2005 REVIEW OF THE FISHERY MANAGEMENT PLAN FOR ATLANTIC MENHADEN
(Brevoortia tyrannus)

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I. Status of the Fishery Management Plan

Amendment 1 to the Interstate Fisheries Management Plan (FMP) for Atlantic Menhaden was approved at the 2001 Spring Meeting of the Atlantic States Marine Fisheries Commission (Commission). Management authority is vested in the states because the vast majority of landings come from state waters. There is a single stock, which migrates along the Atlantic coast. All Atlantic coast states and jurisdictions except Pennsylvania and the District of Columbia have declared an interest in the menhaden management program. Amendment 1 reorganized the Commission's menhaden management program to operate under the direction of the Atlantic Menhaden Management Board (Board), with separate technical and advisory committees, identical to all Commission-managed species. The goal of Amendment 1 is "to manage the Atlantic menhaden fishery in a manner that is biologically, economically, socially and ecologically sound while protecting the resource and those who benefit from it." The 12 objectives of the FMP are as follows:

Biological

- Protect and maintain the Atlantic menhaden stock at levels to maintain viable fisheries and the forage base with sufficient spawning stock biomass to prevent stock depletion and guard against recruitment failure.
- Maintain a uniform data collection system for the reduction fishery and develop new protocols for other harvesting sectors, including biological, economic, and sociological data.
- Evaluate, develop, and improve approaches or methodologies for stock assessment including fishery-independent surveys and variable natural mortality at age or by area.
- Optimize utilization of the resource within the constraints imposed by distribution of the resource, available fishing areas, and harvest capacity.

Social/Economic

- Maintain existing social and cultural features of the fishery to the extent possible.
- Develop a public information program for Atlantic menhaden, including the fishery, biology, estuarine ecology and role of menhaden in the ecosystem.

Ecological

- Protect fishery habitats and water quality in the nursery grounds to insure recruitment levels are adequate to support and maintain a healthy menhaden population.
- Improve understanding of menhaden biology, food web ecology and multispecies interactions that may bear upon predator-prey and recruitment dynamics.
- Protect and maintain the important ecological role Atlantic menhaden play along the coast.

Management

- Insure adequate accessibility to fishing grounds.
- Develop options or programs to control or limit effort, and regulate fishing mortality by time or area.
- Base regulatory measures upon the best available scientific information and coordinate management efforts among the various political entities having jurisdiction over the fisheries.

Amendment 1 was developed during 1999-2000 and established new overfishing/overfished definitions based on fishing mortality and spawning stock biomass. Addendum I to Amendment 1 was approved in August 2004. This addendum revised the biological reference points, changed the frequency of stock assessments, and updated the habitat section. The new biomass target and threshold are based on Fecundity instead of Spawning Stock Biomass, a new fishing mortality target and threshold were also adopted. Stock Assessments will now take place every third year instead of annually, however the Technical Committee is required to meet annually to review the previous year's landings and indices. The habitat section was updated to include descriptions of larval, juvenile, and adult habitats.

The Management Board imitated Addendum II in February of 2005. This addendum presents options for capping the harvest of Atlantic Menhaden. The Management Board will review public comment and potentially take action on Addendum II in August 2005.

II. Status of the Stock

The status of the stock coastwide is considered to be healthy based on newly recommended benchmarks developed in the latest peer-reviewed stock assessment (2003 Stock Assessment). Natural mortality is estimated by age as a scalar times age-specific M from the multi-species VPA (MSVPA). Age-specific estimates of M for the base runs (Ricker and Beverton-Holt models) are as follows: 4.3 for age 0, 0.98 for age 1, 0.56 for age 2, and 0.55 for age 3 and older. Fishing mortality on the fully recruited ages (full F) for 2002 was estimated to be 0.79 (ages 2-8), with age-specific values for the younger ages of F = 0.0015 for age 0 and F = 0.14 for age 1.

Recruitment to age-1 was good to excellent in the late 1950's and the mid-1970's to the early 1990's (Figure 1). Generally low recruitment to age-1 occurred during the 1960's and since 1996. Estimates of recruitment to age-1 for 2002 (2.5 billion fish) is below its 25th percentile (3.2 billion) (Table 1); however this value has a high degree of uncertainty and will likely change as more data from the cohort are added to the analysis. The concern about recent poor recruitment is further substantiated by investigations with state-based juvenile abundance seine indices and development of a coastwide seine index. The most recent values of these indices were compared with their median and interquartile range (Table 1). Estimated fishing mortality (F) in 2002 (0.79) was below the historic 25th percentile (0.83), and well below its historic median (1.04).

Estimated spawning stock biomass and population fecundity (no. of maturing ova) in 2002 (91,900 mt and 40.6 trillion eggs) were above their historic median (76,800 mt and 30.1 trillion eggs), but below their historic 75th percentile (120,100 mt and 48.6 trillion eggs). Recruitment for Atlantic menhaden appears to be largely controlled by environmental conditions and not from lack of reproductive capacity. Environmental conditions such as increased predation (e.g. striped bass), decreased available food, or other physical driving variables (e.g. Ekman transport, river flows, pollutants, etc.) probably have contributed to the recent decline in recruitment.

Table 1. Most recent estimates of VPA-generated indices and juvenile abundance indices compared to long-term median and interquartile range. Values for 2002 that fall within the interquartile range should not be considered different from the long-term median (50th percentile) (2003 Stock Assessment).

Variable	n	2002	25th	50th	75th
Population-Based Variables (Base Ricker Forward-Projection Model):					
Full F (2+)	48	0.79	0.83	1.04	1.27
R_1 (billions)	48	2.5	3.2	4.8	7.7
SSB (1000 t)	48	91.9	56.6	76.8	120.1
Eggs (trillions)	48	40.6	23.2	30.1	48.6
FPR (%)	48	20.7	7.6	11.0	16.9
Standardized Juvenile Abundance Indices for:					
NC Seine	31	0.01	0.04	0.11	0.29
VA Seine	29	0.9	2.1	5.3	24.4
MD Seine	44	12.3	17.1	97.0	222.9
CT Seine	19	742.9	73.5	176.8	456.9
RI Seine	24	95.1	1.4	7.1	26.6
Coastwide Seine	44	11.4	12.3	34.1	118.3

New targets and thresholds were developed for the F-based and SSB-based benchmarks in the latest stock assessment (2003 Stock Assessment). The F-threshold was calculated in the same manner as in Amendment 1 (F_{rep} as estimated from F_{med}). Because F_{max} (the approach for F-target in Amendment 1) was estimated as infinite, an alternative approach similar to the F-threshold was recommended in the latest assessment ($F_{75\%}$). For the SSB-based benchmarks, reproductive capacity is characterized by population fecundity (no. of maturing ova) rather than female biomass (SSB). Otherwise the approach for the SSB-based biomass is the same as in Amendment 1.

Estimated population fecundity (number of maturing ova) in 2002 (40.6 trillion eggs) was well above its target (26.6 trillion eggs), and therefore, above its threshold (13.3 trillion eggs) that defines overfished status (Figure 2). The largest values of population fecundity were present during the late 1950s and early 1960s (well above the target for 1955-1963) and were produced

primarily from two historically large year classes (1951 and 1958). Estimates of population fecundity from 1964 until 1971 were generally below the threshold. From 1977 through 1985, population fecundity was at or about the target, while since 1986 population fecundity has generally been above the target. Estimated fishing mortality (F) in 2002 (0.79) was slightly above the target F (0.75), but well below the limit or threshold F (1.18) that defines overfishing (Figure 3). Fishing mortality has generally declined since the high values of the 1960's.

Spawning potential ratio (also referred to as maximum spawning potential), is inversely related to fishing mortality rate (Gabriel et al. 1989). Although generally calculated as a ratio of spawning stock biomass per recruit, it is more properly related to an index of egg production (Prager et al. 1987). Static FPR for Atlantic menhaden is calculated based on such an index of egg production (2003 Stock Assessment), and provides lower estimates of static SPR than those estimates based on mature female biomass (Figure 4). Although highly variable, generally higher values (above 75th percentile) are associated with two temporal periods (1 out of 7 years between 1955-61, and 8 out of 10 years between 1993-2002). Higher FPR values are associated with lower exploitation regardless of stock size. The estimate for static FPR in 2003 was 21%, above the 75th percentile (17%).

During 2004, about 3,400 Atlantic menhaden were processed for age and size composition from the reduction purse-seine fishery. Coastwide, age-2 fish (67%) far outnumbered all other age classes. Age-1 fish (22%) ranked a distant second, followed by age-3+ fish (9%) and age-0 fish (2%). Catches off New Jersey and Delaware (and beyond 3 miles from shore) during summer and early fall 2004 (but landed in Virginia) were comprised mostly of age-2 (62%) and age-3+ (38%) fish. Catches in Chesapeake Bay during summer were dominated by age-2 fish (83%), followed by age-1s (10%), and age-3+s (6%). Summer fishing south of Cape Hatteras landed age-2 (66%) and age-1 (34%) menhaden. Age-1 Atlantic menhaden (55%) predominated in catches during the 2004 fall fishery, followed by age-2s (27%), then age-3+s (12%), and age-0s (6%). As has been the case since 1994, no reduction landings of Atlantic menhaden were made in the Gulf of Maine in 2004.

III. Status of the Fishery

The 2004 harvest of Atlantic menhaden for reduction was 184,450 metric tons, which was 11% more than purse-seine landings during the 2003 season (166,097 mt), and 1% greater than average landings for the previous five years (182,475 mt) (NMFS 2005) (Figure 5). Nominal fishing effort in 2004 was 345 vessel-weeks, up 14% from nominal fishing effort observed in 2003 of 302 vessel-weeks (Figure 6). The increase in nominal fishing effort in 2004 was in part due to the addition of two vessels from the Gulf of Mexico to the factory at Beaufort, NC, during the fall fishery. Nevertheless, since the factory in Reedville, VA, downsized to 10 vessels in 2000, coastwide nominal fishing effort has varied by minor amounts, averaging 323 vessel weeks for the five-year period, 2000-2004, and ranging from 302 (2003) to 345 (2004) vessel-weeks.

A total of 13 reduction purse-seine vessels landed Atlantic menhaden during the 2004 season for reduction, one more than the previous year. There was no directed purse-seine activity for

Atlantic menhaden in the Gulf of Maine during 2004. Two reduction plants operated in 2004, one in Reedville, VA, with ten vessels, and one in Beaufort, NC, with one vessel fishing summer through fall and two vessels added (from the Gulf of Mexico) in November for the fall fishery. The bait fishery for menhaden has become increasingly more important from North Carolina to New England.

Landings of Atlantic menhaden by the bait fisheries (all gears combined) in 2004 amounted to 34,743 mt; this was 16% of the combined (reduction and bait) total Atlantic menhaden landings in 2004. The majority of the bait landings are from purse-seine gear operating in Virginia and New Jersey waters. Through the period 1985-1997, bait landings generally comprised about 10% or less of the total Atlantic menhaden harvest. With the decline in the reduction landings in recent years, the relative importance of the bait fishery has increased. More comprehensive reporting of bait landings has also contributed to this trend.

IV. Status of Assessment Advice

The most recent assessment was conducted in 2003. This was a benchmark assessment and was externally reviewed by a peer review panel through the Southeast Data Assessment Review (SEDAR) process. A forward-projection, age-structured model was used. This is different from the Murphy Virtual Population Analysis (VPA) used in the past to assess menhaden. Unlike the Murphy VPA, the forward-projection model allows inclusion of ancillary information, such as abundance indices. Five juvenile abundance seine indices were combined into a coastwide index, while a more geographically limited index of older menhaden (ages 1-3) was based on PRFC poundnet landings per license. Since most stock assessment models, including these models, are not spatially-explicit, they are not useful for determining conditions at the subregion level. Estimates of movements between subregions by age would need to be developed to incorporate such a spatial component for menhaden.

In June 2005 , the TC reviewed the 2004 landings, Catch Per Unit Effort (CPUE), Catch at Age, and the Indices used in the 2003 stock assessment. They calculated the triggers set in Addendum 1:

1) The CPUE index falls below the 5th percentile for the past 20 years
2) The ratio of ages 2-4 to the total catch of all ages falls below the second standard deviation unit over the last 20 years

After reviewing the data and calculating the triggers, the TC felt that stock status had not significantly changed since the 2004 assessment. Therefore, a full assessment did not need to be conducted in 2005. The next scheduled stock assessment is in 2006. At this time the Atlantic Menhaden Stock Assessment Subcommittee will conduct an updated stock assessment.

Some of the major recommendations from the Peer Review Panel were: 1) Evaluate commercial purse seine fishery effort (vessel/weeks) series as a possible tuning index in the model and evaluate the data collected in the Captain's Daily Fishing reports for an adult abundance index. 2) Investigate if there are any existing studies that could assist in evaluating current productivity

and develop protocols to quantify contribution of different nursery areas to the adult stock. 3) Identify key sources of non-fishing mortality for menhaden, enhance the coverage of the MSVPA to more predator and prey species, determine if there are temporal patterns in these sources and validate assumptions about applying results from MSVPA to the 1955-1980 period. 4) Evaluate historical change in size (weight and length at age using existing data. 5) Investigate if the selectivity model is causing patterns in residuals of numbers at age for commercial catch and look at spatial changes in fishing pattern as well as fish distribution. 6) Update the fecundity-at-size estimates and maturity ogives. 7) Investigate methods to determine the proportion of the stock that may reside in a particular area in any one season and whether regional reference points can be developed to address local depletion. 8) Develop uncertainty measures or risk analysis for control plots. 9) Develop measures to screen multiple models. 10) Test the assumption of a unit stock using otolith microchemistry and/or genetic markers (2003 Peer Review Report).]

V. Status of Research and Monitoring

The Population Dynamics Team of the NMFS Laboratory in Beaufort, North Carolina has the principal research and monitoring responsibility for the Atlantic menhaden fishery. Their monitoring and analytical work is expected to continue. Several states have improved their juvenile monitoring programs, which include data on menhaden. The industry continues to cooperate by providing set-by-set data through the Captains Daily Fishing Reports (CDFR). The NMFS Population Dynamics Team personnel are entering current year and historical (since 1985) CDFR data into a database for analysis. In addition, the new SAFIS daily electronic dealer reporting system will be required for all federal permitted dealers. This system will allow near real time data acquisition for federally permitted bait dealers. A bait fishery sampling program has been conducted since 1994 in Massachusetts, New Jersey, Virginia, and North Carolina. Some differences in age composition between bait and reduction catches were noted in the past, but sample sizes were small. Increased sampling in recent years has confirmed that there are significant differences in selectivity of the fisheries. Therefore, the forward-projection, age-structured model contains two fisheries (reduction and bait) in the model specification, with separate selectivity estimated for each fishery. This led the technical committee to re-evaluate the biological reference points, subsequently, the Management Board implemented new target and threshold benchmarks through Addendum I.

In October 2004, the ASMFC held a workshop to examine the status of Atlantic menhaden with respect to its ecological role. Representatives from the environmental, recreational fishery, and the commercial fishery communities helped plan the workshop. State, federal, and university scientists participated in the workshop. The full workshop reports and proceedings can be found on the ASMFC website at www.asmfc.org.

In June 2005 the Technical Committee re-addressed the issue of research priorities to examine the possibility of localized depletion of Atlantic menhaden in Chesapeake Bay. The Committee reviewed the research needs that were developed at their June 30, 2004 meeting. The committee reiterated that the prioritized research needs are:

A. Determine menhaden abundance in Chesapeake Bay
B. Determine the estimates of removal of menhaden by predators
C. Exchange of menhaden between Chesapeake Bay and coastal systems
D. Larval Studies (determining recruitment to Chesapeake Bay

VI. Status of Management Measures and Issues

There are no regulatory recommendations contained in Amendment 1 or Addendum 1 to the Interstate FMP for Atlantic Menhaden. Addendum 1 implemented new overfishing/overfished definitions for menhaden, utilizing a target and threshold approach for both fishing mortality and fecundity: F target = 0.75, F threshold = 1.18, fecundity target (trillions) = 26.6 and fecundity threshold (trillions) = 13.3. Control plots of the targets and thresholds were developed for both base spawner-recruit models (Figure 7 and 8).

VII. Implementation of FMP Compliance Requirements as of June 1, 2005

There is only one compliance requirement regarding reporting in Amendment 1 to the Interstate FMP for Atlantic Menhaden. All states are required to implement the reporting requirement contained in *Section 4.2.5.1* (of Amendment 1), that all menhaden purse seine and bait seine vessels (or snapper rigs) be required to submit the Captain's Daily Fishing Reports (CDFRs). Existing reporting requirements may serve as an alternative to implementing this measure. All states are required to submit annual compliance reports, which are due April 1.

Table 2. Atlantic Menhaden Plan Review Team compliance review summary for 2004.

State	Report Submitted	Reporting Requirement	Comments/Recommendations of PRT	Meets FMP Requirement
ME	March 2005	Yes	Reporting requirements cover all baitfish fisheries, including gillnets and purse seines.	Yes
NH	April 2005	Yes	State law prohibits the use of mobile gear in state waters	Yes
MA	March 2005	TBD	There were no reported landings this year, however, it is unclear if there is a reporting requirement in place for purse seines in state waters	TBD
RI	April 2005	TBD	Menhaden harvest by purse seine for reduction purposes is outlawed. However, there is not a reporting requirement for bait harvest in state waters by purse seine.	TBD

CT	April 2005	Yes	Purse seines prohibited in state waters	Yes
NY	April 2005	Yes	Mandatory reporting for all commercial food fish license holders, this includes all who harvest menhaden.	Yes
NJ	March 2005	Yes	Prohibited purse seining for reduction purposes in state waters on January 6, 2002. Mandatory reporting for purse seine (bait) fishery	Yes
DE	April 2005	Yes	Purse-seine fishery prohibited since 1992.	Yes
MD	April 2005	Yes	Purse-seine fishing prohibited; menhaden harvested by pound net primarily; monthly reporting required.	Yes
PRFC	April 2005	Yes	All trawling and purse nets are prohibited.	Yes
VA	March 2005	Yes	Implemented reporting requirement for bait seine/snapper rigs in 2002. The reduction fishery landings in VA are reported via daily catch records and CDFRs to the NMFS.	Yes
NC	March 2005	Yes	Mandatory commercial fishery reporting (trip ticket).	Yes
SC	April 2005	Yes	Purse seines prohibited in state waters; mandatory dealer reporting; requests ***de minimis* status***	Yes
GA	March 2005	Yes	Mandatory commercial fishery reporting (trip ticket); state waters closed to purse-seine fishing; requests ***de minimis* status. ***	Yes

FL	March 2005	Yes	Purse seines prohibited in state waters; primarily a cast net fishery; mandatory commercial fishery reporting (trip-ticket).	Yes

* The PRT Recommends that South Carolina and Georgia be granted de minimis status, however, they should still submit an annual compliance report and keep their reporting requirements the same.

VIII. Recommendations of Atlantic Menhaden Plan Review Team

Compliance Recommendations

1. The states of Georgia and South Carolina have requested *de minimis* status. Amendment 1 does not provide for *de minimis* status from the single compliance criterion (mandatory reporting for purse seine or bait seine vessels). However, both states already require mandatory reporting from dealers (South Carolina) or vessels (Georgia), and purse seines are prohibited in their state waters. Annual compliance reports are required from all states, including those with *de minimis* status.

2. The PRT would like to investigate whether the state of Rhode Island and the Commonwealth of Massachusetts have implemented a reporting requirement for purse-seine bait fisheries in state waters.

3. The PRT requests that all menhaden bait landings are reported to the Technical Committee, even though the compliance criteria is only related to purse seines.

Regulatory Recommendations

1. The PRT has no recommendations relating to options included in Addendum II.

2. There are no further regulatory recommendations at this time.

Amendments/Addenda

Amendment 1 was adopted by the Commission in May 2001. Addendum 1 was approved in August 2004. The addendum revises the reference points contained in Amendment 1 to reflect the latest stock assessment, changes the frequency of stock assessments to every three years and updates the habitat section. Addendum II is currently in the development stage.

Research and Monitoring Recommendations- (number reflects relative ranking with 1 being the highest priority)-

The Technical Committee has identified the following four areas of research the highest priority to determine if localized depletion is occurring in Chesapeake Bay:

a. Determine menhaden abundance in Chesapeake Bay
b. Determine the estimates of removal of menhaden by predators
c. Exchange of menhaden between Chesapeake Bay and coastal systems
d. Larval Studies (determining recruitment to Chesapekae Bay

The following list of research recommendations was developed by the Technical Committee and the Plan Review Team.

1. Conduct new size/age at maturity research by geographic regions along the Atlantic coast (on going).

   Develop a spatially explicit age-structured model to account for spatial and temporal differences in size/age distributions, size/age at maturity, and fishing effort and catchability rates (on going).

   Monitor landings, size, age, gear, and harvest area in the reduction and bait fisheries, and determine age composition by area. Maintain biostatistical sampling of bait samples in purse-seine fisheries for Virginia and New Jersey and enhance this sampling in Maryland, the Potomac, and North Carolina to improve stock assessment (ongoing).

   Study the ecological role of menhaden (predator/prey relationships, nutrient enrichment, oxygen depletion, etc.) in major Atlantic coast embayments and estuaries (predator/prey interactions being evaluated through ASMFC multispecies efforts). Re-evaluate menhaden natural mortality by age and the response to changing predator population sizes (evaluated through MS model, incorporated variable *M* in assessment).

   Maintain and expand seine indices estimating size of recruiting year-classes of juveniles using fishery-independent survey techniques, particularly needed in mid-Atlantic region (ongoing research).

   Periodically monitor the economic structure and sociological characteristics of the menhaden reduction industry (Committee on Economic and Social Sciences - CESS). Determine the effects of regulations on the fishery, the participants and the stock (CESS ongoing project).

   Define local depletion in qualitative and quantitative terms. Determine environmental influences. Studies should not be limited to Chesapeake Bay.

   Coastwide collection of larval menhaden ingressing into estuaries could provide information on reproductive output and/or insight into levels of mortality between early larval and juvenile stages; leading to better predictions of year class strength. Continuation and possible expansion of the Beaufort bridge net sampling program, which has been running since 1985, may provide some of the mortality information. (ongoing)

2. Evaluate effects of selected environmental factors on growth, survival and abundance of juvenile and adult menhaden, particularly in Chesapeake Bay and other coastal nursery areas (NMFS/CBO ongoing project).

   Determine how loss/degradation of critical estuarine and nearshore habitat affects growth, survival, and abundance of juvenile and adult menhaden abundance.

   Determine the causes of fish diseases (such as ulcerative mycosis and toxic dinoflagellates) on the menhaden stock (ongoing research in MD/VA).

   Develop coastwide tagging program to examine stock structure, spatial and temporal patterns in movement and migration, and to estimate exchange rate among geographic regions (i.e. inshore-offshore and latitudinal).

3. Monitor fish kills along the Atlantic coast and use the NMFS Beaufort Laboratory as a repository for these reports (ongoing).

   Investigate the amount or extent of bycatch in the menhaden fishery. Evaluate whether a statistically valid observer program is needed to document possible sea turtle interactions with the various gear types. Develop bycatch studies of menhaden by other fisheries.

   Alternative measures of effort, including spotter pilot logbooks, trip length, or other variables, should be evaluated. Spotter pilot logbooks should be evaluated for spotter plane search time, GPS coordinates, and estimates of school sizes observed by pilots.

   Develop statistical sampling methods to improve catch and effort statistics in the recreational fishery. Evaluate extent of recreational netting of menhaden for bait purposes.

Research Needs Identified as Being Met

1) A study has been completed to characterize the social and economic characteristics of the menhaden reduction fishery.
2) The Power Plant Impingement study has been conducted

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Figure 1. Estimates of Atlantic menhaden recruits to age-1 with median and interquartile range from base Ricker model, 1955-2002 (2003 Stock Assessment).

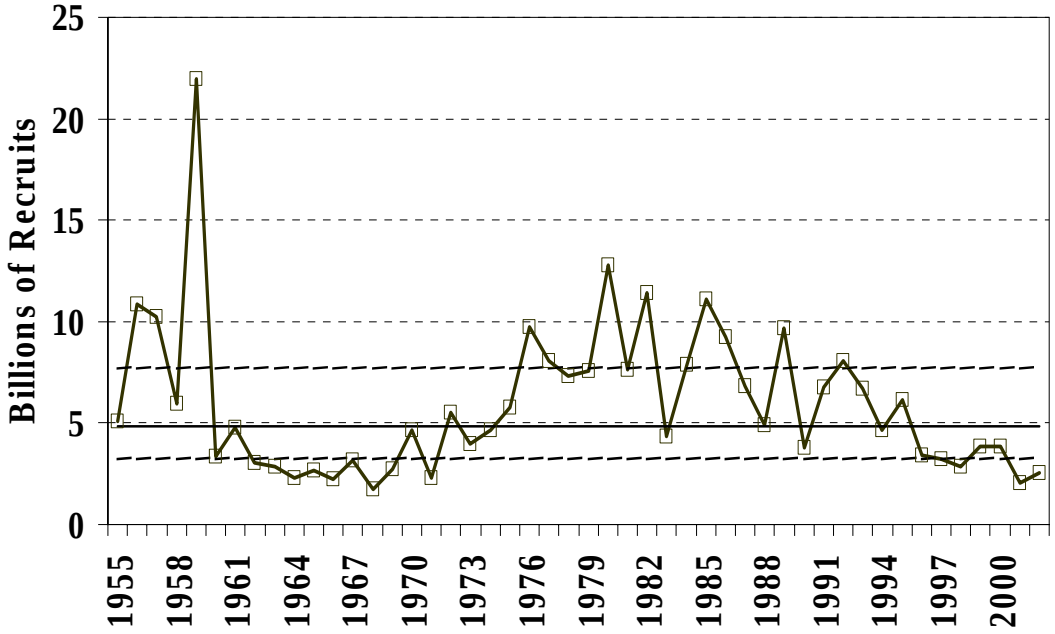

Figure 2. Atlantic menhaden population fecundity (no. maturing ova) plus/minus 2 standard errors from base Ricker model, 1955-2002. Horizontal lines represent target (dashed) and threshold (solid) (2003 Stock Assessment).

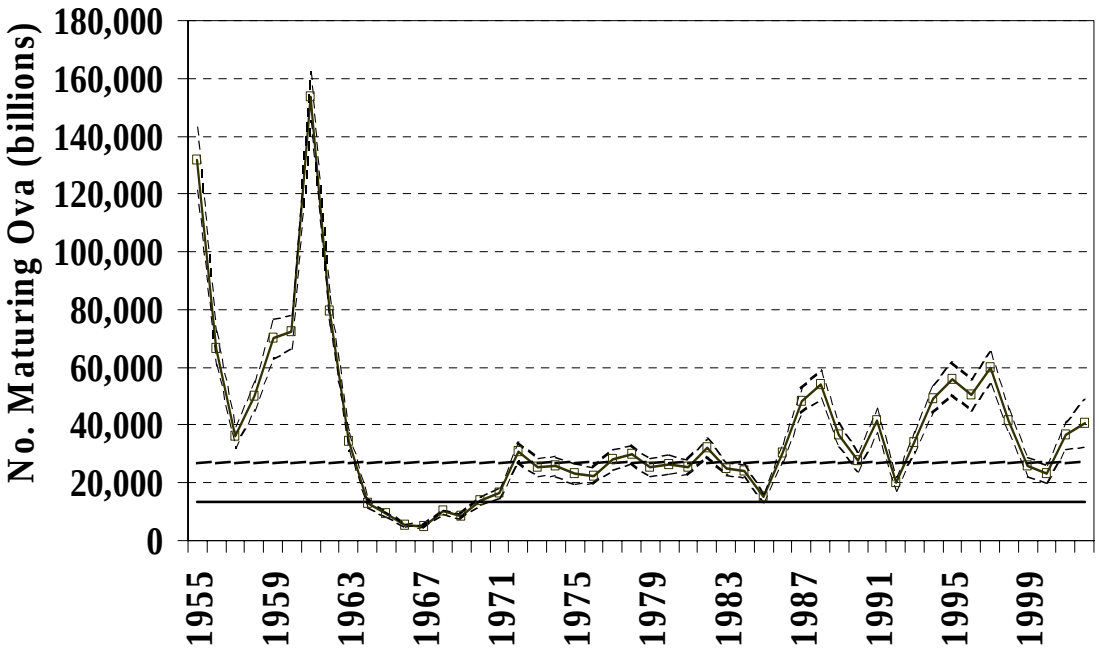

Figure 3. Atlantic menhaden fishing mortality rate, F (ages 2+) plus/minus 2 standard errors from base Ricker model, 1955-2002. Horizontal lines represent target (dashed) and threshold (solid) (2003 Stock Assessment).

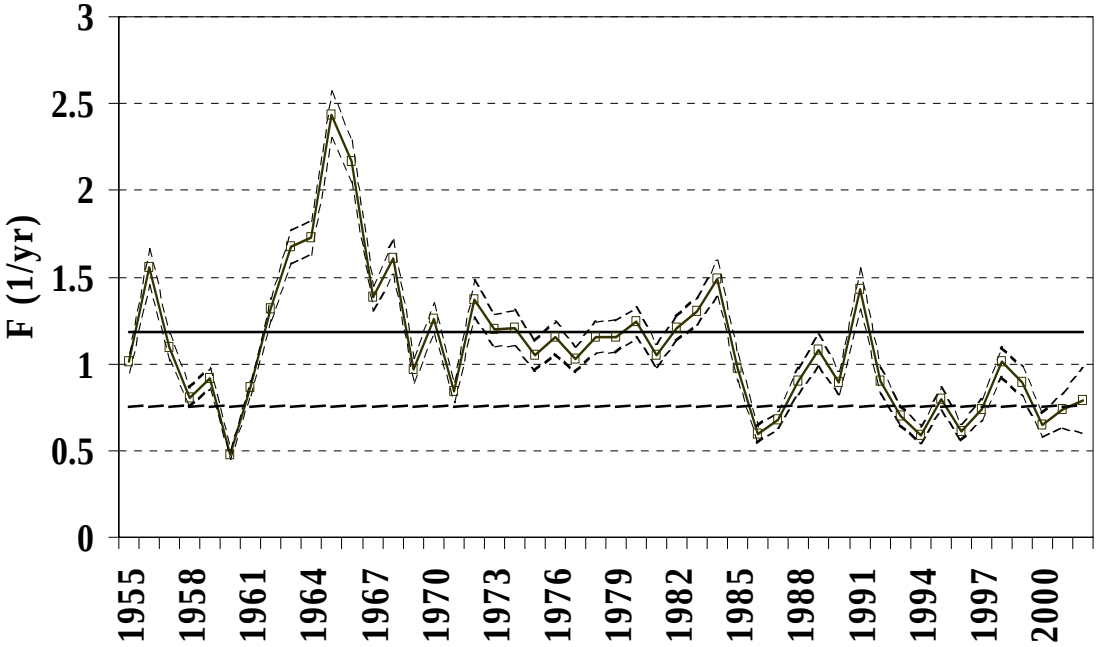

Figure 4. Atlantic menhaden spawner per recruit (static-FPR as fecundity) with median and interquartile range from base Ricker model, 1955-2002 (2003 Stock Assessment).

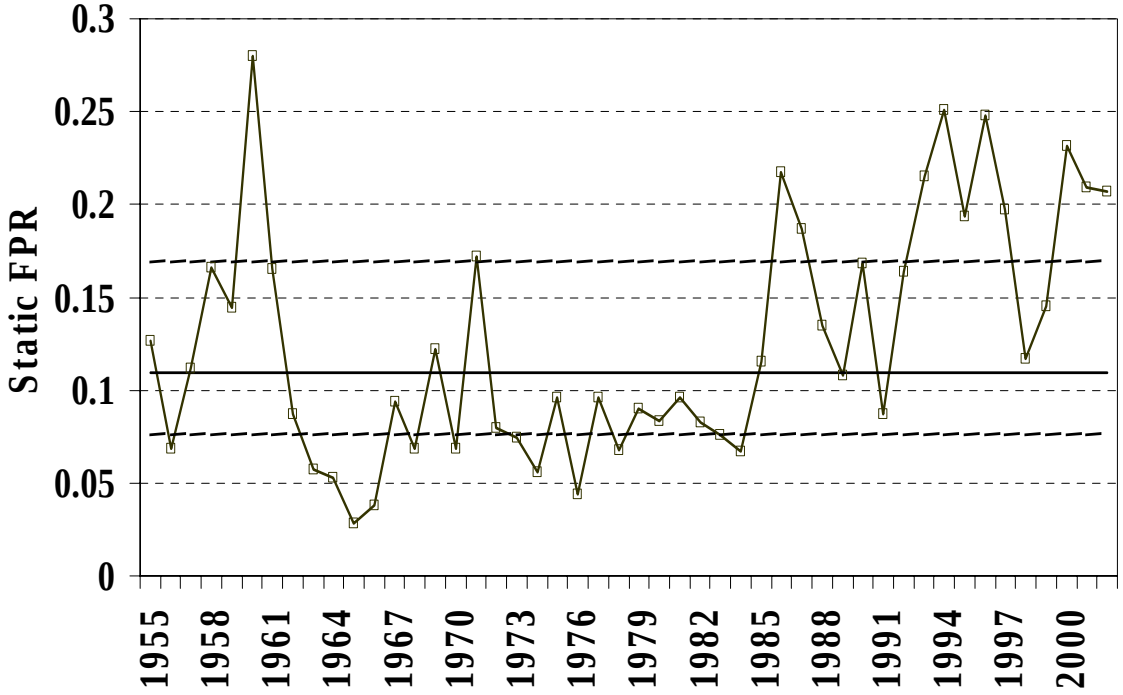

Figure 5. Atlantic menhaden reduction landings and nominal effort, 1940-2002 (2003 Stock Assessment).

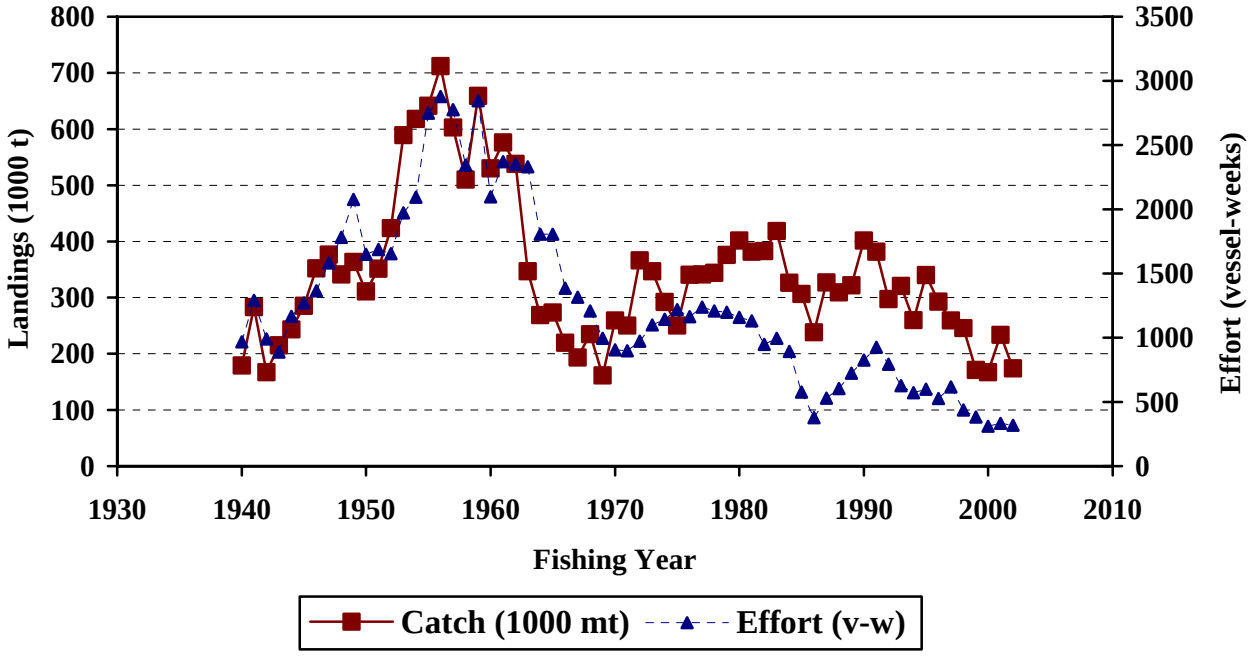

Figure 6. Atlantic menhaden reduction landings versus nominal effort, 1940-2002 (2003 Stock Assessment).

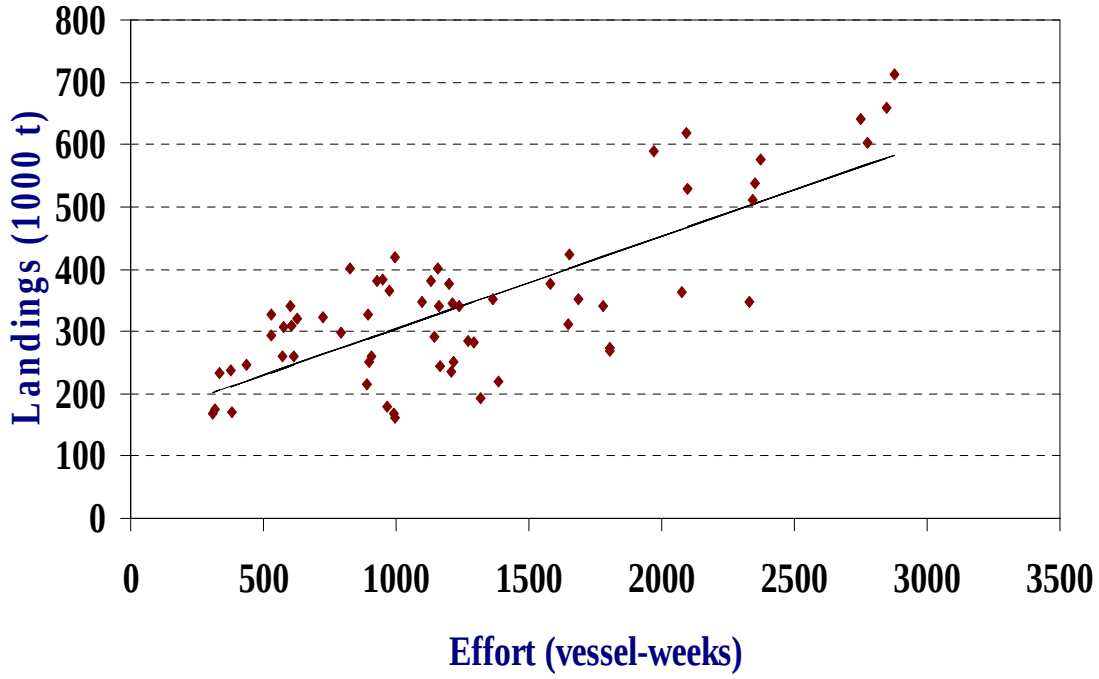

Figure 7. Control plot of F and SSB from base Ricker run in current assessment for Atlantic menhaden with newly recommended benchmarks (solid square represents 2002) (2003 Stock Assessment).