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Atlantic States Marine Fisheries Commission

Working towards healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015

Atlantic Menhaden Workshop Report & Proceedings

December 2004

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A report of a workshop conducted by the
Atlantic States Marine Fisheries Commission
October 12 – 14, 2004
Alexandria, VA

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Executive Summary

In October 2004, the Atlantic States Marine Fisheries Commission (Commission) held a workshop to examine the status of Atlantic menhaden with respect to its ecological role. This workshop was convened in response to a motion made by the Atlantic Menhaden Management Board in May 2004. Representatives from the environmental, recreational fishery, and the commercial fishery communities helped plan the details of the workshop. State, federal, and university scientists were invited to participate in the workshop. The workshop goals were the following:

- Examine the status of Atlantic menhaden with respect to its ecological role
- Explore the implications of current management reference points with respect to menhaden's ecological role
- Explore the effects of concentrated harvest in the Chesapeake Bay
- Develop recommendations for revised or new directions for the Atlantic Menhaden Fishery Management Plan to the Atlantic Menhaden Management Board (and other Boards as necessary) at the annual meeting in November 2004

The workshop was divided into four sessions, one for each of the above goals. Each session included presentations and a discussion period, with specific questions or reference points guiding the discussions. From the discussions, workshop participants developed the following list of consensus statements. These statements reflect the opinion of the participating scientists only, and not the stakeholder representatives at the meeting.

Session 1: Status of menhaden's ecological role

- Atlantic menhaden play a unique role transforming primary productivity directly into fish biomass.

- Menhaden productivity depends on and impacts water quality in the ways it supports primary production.

- Menhaden are important prey for large predators. Historically at least in Chesapeake Bay and North Carolina they were the dominant prey species. This dominance has diminished. We can quantify the role as a filter feeder, we can quantify them as prey coastwide, however, abundance in Chesapeake Bay is needed to quantify this role regionally.

- We have the tools (striped bass and menhaden bio-energetic models,), but have not conducted a holistic quantitative analysis of the ecological role of menhaden.

- The abundance of Atlantic menhaden in Chesapeake Bay remains unknown.

- Menhaden may be the last major abundant inshore clupeid.

- There is a possibility of a link between striped bass disease and abundance of menhaden; however more research is needed.

- There may be a relative imbalance between the prey needs of an increased striped bass population and a decreased abundance of menhaden juveniles (age zeros and ones) in Chesapeake Bay.

- While there was not consensus by the committee as to the causes of low recruitment to age zero in Chesapeake Bay, the following are possible causes:
    1) Insufficient spawning stock biomass
    2) Eggs and larvae not being brought into Chesapeake Bay (transport)
    3) Poor survival to at least several months old (unfavorable conditions of salinity, or temperature, mismatch of food, disease, and predation)
    4) There is emerging evidence that climate forcing may play an important role

- There is an ongoing concern of the decade-long decline in recruitment in Chesapeake Bay.

- Menhaden have diminished compared to its historical abundance in the Chesapeake Bay.

- As a prey species menhaden serve a much stronger role then 10 to 15 years ago.

- Menhaden continue to serve an important ecological role although its relative contribution in terms of forage and filtering has diminished because of reduced abundance.

Session 2: Reference points implications for menhaden's ecological role

- The current reference points are related to the coastwide stock. They use fishing mortality and reproductive capacity. They are based on a single species model. These are biological reference points, they do not take into account socio-economic factors. The reference points are designed for stock replacement.

- There is a need for an additional reference point (threshold) for juvenile abundance (age zeros and ones), which may require management action within a separate fishery within its ecosystem if exceeded.

- The Management Board should task the Technical Committee with exploring the possibility of including the effects of predation mortality on menhaden reference points (Collie and Gislason, 2001, Patterson 1992, Washington State Forage Management Plans, for example). Explore the possibility of including the MSVPA results.

- The Management Board has to provide advice to the Technical Committee on its goals and priorities, and identify a spectrum of possibilities to develop ecologically based reference points.

Session 3: Effects of concentrated harvest in the Chesapeake Bay

- Localized depletion occurs when migratory immigration of menhaden is insufficient to replace removals.

- Localized depletion of Atlantic menhaden effects two factors:
    1) Availability for predation
    2) Filtering capacity

- To determine if localized depletion is occurring, there must be a reference point.

- The localized depletion in the Bay can be characterized both as a forage shortage of recruits and as a shortage of filtering capacity of all ages in the stock.

- The reduction fishery does not directly focus on zeros and ones, but the harvest of the ages 2+ could result in feedback through regional spawning and recruitment processes that impact the Chesapeake Bay.

- Absolute abundance in the Bay and the proportion of age zeros and ones in the Bay is unknown.

- The data that is available to define localized depletion is Catch Per Unit Effort (CPUE), Rhode Island trap survey, Delaware trawl survey and the pound net survey.

- If abundance declines, purse seine CPUE will not decline at the same rate. A decline in CPUE can be used as a conservative (under estimate) indicator of abundance.

- We are limited in our ability to accurately estimate the probability that localized depletion is occurring. We won’t know the probability until we conduct the research that the Technical Committee has outlined.

- The following are risks associated with localized depletion:
    1) Reduced forage for predators
    2) Reduced filtering capacity
    3) Disruption of the food web
    4) Within species genetic diversity

Session 4: Recommendations for a revised or new direction in fisheries management

- Examples of how other forage fisheries are managed:
    1) The Atlantic Herring Fishery uses a precautionary approach: OY is 20% less than MSY. The target is the threshold, which is OY.
    2) Off of Tampa Bay, managers closed a three mile corridor for the sardine/anchovy fishery

3) Some forage fisheries are managed by shutting down the harvest and leaving them for other purposes.

- Given the information presented during this workshop, The Committee offers the following scientific advice to the Board on a revised or new direction in fisheries management.
  1) Time and space closures/openings have potential as a management tool.

  2) Develop reference points specific to Chesapeake Bay

  3) Need to quantify predation mortality and produce estimates of abundance of menhaden to develop ecologically based reference points

  4) Technical Committee/staff should examine the forage fishery management plans of Alaska, Washington, and California and determine if they can be applied to the menhaden fishery.

  5) The Management Board should task the Technical Committee with exploring the possibility of including the effects of predation mortality on menhaden reference points (Collie and Gislason, 2001, Patterson 1992, Washington State Forage Management Plans, for example). Explore the possibility of including the MSVPA results.

  6) A Multispecies Technical Committee should be formed.

  7) Confront the need and potential mechanisms for management that cross single species management boundaries.

  8) Establish values and goals for population utilization that acknowledge ecosystem service and fisheries support provided by the menhaden population.

  9) Have joint meetings between the Management Board and Technical Committee to accomplish above task.

  10) The Technical Committee should evaluate additional reference points to address menhaden's ecological role

  11) Explore the concept of an escapement-based approach, for example, closed seasons, area closures.

  12) Investigate the issue of low recruitment in the Chesapeake Bay and what is causing it. One hypothesis is striped bass predation is reducing YOY abundance prior to YOY surveys. Stomach content field studies and bioenergetic studies can be used to evaluate this hypothesis. Spatial temporal overlap must be taken into account.

13) The Management Board should charge the Technical Committee to meet with the ecopath/ecosim modelers to exchange information as soon as possible.

Recommendations from the workshop were presented to the Atlantic Menhaden Management Board in November 2004.

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Atlantic Menhaden Workshop
October 12 – 14, 2004
Alexandria, VA

Chairs
Jack Travelstead, Atlantic Menhaden Management Board Chair
Matthew Cieri, Atlantic Menhaden Technical Committee Chair

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Chris Bonzek, Virginia Institute of Marine Science
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Steve Meyers, NOAA Fisheries
Niels Moore, Menhaden Resource Council
Amy Schick, Environmental Defense
Jack Travelstead, Management Board Chair
Bill Windley, Advisory Panel Chair

Staff
Robert Beal
Nancy Wallace

BACKGROUND AND GUIDELINES

Background

On May 26, 2004 The Atlantic Menhaden Management Board unanimously passed the following motion:

"Move that ASMFC Atlantic Menhaden Management Board conduct a workshop to examine the status of Atlantic menhaden with respect to its ecological role, especially its role as forage fish, and of the implications of current management reference points with respect to this role. Emphasis should be given to the implications of concentrated harvest in the Chesapeake Bay. The workshop will be held by the fall 2004, with recommendations for revised or new directions for the Atlantic Menhaden FMP for Board action at the annual meeting 2004."

In June 2004 a Steering Committee was formed to develop a workshop to respond to the Board's Charge. The members of the steering committee are listed on page 1.

The Steering Committee held four conference calls to develop the agenda for the workshop, a list of invited participants, and a list of invited speakers. This Committee developed and agreed to the following guidelines for the workshop.

Guidelines

Workshop Goals and Objectives

- Examine the status of Atlantic menhaden with respect to its ecological role
- Explore the implications of current management reference points with respect to menhaden's ecological role
- Explore the effects of concentrated harvest in the Chesapeake Bay
- Develop recommendations for revised or new directions for the Atlantic Menhaden Fishery Management Plan to the Atlantic Menhaden Management Board (and other Boards as necessary) at the annual meeting in November 2004

Terms of Reference/Discussion Questions

The terms of reference were agreed upon by the Atlantic Menhaden Workshop Steering Committee. These were used to help guide discussion, however, each Term of Reference did not have to be specifically answered and reported back to the Management Board.

Session 1: Status of menhaden's ecological role

- What role do menhaden play in coastal marine ecosystems?
- How important is that role in the overall health of the ecosystem?
- What is the status of Atlantic menhaden with respect to its ecological role?

Session 2: Reference points implications for menhaden's ecological role

- What are current reference points designed to do?
- How do menhaden's reference points compare to those used in other forage fisheries?
- Are current reference points sufficient to address menhaden's ecological role?

Session 3: Effects of concentrated harvest in the Chesapeake Bay

- How could localized depletion impact menhaden's ecological role?
- What is the probability that localized depletion is occurring?
- What are the risks associated with localized depletion?

Session 4: Recommendations for a revised or new direction in fisheries management

- How should information about multi-species management and ecosystem-based management be used in the current fisheries management programs?
- How are other forage fisheries managed?
- Given the information presented, what is the scientific advice to the Board on a revised or new direction in fisheries management?

Workshop Format

The Workshop was divided into four sessions to address each of the goals listed above. Each session had a series of presentations followed by question and answer, and discussion periods. Recommendations from each of the sessions were presented to the Management Board.

Stakeholder Involvement

Each of the three interest groups (the commercial industry, recreational fishing community, and the environmental community) were asked to submit two papers each to the workshop participants before the workshop. One person from each of the three interest groups gave a brief presentation (10-15 minutes) at the workshop. The representatives from each stakeholder groups sat at the table and participated in the discussions.

Development of Workshop Recommendations

Recommendations from the workshop were developed through consensus of the scientists at the workshop. The stakeholders and public at the workshop did not participate in the consensus process. In order to achieve consensus the scientists were asked "if they can live with" the recommendation.

Public Participation

On the morning of the second day of the workshop a public comment period was scheduled. A meeting of the Atlantic Menhaden Advisory Panel took place on October 28, 2004. The Panel reviewed the recommendations from the workshop. There was aslo a public comment period at this Advisory Panel meeting.

Recommendations to the Management Board

Following the workshop, the recommendations developed at the workshop were presented to the Management Board at the ASMFC Annual Meeting in November. The input from the Advisory Panel was also presented to the Board. If the Board chooses to initiate an amendment or addendum based on these recommendations, the formal ASMFC process for development, review, and approval of such a document would be initiated. The process will allow for public comment and additional Technical Committee input if necessary

Agenda
October 12, 2004

1. Welcome, Introductions (12:00)
2. Objectives and Goals of the Workshop (12:15)
3. Session One: Status of menhaden's ecological role – Presentations and Questions
- Primary production and filter feeding (12:30) *(Kevin Friedland)*
- Predator-prey interactions (1:00) *(Kyle Hartman)*
- Striped bass diet (1:30) *(Kyle Hartman)*
- Striped bass disease (2:00) *(John Jacobs)*
4. Discussion of Session One (2:30)
5. Break (3:00)
6. Session Two: Implications of reference points to menhaden's ecological role- Presentations and Questions
- Current stock status of menhaden and reference points, ASMFC multispecies overview (3:15) *(Matt Cieri)*
- Weakfish presentation (3:40) *(Jim Uphoff)*
- Bluefish presentation (4:05) *(Laura Lee)*
- Striped bass presentation (4:30) *(Gary Nelson)*
7. Discussion on Session Two (4:55)
8. Adjourn for the Day (5:30)

October 13, 2004

1. Welcome (8:00)
2. Session Three: Effects of concentrated harvest in the Chesapeake Bay- Presentation and Questions
- Historical and current removals from the Bay (8:15) *(Doug Vaughan)*
- Mulitspecies modeling efforts (8:45) *(Rob Latour)*
- Climate effects and recruitment of menhaden (9:15) *(Bob Wood)*
3. Discussion of Session Three (9:45)
4. Break (10:30)
5. Stakeholder Presentations
- Commercial (10:45*) (Jeff Kaelin)*
- Environmental (11:00) *(David Festa)*
- Recreational (11:15) *(Sherman Baynard)*
- Discussion (11:30)
6. Public Comment (11:45)
7. Lunch Break (12:15)
8. Discussion on Session One
- Review terms of reference and Discussion Questions/ Provide Recommendations (1:15)
9. Discussion on Session Two
- Review terms of reference and Discussion Questions/ Provide Recommendations (3:30)
10. Adjourn for the Day (5:30)

October 14, 2004

1. Welcome (8:00)
2. Discussion on Session Three
   - Review terms of reference and Discussion Questions/ Provide Recommendations(8:15)
3. Break (10:15)
4. Session Four: Recommendations for revised or new direction in fisheries management
   - Current menhaden management and ASMFC process (10:30) *(Bob Beal)*
   - Example of forage fish management in the Great Lakes Region (11:00) *(Charles Madenjian)*
   - Summary of presentations and possible ecosystem based approaches in fisheries management (11:30) *(Ed Houde)*
5. Discussion on Session Four (12:00)
6. Lunch (12:30)
7. Summarize recommendations to the Management Board (1:30)
8. Adjourn (5:00)

WORKSHOP PROCEEDINGS

The following are summaries of the presentations followed by a discussion period.

Session One: Status of Menhaden's Ecological Role

Feeding Ecology of Atlantic Menhaden
(Kevin Friedland, UMASS, NOAA Fisheries)
Menhaden are filter feeders, filtering very small particles. They have long slender gill rakers and secondary processes called branchiospinules. These form a network of sieves, which can capture as well as move particles with mucus cells.

There are two major studies looking at particle size of what menhaden consume. It is difficult to look at stomach contents so instead they look at clearing rate experiments. These look at particle size and efficiency. Plankton in the Chesapeake Bay are small. Menhaden have the ability to crop these plankton particles at some level.

Clearing rate experiments with large juveniles, 138mm FL, feeding on uniformly sized cultures of phytoplankton shows that particle retention begins at particle diameters of about 7-8 microns. There is a large difference in efficiency by size of fish. Larger fish are more efficient. Detritus enhances the retention of smaller particles that otherwise might not be filtered.

Dr. Friedland also looked at two distribution studies. One in North Carolina and another in Virginia with two creeks in each. These studies had fixed station parameters. They were looking to see if there were any gradients that related to their distribution. The study indicated there is a correlation between chlorophyll a and menhaden counts. Menhaden counts were higher when there was more chlorophyll a. There was no positive or negative trend with temperature or salinity. Plankton in the water seemed to be the controlling factor for how fish were distributed in the creeks. Spatial analysis demonstrates there is higher menhaden CPUE in areas with higher chlorophyll a suggesting they are gradient searching for the higher chlorophyll a counts.

Another study from the York River with pound nets found that higher migrations of menhaden corresponded with change in water temperature. With the fall plankton bloom in the estuary, there are higher levels of menhaden.

New data presented looks at functional morphology, which systematically characterizes the sieving morphology of the gill rakers as a function and size of the fish. Menhaden have five arches. The study measured the length of the arches, the subsections lengths, and then the raker lengths. They examined the growth of the arch length as a function of fork length of the fish. They found that the arch bone grows linearly with the length of the fish. This is the same as the raker blade; it grows linearly with the fish. However, when you get to the raker gap, this relationship was not linear. Once past 100 mm, the rakers start to spread out again. The fish at this size are in very different waters. They are now migratory fish rather then being focused on the estuaries. The smaller fish have small gaps. This separates them from other fish such as shad. Some of the raker gaps are in the order of 7 microns, which is very small.

Summary Points

1) Menhaden ingest everything in the water column and likely ingest some sediments in shallow areas.
2) Some phytoplankton are capable of passing through the alimentary canal of menhaden.
3) Menhaden distributions are defined by phytoplankton distributions within physical limits and migrational behaviors.
4) Menhaden juveniles retain the ability to crop small phytoplankton in estuaries during the nursery season.
5) Larger, older menhaden filter increasingly larger plankton, but avoid a niche overlap with other filter feeding fish.

Q&A and Discussion

Menhaden feeding selection is based on searching. They retain everything but if they are feeding and they don't like it they will move on. They don't spit out particles but simply move to find particles they want. It also depends on turbidity. Menhaden do consume bacteria but they don't filter very much so it is unclear how much it contributes to the total diet.

Striped Bass Diet and Predator-Prey Interactions
(Kyle Hartman, West Virginia University):

Population Trends

Striped bass population has exploded in past 15 years; pursuant with increases of striped bass, there have been decreases in menhaden.

Diets and Feeding of Striped Bass

Historically, the diets of smaller striped bass in Chesapeake Bay included primarily anchovy. Larger striped bass fed on menhaden, however, there is also a seasonal pattern. Diets in the early 1990s indicate that at age one the importance of menhaden starts to increase. There are similar patterns in age 2 and 3. Striped bass also eat prey other than menhaden such as, spot, croaker, and blue crab.

Recent diet studies (Overton 2003) include more spatial coverage. In spring in the middle bay, ages 3 and 6 are eating a lot of menhaden. In summer, menhaden become increasingly important in the diets of ages 3- 6. Bay anchovy are important through age 3.

Walters et al 2003 did a meta-analysis to look at trends. For The Chesapeake Bay, Delaware and North Carolina, the percentage of menhaden in the diet for age one and younger, increase through the seasons and peak in the fall. This study showed in The Chesapeake Bay and North Carolina, menhaden are clearly an important component of the striped bass diet.

Changes in Predator Demand

Bioenergetics modeling coastwide has been conducted to determine the growth rates for striped bass and how much they need to consume. The population consumption level increased 265% from 1982 to 1988 and 227% from 1988 to 1992. The population consumption peaked in 2001 at 155,500t. There was an 8-fold increase from 1982 to 1995. Striped bass are consuming up to 57% of menhaden harvested per year based on this bioenergetic work.

Feeding shortages for striped bass?

Striped bass have already experienced periods of low or negative growth before population recovery. Age 3 and older striped bass in The Chesapeake Bay historically (1991) had periods of low or negative growth.

Hartman conducted a bioenergetics analysis of two key striped bass cohorts (age 3 and age 5). The cohorts were forced to feed on alternative, lower energy content prey during the "fattening" period of late summer to fall. Feeding on alternate prey required an increase in individual consumption only slightly. Striped bass don't have to eat that much more of the alternative prey to achieve the same growth when they are feeding on menhaden. This suggests that very little additional alternate prey is needed to offset a lack of menhaden during 'fattening." However, there needs to be adequate alternative prey available.

Timing and magnitude of menhaden use

Because age 0 menhaden are growing rapidly during residency in The Chesapeake Bay, the number of menhaden individuals consumed by striped bass per day declines through the year. However, daily consumption of menhaden mass is relatively constant through menhaden residency. With this constant demand for menhaden and given the large increases in striped bass populations, these negative growth periods observed in the early 1990s (Hartman and Brandt 1995) are likely.

Summary

Even in 1991, prey shortages existed and were worse for larger striped bass in The Chesapeake Bay. These prey shortages are likely accentuated, with longer periods and higher variability in growth.

Do striped bass prefer menhaden?

Ruderhausen et al conducted prey selectivity and diet analysis of striped bass in western Albemarle Sound, North Carolina during 2002-03. They collected striped bass and prey fishes from nearshore and pelagic areas (beach seine and purse seine). The results show that, yes, they do prefer menhaden, even more so than other alosids.

Discussion

- The use of age 0 menhaden and timing of striped bass use suggest striped bass take their share before the commercial fishery.

- Given prey shortage and striped bass selection for menhaden, reducing F for menhaden or reducing predator populations may not result in more menhaden, they could just be eaten.

- Striped bass do appear capable of limiting prey populations.

- Striped bass contribute to declines in Chesapeake Bay menhaden since they take their share of age 0 fish "first" before the fishery.

- Menhaden appear to be a buffer species. If menhaden are there, striped bass will feed on them.

- Multispecies management must be followed in order to conserve stocks of many of these interacting species (but results may be slow or dampened by predation).

Q&A and Discussion

While temperature alone will not prohibit the ability of striped bass to feed, dissolved oxygen may have an influence. Consumption feeding rates for juvenile striped bass are based on how dense the fish are. As density increases, there will be more interactions and consumption rates will increase and then level off at a certain point. However, as density increases, growth rates would go down (based on Hartman & Brandt 1993-TAFS).

Based on the 1991 VPA results, it appears that striped bass consume about 50% of the menhaden harvest. This is different from what the Technical Committee has produced because the approaches are very different.

Age 0 menhaden are being cropped by the striped bass before they are subject to harvest by the fishery. They start showing up in the diets of striped bass in July and then build over time. The younger striped bass can't eat large menhaden. It is unusual to find age one and larger menhaden in the diets of striped bass. These studies seem to be based on a snapshot scale, it would be helpful to have more work on the spatial scale.

Health and Condition of Chesapeake Bay Striped Bass
(John Jacobs, NOAA Cooperative Oxford Lab):

There was a peak abundance of striped bass in 1994, which is also when we started seeing disease. At certain times of year, a high percentage of fish (over 25% in some cases) have lesions. In 1997, a new pathogen was isolated called mycobacteriosis. It is a slow progressing systemic disease characterized by granuloma formation in viscera and presence of acid fast bacteria. It is associated with high mortality in culture, which usually implicates stressors. Clinical signs may vary and may include dermal lesions, pigmentary changes, emaciation, stunted growth, exophthalmia, or no signs at all. There are also human health concerns, usually associated with water contact and skin abrasions.

Prevalence of mycobacteriosis in Chesapeake Bay striped bass has an increasing trend of percent affected from 1998 through 2002. There is some evidence of increased prevalence and severity with age but not a lot of data to base this on. This is consistent with reports from watermen and anglers from 1996 through present. There is speculation concerning the relationship of disease states and influence of stressors.

Some possible stressors are: high temperatures/hypoxia, predator-prey imbalance due to increased demand of age 2+ striped bass (Uphoff 2003), and reduction of menhaden in striped bass diet (Overton 2003, Griffin and Margraf 2003, Hartman and Brant 1995). However, mycobacteriosis is known as a "wasting disease" and may be acting independently.

A starvation study was conducted, which found the weight length relationship. The relationship for starved fish was lower than fish with food but it did have the same slope. However, when this slope was overlapped with survey data, the slopes were the same but the weight length relationship of starved fish in lab was similar to the wild fish. Body fat index work also indicated that wild fish have body fat figures more similar to the starved fish rather than the fed fish.

Conclusions

Health and condition of fall Chesapeake Bay striped bass are consistent with a stressed population, however, the condition is not fully explained by mycobacteriosis. The conditions coincide with changes in striped bass abundance, diet, and prey base, but a direct linkage has not been established.

Q&A and Discussion

To make the link between striped bass disease and lack of nutrition the following work needs to be done: 1) increase the numbers in chemical analysis – especially on a seasonal basis; 2) experimentally look at the components of diet, feed the fish and see how it impacts disease on fish.

There is a research need to examine if striped bass build resistance to disease. How many striped bass are going to be impacted and will they die?

The fish in these studies were collected with pound net and hook and line. There is no significant difference between the two collection methods. There has been discussion about the impacts of pound nets. Trawl data may be better to handle the middle of the Bay. There are a lot of surveys being done. It would be helpful to look at all the surveys to offer more spatial and temporal coverage.

There is an implied association between lesions and low lipids. Could lesions cause fish to loose lipids? It is difficult to say which is the cause. Were these fish skinny to begin with? If you have lesions, then you have difficulty maintaining osmotic balance.

There are instances of diseased striped bass outside of Chesapeake Bay. There are instances in Delaware Bay and reports from Long Island Sound.

Session One: Discussion Period:

(The following is a summary discussion statements by topic for Session One. The statements may not reflect the views of the entire group, but the opinion of only one participant. A complete list of consensus statements is at the beginning and end of this document)

Relationship Between Menhaden and Striped Bass

There was general agreement that it is unclear if striped bass disease is related to a lack of nutrition from menhaden. More studies are needed.

Conclusion from studies conducted by VIMS scientists is that environmental factors modulate the disease and we don't fully understand them. The effects of temperature were looked at initially. The results showed slightly more pathogenic evidence but nothing of significance.

A conclusion from the striped bass disease presentation was that they are not ready to say there is a link between nutrition and disease. However, there is enough evidence of a possibility of a link, it just needs to be established. There may be an imbalance of prey needs to an increased striped bass population.

An alternative hypothesis is there does not need to be a link between starvation and disease. It is unclear which came first, starvation or disease. When we look at striped bass datasets historically, there have been undernourished striped bass in the past. Is this the normal cycle for the striped bass? Perhaps they don't feed as much in the summer in Chesapeake Bay. Perhaps the temperature drops and then they start to feed again. This is a possibility. We don't know the relationship between the infectious disease and the environmental variables. We don't have the tools or the money to answer these.

There currently may not be enough menhaden for striped but that does not mean there is an imbalance. There may never have been enough.

There was disagreement over whether there were enough menhaden to meet the needs of striped bass. One participant said that experimental reports are more convincing than observation data. Some participants thought that there is clear and convincing evidence that the striped bass are not getting enough to eat.

Striped bass is not the only predator but is the most obvious. Are there other problems with other indicators? With respect to lipid levels there is concern for striped bass and this is an important first step but does not constitute cause and effect. A next step would be to see if lipids relates to pathogens.

There is a need to define what we mean by imbalance. The system is always in a dynamic state.

There is an imbalance, but it can be a very subjective term. The value judgments are made at the Board level. It is perceived as an imbalance. Several of the values we have for these resources are not optimal because of the imbalances. Anthony Overton's work suggests there is significant predatory demand and consumption.

There is evidence that there are other factors like water quality and environmental factors such as climate that may be affecting recruitment. These will need to be weighed. A possible definition of imbalance is, the quantity and quality of striped bass and the abundance of menhaden.

Importance of Menhaden to Other Species

Paul Spitzer gave an overview of the importance of menhaden to bird populations. It is the single most important prey for osprey. Menhaden banquets for loons have not happened in recent years because there are less menhaden. They are seeing plummeting numbers of menhaden in seine surveys. Large loon die-off in 1993 and an aerial survey and in the 1990s showed loon populations are low as well. The importance of menhaden to osprey, loon, and brown pelican can be assessed in quantitative terms. Birds should be used as a bioindicator.

Multispecies Efforts

The Technical Committee had a hard time defining menhaden's ecological role. Menhaden have several different roles, but the Technical Committee had difficulty honing in on what the management board wanted. The current assessment method is not capable of assuming menhaden's ecological role. In general, the only management measures within the FMP are fishing mortality (F) and fecundity. These reference points are the same as other species. They can't address the ecological role.

The Commission's Management and Science Committee (MSC) is preparing a MSVPA implementation plan. The MSVPA will be peer reviewed next year. It will be quite awhile before it is an integral part of the ASMFC management. It will likely be a stepwise process – at first single species will feed into multispecies and gradually they will look more holistically at predator/prey relationships. The multispecies model will not quantify the role of menhaden. Ecopath and Ecosim will be much more helpful.

The Management Board is aware of the status of these models. They are not looking for a response saying the models aren't ready. If you look at all of the information available, what should we be doing to address any concerns? You should use best available science. Some people think these models are the best. Others do not agree. Pieces of information paint a picture and the pieces are often enough without the quantitative rules. The Board wanted creative, multidisciplinary feedback.

We don't have a quantitative assessment of the biological role but we do have qualitative information. The bioenergetics studies may be a possibility to determine the quantitative role. We have the tools with bioenergetics but we have not applied them at this time. Bioenergetics have been used with striped bass. There was a concern that the Commission's multispecies approach does not use bioenergetics enough.

Jim Uphoff has conducted a Chesapeake Bay assessment based on a Potomac River pound net catch per effort, using a biomass dynamic model and treating it as a localized stock. There is some cohesion, it follows the juvenile index. This approach indicates that F is excessive and biomass is at a low level that approaches previous historic lows. The stumbling block is the unit stock definition. A previous menhaden assessment (Ahrenholz et al, 1987) applied a Chesapeake Bay specific yield-per-recruit analysis because of the potential for stock-specific growth rates. Much of the recruitment process of menhaden occurs on a regional scale (Quinlan et al, 1999). The inseparability of different spawning groups in the fishery necessitates the single managerial stock used in the coastal assessment.

The Atlantic Menhaden Technical Committee had an informal review of Uphoff's assessment, it was not a formal charge from the Management Board. The Technical Committee found that the principal assumptions of the model were violated, so they rejected it, but did make suggestions. A full peer review might be appropriate. However, if the ASMFC wants this model to be reviewed as a product of the Technical Committee through SARC or another type of peer review, then the Technical Committee needs to buy off on it first. It is probably not appropriate to send it to formal peer review at this point but a review that determines how it needs to be improved. It's a starting point, baseline to work from.

Ecological Role of Menhaden

Menhaden play a unique role. They are the only species that take primary productivity and turn it into harvestable biomass. They do it in one step. As you go through the food chain, you loose energy at each step. There was a differing opinion that other fish play that same role.

There are limited number of roles menhaden play, however, these roles are substantial. The hidden assumption is that this is the same everywhere and every time. We should challenge the research community to look at these assumptions. We have the tools (tagging, etc.) to answer these questions, however, it will be expensive because of oceanographic scale. It is more doable than it was in the past.

Menhaden are important for water quality. In Chesapeake Bay, cyanobacteria is increasing in the Bay. Menhaden productivity depends on water quality and how it supports primary production.

Water quality related to menhaden has been studied. It is much less likely that menhaden are being effected by water quality. Water quality is much more difficult to link to juvenile decline, but this doesn't mean that this isn't important.

Habitat quality (salinity, water quality) has not been good for the past several decades. There has been a prevailing southwesterly flow that could create a transportation effect. What is the temporal and spatial overlap? The correlation for striped bass and age 0 menhaden is fairly low. Recruitment of menhaden peaked and declined in mid-70s, this is not the same trend seen in striped bass. There is not a high correlation, but there are similarities.

The Status of Menhaden's Ecological Role

Menhaden have diminished in the Bay based on its historical role since 1950s. As a prey species, with increased consumption by striped bass, it serves a stronger role than 10 to 15 years ago. Right now menhaden are experiencing incredible predatory stress from striped bass.

How important is the role of menhaden to the overall health of the ecosystem? Are the problems we are seeing an indication of how they are fulfilling this role?

Data Needs

Local abundance of menhaden remains unknown, so we don't know how much carbon goes to menhaden. We also need to know what happens to menhaden (what they are bringing into the system and where they are going).

Quantifying the amount of menhaden in the Chesapeake Bay has been a problem. If we knew the number of fish available in the Chesapeake Bay, and the needs of the Bay, and how many pounds remove particles – then it becomes an allocation decision. The managers can say what can be removed and how many should be allocated to striped bass. The question is what do you want this stock to look like?

There are similarities between menhaden and herring. Perhaps we need new tagging studies to get at some of these localized issues. The industry would support funding this. The Technical Committee has developed research needs. The first priority is getting accurate population estimates.

Is it even feasible to clean the water using menhaden? We should examine if the population is capable of removing nutrients from the water. This does not require a multispecies model. There is a need for another workshop to look at this issue, to see if you can clean a water body using just menhaden.

Session Two: Implications of Reference Points to Menhaden's Ecological Role

Atlantic Menhaden Assessment

(Matthew Cieri, Atlantic Menhaden Technical Committee, Chair)

The 2003 Atlantic Menhaden Stock Assessment, with the recommended reference points, was approved by the Southeast Data Assessment and Review (SEDAR) Panel. The data in this assessment is through 2002. Addendum 1, passed in August of 2004, requires the stock assessment be updated every three years. The next full stock assessment is scheduled for 2006.

The methodology in this assessment has changed from a Murphy virtual population analysis (VPA) to a forward projection model. There is an age-specific natural mortality (M), fixed size, percent mature, and fecundity at age. Discards are not counted. The assessment also includes juvenile and adults indices. In the assessment a fecundity-based target and threshold are recommended. This is a better estimate of population reproductive capability. The landings and catch-at-age are derived from the reduction and bait fisheries. The weight-at-age has been increasing as the population is increasing over time.

The bait landings have become increasingly more significant. They now total 17% of the total harvest. The bait fishery generally targets ages 3-5. The reduction fishery takes ages 2 and above. Age 2 is fully selected. Targets and thresholds are set by the Addendum 1. Currently, F is slightly above the F target and fecundity is about twice the level of the target.

In this assessment, M is age variable. M for age is 4.5 and quickly drops off after age 0. Age 2 M is 0.55. Natural mortality is orders of magnitude higher for age 0 than fishing mortality.

There has been a negative trend in recruitment to age 0 over the last 20 years. Age 0 and 1 are not fully selected by the fishery. Age 1 shows a declining trend in recruitment as estimated by the model for age 0 and age 1. However, increases in SSB and fecundity suggest an increase in survivability after age 1.

The latest assessment shows that Atlantic menhaden are not overfished and overfishing is not occurring. The model does not address localized depletion in areas such as the Chesapeake Bay.

Q&A and Discussion
There is concern over why the recruitment estimates have been low. There is also a concern that the fishery has inverse catchability. One unit of fishing effort has a higher F associated with it due to the purse seine fishery itself. Some participants felt unless inverse catchability is explicitly modeled, then the model assumes it is constant. Members of the Technical Committee argue that catchability is not in the model. Jim Uphoff from Maryland DNR would like to meet with the Technical Committee to explain how catchability is in the model, and how it is possible that the trend in F is opposite of what is being seen in the model. This issue was discussed at the peer review and it was determined that this is not an issue in the formulation of the model, and it should be explored further in future iterations of the model. The CPUE index for the adults should also be explored in the future.

Recruitment is not a function of F. Species recruitment is environmentally driven. Fecundity changes more with recruitment variability than with F changes and changes in F may not impact spawning stock biomass. There is an accumulation of three year olds because there is increased survivability once the fish recruits to the fishery.

The reference points in the assessment were not developed on an ecosystem basis. The Technical Committee has discussed this as directed by the Board. It is difficult to determine ecologically-based reference points with a single species model. Menhaden has been managed with a single species approach. The MSVPA will provide a more quantitative approach in the long-term. Both MSVPA and single species assessments use a coastwide unit stock, which does not allow one to define what is occurring within Chesapeake Bay.

Some members of the Technical Committee believe that the menhaden assessment is far more reliable than any other they have worked on because of the length of the time series and accuracy of the data.

MSVPA-X: Model Internal Peer Review
(Matt Cieri, Atlantic Menhaden Technical Committee, Chair)
The multispecies virtual population analysis (MSVPA) includes menhaden, bluefish, weakfish, and striped bass. The model has passed an ASMFC internal peer review. In the Fall of 2005 it will go through a SARC peer review. The MSVPA includes a series of the single species VPAs connected by natural mortality. The approach is similar to ICES VPA, however, the MSVPA does not have a year of the gut like ICES model.

The same inputs are used for each of these species' single species models. Bluefish is used as a biomass predator because the age structured assessment is not available at this time. Once the single species assessments are peer reviewed and accepted, they will be added to the assessment. There are a lot of data gaps for other prey species (polycheate worms, blue crabs).

This model uses data on a coastwide basis. There is flexibility in the model but there are problems with subjectivity. The model is user friendly and there is a lot of user input.

The model should be used to improve single species assessments, determine the age variable M, short term projections for specific species, give guidance for rebuilding predator stocks and identify competing predators. The model should not be used to determine absolute abundances or local abundances/depletion issues.

Q&A and Discussion

This model is useful for guidance to managers. Menhaden's ecological role must be defined before reference points can be determined for menhaden's ecological role. It will be an allocation decision on how many predators and which ones the managers want. We are now moving towards using the MSVPA, and there is a need to determine priorities for the ecosystem.

Currently an Ecosim/Ecopath model is being developed in the Chesapeake Bay. We need to go forward with all the models that are available for managers to base their decisions, however, all models have their limitations. Currently, scientists are trying to evaluate if the ecopath model will give a realistic representation of the conditions in the Chesapeake Bay.

Weakfish Eat Menhaden

(Jim Uphoff, Weakfish Technical Committee Chair)

Weakfish evolved as water column feeders. Age 0 weakfish were reported to eat anchovy, mysid shrimp, and amphipods. Older weakfish eat herring, menhaden, anchovy, spot, weakfish, croaker, butterfish, sand lance, scup, silversides, killifish, and invertebrates such as shrimp, squid, crabs, clams. Weakfish compete with striped bass and bluefish for menhaden. The weakfish migration closely approximates that of Atlantic menhaden, this may not be cause and effect but it does occur. They move north spring and summer and move back during fall and winter.

The last Weakfish Stock Assessment (1981-2000) was ADAPT-based. The results were optimistic, however, the Technical Committee was uneasy with the results because fishing mortality estimates dropped dramatically after Amendments 2 and 3. Spawner biomass estimates were very high by 2000.

90% of weakfish are mature at age 1. Recruitment has improved from the period in the early 1990s when the stock was at very low levels. The FMP had age based criteria for recovery. There has been a change in ageing methodologies so the requirement has since been dropped, but age structure is improving. The fishery is declining. Recreational landings and commercial landings are declining. This is very inconsistent with stock status. Indices have been highly variable and the growth data shows weakfish are not as big as they were historically. The mean weight at age for ages 3+ has dropped in the past decade. These ages are dependent on larger forage.

The Delaware trawl survey shows that quality proportional stock density (PSD) is now very low. PSDs are a form of length-frequency analysis. Length frequencies integrate recruitment, growth and mortality. Growth and mortality could be influenced by forage supply. PSD may be the best indicator of what is happening with the stock. It is significantly correlated with commercial landings, recreational landings, distribution of recreational harvest, and the Delaware, Maryland, and Virginia citations, but not North Carolina.

Weakfish undergo a diet shift as they get older. An early shift in diet implies high growth and high densities. If there are limited resources, the weakfish will not grow as fast and there is a greater chance they will be eaten.

A correlation analysis was used to investigate the association of size distribution and major forage species relative abundance in NC, VA, MD, and DE surveys. Quality + PSD appears associated with forage relative abundance in the southern half of the mid-Atlantic region. The signal is most consistent for menhaden.

Changes that have occurred in the Chesapeake Bay include decreased prevalence of anchovies and menhaden, an absence of spot, a noticeable cannibalization of weakfish are noticeably cannibalized, and a shift to invertebrates are making up a greater part of the diet.

Bluefish Presentation

(Laura Lee, Bluefish Stock Assessment Sub-Committee Chair)

Bluefish is a schooling pelagic found in temperate and tropical marine waters. They have seasonal movements. In the spring, they move north and inshore. In fall, they move south and offshore. Bluefish reach about a 1/3 of their total growth in their third year, the maximum age is 14 years and the natural mortality is approximately 2.5. The recreational harvest has been 1 to 5 times the amount of the commercial harvest. Gillnet is the primary gear, followed by hook and line, pound net, etc.

The Northeast Fishery Science Center Trawl Survey occurs inshore in the spring and offshore in the fall survey. This survey is used to make management decisions and provide abundance estimates.

There is joint management between ASMFC and Mid-Atlantic Fisheries Management Council. A rebuilding plan was put into place in 1999. The purpose was to rebuild to levels that sustain maximum sustainable Yield (MSY). There has not been much discussion about multispecies management. The Target F is set by the reduction schedule or estimate for most recent year, whichever is less. By 2007 the harvest should be at MSY.

The current status of bluefish is unknown, but in the past three peer reviewed assessments the status was determined to be overfished. The current management actions are to maintain the commercial total allowable landings (TAL) and the recreational bag limit. The next steps in the assessment are to continue to assemble/update the database and explore alternative models. The updated assessment is scheduled for a SARC review in June 2005.

Striped Bass Presentation

(Gary Nelson, Striped Bass Technical Committee Chair)

Striped bass are anadromous fish that move into the bays to spawn. The hatching of striped bass eggs is temperature-dependent (64-66 degrees). Some striped bass leave the Bay in the third year of life, about 11-12 inches in size. Migration begins after spawning in the spring. The probability of striped bass migrating from Chesapeake Bay to the Northeast increases as fish get bigger. Females grow larger than males, most of the fish migrating to the northeast are females.

93-95% of the fish greater than 28 inches are female. Chesapeake Bay, Delaware Bay, and Hudson fish migrate up into the Gulf of Maine and winter south of New Jersey. The Chesapeake Bay contribution to the coastal fishery is important.

The stock assessment uses ADAPT VPA, catch-at-age matrix with recreational and commercial data. All stocks are combined. This assessment is for the entire coastwide stock. Natural mortality is 0.15 for all ages. The F on ages 8-11=0.62. F has steadily increased over the target since 1997. The 2003 F has doubled. F target =0.30. F threshold =0.41. There has been a steady increase in abundance through 2002 and then a decline in 2003.

The Striped Bass Technical Committee has reservations about the increase in F for the most recent year. The terminal year has the highest error associated with it, the estimate will likely decline over time (retrospective bias). The VPA cannot be for regional areas because catches cannot be separated out. However, there are survey indices for the Chesapeake Bay that are indicative of stock status.

<u>The Interactions Between Striped Bass and Menhaden</u>
Crecco, Kahn, Hoenig provided separate analyses of tagging data indicating there is an increase in natural mortality. If natural mortality is increasing then where are all the dead fish? Landings have also increased. The question is how can this be true if natural mortality is increasing?

Session Two: Discussion Period
(The following is a summary discussion statements by topic for Session Two. The statements may not reflect the views of the entire group, but the opinion of only one participant. A complete list of consensus statements is at the beginning and end of this document)

<u>Information Needed to Develop Chesapeake Bay Specific Reference Points:</u>
We need measurable goals and objectives for reference points. The current single species assessment cannot address the issue of ecologically-based reference points. Management can always be more restrictive. Targets can be restricted as much as desired but they need to be distinguishable from the threshold. Currently, the Technical Committee cannot develop distinct reference points for The Chesapeake Bay.

The goals are restricted to biological goals. The ASMFC and the states do not have to follow federal guidelines.

The current reference points are based on stock replacement. To move beyond that we need to focus on benchmarks that focus on the juveniles. We need abundance of juveniles if they are important for the ecological function of menhaden. What should the juvenile abundance be?

The Technical Committee is having a hard time making a link between fishing in the Chesapeake Bay and recruitment in the next year. The recruitment series is auto-correlated. We need to come up with a certain threshold. There is a surplus beyond the threshold that would be allocated based on the last several year's to the different ecological roles. Low recruitment may not be directly related to fishing, the Menhaden Management Board will not be able to take action to remedy the situation.

Management

Management can only control the spawning stock biomass of menhaden. It can't control other things like removal by predators. By setting a threshold, we have made a decision that some menhaden need to be left for another purpose other than fishing.

A recommendation could be, if the menhaden fishery takes a quota of juveniles this year, then you take less next year; this could be averaged over years.

The Management Board needs to provide advice to Technical Committee on goals. They should be able to frame a spectrum of possibilities and provide a range for exploration. There may need to be a subcommittee of the Management Board to determine this.

The estimates of overall consumption of menhaden by striped bass is triple what the menhaden fishery is removing. There should be concern and managers should be prepared to take action to change the population size of the top predator. There is a need for a multispecies board. We need reference points that include all the sources of mortality; this may take a long time.

If we are going to be successful with a multispecies approach there must be criteria set for sustainability. We should not be precluded from making suggestions about striped bass management if it plays an important role in menhaden juvenile abundance. Striped bass are having an impact on menhaden. There needs to be a mortality trigger to adjust harvest.

Do we have information that age 0s are controlled by striped bass predation? Some evidence shows this is so. There is concern about age 0s and 1s because when there is low population abundance there is a linear relationship between spawning stock and recruitment.

There was a question of not understanding why you would want to kill predators instead of reducing F on menhaden when the predator reaches a bigger size and has a greater value. The answer was that this conclusion has not been reached, but the Management Boards need to understand all the possibilities. If we are serious about ecosystem management, we need to look at both sides.

There has been no discussion on the filtration aspect of menhaden's ecological role, and no allocation for it. The role as a filter feeder may be important along the whole coast. The water quality is valued at half a billion dollars a year.

Technical Committee Tasks

The Technical Committee should explore the possibility of including the effects of predation and mortality on menhaden reference points (Collie and Gislison, 2001). Collie's analysis is very in-depth. He concludes that total mortality (Z) should be used for reference points for prey species. Z needs to be kept under a certain level. This is something Technical Committee should examine.

Session Three: Effects of Concentrated Harvest in the Chesapeake Bay

Historical and current removals from the Bay

(Doug Vaughan, NOAA Fisheries)

Chesapeake Bay is the center of the species range for Atlantic menhaden (*Brevoortia tyrannus*). Menhaden form large near surface schools and are obligate filter feeders. They are an important pathway from the primary producers to higher-level piscivores.

Menhaden spawn offshore and the larvae are transported into the estuaries. Juveniles reside in estuaries during their first year of life. Juveniles migrate from estuaries to the ocean in late fall. The migratory pattern from tagging demonstrates one population that moves north in spring and stratifies by age and size along the coast in summer. Larger fish of similar age move farther north. In Chesapeake Bay, ages 1-3 predominate. In the Mid-Atlantic, age 2 and 3+ fish mostly occur. In fall, menhaden begin migrating southward. Spawning begins off the New England coast and proceeds southward. In coastal waters outside Chesapeake Bay, spawning is typically in October and November.

Coastwide data for the reduction fishery have been collected since 1955. This data includes landings, biostatistical samples, and captain's daily fishing reports. In 1957, there were 25 menhaden factories and 114 vessels; now, there are 2 factories and 11 vessels.

Direct estimates of Chesapeake Bay catches are available from the Captain's Daily Fishing Reports (CDFR) from 1985. Proportion of biostatistical samples in Chesapeake Bay (based on latitude/longitude) are used to split out landings by port into catches within biostatistical-based estimates for 1985-present. We developed hindcast estimates of Chesapeake Bay removals by the reduction fleet for 1955-1984. Chesapeake Bay catches have declined since 1987 (more in numbers than in weight). Coastwide landings have been declining at a greater rate than in Chesapeake Bay. The reduction catch in weight-at-age from the Chesapeake Bay from 1985 – 2003 is mostly age 2 with some age 1 and age 3.

The average size of the fish in the 2003 reduction fishery port samples were as follows; Age 1-201mm fork and 164 grams, age 2- 230 mm and 271 grams, and age 3 – 285 mm and 483g.

The bait landings from the Bay are less than the reduction landings. The bait landings increased in late 1990s due to improved reporting and data collection. The proportion of bait catch in numbers at age are predominately age 2 fish.

Q&A and Discussion

There appears to be a density-dependent response in menhaden size at age (1+) with the strength of recruitment for that cohort. When recruitment is poor, then the menhaden from that cohort tend to be larger. This apparently has an effect on migration as well. When there are strong recruitment events you see the smaller fish go further north as they age. When recruitment is strong you would see two-year olds in landings in New England, which you wouldn't see with weaker recruitment. Considering the density dependent response, it is fair to say we are in a period of relative poor recruitment, similar to the 1960s.

The menhaden reduction catch in numbers from the Chesapeake Bay has declined since 1985, however, the decline in catch and in biomass is less steep because of the increasing weight at age of menhaden during this period. Because the Chesapeake Bay is an open system, with menhaden migrating in and out as a function of size, age, recruitment strength, time of year, and other unknown factors, the size of the menhaden population at age in the Chesapeake Bay at any specific time is unknown. However, extensive historical tagging of adult and juvenile Atlantic menhaden during the 1960s and 1970s suggest that Atlantic menhaden form a single stock along the Atlantic coast. Juvenile tagging continued into the mid-1980's during fall from Florida to Massachusetts. Menhaden in streams were injected with metal tags. These tags were recovered at the reduction plant with magnets. Tagging may be a way to get at the migratory behavior, but with only two plants now, this may not be as useful.

The status of a stock cannot be determined solely from trends in landings. If the stock size were declining more rapidly than landings, fishing mortality rates would be expected to increase. However, estimated fishing mortality rates have been declining for some years, implying that any decline in population size (ages 1+) is more than compensated by a greater decline landings. Furthermore, while population size (ages 1+) has declined in recent years, it is principally due to declines in abundance of age 1 menhaden. Spawning stock biomass (primarily ages 3 and older) and population egg production have increased in recent years as demonstrated by the recent peer-reviewed stock assessment.

Multispecies modeling approaches with potential application to menhaden in Chesapeake Bay

(Robert Latour, Virginia Institute of Marine Science):

Multispecies Production Model (MSP):

The simplest multispecies modeling approach in terms of model complexity and data requirements is the MSP. The fully developed equation incorporates a model that describes changes in biomass as a function of production and natural mortality. The model can be adjusted to account for time lags between spawning and recruitment. The data is monitored on a population scale. Total biomass must be inputted, which can come from a single species assessment. This model may be applied to menhaden in the Chesapeake Bay, however, total biomass time series data for menhaden, striped bass, weakfish, and bluefish is needed.

Multispecies Virtual Population Analysis (MSVPA):

Conceptually, the Multispecies VPA can be modified to be Bay-specific but you must parameterize it for the Bay. The catch at age data should be obtainable, but a population abundance analysis must be performed.

Ecopath with Ecosim

The Ecopath model requires the most data, but you get the most results out of it. The Ecopath is a mass-balanced snapshot of the resources and interactions in an ecosystem represented by trophically-linked biomass pools. Ecosim takes Ecopath input parameters and creates a time component. For Ecopath, both production and consumption must be parameterized. Biomass and diet are also needed.

Foraging Arena Theory: prey exhibit switching behavior between being vulnerable and not to being prey. In order to obtain resources, they become more vulnerable. The more small fish in a refuge, the more vulnerable they would be. This is in the modeling approach and it is quite sensitive but it is difficult to estimate.

Another strategy is to build a model for an earlier time period and then project to present day and compare to observed survey data and see how it matches up. Then use the time series data to calibrate and validate. However, some of the key parameters weren't measured and are probably different than today.

These three approaches all yield potential information about the ecological role of menhaden in Chesapeake Bay. However, we need to overcome some data deficiencies, particularly the lack of stock assessment information on a Bay-specific spatial scale.

Q&A and Discussion
Ecopath has the potential for top down effects and bottom up effects. This stands to give us the most information. We are trying to improve the input parameters. The timeline is one year until the modelers start presenting to policy makers, but several more years until it is really ready. To ask specific Chesapeake Bay questions it may be longer.

More funding would allow you to bring in a wider range of academic researchers. The bulk of the work is on the input parameters. There are other models that will link in and money could help accelerate those projects.

There has been some work transforming the language of reference points from single species management into multispecies. Ideally, there would be reference points. We either have to take the plunge and do multispecies or not. It may be too difficult to have both single and multispecies. There is nothing that will improve multispecies management more than improving single species management. The only reason there weren't ecological reference points in the last assessment is because the Technical Committee was given very little guidance on what was wanted from them. The Management Board needs to tell the scientists what the goals are so they can develop reference points.

Once the MSVPA is completed, it would be helpful for the Management Board to provide a series of options; vague goals and objectives don't help the Technical Committee. This must be a cooperative effort with an organized approach.

The Ecopath model is almost at the point to break the model apart into smaller components to answer different questions. That may be the stage to work with the various Technical Committees.

Climate forcing of menhaden recruitment declines in Chesapeake Bay
(Robert Wood, NOAA Cooperative Oxford Laboratory):
To identify multispecies recruitment patterns in Chesapeake Bay, five fishery independent data sets were used. The longest, Maryland DNR's striped bass seine survey was treated as the primary data set because it possessed the longest period of record. Four other data sets

throughout Virginia and Maryland were also analyzed for purposes of corroborating the DNR seine survey analysis results.

Principle components analysis (PCA) was used to analyze the multispecies recruitment patterns in the fourteen species best monitored by the DNR survey. For the corroborating analyses, only those species of the DNR survey were included and then only if they were well monitored by each survey's gear and sampling sites. PCA was chosen because it readily identifies and extracts patterns, in order of signal strength, among multiple variables (in this case, fish species) over a number of observations (in this case annual recruitment indices).

PCA revealed that a common dominant (e.g. 38% of the variance among the 14 DNR species) multispecies pattern existed in each of the analyzed fishery survey data sets. This signal revealed that a negative relationship existed between annual recruitment of anadromous and semi-anadromous species (best represented by striped bass and white perch, respectively) and coastal spawning, estuarine dependant fishes utilizing the Bay as a springtime nursery area (e.g. menhaden, spot, summer flounder). This pattern emerged from PCA's of the raw data and became stronger when autocorrelation (which can inflate signal strength) was filtered from the individual time series. Not only were the species patterns common among the data sets, but the interannual variability of this multispecies signal was also highly correlated among all data sets. These properties of the pattern, coupled with the fact that the surveys were collected in different regions and habitats, and conducted by different organizations using different gears, indicates that this signal is real (i.e. not an artifact of any collection method or survey bias), strong, persistent through time, and is caused by a forcing mechanism that acts upon a region at least as large as Chesapeake Bay.

Of those forcing agents known to operate on multiple species across large scales, climate forcing emerged as a leading candidate in this case. Fishing pressure on adult stocks was ruled out because the fishing histories of the species involved do not match the observed recruitment pattern. More specifically, climate is a strong candidate because it is capable of influencing many processes (e.g. growth, predation, egg and larval transport) that can strongly influence mortality rates of fishes during their early life history stages, and while anadromous and coastal spawning species have contrasting life history strategies, they are linked by common nursery areas within the Bay.

Temporal synoptic classification was used to identify the dominant weather conditions that typically occur during the late winter and early spring (March-May), as larval-post larval stage menhaden and spot species are finding their way to their nursery grounds near the fresh-saltwater interface in the Bay and its tributaries. This also includes the spawning and early developmental stages of the anadromous species, which occurs in the same locations.

Using this classification scheme and a model building tool called Classification and Regression Tree (CART) modeling, it was found the frequency of two large scale weather patterns during the month of March could effectively "predict" the time series of the Chesapeake Bay Anadromous – Shelf Spawner (CBASS) recruitment pattern. These patterns are the Azores-Bermuda High (ABH) and the Ohio Valley High (OVH). These patterns bring warmer and dryer or cold wet conditions to the Chesapeake Bay watershed respectively, and, when dominant in March, solicit an early or late spring respectively.

While the exact process(es) cannot be determined from this type of investigation, subsequent analyses of environmental conditions revealed that, during years when the ABH dominated, upstream transport of coastally-spawned planktonic larvae would be facilitated (by southwestly winds and low river flow), and these species' nursery areas become more favorable and extensive (as measured by prey abundance, salinity and temperature). Conversely, when the OVH was dominant in March, opposite conditions occurred favoring anadromous nursery area habitat quality and quantity.

The same model building methods were used to develop a model specific to Atlantic menhaden, however, because the focus was now on a single species for which spawning stock estimates were available, any effect spawning stock biomass had on recruitment was removed by building a model "predicting" the residuals form an Atlantic menhaden Ricker spawning stock – recruitment analysis. It was found that the frequency of the ABH in March was again a major play and was chosen using both CART and stepwise regression to build a model that could account for more than 50% of the variation in menhaden recruitment over the last four decades. In other words, if you know the Spawning Stock Biomass of menhaden for a given year and the climate conditions for March, you can accurately predict recruitment in that year. Importantly, this model describes both the general trend in recruitment and the trend-removed interannual variability. Currently, work is underway to test the model on the last seven years of data that were not used in the analysis.

Conclusions:
1) Spring weather conditions appear to explain about 50% of Chesapeake Bay menhaden recruitment variability.
2) Declines in menhaden recruitment have been accompanied by declines in bay anchovy abundance
3) The predictive power of this climate-recruitment relationship should be evaluated and, if validated, could be used to inform adaptive management actions.

Q&A and Discussion
The recruitment index scores are from the PCA work. It then gives one variable that feeds into other parts. It is either a positive or negative score. If this gets validated, then this may be something we need to watch. As a preliminary Ecopath exercise, Dr. Wood should see if he can force a climate time series into it, however, the system needs to be right before this can be done. This can be seen as an advantage and a drawback of Ecopath. Once the model is run, we can take the residuals out to see if they match the climate data.

The trophic consequences of different climate patters are emphasized but it may well be that there is a similar physical forcing going on. It may be climate leading to patterns that lead to more menhaden being pushed into the Bay and this may lead to recruitment variability. This is why wind vectors are important.

The presentation noted that in dry years menhaden recruit better. There may be similarities in the amount of lesions that are found in menhaden and the years of wet climate.

Session Three: Discussion Period
(The following is a summary discussion statements by topic for Session Three. The statements may not reflect the views of the entire group, but the opinion of only one participant. A complete list of consensus statements is at the beginning and end of this document)

Localized Depletion
The Technical Committee has discussed the possibilities of localized depletion of menhaden in the Chesapeake Bay. They saw a reduction in juveniles (ages one and two). The reduction of 0s and 1s from the Bay may not be a concern because the fishery does not target them. They debated whether age 2 are good for forage. The current assessment is not capable of looking at this issue.

In New Jersey and Long Island Sound, the concern for localized depletion is driving the desire for area closures. There needs to be spatial boundaries and a component of the predator/prey relationship because the concern for localized depletion is the driving force behind many actions. The depletion argument should relate to fishing level. Depletion should be defined in the Bay and on a local scale. We need to look at total mortality instead of just fishing mortality when talking about localized depletion.

Localized depletion of menhaden effects two things 1) availability of prey, and 2) filtering capacity. The stock assessment does not indicate a lot of age 0's and 1's in the Chesapeake Bay. The reduction fishery doesn't target the 0s and 1s. The local depletion seems to be more wrapped up in recruitment. However, the assessment is coastwide. The reduction fishery focuses on age 2's and therefore impacts the spawning stock.

We don't know the absolute abundance in the Bay and we don't know the proportion that should be assigned to the Bay. If the proportion was high, then the depletion would have a larger impact but if it were low then it would be a lower impact. A risk of localized depletion is the destruction of the food web locally. Large-scale gear in a shallow closed system leads to schools being broken up.

A fishery will deplete the stock available to it by fishing. We've got depletion when a stock is down to a certain level. There needs to have a measure of what qualifies as depletion. We also need to look at the adults because they can be depleting filtering capacity.

Is there competition between the fishery and the predators? Striped bass consume an order of magnitude more than the fishery takes. Other studies indicate that striped bass are taking more of the older larger menhaden, there are all coastwide estimates. Predation should be included in depletion discussions. Just because the fishery does not take age 0s and 1s, does not mean it does not impact them.

Current Restrictions on the Fishery

If you cut the Bay in half at to the Potomac, the upper half is in Maryland and the lower half is Virginia. There is no fishing in the upper half with purse seines. The commercial purse seine fishing is the lower half. There is a large percentage of the coast that constitutes a sanctuary from these fishing activities.

Catch Per Unit Effort

There is a problem with using purse seine CPUE as an index of abundance. The industry can keep CPUE up while abundance is declining. CPUE does not decline with abundance with a purse seine fishery. It may decline somewhat but it won't show the overall decline. If CPUE is declining then there is definitely a problem. If it is not declining, then you may or may not have abundance declines. Young-of-the-Year is generally not a good indicator of localized depletion.

Stakeholder Presentations

Following Session Three, there were a series of stakeholder statements. These statements are attached in their entirety in Appendix A.

Public Comment

Charlie Hutchinson: Cambridge MD

He works with MSSA on menhaden fishery. Most of the information is about fish eating fish. Only one speaker talked about filtration. Filtration is getting a lot of down play. The ecological role of menhaden is forage, filtration, and input for commercial products. These various roles need to be identified and prioritized. They are not all given equal weight. It is a difficult task to determine priority. The economic value might be one way to establish priority. If priorities were established then science can focus on the higher priorities. He is sympathetic to Technical Committee's need for better direction on how to evaluate the importance of menhaden.

Durbin and Durbin paper focuses on Narragansett Bay and menhaden's role in filtration. Capacity is out there to help with filtration and water quality, which will help with the rest of the fish in the area. Sara Gotleib's paper shows the value of menhaden in different roles. It dealt with the value of menhaden as filter feeder and the value as input to commercial fishery.

Ken Hinman: National Coalition for Marine Conservation

He thanked the workshop for letting him submit written comments to distribute before the meeting. He responded to a remark made by a panelist that stakeholder claims that the reduction harvest has increased in Chesapeake Bay are not true. Mr. Hinman wanted to explain why it is true. The Bay harvest of menhaden in the 1950s and 60s, the last time striped bass were in abundance as they are now, averaged about 50,000 tons a year. That catch increased dramatically in the 1970s. During the period 1982-95 when predation demand increased by 8 times partly due to the recovery of striped bass the Bay menhaden catch averaged around 150,000 tons a year. That catch has declined since the mid-1990s, but so has the stock. At the same time in the late 90s, problems began appearing in bay stripers – skinny fish, disease, increasing natural mortality. The damage may have been done during that period of peak catches in the Bay and we're seeing the consequences while the harvest from the Bay since then has remained about 100,000 tons a year, or twice the level of the 50s and 60s.

Bob Pride:
Virginia – Participant and observer for several years. When he became involved he was a critic to the process, now as a Mid-Atlantic Council member he is more sensitive to the lack of data issue. We have an abundance of data on coastwide basis but we have a Chesapeake Bay problem. He encourages everyone to think about what information we need to gather. He raised several examples of conflicting information. The menhaden industry is declining and there are economic factors at play. There are probably several factors in play and would encourage the panel to outline those various factors.

Jim Price: Chesapeake Bay Ecological Foundation:
He has a letter from Dr. Overton, who has read his report and found his claims to be accurate. Mr. Price is providing a different perspective on what's happening with the fishery. Assume we don't know what the value for spawning stock biomass. The new Forward Projection Model, is a big improvement with the variable M. He calculated the percentage of age3 removed and found it was incorrect in the Technical Committee's assessment. He divided the landings into the population estimates. In 1965, the population was less than the removals by the reduction fishery. This doesn't discount the whole assessment but does create concern. If spawning stock biomass was not as high as everyone thinks it is, what are the implications?

In 1992, purse seine fishery landings, combined with forage demand of age 8+ striped bass, totaled 87% of the estimated population of age 3+ menhaden. The following year menhaden recruitment in the Chesapeake Bay was the lowest in 23 years. A major concern is that consecutive years of poor recruitment years have occurred since 1993, coupled with increasing mortality of age 3+ menhaden. The 3-fold increase in the percentage of age 3+ menhaden in the landings and increased striped bass predation may have reduced the SSB to an unhealthy level, which can cause recruitment overfishing. When the menhaden stock assessment has been thoroughly examined, without assuming the model is estimating the correct SSB, it becomes evident the SSB has declined below the level needed to sustain the population.

Margaret Berans Ransone: VA Bait Association:
The VA bait Association consists of 6 bait supply companies and 4 vessels and 2 spotter airplanes with 500 employees. They supply industries from Maine to Florida and Louisiana and Texas. Their Territory is only 30% of the Bay, 70% of the Bay is a sanctuary. The season opens May 1 but most years they don't begin to bring in fish until the end of May. Weather permitting they fish 5 days a week and sometimes it is less than that.

The industry is strong. Bait farms pay local fishermen millions of dollars for the menhaden. Watermen would never be able to supply the fishermen alone. Nothing means more to them than the Chesapeake Bay and they would never do anything to deplete a population. They work closely with Maryland, Virginia and The Beaufort Lab. Lots of people are pointing fingers to determine who is to blame. We want to help and do what can be done to help. These are hard working people and work closely with scientists. A quick decision could put a lot of families out of business.

Session Four: Recommendations for Revised or New Direction in Fisheries Management.

Current Menhaden Management and ASMFC Process
(Robert Beal, ASMFC)
Amendment 1 to the Atlantic Menhaden Fishery Management Plan passed in July 2001. This Amendment established goals and objectives that are in place now and established adaptive management process allowing changes to be made if necessary.

The goal of Amendment 1 is "to manage the Atlantic menhaden fishery in a manner that is biologically, economically, socially sound, while protecting the resource and those who benefit from it". The biological objectives are:

- Protect the menhaden stock to maintain viable fisheries and forage base
- Maintain reduction fishery data collection program
- Develop/Improve the stock assessment approach
- Optimize the use of the resource

The social/economic objectives are:

- Maintain existing social and cultural features of the fishery
- Develop a public information program for Atlantic menhaden

The ecological objectives are:

- Protect fishery habitat and water quality in nursery grounds
- Improve the understanding of food web ecology and multispecies interactions
- Protect and maintain the ecological role

The management objectives are:

- Insure adequate accessibility to fishing grounds
- Develop options to control effort and regulate mortality by time or area
- Base regulatory measure upon best available science

Addendum 1, passed in August 2004, updated the biological reference points, adjusted stock assessment frequency and updated the habitat section. In Addendum I, stock assessments occur every three years unless triggered to occur sooner. The triggers are CPUE and ratio of ages 2-4 in the catch. In the interim years, the Technical Committee will review the data to evaluate the current status of the stock without running the assessment.

There are no recreational or commercial management measures in the Amendment 1 or Addendum I. States have individual regulations that are not mandated through ASMFC. Adaptive management can be used to develop an addendum. The tools available are spawning area restrictions, specification of MSY or OY, catch control options, effort control options, gear restrictions, seasonal or area closures.

The Multispecies VPA has been developed and internally reviewed. The recommendations from the review are being incorporated into the model for the SARC peer review in December 2005. Multispecies spatial analysis is currently being developed with completion scheduled for 2005.

ASMFC is developing a guidance document on how to incorporate multispecies into our current single species management process. Recommendations are to use multispecies information as additional information for single species assessment. For instance, start incorporating variable Ms in the single species assessments. The long-term approach is to modify the Technical

Committees and Boards to address multispecies issues and eventually develop multispecies FMPs.

Q&A and Discussion

The MSC has been overseeing the multi-species efforts on behalf of the Commission. The Policy Board has not developed a position on multi-species management or assessments. The Commission has not set its course to multi-species management. The Commission could set up a workshop to review all the available multi-species models.

The modelers of the Ecosim/Ecopath model are excited about this model as a tool for managers. They are moving towards using it in the Chesapeake Bay management plans in about a year. It may work for some FMPs, but it may not be secure enough for others. At the very least, there needs to be an information exchange. A recommendation from the Management Board allows NOAA to prioritize that recommendation and dedicate resources to that effort to explore its potential use.

If the Commission and the Menhaden Management Board, are presented with a documented study that the primary reason for the decline of the menhaden recruitment is the result of the predator effect of striped bass, will the Management Board consider actions to reduce the pressure on menhaden? The Board can't modify another Board's management plan. A recommendation would need to be sent to the Policy Board and then passed onto the Striped Bass Management Board.

It is important for managers to acknowledge the impact of the predators on the prey species. This alone would be tremendous progress. Human values do come into the ecosystem approach. If we choose to manage one species in preference for another species, it does not mean it is not ecosystem management. Ecosystem management can be done incrementally. Initially, adjustments to single species management will be made in response to risk adverse information from multi-species models.

Lake Michigan 2003: Status and Trends of Prey Fish Populations
(Charles Madenjian, USGS Great Lakes Science Center)

The sea lamprey (*Petromyzon marinus*) and alewife (*Alosa pseudoharengus*) invasions during the 1930s and 1940s devastated the Lake Michigan food web. Overfishing and sea lamprey predation led to extirpation of lake trout (*Salvelinus namaycush*), one of the lake's native top predators, during the 1950s. Sea lamprey predation also contributed to drastic declines in abundances of burbot (*Lota lota*), the lake's other native top predator, and lake whitefish (*Coregonus clupeaformis*), a fish of high commercial value. Alewife has been suspected of interfering with natural reproduction of emerald shiner (*Notropis atherinoides*), deepwater sculpin *(Myoxocephalus thompsoni*), yellow perch (*Perca flavescens*), burbot, and lake trout.

As alewife abundance in Lake Michigan rose dramatically during the 1960s, abundances of emerald shiner, deepwater sculpin, yellow perch, and burbot declined. Sea lamprey control, involving chemical treatment of tributaries to kill sea lamprey ammocoetes, began in the 1950s and has continued to the present. A major stocking program for salmonines, including chinook salmon (*Oncorhynchus tshawytscha*) and lake trout, began in 1965 and has continued to the present.

Control of sea lamprey and alewife populations has had profound effects on the lake's food web. Buildup of salmonine biomass during the 1970s and early 1980s led to a substantial reduction in alewife abundance, as these predators have fed primarily on alewives since the stocking program began in 1965. Effective sea lamprey control contributed to the recovery of the lake whitefish population during the 1970s and the burbot populations during the 1980s. Control of alewives by salmonines led to the recovery of the deepwater sculpin, yellow perch, and burbot populations during the 1970s and 1980s.

Bioenergetics modeling has played a role in managing the chinook salmon fishery in Lake Michigan. Bioenergetics models for salmonines have been coupled to population models to estimate the annual consumption of alewives by salmonines. During the 1980s, the decreasing trend in alewife abundance (based on a lakewide bottom trawl survey) combined with relatively high estimates of annual alewife consumption by salmonines prompted fishery managers to reduce the chinook salmon stocking rate. A commercial fishery for alewives in Lake Michigan operated in Wisconsin waters of the lake during the 1960s, 1970s, and 1980s. Annual commercial harvest of alewives declined during the late 1970s and 1980s. Concerns by recreational anglers likely influenced the State of Wisconsin to close the commercial fishery for alewives in 1991; this commercial fishery has remained closed since that time.

Regression analysis have been applied to the long-term series of abundance data generated from the lakewide bottom trawl survey to identify the important factors operating on alewife recruitment in Lake Michigan Results from this analysis has indicated that predation by salmonines and spring-summer water temperatures during the alewife's first year in the lake were the most important environmental variables influencing age-3 alewife recruitment in Lake Michigan. This analysis supported the contention that the decline in alewife abundance during the 1970s and early 1980s was driven by salmonine predation. Further, this analysis showed that alewife recruitment tended to increase with increasing spring and summer water temperatures during the alewife's first year in the lake. The unusually strong 1998 year-class of alewives was likely due, at least in part, to unusually warm spring and summer water temperatures during 1998. The decrease in phosphorus loadings to Lake Michigan has not appeared to have yet had a detectable effect on alewife recruitment in the lake. Also, severity of the alewife's first winter in the lake did not appear to have a substantial effect on alewife recruitment. Bloater (*Coregonus hoyi*) has traditionally been considered an important member of the prey fish community of Lake Michigan, although bloater has represented only a minor portion of salmonine diet since the 1960s. Bloater abundance in the lake appears to exhibit a quasi-regular natural cycle with a period of about 30 years.

Q&A and Discussion

There is good diet information for salmonines. There was only some switching of prey species to bloater during high bloater abundance. The salmon seemed to focus on alewife with only a little bit of bloater. Alewife are responsible for 70-80% of the salmon diet.

Alewives are vulnerable to predation throughout their lives. The alewife behavior is to move to deeper water in older ages, so some may escape that way. A control program was launched to select for lamprey larvae and has reduced the population by 80 to 90%.

Historically, there was a bottom trawl fishery for alewife in the Great Lakes. They were in operation in the 1960s and early 70s harvesting about 20-25,000 mt. The harvest declined in late 70s and 80s. The commercial harvest was only about 5,000 mt. The bottom trawl fishery then only operated out of Wisconsin. In 1991, Wisconsin eliminated the alewife fishery.

The recruitment analysis is worthwhile information to see the most likely candidate for causing a species shift. This should be attempted for Chesapeake Bay. The consumption of alewife far exceeds the fisheries harvest.

The recreational fishery for chinook salmon was more valuable than the alewife fishery and alewives as prey were more valuable to the chinook. There are commercial fisheries operated by the tribes for white fish. In lakes that border Canada there are commercial fisheries for walleye and perch. There are still commercial fisheries operating in the Great Lakes, just not for alewives.

Summary of Presentations and Possible Ecosystem Based Approaches in Fisheries Management

(Ed Houde, University of Maryland, Chesapeake Biological Lab)

Striped bass may be a significant cause of predation mortality on menhaden. The Maryland Seine Index (recruitment index) shows in the mid to late 1970s recruitment peaked, but is very low today. This is what happens around the world with many other species. The fluctuation in stocks is normal.

We are close to the target because there is no concern on a coastwide basis. Localized depletion is an issue in Chesapeake Bay. We need local reference points. How do we evaluate menhaden's role as a prey species in Chesapeake Bay. What models are available? There are foraging models, spatial models, and behavioral models. Can precautionary set-asides or regulations be instituted as an ecosystem-based measure in the absence of firm estimates of the consequences of 'localized depletion'?

The fishing mortality seems to be very low. But we should be able to respond in management to changes in recruitment. The objectives of Amendment 1 acknowledge the important ecological role of menhaden. The Technical Committee and the Management Board are going back and forth with one another.

There are many different ecosystem approaches for reference points. Some include; spawning stock biomass (fecundity), YOY indices for Chesapeake Bay compared to coastwide, age 1-2 biomass, age 1-3 K Biomass, F in Chesapeake Bay relative to F coastwide, spatially explicit measures for biomass distribution and age distribution, menhaden age 1-2 biomass compared to striped bass biomass, and menhaden age 1-2 biomass compared to Piscivore biomass.

The best thing to do now is to develop cautious single species reference points. We've learned the most through the collapses. Beverton (1990) looked at several collapses. Most clupeid species can recover from a collapse.

Patterson (1992) determined exploitation ratios for shoaling pelagic species and found an F/Z less than 0.5 results in a collapse. For menhaden it is currently larger than 0.5. So what is protecting menhaden? Most of the geographic areas where menhaden could be fished are closed to the commercial fishery. This is protecting the mature portion of the stock. It is a de-facto marine protected area. If there is going to be a change, we need to look a spatial implications.

Collie and Gislason (2001) said a threshold Z is a more appropriate reference point. We need to know how M varies from year to year and the natural mortality rates to do this.

The Chesapeake Bay Program has made a commitment to implement some multi-species management plans by 2007. The Fisheries Ecosystem Plan was developed for Chesapeake Bay.

The Bay historically may have supported landings (removals) exceeding 300,000 tons. Was that level sustainable? Total removals must be estimates. These include commercial and recreational landings, and bycatches. What is the carrying capacity and level of landings that can be taken now? How should landings be allocated among trophic levels? Fishing effort, habitats and water quality must be considered.

Current management process manages the prey species separately from all the rest. Eventually we will need to move to a more integrated management process, a multi-species food web. How do you optimize everything? Difficult decisions lay ahead.

Environmental conditions and weather conditions are influential to the Young-Of-the-Year of menhaden. We don't have a good sense on how to response to the issue of disease at this point.

Q&A and Discussion

There is a National Academy Sciences study recommendation for a precautionary single species management. The reference points for menhaden are not conservative as those for other species such as weakfish. They are not as precautionary. However, with species with a short life span like menhaden, we try and take advantage of the quick turn around time and have a higher F target.

If we reduce the amount of striped bass predation on menhaden, the hypothesis is that predation would be replaced by other predators. We don't usually have the ability to adjust M. We could try to adjust F on the predators in effort to effect the M on the menhaden, but there is no certainty that we can have that effect.

Session Four: Discussion Period

(The following is a summary discussion statements by topic for Session Four. The statements may not reflect the views of the entire group, but the opinion of only one participant. A complete list of consensus statements is at the beginning and end of this document)

Management of other Forage Fisheries
Other forage fisheries are managed in a variety of ways. Atlantic herring has a precautionary approach: establish an MSY value and take 20% of the top and that is the OY value. The 20% is to account for forage and uncertainty. The sardine fishery in Florida was managed by closing the corridor off of Tampa Bay to protect the juveniles. There is the possibility of closures during specific time and area management to avoid depletion in the fall so that predators would have enough prey. If we remove fishing during the right time and in the right space then there might be benefits for filtering as well.

Possible Management Tools
If coastal areas were opened it would take some pressure off of the Bay and Virginia. We should suggest time and space openings as well as closings.

In principle, there is certainly the idea that time and space openings and closures are a management tool. It's a potential solution to the problem. The current management plan and the biological reference points are for a coastwide menhaden population. This is based on the assumption that the fleet is evenly spatially distributed. Reference points are estimated for the entire population while the harvest occurs in a very specific area. We must look into the possibility of deriving reference points for the Chesapeake Bay. There were several presentations that stated predation mortality has a significant effect on the dynamics of Atlantic menhaden. We need to quantify the predation mortality, which could come from the MSVPA and to improve the estimates of abundance of menhaden in the coastal waters. Based on those estimates, we can develop better reference points and ecologically based reference points.

There is a situation that has developed where there is a perception that striped bass prey on only age 0-2 in. This may be the case in the Chesapeake Bay, but there may be a direct link or correlation between predation on age 3s and the spawner-recruit relationship. Age 8+ striped bass prey on age 3 menhaden. This comes from Anthony Overton's study reviewing diet research along the coast.

We've talked about localized depletion and immediate effects, but haven't gotten back to the issue of some effect on the menhaden stock as a whole. There have been a number of pieces of information showing that the spawning stock might not be as large as we thought. 31% of age 8+ striped bass diet is comprised of menhaden. There is overlap and competition with the industry. There has been the recommendation of delaying the opening of the season. There may be a robust number of age 3+ menhaden at this time. We should also take into account Patterson's paper and should include some measure of conservatism as a whole for menhaden. The Board wants some direction for interim measures until further work can be done. Industry has no intention of increasing their take. A recommendation to cap the harvest at the average for the last 5 years may be prudent. There are no limits right now. The fishery has the ability to substantially increase its catch. We have the opportunity to be more conservative. In the month of May industry took 5 times more than in last year's month of May.

Age 3+ abundance shows no decline. We don't have any biological information to help make these recommendations, but we have the ability to go with the conservative approach. Just because there are not numbers to back it up doesn't mean the Management Board can't make these decisions, which are allocation decisions.

The industry representative disagreed with the above statements. The Technical Committee has generated science for years now. Based on the FMP reference points, is there a shortage of age 3+ menhaden. The Technical Committee tells us there is not a problem. We need to rely on the best scientific information available. This would result in a legal challenge by the commercial industry. There is no legal standard for applying the precautionary approach.

In the light of the low recruitment and the shortage of forage for striped bass, the rational and responsible thing for management to do is to establish a more conservative set of targets or reference points than exist today. The way to move towards multispecies management is to do single species management well.

This is a Chesapeake Bay issue. We are not sure if this is a localized problem or a recruitment problem. Perhaps there never were enough numbers coming into the Bay. Given 10 – 12 years of low recruitment, it has got to impact the coastal stock at some point unless there is a really large recruitment up north. It would be helpful to see information on the big recruitments in New England. Even if there is equal compensation in other areas it will not solve the problem in the Chesapeake Bay.

Perhaps we need seasonal closures to allow some of the bigger menhaden to provide the filtering role and to provide buffer for some of the younger fish. This allows escapement for some of the larger fish. F has remained constant for a long period of time but now is concentrated into a smaller area. This could lead to an increase of 1 to 5 times in some areas. We should come up with a way to base management on a localized scale to allow this escapement.

Tasks for Staff and Technical Committee

Staff and the Technical Committee should look at plans for Washington, Alaska and California on how they manage their forage fisheries.

Multispecies Technical Committee

If this group thinks the Menhaden Technical Committee is not the appropriate group to address the issues facing the workshop, the Commission can create a Multispecies Technical Committee. There are some reservations about this. The MSVPA has only one prey species. The MSVPA tells us that the M has changed throughout the years and the M can be placed in the single species model. There is no feedback for the striped bass, weakfish or bluefish assessment models. It seems that MSVPA was built for menhaden.

CONSENSUS STATEMENTS

The following is a list of consensus statements from the state, federal and university scientists who participated in the Atlantic Menhaden Workshop.

Session 1: Status of menhaden's ecological role

- Atlantic menhaden play a unique role transforming primary productivity directly into fish biomass.
- Menhaden productivity depends on and impacts water quality in the ways it supports primary production.
- Menhaden are important prey for large predators. Historically at least in Chesapeake Bay and North Carolina they were the dominant prey species. This dominance has diminished. We can quantify the role as a filter feeder, we can quantify them as prey coastwide, however, abundance in Chesapeake Bay is needed to quantify this role regionally.
- We have the tools (striped bass and menhaden bio-energetic models,), but have not conducted a holistic quantitative analysis of the ecological role of menhaden.
- The abundance of Atlantic menhaden in Chesapeake Bay remains unknown.
- Menhaden may be the last major abundant inshore clupeid.
- There is a possibility of a link between striped bass disease and abundance of menhaden; however more research is needed.
- There may be a relative imbalance between the prey needs of an increased striped bass population and a decreased abundance of menhaden juveniles (age zeros and ones) in Chesapeake Bay.
- While there was not consensus by the committee as to the causes of low recruitment to age zero in Chesapeake Bay, the following are possible causes:
    - A) Insufficient spawning stock biomass
    - B) Eggs and larvae not being brought into Chesapeake Bay (transport)
    - C) Poor survival to at least several months old (unfavorable conditions of salinity, or temperature, mismatch of food, disease, and predation)
    - D) There is emerging evidence that climate forcing may play an important role
- There is an ongoing concern of the decade-long decline in recruitment in Chesapeake Bay.

- Menhaden have diminished compared to its historical abundance in the Chesapeake Bay.

- As a prey species menhaden serve a much stronger role then 10 to 15 years ago.

- Menhaden continue to serve an important ecological role although its relative contribution in terms of forage and filtering has diminished because of reduced abundance.

<u>Session 2: Reference points implications for menhaden's ecological role</u>

- The current reference points are related to the coastwide stock. They use fishing mortality and reproductive capacity. They are based on a single species model. These are biological reference points, they do not take into account socio-economic factors. The reference points are designed for stock replacement.

- There is a need for an additional reference point (threshold) for juvenile abundance (age zeros and ones), which may require management action within a separate fishery within its ecosystem if exceeded.

- The Management Board should task the Technical Committee with exploring the possibility of including the effects of predation mortality on menhaden reference points (Collie and Gislason, 2001, Patterson 1992, Washington State Forage Management Plans, for example). Explore the possibility of including the MSVPA results.

- The Management Board has to provide advice to the Technical Committee on its goals and priorities, and identify a spectrum of possibilities to develop ecologically based reference points.

<u>Session 3: Effects of concentrated harvest in the Chesapeake Bay</u>

- Localized depletion occurs when migratory immigration of menhaden is insufficient to replace removals.

- Localized depletion of Atlantic menhaden effects two factors:

1) Availability for predation
2) Filtering capacity

- To determine if localized depletion is occurring, there must be a reference point.

- The localized depletion in the Bay can be characterized both as a forage shortage of recruits and as a shortage of filtering capacity of all ages in the stock.

- The reduction fishery does not directly focus on zeros and ones, but the harvest of the ages 2+ could result in feedback through regional spawning and recruitment processes that impact the Chesapeake Bay.

- Absolute abundance in the Bay and the proportion of age zeros and ones in the Bay is unknown.

- The data that is available to define localized depletion is Catch Per Unit Effort (CPUE), Rhode Island trap survey, Delaware trawl survey and the pound net survey.

- If abundance declines, purse seine CPUE will not decline at the same rate. A decline in CPUE can be used as a conservative (under estimate) indicator of abundance.

- We are limited in our ability to accurately estimate the probability that localized depletion is occurring. We won't know the probability until we conduct the research that the Technical Committee has outlined.

- The following are risks associated with localized depletion:
  1) Reduced forage for predators
  2) Reduced filtering capacity
  3) Disruption of the food web
  4) Within species genetic diversity

Session 4: Recommendations for a revised or new direction in fisheries management

- Examples of how other forage fisheries are managed:

1) The Atlantic Herring Fishery uses a precautionary approach: OY is 20% less than MSY. The target is the threshold, which is OY.
2) Off of Tampa Bay, managers closed a three mile corridor for the sardine/anchovy fishery
3) Some forage fisheries are managed by shutting down the harvest and leaving them for other purposes.

- Given the information presented during this workshop, The Committee offers the following scientific advice to the Board on a revised or new direction in fisheries management.

1) Time and space closures/openings have potential as a management tool.

2) Develop reference points specific to Chesapeake Bay

3) Need to quantify predation mortality and produce estimates of abundance of menhaden to develop ecologically based reference points

4) Technical Committee/staff should examine the forage fishery management plans of Alaska, Washington, and California and determine if they can be applied to the menhaden fishery.

5) The Management Board should task the Technical Committee with exploring the possibility of including the effects of predation mortality on menhaden reference points (Collie and Gislason, 2001, Patterson 1992, Washington State Forage Management Plans, for example). Explore the possibility of including the MSVPA results.

6) A Multispecies Technical Committee should be formed.

7) Confront the need and potential mechanisms for management that cross single species management boundaries.

8) Establish values and goals for population utilization that acknowledge ecosystem service and fisheries support provided by the menhaden population.

9) Have joint meetings between the Management Board and Technical Committee to accomplish above task.

10) The Technical Committee should evaluate additional reference points to address menhaden's ecological role

11) Explore the concept of an escapement based approach, for example, closed seasons, area closures.

12) Investigate the issue of low recruitment in the Chesapeake Bay and what is causing it. One hypothesis is striped bass predation is reducing YOY abundance prior to YOY surveys. Stomach content field studies and bioenergetic studies can be used to evaluate this hypothesis. Spatial temporal overlap must be taken into account.

13) The Management Board should charge the Technical Committee to meet with the ecopath/ecosim modelers to exchange information as soon as possible.

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Appendix A: Verbal Statements from Stakeholder Groups at Workshop

Statement from the Recreational Fishermen

Someone once described fishery management as just like forestry management, except you can't see the trees and they move.

There are millions of recreational anglers on the Atlantic coast, but only a few participate in fishery management. It's not that they don't care. It just that they are smarter than me because they are out there fishing and I am in here with you.

We don't fish for menhaden, but we care about them. CCA MD conducted a member survey and the highest response, 99.7%, was to "How should CCA MD rate the importance of menhaden?" 98.5% responded high.

Human nature is to distrust what we don't understand. Recreational anglers don't understand fishery management or fishery science. They don't have a problem with field biologist because they are fishermen too.

They look at the rest of the process as "Black Magic. Like reading tealeaves or chicken bones. You talk in tongue and spread acronyms around like salt on steak.

We don't even know if you have ever seen a real menhaden or rockfish, or even if you know how to fish. You deal in paper fish and act like your figures are beyond question.

You tell us everything is ok because a model from a computer says it is. Yet only models we know are boats and fashion models, but we know what we see and we remember how things were.

We use to have our coves and creeks filled with peanut bunker in the late spring and summer. The fall brought a Bay full of menhaden being fed on by breaking blues and stripers, with schools of trout waiting below. The gulls circling were almost deafening.
We don't have these things anymore. What we do have is dissatisfied recreational anglers and poor fishing in the Bay.

While I was farming someone would have difficulty putting a nut on a bolt while I was holding a heavy piece of equipment and I would tell them to "Do something even if it's wrong".

Recreational anglers aren't asking you to do something that you know is wrong, but if you are going to manage then do something.

Recreational Angler's Perspective on Atlantic Menhaden

Saltwater anglers on the Atlantic coast are a large and diverse group that pursues many different types of sport fish by varied methods up and down our coast and river systems. Our pursuit of these sport fish drives an expansive Atlantic coast recreational fishing industry with over $5 Billion in annual expenditures; over $10 Billion in annual economic impact, and supports 138,000 jobs with yearly salary and wages of almost $3 Billion. Recreational fishing is a substantial part of the Atlantic coast's economy, far in excess of the reduction fishery's value.

Our passion for fishing is fueled by abundant, healthy sport fish stocks and we as a group, and as individuals, support the conservation of those fish, their habitat and ecosystems with action and money. We also understand the direct relationship between the abundance of sport fish and sufficient forage, especially Atlantic menhaden.

Recreational anglers are not alone in our realization for the need of adequate forage, as the Atlantic Menhaden Peer Review Panel voiced its concerns by recommending the development of a reference point "responsive to menhaden as a forage species …" In addition the Panel referred to the ecological role of menhaden as "critical" and noted evidence that strongly supported the importance of the role of menhaden in ecosystem filtering dynamics. No-where is that role needed more than the degraded Chesapeake Bay.

The Chesapeake Bay and its near shore waters support a high percentage of the purse seine fisheries landings, raising concerns that this heavy exploitation of menhaden in this dominant striped bass spawning and nursery area is impacting striped bass health and sustainability. Some have suggested that industry's landings of menhaden have an insignificant impact for striped bass, but this is far from the reality. The reduction fishery takes enough 0-2 year old menhaden in one season to feed the entire Bay's population of striped bass for over 2 years.

The menhaden reduction fishery can maintain this level of catch, even when populations of menhaden are very low, due to the schooling characteristics of menhaden and the industry's use of their large ships with modern technology including spotter planes. Recreational anglers are much less efficient than most commercial fishers in general and the menhaden fishery in particular. Because of that inherent inefficiency we require an abundance of fish to have a reasonable expectation of fishing success.

Recreational anglers believe that to maintain our industry's economic vitality and growth, and for our own personal fishing success, we need abundant and healthy sport fish stocks. The ASMFC enacted Fishery Management Plans that are "Working toward healthy, self-sustaining populations for all Atlantic coast species or successful restoration well in progress by the year 2015." We also realize that the abundance and health of those sport fish stocks will be dependent on the abundance, health, and availability of forage stocks, including menhaden in the Chesapeake Bay and on the coast.

As a retired farmer I can guarantee that no farmer would try and raise livestock or crops without first assuring that they had provided for adequate feed or fertilizer. Fishery managers should realize they have to do the same with fish.

The estimated abundance of menhaden is at near historic low levels, yet management has not acted. We believe every menhaden is important as forage. Whatever their role in an ecosystem, it is surely enhanced with higher abundance. We should explore an abundance target and threshold; both coast wide and in the Bay?

The abundance of many sport fish species and the health of the saltwater recreational fishing industry may depend in part on the outcome of this workshop. Recreational anglers hope this workshop will suggest possible interim management measures that will protect the present population of menhaden from further decline, both on the coast and in the Chesapeake Bay.

Presentation by David Festa
Director of the Oceans Program, Environmental Defense

Thank you to ASMFC for hosting this workshop and the National Marine Fisheries Service and ASMFC for sponsoring this important meeting.

For those of you who might not be as familiar with Environmental Defense, we were founded in 1967 when a few scientists and lawyers shared a concern for declining populations of osprey and other birds. Their work to trace that decline to DDT played a pivotal role in bringing about the end of DDT use.

Since then we continue to be driven by science and a belief that progress is most enduring when we align economic incentives with environmental objectives - a combination best summed up by our tag line "finding the ways that work.”

Because of our scientific foundations, we understand the importance of bodies like this one. Indeed, we serve on a number of technical and advisory bodies and hold a seat on the New England Fishery Management Council. I myself served in the capacity as Policy Director for Commerce Secretaries Bill Daley and Norman Mineta.

In all of our work, Environmental Defense seeks to bring sound science and sound logic to the table.

Today, I'd like to share with you some of our concerns with regards to the present management regime for menhaden in the Chesapeake. We and others including the Chesapeake Bay Foundation, the Coastal Conservation Association, National Coalition for Marine Conservation, Maryland Saltwater Sportsman Association, and others, have detailed a number of concerns in written comments. Given today's time limits, I will touch only on a few highlights.

Last month, the U.S. Commission on Ocean Policy, appointed by the President over three years ago, released its final report. It has 212 individual recommendations - no one can accuse it of only touching on the highlights!

Despite its detail, the commissioners emphasize throughout their report and in just about every public forum a common theme...I quote: "U.S. ocean and coastal resources should be managed to reflect the relationships among all ecosystem components."

Nowhere should this guiding principle be more important than with menhaden.

Menhaden play a major role in the health of marine ecosystems along the Atlantic coast.
They are especially important to the overall health of the Chesapeake Bay, the biggest estuary in North America and the third largest in the world. As principal filter feeders of the bay's waters - second only to oysters which arc grossly depleted - menhaden feed on plankton and decaying

plant matter. They are a vital food source for a wide variety of fish, birds, and marine mammals up and down the coast.

Clearly, then, menhaden are important to the health of the overall ecosystem.

Menhaden are also commercially important. The Chesapeake menhaden fishery is huge. In fact the third largest fishery landings in the U.S. are in Reedville, Virginia. Let me put that in perspective.

The first and second are the pollock fishery in the Gulf of Alaska and the menhaden fishery in the Gulf of Mexico. In both these cases, the amount of fish being harvested is of the same order of magnitude as the Chesapeake menhaden but the effort is spread out in bodies of water that are much, much bigger than the Chesapeake.

Moreover, I can tell you from my experience at Commerce, the role of pollock in the ecosystem figured prominently in management discussions. There is nowhere near the level of discussion of the impact this fishery has on ecosystem function. This is especially remarkable given the increasing pressure the fishery has place on the Chesapeake Bay ecosystem.

As a result of industry consolidation, and state closing their waters to the industrial scale fishery, the menhaden fishery has concentrated in the Virginia side of the Chesapeake Bay.

Seventy-fiver percent of the industrial catch comes from the Chesapeake Bay and surrounding coastal waters.

The sheer number of fish being taken out of a relatively small area should be cause for concern. In addition, however, there are other indicators that suggest we need to be taking a careful look at the management of menhaden.

The abundance of menhaden matters to predators.

Abundance of menhaden is near historic lows – associated with an overfished condition in the 1960s & 70s.

Recruitment failure has existed for nearly a decade.

State surveys for juvenile fish show extremely low levels of menhaden.

The only approximation for an adult abundance indicates a declining trend in the Chesapeake Bay.

Data indicate that 80% of the menhaden were caught before their third birthday.

The prime forage size of menhaden is fish that are two years old or younger, meaning the predatory fish, such as striped bass and weakfish, are competing directly with the industrial scale fishery for food.

In spite of these declines, the schooling nature of menhaden mean catches can be and are kept relatively high. The landings for 2004 are already up by 25% over last year, based on preliminary data from NOAA Fisheries.

Given the importance of menhaden to the ecosystem, it is not surprising to see indicators that something is out of balance.

Recent studies indicate that striped bass today eat four times less menhaden than in 1950.

Another study showed striped bass in Chesapeake Bay have the same level of body fat as those starved for one month in a controlled environment.

In addition, 50-70% of striped bass in the Bay are infected with a disease called mycobacteriosis. The lack of food may lead to a weakened immune system in striped bass, thus increasing the risk of infection.

Striped bass and other fish are not the only predators that may be affected by low numbers of menhaden.

Seabirds such as loons and osprey have made a strong comeback after nearly succumbing to toxics such DDT. These birds also require a high-energy, nutrient-rich diet.

Because of that, menhaden is a preferred source of food for migrating loons stopping in the Bay. Yet we've seen large declines in loons stopping in the Bay coincident with decreases in abundance of menhaden.

Again, I point out that in other situations – such as horseshoe crabs – this kind of relationship warranted considerable attention and has resulted in management action.

Any one of these indicators, taken alone, may not be compelling enough to demand action by fishery managers.

But collectively, they signal a potentially serious threat and point to the need for management measures to protect, the relationship of menhaden to the other elements of the ecosystem - echoing the call of the U.S. Commission on Ocean Policy.

We know that there are a number of possible natural and man-made factors contributing to the currently low abundance of menhaden. But the only thing fishery managers can control is fishing. Environmental changes can influence recruitment and survivability. However fishery managers cannot do anything to directly affect those environmental variables. They do have the ability to take fishing pressure off the stocks when they are stressed by environmental variables.

So what management measures are in place for menhaden in the Chesapeake?

Currently, there are no measures in place to protect menhaden in the Chesapeake Bay, where the majority of the harvest takes place. No limits on number of fish caught, or size of fish caught.

Evidence from fisheries around the world suggests unregulated fishing leads to fishery collapse.

Let's be clear, we are not looking to shut down the commercial harvest of menhaden.

But measures should be put in place to protect this important forage fish before the current management system shuts down the bay.

Thank you for this opportunity to share our perspective.

Statement of Jeff Kaelin, for the Menhaden Resource Council
To the
Atlantic Menhaden Workshop
October 13, 2004

Good Morning. Thank you for the opportunity to join you in this discussion concerning the sustainability of the coastal stock complex of, and commercial fishery for, Atlantic menhaden. First I want to say that I am not a scientist nor do I pretend to be one on the internet! We are participating today to ensure that the workshop and its recommendations are based upon sound science and an adequate understanding of the menhaden fishery.

A commercial purse seine menhaden fishery has taken place on the Atlantic coast since at least 1845[1]. In those days, the fish were used primarily as fertilizer. By the 1920's animal feeds began to be milled and the use of Atlantic menhaden oil for soaps, linoleum, water proof fabrics and paints had begun.[2] Since the mid-1950's, the Beaufort, North Carolina Laboratory of the National Marine Fisheries Service (NMFS) has monitored landings, fishing effort, and size and age composition of the catch in the Atlantic menhaden fishery. Since that time, menhaden vessel captains have cooperated with state and federal fishery scientists by providing invaluable data about their daily fishing effort, fishing patterns and landings. In the late 1970's the Captain's Daily Fishing Report was developed and is still in use today. The Virginia and North Carolina fleets have been continuous participants in these logbook programs since their inception.[3] This is the most significant time series of fishery-dependent information that is available to assist fishery managers in any United States fishery.

During the mid-1950's the Atlantic menhaden fishery consisted of 150 vessels regularly harvesting 600,000 to 700,000 metric tons each year while supplying 25 processing plants.[4] Over the past 4 years, the Atlantic menhaden fleet has been reduced from 20 vessels[5] to the 12 vessels fishing today for the two remaining plants. The average annual harvest of Atlantic menhaden during the past ten years is about 230,000 metric tons, far below the size of the fishery in the past.

Today's Atlantic menhaden processing sector continues to produce fish meal – a high protein ingredient in dairy, swine, poultry, aquaculture and other livestock feeds – fish solubles, which are used as an organic fertilizer, and heart-healthy fish oil, which contains long-chain Omega-3 fatty acids. 'Omega-Pure', derived from Atlantic menhaden is the only marine-source fish oil that has been directly approved by the U.S. Food and Drug Administration (FDA) as 'Generally Recognized as Safe' (GRAS) for inclusion in several human food categories. Regular use of this product can help reduce the risk of heart disease, can lower blood pressure and decrease the risk

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[1] Marine Fisheries Review, Vol.53, No. 4, 1991.
[2] Ibid.
[3] Distribution of Atlantic Menhaden, *Brevoortia tyrannus*, Purse-seine Sets and Catches from Southern New England to North Carolina, 1985-96, Joseph W. Smith, NOAA Technical Report NMFS 144, March 1999.
[4] Marine Fisheries Review, Vol. 53, No. 4, 1991.
[5] Joseph W. Smith, NMFS, to Atlantic Menhaden Technical Committee, 9/23/04.

of sudden cardiac arrest. The health benefits of the Omega-3 fatty acids found in the oil of Atlantic menhaden also include improved memory, reduced symptoms of rheumatoid arthritis and reduced risk of certain cancers and kidney disorders.

Food manufacturers have already begun to use these highly-refined oils as an ingredient in buttery spreads, liquid eggs, salad dressing and other functional foods. The recent $17 million investment in Omega Protein's Reedville, Virginia plant is designed to allow the company to more efficiently process menhaden for fish oil in the future. The new refinery technology will allow the daily catches of about 100 tons per day to be focused more directly on the growing human food market rather than on the more traditional fish oil market. Overall plant demand will not increase. Omega Protein will no longer have to contract with other companies to process this highly-refined, odorless and tasteless Omega-3- rich oil for human consumption.

The commitment to responsibly manage the Atlantic menhaden resource on a sustainable basis continues in today's Atlantic menhaden fishing industry. We look forward to assisting the Atlantic Menhaden Management Board in developing and participating in a cooperative research agenda, which we hope will be enhanced by this workshop, so that all of us may improve our scientific understanding of the Atlantic menhaden's role as a component of the multispecies complex of the Chesapeake Bay and along the Atlantic coast from North Carolina to Maine. At the same time, the industry wants to be very clear about its expectation that the management of the Atlantic menhaden fishery will continue, following this workshop, according to the goals and objectives of the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fishery Management Plan (FMP) for Atlantic Menhaden, which include the protection of the menhaden harvesting community and the social and economic institutions the fishery supports.

As we all know, the Atlantic Menhaden Technical Committee has already determined this year that the coastal stock complex of Atlantic menhaden is abundant and is not being overfished. Even so, several Chesapeake Bay-specific questions have emerged for discussion by this workshop's participants, some of whom would eliminate this healthy and valuable Atlantic coastal fishery in favor of 'admittedly circumstantial evidence'[6] applied to alter the various components of the Chesapeake Bay marine ecosystem, where a principal species of concern, striped bass, is at historic high levels.

Clearly, the most significant threat to the survivability of juvenile menhaden in the Chesapeake Bay is not today's sustainable coastal fishery but the effect of predation by apex fish, like striped bass, in the Bay. If it is the conclusion of workshop participants that striped bass populations are near historic highs, while menhaden stocks are near historic lows, and since it is of concern to managers that menhaden recruitment to age-1 be enhanced, it seems that a discussion of potential regulatory change should focus on striped bass, not menhaden, management. If workshop participants are to objectively address the status of the Chesapeake Bay ecosystem, which currently provides for a valuable commercial fishery on a sustainable basis, some discussion of a different predator/prey relationship – by increasing the fishing mortality rate of age 3-8 striped bass, for example – would likely improve recruitment to the menhaden fishery.

[6] The Need for a Precautionary Approach to Protect the Ecological Role of Atlantic Menhaden, NCMC.

Coastal pollution is also of grave concern to the Atlantic menhaden industry, particularly its' likely effect on juvenile survivability and recruitment to the fishery. We have heard consistently from the Menhaden Technical Committee that there is no direct relationship between fishery removals in the Chesapeake Bay and recruitment to it from the coastal stock complex of Atlantic menhaden and that environmental effects likely play the most important role. Also, there are large numbers of young menhaden evident throughout North East coastal waters although recruitment to the fishery has only traditionally been measured through fixed gear hauls in a portion of the resource's range. The commercial Atlantic menhaden industry wants to be a partner with those who are truly interested in a cooperative approach to understanding, and minimizing threats to the primary productivity of all of the marine species in the Chesapeake Bay.

Addendum 1 to Amendment One to the Atlantic Menhaden FMP (approved 8/17/04) made several important recommendations, which we hope workshop participants will keep in mind this week, concerning the fundamental need to improve Atlantic menhaden habitat throughout its range. Specifically, the Addendum reads that "State managers should be vigilant with respect to water quality. Juvenile and adult menhaden form dense schools, where hypoxia can occur under certain (natural) circumstances. Poor water quality exacerbates this situation. Atlantic menhaden apparently have a thinner epidermal layer than many species of estuarine fish, making it especially vulnerable to disease and parasites. Water borne contaminants can increase their susceptibility and increase negative impacts at individual and population levels." This is evident by the large menhaden fish kills we have recently experienced along the East Coast. These fish kills have been linked to poor water quality and an over abundance of menhaden in a confined estuary.

The Addendum also advises state fishery managers to "work closely with other agencies that influence freshwater runoff patterns (rates), river drainage basins, and general integrity of estuarine systems…in order to restore or maintain historic salinity gradients." Reports of mycobacteriosis affecting striped bass in the Chesapeake Bay should set off alarm bells for all of us who are concerned with the long-term health of the Atlantic menhaden that frequent the Bay during periods of their life history. It is difficult to imagine how an apparently healthy Atlantic menhaden resource and fishery could in any way be blamed for disease occurrences in the fully recovered striped bass population in the Chesapeake Bay, as has been suggested by some workshop participants[7]. Instead, it seems to us that the striped bass are likely the 'canary in the coal mine' in this context, warning us of the risk to all commercially and recreationally valuable fish species in the Bay. Also, since mycobacteriosis is more commonly reported in aquaculture-reared fish, where food is not expected to be limited but water quality and other stressors, like density-dependency, can become a threat, why would the occurrence of mycobacteriosis in the Bay necessarily suggest a shortage of food for striped bass? A related question could be, what amount of stress does a Chesapeake Bay recreational catch-and-release fishery for striped bass add when considering the prevalence of disease in the resident striped bass population there?

[7] Ibid.

It is an interesting coincidence that this month's National Fisherman[8] contains an article that describes the effect of failing to address this continuing pollution problem in the Chesapeake Bay. In a column entitled "30 Years Ago This Month" it reads:

"Discharge from a sewage treatment plant is blamed for a 100-ton menhaden kill in Back River, in Baltimore County, Maryland. This is the fourth in a series of fish kills. The fish have been coming ashore and rotting as workers struggle to clean the mess. The waste from the sewage plants depletes oxygen in the water. The city of Baltimore, which owns the plant, plans to improve."

Addendum 1 also makes an important point for workshop participants to consider in the context of coastal pollution and Atlantic menhaden's role as a filter feeder in the Bay. One of the important Addendum 1 recommendations - to conserve and restore Atlantic menhaden habitat - tells us that "Although significant filter feeding activity occurs in pelagic areas, Atlantic menhaden feeding schools commonly swirl over bottom areas, suspending and subsequently feeding on diatoms and other settled biotic material…state fishery managers should work closely with appropriate agencies that influence and monitor sediment loads and sediment-borne contaminants that may ultimately affect the well being of the menhaden population." In other words, it may be possible that a polluted Chesapeake Bay can trap, through sediment deposition, the Atlantic menhaden's food from becoming available to it and thereby threaten its long-term survivability in today's Bay ecosystem.

Some workshop participants seem to suggest that leaving every Atlantic menhaden in the Bay (at least the ones that the commercial oil and meal fishery takes) will somehow magically clean it through the fish's filtering action.[9] We believe this is a completely unsubstantiated idea since fish do not remove significant amount of nutrients but simply recycle them. In fact, the principal study cited by industry critics, arguing that menhaden's "highest function"[10] in the Bay is as a filter feeder, actually indicates that menhaden serve a greater public benefit through their continued harvest and utilization in a sustainable fishery.

We are also concerned that a politically-motivated effort to solve all of the Chesapeake Bay's ecological problems, by eliminating the commercial menhaden oil and meal fishery, is also promoting abandoning traditional single-species Atlantic menhaden management in favor of an 'ecosystem-based approach to management' in order to find a way to get there[11]. The NOAA Chesapeake Bay Office, which has not been given responsibility for managing any of the nation's fisheries, has apparently completed a "fisheries ecosystem plan", with absolutely no input from anyone involved in the commercial menhaden fishery, as far as I can tell. Some workshop participants evidently want to see the Atlantic Menhaden Management Board adopt this narrowly- developed plan when it meets on November 9th. It cannot be stated strongly enough that it is not a sufficient outcome to recommend that an otherwise sustainable yield from

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[8] Fishing Back When, National Fisherman, November 2004, page 6.
[9] Comments for Workshop to Address the Ecological Role of Menhaden, R. Weisberg, M. Doebley, Recreational Fishing Alliance.
[10] Gottlieb, S.J., "*Ecological Role of Atlantic Menhaden (Brevoortia Tyrranus)in Chesapeake Bay and Implications for Management of the Fishery*", Masters Thesis, U. of Maryland, 1998.
[11] The Need for a Precautionary Approach to Protect the Ecological Role of Atlantic Menhaden, NCMC.

the Atlantic menhaden resource should be foregone simply to provide marginal improvements in the prospects of other managed stocks.

Quickly moving from managing individual fisheries for a sustainable yield, to managing for the benefit of the 'fishery ecosystem' seems like moving the goalposts in the middle of the game to those of us who are engaged in sustainably-managed commercial fisheries, like menhaden, under ASMFC jurisdiction. While it may be important to consider alternative ways to manage sustainable fishery resources in the future, the very definition of "ecosystem-based management" is unclear to us and many others. Congress, for example, is considering several bills that would create various definitions and recently appropriated $2 million for the New England, Mid-Atlantic, South Atlantic and Gulf of Mexico Regional Fishery Management Councils to begin a public dialogue about how to design effective ecosystem fisheries management plans affecting Atlantic and Gulf fishery species and fisheries. We urge workshop participants to recommend to the Management Board that the design of any ASMFC 'ecosystem fishery management plan' involving Atlantic menhaden in the Chesapeake Bay, or anywhere else throughout the range of the species, be closely coordinated with the work that the Mid-Atlantic and New England Fishery Management Councils are just beginning. We make this suggestion because we believe the Council process, unlike that of the Chesapeake Bay Office, will be deliberative, science-based and will closely involve those who would be affected by any new management recommendations.

The commercial Atlantic menhaden industry wants to emphasize today that the ASMFC's Interstate Fisheries Management Program (ISFMP) Charter clearly requires that each fishery be managed in accordance with the best scientific information available, that measures shall be designed to achieve equivalent management results throughout the range of a stock, and that fishery resources shall be fairly and equitably allocated or assigned among the states. The FMP for Atlantic Menhaden also requires the Management Board to ensure adequate accessibility to the fishing grounds. Accordingly, it seems apparent to us that New Jersey's, and other states', bans on fishing for oil and meal, but not for bait or other end products, is not only scientifically unjustified but is legally untenable and contrary to the requirements of the ISFMP Charter and Atlantic menhaden FMP. If a concentrated harvest in the Chesapeake Bay is of concern to ASMFC managers, ASMFC policies should guide them to find several compact states out of compliance with the existing interstate plan so that menhaden oil and meal fishing can occur once again throughout the range of the coastal stock complex under a science-based management regime.

Finally, I want to remind workshop participants that hundreds of hard working men and women, and their families, make good livings working in the Atlantic menhaden oil and meal fishery and processing sector. The development of highly refined menhaden oil provides great promise for those who are at risk for heart disease, new mothers who are concerned about the brain development of their newborns, and millions of other Americans who are beginning to understand the truly extraordinary benefits of fish oils in human health. The discussion about skinny stripers in limited areas of the species range has taken on an ugly and reprehensible tone. Only yesterday, those who would eliminate these good peoples livelihood, aired misleading radio ads locally promoting the idea that they should lose their jobs so that sportsmen can reserve a public resource for their own limited use.

The Atlantic menhaden industry looks forward to working with fishery managers to facilitate the collection and analysis of relevant new scientific data that will help us to better understand the issues being raised in this workshop, and ensuring that the Atlantic menhaden fishery continues to be managed on a sustainable basis throughout its range, according to the best available scientific information.

Thank you for allowing me this opportunity to speak with you today.

Appendix B: Stakeholder Papers

The following are six background papers from stakeholder groups, submitted to the workshop participants, prior to the workshop.

September 27, 2004

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FAX: 202/289-6051

RE: Comments for Workshop to Address the Ecological Role of Atlantic Menhaden

Menhaden's ability to improve water quality invests the species with important ecological value, particularly in estuaries, and other enclosed marine waters. Thus, estuaries are subject to eutrophication and related problems such as hypoxia. Typically, hypoxia is caused by nutrient overloading, fueling the growth of excessive phytoplankton. When the phytoplankton dies, its decomposition removes oxygen from the water, making the survival of marine life difficult, or impossible. Menhaden are vegetarian filter feeders and prodigious consumers of phytoplankton. A single menhaden can consume sufficient phytoplankton and plant detritus to filter up to a million gallons of water every 180 days.[12] Studies in this emerging area of scientific inquiry indicate that menhaden consume a significant percentage of the phytoplankton and plant detritus produced in estuarine environments.[13] Thus, menhaden seemingly act as a natural barrier to hypoxia by removing, to some significant extent, the plant blooms that result from nutrient overloading.

Menhaden are a critical forage fish and are vital to the health and welfare of marine predators. For example, striped bass and bluefish, two important coastal gamefish, rely heavily

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12 Gottlieb, Sara J., Nutrient removal by age-0 Atlantic Menhaden (Brevoortia tyrranus) in Chesapeake Bay and implications for seasonal management of the fishery, Ecological Modelling 112 (1998) 111-130 at 112.

13 Gottlieb, Sara J., Ecological Role of Atlantic Menhaden (Brevoortia Tyrranus) In Chesapeake Bay and Implications For Management of the Fishery, unpublished Masters Thesis, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Studies, at 66, 71 (1998) .

on menhaden for forage.[14] Given the importance of menhaden as forage, it follows that their depletion carries with it the potential for severe, adverse economic impacts on the many businesses in coastal communities, and beyond, supported by recreational fishing. In 1996 the economic impact of marine recreational angling in the fourteen Atlantic coastal states was approximately as follows: angler expenditures - $5,745,386,176; overall economic impact - $10,727,965,000; salaries and wages - $2,965,317,330; and jobs - 138,287.[15] By way of contrast, Omega Protein, which currently enjoys a near monopoly in the menhaden reduction industry (the "Industry"), had revenues of only $117 million in 2002.[16] While the economic impact of Atlantic recreational fisheries relying on menhaden as a primary forage, including striped bass, bluefish and weakfish, cannot be broken out and precisely quantified by RFA-CT, the foregoing suggests that the economic impact of these recreational fisheries dwarfs the economic impact of the Industry. In sum, Atlantic menhaden in their capacity as a forage species are an extremely valuable public resource.

The Atlantic States Marine Fisheries Commission (the "Commission") has delegated menhaden management to its Atlantic Menhaden Management Board (the "Board"). Historically, the Board was dominated by the menhaden reduction industry (the "Industry"). Consequently, menhaden were managed primarily as a commercial fishery for the benefit of the Industry, with little apparent concern for the public interest in menhaden's ecological value, and menhaden's value as a forage species. This situation was remediated in or about the first half of 2001, through the reconstitution of Board and the creation of a Menhaden Advisory Panel (the "MAP") characterized by a balanced membership representing all the various parties interested in menhaden, including the Industry and the recreational fishing community.

One of the several factors leading to the reconstitution of the Board was the review of the Board's 1998 stock assessment by an external, scientific peer review panel (the "Panel").[17] The Panel concluded, among other things, that the Board's stock assessment had failed to account for menhaden's "critical ecological role" as a consumer of phytoplankton and as a forage fish for piscivores including bluefish, striped bass and weakfish. With reference to menhaden's value as forage the Panel recommended the development of a "reference point responsive to menhaden as a forage species...." The Panel referred on several occasions to the ecological role of menhaden as "critical", stating that "[e]vidence in the literature and new data presented to the Panel <u>strongly support</u> the important role of Atlantic menhaden in...ecosystem phytoplankton and nutrient dynamics...." Finally, the Panel recommended that future stock assessments needed a greater diversity of scientific participants and input, in general, but also to "address menhaden's critical ecological role".

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14 E.g., <u>An Evaluation of the Atlantic Menhaden Fishery in Long Island Sound and Recommendations for Action</u> (Connecticut Department of Environmental Protection, 3/99 at 4).

15 American Sportfishing Association, <u>The Economic Importance of Sport Fishing</u> at 9.

16 Data package submitted to members of he MAP by the Menhaden Resource Council under cover of a letter dated 11/26/03.

17 Peer Review Panel Report (1/99).

The MAP has consistently expressed its concern that the Board implement the recommendations of the Panel and develop reference points for the management of menhaden which reflect their ecological importance and their value as a forage species. Thus, at the MAP's most recent meeting in October 2003, the MAP recommended to the Board that the menhaden FMP focus more on menhaden's value as a forage species, and menhaden's ecological value as a planktonic filter feeder.

In March 2004, the Commission issued a press release indicating that it had initiated development of Addendum I to the FMP. While the press release stated that Addendum I would propose alteration in the frequency of stock assessments, and new biological reference points, it was devoid of any suggestion that the Commission and the Board were prepared to develop reference points for the management of menhaden in terms of their value as an important forage species, and their ecological value as planktonic filter feeders. In response, the undersigned circulated an E-mail to members of the MAP and relevant Commission staff, critical of what appeared to be the indifference of the Commission and the Board to the MAP's recommendation. In reply, the undersigned received an E-mail from Nancy Wallace, the FMP Coordinator, stating that at the March meeting of the Board, there had in fact been discussion "on the role of menhaden as both forage and a filter feeder"; that the Technical Committee was unable to currently address these issues; and that the Board had tasked staff to work with the Technical Committee to "prioritize" a list of research recommendations and the funding necessary to complete this research, on these issues.

It is worth reiterating that the management of menhaden in terms of their economic and ecological value, rather than solely as a commercial fishery, is important to the public. Thus, it is disturbing to learn that more than five years after the Panel recommended the development of reference points to manage menhaden for their value as forage, and for their ecological value, the Board has yet to develop a research plan, and to provide the funding to achieve these ends. Furthermore, the fact that the PCD made no mention of the Board's belated efforts to develop such reference points, creates an appearance of continuing indifference by the Board to these aspects of menhaden management. This is particularly true since the PCD does contain a section on information needs and recommendations for future research.[18] Accordingly, RFA recommends strongly that ASMFS and the Board pursue efforts to "prioritize" the formulation of a research plan to develop reference points to manage menhaden for their value as forage, and for their ecological value.

Respectfully submitted,

Richard J. Weisberg
Connecticut State Legislative Director
Recreational Fishing Alliance

Michael Doebley
Deputy Director for Legislative Affairs
Recreational Fishing Alliance

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18 See, PCD, Section V at 24, "Information Needs/Recommendations for Future Habitat Research.

September 23, 2004

Atlantic States Marine Fisheries Commission
Atlantic Menhaden Workshop
1444 Eye Street, NW
Sixth Floor
Washington, DC 20005

Attention: Ms. Nancy Wallace

Dear Workshop Participants:

On behalf of Omega Protein Corporation, I welcome this opportunity to provide comments to the participants of the ASMFC Atlantic Menhaden Workshop. As this workshop proceeds forward, it is Omega Protein's expectation that together we can gain a better understand of the role of the Atlantic menhaden. My comments below are based on the premise that throughout this exercise, it is imperative that we have a better understanding of the information gathering process and how we can utilize the information for the benefit of the resource and the involved stakeholders.

I. The Precautionary Approach

The Rio Declaration (which contains one of many formulations) describes the precautionary approach as "[w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[19] In other words, the precautionary approach has a narrow,

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[19] UNEP, Rio Declaration on Environment and Development, Principle 15 (Rio de Janeiro June 3-14, 1992). The United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries, adopted in 1995, contains this formulation:

> In implementing the precautionary approach, States should take into account, inter alia, uncertainties relating to the size and productivity of the stocks, reference points, stock condition in relation to such reference points, levels and distribution of fishing mortality and the impact of fishing activities, including discards, on non-target and

legally definable, and perfectly appropriate role to play in the management of fisheries. This definition has, however, either through obfuscation or genuine mistake, been reduced to an inaccurate formulation to the effect that "if an action may engender ecological harm, yet conclusive scientific proof (or indeed, any proof) is lacking, one should do everything possible to avoid that harm." (This may be a rather harsh formulation of what some authorities refer to as the "precautionary principle," which some distinguish as a broader cousin of the precautionary approach. In other places the two are treated as synonyms, and there is no one, agreed upon formulation.)

In its narrow formulation, the precautionary approach may well be an appropriate tool, so long as it presented to policy makers in the context of management decisions, with associated risk factors and cost-benefit trade-offs. *It appears, however, that in the context of menhaden management, the conditions triggering application of the precautionary approach are lacking.* The biomass of Atlantic menhaden is safely above target levels, the fishery consistently underachieves sustainable harvest levels, and fishing mortality is well under levels of concern. Likewise, the stock levels of fish which depend on menhaden for forage, particularly striped bass, are likewise generally within acceptable management parameters.

There is yet another caution against use of the precautionary approach in this workshop, despite the calls for such by those who appear to favor the broader interpretation outlined below.[20] And that is that there is no legal basis for applying the approach, at least where it arguably contradicts the legal mandates imposed on the ASMFC by its Compact and charter. It is, at the very least, clear that those fundamental authorities governing and delimiting ASMFC action trump measures that only have application as non-science based reactions to a perceived lack of information.

It may be instructive to look at the issue by analogy to the Magnuson-Stevens Act, which likewise contains no statutory mandate to implement the precautionary approach and where various interests, including the National Marine Fisheries Service ("NMFS"), the federal entity charged with implementing the Act), have attempted to bootstrap the precautionary approach onto the law's requirements. In that instance, NMFS has included a discussion of the

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> associated or dependent species, as well as environmental and socio-economic conditions.

Id. Art. 7, § 7.5.2.

[20] There are some advocates who would suggest that, for example, if the state of science regarding "ecosystem management" is uncertain, or the web of interactions between predator and prey is not perfectly well understood, or if the theory of localized depletion cannot be proven, then menhaden catches in Virginia's waters in the Chesapeake Bay should be cut or even eliminated, based on being "precautionary." Of course, this approach is entirely non-scientific, and fails to look at the factors which are known, such as those enumerated in the Code of Conduct, quoted above in note 1.

precautionary approach in its non-binding guidelines for establishing of optimum yield (OY) for implementing National Standard One. *See* 50 C.F.R. § 600.310(f)(5).[21]

In that case, where the precautionary approach is used in the narrow context of setting optimal yield levels or determining levels of maximum sustainable yield, the precautionary approach is relatively unobjectionable so long as the methods used meet generally accepted scientific standards. *See*, *e.g.*, NMFS, Amendment 1 to the Atlantic Billfish Fishery Management Plan, Pt. 3.3 (April 1999) (describing the "precautionary" approach to determining OY).

However, Congress itself specifically chose not to mandate use of the precautionary approach in the Magnuson-Stevens Act, choosing instead to require the Secretary of Commerce and the Regional Fishery Management Councils charged with promulgating fishery rules and

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[21] 50 C.F.R. 600.310(f)(5) reads:

> In general, Councils should adopt a precautionary approach to specification of OY. A precautionary approach is characterized by three features:
>
> (i) Target reference points, such as OY, should be set safely below limit reference points, such as the catch level associated with the fishing mortality rate or level defined by the status determination criteria. Because it is a target reference point, OY does not constitute an absolute ceiling, but rather a desired result. An FMP must contain conservation and management measures to achieve OY, and provisions for information collection that are designed to determine the degree to which OY is achieved on a continuing basis--that is, to result in a long-term average catch equal to the long-term average OY, while meeting the status determination criteria. These measures should allow for practical and effective implementation and enforcement of the management regime, so that the harvest is allowed to reach OY, but not to exceed OY by a substantial amount. The Secretary has an obligation to implement and enforce the FMP so that OY is achieved. If management measures prove unenforceable--or too restrictive, or not rigorous enough to realize OY--they should be modified; an alternative is to reexamine the adequacy of the OY specification. Exceeding OY does not necessarily constitute overfishing. However, even if no overfishing resulted from exceeding OY, continual harvest at a level above OY would violate national standard 1, because OY was not achieved on a continuing basis.
>
> (ii) A stock or stock complex that is below the size that would produce MSY should be harvested at a lower rate or level of fishing mortality than if the stock or stock complex were above the size that would produce MSY.
>
> (iii) Criteria used to set target catch levels should be explicitly risk averse, so that greater uncertainty regarding the status or productive capacity of a stock or stock complex corresponds to greater caution in setting target catch levels. Part of the OY may be held as a reserve to allow for factors such as uncertainties in estimates of stock size and DAH. If an OY reserve is established, an adequate mechanism should be included in the FMP to permit timely release of the reserve to domestic or foreign fishermen, if necessary.

regulations to follow all the "national standards for fishery conservation and management."[22] It is these national standards that embody the conflicting mandates the law requires policy makers on the Councils to balance, just as the analogous mandates of the Compact and ISFMP Charter must be reconciled by Commission members. Neither the Magnuson-Stevens Act nor the ASMFC's governing instruments authorize, or even provide for, the unrestrained application of "precautionary principles" by unaccountable scientific or technical committees who may want to control the development of fishing management measures.

It is important to underscore that even the relatively limited application of the precautionary approach outlined above in the advisory guidelines for determining OY may, in fact, run afoul of the intent of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996 ("SFA"). There is no reference to the "precautionary approach" in either the words of the SFA, the Magnuson-Stevens Act itself, or in the Senate Report accompanying the SFA. S. Rep. No. 104-276. This omission was intentional because Congress was aware of the precautionary approach when it passed the SFA, as it had considered the Code of Conduct for Responsible Fisheries just one year earlier.

It is virtually a certainty that environmental groups requested that the SFA incorporate a requirement that the precautionary approach be mandated, as some have in subsequent years. *See* Testimony of Lee R. Crockett, Executive Director, Marine Fish Conservation Network, before the House Resources Subcommittee on Fisheries, H. Rpt. 107-15, at 33 (April 4, 2001), available at *http://resourcescommittee.house.gov/107cong/fisheries/2001apr04/crockett.htm*. In fact, during the reauthorization process in 2001, Rep. Sam Farr of California proposed just such an amendment to the Act, *see* H.R. 2570, Sec. 11 ("Precautionary Approach to Fisheries Management") that would have made this principle a National Standard in its own right. This bill did not become law.

The Commission, as bound by its governing instruments and implemented through the ISFMP for Atlantic Menhaden, has established a series of goals and policies that do not allow for management policy that ignores or subsumes issues such as protection of the menhaden harvesting community and the social and economic institutions the fishery supports. Indeed, these elements of the optimum yield equation recognize that the point of conservation is to *sustain* long-term harvests of fisheries resources, and the general findings, purposes and policies of the Magnuson-Stevens Act that recognize that "[t]hese fishery resources contribute to the food supply, economy, and health of the Nation . . . ." 16 U.S.C. § 1801(a)(1). These same considerations apply with even greater force to the ASMFC, which, as an entity created by solemn compact, entered into by sovereign states and established under the Contract Clause of the U.S. Constitution by an act of Congress, is under a mandate to promote utilization and avoid waste of fisheries resources.

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[22] *See Hall v. Evans*, 2001 WL 474187, *23 (D.R.I. 2001) (citing *Maine v. Kreps*, 563 F.2d 1052, 1055 (1st Cir. 1977); *see also Alliance Against IFQs v. Brown*, 84 F.3d 343, 348 (9th Cir. 1996).

II. The ASMFC's Governing Instruments Prescribe the Standards for Fishery Management Measures and the Means to Implement Them

Because this workshop has been tasked with developing consensus "recommendations for revised or new directions" for menhaden management and reporting such to the Menhaden Management Board, it is helpful that the participants understand the scope of the Commission's authority and the constraints under which it operates. It is of further value that the workshop participants understand the standards governing the promulgation of management recommendations.

A. Overview of the Commission's Rulemaking Authority

The ASMFC gets its authority under a Congressionally approved Compact, and is governed by its adopted rules and regulations. *See* ASMFC Compact & Rules and Regulations (Dec. 2003). These rules provide for the creation and operation of the Interstate Fisheries Management Program. ASMFC Rules and Regulations Art. VI. The ISFMP is designed to "carry out a program to promote the cooperative and coordinated development and implementation of conservation programs for Atlantic coastal fisheries." *Id.* Section 1. Further, these Rules and Regulations provide that, "[t]he ISFMP Charter shall provide that fishery management plans, and any actions taken according thereto, promote conservation, use the best scientific information available, and provide adequate opportunity for public input." *Id.* Art. VI, § 3.

The compacting states have established a charter for the ISFMP. The Charter sets forth standards that are to govern the management of fisheries subject to ASMFC jurisdiction. The Charter states that "an effective fishery management program must be carefully designed in order to fully reflect the varying values and other considerations that are important to the various interest groups involved in coastal fisheries." Charter, Section Six(a). It also mandates that "[m]anagement measures should focus on conservation while allowing states to make allocation decisions." *Id.* (Emphasis added). The primary focus is, of course, on the long term productivity of the fishery resources. *See* ASMFC Compact, Article IV (Commission's recommendations must insure "continuing yield").

Under the Charter, the standards that guide the development of management measures include a requirement that they "shall be based on the best scientific information available." *Id.* (a)(2). Further, and perhaps more relevant for present purposes, such "measures shall be designed to achieve equivalent management results throughout the range of a stock," and "be designed to minimize waste of fishery resources." *Id.* (a)(3)-(4).

The 2002 updates to the Charter add a new standard, entitled "Fairness & equity," which states that:

(i) An FMP should allow internal flexibility within states to achieve its objectives while implemented and administered by the states; and
(ii) Fishery resources shall be fairly and equitably allocated or assigned among the states.

Id. (a)(7).

The Charter also establishes an ISFMP Policy Board. *See generally id.*, Section Three.[23] The ISFMP Policy Board is the administrative body that has authority to establish management boards for specific fisheries under ASMFC jurisdiction, such as the Menhaden Board. *Id.* (d)(3). A function of the Menhaden Board, as it is for other ASMFC management boards, is to "monitor the implementation, enforcement, and effectiveness of the plan, amendment, or addendum or take other actions specified in the applicable document that are necessary to ensure its full and effective implementation." *Id.* Section Four(e)(3).

For their part, management boards have authority to constitute plan development teams to draft fishery management plans and plan amendments, *id.* Section Five(c), as well as plan review teams ("PRT"). *Id.* (d). The PRTs, consisting of about six persons, meet at least annually to review stock status and states' compliance, and issue a report. *Id.* (d)(2). More specifically, the Charter provides that "[e]ach Plan Review Team shall at least annually or as provided in a given fishery management plan, conduct a review of the stock status and ASMFC member states' compliance for which implementation requirements are defined in the fishery management plan." *Id.*

A PRT is, itself, advised by the "appropriate Technical Committee, Stock Assessment Committee, Advisory Panel, and the Habitat, Law Enforcement and Management and Science Committees." *Id.* (d)(3). Such a technical committee is the body that can "provide scientific and technical advice . . . in the development and monitoring of a fishery management plan or amendment as requested in writing . . . ." *Id.* (f)(3). It does not review compliance, but is tasked with providing "a range of management options, risk assessments, and justifications, and probable outcomes of various management options." *Id.* (f)(4).

B. ASMFC Menhaden Management

The Commission developed a coastal fishery management plan for Atlantic menhaden 1992, and extensively amended it in July 2001. The FMP contains no management measures, but rather three triggers that serve as warning signs that the stock may be beginning to be overfished. The plan is replete with reference to the fact that, although the stock is healthy, political pressure alone is responsible for closing state waters, such as South Carolina's, to either all menhaden harvests or just to reduction fishing. *See* Amend. 1 to the Atlantic Menhaden ISFMP § 3.2.2, at 2 (1992).[24] Indeed, one of the original goals of the FMP was to set forth a "coherent approach . . . to provide optimum utilization of the resource throughout its range"

[23] For their part, the ASMFC's Rules and Regulations state that, "[f]ishery management plans and any actions of the Commission or the ISFMP Policy Board taken according thereto, shall be considered 'recommendation[s] . . . in regard to any species of fish,' according to the requirements of Article VI of the Compact establishing the Commission." *Id.* Art. VI, Section 4.

[24] The page numbers refer to those in the Acrobat .pdf version of Amendment 1, which is available at http://www.asmfc.org. These page numbers appear to differ from those in the hard copy version of the Amendment. The section references, however, should be consistent.

because "state marine fisheries management agencies [had] been inconsistent in their approach to managing the menhaden fishery." *Id*. § 3.2.5, at 3.

As noted above, the overarching goal of the menhaden management plan is "[t]o 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." *Id.* §§ 2.2, 2.3, at 44. Among the objectives of management that have remained constant is the need to "maintain existing social and cultural features of the fishery to the extent possible." *Id.* § 2.3, at 45. Amendment 1, furthermore, added a new objective, which was to "[i]nsure adequate accessibility to fishing grounds." *Id.*

The Menhaden ISFMP creates an alternative and somewhat more streamlined process by which management measures may be added or changed than the ISFMP amendment process noted above. This process is called "adaptive management." *Id.* § 4.6, at 62-64. Under this process, the "Management Board may change target fishing mortality rates and harvest specifications, other measures designed to prevent overfishing of the stock complex or any spawning component [sic]." *Id.* at 63. Under this provision the PRT is tasked with monitoring the status of the fishery and report to the Board, or the PRT may be tasked by the Board to investigate matters related to the fishery. *Id.* § 4.6.1, at 63.

The PRT is required to "consult with the Technical Committee, the Stock Assessment Committee and the Advisory Panel" in undertaking such review and preparing any report to the Board. *Id.* The Review Team's report "will contain recommendations concerning proposed adaptive management revisions to the management program." *Id.* If, upon review and, if necessary, further consultation, the Menhaden Board "may direct the PRT to prepare an addendum to make any changes it deems necessary." *Id.*

An "addendum" is analogous to a "framework adjustment" undertaken pursuant to regulations implementing a federal FMP promulgated under the Magnuson-Stevens Act in that it represents a minor adjustment to the fishery management scheme in order to insure that management measures continue to meet the goals and objectives of, and meet the biological targets set by, the management plan. More sweeping changes must be implemented by a full-blown amendment.

Under the Menhaden ISFMP, a draft addendum must be "distributed to all states for review and comment," and public hearings held in and at the request of any state. *Id.* The PRT is directed to "request" comments on the measures proposed to be implemented by addendum from "federal agencies and the public at large. *Id.* Finally, the PRT undertakes a 30-day review in which it must summarize the comments and prepare a final version of the addendum for the Menhaden Management Board, which shall "consider the public comments received and the recommendations of the Technical Committee, the Stock Assessment Committee and the Advisory Panel; and shell then decide wither to adopt or revise the addendum." *Id.* Any measures so adopted shall be implemented by the states.

C. Implications for the Workshop

The purpose of this detailed exposition of the ASMFC's management process and the varied goals and objectives dictated by the ISFMP Charter, generally, and the Atlantic Menhaden ISFMP, specifically, is that the recommendations emanating from the workshop – particularly for any potential management measures – must in some sense take account of these constraints and objectives. It cannot be stated strongly enough that it is not a sufficient outcome to recommend that otherwise sustainable yield from the menhaden stock should be forgone simply to provide marginal improvements in the prospects of other managed stocks. It is even less tenable to suggest that the Commission abandon its fundamental, solemn, interstate compact-based mission with respect to insuring continuing yield in order to meet objectives that are completely outside the Commission's jurisdiction and mandate. For example, the ASMFC simply has no power to manage menhaden for the purposes of increasing water quality or insuring that the Chesapeake Bay has the "right" mix of migratory birds [Emphasis added].

Furthermore, as this workshop has been constituted under the authority of the Menhaden Management Board, the need to accommodate the goals of the Menhaden ISFMP must be given a high priority. Even recognizing that one of the mandates for this workshop is to examine the role of this stock as forage, such a focus should not be limited to the narrow question of whether menhaden is abundant enough to support the largest possible biomass of other stocks. Consideration should properly be given to an ecosystem approach that considers an appropriate balance of all stocks – menhaden, as well as species that prey on it – to help the Board and the Commission make management decisions that achieve the highest sustainable yield from all the fisheries it is charged with managing.

Similarly, the issue of whether "concentrated harvest" of menhaden is in some way problematic cannot be reduced to whether fishing should be restricted in one state's jurisdiction. Rather, there should be an open, science-based discussion, first on whether "localized depletion" is truly an issue with implications for the sustainability of various stocks, and second on whether, if the overall harvest levels for menhaden is sustainable (and the best scientific information has concluded that it is), there are good scientific reasons that the fishery should be allowed to be conducted over a broader geographic area, both in the Bay and coastwide.

In the end, the recommendations will only prove useful if they can pass the necessary review by the Plan Review Team as meeting the goals and objectives the Commission has established for the fishery. Further, they must take into account the legal constraints that the ASMFC Compact and Charter impose.

I would like to thank each of you for your time and attention to this workshop and the health of the menhaden resource. It is Omega Protein's hope that all of these factors are given careful consideration while carrying out the charges of the ASMFC Menhaden Steering Committee and the ASMFC Menhaden Management Board.

Very truly yours,
John D. Held

JDH/jb

CCA's Concerns About Menhaden Management

Recreational fishermen are vitally concerned about the health of the Atlantic coast menhaden population. It was the paucity of menhaden seen by recreational king mackerel fishermen in the late 1980's that led Florida managers to initially ask the ASMFC to re-examine menhaden management. Since then, anglers all along the Atlantic coast have seen fewer menhaden. Menhaden are important prey for virtually every major sport fish species. Their abundance is important to the health of marine fish stocks and thus the health of the recreational fishery.

Different Management Is Needed

Menhaden are managed as a single species in a manner similar to pisciverous species like striped bass, weakfish or bluefish. The targets and thresholds relate to the fishing mortality rate (F) or the size of the spawning stock biomass (SSB). However, menhaden are a prey species, most likely a preferred prey and thus, we believe, should be managed differently.

Atlantic menhaden population levels are at near historic low levels (Figure 1). If menhaden do play a role as a primary forage species then there abundance should be critical to management. We believe there must have a population target for management. If the trend in menhaden population numbers was that of a different species like bluefish or red drum, we believe the ASMFC would have taken action long ago.

Menhaden management has been complicated by the problem of a relatively high SSB and low recruitment. The Menhaden Technical Committee has repeatedly referred to the poor spawner-recruit relationship, yet management still uses SSB as a reference point.

With a large predator species, like striped bass, maintaining SSB is critical. As long as SSB is present, a desired population level can be maintained by keeping F below the target mortality rate. We believe a forage species should be managed differently. Every menhaden is important as forage, not just the adult spawning stock. Whatever their role in an ecosystem, it is better fulfilled by a higher biomass. The difference is more important when there is a low spawner-recruit relationship. We believe menhaden management should examine a biomass target and threshold instead of SSB in recognition of the special role menhaden play, with management measures restricting F when the population falls below the desired level.

Removals In The Chesapeake Bay

As has been widely noted, over 60% of the harvest of menhaden occurs in the Chesapeake Bay, yet we have no method to adequately assess the potential impact of these removals on the Chesapeake Bay portion of the stock. Common sense management indicates this is a potential problem, especially when coupled with low recruitment. We believe management should take a precautionary approach to ensure adequate stocks of menhaden in the Chesapeake Bay.

In 2003 the reduction industry removed approximately 100,000 metric tons of menhaden from the Chesapeake Bay, or about 220,000,000 pounds, according to the Atlantic Menhaden Technical Committee Report, February 2-3, 2004, Figure 1. In order to make the removals more understandable to the lay public, we chose to illustrate this harvest as it relates to the amount consumed by striped bass. We used estimates of the consumption rates of menhaden by striped bass in the Chesapeake Bay from 1998-2002 Dr. Anthony Overton and the estimated abundance of striped bass in the Bay from the 2003 Stock Assessment Report for Atlantic Striped Bass (November 2003). We used Table 16, Estimated Population Size at Age. For this illustration we assumed all age 1-3 year old fish were residents of the Bay; 80% of age 4; 60% of age 5 and 40% of age 6 all were residents, in attempt to account for the emigration of striped bas from the Bay as they age. We believe this method is conservative and actually over-estimates the numbers of striped bass in the Chesapeake Bay.

	# Striped Bass			Overton data lbs menhaden/year	
Age 1	3,607,000	X 1 =	3,607,000	0.4	1,442,800
Age 2	14,547,000	X 1 =	14,547,000	0.7	10,182,900
Age 3	10,932,000	X 1 =	10,932,000	3.7	40,448,400
Age 4	3,506,000	X .8 =	2,804,800	4.7	13,182,560
Age 5	4,263,000	X .6 =	2,557,800	6.6	16,881,480
Age 6	2,509,000	X .4 =	1,003,600	16.3	16,358,680
					98,496,820

We estimated the resident population of striped bass in the Bay consumed approximately 98.5 million pounds of menhaden in 2003. Therefore, the menhaden reduction industry in 2003 removed enough menhaden from the Chesapeake Bay to feed the entire population of striped bass in the Bay for over 2 years. This data is intended to show the scale of harvest as opposed to the needs of the striped bass population. The removals of menhaden from the Bay proper are significant, in our opinion, and thus should be scrutinized by managers.

Summary

In summary, we believe menhaden stocks are at near historic low levels. If any of the important recreational species had exhibited a similar decline, we believe management would have acted long ago. We believe management should examine options to restore the historic abundance. In addition, the rate of removals from the Chesapeake Bay needs to be examined by managers.

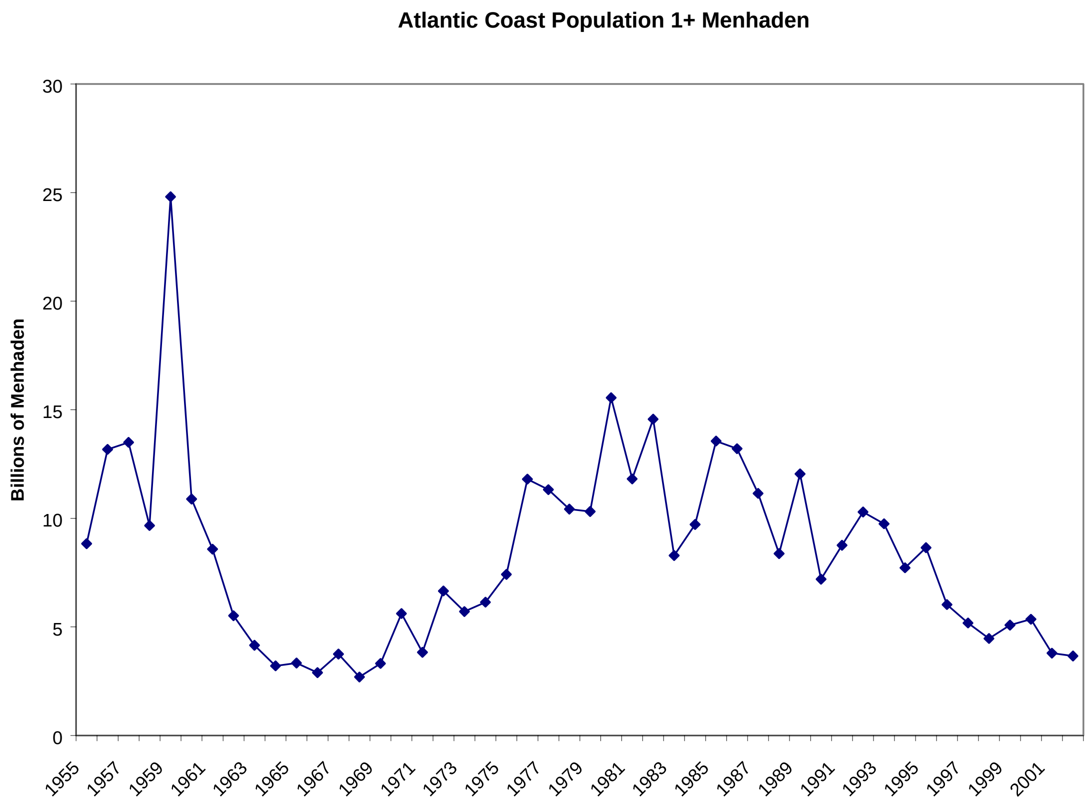

Figure1. The estimated number of 1 + Atlantic menhaden from 1955 – 2002.

September 23, 2004

Atlantic States Marine Fisheries Commission
Attn: Nancy Wallace
1444 Eye Street, N.W., Sixth Floor
Washington, D.C. 20005

Dear ASMFC Atlantic Menhaden Workshop Participant:

The Menhaden Resource Council appreciates the opportunity to provide our views on the Atlantic Menhaden Workshop – its content, charges and objectives – including potential recommendations from workshop participants relating to new or revised directions in fishery management within the ASMFC, the Chesapeake Bay, and Atlantic coastal waters.

Workshop Charges & Goal

The stated goal of the Atlantic Menhaden Workshop is to "*improve our scientific understanding of menhaden's ecological niche*." Workshop participants are charged with (1) examining the status of Atlantic menhaden with respect to its ecological role; (2) exploring the implications of current management reference points with respect to menhaden's ecological role, and (3) exploring the effects of concentrated harvest in the Chesapeake Bay.[25]

While each of the preceding enumerated charges recognize and address the ecological role that menhaden serves, the fourth and final, comprehensive charge of workshop participants – pertaining to actual fishery management advice – does not: (4) developing recommendations for revised or new directions to the Atlantic Menhaden Fishery Management Plan to the Atlantic Menhaden Management Board.

If the goal of this workshop is, indeed, to improve our scientific understanding of menhaden's role in the fish community, then surely any recommendations for revised or new directions in fishery management would similarly reflect a broad ecological approach, rather than a single-species approach? Consequently, we hope it is not the intent of workshop participants to artificially constrain any recommendations solely to the menhaden fishery, but rather to provide guidance relative to all relevant fisheries that both rely upon-, as well as affect-, the menhaden stock.

Current Management : Goals and Ecological Objectives

The goal of the menhaden FMP is to "*manage the Atlantic menhaden fishery in a manner that biologically, economically, socially and ecologically sound, while protecting the resource and those who benefit from it*."

As this workshop focuses on the ecological functions of menhaden, the following three ecological objectives are enumerated in the FMP:

[25] ASMFC News Release: *ASMFC to Hold Atlantic Menhaden Workshop to Address Ecological Ro*le; September 10, 2004.

(1) *Protect fishery habitats and water quality in the nursery grounds to insure recruitment levels are adequate to support and maintain a healthy menhaden population*;

(2) *Improve understanding of menhaden biology, food web ecology and multispecies interactions that may bear upon predator-prey and recruitment dynamics*; and

(3) Protect and maintain the important ecological role Atlantic menhaden play along the coast.

Some critics of the ASMFC and the menhaden management plan argue that draconian steps must be taken by the Menhaden Board to protect the health of species that prey on menhaden, such as striped bass.[26] In fact, these critics, predominately sport fishing advocates, unsuccessfully petitioned the ASMFC recently to ban all purse seine fishing for menhaden in the Chesapeake Bay.

Generally, those seeking drastic regulatory change proffer two primary reasons to impose additional regulations on the menhaden reduction fishery: (1) reports of "skinny" striped bass; and (2) increased occurrence of mycobacteriosis and/or other skin lesions.

"Skinny" Striped Bass

While an increased frequency of "skinny" striped bass may or may not have scientific merit, scientific reports suggest that striped bass populations may have exceeded their natural carrying capacity within the Chesapeake Bay as early as the late 1990s.[27] Indeed, the striped bass stock, which the ASMFC determined as "fully recovered" in 1995, has seemingly grown to a disproportionate, and potentially unsustainable, size within the Bay.

While Technical Committee members over the past decade have debated the potential root causes of relatively poor recruitment of menhaden to age-1, a comparison of the estimated striped bass population to the menhaden population since 1990 suggests a strong inverse predatory/prey relationship between these two species. Moreover, preliminary research by federal scientists suggests that the consumption of age-0 and age-1 by striped bass is significant. When compared to the number of menhaden harvested by the reduction industry, these studies suggest that striped bass consume an <u>order of magnitude</u> more menhaden than harvested by fishermen.[28] These preliminary findings, coupled with existing supporting data (e.g. current estimates of age-specific natural mortality), significantly impact the discussion of menhaden management.

Specifically, from a regulatory perspective, if striped bass remove an order of magnitude more age-0 and age-1 menhaden than industry, it becomes apparent that any potential additional harvest restrictions on menhaden fishing are likely to have significantly less impact, if any, on the condition of the menhaden stock, in comparison to potential changes in the size and composition of the striped bass stock.

Furthermore, while the relationship between overall menhaden fecundity measures and subsequent recruitment to age-1 appears marginal, it is important to highlight that current

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[26] "*Save the Striper – Campaign Overview*". National Coalition for Marine Conservation Website; Winter, 2003.
[27] Uphoff, J.H., "*Predator-Prey Analysis of Striped Bass and Atlantic Menhaden in Upper Chesapeake Bay*"; Fisheries Managmeent and Ecology, vol. 10, pp. 313-322, 2003.
[28] Cieri, Matt, "*Progress of Menhaden Multispecies Model: A Report of the Menhaden Multispecies Subcommittee to Atlantic Menhaden Management Board*", 2002.

fecundity measurements are very healthy -- exceeding both the FMP target and threshold amounts.[29]

Therefore, if it is the conclusion of workshop participants that striped bass populations are near historical highs, while menhaden stocks are near historical lows, and, further, if it is the presumed subsequent goal of regulators to improve menhaden recruitment to age-1, then it seems that discussion of potential regulatory change should focus on striped bass management, not menhaden.

Mycobacteriosis

A second rationale offered by sport fishing advocates to further restrict menhaden harvests in the Bay is the apparent prevalence of mycobacteriosis in striped bass. Some scientists and fishermen have speculated that its initial appearance in the Bay in 1997 suggests a potential causal relationship between the expanding striped bass population and increasingly in-demand prey.[30]

Personally, we know little about mycobacteriosis, and look forward to discussions surrounding its occurrence and potential causes. However, we ask one question: If mycobacteriosis is more commonly reported in aquaculture-reared fish, and, assumedly, fish feed is not limited, *per se*, in most aquaculture operations, why would the occurrence of mycobacteriosis in the wild necessarily suggest a shortage of food in the Bay?

Area Closures / Fishing Grounds Compression

A principle function of the ASMFC Atlantic Menhaden Management Board, as it is for other ASMFC management boards, is to "*monitor the implementation, enforcement, and effectiveness of the* [fishery management] *plan, amendment, or addendum or take other actions specified in the applicable document that are necessary to ensure its full and effective implementation*."[31]

According to the ISFMP Charter, the standards that guide the development of management measures within the Atlantic Menhaden and other FMPs include a requirement that they "*shall be based on the best scientific information available*."[32] Furthermore, such measures "*shall be designed to achieve equivalent management results throughout the range of a stock,"* and *"be designed to minimize waste of fishery resources*."[33] Additionally, the 2002 updates to the Charter add a new standard which states that "*fishery resources shall be fairly and equitably allocated or assigned among the states*".[34]

Historically, it is relevant to highlight that one of the original goals of the FMP was to set forth a "*coherent approach… to provide optimum utilization of the resource throughout its range*" because "*state marine fisheries management agencies [had] been <u>inconsistent</u> in their approach to managing the menhaden fishery*."[35]

[29] "*Addendum I to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Menhaden",* Atlantic States Marine Fisheries Commission, May, 2004.
[30] Blankenship, Karl, "Mycobacteriosis *Infection Rate in Bay's Striped Bass Increasing*", Bay Journal, vol. 14, no. 4.
[31] Atlantic States Marine Fisheries Commission, Interstate Fisheries Management Program Charter, § 4(e)(3).
[32] *Id.* § 6(a)(2).
[33] *Id.* §§ 6(a)(3), (4).
[34] *Id.* § 6(a)(7).
[35] Atlantic Menhaden Fishery Management Plan, § 3.2.5.

Through the FMP Amendment 1 adopted in July, 2001, the overarching goal remains consistent: "*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*."[36]

Similarly, many of its objectives continue to emphasize the importance of maintaining a viable commercial fishery. For example, it remains an objective to "*maintain existing social and cultural features of the fishery to the extent possible*."[37] More importantly, the Amendment adds a new objective to *"insure adequate accessibility to fishing grounds*."[38]

The bottom line is that Amendment 1's goals and objectives still point <u>against</u> denial of access to fishing grounds by industry. If anything, Amendment 1's discussion of accessibility as one of its specific objectives confirms and strengthens the FMP's original intent.

Yet, following the adoption of Amendment 1 of the menhaden FMP, the New Jersey legislature unilaterally enacted a law prohibiting access of reduction vessels to its state-controlled fishing grounds that have historically been utilized by the menhaden fleet. No scientific rationale exists to justify these restrictions. Moreover, the State took this action without any recommendation from the Atlantic Menhaden Management Board, the ISFMP Policy Board, or any component of the ASMFC.

Nonetheless, the ISFMP Charter requires that the fishery be managed in accordance with the best scientific information available, that measures shall be designed to achieve equivalent management results throughout the range of a stock, and that fishery resources shall be fairly and equitably allocated or assigned among the states. The Menhaden FMP also requires that the Management Board insure adequate accessibility to fishing grounds. In sum, it seems readily apparent that New Jersey's ban on reduction fishing does not meet these ISFMP Charter and Atlantic Menhaden FMP requirements.

The rationale that an individual state can opt to adopt more restrictive management measures than those prescribed within the menhaden FMP ignores the reality that <u>all</u> management measures are still required to abide by the ISFMP Charter and its Standards, as previously detailed.

Consequently, the current New Jersey state law – which bans menhaden fishing for reduction purposes, but not menhaden fishing for bait or other end products – is scientifically unjustified, and appears legally untenable.

Precedent for a legal challenge of the New Jersey law is evidenced by *Douglas v. Seacoast Products, Inc.* (1977). In this case, the U.S. Supreme Court overturned a Virginia regulation preventing out-of-state vessels from fishing in the Commonwealth's state waters.[39] According to the Supreme Court:

"*Our decision is very much in keeping with sound policy considerations of federalism. <u>The business of commercial fishing must be conducted by peripatetic entrepreneurs moving, like their quarry, without regard for state boundary lines</u>. Menhaden that spawn in the open ocean or*

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[36] Amendment 1 to the Interstate Fishery Management Plan for Atlantic Menhaden, § 2.2.
[37] *Id.* § 2.3
[38] *Id.* § 2.3
[39] United States Supreme Court Decision: *Douglas v. Seacoast Products, Inc*., 1977.

in coastal waters of a Southern State may swim into Chesapeake Bay and live there for their first summer, migrate south for the following winter, and appear off the shores of New York or Massachusetts in succeeding years. A number of coastal States have discriminatory fisheries laws, and with all natural resources becoming increasingly scarce and more valuable, more such restrictions would be a likely prospect, as both protective and retaliatory measures. Each State's fishermen eventually might be effectively limited to working in the territorial waters of their residence, or in the federally controlled fishery beyond the three-mile limit. Such proliferation of residency requirements for commercial fishermen would create precisely the sort of Balkanization of interstate commercial activity that the Constitution was intended to prevent." [Emphasis added]

Assessing "Localized Depletion"

Discussions have taken place at both the ASMFC Committee- and Board- level regarding the potential occurrence of "localized depletion" of menhaden corresponding with purse seining activities. Moreover, in establishing its priorities and use of staff and fiscal resources, the ASMFC has recently identified this issue within the Atlantic menhaden fishery as one of five ongoing and emerging issues demanding more attention.

However, to date, no concrete definition of what actually constitutes "localized depletion" within the menhaden fishery has been formulated.

If workshop participants intend to explore the effects of "concentrated" harvest within the Bay and discuss the potential existence of "localized depletion", we suggest that initial discussions take place with the goal of actually determining what defines "localized depletion".

Additionally, in terms of developing recommendations or new directions within the FMP, industry wants to offer its resources to advance science related to menhaden. Naturally, the reduction fishery has a great stake in assuring the continued health of the menhaden resource. Over the years, industry has assisted in promoting, expanding and continuing research of many facets of the fishery.

Omega Protein, the principle constituent within the Atlantic reduction fishery, is prepared to offer, to the extent practicable, its assistance and support for a study – conducted by an appropriate scientific institution – that would evaluate the occurrence of properly-defined "localized depletion" within the Chesapeake Bay.

Fishing Landings Trends

Coastwise landings by the menhaden reduction fleet have varied over the years, but have declined from around 400,000 tons in 1990 to 174,000 tons in 2002.[40] Similarly, harvests from the Chesapeake Bay have declined, as well. Nonetheless, some alarmist critics of the menhaden industry have attempted to characterize a marginal percentage increase of overall harvests originating from the Bay as problematic. Yet, this misleading characterization ignores the reality that the absolute harvests, in tons, derived from the Bay continue to decline, not increase.[41]

[40] "*Atlantic Menhaden Stock Assessment Report for Peer Review*", Atlantic States Marine Fisheries Commission, February, 2004.
[41] Doug Vaughan, Technical Presentation to the ASMFC Technical Committee, Baltimore, MD, 2003.

Menhaden as Filter Feeders

The menhaden reduction fishery removes menhaden from the Chesapeake Bay that would otherwise serve an ecological role which includes consuming plankton and detritus from the water column. As plankton uptake nitrogen and phosphorous (thereby reducing 'pollution' within the Bay), some critics of the menhaden industry have argued that keeping a greater percentage of the menhaden population in the water, as opposed to harvested by industry, would result in significant reduction of waterborne nitrogen and phosphorous.

To support this argument, critics have offered a rationale claiming that it makes economic sense to reduce harvests – principally citing a Master's Thesis "*Ecological role of Atlantic Menhaden in Chesapeake Bay and Implications for Management of the Fishery*"[42] [43] According to critics of the ASMFC and the menhaden reduction fishery:

> "*When attempting to assign value to the species* [menhaden] *we contend that menhaden's* <u>*highest function*</u> *is as a natural filter-feeder…Clearly there is great economic value in utilizing natural removal mechanisms for these nutrients* [nitrogen and phosphorous] *to leverage public and private investments in nutrient controls such as tertiary treatment at municipal wastewater treatment plants, agricultural best management practices and storm water management."* [emphasis added]

Ironically, the actual results of the research cited do not support this assertion.

As background summary, the study estimates the nominal amounts of nitrogen and phosphorous that would be removed from the Bay by age 1-3 menhaden under two hypothetical scenarios within the Chesapeake Bay:

(1) Fishing occurs as it has in the past under varying assumptions about overall size of the menhaden population (i.e. low, medium and high starting populations); or

(2) A menhaden fishing moratorium is introduced under the same varying assumptions about overall size of the menhaden population (i.e. low, medium and high starting populations).

The study also assigns economic value to menhaden both as a filter feeder (its removal of nitrogen) and as a harvested fishery. The following table summarizes Gottlieb's findings:

Initial Menhaden Population Size:	"Small"	"Small"	"Medium"	"Medium"	"Large"	"Large"
Fishing:	Y	N	Y	N	Y	N
Kg of N Consumed (Millions):	1.7	1.9	3.0	3.3	11.0	12.0
Gross Fishery Value (Millions):	$20	$0	$32	$0	$130	$0
Value of N Consumption (Millions):	$10	$12	$17	$20	$66	$74

As illustrated by this table, the study suggests several salient points that support continued harvests by the menhaden industry:

[42] Gottlieb, S.J., "*Ecological Role of Atlantic Menhaden (Brevoortia Tyrranus) in Chesapeake Bay aned Implications for Management of the Fishery*", Masters Thesis, U. of Maryland, 1998.
[43] Virginia Association of Municipal Wastewater Agencies, Inc., "*Comments on Menhaden Addendum I*", July 14, 2004.

1. Under the three varying assumptions about the theoretical size of the menhaden population within the Bay, the economic value that menhaden produce through their direct harvest by the reduction fishery is nearly twice the economic value produced through their concurrent value as filter feeders of nitrogen;

2. In the event that the menhaden reduction fishery were theoretically eliminated, a net annual negative economic impact would result in the amount of negative $18 million, negative $29 million, and negative $122 million under the assumptions of a small, medium and large starting menhaden population respectively, solely in regards to menhaden's economic value as a fishery vs. its value as a of nitrogen remover; and

3. The net additional nitrogen removal within the Bay potentially gained by imposing a complete fishing moratorium is marginal at best: 1.9 vs. 1.7 million kg., 3.3 vs. 3.0 M kg., and 12.0 vs. 11.0 M kg. under the assumptions of a small, medium and large starting menhaden population respectively. Therefore, a non-fished menhaden population is capable of removing only approximately 10% more nitrogen from the Bay than a population harvested under "normal" circumstances by the reduction fishery.

Consequently, it would appear that the principle study cited by industry critics purporting that menhaden's "highest function" in the Bay is as a filter feeder, may actually indicate that menhaden serve a higher function through their harvest.

As for potential nitrogen-related "clean-up" efforts in the Bay, it would appear that the focus should remain onshore, as our region's wastewater facilities seem to be a principle source of the Bay's nitrogen problems. According to the Chesapeake Bay Foundation:

> *"There are 304 "significant" STPs* [sewage treatment plants] *in the* [Chesapeake Bay] *watershed, which discharge 1.5 billion gallons of wastewater each day. These plants contribute about 52 million pounds of nitrogen pollution annually to the Bay and its tributaries. To date, more than two-thirds of those plants do not use any technologies to remove nitrogen pollution, and only ten plants are currently reducing nitrogen pollution to state-ot-the-art levels, according to the most recent data available (2002).*[44]

Moreover, specifically in Virginia, of the 81 STPs identified by the Chesapeake Bay Foundation, only 7 maintain an "excellent" or "good" rating based on their nitrogen output, while 57 of the STPs maintain an "unsatisfactory" rating.[45]

From a relative impact statement, according to the Chesapeake Bay Foundation, in Virginia alone, STPs discharge over 23 million pounds of nitrogen annually into the Bay.[46] In comparison, according to Gottlieb's research, even if the menhaden reduction fishery were eliminated completely, the menhaden population would be capable of removing between only 0.4 to 2.4 million additional pounds of nitrogen annually.[47]

Ecosystem Management and Precautionary Principle

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[44] Chesapeake Bay Foundation, "Sewage Treatment Plants: The Chesapeake Bay Watershed's Second Largest Source of Nitrogen Pollution." October 29, 2003.
[45] *Ibid.*
[46] *Ibid.*
[47] Gottlieb, S.J., "Ecological Role of Atlantic Menhaden (Brevoortia Tyrranus} in Chesapeake Bay and Implications for Management of the Fishery." 1998.

The Interstate Fishery Management Program ("ISFMP") Charter is directed towards and focused on consumptive (though sustainable and responsible) use of marine fishery resources. Indeed, the purpose of the organization is:

> "*To promote the better utilization of the fisheries, marine, shell and anadromous, of the Atlantic seaboard by the development of a joint program for the promotion and protection of such fisheries, and by the prevention of the physical waste of the fisheries from any cause*."[48]

In this way, the mandate of the ASMFC is similar to that of Federal Fishery Management Councils under the Magnuson-Stevens Fishery Conservation and Management Act, in that in both cases, the goal of management – and all related conservation requirements such as those dealing with overfishing, habitat, and bycatch – is to insure that stocks are maintained at levels that produce the highest possible levels of sustainable harvest.[49] [50]

This background lays the predicate for a discussion of the issues that face this workshop, and to put them in a realistic legal and management framework. In short, that predicate is that the ASMFC is constrained to manage menhaden for menhaden yield, and this reality must be incorporated into the goals and objectives that workshop participants have with respect to the issues they have been asked to address.

Therefore, the questions of whether striped bass predation and population levels are optimal for menhaden production, whether the water quality of the Chesapeake Bay is suitable for menhaden stocks, and whether, from a scientific perspective, the menhaden fishery should be conducted over a larger area, both within the Bay and coastally, are of equal or greater importance to overall menhaden management, as well as any holistic consideration of the issues presented. Likewise, these questions are inherent in the mandate with which the Board has charged this workshop.

It should also be understood that the ASFMC can only employ management tools such as an "ecosystem approach" – an area that any fair observer would admit is in its infancy – and the "precautionary approach" to the extent they help the ASMFC fulfill its myriad of often conflicting goals.[51] Unfortunately, these concepts are often wielded as bludgeons by some preservationist

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[48] ISFMP Charter, Section One(a) (quoting the Atlantic States Marine Fisheries Compact and Rules and Regulations ("Compact"), Art. I (Dec. 2003)); *see also* Compact, Art. IV (requiring the Commission "to assure continuing yield from the fisheries resources").

[49] Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1801 *et seq.*

[50] The parallel overarching principle upon which the Magnuson-Stevens Act is based is: "The fish off the coasts of the United States, the highly migratory species of the high seas, the species which dwell on or in the Continental Shelf appertaining to the United States, and the anadromous species which spawn in United States rivers or estuaries, constitute valuable and renewable natural resources. These fishery resources contribute to the food supply, economy, and health of the Nation and provide recreational opportunities." 16 U.S.C. § 1801(a)(1).

[51] *See Conservation Law Foundation v. Mineta,* 131 F. Supp.2d 19, 27 (D.D.C. 2001) ("[The National Marine Fisheries Service, etc.] have numerous – and oftentimes competing – statutory objectives to contend with in managing the New England waters; preservation of essential fish habitat is only one of many. Defendants are charged with, among other things, fairly and equitably allocating fishing privileges among the states, rebuilding overfished species, minimizing adverse economic impacts on communities, and promoting the safety of human life at sea."). Although this was a case decided under the Magnuson-Stevens Act, the ASMFC Compact, ISFMP Charter, and ISFMP for Atlantic Menhaden contain either explicitly or implicitly, an identical set of "competing" goals and objectives. *See, e.g.,* ISFMP Charter Section One(a) (calling for both "promotion **and** protection" of fisheries) (emphasis added); Amendment 1 to the ISFMP for Atlantic Menhaden, at ii (July 2001) (establishing the goal of "manag[ing] 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").

advocates, usually to prevail over advocates for- or beneficiaries of- consumptive use of fishery resources.

Ecosystem Management vs. Fundamental ASMFC Management Objectives

Under the authorities governing the ASMFC, any management regime that seeks to utilize an "ecosystem approach" as a tool must conform to the goals and objectives outlined in the ISFMP Charter and the species' own FMP, as well as the general principles which define and limit the ASMFC's powers. Among these requirements are the needs to base measures on the scientific information available, minimize waste of fishery resources, and fairly and equitably allocate resources among states.[52] Furthermore, the Menhaden FMP itself imposes a species-specific set of objectives, among which are some that favor viewing the fishery in the "ecosystem" context.

For example, one of the biological objectives is to "*[p]rotect and maintain the Atlantic menhaden stock at levels to maintain viable fisheries and the forage base* . . . ."[53] Other objectives include protecting and maintaining the "*important ecological role Atlantic menhaden play along the coast*" and developing "*a public information program [on the] role of menhaden in the ecosystem*."[54] Finally, the plan calls upon the Menhaden Board to "*improve understanding of menhaden biology, food web ecology and multispecies interactions that may bear upon predator-prey and recruitment dynamics*."[55]

However, as noted above, the ASMFC's mandates are not always harmonious, and it is charged, as a policy-making body, with weighing competing interests and balancing conflicting demands. This is reflected as well in the Menhaden FMP, which also requires the Menhaden Board to "*optimize utilization of the* [menhaden] *resources*" (within certain constraints), "*maintain existing social and cultural features of the fishery to the extent possible*," and "insure *adequate access to fishing grounds*."[56] All these ambitious objectives are tied into the overall goal of balancing all biological, social, economic, and ecological objectives, while protecting the fish and those who harvest it.[57]

Into this mix of conflicting mandates, workshop participants are tasked to put some substance into the notion of an ecosystem approach for the Chesapeake Bay, and beyond. The lesson that these authorities impart is that any attempt to focus such an investigation solely on the "ecological niche" that menhaden occupy – in other words, which treats the resource solely for its utility to the rest of the marine ecosystem, for example solely as forage or filter-feeders – falls short of what the Menhaden Board and the ASMFC more generally need in order to refine the management of this species. Rather, the workshop must also account for Board's fundamental mandate to achieve continuing yield from the menhaden stock in the overall balance of interests.

Under its governing instruments, the ASMFC must achieve the highest ongoing and sustainable "return" from commercially and/or recreationally managed species under its authority.

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[52] ISFMP Charter, Section Six(a)(2), (4), (7)(ii).
[53] Amendment 1 to the Atlantic Menhaden FMP at ii
[54] *Ibid.*
[55] *Ibid.*
[56] *Ibid.*
[57] *Ibid.*

Furthermore, it must balance the interests of its member states, all user groups, and the public's interest, in which those with aesthetic interests may be counted along with those who benefit from consumptive uses, such as selling/eating fish or manufacturing/using products derived from menhaden. However, the ASMFC, and the Menhaden Board through Amendment 1 and the actions which instituted this workshop, recognize that management of one stock has implications for the management of other stocks. Consequently, the Board has sought guidance on how to jointly manage several stocks, while protecting the very marine ecosystem that fosters all healthy stocks.

Therefore, workshop participants must surely examine the resultant topics which naturally arise from this mandate, including "localized depletion" (however such a term is defined); the sustainability of all fishery harvests from the Chesapeake Bay; and the role of menhaden and Bay water quality.

However, the Board also needs to know the answers to the logical opposites to these questions, such as is the water quality of the Bay sufficient to protect menhaden "*nursery grounds to insure recruitment levels are adequate to support and maintain a healthy menhaden population*"?[58] The Board and the ASMFC more generally need to know how its managed fisheries interact in order to most effectively meet their overarching goals and objectives.

Thus, an ecosystem approach would look at the range of managed species, including striped bass, weakfish, bluefish, anchovies, blue crab, as well as menhaden and others, and describe the web of interactions among them as well as between them and the larger ecosystem in which they play a role. These roles should be understood and explained, including the effects (benefits and drawbacks from the perspective of jointly optimizing yield from an array of fish stocks) of maximizing biomass of apex predators, such as striped bass, on yields of prey species, like menhaden and crab.

Ultimately, it is this information that the Board and the ASMFC needs most in order to fulfill their mandates, because they are not able in a legal sense – nor would it be desirable – for the ASMFC to suppress yield in one commercially-important fishery just to marginally improve yields in another. More to the point, the ASMFC has no authority to manage stocks for exogenous purpose, such as improving water quality, separate and apart from its mandate to promote utilization.

The Future of Menhaden Management

Unilateral closures of state waters such as New Jersey's raise critical issues regarding the role of the ASMFC in regulating Atlantic menhaden.

During the existence of the Atlantic menhaden FMP over the last several decades, at no point has the ASMFC, the Menhaden Management Board, its technical committees, or advisory committees ever recommended that a single, individual state close its waters to the menhaden reduction fishery. Yet, one-by-one, states have done so. Today, the ASMFC body, whose Commissioners represent states from Florida to Maine, now regulates a fishery that only extends in state waters from North Carolina to Virginia.

[58] Amendment 1 to the Atlantic Menhaden FMP, at ii

Clearly, many member states have effectively abandoned the ASMFC regulatory process.

Consequently, in its discussions relative to the recommendations for revised or new directions for the Atlantic Menhaden FMP and its management, workshop participants should address the unilateral actions of individual states, the resultant discriminatory and balkanized patchwork of fishery regulations, and the role the ASMFC should- or should not- take regarding menhaden in the future.

Although the purpose of the ASMFC is to promote the better utilization of fisheries, as states have systematically eliminated their respective menhaden reduction fisheries (which historically have accounted for 80-85% of all coastwise menhaden landings), fishery utilization has effectively been eliminated. As a result, the Atlantic menhaden population now principally constitutes a non-utilized fishery resource north of Virginia and south of North Carolina along the Atlantic coast, rather than a utilized fishery.

As the purpose of the ASMFC is to promote fishery utilization, workshop participants should address the future role of the ASMFC in promulgating the Atlantic menhaden FMP.

The Menhaden Resource Council appreciates this opportunity to provide its views to participants of the Atlantic Menhaden Workshop, and we look forward to taking part in this upcoming meeting.

Sincerely yours,

Niels Moore
Director

NATIONAL COALITION FOR MARINE CONSERVATION
3 North King Street, Leesburg, VA 20176

THE NEED FOR A PRECAUTIONARY APPROACH TO PROTECT THE ECOLOGICAL ROLE OF ATLANTIC MENHADEN

by Ken Hinman, President

The Atlantic States Marine Fisheries Commission has scheduled a workshop October 12-14, 2004 in response to the concerns of fishermen and environmentalists that the concentration of Atlantic menhaden harvest over the past decade and more within Chesapeake Bay may be diminishing the ecological role of this important prey fish. The purpose of the workshop, according to the motion passed by the ASMFC Menhaden Management Board on May 26th, is to (a) examine the status of menhaden with respect to its ecological role, particularly as a forage fish for striped bass and other species, (b) explore the implications of concentrated harvest in Chesapeake Bay and the possibility of localized depletion, and (c) recommend new directions for management of the menhaden fishery.

As president of the National Coalition for Marine Conservation (NCMC), an environmental organization founded in 1973 and supported by conservation-minded fishermen, I have been actively promoting an ecosystem-based approach to managing our marine fisheries for many years. I served as a member of the National Marine Fisheries Service's Ecosystems Principles Advisory Panel and co-authored its 1999 Report to Congress, "Ecosystem-Based Fishery Management." I wrote the NCMC report, "Conservation in a Fish-Eat-Fish World: Managing Related Predator and Prey Species in Marine Fisheries," an attempt to provide direction and drive to emergent efforts to coordinate conservation and management of interdependent species. I am currently a member of the ASMFC's Menhaden Advisory Panel.

The NCMC is convinced that the Atlantic menhaden situation cries out for an ecosystem-based approach to management. The challenge for all of us – at this workshop, within the ASMFC - is to determine how best to apply that approach to this situation, at this point in time.

In an attachment to this statement (Appendix A), we describe the confluence of events and catalogue the evidence that persuades us that the ASMFC should act, and act now, to prevent an existing or pending ecological breakdown in Chesapeake Bay, with possible repercussions for migratory stocks beyond the Bay.

At this point in our scientific understanding of what is happening to menhaden and its impact on other species, the evidence is admittedly circumstantial, but we feel it is nonetheless compelling. Compelling enough, that is, to demand precaution in the way we manage the menhaden fishery – in terms of how many fish are taken, of what age/size, and where they are caught. (At the present time, we do not manage the fishery in this way.)

The **precautionary approach** is widely recognized as an essential ingredient of an ecosystem-based approach to management. The uncertainties inherent in single-species stock assessments are compounded when we look at the broader food web, making it more difficult to "connect all the dots," so to speak, between cause and effect. Research designed to obtain new data and conduct new analyses is definitely needed, but there will always be uncertainties and the need for new information should never be reason for inaction.

The burden of proof must be on scientists and managers to demonstrate that they are doing everything within reason to minimize the risks associated with these uncertainties. The NMFS EPAP advised that "(i)n practice, changing the burden of proof will mean that, when the effects of fishing on either the target fish population, associated species, or the ecosystem are poorly known (*relative to the severity of the potential outcome*), fishery managers should not expand existing fisheries by increasing allowable catch levels or permitting the introduction of new effort…"[59] Under the current management regime, there are no measures to prevent the expansion of the existing fisheries or an increase in catch, including from within Chesapeake Bay.

"High uncertainty calls for a high degree of caution, which in fisheries translates into low fishing mortality rates and low catch levels," says noted ecologist Paul Dayton in a recent study of the ecological effects of fishing. The greater the scientific uncertainty and the risks associated with that uncertainty, the greater the precaution needed to minimize those risks.[60] The need for precaution in management measures both argues for concerted efforts to improve the science and serves as an incentive for gaining a better understanding.

"Uncertainty will always be a defining characteristic of ecosystem-based management, just as it has been for single-species management," declares the Pew Oceans Commission . "Thus, decisions about marine ecosystems should take into account the risks inherent in making incorrect decisions."[61]

Earlier this year, the NOAA Chesapeake Bay Office published the first-ever "fisheries ecosystem plan" for a major marine ecosystem in the U.S., in this case the Chesapeake Bay. The document, "Fisheries Ecosystem Planning for Chesapeake Bay," specifically identifies the Atlantic menhaden fishery management plan (FMP) as a primary candidate for revision to incorporate their ecosystem-based recommendations. Among these recommendations: "Consider explicitly strong linkages between predators and prey in allocating fishery resources. *Be precautionary by determining the needs of predators before allocating forage species to fisheries*."[62] (emphasis added)

Applying the precautionary approach to the Atlantic menhaden fishery requires that fishery managers be *pro-active* or risk-averse. Pro-active management is called for when,

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[59] Ecosystem-Based Fishery Management. A Report to Congress by the Ecosystems Principles Advisory Panel. U.S. Department of Commerce. 1999. p. 19.
[60] Ecological Effects of Fishing in Marine Ecosystems of the United States. Dayton, Paul, et al. Pew Oceans Commission.
[61] America's Living Oceans: Charting a Course for Sea Change. Pew Oceans Commissions. May 2003. p. 90.
[62] Fisheries Ecosystem Planning for Chesapeake Bay. Chesapeake Fisheries Ecosystem Plan Technical Advisory Panel. NOAA Chesapeake Bay Office. February 2004. pp. 321 and 325.

despite scientific or other uncertainties, there is sufficient reason to believe a resource problem exists, or that a problem will exist in the foreseeable future if remedial action isn't taken. A pro-active management strategy accounts explicitly for uncertainty and incorporates risk reduction in the adoption of interim management measures while the science is improved.

Attached to this statement (as Appendix B) is a diagram of a pro-active approach the NCMC believes the Commission should take, beginning with this workshop and culminating in an amendment to the menhaden FMP. First, define the problem(s) based on all the available science. Second, assess the risks associated with inaction (*status quo*). Finally, consider the options for changing the way the fishery is managed with the goal of minimizing risks and ensuring sustainable fisheries for both the target species (menhaden) and associated species (striped bass and others).

Appendix A

ATLANTIC MENHADEN, STRIPED BASS & THE CHESAPEAKE BAY: SIGNS OF TROUBLE

The evidence of a possible ecological breakdown in Chesapeake Bay and beyond is mounting. The case for taking precautionary action to protect the role of menhaden in the ecosystem is compelling. The National Coalition for Marine Conservation believes the following signs of trouble, considered collectively in an ecosystem context, indicate a potentially serious threat and suggest the need for proactive management to minimize the risks to the Bay and its ability to support coastal marine resources. [See endnotes for references and sources.]

- Although the Atlantic stock of menhaden is found from Maine to Florida, the commercial harvest has become more and more concentrated within Chesapeake Bay.[i] Since 1997, 58% of the entire East Coast catch (by weight; nearly 70% by numbers of fish) has been taken from waters of the Bay.[ii]

- Beginning in the 1970s, the total removal of menhaden from the Chesapeake rose from an average of about 50,000 tons a year in the 1950s and '60s to an average of around 150,000 tons a year throughout the 1990s.[iii] The current Bay catch is about 100,000 tons annually.[iv]

- Chesapeake Bay is the main spawning ground for Atlantic striped bass, a key predator of menhaden. Possibly as much as 90% of the coastal migratory population breeds in the Bay.[v]

- Consolidation of the menhaden reduction fishery within Chesapeake Bay has coincided with the return of striped bass, beginning in the early 1990s.

- The numbers of striped bass and other consumers of menhaden (bluefish and gray trout, as well several species of water birds among them) have increased dramatically as a result of concerted efforts to rebuild previously depleted populations. As a result, total demand for prey is now at a level not experienced for decades, and growing.[vi]

- For large adult striped bass, the most prolific egg-producers[vii] and thus the key to a sustainable fishery for the future, immature menhaden are the preferred prey. The diet of mature bass typically consists of 70-80% menhaden, primarily sub-adult fish (under the age of 3).[viii]

- Nearly 9 of 10 menhaden harvested by the purse seine (reduction) fishery[ix] are sub-adult fish (age 0-2)[x] of prime forage size.

- The abundance of juvenile menhaden has been in decline since 1990 and is currently at an all-time low.[xi]

- Chesapeake Bay historically has been a nursery ground for nearly half (47%) of each new generation of menhaden recruiting to the coastwide stock. Indices of juvenile abundance are poorest in the Bay.[xii]

- The number of loons, osprey and other water birds nesting in the Bay or stopping there during their coastal migrations is down from a decade ago. Some scientists speculate the reason for the decline may be a lack of small menhaden.[xiii]

- The catch of underweight or "skinny" rockfish has been commonplace since the early days of the striped bass comeback in the mid-1990s. Samples collected from Chesapeake Bay confirm that on average bass carry only 10-25% of the body fat typically found in healthy fish.[xiv]

- The reduced weight-to-length ratio suggests poor nutritional health among the Bay's striped bass population.[xv] There are indications bass are feeding more on alternative and less nutritious prey, namely bay anchovy and blue crab, which are themselves at historical low supplies.[xvi]

- Over half the Bay's striped bass are infected with mycobacteriosis, a chronic wasting disease that scientists believe is stress-related and could be linked to malnutrition and/or poor water quality. The disease, rare in wild fish, first appeared in 1997 and has been increasing in frequency and severity ever since. It now has been detected in the coastal population as well.[xvii]

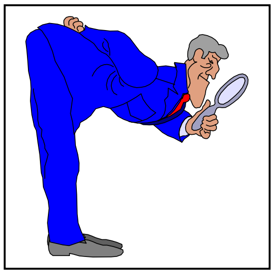
- Menhaden are a principal filter feeder of coastal waters, including Chesapeake Bay, second only to oysters, which are virtually extinct in the Bay. Menhaden control nutrient levels through grazing and transfer into fish tissue and make energy available for consumption by predators. Scientists recognize the potential to control water quality by regulating removals of menhaden.[xviii]

Appendix B

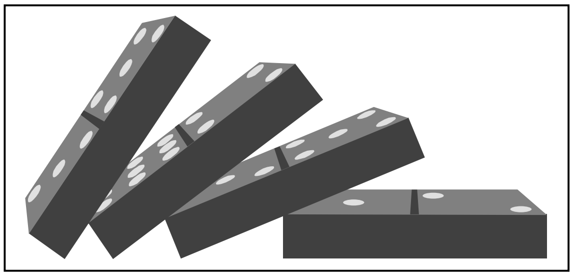
PRO- Active Fisheries Management

Pro-active (or risk-averse) management is called for when, despite scientific or other uncertainties, there is sufficient reason to believe a resource problem exists, or that a problem will exist in the foreseeable future if remedial action isn't taken. A pro-active management strategy accounts explicitly for uncertainty and incorporates risk reduction in the adoption of interim management measures while efforts are underway to improve the science and our understanding.

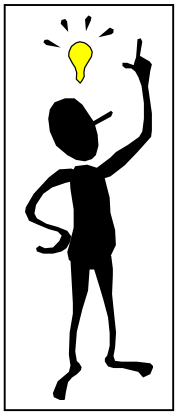
P Define the **P**ROBLEM



R Assess the **R**ISKS



O Consider the **O**PTIONS



Take Action!

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CHESAPEAKE BAY FORAGE BASE COLLAPSE & INTERACTIONS OF STRIPED BASS & ATLANTIC MENHADEN

REPORT TO:
MENHADEN ECOLOGICAL WORKSHOP
FOR THE MENHADEN MANAGEMENT BOARD
ATLANTIC STATES MARINE FISHERIES COMMISSION

October 12-14, 2004
Alexandria, Virginia

PREPARED BY:

CHESAPEAKE BAY ECOLOGICAL FOUNDATION, INC.

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CHESAPEAKE BAY FORAGE BASE COLLAPSE

& INTERACTIONS OF STRIPED BASS & ATLANTIC MENHADEN

The Atlantic coast striped bass fishery re-opened in 1990 following a five-year moratorium. New restrictions adopted by the Atlantic States Marine Fisheries Commission (ASMFC) established an annual quota and raised the striped bass minimum size limit in the Chesapeake Bay from 12" (age-2) to 18" (age-4). These measures altered the striped bass population's size structure and dramatically increased their forage demand in the Bay and along the Atlantic coast. The 18" minimum size limit in our estuarine waters and 28" minimum in coastal waters has resulted in unprecedented numbers of striped bass that must compete with the menhaden purse seine fishery for Atlantic menhaden. Young *menhaden* (ages 0-2), an essential part of the striped bass diet, declined 74% over the past decade and are no longer found throughout the Bay in sufficient numbers or adequate size to supply the forage demand of the Bay's striped bass. Striped bass in the Bay consumed larger prey and 300% more menhaden before the menhaden purse seine (reduction) fishery concentrated its efforts in Virginia's portion of the Bay, during the mid-1960s. From 1955 to 1965, the annual menhaden purse seine (reduction) fishery harvests from the Bay averaged 107 million pounds or approximately 11% of the total coastal landings. During the 1990s average menhaden purse seine (reduction) fishery landings had increased 500% to 379 million pounds from the Bay, approximately 58% of the total coastal landings. Most Atlantic coast striped bass now suffer from poor nutrition and approximately 50% of the Bay's population are infected with a disease called Mycobacteriosis. **The ASMFC has allowed the Atlantic coast migratory striped bass population's forage demand to exceed supply by 150% and menhaden to be overfished by the purse seine fishery.**

An outbreak of disease among striped bass has coincided with the decline of their forage base. Striped bass with sores and lesions (Ulcerative Dermatitis) were first documented in 1994 by Dr. Eric May, Maryland Department of Natural Resources (MD-DNR). In 1997, James Price, president, Chesapeake Bay Ecological Foundation, notified the MD-DNR and the U.S. Fish & Wildlife Service that 12% of the 190 striped bass examined in a Striped Bass Cooperative Survey had external sores and lesions. Most of the striped bass had no fat in their body cavities and showed signs of poor nutrition. Dr. Steve Jordan, MD-DNR, reported that striped bass collected in the 1998-2003 fall surveys had: ***"Weight at length, tissue moisture and lipid levels (that) were not significantly different from wild fish starved for two months at Horn Point Laboratory were not characteristic of values obtained from wild fish in 1990-1991"***. Since 1997, striped bass have shown an increasing prevalence of anomalies (skin abrasions, lesions, or bacterial infections). The MD-DNR striped bass pound net tagging survey found that by August 2004, 29% of the striped bass had external anomalies, more than twice the number in 1997, when the bay-wide survey began. Anomalies are cause for concern because they indicate nutritional stress and disease. Fishery scientists and pathologists from the University of Maryland and Virginia Institute of Marine Science (VIMS) have warned fishery managers that Mycobacteriosis has infected approximately 50% of the striped bass population, with one strain known to cause death. A University of Maryland study by Dr. Anthony Overton from 1998 to 2001 indicates Mycobacterium infections in striped bass originated in the Bay, affecting the health and survival of both resident and migratory fish. A 2003 report by Victor Crecco, Connecticut Marine Fisheries Division, that analyzed striped bass mortality and tagged-based exploitation rates found a dramatic rise in natural mortality rates after 1997 for 18"+ striped bass from the Chesapeake Bay. This could suggest that natural mortality from starvation and disease has reduced the number of older striped bass in the Bay.

The ASMFC has failed to take action that could prevent ***growth overfishing*** by the menhaden purse seine (net that encircles large numbers of fish) fishery. Growth overfishing is defined, according to research funded by the National Oceanographic and Atmospheric Administration (NOAA) as "*When fishing pressure on smaller fish is too heavy to allow the fishery to produce its maximum poundage.*" This intensive fishery, which processes fish into meal and oil, is the largest commercial fishing operation on the Atlantic coast. Fishery scientists, fishermen and the environmental community are concerned that menhaden are being ***overfished,*** causing a depletion of menhaden and damage to the Chesapeake Bay's ecosystem. **The Bay's annual menhaden purse seine (reduction) fishery landings have averaged 315 million pounds since 1965. Historically, this huge biomass of menhaden was an integral component of the Bay's ecology. Atlantic menhaden improved water clarity by consuming an enormous amount of nutrients, and provided essential forage for older striped bass, bluefish and weakfish.**

ASMFC's Interstate Fishery Management Plan (FMP) for Atlantic menhaden fails to comply with national standards specified in the Magnuson Act, e.g.: The first standard to "*...prevent overfishing while achieving, on a continuing basis, the optimum yield for each fishery.*" Optimum yield, according to research funded by NOAA, is defined as "*the amount of fish which will provide the greatest overall benefit to the nation*". The Atlantic Menhaden FMP doesn't limit the number or size of fish that can be caught by the menhaden purse seine fishery. Omega Protein Corporation, based in Houston, Texas, has a monopoly over the menhaden purse seine (reduction) fishery in the Chesapeake Bay, and has been allowed to ***overfish*** menhaden in the Bay and nearby coastal waters. This massive removal of menhaden from the Bay has been equal in biomass to five times Maryland's annual commercial seafood harvest. **NMFS Stock Assessment Report No. 04-01 indicates: From 1992 through 2002, the purse seine fishery harvest annually averaged approximately 50% of the estimated menhaden population ages 3-8, which represent the spawning stock biomass; the estimated landings of the bait fishery accounted for 24% and the reduction fishery 76%.**

A bioenergetics (diet and growth) modeling study by Jennifer Griffin, (2001) examined striped bass data collected by MD-DNR from 1955-1959, before the purse seine (reduction) fishery concentrated their efforts in the Bay. Griffin stated: "*Atlantic menhaden was the primary prey of striped bass in the Chesapeake Bay in the early 1950s...predation demand was only slightly below prey supply throughout the modeled year for all ages*". Hartman and Brandt's (1995) bioenergetics modeling study, conducted from 1990-1992, concluded: "*Total prey demand by age-3 striped bass exceeded supply by 80%, while demand by age-4 through age-6 striped bass was 101-103% higher than supply*", **Overton (2001) suggested prey supply, availability and size were not able to support production of older striped bass in the Bay, and by the time striped bass reach age-6, they annually consume 38% less forage and weigh approximately 40% less than they did from 1955 to 1959.**

The estimated Atlantic coast population of *menhaden* (ages 0-2) averaged 795 billion from 1955 to 1959. Bioenergetics modeling using data for the same time period estimated menhaden comprised 77% of the Bay's ages 3-6 striped bass diet (Griffin 2001). *Menhaden* (ages 0-2) *declined* to an average of 544 billion fish during 1990-1992 and according to Hartman and Brandt's bioenergetics modeling data, they comprised 65% of the Bay's ages 3-6 striped bass diet. *Menhaden* (ages 0-2) declined to an average of 233 billion fish from 1998 to 2001. Overton's bioenergetics modeling study reported that menhaden comprised 21% of the Bay's ages 3-6 striped bass diet during 1998 to 2001. The Atlantic coast population of *menhaden* (ages 0-2) declined to 158 billion fish in 2000, 80% less than from 1955-1959, according to estimates by the National Marine Fisheries Service (NMFS).

The ASMFC continues to focus on increasing the striped bass stock without considering the ecological impact striped bass forage demand has on other species. Atlantic menhaden are no longer available as an abundant source of forage; Maryland and Virginia juvenile indices and pound net catch per effort in the Potomac River and Maryland's portion of the Bay are at their lowest level on record. Predation rates on blue crab, the most important fishery for the Bay's watermen, have dramatically increased; Overton's bioenergetics modeling study reported that blue crab contributed more than 17% to the diet of ages 4-6 striped bass from 1998 to 2001. Blue crab spawning stock abundance also declined over the past decade, according to Virginia and Maryland trawl surveys; estimates for 2000 and 2001 are the lowest on record. Also, Overton reported that age-3 striped bass consumption of bay anchovy increased 500% over the past decade and at the same time bay anchovy declined to the lowest level on record, according to finfish surveys conducted by the MD-DNR and Virginia Institute of Marine Science. **Most alarming is that increased predation on bay anchovy has reduced their total biomass and limited the crucial role they play in the Bay's food web.**

Under the Atlantic Coastal Fisheries Cooperative Management Act, the ASMFC fails to achieve it's primary objectives in the Atlantic menhaden FMP, to *"protect and maintain...the forage base"* and *"the important ecological role Atlantic menhaden play along the coast"*. In 2002 the purse seine (bait) fishery harvest was approximately 65 million pounds; the purse seine (reduction) fishery harvest was 382 million pounds, of which 80% were *menhaden* (ages 0-2). According to research funded by NOAA, **overfishing** is defined as *"harvesting at a rate greater than that, which will meet the management goal"*. D.S. Vaughn stated: "Production-model estimates depict a stock that has been heavily exploited, perhaps excessively so, since at least the 1960s". **NMFS Stock Assessment Report No. 04-01 (Supplement) data indicates: 1. During the1960s, when the purse seine fishery was harvesting a high percentage of the menhaden age 3+ (spawning stock), recruitment of menhaden age-0 in the Bay remained poor. 2. When the percentage of menhaden age 3+ harvested during the 1970s through the 1980s declined, recruitment of menhaden age-0, in the Bay, increased dramatically. 3. In 1992, the purse seine fishery overfished menhaden age 3+ by harvesting approximately 73% of the estimated spawning stock when the stock was low. This was the highest percentage of menhaden age 3+ removed by the purse seine fishery since 1968, and the following year menhaden recruitment in the Bay was the lowest in 23 years. 4. Since 1992, the percentage of menhaden age 3+ harvested by the purse seine fishery increased again and recruitment of menhaden age-0 in the Bay declined to a low level comparable to the 1960s.**

The combination of increased predation by striped bass and overfishing by the purse seine fishery led to poor recruitment of Atlantic menhaden in the Bay since the 1990s. This caused striped bass in the Bay to shift their diet from menhaden to bay anchovy, blue crab and alternative prey in an attempt to survive. Forage demand of striped bass age 8+ increased 15 fold from 1985 to 2002, (totaling 3,491,000 fish), with the potential predatory demand in 2002 to remove 53% of the purse seine reduction fishery harvest of menhaden age 3+. According to Overton's bioenergetics study, striped bass age 8+ forage demand for menhaden age 3+ in 2002 averaged only 24 menhaden per striped bass, but totaled 81,700,000 pounds. In 1992, the number of menhaden age 3+ removed by the purse seine fishery combined with predatory demand of striped bass age 8+ totaled 87% of the estimated menhaden spawning stock. The Atlantic coast striped bass potential forage demand (396,000mt) in 2002 was 200% more than the average purse seine reduction fishery harvest (198,000mt) from 1998 to 2002.

Forage demand by striped bass age 8-15 is 150% higher than supply and the average individual weight at age for the 12 to 15 year old migratory coastal stock declined 15% by 2002, compared to the average weight from 1982 to 2001. This may indicate that forage size menhaden age 3+ are not available in sufficient numbers to supply the forage demand of large migratory striped bass.

A bioenergetics modeling study, conducted by Hartman and Brandt from 1990 to 1992, suggests that growth conditions for striped bass are now much less favorable than they once were in the Chesapeake Bay "*...management measures that permit increased escapement and presumably increased migration of age-1 and older menhaden to the Chesapeake Bay will benefit the production of striped bass, bluefish and weakfish*". Overton stated: *"The consumption of Atlantic menhaden has declined significantly from 1959 to 2001 concurrent with a greater dependence on benthic pathways* (bottom dwelling organisms) *as an energy source for striped bass. Managers must consider new approaches such as managing the abundance and health of prey for top predators"*.

The ASMFC and NMFS should implement management measures to maintain the forage base for coastal predator species in order to achieve the ecological objectives and goals of their FMPs. The striped bass recovery is at risk because their forage base has collapsed and most of the striped bass in the Bay and along the coast suffer from poor nutrition and disease. The ASMFC needs to reduce fishing mortality and natural mortality on Atlantic menhaden. This should eventually help rebuild the menhaden stock, the forage base for many species of fish, birds and mammals along the Atlantic coast, and help restore the Chesapeake Bay ecosystem.

Note: Menhaden age 3+ were estimated to weigh one pound each for the purpose of simplifying comparisons and making calculations. The actual weight chart in the ASMFC stock assessment report for 2003 estimates the weight of age 3 menhaden at 414.1 grams, or .91 pounds at the middle of the fishing year.

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Stock Assessment Report No. 04-01 (Supplement)
of the

Atlantic States Marine Fisheries Commission

Atlantic Menhaden Stock Assessment Report for Peer Review

Conducted on
October 6 & 7, 2003
Raleigh, North Carolina

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Table 5.6 Estimated bait landings of Atlantic menhaden in numbers by age (in millions), 1985-2002.

	Age						
Year	0	1	2	3	4	5	6-8
1985	0.52	8.71	62.74	18.78	6.84	1.35	0.25
1986	0.33	5.08	39.27	31.23	14.84	1.23	0.30
1987	0.43	4.81	48.02	31.64	14.96	1.28	0.30
1988	0.40	6.13	46.02	41.06	20.56	1.70	0.41
1989	0.52	7.87	56.65	30.18	12.44	1.22	0.25
1990	0.61	23.27	44.46	30.89	14.37	1.34	0.29
1991	0.34	15.53	49.15	39.42	19.16	1.81	0.39
1992	0.54	18.46	41.80	41.87	20.00	2.06	0.42
1993	0.76	21.29	23.27	38.88	19.13	1.99	0.40
1994	0.21	8.46	37.05	27.50	15.58	2.24	0.16
1995	0.00	23.41	26.66	36.48	24.84	0.07	0.00
1996	0.04	2.77	34.99	21.69	5.52	0.21	0.00
1997	0.00	2.25	25.36	20.57	16.95	4.86	0.84
1998	3.22	4.91	45.12	32.39	21.80	3.49	0.66
1999	0.14	5.19	74.70	30.46	13.75	1.78	0.29
2000	0.57	17.64	63.40	20.48	8.33	1.04	0.28
2001	0.20	4.63	54.87	37.29	4.76	0.63	0.14
2002	0.00	4.84	36.76	44.13	9.43	0.93	0.06

Table 5.1 Estimated reduction landings of Atlantic menhaden in numbers by age (in millions), 1955-2002.

	Age						
Year	0	1	2	3	4	5	6-8
1955	761.0	674.2	1057.7	267.3	307.2	38.1	13.0
1956	36.4	2073.3	902.7	319.6	44.8	150.7	37.4
1957	299.6	1600.0	1361.8	96.7	70.8	40.5	42.3
1958	106.1	858.2	1635.4	72.1	17.3	15.9	14.4
1959	11.4	4038.7	851.3	388.3	33.4	11.9	18.7
1960	72.2	281.0	2208.6	76.4	102.2	23.8	11.0
1961	0.3	832.4	503.6	1209.6	19.2	29.4	3.9
1962	51.6	514.1	834.5	217.3	423.4	30.8	28.3
1963	96.9	724.2	709.2	122.5	45.0	52.4	14.3
1964	302.6	704.0	605.0	83.5	17.9	7.9	8.3
1965	259.1	745.2	421.4	77.8	12.2	1.8	2.0
1966	349.5	550.8	404.1	31.7	3.9	0.4	0.3
1967	7.0	633.2	265.7	72.8	5.1	0.5	0.0
1968	154.3	377.4	539.0	65.7	10.7	1.0	0.1
1969	158.1	372.3	284.3	47.8	5.4	0.2	0.0
1970	21.4	870.9	473.9	32.6	4.0	0.1	0.0
1971	72.9	263.3	524.3	88.3	17.8	2.5	0.0
1972	50.2	981.3	488.5	173.1	19.1	1.9	0.0
1973	56.0	588.5	1152.9	38.6	7.0	0.3	0.0
1974	316.6	636.7	986.0	48.6	2.5	1.4	0.0
1975	298.6	720.0	1086.5	50.2	6.6	0.2	0.1
1976	274.2	1612.0	1341.1	48.0	8.0	0.3	0.0
1977	484.6	1004.5	2081.8	83.5	17.8	1.4	0.1
1978	457.4	664.1	1670.9	258.1	31.2	3.5	0.0
1979	1492.5	623.1	1603.3	127.9	21.8	1.5	0.1
1980	88.3	1478.1	1458.2	222.7	69.2	14.4	1.4
1981	1107.6	698.7	1811.5	222.2	47.5	15.4	1.3
1982	114.1	919.4	1739.6	379.7	16.3	5.8	0.9
1983	964.4	517.2	2293.1	114.4	47.4	5.0	0.7
1984	1294.2	1024.2	892.1	271.5	50.3	15.2	0.5
1985	637.2	1075.9	1224.6	44.1	35.6	6.3	1.7
1986	98.4	224.2	1523.1	49.1	10.5	6.1	1.1
1987	42.9	504.7	1587.7	151.9	25.2	2.2	0.7
1988	338.8	282.7	1157.7	301.4	69.8	7.1	0.6
1989	149.7	1154.6	1158.5	108.4	47.5	11.6	0.2
1990	308.1	132.8	1553.1	109.0	42.2	12.3	0.4
1991	881.8	1033.9	946.1	254.0	38.0	10.7	2.2
1992	399.7	727.2	795.4	66.1	51.3	10.9	1.9
1993	67.9	379.0	983.1	148.9	10.9	3.9	0.3
1994	88.6	274.5	888.9	165.1	67.2	7.5	0.2
1995	56.8	533.7	671.9	309.1	67.5	4.4	0.0
1996	33.7	209.1	679.1	139.0	29.0	2.0	0.0
1997	25.2	246.9	424.5	237.4	51.6	9.0	1.2
1998	72.8	185.0	540.6	126.3	73.0	9.0	0.8
1999	193.9	301.1	450.8	81.8	25.0	3.2	0.4
2000	77.8	114.2	340.6	111.9	11.1	1.9	0.0
2001	23.0	43.5	369.5	217.6	14.9	0.7	0.0
2002	178.2	211.7	259.8	135.8	17.1	0.5	0.0

Table 7.3 Estimated numbers of Atlantic menhaden (in billions) at start of fishing year from forward-projecting statistical age-structured model (base Ricker run), 1955-2002.

	Age								
Year	0	1	2	3	4	5	6	7	8
1955	809.17	5.11	2.24	0.56	0.796	0.099	0.0144	0.00111	0.00042
1956	765.61	10.83	1.58	0.49	0.110	0.155	0.0194	0.00308	0.00035
1957	446.46	10.23	2.98	0.20	0.054	0.012	0.0172	0.00235	0.00044
1958	1639.96	5.97	3.08	0.57	0.034	0.009	0.0021	0.00324	0.00055
1959	248.49	21.95	1.91	0.80	0.133	0.008	0.0022	0.00053	0.00102
1960	356.50	3.33	6.91	0.45	0.170	0.028	0.0017	0.00050	0.00038
1961	227.92	4.77	1.14	2.45	0.147	0.055	0.0092	0.00060	0.00033
1962	215.65	3.05	1.53	0.30	0.577	0.034	0.0129	0.00238	0.00025
1963	171.89	2.88	0.88	0.25	0.042	0.082	0.0049	0.00202	0.00043
1964	197.98	2.30	0.77	0.10	0.024	0.004	0.0080	0.00053	0.00028
1965	168.86	2.64	0.61	0.08	0.009	0.002	0.0004	0.00079	0.00008
1966	237.61	2.25	0.60	0.03	0.003	0.000	0.0001	0.00002	0.00004
1967	127.99	3.17	0.54	0.04	0.002	0.000	0.0000	0.00001	0.00000
1968	205.64	1.71	0.90	0.08	0.005	0.000	0.0000	0.00000	0.00000
1969	346.46	2.75	0.46	0.10	0.008	0.001	0.0000	0.00000	0.00000
1970	173.14	4.64	0.85	0.10	0.021	0.002	0.0001	0.00000	0.00000
1971	414.37	2.32	1.35	0.14	0.015	0.003	0.0002	0.00002	0.00000
1972	296.42	5.55	0.74	0.34	0.031	0.003	0.0007	0.00006	0.00000
1973	349.14	3.96	1.59	0.11	0.045	0.004	0.0004	0.00010	0.00001
1974	432.57	4.67	1.17	0.28	0.017	0.007	0.0006	0.00008	0.00002
1975	726.07	5.78	1.38	0.20	0.043	0.003	0.0011	0.00011	0.00002
1976	601.24	9.71	1.76	0.28	0.037	0.008	0.0005	0.00022	0.00003
1977	545.05	8.04	2.90	0.32	0.046	0.006	0.0013	0.00009	0.00005
1978	565.96	7.29	2.46	0.60	0.060	0.008	0.0011	0.00026	0.00003
1979	957.30	7.57	2.18	0.45	0.098	0.010	0.0014	0.00020	0.00006
1980	568.67	12.80	2.26	0.40	0.074	0.016	0.0016	0.00025	0.00005
1981	853.32	7.60	3.75	0.38	0.060	0.011	0.0024	0.00027	0.00005
1982	326.84	11.42	2.31	0.76	0.069	0.011	0.0020	0.00048	0.00007
1983	587.15	4.37	3.38	0.41	0.119	0.011	0.0017	0.00035	0.00010
1984	832.01	7.85	1.26	0.53	0.057	0.017	0.0015	0.00026	0.00007
1985	690.11	11.12	2.19	0.17	0.063	0.007	0.0020	0.00020	0.00005
1986	508.51	9.23	3.45	0.48	0.032	0.012	0.0013	0.00042	0.00006
1987	365.29	6.81	3.09	1.10	0.138	0.009	0.0034	0.00041	0.00016
1988	723.87	4.89	2.24	0.91	0.301	0.038	0.0025	0.00101	0.00017
1989	281.93	9.69	1.55	0.54	0.196	0.064	0.0082	0.00061	0.00030

Table 7.3 (*continued*).

	Age								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1990	506.09	3.77	2.97	0.32	0.096	0.035	0.0116	0.00164	0.00019
1991	603.88	6.77	1.19	0.70	0.067	0.020	0.0074	0.00269	0.00045
1992	498.79	8.07	1.94	0.17	0.086	0.008	0.0025	0.00107	0.00049
1993	348.04	6.68	2.56	0.46	0.035	0.017	0.0016	0.00059	0.00040
1994	456.97	4.66	2.19	0.74	0.118	0.009	0.0044	0.00047	0.00030
1995	254.36	6.12	1.56	0.71	0.221	0.035	0.0027	0.00141	0.00026
1996	241.43	3.40	1.97	0.42	0.173	0.054	0.0087	0.00071	0.00046
1997	215.30	3.23	1.13	0.62	0.124	0.051	0.0161	0.00273	0.00038
1998	287.29	2.88	1.05	0.32	0.162	0.032	0.0135	0.00450	0.00090
1999	285.96	3.84	0.90	0.23	0.059	0.030	0.0060	0.00293	0.00129
2000	153.12	3.83	1.24	0.22	0.046	0.012	0.0060	0.00147	0.00116
2001	187.81	2.05	1.28	0.38	0.058	0.012	0.0031	0.00184	0.00088
2002	406.81	2.51	0.67	0.36	0.095	0.014	0.0030	0.00087	0.00082

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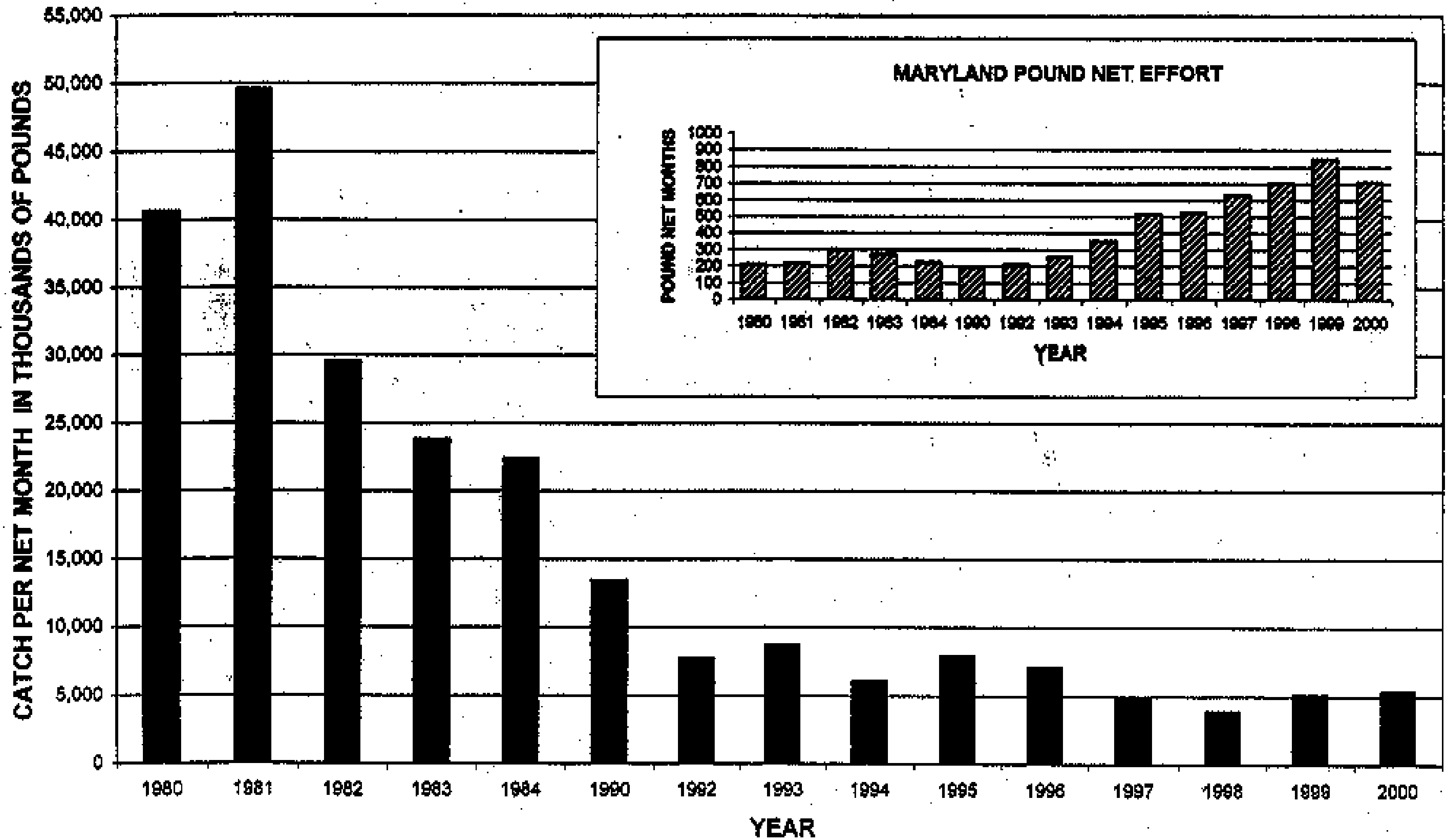
MARYLAND POUND NET LANDINGS OF ATLANTIC MENHADEN

MARYLAND DNR LANDINGS DATA



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The 2000 average catch per net month has declined 89% since 1981 In Maryland's portion of the Chesapeake Bay and It's tributaries

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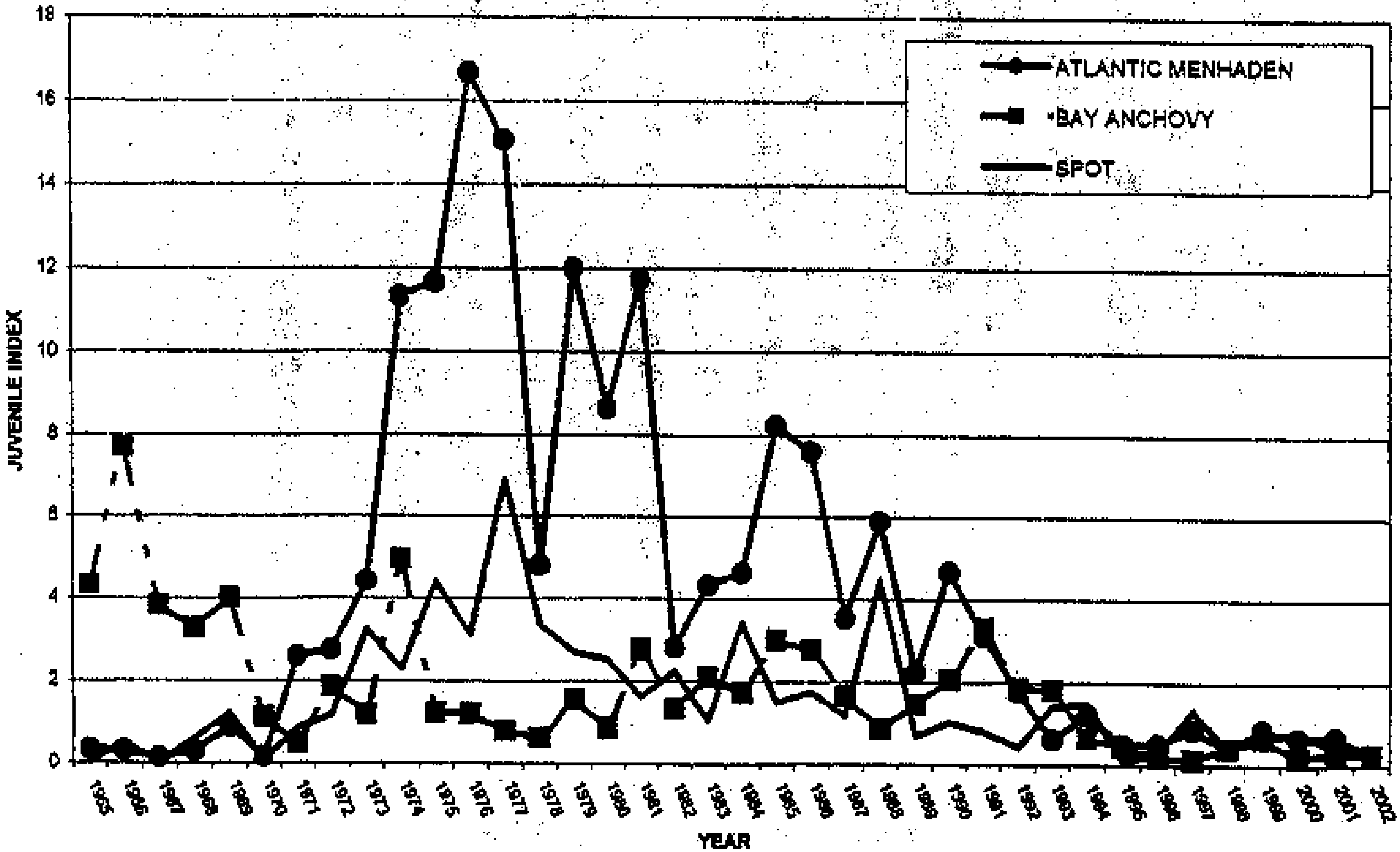
STRIPED BASS FORAGE BASE IN CHESAPEAKE BAY

MARYLAND DNR JUVENILE SEINE SURVEY DATA



Striped Bass minimum size limit 12" until 1983.

Striped Bass minimum size limit 18" from 1990 to present.

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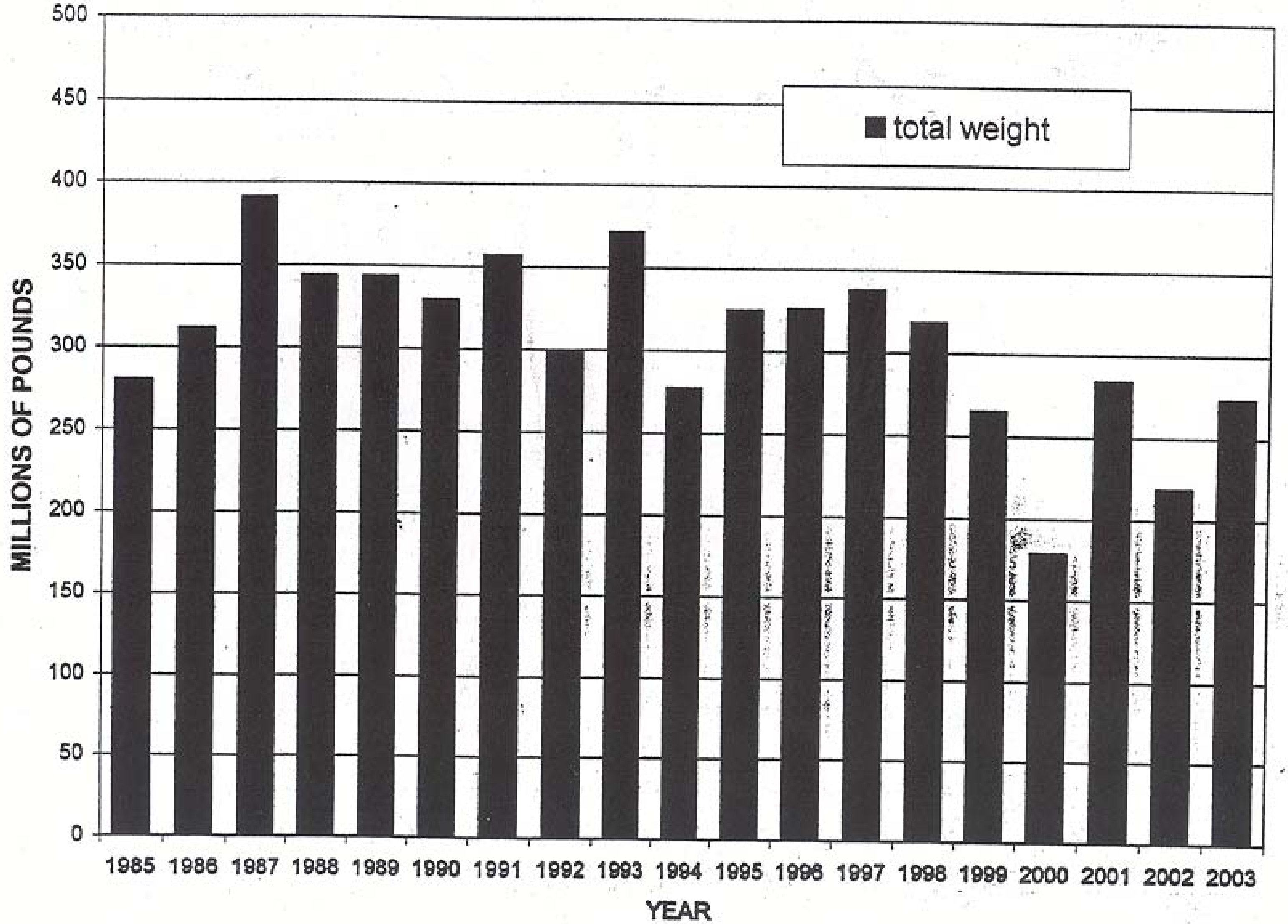
CHESAPEAKE BAY ATLANTIC MENHADEN REDUCTION FISHERY LANDINGS

NMFS POPULATION DYNAMICS TEAM DATA



The total estimated purse-seine landings of 179 million pounds from Virginia's portion of the Chesapeake Bay in 2000 are 45% below the previous 15 year average of 314 million pounds

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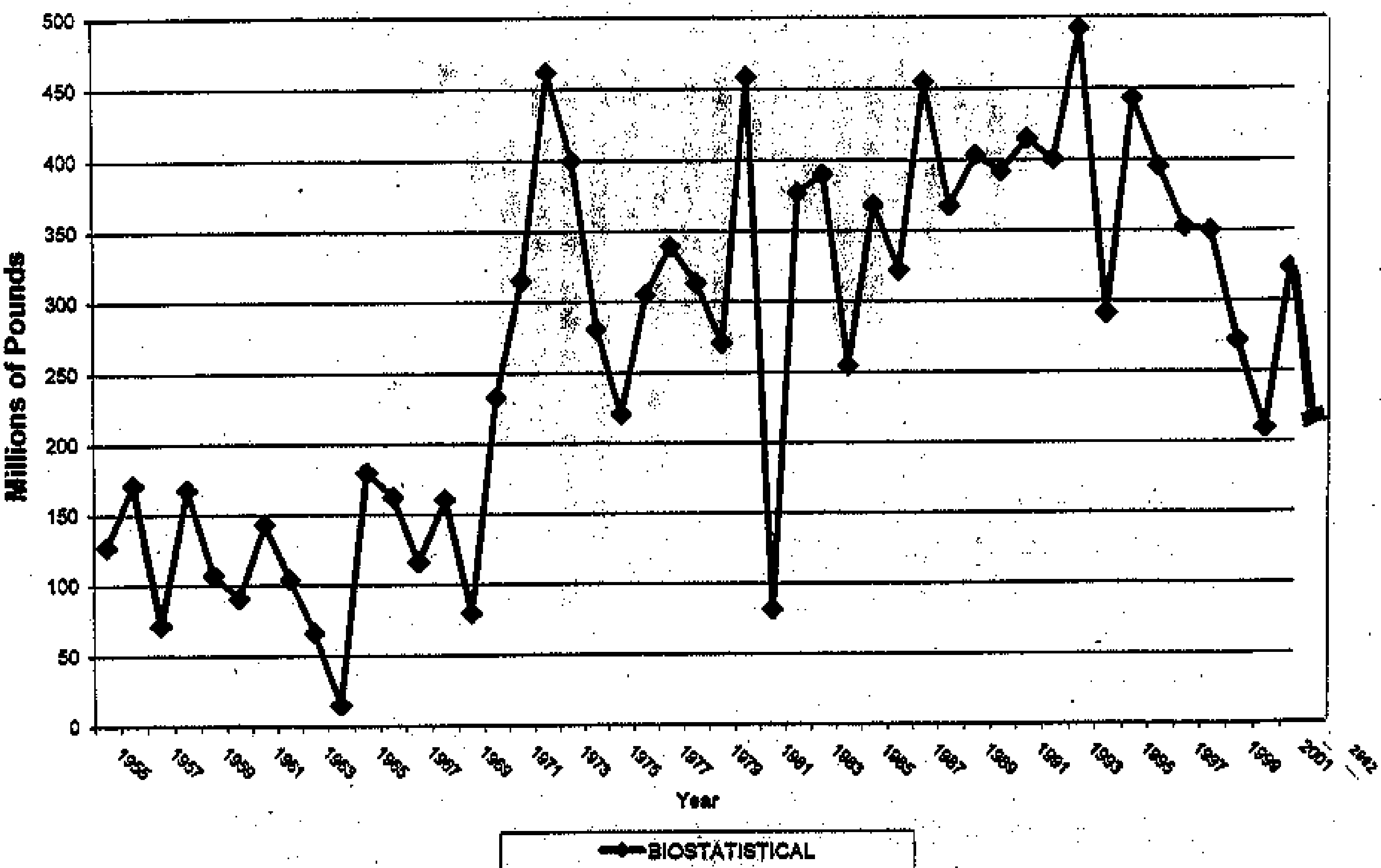
CHESAPEAKE BAY REDUCTION FISHERY LANDINGS

NATIONAL MARINE FISHERIES SERVICE DATA



Estimated catch of Atlantic menhaden from Virginia's portion of the Chesapeake Bay using Biostatistical sampling.

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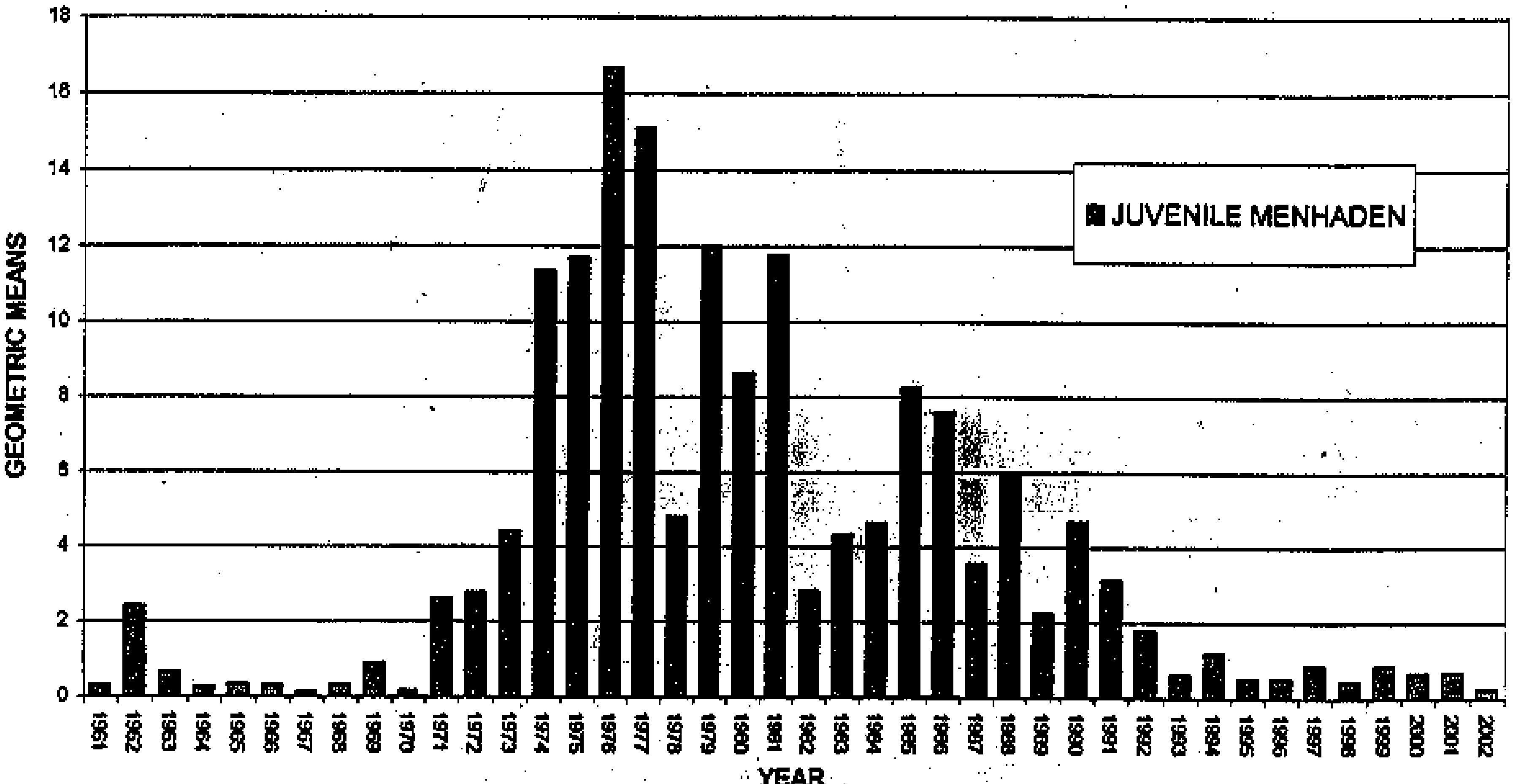
MARYLAND JUVENILE ATLANTIC MENHADEN GEOMETRIC MEAN

MARYLAND DNR JUVENILE SEINE SURVEY DATA



Juvenile Atlantic menhaden utalizing Maryland's portion of the Chesapeake Bay and its tributaries have experienced poor recruitment since 1992.

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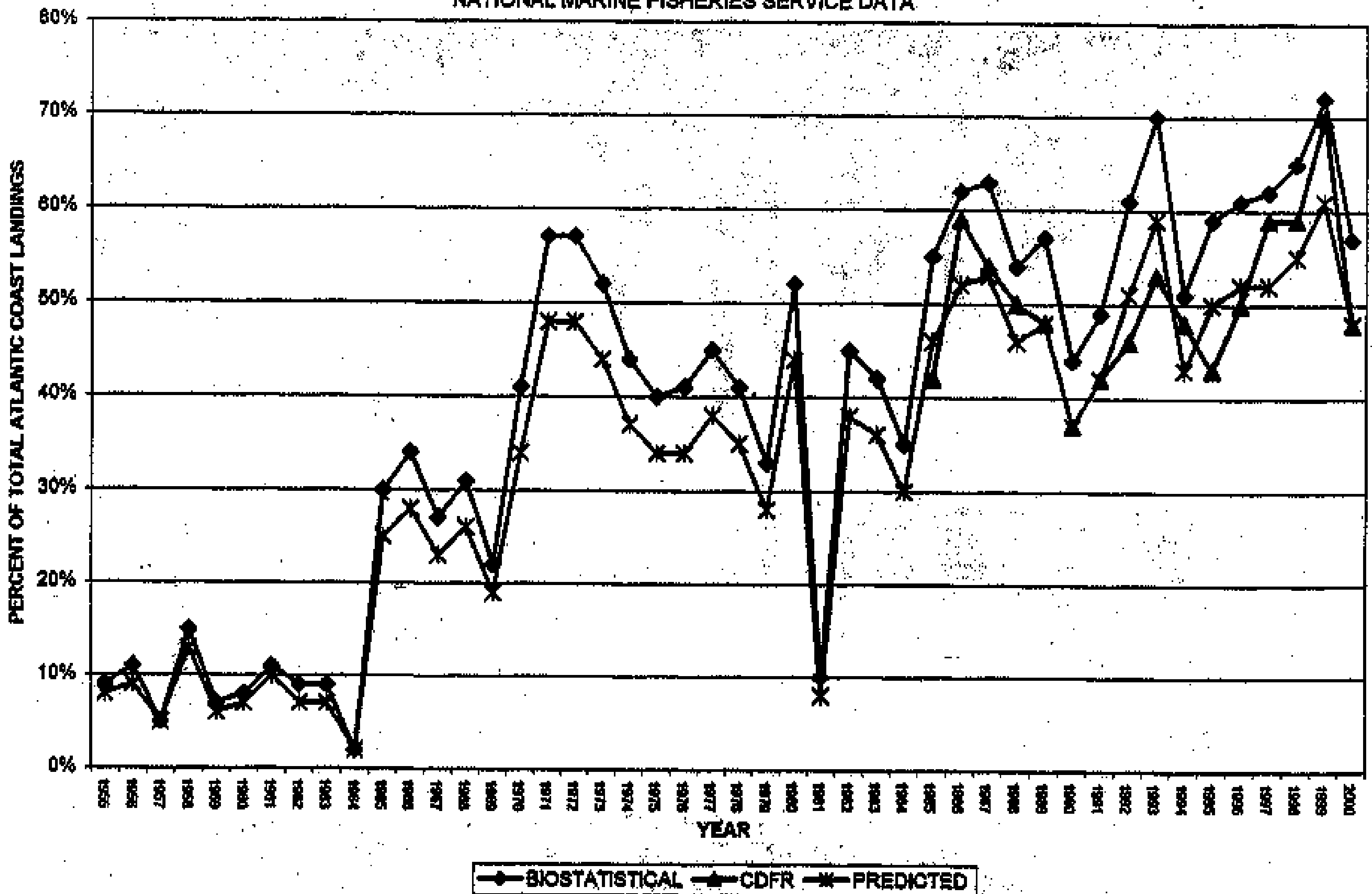
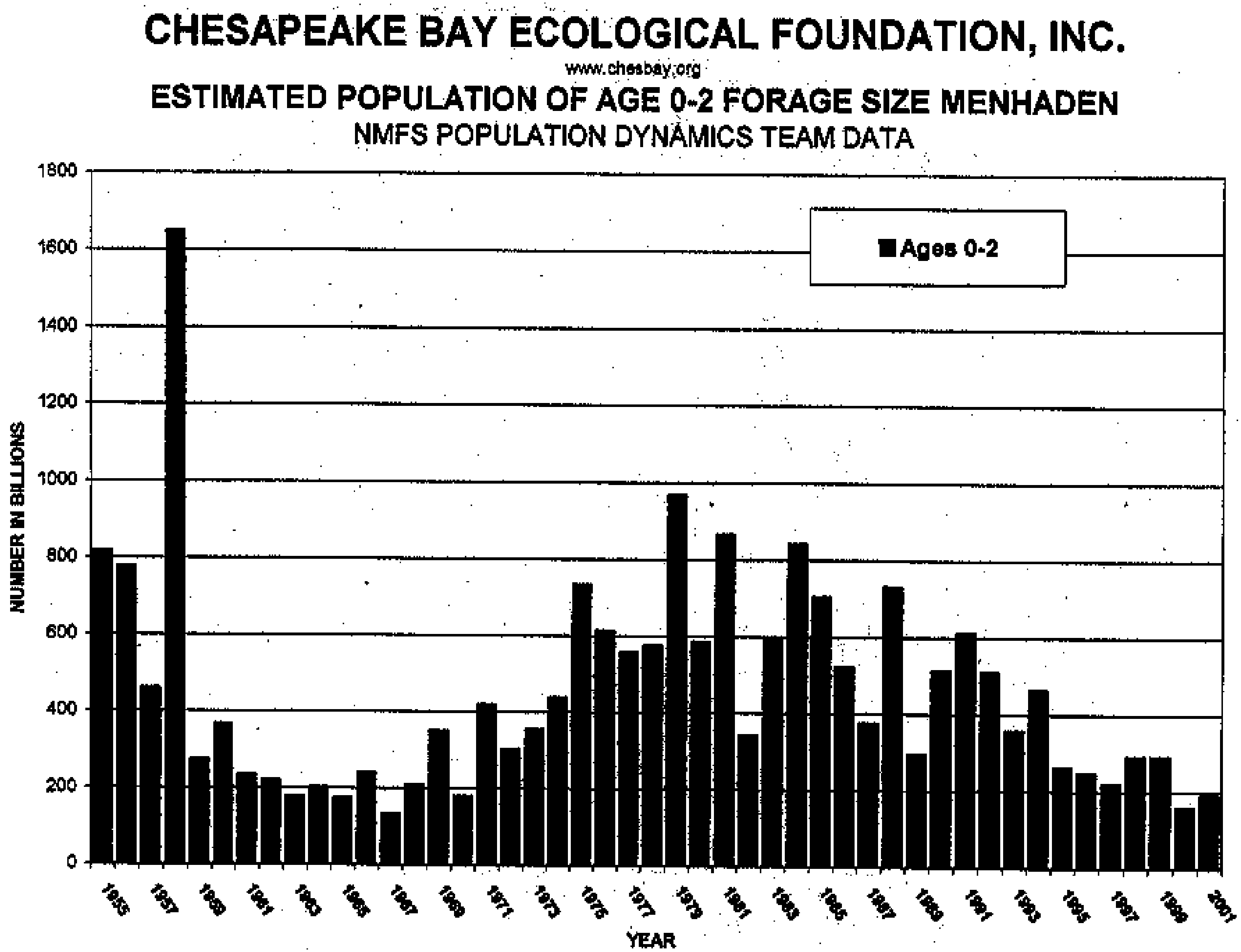
CHESAPEAKE BAY REDUCTION FISHERY LANDINGS

NATIONAL MARINE FISHERIES SERVICE DATA



Estimated Atlantic menhaden landings from VA's portion of the Chesapeake Bay shown as a percent of total Atlantic coast landings using biostatistical sampling, Captain's Daily Fishing Reports, and predicted from no-intercept linear regression.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ESTIMATED POPULATION OF AGE 0-2 FORAGE SIZE MENHADEN
NMFS POPULATION DYNAMICS TEAM DATA
Ages 0-2
NUMBER IN BILLIONS
0
200
400
600
800
1000
1200
1400
1600
1800
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
YEAR

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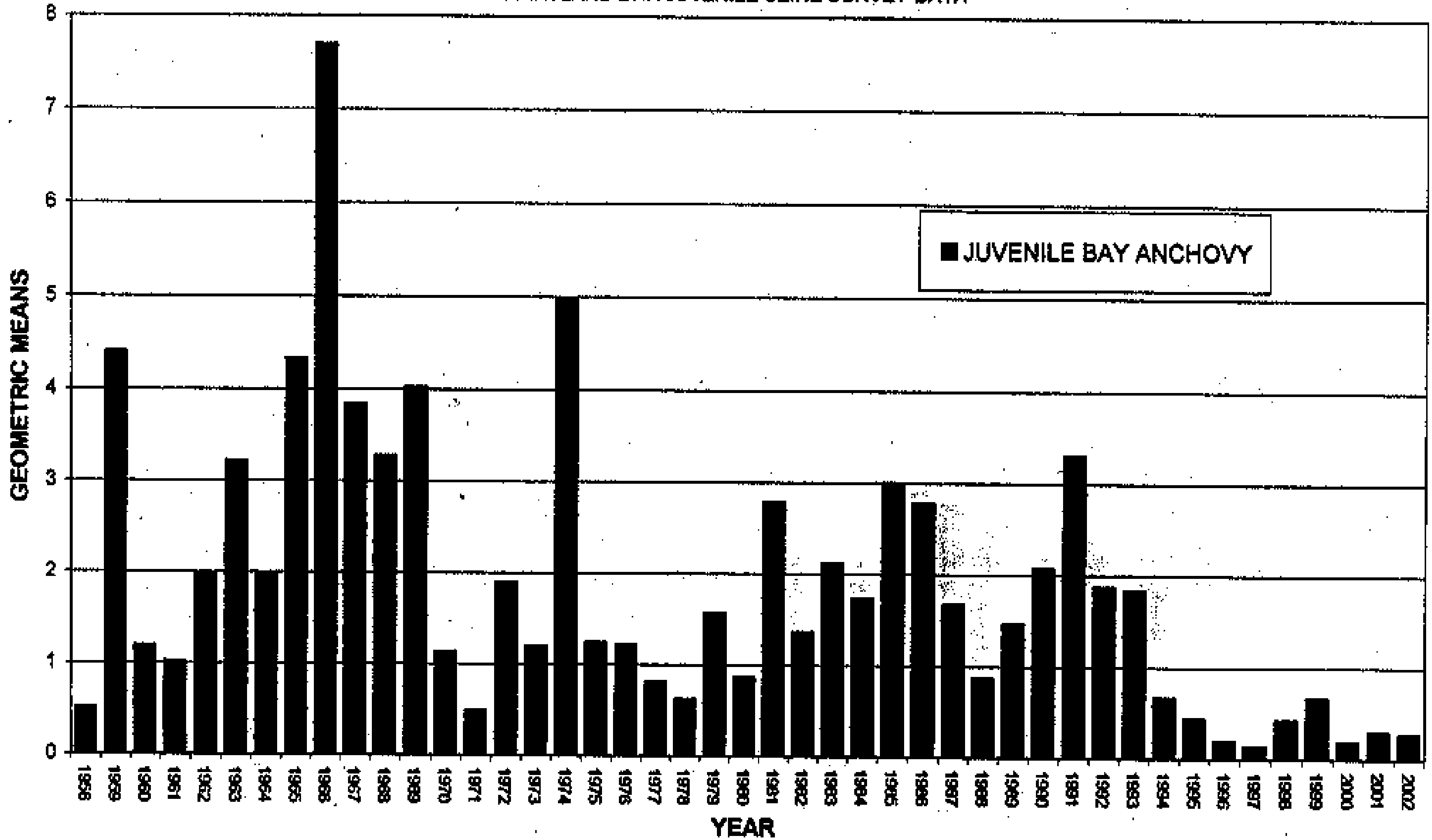
MARYLAND JUVENILE BAY ANCHOVY GEOMETRIC MEAN

MARYLAND DNR JUVENILE SEINE SURVEY DATA



Bay Anchovy Numbers have shown a dramatic decline since 1994 in Maryland's portion of the Chesapeake Bay and it's tributaries. The 1997 Juvenile Seining Survey numbers are the lowest ever recorded.

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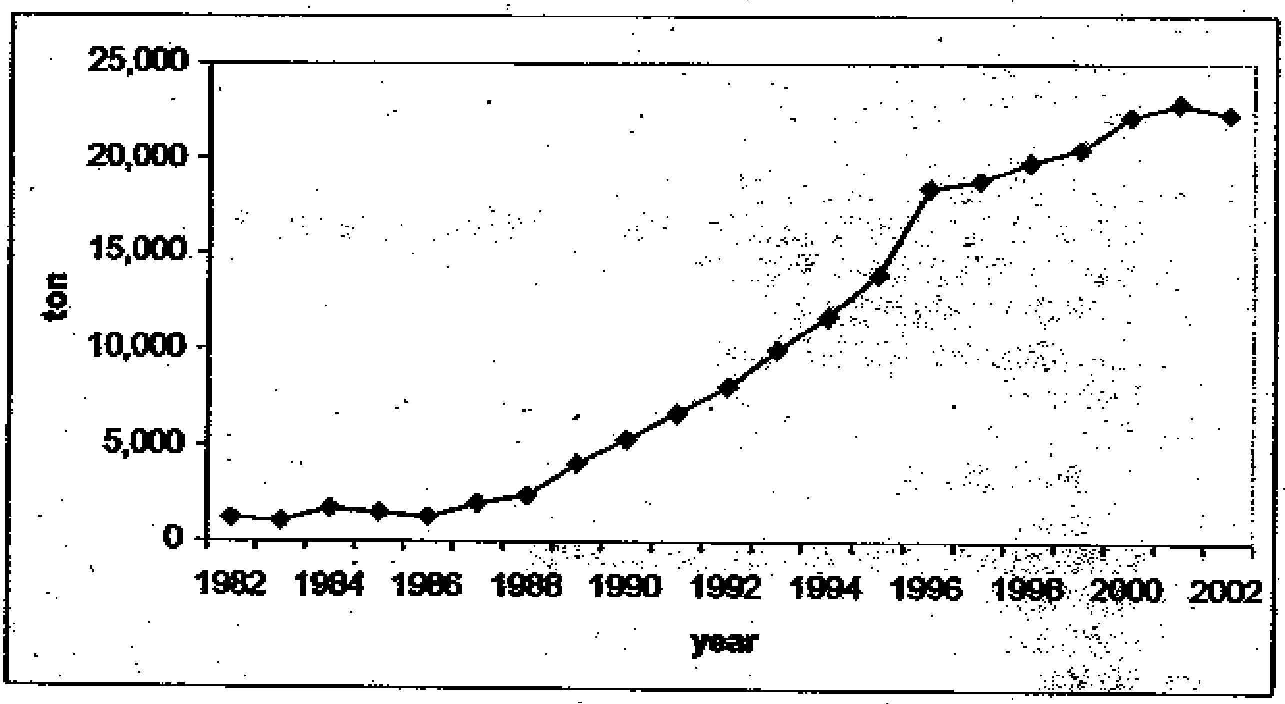
STRIPED BASS FEMALE SPAWNING STOCK BIOMASS FROM VPA MODEL



STRIPED BASS POPULATION SIZE (AGES 1-13+) ESTIMATES FROM VPA