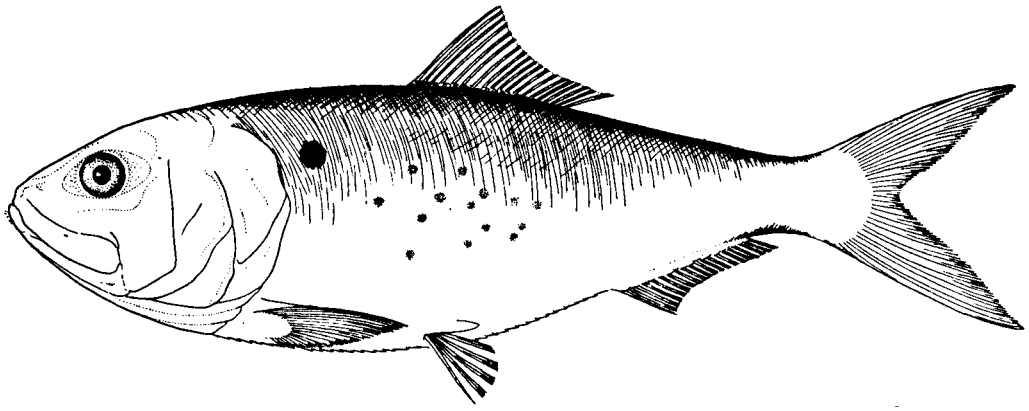
# REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN FOR ATLANTIC MENHADEN
***(Brevoortia tyrannus)***

## 2002 FISHING YEAR



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

## 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. The fishery is managed on the basis of an annual review of the status of the stock in relation to the reference points established by the overfishing definition. The Technical Committee annually updates the stock assessment and forwards a report to the Board. Included in this report is an evaluation of requests for Internal Waters Processing (IWP) allocations by the states. The Commission forwards the Board's IWP recommendations directly to the Governors of States which apply for allocations.

## II. Status of the Stock

The status of the stock 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 mid- to late- 1960's and since 1996. Estimates of recruitment to age-1 for 2002 (2.5 billion fish) is below its 25$^{th}$ 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 25$^{th}$ 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 75$^{th}$ 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. Current conditions for 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 (no. 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 75$^{th}$ 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 75$^{th}$ percentile (17%).

Age composition of Atlantic menhaden in the 2002 reduction landings coastwide (percent numbers of individual fish) were mixed; age-0's comprised 22% of the landings, age-1's were 26%, age-2's were 32%, age-3's were 17%, and age-4+'s were 3%. The South Atlantic "summer" fishery was composed of age-1 (71%) and age-2 (29%) menhaden, while the Chesapeake Bay "summer" fishery was composed of age-1's (23%), age-2's (48%) and age-3's (26%) (Smith et al. 2003). Reduction catches from the Mid-Atlantic area (but landed at Reedville, VA) were predominantly age-2 (35%) and age-3+ menhaden (61%). Landings during the "fall fishery" were composed of age-0's (54%), age-1's (26%), age-2's (15%), and age-3+'s (4%). As has been the case since 1994, no reduction landings of Atlantic menhaden were recorded from the Gulf of Maine in 2002.

## III. Status of the Fishery

The 2002 harvest of Atlantic menhaden for reduction was 174,068 mt, which was 26% less than landings of 233,769 mt in 2001, and 19% less than average landings over the previous five years (215,297 mt) (Smith et al. 2003) (Figure 5). Nominal effort (vessel-weeks) in 2002 was 318 vessel weeks; this was down slightly from 334 vessel weeks observed in 2001 (Figure 6). Nominal effort of 318 vessel weeks in 2002 represents the second lowest level of effort recorded for the Atlantic menhaden reduction fishery since the mid-1950's; the lowest was 311 vessel weeks in 2000. Declining nominal fishing effort has been observed in the fishery since the reduction industry began consolidating in 1997 (AMTC 2002).

Similar to recent years, 12 reduction purse-seine vessels landed Atlantic menhaden during the 2002 season. The small purse-seine vessels from the Gulf of Maine did not fish for menhaden in 2002. Two reduction plants operated in 2002, one in Reedville, Virginia, with ten vessels, and one in Beaufort, North Carolina, with two vessels. The bait fishery for menhaden has become increasingly more important from North Carolina to New England. Landings in the bait fishery were estimated at about 36,780 mt for 2002, or 17.4% of the combined (reduction and bait) total Atlantic menhaden landings. The major portion of bait landings in recent years has been

harvested from New Jersey and Virginia waters, followed by Maryland, North Carolina, Florida and the Potomac River. 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.

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 analytic 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 (CDFRs). The NMFS Population Dynamics Team personnel are entering current year and historical (since 1985) CDFR data into a database for analysis. 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 has led the technical committee to re-evaluate the biological reference points and recommend new target and threshold benchmarks.

## VI. Status of Management Measures and Issues

There are no regulatory recommendations contained in Amendment 1 to the Interstate FMP for Atlantic Menhaden. Commission staff is continuing to compile an updated list of state-by-state management measures pertaining to menhaden, including a list of waters closed to menhaden purse seine fishing. Amendment 1 implemented new overfishing/overfished definitions for menhaden, utilizing a target and threshold approach for both fishing mortality and spawning stock biomass . The target fishing mortality rate is F = 1.04, while the target for spawning stock biomass (SSB) is 37,400 metric tons. The Technical Committee has recommended changing from an (SSB) target and threshold to a more precise fecundity based target and threshold. The new recommended population fecundity target is between 26.5 and 26.6 trillion eggs depending on which model is used, and the threshold is 13.3 trillion eggs . The new recommended F-target is 0.75, the threshold is between 1.18 and 1.19 depending on which model is used. Control plots with the new targets and thresholds were developed for both base spawner-recruit models (Figure 7 and 8).

## VII. Implementation of FMP Compliance Requirements as of October 1, 2002

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 2001.**

| State | Report Submitted | Reporting Requirement | Comments/Recommendations of PRT | Meets FMP Requirement |
|---|---|---|---|---|
| ME | March 2003 | Yes | Reporting requirements cover all baitfish fisheries including gillnets and purse seines. | Yes |
| NH | March 2003 | Yes | State law prohibits the use of mobile gear in state waters. | Yes |
| MA | March 2003 | Yes | Restriction on the use of purse seines. Reporting requirement for the inshore fishery permits. No offshore reporting requirement* | |
| RI | March 2003 | Yes | The taking of menhaden for reduction purposes is prohibited. Mandatory reporting for purse-seine (bait) fishery. | Yes |
| CT | April 2003 | Yes | Purse seines prohibited in state waters; bait harvest primarily by gill net. | Yes |
| NY | April 2003 | Yes | Mandatory reporting requirement for all commercial food fish license holders, this includes all who harvest menhaden. | Yes |
| NJ | March 2003 | Yes | Prohibited purse seining for reduction purposes in state waters on January 6, 2002. Mandatory reporting for purse-seine (bait) fishery. | Yes |
| DE | March 2003 | Yes | Fixed and drift gillnet fisheries only; purse seine fishing prohibited in 1992. | Yes |
| MD | March 2003 | Yes | Purse seine fishing prohibited; menhaden harvested by pound net primarily; monthly reporting required. | Yes |
| PRFC | April 2003 | Yes | Mandatory commercial reporting; menhaden harvested by pound net primarily. | Yes |

| | | | | |
|---|---|---|---|---|
| VA | April 2003 | Yes | Implemented reporting requirement for bait seine/ snapper rigs on Aug. 1, 2002; mandatory reporting for all commercial fisheries. | Yes |
| NC | April 2003 | Yes | Mandatory commercial fishery reporting (trip-ticket). | Yes |
| SC | May 2003 | Yes | Purse seines prohibited in state waters; mandatory dealer reporting; **requests *de minimis* status.** | Yes |
| GA | March 2003 | Yes | Mandatory commercial fishery reporting (trip-ticket); state waters closed to purse seine fishing; **requests *de minimis* status.** | Yes |
| FL | March 2003 | Yes | Purse seines prohibited in state waters; primarily a cast net fishery; mandatory commercial fishery reporting (trip-ticket). | Yes |

* Massachusetts has a mandatory reporting requirement for all of their inshore fishery permits, however, there is no requirement for an offshore fishery of menhaden. Atlantic menhaden are primarily fished in inshore waters. In 2002 only two fishers landed menhaden for in bait in Massachusetts, therefore, all landings are confidential. This represents a very minor portion of the fishery.

## VIII. Recommendations of Atlantic Menhaden Plan Review Team

**General**

Researchers are urged to evaluate use of coastal power plant impingement data as a possible means to estimate young-of-the-year menhaden abundance. This issue is being addressed by the ASMFC Management and Science Committee which will forward a report to the ISFMP Policy Board.

**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

**Regulatory Recommendations**

There are no further regulatory recommendations at this time.

**Amendments/Addenda**

Amendment 1 was adopted by the Commission in May 2001. The Technical Committee has recommended that the reference points contained in Amendment 1 be revised to reflect the recent stock assessment. The Technical Committee has recommended changing from an SSB target and threshold to a fecundity based target and threshold. The new recommended fecundity target is between 26.5 and 26.6 trillion and the threshold is 13.3 trillion. The new recommended F-target is 0.75, the threshold is between 1.18 and 1.19 depending on which model is used. The PRT concurs with the Technical Committee and an addendum should be prepared to accomplish this as soon as possible.

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

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

   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).

   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.

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

   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.

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.

   Evaluate use of coastal power plant impingement data as a possible means to estimate young-of-the-year menhaden abundance (ASMFC MSC project).

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

   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.

**Research Needs Identified as Being Met**

1) A study is underway to characterize the social and economic characteristics of the menhaden reduction fishery.

**Identified Management Issues**

- Non-Governmental Organizations (NGOs) have voiced concern over the possibility of localized depletion of Atlantic menhaden in the lower Chesapeake Bay and the potential affects this may have on the Bay ecosystem due to menhaden's role as a forage fish.

## References


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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).**

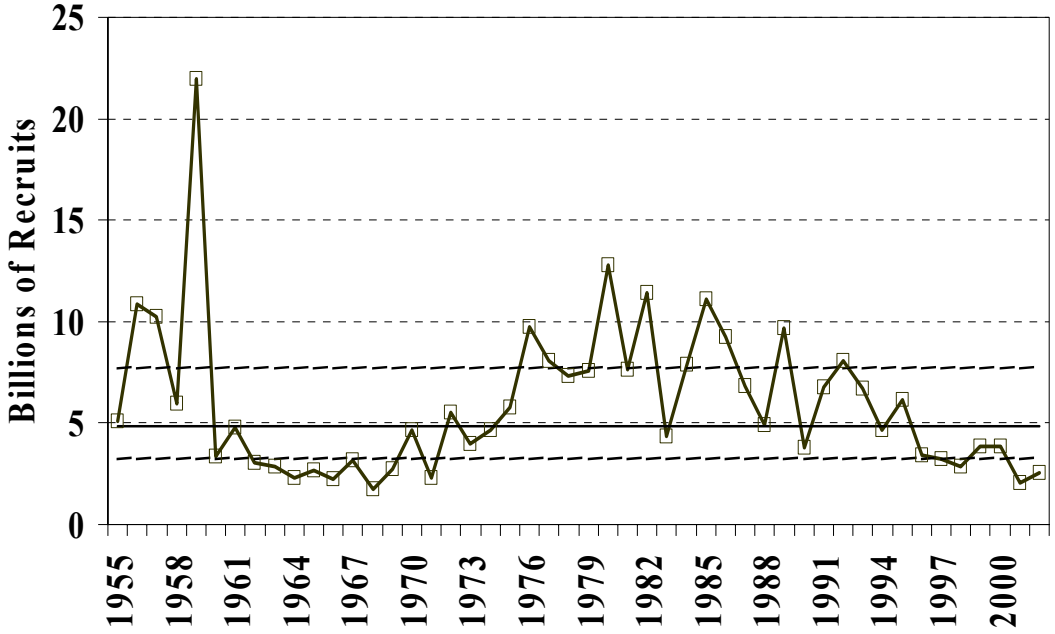


**Figure 2. Atlantic menhaden population fecundity (no. maturing ova) plus/minus 2 standard errors from base Ricker model, 1955-2002. Horizontal lines represent target (dashed) and threshold (solid) (2003 Stock Assessment).**

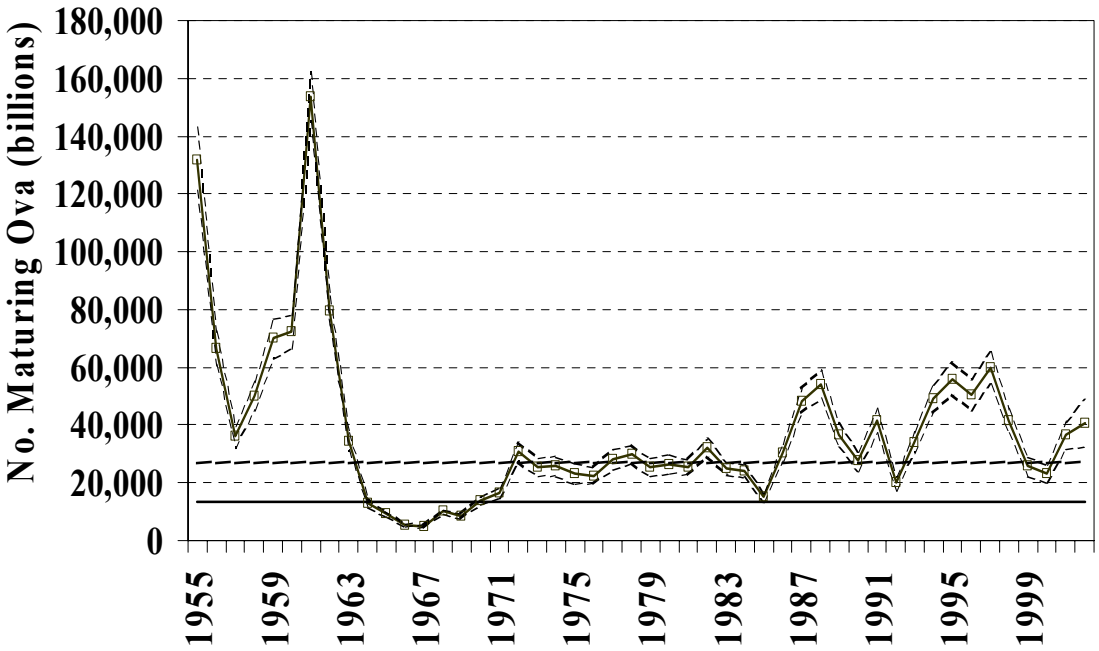

**Figure 3. Atlantic menhaden fishing mortality rate, F (ages 2+) plus/minus 2 standard errors from base Ricker model, 1955-2002. Horizontal lines represent target (dashed) and threshold (solid) (2003 Stock Assessment).**

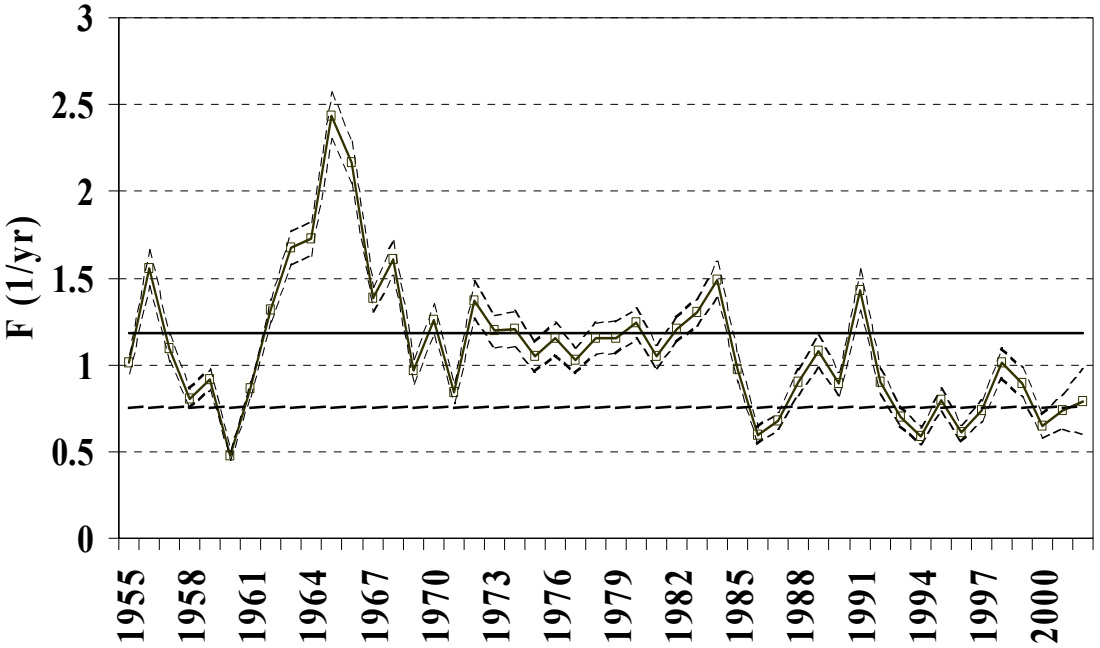


**Figure 4. Atlantic menhaden spawner per recruit (static-FPR as fecundity) with median and interquartile range from base Ricker model, 1955-2002 (2003 Stock Assessment).**

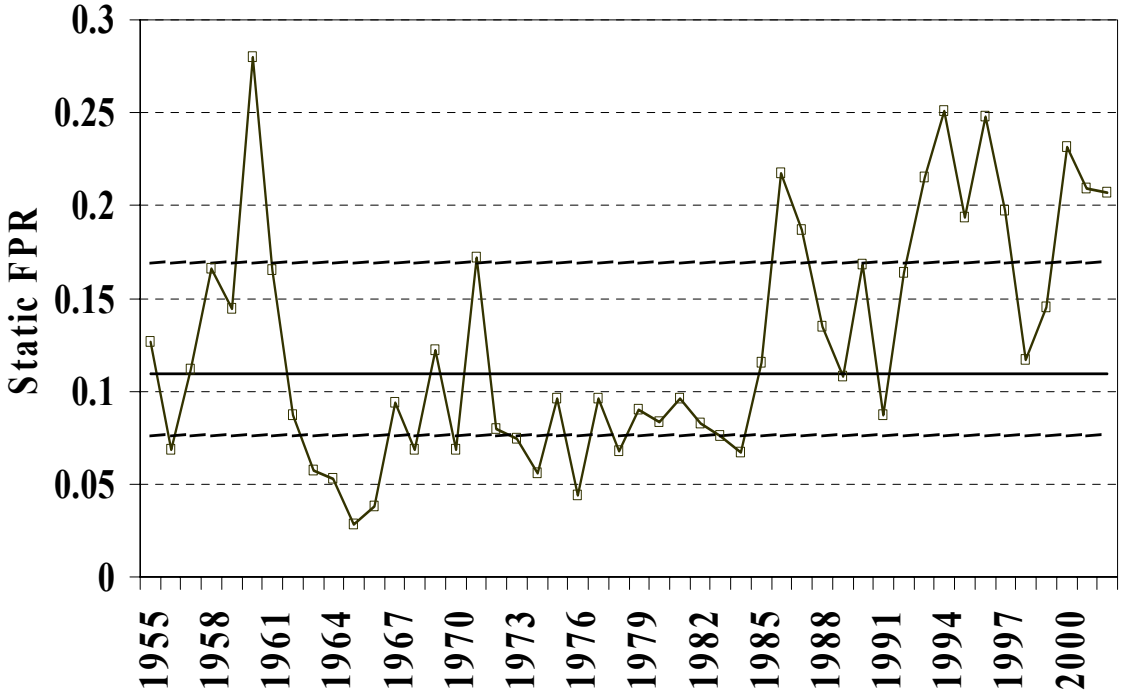

**Figure 5. Atlantic menhaden reduction landings and nominal effort, 1940-2002 (2003 Stock Assessment).**

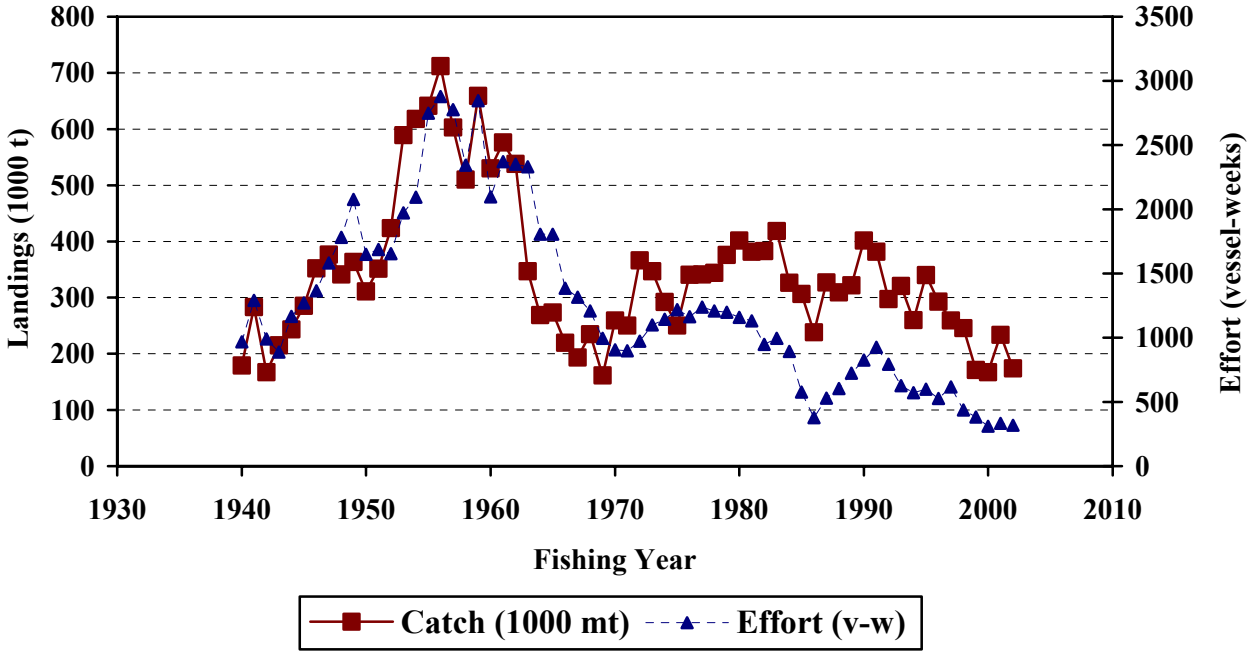


**Figure 6. Atlantic menhaden reduction landings versus nominal effort, 1940-2002 (2003 Stock Assessment).**

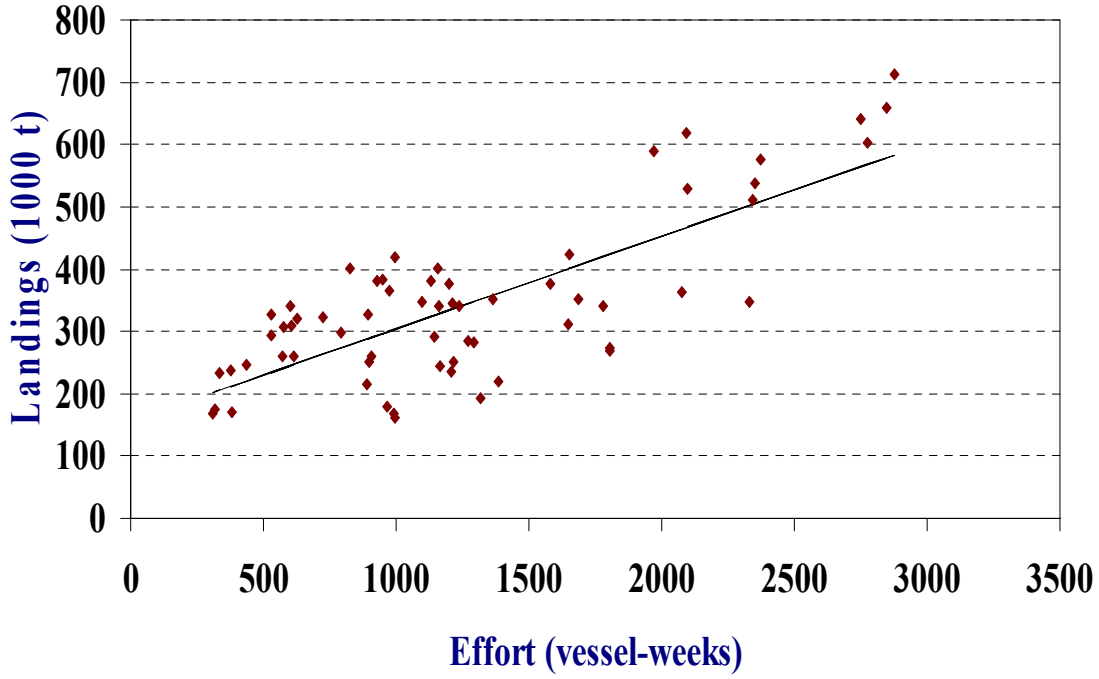

**Figure 7. Control plot of F and SSB from base Ricker run in current assessment for Atlantic menhaden with newly recommended benchmarks ( solid square represents 2002) (2003 Stock Assessment).**

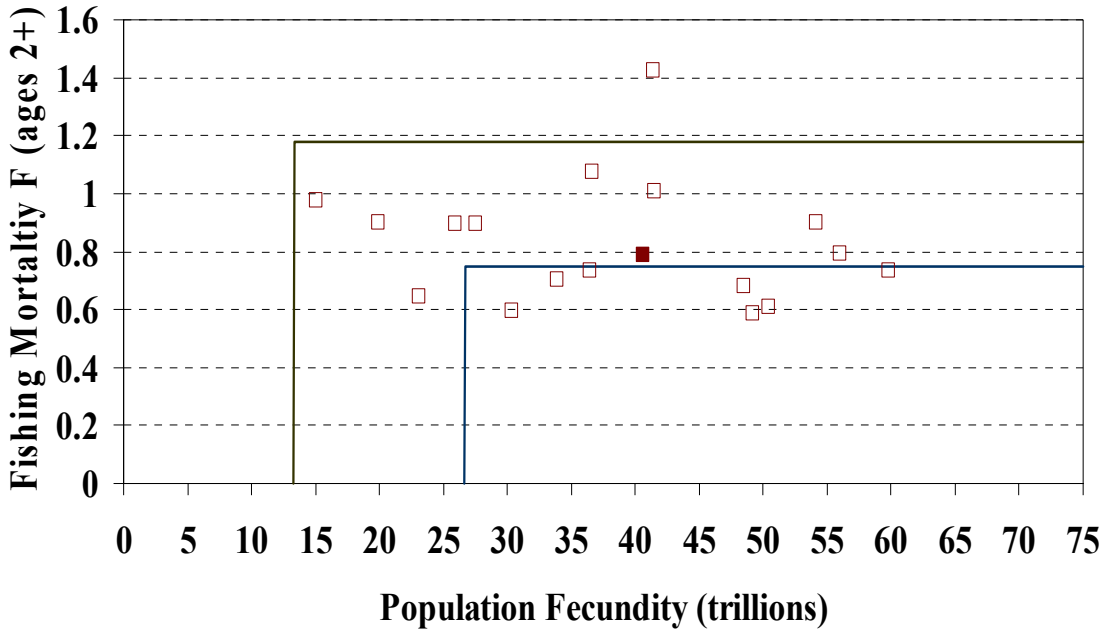


**Figure 8. Control plot of F and SSB from base Beverton-Holt run in current assessment for Atlantic menhaden with newly recommended benchmarks (solid square represents 2002) (2003 Stock Assessment).**