WEAKFISH WP#1. (11/24/08)

MEMORANDUM

TO: Data Poor Working Group Review Panel Members

FROM: Jeff Brust, for Weakfish Stock Assessment Subcommittee

RE: Update to Weakfish Stock Assessment Methodology

Among the materials provided for your review of the weakfish stock assessment is the most recent peer reviewed assessment (ASMFC 2006), which includes the assessment (in two parts), the peer review report, and supplemental information requested by the ASMFC Weakfish Management Board. For the ongoing assessment, we are using very similar methodologies as those outlined in the 2006 peer reviewed assessment. However, there are some changes and updates ASMFC staff and the Stock Assessment Subcommittee felt would benefit from your review.

The attached report is a preliminary draft of portions of the stock assessment report, including management and assessment history, description of primary fisheries, and description of available fishery dependent and fishery independent data sources. Information contained in the current report is consistent with the text of the 2006 assessment, but the current report provides additional detail on certain aspects, such as the survey indices.

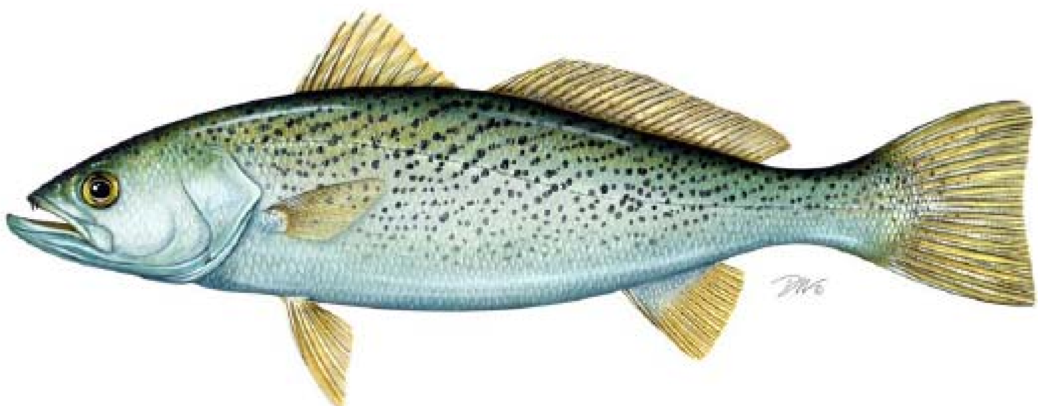
You will note certain sections of this draft are highlighted in yellow. This draft was developed prior to the Weakfish Data Workshop in July 2008. Highlighted text indicates sections that need to be updated based on discussions and decisions made during the July workshop. As these edits will not be done prior to the Data Poor Workshop, I would like to provide you with a list of some of the more substantial changes to input data that were decided on at the July workshop.

- Recreational weakfish catch (A, B1, B2) from Florida were “corrected” for sand seatrout and sand seatrout/weakfish hybrids
- The recreational discard mortality rate was decreased from 20% to 10%
- Recreational discard length frequency were assigned based on recent headboat discard data (previously, discards assumed the same size as harvest)
- Commercial discard rates have been updated with recent data
- New Jersey trawl index now based on delta log-normal for August cruise only (previously arithmetic mean for August and October cruises)
- Recreational index now based on all private boat trips in Mid-Atlantic (previously used only trips that caught a suite of species commonly occurring with weakfish)

Most of these changes could be made retroactive to 2000 (the most recent year age-length keys are available).

In addition to these changes to input data, I have requested the principle modelers for other candidate models to provide updates to changes in their methodology. These updates will hopefully be sufficient to allow you to adequately review the assessment as a work in progress. I look forward to discussing the assessment and any recommendations you may have at the December Data Poor Working Group in Woods Hole.

WEAKFISH STOCK ASSESSMENT REPORT



A Report of the ASMFC Weakfish Technical Committee

Presented to the 49th Stock Assessment Workshop
Stock Assessment Review Committee
Woods Hole, MA

June 2009

NOTE: ZZ Section prefix will be replaced with letter assigned to assessment by J. Weinberg.

ZZ1.0 CONTRIBUTORS

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ZZ2.0 TERMS OF REFERENCE FOR WEAKFISH

1. Evaluate biases, precision, uncertainty, and sampling methodology of the commercial and recreational catch including landings and discards.

2. Evaluate precision, geographical coverage, representation of stock structure, and relative accuracy of the fisheries independent and dependent indices of abundance.

3. Evaluate the catch at age modeling methods and the estimates of F, spawning stock biomass, and total abundance of weakfish produced, along with the uncertainty of those estimates. Review the severity of retrospective bias. (This TOR will change following the stock assessment workshop in September.)

4. Evaluate the aggregated biomass modeling and index methods and the estimates of F, spawning stock biomass, and total abundance of weakfish produced, along with the uncertainty of those estimates. Determine whether these techniques, including predator-prey extensions, could substitute for age-based modeling for management advice. (This TOR will change following the stock assessment workshop in September.)

5. Review evidence for constant or recent systematic changes in natural mortality.

6. Estimate and determine the accuracy and precision of biological reference points.

7. Review stock projections and impacts on the stock under different assumptions of fishing and natural mortality.

8. Make research recommendations for improving data collection and assessment.

ZZ3.0 EXECUTIVE SUMMARY

ZZ3.1 Major findings for TOR 1 - Evaluate biases, precision, uncertainty, and sampling methodology of the commercial and recreational catch including landings and discards.

ZZ3.2 Major findings for TOR 2 – Evaluate precision, geographical coverage, representation of stock structure, and relative accuracy of the fisheries independent and dependent indices of abundance.

ZZ3.3 Major findings for TOR 3 - Evaluate the catch at age modeling methods and the estimates of F, spawning stock biomass, and total abundance of weakfish produced, along with the uncertainty of those estimates. Review the severity of retrospective bias. (This TOR will change following the stock assessment workshop in September.)

ZZ3.4 Major findings for TOR 4 - Evaluate the aggregated biomass modeling and index methods and the estimates of F, spawning stock biomass, and total abundance of weakfish produced, along with the uncertainty of those estimates. Determine whether these techniques, including predator-prey extensions, could substitute for age-based modeling for management advice. (This TOR will change following the stock assessment workshop in September.)

ZZ3.5 Major findings for TOR 5 - Review evidence for constant or recent systematic changes in natural mortality.

ZZ3.6 Major findings for TOR 6 - Estimate and determine the accuracy and precision of biological reference points.

ZZ3.7 Major findings for TOR 7 - Review stock projections and impacts on the stock under different assumptions of fishing and natural mortality.

ZZ3.8 Major findings for TOR 8 - Make research recommendations for improving data collection and assessment.

ZZ4.0 INTRODUCTION

This is the first update to the weakfish stock assessment since 2006 when the assessment was peer reviewed through the Atlantic States Marine Fisheries Commission (ASMFC) External Peer Review process. The 2006 assessment updated the stock through the 2003 fishing season. The current assessment includes harvest data and survey indices through 2007.

ZZ4.1 Management Unit Definition

Weakfish stocks on the U.S. Atlantic coast are managed through the ASMFC Interstate Fishery Management Plan (FMP) for Weakfish. Under this FMP, weakfish are managed as a single unit stock throughout their coastal range. Historically, all states from Massachusetts through Florida had a declared interest in the species. Currently, however, Massachusetts, Connecticut, South Carolina, Georgia, and Florida maintain *de minimus* status.

ZZ4.2 Management History

The first fishery management plan for weakfish was implemented by ASMFC in 1985 to address stock declines, bycatch concerns, the lack of sufficient data for management, and interstate user conflicts. The management measures under the FMP were voluntary and provided no benefit to the stock.

Amendment I, adopted in 1991, established a target fishing mortality rate of $F_{20\%} = 0.34$. This would be achieved by a 52% reduction in directed harvest, as well as reductions in bycatch mortality in the penaeid shrimp fisheries. Although adoption of turtle excluder devices (TEDs) in the shrimp fishery led to bycatch reductions, none of the states with directed fisheries adopted regulations consistent with the Amendment. Consequently, Amendment I was not successful at attaining the target fishing mortality rate.

Continued concern regarding the status of the weakfish stock (as a result of ASMFC fishery management regulations not being mandatory) was a major impetus for the development and passage of the Atlantic Coastal Fisheries Cooperative Management Act, which made compliance with ASMFC fishery management plans mandatory for member states. As an interim measure, the ASMFC approved Amendment II to the Weakfish FMP for implementation in April 1995. The provisions of Amendment 2 were mandatory and included harvest control strategies such as a 12” minimum size, maintaining current minimum mesh sizes, and bycatch reduction requirements. Fishing mortality would be reduced in a stepwise fashion, with a 25% reduction in harvest occurring in 1995 and the remainder occurring in 1996. The effects of Amendment II were positive, although below average fishery catch rates, a lack of older age fish, and below average spawning stock biomass indicated further improvements were necessary.

In response, Amendment III was developed to reduce fishing mortality to $F = 0.50$ by the year 2000, restore an expanded age structure, and restore fish to their full geographical range. Commercial fisheries were regulated by a combination of season and area closures, mesh regulations to minimize harvest of fish less than 12”, and stricter requirements for bycatch reduction devices (BRDs). The minimum recreational requirements were a 12” minimum size limit and four fish possession limit. States were allowed to implement alternate size and bag limit regulations if they were conservationally equivalent to the minimum requirements. Bag limits were not required for minimum sizes of 16" or greater.

In 2000, a peer review of a stock assessment with data through 1998 indicated that weakfish biomass was high and fishing mortality rate was below the target of F = 0.50. Despite being ahead of schedule, it was recommended that low fishing mortality rates be continued to maintain an appropriate spawning biomass and promote expansion of stock size and age composition. Also as a result of the assessment, the Weakfish Technical Committee recognized several inconsistencies between management practices and stock dynamics. These could only be addressed through the development of a new Plan amendment. In the meantime, however, Addendum I to Amendment III was passed to maintain current regulations until approval of the new amendment.

Weakfish stocks on the U.S. Atlantic coast are currently managed under Amendment IV to the FMP. Although Amendment III was successful in reducing fishing mortality and increasing biomass, reference points established in Amendment III were too high to ensure sufficient spawning stock biomass. In addition, the reference period used to develop recreational management measures represented an overexploited stock (insufficient abundance of older, larger individuals). In response to these concerns, Amendment IV, passed in November 2002, established new fishing mortality and spawning stock biomass reference points, and adjusted the reference period to a period of greater stock health (1981 to 1985). Amendment IV establishes new reference points for fishing mortality target of $F_{\text{target}} = F_{30\%}$ = 0.31, a fishing mortality threshold of $F_{\text{threshold}} = F_{20\%}$ = 0.5, and a spawning stock biomass threshold of $SSB_{\text{threshold}} = SSB_{20\%}$ = 31.8 million pounds. A fishing mortality rate greater than F = 0.5 constitutes overfishing, and the stock is considered overfished if SSB is less than 31.8 million pounds. If it is determined that the weakfish stock is overfished, Amendment IV requires ASMFC to implement measures to rebuild the population within 6 years (1½ generations).

Several addenda have been passed to improve management capabilities under Amendment IV. Addendum I was passed in December 2005 to modify biological sampling targets. Addendum III (May 2007) modified bycatch reduction requirements to maintain consistency with the South Atlantic Fishery Management Council. Of greater significance was passage of Addendum II in February 2007. A stock assessment conducted in 2006 showed a significant turn of events from previous assessment results (see full discussion in Section ZZ4.3, **Assessment History**). Model results indicated that weakfish stocks were at historic low levels, despite relatively low fishing mortality rates. A series of supplementary analyses indicated that the primary force behind the stock decline was interactions with other species, such as competition and predation. Projection analyses indicated that even with a full moratorium on harvest, stock rebuilding would occur slowly at best without a significant decrease in other sources of mortality. To minimize overall mortality without unduly penalizing fishermen, and to prevent expansion of the fishery in the event the stock begins to rebuild, Addendum II requires that all states 1) maintain current minimum sizes, 2) implement a recreational six fish bag limit, and 3) impose a 150 pound commercial bycatch trip limit. Addendum II also establishes triggers to re-evaluate these criteria. Commercial measures will be reconsidered when coastwide commercial harvest reaches 80% of the 2000-2004 average harvest. Commercial and recreational measures will be re-evaluated when combined harvest for any state in one year exceeds 125% of their previous five year average.

ZZ4.3 Assessment History

Early stock assessment analyses for weakfish were conducted using a variety of virtual population models, such as the Murphy VPA (ASMFC 1991) and CAGEAN. The first peer reviewed assessment analyzed data through 1996 using Extended Survivor Analysis (XSA). The peer review was conducted in 1997 by the Stock Assessment Review Committee (SARC) at the 26th Northeast Regional Stock Assessment Workshop (SAW). The Review Committee had concerns with the XSA model runs and requested updated runs as well as exploratory CAGEAN and ADAPT model runs. These were conducted, but there was insufficient time to fully review the results. As such, the review committee did not endorse the point estimates of *F* and SSB. Regardless, all models used indicated that SSB was increasing rapidly and fishing mortality rates were decreasing rapidly. SSB had increased an average of 22.5% per year since 1991, while *F* had decreased an average of 21.4% per year since 1990 (NEFSC 1998). The SARC concluded that continuation of low fishing mortality rates and good recruitment would allow for age expansion to a point comparable to that observed in the early 1980s.

The subsequent assessment, including data through 1998, was peer reviewed at the 30th SAW/SARC in 1999 (NEFSC 2000). The stock was assessed using the ADAPT VPA as recommended by the 26th SARC. Ages in recent years had begun to be taken from otoliths, which required a conversion of scale-based ages from earlier years to otolith-based ages. The approved VPA run included only indices from the core abundance area (New York to North Carolina). The model indicated that fishing mortality rates had declined to 0.21 in 1998, well below both $F_{MAX} = 0.27$ and $F_{MSY} = 0.6$. In addition, SSB had increased to about 39,000 metric tons, approximately 55% of an unfished stock. The SARC did observe a noticeable retrospective pattern, which overestimated stock size and underestimated fishing mortality in the last few years. Regardless, the Review Committee concluded that results of the ADAPT VPA could be used to calculate biological reference points, and that figures illustrating the expanded size and age composition of weakfish would be useful for developing management advice.

A stock assessment update was conducted in 2002 (with data through 2000) using the SARC approved methodology (ADAPT VPA with tuning indices from the core area; Kahn 2002). The assessment showed that estimates of fishing mortality decreased further to $F = 0.12$, while SSB increased to over 50,000 mt. Although this assessment was not peer reviewed, the Weakfish Technical Committee (TC) expressed concern about a strong retrospective pattern that resulted in high levels of uncertainty in recent year estimates. The committee recognized poor biological sampling of commercial catches, commercial discards, and recreational discards as a likely source of much of this error, especially when coupled with the assumption of error-free catch at age estimates used by ADAPT. Estimates of *F* and SSB were "corrected" by multiplying each parameter by the average amount each parameter changed in recent years with the addition of more data. Even so, the corrected estimate of $F = 0.23$ was substantially below $F_{Target} = 0.31$, and corrected SSB = 35,000 mt was more than double $SSB_{Threshold} = 14{,}428$ mt.

In 2003, the Weakfish Stock Assessment Subcommittee (WSAS) began preparation for a 2004 peer review through the 40th SAW. Model results using the SARC approved methodology still exhibited a strong retrospective pattern, and results from both ADAPT VPA and biomass dynamic models indicated the stock was at very high levels (carrying capacity in the case of the biomass dynamic model; see Uphoff 2005) with very low fishing mortality. The Technical Committee was concerned that these results were not consistent with low catch rates being observed by commercial and recreational fishermen targeting weakfish.

For these reasons, the WSAS deemed the ADAPT VPA methodology as insufficient to characterize the weakfish resource and proceeded to investigate alternative assessment methods. Although the revised weakfish assessment was incomplete at the time of the SAW, the SARC agreed to review the work and provide guidance on issues that were impeding the progress of the assessment (such as the inconsistency between survey indices and fishery-dependent indices of abundance and catch at age).

The Review Committee agreed with the WSAS that the results of the work in progress, although using the same approach as the SARC-approved assessment in 1999, were not suitable for management. The Review Committee indicated that they felt the problem was conflicting data, and expressed skepticism about the reliability of some survey indices, especially the Northeast Fishery Science Center Fall Survey. Recommendations from the SARC proved to be useful, and some were incorporated into the stock assessment. The assessment was also expanded to include some alternative approaches previously explored by the WSAS in the 2002 update process. (ASMFC 2006, Part A)

The stock assessment was completed in February 2006 and submitted to ASMFC for evaluation through the ASMFC External Peer Review process. The Peer Review Panel consisted of four fisheries biologists with expertise in population dynamics and stock assessment methods. The Panel did not endorse the statements regarding weakfish stock status and identified several issues that required additional work or attention by the Weakfish Technical Committee before they would support its use for management purposes (ASMFC 2006, Part B). In particular, the Panel had concerns regarding stock structure, age composition data, and fishery discards.

The Weakfish Management Board directed the Technical Committee to address the issues identified by the Review Panel. Specifically, the Management Board tasked the Technical Committee with further investigating stock structure and discards; determining agreements and disagreements among the assessment report, the peer review panel report, and the 40th SARC report; and providing an account of the implementation of recommendations from the 40th SARC.

In August 2006, the Technical Committee provided a response to these tasks (ASMFC 2006, Part C). Based on these responses, the Technical Committee's analyses, and significant evidence, the Management Board accepted the following five points for management use:

1. The stock is declining;
2. Total mortality is increasing;
3. There is little evidence of overfishing occurring;
4. Something other than fishing mortality is causing the stock decline, and;

5. There is a strong chance that regulating the fishery will not, in itself, reverse the stock decline.

ZZ4.4 Life History (Lee Paramore)

ZZ4.4.1 Reproduction

ZZ4.4.2 Age and Growth

ZZ4.4.3 Natural mortality

ZZ4.4.4 Stock Definitions

The weakfish range extends along the Atlantic coast from Massachusetts to southern Florida, although strays are occasionally found as far as Nova Scotia, Canada and into the eastern Gulf of Mexico. Primary abundance occurs between New York and North Carolina. Within their range there is evidence of multiple stocks. Munyandorero (2006; see ASMFC 2006, Part C) provides a concise but thorough overview of available information on weakfish stock structure. The following is an excerpt.

> Investigations of weakfish population structure along the US Atlantic coast have been undertaken through tagging, meristic, morphological, life history, genetic and otolith chemistry studies (Table 1). The conclusions reached are conflicting. While Crawford et al (1988), Graves et al. (1992) and Cordes and Graves (2003) did not detect genetic differentiation within the weakfish population, Chapman et al. (unpublished report) found that weakfish are made up of a series of overlapping stocks, without complete panmixia. Non-genetic studies found evidence of existence of multiple weakfish sub-populations (e.g., Nesbit 1954; Shepherd & Grimes 1983, 1984; Scoles 1990) or important spatial structure of the weakfish population (Thorrold et al. 1998, 2001). Mark-recapture, meristic, morphological and life-history studies (e.g., review by Crawford et al. 1988) indicated that weakfish could be partitioned into sub-stocks…

Crawford et al (1988) recommend that weakfish be managed as separate northern and southern stocks, while Graves et al (1992) recommend management of a single unit stock. The Weakfish Technical Committee reviewed the available information and reached the following conclusions.

- Evidence of stock structure exists
- Data is inadequate to define stock structure, and there is enough potential mixing that pinpointing the location of a north/south split is not possible at this time
- If a north to mid-Atlantic subpopulation is in serious decline, this does not warrant a north-south split based on conservation concerns (ASMFC 2006, Part C).

Based on those recommendations, the ASMFC Weakfish FMP continues to manage Atlantic coast weakfish as a single unit stock throughout their coastal range.

ZZ4.5 Habitat description

Weakfish are found in shallow marine and estuarine waters along the Atlantic coast. They can be found in salinities as low as 6 ppt (Dahlberg 1972) and temperatures ranging from 17^{o} to 26.5^{o} C (Merriner 1976).

Like many other North Atlantic species, weakfish exhibit a north-inshore/south-offshore migration pattern, although in the southern part of their range they are considered resident. Shepherd and Grimes (1983) observed that migrations occur in conjunction with movements of the 16-24^{o} isotherms. Warming of coastal waters during springtime triggers a northward and inshore migration of adults from their wintering grounds in the Mid-Atlantic. The spring migration brings fish to nearshore coastal waters, coastal bays, and estuaries where spawning occurs.

Weakfish spawn in estuarine and nearshore habitats throughout their range. Principal spawning areas are from North Carolina to Montauk, NY, although extensive spawning and presence of juveniles has been observed in the bays and inlets of Georgia and South Carolina. Larval and juvenile weakfish generally inhabit estuarine rivers, bays, and sounds, but have been taken in freshwater (Thomas 1971) and as far as 70 km offshore (Berrien et al 1978). Mercer (1983) found that juveniles are most prevalent in shallow bays and navigation channels and are commonly associated with sand or sand/grass bottoms.

Weakfish form aggregations and move southward and offshore as temperatures decline in the fall. Important wintering grounds for the stock are located on the continental shelf from Chesapeake Bay to Cape Lookout, North Carolina.

ZZ4.6 Fishery description

ZZ4.6.1 Overview of fisheries

ZZ4.6.1.1 Commercial Fishery

Records of commercial weakfish landings are available back to 1950 through the National Marine Fisheries Service (NMFS) website. From 1950 through the 1960s commercial landings ranged from about 2,000 to 4,000 metric tons (MT) per year (Figure ZZ4.6-1). Beginning in 1970, reported landings began a dramatic increase to a record high of more than 16,000 MT in 1980. From 1982 to 1988, landings fluctuated between approximately 8,000 and 10,000 MT. Except for a brief recovery in the mid- to late-1990s, landings have declined continuously from 1989 to the present. Estimated harvest in 2007 is the lowest on record at approximately 388 MT.

Throughout this period, three states - New Jersey, Virginia, and North Carolina - have consistently accounted for 70 to 90% of the coastwide total harvest (Table ZZ4.6-1; Figure ZZ4.6-2). North Carolina has predominated with nearly 37% of the coastwide harvest over the last ten years, while Virginia and New Jersey have averaged 25.6% and 17.0% respectively. During this same time period, New York has accounted for nearly 10% of coastwide harvest.

From the mid 1950s to the early 1980s landings from the trawl fishery generally accounted for 50 to 70% of total landings (Figure ZZ4.6-3). Beginning in the early 1980s, harvest from trawlers began a gradual decline, and recently have accounted for approximately 20% of total harvest. Conversely, between 1979 and 1987, landings from gill nets increased from around 10% of annual harvest to 45% of annual harvest, and have remained relatively stable since that time. Over the entire time period, pound nets and haul seines have each averaged between 10 and 20% of total harvest annually, despite exhibiting generally negative trends over time.

Discarding of weakfish by commercial fishermen is known to occur, and discard mortality is assumed to be 100%. De Silva (2004) provided the first quantitative analysis of weakfish discards. Most discarding occurs in conjunction with two gears (trawls and gillnets) and a limited number of target species. Prior to 1996, discards are assumed to have occurred for non-regulatory reasons because few regulations were in place to limit the fishery. Since 1996, both regulatory and non-regulatory discarding has occurred. Regardless, population removals as a result of commercial discarding appear to be minor relative to harvest, even in recent years as harvest has decreased. (ADD SPECIFICS FROM RECENT YEARS AFTER UPDATE JANAKA'S WORK)

ZZ4.6.1.2 Recreational Fishery

Recreational harvest statistics for the weakfish fishery are available on the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) website for the period 1981 to 2007. From 1981 to 1988, the number of weakfish caught and the number harvested fluctuated without trend between 2 million and around 11 million fish; however, during this same time period, harvested weight generally declined from around 16 million pounds to 6 million pounds (Figure ZZ4.6-4). During this time period, nearly 90% of all fish caught were retained.

From 1989 to 1993, catch (numbers) and harvest (numbers and weight) remained relatively stable. Catch fluctuated between 1.6 and 2.2 million fish, while harvest ranged between 0.95 and 1.8 million fish and 1.1 to 2.2 million pounds. The harvest ratio during this period decreased from around 90% to less than 50%. CORRECT MRFSS ESTIMATES FOR FL SEATROUT

In 1994, weakfish catches increased and averaged around 6 million fish until 2000. Harvest numbers increased to a lesser extent and fluctuated between approximately 1.5 and 2.5 million fish. Harvest weight also increased to a relative peak of 4 million pounds during this period. By 2003, all statistics had declined to at or near time series minima and have remained relatively stable. In 2007, total catch was 2.01 million fish, with a harvest of 0.58 million fish and 0.69 million pounds. Since 1994, harvest ratios have fluctuated between approximately 20 and 40% of all fish caught.

The recreational fishery has been dominated in the last fifteen years or so by New Jersey, accounting for 40 to 50% of total harvest (Table ZZ4.6-2). Since 1995, several states have each had periods of substantial landings, with Delaware contributing 20-30% of total harvest for 1995-1998, Maryland accounting for approximately 25% from 1999 to 2001, and North Carolina averaging 22.5% from 2003 to 2007. From 1995 to 2004, Virginia consistently harvested between 10 and 20% of coastwide harvest, but has decreased in recent years.

From 1981 to 1990, recreational harvest decreased from around 35% of total (commercial and recreational) harvest to approximately 15% (Figure ZZ4.6-6). Since 1990, harvest from the recreational fishery has gradually increased, reaching a peak of approximately 58.5% in 2005 but dropping back to around 45% in 2006 and 2007.

Recreational discard mortality is assumed to be 20% of all discarded fish. Change to 10%, provide justification, references From 1981 to 1989, the proportion of landings to catch averaged 89%. Even with high landings, discard mortality was lowest of the time series, with all but one year having fewer than 200,000 fish. Between 1989 and 1995, harvest to catch ratio dropped drastically to the second lowest value (27%), and the number of dead discards increased to more than 800,000 in 1995. Harvest to catch ratio rebounded slightly to 41% in 1997 and 1998, but has since dropped back and has varied between 20 and 40% since 1999. Despite relatively stable discard rates since 1995, the number of dead discards has varied greatly due to large interannual fluctuation in catch. Discard mortality reached a peak of more than one million fish in 1996, with nearly equal values in 2000, but have since decrease along with catch. For the last five years, discard mortality has ranged between 250,000 and 500,000 fish.

ZZ4.7 Current status

Throughout the 1980s and early 1990s, weakfish stocks experienced unsustainably high fishing mortality rates, which led to a decline in abundance into the 1990s. Amendments II and III were successful at reducing fishing mortality, and an increase in biomass was evident in the late 1990s. The most recent assessment indicates that fishing mortality has remained low under Amendment IV, yet weakfish biomass has dropped back to near historic low levels by 2003. Available evidence indicates that interspecific interactions are the primary cause for the biomass declines (ASMFC 2006, Part A). A peer review of the stock assessment did not endorse the statements regarding weakfish stock status and identified several issues that required additional work or attention by the Weakfish Technical Committee before they would support its use for management purposes (ASMFC 2006, part B). In particular, the Panel had concerns regarding stock structure, age composition data, and fishery discards. In August 2006, the Technical Committee responded to the peer review panel's concerns (ASMFC 2006, Part C). Based on these responses, the Technical Committee's analyses, and significant evidence, the Weakfish Management Board accepted the following five points for management use:

1. The stock is declining;
2. Total mortality is increasing;
3. There is little evidence of overfishing occurring;
4. Something other than fishing mortality is causing the stock decline, and;
5. There is a strong chance that regulating the fishery will not, in itself, reverse the stock decline.

ZZ5.0 EVALUATE BIASES, PRECISION, UNCERTAINTY, AND SAMPLING METHODOLOGY OF THE COMMERCIAL AND RECREATIONAL CATCH INCLUDING LANDINGS AND DISCARDS. (TOR #1)

ZZ5.1 Commercial

ZZ5.1.1 Landings

Commercial landings data were taken from two sources. Where available, state-specific harvest records collected through a mandatory reporting system were considered the most reliable source for landings. Unfortunately, not all states require mandatory reporting of weakfish harvest. In such cases, landings estimates were obtained from the NMFS commercial landings database, available through the NMFS Office of Science and Technology, Fisheries Statistics Division website (*http://www.st.nmfs.gov/st1/*). Although estimates are available from NMFS, it is not mandatory to report weakfish harvest to NMFS. Discrepancies between NMFS reported harvest and state reported harvest under mandatory reporting suggest that NMFS harvest estimates for weakfish are a potential source of uncertainty. In an attempt to quantify the uncertainty between the two reporting systems, state reported landings from Delaware and Virginia were compared to federally reported landings in these two states for the period 2004 to 2006. Combined across all gears, NMFS reported landings for a given year differed from state landings by less than 10% in all instances except Virginia in 2006, when the difference exceeded 23% (Figure ZZ5.1-1). However, when evaluated at the gear level, more than one-third of all year/state/gear combinations differed by more than 20%, and in three cases exceeded 100% (Figure ZZ5.1-2). Generally speaking, then, annual estimates of weakfish harvest reported by state and federal agencies are relatively consistent when combined across all gears, but the allocation of landings by gear exhibit moderate to severe uncertainty.

ZZ5.1.1.1 Biological samples

Commercial biological samples include lengths, weights, and ages from state-specific port sampling programs. Commercial samples were combined with similar data from recreational and fishery independent sources to develop length-weight relationships and age-length keys (ALK) for use in the estimation of commercial catch at age.

Lengths

Commercial length data were used for two primary purposes: the development of length-weight equations and characterizing the distribution of commercial catches by length and age. Because a combination of both total length and fork length data were available, lengths were standardized to fork length measurements. A conversion factor was developed using data pooled across all sources for 2004 to 2006. Total length was converted to fork length using the equation

$$FL = (TL + 5.8106) / 1.0437$$

Length-weight equations were developed as in the 2006 assessment (ASMFC 2006, Part A). Length and weight data from all sources were pooled, and relationships were developed by region/year/season. Sample sizes and parameter estimates are presented in Table ZZ5.1-1.

Characterization of fishery catch at size was conducted using the same methods as the 2006 assessment (ASMFC 2006, Part A). Length frequencies were stratified by region/year/season/state/gear and applied to catch at the same level of stratification. Length-weight estimates were used in conjunction with length frequency distributions to convert estimates of harvested weight to a weighted estimate of harvested numbers at size (Quinn and Deriso 1999). Landings not identified to specific gear were pooled at the region/year/season level and classified as "other". In addition, cells with minimal landings (< 1% of region/year/season total) generally had insufficient sample size (see below) to characterize that fishery. These cells were pooled with landings from the "other" gear category and characterized using all available samples for that region/year/season.

Sample size and ratio of sample size per metric ton of landings were used to evaluate adequacy of sampling intensity. It was determined that a minimum sample of 30 lengths per stratum (region/year/season/state/gear) was required to adequately characterize a fishery. Strata with fewer than 30 samples were characterized using data substituted from a representative stratum with sufficient sample size. The minimum of 30 samples is much lower than sample sizes suggested in recent literature (Miranda 2007; Vokoun et al 2001). Insufficient sampling would tend to introduce uncertainty into the catch at size estimates; however, these studies recommend sample sizes necessary to meet an objective (characterizing entire population) much different than the current analysis (characterizing harvest of specific gear). Miranda (2007) notes that distributions with a smaller size range require a smaller sample size. Considering minimum size limits and gear selectivity, the sample size required to characterize a fishery is likely lower than those in published literature. Vaughan (2000) reports that a generally accepted level of sampling during SAW/SARC reviews is 100 fish per 200 MT of landings. A minimum sample size of 30 fish per stratum typically results in thousands of fish per 200 metric tons of landings for strata with direct or substituted samples.

Not all states collect sufficient commercial length frequency data to characterize their fisheries. For strata with insufficient length samples, data were substituted from the next most appropriate stratum. In most cases, substituted data came from the same region/year/season, but was substituted from another state and/or gear (TABLE of CAA substitutions). Care was taken to minimize differences in gear selectivity, and when necessary substituted data were truncated to account for differences in minimum size between the two states. Regardless, the Technical Committee recognizes that substituted data are not always representative of the stratum to which they are applied, resulting in uncertainty in the length frequency distribution of the catch. Of greatest concern are the geographic differences in fish size, coupled with the general lack of samples north of Delaware. In the northern part of their range, weakfish generally attain much larger sizes than in central and southern regions. As such, minimum sizes and average size of harvested fish are much larger in the northern portions of the range. When commercial samples from these states are insufficient and data are substituted from more southern states, the effect is an underestimation of the proportion of large fish in the harvest. In 2006, New Jersey began collecting commercial biological data. These data will serve to better characterize landings from this key state, and likely be more representative of catches in this region, decreasing uncertainty in catch at size estimates. Potential effects of these substitutions are explored in greater detail in Brust (2007, in prep). SUMMARIZE THEM HERE.

In summary, uncertainty in length data can be introduced both by sample size and substitution of data from alternate strata. Although sample sizes are generally less than recommended to characterize the length distribution of a population, they are much higher than levels commonly accepted as necessary to characterize a fishery. A minimum sample of 30 fish per stratum was considered an appropriate compromise between uncertainty due to low sample size from the stratum in question and uncertainty of samples from a substituted stratum.

For the southern region, characterization of the fisheries was done slightly differently. Commercial sampling in North Carolina includes collection of both lengths and weights, so it was possible to develop an average fish weight by gear and season for each fishery. The average weight was applied to the harvest weight to estimate number harvested. The number harvested was then partitioned to catch at size using the length frequency distribution of the samples. Florida, the only other southern region state with landings, collects no biological samples. Biological sample data from North Carolina were used as proxy information for Florida landings.

Ages
The principle use of age data is in the development of age-length keys. Sample sizes of ages by year, season, and source are provided in Table ZZ5.1-2. Prior to 1990, ages were based on scale samples. During the 1990s, otoliths became the principle method for aging weakfish. For the 1998 stock assessment, scale-based ages in previous years were converted to otolith-based ages using a scale-otolith conversion matrix (similar to an age-length key) based on direct comparison of approximately 2,300 samples (Daniel and Vaughan 1997; NEFSC 1998). Uncertainty in either aging method, as well as in the scale-otolith conversion matrix would be propagated through the catch-at-age matrix.

Age-length data from all available sources (commercial, recreational, fishery independent) were pooled by region/year/season to develop stratum specific age-length keys (four keys per year) as described by Vaughan (2000). Length intervals with missing information in the keys were filled by either averaging age distribution for lengths above and below, substitution from another stratum, or interpolating age distribution across several length bins. Results of the catch at size analyses were combined across states and gears within a region to develop estimates of harvest numbers at size by region/year/season.

ZZ5.1.2 Discards

Commercial discards were estimated using the ratio estimation method described in de Silva (2004). Data from the NMFS Observer Database were queried to identify a suite of target species and gears most commonly associated with weakfish discards. The suite of target species was then subset using principle component analysis to minimize duplicate counting. Where available, trip or haul level estimates of discarded weakfish weight and target species harvest weight were used to develop annual ratios of gear/species-specific discard ratios. Ratios for the southern region (NC – FL) were considered insignificant, and the remainder of the analysis was conducted only for the northern region. Gear-species discard ratios were applied to harvest estimates by year/species/gear to estimate total weakfish discard weight by year/species/gear. Weakfish discard length frequency data by gear (all species combined) were used to convert discard weight to discard at size. Annual estimates by gear were partitioned into seasonal estimates by using the proportion of annual landings by season and gear from the NMFS landings database. Gear-season discards at size were summed across gears and converted to seasonal discards at age by applying the appropriate seasonal ALK.

NEED TO UPDATE THIS PARAGRAPH For the current assessment, weakfish discard to target species harvest ratios were not calculated for 2004 to 2006. Instead, the average gear-species ratio for 2001-2003 were applied to each year. Also, discard length frequencies from gillnet trips were extremely low for 2004-2006 (Table of N). As a substitute, combined gillnet length frequencies from 2002-2006 were applied to all years from 2004 to 2006. As with the 2006 assessment, all discards were assumed to be discarded dead and were added to the overall catch at age matrix.

ZZ5.2 Recreational

ZZ5.2.1 Landings

Recreational landings data were obtained from the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) database, which is available through the NMFS Office of Science and Technology, Fisheries Statistics Division website (*http://www.st.nmfs.gov/st1/*). MRFSS provides estimates for three subcategories of catch, including observed harvest (Type A), unobserved harvest (*e.g.* filleted before observation, discarded dead; Type B1) and discarded alive (Type B2). Estimates of harvest were developed for each region/year/season combination as a sum of observed and unobserved harvest (Type A + B1).

Precision in recreational catch and harvest estimates are calculated as a percent standard error (PSE). Lower values indicate better precision, and PSE values less than 20 are generally considered "acceptable" (NEFSC 1998). However, a recent review of the survey identified several potential biases and inadequacies of the sampling and estimation methodologies (NRC 2006; see http://www.nap.edu/catalog.php?record_id=11616). These include the inability to interview anglers at private access sites; the increasing use of household cell phones which are unavailable to the telephone sampling frame; reliance on unverified assumptions; and differences in statistical properties of data collected through different survey methods. The effects of these biases on estimates of recreational catch, harvest, and discards can not easily be quantified, leading to uncertainty in MRFSS recreational estimates. This uncertainty applies to all catch types over the entire time series, which has been collected using the same general methodology throughout.

ZZ5.2.1.1 Biological samples

Biological samples collected by MRFSS include lengths and weights of a subsample of Type A fish. No ages are collected from the recreational fishery. Recreational length-weight data were combined with similar data from commercial and fishery independent sources to develop length-weight relationships (see section ZZ5.1, Commercial). Length data were also used to partition harvest into harvest at size. Because of small sample sizes (Table ZZ5.1-2), length observations were pooled by region/year/season to expand harvest estimates at the same level of stratification. Unlike commercial data, estimates of recreational harvest in numbers are directly available from the MRFSS website. Catch at size was estimated as the proportion measured at size by stratum multiplied by the estimated harvest (A+B1 fish) for that stratum.

The number of length samples collected by MRFSS is very low, but is still above the generally accepted level of 100 lengths per 200 mt of landings. Regardless, limited length samples may introduce error into the characterization of the fishery landings.

ZZ5.2.1.2 Catch at Age

Catch at age estimates for the recreational sector were calculated using similar methods as the commercial CAA (Section 5.1.2.1), except that estimates of harvest numbers were directly available from MRFSS, and estimating catch at size did not require stratifying to the state and gear level. Total harvest number by region/year/season was partitioned into numbers at size using appropriate length frequency distributions. These were converted to recreational catch at age by applying the appropriate ALK. Annual recreational harvest at age was found by summing across regions.

ZZ5.2.2 Discards

Estimates of the number of recreational weakfish discards (Type B2 fish) were obtained from the MRFSS database. As in previous assessments, discard mortality is assumed to equal 20% of all discards. Since discarded fish are not observed by creel samplers, no biological data are available. In the absence of direct information, length frequencies of discards are assumed to be the same as observed (Type A) fish, and discard mortality at size is characterized using these data. The lack of direct observations of length frequencies of discarded fish contributes uncertainty into estimates of harvest.

ZZ5.3 Catch Matrix Development

The catch-at-age matrix for 2004-2007 was developed using the same general procedure used in previous assessments. Catch at size from the four major sources of removals (commercial harvest, commercial discards, recreational harvest, recreational discards) were combined by region/year/season. ALKs for the corresponding stratum were applied to pooled catch at size to estimate catch at age. Results were pooled across regions and seasons to estimate total annual removals at age.

As described in each of the pertinent sections, there are several potential sources of uncertainty in the overall catch at age estimates. These include inaccurate harvest/discard estimates as a result of under/over reporting or inappropriate survey methods; insufficient sample size to characterize the length frequency distribution of a fishery; errors in aging techniques or the scale-otolith age conversion; substitution of data from alternate cells in the catch at size characterization and age-length keys; and others. Attempts have been made to quantify some of these error sources; however, the extent of uncertainty associated with each of these sources, and their cumulative effect, remains largely unknown. A persistent cumulative trend in either direction would result in inaccurate catch at age estimates and may influence assessment results.

NEED EFFORT DATA FOR COMM AND RECR FISHERIES

ZZ6.0 EVALUATE PRECISION, GEOGRAPHICAL COVERAGE, REPRESENTATION OF STOCK STRUCTURE, AND RELATIVE ACCURACY OF THE FISHERIES INDEPENDENT AND DEPENDENT INDICES OF ABUNDANCE.

ZZ6.1 NEFSC Bottom Trawl Survey

The National Marine Fisheries Service (NMFS) Northeast Fishery Science Center (NEFSC) conducts seasonal trawl surveys between Nova Scotia and Cape Hatteras. Stratified random sampling is conducted using a #36 Yankee otter trawl equipped with roller gear and a 1.25 cm mesh codend liner. The survey covers a large portion of the geographic range of weakfish, including their "core" distribution area (NEFSC 1996) of New Jersey to North Carolina. Despite the extended latitudinal range, the survey is not capable of sampling in shallow waters, and few sites are conducted in waters less than 9 m. In addition, the survey does not sample the South Atlantic portion of the range.

Weakfish are infrequent in the winter, spring, and summer surveys, but are commonly intercepted in the fall during their offshore migration. Because weakfish are rarely caught in this survey north of New Jersey the 26th SAW/SARC recommended developing an index of weakfish abundance using only strata from the south end of Long Island to Cape Hatteras during the fall survey. USE NJ to NC index Indices at age are developed by applying annual length frequency data from the survey to the annual mean catch per tow and then applying appropriate age-length keys. (What ALKs are used? Are they survey specific YES, when available!) During 1982 – 1990, the keys were coastwide. Since 1991, the keys used were developed from the Mid-Atlantic region. Because this survey occurs in the fall, true ages are increased by one year to develop an index of abundance on January 1 of the year following the survey (*e.g.* fall 1997 age 0 fish are treated as January 1, 1998 age 1 fish).

The annual mean catch per tow appears nearly cyclical, with relative peaks in abundance generally every 4 to 6 years (FIGURE). From 1981 through the mid 1990s, mean catch per tow cycled without trend, generally ranging between 40 and 120 fish per tow. Beginning in the mid 1990s, abundance gradually increased to a time series maximum of approximately 500 fish per tow in 2004. During 2005 – 2007, abundance decreased to about 200 fish per tow, but increased in 2008 to over 300 fish per tow. Standard error (SE) shows a similar pattern as CPUE, with an overall cyclical pattern and a gradual increase beginning in the mid 1990s. During the early portion of the time series, SE varied between approximately 10 and 50, increasing to a peak of 90 in 2004. Coefficient of variation (CV; SE as a ratio of the mean) has varied without trend between approximately 0.1 and 0.4 since 1990.

The survey index is dominated by age 1 fish (age 0 fish progressed to age 1), although fish have been observed out to age 6. Age distribution was greatest in the early 1980s, but was truncated to predominantly ages 1-3 by the early 1990s. Age distribution expanded somewhat during the late 1990s as the stock began rebuilding as a result of management measures, but has since declined to primarily ages 1-4.

The Technical Committee has expressed concerns that the NEFSC fall survey is not a good indicator of weakfish abundance. The timing of the survey, along with the highly contagious distribution of weakfish, leads to high variability between years and between tows within a year. The Technical Committee is also concerned about the survey's ability to capture larger/older fish. The New Jersey trawl survey, which occurs in the months before and after the NEFSC survey in nearly identical strata (see below), catches a substantially larger proportion of large fish than the NEFSC fall survey(Figure). Finally, catch curve analysis shows in several instances year class abundance increasing over time (TABLE 3 of ASMFC 2006, Part 1). For these reasons, the TC has concluded that the NEFSC fall survey not be utilized as an "aged" or biomass index. What about utility as a YOY index, or as a composite index. What is size range of survey and size range of age 1 and/or age 2 fish?

TC Recommendation?? Not for aged index, not for biomass index, possibly for YOY (needs more evaluation). Problem with dropping is lose coastwide index and lose early part of time series (only survey that goes back to 1981). Being used to help estimate avg weight of discarded fish in recr fishery.

ZZ6.2 New Jersey Ocean Trawl Program

New Jersey has conducted a stratified random trawl survey in nearshore ocean waters (0 to 90 feet) from Ambrose Channel (entrance to New York Harbor) to Cape Henlopen Channel (entrance to Delaware Bay) since 1988. The survey originated as bi-monthly cruises, but since 1991 has consisted of five cruises per year (January, April, June, August, and October). Strata are nearly identical to those used by NEFSC in this region (New Jersey's northern- and southern-most strata are truncated at New Jersey state boundaries). The gear used is a two-seam trawl with a 25 m headrope and 0.25" bar mesh codend liner. Due to funding constraints, several different vessels have been used to conduct the survey.

The geographic range of the survey is limited to nearshore ocean waters of the species distribution within the northern and southern borders of New Jersey. The survey occurs within the region sampled by the NEFSC trawl survey. The use of a smaller vessel, however, allows the New Jersey survey to provide better coverage in shallow waters.

The majority of weakfish are observed during the June, August and October cruises, although catches in June are inconsistent. An index of weakfish abundance is therefore developed using the August and October cruises. Since 1991, length frequencies have been aged using pooled (fishery dependent and fishery independent) late season ALKs from the northern region. Because the survey occurs in the fall, indices at age are progressed forward one age to indicate abundance on January 1 of the following year.

From 1989 to 1994, abundance was relatively stable between 20 and 40 fish per tow. Since 1995, abundance has varied much more widely and exhibits a similar cyclical nature as the NEFSC survey. The time series minimum of 5.72 fish per tow occurred in 1999, while the maximum of over 200 fish per tow occurred in 2005. SE has followed a similar trend as the mean over the time series, and CV has varied without obvious trend, ranging from approximately 0.2 to 0.5. (FIGURE)

From 1989 to 1995, the catch consisted primarily of ages 1-3, with ages 4-6 making up generally less than 10% of the total. Throughout the 1990s, age structure expanded, and in 1998 and 1999, fish ages 4 and older accounted for more than 30% of the total CPUE. Since the turn of the century, age structure has again contracted, with older ages falling to less than 10% of the total since 2006. Regardless, the proportion of age 4 fish in the catch is generally higher now than it was during the early portion of the time series.

The Technical Committee has expressed concern that this survey suffers from some of the same shortcomings of the NEFSC fall survey. In particular, tow-level and annual mean catches show great variability, and catch curve analysis resulted in negative estimates of mortality for some year classes. Other concerns? The Technical Committee has therefore determined that the New Jersey trawl survey should not be used as an aged-index of weakfish abundance.

TC Recommendation?? Keep as is, but also investigate pos tows index; Uphoff's other indices are biomass based

ZZ6.3 Delaware DFW Delaware Bay Trawl Survey

The Delaware Division of Fish and Wildlife has conducted a trawl survey within the Delaware Bay intermittently since 1966 (1966-1971, 1979-1984, and 1990 – present). The survey collects monthly samples (March through December) at nine fixed stations throughout the Delaware portion of the Bay. The net used has a 30.5 foot headrope and 2" stretch mesh codend. For the current assessment, only the 1981-1984 and 1990-present time series are evaluated. Weakfish abundance is calculated as an average number of age 1+ fish per nautical mile for June to October cruises, and the index is treated as a mid-year abundance. Since 1991, length frequencies have been aged using survey specific age-length keys.

The geographic range of this survey is limited to the Delaware Bay, a very small portion of the weakfish stock range; however, the Bay is known to be a major spawning ground for weakfish on the Atlantic coast (REFERENCE). As the survey occurs monthly for a large portion of the year, fish from a wide size and age distribution are available to the survey, from young of year to large older spawners.

Weakfish abundance was moderate in the early 1980s and early 1990s (approximately 15-30 fish/nm). Beginning in 1992, abundance increased sharply to a time series high of over 233 fish in 1996. Abundance decreased by more than half in 1997, and has exhibited a generally declining trend since that time. CV of the composite index showed relatively high variability from 1991 to 1995, ranging from 0.2 to 0.6. Interannual variability in CV stabilized in 1995 and generally ranged from 0.19 to 0.26 until 2001. Since 2001, CV has shown a slight increase, estimated at 0.33 in 2006. (FIGURE)

Age structure advanced from primarily age 1 and 2 fish in the early 1990s to include ages 7 and 8 in 1998-2000. Abundance of age 4+ fish accounted for 30 to 35% of the total index in 1997 and 1998 as the large 1993 year class moved through and benefits of previous regulatory actions were realized. Abundance of older ages has since declined to levels observed in the early 1990s, with 4+ fish accounting for less than 1% of the total.

The Delaware 30-foot trawl survey occurs in one of the major weakfish spawning areas and has been shown to capture a wide size and age range of weakfish throughout the year. Trends in abundance correspond well with anecdotal and observed information from commercial and recreational fisheries. The Technical Committee has determined that the Delaware 30-foot trawl survey provides a reliable index of weakfish abundance. However, due to lack of older fish over most of the time series, abundance at age indices are restricted to ages 1 through 4.

TC Recommendation?? Keep it, ages 1 through 6+

ZZ6.4 SEAMAP Fall Survey

The Southeast Area Monitoring and Assessment Program (SEAMAP) has conducted three seasonal trawl surveys since 1989 between Cape Hatteras, NC and Cape Canaveral, FL. A stratified random design is employed to sample inner (4.6 to 9.1 m) and outer (9.1 to 18.2 m) depth strata using twin 75-foot highrise mongoose trawls towed behind a double rigged St. Augustine shrimp trawler. The geographic range of the survey encompasses nearshore ocean waters south of Cape Hatteras, and SEAMAP is the only fishery independent survey conducted in the southern portion of the weakfish range. Unfortunately, catches of weakfish south of North Carolina are extremely small and of little value as an index of abundance. An index of abundance is therefore generated using only strata off North Carolina during fall cruises. Survey length frequencies are aged with annual late-season keys from 1989-1990, and annual late-season South Atlantic keys since 1991. The keys were developed from pooled commercial and research samples. Survey specific ages where available, otherwise use south late key (primarily NC data). Fall aged fish are progressed one age to estimate January 1 abundance in the following year.

Until 2002, the survey index varied without trend, ranging from approximately 5 to 30 fish per tow, with the exceptions of 1993 with an index of less than 1 fish per tow, and 1994 and 1995 with indices of approximately 44 and 52 fish per tow. From 2003 to 2005, the index increased to between 35 and 60 fish per tow, before jumping drastically to nearly 500 fish per tow in 2006. In 2007, the index dropped back down to 45 fish per tow. (FIGURE)

Survey variability and precision? (updated in trawl surveys.xls)

Age structure is truncated in the survey catch-at-age matrix, and the survey is driven primarily by age 1 and age 2 fish. Barring the 2006 index value, strongest recruitment (age 1) events occurred in 1995 and 2003. The 2006 index is anomalously high, with an age 3 index greater than the age 1 index in most years. Age 4+ fish generally constitute less than 1% of the total catch, with a maximum of 11.2% in 1998 and 7.7% in 1999 as the strong 1994 year class moved through.

TC recommendation? Need catch curve analysis (Des, send data), pres/abs, geo mean (Jim, send him the data), review and present all strata/states, discuss concerns (sand seatrout etc an justify which data we use based on concerns and analyses ; possible vessel problems in 2007 may have delayed survey or stopped sampling. If add in other non-core surveys, can still justify keeping southern SEAMAP stations out because of sand seatrout concerns

ZZ6.5 Massachusetts DMF Trawl Survey

The Massachusetts Division of Marine Fisheries conducts a stratified random trawl survey in six depth zones (0-30, 31-60, 61-90, 91-120, 121-180 and >180 feet) and five geographic regions within the state. Sampling has been conducted twice per year (May and September) since 1978. Survey gear consists of a two-seam whiting trawl with a 39 foot headrope and a 0.5" stretch mesh codend liner. Weakfish, primarily young of year, are most commonly observed during the fall survey in the three regions south of Cape Cod. Mean catch per tow is used as an index of young of year abundance in the survey year.

The MA DMF trawl survey area encompasses nearshore ocean and estuarine areas within Massachusetts state boundaries. Like the New Jersey trawl survey, the survey area overlaps a portion of the NEFSC trawl survey area, but a smaller vessel allows more comprehensive sampling of shallow waters. Although large numbers of weakfish have been observed in Cape Cod Bay and Massachusetts Bay (Collette and Klein-MacPhee 2002), these waters are generally considered the northern extent of the weakfish range.

Mean annual catch per tow is consistently under 2 fish, with only three exceptions since 1981. Abundance generally declined from 1981 to 1984. In 1985, abundance increased more than 100-fold to the time series high of more than 15 fish per tow. Recruitment was again relatively high in 1986 (2.7 fish per tow), before dropping back to near zero levels for 1987 to 1994. Since 1994, abundance has shown a general upward trend, while at the same time exhibiting greater interannual variability. The second highest index value of 2.9 fish per tow occurred in 2006, before dropping back to just 0.2 fish per tow in 2007. (FIGURE)

Standard error is high and exhibits a similar trend as mean abundance. The CV is generally greater than 60%, and exceeds 90% in eight years. Because of the low catch rates and high variability, the TC has determined that this index provides little information on the abundance of weakfish. This is consistent with the NEFSC (2000) recommendation to use only indices from the core area.

TC Recommendation?? CV too high, get rid of it

ZZ6.6 Rhode Island Trawl Survey

NEED DISCUSSION ON RI SURVEY

precision, geographical coverage, stock structure, and relative accuracy??

Keep it for now, but need precision estimates. RI currently converting to Access so it may be a few weeks. Brian will work on this.

ZZ6.7 Connecticut DEP Long Island Sound Trawl Survey

Since 1984, the Connecticut DEP has conducted spring and fall trawl surveys in the Connecticut portion of Long Island Sound between the New York/Connecticut border in the west and New London, CT in the east. Survey effort consists of three spring cruises conducted during April, May and June, and three fall cruises in September and October. Stratified random sampling is employed based on four depth zones and three bottom types. Survey gear consists of a 14 x 9.1

m high-rise otter trawl with 0.196" codend mesh. The survey catches mostly YOY and age 1 weakfish as defined by examination of length frequencies. Indices of abundance for age 0 and age 1+ are developed as geometric mean catch per tow.

Sampling is limited to Long Island Sound. The Sound encompasses a very small portion of the weakfish range, but may serve as a primary spawning/nursery habitat in this region. Not a lot of spawning, but maybe eggs/juvs from other spawning areas come in

From 1984 to 1998, the YOY index varied without trend, and generally ranged from approximately 3 to 10 fish per tow, with relatively strong year classes (10-15 fish per tow) occurring in five years. In 1999, recruitment increased sharply and has remained above 30 fish per tow in all years except 2005 and 2006. Time series highs of more than 63 fish per tow occurred in 2000 and 2007, while minimum catches of approximately 1 fish or less occurred in 1984, 1986, and 2006. Coefficient of variation of the YOY index has exhibited a generally negative trend over the time series. (FIGURE)

The fall and spring age 1+ indices have never exceeded 1 fish per tow and 0.5 fish per tow, respectively. Except for the first few years of the time series, the two 1+ indices exhibit similar trends, and show strong positive correlation (r = 0.55). From 1984 to 1989, the fall index declines in abundance while the spring index remains stable or increases slightly. Both indices increase from 1989 to 1991, decrease through 1994, increase to time series highs in 1997 (fall) and 1999 (spring), and have generally declined since then. The CV for the fall index generally ranges from 0.2 to 0.6 and appears to have been on an increasing trend since 1997.

Low correlation was observed between the fall age 1+ index and the fall age 0 index lagged forward one year (r = 0.06; correlation table). Correlation was slightly better (r = 0.2) for the spring 1+ and fall age 0 lagged forward. One possible explanation is that weakfish in this area recruit to the spawning population at older ages; however, correlations between the 1+ indices and the age 0 index lagged forward two and three years were weaker, and in three of four cases, negative. This suggests that the Long Island Sound survey is inadequate for sampling either age 0 or age 1+ fish.

TC recommendation? Because this survey is conducted outside the apparent core area, NEFSC (2000) recommended that this survey not be used as an index of abundance. But large catches and good precision, so keep it.

ZZ6.8 NYDEC Peconic Bay Juvenile Trawl Survey

The New York Division of Fish, Wildlife and Marine Resources has conducted a juvenile trawl survey in the Peconic Bay estuary of Long Island since1985. Weakfish was the primary target species when the survey was initiated, and Peconic Bay was selected for the survey area because of its importance as a weakfish spawning ground. Random sampling occurs weekly between May and October using a semi-balloon shrimp trawl with a 16 foot headrope and 0.5" stretch mesh codend liner. The survey samples mainly young of year weakfish, and a YOY index has historically been calculated as an arithmetic mean catch per tow over all sampling months. In 2005 and 2006, technical difficulties constrained sampling to May – July (2005) and July – October (2006), so a revised index using only July and August has been calculated. The two indices show a similar increasing trend and are well correlated (r = 0.96). The July/August index provides higher estimates of abundance and appears to be more variable between years, although standard deviation as a ratio of the mean is lower for the July/August index than for all months combined. WHICH TO USE? – use July/August, need CIs but need more data to do it (now in log scale, need to calculate CIs?

The July/August index ranges from less than one fish per tow to more than 30/tow. Despite large interannual variations, there appears to be a gradual increase in recruitment over the time series. Strong year classes occurred in 1991, 1996, and 2005 (time series high). Standard error of the catch has increased over the time series as well; however, CV has decreased greatly from 1987 to 1996, and has remained below 1.5% since then. (FIGURE)

TC recommendation? Because this survey is conducted outside the apparent core area, NEFSC (2000) recommended that this survey not be used as an index of abundance. But good precision, so keep it.

ZZ6.9 Delaware DFW Delaware Bay Juvenile Trawl Survey

In addition to their 30-foot trawl survey, the Delaware DFW conducts a fixed station survey in Delaware Bay targeting juvenile finfish. Sampling is conducted monthly from April through October using a semi-balloon otter trawl. The net has a 17’ headrope and a 0.5” stretch mesh codend liner. Weakfish are a significant component of the catch, with the greatest majority of these weakfish (more than 99% in some years) being young of the year. A YOY index is calculated as the geometric mean number per tow during the June to October cruises.

As with the Delaware 30-foot index, the survey is restricted to Delaware Bay. Although this encompasses only a small portion of the geographic range of weakfish, the Bay is known to provide significant spawning and nursery habitat for the species.

Throughout this timeseries, recruitment indices have generally fallen between 5 and 15 fish per tow, with only 2 values below and three values above this range. Weak recruitment occurred in 1983 and 1988, with less than 5 fish per tow, while the two strongest recruitment events of 20.1 and 16.8 fish per tow occurred in 1991 and 2005, respectively. Average recruitment over the timeseries has been approximately 10.8 fish per tow. The index indicates three general stanzas in recruitment since 1981. From 1981 to 1990, recruitment was generally below the long term average. In 1991, recruitment increased to the timeseries high beginning a decade of above-average recruitment. In 2001, recruitment dropped below average and has remained there for five of the last seven years. (FIGURE)

Precision??

TC recommendation? Keep it

ZZ6.10 Maryland DNR Chesapeake Bay and Coastal Bays Juvenile Trawl Surveys

The Maryland Department of Natural Resources conducts two juvenile trawl surveys: one in the Chesapeake Bay from 1980 to the present, and one in the coastal bays from 1972 to the present. Both surveys sample fixed stations using a 16 foot semi-balloon otter trawl with a 0.5” stretch mesh codend liner. The coastal bays project samples monthly from April through October, while the Chesapeake survey runs monthly from May through October. Due to non-standardized survey methods during the early portions of both surveys, only data from 1989 onward are used to calculate YOY abundance indices. Indices are calculated as geometric mean catch per tow.

Both surveys are confined to Maryland state waters which constitute only a small portion of the weakfish range. Regardless, both survey areas are sheltered estuarine environments and may provide suitable spawning and nursery habitat for the species.

The Chesapeake index shows a steadily increasing trend from a timeseries low of 0.4 fish per tow in 1989 to the timeseries high of 8.1 fish per tow in 2001. Since 2001, the index has exhibited a steady decline to less than 2 fish per tow in 2007. The coastal bays index appears stable between 0.9 and 1.9 fish per tow for 1989 to 1994. In 1995, recruitment increases dramatically to 4.4 fish per tow, decreasing gradually back to 2.6 in 2001. During this period (1989 to 2001), interannual variability has been minor with few exceptions. Beginning in 2001, interannual variability increases dramatically. The weakest recruitment of the timeseries occurred in 2002, followed in 2003 by the timeseries high of 5.6 fish per tow. (FIGURE)

precision?? Get from Jim or Harry,

TC Recommendation?? Keep both but maybe down weight coastal bay index (if we weight the indices)

ZZ6.11 Virginia Institute of Marine Science Chesapeake Bay Trawl Survey

The Virginia Institute of Marine Science (VIMS) has conducted a trawl survey in lower Chesapeake Bay since 1955. Over time there have been several changes to sampling strategy and survey area. Currently, sampling is conducted using a 30 foot semi-balloon otter trawl with a 6.35 mm codend liner. Sampling is performed monthly throughout the year using stratified random sampling in the mainstem bay and fixed stations in tributaries. Young of year are identified through examination of length frequencies (monthly ranges), and an index of recruitment is computed using August-October tows from three major tributaries.

The geographic region covered by the survey includes the Virginia portion of the Chesapeake Bay and lower portions of its three main tributaries (James, York, and Rappahannock Rivers). Although sampling does occur in the main stem, catches of weakfish are generally minimal in the Bay, so the index is limited to the three tributaries. Few large weakfish are present year round, but the estuaries provide suitable nursery grounds for juveniles.

Recruitment varies widely over the timeseries, ranging from less than 5 fish per tow to more than 35 fish per tow. Interannual variability is often large, particularly in the early portion of the timeseries, with the maximum and minimum indices occurring in consecutive years. From 1986 to 1990, the survey shows a rapid increase from 4.7 to 30.0 fish per tow, followed by a sharp drop back to 7.0 fish per tow by 1994. Recruitment rebounded slightly through 1999, but has exhibited a generally declining trend ever since. (FIGURE)

No estimates of survey variability are available for the current index. (Data were not provided, and the program has recently lost some key staff.) Geer (1994), however, indicates that between 1981 and 1993 several changes in gear, vessel, and station type occurred, the most recent between the 1990 and 1991 surveys. It is possible that some of the interannual variability observed in the index is due to these methodological changes.

TC recommendation - need more info – are data standardized re survey changes, is it geo mean, use river only or bay and river, use only stdized portion of time series

ZZ6.12 North Carolina DMF Pamlico Sound Juvenile Trawl Survey

The North Carolina Division of Marine Fisheries conducts a juvenile trawl survey in Pamlico Sound. Sampling is conducted in June and September using a stratified random design. Survey gear consists of twin 30-foot mongoose trawl nets with 0.75" codend mesh. Data from these surveys are used to develop a 1+ index (June) and a YOY index (September), both based on length frequency analysis.

Between 1987 and 1999, the YOU index ranged from approximately 10 to 100 fish per tow, and was characterized by large interannual fluctuations. Strong year classes were present in 1988 and 1999, with weakest recruitment occurring in 1987 and 1993. From 1999 to 2002, recruitment dropped rapidly from 99.9 to 22 fish per tow. Since 2002, the index indicates a modest rebound to 56.8 fish per tow in 2007 and exhibits much less interannual variability.

For the early portion of the time series, the 1+ index shows little correlation with the YOY index. Around the mid 1990s, correlation between the indices improves until the last two years. The time series high occurred in 2000 (consistent with the strong 1999 year class), with the second highest value occurring in 2006. Low values were observed in 1989 to 1992, 2003, and 2007.

precision, geographical coverage

TC Recommendation?? – get geo mean from Lee, rewrite discussion

ZZ6.13 Pamlico Sound Independent Gillnet Study (PSIGNS)

This is the first weakfish stock assessment to evaluate the PSIGNS survey. Sampling in Pamlico Sound was initiated in May of 2001 and has sampled continuously since that time. The major objective of the PSIGNS is to provide independent relative abundance indices for key estuarine species.

Sampling uses a stratified random design based on area and water depth. Twice per month a deep-water and shallow-water sample are collected from each of 8 areas using a gillnet consisting of eight 30 yard segments of 3, 3½, 4, 4½, 5, 5½, 6, 6½ inch stretched mesh gill net. Nets are typically deployed within an hour of sunset and retrieved the next morning, for approximate soak times of 12 h. This sampling design results in a total of approximately 32 gill net samples (16 deep and 16 shallow samples) being collected per month across both the Rivers and Sound. Catch rates of target species were calculated annually and expressed as an overall CPUE along with corresponding length class distributions. The overall CPUE provides a relative index of abundance showing availability of each species to the study, while the length distribution and age CPUE estimates show the size structure of each species for a given year. The overall CPUE was defined as the number of a species of fish captured per sample and was further expressed as the number of a species of fish at length per sample, with a sample being one array of nets fished for 12 hours. Due to disproportionate sizes of each stratum and region, the final CPUE estimate was weighted. For weakfish the CPUE at age was calculated for 6-month periods (Jan-Jun and Jul-Dec) in the same manner as was done for the CAA workup in the last assessment.

ADD NEAMAP and ChesMMAP – not for index, but use bio data

ZZ6.14 MRFSS

Historically, a fishery dependent index of weakfish abundance was developed using recreational catch per “directed trip” (trips where weakfish was identified as a target species; *cf.* NEFSC 1998, 2000). During the review of the 2000 assessment, the SARC expressed concern regarding fishery dependent indices. Potential sources of bias in fishery dependent indices include non-random distribution of effort, and hyperstability of the index (as abundance - and therefore catch – declines, so does the number of trips; Hilborn and Walters 1992).

In 2006, a revised recreational index was developed that the Technical Committee feels largely circumvents the concerns expressed by the 30th SAW. Estimates of catch used are all fish (A+B1+B2) captured by the recreational private/rental boat mode in state waters of the mid-Atlantic region (New York to Virginia). As described in Crecco (2005), the private/rental mode is highly mobile and capable of catching weakfish over a large range of sizes. Catches were constrained to the mid-Atlantic region because private/rental boat catches from this region have accounted for greater than 60% of annual catch. Two estimates of effort were used to convert catch to CPUE. The first, as described in Crecco (2005) uses all private/rental boat trips in state waters of the mid-Atlantic region. The second, detailed by Brust (2004) estimates effort as the number of private/rental boat trips in mid-Atlantic state waters that captured any of a suite of species typically associated with catches of weakfish. The two indices are highly correlated (FIGURE). Although the 2006 assessment used the index based on the suite of associated species, the current assessment uses the index based on all mid-Atlantic private/rental boat trips. This index is preferable because of its ease of calculation without loss of information, and because it provides consistency between assessment methodologies (*i.e.* VPA vs. relative F). (FIGURE)

The methods described above include both harvested and discarded fish. Based on assumptions regarding availability to the fishery (gear and area) at size, this method is considered to provide a composite index of ages 2+. A second index was developed using similar methods, but including only harvested fish. Recreational length frequency data from the northern region, early/late season were used to expand the number harvested to harvest at size. The northern early/late age-length key was then used to partition harvest into ages. This method provides indices at age for 3 through 6+.

Both indices are developed using data from mid-Atlantic state waters. This region encompasses the primary distribution of weakfish within its range. Although all sizes and ages of weakfish are present in this region, younger fish are not considered to be captured or harvested by the fishery, so the indices are only representative of mature fish.

DISCUSS INDICES (Need to develop - 06 assess used assoc spp trips; want to change to all trips)

Estimates of precision are available for the different components of the indices (catch, harvest, and effort); however, there are no direct estimates of survey precision. Discussions on uncertainty in catch and effort estimates are presented in section ZZ5.2.

TC Recommendation??

Jim's work – favors aggregate biomass assessment; looking at alternative methods to analyze indices; trying to ID criteria for good vs bad index; did work on biomass indices, not numerical indices; criteria are precision, accuracy (hard to determine), consistency (low interannual variability) and coherence with other surveys – could use these for indices presented above; NEFSC can't be salvaged; NJ index not weighted by stratum size; 3 possible "usable" NJ biomass indices – "best" is positive tows * mn wt / tow; can use NJ pos tows index as tuning index, can even use aged

Lee's work – include as aged index; Lee to work on write up

Yan – standardized CPUEs – recommends using stdized surveys; right now not all indices are stdized (she hasn't received all data), also none of them have been aged; right now, keep our data, but if in future (even during this assessment) find Yan's data is better, we can reconsider

Joseph – natural mortality – review different non-age based and several age-specific M methods; all have drawbacks; many sensitive to reference value; choice of method is subjective, but leaning towards lorenzen cuz population specific;

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Table ZZ4.6-1. Commercial landings and (percent of annual total) by state and year. Landings are in metric tons.

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1981	18.1	109.8	12.4	615.9	1,701.1	477.0	153.5	1,121.2	7,662.9	0.0	0.2	86.3	11,958.4
	(0.15)	(0.92)	(0.1)	(5.15)	(14.23)	(3.99)	(1.28)	(9.38)	(64.08)	(0)	(0)	(0.72)	
1982	10.4	80.2	11.6	570.2	940.5	587.2	113.0	974.9	5,466.9	0.2	0.3	79.9	8,835.3
	(0.12)	(0.91)	(0.13)	(6.45)	(10.64)	(6.65)	(1.28)	(11.03)	(61.88)	(0)	(0)	(0.9)	
1983	3.1	74.3	19.4	385.6	985.5	409.1	176.9	1,176.1	4,642.0	0.0	1.2	53.4	7,926.6
	(0.04)	(0.94)	(0.24)	(4.86)	(12.43)	(5.16)	(2.23)	(14.84)	(58.56)	(0)	(0.02)	(0.67)	
1984	2.2	76.0	14.2	219.8	1,248.1	354.9	147.4	956.6	5,892.6	0.0	0.4	57.1	8,969.3
	(0.02)	(0.85)	(0.16)	(2.45)	(13.92)	(3.96)	(1.64)	(10.67)	(65.7)	(0)	(0)	(0.64)	
1985	1.4	74.0	12.8	175.2	1,374.4	449.4	143.4	944.5	4,454.9	0.0	0.0	60.0	7,690.0
	(0.02)	(0.96)	(0.17)	(2.28)	(17.87)	(5.84)	(1.86)	(12.28)	(57.93)	(0)	(0)	(0.78)	
1986	2.6	57.9	6.2	163.2	1,455.4	328.2	152.7	904.5	6,490.7	0.0	0.0	49.3	9,610.7
	(0.03)	(0.6)	(0.06)	(1.7)	(15.14)	(3.41)	(1.59)	(9.41)	(67.54)	(0)	(0)	(0.51)	
1987	0.8	35.7	13.4	149.3	949.9	262.1	166.4	890.3	5,220.2	0.0	0.1	55.8	7,744.0
	(0.01)	(0.46)	(0.17)	(1.93)	(12.27)	(3.38)	(2.15)	(11.5)	(67.41)	(0)	(0)	(0.72)	
1988	1.7	8.8	1.1	56.5	1,058.2	240.7	377.7	668.2	6,845.6	0.0	0.0	52.2	9,310.7
	(0.02)	(0.09)	(0.01)	(0.61)	(11.37)	(2.59)	(4.06)	(7.18)	(73.52)	(0)	(0)	(0.56)	
1989	0.9	4.4	1.0	46.9	661.6	240.5	337.4	465.0	4,588.5	0.1	0.0	78.1	6,424.4
	(0.01)	(0.07)	(0.02)	(0.73)	(10.3)	(3.74)	(5.25)	(7.24)	(71.42)	(0)	(0)	(1.22)	
1990	0.8	11.2	0.6	9.0	439.2	278.1	300.4	547.7	2,631.8	0.0	0.0	62.2	4,281.0
	(0.02)	(0.26)	(0.01)	(0.21)	(10.26)	(6.5)	(7.02)	(12.79)	(61.48)	(0)	(0)	(1.45)	
1991	0.9	11.3	9.7	50.6	532.6	225.6	148.9	480.7	2,408.0	0.0	0.0	74.8	3,943.1
	(0.02)	(0.29)	(0.25)	(1.28)	(13.51)	(5.72)	(3.78)	(12.19)	(61.07)	(0)	(0)	(1.9)	
1992	1.4	13.7	1.6	76.2	426.7	164.4	174.8	249.5	2,205.6	0.0	0.0	67.1	3,381.0
	(0.04)	(0.41)	(0.05)	(2.25)	(12.62)	(4.86)	(5.17)	(7.38)	(65.24)	(0)	(0)	(1.98)	
1993	0.5	4.5	0.7	40.1	378.5	88.3	82.5	493.5	1,954.7	0.0	0.0	65.5	3,108.8
	(0.02)	(0.14)	(0.02)	(1.29)	(12.18)	(2.84)	(2.65)	(15.87)	(62.88)	(0)	(0)	(2.11)	
1994	0.0	8.2	5.0	45.1	315.4	118.8	63.9	587.1	1,583.0	0.0	0.0	81.5	2,808.0
	(0)	(0.29)	(0.18)	(1.61)	(11.23)	(4.23)	(2.28)	(20.91)	(56.37)	(0)	(0)	(2.9)	
1995	0.2	23.9	2.9	78.2	393.4	127.6	31.5	673.6	1,865.8	0.0	0.0	22.8	3,219.9
	(0.01)	(0.74)	(0.09)	(2.43)	(12.22)	(3.96)	(0.98)	(20.92)	(57.95)	(0)	(0)	(0.71)	
1996	0.0	19.7	3.1	165.7	372.9	0.0	60.2	719.9	1,804.3	0.0	0.0	2.0	3,147.8
	(0)	(0.63)	(0.1)	(5.26)	(11.85)	(0)	(1.91)	(22.87)	(57.32)	(0)	(0)	(0.06)	
1997	0.0	14.1	5.0	152.7	470.1	253.5	87.4	706.7	1,615.3	0.0	0.0	5.3	3,310.1
	(0)	(0.43)	(0.15)	(4.61)	(14.2)	(7.66)	(2.64)	(21.35)	(48.8)	(0)	(0)	(0.16)	
1998	0.2	35.0	6.6	225.2	818.6	250.7	110.9	845.5	1,521.4	0.0	0.0	6.8	3,820.9
	(0.01)	(0.92)	(0.17)	(5.89)	(21.42)	(6.56)	(2.9)	(22.13)	(39.82)	(0)	(0)	(0.18)	
1999	1.2	57.3	10.1	222.2	585.7	199.7	101.4	759.3	1,187.3	0.0	0.0	7.9	3,132.1
	(0.04)	(1.83)	(0.32)	(7.09)	(18.7)	(6.38)	(3.24)	(24.24)	(37.91)	(0)	(0)	(0.25)	

Table 1 (continued). Commercial landings and (percent of annual total) by state and year. Landings are in metric tons.

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total
2000	0.2	85.9	3.6	160.0	486.0	149.1	94.5	618.2	847.8	0.0	0.0	4.3	2,449.6
	(0.01)	(3.51)	(0.15)	(6.53)	(19.84)	(6.09)	(3.86)	(25.24)	(34.61)	(0)	(0)	(0.18)	
2001	0.1	49.7	3.1	262.5	379.9	85.1	84.3	508.9	889.2	0.0	0.0	4.9	2,267.7
	(0)	(2.19)	(0.14)	(11.58)	(16.75)	(3.75)	(3.72)	(22.44)	(39.21)	(0)	(0)	(0.22)	
2002	0.4	55.7	4.6	233.1	391.5	78.4	50.5	518.9	829.3	0.0	0.0	2.6	2,165.0
	(0.02)	(2.57)	(0.21)	(10.77)	(18.08)	(3.62)	(2.33)	(23.97)	(38.3)	(0)	(0)	(0.12)	
2003	0.2	28.7	1.4	65.5	154.3	41.5	21.5	208.4	385.0	0.0	0.0	1.2	907.7
	(0.02)	(3.16)	(0.15)	(7.22)	(17)	(4.57)	(2.37)	(22.96)	(42.41)	(0)	(0)	(0.13)	
2004	0.0	17.4	2.8	80.9	92.8	23.3	0.0	161.9	310.9	0.0	0.0	1.2	691.2
	(0)	(2.52)	(0.41)	(11.7)	(13.43)	(3.37)	(0)	(23.42)	(44.98)	(0)	(0)	(0.17)	
2005	0.0	18.9	2.8	49.8	29.2	32.1	16.2	176.9	191.2	0.0	0.0	3.3	520.4
	(0)	(3.63)	(0.54)	(9.57)	(5.61)	(6.17)	(3.11)	(33.99)	(36.74)	(0)	(0)	(0.63)	
2006	3.9	20.2	3.2	69.3	93.7	15.6	23.2	85.2	164.6	0.0	0.0	2.7	481.6
	(0.81)	(4.19)	(0.66)	(14.39)	(19.46)	(3.24)	(4.82)	(17.69)	(34.18)	(0)	(0)	(0.56)	
2007	0.2	9.3	0.9	39.3	74.6	11.1	12.6	156.7	79.6	0.0	0.0	3.5	387.9
	(0.04)	(2.41)	(0.22)	(10.13)	(19.23)	(2.87)	(3.26)	(40.39)	(20.53)	(0)	(0)	(0.91)	

Table ZZ4.6-2. Recreational harvest and (percent of annual total) by state and year. Harvest values are numbers of fish.

Year	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1981	5,946	18,371	18,707	275,120	1,028,787	122,744	177,761	7,484,780	204,230	2,580	2,433		9,344,461
	(0.06)	(0.2)	(0.2)	(2.94)	(11.01)	(1.31)	(1.9)	(80.1)	(2.19)	(0.03)	(0.03)	(0)	
1982		18,614	11,769	88,234	104,066	217,821	440,146	715,892	200,045	17,342		40,161	1,854,090
	(0)	(1)	(0.63)	(4.76)	(5.61)	(11.75)	(23.74)	(38.61)	(10.79)	(0.94)	(0)	(2.17)	
1983	2,732	74,608	6,363	36,934	2,857,093	1,009,899	595,286	354,846	387,871	6,807	17,209	293,303	5,642,951
	(0.05)	(1.32)	(0.11)	(0.65)	(50.63)	(17.9)	(10.55)	(6.29)	(6.87)	(0.12)	(0.3)	(5.2)	
1984	2,237	0	1,561	20,133	1,026,043	593,107	104,057	782,848	489,468	7,836		493,521	3,520,811
	(0.06)	(0)	(0.04)	(0.57)	(29.14)	(16.85)	(2.96)	(22.23)	(13.9)	(0.22)	(0)	(14.02)	
1985		17,092	2,874	89,538	812,839	365,693	305,799	505,223	217,671	61,788	4,811	36,340	2,419,668
	(0)	(0.71)	(0.12)	(3.7)	(33.59)	(15.11)	(12.64)	(20.88)	(9)	(2.55)	(0.2)	(1.5)	
1986		4,595	7,315	34,582	2,500,622	914,489	1,947,394	2,418,046	611,363	78,315	18,130	129,270	8,664,121
	(0)	(0.05)	(0.08)	(0.4)	(28.86)	(10.55)	(22.48)	(27.91)	(7.06)	(0.9)	(0.21)	(1.49)	
1987			777	7,447	1,666,619	638,342	824,883	1,015,413	624,160	18,841	10,802	64,248	4,871,532
	(0)	(0)	(0.02)	(0.15)	(34.21)	(13.1)	(16.93)	(20.84)	(12.81)	(0.39)	(0.22)	(1.32)	
1988			0	13,215	642,032	974,712	1,163,766	2,297,053	438,148	1,834	0	95,509	5,626,269
	(0)	(0)	(0)	(0.23)	(11.41)	(17.32)	(20.68)	(40.83)	(7.79)	(0.03)	(0)	(1.7)	
1989				6,436	303,289	254,170	226,505	357,864	190,193	6,810	8,245	141,880	1,495,392
	(0)	(0)	(0)	(0.43)	(20.28)	(17)	(15.15)	(23.93)	(12.72)	(0.46)	(0.55)	(9.49)	
1990		407		3,057	216,385	179,837	370,528	286,458	91,300	8,027	2,273	73,983	1,232,255
	(0)	(0.03)	(0)	(0.25)	(17.56)	(14.59)	(30.07)	(23.25)	(7.41)	(0.65)	(0.18)	(6)	
1991			18,695	28,072	545,665	366,464	221,242	351,947	140,826	19,616	4,954	115,210	1,812,691
	(0)	(0)	(1.03)	(1.55)	(30.1)	(20.22)	(12.21)	(19.42)	(7.77)	(1.08)	(0.27)	(6.36)	
1992		9,624	434	5,282	311,659	100,561	137,260	265,645	35,490	23,501	1,751	68,943	960,150
	(0)	(1)	(0.05)	(0.55)	(32.46)	(10.47)	(14.3)	(27.67)	(3.7)	(2.45)	(0.18)	(7.18)	
1993			2,460	12,610	203,915	235,312	238,768	108,392	106,737	7,360	14,752	148,968	1,079,274
	(0)	(0)	(0.23)	(1.17)	(18.89)	(21.8)	(22.12)	(10.04)	(9.89)	(0.68)	(1.37)	(13.8)	
1994			0	1,872	591,571	300,211	332,846	169,740	177,965	46,858	718	204,714	1,826,495
	(0)	(0)	(0)	(0.1)	(32.39)	(16.44)	(18.22)	(9.29)	(9.74)	(2.57)	(0.04)	(11.21)	
1995		1,568		22,310	671,850	406,730	88,695	226,682	62,475	29,897	22,437	55,435	1,588,079
	(0)	(0.1)	(0)	(1.4)	(42.31)	(25.61)	(5.59)	(14.27)	(3.93)	(1.88)	(1.41)	(3.49)	
1996		0		16,320	1,104,251	633,920	183,408	193,861	90,704	5,695	5,413	35,757	2,269,329
	(0)	(0)	(0)	(0.72)	(48.66)	(27.93)	(8.08)	(8.54)	(4)	(0.25)	(0.24)	(1.58)	
1997		1,415	517	112,986	1,028,334	647,529	162,900	557,809	184,954	2,039	44,202	72,970	2,815,655
	(0)	(0.05)	(0.02)	(4.01)	(36.52)	(23)	(5.79)	(19.81)	(6.57)	(0.07)	(1.57)	(2.59)	
1998	618	0	2,183	21,392	920,558	455,603	290,051	463,525	191,181	15,838	718	24,678	2,386,345
	(0.03)	(0)	(0.09)	(0.9)	(38.58)	(19.09)	(12.15)	(19.42)	(8.01)	(0.66)	(0.03)	(1.03)	
1999		2,296	1,606	18,347	583,883	224,307	340,096	229,209	127,163	3,941	1,679	119,027	1,651,554
	(0)	(0.14)	(0.1)	(1.11)	(35.35)	(13.58)	(20.59)	(13.88)	(7.7)	(0.24)	(0.1)	(7.21)	

Table ZZ4.6-2 (continued). Recreational harvest and (percent of annual total) by state and year. Harvest values are numbers of fish.

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA	FL	Total
2000		712	7,342	42,406	760,279	311,553	475,348	286,752	71,247	5,585	4,181	123,797	2,089,202
	(0)	(0.03)	(0.35)	(2.03)	(36.39)	(14.91)	(22.75)	(13.73)	(3.41)	(0.27)	(0.2)	(5.93)	
2001		2,301	715	28,126	736,069	72,451	302,719	175,872	158,605		3,316	46,409	1,526,583
	(0)	(0.15)	(0.05)	(1.84)	(48.22)	(4.75)	(19.83)	(11.52)	(10.39)	(0)	(0.22)	(3.04)	
2002		1,420	1,796	24,962	492,876	121,884	100,467	178,110	90,170	90,245	852	69,106	1,171,888
	(0)	(0.12)	(0.15)	(2.13)	(42.06)	(10.4)	(8.57)	(15.2)	(7.69)	(7.7)	(0.07)	(5.9)	
2003	109	298	443	9,234	151,101	20,124	41,048	86,112	153,753	4,162	1,573	29,614	497,571
	(0.02)	(0.06)	(0.09)	(1.86)	(30.37)	(4.04)	(8.25)	(17.31)	(30.9)	(0.84)	(0.32)	(5.95)	
2004		0	0	7,596	183,649	6,967	29,645	103,181	237,395	153,589	9,815	46,020	777,857
	(0)	(0)	(0)	(0.98)	(23.61)	(0.9)	(3.81)	(13.26)	(30.52)	(19.75)	(1.26)	(5.92)	
2005		1,009		359	1,053,005	19,031	22,164	30,346	163,265	129,575	5,764	79,021	1,503,539
	(0)	(0.07)	(0)	(0.02)	(70.04)	(1.27)	(1.47)	(2.02)	(10.86)	(8.62)	(0.38)	(5.26)	
2006		3,297		9,123	417,527	11,158	470	58,814	153,696	7,123	3,501	80,427	745,136
	(0)	(0.44)	(0)	(1.22)	(56.03)	(1.5)	(0.06)	(7.89)	(20.63)	(0.96)	(0.47)	(10.79)	
2007		0		7,120	209,310	4,182	10,316	44,493	114,332	71,230	4,712	118,743	584,438
	(0)	(0)	(0)	(1.22)	(35.81)	(0.72)	(1.77)	(7.61)	(19.56)	(12.19)	(0.81)	(20.32)	

Table ZZ5.1-1. Sample size and parameter estimates for weakfish length-weight equations.

Region	Year	Season	N	a	b
North	2004	Early	1487	1.85E-08	3.023663
North	2004	Late	2997	3.2E-08	2.927907
North	2005	Early	878	4.25E-08	2.884075
North	2005	Late	2724	4.2E-08	2.892038
North	2006	Early	1135	2.95E-08	2.956832
North	2006	Late	2028	1.13E-07	2.735412
South	2004	Early	322	5.34E-08	2.867107
South	2004	Late	280	6.78E-08	2.820563
South	2005	Early	295	2.5E-08	2.979039
South	2005	Late	289	2.11E-08	3.009672
South	2006	Early	367	1.68E-08	3.045197
South	2006	Late	278	5.7E-08	2.843432

Table ZZ5.1-2. Biological sampling intensity by state and season for recent years (need to update 2007).

Year	Season	State	Commercial Ages	Commercial Lengths	Commercial Landings (MT)	Commercial Lengths / MT	Recreational Lengths	Recreational Landings (MT)	Recreational Lengths / MT
2001	Early	MA	0	0	0.0	0.0	0	0.0	0.0
		RI	178**	178**	10.8	16.5	0	0.0	0.0
		CT	34	0	0.3	0.0	0	0.0	0.0
		NY	0	0	39.9	0.0	9	39.0	0.2
		NJ	0	0	108.0	0.0	43	114.8	0.4
		DE	300	370	75.0	4.9	69	50.7	1.4
		MD	0	8	27.3	0.3	5	15.6	0.3
		VA	152	758	249.9	3.0	82	107.6	0.8
		NC	328	9,747	723.3	13.5	19	2.4	7.8
		SC				0.0	0	0.0	0.0
		GA			0.0	0.0	1	0.1	8.3
		FL		0	2.4	0.0	6	10.4	0.6
		SEAMAP	99						
		Total	**992**	**11,306**	**1,236.9**	**9.1**	**234**	**340.8**	**0.7**
2001	Late	MA	0	0	0.1	0.0	0	0.0	0.0
		RI	178**	178**	38.9	4.6	0	0.0	0.0
		CT	69	0	2.7	0.0	1	2.2	0.5
		NY	0	372**	222.9	1.7	3	29.7	0.1
		NJ	0	0	271.8	0.0	362	452.7	0.8
		DE	861	0	2.7	0.0	59	27.8	2.1
		MD	193	261	68.2	3.8	294	241.9	1.2
		VA	420	1,806	280.6	6.4	106	61.7	1.7
		NC	220	3,199	158.8	20.1	161	69.4	2.3
		SC				0.0	0	0.0	0.0
		GA				0.0	2	1.2	1.6
		FL		0	2.5	0.0	17	7.6	2.2
		SEAMAP	151						
		NEFSC	617						
		Total	**2,699**	**6,003**	**1,049.2**	**5.7**	**1005**	**894.2**	**1.1**
2002	Early	MA	0	0	0.2	0.0	0	0.0	0.0
		RI	50	50	30.4	1.6	0	0.0	0.0
		CT	22	0	2.6	0.0	0	0.0	0.0
		NY	0	0	45.0	0.0	4	9.5	0.4
		NJ	0	0	92.4	0.0	101	229.0	0.4
		DE	561	1,179	54.9	21.5	201	81.1	2.5
		MD	20	21	11.0	1.9	12	10.8	1.1
		VA	328	2,399	325.8	7.4	110	39.9	2.8
		NC	231	9,121	691.8	13.2	47	7.9	5.9
		SC	0			0.0	0	0.2	0.0
		GA	0			0.0	0	0.0	0.0
		FL	0	0	1.6	0.0	17	21.2	0.8
		SEAMAP	122*			0.0			0.0
		CHESMAP	141			0.0			0.0
		Total	**1,478**	**12,770**	**1,255.7**	**10.2**	**492**	**399.5**	**1.2**

Table ZZ5.1-2 (continued). Biological sampling intensity by state and season for recent years.

			Commercial				Recreational		
Year	Season	State	Ages	Lengths	Landings (MT)	Lengths / MT	Lengths	Landings (MT)	Lengths / MT
2002	Late	MA	0	0	0.2	0.0	0	0.0	0.0
		RI	0	0	25.2	0.0	2	1.7	1.2
		CT	42	0	2.0	0.0	1	5.1	0.2
		NY	0	0	188.1	0.0	8	17.1	0.5
		NJ	0	0	299.0	0.0	164	321.7	0.5
		DE	760	0	23.5	0.0	58	29.2	2.0
		MD	44	216	44.8	4.8	58	68.2	0.9
		VA	318	4,170	211.2	19.7	141	94.1	1.5
		NC	281	3,642	130.8	27.8	59	29.6	2.0
		SC				0.0	7	22.6	0.3
		GA				0.0	1	0.3	3.2
		FL		0	1.1	0.0	21	5.7	3.7
		SEAMAP	153			0.0			0.0
		CHESMAP	550			0.0			0.0
		NEFSC	692			0.0			0.0
		Total	**2,838**	**8,028**	**925.9**	**8.7**	**520**	**595.2**	**0.9**
2003	Early	MA	0	0	0.2	0.0	0	0.0	0.0
		RI	0	0	8.4	0.0	0	0.0	0.0
		CT	4	0	4.6	0.0	0	0.0	0.0
		NY	0	0	30.6	0.0	1	11.6	0.1
		NJ	36	104	70.4	1.5	22	58.2	0.4
		DE	580	944	38.4	24.6	14	4.8	2.9
		MD	0	7	3.2	2.2	0	0.0	0.0
		VA	350	1,900	100.5	18.9	41	49.8	0.8
		NC	269	5,227	267.9	19.5	42	15.6	2.7
		SC				0.0	0	0.0	0.0
		GA				0.0	0	0.0	0.0
		FL		0	1.0	0.0	9	4.5	2.0
		SEAMAP	219*			0.0			0.0
		CHESMAP	78			0.0			0.0
		Total	**1,500**	**8,182**	**525.2**	**15.6**	**129**	**144.5**	**0.9**
2003	Late	MA	0	0	0.0	0.0	1	0.4	2.5
		RI	211	343	20.3	16.9	1	1.1	0.9
		CT	22	0	0.3	0.0	1	1.6	0.6
		NY	0	0	34.7	0.0	4	5.3	0.8
		NJ	29	0	83.6	0.0	38	93.2	0.4
		DE	372	0	3.1	0.0	23	21.5	1.1
		MD	202	276	11.1	24.9	17	11.2	1.5
		VA	323	2,226	108.1	20.6	49	47.9	1.0
		NC	220	3,523	114.1	30.9	89	57.6	1.5
		SC				0.0	2	2.0	1.0
		GA				0.0	3	0.6	5.0
		FL		0	0.2	0.0	13	5.6	2.3
		SEAMAP	0			0.0			0.0
		CHESMAP	595*			0.0			0.0
		NEFSC	0			0.0			0.0
		Total	**1,975**	**6,368**	**375.5**	**17.0**	**241**	**247.8**	**1.0**

Table ZZ5.1-2 (continued). Biological sampling intensity by state and season for recent years.

				Commercial			Recreational		
Year	**Season**	**State**	**Ages**	**Lengths**	**Landings (MT)**	**Lengths / MT**	**Lengths**	**Landings (MT)**	**Lengths / MT**
2004	Early	MA		0	0.0	0.0		0.0	0.0
		RI		0	5.5	0.0		0.0	0.0
		CT		0	0.3	0.0		0.0	0.0
		NY		0	20.8	0.0	1	0.7	1.4
		NJ		0	35.4	0.0	6	48.6	0.1
		DE	46	182	13.7	13.3		0.0	0.0
		MD	12	13	1.2	10.8		0.0	0.0
		VA	353	1,408	47.3	29.8	126	19.2	6.6
		NC	300			0.0	31	36.5	0.8
		SC				0.0	11	1.7	6.5
		GA				0.0	0	0.8	0.0
		FL				0.0	15	9.4	1.6
		SEAMAP	246			0.0			0.0
		CHESMAP	263			0.0			0.0
		Total		**1,603**	**124.3**	**12.9**	**190**	**116.9**	**1.6**
2004	Late	MA		0	0.0	0.0		0.0	0.0
		RI	4	0	11.9	0.0		0.0	0.0
		CT		0	2.5	0.0		0.0	0.0
		NY		0	47.4	0.0	4	8.0	0.5
		NJ		0	57.6	0.0	61	94.4	0.6
		DE	552	0	9.6	0.0	13	3.1	4.2
		MD	136	403	21.8	18.5	44	19.8	2.2
		VA	55	1,848	101.7	18.2	45	27.4	1.6
		NC	289			0.0	142	87.7	1.6
		SC				0.0	38	52.0	0.7
		GA				0.0	15	4.3	3.5
		FL				0.0	14	7.2	1.9
		SEAMAP	316			0.0			0.0
		CHESMAP	811			0.0			0.0
		NEFSC	476			0.0			0.0
		Total		**2,251**	**252.5**	**8.9**	**376**	**303.9**	**1.2**
2005	Early	MA		0	0.0	0.0		0.0	0.0
		RI	1	21	5.2	4.1	1	3.8	0.3
		CT		0	1.1	0.0		0.0	0.0
		NY		0	9.8	0.0		0.0	0.0
		NJ		0	22.7	0.0	2	8.3	0.2
		DE	43	572	21.8	26.3	12	9.6	1.3
		MD	18	18	0.8	23.4		0.0	0.0
		VA	217	1,000	55.4	18.0	294	5.0	58.8
		NC	284			0.0	37	13.2	2.8
		SC				0.0	0	0.1	0.0
		GA				0.0	25	3.0	8.3
		FL				0.0	13	36.8	0.4
		SEAMAP	185			0.0			0.0
		CHESMAP	99			0.0			0.0
		Total		**1,611**	**116.7**	**13.8**	**384**	**79.8**	**4.8**

Table ZZ5.1-2 (continued). Biological sampling intensity by state and season for recent years.

				Commercial				Recreational	
Year	**Season**	**State**	**Ages**	**Lengths**	**Landings (MT)**	**Lengths / MT**	**Lengths**	**Landings (MT)**	**Lengths / MT**
2005	Late	MA		0	1.3	0.0		0.0	0.0
		RI	59	59	13.7	4.3		0.0	0.0
		CT		0	1.6	0.0		0.0	0.0
		NY		0	31.3	0.0	6	0.3	20.0
		NJ		0	71.9	0.0	131	513.3	0.3
		DE	618	0	10.4	0.0	29	8.3	3.5
		MD	260	455	13.3	34.1	30	4.0	7.5
		VA	244	3,046	109.5	27.8	51	4.3	11.9
		NC	277			0.0	117	58.4	2.0
		SC				0.0	31	42.6	0.7
		GA				0.0	4	0.5	8.0
		FL				0.0	25	8.5	2.9
		SEAMAP	285			0.0			0.0
		CHESMAP	1005			0.0			0.0
		NEFSC	594			0.0			0.0
		Total		**3,560**	**253.1**	**14.1**	**424**	**640.2**	**0.7**
2006	Early	MA		0	0.6	0.0		0.0	0.0
		RI	5	0	5.6	0.0		0.0	0.0
		CT		0	2.7	0.0		0.0	0.0
		NY		0	17.6	0.0	1	4.6	0.2
		NJ	43	350	19.3	18.1	17	55.7	0.3
		DE	79	117	10.5	11.2	5	3.5	1.4
		MD		3	0.3	9.1		0.0	0.0
		VA	360	1,738	45.2	38.5	51	22.5	2.3
		NC	396			0.0	95	27.4	3.5
		SC				0.0	3	0.6	5.0
		GA				0.0	0	0.9	0.0
		FL				0.0	37	22.7	1.6
		SEAMAP	120			0.0			0.0
		CHESMAP	167			0.0			0.0
		Total		**2,208**	**101.7**	**21.7**	**209**	**137.9**	**1.5**
2006	Late	MA		0	3.3	0.0		0.0	0.0
		RI	38	38	15.0	2.5	3	17.5	0.2
		CT		0	0.5	0.0		0.0	0.0
		NY		0	51.7	0.0	4	1.7	2.4
		NJ	256	379	74.6	5.1	69	203.6	0.3
		DE	481	0	5.2	0.0	11	5.2	2.1
		MD	180	494	14.4	34.3	0	0.3	0.0
		VA	253	3,540	66.1	53.6	8	1.0	8.0
		NC	341			0.0	149	35.8	4.2
		SC				0.0	75	3.0	25.0
		GA				0.0	1	0.5	2.0
		FL				0.0	13	10.6	1.2
		SEAMAP	197			0.0			0.0
		CHESMAP	550			0.0			0.0
		NEFSC	995			0.0			0.0
		NEAMAP	494						
		Total		**4,451**	**230.7**	**19.3**	**333**	**279.2**	**1.2**

Table ZZ5.1-2 (continued). Biological sampling intensity by state and season for recent years.

			Commercial				Recreational		
Year	**Season**	**State**	**Ages**	**Lengths**	**Landings (MT)**	**Lengths / MT**	**Lengths**	**Landings (MT)**	**Lengths / MT**
2007	Early	MA			0.2	0.0		0.0	0.0
		RI			4.1	0.0		0.0	0.0
		CT			0.6	0.0		0.0	0.0
		NY			14.2	0.0		0.0	0.0
		NJ			53.6	0.0	8	23.5	0.3
		DE			9.9	0.0	2	0.6	3.3
		MD			1.9	0.0		0.0	0.0
		VA		997	94.1	10.6	4	6.6	0.6
		NC				0.0	14	3.9	3.6
		SC				0.0	25	2.3	10.9
		GA				0.0	4	1.3	3.1
		FL				0.0	11	8.8	1.3
		SEAMAP				0.0			0.0
		CHESMAP				0.0			0.0
		Total		**997**	**178.6**	**5.6**	**68**	**47.0**	**1.4**
2007	Late	MA			0.0	0.0		0.0	0.0
		RI			5.3	0.0		0.0	0.0
		CT			0.3	0.0		0.0	0.0
		NY			25.1	0.0	0	3.7	0.0
		NJ			20.2	0.0	30	111.2	0.3
		DE			1.2	0.0	6	1.4	4.3
		MD			6.2	0.0	7	8.8	0.8
		VA		1,831	56.8	32.2	5	15.2	0.3
		NC				0.0	65	53.0	1.2
		SC				0.0	150	18.6	8.1
		GA				0.0	5	0.4	12.5
		FL				0.0	27	51.3	0.5
		SEAMAP				0.0			0.0
		CHESMAP				0.0			0.0
		NEFSC				0.0			0.0
		Total		**1,831**	**115.1**	**15.9**	**295**	**263.6**	**1.1**

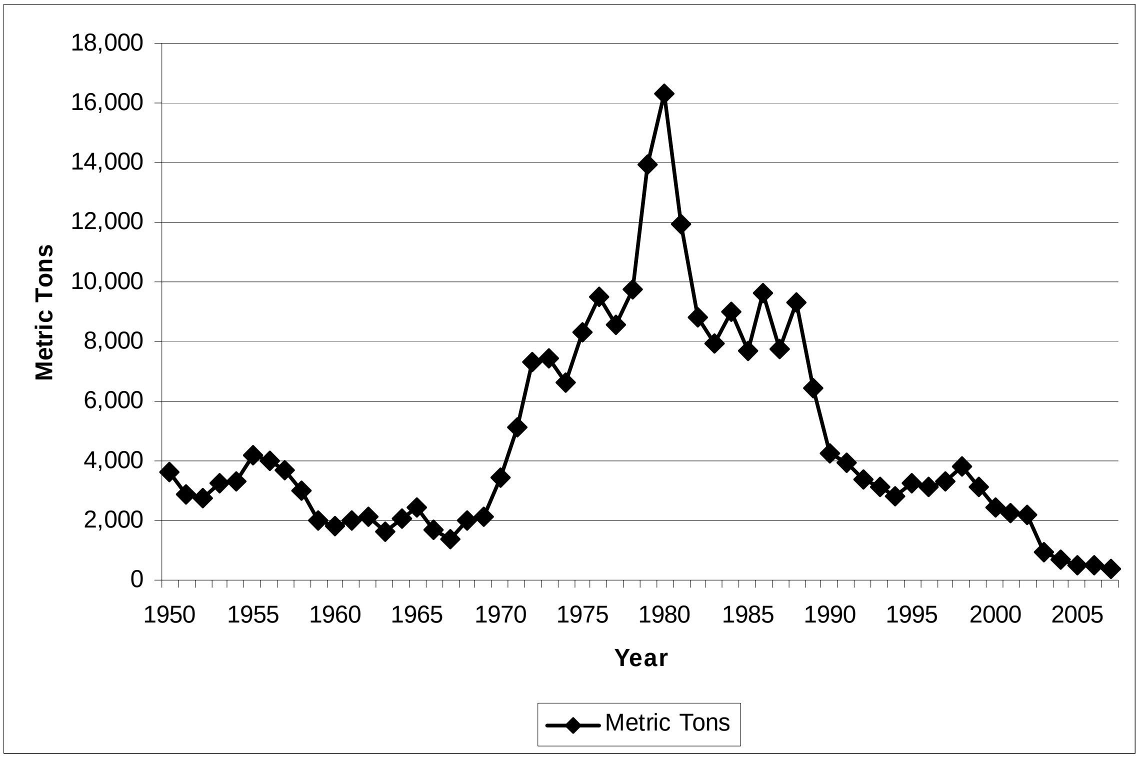


Figure ZZ4.6-1. Commercial harvest of weakfish on the Atlantic coast.

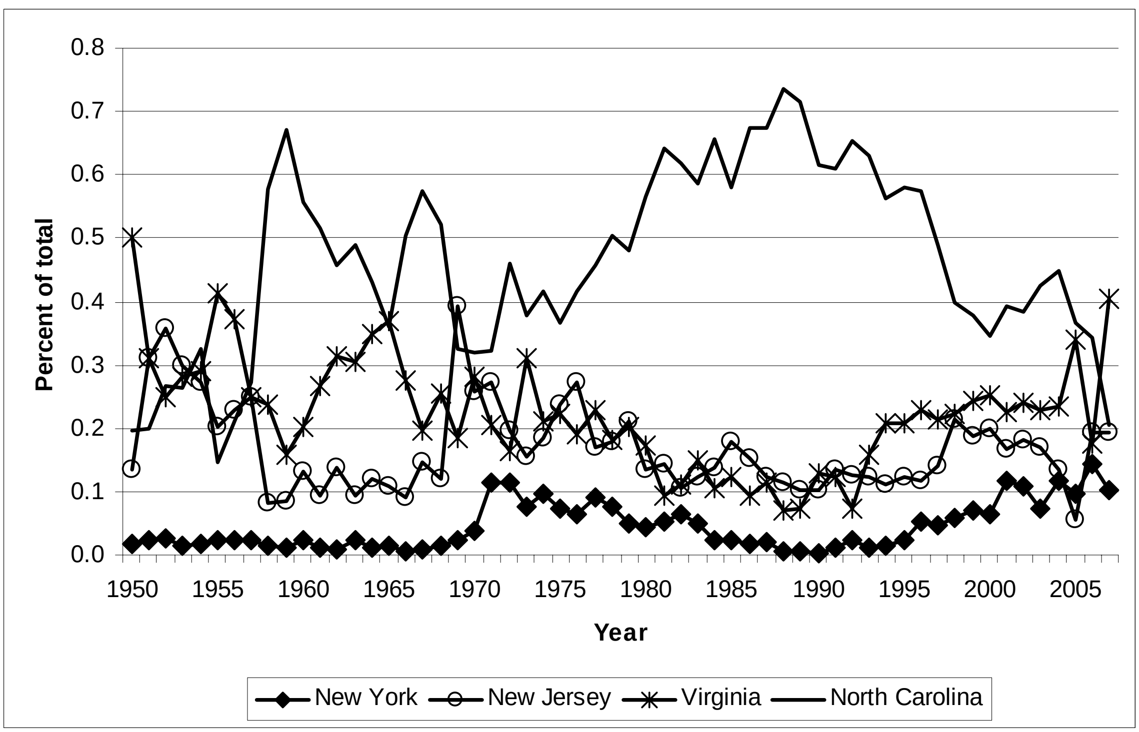


Figure ZZ4.6-2. Proportion of annual commercial weakfish harvest by dominant states.

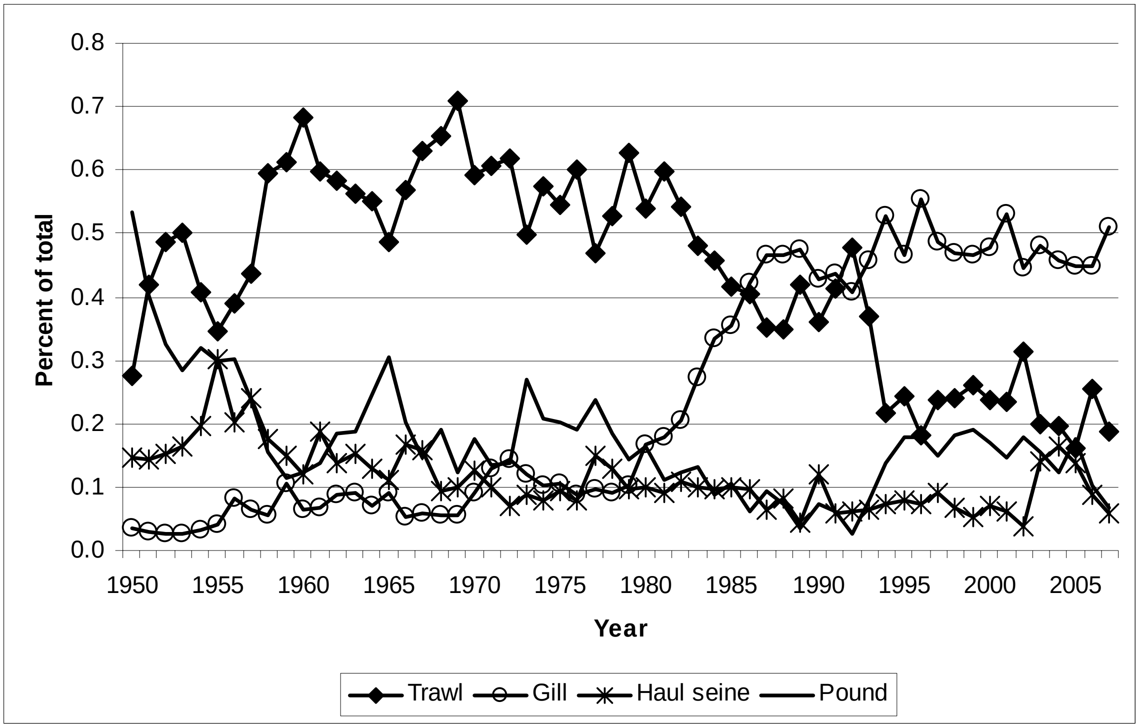


Figure ZZ4.6-3. Proportion of annual commercial weakfish harvest by dominant gears.

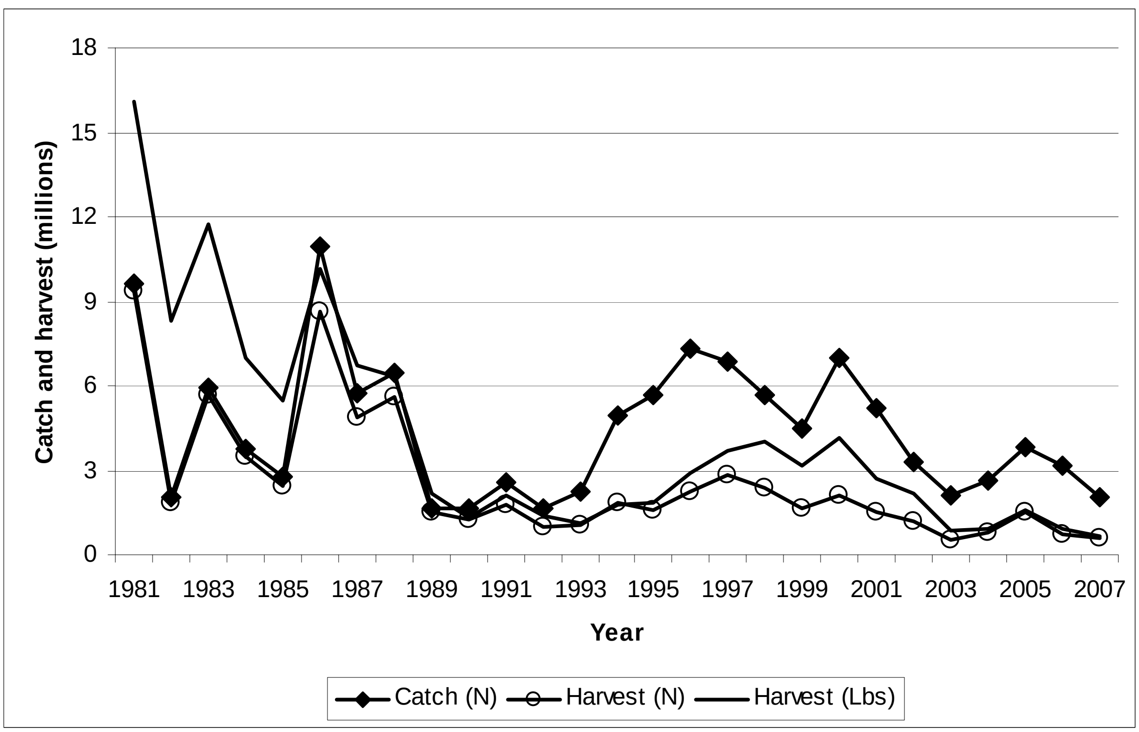


Figure ZZ4.6-4. Recreation catch (numbers) and harvest (numbers and pounds) of weakfish on the Atlantic coast.

Figure 4.6-5. Proportion of annual recreational weakfish harvest by dominant states. (Should this be a table instead?)

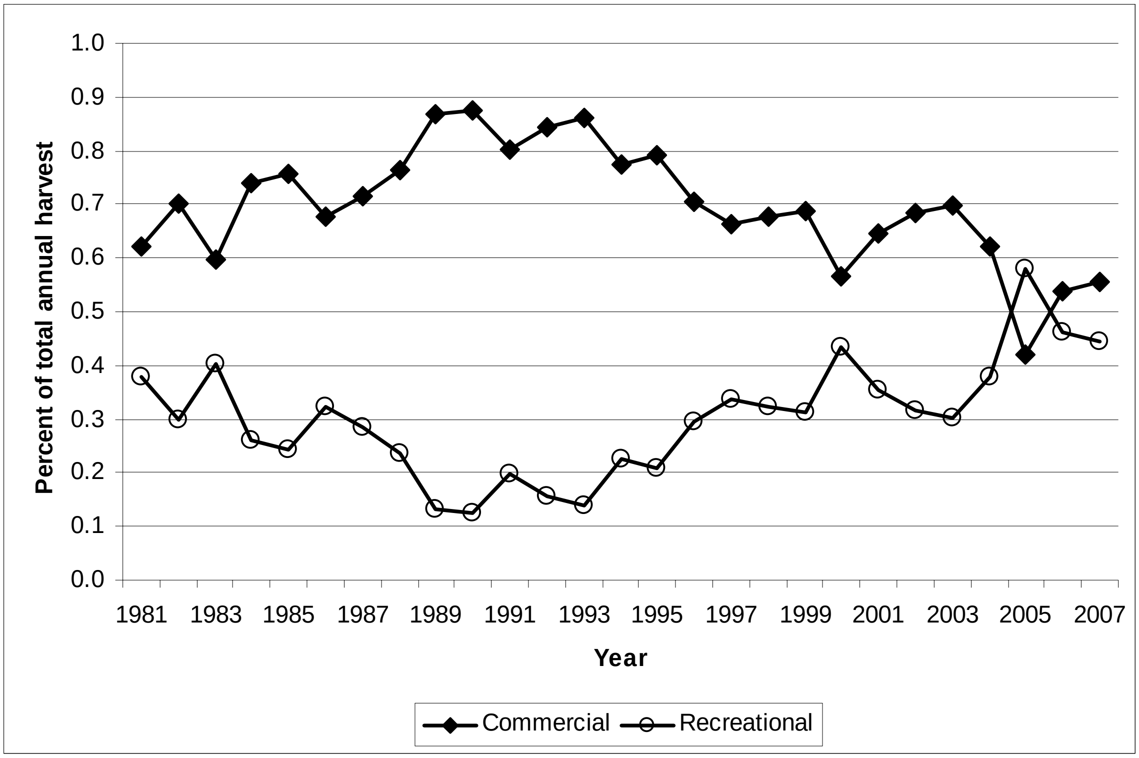
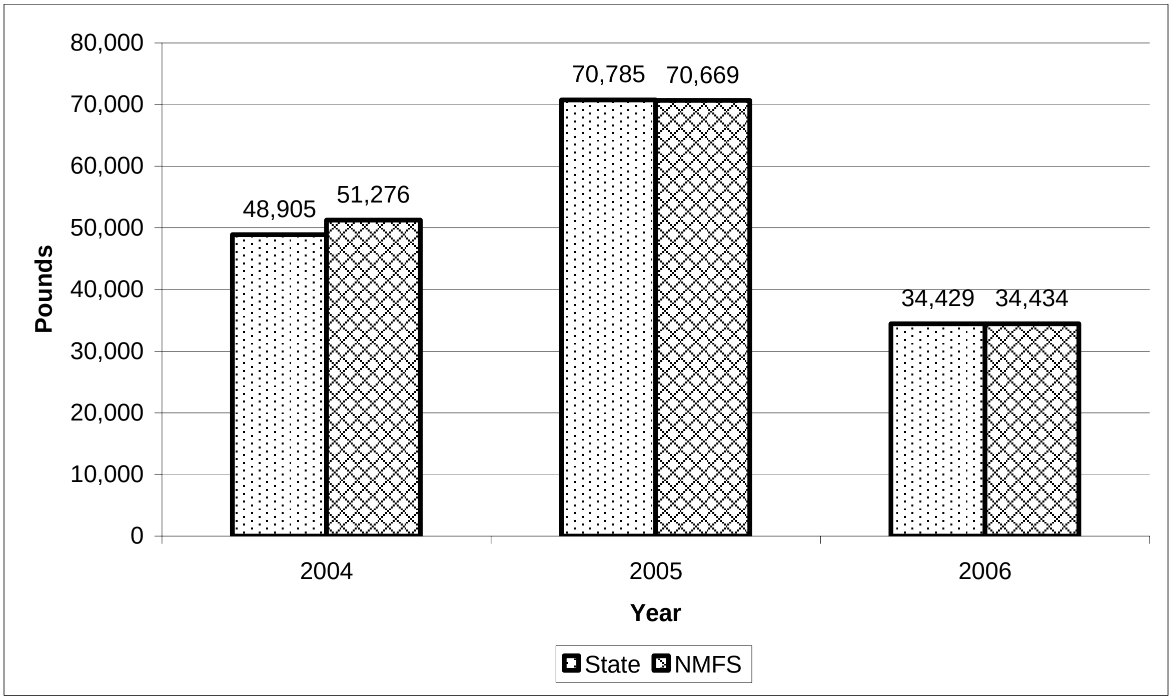


Figure 4.6-6. Proportion of total annual weakfish landings (excluding discards) by the commercial and recreational sectors.

Figure 5.1-1. Comparison of state and federally reported landings on an annual basis for A) Delaware and B) Virginia.

A)



B)

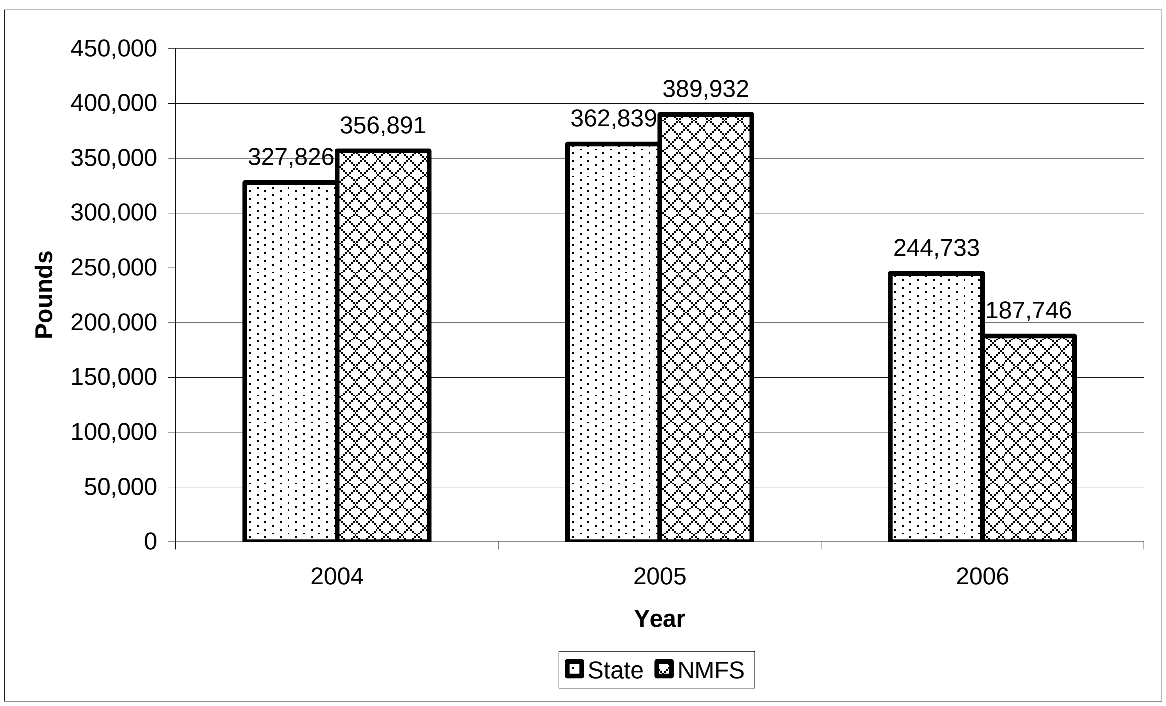
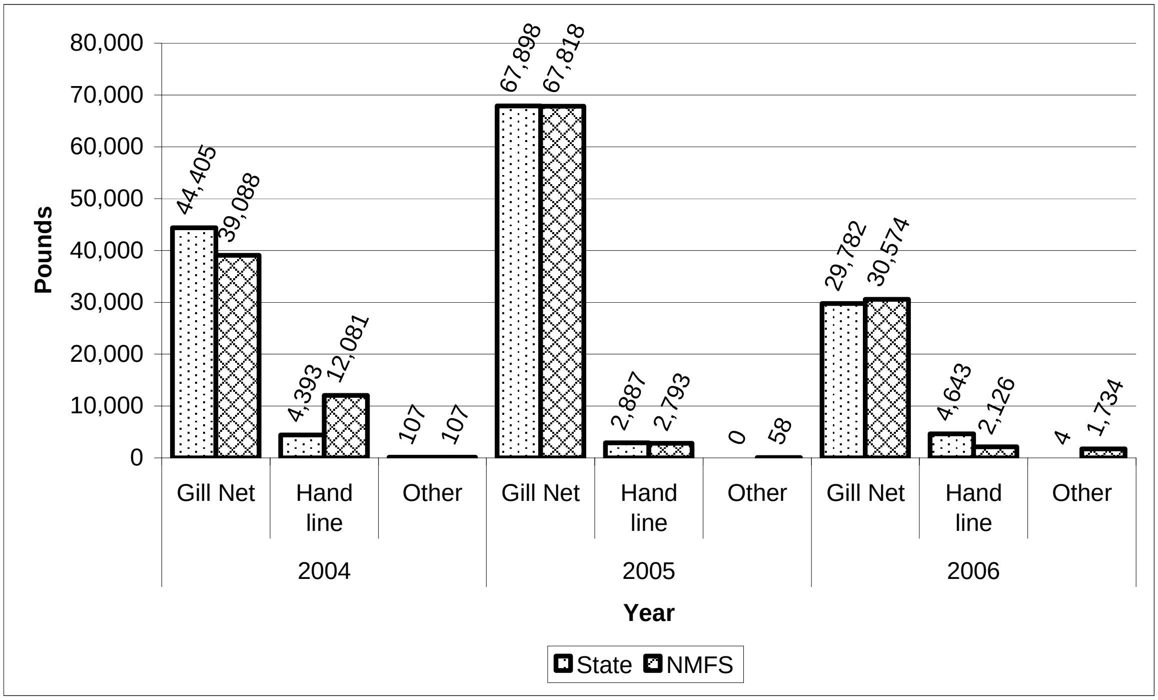


Figure 5.1-2. Comparison of state and federally reported data by gear for A) Delaware and B) Virginia.

A)



B)