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ADDITIONAL CORRESPONDENCE

From: BRUCE KINDSETH <bkindseth@cox.net>
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To: comments <comments@nefmc.org>
Subject: Comments for September NEFMC Meeting

TO: Council Chair, Daniel Salerno

Executive Director Cate O'Keefe

The Atlantic fishery is a very complex and complicated ecosystem, but the underlying biology is quite simple. The main problem right now is with piscivores, or fish eaters, like cod, tuna and striped bass. Piscivores require a balanced diet of lipids, which are fats, oils and waxes for energy, protein for growth and both protein and lipids for egg production. In addition, the forage fish that they consume must be in abundance to protect the young of other more valuable species from predators, and to reduce foraging time which burns energy and can expose the fish to predators such as sharks and seals. So, the solution is very simple and common sense - healthy food and lots of it. The problem is that the current available forage is unbalanced; it is low in lipids and does not provide the necessary energy required.

In the Encyclopedia Brittanica definition of "ecosystem," the first topic discussed is "Energy Flow", and for the marine ecosystem, the source of energy is the sun. Chlorophyll in algae uses the energy in the sun to convert carbon dioxide and water into carbohydrates, protein and lipids, which is called the Total Primary Production (TPP). The annual amount of sunlight is constant but that is not the limiting factor for TPP. The limiting factor is nitrogen, which is a necessary component of chlorophyll. Algae is part of a larger group of sea life called plankton, which are basically floating life. Planktivores are consumers of plankton and include forage fish.

The next feeding group are benthivores, or bottom feeders, which consume invertebrates and crustaceans. This forage is high in proteins and low in lipids, but this is perfectly good for low energy fish like flounder.

The third feeding group is the piscivores, which I mentioned above. These fish, including cod, striped bass and tuna, are very active and need a lot of calories. Not all forages are equal. Herring, mackerel, menhaden and capelin contain large amounts of lipids, which give them twice as many calories as the other forage. This problem with low energy content forage mentioned above has existed since the collapse of the Atlantic herring in 1980, followed by a collapse of capelin in the 1990's. Also, in the 1990's, menhaden disappeared from the Gulf of Maine. The Atlantic herring recovered somewhat, but they collapsed again and along with mackerel, hit bottom in the early 2020's, all due to overfishing. There is another issue in that the energy density of Atlantic herring has declined from about 10.6 kJ/g (1985) and 9.6 kJ/g (1998) to 6.61 kJ/g, however, it is still considered high-quality prey. (LINK)

The feeding habits of the fish are important. Fish are opportunistic feeders but develop patterns that can be explained by Optimum Foraging Theory. (LINK) This theory assumes natural

selection favors strategies that optimize the ratio of benefits (energy/nutrients acquired) to costs (time, energy spent searching/handling, predation risk, missed opportunities for other activities). An example of this is striped bass. The adult bass's primary forage is menhaden, but older bass switch back to a benthic diet of invertebrates and crustaceans because the energy gained from the better quality forage is not worth the energy spent foraging. That may be why fishermen can find large bass just hanging out in a rock garden waiting for their next meal to swim by.

A study (LINK) found that, in 1965, a large cod's diet in the summer was 70% Atlantic herring and in the winter it was about 7% herring. But this is where it gets interesting. A study on cod (LINK) was done in the straight between Denmark and Sweden using a model based on the Wisconsin Bioenergetics Model. This is the most detailed study that I have seen yet, and I strongly recommend reading it. The model is based on the law of conservation of energy, which is taught in junior high general science. The model tracks energy flow through the fish's body and goes into detail how the components from different prey are important. They also did field validation of the model's predictions.

Herring are migratory and appear in this area in September and remain for several months. The cod will feed heavily on herring for several weeks until their fat reserves are built up, and then they will go back to benthic prey, especially crabs, to get needed protein prior to spawning, even though there are still a lot of herring around. An example of Optimal Foraging Theory is given, In this case, the timing of spawning fits right in following a period of high forage availability, and the high forage availability improves the likelihood of spawning success. Foraging is a high-risk activity because of predation from seals. This could be part of the reason for the change of diet, back to benthic prey. Also, when feeding on herring, they only consume 2/3 the amount of herring as when they were feeding on benthic forage. This begs the question, "Who can swim faster, an overstuffed cod or a hungry seal?" It appears that the optimum foraging theory favors the seal. The diet change back to benthic prey is also important, now that the cod's lipids reserves are built up, a higher ratio of protein is necessary to complete the development prior to spawning. In addition, another lipid, arachidonic acid (ARA), is available from the crabs, and ARA improves egg quality and offspring survival. The scientists also learned from the aquaculture industry about the "protein sparing effect of lipids" and put this in their model. "This mechanism is well known in aquaculture, where it has been shown that metabolic energy costs are to a larger extent covered by lipids than by proteins, if there are sufficient dietary lipids available. Hence, aquaculture researchers have experimented with feed formulas that optimize this mechanism without fattening the fish, to make sure the more expensive protein in the feed is retained as new tissue rather than being transpired. The high energy density of lipids makes it more suitable for storing energy."

The energy density of the herring in this area was not mentioned. The area studied is between the Baltic Sea and the North Sea, which have herring densities of 7.28 kJ/g and 7 kJ/g respectively, for an average of 7.14 kJ/g which is only 8% higher than the energy density of the Atlantic herring in the GOM.

Warming waters due to climate change increase fish's metabolism, which causes them to burn more energy. A 10C rise in temperature doubles the energy required. The bottom temperature in the GOM has increased .69C since 1982. That would require an increase in calories consumed of 6.9%.

Another study (LINK), also using the Wisconsin Bioenergetics Model, done in 2007 is very interesting. The Gulf of Maine is deeper and cooler, and the forage is low to medium quality. George's Bank is shallower, warmer (near the upper limit of cod) than GB, and the forage is high quality. For GB, the study found that the fish consumed more food, their efficiency was lower, but their productivity was higher than the GOM. This suggests that with a better food supply the GB cod population can tolerate the warming waters or may have even adapted to the warmer waters.

Because cod have been such an important part of America's history, there has been a lot of research on the biology of cod. A great deal of the knowledge of cod biology is applicable to other fish, both freshwater and saltwater. Striped bass are a little bit better off since they follow the migration pattern of menhaden and are fairly well fed. However, because of the overall low numbers of forage fish, the striper juveniles suffer from predation as they look like bait fish. Meanwhile, the adults suffer from predation from sharks, which would normally feed on menhaden, herring and mackerel. Even lobsters should benefit. With a lot of forage in the water, predation of lobsters by fish such as striped bass and cod should decline. Squid would also benefit from an abundance of forage fish, which will reduce predation pressure on squid.

The people in the aquaculture industry know the biology and formulate feeds made from fish oil and fish meal and test the feeds in controlled conditions in their fish farms. The industry is rapidly growing and there are issues with the supply of food for the future. Looking to the future, they came up with alternative sources. The lipids that give the forage fish high energy density come from algae. A $200,000 factory was built in Blair Nebraska in 2019, to extract lipids from algae. The factory reached maximum capacity in 2024 with a production level that is equivalent to what could be obtained from 1.2 million metric tons of fish (menhaden). That is over 6 times the production of the VA reduction factory and twice the production of that the VA factory and the 3 Gulf states factories combined. The US aquaculture industry no longer needs the VA reduction factory for feed, while the Atlantic fishery desperately needs the food for the Atlantic fishery to reverse the 50-year decline and rebuild to its full potential. We can have both a robust Atlantic fishery and a healthy aquaculture industry and erase the 70% trade deficit in seafood.

With a knowledge of the fishery biology, the solution is obvious and was summed up in paper by Willis ed al, 2013, "Tracking cod diet preference over a century in the northern Gulf of Maine: historic data and modern analysis" (link), the final paragraph says it all. "Historical data provide insights into the structure and function of ecosystems that, today, are impaired in their function. The results from our analysis comparing modern survey data with data from 1896 and 1965 point to significant long-term changes in the GOM marine food web with important implications for

the recovery of cod and other groundfish, and the resilience of an ecosystem now dominated by invertebrates. Restoring alewives, menhaden, and Atlantic herring may be essential in bringing back coastal cod populations and rebuilding complexity in an impoverished ecosystem. Finally, this historical perspective challenges notions of sustainability by reminding us of what a truly productive, diverse, and resilient ecosystem looked like and how the public perspective has drifted to accept remnant populations as the new normal."

The goal for menhaden biomass should be over 3 million metric tons, and over 1 million MT for Atlantic cod and mackerel. Capelin are an arctic species that range as far south as the edge of the GOM, A good start would be passage of the suggestion submitted by Paul Eidman at last year's fall ASMFC Menhaden Board meeting, to set the menhaden TAC at 75,616 MT, with 100% allocated to the bait fishery, 0% to the reduction industry and ban harvesting of menhaden for reduction purposes.

The ASMFC has to make a hard decision, whether to support the striped bass fishery, which brings in billions each year to the entire east coast from recreational fishermen, charter operators and all of the associated businesses, or the reduction factory that brings in much less money and employs a lot less people, all in and around 1 city in VA. Menhaden will have a significant impact immediately as they are starting with a significant biomass, 1.7 million metric tons. Mackerel at about 95,000 metric tons and Atlantic herring at 50,000 metric tons are way behind. I haven't mentioned butterfish, and they are also a high energy density prey and they have a biomass of 83,00 MT. River herring are listed as depleted and no biomass is available for them. Sand eels are also have high energy density but there is no data available data on their population. MAFMC and NEFMC need to get a plan like the Paul Eidman suggestion for Mackerel and Atlantic herring. Atlantic herring and Menhaden will be helped because the expansion of the menhaden population will reduce the pressure from predators, but unfortunately, they are starting from a much smaller population. This leaves menhaden, representing 88% of the known biomass, as the main source of lipids for the entire Atlantic fishery, and makes adoption of the Paul Eidman solution a virtual necessity for the future of the Atlantic fishery.

There is a history of a large cut in menhaden harvest. In 2014, a first ever TAC was imposed and subsequently menhaden expanded to their historical range northward to the NY Bight and the GOM. The Paul Eidman cut would be much larger, and we can expect a much larger result. (LINK) Menhaden are also amazing in that they start laying eggs in their second year. Their rapid expansion should take predatory pressure off other forage fish and young of other fish that are now showing low recruitment rates. Sharks can go back to feeding on menhaden instead of striped bass. Shutting down the menhaden reduction factory in VA will impact the entire Atlantic fishery from ME to FL.

Menhaden have another biological difference that gives them more benefit to the food web. Menhaden are specialized filter feeders and can feed on algae. From the algae, they get the lipids

that the algae produce. Herring and mackerel feed on zooplankton, particularly calanus species that eat algae and store it. The conversion efficiencies can vary, but 10% is an approximate number that is commonly used. So for menhaden eating algae, 10% would be stored in the menhaden's body. For the algae to calanus to herring or mackerel, that is 1 extra step so only 1 % of the nutrients in the algae would be stored in the herring or mackerel. (LINK) This link gets into more details on the numbers, but there is a very important issue with the calanus. Calanus are zooplankton which are sub-arctic and are declining because of climate change. This is believed to have been the cause of the decline in the energy density in Atlantic herring mentioned earlier. The creation of lipids by algae is not affected by climate change. In fact, for the aquaculture industry, algae is grown in ponds in Texas, New Mexico, in addition to the one I mentioned in Blair, Nebraska. The reduction in the calanus population does not stop the algae from producing lipids. The question is, where are the lipids going now?

At the 2025 fall ASMFC Menhaden Board meeting, the menhaden TAC was set at 186,840 MT for 2026-2028 with the option to revisit this issue at the 2026 and 2028 fall meetings. This year's fall meeting will be held will be held Nov 9-12 at the Hotel Viking, Newport, RI. It sure would be great if the Paul Eidman solution could be adopted at this meeting. For sure, it would halt the long-term decline of the Atlantic fishery and begin the rebuilding of the fishery. The fishery operates as an energy system, and "ecosystem structure

and function are fundamentally based on thermodynamic processes" (LINK) Releasing over110,000 metric tons of energy into the fishery ecosystem will positively have an impact, and that's not a hypothetical. We also know from the aquaculture industries that more calories produce more growth, so from that experience we should expect higher levels of calories in the forage base will improve fishery yield.

Finally, I suggest that we set a goal for the next 50 years to rebuild the Atlantic fishery to the max that the ecosystem can support. If a 5% annual growth rate can be maintained, in 50 years we should have about a 10-fold increase, which would be in the ballpark of what it was historically. The management should be based on results and primary metric used during this period should be growth. There will be no losers in this plan. Even Omega Protein could convert their property to a fancy resort area catering to tourists and fishermen, have upscale restaurants etc., and make a bundle. And it wouldn't smell.

The big lesson going forward is that a fishery cannot be managed solely by statistics. The fishery is an energy system, and this must be taken into account, along with the biology and activities of the fish. The Sweden/Denmark study could be a model and if the 50-year plan to rebuild the fishery is adopted, there would be plenty to time to do the research that needs to be done.

I have used AI extensively to dig out relevant information and found it extremely helpful. I am putting up the questions that I asked, along with the AI response with links to the sources of the information in a library on my website. (LINK) I hope that other people will use the information that AI found for me and build on it or even rebut it and find better solutions.

Sincerely,

Bruce Kindseth

Pt. Judith, RI