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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

Prioritized Research Needs in Support of Interjurisdictional Fisheries Management

2008

Atlantic States Marine Fisheries Commission
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with assistance of the
Management and Science Committee

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Acknowledgments

The Atlantic States Marine Fisheries Commission (Commission) would like to thank all state, federal and university representatives who contributed to the completion of this document. Identification and prioritization of research needs was provided by members of various Commission committees, including species stock assessment subcommittees, technical committees, advisory committees, plan development and review teams, and management boards. Input was also provided by the Commission's Habitat Committee, Committee on Economics and Social Sciences, and Management and Science Committee. The research needs 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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Introduction

Research needs 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, Stock Assessment Workshop (SAW) documents conducted by the National Marine Fisheries Service (1996 - 1999), and Commission external peer reviews. This publication is an update of Special Report #62 Prioritized Research Needs in Support of Inter-jurisdictional Fisheries Management published by the Commission in January 1997. Updates are periodically published via the Commission's website at www.asmfc.org.

Research needs 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 prioritized research needs 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 needs are either met or as new research needs are identified. Research needs that have been met since previous publication 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 needs of Commission-managed species and thereby improve the overall management of these fisheries. It also hoped that state, federal and non-profit organizations will utilize this document in prioritization of research projects for future funding programs.

American Eel

High Priority

- A coastwide fishery-independent sampling program for yellow and silver American eels should be formulated using standardized and statistically robust methodologies.
- Regular periodic stock assessments and establishment of sustainable reference points for eel are required to develop a sustainable harvest rate in addition to determining whether the population is stable, decreasing, or increasing.
- A stock assessment committee should identify the best stock assessment methods for American eel.[1]
- Research the effects of swim bladder parasite *Anguillacolla crassus* on the American eel's growth and maturation, migration to the Sargasso Sea, and the spawning potential.
- Investigate, develop, and improve technologies for American eel passage upstream and downstream at various barriers for each life stage. In particular, investigate low-cost alternatives to traditional fishway designs for passage of eel.
- Investigate: fecundity, length, and weight relationships for females throughout their range; growth rates for males and females throughout their range; age and maturity data

Medium Priority

- 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.
- Investigate survival and mortality rates of different life stages (leptocephalus, glass eel, yellow eel, and silver eel) to assist in the assessment of annual recruitment. Continuing and initiating new tagging programs with individual states could aid such research.
- Tagging Programs: A number of issues could be addressed with a properly designed tagging program. These include:
    - Local and regional movement and migration patterns
    - Natural, fishing, and/or discard mortality; survival
    - Growth
    - Validation of aging method(s)
    - Abundance
    - Reporting rates
    - Tag shedding or tag attrition rate

  A tagging study to examine local and regional movement has been completed by a graduate student at Delaware State University and other studies on local movements and abundance are currently being conducted by other Delaware graduate students.

[1] Comment/question: The SAC included a table of stock assessment methods and minimum data requirements for each in Table 1 of the 2006 stock assessment report. Surplus production models had the least data requirements. However, there were convergence problems when ASPIC models were run with five relative abundance indices. Recently the SASC used the SLYME model to assess the impact of maximum size limits. Is SLYME a surplus production model? If so, perhaps the SASC and the TC could review the data needs and sensitivity analysis for SLYME and identify the most critical data needs. For example the model was very sensitive to the assumed value for proportion of future males. It would also be useful to know if data are required for every state (e.g. fecundity) and if long-term or short-term information is needed (biological sampling of a fishery in one year might be possible, but biological sampling every year might not be). A single SLYME model was developed, but perhaps regional version would be more appropriate?

- Research contaminant effects on eel and the effects of bioaccumulation with respect to impacts on survival and growth (by age) and effect on maturation and reproductive success.
- Investigate: predator-prey relationships; behavior and movement of eel during their freshwater residency; oceanic-behavior, movement, and spawning location of adult mature eel; and all information on the leptocephalus stage of eel.
- Assess characteristics and distribution of eel habitat and value of habitat with respect to growth and sex determination.
- Identify location and triggering mechanism for metamorphosis to mature adult, silver eel life stage, with specific emphasis on the size and age of the onset of maturity, by sex. A maturity schedule (proportion mature by size or age) would be extremely useful in combination with migration rates.

Low Priority

- Perform economics studies to determine the value of the fishery and the impact of regulatory management.
- Review the historic participation level of subsistence fishers in wildlife management planning and relevant issues brought forth with respect to those subsistence fishers involved with American eel.
- Examine the mechanisms for exit from the Sargasso Sea and transport across the continental shelf.
- Research mechanisms of recognition of the spawning area by silver eel, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation.
- Examine age at entry of glass eel into estuaries and fresh waters.
- Examine migratory routes and guidance mechanisms for silver eel in the ocean.
- Investigate the degree of dependence on the American eel resource by subsistence harvesters (e.g., Native American Tribes, Asian and European ethnic groups).
- Examine the mode of nutrition for leptocephalus in the ocean.
- Provide analysis of food habits of glass eel while at sea.

Research Needs 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

High Priority

- *Age and Growth*

All assessments of lobster stock status have been based on analyses of length data. Age is assumed by applying per-molt growth increments and molt frequencies to the length data. Based on these analyses, the American lobster has been treated as an extremely long-lived animal, reaching a reproductive maximum at a relatively old age. These assumptions are justified, but are based on no actual age data. Applying aging techniques developed in England and Australia for lobster and other crustaceans would greatly improve our understanding of how many year-classes support the current trap fishery, how length relates to age, and how variable the age structure is over stock area and time.

- *Ecosystem-based Management*

NOAA's 2004 Strategic Plan for Fisheries Research recommends the inclusion of ecosystem and environmental information in all stock assessments. Further examination of lobster mortality not related to the fishery would provide a better understanding of factors limiting productivity and longevity. Topics should include: predator/prey interactions and community structure, climatic shifts in ocean currents and temperature, and toxic substances causing chronic stress or disease.

- *Fishery-Dependent Information*

Accurate and comparable landings are the principal data needed to assess the impact of fishing on lobster populations. The quality of current landings data is not consistent spatially or temporally. Standardized mandatory reporting of landings data resource-wide would improve the assessment. Aligning stock management areas with area designations for landings is necessary. Enhanced sea sampling and port sampling to create a more complete record of biological characteristics of the catch and harvest would also improve the usefulness of these data. This is especially needed in offshore waters.

- *Investigation of Historical Levels of Stock Production*

It has been pointed out that one limitation of the proposed reference points is the period covered by the assessment. Investigations of past levels of stock size and size structure could provide additional insight in to setting reference points that relate to the full range of stock productivity.

- *Investigation of Trans-boundary Assessments*

Investigate conducting joint US and Canadian assessments.

Lower Priority

- *Model Development*

Size based models should be examined to determine their ability to match length frequencies and other biological characteristics observed in local lobster populations. Additionally, the utility of using yield and spawning biomass per recruit and surplus production models should be evaluated through simulation as a basis for developing alternative reference points.

Research Needs Identified as Having Been Met

Fishery-Independent Information

There is a need to develop consistent techniques that monitor distribution and abundance of lobster independent of the fishery. Current methods (e.g. trawls) are limited in area (gear conflicts) and habitat sampled (unable to access complex bottom). Additional methodologies should be investigated that cover a wide range of sizes and habitats. These could include ventless traps, dive/ROV, and settlement surveys.

American Shad/River Herring

High Priority

- Determine the impact of directed fisheries on American shad and river herring stocks and reduce F.
- Determine American shad and river herring bycatch within state and ocean waters.[2]
- Determine predation by fish, mammals and birds on American shad and river herring.
- Verify Juvenile indices of alosa species.
- Verify tag-based estimates of American shad.
- Mandate FMPs for rivers with active restoration plans for American shad or river herring.
- Continue to assess current aging techniques for American shad and river herring, using known age fish, scales, otoliths, and spawning marks.
- Validate the different values of M for shad stocks through verification of shad aging techniques and repeat spawning information and develop methods for calculating M.
- Determine which stocks are impacted by coastal intercept fisheries (including bycatch fisheries) and evaluate the fishing mortality on those stocks. Methods to be considered to differentiate among stocks could include otolith micro-chemistry, oxytetracycline otolith marking, tagging or DNA/RNA methods.
- 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.
- Identify ways to improve fish passage efficiency including hydroacoustics to repel alosines or pheromones or other chemical substances to attract them. Test commercially available acoustic equipment at existing fish passage facility to determine effectiveness. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Refine techniques for tank spawning of American shad. Evaluate the use of hormone implants vs. natural spawning. Secure adequate eggs for culture programs using native broodstock, when possible.
- Conduct population assessments on river herring - particularly needed in the south.
- Evaluate effectiveness of fishways for American shad and river herring. Compare features of effective fishways and in-effective fishways and develop guidelines for fishway design.
- Conduct basic research on American shad behavior as it relates to fishways to assist in development of design parameters.
- Quantify fishing mortality (in-river, ocean bycatch, bait fisheries) for major river stocks.

Medium Priority

- Determine and update biological benchmarks used in assessment modeling (fecundity at age, mean weight at age for both sexes, partial recruitment vector/maturity schedules) for American shad and river herring stocks in a variety of coastal river systems, including both semelparous and iteroparous stocks.
- Develop effective culture and marking techniques for river herring.
- Develop and implement techniques to determine shad and herring population targets for tributaries.
- Characterize passage-associated mortality, migration delay, and sub-lethal effects on American shad at hydroelectric dams.
- Conduct studies of river herring egg and larval survival and development.

[2] ASMFC American Shad Stock Assessment, 2007

- Identify directed harvest and bycatch losses of American shad in ocean and bay waters of Atlantic Maritime Canada.
- Spatially delineate between mixed stock and Delaware stock areas within the Delaware system.

Low Priority

- Characterize tributary habitat quality and quantity for Alosa reintroductions and fish passage development.
- Evaluate and ultimately validate large-scale hydroacoustic methods to quantify American shad escapement (spawning run numbers) in major river systems. Identify how shad respond (attract/repelled) by various hydroacoustic signals.
- Identify and quantify potential American shad spawning and rearing habitat not presently utilized and conduct an analysis of the cost of recovery.
- Conduct studies on energetics of feeding and spawning migrations of shad on the Atlantic coast.
- Encourage university research on hickory shad.
- Conduct studies of shad egg and larval survival and development.
- Conduct and evaluate historical characterization of socio-economic development (potential pollutant sources and habitat modification) of selected shad rivers along the east coast.
- Review studies dealing with the effects of acid deposition on anadromous alosids.

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

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Atlantic Croaker

High Priority

- Studies of croaker growth rates and age structure need to be conducted throughout the species range.
- Age-length keys that are representative of all gear types in the fishery should be developed.
- Fishery dependent and independent size, age and sex specific relative abundance estimates should be developed to monitor long term changes in croaker abundance.
- Improve catch and effort statistics from the commercial and recreational fisheries, along with size and age structure of the catch.
- Examine reproductive biology of croaker with emphasis on developing maturity schedules and estimates of fecundity.
- Determine migratory patterns and mixing rates through cooperative, multi-jurisdictional tagging studies.
- Conduct stock identification research on croaker.

Medium Priority

- Cooperative coastwide croaker juvenile indices should be developed and validated to clarify stock status.
- Evaluate hook and release mortality under varying environmental factors and fishery practices.
- The effects of mandated bycatch reduction devices (BRD's) on croaker catch should be evaluated and compiled.
- In trawl fisheries or other fisheries that historically take significant numbers of croaker, states should monitor and report on the extent of unutilized bycatch and fishing mortality on fish less than age-1. Incorporate bycatch estimates into croaker assessment models.
- The optimum utilization (economic and biological) of a long term fluctuating population such as croaker should be evaluated.
- Continue monitoring of juvenile croaker populations in major nursery areas.
- Cooperatively develop a yield per recruit analysis to establish a minimum size that maximizes YPR.
- Determine the onshore vs. offshore components of the croaker fishery.
- Identify essential habitat requirements.

Low Priority

- Determine species interactions and predator/prey relationships for croaker (prey) and other more highly valued fisheries (predators).
- Determine the impacts of any dredging activity (i.e. for beach re-nourishment) on all life history stages of croaker.

Research Needs Identified as Being Met

Criteria should be cooperatively developed for aging croaker otoliths. ***To be met at October 2008 aging workshop.***

Atlantic Menhaden

High Priority

- Monitor landings, size, age, gear, effort and harvest area in the reduction and bait fisheries, and determine age composition by area. Continue biostatistical sampling of bait samples in purse seine fisheries for Virginia and New Jersey to improve stock assessment.
- Develop and test methods for estimating size of recruiting year-classes of juveniles using fishery-independent survey techniques.
- Re-evaluate menhaden natural mortality, by age and response to changing predator population sizes.
- Develop and improve fishery independent estimates of adult abundance at age on a coast-wide scale to replace or augment the existing pound net index.

Medium Priority

- Determine how loss/degradation of critical estuarine and nearshore habitat affects growth, survival and abundance of juvenile and adult menhaden abundance.
- Study the coast wide ecological role of menhaden (predator/prey relationships, nutrient enrichment, oxygen depletion, etc.) in major Atlantic coast embayments and estuaries.
- The feasibility of estimating yearclass strength using biologically stratified sampling design should be evaluated. The efforts could be supported by process studies linking plankton production to abundance of young menhaden (need resources).
- Monte Carlo simulations should be conducted to evaluate precision of current assessment models.
- Alternative measures of effort, including spotter pilot logbooks, trip length, or other variables, should be evaluated. Spotter pilot logbooks should be evaluated for spotter plane search time, GPS coordinates, and estimates of school sizes observed by pilots.
- Evaluate effects of selected environmental factors on growth, survival and abundance of juvenile and adult menhaden, particularly in Chesapeake Bay and other coastal nursery areas.
- Determine the effects of fish diseases (such as ulcerative mycosis and toxic dinoflagellates) on the menhaden stock.
- Update fecundity and maturity schedules.
- Update estuary-specific productivity estimates used to weight the juvenile abundance indices.

Low Priority

- Growth back-calculation studies should be pursued to investigate historical trends in growth rate. The NMFS has an extensive database on scale growth increments which should be utilized for this purpose.
- Determine the effects of regulations on the fishery, the participants and the stock.
- Monitor fish kills along the Atlantic coast and use the NMFS Beaufort Laboratory as a repository for these reports.
- Develop bycatch studies of menhaden by other fisheries. DISCARDS
- Periodically monitor the economic structure and sociological characteristics of the menhaden reduction industry.

Notes:

MSVPA model provides new insight on menhaden natural mortality, by age and response to changing predator population sizes.

Ongoing research in Chesapeake Bay to evaluate effects of selected environmental factors on growth, survival and abundance of juvenile and adult menhaden

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

Ongoing research is being conducted to determine the effects of fish diseases (such as ulcerative mycosis and toxic dinoflagellates) on the menhaden stock.

Research Needs Identified as Being Met

Evaluate use of coastal power plant impingement data as a possible means to estimate young-of-the-year menhaden abundance.

Atlantic Sea Herring

High Priority

- 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.
- Continue resource-monitoring activities, especially larval surveys to evaluate distribution and abundance of herring larvae, and to indicate the relative importance of individual spawning areas and stocks and the degree of spawning stock recovery on Georges Bank and Nantucket Shoals.
- 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.
- Investigate bycatch/discards in the directed herring fishery through both at-sea and portside sampling.
- Continue commercial catch sampling of Atlantic herring fishery according to ACCSP protocols.
- Continue to organize annual U.S.-Canada workshops to coordinate stock assessment activities and optimize cooperation in management approaches between the two countries.
- Synthesize predator/prey information and conduct investigations to address information gaps; investigate the role of herring in the Northwest Atlantic ecosystem and the importance of herring as a forage species for other commercial fish stocks; assess the importance of herring as forage relative to other forage species in the region. Re-evaluate Atlantic herring natural mortality by age and the response to changing predator population sizes through an ecosystem based assessment.

Medium Priority

- Develop new approaches to estimating recruitment (i.e. juvenile abundance) from fishery-independent data.
- 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.
- Develop socio-economic analyses appropriate to the determination of optimum yield.
- 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.

Low Priority

- Possible effects of density-dependence (e.g. reduced growth rates at high population size) on parameter estimates used in assessments should be examined.
- Investigate the natural mortality rate assumed for all ages, the use of catch-per-unit-effort tuning indices, and the use of NEFSC fall bottom trawl survey tuning indices in the analytical assessment of herring.
- Develop economic analyses necessary to evaluate the costs and benefits associated with different segments of the industry.

Maine DMR proposed Research Needs:

Investigate/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.

Research Needs Identified as Being Met

Evaluate the merit of acoustic surveys and other techniques to achieve sub stock complex monitoring.

Atlantic Striped Bass

STOCK ASSESSMENT AND POPULATION DYNAMICS

High Priority

- Develop method to integrate VPA and tagging models to produce a single estimate of F and stock status (ongoing, G. Nelson)
- Develop a spatial and temporal catch at age model incorporating tag-based movement information
- Examine reporting rates by commercial and recreational fishermen using high reward tags (ongoing, J. Hoenig)
- 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.

Medium Priority

- Improve methods for determining population sex ratio for use in estimates of spawning stock biomass and biological reference points.
- Evaluate the overfishing definition relative to uncertainty in biological parameters.
- Develop studies to provide information on gear-specific discard morality rates and to determine the magnitude of bycatch mortality (ongoing, G. Nelson).
- Develop refined and cost-efficient fisheries-independent coastal population index for striped bass stocks.
- Examine methods to estimate annual variation in natural mortality (ongoing, Striped Bass Tagging Subcommittee).
- Examine causes of different tag-based survival estimates among programs estimating similar segments of the population.
- Evaluate truncated matrices and covariate-based tagging models.
- Develop reliable estimates of poaching loss from striped bass fisheries.
- Develop maturity ogive applicable to coastal migratory stock.
- Improve estimates of striped bass harvest removals in coastal areas during wave 1 and in inland waters of all jurisdictions year-round.

Low Priority

- 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.
- Examine issues with time saturated tagging models for the = 18 inch length group.

RESEARCH AND DATA NEEDS

High Priority

- Continue in-depth analysis of migrations, stock compositions, etc. using mark-recapture data (ongoing, e.g., Cooperative Winter Tagging Cruise 20 Year Report, W. Laney)
- Continue evaluation of striped bass dietary needs and relation to health condition.

Medium Priority

- Continue to conduct research to determine limiting factors affecting recruitment and possible density implications.
- Evaluate the percentage of fishermen using circle hooks.
- 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 Priority

- 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

Atlantic Sturgeon

High Priority

- Characterize size, condition, and relative abundance of Atlantic sturgeon by gear and season taken as bycatch in various fisheries.
- Develop methods to determine sex and maturity of captured sturgeon. [3]
- Develop sperm cryo-preservation techniques and refine to assure availability of male gametes. Refine induced spawning procedures.
- Evaluate aging techniques for Atlantic sturgeon with known age fish. Emphasis should be placed on verifying current methodology based on fin rays. Determine length, fecundity, and maturity at age for North, Mid and South Atlantic stocks.
- Conduct basic cultural experiments to provide information on: a) efficacy of alternative spawning techniques, b) egg incubation and fry production techniques, c) holding and rearing densities, d) prophylactic treatments, e) nutritional requirements and feeding techniques, and f) optimal environmental rearing conditions and systems.
- Establish stocking goals and success criteria prior to development of stock enhancement or recovery programs. *Partially done*.
- Conduct research to identify suitable fish sizes, and time of year for stocking cultured fish
- Conduct and monitor pilot-scale-stocking programs before conducting large-scale efforts over broad geographic areas.
- Establish tolerance of different life stages to important contaminants and levels of such environmental factors such as DO, pH, and temperature.
- Utilize pilot-scale stocking trials to evaluate available habitat, survival and distribution in potential restoration target tributaries
- 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.

Medium Priority

- Obtain baseline data on habitat condition and quantity in important sturgeon rivers. Data should address both spawning and nursery habitat.
- Evaluate the exposure and effect of endocrine disrupting chemicals.
- Assess loss to ship/boat strikes.

Low Priority

- Determine the extent to which Atlantic sturgeon are genetically differentiable among rivers.
- Research should be conducted to determine the susceptibility of Atlantic sturgeon to sturgeon adenovirus and white sturgeon iridovirus. Methods should be developed to isolate the sturgeon Adenovirus and an Atlantic sturgeon cell line should be established for infection trials.
- Encourage shortnose sturgeon researchers to include Atlantic sturgeon research in their projects.
- Identify rates of tag loss and tag reporting.
- Evaluate existing sea sampling data to characterize at-sea migratory behavior. *Partially done.*

[3] Partially done. Laparoscopic techniques have been developed to visually inspect gonads (Dr. Rob Bakal, USFWS, Aquatic Animal Health Coordinator, National Fish Hatchery System). The focus should be directed to blood chemistry analysis of compounds such as vitellogenin or sex steroids.

- Research should be conducted to identify the major pathogens of Atlantic sturgeon and a cell line for this species should be developed.
- Conduct a cost benefit analysis of various stocking protocols.
- Conduct further analyses to assess the sensitivity of F50 to model inputs.

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.***

Black Sea Bass

High Priority

- Sampling should be increased for commercial landing in black sea bass fisheries, specifically the fish pot fisheries in the Mid-Atlantic.
- Sampling should be increased in the recreational fisheries.
- Age sampling should be increased across all components of the fishery.
- Sampling should be done to characterize discards.
- Develop fishery independent surveys and expand existing surveys to capture all sizes and age classes in order to develop independent catch-at-age and CPUE.
- Investigate the effect of sex transition rates, sex ratio and differential natural mortality by sex on the calculation of spawning stock biomass per recruit and eggs per recruit.
- Investigate the impact of the removal of large males from the population has on reproduction.
- Studies on sex-specific mortality rates and growth are needed.
- Increase sea sampling to verify information from commercial logbooks to provide better estimates of discards.
- Consideration should be given to a pot survey for an index of abundance

Medium Priority

- Explore alternative assessment models, including non-age based alternatives.
- Further delineate essential fish habitat (EFH), particularly in nursery areas. Further investigate possible gear impacts on EFH.
- Identify transport mechanisms or behavior that move early juvenile black sea bass into estuaries.
- Evaluate habitat use by overwintering yearling, young-of-the-year, and adult black sea bass.
- Evaluate food habits of black sea bass larvae and overwintering adults.

Low Priority

- Develop mariculture techniques.
- A study determining the value of artificial reefs for increased production of black sea bass would be valuable in estimating potential yield.

Notes:

Black sea bass are currently scheduled to take part in a data poor workshop to be scheduled for November-December 2008. The workshop participants will be looking for innovative ways to conduct stock assessments on species with little data.

Research Needs Identified as Being Met

A tagging program should be initiated through state fisheries agencies to estimate mortality independent of traditional methods. ***Tagging study complete with peer reviewed results to be published in 2008, G. Shepherd, NMFS.***

Bluefish

High Priority

- Evaluate amount and length frequency of discards from the commercial and recreational fisheries.
- Initiate fisheries-dependent and independent sampling of offshore populations of bluefish during the winter months.
- Test the sensitivity of the bluefish assessment to assumptions concerning age-varying M, level of age-0 discard, and selection patterns.
- Measures of CPUE under different assumptions of effective effort should be evaluated to allow evaluation of sensitivity of results.
- 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.[1]
- Collect size and age composition of the fisheries by gear type and statistical area.[2]
- Target commercial and recreational landings for biological data collection when possible.[3]

Medium Priority

- Age any archived age data for bluefish and use the data to supplement North Carolina age keys.
- Increase intensity of biological sampling of the NER commercial and coastwide recreational fisheries.
- Conduct research on oceanographic influences on bluefish recruitment, including information on migratory pathways of larval bluefish.
- Increase sampling frequencies when bluefish are encountered, especially when medium size fish are encountered.
- Conduct studies on the interactive effects of pH, contaminants, and other environmental variables on survival of bluefish.
- Initiate research on species interactions and predator-prey relationships.
- Study tag mortality and retention rates for American Littoral Society dorsal loop and other tags used for bluefish.

Low Priority

- Continue work on catch and release mortality.
- Initiate a coastal surf-zone seine study to provide more complete indices of juvenile abundance.
- Investigate the long term, synergistic effects of combinations of environmental variables on various biological and sociological parameters such as reproductive capability, genetic changes, and suitability for human consumption.
- Explore alternative methods for assessing bluefish, such as length-based and modified DeLury models.

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[1] 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.

[2] Perhaps this should continue and remain a priority (e.g., Robillard et al. (2008) have data on 36 fish in 2003 from the southernmost extent of range predominantly from the recreational fishery; analogously, Robillard et al. (2008) report that data from NC were primarily from commercial gillnet fishers in 2002 and 2003).

[3] Same comment as footnote 2.

Research Needs Identified as Being Met

- Complete a scale-otolith age comparison study.
  Robillard, E., et al. 2008. Age-validation and growth of bluefish (*Pomatomus saltatrix*) along the East Coast of the United States. Fish. Res.doi:10.1016/j.fishres.2008.07.012
- Conduct research to determine the timing of sexual maturity and fecundity of bluefish.
  Robillard, E. et al. Reproductive biology of bluefish (Pomatomus saltatrix) along the East Coast of the United States. Fish. Res. 90 (2008) 198-208.

Coastal Sharks

High Priority

- Continue to acquire better species-specific landings information on number of species, by weight, from dealers should be sought.
- Initiation or expansion of dockside sampling for sharks.
- Conduct species-specific assessments for all shark species, with a priority for smooth dogfish.
- Re-evaluate finetooth life history in the Atlantic Ocean in order to validate fecundity and reproductive periodicity.
- Determine bonnethead life history in Atlantic Ocean, spanning the range of the stock.
- Re-evaluate blacknose life history in Atlantic Ocean, spanning the range of the stock. Expand research efforts directed towards tagging of individuals in south Florida and Texas/Mexico border to get better data discerning potential stock mixing.
- Identify Essential Fish Habitat and nursery areas for shark species found along the Atlantic Coast of the U.S.

Medium Priority

- Develop empirically based estimates of natural mortality.
- Additional life history studies for all species of the shark complex should be carried out to allow for additional species specific assessments.
- Additional length sampling and age composition collection to improve information for developing selectivities.
- The Atlantic menhaden fishery data should be examined to determine shark bycatch estimates, if available.
- Additional life history research into sandbar sharks to supplement or replace the available data from the mid 1990's
- 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 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.
- Dockside sampling information would be helpful to verify landings information such as species composition.
- 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.
- Develop a fishery-independent porbeagle shark survey to provide additional size composition and catch rate data to calculate index of abundance.

Low Priority

- Biological data should be collected on the illegal Mexican Shark catch confiscated in U.S. waters, including species, sex, and length.
- Gear-related information, including effort and gear used for each species should be collected on the interdicted Mexican vessels.
- One central electronic database for biological and gear data should be created to keep information regarding the confiscated sharks and vessels.

- Scientists should help the Coast Guard create the database and teach the agents how to identify the species and gear information.
- Determine reproduction biology for finetooth in the Gulf of Mexico.

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

Horseshoe Crab

High Priority

- Investigate factors (habitat, harvest, sampling methods, etc) that might be causing the large discrepancies between DE and NJ in egg survey numbers.
- Expand or implement fishery-independent surveys to encompass the full range of horseshoe crabs along the coast including inland waters.
- Estimate juvenile age/size-specific survivorship for year 0 to adult.
- Estimate size-specific fecundity of Delaware Bay females.
- Estimate catchability for gear used in benthic trawl surveys and determine effect of size, sex, substrate, topography, timing, and temperature.
- Model relationship between egg availability and spawning biomass/abundance.
- Assess horseshoe crab prey availability and determine whether horseshoe crab population growth will be/is limited by prey availability.
- Determine stock composition of Virginia, Maryland, and New York landings.
- 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.

Medium Priority

- Further evaluate life table information including sex ratio and population age structure.
- Evaluate the impacts of beach nourishment projects on horseshoe crab populations.
- Estimate the proportion of sub-tidal spawning and determine if this affects spawning success (i.e. egg survivability).
- Identify coastal populations through tagging studies (mark-recapture) and genetics work.
- Ground truth sub-sampling method used in DE Bay spawning survey for calibration to the "population" scale.
- Improve measures to characterize landings and bycatch in the commercial fisheries by life stage.
- Investigate analysis of tagging data to provide mortality rates and population abundance in addition to migration and movements.
- Characterize essential horseshoe crab habitat, other than spawning habitat, in different regions.
- Characterize abundance and size structure of juveniles coastwide as indicators of recruitment to adulthood.
- Investigate supplemental bait and alternative trap designs to reduce the commercial fisheries need for horseshoe crabs.
- Estimate mortality from the entire biomedical collection process, from capture to post-return.

Low Priority

- Evaluate the effect of mosquito control chemicals on horseshoe crab populations.
- Estimate fishing discard numbers and associated mortality rates.
- Evaluate the importance of horseshoe crabs to other marine resources such as sea turtles.

- Continue to conduct additional stock assessments and determine harvest mortality rates (F). Use these data to develop a more reliable sustainable harvest rate.

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.

Research Needs 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 young-of-year 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

High Priority

- Continue to examine values of natural mortality, M. Revisit older work that established M=0.25 (Rinaldo, Clark). Estimate M from year-sex-stage-class ratio data from surveys. Examine predation data and other environmental factors. Investigate possible annual variation in M. Benefits: better understanding of ecological role; more accurate model estimates of F and B. Resources required: several person-months for data analysis.
- Examine several survey issues: recalculate fall survey indices for shrimp, eliminating the nighttime tows; verify that summer survey tow bottom tending times have been consistent; investigate survey design for optimal number and stratification of tows; explore ways to quantify age 1 and younger shrimp. Benefits: more accurate survey indices for model estimates of F and B; earlier estimates of future recruitment. Resources required: several person-months for data analysis, and further research into collecting small shrimp, possibly development of a trap survey.
- Explore the stock-recruitment relationship and the impact of environmental factors on recruitment. Consider impacts of climate change. Benefits: better understanding of natural population fluctuations; better modeling of population dynamics. Resources required: many person-months for data analysis.
- Better characterize shrimp discards in the shrimp and other small-mesh (i.e., herring and whiting) fisheries. Benefits: more accurate estimate of shrimp removals for modeling. Resources required: more at-sea sampling; several person-months for analysis of existing VTR and sea-sampling databases.
- Evaluate the stock recruitment relationship for northern shrimp.
- Evaluate natural mortality, including relative impacts of predation and disease and variation at age and over time.
- Evaluate larval growth and survival in response to environmental conditions.
- Further research to refine annual estimates of consumption by predators could be useful in several ways. Consumption estimates could lead to annual estimates of *M* that would be more realistic than assuming constant *M*, for use in models that include *M* explicitly. Alternatively, consumption estimates could be used in production models as annual removals similar to fishery removals.
- Power analysis of estimates of mean weight from port sampling should be investigated to optimize sample design.
- Improve separator and excluder devices to reduce bycatch and discard of non-targeted species. Explore gear modifications, such as larger mesh, to minimize shrimp bycatch in finfish trawl fisheries.[1]
- Characterize demographics of the fishing fleet by area and season; perform comparative analysis of fishing practices between areas.
- Develop an understanding of product flow and utilization through the marketplace; identify performance indicators for various sectors of the shrimp industry.
- Efforts to quantify the magnitude of bycatch by species, area, and season should be continued and the steps necessary to limit negative impacts taken.

[1] Some work has been done by Schick and He.

- Explore new markets for Gulf of Maine shrimp.[1]
- Develop a framework to aid evaluation of the impact of limited entry proposals on the Maine fishing industry.[2]
- Broad-based and detailed socioeconomic description and analysis of the structure, operations, markets, revenues and expenditures of the northern shrimp fishery itself and in relation to other commercial fisheries in northern New England.
- Ground-truthing for all of the data gathered via Federal and State databases. Contradictions and inaccuracies abound, so face-to-face interviews with a randomized sample of participants in all sectors of the fishery are needed.
- Determine the relative power relationships between the harvesting and processing sector and the larger markets for shrimp and shrimp products. Identify significant variables driving market prices and how their dynamic interactions result in the observed intraannual and inter-annual fluctuations in market price for northern shrimp.
- Study the effects of large-scale climatic events (like the North Atlantic Oscillation) on the cold water refuges for shrimp in the Gulf of Maine.

Medium Priority

- Recover/convert older port sampling data to useable database. Benefit: Data will be available for future queries re fishing locations, catch rates, size distributions, sex stage and timing of egg hatch, other shrimp species, etc. Resources required: several person-months for data entry, uploads, and proofing.
- Evaluate appropriate biological reference points and define sustainable harvest levels. The potential for improving estimates of mortality, abundance, and biomass from historical fishery and survey data from the 1960s should be investigated for further guidance on appropriate biological reference points.
- Target and threshold reference points for northern shrimp are set equal to one another at F = 0.22/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. When a common agreement exists about the function of each reference point, assessment scientists can calculate values to best serve each function
- Research on annual variation of size at age could increase precision of the assessment.
- The possibility of using a more detailed assessment model, such as the CASA model used for Atlantic sea scallop, should be studied. Use of a model with a more detailed treatment of northern shrimp population dynamics could increase accuracy and precision of assessment results.
- Evaluate maturation, fecundity and lifetime spawning potential.
- Evaluate growth, including frequency of molting and variation in growth rates as a function of environmental factors and population density.
- Evaluate distribution of larval, juvenile, and adult shrimp. Evaluate migration and local movements.[3]

[1] Maine Fishermen's Forum panel discussions, 2006 and 2007
[2] Maine Coastal Fishery Research Priorites, 2001, online at http://www.maine.gov/dmr/research/table_of_contents.htm, and Maine Fishermen's Forum panel discussion, 2007
[3] Some migration work has been done by Schick et al. 2006 NEC

- Estimates of fecundity at length should be updated, and the potential for annual variability should be explored.
- Investigate changes in transition and maturation as a function of stock size and temperature.[1]
- Evaluate competition and predator-prey relationships between species.
- Continue sea-sampling efforts.
- Evaluate vulnerability of shrimp to various fishing gear.
- Exploration of any spatial, depth, or temperature influences on survey catchability could contribute to better standardization of the survey abundance index.
- Environmental effects could likewise be examined through development of a surplus-production model that includes effects of environmental variation on per-capita production or carrying capacity.
- The CSA model as used here 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 better estimating this parameter could reduce uncertainty in the assessment.
- Develop a time series of standardized effort to corroborate patterns of estimated F.
- Methods for age determination from length and ontogenetic stage information should be continued to develop the possibility of using age-based assessment methods.
- Expand the time series of stock and recruitment data using catchability estimates from the production model.
- Modify sea sampling protocol to characterize discards of shrimp in the shrimp trawl fishery and the small-mesh whiting fishery.
- Perform cost-benefit analyses to evaluate management measures.
- Develop a bioeconomic model to study the interactions between four variables: movements of shrimp, catchability of shrimp, days fished, and market price.
- Develop an economic-management model to determine (1) the most profitable times to fish, (2) how harvest timing effects markets, and (3) how the market effects the timing of harvesting.
- Study specific habitat requirements for all life history stages.
- Evaluate effects of habitat loss/degradation on northern shrimp.
- Develop habitat maps for all life history stages.
- Identify migration routes of immature males offshore, and ovigerous females inshore.
- Determine the short and long-term effects of mobile fishing gear on shrimp habitat.[2]

Low Priority

- Increased sampling of commercial catches, ensuring good allocation of samples among ports and months, could provide better estimates of size composition.[3]

Notes:

In 2008, the greatest problems facing the Gulf of Maine shrimp industry were not a lack of research on stock dynamics, assessment methods, or management practices; they were high fuel prices and poor shrimp prices. Government research efforts should target energy policy and the development of markets, as well as good fishery management.

[1] Some work has been done by Wieland 2004, 2005

[2] Short term effects have been studied by A. Simpson and L. Watling, 2006.

[3] It would be useful to first analyze the existing sampling protocol, to determine whether more or less sampling is necessary, and whether existing sampling is representative.

Sea sampling effort to date has probably identified adequately the catch and bycatch in the shrimp fishery in the Gulf of Maine under current gear and season constraints. Until changes are made in gear and season, sea sampling may remain minimal. Research to improve on excluder devices to reduce bycatch is still a reasonable investment in that bycatch of small whiting and small flatfish is still a problem. Bycatch by species, area and season has been adequately quantified as long as the fishing season and gear remain generally the same. Limiting negative impacts is still a fairly important area of research focus.

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

Some recent work has been done on the relative distribution of shrimp and juvenile groundfish along the Maine coast. Little is known of the distribution and/or life history of the juvenile stage of *P. borealis*, therefore the age structure of the population is less certain.

Migration of *P. borealis* is known to occur to a greater extent in the Gulf of Maine than anywhere else in the world. Several aspects of this migration remain an enigma.

Red Drum

High Priority

- Support fishery-independent sampling of sub-adult and adult red drum in each state from Virginia to Florida. The purpose of this survey would be to: 1) verify escapement to the spawning population, 2) provide an index of recruitment to age 1, and 3) provide an estimate of the biomass of adult red drum.
- Continue tagging studies to determine stock identity, inshore/offshore migration patterns and mortality estimation.
- Determine the survival rate of red drum following regulatory and voluntary discard from commercial and recreational gear, including recreational net fisheries. Evaluate effects of water temperature and depth of capture.
- Quantify relationships between red drum production and habitat.

Medium Priority

- Develop a more reliable estimate of natural and fishing mortality through directed sampling of the adult population.
- Identify spawning areas of red drum in each state from Virginia to Florida so these areas may be protected from degradation and/or destruction. Determine qualities of those areas (bottom type, depth, temperature, salinity, etc.). Determine the impacts of dredging and beach re-nourishment on red drum spawning and early life history stages.
- Improve catch/effort estimates and biological sampling from recreational and commercial fisheries for red drum, including increased efforts to intercept night-time fisheries for red drum by the NMFS MRFSS. Characterize magnitude of commercial and recreational discards.
- States with significant fisheries should be encouraged to collect socio-economic data on red drum fisheries through add-ons to the MRFSS or by other means so as to determine the economic value of the Atlantic coast recreational red drum fishery.
- Investigate and evaluate new stock assessment techniques as alternatives to age-structured models. Conduct yield modeling on red drum.
- Fully evaluate the efficacy of using cultured red drum to restore native stocks along the Atlantic coast, including cost-benefit analyses.
- Identify the effects of water quality degradation on the survival of red drum eggs, post-larvae, larvae, and juveniles.
- Refine maturity schedules on a geographic basis, determine relationships between annual egg production over a range of sizes, ages and across latitude.
- Determine methods for restoring red drum habitat and/or improving existing environmental conditions that adversely affect red drum production.

Low Priority

- 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.
- Investigate the concept of estuarine reserves to increase the escapement rate of red drum along the Atlantic coast.
- Document and characterize schooling behavior for Atlantic coast red drum.

- Continue to support and fund both the RI commercial fish trap survey and the Fishery Independent Scup Survey of Hard Bottom Areas in Southern New England Waters. It is recommended that the fishery independent survey be expanded to include waters further west and that scales should be collected for aging.

- Increased and more representative sea and port sampling of the various fisheries in which scup are landed and discarded is needed to adequately characterize the length composition of both landings and discards. The current level of sampling, particularly of the discards, seriously impedes the development of analytic assessment and forecasts of catch and stock biomass for this stock. A pilot study to develop a sampling program to estimate discards should be implemented. Expanded age sampling of scup from commercial and recreational catches is required, with special emphasis on the acquisition of large specimens. *Improved sampling intensity for landings, increase in funding for observer program since 2004, this has improved discard sampling intensity in the directed and bycatch fisheries for scup, but* ***still need to increase observer coverage for winter I offshore directed scup fishery and bycatch squid fishery****.*

- Commercial discard mortality had previously been assumed to be 100% for all gear types. The committee recommends that studies 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.

- Explore alternative biomass indices for development of biomass proxies for reference point determination based on multiple survey indices.

- Evaluate the current biomass reference point and consider alternative proxy reference points such as B_{MAX} (the relative biomass associated with F_{MAX}).

- Continue exploration of relative biomass and relative exploitation calculations based on CPUE data from the recreational private boat fishery. *Use a different CPUE measure than what is in the trawl survey, Paul will do it.*

- Surveys should be evaluated to test the assumption of equal catchability at age in projections (i.e. through forward projection methods).

- 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 Done, Done in AIM resulted in no improvement over VPA because inconstancy between fishery dependent and independent data.

- Design an optimal sampling plan that would be considered for implementation by the fishery observer sampling, recreational, and commercial port sampling program. Formal sampling design has been implemented in the at sea observer program (SBRM), Redesign of MRFSS (MRIP), For all sampling these programs are designed for multi-species and are designed for optimal sampling of all species and not a single species.

- Explore alternative decision support methodologies for updating TALs directly from relative trends in abundance without relying on direct estimates of F. *Explored but no alternatives have been acceptable.*

- Age backlog of samples. (NMFS, MA)

- Conduct an aging comparison/workshop to (1) compare ototliths and scales (2) compare state age length keys.

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

- Explore other approaches for analyzing survey data, including bootstrap resampling methods to generate approximate confidence intervals around the survey index point estimates. *Needs to be done, low priority*

Research Needs Identified as Being Met or in Progress

- 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.*
- Investigate the statistical properties of the three commercial discard estimation approaches presented for consideration in future analyses. *In progress.*
- Quantify the percentage of commercial fishery trips that had discards, but no landings, and evaluate how such trips contribute to the total commercial fishery discard estimate. *In progress*

Spanish Mackerel

High Priority

- Biological data collection should be increased and should include all states where Spanish mackerel are landed.
- Evaluation of weight and especially length at age of Spanish mackerel, including updated conversion equations (e.g., gutted to whole weight) and sampling of age-0 fish.
- Development of fishery-independent methods to monitor stock size of Atlantic Spanish mackerel (consider aerial surveys used in south Florida waters).
- Improved information on discard rates and discard mortality, including 5-10% observer coverage of commercial fisheries.
- Simulations on CPUE trends should be explored and impacts on VPA and assessment results determined.
- Determine the bycatch of Spanish mackerel in the directed shrimp fishery in Atlantic
- Coastal waters.
- Conduct an aging workshop to develop approved methods and reporting standards, include lab exchanges of structures
- More timely reporting of mid-Atlantic catches for quota monitoring.
- Provide better estimates of recruitment, natural mortality rates, fishing mortality rates, and standing stock. Specific information should include an estimate of total amount caught and distribution of catch by area, season, and type of gear.
- Develop methodology for predicting year class strength and determination of the relationship between larval abundance and subsequent year class strength.
- Commission and member states should support and provide the identified data & input needed to improve the SAFMC's SEDAR process.

Medium Priority

- Yield per recruit analyses should be conducted relative to alternative selective fishing patterns.
- Evaluate potential bias of the lack of appropriate stratification of the data used to generate age-length keys for Atlantic and Gulf Spanish mackerel.
- Evaluate CPUE indices related to standardization methods and management history, with emphasis on greater temporal and spatial resolution in estimates of CPUE.
- Evaluate whether catchability varies with abundance or environmental conditions
- Determine normal Spanish mackerel migration routes and changes therein, as well as the climatic or other factors responsible for changes in the environmental and habitat conditions, which may affect the habitat and availability of stocks.
- Determine the relationship, if any, between migration of prey species (i.e., engraulids, clupeids, carangids), and migration patterns of the Spanish mackerel stock.

Low Priority

- Complete research on the application of assessment and management models relative to dynamic species such as Spanish mackerel.
- Delineation of spawning areas and areas of larval abundance through temporal and spatial sampling.
- Consideration of MRFSS add-ons or other mechanisms for collection of socioeconomic data for recreational and commercial fisheries.
- The full implementation of ecosystem-based management and the implementation of monitoring /research efforts needed to support ecosystem-based management needs should be conducted.

Spiny Dogfish

High Priority

- Determine coastwide discard mortality rate for fixed and mobile gear fisheries that catch dogfish as bycatch.
- Characterize and quantify bycatch of spiny dogfish in other fisheries.
- Monitor the level of effort and harvest in other fisheries as a result of no directed fishery for spiny dogfish.
- Increase observer trips to document the level of incidental capture of spiny dogfish during the spawning stock rebuilding period.
- Continue work on the change-in-ratio estimators for mortality rates and suggest several options for analyses
- Standardize age determination along the entire East coast. Conduct an aging workshop for spiny dogfish, encouraging participation by NEFSC, NCDMF, Canada DFO, and other interested agencies, academia and other international investigators with and interest in dogfish aging (US and Canada Pacific Coast, ICES).
- Quantify effort directed on spiny dogfish in waters outside of the U.S.
- Conduct a coastwide tagging study to explore stock structure, migration, and mixing rates.

Medium Priority

- Increase the biological sampling of dogfish in the commercial fishery and on research trawl surveys.
- Identify how spiny dogfish abundance and movement affect other organisms.
- Monitor the changes to the foreign export markets for spiny dogfish, and evaluate the potential to recover lost markets or expand existing ones.

Low Priority

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

Research Needs Identified as Being Met

- **Genetic analysis of spiny dogfish to determine if more than one unit stock exist along the Northwest Atlantic. *Canadian researchers are working on this but not published yet.***
- **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 U.S.** ***Canada should have numbers available on this soon.***

Spot

High Priority

- In trawl fisheries or other fisheries that take significant numbers of spot, states should monitor and report on the extent of unutilized bycatch and fishing mortality on fish less than age-1. Incorporate bycatch estimates into spot assessment models.
- The effects of mandated bycatch reduction devices (BRD's) on spot catch should be evaluated in those states with significant commercial harvests.
- Fishery dependent and independent size and sex specific relative abundance estimates should be developed.
- Cooperative coastwide spot juvenile indices should be developed to clarify stock status.
- Monitor long term changes in spot abundance, growth rates, and age structure.
- Continue monitoring of juvenile spot populations in major nursery areas.
- 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.
- Criteria should be cooperatively developed for aging spot otoliths and scales, and an age validation study should be conducted.

Medium Priority

- A yield per recruit analysis should be cooperatively developed.
- Develop stock identification methods.
- Determine migratory patterns through tagging studies.
- Determine the onshore vs. offshore components of the spot fishery.

Spotted Seatrout

High Priority

- Stock assessments should be conducted to determine the status of stocks relative to the plan objective of maintaining a spawning potential of at least 20%.
- 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.
- Age structure analyses by sex should be utilized in stock assessments.
- Collect data on the size or age of spotted seatrout released alive by anglers and the size and age of commercial discards.
- Continue work to examine the stock structure of spotted seatrout on a regional basis, with particular emphasis on advanced tagging techniques.
- Expand the NMFS recreational fishery survey to assure adequate data collection for catch and effort data, increased intercepts, and state add-ons of social and economic data needs.

Medium Priority

- Collection of commercial and recreational landings data should be continued and expanded.
- Identify essential habitat requirements.
- Evaluate effects of environmental factors on stock density.
- Work should be continued to examine the stock structure of spotted seatrout on a regional basis, with particular emphasis on molecular techniques.
- Collection of social and economic aspects of the spotted seatrout fishery should be initiated.
- Improve precision of effort reporting through commercial trip ticket programs.

Notes:

Florida Department of Environmental Protection developed a spotted seatrout stock assessment in January 1995 that addressed by sex yield modeling, spawning potential ratios, use of fishery independent monitoring to tune virtual population models.

Commercial effort is collected through Florida's Marine Fisheries Information System (Trip Tickets).

Trip level landings data is collected through North Carolina’s Trip Ticket Program.

The North Carolina Division of Marine Fisheries is currently reviewing an assessment of spotted seatrout as part of the state’s first FMP for the species, due for completion in late 2008. A statistical catch-at-age model was used to determine the status of the NC spotted seatrout population.

Summer Flounder

High Priority

- Develop a program to annually sample the length and age frequency of summer flounder discards from the recreational fishery.
- Collect and evaluate information on the reporting accuracy of recreational discards estimates in the recreational fishery.
- The SDWG noted that more comprehensive collection of otoliths, for all components of the catch-at-age matrix, needs to be collected 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.
- The SDWG recommends that a reference collection of summer flounder scales and otoliths be developed to facilitate future quality control of summer flounder production aging. In addition, a comparison study between scales and otoliths as aging structures for summer flounder should be completed.
- The SDWG noted that the 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. Collecting information on overall fecundity for the stock, both egg condition and production may be a better indicator of stock productivity.
- Investigate trends in sex ratios and mean lengths and weights of summer flounder in state agency and federal surveys catches.
- Examine mesh selectivity patterns for a range of commonly used mesh sizes greater than the currently mandated sizes (5.5 Diamond/6 inch square)
- 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.
- Continue to collect and analyze age/length samples and catch/effort data from the commercial and recreational fisheries throughout the range of summer flounder.

Medium Priority

- Use NEFSC fishery observer age-length keys for 1994 and later years (as they become available) to supplement NEFSC survey data in aging the commercial fishery discard.
- Consider use of management strategy evaluation techniques to address the implications of harvest policies that incorporate consideration of retrospective patterns (see ICES Journal of Marine Science issue of May 2007).
- 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.
- Conduct a detailed socio-economic study of the summer flounder fisheries.
- Research directed at evaluating the mesh exemption program should be continued, with increased sample sizes to allow reliable statistical testing of results.
- Develop stock identification methods via meristics, morphometrics, biochemical research and tagging; particularly off Virginia and North Carolina.
- Develop fish excluder devices to reduce bycatch of immature flatfish in fisheries that target species other than flounder.
- Collect data to determine the sex ratio for all of the catch components

Low Priority

- Consider treating scallop-closed areas as separate strata in calculations of summer flounder discards in the commercial fisheries.
- Conduct the basic research necessary to develop land and pen culture techniques.
- 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 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.
- 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.
- Examine male female ratio at age-0 and potential factors (eg. environmental) that may influence determination of that ratio.
- Evaluate potential changes in fishery selectivity relative to the spawning potential of the stock; analysis should consider the potential influence of the recreational and commercial fisheries.
- Determine the appropriate level for the steepness of the S-R relationship and investigate how that influences the biological reference points.

Tautog

High Priority

- Establish standardized state-by-state long-term fisheries independent surveys to monitor tautog abundance and length-frequency distributions, and to develop young-of-the-year indices.
- 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).
- Increase collection of effort data for determining commercial and recreational CPUE.
- Increase MRFSS 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 than in early spring/late fall when tautog catches are more likely.

Medium Priority

- 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 insights into questions of aggregation vs. 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 predation exposure when leaving shelter to forage open bottom), and relationship between reef prey availability/quality on tautog condition/fecundity.
- 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 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 young of the year tautog. The synergistic effects of leaked fuel, bilge water, treated pilings, and antifouling paints on tautog health should also be studied.

Low Priority

- 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 are there 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.

Research Needs Identified as Being Met

Ongoing effort to explore possible regional and local genetic differences (stock differentiation) and relate these to recruitment, growth, exploitation rates, and habitat differences. These differences can help support appropriate region-specific management strategies.

Ongoing effort to determine pot and trap escape vent dimensions needed to release tautog over a range of sizes.

Sample hard parts for annual aging 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

High Priority

- 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, particularly in fisheries from Maryland and further north.
- Derive estimates of discard mortality rates and the magnitude of discards for all commercial gear types from both directed and non-directed fisheries. In particular, quantify trawl bycatch, refine estimates of mortality for below minimum size fish, and focus on factors such as distance from shore and geographical differences.
- Conduct an age validation study.
- Identify stocks and determine coastal movements and the extent of stock mixing, including characterization of stocks in over-wintering grounds (e.g., tagging).
- 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 on their (survey) use as stock indicators.
- Analyze the spawner recruit relationship and examine the relationships between parental stock size and environmental factors on year-class strength.
- Develop latitudinal/seasonal/gear specific age length keys for the Atlantic coast. Increase sample sizes to consider gear specific keys.

Medium Priority

- The impact of aging errors and other statistical uncertainties in the catch-at-age matrix on virtual population analysis (VPA) should be included. Retrospective analyses are needed on all VPA approaches investigated.
- Biological studies should be conducted to better understand migratory aspects and how this relates to observed trends in weight at age. Test for individual growth differences and their geospatial pattern, as well as the geospatial pattern of the catch rate surveys.
- 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?[1]
- Compile existing data on larval and juvenile distribution from existing databases in order to obtain preliminary indications of spawning and nursery habitat location and extent.
- Conduct hydrophonic studies to delineate weakfish spawning habitat locations and environmental preferences (temperature, depth, substrate, etc.) and enable quantification of spawning habitat.
- Continue studies on mesh-size selectivity; up-to-date (1995) information is available only for North Carolina's gill net fishery. Mesh-size selectivity studies for trawl fisheries are particularly sparse.
- Assemble socio-demographic-economic data as it becomes available from ACCSP.

[1] This is important information, but care must be taken in analysis. For instance, if a fish is captured in a net and used for fecundity, are there mechanical POFs present that would compromise assessments? Regarding maturity schedules, here is a prime example of how the NMFS survey, and NEAMAP survey, can be helpful. Right now NEFSC is cataloguing photos and histo samples of species to verify gross assessments of maturity (otos are taken for age). Consideration for this sampling should be given during the new NEAMAP survey. Most important, maturity assessments must be consistent among institutions.

- Continue studies on recreational hook-and-release mortality rates, including factors such as depth, warmer water temperatures, and fish size in the analysis. Studies are needed in deep and warm water conditions. Further consideration of release mortality in both the recreational and commercial fisheries is needed, and methods investigated to improve survival among released fish.

Low Priority

- Define restrictions necessary for implementation of projects in spawning and over-wintering areas and develop policies on limiting development projects seasonally or spatially.
- Document the impact of power plants and other water intakes on larval, post larval and juvenile weakfish mortality in spawning and nursery areas, and calculate the resultant impact to adult stock size.
- Develop a coastwide tagging database.
- Determine the onshore versus offshore components of the weakfish fishery.

Research Needs Identified as Having Being Met

Update the scale – otolith comparison for weakfish.

Winter Flounder

Coastwide

High Priority

- Expand sea sampling for estimation of commercial discards.
- Increase the intensity of commercial fishery discard length sampling.
- Focus research on quantifying mortality associated with habitat loss and alteration, contamination by toxics and power plant entrainment and impingement. Examine the implications of these anthropogenic mortalities on estimation of yield per recruit, if feasible.
- Provide reliable estimates of anthropogenic mortality from sources other than fishing. Both mortality sources should then be incorporated into fisheries yield/recruit models to simultaneously evaluate these dual mortality factors.

Lower Priority

- Conduct studies of flounder populations in impacted areas to fully quantify physiological adaptation to habitat alteration, and interactive effects, on an individual and population level.
- Evaluate the maturity at age of fish sampled in the NEFSC fall and winter surveys, as well as other inshore surveys (i.e., MEDMR, MADMF, NEAMAP, etc.).
- Develop mortality estimates from the American Littoral Society tagging data, if feasible.

Southern New England - Mid-Atlantic Stock Complex

High Priority

- Maintain or increase sampling levels and collect age information from MRFSS samples.
- Conduct studies to delineate all major substocks in terms of geographic spawning area and seasonal offshore movements (e.g. exposure to fishing pressure).
- Examine the sources of differences between NEFSC, MA, and CT 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. Compare confidence intervals for maturity ogives. Calculate annual ogives and investigate for progression of maturity changes over time. Examine maturity data from NEFSC strata on Nantucket Shoals and near George=s Bank separately from more inshore areas. Consider methods for combining maturity data from different survey programs. *Note that this work is in progress.*
- Conduct periodic maturity staging workshops involving state and NEFSC trawl survey staff.
- Examine the implications of anthropogenic mortalities caused by pollution and power plant entrainment in estimation of yield per recruit, if feasible.

Medium Priority

- Examine egg and larvae distribution and abundance to determine yield per recruit to predict future biomass development for the fishery.
- Understand distribution of winter flounder during each life stage by conducting tagging methods; in which majority of research focuses on juvenile to adult life stages, which would be useful for estimating yield per recruit and helpful to find answers as to why recruitment is at a vulnerable state.
- Examine winter flounder distribution, abundance, and productivity based on oceanographic and climatic warming temperatures and how that impacts biomass for the fishery in SNE/MA waters.

Low Priority

- 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).
- Quantify adult female to male ratios to determine the possibility of populations decline due to a skewed gender ratio.

Gulf of Maine Stock

High Priority

- Process archived age samples from surveys and commercial landings, and develop analytical age based assessment.[1]
- Improve sampling for biological data (particularly hard parts for ageing) of commercial landings of winter flounder.
- Expand sea sampling in order to validate commercial discard estimates from Vessel Trip Reports (logbooks).
- Update or conduct regional maturity studies. This may require a maturity workshop to ensure the use of standardized criteria among regional studies.
- Develop a geographically more comprehensive data set to calculate maturity at age, reflecting any differential availability of mature fish to inshore and offshore surveys. Re-examine the maturity ogive to incorporate any recent research results. (see below also)
- Incorporate the results from the MEDMR research trawl survey (begun in 2000) into the assessment as they become available.
- Further examine the stock boundaries to determine if Bay of Fundy winter flounder should be included in the Gulf of Maine stock complex.
- Examine growth variations within the Gulf of Maine, using results from the Gulf of Maine Biological Sampling Survey (1993-94).[2]

Medium Priority

- Maintain or increase sampling levels and collect age information from MRFSS samples.
- 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.
- Evaluate the feasibility of virtual population analysis based only on ages fully recruited to landings (i.e. no discards).

Low Priority

- Evaluate effects of smoothed length-frequency distributions on the relationship between survey and commercial catches at length.
- Estimate/evaluate effects of catch-and-release components of recreational fishery on discard at age.

[1] MEDMR has archived WF otoliths since 2002.

[2] Biological data on WF has been collected on the MEDMR trawl survey from 2000-2008, we need to use this data as well.

FUTURE HABITAT RESEARCH INFORMATION NEEDS FOR DIADROMOUS SPECIES

Group I. Research Needs for All Commission-Managed Diadromous Species

Dams and Other Obstructions

Fish Passage

1) 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.
2) Conduct basic research into diadromous fish migratory behavior as it relates to depth, current velocity, turbulence, entrained air, light, structures, and other relevant factors.
3) Use information from (1) and (2) to conduct computer fluid dynamics (CFD) modeling to develop more effective fishway designs.
4) Research technologies (barriers, guidance systems, etc.) for directing emigrating fish to preferred passage routes at dams.
5) Identify low-cost alternatives to traditional fishway designs.
6) Develop effective downstream passage strategies to reduce mortality.

Other Dam Issues

1) Document the impact of power plants and other water intakes on larval, postlarval, and juvenile mortality in anadromous fish spawning areas, and calculate the resultant impacts to adult population sizes.
2) Evaluate the upstream and downstream impacts of barriers on diadromous species, including population and distribution effects.

Water Quality and Contamination

1) 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.
2) 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.
3) Determine unknown optima and tolerance ranges for depth, temperature, salinity, dissolved oxygen, pH, substrate, current velocity, and suspended solids.

Habitat Protection and Restoration

1) 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).
2) 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.
3) Conduct studies on the effects of land use change on diadromous species population size, density, distribution, health, and sustainability.

4) 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.
5) Investigate consequences to diadromous stocks from wetland alterations.

Other

1) Determine survival and mortality rates for all life stages of all diadromous species.
2) Investigate predator-prey relationships for all life stages of all diadromous species.
3) Determine the effects of channel dredging, shoreline filling, and overboard spoil disposal in the Atlantic coast on diadromous species.
4) Define restrictions necessary for implementation of energy projects in diadromous species habitat areas, and develop policies on limiting development projects seasonally or spatially.

Group II. Alosine-Specific Research Needs

Water Quality and Contamination

1) Review studies dealing with the effects of acid deposition on anadromous alosines.
2) 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.
3) Determine if chlorinated sewage effluents are slowing the recovery of depressed shad stocks.

Habitat Protection and Restoration

1) Conduct research on habitat requirements for all life stages of hickory shad.

Migration

1) Determine factors that regulate and potentially limit downstream migration, seawater tolerance, and early ocean survival of juvenile alosines.
2) Conduct research on hickory shad migratory behavior.

Other

1) Focus research on within-species variation in genetic, reproductive, morphological, and ecological characteristics, given the wide geographic range and variation at the intraspecific level that occurs in alosines.
2) Research predation rates and impacts on alosines.
3) Evaluate the effect of bycatch on alosines.
4) Ascertain how abundance and distribution of potential prey affect growth and mortality of early life stages of alosines.

Group III. American Eel-Specific Research Needs

Dams and Other Obstructions

Fish Passage

1) 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.
2) Investigate, develop, and improve technologies for American eel passage upstream and downstream at various barriers for each life stage.
3) 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.
4) 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.

Water Quality and Contamination

1) Determine the effects of contaminant bioaccumulation on American eel, including impacts on survival and growth (by age), maturation, and reproductive success.
2) Research the ability of contaminated eels to carry out successful breeding.
3) Examine the environmental conditions required for the hatching success of American eel.

Habitat Protection and Restoration

1) Establish characteristics and distribution of American eel habitat (using conventional methods as well as GIS), and the value of that habitat with respect to growth and sex determination.
2) Determine the effects of loss of historic habitat to potential American eel population and reproductive capacity.
3) Investigate the impact of seaweed harvesting on American eel.
4) 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.
5) Determine the importance of coastal lakes and reservoirs to American eel populations.

Migration

Silver-phase

1) Identify migratory routes and guidance mechanisms of silver eels migrating to the ocean.
2) Determine mechanisms for the recognition of the spawning area by silver eels, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation.

3) Identify verify specific American eel spawning locations in the Sargasso Sea.
4) Research the factors that cause American eel to initiate downstream migration and affect their patterns of movement.

Leptocephalus

1) Identify the precise mechanisms of larval transport for American eel.
2) Examine the mechanisms for leptocephalus exit from the Sargasso Sea and transport across the continental shelf.
3) Determine mechanisms of recruitment of leptocephali and glass eels to coastal areas.

Glass Eel

1) Investigate the impact of stream velocity/discharge and stream morphology on upstream migration of glass eel and elvers.

Yellow-phase

1) Research behaviors and movements of American eel during their freshwater residency.

Parasitism

1) Evaluate the occurrence and impact of the nematode parasite, *Anguillicola crassus*, on all life stages.

Feeding

1) Examine the mode of nutrition for leptocephali in the ocean.
2) Examine food habits for glass eels at sea.

Other

1) Research all aspects of the leptocephalus life history stage.

Group IV. Atlantic Sturgeon-Specific Research Needs

Dams and Other Obstructions

Fish Passage

1) Fish passage requirements and appropriate structures for Atlantic sturgeon are largely unknown. Research all fish passage requirements for Atlantic sturgeon.

Bycatch

1) Determine levels of bycatch and compare to F_{50} target levels for individual Atlantic sturgeon populations.
2) 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.
3) Develop markers that permit identification of bycatch of Atlantic sturgeon by population origin.

Population Status

1) Conduct assessments of population abundance and age structure in various river systems, with particular emphasis on documenting occurrence of age 0-12 juveniles and spawning adult Atlantic sturgeon as indicators of natural reproduction.
2) Continue to determine the extent to which Atlantic sturgeon are genetically differentiable among rivers, and interpret biological significance of findings.
3) Conduct further analyses to assess the sensitivity of F_{50} to model inputs for northern and southern stocks of Atlantic sturgeon.

Culture and Stock Enhancement

1) Further develop techniques for capture, transport, and long-term holding of wild Atlantic sturgeon brood stock.
2) Refine maturation-induced spawning procedures, and sperm cryo-preservation techniques for Atlantic sturgeon to assure availability of male gametes.
3) Continue basic cultural experiments at all life stages of Atlantic sturgeon to provide information on:
    a. Efficacy of alternative spawning techniques
    b. Egg incubation and fry production techniques
    c. Holding and rearing densities
    d. Prophylactic treatments
    e. Nutritional requirements and feeding techniques, and
    f. Optimal environmental rearing conditions and systems.
4) Identify suitable stocking protocols for hatchery-reared Atlantic sturgeon (e.g., individual size, time of year, site, and marking technique).
5) Conduct and monitor pilot-scale Atlantic sturgeon stocking programs before conducting large-scale efforts that encompass a broad geographic area.
6) Establish Atlantic sturgeon stocking goals and success criteria prior to development of large-scale stock enhancement or recovery programs.

Tagging and Tissues

1) Standardize collection procedures, and develop a suitable long-term repository for Atlantic sturgeon biological tissues for use in genetic and other studies.
2) Establish coordinated tagging programs to delineate migratory patterns and stock composition, giving priority to marking juveniles in important sturgeon rivers before they migrate to the ocean.
3) Maintain database for tagged Atlantic sturgeon.
4) Identify rates of tag loss and tag reporting for Atlantic sturgeon.
5) Analyze existing sea sampling data to characterize at-sea migratory behavior. Use electronic tagging to model coastal migrations of juvenile and adult Atlantic sturgeon.

Maturity and Aging

1) Develop methods to determine sex and maturity of captured Atlantic sturgeon.
2) Evaluate aging techniques for Atlantic sturgeon with known-age fish, with emphasis on verifying current methodology based on fin rays.

3) Determine length, fecundity, and maturity at age for all Atlantic sturgeon stocks.
4) Develop a protocol for ageing validation in Atlantic sturgeon.

Group V. Striped Bass-Specific Research Needs

To be identified shortly.