Mid-Atlantic Fishery Management Council

Comprehensive Five Year (2016-2020) Research Plan

Approved December 7, 2015

Introduction

The Magnuson Stevens Reauthorization Act of 2006 requires that each Council develop a five-year research priority plan. The Mid-Atlantic Fishery Management Council (Council), in consultation with its Scientific and Statistical Committee, first developed a research plan to meet this requirement in 2008 through examination of research needs identified in numerous stock assessments, Council FMP/Amendment documents and through the Council's Research Set Aside Program.

Since then, the Council embarked on a Visioning Project to map out the future course of marine fisheries management in the Mid-Atlantic region. The Visioning Project resulted in the development of the Council's Strategic Plan (http://mafmc.org) which outlines the Councils strategies for implementing the Council's vision for improved federal fisheries management in the Mid-Atlantic. A central theme that emerged from this exercise was the lack of public confidence in the data and science that drive fishery management decisions. As a result, one of the major goals of the Council's Strategic Plan is *to ensure that Council management decisions are based on timely and accurate scientific data that are analyzed and modeled in a manner that improves management performance and build stakeholder confidence.* To this end, the Council's intent is to expand cooperative research and rebuild stakeholder confidence in the data and analyses which support its management programs. This updated research plan is responsive to and organized around key themes/elements articulated in the Strategic Plan relative to improving the timeliness and accuracy of information used in the management of marine resources under the purview of the Council.

Stock assessment improvement

Improvement of the data and analyses supporting the stock assessment process in the Northeastern US is the Council's top priority. Scientific uncertainty is generally a function of the quality of the information input into stock assessments and directly impacts the specification of catch limits and hence the amount of fish that can be harvested. Stock assessment improvement was also identified by the NEFSC as a top priority in its Draft Strategic Plan (NEFSC, Draft Strategic Plan 2016-2021). The Council currently has lead management responsibility for 12 species of fish and shellfish, all of which are periodically assessed to determine stock status and set annual catch limits. Of the species currently under management, four do not have acceptable quantitative stock assessments (annual catch limits set on an ad hoc basis). The Council's highest priority is to improve the stock assessments in the region such that all managed species are assessed in a quantitative framework, and to continue to improve those that are currently assessed quantitatively. Accomplishing this objective will require close coordination with the NEFSC since the Center has the primary responsibility for conducting stock assessments for Mid-Atlantic species. However, a high priority of the Council is to foster increased collaboration with industry in efforts to systematically improve stock assessments in the Mid-

Atlantic through improved data collection and through other research to address the primary needs identified for each species (Table 1).

Two primary sources of data are integral to the development of acceptable quantitative stock assessments: 1) fishery dependent information about the magnitude and size/age composition of the catch (including discards) and fishing effort and 2) fishery independent abundance information. The SSC has highlighted the need for improved catch at age matrices for all species currently assessed, but the quality of catch information varies considerably among species (Table 1). In addition to adequate sampling of the landed portion of the catch, the magnitude of the discarded portion of the catch and the mortality rate of those discards must also be adequately characterized. Improved estimates of the discarded component of the catch are needed for scup, summer flounder, black seabass, butterfish, and spiny dogfish (Table 1). In addition, improved estimates of discard mortality by gear type are needed.

The need for auxiliary fishery independent abundance information is under-scored by the fact the majority of the species managed by the Council that lack an acceptable quantitative stock assessment also lack acceptable fishery independent indices of abundance (Atlantic mackerel, black sea bass and *Illex* squid). An exception is the golden tilefish assessment which is currently conducted within a quantitative framework, but it could be greatly improved if a fishery independent index of abundance could be incorporated into the assessment.

In addition to the development of novel abundance indices for the species identified above, a top priority of the Council is to foster greater collaboration with industry to supplement existing NEFSC survey information. Especially important is the need to better understand and improve NEFSC survey derived estimates of abundance by collecting supplemental abundance data for flatfishes (summer flounder) and pelagic or semi-pelagic species (Atlantic mackerel, scup, and *Illex*) utilizing fishing vessels as sampling platforms of opportunity. This need is likely to become more acute as future funding of existing NEFSC surveys at historical levels is uncertain. The Council's new Cooperative Research Program should focus on ways to incorporate observations of fishermen into the current stock assessment process and high priority is given to the development of auxiliary surveys or experiments designed to complement existing state and federal fishery independent trawl surveys. Close coordination with NMFS and state stock assessment scientists is critical in this regard to ensure that auxiliary information collected can be utilized directly in existing stock assessment analyses.

Another major area of research supported universally during the Visioning Project was the incorporation of species interactions and the impacts of climate change and variability in stock assessments and management. All existing stock assessments used for management purposes in the Mid-Atlantic are currently conducted on a single species basis and only a few have begun to incorporate environmental drivers into population dynamics models. The development of multi-species models which incorporate environmental covariates is a high priority.

Research to support measures which reduce/eliminate discards

The Council's Visioning Project highlighted the universal view shared by stakeholders about the need to greatly reduce or eliminate discards in Mid-Atlantic fisheries, especially those which occur as a result of fishery regulations. Regulatory discards represent economic and biological waste and can be reduced through improved gear performance (i.e., improved selectivity) and/or adoption of management procedures or approaches which allow for greater retention of the catch or the avoidance of unmarketable, sub-legal or otherwise prohibited species.

The gear selectivity component of the discard problem should be addressed through collaborative research with fishermen from both the commercial and recreational sectors. On the commercial side, cooperative studies with industry which evaluate the selectivity of commercial gear types in various fisheries are warranted (see Table 1). These studies should evaluate the efficacy of current mesh and gear configuration regulations in trawl and gill net fisheries and test gear innovations which improve selectivity (i.e., achieve desired size/age at retention with greater precision) through cooperative gear research. Gear selectivity in the recreational fisheries should be addressed through cooperative research on hook size and type. In addition, collaborative research with the recreational sector should be conducted to evaluate current estimates of discard mortality for species where the recreational component of the catch is significant and to find innovative ways to reduce the mortality of unavoidable discards (i.e., identification of best practices for handling and releasing fish, mitigating effects of barotrauma, etc.).

In addition to research on gear selectivity, the Council seeks innovative management solutions which could also reduce discards. These include management approaches which achieve the primary management objectives of preventing overfishing while maximizing yield, but in a manner that minimizes discards and/or mortality of the discarded component of the catch. Research which identifies management measures such as closed areas and/or seasonal gear or other fishery restrictions which minimize or eliminate discards in known time/areas of high discards is a high priority. In the commercial fisheries, a system of cooperative communication among fishery participants to identify and avoid bycatch in known hot spots in or near real-time should be investigated. In the recreational fisheries, alternative approaches to the current system of seasons, size and bag limits should be investigated. These could include requirements for full retention of catch, slot limits, and other combinations of management measures which seek to minimize discards and discard mortality in the recreational fisheries.

Collect and incorporate social and economic data into fishery management decision process and stabilize yields (develop management strategy evaluations)

The lack of adequate policy analysis of the social and economic consequences of management actions taken by the Council prior to decision making was identified as a major problem by stakeholders during the Visioning Project. The 2006 Magnuson Act reauthorization placed major emphasis on the biological imperative to end overfishing and rebuild overfished stocks under specified time constraints. While the Council has been successful in meeting the biological mandates of the MSA, the resulting social and economic consequences have been viewed as unnecessarily severe by both commercial and recreational stakeholders. The collection and analysis of improved social and economic data in support of management decisions (prior to actual decision making) is a high priority.

In addition to better characterization of the social and economic impacts of current Council management programs, stakeholders universally favored stabilization of yields in Mid-Atlantic fisheries. To comply with the MSA Reauthorization, the Council adopted a management system which combines quantitatively based ABC control rules with a specified tolerance for risk of overfishing (which varies as a function of stock status). This system can result in substantial short term changes to the allowable harvest due to real changes in stock abundance as well as to the manner in which stock assessments are conducted. The management system is highly dependent on having quality stock assessment data on a continuing basis. For data poor species, a high priority is research into the development of ABC control rules in cases where adequate data are not available to specify annual catch limits using the quantitative approach adopted by the Council (black sea bass is the species of greatest concern in this regard).

Another area of research given high priority by the Council is the development of management strategy evaluations for its managed species. Management strategy evaluation (MSE), the evaluation of management strategies using simulation, is widely considered to be the most appropriate way to evaluate the trade-offs

achieved by alternative management strategies and to assess the consequences of uncertainty for achieving management goals. The Council has previously funded evaluations of its ABC control rules (based on the P* approach described above) to evaluate their performance over a wide range of stock conditions, fishing effort and levels of stock assessment information. Lacking in these analyses is a thorough evaluation of the long term social and economic implications of the application of the Council's ABC control rules.

A *comprehensive* management strategy evaluation of the current management system for Mid-Atlantic fisheries which incorporates social and economic considerations is warranted. In addition to an evaluation of the current management system, high priority is given to the development and evaluation of management procedures that perform well in the absence of high quality stock assessment information and provide more stable streams of allowable catches over time. These management procedures could be applied in both data-rich and data-poor situations and have the potential to stabilize and improve fishery performance and attainment of management goals.

Improving timeliness and accuracy of fishery data collection through electronic reporting

Council FMPs currently contain numerous reporting requirements (including vessel trip reports or paper logbooks), many of which could be made more cost and time efficient through the use of modern electronic reporting methods. Stakeholders identified the need for the implementation of electronic reporting methods to improve the timeliness and accuracy of reports of fishing effort and catch in the commercial fisheries. Electronic reporting has the potential to greatly streamline catch reporting and reduce the cost and burden of reporting catch by stakeholders. Collaborative research projects with both commercial, party/charter (for–hire) and recreational (volunteer angler) fishermen should be conducted to test the efficacy of electronic reporting and to beta-test these applications for eventual integration into the current data reporting system.

Evaluation of Existing Allocations to Fishery Sectors

The Mid-Atlantic Council has utilized output controls to manage the fisheries under its jurisdiction throughout its history. During the initial development of these quota-based management systems, the Council chose to allocate quotas by fishery sector (commercial and recreational) and, in some cases, regionally by state for some species. The initial allocation of quota was generally based on the historical catch by sector or state for the preceding ten year period. Thus, the historical performance of each fishery defined the percentage share of annual quotas by sector and/or area in perpetuity. Stakeholders have noted the general inflexibility of the fixed quota allocation system currently in place and recommended that the Council consider alternative methods to allocate annual quotas. Major issues of fairness and equity have arisen with respect to access to the fish allocated to sectors and states due to the dynamic nature of fish abundance and distribution since the initial allocations were made. For example, recent research indicates that the geographical distribution of species of major importance to both sectors (i.e., summer flounder, scup and black sea bass) have shifted northward over time such that there is a major disconnect between the quota allocations based on prior states of nature and current conditions. The Council seeks research which evaluates alternative methods of allocating quotas which are capable of accommodating distributional shifts which are likely to continue to occur. In addition, the Council seeks research into methods and analyses which allow for optimal allocation of quota share among fishery sectors based on biological, social and economic considerations.

Comprehensive list of research needs for Mid-Atlantic Council managed species

Key: ● = first priority ● = first and second runners-up

GENERAL

SURVEYS

Fishery-Dependent

1. Collect accurate size and age composition of commercial and recreational catch (including the discarded component of the catch) to develop or improve catch at age matrices for all managed stocks.

Fishery-Independent

2. Implement novel supplemental surveys to derive fishery independent indices of abundance (black sea bass, golden and blueline tilefish, Atlantic mackerel).

MODELING/QUANTITATIVE

3. Develop assessment models to support fishery management control rules for data poor stocks (i.e., using fishery dependent data).
4. Establish a framework for risk analysis of alternative harvest policies.
5. Incorporate ecosystem level data (predator/prey interactions, trophic dynamics, etc.) into single and multi-species assessment and management models.
6. Quantify uncertainty in biological reference points.

BIOLOGY/LIFE HISTORY/HABITAT

7. Investigate effects of climate variability and change on ecosystems and fisheries they support.

MANAGEMENT & SOCIOECONOMIC

8. Build the regional capacity within governmental agencies and academia to undertake management strategy evaluations of MAFMC managed stocks to evaluate assessment and management performance.
9. Estimate mortality of discards by gear type.
10. Evaluate existing allocations among fishery sectors and regions.
11. Review and improve capacity for social and economic impact analyses, including updated data on fisheries organization and structure, participation, community linkages; for regular FMP work and at scales appropriate for ecosystem-based management.

SUMMER FLOUNDER

SURVEYS

Fishery-Dependent

12. ● Collect data to evaluate the length, weight, and age compositions of landed and discarded fish in the summer flounder fisheries (recreational and commercial) by sex. Focus should be placed on age sampling of summer flounder 24 inches or larger in total length, using paired hard part samples (i.e., scales, and when possible, otoliths).
13. Evaluate gear modifications to reduce discard mortality in the recreational fishery.

MODELING/QUANTITATIVE

14. ● Evaluate past and possible future changes to size regulations on retention and selectivity in stock assessments and projections.
15. ● Evaluate uncertainties in biomass to determine potential modifications to default OFL CV.
16. Incorporate sex-specific differences in size at age into the stock assessment.

Key: ● = first priority ● = first and second runners-up

BIOLOGY/LIFE HISTORY/HABITAT

17. Evaluate range expansion and/or changes in distribution and their implications for stock assessment and management.

MANAGEMENT & SOCIOECONOMIC

18. Investigate social and economic implications of alternative allocations among fishery sectors.

BLACK SEA BASS

SURVEYS

Fishery-Dependent

19. Increase sea sampling to verify information from commercial logbooks to provide better estimates of discards (with emphasis on pot trap and hook and line gear).

Fishery-Independent

20. ● Develop a reliable fishery index for black sea bass beyond the existing surveys.

MODELING/QUANTITATIVE

21. ● Develop a first principles foundation for establishing reference points and assessment methods to account for black sea bass' life history.

22. ● Explore the utility of a spatially-structured assessment model for black sea bass to address the incomplete mixing in the stock.

BIOLOGY/LIFE HISTORY/HABITAT

23. Consider a directed study of the genetic structure in the population north of Cape Hatteras.

24. Evaluate the implications of range expansion to fishery and stock dynamics.

MANAGEMENT & SOCIOECONOMIC

25. Evaluate current monitoring programs and compliance with existing regulations.

SCUP

SURVEYS

Fishery-Dependent

26. ● Improve estimates of discards and discard mortality for commercial and recreational fisheries.

27. Evaluate the degree of bias in the catch, particularly the commercial catch.

Fishery-Independent

28. ● Conduct experiments to estimate catchability of scup in NEFSC surveys.

MODELING/QUANTITATIVE

29. Explore additional sources of age-length data from historical surveys to inform the early part of the time series to provide additional context for model results.

30. Explore the utility of incorporating ecological relationships, predation, and oceanic events that influence population size on the continental shelf and its availability to resource surveys into the stock assessment model.

MANAGEMENT & SOCIOECONOMIC

31. Conduct management strategy evaluation to evaluate the effectiveness of scup management.

Key: ● = first priority ● = first and second runners-up

OCEAN QUAHOGS

SURVEYS

32. Evaluate the potential use of HABCAM or other optical surveys for measuring ocean quahog abundance and habitat.

MODELING/QUANTITATIVE

33. ● Develop credible biological reference points for an extremely long-lived species with highly uncertain recruitments (fecundity and maturity at-length information is required).
34. ● Evaluate the reliability of estimates of stock biomass.

BIOLOGY/LIFE HISTORY/HABITAT

35. ● Conduct region-specific growth analyses based on aging of ocean quahogs to allow for spatially explicit stock assessments.

SURFCLAMS

SURVEYS

36. Determine if depletion and selectivity experiments conducted in the Mid-Atlantic are applicable to the Georges Bank region.
37. Evaluate the potential use of HABCAM or other optical surveys for measuring surfclam abundance and habitat.

MODELING/QUANTITATIVE

38. ● Further develop fishing mortality and biomass reference points to reduce the reliance on the scaling of biomass to an assumed 1999 level.
39. ● Characterize how uncertainties affect the estimated distribution of OFL.

BIOLOGY/LIFE HISTORY/HABITAT

40. ● Improve estimates of natural mortality, perhaps incorporating age- or size-dependencies in M.
41. Assess whether spatial and/or density-dependent patterns in vital rates, independent of stock structure, are present in the population.
42. Collect fecundity and maturity at length information to improve biological reference point estimation.
43. Evaluate factors influencing recruitment.
44. Examine the effects of climate change on the spatial distribution of clams, on the operation of the fishery, and on the overall productivity of the stock.
45. Quantify the spatial scale at which population replenishment occurs.

Key: ● = first priority ● = first and second runners-up

ATLANTIC MACKEREL

SURVEYS

Fishery-Dependent

46. ● Collaborate with industry to explore the spatial and temporal pattern and variability in catch to evaluate issues of abundance and availability; investigate the contemporary overlap of survey stock area, commercial fishery, and mackerel distribution and explore historical databases for the same purpose to better understand interpretation of abundance indices (survey, cpue).

47. Collection and analysis of fishery-dependent information (catch, effort, size/age composition, etc.).

Fishery-Independent

48. ● Collaborate with industry to investigate alternative sampling gear or survey methods to estimate adult mackerel abundance.

49. ● Evaluate catchability of mackerel in bottom trawl surveys.

50. Initiate broad scale international egg surveys covering potential spawning habitat that is consistently representative of the total stock area, including the shelf break.

MODELING/QUANTITATIVE

51. Evaluate egg production data from existing fishery independent surveys (e.g., Marmap and EcoMon) to evaluate patterns in reproduction of the stock in the US portion of its range, and to evaluate correlations in recruitment between US and Canadian reproduction.

52. Examine covariation among survey and fishery-dependent indices.

53. Examine methodology for incorporating consumptions estimates in the assessment.

54. Explore alternative assessment models that incorporate covariates.

55. Explore development of alternative indices of abundance (e.g., by examining patterns in consumption of mackerel by key predators); extend predation estimates to include DFO data and entire predator spectrum (marine mammals and highly migratory species).

56. Improve analysis of fishery-independent survey data to evaluate the distribution of positive tows and total catches.

57. Investigate alternative assessment models that incorporate spatial structure (i.e. northern and southern contingents, different age groups).

BIOLOGY/LIFE HISTORY/HABITAT

58. ● Develop approaches to evaluate the potential for stock structure and movement throughout the species range (i.e., tagging, genetics, chemical assay, microchemistry of otoliths, etc.).

59. Explore influence of environmental factors on spatial distribution of the stock e.g. rate of mixing and distribution of stock relative to the survey area (high priority, short term).

MANAGEMENT & SOCIOECONOMIC

60. ● Investigate mesh size and/or gear technologies (e.g., grates or separators) to reduce retention of small Atlantic mackerel and river herring in the Atlantic mackerel fishery.

61. Evaluate spatial catch patterns in the small pelagic fisheries to identify "hot spots" of co-occurrence; explore management complementarities among small pelagic fisheries (e.g., mackerel, Atlantic herring and river herring).

Key: ● = first priority ● = first and second runners-up

LONGFIN SQUID

SURVEYS

Fishery-Dependent

62. ● Explore ways to reduce bycatch including testing time/area correlations and gear modifications (in addition to mesh size), videography and/or alternative gear types (e.g., jigging).
63. Estimate mortality rates of longfin squid that pass through trawl mesh to evaluate effects of mesh regulations on fishing mortality of longfin squid by size and age.

Fishery-Independent

64. ● Determine what portion of stock is outside current research trawl surveys.
65. Refine understanding of catchability in surveys (especially NEAMAP).

MODELING/QUANTITATIVE

66. ● Until real-time assessment is feasible, expand cohort analysis to refine stock assessments and their incorporation of seasonal indices (currently spring and fall are just averaged).
67. Explore alternative weightings of semi-annual surveys other than simple averaging.
68. Understanding the spatial coverage and availability to the surveys.

BIOLOGY/LIFE HISTORY/HABITAT

69. Evaluate methods of incorporating ecological relationships, predation, and oceanic events that influence abundance and availability.
70. Refine understanding of stock range and structure (especially proportion of stock inhabiting 400-800 m when NEFSC fall survey is conducted).

MANAGEMENT & SOCIOECONOMIC

71. ● Evaluate approaches to real time management including expanding age and growth studies to better estimate average growth patterns and to discern seasonal productivity/catchability patterns.
72. Examine the performance of the squid fisheries and related fisheries in relation to the regulatory measures with a view towards improving the economics of the fisheries.

ILLEX SQUID

SURVEYS

Fishery-Independent

73. ● Investigate beyond-shelf availability.
74. Investigate feasibility of real-time management, including undertaking cooperative research with the fishing industry.

Modeling/Quantitative

75. ● Analyze the change in availability of *Illex* to the survey and fishery, resulting from long-term changes in climate or other oceanographic factors.
76. Consider an *Illex* index standardization for the NEFSC trawl survey.
77. Expand investigations into oceanographic correlates with trends in recruitment and abundance.
78. Refine between-vessel survey calibration estimate for Ilex, and consider a size-based calibration.

BIOLOGY/LIFE HISTORY/HABITAT

79. ● Collect demographic information on growth, mortality, reproduction by sex, season, and cohort.

Key: ● = first priority ● = first and second runners-up

BUTTERFISH

MODELING/QUANTITATIVE

80. ● Develop a parallel catchability estimate for Spring surveys so that both Spring and Fall surveys can be included in the model.
81. Conduct simulation studies to evaluate the uncertainty in the ad hoc Fmsy proxy.
82. Develop reference points that are internal to the stock assessment model.
83. Evaluate approaches to include additional surveys, e.g., from States, in the assessment model.

BIOLOGY/LIFE HISTORY/HABITAT

84. ● Analyze additional estimation of consumptive demand of predators to identify critical periods of overlap of predators and prey.
85. ● Analyze spatial patterns in survey data to examine potential for changes in spatial distribution of the stock.
86. Reconsider stock structure and degree of exchange with south Atlantic stock component (i.e., stock ID).

SPINY DOGFISH

SURVEYS

Fishery-Independent
87. ● Determine the efficiency of the NEFSC survey gear.
88. ● Investigate catchability as it relates to distribution of spiny dogfish beyond the depth range of current NEFSC trawl surveys (including inter annual differences), possibly by using experimental research or supplemental surveys.

MODELING/QUANTITATIVE

89. ● Investigate alternative stock assessment modeling frameworks.
90. Revise the assessment model to investigate the effects of stock structure or distribution, sex ratio, and size of pups on birth rate and first year survival of pups.

BIOLOGY/LIFE HISTORY/HABITAT

91. Continue aging studies for spiny dogfish age structures (e.g., fins, spines) obtained from all sampling programs (include additional age validation and age structure exchanges), and conduct an aging workshop for spiny dogfish, encouraging participation by NEFSC, Canada DFO, other interested state agencies, academia, and other international investigators with an interest in dogfish aging (US and Canada Pacific Coast, ICES).
92. Continue large scale (international) tagging programs, including conventional external tags, data storage tags, and satellite pop-up tags, to help clarify movement patterns and migration rates.
93. Evaluate ecosystem effects on spiny dogfish acting through changes in dogfish vital rates.

Key: ● = first priority ● = first and second runners-up

BLUEFISH

SURVEYS

Fishery-Dependent

94. ● Evaluate species associations with recreational angler trips targeting bluefish to potentially modify the bluefish recreational CPUE index used in the assessment.

95. Initiate fishery-dependent sampling of offshore populations of bluefish.

Fishery-Independent

96. ● Develop a fishery independent index that better captures older, larger fish (which would reduce reliance on MRIP sampling).

MODELING/QUANTITATIVE

97. ● Develop bluefish-specific MSY reference points or proxies.

98. Evaluate changes in selectivity of age-0 bluefish relative to water temperature.

99. Evaluate methods for integrating disparate indices produced at multiple spatial and temporal scales into a stock-wide assessment model.

BIOLOGY/LIFE HISTORY/HABITAT

100. Investigate how environmental variability may affect juvenile movements and distribution, which in turn, may affect availability.

GOLDEN TILEFISH

SURVEYS

Fishery-Dependent

101. Expand observer coverage to improve index standardization of fishery-dependent data.

102. Leverage large pelagic recreational fishing activity/surveys to collect improved life history information.

Fishery-Independent

103. ● Develop a fishery-independent survey.

MODELING/QUANTITATIVE

104. ● Perform exploratory analyses of fish distributions to assess whether the dome-shaped selectivity curve used in the assessment reflects fishery selectivity or availability, or both.

BIOLOGY/LIFE HISTORY/HABITAT

105. ● Assess the accuracy and reliability of aging techniques.

106. Consider genetic approaches to assess possible stock structure.

107. Evaluate the reliability of the report of protogynous hermaphroditism in the S. Atlantic stock.

Key: ● = first priority ● = first and second runners-up

BLUELINE TILEFISH

SURVEYS

Fishery-Dependent

108. Collect discard length and age data from the private sector.

109. Research efforts to incorporate/require logbook reporting from recreational anglers.

BIOLOGY/LIFE HISTORY/HABITAT

110. ● Conduct habitat studies of deep water sites in the mid-Atlantic (Norfolk Canyon, Baltimore Canyon, and Hudson Canyon).

111. ● Age readings need to be validated. Marginal increment analysis needs to be undertaken in order to convert increment counts to calendar ages. More recreational fishery age samples need to be collected.

112. ● Overall, more reproductive samples need to be collected. Because small, young fish were lacking from the biological collections, specimens under 8 inches will be needed to address age and size at maturity. Whole gonads will need to be collected for a fecundity study. Specimens collected from throughout the species range and covering all months of the year are needed to better describe spawning season and spawning periodicity.

113. Conduct genetic study or some other form of stock identification study.

114. Increase untargeted biological sampling in NE and Mid-Atlantic observer programs and increase untargeted dockside sampling in NE and Mid-Atlantic.

RIVER HERRING AND SHAD

SURVEYS

Fishery-Dependent

115. Support data collection standardization efforts and improve methods to develop biological benchmarks used in assessment modeling & management (including catch caps) for RH/S stocks.

MODELING/QUANTITATIVE

116. Calculate and/or improve life stage-specific estimates of range-wide natural and human mortality rates, including fishing.

BIOLOGY/LIFE HISTORY/HABITAT

117. Collect information on the marine phases of RH/S specific to: migrations at sea (e.g., determination of river origin of individual catch in coastal/ocean independent surveys, tagging); determination of river origin of incidental catch in non- targeted ocean fisheries; and marine survival.

MANAGEMENT & SOCIOECONOMIC

118. Develop and/or evaluate innovative approaches for avoidance or monitoring river herring and/or shad (RH/S) catch in small mesh fisheries (e.g., environmental cues and bycatch avoidance, electronic monitoring and portside sampling).