Research Priorities and Recommendations to Support Interjurisdictional Fisheries Management

ATLANTIC MENHADEN

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Many of the research and modeling recommendations from the last benchmark stock assessment (SEDAR 2015)[1] remain relevant for this update stock assessment. Research recommendations are broken down into two categories: data and modeling. While all recommendations are high priority, the first recommendation is the highest priority. Each category is further broken down into recommendations that can be completed in the short term and recommendations that will require long term commitment. Notes have been added for this report regarding work that has been addressed or initiated since SEDAR 2015.

<u>Annual Data Collection</u>

Short-term (next 3-6 years):

1. Continue current level of sampling from bait fisheries, particularly in the Mid-Atlantic and New England. Analyze sampling adequacy of the reduction fishery and effectively sample areas outside of that fishery (e.g., work with industry and states to collect age structure data and biological data outside the range of the fishery). **NOTE**: Work to assess the sampling adequacy of the bait and reduction fisheries has been initiated by Genevieve Nesslage's research group at the University of Maryland Center for Environmental Science.
2. Ageing:
    a. Conduct ageing validation study (e.g., scale:otolith comparison), making sure to sample older age classes. Use archived scales to do radio isotope analysis.
    b. Ageing precision: conduct an ageing workshop to assess precision and error among readers (currently planned for January 2015). **NOTE**: A workshop was completed and described in ASMFC 2015[2] and Atlantic menhaden scales have been added to the annual ASMFC QA/QC Fish Ageing Workshop (ASMFC 2017)[3] to address an ongoing need for information on ageing precision and error.
3. Conduct a comprehensive fecundity study. **NOTE**: This work has been initiated and is ongoing with Rob Latour's research group at Virginia Institute of Marine Science.

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[1] Southeast Data, Assessment, and Review (SEDAR). 2015. SEDAR 40 - Atlantic menhaden stock assessment report. SEDAR, North Charleston SC. 643 p.

[2] Atlantic States Marine Fisheries Commission (ASMFC). 2015. Atlantic Menhaden Ageing Workshop Report. ASMFC, Arlington, VA.

[3] Atlantic States Marine Fisheries Commission (ASMFC). 2017. Report of the Quality Assurance/Quality Control Fish Ageing Workshop. ASMFC, Arlington, VA.

4. Place observers on boats to collect at-sea samples from purse-seine sets, or collect samples at dockside during vessel pump-out operations (as opposed to current top of hold sampling) to address sampling adequacy.
5. Investigate relationship between fish size and school size in order to address selectivity (specifically addressing fisher behavior related to harvest of specific school sizes).
6. Investigate relationship between fish size and distance from shore (addressing selectivity).
7. Evaluate alternative fleet configurations for the removal and catch-at-age data.

Long-term (6+ years):

1. Develop a menhaden specific coastwide fishery-independent index of adult abundance at age. One possible methodology is an air spotter survey complemented with ground truthing for biological information (e.g., size and age composition). In all cases, a sound statistical design is essential (involving statisticians in the development and review of the design; some trial surveys may be necessary). **[Highest Priority] NOTE:** Design of a winter pelagic survey of adult Atlantic menhaden in the Mid-Atlantic has been initiated by Genevieve Nesslage's research group at the University of Maryland Center for Environmental Science.
2. Conduct studies on spatial and temporal dynamics of spawning (how often, how much of the year, batch spawning, etc.)
3. Conduct studies on productivity of estuarine environments related to recruitment. **NOTE**: Anstead et al. 2016[4] and 2017[5] used otolith chemistry to evaluate the proportional contribution of each nursery area along the US Atlantic coast for recruits for 2010-2012.
4. Investigation of environmental covariates related to recruitment. **NOTE**: Buchheister et al. 2016[6] evaluated coast wide recruitment patters from 1959-2013 and found the Atlantic Multidecal Oscillation was the best predictor of regional recruitment. Simpson et al. 2016[7] evaluated several environmental covariates for an effect on larval survival and found temperature had the greatest effect on early life survival which was more related to recruitment than larval supply.

<u>Assessment Methodology</u>

Short term (3-6 year):

[4] Anstead, K. A., J. J. Schaffler and C.M. Jones. 2016. Coast-wide nursery contribution of new recruits to the population of Atlantic Menhaden. Transactions of the American Fisheries Society, 145(3): 627-636.
[5] Anstead, K. A., J. J. Schaffler and C.M. Jones. 2017. Contribution of Nursery Areas to the Adult Population of Atlantic Menhaden. Transactions of the American Fisheries Society 146(1): 36-46.
[6] Buchheister, A., T. J. Miller, E. D. Houde, D. H. Secor, and R. J. Latour. 2016. Spatial and temporal dynamics of Atlantic menhaden (Brevoortia tyrannus) recruitment in the Northwest Atlantic Ocean. ICES Journal of Marine Science: Journal du Conseil, fsv260.
[7] Simpson, C. A., M. J. Wilberg, H. Bi, A. M. Schueller, G. M. Nesslage, and H. J. Walsh. 2016. Trends in Relative Abundance and Early Life Survival of Atlantic Menhaden during 1977–2013 from Long-Term Ichthyoplankton Programs. Transactions of the American Fisheries Society, 145(5): 1139-1151.

1. Conduct management strategy evaluation (MSE). **[Highest Priority] NOTE:** This work has been initiated and is ongoing with Amy Schueller's research group at the Southeast Fisheries Science Center in Beaufort, North Carolina.
2. Conduct multi-objective decision analysis (MODA). **[Highest Priority] NOTE:** This will be addressed through the ongoing BERP WG activities.
3. Continue to develop an integrated length and age based model (e.g., SS3).
4. Continue to improve methods for incorporation of natural mortality (e.g., multi-species statistical catch-at-age model). **NOTE**: This work will be addressed by McNamee's doctoral thesis (*in prep*)[8] and through current BERP WG activities.
5. During the next benchmark stock assessment process (scheduled for 2019), the SAS recommends that the following items be considered during modeling workshops:
    a. Re-examine the methodology and surveys used for the development of the NAD index.
    b. Explore the likelihood component for the length composition data.
    c. Examine the age composition of the bait fishery.

Long term (6+ years):

1. Develop a seasonal spatially-explicit model, once sufficient age-specific data on movement rates of menhaden are available.

[8] McNamee, J. E. *in prep*. A Multispecies statistical catch-at-age (MSSCAA) model for a Mid-Atlantic species complex. Doctoral dissertation for University of Rhode Island.