

**Special Report No. 89 of the
Atlantic States Marine Fisheries Commission**

*Working towards healthy, self-sustaining populations for all Atlantic coast fish species or
successful restoration well in progress by the year 2015*



**Research Priorities and Recommendations to Support
Interjurisdictional Fisheries Management**

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Atlantic States Marine Fisheries Commission

Research Priorities and Recommendations to Support Interjurisdictional Fisheries Management

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Input was also provided by the Commission's Habitat Committee, Committee on Economics and Social Sciences, and Management and Science Committee. The research topics listed in this publication are consistent with those developed by the National Marine Fisheries Service Northeast Fisheries Science Center for organization and classification of Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) research recommendations. The Commission extends its appreciation to the members of the Management and Science Committee for providing oversight to the effort to identify and prioritize Commission research needs.

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Preface

Research priorities listed in this document were identified from Atlantic States Marine Fisheries Commission (Commission) fishery management plans and amendments, annual plan reviews, special reports conducted by the Commission on species technical and stock assessment issues, Commission external peer reviews, and Stock Assessment Workshop (SAW) documents by the Stock Assessment Review Committee (SARC, 1996-2012) in the Northeast US and SouthEast Data, Assessment, and Review (SEDAR, 2002-2012) process in the Southeast US in collaboration with the National Marine Fisheries Service. This publication is an update of Special Report #88 *Prioritized Research Needs in Support of Interjurisdictional Fisheries Management* published by the Commission in August 2008. Updates are periodically published via the Commission's website at www.asmfc.org.

Research priorities were prioritized by Commission stock assessment subcommittees and technical committees under the purview of the Plan Development/Review Teams. Additional input to priorities is provided periodically by Advisory Committees, Management Boards, the Habitat Committee, the Committee on Economics and Social Sciences, and the Management and Science Committee. The research priorities in this document should not supplant any prioritization conducted by Commission technical committees or management boards on an annual basis, or in any way hinder the management process.

It is the intent of the Commission to periodically update this document as research priorities are either met or as new research needs are identified. Research priorities that have been met since previous publications of this document have been moved to a separate section for each species and appropriate references have been included. The overall purpose of this document is to encourage state, federal, and university research programs to develop projects to meet the research priorities of Commission-managed species and thereby improve the overall management of these fisheries. It is also hoped that state, federal, and non-profit organizations will utilize this document in prioritization of research projects for future funding programs.

Abbreviations and Acronyms

ACCSP	Atlantic Coastal Cooperative Statistics Program
ASMFC	Atlantic States Marine Fisheries Commission
ASPIC	A Stock Production Model Incorporating Covariates
ASPM	age structured production model
BMP	best management practice
BRD	Bycatch Reduction Device
CAA	Catch-at-Age Analysis
CFD	computer fluid dynamics
CPUE	catch-per-unit-effort
CSA	Collie-Sissenwine Analysis; also Catch Survey Analysis
DFO	Department of Fisheries and Oceans (Canada)
DO	dissolved oxygen
EFH	Essential Fish Habitat
F	instantaneous fishing mortality rate
FERC	Federal Energy Regulatory Commission
FMP	Fishery Management Plan
GIS	Geographic Information Systems
GLM	generalized linear model
GLOBEC	Global Ocean Ecosystems Dynamics
GPS	Global Positioning System
HAPC	habitat areas of particular concern
IPN	infectious pancreatic necrosis
LPUE	landings-per-unit-effort
M	instantaneous natural mortality rate
MARMAP	Marine Resources, Monitoring, Assessment, and Prediction
MCMC	Markov chain Monte Carlo
MEDMR	Maine Department of Marine Resources
MRIP	Marine Recreational Information Program
MSE	Management Strategy Evaluation
MSVPA	multispecies virtual population analysis
MSY	maximum sustainable yield
NEAMAP	Northeast Area Monitoring and Assessment Program
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCC	Northeast Regional Coordinating Council
PCB	polychlorinated biphenyl
PIT	passive integrated transponder
PRFC	Potomac River Fisheries Commission
SARC	Stock Assessment Review Committee
SCA	statistical catch-at-age
SCDNR	South Carolina Department of Natural Resources
SEAMAP	Southeast Area Monitoring and Assessment Program

SEDAR	SouthEast Data, Assessment, and Review
SS	Stock Synthesis
SSB	spawning stock biomass
TAL	total allowable landings
TIP	Trip Interview Program
TOR	Terms of Reference
TRAC	Transboundary Resources Assessment Committee
USFWS	United States Fish and Wildlife Service
VPA	virtual population analysis
VT	Virginia Tech University
VTR	Vessel Trip Reporting
YOY	young-of-the-year
YPR	yield-per-recruit

Research Priorities by Species/Species Complex

AMERICAN EEL

Fishery-Dependent Priorities

High

- Monitor catch and effort in bait fisheries (commercial and personal-use) and in personal-use fisheries that are not currently covered by MRIP or commercial fisheries monitoring programs.
- Improve knowledge of the proportion of the American eel population and the fisheries occurring south of the US that may affect the US portion of the stock.
- Require standardized reporting of trip-level landings and effort data for all states in inland waters. Data should be collected using the ACCSP standards for collection of catch and effort data (ACCSP 2004).
- Compare buyer reports to reported state landings.

Moderate

- Collect site specific information on the recreational harvest of American eel in inland waters, potentially through expansion of MRIP to riverine/inland areas.
- Monitor discards in targeted and non-targeted fisheries.
- Require states to collect fishery-dependent biological information by life stage, potentially through collaborative monitoring and research programs with dealers. Samples should be collected from gear types that target each life stage.¹
- Review the historical participation level of subsistence fishers and relevant issues brought forth with respect to those subsistence fishers involved with American eel to provide information on the changing exploitation of American eels.
- Investigate American eel harvest and resource by subsistence harvesters (e.g., Native American tribes, Asian and European ethnic groups).

Fishery-Independent Priorities

High

- Maintain and update the list of fishery-independent surveys that have caught American eels and note the appropriate contact person for each survey.
- Request that states record the number of eels caught by fishery-independent surveys. Recommend states collect biological information by life stage including length, weight, age, and sex of eels caught in fishery-independent sampling programs; at a minimum, length samples should be routinely collected from fishery-independent surveys.
- Encourage states to implement surveys that directly target and measure abundance of yellow and silver stage American eels, especially in states where few targeted eel surveys are conducted.
- Develop a coastwide sampling program for yellow and silver stage American eels using standardized and statistically robust methodologies.

¹ SASC is developing a draft protocol for sampling fisheries.

- Continue the ASMFC-mandated YOY surveys; these surveys could be particularly valuable as an early warning signal of recruitment failure. Standardize sampling across all surveys. Develop proceedings document for the 2006 ASMFC YOY Survey Workshop. Follow-up on decisions and recommendations made at the workshop.

Moderate

- Develop standardized sampling gear, habitat, and ageing methods and conduct intensive age and growth studies at regional index sites to support development of reference points and estimates of exploitation.

Modeling / Quantitative Priorities

High

- Perform periodic stock assessments (every 5-7 years) and establish sustainable reference points for American eel required to develop a sustainable harvest rate in addition to determining whether the population is stable, decreasing, or increasing. Investigate if a longer time interval (8-10 years) between assessments will improve population trend estimates. Longer time periods may better reflect eel generation time.

Moderate

- Develop new assessment models (e.g., delay-difference model) specific to eel life history and fit to available indices.
- Develop GIS-type model incorporating habitat type, abundance, contamination, and other environmental factors.

Life History, Biological, and Habitat Priorities

High

- Monitor non-harvest losses due to barriers such as impingement, entrainment, spill, and hydropower turbine mortality.
- Develop, investigate, and improve technologies for upstream and downstream American eel passage at various barriers for each life stage. Identify effective low-cost alternatives to traditional passage designs. Develop design standards for upstream passage devices.²
- Evaluate the impact, both upstream and downstream, of barriers to eel movement with respect to population and distribution effects. Determine relative contribution of historic loss of habitat to potential eel population and reproductive capacity.
- Implement large-scale (coastwide or regional) tagging studies of eels at different life stages to determine growth, passage mortality, movement and migration, validated ageing methods, reporting rates, and tag shredding/tag attrition rates.³
- Identify the mechanism driving sexual determination and the potential management implications.
- Identify spatially explicit, sex specific, triggering mechanism for metamorphosis to mature adult and silver eel life stage, with specific emphasis on the size and age at onset of maturity. A maturity schedule (proportion mature by size or age) would be extremely useful in combination with migration rates.

² An ASMFC Eel Passage Workshop occurred in 2011 reviewing details on passage design.

³ Current tagging studies are ongoing in the St. Lawrence River system. A tagging study to examine local and regional movement has been completed by a graduate student at Delaware State University.

- Improve understanding of the effects of contaminants on fecundity, natural mortality, and overall health (non-lethal population stressors). Research the effects of bioaccumulation with respect to impacts on survival and growth by age and effect on maturation and reproductive success.⁴
- Conduct research on the prevalence, incidence of infection, and effects of the swim bladder parasite *Anguillicola crassus* on American eel growth and maturation, migration to the Sargasso Sea, and spawning potential. Investigate the impact of the introduction of *A. crassus* into areas that are presently free of the parasite.

Moderate

- Recommend monitoring of upstream and downstream movement at migratory barriers that are efficient at passing eels (e.g., fish ladder/lift counts). Data that should be collected include presence/absence, abundance, and biological information. Provide standardized protocols for monitoring eels at passage facilities, coordinate compilation of these data, and provide guidance on the need and purpose of site-specific monitoring.
- Evaluate eel impingement and entrainment at facilities with NPDES authorization for large water withdrawals. Quantify regional mortality and determine if indices of abundance could be established at specific facilities.
- Assess available drainage area over time to account for temporal changes in carrying capacity and sex ratio. Develop GIS of major passage barriers.
- Assess characteristics and distribution of American eel habitat and value of habitat with respect to growth and sex determination. Develop GIS of American eel habitat in US. This will have to be a habitat-specific analysis based on past studies that show high habitat-specific variability in sex ratios within a drainage system.
- Improve understanding of within-drainage behavior and movement and the exchange between freshwater and estuarine systems.
- Improve understanding of predator-prey relationships, behavior and movement of eel during their freshwater residency, oceanic behavior, and movement and specific spawning location of adult mature eel in the Sargasso Sea. Determine if larger females have a size refuge during the freshwater phase.
- Examine the mechanisms for exit from the Sargasso Sea and transport across the continental shelf to determine implications for recruitment. Examine migratory routes and guidance mechanisms for silver eel in the ocean.
- Research mechanisms of recognition of the spawning area by silver eel, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation.
- Continue investigation of the length and weight specific fecundities of American eel.
- Examine age-at-entry of glass eel into estuaries and freshwater to determine time lag between spawner escapement and glass eel recruitment.
- Improve understanding of all information on the leptocephalus and glass stages of eel, including mode of nutrition and transport/recruitment mechanisms.
- Develop a monitoring framework to collect and provide coastwide information on the influence of environmental factors and climate change on recruitment for future modeling.

Additional Habitat Research Recommendations

- Research the behavior of silver eels at downstream passages; determine specific behavior of eels migrating downstream, and research how they negotiate and pass hydropower facilities.

⁴ USFWS currently has a project examining maternal transfer of contaminants in American eel.

- Research the behavior of American eel approaching hydropower dams to determine searching behavior and preferred routes of approach to confirm best siting options for upstream passage.
- Investigate how river flow, lunar phase, water temperature, and behavior near artificial lighting impact the behavior of American eel, and influence the amount of time that the eels spend at a dam.
- Investigate the impact of stream velocity/discharge and stream morphology on upstream migration of glass eel and elvers.
- Research the factors that cause American eel to initiate downstream migration and affect their patterns of movement.
- Examine the environmental conditions required for the hatching success of American eel.
- Research the changes in ocean climate and environmental quality that might influence larval and adult eel migration, spawning, recruitment, and survival, including oceanic heat transport and interactions with the atmosphere and greenhouse gas warming.
- Determine the importance of coastal lakes and reservoirs to American eel populations.
- Investigate the impact of seaweed harvesting on American eel.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Implement a special permit for use of commercial fixed gear (e.g., pots and traps) to harvest American eels for personal use. Special-use permit holders should be subject to the same reporting requirements for landings and effort as the commercial fishery.
- Coordinate monitoring, assessment, and management among agencies that have jurisdiction within the species' range.
- Perform a joint US-Canadian stock assessment.
- Improve compliance with landing and effort reporting requirements as outlined in the ASMFC FMP for American eel.

Moderate

- Continue to require states to report non-harvest losses in their annual compliance reports.
- Conduct socioeconomic studies to determine the value of the fishery and the impact of regulatory management.
- Develop population targets based on habitat availability at the local level.

American Eel Research Priorities Identified As Being Met

- ✓ Accurately document the commercial eel fishery so that our understanding of participation in the fishery and the amount of directed effort could be known. *Trip-level reporting of catch and effort became mandatory in 2007.*
- ✓ Evaluate the use of American eel as a water quality indicator.
- ✓ Investigate practical and cost-effective methods of re-establishing American eel in underutilized habitat.

AMERICAN LOBSTER

Fishery-Dependent Priorities

High

- Improve spatial and temporal consistency of commercial data through standardized 100% mandatory trip level harvester reporting.
- Identify a dedicated funding source for sea and port sampling programs, these programs are essential for characterization of the commercial catch for assessment purposes.
- Develop and utilize volunteer industry data collection program (e.g., standardize protocols and ground-truth data) as funding for sea and port sampling declines or does not exist.

Fishery-Independent Priorities

High

- Identify a dedicated funding source to continue the ventless trap survey for an accurate coastwide index of relative abundance.⁵
- Update the maturity and growth estimates for the Gulf of Maine stock.
- Establish permanent data loggers in offshore areas for all 3 stock units to collect bottom temperatures.

Moderate

- Identify a dedicated funding source to continue and expand an early life history larval survey.
- Update the maturity and growth estimates for the Southern New England and Georges Bank stock.

Modeling / Quantitative Priorities

High

- Improve reference points to ensure that they are compatible with current environmental conditions.

The University of Maine lobster model used for this assessment should be revised and enhanced in the following ways in order to improve future assessments:

High

- Explore feasibility of estimating all or a portion of the growth transition matrix.
- Incorporate trends in natural mortality, maturity, and growth, where appropriate.
- Explore incorporation of ventless trap and settlement surveys.

Moderate

- Reduce gap-filling of landings and biosamples to the extent possible and allow the model to handle data gaps statistically.

Low

- Check estimation and form of non-linear CPUE relationship with abundance, explore standardization/treatment of commercial CPUE.
- Specify number of years across which to conduct the assessment (e.g., to ease performance of sensitivity and retrospective analyses).

⁵ A coastwide (Gulf of Maine to Long Island Sound) ventless trap survey was conducted from 2006-2008, but was discontinued due to lack of funding.

Life History, Biological, and Habitat Priorities

High

- Expand data collection and modeling of the impacts of oceanographic and water temperature shifts to larval and adult survival and distribution.
- Continue and expand research on ageing techniques to improve the understanding of how many year classes support the current trap fishery, how length relates to age, and how variable the age structure is temporally and spatially.⁶
- Conduct research on harvest policies for management of lobster in the face of climate change and uncertainty about future productivity.

Moderate

- Evaluate and quantify sources of variability in natural mortality rates for lobster.
- Explain changes in the abundance and distribution of sex ratios for lobster across their range.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Align stock management areas with area designations for landings.
- Explore industry based funding mechanisms for routine fishery sampling and monitoring.

Moderate

- Explore the possibility of joint US and Canadian lobster stock assessments by the TRAC.

American Lobster Research Priorities Identified as Being Met

- ✓ Calibrate NEFSC trawl survey data from old versus new vessels (Albatross versus Bigelow).
- ✓ Examine size based models to determine their ability to match length frequencies and other biological characteristics observed in local lobster populations.
- ✓ Expand the University of Maine lobster model to include any number of surveys by sex. This includes changing the structure of input data files, modifying corresponding sections of code to accommodate any number of surveys and fishery types by sex or both sexes combined, and estimation of survey selectivity by sex.
- ✓ Create graphics viewer in R for examining MCMC and projection outputs; include MCMC chain convergence criteria / diagnostics. *In progress.*

AMERICAN SHAD/RIVER HERRING

Fishery-Dependent Priorities

High

- Expand observer and port sampling coverage to quantify additional sources of mortality for alosine species, including bait fisheries, as well as rates of bycatch in other fisheries to reduce uncertainty.⁷

⁶ Research on ageing techniques has been conducted in England and Australia and has been initiated in Maine and Connecticut.

⁷ A prior statistical study of observer allocation and coverage should be conducted (see Hanke et al. 2012).

Moderate

- Identify directed harvest and bycatch losses of American shad in ocean and bay waters of Atlantic Maritime Canada.

Low

- Identify additional sources of historical catch data of the US small pelagic fisheries to better represent earlier harvest of river herring and improve model formulation.

Fishery-Independent Priorities

Moderate

- Develop demersal and pelagic trawl CPUE indices of offshore river herring biomass.

Modeling / Quantitative Priorities

High

- Conduct population assessments on river herring, particularly in the south.⁸
- Analyze the consequences of interactions between the offshore bycatch fisheries and population trends in the rivers.
- Quantify fishing mortality for major river stocks after ocean closure of directed fisheries (river, ocean bycatch, bait fisheries).
- Improve methods to develop biological benchmarks used in assessment modeling (fecundity-at-age, sex specific mean weight-at-age, partial recruitment vector/maturity schedules) for river herring and American shad of both semelparous and iteroparous stocks.
- Improve methods for calculating M.

Moderate

- Consider standardization of indices with a GLM to improve trend estimates and uncertainty characterization.
- Explore peer-reviewed stock assessment models for use in additional river systems as more data become available.

Low

- Develop models to predict the potential impacts of climate change on river herring distribution and stock persistence.

Life History, Biological, and Habitat Priorities

High

- Conduct studies to quantify and improve fish passage efficiency and support the implementation of standard practices.
- Assess the efficiency of using hydroacoustics to repel alosines or pheromones to attract alosines to fish passage structures. Test commercially available acoustic equipment at existing fish passage facilities. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Investigate the relationship between juvenile river herring/American shad and subsequent year class strength, with emphasis on the validity of juvenile abundance indices, rates and sources of immature mortality, migratory behavior of juveniles, and life history requirements.

⁸ A peer reviewed river herring stock assessment was completed in 2012 by the ASMFC.

- Develop an integrated coastal remote telemetry system or network that would allow tagged fish to be tracked throughout their coastal migration and into the estuarine and riverine environments.
- Verify tag-based estimates of American shad.
- Continue studies to determine river herring population stock structure along the coast and enable determination of river origin of catch in mixed stock fisheries and incidental catch in non-targeted ocean fisheries. Spatially delineate mixed stock and Delaware stock areas within the Delaware system. Methods to be considered could include otolith microchemistry, oxytetracycline otolith marking, genetic analysis, and/or tagging.⁹
- Validate the different values of M for river herring and American shad stocks through shad ageing techniques and repeat spawning information.
- Continue to assess current ageing techniques for river herring and American shad, using known-age fish, scales, otoliths, and spawning marks. Conduct biannual ageing workshops to maintain consistency and accuracy of ageing fish sampled in state programs.¹⁰
- Summarize existing information on predation by striped bass and other species. Quantify consumption through modeling (e.g., MSVPA), diet, and bioenergetics studies.
- Refine techniques for tank spawning of American shad. Secure adequate eggs for culture programs using native broodstock.

Moderate

- Determine the effects of passage barriers on all life history stages of American shad and river herring. Conduct studies on turbine mortality, migration delay, downstream passage, and sub-lethal effects.
- Evaluate and ultimately validate large-scale hydroacoustic methods to quantify river herring and American shad escapement in major river systems.
- Conduct studies of egg and larval survival and development.
- Conduct studies on energetics of feeding and spawning migrations of American shad on the Atlantic coast.
- Resource management agencies in each state shall evaluate their respective state water quality standards and criteria and identify hard limits to ensure that those standards, criteria, and limits account for the special needs of alosines. Primary emphasis should be on locations where sensitive egg and larval stages are found.
- Encourage university research on hickory shad.
- Develop better fish culture techniques, marking techniques, and supplemental stocking strategies for river herring.

Low

- Characterize tributary habitat quality and quantity for Alosine reintroductions and fish passage development.
- States should identify and quantify potential shad and river herring spawning and nursery habitat not presently utilized, including a list of areas that would support such habitat if water quality and access were improved or created, and analyze the cost of recovery within those areas. States may wish to identify areas targeted for restoration as essential habitat.¹¹
- Investigate contribution of landlocked versus anadromous produced river herring.

⁹ Genetic research currently underway in combination with otolith chemistry.

¹⁰ River herring ageing workshop to occur in 2013.

Additional Habitat Research Recommendations

- When considering options for restoring alosine habitat, include study of, and possible adjustment to, dam-related altered river flows.
- Ascertain how abundance and distribution of potential prey affect growth and mortality of early life stages of alosines.
- Determine factors that regulate and potentially limit downstream migration, seawater tolerance, and early ocean survival of juvenile alosines.
- Determine if chlorinated sewage effluents are slowing the recovery of depressed shad stocks.
- Determine if intermittent episodes of pH depressions and aluminum elevations (caused by acid rain) affect any life stage in freshwater that might lead to reduced reproductive success of alosines, especially in poorly buffered river systems.
- ASMFC should designate important shad and river herring spawning and nursery habitat as HAPC.¹¹
- When populations have been extirpated from their habitat, coordinate alosine stocking programs, including: reintroduction to the historic spawning area, expansion of existing stock restoration programs, and initiation of new strategies to enhance depressed stocks.
- When releasing hatchery-reared larvae into river systems for purposes of restoring stocks, synchronize the release with periods of natural prey abundance to minimize mortality and maximize nutritional condition. Determine functional response of predators on larval shad at restoration sites to ascertain appropriate stocking level so that predation is accounted for, and juvenile out-migration goals are met. Also, determine if night stocking will reduce mortality.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Develop and implement monitoring protocols and analyses to determine river herring and American shad population responses and targets for rivers and tributaries, particularly those undergoing restoration (passage, supplemental stocking, etc.).
- Determine the impact of directed fisheries on American shad and river herring stocks and reduce F.
- Mandate FMPs for rivers with active restoration plans for American shad or river herring.
- Improve spatial and gear specific reporting of harvest.

Low

- Conduct and evaluate historical characterization of socioeconomic development (potential pollutant sources and habitat modification) of selected shad rivers along the east coast.⁵
- Develop appropriate Habitat Suitability Index Models for alosine species in the fishery management plan. Possibly consider expansion of species of importance or go with the most protective criteria for the most susceptible species.

¹¹ River-specific habitat recommendations for American shad can be found in: Atlantic States Marine Fisheries Commission. 2007. American shad stock assessment report for peer review, volumes II and III. Atlantic States Marine Fisheries Commission Stock Assessment Report No. 07-01 (Supplement), Washington, D.C.

American Shad / River Herring Research Needs Identified as Being Met

- ✓ Develop comprehensive angler use and harvest survey techniques for use by Atlantic states to assess recreational fisheries for American shad. *To be accomplished through MRIP.*
- ✓ Determine the stock/recruitment relationships for American shad and river herring stocks.

ATLANTIC CROAKER

Fishery-Dependent Priorities

High

- Encourage fishery-dependent biological sampling, including extraction of ageing structures, to improve age-length keys. Age-length keys should be representative of all gear types in the fishery. Supplement underrepresented length bins with additional ageing samples to avoid the necessity of weighting length-at-age estimates by length frequencies.
- Obtain gear specific effort information and improve fishery-dependent catch and effort statistics and catch size and age structure.
- Recover detailed historical landings data from NOAA as indicated by historical summaries.

Moderate

- Develop and implement state-specific commercial scrap fisheries monitoring programs to evaluate relative importance of croaker in scrap landing.
- Conduct studies on discard mortality from varying gears in recreational and commercial fisheries.
- Assess and monitor the effects of bycatch reduction devices (BRD's) on croaker catch.
- Monitor fisheries with significant croaker bycatch and determine extent of unutilized bycatch and F on fish less than age 1.
- Determine the onshore versus offshore components of the croaker fishery.
- Increase observer coverage of commercial discards.

Fishery-Independent Priorities

Moderate

- Expand fishery-independent surveys and subsample for individual weights and ages, especially in the southern range.
- Continue monitoring juvenile croaker populations in major nursery areas.
- Develop coastwide juvenile croaker indices to clarify stock status.

Modeling / Quantitative Priorities

High

- Develop size, age, and sex specific relative abundance estimates from fishery-independent and fishery-dependent data.
- Identify and evaluate environmental covariates in stock assessment models.

Moderate

- Incorporate bycatch estimates into croaker assessment models.
- Analyze croaker YPR to establish a minimum size that maximizes YPR.

Life History, Biological, and Habitat Priorities

High

- Conduct studies on fecundity and reproductive dynamics and develop maturity schedules.¹²
- Conduct studies on growth rates and age structure throughout species range.
- Conduct collaborative coastwide genetics and tagging studies to determine migratory patterns, stock identification, and stock mixing.

Moderate

- Identify essential habitat requirements.
- Re-examine historical ichthyoplankton studies of the Chesapeake Bay for an indication of the magnitude of estuarine spawning

Low

- Determine species interactions and predator-prey relationships between croaker (prey) and predator species targeted in more valued fisheries.
- Assess the impacts of any dredging activity (i.e., for beach re-nourishment) on all life history stages of croaker.

Management, Law Enforcement, and Socioeconomic Priorities

Moderate

- Determine the optimum utilization (economic and biological) of a long term fluctuating croaker population.
- Evaluate socioeconomic aspects of croaker fisheries.

Atlantic Croaker Research Priorities Identified as Being Met

- ✓ Criteria should be cooperatively developed for ageing croaker otoliths. *Addressed at 2008 croaker and red drum ageing workshop.*

ATLANTIC MENHADEN

**Atlantic Menhaden research recommendations are listed in chronological order: recommendations from the 2012 stock assessment update, recommendations from the 2010 benchmark stock assessment peer review panel, and recommendations from the 2008 update of this report that have not been addressed. Research recommendations from the 2012 stock assessment update are broken down into two categories: data and modeling. While all recommendations are high priority, the first recommendation is the highest priority. Each category is further broken down into recommendations that can be completed in the short term and recommendations that will require long term commitment.

2012 Stock Assessment Update Recommendations

Annual Data Collection

Long Term

- Develop a coast wide, fishery-independent index of adult abundance at age to replace or augment the existing Potomac River pound net index used in the assessment model. Possible methodologies include an air spotter survey or an industry-based survey with scientific

¹² Work by Fabrizio and Tuckey examining the effects of hypoxia on reproduction of Chesapeake Bay croaker in progress.

observers on board collecting the data. In all cases, a sound statistical design is essential (involve statisticians in the development and review of the design; some trial surveys may be necessary).¹³

- Work with industry to collect age structure data outside the range of the fishery.
- Validate MSVPA model parameters through the development and implementation of stomach sampling program that will cover major menhaden predators along the Atlantic coast. Validation of prey preferences, size selectivity and spatial overlap is critically important to the appropriate use of MSVPA model results.

Short Term

- Increase level of sampling from bait fisheries, particularly in the mid-Atlantic and New England.
- Investigate interannual maturity variability via collection of annual samples of mature fish along the Atlantic coast.
- Recover historical tagging data from paper data sheets to characterize coastwide movements and mortality estimates for adult Atlantic menhaden.
- Increase annual sampling and processing of menhaden from the PRFC pound net fishery to better characterize age and size structure of catch.
- Compare age composition of PRFC catch with the age composition of the reduction bait fishery catch in Chesapeake Bay. Upon completion of comparative analysis develop most efficient and representative method of sampling for age structure.
- Consider developing an adult index, similar to PRFC CPUE index, using MD, VA, NJ and RI pound net information including biological data.
- Explore additional sources of information that could be used as additional indices of abundance for juvenile and adult menhaden (ichthyoplankton surveys, NEAMAP, etc.).

Assessment Methodology

Long Term

- Develop a spatially-explicit model, once sufficient age-specific data on movement rates of menhaden are available.
- Develop multispecies statistical catch-at-age model to estimate menhaden natural mortality at age.

Short Term

- Thoroughly explore causes of retrospective pattern in model results.
- Explore alternative treatments of the reduction and bait fleets (e.g., spatial split, alternative selectivity configurations) in the BAM to reflect latitudinal variability in menhaden biology (larger and older fish migrating farther north during summer).
- Review underlying data and evaluate generation of JAI and PRFC indices.
- Perform likelihood profiling analysis to guide model selection decision-making.

¹³ An industry funded feasibility study conducted in 2011 further supported the need for this work (Sulikowski et al. 2012). A subcommittee of the Menhaden Technical Committee began discussions for development of a coastwide aerial survey in 2008. As of July 2012, a contract has been awarded to develop the survey design, with results expected by the end of 2012. The Technical Committee is in consensus that an index of adult abundance is the highest priority research recommendations but recognizes that implementation of the survey will require significant levels of funding.

- Examine the variance assumptions and weighting factors of all the likelihood components in the model.
- Re-evaluate menhaden natural mortality-at-age and population response to changing predator populations by updating and augmenting the MSVPA (e.g., add additional predator, prey, and diet data when available).
- Incorporate maturity-at-age variability in the assessment model.

Future Research

- Evaluate productivity of different estuaries (e.g., replicate similar methodology to Ahrenholz et al. 1987).
- Collect age-specific data on movement rates of menhaden to develop regional abundance trends.
- Determine selectivity of PRFC pound nets.
- Update information on maturity, fecundity, spatial and temporal patterns of spawning and larval survivorship.
- Investigate the effects of global climate change on distribution, movement, and behavior of menhaden.

2010 Benchmark Stock Assessment Peer Review Panel Recommendations

Short Term (improvements for the next benchmark review)

- Cap effective sample size in future model specifications at 200, allow the gaps in the pound net index and bait fishery age composition where data are not available, modify the reduction and bait fleets to northern and southern fleets, and allow time-varying domed shaped selectivity for the southern region.
- Calculate fishing mortality as full F. The N-weighted fishing mortalities relative to the N-weighted F-reference points do not provide correct interpretation with regard to overfishing.
- Examine alternative reference points which provide more protection to SSB or fecundity than FMED. The Panel has concerns about the use of FMED and the fecundity associated with it as reference points. The concern is that there was no information on the relationship of the target and threshold fecundity in relation to virgin fecundity levels.
- Examine weighting of datasets in the model. As a starting point, some experts assert that the input variance assumptions should be consistent with the estimated variance of residuals. In the base model the effective sample sizes for catch-at-age data are far too high and consequently estimates of uncertainty are too low.
- Evaluate alternative use of the juvenile indices: combining relative abundance data from groups of adjacent states according to the similarity of trends in the state-specific time series; and cumulatively-combining these indices within the model. This allows for different regional patterns of recruitment to provide a stock-wide recruitment pattern.
- Examine the timing of fisheries and indices in the model. Many of the fisheries are seasonal and need to be timed appropriately with the abundance indices. Incorrect timing may affect model fits.

Recommendations from the 2008 Update of the Research Priorities Report

Fishery Dependent

Moderate

- Evaluate other measures of effort, including spotter pilot logbooks, trip length, etc. Spotter pilot logbooks should be evaluated for search time, GPS coordinates, and estimates of observed school size.

Low

- Conduct studies on bycatch and discard of menhaden in other fisheries.

Fishery-Independent Priorities

High

- Develop and implement fishery-independent surveys to estimate size of recruiting year classes.¹

Modeling / Quantitative Priorities

Moderate

- Evaluate precision of current assessment models with Monte Carlo simulations.
- Assess the feasibility of estimating year class strength using a biologically stratified sampling design. The efforts could be supported by process studies linking plankton production to abundance of young menhaden.

Low

- Conduct growth back-calculation studies to determine historical trends in growth rate. The NMFS has an extensive database on scale growth increments which should be utilized for these studies.

Life History, Biological, and Habitat Priorities

Moderate

- Determine the effects of critical estuarine habitat loss/degradation on juvenile and adult menhaden growth, survival, and abundance.
- Evaluate the effects of selected environmental factors on growth, survival, and abundance of juvenile and adult menhaden, particularly in the Chesapeake Bay and other coastal nursery areas.²
- Assess effects of fish disease (e.g., ulcerative mycosis and toxic dinoflagellates) on menhaden.³
- Determine the ecological role of menhaden (predator-prey relationships, nutrient enrichment, oxygen depletion, etc.) in major Atlantic coast embayments and estuaries.

Low

- Monitor fish kills along the Atlantic coast and use the NMFS Beaufort Laboratory as a repository for these reports.

¹ Ongoing research is being conducted to develop and test methods for estimating size of recruiting year classes of juveniles using fishery-independent survey techniques.

² Ongoing research is being conducted in the Chesapeake Bay to evaluate effects of selected environmental factors on growth, survival, and abundance of juvenile and adult menhaden.

³ Ongoing research is being conducted to determine the effects of fish diseases (e.g., ulcerative mycosis and toxic dinoflagellates) on menhaden.

Management, Law Enforcement, and Socioeconomic Priorities

Low

- Determine effects of regulations on the fishery, the participants, and the stock.
- Monitor the socioeconomic aspects of the menhaden reduction fishery.

Atlantic Menhaden Research Needs Identified as Being Met

- ✓ Evaluate use of coastal power plant impingement data as a possible means to estimate YOY menhaden abundance.

ATLANTIC SEA HERRING

Fishery-Dependent Priorities

High

- Develop (simple) methods to partition stocks in mixed stock fisheries.
- Investigate bycatch and discards in the directed herring fishery through both at sea and portside sampling.
- Continue commercial catch sampling of Atlantic herring fisheries according to ACCSP protocols.

Fishery-Independent Priorities

High

- Conduct more extensive stock composition sampling including all stocks (i.e., Scotian Shelf).
- Expand monitoring of spawning components.

Low

- Continue to utilize the inshore and offshore hydroacoustic and trawl surveys to provide an independent means of estimating stock sizes. Collaborative work between NMFS, DFO, state agencies, and the herring industry on acoustic surveys for herring should continue to be encouraged.
- Consider alternative sampling methods such as HabCam.

Modeling / Quantitative Priorities

High

- Evaluate use of length based models (Stock Synthesis and Chen model).
- Develop statistical comparison of consumption estimates and biomass from model M.

Moderate

- Develop indices at age from shrimp survey samples.
- Conduct simulation studies to evaluate ways in which various time series can be evaluated and folded into the assessment model.
- Develop new approaches to estimating recruitment (i.e., juvenile abundance) from fishery-independent data.
- Examine the possible effects of density dependence (e.g., reduced growth rates at high population size) on parameter estimates used in assessments.

Low

- Develop an industry based LPUE or some other abundance index (Industry Based Survey).

- Conduct a retrospective analysis of herring larval and assessment data to determine the role larval data plays in anticipating stock collapse and as a tuning index in the age structured assessment.
- Investigate the M rate assumed for all ages, the use of CPUE tuning indices, and the use of NEFSC fall bottom trawl survey tuning indices in the analytical assessment of herring.
- Develop objective criteria for inclusion of novel data streams (consumption, acoustic, larval, etc.) and how this can be applied.

Life History, Biological, and Habitat Priorities

High

- Consider information on consumption from other sources (i.e. striped bass in other areas) and predators inshore of the current surveys.

Moderate

- Continue tagging and morphometric studies to explore uncertainties in stock structure and the impacts of harvest mortality on different components of the stock. Although tagging studies may be problematic for assessing survivorship for a species like herring, they may be helpful in identifying the stock components and the proportion of these components taken in the fishery on a seasonal basis.
- Analyze diet composition of archived mammal and sea bird stomachs. Improve knowledge on prey size selectivity of mammals and sea birds.
- Evaluate prey field to determine what other prey species are available to predators that could explain some of the annual trends in herring consumption.
- Investigate why small herring are not found in the stomachs of predators in the NEFSC food habits database.

Low

- Research depth preferences of herring.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Evaluate the current herring spawning closure design in terms of areas covered, closure periods, catch-at-age within (before fishing prohibition in 2007) and outside of spawning areas to determine minimal spawning regulations (Maine DMR).
- Continue to organize annual US-Canadian workshops to coordinate stock assessment activities and optimize cooperation in management approaches between the two countries.

Moderate

- Develop a strategy for assessing individual spawning components to better manage heavily exploited portion(s) of the stock complex, particularly the Gulf of Maine inshore spawning component.
- Develop socioeconomic analyses appropriate to the determination of optimum yield.

Low

- Develop economic analyses necessary to evaluate the costs and benefits associated with different segments of the industry.

Atlantic Sea Herring Research Priorities Identified as Being Met

- ✓ Evaluate the merit of acoustic surveys and other techniques to achieve sub stock complex monitoring. *Gulf of Maine Research Institute.*

ATLANTIC STRIPED BASS

Fishery-Dependent Priorities

Moderate

- Develop studies to provide information on gear specific discard mortality rates and to determine the magnitude of bycatch mortality.⁴
- Improve estimates of striped bass harvest removals in coastal areas during wave 1 and inland waters of all jurisdictions year round.
- Evaluate the percentage of fishermen using circle hooks.⁵

Fishery-Independent Priorities

Moderate

- Develop a refined and cost-efficient, fisheries-independent coastal population index for striped bass stocks.

Modeling / Quantitative Priorities

High

- Develop a method to integrate catch-at-age and tagging models to produce a single estimate of F and stock status.⁶
- Develop a spatially and temporally explicit catch-at-age model incorporating tag based movement information.⁷
- Review model averaging approach to estimate annual fishing mortality with tag based models. Review validity and sensitivity to year groupings.⁸
- Develop methods for combining tag results from programs releasing fish from different areas on different dates.
- Examine potential biases associated with the number of tagged individuals, such as gear specific mortality (associated with trawls, pound nets, gill nets, and electrofishing), tag induced mortality, and tag loss.⁹
- Develop field or modeling studies to aid in estimation of natural mortality or other factors affecting the tag return rate.

⁴ Literature search and some modeling work completed.

⁵ Work ongoing in New York through the Hudson River Angler Diary, Striped Bass Cooperative Angler Program, and ACCSP elogbook.

⁶ Model developed, but the tagging data overwhelms the model. Issues remain with proper weighting.

⁷ Model developed with Chesapeake Bay and the rest of the coast as two fleets. However, no tagging data has been used in the model.

⁸ Work ongoing by Striped Bass Tagging Subcommittee to evaluate the best years to use for the IRCR and the periods to use for the MARK models.

⁹ Gear specific survival being examined in Hudson River.

Moderate

- Develop maturity ogives applicable to coastal migratory stocks.
- Examine methods to estimate annual variation in natural mortality.¹⁰
- Develop reliable estimates of poaching loss from striped bass fisheries.
- Improve methods for determining population sex ratio for use in estimates of SSB and biological reference points.
- Evaluate truncated matrices and covariate based tagging models.

Low

- Examine issues with time saturated tagging models for the 18 inch length group.
- Develop tag based reference points.

Life History, Biological, and Habitat Priorities

High

- Continue in-depth analysis of migrations, stock compositions, etc. using mark-recapture data.¹¹
- Continue evaluation of striped bass dietary needs and relation to health condition.¹²
- Continue analysis to determine linkages between the mycobacteriosis outbreak in Chesapeake Bay and sex ratio of Chesapeake spawning stock, Chesapeake juvenile production, and recruitment success into coastal fisheries.

Moderate

- Examine causes of different tag based survival estimates among programs estimating similar segments of the population.
- Continue to conduct research to determine limiting factors affecting recruitment and possible density implications.
- Conduct study to calculate the emigration rates from producer areas now that population levels are high and conduct multi-year study to determine inter-annual variation in emigration rates.

Low

- Determine inherent viability of eggs and larvae.
- Conduct additional research to determine the pathogenicity of the IPN virus isolated from striped bass to other warm water marine species, such as flounder, menhaden, shad, and largemouth bass.

Additional Habitat Research Recommendations

- Passage facilities should be designed specifically for passing striped bass for optimum efficiency at passing this species.
- Conduct studies to determine whether passing migrating adults upstream earlier in the year in some rivers would increase striped bass production and larval survival, and opening downstream bypass facilities sooner would reduce mortality of early emigrants (both adult and early-hatched juveniles).

¹⁰ Ongoing work by the Striped Bass Tagging Subcommittee

¹¹ Ongoing through Cooperative Winter Tagging Cruise and striped bass charter boat tagging trips. See Cooperative Winter Tagging Cruise 20 Year Report.

¹² Plans for a stomach content collection program in the Chesapeake Bay by the Chesapeake Bay Ecological Foundation.

- All state and federal agencies responsible for reviewing impact statements and permit applications for projects or facilities proposed for striped bass spawning and nursery areas shall ensure that those projects will have no or only minimal impact on local stocks, especially natal rivers of stocks considered depressed or undergoing restoration.¹³
- Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known to be accumulated in striped bass tissues and which pose a threat to human health or striped bass health.
- Every effort should be made to eliminate existing contaminants from striped bass habitats where a documented adverse impact occurs.
- Water quality criteria for striped bass spawning and nursery areas should be established, or existing criteria should be upgraded to levels that are sufficient to ensure successful striped bass reproduction.
- Each state should implement protection for the striped bass habitat within its jurisdiction to ensure the sustainability of that portion of the migratory stock. Such a program should include: inventory of historical habitats, identification of habitats presently used, specification of areas targeted for restoration, and imposition or encouragement of measures to retain or increase the quantity and quality of striped bass essential habitats.
- States in which striped bass spawning occurs should make every effort to declare striped bass spawning and nursery areas to be in need of special protection; such declaration should be accompanied by requirements of non-degradation of habitat quality, including minimization of non-point source runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area. For those agencies without water quality regulatory authority, protocols and schedules for providing input on water quality regulations to the responsible agency should be identified or created, to ensure that water quality needs of striped bass stocks are met.¹⁴
- ASMFC should designate important habitats for striped bass spawning and nursery areas as HAPC.
- Each state should survey existing literature and data to determine the historical extent of striped bass occurrence and use within its jurisdiction. An assessment should be conducted of those areas not presently used for which restoration is feasible.

Management, Law Enforcement, and Socioeconomic Priorities

Moderate

- Examine the potential public health trade-offs between the continued reliance on the use of high minimum size limits (28 inches) on coastal recreational anglers and its long-term effects on enhanced PCB contamination among recreational stakeholders.¹⁵

¹³ Ongoing in New York.

¹⁴ Significant habitat designations completed in the Hudson River and New York Marine Districts.

¹⁵ Samples collected from two size groups (≥ 28 inches and 20-26 inches) in Pennsylvania and processed by the Department of Environmental Protection to compare contamination of the two size groups.

Striped Bass Research Priorities Identified as Being Met

- ✓ Continue improvements to the statistical catch-at-age model as recommended by the 46th SARC (e.g., include error from catch estimates, fit each sector of removals individually, run additional diagnostics, account for spatial differences in indices, incorporate stock-recruitment relationship).
- ✓ Evaluate to what extent rising natural mortality among Chesapeake Bay striped bass affects the existing F and SSB thresholds, which are based on a fixed M assumption ($M = 0.15$). *In progress for next benchmark stock assessment.*
- ✓ Develop simulation models to look at the implications of overfishing definitions relative to development of a striped bass population that will provide “quality” fishing. Quality fishing must first be defined.
- ✓ Evaluate the overfishing definition relative to uncertainty in biological parameters. *In progress for next benchmark stock assessment.*

ATLANTIC STURGEON

Fishery-Independent Priorities

High

- Determine levels of bycatch and compare to F_{50} target levels for individual populations. Characterize Atlantic sturgeon bycatch in various fisheries by gear and season. Include data on fish size, health condition at capture, and number of fish captured.

Modeling / Quantitative Priorities

High

- Conduct assessments of population abundance and age structure in various river systems. Particular emphasis should be placed in documenting occurrence of age 0-1 juveniles and spawning adults as indicators of natural reproduction.¹⁶
- Conduct further analyses to assess the sensitivity of F_{50} to model inputs for northern and southern stocks.

Life History, Biological, and Habitat Priorities

High

- Continue development of genetic markers to determine the extent to which Atlantic sturgeon are genetically differentiable among rivers and that permit identification of bycatch by population origin. Interpret biological significance of findings.¹⁷
- Develop methods to determine sex and maturity of captured sturgeon.¹⁸

¹⁶ There are two surveys in the Hudson River estuary, one by Hudson Valley power generating companies started in 1985 and one by NYSDEC started in 2004. There is a survey in Edisto River, SC that started in 2004. Additionally, there are ongoing telemetry studies in many southeastern rivers which capture spawning adults.

¹⁷ Work done by Tim King.

- Determine length, fecundity, and maturity-at-age for north, mid, and south Atlantic stocks.
- Refine maturation induced spawning procedures. Refine sperm cryopreservation techniques to assure availability of male gametes.¹⁹
- Continue basic cultural experiments at all life stages to provide information on efficacy of alternative spawning techniques, egg incubation and fry production techniques, holding and rearing densities, prophylactic treatments, nutritional requirements and feeding techniques, and optimal environmental rearing conditions and systems.²⁰
- Conduct research to identify suitable stocking protocols for hatchery fish (e.g., fish size, time of year, site, marking technique).²¹
- Conduct and monitor pilot scale stocking programs before conducting large-scale efforts that encompass broad geographic area.²²
- Establish stocking goals and success criteria prior to development of large-scale stock enhancement or recovery programs.
- Evaluate aging techniques for Atlantic sturgeon with known age fish. Emphasis should be placed on verifying current methodology based on fin spines.²³
- Establish tolerance of different life stages in all populations to important contaminants and environmental factors (e.g., DO, pH, temperature, salinity).²⁴
- Quantify the amount and quality of sturgeon habitat in important sturgeon estuaries and rivers, including spawning and nursery habitats. Define and map bottom water quality, velocity, and substrates types for suitable sturgeon spawning and nursery habitat.²⁵
- Determine behavior and effects on life history from the effects of dredging and increased suspended sediment loads.²⁶
- Determine impacts of pile driving and other in-river construction on behavior and life history.

¹⁸ Work being done by James Sulikowski investigating the use of steroid hormones to determine sex by maturity. Laparoscopic techniques have been developed to visually inspect gonads by Dr. Rob Bakal, USFWS, Aquatic Animal Health Coordinator, National Fish Hatchery System.

¹⁹ Successful spawning of wild female sturgeon in captivity has been documented at Bears Bluff National Fish Hatchery. There has been some work done on sperm cryopreservation techniques by William Wayman and Curry Woods.

²⁰ Transport, long-term holding, and feeding work done at Bears Bluff National Fish Hatchery. Atlantic sturgeon also being held at USFWS Northeast Fishery Center.

²¹ Work has been done on long-term survival of hatchery-produced fish stocked in the Hudson River (Mohler et al. 2012).

²² Stocking programs were initiated in the Hudson River in 1994 and 2004 and in the Nanticoke River in 1994.

²³ Work done by Stevenson and Secor, Dunton et al. in the NJ-NY region, and Balazik et al. in the James River. Work also in progress by SCDNR assessing telomeres as a possible method to age Atlantic sturgeon.

²⁴ Work done by Secor (D.O.), Roy et al.(contaminants) and Matsche et al. (nitrite). Work in progress by Markin and MDNR (salinity, temperature, D.O. and turbidity) for different ages and life history stages.

²⁵ Data on benthic substrate and telemetry of juvenile and mature fish available for the Hudson River Estuary.

²⁶ SCDNR is currently monitoring sturgeon behavior as part of dredging events in Savannah and Charleston.

Moderate

- Analyze existing sea sampling data to characterize at sea migratory behavior. Use electronic tagging to model coastal migrations of juvenile and adult Atlantic sturgeon.²⁷
- Assess loss to ship/boat strikes.²⁸

Low

- Identify rates of tag loss and tag reporting.
- Encourage shortnose sturgeon researchers to include data collection for incidentally captured Atlantic sturgeon.

Additional Habitat Research Recommendations

- Fish passage requirements and appropriate structures for Atlantic sturgeon are largely unknown. Research all fish passage requirements for Atlantic sturgeon.
- Passage facilities should be designed specifically for passing Atlantic sturgeon for optimum efficiency at passing this species.
- Fish passage facilities should be designed to aid in the upstream and downstream passage of all life stages of Atlantic sturgeon. Most fish ladders in Atlantic coast streams and rivers are designed to pass alosines, and the specific needs of sturgeon will need to be considered as passage facilities are improved or constructed.
- The removal of dams, or the consideration of passage efforts, should be focused on those systems where Atlantic sturgeon historical habitat loss through blockage is greatest.
- Determine appropriate water flow for spawning Atlantic sturgeon. Water flows should be restored to appropriate levels during spawning season.
- Protection or restoration of critical habitat is considered the most beneficial conservation method for the restoration of sturgeons. Restore degraded historical habitat wherever possible. Also, habitat improvements that increase the survival of YOY are likely to make a strong contribution to population growth.
- New spawning habitat should be created with the use of artificial reef materials in areas where hard substrate has been degraded. Created habitat should be evaluated for effectiveness and longevity.²⁹
- ASMFC should designate important habitats for Atlantic sturgeon spawning and nursery areas as HAPC.
- Standardize PIT tagging and ultrasonic telemetry equipment and procedures.³⁰
- Further develop techniques for capture, transport, and long-term holding of wild brood stock.³³
- Standardize collection procedures, and develop a suitable long-term repository for Atlantic sturgeon biological tissues for use in genetic and other studies.³¹
- Map all known ocean captures and delineate winter range and foraging hotspots.

²⁷ Work done by Erickson et al. and Dunton et al. with PSAT tags and trawl surveys. Work done by Laney et al. 2007 in AFS Symposium 56. Telemetry work in progress along the coast.

²⁸ Work done in the James River by Balazik et al. 2012. Some work done by Brown and Murphy on the Delaware River. NYSDEC maintains a log of annual losses in the Hudson River Estuary.

²⁹ Some work done on the James River and work proposed on the Delaware River by Brundage et al.

³⁰ PIT tagging has been standardized.

³¹ Collection work done by Damon-Randall et al. and Kahn and Mohead. Tissue repository at CCEHBR in Charleston, SC.

Atlantic Sturgeon Research Needs Identified as Being Met

- ✓ Develop and implement long-term marking/tagging procedures to provide information on individual tagged Atlantic sturgeon for up to 20 years. *PIT tags.*
- ✓ Standardize collection procedures and develop suitable long-term repository for biological tissues for use in genetic and other studies.
- ✓ Develop the capability to capture wild broodstock and develop adequate holding and transport techniques for large broodstock.
- ✓ Establish a tag recovery clearinghouse and database for consolidation and evaluation of tagging and tag return information including associated biological, geographic, and hydrographic data. *Uncertainty whether this includes acoustic tag information.*
- ✓ Maintain database for tagged Atlantic sturgeon. *USFWS, Maryland Fishery Resources Office.*

BLACK DRUM

Fishery-Dependent Priorities

High

- Obtain better estimates of harvest from the black drum recreational fishery, especially in states with short seasons. Obtain better coverage of shore and nighttime anglers.³²
- Conduct studies to estimate catch and release mortality estimates.
- Increase spatial and temporal coverage of age samples collected regularly in fishery-dependent sources.
- Conduct a high reward tagging program to obtain improved return rates.

Moderate

- Obtain better estimates of bycatch of black drum in other fisheries, especially juvenile fish in South Atlantic states.

Fishery-Independent Priorities

High

- Increase spatial and temporal coverage of age samples collected regularly in fishery-independent sources.
- Prioritize collection of adult age data from fishery-independent sources in states where maximum size regulations preclude the collection of adequate adult ages.
- Expand existing fishery-independent surveys temporally and spatially to better cover black drum habitats, especially adult fish.
- Continue to collect and analyze current life history data from fishery-independent programs, including full size, age, maturity, histology workups and information on spawning season timing and duration. Any additional data that can be collected on adult black drum would be highly beneficial.

³² Nighttime sampling of anglers implemented in the Marine Recreational Information Program (MRIP) beginning in 2013.

Modeling / Quantitative Priorities

High

- Obtain estimates of selectivity-at-age for black drum through observer programs or tagging studies.

Life History, Biological, and Habitat Priorities

High

- Conduct studies to estimate fecundity-at-age coastwide and to estimate batch fecundity, especially for adults in South Atlantic.
- Analyze existing otoliths that have been collected but not aged.
- Conduct otolith microchemistry studies to identify regional recruitment contributions.
- Continue and expand current tagging programs to obtain mortality and growth information and movement-at-size data.
- Conduct new and expand existing acoustic tagging programs to help identify spawning and juvenile habitat use and regional recruitment sources.
- Collect genetic material (i.e., create “genetic tags”) over long time span to obtain information on movement and population structure and potentially estimate population size.

BLACK SEA BASS

Fishery-Dependent Priorities

High

- Increase sampling of commercial landings.
- Increase sample size of at sea observers and dockside validation for headboats. Increase recreational fisheries sampling.
- Determine depth, temperature, and season specific discard mortality rates. Assess and incorporate the impact of circle hook fishing regulations on discard mortality. Obtain more depth specific information from the private recreational fleet, MRIP At-Sea observer program, and Headboat Survey in the range of the southern stock.

Moderate

- Collect better spatial information in black sea bass fisheries to determine potential localized depletion effects.

Low

- Determine the impact/landings of the historical foreign fleet in the South Atlantic.

Additional Fishery-Dependent Priorities

- Develop hard part sampling coordinated with intercept surveys.
- Expand electronic reporting of headboat logbook for full implementation.

Fishery-Independent Priorities

High

- Conduct a pot survey throughout the range of the northern management unit and consider for an index of abundance.³³

³³ A pilot project is ongoing and proposals are being considered for funding to expand the program.

- Expand fishery-independent surveys to sample all sizes and age classes to develop more reliable catch-at-age and CPUE.
- Expand sampling to cover the entire range of the southern stock over a longer time period.

Additional Fishery-Independent Priorities

- Conduct at sea sex sampling to determine trend of sex change timing and assess the potential influence of population size on sex switching.³⁴

Modeling / Quantitative Priorities

High

- Investigate the effect of sex transition rates, sex ratio, and differential M by sex on the calculations of SSB per recruit and eggs per recruit.

Moderate

- Explore alternative assessment models, including non-age based alternatives.

Additional Modeling / Quantitative Priorities

- Continue development of a standardized method for calculating incomplete weight data.
- Further develop the tagging model described by Rudershausen et al. (2010) to address the assumptions of the model.

Life History, Biological, and Habitat Priorities

High

- Analyze size or age specific spawning frequency and seasonality.
- Investigate the movement and migrations of black sea bass using otolith microchemistry, genetic studies, and expanding tagging studies.
- Conduct meta-analysis of patterns of M in protogynous fishes, specifically black sea bass. Determine sex specific mortality rates and growth rates.
- Determine the implications of removing large males on population dynamics through field studies or large scale mesocosm experiments.
- Conduct studies on the efficacy of recompression techniques such as venting to reduce discard mortality.
- Study the movement and mixing of larval and juvenile black sea bass in the southern stock.

Moderate

- Further delineate essential fish habitat (EFH), particularly in nursery areas. Further investigate possible gear impacts on EFH.
- Identify transport mechanisms or behaviors that transport early juvenile black sea bass into estuaries.
- Evaluate overwintering habitat of all black sea bass life stages.
- Evaluate feeding of black sea bass larvae and overwintering adults.
- Develop mariculture techniques.

Low

- Conduct studies determining the value of artificial reefs for increased production of black sea bass to improve potential yield estimates.

³⁴ The NEFSC and UMass-Dartmouth are working on trends in sex change timing for the northern stock and UNC-Wilmington is working on the same for the southern stock.

Additional Life History, Biological, and Habitat Priorities

- Continue ageing studies to provide a foundation for an age based assessment. Compare scale to otolith age estimates.
- Conduct ageing validation studies to examine the implications of sex change, as well as temperature and salinity changes associated with movement onshore and offshore, on ageing reliability.
- Continue genetics work to determine potential stock delineation in the northern range.

Management, Law Enforcement, and Socioeconomic Priorities

- Evaluate the potential influence of non-compliance on high assumed M.
- Analyze logbook programs to determine current compliance and develop recommendations for improving compliance (i.e., increased education on the effect of not reporting accurately).
- Continue evaluation of methodology for mandatory reporting in the For-hire sector (e.g., Gulf MRIP Pilot).

Black Sea Bass Research Priorities Identified as Being Met

- ✓ A tagging program should be initiated through state fisheries agencies to estimate mortality independent of traditional methods.

BLUEFISH

Fishery-Dependent Priorities

High

- Evaluate magnitude and length frequency of discards from the commercial and recreational fisheries.
- Collect size and age composition of the fisheries by gear type and statistical area.³⁵
- Target commercial (especially in the northeast region) and recreational landings for biological data collection when possible.⁴⁸
- Initiate fisheries-dependent sampling of offshore populations of bluefish during the winter months.

Fishery-Independent Priorities

High

- Increase sampling frequencies when bluefish are encountered, especially when medium size fish are encountered.⁴⁸
- Evaluate fishery-independent surveys to determine if the state surveys can be combined or coordinated to yield broader temporal and spatial representation of the stock.³⁶

³⁵ A biological sampling program has been implemented for states that accounted for >5% of the coast wide bluefish harvest between 1998-2008. See Addendum 1 to Amendment 1 of the ASMFC Bluefish FMP.

³⁶ SARC-41. 2005. 41st Chair's Report from the Northeast Regional Stock Assessment Workshop (SAW-41) Stock Assessment Review Committee (SARC) Meeting, Northeast Fisheries Science Center, National Marine Fisheries Service, Woods Hole, Massachusetts, June 6-9, 2005.

- Initiate fisheries-independent sampling of offshore populations of bluefish during the winter months.

Low

- Initiate a coastal surf-zone seine study to provide more complete indices of juvenile abundance.

Modeling / Quantitative Priorities

High

- Test the sensitivity of the bluefish assessment to assumptions concerning age varying M, level of age 0 discards, and selection patterns.
- Evaluate measures of CPUE under different assumptions of effective effort to allow evaluation of sensitivity of results.

Low

- Explore alternative methods for assessing bluefish, such as length based and modified DeLury models.

Life History, Biological, and Habitat Priorities

High

- Conduct research on oceanographic influences on bluefish recruitment, including information on migratory pathways of larval bluefish.

Moderate

- Study tag mortality and retention rates for American Littoral Society dorsal loop and other tags used for bluefish.
- Conduct studies on interactive effects of pH, other environmental variables, and contaminants on various biological and sociological parameters such as reproductive capability, survival, genetic changes, and suitability for human consumption.
- Initiate research on species interactions and predator-prey relationships.

Low

- Continue work on catch and release mortality.³⁷

Bluefish Research Priorities Identified as Being Met

- ✓ Complete a scale-otolith age comparison study. *Robillard, E., et al. 2009. Age-validation and growth of bluefish (Pomatomus saltatrix) along the East Coast of the United States. Fisheries Research 95: 65-75.*
- ✓ Conduct research to determine the timing of sexual maturity and fecundity of bluefish. *Robillard, E. et al. 2008. Reproductive biology of bluefish (Pomatomus saltatrix) along the East Coast of the United States. Fisheries Research 90: 198-208.*
- ✓ Age any archived age data for bluefish and use the data to supplement North Carolina age keys.

³⁷ Some work completed, see: Fabrizio, et al. 2008. Factors affecting catch-and-release mortality of bluefish. *North American Journal of Fisheries Management* 28:533-546.

COASTAL SHARKS³⁸

Fishery-Dependent Priorities

High

- Initiate or expand dockside sampling for sharks to verify landings information and species composition.

Moderate

- The Atlantic menhaden fishery data should be examined to determine shark bycatch estimates, if available.
- Conduct additional length sampling and age composition collection to improve information for developing selectivities.
- Shrimp trawl observer coverage should be expanded to 2 to 5% of total effort, particularly during periods of regulatory or gear changes. The observer coverage program should strive for even spatial coverage (particularly adding more south Atlantic coverage), randomness in vessel selection and full identification of elasmobranch species (continuing on from the 2009 Bycatch Characterization Protocol).
- Increase research on post-release survivorship of all shark species by gear type.
- Continue to acquire better species specific landings information on number of species, by weight, from dealers.³⁹

Fishery-Independent Priorities

High

- Investigate the appropriateness of using vertebrae for ageing adult sandbar sharks. If appropriate, implement a systematic sampling program that gathers vertebral samples from entire size range for annual ageing to allow tracking the age distribution of the catch as well as updating of age-length keys.⁴⁰

Moderate

- Develop a fishery-independent porbeagle shark survey to provide additional size composition and catch rate data to calculate an index of abundance.
- Develop a stock wide fishery-independent monitoring program in state coastal waters for dusky sharks that includes annual samples of length and age frequencies.

Modeling / Quantitative Priorities

High

- Explore modeling approaches that do not require an assumption that the population is at virgin level at some point in time.

Moderate

- Develop empirically based estimates of natural mortality.
- Explore alternative approaches to age-length keys for estimating age from length.

³⁸ Work with NMFS on all priorities to ensure no duplication of efforts.

³⁹ All dealers must report landings by species.

⁴⁰ Recent bomb radiocarbon research has indicated that past age estimates based on tagging data for sandbar sharks may be correct and that vertebral ageing may not be the most reliable method for mature individuals. See Andrews et al. 2011.

- Improve estimates of removals by identifying and incorporating the sources of uncertainty (species misidentification, non-reporting).
- Quantify the uncertainty in time series of catch data.
- Perform exploratory analyses with CPUE indices to identify indices that contribute the most information on stock trends.
- Conduct simulation tests (management strategy evaluation) to assess the performance of alternative assessment methods (including the catch-free model, ASPM, ASPIC, SS, or stock specific models), recruitment parameterizations, harvest control rules, assessment frequency and data collection.
- Develop a two sex model for more direct estimation of the dusky and blacknose shark spawning stocks.
- Explore alternative modeling approaches in the presence of uncertain reproductive information that model reproduction as a function of the number of mature females. Integrate uncertainty in the reproductive frequency, fecundity, and pup-survival into a single parameter (the slope at the origin of the stock-recruit function) and incorporate this uncertainty via priors on the parameter.

Low

- Conduct sensitivity analyses to determine if discard survival estimates have a significant impact on the estimated status of the dusky and blacknose shark stocks in relation to MSY reference points.
- Develop a set of indicators (age-structure, total mortality estimates from catch curves, changes in abundance indices values) to determine whether dusky shark stock status has changed sufficiently to warrant a full assessment.

Life History, Biological, and Habitat Priorities

High

- Re-evaluate finetooth life history in the Atlantic Ocean in order to validate fecundity and reproductive periodicity.⁴¹
- Develop and conduct tagging studies on dusky and blacknose stock structure with increased international collaboration (e.g., Mexico) to ensure wider distribution and returns of tags. Expand research efforts directed towards tagging of individuals in south Florida and Texas/Mexico border to get better data discerning potential stock mixing.
- Examine female sharks during the spawning periods to determine the proportion of spawning females.⁴²

Moderate

- Continue life history studies for all species of the shark complex to allow for additional species specific assessments. Particularly, natural mortality, age, fecundity, and reproductive frequency. Update age, growth, and reproductive studies of blacknose sharks, with emphasis on smaller individuals in the Atlantic and larger individuals in the Gulf of Mexico.
- Coordinate a biological study for Atlantic sharpnose so that samples are made at least monthly, and, within each month, samples would be made consistently at distinct geographic locations. For example, sampling locations would be defined in the northern Gulf, west coast of Florida, the Florida Keys (where temperature is expected to be fairly constant over all

⁴¹ Work by Frazier, Belcher, and Gelsleichter is underway.

⁴² Biological information indicates that females of some shark species spawn less often than annually.

seasons), and also several locations in the South Atlantic, including the east coast of Florida, Georgia, South Carolina, and North Carolina. This same sampling design could be applied to all small coastal sharks.

- Population level genetic studies are needed that could lend support to arguments for stock discriminations using new loci and/or methodology that has increased levels of sensitivity.

Low

- Determine what is missing in terms of experimental design and/or data analysis to arrive at incontrovertible (to the extent that it may be scientifically possible) conclusions on the reproductive periodicity of the sandbar shark stock.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Conduct species specific assessments for all shark species, with a priority for smooth dogfish.

Coastal Sharks Research Priorities Identified as Being Met

- ✓ Identify EFH and nursery areas for shark species found along the Atlantic coast of the US. *Ongoing survey (COASTSPAN) addressing this priority. Also see McCandless et al. 2007.*
- ✓ Determine bonnethead life history in Atlantic Ocean, spanning the range of the stock. *Work done by Frazier and Driggers.*
- ✓ Conduct additional life history research on sandbar sharks to supplement or replace the available data from the mid 1990s. *See working papers in SEDAR 21.*

HORSESHOE CRAB

Fishery-Dependent Priorities

Moderate

- Characterize the proportion of states' landings that comprise crabs of Delaware Bay origin. This can be done through a directed tag/release study, genetics/microchemistry study, or both.
- Improve measures to characterize landings and bycatch in the commercial fisheries by life stage.
- Estimate fishing discard numbers and associated mortality rates.
- Investigate supplemental bait and alternative trap designs to reduce the commercial fisheries need for horseshoe crabs.

Fishery-Independent Priorities

High

- Expand or implement fishery-independent surveys (e.g., spawning, benthic trawl, tagging) to target horseshoe crabs throughout their full range including estuaries. Highest priority should be given to implementing directed surveys in the New England and New York regions.⁴³

⁴³ Some survey design work done by Landi (2011).

- Estimate catchability for gear used in benthic trawl surveys and determine effect of size, sex, substrate, topography, timing, and temperature.
- Investigate factors (habitat, harvest, sampling methods, etc.) that might be causing the large discrepancies between Delaware and New Jersey in egg survey numbers.

Moderate

- Estimate the proportion of the Delaware Bay population that is available in time and space within existing VT benthic trawl survey area. Estimate the selectivity of gear used in the survey. These estimations should take into account age class (i.e., primiparous, multiparous).
- Ground truth sub-sampling method used in Delaware Bay spawning survey for calibration to the “population” scale.

Modeling / Quantitative Priorities

High

- Estimate age/size specific survival of all life stages (e.g., age 0 to adult) and growth rate by instar within Delaware Bay.
- Estimate size specific fecundity of Delaware Bay females.
- Model relationship between egg availability and spawning biomass/abundance.

Moderate

- Further develop catch-survey analysis and apply assessment modeling beyond the Delaware Bay region.
- Continue to conduct additional stock assessments and determine F. Use these data to develop a more reliable sustainable F.
- Estimate mortality from the entire biomedical collection process, from capture to post-return.⁴⁴

Life History, Biological, and Habitat Priorities

High

- Assess horseshoe crab prey availability and determine whether horseshoe crab population growth will be/is limited by prey availability.
- Evaluate the impacts of beach nourishment projects on horseshoe crab populations.

Moderate

- Characterize essential horseshoe crab habitat, other than spawning habitat, in different regions.
- Further evaluate life table information including sex ratio and population age structure.
- Estimate the proportion of sub-tidal spawning and determine if this affects spawning success (i.e., egg survivability).
- Conduct tagging studies and analyze tagging data to identify costal populations, population abundance, mortality rates, migration, and other movements.⁴⁵
- Characterize abundance and size structure of juveniles coastwide as indicators of recruitment to adulthood.
- Evaluate the effect of mosquito control chemicals on horseshoe crab populations.
- Evaluate the importance of horseshoe crabs to other marine resources such as sea turtles.

⁴⁴ Tagging work has been done by DeLancey and Floyd (SC DNR) in South Carolina to evaluate mortality from the biomedical bleeding process.

⁴⁵ United States Fish and Wildlife Service tagging program in progress.

- Conduct risk assessment for the effect of oil spill (timing, location, and amount) on horseshoe crab and shorebird populations and determine best practices to reduce risk.

Notes:

Several priority research needs are currently being addressed through the following surveys:

Delaware Bay spawning beach survey:

- a) Determine sampling frame or list of beaches in the Bay with a nonzero probability of being sampled in a given year.
- b) Determine how many beaches need to be surveyed on how many days to meet survey objectives.
- c) Determine whether subsampling effort (no. of quadrats per beach) was adequate.
- d) Consider a survey design that includes both fixed and random beaches.

Delaware Bay egg count survey:

- a) Set primary objective of egg count surveys to be shorebird food availability and focus on density of eggs at the surface (< 5cm).
- b) Determine survey frequency (i.e., survey eggs annually, every 3 years, every 5 years, or other?).
- c) Determine where, along the beach profile, eggs should be sampled.
- d) Determine sample size for sampling eggs on a beach.
- e) Determine the relationship between spawning activity and density of eggs at the surface (<5cm). Is there a threshold of spawning activity below which eggs remain buried and unavailable to shorebirds?

Offshore benthic survey:

- a) Design comparative surveys or experiments to determine gear efficiencies.

Horseshoe Crab Research Priorities Identified as Being Met

- ✓ Evaluate the effectiveness of currently used benthic sampling gear for stock assessment (Qualitative evaluation completed through 2006 peer review).
- ✓ Determine beach fidelity by horseshoe crabs to determine habitat use.
- ✓ Develop a YOY or age 1 recruitment index from the Delaware 16-foot trawl survey.
- ✓ Conduct economic studies to determine the value of the commercial fishery and the impact of regulatory management. Such economic studies should also include an assessment of economic impacts on other fisheries as they relate to horseshoe crabs.

NORTHERN SHRIMP

Fishery-Dependent Priorities

High

- Better characterize shrimp discards in the shrimp and other small-mesh (i.e., herring and whiting) fisheries to provide more accurate estimates of shrimp removals for modeling.
- Continue to quantify the magnitude of bycatch of other species in the shrimp fishery by area and season and take steps necessary to limit negative impacts.⁴⁶

⁴⁶ Some work has been done evaluating bycatch (Eayrs 2009) and bycatch in traps (Moffet 2012).

- Conduct ground truthing of historical commercial data gathered via Federal and state databases.
- Improve separator and excluder devices to reduce bycatch and discard of non-targeted species and small shrimp in the shrimp fishery and fisheries targeting other species.⁴⁷
- Evaluate selectivity of shrimp by traps and trawls.

Moderate

- Continue sea sampling efforts.
- Evaluate commercial fishery sampling design. Increase and/or redistribute sampling of commercial catches as necessary, ensuring good allocation of samples among ports and months, to provide better estimates of size composition.

Fishery-Independent Priorities

High

- Evaluate effectiveness of summer shrimp survey statistical design, including geographic coverage.

Moderate

- Explore ways to quantify age 1 and younger shrimp.

Low

- Verify that summer shrimp survey tow bottom tending times have been consistent.

Modeling / Quantitative Priorities

High

- Continue to examine values of M. Revisit older work that established $M=0.25$ (Rinaldo, Clark). Estimate M using various existing methods. Investigate annual and life history variation in M and potential causes.
- Continue research to refine annual estimates of consumption by predators, and include in models as appropriate.

Moderate

- Explore explicit inclusion of temperature effects in stock assessment models.
- Expand the time series of stock and recruitment data using catchability estimates from the production model.
- The CSA model requires a parameter that is the ratio of catchabilities for the two age or size classes. Sensitivity analysis on the values used would contribute to a better understanding of model stability. A thorough evaluation of possible methods for improved estimation of this parameter could reduce uncertainty in the assessment.
- Continue examination of methods for age determination to develop the possibility of using age based assessment methods.
- Develop a bioeconomic model to study the interactions between four variables: movements of shrimp, catchability of shrimp, days fished, and market price.

Life History, Biological, and Habitat Priorities

High

- Investigate application of newly developed direct ageing methods to ground truth assumed ages based on size and stage compositions.

⁴⁷ Some work has been done, see He and Balzano (2007) and Pinkham et al. (2006).

- Evaluate larval and adult survival and growth, including frequency of molting and variation in growth rates, as a function of environmental factors and population density.⁴⁸
- Study the effects of oceanographic and climatic variation (i.e., North Atlantic Oscillation) on the cold water refuges for shrimp in the Gulf of Maine.
- Explore the mechanisms behind the stock-recruitment and temperature relationship for Gulf of Maine northern shrimp.⁴⁹

Moderate

- Determine the short and long-term effects of mobile fishing gear on shrimp habitat.⁵⁰
- Study specific habitat requirements and develop habitat maps for early life history stages.
- Evaluate effects of potential habitat loss/degradation on northern shrimp.
- Identify migration routes of immature males offshore and ovigerous females inshore.⁵¹
- Evaluate maturation, fecundity, and lifetime spawning potential. Estimates of fecundity at length should be updated and the potential for annual variability should be explored. Examine variability of egg quality with female size and stage over time.
- Investigate changes in transition and maturation as a function of stock size and individual size and temperature.⁵²
- Investigate diet of northern shrimp for different life history stages.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Characterize demographics of the fishing fleet by area and season. Perform comparative analysis of fishing practices between areas.⁵³
- Develop an understanding of product flow and utilization through the marketplace. Identify performance indicators for various sectors of the shrimp industry. Identify significant variables driving market prices and how their dynamic interactions result in the observed intra-annual and inter-annual fluctuations in market price for northern shrimp.
- Explore new markets for Gulf of Maine shrimp, including community supported fisheries.⁵⁴
- Develop a framework to aid evaluation of the impact of limited entry proposals on the Maine fishing industry.^{67,55}
- Develop a socioeconomic analysis assessing the importance of the northern shrimp fishery in annual activities of commercial fishing.
- Determine the relative power relationships between the harvesting and processing sector and the larger markets for shrimp and shrimp products.
- Develop an economic-management model to determine the most profitable times to fish, how harvest timing affects markets, and how the market affects the timing of harvesting.

⁴⁸ Some work has been done by Stickney and Perkins.

⁴⁹ Some work has been done, see Richards et al. (2012).

⁵⁰ Short term effects have been studied, see Simpson and Watling (2006).

⁵¹ Some migration work has been done, see Schick et al. (2006) NEC

⁵² Some work has been done, see Wieland (2004, 2005).

⁵³ Dunham and Muller at the University of Maine conducted an economic study characterizing demographics of the fishing fleet by area and season in 1976. This study should be updated.

⁵⁴ Maine Fishermen's Forum panel discussions, 2006 and 2007

⁵⁵ Maine Coastal Fishery Research Priorities, 2001, online at

http://www.maine.gov/dmr/research/table_of_contents.htm

Moderate

- Perform cost-benefit analyses to evaluate management measures.

Northern Shrimp Research Priorities Identified as Being Met

- ✓ Develop a time series of standardized effort to corroborate patterns of estimated F. *In progress for next benchmark stock assessment.*
- ✓ Recover and convert older port sampling data to useable database to make data available for future queries on fishing locations, catch rates, size distributions, sex stage and timing of egg hatch, other shrimp species, etc.
- ✓ Recalculate fall survey indices for shrimp, eliminating the nighttime tows. *In progress for next benchmark stock assessment.*
- ✓ Investigate power analysis of estimates of mean weight from port sampling to optimize sample design. *In progress for next benchmark stock assessment.*
- ✓ Target and threshold reference points for northern shrimp are set equal to one another at $F = 0.22/\text{yr}$. Using a buffer of zero between target and threshold reduces the relevance of reference points to management. Specifically, the distinction between desirable exploitation rates and those that indicate overfishing is blurred. The SARC recommends dialogue with managers and industry on this matter, as well as research to illustrate whether separating threshold from target would allow more stable or robust management techniques.
- ✓ Study the possibility of using a more detailed assessment model, such as the CAA model used for Atlantic sea scallop. *In progress for next benchmark stock assessment.*
- ✓ Explore spatial, depth, and/or temperature influences on survey catchability to contribute to better standardization of the survey abundance index. *Addressed for stock assessment updates.*
- ✓ Conduct research on annual variation of size-at-age to increase precision of the assessment. *In progress for next benchmark stock assessment.*
- ✓ Evaluate alternative biological reference points and define sustainable harvest levels. *In progress for next benchmark stock assessment.*

RED DRUM

Fishery-Dependent Priorities

High

- Conduct studies and collect time series data on discard mortality from varying commercial and recreational gears in directed and non-directed fisheries. Continue and expand observer coverage (5-10%) across all gear types in commercial fisheries or volunteer angler logbooks in recreational fisheries to characterize discards. Evaluate effects of water temperature, depth of capture, and other factors on discard mortality.

Moderate

- Improve CPUE estimates and fishery-dependent biological sampling to characterize the age/size composition of removals. Increase efforts to intercept nighttime fisheries for red drum by the MRIP.⁵⁶

⁵⁶ Nighttime sampling of anglers implemented in the MRIP beginning in 2013.

- Develop a more reliable estimate of natural and fishing mortality through directed sampling of the adult population.

Fishery-Independent Priorities

High

- Conduct fishery-independent sampling of sub-adult and adult red drum (age 4 and older) in each state from Virginia to Florida.

Modeling / Quantitative Priorities

High

- Determine escapement to the spawning population, develop an index of recruitment to age 1, and develop an estimate of adult red drum biomass.
- Integrate tagging data in assessment models.
- Develop age based estimates of abundance based on survey specific age-length keys.
- Explore the use of estimates of F directly from tagging data (i.e., northern stock) as the basis for stock assessment and guidance for fisheries management.

Moderate

- Evaluate new stock assessment techniques as alternatives to age-structured models.

Low

- Quantify relationships between red drum production and habitat.

Life History, Biological, and Habitat Priorities

High

- Continue tagging studies to determine stock identity, inshore/offshore migration patterns, abundance, and mortality.
- Refine maturity schedules for northern and southern stocks. Conduct studies on size, age, and spatial specific fecundity.

Moderate

- Conduct otolith microchemistry studies to determine the life stage linking estuarine and offshore red drum and/or regional stock differentiation.

Low

- Identify spawning areas and abiotic components of these areas through the entire range so these areas can be protected from degradation and/or destruction. Determine the impacts of dredging and beach re-nourishment on red drum spawning and early life history stages. Identify the effects of water quality degradation on the survival of red drum eggs, larvae, post-larvae, and juveniles.
- Assess the efficacy of using cultured red drum to restore native stocks along the Atlantic coast, including cost-benefit analysis.
- Determine methods for restoring red drum habitat and/or improving existing environmental conditions that adversely affect red drum production.
- Determine habitat preferences, environmental conditions, growth rates, and food habits of larval and juvenile red drum throughout the species range along the Atlantic coast. Assess the effects of environmental factors on stock density.

Management, Law Enforcement, and Socioeconomic Priorities

Low

- Collect socioeconomic data, possibly by add-ons to the MRIP or other methods, to determine economic value of Atlantic coast recreational red drum fishery.

SCUP

Fishery-Dependent Priorities

- Continue current level of sea and port sampling of the various fisheries in which scup are landed and discarded to adequately characterize the length composition of both landings and discards. Expanded age sampling of scup from commercial and recreational catches would be beneficial, with special emphasis on the acquisition of large specimens.⁵⁷
- Commercial discard mortality had previously been assumed to be 100% for all gear types. Studies need to be conducted to better characterize the mortality of scup in different gear types to more accurately assess discard mortality.
- Additional information on compliance with regulations (e.g., length limits) and hooking mortality is needed to interpret recreational discard data and confirm weightings used in stock assessment model.

Fishery-Independent Priorities

- Fund, support, and expand the spatial coverage of the ventless trap-based Scup and Black Sea Bass Survey of Hard Bottom Areas.
- Collect total and fork lengths from individual scup in a standardized manner throughout their size and geographic range and across gear types to improve upon the length conversion equation currently cited in the FMP (Hamer, 1979).

Modeling / Quantitative Priorities

- Continue exploration of relative biomass and relative exploitation calculations based on CPUE data from fishery-dependent data (e.g., observer, commercial, P/C VTR, MRIP, etc).
- Evaluate the current biomass reference point and consider alternative proxy reference points such as B_{MAX} (the relative biomass associated with F_{MAX}).
- Explore other approaches for analyzing survey data, including bootstrap resampling methods to generate approximate confidence intervals around the survey index point estimates.⁵⁸
- Evaluate indicators of potential changes in stock status that could provide signs to management of potential reductions of stock productivity in the future.

Life History, Biological, and Habitat Priorities

- Conduct an ageing comparison workshop to (1) compare otoliths and scales and (2) compare state age-length keys.⁵⁹

⁵⁷ Improved sampling intensity of landings and increased funding for the observer program since 2004 have improved discard sampling in the directed and bycatch fisheries for scup.

⁵⁸ Completed for the NEFSC surveys, could be applied to state survey data.

⁵⁹ Contact and inform Eric Robillard of NEFSC Population Biology Branch.

- Conduct biological studies to investigate factors affecting annual availability of scup to research surveys and maturity schedules.

Management, Law Enforcement, and Socioeconomic Priorities

- A Management Strategy Evaluation of alternative approaches to setting quotas, with attention paid to compliance related to minimum size, would be helpful.

Scup Research Needs Identified as Being Met

- ✓ The SARC discussed some of the reasons why the research recommendations from previous SARCs had not been adequately addressed. There is currently no mechanism for accountability, resulting in other research needs taking priority. It was suggested that summaries of research recommendations be forwarded to the NRCC for review and comment, followed by a feasibility analysis. At that point a list of priorities and perhaps assignments for research could be made. The SARC recommends that a working group be developed to assess what group would be best suited to address each research need. *This is now a TOR that must be responded to in each assessment.*
- ✓ In the absence of reliable estimates of the catch, consideration should be given to simple forward projection models that rely on trends from the survey indices in the absence of catch information. *35th SAW Consensus Summary 141. Completed in AIM, resulted in no improvement over VPA because inconstancy between fishery dependent and independent data.*
- ✓ Investigate the statistical properties of the three commercial discard estimation approaches presented for consideration in future analyses. *Completed, awaiting review at next benchmark assessment.*

SPANISH MACKEREL

Fishery-Dependent Priorities

- Increase proportion of fish with biological data within MRIP sampling.
- Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.
- Require mandatory reporting for all charter boats state and federal.
- Continue development of electronic mandatory reporting for for-hire sector.
- Continue research efforts to incorporate/require logbook reporting from recreational anglers.
- Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).
- Quantify historical fishing photos for use in reconstructing recreational historical landings.
- Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deepwater complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.
- Continue and expand fishery-dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

- Implement observer coverage for the fisheries for Spanish mackerel (gillnets, castnets (FL), handlines, poundnets, and shrimp trawls for bycatch). Allocate 5-10% observer coverage by strata within states and collect maximum information from fish.
- Expand TIP sampling to better cover all statistical strata, predominantly from FL and by gillnet and castnet gears.
- Determine the tradeoff with length versus ages, need for more ages (i.e., hard parts).
- Consider the use of VMS to improve spatial resolution of data.
- Consider simplified logbook language in regard to discards (e.g., list them as dead or alive).⁶⁰
- Develop uniform state and federal reporting systems/forms to improve the ease and efficiency of data compilation.
- Establish online reporting and use logbooks as a backup.
- Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- Continue improving “one-stop shopping” for commercial data from NMFS, ACCSP, and states.

Fishery-Independent Priorities

- Collect and analyze fishery independent data for adult Spanish mackerel.

Modeling / Quantitative Priorities

- Using simulation analysis, evaluate the utility of including interaction terms in the development of a standardized index and identify the potential effects these interaction terms have on stock assessments.
- Establish a fishery-independent survey meant to capture the population trends of coastal pelagic in the south Atlantic.
- Examine how schooling or migratory dynamics may influence the catchability of the species. In particular, research the assumption of the hyperstability of indices that sample the schooling portion of the stock.
- Determine whether it is important to model both sexes in the population for assessment purposes.
- Investigate steepness and alternative models for the stock recruit relationship. In particular, evaluate if there is newer data available on steepness from other analyses of S-R for pelagic stocks with similar reproductive strategies.⁶¹

Life History, Biological, and Habitat Priorities

- Utilize recently developed genetic techniques to investigate the stock structure of Spanish mackerel. Microsatellite information should be explored to consider both stock identity and internal population structure.
- Collect Spanish mackerel maturity data from both regions and both sexes from specimens approximately 275 mm FL and lower to be staged via histological methods.

⁶⁰ Current logbook categories for discards (all dead, majority dead, majority alive, all alive) are not useful for informing discard mortality.

⁶¹ The Review Panel for the 2012 SEDAR was uncertain as to how much the analysis would further inform the model or management at present

SPINY DOGFISH

Fishery-Dependent Priorities

High

- Determine area, season, and gear specific discard mortality estimates coastwide in the recreational, commercial, and non-directed (bycatch) fisheries.⁶²
- Characterize and quantify bycatch of spiny dogfish in other fisheries.

Moderate

- Increase the biological sampling of dogfish in the commercial fishery and on research trawl surveys.

Low

- Further analyses of the commercial fishery is also warranted, especially with respect to the effects of gear types, mesh sizes, and market acceptability on the mean size of landed spiny dogfish.

Fishery-Independent Priorities

Moderate

- Conduct experimental work on NEFSC trawl survey gear performance, with focus on video work to study the fish herding properties of the gear for species like dogfish and other demersal roundfish.
- Investigate the distribution of spiny dogfish beyond the depth range of current NEFSC trawl surveys, possibly using experimental research or supplemental surveys.

Low

- Continue to analyze the effects of environmental conditions on survey catch rates.

Modeling / Quantitative Priorities

High

- Continue work on the change-in-ratio estimators for mortality rates and suggest several options for analyses.

Moderate

- Examine observer data to calculate a weighted average discard mortality rate based on an assumption that the rate increased with catch size.

Life History, Biological, and Habitat Priorities

High

- Conduct a coastwide tagging study to explore stock structure, migration, and mixing rates.
- Standardize age determination along the entire East Coast. Conduct an ageing workshop for spiny dogfish, encouraging participation by NEFSC, NCDMF, Canada DFO, other interested agencies, academia, and other international investigators with an interest in dogfish ageing.

Moderate

- Identify how spiny dogfish abundance and movement affect other organisms.

⁶² Multiple studies have evaluated discard mortality rates of commercial and recreational gears (Rulifson 2007, Mandelman and Farrington 2007a, Mandelman and Farrington 2007b, & Tallack and Slifka 2007).

Management, Law Enforcement, and Socioeconomic Priorities

Moderate

- Monitor the changes to the foreign export markets for spiny dogfish, and evaluate the potential to recover lost markets or expand existing ones.

Low

- Update on a regular basis the characterization of fishing communities involved in the spiny dogfish fishery, including the processing and harvesting sectors, based upon Hall-Arber et al. (2001) and McCay and Cieri (2000).
- Characterize the value and demand for spiny dogfish in the biomedical industry on a state by state basis.
- Characterize the spiny dogfish processing sector

Spiny Dogfish Research Needs Identified as Being Met

- ✓ Genetic analysis of spiny dogfish to determine if more than one unit stock exists along the Northwest Atlantic.
- ✓ Update maturation and fecundity estimates by length class.
- ✓ Recover and encode information on the sex composition prior to 1980 from the survey database.
- ✓ Quantify effort directed on spiny dogfish in waters outside of the US.

SPOT

Fishery-Dependent Priorities

High

- Conduct state monitoring and reporting on the extent of unutilized bycatch and fishing mortality on fish less than age 1 in fisheries that take significant numbers of spot.
- Improve spot catch and effort statistics from the commercial and recreational fisheries, along with size and age structure of the catch, in order to develop production models.
- Determine the onshore versus offshore components of the spot fishery.
- Evaluate the effects of mandated BRDs on spot catch in those states with significant commercial harvests.⁶³

Fishery-Independent Priorities

High

- Begin collection of otoliths from the NMFS and SEAMAP surveys and continue collection of otoliths from the NEAMAP survey.⁶⁴
- Develop cooperative coastwide spot juvenile indices to clarify stock status.
- Continue monitoring long-term changes in spot abundance, growth rates, and age structure.
- Continue monitoring juvenile spot populations in major nursery areas.

⁶³ North Carolina began a statewide characterization study of the commercial shrimp trawl fishery in August 2012 that will be conducted through June 2014, including discard mortality data collection.

⁶⁴ Personnel to process and age these collected otoliths should be identified.

Modeling / Quantitative Priorities

High

- Develop fishery-dependent and fishery-independent size and sex specific relative abundance estimates.⁶⁵
- Develop catch-at-age matrices for recreational and commercial fisheries.
- Develop stock assessment analyses appropriate to current data.
- Cooperatively develop a YPR analysis.

Life History, Biological, and Habitat Priorities

High

- Add the North Carolina commercial and fishery-independent (gill net survey) data that were unavailable at the data workshop to the life history analyses.⁶⁶
- Process and read the backlog of otoliths collected from the Maryland and North Carolina commercial fisheries and the NEAMAP Survey.⁶⁷
- Continue evaluation of size and age at maturity.⁶⁸
- Define reproductive output based on fecundity and spawning periodicity.⁶⁹
- Conduct age validation studies.⁷⁰
- Organize an otolith exchange between the major spot ageing labs (ODU/SCDNR/NCDMF). If there are differences in age assignments, hold a spot ageing workshop to establish a coastwide ageing protocol.
- Determine the effect that anthropogenic perturbations may be having on growth, survival, and recruitment.
- Develop stock identification methods and investigate the degree of mixing between state stocks during the annual fall migration (genetic and tagging studies).⁷¹

Moderate

- Evaluate natural mortality by age once confident that otoliths have been aged consistently between labs.
- Conduct discard mortality studies for gears used in the recreational and commercial fisheries.⁷⁶

SPOTTED SEATROUT

Fishery-Dependent Priorities

High

- Collect data on the size and age of spotted seatrout released alive by anglers and the size and age of commercial discards.
- Increase observer coverage in states that have a commercial fishery for spotted seatrout.

⁶⁵ Some recent data from South Carolina is available for this work.

⁶⁶ See Kevin Brown (NC DMF) for the available data.

⁶⁷ North Carolina backlog through 2011 is processed and aged.

⁶⁸ Age, growth, and reproduction work done in South Carolina thesis project.

⁶⁹ Some maturity schedule data available from South Carolina.

⁷⁰ South Carolina age validation study completed in 2012.

⁷¹ Archived genetic samples available in South Carolina.

- Expand the MRIP to assure adequate data collection for catch and effort data, increase intercepts, and include state add-ons of social and economic data needs.

Moderate

- Collection of commercial and recreational landings data should be continued and expanded.
- Improve precision of effort reporting through commercial trip ticket programs.

Fishery-Independent Priorities

High

- Develop state-specific juvenile abundance indices.
- Initiate fishery-independent surveys of spotted seatrout.
- Emphasis should be placed on collecting the necessary biological data to be able to conduct stock assessments and to assist in drafting fishery management plans.

Modeling / Quantitative Priorities

High

- Utilize age structure analyses by sex in stock assessments.
- Conduct state specific stock assessments to determine the status of stocks relative to the plan objective of maintaining a spawning potential of at least 20%.
- Provide state specific batch fecundity estimates for use in stock assessments.⁷²

Life History, Biological, and Habitat Priorities

High

- Identify essential habitat requirements.
- Evaluate effects of environmental factors, especially cold winters, on spawning frequency and stock density.
- Continue work to examine the stock structure of spotted seatrout on a regional basis, with particular emphasis on advanced tagging and molecular techniques.⁷³
- Conduct telemetry tagging surveys to provide precise estimates of mortality attributed to winter kills.⁷⁴

Management, Law Enforcement, and Socioeconomic Priorities

High

- Initiate collection of social and economic aspects of the spotted seatrout fishery.

SUMMER FLOUNDER

Fishery-Dependent Priorities

High

- Develop a program to annually sample the length and age frequency of summer flounder discards from the recreational fishery.

⁷² South Carolina fecundity information available in Roumillat and Brouwer (2002).

⁷³ Masters project in progress examining the genetic structure of spotted seatrout along the Atlantic coast and the effects of winter conditions on genetic diversity of spotted seatrout.

⁷⁴ Masters project in progress examining lethal temperature thresholds of spotted seatrout.

- Collect and evaluate information on the reporting accuracy of recreational discard estimates in the recreational fishery.
- Conduct more comprehensive collection of otoliths, for all components of the catch-at-age matrix, on a continuing basis for fish larger than 60 cm (~7 years). The collection of otoliths and the proportion at sex for all of the catch components could provide a better indicator of stock productivity.
- Develop a reference collection of summer flounder scales and otoliths to facilitate future quality control of summer flounder production ageing. In addition, a comparison study between scales and otoliths as ageing structures for summer flounder should be completed.⁷⁵
- Examine mesh selectivity patterns for a range of commonly used mesh sizes greater than the currently mandated sizes (5.5 Diamond/6 inch square).⁷⁶
- Continue to collect and analyze age-length samples and CPUE data from the commercial and recreational fisheries throughout the range of summer flounder.

Moderate

- Research directed at evaluating the mesh exemption program should be continued, with increased sample sizes to allow reliable statistical testing of results.
- Use NEFSC fishery observer age-length keys for 1994 and later years (as they become available) to supplement NEFSC survey data in ageing the commercial fishery discard.
- Undertake research to determine hooking mortality on summer flounder by circle, kahle, and regular “J” hooks and make the results of work already completed available to the Management Board.
- Collect data to determine the sex ratio for all of the catch components.
- Develop fish excluder devices to reduce bycatch of immature flatfish in fisheries that target species other than flounder.

Fishery-Independent Priorities

High

- Collect information on overall fecundity for the stock, both egg condition and production, as a better indicator of stock productivity.⁷⁷

⁷⁵ The SDWG reported that an exchange of aging structures between NEFSC and NCDMF was completed and a report was reviewed by the 2007 SDWG, in response to a 2005 SAW 41 high priority Research Recommendation. The SDWG noted that while the Fall 2006 ageing exchange between NC-DMF and the NEFSC indicated that the current level of ageing consistency between NC and NEFSC is acceptable, there is a need to conduct and fund these exchanges more frequently, on a schedule consistent with benchmark assessments.

⁷⁶ This research should only be a high priority if managers want to change the commercial minimum size. This research should wait until changes in minimum size are anticipated so outdated research does not have to be updated.

⁷⁷ The SDWG noted that observed change in the sex ratio in NEFSC survey samples may result in the SSB estimates not translating as directly to egg production since there are more males proportionally in those older age categories. While these trends have not been examined in the state survey catches, these trends were examined in the NEFSC spring, autumn, and winter survey data. Additional work to examine and explain these trends in greater detail should be conducted.

- Continue fishery-independent surveys and expand existing surveys to capture all sizes and age classes in order to develop independent catch-at-age and CPUE should focus on YOY and the southern region.

Modeling / Quantitative Priorities

High

- Investigate trends in sex ratios and mean lengths and weights of summer flounder in state agency and federal survey catches.

Low

- Examine the sensitivity of the summer flounder assessment to the various unit stock hypotheses and evaluate spatial aspects of the stock to facilitate sex and spatially explicit modeling of summer flounder.⁷⁸

Life History, Biological, and Habitat Priorities

Moderate

- Develop or determine stock identification methods via meristics, morphometrics, biochemical research, and tagging (particularly off Virginia and North Carolina).

Low

- Evaluate effects of dissolved oxygen and water current requirements for adult summer flounder and summer flounder eggs.
- Evaluate the relationship between recruitment of summer flounder to nursery areas and Ekman transport or prevailing directions of water flow.
- Examine male female ratio at age 0 and potential factors (e.g., environmental) that may influence determination of that ratio.
- Conduct the basic research necessary to develop land and pen culture techniques.
- Conduct further research to examine the predator-prey interactions of summer flounder and other species, including food habitat studies, to better understand the influence of these other factors on the summer flounder population.

Management, Law Enforcement, and Socioeconomic Priorities

Moderate

- Consider use of MSE techniques to address the implications of harvest policies that incorporate consideration of retrospective patterns (see ICES Journal of Marine Science issue of May 2007).
- Conduct a detailed socioeconomic study of the summer flounder fisheries.

⁷⁸ Current ASAP model lacks the capability to do sex and spatial modeling, so Stock Synthesis version of this approach (e.g., M. Maunder 2008 SAW 47 work) would be necessary. Above all, there is a lack of sufficient time series data to sex all catch and surveys, and lack of information on spatial movement and/or recruitment patterns.

TAUTOG

Fishery-Dependent Priorities

High

- Initiate biological sampling of the commercial catch for each gear type over the entire range of the stock (including weight, lengths, age, sex, and discards).⁷⁹
- Increase catch and discard length sampling from the commercial and recreational fishery for all states from Massachusetts through Virginia.
- Increase collection of effort data for determining commercial and recreational CPUE.
- Increase MRIP sampling levels to improve recreational catch estimates by state and mode. Current sampling levels are high during times of the year when more abundant and popular species are abundant in catches, but much lower in early spring and late fall when tautog catches are more likely.

Fishery-Independent Priorities

High

- Establish standardized state by state long-term fisheries-independent surveys to monitor tautog abundance and length-frequency distributions, and to develop YOY indices.
- Continue collecting operculum from the tautog catch as the standard for biological sampling in addition to collecting paired sub-samples of otoliths and operculum.

Life History, Biological, and Habitat Priorities

Moderate

- Define the status (condition and extent) of optimum or suitable juvenile habitats and trends in specific areas important to the species. It is critical to protect these habitats or to stimulate restoration or enhancement, if required.
- Define the specific spawning and pre-spawning aggregating areas and wintering areas of juveniles and adults used by all major local populations, as well as the migration routes used by tautog to get to and from spawning and wintering areas and the criteria or times of use. This information is required to protect these areas from damage and overuse or excessive exploitation.
- Define larval diets and prey availability requirements. This information can be used as determinants of recruitment success and habitat function status. Information can also be used to support aquaculture ventures with this species.
- Define local and regional movement patterns and site fidelity in the southern part of the species range. This information may provide insight into questions of aggregation versus recruitment to artificial reef locations. More clarification is required on what the southern part of the range is and to clarify the need for local and regional assessment.
- Define the role of prey type and availability in local juvenile/adult population dynamics over the species range. This information can explain differences in local abundance, movements, growth, fecundity, etc. Conduct studies in areas where the availability of primary prey, such as blue mussels or crabs, is dependent on annual recruitment, the effect of prey recruitment variability as a factor in tautog movements (to find better prey fields), mortality (greater

⁷⁹ Limited sampling of New Jersey hook and line and pot fisheries in progress.

predation exposure when leaving shelter to forage open bottom), and relationship between reef prey availability/quality on tautog condition/fecundity.

- Define the susceptibility of juveniles to coastal/anthropogenic contamination and resulting effects. This information can explain differences in local abundance, movements, growth, fecundity, and serve to support continued or increased regulation of the inputs of these contaminants and to assess potential damage. Since oil spills seem to be a too frequent coastal impact problem where juvenile tautog live, it may be helpful to conduct specific studies on effects of various fuel oils and typical exposure concentrations, at various seasonal temperatures and salinities. Studies should also be conducted to evaluate the effect of common piling treatment leachates and common antifouling paints on YOY tautog. The synergistic effects of leaked fuel, bilge water, treated pilings, and antifouling paints on tautog health should also be studied.
- Assemble regional reference collections of paired operculum and otolith samples and schedule regular exchanges to maintain and improve the precision of age readings between states that will be pooled in the regional age-length keys.

Low

- Define the source of offshore eggs and larvae (in situ or washed out coastal spawning).
- Confirm that tautog, like cunner, hibernate in the winter, and in what areas and temperature thresholds, for how long, and if there are special habitat requirements during these times that should be protected or conserved from damage or disturbance. This information will aid in understanding behavior variability and harvest availability.
- Calibrate age readings every year by re-reading a subset of samples from previous years before ageing new samples. States that do not currently assess the precision of their age readings over time should do so by re-ageing a subset of their historical samples.

Management, Law Enforcement, and Socioeconomic Priorities

Low

- Collect basic sociocultural data on tautog user groups including demographics, location, and aspects of fishing practices such as seasonality.

Tautog Research Priorities Identified as Being Met

- ✓ Sample hard parts for annual ageing from the catches of recreational and commercial fisheries and fishery-independent surveys throughout the range of the stock. *Being conducted by all participating states.*

WEAKFISH

Fishery-Dependent Priorities

High

- Increase observer coverage to identify the magnitude of discards for all commercial gear types from both directed and non-directed fisheries.⁸⁰

⁸⁰ Some Mid-Atlantic trawl fleet observer coverage has been implemented under ACCSP funding.

Moderate

- Continue studies on temperature, size, and depth specific recreational hook and release mortality rates, particularly catches from warm, deep waters. Investigate methods to increase survival of released fish.
- Continue studies on mesh size selectivity, particularly trawl fisheries.⁸¹

Low

- Determine the onshore versus offshore components of the weakfish fishery.
- Collect catch and effort data including size and age composition of the catch, determine stock mortality throughout the range, and define gear characteristics. In particular, increase length frequency sampling in fisheries from Maryland and further north.
- Develop latitudinal, seasonal, and gear specific age length keys coastwide. Increase sample sizes for gear specific keys.

Modeling / Quantitative Priorities

High

- Evaluate predation of weakfish with a more advanced multispecies model (e.g., the ASMFC MSVPA or Ecopath with Ecosim) to validate estimates calculated by production models with predation-competition extensions.
- Develop a bioenergetics model that encompasses a broader range of ages than Hartman and Brandt (1995) and use it to evaluate diet and growth data.
- Analyze the spawner-recruit relationship and examine the effects of the relationship between adult stock size and environmental factors on year class strength.
- Quantify trawl bycatch. Refine estimates of discard mortality based on factors such as distance from shore and other geographical differences for all sizes including below minimum size.

Life History, Biological, and Habitat Priorities

High

- Develop a coastwide tagging program to identify stocks and determine migration, stock mixing, and characteristics of stocks in over wintering grounds. Determine the relationship between migratory aspects and the observed trend in weight-at-age.⁸²
- Monitor weakfish diets over a broad regional and spatial scale.

Moderate

- Identify and delineate weakfish spawning habitat locations and environmental preferences to quantify spawning habitat.
- Compile data on larval and juvenile distribution from existing databases to obtain preliminary indications of spawning and nursery habitat location and extent.
- Examine geographical and temporal differences in growth rate (length and weight-at-age).

⁸¹ Gillnet selectivity has been investigated by Swihart et al (2000). Some gear selectivity information in Amendment 3 to the ASMFC Weakfish FMP. Information can also be obtained from the North Carolina Pamlico Sound Independent Gill Net Survey.

⁸² Tagging work to evaluate mortality, movement, stock mixing, and weakfish predator information is scheduled to begin in North Carolina in 2013. Otolith samples have been obtained by Old Dominion University, but funding has not been available for processing.

Low

- Determine the impact of power plants and other water intakes on larval, post larval, and juvenile weakfish mortality in spawning and nursery areas. Calculate the resulting impact on adult stock size.⁸³

Management, Law Enforcement, and Socioeconomic Priorities

Moderate

- Assemble socioeconomic data as it becomes available from ACCSP.

Low

- Define restrictions necessary for implementation of projects in spawning and over wintering areas and develop policies on limiting development projects seasonally or spatially.

Weakfish Research Priorities Identified as Being Met

- ✓ Conduct an age validation study. *An age validation study was completed by Lowerre-Barbieri et al. (1995). (2009 SARC)*
- ✓ Define reproductive biology of weakfish, including size at sexual maturity, maturity schedules, fecundity, and spawning periodicity. Continue research on female spawning patterns: What is the seasonal and geographical extent of “batch” spawning; do females exhibit spawning site fidelity? *This work has been completed by Nye et al 2008 and Lowerre-Barbieri et al 1996.*
- ✓ Update the scale – otolith comparison for weakfish. *See work by Vaughan et al. at 1998 AFS Annual Meeting in the SARC 30.*
- ✓ Investigate alternative age based models that allow error in catch-at-age estimates (e.g., SCA) and/or are less prone to retrospective patterns (e.g., extended survivor analysis).
- ✓ Conduct spatial and temporal analysis of the fishery-independent survey data. The analysis should assess the impact of the variability of the surveys in regards to gear, time of year, and geographic coverage of their (survey) use as stock indicators. *Work by Dr. Yan Jiao of Virginia Tech University. See Winter et al. 2009.*

WINTER FLOUNDER

Coast Wide

Fishery-Dependent Priorities

High

- Increase the intensity of commercial fishery discard length sampling.
- Expand sea sampling to validate commercial discard estimates from VTR.

⁸³ Data are available for power plants in the Delaware Bay area and North Carolina. Also see Heimbuch et al. 2007. Assessing coastwide effects of power plant entrainment and impingement on fish populations: Atlantic menhaden example. *North American Journal of Fisheries Management*. 27: 569-577.

Fishery-Independent Priorities

Moderate

- Evaluate the maturity-at-age of fish sampled in inshore surveys (i.e., MEDMR, MADMF, NEAMAP, etc.).⁸⁴
- Encourage support for Industry Based Surveys, which can provide valuable information on stock abundance, distribution, and catchability in research surveys that are independent of and supplemental to NMFS effort.

Modeling / Quantitative Priorities

Moderate

- Investigate the skipped spawning percentage for each stock and estimate inter-annual variation when sufficient data have been collected.

Low

- Develop mortality estimates from the American Littoral Society tagging data, if feasible.
- Explore use of a more complex Stock Synthesis model with small rates of migration between stocks.
- Revise the NEFSC assessment software to include the ability to model stock-recruit functions including environmental factors with errors/probabilities.
- Develop time series of winter flounder consumption by the major fish predators of winter flounder.
- Explore development of an index of winter flounder larval abundance based on MARMAP, GLOBEC, and other time series.

Life History, Biological, and Habitat Priorities

High

- Focus research on quantifying mortality associated with habitat loss and alteration, contamination by toxins, and power plant entrainment and impingement. Examine the implications of these anthropogenic mortalities on estimation of YPR, if feasible.
- Conduct studies to delineate all major sub-stocks in terms of geographic spawning area and seasonal offshore movements (e.g., exposure to fishing pressure).^{85,99}

Moderate

- Update and investigate migration rates between stocks and movement patterns. Investigate localized structure/genetics within the stocks.^{98,86}

Low

- Conduct studies of flounder populations in impacted areas to quantify physiological adaptation to habitat alteration, and interactive effects, on an individual and population level.

⁸⁴ See McBride et al. 2013. Latitudinal and stock-specific variation in size- and age-at-maturity of female winter flounder, *Pseudopleuronectes americanus*, as determined with gonad histology. *Journal of Sea Research*. 75: 41-51.

⁸⁵ The most recent comprehensive tagging study was completed in the 1960's (Howe and Coates). Some telemetry work done in southern Gulf of Maine, see DeCelles and Cadrin 2010. Movement patterns of winter flounder (*Pseudopleuronectes americanus*) in the southern Gulf of Maine: observations with the use of passive acoustic telemetry. *Fisheries Bulletin*. 108: 408-419.

⁸⁶ See Fairchild et al. 2009. Using telemetry to monitor movements and habitat use of cultured and wild juvenile winter flounder in a shallow estuary. *Tagging and Tracking of Marine Animals with Electronic Devices*. 9: 5-22.

Management, Law Enforcement, and Socioeconomic Priorities

High

- Investigate ways to improve compliance to help VTR. Currently about 300 of the 1,500 permitted vessels consistently under report the number of statistical areas fished.

Southern New England – Mid-Atlantic Stock Complex

Modeling / Quantitative Priorities

Low

- Quantify adult sex ratio to determine the possibility of population decline due to a skewed sex ratio.

Life History, Biological, and Habitat Priorities

Moderate

- Examine egg and larvae distribution and abundance to determine YPR to predict future biomass development for the fishery.
- Assess distribution of winter flounder during each life stage by conducting tagging methods, focusing on juvenile to adult life stages. This information would be useful for estimating YPR and helpful to find answers as to why recruitment is at a vulnerable state.⁹⁹
- Examine winter flounder distribution, abundance, and productivity based on oceanographic and climate warming and how that impacts biomass for the fishery.

Low

- Examine predator-prey relationships due to increased populations of cormorants, seals, and striped bass (examine stomach contents of predators to get a better idea on the quantification of predation on winter flounder by these predators).

Georges Bank Stock

Fishery-Independent Priorities

High

- Examine maturity data from NEFSC strata on Nantucket Shoals and near Georges Bank separately from more inshore areas.⁹⁷

Life History, Biological, and Habitat Priorities

High

- Investigate use of periodic gonad histology studies to validate maturity estimates, with particular attention to obtaining sufficient samples from the Georges Bank stock.⁹⁷
- Conduct studies to better understand recruitment processes of winter flounder, particularly in the Gulf of Maine and on Georges Bank.

Moderate

- Further explore the relationship between large scale environmental forcing (e.g., temperature, circulation, and climate) for effects on life history, reproduction, and recruitment in the Georges Bank stock.

Gulf of Maine Stock

Fishery-Dependent Priorities

High

- Improve sampling for biological data (particularly hard parts for ageing) of commercial landings for winter flounder.
- Process archived age samples from surveys and commercial landings and develop analytical based assessments.⁸⁷

Low

- Estimate and evaluate the effects of catch and release components of recreational fishery on discard-at-age.

Fishery-Independent Priorities

Moderate

- Evaluate size selectivity performance of survey gear compared to typical commercial gear and implications for estimation of commercial discards from research survey length frequency information.

Modeling / Quantitative Priorities

Low

- Evaluate the effects of smoothed length frequency distributions on the relationship between survey and commercial catches-at-length.

Life History, Biological, and Habitat Priorities

High

- Examine growth variations within the Gulf of Maine, using results from the Gulf of Maine Biological Sampling Survey (1993-94).⁸⁸
- Conduct studies to better understand recruitment processes of winter flounder, particularly in the Gulf of Maine and on Georges Bank.

Moderate

- Further examine the stock boundaries to determine if Bay of Fundy winter flounder should be included in the Gulf of Maine stock complex.⁹⁸

Winter Flounder Research Priorities Identified as Being Met

- ✓ Investigate the feasibility of port samplers collecting otoliths in place of scales to mitigate under ageing larger fish. *Port sampling protocols have been changed to collect otoliths from large winter flounder. The Massachusetts and Maine-New Hampshire surveys are also collecting winter flounder otoliths. Work by Thornton and Robillard evaluating the collection of otoliths was presented at the 2012 Flatfish Biology Conference (<http://mi.nefsc.noaa.gov/flatfishbiologyworkshop>).*
- ✓ Examine the sources of differences between NEFSC, Massachusetts, and Connecticut survey maturity (validity of evidence for younger size/age at 50% maturity in NEFSC data). Compare NEFSC inshore versus offshore strata for differences in maturity.

⁸⁷ Maine DMR has archived winter flounder otoliths since 2002.

⁸⁸ Biological data on winter flounder has been collected on the Maine DMR trawl survey from 2000-2008 and should be included.

Consider methods for combining maturity data from different survey programs. Conduct periodic maturity staging workshops involving State and NEFSC trawl survey staff. See McBride et al. 2013. *Latitudinal and stock-specific variation in size- and age-at-maturity of female winter flounder, Pseudopleuronectes americanus, as determined with gonad histology. Journal of Sea Research 75: 41-51. Also see SARC 52* (<http://www.nefsc.noaa.gov/saw/saw52/crd1117.pdf>).

- ✓ Compare confidence intervals for maturity ogives. Calculate annual ogives and investigate for progression of maturity changes over time. See SARC 52 (<http://www.nefsc.noaa.gov/saw/saw52/crd1117.pdf>). Also see McBride et al. 2013. *Latitudinal and stock-specific variation in size- and age-at-maturity of female winter flounder, Pseudopleuronectes americanus, as determined with gonad histology. Journal of Sea Research 75: 41-51.*

Common Research Recommendations for All ASMFC Managed Diadromous Species

Dams and Other Obstructions

General Fish Passage

- States should work in concert with the USFWS and the NOAA Fisheries Service to identify hydropower dams that pose significant impediment to diadromous fish migration and target them for appropriate recommendations during FERC relicensing.
- States should identify and prioritize barriers in need of fish passage based on clear ecological criteria (e.g., amount and quality of habitat upstream of barrier, size, status of affected populations, etc.). These prioritizations could apply to a single species, but are likely to be more useful when all diadromous species are evaluated together.
- A focused, coordinated, well supported effort among federal, state, and associated interests should be undertaken to address the issue of fish passage development and efficiency. The effort should attempt to develop new technologies and approaches to improve passage efficiency with the premise that existing technology is insufficient to achieve restoration and management goals for several East Coast river systems.
- Where obstruction removal is not feasible, install appropriate passage facilities, including fish lifts, fish locks, fishways, navigation locks, or notches (low-head dams and culverts).
- At sites with passage facilities, evaluate the effectiveness of upstream and downstream passage; when passage is inadequate, facilities should be improved.
- Dams/obstructions where upstream passage structures will be installed should be evaluated for effectiveness of downstream passage. Upstream passage structures should not be installed at these sites, unless downstream passage can be made safe, effective, and timely.
- Facilities for monitoring the effectiveness of the pass should be incorporated into the design where possible.
- Before designing and constructing fish passage systems, determine the behavioral response of each species of interest to major physical factors so that effectiveness can be maximized.
- Protection from predation should be provided at the entrance, exit, and throughout the pass.
- The passage facility should be designed to work under all conditions of head and tail water levels that prevail during periods of migration.
- Passages are vulnerable to damage by high flows and waterborne debris. Techniques for preventing damage include robust construction, siting facilities where they are least exposed to adverse conditions, and removing the facilities in the winter.
- Evaluate performance of conventional fishways, fish lifts, and eel ladders, and determine features common to effective passage structures and those common to ineffective passage structures.
- Conduct basic research into diadromous fish migratory behavior as it relates to depth, current velocity, turbulence, entrained air, light, structures, and other relevant factors.
- Use information from the previous two research recommendations to conduct CFD modeling to develop more effective fishway designs.
- Research technologies (barriers, guidance systems, etc.) for directing emigrating fish to preferred passage routes at dams.

- Identify low-cost alternatives to traditional fishway designs.
- Develop effective downstream passage strategies to reduce mortality.

Upstream Fish Passage

- Diadromous fish must be able to enter the passage facility with little effort and without stress.
- To prevent fish from becoming entrained in intake flow areas of hydropower facilities, construct behavioral barrier devices and re-direct them to safer passage areas.
- Fish ascending the pass should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Fish Passage

- To enhance survival at dams during emigration, evaluate survival of fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and pass fish via the route with the best survival rate.

Other Dam Issues

- Where practicable, remove obstructions to upstream and downstream migration.
- Locate facilities along the river where impingement rates are likely to be lowest.
- Alter water intake velocities, if necessary, to reduce mortality to diadromous species.
- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- Natural river discharge should be taken into account when alterations are being made to a river because it plays a role in the migration patterns of diadromous fish.
- Document the impact of power plants and other water intakes on larval, post-larval, and juvenile mortality in anadromous fish spawning areas, and calculate the resultant impacts to adult population sizes.
- Evaluate the upstream and downstream impacts of barriers on diadromous species, including population and distribution effects.

Water Quality and Contamination

- Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.
- Non-point and point source pollution should be reduced in diadromous fish habitat areas.
- Implement BMPs along rivers and streams, restore wetlands, and utilize stream buffers to control non-point source pollution.
- Implement erosion control measures and BMPs in agricultural, suburban, and urban areas to reduce sediment input, toxic materials, and nutrients and organics into streams.
- Upgrade wastewater treatment plants and remove biological and organic nutrients from wastewater.
- Reduce the amount of thermal effluent into rivers. On larger rivers, include a thermal zone of passage.
- Provide management options regarding water withdrawal and land use to minimize the impacts of climate change on temperature and flow regimes.
- Discharge earlier in the year to reduce impacts to migrating fish.
- Conduct studies to determine the effects of dredging on diadromous habitat and migration; appropriate best management practices, including environmental windows, should be

considered whenever navigation dredging or dredged material disposal operations would occur in a given waterway occupied by diadromous species.

- Introduction of new categories of contaminants should be prevented.
- Determine effects of change in temperature and pH for all life stages of all diadromous species. Use this information to model impacts of climate change on species.
- Develop studies to document which contaminants have an impact on the various life stages of each diadromous species; also note the life stages that are affected and at what concentrations.
- Determine unknown optima and tolerance ranges for depth, temperature, salinity, dissolved oxygen, pH, substrate, current velocity, and suspended solids.

Habitat Protection and Restoration

- Use multi-scale approaches (including GIS) to assess indicators of suitable habitat, using watershed and stream-reach metrics if possible (it should be noted, that where site specific data is lacking, it may not be appropriate to assess at this scale).
- Use multi-scale approaches for restoring diadromous fish habitat, including vegetated buffer zones along streams and wetlands, and implementing measures to enhance acid-neutralizing capacity.
- Conduct studies on the effects of land use change on diadromous species population size, density, distribution, health, and sustainability.
- Examine how deviation from the natural flow regime impacts all diadromous species. This work should focus on key parameters such as rate of change (increase and decrease), seasonal peak flow, and seasonal base flow, so that the results can be more easily integrated into a year-round flow management recommendation by state officials.
- Investigate consequences to diadromous stocks from wetland alterations.
- When states have identified habitat protection or restoration as a need, state marine fisheries agencies should coordinate with other agencies to ensure that habitat restoration plans are developed, and funding is actively sought for plan implementation and monitoring.
- Any project resulting in elimination of EFH (e.g., dredging, filling) should be avoided.
- Substrate mapping of freshwater tidal portions of rivers should be performed to determine suitable diadromous fish habitat, and that habitat should be protected and restored as needed.
- States should notify in writing the appropriate federal and state regulatory agencies of the locations of habitats used by diadromous species. Regulatory agencies should be advised of the types of threats to diadromous fish populations, and recommended measures that should be employed to avoid, minimize, or eliminate any threat to current habitat quantity or quality.
- Each state encompassing diadromous fish spawning rivers and/or producer areas should develop water use and flow regime guidelines protective of diadromous spawning and nursery areas to ensure the long-term health and sustainability of the stocks.

Permitting

- Develop policies for limiting development projects seasonally or spatially in spawning and nursery areas; define and codify minimum riparian buffers and other restrictions where necessary.
- Projects involving water withdrawal (e.g., power plants, irrigation, water supply projects) should be scrutinized to ensure that adverse impacts resulting from impingement,

entrainment, and/or modifications of flow and salinity regimes due to water removal will not adversely impact diadromous fish stocks.

- State fishery regulatory agencies should develop protocols and schedules for providing input on Federal permits and licenses required by the Clean Water Act, Federal Power Act, and other appropriate vehicles, to ensure that diadromous fish habitats are protected.

Other

- Determine survival and mortality rates for all life stages of all diadromous species.
- Investigate predator-prey relationships for all life stages of all diadromous species.
- Determine the effects of channel dredging, shoreline filling, and overboard spoil disposal in the Atlantic coast on diadromous species.
- Define restrictions necessary for implementation of energy projects in diadromous species habitat areas and develop policies on limiting development projects seasonally and/or spatially.
- Promote cooperative interstate research monitoring and law enforcement. Establish criteria, standards, and procedures for plan implementation as well as determination of state compliance with management plan provisions.
- Diadromous fish may be vulnerable to mortality in hydrokinetic power generation facilities, and such projects should be designed and monitored to eliminate, or minimize, fish mortality.
- The use of any fishing gear that is deemed by management agencies to have an unacceptable impact on diadromous fish habitat should be prohibited within appropriate essential habitats (e.g., trawling in spawning areas or primary nursery areas should be prohibited).

Common Socioeconomic Research Recommendations for all ASMFC Managed Species

- Establish time series of social and economic data for use in management decisions. This is analogous to biological time series data that are currently being used in decision making for monitoring and fisheries management.
- Existing social and economic data sets are deficient and remedial. Develop and collect baseline of sociodemographic data for all Atlantic states by state, species, and community for commercial fishing and by state, species, community, and sector (boat, shore, and for-hire) for recreational and subsistence fisheries. Community profiles should include information on the infrastructure in support of the fisheries (e.g., provision of boat launches, haul-out yards, marine suppliers, recreational fishing docks).
- Update baseline data on a regular basis (e.g., every 3 years).
- Focus on research additional to the baseline for decisions to be made in the next few years.
- Evaluate existence value and non-consumptive use value (cultural and economic) for species that the ASMFC has protected through moratoria.