2004 Stock Assessment Report for Atlantic Striped Bass:

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

SBTC Report #2004-4

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

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

2004 Atlantic Striped Bass Advisory Report

State of the Stock

Stock Size: The estimate of total abundance for January 1, 2004 is 56.7 million age-1 and older fish due to the strong 2003 year-class. This estimate is about 11 million fish higher than the average stock size for the previous five years and 23.8% higher than the 2003 abundance.

Spawning Stock Biomass (SSB): The female spawning stock biomass for 2003 is estimated at 30 million pounds which is above the recommended biomass threshold of 28 millions pounds (12,726 mt). However, most TC members expressed concern over the current estimates spawning stock biomass and, hence, the conclusions derived from these estimates.

Recruitment: Recruitment of the 2003 cohort for all stocks combined is 21.6 million age-1 fish and is the highest observed in the time series. Preliminary survey indices for young-of-the-year striped bass for 2004 in Chesapeake Bay indicate that the 2004 year-class is of average strength.

Fishing Mortality Rates: Based on VPA results**,** average age 8-11 fishing mortality in 2003 is estimated at F=0.62 (a 77% increase compared to 2002) and exceeds the Amendment 6 target of 0.30, and above the threshold of 0.41. However, all technical committee members expressed concern over the terminal year estimate of F from the VPA and, hence, the conclusions derived from this estimate.

Based on spawning area tagging programs, stock-specific, model-based estimates of fishing mortality in 2003, for fish greater than twenty-eight inches total length, were 0.40 for the Maryland portion of the Chesapeake Bay; 0.28 for the Rappahannock River; 0.28 for the Delaware River, and 0.09 for the Hudson River. Based on coastal tagging programs, fishing mortality estimates ranged from 0.09 for MA to 0.24 for the New York Ocean Haul Seine. The tag-based F estimates were not similar to the F (N-weighted) estimates (F in 2003 = 0.53) produced in the VPA and did not show an increase in F for 2004 (except for Maryland).

Chesapeake Bay fishing mortality in 2003 is estimated at F=0.20 by the direct enumeration study. This F represents mortality during the June 2002 – June 2003 period, so it is not directly comparable to the average, weighted (by N) VPA calendar-year F on age 3-8 striped bass equal to 0.18.

Exploitation Rates: Based on the tagging programs, R/M estimates produced by 3 (New York Ocean Haul Seine, Delaware River, Maryland/Chesapeake Bay) out of 8 programs were generally similar in magnitude to the exploitation rates derived using F estimates from the current ADAPT assessment for years 1990-1999. However since 2000, the R/M estimates have declined, indicating exploitation has decreased.

Catch: Total catch in numbers including landings and discards increased from 3.7 million fish in 2002 to 4.7 million fish in 2003, a 26.3 % rise losses. The 2003 catch was above the 1996-2003 average of 4.0 million. Ages 3 to 7 represented 64%, and ages 8+ represented 30% of the total catch in 2003. The 1998 and 1996 year-classes dominated the catch, accounting for 29% of total catch. Total catch of age 8+ fish increased from 926 thousand fish in 2002 to 1.4 million fish in 2003 (the highest level recorded in the time series) and the proportion of 8+ fish in the catch increased to 30% in 2003 from 25% in 2002.

Recreational harvest (2.4 million fish) and discards (1.2 million fish) accounted for 76% of the total 2003 catch. Maryland recreational fisheries harvested 21.8% of total recreational landings, followed by MA (16.9%), VA (16.7%), NJ (16.3%), and NY (13%). The remaining states each landed 5% or less of the total recreational landings.

Commercial harvest (0.86 million fish) and discards (0.27 million fish) accounted for 24% of the total 2003 catch. Maryland commercial fisheries harvested 50.8% of the total commercial landings, followed by VA (18.7%), PRFC (9.6%), NY (7.9%), and MA (6.4%). The remaining states each landed 4% or less of the total commercial landings.

Data and Uncertainty: No new data sources are included in this year's assessment. Tuning indices are similar to those used in past years, with some minor adjustments to the age-specific indices (Maryland SSN, Massachusetts, and NEFSC).

The Technical Committee expressed great concern over the divergent patterns in F observed among the VPA and tag-based programs and believes that both methods need to be further scrutinized to reconcile the differences. Violation of the model assumptions is the primary reason believed to have created the model differences, and these are discussed below.

Some members of the Technical Committee were concerned that the VPA is not adequately robust when dealing with a mixed stock such as coastal striped bass. In addition, the survey indices used in the tuning process of the VPA may not be providing accurate trend estimates for older fish due to the surveys' abilities to track the striped bass abundance as the population abundance has potentially plateaued in recent years. Some members of the Technical Committee were concerned that the distribution of larger striped bass may have shifted to offshore waters as the population has increased in abundance. Since the EEZ is closed to harvest and there is limited fishery independent survey data for older striped bass beyond state waters, these fish may not be fully represented in the assessment. However, other TC members suggest this may not be an issue since MD and VA spawning ground surveys provide relative abundance data on these larger fish when they have migrated from the EEZ to the spawning grounds in the spring. Other methods that are capable of directly accounting for mixed stock management units should be explored in the future and self-evaluation of surveys by each state should be performed, following recommendation made by the VPA indices workshop.

Other members expressed concern that there is considerable error in the catch produced by the MRFSS survey in 2003. Some states did not believe that the increased harvest in some waves was real because the trend contradicted independent observations on fishing effort (hurricanes interrupted angling in 2003) and angler opinions. However, some states could account for the increases in harvest. Other members expressed concern that the estimates of harvest are underestimates because the winter fisheries in North Carolina and Virginia are not being taken into account. It is recommended by the TC that, at least, MRFSS survey in NC should be expanded into wave 1 to account for winter fisheries' harvest. Due to error in MRFSS catch estimates, the TC also recommends that some statistical catch-at-age models that be explored that could incorporate error and tagging information.

Some members were also concerned that the tag based estimates of survival among coastal programs were so variable and that the estimates changed considerably depending on the year reported. It is possible that the assumption of mixing and dispersal is not being adequately met to provide a comprehensive estimate of mortality. If such assumptions are violated, the estimates could change in trend and magnitude. Others questioned whether the reporting rate derived by DE and used by all states is accurate. Since reporting rate is an important variable used in tagging model and R/M estimates, the TC recommends that a high-reward, coast-wide tagging study be conducted in the future. In addition, more analyses to examine the violation of assumption in the tagging models should be conducted.

Some Technical Committee members believed it is time to notify the Board that there appears to be a problem with increasing natural mortality in Chesapeake Bay. Des Kahn, Vic Crecco, and John Hoenig presented analyses that showed an increase in natural mortality on younger individuals, which is concurrent with the incidence of mycobacterial disease. Several members agreed that the TC should tell the Board that there is some statistical evidence for an increase, but that not all empirical data (e.g., landings in Chesapeake Bay have increased despite supposed rise in M) supports the results of the model estimates. The TC could not resolve any plan of attack to address this issue, but recommends that it be further addressed over the next few months via email discussions.

Management Advice

Most striped bass technical committee members expressed concern over the current terminal estimates of F and spawning stock biomass from the VPA and, hence, the conclusions derived from these estimates. Most members agreed that the landings increased in 2003 compared to 2002 (some states liberalized regulations), and fishing mortality has probably increased compared to 2002, but they are skeptical that the F estimate from the VPA doubled. Since the 2003 F is a terminal year estimate and it has the highest error, most members believe that the F estimate produced by the ADAPT model will likely decrease when the stock assessment is updated in 2005, given the current retrospective pattern. Based on the ADAPT VPA estimates, the technical committee cannot say with certainty that overfishing is not occurring and that the population is not overfished. However, since since harvest increased compared to 2002, and the F estimates have been over the target since 1997, there is certainty that the target is still being exceeded. Until the uncertainties and divergences between the VPA and tag-based models are more fully investigated, the technical committee recommends that no liberalization of regulations occur at this time.

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I. Introduction

This report summarizes results of catch-age based virtual population analyses (VPA) of Atlantic striped bass for 2003. The VPA analysis provides estimates of fishing mortality, stock abundance, and biomass for the mixed coastal stock.

II. Catch-at-Age VPA Analysis

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. This report adds the 2003 catch and survey data and includes assessments using ADAPT.

Data Summary

The catch-at-age matrix was assembled 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 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.

Commercial Fishery in 2003

Commercial landings in 2003 totaled 866 thousand fish or 3,199 mt (7,053,795 lbs) (Table 1). Landings increased 32.4% in numbers (212 thousand fish) and 17.5% in weight (476 mt) compared to 2002. This increase was primarily due to increased harvest in the Chesapeake Region (Maryland, PRFC, and Virginia). These jurisdictions accounted for 79% by number (Table 2) and 61% by weight of the commercial harvest in 2003. However, harvest increased in all coastal states with commercial fisheries except North Carolina (Table 2). Overall, commercial harvest represented 18% of total losses in number in 2003 (Table 3, Figure 1). More than half of the commercial landings (53%) were comprised of fish ages 4-6 (Table 4). Ages 3-8 comprised 79% of the harvest. Most (60%) of the Chesapeake Bay harvest was ages four through six (Table 5). Most coastal harvest (84%) was ages 5-10.

Direct measurements of commercial discards of striped bass are only available for fisheries in the Hudson River Estuary and Delaware Bay and River. For fisheries in all other locations, discard estimates since 1982 have been 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:

$$\mathbf{CD = RD*(CT/RT)}$$

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 are multiplied by gear specific release mortalities and summed to estimate total number of fish killed in a given year. 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. The ratio of tags from fish discarded by commercial fishermen to tags returned from fish discarded by recreational fishermen in 2003 was 0.28 in Chesapeake Bay and 0.02 along the coast (ME - NC). Tag return data and release mortality by gear for 2003 are given in 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 7). 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 two fisheries. The correction factors for 2003 were 1.30 for Chesapeake Bay and 1.59 for the coast (Table 7).

In summary, commercial discard losses were calculated for all fisheries excluding those in the Hudson and Delaware Rivers by multiplying recreational discards by the commercial/recreational tag ratio from discarded fish, then by the corresponding correction factor, and finally by appropriate gear specific discard mortalities. Total commercial discards losses for 2003 were estimated as 262,078 fish, representing 5.6 % of total removals in number (Table 3, Figure 1).

Commercial discard proportions at age were obtained by applying age distributions from fishery dependent sampling or independent surveys using comparable gear. These proportions at age were applied to discard estimates by gear and expanded estimates summed across all gears. Total commercial discards were dominated by fish of ages 4-5 (Table 8).

Total commercial striped bass losses (landings and discards) were 1.13 million fish in 2003. Although total losses in 2003 exceeded those in 2002, annual commercial losses, in terms of numbers of fish, have generally declined since a high in 1997 (Figure 2). Landings have generally exceeded discards since the mid 1990's (Figure 3). Age five (1998 year class) sustained the highest commercial losses in 2003 (Figure 4).

Recreational Fishery in 2003

Recreational statistics were collected as part of the MRFSS (Marine Recreational Fishery Statistics Survey) program. Details of the assessment methodology can be found on the MRFSS web site (http://www.st.nmfs.gov/st1/recreational/the_mrfss.html). Landings (A+B1) in 2003 were estimated at 2.4 million fish totaling 11,486 mt (25.33 million pounds) (Table 1). Landings increased by 600,432 fish (33.3 %) or 3237 mt (39.2 %) compared to 2002 (Table 1). Overall, recreational harvest represented 51.2 % by number of all losses (Table 3, Figure 1). Striped bass ages five through nine comprised 71% of landings (Table 9). Highest landings occurred for age seven (1996 year class) which made up 19.4 % of the total (Figure 5). The states landing the largest proportion were Massachusetts, New York, New Jersey, Maryland, and Virginia (Table 9). Landings in Maryland made up 21.8 % of the total and were the highest of all states.

Recreational discards (B2) increased in 2003 to 14.6 million fish (Table 3, Figure 1) compared to 13.8 million fish in 2002. Application of an 8% hooking mortality rate resulted in estimated losses of 1.2 million fish (Table 3, Figure 1). The states with the largest proportion of the overall discards were Massachusetts and Maryland (Table 10). Recreational discard losses represented 25% by number of total losses (Table 3). The 2000 year class (Age 3) had highest numbers discarded among all cohorts in 2003 (Figure 5)

Total recreational striped bass losses (landings and discard losses) in 2003 were 3.57 million fish. The catch was dominated by ages 3-8 (73% of total) (Figure 6). Total recreational discard and landings losses have generally increased since 1982, with intermittent declines in 1998-1999 and 2001-2002 (Figure 7). Recreational losses in 2003 were the highest of the time series. The proportion of recreational losses caused by discards has generally decreased since the mid 1990's (Figure 8).

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 loss of striped bass in 2003 was 4.7 million fish, an increase from 3.6 million fish in 2002 and 4.3 million fish in 2001. These changes reflect a 26.3 % and 8.3 % increase over 2002 and 2001, respectively. More importantly, losses of fish age eight and older in 2003 were a 51.1% and a 39.4 % increase over losses of age eight and older fish in 2002 and 2001. Total losses in 2003 were the second highest since 1982 (Figure 9). The increase in harvest from 2002 was spread among all age classes with the exception of age six as the 1996 year class shifted from age six to age seven (Figure 10). Ages 5 (1998 year class) and 7 (1996 year class) sustained the highest losses in 2003.

Weight at Age

Weight at age information was updated for the period 1997-2003. Mean weights at age for the 2003 striped bass catch were determined 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. The estimated weights at age for 1999 were applied to 1997 and 1998 where weight data were unavailable. Details of developing weights at age for 1982 to 1996 can be found in NEFSC Lab Ref. 98-03. Weights at age for 1982-2003 are presented in Table 13.

Survey Indices

Striped bass indices of abundances were available from fisheries independent and fisheries dependent sources. Multiple age fishery independent surveys were the Maryland gillnet survey of the spawning population (ages 2-13+), Virginia pound net CPUE (ages 2-13+), New York ocean haul seine (ages 3-13+), NEFSC spring inshore survey (ages 3-13+), and three age-aggregated trawl indices from Connecticut (ages 2-6), New Jersey (ages 2+) and Delaware (ages 2-7). Multiple age fishery dependent surveys were Massachusetts commercial harvest per trip (ages 7-13+), and the Connecticut volunteer angler catch per trip (ages 2-13+). Juvenile surveys produce indices of young-of-year (age 0) in Maryland, Virginia, New York and New Jersey as well as age 1 indices for Maryland and Long Island, New York.

Changes were implemented in three indices for 2003. The Maryland fishery-independent gill net indices of spawning stock abundance were re-adjusted to reflect the use of the skew-normal model throughout the time series. The NEFSC indices were modified by using coast-wide age-length keys to reflect the coast-wide nature of the trawl survey. The entire time series of the Massachusetts fishery-dependent survey was modified to standardize catches for size limit changes instituted in 1995.

Among the fisheries-dependent indices, trends in the MA Commercial CPUE, CT Recreational CPUE, and VA pound net indices suggest increasing or steady population levels since the mid 90s (Figure 11).

The fishery-independent indices for combined ages generally show a stable, high level of population abundance punctuated by strong year classes (Figure 12). 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 12).

Indices of young-of-the-year recruitment show moderate to high recruitment in the Chesapeake Bay, Delaware Bay, and the Hudson River in 2003 (Figure 13). The poor 2002 MD index continues as age one in 2003. The low numbers of age one striped bass in the Western Long Island survey in 2003 suggests the possibility that there was poor survival of the 2002 year class in New York coastal waters (Figure 13).

ADAPT Virtual Population Analysis

Catch at Age and Indices

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). Consequently in the 2004 assessment (fishing year through 2003) a combination of 55 age-specific fishery independent and fishery dependent indices were used in a configuration comparable to the 2003 VPA run. These included MA commercial CPUE ages 7-13+, CT CPUE for ages 2-13+, MD SSB index for ages 6-13+, NY Ocean Haul seine ages 3-13+, NEFSC 2-11, young-of-year (age 0) in Maryland, Virginia, New York and New Jersey, age 1 index for Maryland and Long Island, New York, age 1 from MD and Long Island and multiple age trawl indices from NJ and DE. Indices adjusted to the appropriate 1 January measurement period as used in ADAPT are given in Table 14.

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. 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. 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 9 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 2003 average fishing mortality rate (F) for fully recruited ages 8 through 11 equaled 0.62 and was above the current target (0.30) and overfishing definition (0.41) (Table 15, Figure 14). This represents a 77% increase in F on fully recruited ages from 2002 (reported as F = 0.35 in 2003, SBSASC 2003). Fishing mortality on ages 3-8, which are generally targeted in producer areas, was 0.29 (Table 15, Figure 14). Among the individual age groups the highest value of F (0.75) was estimated for 10 year old fish (1993 year class) (Table 16). The previous year's assessment also found that the highest level of F was attributed to the 1993 year class. F on the 1993 year class was second highest among all age groups in 2001 and again highest in 2000. An F weighted by N was calculated for comparison to tagging results since the tag releases and recaptures are weighted by abundance as part of the experimental design. The VPA F weighted by N for ages 7-11 (age 7 to compare with tagged fish > 28") was 0.53 (Table 15). An F weighted by N for ages 3-8, comparable to the direct enumeration estimate for Chesapeake Bay, was equal to 0.18.

The iterative re-weight option used in ADAPT applies extra weight to those indices which have the best model fit. The indices with the highest weight were generally the CT recreational CPUE and MA commercial CPUE while the NEFSC indices generally received the lowest weight (Table 17).

A bootstrap procedure was used to estimate variation in fully-recruited fishing mortality (ages 8-11). Bootstrapped estimates were made without the iterative re-weighting option because of difficulties applying the weighting parameters in a bootstrap procedure. One thousand bootstrap iterations estimated a full F in 2003 of 0.59 with an 80% probability F was between 0.51 and 0.80 with (Figure 15). The non-linear least squares estimate of F corrected for bias was equal to 0.56.

Population Abundance (January 1)

Striped bass abundance has been increasing steadily since 1982 and reached a level around 45 million fish by 1996 (Table 18, Figure 16) and remained at this general level with some inter-annual variation until 2002. Population abundance peaked in 2002 to 52 million fish but declined to about 46 million fish in 2003 due to a poor 2002 year class. Estimated population size increased to 56 million on Jan 1, 2004 with the appearance of the very strong 2003 cohort. This cohort was estimated at 21.6 million fish (age 1), which exceeds the size of the strong 1993 and 2001 year classes. However, this estimate has large confidence intervals and will be likely be modified in future assessments. The 1993 year class remains the most abundant among the exploited cohorts for the time series, while the 2001 year class continues to be estimated as very strong. Bootstrap estimates of population abundance are shown in Figure 17.

Spawning Stock Biomass

All VPA runs indicated that female spawning stock biomass (SSB) grew steadily since 1982 and peaked at about 19 thousand metric tons by 2001 (Table 19, Figure 18). Female SSB has declined since 2001 and was estimated at 13.6 thousand metric tons in 2003, assuming 1:1 male-female ratio. The estimated SSB remained above the threshold level of 1995, which was estimated as 12.7 thousand metric tons. Bootstrap estimates of total biomass are provided in Figure 19.

Retrospective Patterns

A retrospective analysis was conducted on the VPA results with successive terminal years extending back to 1999, in order to determine trends in estimation of F or total abundance in the terminal year. The initial 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 there was slight retrospective bias in average fishing mortality estimates for ages 8-11 (Figure 20a). There was a tendency in recent years for overestimation of F. With the updated input file, the 2002 terminal year estimate of F equaled 0.405 but decreased to 0.336 as year T-1 in 2003. Conversely, there was slight overestimation of total population abundance (Figure 21a).

A second analysis was made removing the iterative re-weighting option. This approach, which gives equal weighting to all survey indices, showed a significant retrospective pattern of over-estimating F. The terminal year estimate of F for 2003 was 0.59 with a 2002 estimate of 0.33. Overestimation of F was evident with 2002 as the terminal, in which case the estimate of F was 0.54 rather than 0.33. A similar pattern of over-estimation occurred in each terminal year evaluated (Figure 20b). The removal of the iterative re-weighting did not produce any significant retrospective pattern in the abundance estimates (Figure 21b).

Sensitivity Runs

A variety of input options in the ADAPT model were examined to evaluate the sensitivity to combinations of indices. The variations included the addition of VA pound net indices, removal of the re-weighting option, inclusion of all indices to the base run, the removal of indices with a time trend in the residuals, an increase in natural mortality for ages 2-5 since 1998, a reduction in the 2003 catch at age by 40% for all ages, restricting the run to coastal programs and juvenile indices only, CT and JAIs only, MA and JAIs only, MD and JAIs only, NMFS and JAIs only, NY and JAIs only, removal of NY and NMFS indices and a run with the old time series of indices in MA and MD.

The estimates of fishing mortality generally ranged from 0.44 to 0.7, with the exception of the NMFS only run which produced an F of 1.38, and the 40% catch at age reduction, which reduced F to 0.37 (Table 20). Population size estimates were similarly robust with estimates ranging from 46 to 60 million, with the exception of 36 million using only the MD indices.

The inclusion or exclusion of tuning indices seemed to have relatively little influence on the terminal year estimate of fishing mortality. The only variation that resulted in a significant reduction was a large reduction in estimated catch at age in 2003.

Summary

Striped bass population remains at high level of abundance due in part to strong incoming cohorts. The fully exploited population abundance (age 8+) has decreased since 2002. Average fishing mortality for fully recruited ages (8+) in 2003 increased substantially to 0.62 from the 2002 estimate of 0.35 reported in 2003 (SBSASC 2003). The 2003 fully recruited fishing mortality estimate is above both the target of 0.3 and the overfishing threshold of 0.42. Average fishing mortality for ages 7-11 weighted by N was 0.53 and for ages 3-8 weighted by N was 0.18. Spawning stock biomass has decreased but remains above the 1995 level.

III. Tagging Program Analyses

Introduction

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

Description of Tagging Programs:

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). The tag recovery data is analyzed in program MARK (White, 1999). Important assumptions of the tagging programs (as reported in Brownie 1985) are as follows:

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

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

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

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

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

S(.) r(.)	Constant survival and reporting
S(t) r(t)	Time specific survival and reporting
S(.) r(t)	Constant survival and time specific reporting
S(p) r(t)	*Regulatory period based survival and time specific reporting
S(p) r(p)	*Regulatory period based survival and reporting
S(.) r(p)	*Constant survival and regulatory period based reporting
S(t) r(p)	*Time specific survival and regulatory period reporting
S(d) r(p)	**Regulatory period based survival with unique terminal year and regulatory period based reporting
S(v) r(p)	***Regulatory period based survival with 2 terminal years unique and regulatory period based reporting
S(Tp) r(Tp)	*Linear trend within regulatory period for both survival and reporting
S(Tp) r(p)	*Linear trend within regulatory period survival and regulatory period based reporting (no trend)
S(Tp) r(t)	*Linear trend within regulatory period survival and time specific reporting (no trend)
S(Va) r(Va)	Three period model for VA program (1990-1992, 1993-1994, 1995-2003)
* Periods (p)	1 = {1987-1989}, 2 = {1990-1994}, 3 = {1995- 2003}
** Periods (d)	1 = {1987-1989}, 2 = {1990-1994}, 3 = {1995- 2002}, 4 = {2003}
*** Periods (v)	1 = {1987-1989}, 2 = {1990-1994}, 3 = {1995- 2001}, 4 = {2002-2003}

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 - 2003). Three regulatory periods are defined as follows: moratorium years (1987-1989), an interim fishery (1990-1994), and a full fishery (1995 - 2003). Given the importance of recent years (2002 and 2003) within the 9-year full fishery period, we model the terminal year separately {S(d)r(p)}and the most recent two years separately {S(v)r(p)}. The Virginia tagging program models an additional period-specific model (1990-1992, 1993-1994, 1995-2003). 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 {S(Tp)r(Tp), S(Tp)r(t), S(Tp)r(p)} support increasing or decreasing monotonic trends in survival. These models are reasonable given increases in fishing effort during the time series. However, Welsh (2004) provided evidence that monotonic linear trend models may over or underestimate terminal-year survival rates, when real trends are non-monotonic.

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),

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

where θ = 0.92 (based on an 8% hook-and-release mortality rate, Diodati and Richards 1996), P_L = annual proportion of tagged striped bass released alive, f = annual recovery rate estimated with a Brownie recovery model (Brownie et al. 1985), and λ = reporting rate. Annual and geographic-based reporting rates are desirable, but unavailable; consequently we use a constant reporting rate of 0.43 based on the Delaware Division of Fish and Wildlife Agency's high-reward tag study (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

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) is 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).

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 - 2003) of the Cooperative Striped Bass Tagging Program. Each time series of annual catch rates and annual exploitation rates reflects trends in fishing effort and exploitation, respectively. 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. Annual catch rates and annual exploitation rates are adjusted R/M ratios as described below (reporting rate = 0.43, hooking mortality rate = 0.08, R_k = killed recaptures, R_L = recaptures released alive):

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

Tagging Assessment Results

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

The 2003 estimates for producer area programs in the Hudson River, Delaware River, Chesapeake Bay and Virginia's Rappahannock River (HUDSON, DE/PA, MDDNR, VARAP) were 0.09, 0.28, 0.40, and 0.28, respectively, with a weighted mean fishing mortality (F) of 0.31 (Tables 21 and 22; Figure 22). The 2003 estimates of F for the four mixed-stock coastal programs (Massachusetts, New York Ocean Haul, New Jersey, and North Carolina winter trawl) were 0.09, 0.24, 0.10, and 0.19, respectively, with an unweighted-mean F of 0.15 (Table 21; Figure 22).

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

The 2003 estimates for producer area programs of Hudson River, Delaware River, Maryland Chesapeake Bay, and Virginia Rappahannock River were 0.09, 0.24, 0.67, and 0.62 respectively (Tables 23 and 24; Figure 23). High terminal-year Fs of MDDNR (0.67) and VARAP (0.62) are likely overestimated owing to linear monotonic trend models (see Welsh 2004). Estimates from mixed-stock coastal programs of NCCOOP, NYOHS, and NJDEL are reported herein, but large year-to-year difference occurred in the time series and indicate problems with data or model structure (Tables 23 and 24). Modeling issues with the >= 18 group are addressed in the Discussion section.

Live release bias adjustment

Bias-adjusted estimates of survival are used to estimate F, and incorporate estimates of the proportion of fish released alive, a constant hooking mortality rate (0.08), and a constant reporting rate (0.43). For most tagging programs, the proportion of live releases and live-release bias have decreased across the time series (Tables 22 and 24).

Model selection and diagnostics

Akaike weights were used to calculate the model averaged survival estimates for each program (Tables 25 and 26). In general, best fitting models for the 2003 assessment differed among tagging programs. For most tagging programs, model averaged survival estimates were derived from three or four models with influential weights. Estimates for MDDNR and NCCOOP, however, were primarily determined by trend and time-saturated models, respectively. Survival estimates for the >18 inch group of Virginia Rappahannock were based on the time-saturated model, except a trend model influenced the final year owing to removal of the time-saturated model (see Methods section *Estimates of survival*). Based on the goodness-of-fit (GOF) bootstrap method, the time saturated models fit the data well (p>0.10) for most programs, except for the >= 28 and >=18 inch size groups (p = 0.023 and p < 0.001, respectively) of the North Carolina winter trawl survey (Tables 22 and 24), and the >= 18 inch size group of NYOHS (p < 0.001; Table 24). The relatively low estimates of c-hat (c-hat < 3) for programs with low GOF p-values support an overdispersion contribution to lack of fit (which in some cases can be corrected through c-hat adjustment). However, additional problems with data structure or model structure cause unrealistic large year-to-year fluctuations in survival rate estimates for the >= 18 inch group of mixed-stock coastal programs, and require further research for resolution.

Length frequency, age, and geographic distribution of recaptures

Total length frequencies of fish tagged in 2003 and age distributions of fish recaptured in 2003 were tabulated by program (Tables 27 and 28; Figure 24). Total length frequencies represent the length of fish at the time of tagging. Age distributions are based on a subsample of the total number of tagged fish, because not all fish are aged. Ages (from scales) estimated at the time of tagging are adjusted to the recovery date. For each tagging program, geographic distributions of all recaptures during 2003 (from fish tagged and released during the full time series) were depicted by state and month (Table 29).

Catch and exploitation rates

Overall increases in annual catch rates and annual exploitation rates from 1987 - 1998 or 1987 - 1999 suggest an increase in fishing pressure over that part of the time series (Tables 30 – 33; Figure 26). This increase during the first part of the time series is consistent with regulatory changes to the fishery, but recent estimates (i.e., the previous three years) of annual catch rates and annual exploitation rates do not support large increases for most tagging programs.

Tagging Assessment Discussion

Fishing mortality and exploitation (>= 28 inch group)

For fishes >= 28 inches, estimates of F for the four producer area programs (HUDSON, DE-PA, MDDNR, and VARAP) have increased across the first part of the time series, but have remained relatively constant across the last three years. The weighted average of producer areas receives highest weight from the MDDNR estimates, and a trend model for MDDNR supported an increase in F. Weighted averages of the four producer area programs, however, are similar among recent years. Consequently, analyses of tagging data for fish >= 28 inches do not support a recent large increase in fishing mortality. Likewise, catch rates and exploitation rates of >=28 inch fish from producer areas do not support an increase in harvest or exploitation, where rates were typically highest during 1996 – 1999. Unlike producer areas, estimates of F for the >= 28 inch group vary among coastal programs. Estimates from MA and NJ programs have been consistently low across the time series.

Fishing mortality and exploitation (>= 18 inch group)

A trend model received highest weight for fish tagged at >=18 for MDDNR, and suggests an increase in F across the last nine years of the time series (with the highest estimate in terminal year 2003 as 0.67). A trend model also influenced the terminal year estimate of F for VARAP, where the terminal year estimate is 0.62. Models selected for DE-PA and HUDSON, however, did not support an increase in F across the time series. Independent analyses of Crecco (2003), Kahn (2004), and Hoenig et al. (2004) suggest that high natural mortality rates influence recent high F estimates for the > 18 inch group of striped bass (tagged within Chesapeake Bay). Further analyses of natural mortality rates are needed; currently, the tagging committee assumes a natural mortality rate of 0.15. A concern of overestimated Fs from trend models has occurred over the last several years; the DE-PA program requested reporting of results with and without trend models during the previous two tag-based assessments. Based on an evaluation of trend models, Welsh (2004) provided evidence for overestimation of terminal-year F for the >= 18 inch group of MDDNR and VARAP.

The 2003 estimates from the >= 18 group were questionable for three of the mixed-stock coastal programs (NCCOOP, NJDEL, NYOHS). Specifically, large unrealistic year-to-year differences in survival estimates for these programs resulted from inference from the time saturated model {S(t)r(t)}. Results for the >= 18 inch group of mixed-stock coastal programs were excluded from previous assessment reports due to issues addressed above, but were included herein at the request of the Striped Bass Technical Committee. Further analyses are needed to resolve these modeling and data issues associated with analysis of the >= 18 inch groups.

Exploitation rates

For many tagging programs, upward trends in exploitation rates for the first half of the time series are consistent with trends in F from survival rate analysis (Fig. 38). For the latter part of the time series, however, downward or no trends in catch rates and exploitation rates for many programs are supported by year-independent tagging data, and are inconsistent with many trends from survival rate analysis. Exploitation estimates are based on fish recaptured within the first recovery-year after release, and are independent among years. Fishing mortality estimates (from survival rate analysis) include recoveries after one year post-release, so the number of fishes captured within the 2^{nd} and 3^{rd} year post-release influence discrepancies between the two methods. Possibly, high natural mortality rates contribute to discrepancies between exploitation rates from R/M analysis and fishing mortality rates from recovery models in MARK (as discussed above). Additional analyses, however, are needed to address differences between the two methods.

Length frequency, age, and geographic distribution of recaptures

Total length frequencies were plotted for fish tagged and released by program for 2003 (Table 27), as well as age frequencies of 2003 recaptures (Table 28). The length frequency data show the relative differences within and between fish tagged on the coast and in producer area programs. The bimodal length frequencies of producer area programs are probably related to differences between sexes or differences between resident fish and coastal migrants. The coast programs exhibit single modes, likely related to differences in program design and gear type. In general, the Massachusetts program (which captures fish with hook and line) tags and releases larger fish than other coastal programs. Age distributions of recaptured fish are problematic since few programs assign ages to all tagged fish. Hence, fish not aged at release cannot be assigned an age at recapture. Geographic distributions of recaptures by state and month during 2003 depict northward spring movements followed by southward returns during fall (Table 12). These geographic patterns are consistent across programs and reflect migration and fishing effort.

Retrospective Examination of Tagging Estimates

Plots comparing current (2004) estimates of F to estimates reported in 2002 and 2003 are shown in Figure 25. F estimates for the same years have differed in magnitude and trend depending on the year reported, particularly near the terminal year; however, stability in the estimates during the early years of the time series' is evident for some programs (Fig. 25).

Sources of uncertainty

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

Resolution of many of these issues requires further evaluation, and may require a change in the analysis protocol or the suite of candidate models used by the tagging committee. Additional research is needed to investigate differences in release mortality associated with different capture gears. Also, alternative methods to directly determine instantaneous fishing mortality (F) should be explored. Some solutions may take longer, as the state of the theoretical science is generally in advance of any practical application. Our modeling and analysis approach, however, is consistent with the current literature on mark-recapture techniques.

IV. Status of Individual Stocks

Chesapeake Bay

Fishing mortality

Tag-based estimates of fishing mortality in 2002 for the Chesapeake Bay stock were available from the Maryland spring tagging program, Virginia pound net spring tagging in Rappahannock River and the direct enumeration study conducted through the calendar year of June 2002-June 2003. For fish ≥28 inches, the spring data based estimates were 0.40 for Maryland and 0. 28 for Virginia. Spring tag based estimates for striped bass 18 inches and larger indicate much higher fishing mortality (F = 0.67 in Maryland and F = 0.62 in Virginia) and overall increasing trend in F in recent years, assuming constant natural mortality of M=0.15. However, recent analysis by V. Crecco (2003) and D Kahn (2004) suggests that overall increase in total mortality may be attributed to an increase in natural rather than fishing mortality. There were some doubts expressed by the tagging committee members regarding the validity of MARK model specifications that may have affected the results (S. Welsh, personal communication). TC suggests that additional analyses are needed to verify reported decline in striped bass survival in Chesapeake Bay and potential increase either in natural or fishing mortality.

A direct enumeration study to estimate the bay-wide fishing mortality based on the tag release and recovery data are conducted by Maryland and Virginia since 1993. The multiple release design and analysis used in this study was reported in Hebert et. al. 1997; Goshorn et al. 1998; Goshorn et al. 1999; Goshorn et al. 2000; Hornick et al. 2000; Hornick et al. 2001, Hornick et al. 2002. Striped bass were tagged and released throughout the Chesapeake Bay prior to and during the recreational fishing seasons for each respective jurisdiction during six release rounds in Maryland, and three in Virginia. Jurisdictional regions within the Chesapeake Bay were open for recreational striped bass fisheries for a combined total of approximately 31 weeks (6/1/01 - 12/31/01) during the 2003 fall season. All tagging was done cooperatively with commercial watermen. Tag recoveries were handled and recorded by each management jurisdiction and by the U. S. Fish and Wildlife Service (USFWS). USFWS internal anchor tags were applied to 8,676 striped bass. A logistic model was applied to tag recovery and release data. The proportion of the number of recovered tags to the number of tags released was the response variable and the explanatory variables consisted of one categorical variable (interval number, which accounted for unequal interval lengths) and two binary variables, disposition and angler type.

Estimates of exploitation for the recreational/charter season were converted to instantaneous rates for each round and summed across intervals to determine F for the recreational/charter fishery (F_R). This estimate was then adjusted to include the Chesapeake Bay resident portion of the commercial and recreational fisheries that occurred during summer 2002, winter 2002-2003 and during spring of 2003, respectively. The expanded estimates of total F were calculated based on weighting of recreational/charter estimates of F_R by proportional additions of spring recreational or commercial harvest in numbers. The estimate of the Chesapeake Bay-wide F (F_{Bay}) for 2003 is F_{Bay}= 0.10. Non-harvest mortality (0.10) was added to the point estimate of F = 0.10 to obtain the final estimate of bay-wide fishing mortality of F_{Bay} = 0.20 for 2003.

Spawning stock

Spawning stock relative abundance (ages 8+) measured through the Maryland spawning stock survey has been increasing since 1999. The 2003 index for eight year and older spawners was 134.6, the highest in time series (1985-2004). The preliminary estimate of the 2004 value for 8+ fish was 69.9, slightly above the 20 year average of 56.5 (Table 14).

Recruitment

Both Maryland and Virginia indices of YOY striped bass abundance (geometric mean) in 2003 were well above the 1957-2003 average ((MD JI=10.83;VA=22.85, Figure 13), indicating another strong year class similar to the very strong 1993, 1996 and 2001 year classes.

Hudson River

Fishing mortality

Tagging data from 2000 through 2003 have resulted in questionable conclusions. Tag-based S values have been increasing since 1997, with F's decreasing steadily over the same time series. Since 2000, adjusted values of F have been less than 0.0. The current F values (2003) estimated from tagging are less than 0.1. The lower confidence intervals of these values are less than zero which makes all recent values of F suspect. NY staff is currently examining the tag analysis methods to evaluate these results.

Spawning stock

Spawning stock relative abundance (gillnet CPUE; ages 8+) increased slightly in 2001 to 633.2; however, the index is still below the 1985-2000 average of 746.9. This index had to be abandoned after 2001 given that sample size (in gillnet CPUE) has fallen to extremely low levels, making any future index invalid. Other methods of estimating spawning stock relative abundance are being explored. These methods rely on sampling of age zero fish from Hudson River Utility Monitoring surveys. However, data for 2002 and 2003 have not yet been made available to the NYSDEC.

Recruitment

The Hudson River index of YOY striped bass abundance (geometric mean) decreased to 12.3 in 2003. The 2003 value is slightly below the 1982-2002 average of 14.7, indicating that the 2003 year class was not large. The index increased in 2004 to 16.88, only slightly above the 1982 to 2003 mean of 14.6.

Delaware River

Fishing mortality

Tag-recapture data is employed in two analyses, a Petersen exploitation estimate and an estimate of F based on survival modeling with MARK program software. Both estimates, when translated into F, are F weighted by N. The exploitation estimate for 2003 declined in 2003 to 16%, which translates into F_{2003} = 0.19. The 2003 F estimate from the MARK program with trend models included was F_{2003} = 0.28. The addition of new data from recaptured in 2003 also caused the MARK program to reduce estimates of mortality and thus F in previous years as well.

Spawning stock

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

The PFBC CPUE declined in 2003, but the decline was attributed partly to high flows and low temperatures, which may have negatively influenced catch rates during the study. The PFBC samples over a more limited time period than the DDFW.

Recruitment

The YOY estimate from the New Jersey Division of Fish, Game and Wildlife's beach seine survey of the Delaware River was the highest on record; the record extends back to 1980.

IV. Discussion

VPA Analysis

The results of the VPA analysis indicate that the overall fishing mortality (0.62) for fully recruited ages 8-11 in 2003 is above the F target of 0.30 and F threshold of 0.41 under Amendment 6, suggesting overfishing is occurring. The spawning stock biomass in 2003 has decreased but remains above the 1995 level, suggesting the population is not overfished. **However, most TC members expressed concern over the current terminal year estimates of F and spawning stock biomass and, hence, the conclusions derived from these estimates**. Most members agreed that the landings increased in 2003 compared to 2002 (some states liberalized regulations), and fishing mortality has probably increased compared to 2002, but they are skeptical that the F estimate from the VPA doubled. Since the 2003 F is a terminal year estimate and it has the highest error, most members believe that the F estimate produced by the ADAPT model will likely decrease when the stock assessment is updated in 2005, given the current retrospective pattern. Based on the ADAPT VPA estimates, the TC cannot say with certainty that the threshold was exceeded in 2003; **however, since harvest increased compared to 2002, and the annual F estimates have been over the target since 1997, there is certainty that the target is still being exceeded.**

Tag Analysis

The tagging programs produced MARK model-derived estimates of F for ≥28 inch striped bass that formed three distinct groups based on similarity of trends. F estimates from the New York Ocean Haul Seine, New Jersey, Delaware River, and Virginia Rappahannock programs indicated that fishing mortality generally had increased from the beginning of the time series, peaked between 1995 and 1998, and has fluctuated without trend since about 1999. Similarly, tag-based F estimates from the Massachusetts and Hudson River programs increased and peaked between 1995-1998, but F estimates have since declined. F estimates from North Carolina and Maryland have indicated a general increase since the early 1990s. Most analyses of tagging data for fish >= 28 inches do not support a recent large increase in fishing. However, the trends in F reported here for some programs are contrast to trends reported in 2003. For instance, the F estimates from the New York Ocean Haul Seine program in 2003 showed a steadily increase through 2002, but those reported in 2004 now show that F has simply fluctuated without trend since 1997. Such inconsistencies question the reliability of the F estimates near the terminal year for some programs.

The R/M estimates for New York Ocean Haul Seine, New Jersey, Delaware River, Maryland/Chesapeake Bay, and Virginia Rappahannock were generally similar in magnitude to the exploitation rates derived using F estimates from the current ADAPT assessment for years 1990-1999. However since 2000, the R/M estimates have declined, indicating exploitation has decreased.

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

Resolution of many of these issues requires further evaluation, and may require a change in the analysis protocol or the suite of candidate models used by the tagging committee. Additional research is needed to investigate differences in release mortality associated with different capture gears. Also, alternative methods to directly determine instantaneous fishing mortality (F) should be explored. Some solutions may take longer, as the state of the theoretical science is generally in advance of any practical application. Our modeling and analysis approach, however, is consistent with the current literature.

TAG-VPA F Comparison

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

Examination of tag based Fs among programs show two general trends (Figure 38). NCCOOP, DE/PA, MDCB and VARAP results show similar magnitude and increasing trend as the VPA F estimates through 2000. After 2000, VARAP and DE/PA F estimates fluctuated without trend or declined slightly compared to the VPA F estimates. The MDCB F estimates continued to increase, but did not show the same dramatic increase in F during 2003 as the VPA F estimate (Figure 26). A second group (MA, NJ/DEL, NYOHS and Hudson) has F values that peaked about 1998 at much lower levels than the VPA estimates and have since fluctuated without trend or have declined. There are no clear reasons for the differences. None of the programs produced estimates comparable to the VPA results in 2003. Overall, there is a great deal of variation among tagging estimates but at least one group of programs did follow the trends and magnitude of the VPA results until recently.

The R/M estimates provide an alternative approach to calculating exploitation rates. The R/M estimates produced by 3 (NYOHS, DE/PA, MDCB) out of 8 programs were generally similar in magnitude to the exploitation rates derived using F estimates from the current ADAPT assessment for year 1990-1999 (Figure 27). Since 2000, R/M estimates have indicated exploitation has decreased. None of the programs produced an estimate comparable to the VPA results in 2003 (Figure 27).

V. Concerns

The Technical Committee expressed great concern over the divergent patterns in F observed among the VPA and tag-based programs and believes that both methods need to be further scrutinized to reconcile the differences. Violation of the model assumptions is the primary reason believed to have created the model differences, and these are discussed below.

Some members of the Technical Committee were concerned that the VPA is not adequately robust when dealing with a mixed stock such as coastal striped bass. In addition, the survey indices used in the tuning process of the VPA may not be providing accurate trend estimates for older fish due to the surveys' abilities to track the striped bass abundance as the population has potentially plateaued in recent years. Some members of the Technical Committee were concerned that the distribution of larger striped bass may have shifted to offshore waters as the population has increased in abundance. Since the EEZ is closed to harvest and there is limited fishery independent survey data for older striped bass beyond state waters, these fish may not be represented in the assessment. However, other TC members suggest this may not be an issue since MD and VA spawning ground surveys provide relative abundance data on these larger fish when they have migrated from the EEZ to the spawning grounds in the spring. Other methods that are capable of directly accounting for mixed stock management units should be explored in the future and self-evaluation of surveys by each state should be performed, following recommendation made by the VPA indices workshop.

Other members have expressed concern that there is considerable error in the catch produced by the MRFSS survey in 2003. Some states did not believe that the increase harvest in some waves was real because the trend contradicted independent observations on fishing effort (hurricanes interrupted angling in 2003) and angler opinions. However, some states could account for the increases in harvest. Other members expressed concern that the estimates of harvest are underestimates because the winter fisheries in North Carolina and Virginia are not being taken into account. It is recommended by the TC that, at least, MRFSS survey should be expanded into wave 1 to account for winter fisheries' harvest. Due to error in MRFSS catch estimates, the TC also recommends that statistical catch-at-age models be explored that incorporate error in catch and tagging information.

Some members were also concerned that the tag based estimates of survival among coastal programs were so variable and that the estimates changed considerably depending on the year reported. It is possible that the assumption of mixing and dispersal is not being adequately met to provide a comprehensive estimate of mortality. If such assumptions are violated, the estimates could change in trend and magnitude. Others questioned whether the reporting rate derived by DE and used by all states is accurate. Since reporting rate is an important variable used in tagging model and R/M estimates, the TC recommends that a high-reward, coast-wide tagging study be conducted in the future. In addition, more analyses to examine the violation of assumption in the tagging models should be conducted.

Some Technical Committee members believed it is time to notify the Board that there appears to be a problem with increasing natural mortality in Chesapeake Bay. Des Kahn, Vic Crecco, and John Hoenig presented analyses that showed an increase in natural mortality on younger individuals, which is concurrent with the incidence of mycobacterial disease. Several members agreed that the TC should tell the Board that there is some statistical evidence for an increase, but that not all empirical data (e.g., landings in Chesapeake Bay have increased despite the rise in M) supports the results of the model analyses. The TC could not resolve any plan of attack to address this issues, but recommends that it be addressed over the next few months.

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Figure 1. Proportions of 2003 striped bass losses by fishery component

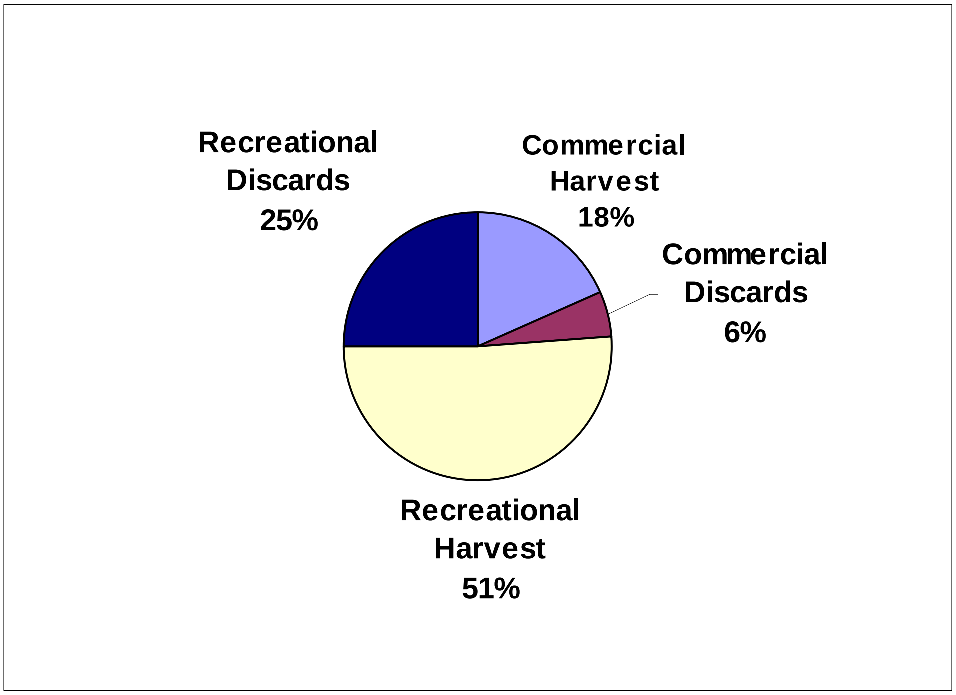


Figure 2. Total commercial losses of Atlantic striped bass (landings and discards), 1982-2003

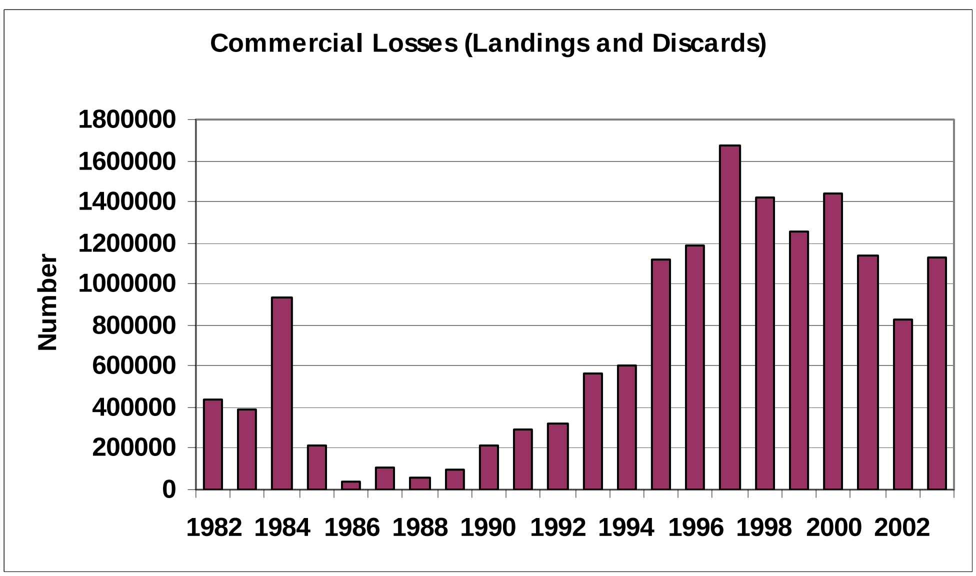


Figure 3. Commercial losses (landings and discards) of Atlantic striped bass, 1982-2003

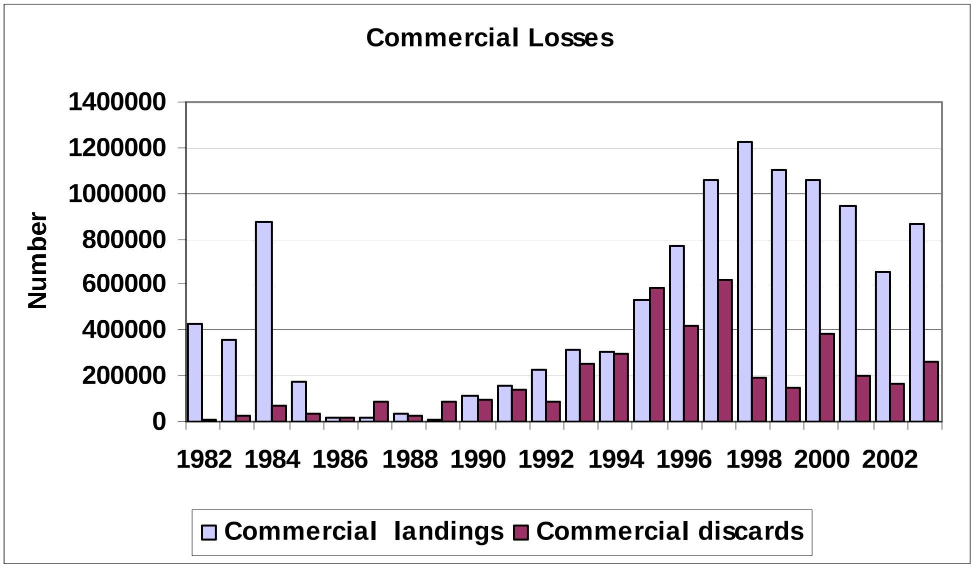


Figure 4. Total commercial losses (landings and discards) at age in 2003

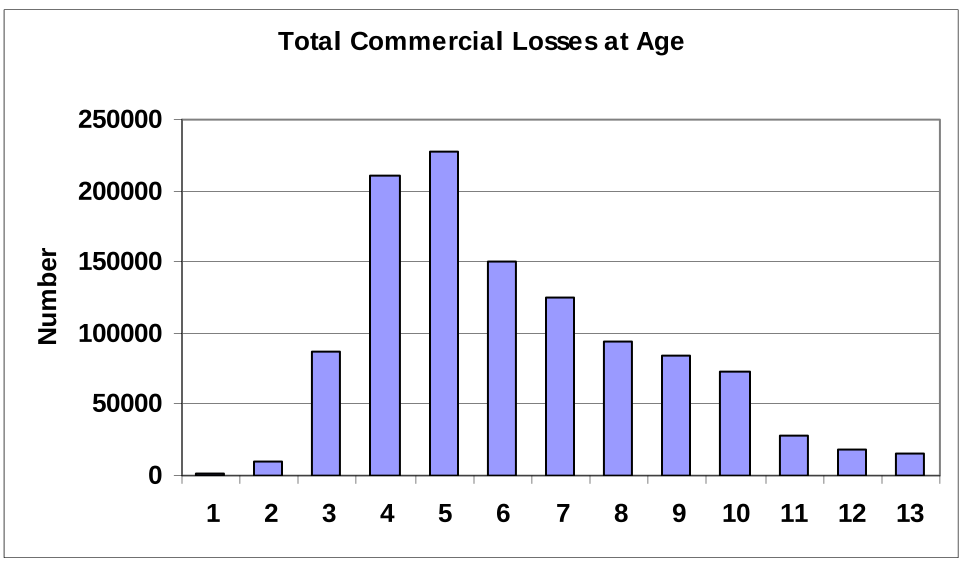


Figure 5. Recreational losses (landings and discards) of Atlantic striped bass at age in 2003

Figure 6. Total recreational losses (landings and discards) of Atlantic striped bass in 2003

Figure 7. Total losses of Atlantic striped bass (landings and discards), 1982-2003

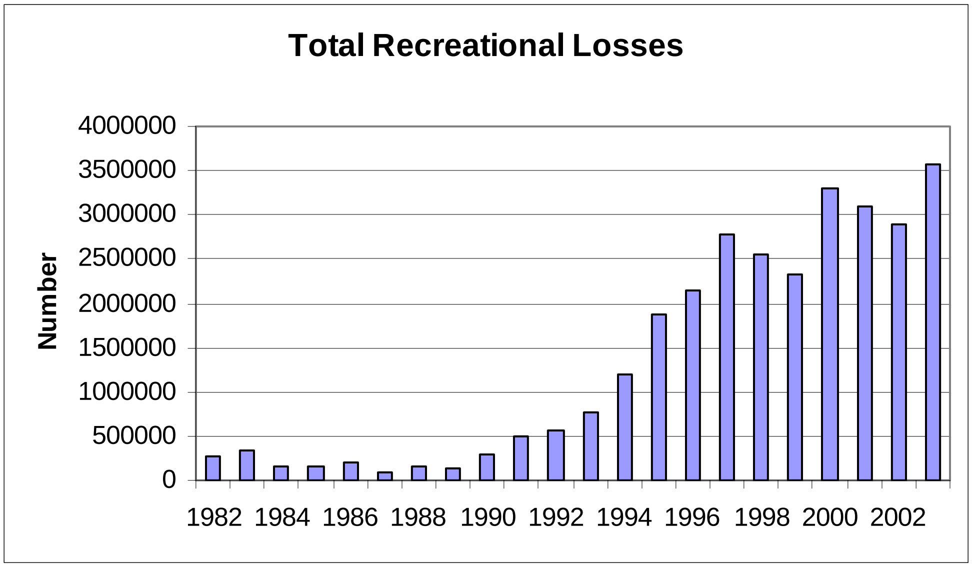


Figure 8. Recreational losses (landings and discards) of Atlantic striped bass, 1982-2003

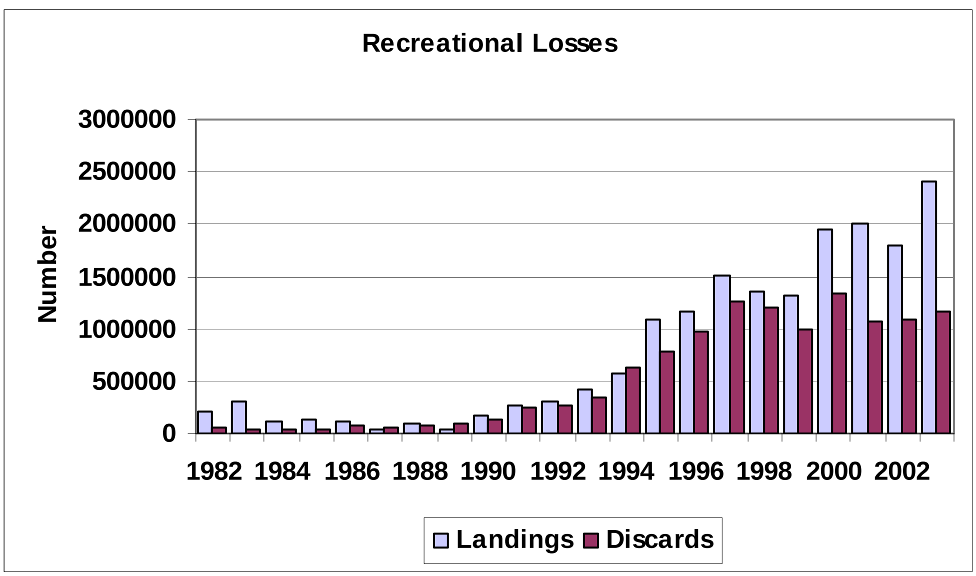


Figure 9. Recreational and commercial losses (landings and discard) in number of Atlantic striped bass, 1982 - 2003.

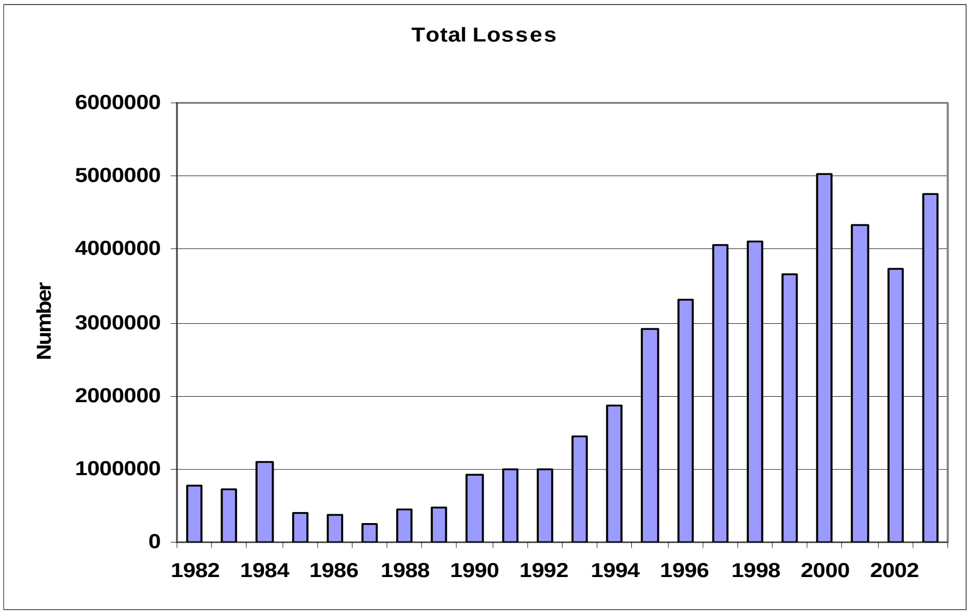


Figure 10. Recreational and commercial losses (landings and discard) at age in number in 2002 and 2003.

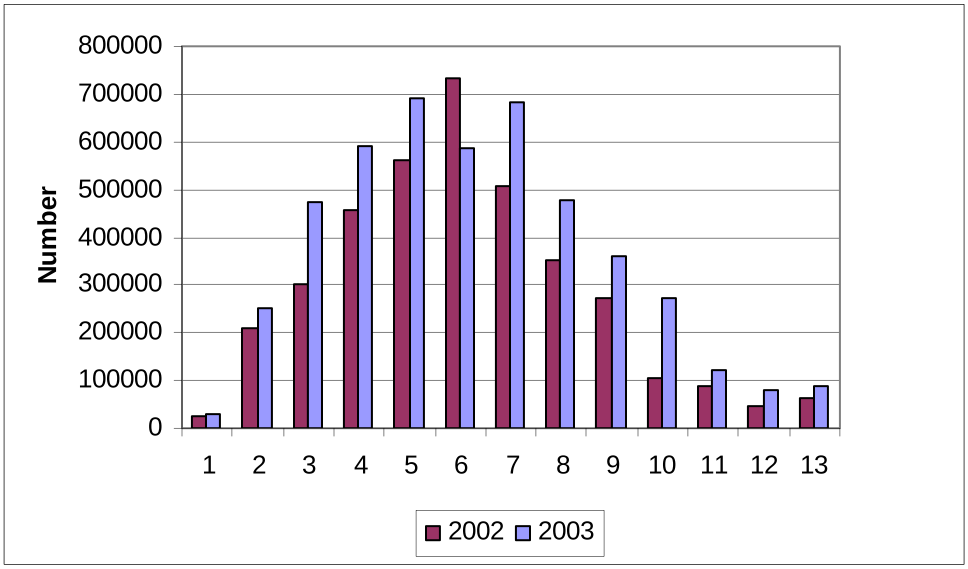
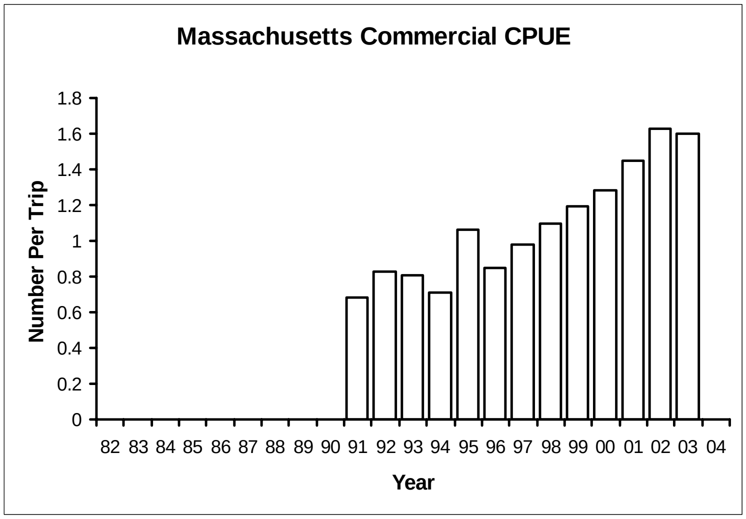
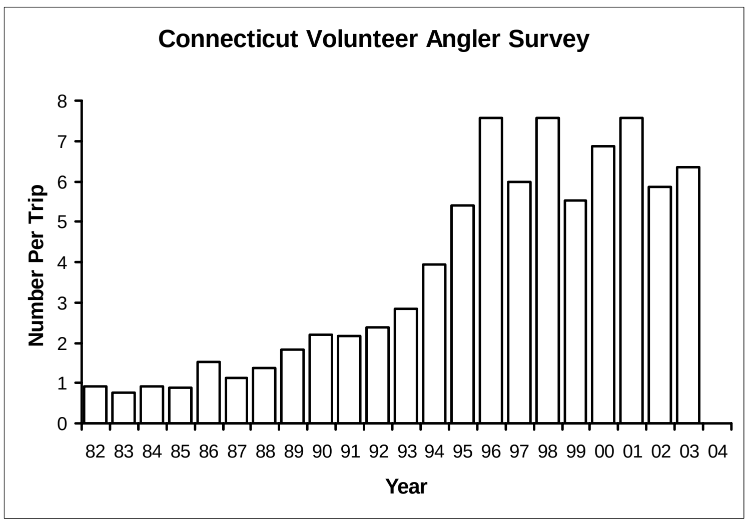


Figure 11. Fishery-dependent striped bass indices, all ages combined





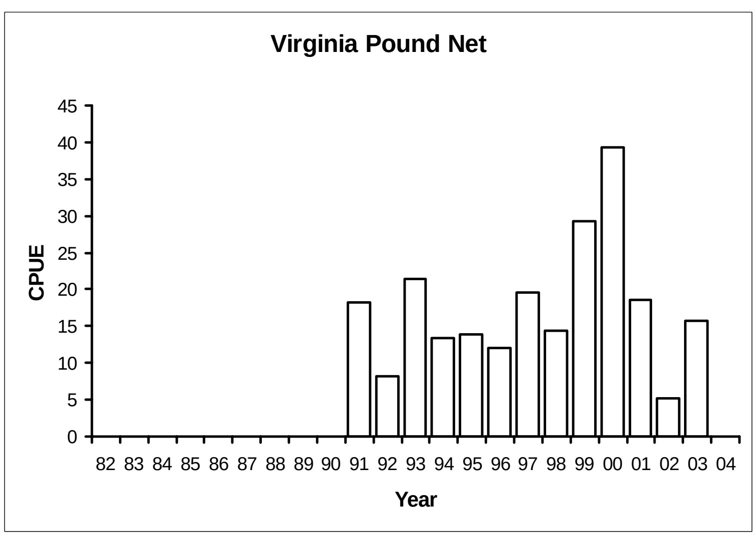
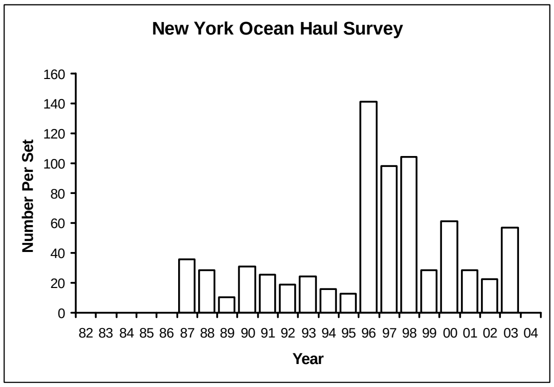
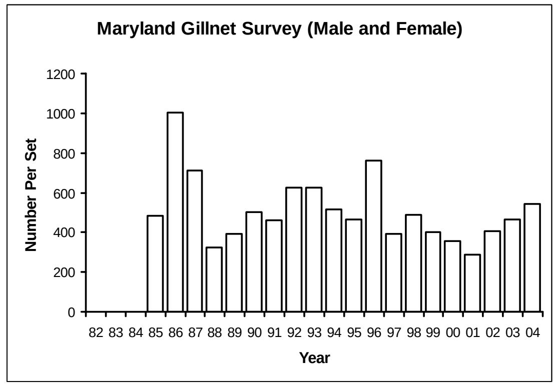
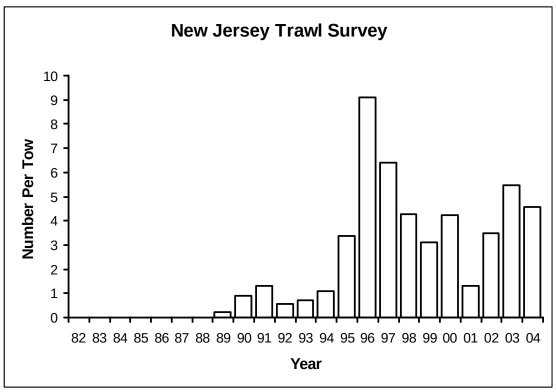
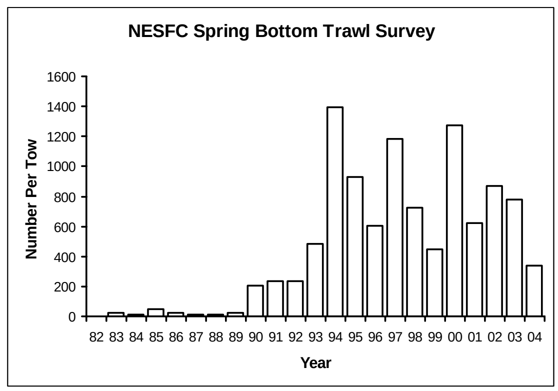


Figure 12. Fishery-independent multiple age surveys of striped bass abundance, all ages combined.









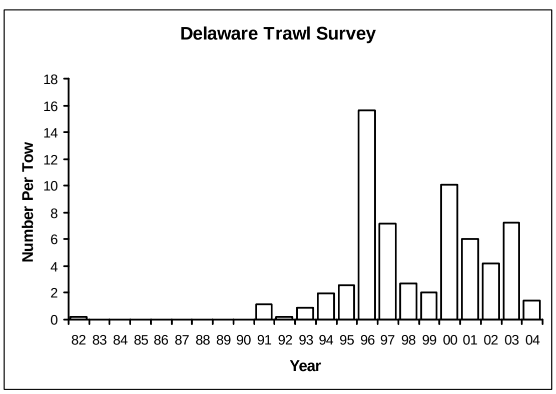


Figure 13. Young-of-the-year and yearling indices, 1982-2003.

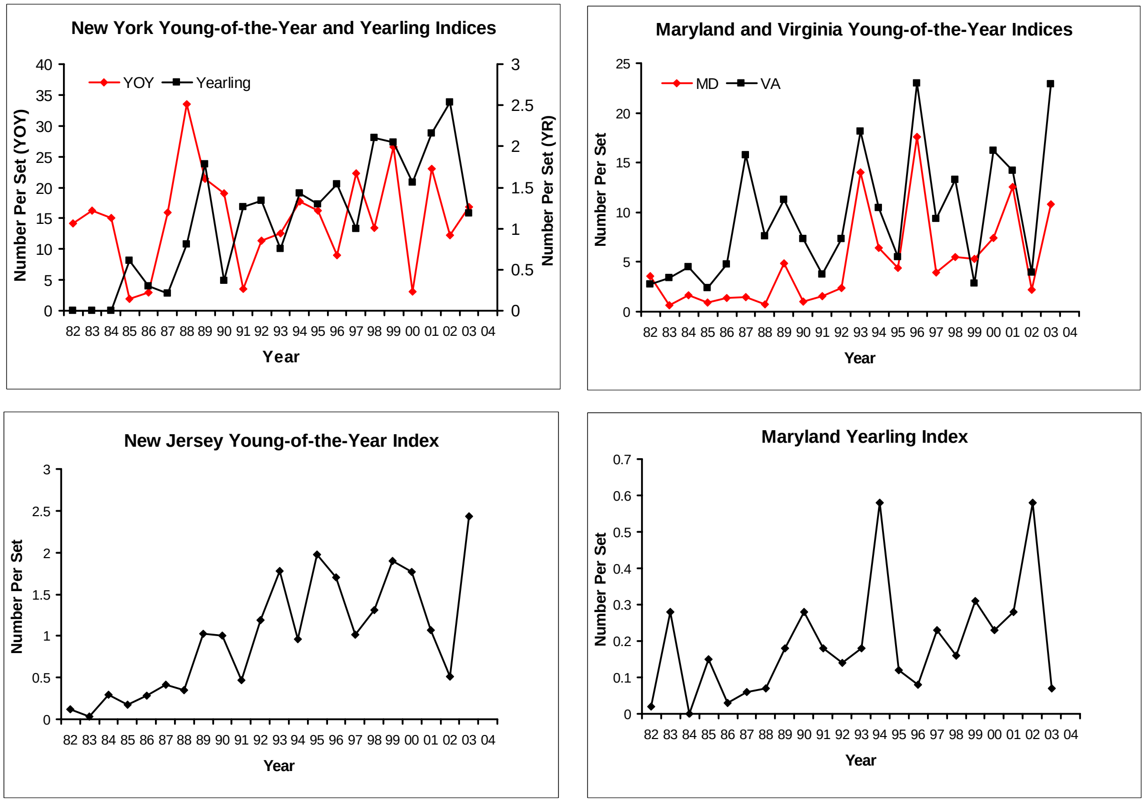


Figure 14. Striped bass fishing mortality estimates from ADAPT model.

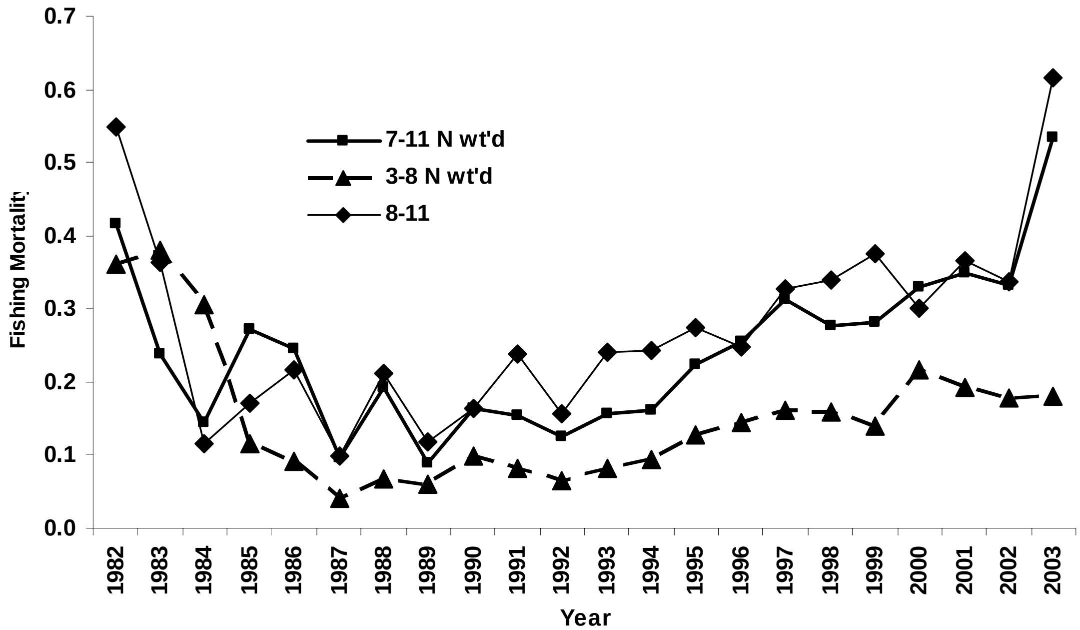


Figure 15. Striped bass bootstrap distribution of fishing mortality from ADAPT.

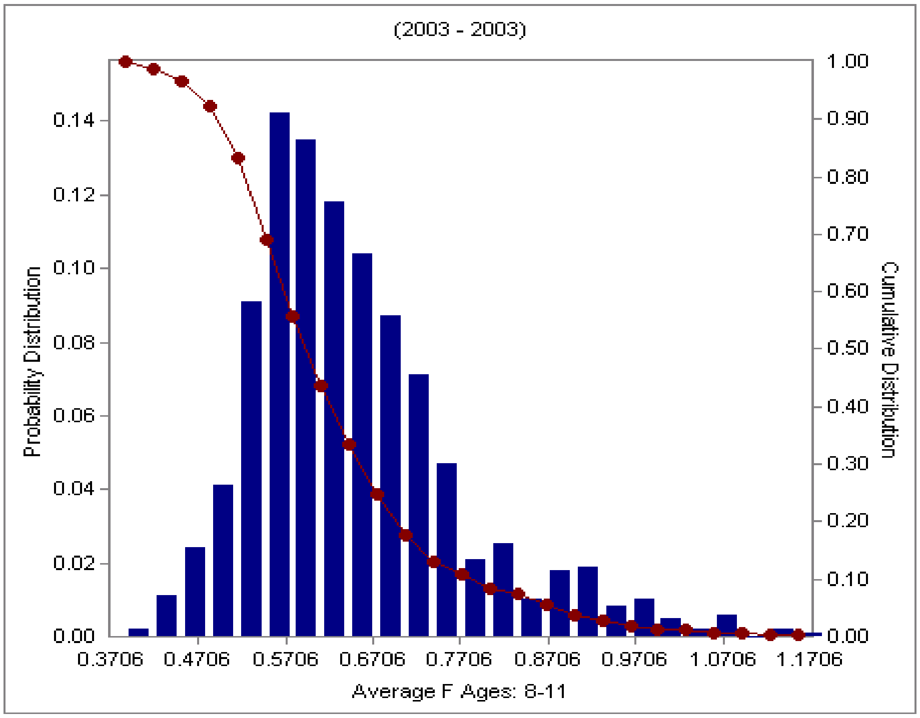


Figure 16. Striped bass population abundance estimates from 2003 ADAPT model.

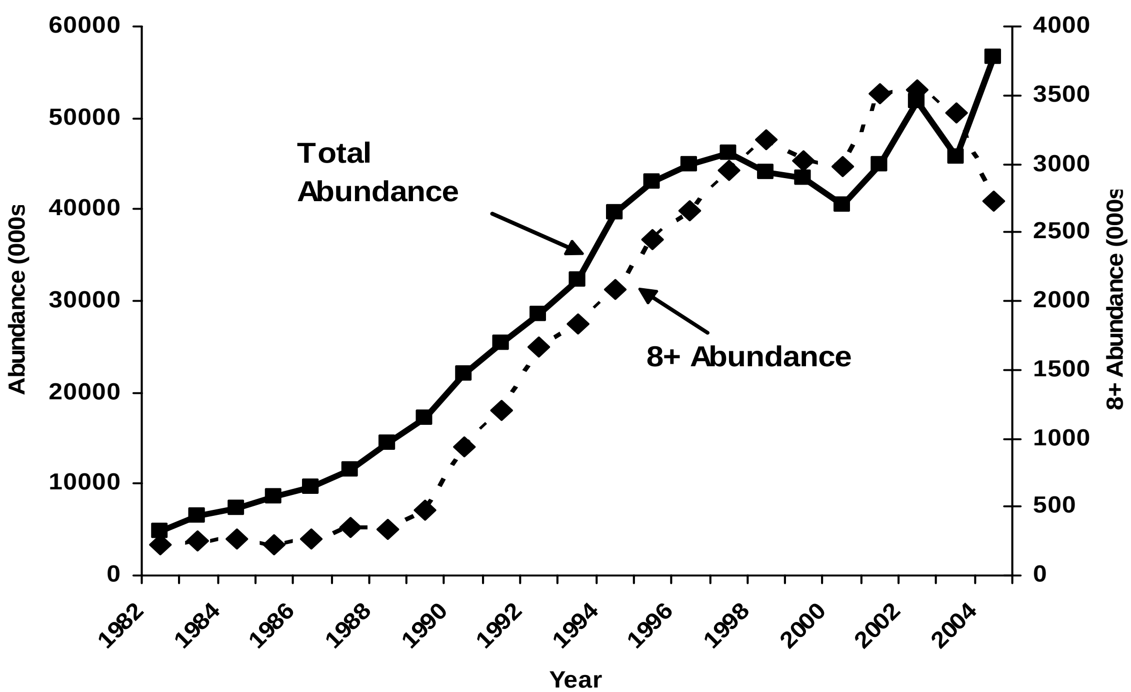


Figure 17. Striped bass bootstrap distribution of population abundance from ADAPT.

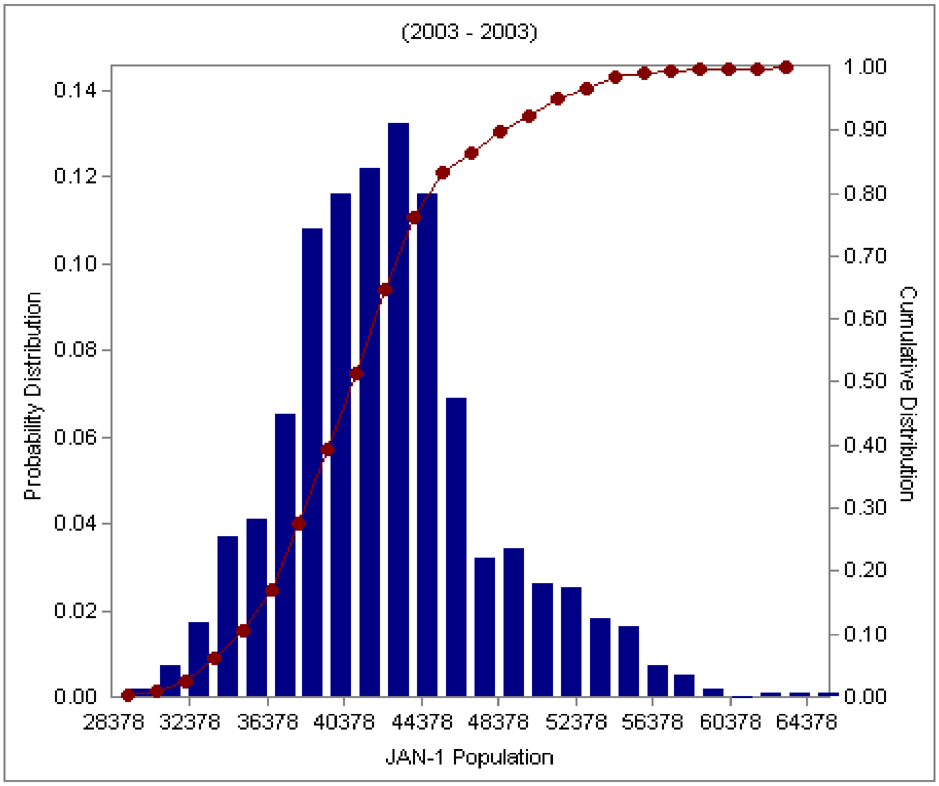


Figure 18. Female striped bass spawning stock biomass (mt) from ADAPT.

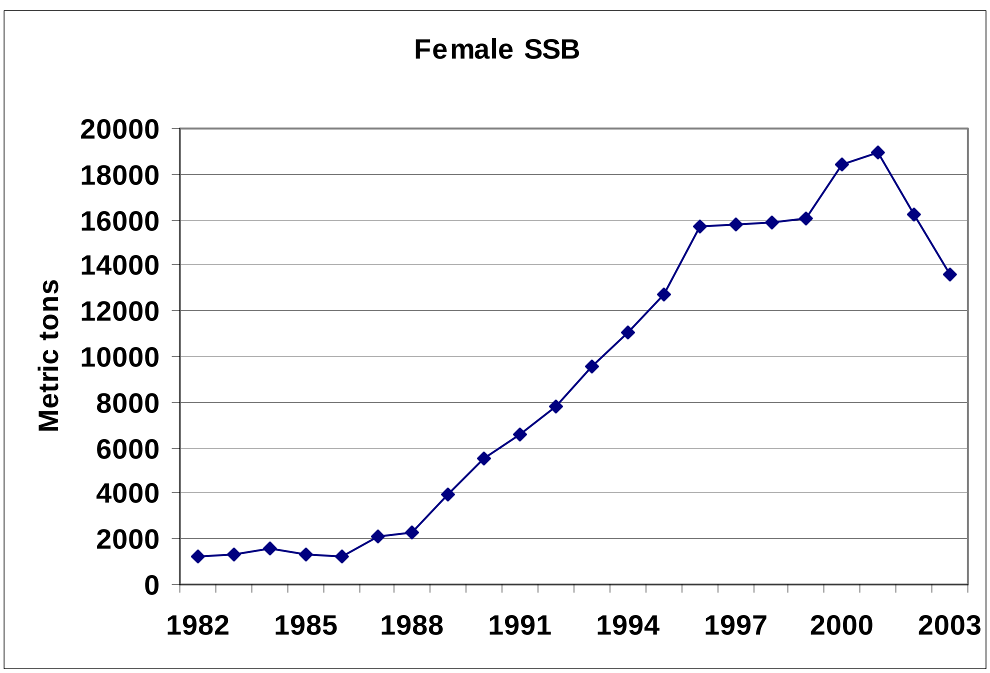


Figure 19. Striped bass bootstrap distribution of total spawning stock biomass from ADAPT.

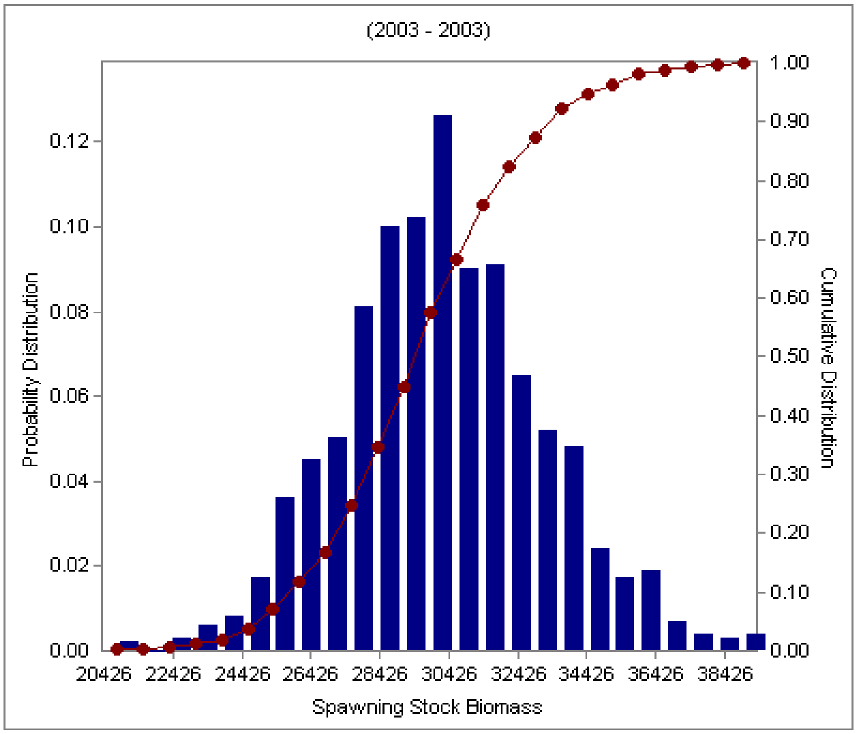


Figure 20a. Striped bass retrospective pattern in fishing mortality from ADAPT using re-weights.

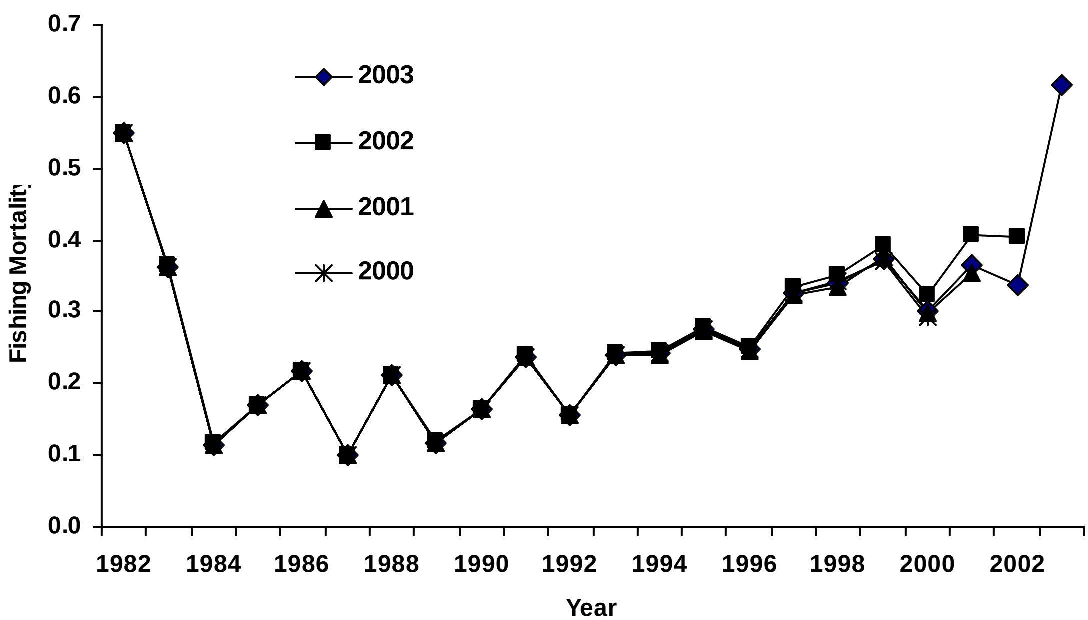


Figure 20b. Striped bass retrospective pattern in fishing mortality from ADAPT without iterative re-weights.

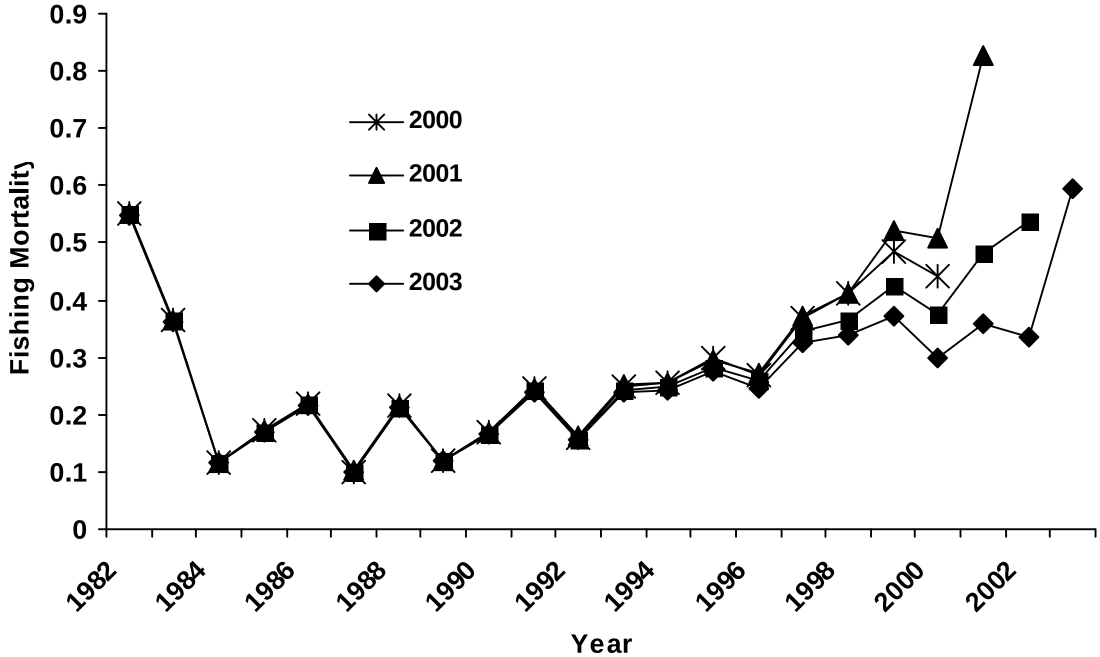


Figure 21a. Striped bass retrospective patterns for abundance from ADAPT.

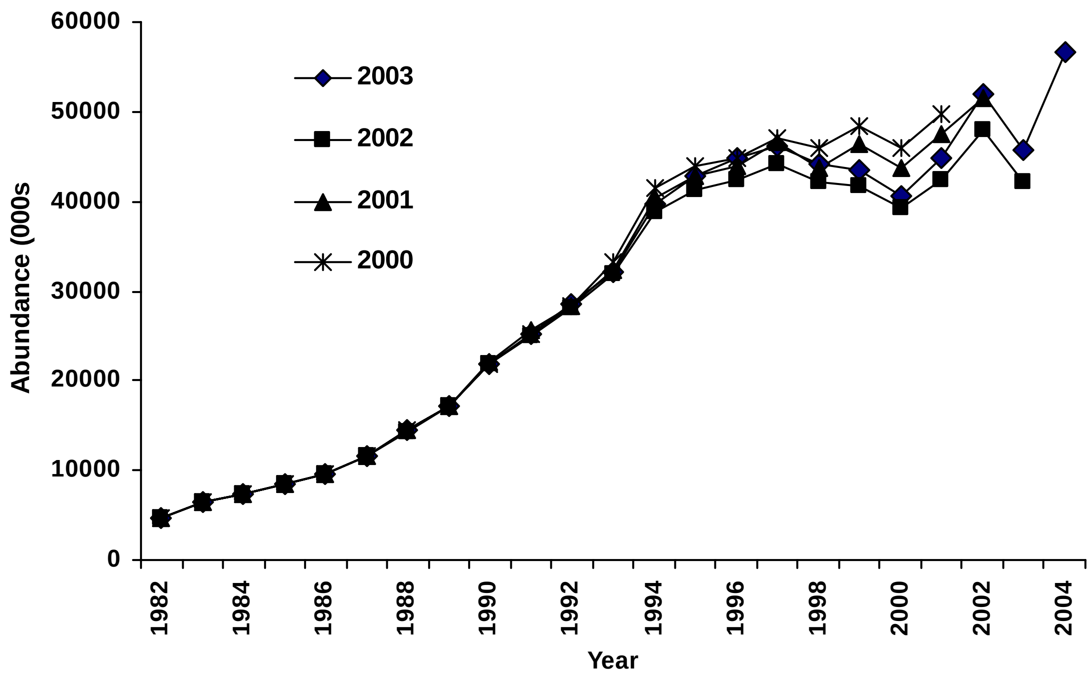


Figure 21b. Striped bass retrospective patterns for abundance from ADAPT with no iterative re-weighting.

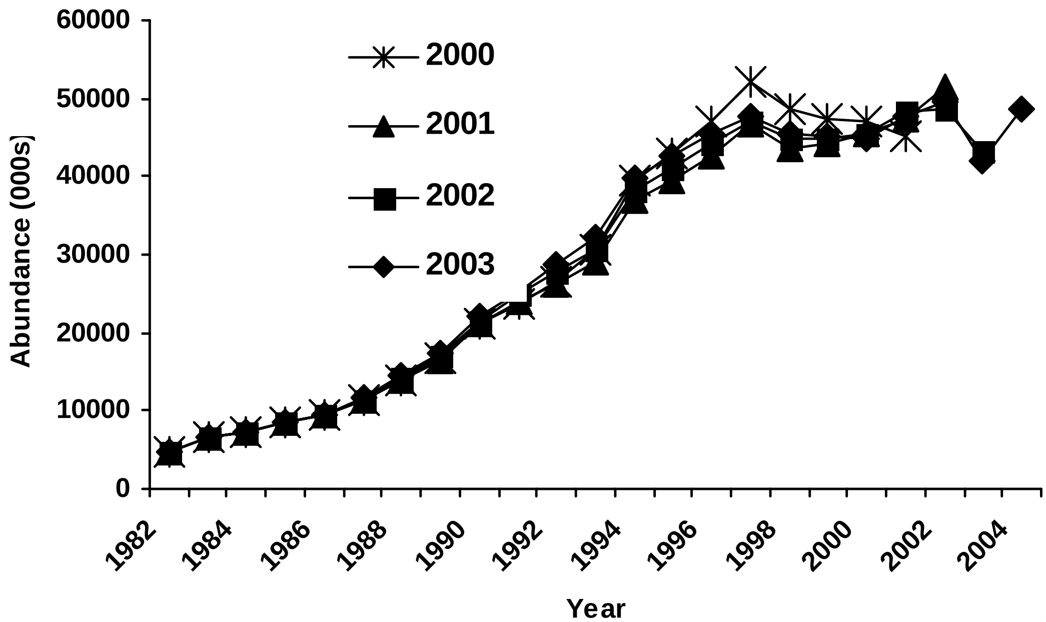
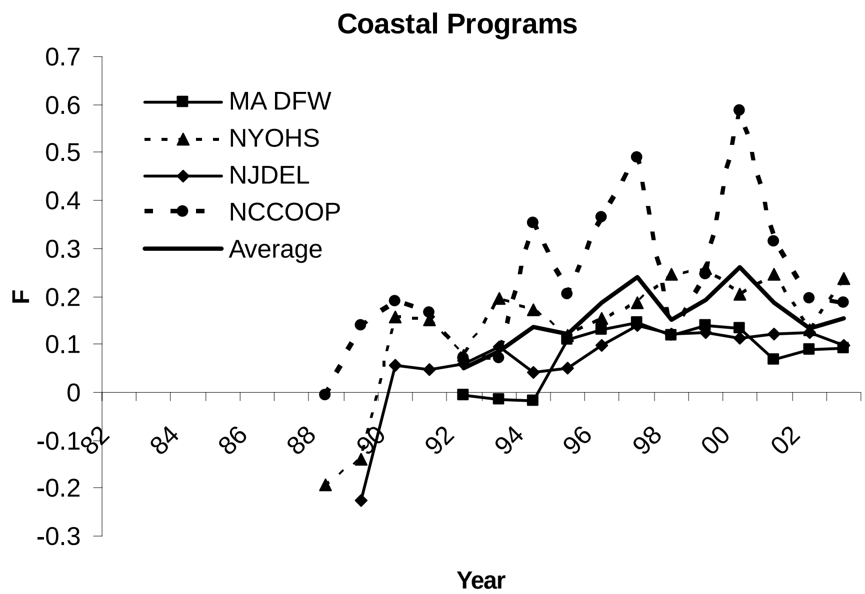


Figure 22. Tag-based estimates of annual instantaneous fishing mortality of striped bass ≥ 28 inches.



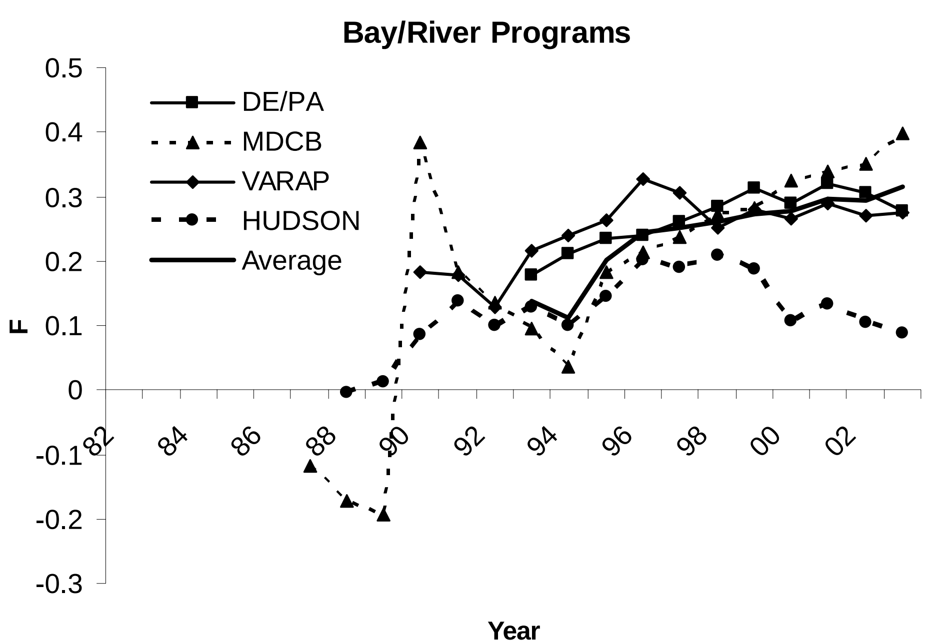


Figure 23. Tag-based estimates of fishing mortality for striped bass ≥18 inches.

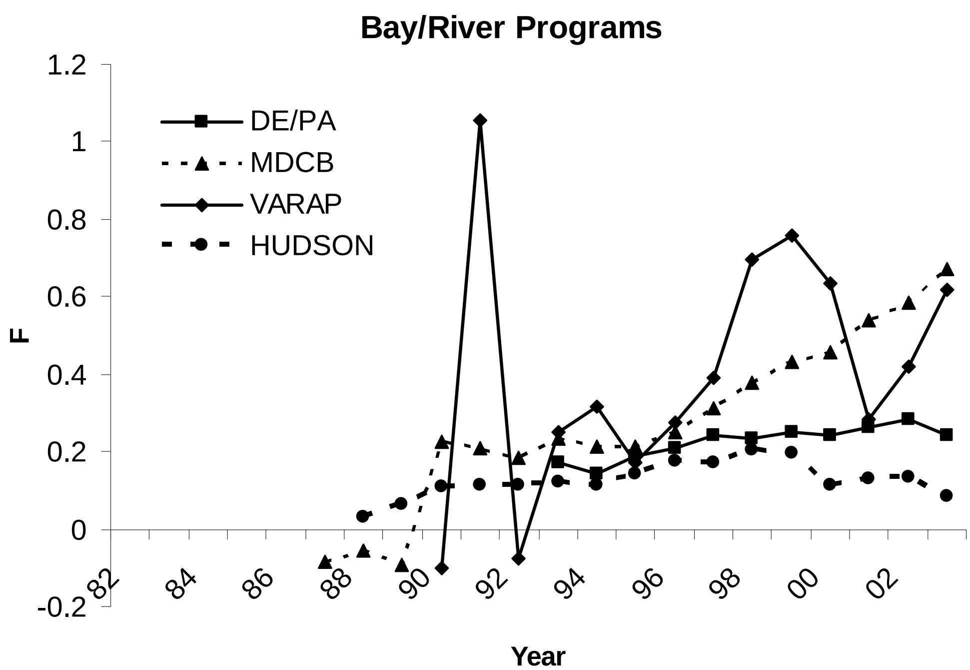


Figure 24. Length frequencies of 2003 tagged striped bass > 699 mm total length.

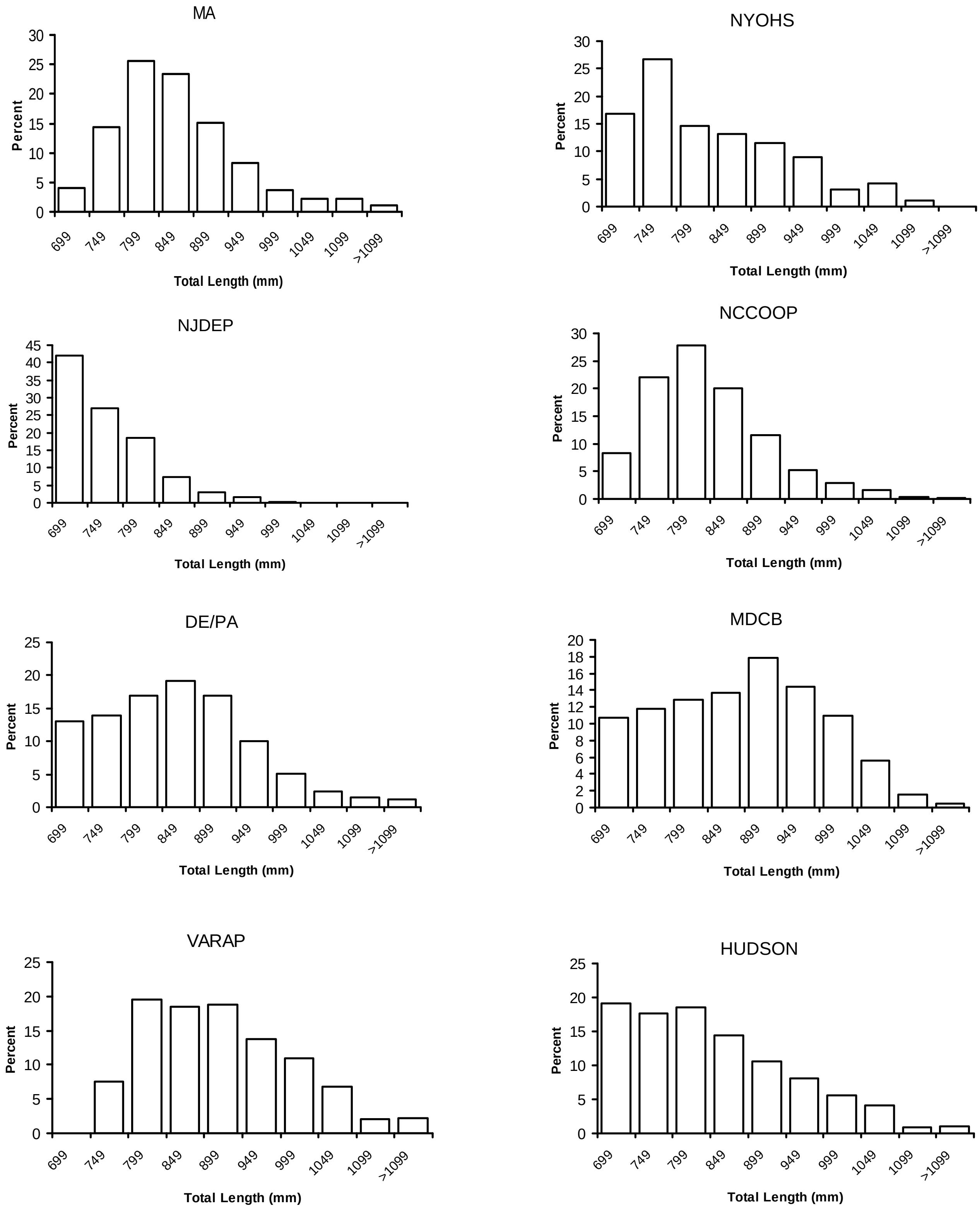


Figure 25. Comparison of F estimates for striped bass ≥28 inches from tagging programs reported in 2002, 2003, and 2004.

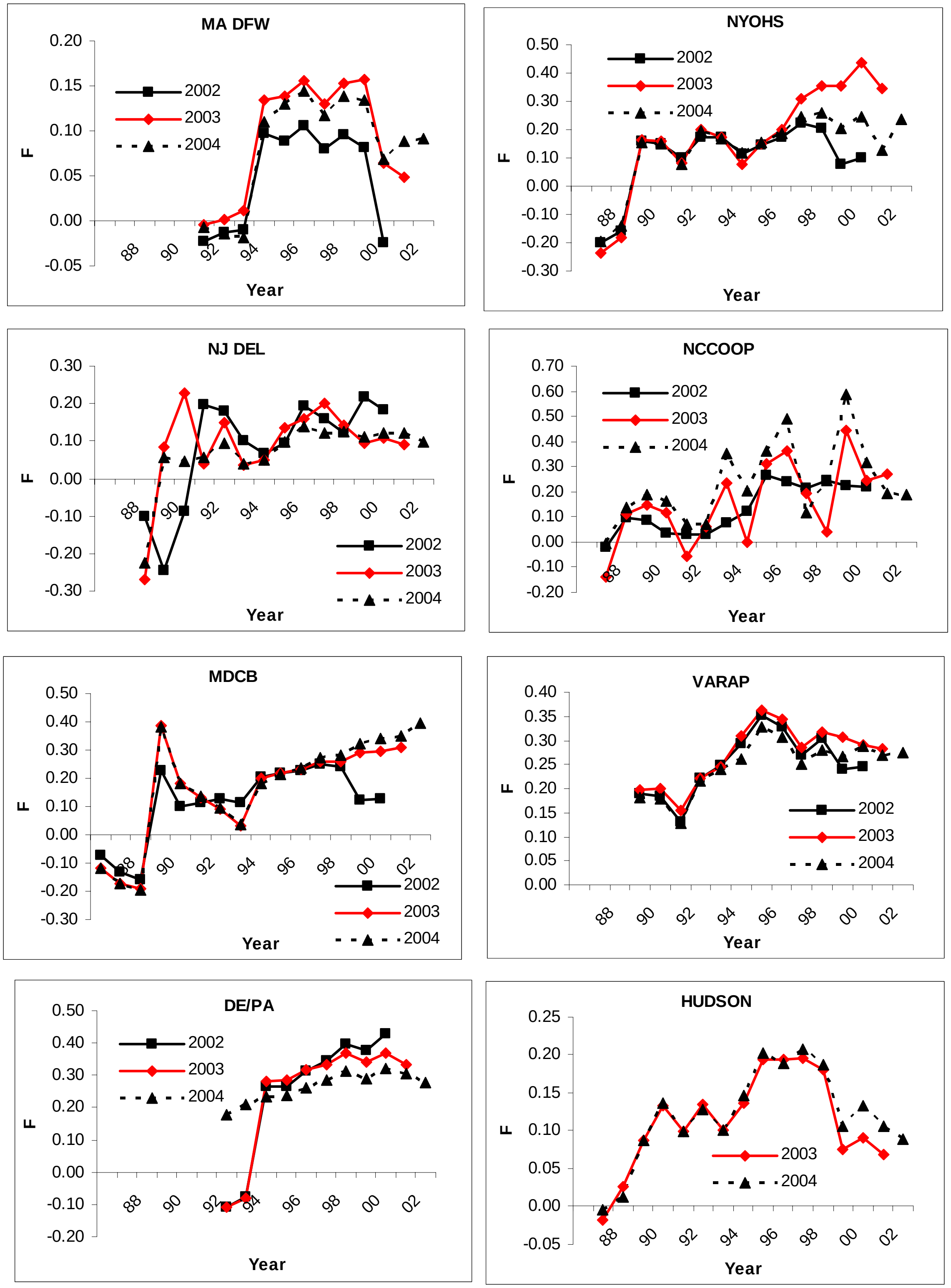


Figure 26. Comparison of N-weighted VPA and tag-based (>28 inches) F estimates.

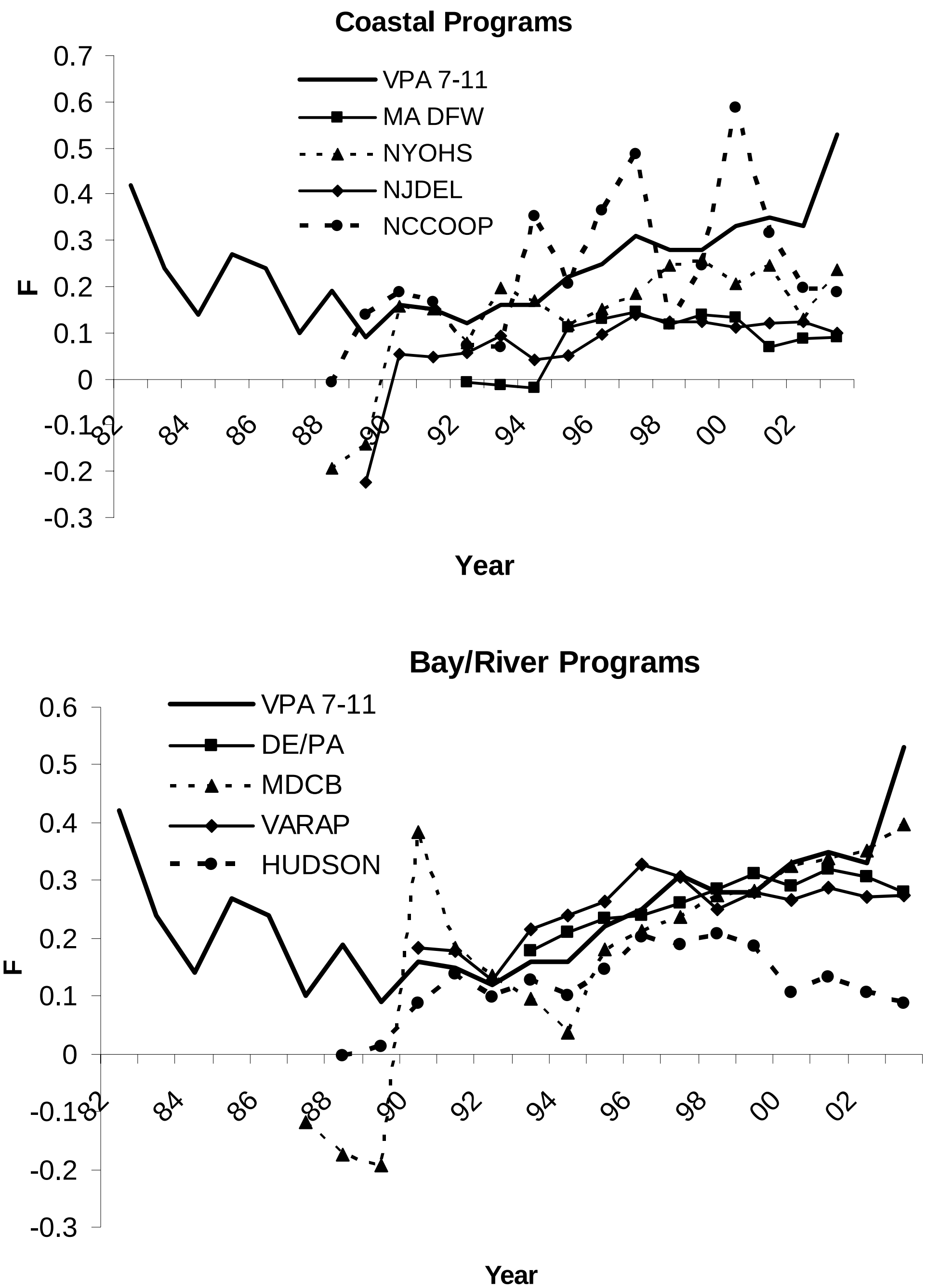
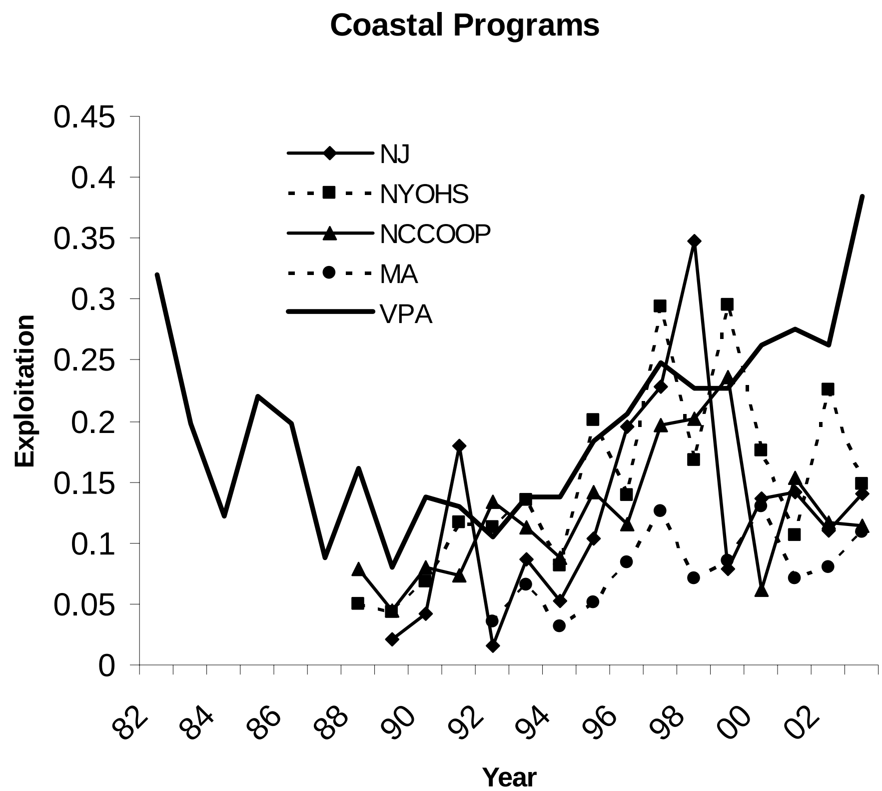


Figure 27. R/M estimates of exploitation from each tagging program and the VPA (n Weighted) exploitation (converted from F).



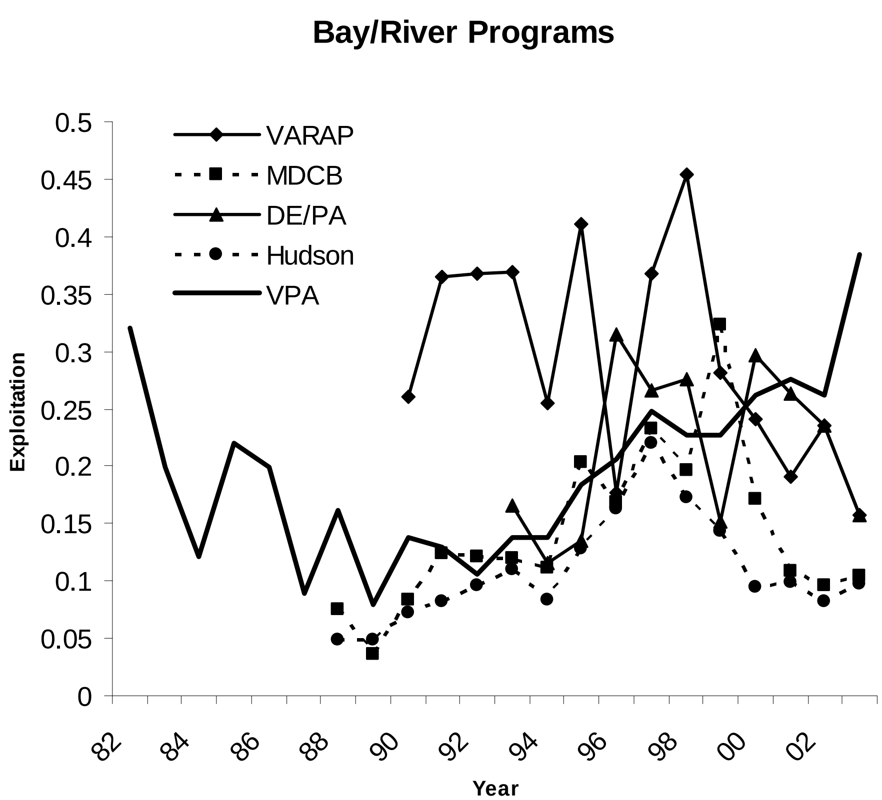


Table 1. Total Atlantic Coast harvest of striped bass in metric tons and numbers from 1982 through 2003.

	Commercial		Recreational		Total	
Year	MT	N	MT	N	MT	N
1982	992	428,630	1,144	217,256	2,136	645,886
1983	639	357,541	1,217	299,444	1,856	656,985
1984	1,104	870,871	579	114,463	1,683	985,334
1985	4,312	174,621	372	133,522	4,684	308,143
1986	68	17,681	501	114,623	569	132,304
1987	63	13,552	388	43,755	451	57,307
1988	117	33,310	570	86,705	687	120,035
1989	91	7,402	332	37,562	423	44,964
1990	313	115,636	1,010	163,242	1,323	278,878
1991	460	153,798	1,653	262,469	2,113	416,267
1992	638	230,714	1,830	300,180	2,468	530,894
1993	777	312,860	2,564	428,719	3,341	741,579
1994	805	307,443	3,084	565,167	3,889	872,610
1995	1,555	534,914	5,636	1,089,223	7,230	1,624,097
1996	2,178	766,518	5,953	1,174,407	8,181	1,941,630
1997	2,679	1,058,181	7,128	1,514,141	9,946	2,573,477
1998	2,936	1,223,828	5,651	1,363,675	8,707	2,590,181
1999	2,941	1,103,783	6,114	1,322,206	9,186	2,423,606
2000	3,003	1,057,711	7,947	1,951,274	10,759	2,975,276
2001	2,826	941,733	8,684	2,012,399	11,715	2,954,047
2002	2,723	654,062	8,249	1,805,275	10,972	2,459,337
2003	3,199	865,689	11,486	2,405,707	14,685	3,271,396

Table 2. Commercial landings in number of Atlantic striped bass by state, 1982-2003.

	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	30,91	31,880	44,521	44,970	413	153,798
1992		11,532	9,095		20,150	27,03	119,286	23,291	42,912	1,745	230,714
1993		13,099	6,294		11,181	42,73	211,089	24,451	39,059	3,414	312,860
1994		11,066	4,512		15,212	48,86	208,914	25,196	32,382	5,275	307,443
1995		44,965	19,722		43,704	55,65	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	64,80	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		55,432	12,200		68,354	31,530	439,482	83,090	161,778	13,823	865,689

Table 3. Total 2003 striped bass harvest and discard in numbers (A) and percent of total by fishery (B).

A

Fishery component	Harvest	Discards	Discard Losses	Total Losses
Recreational	2,405,707	14,611,333	1,168,907	3,574,614
Commercial	865,689	2,352,983	262,078	1,127,767
Total	3,271,396	16,964,316	1,430,985	4,702,381

B

Fishery component	Harvest	Discard Losses	Totals
Recreational	51.2	24.9	76.0
Commercial	18.4	5.6	24.0
Total	69.6	30.4	100.0

Table 4. Atlantic coast striped bass commercial landings in numbers at age, 1982-2003.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1982	0	45,129	200,221	117,158	22,927	5,035	3,328	2,861	1,871	4,407	5,837	7,639	12,217	428,630
1983	0	54,348	120,639	120,999	38,278	7,416	1,954	677	607	1,690	1,314	2,375	7,245	357,542
1984	0	478,268	270,140	55,598	30,580	21,688	6,441	1,744	1,020	771	146	279	4,196	870,871
1985	0	53,699	45,492	7,545	9,448	19,248	21,569	6,581	3,692	1,514	466	607	4,760	174,621
1986	0	639	6,020	3,207	180	703	1,425	1,199	546	182	105	220	3,255	17,681
1987	0	0	3,087	4,265	1,618	252	1,104	1,075	448	233	95	273	1,102	13,552
1988	0	0	2,086	3,961	15,491	6,469	2,803	539	541	218	266	108	828	33,310
1989	0	0	0	0	0	139	1,111	959	1,007	631	475	164	2,916	7,402
1990	0	650	12,551	48,024	29,596	15,122	3,111	2,357	1,147	519	272	130	2,157	115,636
1991	0	2,082	22,430	44,723	41,048	21,614	8,546	4,412	4,816	1,163	269	125	2,570	153,798
1992	0	640	32,277	58,009	46,661	41,581	22,186	11,514	8,746	6,314	1,062	464	1,260	230,714
1993	0	1,848	21,073	93,868	87,447	42,112	32,485	13,829	8,396	6,420	3,955	763	664	312,860
1994	0	1,179	22,873	71,614	101,512	48,269	28,530	14,886	89,02	5,323	2,513	1,250	592	307,443
1995	0	6,726	35,190	114,519	134,709	98,471	38,918	34,191	37,324	21,827	8,364	3,166	1,509	534,914
1996	0	557	50,102	127,825	179,031	161,361	120,693	51,995	29,907	18,864	11,663	9,674	4,847	766,518
1997	0	335	96,860	293,511	225,218	201,397	103,129	60,000	33,262	18,888	11,811	7,861	5,909	1,058,181
1998	0	3,122	65,861	209,898	526,183	192,473	70,124	59,604	44,017	25,365	14,592	5,878	6,711	1,223,828
1999	0	7,344	93,995	233,713	275,297	235,918	76,753	47,251	54,775	35,386	24,005	9,883	9,463	1,103,783
2000	0	0	50,700	218,544	310,504	184,168	128,696	57,289	39,004	42,523	15,946	5,467	4,870	1,057,711
2001	0	165	86,190	189,602	240,736	138,678	86,825	92,095	33,367	31,165	21,960	12,759	8,191	941,733
2002	209	1,076	42,700	140,166	148,605	110,374	60,436	53,728	36,312	22,496	16,592	9,634	11,736	654,064
2003	0	3,932	59,026	156,820	171,410	130,960	94,246	74,842	68,463	58,774	20,479	15,527	11,210	865,689

Table 5. Atlantic Coast striped bass commercial harvest in numbers at age by state in 2003.

	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
Massachusetts							4,089	9,897	16,387	9,417	6,327	6,164	3,151	55,432
Rhode Island			1	30	269	951	2,074	1,986	2,325	1,493	1,003	1,137	931	12,200
New York			131	2,806	8,907	13,624	17,755	10,201	8,277	5,057	1,204	261	131	68,354
Delaware			443	1,890	7,973	9,992	7,447	3,047	520	166		53		31,530
Maryland			28,819	120,176	140,003	87,950	23,627	16,469	10,463	8,621	1,184	2,019	153	439,484
PRFC			26,672	28,251	5,733	7,063	5,484	5,484	3,407	748	249			83,090
Virginia		3,932	2,961	3,668	8,525	11,348	33,342	25,103	24,130	28,329	8,520	5,283	6,637	161,778
North Carolina						34	428	2,656	2,954	4,943	1,992	609	208	13,823
Total		3,932	59,026	156,820	171,410	130,961	94,246	74,842	68,463	58,774	20,479	15,527	11,210	865,691

Table 6. Recovery of tagged striped bass by commercial gear in 2003 and assumed Gear specific release mortalities.

	Commercial Gear						
	Anchor Gill Net	Drift Gill Net	Hook&Line	Pound Net	Seine	Trawl	Total
Number							
Chesapeake Bay	51	27	17	345	0	0	440
Coast	12	2	26	3	0	5	48
Percent							
Chesapeake Bay	0.12	0.06	0.04	0.78	0.00	0.00	1.00
Coast	0.25	0.04	0.54	0.06	0.00	0.10	1.00
Release Mortality	0.43	0.08	0.08	0.05	0.15	0.35	

Table 7. Ratios of commercial and recreational landings and tag recaptures from released and kept fish in Chesapeake Bay and the Atlantic Coast

		Bay			Coast		
		Com	Rec	Ratio	Com	Rec	Ratio
2001	Landings			0.59			0.10
	Landed tags	379	630	0.60	60	676	0.09
	Discard tags	173	330	0.52	24	692	0.03
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
Three year mean of landings ratios				0.72			0.11
Three year mean of landings tags				0.56			0.07
Correction factor				1.30			1.59

Table 8. Atlantic Coast striped bass commercial discard losses in numbers at age, 1982-2003.

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1982	0	4,210	545	2,340	1,294	297	551	233	85	21	21	0	0	9,597
1983	0	14,420	1,017	2,694	7,265	2,163	571	571	245	163	0	0	0	29,111
1984	0	32,809	1,896	6,036	10,020	11,711	2,897	121	604	121	0	0	0	66,214
1985	0	3,435	17,224	3,826	8,487	2,657	2,146	818	204	102	102	0	0	39,001
1986	0	272	2,142	11,687	4,296	2,036	661	215	54	0	0	0	0	21,363
1987	9	2,005	6,762	22,278	37,792	14,226	5,207	1,064	819	327	82	82	82	90,735
1988	1	72	672	2,153	8,566	9,240	3,589	1,405	478	255	32	32	0	26,494
1989	3	1,121	1,278	1,921	24,591	31,747	13,929	7,647	3,128	348	695	695	348	87,451
1990	1	2,460	11,479	15,602	21,939	22,534	13,155	5,005	1,371	353	349	348	0	94,594
1991	53	3,727	13,239	30,481	38,119	24,483	14,093	9,418	2,623	2,218	3,494	13	0	141,961
1992	19	1,445	15,429	18,288	23,464	16,933	6,414	5,241	1,873	1,432	615	0	0	91,154
1993	16	2,538	37,277	56,061	74,809	49,468	12,323	9,098	6,951	4,097	1,552	514	241	254,945
1994	0	28,229	42,864	38,408	71,730	69,102	32,843	7,848	4,521	3,745	762	509	0	300,562
1995	14	94,310	83,969	61,558	117,611	137,807	57,218	18,698	6,233	4,358	3,056	3,032	985	588,851
1996	9	28,128	118,360	79,404	64,768	61,079	32,846	16,476	7,290	5,500	3,539	1,036	514	418,952
1997	102	29,801	74,393	211,540	123,175	71,255	43,727	24,346	11,721	17,168	8,167	1,314	1,284	617,994
1998	0	7,816	31,762	57,300	48,618	17,678	8,097	7,640	4,734	2,602	2,301	1,397	2,193	192,138
1999	574	35,388	30,029	26,306	34,943	10,631	3,593	2,458	1,308	839	422	388	152	147,031
2000	109	101,718	107,764	91,931	37,496	20,662	16,479	4,878	2,506	2,269	489	519	63	386,884
2001	1	1,623	35,166	45,653	58,743	22,148	13,114	7,431	5,700	3,591	2,771	1,100	422	197,464
2002	1,700	20,888	42,641	21,409	28,791	23,720	12,381	6,854	5,645	2,255	1,522	149	248	168,201
2003	1,511	6,227	28,061	54,464	56,728	19,866	30,850	18,633	16,410	13,572	8,164	3,207	4,281	261,973

Table 9. Total Atlantic Coast striped bass recreational harvest in numbers at age by state, 2003.

State	Age													
	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
Maine	0	0	4,916	15,311	21,712	5,192	5,551	4,701	40	38	113	116	75	57,765
New Hampshire	0	0	0	105	1,551	4,617	8,578	4,577	2,707	1,436	599	483	227	24,878
Massachusetts	0	0	0	1,067	12,924	57,536	115,635	79,156	62,410	36,110	14,616	15,235	12,412	407,100
Rhode Island	0	0	180	2,124	7,566	13,727	30,170	13,038	13,728	13,662	9,046	5,416	6,813	115,471
Connecticut	0	0	886	2,551	5,875	9,662	10,351	15,669	15,100	10,567	8,576	3,340	13,406	95,983
New York	0	0	4,594	16,716	42,976	58,013	59,908	57,627	27,272	21,721	13,436	2,656	8,842	313,761
New Jersey	0	0	0	7,006	6,4516	66,247	88,168	64,181	40,834	24,443	13,218	9,526	13,704	391,842
Delaware	0	0	325	1,471	4,128	6,892	7,603	3,507	1,251	1,817	616	904	1,008	29,522
Maryland	0	3,642	47,239	109,306	119,517	89,479	51,360	31,112	30,083	24,560	8,709	6,172	4,011	525,191
Virginia	0	36,619	21,300	28,246	39,655	41,660	87,058	47,082	41,096	36,433	10,306	5,504	6,986	401,945
North Carolina				130	144	2,752	2,684	6,721	11,180	8,500	5,917	4,026	197	42,249
Total	0	40,260	79,440	184,034	320,563	355,777	467,066	327,371	245,701	179,286	85,150	53,378	67,681	2,405,707

Table 10. Total Atlantic Coast striped bass recreational discard losses in numbers at age by state, 2003.

State	Age													
	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
Maine	0	7,778	19,923	12,337	12,211	4,543	6,204	3,316	852	324	97	85	67	67,737
New Hampshire	0	4,412	5,768	3,438	3,157	1,116	1,550	808	273	134	56	60	42	20,813
Massachusetts	0	37,638	65,680	48,326	61,092	33,325	50,421	28,188	12,721	6,342	2,431	2,026	748	348,937
Rhode Island	272	11,943	6,304	5,332	2,968	2,857	3,589	1,180	691	440	198	72	50	35,897
Connecticut	425	14,102	14,291	6,631	7,935	4,365	4,069	4,028	3,576	2,969	1,761	681	2,610	67,443
New York	66	17,297	25,418	12,827	11,028	5,980	5,651	4,419	1,811	1,286	567	86	267	86,705
New Jersey	712	9,885	13,592	11,250	16,649	6,545	6,330	4,263	2,287	1,224	558	380	394	74,071
Delaware	12	2,269	3,017	1,943	2,026	1,138	1,388	864	411	225	79	73	76	13,521
Maryland	25,381	76,369	123,972	74,499	18,067	15,275	9,277	7,155	6,407	8,521	3,161	2,045	2,095	372,224
Virginia	0	19,537	26,311	18,412	5,449	2,470	1,393	813	867	1,083	509	345	452	77,644
North Carolina	3	704	1,070	676	454	261	306	186	101	79	33	20	24	3916
Total	26,871	201,935	305,346	195,671	141,037	77,876	90,178	55,221	29,999	22,626	9,450	5,873	6,825	1,168,908

Table 11. Total Atlantic Coast striped bass recreational harvest and discard losses in number at age by state, 2003

	Age													
State	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
Maine	0	7,778	24,839	27,648	33,923	9,735	11,755	8,017	892	362	209	200	142	125,502
New Hampshire	0	4,412	5,768	3,543	4,708	5,732	10,128	5,384	2,980	1,570	655	542	269	45,691
Massachusetts	0	37,638	65,680	49,392	74,015	90,862	166,055	107,343	75,131	42,451	17,046	17,262	13,161	756,037
Rhode Island	272	11,943	6,484	7,456	10,535	16,584	33,759	14,217	14,419	14,103	9,244	5,489	6,863	151,368
Connecticut	425	14,102	15,177	9,182	13,809	14,027	14,420	19,697	18,677	13,536	10,337	4,021	16,016	163,426
New York	66	17,297	30,012	29,544	54,005	63,994	65,559	62,046	29,083	23,006	14,003	2,741	9,109	400,466
New Jersey	712	9,885	13,592	18,256	81,165	72,792	94,498	68,445	43,121	25,667	13,776	9,906	14,098	465,913
Delaware	12	2,269	3,342	3,413	6,155	8,030	8,991	4,371	1,663	2,041	695	977	1,084	43,043
Maryland	25,381	80,011	171,211	183,805	137,584	104,754	60,638	38,268	36,490	3,3081	11,870	8,217	6,105	897,415
Virginia	0	56,156	47,611	46,658	45,104	44,130	88,451	47,895	41,963	3,7517	10,815	5,850	7,439	479,589
North Carolina	3	704	1,070	806	597	3,012	2,990	6,907	11,281	8,578	5,950	4,046	220	46,165
Total	26,871	242,195	384,786	379,705	461,600	433,653	557,245	382,591	275,700	201,911	94,600	59,250	74,506	3,574,615

Table 12. Total Atlantic Coast striped bass catch at age, including recreational and commercial harvest and discard losses, 1982-2003

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1982	1,958	105,276	256,550	221,480	58,474	19,297	24,703	16,868	11,251	10,506	10,928	13,646	15,228	766,164
1983	4,039	109,881	178,561	193,251	150,563	38,868	18,642	4,302	2,879	3,874	4,329	5,390	13,274	727,850
1984	5,096	543,086	302,904	82,431	60,250	51,901	18,214	4,847	1,606	1,832	1,141	331	11,163	1,084,804
1985	1,070	73,067	102,995	39,785	58,554	42,721	43,386	17,665	5,961	3,653	597	607	10,784	400,845
1986	11,035	21,413	63,582	133,202	49,184	32,079	20,790	25,715	8,936	5,209	3,121	1,225	9,288	384,779
1987	2,006	10,259	37,650	51,037	67,084	25,216	13,625	6,389	6,448	2,617	1,200	2,348	13,146	239,027
1988	2,048	30,743	45,192	62,118	106,956	97,604	40,346	23,951	13,859	4,931	3,544	3,363	10,033	444,686
1989	990	36,632	80,110	66,961	105,396	96,089	44,865	21,625	10,426	3,423	2,927	1,573	8,837	479,854
1990	3,007	53,321	129,427	187,137	171,856	163,576	102,014	64,976	19,431	7,193	4,428	3,011	11,800	921,177
1991	942	76,326	148,830	209,398	161,705	101,536	91,226	81,800	57,766	23,079	14,007	1,868	19,838	988,321
1992	2,741	48,554	205,063	190,400	177,375	109,570	62,223	66,351	55,041	42,884	8,734	3,709	14,241	986,887
1993	0	74,241	190,327	330,404	290,159	185,167	86,981	64,545	79,506	71,711	39,364	9,136	15,442	1,436,983
1994	6,015	146,321	350,236	291,513	368,465	231,323	134,147	85,865	99,877	81,678	35,537	22,866	12,754	1,866,596
1995	4,044	421,635	459,068	447,374	391,192	471,816	205,161	192,952	152,420	89,490	52,815	17,139	13,994	2,919,100
1996	465	92,673	639,877	634,862	533,692	457,493	436,394	208,363	140,050	67,692	42,027	44,643	20,612	3,318,842
1997	2,533	285,465	486,407	850,167	615,831	593,648	405,333	372,114	200,203	120,413	59,611	29,972	24,838	4,046,534
1998	26,248	182,376	483,497	704,729	1,122,875	509,827	279,753	264,441	215,079	113,631	94,887	45,089	65,373	4,107,804
1999	9,146	116,257	431,971	655,589	651,700	714,395	336,810	227,017	193,687	138,658	97,722	45,087	45,746	3,663,786
2000	38,520	323,936	425,134	1,001,655	101,5100	770,233	704,364	306,883	163,455	145,561	63,109	31,142	31,594	5,020,687
2001	34,710	161,810	431,026	604,260	829,724	696,426	576,599	480,263	205,763	119,490	102,939	49,621	47,961	4,340,592
2002	24,708	209,338	301,972	457,336	563,208	732,209	508,360	350,718	273,298	105,306	86,967	47,919	61,647	3,722,985
2003	28,382	252,354	471,872	590,989	689,737	584,480	682,340	476,066	360,573	274,257	123,243	77,984	89,997	4,702,275

Table 13. Atlantic striped bass weight at age in Kg, 1982-2003

	Age												
Year	1	2	3	4	5	6	7	8	9	10	11	12	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	15.11
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	11.12
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	13.74
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	15.09
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	14.53
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	15.04
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	15.40
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	15.50
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	15.49
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	15.86
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	16.07
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	15.02
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	15.60
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	18.78
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	15.76
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	16.58
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	16.58
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	16.58
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	15.76
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	16.58
2002	0.12	0.81	1.25	1.75	2.47	3.30	4.16	5.48	6.36	7.45	8.75	8.89	12.97
2003	0.09	0.58	0.96	1.44	2.24	3.16	4.14	5.16	6.11	7.19	8.53	9.44	11.00

Table 14. Indices of abundance for Atlantic striped bass adjusted to appropriate 1 January measurement time and used in ADAPT, 1982-2003.

State/type	MACOM	MACOM	MACOM	MACOM	MACOM	MACOM	MACOM	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE	CTCPUE
Age>>	7	8	9	10	11	12	13+	2	3	4	5	6	7	8	9	10
Measurement	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean
Year																
1982	0	0	0	0	0	0	0	0.33	0.21	0.11	0.09	0.08	0.04	0.02	0.01	0.01
1983	0	0	0	0	0	0	0	0.4	0.19	0.08	0.04	0.03	0.01	0	0	0
1984	0	0	0	0	0	0	0	0.12	0.33	0.23	0.14	0.05	0.04	0.01	0	0
1985	0	0	0	0	0	0	0	0.06	0.32	0.22	0.12	0.09	0.04	0.03	0.01	0
1986	0	0	0	0	0	0	0	0.08	0.2	0.47	0.45	0.18	0.05	0.01	0.05	0.02
1987	0	0	0	0	0	0	0	0.04	0.24	0.34	0.2	0.14	0.06	0.04	0.03	0.03
1988	0	0	0	0	0	0	0	0.02	0.52	0.28	0.18	0.15	0.12	0.05	0.03	0.01
1989	0	0	0	0	0	0	0	0.27	0.48	0.47	0.16	0.18	0.13	0.09	0.03	0.02
1990	0	0	0	0	0	0	0	0.17	0.58	0.56	0.27	0.12	0.13	0.15	0.13	0.05
1991	0.05	0.2	0.26	0.05	0.02	0.02	0.08	0.15	0.67	0.43	0.35	0.14	0.07	0.09	0.13	0.09
1992	0.02	0.15	0.3	0.29	0.02	0.01	0.04	0.17	0.48	0.57	0.29	0.23	0.11	0.1	0.16	0.15
1993	0.01	0.07	0.22	0.29	0.18	0.03	0.01	0.07	0.7	0.62	0.49	0.28	0.22	0.1	0.08	0.11
1994	0.02	0.12	0.27	0.18	0.07	0.03	0.02	0.21	0.61	0.88	0.46	0.57	0.36	0.23	0.16	0.2
1995	0.01	0.07	0.34	0.37	0.18	0.07	0.02	0.6	1.2	1.34	0.59	0.59	0.32	0.18	0.19	0.19
1996	0	0.07	0.13	0.23	0.23	0.12	0.07	0.47	1.09	2.39	0.9	0.84	0.38	0.6	0.37	0.23
1997	0	0.14	0.2	0.2	0.19	0.12	0.13	0.18	1.11	1.28	1.64	0.58	0.31	0.23	0.21	0.12
1998	0.03	0.14	0.3	0.23	0.22	0.1	0.08	0.21	2.29	1.53	0.74	1.59	0.43	0.21	0.17	0.2
1999	0	0.02	0.25	0.38	0.26	0.18	0.1	0.38	0.43	1.28	0.37	0.39	0.6	0.62	0.41	0.24
2000	0.01	0.03	0.31	0.37	0.31	0.13	0.12	0	0.01	0.65	1.04	1.11	2.46	0.55	0.3	0.3
2001	0.01	0.17	0.23	0.37	0.41	0.14	0.12	0.89	0.67	0.56	2.24	1.12	0.67	0.65	0.41	0.05
2002	0.06	0.11	0.24	0.29	0.35	0.22	0.36	1.41	1.13	0.58	1.61	0.22	0.2	0.26	0.19	0.06
2003	0.02	0.18	0.41	0.33	0.27	0.26	0.13	1.33	1.36	0.63	0.75	0.41	0.39	0.38	0.34	0.28
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 14. Continued.

State/type	CTCPUE	CTCPUE	CTCPUE	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	MDSSN	NYOHS
Age>>	11	12	13+	2	3	4	5	6	7	8	9	10	11	12	13+	3
Measurement time>	mean	mean	mean	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan
Year																
1982	0	0	0.003	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0.001	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0.002	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0.001	140.1	303.6	31.9	4.5	1.2	1.7	0	0.3	0.1	0	0.2	0.9	0
1986	0	0	0.008	230.2	260	495.8	4.1	5.3	2.1	3	3	0	0	0	0.9	0
1987	0.01	0	0.005	140.1	251.7	111.1	188.8	1.8	1.6	4.2	0.2	0	0	0	10.8	0
1988	0	0	0.001	38.5	73.6	70.7	57.7	77.4	1.4	0	0	4.3	0	0	0.4	1.13
1989	0.01	0	0	33.1	152.5	80.4	45.5	48.9	33.3	0.2	0.1	0	0	0	0	6.41
1990	0.02	0.01	0.013	78.1	158.1	120.3	48.3	34.3	32	29.8	0.9	0.1	0.1	0.5	1.5	1.86
1991	0.03	0.01	0.003	73.4	191.1	62.2	47.1	26.7	26.1	19.2	10.7	0.4	1.5	0	2.3	1.89
1992	0.09	0.02	0.007	27.4	218.7	152.6	58.8	70.1	43.2	29.4	13.9	7.3	3.3	0	2.4	5.23
1993	0.1	0.05	0.025	41	132	186	88.5	51.2	52.2	37.5	23	7.7	3.2	0.8	3.9	1.49
1994	0.14	0.07	0.064	26.8	103.5	97.3	118	59.6	34.1	43.1	17.8	8.7	3.1	1.3	1.6	3.81
1995	0.12	0.05	0.026	50	117.2	67.3	60.9	51.8	40.2	25.1	19.8	11.6	9.7	3.5	8.2	2.22
1996	0.1	0.08	0.133	4	368.3	102.2	34.7	69.5	64.4	42.3	35.4	16.7	15.2	4.7	6.3	3.2
1997	0.06	0.07	0.2	40.6	46.3	134.6	46	21.7	19.7	25.8	22.3	12.3	12	3.7	5.5	11.75
1998	0.03	0.1	0.074	36.1	142.8	32.7	149.3	32.3	13.2	18.5	17.3	15	9.1	9.9	12.4	20.24
1999	0.42	0.21	0.176	7	174.2	80.1	56.8	35.3	11.4	6.6	11.1	5.2	5.1	2.7	3.9	19.6
2000	0.23	0.15	0.073	10.2	50.7	107.6	50.3	58.2	27.2	14.1	8.1	7.9	7.8	4.9	10.4	1.97
2001	0.08	0.12	0.1	4.7	39.1	52.3	51.6	23.2	28.5	38	13.2	11.9	9.8	5.5	10.3	7.79
2002	0.05	0.04	0.12	96.3	41.5	38.5	83.3	34	29.9	31.6	22.8	7.4	4.1	5.4	11	1.49
2003	0.17	0.06	0.25	17.7	110	47.8	37.1	61.5	56.8	30.8	27.5	34.4	9.9	10.6	21.5	7.33
2004	0	0	0	21.3	175.8	131.3	25.7	70.8	49.9	16	12	18.6	6.3	2.9	14.2	11.51

Table 14. Continued.

State/type	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NYOHS	NEFSC	NEFSC	NEFSC	NEFSC	NEFSC	NEFSC
Age>>	4	5	6	7	8	9	10	11	12	13+	2	3	4	5	6	7
Measurement time>	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan
Year																
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0.3	2.8	5	1.7	3.9
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	2.2	5	3.9
1988	6.93	12.77	9.91	3.14	1.24	0.24	0.06	0	0.02	0.1	0	0	0	0	0	0
1989	7.64	5.53	4.72	2.42	0.62	0.41	0.11	0.06	0.02	0.39	0	0	1.3	7.1	12	3.6
1990	2.73	1.5	1.62	1.04	0.95	0.22	0.03	0.02	0.03	0.13	0	0	2.7	9.7	45.6	67.7
1991	9.19	9.52	3.54	3.06	1.73	1.38	0.49	0.18	0.03	0.07	0	3.2	0	3.3	17.9	73.3
1992	9.26	6.16	1.31	0.42	0.64	1.05	0.58	0.16	0.05	0.38	0	12.8	5.5	7.2	18.3	40.8
1993	7.84	4.85	2.28	0.62	0.27	0.32	0.47	0.33	0.06	0.29	0	0	0	17.8	28.3	58.9
1994	9.43	7.09	1.71	0.8	0.23	0.22	0.28	0.32	0.17	0.26	0	17.1	105.1	399.7	364.8	211.8
1995	4.26	2.46	2.12	1.31	0.86	0.59	0.35	0.64	0.2	0.7	389.3	76.7	123.7	84.2	138.3	55.4
1996	3.52	3.32	0.94	0.86	0.46	0.16	0.07	0.16	0.15	0.15	11.1	45	31.6	42.8	142.9	190.4
1997	105.61	16.13	4.64	1.33	1.03	0.38	0.19	0.1	0	0.11	17.7	137	140.7	102.4	126.7	188.6
1998	23.79	44.23	6.56	1.81	0.36	0.36	0.38	0.17	0.07	0.15	146.8	226.4	72.5	80	62.4	68.1
1999	31.02	17.91	29.83	3.82	0.95	0.61	0.3	0.02	0.1	0.28	100.7	40.5	168.9	68.9	22.4	33.9
2000	17.75	4.87	1.68	1.24	0.14	0.09	0.13	0.1	0.11	0.15	31.6	112.7	69.4	122.5	164	357.3
2001	11.81	26.54	9.43	2.23	2.25	0.25	0.24	0.1	0.11	0.33	0	3.8	21.4	156.7	159.6	77.4
2002	12.94	4.19	6.05	2.09	0.78	0.55	0.09	0.11	0.03	0.07	235.4	77.3	252.8	83.2	120	62.6
2003	5.14	4.19	1.83	1.67	1.3	0.45	0.45	0.03	0.11	0.17	3.4	9.8	55.5	85.1	80.9	204.7
2004	20.76	7.12	5.25	2.31	3.68	2.88	1.29	1.01	0.72	0.33	0.2	30.5	70.7	46.8	71.5	31.6

Table 14. Continued.

State/type	NEFSC	NEFSC	NEFSC	NEFSC	NEFSC	NEFSC	HUDSHD	YOYNY	YOYNJ	YOYMD	YOYVA	YRLLI	YRLMD	NJTRL	CTTRL	DE TRWL
Age>>	8	9	10	11	12	13+	8:13	1	1	1	1	2	2	2:13	4:06	2:08
Measurement time>	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	mean
Year																
1982	0	0	0	0	0	0	0	8.86	0	0.59	1.56	0	0.02	0	0	0.19
1983	0	0	11.5	1.4	4.3	5.8	0	14.17	0.12	3.57	2.71	0	0.02	0	0	0.01
1984	1.9	0	0	0	0	11.1	0	16.25	0.03	0.61	3.4	0	0.28	0	0.02	0.01
1985	8.6	0.9	0.4	0	0	22.5	14.2	15	0.29	1.64	4.47	0	0	0	0	0.01
1986	3	3	0	0	3	15	32.1	1.92	0.18	0.91	2.41	0.61	0.15	0	0	0
1987	0	1.1	0.6	0.6	0.6	0	86.8	2.92	0.28	1.34	4.74	0.3	0.03	0	0.05	0
1988	13.6	0	0	0	0	0	65	15.9	0.41	1.46	15.74	0.21	0.06	0	0.04	0
1989	0	0	0	0	0	0	361.4	33.46	0.35	0.73	7.64	0.81	0.07	0.21	0.06	0
1990	35.8	10.5	31.1	0	0	0	231.2	21.35	1.03	4.87	11.23	1.78	0.18	0.91	0.16	0
1991	77.9	50.8	6.9	1.8	0	0	1,136.9	19.08	1	1.03	7.34	0.37	0.28	1.3	0.15	1.17
1992	45.3	46.1	46.6	14.4	0	0	646.3	3.6	0.47	1.52	3.76	1.26	0.18	0.56	0.22	0.23
1993	120.3	145.9	78.2	22.2	9.3	0	1,438.5	11.43	1.19	2.34	7.35	1.34	0.14	0.7	0.27	0.89
1994	184.6	51.2	18.1	29.4	12.4	0	1,585.6	12.59	1.78	13.97	18.11	0.75	0.18	1.07	0.3	1.96
1995	33.7	10.9	9.1	10.2	1.3	0	641.6	17.64	0.96	6.4	10.48	1.43	0.58	3.36	0.59	2.59
1996	106.5	19.3	7.8	4.6	0	0	2,708.3	16.23	1.98	4.41	5.45	1.29	0.12	9.11	0.63	15.65
1997	180.7	114.1	69.6	72.3	20.2	11.8	728.4	8.93	1.7	17.61	23	1.54	0.08	6.4	0.85	7.2
1998	24.4	30.5	13.4	0	0	0	737.3	22.3	1.01	3.91	9.35	1	0.23	4.26	0.97	2.73
1999	8.1	4.4	0	0	0	0	1,319.7	13.39	1.31	5.5	13.25	2.1	0.16	3.12	1.1	2.04
2000	288.8	96.2	28.9	2.7	0	0	216.9	26.64	1.9	5.34	2.8	2.05	0.31	4.23	0.84	10.05
2001	106	43.9	38.9	5.7	9.5	0	633.2	3.16	1.77	7.42	16.18	1.56	0.23	1.31	0.61	6.03
2002	26.4	12.7	0.2	0.4	0.7	0	0	23	1.07	12.57	14.17	2.16	0.28	3.5	1.3	4.17
2003	135.8	85.8	69.5	22.5	12.7	12.7	0	12.3	0.51	2.2	3.98	2.53	0.58	5.45	0.87	7.21
2004	28.8	31	11	4.5	1.6	6.9	0	16.88	2.43	10.83	22.89	1.19	0.07	4.57	0	1.45

Table 14 Continued.

State/type	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN	VAPN
Age>>	2	3	4	5	6	7	8	9	10	11	12	13+
Measurement time>	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan	1-Jan
Year												
1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0.42	0.33	3.58	8	2.67	1.67	0.5	0.25	0.17	0.5	0.08	0
1992	0.2	0.5	0.6	1.6	2.75	1.15	0.3	0.4	0.2	0.3	0.15	0
1993	0.12	0.57	1.04	3.58	9.54	3.65	0.65	0.42	0.58	0.46	0.31	0.42
1994	0	1.44	0.48	1.33	4.59	2.22	1.15	0.59	0.52	0.33	0.33	0.34
1995	0.04	3.04	4.8	1	2.24	0.68	0.6	0.68	0.4	0.08	0.28	0.08
1996	0	0.51	3.97	2.86	1.63	1.26	0.89	0.37	0.37	0.09	0	0.03
1997	0	0.6	3.9	8.1	1.25	0.05	0.7	0.8	1.5	1	1	0.7
1998	0	0.19	2.15	6.33	1.48	0.04	0.52	0.7	0.78	0.89	0.89	0.44
1999	0	0.79	11.54	11.5	2.79	0.11	0.5	0.43	0.32	0.36	0.39	0.62
2000	0	0.03	15.61	18.13	3.34	0.11	0.5	0.5	0.4	0.29	0.37	0.1
2001	0	0.07	2.74	7.49	4.29	0.1	0.58	0.87	0.87	0.81	0.45	0.36
2002	0	0	0.51	1.44	1.38	0.25	0.68	0.41	0.28	0.19	0.06	0.03
2003	0	0	0.76	3	3.33	0.37	1.83	1.4	1.7	1.43	1.13	0.7
2004	0	0	0	0	0	0	0	0	0	0	0	0

Table 15. Average F and F estimates weighted by N

	Ave F	Average F Weighted by N	
Year	8 - 11	7 - 11	3 - 8
1982	0.55	0.42	0.36
1983	0.36	0.24	0.38
1984	0.12	0.14	0.30
1985	0.17	0.27	0.12
1986	0.22	0.24	0.09
1987	0.10	0.10	0.04
1988	0.21	0.19	0.07
1989	0.12	0.09	0.06
1990	0.16	0.16	0.10
1991	0.24	0.15	0.08
1992	0.16	0.12	0.07
1993	0.24	0.16	0.08
1994	0.24	0.16	0.09
1995	0.28	0.22	0.13
1996	0.25	0.25	0.15
1997	0.33	0.31	0.16
1998	0.34	0.28	0.16
1999	0.37	0.28	0.14
2000	0.30	0.33	0.22
2001	0.36	0.35	0.19
2002	0.34	0.33	0.18
2003	0.62	0.53	0.18

Table 16. Estimated fishing mortality (F) at age

AGE	Fishing Mortality																					
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
2	0.12	0.10	0.25	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.01	0.03	0.02	0.02	0.04	0.03	0.02	0.02
3	0.38	0.30	0.39	0.06	0.04	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.07	0.08	0.08	0.07	0.07	0.06	0.08	0.07	0.07	0.05
4	0.38	0.53	0.20	0.08	0.10	0.04	0.03	0.05	0.10	0.08	0.07	0.08	0.07	0.11	0.15	0.13	0.13	0.12	0.18	0.16	0.10	0.18
5	0.28	0.45	0.29	0.21	0.12	0.07	0.11	0.07	0.15	0.11	0.09	0.13	0.12	0.13	0.18	0.20	0.24	0.16	0.27	0.22	0.20	0.19
6	0.19	0.29	0.26	0.33	0.16	0.08	0.13	0.13	0.14	0.12	0.09	0.12	0.14	0.20	0.20	0.30	0.24	0.22	0.28	0.28	0.29	0.31
7	0.34	0.27	0.20	0.34	0.24	0.09	0.17	0.08	0.19	0.10	0.09	0.09	0.11	0.17	0.27	0.26	0.21	0.23	0.35	0.32	0.33	0.45
8	0.60	0.08	0.10	0.28	0.30	0.11	0.21	0.12	0.14	0.21	0.10	0.13	0.12	0.21	0.25	0.37	0.26	0.25	0.33	0.39	0.31	0.53
9	0.68	0.18	0.05	0.17	0.23	0.12	0.33	0.13	0.15	0.17	0.21	0.15	0.27	0.30	0.23	0.38	0.36	0.29	0.26	0.35	0.38	0.57
10	0.71	0.45	0.18	0.11	0.20	0.10	0.14	0.13	0.12	0.25	0.18	0.44	0.21	0.39	0.20	0.29	0.36	0.39	0.34	0.30	0.30	0.75
11	0.20	0.74	0.13	0.12	0.14	0.08	0.17	0.10	0.25	0.32	0.13	0.23	0.36	0.19	0.31	0.26	0.38	0.57	0.27	0.42	0.36	0.62
12	0.65	0.14	0.09	0.21	0.26	0.11	0.22	0.12	0.14	0.20	0.14	0.18	0.18	0.27	0.23	0.36	0.31	0.29	0.31	0.36	0.33	0.59
13	0.65	0.14	0.09	0.21	0.26	0.11	0.22	0.12	0.14	0.20	0.14	0.18	0.18	0.27	0.23	0.36	0.31	0.29	0.31	0.36	0.33	0.59

Table 17. Iterative weighting factors

Survey Index	Age	Chi Weight Factor
NEFSC	2	0.2399
NEFSC	10	0.3322
DETRWL	2-8	0.3504
NEFSC	3	0.4384
NEFSC	11	0.4681
MDSSN	13	0.6168
NYOHS	11	0.7112
NEFSC	4	0.7146
MDSSN	10	0.777
NYOHS	9	0.8241
NYOHS	8	0.8672
CTCPUE	3	0.8781
NEFSC	5	0.9248
NEFSC	9	0.9299
MDSSN	9	0.9643
CTCPUE	2	0.9697
NYOHS	10	0.9979
MDSSN	8	1.0206
NEFSC	8	1.0348
NYOHS	6	1.1253
YOYNY	1	1.2388
NYOHS	7	1.3719
NEFSC	7	1.3787
NYOHS	13	1.4002
NYOHS	5	1.4364
MACOM	13	1.4838
NEFSC	6	1.5303
MACOM	8	1.5556

Survey Index	Age	Chi Weight Factor
CTCPUE	11	1.5823
MACOM	7	1.5838
NYOHS	12	1.5863
NYOHS	3	1.6476
NJTRL	2-13	1.7303
MDSSN	7	1.8918
NYOHS	4	1.9178
MDSSN	6	1.9822
MDSSN	11	2.1476
CTCPUE	6	2.2662
CTCPUE	5	2.3418
MDSSN	12	2.456
YOYMD	1	2.5418
MACOM	12	2.6607
YOYNJ	1	2.6994
CTCPUE	7	2.7529
CTCPUE	10	2.8519
YRLMD	2	3.0479
YRLLI	2	3.3005
CTCPUE	8	3.3131
MACOM	11	3.4848
YOYVA	1	4.1405
CTCPUE	9	4.171
CTCPUE	12	4.375
CTCPUE	4	4.4097
MACOM	9	4.9943
MACOM	10	5.8289

Table 18. Estimated population size at age

	Population Abundance (000s)																						
AGE	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	1,501	3,079	2,323	3,305	2,626	3,595	4,753	5,128	7,556	7,238	7,652	8,587	13,269	10,638	10,633	10,820	7,876	9,461	6,623	14,527	17,298	4,680	21,622
2	981	1,291	2,647	1,994	2,844	2,250	3,093	4,088	4,413	6,501	6,228	6,583	7,390	11,416	9,153	9,151	9,311	6,755	8,135	5,666	12,472	14,865	4,002
3	861	747	1,009	1,777	1,649	2,428	1,926	2,633	3,486	3,755	5,528	5,318	5,602	6,226	9,430	7,792	7,612	7,844	5,706	6,702	4,726	10,537	12,561
4	752	505	478	589	1,435	1,360	2,055	1,619	2,193	2,885	3,098	4,573	4,406	4,499	4,934	7,524	6,256	6,102	6,350	4,522	5,369	3,784	8,632
5	256	443	256	335	469	1,112	1,123	1,710	1,330	1,713	2,290	2,491	3,633	3,523	3,457	3,659	5,689	4,731	4,645	4,551	3,332	4,192	2,711
6	119	167	243	165	234	358	895	868	1,375	985	1,325	1,807	1,877	2,787	2,670	2,482	2,580	3,857	3,469	3,054	3,149	2,341	2,971
7	91	85	107	162	102	172	285	679	659	1,031	754	1,039	1,383	1,400	1,963	1,875	1,588	1,748	2,660	2,265	1,985	2,025	1,476
8	40	56	56	75	99	69	136	208	543	471	802	591	814	1,065	1,016	1,287	1,239	1,108	1,194	1,608	1,417	1,234	1,114
9	25	19	44	44	49	63	53	94	159	404	328	628	446	620	741	682	764	822	744	740	941	892	623
10	22	11	14	36	32	34	48	33	72	118	293	229	464	292	394	508	402	459	529	492	447	555	436
11	64	9	6	10	28	22	26	36	25	55	79	211	127	325	170	277	326	241	267	324	313	286	226
12	31	45	4	5	7	21	18	19	28	17	34	60	144	76	231	107	183	193	118	175	184	188	133
13	35	109	141	59	47	134	52	85	110	134	132	112	94	68	106	89	265	195	124	169	237	217	194
Total	4,778	6,564	7,328	8,555	9,621	11,618	14,463	17,201	21,948	25,306	28,545	32,229	39,650	42,935	44,898	46,252	44,091	43,515	40,562	44,794	51,869	45,797	56,700
8+	217	249	265	229	262	343	333	475	937	1,199	1,668	1,831	2,089	2,446	2,658	2,950	3,179	3,018	2,976	3,508	3,539	3,372	2,726

Table 19. Estimated female spawning stock population biomass at age

	Female Spawning Stock Biomass (MT)																					
AGE	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	17	11	11	19	43	43	65	48	66	86	93	139	142	163	164	269	200	195	196	161	145	90
5	32	50	30	38	58	167	176	259	186	244	347	352	530	533	557	566	904	757	789	703	498	490
6	94	98	144	106	129	203	599	689	994	569	872	1,213	1,234	1,888	1,983	1,767	1,723	2,580	2,573	2,178	1,995	1,303
7	171	131	182	270	159	243	424	1,326	1,290	1,855	1,247	1,828	2,437	2,531	3,907	3,491	2,666	2,929	5,241	4,195	3,163	2,893
8	96	126	114	173	214	132	245	480	1,353	1,085	1,876	1,428	1,962	2,573	2,743	3,154	2,581	2,310	2,925	3,939	3,054	2,345
9	61	52	126	126	124	157	123	236	445	1,174	959	1,877	1,332	1,923	2,390	2,162	2,048	2,218	2,169	2,350	2,448	2,241
10	81	36	44	121	95	94	127	105	203	327	996	777	1,574	1,037	1,502	1,987	1,450	1,649	1,914	1,922	1,461	1,593
11	328	38	24	39	100	72	91	121	93	190	291	865	513	1,144	711	1,226	1,426	1,035	1,142	1,417	1,287	968
12	150	223	20	20	32	86	74	82	120	62	174	286	678	342	939	481	852	899	544	783	798	726
13	237	568	916	414	317	952	370	618	803	988	999	787	686	595	780	678	2,028	1,497	900	1,287	1,413	955
Total	1,265	1,332	1,608	1,324	1,269	2,147	2,294	3,963	5,550	6,577	7,851	9,551	11,087	12,726	15,673	15,778	15,875	16,067	18,391	18,933	16,260	13,602

Table 20. Results of sensitivity runs to evaluate effects of various inputs on ADAPT estimates of F and population size.

Input options	total # indices	M	re-wt	RSS	2003 8-11 F	2003 pop size
2004 base	55	0.15	yes	1,705.2	0.62	56,700
base w/o wts	55	0.15	no	749.7	0.59	48,499
with VA	67	0.15	yes	2,017.9	0.63	57,834
all indices	76	0.15	yes	2,166.2	0.64	54,067
select for trends	47	0.15	yes	1,564.4	0.70	55,680
Des M (.5 ages 2-5 since 98)	55	vary	yes	1,665.9	0.64	57,444
40% caa reduction in 2003	55	0.15	yes	1,722.4	0.37	57,776
coast only indices (plus ji's)	51	0.15	yes	1,586.8	0.63	57,610
CT only (& ji's)	16	0.15	yes	198.2	0.44	53,073
MA only (with ji's)	11	0.15	yes	70.1	0.44	56,684
MD only (with ji's)	15	0.15	yes	230.2	0.51	36,068
NMFS only (with ji's)	14	0.15	yes	279.2	1.38	46,086
NY only (with ji's)	14	0.15	yes	181.0	0.68	52,141
no NY or NMFS	34	0.15	yes	1,382.6	0.58	60,481
old index series	55	0.15	yes	1,762.6	0.53	59,239

Table 21. Tag-based estimates of annual instantaneous fishing mortality of striped bass >= 28 inches. Estimates are adjusted for live-release bias, hooking mortality (0.08), and reporting rate (0.43).

Coast Programs

Year	MADFW	NYOHS	NJDEL	NCCOOP	Unweighted average	lower 95% CI	upper 95% CI
1988		-0.19		-0.14			
1989		-0.14	-0.23	0.14			
1990		0.16	0.05	0.19			
1991		0.15	0.05	0.17			
1992	-0.01	0.08	0.06	0.07	0.05	0.00	0.17
1993	-0.01	0.20	0.09	0.07	0.09	0.00	0.28
1994	-0.02	0.17	0.04	0.35	0.14	0.01	0.31
1995	0.11	0.12	0.05	0.21	0.12	0.05	0.21
1996	0.13	0.15	0.10	0.36	0.19	0.08	0.31
1997	0.14	0.19	0.14	0.49	0.24	0.11	0.42
1998	0.12	0.25	0.12	0.12	0.15	0.01	0.44
1999	0.14	0.26	0.12	0.25	0.19	0.12	0.28
2000	0.13	0.20	0.11	0.59	0.26	0.09	0.50
2001	0.07	0.25	0.12	0.31	0.19	0.04	0.41
2002	0.09	0.13	0.12	0.20	0.13	0.02	0.29
2003	0.09	0.24	0.10	0.19	0.15	0.03	0.33

Producer Area Programs

Year	HUDSON	DE/PA	MDCB	VARAP	Weighted average*	lower 95% CI	upper 95% CI
1987			-0.12				
1988	0.00		-0.17				
1989	0.01		-0.19				
1990	0.09		0.38	0.18			
1991	0.14		0.18	0.18			
1992	0.10		0.14	0.13			
1993	0.13	0.18	0.09	0.22	0.14	0.06	0.23
1994	0.10	0.21	0.04	0.24	0.11	0.03	0.22
1995	0.15	0.23	0.18	0.26	0.20	0.13	0.29
1996	0.20	0.24	0.21	0.33	0.24	0.18	0.32
1997	0.19	0.26	0.24	0.31	0.25	0.19	0.32
1998	0.21	0.29	0.27	0.25	0.26	0.20	0.32
1999	0.19	0.31	0.28	0.28	0.27	0.20	0.35
2000	0.11	0.29	0.32	0.27	0.28	0.20	0.38
2001	0.13	0.32	0.34	0.29	0.30	0.20	0.42
2002	0.11	0.31	0.35	0.27	0.29	0.17	0.44
2003	0.09	0.28	0.40	0.28	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 22. Survival (S) and fishing mortality (F) rates of striped bass>= 28 inches, including estimates adjusted (adj.) for repoting rate (0.433), bias from live releases, and hooking mortality (0.08).

Coast Programs

Massachusetts; C-hat = 1.0; 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	0.797	0.077	0.049	0.750	-0.081	0.867	-0.007	-0.113	0.173
1993	0.795	0.080	0.068	0.569	-0.090	0.873	-0.014	-0.098	0.111
1994	0.818	0.051	0.056	0.523	-0.067	0.876	-0.018	-0.111	0.141
1995	0.728	0.168	0.062	0.380	-0.056	0.771	0.110	0.027	0.217
1996	0.711	0.191	0.088	0.263	-0.059	0.756	0.130	0.060	0.215
1997	0.716	0.184	0.073	0.216	-0.039	0.745	0.144	0.079	0.222
1998	0.714	0.187	0.094	0.280	-0.067	0.766	0.117	0.048	0.201
1999	0.708	0.195	0.080	0.279	-0.055	0.749	0.139	0.047	0.256
2000	0.726	0.170	0.069	0.208	-0.035	0.753	0.134	0.052	0.239
2001	0.775	0.105	0.047	0.333	-0.036	0.804	0.068	-0.046	0.258
2002	0.747	0.142	0.068	0.319	-0.052	0.788	0.089	0.001	0.207
2003	0.768	0.114	0.052	0.182	-0.022	0.785	0.092	-0.013	0.253

New York - Ocean Haul Seine
C-hat adjustment = 1.00; bootstrap GOF probability = 0.326 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	0.798	0.076	0.117	0.900	-0.236	1.044	-0.194	-0.299	-0.014
1989	0.803	0.070	0.098	0.860	-0.189	0.990	-0.140	-0.242	0.035
1990	0.636	0.303	0.089	0.660	-0.137	0.736	0.156	0.072	0.255
1991	0.631	0.311	0.113	0.530	-0.148	0.741	0.150	0.080	0.231
1992	0.636	0.302	0.145	0.540	-0.202	0.797	0.077	0.010	0.152
1993	0.625	0.320	0.108	0.430	-0.117	0.708	0.195	0.121	0.281
1994	0.629	0.314	0.110	0.490	-0.134	0.726	0.170	0.084	0.272
1995	0.660	0.265	0.147	0.330	-0.136	0.764	0.119	0.034	0.220
1996	0.657	0.270	0.134	0.300	-0.111	0.739	0.153	0.079	0.238
1997	0.655	0.273	0.138	0.210	-0.084	0.715	0.185	0.117	0.264
1998	0.640	0.296	0.098	0.190	-0.049	0.673	0.246	0.171	0.333
1999	0.639	0.298	0.132	0.100	-0.039	0.665	0.258	0.181	0.346
2000	0.644	0.291	0.132	0.220	-0.082	0.701	0.205	0.111	0.318
2001	0.632	0.309	0.099	0.240	-0.062	0.674	0.245	0.138	0.377
2002	0.646	0.288	0.137	0.400	-0.147	0.757	0.129	-0.018	0.330
2003	0.646	0.287	0.090	0.210	-0.049	0.679	0.237	0.063	0.492

Table 22. Continued.

New Jersey - Delaware Bay
C-hat adjustment = 1.00; bootstrap GOF probability = 0.714 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1989	0.811	0.059	0.114	1.000	-0.248	1.078	-0.225	-0.376	0.205
1990	0.696	0.212	0.117	0.500	-0.145	0.815	0.055	-0.102	0.302
1991	0.604	0.355	0.220	0.380	-0.265	0.822	0.047	-0.239	0.557
1992	0.678	0.239	0.077	1.000	-0.166	0.812	0.058	-0.066	0.225
1993	0.647	0.286	0.100	0.770	-0.175	0.784	0.094	-0.057	0.302
1994	0.683	0.231	0.097	0.790	-0.173	0.826	0.041	-0.059	0.168
1995	0.695	0.214	0.104	0.610	-0.151	0.818	0.050	-0.021	0.136
1996	0.674	0.245	0.127	0.420	-0.138	0.782	0.096	0.021	0.185
1997	0.676	0.241	0.095	0.420	-0.098	0.750	0.138	0.072	0.215
1998	0.655	0.273	0.163	0.290	-0.139	0.761	0.123	-0.003	0.288
1999	0.697	0.212	0.108	0.300	-0.084	0.760	0.124	0.053	0.209
2000	0.712	0.189	0.098	0.300	-0.075	0.770	0.112	0.017	0.236
2001	0.711	0.191	0.090	0.300	-0.068	0.763	0.120	0.028	0.240
2002	0.713	0.189	0.075	0.350	-0.064	0.761	0.123	0.021	0.260
2003	0.711	0.191	0.097	0.360	-0.088	0.780	0.099	0.007	0.218

North Carolina - Cooperative Trawl Cruise
C-hat adjustment = 1.223; bootstrap GOF probability = 0.023 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	0.713	0.188	0.106	0.714	-0.177	0.867	-0.007	-0.145	0.203
1989	0.678	0.239	0.060	0.703	-0.095	0.749	0.140	-0.066	0.503
1990	0.637	0.301	0.075	0.611	-0.107	0.713	0.188	-0.012	0.497
1991	0.629	0.313	0.089	0.664	-0.138	0.730	0.165	0.005	0.386
1992	0.706	0.198	0.106	0.449	-0.118	0.801	0.072	0.022	0.129
1993	0.709	0.194	0.092	0.529	-0.117	0.803	0.070	-0.116	0.408
1994	0.547	0.453	0.078	0.509	-0.095	0.605	0.353	0.139	0.643
1995	0.637	0.301	0.103	0.342	-0.091	0.701	0.206	0.144	0.275
1996	0.582	0.392	0.054	0.211	-0.027	0.598	0.364	0.179	0.613
1997	0.502	0.539	0.095	0.201	-0.050	0.528	0.488	0.168	0.963
1998	0.704	0.201	0.113	0.261	-0.079	0.764	0.119	-0.156	0.939
1999	0.632	0.308	0.097	0.244	-0.061	0.673	0.245	0.191	0.306
2000	0.457	0.633	0.053	0.354	-0.044	0.478	0.587	0.179	1.217
2001	0.594	0.370	0.095	0.218	-0.054	0.628	0.315	0.043	0.771
2002	0.684	0.229	0.068	0.198	-0.033	0.707	0.196	0.068	0.374
2003	0.684	0.229	0.061	0.276	-0.040	0.713	0.188	0.057	0.371

Table 22. Continued.

Producer Area Programs

Delaware / Pennsylvania - Delaware River
C-hat = 1.00; bootstrap GOF probability = 0.384 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	0.655	0.273	0.106	0.330	-0.090	0.720	0.178	0.020	0.407
1994	0.641	0.295	0.108	0.286	-0.081	0.697	0.210	0.066	0.405
1995	0.608	0.348	0.117	0.350	-0.107	0.681	0.235	0.175	0.300
1996	0.604	0.354	0.138	0.280	-0.109	0.678	0.239	0.177	0.308
1997	0.610	0.344	0.108	0.280	-0.079	0.662	0.262	0.204	0.325
1998	0.599	0.362	0.145	0.170	-0.074	0.647	0.286	0.222	0.356
1999	0.604	0.355	0.079	0.210	-0.042	0.630	0.312	0.262	0.366
2000	0.601	0.359	0.136	0.170	-0.068	0.644	0.289	0.235	0.349
2001	0.600	0.361	0.117	0.120	-0.040	0.625	0.320	0.262	0.384
2002	0.604	0.354	0.100	0.180	-0.048	0.634	0.306	0.238	0.380
2003	0.593	0.373	0.108	0.320	-0.090	0.652	0.278	0.194	0.375

Maryland - Chesapeake Bay Spring Spawning Stock
C-hat = 1.0; bootstrap GOF probability = 0.72 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1987	0.969	-0.119	0.034		0.000	0.969	-0.119	-0.141	-0.038
1988	0.960	-0.110	0.041	0.670	-0.062	1.023	-0.173	-0.192	-0.138
1989	0.949	-0.098	0.052	0.790	-0.091	1.044	-0.193	-0.212	-0.164
1990	0.532	0.480	0.070	0.570	-0.092	0.586	0.384	0.258	0.531
1991	0.589	0.379	0.123	0.590	-0.178	0.717	0.183	0.112	0.262
1992	0.644	0.290	0.113	0.510	-0.143	0.751	0.136	0.087	0.189
1993	0.695	0.214	0.099	0.460	-0.113	0.783	0.095	0.033	0.166
1994	0.742	0.149	0.093	0.470	-0.107	0.830	0.036	-0.041	0.135
1995	0.659	0.267	0.117	0.260	-0.082	0.717	0.182	0.100	0.280
1996	0.647	0.285	0.096	0.280	-0.069	0.695	0.214	0.150	0.286
1997	0.635	0.304	0.110	0.220	-0.065	0.679	0.237	0.187	0.292
1998	0.623	0.324	0.098	0.190	-0.049	0.655	0.274	0.225	0.327
1999	0.610	0.344	0.121	0.180	-0.061	0.650	0.281	0.217	0.353
2000	0.598	0.365	0.082	0.190	-0.040	0.622	0.324	0.234	0.428
2001	0.585	0.386	0.075	0.250	-0.046	0.613	0.339	0.220	0.482
2002	0.572	0.408	0.065	0.360	-0.056	0.606	0.350	0.200	0.539
2003	0.559	0.431	0.068	0.200	-0.033	0.579	0.397	0.214	0.636

Table 22. Continued.

Virginia - Rappahannock River
C-hat adjustment = 1.372; bootstrap GOF probability = 0.13 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	0.626	0.318	0.086	0.577	-0.127	0.717	0.182	0.105	0.271
1991	0.626	0.318	0.091	0.560	-0.131	0.721	0.178	0.103	0.263
1992	0.626	0.318	0.121	0.535	-0.172	0.757	0.128	0.055	0.212
1993	0.629	0.313	0.097	0.349	-0.093	0.694	0.216	0.137	0.307
1994	0.629	0.313	0.083	0.318	-0.070	0.677	0.240	0.158	0.335
1995	0.610	0.344	0.126	0.204	-0.078	0.662	0.263	0.189	0.346
1996	0.611	0.343	0.048	0.125	-0.016	0.620	0.328	0.256	0.408
1997	0.611	0.342	0.079	0.167	-0.036	0.634	0.305	0.235	0.384
1998	0.612	0.342	0.131	0.217	-0.087	0.670	0.251	0.181	0.329
1999	0.612	0.341	0.102	0.200	-0.058	0.650	0.281	0.211	0.359
2000	0.613	0.340	0.077	0.349	-0.071	0.659	0.267	0.227	0.347
2001	0.613	0.339	0.064	0.298	-0.050	0.645	0.289	0.216	0.370
2002	0.614	0.338	0.082	0.295	-0.065	0.657	0.271	0.193	0.359
2003	0.615	0.336	0.088	0.246	-0.059	0.653	0.275	0.189	0.376

Hudson River
C-hat adjustment = 1.223; bootstrap GOF probability = 0.206 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	0.760	0.125	0.091	0.560	-0.121	0.864	-0.004	-0.127	0.197
1989	0.690	0.222	0.110	0.740	-0.188	0.849	0.013	-0.134	0.232
1990	0.624	0.321	0.131	0.661	-0.209	0.789	0.087	0.000	0.188
1991	0.654	0.274	0.105	0.500	-0.128	0.750	0.137	0.053	0.237
1992	0.630	0.312	0.134	0.578	-0.192	0.780	0.099	0.032	0.175
1993	0.633	0.307	0.131	0.491	-0.164	0.757	0.128	0.058	0.207
1994	0.655	0.272	0.121	0.524	-0.158	0.778	0.101	0.025	0.189
1995	0.660	0.266	0.116	0.378	-0.113	0.744	0.146	0.079	0.223
1996	0.642	0.294	0.128	0.249	-0.087	0.703	0.202	0.142	0.270
1997	0.612	0.341	0.156	0.318	-0.141	0.712	0.189	0.076	0.327
1998	0.639	0.297	0.132	0.231	-0.085	0.699	0.208	0.138	0.288
1999	0.635	0.304	0.132	0.310	-0.111	0.714	0.187	0.105	0.283
2000	0.719	0.180	0.080	0.364	-0.071	0.774	0.107	-0.022	0.299
2001	0.715	0.186	0.079	0.265	-0.052	0.754	0.133	0.009	0.312
2002	0.704	0.200	0.103	0.347	-0.091	0.775	0.106	-0.010	0.266
2003	0.734	0.160	0.090	0.305	-0.069	0.788	0.088	-0.051	0.316

Table 23. Tag-based estimates of annual instantaneous fishing mortality of striped bass >= 18 inches. Estimates are adjusted for live-release bias, hooking mortality (0.08), and reporting rate (0.43).

<u>Producer Area Programs</u>

Year	HUDSON	DE/PA	MDCB	VARAP
1987			-0.08	
1988	0.03		-0.06	
1989	0.06		-0.09	
1990	0.11		0.23	-0.10
1991	0.11		0.21	1.06
1992	0.11		0.19	-0.07
1993	0.12	0.17	0.23	0.25
1994	0.11	0.14	0.21	0.32
1995	0.14	0.19	0.21	0.17
1996	0.18	0.21	0.25	0.28
1997	0.17	0.24	0.31	0.39
1998	0.20	0.23	0.38	0.70
1999	0.19	0.25	0.43	0.76
2000	Coastal Programs		0.46	0.63
2001			0.54	0.28
2002	0.13	0.28	0.58	0.42
2003	0.09	0.24	0.67	0.62

Year	MADFW	NYOHS	NJDEL	NCCOOP
1987				
1988		0.27		-0.25
1989		-0.26	-0.28	0.26
1990		0.3	-0.19	0.32
1991		-0.01	0.25	0.21
1992	0	-0.2	0.15	-0.08
1993	0.01	0.49	0.3	0.03
1994	0.02	0.12	0.06	0.42
1995	0.07	-0.17	-0.07	-0.15
1996	0.05	0	-0.02	0.39
1997	0.1	0.34	0.39	0.51
1998	0.08	0.48	-0.01	0.28
1999	0.1	0.24	0.18	-0.12
2000	0.1	0.28	0.1	0.9
2001	0.08	0.4	-0.06	0.47
2002	0.08	0.04	0.28	0.17
2003	0.09	0.51	0.11	0.63

Table 24. Survival (S) and fishing mortality (F) rates of striped bass >= 18 inches including estimates adjusted (adj.) for reporting rate (0.433), bias from live releases, and hooking mortality (0.08).

Producer Area Programs

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	0.742	0.148	0.067	0.745	-0.111	0.835	0.030	-0.085	0.203
1989	0.681	0.234	0.088	0.790	-0.156	0.807	0.065	-0.052	0.220
1990	0.625	0.320	0.112	0.735	-0.190	0.772	0.109	0.023	0.209
1991	0.651	0.279	0.103	0.621	-0.152	0.768	0.114	0.051	0.187
1992	0.645	0.288	0.105	0.649	-0.160	0.768	0.114	0.061	0.173
1993	0.650	0.280	0.106	0.565	-0.145	0.760	0.124	0.069	0.185
1994	0.667	0.255	0.095	0.599	-0.134	0.769	0.112	0.043	0.192
1995	0.671	0.249	0.096	0.434	-0.102	0.747	0.141	0.079	0.212
1996	0.651	0.279	0.112	0.335	-0.097	0.721	0.178	0.126	0.235
1997	0.633	0.307	0.127	0.378	-0.126	0.724	0.173	0.082	0.281
1998	0.643	0.291	0.114	0.282	-0.085	0.703	0.203	0.131	0.285
1999	0.647	0.286	0.100	0.344	-0.087	0.709	0.194	0.127	0.271
2000	0.700	0.207	0.079	0.466	-0.087	0.767	0.115	0.010	0.256
2001	0.707	0.196	0.072	0.377	-0.064	0.756	0.130	0.013	0.293
2002	0.698	0.210	0.072	0.431	-0.073	0.753	0.134	0.026	0.278
2003	0.718	0.181	0.084	0.446	-0.090	0.789	0.087	-0.046	0.286

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	0.655	0.273	0.099	0.390	-0.097	0.725	0.171	0.012	0.399
1994	0.641	0.295	0.106	0.550	-0.141	0.747	0.142	-0.002	0.337
1995	0.608	0.348	0.118	0.500	-0.149	0.714	0.187	0.127	0.253
1996	0.604	0.354	0.121	0.440	-0.136	0.699	0.208	0.146	0.276
1997	0.610	0.344	0.078	0.520	-0.096	0.675	0.243	0.186	0.307
1998	0.599	0.362	0.104	0.470	-0.122	0.682	0.232	0.169	0.302
1999	0.604	0.355	0.087	0.470	-0.098	0.669	0.251	0.201	0.305
2000	0.601	0.359	0.098	0.460	-0.111	0.676	0.242	0.187	0.301
2001	0.600	0.361	0.072	0.560	-0.094	0.663	0.262	0.203	0.326
2002	0.604	0.354	0.080	0.350	-0.069	0.648	0.283	0.216	0.358
2003	0.593	0.372	0.107	0.460	-0.123	0.676	0.241	-0.151	1.195

Table 24. Continued.

Maryland - Chesapeake Bay Spring Spawning Stock
C-hat adjustment = 1.215; bootstrap GOF probability = 0.13 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1987	0.801	0.072	0.070	0.95	-0.145	0.937	-0.08	-0.179	0.066
1988	0.840	0.025	0.042	0.84	-0.077	0.909	-0.06	-0.103	0.009
1989	0.880	-0.022	0.034	0.93	-0.068	0.944	-0.09	-0.159	0.037
1990	0.637	0.301	0.055	0.58	-0.073	0.687	0.23	0.155	0.305
1991	0.635	0.304	0.083	0.45	-0.090	0.698	0.21	0.162	0.261
1992	0.629	0.314	0.111	0.43	-0.120	0.715	0.19	0.154	0.219
1993	0.624	0.321	0.090	0.38	-0.084	0.682	0.23	0.191	0.279
1994	0.620	0.327	0.099	0.43	-0.106	0.694	0.21	0.148	0.290
1995	0.626	0.319	0.119	0.32	-0.101	0.696	0.21	0.150	0.281
1996	0.603	0.356	0.110	0.35	-0.099	0.669	0.25	0.199	0.308
1997	0.579	0.396	0.113	0.27	-0.081	0.630	0.31	0.262	0.364
1998	0.547	0.454	0.111	0.25	-0.074	0.591	0.38	0.324	0.433
1999	0.525	0.495	0.107	0.21	-0.060	0.558	0.43	0.376	0.494
2000	0.498	0.547	0.096	0.36	-0.086	0.545	0.46	0.380	0.539
2001	0.470	0.606	0.080	0.33	-0.065	0.502	0.54	0.434	0.653
2002	0.452	0.644	0.075	0.32	-0.059	0.480	0.58	0.435	0.754
2003	0.420	0.718	0.080	0.24	-0.048	0.441	0.67	0.514	0.845

Virginia - Rappahannock River
C-hat adjustment = 1.432; 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)
1990	0.816	0.053	0.111	0.519	-0.142	0.951	-0.100	-0.232	0.221
1991	0.276	1.136	0.063	0.524	-0.076	0.299	1.057	0.725	1.438
1992	0.804	0.068	0.124	0.408	-0.132	0.927	-0.074	-0.260	0.745
1993	0.604	0.354	0.088	0.456	-0.098	0.669	0.251	-0.047	0.805
1994	0.573	0.407	0.086	0.402	-0.085	0.626	0.318	0.002	0.875
1995	0.689	0.223	0.077	0.262	-0.050	0.725	0.172	-0.078	0.738
1996	0.629	0.313	0.056	0.279	-0.037	0.654	0.275	-0.007	0.825
1997	0.552	0.444	0.067	0.330	-0.053	0.583	0.390	0.101	0.840
1998	0.405	0.754	0.064	0.371	-0.057	0.430	0.695	0.372	1.110
1999	0.380	0.818	0.079	0.294	-0.057	0.403	0.759	0.452	1.139
2000	0.426	0.704	0.067	0.436	-0.069	0.457	0.633	0.360	0.976
2001	0.609	0.347	0.071	0.367	-0.063	0.649	0.282	-0.054	0.998
2002	0.540	0.467	0.054	0.382	-0.048	0.567	0.417	0.016	1.195
2003	0.445	0.661	0.065	0.279	-0.043	0.465	0.616	0.364	0.933

Table 24. Continued.

Coast Programs

Massachusetts; C-hat = 1.04; bootstrap GOF probability = 0.445 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	0.781436	0.097	0.054	0.762	-0.092	0.860	0.001	-0.079	0.111
1993	0.780077	0.098	0.060	0.586	-0.080	0.848	0.015	-0.053	0.104
1994	0.784666	0.092	0.055	0.580	-0.073	0.847	0.017	-0.061	0.124
1995	0.755677	0.130	0.056	0.474	-0.061	0.805	0.067	0.014	0.130
1996	0.742202	0.148	0.089	0.433	-0.094	0.819	0.049	-0.015	0.128
1997	0.745631	0.144	0.058	0.279	-0.038	0.775	0.104	0.049	0.170
1998	0.746157	0.143	0.081	0.327	-0.065	0.798	0.075	0.020	0.142
1999	0.749466	0.138	0.054	0.315	-0.040	0.781	0.098	0.044	0.161
2000	0.755006	0.131	0.053	0.242	-0.030	0.779	0.100	0.046	0.165
2001	0.771561	0.109	0.041	0.352	-0.033	0.798	0.076	-0.004	0.186
2002	0.76001	0.124	0.062	0.290	-0.043	0.794	0.080	0.021	0.153
2003	0.767612	0.114	0.042	0.225	-0.022	0.785	0.092	0.018	0.190

New York - Ocean Haul Seine
C-hat adjustment = 1.71; 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	0.551	0.446	0.077	0.940	-0.159	0.655	0.273	0.124	0.456
1989	0.908	-0.054	0.092	0.930	-0.189	1.120	-0.263	-0.278	-0.246
1990	0.550	0.448	0.073	0.830	-0.135	0.636	0.303	0.141	0.504
1991	0.757	0.128	0.080	0.690	-0.127	0.867	-0.008	-0.148	0.241
1992	0.932	-0.079	0.069	0.720	-0.112	1.050	-0.199	-0.211	-0.183
1993	0.486	0.572	0.055	0.620	-0.077	0.526	0.492	0.327	0.688
1994	0.683	0.231	0.063	0.710	-0.101	0.760	0.124	-0.012	0.318
1995	0.938	-0.086	0.063	0.550	-0.080	1.019	-0.169	-0.179	-0.156
1996	0.792	0.084	0.058	0.610	-0.080	0.861	0.000	-0.141	0.302
1997	0.571	0.410	0.051	0.560	-0.065	0.611	0.343	0.135	0.633
1998	0.494	0.554	0.055	0.570	-0.071	0.533	0.480	0.257	0.767
1999	0.635	0.303	0.057	0.490	-0.064	0.679	0.237	0.024	0.575
2000	0.612	0.342	0.049	0.580	-0.064	0.654	0.275	0.050	0.627
2001	0.542	0.462	0.054	0.510	-0.063	0.579	0.397	0.137	0.773
2002	0.835	0.031	0.069	0.420	-0.069	0.896	-0.040	-0.208	1.129
2003	0.486	0.572	0.048	0.550	-0.060	0.517	0.510	0.336	0.720

Table 24. Continued.

New Jersey - Delaware Bay
C-hat adjustment = 1.03; bootstrap GOF probability = 0.41 for the full parameterized model.

Year	S(unadj.)	F(unadj.)	Recovery Rate	% Live Release	Bias Live Release	S(adj.)	F(adj.)	95%LCL F(adj)	95%UCL F(adj)
1989	0.893	-0.037	0.107	0.920	-0.218	1.142	-0.282	-0.247	-0.247
1990	0.823	0.045	0.111	0.830	-0.208	1.038	-0.188	0.349	0.349
1991	0.582	0.391	0.078	0.770	-0.136	0.673	0.246	0.572	0.572
1992	0.641	0.295	0.069	0.880	-0.133	0.739	0.153	0.341	0.341
1993	0.544	0.459	0.078	0.840	-0.145	0.636	0.302	0.431	0.431
1994	0.690	0.221	0.077	0.860	-0.147	0.809	0.062	0.171	0.171
1995	0.799	0.075	0.088	0.660	-0.134	0.923	-0.070	0.053	0.053
1996	0.737	0.156	0.111	0.600	-0.160	0.877	-0.019	0.205	0.205
1997	0.518	0.508	0.090	0.500	-0.108	0.581	0.393	0.610	0.610
1998	0.739	0.152	0.123	0.470	-0.146	0.866	-0.006	0.178	0.178
1999	0.652	0.278	0.078	0.500	-0.092	0.717	0.182	0.324	0.324
2000	0.697	0.211	0.087	0.500	-0.104	0.778	0.101	0.247	0.247
2001	0.822	0.046	0.089	0.460	-0.099	0.912	-0.058	0.191	0.191
2002	0.615	0.336	0.060	0.420	-0.058	0.653	0.275	0.518	0.518
2003	0.706	0.198	0.078	0.470	-0.087	0.773	0.107	0.214	0.214

North Carolina - Cooperative Trawl Cruise
C-hat adjustment = 2.01; 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	0.909	-0.054	0.094	0.852	-0.179	1.107	-0.252	-0.273	-0.225
1989	0.604	0.354	0.046	0.864	-0.087	0.662	0.263	0.102	0.477
1990	0.555	0.439	0.070	0.683	-0.109	0.623	0.323	0.168	0.514
1991	0.615	0.337	0.090	0.566	-0.122	0.700	0.207	0.051	0.415
1992	0.817	0.052	0.106	0.450	-0.120	0.929	-0.076	-0.226	0.384
1993	0.752	0.135	0.089	0.457	-0.098	0.834	0.032	-0.137	0.380
1994	0.507	0.529	0.077	0.552	-0.099	0.563	0.424	0.260	0.621
1995	0.904	-0.049	0.098	0.389	-0.096	0.999	-0.149	-0.168	-0.126
1996	0.561	0.427	0.053	0.265	-0.033	0.581	0.394	0.190	0.669
1997	0.490	0.564	0.085	0.231	-0.050	0.515	0.513	0.253	0.860
1998	0.598	0.364	0.104	0.298	-0.080	0.650	0.281	0.032	0.678
1999	0.902	-0.046	0.099	0.280	-0.071	0.971	-0.121	-0.188	0.056
2000	0.327	0.968	0.062	0.438	-0.063	0.349	0.903	0.691	1.138
2001	0.504	0.535	0.079	0.342	-0.066	0.539	0.467	0.263	0.725
2002	0.682	0.233	0.075	0.318	-0.058	0.724	0.173	-0.050	0.605
2003	0.440	0.670	0.060	0.281	-0.040	0.459	0.629	0.474	0.806

Table 25. Akaike weights used to derive model averaged parameter estimates. Results are for striped bass tagged at >= 28 inches.

Coast Programs

Model	MADFW	NYOHS	NJDEL	NCCOOP
{S(.)r(.)}	0.0002	0.00528	0.0023	0
{S(.)r(p)}	0.0002	0.00693	0.0004	0
{S(.)r(t)}	**0.1330**	0.00013	**0.3707**	0.00095
{S(p)r(p)}	0.0329	**0.15060**	0.0004	0.00008
{S(p)r(t)}	**0.1921**	0.01215	**0.1559**	0.00543
{S(d)r(p)}	0.0361	**0.14352**	0.0003	0.00043
{S(v)r(p)}	0.0188	**0.17721**	0.0022	0.01295
{S(Tp)r(t)}	**0.1610**	0.00387	0.0818	0.00246
{S(Tp)r(Tp)}	0.0161	**0.40906**	0.0387	0.00035
{S(Tp)r(p)}	0.0165	0.06350	0.0230	0.00004
{S(t)r(p)}	**0.3924**	0.00531	**0.3049**	0.00023
{S(t)r(t)}	0.0006	0.02244	0.0194	**0.97708**

Producer Area Programs

Model	DE/PA	HUDSON	MDCB	VARAP
{S(.)r(.)}	0.02496	0	0	**0.34506**
{S(.)r(p)}	0.01141	0	0	**0.27477**
{S(.)r(t)}	0.00021	**0.13738**	0	0.00108
{S(p)r(p)}	**0.41902**	0	0	**0.18906**
{S(p)r(t)}	0.00198	**0.18880**	0.00069	0.00041
{S(d)r(p)}	**0.15525**	0.00002	0	0.06999
{S(v)r(p)}	**0.28465**	0.00001	0	0.02578
S(Va)r(va)	NA	NA	NA	0.03993
{S(Tp)r(t)}	0.00088	0.07359	**0.96338**	0.00007
{S(Tp)r(Tp)}	0.03628	0.00940	0.03536	0.01187
{S(Tp)r(p)}	0.0645	0.00052	0	0.04183
{S(t)r(p)}	0.00082	**0.58942**	0.00038	0.00014
{S(t)r(t)}	0.00003	0.00085	0.00019	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, 95-03)

Table 26. Akaike weights used to derive model averaged parameter estimates. Results are for striped bass >= 18 inches. Models are described in Table 25.

Producer Area Programs

Model	HUDSON	DE/PA	MDCB	VARAP
{S(.)r(.)}	0	0	0	0
{S(.)r(p)}	0	0	0	0
{S(.)r(t)}	**0.1845**	**0.4344**	0	0
{S(p)r(p)}	0	0.0003	0	0
{S(p)r(t)}	**0.2034**	**0.3797**	0.0037	0
{S(d)r(p)}	0	0.0025	0	0
{S(v)r(p)}	0	0.0003	0	0
S(Va)r(va)	NA	NA	NA	0
{S(Tp)r(t)}	0.0933	**0.1203**	**0.9633**	0.0001
{S(Tp)r(Tp)}	0.0165	0	0	0
{S(Tp)r(p)}	0.0001	0.0001	0	0
{S(t)r(p)}	**0.4973**	0.0578	0	0
{S(t)r(t)}	0.0049	0.0047	0.0330	**0.9998**

Coastal Programs

Model	MADFW	NYOHS	NJDEL	NCCOOP
{S(.)r(.)}	0.0000	0	0	0
{S(.)r(p)}	0.0000	0	0	0
{S(.)r(t)}	**0.4761**	0	0	0
{S(p)r(p)}	0.0013	0	0	0
{S(p)r(t)}	**0.2450**	0	0	0
{S(d)r(p)}	0.0016	0	0	0
{S(v)r(p)}	0.0008	0	0	0
{S(Tp)r(t)}	0.0805	0	0	0
{S(Tp)r(Tp)}	0.0047	0	0	0
{S(Tp)r(p)}	0.0029	0	0	0
{S(t)r(p)}	**0.1849**	0	0	0
{S(t)r(t)}	0.0021	**1.0000**	**1.0000**	**1.0000**

Table 27. Total length frequencies of fish tagged in 2003 by program.

	Coast Programs				Producer Area Programs			
TL	MADFW	NYOHS	NJDEP	NCCOOP	DE/PA	MDCB	VARAP	HUDSON
199								
249								
299								
349					1	16		
399		2			1	34		
449		111	1		80	84		
499		196	7		78	115	106	46
549		182	93	2	79	150	203	141
599		72	375	22	95	97	123	168
649	3	45	745	80	84	65	20	140
699	26	32	491	151	44	40	0	169
749	93	51	317	396	47	44	30	156
799	167	28	218	500	57	48	78	164
849	153	25	87	361	65	51	74	128
899	98	22	36	209	57	67	75	93
949	54	17	20	95	34	54	55	71
999	24	6	2	53	17	41	44	49
1049	15	8		28	8	21	27	37
1099	15	2		6	5	6	8	8
>1099	7			3	4	2	9	9
Total	655	799	2392	1906	756	935	852	1379

Table 28. Age frequencies of tagged fish recaptured in 2003 by program.

	Coast Programs			Producer Area Programs		
AGE	MADFW	NYOHS	NJDEP	DE/PA	MDCB	VARAP
1						
2		1				
3		16	3	4		
4		15	53	17		9
5	1	14	186	17		13
6	1	13	151	17	4	7
7	5	29	76	30	9	18
8	10	16	33	26	5	17
9	10	11	12	33	9	8
10	6	19		30	16	6
11	2	4	1	12	9	9
12	3	2		4	4	2
13	6	2		2	6	2
14	7	3		4	4	5
15	2	3		1		3
16	2	2		1	3	1
17		2			1	
18		1				
19		3		1		
20	1				1	2
21						1
22						1
Total	56	156	515	199	71	104

Table 29. Distribution of tag recaptures by state (program) and month.

Coast Programs

Massachusetts (recaptures in 2003 from fish tagged and released during 1992-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME							1						1
NH							1						1
MA					2	6	4	1	4	1			18
RI							1				1		2
CT								1					1
NY					8	5	1			2	2	1	19
NJ						1				1	4	1	7
DE					1						1		2
MD		1		4	4						1		10
VA		1		1							2	2	6
NC	2	1											
Total	2	3	0	5	15	12	8	2	4	4	11	4	67

New York - Ocean Haul Seine (recaptures in 2003 from fish tagged/release during 1988-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME						2	4	1					7
NH							2						2
MA					3	7	16	6	1	1			34
RI					1	4	2	1		1		1	10
CT				1	2	3	3	1			1		11
NY			1	3	14	3	4	6	4	7	7	1	50
NJ			1	3	9	5	1			3	9	1	32
PA													0
DE				1									1
MD					2	1					1		4
VA	1		1								1	2	5
NC	1												1
Total	2	0	3	8	31	25	32	15	5	12	19	5	157

Table 29. Continued.

New Jersey - Delaware Bay (recaptures in 2003 from fish tagged/release during 1989-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME					1	5	9	3	2				20
NH						1	3	2					6
MA					21	34	38	23	16	7	1		140
RI					6	7	11	6	4	2	1		37
CT					9	4	7	3	2	2		1	28
NY		1			30	21	16	3	8	11	14	1	105
NJ			5	14	30	22	9	3	1	15	19	1	119
PA				1	1								2
DE	1			3	1						1		6
MD			2	6	17	1				1	3		30
VA	5	1	2								1	2	11
NC	3	4	2									3	12
Total	9	6	11	24	116	95	93	43	33	38	40	8	516

North Carolina - Cooperative Trawl Cruise
(recaptures in 2003 from fish tagged/release during 1988-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME							1						1
NH													0
MA					3	9	11	13	7	1			44
RI						6	5	1	3				15
CT					2	2	2	1		2			9
NY					10	9	5	4	4	6	1		39
NJ				1	12	7	3			6	12	1	42
PA					1								1
DE							1	1			1		3
MD		1	1	9	19	33	19	11	8	20	4	1	126
VA	1	2	4	1	10	8	3	4		15	16	13	77
NC	1	8	2								3	5	19
Total	2	11	7	11	57	74	50	35	22	50	37	20	376

Table 29. Continued.

Producer Area Programs

Delaware / Pennsylvania - Delaware River
(recaptures in 2003 from fish tagged/release during 1993-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME													0
NH													0
MA						4	4	2	2				12
RI					1		1	3	1	2			8
CT							1						1
NY					1	2	4	1		3	2		13
NJ			2	6	7	17	16	6	3	26	26	2	111
PA					3	2							5
DE					1	2	6		1	5	3	1	19
MD						8	4		1	3	2		18
VA											3	2	5
NC	4	1	1									1	7
Total	4	1	3	6	13	35	36	12	8	39	36	6	199

Maryland - Chesapeake Bay Spring Spawning Stock
(recaptures in 2003 from fish tagged/release during 1987-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME						1		1					2
NH													0
MA						3	5	2		2			12
RI							1	1					2
CT					1		4	1	1				7
NY						6	1	2	1		1		11
NJ					3	6			1	1	3		14
PA													0
DE						3							3
MD		1	1	2	4	32	13	9	3	8	5	4	82
VA			1		3	5	1		1	5	12	2	30
NC	1											6	7
Total	1	1	2	2	11	56	25	16	7	16	21	12	170

Table 29. Continued.

Virginia - Rappahannock River (recaptures in 2003 from fish tagged/release during 1990-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
MA						3	12		1	1		1	18
RI								1	2				3
CT								2			1		3
NY					3	2	1	3	2			1	12
NJ					1	3			1	3	3		11
MD			2	1	2	2	3	2	1		2		15
VA			4	14	9	5	2			4	6	12	56
NC	1				1								2
													0
Total	1	0	6	15	16	15	18	8	7	8	12	14	120

Hudson River
(recaptures in 2003 from fish tagged/release during 1988-2003)

State	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ME								1					1
NH							2	1					3
MA						5	13	4	2	2			26
RI						3	2	3					8
CT						6	5	5	2	3	1		22
NY				3	18	25	15	9	7	11	16		104
NJ				1		11	11	1	3	7	13	3	50
PA													0
DE											1		1
MD										1			1
VA	1											2	3
NC	1	1										1	3
Total	2	1	0	4	18	50	48	24	14	24	31	6	222

Table 30. R/M estimates of exploitation rates of >= 28 inch striped bass from tagging programs (with reporting rate adjustment of 0.42, and hooking mortality rate adjustment of 0.08).

Year	NJDB	NYOHS**	NCCOOP	MA**	VA Rap	MDCB	DE/PA	NYHUD
1987	*	*	*	*	*	*	*	*
1988	*	0.050	0.078	*	*	0.075	*	0.049
1989	0.021	0.043	0.045	*	*	0.037	*	0.048
1990	0.041	0.068	0.080	*	0.261	0.084	*	0.073
1991	0.180	0.116	0.074	*	0.365	0.124	*	0.083
1992	0.016	0.113	0.134	0.035	0.367	0.122	*	0.097
1993	0.087	0.135	0.112	0.066	0.369	0.119	0.166	0.110
1994	0.052	0.081	0.088	0.031	0.255	0.111	0.116	0.084
1995	0.104	0.200	0.142	0.052	0.411	0.204	0.136	0.127
1996	0.195	0.140	0.116	0.085	0.176	0.169	0.315	0.164
1997	0.228	0.294	0.196	0.126	0.367	0.233	0.266	0.220
1998	0.348	0.168	0.202	0.070	0.455	0.197	0.276	0.173
1999	0.079	0.295	0.236	0.085	0.281	0.323	0.152	0.143
2000	0.137	0.176	0.062	0.130	0.241	0.171	0.296	0.094
2001	0.141	0.107	0.154	0.071	0.191	0.108	0.263	0.099
2002	0.110	0.225	0.117	0.080	0.235	0.096	0.236	0.082
2003	0.140	0.148	0.114	0.109	0.157	0.105	0.157	0.098

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

Year	NJDB	NYOHS**	NCCOOP	MA**	VA Rap	MDCB	DE/PA	NYHUD
1987	*	*	*	*	*	0.080	*	*
1988	*	0.262	0.244	*	*	0.108	*	0.155
1989	0.266	0.235	0.141	*	*	0.095	*	0.205
1990	0.517	0.215	0.173	*	0.502	0.175	*	0.267
1991	0.465	0.243	0.204	*	0.584	0.276	*	0.247
1992	0.199	0.327	0.263	0.113	0.581	0.240	*	0.240
1993	0.204	0.267	0.278	0.125	0.570	0.214	0.245	0.271
1994	0.207	0.209	0.208	0.100	0.359	0.221	0.199	0.213
1995	0.232	0.334	0.275	0.159	0.554	0.269	0.214	0.233
1996	0.326	0.311	0.154	0.178	0.208	0.254	0.408	0.271
1997	0.339	0.350	0.249	0.217	0.428	0.284	0.286	0.309
1998	0.382	0.168	0.263	0.148	0.603	0.229	0.342	0.250
1999	0.205	0.344	0.273	0.158	0.373	0.378	0.194	0.221
2000	0.220	0.326	0.128	0.143	0.376	0.197	0.357	0.201
2001	0.219	0.198	0.212	0.108	0.294	0.154	0.283	0.187
2002	0.175	0.383	0.150	0.165	0.305	0.129	0.236	0.175
2003	0.226	0.207	0.156	0.122	0.221	0.157	0.252	0.196

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

Table 32. R/M estimates of exploitation rates of >= 18 inches striped bass from tagging programs (with reporting rate adjustment of 0.43, and hooking mortality rate adjustment of 0.08).

Year	NJDB	NYOHS**	NCCOOP	MA**	VA Rap	MDCB	DE/PA	NYHUD
1987	*	*	*	*	*	0.008	*	*
1988	*	0.025	0.044	*	*	0.014	*	0.102
1989	0.033	0.030	0.032	*	*	0.010	*	0.070
1990	0.069	0.038	0.070	*	0.172	0.066	*	0.107
1991	0.030	0.056	0.084	*	0.138	0.098	*	0.108
1992	0.034	0.044	0.151	0.038	0.306	0.131	*	0.134
1993	0.026	0.047	0.106	0.054	0.228	0.109	0.124	0.166
1994	0.032	0.034	0.085	0.034	0.249	0.116	0.123	0.116
1995	0.058	0.053	0.139	0.039	0.190	0.184	0.135	0.156
1996	0.090	0.031	0.109	0.062	0.140	0.165	0.157	0.232
1997	0.080	0.035	0.163	0.089	0.193	0.197	0.094	0.285
1998	0.115	0.029	0.144	0.080	0.153	0.192	0.144	0.217
1999	0.054	0.047	0.219	0.058	0.131	0.163	0.115	0.215
2000	0.074	0.033	0.083	0.084	0.123	0.133	0.141	0.132
2001	0.088	0.047	0.116	0.050	0.163	0.120	0.135	0.138
2002	0.058	0.064	0.120	0.088	0.126	0.117	0.144	0.194
2003	0.069	0.036	0.107	0.079	0.105	0.131	0.133	0.137

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

Year	NJDB	NYOHS**	NCCOOP	MA**	VA Rap	MDCB	DE/PA	NYHUD
1987	*	*	*	*	*	0.163	*	*
1988	*	0.168	0.212	*	*	0.101	*	0.210
1989	0.250	0.224	0.119	*	*	0.081	*	0.252
1990	0.377	0.194	0.179	*	0.381	0.146	*	0.323
1991	0.205	0.171	0.198	*	0.284	0.187	*	0.243
1992	0.177	0.185	0.279	0.126	0.537	0.245	*	0.299
1993	0.172	0.140	0.207	0.114	0.397	0.178	0.230	0.338
1994	0.172	0.165	0.195	0.113	0.370	0.219	0.246	0.262
1995	0.204	0.146	0.232	0.136	0.310	0.279	0.280	0.267
1996	0.243	0.170	0.151	0.178	0.254	0.273	0.265	0.317
1997	0.254	0.149	0.224	0.184	0.271	0.291	0.191	0.367
1998	0.274	0.151	0.237	0.154	0.243	0.281	0.255	0.294
1999	0.175	0.135	0.274	0.107	0.229	0.227	0.204	0.301
2000	0.201	0.136	0.153	0.101	0.229	0.234	0.243	0.211
2001	0.211	0.138	0.178	0.086	0.263	0.192	0.222	0.197
2002	0.135	0.181	0.177	0.158	0.214	0.172	0.193	0.237
2003	0.181	0.112	0.151	0.097	0.150	0.185	0.249	0.210

* Years when few or no striped bass were tagged and released.
** See footnote in Table 13.