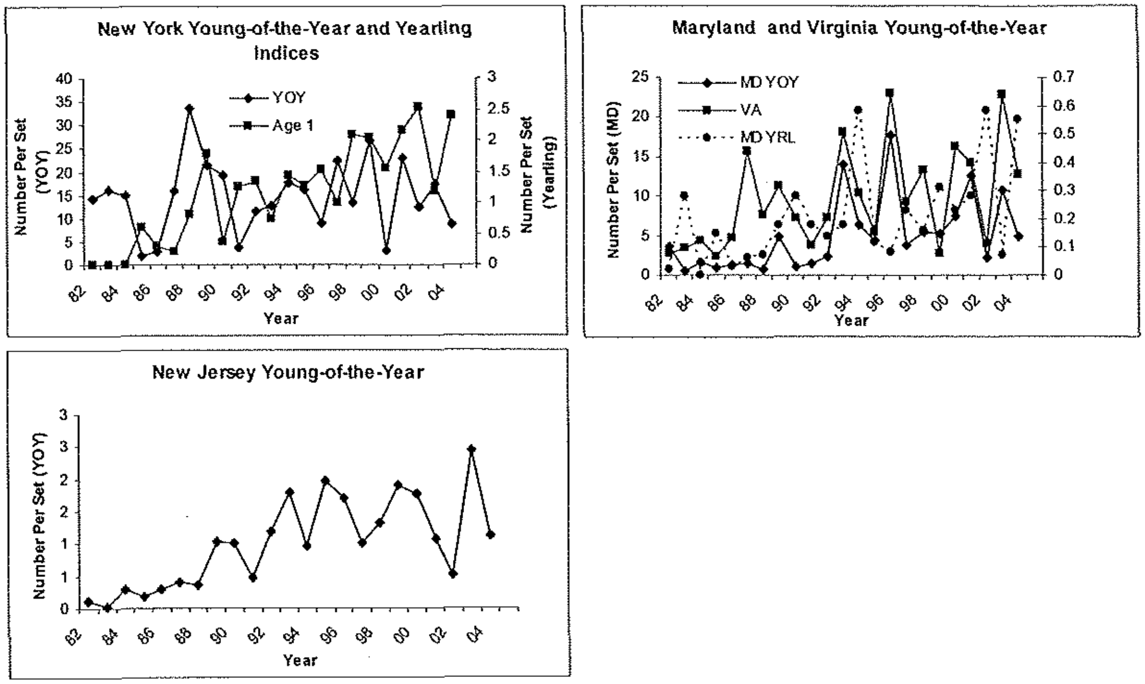


Figure 15. Young-of-the-year and yearling indices, 1982-2004.

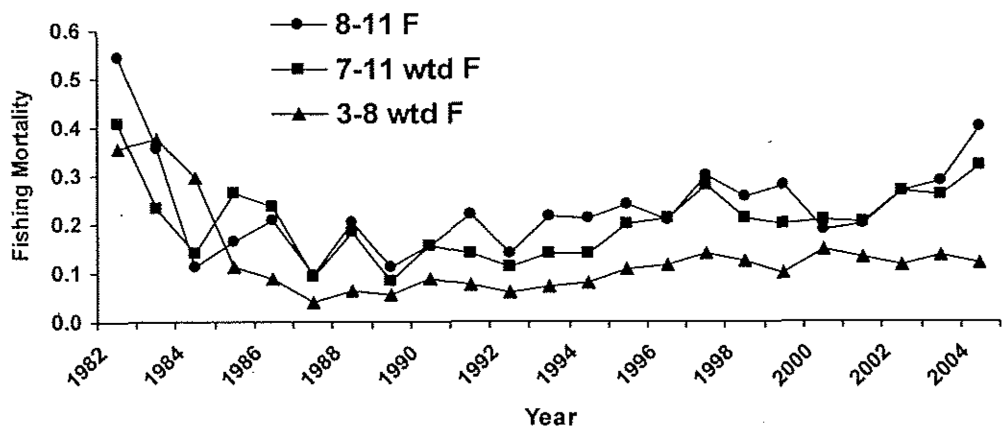


Figure 16. Striped bass fishing mortality estimates from ADAPT model.

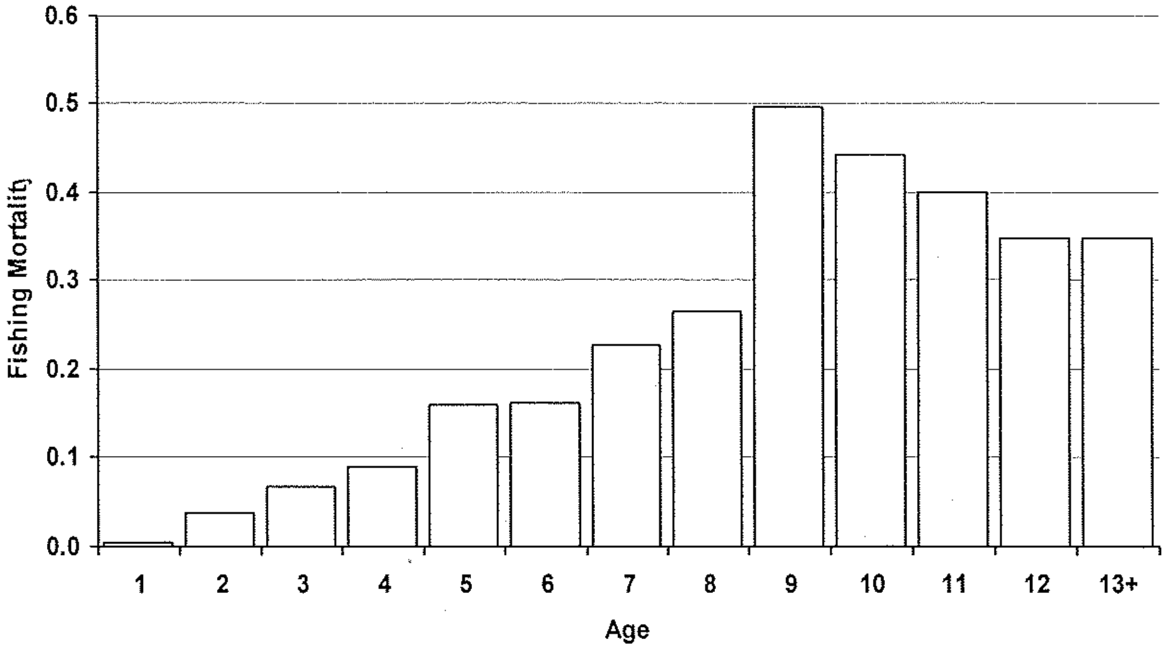


Figure 17. 2004 Fishing mortality at age estimated from ADAPT VPA.

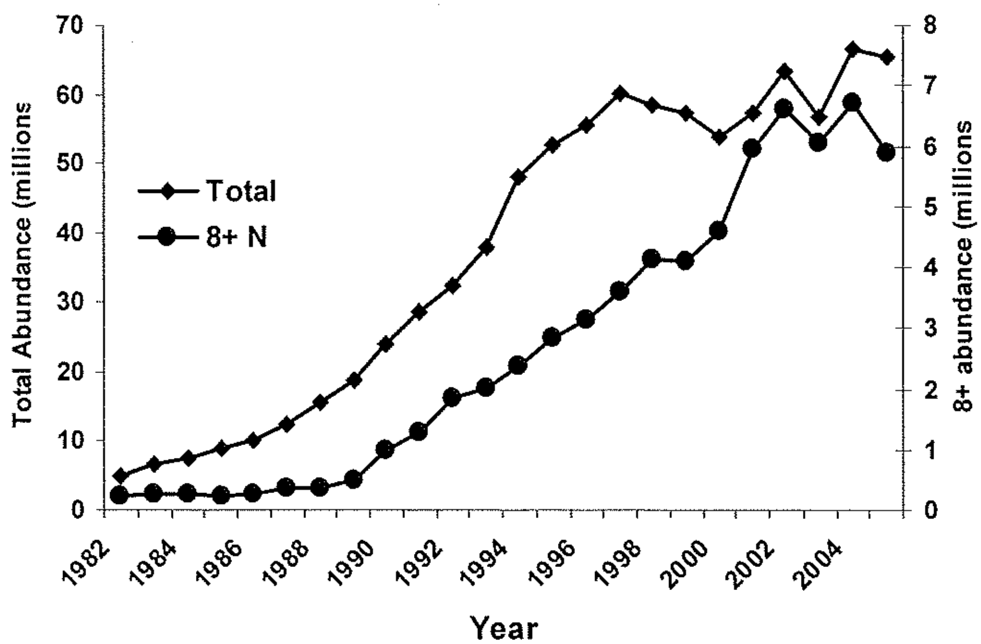


Figure 18. Striped bass population abundance estimates from 2004 ADAPT model

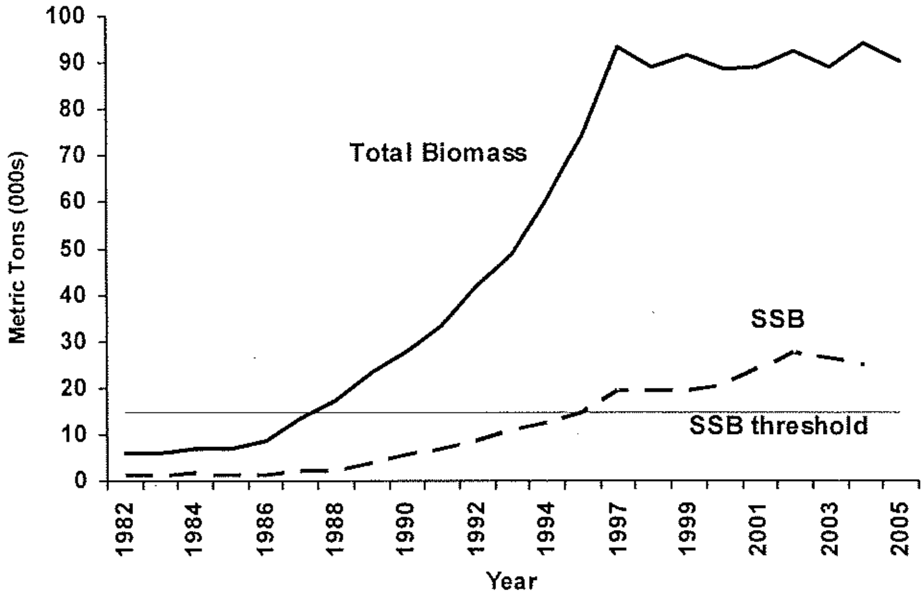
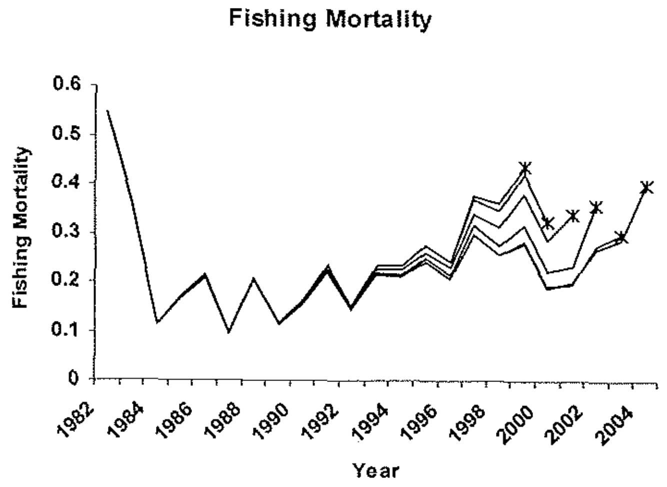


Figure 19. Striped bass female spawning stock biomass (000s mt) and Jan. 1 total biomass (000s mt) from 2004 assessment.



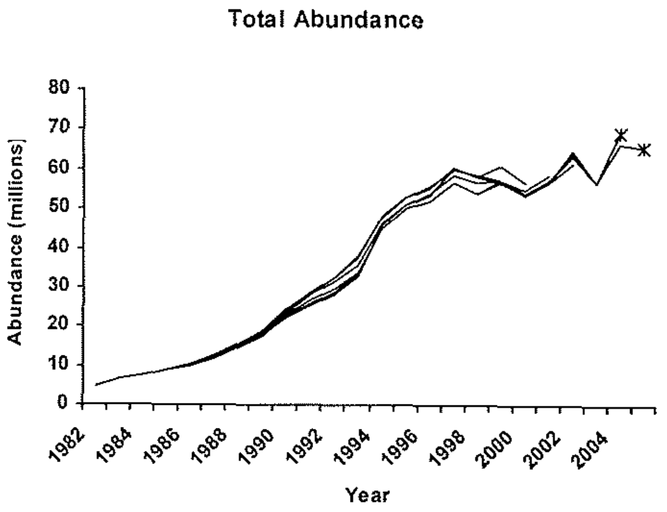
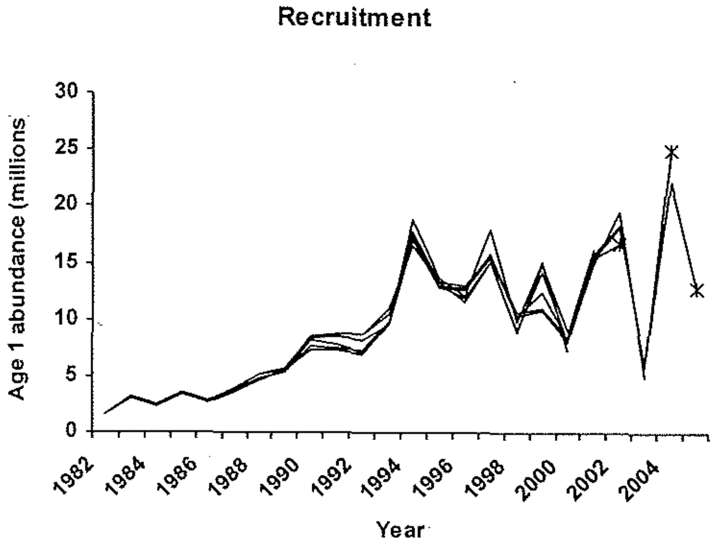


Figure 20. Retrospective analysis of fishing mortality and abundance from the 2004 striped bass VPA.



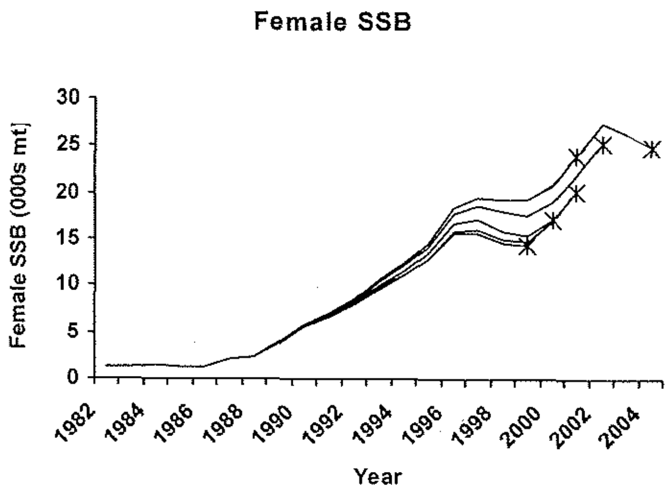
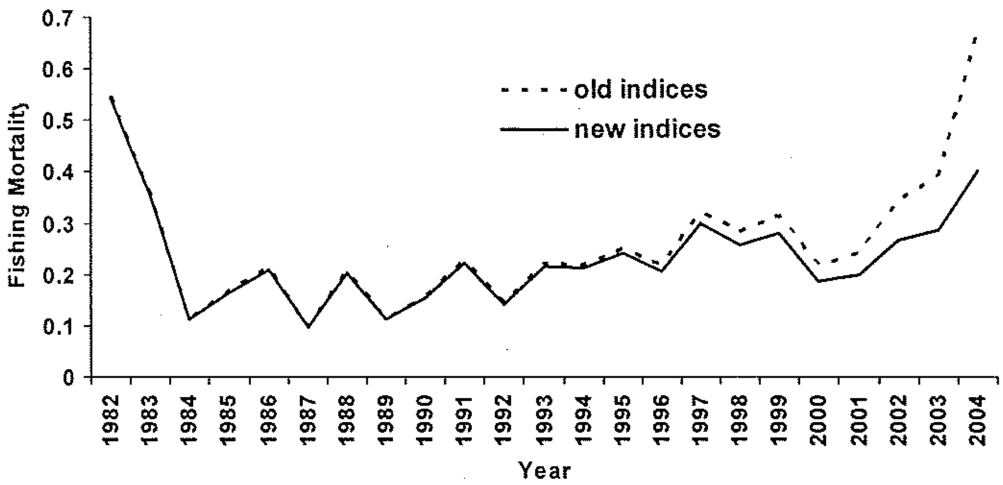


Figure 21. Retrospective analysis of recruitment and female SSB from the 2004 striped bass VPA.

Fishing Mortality



8+ Abundance

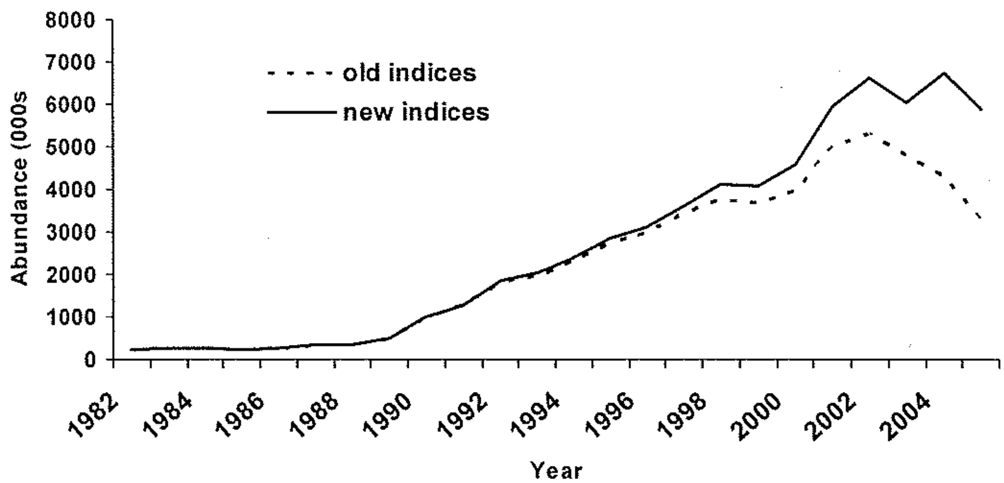


Figure 22. Differences in assessment results resulting from changes in tuning indices used in VPA. Old indices as used in 2004 assessment. New indices as used in 2005 assessment.