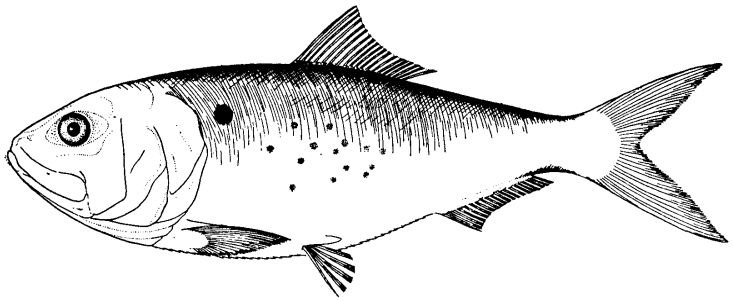
REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN FOR ATLANTIC MENHADEN
(Brevoortia tyrannus)

2001 FISHING YEAR



Prepared by:

The Atlantic Menhaden Plan Review Team

Joseph C. Desfosse, Ph.D., Atlantic States Marine Fisheries Commission
Matthew Cieri, Ph.D., Maine Department of Marine Resources
Ellen Cosby, Virginia Marine Resources Commission
Trish Murphey, North Carolina Division of Marine Fisheries
Douglas Vaughan, Ph.D., National Marine Fisheries Service

Approved November 19, 2002

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) and published in July 2001. 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 a new overfishing definition 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, with 9 age classes estimated in the 2001 assessment (ages 0-8). Natural mortality is estimated to be M = 0.45 over all age classes. Fishing mortality on the fully recruited ages (full F) for 2001 was estimated to be 1.0 (ages 2-8), with age-specific values ranging from F = 0.016 for age-0, F = 0.12 for age-1, and F = 1.0 for age-2 and age-3+.

Recruitment to age-1 was good to excellent from the mid-1970's to the late 1980's (Figure 1). Generally low recruitment to age-1 has occurred since 1996; however recruitment to age-1 in 1999 (1998 yearclass) was about average at 2.4 billion fish. Estimates of recruitment to age-1 for 2001 (0.5 billion fish) is well below its 25th percentile (2.1 billion) (Table 1); however this value has a high degree of uncertainty and will likely change considerably 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 indices and development of a coastwide index. The most recent values of these indices were compared with their median and interquartile range (Table 1). Estimated fishing mortality (F) in 2001 was below its historical 25th percentile (Figure 2), while the estimated spawning stock biomass (SSB) in 2001 was above its 75th percentile (Figure 3). Similarly high SSB values were noted in 1993, 1995, and 1997. Recruitment for Atlantic menhaden appears to be largely controlled by environmental conditions and not from lack of spawning stock biomass. 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.

The preliminary estimate of spawning stock biomass (mature females) for 2001 was 104,500 metric tons (mt), well over the target level (37,400 mt) specified in Amendment 1 and also above its 75th percentile. The largest values of SSB were present during the late 1950s and early 1960s (generally above the 75th percentile for 1955-1962, except for the 1958 year class which produced the most recruits to age-1) and were produced primarily from two historically large year classes (1951 and 1958). Estimates of SSB from 1965 until 1978 were generally below the 25th percentile. Since 1978, an estimate of SSB below the 25th percentile occurred only in 1986, and is probably an artifact of the economic conditions that resulted in an industry decision by one plant in Reedville, Virginia to decide not to fish that year. For those years when estimates of spawning stock biomass are above the 75th percentile (i.e., 1955-1957, 1959-1962, 1993, 1995, 1997 and 2001), the spawning stock biomass can be considered very healthy. For those years when estimates of spawning stock biomass are below the 25th percentile (i.e., 1965-1970, 1973-1977 and 1986), the spawning stock biomass can be considered depleted.

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 SPR for Atlantic menhaden is calculated based on such an index of egg production (Vaughan et al. 2002), and provides lower estimates of static SPR than those estimates based on mature female biomass. Although

highly variable, generally higher values (above 75th percentile) are associated with two temporal periods (4 out of 7 years between 1955-61, and 8 out of 12 years between 1990-2001). Higher SPR values are associated with lower exploitation regardless of stock size. The preliminary estimate for static SPR in 2001 was 12.6%, above the 75th percentile (10.5%).

Age composition of fish in the 2001 reduction landings coastwide (numbers of individual fish) was age-0 (3.4%), age-1 (6.5%), age-2 (55.2%), age-3 (32.5%) and age-4+ (2.3%). The South Atlantic "summer" fishery was composed of age-2 (37%) and age-3+ (63%) menhaden, while the Chesapeake Bay "summer" fishery was composed primarily of age-2 fish (67%) and age-3+ (25%) (Smith et al. 2002). Reduction landings from the Mid-Atlantic area were predominantly age-3+ menhaden (86%). The "fall fishery" was composed of equal numbers of age-2 and age-3+ menhaden (38% each), with the remainder of the landings made up of age-1 (18%) and age-0 (5%). No reduction landings of menhaden were recorded from the Gulf of Maine in 2001.

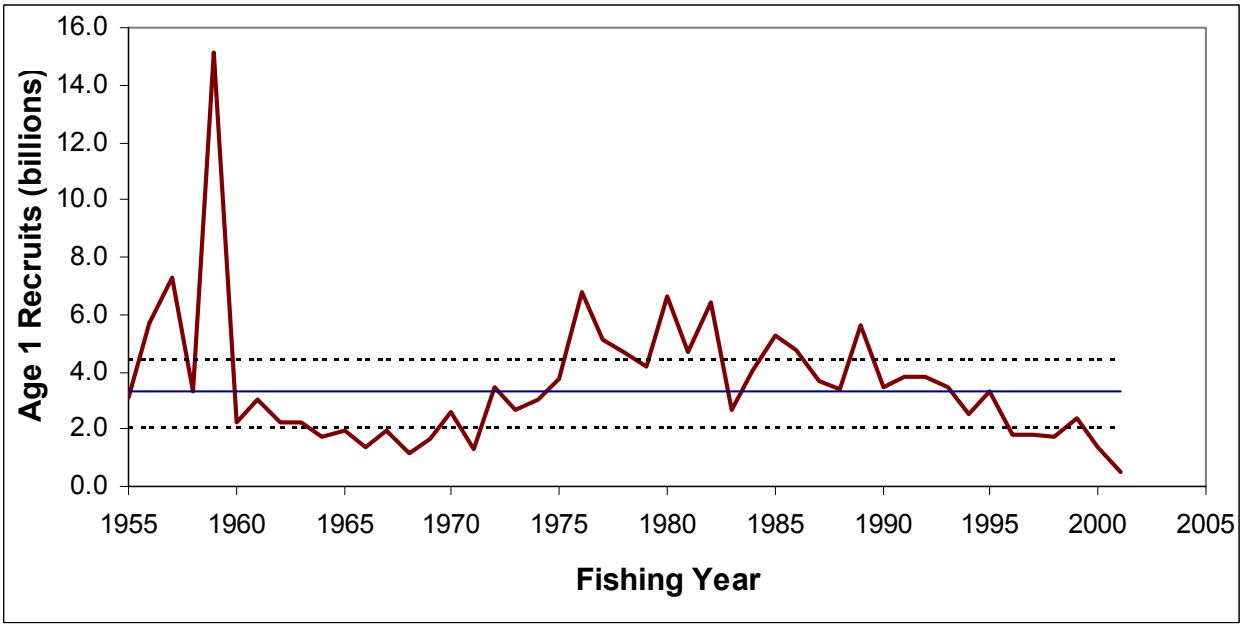


Figure 1. Estimates of Atlantic menhaden recruits to age-1 with median and interquartile range (Vaughan et al. 2002).

Table 1. Current conditions for VPA-generated indices and juvenile abundance indices compared to long-term median and interquartile range. Values for 2001 that fall within the interquartile range should not be considered different from the long-term median (50th percentile) (Vaughan et al. 2002).

Variable	n	2001	25th	50th	75th
Population-Based (VPA) Variables (Murphy)					
Full F (2+)	47	1.0	1.1	1.3	1.6
R1 (billions)	47	0.5	2.1	3.3	4.5
SSB (1000 t)	47	104.5	31.3	56.4	94.4
SPR (%)	47	11.3	3.4	6.2	10.5
Standardized Juvenile Abundance Indices for:					
SEAMAP (Age 1)	13	-0.72	-0.72	-0.12	0.69
SEAMAP (Age 2)	13	0.95	-0.61	0.14	0.44
NC Combined	30	0.23	-0.83	0.09	0.43
VA Seine	28	-0.73	-0.64	-0.43	0.26
MD Seine	43	-0.67	-0.69	-0.40	0.31
CT Combined	18	-0.62	-0.62	-0.42	0.30
RI Combined	23	-0.03	-0.30	-0.29	-0.22
Coastwide	43	-0.29	-0.79	-0.29	0.34

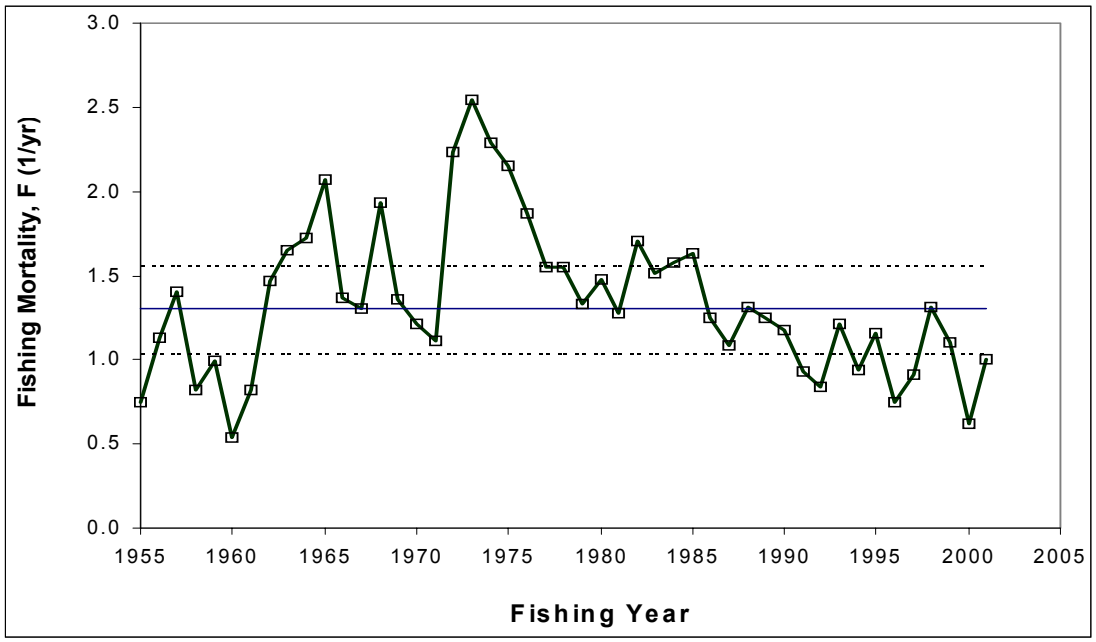


Figure 2. Annual estimates of fishing mortality rates, F, averaged over fully recruited ages (ages 2-8, weighted by population number at age) with median and interquartile range (Vaughan et al. 2002).

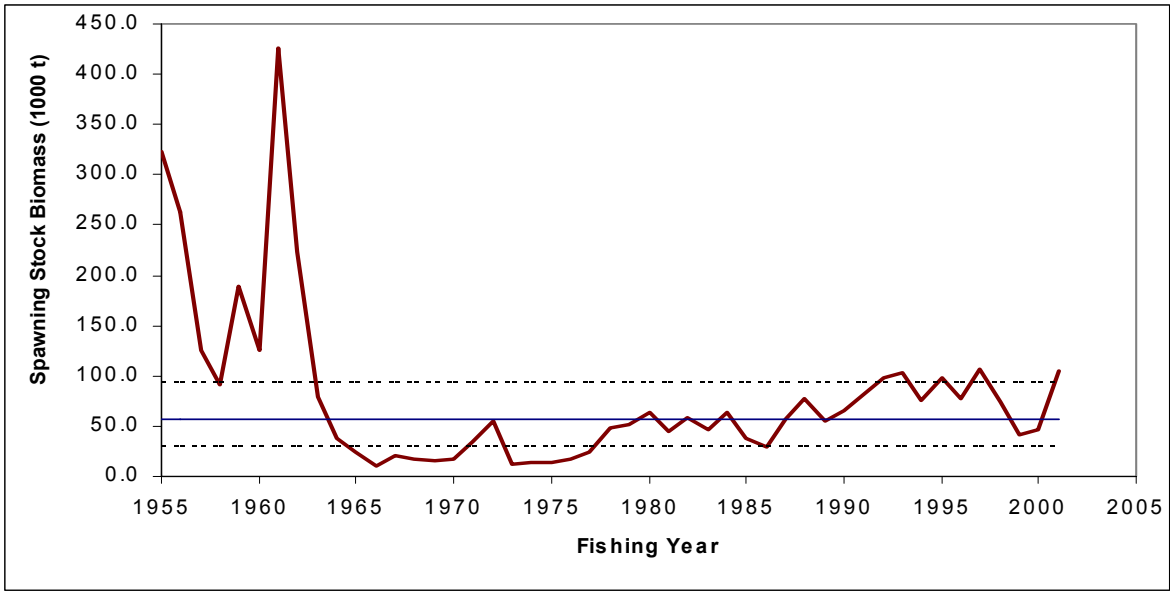


Figure 3. Estimates of Atlantic menhaden spawning stock biomass (SSB, age 3-8) with median and interquartile range (Vaughan et al. 2002).

III. Status of the Fishery

The 2001 harvest for reduction was 233,769 mt, which was 40% above the 2000 level of 167,253 mt, and about 3% above the average of the five previous years (227,285 mt) (Smith et al. 2002) (Figure 4). Nominal effort (vessel-weeks) in 2001 increased slightly from 311 vessel weeks in 2000 to 334 vessel weeks (Figure 5). This represents the second lowest level of effort recorded for the Atlantic menhaden reduction fishery since the mid-1950's. This decline in effort was anticipated due to the recent industry consolidation (AMTC 2002). A total of 12 reduction fishery vessels landed menhaden during the 2001 season; the small purse seine vessels from the Gulf of Maine did not fish for menhaden in 2001. Two shoreside plants operated in 2001, one in Reedville, Virginia; and one in Beaufort, North Carolina. The bait fishery for menhaden has become increasingly more important from North Carolina to New England. Landings from the bait fishery were estimated at about 36,200 mt for 2001, or 13.4% of the 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.

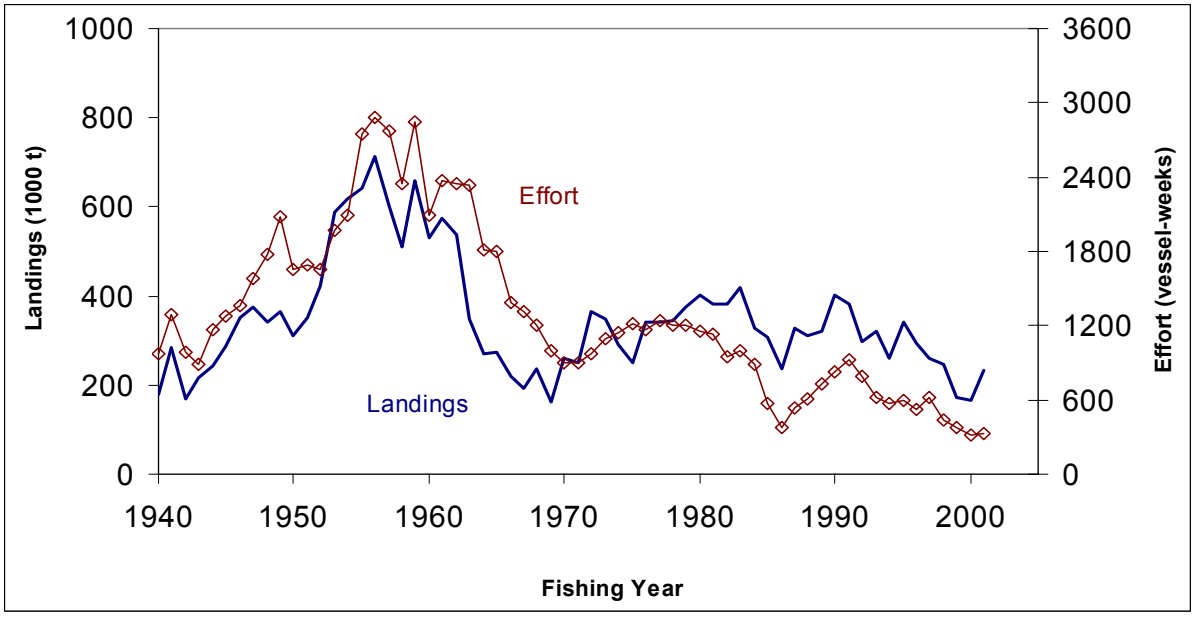


Figure 4. Atlantic menhaden landings and nominal effort, 1940-2001 (Vaughan et al. 2002).

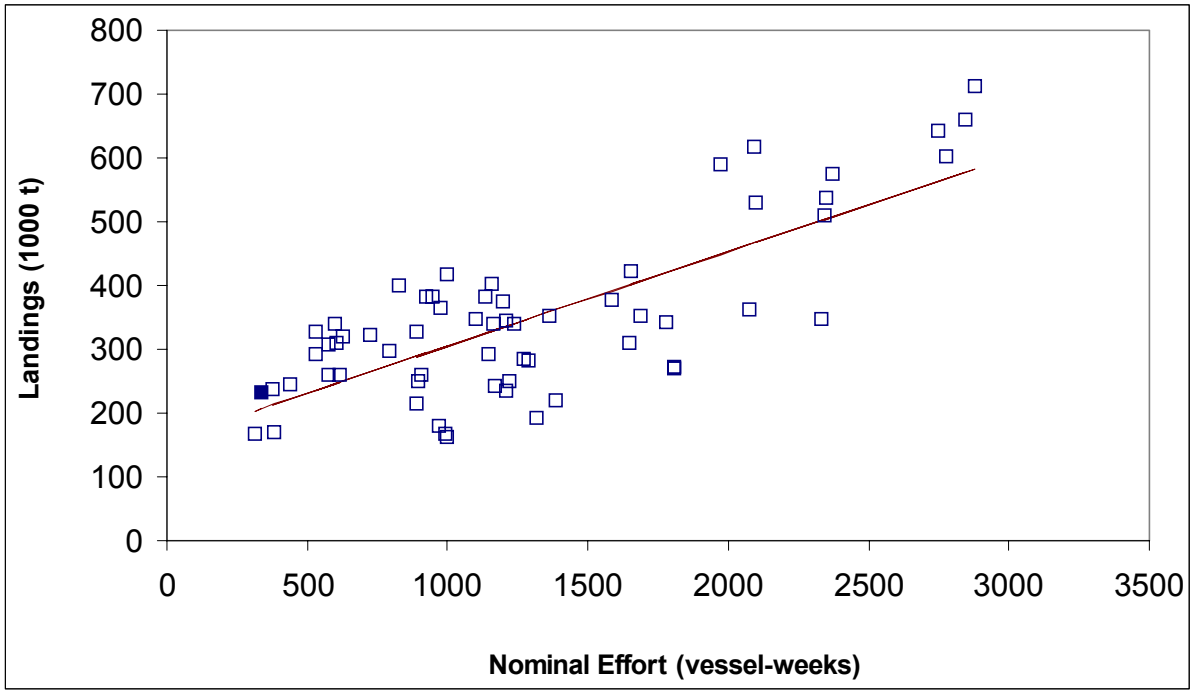


Figure 5. Atlantic menhaden landings versus nominal effort, 1940-2001 (2001 is represented by solid square) (Vaughan et al. 2002).

IV. Status of Assessment Advice

The Atlantic menhaden resource is assessed each spring prior to the annual Technical Committee and Advisory Panel meetings. The most recent assessment was performed by the NMFS Population Dynamics Team in June 2002 (Vaughan et al. 2002) and was reviewed (internally) by the Technical Committee in July 2002. A Murphy Virtual Population Analysis (VPA) is used to assess menhaden. Possible sources of uncertainty in the assessment include the accuracy of the bait landings, and the limited number of abundance indices for juveniles as well as adults (multi-age). The application of a coastwide assessment to answer questions of stock abundance in subareas (i.e. Chesapeake Bay), adds considerable uncertainty to subregional assessments.

The assessment methodology was peer reviewed in November 1998, and a report is available (ASMFC 1999, SAR No. 99-01). Some of the major recommendations from the review were: 1) examine and evaluate the number of samples per catch; 2) evaluate the feasibility of multispecies assessment techniques; 3) examine various fishery-independent data sources as tuning indices for the VPA; 4) monitor reproductive parameters; 5) conduct yield-per-recruit and spawning stock biomass-per-recruit analyses and develop estimates of biological reference points ($F_{0.1}$, $F_{threshold}$, F_{MAX}) for future assessments; 6) examine alternatives to the Ricker spawner-recruit relationship; and 7) investigate the precision of the VPA results and management trigger variables using error estimates associated with the catch-at-age data and catch curve analyses. All of these recommendations have been evaluated and the results will be included in the 2003 stock assessment report. A multispecies VPA has been developed incorporating menhaden and three key predator species, striped bass, bluefish and weakfish. The stock assessment(s) and methodology are scheduled to undergo another peer review in 2003 in accordance with the Commission's peer review process.

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 shown little difference in selectivity of the fisheries. Therefore, the catch at age matrices for both the reduction and bait fisheries have now been combined into a single matrix. This has led the technical committee to re-estimate the biological reference points and recommend higher biomass target and threshold levels.

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 a new overfishing definition for menhaden, utilizing a target and threshold approach for both fishing mortality and spawning stock biomass (Figure 6). The target fishing mortality rate is F = 1.04, while the target for spawning stock biomass is 37,400 metric tons. The technical

committee has recommended increasing the SSB target to 57,200 mt and increasing the SSB threshold to 31,500 mt.

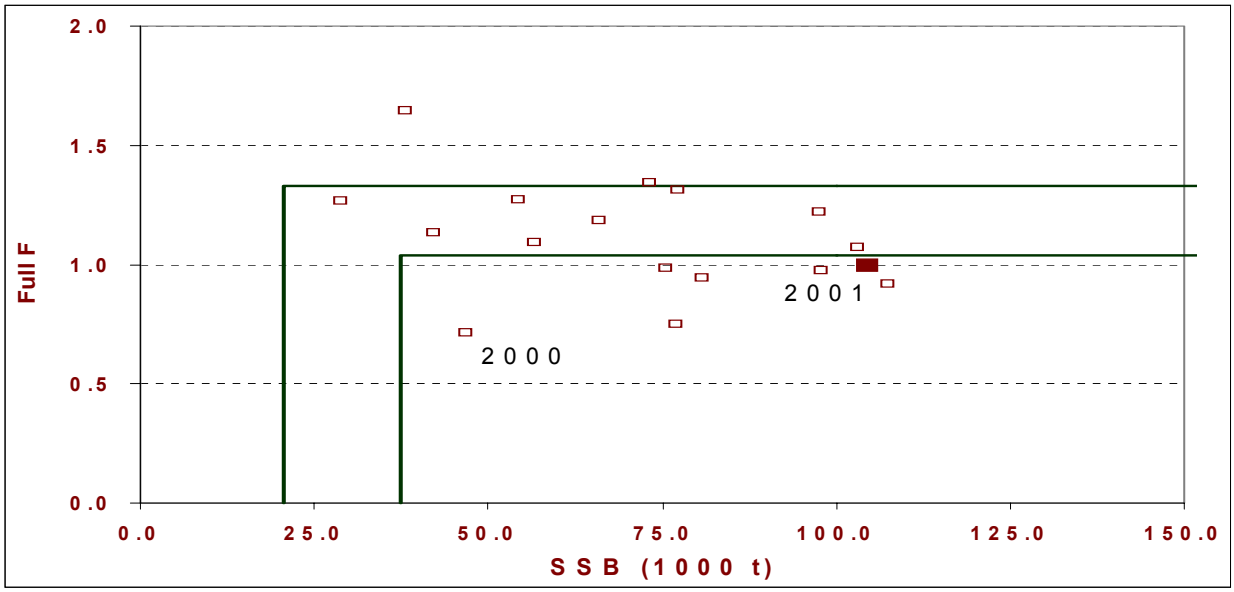


Figure 6. F and SSB from current assessment for Atlantic menhaden with benchmarks from Amendment 1 (solid square represents 2001) (Vaughan et al. 2002)

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 (in 2002 this was delayed until July 1). As of October 1, 2002, all states are in compliance with Amendment 1 with the exception of Massachusetts, Rhode Island and New York (Table 2). The compliance status of these states could not be determined since they have not submitted an annual report at this time (Table 1). In addition, the compliance status of New Hampshire was unclear since the report submitted was considered to be incomplete by the PRT. The PRT recommends that New Hampshire submit an annual compliance report which follows the standard report outline approved by the ISFMP Policy Board. Specifically, the PRT could not determine whether New Hampshire has a mandatory reporting requirement for purse seine or bait seine vessels.

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	June 2002	Yes	Reporting requirements cover all baitfish fisheries including gillnets and purse seines.	Yes
NH	May 15, 2002	**Unknown**	**No landings of menhaden in 2001; unable to determiine compliance status.**	**Unknown**
MA	**No report**	**Unknown**	**Unable to determine compliance status.**	**Unknown**
RI	**No report**	**Unknown**	**Unable to determine compliance status.**	**Unknown**
CT	Oct. 16, 2002	Yes	Purse seines prohibited in state waters; bait harvest primarily (99.97%) by gill net.	Yes
NY	**No report**	**Unknown**	**Unable to determine compliance status.**	**Unknown**
NJ	June 24, 2002	Yes	Prohibited purse seining for reduction purposes in state waters on January 6, 2002. Mandatory reporting for purse-seine (bait) fishery.	Yes
DE	Sep. 20, 2002	Yes	Fixed and drift gillnet fisheries only; purse seine fishing prohibited in 1992.	Yes
MD	June 2002	Yes	Purse seine fishing prohibited; menhaden harvested by pound net primarily; monthly reporting required.	Yes
PRFC	June 1, 2002	Yes	Mandatory commercial reporting; menhaden harvested by pound net primarily.	Yes
VA	July 1, 2002	Yes	Implemented reporting requirement for bait seine/ snapper rigs on Aug. 1, 2002; mandatory reporting for all commercial fisheries.	Yes
NC	June 27, 2002	Yes	Mandatory commercial fishery reporting (trip-ticket).	Yes
SC	June 25, 2002	Yes	Purse seines prohibited in state waters; mandatory dealer reporting; **requests *de minimis* status.**	Yes
GA	April 1, 2002	Yes	Mandatory commercial fishery reporting (trip-ticket); state waters closed to purse seine fishing; **requests *de minimis* status.**	Yes
FL	April 4, 2002	Yes	Purse seines prohibited in state waters; primarily a cast net fishery; mandatory commercial fishery reporting (trip-ticket).	Yes

VIII. Recommendations of Atlantic Menhaden Plan Review Team

General

In light of the recent poor recruitment but increasing spawning stock biomass, a more thorough examination of the population status is being conducted annually (Vaughan et al. 2002).

The menhaden "Fact Sheet" should be revised and published following the development of Amendment 1.

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.

Under the Commission's Stock Assessment Peer Review Process, the Atlantic Menhaden stock assessment should undergo a peer review in 2003. The Management Board needs to recommend what type of peer review should be conducted. Since this is triggered under the 5 year window, the choices are either through the SARC or an external panel review.

Compliance Recommendations

1. The following states should submit annual compliance reports for 2001: Massachusetts, Rhode Island and New York. In addition, the state of New Hampshire should resubmit its report following the approved compliance report format.

2. 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. Therefore, the PRT feels that these requests are unnecessary under these conditions and the provisions of Amendment 1.

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 spawning stock biomass (SSB) reference points contained in Amendment 1 be revised to reflect the incorporation of the bait fisheries data in the stock assessment. The combined reduction and bait catch matrix has resulted in historically higher estimates of SSB, especially for the period 1985-2001, than those obtained from just the reduction catch matrix. The committee has proposed increasing the SSB_{target} to 57,200 mt, and the $SSB_{threshold}$ to 31,500 mt based on the same methodology used in Amendment 1 to develop the biological reference points. 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. 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).

Develop and test methods for estimating size of recruiting year-classes of juveniles using fishery-independent survey techniques (ongoing research).

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

Monitor landings, size, age, gear, and harvest area in the reduction and bait fisheries, and determine age composition by area. Enhance biostatistical sampling of bait samples in purse seine fisheries for Virginia and New Jersey 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).

The feasibility of estimating yearclass strength using biologically stratified sampling design should be evaluated. The efforts could be supported by process studies linking plankton production to abundance of young menhaden (need resources).

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

   Monte Carlo simulations should be conducted to evaluate precision of VPA (part of efforts to improve current stock assessment methodology).

   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.

   Re-evaluate menhaden natural mortality, by age and response to changing predator population sizes (evaluated through MS model, incorporated variable M in assessment).

   Evaluate whether a statistically valid observer program is needed to document possible sea turtle interactions with the various gear types.

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

   Determine the effects of regulations on the fishery, the participants and the stock (CESS).

   Growth back-calculation studies should be pursued to investigate historical trends in growth rate. The NMFS has an extensive data base on scale growth increments which should be utilized for this purpose.

4. 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 when it operates in nearshore waters of North Carolina.

5. Develop bycatch studies of menhaden by other fisheries.

   Evaluate extent of recreational netting of menhaden for bait purposes.

6. Periodically monitor the economic structure and sociological characteristics of the menhaden reduction industry (CESS).

Identified Management Issues

- Make annual prediction for the Atlantic coast fishery (ongoing as part of annual stock assessment).
- Analyze vessel catch records (ongoing as part of annual stock assessment).

Research Needs Identified as Being Met - none at this time

References

Atlantic Menhaden Technical Committee. 2002. 2002 Report of the Atlantic Menhaden Technical Committee. Report to the Atlantic Menhaden Management Board. July 2002. 37 pp.

Atlantic States Marine Fisheries Commission. 1999. Stock Assessment Report No. 99-01, 16 pp.

Gabriel, W.L., M.P. Sissenwine and W.J. Overholtz. 1989. Analysis of spawning stock biomass per recruit: An example for Georges Bank haddock. N. Amer. J. Fish. Mgmt. 9: 383-391.

Prager, M.H., J.F. O'Brien and S.B. Saila. 1987. Using lifetime fecundity to compare management strategies: a case history for striped bass. N. Amer. J. Fish. Mgmt. 7: 403-409.

Smith, J.W., et al. 2002. Forecast for the 2002 Gulf and Atlantic menhaden purse-seine fisheries and review of the 2001 fishing season. Report of the NMFS Population Dynamics Team, Beaufort, North Carolina. 8 pp.

Vaughan, D.S., J.W. Smith, and E.R. Williams. 2002. Analyses on the Status of the Atlantic Menhaden Stock. Report prepared for the Atlantic Menhaden Technical Committee, ASMFC. 48 pp + app.