Atlantic States Marine Fisheries Commission

Management and Science Committee

October 28, 2013, 1 p.m. – 5:30 p.m.;
October 29, 2013, 8:00 a.m. – 12:00 p.m.
St. Simons Island, GA

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

October 28

1. Welcome and introductions *(M. Armstrong)* 1:00 p.m.
2. Approval of agenda
3. Approval of minutes—May 21-22, 2013
4. Public comment

5. Climate change and stock distributions subcommittee report

   - Summer flounder distribution analyses *(J. Hare)* 1:10 p.m.
   - Management implications for fluke *(C. Kennedy)* 1:40 p.m.
   - NMFS reallocation tool *(W. Morrison)* 1:55 p.m.

6. MRIP report *(G. Colvin)* 2:10 p.m.

   - Q&A

7. Commercial/recreational fisheries regs by state/species matrix *(M. Hawk)* 3:10 p.m.

8. E-compliance reporting and assessment data delivery *(P. Campfield)* 3:30 p.m.

9. Mid-Atlantic Telemetry Observation System *(D. Wilson)* 4:00 p.m.

   - Pilot testing with sturgeon

10. Review Stock Assessment Schedule 4:30 p.m.

    - Peer review subcommittee planning (tautog, black drum, lobster, sturgeon)

11. Updates 5:15 p.m.

- Atlantic Coastal Fish Habitat Partnership *(E. Greene)*
- Cooperative Winter Tagging Cruise *(W. Laney)*
- SEAMAP *(S. Madsen)*
- NEAMAP *(J. Gartland)*
- Coast-wide ageing activities *(J. Kipp)*

12. Other Business 5:25 p.m.

13. Adjourn 5:30 p.m.

<u>October 29</u>

1. Climate change and stock distributions working session 8:00 a.m.

2. Management risk and uncertainty working session 10:00 a.m.

3. Adjourn 12:00 p.m.

Atlantic States Marine Fisheries Commission

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MEMORANDUM

February 13, 2013

To: **ISMFP Policy Board**
From: **Mike Armstrong, Management and Science Committee Chair**
RE: **Climate change, stock distributions, and state quota allocations**

The ISFMP Policy Board charged the Management and Science Committee with investigating whether climate change and warming coastal water temperatures are causing shifts in the geographic distributions of several stocks. And, where shifts are occurring, to reconsider the state-by-state allocation schemes and need for adjustment. The Committee has outlined the following plan to address the charge:

1. Define focal species to investigate, based on state allocation scheme and region

2. Evaluate fishery-independent survey data to examine changes in stock ranges and centers of distribution; also evaluate MRIP and commercial catch data
   - Consider both North/South and inshore/offshore distribution shifts
   - Conduct a literature search for existing documentation of stock distribution shifts

3. Summarize the state of knowledge for focal species, define criteria for a significant stock distribution shift, and demonstrate distribution shifts for stocks where it is occurring.

4. Define the methods for possibly adjusting state-by-state allocations

5. Define the frequency for re-evaluating stock distribution changes and allocations

6. Task Technical Committees to re-evaluate stock distributions periodically

7. For stocks where redistribution has been demonstrated, evaluate scientific ramifications:
   - For fishery-independent survey data applications, evaluate the weighting scheme of trawl stations (and other sampling gears), area designations, etc. and the effects on index calculations
   - Evaluate the ecological costs of longer migration pathways that lower production, especially for mid-Atlantic estuarine-dependent stocks

Proposed initial focal species are black sea bass, scup, and summer flounder in the Mid-Atlantic, lobster and Northern shrimp in New England, and red drum and spot in the South Atlantic. However, after the literature search, MSC may pare down the number of species to ensure thorough and quality research that will lead to better evaluations and recommendations from the Committee within the proposed timeline.

Timeline:

	2013										2014				
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Form MSC subcommittee; begin work on steps 1, 2, 3	X	X	X												
Subcommittee report to MSC			X					X							X
Continue work on steps 1, 2, 3; begin work on steps 4 and 5			X	X	X	X	X	X							
MSC initial report to Policy Board								X							
Complete steps 1- 5, based on Board feedback and with TC consultation; draft conclusions and recommendations								X	X	X	X	X	X	X	
Subcommittee investigate step 7												X	X	X	
MSC final report to Policy Board, consider new allocations for implementation in 2015															X

PI: Malin Pinsky
Co-PIs: Ken Able, Joel Fodrie, Olaf Jensen, Chris Kennedy, Janet Nye

Understanding the impacts of climate change on the distribution, population connectivity, and productivity of summer flounder (*Paralichthys dentatus*) in the Mid-Atlantic

Introduction

Summer flounder is a critically important species to commercial and recreational fishermen throughout the Middle Atlantic Bight (MAB) region, but management is complicated by rapid poleward shifts in their distribution that have been observed as temperatures warm. Stock assessment and management of summer flounder have already been controversial, largely because of scientific uncertainties which result in ambiguity in estimates of population status relative to reference points. Climate change will likely further impact the distribution, stock structure, and productivity of summer flounder. Unless these dynamics can be resolved and the consequences for management determined, they will continue to hamper efforts to manage summer flounder for both high yields and long-term sustainability.

We propose a multi-pronged approach - including genetics, otolith microchemistry, analysis of trawl surveys, modeling of fishermen's behavior, and stock assessment modeling - to understanding the impact of climate change on regional connectivity and population dynamics of summer flounder. The research will integrate existing data and samples previously collected as part of long-term research efforts. First, genetic analyses of long-term summer flounder larval collections near the two extremes of its range (1989-2013 in New Jersey and 1986-2013 in North Carolina) will be used to explore long-term (multi-generation) population substructure and connectivity within the MAB. Second, we will examine otolith microchemistry from the same larvae to refine our understanding of substructure and connectivity over shorter (intra-generation) timescales. Third, we will assess changes in the spatial distribution and size structure of adults captured in the National Marine Fisheries Service and state trawl surveys. Fourth, we will utilize historical data in the development of a spatially-explicit, dynamic bioeconomic model to describe the evolution of catch and effort in the commercial and recreational summer flounder fisheries, with a focus on how changes to spatial distribution and age structure affect fishery outcomes. Finally, we will use statistical analysis and population models to assess the interactions between dynamic reproductive connectivity, climate, and changes in the apparent productivity, age structure, and spatial extent of the stock, and the implications for fishery management.

Background

Summer flounder (*Paralichthys dentatus*) support important commercial and recreational fisheries throughout the Middle Atlantic Bight (MAB). Summer flounder are one of the top ten recreational species in the U.S. by landed weight and are by far the most commercially valuable flatfish species in U.S. Atlantic/Gulf waters, comprising over half of the total landed value of flatfishes in this region in recent years (NMFS 2012). Although summer flounder are currently considered to be rebuilt (Terceiro 2012), management of the stock has been extremely controversial, with numerous lawsuits from both fishing industry groups and environmental organizations (Terceiro 2002, 2011). While overfishing is no longer a primary concern, the longer-term effect of climate change is both poorly understood (and thus not included in stock assessment) and a potentially dominant factor in the population dynamics of this species in the future. Further, given the current structure of the fishery management plan (FMP) for summer flounder, overfishing could again become a problem if climate change leads to significant changes in the spatial distribution or age structure of the stock. Key to understanding the overall impact of climate change is understanding how landings will respond to changes in the structure and spatial extent of the stock.

The most recent stock assessment (Terceiro 2012) concluded that the spawning stock biomass of summer flounder increased more than eight-fold between 1989 and 2011, but the availability of summer flounder to fishermen at different locations within its range is a function of both the overall abundance and productivity of the stock as well as spatial dynamics within the stock boundaries. Published research by the PIs of this proposal and others suggests that both of these factors are currently being affected by climate change. For example, Nye et al. (2009) found a significant northward movement of the maximum latitude of summer flounder in the Northeast Fishery Science Center's spring trawl survey indicating a northward range expansion, and Pinsky and Fogarty (2012) found that summer flounder are one of the only species in the MAB to exhibit clear northward shifts in both the spring and fall trawl surveys. Summer flounder has also increased in abundance in both Long Island Sound and Narragansett Bay, RI, contributing to a shift from cold-water to warm-water dominated species in these ecosystems (Howell and Auster 2012, Collie et al. 2009). Range and population size of marine populations are often positively related (MacCall 1990), but how density-mediated shifts in distribution affect the fishery are unknown. At the same time, isotherms in the MAB have been shifting northward at a rate of 20-100 km per decade (Burrows et al. 2011), temperatures have been warming at close to twice the global rate (Belkin 2009), and many other fish species in the region appear to be responding with northward shifts in their distribution (Nye 2009, Murawski 1993).

As populations shift geographically, a number of ecological changes may also occur, resulting in changes to productivity of the stock and thus changes in biological reference points (Link et al. 2011). Productivity of summer flounder appears to have varied without trend since the early 1980s (Fig. 1), despite substantial changes in biomass – a pattern sharply at odds with predictions from standard stock assessment models which link biomass changes to changes in productivity. This pattern suggests that models of summer flounder population dynamics which account for the

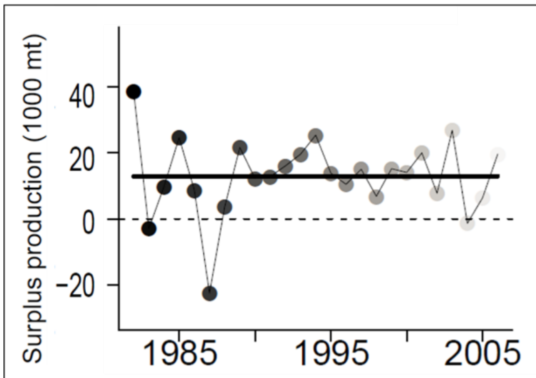

Figure 1. Time series of summer flounder surplus production (net population growth in the absence of fishing) calculated from stock assessment data provided by Terceiro 2008.

influence of external environmental factors and connectivity among subpopulations are likely to perform better. New assessment approaches that account for range shifts (Nye 2009) and environmental influences on stock productivity (Vert-pre et al. 2013) are needed if we are to effectively manage shifting marine populations (Link et al. 2011). However, for summer flounder, the development of models that incorporate environment and population structure is hampered by our limited understanding of connectivity among putative subpopulations and environmental influences on growth, recruitment, and adult survival.

Summer flounder has its center of distribution in the MAB but the metamorphosing larvae and settled juveniles are found exclusively in estuaries and that is where most growth occurs in the first year of life. Thus, this species is strictly estuarine dependent (see Able 2005) and events in the estuarine nurseries are critical to the population dynamics of this species, the contribution of recruits to the fishable stock (Able et al. in press) and as a result, effective management of this species. Unfortunately, this relationship between events in estuarine nurseries (see Beck at al. 2001 and Dohlgren et al. 2006 for treatment of nursery concept) and the fishable stock are difficult to resolve because: (1) there may be multiple stocks or contingents in the MAB (Kraus and Musick 2001, Able et al. in press), (2) there may be multiple sources of larvae to estuaries from spawning in the MAB and, potentially the South Atlantic Bight (SAB) (Able and Fahay 1998), and (3) some estuaries may contribute more juveniles than others to the adult population. Possible factors influencing the variable contribution of estuaries might include latitudinal differences in larval delivery systems, overwinter mortality and contributing parasite loads, and habitat quality (Szedlmayer et al. 1992, Keefe and Able 1993, Burreson and Zwerner 1984). Fortunately, a combination of genetic and otolith microchemistry techniques applied to fish collected over multiple decades, along with data synthesis and modeling, may resolve many of these issues.

All of these ecological changes are set against the background of shifting fishing patterns and an ever-evolving regulatory landscape. In 1992, Amendment 2 to the summer flounder, scup, and black sea bass (FMP) was passed to help speed the recovery of the fishery. This amendment established annually-specified commercial quotas, a moratorium on new commercial vessel licenses, and recreational harvest limits (RHLs), as well as a review process for establishing gear restrictions, size limits, and season lengths. 60% of the aggregate quota was assigned to the commercial sector and 40% to the recreational sector, based on the 1980-1989 average division of landings. The commercial quota was further distributed to the states based on average proportional landings from the same period, while the RHL applied coastwide (Terceiro, 2002). The major features of the management of the commercial fishery have remained relatively consistent since 1992, including fishery-wide regulations on gear and minimum size, and state-wide quotas[1]. This is, in part, due to the fact that the commercial fishery has been relatively effective in meeting necessary harvest reductions. Aggregate annual landings have fallen within 6% of targets in every year since 1998 (Terceiro, 2002, 2011a, 2011b, 2012). Additionally, the larger size of the vessels prosecuting the commercial fishery

[1] States have the authority to transfer or combine commercial quota if they so choose.

have seemingly been able to adapt to the afore-mentioned shifts in spatial distribution of the summer flounder stock, with fleets from southern states within the FMP, such as North Carolina, traveling northward to engage in fishing operations (Editor, 2013).

The recreational fishery, however, has not fared as well in meeting the RHL. Estimated annual landings have ranged from 50% below to more than 100% above targets (Terceiro, 2002, 2011a, 2011b, 2012). Partly in response to this, regulations on the recreational fishery have undergone much more significant adjustment since 1993, with the most substantial changes occurring with the establishment of Framework Adjustment 2 in 2001, and Addendum VIII in 2003. The former abandoned uniform coastwide regulations for summer flounder in favor of a system of "conservation equivalency." This approach was implemented in recognition of temporal and spatial variability in the availability and age structure of summer flounder between states, and granted authority to states to implement customized measures targeting size limits, bag limits, and season length in order to meet the coastwide target (Kerns, 2010). Addendum VIII augmented the Framework Adjustment with state-specific harvest targets based on the share of recreational harvests accruing to each state in 1998. This change was designed to provide managers with specific targets when adjusting regulations. However, the absence of a recreational quota or limitations on the number of recreational fishing licenses that may be issued has resulted in a pattern of recreational fishery regulations that vary dramatically between jurisdictions, and continuously-tightening regulations in states such as New York, which find it increasingly difficult to meet FMP-mandated recreational fishery targets using the regulatory levers set out by the Framework Adjustment (ASMFC, 2013).

As it stands, the system of conservation equivalency for the recreational summer flounder fishery does not allow for automatic adjustments to harvest targets or management strategies in response to environmental or economic changes along the coast. Instead, ASMFC utilizes the addendum process, authorized by Amendment 12 to the multi-species FMP in 1999, which provides a streamlined process for adjusting management measures. The addendum procedure has been used in a series of instances (e.g., 2006, 2012, 2013) to relieve northern states – including Massachusetts, New Jersey, Connecticut, and New York – from the possibility of drastic cuts to recreational harvest targets. This is done by allowing these states to take advantage of other states' harvest opportunities that are foregone by maintaining existing fishing rules in the face of falling harvests (Kerns, 2010). For instance, despite significantly restrictive minimum size, bag limits, and seasonal imposed on anglers targeting New York and New Jersey waters (in New York, minimum size limits were approximately 50% larger than those in North Carolina), estimated recreational mortality exceed targets in both states in 2012. These were the only states to exceed harvest targets in a year in which coast-wide recreational harvests of summer flounder were estimated to be at 82% of the target (ASMFC, 2013). It can be expected that a continued northward movement of the stock – and increasing angler participation rates in northern states in response to higher catch rates (Gentner et al., 2010) – may exacerbate the disparity in harvests. This, in turn, could lead to greater conflict between stakeholders and undermine the ability of the ASMFC to utilize the addendum process effectively, particularly given the historically contentious nature of the management process (Terceiro, 2011a).

Relevance to Mid-Atlantic Regional Ocean Research Plan Focus Areas

The questions of summer flounder population dynamics, stock structure, and range shifts raised above correspond directly with the Mid-Atlantic Regional Ocean Research Plan's goal of:

"Understand[ing] impacts of climate variability and sea level rise on the ecology and biology of living resources in coastal and ocean ecosystems, (e.g., mortality, fecundity, recruitment, distribution, migration and predator-prey interactions)."

In addition, these questions are of direct relevance to the research priorities of the individual state Sea Grant programs:

New Jersey Sea Grant – "Understand **stock recruitment relationship or the human impacts** (e.g., dredging, coastal development) on the ecology of commercially and recreationally important fish species including weakfish, black sea bass, blue crab, **summer flounder**…"

New York Sea Grant – "Research [is needed] to determine the causes and potential remedies for actual and predicted changes in populations and population dynamics of finfish and shellfish of economic importance to New York." Majority of recreational landings occur in New York and New Jersey. New York had the highest number of Federally permitted dealers (52) who bought summer flounder in 2011

North Carolina Sea Grant : "Determine how commercially and recreationally valuable fishes respond to environmental factors, habitat alteration and harvest activities". Furthermore, NCSG's strategic plan explicitly seeks to "understand the complex processes and issues that dictate the best use of marine and coastal resources… including the interaction of the coastal ocean and estuarine systems [which] respond to long-term changes in climate. Many issues facing marine and coastal resource users transcend jurisdictional boundaries. Thus, North Carolina Sea Grant encourages inter-institutional, multi-disciplinary and regional collaborations"

Virginia Sea Grant 2010 – 2014 strategic plan priorities: "Provide resource managers with the best available science and decision-support tools to promote effective regulatory actions, resource allocations between user groups, and resource sustainability"; "Support use of integrated, ecosystem-based approaches to managing coastal and marine resources and enhancing ecosystem resilience"

The research strategy proposed here – which includes three separate but related approaches applied to existing data and samples – is also an excellent match for the Mid-Atlantic Sea Grant RFP's focus on: "Cross-disciplinary, integrative research that analyzes and synthesizes existing data to address major, large-scale issues of relevance to coastal and marine communities."

General Work Plan and Milestones

Objectives

1. Elucidate patterns of larval connectivity by testing which subpopulations contribute to settlement of summer flounder larvae in New Jersey and North Carolina estuaries and whether this contribution has varied through time.
2. Assess the interactions between regional climate variability, shifting spatial distribution of summer flounder stocks, variability in productivity and the relative contribution of subpopulations.
3. Develop an understanding of how the commercial and recreational summer flounder fisheries respond to changing spatial distribution and age structure.
4. Evaluate the implications of climate-driven shifts in summer flounder and fishing effort for stock assessment and fisheries management, including the evaluation of fishery outcomes under alternative climate scenarios and the expected performance of the existing regulatory system.

Approach

We propose a multi-pronged approach to understanding the impact of climate change on population dynamics of summer flounder based on analysis of long-term trawl survey data, collections of pre-settlement larvae in Little Egg Inlet, NJ (1989-2013) and Beaufort Inlet, NC (1986-2013):

1. Genetic analysis of summer flounder larvae collected near the extremes of its range within the MAB (NJ and NC) will help resolve population substructure and connectivity (Obj. 1) on evolutionary time scales.
2. Otolith microchemistry of the same larvae will assess whether the natal sources and larval dispersal corridors for individual cohorts have changed (especially across latitudes) over the last 25 years as regional temperatures have warmed (Obj. 1).
3. Statistical analysis will be used to assess the interactions between climate and the spatial distribution of adults captured in the National Marine Fisheries Service and state trawl surveys (Obj. 2).
4. Develop a bioeconomic model of the summer flounder fishery using state-level historical effort and catch data and outputs from the, biophysical model of fish distribution and age structure..
5. Modeling will integrate the effects of climate, dynamic reproductive connectivity, and shifting patterns of fishing effort on the sustainability of the stock and provide a predictive tool for forecasting (Obj. 4).

Objective 1:

In Little Egg Inlet, NJ, summer flounder larvae have been sampled weekly on night flood tides since 1989 and stored in ethanol (Able et al. 2011). A total of 5996 larvae have been identified, providing ample material for this project. A similar effort at Beaufort Inlet, NC has been collecting summer flounder larvae since 1986. The feasibility of genetic analyses from the archived samples has been verified in two previous projects (Fatimo Soriano and Jens Frankowski, pers. comm.). Preliminary microchemical analysis of otoliths retrieved from these samples showed that the natal core could be identified in ingressing larvae based on Mn peaks in the region surrounding the primordia (sensu Ruttenberg et al. 2005). Furthermore, 19 specimens collected from NJ were characterized by notably higher Sr:Ca levels in larval growth bands than were 2 summer flounder captured entering NC estuaries (at a different location).

We will sequence ~5,000 Single Nucleotide Polymorphisms (SNPs) in 1000 larval samples from each of NJ and NC (50 larvae/year in each site) using double-digest Restriction Associated DNA sequencing (ddRADseq) (Peterson et al. 2012). These SNP markers will provide substantially greater genetic resolution than has been available previously (Jones & Quattro 1999). We will use Bayesian Markov Chain Monte Carlo methods (Structure and Structurama), to detect whether summer flounder form distinct populations, assign larvae to populations, and generate a time-series of each population's contribution to settlement in NC and NJ (Hubisz et al. 2009; Huelsenbeck and Andolfatto 2007). We hypothesize at least two genetically distinct populations north and south of Cape Hatteras based on recent reviews (Terceiro 2011) and expect them to contribute differentially to NC and NJ larval time-series. In addition, we hypothesize that connectivity has changed through time, with a southern population contributing more to NJ as the stocks shift north. Contingent on funding from a related NJ Sea Grant proposal (Pinsky, Jensen, and Able), we will also sample 1000 adults in collaboration with the commercial fishery, sequence them, and assign larvae to georeferenced larval sources on the continental shelf.

On the same individuals used for genetic analyses, we will exploit otolith microchemistry to determine the natal sources and dispersal history of ingressing larvae along NJ and NC. Otoliths grow as daily bands and incorporate trace elements in a manner that reflects the chemistry of the ambient environment (Campana 1999). Thus, provided that regional differences exist in environmental conditions (i.e., temperature across latitudes), otoliths can carry a permanent record, or "flight data recorder", that allows researchers to retroactively track fish though space and time. Previously, this approach has been used with notable success to track the connectivity of larval fishes representing multiple families (Barbee and Swearer 2007, Thorrold et al. 2007, Standish et al. 2008, Cook 2011). Otoliths from ingressing summer flounder will be prepared for

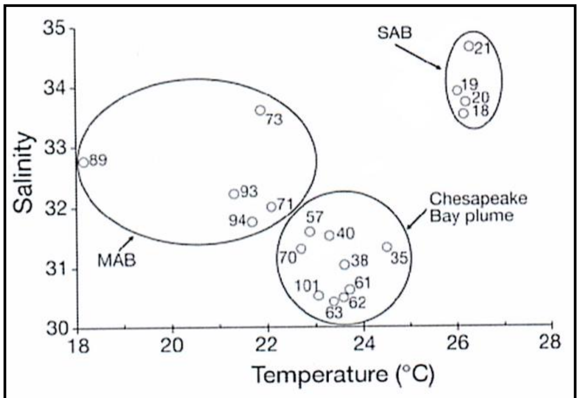

Figure 2. Differences in salinity and temperature among Mid-Atlantic Bight (MAB), South-Atlantic Bight (SAB) and Chesapeake Bay water masses that should contribute toward distinct regional geochemical tags in the otoliths of summer flounder. Figure from Shaffler et al. (2009).

micochemical analyses following standard protocols for cleaning, mounting and storage in class-100 clean environments (Cook 2011, Fodrie and Herzka in press). We intend to analyze ~600 otoliths using this approach: 50 individuals from both NJ and NC across 5 time periods: 1989-1993; 1994-1998; 1999-2003; 2004-2008; 2009-2013. Left sagittal otoliths from each fish will be analyzed using laser ablation inductively coupled plasma mass spectrometry (a LA-ICP-MS unit located at the University of North Carolina) to measure trace element concentrations. Our general approach will be to mount whole otoliths and drill (ablate) completely through the structure to intercept the natal core as identified by the presence of a manganese peak. Based on our own previous analyses and published reports (Fig. 2, Shaffer et al. 2009), we anticipate that ^{26}Mg, ^{55}Mn, ^{88}Sr, ^{112}Cd, ^{138}Ba, and ^{208}Pb are potentially useful markers in distinguishing between regional water masses. Based on the suite of elemental concentrations we find in the natal core of individual fishes, we will assign a probable site of origin (north, south, undefined) or, at the very least, assess the diversity of natal signatures present within the population using maximum likelihood analyses, neural network and Markov chain Monte Carlo methods.

Objective 2:

Basin-scale processes (e.g., Atlantic Multidecadal Oscillation; AMO) were correlated with the observed shifts in distribution of fish stocks in the Northeast US (Nye et al. 2009) and zooplankton assemblages (Kane 2011). The AMO is a basin-scale indicator of regional-scale temperature and circulation changes to which marine organisms respond more directly (Nye et al. 2011). In the Northeast US shelf, bottom water temperature on the shelf is strongly influenced by the interplay between cold Labrador slope water and warm slope water influenced by the Gulf Stream. This process is best represented by the index of the north wall of the Gulf Stream (Pena-Molina and Joyce 2008). Basin-scale processes such as the north wall of the Gulf Stream rather than local temperature changes tend to be better indicators of the regional scale temperature-induced shifts in spatial distribution in which we are interested. We propose to examine the shifts in adult summer flounder distribution on the shelf in relation to broad scale oceanographic processes, spawning stock biomass and the subsequent effect of climate on population structure revealed in genetics and otolith microchemistry of larval summer flounder.

Objective 3:

This particular fishery offers benefits for an integrated study such as that being proposed. In addition to having a strong base of biological knowledge supporting this project, the summer flounder fishery has been studied in the past as a test case for improving the fishery management (NRC, 2000). Further, and more important for this component of the project, there already exists a body of research dedicated to understanding how effort evolves in this fishery, particularly on the recreational side, from which we can draw important fundamental knowledge as the model is developed (Gentner et al., 2010; Massey et al., 2006; Newbold and Massey, 2010). We propose to develop a two-module, spatially-explicit bioeconomic model, representing, respectively, the commercial and recreational summer flounder fisheries. The model will be estimated and simulated in

STATA, building on similar models developed by Kennedy and Barbier (2013), and Min-Yang Lee and Scott Steinback of the NMFS Northeast Fisheries Science Center.

Kennedy (co-PI) and Barbier (2013) developed a spatially-explicit, age-structured bioeconomic model of the commercial blue crab fishery in Georgia, USA – implemented in STATA – with the purpose of investigating the role of changing freshwater inputs to coastal estuaries on the blue crab stock and resulting fishery outcomes. This work is unique in that biological and physical data were able to be correlated temporally and spatially with harvest and effort records at a relatively high temporal and spatial resolution, allowing for a detailed structural model of the fishery that is rare in bioeconomic modeling efforts. This allowed for the development of an explicit structural model describing dynamic transitions in adult crab abundance, juvenile abundance, effort, and harvests. The system of equations is estimated across six sounds (estuarine systems) for twelve years assuming quarterly transitions. This produced a robust model of the relationship between salinity, the age structure of the stock, abundance measures, harvests, and the evolution of effort in response to fishery revenue. To determine how river flow impacted the fishery, the relationship between flow and estuarine salinity was estimated for three riverine sounds. The resulting physical model was used in conjunction with hypothetical minimum flow standards to develop counterfactual salinity profiles, which subsequently feed into the bioeconomic model to determine the economic impact of imposing a minimum flow standard.

This approach will form the backbone of the bioeconomic model and the commercial module. However, there are both complications and simplifications that arise in the application to summer flounder. Regarding the commercial fishery model, the small scale of the blue crab fishery and resulting data privacy concerns prevented an analysis of how commercial fisher behavior responds to varying stock abundance between sounds, as we could not identify characteristics of individual crabbers. For the commercial summer flounder fishery, this process is integral for understanding how a changing stock will impact state-specific fisheries. Also important for this goal is developing a measure of effort and the cost of effort that can be mapped across the fleet based, in part, on the matching of fishing location and port or state of departure. One potentially simplifying characteristic of this fishery is the fact that behavioral participation dynamics will likely not be as pronounced, given the historically binding nature of the harvest quota for most states, uniformity of regulations across jurisdictions, and current flexibility of the fleets revealed by their ability to travel – and thus adapt – in response to changing spatial abundance patterns. If quotas continue to bind, the choice of effort is not the result of profit-maximizing behavior, and modeling vessel-level participation and harvest decisions may not be necessary.

Regarding the integration of the biophysical model, this project presents a unique opportunity to develop the bioeconomic model in concert with biophysical dynamics. Historically, developing robust models designed to predict outcomes associated with coupled human and natural systems is difficult, in part because it is rare for scenario-building efforts to be multi-disciplinary from conception. The result is an inability to account for important feedbacks and nonlinearities and, often, a reliance on less-than-ideal proxies for key variables vital for bioeconomic modeling methodologies (Barbier et al., 2008). This separation limits the robustness of models, risks misinterpretation of key proxies (e.g., how, or if, to develop biomass estimates from scientific surveys; the appropriateness of using fishery-dependent stock estimates as an input to harvest production functions), and may limit the applicability of results to the policy-making process, if bioeconomic model outputs are not viewed by fisheries scientists and managers as relevant. By working together from the beginning, we can develop models jointly such that outputs from the biophysical modeling efforts match in content, context, and spatial and temporal scale to the economic model of fisher behavior (and vice versa). The collaborative process greatly reduces the amount of work needed to develop the biological side of the bioeconomic model. Instead of having to speculate about the validity of proxies, or mold models around existing, but less than ideal data, key biophysical and ecological relationships affecting the MAB and the summer flounder fishery are embedded in the relevant measures of distribution, abundance, and age structure of the stock.

A more complicating factor in extending this model is developing a suitable modeling strategy for the recreational fishery. Fortunately, the Lee and Steinbeck model mentioned above is an excellent fit, both for representing the evolution of recreational participation and effort, as well as utilizing as inputs the same biophysical outputs as the commercial model. Their model – also implemented in STATA – is used to estimate angler welfare, or the personal benefit derived from participating in recreational fishing, and subsequently predict participation and effort as a function of angler characteristics (e.g., distance travelled), regulations (e.g., bag limits or minimum length limits), and the characteristics of the exploited stock. The model utilizes data from the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS) and a follow-up choice experiment survey administered to anglers in 2009 and 2010 to estimate behavioral parameters of a random utility model. This model can then be used to simulate angler behavior in response to changing regulations and changes to coastwide abundance and age structure. These last variables are major inputs to the model, and would be extended in this project to allow for spatially non-uniform stock characteristics, something that the available data has not allowed for. In addition to expressing interest in the goals of this project, Lee and Steinbeck have agreed to provide technical advice and collaboratively work on the development of this component of the model as they refine their own approach.

The goals of the combined bioeconomic model are as follows:

Estimate the relative profitability of the commercial fishery as a function of abundance, age structure, and spatial distribution of the stock, as well as data on home port and spatial location of fishing activities.

Estimate angler welfare as a function of stock characteristics, angler characteristics, and regulatory characteristics. Use this model to predict participation rates.

Use the biophysical model as a basis for simulating commercial and recreational fishery outcomes under various climate scenarios.

Determine how the current regulatory regime would perform under these scenarios, and in particular, how the conservation equivalency management tools of minimum size, bag limits, and season length would have to change for northern states to meet targets.

Objective 4:

Unless our improved understanding of summer flounder response to climate change is incorporated into the operational stock assessment model, it will have little impact on management. Therefore, we will develop population models that include climate indices (e.g., the AMO) in the stock recruitment relationship (Jensen et al. 2010) or environmental shifts in the biomass-productivity relationship (Vert-pre et al. 2013). If otolith microchemistry and genetics suggest a substantial contribution to recruitment from outside the stock boundary (i.e., south of Cape Hatteras), we will also develop a model with (potentially climate-linked) immigration of recruits. These population models will be coupled with regional climate prediction models to forecast expected changes in biological reference points used for management.

Milestones

Stage I – data compilation and preliminary laboratory work

(1) DNA extraction completed - <Month Year>
(2) Otoliths extracted and mounted - <Month Year>
(3) <Something about the oceanographic data sets> - <Month Year>
(4) <Something about data for the fleet dynamics model> - <Month Year> **working on this**
(5) Population model data (catch records and survey indices) compiled – August 2014

Stage II – data and laboratory analysis

(1) Sequencing completed
(2) Laser ablation of otoliths completed
(3) <Something about analysis of distribution shifts and oceanography> - <Month Year>
(4) <Something about analysis of the fleet dynamics model> - <Month Year> **working on this as well**
(5) Population model completed using *simulated* data for range, connectivity, and fishing effort shifts – January 2015

Stage III – synthesis and manuscript writing

(1) Joint analysis of otolith microchemistry, genetic, and range shift data to understand changes to spatial distribution and connectivity – May 2015
(2) Population model completed using *real* data for range, connectivity, and fishing effort shifts – August 2015

(3) Presentation of research results at the 2016 summer flounder stock assessment data meeting – Spring 2016
(4) Submission of manuscripts on individual project components (Fall 2015) and the population model incorporating all components (Spring 2016).

Outcomes

Research

This project will provide much of the scientific understanding needed to begin including climate change and range shifts in assessment and management of summer flounder. Link et al. (2011) suggest three general approaches to accounting for range shifts: "re-evaluate stock identification, re-evaluate a stock unit area, or implement spatially explicit modelling." None of these approaches are feasible yet for summer flounder given our limited scientific understanding.

The combination of genetic analysis and otolith microchemistry proposed here will help resolve larval sources and will provide much of the information needed to apply Link et al.'s (2011) first two approaches. Neither genetics nor otolith microchemistry alone are likely to be definitive; both have temporal and methodological limitations. However, their uncertainties are largely independent and congruous, and thus in combination they should provide robust answers to questions of summer flounder connectivity.

The need for spatially explicit modeling will be assessed through evaluation of the impact of range shifts, changes to connectivity, and shifting fishing effort patterns on the dynamics of the stock. These approaches, if successful, will provide a model for evaluating the effects of climate change on other MAB species in the future.

Outreach

Information transfer to the fishing industry will be facilitated by strong existing contacts between the PIs and fishing industry organizations in all four states, including ongoing University/industry collaborative research projects. We have discussed this project with leaders of the Save the Summer Flounder Fishery Fund (SSFFF, an industry group dedicated to improving the science used for fishery management), and they are strongly supportive of our goals and approach. We will present interim and final project results to SSFFF and other fishing organizations in NY, NJ (e.g., Jersey Coast Anglers Association and Fish Hawks) and NC (e.g., Coastal Conservation Association) at their regular meetings. We have also discussed this proposal with Mark Terceiro, NOAA scientist in charge of summer flounder stock assessment, Min-Yang Lee and Scott Steinbeck, fisheries economists at the NOAA NEFSC, and Moira Kelly, the Fishery Policy Analyst at the NMFS Northeast regional office responsible for the summer flounder, scup, and black sea bass FMP. All three have expressed a strong interest in the results of this project, and we plan to regularly update them and other NEFSC, MAFMC, and ASFMC staff on our progress.

Coordination

The research team includes scientists with complementary expertise in fish population genetics (Pinsky), otolith microchemistry (Fodrie), climate change impacts on fish ecology (Able, Fodrie, Nye, Pinsky), larval ecology (Able), summer flounder biology (Able), stock assessment (Jensen), and resource economics (Kennedy). The team includes both pre-tenure (Fodrie, Nye, Jensen, Pinsky, Kennedy) and senior (Able) faculty. Pinsky will be responsible for overall project coordination and will lead the genetic component. Fodrie will lead the otolith microchemistry work. Able will coordinate retrieval and identification of larval fish samples from the Little Egg Inlet and Beaufort Inlet collections. Nye and Jensen will lead the statistical analyses and population modeling. Kennedy will lead the bioeconomic modeling.

Data Management Plan

Meta-data and sample archiving at the Rutgers University Marine Field Station (RUMFS) will follow the procedures described in our past (Hagan et al. 2002) and current (Vasslides et al. 2011) methods. Survey and environmental data from field sampling are archived in TUCKFILE, a relational database written in MySQL, stored on a server at RUMFS (Tuckerton, NJ), and backed up daily. Data entry is through a PHP/HTML webpage system.

Microsatellite genotype data will be archived as ASCII comma-separated value (CSV) files to ensure long-term readability and interoperability, while the original electropherograms will also be archived. Files will be stored on a server in the Pinsky lab at the Department of Ecology, Evolution, and Natural Resources (New Brunswick, NJ) with unique individual identifiers to permit linking of genotypes back to the TUCKFILE database. Meta-data will follow Ecological Markup Language (EML) standards and will identify the contents of each file, document the source of each sample, and record the lab protocols used. Analysis will be accomplished through scripts written in R, Perl and Python to ensure complete repeatability. Genetic data will be available to the team through Secure File Transfer Protocol (SFTP) connections and will be backed up daily along with meta-data and analysis scripts.

To permit other researchers and the public access to the results of this project, we will post all data related to published papers from this project on the Dryad data repository (http://www.datadryad.org), a National Science Foundation-funded initiative. Data in this repository have a Creative Commons license for free re-use. Any unpublished data will be posted on the Rutgers Community Repository (RUcore, http://rucore.libraries.rutgers.edu) within two years of project completion where they will be fully searchable and available to other researchers for analysis.

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Results From Prior Research

Able

Fodrie

Jensen

Reducing uncertainty in stock-recruitment relationships and fishery reference points using Bayesian meta-analysis - NJSGC project # 6010-0011

Summary of project results: This research funding supported the completion, publication (Ricard et al. 2012) and public dissemination (via an open-access website: http://ramlegacy.marinebiodiversity.ca/ram-legacy-stock-assessment-database) of a global database of fishery stock assessments, the RAM Legacy Stock Assessment Database. Data from the RAM Legacy database were then used to develop informative Bayesian priors for an important stock assessment quantity: the ratio of spawning stock biomass at which maximum sustainable yield is obtained to the spawning stock biomass in the absence of fishing (Thorson et al. 2012). Values of this reference point were found to differ by taxonomic order and priors were developed for orders (e.g., Perciformes and Clupeiformes) that include data-poor stocks of importance to New Jersey and the Mid Atlantic region.

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To: Management and Science Committee

From: ASMFC Staff

RE: Comparison of Compliance Report and Stock Assessment Data Delivery Processes

Date: October 9, 2013

At its October 2012 meeting, the Management and Science Committee (MSC) discussed the concept of standardized annual data collection for stock assessment purposes. It was noted that valuable agency staff time is spent each year gathering and preparing data for compliance reports, yet the format of reports and required data submissions are rarely sufficient to be useful for stock assessments. MSC members suggested it may be possible, with careful planning, to make progress reporting more efficient and expedite the data-gathering step of the assessment process.

The MSC decided to explore options for streamlining the compliance report and stock assessment data delivery processes. The goal is to determine if annual compliance reporting and stock assessment data delivery processes could be improved such that data are delivered in a timely and efficient manner for both purposes.

ASMFC staff were tasked with:

1. Identifying the required data sources for each species' stock assessment
2. Summarizing the data required for compliance reports and the annual timing of report delivery for each species
3. Comparing compliance report content with the data sources required for each species' assessments to identify data already required and submitted annually, and data that are not.

ASMFC Stock Assessment Scientists compiled a list of all data sets used in the base model run of the latest benchmark stock assessment for each species or species group (see Summary ComplianceRptSA datareqsFinalDraft.xlsx). They also determined if each data source was part of a completed study or an ongoing data collection program. Next, FMP Coordinators noted which data sets were <u>required</u> by an FMP and which were <u>voluntarily</u> reported in the latest compliance report.

Staff compared datasets among species and created two lists. The first displays the number of assessments in which each data source is used, and the second displays the number of distinct, ongoing surveys used by each species for indices of abundance (see Tab "Summary Stats").

In summary, staff noted the following:

- The data summaries provided to MSC are draft in nature and require further review by each Technical Committee before specific recommendations are made to the Policy Board.
- Requesting annual data deliveries for each data source may not be more efficient than the current assessment data gathering process given the unique data formatting needs and the vetting, sub-setting, and post-processing (e.g., standardization) requirements for each species. Species-specific issues are the most time-consuming aspects of the data workshop. However, some aspects of data submission such as survey descriptions and metadata could be updated annually and delivered once (covering all species) to ASMFC staff to save time.
- It may be more efficient to align stock assessment data requests with the trigger exercise schedule for each species. The MSC or Policy Board could rank the annual list of data requests from the Commission in order of importance, to help state scientists prioritize fulfillment of requests.
- Coordinating the timing of annual compliance report delivery (see tab "Compliance Report Due Dates") relative to stock assessment needs may be challenging given that only a subset of species undergo annual assessment updates and ISFMP staff need compliance report data annually.

Additionally, benchmark stock assessments are initiated based on Board directive and personnel time as opposed to availability of data.

- Synchronizing all annual compliance report dates may be challenging as state staff members serve on more than one species technical committee and the time to compile multiple reports may be too burdensome. Similarly, ISFMP staff would be overwhelmed if compiling all state reports for each species simultaneously, and unable to address compliance issues in a timely manner.
- Revising and shortening compliance reports would make annual compliance reviews less burdensome on state and ASMFC staff in the long-term; however, it may initially increase the amount of time required for state agency biologists to revise and prepare reformatted reports. Additionally, the ASMFC compliance reports may double as annual summaries for individual states' outreach purposes and grant reporting requirements.
- Several species' Technical Committees already provide all or most of the data required for stock assessments on an annual basis (e.g., Atlantic croaker, Atlantic striped bass, tautog). However, those deliveries are rarely sufficient for stock assessment purposes. Annual vetting and QA/QC data revisions occur for many data sources; therefore, updates of the entire time series may be required annually or before each assessment. Also, time would need to be set aside annually by ASMFC Science staff or the SAS chair for the vetting of each submission.

Based on the summaries and findings developed by staff, would MSC like to continue pursuing the streamlining of the compliance report and stock assessment data delivery processes? If so, a valuable next step is to create a list of direct contacts (e.g., Jim Gartland for NEAMAP) for each data source and an estimate of the realistic timeframe for annual delivery of each dataset.

MATOS: The Mid-Atlantic Acoustic Tag Observing System

Recent years have seen expansions in the number of fish and marine animals marked with acoustic tracking tags, in the methods available to collect tag reception data, and in the scope and resolution of ocean and coastal observing systems collecting information about the animal's environment. MATOS aspires to bring together the GOOS and IOOS principles of integrated ocean data collection and management and the MARACOOS commitment to supporting regional ocean and coastal science, management, and economic activities to add value to the efforts of individuals and organizations within the region working in this field.

The Objectives of MATOS are to support:

- Broader and more efficient use of acoustic tag tracking information collected in the Mid-Atlantic and adjacent regions;
- The integration of regional tag tracking information with the IOOS, GOOS, and other observational networks, for the benefit of all parties;
- Scientists, Managers, Fishermen, Conservationists, and other users and potential users of acoustic tag tracking information.

MATOS will be implemented following these principles:

- MATOS is committed to supporting regional acoustic tagging activities by working with taggers and receiver operators to rapidly and easily connect tag identification and metadata to reception data and exposing the results only as specified by the tag operator.
- MATOS will have data security and distribution limits determined by the data providers.
- MATOS is committed to working with existing tagging investigators, networks, suppliers, and systems to add value, efficiency, and streamlining to their ongoing operations.
- MATOS will partner with MARACOOS, IOOS, GOOS, and OTN in attempting to establish and utilize community data and metadata standards and data access capabilities.
- MATOS covers the MARACOOS, SECOOS, NERACOOS, and adjacent regions
- MATOS will support real-time receiver data, including buoys and mobile receivers (fish, AUVs, gliders)
- MATOS will support delayed mode receiver data input in VEMCO other formats supporting ease of submission (drag and drop, direct IP transfer)
- The resulting MATOS database will be available for data queries, visualization, display, product development

Concept of Operations

MATOS will consist of the following basic components:

- An online, searchable, full metadata TAG database
- An online, searchable, full metadata RECEIVER database
- Both based on OTN & other community technical and metadata standards,
- With data access and distribution controls
- Automated INPUT of real-time RECEPTION data and delayed mode RECEIVER FILES
- Machine level matchups of RECEPTION information with TAG ID information, resulting in a continuously updated TAG / TIME / POSITION / ANCILLARY DATA / DISTRIBUTION LIMITS ('HITS') database
- Login-enabled graphical user interfaces to facilitate access, input, manipulation, and viewing of all databases
- Map-based visualization tools for each database
- Web services to facilitate data exchanges, integration, and downloading

Access and Data Protection
Access to the MATOS site will be by password-protected login. Users submitting tag or receiver data will set up preferences for sharing of that data – either public or private, with private limiting access to the individual or a project group designated by the individual. Public data will be available through the MARACOOS data system.

Data Input
MATOS will accept tag and reception data in almost any format.
Tags: Online templates associated with a user will be available for efficient tag and metadata input. Release forms are available to be filed with VEMCO to allow VEMCO to forward purchased tag metadata directly to MATOS. ACT collaborators may allow ACT data to be shared with MATOS, subject to individual privacy settings.
Receptions: MATOS will accept .vrl files or .csv files created by VUE. There is an FTP site for uploading; we are working with VEMCO so that future versions of VUE will allow direct uploading to MATOS, with including ancillary data for services like false detection analysis and site evaluations. MATOS will have an email address for accepting Iridium and other real time and near-real time data messages. MATOS will develop standard data exchange protocols with individual platforms (buoys, gliders, etc.) collecting real-time reception data, including other concurrent environmental measurements taken by the platform.

Data Integration
MATOS will support IOOS DMAC compliant and other standard Web Services. MATOS will be integrated into the MARACOOS data management system, with public data

accessible via the MARACOOS asset viewer, and protected data available to investigators and projects via MyMARACOOS. Data services will be incorporated into MATOS to support activities conducted by ACT and other projects.

Oversight

MATOS will be operated and maintained under the guidance of MARACOOS and an advisory group composed of active users and contributors.

Long Term Funding and support

MARACOOS will seek funding to support MATOS from interested agencies and other interests, in consultation with the MATOS Advisory Group.

Example page view for tag A69-9001-xxxxx (withheld pending permission). 14 Hits from 12/26/2012 to 01/05/2013. MATOS automatically displays all 'hits, receivers, and trackline. In this case the fish was seen just off Cape Henry at the southern edge of the map, then in the mouth of the James R, then up to Cape Charles, and back across the entrance to Cape Henry and into the Chesapeake Bay.

MATOS
Mid-Atlantic Acoustic Telemetry Observation System

Logout | Edit account | Help

EXPLORE SEARCH REWARD

A69-9001[redacted]

2011-11-09

Tag	Link
Model	v16-6h
Serial	
Manufacturer	

Total Hits	85
Receivers with Hits	14
Report	

Study that deployed tag	ACT
Tagger	
Common name	atlantic sturgeon
Scientific name	acipenser oxyrinchus oxyrinchus
Capture location	
Capture geo	
Capture date	
Capture depth	
Wild or hatchery	
Stock	
Length	
Weight	
Age	
Sex	
Dna sample taken	
Treatment type	
Temperature change	
Holding temperature	
Surgery location	
Surgery geo	
Surgery date	
Sedative	
Sedative concentration	
Anaesthetic	
Buffer	
Anaesthetic concentration	
Buffer concentration in anaesthetic	
Anesthetic concentration in recirculation	
Buffer concentration in recirculation	
Do	
Description	
Release group	
Release location	NY/NJ Coast
Release geo	
Release date	2011-11-09 00:00:00 UTC
External codes	
Length type	
Implant type	internal
Reward	
Sensor codes	
Lifespan	
Expiration date	2018-03-28 00:00:00 UTC

Hit	Time	Lat	Lon	Receiver
1	2012-12-26T07:45:11Z	36.83067	-75.96231	DOD -RR2
2	2012-12-26T07:46:53Z	36.83067	-75.96231	DOD -RR2
3	2012-12-27T12:03:39Z	36.96698	-76.33364	DOD -ER5new
4	2012-12-27T12:05:33Z	36.96864	-76.34184	DOD -NN2
5	2012-12-27T12:09:47Z	36.96698	-76.33364	DOD -ER5new
6	2012-12-27T12:11:32Z	36.96698	-76.33364	DOD -ER5new
7	2012-12-27T12:46:34Z	36.95066	-76.33902	DOD -NH8
8	2012-12-27T12:48:21Z	36.95066	-76.33902	DOD -NH8
9	2012-12-27T12:52:43Z	36.95066	-76.33902	DOD -NH8
10	2012-12-27T12:54:15Z	36.95066	-76.33902	DOD -NH8
11	2012-12-27T12:56:03Z	36.95066	-76.33902	DOD -NH8
12	2012-12-27T12:58:23Z	36.95066	-76.33902	DOD -NH8
13	2012-12-27T13:02:05Z	36.95066	-76.33902	DOD -NH8
14	2012-12-27T13:04:03Z	36.95066	-76.33902	DOD -NH8
15	2012-12-27T13:05:23Z	36.95066	-76.33902	DOD -NH8
16	2012-12-27T13:06:48Z	36.95066	-76.33902	DOD -NH8

Long-Term Benchmark Assessment and Peer Review Schedule

Approved by Policy Board October 2012

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	SA Staff	Species
American Eel	E							E					x		GN	American Eel
American Shad			E					x							KD	American Shad
River Herring								E					x		KD	River Herring
American Lobster	E				E					E					GN	American Lobster
Atlantic Croaker						SE						x			KD	Atlantic Croaker
Atlantic Menhaden		*				SE		*		SE			*		GN	Atlantic Menhaden
Atlantic Sea Herring		T			*			S-S							KD	Atlantic Sea Herring
Atlantic Striped Bass	*		S-F		*		*		S-S		*		*		KD	Atlantic Striped Bass
Atlantic Sturgeon **										E					KD, JK	Atlantic Sturgeon **
Black Drum											E				JK	Black Drum
Black Sea Bass		S-S		DP	*	*	S-F	*	*	*	*	x	*	*	GN	Black Sea Bass
Bluefish	S-S	*	*	*	*	*	*	*	*	*S-S*	*	*	*	*	KD	Bluefish
Horseshoe Crab					E				*			x			KD	Horseshoe Crab
Multispecies VPA	S-F				*			*				x			GN, KD	Multispecies VPA
Northern Shrimp	*	*	S-S	*	*	*	*	*	S-F	*	*	*	*	*	KD	Northern Shrimp
Red Drum					SE						SE				JK	Red Drum
Scup				DP	*	*	*	*	* (x)	*	*	*	*	*	GN	Scup
Spanish Mackerel				SE				SE							KD	Spanish Mackerel
Spiny Dogfish	*	S-S	*	*	*	T	*	*	*	*	*	*	*	*	GN	Spiny Dogfish
Large Coastal Sharks		SE					SE								GN	Large Coastal Sharks
Small Coastal Sharks			SE				SE		SE						GN	Small Coastal Sharks
Spot															GN	Spot
Spotted Seatrout															KD	Spotted Seatrout
Summer Flounder	S-S	*	*	S-S	*	*	*	*	S-S	*	*	*	*	*	GN	Summer Flounder
Tautog	E	*					*			E					KD	Tautog
Weakfish		E		DP	S-S						E				KD	Weakfish
Winter Flounder - SNE	*			S-S			S-S					x			KD	Winter Flounder - SNE
Winter Flounder - GOM	*			S-S			S-S					x			KD	Winter Flounder - GOM

S = SARC (F = Fall, S = Spring) Green = SEDAR External Review
E = EXTERNAL Red = ASMFC External Review
I = INTERNAL Orange = Fall SARC Review
X = SCHEDULED FOR REVIEW Light Blue = Spring SARC Review
x = 5 year trigger date or potenti Light Yellow = No assessments scheduled
T = TRAC Grey = Completed
SE = SEDAR
* = Assessment update DP = DATA POOR WORKSHOP by the Northeast Region

Italics = under consideration, but not officially scheduled 2013 marks transitioning to the new NE Stock Assessment Process

** These species are reviewed by their respective Plan Review Team during annual FMP reviews. Due to existing management measures for these species, no formal stock assessment or peer review will be conducted until requested by the PRT.

Board for the type of review.

Species	Future Benchmark Assessments
American Eel	Benchmark assessment and ASMFC Review in March 2012 in conjunction with RH
American Shad	Benchmark assessment and ASMFC Review completed in 2007. Next benchmark assessment not scheduled.
River Herring	Benchmark assessment and ASMFC Review in March 2012 in conjunction with eel
American Lobster	Schedule for benchmark assessment and ASMFC Review in 2014.
Atlantic Croaker	Reviewed in March 2010 through SEDAR 20
Atlantic Menhaden	Scheduled for SEDAR Benchmark Review 2014

Atlantic Sea Herring	Review in June 2012, SARC 54
Atlantic Striped Bass	Benchmark assessment and reviewed SARC 57 July 2013
Atlantic Sturgeon **	Scheduled for ASMFC review in 2014
Black Drum	Scheduled for ASMFC review in 2015
Black Sea Bass	Delayed to 2016 for new model development; was scheduled for Fall 2014 SARC
Bluefish	Scheduled for June 2014 through SARC 59
Horseshoe Crab	Update underway in 2013; TC recommends new benchmark assessment in 2016.
Multispecies VPA	Update presented to Policy Board February 2009; next benchmark review not scheduled.
Northern Shrimp	Scheduled for SARC 58 Dec 2013
Red Drum	Scheduled for SEDAR 51 2015
Scup	not on latest SARC schedule; 5-year trigger 2013
Spanish Mackerel	Benchmark assessment and reviewed in 2012 SEDAR 28
Spiny Dogfish	TRAC reviewed 2010
Large Coastal Sharks	SEDAR 21-Sandbar (was LCS, now research); LCS-Dusky (prohibited); SCS-Blacknose (quota); DW Jun; AW Sep-Mar; RW Apr 2011
Small Coastal Sharks	SEDAR 34-HMS bonnethead and Atlantic sharpnose 2013
Spot	PRT annually reviews; not yet recommended for SEDAR schedule
Spotted Seatrout	States conducting individual assessments
Summer Flounder	Benchmark assessment and reviewed SARC 57 July 2013
Tautog	Scheduled for ASMFC review in 2014
Weakfish	Scheduled for ASMFC review in 2015
Winter Flounder - SNE	Benchmark assessment and reviewed SARC 52, June 2011
Winter Flounder - GOM	Benchmark assessment and reviewed SARC 52, June 2011