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SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS
HOUSE RESOURCES COMMITTEE
U.S. HOUSE OF REPRESENTATIVES

Oversight Hearing on Chesapeake Bay Restoration

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Mr. Chairman and Members of the Committee, I am Kevin Friedland, Director of the UMass NOAA Cooperative Marine Education and Research program (CMER), a cooperative program between the National Oceanic and Atmospheric Administration and the University of Massachusetts. Thank you for inviting me to testify on the ecological role of menhaden in the Chesapeake Bay.

Before I respond to your questions, Mr. Chairman, I would like to provide you with some background information on the Atlantic menhaden. The Atlantic menhaden (Brevoortia tyrannus) is a member of the herring family and is found in coastal and estuarine waters from Nova Scotia to northern Florida. Menhaden undergo a coast-wide (along the coast of the Eastern United States) migration. On their northerly spring migration, the schools stratify by size and age along the coast so that by the summer, younger and smaller fish are found in the Chesapeake Bay and south, while the older, larger fish are distributed to the north. The menhaden return to the shelf waters during fall, forced out of estuaries by cooling temperature conditions they find intolerable.

Most spawning activity occurs during winter off the North Carolina and Virginia coasts. Larvae appear in the Chesapeake Bay in large numbers during May and June, with a smaller influx in November. The larvae are transported to the brackish waters of the Bay, which they use as nursery areas. It is here they transform into the filter-feeding fish much as they appear as adults. By late summer, the juveniles reach a length of 4 inches and leave the nursery area to join the adult population.

Atlantic menhaden play an important ecological role. As adults, menhaden are common in all salinities of the Chesapeake Bay, swimming in large schools close to the water’s surface. Feeding on both phytoplankton and zooplankton, menhaden can reach a length of 15 inches. Menhaden, in turn, serve as prey for many fish and birds species.
Atlantic menhaden also play an important social role in the Chesapeake Bay. The menhaden fishery is one of the most important and productive fisheries on the Atlantic coast, providing fish meal, fish oil, and fish solubles, as well as bait for other fisheries. A majority of catches come from estuaries and nearshore coastal state waters, and are caught with a variety of gear.

Now I would like to address the questions you raised in the letter of invitation.

What is the population status of Atlantic menhaden in the Chesapeake Bay?

While the status of the coast-wide stock of Atlantic menhaden is healthy and is not overfished, the status of menhaden in the Chesapeake Bay is unknown. Recognizing the need to better determine the status of menhaden in the Bay, the Atlantic States Marine Fisheries Commission (ASMFC) is working closely with its state and Federal partners.

On the other hand, recruitment, or the number of new fish added to the population annually, has been poor in recent years. This observation is supported by the data coming from the stock assessment and from fishery independent survey indices on the nursery grounds. The stock assessment estimation of year class strength does not indicate recruitment failure or the absence of sufficient new recruits to sustain the population. However, the regional juvenile abundance indices, although providing a fragmented view of the potential nursery areas for menhaden along the coast, suggest that recruitment may have shifted geographically. These indices suggest the nursery grounds of North Carolina and Virginia have been under-seeded in recent years, whereas there are indications that the nursery grounds in northern estuaries are experiencing higher abundances. There is currently no indication that the population is limited by reproductive capacity.

For the Chesapeake Bay, older larger menhaden are the first to enter the Bay during spring and are also likely to leave as the season progresses. Younger adults are more likely to enter the Chesapeake Bay later in the season, and may spend much of the summer there. The adult portion of the population is at a relatively low level, but as measured by the assessment benchmarks, the stock is still healthy. Juveniles enter the Bay in early spring as larvae, initially feeding on zooplankton and inhabiting transition zones where freshwater intersects with salt water. Their abundance appears to be low compared to historical values, but the survey index of juvenile abundance also suggests that low abundances have occurred before in the Bay, with the population returning to higher levels.

Several factors contribute to the uncertainty about the population status of Atlantic menhaden in the Bay, and like most biological systems, Atlantic menhaden recruitment is complex. Like so many other marine and estuarine dependent species, recruitment for Atlantic menhaden appears to be influenced by climate variation. Recent NOAA studies suggest a relationship between springtime weather patterns and spawning success in the Bay. Species that spawn offshore and have their eggs and larvae transported into the Bay in the late winter and early spring appear to recruit better with an early onset of warm and dry conditions and prevailing southwesterly winds brought on by the weather system known as the Azores-Bermuda High. Conversely, cool and wet spring conditions apparently hamper recruitment levels of menhaden within the Chesapeake Bay.

The scientific community has identified a number of potential bottlenecks for menhaden recruitment including transport of eggs and larvae across the continental shelf from the spawning grounds to the estuaries, predation on juveniles by other species, poor water quality (low oxygen, high water temperature), and disease. These and other factors may be working in concert to shape recruitment patterns.

Recently, the ASMFC charged its Menhaden Management Board (Board) and the Menhaden Technical Committee to review the ecological role of menhaden coastwide and to specifically focus on the population's status in the Chesapeake Bay. Accordingly, a scientific advisory panel was convened to discuss this topic and report to the ASMFC and its partners on the current state of knowledge about menhaden and the precision with which this knowledge is known. The Board will provide guidance about how to proceed.

The Technical Committee will soon be analyzing a wide range of research and management issues. The first question to be addressed will be whether localized depletion of menhaden stocks in the Chesapeake Bay is occurring or likely to occur under the existing ISFMP. Other issues include assessment of likely causes of low recruitment of menhaden in the Chesapeake Bay; evaluation of ecological reference points and recruitment indices for the Bay; and determining whether the effects of time and space openings or closures and harvest caps can be modeled, measured, or monitored well enough to be considered for management tools. A preliminary report will be submitted to the Management Board by August 2005.

Are menhaden significant consumers of primary productivity in the Bay?

Yes, menhaden are significant consumers of primary productivity in the Bay. Primary production refers collectively to the food in marine ecosystems produced by phytoplankton. Though not explicitly estimated, we know menhaden are significant consumers of primary production due to their large population numbers, filtration efficiency, and total volume filtered by individual fish.

Atlantic menhaden occupy a unique ecological niche in the food web of the Bay. For a relatively large body size animal they are able to filter extremely small plankton particles. Menhaden ram feed, i.e., they open their mouths and push their gill rakers through the water trapping planktonic organisms. Juvenile menhaden can filter the smallest plankton and are also capable of cropping down large multi-cell phytoplankton and zooplankton.

Menhaden adults in the Bay retain the ability to graze on small phytoplankton, but with lower efficiency than juveniles. New studies of the functional morphology of their gill raker feeding apparatus explain why juvenile fish maintain high filtering efficiency on the small phytoplankton found in the juvenile nursery. As adults, they progressively lose filtering efficiency on the smallest phytoplankton as a tradeoff to be able to filter larger quantities of water. This ensures that the adults can compete with other planktivores in coastal waters.

Menhaden are believed to filter feed during much of the day, so the estimates of the amount of water they filter can quickly become large depending on the size of the resident population in the area. Menhaden exhibit feeding selectivity by modifying their distribution. They are not capable of rejecting individual food particles, so they rely on taste to evaluate the quality of the food they are filtering. They search for productive feeding areas by modifying swimming and turning behavior to find more suitable foods to filter. As a result, menhaden are usually distributed with gradients of phytoplankton.

Not all the material that menhaden ingest is completely digested. As with all animals, menhaden do not convert all foods into growth and the amounts of unused digestive wastes that menhaden eject into their surroundings are unknown. The meaning of these observations is not clear, but they may be significant to the flow of nutrients in the estuaries.

Could changes in the current management regime of the fishery improve water quality?

Yes, changes in the current management regime of the fishery could theoretically improve water quality, but there is uncertainty as to how, since the question of menhaden recruitment and predation level and water quality is complex.

Because menhaden occupy such an important position in the pelagic food web of the Chesapeake Bay, any change in their management or the management of interacting species will likely affect water quality. However, we are not aware of a comprehensive modeling tool to predict changes in water quality metrics that explicitly incorporates adult and juvenile menhaden grazing. Some progress has been made to model juvenile menhaden grazing impacts in the Bay using a bioenergetics approach. These models suggest that juvenile menhaden consume a significant portion of the primary production in the Bay and that when the fish migrate they remove significant amount of nutrients used in their growth from the Bay system. Spatially explicit modeling approaches have also been used to determine if there is a carrying capacity for juveniles in the Bay. The model results suggest there isn't, but these models could be formulated to ask questions about water quality. The problem of estimating the grazing impact of adult menhaden has been addressed for the Narragansett Bay; however, the ecology of menhaden is different in northern estuaries because the fish tend to be much larger. The model illustrates the feasibility of assessing adult grazing in the Chesapeake Bay. These modeling approaches warrant further development.

Without the benefit of specific modeling advice, we have to rely on qualitative judgments about the impact juvenile and adult fish have on the flow of nutrients in the Bay. Juvenile fish will filter the smallest phytoplankton, especially those associated with eutrophication, and contribute to clearer water column conditions by removing both live and detritus particles. They will also export large quantities of nitrogen and phosphorus used in growth when they migrate in the fall, which will be a net loss of nutrients to these systems represented by those fish that do not return and are harvested elsewhere. These benefits will be most concentrated in the portions of the Bay that serve as the juvenile nursery, which are the salinity transition zones located in the rivers and parts of the upper Bay. Juveniles would not be expected to have a significant effect on the main part of the Bay.

Under the operational assumption that larger populations of menhaden juveniles will contribute to improved water quality, what management measures might increase juvenile abundance? Since there is no directed fishery for juvenile menhaden in the Bay, we can only affect juvenile abundance by improving recruitment or reducing natural mortality on juvenile menhaden. The likelihood of larger recruitments is enhanced by larger spawning stock size, so management measures for the adult stock that increases spawning stock may be beneficial. However, if the recruitment mechanism for menhaden is climate driven, the sacrifices to increase spawning stock may not yield the larger recruitments desired. Reducing the natural mortality on juvenile menhaden will also increase their abundance in the Bay. This could be achieved by better water quality and lower consumption by predators.

Adult menhaden play a different ecological role than the juveniles, thus their anticipated effect on water quality would also be different. The adults more commonly utilize the algal blooms that occur in the Bay main stem and associated water temperature fronts that form between the Bay and its sub-tributaries. They will yield many of the same water quality benefits as previously described for the juveniles, they will clear the water column and incorporate nitrogen and phosphorus as they grow, but they will do so in different parts of the Bay and impact different components of the plankton community. Unlike the juveniles, there is a directed fishery for the adults. Therefore, fishing immediately removes the nutrients used in the growth of menhaden from the system, but reduce their filtering capacity in the system. Finally, the adult population is dependent on successful recruitment, so any management measure that ensures robust spawning stock size would be beneficial.

What is the correct balance between removal and retention of the fish? Is there any benefit in foregoing harvest in that the fish will reappear the following year and reintroduce the nutrients back into the system? Does some level of harvest improve the filtering efficiency of schools by reducing competition? The question of menhaden harvest level and water quality is complex. NOAA recognizes the need to enhance fisheries management plans to explicitly include ecosystem considerations that provides a framework to enhance management performance. These considerations incorporate increased attention to predator-prey relationships, habitats, and understanding the impacts of human activities. Atlantic menhaden is being discussed by multiple partners, including NOAA and ASMFC, in this ecosystem context.

This concludes my testimony, Mr. Chairman. I will be happy to respond to any questions that you or members of the Subcommittee may have.